TMDLS FOR TURBIDITY FOR BAYOU BARTHOLOMEW, AR

October 8, 2002

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Prepared for

EPA Region VI
Watershed Management Section
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Prepared by

FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211

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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 standard for that pollutant. Through a TMDL, pollutant loads can be allocated to point sources and nonpoint sources discharging to the waterbody.

Bayou Bartholomew begins near Pine Bluff, Arkansas and flows generally southward towards its confluence with the Ouachita River near Bastrop, Louisiana. The scope of this project is limited to the Arkansas portion of the bayou, which is designated by the Arkansas Department of Environmental Quality (ADEQ) as Planning Segment 2B. The designated beneficial uses that have been established by ADEQ for Bayou Bartholomew include primary and secondary contact recreation; domestic, industrial, and agricultural water supply; and seasonal and perennial Gulf Coastal Plains fishery and perennial Delta fishery.

The Bayou Bartholomew watershed lies within both the Gulf Coastal Plain and Delta ecoregions. The main stem of Bayou Bartholomew and the tributaries on the east side are mostly in the Delta ecoregion, while the tributaries on the west side are mostly in the Gulf Coastal Plains ecoregion. The numeric turbidity standard for streams in the Gulf Coastal Plain ecoregion is 21 NTU, while the standard for the Delta ecoregion is 45 NTU for “least-altered” streams and 75 NTU for “channel-altered” streams. ADEQ considers the main stem of Bayou Bartholomew to be “least-altered”. ADEQ’s historical water quality data for Bayou Bartholomew show that turbidity values frequently exceed the standards. Because of its elevated turbidity levels, the entire length of the main stem of Bayou Bartholomew (6 reaches) was included on the Arkansas 1998 303(d) list for not supporting aquatic life due to siltation/turbidity. Deep Bayou, which is a tributary to Bayou Bartholomew, was not on the 1998 303(d) list, but it is included on the proposed 2002 303(d) list due to siltation/turbidity.

ADEQ historical water quality data for Bayou Bartholomew near Ladd, Arkansas (OUA33) and Bayou Bartholomew near Jones, Louisiana (OUA13) were analyzed for long term trends, seasonal patterns, and relationships between parameters. Relationships of turbidity to total suspended solids (TSS), stream flow, total dissolved solids (TDS), chlorophyll a, total organic carbon (TOC), and Secchi disk transparency were investigated. Additional data analysis was performed for water quality data collected by ADEQ at 23 other stations in the Bayou Bartholomew basin during 1998 through 2000. These data were used mainly to study spatial variations due to ecoregion and land use.

Based on the results of the data analyses, the TMDLs for turbidity for Bayou Bartholomew were expressed using total suspended solids (TSS) as a surrogate for turbidity. Due to the monthly distributions of turbidity data and other parameters, seasonal relationships between TSS and turbidity were developed for winter (December to June) and summer (July through November). The wasteload allocations for point source contributions were set to zero because TSS in these TMDLs was considered to represent inorganic suspended solids (i.e., soil and sediment particles from erosion or sediment resuspension). The suspended solids discharged by point sources in the Bayou Bartholomew basin 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 through their permitting of point sources to maintain water quality standards for DO.

Because point source contributions of inorganic suspended solids were negligible, load allocations for nonpoint source contributions of TSS were set equal to the total allowable loads. In order to meet these load allocations, the existing nonpoint source loads of TSS in Bayou Bartholomew must be reduced by 29% to 37% during December through June and 0% to 3% during July through November. An implicit margin of safety was incorporated through conservative assumptions.

A watershed analysis was used to compare the relative contributions of sediment to Bayou Bartholomew from different parts of the watershed. This analysis was performed using the Soil and Water Assessment Tool (SWAT), which is a watershed model that simulates the hydrologic, erosion, and sediment transport processes in the watershed based on land use, land management practices (e.g., farming practices), soils, topography, precipitation, and other watershed characteristics. The model was run for 1987-2000, which is the period when observed data were available. The model results for sediment yield per unit area were displayed for each subbasin.

Technical assistance for implementation of these TMDLs will be provided by the Arkansas Soil and Water Conservation Commission (ASWCC) with input from local stakeholders and other agencies. ASWCC will likely use the SWAT model to evaluate specific best management practices (BMPs) in certain areas of the watershed to reduce sediment loads to Bayou Bartholomew, which should reduce turbidity in Bayou Bartholomew.

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1.0 INTRODUCTION

Bayou Bartholomew, located in Planning Segment 2B, is a tributary to the Ouachita River and is located in southeastern Arkansas, in the Gulf Coastal Plains and Delta ecoregions. The Arkansas Department of Environmental Quality (ADEQ) has established narrative and numeric water quality standards for turbidity. The numeric turbidity standard for streams in the Gulf Coastal Plain ecoregion is 21 NTU, while the standard for the Delta ecoregion is 45 NTU for "least-altered" streams and 75 NTU for "channel-altered" streams. ADEQ considers the main stem of Bayou Bartholomew to be "least-altered". ADEQ's historical water quality data for Bayou Bartholomew and some tributaries show that turbidity values frequently exceed the standards. Because of its elevated turbidity levels, the entire length of the main stem of Bayou Bartholomew (6 reaches) was included on the Arkansas 1998 303(d) list for not supporting aquatic life due to siltation/turbidity (ADEQ 1998b). Deep Bayou, which is a tributary to Bayou Bartholomew, was not on the 1998 303(d) list, but it is included on the proposed 2002 303(d) list due to siltation/turbidity. Also, three reaches in the Bayou Bartholomew basin were listed for mercury contamination of edible fish tissue and one reach was listed as "waters of concern" for nutrients. The 303(d) listings for mercury are being addressed by ADEQ and EPA in other documents. EPA and ADEQ have agreed that nutrients will be addressed in the future.

This project is limited to developing TMDLs for siltation/turbidity. These TMDLs are being developed under EPA Contract #68-C-99-249, Work Assignment #2-109.

2.0 BACKGROUND INFORMATION

Bayou Bartholomew begins near Pine Bluff, Arkansas and flows generally southward through southeastern Arkansas and into northern Louisiana (see Figure 2.1; figures are located at the end of the section). The watershed includes areas in both the Gulf Coastal Plains and Delta ecoregions. Bayou Bartholomew and its tributaries form USGS Hydrologic Unit 08040205 and the Arkansas portion of the basin is designated by ADEQ as Planning Segment 2B. The drainage area of Bayou Bartholomew is 1,187 mi^2 at the USGS flow gage located 1 mile south of the Arkansas – Louisiana state line (USGS 2001b) and 1,665 mi^2 at the mouth (USGS 1971). The Arkansas portion of the basin includes parts of Jefferson, Cleveland, Drew, Chicot, Lincoln, Desha, and Ashley counties. The main tributaries of Bayou Bartholomew in Arkansas are Deep Bayou, Ables Creek, Cutoff Creek, Bearhouse Creek, Overflow Creek, and Chemin-A-Haut Creek.

2.1 Topography

The following description of the topography of the watershed was taken from county soil surveys (USDA 1976; USDA 1979; USDA 1981). The topography of the Bayou Bartholomew watershed can be divided into three main areas: the rolling uplands, the flatwoods uplands, and the stream flood plains. The rolling uplands area runs north–south along the west side of the watershed and forms most of the drainage divide on the west edge of the watershed. Slopes range mainly from 0 to 12% and can be as much as 20% in isolated areas. The flatwoods uplands lie generally east of the rolling uplands. Slopes are predominantly less than 1%, but may be as steep as 12% for low ridges within the area. Short escarpments of 5 to 20 feet are present where abrupt transitions to the flood plains occur on the eastern edge of the flatwoods uplands in Ashley County. The stream flood plains areas are sloped at less than 1% and occur in small areas along tributaries to Bayou Bartholomew, and in larger areas along Bayou Bartholomew and major tributaries.

2.2 Soils

Soil characteristics for the watershed are also provided by the county soil surveys (USDA 1976; USDA 1979; USDA 1981). The majority of soils in the Bayou Bartholomew watershed are classified as silt loam or sandy loam. Soil series that are common in the rolling uplands areas are Amy, Sacul, and Smithdale. Amy is classified as a silt loam, and Sacul and Smithdale are sandy loams. Most common in the flatwoods uplands is the Henry series, which is classified as a silt loam. Common soil series in the flood plains areas are Perry, which classified as clay and Rilla, which is classified as silt loam. These soil series are found primarily along the main stem of Bayou Bartholomew and major tributaries.

Maps showing spatial distributions of soils information were developed using data in GIS format from the STATSGO database, which is maintained by the Natural Resources Conservation Service (NRCS). The published soil surveys for these counties provide soils mapping that is more detailed than the STATSGO data, but that information is not yet available in GIS format. The predominant soil series in the Bayou Bartholomew basin are shown on Figure 2.2. The values of soil erodibility (the K factor in the Universal Soil Loss Equation) are shown on Figure 2.3 and the hydrologic soil groups are shown on Figure 2.4. Hydrologic soil groups are classifications of soils based on runoff potential; group A has the lowest runoff potential and group D has the highest runoff potential.

2.3 Land Use

Land use data for the Arkansas portion of the Bayou Bartholomew watershed 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 1999. Because this data set included many detailed land use classifications, similar land uses were combined to reduce the number of different land uses to 13. The spatial distribution of these land uses is shown on Figure 2.5. Approximate percentages of these land uses in the watershed are:

23.0%	mixed forest
17.7%	deciduous forest
11.5%	evergreen forest
19.8%	soybeans
12.5%	cotton
3.3%	rice
2.1%	corn
3.6%	winter pasture
1.4%	summer pasture
1.6%	range brush
1.1%	open water
2.3%	residential
0.1%	industrial

Forest occupies over 52% of the watershed and is located mainly in the western portion of the watershed. Cropland occupies almost 38% of the watershed and is located mainly along the east side of the watershed.

Information on confined animal operations (CAOs) in the Bayou Bartholomew watershed was provided in the Bayou Bartholomew Assessment Report (ADEQ 2001a). According to this report, there are 43 CAOs in the watershed, most of which are broiler production facilities. Most of these CAOs are located in Lincoln County around Star City. Most of the litter from these operations is applied to adjacent pasture land, but some is applied to cropland within the county.

2.4 Channel Network

Some of the smaller stream channels along the northeastern edge and east central portions of the watershed have been straightened. The main stem of Bayou Bartholomew is a highly meandering channel that has not been straightened. The overbanks along the main stem are moderately forested and typically a few hundred feet wide. The gradient of the channel along the length of the main stem is small. Many oxbow cutoffs, or brakes, have been formed on both sides and throughout most of the length of the bayou.

2.5 Description of Hydrology

Average annual precipitation for the Bayou Bartholomew watershed is about 51.75 inches based on data from five weather stations in or near the Bayou Bartholomew watershed

(Pine Bluff, Dumas, Monticello, Hamburg, and Portland). Mean monthly precipitation totals for the Portland weather station are shown on Figure 2.6. The mean monthly precipitation values are highest for December and March and lowest for September.

The USGS has published daily stream flow data for Bayou Bartholomew at 3 locations in Arkansas and one location in Louisiana about 1 mile downstream of the state line. The locations of the gages are shown on Figure 2.7. Basic information and summary statistics for these gages are summarized in Table 2.1 (tables are located at the end of the section). Mean monthly flows for Bayou Bartholomew at the Jones, LA gaging station are shown on Figure 2.8.

In some instances, the flow in Bayou Bartholomew is influenced by withdrawals of irrigation water directly from the bayou and by return flows of irrigation water draining from the fields (ADEQ 2001a). Irrigation water is also withdrawn from groundwater. A database obtained from the Arkansas Soil and Water Conservation Commission (ASWCC) showed that there are 275 surface water withdrawal sites and 1207 groundwater withdrawal sites within the Arkansas portion of the Bayou Bartholomew watershed. Over 94% of these withdrawal permits are for irrigation or other agricultural uses.

2.6 Designated Uses and Water Quality Standards

The state of Arkansas has developed water quality standards for waters of the state (ADEQ 1998a). The standards are defined according to ecoregions and designated waterbody uses. The Bayou Bartholomew watershed lies within both the Gulf Coastal Plain and Delta ecoregions. The main stem of Bayou Bartholomew and the tributaries on the east side are mostly in the Delta ecoregion, while the tributaries on the west side are mostly in the Gulf Coastal Plains ecoregion. Designated uses for Bayou Bartholomew include primary and secondary contact recreation; domestic, industrial and agricultural water supply; and seasonal and perennial Gulf Coastal Plains fishery and perennial Delta ecoregion fishery.

Turbidity is addressed in Section 2.503 of the Arkansas Water Quality Standards (ADEQ 1998a). The general narrative standard 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 standard for streams in the Gulf Coastal

Plain ecoregion is 21 NTU, while the standard for the Delta ecoregion is 45 NTU for "least-altered" streams and 75 NTU for "channel-altered" streams. ADEQ considers the main stem of Bayou Bartholomew to be "least-altered".

2.7 Point Sources

Information for point source discharges in the Bayou Bartholomew basin (Hydrologic Unit 08040205) was obtained by searching the Permit Compliance System (PCS) on the EPA website, reviewing ADEQ files, and reviewing information found in published technical reports (ADEQ 2000, ADEQ 2001a). The search yielded 18 facilities with point source discharges. Search results, including flow rate and permit limits for TSS, are included as Table 2.2. A permit limit for TSS was not given for one of the facilities. Locations of the permitted facilities are shown on Figure A.1 in Appendix A. Any point source discharges authorized under a general permit (rather than an individual permit) would not be revealed by this search.

2.8 Nonpoint Sources

Nonpoint sources of pollution in the Bayou Bartholomew watershed are discussed in several reports. The discussion of water quality for Segment 2B in the 305(b) report (ADEQ 2000) states that "Water quality is impacted in much of this segment by nonpoint pollution generated by row crop agriculture. Silt loads and turbidity are consistently very high, thus causing degradation to the aquatic life contained in many of these streams." The Bayou Bartholomew Assessment Report (ADEQ 2001a) recommends that nonpoint source best management practices (BMPs) be disbursed within the watershed based on land use and deficiencies of the receiving streams, and that practices to reduce contaminants from urban runoff into streams in the Pine Bluff area be implemented. The Bayou Bartholomew Alliance (BBA 1996) lists the following as potential sources or causes of sediment: cropland, riparian, streambanks, construction, bedload, silviculture, and county roads.

2.9 Previous Water Quality Studies

Following is a list of relevant water quality studies that were identified for the Bayou Bartholomew watershed:

1) Unassessed Waters Survey by ADEQ. This consists of unpublished data collected by the ADEQ during 1994 – 1996 at five sites on Cut-Off Creek and the main stem of Bayou Bartholomew.

2) “Short and Long Term Strategies for Protecting and Enhancing Natural Resources in the Bayou Bartholomew Watershed” (BBA 1996), prepared by the Bayou Bartholomew Alliance Technical Support Group.

3) “Watershed Restoration Action Strategy for the Bayou Bartholomew Watershed” (ASWCC 1999). This discusses existing conditions within the watershed, expected future uses and needs, and strategies for restoration actions within the watershed.

4) “Physical, Chemical and Biological Assessment of the Bayou Bartholomew Watershed” (ADEQ 2001a). See Section 3.2 for a discussion of this report.

5) “Bayou Bartholomew Watershed Modeling Feasibility Study”, draft report (ADEQ 2001b). This report examines the feasibility of applying different watershed models to Bayou Bartholomew.

6) “Bayou Bartholomew Wetland Planning Area Report” (Layher and Phillips 2002). This includes discussion of physical and biological watershed characteristics, historical land use and wetlands protection, characteristics of wetland ecosystems in the Bayou Bartholomew Wetland Planning Area, and the potential for wetlands losses and gain in the area.

2.10 Ongoing Conservation Activities

Conservation activities for improving the environment are currently being carried out by numerous groups and individuals in the Bayou Bartholomew watershed. Most notable is the Bayou Bartholomew Alliance (BBA), which is a group of concerned citizens who have organized as a non-profit organization for the purpose of restoring the scenic beauty and natural habitat and function of the bayou. The BBA gathers and disseminates information, conducts meetings, and participates in and coordinates activities with government agencies and other organizations.

The NRCS and the local soil and water conservation districts are working with individuals in the watershed to increase the use of conservation tillage, convert cropland to grass or forest through the Conservation Reserve Program (CRP), develop and maintain riparian buffer zones and filter strips, restore wetlands, and develop and implement nutrient and pesticide management plans.

The Vicksburg District Corps of Engineers is currently proceeding with a project called the "Southeast Arkansas Feasibility Study". Flood damages and the impact of extensive agricultural water use on groundwater resources have been identified as concerns in the Bayou Bartholomew and Beouf River basins of southeast Arkansas. This study will address these problems along with environmental problems and needs including the loss of wetland and aquatic habitat and waterfowl needs.

Following are examples of other ongoing conservation activities in the Bayou Bartholomew watershed listed on the ASWCC website (http://www.state.ar.us/aswcc/NPS_Webpage/Bayou_Bartholomew.html):

1) The Cooperative Extension Service is conducting a technology transfer project in the Bayou Bartholomew watershed concerning best management practices for row crop agriculture and irrigation management.
2) The University of Arkansas at Monticello is conducting demonstrations of no-till cotton in southeast Arkansas, including annual tours and field days.
3) Ducks Unlimited provides stop logs for farmers to allow them to re-flood their fields after harvest. This practice provides habitat for ducks and also has a water quality benefit of reducing erosion and sedimentation from these fields.
4) The Arkansas Forestry Commission conducts logger-training programs annually in the Bayou Bartholomew watershed.
5) The BBA has effectively used donations from the forestry industry and volunteer labor to replant over 14 miles of riparian forest over the last year.
6) The BBA is working with the City of Pine Bluff to control urban erosion and sediment.

Table 2.1. Information for stream flow gaging stations (USGS 2001a and USGS 2001b).

	Bayou Bartholomew at Garret Bridge, AR	Bayou Bartholomew near McGehee, AR	Bayou Bartholomew near Portland, AR	Bayou Bartholomew near Jones, LA
USGS gage number	07364133	07364150	07364185	07364200
Descriptive location	Hwy 54, 1.9 mi upstream of Flat Cr.	Hwy 4, 2.7 mi west of McGehee	Hwy 278, 1.4 mi west of Portland	Hwy 834, 1.6 mi northwest of Jones
Drainage area (mi^2)	380	576	1109	1187
Period of record	October 1987 to current	October 1945 to current	August 1998 to current	October 1957 to current
Mean annual flow (cfs)	535	686	--	1320
Mean annual runoff (in)	19.1	16.2	--	15.1

Table 2.2. Inventory of point source dischargers.

NPDES Permit Number	Facility Name	City Name	Permit Flow Rate (MGD)	Receiving Stream	Monthly Average Limit, TSS (mg/L)
AR0047872	Robert Floyd Sawmill Inc	Star City	0.0255	Tributary of Cane Creek	35
ARG640143	Fountain Hill, City of-PWTP	Fountain Hill	0.0018	Fountain Creek	20
ARG640110	Hwy 15 Water Users-Jefferson Co	Pinebergen		Bayou Bartholomew	20
AR0041602	Suburbia Sid #1	Pine Bluff	0.012	Nevins Creek	20
AR0022071	McGehee, City of	McGehee	0.6	Bayou Bartholomew	90
AR0037885	Boggy Bayou Sid	Jefferson County	0.025	Boggy Bayou	20
AR0037141	Parkdale, City of	Parkdale	0.05	Bayou Bartholomew	90
AR0039144	Pinewood Sid #1	Jefferson County	0.05	Nevins Creek	20
AR0022144	Wilmot, City of	Wilmot	0.165	Bayou Bartholomew	90
AR0046477	Star City, City of	Star City	0.375	Cane Creek	15
AR0022250	Dermott, City of	Dermott	0.6	Bayou Bartholomew	90
AR0034029	Hamburg City of	Hamburg	0.94	Chemin-A-Hart Creek	90
AR0021831	Monticello, City of-East WWTP	Monticello	2.5	Godfrey Creek	90
ARG160027	Ashley County Landfill	Hamburg	0.15	Tributary of Hanks Creek	No Limit
AR0047350	Pine Haven Mobile Lodge	Monticello	0.0075	Tributary of Godfrey Creek	20
AR0045888	AR Parks & Tourism-Cane Creek	Star City	0.01	Cane Creek	15
AR0041297	Montrose, City of	Montrose	0.1	Tributary of Hanks Creek	90
AR0034371	Portland, City of	Portland	0.1	Tributary of Bayou Bartholomew	30

Figure 2.1. Bayou Bartholomew Basin.

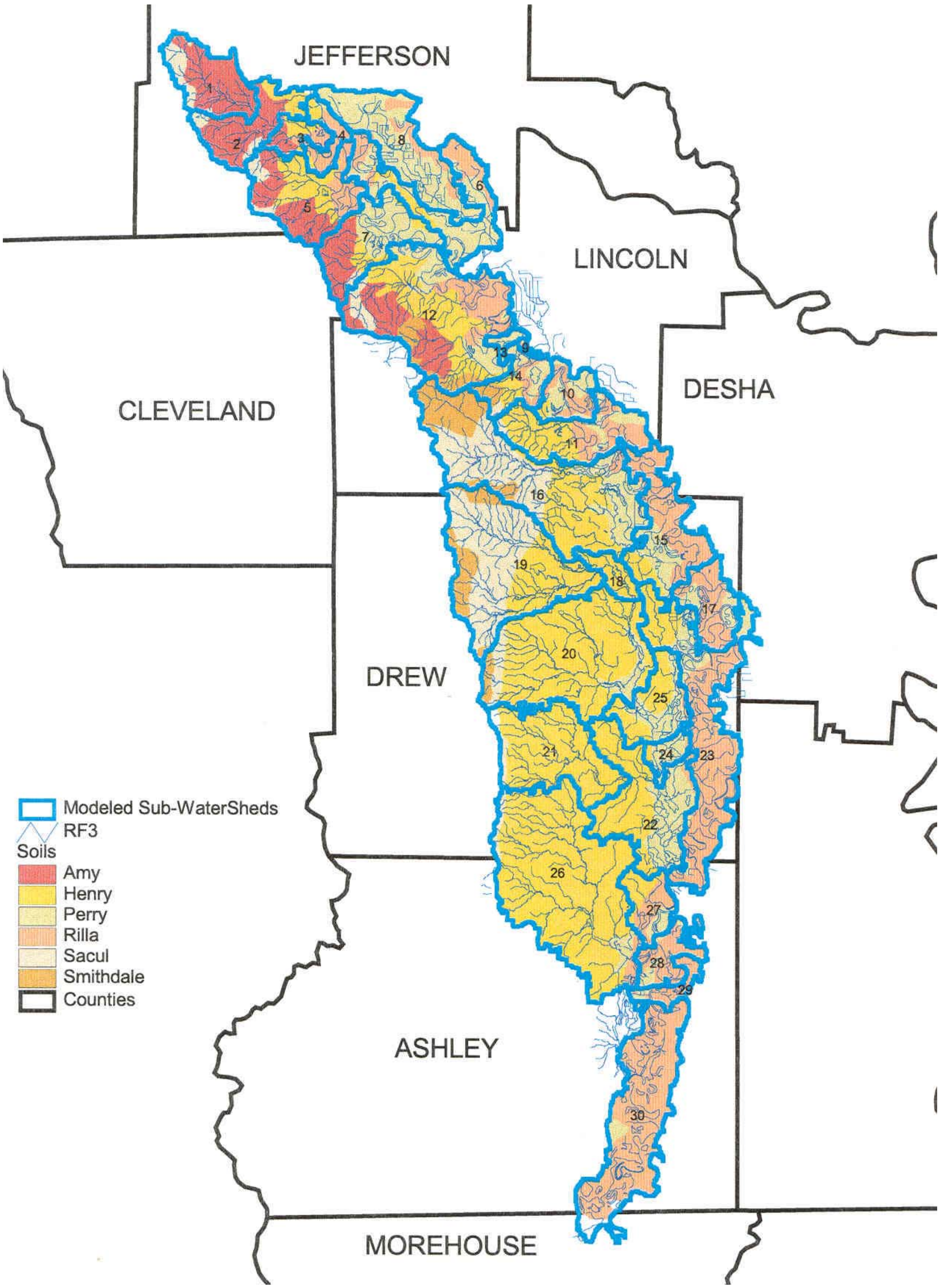

Figure 2.2. Predominant soil types in Bayou Bartholomew Watershed.

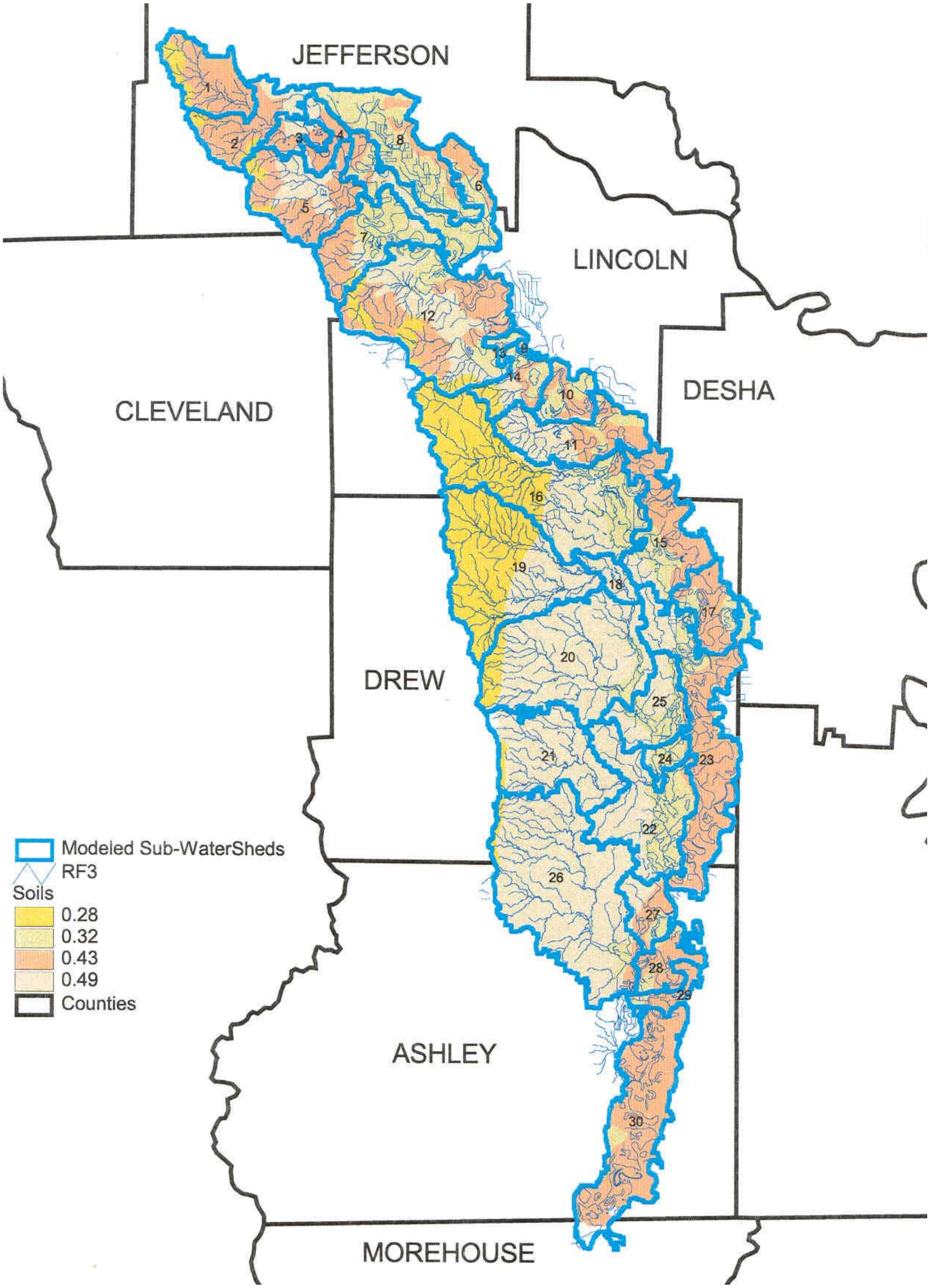

Figure 2.3. Soil erodibility factors in Bayou Bartholomew Watershed.

