TMDLs FOR CHLORIDE, SULFATE, AND TDS IN FLAT CREEK AND SALT CREEK, ARKANSAS

(Reaches 08040201-706 and -806)

October 8, 2003

TMDLs FOR CHLORIDE, SULFATE, AND TDS IN FLAT CREEK AND SALT CREEK, ARKANSAS

(Reaches 08040201-706 and -806)

Prepared for

EPA Region VI
Watershed Management Section
Dallas, TX 75202

Contract #68-C-99-249
Work Assignment #2-124

Prepared by

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

October 8, 2003

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.

The Flat Creek/Salt Creek basin, which is located in Planning Segment 2D, flows into Haynes Creek, which is a tributary of Smackover Creek in south central Arkansas in the Gulf Coastal Plain Ecoregion. The designated beneficial uses that have been established by the Arkansas Department of Environmental Quality (ADEQ) for all parts of the Flat Creek/Salt Creek basin are seasonal Gulf Coastal fishery; secondary contact recreation; and domestic, industrial and agricultural water supply. Where the drainage area is 10 mi^2 or more, the designated uses also include perennial Gulf Coastal fishery and primary contact recreation (ADEQ 2000).

The numeric standards that apply to the Flat Creek/Salt Creek basin for chlorides, sulfates, and total dissolved solids (TDS), are 19, 41, and 138 mg/L, respectively. ADEQ's historical water quality data for the Salt/Flat Creek basin show that the chloride, sulfates, and TDS standards are frequently exceeded. Because of this, Flat Creek and Salt Creek (reaches 08040201-706 and 08040201-806) were included on the Arkansas 1998 303(d) list for not supporting aquatic life and water supply uses due to nonpoint pollution from historical oil exploration activities in the watershed (ADEQ 2000). Both of these reaches were classified as medium priority on the 1998 303(d) list.

Historical water quality data from ADEQ monitoring stations OUA137A through I during two time periods in the basin were analyzed and plotted to examine relationships, seasonal patterns, and long-term trends.

TMDLs for dissolved minerals were developed for Flat Creek (chlorides, sulfates, and TDS) and Salt Creek (chlorides and TDS) based on mean annual conditions. A TMDL for

sulfates was not needed for Salt Creek because the data showed that the standard for sulfates was being met in Salt Creek. Total allowable loads were calculated based on the water quality standards and estimates of average annual streamflow. Each of the dissolved mineral TMDLs for Flat and Salt Creeks included a background component, a load allocation for man-induced nonpoint sources from the watershed, and an explicit margin of safety of 10%. The percent reductions required to meet the water quality standards for dissolved minerals varied from 12% for sulfates in Flat Creek to 99% for chlorides in Salt Creek.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Flat Creek and Salt Creek, which are located in Planning Segment 2D, combine to form Haynes Creek, a tributary of Smackover Creek within the Ouachita River Basin in hydrologic unit code (HUC) 08040201. Additional RF-1 river reach numbers were created for Flat Creek as 706 and for Salt Creek as 806. The Flat Creek/Salt Creek basin is located in south central Arkansas in the Gulf Coastal Plain ecoregion. The Arkansas Department of Environmental Quality (ADEQ) has established numeric water quality standards for chlorides, sulfates, and total dissolved solids (TDS) to protect the designated use of domestic, industrial, and agricultural water supply. The standards for chlorides, sulfates, and TDS are 19, 41, and 138 mg/L, respectively. Because the chlorides, sulfates, and TDS standards are exceeded frequently in the watershed, Flat Creek and Salt Creek (reaches 706 and 806) were included on the Arkansas 1998 303(d) list for not supporting the aquatic life and water supply uses due to historical oil exploration activity (ADEQ 2000). Therefore, the development of TMDLs for chloride, sulfates, and TDS was required. These TMDLs were developed under Environmental Protection Agency (EPA) Contract #68-C-99-249, Work Assignment #2-124.

2.0 BACKGROUND INFORMATION

2.1 General Description

The Flat Creek/Salt Creek basin is located in south central Arkansas in the Gulf Coastal Plain Ecoregion (Figure 2.1). The Flat Creek/Salt Creek basin is in US Geological Survey (USGS) HUC 08040201 and ADEQ Planning Segment 2D. Salt Creek starts just north of Smithville and flows generally north to its confluence with Flat Creek. Flat Creek starts along the eastern edge of El Dorado and flows north as well. About 0.4 miles southeast of Norphlet, the unnamed tributary from El Dorado Chemical Company (ELCC) joins Flat Creek. Flat Creek and Salt Creek then come together to form Haynes Creek which then flows into Smackover Creek. The total drainage area of the basin at the confluence of Flat and Salt Creeks is approximately 56.1 mi^2 (USGS 1979), all of which is in Union County.

The Flat Creek/Salt Creek watershed consists of a coastal plain of rolling terrain broken by stream valleys. Streams meander and are of moderate to low gradient (all less than 10 ft/mi). Substrate types are dominated by sand mixed with mud and silt, and rounded small sized gravel.

The soils in the basin are broadly classified as ultisols (SCS 1982) which are usually associated with forest vegetation and which have moderate to high permeability, argillic horizons, and low base saturations. The upland area soils are represented by the Briley, Darden, Harleston, Rosalie, Warnock, and Smithdale map units. Bibb and Guyton loams soils are found predominantly in the flood plains.

Of particular interest for this study is the Oil Wasteland-Fluvaquent complex, found on flood plains of local drainages and major streams. Mapped areas range from 20 to 1,000 acres in size. Sixty percent of the mapped areas consist of oil and wasteland soils that have been impacted by oil and saltwater, typically lack plant cover, and are severely eroded. Even though these soils have been affected by oil waste and salt water runoff, they support salt water grasses and cattails.

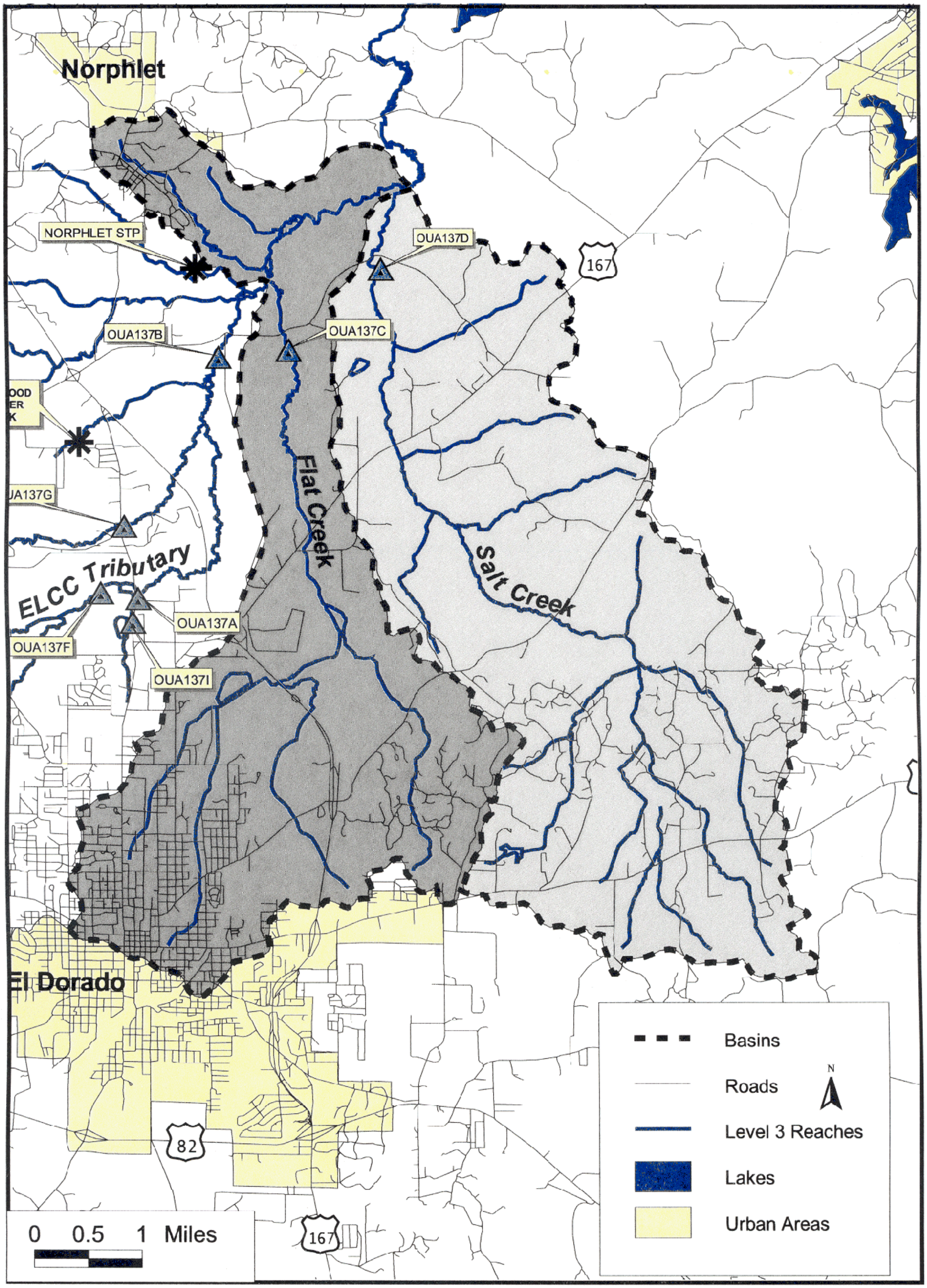


Figure 2.1. Flat Creek and Salt Creek (reaches -706 and -806).

2.2 Land Use

Land use in the Flat Creek/Salt Creek basin is predominantly forest and pasture with some urban development. Historically, oil and gas development has occurred in the basin in the forest and wetland areas (Figure 2.2). The USGS topographic maps of the area identify the headwaters of Flat and Salt Creeks as being located in the East El Dorado Oil Field. Approximate percentages of each land use by basin are shown in Table 2.1.

Table 2.1. Land uses in the Flat Creek/Salt Creek basin.

