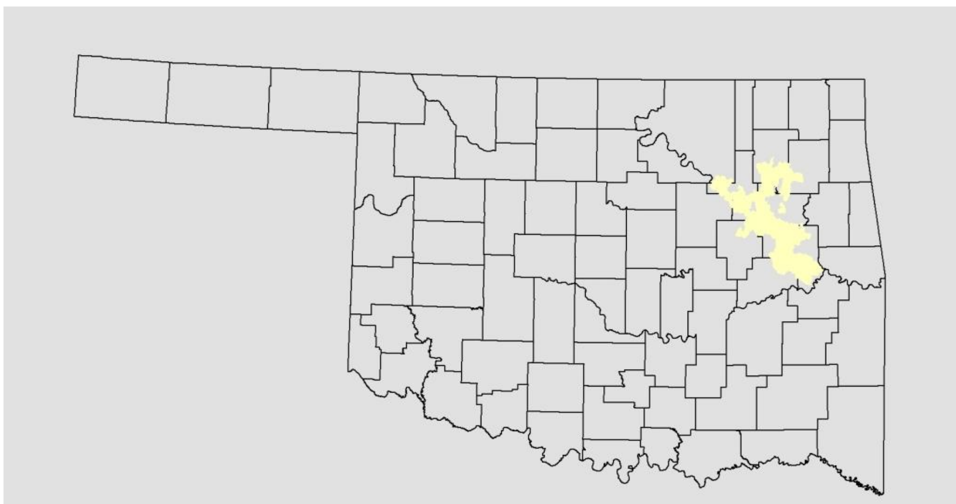
FINAL

BACTERIAL AND TURBIDITY TOTAL MAXIMUM DAILY LOADS FOR THE ARKANSAS-VERDIGRIS RIVER STUDY AREA, OKLAHOMA (OK120400, OK120410, OK120420, OK121500, OK121600)



OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

SEPTEMBER 2012

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BACTERIAL AND TURBIDITY TOTAL MAXIMUM DAILY LOADS FOR THE ARKANSAS-VERDIGRIS RIVER STUDY AREA, OKLAHOMA
(OK120400, OK120410, OK120420, OK121500, OK121600)

OKWBID

Arkansas River	OK120400010260_00	Arkansas River	OK120420010130_00
Coody Creek	OK120400010400_00	Polecat Creek	OK120420020010_00
Dirty Creek	OK120400020010_00	Polecat Creek	OK120420020050_00
Dirty Creek, South Fork	OK120400020030_00	Verdigris River	OK121500010200_00
Dirty Creek, Georges Fork	OK120400020110_00	Bull Creek	OK121500020090_00
Butler Creek	OK120400020160_00	Pea Creek	OK121500020100_00
Elk Creek	OK120400020190_00	Verdigris River	OK121500020260_00
Shady Grove Creek	OK120400020240_00	Dog Creek	OK121500020360_00
Arkansas River	OK120410010080_00	Verdigris River	OK121500030010_00
Cloud Creek	OK120410010100_00	Neosho River	OK121600010010_00
Snake Creek	OK120410010220_00	Chouteau Creek	OK121600010430_00
Arkansas River	OK120420010010_00		

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

SEPTEMBER 2012

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

AEMS	Agricultural Environmental Management Service
ASAE	American Society of Agricultural Engineers
BMP	Best management practices
BOD	Biochemical Oxygen Demand
CAFO	Concentrated Animal Feeding Operation
CBOD	Carbonaceous Biochemical Oxygen Demand
CFR	Code of Federal Regulations
cfs	cubic feet per second
cfu	colony-forming unit
CPP	Continuing Planning Process
CWA	Clean Water Act
DEQ	Oklahoma Department of Environmental Quality
DMR	Discharge monitoring report
E. coli	Escherichia coli
ENT	Enterococci
EPA	U.S. Environmental Protection Agency
HUC	Hydrologic unit code
IQR	Interquartile range
LA	Load allocation
LDC	Load duration curve
LOC	Line of organic correlation
mg	Million gallons
mgd	Million gallons per day
mg/L	Milligram per liter
mL	Milliliter
MOS	Margin of safety
MS4	Municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRMSE	Normalized root mean square error
NTU	Nephelometric turbidity unit

OAC	Oklahoma Administrative Code
OLS	Ordinary least square
O.S.	Oklahoma statute
ODAFF	Oklahoma Department of Agriculture, Food and Forestry
OKWBID	Oklahoma Waterbody Identification Number
OPDES	Oklahoma Pollutant Discharge Elimination System
OSWD	Onsite wastewater disposal
OWQS	Oklahoma Water Quality Standards
OWRB	Oklahoma Water Resources Board
PBCR	Primary Body Contact Recreation
PRG	Percent reduction goal
RMSE	Root mean square error
SH	State Highway
SSO	Sanitary sewer overflow
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WWAC	warm water aquatic community
WLA	wasteload allocation
WQM	Water quality monitoring
WQMP	Water Quality Management Plan
WQS	Water quality standard
WWTP	wastewater treatment plant

Executive Summary

This report documents the data and assessment used to establish TMDLs for the pathogen indicator bacteria [*E. coli and* Enterococci] and turbidity for certain waterbodies in the Arkansas-Verdigris River basin area. Elevated levels of pathogen indicator bacteria in aquatic environments indicate that a waterbody is contaminated with human or animal feces and that a potential health risk exists for individuals exposed to the water. Elevated turbidity levels caused by excessive sediment loading and stream bank erosion impact aquatic communities. Data assessment and total maximum daily load (TMDL) calculations are conducted in accordance with requirements of Section 303(d) of the Clean Water Act (CWA), Water Quality Planning and Management Regulations (40 CFR Part 130), U.S. Environmental Protection Agency (EPA) guidance, and Oklahoma Department of Environmental Quality (DEQ) guidance and procedures. DEQ is required to submit all TMDLs to EPA for review. TMDLs for approved 303(d) listed waterbody-pollutant pairs or surrogates will receive notification of EPA's approval or disapproval action. Once the EPA approves a TMDL, then the waterbody may be moved to Category 4a of a state's Integrated Water Quality Monitoring and Assessment Report, where it remains until compliance with water quality standards (WQS) is achieved (EPA 2003).

The purpose of this TMDL report is to establish pollutant load allocations for indicator bacteria and turbidity in impaired waterbodies, which is the first step toward restoring water quality and protecting public health. TMDLs determine the pollutant loading a waterbody can assimilate without exceeding the WQS for that pollutant. TMDLs also establish the pollutant load allocation necessary to meet the WQS established for a waterbody based on the relationship between pollutant sources and instream water quality conditions. A TMDL consists of a wasteload allocation (WLA), load allocation (LA), and a margin of safety (MOS). The WLA is the fraction of the total pollutant load apportioned to point sources, and includes stormwater discharges regulated under the National Pollutant Discharge Elimination System (NPDES) as point sources. The LA is the fraction of the total pollutant load apportioned to nonpoint sources. MOS can be implicit and/or explicit. An implicit MOS is achieved by using conservative assumptions in the TMDL calculations. An explicit MOS is a percentage of the TMDL set aside to account for the lack of knowledge associated with natural process in aquatic systems, model assumptions, and data limitations.

This report does not stipulate specific control actions (regulatory controls) or management measures (voluntary best management practices) necessary to reduce bacteria or turbidity within each watershed. Watershed-specific control actions and management measures will be identified, selected, and implemented under a separate process.

E.1 Problem Identification and Water Quality Target

This TMDL report focuses on waterbodies identified in Table ES-1 that DEQ placed in Category 5 [303(d) list] of the *Water Quality in Oklahoma, 2008 Integrated Report* (2008 Integrated Report) for nonsupport of primary body contact recreation (PBCR) or warm water aquatic community (WWAC).

Elevated levels of bacteria or turbidity above the WQS necessitates the development of a TMDL. The TMDLs established in this report are a necessary step in the process to develop the pollutant loading controls needed to restore the primary body contact recreation or fish and wildlife propagation beneficial uses designated for each waterbody.

Table ES-1 Excerpt from the 2008 Integrated Report – Oklahoma 303(d) List of Impaired Waters (Category 5)

Waterbody Name	Waterbody ID	Stream Miles	TMDL Date	Priority	ENT	*E. coli*	Turbidity
Arkansas River near Muskogee	OK120400010260_00	11	2013	2	X		
Coody Creek	OK120400010400_00	16	2013	2	X		
Dirty Creek	OK120400020010_00	44	2016	3			X
Dirty Creek, South Fork	OK120400020030_00	16	2019	4	X		
Dirty Creek, Georges Fork	OK120400020110_00	10	2016	3	X		
Butler Creek	OK120400020160_00	10	2019	4	X		
Elk Creek	OK120400020190_00	14	2019	4			X
Shady Grove Creek	OK120400020240_00	11	2019	4	X		
Arkansas River near Haskell	OK120410010080_00	42	2016	3	X		
Cloud Creek	OK120410010100_00	6	2019	4			X
Haikey Creek	OK120410010210_00	11	2016	3		X	
Snake Creek	OK120410010220_00	31	2013	2	X		
Arkansas River near Bixby	OK120420010010_00	17	2013	2	X		
Fred Creek	OK120420010060_00	3	2013	2		X	
Mooser Creek	OK120420010070_00	4	2013	2		X	
Crow Creek	OK120420010090_00	3	2013	2		X	
Arkansas River near Sand Springs	OK120420010130_00	12	2013	2			X
Blackboy Creek	OK120420010140_00	4	2013	2		X	
Harlow Creek	OK120420010170_00	6	2013	2		X	
Polecat Creek	OK120420020010_00	7	2013	2	X		
Nickel Creek	OK120420020040_00	12	2016	3		X	
Polecat Creek	OK120420020050_00	8	2016	3	X		
Verdigris River near Wagoner	OK121500010200_00	6	2013	2	X		X
Bull Creek	OK121500020090_00	18	2013	2	X	X	X
Pea Creek	OK121500020100_00	10	2013	2	X	X	
Adams Creek	OK121500020150_00	18	2013	2		X	
Verdigris River near Inola	OK121500020260_00	23	2013	2	X		X
Dog Creek	OK121500020360_00	10	2013	2	X	X	
Cat Creek	OK121500020390_00	7	2013	2	X	X	
Verdigris River near Claremore	OK121500030010_00	10	2016	3	X		
Neosho River below Ft. Gibson Lake	OK121600010010_00	1	2010	1	X		
Chouteau Creek	OK121600010430_00	22	2016	3	X	X	

ENT = Enterococci; EC = *E. coli* Source: 2008 Integrated Report, DEQ 2008.

Table ES-2 summarizes water quality data collected during primary contact recreation season (May 1 through September 30) from the water quality monitoring (WQM) stations for each bacterial indicator. The data summary in Table ES-2 provides a general understanding of the amount of water quality data available and the severity of exceedances of the water quality criteria. This data collected during the primary contact recreation season includes the data used to support the decision to place specific waterbodies within the Study Area on the DEQ 2008 303(d) list (DEQ 2008). It also includes the new date collected after the data cutoff date for the 2008 303(d) list.

Table ES-2 Summary of Indicator Bacterial Samples from Primary Body Contact Recreation subcategory Season, May 1 to September 30, 2000-2010

Waterbody ID	Stream Segments	Bacterial Indicator	Standards	GeoMean (cfu/100ml)	# of Samples	2008 303(d)	Comments
OK120400010260_00	Arkansas River near Muskogee	ENT	33	83	18	X	TMDL Required
OK120400010400_00	Coody Creek	ENT	33	219	18	X	TMDL Required
		EC	126	152	18		Does not meet standards,TMDL Required
OK120400020010_00	Dirty Creek	ENT	33	55	18		Does not meet standards,TMDL Required
OK120400020030_00	Dirty Creek, South Fork	ENT	33	207	18	X	TMDL Required
OK120400020110_00	Dirty Creek, Georges Fork	ENT	33	136	18	X	TMDL Required
OK120400020160_00	Butler Creek	ENT	33	94	16	X	TMDL Required
		EC	126	165	16		Does not meet standards,TMDL Required
OK120400020190_00	Elk Creek	ENT	33	61	18		Does not meet standards,TMDL Required
OK120400020240_00	Shady Grove Creek	ENT	33	36	17	X	TMDL Required
OK120410010080_00	Arkansas River near Haskell	ENT	33	44	25	X	TMDL Required
OK120410010100_00	Cloud Creek	ENT	33	56	18		Does not meet standards,TMDL Required
OK120410010210_00	Haikey Creek	EC	126				Delist for 2010: No data Available
OK120410010220_00	Snake Creek	ENT	33	58	18	X	TMDL Required
OK120420010010_00	Arkansas River near Bixby	ENT	33	108	25		TMDL Required
OK120420010060_00	Fred Creek	EC	126			X	Delist for 2010: No data Available
OK120420010070_00	Mooser Creek	EC	126			X	Delist for 2010: No data Available
OK120420010090_00	Crow Creek	EC	126			X	Delist for 2010: No data Available
OK120420010130_00	Arkansas River near Sand Springs	ENT	33	36	22		TMDL Required
OK120420010140_00	Blackboy Creek	ENT	33			X	Delist for 2010: No data Available
OK120420010170_00	Harlow Creek	ENT	33			X	Delist for 2010: No data Available
OK120420020010_00	Polecat Creek	ENT	33			X	Delist for 2010: No data Available
		EC	126	154	17		Does not meet standards,TMDL Required
OK120420020040_00	Nickel Creek	EC	126			X	Delist for 2010: No data Available
OK120420020050_00	Polecat Creek	ENT	33	58	20	X	TMDL Required
OK121500010200_00	Verdigris River near Wagoner	ENT	33	123	25	X	TMDL Required
OK121500020090_00	Bull Creek	ENT	33	203	20	X	TMDL Required
		EC	126	167	20	X	TMDL Required
OK121500020100_00	Pea Creek	ENT	33	940	17	X	TMDL Required
		EC	126	331	17	X	TMDL Required
OK121500020150_00	Adams Creek	EC	126				Delist for 2010: No data Available
OK121500020260_00	Verdigris River near Inola	ENT	33	157	20	X	TMDL Required
OK121500020360_00	Dog Creek	ENT	33	169	28	X	TMDL Required
		EC	126	240	28	X	TMDL Required
OK121500020390_00	Cat Creek	ENT	33	228	8	X	Delist for 2010: Samples < 10
		EC	126	261	8	X	Delist for 2010: Samples < 10
OK121500030010_00	Verdigris River near Claremore	ENT	33	114	21	X	TMDL Required
OK121600010010_00	Neosho River below Ft. Gibson Lake	ENT	33	63	13	X	TMDL Required
OK121600010430_00	Chouteau Creek	ENT	33	220	16	X	TMDL Required
		EC	126	138	17	X	TMDL Required

The definition of PBCR and the bacterial WQSs for PBCR are summarized by the following excerpt from Chapter 45 of the Oklahoma WQSs:

(a) Primary Body Contact Recreation involves direct body contact with the water where a possibility of ingestion exists. In these cases the water shall not contain chemical, physical or biological substances in concentrations that are irritating to skin or sense organs or are toxic or cause illness upon ingestion by human beings.

(b) In waters designated for Primary Body Contact Recreation...limits...shall apply only during the recreation period of May 1 to September 30. The criteria for Secondary Body Contact Recreation will apply during the remainder of the year.

(c) Compliance with 785:45-5-16 shall be based upon meeting the requirements of one of the options specified in (1) or (2) of this subsection (c) for bacteria. Upon selection of one (1) group or test method, said method shall be used exclusively over the time period prescribed therefor. Provided, where concurrent data exist for multiple bacterial indicators on the same waterbody or waterbody segment, no criteria exceedances shall be allowed for any indicator group.

(1) Escherichia coli (E. coli): The E. coli geometric mean criterion is 126/100 ml. For swimming advisory and permitting purposes, E. coli shall not exceed a monthly geometric mean of 126/100 ml based upon a minimum of not less than five (5) samples collected over a period of not more than thirty (30) days. For swimming advisory and permitting purposes, no sample shall exceed a 75% one-sided confidence level of 235/100 ml in lakes and high use waterbodies and the 90% one-sided confidence level of 406/100 ml in all other Primary Body Contact Recreation beneficial use areas. These values are based upon all samples collected over the recreation period. For purposes of sections 303(d) and 305(b) of the federal Clean Water Act as amended, beneficial use support status shall be assessed using only the geometric mean criterion of 126/100 milliliters compared to the geometric mean of all samples collected over the recreation period.

(2) Enterococci: The Enterococci geometric mean criterion is 33/100 ml. For swimming advisory and permitting purposes, Enterococci shall not exceed a monthly geometric mean of 33/100 ml based upon a minimum of not less than five (5) samples collected over a period of not more than thirty (30) days. For swimming advisory and permitting purposes, no sample shall exceed a 75% one-sided confidence level of 61/100 ml in lakes and high use waterbodies and the 90% one-sided confidence level of 108/100 ml in all other Primary Body Contact Recreation beneficial use areas. These values are based upon all samples collected over the recreation period. For purposes of sections 303(d) and 305(b) of the federal Clean Water Act as amended, beneficial use support status shall be assessed using only the geometric mean criterion of 33/100 milliliters compared to the geometric mean of all samples collected over the recreation period.

To implement Oklahoma's WQS for PBCR, the Oklahoma Water Resources Board (OWRB) promulgated Chapter 46, *Implementation of Oklahoma's Water Quality Standards* (OWRB 2011). The abbreviated excerpt below from Chapter 46: 785:46-15-6, stipulates how water quality data will be assessed to determine support of the PBCR use as well as how the water quality target for TMDLs will be defined for each bacterial indicator:

(a) ***Scope.*** *The provisions of this Section shall be used to determine whether the subcategory of Primary Body Contact of the beneficial use of Recreation designated in OAC 785:45 for a waterbody is supported during the recreation season from May 1 through September 30 each year. Where data exist for multiple bacterial indicators on the same waterbody or waterbody segment, the determination of use support shall be based upon the use and application of all applicable tests and data.*

(b) ***Escherichia coli (E.coli).***

(1) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be fully supported with respect to E. coli if the geometric mean of 126 colonies per 100 ml is met. These values are based upon all samples collected over the recreation period in accordance with OAC 785:46-15-3(c).

(2) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be not supported with respect to E. coli if the geometric mean of 126 colonies per 100 ml is not met. These values are based upon all samples collected over the recreation period in accordance with OAC 785:46-15-3(c).

(c) ***Enterococci.***

(1) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be fully supported with respect to Enterococci if the geometric mean of 33 colonies per 100 ml is met. These values are based upon all samples collected over the recreation period in accordance with OAC 785:46-15-3(c).

(2) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be not supported with respect to Enterococci if the geometric mean of 33 colonies per 100 ml is not met. These values are based upon all samples collected over the recreation period in accordance with OAC 785:46-15-3(c).

Where concurrent data exist for multiple bacterial indicators on the same waterbody or waterbody segment, each indicator group must demonstrate compliance with the numeric criteria prescribed (OWRB 2011).

As stipulated in the WQS, only the geometric mean of all samples collected over the recreation period shall be used to assess the impairment status of a stream segment. Therefore, only the geometric mean criteria will be used to develop TMDLs for *E. coli* and Enterococci bacterial indicators.

It is worth noting that the Oklahoma Water Quality Standards (OWQS) prior to July 1, 2011 contains three bacterial indicators (fecal coliform, *E. coli* and Enterococci) and the new OWQS effective on July 1, 2011 contains only *E. coli* and Enterococci. Because the new OWQS no longer have a standard for fecal coliform, fecal coliform TMDLs will not be developed for any stream segment in this report even though the stream segments were listed for fecal coliform impairment in the 2008 303(d) list. Bacterial TMDLs will be developed only for *E. coli* and/or Enterococci impaired streams.

Turbidity is a measure of water clarity and is caused by suspended particles in the water column. Because turbidity cannot be expressed as a mass load, total suspended solids (TSS) are used as a surrogate for the TMDLs in this report. Therefore, both turbidity and TSS data are presented.

Table ES-3 summarizes a subset of turbidity and TSS data collected from the WQM stations under base flow conditions, which DEQ considers to be all flows less than the 25^{th} flow exceedance percentile (i.e., the lower 75% of flows) Water quality samples collected under flow conditions greater than the 25^{th} flow exceedance percentile (highest flows) were therefore excluded from the data set used for TMDL analysis.

The beneficial use of WWAC is one of several subcategories of the Fish and Wildlife Propagation use established to manage the variety of communities of fish and shellfish throughout the state (OWRB 2008). The numeric criteria for turbidity to maintain and protect the use of "Fish and Wildlife Propagation" from Title 785:45-5-12 (f) (7) is as follows:

(A) Turbidity from other than natural sources shall be restricted to not exceed the following numerical limits:

1. *Cool Water Aquatic Community/Trout Fisheries: 10 NTUs;*
2. *Lakes: 25 NTU; and*
3. *Other surface waters: 50 NTUs.*

(B) In waters where background turbidity exceeds these values, turbidity from point sources will be restricted to not exceed ambient levels.

(C) Numerical criteria listed in (A) of this paragraph apply only to seasonal base flow conditions.

(D) Elevated turbidity levels may be expected during, and for several days after, a runoff event.

The abbreviated excerpt below from Chapter 46: 785:46-15-5, stipulates how water quality data will be assessed to determine support of fish and wildlife propagation as well as how the water quality target for TMDLs will be defined for turbidity.

Assessment of Fish and Wildlife Propagation support

(a) Scope. The provisions of this Section shall be used to determine whether the beneficial use of Fish and Wildlife Propagation or any subcategory thereof designated in OAC 785:45 for a waterbody is supported.

(e) Turbidity. The criteria for turbidity stated in 785:45-5-12(f)(7) shall constitute the screening levels for turbidity. The tests for use support shall follow the default protocol in 785:46-15-4(b).

Table ES-3 Summary of Turbidity and TSS Samples Collected Under Base Flow Condition, 1998 - 2011

Waterbody ID	Waterbody Name	Number of turbidity samples	Number of TSS samples	Number of Turbidity samples greater than 50 NTU	% turbidity samples exceeding criterion	2008 303(d)	Comments
OK120400020010_00	Dirty Creek	32	31	6	19%	X	TMDL Required
OK120400020160_00	Butler creek	30	29	4	13%		Impaired,TMDL Required
OK120400020190_00	Elk Creek	34	32	3	9%	X	Delist for 2010: Meets Standards
OK120410010100_00	Cloud Creek	30	29	5	17%	X	TMDL Required
OK120410010220_00	Snake Creek	31	29	4	13%		Impaired,TMDL Required
OK121500010200_00	Verdigris River at US 51,Wagoner	49	12	12	24%	X	TMDL Required
OK121500020090_00	Bull Creek	61	51	16	26%	X	TMDL Required
OK121500020260_00	Verdigris, Inola	47	4	13	28%	X	TMDL Required

785:46-15-4. Default protocols

(b) Short term average numerical parameters.

(1) Short term average numerical parameters are based upon exposure periods of less than seven days. Short term average parameters to which this Section applies include, but are not limited to, sample standards and turbidity.

(2) A beneficial use shall be deemed to be fully supported for a given parameter whose criterion is based upon a short term average if 10% or less of the samples for that parameter exceeds the applicable screening level prescribed in this Subchapter.

TMDLs for turbidity in streams designated as WWAC must take into account that no more than 10% of the samples may exceed the numeric criterion of 50 nephelometric turbidity units (NTU). However, as described above, because turbidity cannot be expressed as a mass load, TSS is used as a surrogate in this TMDL. Since there is no numeric criterion in the Oklahoma WQS for TSS, a regression method to convert the turbidity criterion to TSS based on a relationship between turbidity and TSS was used to establish TSS goals as surrogates. Table ES-4 provides the results of the waterbody specific regression analysis.

Table ES-4 Regression Statistics and TSS Goals

Waterbody ID	Waterbody Name	R-square	NRMSE	MOS[b]	TSS Goal (mg/L)[a]
OK120400020010_00	Dirty Creek	0.71	9.8%	10%	30
OK120400020160_00	Butler creek	0.83	8.4%	10%	38
OK120410010100_00	Cloud Creek	0.82	8.5%	10%	46
OK120410010220_00	Snake Creek	0.81	11.2%	15%	47
OK121500010200_00	Verdigris River, US 51, Wagoner	0.77	14.1%	15%	42
OK121500020090_00	Bull Creek	0.77	8.3%	10%	34
OK121500020260_00	Verdigris River near Inola	0.92	6.8%	10%	35

After re-evaluating bacterial and turbidity/TSS data for the streams listed in Table ES-1, Table ES-5 shows the bacterial and turbidity TMDLs that will be developed in this report.

E.2 Pollutant Source Assessment

A pollutant source assessment characterizes known and suspected sources of pollutant loading to impaired waterbodies. Sources within a watershed are categorized and quantified to the extent that information is available. Bacteria originate from warm-blooded animals and sources may be point or nonpoint in nature. Turbidity may originate from NPDES-permitted facilities, fields, construction sites, quarries, stormwater runoff and eroding stream banks.

Point sources are permitted through the NPDES program. NPDES-permitted facilities that discharge treated sanitary wastewater are required to monitor fecal coliform under the current permits and will be required to monitor *E. coli* when their permits come to renew. These facilities are also required to monitor TSS in accordance with their permits. Nonpoint sources are diffuse sources that typically cannot be identified as entering a waterbody through a discrete conveyance at a single location. Nonpoint sources may emanate from land activities that contribute bacteria or TSS to surface water as a result of rainfall runoff. For the TMDLs in this report, all sources of pollutant loading not regulated by NPDES permits are considered nonpoint sources. Sediment loading of streams can originate from natural erosion processes, including the weathering of soil, rocks, and uncultivated land; geological abrasion; and other natural phenomena. There is insufficient data available to quantify contributions of TSS from these natural processes. TSS or sediment loading can also occur under non-runoff conditions as a result of anthropogenic activities in riparian corridors which cause erosive conditions. Given the lack of data to establish the background conditions for TSS/turbidity, separating background loading from nonpoint sources whether it is from natural or anthropogenic processes is not feasible in this TMDL development. Table ES-6 summarizes the point and nonpoint sources that contribute bacteria or TSS to each respective waterbody.

Table ES-5 Stream Segments and Pollutants for TMDL Development

Waterbody ID	Waterbody Name	Stream Miles	TMDL Date	Priority	E.coli	ENT	Turbidity
OK120400010260_00	Arkansas River near Muskogee	11	2013	2		X	
OK120400010400_00	Coody Creek	16	2013	2	X	X	
OK120400020010_00	Dirty Creek	44	2016	3		X	X
OK120400020030_00	Dirty Creek, South Fork	16	2019	4		X	
OK120400020110_00	Dirty Creek, Georges Fork	10	2016	3		X	
OK120400020160_00	Butler Creek	10	2019	4	X	X	X
OK120400020190_00	Elk Creek	14	2019	4		X	
OK120400020240_00	Shady Grove Creek	11	2019	4		X	
OK120410010080_00	Arkansas River near Haskell	42	2016	3		X	
OK120410010100_00	Cloud Creek	6	2019	4		X	X
OK120410010220_00	Snake Creek	31	2013	2		X	X
OK120420010010_00	Arkansas River near Bixby	17	2013	2		X	
OK120420010130_00	Arkansas River near Sand Springs	12	2013	2		X	
OK120420020010_00	Polecat Creek	7	2013	2	X		
OK120420020050_00	Polecat Creek	8	2016	3		X	
OK121500010200_00	Verdigris River near Wagoner	6	2013	2		X	X
OK121500020090_00	Bull Creek	18	2013	2	X	X	X
OK121500020100_00	Pea Creek	10	2013	2	X	X	
OK121500020260_00	Verdigris River near Inola	23	2013	2		X	X
OK121500020360_00	Dog Creek	10	2013	2	X	X	
OK121500030010_00	Verdigris River near Claremore	10	2016	3		X	
OK121600010010_00	Neosho River below Ft. Gibson Lake	1	2010	1		X	
OK121600010430_00	Chouteau Creek	22	2016	3	X	X	

Table ES-6 Summary of Potential Pollutant Sources by Category

Waterbody ID	Waterbody Name	Municipal NPDES Facility	Industrial NPDES Facility	MS4	NPDES No Discharge Facility	CAFO	PFO	Mines	Construction Stormwater Permit	Nonpoint Source
OK120400010260_00	Arkansas River near Muskogee	Bacteria		Bacteria	Bacteria					Bacteria
OK120400010400_00	Coody Creek			Bacteria						Bacteria
OK120400020010_00	Dirty Creek	Bacteria			Bacteria		Bacteria		TSS	Bacteria & Turbidity
OK120400020030_00	Dirty Creek, South Fork	Bacteria					Bacteria			Bacteria
OK120400020110_00	Dirty Creek, Georges Fork	Bacteria								Bacteria
OK120400020160_00	Butler Creek									Bacteria & Turbidity
OK120400020190_00	Elk Creek	Bacteria					Bacteria			Bacteria
OK120400020240_00	Shady Grove Creek						Bacteria			Bacteria
OK120410010080_00	Arkansas River near Haskell	Bacteria		Bacteria	Bacteria					Bacteria
OK120410010100_00	Cloud Creek									Bacteria & Turbidity
OK120410010220_00	Snake Creek		TSS	Bacteria					TSS	Bacteria & Turbidity
OK120420010010_00	Arkansas River near Bixby	Bacteria		Bacteria	Bacteria					Bacteria
OK120420010130_00	Arkansas River near Sand Springs	Bacteria			Bacteria					Bacteria
OK120420020010_00	Polecat Creek			Bacteria	Bacteria					Bacteria
OK120420020050_00	Polecat Creek	Bacteria		Bacteria	Bacteria					Bacteria
OK121500010200_00	Verdigris River near Wagoner									Bacteria & Turbidity
OK121500020090_00	Bull Creek									Bacteria & Turbidity
OK121500020100_00	Pea Creek									
OK121500020260_00	Verdigris River near Inola	Bacteria	TSS	Bacteria	Bacteria			TSS	TSS	Bacteria & Turbidity
OK121500020360_00	Dog Creek	Bacteria			Bacteria					Bacteria
OK121500030010_00	Verdigris River near Claremore	Bacteria		Bacteria						Bacteria
OK121600010010_00	Neosho River below Ft. Gibson Lake									Bacteria
OK121600010430_00	Chouteau Creek	Bacteria								Bacteria

Facility present in watershed and potential as contributing pollutant source.

Facility present in watershed, but not recognized as pollutant source.

No facility present in watershed

E.3 Using Load Duration Curves to Develop TMDLs

The TMDL calculations presented in this report are derived from load duration curves (LDC). LDCs facilitate rapid development of TMDLs, and as a TMDL development tool can provide some information for identifying whether impairments are associated with point or nonpoint sources. The efficiency and simplicity of the LDC method should not be considered as bad descriptors of this powerful tool for displaying the changing water quality over changing flows that provides information as to the sources of the pollutant that is not apparent in the raw data. The LDC has additional valuable uses in the post-TMDL implementation phase of the restoration of the water quality for a segment. Plotting future monitoring information on the LDC will show trends of improvement to sources that will identify areas for revision to the segment restoration plan. The low cost of the LDC method allows the development of TMDL plans on more segments and the evaluation of the implementation of WLAs and BMPs on more segments. The technical approach for using LDCs for TMDL development includes the following steps:

- Preparing flow duration curves for gaged and ungaged WQM stations;
- Estimating existing loading in the waterbody using ambient bacterial water quality data; and estimating loading in the waterbody using measured TSS water quality data and turbidity-converted data; and
- Using LDCs to identify the critical condition that will dictate loading reductions and the overall percent reduction goal (PRG) necessary to attain WQS.

Use of the LDC obviates the need to determine a design storm or selected flow recurrence interval with which to characterize the appropriate flow level for the assessment of critical conditions. For waterbodies impacted by both point and nonpoint sources, the “nonpoint source critical condition” would typically occur during high flows, when rainfall runoff would contribute the bulk of the pollutant load, while the “point source critical condition” would typically occur during low flows, when wastewater treatment plant (WWTP) effluents would dominate the base flow of the impaired water. However, flow range is only a general indicator of the relative proportion of point/nonpoint contributions. Violations have been noted under low flow conditions in some watersheds that contain no point sources.

LDCs display the maximum allowable load over the complete range of flow conditions by a line using the calculation of flow multiplied by a water quality criterion. The TMDL can be expressed as a continuous function of flow, equal to the line, or as a discrete value derived from a specific flow condition.

The basic steps to generating an LDC involve:

- Obtaining daily flow data for the site of interest from the U.S. Geological Survey (USGS), or if unavailable, projected from a nearby USGS site;
- Sorting the flow data and calculating flow exceedance percentiles
- Obtaining the water quality data from the primary contact recreation season (May 1 through September 30); or obtaining available turbidity and TSS water quality data;
- Displaying a curve on a plot that represents the allowable load determined by multiplying the actual or estimated flow by the WQS for each respective bacterial

indicator; or displaying a curve on a plot that represents the allowable load determined by multiplying the actual or estimated flow by the WQ_{goal} for TSS;

- For bacterial TMDLs, displaying and differentiating another curve derived by plotting the geometric mean of all existing bacterial samples continuously along the full spectrum of flow exceedance percentiles which represents the observed load in the stream; or
- For turbidity TMDLs, matching the water quality observations with the flow data from the same date and determining the corresponding exceedance percentile. Plotting the flow exceedance percentiles and daily load observations in a load duration plot (See Section 5).

For bacterial TMDLs the culmination of these steps is expressed in the following formula, which is displayed on the LDC as the TMDL curve:

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

Where: WQS = 126 cfu/100 mL (E. coli); or 33 cfu/100 mL (Enterococci)

unit conversion factor = 24,465,525

For turbidity (TSS) TMDLs the culmination of these steps is expressed in the following formula, which is displayed on the LDC as the TMDL curve:

TMDL (lb/day) = WQ_{goal} * flow (cfs) * unit conversion factor

where: WQ_{goal} = waterbody specific TSS concentration derived from regression analysis results presented in Table 5-1

unit conversion factor = 5.39377

Historical observations of bacteria were plotted as a separate LDC based on the geometric mean of all samples. Historical observations of TSS and/or turbidity concentrations are paired with flow data and are plotted on the LDC for a stream. It is noted that the LDCs for bacteria were based on the geometric mean standards or geometric mean of all samples. It is inappropriate to compare single sample bacterial observations to a geometric mean water quality criterion in the LDC; therefore individual bacterial samples are not plotted on the LDCs.

E.4 TMDL Calculations

A TMDL is expressed as the sum of all WLAs (point source loads), LAs (nonpoint source loads), and an appropriate MOS, which attempts to account for the lack of knowledge concerning the relationship between pollutant loading and water quality.

This definition can be expressed by the following equation:

$$TMDL = WLA\_{WWTP} + WLA\_{MS4} + LA + MOS$$

For each waterbody the TMDLs presented in this report are expressed as a colony forming units per day across the full range of flow conditions. For information purpose, percent reductions are also provided. The difference between existing loading and the water quality target is used to calculate the loading reductions required. For bacteria, the PRG is calculated by reducing all samples by the same percentage until the geomean of the reduced sample values meets the corresponding bacterial geomean standard (126 cfu/100 ml for *E. coli* and 33 cfu/100 ml for Enterococci) with 10% of margin of safety. For turbidity, the PRG is the load reduction that ensures that no more than 10% of the samples under flow-base conditions exceed the TMDL.

Table ES-7 presents the percent reductions necessary for each bacterial indicator causing nonsupport of the PBCR use in each waterbody of the Study Area.

Table ES-7 Percent Reductions Required to Meet Water Quality Standards for Indicator Bacteria

Waterbody Name	Waterbody ID	Geomean		Reduction Rate	
		EC	ENT	EC	ENT
Arkansas River near Muskogee	OK120400010260_00	-	83.3	-	60.4%
Coody Creek	OK120400010400_00	152.3	219.5	17.3%	85.0%
Dirty Creek	OK120400020010_00	-	54.6	-	39.5%
Dirty Creek, South Fork	OK120400020030_00	-	207.0	-	84.1%
Dirty Creek, Georges Fork	OK120400020110_00	-	136.4	-	75.8%
Butler Creek	OK120400020160_00	164.7	94.3	23.5%	65.0%
Elk Creek	OK120400020190_00	-	61.1	-	46.0%
Shady Grove Creek	OK120400020240_00	-	36.2	-	8.8%
Arkansas River near Haskell	OK120410010080_00	-	43.7	-	24.5%
Cloud Creek	OK120410010100_00	-	55.5	-	40.6%
Snake Creek	OK120410010220_00	-	58.4	-	43.5%
Arkansas River near Bixby	OK120420010010_00	-	108.4	-	69.5%
Arkansas River near Sand Springs	OK120420010130_00	-	35.5	-	7.2%
Polecat Creek	OK120420020010_00	154.0	-	18.2%	
Polecat Creek	OK120420020050_00	-	57.5	-	42.7%
Verdigris River near Wagoner	OK121500010200_00	-	122.8	-	73.1%
Bull Creek	OK121500020090_00	166.8	202.6	24.5%	83.7%
Pea Creek	OK121500020100_00	331.4	939.8	62.0%	96.5%
Verdigris River near Inola	OK121500020260_00	-	156.8	-	79.0%
Dog Creek	OK121500020360_00	240.4	169.0	47.6%	80.5%
Verdigris River near Claremore	OK121500030010_00	-	114.0	-	71.0%
Neosho River below Ft. Gibson Lake	OK121600010010_00	-	63.0	-	47.6%
Chouteau Creek	OK121600010430_00	137.9	219.8	8.6%	85.0%

Similarly, percent reduction goals for TSS are calculated as the required overall reduction so that no more than 10% of the samples exceed the water quality target for TSS. The PRGs for the four waterbodies included in this TMDL report are summarized in Table ES-8.

Table ES-8 TMDL Percent Reductions Required to Meet Water Quality Targets for Total Suspended Solids

Waterbody ID	Waterbody Name	Reduction Rate
OK120400020010_00	Dirty Creek	19%
OK120400020160_00	Butler creek	5%
OK120410010100_00	Cloud Creek	36%
OK120410010220_00	Snake Creek	27%
OK121500010200_00	Verdigris River near Wagoner	64%
OK121500020090_00	Bull Creek	21%
OK121500020260_00	Verdigris River near Inola	63%

The TMDL, WLA, LA, and MOS vary with flow condition, and are calculated at every 5th flow interval percentile. The WLA component of each TMDL is the sum of all WLAs within each contributing watershed. The LA can then be calculated as follows:

$$LA = TMDL - MOS - \sum WLA$$

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs include an MOS and account for seasonal variability. The MOS, which can be implicit or explicit, is a conservative measure incorporated into the TMDL equation that accounts for the lack of knowledge associated with calculating the allowable pollutant loading to ensure WQSs are attained.

For bacterial TMDLs, an explicit MOS was set at 10%.

For turbidity, the TMDLs are calculated for TSS instead of turbidity. Thus, the quality of the regression has a direct impact on confidence of the TMDL calculations. The better the regression is, the more confidence there is in the TMDL targets. As a result, it leads to a smaller margin of safety. The selection of MOS is based on the normalized root mean square error (NRMSE) for each waterbody (Table ES-4).

The bacterial TMDLs established in this report adhere to the seasonal application of the Oklahoma WQS which limits the PBCR use to the period of May 1st through September 30th. Similarly, the TSS TMDLs established in this report adhere to the seasonal application of the Oklahoma WQS for turbidity, which applies to seasonal base flow conditions only. Seasonal variation was also accounted for in these TMDLs by using more than five years of water quality data and by using the longest period of USGS flow records when estimating flows to develop flow exceedance percentiles.

E.5 Reasonable Assurance

Reasonable assurance is required by the EPA rules for a TMDL to be approvable only when a waterbody is impaired by both point and non-point sources and where a point source is given a less stringent WLA based on an assumption that nonpoint source load reductions will occur. In such a case, “reasonable assurances” that non-point source (NPS) load reductions will actually occur must be demonstrated. In this report, all point source discharges either already have or will be given discharge limitations less than or equal to the water quality standard numerical criteria.. This ensures that the impairments of the waterbodies in this report will not be caused by point sources. Since the point source WLAs in this TMDL report are not dependent on NPS load reduction, reasonable assurance does not apply.

SECTION 1
INTRODUCTION

1.1 TMDL Program Background

Section 303(d) of the Clean Water Act (CWA) and U.S. Environmental Protection Agency (EPA) Water Quality Planning and Management Regulations (40 Code of Federal Regulations [CFR] Part 130) require states to develop total maximum daily loads (TMDL) for all segments and pollutants identified by the Regional Administrator as suitable for TMDL calculation. Segments and pollutants identified on the approved 303(d) list as not meeting designated uses where technology-based controls are in place will be given a higher priority for development of TMDLs. TMDLs establish the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and instream water quality conditions, so states can implement water quality-based controls to reduce pollution from point and nonpoint sources and restore and maintain water quality (EPA 1991).

This report documents the data and assessment used to establish TMDLs for the pathogen indicator bacteria (*E. coli* and Enterococci) and turbidity for selected waterbodies in the Arkansas-Verdigris River basin. (All future references to bacteria in this document imply these two fecal pathogen indicator bacterial group unless specifically stated otherwise.) Elevated levels of pathogen indicator bacteria in aquatic environments indicate that a waterbody is contaminated with human or animal feces and that a potential health risk exists for individuals exposed to the water. Elevated turbidity levels caused by excessive sediment loading and stream bank erosion impact aquatic biological communities. Data assessment and TMDL calculations are conducted in accordance with requirements of Section 303(d) of the CWA, Water Quality Planning and Management Regulations (40 CFR Part 130), EPA guidance, and Oklahoma Department of Environmental Quality (DEQ) guidance and procedures. DEQ is required to submit all TMDLs to EPA for review. Approved 303(d) listed waterbody-pollutant pairs or surrogates TMDLs will received notification of the approval or disapproval action. Once the EPA approves a TMDL, then the waterbody may be moved to Category 4a of a state's Integrated Water Quality Monitoring and Assessment Report, where it remains until compliance with water quality standards (WQS) is achieved (EPA 2003).

The purpose of this TMDL report is to establish pollutant load allocations for indicator bacteria and turbidity in impaired waterbodies, which is the first step toward restoring water quality and protecting public health. TMDLs determine the pollutant loading a waterbody can assimilate without exceeding the WQS for that pollutant. TMDLs also establish the pollutant load allocation necessary to meet the WQS established for a waterbody based on the relationship between pollutant sources and instream water quality conditions. A TMDL consists of a wasteload allocation (WLA), load allocation (LA), and a margin of safety (MOS). The WLA is the fraction of the total pollutant load apportioned to point sources, and includes stormwater discharges regulated under the National Pollutant Discharge Elimination System (NPDES). The LA is the fraction of the total pollutant load apportioned to nonpoint sources. MOS can be implicit and/or explicit. An implicit MOS is achieved by using conservative assumptions in the TMDL calculations. An explicit MOS is a percentage of the TMDL set aside to account for the lack of knowledge associated with natural process in aquatic systems, model assumptions, and data limitations.

This report does not stipulate specific control actions (regulatory controls) or management measures (voluntary best management practices) necessary to reduce bacteria or turbidity within each watershed. Watershed-specific control actions and management measures will be identified, selected, and implemented under a separate process involving stakeholders who live and work in the watersheds, along with tribes, and local, state, and federal government agencies.

This TMDL report focuses on waterbodies that DEQ placed in Category 5 [303(d) list] of the *Water Quality in Oklahoma, 2008 Integrated Report* (2008 Integrated Report) for nonsupport of primary body contact recreation (PBCR) or warm water aquatic community (WWAC) designated uses. The waterbodies addressed in this report include:

Arkansas River near Muskogee	OK120400010260_00
Coody Creek	OK120400010400_00
Dirty Creek	OK120400020010_00
Dirty Creek, South Fork	OK120400020030_00
Dirty Creek, Georges Fork	OK120400020110_00
Butler Creek	OK120400020160_00
Elk Creek	OK120400020190_00
Shady Grove Creek	OK120400020240_00
Arkansas River near Haskell	OK120410010080_00
Cloud Creek	OK120410010100_00
Haikey Creek	OK120410010210_00
Snake Creek	OK120410010220_00
Arkansas River, US 64, Bixby	OK120420010010_00
Fred Creek	OK120420010060_00
Mooser Creek	OK120420010070_00
Crow Creek	OK120420010090_00
Arkansas River near Sand Springs	OK120420010130_00
Blackboy Creek	OK120420010140_00
Harlow Creek	OK120420010170_00
Polecat Creek	OK120420020010_00
Nickel Creek	OK120420020040_00
Polecat Creek	OK120420020050_00
Verdigris River, US 51, Wagoner	OK121500010200_00

Bull Creek	OK121500020090_00
Pea Creek	OK121500020100_00
Adams Creek	OK121500020150_00
Verdigris River near Inola,	OK121500020260_00
Dog Creek	OK121500020360_00
Cat Creek	OK121500020390_00
Verdigris River near Claremore,OK	OK121500030010_00
Neosho River below Ft Gibson Lake near Ft Gibson	OK121600010010_00
Chouteau Creek	OK121600010430_00

Figure 1-1 and Figure 1-2 show these Oklahoma waterbodies and their contributing watersheds. These maps also display locations of the water quality monitoring (WQM) stations used as the basis for placement of these waterbodies on the Oklahoma 303(d) list. These waterbodies and their surrounding watersheds are hereinafter referred to as the Study Area.

Figure 1-1 Arkansas-Verdigris River Area (upper) Not Supporting Primary Body Contact Recreation or Fish and Wildlife Propagation

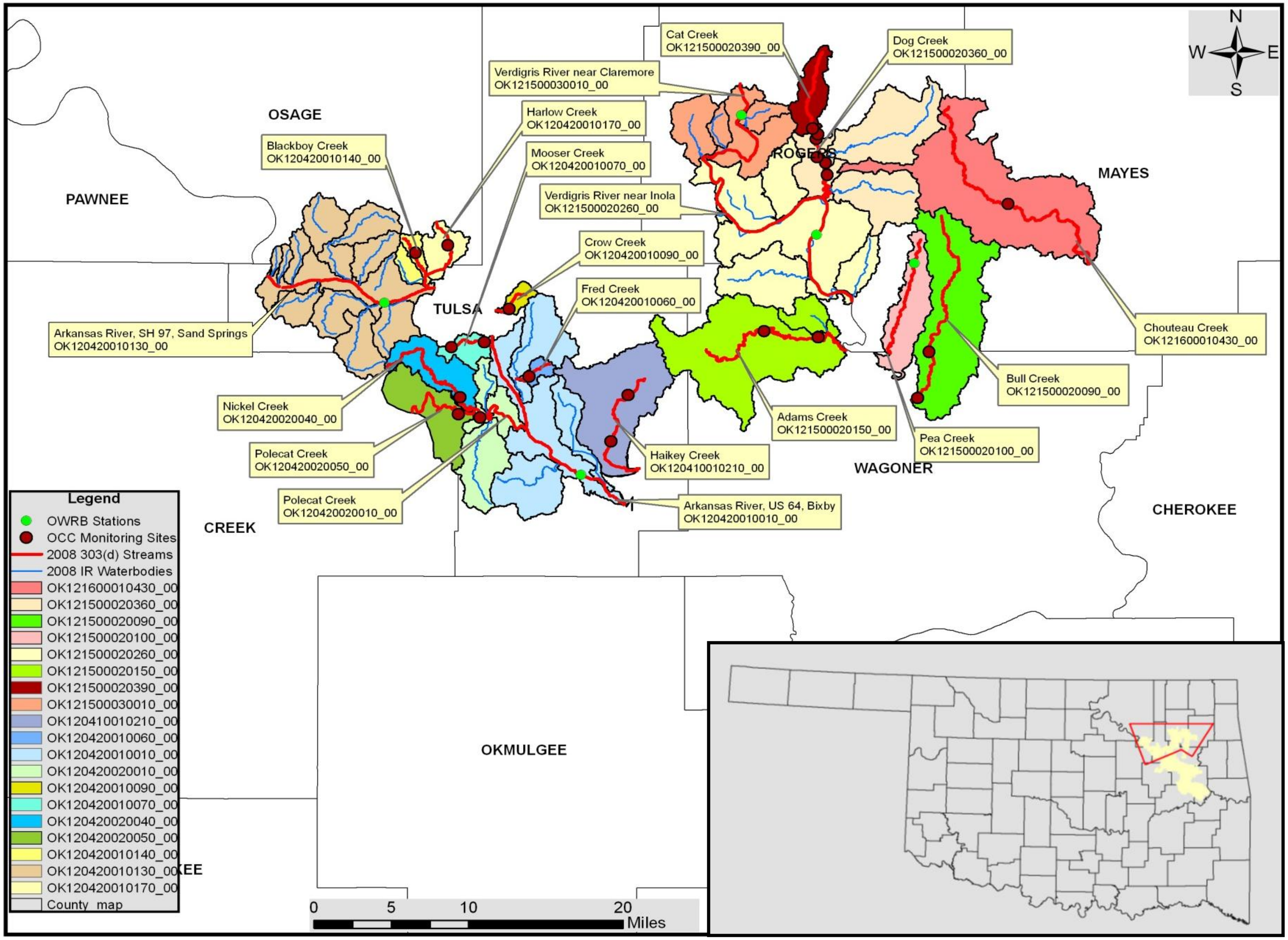
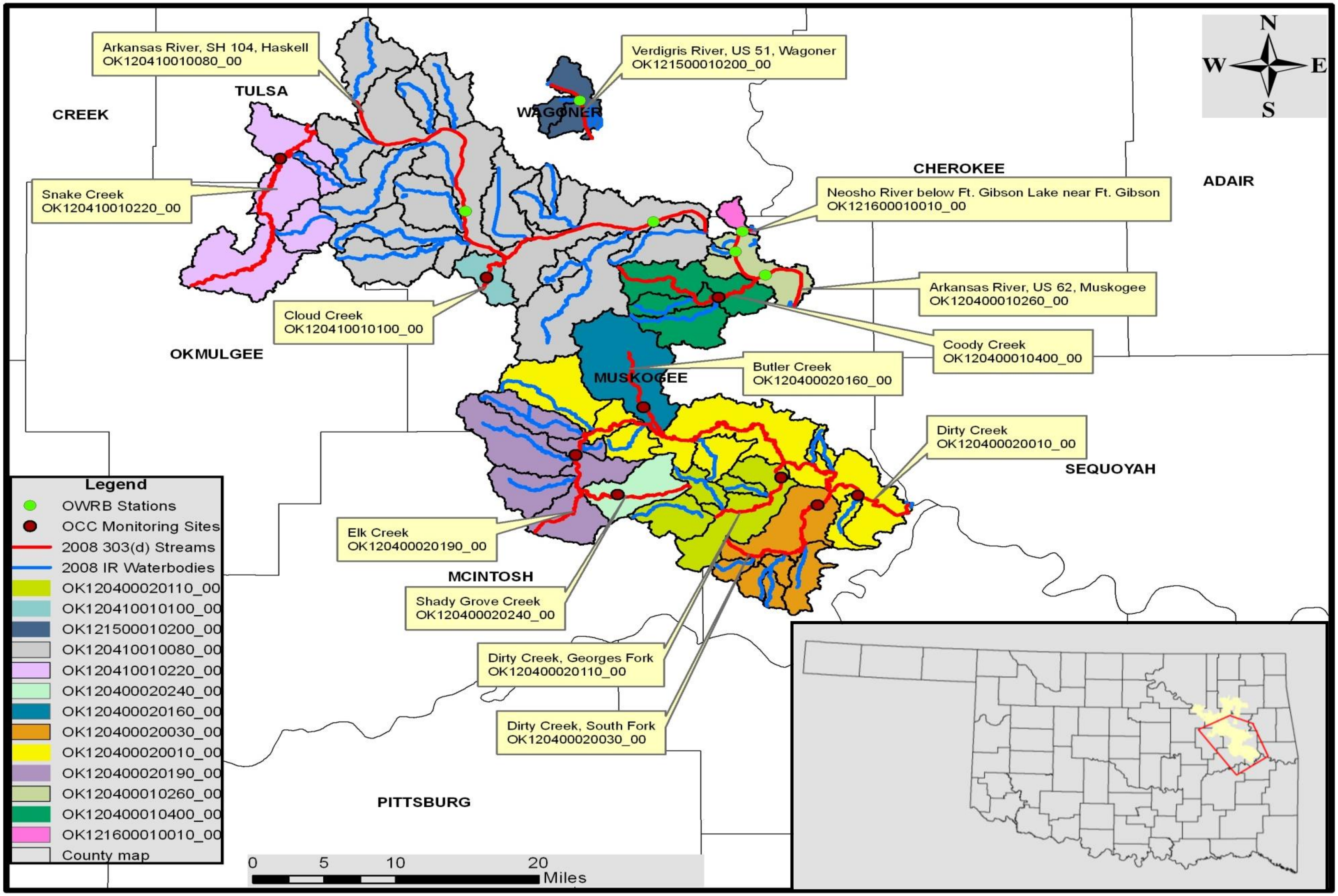


Figure 1-2 Arkansas-Verdigris River Area (lower) Not Supporting Primary Body Contact Recreation or Fish and Wildlife Propagation



Elevated levels of pathogen indicator bacteria or turbidity above the WQS numeric criterion result in the requirement that a TMDL be developed. The TMDLs established in this report are a necessary step in the process to develop the pollutant loading controls needed to restore the primary body contact recreation or fish and wildlife propagation use designated for each waterbody. Table 1-1 provides a description of the locations of WQM stations on the 303(d)-listed waterbodies.

Table 1-1 Water Quality Monitoring Stations Used for Stream Assessments

Waterbody Name	Waterbody ID	WQM Station	Legal Description
Arkansas River near Muskogee	OK120400010260_00	121400010260-001AT	Section 21 Township 15N Range 19E
Coody Creek	OK120400010400_00	OK120400-01-0400F	SW¼ NW¼ SW¼ Section 5-14N-19E
Dirty Creek	OK120400020010_00	OK120400-02-0010F	SE¼ SE¼ NE¼ Section 35-12N-20E
Dirty Creek, South Fork	OK120400020030_00	OK120400-02-0030F	NE¼ SW¼ NW¼ Section 4-11N-20E
Dirty Creek, Georges Fork	OK120400020110_00	OK120400-02-0110D	NW¼ NE¼ NE¼ Section 25-12N-19E
Butler Creek	OK120400020160_00	OK120400-02-0160D	SW¼ SW¼ SE¼ Section 20-13N-18E
Elk Creek	OK120400020190_00	OK120400-02-0190D	SW¼ SW¼ SW¼ Section 10-12N-17E
Shady Grove Creek	OK120400020240_00	OK120400-02-0240H	NE¼ SE¼ NE¼ Section 36-12N-17E
Arkansas River near Haskell	OK120410010080_00	120410010080-001AT	Section 32 Township 16N Range 16E
Cloud Creek	OK120410010100_00	OK120410-01-0100T	NW¼ NW¼ NE¼ Section 33-15N-16E
Haikey Creek	OK120410010210_00	OK120410-01-0210G	SE¼ SE¼ SE¼ Section 31-18N-14E
Snake Creek	OK120410010220_00	OK120410-01-0220G	SW¼ SW¼ SW¼ Section 6-16N-14E
Arkansas River, US 64, Bixby	OK120420010010_00	120420010010-001AT	Section 13 Township 17N Range 13E
Fred Creek	OK120420010060_00	OK120420-01-0060G	NE¼ NW¼ SE¼ Section 8-18N-13E
Mooser Creek	OK120420010070_00	OK120420-01-0070A	SE¼ NE¼ NE¼ Section 35-19N-12E
		OK120420-01-0070J	NW¼ SW¼ SE¼ Section 34-19N-12E
		OK120420-01-0070P	SE¼ NE¼ SW¼ Section 33-19N-12E
Crow Creek	OK120420010090_00	OK120420-01-0090G	NW¼ NE¼ NW¼ Section 19-19N-13E
Arkansas River near Sand Springs	OK120420010130_00	120420010130-001AT	Section 14 Township 19N Range 11E
Blackboy Creek	OK120420010140_00	OK120420-01-0140T	NW¼ NW¼ NE¼ Section 36-20N-11E
Harlow Creek	OK120420010170_00	OK120420-01-0170F	NE¼ NW¼ NW¼ Section 4-19N-12E
Polecat Creek	OK120420020010_00	OK120420-02-0010D	SW¼ SW¼ NW¼ Section 25-18N-12E
Nickel Creek	OK120420020040_00	OK120420-02-0040G	NE¼ NW¼ NW¼ Section 22-18N-12E
Polecat Creek	OK120420020050_00	OK120420-02-0050G	SW¼ NW¼ NW¼ Section 27-18N-12E
Verdigris River, US 51, Wagoner	OK121500010200_00	121500010200-001AT	Section 16 Township 17N Range 17E
Bull Creek	OK121500020090_00	OK121500-02-0090D	N½ Section 3-18N-17E
		OK121500-02-0090K	NW¼ Section 22-18N-17E
Pea Creek	OK121500020100_00	121500020100-001SR	Lat: 36 04' 23"N Long: 95 31' 32" W
Adams Creek	OK121500020150_00	OK121500-02-0150G	NW¼ NW¼SW¼ Section 25-19N-15E
Verdigris River near Inola	OK121500020260_00	121500020260-001AT	Section 04 Township 19N Range 16E
Dog Creek	OK121500020360_00	OK121500-02-0360D	NE¼ NW¼ NW¼ Section 3-20N-16E
		OK121500-02-0360F	SE¼ NW¼ SE¼ Section 33-21N-16E
		OK121500-02-0360H	S.B. SE¼SW¼SW¼ S21-T21N-R16E
		OK121500-02-0360J	SW¼ NW¼SW¼ Section 21-21N-16E
Cat Creek	OK121500020390_00	OK121500-02-0390B	SE¼ SE¼ SE¼ Section 17-21N-16E
		OK121500-02-0390A	NW¼ SE¼ NW¼ Section 21-21N-16E
Verdigris River near Claremore	OK121500030010_00	121500030010-001AT	Section 15 Township 15N Range 15E
Neosho River below Ft. Gibson Lake near Ft. Gibson	OK121600010010_00	121600010010-001AT	Section 19 Township 16N Range 20E
Chouteau Creek	OK121600010430_00	OK121600-01-0430M	Sections 15/16 -20N -18E

1.2 Watershed Description

1.2.1 General

The Arkansas-Verdigris River Study Area is located in the Central Eastern portion of Oklahoma. The waterbodies addressed in this report are located in in Creek, Haskell, Mayes, McIntosh, Muskogee, Okmulgee, Osage, Rogers, Tulsa, and Wagoner Counties. These counties are part of the Central Irregular Plains and Cross Timbers Level III ecoregions (Woods, A.J, Omerik, J.M., et al 2005). Table 1-2, derived from the 2010 U.S. Census, demonstrates that the counties in which these watersheds are located are sparsely populated (U.S. Census Bureau 2010) with the exception of Tulsa county which is densely populated.

Table 1-2 County Population and Density

County Name	Population (2010 Census)	Area (Square mile)	Population Density (per square mile)
Creek	69,967	950	74
Haskell	12,769	576	22
Mayes	41,259	655	63
McIntosh	20,252	618	33
Muskogee	70,990	810	88
Okmulgee	40,069	697	57
Osage	47,472	2,246	21
Rogers	86,905	675	129
Tulsa	603,403	570	1,058
Wagoner	73,085	561	130

1.2.2 Climate

Table 1-3 summarizes the average annual precipitation for each Oklahoma waterbody based on the approximate midpoint of each watershed. Average annual precipitation values among the watersheds in this portion of Oklahoma range between 40 and 46 inches (Oklahoma Climate Survey 2007).

Table 1-3 Average Annual Precipitation by Watershed

Waterbody Name	Waterbody ID	Average Annual Precipitation (Inches)
Arkansas River near Muskogee	OK120400010260_00	45.22
Coody Creek	OK120400010400_00	45.16
Dirty Creek	OK120400020010_00	46.06
Dirty Creek, South Fork	OK120400020030_00	46.65
Dirty Creek, Georges Fork	OK120400020110_00	46.24
Butler Creek	OK120400020160_00	45.01
Elk Creek	OK120400020190_00	44.93
Shady Grove Creek	OK120400020240_00	45.44
Arkansas River near Haskell	OK120410010080_00	43.82
Cloud Creek	OK120410010100_00	44.19
Haikey Creek	OK120410010210_00	41.53
Snake Creek	OK120410010220_00	42.34
Arkansas River, US 64, Bixby	OK120420010010_00	41.31
Fred Creek	OK120420010060_00	41.45
Mooser Creek	OK120420010070_00	41.37
Crow Creek	OK120420010090_00	41.68
Arkansas River near Sand Springs	OK120420010130_00	40.69
Blackboy Creek	OK120420010140_00	41.07
Harlow Creek	OK120420010170_00	41.26
Polecat Creek	OK120420020010_00	41.24
Nickel Creek	OK120420020040_00	41.25
Polecat Creek	OK120420020050_00	41.22
Verdigris River, US 51, Wagoner	OK121500010200_00	44.27
Bull Creek	OK121500020090_00	43.88
Pea Creek	OK121500020100_00	43.52
Adams Creek	OK121500020150_00	42.42
Verdigris River near Inola,	OK121500020260_00	43.01
Dog Creek	OK121500020360_00	43.36
Cat Creek	OK121500020390_00	43.27
Verdigris River near Claremore	OK121500030010_00	42.51
Neosho River below Ft. Gibson Lake near Ft. Gibson	OK121600010010_00	45.29
Chouteau Creek	OK121600010430_00	43.57

1.2.3 Land Use

Tables1-4a through 1-4d summarize the percentages and acreages of the land use categories for the contributing watershed associated with each respective Oklahoma waterbody addressed in the Study Area. The land use/land cover data were derived from the U.S. Geological Survey (USGS) 2001 National Land Cover Dataset (USGS 2007). The land use categories are displayed in Figures 1-3 and 1-4. The two most dominant land use categories throughout the Study Area are deciduous forest and pasture/hay.

Figure 1-3 Land Use Map (upper)

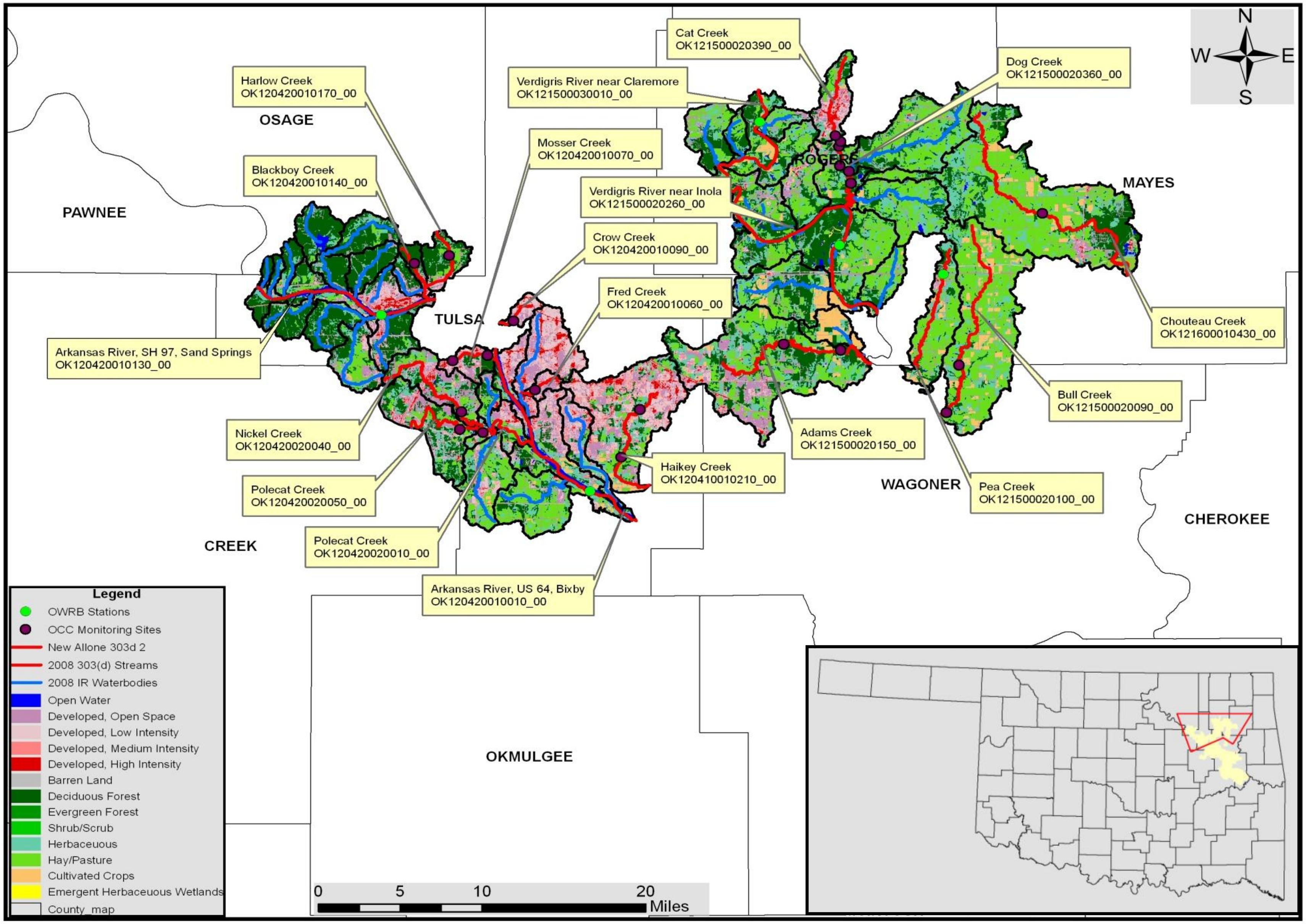


Figure 1-4 Land Use Map (lower)

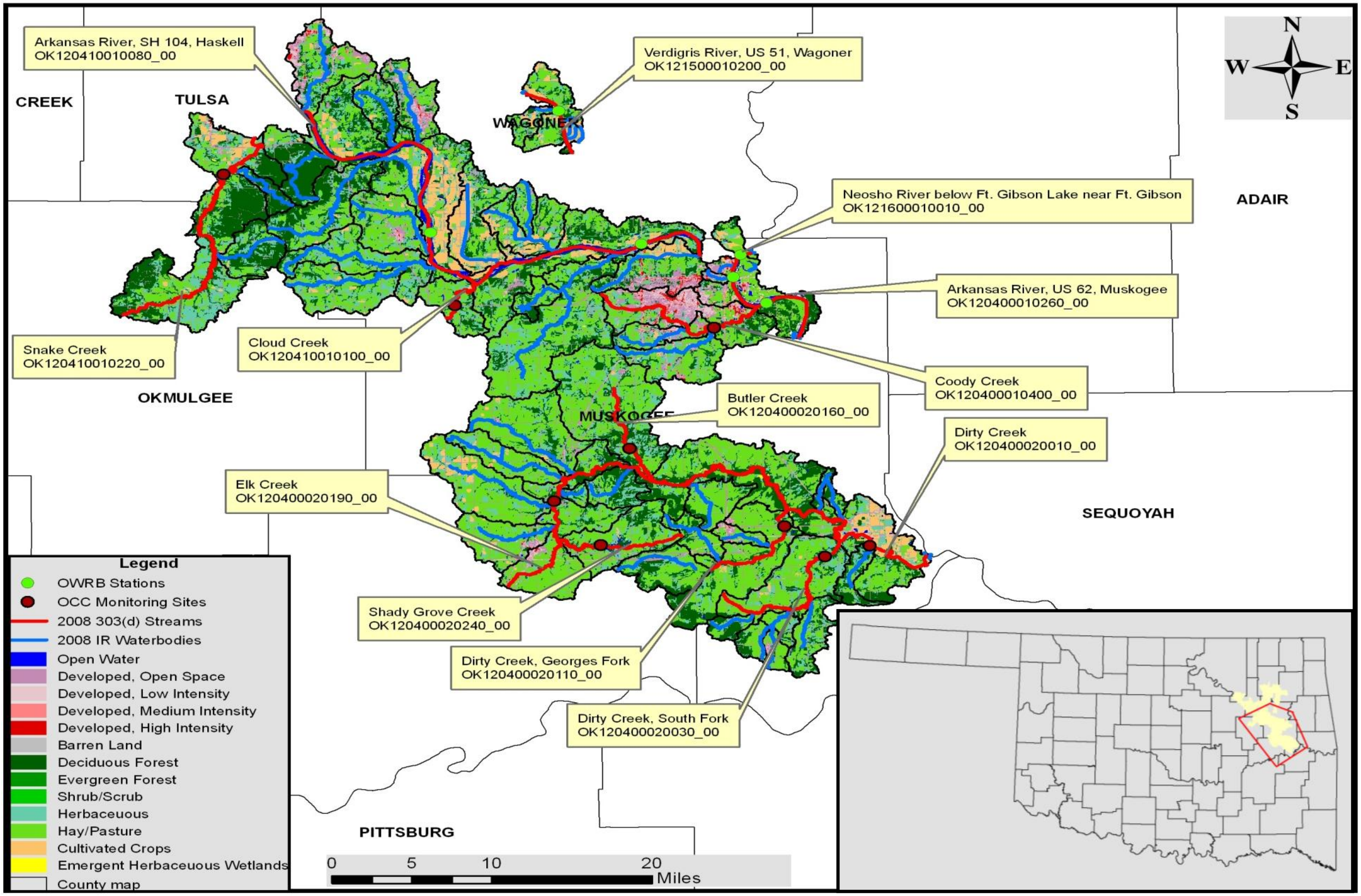


Table 1-4a Land Use Summaries by Watershed

Land Use Category	Watershed							
	Arkansas River near Muskogee	Coody Creek	Dirty Creek	Dirty Creek, South Fork	Dirty Creek, Georges Fork	Butler Creek	Elk Creek	Shady Grove Creek
Waterbody ID	OK120400010260_00	OK120400010400_00	OK120400020010_00	OK120400020030_00	OK120400020110_00	OK120400020160_00	OK120400020190_00	OK120400020240_00
Open Water	1,790	1,283	638	330	331	110	382	193
Medium Intensity Residential	1,804	3,234	572	157	465	122	714	68
High Intensity Residential	409	743	11	4	30	2	80	0
Bare Rock/Sand/Clay	19	36	16	8	0	0	0	2
Deciduous Forest	3,540	4,955	24,767	7,832	9,186	6,314	4,930	3,004
Evergreen Forest	41	18	20	23	10	38	48	8
Mixed Forest	15	0	0	0	0	0	0	0
Shrubland	11	2	15	5	0	0	0	1
Grasslands/Herbaceous	2,531	5,640	11,118	6,627	3,826	6,545	9,308	2,893
Pasture/Hay	7,106	12,265	25,754	17,980	20,768	15,161	34,114	6,699
Cultivated Crops	209	272	3,968	224	162	53	2,600	45
Urban/Recreational Grasses	2,806	5,237	3,231	1,751	2,553	1,641	3,228	718
Woody Wetlands	251	23	52	0	0	0	0	0
Emergent Herbaceous Wetlands	6	14	220	18	11	10	4	21
Total (Acres)	**20,538**	**33,722**	**70,382**	**34,959**	**37,343**	**29,997**	**55,408**	**13,653**
Open Water	8.72%	3.80%	0.91%	0.95%	0.89%	0.37%	0.69%	1.42%
Medium Intensity Residential	8.78%	9.59%	0.81%	0.45%	1.25%	0.41%	1.29%	0.50%
High Intensity Residential	1.99%	2.20%	0.02%	0.01%	0.08%	0.01%	0.14%	0.00%
Bare Rock/Sand/Clay	0.09%	0.11%	0.02%	0.02%	0.00%	0.00%	0.00%	0.01%
Deciduous Forest	17.23%	14.69%	35.19%	22.40%	24.60%	21.05%	8.90%	22.01%
Evergreen Forest	0.20%	0.05%	0.03%	0.07%	0.03%	0.13%	0.09%	0.06%
Mixed Forest	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Shrubland	0.05%	0.01%	0.02%	0.02%	0.00%	0.00%	0.00%	0.01%
Grasslands/Herbaceous	12.32%	16.72%	15.80%	18.96%	10.24%	21.82%	16.80%	21.19%
Pasture/Hay	34.60%	36.37%	36.59%	51.43%	55.61%	50.54%	61.57%	49.06%
Cultivated Crops	1.02%	0.81%	5.64%	0.64%	0.43%	0.18%	4.69%	0.33%
Urban/Recreational Grasses	13.66%	15.53%	4.59%	5.01%	6.84%	5.47%	5.83%	5.26%
Woody Wetlands	1.22%	0.07%	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%
Emergent Herbaceous Wetlands	0.03%	0.04%	0.31%	0.05%	0.03%	0.03%	0.01%	0.15%
Total Percentage:	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

Table 1-4b Land Use Summaries by Watershed

Land Use Category	Watershed							
	Arkansas River near Haskell	Cloud Creek	Haikey Creek	Snake Creek	Arkansas River near Bixby	Fred Creek	Mooser Creek	Crow Creek
Waterbody ID	OK120410010080_00	OK120410010100_00	OK120410010210_00	OK120410010220_00	OK120420010010_00	OK120420010060_00	OK120420010070_00	OK120420010090_00
Open Water	9,638	88	3,267	297	8,740	175	333	142
Medium Intensity Residential	2,998	6	6,187	226	14,471	626	755	943
High Intensity Residential	817	0	1,261	64	2,616	105	162	146
Bare Rock/Sand/Clay	458	7	4	0	26	0	0	0
Deciduous Forest	39,085	1,006	2,433	18,119	24,897	10	910	2
Evergreen Forest	147	0	0	2	2	0	0	0
Mixed Forest	0	0	0	0	0	0	0	0
Shrubland	0	0	0	0	0	0	0	0
Grasslands/Herbaceous	37,932	1,683	3,559	12,116	18,817	0	119	0
Pasture/Hay	64,716	3,301	2,323	10,041	18,455	0	0	0
Row Crops	13,374	95	1,228	2,133	1,799	0	0	0
Urban/Recreational Grasses	14,208	383	4,325	1,876	18,598	652	908	555
Woody Wetlands	3	0	0	0	0	0	0	0
Emergent Herbaceous Wetlands	106	0	8	25	12	0	0	0
Total (Acres)	**183,483**	**6,569**	**24,596**	**44,900**	**108,434**	**1,569**	**3,187**	**1,787**
Open Water	5.25%	1.33%	13.28%	0.66%	8.06%	11.16%	10.44%	7.96%
Medium Intensity Residential	1.63%	0.09%	25.16%	0.50%	13.35%	39.91%	23.68%	52.74%
High Intensity Residential	0.45%	0.00%	5.13%	0.14%	2.41%	6.71%	5.09%	8.18%
Bare Rock/Sand/Clay	0.25%	0.10%	0.02%	0.00%	0.02%	0.00%	0.00%	0.00%
Deciduous Forest	21.30%	15.31%	9.89%	40.35%	22.96%	0.64%	28.56%	0.09%
Evergreen Forest	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Mixed Forest	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Shrubland	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Grasslands/Herbaceous	20.67%	25.62%	14.47%	26.98%	17.35%	0.00%	3.73%	0.00%
Pasture/Hay	35.27%	50.25%	9.45%	22.36%	17.02%	0.00%	0.00%	0.00%
Row Crops	7.29%	1.45%	4.99%	4.75%	1.66%	0.00%	0.00%	0.00%
Urban/Recreational Grasses	7.74%	5.83%	17.59%	4.18%	17.15%	41.59%	28.50%	31.04%
Woody Wetlands	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Emergent Herbaceous Wetlands	0.06%	0.00%	0.03%	0.06%	0.01%	0.00%	0.00%	0.00%
Total Percentage:	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

Table 1-4c Land Use Summaries by Watershed

Land Use Category	Watershed							
	Arkansas River near Sand Springs	**Blackboy Creek**	**Harlow Creek**	**Polecat Creek**	**Nickel Creek**	**Polecat Creek**	**Verdigris River near Wagoner**	**Bull Creek**
Waterbody ID	OK120420010130_00	OK120420010140_00	OK120420010170_00	OK120420020010_00	OK120420020040_00	OK120420020050_00	OK121500010200_00	OK121500020090_00
Open Water	4,063	104	92	1,275	293	746	596	134
Medium Intensity Residential	3,002	208	262	2,762	655	1,819	56	192
High Intensity Residential	677	31	20	519	137	318	8	6
Bare Rock/Sand/Clay	5	1	0	0	0	0	0	0
Deciduous Forest	32,824	2,216	2,567	16,117	2,083	15,658	2,276	1,991
Evergreen Forest	13	0	0	2	0	2	36	22
Mixed Forest	0	0	0	0	0	0	0	0
Shrubland	0	0	0	0	0	0	0	0
Grasslands/Herbaceous	8,705	350	600	9,570	1,591	8,365	2,813	6,223
Pasture/Hay	4,237	2	683	7,140	1,269	6,129	3,969	17,868
Cultivated Crops	169	0	0	249	45	212	2,536	3,532
Urban/Recreational Grasses	6,845	793	553	7,304	3,094	4,488	404	1,290
Woody Wetlands	0	0	0	0	0	0	6	0
Emergent Herbaceous Wetlands	24	0	0	2	0	2	18	0
Total (Acres)	**60,566**	**3,704**	**4,777**	44,941	**9,166**	**37,738**	**12,719**	**31,259**
Open Water	6.71%	2.79%	1.92%	2.84%	3.19%	1.98%	4.69%	0.43%
Medium Intensity Residential	4.96%	5.61%	5.49%	6.15%	7.15%	4.82%	0.44%	0.61%
High Intensity Residential	1.12%	0.83%	0.41%	1.16%	1.49%	0.84%	0.06%	0.02%
Bare Rock/Sand/Clay	0.01%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Deciduous Forest	54.20%	59.82%	53.74%	35.86%	22.72%	41.49%	17.90%	6.37%
Evergreen Forest	0.02%	0.00%	0.00%	0.00%	0.00%	0.01%	0.29%	0.07%
Mixed Forest	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Shrubland	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Grasslands/Herbaceous	14.37%	9.45%	12.56%	21.29%	17.36%	22.17%	22.11%	19.91%
Pasture/Hay	7.00%	0.04%	14.31%	15.89%	13.85%	16.24%	31.21%	57.16%
Cultivated Crops	0.28%	0.00%	0.00%	0.55%	0.49%	0.56%	19.94%	11.30%
Urban/Recreational Grasses	11.30%	21.42%	11.58%	16.25%	33.76%	11.89%	3.18%	4.13%
Woody Wetlands	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%
Emergent Herbaceous Wetlands	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.14%	0.00%
Total Percentage:	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

Table 1-4d Land Use Summaries by Watershed

Land Use Category	Watershed							
	Pea Creek	**Adams Creek**	**Verdigris River near Inola**	**Dog Creek**	**Cat Creek**	**Verdigris River near Claremore**	**Neosho River below Ft Gibson Lake near Ft Gibson**	**Chouteau Creek**
Waterbody ID	OK121500020100_00	OK121500020150_00	OK121500020260_00	OK121500020360_00	OK121500020390_00	OK121500030010_00	OK121600010010_00	OK121600010430_00
Open Water	70	996	3,317	1,103	525	533	121	695
Medium Intensity Residential	127	1,666	2,326	1,321	1,139	244	11	375
High Intensity Residential	21	277	540	411	387	12	0	113
Bare Rock/Sand/Clay	0	1	8	0	0	0	1	1
Deciduous Forest	1,626	8,694	25,258	8,628	1,035	6,707	418	9,113
Evergreen Forest	8	82	433	136	6	13	1	0
Mixed Forest	0	0	0	0	0	0	0	0
Shrubland	0	0	0	0	0	0	0	0
Grasslands/Herbaceous	2,443	8,491	20,837	9,954	903	5,259	490	10,006
Pasture/Hay	5,040	9,090	30,299	14,825	818	5,962	1,210	20,581
Cultivated Crops	890	3,343	3,092	361	64	775	417	2,451
Urban/Recreational Grasses	1,012	5,385	7,394	3,135	1,231	1,796	85	2,563
Woody Wetlands	0	0	3	0	0	0	7	94
Emergent Herbaceous Wetlands	10	5	135	5	0	17	14	11
Total (Acres)	**11,247**	**38,030**	**93,643**	**39,880**	**6,109**	**21,316**	**2,776**	**46,002**
Open Water	0.63%	2.62%	3.54%	2.77%	8.59%	2.50%	4.35%	1.51%
Medium Intensity Residential	1.13%	4.38%	2.48%	3.31%	18.65%	1.14%	0.38%	0.81%
High Intensity Residential	0.19%	0.73%	0.58%	1.03%	6.33%	0.06%	0.00%	0.24%
Bare Rock/Sand/Clay	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.05%	0.00%
Deciduous Forest	14.46%	22.86%	26.97%	21.64%	16.94%	31.47%	15.07%	19.81%
Evergreen Forest	0.07%	0.22%	0.46%	0.34%	0.10%	0.06%	0.05%	0.00%
Mixed Forest	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Shrubland	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Grasslands/Herbaceous	21.72%	22.33%	22.25%	24.96%	14.78%	24.67%	17.67%	21.75%
Pasture/Hay	44.82%	23.90%	32.36%	37.17%	13.40%	27.97%	43.59%	44.74%
Cultivated Crops	7.92%	8.79%	3.30%	0.91%	1.04%	3.64%	15.04%	5.33%
Urban/Recreational Grasses	9.00%	14.16%	7.90%	7.86%	20.16%	8.42%	3.04%	5.57%
Woody Wetlands	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.26%	0.20%
Emergent Herbaceous Wetlands	0.09%	0.01%	0.14%	0.01%	0.00%	0.08%	0.50%	0.02%
Total Percentage:	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

1.3 Stream Flow Conditions

Stream flow characteristics and data are key information when conducting water quality assessments such as TMDLs. The USGS operates flow gages throughout Oklahoma, from which long-term stream flow records can be obtained. At various WQM stations additional flow measurements are available which were collected at the same time bacterial, total suspended solids (TSS), and turbidity water quality samples were collected. Not all of the waterbodies in this Study Area have historical flow data available. Flow data from the surrounding USGS gage stations and the instantaneous flow measurement data taken with water quality samples have been used to estimate flows for ungaged streams. Flow data collected at the time of water quality sampling are included in Appendix A along with corresponding water chemistry data results. A summary of the method used to project flows for ungaged streams and flow exceedance percentiles from projected flow data are provided in Appendix B.