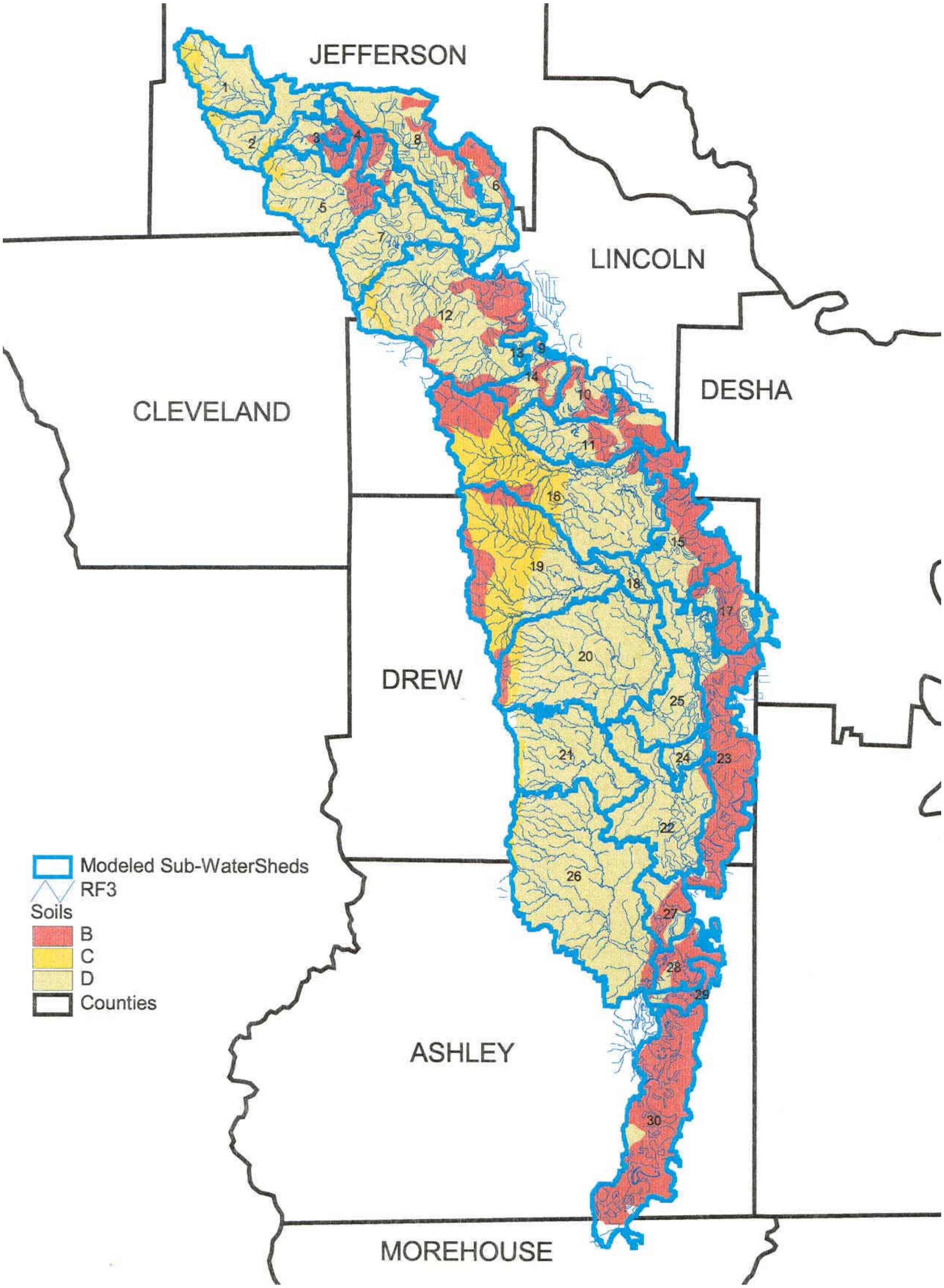

Figure 2.4. Hydrologic soil groups in Bayou Bartholomew Watershed.

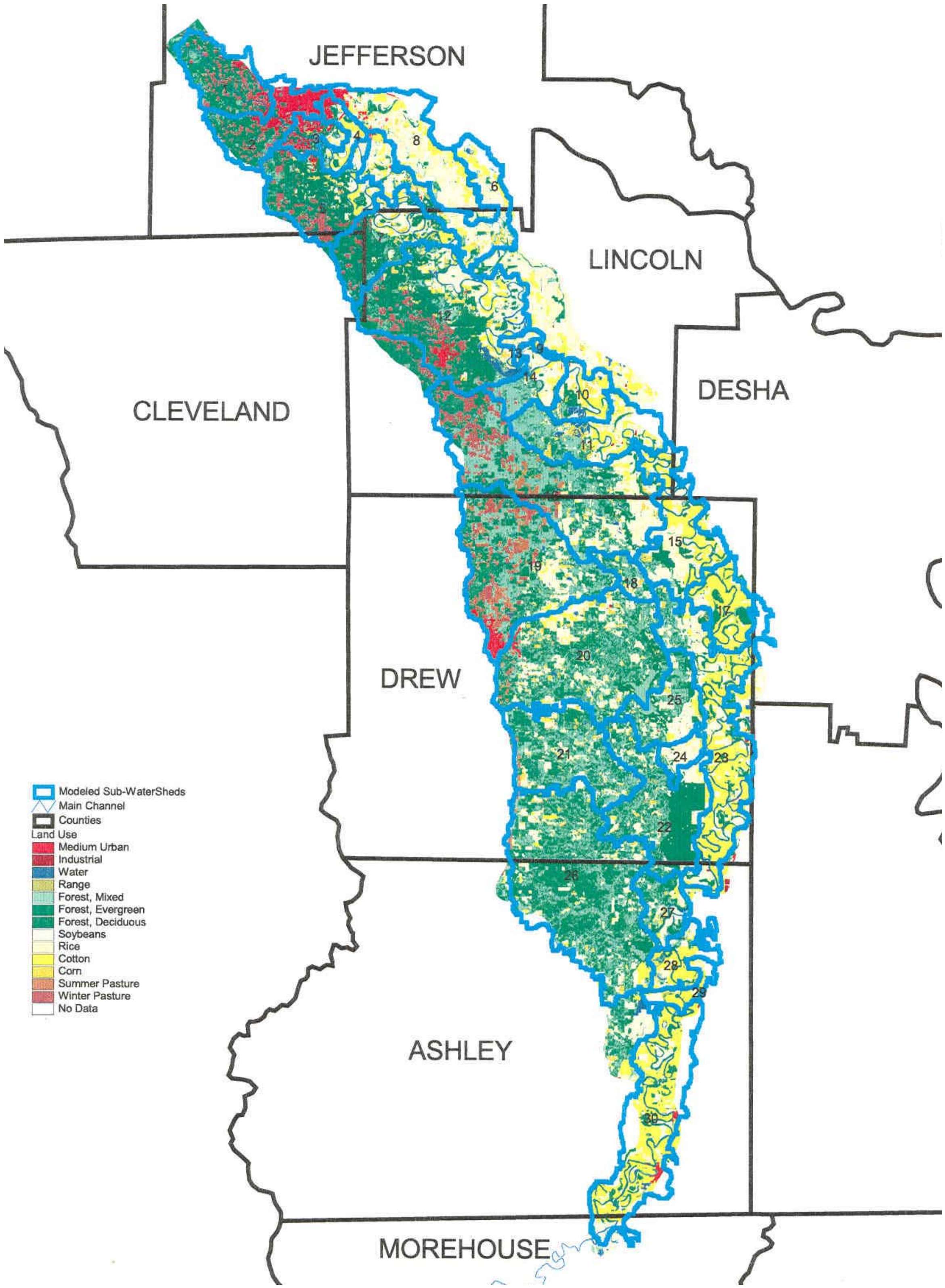

Figure 2.5. Land use in Bayou Bartholomew Watershed.

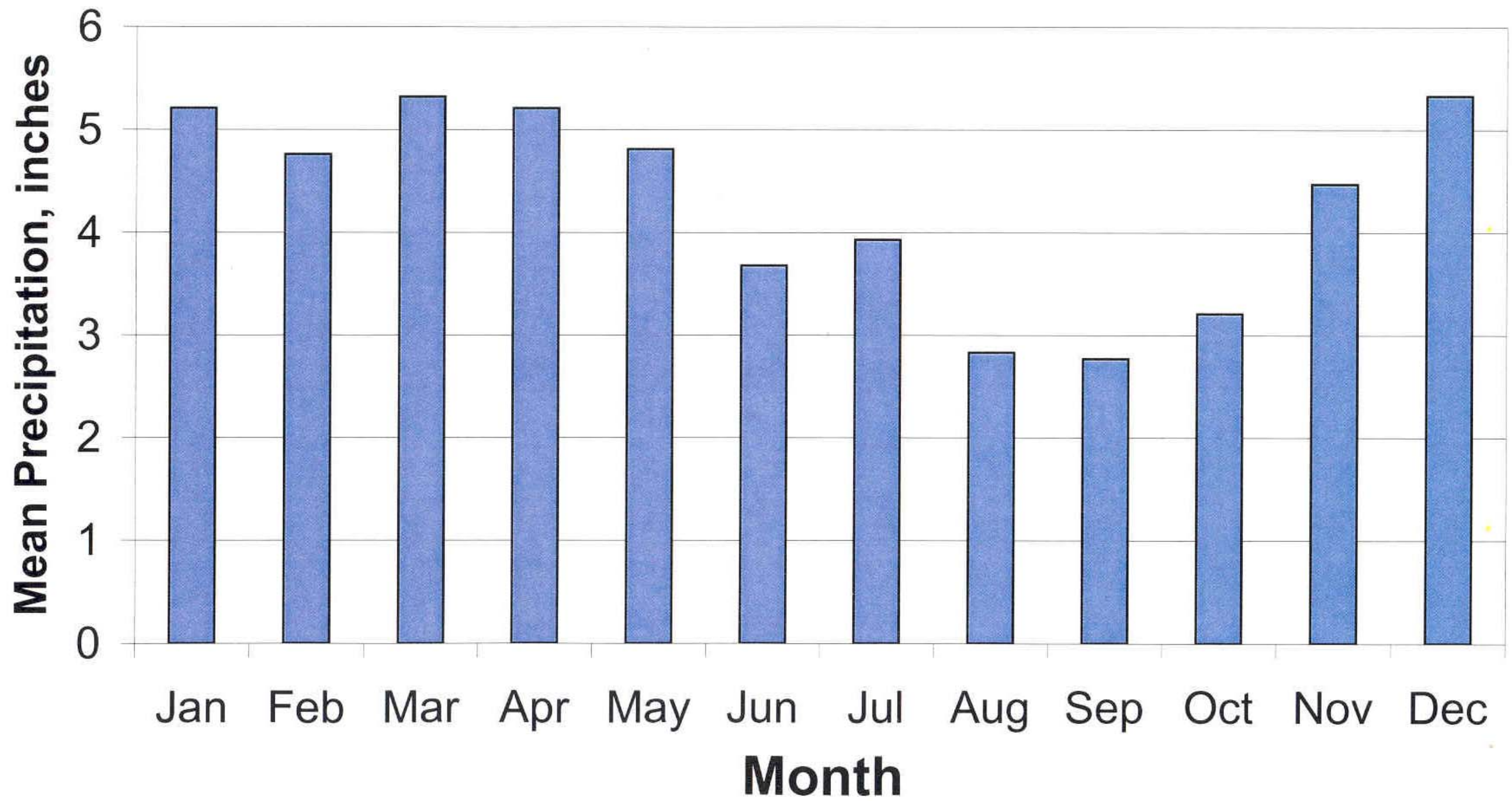

Figure 2.6. Mean Monthly Precipitation, Portland, AR.

Figure 2.7. Selected streams and water quality stations in Bayou Bartholomew Watershed.

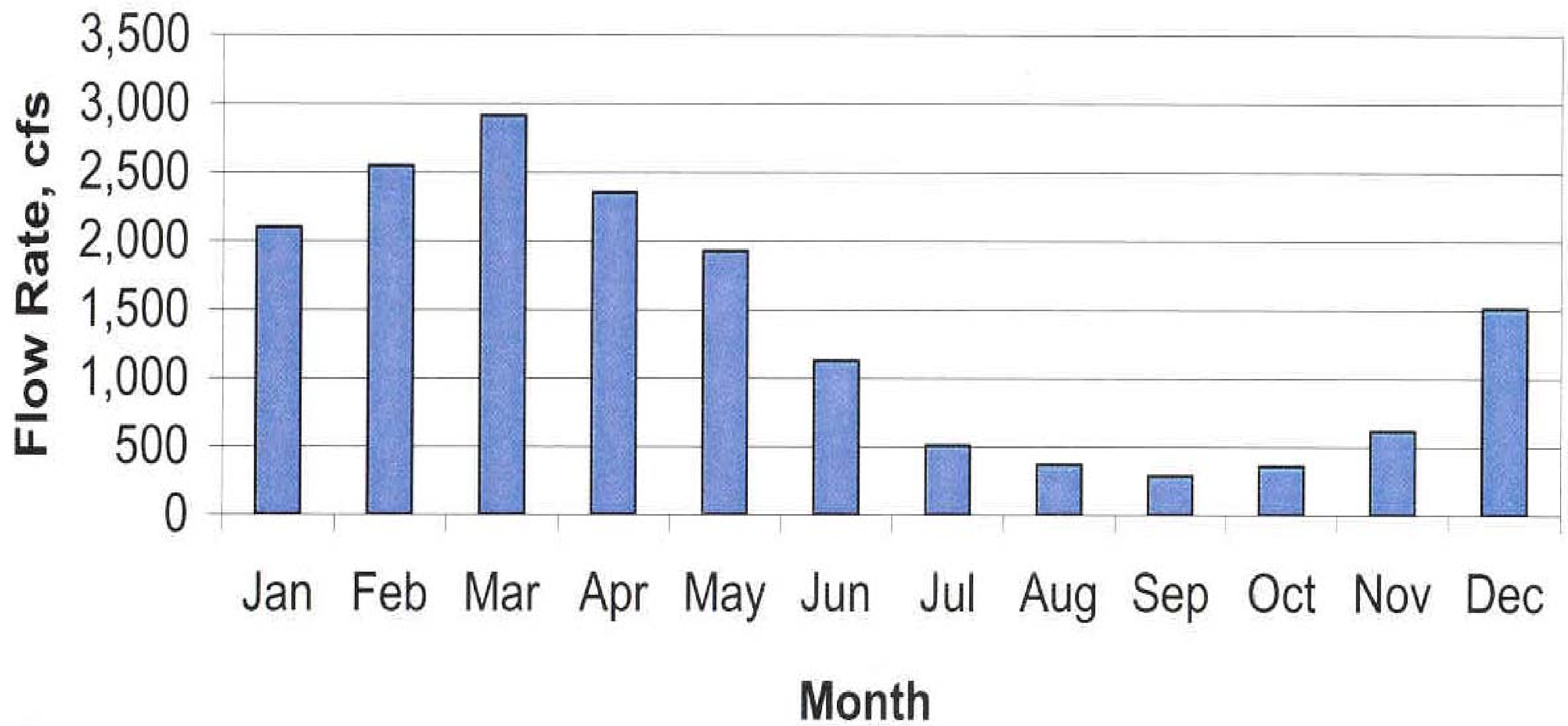

Figure 2.8. Mean Monthly flows, Jones, LA.

3.0 CHARACTERIZATION OF EXISTING WATER QUALITY

3.1 Inventory of Data

A detailed inventory and discussion of the existing water quality data was developed by FTN and submitted to EPA Region 6 as part of this project (FTN 2001).

Information on water quality monitoring stations in Bayou Bartholomew (Hydrologic Unit 08040205) was obtained by searching the EPA STORET database and from information provided by the U.S. Geological Survey (USGS). Based on the 303(d) listings, the emphasis of the search was on parameters related to turbidity. The search was conducted for all water quality stations on streams within the basin north of the Louisiana-Arkansas border, although the 3 northernmost stations in Louisiana were also included. The search was conducted for data collected by all agencies. The search yielded a total of 26 stations as listed in Tables 3.1 through 3.3 (tables are located at the end of this section). A plan showing the location of the stations within the watershed is included in the previous section as Figure 2.7. Three stations had data collected by the USGS, and all 26 stations had data collected by the Arkansas Department of Environmental Quality (ADEQ). Twenty-five of the stations had approximately 8 to 13 values that were collected during 1998-2000 as part of a special study by ADEQ on the Bayou Bartholomew watershed (ADEQ 2001a). Two of the ADEQ stations were long term stations with data from about 1970 to present. These two stations were OUA33 (Bayou Bartholomew south of Ladd, Arkansas) and OUA13 (Bayou Bartholomew west of Jones, Louisiana).

Tables 3.1 through 3.3 include an inventory of data for turbidity, total suspended solids (TSS), stream flow, total organic carbon (TOC), total dissolved solids (TDS), and chlorophyll a for each station. The flow data represent only the data in STORET and not the USGS daily flow data. The inventory in Tables 3.1 through 3.3 includes periods of record and numbers of measurements available.

3.2 Assessment Report

The Bayou Bartholomew Assessment Report (ADEQ 2001a) documents much of the water quality data referred to above, and is an assessment of the waters of the Bayou

Bartholomew watershed. For this study, water quality data were collected on numerous streams throughout the watershed during wet weather conditions, which provided data that are not often available from routine monitoring datasets. The report provides a thorough summary and analysis of the data. Some of the conclusions of the report are restated here:

1) Historical water quality data indicate occasional very high values of instream turbidity.

2) Land use in the upper watershed has mainly row crop agriculture and urbanization. Silviculture is the main land use in the Gulf Coastal Plains section, with numerous small farms. Land use in the Delta ecoregion consists mainly of row-crop agriculture.

3) Two stations exceeded base flow turbidity criteria, and 10 sites exceeded storm flow turbidity criteria. Most of these sites are in the Deep Bayou watershed or heavily influenced by row-crop agriculture.

4) For the most part, TSS concentrations reflected turbidity values, though at times clay particles were the main contributor to high turbidity values.

5) TDS concentrations exceeded Delta ecoregion criteria at five sites and Gulf Coastal Plains criteria at one site.

3.3 Comparison Between Observed Data and Standards

Tables 3.4 through 3.8 present information comparing the measured turbidity values in NTU for the various water quality stations throughout the watershed to the appropriate turbidity standard. The turbidity standards used in the comparisons were based on the ecoregion in which the sampling station was located. The period of record for the information obtained is noted in the tables and the tables are separated seasonally. Tables 3.4 through 3.7 are for stations sampled in the time period 1998 to 2000. Table 3.8 provides information for the two long-term stations within the watershed.

The turbidity values at each station were separated into 2 seasons, December through June and July through November, to assess the seasonal distribution of turbidity. The short-term and long-term data both indicate zero to low percentages of values above the water quality standard in the July through November season (except OUA152, with 1 of 2 samples exceeding standard). The December through June season had generally moderate to very high percentages of values exceeding the water quality standard for stations throughout the watershed.

These percentages of values above the water quality standard can be compared with the assessment guidance used by ADEQ for determining whether or not a stream is supporting its aquatic life use due to turbidity (ADEQ 2000). According to these criteria, a stream is not supporting uses if more than 25% of the values at base flow exceed the standard or if more than 15% of the values for storm flow exceed the 90th percentile ecoregion value.

3.4 Analysis at Selected Stations

The 25 station locations for which data were obtained for this study are shown on Figure 2.7 in the previous section. There were 2 stations with sufficient historical water quality data to be analyzed for long term trends, seasonal patterns, and relationships between and among parameters. Most of the analysis was performed on this data from stations OUA33 (upstream end of Bayou Bartholomew) and OUA13 (downstream end of Bayou Bartholomew). Unless otherwise noted, the discussions below refer to the long-term data from stations OUA33 and OUA13. The water quality data from 23 other stations, which were collected during 1998 to 2000, were used to study spatial variations due to ecoregion and land use.

Regression analyses were performed on various combinations of both short-term and long-term data. Single-variable analyses were done in a spreadsheet (Microsoft Excel) and multiple variable regression analyses were done using a statistics package (SYSTAT). Assumptions about the data include that the errors are independent and identically distributed. Other assumptions made in the course of the analyses are stated below.

3.4.1 Long Term Trends

The plots of turbidity by year (Figures 3.1 and 3.2; figures are located at the end of this section) indicate a constant or slightly increasing trend at station OUA33 and a possible decreasing trend at station OUA13. These trends are probably not statistically significant. At station OUA13 there appears to be a transition point around 1990. For this reason, only data collected since 1991 was used for further analysis. Long term data for TSS indicate a slightly decreasing trend at both stations (Figures 3.3 and 3.4).

3.4.2 Seasonal Patterns

The plots of turbidity by month (Figures 3.5 and 3.6) show higher values during the winter and high flow months (December – June) compared to the summer and low flow months (July – November). The winter and spring period is also the time when row crop fields are usually barren. During the summer months, there is less runoff and more vegetation to reduce erosion.

Seasonal trends in TSS are not similar at stations OUA13 and OUA33 (Figures 3.7 and 3.8). At station OUA13, TSS concentrations appear to be higher during the summer months, compared to the high flow, winter months. In contrast, at station OUA33, TSS values are highest in May and lowest during the summer. This indicates that location in the watershed and the seasonal period may be important and characterized by different types of loading.

3.4.3 Spatial Variations

For the period 1991 – 2000, the median turbidity values increased slightly from the upper watershed at station OUA33 (31 NTU) to the lower watershed at station OUA13 (38 NTU). Median TSS concentrations also increased from about 14 mg/L at OUA33 to 20 mg/L at OUA13.

During the period 1998 – 2000, turbidity and TSS concentrations were collected at 25 stations throughout the watershed including stations OUA33 and OUA13. Data for this period was examined seasonally, for one period from December through June and another from July through November, to identify spatial patterns for loading. Median values of turbidity and TSS for the months December through June are shown near station location on Figures A.2 and A.3 of Appendix A, and for July through November on Figures A.4 and A.5 of Appendix A. These figures indicate possible seasonal and spatial variations in the relationship between turbidity and TSS.

For the 1998 – 2000 data, the median turbidities for the main stem of Bayou Bartholomew increased in the downstream direction. The highest median turbidities occurred at and downstream of the Deep Bayou confluence (BYB03 and BYB02), and decreased somewhat at stations further downstream. The median turbidities for the bayou at station OUA13 in Jones, LA were about double those measured at station OUA33 near Ladd, AR.

3.4.4 Relationships between Parameters

Relationships between and among parameters were examined for the following combinations:

- turbidity and TSS
- turbidity and stream flow
- turbidity and TOC
- turbidity and TDS
- turbidity and chlorophyll a

The initial analysis included data collected from 1998 – 2000 for the 25 stations monitored by ADEQ, and data from 1977 to 2000, generally, for the two long term stations OUA13 and OUA33. The chlorophyll a and TDS data were not available for the entire 1977 to 2000 time period. The analyses were conducted seasonally. The multiple variable regressions examined turbidity and TSS, stream flow, TOC, and TDS, in various combinations, and did not yield results significantly different than the single-variable regressions; therefore, the remainder of analyses were performed on single-variable regressions. The strongest relationships were of turbidity to TSS.

The distribution of data for the parameters investigated closely approximates a log-normal distribution, except for TOC data which more closely approximates a normal distribution. Linear regressions for each season using long-term data (1991-2000) were performed on the log-transformed TSS and turbidity data for stations OUA 33 and OUA 13. Similarly, linear regressions for each season using short term data (1998-2000) were performed on the log-transformed TSS and turbidity data for 25 stations.

3.4.5 Results of Analyses of Long-Term Data

Table 3.9 shows the equations obtained with the regressions, R^2 values, the percent of turbidity data exceeding the standard for various time periods and seasons, and other related information. All of the slopes for the regression equations are statistically significant ($p < 0.001$).

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). Therefore, for Station OUA33 during the December to June season, 55% of the variation in TSS is accounted for by turbidity and the remaining 45% of variation in TSS is unexplained. Likewise, during the July to November season, 44% of the variation in TSS is accounted for by turbidity and the remaining 56% of variation in TSS is unexplained. For Station OUA13, during the December to June season, 31% of the variation in TSS is accounted for by turbidity and the remaining 69% of the variation in TSS is unexplained. Likewise, during the July to November season, 37% of the variation in TSS is account for by turbidity and the remaining 63% of the variation in TSS is unexplained. The unexplained portion is attributed to factors other than turbidity such as chlorophyll *a*, color, and bacteria.

Plots of the regressed data are included as Figures 3.9 through 3.12. The regression equations are:

Station	**Season**	**Equation**
OUA33	Dec – Jun	ln TSS = 0.9134 ln Turb - 0.386
	Jul – Nov	ln TSS = 0.8951 ln Turb - 0.1137
OUA13	Dec – Jun	ln TSS = 0.963 ln Turb - 0.9283
	Jul – Nov	ln TSS = 0.5973 ln Turb + 1.251

3.4.6 Results of Analyses of Short-Term Data

Tables 3.4 through 3.8 show the percent of measured turbidity values that exceed the water quality standard of 21 or 45 NTU, as appropriate, for each of the 25 stations used in the 1998 – 2000 study. The stations are grouped by land use. The exceedances of the standard appear to be mainly during the December – June months.

Regression of the short-term data were performed by season for 25 stations for TSS and turbidity. In most cases the slope was not statistically significant (p-value > 0.05), meaning that a linear relationship does not exist. This is probably due to the variability and the small number of values in the data ranging from 1 to 8. The slope obtained for regressions for the December to June data for 5 of the 6 stations in croplands land use areas were statistically significant (p-value $\leq$0.05). R^2 values ranged from 53% to 91%. The average predicted TSS (15.8 mg/L) obtained from these 5 regressions based on a NTU value of 45 were similar to that obtained for the December through June season for station OUA13 (15 mg/L). Likewise, the average predicted TSS (7 mg/L) obtained from these 5 regressions based on a NTU value of 21 was the same as that obtained for the December through June season for station OUA13.

Based on these results, the regression relationships for the short-term data were not used for developing the TMDLs. The equations obtained from the regressions, and associated R^2 values and significance levels for the short-term data for the croplands land use areas are included as Table 3.10.

Table 3.1. Inventory of historical data for turbidity and total suspended solids.

Station ID (USGS ID)	Agency	Station Description	Turbidity			Total Suspended Solids (mg/L)*	
			Units	# Values	Period of Record	# Values	Period of Record
OUA12 (USGS07364300)	1116APCC	Chemin A Haut Cr near Beekman LA	NTU	13	1998-2000	10	1998-2000
OUA12A (USGS07364210)	1116APCC	Overflow Creek near Bonita LA	NTU	13	1998-2000	11	1998-2000
OUA13 (USGS07364200)	1116APCC	Bayou Bartholomew near Jones LA	NTU	245	1977-2000	303	1968-2000
			JCU	182	1968-1977		
OUA33 (USGS07364115)	1116APCC	Bayou Bartholomew near Ladd, AR	NTU	255	1977-2000	286	1972-2000
			JCU	72	1974-1977		
OUA143	21ARAPCC	Bayou Bartholomew near Pine Bluff AR	NTU	8	1998-2000	8	1998-2000
OUA144	21ARAPCC	Nevins Creek S. of Pine Bluff AR	NTU	11	1998-2000	11	1998-2000
OUA145	21ARAPCC	Harding Creek In Sw Pine Bluff AR	NTU	13	1998-2000	13	1998-2000
OUA146	21ARAPCC	Unnamed Tributary In Se Pine Bluff AR	NTU	13	1998-2000	13	1998-2000
OUA147	21ARAPCC	Bayou Imbeau S.E. of Pine Bluff AR	NTU	13	1998-2000	13	1998-2000
OUA148	21ARAPCC	Meltons Creek S. of Tarry AR	NTU	12	1998-2000	12	1998-2000
OUA149	21ARAPCC	Cousart Bayou S. of Tamo AR	NTU	12	1998-2000	11	1998-2000
OUA150	21ARAPCC	Jacks Bayou South of Tamo AR	NTU	13	1998-2000	13	1998-2000
OUA151	21ARAPCC	Deep Bayou South of Grady AR	NTU	13	1998-2000	13	1998-2000
OUA152	21ARAPCC	Cross Bayou S.E. of Fresno AR	NTU	8	1998-2000	8	1998-2000
OUA154	21ARAPCC	Bayou Bartholomew Near Portland AR	NTU	13	1998-2000	13	1998-2000

Table 3.1. Continued.