	Flat Creek (Reach 706)	**Salt Creek (Reach 806)**
Alluvial/Wetland Forest	17.3%	22.7%
Forest	50.0%	67.0%
Bare	16.8%	9.0%
Water	1.1%	1.3%
Urban Residential	11.9%	0.0%
Urban Commercial	2.9%	0.0%
Total	100.0%	100.0%

Prior to development, the Flat Creek/Salt Creek basin was predominantly bottomland hardwood forest.

2.3 Hydrology

A search for USGS flow monitoring gages within the Flat Creek/Salt Creek basin indicated that there were no active or inactive flow gages. The nearest, most relevant USGS flow gage appears to be USGS Gage No. 07362100 (Smackover Creek near Smackover, AR). It is located approximately 8 miles northwest of the study area in the Gulf Coastal Plain ecoregion and has a drainage area of 385 mi^2 (USGS 2000) compared to 56.1 mi^2 (USGS 1979) for the Flat Creek/Salt Creek basin. Based on this gage, the average annual runoff for the Flat Creek/Salt Creek basin is estimated to be approximately 15.0 inches (USGS 2000). The seasonal distribution of flow based on this gage is shown on Figure 2.3. Low flow months occur in late

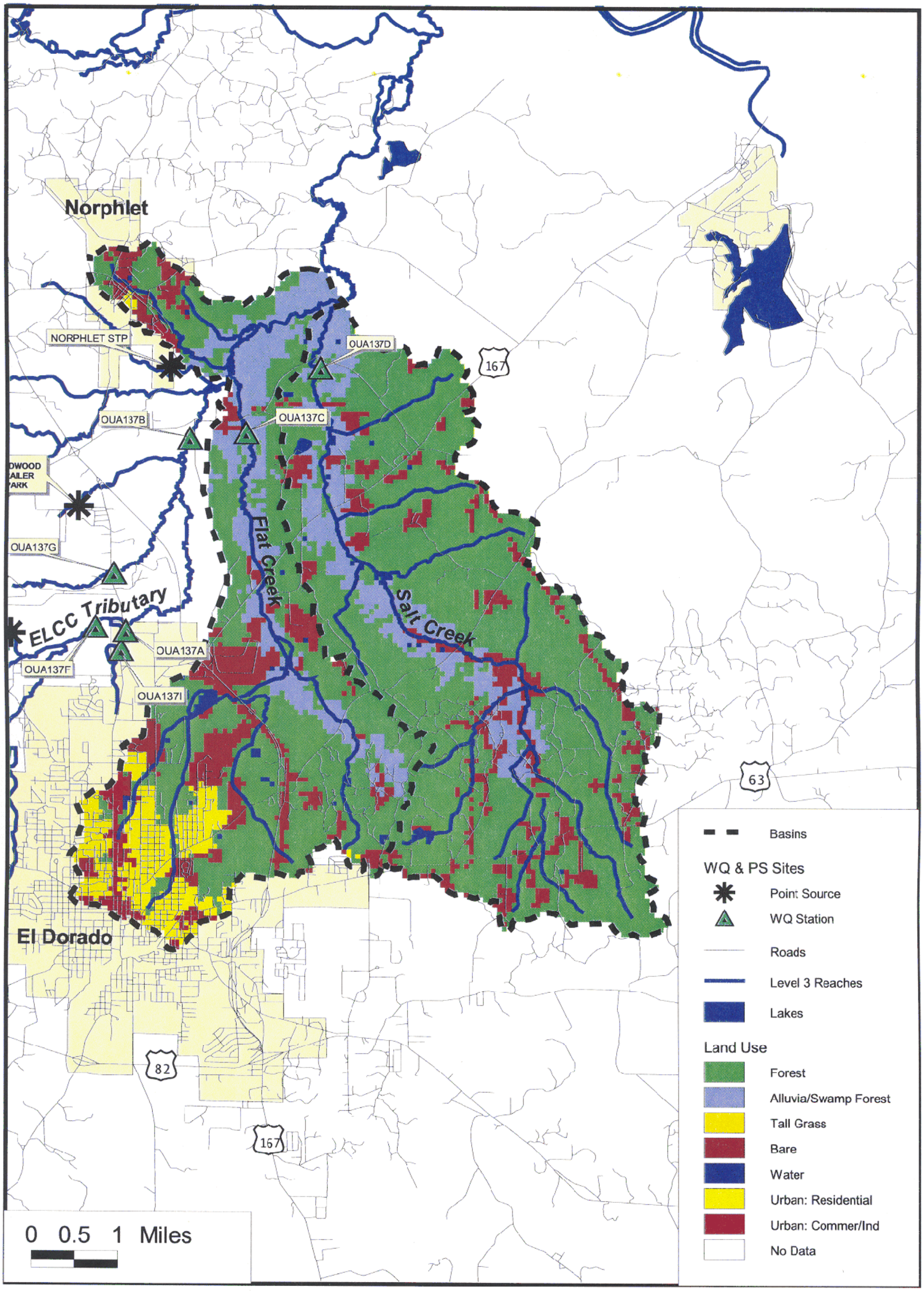


Figure 2.2. Land use in Flat Creek and Salt Creek (reaches -706 and -806).

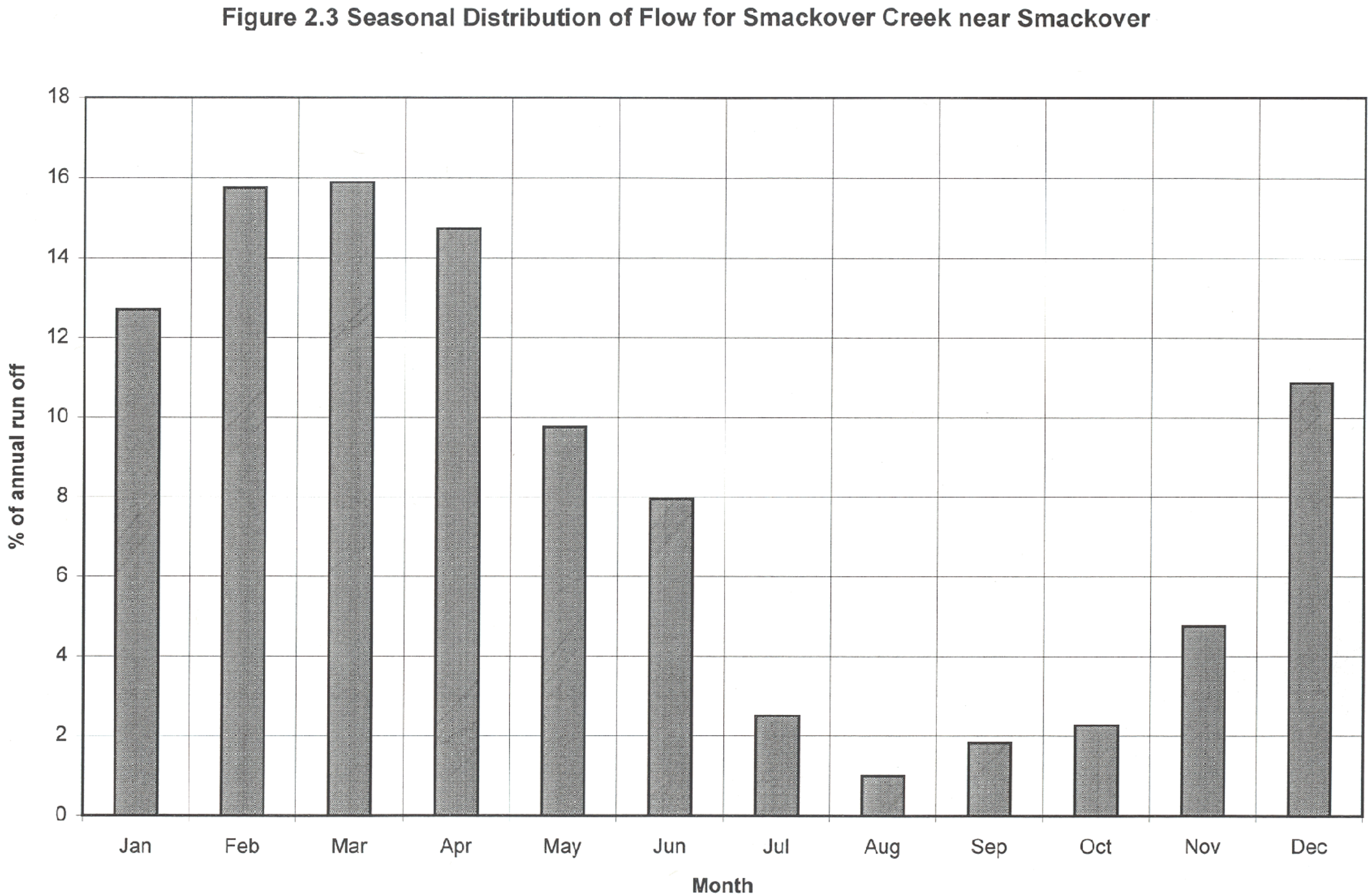


Figure 2.3. Seasonal distribution of flow for Smackover Creek near Smackover.

summer and high flow months occur in late winter to early spring. The 7Q10 critical low flows for Flat and Salt Creeks are 0 cubic feet per second (cfs) (USGS 1992).

Precipitation data were obtained from the NWS station in El Dorado, which had a long period of record (1930 to 2000). Average annual precipitation for the Flat Creek/Salt Creek basin is approximately 51.8 inches (Hydrosphere 2001) of which approximately 29% is runoff. Mean monthly precipitation totals for the El Dorado station are shown on Figure 2.4. The mean monthly precipitation values are highest from December through May and lowest for August and September.

2.4 Designated Uses and Water Quality Standards

The State of Arkansas has developed water quality standards for waters of the state (ADEQ 2001). The standards are defined according to ecoregions and designated uses of the waterbodies. The Flat Creek/Salt Creek basin lies entirely within the Gulf Coastal Plain ecoregion. Designated beneficial uses for all parts of the Flat Creek/Salt Creek basin include seasonal Gulf Coastal fishery; secondary contact recreation; and domestic, industrial, and agricultural water supply. Where the drainage area is 10 mi^2 or more, the designated uses also include perennial Gulf Coastal fishery and primary contact recreation.