SECTION 2
PROBLEM IDENTIFICATION AND WATER QUALITY TARGET

2.1 Oklahoma Water Quality Standards

Title 785 of the Oklahoma Administrative Code contains Oklahoma's Water Quality Standards (OWQS) and implementation procedures (OWRB 2011 & OWRB 2011a). The Oklahoma Water Resources Board (OWRB) has statutory authority and responsibility concerning establishment of state water quality standards, as provided under 82 Oklahoma Statute [O.S.], §1085.30. This statute authorizes the OWRB to promulgate rules …*which establish classifications of uses of waters of the state, criteria to maintain and protect such classifications, and other standards or policies pertaining to the quality of such waters.* [O.S. 82:1085:30(A)]. Beneficial uses are designated for all waters of the state. Such uses are protected through restrictions imposed by the antidegradation policy statement, narrative water quality criteria, and numerical criteria (OWRB 2011). An excerpt of the Oklahoma WQS (Title 785) summarizing the State of Oklahoma Antidegradation Policy is provided in Appendix D. Table 2-1, an excerpt from the 2008 Integrated Report (DEQ 2008), lists beneficial uses designated for each bacterial and/or turbidity impaired stream segment in the Study Area. The beneficial uses include:

- AES – Aesthetics
- AG – Agriculture Water Supply
- Fish and Wildlife Propagation
  - WWAC – Warm Water Aquatic Community
- FISH – Fish Consumption
- PBCR – Primary Body Contact Recreation
- SBCR – Secondary Body contact Recreation
- PPWS – Public & Private Water Supply
- EWS – Emergency Water Supply

Table 2-2 summarizes the bacterial and turbidity impairment status for streams in the Study Area. The TMDL priority shown in Table 2-2 is directly related to the TMDL target date. The TMDLs established in this report, which are a necessary step in the process of restoring water quality, only address bacterial and/or turbidity impairments that affect the PBCR and Fish and Wildlife Propagation uses.

The definition of PBCR and the bacterial WQSs for PBCR are summarized by the following excerpt from the Oklahoma Water Quality Standards (785-:45-5-16):

(a) *Primary Body Contact Recreation involves direct body contact with the water where a possibility of ingestion exists. In these cases the water shall not contain chemical, physical or biological substances in concentrations that are irritating to skin or sense organs or are toxic or cause illness upon ingestion by human beings.*

(b) *In waters designated for Primary Body Contact Recreation...limits...shall apply only during the recreation period of May 1 to September 30. The criteria for Secondary Body Contact Recreation will apply during the remainder of the year.*

(c) Compliance with 785:45-5-16 shall be based upon meeting the requirements of one of the options specified in (1) or (2) of this subsection (c) for bacteria. Upon selection of one (1) group or test method, said method shall be used exclusively over the time period prescribed therefor. Provided, where concurrent data exist for multiple bacterial indicators on the same waterbody or waterbody segment, no criteria exceedances shall be allowed for any indicator group.

(1) Escherichia coli (E. coli): The E. coli geometric mean criterion is 126/100 ml. For swimming advisory and permitting purposes, E. coli shall not exceed a monthly geometric mean of 126/100 ml based upon a minimum of not less than five (5) samples collected over a period of not more than thirty (30) days. For swimming advisory and permitting purposes, no sample shall exceed a 75% one-sided confidence level of 235/100 ml in lakes and high use waterbodies and the 90% one-sided confidence level of 406/100 ml in all other Primary Body Contact Recreation beneficial use areas. These values are based upon all samples collected over the recreation period. For purposes of sections 303(d) and 305(b) of the federal Clean Water Act as amended, beneficial use support status shall be assessed using only the geometric mean criterion of 126/100 milliliters compared to the geometric mean of all samples collected over the recreation period.

(2) Enterococci: The Enterococci geometric mean criterion is 33/100 ml. For swimming advisory and permitting purposes, Enterococci shall not exceed a monthly geometric mean of 33/100 ml based upon a minimum of not less than five (5) samples collected over a period of not more than thirty (30) days. For swimming advisory and permitting purposes, no sample shall exceed a 75% one-sided confidence level of 61/100 ml in lakes and high use waterbodies and the 90% one-sided confidence level of 108/100 ml in all other Primary Body Contact Recreation beneficial use areas. These values are based upon all samples collected over the recreation period. For purposes of sections 303(d) and 305(b) of the federal Clean Water Act as amended, beneficial use support status shall be assessed using only the geometric mean criterion of 33/100 milliliters compared to the geometric mean of all samples collected over the recreation period.

Table 2-1 Designated Beneficial Uses for Each Stream Segments in this Report

Waterbody Name	Waterbody ID	AES	AG	WWAC	*FISH*	PBCR	SBCR	PPWS	Limitation
Arkansas River near Muskogee	OK120400010260_00	I	N	N	N	N			EWS
Coody Creek	OK120400010400_00	F	F	N	X	N		I	
Dirty Creek	OK120400020010_00	I	F	N	X	I		F	
Dirty Creek, South Fork	OK120400020030_00	I	F	N	X	N			
Dirty Creek, Georges Fork	OK120400020110_00	F	F	N	X	N		I	EWS
Butler Creek	OK120400020160_00	F	F	N	X	N			
Elk Creek	OK120400020190_00	F	N	N	X	N			
Shady Grove Creek	OK120400020240_00	F	N	N	X	F			
Arkansas River near Haskell	OK120410010080_00	I	N	N	F		N		EWS
Cloud Creek	OK120410010100_00	I	F	N	X	F		I	
Haikey Creek	OK120410010210_00	I	I	N	X	N			
Snake Creek	OK120410010220_00	F	F	N	X	N		I	
Arkansas River near Bixby	OK120420010010_00	I	N	N	F		N		EWS
Fred Creek	OK120420010060_00	I	I	I	X	N			
Mooser Creek	OK120420010070_00	I	I	I	X	N			
Crow Creek	OK120420010090_00	I	I	N	X	N			
Arkansas River near Sand Springs	OK120420010130_00	I	N	N	F	F	X		EWS
Blackboy Creek	OK120420010140_00	I	X	I	X	N			
Harlow Creek	OK120420010170_00	I	X	I	X	N			
Polecat Creek	OK120420020010_00	I	F	F	X	F			
Nickel Creek	OK120420020040_00	I	X	I	X	N			
Polecat Creek	OK120420020050_00	I	F	I	X	N			
Verdigris River near Wagoner	OK121500010200_00	I	F	N	N	N		F	
Bull Creek	OK121500020090_00	F	F	N	X	N			
Pea Creek	OK121500020100_00	I	X	I	X	N			
Adams Creek	OK121500020150_00	I	I	N	X	N		X	
Verdigris River near Inola	OK121500020260_00	I	F	N	N	N		I	
Dog Creek	OK121500020360_00	F	F	N	X	N		I	
Cat Creek	OK121500020390_00	I	N	N	X	N			EWS
Verdigris River near Claremore	OK121500030010_00	I	F	F	F	N		I	
Neosho River below Ft. Gibson Lake	OK121600010010_00	I	X	I	I	N		X	
Chouteau Creek	OK121600010430_00	I	F	N	X	N		I	

F – Fully supporting; N – Not supporting; I – Insufficient information; X – Not assessed

Table 2-2 Excerpt from the 2008 Integrated Report – Oklahoma 303(d) List of Impaired Waters (Category 5)

Waterbody Name	Waterbody ID	Stream Miles	TMDL Date	Priority	ENT	*E. coli*	Turbidity
Arkansas River near Muskogee	OK120400010260_00	11	2013	2	X		
Coody Creek	OK120400010400_00	16	2013	2	X		
Dirty Creek	OK120400020010_00	44	2016	3			X
Dirty Creek, South Fork	OK120400020030_00	16	2019	4	X		
Dirty Creek, Georges Fork	OK120400020110_00	10	2016	3	X		
Butler Creek	OK120400020160_00	10	2019	4	X		
Elk Creek	OK120400020190_00	14	2019	4			X
Shady Grove Creek	OK120400020240_00	11	2019	4	X		
Arkansas River near Haskell	OK120410010080_00	42	2016	3	X		
Cloud Creek	OK120410010100_00	6	2019	4			X
Haikey Creek	OK120410010210_00	11	2016	3		X	
Snake Creek	OK120410010220_00	31	2013	2	X		
Arkansas River near Bixby	OK120420010010_00	17	2013	2	X		
Fred Creek	OK120420010060_00	3	2013	2		X	
Mooser Creek	OK120420010070_00	4	2013	2		X	
Crow Creek	OK120420010090_00	3	2013	2		X	
Arkansas River near Sand Springs	OK120420010130_00	12	2013	2			X
Blackboy Creek	OK120420010140_00	4	2013	2		X	
Harlow Creek	OK120420010170_00	6	2013	2		X	
Polecat Creek	OK120420020010_00	7	2013	2	X		
Nickel Creek	OK120420020040_00	12	2016	3		X	
Polecat Creek	OK120420020050_00	8	2016	3	X		
Verdigris River near Wagoner	OK121500010200_00	6	2013	2	X		X
Bull Creek	OK121500020090_00	18	2013	2	X	X	X
Pea Creek	OK121500020100_00	10	2013	2	X	X	
Adams Creek	OK121500020150_00	18	2013	2		X	
Verdigris River near Inola	OK121500020260_00	23	2013	2	X		X
Dog Creek	OK121500020360_00	10	2013	2	X	X	
Cat Creek	OK121500020390_00	7	2013	2	X	X	
Verdigris River near Claremore	OK121500030010_00	10	2016	3	X		
Neosho River below Ft. Gibson Lake	OK121600010010_00	1	2010	1	X		
Chouteau Creek	OK121600010430_00	22	2016	3	X	X	

ENT = Enterococci; EC = *E. coli*
X = Criterion exceeded
Source: 2008 Integrated Report, DEQ 2008.

To implement Oklahoma's WQS for PBCR, OWRB promulgated Chapter 46, *Implementation of Oklahoma's Water Quality Standards* (OWRB 2011a). The excerpt below from Chapter 46: 785:46-15-6, stipulates how water quality data will be assessed to determine support of the PBCR use as well as how the water quality target for TMDLs will be defined for each bacterial indicator:

(a) ***Scope.*** *The provisions of this Section shall be used to determine whether the subcategory of Primary Body Contact of the beneficial use of Recreation designated in OAC 785:45 for a waterbody is supported during the recreation season from May 1 through September 30 each year. Where data exist for multiple bacterial indicators on the same waterbody or waterbody segment, the determination of use support shall be based upon the use and application of all applicable tests and data.*

(b) ***Escherichia coli (E.coli).***

(1) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be fully supported with respect to E. coli if the geometric mean of 126 colonies per 100 ml is met. These values are based upon all samples collected over the recreation period in accordance with OAC 785:46-15-3(c).

(2) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be not supported with respect to E. coli if the geometric mean of 126 colonies per 100 ml is not met. These values are based upon all samples collected over the recreation period in accordance with OAC 785:46-15-3(c).

(c) ***Enterococci.***

(1) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be fully supported with respect to Enterococci if the geometric mean of 33 colonies per 100 ml is met. These values are based upon all samples collected over the recreation period in accordance with OAC 785:46-15-3(c).

(2) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be not supported with respect to Enterococci if the geometric mean of 33 colonies per 100 ml is not met. These values are based upon all samples collected over the recreation period in accordance with OAC 785:46-15-3(c).

Compliance with the Oklahoma WQS is based on meeting requirements for both *E. coli* and Enterococci bacterial indicators in addition to the minimum sample requirements for assessment. Where concurrent data exist for multiple bacterial indicators on the same waterbody or waterbody segment, each indicator group must demonstrate compliance with the numeric criteria prescribed (OWRB 2011).

As stipulated in the WQS, only the geometric mean of all samples collected over the recreation period shall be used to assess the impairment status of a stream segment. Therefore, only the geometric mean criteria will be used to develop TMDLs for *E. coli* and Enterococci bacterial indicators. .

It is worth noting that the Oklahoma Water Quality Standards (OWQS) prior to July 1, 2011 contains three bacterial indicators (fecal coliform, *E. coli* and Enterococci) and the new OWQS effective on July 1, 2011 contains only *E. coli* and Enterococci. Because the new OWQS no longer have a standard for fecal coliform, fecal coliform TMDLs will not be developed for any stream segment in this report even though the stream segments were listed for fecal coliform impairment in the 2008 303(d) list. Bacterial TMDLs will be developed only for *E. coli* and/or Enterococci impaired streams.

The beneficial use of WWAC is one of several subcategories of the Fish and Wildlife Propagation use established to manage the variety of communities of fish and shellfish throughout the state (OWRB 2011). The numeric criteria for turbidity to maintain and protect the use of "Fish and Wildlife Propagation" from Title 785:45-5-12 (f) (7) is as follows:

(A) Turbidity from other than natural sources shall be restricted to not exceed the following numerical limits:

i. Cool Water Aquatic Community/Trout Fisheries: 10 NTUs;

ii. Lakes: 25 NTU; and

iii. Other surface waters: 50 NTUs.

(B) In waters where background turbidity exceeds these values, turbidity from point sources will be restricted to not exceed ambient levels.

(C) Numerical criteria listed in (A) of this paragraph apply only to seasonal base flow conditions.

(D) Elevated turbidity levels may be expected during, and for several days after, a runoff event.

To implement Oklahoma's WQS for Fish and Wildlife Propagation, promulgated Chapter 46, *Implementation of Oklahoma's Water Quality Standards* (OWRB 2011a). The excerpt below from Chapter 46: 785:46-15-5, stipulates how water quality data will be assessed to determine support of fish and wildlife propagation as well as how the water quality target for TMDLs will be defined for turbidity.

Assessment of Fish and Wildlife Propagation support

(a) Scope. The provisions of this Section shall be used to determine whether the beneficial use of Fish and Wildlife Propagation or any subcategory thereof designated in OAC 785:45 for a waterbody is supported.

(e) Turbidity. The criteria for turbidity stated in 785:45-5-12(f)(7) shall constitute the screening levels for turbidity. The tests for use support shall follow the default protocol in 785:46-15-4(b).

785:46-15-4. Default protocols

(b) Short term average numerical parameters.

(1) Short term average numerical parameters are based upon exposure periods of less than seven days. Short term average parameters to which this Section applies include, but are not limited to, sample standards and turbidity.

(2) A beneficial use shall be deemed to be fully supported for a given parameter whose criterion is based upon a short term average if 10% or less of the samples for that parameter exceeds the applicable screening level prescribed in this Subchapter.

(3) A beneficial use shall be deemed to be fully supported but threatened if the use is supported currently but the appropriate state environmental agency determines that available

data indicate that during the next five years the use may become not supported due to anticipated sources or adverse trends of pollution not prevented or controlled. If data from the preceding two year period indicate a trend away from impairment, the appropriate agency shall remove the threatened status.

(4) A beneficial use shall be deemed to be not supported for a given parameter whose criterion is based upon a short term average if at least 10% of the samples for that parameter exceed the applicable screening level prescribed in this Subchapter.

2.2 Problem Identification

In this subsection water quality data summarizing waterbody impairments caused by elevated levels of bacteria are summarized first followed by the data summarizing impairments caused by elevated levels of turbidity.

2.2.1 Bacterial Data Summary

Table 2-3 summarizes water quality data collected during primary contact recreation season from the WQM stations between 2000 and 2010 for each indicator bacteria. The data summary in Table 2-3 provides a general understanding of the amount of water quality data available and the severity of exceedances of the water quality criteria. This data collected during the primary contact recreation season was used to support the decision to place specific waterbodies within the Study Area on the DEQ 2008 303(d) list (DEQ 2008). Water quality data from the primary contact recreation seasons are provided in Appendix A. For the data collected between 2000 and 2010, evidence of nonsupport of the PBCR use based on elevated *E. coli* and Enterococci concentrations was observed in twenty-three sub-watersheds.

2.2.2 Turbidity Data Summary

Turbidity is a measure of water clarity and is caused by suspended particles in the water column. Because turbidity cannot be expressed as a mass load, total suspended solids (TSS) are used as a surrogate in this TMDL. Therefore, both turbidity and TSS data are presented in this subsection.

Table 2-4 summarizes turbidity and TSS data collected from the WQM stations between 1998 and 2011. However, as stipulated in Title *785:45-5-12 (f) (7) (C),* numeric criteria for turbidity only apply under base flow conditions. While the base flow condition is not specifically defined in the Oklahoma Water Quality Standards, DEQ considers base flow conditions to be all flows less than the 25^{th} flow exceedance percentile (i.e., the lower 75% of flows) which is consistent with the USGS Streamflow Conditions Index (USGS 2007a). Therefore, Water quality samples collected under flow conditions greater than the 25^{th} flow exceedance percentile (highest flows) were therefore excluded from the data set used for TMDL analysis. Table 2-5 was prepared to represent the subset of these data when samples under high flow conditions were excluded. An impairment assessment was performed based on this subset of the turbidity data and the results were shown in Table 2-5. Water quality data for turbidity and TSS are provided in Appendix A.

Table 2-3 Summary of Assessment of Indicator Bacterial Samples from Primary Contact Recreation Subcategory Season May 1 to September 30, 2000 - 2010

Waterbody ID	Stream Segments	Bacterial Indicator	Standards	GeoMean (cfu/100ml)	# of Samples	2008 303(d)	Assessment Results
OK120400010260_00	Arkansas River near Muskogee	ENT	33	83	18	X	TMDL Required
OK120400010400_00	Coody Creek	ENT	33	219	18	X	TMDL Required
		EC	126	152	18		Does not meet standards,TMDL Required
OK120400020010_00	Dirty Creek	ENT	33	55	18		Does not meet standards,TMDL Required
OK120400020030_00	Dirty Creek, South Fork	ENT	33	207	18	X	TMDL Required
OK120400020110_00	Dirty Creek, Georges Fork	ENT	33	136	18	X	TMDL Required
OK120400020160_00	Butler Creek	ENT	33	94	16	X	TMDL Required
		EC	126	165	16		Does not meet standards,TMDL Required
OK120400020190_00	Elk Creek	ENT	33	61	18		Does not meet standards,TMDL Required
OK120400020240_00	Shady Grove Creek	ENT	33	36	17	X	TMDL Required
OK120410010080_00	Arkansas River near Haskell	ENT	33	44	25	X	TMDL Required
OK120410010100_00	Cloud Creek	ENT	33	56	18		Does not meet standards,TMDL Required
OK120410010210_00	Haikey Creek	EC	126				Delist for 2010: No data Available
OK120410010220_00	Snake Creek	ENT	33	58	18	X	TMDL Required
OK120420010010_00	Arkansas River near Bixby	ENT	33	108	25		TMDL Required
OK120420010060_00	Fred Creek	EC	126			X	Delist for 2010: No data Available
OK120420010070_00	Mooser Creek	EC	126			X	Delist for 2010: No data Available
OK120420010090_00	Crow Creek	EC	126			X	Delist for 2010: No data Available
OK120420010130_00	Arkansas River near Sand Springs	ENT	33	36	22		TMDL Required
OK120420010140_00	Blackboy Creek	ENT	33			X	Delist for 2010: No data Available
OK120420010170_00	Harlow Creek	ENT	33			X	Delist for 2010: No data Available
OK120420020010_00	Polecat Creek	ENT	33			X	Delist for 2010: No data Available
		EC	126	154	17		Does not meet standards,TMDL Required
OK120420020040_00	Nickel Creek	EC	126			X	Delist for 2010: No data Available
OK120420020050_00	Polecat Creek	ENT	33	58	20	X	TMDL Required
OK121500010200_00	Verdigris River near Wagoner	ENT	33	123	25	X	TMDL Required
OK121500020090_00	Bull Creek	ENT	33	203	20	X	TMDL Required
		EC	126	167	20	X	TMDL Required
OK121500020100_00	Pea Creek	ENT	33	940	17	X	TMDL Required
		EC	126	331	17	X	TMDL Required
OK121500020150_00	Adams Creek	EC	126				Delist for 2010: No data Available
OK121500020260_00	Verdigris River near Inola	ENT	33	157	20	X	TMDL Required
OK121500020360_00	Dog Creek	ENT	33	169	28	X	TMDL Required
		EC	126	240	28	X	TMDL Required
OK121500020390_00	Cat Creek	ENT	33	228	8	X	Delist for 2010: Samples < 10
		EC	126	261	8	X	Delist for 2010: Samples < 10
OK121500030010_00	Verdigris River near Claremore	ENT	33	114	21	X	TMDL Required
OK121600010010_00	Neosho River below Ft. Gibson Lake	ENT	33	63	13	X	TMDL Required
OK121600010430_00	Chouteau Creek	ENT	33	220	16	X	TMDL Required
		EC	126	138	17	X	TMDL Required

Table 2-4 Summary of All Turbidity and TSS Samples, 1998 to 2011

Waterbody ID	Waterbody Name	Number of turbidity samples	Number of TSS samples	Number of turbidity samples greater than 50 NTU	% turbidity samples exceeding criterion	Sampling period
OK120400020010_00	Dirty Creek	40	39	12	30%	2003-2010
OK120400020160_00	Butler Creek	37	37	7	19%	2003-2010
OK120400020190_00	Elk Creek	40	38	6	15%	2003-2010
OK120410010100_00	Cloud Creek	38	37	9	24%	2003-2010
OK120410010220_00	Snake Creek	40	38	10	25%	2003-2010
OK121500010200_00	Verdigris River at US 51,Wagoner	69	17	28	41%	1999-2011
OK121500020090_00	Bull Creek	70	60	24	34%	1998-2008
OK121500020260_00	Verdigris River, Inola	61	6	22	36%	2000-2011

Table 2-5 Summary of Turbidity and TSS Samples During Baseflow Conditions, 1998 - 2011

Waterbody ID	Waterbody Name	Number of turbidity samples	Number of TSS samples	Number of Turbidity samples greater than 50 NTU	% turbidity samples exceeding criterion	2008 303(d)	Assessment Results
OK120400020010_00	Dirty Creek	32	31	6	19%	X	TMDL Required
OK120400020160_00	Butler creek	30	29	4	13%		Impaired,TMDL Required
OK120400020190_00	Elk Creek	34	32	3	9%	X	Delist for 2010: Meets Standards
OK120410010100_00	Cloud Creek	30	29	5	17%	X	TMDL Required
OK120410010220_00	Snake Creek	31	29	4	13%		Impaired,TMDL Required
OK121500010200_00	Verdigris River at US 51,Wagoner	49	12	12	24%	X	TMDL Required
OK121500020090_00	Bull Creek	61	51	16	26%	X	TMDL Required
OK121500020260_00	Verdigris, Inola	47	4	13	28%	X	TMDL Required

After re-evaluating both bacterial and turbidity data following Oklahoma's assessment protocol, TMDLs will be developed only for the streams and pollutants listed in Table 2-6. A total of 36 bacterial/turbidity TMDLs will be developed in this report.

Table 2-6 Stream Segments and Pollutants for TMDL Development

Waterbody ID	Waterbody Name	Stream Miles	TMDL Date	Priority	*E. coli*	ENT	Turbidity
OK120400010260_00	Arkansas River near Muskogee	11	2013	2		X	
OK120400010400_00	Coody Creek	16	2013	2	X	X	
OK120400020010_00	Dirty Creek	44	2016	3		X	X
OK120400020030_00	Dirty Creek, South Fork	16	2019	4		X	
OK120400020110_00	Dirty Creek, Georges Fork	10	2016	3		X	
OK120400020160_00	Butler Creek	10	2019	4	X	X	X
OK120400020190_00	Elk Creek	14	2019	4		X	
OK120400020240_00	Shady Grove Creek	11	2019	4		X	
OK120410010080_00	Arkansas River near Haskell	42	2016	3		X	
OK120410010100_00	Cloud Creek	6	2019	4		X	X
OK120410010220_00	Snake Creek	31	2013	2		X	X
OK120420010010_00	Arkansas River near Bixby	17	2013	2		X	
OK120420010130_00	Arkansas River near Sand Springs	12	2013	2		X	
OK120420020010_00	Polecat Creek	7	2013	2	X		
OK120420020050_00	Polecat Creek	8	2016	3		X	
OK121500010200_00	Verdigris River near Wagoner	6	2013	2		X	X
OK121500020090_00	Bull Creek	18	2013	2	X	X	X
OK121500020100_00	Pea Creek	10	2013	2	X	X	
OK121500020260_00	Verdigris River near Inola	23	2013	2		X	X
OK121500020360_00	Dog Creek	10	2013	2	X	X	
OK121500030010_00	Verdigris River near Claremore	10	2016	3		X	
OK121600010010_00	Neosho River below Ft. Gibson Lake	1	2010	1		X	
OK121600010430_00	Chouteau Creek	22	2016	3	X	X	

2.3 Water Quality Target

The Code of Federal Regulations (40 CFR §130.7(c)(1)) states that, "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numerical water quality standards." The water quality targets for *E. coli* and Enterococci are geometric mean standards of 126 cfu/100ml and 33 cfu/100ml, respectively.

The TMDL for bacteria will incorporate an explicit 10% margin of safety.

An individual water quality target established for turbidity must demonstrate compliance with the numeric criteria prescribed in the Oklahoma WQS (OWRB 2011a). According to the Oklahoma WQS [785:45-5-12(f)(7)], the turbidity criterion for streams with WWAC beneficial use is 50 NTUs (OWRB 2008). The turbidity of 50 NTUs applies only to seasonal base flow conditions. Turbidity levels are expected to be elevated during, and for several days after, a storm event.

TMDLs for turbidity in streams designated as WWAC must take into account that no more than 10% of the samples may exceed the numeric criterion of 50 NTU. However, as described above, because turbidity cannot be expressed as a mass load, TSS is used as a surrogate for TMDL development. Since there is no numeric criterion in the Oklahoma WQS for TSS, a specific method must be developed to convert the turbidity criterion to TSS based on a relationship between turbidity and TSS. The method for deriving the relationship between turbidity and TSS and for calculating a water body specific water quality goal using TSS is summarized in Section 4 of this report.

The MOS for the TSS TMDLs varies by waterbody and is related to the goodness-of-fit metrics of the turbidity-TSS regressions. The method for defining MOS percentages is described in Section 5 of this report.

SECTION 3
POLLUTANT SOURCE ASSESSMENT

A pollutant source assessment characterizes known and suspected sources of pollutant loading to impaired waterbodies. Sources within a watershed are categorized and quantified to the extent that information is available. Pathogen indicator bacteria originate from the digestive tract of warm-blooded animals and sources may be point or nonpoint in nature. Turbidity may originate from NPDES-permitted facilities, fields, construction sites, quarries, stormwater runoff and eroding stream banks.

Point sources are permitted through the NPDES program. NPDES-permitted facilities that discharge treated wastewater in Oklahoma are currently required to monitor for fecal coliform and TSS in accordance with their permits. The discharges with bacterial limits will be required to monitor for *E. coli* when their permits come to renew. Nonpoint sources are diffuse sources that typically cannot be identified as entering a waterbody through a discrete conveyance at a single location. Nonpoint sources may emanate from land activities that contribute bacteria or TSS to surface water as a result of rainfall runoff. For the TMDLs in this report, all sources of pollutant loading not regulated by NPDES permits are considered nonpoint sources.

The potential non-point sources for bacteria were compared based on the fecal coliform load produced in each sub-watershed. Although fecal coliform is no longer used as a bacterial indicator in the Oklahoma WQS, it is still valid to use fecal coliform load to compare the potential non-point sources because *E. coli* is a sub-set of fecal coliform. Not enough references on *E. coli* can be found to do the same comparison directly.

The following non-point sources were considered in this report:

- Wildlife (deer)
- Non-Permitted Agricultural Activities and Domesticated Animals
- Failing Onsite Wastewater Disposal Systems and Illicit Discharges
- Pets (dogs and cats)

The 2008 Integrated Water Quality Assessment Report (DEQ 2008) listed potential sources of turbidity as clean sediment, grazing in riparian corridors of streams and creeks, highway/road/bridge runoff (non-construction related), non-irrigated crop production, petroleum/natural gas activities, rangeland grazing, as well as other unknown sources. The following discussion describes what is known regarding point and nonpoint sources of bacteria in the impaired watersheds. Where information was available on point and nonpoint sources of indicator bacteria or TSS, data were provided and summarized as part of each category.

3.1 NPDES-Permitted Facilities

Under 40 CFR, §122.2, a point source is described as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Certain municipal plants are classified as no-discharge facilities. These facilities are required to sign an affidavit of no discharge. NPDES-permitted facilities classified as point sources that may contribute bacterial or TSS loading includes:

- NPDES municipal wastewater treatment plant (WWTP);
- NPDES Industrial WWTP Discharges;

- Municipal no-discharge WWTP;
- NPDES Concentrated Animal Feeding Operation (CAFO);
- NPDES municipal separate storm sewer system (MS4) discharges;
- NPDES multi-sector general permits; and
- NPDES construction stormwater discharges.

Continuous point source discharges such as WWTPs could result in discharge of elevated concentrations of fecal bacteria if the disinfection unit is not properly maintained, is of poor design, or if flow rates are above the disinfection capacity. It is possible that continuous point source discharges from municipal and industrial WWTPs could result in discharge of elevated concentrations of TSS if a facility is not properly maintained, is of poor design, or flow rates exceed capacity. However, in most cases suspended solids discharged by WWTPs consist primarily of organic solids rather than inorganic suspended solids (i.e., soil and sediment particles from erosion or sediment resuspension). Discharges of organic suspended solids from WWTPs are addressed by DEQ through its permitting of point sources to maintain WQS for dissolved oxygen and are not considered a potential source of turbidity in this TMDL. Discharges of TSS will be considered to be organic suspended solids if the discharge permit includes a limit for BOD or CBOD. Only WWTP discharges of inorganic suspended solids will be considered and will receive wasteload allocations.

While the no-discharge facilities do not discharge wastewater directly to a waterbody, it is possible that the collection systems associated with each facility may be a source of bacterial loading to surface waters. CAFOs are recognized by EPA as potential significant sources of pollution, and may have the potential to cause serious impacts to water quality if not properly managed.

Stormwater runoff from MS4 areas, which is now regulated under the EPA NPDES Program, can also contain high fecal coliform bacterial concentrations. Stormwater runoff from MS4 areas, facilities under multi-sector general permits, and NPDES construction stormwater discharges, which are regulated under the EPA NPDES Program, can contain TSS concentrations. 40 C.F.R. § 130.2(h) requires that NPDES-regulated stormwater discharges must be addressed by the wasteload allocation component of a TMDL. However, any stormwater discharge by definition occurs during or immediately following periods of rainfall and elevated flow conditions when Oklahoma Water Quality Standard for turbidity does not apply. Oklahoma Water Quality Standards specify that the criteria for turbidity “apply only to seasonal base flow conditions” and go on to say “Elevated turbidity levels may be expected during, and for several days after, a runoff event” [OAC 785:45-5-12(f)(7)]. In other words, the turbidity impairment status is limited to base flow conditions and stormwater discharges from MS4 areas or construction sites do not contribute to the violation of Oklahoma’s turbidity standard. Therefore, WLAs for NPDES-regulated stormwater discharges is essentially considered unnecessary in this TMDL report and will not be included in the TMDL calculations.

There is at least one NPDES-permitted facility in each sub-watershed with the exception of Butler Creek, Shady Grove Creek, Cloud Creek, Polecat Creek, and Verdigris River near Wagoner, Bull Creek, Pea Creek, Dog Creek and the Neosho River below Fort Gibson.

3.1.1 Continuous Point Source Dischargers

The locations of the NPDES-permitted facilities that discharge wastewater to surface waters addressed in these TMDLs are listed in Table 3-1 and displayed in Figures 3-1 and 3-2. For some continuous point source discharge facilities the permitted design flow was not available and therefore is not provided in Table 3-1. There are 36 active continuous and 4 seasonal point source discharging facilities within the Study Area but they are not all sources of concern for bacterial or TSS loading. All of these facilities are discharging to a waterbody that requires a TMDL for bacteria. All of the facilities in Table 3-1 discharge TSS and have specific permit limits for TSS which are provided in Table 3-1. However, the municipal WWTPs designated with a Standard Industrial Code number 4952 in Table 3-1 discharge organic TSS and therefore are not considered a potential source of turbidity within their respective watershed.

3.1.2 No-Discharge Facilities and Sanitary Sewer Overflows

For the purposes of these TMDLs, it is assumed that no-discharge facilities do not contribute indicator bacterial or TSS loading. However, it is possible the wastewater collection systems associated with these no-discharge facilities could be a source of indicator bacterial loading, or that discharges from the wastewater plant may occur during large rainfall events that exceed the systems' storage capacities. There are 16 no-discharge facilities in the Study Area (Table 3-2).

Sanitary sewer overflows (SSO) from wastewater collection systems, although infrequent, can be a major source of indicator bacterial loading to streams. SSOs have existed since the introduction of separate sanitary sewers, and most are caused by blockage of sewer pipes by grease, tree roots, and other debris that clog sewer lines, by sewer line breaks and leaks, cross connections with storm sewers, and inflow and infiltration of groundwater into sanitary sewers. SSOs are permit violations that must be addressed by the responsible NPDES permittee. The reporting of SSOs has been strongly encouraged by EPA, primarily through enforcement and fines. While not all sewer overflows are reported, DEQ has data on reported SSOs. There were 1,693 overflows reported since 2005 ranging from 1 gallon to 4.2 million gallons. Table 3-3 summarizes the SSO occurrences by NPDES facility. SSO data are provided in Appendix D.

Table 3-1 Point Source Discharges in the Study Area

Waterbody Name & Waterbody ID	OPDES Permit No.	Facility	Facility ID	SIC code	Facility Type	Design Flow (MGD)	Ave/Max FC (cfu/100mL)	Avg/Max TSS (mg/L)	Expiration Date	Status
Arkansas River near Muskogee OK120400010260_00	OK0034321	Fort James Operating Co.	I-51001210	2621	Paper mill	18.750	NA	125		Active
	OK0029131	Muskogee Utilities Authority	S20415	4952	Sewerage systems	13.740	200/400	30/45	4/30/2014	Active
	OK0001643	Fansteel, Inc.-Muskogee	I-51000040	3339	Primary Smelting & Refining	0.580		28	12/11/2008	Inactive
	OK0038881	Koch Materials Co.- Muskogee	I-51001450	2951	Asphalt Paving & Roofing Materials				11/30/2000	Inactive
Coody Creek OK120400010400_00	OK0042846	Boral Bricks Inc-Muskogee plnt	I-51001360	3251	Structural Clay Products	0.0432			5/3/2014	Active
	OK0043451	Owens-Brockway Glass Container	I-51001710	3221	Glass &Glassware, Pressed or	0.500			pending	Active
	OK0041874	Yaffe Iron and Metal Co Inc	I-51000050	5093	Scrap and waste materials	0.105			pending	Active
Dirty Creek OK120400020010_00	OK0034631	Webbers Falls, Town of	S20428	4952	Sewerage systems	0.045	NA	90/135	pending	Active
Dirty Creek, South Fork OK120400020030_00	OK0021636	Porum Public Works authority	S20421	4952	Sewerage systems	0.800	NA	90/135	6/30/2016	Active
Dirty Creek, Georges Fork OK120400020110_00	OK0033405	Connors State College	S20419	4952	Sewerage systems	0.060	200/400	30/90	1/31/2016	Active
	OK0031003	Warner Utilities Authority	S20420	4952	Sewerage systems	0.280	NA	90/135	12/31/2015	Active
Elk Creek OK120400020190_00	OK0028100	Checotah PWA	S20418	4952	Sewerage systems	1.940	200/400	15/30	11/30/2015	Active
	OK0043397	Wabash Alloys, L.L.C.	I-49000190	3341	Secondary Smelting & Refining				1/31/2005	Inactive
	OK0042994	Flying J Truck Plaza	I-49000230	5541	Gasoline Service Stations				6/30/2008	Inactive
Arkansas River near Haskell OK120410010080_00	OK0000400	Arkhola sand & gravel Co	I-51001160	1442	Construction Sand and Gravel		NA		8/31/2014	Active
	OK0043273	Muskogee Sand Company, Inc.	I-73000430	1442	Construction Sand and Gravel	3.200	NA		8/31/2016	Active
	OK0040053	City of Broken Arrow	S20409	4952	Sewerage systems	8.000	200/400	30/45	2/28/2017	Active
	OK0020281	Coweta PWA	S20410	4952	Sewerage systems	3.000	200/400	90/135	7/31/2016	Active
	OK0032271	Haskell PWA	S20411	4952	Sewerage Systems	0.390	NA	90/135	5/31/2013	Active
	OK0043435	Cherokee Sand & Gravel	I-72002400	1442	Construction Sand and Gravel				8/31/2004	Inactive
	OK0001210	Longview Lake Homeowner's Assn	I-72002710	7999	Amusement and Recreation				3/31/2011	Inactive
	OK0043923	Coweta Sand & Transportation	I-73000510	1442	Construction Sand and Gravel				12/31/2004	Inactive
	OKG110049	Mid-Continent Coweta	I-73000560	3273	Concrete, Gypsum, & Plaster				3/31/2003	Inactive
Snake Creek OK120410010220_00	OK0043095	Holliday Sand & Gravel-Coweta	I-73000370	1442	Construction Sand and Gravel	3.360	NA	45	7/31/2013	Active
	OK0044121	Ken Laster Co.-Mountain Creek	I-72002420	1442	Construction Sand and Gravel				10/31/2005	Inactive
Arkansas River, US 64, Bixby OK120420010010_00	OK0002429	Public Service Co-Riverside	I-72000540	4911	Electric Services	2.500	NA	30	9/30/2016	Active
	OK0035319	Holliday Sand & Gravel-Bixby#1	I-72001550	1442	Construction Sand and Gravel	2.120	NA	45	9/30/2013	Active
	OK0040827	Kimberly-Clark Corp-Jenks Facility	I-72002100	2676	Sanitary paper products	2.240	NA	45	10/31/2014	Active
	OK0042404	Anchor Stone Co.-Delaware Sand	I-72002200	1442	Construction Sand and Gravel	3.600	NA	30/45	3/31/2012	Active
	OK0043869	Green Country Eng-Cogentrix	I-72002410	4911	Electric Services	0.250	NA	45	6/30/2016	Active
	OK0044547	Anchor Stone Co.-Jenks Sand Plant	I-72002600	1442	Construction Sand and Gravel	3.600	NA	45	9/30/2013	Active
	OK0026239	TMUA-Southside plant	S20402	4952	Sewerage systems	42.00	200/400	30/45	4/30/13	Active
	OK0037401	Jenks PWA	S20403	4952	Sewerage systems	2.000	200/400	30/45	11/30/2012	Active

Waterbody Name & Waterbody ID	Facility	NPDES	Facility ID	SIC code	Facility Type	Design Flow (MGD)	Ave/Max FC (cfu/100mL)	Avg/Max TSS (mg/L)	Expiration Date	Notes
Arkansas River, US 64, Bixby OK120420010010_00	OK0026913	Bixby PWA-South	S20407	4952	Sewerage systems	0.684	200/400	90/13	11/30/2012	Active
	OK0027138	Glenpool Utility Service Authority	S20430	4952	Sewerage systems	1.440	200/400	90/13	9/30/2016	Active
	OK0022888	Mounds PWA*	S20431	4952	Sewerage systems	0.310	NA	30/45	6/3/2016	Active
	OK0034363	RMUA-Haikey Creek	S20434	4952	Sewerage systems	16.000	200/400	30/45	5/31/2013	Active
	OK0036153	Bixby PWA (North)	S20438	4952	Sewerage systems	0.853	200/400	30/45	3/31/2015	Active
	OK0038148	Carrera Gas Gathering, LLC	I-45000650	1321	Natural Gas liquids				9/6/2007	Inactive
	OKG040004	Inter-Chem Coal Company-Eagle	I-51001580	1221	Bituminous coal & Lignite surface					Inactive
Arkansas River near Sand Springs OK120420010130_00	OK0000388	Baker Performance Chemicals	I-72000120	2899	Plastics Materials And Synthetic	2.350	NA	45	9/30/2016	Active
	OK0040096	Sand Springs Sand & Gravel	I-72001520	1442	Construction Sand and Gravel		NA	45	11/30/2012	Active
	OK0030864	City of Sand Springs	S20457	4952	Sewerage systems	5.500	200/400	30/45	10/31/2014	Active
	OK0034193	Webco Industries, SW Tube Div.	I-72000680	3317	Steel Works, Blast Furnaces,					Inactive
	OKG830014	Tulsa, City of -Transportation	I-72200003	4959	Sanitary Sevices not classified				12/14/2002	Inactive
Polecat Creek OK120420020050_00	OK0043974	City of Sapulpa	S20466	4952	Sewerage Systems	7.000	200/400	30/45	2/29/2012	Active
Verdigris River near Inola OK121500020260_00	OK0029149	Terra Nitrogen, L.P.- Verdigris	I-66000780	2873	Agricultural Chemicals	1.600	NA	40	pending	Active
	OK0038032	Rogers Co Rural Sewer Dist #1	S21521	4952	Sewerage Systems	0.500	NA	90/13	4/30/2015	Active
	OK0037494	Trails End Mobile Home	S21525	4952	Sewerage Systems	0.020	NA	30/45	3/31/2013	Active
	OK0037702	Lake Valley MHP	S21513	4952	Sewerage Systems	0.060	200/400	30/45		Inactive
	OK0027049	Claremore, City of	S21506	4952	Sewerage Systems	3.500	200/400	30/45	1/31/2015	Active
Verdigris River near Claremore OK121500030010_00	OK0037664	Lone Elm Mobile Home Park	S21526	4952	Sewerage systems	0.035	200/400	30/45	12/31/2014	Active
Chouteau Creek OK121600010430_00	OK0035149	Grand River Dam AuthorityChouteau	I-46000340	4911	Electric Services	3.5	NA	30/45	12/31/2014	Active
	OK0022764	Chouteau PWA	S21624	4952	Sewerage systems	0.320	200/400	30/45	2/28/2017	Active

Inactive facilities

Table 3-2 NPDES No-Discharge Facilities in the Study Area

Waterbody Name	Waterbody ID	Facility Name	Facility Type	Facility No.	OWRB	County
Arkansas River near Muskogee	OK120400010260_00	Muskogee Ready Mix Gallery	Total Retention		WD91-001	Muskogee
Dirty Creek	OK120400020010_00	Oktaha WWT	Total Retention	S20439		Muskogee
Elk Creek	OK120400020190_00	Foresee Ready Mix Checotah Plant	Total Retention			McIntosh
Arkansas River near Haskell	OK120410010080_00	Golf Club of OK WWT	Land Application	S20462		Wagoner
		Jess Dunn Correctional Center WWT	Land Application	S20414		Muskogee
		Little Pumpkins Car Wash	Total Retention		WD85-016	Tulsa
Arkansas River near Bixby	OK120420010010_00	American Golf Corp. - Whitehaw	Land Application		WD94-032	Tulsa
		Mid-Continent Concrete Co	Total Retention		WD94-022	Tulsa
Arkansas River near Sand Springs	OK120420010130_00	Air Liquide Sand Springs Site	Total Retention		CW72-038	Tulsa
		Sand Creek WWT	Total Retention	S20460		Creek
		Sand Springs Metal Processing	Total Retention		WD90-001	Tulsa
Polecat Creek	OK120420020010_00	Stepping Stones Mfg Inc.	Total Retention		WD90-033	Tulsa
Polecat Creek	OK120420020050_00	Rolling Hills Mobile Est WWT	Total Retention	S20447		Creek
		Windmill TP WWT	Total Retention	S20445		Creek
Verdigris River near Inola	OK121500020260_00	Upco Manufacturing Co	Total Retention		WD90-009	Rogers
Dog Creek	OK121500020360_00	Mid-Continent Concrete	Total Retention		WD93-009	Rogers

Table 3-3 Sanitary Sewer Overflow (SSO) Summary

Facility Name	Facility ID	Receiving Stream	Waterbody ID	Number of Occurrences	Date Range		Amount (Gallons)	
					From	To	Min	Max
Muskogee Utilities Authority	S20415	Arkansas River near Muskogee	OK120400010260_00	295	1/18/2005	2/3/2012	10	1,000,000
Porum PWA	S20421	Dirty Creek, South Fork	OK120400020030_00	4	9/13/2008	6/1/2010	1	35,000
Warner Utilities Authority	S20420	Dirty Creek, Georges Fork	OK120400020110_00	10	5/24/2009	11/15/2011	75	120,000
Checotah PWA	S20418	Elk Creek	OK120400020190_00	141	8/13/2005	2/6/2012	20	150,000
City of Broken Arrow	S20409	Arkansas River near Haskell	OK120410010080_00	125	1/6/2005	12/27/2011	112	2,000,000
Coweta PWA	S20410	Arkansas River near Haskell	OK120410010080_00	105	2/10/2005	2/7/2012	10	90,000
RMUA- Haikey Creek	S20434	Arkansas River near Bixby	OK120420010010_00	73	1/17/2007	1/20/2012	50	1,500,000
TMUA- Southside	S20402	Arkansas River near Bixby	OK120420010010_00	644	1/1/2005	1/15/2012	3	4,200,000
Jenks PWA	S20403	Arkansas River near Bixby	OK120420010010_00	20	12/12/2006	2/9/2012	55	1,000,000
Bixby PWA -South	S20407	Arkansas River near Bixby	OK120420010010_00	31	4/20/2005	10/26/2010	10	800
Glenpool Utility Authority	S20430	Arkansas River near Bixby	OK120420010010_00	27	2/20/2005	11/14/2011	100	200,000
Mounds PWA	S20431	Arkansas River near Bixby	OK120420010010_00	5	5/17/2002	3/4/2010	100	8,000
Bixby PWA - North	S20438	Arkansas River near Bixby	OK120420010010_00	41	7/21/2006	11/28/2011	1	1,000
City of Sand Springs	S20457	Arkansas River near Sand Springs	OK120420010130_00	64	1/31/2005	1/11/2012	10	360,000
Rogers Co RSD #1	S21521	Verdigris River near Inola	OK121500020260_00	14	2/26/2006	12/12/2011	150	10,000
City of Claremore	S21506	Verdigris River near Inola	OK121500020260_00	73	2/5/2006	2/4/2012	7	500,000
Chouteau PWA	S21624	Chouteau Creek	OK121600010430_00	21	1/4/2005	4/25/2011	100	3,000,000

Figure 3-1 Locations of NPDES-Permitted Facilities for Discharges, Total Retention PFO's and Quarries in the Study Area (Upper)

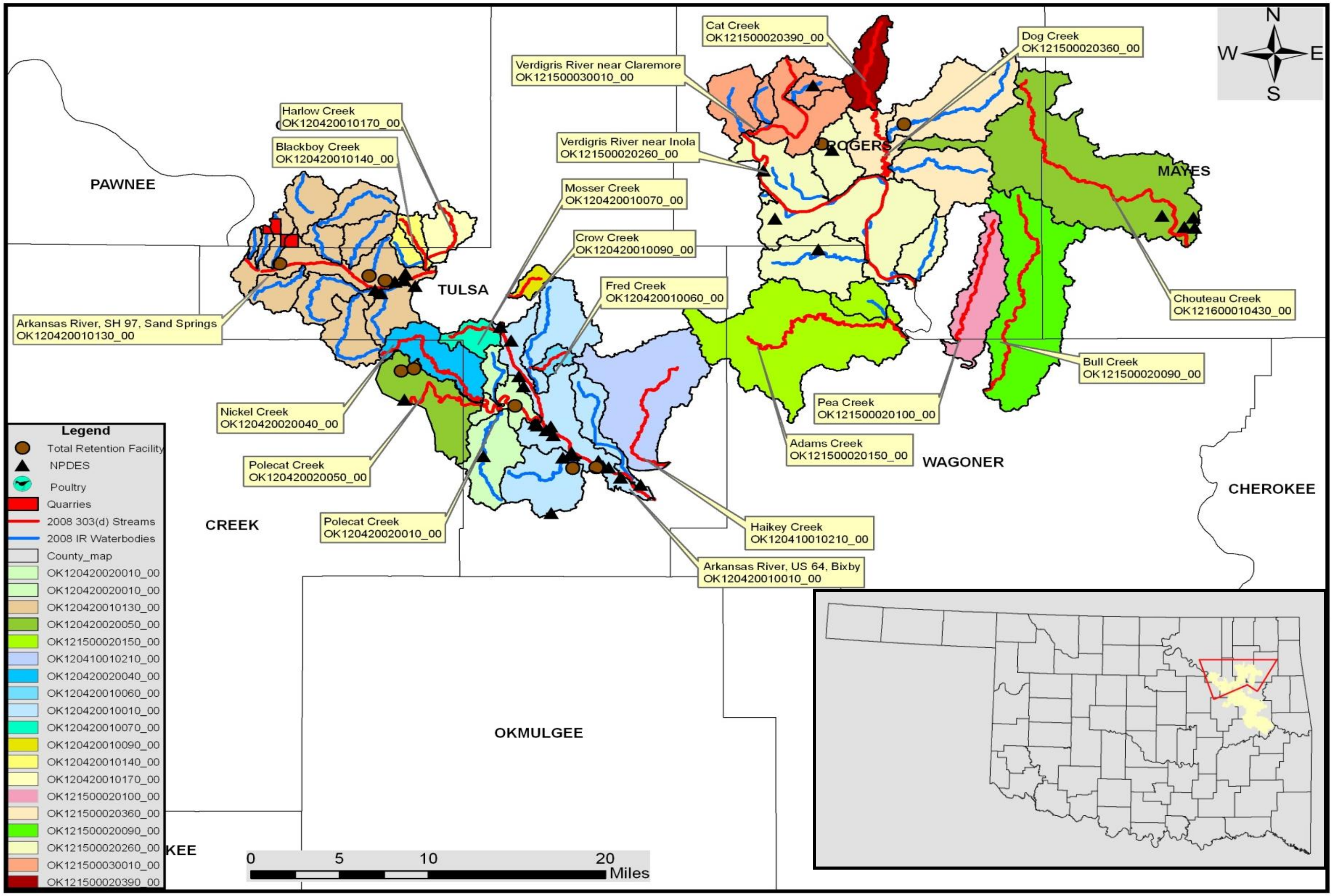


Figure 3-2 Locations of NPDES-Permitted Facilities for Discharges, Total Retention, PFO's and Quarries in the Study Area (Lower)

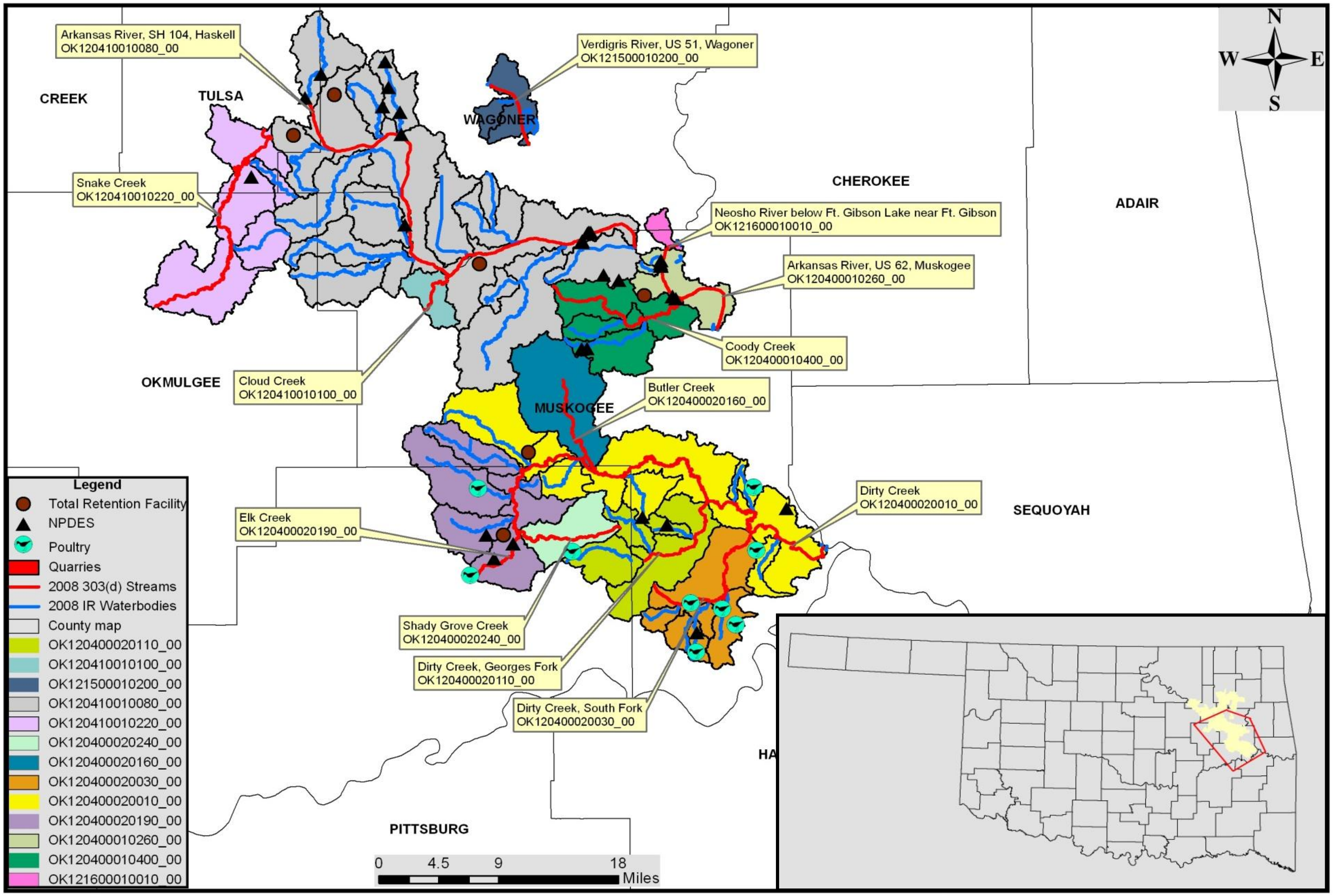


Figure 3-3 Locations of Land Application and Construction Activity Sites in the Study Area (Upper)

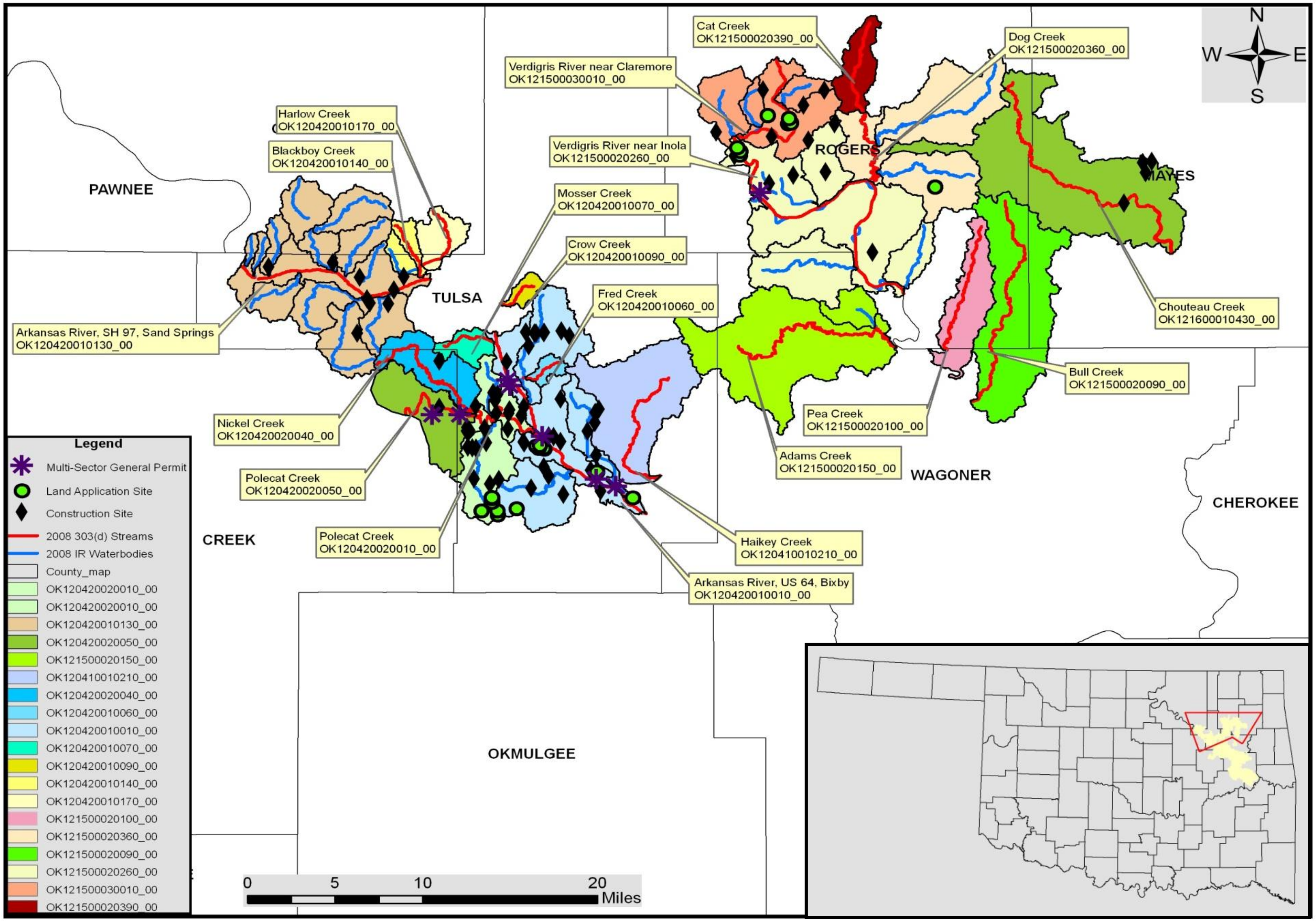
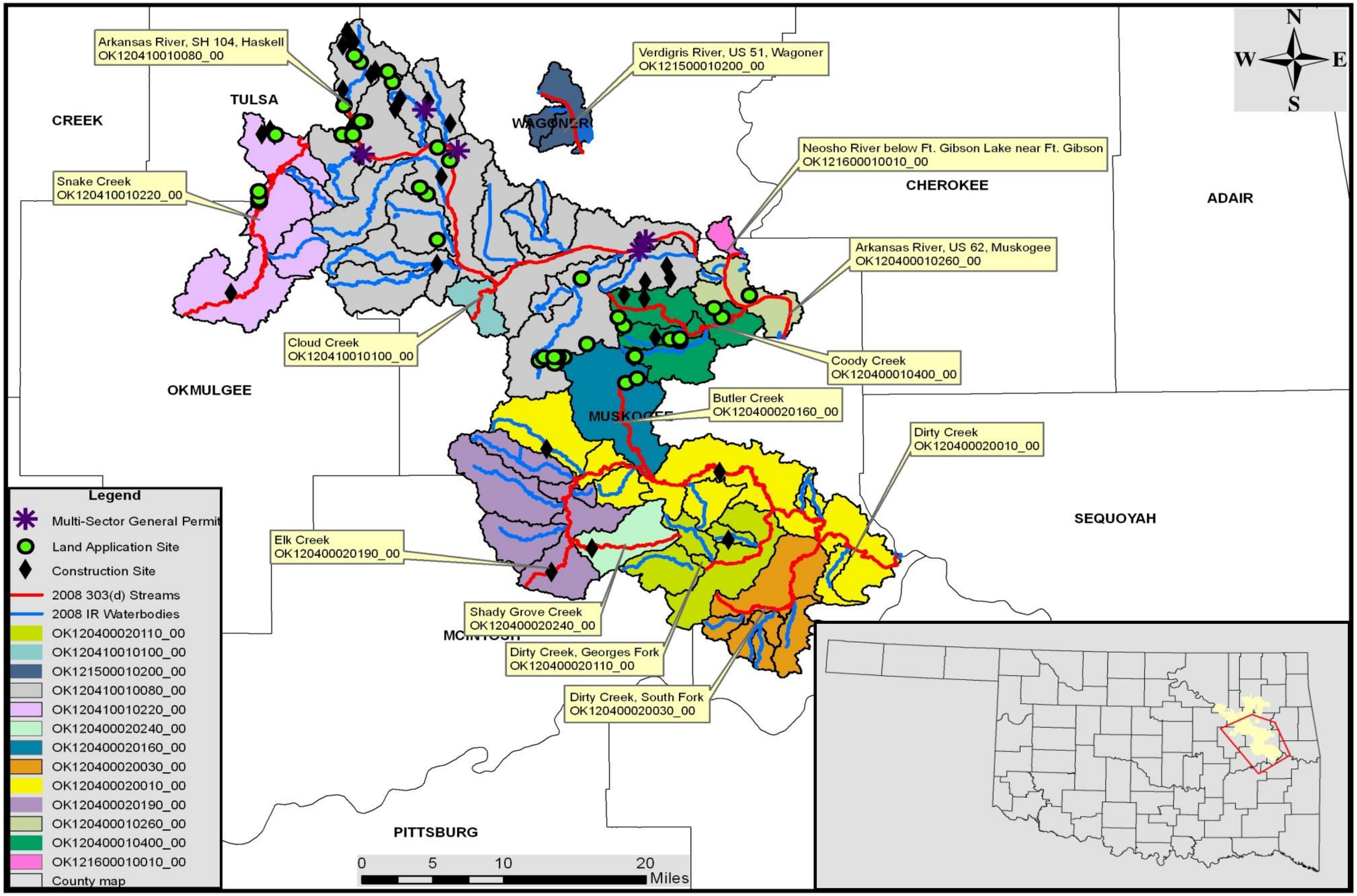


Figure 3-4 Locations of Land Application and Construction Activity Sites in the Study Area (Lower)



3.1.3 NPDES Municipal Separate Storm Sewer System

Phase I MS4

In 1990 the EPA developed rules establishing Phase I of the NPDES Stormwater Program, designed to prevent harmful pollutants from being washed by stormwater runoff into MS4s (or from being dumped directly into the MS4) and then discharged into local water bodies (EPA 2005). Phase I of the program required operators of medium and large MS4s (those generally serving populations of 100,000 or greater) to implement a stormwater management program as a means to control polluted discharges. Approved stormwater management programs for medium and large MS4s are required to address a variety of water quality-related issues, including roadway runoff management, municipal-owned operations, and hazardous waste treatment. There is one Phase I MS4 permit in the Study Area.

Phase II MS4

Phase II of the rule extends coverage of the NPDES stormwater program to certain small MS4s. Small MS4s are defined as any MS4 that is not a medium or large MS4 covered by Phase I of the NPDES Stormwater Program. Phase II requires operators of regulated small MS4s to obtain NPDES permits and develop a stormwater management program. Programs are designed to reduce discharges of pollutants to the "maximum extent practicable," protect water quality, and satisfy appropriate water quality requirements of the CWA. Small MS4 stormwater programs must address the following minimum control measures:

- Public Education and Outreach;
- Public Participation/Involvement;
- Illicit Discharge Detection and Elimination;
- Construction Site Runoff Control;
- Post- Construction Runoff Control; and
- Pollution Prevention/Good Housekeeping.

The small MS4 General Permit for communities in Oklahoma became effective on February 8, 2005. DEQ provides information on the current status of the MS4 program on its website, which can be found at: http://www.deq.state.ok.us/WQDnew/stormwater/ms4/. Table 3-3a lists the entities with Phase I/ Phase II MS4 permits in the Study Area:

Table 3-3a MS4 Entities in the Study Area

Entity	Permit No.	MS4 Phase	Date Issued
City of Bixby	OKR040042	Phase 2 MS4	12/8/2005
City of Broken Arrow	OKR040001	Phase 2 MS4	11/21/2005
City of Claremore	OKR040028	Phase 2 MS4	10/31/2005
City of Coweta	OKR040009	Phase 2 MS4	3/3/2006
City of Muskogee	OKR040013	Phase 2 MS4	11/14/2005
City of Jenks	OKR040024	Phase 2 MS4	12/8/2005
City of Sand Springs	OKR040017	Phase 2 MS4	11/30/2005
City of Sapulpa	OKR040018	Phase 2 MS4	10/27/2006
City of Tulsa[1]	OKS000201	Phase 1 MS4	11/14/2005

[1] Co-permittee with ODOT &OTA

3.1.4 Concentrated Animal Feeding Operations and Poultry Feeding Operations

The Agricultural Environmental Management Services (AEMS) of the Oklahoma Department of Agriculture, Food and Forestry (ODAFF) was created to help develop, coordinate, and oversee environmental policies and programs aimed at protecting the Oklahoma environment from pollutants associated with agricultural animals and their waste. Through regulations established by the Oklahoma Concentrated Animal Feeding Operation (CAFO) Act, Swine Feeding Operation (SFO) Act and Poultry Feeding Operation (PFO) Registration Act, AEMS works with producers and concerned citizens to ensure that animal waste does not impact the waters of the state.

(1) CAFOs

A CAFO is an animal feeding operation that confines and feeds at least 1,000 animal units for 45 days or more in a 12 month period (ODAFF 2009). The CAFO Act is designed to protect water quality through the use of best management practices (BMP) such as dikes, berms, terraces, ditches, or other similar structures used to isolate animal waste from outside surface drainage, except for a 25 year, 24–hour rainfall event (ODAFF 2009). CAFOs are considered no-discharge facilities for the purpose of the TMDL calculations in this report.

CAFOs are designated by EPA as significant sources of pollution (ODAFF 2009), and may have the potential to cause serious impacts to water quality if not managed properly. Potential problems for CAFOs can include animal waste discharges to waters of the state and failure to properly operate wastewater lagoons. Per data provided by ODAFF in May 2011, there are no CAFOs located in the Study Area.

Regulated CAFOs within the Study Area operate under state CAFO licenses issued and overseen by ODAFF and NPDES permits by EPA. In order to comply with this TMDL, those CAFO permits in the watershed and their associated management plans must be reviewed and evaluated. Further actions to reduce bacterial loads and achieve progress toward meeting the specified reduction goals must be implemented. This provision will be forwarded to EPA and ODAFF for follow up.

(2). PFOs

Poultry feeding operations not licensed under the Oklahoma Concentrated Animal Feeding Operation Act must register with the State Board of Agriculture. A registered PFO is an animal feeding operation which raises poultry and generates more than 10 tons of poultry waste (litter) per year. PFOs are required to develop an Animal Waste Management Plan (AWMP) or an equivalent document such as a Nutrient Management Plan (NMP). These plans describe how litter will be stored and applied properly in order to protect water quality of streams and lakes located in the watershed. Applicable BMPs shall be included in the Plan.

In order to comply with this TMDL, the registered PFOs in the watershed and their associated management plans must be reviewed. Further actions to reduce bacterial loads and achieve progress toward meeting the specified reduction goals must be implemented. This provision will be forwarded to EPA and ODAFF for follow up.

Per data provided by ODAFF in May 2011, there are ten PFOs located in the watershed as shown in Table 3-4. These PFOs are small animal feeding oerations and are not required to get NPDES permits; they are required only to register with ODAFF. They generate dry litter and do not have any significant impact on the watershed.