Station ID (USGS ID)	Agency	Station Description	Turbidity			Total Suspended Solids (mg/L)*	
			Units	# Values	Period of Record	# Values	Period of Record
OUA156	21ARAPCC	Wolf Creek South of Collins AR	NTU	13	1998-2000	12	1998-2000
OUA157	21ARAPCC	Cutoff Creek East of Collens AR	NTU	13	1998-2000	13	1998-2000
OUA158	21ARAPCC	Ables Creek North of Selma AR	NTU	13	1998-2000	12	1998-2000
UWBYB01	21ARAPCC	Bayou Bartholomew at Hwy 82 near Thebes	NTU	9	1994-1996	9	1994-1996
UWCOC01	21ARAPCC	Cut off Creek at Co. Rd. N.E. of Bydell	NTU	21	1994-2000	21	1994-2000
UWCOC02	21ARAPCC	Cutoff Creek at Hwy 4 10 Mi. E. of Monticello	NTU	21	1994-2000	21	1994-2000
UWBYB02	21ARAPCC	Bayou Bartholomew at Hwy 4 near. McGehee	NTU	22	1994-2000	22	1994-2000
(USGS 07364150)		Bayou Bartholomew Near McGehee, AR	JCU	1	1975	24	1972, 1995-99
UWBYB03	21ARAPCC	Bayou Bartholomew at Hwy 54 at Garrett Bridge	NTU	21	1994-2000	21	1994-2000
(USGS 07364133)		Bayou Bartholomew at Garrett Bridge, AR				8	1998 - 1999
OUA0160	ARDEQH2O	Bayou Bartholomew South of Tarry, AR	NTU	5	1998-2000	5	1998-2000
OUA0153	ARDEQH2O	Ables Southwest of Tyro, AR	NTU	7	1998-2000	7	1998-2000
OUA0155	ARDEQH2O	Bearhouse Creek Near Snyder, AR	NTU	7	1998-2000	7	1998-2000

*Total Suspended Solids, Parameter 00530, except is Suspended Sediment, Parameter 80154 when in USGS station row

Table 3.2. Inventory of historical data for flow and total organic carbon.

Station ID (USGS ID)	Agency	Station Description	Flow (cfs)		Total Organic Carbon (mg/L)	
			# Values	Period of Record	# Values	Period of Record
OUA12 (USGS07364300)	1116APCC	Chemin A Haut Cr near Beekman LA	0	1998-2000	13	1998-2000
OUA12A (USGS07364210)	1116APCC	Overflow Creek near Bonita LA	0	1998-2000	13	1998-2000
OUA13 (USGS07364200)	1116APCC	Bayou Bartholomew near Jones LA	635	1968-2000	271	1986-2000
OUA33 (USGS07364115)	1116APCC	Bayou Bartholomew near Ladd, AR	158	1982-2000	281	1986-2000
OUA143	21ARAPCC	Bayou Bartholomew near Pine Bluff AR	1	1998-2000	7	1998-2000
OUA144	21ARAPCC	Nevins Creek S. of Pine Bluff AR	4	1998-2000	10	1998-2000
OUA145	21ARAPCC	Harding Creek In Sw Pine Bluff AR	5	1998-2000	12	1998-2000
OUA146	21ARAPCC	Unnamed Tributary In Se Pine Bluff AR	1	1998-2000	12	1998-2000
OUA147	21ARAPCC	Bayou Imbeau S.E. of Pine Bluff AR	5	1998-2000	12	1998-2000
OUA148	21ARAPCC	Meltons Creek S. of Tarry AR	1	1998-2000	11	1998-2000
OUA149	21ARAPCC	Cousart Bayou S. of Tamo AR	6	1998-2000	11	1998-2000
OUA150	21ARAPCC	Jacks Bayou South of Tamo AR	8	1998-2000	13	1998-2000
OUA151	21ARAPCC	Deep Bayou South of Grady AR	12	1998-2000	13	1998-2000
OUA152	21ARAPCC	Cross Bayou S.E. of Fresno AR	4	1998-2000	8	1998-2000
OUA154	21ARAPCC	Bayou Bartholomew Near Portland AR	13	1998-2000	13	1998-2000
OUA156	21ARAPCC	Wolf Creek South of Collins AR	0	1998-2000	13	1998-2000
OUA157	21ARAPCC	Cutoff Creek East of Collens AR	3	1998-2000	13	1998-2000

Table 3.2. Continued.

Station ID (USGS ID)	Agency	Station Description	Flow (cfs)			Total Organic Carbon (mg/L)	
			# Values		Period of Record	# Values	Period of Record
OUA158	21ARAPCC	Ables Creek North of Selma AR	9		1998-2000	13	1998-2000
UWBYB01	21ARAPCC	Bayou Bartholomew at Hwy 82 near Thebes	0			6	1994-1995
UWCOC01	21ARAPCC	Cut off Creek at Co. Rd. N.E. of Bydell	1		1998-2000	18	1994-2000
UWCOC02	21ARAPCC	Cutoff Creek at Hwy 4 10 Mi. E. of Monticello	3		1998-2000	19	1994-2000
UWBYB02	21ARAPCC	Bayou Bartholomew at Hwy 4 near. McGehee	13		1998-2000	19	1994-2000
(USGS 07364150)		Bayou Bartholomew Near McGehee, AR	244	71***	1959-1999	2	1972, 1975
UWBYB03	21ARAPCC	Bayou Bartholomew at Hwy 54 at Garrett Bridge	13		1998-2000	19	1994-2000
(USGS 07364133)		Bayou Bartholomew at Garrett Bridge, AR		8***	1998 - 1999		
OUA0160	ARDEQH2O	Bayou Bartholomew South of Tarry, AR	2		1998-2000	4	1998-2000
OUA0153	ARDEQH2O	Ables Southwest of Tyro, AR	4		1998-2000	7	1998-2000
OUA0155	ARDEQH2O	Bearhouse Creek Near Snyder, AR	3		1998-2000	7	1998-2000

***: Instantaneous Flow Rate, cfs, rather than Mean Daily Flow rate, cfs

Table 3.3. Inventory of historical data for total suspended solids and Chlorophyll a.

Station ID (USGS ID)	Agency	Station Description	Total Dissolved Solids (mg/L)**		Chlorophyll a (ug/L)	
			# Values	Period of Record	# Values	Period of Record
OUA12 (USGS07364300)	1116APCC	Chemin A Haut Cr near Beekman LA	12	1998-2000		
OUA12A (USGS07364210)	1116APCC	Overflow Creek near Bonita LA	12	1998-2000		
OUA13 (USGS07364200)	1116APCC	Bayou Bartholomew near Jones LA	12	1998-2000	105	1978-1983
OUA33 (USGS07364115)	1116APCC	Bayou Bartholomew near Ladd AR	12	1998-2000	108	1978-1983
OUA143	21ARAPCC	Bayou Bartholomew near Pine Bluff AR	8	1998-2000		
OUA144	21ARAPCC	Nevins Creek S. of Pine Bluff AR	11	1998-2000		
OUA145	21ARAPCC	Harding Creek In Sw Pine Bluff AR	13	1998-2000		
OUA146	21ARAPCC	Unnamed Tributary In Se Pine Bluff AR	13	1998-2000		
OUA147	21ARAPCC	Bayou Imbeau S.E. of Pine Bluff AR	13	1998-2000		
OUA148	21ARAPCC	Meltons Creek S. of Tarry AR	12	1998-2000		
OUA149	21ARAPCC	Cousart Bayou S. of Tamo AR	12	1998-2000		
OUA150	21ARAPCC	Jacks Bayou South of Tamo AR	13	1998-2000		
OUA151	21ARAPCC	Deep Bayou South of Grady AR	13	1998-2000		
OUA152	21ARAPCC	Cross Bayou S.E. of Fresno AR	8	1998-2000		
OUA154	21ARAPCC	Bayou Bartholomew Near Portland AR	12	1998-2000		
OUA156	21ARAPCC	Wolf Creek South of Collins AR	12	1998-2000		

Table 3.3. Continued.

Station ID (USGS ID)	Agency	Station Description	Total Dissolved Solids (mg/L)**		Chlorophyll a (ug/L)	
			# Values	Period of Record	# Values	Period of Record
OUA157	21ARAPCC	Cutoff Creek East of Collens AR	12	1998-2000		
OUA158	21ARAPCC	Ables Creek North of Selma AR	12	1998-2000		
UWBYB01	21ARAPCC	Bayou Bartholomew at Hwy 82 near Thebes	9	1994-1996		
UWCOC01	21ARAPCC	Cut off Creek at Co. Rd. N.E. of Bydell	21	1994-2000		
UWCOC02	21ARAPCC	Cutoff Creek at Hwy 4 10 Mi. E. of Monticello	21	1994-2000		
UWBYB02	21ARAPCC	Bayou Bartholomew at Hwy 4 near. McGehee	22	1994-2000		
(USGS 07364150)		Bayou Bartholomew Near McGehee, AR	241	1959-1999		
UWBYB03	21ARAPCC	Bayou Bartholomew at Hwy 54 at Garrett Bridge	21	1994-2000		
(USGS 07364133)		Bayou Bartholomew at Garrett Bridge, AR	8	1998-1999		
OUA0160	ARDEQH2O	Bayou Bartholomew South of Tarry, AR	5	1998-2000		
OUA0153	ARDEQH2O	Ables Southwest of Tyro, AR	7	1998-2000		
OUA0155	ARDEQH2O	Bearhouse Creek Near Snyder, AR	7	1998-2000		

** Total Dissolved Solids, Parameter 00515, except is Dissolved Solids Residue on Evaporation, 70300 when in USGS station row

Table 3.4. Summary statistics for turbidity for urban land use area stations, Gulf Coastal Plains Ecoregion.

Station Name	OUA143	OUA145	OUA144	OUA146	OUA143	OUA145	OUA144	OUA146
Period of Record Used for statistics	1998 – 2000 July - November				1998 – 2000 December - June			
Number of Values	1	5	3	5	7	8	8	8
Minimum (NTU)	5.9	1.5	5.9	3.2	4.2	2.2	8.9	4.7
Maximum (NTU)	5.9	8.2	15	10	22	40	30	26
Median (NTU)	5.9	4.0	14	6.1	12	20	18	19
Percent of Values Above 21 NTU	0	0	0	0	14	38	38	38

Table 3.5. Summary statistics for turbidity for row-crop land use area stations, Delta Ecoregion.

Station Name	OUA147	OUA149	OUA150	OUA151	OUA152	OUA158	OUA147	OUA149	OUA150	OUA151	OUA152	OUA158
Period of Record Used for Statistics	1998 – 2000 December – June						1998 – 2000 July - November					
Number of Values	8	7	8	8	6	8	5	5	5	5	2	5
Minimum (NTU)	14	4.5	7.1	12	100	22	5.6	1.3	1.4	3.0	8.8	12
Maximum (NTU)	37	330	400	260	580	520	15	8.6	12	25	51	34
Median (NTU)	27	128	180	145	155	76	7.6	6.0	5.1	6.8	29.9	15
Percent of Values Above 45 NTU	0	71	75	88	100	75	0	0	0	0	50	0

Table 3.6. Summary statistics for turbidity for stations in forest land use area, Gulf Coastal Plains Ecoregion.

Station Name	OUA153	COC02	OUA157	OUA156	COC01	OUA155	OUA160	OUA12A	OUA12
Period of Record Used for Statistics					1998 – 2000 December - June				
Number of Values	7	8	8	8	8	7	5	8	8
Minimum (NTU)	8.5	9.2	3.2	2.3	6.9	13	5.8	4.2	3.3
Maximum (NTU)	55	36	24	17	69	25	55	74	25
Median (NTU)	19	20	10	9	25	23	8.9	33	13
Percent of Values Above 21 NTU	29	38	13	0	63	57	20	75	12
Station Name	**OUA153**	**COC02**	**OUA157**	**OUA156**	**COC01**	**OUA155**	**OUA160**	**OUA12A**	**OUA12**
Period of Record Used for Statistics					1998 – 2000 July - November				
Number of Values		5	5	5	5			5	5
Minimum (NTU)	DRY	3.7	1.9	6.6	4.2	DRY	DRY	2.2	2.7
Maximum (NTU)		29	22	16	32			9.2	5.8
Median (NTU)		5.8	4.4	8.1	5.8			4.1	3.7
Percent of Values Above 21 NTU		20	20	0	20			0	0

Table 3.7. Summary statistics for turbidity for stations along Bartholomew Bayou, Delta Ecoregion.

	Station Name	OUA33	OUA148	BYB03	BYB02	OUA154	OUA13
	Period of Record Used for Statistics	1998 – 2000 December - June					
	Number of Values	8	8	8	8	8	8
	Minimum (NTU)	15	15	33	30	33	36
	Maximum (NTU)	65	100	280	280	100	100
	Median (NTU)	36	44	140	120	56	59
	Percent of Values						
	Above 45 NTU	25	50	88	88	75	88
	Above 21 NTU	63	100	100	100	100	100
	Station Name	**OUA33**	**OUA148**	**BYB03**	**BYB02**	**OUA154**	**OUA13**
	Period of Record Used for Statistics	1998 – 2000 July - November					
	Number of Values	4	4	4	5	5	5
	Minimum (NTU)	7.1	3.3	5.8	10	4.4	7.2
	Maximum (NTU)	13	8.1	19	46	23	24
	Median (NTU)	7	6.1	13	18	15	19
	Percent of Values						
	Above 21 NTU	0	0	0	20	40	40
	Above 45 NTU	0	0	0	20	0	0

Table 3.8. Summary statistics for long-term turbidity data for stations on Bayou Bartholomew, 1991-2000.

Station Name	OUA33	OUA33	OUA13	OUA13
Period of Record Used for Statistics	1991-2000 July-November	1991-2000 December-June	1991-2000 July-November	1991-2000 December-June
Number of Values	50	58	51	68
Minimum (NTU)	4.3	5.0	7.2	14
Maximum (NTU)	130	620	58	265
Median (NTU)	15	41	24	53
Percent of Values				
Above 21 NTU	30	86	61	98
Above 45 NTU	5.6	33	2.0	62

Table 3.9. Bayou Bartholomew seasonal regression relationships.

Station	Seasonal Period	Regression Equation (1991-2000 data)	Number of Observations Used in Regression*	R^2	Significance Level, or P value	Percent of Turbidity Data Exceeding the 21 or 45 NTU Standard ** 1977 - 2000 21/45 NTU	1991 – 2000 21/45 NTU	1996 - 2000 21/45 NTU
OUA33	Dec - Jun	ln TSS = 0.9134 * ln Turb - 0.386	54	0.55	1.51 e-10	88% / 30%	86% / 33%	87% / 34%
	Jul - Nov	ln TSS = 0.8951 * ln Turb - 0.1137	50	0.44	3.59 e-6	46% / 15%	30% / 5%	17% / 7%
OUA13	Dec - Jun	ln TSS = 0.963 * lnTurb - 0.9283	61	0.31	3.69 e-6	99% / 69%	98% / 62%	97% / 71%
	Jul - Nov	ln TSS = 0.5973 *ln Turb + 1.251	50	0.37	2.7 e-6	72% / 15%	61% / 2%	63% / 4%

* The data used for regression necessarily is comprised of both TSS and Turbidity values for a single sampling event. However, TSS was not measured for every sampling event that turbidity was measured. Thus the total number of observations for the regression is slightly less than the total number of turbidity measurements for the period.

** All turbidity data available for the time periods shown were used to compute the percent of data exceeding the standard.

Table 3.10. Short-term data seasonal regression relationships, croplands.

Station	Seasonal Period	Regression Equation (1998-2000 data)	Number of Observations Used in Regression	R^2	Significance Level, or P-value
OUA147	Dec - Jun	ln TSS = 1.546 * ln Turb - 2.823	8	0.53	0.0418
OUA149	Dec - Jun	ln TSS = 0.791 * ln Turb - 0.390	7	0.91	9.59 e-4
OUA150	Dec - Jun	ln TSS = 0.753 * ln Turb - 0.0958	8	0.9	3.76 e-4
OUA151	Dec - Jun	ln TSS = 1.091 * ln Turb - 1.3162	8	0.79	2.96 e-3
OUA158	Dec - Jun	ln TSS = 1.405 * ln Turb - 2.944	8	0.68	0.0117

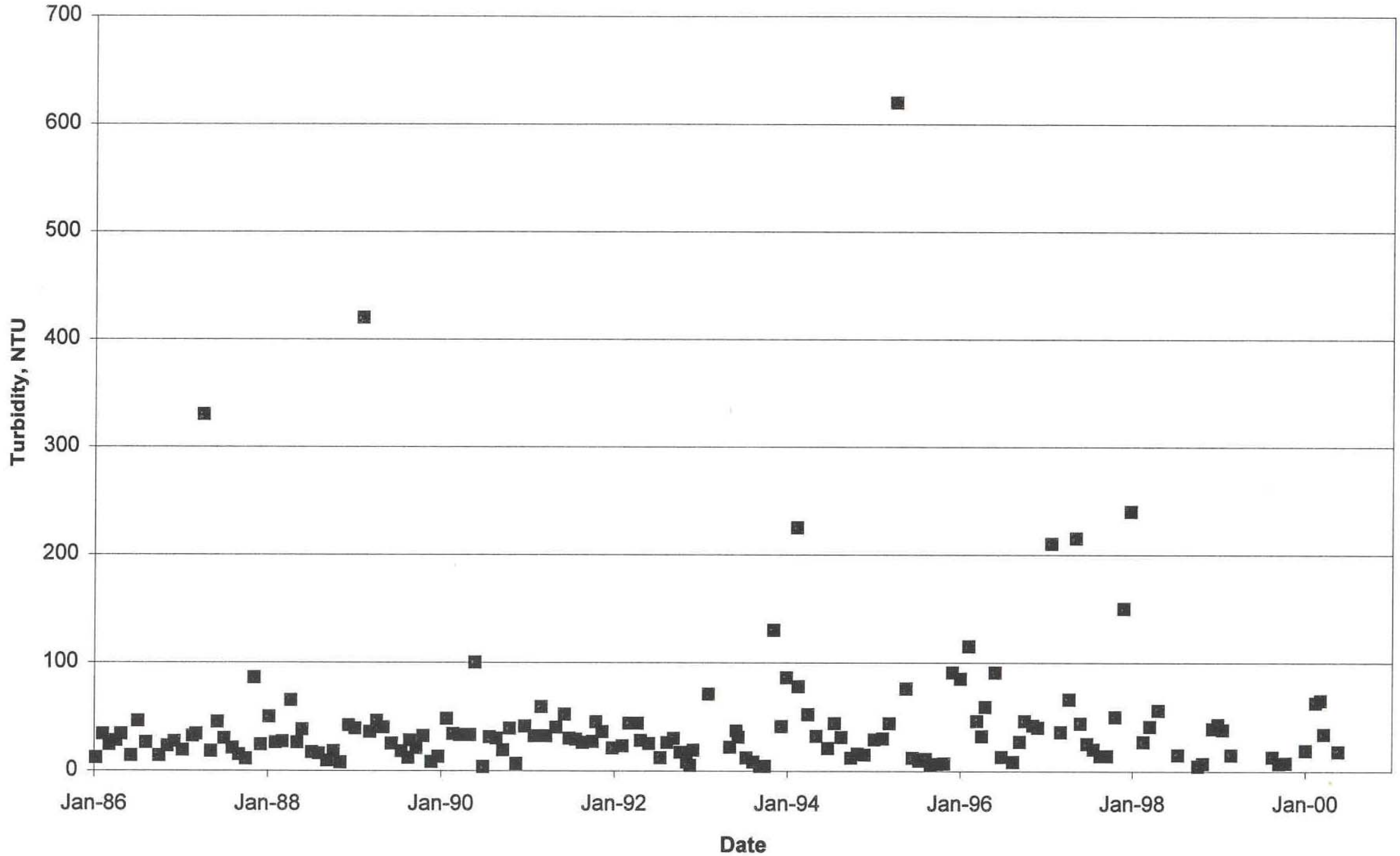

Figure 3.1. Long term turbidity, OUA33; 1986-2000.

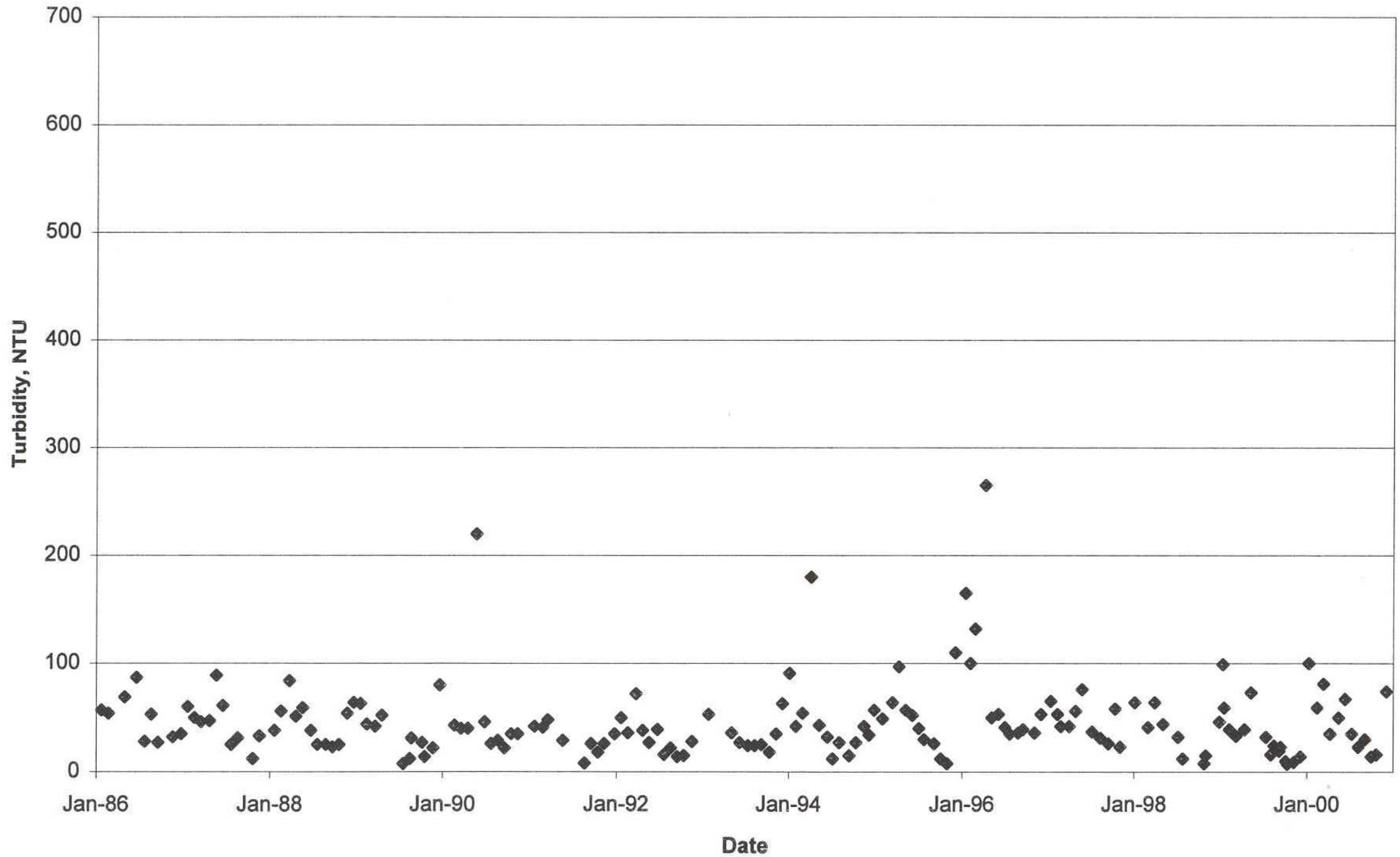

Figure 3.2. Long term turbidity, OUA13; 1986-2000.

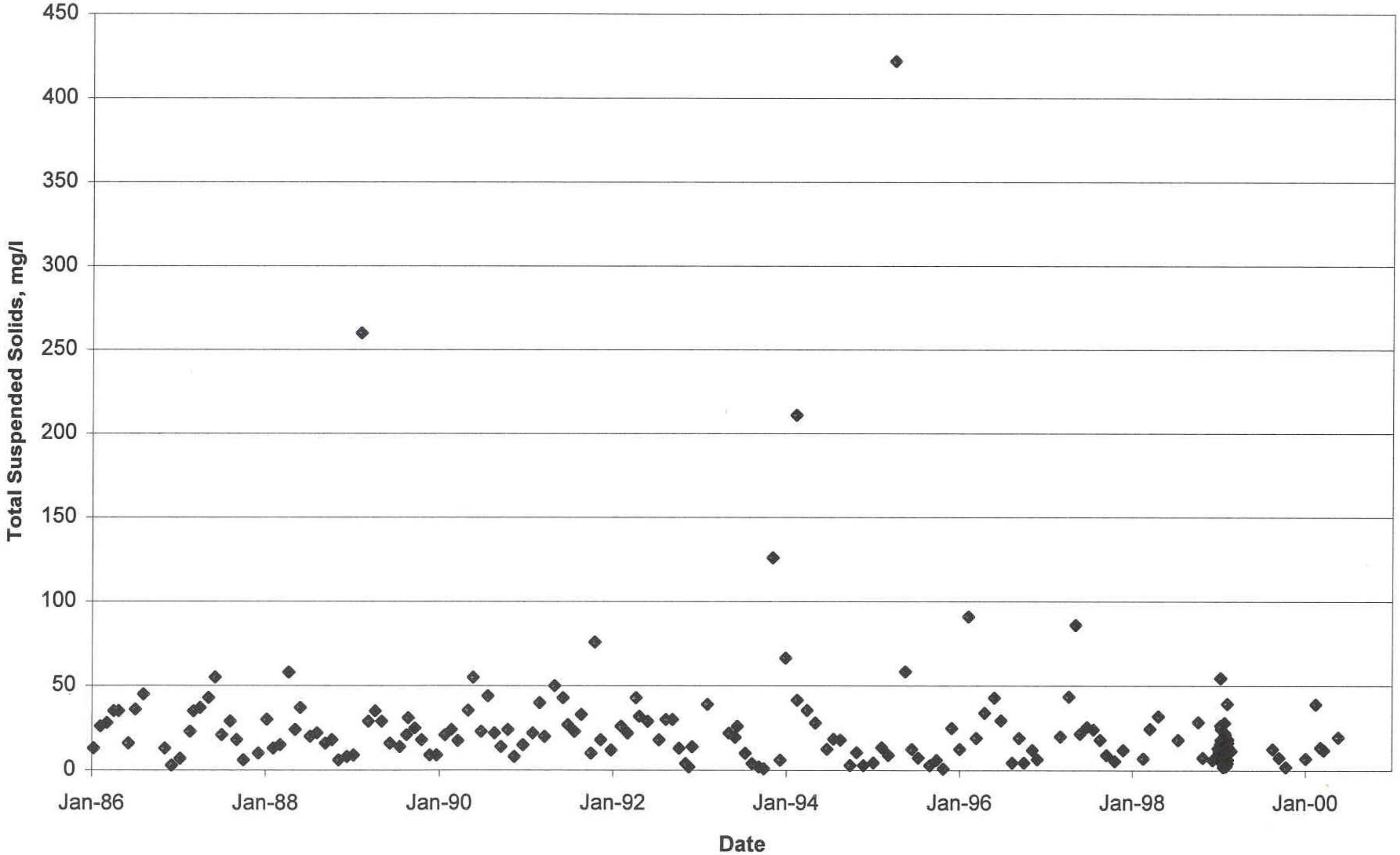

Figure 3.3. Long term TSS, OUA33; 1986-2000.