Dissolved mineral standards (i.e., chlorides, sulfates, and TDS) are addressed in Section 2.511 of the Arkansas Water Quality Standards (ADEQ 2001). The specific standards for the Flat Creek/Salt Creek basin are:

CL – 19 mg/L
SO4 – 41 mg/L
TDS – 138 mg/L

The DO standards for the Flat Creek/ Salt Creek basin during the critical season are 2 mg/L for watersheds less than 10 mi^2 and 3 mg/L for watersheds greater than 10 mi^2 and less than 500 mi^2. For the primary season, the DO standard is 5 mg/L (regardless of watershed size).

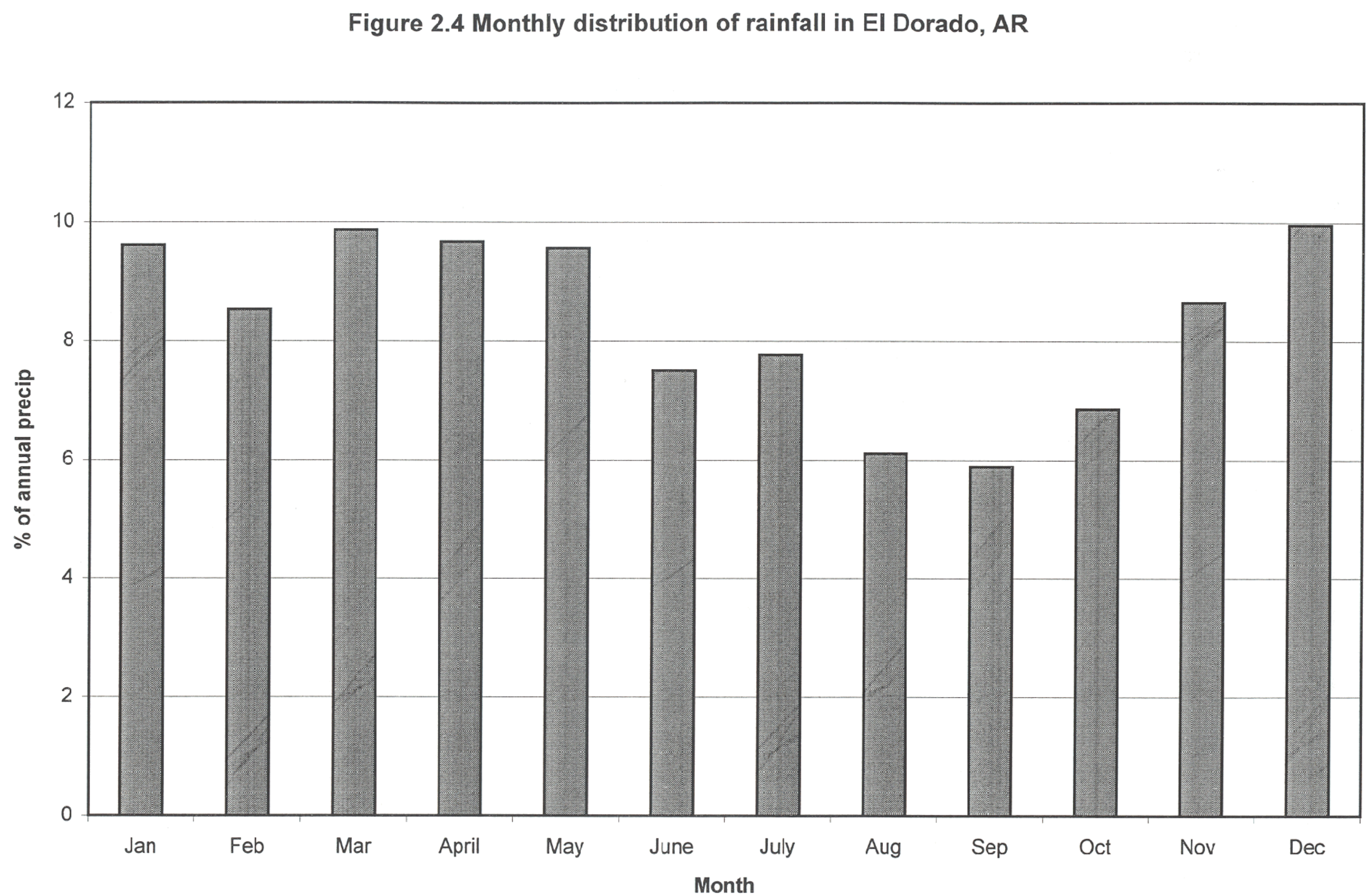


Figure 2.4. Monthly distribution of rainfall in El Dorado, Arkansas.

2.5 Point Sources

Information on point source discharges in the Flat Creek/Salt Creek basin (within HUC 08040201) was obtained by searching the Permit Compliance System (PCS) on the EPA website, reviewing ADEQ files, and reviewing information found in published technical reports. The search did not yield any facilities with point source discharges to reaches 08040201-706 (Flat Creek) or 08040201-806 (Salt Creek).

2.6 Nonpoint Sources

Nonpoint sources of pollution in the Flat Creek/Salt Creek basin have been discussed in the Arkansas 305(b) report (ADEQ 2000). ADEQ suggests that nonpoint source pollution is due to oil exploration activities from past and present. This is confirmed by the description of the soils in Section 2.1. There is no significant agricultural development with most of the land either being used for oil exploration or for timber for the forestry industry. Another source of dissolved minerals to Flat Creek may be urban runoff from El Dorado.

2.7 Previous Water Quality Studies

The following is a list of relevant water quality studies that were identified for the Flat Creek/Salt Creek basin:

1. ADEQ. 1998. TMDL Investigation of Water Quality Impairment to Unnamed Tributary to Flat Creek, Union County, Arkansas. WQ-98-04-1. Published by Arkansas Department of Environmental Quality.
2. FTN. 1991. Surface Water Quality Study for El Dorado Chemical Company. Prepared by FTN Associates, Ltd. for El Dorado Chemical Company.

3.0 CHARACTERIZATION OF EXISTING WATER QUALITY

3.1 Inventory of Data

Information on water quality monitoring stations in the Flat Creek/Salt Creek basin was obtained by searching the EPA STORET database and from reviewing technical reports of studies in the area. The search was conducted for data collected by all agencies at all water quality stations on Flat Creek/Salt Creek streams within HUC 08040201. The search yielded only the stations that were included in the ADEQ report (ADEQ 1998). One USGS water quality monitoring station was found in the watershed. Data for that station (07362203, Haynes Creek near Norphlet) were retrieved from the USGS website but included only three sampling events for chloride, sulfate, and TDS.

3.2 Assessment Report

The most relevant data for this study were collected by ADEQ and documented in a report titled "TMDL Investigation of Water Quality Impairment to Unnamed Tributary to Flat Creek, Union County, Arkansas" (ADEQ 1998). Water quality data were collected by ADEQ from 9 sampling locations on several occasions throughout the watershed from January 1995 to July 1996 and from March 1997 to December 1997. Parameters measured included flow, sulfates, chlorides, TDS, ammonia, and a suite of other parameters including biological data (Appendix A). These data were used to support this TMDL. The ADEQ report summarizes these data and presents several conclusions including the following:

a. "Water quality data demonstrates problem areas of minerals, heavy metals, ammonia, and nitrates."

b. "Flat Creek receives elevated levels of sulfates and TDS from the ELCC tributary and very high levels of chlorides from its upstream watershed; Salt Creek has chloride values as high as 3,000 mg/L contributed from its upstream watershed."

3.3 Data Analysis

Table 3.1 summarizes the dissolved minerals data collected by ADEQ (1998) for representative stations for the two reaches of interest in this study (08040201-706 and -806).

Data for all the ADEQ stations are summarized in Appendix A. For Salt Creek, 100% of the chloride and TDS samples exceeded the state water quality standards (WQS). No exceedances of the sulfate standard were recorded in Salt Creek; therefore, a TMDL for sulfates was not needed for Salt Creek. TDS and chloride concentrations were lower in Flat Creek compared to Salt Creek, but still exceeded WQS 100% and 91% of the time, respectively. Sulfate concentrations were higher in Flat Creek than Salt Creek, and exceeded WQS in 55% of the samples.

The seasonal variability in dissolved mineral concentrations is illustrated on Figures 3.1 through 3.3 for Flat Creek and Figure 3.4 through 3.6 for Salt Creek (these figures are located in Appendix B). Although there appears to be a trend of higher concentrations during the summer low flow period, limited data and large variability make it difficult to conclude the seasonal trend is significant. However, higher concentrations are expected during the summer because of less dilution from uncontaminated surface runoff.

Table 3.1. Summary of instream dissolved mineral data.

	Flat Creek (08040201-706)	**Salt Creek (08040201-806)**
	OUA137C	OUA137D
Chloride (mg/L)		
Period of Record for statistics	Jan 1995 to Dec 1997	Jan 1995 to Dec 1997
Number of samples	11	12
Minimum	16.6	170
Maximum	1,160	2,970
Median	287	948
Number above standards	10	12
Percent above standards	91%	100%
Sulfate (mg/L)		
Period of Record for statistics	Jan 1995 to Dec 1997	Jan 1995 to Dec 1997
Number of samples	11	12
Minimum	9.3	0.5
Maximum	125	11.6
Median	43.6	6.7
Number above standards	6	0
Percent above standards	55%	0%
TDS (mg/L)		
Period of Record for statistics	Jan 1995 to Dec 1997	Jan 1995 to Dec 1997
Number of samples	11	12
Minimum	496	780
Maximum	2,000	5,231
Median	675	1,693
Number above standards	11	12
Percent above standards	100%	100%

4.0 TMDL DEVELOPMENT

4.1 Dissolved Minerals for Salt and Flat Creeks

In this section, the TMDLs for dissolved minerals (chlorides, sulfates, and TDS) for Salt Creek and for Flat Creek (excluding the ELCC tributary) are developed. Since the major sources of dissolved minerals are located in the upper parts of Flat Creek and the ELCC tributary, it is assumed that successful implementation of the TMDL for upper Flat Creek and the ELCC tributary will result in water quality standards being maintained in the lower part of Flat Creek (i.e., downstream of the confluence with the ELCC tributary). Printouts of spreadsheets with the TMDL computations are included in Appendices C and D.