Table 3-4 Registered PFOs in Study Area

Waterbody Name	Waterbody ID	Company Name	Poultry ID	County	Type	Total Birds
Dirty Creek	OK120400020010_00	Aviagen Inc	112	Muskogee	Genetics	20,000
Dirty Creek, South Fork	OK120400020030_00	OK Farms	716	Muskogee	Layers	20,000
		OK Farms	1241		Layers	48,000
		OK Farms	1386		Broilers	98,000
		OK Farms	1530		Layers	59,500
		Aviagen Inc	1667		Layers	10,000
		Aviagen Inc	1668		Pullets	22,000
Elk Creek	OK120400020190_00	OK Farms	862	McIntosh	Layers	27,800
		OK Farms	1540		Layers & Roosters	28,050
Shady Grove Creek	OK120400020240_00	OK Farms	524		Layers	18,000

3.1.5 Stormwater Permits

3.1.5.1 Construction Activities

A general stormwater permit (OKR10) is required by the DEQ for any stormwater discharges associated with construction activities that result in land disturbance of equal to or greater than one (1) acre, or less than one (1) acre if they are part of a larger common plan of development or sale that totals at least one (1) acre. The permit also authorizes any stormwater discharges from support activities (e.g. concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas, and borrow areas) that are directly related to a construction site that is required to have permit coverage, and is not a commercial operation serving unrelated different sites (DEQ 2007). Stormwater discharges occur only during or immediately following periods of rainfall and elevated flow conditions when the turbidity criteria do not apply and are not considered potential contributors to turbidity impairment. The permits for construction projects that were active during the time period that samples were taken are summarized in Table 3-5.

3.1.5.2 Multi-Sector General Permits

A multi-sector industrial general permit (OKR05) is also required by the DEQ for stormwater discharges from industrial facilities (DEQ 2011). Stormwater discharges from all industrial facilities, except mine dewatering discharges at crushed stone, construction sand and gravel, or industrial sand mining facilities, occur only during or immediately following periods of rainfall and elevated flow conditions when the turbidity criteria do not apply and therefore are not considered potential contributors of turbidity impairment. Mine dewatering discharges can happen at any time and have the following specific number effluent limitations for TSS:

- Daily Maximum: 45 mg/L
- Monthly Average: 25 mg/L

If the TMDL shows that a TSS limit more stringent than 45 mg/L is required, additional TSS limitations and monitoring requirements will be required. These additional requirements will be implemented under the multi-sector general permit (MSGP). Table 3-5a summarizes the general permits for 13 dewatering discharges in the Study Area.

3.1.6 Rock, Sand and Gravel Quarries

Operators of rock, sand and gravel quarries in Oklahoma are regulated with a general permit (OKG950000) issued by the DEQ. The general permit does not allow discharge of wastewater to waterbodies included in Oklahoma's 303(d) List of impaired water bodies listed for turbidity for which a TMDL has not been performed or the result of the TMDL indicates that discharge limits more stringent than 45 mg/l for TSS are required (DEQ 2009). If the TMDL shows that a TSS limit more stringent than 45 mg/L is required, an individual discharge permit with the TMDL required TSS limit will be issued to the facility. Table 3-5b summarizes the permits for two rock, sand and gravel quarries located within the Study Area but are not in a turbidity impaired watershed.

3.1.7 Section 404 permits

Section 404 of the Clean Water Act (CWA) establishes a program to regulate the discharge of dredged or fills material into waters of the United States, including wetlands. Activities in waters of the United States regulated under this program include fill for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports) and mining projects. Section 404 requires a permit before dredged or fill material may be discharged into waters of the United States, unless the activity is exempt from Section 404 regulation (e.g. certain farming and forestry activities).

Section 404 Permits are administrated by the U.S. Army Corps of Engineers (USACE). EPA reviews and provides comments on each permit application to make sure it adequately protects water quality and complies with applicable guidelines. Both USACE and EPA can take enforcement actions for violations of Section 404.

Discharge of dredged or fill material in waters can be a significant source of turbidity/TSS. The federal Clean Water Act requires that a permit be issued for activities which discharge dredged or fill materials into the waters of the United States, including wetlands. The State of Oklahoma will use its Section 401 Certification authority to ensure Section 404 Permits protect Oklahoma water quality standards.

Table 3-5 Construction Permits Summary

Company Name	County	Permit ID	Date Issued	Waterbody ID	Receiving Water (Permit)	Estimated Acres
FACILITY EXPANSION	Muskogee	OKR109056	5/23/2008	OK120400010400_00	Coody Creek	14
BRAUM'S	Muskogee	OKR108912	3/31/2008			1
WESTWOOD ADDITION	Muskogee	OKR108309	1/19/2008			
ODOT JP #14994(10)	Muskogee	OKR108491	10/24/2007	OK120400020010_00	Dirty Creek	73
ODOT JP# 15952(04)	Muskogee	OKR109220				3
ODOT JP #20238(04)	Muskogee	OKR108492	12/4/2007	OK120400020110_00	Dirty Creek, Georges Fork	208
ODOT JP# 21254(04)	Mcintosh	OKR108768	3/14/2008	OK120400020190_00	Elk Creek	1
WAL-MART SUPERCTR #340-02	Mcintosh	OKR107621	1/10/2008	OK120400020240_00	Shady Grove Creek	28
FAIRFIELD INN	Muskogee	OKR108853	3/31/2008	OK120410010080_00	Arkansas River near Haskell	4
CARMART FACTORY &	Muskogee	OKR109206				2
ODOT JP #20142(04)	Muskogee	OKR107875	1/18/2008			24
MUSKOGEE COMMUNITY	Muskogee	OKR108213	9/28/2007			25
MUSKOGEE SAND, INC	Wagoner	OKR107330				20
YOCHAM TRUCKING OFFICE	Wagoner	OKR109027				17
COBBLESTONE ADDITION	Pittsburg	OKR108725	1/19/2008			2.8
THE RESERVE AT BRADFORD	Tulsa	OKR108020	12/27/2007			38.23
COWETA SOUTH INTERMEDIATE	Wagoner	OKR108606	12/17/2007			6
COWETA 9TH GRADE CTR	Wagoner	OKR108164	4/18/2008			4
PRAIRIE HAVEN II	Wagoner	OKR108536	12/4/2007			4
RALEIGH WAITES	Wagoner	OKR106979				4
PECAN GROVE	Wagoner	OKR105964	1/18/2008			31.85
ASPEN CROSSING WEST	Tulsa	OKR108980	6/17/2008			22
REMINGTON TRAILS	Wagoner	OKR107199				45
EAGLE POINT	Wagoner	OKR109099				120
LYNN LANE VILLAGE	Tulsa	OKR105935	3/31/2008			27
WASHINGTON LANE	Tulsa	OKR109100				200
SEVEN OAKS	Tulsa	OKR106768	1/10/2008			10
KENCO MINI STORAGE	Tulsa	OKR108531	12/4/2007			2
ODOT JP #20002(04)	Okmulgee	OKR107635	1/19/2008	OK120410010220_00	Snake Creek	3
THE TERRITORY	Tulsa	OKR105783				34
DOWNTOWN BIXBY CHURCH OF	Tulsa	OKR108634	1/19/2008			6
BIXBY HIGH SCHOOL	Tulsa	OKR108698	3/6/2008			1
BIXBY HS FOOTBALL FIELD	Tulsa	OKR108937	3/31/2008			1
HENDRIX BUSINESS PARK	Tulsa	OKR109180	6/17/2008	OK120420010010_00	Arkansas River near Bixby	8
MARQUIS ON MEMORIAL	Tulsa	OKR108746	6/10/2008			8
ODOT JP #21555(04)	Tulsa	OKR107489	1/11/2008			8.8
DUTCHERS CROSSING	Tulsa	OKR105729	2/11/2008			59
SOUTH VILLAGE	Tulsa	OKR107794				20

Company Name	County	Permit ID	Date Issued	Waterbody ID	Receiving Water (Permit)	Estimated Acres
RIVER'S EDGE	Tulsa	OKR108726	4/18/2008	OK120420010010_00	Arkansas River near Bixby	53
BIXBY CROSSING	Tulsa	OKR107280	1/19/2008			14
PROVIDENCE HILLS	Tulsa	OKR106062				93
CROSSCREEK	Tulsa	OKR106253	3/5/2008			19
VINTAGE OAK ESTATES	Tulsa	OKR108206	11/8/2007			30
FEATHERSTONE	Tulsa	OKR108461	1/10/2008			
CARRINGTON TRACT	Tulsa	OKR108618	5/8/2008			8.3
SCISSORTAIL AT WIND RIVER	Tulsa	OKR106948	2/20/2008			23
ESTATES OF WATERSTONE	Tulsa	OKR108879				10
WOODCREEK SUBDIVISION	Tulsa	OKR109196				
LIFE TIME FITNESS	Tulsa	OKR108914	3/31/2008			11
RIVER DISTRICT	Tulsa	OKR108944				255
NELSON BUSINESS COMPLEX	Tulsa	OKR108993	5/8/2008			5
JIM NORTON MAKE READY SITE	Tulsa	OKR108449	10/30/2007			5
RIVERVIEW RETAIL CENTER	Tulsa	OKR108860	5/8/2008			2
SW CORNER S YALE AVE & E 91S	Tulsa	OKR108839	3/13/2008			8
RL JONES JR AIRPORT	Tulsa	OKR109095				35
7000 RIVERSIDE	Tulsa	OKR108997				9
STONEGATE SENIOR CENTER	Tulsa	OKR108805	3/6/2008			8.16
THE GARDENS OF LAFORTUNE	Tulsa	OKR106199	3/5/2008			5
ODOT JP #06374(74)	Tulsa	OKR109113				10
ODOT JP#06374(72)	Tulsa	OKR108710	1/19/2008			82
ODOT JP# 06374(75)	Tulsa	OKR109262				6
ODOT JP#06374(73)	Tulsa	OKR108852	3/24/2008			8
ODOT JP #06374(66)	Tulsa	OKR108065	1/19/2008			5.5
TEXAS ROADHOUSE	Tulsa	OKR109072	6/11/2008			2
SOUTH 49TH WEST AVE	Creek	OKR108978	5/8/2008	OK120420010130_00	Arkansas River near Sand Springs	28
STONE VILLA SECOND	Tulsa	OKR108071	10/8/2007			20
CUST-O-FAB EXPANSION	Tulsa	OKR107814				1.5
RIVER HEIGHTS	Tulsa	OKR107641	10/3/2007			2
S/2 SE/4 S15-T19N-R11E	Tulsa	OKR108566	2/11/2008			41
WAREHOUSE 19 DRUM OUT	Tulsa	OKR108228	6/16/2008			1.3766
SAND SPRINGS COMMUNITY CTR	Tulsa	OKR107727	10/8/2007			10
RSC SITE	Tulsa	OKR109159				1
SANDEL MFG HOME PARK	Tulsa	OKR108304				10
ODOT JP#24108(04)	Tulsa	OKR108771				30
GLENPOOL PUBLIC SAFETY	Tulsa	OKR109204		OK120420020010_00	Polecat Creek	9
GLENVILLAGE 2ND	Tulsa	OKR106643	2/11/2008			32
GLENPOOL 35	Tulsa	OKR108661	1/18/2008			30
CRYSTAL POOLS	Tulsa	OKR108586	12/18/2007			1

Company Name	County	Permit ID	Date Issued	Waterbody ID	Receiving Water (Permit)	Estimated Acres
SOUTHWEST CROSSROADS	Tulsa	OKR108614	3/24/2008	OK120420020010_00	Polecat Creek	22.7
UTICA PARK CLINIC	Tulsa	OKR109075	6/11/2008			2.65
EDDINGTON PLACE	Tulsa	OKR106386	1/18/2008			5.66
COUNTRY VIEW OF JENKS	Tulsa	OKR107647	1/10/2008			15
TULSA WINCH	Tulsa	OKR108699	3/6/2008			8
SIMMONS-NORTH SUBDIVISION	Tulsa	OKR105796	1/18/2008			45
MELODY DEVELOPMENT	Tulsa	OKR105880	10/2/2007			37
POLECAT CREEK FLOOD	Tulsa	OKR109104	6/10/2008			1
ELM STREET CROSSING	Tulsa	OKR105989	3/24/2008			7
CSB- BRANCH OFFICE	Tulsa	OKR108902	5/23/2008			1
SOUTH LAKES COMMERCIAL CTR	Tulsa	OKR105600	5/23/2008			1
SOUTH LAKES COMMERCIAL CTR	Tulsa	OKR105965	5/23/2008			2
RL JONES AIRPORT STORM	Tulsa	OKR107288				4
ODOT JP# 17387(07)	Tulsa	OKR109268		OK120420020050_00	Polecat Creek	10
RUBY ESTATE	Rogers	OKR106047	2/11/2008	OK121500020260_00	Verdigris River near Inola	15
ODOT JP #13400(04)	Rogers	OKR107831	2/20/2008			48
VINTAGE PHASE III AND PHASE	Rogers	OKR106823				90
CHURCH AT CLAREMORE	Rogers	OKR108390	6/17/2008			3
ODOT JP #22800(04)	Rogers	OKR107499	1/11/2008			5.8
OAKRIDGE PHASE III	Rogers	OKR106511	6/10/2008			5
TULSA FEDERAL EMPLOYEES	Rogers	OKR108948	6/10/2008			1
RWD 5 ROGERS COUNTY	Rogers	OKR108452	10/30/2007	OK121500030010_00	Verdigris River near Claremore	2.3
TIMBER GATE	Rogers	OKR108317	1/18/2008			27
RIVERWOOD CROSSING	Rogers	OKR107315	3/5/2008			27
ODOT JP# 25779(04)	Rogers	OKR109062	5/8/2008			6
AFFORDABLE SELF STORAGE	Rogers	OKR108242	9/27/2007			3
ODOT JP#20893(04)	Mayes	OKR108720	1/11/2008	OK121600010430_00	Chouteau Creek	2
MIDAMERICA INDUSTRIAL PARK	Mayes	OKR108471	10/30/2007			33
WEST MAINSTREET SUBSTATION	Mayes	OKR108098	1/10/2008			2
NORTHWEST MAID SUBSTATION	Mayes	OKR107989	12/18/2007			4

Table 3-5a Multi-Sector Industrial General Permit for Mine Dewatering Discharges

Company Name	SIC Code	County	Permit ID	Date Issued	Waterbody ID	Receiving Water (Permit)
Arkhola Div. APAC, Arkansas Inc	1442	Muskogee	OKR050955	8/22/2006	OK120410010080_00	Arkansas River near Haskell
Watkins Sand Company, Inc	1442	Tulsa	OKR051746	8/18/2008	OK120410010080_00	Arkansas River near Haskell
HSG Acquistion Company LLC	1442	Tulsa	OKR051777	9/10/2008	OK120410010080_00	Arkansas River near Haskell
HSG Acquistion Company LLC	1442	Wagoner	OKR051779	9/10/2008	OK120410010080_00	Arkansas River near Haskell
Muskogee Sand Co., Inc	1442	Wagoner	OKR051879	3/19/2009	OK120410010080_00	Arkansas River near Haskell
Anchor Stone Company	1442	Tulsa	OKR050568	7/24/2006	OK120420010010_00	Arkansas River near Bixby
Watkins Sand Co., Inc	1442	Tulsa	OKR050954	8/22/2006	OK120420010010_00	Arkansas River near Bixby
Anchor Stone Company	1442	Tulsa	OKR051123	9/13/2006	OK120420010010_00	Arkansas River near Bixby
Anchor Stone Company	1442	Tulsa	OKR051580	4/27/2007	OK120420010010_00	Arkansas River near Bixby
HSG Acquistion Company LLC	1442	Tulsa	OKR051778	9/10/2008	OK120420010010_00	Arkansas River near Bixby
Ed Gorman	1442	Tulsa	OKR050084	6/26/2006	OK120420020050_00	Polecat Creek
Gem Dirt 2	1442	Creek	OKR050752	8/1/2006	OK120420020050_00	Polecat Creek
Rerock	1422	Rogers	OKR051813	11/19/2008	OK121500020260_00	Verdigris River near Inola

Table 3-5b Rock, Sand and Gravel Quarries

Company Name	County	Permit ID	Product	Permitted Acres	Permit Issue Date	Permit Renewal Date	Mining Expiration Date	Waterbody Name & ID
Keystone Sand & Gravel (Glen Quimby)	Osage	L.E-1794	Sand & Gravel	13.04	8/1/2005	7/31/2008	7/31/2020	Arkansas River near Sand Springs OK120420010130_00
Earl W. Holcomb (Sand Creek)	Osage	L.E.-1924	Sand	10	7/1/2002	6/30/2009	6/30/2012	

3.2 Nonpoint Sources

Nonpoint sources include those sources that cannot be identified as entering the waterbody at a specific location. The relatively homogeneous land use/land cover categories throughout the Study Area associated with rural agricultural, forest and range management activities has an influence on the origin and pathways of pollutant sources to surface water. Pathogen indicator bacteria originate from warm-blooded animals in rural, suburban, and urban areas. These sources include wildlife, various agricultural activities and domesticated animals, land application fields, urban runoff, failing onsite wastewater disposal (OSWD) systems and domestic pets. Water quality data collected from streams draining urban communities often show existing concentrations of fecal coliform bacteria at levels greater than water quality standards. A study under EPA's National Urban Runoff Project indicated that the average fecal coliform concentration from 14 watersheds in different areas within the United States was approximately 15,000/100 mL in stormwater runoff (EPA 1983). Runoff from urban areas not permitted under the MS4 program can be a significant source of fecal coliform bacteria. Water quality data collected from streams draining many of the non-permitted communities show a high level of fecal coliform bacteria. The specific requirements for bacterial control in a MS4 permit can be found in Appendix E. Appendix E also includes information on a list of BMPs and their effectiveness. Best management practices (BMP) such as buffer strips, repair of leaking sewage collection systems, elimination of illicit discharges, and proper disposal of domestic animal waste can reduce bacterial loading to waterbodies.

Various potential nonpoint sources of TSS as indicated in the 2008 Integrated Report include sediments originating from grazing in riparian corridors of streams and creeks, highway/road/bridge runoff, non-irrigated crop production, rangeland grazing and other sources of sediment loading (DEQ 2008). Elevated turbidity measurements can be caused by stream bank erosion processes, stormwater runoff events and other channel disturbances. The following section provides general information on nonpoint sources contributing bacteria or TSS loading within the Study Area.

3.2.1 Wildlife

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

However, adequate data are available by county to estimate the number of deer by watershed. This report assumes that deer habitat includes forests, croplands, and pastures. Using Oklahoma Department of Wildlife and Conservation county data, the population of deer can be roughly estimated from the actual number of deer harvested and harvest rate estimates. Because harvest success varies from year to year based on weather and other factors, the average harvest from 2005 to 2009 was combined with an estimated annual harvest rate of 20% to predict deer population by county. Using the estimated deer population by county and the percentage of the watershed area within each county, a wild deer population can be calculated for each watershed.

According to a study conducted by the American Society of Agricultural Engineers (ASAE), deer release approximately $5x10^8$ fecal coliform units per animal per day (ASAE 1999). Although only a fraction of the total fecal coliform loading produced by the deer population may actually enter a waterbody, the estimated fecal coliform production based on the estimated deer population provided in Table 3-6 in cfu/day provides a relative magnitude of loading in each watershed.

Table 3-6 Estimated Population and Fecal Coliform Production for Deer

Waterbody ID	Waterbody Name	Watershed Area (acres)	Wild Deer Population	Estimated Wild Deer per acre	Fecal Production (x 10^9 cfu/day) of Deer Population
OK120400010260_00	Arkansas River near Muskogee	20,538	260	0.0127	130
OK120400010400_00	Coody Creek	33,722	427	0.0127	214
OK120400020010_00	Dirty Creek	70,382	842	0.0120	421
OK120400020030_00	Dirty Creek, South Fork	34,959	443	0.0127	221
OK120400020110_00	Dirty Creek, Georges Fork	37,343	424	0.0114	212
OK120400020160_00	Butler Creek	29,997	377	0.0126	189
OK120400020190_00	Elk Creek	55,408	553	0.0100	276
OK120400020240_00	Shady Grove Creek	13,653	128	0.0094	64
OK120410010080_00	Arkansas River near Haskell	183,483	2369	0.0129	1184
OK120410010100_00	Cloud Creek	6,569	83	0.0127	42
OK120410010220_00	Snake Creek	44,900	616	0.0137	308
OK120420010010_00	Arkansas River near Bixby	108,434	967	0.0089	483
OK120420010130_00	Arkansas River near Sand Springs	60,566	321	0.0053	160
OK120420020010_00	Polecat Creek	44,941	520	0.0116	296
OK120420020050_00	Polecat Creek	37,738	466	0.0124	233
OK121500010200_00	Verdigris River near Wagoner	12,719	168	0.0132	84
OK121500020090_00	Bull Creek	31,259	475	0.0152	237
OK121500020100_00	Pea Creek	11,247	170	0.0152	85
OK121500020260_00	Verdigris River near Inola	93,643	1426	0.0152	713
OK121500020360_00	Dog Creek	39,880	621	0.0156	311
OK121500030010_00	Verdigris River near Claremore	21,316	332	0.0156	166
OK121600010010_00	Neosho River below Ft. Gibson Lake	2,776	36	0.0129	18
OK121600010430_00	Chouteau Creek	46,002	763	0.0166	381

3.2.2 Non-Permitted Agricultural Activities and Domesticated Animals

There are a number of non-permitted agricultural activities that can also be sources of bacterial or TSS loading. Agricultural activities of greatest concern are typically those associated with livestock operations (Drapcho and Hubbs 2002). Examples of commercially raised farm animal activities that can contribute to bacterial sources include:

- Processed commercially raised farm animal manure is often applied to fields as fertilizer, and can contribute to fecal bacterial loading to waterbodies if washed into streams by runoff.
- Animals grazing in pastures deposit manure containing fecal bacteria onto land surfaces. These bacteria may be washed into waterbodies by runoff.
- Animals often have direct access to waterbodies and can provide a concentrated source of fecal bacterial loading directly into streams or can cause unstable stream banks which can contribute TSS.

Table 3-7 provides estimated numbers of selected livestock by watershed based on the 2007 U.S. Department of Agriculture (USDA) county agricultural census data (USDA 2007). The estimated commercially raised farm animal populations in Table 3-7 were derived by using the percentage of the watershed within each county. Because the watersheds are generally much smaller than the counties, and commercially raised farm animals are not evenly distributed across counties or constant with time, these are rough estimates only. Cattle are clearly the most abundant species of commercially raised farm animals in the Study Area and often have direct access to the waterbodies and their tributaries.

Detailed information is not available to describe or quantify the relationship between instream concentrations of bacteria and land application of manure from commercially raised farm animal. Nor is sufficient information available to describe or quantify the contributions of sediment loading caused by commercially raised farm animal responsible for destabilizing stream banks or erosion in pasture fields. The estimated acreage by watershed where manure was applied in 2007 is shown in Table 3-7. These estimates are also based on the county level reports from the 2007 USDA county agricultural census, and thus, represent approximations of the commercially raised farm animal populations in each watershed. Despite the lack of specific data, for the purpose of these TMDLs, land application of commercially raised farm animal manure is considered a potential source of bacterial loading to the watersheds in the Study Area.

According to a livestock study conducted by the ASAE, the daily fecal coliform production rates by livestock species were estimated as follows (ASAE 1999):

- Beef cattle release approximately 1.04E+11 fecal coliform counts per animal per day;
- Dairy cattle release approximately 1.01E+11 per animal per day
- Swine release approximately 1.08E+10 per animal per day
- Chickens release approximately 1.36E+08 per animal per day
- Sheep release approximately 1.20E+10 per animal per day
- Horses release approximately 4.20E+08 per animal per day;
- Turkey release approximately 9.30E+07 per animal per day
- Ducks release approximately 2.43E+09 per animal per day
- Geese release approximately 4.90E+10 per animal per day

Using the estimated animal populations and the fecal coliform production rates from ASAE, an estimate of fecal coliform production from each group of commercially raised farm animal was calculated in each watershed of the Study Area. These estimates are presented in Table 3-8. Note that only a small fraction of these fecal coliform are expected to represent loading into waterbodies, either washed into streams by runoff or by direct deposition from wading animals. Because of their numbers and animal unit production of bacteria, cattle again appear to represent the most likely commercially raised farm animal source of fecal bacteria.

Table 3-7 Commercially Raised Farm Animals and Manure Application Area Estimates by Watershed

Waterbody ID	Waterbody Name	Cattle & Calves-all	Dairy Cows	Horses & Ponies	Goats	Sheep & Lambs	Hogs & Pigs	Ducks & Geese	Acres of Manure Application
OK120400010260_00	Arkansas River near Muskogee	2,809	64	135	2	55	26	8	382
OK120400010400_00	Coody Creek	4,612	105	222	4	91	42	13	627
OK120400020010_00	Dirty Creek	9,227	187	434	6	151	71	22	1,204
OK120400020030_00	Dirty Creek, South Fork	4,781	108	230	4	94	44	13	650
OK120400020110_00	Dirty Creek, Georges Fork	4,713	85	217	2	62	28	10	592
OK120400020160_00	Butler Creek	4,081	91	196	3	79	37	11	552
OK120400020190_00	Elk Creek	6,376	79	277	1	32	13	9	719
OK120400020240_00	Shady Grove Creek	1,504	14	63	0	1	0	1	160
OK120410010080_00	Arkansas River near Haskell	21,990	490	1,245	10	476	193	147	2,219
OK120410010100_00	Cloud Creek	898	20	43	1	18	8	2	122
OK120410010220_00	Snake Creek	3,859	18	317	1	66	60	40	171
OK120420010010_00	Arkansas River near Bixby	6,622	39	821	7	185	114	212	322
OK120420010130_00	Arkansas River near Sand Springs	4,620	13	397	4	86	29	81	140
OK120420020010_00	Polecat Creek	2,949	23	309	2	77	82	93	140
OK120420020050_00	Polecat Creek	2,526	21	251	1	65	77	80	119
OK121500010200_00	Verdigris River near Wagoner	1,389	36	88	0	36	9	17	78
OK121500020090_00	Bull Creek	4,186	149	255	1	54	36	50	402
OK121500020100_00	Pea Creek	1,405	25	104	1	15	12	24	87
OK121500020260_00	Verdigris River near Inola	11,755	210	870	7	117	105	200	729
OK121500020360_00	Dog Creek	5,122	85	387	4	38	48	91	322
OK121500030010_00	Verdigris River near Claremore	2,738	45	207	2	21	25	49	172
OK121600010010_00	Neosho River below Ft. Gibson Lake	355	8	19	0	8	3	2	40
OK121600010430_00	Chouteau Creek	7,433	415	360	2	67	67	56	1,079

Table 3-8 Fecal Coliform Production Estimates for Commercially Raised Farm Animals (x10^9 number/day)

Waterbody ID	Waterbody Name	Cattle & Calves-all	Dairy Cows	Horses & Ponies	Goats	Sheep & Lambs	Hogs & Pigs	Ducks & Geese	Total
OK120400010260_00	Arkansas River near Muskogee	292,115	6,431	57	26	665	278	196	299,766
OK120400010400_00	Coody Creek	479,628	10,559	93	42	1,091	456	321	492,191
OK120400020010_00	Dirty Creek	959,563	18,895	182	69	1,807	767	570	981,853
OK120400020030_00	Dirty Creek, South Fork	497,233	10,947	97	44	1,132	473	333	510,257
OK120400020110_00	Dirty Creek, Georges Fork	490,104	8,600	91	28	744	304	256	500,128
OK120400020160_00	Butler Creek	424,379	9,221	82	36	945	395	280	435,340
OK120400020190_00	Elk Creek	663,091	7,930	116	13	379	138	224	671,891
OK120400020240_00	Shady Grove Creek	156,457	1,431	27	0	15	0	38	157,968
OK120410010080_00	Arkansas River near Haskell	2,287,003	49,488	523	125	5,709	2,084	3,772	2,348,704
OK120410010100_00	Cloud Creek	93,425	2,057	18	8	213	89	63	95,873
OK120410010220_00	Snake Creek	401,315	1,842	133	17	794	650	1,027	405,777
OK120420010010_00	Arkansas River near Bixby	688,723	3,974	345	89	2,215	1,229	5,442	702,017
OK120420010130_00	Arkansas River near Sand Springs	480,464	1,301	167	47	1,030	308	2,077	485,394
OK120420020010_00	Polecat Creek	306,671	2,315	130	22	930	879	2,342	313,290
OK120420020050_00	Polecat Creek	262,753	2,089	106	9	782	834	2,056	268,629
OK121500010200_00	Verdigris River near Wagoner	144,470	3,626	37	0	429	102	427	149,090
OK121500020090_00	Bull Creek	435,317	15,088	107	17	651	385	1,277	452,842
OK121500020100_00	Pea Creek	146,141	2,567	44	10	176	135	608	149,680
OK121500020260_00	Verdigris River near Inola	1,222,548	21,173	366	86	1,398	1,138	5,134	1,251,843
OK121500020360_00	Dog Creek	532,734	8,597	163	43	462	514	2,338	544,851
OK121500030010_00	Verdigris River near Claremore	284,745	4,595	87	23	247	275	1,250	291,221
OK121600010010_00	Neosho River below Ft. Gibson Lake	36,872	844	8	2	91	33	48	37,898
OK121600010430_00	Chouteau Creek	773,038	41,906	151	24	809	723	1,430	818,082

3.2.3 Failing Onsite Wastewater Disposal Systems and Illicit Discharges

DEQ is responsible for implementing the regulations of Title 252, Chapter 641 of the Oklahoma Administrative Code, which defines design standards for individual and small public onsite sewage disposal systems (DEQ 2010a). OSWD systems and illicit discharges can be a source of bacterial loading to streams and rivers. Bacterial loading from failing OSWD systems can be transported to streams in a variety of ways, including runoff from surface ponding or through groundwater. Fecal coliform-contaminated groundwater may discharge to creeks through springs and seeps.

To estimate the potential magnitude of OSWDs fecal bacterial loading, the number of OSWD systems was estimated for each watershed. The estimate of OSWD systems was derived by using data from the 1990 U.S. Census which was the last year in which there were Census questions about plumbing facilities (U.S. Department of Commerce, Bureau of the Census 1990). The density of OSWD systems within each watershed was estimated by dividing the number of OSWD systems in each census block by the number of acres in each census block. This density was then applied to the number of acres of each census block within a WQM station watershed. Census blocks crossing a watershed boundary required additional calculation to estimate the number of OSWD systems based on the proportion of the census block falling within each watershed. This step involved adding all OSWD systems for each whole or partial census block.

Over time, most OSWD systems operating at full capacity will fail. OSWD system failures are proportional to the adequacy of a state's minimum design criteria (Hall 2002). The 1990 American Housing Survey for Oklahoma conducted by the U.S. Census Bureau estimates that, nationwide, 10% of occupied homes with OSWD systems experience malfunctions during the year (U.S. Department of Commerce, Bureau of the Census 1990). A study conducted by Reed, Stowe & Yanke, LLC (2001) reported that approximately 12% of the OSWD systems in east Texas and 8% in the Texas Panhandle were chronically malfunctioning. Most studies estimate that the minimum lot size necessary to ensure against contamination is roughly one-half to one acre (Hall 2002). Some studies, however, found that lot sizes in this range or even larger could still cause contamination of ground or surface water (University of Florida 1987). It is estimated that areas with more than 40 OSWD systems per square mile (6.25 septic systems per 100 acres) can be considered to have potential contamination problems (Canter and Knox 1986). Table 3-9 summarizes estimates of sewered and unsewered households and the average number of septic tanks per square mile for each watershed in the Study Area.

Table 3-9 Estimates of Sewered and Unsewered Households

Waterbody ID	Waterbody Name	Public Sewer	Septic Tank	Other Means	Housing Units	# of Septic Tanks / $Mile^2$
OK120400010260_00	Arkansas River near Muskogee	5,066	518	20	5,604	16.37
OK120400010400_00	Coody Creek	10,501	940	39	11,480	17.84
OK120400020010_00	Dirty Creek	491	909	19	1,419	8.27
OK120400020030_00	Dirty Creek, South Fork	292	270	11	573	4.94
OK120400020110_00	Dirty Creek, Georges Fork	204	470	13	687	8.06
OK120400020160_00	Butler Creek	80	373	6	459	7.96
OK120400020190_00	Elk Creek	1,437	1,074	29	2,540	12.41

Waterbody ID	Waterbody Name	Public Sewer	Septic Tank	Other Means	Housing Units	# of Septic Tanks / Mile^2
OK120400020240_00	Shady Grove Creek	39	287	6	332	16.15
OK120410010080_00	Arkansas River near Haskell	11,275	3,830	62	15,167	13.45
OK120410010100_00	Cloud Creek	82	93	3	178	13.36
OK120410010220_00	Snake Creek	605	806	22	1,433	9.06
OK120420010010_00	Arkansas River near Bixby	56,715	7,189	62	63,966	11.49
OK120420010130_00	Arkansas River near Sand Springs	7,978	3,858	31	11,867	42.43
OK120420020010_00	Polecat Creek	5,903	2,920	37	8,860	41.58
OK120420020050_00	Polecat Creek	4,516	2,162	26	6,704	41.58
OK121500010200_00	Verdigris River near Wagoner	35	107	2	144	36.67
OK121500020090_00	Bull Creek	260	408	2	670	5.38
OK121500020100_00	Pea Creek	103	178	0	281	8.35
OK121500020260_00	Verdigris River near Inola	3,022	3,176	7	6,205	10.13
OK121500020360_00	Dog Creek	2,230	1,359	7	3,596	21.71
OK121500030010_00	Verdigris River near Claremore	1,030	1,158	2	2,190	21.81
OK121600010010_00	Neosho River below Ft. Gibson Lake	29	70	2	101	34.77
OK121600010430_00	Chouteau Creek	390	925	6	1,321	16.14

For the purpose of estimating fecal coliform loading in watersheds, an OSWD failure rate of 8% was used in the calculations made to characterize fecal coliform loads in each watershed.

Fecal coliform loads were estimated using the following equation (EPA 2001):

$$\#\frac{counts}{day} = (\#Failing\_systems) \times \left(\frac{10^6 counts}{100ml}\right) \times \left(\frac{70gal}{personday}\right) \times \left(\#\frac{person}{household}\right) \times \left(3785.2\frac{ml}{gal}\right)$$

The average of number of people per household was calculated to be 2.36 for counties in the Study Area (U.S. Census Bureau 2010). Approximately 70 gallons of wastewater were estimated to be produced on average per person per day (Metcalf and Eddy 1991). The fecal coliform concentration in septic tank effluent was estimated to be 10^6 per 100 mL of effluent based on reported concentrations from a number of publications (Metcalf and Eddy 1991; Canter and Knox 1985; Cogger and Carlile 1984). Using this information, the estimated load from failing septic systems within the watersheds was summarized below in Table 3-10.

Table 3-10 Estimated Fecal Coliform Load from OSWD Systems

Waterbody ID	Waterbody Name	Watershed Area (Acres)	Septic Tank	# of Failing Septic Tanks	Estimated Loads from Septic Tanks (x 10^9 counts/day)
OK120400010260_00	Arkansas River near Muskogee	20,538	518	41	272
OK120400010400_00	Coody Creek	33,722	940	75	494
OK120400020010_00	Dirty Creek	70,382	909	73	478
OK120400020030_00	Dirty Creek, South Fork	34,959	270	22	142
OK120400020110_00	Dirty Creek, Georges Fork	37,343	470	38	247
OK120400020160_00	Butler Creek	29,997	373	30	196
OK120400020190_00	Elk Creek	55,408	1,074	86	565
OK120400020240_00	Shady Grove Creek	13,653	287	23	151
OK120410010080_00	Arkansas River near Haskell	183,483	3,830	306	2,014
OK120410010100_00	Cloud Creek	6,569	93	7	49
OK120410010220_00	Snake Creek	44,900	806	64	424
OK120420010010_00	Arkansas River near Bixby	108,434	7,189	575	3,781
OK120420010130_00	Arkansas River near Sand Springs	60,566	3,858	309	2,029
OK120420020010_00	Polecat Creek	44,941	2920	234	1,536
OK120420020050_00	Polecat Creek	37,738	2,162	173	1,137
OK121500010200_00	Verdigris River near Wagoner	12,719	107	9	56
OK121500020090_00	Bull Creek	31,259	408	33	215
OK121500020100_00	Pea Creek	11,247	178	14	94
OK121500020260_00	Verdigris River near Inola	93,643	3,176	254	1,670
OK121500020360_00	Dog Creek	39,880	1,359	109	715
OK121500030010_00	Verdigris River near Claremore	21,316	1,158	93	609
OK121600010010_00	Neosho River below Ft. Gibson Lake	2,776	70	6	37
OK121600010430_00	Chouteau Creek	46,002	925	74	486

3.2.4 Domestic Pets

Fecal matter from dogs and cats, which is transported to streams by runoff from urban and suburban areas, can be a potential source of bacterial loading. On average 37.2% of the nation's households own dogs and 32.4% own cats and in these households the average number of dogs is 1.7 and 2.2 cats per household (American Veterinary Medical Association 2007). Using the U.S. Census data at the block level (U.S. Census Bureau 2010), dog and cat populations can be estimated for each watershed. Table 3-11 summarizes the estimated number of dogs and cats for the watersheds of the Study Area.

Table 3-11 Estimated Numbers of Pets

Waterbody ID	Waterbody Name	Dogs	Cats
OK120400010260_00	Arkansas River near Muskogee	9,527	12,329
OK120400010400_00	Coody Creek	19,516	25,256
OK120400020010_00	Dirty Creek	2,412	3,122
OK120400020030_00	Dirty Creek, South Fork	974	1,261
OK120400020110_00	Dirty Creek, Georges Fork	1,168	1,511
OK120400020160_00	Butler Creek	780	1,010
OK120400020190_00	Elk Creek	4,318	5,588
OK120400020240_00	Shady Grove Creek	564	730
OK120410010080_00	Arkansas River near Haskell	25,784	33,367
OK120410010100_00	Cloud Creek	303	392
OK120410010220_00	Snake Creek	2,436	3,153
OK120420010010_00	Arkansas River near Bixby	108,742	140,725
OK120420010130_00	Arkansas River near Sand Springs	20,174	26,107
OK120420020010_00	Polecat Creek	15,062	19,492
OK120420020050_00	Polecat Creek	11,397	14,749
OK121500010200_00	Verdigris River near Wagoner	245	317
OK121500020090_00	Bull Creek	1,139	1,474
OK121500020100_00	Pea Creek	478	618
OK121500020260_00	Verdigris River near Inola	10,549	13,651
OK121500020360_00	Dog Creek	6,113	7,911
OK121500030010_00	Verdigris River near Claremore	3,723	4,818
OK121600010010_00	Neosho River below Ft. Gibson Lake	172	222
OK121600010430_00	Chouteau Creek	2,246	2,906

Table 3-12 provides an estimate of the fecal coliform production from pets. These estimates are based on estimated fecal coliform production rates of 5.4×10^8 per day for cats and 3.3×10^9 per day for dogs (Schueler 2000).

Table 3-12 Estimated Fecal Coliform Daily Production by Pets ($\times 10^9$ counts/day)

Waterbody ID	Waterbody Name	Dogs	Cats	Total
OK120400010260_00	Arkansas River near Muskogee	31,440	6,658	38,098
OK120400010400_00	Coody Creek	64,403	13,638	78,041
OK120400020010_00	Dirty Creek	7,961	1,686	9,646
OK120400020030_00	Dirty Creek, South Fork	3,215	681	3,895
OK120400020110_00	Dirty Creek, Georges Fork	3,854	816	4,670
OK120400020160_00	Butler Creek	2,575	545	3,120
OK120400020190_00	Elk Creek	14,249	3,018	17,267
OK120400020240_00	Shady Grove Creek	1,863	394	2,257
OK120410010080_00	Arkansas River near Haskell	85,087	18,018	103,105
OK120410010100_00	Cloud Creek	999	211	1,210
OK120410010220_00	Snake Creek	8,039	1,702	9,742

Waterbody ID	Waterbody Name	Dogs	Cats	Total
OK120420010010_00	Arkansas River near Bixby	358,849	75,992	434,841
OK120420010130_00	Arkansas River near Sand Springs	66,574	14,098	80,672
OK120420020010_00	Polecat Creek	49,704	10,525	60,229
OK120420020050_00	Polecat Creek	37,609	7,964	45,574
OK121500010200_00	Verdigris River near Wagoner	808	171	979
OK121500020090_00	Bull Creek	3,759	796	4,555
OK121500020100_00	Pea Creek	1,576	334	1,910
OK121500020260_00	Verdigris River near Inola	34,810	7,372	42,182
OK121500020360_00	Dog Creek	20,174	4,272	24,446
OK121500030010_00	Verdigris River near Claremore	12,286	2,602	14,888
OK121600010010_00	Neosho River below Ft. Gibson Lake	567	120	687
OK121600010430_00	Chouteau Creek	7,411	1,569	8,980

3.3 Summary of Sources of Impairments

3.3.1 Bacteria

Twelve of the twenty-three watersheds requiring a bacterial TMDL have one or more continuous point source discharges. Although there are no CAFOs in the Study Area, there are ten PFOs scattered in the lower portion of the Study Area. All the stream segments in Table 3-13 require bacterial TMDLs. The various nonpoint sources are considered to be the major source of bacterial loading in each watershed that requires a TMDL for bacteria.

Table 3-13 below provides a summary of the estimated fecal coliform loads in cfu/day for the four major nonpoint source categories (commercially raised farm animals, pets, deer, and septic tanks) that contribute to the elevated bacterial concentrations in each watershed. Because of their numbers and animal unit production of bacteria, livestock are estimated to be the largest contributors of fecal coliform loading to land surfaces. It must be noted that while no data are available to estimate populations and fecal loading of wildlife other than deer, a number of bacterial source tracking studies around the nation demonstrate that wild birds and mammals may represent a major source of the fecal bacteria found in streams.

Table 3-13 Summary of Fecal Coliform Load Estimates from Nonpoint Sources to Land Surfaces

Waterbody ID	Waterbody Name	Commercially Raised Farm Animals	Pets	Deer	Estimated Loads from Septic Tanks
OK120400010260_00	Arkansas River near Muskogee	88.62%	11.26%	0.04%	0.08%
OK120400010400_00	Coody Creek	86.21%	13.67%	0.04%	0.09%
OK120400020010_00	Dirty Creek	98.94%	0.97%	0.04%	0.05%
OK120400020030_00	Dirty Creek, South Fork	99.17%	0.76%	0.04%	0.03%
OK120400020110_00	Dirty Creek, Georges Fork	98.98%	0.92%	0.04%	0.05%
OK120400020160_00	Butler Creek	99.20%	0.71%	0.04%	0.04%
OK120400020190_00	Elk Creek	97.38%	2.50%	0.04%	0.08%
OK120400020240_00	Shady Grove Creek	98.46%	1.41%	0.04%	0.09%

Waterbody ID	Waterbody Name	Commercially Raised Farm Animals	Pets	Deer	Estimated Loads from Septic Tanks
OK120410010080_00	Arkansas River near Haskell	95.67%	4.20%	0.05%	0.08%
OK120410010100_00	Cloud Creek	98.66%	1.25%	0.04%	0.05%
OK120410010220_00	Snake Creek	97.48%	2.34%	0.07%	0.10%
OK120420010010_00	Arkansas River near Bixby	61.52%	38.11%	0.04%	0.33%
OK120420010130_00	Arkansas River near Sand Springs	85.42%	14.20%	0.03%	0.36%
OK120420020010_00	Polecat Creek	83.48%	16.05%	0.07%	0.41%
OK120420020050_00	Polecat Creek	85.12%	14.44%	0.07%	0.36%
OK121500010200_00	Verdigris River near Wagoner	99.25%	0.65%	0.06%	0.04%
OK121500020090_00	Bull Creek	98.91%	0.99%	0.05%	0.05%
OK121500020100_00	Pea Creek	98.62%	1.26%	0.06%	0.06%
OK121500020260_00	Verdigris River near Inola	96.56%	3.25%	0.05%	0.13%
OK121500020360_00	Dog Creek	95.53%	4.29%	0.05%	0.13%
OK121500030010_00	Verdigris River near Claremore	94.90%	4.85%	0.05%	0.20%
OK121600010010_00	Neosho River below Ft. Gibson Lake	98.08%	1.78%	0.05%	0.10%
OK121600010430_00	Chouteau Creek	98.81%	1.08%	0.05%	0.06%

The magnitude of loading to a stream may not reflect the magnitude of loading to land surfaces. While no studies have quantified these effects, bacteria may die off or survive at different rates depending on the manure characteristics and a number of other environmental conditions. Also, the structural properties of some manure, such as cow patties, may limit their washoff into streams by runoff. In contrast, malfunctioning septic tank effluent may be present in standing water on the surface, or in shallow groundwater, which may enhance its conveyance to streams.

3.3.2 Turbidity

Of the seven watersheds in the Study Area that require turbidity TMDLs, one of them has an industrial permitted source of TSS that will necessitate a WLA. Therefore, nonsupport of WWAC use in almost all of the watersheds is caused primarily by nonpoint sources of TSS. Sediment loading of streams can originate from natural erosion processes, including the weathering of soil, rocks, and uncultivated land; geological abrasion; and other natural phenomena. There is insufficient data available to quantify contributions of TSS from these natural processes. TSS or sediment loading can also occur under non-runoff conditions as a result of anthropogenic activities in riparian corridors which cause erosive conditions. Given the lack of data to establish the background conditions for TSS/turbidity, separating background loading from nonpoint sources whether it is from natural or anthropogenic processes is not feasible in this TMDL development.

SECTION 4
TECHNICAL APPROACH AND METHODS

The objective of a TMDL is to estimate allowable pollutant loads and to allocate these loads to the known pollutant sources in the watershed so appropriate control measures can be implemented and the WQS achieved. A TMDL is expressed as the sum of three elements as described in the following mathematical equation:

$$TMDL = WLA\_{WWTP} + WLA\_{MS4} + LA + MOS$$

The WLA is the portion of the TMDL allocated to existing and future point sources. The LA is the portion of the TMDL allocated to nonpoint sources, including natural background sources. The MOS is intended to ensure that WQSs will be met.

For *E. coli* or Enterococci bacteria, TMDLs are expressed as colony-forming units per day, and represent the maximum one-day load the stream can assimilate while still attaining the WQS. Percent reduction goals are also calculated to aid to characterizing the possible magnitude of the effort to restore the segment to meeting water quality criterion. Turbidity TMDLs will be derived from TSS calculations and expressed in pounds (lbs) per day which will represent the maximum one-day load the stream can assimilate while still attaining the WQS, as well as a PRG.

4.1 Determining a Surrogate Target for Turbidity

Turbidity is a commonly measured indicator of the suspended solids load in streams. However, turbidity is an optical property of water, which measures scattering of light by suspended solids and colloidal matter. To develop TMDLs, a gravimetric (mass-based) measure of solids loading is required to express loads. There is often a strong relationship between the total suspended solids concentration and turbidity. Therefore, the TSS load, which is expressed as mass per time, is used as a surrogate for turbidity.

To determine the relationship between turbidity and TSS, a linear regression between TSS and turbidity was developed using data collected at stations within the Study Area. Prior to developing the regression the following steps were taken to refine the dataset:

- Replace TSS samples of “<10” with 9.99;
- Remove data collected under high flow conditions exceeding the base-flow criterion. This means that measurements corresponding to flow exceedance percentiles lower than 25^{th} were not used in the regression;
- Check rainfall data on the day when samples were collected and on the previous two days. If there was a significant rainfall event (>= 1.0 inch) in any of these days, the sample will be excluded from regression analysis with one exception. If the significant rainfall happened on the sampling day and the turbidity reading was less than 25 NTUs (half of turbidity standard for streams), the sample will not be excluded from analysis because most likely the rainfall occurred after the sample was taken, and

- Log-transform both turbidity and TSS data to minimize effects of their non-linear data distributions.

When ordinary least squares regression (OLS) is applied to ascertain the best relationship between two variables (i.e., X and Y), one variable (Y) is considered "dependent" on the other variable (X), but X must be considered "independent" of the other, and known without measurement error. OLS minimizes the differences, or residuals, between measured Y values and Y values predicted based on the X variable.

For current purposes, a relationship is necessary to predict TSS concentrations from measured turbidity values, but also to translate the TSS-based TMDL back to instream turbidity values. For this purpose, an alternate regression fitting procedure known as the line of organic correlation (LOC) was applied. The LOC has three advantages over OLS (Helsel and Hirsch 2002):

LOC minimizes fitted residuals in both the X and Y directions;

It provides a unique best-fit line regardless of which parameter is used as the independent variable; and

Regression-fitted values have the same variance as the original data.

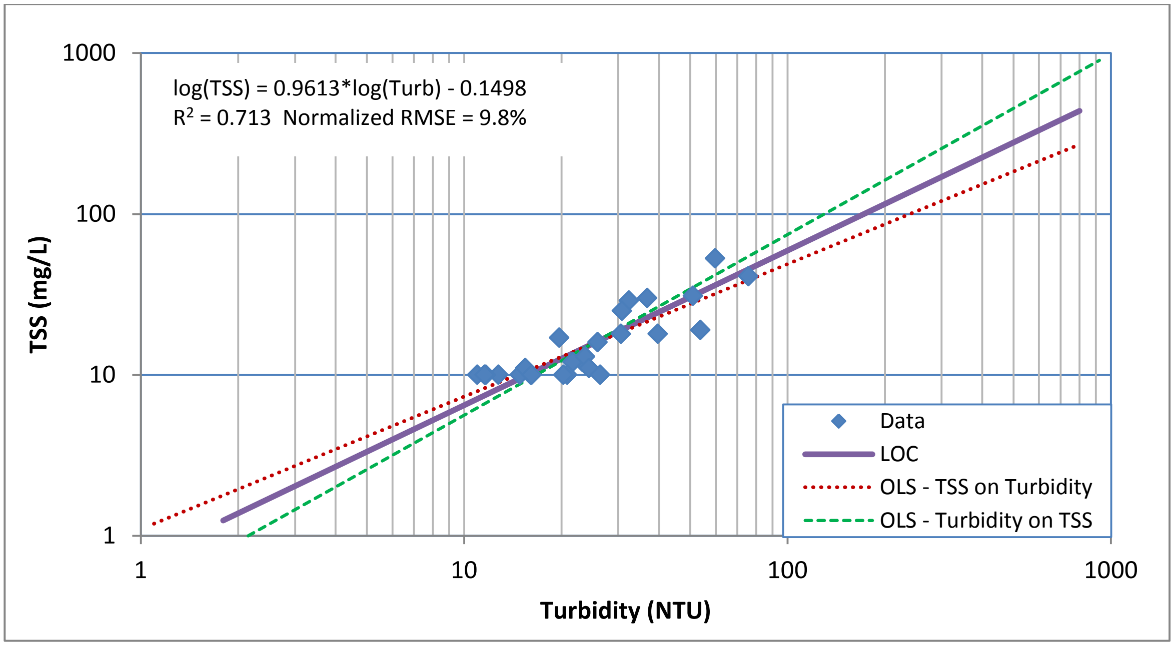
The LOC minimizes the areas of the right triangles formed by horizontal and vertical lines drawn from observations to the fitted line. The slope of the LOC line equals the geometric mean of the Y on X (TSS on turbidity) and X on Y (turbidity on TSS) OLS slopes, and is calculated as:

$$m1 = \sqrt{m \cdot m'} = sign[r] \cdot \frac{s_y}{s_x}$$

where $m1$ is the slope of the LOC line, m is the TSS on turbidity OLS slope, m' is the turbidity on TSS OLS slope, r is the TSS-turbidity correlation coefficient, s_y is the standard deviation of the TSS measurements, and s_x is the standard deviation of the turbidity measurements.

The intercept of the LOC ($b1$) is subsequently found by fitting the line with the LOC slope through the point (mean turbidity, mean TSS). Figures 4-1 shows an example of the correlation between TSS and turbidity, along with the LOC and the OLS lines.

Figure 4-1 Linear Regression for TSS-Turbidity for Dirty Creek, (OK120400020010_00)



The NRMSE and R-square (r^2) were used as the primary measures of goodness-of-fit. As shown in Figure 4-1, the LOC yields a NRMSE value of 11% which means the root mean square error (RMSE) is 11% of the average of the measured TSS values. The R-square (r^2) value indicates the fraction of the total variance in TSS or turbidity observations that is explained by the LOC. The regression equation can be used to convert turbidity standard of 50 NTUs to TSS goals.

It was noted that there may be a few outliers that exerted undue influence on the regression relationship. These outliers were identified by applying the Tukey's Boxplot method (Tukey 1977) to the dataset of the distances from observed points to the regression line. The Tukey Method is based on the interquartile range (IQR), the difference between the 75th percentile (Q_3) and 25th percentile (Q_1) of distances between observed points and the LOC. Using the Tukey method, any point with an error greater than Q_3 + 1.5* IQR or less than Q_1 – 1.5*IQR was identified as an outlier and removed from the regression dataset. The above regressions were calculated using the dataset with outliers removed.

The Tukey Method is equivalent to using three times the standard deviation to identify outliers if the residuals (observed - predicted) follow a normal distribution. The probability of sampling results being within three standard deviations of the mean is 99.73% while the probability for the Tukey Method is 99.65%. If three times the standard deviation is used to identify outliers, it is necessary to first confirm that the residuals are indeed normally distributed. This is difficult to do because of the size limitations of the existing turbidity & TSS dataset. Tukey's method does not rely on any assumption about the distribution of the residuals. It can be used regardless of the shape of distribution.

Outliers were removed from the dataset only for calculating the turbidity-TSS relationship, not from the dataset used to develop the TMDL.

The regression between TSS and turbidity and its statistics for each turbidity impaired stream segments will be shown in Section 5.1.

4.2 Using Load Duration Curves to Develop TMDLs

The TMDL calculations presented in this report are derived from load duration curves (LDC). LDCs facilitate rapid development of TMDLs, and as a TMDL development tool can help identify whether impairments are associated with point or nonpoint sources. The technical approach for using LDCs for TMDL development includes the following steps that are described in Subsections 4.3 through 4.5 below:

- Preparing flow duration curves for gaged and ungaged WQM stations;
- Estimating existing loading in the waterbody using ambient bacterial water quality data; and estimating loading in the waterbody using measured TSS water quality data and turbidity-converted data; and
- Using LDCs to identify it there is a critical condition.

Historically, in developing WLAs for pollutants from point sources, it was customary to designate a critical low flow condition (*e.g.*, 7Q2) at which the maximum permissible loading was calculated. As water quality management efforts expanded in scope to quantitatively address nonpoint sources of pollution and types of pollutants, it became clear that this single critical low flow condition was inadequate to ensure adequate water quality across a range of flow conditions. Use of the LDC obviates the need to determine a design storm or selected flow recurrence interval with which to characterize the appropriate flow level for the assessment of critical conditions. For waterbodies impacted by both point and nonpoint sources, the "nonpoint source critical condition" would typically occur during high flows, when rainfall runoff would contribute the bulk of the pollutant load, while the "point source critical condition" would typically occur during low flows, when WWTP effluents would dominate the base flow of the impaired water. However, flow range is only a general indicator of the relative proportion of point/nonpoint contributions. It is not used in this report to quantify point source or nonpoint source contributions. Violations that occur during low flows may not be caused exclusively by point sources. Violations during low flows have been noted in some watersheds that contain no point sources.

LDCs display the maximum allowable load over the complete range of flow conditions by a line using the calculation of flow multiplied by a water quality criterion. The TMDL can be expressed as a continuous function of flow, equal to the line, or as a discrete value derived from a specific flow condition.

4.3 Development of Flow Duration Curves

Flow duration curves (FDC) serve as the foundation of LDCs and are graphical representations of the flow characteristics of a stream at a given site. Flow duration curves utilize the historical hydrologic record from stream gages to forecast future recurrence frequencies. Many WQM stations throughout Oklahoma do not have long-term flow data and therefore, flow frequencies must be estimated. Seventeen of the twenty-three waterbodies in the Study Area do not have USGS gage stations. The default approach used to develop flow frequencies necessary to establish flow duration curves considers watershed differences in rainfall, land use, and the hydrologic properties of soil that govern runoff and retention. A detailed explanation of the methods for estimating flow for ungaged streams is provided in Appendix B. The most basic method to estimate flows at an ungaged site involves 1) identifying an upstream or downstream flow gage; 2) calculating the contributing drainage areas of the ungaged sites and the flow gage; and 3) calculating daily flows at the ungaged site by using the flow at the gaged site multiplied by the drainage area ratio.

Flow duration curves are a type of cumulative distribution function. The flow duration curve represents the fraction of flow observations that exceed a given flow at the site of interest. The observed flow values are first ranked from highest to lowest, then, for each observation, the percentage of observations exceeding that flow is calculated. The flow value is read from the ordinate (y-axis), which is typically on a logarithmic scale since the high flows would otherwise overwhelm the low flows. The flow exceedance frequency is read from the abscissa (x-axis), which is numbered from 0% to 100%, and may or may not be logarithmic. The lowest measured flow occurs at an exceedance frequency of 100% indicating that flow has equaled or exceeded this value 100% of the time, while the highest measured flow is found at an exceedance frequency of 0%. The median flow occurs at a flow exceedance frequency of 50%. The flow exceedance percentiles for each waterbody addressed in this report are provided in Appendix B.

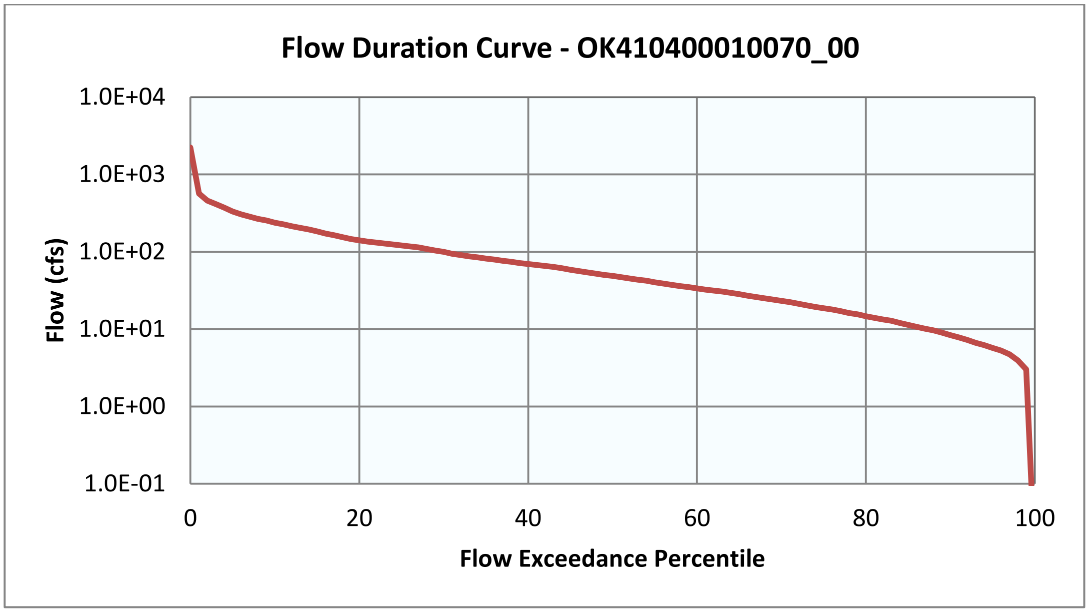
While the number of observations required to develop a flow duration curve is not rigorously specified, a flow duration curve is usually based on more than one year of observations, and encompasses inter-annual and seasonal variation. Ideally, the drought of record and flood of record are included in the observations. For this purpose, the long-term flow gaging stations operated by the USGS are utilized (USGS 2007a) to support the Oklahoma TMDL Toolbox.

The USGS National Water Information System serves as the primary source of flow measurements for the Oklahoma TMDL Toolbox. All available daily average flow values for all gages in Oklahoma, as well as the nearest upstream and downstream gages in adjacent states, were retrieved for use in the Oklahoma TMDL Toolbox to generate flow duration curves for gaged and ungaged waterbodies. The application includes a data update module that automatically downloads the most recent USGS data and appends it to the existing flow database.

Some instantaneous flow measurements were available from various agencies. These were not combined with the daily average flows or used in calculating flow percentiles, but were matched to turbidity, or TSS grab measurements collected at the same site and time. When available, these instantaneous flow measurements were used in lieu of projected flows to calculate pollutant loads.

A typical semi-log flow duration curve exhibits a sigmoidal shape, bending upward near a flow exceedance frequency value of 0% and downward at a frequency near 100%, often with a relatively constant slope in between. For sites that on occasion exhibit no flow, the curve will intersect the abscissa at a frequency less than 100%. As the number of observations at a site increases, the line of the LDC tends to appear smoother. However, at extreme low and high flow values, flow duration curves may exhibit a “stair step” effect due to the USGS flow data rounding conventions near the limits of quantitation. An example of a typical flow duration curve was shown in Figure 4-2.

Figure 4-2 Flow Duration Curve for Dirty Creek, (OK120400020010_00)



Flow duration curve for each stream segment in this study will be developed in Section 5.2.

4.4 Estimating Existing Loading

Existing instream loads can be estimated using FDCs. For bacteria, this is accomplished by:

- Calculating the geometric mean of all water quality observations from the period of record selected for the waterbody;
- Converting the geometric mean concentration value to loads by multiplying the flow duration curve by the geometric mean of the ambient water quality data for each bacterial indicator.

For TSS, this is accomplished by:

- Matching the water quality observations with the flow data from the same date;
- Converting measured concentration values to loads by multiplying the flow at the time the sample was collected by the water quality parameter concentration (for sampling events with both TSS and turbidity data, the measured TSS value is used; if only turbidity was measured, the value was converted to TSS using the regression equations described); or multiplying the flow by the bacterial indicator concentration to calculate daily loads.

4.5 Development of TMDLs Using Load Duration Curves

The final step in the TMDL calculation process involves a group of additional computations derived from the preparation of LDCs. These computations are necessary to derive a PRG (which is one method of presenting how much pollutant loads must be reduced to meet WQSs in the impaired watershed).

Step 1: Generate LDCs. LDCs are similar in appearance to flow duration curves; however for bacteria, the ordinate is expressed in terms of a bacterial load in cfu/day, and for TSS the ordinate is expressed in terms of a load in lbs/day. The bacterial curve represents the geometric mean water quality criterion for *E. coli* or Enterococci bacteria expressed in terms of a load through multiplication by the continuum of flows historically observed at the site. Bacterial TMDLs are not easily expressed in mass per day, the following equation calculates a load in the units of cfu per day. The cfu is a total for the day at a specific flow for bacteria, which is the best equivalent to a mass per day of a pollutant such as sulfate. Expressing bacterial TMDLs as cfu per day is consistent with EPA's Protocol for Developing Pathogen TMDLs (EPA 2001).

For turbidity, the curve represents the water quality target for TSS from Table 5-1 expressed in terms of a load obtained through multiplication of the TSS goal by the continuum of flows historically observed at the site. The basic steps to generating an LDC involve:

- Obtaining daily flow data for the site of interest from the USGS;
- Sorting the flow data and calculating flow exceedance percentiles;
- Obtaining the water quality data from the primary contact recreation season (May 1 through September 30); or obtaining available turbidity and TSS water quality data;
- Displaying a curve on a plot that represents the allowable load determined by multiplying the actual or estimated flow by the WQS numerical criterion for each respective bacterial indicator; or displaying a curve on a plot that represents the allowable load determined by multiplying the actual or estimated flow by the WQ_{goal} for TSS;
- For bacterial TMDLs, displaying another curve derived by plotting the geometric mean of all existing bacterial samples continuously along the full spectrum of flow exceedance percentiles which represents load duration curve (See Section 5); or
- For turbidity TMDLs, matching the water quality observations with the flow data from the same date and determining the corresponding exceedance percentile. (See Section 5).

For bacterial TMDLs the culmination of these steps is expressed in the following formula, which is displayed on the LDC as the TMDL curve:

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

Where: WQS = 126 cfu/100 mL (E. coli); or 33 cfu/100 mL (Enterococci)

unit conversion factor = 24,465,525

For turbidity (TSS) TMDLs the culmination of these steps is expressed in the following formula, which is displayed on the LDC as the TMDL curve:

TMDL (lb/day) = WQ_{goal} * flow (cfs) * unit conversion factor

where: WQ_{goal} = waterbody specific TSS concentration derived from regression analysis results presented in Table 5-1

unit conversion factor = 5.39377

The flow exceedance frequency (x-value of each point) is obtained by looking up the historical exceedance frequency of the measured or estimated flow, in other words, the percent of historical observations that are equal to or exceed the measured or estimated flow. Historical observations of bacteria were plotted as a separate LDC based on the geometric mean of all samples. Historical observations of TSS and/or turbidity concentrations are paired with flow data and are plotted on the LDC for a stream. TSS loads representing exceedance of water quality criteria fall above the TMDL line. It is noted that the LDCs for bacteria were based on the geometric mean standards or geometric mean of all samples. It is inappropriate to compare single sample bacterial observations to a geometric mean water quality criterion in the LDC; therefore individual bacterial samples are not plotted on the LDCs.

As noted earlier, runoff has a strong influence on loading of nonpoint pollution. Yet flows do not always correspond directly to runoff; high flows may occur in dry weather (e.g., lake release to provide water downstream) and runoff influence may be observed with low or moderate flows (e.g., persistent high turbidity due to previous storm).

Step 2: Define MOS. The MOS may be defined explicitly or implicitly. A typical explicit approach would reserve some specific fraction of the TMDL as the MOS. In an implicit approach, conservative assumptions used in developing the TMDL are relied upon to provide an MOS to assure that WQSs are attained. For bacterial TMDLs in this report, an explicit MOS of 10% was selected. The 10% MOS has been used in other approved bacterial TMDLs. For turbidity (TSS) TMDLs an explicit MOS is derived from the NRMSE established by the turbidity/TSS regression analysis conducted for each waterbody. This approach for setting an explicit MOS has been used in other approved turbidity TMDLs.

Step 3: Calculate WLA. As previously stated, the pollutant load allocation for point sources is defined by the WLA. For bacterial TMDLs a point source can be either a wastewater (continuous) or stormwater (MS4) discharge. Stormwater point sources are typically associated with urban and industrialized areas, and recent EPA guidance includes NPDES-permitted stormwater discharges as point source discharges and, therefore, part of the WLA. For TMDL development purposes when addressing turbidity or TSS, a WLA will be established for wastewater (continuous) discharges in impaired watersheds that do not have a BOD or CBOD permit limit but do have a TSS limit. These point source discharges of inorganic suspended solids will be assigned a TSS WLA as part of turbidity TMDLs to ensure WQS can be maintained. As discussed in Section 3.1, a WLA for TSS is not necessary for MS4s.

The LDC approach recognizes that the assimilative capacity of a waterbody depends on the flow, and that maximum allowable loading will vary with flow condition. WLAs can be expressed in terms of a single load, or as different loads allowable under different flows. WLAs may be set to zero in cases of watersheds with no existing or planned continuous permitted point sources. For turbidity (TSS) TMDLs a load-based approach also meets the requirements of 40 CFR, 130.2(i) for expressing TMDLs "in terms of mass per time, toxicity, or other appropriate measures."

WLA for WWTP. For watersheds with permitted point sources discharging the pollutant of concern, NPDES permit limits are used to derive WLAs for evaluation as appropriate for use in the TMDL. The permitted flow rate used for each point source discharge and the water quality concentration defined in a permit are used to estimate the WLA for each wastewater facility. In cases where a permitted flow rate is not available for a WWTP, then the average of monthly flow rates derived from DMRs can be used. WLA values for each NPDES wastewater discharger are then summed to represent the total WLA for a given segment. Using this information bacterial and TSS WLAs can be calculated using the approach as shown in the equations below.

WLA for bacteria:

WLA = WQS * flow * unit conversion factor (#/day)

Where:

WQS = 126 cfu/100 mL (E. coli); or 33 cfu/100 mL (Enterococci)

flow (MGD) = permitted flow

unit conversion factor = 37,854,120

WLA for TSS:

WLA = WQ goal * flow * unit conversion factor (lb/day)

Where:

WQ goal = Waterbody specific water quality goal provided in Table 5-1, or monthly TSS limit in the current permit, whichever is smaller

flow (gal/day) = permitted flow or average monthly flow

unit conversion factor = 8.3445

Step 4: Calculate LA and WLA for MS4s. Given the lack of data and the variability of storm events and discharges from storm sewer system discharges, it is difficult to establish numeric limits on stormwater discharges that accurately address projected loadings. As a result, EPA regulations and guidance recommend expressing NPDES permit limits for MS4s as BMPs.

LAs can be calculated under different flow conditions. The LA at any particular flow exceedance is calculated as shown in the equation below:

LA = TMDL - WLA_WWTP - WLA_MS4 - MOS

WLA for MS4s. For bacterial TMDLs, if there are no permitted MS4s in the Study Area, WLA_MS4 is set to zero. When there are permitted MS4s in the watershed, we can first calculate the sum of LA + WLA_MS4 using the above formula, then separate WLA for MS4s from the sum based on the percentage of a watershed that is under a MS4 jurisdiction. This WLA for MS4s may not be the total load allocated for permitted MS4s unless the whole MS4 area is located within the study watershed boundary. However, in most case the study watershed intersects only a portion of the permitted MS4 coverage areas.

For turbidity TMDLs, WLAs for permitted stormwater such as MS4s, construction, and multi-sector general permits are not calculated since these discharges occur under high flow conditions when the turbidity criteria do not apply.

Step 5: Estimate Percent Load Reduction. Percent load reductions are not required items and are provided for informational purposes when making inferences about individual TMDLs or between TMDLs usually in regard to implementation of the TMDL.

The LDC approach recognizes that the assimilative capacity of a waterbody depends on stream flow and that the maximum allowable loading varies with flow condition. Existing loading and load reductions required to meet the TMDL can also be calculated under different flow conditions. The difference between existing loading and the TMDL is used to calculate the loading reductions required. Percent reduction goals are calculated through an iterative process of taking a series of percent reduction values applying each value uniformly to the measured concentrations of samples and verifying if the geometric mean of the reduced values of all samples is less than the geomean standards.

WLA Load Reduction: The WLA load reduction for bacteria was not calculated as it was assumed that continuous dischargers (NPDES-permitted WWTPs) are adequately regulated under existing permits to achieve WQS at the end-of-pipe and, therefore, no WLA reduction would be required. Currently, bacterial limits are not required for lagoon systems. Lagoon systems located within a sub-watershed of bacterial impaired stream segment will be required to meet *E. coli* standards at the discharge when the permits are renewed.

MS4s are classified as point sources, but they are non-point sources in nature. Therefore, the percent reduction goal calculated for LA will also apply to the MS4 area within the bacterial impaired sub-watershed. If there are no MS4s located within the Study Area requiring a TMDL, then there is no need to establish a PRG for permitted stormwater.

The WLA load reduction for TSS for dischargers without BOD/CBOD limits can be determined as follows:

- If permitted TSS limit is less than TSS goal for the receiving stream, there will be no reductions;
- If permitted TSS limit is greater than TSS goal for the receiving stream, the permit limit will be set at the TSS goal.

LA Load Reduction. After existing loading estimates are computed for each pollutant, nonpoint load reduction estimates for each segment are calculated by using the difference between the estimate of existing loading and the allowable loading (TMDL) under all flow conditions. This difference is expressed as the overall PRG for the impaired waterbody. The PRG serves as a guide for the amount of pollutant reduction necessary to meet the TMDL. For *E. coli* and Enterococci, because WQSs are considered to be met if the geometric mean of all future data is maintained below the geometric mean criteria (TMDL). For turbidity, the PRG is the load reduction that ensures that no more than 10% of the samples under flow-base conditions exceed the TMDL.

SECTION 5
TMDL CALCULATIONS

5.1 Surrogate TMDL Target for Turbidity

Using the LOC method described in Section 4.1, the correlation between TSS and turbidity were developed for establishing the statistics of the regressions and the resulting TSS goals provided in Table 5-1. The regression analysis for each impaired waterbody in the Study Area (Dirty Creek, Butler Creek, Cloud Creek, and Verdigris River at Wagoner, Bull Creek and the Verdigris River near Inola) using the LOC method is displayed in Figures 5-1 through 5-7.