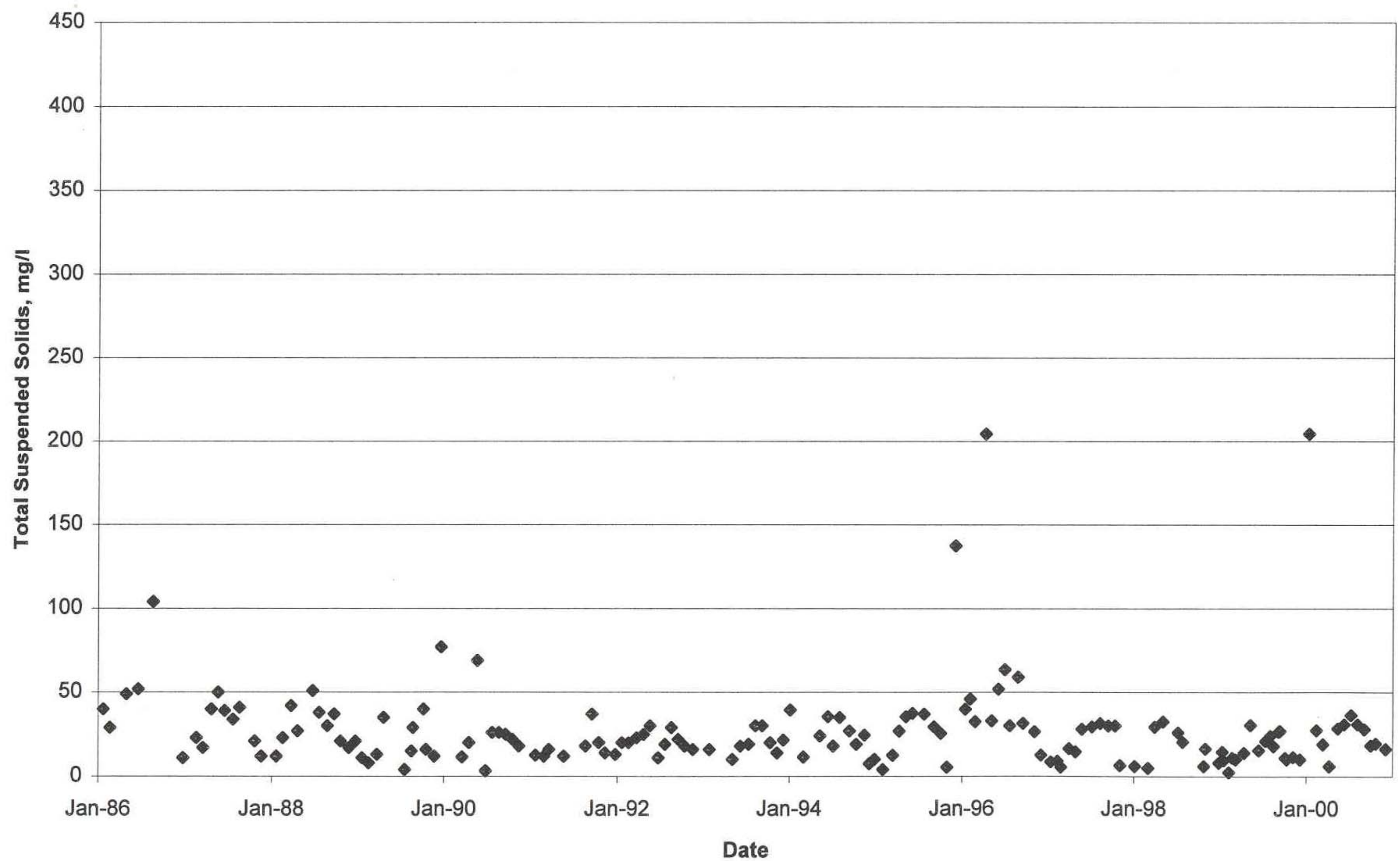

Figure 3.4. Long term TSS, OUA13; 1986-2000.

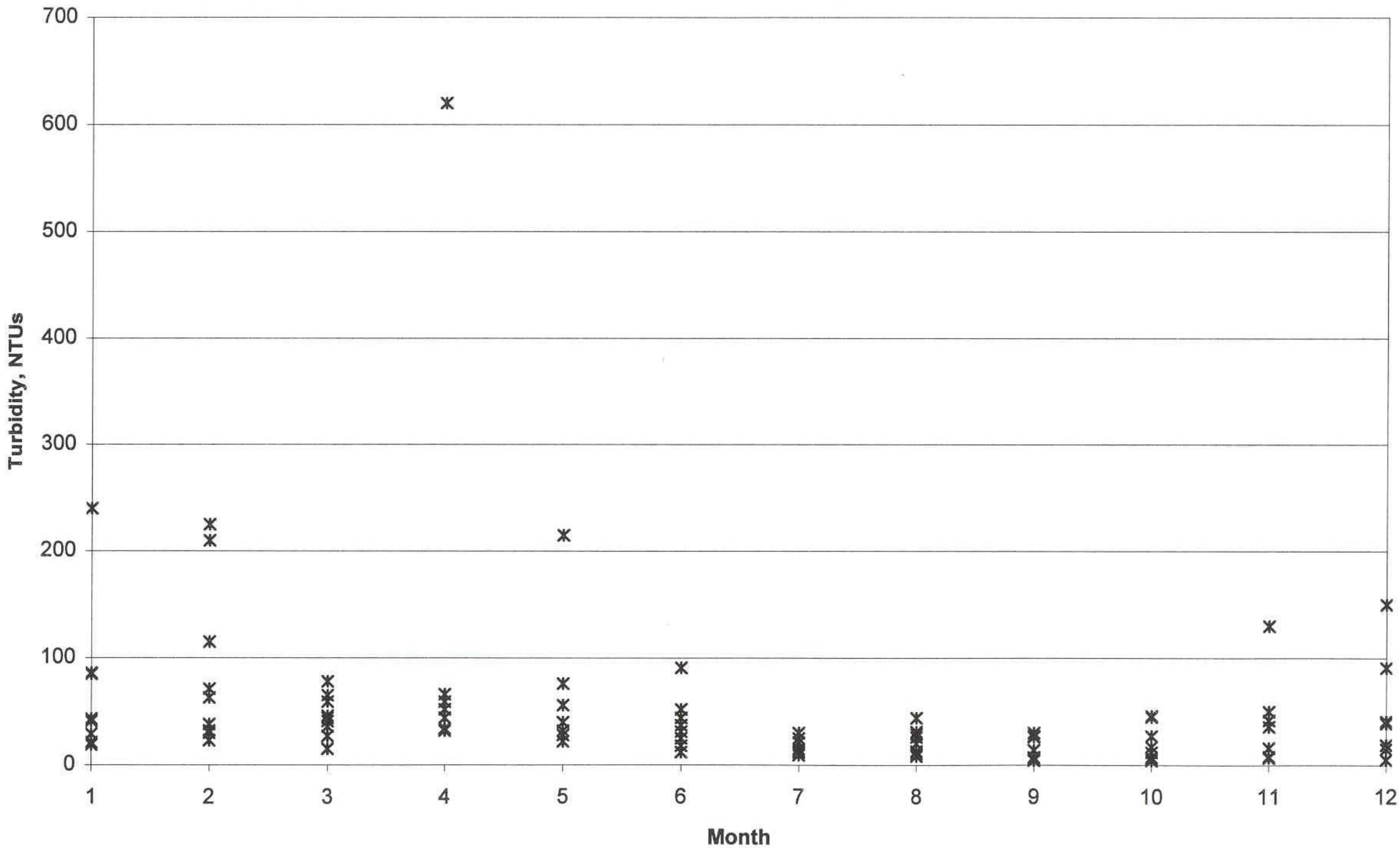

Figure 3.5. Turbidity by month, station OUA33; 1986-2000.

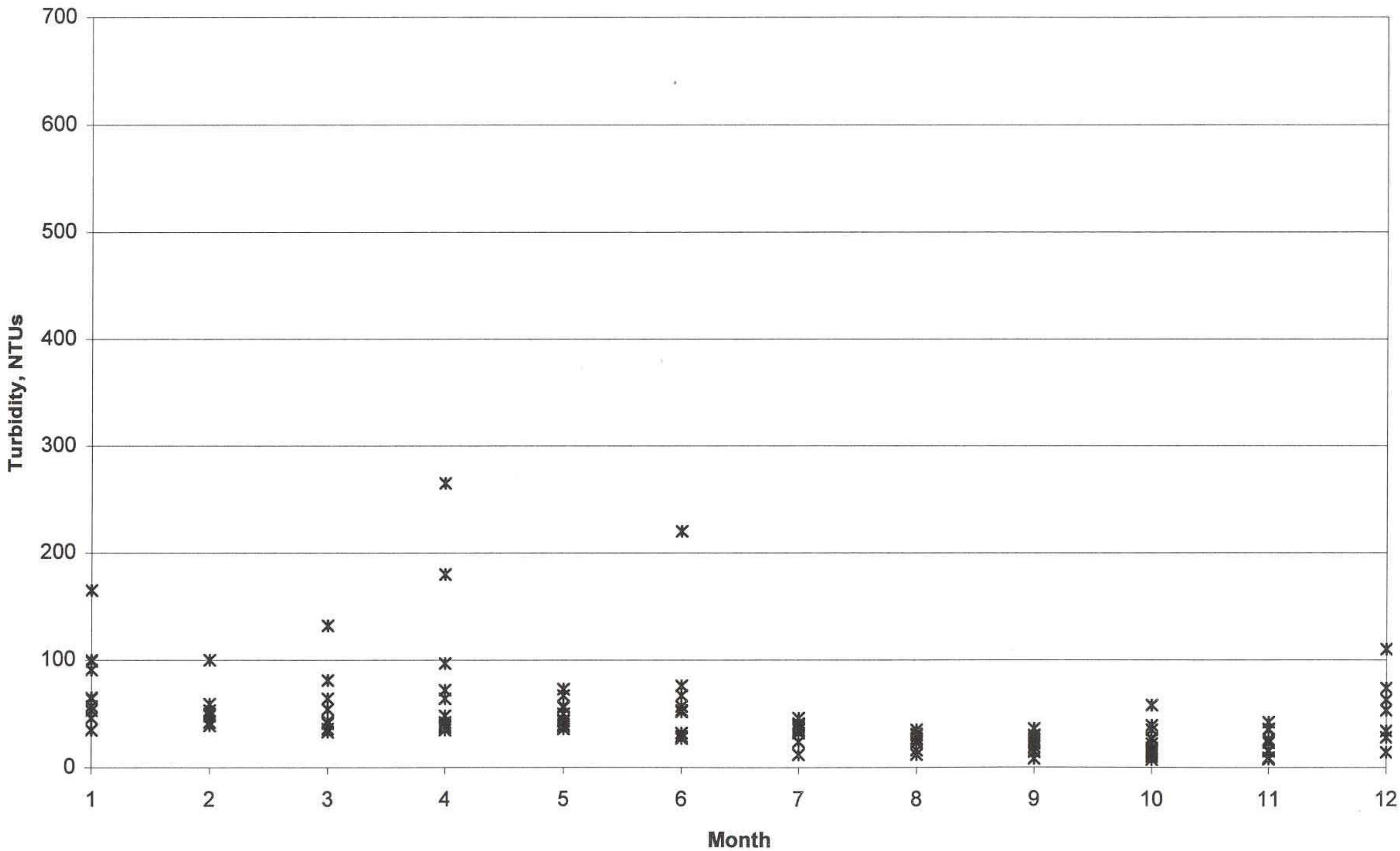

Figure 3.6. Turbidity by month, station OUA13; 1986-2000.

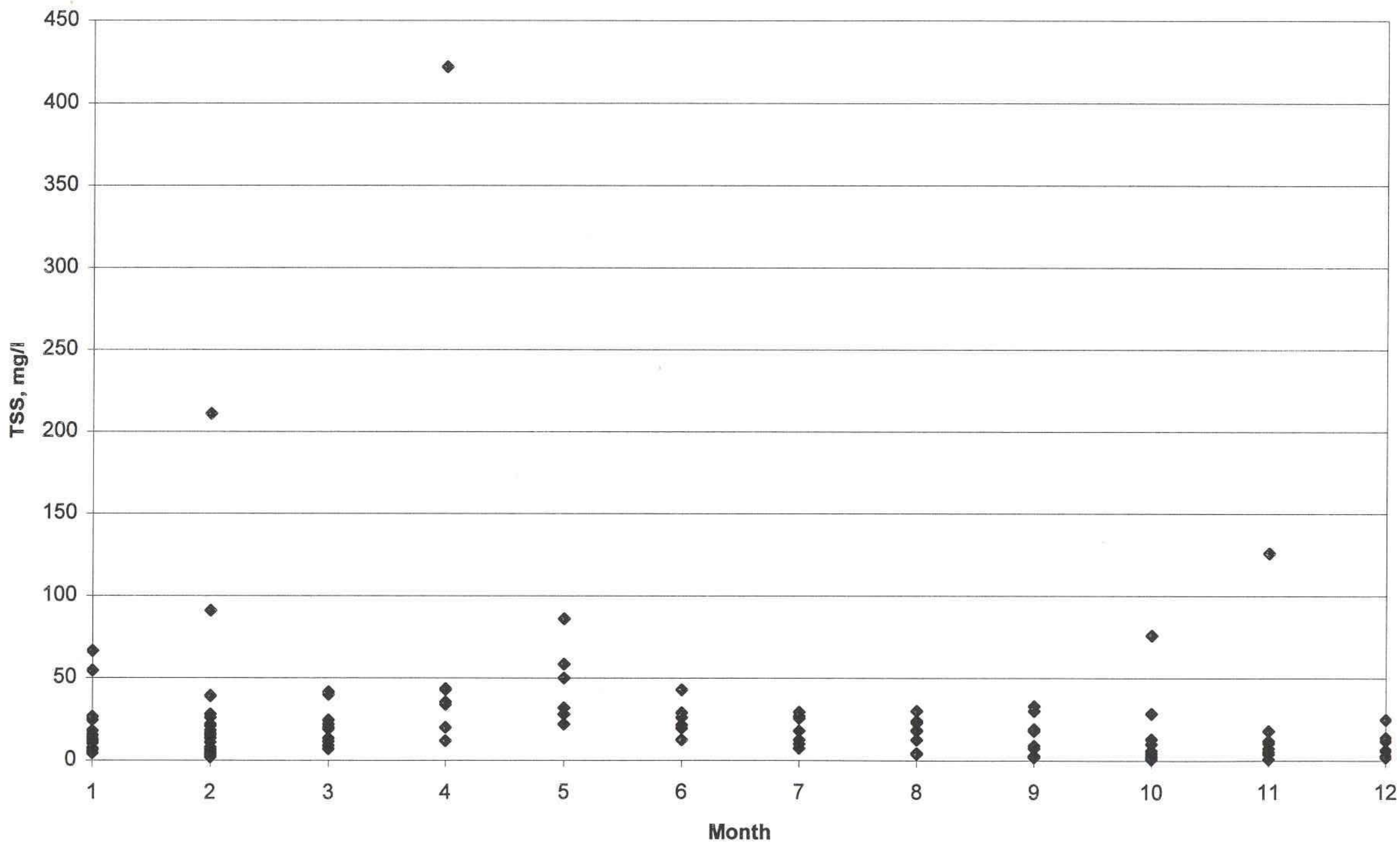

Figure 3.7. TSS by month, station OUA33; 1986-2000.

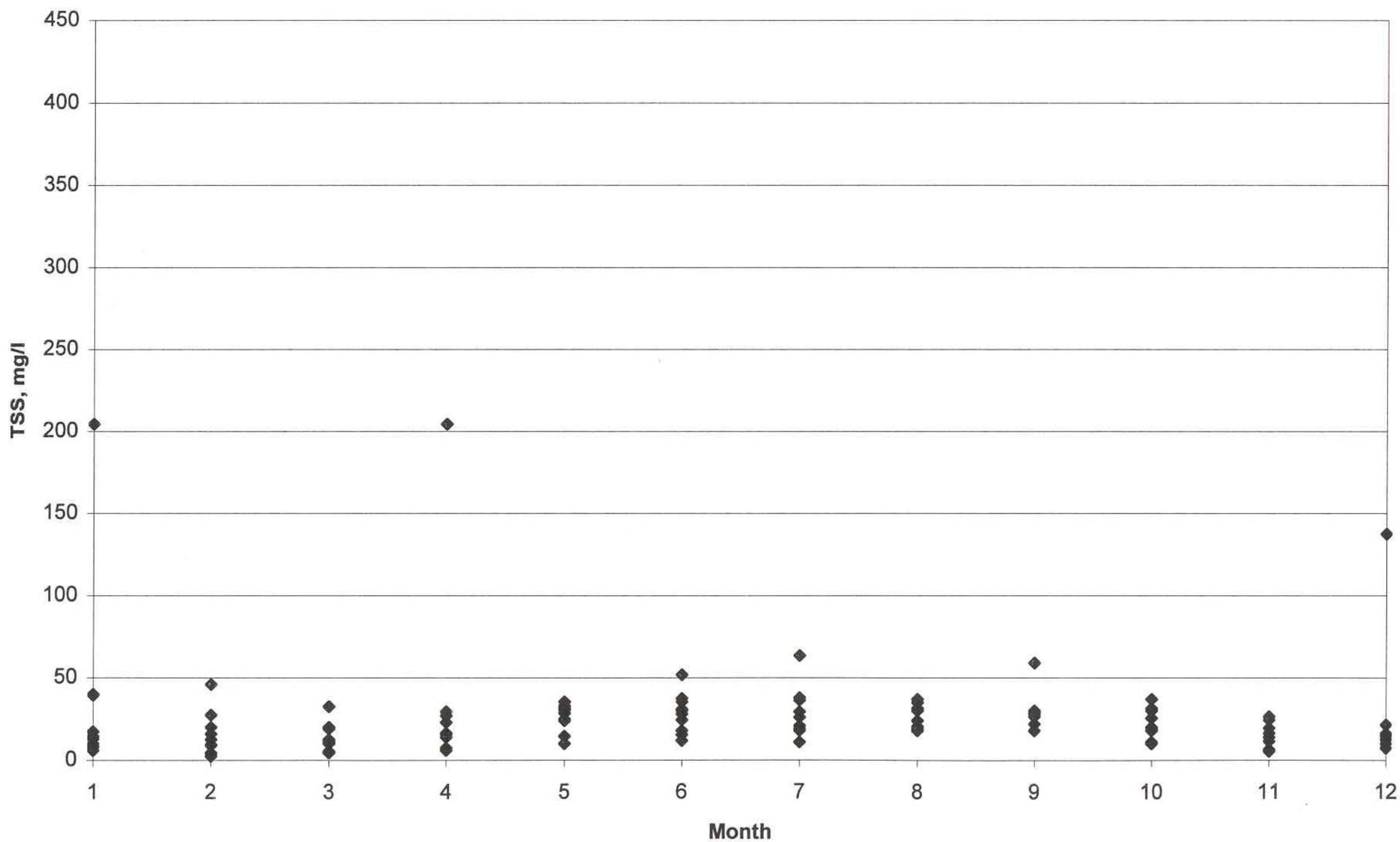

Figure 3.8. TSS by month, station OUA13; 1986-2000.

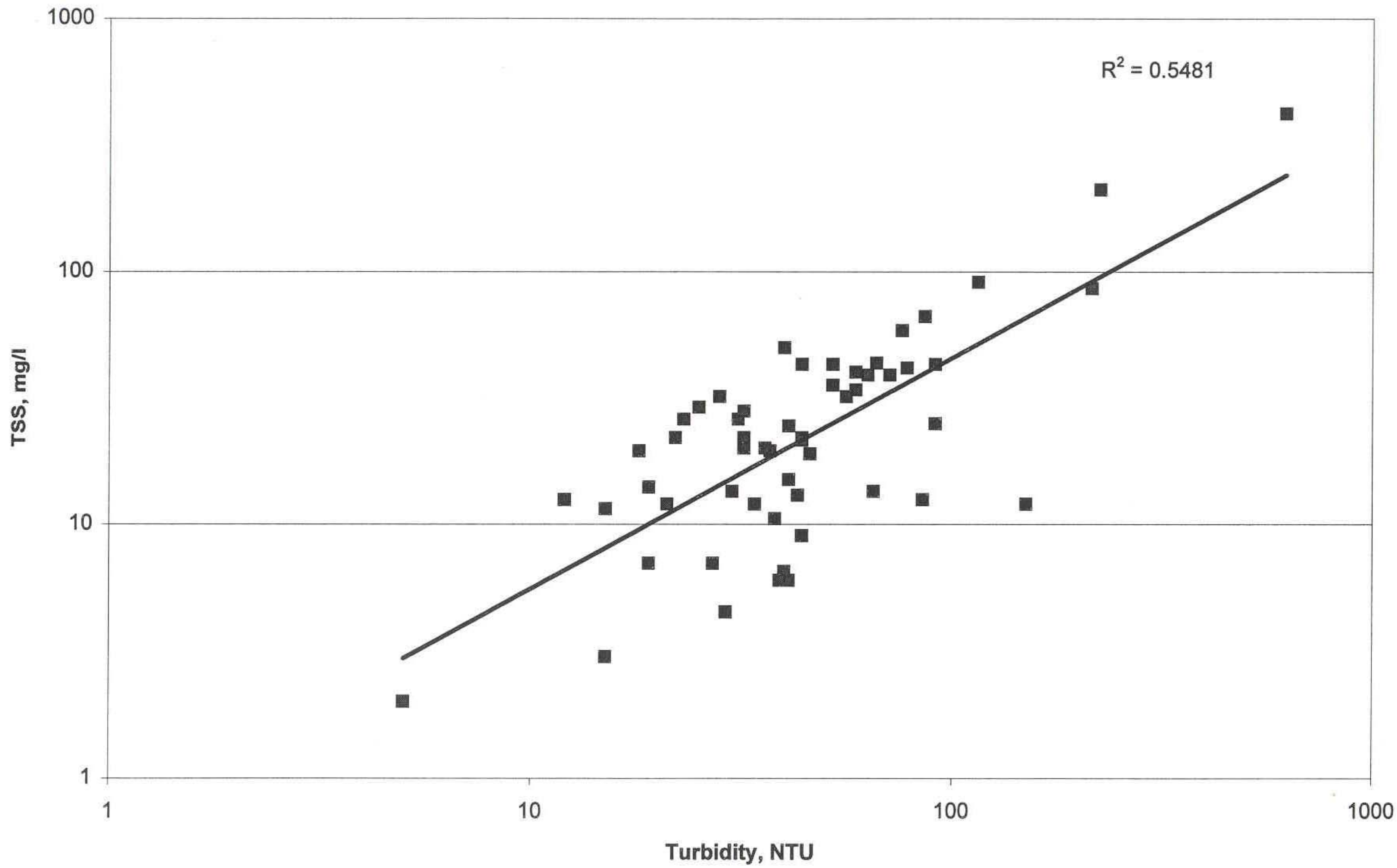

Figure 3.9. Turbidity and TSS relation, station OUA33; Dec-Jun 1991-2000.

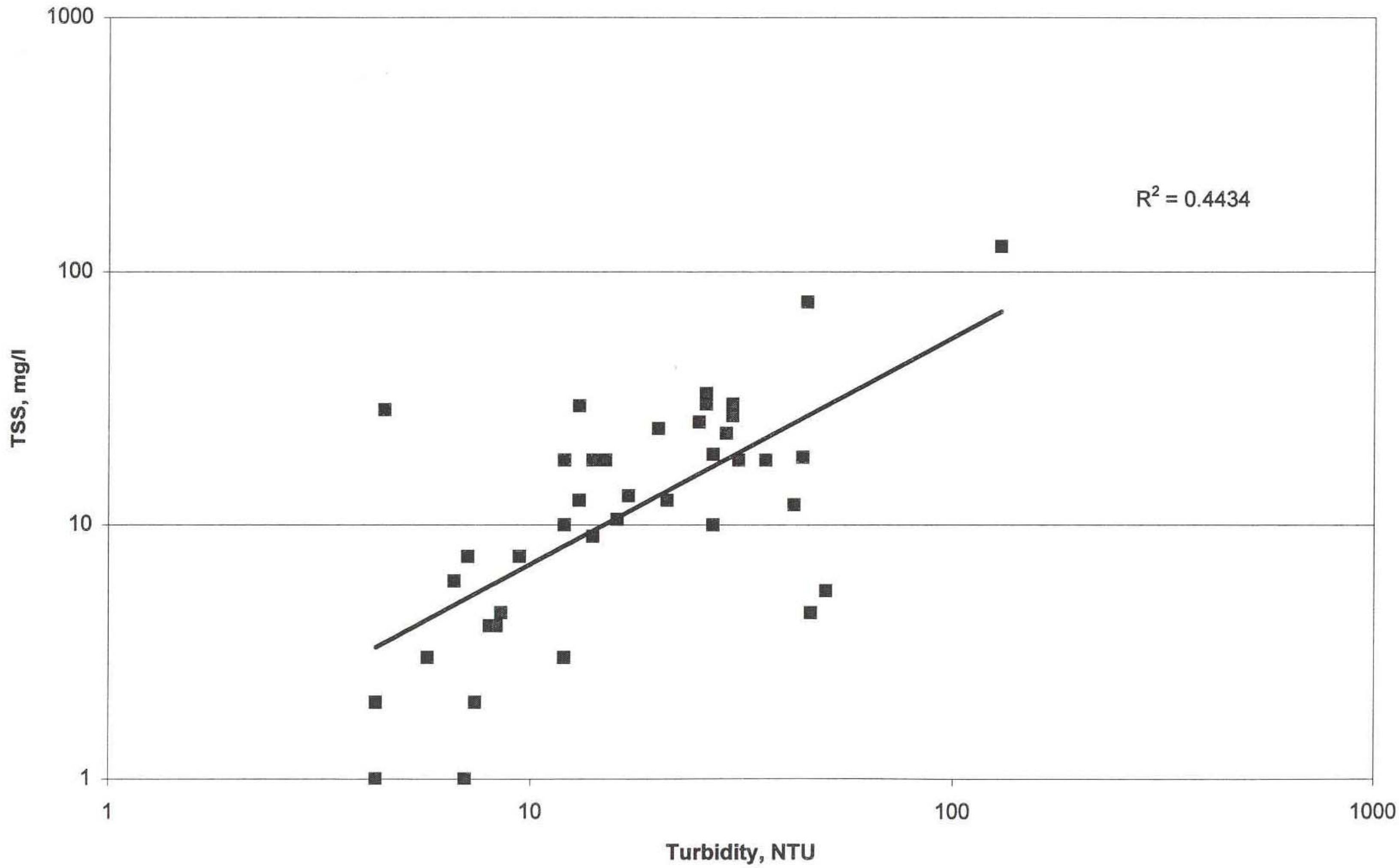

Figure 3.10. Turbidity and TSS relation, station OUA33; Nov-Jul 1991-2000.