4.1.1 Seasonality and 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. Although dissolved mineral concentrations appeared to be slightly higher during the summer low flow months, no significant relationships were found for dissolved minerals with flow or season. The exceedances of water quality standards for dissolved minerals occurred fairly uniformly throughout the year in both Salt and Flat Creeks. Also, Arkansas's water quality standards for dissolved minerals are not seasonal. Due to year-round standards and limited data, including no flow data, no critical conditions were identified for the dissolved minerals TMDLs for Flat and Salt Creeks, and mean annual conditions were used.

4.1.2 Linking Water Quality and Pollutant Sources

The high dissolved mineral concentrations in Flat Creek and Salt Creek have been attributed to historical oil field development that left oil waste and salt water. It has been estimated that approximately 60% of lands occupied by forest and wetlands have been impacted (Section 2.1). For Salt Creek, all chloride and TDS concentrations exceeded standards but sulfate concentrations did not. For Flat Creek, chlorides, TDS, and sulfate concentrations exceeded water quality standards, indicating an additional source of pollution in the Flat Creek basin possibly attributable to nonpoint source runoff from urban and industrial areas as indicated by the differences in land use (Figure 2.2). There are no point sources for either reach (08040201-706 or 08040201-806).

4.1.3 Current Load

Current loads of dissolved minerals for Flat and Salt Creeks were calculated using the average concentrations and the average annual flow for each stream. The following equation was used to compute the loads:

Load in lbs/day = C x Q x 8.34
where C = concentration in mg/L and Q = flow in MGD.

Mean annual conditions were used since the limited available data did not indicate any significant seasonality or critical conditions. For Salt Creek, the mean concentrations for all data collected at station OUA137D were used. The mean annual flow was estimated by using the watershed area at its confluence with Flat Creek and multiplying it by the mean annual runoff for the USGS gage at Smackover (i.e., 15 inches per year). The resulting loads are summarized in Table 4.1.

For Flat Creek, the mean concentrations of data collected at station OUA137C were used and the flow was estimated by multiplying the watershed area of Flat Creek at its mouth (excluding the ELCC tributary) by the mean annual runoff from the USGS gage at Smackover. The results are summarized in Table 4.1.

4.1.4 TMDL

The allowable loads (i.e., TMDLs) for dissolved minerals were calculated by multiplying the existing water quality standards (Section 2.4) by the same mean annual flows that were used to calculate current loads. The results are summarized in Table 4.1. As shown on Figure 3.5 in Appendix B, none of the observed sulfate concentrations in Salt Creek exceeded the water quality standard of 41 mg/L. Therefore, a sulfate TMDL was not developed for Salt Creek.

Table 4.1. Dissolved minerals TMDLs for Flat and Salt Creeks in lbs/day.

	Flat Creek (08040201-706)			Salt Creek (08040201-806)	
	Chlorides	**Sulfates**	**TDS**	**Chlorides**	**TDS**
WLA for point sources	0	0	0	0	0
LA for NPS	1,093	2,185	5,543	1,346	6,826
Background	434	1,128	5,811	534	7,158
MOS for all sources	121	243	616	150	759
TMDL	1,648	3,556	11,970	2,030	14,743
Percent Reduction	97%	12%	93%	99%	97%

4.1.5 Wasteload Allocations

There are no point sources in these two reaches and the wasteload allocations (WLAs) are therefore zero.

4.1.6 Load Allocations

Load allocations (LAs) for nonpoint source contributions were calculated using the following equation:

LA = (TMDL – Background – WLA) x (1-MOS)

Therefore, these LAs represent man-induced nonpoint source contributions. Natural background loads were estimated using ADEQ reference stream data for the Gulf Coastal Plain ecoregion as defined in the ADEQ Continuing Planning Process (CPP).

The reductions in existing man-induced loads that are needed to maintain the dissolved minerals standards in Salt and Flat Creeks were estimated using the following equations:

Current man-induced load = Current total load – background load

% Reduction = 100% x (Current man-induced load – LA) / Current man-induced load

The percent reductions for each constituent are shown in Table 4.1.

4.1.7 Margin of Safety

Section 303(d) of the Federal Clean Water Act and EPA's regulations at 40 CFR 130.7 both require the inclusion of a margin of safety (MOS) in the development of a TMDL. An explicit MOS was incorporated in these TMDLs; it was calculated as 10% of the allowable man-induced load (i.e., 10% x (TMDL minus background)).

5.0 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.

6.0 PUBLIC PARTICIPATION

When EPA establishes a TMDL, federal regulations require EPA to publicly notice and seek comment concerning the TMDL. Pursuant to a May 2000 consent decree, these TMDLs were prepared under contract to EPA. After developing these TMDLs, EPA prepared a notice seeking comments, information, and data from the general public and affected public. Comments were submitted during the public comment period, and these TMDLs were revised accordingly. Responses to these comments are included in Appendix E. EPA has transmitted the revised TMDLs to the ADEQ for implementation and incorporation into ADEQ's current water quality management plan.

7.0 REFERENCES

ADEQ. 1998. TMDL Investigation of Water Quality Impairment to Unnamed Tributary to Flat Creek, Union County, Arkansas. WQ-98-04-1. Published by Arkansas Department of Environmental Quality.

ADEQ. 2000. Water Quality Inventory Report, Prepared Pursuant to Section 305(B) of the Federal Water Pollution Control Act. Published by Arkansas Department of Environmental Quality.

ADEQ. 2001. Arkansas Pollution Control and Ecology Commission Regulation 2, Regulation Establishing Water Quality Standards for Surface Waters of the State of Arkansas. Downloaded from ADEQ website (http//www.adeq.state.ar.us/regs).

FTN. 1991. Surface Water Quality Study for El Dorado Chemical Company. Prepared by FTN for El Dorado Chemical Company.

Hydrosphere. 2001. ClimateData CD for Central Region (daily data and selected statistics for temperature and precipitation). Hydrosphere Data Products, Boulder, CO.

Soil Conservation Service. 1982. General Soil Map, State of Arkansas. United States Department of Agriculture.

USGS. 1979. Drainage Areas of Streams in Arkansas, Ouachita River Basin. Open File Report 80-334. Prepared in cooperation with the Arkansas State Highway and Transportation Commission, Little Rock, AR.

USGS. 1992. Flow Duration and Low-Flow Characteristics of Selected Arkansas Streams, Water-Resources Investigations Report 92-4026, Little Rock, AR.

USGS. 2000. Water Resources Data Arkansas Water Year 2000. Water Data Report AR-00-1.

APPENDIX A

Summary of ADEQ Water Quality Data

Table A1. Summary of In-Stream Chloride Data.

Station Name	OUA0137A	OUA0137B	OUA0137C	OUA0137D	OUA0137E	OUA0137H	OUA0137F	OUA0137G	OUA0137I
Period of Record for statisitics	1997 March to December								
Number of samples	1	1	1	1	5	4	4	5	1
MIN	25.498	27.92	254.4	771	19.0	41.8	23.8	18.3	16.475
MAX	NA	NA	NA	NA	46.7	77.9	70.1	31.4	NA
MEDIAN	NA	NA	NA	NA	35.1	63.4	33.3	22.9	NA
# above standards	1	1	1	1	4	3	4	3	0
% above standards	100	100	100	100	80	75	100	60	0

Station Name	OUA0137A	OUA0137B	OUA0137C	OUA0137D
Period of Record for statisitics	1995 -1996 January to July			
Number of samples	11	11	10	11
MIN	20.1	15.0	17	170
MAX	71.9	63.6	1160	2970
MEDIAN	34.1	25.5	293	1020
# above standards	11	8	9	11
% above standards	100.0	72.7	90.0	100.0

Table A2. Summary of In-Stream Sulfate Data.

Station Name	OUA0137A	OUA0137B	OUA0137C	OUA0137D	OUA0137E	OUA0137H	OUA0137F	OUA0137G	OUA0137I
Period of Record for statisitics	1997 March to December								
Number of samples	1	1	1	1	5	4	4	5	1
MIN	73.6	50.8	70.9	1.7	3.98	184	49.8	12.5	12
MAX	NA	NA	NA	NA	16.2	553	412	74.2	NA
MEDIAN	NA	NA	NA	NA	12.7	233	77.1	38.6	NA
# above standards	1	1	1	0	0	4	4	1	0
% above standards	100	100	100	0	0	100	100	20	0

Station Name	OUA0137A	OUA0137B	OUA0137C	OUA0137D
Period of Record for statisitics	1995 -1996 January to July			
Number of samples	11	11	10	11
MIN	47.6	33.4	9.3	2.3
MAX	700	652	125	11.6
MEDIAN	124	41.7	41.7	7.4
# above standards	11	9	5	0
% above standards	100.0	81.8	50.0	0.0

Table A3. Summary of In-Stream TDS Data.

Station Name	OUA0137A	OUA0137B	OUA0137C	OUA0137D	OUA0137E	OUA0137H	OUA0137F	OUA0137G	OUA0137I
Period of Record for statisitics	1997 March to December								
Number of samples	1	1	1	1	5	4	4	5	1
MIN	303	229	675	1562	104	734	307	163	131
MAX	NA	NA	NA	NA	174	1769	1373	284	NA
MEDIAN	NA	NA	NA	NA	144	1238	355	216	NA
# above standards	1	1	1	1	4	4	4	5	0
% above standards	100	100	100	100	80	100	100	100	0

Station Name	OUA0137A	OUA0137B	OUA0137C	OUA0137D
Period of Record for statisitics	1995 -1996 January to July			
Number of samples	11	11	10	11
MIN	206	159	496	780
MAX	1589	1447	2000	5231
MEDIAN	440	393	659	1704
# above standards	11	11	10	11
% above standards	100.0	100.0	100.0	100.0

APPENDIX B

Figures 3.1 Through 3.6

Figure 3.1 Chloride Concentrations Measured in Flat Creek (OUA137C).