Table 5-1 Regression Statistics and TSS Goals

Waterbody ID	Waterbody Name	R-square	NRMSE	MOS[b]	TSS Goal (mg/L)[a]
OK120400020010_00	Dirty Creek	0.71	9.8%	10%	30
OK120400020160_00	Butler Creek	0.83	8.4%	10%	38
OK120410010100_00	Cloud Creek	0.82	8.5%	10%	46
OK120410010220_00	Snake Creek	0.81	11.2%	15%	47
OK121500010200_00	Verdigris River, US 51, Wagoner	0.77	14.1%	15%	42
OK121500020090_00	Bull Creek	0.77	8.3%	10%	34
OK121500020260_00	Verdigris River near Inola	0.92	6.8%	10%	35

[a] Calculated using the regression equation and the turbidity standard (50 NTU)
[b] Based on the goodness-of-fit of the turbidity-TSS regression (NRMSE)

Figure 5-1 Linear Regression for TSS-Turbidity for Dirty Creek (OK120400020010_00)

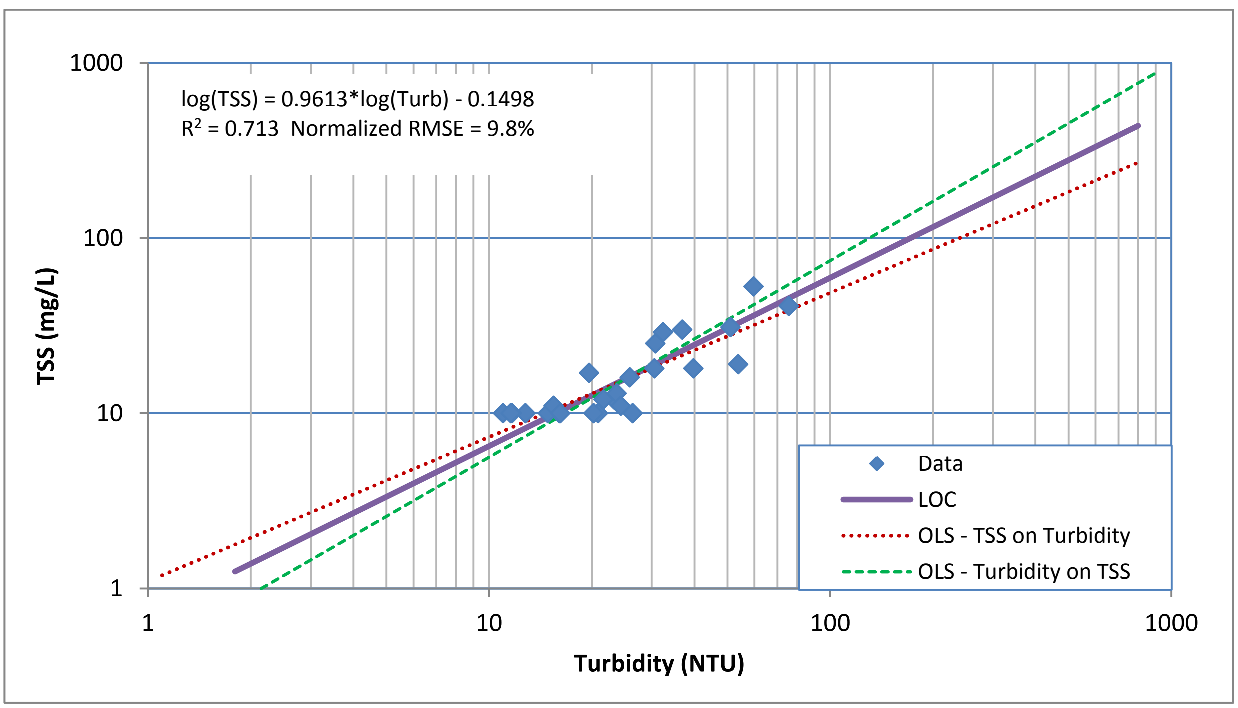


Figure 5-2 Linear Regression for TSS-Turbidity for Butler Creek (OK120400020160_00)

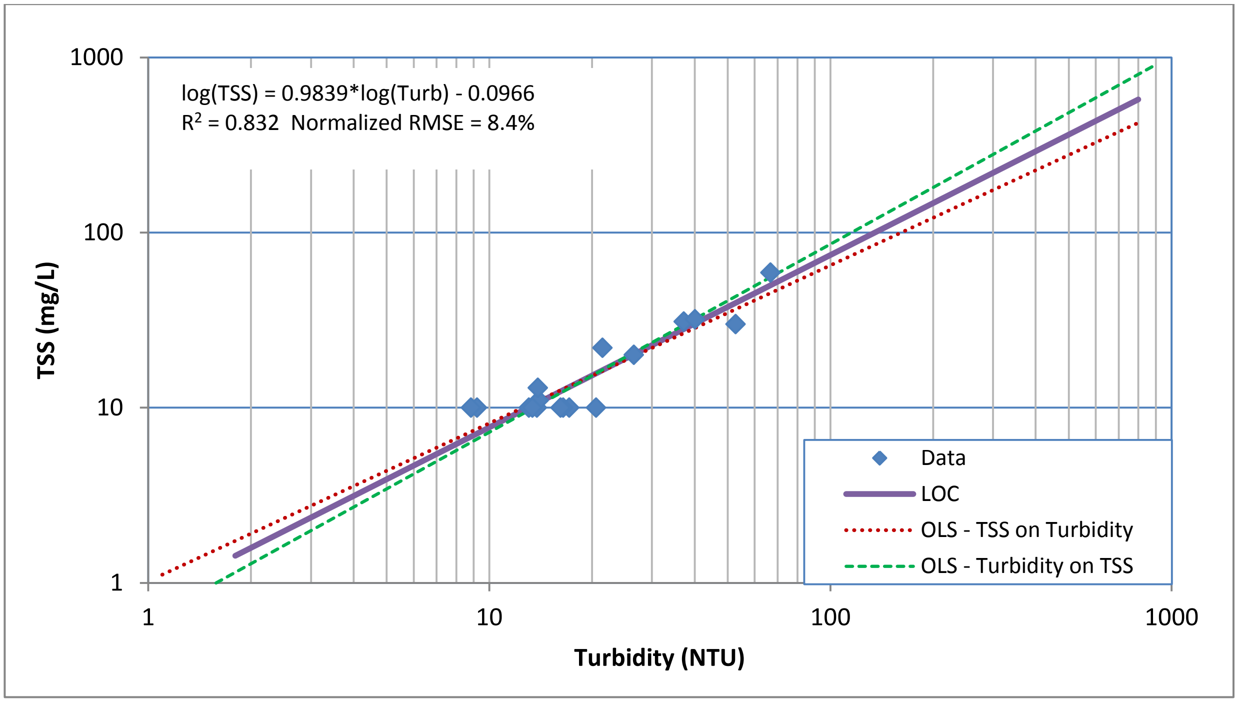


Figure 5-3 Linear Regression for TSS-Turbidity for Cloud Creek (OK120410010100_00)

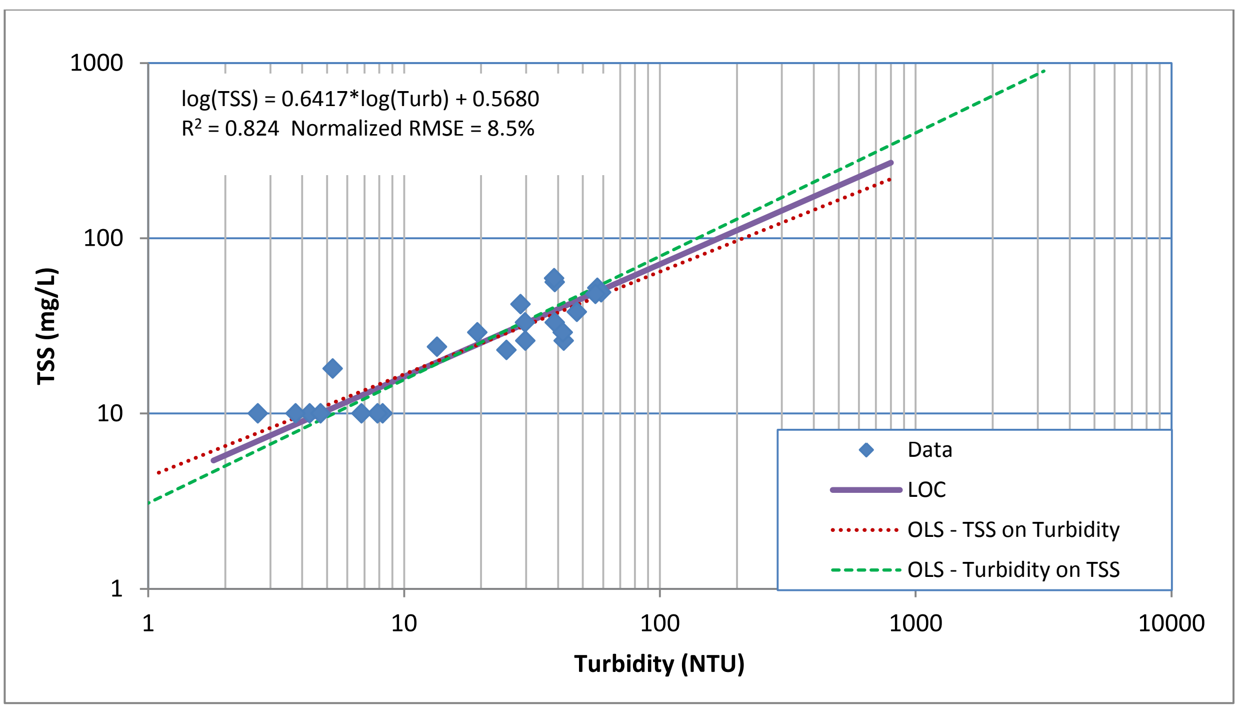


Figure 5-4 Linear Regression for TSS-Turbidity for Snake Creek (OK12010010220_00)

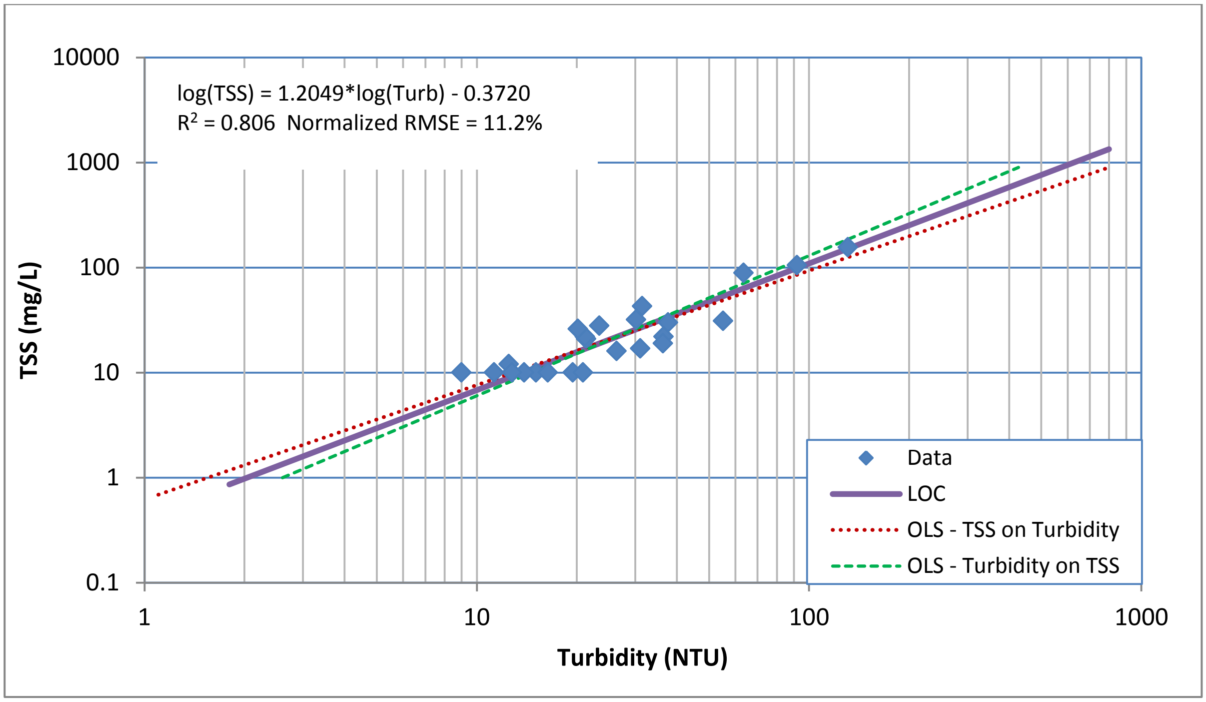


Figure 5-5 Linear Regression for TSS-Turbidity for Verdigris River, US 51, Wagoner (OK121500010200_00)

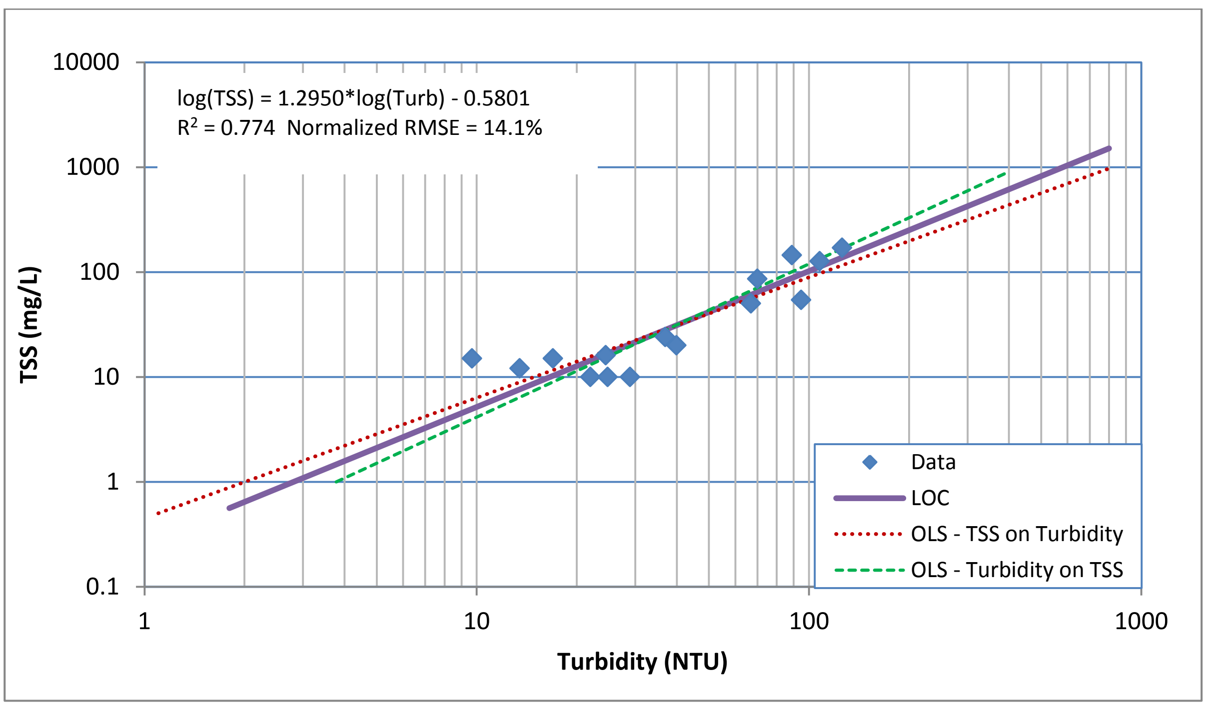


Figure 5-6 Linear Regression for TSS-Turbidity for Bull Creek (OK121500020090_00)

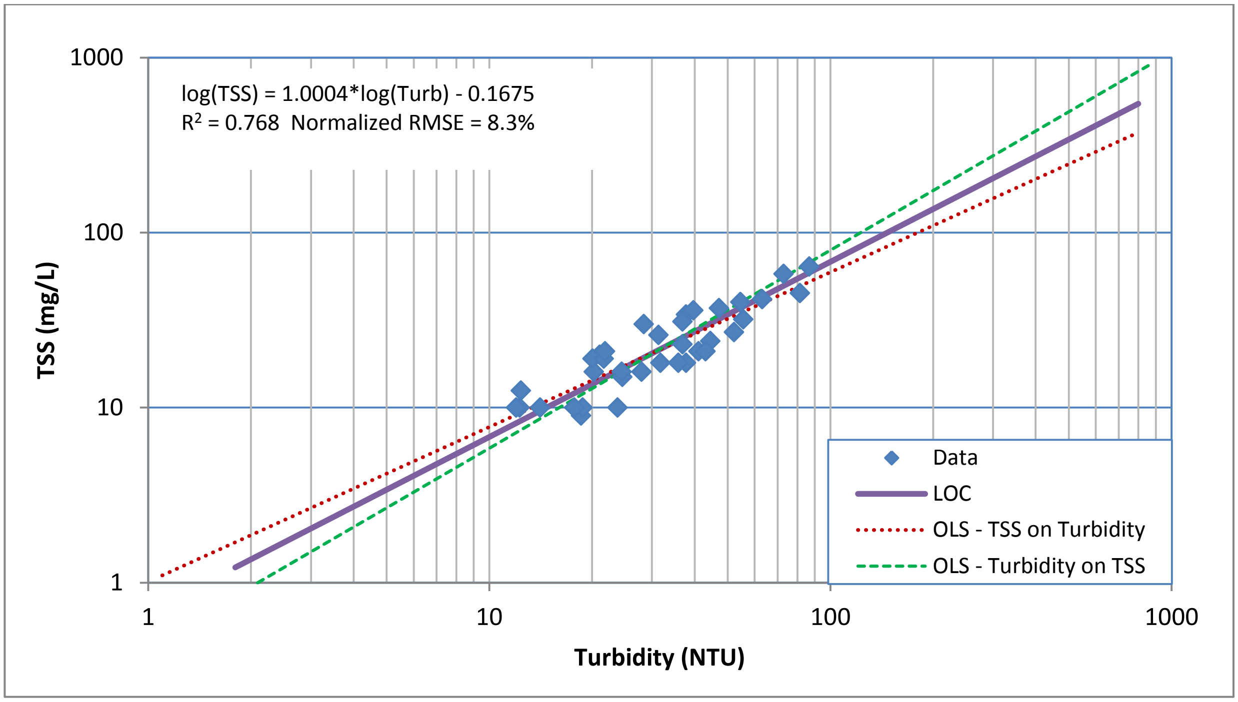
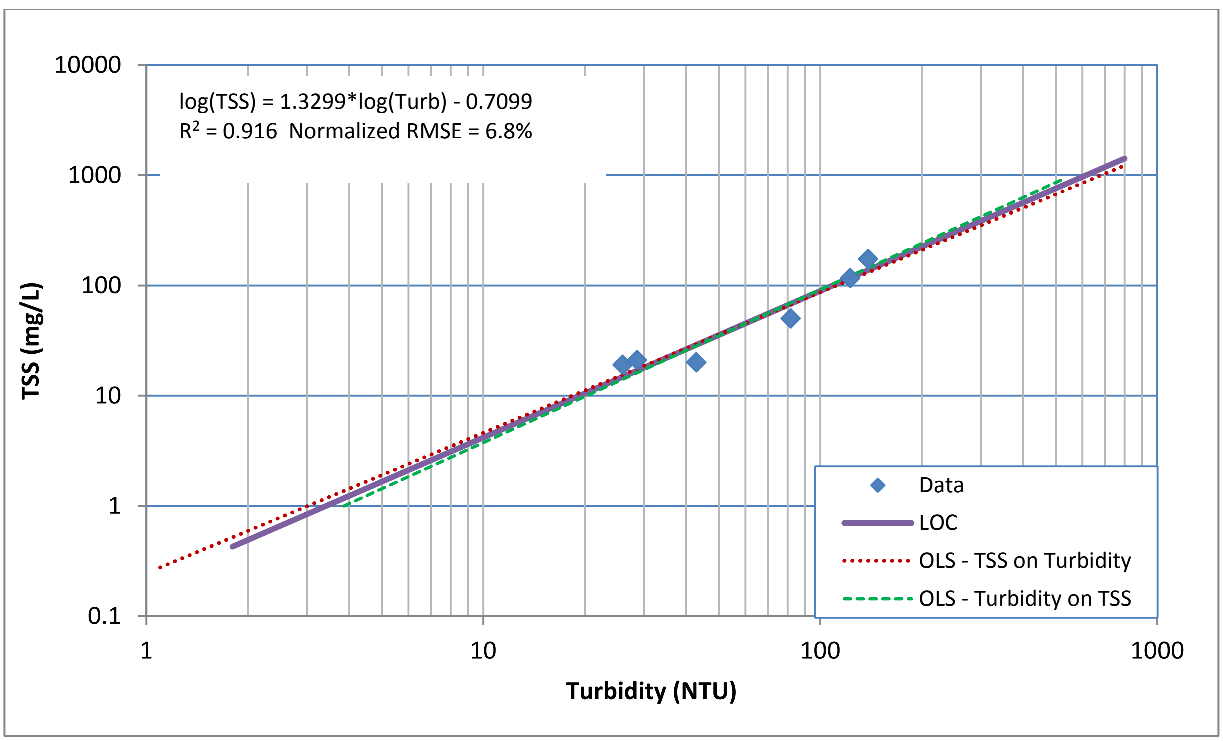


Figure 5-7 Linear Regression for TSS-Turbidity for Verdigris near Inola (OK121500020260_00)

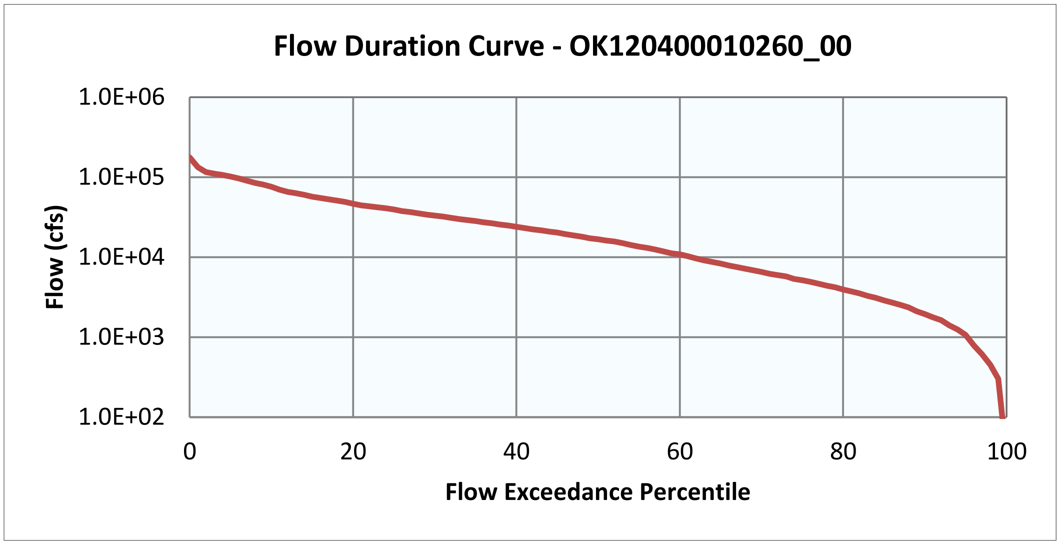


5.2 Flow Duration Curve

Following the same procedures described in Section 4.3, a flow duration curve for each stream segment in this study was developed and shown in Figure 5-8 through Figure 5-30.

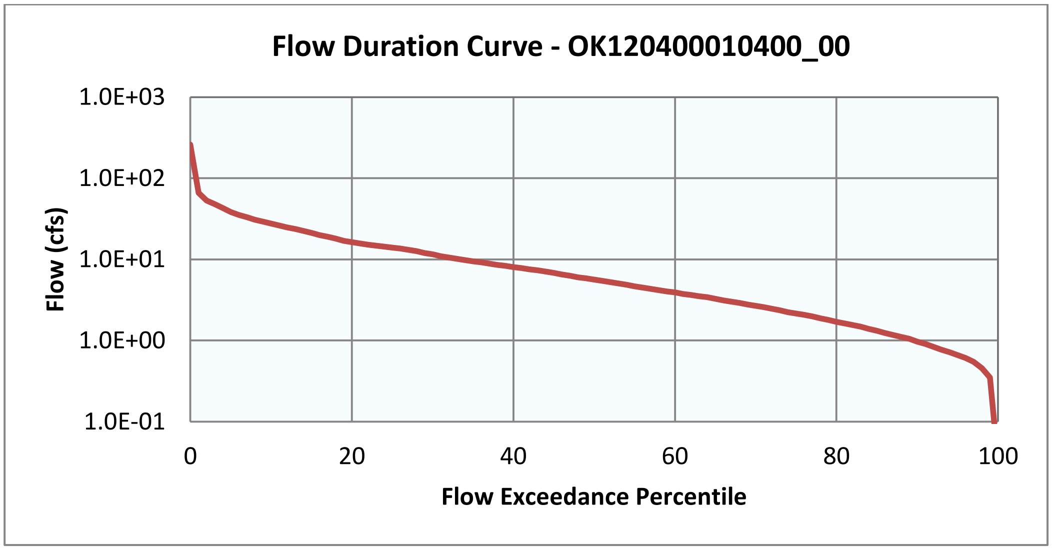
The flow duration curve for Arkansas River near Muskogee (OK120400010260_00) was based on measured flows at USGS gage station 07194500 near Muskogee, Oklahoma. USGS flow data used to develop the flow duration curve range from 2003 to 2011.

Figure 5-8 Flow Duration Curve for Arkansas River near Muskogee (OK120400010260_00)



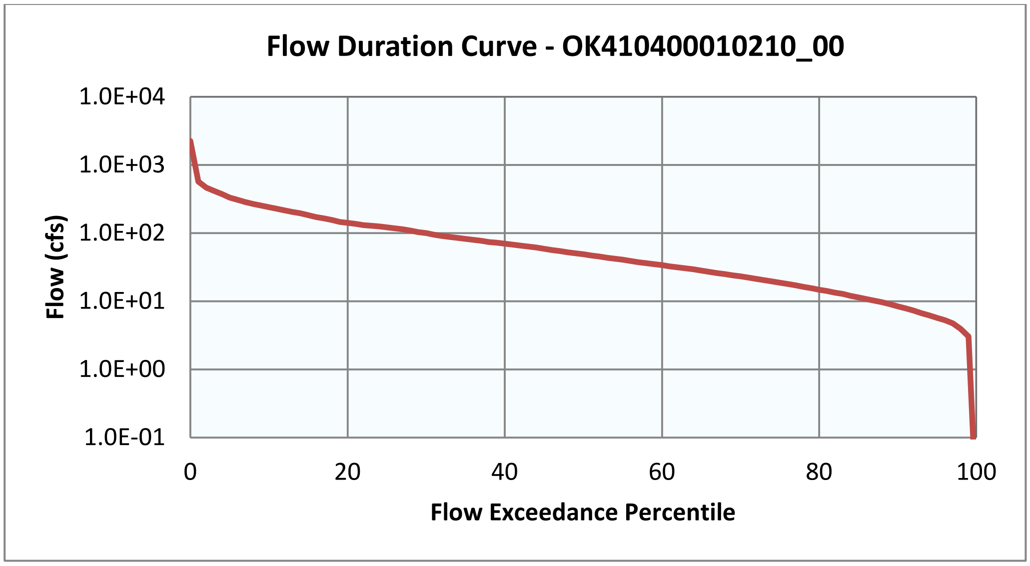
The flow duration curve for Coody Creek (OK120400010400_00) was estimated based on measured flows at USGS gage station 07194500 near Muskogee, Oklahoma. USGS flow data used to develop the flow duration curve range from 2003 to 2011.

Figure 5-9 Flow Duration Curve for Coody Creek (OK120400010400_00)



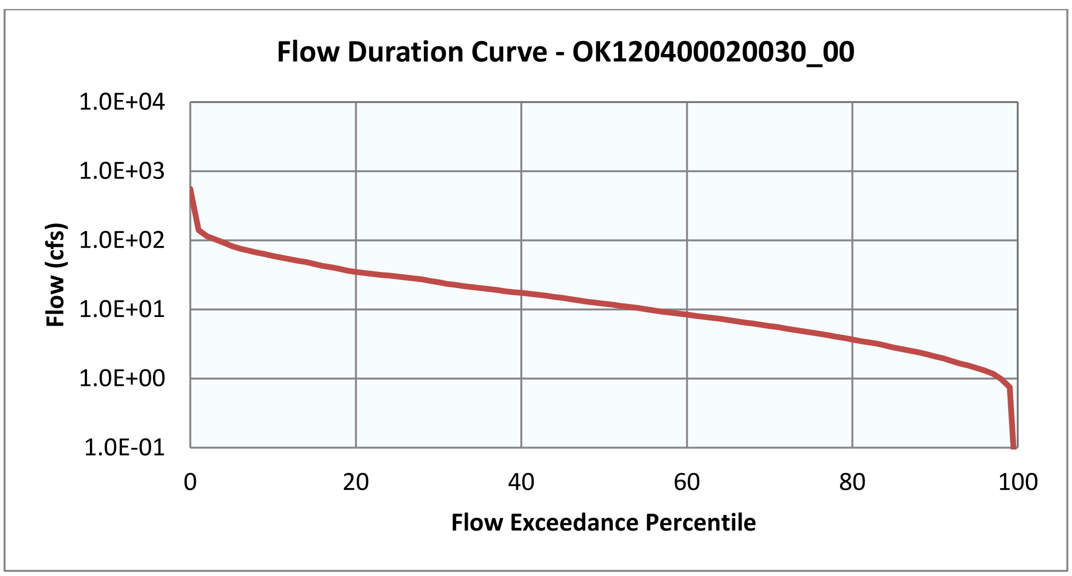
The flow duration curve for Dirty Creek (OK410400010210_00) was estimated based on measured flows at USGS gage station 07194500 near Muskogee, Oklahoma. USGS flow data used to develop the flow duration curve range from 2003 to 2011.

Figure 5-10 Flow Duration Curve for Dirty Creek (OK410400010210_00)



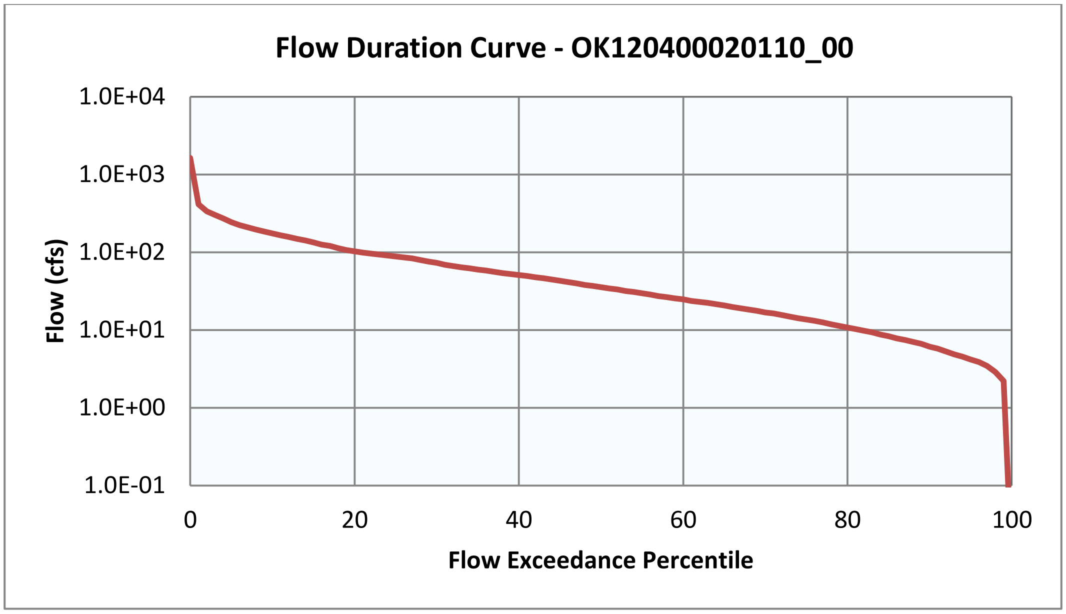
The flow duration curve for South Fork of Dirty Creek (OK120400020030_00) was estimated based on measured flows at USGS gage station 07194500 near Muskogee, Oklahoma. USGS flow data used to develop the flow duration curve range from 2003 to 2011.

Figure 5-11 Flow Duration Curve for South Fork of Dirty Creek (OK120400020030_00)



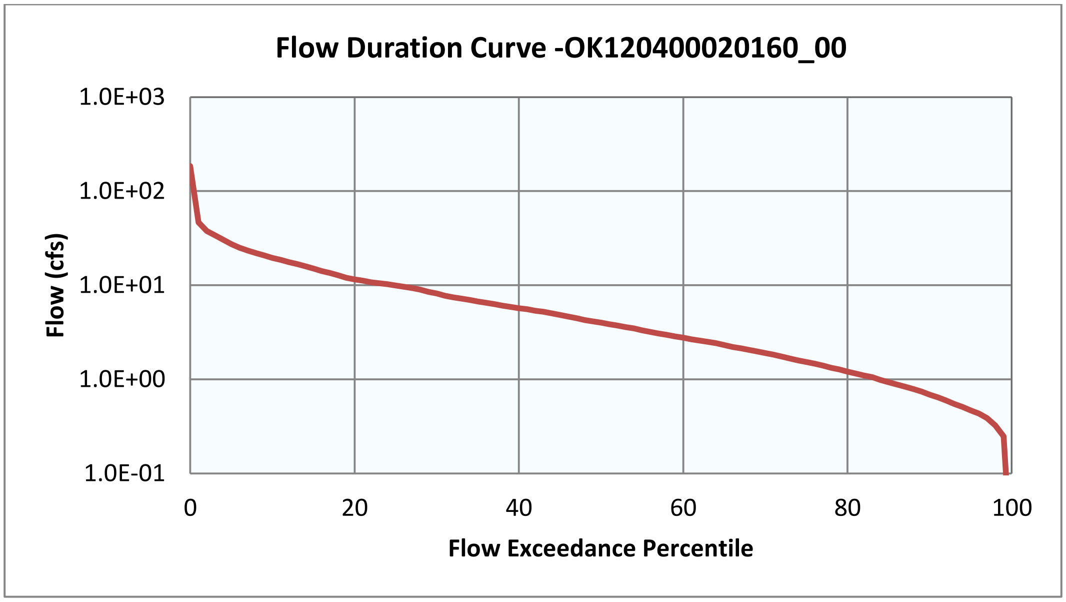
The flow duration curve for George's Fork of Dirty Creek, (OK120400020110_00) was estimated based on measured flows at USGS gage station 07194500 near Muskogee, Oklahoma. USGS flow data used to develop the flow duration curve range from 2003 to 2011.

Figure 5-12 Flow Duration Curve for George's Fork of Dirty Creek (OK120400020110_00)



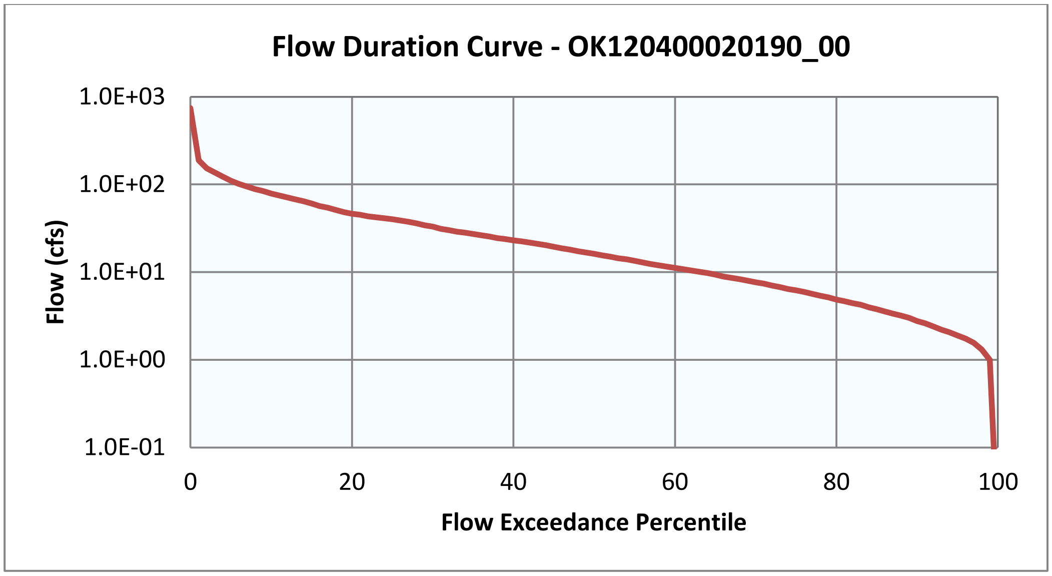
The flow duration curve for Butler Creek (OK120400020160_00) was estimated based on measured flows at USGS gage station 07194500 near Muskogee, Oklahoma. USGS flow data used to develop the flow duration curve range from 2003 to 2011.

Figure 5-13 Flow Duration Curve for Butler Creek (OK410400030490_00)



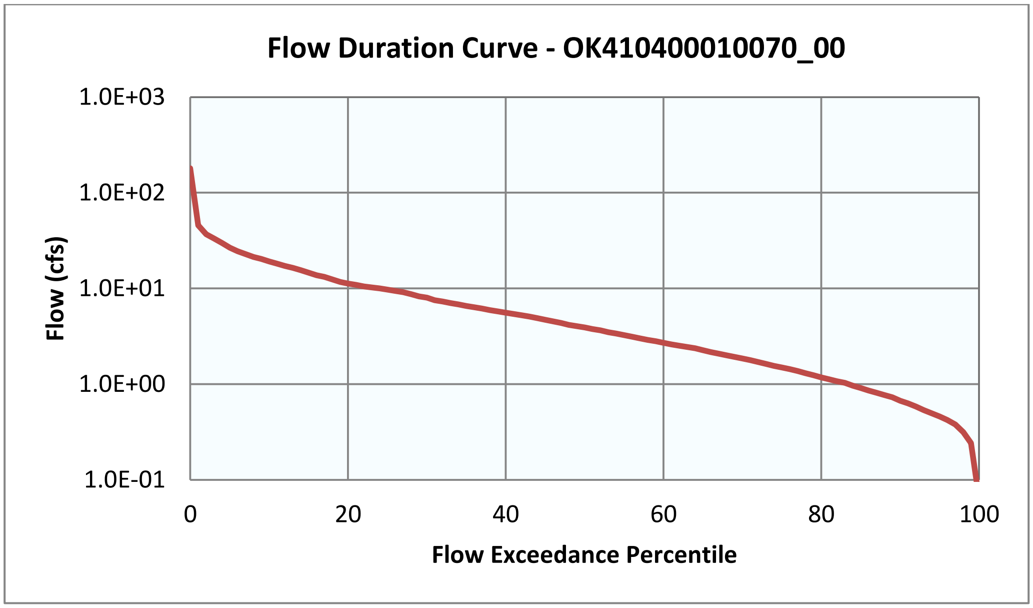
The flow duration curve for Elk Creek (OK120400020190_00) was estimated based on measured flows at USGS gage station 07194500 near Muskogee, Oklahoma. USGS flow data used to develop the flow duration curve range from 2003 to 2011.

Figure 5-14 Flow Duration Curve for Elk Creek (OK120400020190_00)



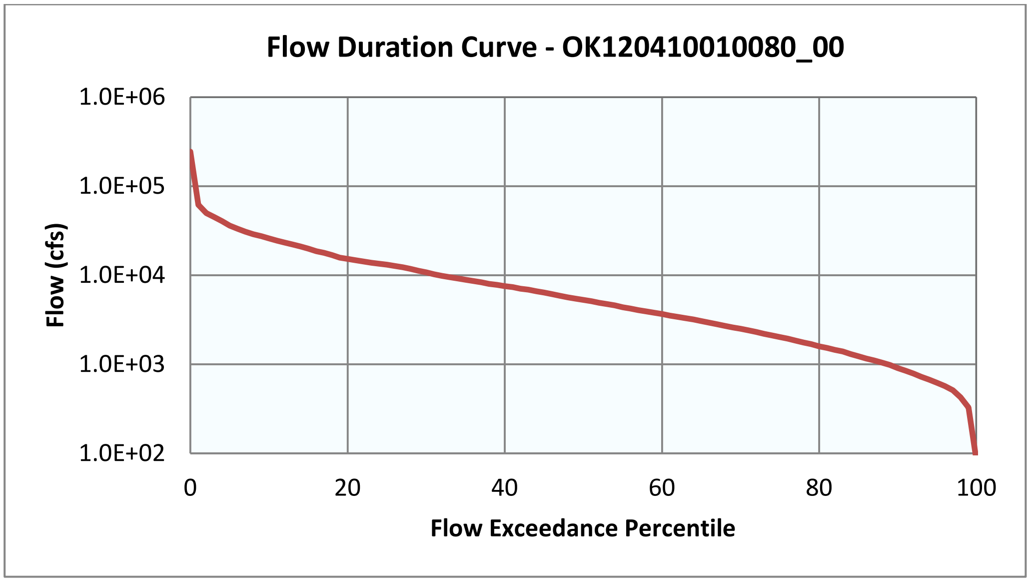
The flow duration curve for Shady Grove Creek (OK120400020240_00) was estimated based on measured flows at USGS gage station 07194500 near Muskogee, Oklahoma. USGS flow data used to develop the flow duration curve range from 2003 to 2011.

Figure 5-15 Flow Duration Curve for Shady Grove Creek (OK410400060120_00)



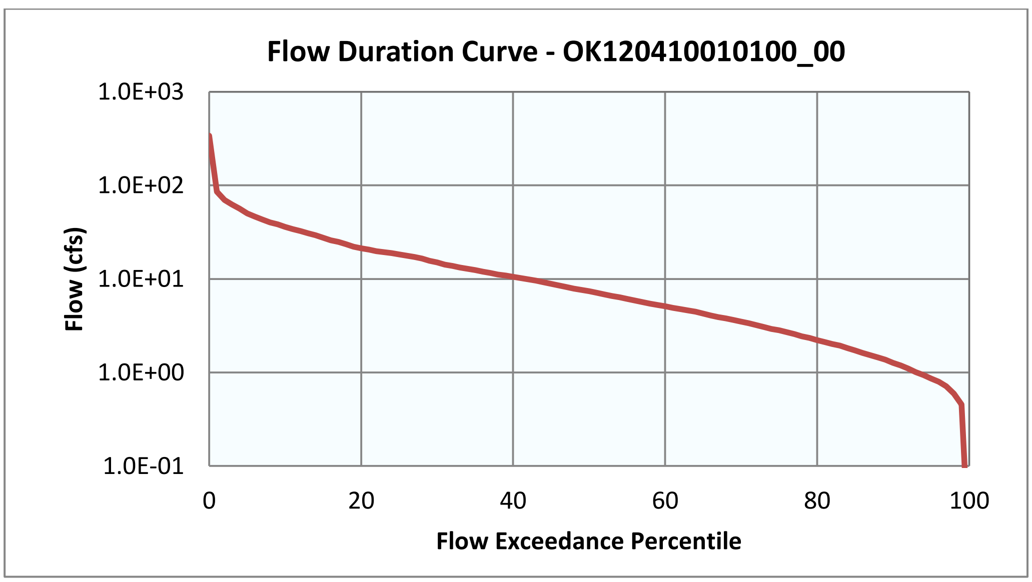
The flow duration curve for Arkansas River near Haskell (OK120410010080_00) was based on measured flows at USGS gage stations 07165600 and 07165570 near Tullahassee and Haskell, Oklahoma respectively. USGS flow data used to develop the flow duration curve range from 1969 to 2011.

Figure 5-16 Flow Duration Curve for Arkansas River near Haskell (OK120410010080_00)



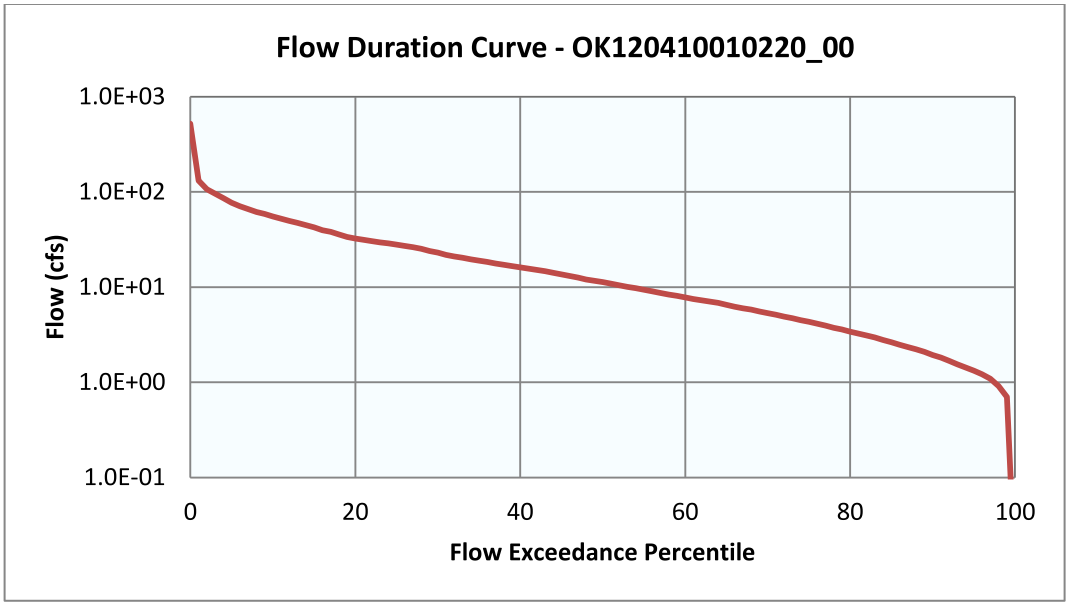
The flow duration curve for Cloud Creek (OK120410010100_00) was estimated based on measured flows at USGS gage stations 07165600 and 07165570 near Tullahassee and Haskell, Oklahoma. USGS flow data used to develop the flow duration curve range from 1969 to 2011.

Figure 5-17 Flow Duration Curve for Cloud Creek (OK120410010100_00)



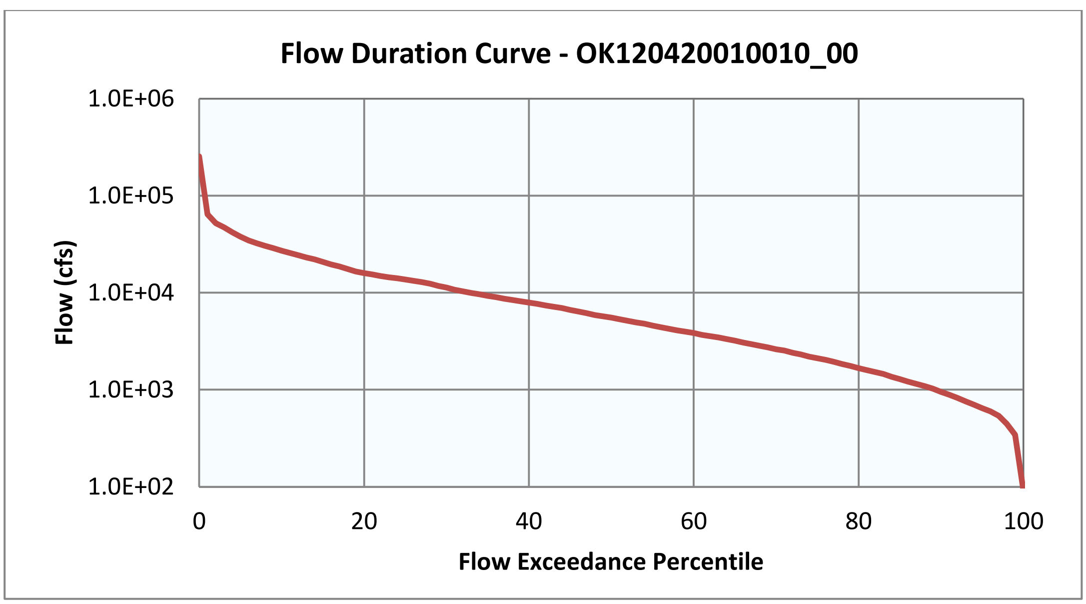
The flow duration curve for Snake Creek (OK120410010220_00) was estimated based on measured flows at USGS gage stations 07165600 and 07165570 near Tullahassee and Haskell, Oklahoma. USGS flow data used to develop the flow duration curve range from 1969 to 2011.

Figure 5-18 Flow Duration Curve for Snake Creek (OK120410010220_00)



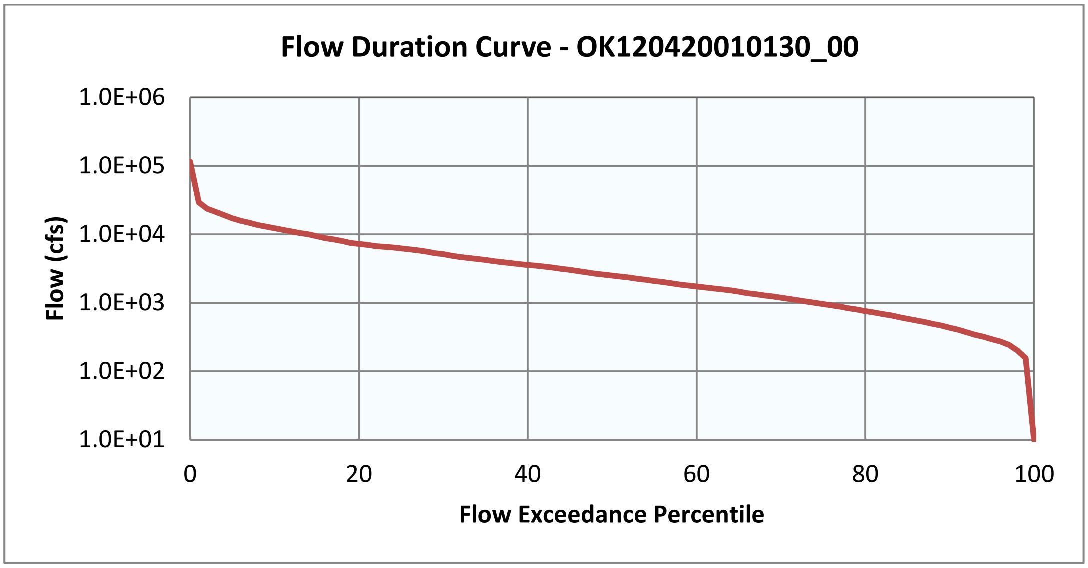
The flow duration curve for Arkansas River near Bixby (OK120420010010_00) was based on measured flows at USGS gage stations 07165600 and 07165570 near Tullahassee and Haskell, Oklahoma. USGS flow data used to develop the flow duration curve range from 1969 to 2011.

Figure 5-19 Flow Duration Curve for Arkansas River near Bixby (OK120420010010_00)



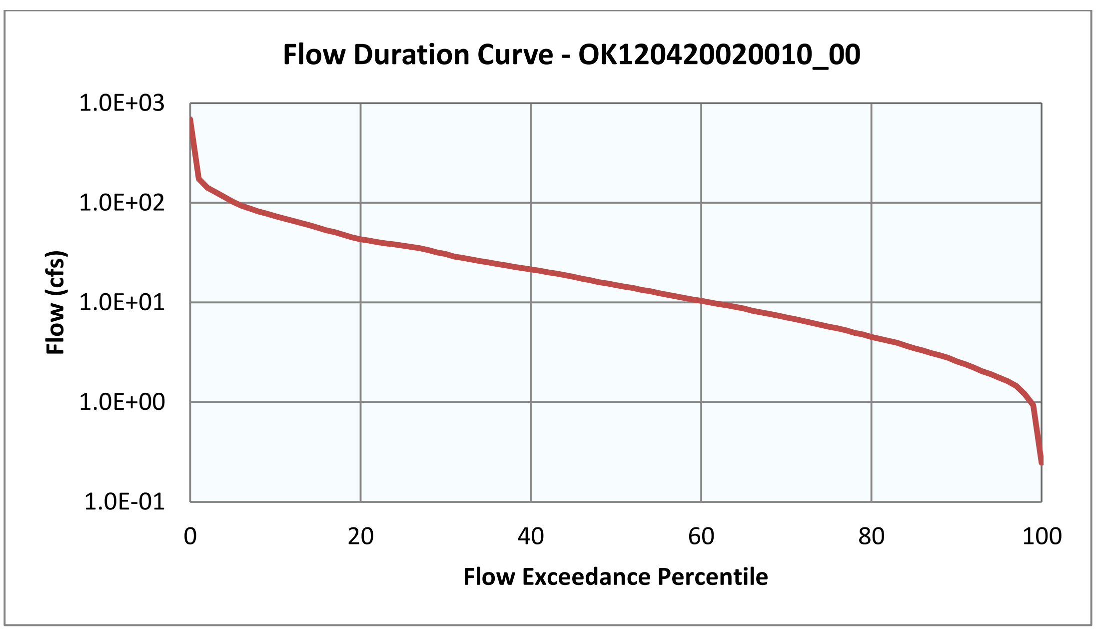
The flow duration curve for Arkansas River near Sand Springs (OK120420010130_00) was estimated based on measured flows at USGS gage stations 07164200, Keystone Lake near Sand Springs, Oklahoma. USGS flow data used to develop the flow duration curve range from 1999 to 2001.

Figure 5-20 Flow Duration Curve for Arkansas River near Sand Springs (OK120420010130_00)



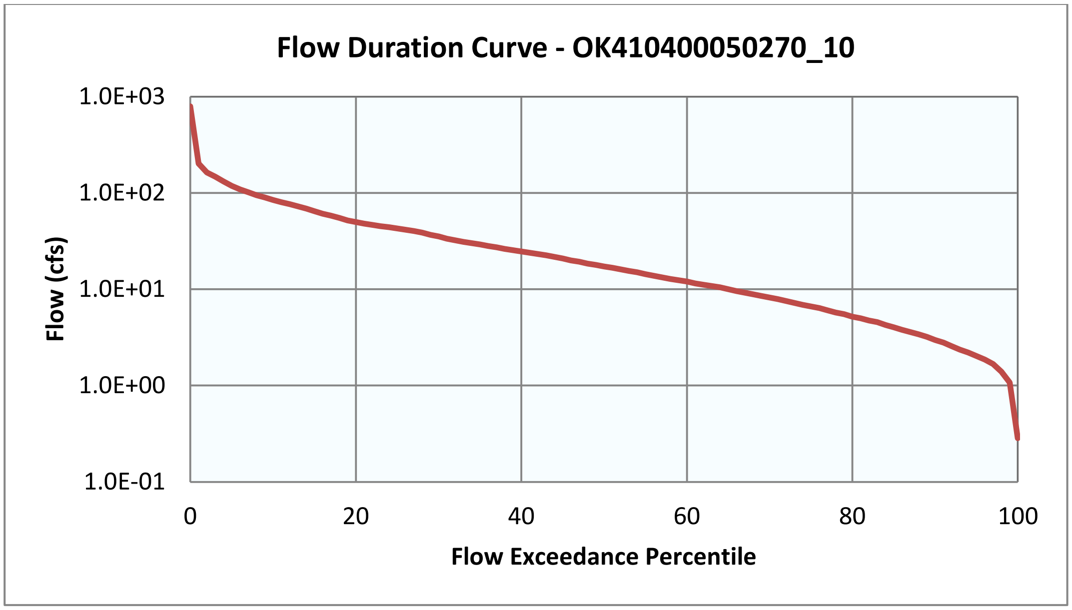
The flow duration curve for Polecat Creek (OK120420020010_00) was estimated based on measured flows at USGS gage stations 07164200, Keystone Lake near Sand Springs, Oklahoma. USGS flow data used to develop the flow duration curve range from 1999 to 2001.

Figure 5-21 Flow Duration Curve for Polecat Creek (OK120420020010_00)



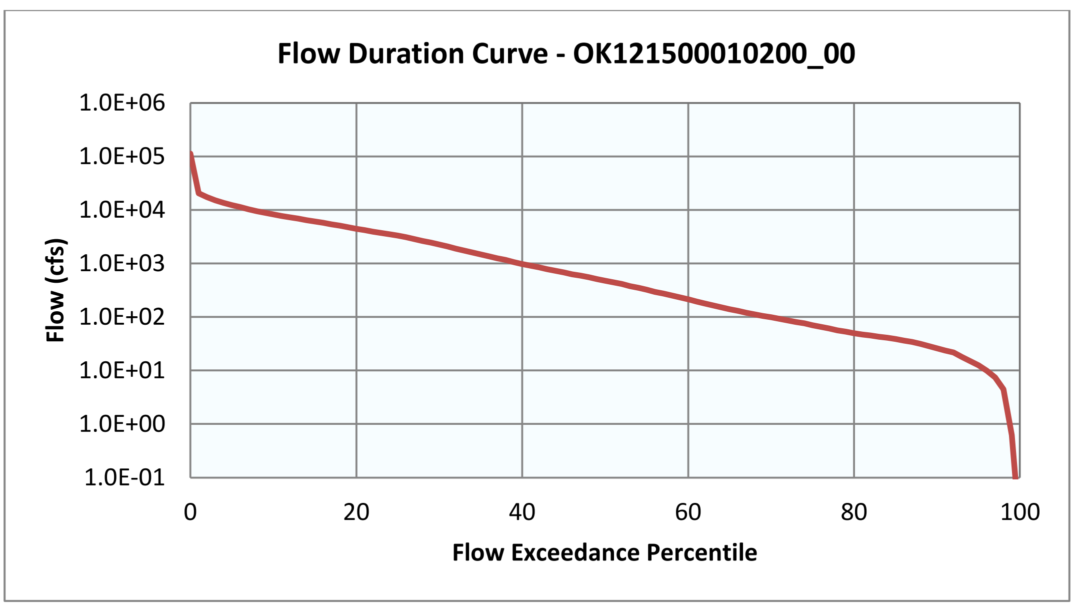
The flow duration curve for Polecat Creek (OK120420020050_00) was estimated based on measured flows at USGS gage stations 07164200, Keystone Lake near Sand Springs, Oklahoma. USGS flow data used to develop the flow duration curve range from 1999 to 2001.

Figure 5-22 Flow Duration Curve for Polecat Creek (OK120420020050_00)



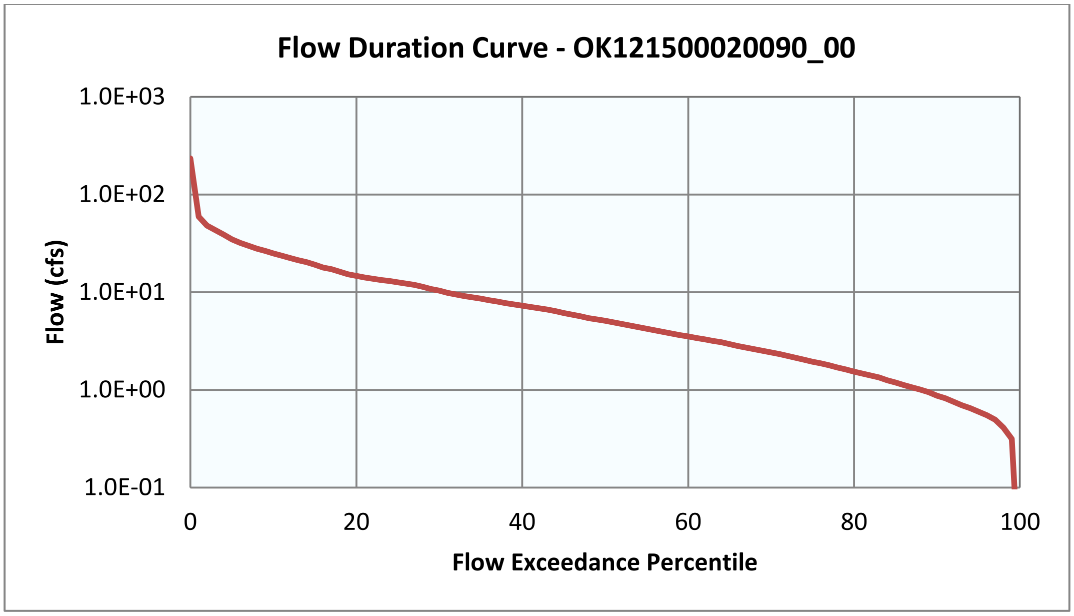
The flow duration curve for Verdigris River near Wagoner (OK121500010200_00) was estimated based on measured flows at USGS gage stations 07176000 near Claremore, Oklahoma. USGS flow data used to develop the flow duration curve range from 1935 to 2011.

Figure 5-23 Flow Duration Curve for Verdigris River near Wagoner (OK121500010200_00)



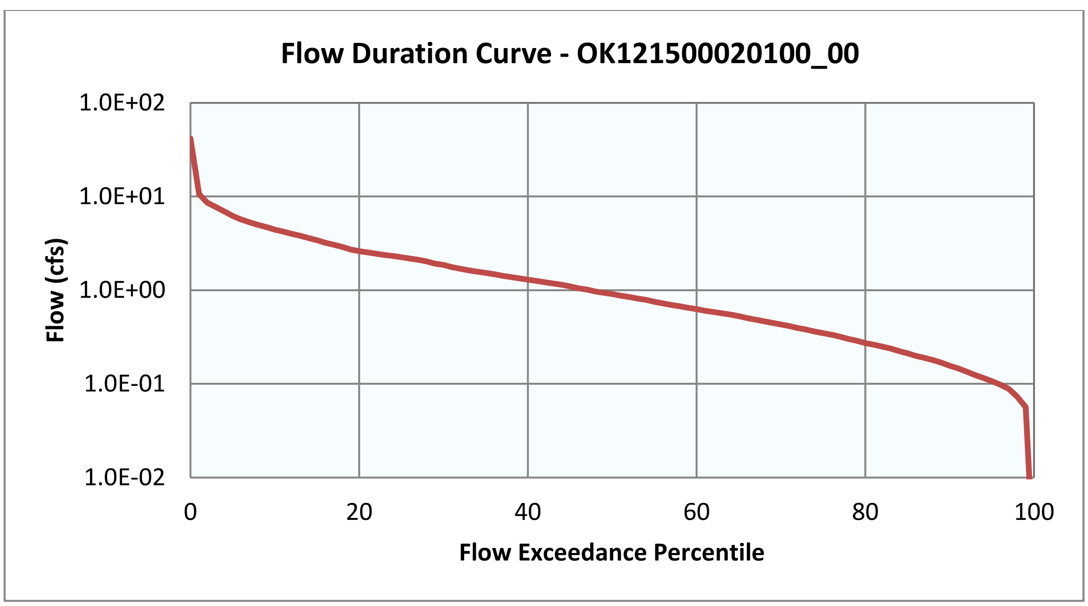
The flow duration curve for Bull Creek (OK121500020090_00) was estimated based on measured flows at USGS gage stations 07176000 near Claremore, Oklahoma. USGS flow data used to develop the flow duration curve range from 1935 to 2011.

Figure 5-24 Flow Duration Curve for Bull Creek (OK121500020090_00)



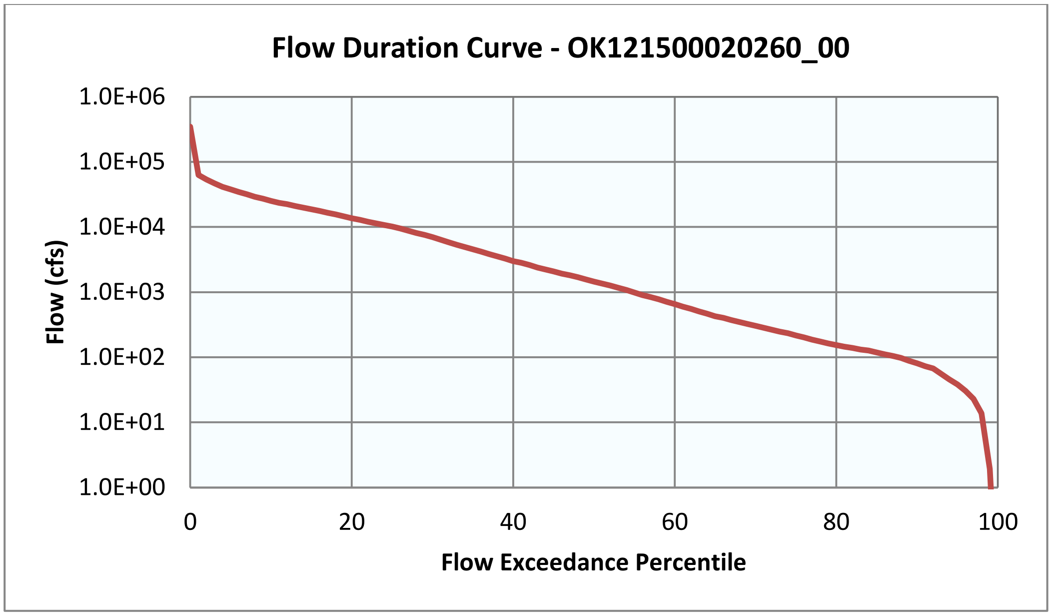
The flow duration curve for Pea Creek (OK121500020100_00) was estimated based on measured flows at USGS gage stations 07176000 near Claremore, Oklahoma. USGS flow data used to develop the flow duration curve range from 1935 to 2011.

Figure 5-25 Flow Duration Curve for Pea Creek (OK121500020100_00)



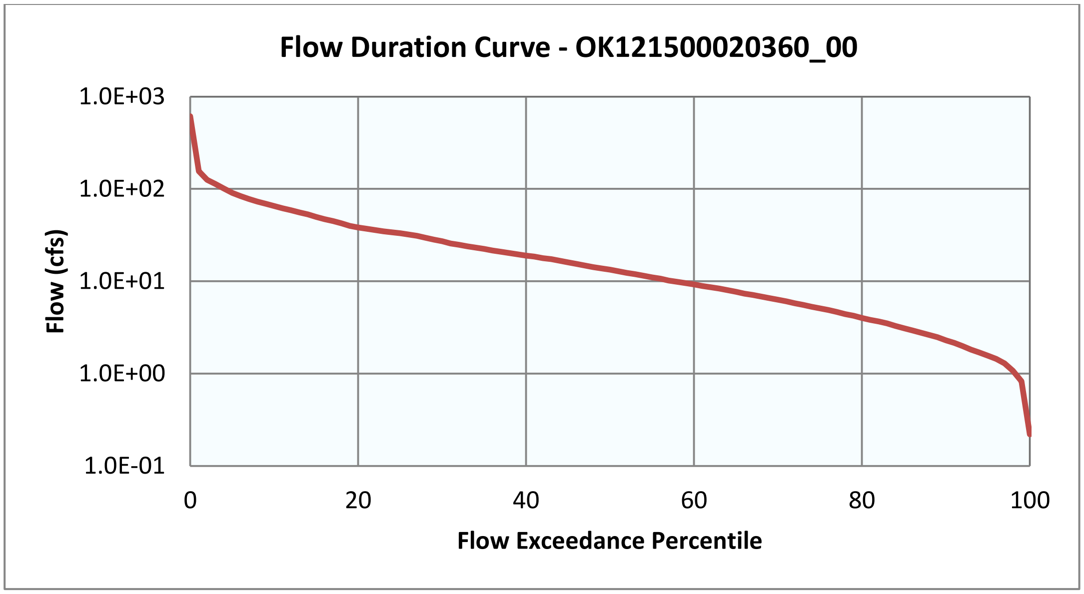
The flow duration curve for Verdigris River near Inola (OK121500020260_00) was estimated based on measured flows at USGS gage stations 07176000 near Claremore, Oklahoma. USGS flow data used to develop the flow duration curve range from 1935 to 2011.

Figure 5-26 Flow Duration Curve for Verdigris River near Inola (OK410400060120_00)



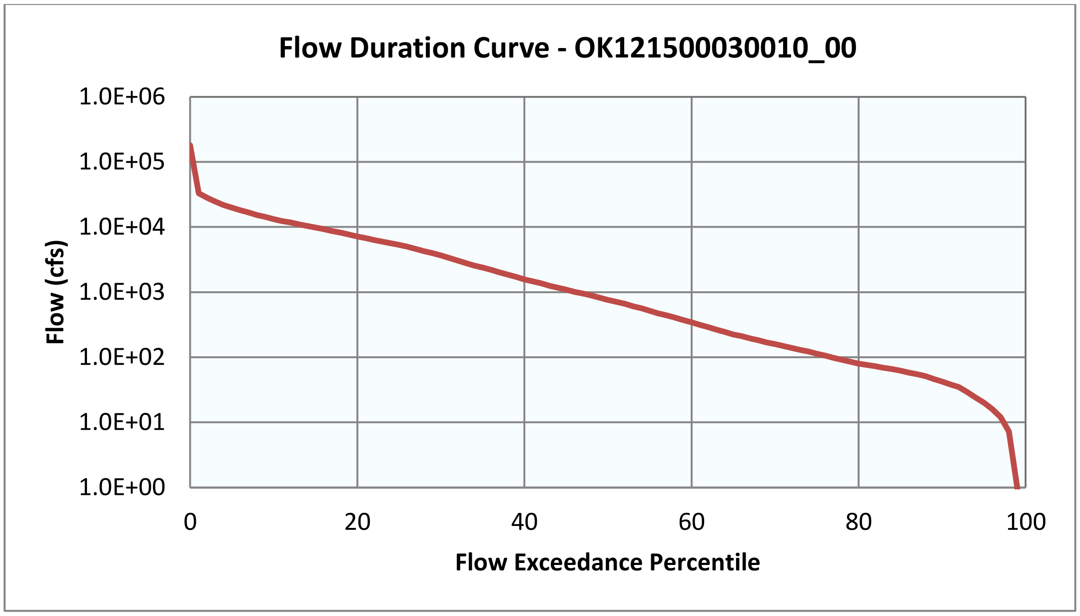
The flow duration curve for Dog Creek (OK121500020360_00) was estimated based on measured flows at USGS gage stations 07176000 near Claremore, Oklahoma. USGS flow data used to develop the flow duration curve range from 1935 to 2011.

Figure 5-27 Flow Duration Curve for Dog Creek (OK121500020360_00)



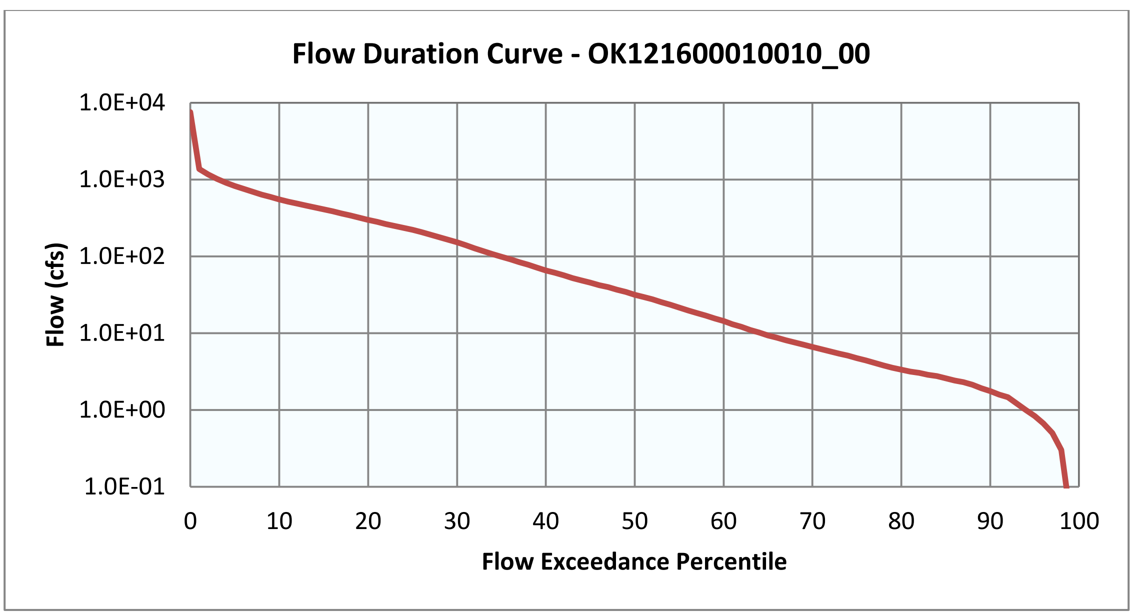
The flow duration curve for Verdigris River near Claremore (OK121500030010_00) was estimated based on measured flows at USGS gage stations 07176000 near Claremore, Oklahoma. USGS flow data used to develop the flow duration curve range from 1935 to 2011.

Figure 5-28 Flow Duration Curve for Verdigris River near Claremore (OK121500030010_00)



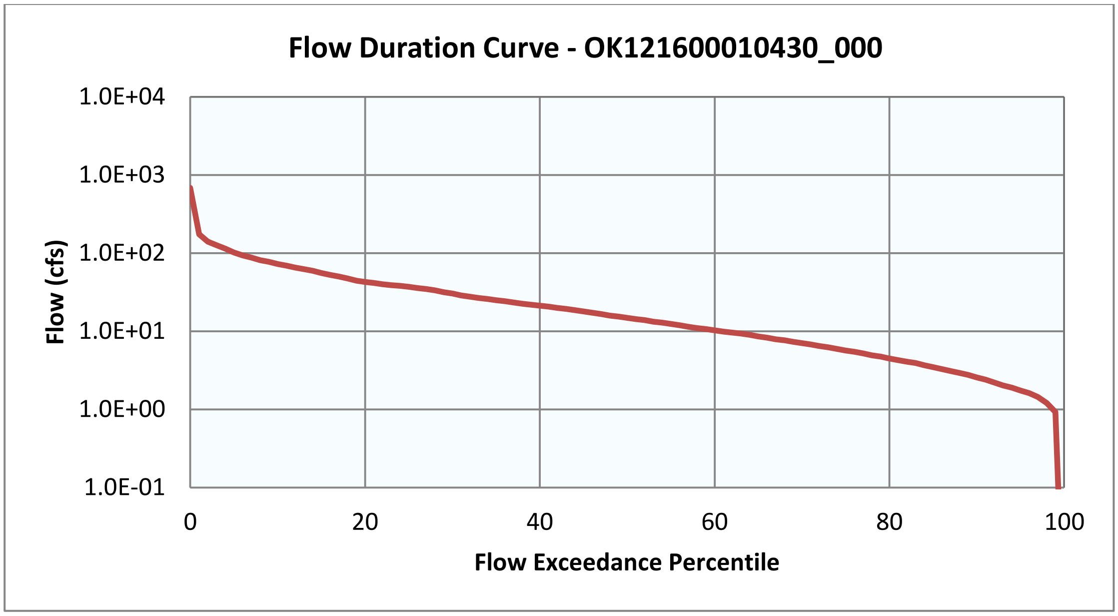
The flow duration curve for Neosho River near Fort Gibson Lake (OK121600010010_00) was estimated based on measured flows at USGS gage stations 07193500 near Fort Gibson, Oklahoma. USGS flow data used to develop the flow duration curve range from 1944 to 1970.

Figure 5-29 Flow Duration Curve for Neosho River near Ft. Gibson (OK121600010010_00)



The flow duration curve for Chouteau Creek (OK121600010430_00) was estimated based on measured flows at USGS gage stations 07176000 near Claremore, Oklahoma. USGS flow data used to develop the flow duration curve range from 1935 to 2011.

Figure 5-30 Flow Duration Curve for Chouteau Creek (OK121600010430_00)



5.3 Estimated Loading and Critical Conditions

EPA regulations at 40 CFR 130.7(c) (1) require TMDLs to take into account critical conditions for stream flow, loading, and all applicable water quality standards. To accomplish this, available instream WQM data were evaluated with respect to flows and magnitude of water quality criteria exceedance using LDCs.

5.3.1 Bacterial LDC

To calculate the allowable bacterial load, the flow rate at each flow exceedance percentile is multiplied by a unit conversion factor (*24,465,525*) and the geometric mean water quality criterion for each bacterial indicator. This calculation produces the maximum allowable bacterial load in the stream over the range of flow conditions. The allowable bacterial (*E. coli* or Enterococci) loads at the WQS establishes the TMDL and are plotted versus flow exceedance percentile as a LDC. The x-axis indicates the flow exceedance percentile, while the y-axis is expressed in terms of a bacterial load.

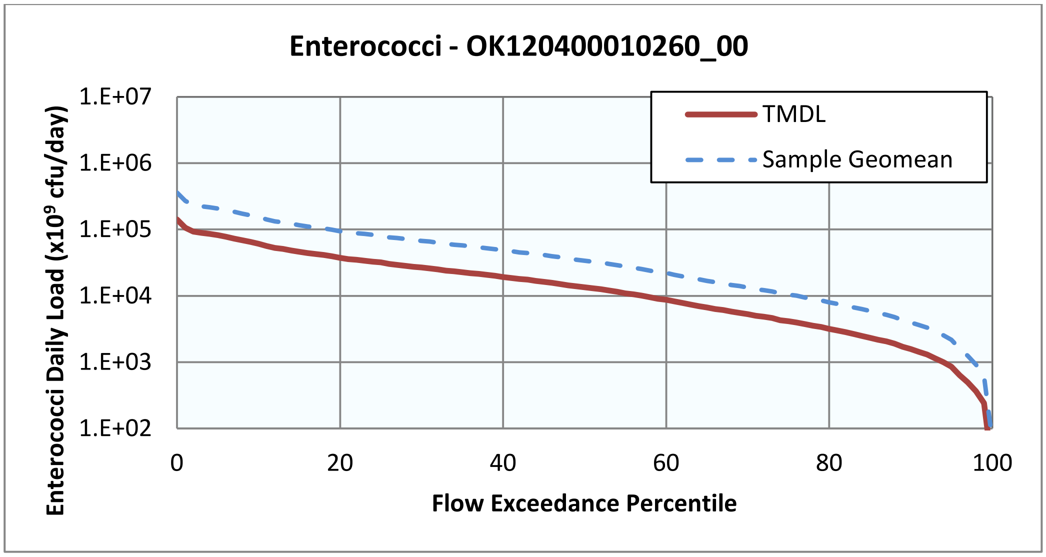
To estimate existing loading, the geometric mean of all bacterial observations (concentrations) for the primary contact recreation season (May 1st through September 30th) from 2000 to 2010 are paired with the flows measured or estimated in that waterbody. Pollutant loads are then calculated by multiplying the measured bacterial concentration by the flow rate and the unit conversion factor of *24,465,756*.