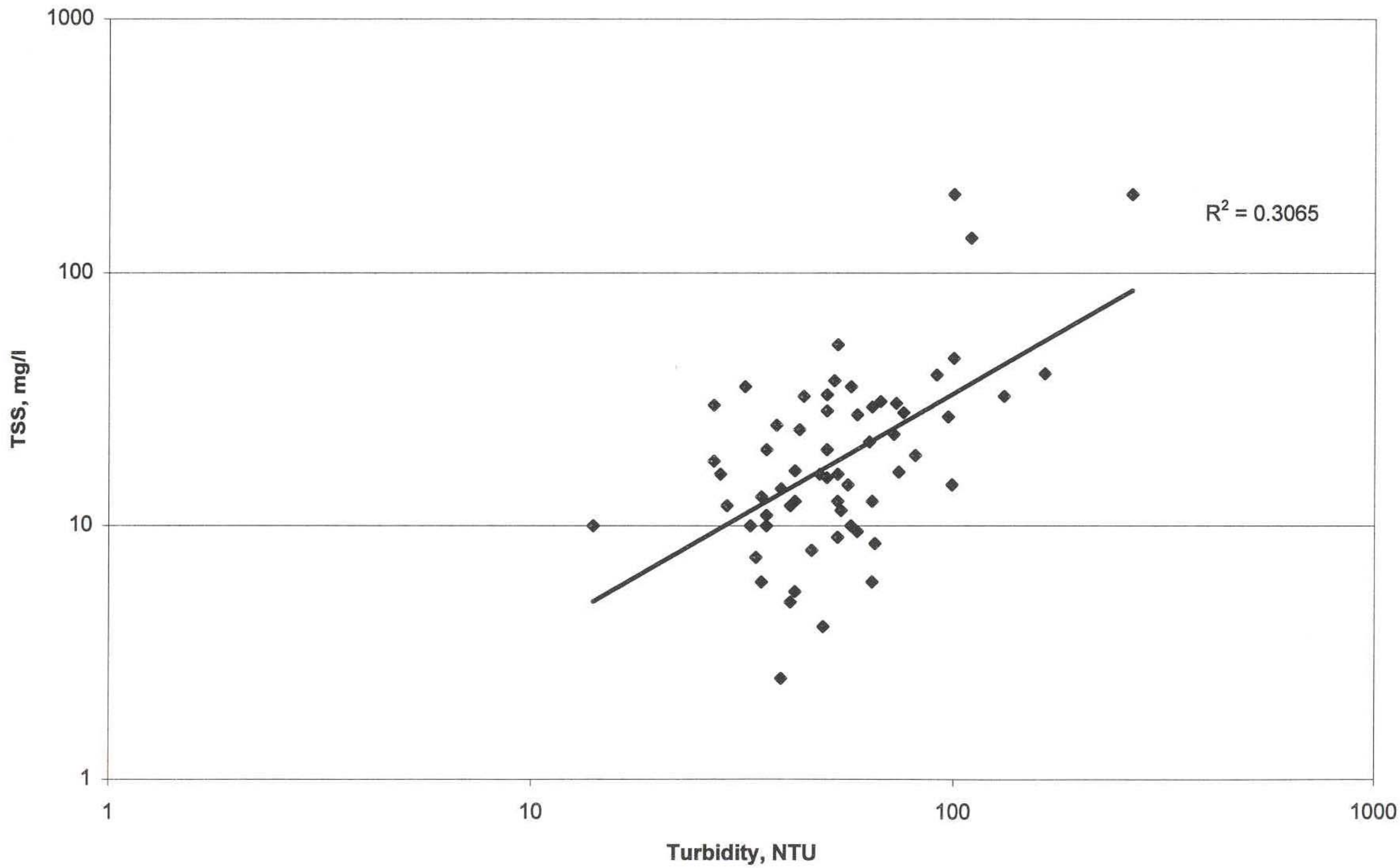

Figure 3.11. Turbidity and TSS relation, station OUA13; Dec-Jun 1991-2000.

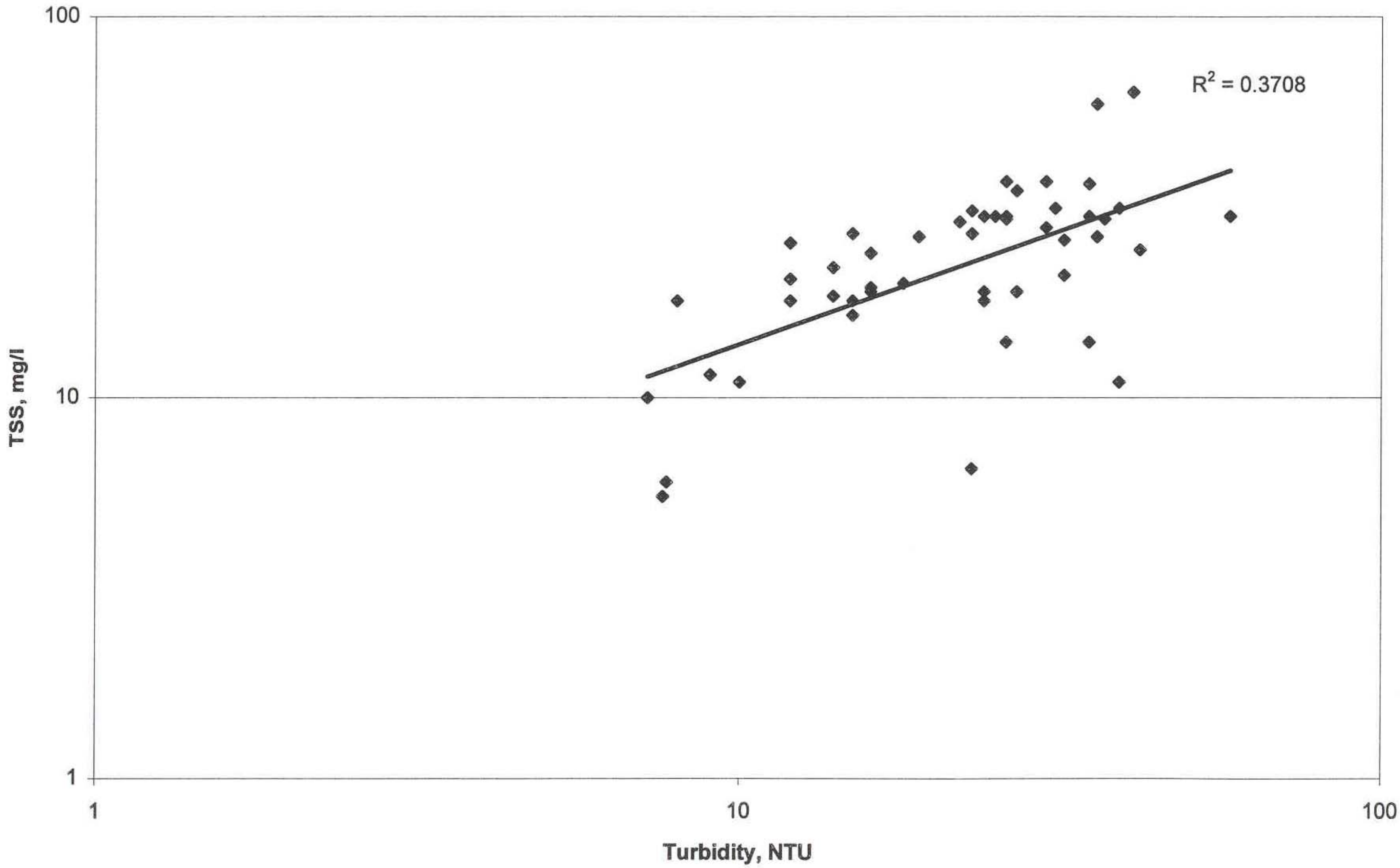

Figure 3.12. Turbidity and TSS relation, station OUA13; Jul-Nov 1991-2000.

4.0 TMDL DEVELOPMENT

4.1 Determination of Critical Conditions

The historical data and analyses discussed in Section 3.0 were used to evaluate whether there were certain flow conditions, spatial locations, or certain periods of the year that could be used to characterize critical conditions. No significant relationships were found for turbidity with flow for the long term data. The exceedances of standards occurred fairly uniformly for stations throughout the watershed for the data examined. Fairly consistent seasonal variations in turbidity were noted for stations throughout the watershed. The plots of turbidity by month for the two long-term stations, OUA33 and OUA13 (Figures 3.5 and 3.6) show higher values during the winter and high flow months (December through June) compared to the summer and low flow months (July through November) and are consistent with the short-term data for stations throughout the watershed. Tables 3.4 through 3.9 indicate the percent of turbidity measurements exceeding the standard for various stations throughout the watershed and for different seasons.

TMDLs were developed using the same seasons as in the data analysis in Section 3 (December through June and July through November). December through June is when the turbidities are the highest throughout the watershed. There are two factors that may contribute to the high values. The winter and spring period is the time when row crop fields are barren and stream flow rates are high, which may create velocities that prevent settling of small suspended particles in runoff from bare cropland. During the summer months, there is less runoff and more vegetation to reduce erosion.

4.2 Establishing the Water Quality Target

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 required by TMDL regulations. To achieve a load based value, turbidity is often correlated with common measures such as flow and sediment that may be expressed as a load.

For this TMDL, the relationships between turbidity and TSS presented in Section 3.4.5 were used. The regression coefficients and significance levels obtained are reported in Table 3.9. The relationships used were:

Station	Season	Regression Equation
OUA33	Dec – Jun	ln TSS = 0.9134 ln Turbidity - 0.386
OUA33	Jul – Nov	ln TSS = 0.8951 ln Turbidity - 0.1137
OUA13	Dec – Jun	ln TSS = 0.963 ln Turbidity - 0.9283
OUA13	Jul – Nov	ln TSS = 0.5973 ln Turbidity + 1.251

Using the turbidity standard of 45 NTU (for the main stem of Bayou Bartholomew and Deep Bayou) and the relationships for station OUA13, target TSS concentrations were calculated to be 15 mg/L for the December through June period and 34 mg/L for the July through November period. The turbidity standard of 45 NTU and the relationships for station OUA33 yielded target concentrations of 22 mg/L and 27 mg/L for the same two periods, respectively.

Next, the target concentrations of TSS were converted to target loads of TSS. Seasonal stream flow values were calculated for the two periods using historical stream flow data for Bayou Bartholomew at McGehee, AR and at Jones, LA. These calculations (Table B.1 in Appendix B) yielded average flows for Bayou Bartholomew of 2,085 cfs for the December through June period and 421 cfs for the July through November period. The seasonal flows for the entire basin were divided among Deep Bayou and the 6 reaches of the Bayou Bartholomew main stem based on drainage area. The division of the main stem of Bayou Bartholomew into 6 reaches was based on the Arkansas 305(b) report (ADEQ 2000). The drainage area at the downstream end of each reach was estimated from computed drainage areas from the SWAT model output, considering the subbasins that contribute flow to each reach. The target loads of TSS were then obtained by multiplying the seasonal target TSS concentrations by the seasonal flows for each reach. Target concentrations for each reach were based on regressions from the OUA33 or OUA13 water quality station, whichever was closer. The three upper most reaches (005, 006, and 013) were closest to OUA33 and the other four reaches were closest to OUA13. As shown in Table B.2 in Appendix B, the total target TSS loads for the entire basin were calculated to be 195,555 lbs/day for December through June and 71,815 lbs/day for July through November.

Each target load was calculated for a single stream flow rate for the purpose of developing a TMDL for critical conditions. However, the target loads should be considered as single points along a line representing maximum allowable TSS loads to maintain the turbidity standard at different stream flow rates. Therefore, implementation of the turbidity TMDL should be based on concentration or percent reduction of TSS rather than a single loading value of TSS.

4.3 Linking Water Quality and Pollutant Sources

The exact causes of the elevated turbidity levels in Bayou Bartholomew are not completely known. However, some conclusions can be drawn from the information that is available for the basin.

Cropland appears to have a significant impact on turbidity in Bayou Bartholomew. Cropland represents a large portion of the watershed (about 38 %) and there is little or no cover on the soil at times. The 1998 303(d) list for Arkansas (ADEQ 1998b) indicated that agriculture was suspected to be the major source for four reaches and the minor source for two reaches of Bayou Bartholomew that do not support the aquatic life designated use due to siltation/turbidity. The analysis of historical water quality data (Section 3.0) showed TSS is correlated to turbidity, indicating that erosion/sediment contributes to turbidity.

Point source discharges appear to have relatively little impact on turbidity in Bayou Bartholomew. The primary cause of high turbidity levels appears to be inorganic suspended solids (i.e., soil and sediment particles from erosion or sediment resuspension) rather than organic suspended solids or nutrients from discharges of treated wastewater. This conclusion is based on our analysis of the data, including TSS, the components of TDS, and TOC data. Also, the sum of the flows from all of the permitted NPDES discharges is small compared to the seasonal average flow rates of Bayou Bartholomew. Many of the municipal wastewater treatment plants do not discharge to the bayou at all during the summer months.

4.4 Wasteload Allocations

Wasteload allocations (WLA) for the point sources were set to zero 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 point sources in the Bayou Bartholomew basin 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 through their permitting of point sources to maintain water quality standards for DO.

4.5 Load Allocations

Load allocations (LA) for nonpoint source contributions were calculated as the target loads of TSS minus the WLA for point source contributions. Therefore, these LAs include both natural nonpoint source contributions as well as man-induced nonpoint source contributions. Because the WLAs were set to zero as described above, the LAs were the same as the target loads of TSS (195,555 lbs/day for December through June and 71,815 lbs/day for July through November for the entire basin).

To estimate the reductions in existing TSS loads that are required to maintain the turbidity standard, existing nonpoint source loads were compared to the LAs. In order to estimate existing nonpoint source loads for the whole basin, an arithmetic average TSS concentration was calculated for Bayou Bartholomew at the McGehee station (OUA33) and a flow weighted average concentration was calculated at the Jones, LA station (OUA13) for each season. (Limited flow data at station OUA33 precluded the calculation of a reliable flow weighted average concentration.) The average concentrations for OUA33 (31 mg/L for the December to June critical period and 28 mg/L for the July to November period) were multiplied by the seasonal average stream flow rates for reaches 005, 006, and 013. The average concentrations for OUA13 (24 mg/L for December to June and 26 mg/L for July to November) were multiplied by the seasonal average stream flow rates for reaches 012U, 012, 002, and 001. These calculations yielded existing nonpoint source TSS loads for the entire basin of 296,960 lbs/day for the December through June critical period and 59,897 lbs/day for the July through November period (see Table B.3 in Appendix B). For each reach, the percent reduction in existing nonpoint source TSS loads needed to meet the LA was by subtracting the LA from the existing load and then dividing by the existing load. This resulted in percent reductions of 29% to 37% for December through June and 0% to 3% for July through November. The results of the TMDL calculations are summarized in Tables 4.1 and 4.2.

Table 4.1. Summary of turbidity TMDLs for December through June.

Reach ID	Loads (lbs/day of TSS)				Percent Reduction Needed
	WLA	LA	MOS	TMDL	
08040205-005 (Deep Bayou)	0	30451	implicit	21480	29%
08040205-006 (Bayou Bartholomew)	0	68641	implicit	48419	29%
08040205-013 (Bayou Bartholomew)	0	20525	implicit	14478	29%
08040205-012U (Bayou Bartholomew)	0	3098	implicit	1942	37%
08040205-012 (Bayou Bartholomew)	0	50596	implicit	31719	37%
08040205-002 (Bayou Bartholomew)	0	106613	implicit	66836	37%
08040205-001 (Bayou Bartholomew)	0	17037	implicit	10681	37%

Table 4.2. Summary of turbidity TMDLs for July through November.

Reach ID	Loads (lbs/day of TSS)				Percent Reduction Needed
	WLA	LA	MOS	TMDL	
08040205-005 (Deep Bayou)	0	5388	implicit	5243	3%
08040205-006 (Bayou Bartholomew)	0	12422	implicit	12089	3%
08040205-013 (Bayou Bartholomew)	0	3592	implicit	3496	3%
08040205-012U (Bayou Bartholomew)	0	692	implicit	917	0%
08040205-012 (Bayou Bartholomew)	0	10939	implicit	14489	0%
08040205-002 (Bayou Bartholomew)	0	23125	implicit	30629	0%
08040205-001 (Bayou Bartholomew)	0	3739	implicit	4952	0%

4.6 Seasonality and Margin of Safety

The Clean Water Act requires the consideration of seasonal variation of conditions affecting the constituent of concern, and the inclusion of a margin of safety (MOS) in the development of a TMDL. The MOS is intended to account for uncertainty in available data or in the actual effect 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 analytical assumptions used in establishing the TMDL. For the turbidity TMDL for the Bayou Bartholomew basin, critical conditions were determined through an analysis of historical water quality data as discussed in Section 4.1. An implicit MOS was incorporated through the use of conservative assumptions. The TMDL was calculated assuming that TSS is a conservative parameter and does not settle out of the water column.

5.0 WATERSHED ANALYSIS

5.1 Introduction

The watershed analysis was performed using the Soil and Water Assessment Tool (SWAT) watershed model. The SWAT model was evaluated by ADEQ in the Bayou Bartholomew Watershed Modeling Feasibility Study (ADEQ 2001b), which concluded this model is suitable for this watershed. The SWAT model was used in this work assignment only to compare relative sediment contributions from different subwatersheds. Resources were not available to develop a detailed calibration for the model. In the future, this model will serve as the vehicle for evaluation of management practices as part of the implementation plan for the watershed. ASWCC has been using SWAT to evaluate management practices on other agricultural watersheds in Arkansas.

5.2 Model Development and Input Data

The downstream limit for the model is the sampling and gaging station located near Jones, Louisiana (USGS gage no. 07364200 and ADEQ sampling station OUA13). The downstream limit excludes two large tributaries to Bayou Bartholomew that are in Arkansas. These two tributaries are Chemin-A-Haut Creek and Overflow Creek, neither of which is included on the 303(d) list. All six reaches of the main stem of Bayou Bartholomew were included on the 1998 303(d) list, and one tributary reach (Deep Bayou) was added to the 2002 proposed 303(d) list. These seven reaches are included within the selected watershed boundary. The watershed boundary delineation is included as Figure 5.1.

The division of the Bayou Bartholomew basin into subbasins is based on the location of the listed reaches, the location of USGS gaging stations, and the locations of the water quality sampling stations. Additional partitioning of the watershed is dependent on, but not limited to, issues such as tributary locations, landuse definition and practice, and geologic features.

The Bayou Bartholomew watershed delineation process using the SWAT model was developed using a 90-meter digital elevation model (DEM) of the watershed. In addition to the DEM, the HUC watershed boundary and the RF3 stream network, developed by EPA, were utilized in the computation of the model basin. The computed watershed basin encompasses a drainage area of approximately 1,177 square miles at the Jones, Louisiana USGS gaging station. According to the USGS (2001b), the published drainage area at the gage is 1,187 square miles. There are land areas included in the HUC watershed boundary that are excluded from the modeled basin boundary due to interpretations of the flow direction.

The model watershed is divided up into 30 subbasins. Each of the subbasins is then broken up into a series of hydrologic response unit (HRU) designations. Each HRU is specific to a landuse and an associated soil type. The landuse categories were selected such that any landuse occurrence equal to or greater than 4% of the subbasin would be identified. In addition, any soil type present on 15% or more of the subbasin would also be included. Any landuse or soil type less than 4% or 15% respectively, of the subbasin was combined with the predominant categories. The determination of the soil threshold (15%) was accomplished by reviewing the occurrence of hydrologic soil groupings in conjunction with the soil erodibility factor. These maps are included as Figures 2.3 and 2.4. This combination of landuse and soil type specifications resulted in 253 HRUs spread throughout the 30 subbasins. A summary of the distribution of the HRUs is included in Appendix C.

The landuse designations represented on the modeled Bayou Bartholomew watershed are included on Figure 2.5 and described in Section 2.3. The soil types are also represented on Figure 2.2.

In an attempt to represent the existing cropping practices occurring on the basin, management plans were incorporated into the model. These management plans include crop rotation, tillage practices, and planting and harvesting dates. The management data was compiled from various sources including but not limited to county extension offices and the NRCS. These management practices were applied to the subbasin based on the soil type.

Weather data is a primary input for the SWAT watershed model. In and around the Bayou Bartholomew modeled watershed are five weather stations that provide daily temperature and/or precipitation data for the simulation period. The locations of the five stations are included on Figure 5.1, identified as Met Data Stations.

5.3 Model Results

The annual sediment yield computed from the model was extracted on a subbasin level and is depicted on Figure 5.2. The sediment yield computations provide a glimpse of the specific subbasins where management practices may prove to be the most advantageous and effective.

Additional output summaries are included in Appendix C providing data by subbasin, by reach, and at the outlet.

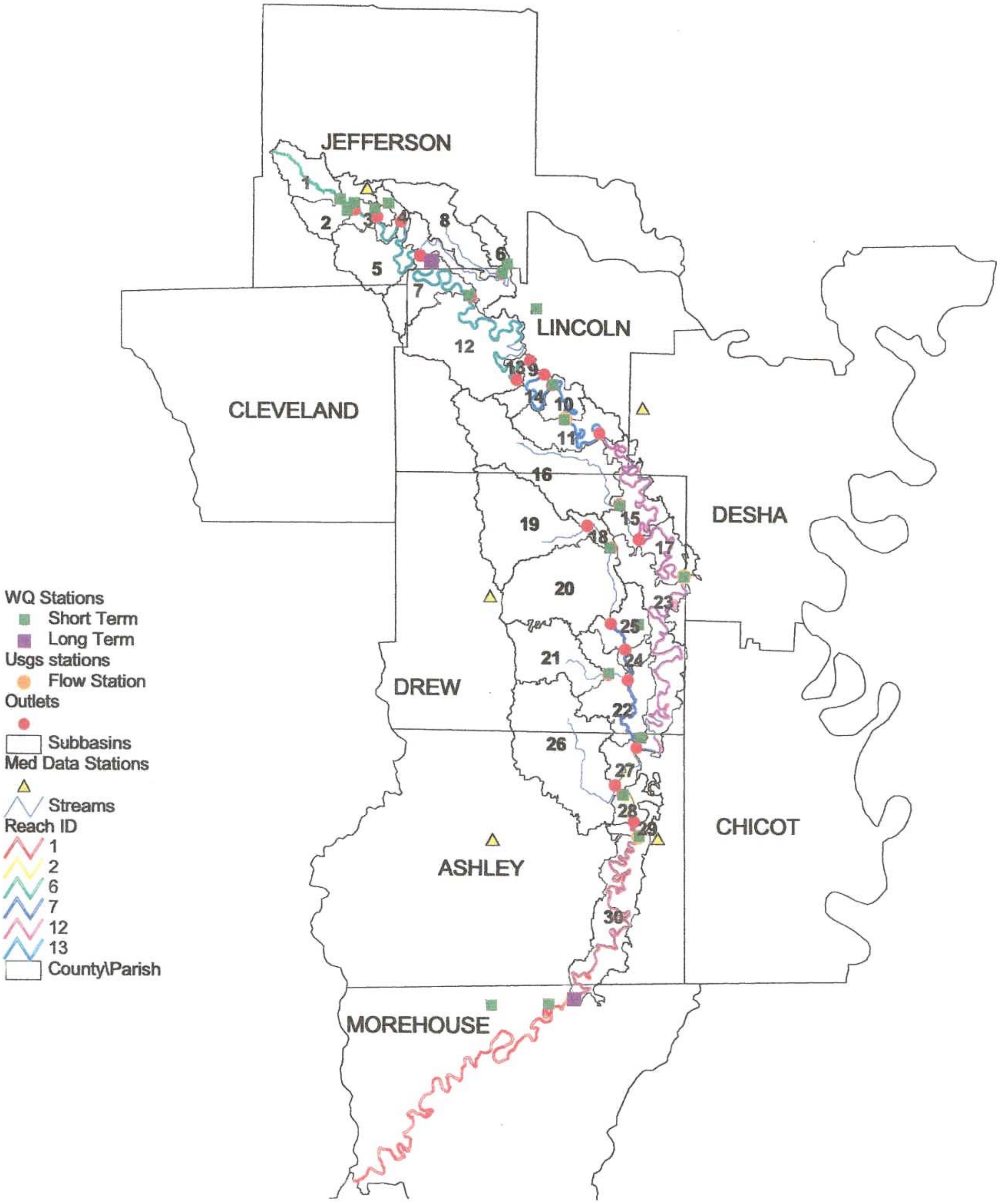

Figure 5.1. Watershed boundaries and locations for observed data for SWAT model.

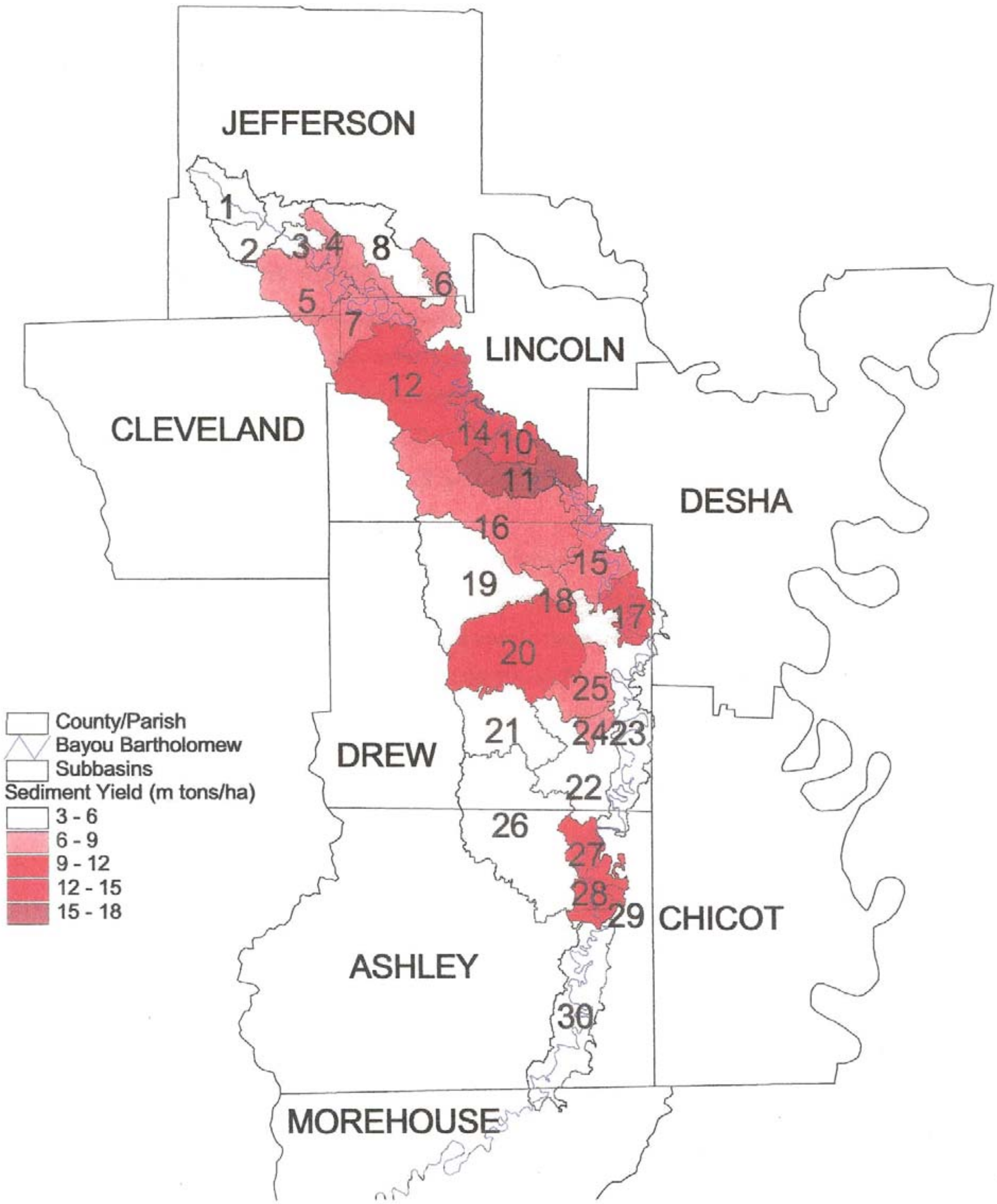

Figure 5.2. Sediment yield per unit area predicted by SWAT model.

6.0 MONITORING AND IMPLEMENTATION

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.

This information is also utilized to establish priorities for the Arkansas Soil and Water Conservation Commission (ASWCC) nonpoint source program so that voluntary nonpoint source program activities may be directed toward these priority sources. ASWCC receives federal funding under the Clean Water Act Section 319(h) nonpoint source program. The latest annual report of the Arkansas Nonpoint Source Pollution Management Program (ASWCC 2001) states that the ASWCC will continue to work cooperatively with federal, state, and local partners that assist in implementation of educational programs and watershed protection and restoration projects to restore the designated uses of waterbodies, including Bayou Bartholomew. Funding for implementation projects in the ten priority watersheds in Arkansas (of which Bayou Bartholomew is one) receives priority over funding for projects in other watersheds. The BBA's short and long term strategies document (BBA 1996) identifies 9 short-term actions and 10 long-term actions for addressing nonpoint sources of pollution in the Bayou Bartholomew basin with funding from private donations, Section 319 program, ADEQ, USDA Environmental Quality Incentives Program (EQIP), USDA Wetland Reserve Program (WRP), USDA Conservation Reserve Program (CRP), EPA 104(b)3 funds, Partners for Wildlife, Arkansas Stream Team, local Audubon Club, CD Water Use Reporting Funds, and ASWCC Wetland & Riparian Zone tax credits. Additionally, the Watershed Restoration Action Strategy (WRAS) document for Bayou Bartholomew (ASWCC 1999) lists one long-term goal and 9 short-term goals, which are to be reached through implementation of 13 action items (with the same sources of funding). Water quality improvement projects that are planned or already ongoing for Bayou Bartholomew have been summarized in the BBA's short and long term strategies document (BBA 1996), the Watershed Restoration Action Strategy document for Bayou Bartholomew (ASWCC 1999), the Arkansas Nonpoint Source Pollution Management Program (ASWCC 2001), and the BBA newsletters (BBA 2002). For example, during 2000, local conservation districts helped prepare 49 farm conservation plans in Jefferson County and 45 in Lincoln County (ASWCC 2001). Also, the Lincoln County Conservation District recently used EPA 319 grant money to purchase a no-till drill and other conservation equipment for farmers to rent (BBA 2002). Examples of other ongoing conservation activities are listed in Section 2.10.