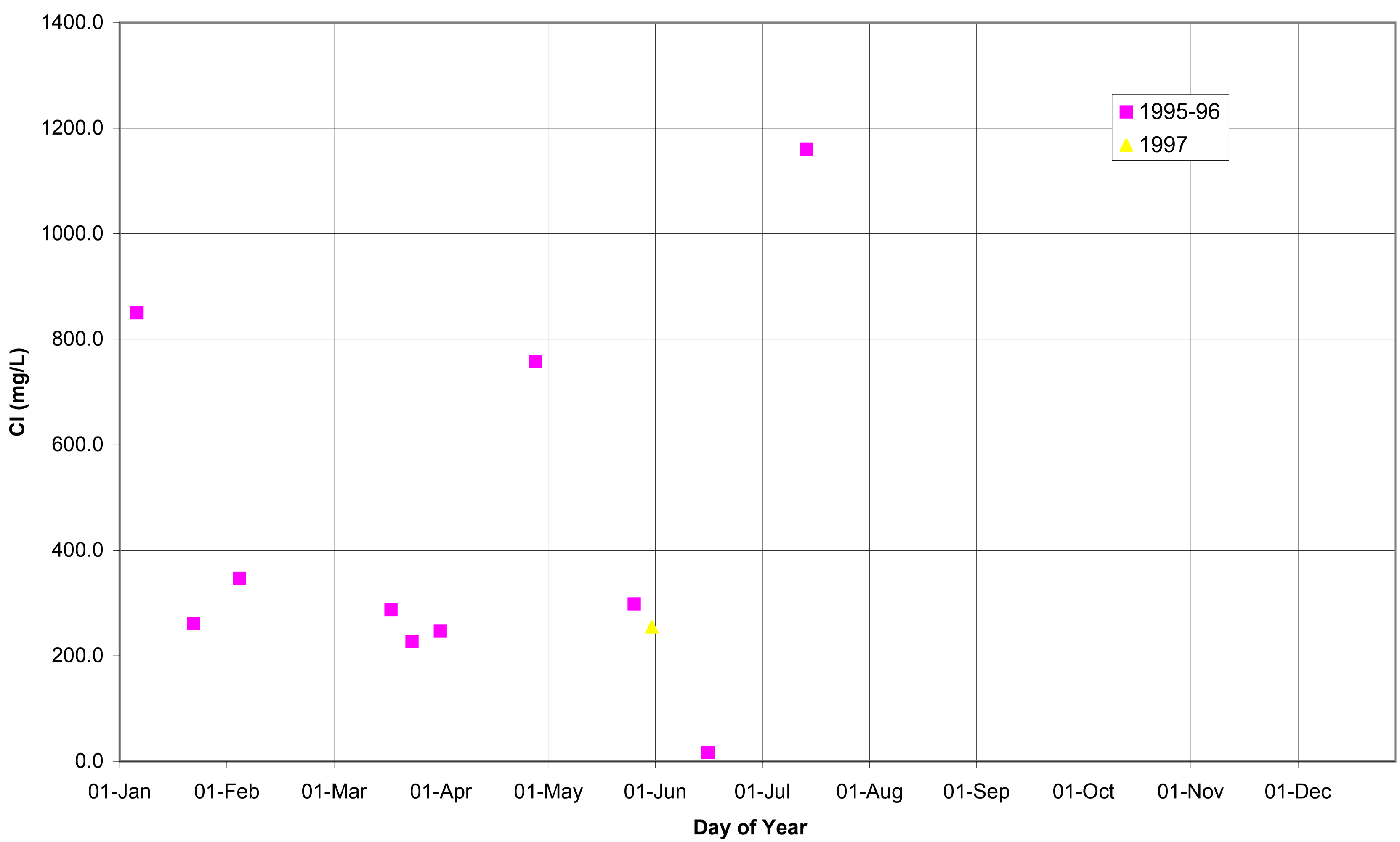


Figure 3.2 Sulfate Concentrations Measured in FLat Creek (OUA137C).

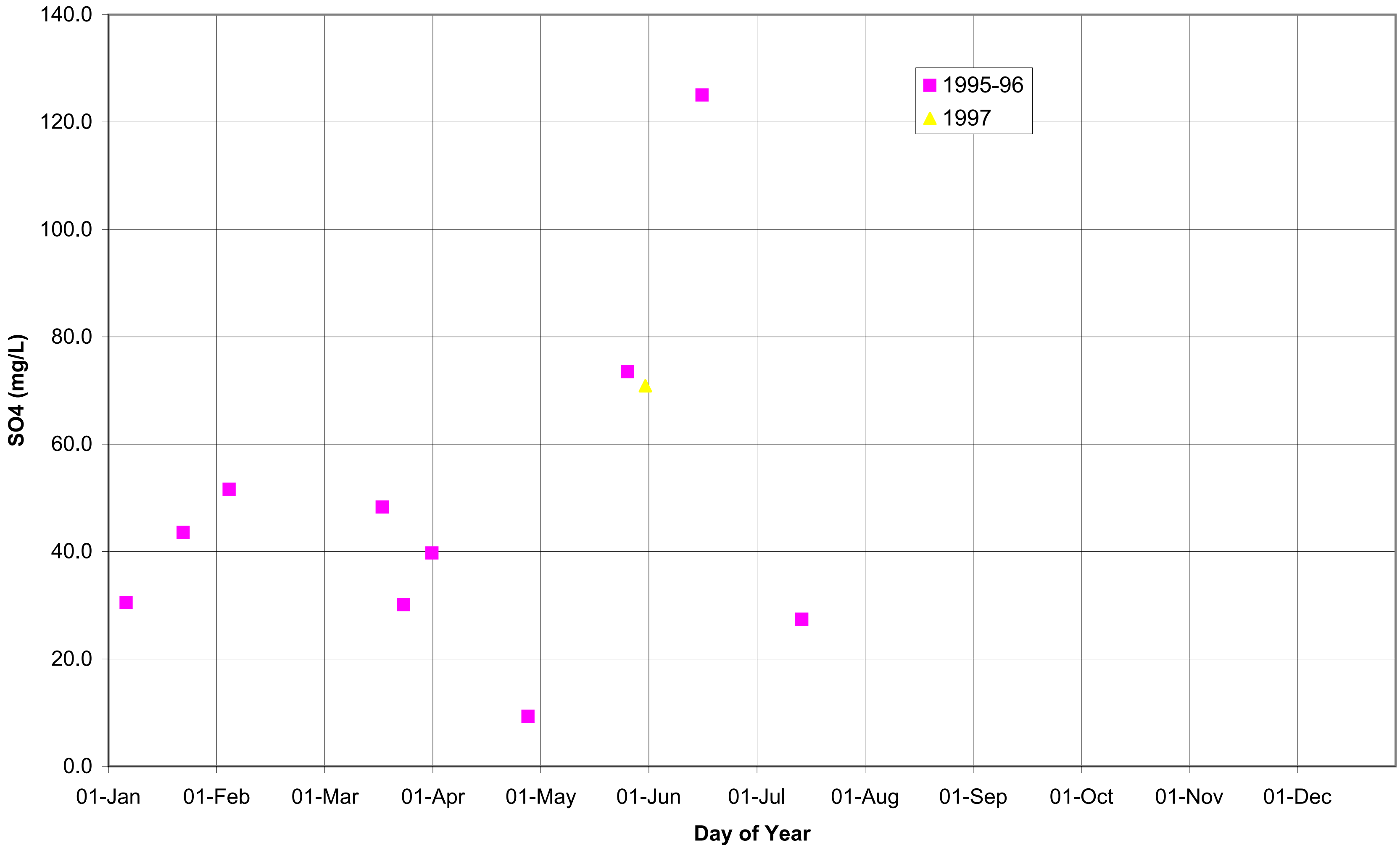


Figure 3.3 TDS Concentrations Measured in Flat Creek (OUA137C).

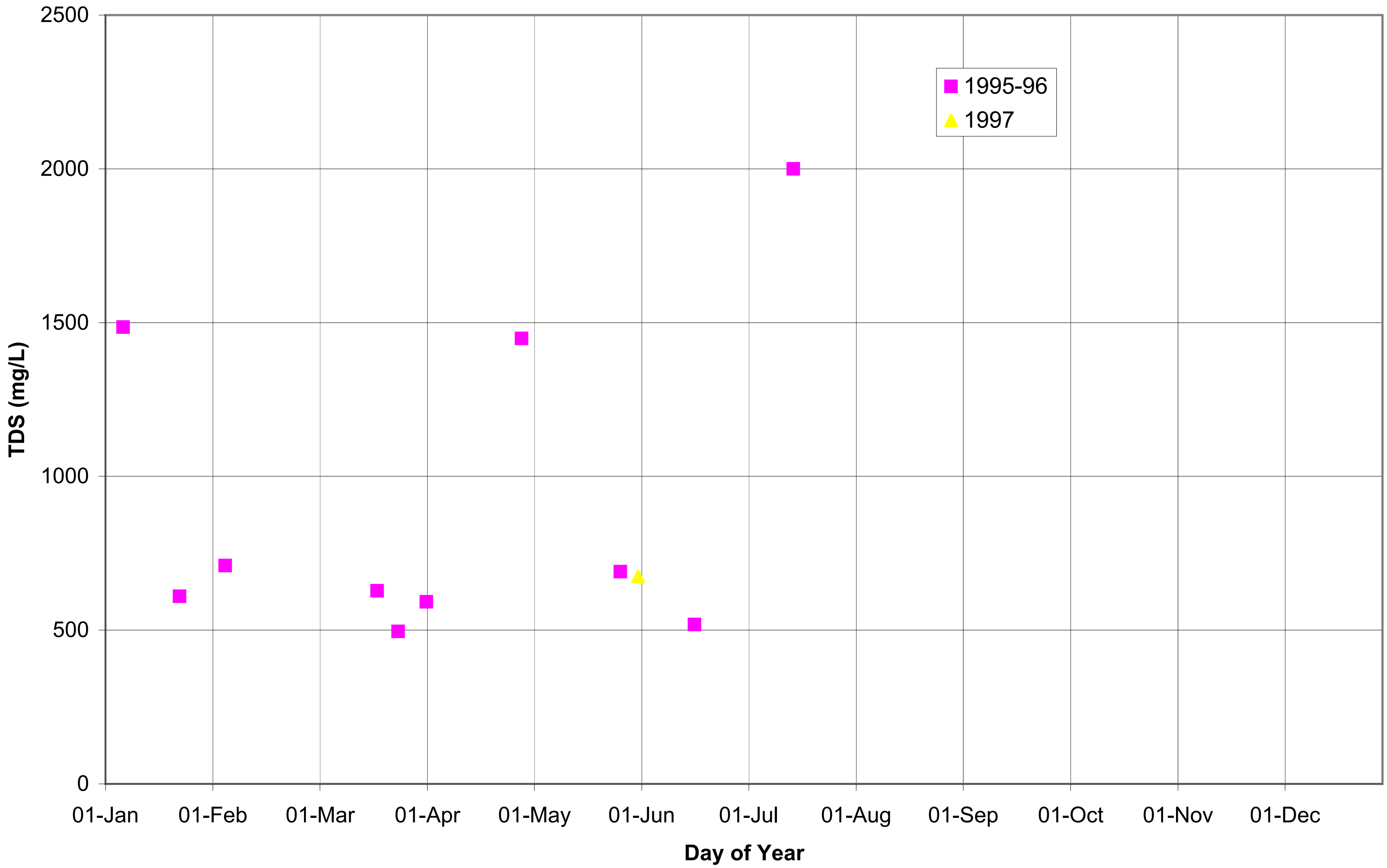


Figure 3.4 Chloride Concetrations Measured in Salt Creek (OUA137D).