The bacterial LDCs developed for each impaired waterbody (representing the primary contact recreation season from 2000 through 2010) are shown in Figures 5-31 through 5-59.

Waterbodies may have more than one LDC because for the PBCR use to be supported, criteria for each bacterial indicator must be met in each impaired waterbody.

The LDC (Figure 5-31) for Arkansas River near Muskogee (OK120400010260_00) are based on Enterococci bacterial measurements collected during primary contact recreation season at WQM station 121400010260-001AT.

Figure 5-31 Load Duration Curve for Enterococci in Arkansas River near Muskogee (OK120400010260_00)



The LDCs (Figure 5-32 and 5-33) for Coody Creek (OK120400010400_00) are based on E.coli and Enterococci bacterial measurements collected during primary contact recreation season at WQM station OK120400-01-0400F.

Figure 5-32 Load Duration Curve for E.coli in Coody Creek (OK120400010400_00)

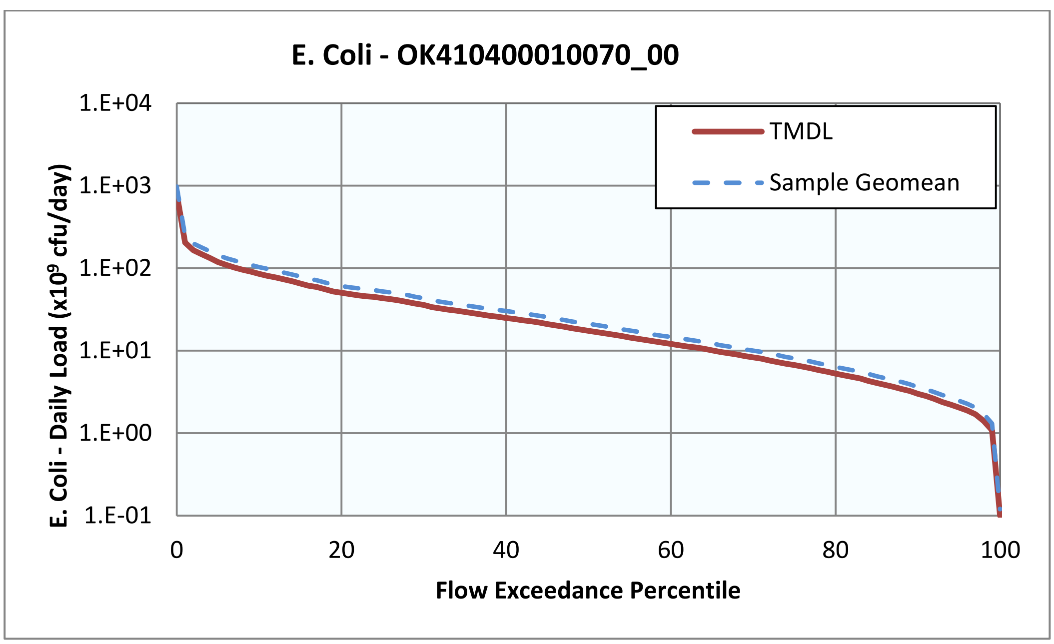
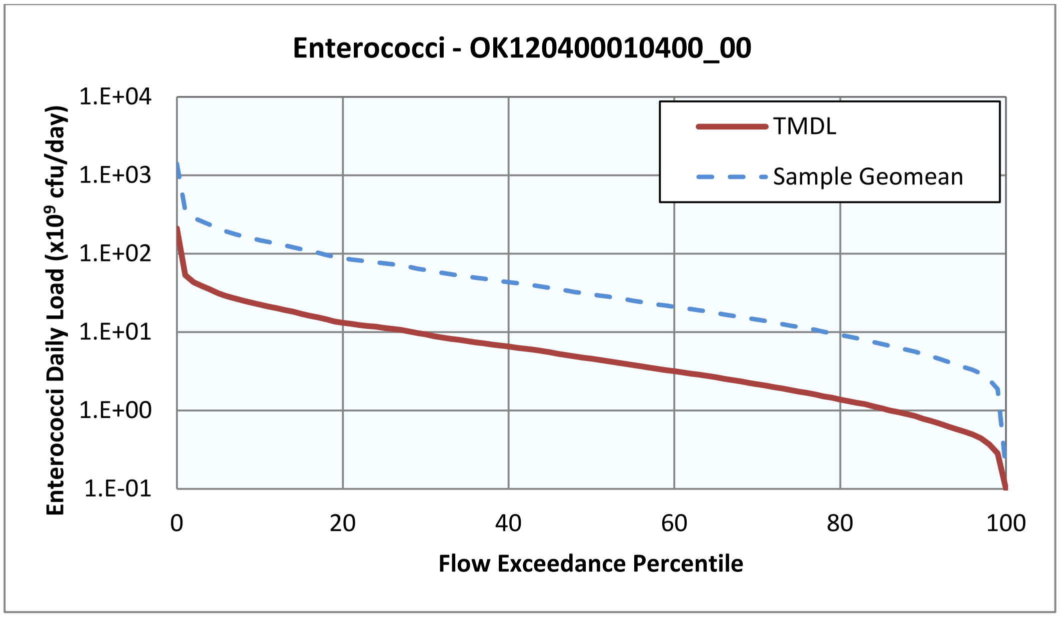
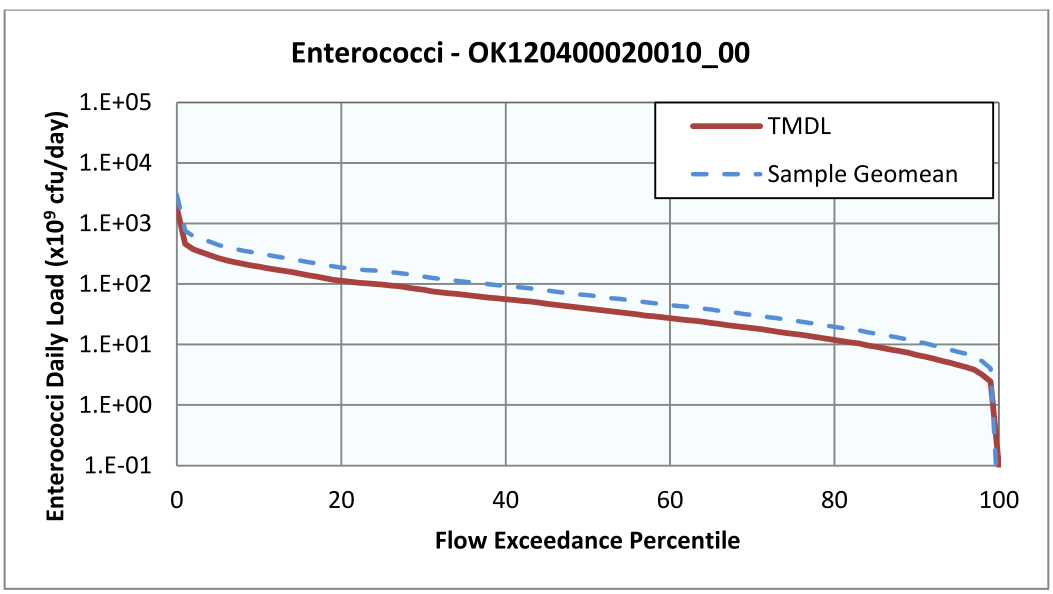


Figure 5-33 Load Duration Curve for Enterococci in Coody Creek (OK120400010400_00)



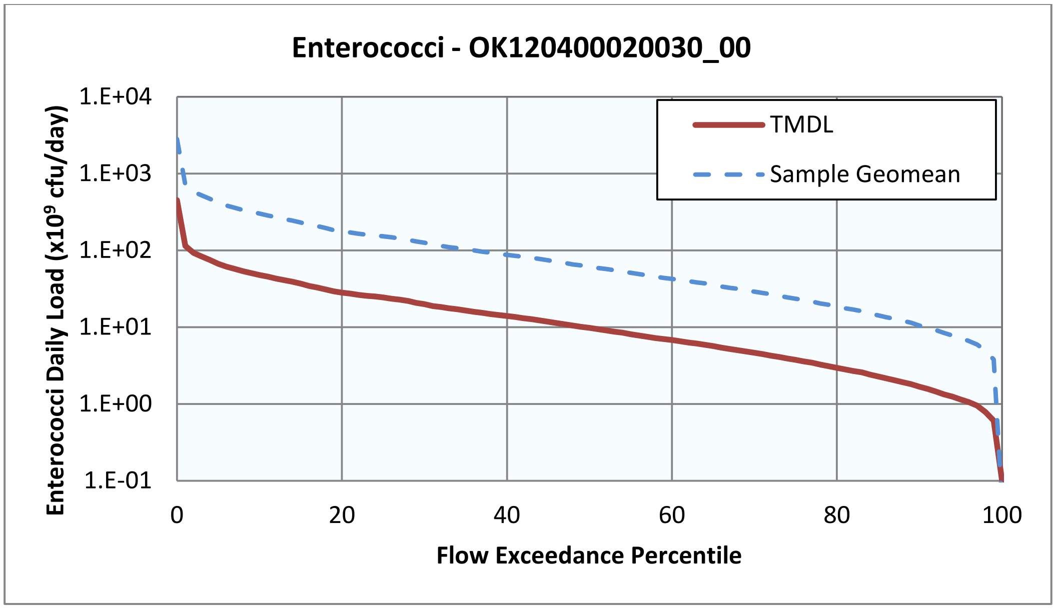
The LDC (Figure 5-34) for Dirty Creek (OK120400020010_00) are based on Enterococci bacterial measurements collected during primary contact recreation season at WQM station OK120400-02-0010F.

Figure 5-34 Load Duration Curve for Enterococci in Dirty Creek (OK120400020010_00)



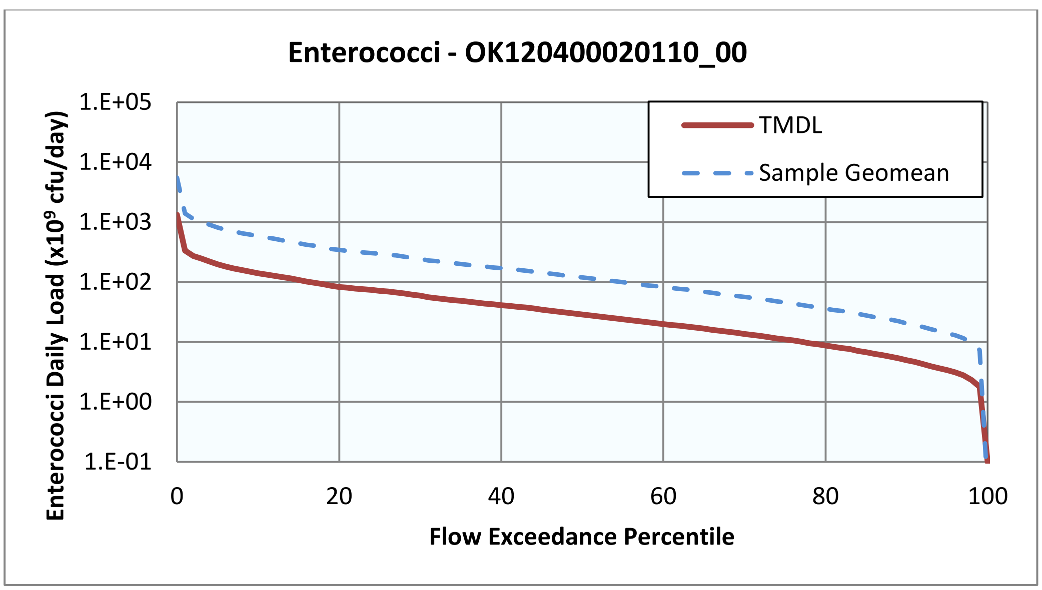
The LDC (Figure 5-35) for South Fork of Dirty Creek (OK120400020030_00) are based on Enterococci bacterial measurements collected during primary contact recreation season at WQM station OK120400-02-0030F.

Figure 5-35 Load Duration Curve for Enterococci in Dirty Creek, South Fork (OK120400020030_00)



The LDC (Figure 5-36) for George's Fork of Dirty Creek (OK120400020110_00) are based on Enterococci bacterial measurements collected during primary contact recreation season at WQM station OK120400-02-0110D.

Figure 5-36 Load Duration Curve for Enterococci in Dirty Creek, George's Fork (OK120400020110_00)



The LDCs (Figure 5-37 and 5-38) for Butler Creek (OK120400020160_00) are based on E.coli and Enterococci bacterial measurements collected during primary contact recreation season at WQM station OK120400-02-0160D.

Figure 5-37 Load Duration Curve for E.coli in Butler Creek (OK120400020160_00)

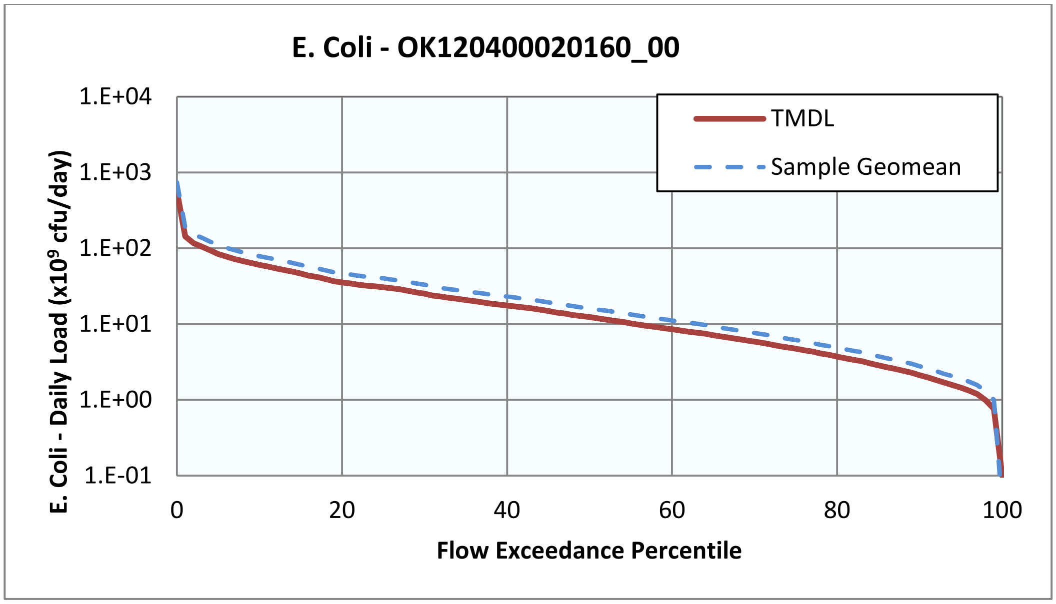
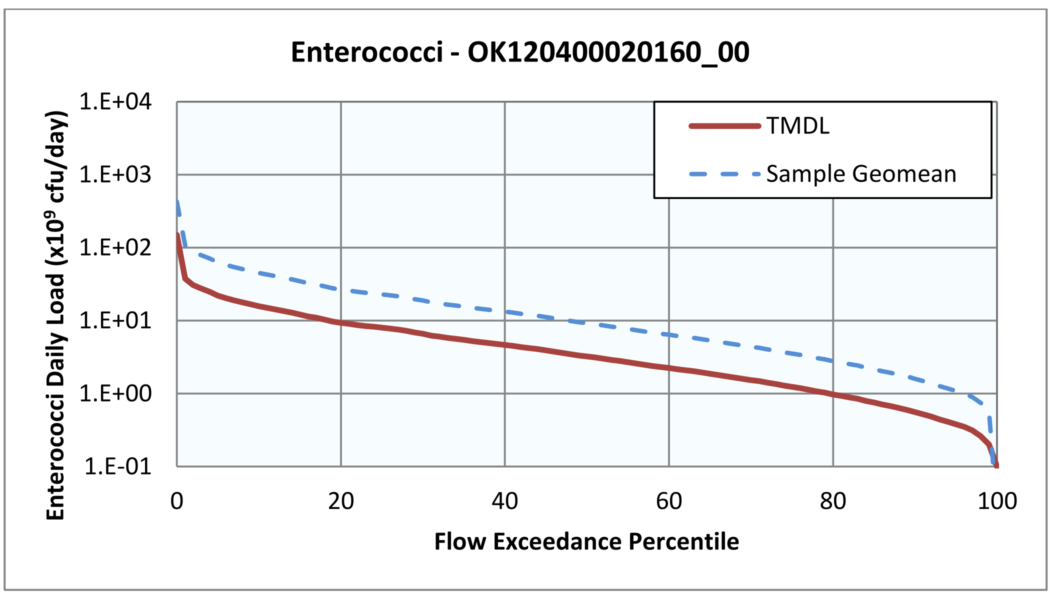
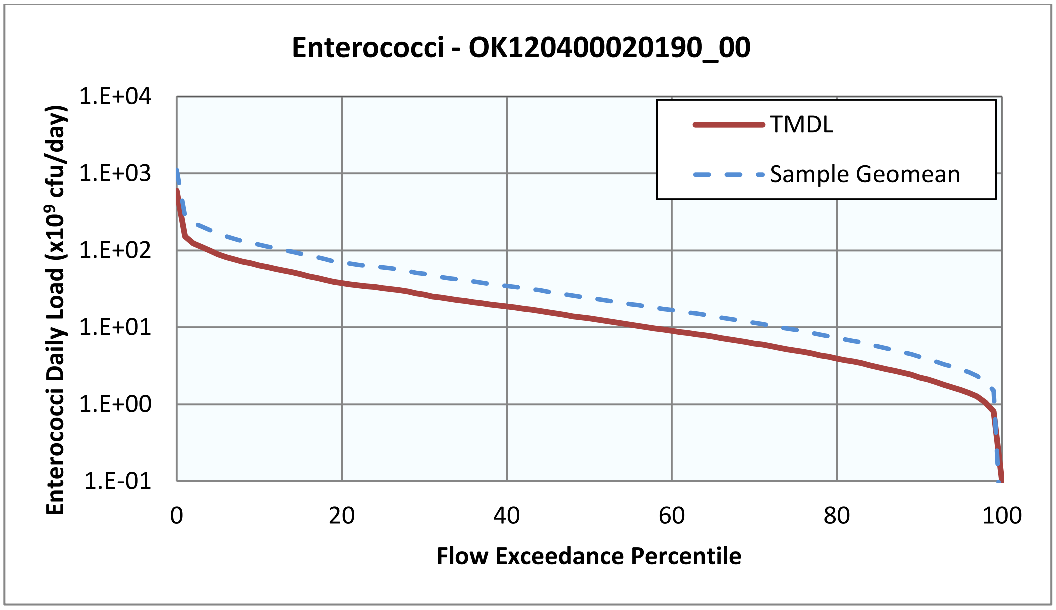


Figure 5-38 Load Duration Curve for Enterococci in Butler Creek (OK120400020160_00)



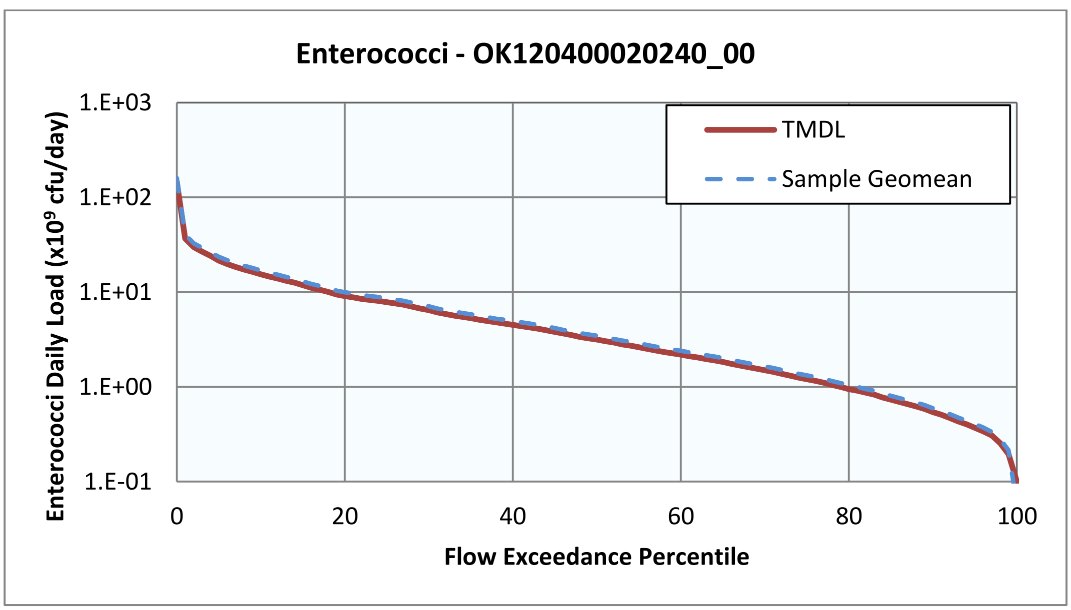
The LDC (Figure 5-39) for Elk Creek (OK120400020190_00) are based on Enterococci bacterial measurements collected during primary contact recreation season at WQM station OK120400-02-0190D.

Figure 5-39 Load Duration Curve for Enterococci in Elk Creek (OK120400020190_00)



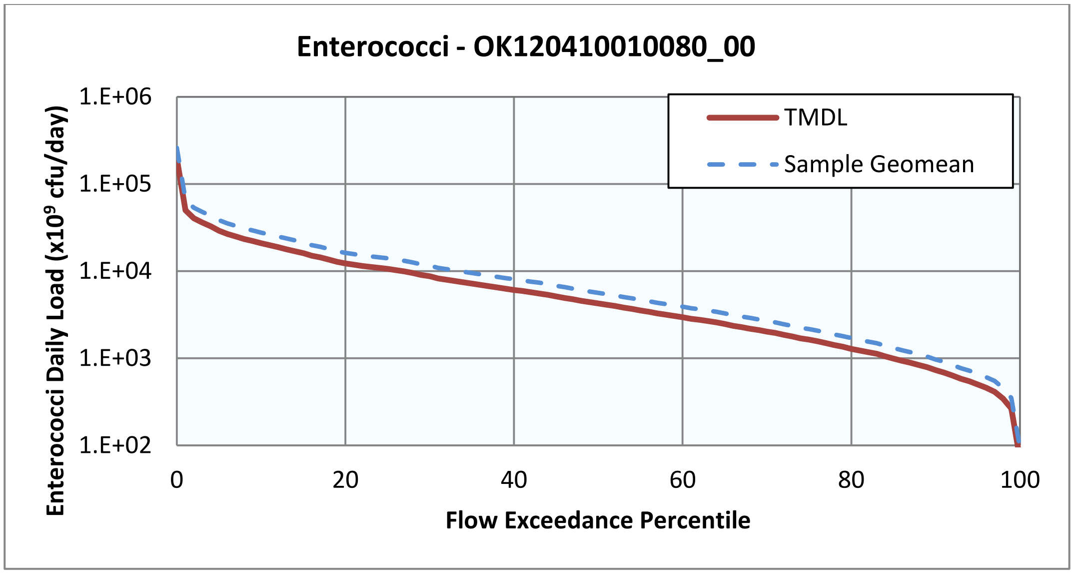
The LDC (Figure 5-40) for Shady Grove Creek (OK120400020240_00) are based on Enterococci bacterial measurements collected during primary contact recreation season at WQM station OK120400-02-0240H.

Figure 5-40 Load Duration Curve for Enterococci in Shady Grove Creek (OK120400020240_00)



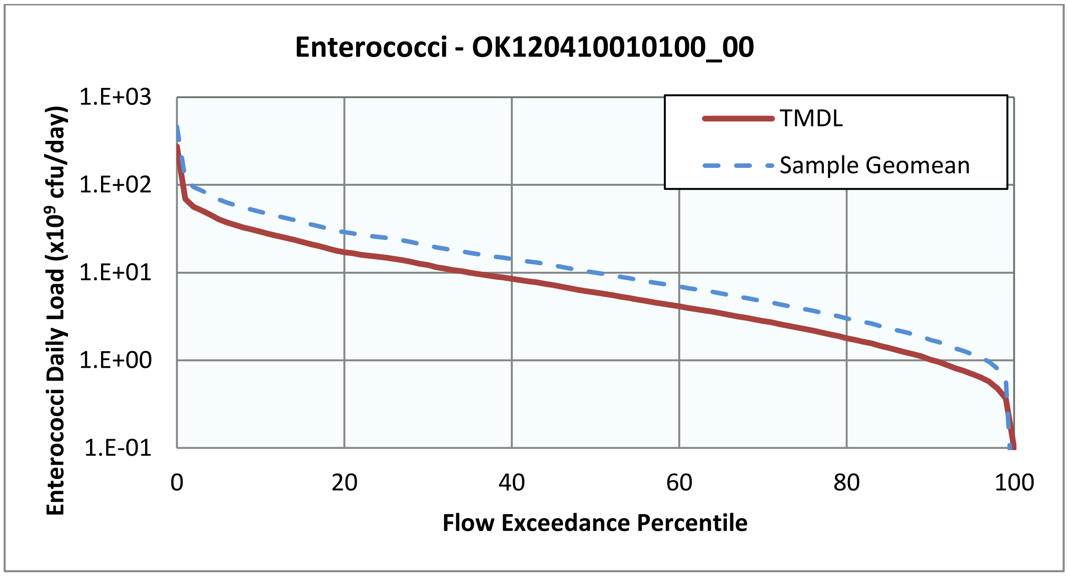
The LDC (Figure 5-41) for Arkansas River near Haskell (OK120410010080_00) are based on Enterococci bacterial measurements collected during primary contact recreation season at WQM station 120410010080-001AT.

Figure 5-41 Load Duration Curve for Enterococci in Arkansas River near Haskell (OK120410010080_00)



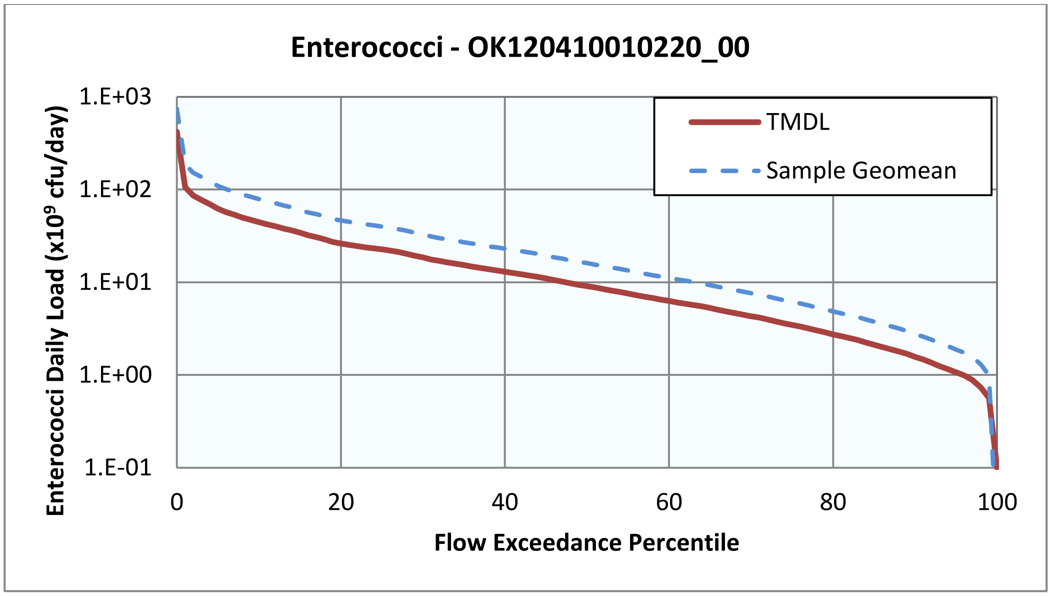
The LDC (Figure 5-42) for Cloud Creek (OK120410010100_00) are based on Enterococci bacterial measurements collected during primary contact recreation season at WQM station OK120410-01-0100T.

Figure 5-42 Load Duration Curve for Enterococci in Cloud Creek (OK120410010100_00)



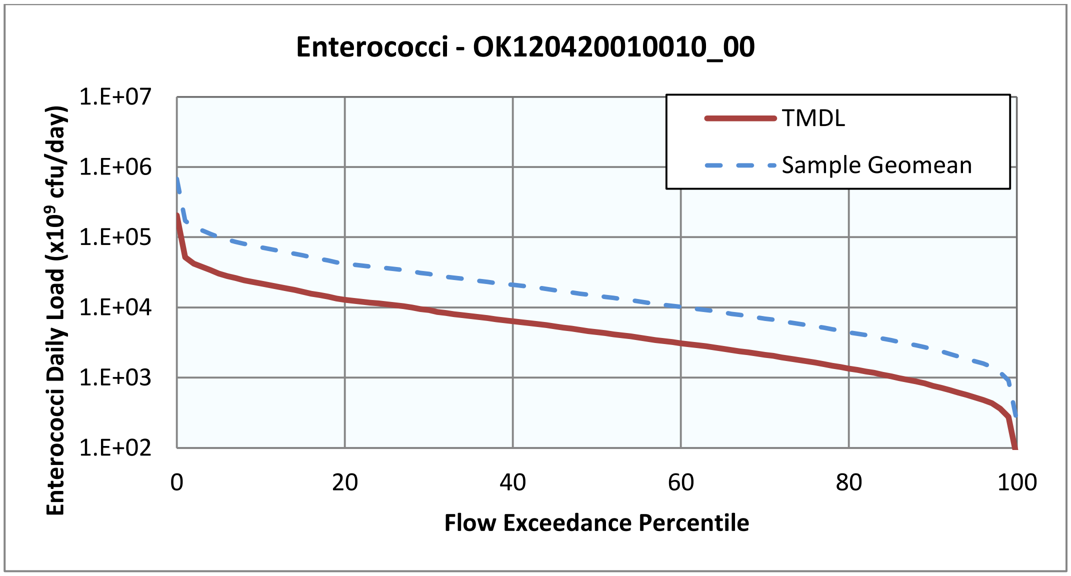
The LDC (Figure 5-43) for Snake Creek (OK120410010220_00) are based on Enterococci bacterial measurements collected during primary contact recreation season at WQM station OK120410-01-0220G.

Figure 5-43 Load Duration Curve for Enterococci in Snake Creek (OK120410010220_00)



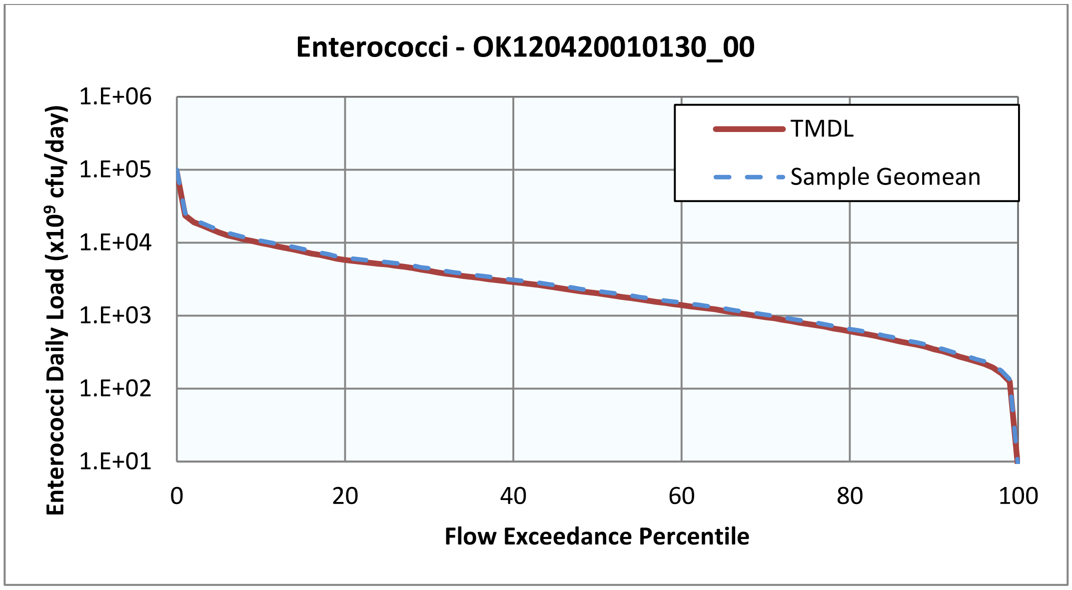
The LDC (Figure 5-44) for Arkansas River near Bixby (OK120420010010_00) are based on Enterococci bacterial measurements collected during primary contact recreation season at WQM station 120420010010-001AT.

Figure 5-44 Load Duration Curve for Enterococci in Arkansas River near Bixby (OK120420010010_00)



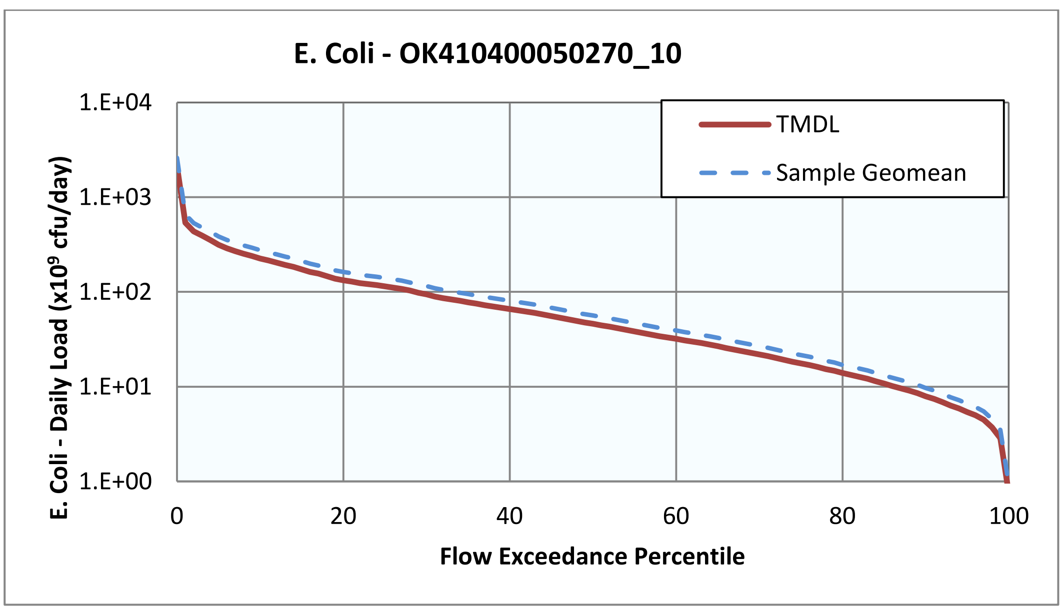
The LDC (Figure 5-45) for Arkansas River near Sand Springs (OK120420010130_00) are based on Enterococci bacterial measurements collected during primary contact recreation season at WQM station 120420010130-001AT.

Figure 5-45 Load Duration Curve for Enterococci in Arkansas River near Sand Springs (OK120420010130_00)



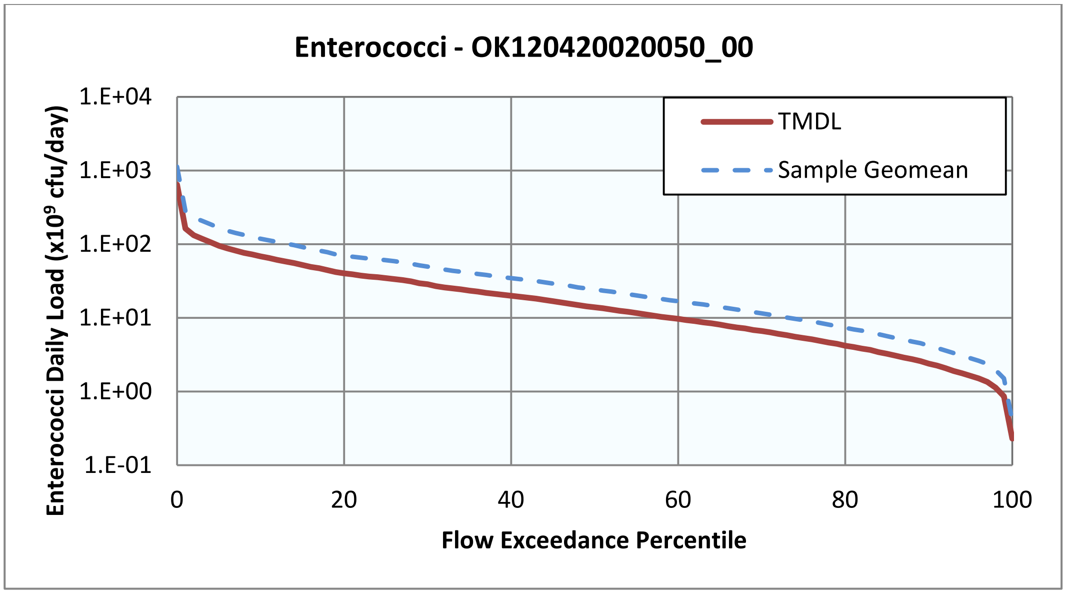
The LDC (Figure 5-46) for Polecat Creek (OK120420020010_00) are based on E.coli bacterial measurements collected during primary contact recreation season at WQM station OK120420-02-0010D.

Figure 5-46 Load Duration Curve for E.coli in Polecat Creek (OK120420020010_00)



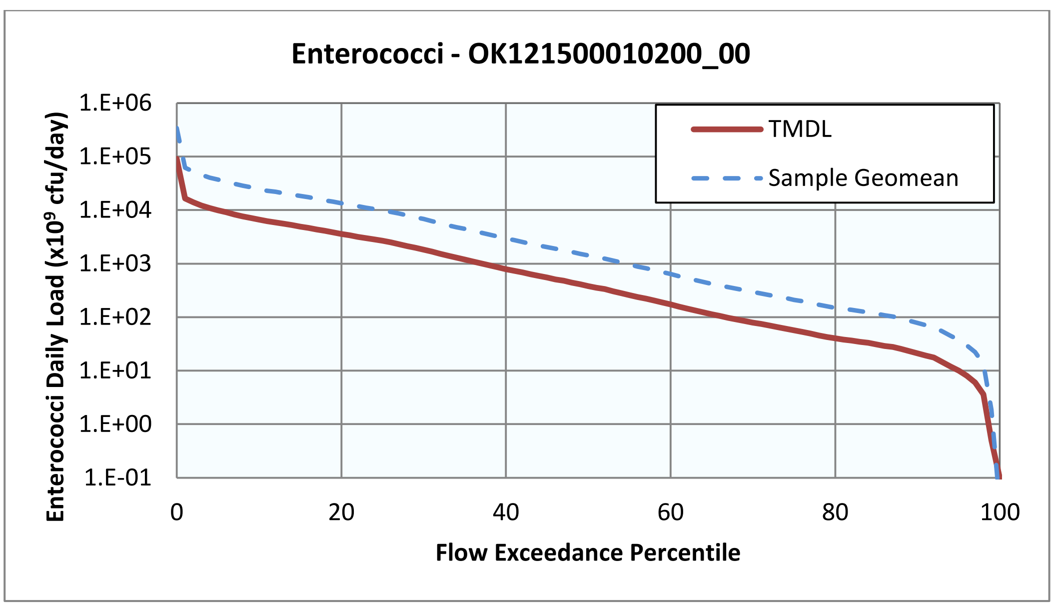
The LDC (Figure 5-47) for Polecat Creek (OK120420020050_00) are based on Enterococci bacterial measurements collected during primary contact recreation season at WQM station OK120420-02-0050G.

Figure 5-47 Load Duration Curve for Enterococci in Polecat Creek (OK120420020050_00)



The LDC (Figure 5-48) for Verdigris River near Wagoner (OK121500010200_00) are based on Enterococci bacterial measurements collected during primary contact recreation season at WQM station 121500010200-001AT.

Figure 5-48 Load Duration Curve for Enterococci in Verdigris River near Wagoner (OK121500010200_00)



The LDC (Figure 5-49 and 5-50) for Bull Creek (OK121500020090_00) are based on E.coli and Enterococci bacterial measurements collected during primary contact recreation season at WQM stations OK121500-02-0090K and OK121500-02-0090D.

Figure 5-49 Load Duration Curve for E.coli in Bull Creek (OK121500020090_00)

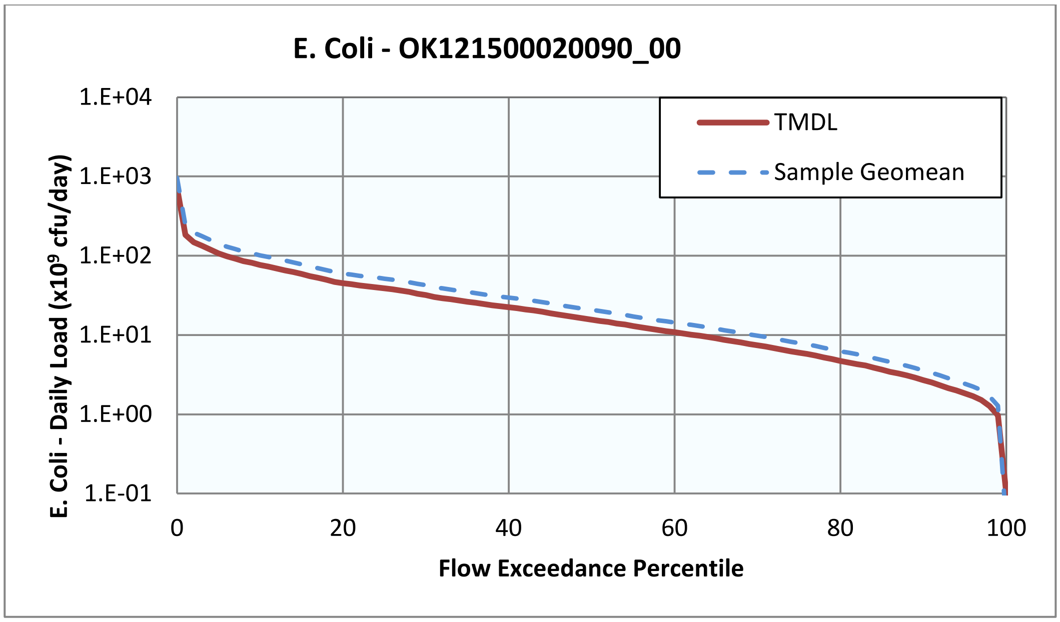
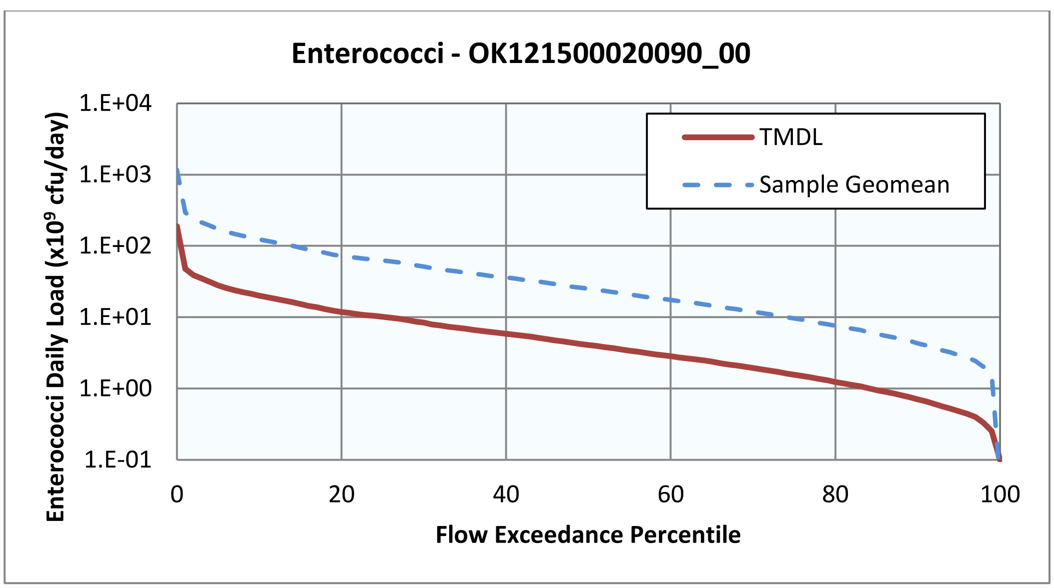


Figure 5-50 Load Duration Curve for Enterococci in Bull Creek (OK121500020090_00)



The LDCs (Figure 5-51 and 5-52) for Pea Creek (OK121500020100_00) are based on E.coli and Enterococci bacterial measurements collected during primary contact recreation season at WQM station OK121500020100-001AT.

Figure 5-51 Load Duration Curve for E.coli in Pea Creek (OK121500020100_00)

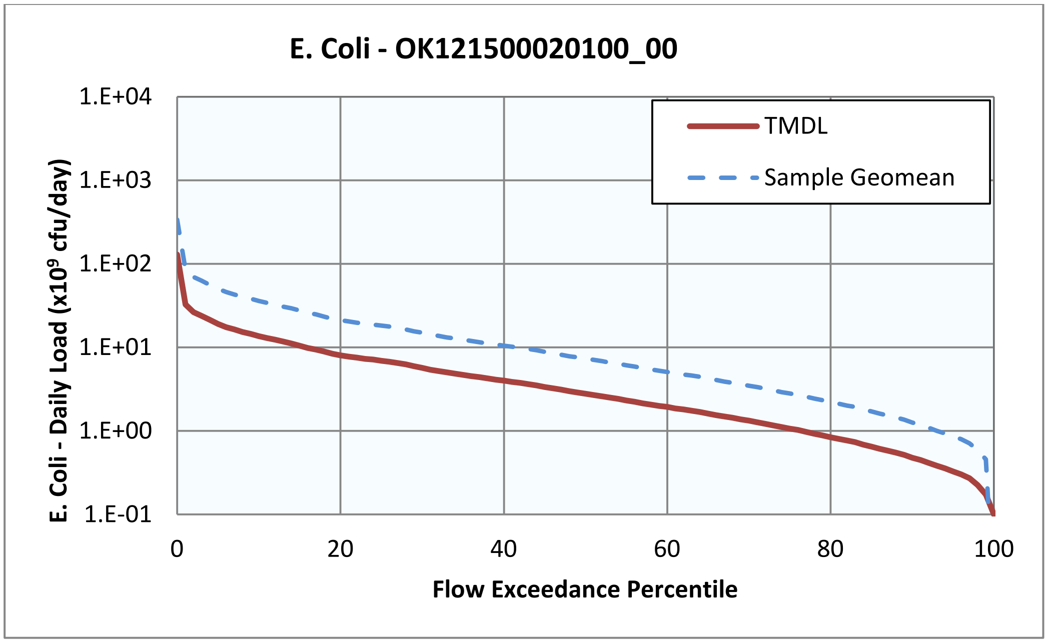
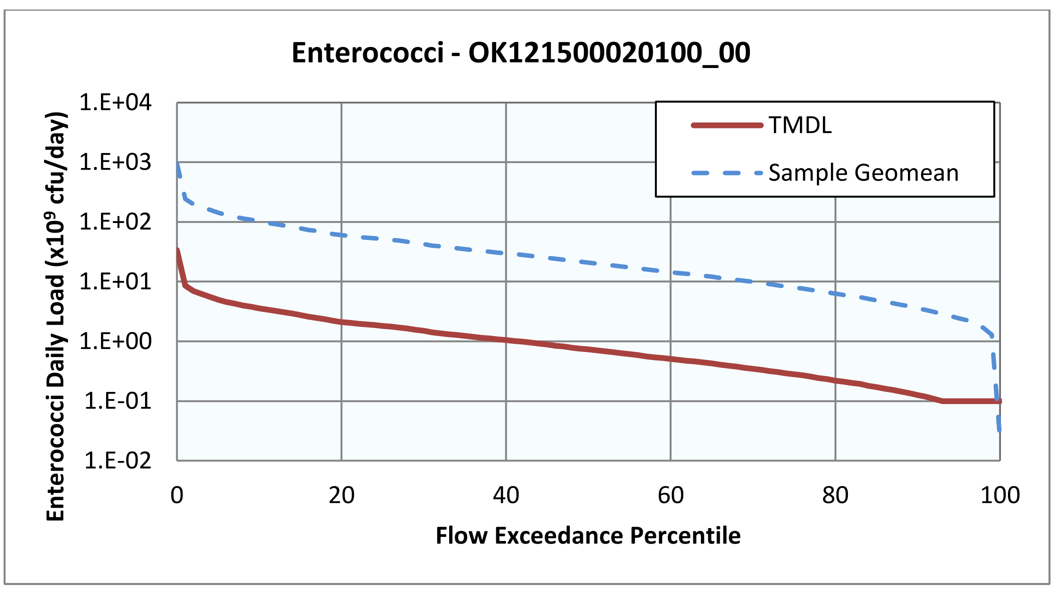
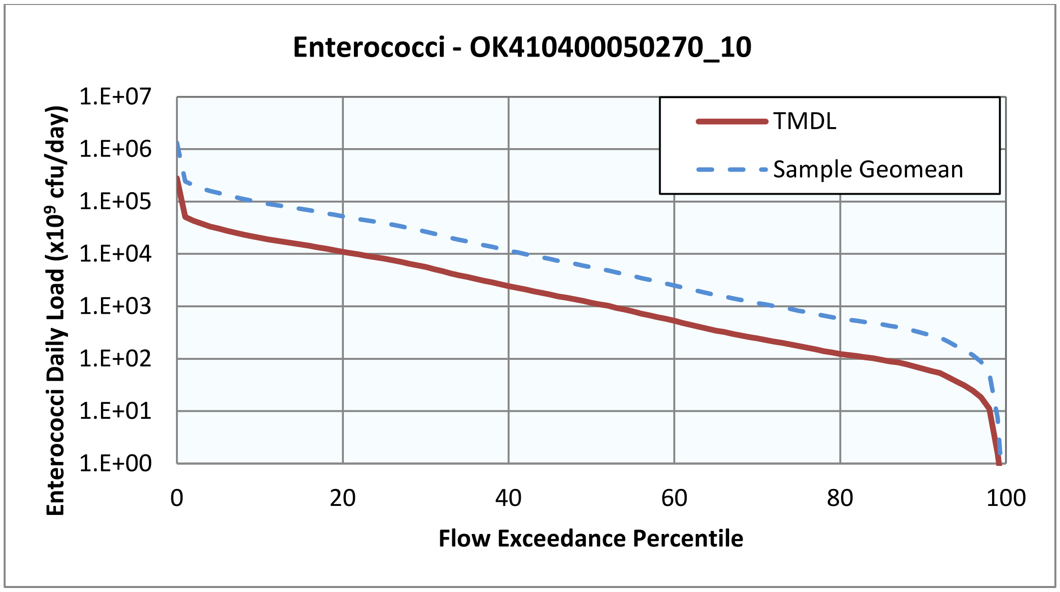


Figure 5-52 Load Duration Curve for Enterococci in Pea Creek (OK121500020100_00)



The LDC (Figure 5-53) for Verdigris River near Inola (OK121500020260_00) are based on Enterococci bacterial measurements collected during primary contact recreation season at WQM station 121500020260-001AT.

Figure 5-53 Load Duration Curve for Enterococci in Verdigris River near Inola (OK121500020260_00)



The LDCs (Figure 5-54 and 5-55) for Dog Creek (OK121500020360_00) are based on E.coli and Enterococci bacterial measurements collected during primary contact recreation season at WQM stations OK121500-02-0360D, OK121500-02-0360F and OK121500-02-0360H.

Figure 5-54 Load Duration Curve for E.coli in Dog Creek (OK121500020360_00)

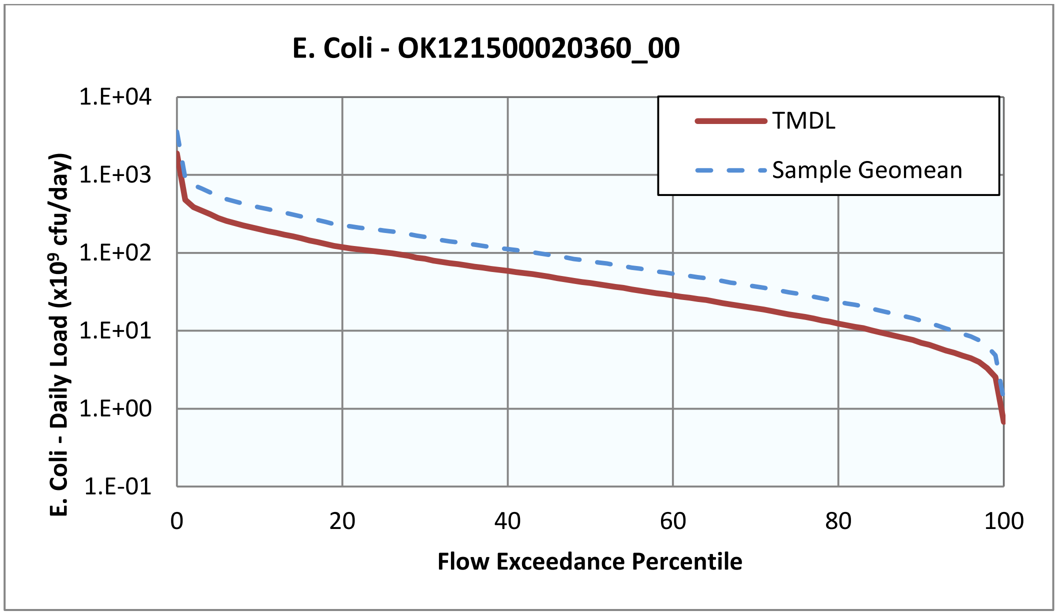
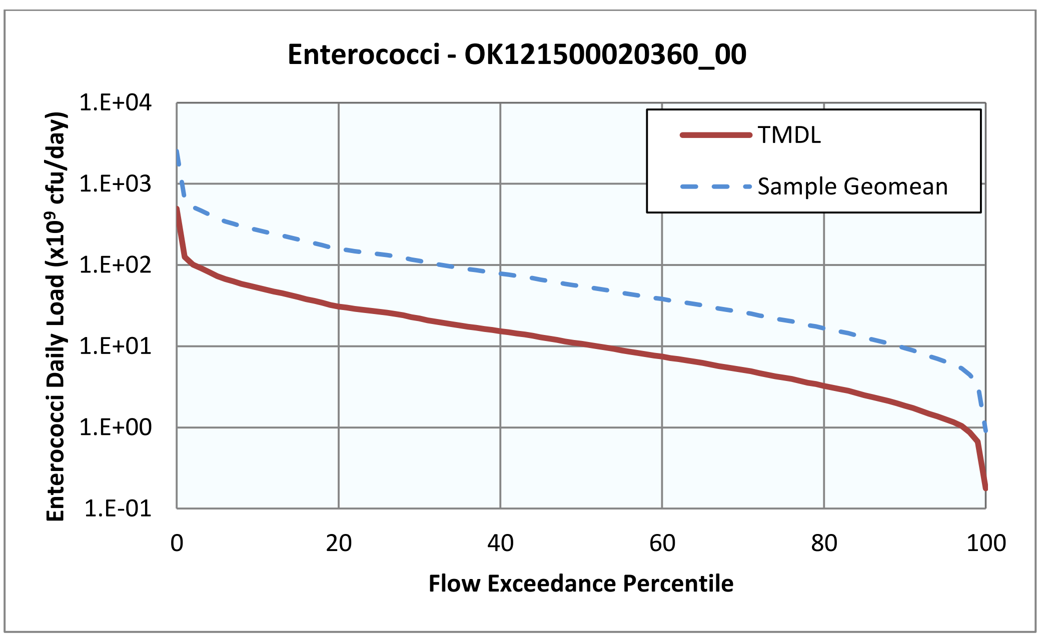
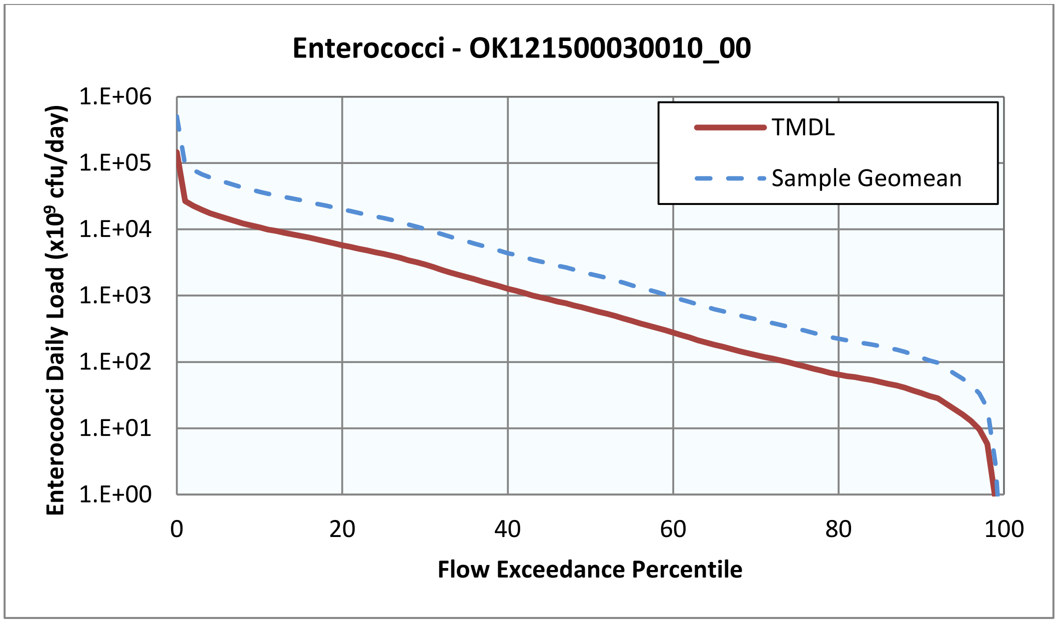


Figure 5-55 Load Duration Curve for Enterococci in Dog Creek (OK121500020360_00)



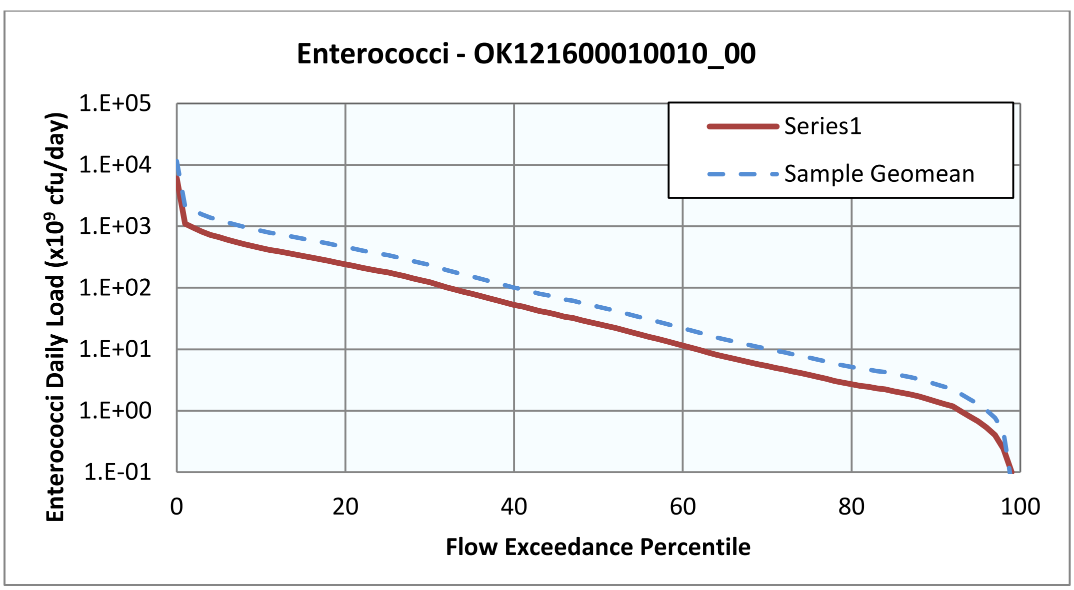
The LDC (Figure 5-56) for Verdigris River near Claremore (OK121500030010_00) are based on Enterococci bacterial measurements collected during primary contact recreation season at WQM station 121500030010-001AT.

Figure 5-56 Load Duration Curve for Enterococci in Verdigris River near Claremore (OK121500030010_00)



The LDC (Figure 5-57) for Neosho River near Fort Gibson (OK121600010010_00) are based on Enterococci bacterial measurements collected during primary contact recreation season at WQM station 121600010010-001SR.

Figure 5-57 Load Duration Curve for Enterococci in Neosho River near Fort Gibson (OK121600010010_00)



The LDCs (Figure 5-58 and 5-59) for Chouteau Creek (OK121600010430_00) are based on E. coli and Enterococci bacterial measurements collected during primary contact recreation season at WQM station OK121600-01-0430M.

Figure 5-58 Load Duration Curve for E.coli in Chouteau Creek (OK121600010430_00)

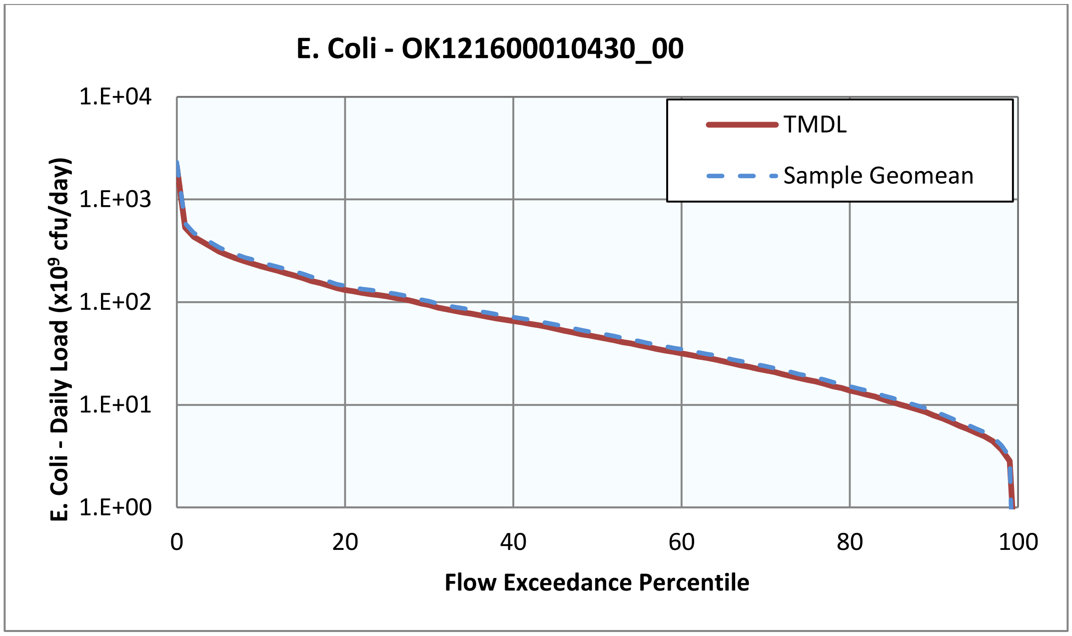
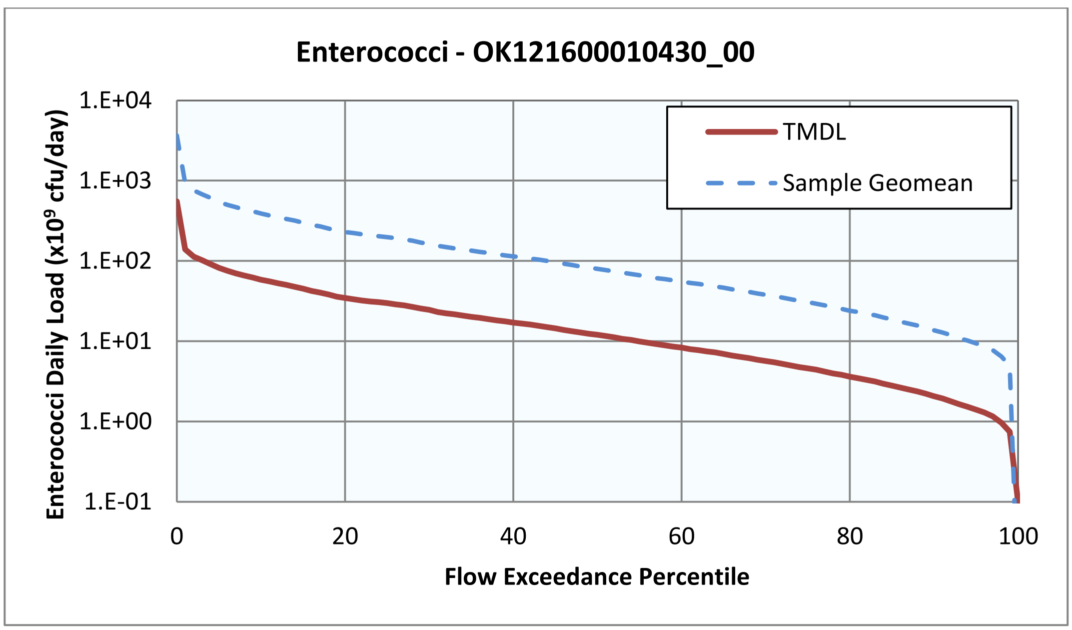


Figure 5-59 Load Duration Curve for Enterococci in Chouteau Creek (OK121600010430_00)



5.3.2 TSS LDC

To calculate the TSS load at the WQ target, the flow rate at each flow exceedance percentile is multiplied by a unit conversion factor (*5.39377 L*s*lb /ft*^{3}*/day/mg*) and the TSS goal for each waterbody. This calculation produces the maximum TSS load in the waterbody that will result in attainment of the 50 NTU target for turbidity. The allowable TSS loads at the WQS establish the TMDL and are plotted versus flow exceedance percentile as a LDC. The x-axis indicates the flow exceedance percentile, while the y-axis is expressed in terms of a TSS load in pounds per day.

To estimate existing loading, TSS and turbidity observations from 1998 to 2011 are paired with the flows measured or projected on the same date for the waterbody. For sampling events with both TSS and turbidity data, the measured TSS value is used. Pollutant loads are then calculated by multiplying the TSS concentration by the flow rate and the unit conversion factor. The associated flow exceedance percentile is then matched with the flow from the tables provided in Appendix B. The observed TSS or converted turbidity loads are then added to the LDC plot as points. These points represent individual ambient water quality samples of TSS. Points above the LDC indicate the TSS goal was exceeded at the time of sampling. Conversely, points under the LDC indicate the sample did not exceed the TSS goal. For sampling events with only turbidity data, the turbidity data were converted to TSS with the corresponding regression relation developed in Section 5.1.

Figures 5-60 through Figure 5-66 show the TSS LDCs developed for the seven turbidity impaired waterbodies addressed in this TMDL report. Data in the figures indicate that TSS levels exceed the water quality target during all flow conditions, indicating water quality impairments due to nonpoint sources or a combination of point and nonpoint sources. Wet weather influenced samples found during low flow conditions can be caused by an isolated rainfall event during dry weather conditions. It is noted that the LDC plots include data under all flow conditions to show the overall condition of the waterbody. However, the turbidity standard only applies for base-flow conditions. Thus, when interpreting the LDC to derive TMDLs for TSS, only the portion of the graph corresponding to flows above the 25th flow exceedance percentile should be used. WLAs for point sources discharges (continuous) of inorganic TSS are shown on a LDC as a horizontal line which represents the sum of all WLAs for TSS in a given watershed.