7.0 PUBLIC PARTICIPATION

When EPA establishes a TMDL, federal regulations require EPA to publicly notice and seek comment concerning the TMDL. This TMDL has been prepared under contract to EPA. After development of this TMDL, EPA and/or a designated state agency will commence preparation of a notice seeking comments, information, and data from the general public and affected public. If comments, data, or information are submitted during the public comment period, then EPA may revise the TMDL accordingly. After considering public comment, information, and data, and making any appropriate revisions, EPA will transmit the revised TMDL to the ADEQ for incorporation into ADEQ's current water quality management plan.

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APPENDIX A

Maps Showing Historical Water Quality Data

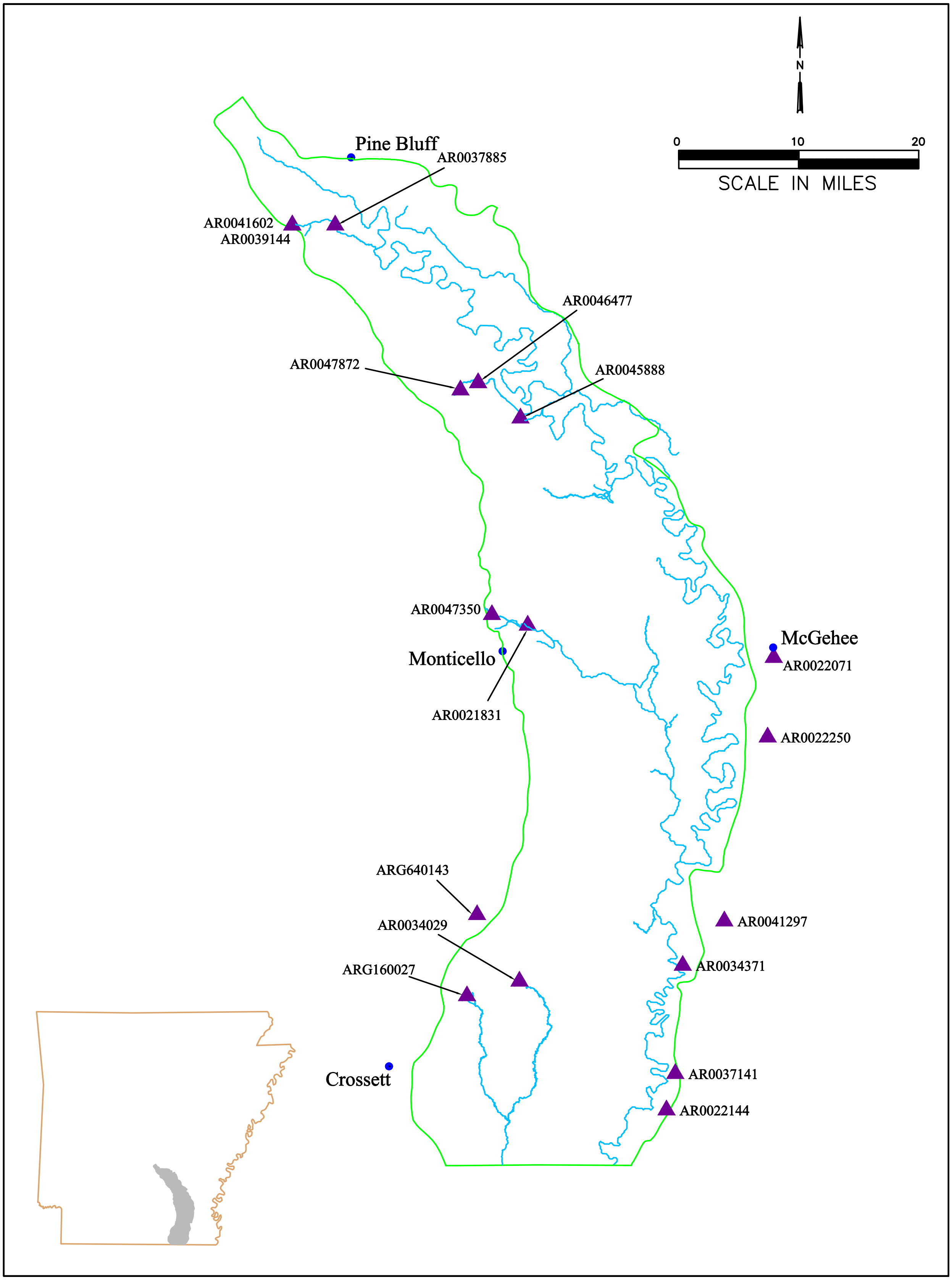

Figure A.1 Point Source Discharge Locations in the Bayou Bartholomew-Arkansas Watershed

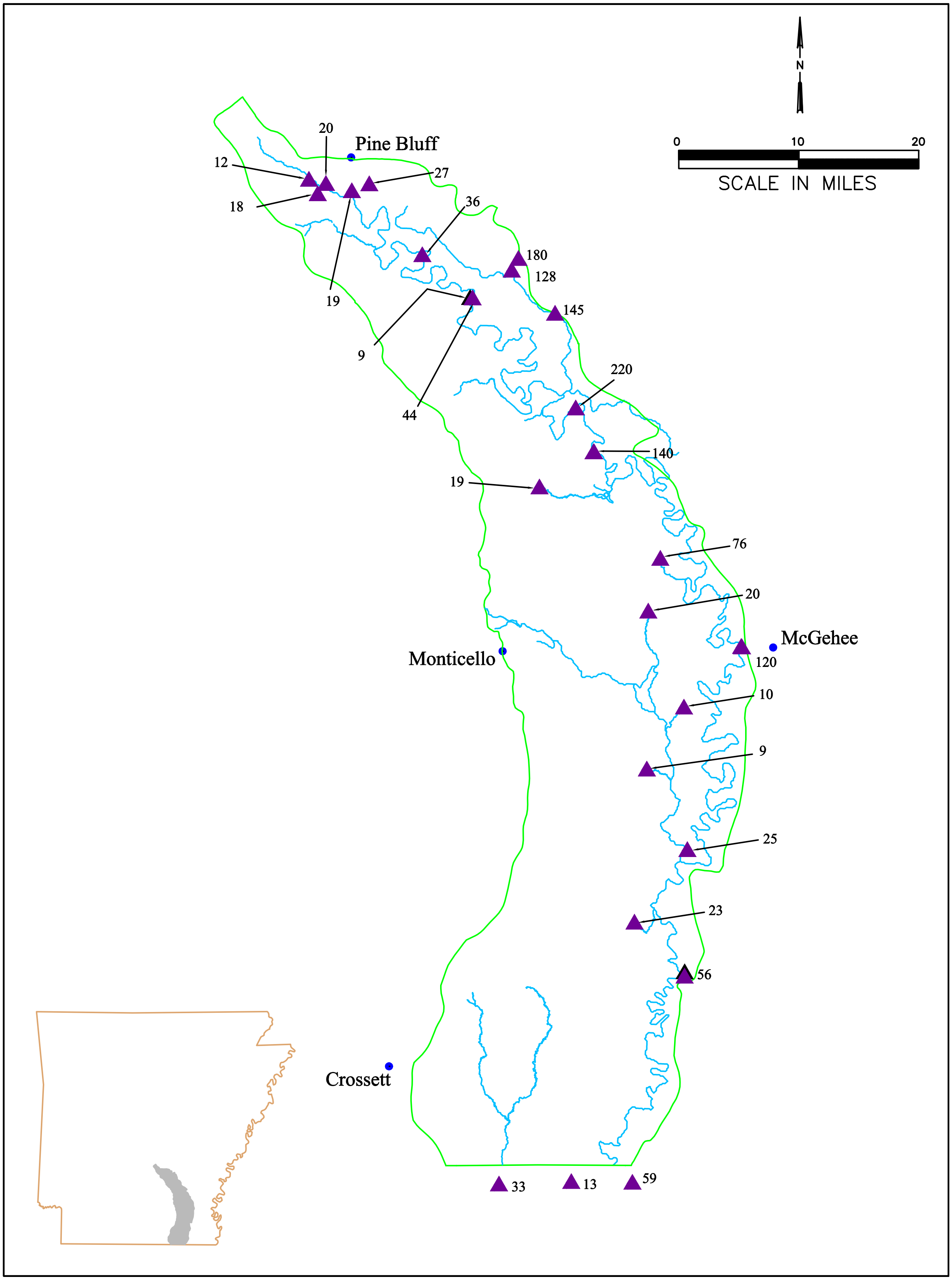

Figure A.2 Median Turbidity at Selected Stations; December-June

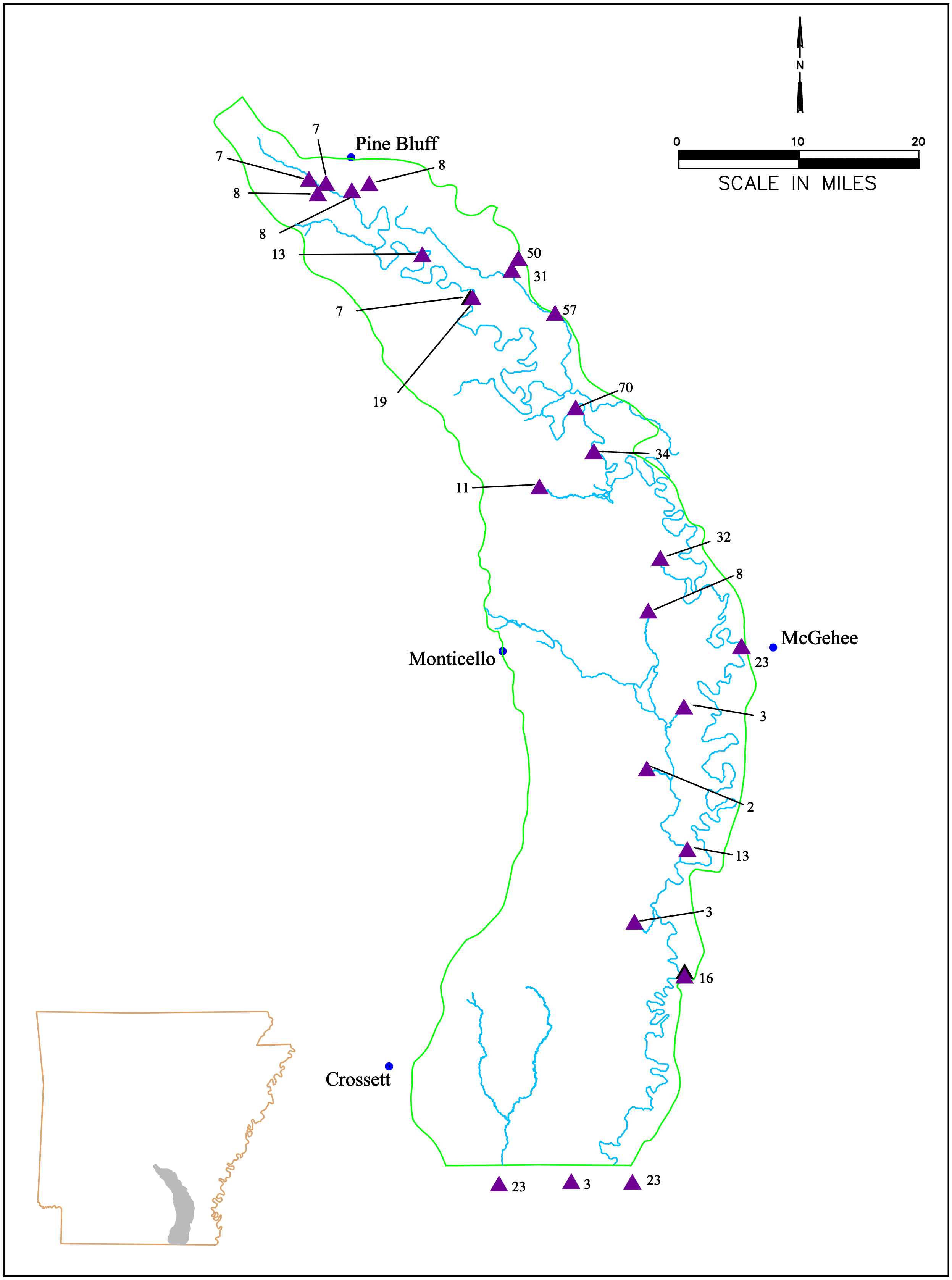

Figure A.3 Median Total Suspended Solids at Selected Stations; December-June

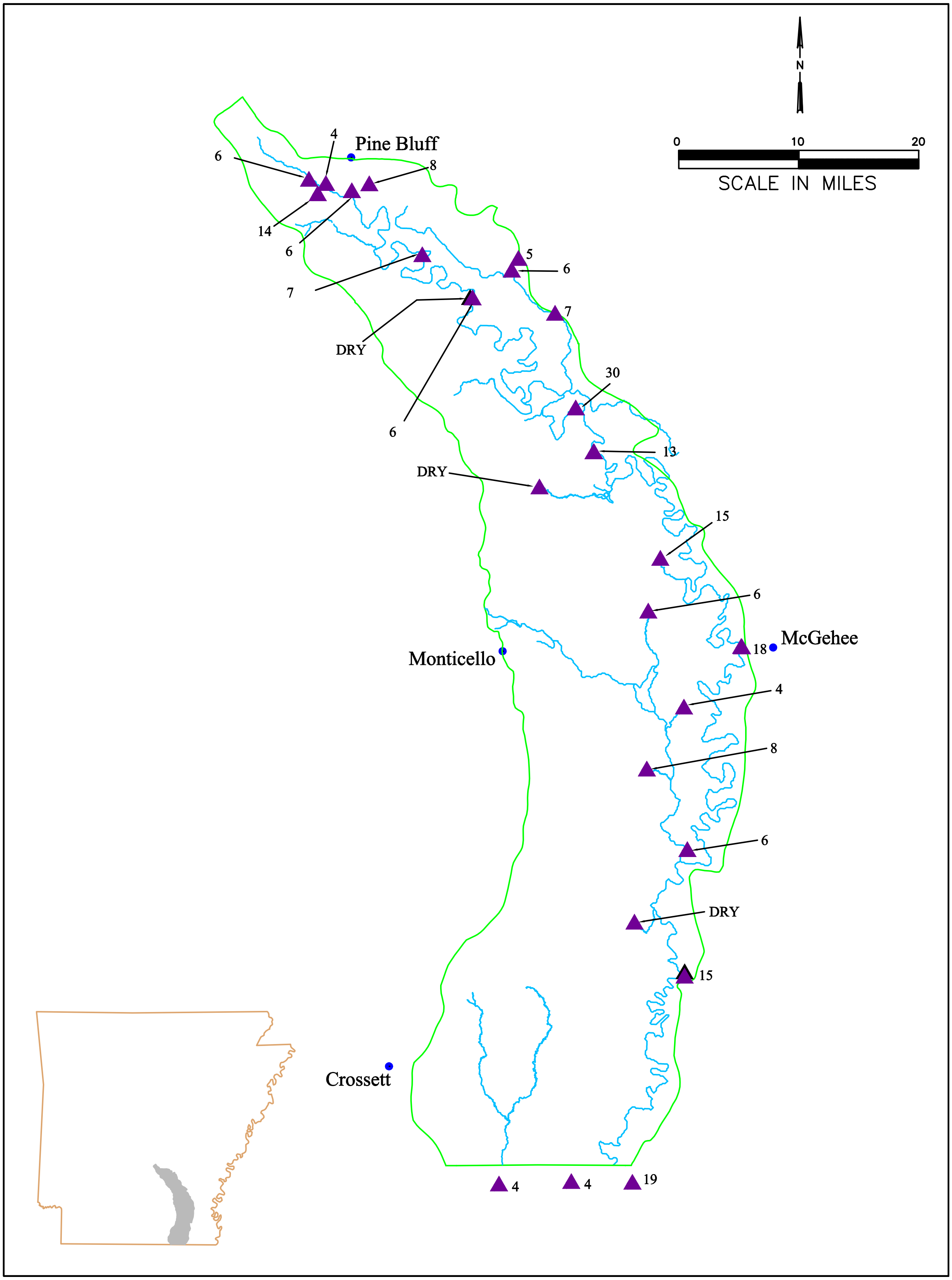

Figure A.4 Median Turbidity at Selected Stations; July-November

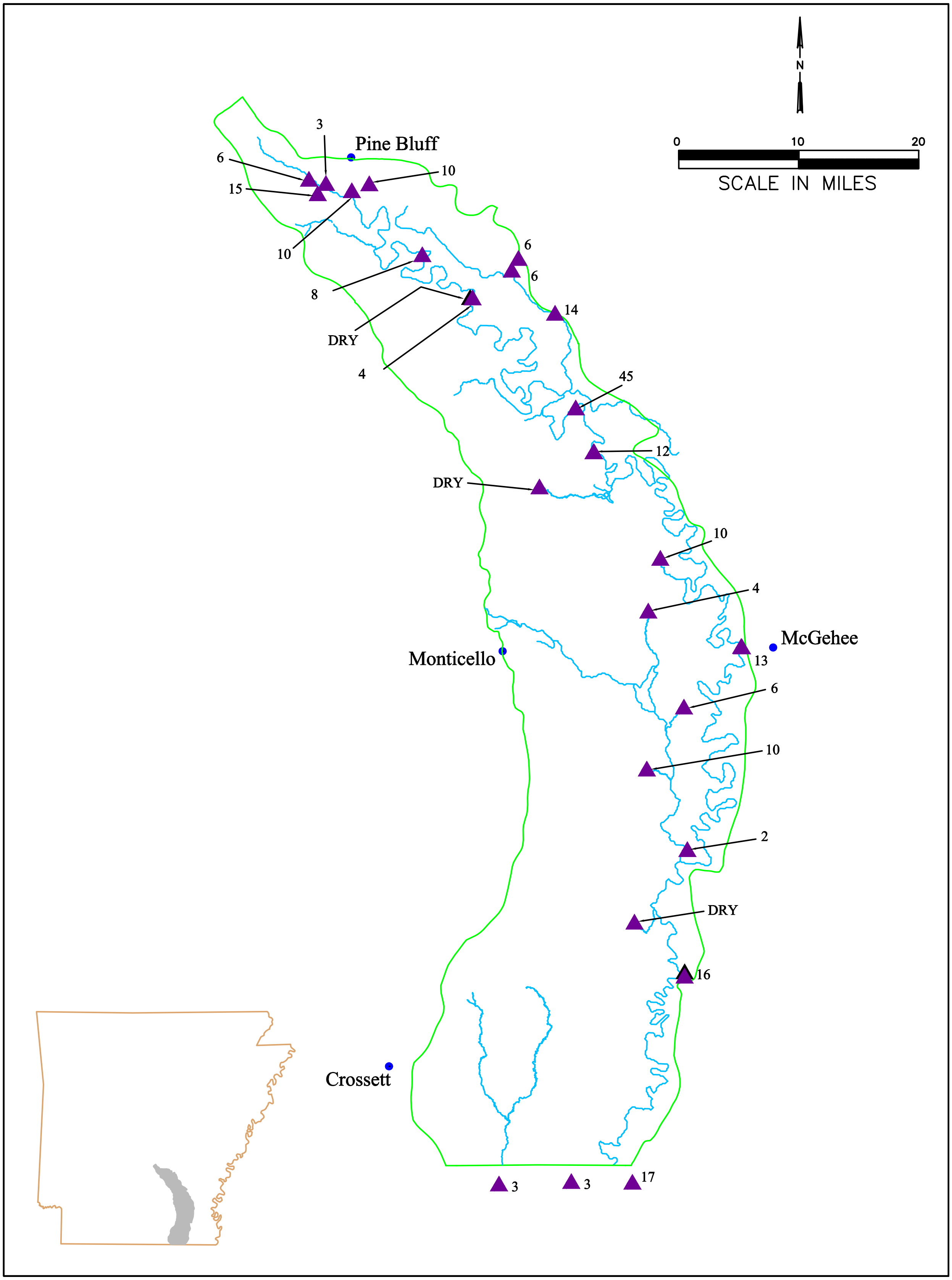

Figure A.5 Median Total Suspended Solids at Selected Stations; July-November

APPENDIX B

TMDL Calculations

TABLE B.1. CALCULATION OF AVERAGE FLOWS FOR BAYOU BARTHOLOMEW REACHES
(FOR TSS LOADING CALCULATIONS)

USGS gages with long periods of historical daily flow data:

1. Bayou Bartholomew near McGehee, AR (07364150)
   Available period of record: 1939 - 1942, Oct. 1945 - current
   Drainage area at gage = 576 mi2

2. Bayou Bartholomew near Jones, LA (07364200)
   Available period of record: Oct. 1957 - current
   Drainage area at gage = 1187 mi2

	Mean monthly flows (cfs) for period of record		Mean monthly flow per unit area (cfs/mi2)	
	McGehee, AR	Jones, LA	McGehee, AR	Jones, LA
January	1025	2102	1.78	1.77
February	1403	2550	2.44	2.15
March	1384	2914	2.40	2.45
April	1214	2355	2.11	1.98
May	1057	1928	1.84	1.62
June	458	1125	0.80	0.95
July	215	506	0.37	0.43
August	152	368	0.26	0.31
September	150	286	0.26	0.24
October	168	358	0.29	0.30
November	340	613	0.59	0.52
December	716	1511	1.24	1.27

Average flow per square mile for:	McGehee	Jones	Average for both gages
Period Dec. - June:	1.80	1.74	1.77
Period July - Nov.:	0.36	0.36	0.36

Reach ID	Reach Description	Drainage area at downstream end of reach (mi2)	Average flow for Dec - Jun (cfs)	Average flow for Jul - Nov (cfs)
08040205-005	Deep Bayou at mouth	102	181	36
08040205-006	Headwaters to Hwy. 293 near Star City, AR	332	589	119
08040205-013	Hwy. 293 near Star City, AR to Gourd, AR	401	711	143
08040205-012U	Gourd, AR to NE corner Drew Co., AR	415	735	148
08040205-012	NE corner Drew Co. to NE corner Ashley, Co., AR	636	1127	227
08040205-002	NE corner Ashley, Co., AR to near Portland, AR	1102	1953	394
08040205-001	Near Portland, AR to gage @ Jones, LA	1177	2085	421

FILE: R:\PROJECTS\2110-545\TMDL CALCS\TSS_BUDGET.XLS

TABLE B.2. ESTIMATION OF TARGET TSS LOADS FOR BAYOU BARTHOLOMEW

Applicable water quality standard for turbidity = 45 NTU (for "least-altered" streams)

Regression for ln TSS (mg/L) vs. ln turbidity (NTU) based on data at OUA33 (2 mi. south of Ladd, AR):

Dec. - June ln TSS = 0.9134 ln Turb - 0.386 (R squared = 0.55)
July - Nov. ln TSS = 0.8951 ln Turb - 0.1137 (R squared = 0.44)

Regression for ln TSS (mg/L) vs. ln turbidity (NTU) based on data at OUA13 (west of Jones, LA):

Dec. - June ln TSS = 0.963 ln Turb - 0.9283 (R squared = 0.31)
July - Nov. ln TSS = 0.5973 ln Turb + 1.251 (R squared = 0.37)

Max. TSS to maintain turbidity std. Using OUA33 eqn for Dec. - June:
TSS = e ^(a * ln Turbidity + b), where a = 0.9134 and b = -0.386
TSS = e^(0.9134 * ln 45 + -0.3860) = 22 mg/L

Max. TSS to maintain turbidity std. Using OUA33 eqn for July - Nov.:
TSS = e ^(a * ln Turbidity + b), where a = 0.8951 and b = -0.1137
TSS = e^(0.8951 * ln 45 + -0.1137) = 27 mg/L

Max. TSS to maintain turbidity std. Using OUA13 eqn for Dec. - June:
TSS = e ^(a * ln Turbidity + b), where a = 0.963 and b = -0.9283
TSS = e^(0.9630 * ln 45 + -0.9283) = 15 mg/L

Max. TSS to maintain turbidity std. Using OUA13 eqn for July - Nov.:
TSS = e ^(a * ln Turbidity + b), where a = 0.5973 and b = 1.251
TSS = e^(0.5973 * ln 45 + 1.2510) = 34 mg/L

Reach ID	Total flow at downstream end of reach (cfs)		Inflow entering each reach (cfs)		Water quality station used	Maximum TSS load entering each reach to maintain turbidity standard (lbs/day)	
	Dec - Jun	Jul - Nov	Dec - Jun	Jul - Nov		Dec - Jun	Jul - Nov
08040205-005	181	36	181	36	OUA33	21480	5243
08040205-006	589	119	408	83	OUA33	48419	12089
08040205-013	711	143	122	24	OUA33	14478	3496
08040205-012U	735	148	24	5	OUA13	1942	917
08040205-012	1127	227	392	79	OUA13	31719	14489
08040205-002	1953	394	826	167	OUA13	66836	30629
08040205-001	2085	421	132	27	OUA13	10681	4952

Max. TSS loads for entire basin to maintain turb. standard (lbs/day) = 195555 71815

FILE: R:\PROJECTS\2110-545\TMDL CALCS\TSS_BUDGET.XLS

TABLE B.3. ESTIMATION OF **EXISTING** TSS LOADS AND PERCENT REDUCTIONS FOR BAYOU BARTHOLOMEW

Flow weighted average TSS conc's for OUA33 (2 mi. south of Ladd, AR):

Period Dec. - June: 31 mg/L
Period July - Nov.: 28 mg/L

Flow weighted average TSS conc's for OUA13 (west of Jones, LA):

Period Dec. - June: 24 mg/L
Period July - Nov.: 26 mg/L

Reach ID	Total flow at downstream end of reach (cfs)		Inflow entering each reach (cfs)		Water quality station used	Existing TSS load entering each reach (lbs/day)		Allowable TSS load entering each reach (lbs/day)		Percent reduction required	
	Dec - Jun	Jul - Nov	Dec - Jun	Jul - Nov		Dec - Jun	Jul - Nov	Dec - Jun	Jul - Nov	Dec - Jun	Jul - Nov
08040205-005	181	36	181	36	OUA33	30451	5388	21480	5243	29%	3%
08040205-006	589	119	408	83	OUA33	68641	12422	48419	12089	29%	3%
08040205-013	711	143	122	24	OUA33	20525	3592	14478	3496	29%	3%
08040205-012U	735	148	24	5	OUA13	3098	692	1942	917	37%	0%
08040205-012	1127	227	392	79	OUA13	50596	10939	31719	14489	37%	0%
08040205-002	1953	394	826	167	OUA13	106613	23125	66836	30629	37%	0%
08040205-001	2085	421	132	27	OUA13	17037	3739	10681	4952	37%	0%

Existing total TSS loads for entire basin (lbs/day) = 266510 54509

Existing point source TSS loads for entire basin (lbs/day) = 0 * 0 *

Existing nonpoint source TSS loads for entire basin (lbs/day) = 266510 54509

* Note: Point source TSS loads were considered to be zero because this TMDL addresses inorganic suspended solids rather than organic suspended solids as explained in Section 4.4 of the text.