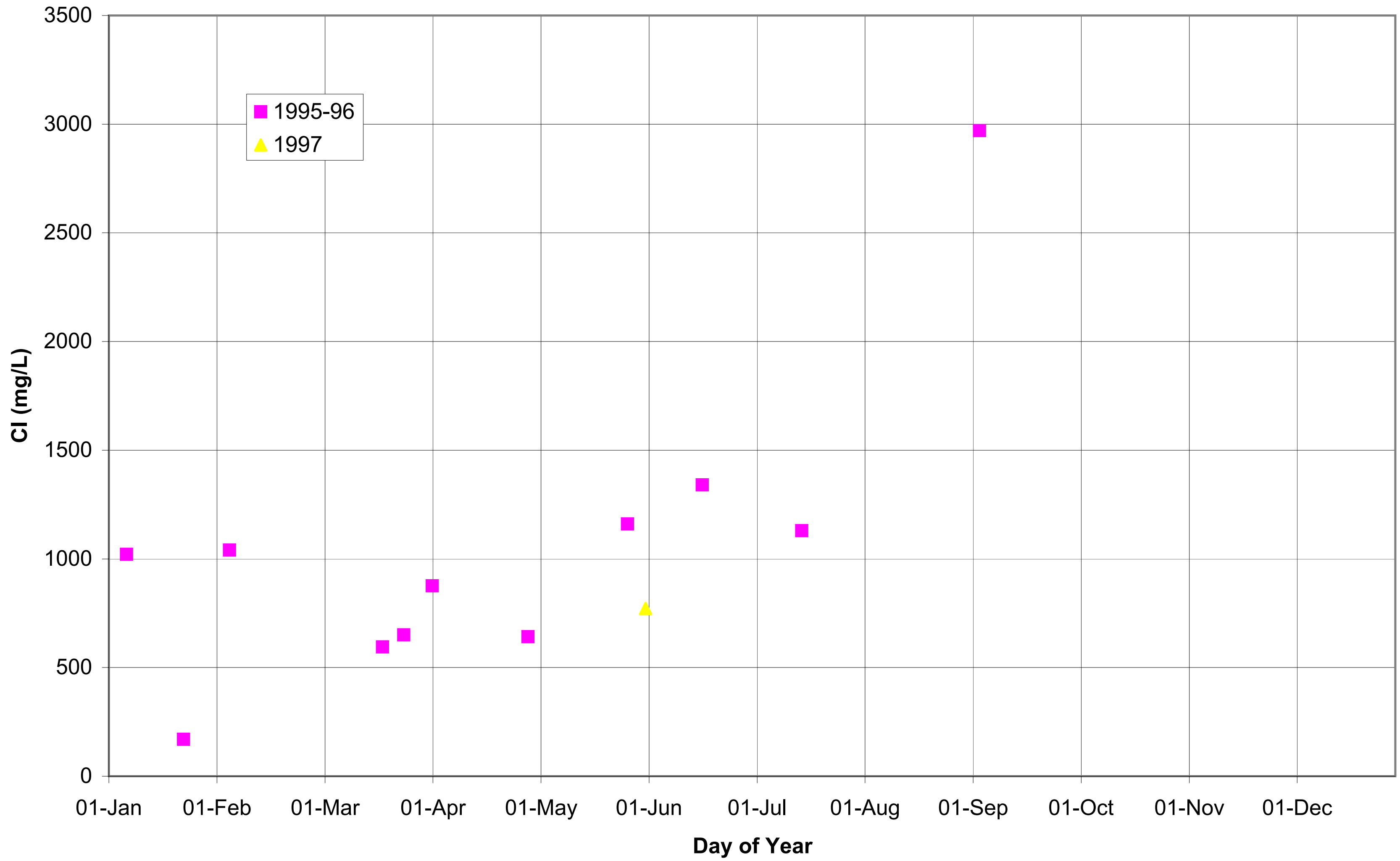


Figure 3.5 Sulfate Concentration Measured in Salt Creek (OUA137D).

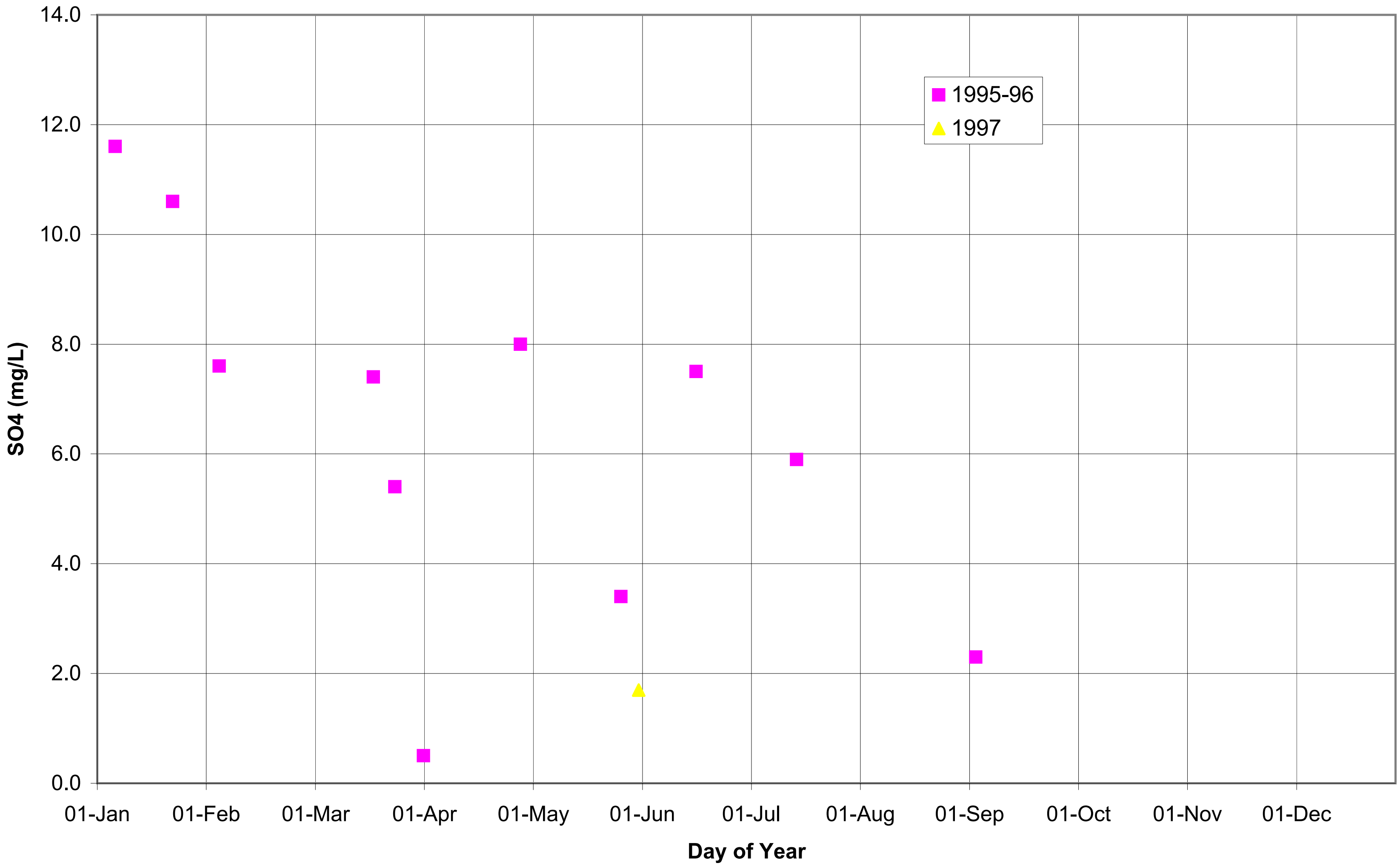
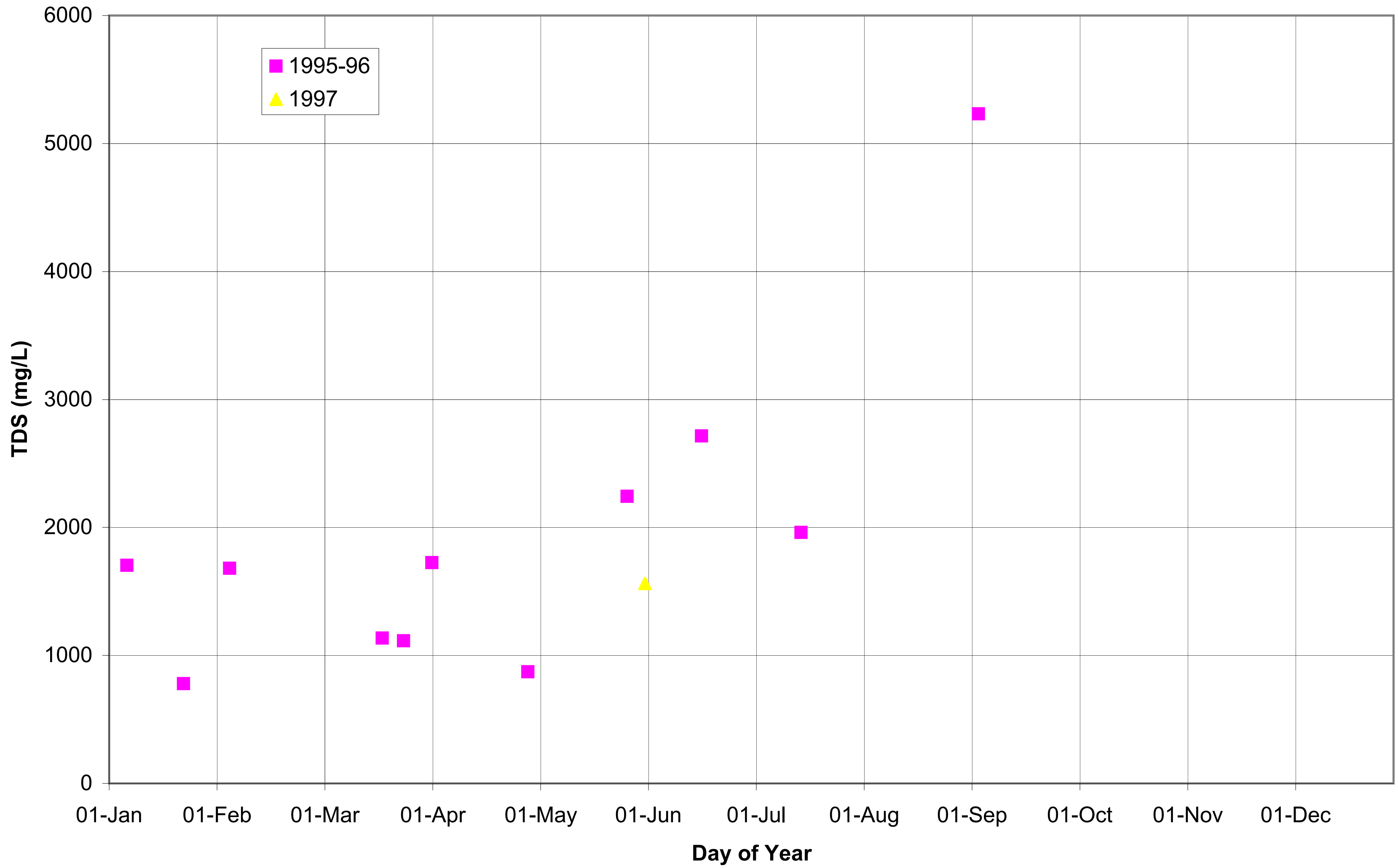