Figure 5-60 Load Duration Curve for Total Suspended Solids in Dirty Creek (OK120400020010_00)

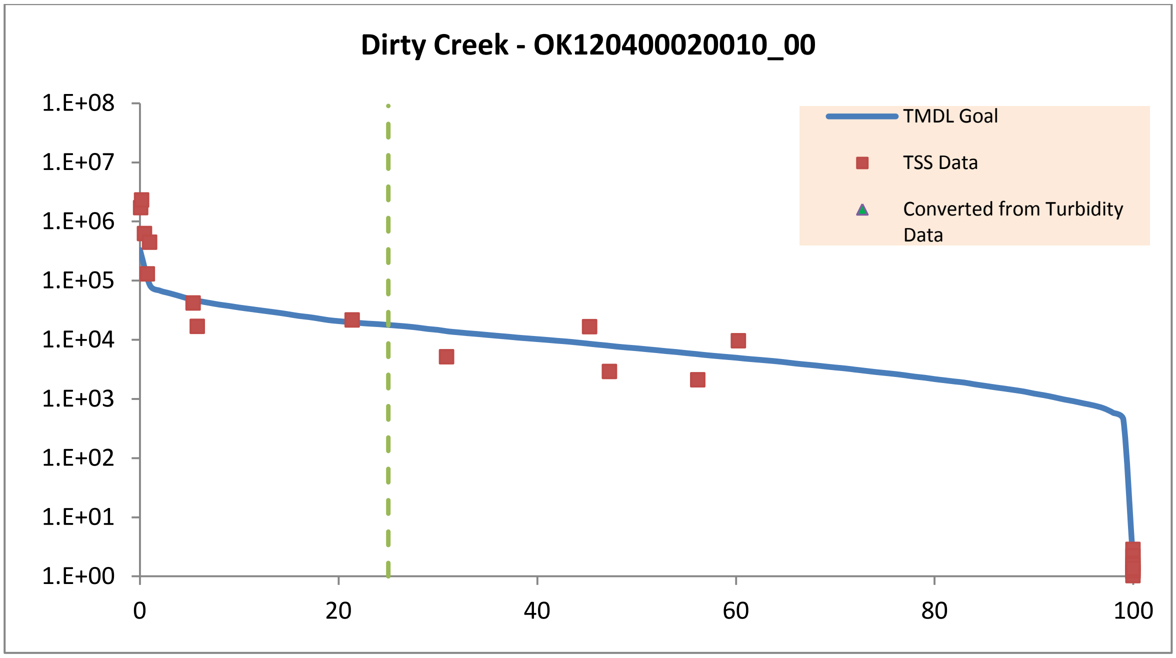


Figure 5-61 Load Duration Curve for Total Suspended Solids in Butler Creek (OK120400020160_00)

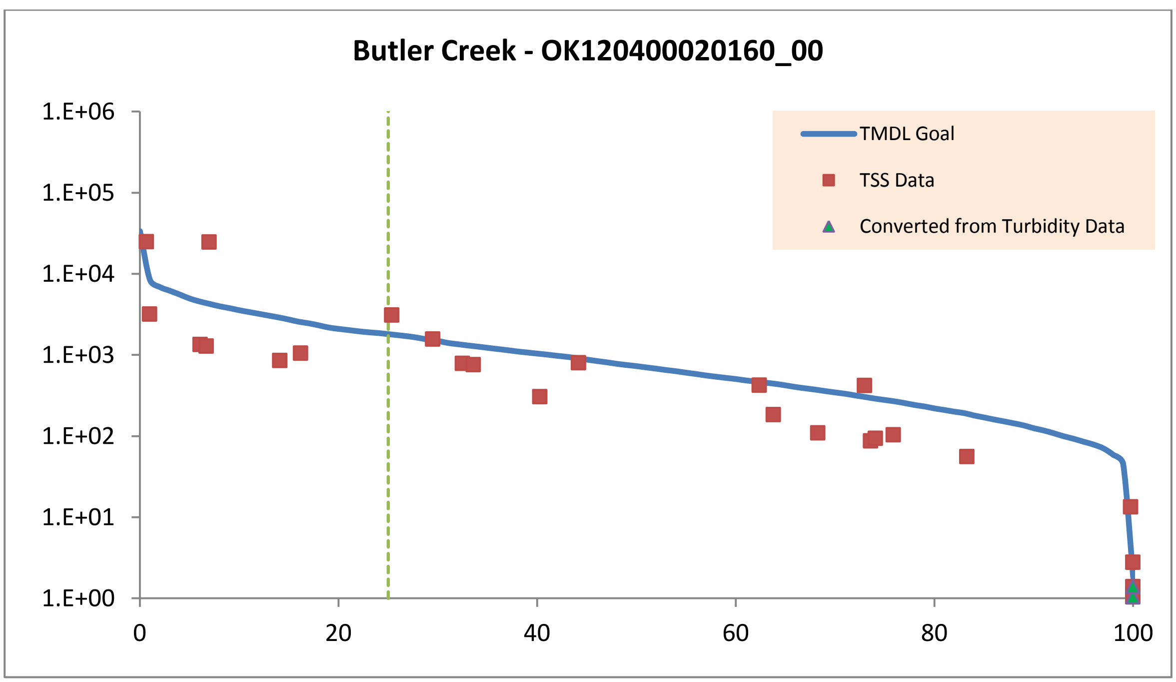


Figure 5-62 Load Duration Curve for Total Suspended Solids in Cloud Creek (OK120410010100_00)

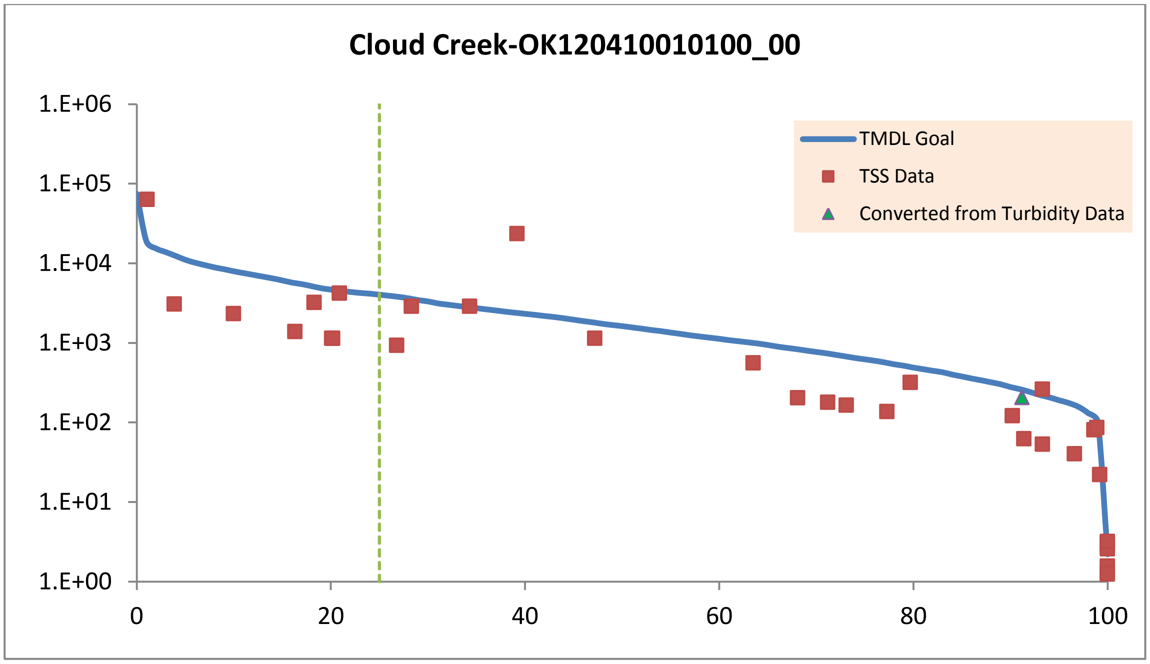


Figure 5-63 Load Duration Curve for Total Suspended Solids in Snake Creek (OK120410010220_00)

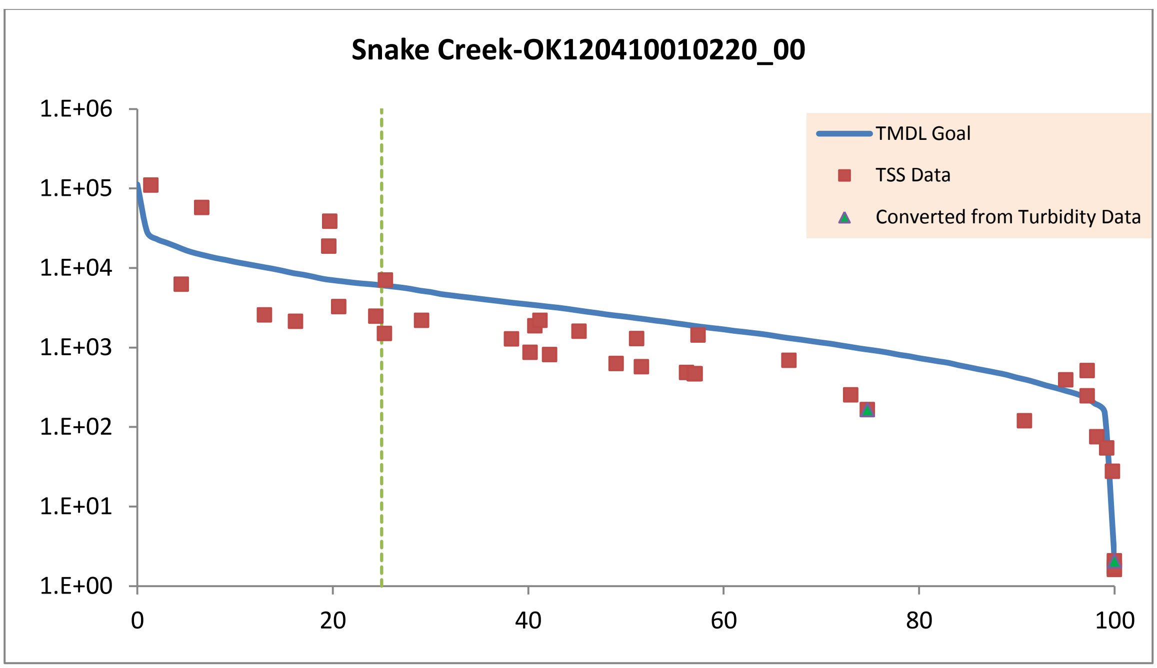


Figure 5-64 Load Duration Curve for Total Suspended Solids in Verdigris River near Wagoner (OK121500010200_00)

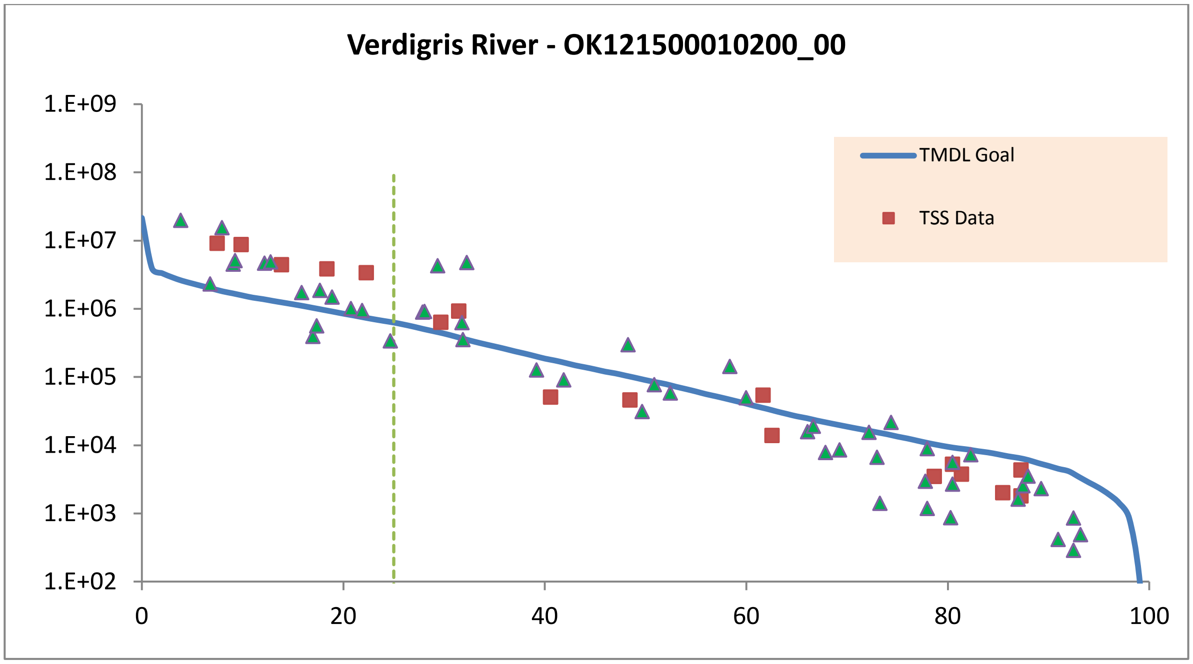


Figure 5-65 Load Duration Curve for Total Suspended Solids in Bull Creek (OK121500020090_00)

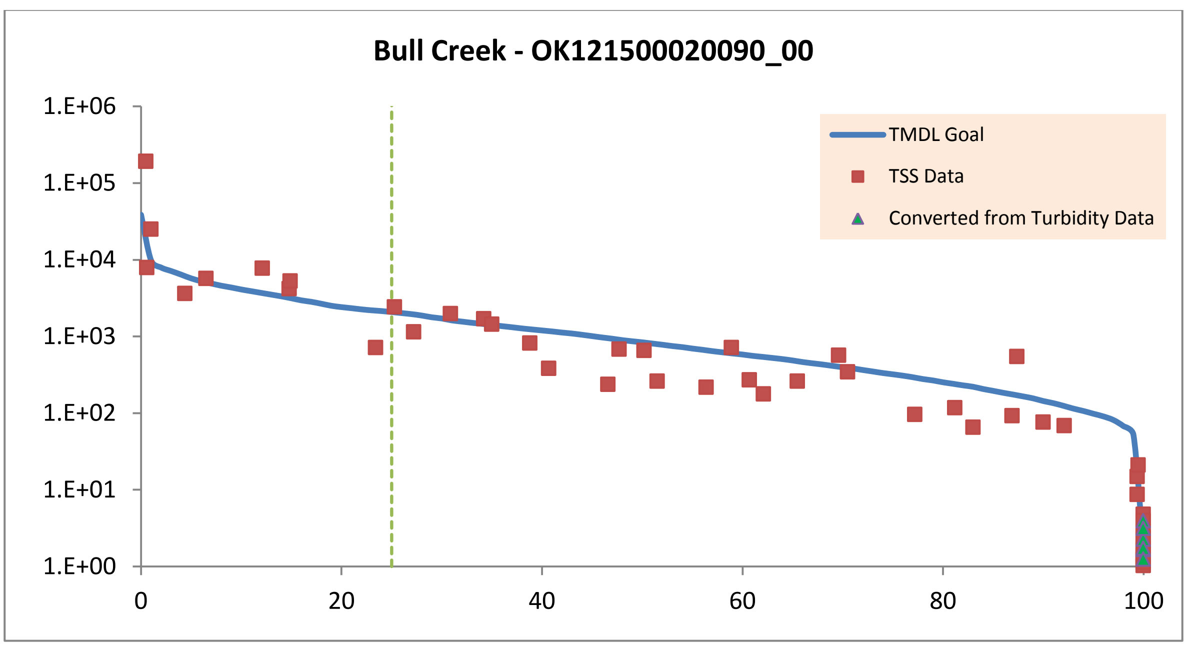
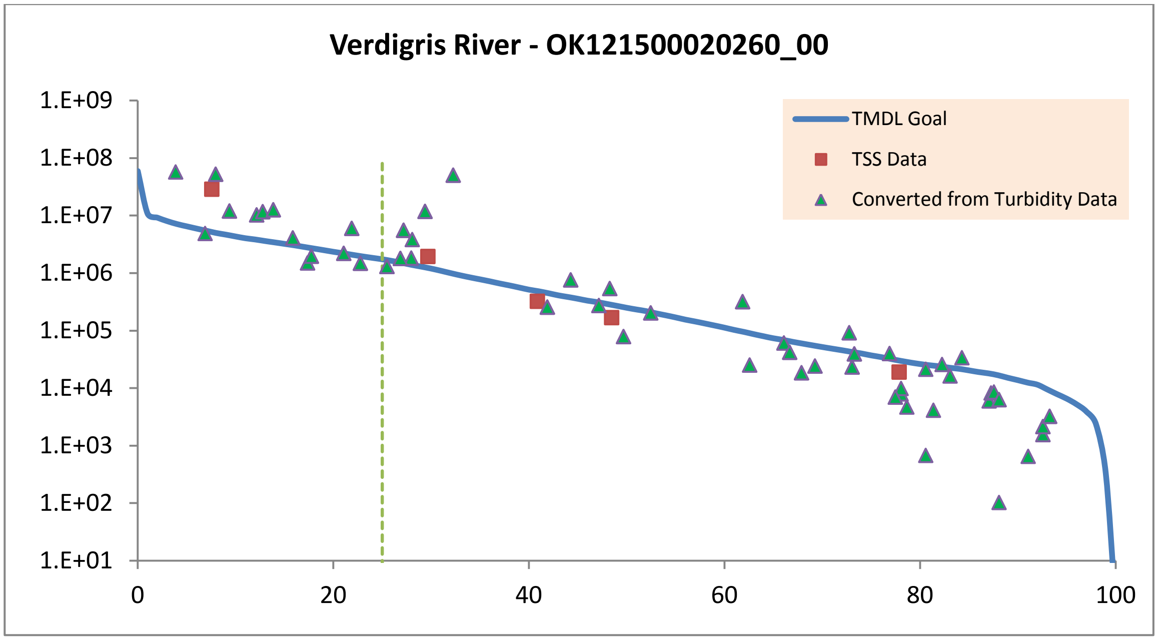


Figure 5-66 Load Duration Curve for Total Suspended Solids in Verdigris River near Inola (OK121500020260_00)



5.3.3 Establishing Percent Reduction Goals

The LDC approach recognizes that the assimilative capacity of a waterbody depends on the flow, and that maximum allowable loading varies with flow condition. Existing loading and load reductions required to meet the TMDL can also be calculated under different flow conditions. The difference between existing loading and the TMDL is used to calculate the loading reductions required. Percent reduction goals are calculated through an iterative process of taking a series of percent reduction values applying each value uniformly to the concentrations of samples and verifying if the geometric mean of the reduced values of all samples is less than the geomean standards. Table 5-2 presents the percent reductions necessary to meet the TMDL water quality target for each bacterial indicator in each of the impaired waterbodies in the Study Area. The PRGs range from 7% to 97%.

Table 5-2 TMDL Percent Reductions Required to Meet Water Quality Standards for Indicator Bacteria

Waterbody Name	Waterbody ID	Geomean		Reduction Rate	
		EC	ENT	EC	ENT
Arkansas River near Muskogee	OK120400010260_00	-	83.3	-	60.4%
Coody Creek	OK120400010400_00	152.3	219.5	17.3%	85.0%
Dirty Creek	OK120400020010_00	-	54.6	-	39.5%
Dirty Creek, South Fork	OK120400020030_00	-	207.0	-	84.1%
Dirty Creek, Georges Fork	OK120400020110_00	-	136.4	-	75.8%
Butler Creek	OK120400020160_00	164.7	94.3	23.5%	65.0%
Elk Creek	OK120400020190_00	-	61.1	-	46.0%
Shady Grove Creek	OK120400020240_00	-	36.2	-	8.8%

Waterbody Name	Waterbody ID	Geomean		Reduction Rate	
		EC	ENT	EC	ENT
Arkansas River near Haskell	OK120410010080_00	-	43.7	-	24.5%
Cloud Creek	OK120410010100_00	-	55.5	-	40.6%
Snake Creek	OK120410010220_00	-	58.4	-	43.5%
Arkansas River, US 64, Bixby	OK120420010010_00	-	108.4	-	69.5%
Arkansas River near Sand Springs	OK120420010130_00	-	35.5	-	7.2%
Polecat Creek	OK120420020010_00	154.0	-	18.2%	
Polecat Creek	OK120420020050_00	-	57.5	-	42.7%
Verdigris River, US 51, Wagoner	OK121500010200_00	-	122.8	-	73.1%
Bull Creek	OK121500020090_00	166.8	202.6	24.5%	83.7%
Pea Creek	OK121500020100_00	331.4	939.8	62.0%	96.5%
Verdigris River near Inola	OK121500020260_00	-	156.8	-	79.0%
Dog Creek	OK121500020360_00	240.4	169.0	47.6%	80.5%
Verdigris River near Claremore	OK121500030010_00	-	114.0	-	71.0%
Neosho River below Ft. Gibson Lake	OK121600010010_00	-	63.0	-	47.6%
Chouteau Creek	OK121600010430_00	137.9	219.8	8.6%	85.0%

Similarly, percent reduction goals for TSS are calculated as the required overall reduction so that no more than 10% of the samples exceed the water quality target for TSS. The PRGs for the three waterbodies included in this TMDL report are summarized in Table 5-3 and range from 5% to 64%.

Table 5-3 TMDL Percent Reductions Required to Meet Water Quality Targets for Total Suspended Solids

Waterbody ID	Waterbody Name	Required Reduction Rate
OK120400020010_00	Dirty Creek	19%
OK120400020160_00	Butler creek	5%
OK120410010100_00	Cloud Creek	36%
OK120410010220_00	Snake Creek	27%
OK121500010200_00	Verdigris River near Wagoner	64%
OK121500020090_00	Bull Creek	21%
OK121500020260_00	Verdigris River near Inola	63%

5.4 Wasteload Allocation

5.4.1 Indicator Bacteria

For bacterial TMDLs, NPDES-permitted facilities are allocated a daily wasteload calculated as their permitted flow rate multiplied by the instream geometric mean water quality criterion. In other words, the facilities are required to meet instream criteria in their discharge. Table 5-4 summarizes the WLA for the NPDES-permitted facilities within the Study Area. The WLA for each facility discharging to a bacterially-impaired reach is derived from the following equation:

WLA = WQS * flow * unit conversion factor (cfu/day)

Where:

WQS = 33, and 126 cfu/100 mL for Enterococci and E. coli respectively

flow (mgd) = permitted flow

unit conversion factor = 37,854,120-

When multiple NPDES facilities occur within a watershed, individual WLAs are summed and the total WLA for continuous point sources is included in the TMDL calculation for the corresponding waterbody. When there are no NPDES WWTPs discharging into the contributing watershed of a stream segment, then the WLA is zero. Compliance with the WLA will be achieved by adhering to the fecal coliform or *E. coli* limits and disinfection requirements of NPDES permits. Currently, facilities that discharge treated wastewater are currently required to monitor for fecal coliform. These discharges or any other discharges with bacterial WLA will be required to monitor for *E. coli* as their permits are renewed.

Table 5-4 indicates which point source dischargers within the Study Area currently have a disinfection requirement in their permit. Certain facilities that utilize lagoons for treatment have not been required to provide disinfection since storage time and exposure to ultraviolet radiation from sunlight should reduce bacterial levels. In the future, all point source dischargers which are assigned a wasteload allocation but do not currently have a bacterial limit in their permit will receive a permit limit consistent with the wasteload allocation as their permits are reissued. Regardless of the magnitude of the WLA calculated in these TMDLs, future new discharges of bacteria or increased bacterial load from existing discharges will be considered consistent with the TMDL provided that the NPDES permit requires instream criteria to be met.

Table 5-4 Permit Information for NPDES-Permitted Facilities

Waterbody ID	Facility Name	NPDES Permit No.	Dis-infection	Design Flow (MGD)	WLA (cfu/day)	
					E.coli	Ent
OK120400010260_00	Muskogee Utilities Authority	OK0029131	Yes	13.74	-	1.72E+10
OK120400020010_00	Town of Webbers Falls	OK0034631	No	0.045	-	5.62E+07
OK120400020030_00	Porum PWA	OK0021636	No	0.080	-	1.00E+08
OK120400020110_00	Connors State College	OK0033405	Yes	0.060	-	7.50E+07
OK120400020110_00	Warner Utilities Authority	OK0031003	No	0.280	-	3.50E+08
OK120400020190_00	Checotah PWA	OK0028100	No	1.940	-	2.42E+09
OK120410010080_00	City of Broken Arrow	OK0040053	Yes	8.000	-	1.00E+10
OK120410010080_00	Coweta Public Works Authority	OK0020281	Yes	3.000	-	3.75E+09
OK120410010080_00	Haskell Public Works Authority	OK0032271	No	0.390	-	4.87E+08
OK120420010010_00	Tulsa Metropolitan Utility Authority	OK0026239	Yes	42.00	-	5.25E+10
OK120420010010_00	Jenks Public Works Authority	OK0037401	No	2.000	-	2.50E+09
OK120420010010_00	Bixby PWA (South)	OK0026913	Yes	0.684	-	8.55E+08
OK120420010010_00	Glenpool Utility Services Authority	OK0027138	Yes	1.440	-	1.80E+09
OK120420010010_00	Mounds Public Works Authority	OK0022888	No	0.310	-	3.87E+08
OK120420010010_00	RMUA-Haikey Creek	OK0034363	Yes	16.00	-	2.00E+10
OK120420010010_00	Bixby PWA (North)	OK0036153	Yes	0.853	-	1.07E+09
OK120420010130_00	City of Sand Springs (Main)	OK0030864	Yes	5.500	-	6.87E+09
OK120420020050_00	City of Sapulpa (Northeast)	OK0043974	No	7.000	-	8.75E+09
OK121500020260_00	Rogers County Rural Sewer Dist	OK0038032	No	0.500	-	6.25E+08

Waterbody ID	Facility Name	NPDES Permit No.	Dis-infection	Design Flow (MGD)	WLA (cfu/day)	
					E.coli	Ent
OK121500020260_00	Trails End Mobile Home Park	OK0037494	No	0.020	-	2.50E+07
OK121500020260_00	City of Claremore	OK0027049	Yes	6.000	-	7.50E+09
OK121500030010_00	Lone Elm Mobile Home Park	OK0037664	No	0.035	-	4.37E+07
OK121600010430_00	Chouteau PWA	OK0022764	Yes	0.320	1.53E+09	4.00E+08

Permitted stormwater discharges are considered point sources; There are areas designated as MS4s within the watersheds of the waterbodies impaired for contact recreation, hence the WLA for MS4 has been calculated and summarized in Table 5-7b.

5.4.2 Total Suspended Solids

NPDES-permitted facilities discharging inorganic TSS are allocated a daily wasteload calculated by using the average of self-reported monthly flow multiplied by the water quality target. In other words, the facilities are required to meet instream criteria in their discharge. If the current monthly TSS limits of a facility are greater than instream TSS criteria, the new limits equal to instream criteria will be applied to the facility as their permit is renewed. The instream TSS criteria for each stream segment can be found in Table 5-1.The WLA for each facility is derived as follows:

WLA_WWTP = TSS limit * flow * unit conversion factor (lb/day)

Where:

WQ goal = Waterbody specific water quality goal provided in Table 5-1, or monthly TSS limit in the current permit, whichever is smaller

flow (mgd) = average monthly flow

unit conversion factor = 8.3445

There are two NPDES permitted facilities that discharge inorganic TSS in the Study Area. Table 5-4a summarizes the WLA of inorganic TSS for the NPDES permitted facilities within the Study Area.

No wasteload allocations are needed for stormwater dischargers in the Study Area. By definition, any stormwater discharge occurs during periods of rainfall and elevated flow conditions. Oklahoma's Water Quality Standards specify that the criteria for turbidity "apply only to seasonal base flow conditions" and go on to say "Elevated turbidity levels may be expected during, and for several days after, a runoff event" [OAC 785:45-5-12(f)(7)]. To accommodate the potential for future growth in those watersheds with no WLA for TSS, 1% of TSS loading is reserved as part of the WLA.

Table 5-4a TSS Wasteload Allocations for NPDES-Permitted Facilities

Waterbody ID	Facility Name	NPDES Permit No.	Design Flow (MGD)	WLA (mg/L)
OK120410010220_00	Holiday Sand and Gravel- Coweta	OK0043095	3.36	47
OK121500020260_00	Terra Nitrogen, L.P.- Verdigris	OK0029149	1.60	35

5.4.3 Section 404 permits

No TSS wasteload allocations were set aside for Section 404 Permits. The State will use its Section 401 Certification authority to ensure Section 404 Permits protect Oklahoma Water Quality Standards and comply with the turbidity TMDLs in this report. For any project requiring a Section 404 Permit that is located on a waterbody with a turbidity TMDL established in this report, the Section 401 Water Quality Certification will be conditioned to include one of the following two conditions:

- Include TSS limits consistent with this TMDL in the certification and establish a monitoring requirement to ensure compliance with the turbidity standards and TSS TMDLs.

or

- Submit to DEQ a BMP-based turbidity reduction plan which should include all practicable turbidity control techniques. The turbidity reduction plan must be approved by DEQ before a Section 401 Water Quality Certification will be issued. The certification will include a condition requiring compliance with the approved plan.

Compliance with the Section 401 Certification condition will be considered compliance with this TMDL.

5.5 Load Allocation

As discussed in Section 3, nonpoint source bacterial loading to each waterbody emanate from a number of different sources. The data analysis and the LDCs indicate that exceedances for each waterbody are the result of a variety of nonpoint source loading. The LAs for each bacterial indicator in waterbodies not supporting the PBCR use are calculated as the difference between the TMDL, MOS, and WLA, as follows:

LA = TMDL – WLA_WWTP – WLA_MS4 – MOS

This equation is used to calculate the LA for TSS however the LA is further reduced by allocating 1% of the TMDL as part of the WLA:

LA = TMDL – WLA_WWTP – WLA_MS4 – WLA_growth – MOS

5.6 Seasonal Variability

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs account for seasonal variation in watershed conditions and pollutant loading. The bacterial TMDLs established in this report adhere to the seasonal application of the Oklahoma WQS which limits the PBCR use to the period of May 1st through September 30th. Similarly, the turbidity TMDLs established in this report adhere to the seasonal application of the Oklahoma WQS for turbidity, which applies to seasonal base flow conditions only. Seasonal variation was also accounted for in these TMDLs by using five years of water quality data and by using the longest period of USGS flow records when estimating flows to develop flow exceedance percentiles.

5.7 Margin of Safety

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs include an MOS. The MOS is a conservative measure incorporated into the TMDL equation that accounts for the lack of knowledge associated with calculating the allowable pollutant loading to ensure WQSs are attained.

For bacterial TMDLs, an explicit MOS was set at 10%.

For turbidity, the TMDLs are calculated for TSS instead of turbidity. Thus, the quality of the regression has a direct impact on confidence of the TMDL calculations. The better the regression is, the more confidence there is in the TMDL targets. As a result, it leads to a smaller margin of safety. The selection of MOS is based on the NRMSE for each waterbody. Table 5-5 shows the MOS for each waterbody.

Table 5-5 Explicit Margin of Safety for Total Suspended Solids TMDLs

Waterbody ID	Waterbody Name	NRMSE	Margin of Safety
OK120400020010_00	Dirty Creek	9.8%	10%
OK120400020160_00	Butler creek	8.4%	10%
OK120410010100_00	Cloud Creek	8.5%	10%
OK120410010220_00	Snake Creek	11.2%	15%
OK121500010200_00	Verdigris River, US 51, Wagoner	14.1%	15%
OK121500020090_00	Bull Creek	8.3%	10%
OK121500020260_00	Verdigris River near Inola	6.8%	10%

5.8 TMDL Calculations

The TMDLs for the 303(d)-listed waterbodies covered in this report were derived using LDCs. A TMDL is expressed as the sum of all WLAs (point source loads), LAs (nonpoint source loads), and an appropriate MOS, which attempts to account for the lack of knowledge concerning the relationship between pollutant loading and water quality.

This definition can be expressed by the following equation:

$$TMDL = \Sigma\ WLA + LA + MOS$$

The TMDL represents a continuum of desired load over all flow conditions, rather than fixed at a single value, because loading capacity varies as a function of the flow present in the stream. The higher the flow is, the more wasteload the stream can handle without violating water quality standards. Regardless of the magnitude of the WLA calculated in these TMDLs, future new discharges or increased load from existing discharges will be considered consistent with the TMDL provided the NPDES permit requires instream criteria to be met.

The TMDL, WLA, LA, and MOS will vary with flow condition, and are calculated at every 5th flow interval percentile. Table 5-6 & 5-7a summarize the TMDL, WLA, LA and MOS loadings at the 50% flow percentile. Table 5-7b summarizes MS4 permittees and their respective WLAs. Tables 5-8 through 5-36 summarize the allocations for indicator bacteria. The bacterial TMDLs calculated in these tables apply to the recreation season (May 1 through September 30) only. Tables 5-37 to 5-44 present the allocations for total suspended solids.

Table 5-6 Summaries of Bacterial TMDLs

Stream Name	Waterbody ID	Pollutant	TMDL (cfu/day)	$WLA_{\_WWTP}$ (cfu/day)	$WLA_{\_MS4}$ (cfu/day)	LA (cfu/day)	MOS (cfu/day)
Arkansas River near Muskogee	OK120400010260_00	ENT	1.34E+13	1.72E+10	3.83E+12	8.25E+12	1.34E+12
Coody Creek	OK120400010400_00	ENT	4.55E+09	0.00E+00	1.32E+09	2.78E+09	4.55E+08
		EC	1.74E+10	0.00E+00	5.05E+09	1.06E+10	1.74E+09
Dirty Creek	OK120400020010_00	ENT	3.93E+10	5.62E+07	0.00E+00	3.53E+10	3.93E+09
Dirty Creek, South Fork	OK120400020030_00	ENT	9.75E+09	1.00E+08	0.00E+00	8.68E+09	9.75E+08
Dirty Creek, Georges Fork	OK120400020110_00	ENT	2.87E+10	4.25E+08	0.00E+00	2.54E+10	2.87E+09
Butler Creek	OK120400020160_00	ENT	3.23E+09	0.00E+00	0.00E+00	2.91E+09	3.23E+08
		EC	1.23E+10	0.00E+00	0.00E+00	1.11E+10	1.23E+09
Elk Creek	OK120400020190_00	ENT	1.30E+10	2.42E+09	0.00E+00	9.30E+09	1.30E+09
Shady Grove Creek	OK120400020240_00	ENT	3.15E+09	0.00E+00	0.00E+00	2.84E+09	3.15E+08
Arkansas River near Haskell	OK120410010080_00	ENT	4.26E+12	1.42E+10	2.50E+11	3.57E+12	4.26E+11
Cloud Creek	OK120410010100_00	ENT	5.94E+09	0.00E+00	0.00E+00	5.35E+09	5.94E+08
Snake Creek	OK120410010220_00	ENT	9.09E+09	0.00E+00	8.20E+08	7.36E+09	9.09E+08
Arkansas River near Bixby	OK120420010010_00	ENT	4.46E+12	7.91E+10	1.49E+12	2.45E+12	4.46E+11
Arkansas River near Sand Springs	OK120420010130_00	ENT	2.01E+12	6.87E+09	5.37E+11	1.27E+12	2.01E+11
Polecat Creek	OK120420020010_00	EC	4.61E+10	0.00E+00	4.14E+10	1.25E+08	4.61E+09
Polecat Creek	OK120420020050_00	ENT	1.40E+10	8.75E+09	3.37E+08	3.47E+09	1.40E+09
Verdigris River near Wagoner	OK121500010200_00	ENT	3.81E+11	0.00E+00	0.00E+00	3.43E+11	3.81E+10
Bull Creek	OK121500020090_00	ENT	4.10E+09	0.00E+00	0.00E+00	3.69E+09	4.10E+08
		EC	1.57E+10	0.00E+00	0.00E+00	1.41E+10	1.57E+09
Pea Creek	OK121500020100_00	ENT	7.32E+08	0.00E+00	0.00E+00	6.58E+08	7.32E+07
		EC	2.79E+09	0.00E+00	0.00E+00	2.51E+09	2.79E+08
Verdigris River near Inola	OK121500020260_00	ENT	1.17E+12	8.15E+09	0.00E+00	1.05E+12	1.17E+11
Dog Creek	OK121500020360_00	ENT	1.07E+10	0.00E+00	0.00E+00	9.66E+09	1.07E+09
		EC	4.10E+10	0.00E+00	0.00E+00	3.69E+10	4.10E+09
Verdigris River near Claremore	OK121500030010_00	ENT	6.14E+11	4.37E+07	3.89E+10	5.13E+11	6.14E+10
Neosho River below Ft. Gibson Lake	OK121600010010_00	ENT	2.55E+10	0.00E+00	0.00E+00	2.30E+10	2.55E+09
Chouteau Creek	OK121600010430_00	ENT	1.20E+10	4.00E+08	0.00E+00	1.04E+10	1.20E+09
		EC	4.58E+10	1.53E+09	0.00E+00	3.97E+10	4.58E+09

Table 5-7a Summaries of TSS TMDLs

Stream Name	Waterbody ID	Pollutant	TMDL (lbs/day)	WLA (lbs/day)	$WLA_{\_MS4}$ (cfu/day)	$WLA_{\_Growth}$ (lbs/day)	LA (lbs/day)	MOS (lbs/day)
Dirty Creek	OK120400020010_00	TSS	2.67E+04	0.00E+00	0.00E+00	2.67E+02	2.38E+04	2.67E+03
Butler creek	OK120400020160_00	TSS	2.20E+03	0.00E+00	0.00E+00	2.20E+01	1.96E+03	2.20E+02
Cloud Creek	OK120410010100_00	TSS	4.05E+03	0.00E+00	0.00E+00	4.05E+01	3.60E+03	4.05E+02
Snake Creek	OK120410010220_00	TSS	6.19E+03	7.01E+02	0.00E+00	6.19E+01	4.05E+03	9.28E+02
Verdigris River near Wagoner	OK121500010200_00	TSS	2.60E+05	0.00E+00	0.00E+00	2.60E+03	2.18E+05	3.89E+04
Bull Creek	OK121500020090_00	TSS	2.79E+03	0.00E+00	0.00E+00	2.79E+01	2.48E+03	2.79E+02
Verdigris River near Inola	OK121500020260_00	TSS	7.98E+05	5.34E+02	0.00E+00	7.98E+03	7.09E+05	7.98E+04

Table 5-7b Summaries of WLAs for MS4 Permitees

MS4 City	Permit No.	Subwatershed Name	Waterbody ID	Pollutant	$WLA_{\_MS4}$ (cfu/day)
City of Muskogee	OKR040013	Arkansas River near Muskogee	OK120400010260_00	ENT	3.83E+12
		Coody Creek	OK120400010400_00	ENT	1.32E+09
				EC	5.05E+09
City of Bixby	OKR040042	Arkansas River near Haskell	OK120410010080_00	ENT	2.50E+11
City of Broken Arrow	OKR040001				
City of Coweta	OKR040009				
City of Muskogee	OKR040013				
City of Bixby	OKR040042	Snake Creek	OK120410010220_00	ENT	8.20E+08
City of Broken Arrow	OKR040001	Arkansas River near Bixby	OK120420010010_00	ENT	1.49E+12
City of Jenks	OKR040024				
Cityof Tulsa	OKS000201				
City of Sand Springs	OKR040017	Arkansas River near Sand Springs	OK120420010130_00	ENT	5.37E+11
City of Jenks	OKR040024	Polecat Creek	OK120420020010_00	EC	4.14E+10
Cityof Sapulpa	OKR040018	Polecat Creek	OK120420020050_00	ENT	2.86E+09
City of Claremore	OKR040028	Verdigris River near Claremore	OK121500030010_00	ENT	3.89E+10

Table 5-8 Enterococci TMDL Calculations for Arkansas River near Muskogee (OK121400010260_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	176000.00	1.42E+14	1.72E+10	4.05E+13	8.74E+13	1.42E+13
5	101750.00	8.21E+13	1.72E+10	2.34E+13	5.05E+13	8.21E+12
10	75700.00	6.11E+13	1.72E+10	1.74E+13	3.76E+13	6.11E+12
15	56925.00	4.60E+13	1.72E+10	1.31E+13	2.82E+13	4.60E+12
20	46200.00	3.73E+13	1.72E+10	1.06E+13	2.29E+13	3.73E+12
25	39375.00	3.18E+13	1.72E+10	9.06E+12	1.95E+13	3.18E+12
30	33100.00	2.67E+13	1.72E+10	7.61E+12	1.64E+13	2.67E+12
35	28125.00	2.27E+13	1.72E+10	6.47E+12	1.40E+13	2.27E+12
40	23800.00	1.92E+13	1.72E+10	5.47E+12	1.18E+13	1.92E+12
45	20175.00	1.63E+13	1.72E+10	4.64E+12	1.00E+13	1.63E+12
50	16650.00	1.34E+13	1.72E+10	3.83E+12	8.25E+12	1.34E+12
55	13500.00	1.09E+13	1.72E+10	3.10E+12	6.69E+12	1.09E+12
60	10800.00	8.72E+12	1.72E+10	2.48E+12	5.35E+12	8.72E+11
65	8260.00	6.67E+12	1.72E+10	1.90E+12	4.09E+12	6.67E+11
70	6525.00	5.27E+12	1.72E+10	1.50E+12	3.23E+12	5.27E+11
75	5122.50	4.14E+12	1.72E+10	1.17E+12	2.53E+12	4.14E+11
80	3930.00	3.17E+12	1.72E+10	8.99E+11	1.94E+12	3.17E+11
85	2880.00	2.33E+12	1.72E+10	6.57E+11	1.42E+12	2.33E+11
90	1940.00	1.57E+12	1.72E+10	4.41E+11	9.51E+11	1.57E+11
95	1060.00	8.56E+11	1.72E+10	2.39E+11	5.15E+11	8.56E+10
100	31.00	2.50E+10	1.72E+10	1.70E+09	3.66E+09	2.50E+09

Table 5-9 E.coli TMDL Calculations for Coody Creek (OK120400010400_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	259.53	8.00E+11	0	2.32E+11	4.88E+11	8.00E+10
5	38.45	1.19E+11	0	3.44E+10	7.23E+10	1.19E+10
10	27.55	8.49E+10	0	2.47E+10	5.18E+10	8.49E+09
15	21.15	6.52E+10	0	1.89E+10	3.97E+10	6.52E+09
20	16.23	5.00E+10	0	1.45E+10	3.05E+10	5.00E+09
25	13.99	4.31E+10	0	1.25E+10	2.63E+10	4.31E+09
30	11.53	3.56E+10	0	1.03E+10	2.17E+10	3.56E+09
35	9.48	2.92E+10	0	8.49E+09	1.78E+10	2.92E+09
40	8.05	2.48E+10	0	7.21E+09	1.51E+10	2.48E+09
45	6.79	2.09E+10	0	6.08E+09	1.28E+10	2.09E+09
50	5.64	1.74E+10	0	5.05E+09	1.06E+10	1.74E+09
55	4.68	1.44E+10	0	4.19E+09	8.79E+09	1.44E+09
60	3.91	1.21E+10	0	3.50E+09	7.35E+09	1.21E+09
65	3.27	1.01E+10	0	2.93E+09	6.14E+09	1.01E+09
70	2.67	8.23E+09	0	2.39E+09	5.02E+09	8.23E+08
75	2.16	6.65E+09	0	1.93E+09	4.05E+09	6.65E+08
80	1.70	5.23E+09	0	1.52E+09	3.19E+09	5.23E+08
85	1.31	4.05E+09	0	1.18E+09	2.47E+09	4.05E+08
90	0.97	2.98E+09	0	8.66E+08	1.82E+09	2.98E+08
95	0.66	2.04E+09	0	5.91E+08	1.24E+09	2.04E+08
100	0.03	9.86E+07	0	2.86E+07	6.01E+07	9.86E+06

Table 5-10 Enterococci TMDL Calculations for Coody Creek (OK120400010400_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA $_{MS4}$ (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	259.53	2.10E+11	0	6.08E+10	1.28E+11	2.10E+10
5	38.45	3.10E+10	0	9.01E+09	1.89E+10	3.10E+09
10	27.55	2.22E+10	0	6.46E+09	1.36E+10	2.22E+09
15	21.15	1.71E+10	0	4.96E+09	1.04E+10	1.71E+09
20	16.23	1.31E+10	0	3.81E+09	7.99E+09	1.31E+09
25	13.99	1.13E+10	0	3.28E+09	6.89E+09	1.13E+09
30	11.53	9.31E+09	0	2.70E+09	5.68E+09	9.31E+08
35	9.48	7.66E+09	0	2.22E+09	4.67E+09	7.66E+08
40	8.05	6.50E+09	0	1.89E+09	3.96E+09	6.50E+08
45	6.79	5.48E+09	0	1.59E+09	3.34E+09	5.48E+08
50	5.64	4.55E+09	0	1.32E+09	2.78E+09	4.55E+08
55	4.68	3.78E+09	0	1.10E+09	2.30E+09	3.78E+08
60	3.91	3.16E+09	0	9.16E+08	1.92E+09	3.16E+08
65	3.27	2.64E+09	0	7.66E+08	1.61E+09	2.64E+08
70	2.67	2.16E+09	0	6.26E+08	1.31E+09	2.16E+08
75	2.16	1.74E+09	0	5.06E+08	1.06E+09	1.74E+08
80	1.70	1.37E+09	0	3.98E+08	8.36E+08	1.37E+08
85	1.31	1.06E+09	0	3.08E+08	6.47E+08	1.06E+08
90	0.97	7.81E+08	0	2.27E+08	4.76E+08	7.81E+07
95	0.66	5.33E+08	0	1.55E+08	3.25E+08	5.33E+07
100	0.03	2.58E+07	0	7.50E+06	1.58E+07	2.58E+06

Table 5-11 Enterococci TMDL Calculations for Dirty Creek (OK120400020010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	2240.06	1.81E+12	5.62E+07	0	1.63E+12	1.81E+11
5	331.86	2.68E+11	5.62E+07	0	2.41E+11	2.68E+10
10	237.83	1.92E+11	5.62E+07	0	1.73E+11	1.92E+10
15	182.52	1.47E+11	5.62E+07	0	1.33E+11	1.47E+10
20	140.12	1.13E+11	5.62E+07	0	1.02E+11	1.13E+10
25	120.76	9.75E+10	5.62E+07	0	8.77E+10	9.75E+09
30	99.56	8.04E+10	5.62E+07	0	7.23E+10	8.04E+09
35	81.86	6.61E+10	5.62E+07	0	5.94E+10	6.61E+09
40	69.51	5.61E+10	5.62E+07	0	5.04E+10	5.61E+09
45	58.62	4.73E+10	5.62E+07	0	4.25E+10	4.73E+09
50	48.67	3.93E+10	5.62E+07	0	3.53E+10	3.93E+09
55	40.38	3.26E+10	5.62E+07	0	2.93E+10	3.26E+09
60	33.74	2.72E+10	5.62E+07	0	2.45E+10	2.72E+09
65	28.21	2.28E+10	5.62E+07	0	2.04E+10	2.28E+09
70	23.05	1.86E+10	5.62E+07	0	1.67E+10	1.86E+09
75	18.62	1.50E+10	5.62E+07	0	1.35E+10	1.50E+09
80	14.66	1.18E+10	5.62E+07	0	1.06E+10	1.18E+09
85	11.34	9.15E+09	5.62E+07	0	8.18E+09	9.15E+08
90	8.35	6.74E+09	5.62E+07	0	6.01E+09	6.74E+08
95	5.70	4.60E+09	5.62E+07	0	4.09E+09	4.60E+08
100	0.0	5.62E+07	5.62E+07	0	0	0

Table 5-12 Enterococci TMDL Calculations for South Fork of Dirty Creek (OK120400020030_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	555.80	4.49E+11	1.00E+08	0	4.04E+11	4.49E+10
5	82.34	6.65E+10	1.00E+08	0	5.97E+10	6.65E+09
10	59.01	4.76E+10	1.00E+08	0	4.28E+10	4.76E+09
15	45.29	3.66E+10	1.00E+08	0	3.28E+10	3.66E+09
20	34.77	2.81E+10	1.00E+08	0	2.52E+10	2.81E+09
25	29.96	2.42E+10	1.00E+08	0	2.17E+10	2.42E+09
30	24.70	1.99E+10	1.00E+08	0	1.78E+10	1.99E+09
35	20.31	1.64E+10	1.00E+08	0	1.47E+10	1.64E+09
40	17.25	1.39E+10	1.00E+08	0	1.24E+10	1.39E+09
45	14.55	1.17E+10	1.00E+08	0	1.05E+10	1.17E+09
50	12.08	9.75E+09	1.00E+08	0	8.68E+09	9.75E+08
55	10.02	8.09E+09	1.00E+08	0	7.18E+09	8.09E+08
60	8.37	6.76E+09	1.00E+08	0	5.98E+09	6.76E+08
65	7.00	5.65E+09	1.00E+08	0	4.99E+09	5.65E+08
70	5.72	4.62E+09	1.00E+08	0	4.05E+09	4.62E+08
75	4.62	3.73E+09	1.00E+08	0	3.26E+09	3.73E+08
80	3.64	2.94E+09	1.00E+08	0	2.54E+09	2.94E+08
85	2.81	2.27E+09	1.00E+08	0	1.94E+09	2.27E+08
90	2.07	1.67E+09	1.00E+08	0	1.41E+09	1.67E+08
95	1.41	1.14E+09	1.00E+08	0	9.28E+08	1.14E+08
100	0.0	1.00E+08	1.00E+08	0	0	0

Table 5-13 Enterococci TMDL Calculations for George's Fork of Dirty Creek (OK120400020110_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	1635.99	1.32E+12	4.25E+08	0	1.19E+12	1.32E+11
5	242.37	1.96E+11	4.25E+08	0	1.76E+11	1.96E+10
10	173.70	1.40E+11	4.25E+08	0	1.26E+11	1.40E+10
15	133.30	1.08E+11	4.25E+08	0	9.64E+10	1.08E+10
20	102.33	8.26E+10	4.25E+08	0	7.39E+10	8.26E+09
25	88.20	7.12E+10	4.25E+08	0	6.37E+10	7.12E+09
30	72.71	5.87E+10	4.25E+08	0	5.24E+10	5.87E+09
35	59.78	4.83E+10	4.25E+08	0	4.30E+10	4.83E+09
40	50.76	4.10E+10	4.25E+08	0	3.65E+10	4.10E+09
45	42.82	3.46E+10	4.25E+08	0	3.07E+10	3.46E+09
50	35.55	2.87E+10	4.25E+08	0	2.54E+10	2.87E+09
55	29.49	2.38E+10	4.25E+08	0	2.10E+10	2.38E+09
60	24.64	1.99E+10	4.25E+08	0	1.75E+10	1.99E+09
65	20.60	1.66E+10	4.25E+08	0	1.45E+10	1.66E+09
70	16.83	1.36E+10	4.25E+08	0	1.18E+10	1.36E+09
75	13.60	1.10E+10	4.25E+08	0	9.46E+09	1.10E+09
80	10.70	8.64E+09	4.25E+08	0	7.35E+09	8.64E+08
85	8.28	6.69E+09	4.25E+08	0	5.59E+09	6.69E+08
90	6.10	4.92E+09	4.25E+08	0	4.01E+09	4.92E+08
95	4.16	3.36E+09	4.25E+08	0	2.60E+09	3.36E+08
100	0.0	4.25E+08	4.25E+08	0	0	0

Table 5-14 E.coli TMDL Calculations for Butler Creek (OK120400020160_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	184.09	5.67E+11	0	0	5.11E+11	5.67E+10
5	27.27	8.41E+10	0	0	7.57E+10	8.41E+09
10	19.54	6.03E+10	0	0	5.42E+10	6.03E+09
15	15.00	4.62E+10	0	0	4.16E+10	4.62E+09
20	11.51	3.55E+10	0	0	3.19E+10	3.55E+09
25	9.92	3.06E+10	0	0	2.75E+10	3.06E+09
30	8.18	2.52E+10	0	0	2.27E+10	2.52E+09
35	6.73	2.07E+10	0	0	1.87E+10	2.07E+09
40	5.71	1.76E+10	0	0	1.58E+10	1.76E+09
45	4.82	1.49E+10	0	0	1.34E+10	1.49E+09
50	4.00	1.23E+10	0	0	1.11E+10	1.23E+09
55	3.32	1.02E+10	0	0	9.21E+09	1.02E+09
60	2.77	8.55E+09	0	0	7.69E+09	8.55E+08
65	2.32	7.15E+09	0	0	6.43E+09	7.15E+08
70	1.89	5.84E+09	0	0	5.25E+09	5.84E+08
75	1.53	4.72E+09	0	0	4.25E+09	4.72E+08
80	1.20	3.71E+09	0	0	3.34E+09	3.71E+08
85	0.93	2.87E+09	0	0	2.59E+09	2.87E+08
90	0.69	2.12E+09	0	0	1.90E+09	2.12E+08
95	0.47	1.44E+09	0	0	1.30E+09	1.44E+08
100	0.0	3.08E+07	0	0	2.77E+07	3.08E+06

Table 5-15 Enterococci TMDL Calculations for Butler Creek (OK120400020160_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA $_{MS4}$ (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	184.09	1.49E+11	0	0	1.34E+11	1.49E+10
5	27.27	2.20E+10	0	0	1.98E+10	2.20E+09
10	19.54	1.58E+10	0	0	1.42E+10	1.58E+09
15	15.00	1.21E+10	0	0	1.09E+10	1.21E+09
20	11.51	9.30E+09	0	0	8.37E+09	9.30E+08
25	9.92	8.01E+09	0	0	7.21E+09	8.01E+08
30	8.18	6.61E+09	0	0	5.95E+09	6.61E+08
35	6.73	5.43E+09	0	0	4.89E+09	5.43E+08
40	5.71	4.61E+09	0	0	4.15E+09	4.61E+08
45	4.82	3.89E+09	0	0	3.50E+09	3.89E+08
50	4.00	3.23E+09	0	0	2.91E+09	3.23E+08
55	3.32	2.68E+09	0	0	2.41E+09	2.68E+08
60	2.77	2.24E+09	0	0	2.01E+09	2.24E+08
65	2.32	1.87E+09	0	0	1.68E+09	1.87E+08
70	1.89	1.53E+09	0	0	1.38E+09	1.53E+08
75	1.53	1.24E+09	0	0	1.11E+09	1.24E+08
80	1.20	9.72E+08	0	0	8.75E+08	9.72E+07
85	0.93	7.52E+08	0	0	6.77E+08	7.52E+07
90	0.69	5.54E+08	0	0	4.99E+08	5.54E+07
95	0.47	3.78E+08	0	0	3.40E+08	3.78E+07
100	0.0	8.07E+06	0	0	7.27E+06	8.07E+05

Table 5-16 Enterococci TMDL Calculations for Elk Creek (OK120400020190_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	742.48	5.99E+11	2.42E+09	0	5.37E+11	5.99E+10
5	110.00	8.88E+10	2.42E+09	0	7.75E+10	8.88E+09
10	78.83	6.36E+10	2.42E+09	0	5.49E+10	6.36E+09
15	60.50	4.88E+10	2.42E+09	0	4.15E+10	4.88E+09
20	46.44	3.75E+10	2.42E+09	0	3.13E+10	3.75E+09
25	40.03	3.23E+10	2.42E+09	0	2.67E+10	3.23E+09
30	33.00	2.66E+10	2.42E+09	0	2.16E+10	2.66E+09
35	27.13	2.19E+10	2.42E+09	0	1.73E+10	2.19E+09
40	23.04	1.86E+10	2.42E+09	0	1.43E+10	1.86E+09
45	19.43	1.57E+10	2.42E+09	0	1.17E+10	1.57E+09
50	16.13	1.30E+10	2.42E+09	0	9.30E+09	1.30E+09
55	13.38	1.08E+10	2.42E+09	0	7.30E+09	1.08E+09
60	11.18	9.03E+09	2.42E+09	0	5.70E+09	9.03E+08
65	9.35	7.55E+09	2.42E+09	0	4.37E+09	7.55E+08
70	7.64	6.17E+09	2.42E+09	0	3.13E+09	6.17E+08
75	6.17	4.98E+09	2.42E+09	0	2.06E+09	4.98E+08
80	4.86	3.92E+09	2.42E+09	0	1.11E+09	3.92E+08
85	3.76	3.03E+09	2.42E+09	0	3.06E+08	3.03E+08
90	2.77	2.23E+09	2.42E+09	0	-4.13E+08	2.23E+08
95	1.89	1.53E+09	2.42E+09	0	-1.05E+09	1.53E+08
100	0.0	2.42E+09	2.42E+09	0	0	0

Table 5-17 Enterococci TMDL Calculations for Shady Grove Creek (OK120400020240_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	179.71	1.45E+11	0	0	1.31E+11	1.45E+10
5	26.62	2.15E+10	0	0	1.93E+10	2.15E+09
10	19.08	1.54E+10	0	0	1.39E+10	1.54E+09
15	14.64	1.18E+10	0	0	1.06E+10	1.18E+09
20	11.24	9.08E+09	0	0	8.17E+09	9.08E+08
25	9.69	7.82E+09	0	0	7.04E+09	7.82E+08
30	7.99	6.45E+09	0	0	5.80E+09	6.45E+08
35	6.57	5.30E+09	0	0	4.77E+09	5.30E+08
40	5.58	4.50E+09	0	0	4.05E+09	4.50E+08
45	4.70	3.80E+09	0	0	3.42E+09	3.80E+08
50	3.90	3.15E+09	0	0	2.84E+09	3.15E+08
55	3.24	2.62E+09	0	0	2.35E+09	2.62E+08
60	2.71	2.19E+09	0	0	1.97E+09	2.19E+08
65	2.26	1.83E+09	0	0	1.64E+09	1.83E+08
70	1.85	1.49E+09	0	0	1.34E+09	1.49E+08
75	1.49	1.21E+09	0	0	1.09E+09	1.21E+08
80	1.18	9.49E+08	0	0	8.54E+08	9.49E+07
85	0.91	7.34E+08	0	0	6.61E+08	7.34E+07
90	0.67	5.41E+08	0	0	4.87E+08	5.41E+07
95	0.46	3.69E+08	0	0	3.32E+08	3.69E+07
100	0.06	5.19E+07	0	0	4.68E+07	5.19E+06

Table 5-18 Enterococci TMDL Calculations for Arkansas River near Haskell (OK120410010080_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA $_{MS4}$ (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	243000.00	1.96E+14	1.42E+10	1.155E+13	1.65E+14	1.96E+13
5	36000.00	2.91E+13	1.42E+10	1.71E+12	2.44E+13	2.91E+12
10	25800.00	2.08E+13	1.42E+10	1.225E+12	1.75E+13	2.08E+12
15	19800.00	1.60E+13	1.42E+10	9.4E+11	1.34E+13	1.60E+12
20	15200.00	1.23E+13	1.42E+10	7.214E+11	1.03E+13	1.23E+12
25	13100.00	1.06E+13	1.42E+10	6.216E+11	8.88E+12	1.06E+12
30	10800.00	8.72E+12	1.42E+10	5.123E+11	7.32E+12	8.72E+11
35	8880.00	7.17E+12	1.42E+10	4.211E+11	6.02E+12	7.17E+11
40	7540.00	6.09E+12	1.42E+10	3.574E+11	5.11E+12	6.09E+11
45	6359.50	5.13E+12	1.42E+10	3.013E+11	4.31E+12	5.13E+11
50	5280.00	4.26E+12	1.42E+10	2.5E+11	3.57E+12	4.26E+11
55	4380.00	3.54E+12	1.42E+10	2.072E+11	2.96E+12	3.54E+11
60	3660.00	2.95E+12	1.42E+10	1.73E+11	2.47E+12	2.95E+11
65	3060.00	2.47E+12	1.42E+10	1.445E+11	2.06E+12	2.47E+11
70	2500.00	2.02E+12	1.42E+10	1.179E+11	1.68E+12	2.02E+11
75	2020.00	1.63E+12	1.42E+10	9.506E+10	1.36E+12	1.63E+11
80	1590.00	1.28E+12	1.42E+10	7.463E+10	1.07E+12	1.28E+11
85	1230.00	9.93E+11	1.42E+10	5.752E+10	8.22E+11	9.93E+10
90	905.90	7.31E+11	1.42E+10	4.212E+10	6.02E+11	7.31E+10
95	618.45	4.99E+11	1.42E+10	2.846E+10	4.07E+11	4.99E+10
100	87.00	7.02E+10	1.42E+10	3.203E+09	4.58E+10	7.02E+09

Table 5-19 Enterococci TMDL Calculations for Cloud Creek (OK120410010100_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	338.79	2.74E+11	0	0	2.46E+11	2.74E+10
5	50.19	4.05E+10	0	0	3.65E+10	4.05E+09
10	35.97	2.90E+10	0	0	2.61E+10	2.90E+09
15	27.60	2.23E+10	0	0	2.01E+10	2.23E+09
20	21.19	1.71E+10	0	0	1.54E+10	1.71E+09
25	18.26	1.47E+10	0	0	1.33E+10	1.47E+09
30	15.06	1.22E+10	0	0	1.09E+10	1.22E+09
35	12.38	1.00E+10	0	0	9.00E+09	1.00E+09
40	10.51	8.49E+09	0	0	7.64E+09	8.49E+08
45	8.87	7.16E+09	0	0	6.44E+09	7.16E+08
50	7.36	5.94E+09	0	0	5.35E+09	5.94E+08
55	6.11	4.93E+09	0	0	4.44E+09	4.93E+08
60	5.10	4.12E+09	0	0	3.71E+09	4.12E+08
65	4.27	3.44E+09	0	0	3.10E+09	3.44E+08
70	3.49	2.81E+09	0	0	2.53E+09	2.81E+08
75	2.82	2.27E+09	0	0	2.05E+09	2.27E+08
80	2.22	1.79E+09	0	0	1.61E+09	1.79E+08
85	1.71	1.38E+09	0	0	1.25E+09	1.38E+08
90	1.26	1.02E+09	0	0	9.18E+08	1.02E+08
95	0.86	6.96E+08	0	0	6.27E+08	6.96E+07
100	0.0	8.07E+06	0	0	7.27E+06	8.07E+05

Table 5-20 Enterococci TMDL Calculations for Snake Creek (OK120400010220_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	518.35	4.19E+11	0	3.77E+10	3.39E+11	4.19E+10
5	76.79	6.20E+10	0	5.59E+09	5.02E+10	6.20E+09
10	55.04	4.44E+10	0	4.01E+09	3.60E+10	4.44E+09
15	42.24	3.41E+10	0	3.08E+09	2.76E+10	3.41E+09
20	32.42	2.62E+10	0	2.36E+09	2.12E+10	2.62E+09
25	27.94	2.26E+10	0	2.04E+09	1.83E+10	2.26E+09
30	23.04	1.86E+10	0	1.68E+09	1.51E+10	1.86E+09
35	18.94	1.53E+10	0	1.38E+09	1.24E+10	1.53E+09
40	16.08	1.30E+10	0	1.17E+09	1.05E+10	1.30E+09
45	13.57	1.10E+10	0	9.88E+08	8.87E+09	1.10E+09
50	11.26	9.09E+09	0	8.20E+08	7.36E+09	9.09E+08
55	9.34	7.54E+09	0	6.80E+08	6.11E+09	7.54E+08
60	7.81	6.30E+09	0	5.69E+08	5.10E+09	6.30E+08
65	6.53	5.27E+09	0	4.75E+08	4.27E+09	5.27E+08
70	5.33	4.31E+09	0	3.88E+08	3.49E+09	4.31E+08
75	4.31	3.48E+09	0	3.14E+08	2.82E+09	3.48E+08
80	3.39	2.74E+09	0	2.47E+08	2.22E+09	2.74E+08
85	2.62	2.12E+09	0	1.91E+08	1.72E+09	2.12E+08
90	1.93	1.56E+09	0	1.41E+08	1.26E+09	1.56E+08
95	1.32	1.07E+09	0	9.61E+07	8.63E+08	1.07E+08
100	0.01	8.07E+06	0	7.28E+05	6.54E+06	8.07E+05

Table 5-21 Enterococci TMDL Calculations for Arkansas River near Bixby (OK120420010010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA $_{MS4}$ (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	254518.66	2.05E+14	7.91E+10	6.99E+13	1.15E+14	2.05E+13
5	37706.47	3.04E+13	7.91E+10	1.033E+13	1.70E+13	3.04E+12
10	27022.97	2.18E+13	7.91E+10	7.395E+12	1.22E+13	2.18E+12
15	20738.56	1.67E+13	7.91E+10	5.668E+12	9.32E+12	1.67E+12
20	15920.51	1.29E+13	7.91E+10	4.344E+12	7.15E+12	1.29E+12
25	13720.96	1.11E+13	7.91E+10	3.74E+12	6.15E+12	1.11E+12
30	11311.94	9.13E+12	7.91E+10	3.078E+12	5.06E+12	9.13E+11
35	9300.93	7.51E+12	7.91E+10	2.525E+12	4.15E+12	7.51E+11
40	7897.41	6.38E+12	7.91E+10	2.14E+12	3.52E+12	6.38E+11
45	6660.95	5.38E+12	7.91E+10	1.8E+12	2.96E+12	5.38E+11
50	5530.28	4.46E+12	7.91E+10	1.49E+12	2.45E+12	4.46E+11
55	4587.62	3.70E+12	7.91E+10	1.231E+12	2.02E+12	3.70E+11
60	3833.49	3.10E+12	7.91E+10	1.023E+12	1.68E+12	3.10E+11
65	3205.05	2.59E+12	7.91E+10	8.507E+11	1.40E+12	2.59E+11
70	2618.50	2.11E+12	7.91E+10	6.895E+11	1.13E+12	2.11E+11
75	2115.75	1.71E+12	7.91E+10	5.514E+11	9.07E+11	1.71E+11
80	1665.37	1.34E+12	7.91E+10	4.276E+11	7.03E+11	1.34E+11
85	1288.30	1.04E+12	7.91E+10	3.241E+11	5.33E+11	1.04E+11
90	948.84	7.66E+11	7.91E+10	2.308E+11	3.80E+11	7.66E+10
95	647.77	5.23E+11	7.91E+10	1.481E+11	2.44E+11	5.23E+10
100	91.12	7.36E+10	7.91E+10	0	0	7.36E+09

Table 5-22 Enterococci TMDL Calculations for Arkansas River near Sand Springs (OK120420010130_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	114776.92	9.27E+13	6.87E+09	2.48E+13	5.86E+13	9.27E+12
5	17003.99	1.37E+13	6.87E+09	3.67E+12	8.68E+12	1.37E+12
10	12186.19	9.84E+12	6.87E+09	2.63E+12	6.22E+12	9.84E+11
15	9352.19	7.55E+12	6.87E+09	2.02E+12	4.77E+12	7.55E+11
20	7179.46	5.80E+12	6.87E+09	1.55E+12	3.66E+12	5.80E+11
25	6187.56	5.00E+12	6.87E+09	1.33E+12	3.15E+12	5.00E+11
30	5101.20	4.12E+12	6.87E+09	1.10E+12	2.60E+12	4.12E+11
35	4194.32	3.39E+12	6.87E+09	9.04E+11	2.14E+12	3.39E+11
40	3561.39	2.88E+12	6.87E+09	7.67E+11	1.81E+12	2.88E+11
45	3003.80	2.43E+12	6.87E+09	6.47E+11	1.53E+12	2.43E+11
50	2493.92	2.01E+12	6.87E+09	5.37E+11	1.27E+12	2.01E+11
55	2068.82	1.67E+12	6.87E+09	4.45E+11	1.05E+12	1.67E+11
60	1728.74	1.40E+12	6.87E+09	3.71E+11	8.78E+11	1.40E+11
65	1445.34	1.17E+12	6.87E+09	3.10E+11	7.33E+11	1.17E+11
70	1180.83	9.53E+11	6.87E+09	2.53E+11	5.98E+11	9.53E+10
75	954.11	7.70E+11	6.87E+09	2.04E+11	4.82E+11	7.70E+10
80	751.01	6.06E+11	6.87E+09	1.60E+11	3.79E+11	6.06E+10
85	580.97	4.69E+11	6.87E+09	1.23E+11	2.92E+11	4.69E+10
90	427.89	3.45E+11	6.87E+09	9.04E+10	2.14E+11	3.45E+10
95	292.11	2.36E+11	6.87E+09	6.11E+10	1.44E+11	2.36E+10
100	10.00	8.07E+09	6.87E+09	1.17E+08	2.76E+08	8.07E+08

Table 5-23 E.coli TMDL Calculations for Polecat Creek (OK120420020010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	688.45	2.12E+12	0	1.90E+12	5.73E+09	2.12E+11
5	101.99	3.14E+11	0	2.82E+11	8.49E+08	3.14E+10
10	73.09	2.25E+11	0	2.02E+11	6.08E+08	2.25E+10
15	56.10	1.73E+11	0	1.55E+11	4.67E+08	1.73E+10
20	43.06	1.33E+11	0	1.19E+11	3.58E+08	1.33E+10
25	37.11	1.14E+11	0	1.03E+11	3.09E+08	1.14E+10
30	30.60	9.43E+10	0	8.46E+10	2.55E+08	9.43E+09
35	25.16	7.76E+10	0	6.96E+10	2.09E+08	7.76E+09
40	21.36	6.59E+10	0	5.91E+10	1.78E+08	6.59E+09
45	18.02	5.55E+10	0	4.98E+10	1.50E+08	5.55E+09
50	14.96	4.61E+10	0	4.14E+10	1.25E+08	4.61E+09
55	12.41	3.83E+10	0	3.43E+10	1.03E+08	3.83E+09
60	10.37	3.20E+10	0	2.87E+10	8.63E+07	3.20E+09
65	8.67	2.67E+10	0	2.40E+10	7.22E+07	2.67E+09
70	7.08	2.18E+10	0	1.96E+10	5.90E+07	2.18E+09
75	5.72	1.76E+10	0	1.58E+10	4.76E+07	1.76E+09
80	4.50	1.39E+10	0	1.25E+10	3.75E+07	1.39E+09
85	3.48	1.07E+10	0	9.64E+09	2.90E+07	1.07E+09
90	2.57	7.91E+09	0	7.10E+09	2.14E+07	7.91E+08
95	1.75	5.40E+09	0	4.85E+09	1.46E+07	5.40E+08
100	0.25	7.60E+08	0	6.82E+08	2.05E+06	7.60E+07

Table 5-24 Enterococci TMDL Calculations for Polecat Creek (OK120420020050_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	795.33	6.42E+11	8.75E+09	5.04E+10	5.19E+11	6.42E+10
5	117.83	9.51E+10	8.75E+09	6.80E+09	7.01E+10	9.51E+09
10	84.44	6.82E+10	8.75E+09	4.66E+09	4.80E+10	6.82E+09
15	64.80	5.23E+10	8.75E+09	3.39E+09	3.49E+10	5.23E+09
20	49.75	4.02E+10	8.75E+09	2.43E+09	2.50E+10	4.02E+09
25	42.88	3.46E+10	8.75E+09	1.98E+09	2.04E+10	3.46E+09
30	35.35	2.85E+10	8.75E+09	1.50E+09	1.54E+10	2.85E+09
35	29.06	2.35E+10	8.75E+09	1.09E+09	1.13E+10	2.35E+09
40	24.68	1.99E+10	8.75E+09	8.13E+08	8.37E+09	1.99E+09
45	20.81	1.68E+10	8.75E+09	5.64E+08	5.81E+09	1.68E+09
50	17.28	1.40E+10	8.75E+09	3.37E+08	3.47E+09	1.40E+09
55	14.34	1.16E+10	8.75E+09	1.48E+08	1.52E+09	1.16E+09
60	11.98	9.67E+09	8.75E+09	0	0	9.67E+08
65	10.02	8.09E+09	8.75E+09	0	0	8.09E+08
70	8.18	6.61E+09	8.75E+09	0	0	6.61E+08
75	6.61	5.34E+09	8.75E+09	0	0	5.34E+08
80	5.20	4.20E+09	8.75E+09	0	0	4.20E+08
85	4.03	3.25E+09	8.75E+09	0	0	3.25E+08
90	2.96	2.39E+09	8.75E+09	0	0	2.39E+08
95	2.02	1.63E+09	8.75E+09	0	0	1.63E+08
100	0.28	2.30E+08	8.75E+09	0	0	2.30E+07

Table 5-25 Enterococci TMDL Calculations for Verdigris River near Wagoner (OK121500010200_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	112475.91	9.08E+13	0	0	8.17E+13	9.08E+12
5	12303.99	9.93E+12	0	0	8.94E+12	9.93E+11
10	8202.66	6.62E+12	0	0	5.96E+12	6.62E+11
15	6102.28	4.93E+12	0	0	4.43E+12	4.93E+11
20	4443.11	3.59E+12	0	0	3.23E+12	3.59E+11
25	3293.49	2.66E+12	0	0	2.39E+12	2.66E+11
30	2268.16	1.83E+12	0	0	1.65E+12	1.83E+11
35	1472.75	1.19E+12	0	0	1.07E+12	1.19E+11
40	975.62	7.88E+11	0	0	7.09E+11	7.88E+10
45	677.34	5.47E+11	0	0	4.92E+11	5.47E+10
50	472.27	3.81E+11	0	0	3.43E+11	3.81E+10
55	321.27	2.59E+11	0	0	2.33E+11	2.59E+10
60	213.14	1.72E+11	0	0	1.55E+11	1.72E+10
65	139.20	1.12E+11	0	0	1.01E+11	1.12E+10
70	98.18	7.93E+10	0	0	7.13E+10	7.93E+09
75	70.22	5.67E+10	0	0	5.10E+10	5.67E+09
80	49.71	4.01E+10	0	0	3.61E+10	4.01E+09
85	38.53	3.11E+10	0	0	2.80E+10	3.11E+09
90	26.10	2.11E+10	0	0	1.90E+10	2.11E+09
95	12.43	1.00E+10	0	0	9.03E+09	1.00E+09
100	0.01	8.07E+06	0	0	7.27E+06	8.07E+05

Table 5-26 E.coli TMDL Calculations for Bull Creek (OK121500020090_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	233.75	7.21E+11	0	0	6.49E+11	7.21E+10
5	34.63	1.07E+11	0	0	9.61E+10	1.07E+10
10	24.82	7.65E+10	0	0	6.89E+10	7.65E+09
15	19.05	5.87E+10	0	0	5.28E+10	5.87E+09
20	14.62	4.51E+10	0	0	4.06E+10	4.51E+09
25	12.60	3.88E+10	0	0	3.50E+10	3.88E+09
30	10.39	3.20E+10	0	0	2.88E+10	3.20E+09
35	8.54	2.63E+10	0	0	2.37E+10	2.63E+09
40	7.25	2.24E+10	0	0	2.01E+10	2.24E+09
45	6.12	1.89E+10	0	0	1.70E+10	1.89E+09
50	5.08	1.57E+10	0	0	1.41E+10	1.57E+09
55	4.21	1.30E+10	0	0	1.17E+10	1.30E+09
60	3.52	1.09E+10	0	0	9.77E+09	1.09E+09
65	2.94	9.07E+09	0	0	8.17E+09	9.07E+08
70	2.40	7.41E+09	0	0	6.67E+09	7.41E+08
75	1.94	5.99E+09	0	0	5.39E+09	5.99E+08
80	1.53	4.71E+09	0	0	4.24E+09	4.71E+08
85	1.18	3.65E+09	0	0	3.28E+09	3.65E+08
90	0.87	2.69E+09	0	0	2.42E+09	2.69E+08
95	0.59	1.83E+09	0	0	1.65E+09	1.83E+08
100	0.0	3.08E+07	0	0	2.77E+07	3.08E+06

Table 5-27 Enterococci TMDL Calculations for Bull Creek (OK121500020090_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	233.75	1.89E+11	0	0	1.70E+11	1.89E+10
5	34.63	2.80E+10	0	0	2.52E+10	2.80E+09
10	24.82	2.00E+10	0	0	1.80E+10	2.00E+09
15	19.05	1.54E+10	0	0	1.38E+10	1.54E+09
20	14.62	1.18E+10	0	0	1.06E+10	1.18E+09
25	12.60	1.02E+10	0	0	9.16E+09	1.02E+09
30	10.39	8.39E+09	0	0	7.55E+09	8.39E+08
35	8.54	6.90E+09	0	0	6.21E+09	6.90E+08
40	7.25	5.86E+09	0	0	5.27E+09	5.86E+08
45	6.12	4.94E+09	0	0	4.45E+09	4.94E+08
50	5.08	4.10E+09	0	0	3.69E+09	4.10E+08
55	4.21	3.40E+09	0	0	3.06E+09	3.40E+08
60	3.52	2.84E+09	0	0	2.56E+09	2.84E+08
65	2.94	2.38E+09	0	0	2.14E+09	2.38E+08
70	2.40	1.94E+09	0	0	1.75E+09	1.94E+08
75	1.94	1.57E+09	0	0	1.41E+09	1.57E+08
80	1.53	1.23E+09	0	0	1.11E+09	1.23E+08
85	1.18	9.55E+08	0	0	8.60E+08	9.55E+07
90	0.87	7.04E+08	0	0	6.33E+08	7.04E+07
95	0.59	4.80E+08	0	0	4.32E+08	4.80E+07
100	0.0	8.07E+06	0	0	7.27E+06	8.07E+05

Table 5-28 E.coli TMDL Calculations for Pea Creek (OK121500020100_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA $_{MS4}$ (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	41.70	1.29E+11	0	0	1.16E+11	1.29E+10
5	6.18	1.90E+10	0	0	1.71E+10	1.90E+09
10	4.43	1.36E+10	0	0	1.23E+10	1.36E+09
15	3.40	1.05E+10	0	0	9.43E+09	1.05E+09
20	2.61	8.04E+09	0	0	7.24E+09	8.04E+08
25	2.25	6.93E+09	0	0	6.24E+09	6.93E+08
30	1.85	5.71E+09	0	0	5.14E+09	5.71E+08
35	1.52	4.70E+09	0	0	4.23E+09	4.70E+08
40	1.29	3.99E+09	0	0	3.59E+09	3.99E+08
45	1.09	3.36E+09	0	0	3.03E+09	3.36E+08
50	0.91	2.79E+09	0	0	2.51E+09	2.79E+08
55	0.75	2.32E+09	0	0	2.09E+09	2.32E+08
60	0.63	1.94E+09	0	0	1.74E+09	1.94E+08
65	0.53	1.62E+09	0	0	1.46E+09	1.62E+08
70	0.43	1.32E+09	0	0	1.19E+09	1.32E+08
75	0.35	1.07E+09	0	0	9.62E+08	1.07E+08
80	0.27	8.41E+08	0	0	7.57E+08	8.41E+07
85	0.21	6.51E+08	0	0	5.86E+08	6.51E+07
90	0.16	4.79E+08	0	0	4.31E+08	4.79E+07
95	0.11	3.27E+08	0	0	2.94E+08	3.27E+07
100	0.00	3.08E+06	0	0	2.77E+06	3.08E+05

Table 5-29 Enterococci TMDL Calculations for Pea Creek (OK121500020100_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	41.70	3.37E+10	0	0	3.03E+10	3.37E+09
5	6.18	4.99E+09	0	0	4.49E+09	4.99E+08
10	4.43	3.57E+09	0	0	3.22E+09	3.57E+08
15	3.40	2.74E+09	0	0	2.47E+09	2.74E+08
20	2.61	2.11E+09	0	0	1.90E+09	2.11E+08
25	2.25	1.82E+09	0	0	1.63E+09	1.82E+08
30	1.85	1.50E+09	0	0	1.35E+09	1.50E+08
35	1.52	1.23E+09	0	0	1.11E+09	1.23E+08
40	1.29	1.04E+09	0	0	9.40E+08	1.04E+08
45	1.09	8.81E+08	0	0	7.93E+08	8.81E+07
50	0.91	7.32E+08	0	0	6.58E+08	7.32E+07
55	0.75	6.07E+08	0	0	5.46E+08	6.07E+07
60	0.63	5.07E+08	0	0	4.56E+08	5.07E+07
65	0.53	4.24E+08	0	0	3.82E+08	4.24E+07
70	0.43	3.46E+08	0	0	3.12E+08	3.46E+07
75	0.35	2.80E+08	0	0	2.52E+08	2.80E+07
80	0.27	2.20E+08	0	0	1.98E+08	2.20E+07
85	0.21	1.70E+08	0	0	1.53E+08	1.70E+07
90	0.16	1.26E+08	0	0	1.13E+08	1.26E+07
95	0.11	8.57E+07	0	0	7.71E+07	8.57E+06
100	0.00	8.07E+05	0	0	7.27E+05	8.07E+04

Table 5-30 Enterococci TMDL Calculations for Verdigris River near Inola (OK121500020260_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	345660.06	2.79E+14	8.15E+09	0.00E+00	2.51E+14	2.79E+13
5	37812.54	3.05E+13	8.15E+09	0.00E+00	2.75E+13	3.05E+12
10	25208.36	2.04E+13	8.15E+09	0.00E+00	1.83E+13	2.04E+12
15	18753.49	1.51E+13	8.15E+09	0.00E+00	1.36E+13	1.51E+12
20	13654.53	1.10E+13	8.15E+09	0.00E+00	9.91E+12	1.10E+12
25	10121.54	8.17E+12	8.15E+09	0.00E+00	7.35E+12	8.17E+11
30	6970.49	5.63E+12	8.15E+09	0.00E+00	5.06E+12	5.63E+11
35	4526.05	3.65E+12	8.15E+09	0.00E+00	3.28E+12	3.65E+11
40	2998.27	2.42E+12	8.15E+09	0.00E+00	2.17E+12	2.42E+11
45	2081.60	1.68E+12	8.15E+09	0.00E+00	1.50E+12	1.68E+11
50	1451.39	1.17E+12	8.15E+09	0.00E+00	1.05E+12	1.17E+11
55	987.33	7.97E+11	8.15E+09	0.00E+00	7.09E+11	7.97E+10
60	655.04	5.29E+11	8.15E+09	0.00E+00	4.68E+11	5.29E+10
65	427.78	3.45E+11	8.15E+09	0.00E+00	3.03E+11	3.45E+10
70	301.74	2.44E+11	8.15E+09	0.00E+00	2.11E+11	2.44E+10
75	215.80	1.74E+11	8.15E+09	0.00E+00	1.49E+11	1.74E+10
80	152.78	1.23E+11	8.15E+09	0.00E+00	1.03E+11	1.23E+10
85	118.40	9.56E+10	8.15E+09	0.00E+00	7.79E+10	9.56E+09
90	80.21	6.48E+10	8.15E+09	0.00E+00	5.01E+10	6.48E+09
95	38.19	3.08E+10	8.15E+09	0.00E+00	1.96E+10	3.08E+09
100	0.01	8.07E+06	8.15E+09	0	0	8.07E+05