FILE: R:\PROJECTS\2110-545\TMDL CALCS\TSS_BUDGET.XLS

APPENDIX C

SWAT Output

D:\2110-545\swat\reach_summaryoutput.xls

data copied from output of Dec 13, 2001 run -- D:\2110-545\swat\byubart_dec\scenarios\default\tablesout\rch.dbf

SUBBASIN	DATE	FLOW_IN (m^3/s)	FLOW_OUT (m^3/s)	EVAP (avg daily) (m^3/s)	TLOSS loss by transmission (m^3/s)	SED_IN (m tons/ha)	SED_OUT (m tons/ha)	SEDCONC (mg/L)
1	Aver	1.071	1.071	0.00010	0.00	39260.0	39260.0	388.80
2	Aver	2.224	2.224	0.00029	0.00	70980.0	57410.0	195.30
3	Aver	2.656	2.654	0.00194	0.00	71380.0	49020.0	90.21
4	Aver	3.137	3.130	0.00645	0.00	65840.0	52040.0	80.84
5	Aver	4.754	4.733	0.02041	0.00	130800.0	80520.0	78.60
6	Aver	9.218	9.166	0.05234	0.00	207400.0	144300.0	133.50
7	Aver	10.730	10.670	0.05871	0.00	223600.0	180100.0	136.30
8	Aver	2.415	2.404	0.01125	0.00	57490.0	57490.0	298.00
9	Aver	14.350	14.350	0.00273	0.00	209800.0	207100.0	153.20
10	Aver	16.120	16.100	0.02277	0.00	310500.0	258200.0	163.50
11	Aver	18.050	18.040	0.01238	0.00	412400.0	406800.0	251.70
12	Aver	14.210	14.080	0.12840	0.00	410200.0	195100.0	135.20
13	Aver	14.300	14.290	0.00165	0.00	205700.0	205300.0	167.20
14	Aver	15.260	15.250	0.01732	0.00	259200.0	255000.0	201.60
15	Aver	25.580	25.390	0.19050	0.00	685400.0	393800.0	183.10
16	Aver	5.193	5.173	0.01948	0.00	191400.0	191400.0	380.40
17	Aver	26.630	26.530	0.09539	0.00	449400.0	395300.0	185.10
18	Aver	4.650	4.649	0.00145	0.00	137300.0	119600.0	194.00
19	Aver	4.220	4.218	0.00251	0.00	120800.0	120800.0	293.30
20	Aver	8.940	8.932	0.00761	0.00	359500.0	322200.0	227.20
21	Aver	2.307	2.304	0.00302	0.00	53470.0	53470.0	411.60
22	Aver	15.960	15.920	0.03878	0.00	483100.0	341600.0	121.00
23	Aver	46.770	46.410	0.35430	0.00	845200.0	657100.0	203.90
24	Aver	10.860	10.860	0.00187	0.00	387100.0	386800.0	236.20
25	Aver	10.330	10.330	0.00137	0.00	377600.0	374200.0	230.90
26	Aver	5.387	5.369	0.01852	0.00	105100.0	105100.0	339.10
27	Aver	52.620	52.620	0.00026	0.00	803200.0	802700.0	232.10
28	Aver	53.580	53.570	0.00653	0.00	849200.0	848200.0	236.80
29	Aver	54.090	54.090	0.00079	0.00	878300.0	878000.0	241.70
30	Aver	58.060	57.610	0.43760	0.00	944400.0	817400.0	228.60

Aver = 1985 thru 2000

D:\2110-545\swat\subbasin_summary.xls

data copied from output of Dec 13, 2001 run -- D:\2110-545\swat\byubart_dec\scenarios\default\tablesout\sbs.dbf

SUBBASIN	DATE	PRECIP (mm)	SNOMELT (H2O equiv, mm)	PET (mm H2O)	ET (mm)	SW (soil/water content, mm)	PERC (mm)	SURQ runoff (mm)	GW_Q (mm)	WYLD[1] (mm) (water yield)	SYLD (m tons/ha) (sediment yield)
1	Aver	1114.725	32.106	1115.746	621.856	291.057	148.394	339.136	136.619	476.580	5.537
2	Aver	1114.725	30.469	1115.012	576.159	302.176	99.113	433.106	90.773	524.223	4.571
3	Aver	1114.725	30.469	1098.421	564.418	322.640	148.554	396.807	136.488	533.393	5.473
4	Aver	1114.725	30.469	1098.443	520.821	323.057	245.466	341.253	226.513	567.865	6.267
5	Aver	1114.725	30.469	1098.999	631.041	314.367	169.240	308.908	155.952	465.092	7.149
6	Aver	1114.725	30.469	1098.674	459.584	224.158	186.564	453.034	175.592	628.658	6.641
7	Aver	1114.725	30.469	1098.971	567.108	234.421	133.726	406.270	123.704	530.050	8.506
8	Aver	1114.725	30.469	1098.429	426.602	195.513	163.839	510.256	153.521	663.790	5.008
9	Aver	1268.081	42.378	1125.390	526.075	285.365	316.919	417.419	292.673	710.333	17.103
10	Aver	1268.081	40.224	1170.615	554.381	256.035	237.035	475.976	218.751	694.815	13.972
11	Aver	1268.081	42.378	1125.829	598.434	333.610	226.111	436.633	208.602	645.382	16.163
12	Aver	1114.725	30.469	1100.240	617.947	302.321	177.476	311.077	164.992	476.396	9.823
13	Aver	1268.081	42.378	1125.412	434.412	179.417	174.684	652.033	160.649	812.701	12.708
14	Aver	1268.081	42.378	1125.823	585.206	281.598	265.491	409.541	245.819	656.139	11.874
15	Aver	1268.081	42.378	1126.334	520.118	297.642	292.664	439.056	275.861	715.099	8.347
16	Aver	1268.081	42.378	1126.214	610.767	309.798	252.644	395.657	233.215	630.685	7.367
17	Aver	1268.082	42.378	1126.769	529.223	282.305	278.710	446.964	261.218	708.302	10.075
18	Aver	1342.450	29.467	1074.316	714.917	413.406	232.596	386.269	214.576	600.958	7.281
19	Aver	1342.450	29.467	1074.771	674.164	355.040	296.716	360.504	273.742	637.055	5.779
20	Aver	1342.450	29.467	1074.953	745.456	398.340	215.389	373.712	198.177	572.025	10.136
21	Aver	1342.450	29.467	1075.259	756.979	404.805	218.861	358.029	202.307	560.463	4.118
22	Aver	1371.213	26.662	1124.810	706.359	329.223	173.890	480.992	160.202	641.264	3.110
23	Aver	1342.450	29.467	1074.908	577.035	322.186	341.486	390.766	329.603	720.567	5.727
24	Aver	1342.450	29.467	1074.903	476.198	204.493	204.954	649.336	191.540	840.902	6.514
25	Aver	1342.450	29.467	1074.779	652.580	310.999	197.601	483.976	182.185	666.244	8.352
26	Aver	1371.213	26.662	1125.324	785.734	406.290	200.508	375.148	185.338	560.626	3.466
27	Aver	1371.213	26.662	1124.957	687.506	337.904	291.009	383.654	268.173	652.128	10.049
28	Aver	1371.213	26.662	1125.247	582.894	314.130	332.892	444.085	308.005	752.216	11.582
29	Aver	1371.213	26.662	1125.404	548.446	318.674	334.191	479.224	307.358	786.682	14.429
30	Aver	1371.213	26.662	1126.124	594.072	333.996	368.479	370.048	356.446	726.671	3.859

Aver = 1985 - 2000

1: WYLD = SURQ + LATQ = GW_Q - TLOSS - POND ABSTRACTIONS

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SWAT  model simulation                    Wed Dec 12 15:19:17 2001
MDL

MULTIPLE HRUs LandUse/Soil OPTION      THRESHOLDS : 4 / 15 [%]
Number of HRUs: 253
Number of Subbasins: 30

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                                                                    Area [ha]   Area [acres] %Wat.Area

WATERSHED:                                                        304760.0700    753077.3710

LANDUSE:
                                                   Soybean-->SOYB     65193.2185    161095.7026     21.39
                                               Range-Brush-->RNGB       249.1783       615.7320      0.08
                                                     Water-->WATR       201.8652       498.8190      0.07
                                            Winter Pasture-->WPAS     11429.7443     28243.4696      3.75
                                          Forest-Deciduous-->FRSD     58589.1536    144776.7281     19.22
                              Upland Cotton-harv w/ picker-->COTP     38283.0847     94599.4165     12.56
                                          Forest-Evergreen-->FRSE     37803.7250     93414.8947     12.40
                                              Forest-Mixed-->FRST     75399.5310    186316.0111     24.74
                                                      Rice-->RICE      7700.5979     19028.5623      2.53
                                               Corn Silage-->CSIL      2501.8652      6182.2340      0.82
                                Residential-Medium Density-->URMD      4901.3633     12111.5137      1.61
                                            Summer Pasture-->SPAS      2506.7430      6194.2872      0.82

SOIL:
                                                            AR029     53930.7006    133265.4578     17.70
                                                            AR032     67304.3546    166312.4254     22.08
                                                            AR040     27413.7018     67740.6279      9.00
                                                            AR041      8389.5159     20730.9132      2.75
                                                            AR042     22622.4151     55901.1189      7.42
                                                            AR044    125099.3820    309126.8278     41.05

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                                                                    Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                                              1      7089.9296     17519.5705      2.33

LANDUSE:
                                            Winter Pasture-->WPAS      1398.1734      3454.9564      0.46     19.72
                                          Forest-Deciduous-->FRSD      2225.4332      5499.1568      0.73     31.39
                                          Forest-Evergreen-->FRSE      1684.0647      4161.4080      0.55     23.75
                                              Forest-Mixed-->FRST      1359.0697      3358.3292      0.45     19.17
                                Residential-Medium Density-->URMD       423.1886      1045.7202      0.14      5.97

SOIL:
                                                            AR040      5889.8815     14554.1916      1.93     83.07
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                                          AR042      1200.0481      2965.3790      0.39     16.93

HRUs:
1                          Winter Pasture-->WPAS/AR040      1398.1734      3454.9564      0.46     19.72    1
2                        Forest-Deciduous-->FRSD/AR040      2225.4332      5499.1568      0.73     31.39    2
3                        Forest-Evergreen-->FRSE/AR042       632.6105      1563.2121      0.21      8.92    3
4                        Forest-Evergreen-->FRSE/AR040      1051.4542      2598.1959      0.35     14.83    4
5                            Forest-Mixed-->FRST/AR042       567.4377      1402.1669      0.19      8.00    5
6                            Forest-Mixed-->FRST/AR040       791.6320      1956.1624      0.26     11.17    6
7             Residential-Medium Density-->URMD/AR040       423.1886      1045.7202      0.14      5.97    7
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                                                        Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                            2      6940.0800     17149.2847      2.28

LANDUSE:
                              Winter Pasture-->WPAS       894.7873      2211.0642      0.29     12.89
                            Forest-Deciduous-->FRSD      1753.0527      4331.8809      0.58     25.26
                            Forest-Evergreen-->FRSE       869.2220      2147.8909      0.29     12.52
                                Forest-Mixed-->FRST       893.8743      2208.8080      0.29     12.88
                  Residential-Medium Density-->URMD      2529.1437      6249.6406      0.83     36.44

SOIL:
                                              AR040      5108.5756     12623.5458      1.68     73.61
                                              AR042       640.6477      1583.0724      0.21      9.23
                                              AR044      1190.8567      2942.6665      0.39     17.16

HRUs:
8                          Winter Pasture-->WPAS/AR042       189.9140       469.2871      0.06      2.74    1
9                          Winter Pasture-->WPAS/AR040       704.8733      1741.7771      0.23     10.16    2
10                       Forest-Deciduous-->FRSD/AR040      1753.0527      4331.8809      0.58     25.26    3
11                       Forest-Evergreen-->FRSE/AR042       146.3953       361.7501      0.05      2.11    4
12                       Forest-Evergreen-->FRSE/AR040       722.8267      1786.1409      0.24     10.42    5
13                           Forest-Mixed-->FRST/AR042       304.3383       752.0353      0.10      4.39    6
14                           Forest-Mixed-->FRST/AR040       589.5359      1456.7727      0.19      8.49    7
15            Residential-Medium Density-->URMD/AR040      1338.2870      3306.9742      0.44     19.28    8
16            Residential-Medium Density-->URMD/AR044      1190.8567      2942.6665      0.39     17.16    9
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                                                        Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                            3      2553.9300      6310.8887      0.84

LANDUSE:
                                     Soybean-->SOYB       289.5419       715.4725      0.10     11.34
                              Winter Pasture-->WPAS       149.8805       370.3623      0.05      5.87
                            Forest-Deciduous-->FRSD       576.5290      1424.6321      0.19     22.57
                Upland Cotton-harv w/ picker-->COTP       176.2799       435.5965      0.06      6.90
                            Forest-Evergreen-->FRSE       112.4104       277.7717      0.04      4.40
                                Forest-Mixed-->FRST       352.5599       871.1930      0.12     13.80
```

	Residential-Medium Density-->URMD	896.7283	2215.8606	0.29	35.11	
SOIL:						
	AR040	912.2616	2254.2440	0.30	35.72	
	AR044	904.1881	2234.2941	0.30	35.40	
	AR032	737.4803	1822.3507	0.24	28.88	
HRUs:						
17	Soybean-->SOYB/AR032	289.5419	715.4725	0.10	11.34	1
18	Winter Pasture-->WPAS/AR040	149.8805	370.3623	0.05	5.87	2
19	Forest-Deciduous-->FRSD/AR040	169.4672	418.7619	0.06	6.64	3
20	Forest-Deciduous-->FRSD/AR044	239.2979	591.3170	0.08	9.37	4
21	Forest-Deciduous-->FRSD/AR032	167.7640	414.5532	0.06	6.57	5
22	Upland Cotton-harv w/ picker-->COTP/AR032	176.2799	435.5965	0.06	6.90	6
23	Forest-Evergreen-->FRSE/AR040	112.4104	277.7717	0.04	4.40	7
24	Forest-Mixed-->FRST/AR040	90.2689	223.0591	0.03	3.53	8
25	Forest-Mixed-->FRST/AR044	158.3965	391.4056	0.05	6.20	9
26	Forest-Mixed-->FRST/AR032	103.8945	256.7284	0.03	4.07	10
27	Residential-Medium Density-->URMD/AR040	390.2345	964.2891	0.13	15.28	11
28	Residential-Medium Density-->URMD/AR044	506.4938	1251.5715	0.17	19.83	12

		Area [ha]	Area [acres]	%Wat.Area	%Sub.Area	
SUBBASIN #	4	2684.3400	6633.1384	0.88		
LANDUSE:						
	Soybean-->SOYB	677.6830	1674.5887	0.22	25.25	
	Forest-Deciduous-->FRSD	472.5051	1167.5838	0.16	17.60	
	Upland Cotton-harv w/ picker-->COTP	650.4395	1607.2685	0.21	24.23	
	Forest-Mixed-->FRST	372.8959	921.4445	0.12	13.89	
	Residential-Medium Density-->URMD	510.8164	1262.2528	0.17	19.03	
SOIL:						
	AR029	148.0627	365.8704	0.05	5.52	
	AR044	680.3524	1681.1848	0.22	25.35	
	AR032	1855.9249	4586.0832	0.61	69.14	
HRUs:						
29	Soybean-->SOYB/AR032	677.6830	1674.5887	0.22	25.25	1
30	Forest-Deciduous-->FRSD/AR044	195.6398	483.4358	0.06	7.29	2
31	Forest-Deciduous-->FRSD/AR032	276.8653	684.1480	0.09	10.31	3
32	Upland Cotton-harv w/ picker-->COTP/AR032	650.4395	1607.2685	0.21	24.23	4
33	Forest-Mixed-->FRST/AR044	121.9589	301.3666	0.04	4.54	5
34	Forest-Mixed-->FRST/AR032	250.9370	620.0780	0.08	9.35	6
35	Residential-Medium Density-->URMD/AR044	362.7537	896.3824	0.12	13.51	7
36	Residential-Medium Density-->URMD/AR029	148.0627	365.8704	0.05	5.52	8

		Area [ha]	Area [acres]	%Wat.Area	%Sub.Area	

```
SUBBASIN #                                              5     11013.5696     27215.0812      3.61

LANDUSE:
                                        Soybean-->SOYB      1326.7041      3278.3522      0.44     12.05
                                 Winter Pasture-->WPAS      1557.7397      3849.2526      0.51     14.14
                               Forest-Deciduous-->FRSD      4606.7088     11383.4078      1.51     41.83
                     Upland Cotton-harv w/ picker-->COTP     518.0797      1280.2009      0.17      4.70
                               Forest-Evergreen-->FRSE      1440.4716      3559.4774      0.47     13.08
                                   Forest-Mixed-->FRST      1563.8656      3864.3901      0.51     14.20

SOIL:
                                                 AR040      5393.4176     13327.4045      1.77     48.97
                                                 AR042       360.2162       890.1123      0.12      3.27
                                                 AR044      3562.8030      8803.8645      1.17     32.35
                                                 AR032      1697.1328      4193.6999      0.56     15.41

HRUs:
37                                 Soybean-->SOYB/AR044      407.7096      1007.4709      0.13      3.70    1
38                                 Soybean-->SOYB/AR032      918.9945      2270.8813      0.30      8.34    2
39                          Winter Pasture-->WPAS/AR040     1557.7397      3849.2526      0.51     14.14    3
40                        Forest-Deciduous-->FRSD/AR040     1828.5246      4518.3757      0.60     16.60    4
41                        Forest-Deciduous-->FRSD/AR044     2778.1842      6865.0321      0.91     25.23    5
42            Upland Cotton-harv w/ picker-->COTP/AR032      518.0797      1280.2009      0.17      4.70    6
43                        Forest-Evergreen-->FRSE/AR040     1440.4716      3559.4774      0.47     13.08    7
44                            Forest-Mixed-->FRST/AR042      360.2162       890.1123      0.12      3.27    8
45                            Forest-Mixed-->FRST/AR040      566.6816      1400.2987      0.19      5.15    9
46                            Forest-Mixed-->FRST/AR044      376.9092       931.3614      0.12      3.42   10
47                            Forest-Mixed-->FRST/AR032      260.0586       642.6177      0.09      2.36   11
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                                                       Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                              6     10444.1400     25807.9921      3.43

LANDUSE:
                                        Soybean-->SOYB      4803.6234     11869.9936      1.58     45.99
                               Forest-Deciduous-->FRSD      1008.0351      2490.9052      0.33      9.65
                     Upland Cotton-harv w/ picker-->COTP    1640.6332      4054.0866      0.54     15.71
                                   Forest-Mixed-->FRST       858.3979      2121.1442      0.28      8.22
                                           Rice-->RICE      1338.6707      3307.9221      0.44     12.82
                                   Corn Silage-->CSIL        794.7797      1963.9404      0.26      7.61

SOIL:
                                                 AR029      7569.3587     18704.2639      2.48     72.47
                                                 AR044       639.7416      1580.8336      0.21      6.13
                                                 AR032      2235.0396      5522.8947      0.73     21.40

HRUs:
48                                 Soybean-->SOYB/AR029     3663.8466      9053.5482      1.20     35.08    1
49                                 Soybean-->SOYB/AR032     1139.7768      2816.4455      0.37     10.91    2
50                        Forest-Deciduous-->FRSD/AR044      494.4898      1221.9091      0.16      4.73    3
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51                         Forest-Deciduous-->FRSD/AR029      513.5453     1268.9961      0.17      4.92    4
52            Upland Cotton-harv w/ picker-->COTP/AR029      545.3703     1347.6374      0.18      5.22    5
53            Upland Cotton-harv w/ picker-->COTP/AR032     1095.2628     2706.4492      0.36     10.49    6
54                             Forest-Mixed-->FRST/AR044      145.2518      358.9245      0.05      1.39    7
55                             Forest-Mixed-->FRST/AR029      713.1461     1762.2197      0.23      6.83    8
56                                     Rice-->RICE/AR029     1338.6707     3307.9221      0.44     12.82    9
57                              Corn Silage-->CSIL/AR029      794.7797     1963.9404      0.26      7.61   10
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                                                           Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                               7     9322.2896    23035.8437      3.06

LANDUSE:
                                            Soybean-->SOYB     1836.2465     4537.4569      0.60     19.70
                                     Winter Pasture-->WPAS      452.3844     1117.8644      0.15      4.85
                                   Forest-Deciduous-->FRSD     3334.4567     8239.6092      1.09     35.77
                       Upland Cotton-harv w/ picker-->COTP      459.8963     1136.4267      0.15      4.93
                                   Forest-Evergreen-->FRSE     1175.1978     2903.9724      0.39     12.61
                                       Forest-Mixed-->FRST     1519.9113     3755.7768      0.50     16.30
                                        Corn Silage-->CSIL      544.1967     1344.7372      0.18      5.84

SOIL:
                                                     AR040     3361.3837     8306.1472      1.10     36.06
                                                     AR029     5041.6088    12458.0675      1.65     54.08
                                                     AR044      919.2971     2271.6290      0.30      9.86

HRUs:
58                                    Soybean-->SOYB/AR029     1836.2465     4537.4569      0.60     19.70    1
59                             Winter Pasture-->WPAS/AR040      452.3844     1117.8644      0.15      4.85    2
60                           Forest-Deciduous-->FRSD/AR040     1283.9769     3172.7711      0.42     13.77    3
61                           Forest-Deciduous-->FRSD/AR044      919.2971     2271.6290      0.30      9.86    4
62                           Forest-Deciduous-->FRSD/AR029     1131.1828     2795.2092      0.37     12.13    5
63              Upland Cotton-harv w/ picker-->COTP/AR029      459.8963     1136.4267      0.15      4.93    6
64                           Forest-Evergreen-->FRSE/AR040     1175.1978     2903.9724      0.39     12.61    7
65                               Forest-Mixed-->FRST/AR040      449.8247     1111.5393      0.15      4.83    8
66                               Forest-Mixed-->FRST/AR029     1070.0866     2644.2375      0.35     11.48    9
67                                Corn Silage-->CSIL/AR029      544.1967     1344.7372      0.18      5.84   10
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                                                           Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                               8    11479.3200    28365.9737      3.77

LANDUSE:
                                            Soybean-->SOYB     5498.5294    13587.1411      1.80     47.90
                                   Forest-Deciduous-->FRSD      484.1413     1196.3374      0.16      4.22
                       Upland Cotton-harv w/ picker-->COTP     1663.9421     4111.6840      0.55     14.50
                                       Forest-Mixed-->FRST      607.2918     1500.6485      0.20      5.29
                                               Rice-->RICE     2683.9291     6632.1231      0.88     23.38
                         Residential-Medium Density-->URMD      541.4862     1338.0395      0.18      4.72
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SOIL:
                                              AR029    10596.0856    26183.4574      3.48     92.31
                                              AR032      883.2344     2182.5163      0.29      7.69

HRUs:
68                              Soybean-->SOYB/AR029    5498.5294    13587.1411      1.80     47.90    1
69                     Forest-Deciduous-->FRSD/AR029     484.1413     1196.3374      0.16      4.22    2
70         Upland Cotton-harv w/ picker-->COTP/AR029     780.7077     1929.1677      0.26      6.80    3
71         Upland Cotton-harv w/ picker-->COTP/AR032     883.2344     2182.5163      0.29      7.69    4
72                         Forest-Mixed-->FRST/AR029     607.2918     1500.6485      0.20      5.29    5
73                                 Rice-->RICE/AR029    2683.9291     6632.1231      0.88     23.38    6
74           Residential-Medium Density-->URMD/AR029     541.4862     1338.0395      0.18      4.72    7
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                                                      Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                        9     265.6800      656.5086      0.09

LANDUSE:
                                     Soybean-->SOYB     136.2681      336.7254      0.04     51.29
                            Forest-Deciduous-->FRSD      30.8532       76.2397      0.01     11.61
                Upland Cotton-harv w/ picker-->COTP      61.7063      152.4794      0.02     23.23
                                Forest-Mixed-->FRST      36.8524       91.0641      0.01     13.87

SOIL:
                                              AR029      74.5618      184.2460      0.02     28.06
                                              AR032     191.1182      472.2626      0.06     71.94

HRUs:
75                              Soybean-->SOYB/AR029      63.4204      156.7149      0.02     23.87    1
76                              Soybean-->SOYB/AR032      72.8477      180.0104      0.02     27.42    2
77                     Forest-Deciduous-->FRSD/AR032      30.8532       76.2397      0.01     11.61    3
78         Upland Cotton-harv w/ picker-->COTP/AR032      61.7063      152.4794      0.02     23.23    4
79                         Forest-Mixed-->FRST/AR029      11.1414       27.5310      0.00      4.19    5
80                         Forest-Mixed-->FRST/AR032      25.7110       63.5331      0.01      9.68    6
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                                                      Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                       10    3972.2400     9815.6037      1.30

LANDUSE:
                                     Soybean-->SOYB    1358.8364     3357.7527      0.45     34.21
                                       Water-->WATR     201.8652      498.8190      0.07      5.08
                            Forest-Deciduous-->FRSD     622.2787     1537.6817      0.20     15.67
                Upland Cotton-harv w/ picker-->COTP    1051.0337     2597.1568      0.34     26.46
                                Forest-Mixed-->FRST     300.2953      742.0448      0.10      7.56
                                        Rice-->RICE     182.6797      451.4106      0.06      4.60
                                Corn Silage-->CSIL     255.2510      630.7381      0.08      6.43
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		Area [ha]	Area [acres]	%Wat.Area	%Sub.Area	
SOIL:						
	AR029	1813.2450	4480.6191	0.59	45.65	
	AR044	219.7995	543.1356	0.07	5.53	
	AR032	1939.1955	4791.8490	0.64	48.82	
HRUs:						
81	Soybean-->SOYB/AR029	592.6280	1464.4134	0.19	14.92	1
82	Soybean-->SOYB/AR032	766.2084	1893.3393	0.25	19.29	2
83	Water-->WATR/AR029	106.4227	262.9757	0.03	2.68	3
84	Water-->WATR/AR032	95.4425	235.8433	0.03	2.40	4
85	Forest-Deciduous-->FRSD/AR029	376.3854	930.0671	0.12	9.48	5
86	Forest-Deciduous-->FRSD/AR032	245.8933	607.6146	0.08	6.19	6
87	Upland Cotton-harv w/ picker-->COTP/AR029	378.7058	935.8009	0.12	9.53	7
88	Upland Cotton-harv w/ picker-->COTP/AR032	672.3279	1661.3558	0.22	16.93	8
89	Forest-Mixed-->FRST/AR044	113.4449	280.3280	0.04	2.86	9
90	Forest-Mixed-->FRST/AR029	100.0984	247.3483	0.03	2.52	10
91	Forest-Mixed-->FRST/AR032	86.7520	214.3685	0.03	2.18	11
92	Rice-->RICE/AR029	110.1083	272.0831	0.04	2.77	12
93	Rice-->RICE/AR032	72.5714	179.3275	0.02	1.83	13
94	Corn Silage-->CSIL/AR044	106.3546	262.8075	0.03	2.68	14
95	Corn Silage-->CSIL/AR029	148.8964	367.9305	0.05	3.75	15

		Area [ha]	Area [acres]	%Wat.Area	%Sub.Area	
SUBBASIN #	11	9542.6096	23580.2655	3.13		
LANDUSE:						
	Soybean-->SOYB	2228.4411	5506.5894	0.73	23.35	
	Forest-Deciduous-->FRSD	1052.7335	2601.3570	0.35	11.03	
	Upland Cotton-harv w/ picker-->COTP	1458.9209	3605.0665	0.48	15.29	
	Forest-Evergreen-->FRSE	449.9737	1111.9075	0.15	4.72	
	Forest-Mixed-->FRST	3197.3285	7900.7587	1.05	33.51	
	Rice-->RICE	422.0250	1042.8449	0.14	4.42	
	Corn Silage-->CSIL	733.1869	1811.7416	0.24	7.68	
SOIL:						
	AR029	761.1356	1880.8041	0.25	7.98	
	AR044	5352.0500	13225.1832	1.76	56.09	
	AR032	3429.4240	8474.2781	1.13	35.94	
HRUs:						
96	Soybean-->SOYB/AR044	444.3839	1098.0950	0.15	4.66	1
97	Soybean-->SOYB/AR029	542.2043	1339.8140	0.18	5.68	2
98	Soybean-->SOYB/AR032	1241.8528	3068.6804	0.41	13.01	3
99	Forest-Deciduous-->FRSD/AR044	607.4948	1501.1501	0.20	6.37	4
100	Forest-Deciduous-->FRSD/AR032	445.2386	1100.2070	0.15	4.67	5
101	Upland Cotton-harv w/ picker-->COTP/AR032	1458.9209	3605.0665	0.48	15.29	6
102	Forest-Evergreen-->FRSE/AR044	369.6558	913.4380	0.12	3.87	7
103	Forest-Evergreen-->FRSE/AR032	80.3179	198.4695	0.03	0.84	8
104	Forest-Mixed-->FRST/AR044	3197.3285	7900.7587	1.05	33.51	9