Figure 3.6 TDS Concentrations Measured in Salt Creek (OUA137D).



APPENDIX C

Dissolved Mineral TMDL Calculations for Flat Creek

TABLE C.1. TOTAL **CURRENT** LOADS OF DISSOLVED MINERALS FOR FLAT CREEK

Measured concentrations at Station OUA137C:
(upstream of confluence with ELCC Tributary)

	Chlorides (mg/L)	Sulfates (mg/L)	TDS (mg/L)
5/17/94	278	9.0	1137
6/21/94	404	17.3	839
7/26/94	159	20.8	395
9/26/94	349	56.9	1730
10/18/94	382	37.6	763
12/6/94	1240	11.3	1900
1/24/95	261	43.6	610
3/21/95	287	48.3	628
4/4/95	247	39.7	592
9/5/95	936	46.2	1745
1/8/96	850	30.5	1485
2/6/96	347	51.6	710
3/26/96	227	30.1	496
4/30/96	758	9.3	1448
5/28/96	298	73.5	690
6/18/96	16.6	125	518
7/16/96	1160	27.4	2000
6/3/97	254	70.9	675
Averages:	470	41.6	1020

Calculation of flow and loads at mouth of Flat Creek (excluding ELCC Tributary inputs):

Avg annual runoff for USGS gage on Smackover Creek = 15.0 in/yr
Drainage area for Flat Cr. at mouth (exclud. ELCC Trib) = 14.56 mi2

Average annual streamflow for Flat Creek = 10.40 MGD
(Flow = Runoff, in/yr * Drainage area, mi2 * conversions)

Average annual loads for Flat Creek (excluding ELCC Tributary):
(Load = Flow, MGD * Conc, mg/L * 8.34)

Chlorides =	40766	lbs/day	(using OUA137C concs)
Sulfates =	3608	lbs/day	(using OUA137C concs)
TDS =	88471	lbs/day	(using OUA137C concs)

Note: The flows and loads for these TMDLs are calculated for Reach 08040201-706, which includes Flat Creek but not the ELCC Tributary (which is Reach 08040201-606). As mentioned in Section 4.1, it is assumed that water quality standards will be maintained in Flat Creek downstream of the ELCC Tributary if the recently established TMDLs for the ELCC Tributary are successfully implemented and water quality standards are maintained in Flat Creek upstream of the ELCC Tributary.

FILE: R:\PROJECTS\2110-550\TMDL_FLAT_MINERALS.XLS

TABLE C.2. TOTAL **ALLOWABLE** LOADS (TMDLs) OF DISSOLVED MINERALS FOR FLAT CREEK

Maximum naturally occurring levels:	Chlorides =	14	mg/L	(Reg 2, page 5-11)
	Sulfates =	31	mg/L	(Reg 2, page 5-11)
	TDS =	123	mg/L	(Reg 2, page 5-11)

For chlorides and sulfates, standards are 1/3 increase or 15 mg/L increase, whichever is less, over maximum naturally occurring levels. For TDS, standard is maximum naturally occurring level plus sum of increases in chlorides and sulfates (over maximum naturally occurring levels). (Reg 2, Section 2.511)

Water quality standards:	Chlorides =	19	mg/L
	Sulfates =	41	mg/L
	TDS =	138	mg/L

Average annual streamflow for Flat Creek = 10.40 MGD (from Table C.1)

Average annual allowable loads (TMDLs) for Flat Creek (excluding ELCC Tributary):

(Load = Flow, MGD * Conc, mg/L * 8.34)	Chlorides =	1648	lbs/day	Note: Values in shaded cells used in Table 4.1
	Sulfates =	3556	lbs/day	
	TDS =	11970	lbs/day	

FILE: R:\PROJECTS\2110-550\TMDL_FLAT_MINERALS.XLS

TABLE C.3. ALLOCATION OF LOADS AND PERCENT REDUCTIONS FOR FLAT CREEK

	Chlorides	Sulfates	TDS	
Average annual streamflow for Flat Creek =	10.40 MGD			(from Table C.1)
	Chlorides (mg/L)	Sulfates (mg/L)	TDS (mg/L)	
Concentrations for background sources: (based on reference stream data):	5	13	67	(from CPP)
	Chlorides (lbs/day)	Sulfates (lbs/day)	TDS (lbs/day)	
Avg annual loads for background sources: (Load = Flow, MGD * Conc, mg/L * 8.34)	434	1128	5811	Note: Values in shaded cells used in Table 4.1
LA for man-induced nonpoint sources + MOS:				
TMDL for Flat Creek	1648	3556	11970	(from Table C.2)
minus background load	-434	-1128	-5811	(from immed. above)
minus WLA for point sources	-0	-0	-0	(no point sources)
Totals:	1214	2428	6159	
times 90% (to incorporate MOS)	x 90%	x 90%	x 90%	
equals LA for man-induced NPS	1093	2185	5543	Note: Values in shaded cells used in Table 4.1
Margin of safety (MOS):				
Totals from above (before multiplying by 90%)	1214	2428	6159	
times 10%	x 10%	x 10%	x 10%	
equals margin of safety	121	243	616	
Total CURRENT load for man-induced NPS:				
Total current load for Flat Creek	40766	3608	88471	(from Table C.1)
minus background load	-434	-1128	-5811	(from above)
minus current point source loading	-0	-0	-0	
equals total current load for man-induced NPS:	40332	2480	82660	
Load allocation for man-induced NPS (i.e., allowable):	1093	2185	5543	(from above)
Percent reduction needed for man-induced NPS: % reduc. = 100% x (current load - LA) / current load	97%	12%	93%	

FILE: R:\PROJECTS\2110-550\TMDL_FLAT_MINERALS.XLS

APPENDIX D

Dissolved Mineral TMDL Calculations for Salt Creek

TABLE D.1. TOTAL **CURRENT** LOADS OF DISSOLVED MINERALS FOR SALT CREEK

Measured concentrations at Station OUA137D:

	Chlorides (mg/L)	TDS (mg/L)
5/17/94	490	1819
6/21/94	1300	2482
7/26/94	928	1730
9/26/94	746	3200
10/18/94	938	1642
12/6/94	1290	2060
1/24/95	170	780
3/21/95	594	1136
4/4/95	876	1724
9/5/95	2970	5231
1/8/96	1020	1704
2/6/96	1040	1681
3/26/96	650	1114
4/30/96	642	871
5/28/96	1160	2242
6/18/96	1340	2714
7/16/96	1130	1961
6/3/97	771	1562
Averages:	1003	1981

Note: Sulfate data are not shown here because a TMDL for sulfates is not needed for Salt Creek.

Calculation of flow and loads at mouth of Salt Creek:

Avg annual runoff for USGS gage on Smackover Creek =	15.0	in/yr
Drainage area for Salt Creek at mouth =	17.94	mi2

Average annual streamflow for Salt Creek at mouth = 12.81 MGD
(Flow = Runoff, in/yr * Drainage area, mi2 * conversions)

Average annual loads for Salt Creek at mouth:
(Load = Flow, MGD * Conc, mg/L * 8.34)

Chlorides =	107156	lbs/day	(using OUA137D concs)
TDS =	211641	lbs/day	(using OUA137D concs)

FILE: R:\PROJECTS\2110-550\TMDL_SALT_MINERALS.XLS

TABLE D.2. TOTAL **ALLOWABLE** LOADS (TMDLs) OF DISSOLVED MINERALS FOR SALT CREEK

Maximum naturally occurring levels:	Chlorides =	14	mg/L	(Reg 2, page 5-11)
	Sulfates =	31	mg/L	(Reg 2, page 5-11)
	TDS =	123	mg/L	(Reg 2, page 5-11)

For chlorides and sulfates, standards are 1/3 increase or 15 mg/L increase, whichever is less, over maximum naturally occurring levels. For TDS, standard is maximum naturally occurring level plus sum of increases in chlorides and sulfates (over maximum naturally occurring levels). (Reg 2, Section 2.511)

Water quality standards:	Chlorides =	19	mg/L
	Sulfates =	41	mg/L
	TDS =	138	mg/L

Average annual streamflow for Salt Creek at mouth = 12.81 MGD (from Table D.1)

Average annual allowable loads (TMDLs) for Salt Creek at mouth:

(Load = Flow, MGD * Conc, mg/L * 8.34)	Chlorides =	2030	lbs/day	Note: Values in shaded
	TDS =	14743	lbs/day	cells used in Table 4.1

Note: No TMDL for sulfates is needed for Salt Creek.