Table 5-31 E.coli TMDL Calculations for Dog Creek (OK121500020360_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	611.70	1.89E+12	0	0	1.70E+12	1.89E+11
5	90.62	2.79E+11	0	0	2.51E+11	2.79E+10
10	64.95	2.00E+11	0	0	1.80E+11	2.00E+10
15	49.84	1.54E+11	0	0	1.38E+11	1.54E+10
20	38.26	1.18E+11	0	0	1.06E+11	1.18E+10
25	32.98	1.02E+11	0	0	9.15E+10	1.02E+10
30	27.19	8.38E+10	0	0	7.54E+10	8.38E+09
35	22.35	6.89E+10	0	0	6.20E+10	6.89E+09
40	18.98	5.85E+10	0	0	5.27E+10	5.85E+09
45	16.01	4.93E+10	0	0	4.44E+10	4.93E+09
50	13.29	4.10E+10	0	0	3.69E+10	4.10E+09
55	11.03	3.40E+10	0	0	3.06E+10	3.40E+09
60	9.21	2.84E+10	0	0	2.56E+10	2.84E+09
65	7.70	2.37E+10	0	0	2.14E+10	2.37E+09
70	6.29	1.94E+10	0	0	1.75E+10	1.94E+09
75	5.08	1.57E+10	0	0	1.41E+10	1.57E+09
80	4.00	1.23E+10	0	0	1.11E+10	1.23E+09
85	3.10	9.54E+09	0	0	8.59E+09	9.54E+08
90	2.28	7.03E+09	0	0	6.33E+09	7.03E+08
95	1.56	4.80E+09	0	0	4.32E+09	4.80E+08
100	0.22	6.75E+08	0	0	6.08E+08	6.75E+07

Table 5-32 Enterococci TMDL Calculations for Dog Creek (OK121500020360_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	611.70	4.94E+11	0	0	4.44E+11	4.94E+10
5	90.62	7.32E+10	0	0	6.58E+10	7.32E+09
10	64.95	5.24E+10	0	0	4.72E+10	5.24E+09
15	49.84	4.02E+10	0	0	3.62E+10	4.02E+09
20	38.26	3.09E+10	0	0	2.78E+10	3.09E+09
25	32.98	2.66E+10	0	0	2.40E+10	2.66E+09
30	27.19	2.19E+10	0	0	1.98E+10	2.19E+09
35	22.35	1.80E+10	0	0	1.62E+10	1.80E+09
40	18.98	1.53E+10	0	0	1.38E+10	1.53E+09
45	16.01	1.29E+10	0	0	1.16E+10	1.29E+09
50	13.29	1.07E+10	0	0	9.66E+09	1.07E+09
55	11.03	8.90E+09	0	0	8.01E+09	8.90E+08
60	9.21	7.44E+09	0	0	6.69E+09	7.44E+08
65	7.70	6.22E+09	0	0	5.60E+09	6.22E+08
70	6.29	5.08E+09	0	0	4.57E+09	5.08E+08
75	5.08	4.11E+09	0	0	3.69E+09	4.11E+08
80	4.00	3.23E+09	0	0	2.91E+09	3.23E+08
85	3.10	2.50E+09	0	0	2.25E+09	2.50E+08
90	2.28	1.84E+09	0	0	1.66E+09	1.84E+08
95	1.56	1.26E+09	0	0	1.13E+09	1.26E+08
100	0.22	1.77E+08	0	0	1.59E+08	1.77E+07

Table 5-33 Enterococci TMDL Calculations for Verdigris River near Claremore (OK121500030010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	181000.00	1.46E+14	4.37E+07	9.26E+12	1.22E+14	1.46E+13
5	19800.00	1.60E+13	4.37E+07	1.01E+12	1.34E+13	1.60E+12
10	13200.00	1.07E+13	4.37E+07	6.75E+11	8.92E+12	1.07E+12
15	9820.00	7.93E+12	4.37E+07	5.02E+11	6.63E+12	7.93E+11
20	7150.00	5.77E+12	4.37E+07	3.66E+11	4.83E+12	5.77E+11
25	5300.00	4.28E+12	4.37E+07	2.71E+11	3.58E+12	4.28E+11
30	3650.00	2.95E+12	4.37E+07	1.87E+11	2.47E+12	2.95E+11
35	2370.00	1.91E+12	4.37E+07	1.21E+11	1.60E+12	1.91E+11
40	1570.00	1.27E+12	4.37E+07	8.03E+10	1.06E+12	1.27E+11
45	1090.00	8.80E+11	4.37E+07	5.57E+10	7.36E+11	8.80E+10
50	760.00	6.14E+11	4.37E+07	3.89E+10	5.13E+11	6.14E+10
55	517.00	4.17E+11	4.37E+07	2.64E+10	3.49E+11	4.17E+10
60	343.00	2.77E+11	4.37E+07	1.75E+10	2.32E+11	2.77E+10
65	224.00	1.81E+11	4.37E+07	1.15E+10	1.51E+11	1.81E+10
70	158.00	1.28E+11	4.37E+07	8.08E+09	1.07E+11	1.28E+10
75	113.00	9.12E+10	4.37E+07	5.77E+09	7.63E+10	9.12E+09
80	80.00	6.46E+10	4.37E+07	4.09E+09	5.40E+10	6.46E+09
85	62.00	5.01E+10	4.37E+07	3.17E+09	4.18E+10	5.01E+09
90	42.00	3.39E+10	4.37E+07	2.14E+09	2.83E+10	3.39E+09
95	20.00	1.61E+10	4.37E+07	1.02E+09	1.35E+10	1.61E+09
100	0.0	8.07E+06	4.37E+07	0	0	8.07E+05

Table 5-34 Enterococci TMDL Calculations for Neosho River near Fort. Gibson (OK121600010010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	7533.12	6.08E+12	0	0	5.47E+12	6.08E+11
5	824.07	6.65E+11	0	0	5.99E+11	6.65E+10
10	549.38	4.44E+11	0	0	3.99E+11	4.44E+10
15	408.70	3.30E+11	0	0	2.97E+11	3.30E+10
20	297.58	2.40E+11	0	0	2.16E+11	2.40E+10
25	220.58	1.78E+11	0	0	1.60E+11	1.78E+10
30	151.91	1.23E+11	0	0	1.10E+11	1.23E+10
35	98.64	7.96E+10	0	0	7.17E+10	7.96E+09
40	65.34	5.28E+10	0	0	4.75E+10	5.28E+09
45	45.37	3.66E+10	0	0	3.30E+10	3.66E+09
50	31.63	2.55E+10	0	0	2.30E+10	2.55E+09
55	21.52	1.74E+10	0	0	1.56E+10	1.74E+09
60	14.28	1.15E+10	0	0	1.04E+10	1.15E+09
65	9.32	7.53E+09	0	0	6.77E+09	7.53E+08
70	6.58	5.31E+09	0	0	4.78E+09	5.31E+08
75	4.70	3.80E+09	0	0	3.42E+09	3.80E+08
80	3.33	2.69E+09	0	0	2.42E+09	2.69E+08
85	2.58	2.08E+09	0	0	1.88E+09	2.08E+08
90	1.75	1.41E+09	0	0	1.27E+09	1.41E+08
95	0.83	6.72E+08	0	0	6.05E+08	6.72E+07
100	0.00	0.00E+00	0	0	0.00E+00	0.00E+00

Table 5-35 E.coli TMDL Calculations for Chouteau Creek (OK121600010430_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA $_{MS4}$ (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	683.19	2.11E+12	1.53E+09	0	1.89E+12	2.11E+11
5	101.21	3.12E+11	1.53E+09	0	2.79E+11	3.12E+10
10	72.54	2.24E+11	1.53E+09	0	2.00E+11	2.24E+10
15	55.67	1.72E+11	1.53E+09	0	1.53E+11	1.72E+10
20	42.73	1.32E+11	1.53E+09	0	1.17E+11	1.32E+10
25	36.83	1.14E+11	1.53E+09	0	1.01E+11	1.14E+10
30	30.36	9.36E+10	1.53E+09	0	8.27E+10	9.36E+09
35	24.97	7.70E+10	1.53E+09	0	6.77E+10	7.70E+09
40	21.20	6.53E+10	1.53E+09	0	5.73E+10	6.53E+09
45	17.88	5.51E+10	1.53E+09	0	4.81E+10	5.51E+09
50	14.84	4.58E+10	1.53E+09	0	3.97E+10	4.58E+09
55	12.31	3.80E+10	1.53E+09	0	3.26E+10	3.80E+09
60	10.29	3.17E+10	1.53E+09	0	2.70E+10	3.17E+09
65	8.60	2.65E+10	1.53E+09	0	2.23E+10	2.65E+09
70	7.03	2.17E+10	1.53E+09	0	1.80E+10	2.17E+09
75	5.68	1.75E+10	1.53E+09	0	1.42E+10	1.75E+09
80	4.47	1.38E+10	1.53E+09	0	1.09E+10	1.38E+09
85	3.46	1.07E+10	1.53E+09	0	8.07E+09	1.07E+09
90	2.55	7.85E+09	1.53E+09	0	5.54E+09	7.85E+08
95	1.74	5.36E+09	1.53E+09	0	3.30E+09	5.36E+08
100	0.00	1.53E+09	1.53E+09	0	0	0

Table 5-36 Enterococci TMDL Calculations for Chouteau Creek (OK121600010430_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA $_{MS4}$ (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	683.19	5.52E+11	4.00E+08	0	4.96E+11	5.52E+10
5	101.21	8.17E+10	4.00E+08	0	7.31E+10	8.17E+09
10	72.54	5.86E+10	4.00E+08	0	5.23E+10	5.86E+09
15	55.67	4.49E+10	4.00E+08	0	4.00E+10	4.49E+09
20	42.73	3.45E+10	4.00E+08	0	3.07E+10	3.45E+09
25	36.83	2.97E+10	4.00E+08	0	2.64E+10	2.97E+09
30	30.36	2.45E+10	4.00E+08	0	2.17E+10	2.45E+09
35	24.97	2.02E+10	4.00E+08	0	1.77E+10	2.02E+09
40	21.20	1.71E+10	4.00E+08	0	1.50E+10	1.71E+09
45	17.88	1.44E+10	4.00E+08	0	1.26E+10	1.44E+09
50	14.84	1.20E+10	4.00E+08	0	1.04E+10	1.20E+09
55	12.31	9.94E+09	4.00E+08	0	8.55E+09	9.94E+08
60	10.29	8.31E+09	4.00E+08	0	7.08E+09	8.31E+08
65	8.60	6.95E+09	4.00E+08	0	5.85E+09	6.95E+08
70	7.03	5.67E+09	4.00E+08	0	4.71E+09	5.67E+08
75	5.68	4.59E+09	4.00E+08	0	3.73E+09	4.59E+08
80	4.47	3.61E+09	4.00E+08	0	2.85E+09	3.61E+08
85	3.46	2.79E+09	4.00E+08	0	2.11E+09	2.79E+08
90	2.55	2.06E+09	4.00E+08	0	1.45E+09	2.06E+08
95	1.74	1.40E+09	4.00E+08	0	8.64E+08	1.40E+08
100	0.00	8.07E+05	4.00E+08	0	0	8.07E+04

Table 5-37 Total Suspended Solids TMDL Calculations for Dirty Creek (OK410400010070_00)

Flow Exceedance Frequency	Flow (cfs)	TMDL (lbs/day)	WWTP (lbs/day)	MS4 (lbs/day)	Growth (lbs/day)	LA (lbs/day)	MOS (lbs/day)
0	2240.06	N/A	0	0	N/A	N/A	N/A
5	331.86	N/A	0	0	N/A	N/A	N/A
10	237.83	N/A	0	0	N/A	N/A	N/A
15	182.52	N/A	0	0	N/A	N/A	N/A
20	140.12	N/A	0	0	N/A	N/A	N/A
25	120.76	66362.70	0	0	663.63	59062.80	6636.27
30	99.56	54711.23	0	0	547.11	48693.00	5471.12
35	81.86	44984.79	0	0	449.85	40036.46	4498.48
40	69.51	38196.55	0	0	381.97	33994.93	3819.65
45	58.62	32216.30	0	0	322.16	28672.51	3221.63
50	48.67	26747.71	0	0	267.48	23805.46	2674.77
55	40.38	22188.44	0	0	221.88	19747.72	2218.84
60	33.74	18541.03	0	0	185.41	16501.52	1854.10
65	28.21	15501.52	0	0	155.02	13796.35	1550.15
70	23.05	12664.64	0	0	126.65	11271.53	1266.46
75	18.62	10233.03	0	0	102.33	9107.39	1023.30
80	14.66	8054.71	0	0	80.55	7168.69	805.47
85	11.34	6231.00	0	0	62.31	5545.59	623.10
90	8.35	4589.16	0	0	45.89	4084.35	458.92
95	5.70	3132.98	0	0	31.33	2788.35	313.30
100	0.01	5.50	0	0	0.05	4.89	0.55

Table 5-38 Total Suspended Solids TMDL Calculations for Butler Creek (OK120400020160_00)

Flow Exceedance Frequency	Flow (cfs)	TMDL (lbs/day)	WWTP (lbs/day)	MS4 (lbs/day)	Growth (lbs/day)	LA (lbs/day)	MOS (lbs/day)
0	184.09	N/A	0	0	N/A	N/A	N/A
5	27.27	N/A	0	0	N/A	N/A	N/A
10	19.54	N/A	0	0	N/A	N/A	N/A
15	15.00	N/A	0	0	N/A	N/A	N/A
20	11.51	N/A	0	0	N/A	N/A	N/A
25	9.92	5453.61	0	0	54.54	4853.71	545.36
30	8.18	4496.11	0	0	44.96	4001.54	449.61
35	6.73	3696.80	0	0	36.97	3290.15	369.68
40	5.71	3138.95	0	0	31.39	2793.66	313.89
45	4.82	2647.50	0	0	26.47	2356.27	264.75
50	4.00	2198.10	0	0	21.98	1956.31	219.81
55	3.32	1823.42	0	0	18.23	1622.84	182.34
60	2.77	1523.68	0	0	15.24	1356.08	152.37
65	2.32	1273.90	0	0	12.74	1133.77	127.39
70	1.89	1040.77	0	0	10.41	926.28	104.08
75	1.53	840.94	0	0	8.41	748.44	84.09
80	1.20	661.93	0	0	6.62	589.11	66.19
85	0.93	512.06	0	0	5.12	455.73	51.21
90	0.69	377.13	0	0	3.77	335.65	37.71
95	0.47	257.46	0	0	2.57	229.14	25.75
100	0.01	5.50	0	0	0.05	4.89	0.55

Table 5-39 Total Suspended Solids TMDL Calculations for Cloud Creek (OK120410010100_00)

Flow Exceedance Frequency	Flow (cfs)	TMDL (lbs/day)	WWTP (lbs/day)	MS4 (lbs/day)	Growth (lbs/day)	LA (lbs/day)	MOS (lbs/day)
0	339	N/A	0	0	N/A	N/A	N/A
5	50	N/A	0	0	N/A	N/A	N/A
10	36	N/A	0	0	N/A	N/A	N/A
15	28	N/A	0	0	N/A	N/A	N/A
20	21	N/A	0	0	N/A	N/A	N/A
25	18	10036.69	0	0	100.37	8932.66	1003.67
30	15	8274.53	0	0	82.75	7364.33	827.45
35	12	6803.50	0	0	68.03	6055.11	680.35
40	11	5776.85	0	0	57.77	5141.39	577.68
45	9	4872.39	0	0	48.72	4336.43	487.24
50	7	4045.32	0	0	40.45	3600.34	404.53
55	6	3355.78	0	0	33.56	2986.64	335.58
60	5	2804.15	0	0	28.04	2495.69	280.41
65	4	2344.45	0	0	23.44	2086.56	234.44
70	3	1915.40	0	0	19.15	1704.71	191.54
75	3	1547.64	0	0	15.48	1377.40	154.76
80	2	1218.19	0	0	12.18	1084.19	121.82
85	2	942.38	0	0	9.42	838.72	94.24
90	1	694.06	0	0	6.94	617.72	69.41
95	1	473.83	0	0	4.74	421.71	47.38
100	0.01	5.50	0	0	0.05	4.89	0.55

Table 5-40 Total Suspended Solids TMDL Calculations for Snake Creek (OK120410010220_00)

Flow Exceedance Frequency	Flow (cfs)	TMDL (lbs/day)	WWTP (lbs/day)	MS4 (lbs/day)	Growth (lbs/day)	LA (lbs/day)	MOS (lbs/day)
0	518	N/A	700.56	0	N/A	N/A	N/A
5	77	N/A	700.56	0	N/A	N/A	N/A
10	55	N/A	700.56	0	N/A	N/A	N/A
15	42	N/A	700.56	0	N/A	N/A	N/A
20	32	N/A	700.56	0	N/A	N/A	N/A
25	27.94	15356.46	700.56	0	153.56	12198.86	2303.47
30	23.04	12660.29	700.56	0	126.60	9934.08	1899.04
35	18.94	10409.57	700.56	0	104.10	8043.48	1561.44
40	16.08	8838.75	700.56	0	88.39	6723.99	1325.81
45	13.57	7454.92	700.56	0	74.55	5561.57	1118.24
50	11.26	6189.47	700.56	0	61.89	4498.60	928.42
55	9.34	5134.45	700.56	0	51.34	3612.38	770.17
60	7.81	4290.43	700.56	0	42.90	2903.40	643.56
65	6.53	3587.08	700.56	0	35.87	2312.59	538.06
70	5.33	2930.62	700.56	0	29.31	1761.16	439.59
75	4.31	2367.94	700.56	0	23.68	1288.51	355.19
80	3.39	1863.88	700.56	0	18.64	865.10	279.58
85	2.62	1441.87	700.56	0	14.42	510.61	216.28
90	1.93	1061.94	700.56	0	10.62	191.47	159.29
95	1.32	724.98	700.56	0	0.00	24.42	0.00
100	0.01	5.50	700.56	0	0.00	0.00	0.00

Table 5-41 Total Suspended Solids TMDL Calculations for Verdigris River near Wagoner (OK121500010200_00)

Flow Exceedance Frequency	Flow (cfs)	TMDL (lbs/day)	WWTP (lbs/day)	MS4 (lbs/day)	Growth (lbs/day)	LA (lbs/day)	MOS (lbs/day)
0	112476	N/A	0	0	N/A	N/A	N/A
5	12304	N/A	0	0	N/A	N/A	N/A
10	8203	N/A	0	0	N/A	N/A	N/A
15	6102	N/A	0	0	N/A	N/A	N/A
20	4443	N/A	0	0	N/A	N/A	N/A
25	3293	1809904.04	0	0	18099.04	1520319.39	271485.61
30	2268	1246443.35	0	0	12464.43	1047012.41	186966.50
35	1473	809334.45	0	0	8093.34	679840.93	121400.17
40	976	536141.38	0	0	5361.41	450358.76	80421.21
45	677	372225.55	0	0	3722.26	312669.46	55833.83
50	472	259533.41	0	0	2595.33	218008.06	38930.01
55	321	176551.02	0	0	1765.51	148302.85	26482.65
60	213	117131.53	0	0	1171.32	98390.48	17569.73
65	139	76494.06	0	0	764.94	64255.01	11474.11
70	98	53955.63	0	0	539.56	45322.73	8093.34
75	70	38588.52	0	0	385.89	32414.36	5788.28
80	50	27319.31	0	0	273.19	22948.22	4097.90
85	39	21172.46	0	0	211.72	17784.87	3175.87
90	26	14342.64	0	0	143.43	12047.81	2151.40
95	12	6829.83	0	0	68.30	5737.05	1024.47
100	0.01	5.50	0	0	0.05	4.62	0.82

Table 5-42 Total Suspended Solids TMDL Calculations for Bull Creek (OK121500020090_00)

Flow Exceedance Frequency	Flow (cfs)	TMDL (lbs/day)	WWTP (lbs/day)	MS4 (lbs/day)	Growth (lbs/day)	LA (lbs/day)	MOS (lbs/day)
0	234	N/A	0	0	N/A	N/A	N/A
5	35	N/A	0	0	N/A	N/A	N/A
10	25	N/A	0	0	N/A	N/A	N/A
15	19	N/A	0	0	N/A	N/A	N/A
20	15	N/A	0	0	N/A	N/A	N/A
25	13	6924.82	0	0	69.25	6163.09	692.48
30	10	5709.01	0	0	57.09	5081.02	570.90
35	9	4694.08	0	0	46.94	4177.73	469.41
40	7	3985.74	0	0	39.86	3547.31	398.57
45	6	3361.71	0	0	33.62	2991.92	336.17
50	5	2791.07	0	0	27.91	2484.06	279.11
55	4	2315.32	0	0	23.15	2060.64	231.53
60	4	1934.72	0	0	19.35	1721.90	193.47
65	3	1617.55	0	0	16.18	1439.62	161.76
70	2	1321.53	0	0	13.22	1176.16	132.15
75	2	1067.80	0	0	10.68	950.34	106.78
80	2	840.49	0	0	8.40	748.04	84.05
85	1	650.19	0	0	6.50	578.67	65.02
90	1	478.87	0	0	4.79	426.19	47.89
95	1	326.92	0	0	3.27	290.96	32.69
100	0.01	5.50	0	0	0.05	4.89	0.55

Table 5-43 Total Suspended Solids TMDL Calculations for Verdigris River near Inola (OK121500020260_00)

Flow Exceedance Frequency	Flow (cfs)	TMDL (lbs/day)	WWTP (lbs/day)	MS4 (lbs/day)	Growth (lbs/day)	LA (lbs/day)	MOS (lbs/day)
0	345660	N/A	5.34E+02	0	N/A	N/A	N/A
5	37813	N/A	5.34E+02	0	N/A	N/A	N/A
10	25208	N/A	5.34E+02	0	N/A	N/A	N/A
15	18753	N/A	5.34E+02	0	N/A	N/A	N/A
20	13655	N/A	5.34E+02	0	N/A	N/A	N/A
25	10122	5.56E+06	5.34E+02	0	5.56E+04	4.95E+06	5.56E+05
30	6970	3.83E+06	5.34E+02	0	3.83E+04	3.41E+06	3.83E+05
35	4526	2.49E+06	5.34E+02	0	2.49E+04	2.21E+06	2.49E+05
40	2998	1.65E+06	5.34E+02	0	1.65E+04	1.47E+06	1.65E+05
45	2082	1.14E+06	5.34E+02	0	1.14E+04	1.02E+06	1.14E+05
50	1451	7.98E+05	5.34E+02	0	7.98E+03	7.09E+05	7.98E+04
55	987	5.43E+05	5.34E+02	0	5.43E+03	4.82E+05	5.43E+04
60	655	3.60E+05	5.34E+02	0	3.60E+03	3.20E+05	3.60E+04
65	428	2.35E+05	5.34E+02	0	2.35E+03	2.09E+05	2.35E+04
70	302	1.66E+05	5.34E+02	0	1.66E+03	1.47E+05	1.66E+04
75	216	1.19E+05	5.34E+02	0	1.19E+03	1.05E+05	1.19E+04
80	153	8.40E+04	5.34E+02	0	8.40E+02	7.42E+04	8.40E+03
85	118	6.51E+04	5.34E+02	0	6.51E+02	5.74E+04	6.51E+03
90	80	4.41E+04	5.34E+02	0	4.41E+02	3.87E+04	4.41E+03
95	38	2.10E+04	5.34E+02	0	2.10E+02	1.81E+04	2.10E+03
100	0.01	5.34E+02	5.34E+02	0	5.34E+00	0.00E+00	0.00E+00

5.9 TMDL Implementation

DEQ will collaborate with a host of other state agencies and local governments working within the boundaries of state and local regulations to target available funding and technical assistance to support implementation of pollution controls and management measures. Various water quality management programs and funding sources will be utilized so that the pollutant reductions as required by these TMDLs can be achieved and water quality can be restored to maintain designated uses. DEQ's Continuing Planning Process (CPP), required by the CWA §303(e)(3) and 40 CFR 130.5, summarizes Oklahoma's commitments and programs aimed at restoring and protecting water quality throughout the State (DEQ 2006). The CPP can be viewed from DEQ's website at http://www.deq.state.ok.us/wqdnew/pubs/2006_CPP_final.pdf

Table 5-19 provides a partial list of the State partner agencies DEQ will collaborate with to address point and nonpoint source reduction goals established by TMDLs.

Table 5-45 Partial List of Oklahoma Water Quality Management Agencies

Agency	Web Link
Oklahoma Conservation Commission	http://www.ok.gov/conservation/Agency_Divisions/Water_Quality_Division
Oklahoma Department of Wildlife Conservation	http://www.wildlifedepartment.com/wildlifemgmt/endangeredspecies.htm
Oklahoma Department of Agriculture, Food, and Forestry	http://www.ok.gov/~okag/aems
Oklahoma Water Resources Board	http://www.owrb.state.ok.us/quality/index.php

5.9.1 Point Sources

As authorized by Section 402 of the CWA, the DEQ has delegation of the NPDES Program in Oklahoma, except for certain jurisdictional areas related to agriculture (retained by State Department of Agriculture, Food, and Forestry), and the oil & gas industry (retained by the Oklahoma Corporation Commission) for which the EPA has retained permitting authority. The NPDES Program in Oklahoma, in accordance with an agreement between DEQ and EPA relating to administration and enforcement of the delegated NPDES Program, is implemented via the Oklahoma Pollution Discharge Elimination System (OPDES) Act [Title 252, Chapter 606 (http://www.deq.state.ok.us/rules/611.pdf)]. Point source WLAs are outlined in the Oklahoma Water Quality Management Plan (aka the 208 Plan) under the OPDES program.

5.9.2 Non-Point Sources

Nonpoint source pollution in Oklahoma is managed by the Oklahoma Conservation Commission. The Oklahoma Conservation Commission works with state partners such as ODAFF and federal partners such as the EPA and the National Resources Conservation Service of the U.S. Department of Agriculture, to address water quality problems similar to those seen in the Study Area. The primary mechanisms used for management of nonpoint source pollution are incentive-based programs that support the installation of BMPs and public education and outreach. Other programs include regulations and permits for CAFOs. The CAFO Act, as administered by the ODAFF, provides CAFO operators the necessary tools and information to deal with the manure and wastewater animals produce so streams, lakes, ponds, and groundwater sources are not polluted.

The reduction rates called for in this TMDL report are as high as 96.5%. The DEQ recognizes that achieving such high reductions will be a challenge, especially since unregulated nonpoint sources are a major cause of both bacterial and TSS loading. The high reduction rates are not uncommon for pathogen- or TSS-impaired waters. Similar reduction rates are often found in other pathogen and TSS TMDLs around the nation. The suitability of the current criteria for pathogens and the beneficial uses of a waterbody should be reviewed. For example, the Kansas Department of Environmental Quality has proposed to exclude certain high flow conditions during which pathogen standards will not apply, although that exclusion was not approved by the EPA. Additionally, EPA has been conducting new epidemiology studies and may develop new recommendations for pathogen criteria in the near future.

Revisions to the current pathogen provisions of Oklahoma's WQSs should be considered. There are three basic approaches to such revisions that may apply.

- Removing the PBCR use: This revision would require documentation in a Use Attainability Analysis that the use is not an existing use and cannot be attained. It is unlikely that this approach would be successful since there is evidence that people do swim in this segment of the river, thus constituting an existing use. Existing uses cannot be removed.

- Modifying application of the existing criteria: This approach would include considerations such as an exemption under certain high flow conditions, an allowance for wildlife or "natural conditions," a sub-category of the use or other special provision for urban areas, or other special provisions for storm flows. Since large bacterial violations occur over all flow ranges, it is likely that large reductions would still be necessary. However, this approach may have merit and should be considered.

- Revising the existing numeric criteria: Oklahoma's current pathogen criteria, revised in 2011, are based on EPA guidelines (See the *2012 Draft Recreational Water Quality Criteria*, December 2011; Implementation Guidance for Ambient Water Quality Criteria for Bacteria, May 2002 Draft; and Ambient Water Quality Criteria for Bacteria-1986, January 1986). However, those guidelines have received much criticism and EPA studies that could result in revisions to their recommendations are ongoing. The numeric criteria values should also be evaluated using a risk-based method such as that found in EPA guidance.

Unless or until the WQSs are revised and approved by EPA, federal rules require that the TMDLs in this report must be based on attainment of the current standards. If revisions to the pathogen standards are approved in the future, reductions specified in these TMDLs will be re-evaluated.

5.10 Reasonable Assurances

Reasonable assurance is required by the EPA guidance for a TMDL to be approvable only when a waterbody is impaired by both point and non-point sources and where a point source is given a less stringent wasteload allocation based on an assumption that nonpoint source load reductions will occur. In such a case, "reasonable assurance" that the NPS load reductions will actually occur must be demonstrated. In this report, all point source discharges either already have or will be given discharging discharge limitations less than or equal to the water quality standards numerical criteria. This ensures that the impairments to of the waterbodies in this report will not be caused by point sources. Since the point source WLAs in this TMDL report are not dependent on NPS load reduction, reasonable assurance does not apply.

SECTION 6
PUBLIC PARTICIPATION

This report was preliminarily reviewed by EPA prior to the public notice. The public notice was then sent to local newspapers, to stakeholders in the area affected by the TMDLs in this Study Area, and to stakeholders who have requested all copies of TMDL public notices. The public notice was also posted at the DEQ website: http://www.deq.state.ok.us/wqdnew/index.htm.

The public comment period lasted 45 days. During that time, the public had the opportunity to review the TMDL report and make written comments. Public comments were received from four people during the public notice period. The comments and responses to those comments can be found in Appendix F. There were no requests for a public meeting.

After EPA's final approval, each TMDL will be adopted into the Water Quality Management Plan (WQMP). These TMDLs provide a mathematical solution to meet ambient water quality criteria with a given set of facts. The adoption of these TMDLs into the WQMP provides a mechanism to recalculate acceptable loads when information changes in the future. Updates to the WQMP demonstrate compliance with the water quality criteria. The updates to the WQMP are also useful when the water quality criteria change and the loading scenario is reviewed to ensure that the instream criterion is predicted to be met.

SECTION 7
REFERENCES

American Veterinary Medical Association 2007. U.S. Pet Ownership and Demographics Sourcebook (2007 Edition). Schaumberg, IL.

ASAE (American Society of Agricultural Engineers) 1999. ASAE standards, 46th edition: standards, engineering practices, data. St. Joseph, MI.

Canter, LW and RC Knox 1985. Septic tank system effects on ground water quality. Lewis Publishers, Boca Raton, FL.

Cogger, CG and BL Carlile 1984. Field performance of conventional and alternative septic systems in wet soils. *J. Environ. Qual*. 13 (1).

DEQ 2006. The State of Oklahoma 2006 Continuing Planning Process. http://www.deq.state.ok.us/wqdnew/pubs/2006_CPP_final.pdf.

DEQ 2007. Reissuance of General Permit OKR10 for Storm Water Discharges from Construction Activities within the State of Oklahoma. Fact Sheet. July 24, 2007.

DEQ 2008. *Water Quality in Oklahoma, 2008 Integrated Report*. http://www.deq.state.ok.us/WQDnew/305b_303d/2008_integrated_report_entire_document.pdf

DEQ 2011. General Permit for Storm Water Discharges From Industrial Activities Under The Multi-Sector Industrial General Permit. Fact Sheet. August 5, 2011. http://www.deq.state.ok.us/WQDnew/stormwater/msgp/msgp_okr05_fact_sheet_2011-08-05.pdf

DEQ 2011a *Individual and Small Public On-Site Sewage Treatment systems (Chapter 641).* July 1, 2011.

Drapcho, C.M. and A.K.B. Hubbs 2002. Fecal Coliform Concentration in Runoff from Fields with Applied Dairy Manure. http://www.lwrri.lsu.edu/downloads/Drapcho_annual%20report01-02.pdf

EPA 1983. Final Report of the Nationwide Urban Runoff Program. U.S. Environmental Protection Agency, Water Planning Division.

EPA 1991. Guidance for Water Quality-Based Decisions: The TMDL Process. Office of Water, EPA 440/4-91-001.

EPA 2001. 2001 Protocol for Developing Pathogen TMDLs. First Edition. Office of Water, EPA 841-R-00-002.

EPA 2003. Guidance for 2004 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d) and 305(b) of the Clean Water Act, TMDL -01-03 - Diane Regas-- July 21, 2003.

EPA 2005. U.S. Environmental Protection Agency, Office of Water. Stormwater Phase II Final Rule. EPA833-F-00-002 Fact Sheet 2.0. December 2005.

Hall, S. 2002. Washington State Department of Health, Wastewater Management Program Rule Development Committee, Issue Research Report - Failing Systems, June 2002.

Helsel, D.R. and R.M. Hirsch 2002. Statistical Methods in Water Resources. U.S. Department of the Interior, U.S. Geological Survey, September 2002.

Metcalf and Eddy 1991. Wastewater Engineering: Treatment, Disposal, Reuse: 2nd Edition.

ODAFF 2009, Agricultural Environmental Management Services, http://www.ok.gov/~okag/aems/

Oklahoma Climate Survey. 2005. Viewed August 29, 2005 in http://climate.ocs.ou.edu/county_climate/Products/County_Climatologies/

Oklahoma Department of Wildlife Conservation (ODWC) 2009. Deer Harvest Totals. http://www.wildlifedepartment.com/hunting/deerharvesttotals.htm

OWRB 2011. Oklahoma Water Resources Board. *Chapter 45: Oklahoma Water Quality Standards*. http://www.owrb.ok.gov/util/rules/pdf_rul/RulesCurrent2011/Ch45-Current2011.pdf

OWRB 2011a. Oklahoma Water Resources Board. Chapter 46: Implementation of Oklahoma's Water Quality Standards . http://www.owrb.ok.gov/util/rules/pdf_rul/RulesCurrent2011/Ch46Current2011.pdf.

Reed, Stowe &Yanke, LLC 2001. *Study to Determine the Magnitude of, and Reasons for, Chronically Malfunctioning On-Site Sewage Facility Systems in Texas*. September 2001.

Schueler, TR 2000. Microbes and Urban Watersheds: Concentrations, Sources, and Pathways. In *The Practice of Watershed Protection*, TR Schueler and HK Holland, eds. Center for Watershed Protection, Ellicott City, MD.

Tukey, J.W. 1977. Exploratory Data Analysis. Addison-Wesely.

University of Florida 1987. Institute of Food and Agricultural Sciences, University Of Florida, Florida Cooperative Extension Service, No. 31, December, 1987.

U.S. Census Bureau 1990. http://www.census.gov/prod/cen1990/ch2/ch-2-38.pdf.

U.S. Census Bureau 2010. http://2010.census.gov/2010census/data/.

USDA 2007. Census of Agriculture, National Agricultural Statistics Service, United States Department of Agriculture. http://www.agcensus.usda.gov/Publications/2007/Full_Report/Census_by_State/Oklahoma/index.asp

U.S. Department of Commerce, Bureau of the Census 1990. 1990 Census of Housing, Detailed Housing Characteristics Oklahoma. http://www.census.gov/prod/cen1990/ch2/ch-2-38.pdf

USGS 2007. Multi-Resolution Land Characteristics Consortium. http://www.mrlc.gov/index.asp

USGS 2007a. USGS Daily Streamflow Data. http://waterdata.usgs.gov/nwis/sw

Woods, A.J., Omernik, J.M., Butler, D.R., Ford, J.G., Henley, J.E., Hoagland, B.W., Arndt, D.S., and Moran, B.C., 2005. Ecoregions of Oklahoma (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,250,000).

APPENDIX A

AMBIENT WATER QUALITY DATA

BACTERIAL DATA — 2000 TO 2010

TURBIDITY AND TOTAL SUSPENDED SOLIDS DATA — 1998 TO 2011

Ambient Water Quality Bacterial Data, 2000-2010

Waterbody ID	Streams	WQM Station	Date	EC[1]	ENT[1]
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	5/30/2001	5492	28000
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	7/31/2001	9.99	9.99
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	9/18/2001	62	200
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	5/29/2002	4884	75000
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	6/25/2002	9.99	200
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	8/6/2002	41	100
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	9/4/2002	9.99	10
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	9/25/2002	31	80
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	5/4/2004	96	100
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	6/2/2004	52	200
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	7/6/2004	74	700
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	7/21/2004	10	10
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	8/10/2004	20	10
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	8/25/2004	31	10
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	9/14/2004	9.99	10
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	6/14/2006	15	10
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	7/18/2006	10	10
OK121400010260_00	Arkansas River near Muskogee	121400010260-001AT	9/19/2006	10	40
OK120400010400_00	Coody Creek	OK120400-01-0400F	07/22/03	240	610
OK120400010400_00	Coody Creek	OK120400-01-0400F	08/26/03	60	80
OK120400010400_00	Coody Creek	OK120400-01-0400F	09/30/03	50	140
OK120400010400_00	Coody Creek	OK120400-01-0400F	05/04/04	80	300
OK120400010400_00	Coody Creek	OK120400-01-0400F	06/15/04	140	270
OK120400010400_00	Coody Creek	OK120400-01-0400F	07/13/04	45	330
OK120400010400_00	Coody Creek	OK120400-01-0400F	08/17/04	125	115
OK120400010400_00	Coody Creek	OK120400-01-0400F	09/21/04	40	70
OK120400010400_00	Coody Creek	OK120400-01-0400F	05/25/05	150	160
OK120400010400_00	Coody Creek	OK120400-01-0400F	06/03/08	440	300
OK120400010400_00	Coody Creek	OK120400-01-0400F	07/08/08	700	180
OK120400010400_00	Coody Creek	OK120400-01-0400F	08/12/08	2000	2000
OK120400010400_00	Coody Creek	OK120400-01-0400F	09/23/08	60	40
OK120400010400_00	Coody Creek	OK120400-01-0400F	06/02/09	210	160
OK120400010400_00	Coody Creek	OK120400-01-0400F	07/07/09	660	200
OK120400010400_00	Coody Creek	OK120400-01-0400F	08/11/09	1000	1000
OK120400010400_00	Coody Creek	OK120400-01-0400F	09/15/09	28	860
OK120400010400_00	Coody Creek	OK120400-01-0400F	05/05/10	50	50
OK120400020010_00	Dirty Creek	OK120400-02-0010F	07/22/03	30	80
OK120400020010_00	Dirty Creek	OK120400-02-0010F	08/26/03	20	30

Waterbody ID	Streams	WQM Station	Date	EC[1]	ENT[1]
OK120400020010_00	Dirty Creek	OK120400-02-0010F	09/29/03	20	50
OK120400020010_00	Dirty Creek	OK120400-02-0010F	05/11/04	5	85
OK120400020010_00	Dirty Creek	OK120400-02-0010F	06/15/04	90	90
OK120400020010_00	Dirty Creek	OK120400-02-0010F	07/19/04	5	5
OK120400020010_00	Dirty Creek	OK120400-02-0010F	08/23/04	5	30
OK120400020010_00	Dirty Creek	OK120400-02-0010F	09/28/04	5	10
OK120400020010_00	Dirty Creek	OK120400-02-0010F	05/24/05	30	10
OK120400020010_00	Dirty Creek	OK120400-02-0010F	06/03/08	220	80
OK120400020010_00	Dirty Creek	OK120400-02-0010F	07/08/08	30	10
OK120400020010_00	Dirty Creek	OK120400-02-0010F	08/12/08	3200	10000
OK120400020010_00	Dirty Creek	OK120400-02-0010F	09/23/08	220	10
OK120400020010_00	Dirty Creek	OK120400-02-0010F	06/02/09	600	200
OK120400020010_00	Dirty Creek	OK120400-02-0010F	07/07/09	10	100
OK120400020010_00	Dirty Creek	OK120400-02-0010F	08/11/09	10	30
OK120400020010_00	Dirty Creek	OK120400-02-0010F	09/15/09	200	140
OK120400020010_00	Dirty Creek	OK120400-02-0010F	05/05/10	60	200
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	07/22/03	20	510
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	08/26/03	10	70
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	09/30/03	10	150
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	05/04/04	90	530
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	06/15/04	20	150
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	07/13/04	85	140
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	08/17/04	5	80
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	09/21/04	10	710
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	05/25/05	1000	1000
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	06/03/08	220	160
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	07/08/08	30	160
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	08/12/08	1800	5100
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	09/23/08	40	60
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	06/02/09	30	40
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	07/07/09	40	240
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	08/11/09	60	400
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	09/15/09	160	120
OK120400020030_00	South Fork of Dirty Creek	OK120400-02-0030F	05/05/10	140	40
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	07/22/03	30	270
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	08/26/03	40	60
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	09/30/03	50	50
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	05/04/04	80	440
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	06/15/04	50	415

Waterbody ID	Streams	WQM Station	Date	EC[1]	ENT[1]
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	07/13/04	100	200
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	08/17/04	20	50
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	09/21/04	30	80
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	05/25/05	1000	1000
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	06/03/08	240	100
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	07/08/08	60	80
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	08/12/08	2000	2000
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	09/23/08	70	150
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	06/02/09	190	60
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	07/07/09	10	70
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	08/11/09	20	160
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	09/14/09	80	140
OK120400020110_00	George's Fork of Dirty Creek	OK120400-02-0110D	05/05/10	20	10
OK120400020160_00	Butler Creek	OK120400-02-0160D	08/25/03	40	10
OK120400020160_00	Butler Creek	OK120400-02-0160D	09/29/03	10	10
OK120400020160_00	Butler Creek	OK120400-02-0160D	05/03/04	80	480
OK120400020160_00	Butler Creek	OK120400-02-0160D	06/14/04	125	80
OK120400020160_00	Butler Creek	OK120400-02-0160D	07/12/04	165	170
OK120400020160_00	Butler Creek	OK120400-02-0160D	08/16/04	20	60
OK120400020160_00	Butler Creek	OK120400-02-0160D	09/20/04	500	50
OK120400020160_00	Butler Creek	OK120400-02-0160D	05/24/05	50	90
OK120400020160_00	Butler Creek	OK120400-02-0160D	06/02/08	5300	2600
OK120400020160_00	Butler Creek	OK120400-02-0160D	07/07/08	70	20
OK120400020160_00	Butler Creek	OK120400-02-0160D	08/11/08	9900	10000
OK120400020160_00	Butler Creek	OK120400-02-0160D	09/22/08	200	50
OK120400020160_00	Butler Creek	OK120400-02-0160D	06/01/09	1200	10
OK120400020160_00	Butler Creek	OK120400-02-0160D	07/06/09	210	130
OK120400020160_00	Butler Creek	OK120400-02-0160D	09/14/09	480	660
OK120400020160_00	Butler Creek	OK120400-02-0160D	05/04/10	10	10
OK120400020190_00	Elk Creek	OK120400-02-0190D	07/21/03	10	100
OK120400020190_00	Elk Creek	OK120400-02-0190D	08/25/03	230	10
OK120400020190_00	Elk Creek	OK120400-02-0190D	09/30/03	100	160
OK120400020190_00	Elk Creek	OK120400-02-0190D	05/03/04	75	305
OK120400020190_00	Elk Creek	OK120400-02-0190D	06/14/04	500	175
OK120400020190_00	Elk Creek	OK120400-02-0190D	07/12/04	230	80
OK120400020190_00	Elk Creek	OK120400-02-0190D	08/16/04	100	90
OK120400020190_00	Elk Creek	OK120400-02-0190D	09/20/04	35	340
OK120400020190_00	Elk Creek	OK120400-02-0190D	05/24/05	50	60
OK120400020190_00	Elk Creek	OK120400-02-0190D	06/02/08	220	180

Waterbody ID	Streams	WQM Station	Date	EC[1]	ENT[1]
OK120400020190_00	Elk Creek	OK120400-02-0190D	07/07/08	30	10
OK120400020190_00	Elk Creek	OK120400-02-0190D	08/11/08	320	980
OK120400020190_00	Elk Creek	OK120400-02-0190D	09/22/08	20	20
OK120400020190_00	Elk Creek	OK120400-02-0190D	06/02/09	690	10
OK120400020190_00	Elk Creek	OK120400-02-0190D	07/06/09	130	10
OK120400020190_00	Elk Creek	OK120400-02-0190D	08/10/09	450	20
OK120400020190_00	Elk Creek	OK120400-02-0190D	09/14/09	100	160
OK120400020190_00	Elk Creek	OK120400-02-0190D	05/04/10	20	10
OK120400020240_00	Shady Grove Creek	OK120400-02-0240H	07/21/03	1000	10
OK120400020240_00	Shady Grove Creek	OK120400-02-0240H	09/29/03	40	50
OK120400020240_00	Shady Grove Creek	OK120400-02-0240H	05/03/04	60	320
OK120400020240_00	Shady Grove Creek	OK120400-02-0240H	06/14/04	60	25
OK120400020240_00	Shady Grove Creek	OK120400-02-0240H	07/12/04	25	20
OK120400020240_00	Shady Grove Creek	OK120400-02-0240H	08/16/04	60	10
OK120400020240_00	Shady Grove Creek	OK120400-02-0240H	09/20/04	5	20
OK120400020240_00	Shady Grove Creek	OK120400-02-0240H	05/24/05	5	5
OK120400020240_00	Shady Grove Creek	OK120400-02-0240H	06/02/08	1120	380
OK120400020240_00	Shady Grove Creek	OK120400-02-0240H	07/07/08	90	10
OK120400020240_00	Shady Grove Creek	OK120400-02-0240H	08/11/08	480	1960
OK120400020240_00	Shady Grove Creek	OK120400-02-0240H	09/22/08	10	15
OK120400020240_00	Shady Grove Creek	OK120400-02-0240H	06/01/09	20	10
OK120400020240_00	Shady Grove Creek	OK120400-02-0240H	07/06/09	80	80
OK120400020240_00	Shady Grove Creek	OK120400-02-0240H	08/10/09	40	10
OK120400020240_00	Shady Grove Creek	OK120400-02-0240H	09/14/09	220	220
OK120400020240_00	Shady Grove Creek	OK120400-02-0240H	05/01/10	10	20
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	6/4/2001	41	300
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	7/9/2001	10	10
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	8/6/2001	10	300
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	9/10/2001	10	10
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	5/8/2002	52	30
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	6/3/2002	84	100
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	7/8/2002	9.99	50
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	9/3/2002	9.99	9.99
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	9/30/2002	9.99	50
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	6/2/2003	20	100
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	6/18/2003	31	20
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	7/7/2003	10	10
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	7/29/2003	9.99	20
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	8/11/2003	9.99	9.99

Waterbody ID	Streams	WQM Station	Date	EC[1]	ENT[1]
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	9/15/2003	231	200
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	5/23/2006	10	20
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	6/12/2006	52	49.5
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	6/26/2006	9.99	10
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	7/5/2006	10	15
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	7/24/2006	20	42
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	8/7/2006	10	114
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	8/21/2006	63	84
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	8/22/2006	211	187
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	9/5/2006	9.99	10
OK120410010080_00	Arkansas River near Haskell	120410010080-001AT	9/18/2006	1515	1695
OK120410010100_00	Cloud Creek	OK120410-01-0100T	07/21/03	190	220
OK120410010100_00	Cloud Creek	OK120410-01-0100T	08/25/03	250	20
OK120410010100_00	Cloud Creek	OK120410-01-0100T	09/30/03	80	60
OK120410010100_00	Cloud Creek	OK120410-01-0100T	05/03/04	205	345
OK120410010100_00	Cloud Creek	OK120410-01-0100T	06/01/04	60	60
OK120410010100_00	Cloud Creek	OK120410-01-0100T	07/12/04	170	320
OK120410010100_00	Cloud Creek	OK120410-01-0100T	08/16/04	130	100
OK120410010100_00	Cloud Creek	OK120410-01-0100T	09/20/04	125	50
OK120410010100_00	Cloud Creek	OK120410-01-0100T	05/24/05	70	30
OK120410010100_00	Cloud Creek	OK120410-01-0100T	06/02/08	2700	1200
OK120410010100_00	Cloud Creek	OK120410-01-0100T	07/07/08	220	10
OK120410010100_00	Cloud Creek	OK120410-01-0100T	08/11/08	2000	2000
OK120410010100_00	Cloud Creek	OK120410-01-0100T	09/22/08	10	5
OK120410010100_00	Cloud Creek	OK120410-01-0100T	06/01/09	10	10
OK120410010100_00	Cloud Creek	OK120410-01-0100T	07/06/09	10	10
OK120410010100_00	Cloud Creek	OK120410-01-0100T	08/10/09	220	10
OK120410010100_00	Cloud Creek	OK120410-01-0100T	09/14/09	100	80
OK120410010100_00	Cloud Creek	OK120410-01-0100T	05/04/10	20	10
OK120410010220_00	Snake Creek	OK120410-01-0220G	07/21/03	190	430
OK120410010220_00	Snake Creek	OK120410-01-0220G	08/25/03	10	10
OK120410010220_00	Snake Creek	OK120410-01-0220G	09/30/03	50	90
OK120410010220_00	Snake Creek	OK120410-01-0220G	05/03/04	35	190
OK120410010220_00	Snake Creek	OK120410-01-0220G	06/14/04	10	125
OK120410010220_00	Snake Creek	OK120410-01-0220G	07/12/04	140	210
OK120410010220_00	Snake Creek	OK120410-01-0220G	08/16/04	20	10
OK120410010220_00	Snake Creek	OK120410-01-0220G	09/20/04	5	10
OK120410010220_00	Snake Creek	OK120410-01-0220G	05/24/05	210	80
OK120410010220_00	Snake Creek	OK120410-01-0220G	06/02/08	4800	1800

Waterbody ID	Streams	WQM Station	Date	EC[1]	ENT[1]
OK120410010220_00	Snake Creek	OK120410-01-0220G	07/07/08	130	10
OK120410010220_00	Snake Creek	OK120410-01-0220G	08/11/08	800	1120
OK120410010220_00	Snake Creek	OK120410-01-0220G	09/22/08	220	100
OK120410010220_00	Snake Creek	OK120410-01-0220G	06/01/09	170	10
OK120410010220_00	Snake Creek	OK120410-01-0220G	07/06/09	10	10
OK120410010220_00	Snake Creek	OK120410-01-0220G	08/10/09	10	10
OK120410010220_00	Snake Creek	OK120410-01-0220G	09/14/09	320	200
OK120410010220_00	Snake Creek	OK120410-01-0220G	05/04/10	40	10
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	6/4/2001	20	400
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	7/9/2001	10	70
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	8/6/2001	10	30
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	9/10/2001	10	30
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	5/8/2002	30	150
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	6/3/2002	228	200
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	7/8/2002	10	10
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	9/3/2002	31	50
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	6/2/2003	836	4000
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	6/18/2003	20	70
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	7/7/2003	73	110
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	7/29/2003	31	300
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	8/11/2003	512	1700
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	9/15/2003	146	800
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	5/23/2006	107	31
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	6/12/2006	85	10
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	6/26/2006	235	471
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	7/5/2006	41	323
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	07/05/06	41	10
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	07/24/06	10	243
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	08/07/06	10	10
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	08/21/06	51	314
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	08/22/06	173	259
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	09/05/06	10	41
OK120420010010_00	Arkansas River near Bixby	120420010010-001AT	09/18/06	171	41
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	6/5/2001	10	100
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	9/11/2001	10	10
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	8/7/2001	10	10
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	6/3/2002	52	10
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	7/9/2002	10	50
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	10/1/2002	10	400

Waterbody ID	Streams	WQM Station	Date	EC[1]	ENT[1]
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	9/4/2002	10	10
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	5/8/2002	10	40
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	8/11/2003	31	60
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	7/30/2003	108	10
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	6/18/2003	10	100
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	10/1/2003	10	400
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	6/2/2003	31	20
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	9/16/2003	20	20
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	7/10/2001	10	10
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	7/7/2003	10	10
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	7/24/2006	31	31
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	9/28/2006	41	63
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	06/12/06	20	10
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	05/23/06	41	109
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	06/26/06	10	108
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	08/08/06	20	74
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	08/22/06	52	
OK120420010130_00	Arkansas River near Sand Springs	120420010130-001AT	09/06/06	119	
OK120420020010_00	Polecat Creek	OK120420-02-0010D	05/24/00	76	
OK120420020010_00	Polecat Creek	OK120420-02-0010D	06/29/00	2400	
OK120420020010_00	Polecat Creek	OK120420-02-0010D	07/27/00	460	
OK120420020010_00	Polecat Creek	OK120420-02-0010D	09/21/00	47	
OK120420020010_00	Polecat Creek	OK120420-02-0010D	05/31/01	2000	
OK120420020010_00	Polecat Creek	OK120420-02-0010D	06/27/01	1700	
OK120420020010_00	Polecat Creek	OK120420-02-0010D	07/24/01	70	
OK120420020010_00	Polecat Creek	OK120420-02-0010D	08/25/01	54	
OK120420020010_00	Polecat Creek	OK120420-02-0010D	09/29/01	46	
OK120420020010_00	Polecat Creek	OK120420-02-0010D	05/23/02	261	
OK120420020010_00	Polecat Creek	OK120420-02-0010D	06/20/02	291	
OK120420020010_00	Polecat Creek	OK120420-02-0010D	07/18/02	65	
OK120420020010_00	Polecat Creek	OK120420-02-0010D	08/22/02	56	
OK120420020010_00	Polecat Creek	OK120420-02-0010D	06/26/03	2400	
OK120420020010_00	Polecat Creek	OK120420-02-0010D	07/21/03	9.99	
OK120420020010_00	Polecat Creek	OK120420-02-0010D	07/24/03	8	
OK120420020010_00	Polecat Creek	OK120420-02-0010D	08/21/03	125	
OK120420020050_00	Polecat Creek	OK120420-02-0050D	07/21/03	10	20
OK120420020050_00	Polecat Creek	OK120420-02-0050D	08/25/03	10	10
OK120420020050_00	Polecat Creek	OK120420-02-0050D	09/29/03	30	230
OK120420020050_00	Polecat Creek	OK120420-02-0050D	05/03/04	130	175

Waterbody ID	Streams	WQM Station	Date	EC[1]	ENT[1]
OK120420020050_00	Polecat Creek	OK120420-02-0050D	06/14/04	65	65
OK120420020050_00	Polecat Creek	OK120420-02-0050D	07/12/04	275	200
OK120420020050_00	Polecat Creek	OK120420-02-0050D	08/16/04	45	120
OK120420020050_00	Polecat Creek	OK120420-02-0050D	09/20/04	45	70
OK120420020050_00	Polecat Creek	OK120420-02-0050D	05/24/05	160	40
OK120420020050_00	Polecat Creek	OK120420-02-0050D	06/02/08	4000	800
OK120420020050_00	Polecat Creek	OK120420-02-0050D	07/07/08	10	10
OK120420020050_00	Polecat Creek	OK120420-02-0050D	08/11/08	100	120
OK120420020050_00	Polecat Creek	OK120420-02-0050D	09/22/08	40	15
OK120420020050_00	Polecat Creek	OK120420-02-0050D	06/01/09	100	10
OK120420020050_00	Polecat Creek	OK120420-02-0050D	07/06/09	10	10
OK120420020050_00	Polecat Creek	OK120420-02-0050D	08/10/09	110	10
OK120420020050_00	Polecat Creek	OK120420-02-0050D	09/14/09	660	1000
OK120420020050_00	Polecat Creek	OK120420-02-0050D	05/04/10	10	10
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	05/30/01		37000
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	05/30/01		82000
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	06/26/01		60
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	07/30/01		10
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	09/17/01		190
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	05/28/02		300
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	05/28/02		500
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	06/24/02		80
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	06/24/02		30
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	08/05/02		20
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	08/05/02		30
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	08/26/02		20
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	08/26/02		10
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	09/23/02		100
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	09/23/02		100
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	05/04/04		300
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	06/02/04		1500
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	06/22/04		2800
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	07/06/04		4100
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	07/20/04		10
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	08/10/04		20
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	09/14/04		10
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	06/14/06		10
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	07/18/06		10
OK121500010200_00	Verdigris River near Wagoner	121500010200-001AT	09/19/06		109

Waterbody ID	Streams	WQM Station	Date	EC[1]	ENT[1]
OK121500020090_00	Bull Creek	OK121500-02-0090K	05/15/01	1296	600
OK121500020090_00	Bull Creek	OK121500-02-0090K	06/19/01	823	500
OK121500020090_00	Bull Creek	OK121500-02-0090K	07/17/01	30	22
OK121500020090_00	Bull Creek	OK121500-02-0090D	08/14/01	65	20
OK121500020090_00	Bull Creek	OK121500-02-0090K	08/21/01	20	190
OK121500020090_00	Bull Creek	OK121500-02-0090D	09/18/01	800	1000
OK121500020090_00	Bull Creek	OK121500-02-0090D	05/29/02	800	820
OK121500020090_00	Bull Creek	OK121500-02-0090D	07/09/02	160	240
OK121500020090_00	Bull Creek	OK121500-02-0090D	08/06/02	170	230
OK121500020090_00	Bull Creek	OK121500-02-0090D	09/17/02	900	200
OK121500020090_00	Bull Creek	OK121500-02-0090D	05/13/03	50	20
OK121500020090_00	Bull Creek	OK121500-02-0090D	06/17/03	400	460
OK121500020090_00	Bull Creek	OK121500-02-0090D	06/20/06	450	480
OK121500020090_00	Bull Creek	OK121500-02-0090D	08/15/06	10	170
OK121500020090_00	Bull Creek	OK121500-02-0090D	09/19/06	670	280
OK121500020090_00	Bull Creek	OK121500-02-0090D	05/14/07	240	800
OK121500020090_00	Bull Creek	OK121500-02-0090D	06/18/07	160	380
OK121500020090_00	Bull Creek	OK121500-02-0090D	07/23/07	10	30
OK121500020090_00	Bull Creek	OK121500-02-0090D	08/28/07	230	390
OK121500020090_00	Bull Creek	OK121500-02-0090D	05/06/08	80	80
OK121500020100_00	Pea Creek	121500020100-001SR	06/27/01	259	10
OK121500020100_00	Pea Creek	121500020100-001SR	06/27/01	10	40
OK121500020100_00	Pea Creek	121500020100-001SR	07/30/01	933	13000
OK121500020100_00	Pea Creek	121500020100-001SR	07/30/01	96	50
OK121500020100_00	Pea Creek	121500020100-001SR	08/27/01	933	3100
OK121500020100_00	Pea Creek	121500020100-001SR	09/24/01	256	1600
OK121500020100_00	Pea Creek	121500020100-001SR	09/24/01	10	200
OK121500020100_00	Pea Creek	121500020100-001SR	05/21/02	327	500
OK121500020100_00	Pea Creek	121500020100-001SR	05/21/02	171	10
OK121500020100_00	Pea Creek	121500020100-001SR	06/19/02	168	400
OK121500020100_00	Pea Creek	121500020100-001SR	06/19/02	169	700
OK121500020100_00	Pea Creek	121500020100-001SR	07/23/02	845	16000
OK121500020100_00	Pea Creek	121500020100-001SR	07/23/02	158	2100
OK121500020100_00	Pea Creek	121500020100-001SR	08/14/02	15531	51100
OK121500020100_00	Pea Creek	121500020100-001SR	08/14/02	5172	35100
OK121500020100_00	Pea Creek	121500020100-001SR	09/17/02	3282	8000
OK121500020100_00	Pea Creek	121500020100-001SR	09/17/02	226	2000
OK121500020150_00	Adams Creek	OK121500-02-0150G	10/07/96		
OK121500020150_00	Adams Creek	OK121500-02-0150G	10/16/96		

Waterbody ID	Streams	WQM Station	Date	EC[1]	ENT[1]
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	05/30/01		81000
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	06/26/01		160
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	06/26/01		100
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	07/30/01		9.99
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	05/28/02		400
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	06/24/02		30
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	08/05/02		10
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	08/26/02		10
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	09/23/02		40
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	05/04/04		1000
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	06/02/04		30100
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	06/22/04		23900
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	07/07/04		1100
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	07/21/04		80
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	08/10/04		110
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	08/23/04		20
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	09/15/04		20
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	06/14/06		10
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	07/18/06		74
OK121500020260_00	Verdigris River near Inola	121500020260-001AT	09/19/06		63
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	05/15/01	309	800
OK121500020360_00	Dog Creek: Gordon Property	OK121500-02-0360F	05/15/01	189	100
OK121500020360_00	Dog Creek: Flint Road	OK121500-02-0360H	05/15/01	959	300
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	06/19/01	146	130
OK121500020360_00	Dog Creek: Gordon Property	OK121500-02-0360F	06/19/01	10	100
OK121500020360_00	Dog Creek: Flint Road	OK121500-02-0360H	06/19/01	216	150
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	07/17/01	160	102
OK121500020360_00	Dog Creek: Gordon Property	OK121500-02-0360F	07/17/01	160	72
OK121500020360_00	Dog Creek: McCombs Property	OK121500-02-0360G	07/17/01	160	42
OK121500020360_00	Dog Creek: Flint Road	OK121500-02-0360H	07/17/01	160	94
OK121500020360_00	Dog Creek	OK121500-02-0360J	07/17/01	160	76
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	08/14/01	150	295
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	08/21/01	690	250
OK121500020360_00	Dog Creek: Gordon Property	OK121500-02-0360F	08/21/01	800	460
OK121500020360_00	Dog Creek: Flint Road	OK121500-02-0360H	08/21/01	1800	190
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	07/09/02	1340	280
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	08/06/02	800	390
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	09/17/02	400	540
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	05/13/03	10	90

Waterbody ID	Streams	WQM Station	Date	EC[1]	ENT[1]
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	06/19/06	140	190
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	08/14/06	60	30
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	09/18/06	1000	1000
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	05/14/07	480	260
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	06/19/07	280	180
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	07/10/07	260	630
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	07/23/07	30	20
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	08/27/07	100	170
OK121500020360_00	Dog Creek: Spavinaw Flowline	OK121500-02-0360D	05/06/08	120	120
OK121500020390_00	Cat Creek: Downstream	OK121500-02-0390A	05/15/01	135	400
OK121500020390_00	Cat Creek: Upstream	OK121500-02-0390B	05/15/01	173	500
OK121500020390_00	Cat Creek: Downstream	OK121500-02-0390A	06/19/01	384	1000
OK121500020390_00	Cat Creek: Upstream	OK121500-02-0390B	06/19/01	158	100
OK121500020390_00	Cat Creek: Downstream	OK121500-02-0390A	07/17/01	160	44
OK121500020390_00	Cat Creek: Upstream	OK121500-02-0390B	07/17/01	160	80
OK121500020390_00	Cat Creek: Downstream	OK121500-02-0390A	08/21/01	800	610
OK121500020390_00	Cat Creek: Upstream	OK121500-02-0390B	08/21/01	740	170
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	06/04/01		430
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	07/09/01		80
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	05/08/02		89000
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	06/04/02		200
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	07/10/02		240
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	09/04/02		2000
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	05/16/06		52
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	05/23/06		31
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	06/12/06		10
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	07/05/06		41
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	07/24/06		31
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	08/07/06		10
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	08/21/06		9208
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	08/28/06		10
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	09/05/06		31
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	09/18/06		20
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	05/28/08		288
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	06/16/08		5247
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	07/08/08		10
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	07/29/08		10
OK121500030010_00	Verdigris River near Claremore	121500030010-001AT	08/19/08		30
OK121600010010_00	Neosho River below Ft Gibson	121600010010-001SR	09/19/01	31	3000

Waterbody ID	Streams	WQM Station	Date	EC[1]	ENT[1]
OK121600010010_00	Neosho River below Ft Gibson	121600010010-001SR	09/05/02	9.99	10
OK121600010010_00	Neosho River below Ft Gibson	121600010010-001SR	05/29/02	9.99	200
OK121600010010_00	Neosho River below Ft Gibson	121600010010-001SR	09/25/02	9.99	9.99
OK121600010010_00	Neosho River below Ft Gibson	121600010010-001SR	08/06/02	9.99	9.99
OK121600010010_00	Neosho River below Ft Gibson	121600010010-001SR	06/26/02	9.99	100
OK121600010010_00	Neosho River below Ft Gibson	121600010010-002SR	09/19/01	31	100
OK121600010010_00	Neosho River below Ft Gibson	121600010010-002SR	07/31/01	9.99	60
OK121600010010_00	Neosho River below Ft Gibson	121600010010-002SR	09/05/02	10	10
OK121600010010_00	Neosho River below Ft Gibson	121600010010-002SR	05/29/02	3654	69000
OK121600010010_00	Neosho River below Ft Gibson	121600010010-002SR	06/26/02	10	9.99
OK121600010010_00	Neosho River below Ft Gibson	121600010010-002SR	09/25/02	31	9.99
OK121600010010_00	Neosho River below Ft Gibson	121600010010-002SR	08/06/02	10	9.99
OK121600010430_00	Chouteau Creek	OK121600-01-0430M	08/15/00	108	
OK121600010430_00	Chouteau Creek	OK121600-01-0430M	09/18/00	52	150
OK121600010430_00	Chouteau Creek	OK121600-01-0430M	08/14/01	35	10
OK121600010430_00	Chouteau Creek	OK121600-01-0430M	09/18/01	800	90
OK121600010430_00	Chouteau Creek	OK121600-01-0430M	05/29/02	800	310
OK121600010430_00	Chouteau Creek	OK121600-01-0430M	08/06/02	90	70
OK121600010430_00	Chouteau Creek	OK121600-01-0430M	09/17/02	20	60
OK121600010430_00	Chouteau Creek	OK121600-01-0430M	05/13/03	20	170
OK121600010430_00	Chouteau Creek	OK121600-01-0430M	06/17/03	280	400
OK121600010430_00	Chouteau Creek	OK121600-01-0430M	06/20/06	10	40
OK121600010430_00	Chouteau Creek	OK121600-01-0430M	08/15/06	1000	760
OK121600010430_00	Chouteau Creek	OK121600-01-0430M	09/19/06	400	400
OK121600010430_00	Chouteau Creek	OK121600-01-0430M	05/14/07	160	420
OK121600010430_00	Chouteau Creek	OK121600-01-0430M	06/18/07	420	640
OK121600010430_00	Chouteau Creek	OK121600-01-0430M	07/23/07	50	410
OK121600010430_00	Chouteau Creek	OK121600-01-0430M	08/28/07	130	480
OK121600010430_00	Chouteau Creek	OK121600-01-0430M	05/06/08	80	120

EC = *E. coli*; ENT = Enterococci

[1] Units = counts/100 mL

Ambient Water Quality Turbidity and TSS Data, 1998 - 2011

Stream Name	Station ID	Date	Turbidity (NTU)	TSS (mg/L)	Flow (cfs)	Flow Condition	Data Sources
Dirty Creek	OK120400-02-0010F	07/22/03	19.7	17	0		OCC
Dirty Creek	OK120400-02-0010F	08/26/03	15.4	22	0		OCC
Dirty Creek	OK120400-02-0010F	08/27/03			0		OCC
Dirty Creek	OK120400-02-0010F	09/29/03	59.8	53	0		OCC
Dirty Creek	OK120400-02-0010F	11/04/03	75.8	41	0		OCC
Dirty Creek	OK120400-02-0010F	12/15/03	53.9	19	0		OCC
Dirty Creek	OK120400-02-0010F	01/20/04	104	53			OCC
Dirty Creek	OK120400-02-0010F	02/23/04	51.2	31	0		OCC
Dirty Creek	OK120400-02-0010F	04/05/04	32.4	29	0		OCC
Dirty Creek	OK120400-02-0010F	05/11/04	12.8	10	0		OCC
Dirty Creek	OK120400-02-0010F	05/26/04	18		0		OCC
Dirty Creek	OK120400-02-0010F	06/15/04	32.4	10			OCC
Dirty Creek	OK120400-02-0010F	07/19/04	16.1	10	0		OCC
Dirty Creek	OK120400-02-0010F	08/23/04		16	0		OCC
Dirty Creek	OK120400-02-0010F	09/28/04	11.7	10	0		OCC
Dirty Creek	OK120400-02-0010F	11/03/04	80.8	10		High Flow	OCC
Dirty Creek	OK120400-02-0010F	12/06/04	40.4	24		High Flow	OCC
Dirty Creek	OK120400-02-0010F	12/08/04	205	151	2093.447	High Flow	OCC
Dirty Creek	OK120400-02-0010F	01/04/05	190	113		High Flow	OCC
Dirty Creek	OK120400-02-0010F	02/14/05	36.9	30			OCC
Dirty Creek	OK120400-02-0010F	03/14/05	11	10			OCC
Dirty Creek	OK120400-02-0010F	04/18/05	39.6	10	0		OCC
Dirty Creek	OK120400-02-0010F	05/24/05	18.8	23	0		OCC
Dirty Creek	OK120400-02-0010F	06/03/08	39.8	18	0		OCC
Dirty Creek	OK120400-02-0010F	07/08/08	23.3	12	0		OCC
Dirty Creek	OK120400-02-0010F	08/12/08	136	81		High Flow	OCC
Dirty Creek	OK120400-02-0010F	09/23/08	25.9	16	0		OCC
Dirty Creek	OK120400-02-0010F	10/28/08	21.7	12	0		OCC
Dirty Creek	OK120400-02-0010F	12/02/08	14.9	10	0		OCC
Dirty Creek	OK120400-02-0010F	01/06/09	23.7	13	0		OCC
Dirty Creek	OK120400-02-0010F	02/18/09	58.2	26		High Flow	OCC
Dirty Creek	OK120400-02-0010F	03/24/09	15.5	11	0		OCC
Dirty Creek	OK120400-02-0010F	04/28/09	20.9	10	0		OCC
Dirty Creek	OK120400-02-0010F	06/02/09	30.8	25	0		OCC
Dirty Creek	OK120400-02-0010F	07/07/09	20.3	10	0		OCC
Dirty Creek	OK120400-02-0010F	08/11/09	30.6	18	0		OCC
Dirty Creek	OK120400-02-0010F	09/15/09	99.6	53		High Flow	OCC
Dirty Creek	OK120400-02-0010F	10/20/09	24.4	11	0		OCC

Stream Name	Station ID	Date	Turbidity (NTU)	TSS (mg/L)	Flow (cfs)	Flow Condition	Data Sources
Dirty Creek	OK120400-02-0010F	12/01/09	16.2	10	0		OCC
Dirty Creek	OK120400-02-0010F	02/17/10	26.4	10	0		OCC
Dirty Creek	OK120400-02-0010F	03/23/10	111	215		High Flow	OCC
Dirty Creek	OK120400-02-0010F	05/05/10	11.6	10			OCC
Butler Creek	OK120400-02-0160D	05/21/98	22.3		0.1		OCC
Butler Creek	OK120400-02-0160D	07/23/03	25.5		0		OCC
Butler Creek	OK120400-02-0160D	08/25/03	19.3	52	0		OCC
Butler Creek	OK120400-02-0160D	09/29/03	31.6	47	1.671		OCC
Butler Creek	OK120400-02-0160D	11/03/03	13.8	10	0		OCC
Butler Creek	OK120400-02-0160D	12/15/03	39.9	14	2.434		OCC
Butler Creek	OK120400-02-0160D	01/21/04	52.8	30	4.976		OCC
Butler Creek	OK120400-02-0160D	02/23/04	21.3	10	1.035		OCC
Butler Creek	OK120400-02-0160D	03/29/04	66.8	59	9.82		OCC
Butler Creek	OK120400-02-0160D	05/03/04	26.6	20	7.323		OCC
Butler Creek	OK120400-02-0160D	06/14/04	33.9	13	1.481		OCC
Butler Creek	OK120400-02-0160D	07/12/04	37.2	31	2.55		OCC
Butler Creek	OK120400-02-0160D	08/16/04	21.5	22	0		OCC
Butler Creek	OK120400-02-0160D	09/20/04	9.23	10	0		OCC
Butler Creek	OK120400-02-0160D	10/25/04	3.27	10	0		OCC
Butler Creek	OK120400-02-0160D	11/29/04	39.2	14	13.977		OCC
Butler Creek	OK120400-02-0160D	01/10/05	39.4	10	23.976		OCC
Butler Creek	OK120400-02-0160D	02/07/05		27	28.857		OCC
Butler Creek	OK120400-02-0160D	03/14/05	14	11	1.59		OCC
Butler Creek	OK120400-02-0160D	04/18/05	17.2	10	1.623		OCC
Butler Creek	OK120400-02-0160D	05/24/05		18			OCC
Butler Creek	OK120400-02-0160D	06/02/08	168	50		High Flow	OCC
Butler Creek	OK120400-02-0160D	07/07/08	40.2	32	0.078		OCC
Butler Creek	OK120400-02-0160D	07/29/08	34.4		0		OCC
Butler Creek	OK120400-02-0160D	08/11/08	304	196		High Flow	OCC
Butler Creek	OK120400-02-0160D	09/22/08	59	35			OCC
Butler Creek	OK120400-02-0160D	10/27/08	13.9	13	0		OCC
Butler Creek	OK120400-02-0160D	12/01/08	16.5	10	0		OCC
Butler Creek	OK120400-02-0160D	01/05/09	16.2	10	0		OCC
Butler Creek	OK120400-02-0160D	02/17/09	47.2	10	59.615		OCC
Butler Creek	OK120400-02-0160D	03/23/09	8.86	10	0		OCC
Butler Creek	OK120400-02-0160D	04/27/09	25.7	10	2.028		OCC
Butler Creek	OK120400-02-0160D	06/01/09	13.1	10	0		OCC
Butler Creek	OK120400-02-0160D	07/06/09	6.62	10	0		OCC
Butler Creek	OK120400-02-0160D	09/14/09	51.3	20	7.059		OCC