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105                                   Rice-->RICE/AR029      218.9313       540.9902      0.07       2.29   10
106                                   Rice-->RICE/AR032      203.0937       501.8547      0.07       2.13   11
107                            Corn Silage-->CSIL/AR044      733.1869      1811.7416      0.24       7.68   12
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                                                          Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                           12   23430.0608     57896.8517      7.69

LANDUSE:
                                         Soybean-->SOYB    4890.8472     12085.5280      1.60      20.87
                                  Winter Pasture-->WPAS    2027.3557      5009.6972      0.67       8.65
                                Forest-Deciduous-->FRSD    9216.6637     22774.8368      3.02      39.34
                    Upland Cotton-harv w/ picker-->COTP    1317.1879      3254.8370      0.43       5.62
                                Forest-Evergreen-->FRSE    2399.7830      5929.9838      0.79      10.24
                                    Forest-Mixed-->FRST    3578.2234      8841.9689      1.17      15.27

SOIL:
                                                  AR040    6748.1819     16675.0948      2.21      28.80
                                                  AR029    2616.2086      6464.7823      0.86      11.17
                                                  AR041    1021.3961      2523.9208      0.34       4.36
                                                  AR044    9358.1877     23124.5498      3.07      39.94
                                                  AR032    3686.0865      9108.5040      1.21      15.73

HRUs:
108                                Soybean-->SOYB/AR044      743.6429      1837.5789      0.24       3.17    1
109                                Soybean-->SOYB/AR029     1554.9729      3842.4158      0.51       6.64    2
110                                Soybean-->SOYB/AR032     2592.2313      6405.5332      0.85      11.06    3
111                         Winter Pasture-->WPAS/AR040     1439.3580      3556.7256      0.47       6.14    4
112                         Winter Pasture-->WPAS/AR041      587.9976      1452.9716      0.19       2.51    5
113                       Forest-Deciduous-->FRSD/AR040     2298.9074      5680.7151      0.75       9.81    6
114                       Forest-Deciduous-->FRSD/AR044     6917.7563     17094.1217      2.27      29.53    7
115           Upland Cotton-harv w/ picker-->COTP/AR029      223.3327       551.8663      0.07       0.95    8
116           Upland Cotton-harv w/ picker-->COTP/AR032     1093.8551      2702.9707      0.36       4.67    9
117                       Forest-Evergreen-->FRSE/AR040     1966.3845      4859.0345      0.65       8.39   10
118                       Forest-Evergreen-->FRSE/AR041      433.3984      1070.9492      0.14       1.85   11
119                           Forest-Mixed-->FRST/AR040     1043.5319      2578.6196      0.34       4.45   12
120                           Forest-Mixed-->FRST/AR044     1696.7885      4192.8492      0.56       7.24   13
121                           Forest-Mixed-->FRST/AR029      837.9030      2070.5002      0.27       3.58   14
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                                                          Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                           13     832.6800      2057.5939      0.27

LANDUSE:
                                         Soybean-->SOYB     482.3919      1192.0145      0.16      57.93
                                Forest-Deciduous-->FRSD      37.5004        92.6654      0.01       4.50
                    Upland Cotton-harv w/ picker-->COTP      83.5237       206.3912      0.03      10.03
                                    Forest-Mixed-->FRST      65.6258       162.1645      0.02       7.88
                                            Rice-->RICE     119.3195       294.8446      0.04      14.33
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                                  Corn Silage-->CSIL        44.3187       109.5137      0.01       5.32

SOIL:
                                               AR029       832.6800      2057.5939      0.27     100.00

HRUs:
122                           Soybean-->SOYB/AR029       482.3919      1192.0145      0.16      57.93    1
123                  Forest-Deciduous-->FRSD/AR029        37.5004        92.6654      0.01       4.50    2
124       Upland Cotton-harv w/ picker-->COTP/AR029        83.5237       206.3912      0.03      10.03    3
125                     Forest-Mixed-->FRST/AR029        65.6258       162.1645      0.02       7.88    4
126                             Rice-->RICE/AR029       119.3195       294.8446      0.04      14.33    5
127                      Corn Silage-->CSIL/AR029        44.3187       109.5137      0.01       5.32    6
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                                                     Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                        14      4391.8200     10852.4068      1.44

LANDUSE:
                                      Soybean-->SOYB      1458.0842      3602.9991      0.48      33.20
                             Forest-Deciduous-->FRSD       489.2487      1208.9581      0.16      11.14
                  Upland Cotton-harv w/ picker-->COTP       393.5071       972.3757      0.13       8.96
                                 Forest-Mixed-->FRST      1825.2404      4510.2603      0.60      41.56
                                         Rice-->RICE       225.7395       557.8137      0.07       5.14

SOIL:
                                               AR029      1290.1182      3187.9466      0.42      29.38
                                               AR041       755.2321      1866.2163      0.25      17.20
                                               AR044      1264.8697      3125.5562      0.42      28.80
                                               AR032      1081.6000      2672.6877      0.35      24.63

HRUs:
128                           Soybean-->SOYB/AR029       930.8673      2300.2197      0.31      21.20    1
129                           Soybean-->SOYB/AR032       527.2169      1302.7793      0.17      12.00    2
130                  Forest-Deciduous-->FRSD/AR044       194.8614       481.5122      0.06       4.44    3
131                  Forest-Deciduous-->FRSD/AR032       294.3874       727.4459      0.10       6.70    4
132       Upland Cotton-harv w/ picker-->COTP/AR029       193.2401       477.5059      0.06       4.40    5
133       Upland Cotton-harv w/ picker-->COTP/AR032       200.2670       494.8698      0.07       4.56    6
134                     Forest-Mixed-->FRST/AR044      1070.0083      2644.0439      0.35      24.36    7
135                     Forest-Mixed-->FRST/AR041       755.2321      1866.2163      0.25      17.20    8
136                             Rice-->RICE/AR029       166.0108       410.2210      0.05       3.78    9
137                             Rice-->RICE/AR032        59.7288       147.5927      0.02       1.36   10
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                                                     Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                        15     10451.4304     25826.0071      3.43

LANDUSE:
                                      Soybean-->SOYB      3824.3081      9450.0566      1.25      36.59
                             Forest-Deciduous-->FRSD      2073.5609      5123.8727      0.68      19.84
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                     Upland Cotton-harv w/ picker-->COTP      3175.0839      7845.7912      1.04     30.38
                                Forest-Mixed-->FRST       651.9218      1610.9314      0.21      6.24
                                      Rice-->RICE       726.5556      1795.3552      0.24      6.95

SOIL:
                                            AR029      2488.7738      6149.8844      0.82     23.81
                                            AR044      1098.1435      2713.5674      0.36     10.51
                                            AR032      6864.5132     16962.5553      2.25     65.68

HRUs:
138                         Soybean-->SOYB/AR044       627.6433      1550.9380      0.21      6.01    1
139                         Soybean-->SOYB/AR029      1351.5013      3339.6273      0.44     12.93    2
140                         Soybean-->SOYB/AR032      1845.1635      4559.4912      0.61     17.65    3
141                Forest-Deciduous-->FRSD/AR029       733.5305      1812.5906      0.24      7.02    4
142                Forest-Deciduous-->FRSD/AR032      1340.0304      3311.2821      0.44     12.82    5
143          Upland Cotton-harv w/ picker-->COTP/AR032      3175.0839      7845.7912      1.04     30.38    6
144                    Forest-Mixed-->FRST/AR044       470.5001      1162.6294      0.15      4.50    7
145                    Forest-Mixed-->FRST/AR032       181.4217       448.3020      0.06      1.74    8
146                          Rice-->RICE/AR029       403.7419       997.6665      0.13      3.86    9
147                          Rice-->RICE/AR032       322.8137       797.6888      0.11      3.09   10
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                                                 Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                          16     25979.1296     64195.7282      8.52

LANDUSE:
                                   Soybean-->SOYB      5446.3193     13458.1273      1.79     20.96
                           Winter Pasture-->WPAS      3261.2635      8058.7451      1.07     12.55
                         Forest-Deciduous-->FRSD      3394.6237      8388.2848      1.11     13.07
                         Forest-Evergreen-->FRSE      4020.3908      9934.5868      1.32     15.48
                             Forest-Mixed-->FRST      9856.5323     24355.9842      3.23     37.94

SOIL:
                                            AR029      4221.4256     10431.3538      1.39     16.25
                                            AR041      3948.2766      9756.3890      1.30     15.20
                                            AR042      8862.5480     21899.7992      2.91     34.11
                                            AR044      8946.8794     22108.1863      2.94     34.44

HRUs:
148                         Soybean-->SOYB/AR044      2408.2026      5950.7890      0.79      9.27    1
149                         Soybean-->SOYB/AR029      3038.1167      7507.3383      1.00     11.69    2
150                  Winter Pasture-->WPAS/AR042      1556.4485      3846.0620      0.51      5.99    3
151                  Winter Pasture-->WPAS/AR041      1704.8150      4212.6830      0.56      6.56    4
152                Forest-Deciduous-->FRSD/AR044      1248.4360      3084.9477      0.41      4.81    5
153                Forest-Deciduous-->FRSD/AR029      1183.3089      2924.0155      0.39      4.55    6
154                Forest-Deciduous-->FRSD/AR041       962.8788      2379.3216      0.32      3.71    7
155                Forest-Evergreen-->FRSE/AR042      1834.3738      4532.8295      0.60      7.06    8
156                Forest-Evergreen-->FRSE/AR044       905.4341      2237.3730      0.30      3.49    9
157                Forest-Evergreen-->FRSE/AR041      1280.5829      3164.3843      0.42      4.93   10
158                    Forest-Mixed-->FRST/AR042      5471.7256     13520.9077      1.80     21.06   11
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159                             Forest-Mixed-->FRST/AR044      4384.8067     10835.0765      1.44     16.88   12
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                                                               Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                             17      5516.9100     13632.5605      1.81

LANDUSE:
                                           Soybean-->SOYB       546.9976      1351.6584      0.18      9.91
                                       Range-Brush-->RNGB       249.1783       615.7320      0.08      4.52
                                  Forest-Deciduous-->FRSD      1279.1722      3160.8984      0.42     23.19
                      Upland Cotton-harv w/ picker-->COTP      3129.2357      7732.4979      1.03     56.72
                                              Rice-->RICE       312.3262       771.7737      0.10      5.66

SOIL:
                                                    AR029      1562.2325      3860.3546      0.51     28.32
                                                    AR032      3954.6775      9772.2059      1.30     71.68

HRUs:
160                                Soybean-->SOYB/AR029       385.4624       952.4967      0.13      6.99    1
161                                Soybean-->SOYB/AR032       161.5352       399.1616      0.05      2.93    2
162                            Range-Brush-->RNGB/AR029        40.1075        99.1076      0.01      0.73    3
163                            Range-Brush-->RNGB/AR032       209.0708       516.6245      0.07      3.79    4
164                       Forest-Deciduous-->FRSD/AR029       374.6208       925.7067      0.12      6.79    5
165                       Forest-Deciduous-->FRSD/AR032       904.5514      2235.1917      0.30     16.40    6
166            Upland Cotton-harv w/ picker-->COTP/AR029       619.5324      1530.8954      0.20     11.23    7
167            Upland Cotton-harv w/ picker-->COTP/AR032      2509.7034      6201.6025      0.82     45.49    8
168                                   Rice-->RICE/AR029       142.5095       352.1481      0.05      2.58    9
169                                   Rice-->RICE/AR032       169.8167       419.6256      0.06      3.08   10
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                                                               Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                             18      2271.2400      5612.3476      0.75

LANDUSE:
                                           Soybean-->SOYB       564.7736      1395.5838      0.19     24.87
                                  Forest-Deciduous-->FRSD       242.9134       600.2511      0.08     10.70
                                  Forest-Evergreen-->FRSE       257.6617       636.6949      0.08     11.34
                                      Forest-Mixed-->FRST      1075.7592      2658.2548      0.35     47.36
                                       Corn Silage-->CSIL       130.1322       321.5631      0.04      5.73

SOIL:
                                                    AR044      2271.2400      5612.3476      0.75    100.00

HRUs:
170                                Soybean-->SOYB/AR044       564.7736      1395.5838      0.19     24.87    1
171                       Forest-Deciduous-->FRSD/AR044       242.9134       600.2511      0.08     10.70    2
172                       Forest-Evergreen-->FRSE/AR044       257.6617       636.6949      0.08     11.34    3
173                           Forest-Mixed-->FRST/AR044      1075.7592      2658.2548      0.35     47.36    4
174                            Corn Silage-->CSIL/AR044       130.1322       321.5631      0.04      5.73    5
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                                                      Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                     19     20902.0496     51650.0097      6.86

LANDUSE:
                                  Soybean-->SOYB      2241.9336      5539.9300      0.74     10.73
                           Winter Pasture-->WPAS      1688.1599      4171.5275      0.55      8.08
                         Forest-Deciduous-->FRSD      1286.4727      3178.9383      0.42      6.15
                         Forest-Evergreen-->FRSE      4847.0855     11977.3905      1.59     23.19
                             Forest-Mixed-->FRST      8331.6550     20587.9361      2.73     39.86
                           Summer Pasture-->SPAS      2506.7430      6194.2872      0.82     11.99

SOIL:
                                           AR041      2664.6110      6584.3871      0.87     12.75
                                           AR042     11558.9551     28562.7561      3.79     55.30
                                           AR044      6678.4834     16502.8665      2.19     31.95

HRUs:
175                         Soybean-->SOYB/AR044      2241.9336      5539.9300      0.74     10.73    1
176                  Winter Pasture-->WPAS/AR042      1392.9332      3442.0076      0.46      6.66    2
177                  Winter Pasture-->WPAS/AR041       295.2267       729.5199      0.10      1.41    3
178                Forest-Deciduous-->FRSD/AR044       682.3898      1686.2194      0.22      3.26    4
179                Forest-Deciduous-->FRSD/AR041       604.0828      1492.7188      0.20      2.89    5
180                Forest-Evergreen-->FRSE/AR042      2726.8211      6738.1112      0.89     13.05    6
181                Forest-Evergreen-->FRSE/AR044       925.9383      2288.0397      0.30      4.43    7
182                Forest-Evergreen-->FRSE/AR041      1194.3262      2951.2396      0.39      5.71    8
183                    Forest-Mixed-->FRST/AR042      5503.4333     13599.2588      1.81     26.33    9
184                    Forest-Mixed-->FRST/AR044      2828.2218      6988.6774      0.93     13.53   10
185                  Summer Pasture-->SPAS/AR042      1935.7676      4783.3785      0.64      9.26   11
186                  Summer Pasture-->SPAS/AR041       570.9754      1410.9087      0.19      2.73   12
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                                                      Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                     20     23668.2000     58485.3056      7.77

LANDUSE:
                                  Soybean-->SOYB      5038.2343     12449.7288      1.65     21.29
                         Forest-Deciduous-->FRSD      4094.0291     10116.5506      1.34     17.30
                         Forest-Evergreen-->FRSE      4110.7243     10157.8053      1.35     17.37
                             Forest-Mixed-->FRST     10425.2123     25761.2209      3.42     44.05

SOIL:
                                           AR029       931.9506      2302.8965      0.31      3.94
                                           AR044     22736.2494     56182.4091      7.46     96.06

HRUs:
187                         Soybean-->SOYB/AR044      5038.2343     12449.7288      1.65     21.29    1
188                Forest-Deciduous-->FRSD/AR044      3162.0785      7813.6541      1.04     13.36    2
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189                        Forest-Deciduous-->FRSD/AR029      931.9506     2302.8965      0.31      3.94    3
190                        Forest-Evergreen-->FRSE/AR044     4110.7243    10157.8053      1.35     17.37    4
191                           Forest-Mixed-->FRST/AR044    10425.2123    25761.2209      3.42     44.05    5
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                                                        Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                           21  12986.7296    32090.8582      4.26

LANDUSE:
                                          Soybean-->SOYB  2234.6511     5521.9345      0.73     17.21
                                  Forest-Deciduous-->FRSD  1241.1747     3067.0048      0.41      9.56
                                  Forest-Evergreen-->FRSE  3428.4322     8471.8275      1.12     26.40
                                     Forest-Mixed-->FRST  6082.4716    15030.0914      2.00     46.84

SOIL:
                                                  AR044  12986.7296    32090.8582      4.26    100.00

HRUs:
192                             Soybean-->SOYB/AR044     2234.6511     5521.9345      0.73     17.21    1
193                        Forest-Deciduous-->FRSD/AR044     1241.1747     3067.0048      0.41      9.56    2
194                        Forest-Evergreen-->FRSE/AR044     3428.4322     8471.8275      1.12     26.40    3
195                           Forest-Mixed-->FRST/AR044     6082.4716    15030.0914      2.00     46.84    4
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                                                        Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                           22  13777.2896    34044.3715      4.52

LANDUSE:
                                          Soybean-->SOYB  2428.4793     6000.8937      0.80     17.63
                                  Forest-Deciduous-->FRSD  5396.0314    13333.8635      1.77     39.17
                                  Forest-Evergreen-->FRSE  1649.0329     4074.8427      0.54     11.97
                                     Forest-Mixed-->FRST  4303.7460    10634.7716      1.41     31.24

SOIL:
                                                  AR029   5064.4563    12514.5248      1.66     36.76
                                                  AR044   8712.8333    21529.8467      2.86     63.24

HRUs:
196                             Soybean-->SOYB/AR044     1470.2973     3633.1781      0.48     10.67    1
197                             Soybean-->SOYB/AR029      958.1820     2367.7156      0.31      6.95    2
198                        Forest-Deciduous-->FRSD/AR044     1289.7571     3187.0544      0.42      9.36    3
199                        Forest-Deciduous-->FRSD/AR029     4106.2743    10146.8091      1.35     29.80    4
200                        Forest-Evergreen-->FRSE/AR044     1649.0329     4074.8427      0.54     11.97    5
201                           Forest-Mixed-->FRST/AR044     4303.7460    10634.7716      1.41     31.24    6
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                                                        Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                           23  18908.6400    46724.1949      6.20
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LANDUSE:
                                 Soybean-->SOYB      4855.6707     11998.6051      1.59     25.68
                      Forest-Deciduous-->FRSD      3454.0719      8535.1844      1.13     18.27
         Upland Cotton-harv w/ picker-->COTP      8061.0421     19919.2380      2.65     42.63
                          Forest-Mixed-->FRST      1563.3928      3863.2219      0.51      8.27
                                    Rice-->RICE       974.4625      2407.9455      0.32      5.15

SOIL:
                                          AR029      2505.0662      6190.1438      0.82     13.25
                                          AR044      2169.9874      5362.1474      0.71     11.48
                                          AR032     14233.5864     35171.9036      4.67     75.28

HRUs:
202                      Soybean-->SOYB/AR044       905.1222      2236.6021      0.30      4.79    1
203                      Soybean-->SOYB/AR029      1400.6742      3461.1361      0.46      7.41    2
204                      Soybean-->SOYB/AR032      2549.8743      6300.8669      0.84     13.49    3
205             Forest-Deciduous-->FRSD/AR029       649.5101      1604.9719      0.21      3.43    4
206             Forest-Deciduous-->FRSD/AR032      2804.5618      6930.2125      0.92     14.83    5
207 Upland Cotton-harv w/ picker-->COTP/AR032      8061.0421     19919.2380      2.65     42.63    6
208                 Forest-Mixed-->FRST/AR044      1264.8653      3125.5453      0.42      6.69    7
209                 Forest-Mixed-->FRST/AR032       298.5276       737.6766      0.10      1.58    8
210                         Rice-->RICE/AR029       454.8819      1124.0358      0.15      2.41    9
211                         Rice-->RICE/AR032       519.5806      1283.9097      0.17      2.75   10
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                                               Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                   24      1978.8300      4889.7879      0.65

LANDUSE:
                                 Soybean-->SOYB      1169.9843      2891.0898      0.38     59.13
                      Forest-Deciduous-->FRSD       276.3192       682.7985      0.09     13.96
         Upland Cotton-harv w/ picker-->COTP       222.1046       548.8317      0.07     11.22
                                    Rice-->RICE       310.4219       767.0679      0.10     15.69

SOIL:
                                          AR029      1833.6750      4531.1026      0.60     92.66
                                          AR032       145.1550       358.6853      0.05      7.34

HRUs:
212                      Soybean-->SOYB/AR029      1169.9843      2891.0898      0.38     59.13    1
213             Forest-Deciduous-->FRSD/AR029       276.3192       682.7985      0.09     13.96    2
214 Upland Cotton-harv w/ picker-->COTP/AR029        76.9496       190.1464      0.03      3.89    3
215 Upland Cotton-harv w/ picker-->COTP/AR032       145.1550       358.6853      0.05      7.34    4
216                         Rice-->RICE/AR029       310.4219       767.0679      0.10     15.69    5
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                                               Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                   25      6637.1400     16400.7048      2.18
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LANDUSE:
                                   Soybean-->SOYB     2321.4910     5736.5202      0.76     34.98
                         Forest-Deciduous-->FRSD     1594.0845     3939.0626      0.52     24.02
                         Forest-Evergreen-->FRSE      494.1041     1220.9560      0.16      7.44
                             Forest-Mixed-->FRST     2227.4604     5504.1660      0.73     33.56

SOIL:
                                           AR029     2986.4970     7379.7834      0.98     45.00
                                           AR044     3650.6430     9020.9214      1.20     55.00

HRUs:
217                          Soybean-->SOYB/AR044      853.7154     2109.5735      0.28     12.86    1
218                          Soybean-->SOYB/AR029     1467.7755     3626.9468      0.48     22.11    2
219                 Forest-Deciduous-->FRSD/AR044      580.7160     1434.9782      0.19      8.75    3
220                 Forest-Deciduous-->FRSD/AR029     1013.3686     2504.0844      0.33     15.27    4
221                 Forest-Evergreen-->FRSE/AR044      494.1041     1220.9560      0.16      7.44    5
222                     Forest-Mixed-->FRST/AR044     1722.1075     4255.4138      0.57     25.95    6
223                     Forest-Mixed-->FRST/AR029      505.3529     1248.7522      0.17      7.61    7
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                                                      Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                        26    30317.4912    74916.0366      9.95

LANDUSE:
                                   Soybean-->SOYB     4056.8780    10024.7485      1.33     13.38
                         Forest-Deciduous-->FRSD     3259.5161     8054.4273      1.07     10.75
                         Forest-Evergreen-->FRSE    10279.6713    25401.5817      3.37     33.91
                             Forest-Mixed-->FRST    12721.4258    31435.2792      4.17     41.96

SOIL:
                                           AR044    30317.4912    74916.0366      9.95    100.00

HRUs:
224                          Soybean-->SOYB/AR044     4056.8780    10024.7485      1.33     13.38    1
225                 Forest-Deciduous-->FRSD/AR044     3259.5161     8054.4273      1.07     10.75    2
226                 Forest-Evergreen-->FRSE/AR044    10279.6713    25401.5817      3.37     33.91    3
227                     Forest-Mixed-->FRST/AR044    12721.4258    31435.2792      4.17     41.96    4
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                                                      Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                        27     4088.0700    10101.8254      1.34

LANDUSE:
                                   Soybean-->SOYB      998.1284     2466.4253      0.33     24.42
                         Forest-Deciduous-->FRSD      946.8755     2339.7768      0.31     23.16
             Upland Cotton-harv w/ picker-->COTP      277.9818      686.9070      0.09      6.80
                         Forest-Evergreen-->FRSE      585.4992     1446.7978      0.19     14.32
                             Forest-Mixed-->FRST     1279.5850     3161.9186      0.42     31.30
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SOIL:
                                     AR029      759.9194      1877.7989      0.25     18.59
                                     AR044     1438.5559      3554.7435      0.47     35.19
                                     AR032     1889.5947      4669.2830      0.62     46.22

HRUs:
228                     Soybean-->SOYB/AR044      227.5976       562.4051      0.07      5.57    1
229                     Soybean-->SOYB/AR029      335.3156       828.5815      0.11      8.20    2
230                     Soybean-->SOYB/AR032      435.2153      1075.4387      0.14     10.65    3
231            Forest-Deciduous-->FRSD/AR029      229.1479       566.2360      0.08      5.61    4
232            Forest-Deciduous-->FRSD/AR032      717.7276      1773.5408      0.24     17.56    5
233  Upland Cotton-harv w/ picker-->COTP/AR032      277.9818       686.9070      0.09      6.80    6
234            Forest-Evergreen-->FRSE/AR044      585.4992      1446.7978      0.19     14.32    7
235                Forest-Mixed-->FRST/AR044      625.4591      1545.5406      0.21     15.30    8
236                Forest-Mixed-->FRST/AR029      195.4560       482.9815      0.06      4.78    9
237                Forest-Mixed-->FRST/AR032      458.6700      1133.3965      0.15     11.22   10
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                                             Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                      28     4014.3600      9919.6843      1.32

LANDUSE:
                                 Soybean-->SOYB      740.2968      1829.3103      0.24     18.44
                        Forest-Deciduous-->FRSD      486.8141      1202.9419      0.16     12.13
            Upland Cotton-harv w/ picker-->COTP     2226.1933      5501.0350      0.73     55.46
                            Forest-Mixed-->FRST      348.9364       862.2394      0.11      8.69
                                    Rice-->RICE      212.1194       524.1577      0.07      5.28

SOIL:
                                     AR029      600.2980      1483.3663      0.20     14.95
                                     AR032     3414.0620      8436.3180      1.12     85.05

HRUs:
238                     Soybean-->SOYB/AR029      393.4815       972.3125      0.13      9.80    1
239                     Soybean-->SOYB/AR032      346.8152       856.9978      0.11      8.64    2
240            Forest-Deciduous-->FRSD/AR032      486.8141      1202.9419      0.16     12.13    3
241  Upland Cotton-harv w/ picker-->COTP/AR032     2226.1933      5501.0350      0.73     55.46    4
242                Forest-Mixed-->FRST/AR029      110.3021       272.5620      0.04      2.75    5
243                Forest-Mixed-->FRST/AR032      238.6343       589.6774      0.08      5.94    6
244                        Rice-->RICE/AR029       96.5143       238.4917      0.03      2.40    7
245                        Rice-->RICE/AR032      115.6051       285.6659      0.04      2.88    8
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                                             Area [ha]   Area [acres] %Wat.Area %Sub.Area

SUBBASIN #                                      29     2090.6100      5166.0018      0.69

LANDUSE:
                                 Soybean-->SOYB      489.8061      1210.3353      0.16     23.43
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		Area [ha]	Area [acres]	%Wat.Area	%Sub.Area	
	Forest-Deciduous-->FRSD	147.1520	363.6200	0.05	7.04	
	Upland Cotton-harv w/ picker-->COTP	1261.3032	3116.7432	0.41	60.33	
	Rice-->RICE	192.3487	475.3033	0.06	9.20	
SOIL:						
	AR029	233.3411	576.5975	0.08	11.16	
	AR032	1857.2689	4589.4044	0.61	88.84	
HRUs:						
246	Soybean-->SOYB/AR029	233.3411	576.5975	0.08	11.16	1
247	Soybean-->SOYB/AR032	256.4650	633.7378	0.08	12.27	2
248	Forest-Deciduous-->FRSD/AR032	147.1520	363.6200	0.05	7.04	3
249	Upland Cotton-harv w/ picker-->COTP/AR032	1261.3032	3116.7432	0.41	60.33	4
250	Rice-->RICE/AR032	192.3487	475.3033	0.06	9.20	5

		Area [ha]	Area [acres]	%Wat.Area	%Sub.Area	
SUBBASIN #	30	17209.2608	42524.9439	5.65		
LANDUSE:						
	Soybean-->SOYB	3248.0691	8026.1410	1.07	18.87	
	Forest-Deciduous-->FRSD	3506.2019	8664.0001	1.15	20.37	
	Upland Cotton-harv w/ picker-->COTP	10454.9899	25834.8028	3.43	60.75	
SOIL:						
	AR032	17209.2608	42524.9439	5.65	100.00	
HRUs:						
251	Soybean-->SOYB/AR032	3248.0691	8026.1410	1.07	18.87	1
252	Forest-Deciduous-->FRSD/AR032	3506.2019	8664.0001	1.15	20.37	2
253	Upland Cotton-harv w/ picker-->COTP/AR032	10454.9899	25834.8028	3.43	60.75	3