FILE: R:\PROJECTS\2110-550\TMDL_SALT_MINERALS.XLS

TABLE D.3. ALLOCATION OF LOADS AND PERCENT REDUCTIONS FOR SALT CREEK

	Chlorides	TDS	
Average annual streamflow for Salt Creek at mouth =	12.81 MGD		(from Table D.1)
	Chlorides (mg/L)	TDS (mg/L)	
Concentrations for background sources: (based on reference stream data):	5	67	(from CPP)
	Chlorides (lbs/day)	TDS (lbs/day)	
Avg annual loads for background sources: (Load = Flow, MGD * Conc, mg/L * 8.34)	534	7158	Note: Values in shaded cells used in Table 4.1
LA for man-induced nonpoint sources + MOS:			
TMDL for Salt Creek at mouth	2030	14743	(from Table D.2)
minus background load	-534	-7158	(from immed. above)
minus WLA for point sources	-0	-0	(no point sources)
Totals:	1496	7585	
times 90% (to incorporate MOS)	x 90%	x 90%	
equals LA for man-induced NPS	1346	6826	Note: Values in shaded cells used in Table 4.1
Margin of safety (MOS):			
Totals from above (before multiplying by 90%)	1496	7585	
times 10%	x 10%	x 10%	
equals margin of safety	150	759	
Total CURRENT load for man-induced NPS:			
Total current load for Flat Creek	107156	211641	(from Table D.1)
minus background load	-534	-7158	(from above)
minus current point source loading	-0	-0	
equals total current load for man-induced NPS:	106622	204483	
Load allocation for man-induced NPS (i.e., allowable):	1346	6826	(from above)
Percent reduction needed for man-induced NPS: % reduc. = 100% x (current load - LA) / current load	99%	97%	

FILE: R:\PROJECTS\2110-550\TMDL_SALT_MINERALS.XLS

APPENDIX E

Responses to Public Comments

COMMENTS AND RESPONSES
TMDLs FOR CHLORIDE, SULFATE, AND TDS
IN FLAT CREEK AND SALT CREEK, ARKANSAS
October 8, 2003

EPA appreciates all comments concerning these TMDLs. Comments that were received are shown below with EPA responses or notes inserted in a different font.

COMMENTS FROM GBMc & ASSOCIATES ON BEHALF OF EL DORADO CHEMICAL COMPANY:

We have reviewed the referenced TMDLs and the related documentation. As you may be aware, El Dorado Chemical Company (EDCC) discharges into an unnamed tributary of Flat Creek. This unnamed tributary was the subject of a previous TMDL and is "incorporated" into this TMDL for Flat Creek by reference. As we commented on during the preparation of the TMDL for the unnamed tributary of Flat Creek (reach 08040201-606), there were technical and regulatory issues which needed to be resolved before that TMDL could be finalized in a satisfactory manner. As such, the Flat Creek TMDL continues several of the same deficiencies. EDCC has no discharges in direct relation to Salt Creek. Our comments are as follows:

Ambient Water Quality Data Limitations

The ambient water quality data for both Flat and Salt Creeks, as used in the preparation of the TMDLs, has significant deficiencies. As is seen upon review, the data were collected between January 1995 to December 1997. Data that old is not normally used to assess current conditions and we do not see how it can be considered to be representative.

Response: The allowable loadings of dissolved minerals for these streams were calculated based on water quality standards, not ambient water quality data. The ambient data were used to characterize current conditions and estimate percent reductions needed to meet standards. These TMDLs were developed using the most recent set of ambient data that were available for the whole watershed. In 2000, ADEQ collected a limited amount of water quality data at stations OUA137C (Flat Creek) and OUA137D (Salt Creek). The 2000 data are summarized and compared to the 1995-97 data in the table below. The 2000 data are similar to the 1995-97 data. This is not surprising because there have been no major land use changes or remediation activities on a widespread scale in the watershed. Therefore, EPA considers the 1995-97 data to be appropriate for use in these TMDLs.

Table E.1. Comparison of dissolved mineral data for 1995-97 and 2000.

	Flat Creek (OUA137C)		Salt Creek (OUA137D)	
	1995-97	**2000**	**1995-97**	**2000**
Chloride (mg/L)				
Number of samples	11	4	12	4
Minimum	16.6	287	170	155
Maximum	1,160	810	2,970	925
Median	287	406	948	804
Number above standards	10	4	12	4
Percent above standards	91%	100%	100%	100%
Sulfate (mg/L)				
Number of samples	11	5	12	5
Minimum	9.3	7.6	0.5	1.3
Maximum	125	151	11.6	4.7
Median	43.6	12.7	6.7	2.0
Number above standards	6	2	0	0
Percent above standards	55%	40%	0%	0%
TDS (mg/L)				
Number of samples	11	4	12	4
Minimum	496	478	780	380
Maximum	2,000	1,629	5,231	1,846
Median	675	817	1,693	1,824
Number above standards	11	4	12	4
Percent above standards	100%	100%	100%	100%

In addition, although the dissolved mineral TMDLs are based upon the maintenance of water quality criteria under average flow conditions, there is no information to correlate the ambient monitoring data to waterbody flows. Based on the data presented, it appears that no storm event sampling was utilized in either study nor was the sampling data for Flat Creek correlated with the intermittent discharges from EDCC. It should be noted that EDCC's Outfall 001, which discharges to Flat Creek, does not have a constant discharge and often is shut off for months during the summer. EDCC has NPDES permitted storm water outfalls which discharge solely in response to rain events at which time elevated stream flows occur. These characteristics were not considered in the TMDL report for Flat Creek.

Response: As discussed in Section 4.1.1 of the report, the determination of critical conditions was based on analysis of available data, which did not include continuous stream flow data or daily effluent flow data from El Dorado Chemical Company. EPA agrees that it would be useful to have flow data to correlate with water quality data, but having flow data is not required for development of TMDLs. The available water quality data did not show any significant patterns that suggested a strong correlation with flows.

The TMDL study does not appropriately document current ambient waterbody conditions as needed to correctly assess either point or nonpoint source loadings. This is due to the age of the data and because the data was not collected under a long-term sampling program designed specifically to characterize the variable water quality resulting from the intermittent nature of the flow regime of the waterbodies. In addition the discharges from EDCC into the unnamed tributary to Flat Creek were not correlated to instream Flat Creek data in any way. We recommend that no TMDL be finalized for either waterbody until such time as appropriate ambient monitoring (including flow measurement) is conducted.

Response: Because there are no point source discharges to either of these two reaches (08040201-706 and -806), there are no point source loadings to assess for these TMDLs. The ELCC facility has no impact on Salt Creek, and the ambient water quality data for Flat Creek were collected upstream of where the ELCC tributary flows into Flat Creek. The available data were sufficient for assessing nonpoint source loadings for these two reaches.

Regulatory Context for Dissolved Minerals

The TMDL allocations as developed for dissolved mineral (chloride, sulfate and TDS) are based on erroneous regulatory interpretations of Regulation No.2, the State of Arkansas Water Quality Standards (WQS). This misinterpretation is based on the definition of critical flow as contained in Section 2.106 of the WQS. This section reads as follows:

"Critical flows: The flow volume used as background dilution flows in calculating concentrations of pollutants from permitted discharges. These flows may be adjusted for mixing zones. The following critical flows are applicable:

For a seasonal fishery – 1 cfs minus the design flow of any point source discharge (may not be less than zero).

For human health criteria – harmonic mean flow or long term average flow.

For minerals criteria – harmonic mean flow or 4 cfs, except in those waters listed in Section 2.510. Those waters in Section 2.510 which are noted with an asterisk will have a critical flow of 4 cfs. (Also see minerals implementation procedure in CPP).

For all others – the critical flow will be Q7 – 10."

As is evident by this definition, under the WQS critical flows are specifically applicable to permitted discharges and nonpoint sources are not mentioned. Under this regulatory framework, the allocation of dissolved minerals loadings from permitted discharges are primary to those for nonpoint sources.

In this context, the TMDL for Flat Creek (which includes point source loadings to the unnamed tributary) should be amended to allocate dissolved minerals loadings at the appropriate critical flows to the permitted point source discharges pursuant to the definition of the WQS. The Flat Creek TMDLs' current allocation processes, which treats unpermitted nonpoint sources as equal to permitted discharges in the unnamed tributary at the critical flow, is not supported by the WQS. Through its inclusion of nonpoint sources as being equal to permitted discharges, the TMDL constitutes a revision to the critical flow definition of the WQS without the benefit of rulemaking and due process.

Response: As evident from Section 4 of this report, the TMDL for Flat Creek does not include loadings from point sources that discharge into the ELCC Tributary. Those loadings were already accounted for in the ELCC Tributary TMDL (final report dated December 16, 2002). Therefore, the language cited by the commenter is applicable for "calculating concentrations of pollutants from permitted dischargers." Since there are no permitted dischargers this language does not apply.

As noted in the comment above, the critical flows were developed for calculating concentrations of pollutants from permitted discharges. Federal regulations (40 CFR 130.7) require TMDLs to take into account critical conditions. Because the available water quality data did not show any significant patterns related to seasonal variation or other factors, the TMDLs were developed for mean annual conditions (i.e., using mean annual flow conditions).

Conclusion

The TMDLs for both Flat Creek and Salt Creek as developed have significant limitations. These include the interpretation of the WQS and the use of outdated ambient water quality data. For these reasons we request that the TMDLs be revised to address these concerns. Due to the fact that the Flat Creek TMDL incorporates the previously completed unnamed tributary TMDL by reference, we request that our letter of November 15, 2002 regarding dissolved minerals be made part of the record for the Flat Creek TMDL. For your convenience, we have attached those comments to this letter.

Response: See responses to specific comments above. EPA's responses to the comments on the ELCC Tributary TMDL are included in the last appendix in the ELCC Tributary TMDL report dated December 16, 2002.