Stream Name	Station ID	Date	Turbidity (NTU)	TSS (mg/L)	Flow (cfs)	Flow Condition	Data Sources
Butler Creek	OK120400-02-0160D	10/19/09	40.8	10	0		OCC
Butler Creek	OK120400-02-0160D	11/30/09	13.4	10	5.674		OCC
Butler Creek	OK120400-02-0160D	02/16/10	20.6	10	0		OCC
Butler Creek	OK120400-02-0160D	03/22/10	97.8	10		High Flow	OCC
Butler Creek	OK120400-02-0160D	05/04/10	5.02	10			OCC
Elk Creek	OK120400-02-0190D	04/21/98	31.6		0		OCC
Elk Creek	OK120400-02-0190D	07/08/03	29.9		0.309		OCC
Elk Creek	OK120400-02-0190D	07/21/03	20.5	16	0		OCC
Elk Creek	OK120400-02-0190D	08/25/03	51.2	79	0		OCC
Elk Creek	OK120400-02-0190D	09/30/03	19.8	33	0.214		OCC
Elk Creek	OK120400-02-0190D	11/03/03	36.7	68	3.956		OCC
Elk Creek	OK120400-02-0190D	12/15/03	18.7	16	4.504		OCC
Elk Creek	OK120400-02-0190D	01/20/04	40.1	53	43.859		OCC
Elk Creek	OK120400-02-0190D	02/23/04	195	11	3.521		OCC
Elk Creek	OK120400-02-0190D	03/29/04	32.7	17	12.453		OCC
Elk Creek	OK120400-02-0190D	05/03/04	30.4	30	27.666		OCC
Elk Creek	OK120400-02-0190D	06/14/04	43.1	56	10.102		OCC
Elk Creek	OK120400-02-0190D	07/12/04	12.4	10	13.943		OCC
Elk Creek	OK120400-02-0190D	08/16/04	132	16	7.261		OCC
Elk Creek	OK120400-02-0190D	09/20/04	8.72	10	0		OCC
Elk Creek	OK120400-02-0190D	10/25/04	6.45	18	4.809		OCC
Elk Creek	OK120400-02-0190D	11/29/04	30.2	10	69.116		OCC
Elk Creek	OK120400-02-0190D	01/03/05	146	113	732.175	High Flow	OCC
Elk Creek	OK120400-02-0190D	02/07/05		73	109.096		OCC
Elk Creek	OK120400-02-0190D	03/14/05	4.9	10	3.326		OCC
Elk Creek	OK120400-02-0190D	04/18/05	14.3	10	8.704		OCC
Elk Creek	OK120400-02-0190D	05/24/05		19	0		OCC
Elk Creek	OK120400-02-0190D	06/02/08	23.2	18			OCC
Elk Creek	OK120400-02-0190D	07/07/08	9.28	10	2.367		OCC
Elk Creek	OK120400-02-0190D	07/29/08	5.05		0.196		OCC
Elk Creek	OK120400-02-0190D	08/11/08	27.2	15	7.994		OCC
Elk Creek	OK120400-02-0190D	09/22/08	8.04	10	1.378		OCC
Elk Creek	OK120400-02-0190D	10/27/08	8.75	10	0.31		OCC
Elk Creek	OK120400-02-0190D	12/01/08	6.11	10	1.952		OCC
Elk Creek	OK120400-02-0190D	01/05/09	8.04	10	5.577		OCC
Elk Creek	OK120400-02-0190D	02/17/09	21	10	16.483		OCC
Elk Creek	OK120400-02-0190D	03/23/09	19.4	10	0		OCC
Elk Creek	OK120400-02-0190D	04/27/09	15.6	10	11.299		OCC
Elk Creek	OK120400-02-0190D	06/02/09	8.11	28	2.058		OCC

Stream Name	Station ID	Date	Turbidity (NTU)	TSS (mg/L)	Flow (cfs)	Flow Condition	Data Sources
Elk Creek	OK120400-02-0190D	07/06/09	13.4	10	0		OCC
Elk Creek	OK120400-02-0190D	08/10/09	6.61	10	0.105		OCC
Elk Creek	OK120400-02-0190D	09/14/09	55.9	27	0	High Flow	OCC
Elk Creek	OK120400-02-0190D	10/19/09	13.8	10	0	High Flow	OCC
Elk Creek	OK120400-02-0190D	11/30/09	10.6	10	31.458	Stormwater	OCC
Elk Creek	OK120400-02-0190D	01/11/10	12.2	10	20.753		OCC
Elk Creek	OK120400-02-0190D	02/16/10	13.3	10	19.574		OCC
Elk Creek	OK120400-02-0190D	03/22/10	73.4	49	0	High Flow	OCC
Elk Creek	OK120400-02-0190D	05/04/10	5.51	10	14.193		OCC
Cloud Creek	OK120410-01-0100T	07/21/03	57.1	52	0		OCC
Cloud Creek	OK120410-01-0100T	08/25/03	39	56	0		OCC
Cloud Creek	OK120410-01-0100T	09/30/03	59.2	49	0.988		OCC
Cloud Creek	OK120410-01-0100T	11/03/03	19.4	29	0.518		OCC
Cloud Creek	OK120410-01-0100T	12/15/03	17.1	10	3.34		OCC
Cloud Creek	OK120410-01-0100T	01/20/04	65	23	4.534		OCC
Cloud Creek	OK120410-01-0100T	02/23/04	29.9	26	2.262		OCC
Cloud Creek	OK120410-01-0100T	03/29/04	56.1	48	0		OCC
Cloud Creek	OK120410-01-0100T	05/03/04	39	33	16.214		OCC
Cloud Creek	OK120410-01-0100T	06/01/04	42.2	26	8.157		OCC
Cloud Creek	OK120410-01-0100T	07/12/04	41.9	29	0		OCC
Cloud Creek	OK120410-01-0100T	08/16/04	29.8	33	0.483		OCC
Cloud Creek	OK120410-01-0100T	09/20/04	38.7	59	0		OCC
Cloud Creek	OK120410-01-0100T	10/25/04	13.5	24	0		OCC
Cloud Creek	OK120410-01-0100T	11/29/04	51.3	12	36.153		OCC
Cloud Creek	OK120410-01-0100T	01/03/05		2603	3952.688	High Flow	OCC
Cloud Creek	OK120410-01-0100T	02/07/05		228	0	High Flow	OCC
Cloud Creek	OK120410-01-0100T	03/14/05	8.28	10	21.09		OCC
Cloud Creek	OK120410-01-0100T	04/18/05	28.6	42	12.726		OCC
Cloud Creek	OK120410-01-0100T	05/24/05		30	1.196		OCC
Cloud Creek	OK120410-01-0100T	06/02/08	205	138		High Flow	OCC
Cloud Creek	OK120410-01-0100T	07/07/08	32.3	10		High Flow	OCC
Cloud Creek	OK120410-01-0100T	08/11/08	336.1	406		High Flow	OCC
Cloud Creek	OK120410-01-0100T	09/08/08	29.5				OCC
Cloud Creek	OK120410-01-0100T	09/22/08	23.1	10	0		OCC
Cloud Creek	OK120410-01-0100T	10/27/08	4.29	10	0.41		OCC
Cloud Creek	OK120410-01-0100T	12/01/08	7.89	10	0.749		OCC
Cloud Creek	OK120410-01-0100T	01/05/09	2.69	10	0		OCC
Cloud Creek	OK120410-01-0100T	02/17/09	40.9	10	21.168		OCC
Cloud Creek	OK120410-01-0100T	03/23/09	6.83	10	1.154		OCC

Stream Name	Station ID	Date	Turbidity (NTU)	TSS (mg/L)	Flow (cfs)	Flow Condition	Data Sources
Cloud Creek	OK120410-01-0100T	04/27/09	82.4	10	0	High Flow	OCC
Cloud Creek	OK120410-01-0100T	06/01/09	5.27	18	1.251		OCC
Cloud Creek	OK120410-01-0100T	07/06/09	3.78	10	0		OCC
Cloud Creek	OK120410-01-0100T	08/10/09	25.2	23	0		OCC
Cloud Creek	OK120410-01-0100T	09/14/09	47.5	38	20.631		OCC
Cloud Creek	OK120410-01-0100T	10/19/09	40.9	10	0	High Flow	OCC
Cloud Creek	OK120410-01-0100T	11/30/09	46.7	10	0.988		OCC
Cloud Creek	OK120410-01-0100T	01/11/10	35.8	10	3.067		OCC
Cloud Creek	OK120410-01-0100T	02/16/10	28	10	3.774		OCC
Cloud Creek	OK120410-01-0100T	03/22/10	58	26	0	High Flow	OCC
Cloud Creek	OK120410-01-0100T	05/04/10	4.73	10	2.541		OCC
Snake Creek	OK120410-01-0220G	10/06/97	51.6		1		OCC
Snake Creek	OK120410-01-0220G	07/21/03	36.3	11	0		OCC
Snake Creek	OK120410-01-0220G	08/19/03	41.9		0		OCC
Snake Creek	OK120410-01-0220G	08/25/03	37.7	30	0		OCC
Snake Creek	OK120410-01-0220G	09/30/03	63.7	89	1.062		OCC
Snake Creek	OK120410-01-0220G	11/03/03	6.6	55	1.321		OCC
Snake Creek	OK120410-01-0220G	12/15/03	49.9	17	23.844		OCC
Snake Creek	OK120410-01-0220G	01/20/04	112	16	28.483		OCC
Snake Creek	OK120410-01-0220G	02/23/04	21.4	21	6.077		OCC
Snake Creek	OK120410-01-0220G	03/29/04	131	156	68.172		OCC
Snake Creek	OK120410-01-0220G	05/03/04	36.6	22	15.798		OCC
Snake Creek	OK120410-01-0220G	06/14/04	31.1	17	0.59		OCC
Snake Creek	OK120410-01-0220G	07/12/04	55.2	31	8.544		OCC
Snake Creek	OK120410-01-0220G	08/16/04	31.5	43	1.056		OCC
Snake Creek	OK120410-01-0220G	09/20/04	30.2	32	0		OCC
Snake Creek	OK120410-01-0220G	10/25/04	23.4	28	0.183		OCC
Snake Creek	OK120410-01-0220G	11/29/04	46.1	14	16.941		OCC
Snake Creek	OK120410-01-0220G	01/03/05	204	217	32.878		OCC
Snake Creek	OK120410-01-0220G	02/07/05		253	126.735		OCC
Snake Creek	OK120410-01-0220G	03/14/05	21.2	22	10.828		OCC
Snake Creek	OK120410-01-0220G	04/18/05	20.2	26	15.519		OCC
Snake Creek	OK120410-01-0220G	05/24/05		35	4.773		OCC
Snake Creek	OK120410-01-0220G	06/02/08	169	166		High Flow	OCC
Snake Creek	OK120410-01-0220G	07/07/08	59.4	14			OCC
Snake Creek	OK120410-01-0220G	07/30/08	10.2		4.376		OCC
Snake Creek	OK120410-01-0220G	08/11/08	68.9	22	13.492		OCC
Snake Creek	OK120410-01-0220G	09/22/08	30.4	10	0		OCC
Snake Creek	OK120410-01-0220G	10/27/08	15.1	10	10.628		OCC

Stream Name	Station ID	Date	Turbidity (NTU)	TSS (mg/L)	Flow (cfs)	Flow Condition	Data Sources
Snake Creek	OK120410-01-0220G	12/01/08	9.02	10	4.696		OCC
Snake Creek	OK120410-01-0220G	01/05/09	26.5	10	11.643		OCC
Snake Creek	OK120410-01-0220G	02/17/09	38	10	27.756		OCC
Snake Creek	OK120410-01-0220G	03/23/09	13.9	10	8.96		OCC
Snake Creek	OK120410-01-0220G	04/27/09	36.4	19	31.87		OCC
Snake Creek	OK120410-01-0220G	06/01/09	16.4	10	8.621		OCC
Snake Creek	OK120410-01-0220G	07/06/09	12.5	12	1.848		OCC
Snake Creek	OK120410-01-0220G	08/10/09	26.4	16	0.867		OCC
Snake Creek	OK120410-01-0220G	09/14/09	75.2	47	27.618		OCC
Snake Creek	OK120410-01-0220G	10/19/09	24.8	10	15.994		OCC
Snake Creek	OK120410-01-0220G	11/30/09	12.8	10	15.048		OCC
Snake Creek	OK120410-01-0220G	01/11/10	19.5	10	47.39		OCC
Snake Creek	OK120410-01-0220G	02/16/10	20.9	10	39.424		OCC
Snake Creek	OK120410-01-0220G	03/22/10	92.1	105	0		OCC
Snake Creek	OK120410-01-0220G	05/04/10	11.3	10	8.657		OCC
Verdigris River near Wagoner	121500010200-001AT	9/29/1999	95	54			OWRB
Verdigris River near Wagoner	121500010200-001AT	10/18/1999	37	24			OWRB
Verdigris River near Wagoner	121500010200-001AT	11/10/1999	29	10			OWRB
Verdigris River near Wagoner	121500010200-001AT	2/28/2000	89	144			OWRB
Verdigris River near Wagoner	121500010200-001AT	4/3/2000	72				OWRB
Verdigris River near Wagoner	121500010200-001AT	5/31/2000	106	162			OWRB
Verdigris River near Wagoner	121500010200-001AT	6/19/2000	70	86			OWRB
Verdigris River near Wagoner	121500010200-001AT	7/31/2000	127	196			OWRB
Verdigris River near Wagoner	121500010200-001AT	8/22/2000	40	20			OWRB
Verdigris River near Wagoner	121500010200-001AT	9/28/2000	22	9.99			OWRB
Verdigris River near Wagoner	121500010200-001AT	5/2/2001	100				OWRB
Verdigris River near Wagoner	121500010200-001AT	5/30/2001	327				OWRB
Verdigris River near Wagoner	121500010200-001AT	6/26/2001	62				OWRB
Verdigris River near Wagoner	121500010200-001AT	7/30/2001	17				OWRB
Verdigris River near Wagoner	121500010200-001AT	9/17/2001	22				OWRB
Verdigris River near Wagoner	121500010200-001AT	11/27/2001	29				OWRB
Verdigris River near Wagoner	121500010200-001AT	4/1/2002	39				OWRB
Verdigris River near Wagoner	121500010200-001AT	5/28/2002	70				OWRB
Verdigris River near Wagoner	121500010200-001AT	6/24/2002	105				OWRB
Verdigris River near Wagoner	121500010200-001AT	8/5/2002	23				OWRB
Verdigris River near Wagoner	121500010200-001AT	8/26/2002	31				OWRB
Verdigris River near Wagoner	121500010200-001AT	9/23/2002	37				OWRB
Verdigris River near Wagoner	121500010200-001AT	11/18/2002	30				OWRB
Verdigris River near Wagoner	121500010200-001AT	12/16/2002	15				OWRB

Stream Name	Station ID	Date	Turbidity (NTU)	TSS (mg/L)	Flow (cfs)	Flow Condition	Data Sources
Verdigris River near Wagoner	121500010200-001AT	2/3/2003	7				OWRB
Verdigris River near Wagoner	121500010200-001AT	3/4/2003	19				OWRB
Verdigris River near Wagoner	121500010200-001AT	3/31/2003	120				OWRB
Verdigris River near Wagoner	121500010200-001AT	5/5/2003	64				OWRB
Verdigris River near Wagoner	121500010200-001AT	7/8/2003	104				OWRB
Verdigris River near Wagoner	121500010200-001AT	10/6/2003	28				OWRB
Verdigris River near Wagoner	121500010200-001AT	11/3/2003	42				OWRB
Verdigris River near Wagoner	121500010200-001AT	3/10/2004	210				OWRB
Verdigris River near Wagoner	121500010200-001AT	4/5/2004	95				OWRB
Verdigris River near Wagoner	121500010200-001AT	5/4/2004	113				OWRB
Verdigris River near Wagoner	121500010200-001AT	7/6/2004	66				OWRB
Verdigris River near Wagoner	121500010200-001AT	7/20/2004	28				OWRB
Verdigris River near Wagoner	121500010200-001AT	8/24/2004	23				OWRB
Verdigris River near Wagoner	121500010200-001AT	10/12/2004	41				OWRB
Verdigris River near Wagoner	121500010200-001AT	10/26/2004	51				OWRB
Verdigris River near Wagoner	121500010200-001AT	11/30/2004	52				OWRB
Verdigris River near Wagoner	121500010200-001AT	2/22/2005	31				OWRB
Verdigris River near Wagoner	121500010200-001AT	7/12/2005	49				OWRB
Verdigris River near Wagoner	121500010200-001AT	10/4/2005	20				OWRB
Verdigris River near Wagoner	121500010200-001AT	11/16/2005	16				OWRB
Verdigris River near Wagoner	121500010200-001AT	1/10/2006	10				OWRB
Verdigris River near Wagoner	121500010200-001AT	2/28/2006	6				OWRB
Verdigris River near Wagoner	121500010200-001AT	4/11/2006	7				OWRB
Verdigris River near Wagoner	121500010200-001AT	6/14/2006	8				OWRB
Verdigris River near Wagoner	121500010200-001AT	7/18/2006	7				OWRB
Verdigris River near Wagoner	121500010200-001AT	9/19/2006	23				OWRB
Verdigris River near Wagoner	121500010200-001AT	12/18/2006	14				OWRB
Verdigris River near Wagoner	121500010200-001AT	2/27/2007	61				OWRB
Verdigris River near Wagoner	121500010200-001AT	3/27/2007	248				OWRB
Verdigris River near Wagoner	121500010200-001AT	10/22/2007	36				OWRB
Verdigris River near Wagoner	121500010200-001AT	12/4/2007	38				OWRB
Verdigris River near Wagoner	121500010200-001AT	2/11/2008	52				OWRB
Verdigris River near Wagoner	121500010200-001AT	4/22/2008	230				OWRB
Verdigris River near Wagoner	121500010200-001AT	7/29/2008	27				OWRB
Verdigris River near Wagoner	121500010200-001AT	10/7/2008	21				OWRB
Verdigris River near Wagoner	121500010200-001AT	11/18/2008	43				OWRB
Verdigris River near Wagoner	121500010200-001AT	4/21/2009	126	170			OWRB
Verdigris River near Wagoner	121500010200-001AT	7/28/2009	67	50			OWRB
Verdigris River near Wagoner	121500010200-001AT	10/27/2009	24.5	16			OWRB

Stream Name	Station ID	Date	Turbidity (NTU)	TSS (mg/L)	Flow (cfs)	Flow Condition	Data Sources
Bull Creek	OK121500-02-0090K	02/26/98	24.9		0.75		OCC
Bull Creek	OK121500-02-0090K	09/13/99	149	97	1.039		OCC
Bull Creek	OK121500-02-0090K	09/30/99	75.8				OCC
Bull Creek	OK121500-02-0090K	10/12/99	99.2	88.5	0		OCC
Bull Creek	OK121500-02-0090K	11/16/99	63.2	41.7	0		OCC
Bull Creek	OK121500-02-0090K	12/15/99	44.5	24	5.052		OCC
Bull Creek	OK121500-02-0090K	01/25/00	12.4	12.5	0.22		OCC
Bull Creek	OK121500-02-0090K	02/03/00	11.2				OCC
Bull Creek	OK121500-02-0090K	02/17/00	21.4				OCC
Bull Creek	OK121500-02-0090K	02/23/00	189	224		High Flow	OCC
Bull Creek	OK121500-02-0090K	03/22/00	36.9	23	5.498		OCC
Bull Creek	OK121500-02-0090K	04/18/00	28	16	1.064		OCC
Bull Creek	OK121500-02-0090K	05/17/00	31.8	18	11.741		OCC
Bull Creek	OK121500-02-0090K	06/20/00	89	61	75.761		OCC
Bull Creek	OK121500-02-0090K	07/26/00	34.2	10	1.768		OCC
Bull Creek	OK121500-02-0090K	08/03/00	52.4				OCC
Bull Creek	OK121500-02-0090K	08/17/00	45.3		0		OCC
Bull Creek	OK121500-02-0090K	08/31/00	21.6		0		OCC
Bull Creek	OK121500-02-0090K	10/10/00	55.7	32	0		OCC
Bull Creek	OK121500-02-0090K	11/14/00	32.7	8	0.201		OCC
Bull Creek	OK121500-02-0090K	12/19/00	18.6	9	1.341		OCC
Bull Creek	OK121500-02-0090K	01/23/01	20.3	16	0.878		OCC
Bull Creek	OK121500-02-0090K	03/13/01	37.8	34	30.918		OCC
Bull Creek	OK121500-02-0090K	04/17/01	24.6		2.888		OCC
Bull Creek	OK121500-02-0090K	05/15/01	39.7	36	3.656		OCC
Bull Creek	OK121500-02-0090K	06/19/01	54.6	40			OCC
Bull Creek	OK121500-02-0090K	07/17/01	21.1	20			OCC
Bull Creek	OK121500-02-0090D	08/14/01	54.5	73	0		OCC
Bull Creek	OK121500-02-0090K	08/21/01	17.7	23	0		OCC
Bull Creek	OK121500-02-0090D	08/27/01	9.57		0		OCC
Bull Creek	OK121500-02-0090D	09/18/01	73.1	58	0		OCC
Bull Creek	OK121500-02-0090D	10/23/01	81.5	45	0		OCC
Bull Creek	OK121500-02-0090D	12/04/01	41.1	21	0.186		OCC
Bull Creek	OK121500-02-0090D	01/08/02	61.7	12	0		OCC
Bull Creek	OK121500-02-0090D	02/12/02	37.8	18	0		OCC
Bull Creek	OK121500-02-0090D	03/19/02	86.8	64	22.314		OCC
Bull Creek	OK121500-02-0090D	04/23/02	188.9	11	132.686	High Flow	OCC
Bull Creek	OK121500-02-0090D	05/29/02	62.8	18	37.372		OCC
Bull Creek	OK121500-02-0090D	07/09/02	46.3	12	0		OCC

Stream Name	Station ID	Date	Turbidity (NTU)	TSS (mg/L)	Flow (cfs)	Flow Condition	Data Sources
Bull Creek	OK121500-02-0090D	08/06/02	56.4	10	0		OCC
Bull Creek	OK121500-02-0090D	09/17/02	20.1	19	0		OCC
Bull Creek	OK121500-02-0090D	10/15/02	21.7	19	0		OCC
Bull Creek	OK121500-02-0090D	11/19/02	31.4	26	0		OCC
Bull Creek	OK121500-02-0090D	12/17/02	37.9	10	0		OCC
Bull Creek	OK121500-02-0090D	01/28/03	28.5	10	0		OCC
Bull Creek	OK121500-02-0090D	03/04/03	52.5	10	3.277		OCC
Bull Creek	OK121500-02-0090D	04/08/03	36.9	31	8.564		OCC
Bull Creek	OK121500-02-0090D	05/13/03	28.4	30	0		OCC
Bull Creek	OK121500-02-0090D	06/17/03	52.3	27	2.369		OCC
Bull Creek	OK121500-02-0090D	06/20/06	14.1	10	0		OCC
Bull Creek	OK121500-02-0090D	06/27/06	10.4		0		OCC
Bull Creek	OK121500-02-0090D	08/15/06	21.9	21	0		OCC
Bull Creek	OK121500-02-0090D	09/19/06	131	43	2.446		OCC
Bull Creek	OK121500-02-0090D	10/24/06	61.2	24	0		OCC
Bull Creek	OK121500-02-0090D	11/28/06	43.1	21	0		OCC
Bull Creek	OK121500-02-0090D	01/03/07	52.2	10	13.172		OCC
Bull Creek	OK121500-02-0090D	01/30/07	35.8	10	7.11		OCC
Bull Creek	OK121500-02-0090D	03/06/07	24.6	15	1.454		OCC
Bull Creek	OK121500-02-0090D	04/10/07	12.3	10	4.818		OCC
Bull Creek	OK121500-02-0090D	05/14/07	35.9	18	0		OCC
Bull Creek	OK121500-02-0090D	06/18/07	23.8	10	4		OCC
Bull Creek	OK121500-02-0090D	07/23/07	150	23	0		OCC
Bull Creek	OK121500-02-0090D	08/28/07	47.2	37	9.894		OCC
Bull Creek	OK121500-02-0090D	10/02/07	44.2	17	0		OCC
Bull Creek	OK121500-02-0090D	11/07/07	18.8	10	0		OCC
Bull Creek	OK121500-02-0090D	12/05/07	24.5	16	0		OCC
Bull Creek	OK121500-02-0090D	01/29/08	17.8	10	0		OCC
Bull Creek	OK121500-02-0090D	02/26/08	35.1	12	0		OCC
Bull Creek	OK121500-02-0090D	04/01/08	116	51			OCC
Bull Creek	OK121500-02-0090D	05/06/08	12	10	0	High Flow	OCC
Verdigris River near Inola	121500020260-001AT	11/27/2000	43	20			OWRB
Verdigris River near Inola	121500020260-001AT	5/2/2001	74				OWRB
Verdigris River near Inola	121500020260-001AT	5/30/2001	891				OWRB
Verdigris River near Inola	121500020260-001AT	6/26/2001	57				OWRB
Verdigris River near Inola	121500020260-001AT	7/30/2001	3				OWRB
Verdigris River near Inola	121500020260-001AT	9/17/2001	27				OWRB
Verdigris River near Inola	121500020260-001AT	11/27/2001	22				OWRB
Verdigris River near Inola	121500020260-001AT	11/27/2001	1				OWRB

Stream Name	Station ID	Date	Turbidity (NTU)	TSS (mg/L)	Flow (cfs)	Flow Condition	Data Sources
Verdigris River near Inola	121500020260-001AT	2/25/2002	36				OWRB
Verdigris River near Inola	121500020260-001AT	4/1/2002	49				OWRB
Verdigris River near Inola	121500020260-001AT	5/28/2002	99				OWRB
Verdigris River near Inola	121500020260-001AT	6/24/2002	95				OWRB
Verdigris River near Inola	121500020260-001AT	8/5/2002	29.3				OWRB
Verdigris River near Inola	121500020260-001AT	8/26/2002	42				OWRB
Verdigris River near Inola	121500020260-001AT	9/23/2002	33				OWRB
Verdigris River near Inola	121500020260-001AT	11/18/2002	40				OWRB
Verdigris River near Inola	121500020260-001AT	12/16/2002	20				OWRB
Verdigris River near Inola	121500020260-001AT	2/3/2003	5				OWRB
Verdigris River near Inola	121500020260-001AT	3/4/2003	19				OWRB
Verdigris River near Inola	121500020260-001AT	3/31/2003	110				OWRB
Verdigris River near Inola	121500020260-001AT	5/6/2003	36				OWRB
Verdigris River near Inola	121500020260-001AT	7/9/2003	113				OWRB
Verdigris River near Inola	121500020260-001AT	10/6/2003	30				OWRB
Verdigris River near Inola	121500020260-001AT	11/4/2003	81				OWRB
Verdigris River near Inola	121500020260-001AT	3/10/2004	218				OWRB
Verdigris River near Inola	121500020260-001AT	5/4/2004	97				OWRB
Verdigris River near Inola	121500020260-001AT	7/7/2004	124				OWRB
Verdigris River near Inola	121500020260-001AT	7/21/2004	29				OWRB
Verdigris River near Inola	121500020260-001AT	8/24/2004	25				OWRB
Verdigris River near Inola	121500020260-001AT	10/13/2004	78				OWRB
Verdigris River near Inola	121500020260-001AT	10/27/2004	42				OWRB
Verdigris River near Inola	121500020260-001AT	12/1/2004	46				OWRB
Verdigris River near Inola	121500020260-001AT	2/23/2005	37				OWRB
Verdigris River near Inola	121500020260-001AT	7/12/2005	42				OWRB
Verdigris River near Inola	121500020260-001AT	10/4/2005	19				OWRB
Verdigris River near Inola	121500020260-001AT	11/15/2005	15				OWRB
Verdigris River near Inola	121500020260-001AT	1/10/2006	21				OWRB
Verdigris River near Inola	121500020260-001AT	2/28/2006	11				OWRB
Verdigris River near Inola	121500020260-001AT	4/10/2006	65				OWRB
Verdigris River near Inola	121500020260-001AT	6/14/2006	17				OWRB
Verdigris River near Inola	121500020260-001AT	7/18/2006	44				OWRB
Verdigris River near Inola	121500020260-001AT	9/18/2006	26				OWRB
Verdigris River near Inola	121500020260-001AT	12/18/2006	14				OWRB
Verdigris River near Inola	121500020260-001AT	2/28/2007	54				OWRB
Verdigris River near Inola	121500020260-001AT	3/27/2007	249				OWRB
Verdigris River near Inola	121500020260-001AT	10/22/2007	45				OWRB
Verdigris River near Inola	121500020260-001AT	12/4/2007	20				OWRB

Stream Name	Station ID	Date	Turbidity (NTU)	TSS (mg/L)	Flow (cfs)	Flow Condition	Data Sources
Verdigris River near Inola	121500020260-001AT	2/11/2008	102				OWRB
Verdigris River near Inola	121500020260-001AT	4/22/2008	269				OWRB
Verdigris River near Inola	121500020260-001AT	7/28/2008	38				OWRB
Verdigris River near Inola	121500020260-001AT	11/17/2008	52				OWRB
Verdigris River near Inola	121500020260-001AT	4/21/2009	139	174			OWRB
Verdigris River near Inola	121500020260-001AT	7/28/2009	82	50			OWRB
Verdigris River near Inola	121500020260-001AT	10/27/2009	26	19			OWRB
Verdigris River near Inola	121500020260-001AT	12/14/2009	28.7	21			OWRB
Verdigris River near Inola	121500020260-001AT	5/25/2010	123	116.5			OWRB
Verdigris River near Inola	121500020260-001AT	8/30/2010	17.6667				OWRB
Verdigris River near Inola	121500020260-001AT	11/30/2010	11.8				OWRB
Verdigris River near Inola	121500020260-001AT	2/14/2011	12				OWRB
Verdigris River near Inola	121500020260-001AT	6/7/2011	56				OWRB

APPENDIX B

GENERAL METHOD FOR ESTIMATING FLOW FOR UNGAGED STREAMS

AND

ESTIMATED FLOW EXCEEDANCE PERCENTILES

Appendix B
General Method for Estimating Flow for Ungaged Streams

Flows duration curve will be developed using existing USGS measured flow where the data exist from a gage on the stream segment of interest, or by estimating flow for stream segments with no corresponding flow record. Flow data to support flow duration curves and load duration curves will be derived for each Oklahoma stream segment in the following priority:

i) In cases where a USGS flow gage occurs on, or within one-half mile upstream or downstream of the Oklahoma stream segment.

   a. If simultaneously collected flow data matching the water quality sample collection date are available, these flow measurements will be used.

   b. If flow measurements at the coincident gage are missing for some dates on which water quality samples were collected, the gaps in the flow record will be filled, or the record will be extended, by estimating flow based on measured streamflows at a nearby gages. All gages within 150 km radius are identified. For each of the identified gage with a minimum of 99 flow measurements on matching dates, four different regressions are calculated including linear, log linear, logarithmic and exponential regressions. The regression with the lowest root mean square error (RMSE) is chosen for each gage. The potential filling gages are ranked by RMSE from lowest to highest. The record is filled from the first gage (lowest RMSE) for those dates that exist in both records. If dates remain unfilled in the desired timespan of the time series, the filling process is repeated with the next gage with the next lowest RMSE and proceeds in this fashion until all missing values in the desired timespan are filled.

   c. The flow frequency for the flow duration curves will be based on measured flows only. The filled time series described above is used to match flows to sampling dates to calculate loads.

   d. On a stream impounded by dams to form reservoirs of sufficient size to impact stream flow, only flows measured after the date of the most recent impoundment will be used to develop the flow duration curve. This also applies to reservoirs on major tributaries to the stream.

ii) In the case no coincident flow data are available for a stream segment, but flow gage(s) are present upstream and/or downstream without a major reservoir between, flows will be estimated for the stream segment from an upstream or downstream gage using a watershed area ratio method derived by delineating subwatersheds, and relying on the NRCS runoff curve numbers and antecedent rainfall condition. Drainage subbasins will first be delineated for all impaired 303(d)-listed WQM stations, along with all USGS flow stations located in the 8-digit HUCs with impaired streams. Parsons will then identify all the USGS gage stations upstream and downstream of the subwatersheds with 303(d) listed WQM stations.

   a. Watershed delineations are performed using ESRI Arc Hydro with a 30 m resolution National Elevation Dataset digital elevation model, and National

Hydrography Dataset (NHD) streams. The area of each watershed will be calculated following watershed delineation.

b. The watershed average curve number is calculated from soil properties and land cover as described in the U.S. Department of Agriculture (USDA) Publication *TR-55: Urban Hydrology for Small Watersheds*. The soil hydrologic group is extracted from NRCS STATSGO soil data, and land use category from the 2001 National Land Cover Dataset (NLCD). Based on land use and the hydrologic soil group, SCS curve numbers are estimated at the 30-meter resolution of the NLCD grid as shown in the table below. The average curve number is then calculated from all the grid cells within the delineated watershed.

c. The average rainfall is calculated for each watershed from gridded average annual precipitation datasets for the period 1971-2000 (Spatial Climate Analysis Service, Oregon State University, http://www.ocs.oregonstate.edu/prism/, created February 20, 2004).

Runoff Curve Numbers for Various Land Use Categories

and Hydrologic Soil Groups

NLCD Land Use Category	Curve number for hydrologic soil group			
	A	B	C	D
0 in case of zero	100	100	100	100
11 Open Water	100	100	100	100
12 Perennial Ice/Snow	100	100	100	100
21 Developed, Open Space	39	61	74	80
22 Developed, Low Intensity	57	72	81	86
23 Developed, Medium Intensity	77	85	90	92
24 Developed, High Intensity	89	92	94	95
31 Barren Land (Rock/Sand/Clay)	77	86	91	94
32 Unconsolidated Shore	77	86	91	94
41 Deciduous Forest	37	48	57	63
42 Evergreen Forest	45	58	73	80
43 Mixed Forest	43	65	76	82
51 Dwarf Scrub	40	51	63	70
52 Shrub/Scrub	40	51	63	70
71 Grasslands/Herbaceous	40	51	63	70
72 Sedge/Herbaceous	40	51	63	70
73 Lichens	40	51	63	70
74 Moss	40	51	63	70
81 Pasture/Hay	35	56	70	77
82 Cultivated Crops	64	75	82	85
90-99 Wetlands	100	100	100	100

d. The method used to project flow from a gaged location to an ungaged location was adapted by combining aspects of two other flow projection methodologies developed by Furness (Furness 1959) and Wurbs (Wurbs 1999).

Furness Method

The Furness method has been employed in Kansas by both the USGS and Kansas Department of Health and Environment to estimate flow-duration curves. The method typically uses maps, graphs, and computations to identify six unique factors of flow duration for ungaged sites. These factors include:

- the mean streamflow and percentage duration of mean streamflow;
- the ratio of 1-percent-duration streamflow to mean streamflow;
- the ratio of 0.1-percent-duration streamflow to 1-percent-duration streamflow;
- the ratio of 50-percentduration streamflow to mean streamflow;
- the percentage duration of appreciable (0.10 ft /s) streamflow; and
- average slope of the flow-duration curve.

Furness defined appreciable flow as 0.10 ft/s. This value of streamflow was important because, for many years, this was the smallest non-zero streamflow value reported in most Kansas streamflow records. The average slope of the duration curve is a graphical approximation of the variability index, which is the standard deviation of the logarithms of the streamflows (Furness 1959, p. 202-204, figs. 147 and 148). On a duration curve that fits the log-normal distribution exactly, the variability index is equal to the ratio of the streamflow at the 15.87-percent-duration point to the streamflow at the 50-percent-duration point. Because duration curves usually do not exactly fit the log-normal distribution, the average-slope line is drawn through an arbitrary point, and the slope is transferred to a position approximately defined by the previously estimated points.

The method provides a means of both describing shape of the flow duration curve and scaling the magnitude of the curve to another location, basically generating a new flow duration curve with a very similar shape but different magnitude at the ungaged location.

Wurbs Modified NRCS Method

As a part of the Texas water availability modeling (WAM) system developed by Texas Natural Resources Conservation Commission, now known as the Texas Commission on Environmental Quality (TCEQ), and partner agencies, various contractors developed models of all Texas rivers. As a part of developing the model code to be used, Dr. Ralph Wurbs of Texas A&M University researched methods to distribute flows from gaged locations to ungaged locations. (Wurbs 2006) His results included the development of a modified NRCS curve-number (CN) method for distributing flows from gaged locations to ungaged locations.

This modified NRCS method is based on the following relationship between rainfall depth, P in inches, and runoff depth, Q in inches (NRCS 1985; McCuen 2005):

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \qquad (1)$$

where:

Q = runoff depth (inches)

P = rainfall (inches)

S = potential maximum retention after runoff begins (inches)

I_a = initial abstraction (inches)

If $P < 0.2$, $Q = 0$. Initial abstraction has been found to be empirically related to S by the equation

$$I_a = 0.2*S \qquad (2)$$

Thus, the runoff curve number equation can be rewritten:

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S} \qquad (3)$$

S is related to the curve number (CN) by:

$$S = \frac{1000}{CN} - 10 \qquad (4)$$

P and Q in inches must be multiplied by the watershed area to obtain volumes. The potential maximum retention, S in inches, represents an upper limit on the amount of water that can be abstracted by the watershed through surface storage, infiltration, and other hydrologic abstractions. For convenience, S is expressed in terms of a curve number CN, which is a dimensionless watershed parameter ranging from 0 to 100. A CN of 100 represents a limiting condition of a perfectly impervious watershed with zero retention and thus all the rainfall becoming runoff. A CN of zero conceptually represents the other extreme with the watershed abstracting all rainfall with no runoff regardless of the rainfall amount.

First, S is calculated from the average curve number for the gaged watershed. Next, the daily historic flows at the gage are converted to depth basis (as used in equations 1 and 3) by dividing by its drainage area, then converted to inches. Equation 3 is then solved for daily precipitation depth of the gaged site, Pgaged. The daily precipitation depth for the ungaged site is then calculated as the precipitation depth of the gaged site multiplied by the ratio of the long-term average precipitation in the watersheds of the ungaged and gaged sites:

$$P_{ungaged} = P_{gaged}\left(\frac{M_{ungaged}}{M_{gaged}}\right) \tag{5}$$

where M is the mean annual precipitation of the watershed in inches. The daily precipitation depth for the ungaged watershed, along with the average curve number of the ungaged watershed, are then used to calculate the depth equivalent daily flow Q of the ungaged site. Finally, the volumetric flow rate at the ungaged site is calculated by multiplying by the area of the watershed of the ungaged site and converted to cubic feet.

In a subsequent study (Wurbs 2006), Wurbs evaluated the predictive ability of various flow distribution methods including:

- Distribution of flows in proportion to drainage area;
- Flow distribution equation with ratios for various watershed parameters;
- Modified NRCS curve-number method;
- Regression equations relating flows to watershed characteristics;
- Use of recorded data at gaging stations to develop precipitation-runoff relationships; and
- Use of watershed (precipitation-runoff) computer models such as SWAT.

As a part of the analysis, the methods were used to predict flows at one gaged station to another gage station so that fit statistics could be calculated to evaluate the efficacy of each of the methods. Based upon similar analyses performed for many gaged sites which reinforced the tests performed as part of the study, Wurbs observed that temporal variations in flows are dramatic, ranging from zero flows to major floods. Mean flows are reproduced reasonably well with the all flow distribution methods and the NRCS CN method reproduces the mean closest. Accuracy in predicting mean flows is much better than the accuracy of predicting the flow-frequency relationship. Performance in reproducing flow-frequency relationships is better than for reproducing flows for individual flows.

Wurbs concluded that the NRCS CN method, the drainage area ratio method, and drainage area – CN – mean annual precipitation depth (MP) ratio methods all yield similar levels of accuracy. If the CN and MP are the same for the gaged and ungaged watersheds, the three alternative methods yield identical results. Drainage area is the most important watershed parameter. However, the NRCS method adaptation is preferable in those situations in which differences in CN (land use and soil type) and long-term MP are significantly different between the gaged and ungaged watersheds. The CN and MP are usually similar but not identical.

Generalized Flow Projection Methodology

In the first several versions of the Oklahoma TMDL toolbox, all flows at ungaged sites that required projection from a gaged site were performed with the Modified NRCS CN method. This led a number of problems with flow projections in the early versions. As described previously, the NRCS method, in common with all others, reproduces the mean or central tendency best but the accuracy of the fit degrades towards the extremes of the frequency spectrum. Part of the degradation in accuracy is due to the quite non-linear nature of the NRCS equations. On the low flow end of the frequency spectrum, Equation 2 above constitutes a low flow limit below which the NRCS equations are not applicable at all. Given the flashy nature of most streams in locations for which the toolbox was developed, high and low flows are relatively more common and spurious results from the limits of the equations abounded.

In an effort to increase the flow prediction efficacy and remedy the failure of the NRCS CN method at the extremes of the flow spectrum, a hybrid of the NRCS CN method and the Furness method was developed. Noting the facts that all tested projection methods, and particularly the NRCS CN method, perform best near the central tendency or mean and that none of the methods predict the entire flow frequency spectrum well, an assumption that is implicit in the Furness method is applied. The Furness method implicitly assumes that the shape of the flow frequency curve at an upstream site is related to and similar to the shape of the flow frequency curve at a site downstream. As described previously, the Furness method employs several relationships derived between the mean flows and flows at differing frequencies to replicate the shape of the flow frequency curve at the projected site, while utilizing other regressed relationships to scale the magnitude of the curve. Since, as part of the toolbox calculations, the entire flow frequency curve at a 1% interval is calculated for every USGS gage utilizing very long periods of record, this vector in association with the mean flow was used to project the flow frequency curve.

In the ideal situation flows are projected from an ungaged location from a downstream gaged location. The toolbox also has the capability to project flows from and upstream gaged location if there is no useable downstream gage.

iii) In the rare case where no coincident flow data are available for a WQM station and no gages are present upstream or downstream, flows will be estimated for the WQM station from a gage on an adjacent watershed of similar size and properties, via the same procedure described above for upstream or downstream gages.

References

Furness, L.W., 1959, *Kansas Streamflow Characteristics- Part 1, Flow Duration*: Kansas Water Resources Board Technical Report No. 1.

Wurbs, R.A., and E.D. Sisson, *Evaluation of Methods for Distributing Naturalized Streamflows from Gaged Watersheds to Ungaged Subwatersheds*, Technical Report 179, Texas Water Resources Institute and Texas Natural Resource Conservation Commission, August 1999.

Wurbs, R.A . 2006. *Methods for Developing Naturalized Monthly Flows at Gaged and Ungaged Sites*. Journal of Hydrologic Engineering, January/February 2006, ASCE

Estimated Flow Exceedance Percentiles

Stream Name	Arkansas River near Muskogee	Coody Creek	Dirty Creek	Dirty Creek, South Fork	Dirty Creek, Georges Fork	Butler Creek	Elk Creek	Shady Grove Creek	Arkansas River near Haskell	Cloud Creek	Snake Creek	Arkansas River near Bixby
WBID Segment	OK120400010260_00	OK120400010400_00	OK120400020010_00	OK120400020030_00	OK120400020110_00	OK120400020160_00	OK120400020190_00	OK120400020240_00	OK120410010080_00	OK120410010100_00	OK120410010220_00	OK120420010010_00
USGS Gage Reference	07194500	07194500	07198500	07194500	07194500	07194500	07194500	07194500	07165570 & 07165600	07165570 & 07165600	07165570 & 07165600	07165570 & 07165600
Drainage Area (sq. mile)	135.30	52.69	222.94	54.62	58.35	46.87	86.57	21.33	296.96	10.26	70.16	329.94
NRCS Curve Number	74.11	73.79	67.58	72.35	70.94	69.60	72.45	71.13	69.25	68.33	66.37	70.04
Ave. Annual Rainfall (inch)	45.22	45.16	46.06	46.65	46.24	45.01	44.93	45.44	43.82	44.19	42.34	41.31
Flow Exceedance Frequency	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**
0	176000	259.5	2240	556	1636	184	742	179.7	243000	339	518	254519
1	132000	65.7	567	141	414	47	188	45.5	61531	86	131	64448
2	115000	53.3	460	114	336	38	152	36.9	49862	70	106	52226
3	110000	48.0	414	103	302	34	137	33.2	44900	63	96	47028
4	106000	43.0	372	92	271	31	123	29.8	40300	56	86	42210
5	101750	38.4	332	82	242	27	110	26.6	36000	50	77	37706
6	96050	35.3	305	76	223	25	101	24.5	33086	46	71	34654
7	90400	33.0	285	71	208	23	94	22.9	30900	43	66	32365
8	84740	30.9	266	66	195	22	88	21.4	28900	40	62	30270
9	80430	29.3	253	63	184	21	84	20.3	27400	38	58	28699
10	75700	27.6	238	59	174	20	79	19.1	25800	36	55	27023
11	69470	26.2	226	56	165	19	75	18.1	24500	34	52	25661
12	65120	24.9	215	53	157	18	71	17.2	23272	32	50	24375
13	62900	23.6	204	51	149	17	68	16.3	22100	31	47	23148
14	59970	22.4	194	48	141	16	64	15.5	21000	29	45	21995
15	56925	21.1	183	45	133	15	60	14.6	19800	28	42	20739
16	54600	19.9	171	43	125	14	57	13.8	18600	26	40	19482
17	52795	19.0	164	41	120	13	54	13.2	17800	25	38	18644
18	50960	17.9	155	38	113	13	51	12.4	16800	23	36	17596
19	48800	16.9	146	36	106	12	48	11.7	15800	22	34	16549
20	46200	16.2	140	35	102	12	46	11.2	15200	21	32	15921
21	44335	15.7	136	34	99	11	45	10.9	14700	20	31	15397
22	43100	15.2	131	32	96	11	43	10.5	14200	20	30	14873
23	41900	14.7	127	32	93	10	42	10.2	13800	19	29	14454
24	40580	14.4	124	31	91	10	41	10.0	13500	19	29	14140
25	39375	14.0	121	30	88	10	40	9.7	13100	18	28	13721
26	37410	13.6	117	29	86	10	39	9.4	12700	18	27	13302
27	36345	13.1	113	28	83	9	38	9.1	12300	17	26	12883

Stream Name	Arkansas River near Muskogee	Coody Creek	Dirty Creek	Dirty Creek, South Fork	Dirty Creek, Georges Fork	Butler Creek	Elk Creek	Shady Grove Creek	Arkansas River near Haskell	Cloud Creek	Snake Creek	Arkansas River near Bixby
WBID Segment	OK120400010260_00	OK120400010400_00	OK120400020010_00	OK120400020030_00	OK120400020110_00	OK120400020160_00	OK120400020190_00	OK120400020240_00	OK120410010080_00	OK120410010100_00	OK120410010220_00	OK120420010010_00
USGS Gage Reference	07194500	07194500	07198500	07194500	07194500	07194500	07194500	07194500	07165570 & 07165600	07165570 & 07165600	07165570 & 07165600	07165570 & 07165600
Drainage Area (sq. mile)	135.30	52.69	222.94	54.62	58.35	46.87	86.57	21.33	296.96	10.26	70.16	329.94
NRCS Curve Number	74.11	73.79	67.58	72.35	70.94	69.60	72.45	71.13	69.25	68.33	66.37	70.04
Ave. Annual Rainfall (inch)	45.22	45.16	46.06	46.65	46.24	45.01	44.93	45.44	43.82	44.19	42.34	41.31
Flow Exceedance Frequency	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**
28	35080	12.6	109	27	79	9	36	8.7	11800	16	25	12359
29	34000	12.0	103	26	75	8	34	8.3	11200	16	24	11731
30	33100	11.5	100	25	73	8	33	8.0	10800	15	23	11312
31	32100	10.9	94	23	69	8	31	7.5	10200	14	22	10683
32	30900	10.5	91	23	66	7	30	7.3	9840	14	21	10306
33	29700	10.1	87	22	64	7	29	7.0	9490	13	20	9940
34	28890	9.8	85	21	62	7	28	6.8	9195	13	20	9631
35	28125	9.5	82	20	60	7	27	6.6	8880	12	19	9301
36	27200	9.2	79	20	58	6	26	6.3	8580	12	18	8987
37	26400	8.9	77	19	56	6	25	6.1	8305	12	18	8698
38	25600	8.6	74	18	54	6	24	5.9	8010	11	17	8390
39	24765	8.3	72	18	52	6	24	5.7	7770	11	17	8138
40	23800	8.1	70	17	51	6	23	5.6	7540	11	16	7897
41	23000	7.8	67	17	49	6	22	5.4	7320	10	16	7667
42	22200	7.6	65	16	48	5	22	5.2	7080	10	15	7416
43	21600	7.3	63	16	46	5	21	5.1	6870	10	15	7196
44	20780	7.1	61	15	45	5	20	4.9	6620	9	14	6934
45	20175	6.8	59	15	43	5	19	4.7	6360	9	14	6661
46	19410	6.5	56	14	41	5	19	4.5	6103	9	13	6392
47	18645	6.3	54	13	40	4	18	4.4	5886	8	13	6165
48	17880	6.0	52	13	38	4	17	4.2	5640	8	12	5907
49	17200	5.8	50	12	37	4	17	4.0	5450	8	12	5708
50	16650	5.6	49	12	36	4	16	3.9	5280	7	11	5530
51	16100	5.4	47	12	34	4	16	3.8	5088	7	11	5329
52	15600	5.2	45.3	11.2	33.1	3.7	15.0	3.6	4910	6.8	10.5	5143
53	14900	5.0	43.5	10.8	31.8	3.6	14.4	3.5	4720	6.6	10.1	4944
54	14190	4.9	42.1	10.4	30.7	3.5	14.0	3.4	4567	6.4	9.7	4784
55	13500	4.7	40.4	10.0	29.5	3.3	13.4	3.2	4380	6.1	9.3	4588
56	12960	4.5	38.9	9.7	28.4	3.2	12.9	3.1	4220	5.9	9.0	4420
57	12400	4.3	37.3	9.3	27.3	3.1	12.4	3.0	4050	5.6	8.6	4242

Stream Name	Arkansas River near Muskogee	Coody Creek	Dirty Creek	Dirty Creek, South Fork	Dirty Creek, Georges Fork	Butler Creek	Elk Creek	Shady Grove Creek	Arkansas River near Haskell	Cloud Creek	Snake Creek	Arkansas River near Bixby
WBID Segment	OK120400010260_00	OK120400010400_00	OK120400020010_00	OK120400020030_00	OK120400020110_00	OK120400020160_00	OK120400020190_00	OK120400020240_00	OK120410010080_00	OK120410010100_00	OK120410010220_00	OK120420010010_00
USGS Gage Reference	07194500	07194500	07198500	07194500	07194500	07194500	07194500	07194500	07165570 & 07165600	07165570 & 07165600	07165570 & 07165600	07165570 & 07165600
Drainage Area (sq. mile)	135.30	52.69	222.94	54.62	58.35	46.87	86.57	21.33	296.96	10.26	70.16	329.94
NRCS Curve Number	74.11	73.79	67.58	72.35	70.94	69.60	72.45	71.13	69.25	68.33	66.37	70.04
Ave. Annual Rainfall (inch)	45.22	45.16	46.06	46.65	46.24	45.01	44.93	45.44	43.82	44.19	42.34	41.31
Flow Exceedance Frequency	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**
58	11800	4.2	36.0	8.9	26.3	3.0	11.9	2.9	3910	5.5	8.3	4095
59	11100	4.0	34.8	8.6	25.4	2.9	11.5	2.8	3780	5.3	8.1	3959
60	10800	3.9	33.7	8.4	24.6	2.8	11.2	2.7	3660	5.1	7.8	3833
61	10200	3.8	32.4	8.0	23.7	2.7	10.8	2.6	3519	4.9	7.5	3686
62	9617	3.6	31.4	7.8	23.0	2.6	10.4	2.5	3410	4.8	7.3	3572
63	9102	3.5	30.4	7.5	22.2	2.5	10.1	2.4	3300	4.6	7.0	3456
64	8664	3.4	29.4	7.3	21.5	2.4	9.7	2.4	3190	4.4	6.8	3341
65	8260	3.3	28.2	7.0	20.6	2.3	9.3	2.3	3060	4.3	6.5	3205
66	7850	3.1	26.9	6.7	19.7	2.2	8.9	2.2	2920	4.1	6.2	3058
67	7520	3.0	25.9	6.4	18.9	2.1	8.6	2.1	2810	3.9	6.0	2943
68	7156	2.9	25.0	6.2	18.2	2.1	8.3	2.0	2710	3.8	5.8	2838
69	6855	2.8	24.0	5.9	17.5	2.0	7.9	1.9	2600	3.6	5.5	2723
70	6525	2.7	23.0	5.7	16.8	1.9	7.6	1.8	2500	3.5	5.3	2619
71	6190	2.6	22.2	5.5	16.2	1.8	7.4	1.8	2410	3.4	5.1	2524
72	5962	2.5	21.2	5.3	15.5	1.7	7.0	1.7	2300	3.2	4.9	2409
73	5706	2.3	20.3	5.0	14.8	1.7	6.7	1.6	2200	3.1	4.7	2304
74	5320	2.2	19.4	4.8	14.1	1.6	6.4	1.6	2100	2.9	4.5	2200
75	5123	2.2	18.6	4.6	13.6	1.5	6.2	1.5	2020	2.8	4.3	2116
76	4922	2.1	17.9	4.4	13.1	1.5	5.9	1.4	1940	2.7	4.1	2032
77	4620	2.0	17.1	4.2	12.5	1.4	5.7	1.4	1850	2.6	3.9	1938
78	4373	1.9	16.1	4.0	11.8	1.3	5.4	1.3	1752	2.4	3.7	1835
79	4187	1.8	15.5	3.8	11.3	1.3	5.1	1.2	1680	2.3	3.6	1760
80	3930	1.7	14.7	3.6	10.7	1.2	4.9	1.2	1590	2.2	3.4	1665
81	3717	1.6	14.0	3.5	10.2	1.2	4.6	1.1	1520	2.1	3.2	1592
82	3517	1.5	13.4	3.3	9.8	1.1	4.4	1.1	1450	2.0	3.1	1519
83	3270	1.5	12.8	3.2	9.4	1.1	4.2	1.0	1390	1.9	3.0	1456
84	3080	1.4	12.0	3.0	8.8	0.98	3.97	1.0	1300	1.8	2.77	1362
85	2880	1.3	11.3	2.8	8.3	0.93	3.76	0.9	1230	1.7	2.62	1288
86	2701	1.2	10.7	2.7	7.8	0.88	3.54	0.9	1160	1.6	2.47	1215
87	2535	1.2	10.1	2.5	7.4	0.83	3.36	0.8	1100	1.5	2.35	1152

Stream Name	Arkansas River near Muskogee	Coody Creek	Dirty Creek	Dirty Creek, South Fork	Dirty Creek, Georges Fork	Butler Creek	Elk Creek	Shady Grove Creek	Arkansas River near Haskell	Cloud Creek	Snake Creek	Arkansas River near Bixby
WBID Segment	OK120400010260_00	OK120400010400_00	OK120400020010_00	OK120400020030_00	OK120400020110_00	OK120400020160_00	OK120400020190_00	OK120400020240_00	OK120410010080_00	OK120410010100_00	OK120410010220_00	OK120420010010_00
USGS Gage Reference	07194500	07194500	07198500	07194500	07194500	07194500	07194500	07194500	07165570 & 07165600	07165570 & 07165600	07165570 & 07165600	07165570 & 07165600
Drainage Area (sq. mile)	135.30	52.69	222.94	54.62	58.35	46.87	86.57	21.33	296.96	10.26	70.16	329.94
NRCS Curve Number	74.11	73.79	67.58	72.35	70.94	69.60	72.45	71.13	69.25	68.33	66.37	70.04
Ave. Annual Rainfall (inch)	45.22	45.16	46.06	46.65	46.24	45.01	44.93	45.44	43.82	44.19	42.34	41.31
Flow Exceedance Frequency	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**
88	2350	1.1	9.6	2.4	7.0	0.79	3.18	0.8	1040	1.4	2.22	1089
89	2102	1.0	9.0	2.2	6.6	0.74	3.00	0.7	981	1.4	2.09	1027
90	1940	1.0	8.4	2.1	6.1	0.69	2.77	0.7	906	1.3	1.93	949
91	1770	0.9	7.8	1.9	5.7	0.64	2.60	0.6	850	1.2	1.81	890
92	1622	0.8	7.2	1.8	5.3	0.60	2.40	0.6	786	1.1	1.68	823
93	1406	0.8	6.7	1.7	4.9	0.55	2.21	0.5	722	1.0	1.54	756
94	1239	0.7	6.2	1.5	4.5	0.51	2.05	0.5	672	0.9	1.43	704
95	1060	0.7	5.7	1.4	4.2	0.47	1.89	0.5	618	0.9	1.32	648
96	782	0.6	5.3	1.3	3.8	0.43	1.74	0.4	571	0.8	1.22	598
97	612	0.5	4.7	1.2	3.4	0.39	1.56	0.4	512	0.7	1.09	536
98	450	0.5	3.9	1.0	2.9	0.32	1.30	0.3	426	0.6	0.91	446
99	300	0.3	3.0	0.7	2.2	0.25	1.00	0.2	327	0.5	0.70	343
100	31	0.0	0.0	0.0	0.0	0.0	0.0	0.1	87	0.0	0	91

Stream Name	Arkansas River near Sand Springs	Polecat Creek	Polecat Creek	Verdigris River near Wagoner	Bull Creek	Pea Creek	Verdigris River near Inola, OK	Dog Creek	Verdigris River near Claremore	Neosho River below Ft. Gibson Lake near Ft. Gibson	Chouteau Creek
WBID Segment	OK120420010130_00	OK120420020010_00	OK120420020050_00	OK121500010200_00	OK121500020090_00	OK121500020100_00	OK121500020260_00	OK121500020360_00	OK121500030010_00	OK121600010010_00	OK121600010430_00
USGS Gage Reference	07164200	07164200	07164200	07176000	07176000	07176000	07176000	07176000	07176000	07193500	07193500
Drainage Area (sq. mile)	108	153.08	58.96	19.87	48.84	17.57	251.48	71.86	33.31	4.34	71.88
NRCS Curve Number	62.35	66.35	65.04	73.63	73.48	71.15	70.51	69.88	70.40	69.39	70.89
Ave. Annual Rainfall (inch)	40.69	41.24	41.22	44.27	43.88	43.52	43.01	43.36	42.51	45.29	43.57
Flow Exceedance Frequency	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**
0	114777	688	795.3	112476	233.7	41.7	345660	612	181000	7533	683
1	29063	174	201.4	20510	59.2	10.6	63030	155	33005	1374	173
2	23551	141	163.2	17406	48.0	8.6	53491	126	28010	1166	140
3	21208	127	147.0	15162	43.2	7.7	46597	113	24400	1016	126
4	19035	114	131.9	13485	38.8	6.9	41441	101	21700	903	113
5	17004	102	117.8	12304	34.6	6.2	37813	91	19800	824	101
6	15628	94	108.3	11248	31.8	5.7	34566	83	18100	753	93
7	14595	88	101.1	10315	29.7	5.3	31701	78	16600	691	87
8	13650	82	94.6	9445	27.8	5.0	29028	73	15200	633	81
9	12942	78	89.7	8824	26.4	4.7	27118	69	14200	591	77
10	12186	73	84.4	8203	24.8	4.4	25208	65	13200	549	73
11	11572	69	80.2	7643	23.6	4.2	23490	62	12300	512	69
12	10992	66	76.2	7271	22.4	4.0	22344	59	11700	487	65
13	10439	63	72.3	6836	21.3	3.8	21007	56	11000	458	62
14	9919	59	68.7	6463	20.2	3.6	19861	53	10400	433	59
15	9352	56	64.8	6102	19.0	3.4	18753	50	9820	409	56
16	8785	53	60.9	5754	17.9	3.2	17684	47	9260	385	52
17	8408	50	58.3	5394	17.1	3.1	16576	45	8680	361	50
18	7935	48	55.0	5058	16.2	2.9	15545	42	8140	339	47
19	7463	45	51.7	4747	15.2	2.7	14589	40	7640	318	44
20	7179	43	49.7	4443	14.6	2.6	13655	38	7150	298	43
21	6943	42	48.1	4182	14.1	2.5	12853	37	6730	280	41
22	6707	40	46.5	3921	13.7	2.4	12050	36	6310	263	40
23	6518	39	45.2	3685	13.3	2.4	11325	35	5930	247	39
24	6376	38	44.2	3480	13.0	2.3	10694	34	5600	233	38
25	6188	37	42.9	3293	12.6	2.2	10122	33	5300	221	37
26	5999	36	41.6	3076	12.2	2.2	9453	32	4950	206	36
27	5810	35	40.3	2859	11.8	2.1	8785	31	4600	191	35
28	5574	33	38.6	2635	11.4	2.0	8097	30	4240	176	33

Stream Name	Arkansas River near Sand Springs	Polecat Creek	Polecat Creek	Verdigris River near Wagoner	Bull Creek	Pea Creek	Verdigris River near Inola, OK	Dog Creek	Verdigris River near Claremore	Neosho River below Ft. Gibson Lake near Ft. Gibson	Chouteau Creek
WBID Segment	OK120420010130_00	OK120420020010_00	OK120420020050_00	OK121500010200_00	OK121500020090_00	OK121500020100_00	OK121500020260_00	OK121500020360_00	OK121500030010_00	OK121600010010_00	OK121600010430_00
USGS Gage Reference	07164200	07164200	07164200	07176000	07176000	07176000	07176000	07176000	07176000	07193500	07193500
Drainage Area (sq. mile)	108	153.08	58.96	19.87	48.84	17.57	251.48	71.86	33.31	4.34	71.88
NRCS Curve Number	62.35	66.35	65.04	73.63	73.48	71.15	70.51	69.88	70.40	69.39	70.89
Ave. Annual Rainfall (inch)	40.69	41.24	41.22	44.27	43.88	43.52	43.01	43.36	42.51	45.29	43.57
Flow Exceedance Frequency	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**
29	5290	32	36.7	2448	10.8	1.9	7524	28	3940	164	31
30	5101	31	35.3	2268	10.4	1.9	6970	27	3650	152	30
31	4818	29	33.4	2076	9.8	1.8	6378	26	3340	139	29
32	4648	28	32.2	1889	9.5	1.7	5806	25	3040	127	28
33	4482	27	31.1	1728	9.1	1.6	5309	24	2780	116	27
34	4343	26	30.1	1591	8.8	1.6	4889	23	2560	107	26
35	4194	25	29.1	1473	8.5	1.5	4526	22	2370	99	25
36	4053	24	28.1	1361	8.3	1.5	4182	22	2190	91	24
37	3923	24	27.2	1249	8.0	1.4	3839	21	2010	84	23
38	3783	23	26.2	1156	7.7	1.4	3552	20	1860	77	23
39	3670	22	25.4	1063	7.5	1.3	3266	20	1710	71	22
40	3561	21	24.7	976	7.3	1.3	2998	19	1570	65	21
41	3457	21	24.0	913	7.0	1.3	2807	18	1470	61	21
42	3344	20	23.2	845	6.8	1.2	2597	18	1360	57	20
43	3245	19	22.5	777	6.6	1.2	2387	17	1250	52	19
44	3127	19	21.7	727	6.4	1.1	2234	17	1170	49	19
45	3004	18	20.8	677	6.1	1.1	2082	16	1090	45	18
46	2882	17	20.0	628	5.9	1.0	1929	15	1010	42	17
47	2780	17	19.3	592	5.7	1.0	1820	15	953	40	17
48	2664	16	18.5	549	5.4	1.0	1688	14	884	37	16
49	2574	15	17.8	510	5.2	0.9	1568	14	821	34	15
50	2494	15	17.3	472	5.1	0.9	1451	13	760	32	15
51	2403	14	16.7	441	4.9	0.9	1354	13	709	30	14
52	2319	14	16.1	413	4.7	0.8	1268	12	664	28	14
53	2229	13	15.4	378	4.5	0.8	1161	12	608	25	13
54	2157	13	14.9	349	4.4	0.8	1073	11	562	23	13
55	2069	12	14.3	321	4.2	0.8	987	11	517	22	12
56	1993	12	13.8	294	4.1	0.7	903	11	473	20	12
57	1913	11	13.3	273	3.9	0.7	838	10	439	18	11

Stream Name	Arkansas River near Sand Springs	Polecat Creek	Polecat Creek	Verdigris River near Wagoner	Bull Creek	Pea Creek	Verdigris River near Inola, OK	Dog Creek	Verdigris River near Claremore	Neosho River below Ft. Gibson Lake near Ft. Gibson	Chouteau Creek
WBID Segment	OK120420010130_00	OK120420020010_00	OK120420020050_00	OK121500010200_00	OK121500020090_00	OK121500020100_00	OK121500020260_00	OK121500020360_00	OK121500030010_00	OK121600010010_00	OK121600010430_00
USGS Gage Reference	07164200	07164200	07164200	07176000	07176000	07176000	07176000	07176000	07176000	07193500	07193500
Drainage Area (sq. mile)	108	153.08	58.96	19.87	48.84	17.57	251.48	71.86	33.31	4.34	71.88
NRCS Curve Number	62.35	66.35	65.04	73.63	73.48	71.15	70.51	69.88	70.40	69.39	70.89
Ave. Annual Rainfall (inch)	40.69	41.24	41.22	44.27	43.88	43.52	43.01	43.36	42.51	45.29	43.57
Flow Exceedance Frequency	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**
58	1847	11	12.8	252	3.8	0.7	773	10	405	17	11
59	1785	11	12.4	232	3.6	0.6	712	10	373	16	11
60	1729	10	12.0	213	3.5	0.6	655	9	343	14	10
61	1662	10	11.5	195	3.4	0.6	598	9	313	13	10
62	1611	10	11.2	180	3.3	0.6	552	8.6	289	12	10
63	1559	9	10.8	164	3.2	0.6	504	8.3	264	11	9
64	1507	9	10.4	151	3.1	0.5	464	8.0	243	10	9
65	1445	9	10.0	139	2.9	0.5	428	7.7	224	9	9
66	1379	8	9.6	130	2.8	0.5	401	7.4	210	9	8
67	1327	8	9.2	121	2.7	0.5	370	7.1	194	8	8
68	1280	8	8.9	112	2.6	0.5	346	6.8	181	8	8
69	1228	7	8.5	105	2.5	0.4	323	6.5	169	7	7
70	1181	7	8.2	98	2.4	0.4	302	6.3	158	7	7
71	1138	7	7.9	92	2.3	0.4	283	6.1	148	6	7
72	1086	7	7.5	86	2.2	0.4	265	5.8	139	6	6
73	1039	6	7.2	81	2.1	0.4	248	5.5	130	5	6
74	992	6	6.9	76	2.0	0.4	233	5.3	122	5	6
75	954	6	6.6	70	1.9	0.3	216	5.1	113	5	6
76	916	5	6.3	66	1.9	0.3	202	4.9	106	4	5
77	874	5	6.1	61	1.8	0.3	187	4.7	98	4	5
78	827	5	5.7	57	1.7	0.3	174	4.4	91	4	5
79	794	5	5.5	53	1.6	0.3	162	4.2	85	4	5
80	751	5	5.2	50	1.5	0.3	153	4.0	80	3	4
81	718	4.3	5.0	47	1.5	0.3	145	3.8	76	3	4
82	685	4.1	4.7	45	1.4	0.2	139	3.7	73	3	4.1
83	657	3.9	4.5	43	1.3	0.2	132	3.5	69	3	3.9
84	614	3.7	4.3	41	1.3	0.2	126	3.3	66	3	3.7
85	581	3.5	4.0	39	1.2	0.2	118	3.1	62	3	3.5
86	548	3.3	3.8	36	1.1	0.2	111	2.9	58	2	3.3

Stream Name	Arkansas River near Sand Springs	Polecat Creek	Polecat Creek	Verdigris River near Wagoner	Bull Creek	Pea Creek	Verdigris River near Inola, OK	Dog Creek	Verdigris River near Claremore	Neosho River below Ft. Gibson Lake near Ft. Gibson	Chouteau Creek
WBID Segment	OK120420010130_00	OK120420020010_00	OK120420020050_00	OK121500010200_00	OK121500020090_00	OK121500020100_00	OK121500020260_00	OK121500020360_00	OK121500030010_00	OK121600010010_00	OK121600010430_00
USGS Gage Reference	07164200	07164200	07164200	07176000	07176000	07176000	07176000	07176000	07176000	07193500	07193500
Drainage Area (sq. mile)	108	153.08	58.96	19.87	48.84	17.57	251.48	71.86	33.31	4.34	71.88
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Ave. Annual Rainfall (inch)	40.69	41.24	41.22	44.27	43.88	43.52	43.01	43.36	42.51	45.29	43.57
Flow Exceedance Frequency	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**	**Q (cfs)**
87	520	3.1	3.6	34	1.1	0.2	105	2.8	55	2	3.1
88	491	2.9	3.4	32	1.0	0.2	97	2.6	51	2	2.9
89	463	2.8	3.2	29	0.9	0.2	88	2.5	46	2	2.8
90	428	2.6	3.0	26	0.9	0.2	80	2.3	42	2	2.5
91	401	2.4	2.8	24	0.8	0.1	73	2.1	38	2	2.4
92	371	2.2	2.6	22	0.8	0.1	67	2.0	35	1	2.2
93	341	2.0	2.4	18	0.7	0.1	55	1.8	29	1	2.0
94	317	1.9	2.2	15	0.6	0.1	46	1.7	24	1	1.9
95	292	1.8	2.0	12.4	0.6	0.1	38	1.6	20	1	1.7
96	270	1.6	1.9	9.9	0.5	0.1	31	1.4	16	1	1.6
97	242	1.5	1.7	7.5	0.5	0.1	23	1.3	12	0	1.4
98	201	1.2	1.4	4.5	0.4	0.1	14	1.1	7	0	1.2
99	155	0.9	1.1	0.6	0.3	0.1	2	0.8	1	0	0.9
100	10	0.2	0.3	0.0	0.0	0.0	0	0.2	0	0	0.0

APPENDIX C

STATE OF OKLAHOMA ANTIDEGRADATION POLICY

Appendix C
State of Oklahoma Antidegradation Policy

785:45-3-1. Purpose; Antidegradation policy statement

(a) Waters of the state constitute a valuable resource and shall be protected, maintained and improved for the benefit of all the citizens.

(b) It is the policy of the State of Oklahoma to protect all waters of the state from degradation of water quality, as provided in OAC 785:45-3-2 and Subchapter 13 of OAC 785:46.

785:45-3-2. Applications of antidegradation policy

(a) Application to outstanding resource waters (ORW). Certain waters of the state constitute an outstanding resource or have exceptional recreational and/or ecological significance. These waters include streams designated "Scenic River" or "ORW" in Appendix A of this Chapter, and waters of the State located within watersheds of Scenic Rivers. Additionally, these may include waters located within National and State parks, forests, wilderness areas, wildlife management areas, and wildlife refuges, and waters which contain species listed pursuant to the federal Endangered Species Act as described in 785:45-5-25(c)(2)(A) and 785:46-13-6(c). No degradation of water quality shall be allowed in these waters.

(b) Application to high quality waters (HQW). It is recognized that certain waters of the state possess existing water quality which exceeds those levels necessary to support propagation of fishes, shellfishes, wildlife, and recreation in and on the water. These high quality waters shall be maintained and protected.

(c) Application to beneficial uses. No water quality degradation which will interfere with the attainment or maintenance of an existing or designated beneficial use shall be allowed.

(d) Application to improved waters. As the quality of any waters of the state improve, no degradation of such improved waters shall be allowed.

785:46-13-1. Applicability and scope

(a) The rules in this Subchapter provide a framework for implementing the antidegradation policy stated in OAC 785:45-3-2 for all waters of the state. This policy and framework includes three tiers, or levels, of protection.

(b) The three tiers of protection are as follows:

(1) Tier 1. Attainment or maintenance of an existing or designated beneficial use.

(2) Tier 2. Maintenance or protection of High Quality Waters and Sensitive Public and Private Water Supply waters.

(3) Tier 3. No degradation of water quality allowed in Outstanding Resource Waters.

(c) In addition to the three tiers of protection, this Subchapter provides rules to implement the protection of waters in areas listed in Appendix B of OAC 785:45. Although Appendix B areas are not mentioned in OAC 785:45-3-2, the framework for protection of Appendix B areas is similar to the implementation framework for the antidegradation policy.

(d) In circumstances where more than one beneficial use limitation exists for a waterbody, the most protective limitation shall apply. For example, all antidegradation policy implementation rules applicable to Tier 1 waterbodies shall be applicable also to Tier 2 and Tier 3 waterbodies or areas, and implementation rules applicable to Tier 2 waterbodies shall be applicable also to Tier 3 waterbodies.

(e) Publicly owned treatment works may use design flow, mass loadings or concentration, as appropriate, to calculate compliance with the increased loading requirements of this section if those flows, loadings or concentrations were approved by the Oklahoma Department of Environmental Quality as a portion of Oklahoma's Water Quality Management Plan prior to the application of the ORW, HQW or SWS limitation.

785:46-13-2. Definitions

The following words and terms, when used in this Subchapter, shall have the following meaning, unless the context clearly indicates otherwise:

"Specified pollutants" means

(A) Oxygen demanding substances, measured as Carbonaceous Biochemical Oxygen Demand (CBOD) and/or Biochemical Oxygen Demand (BOD);

(B) Ammonia Nitrogen and/or Total Organic Nitrogen;

(C) Phosphorus;

(D) Total Suspended Solids (TSS); and

(E) Such other substances as may be determined by the Oklahoma Water Resources Board or the permitting authority.

785:46-13-3. Tier 1 protection; attainment or maintenance of an existing or designated beneficial use

(a) General.

(1) Beneficial uses which are existing or designated shall be maintained and protected.

(2) The process of issuing permits for discharges to waters of the state is one of several means employed by governmental agencies and affected persons which are designed to attain or maintain beneficial uses which have been designated for those waters. For example, Subchapters 3, 5, 7, 9 and 11 of this Chapter are rules for the permitting process. As such, the latter Subchapters not only implement numerical and narrative criteria, but also implement Tier 1 of the antidegradation policy.

(b) Thermal pollution. Thermal pollution shall be prohibited in all waters of the state. Temperatures greater than 52 degrees Centigrade shall constitute thermal pollution and shall be prohibited in all waters of the state.

(c) Prohibition against degradation of improved waters. As the quality of any waters of the state improves, no degradation of such improved waters shall be allowed.

785:46-13-4. Tier 2 protection; maintenance and protection of High Quality Waters and Sensitive Water Supplies

(a) General rules for High Quality Waters. New point source discharges of any pollutant after June 11, 1989, and increased load or concentration of any specified pollutant from any point source discharge existing as of June 11, 1989, shall be prohibited in any waterbody or watershed designated in Appendix A of OAC 785:45 with the limitation "HQW". Any discharge of any pollutant to a waterbody designated "HQW" which would, if it occurred, lower existing water quality shall be prohibited. Provided however, new point source discharges or increased load or concentration of any specified pollutant from a discharge existing as of June 11, 1989, may be approved by the permitting authority in circumstances where the discharger demonstrates to the satisfaction of the permitting authority that such new discharge or increased load or concentration would result in maintaining or improving the level of water quality which exceeds that necessary to support recreation and propagation of fishes, shellfishes, and wildlife in the receiving water.

(b) General rules for Sensitive Public and Private Water Supplies. New point source discharges of any pollutant after June 11, 1989, and increased load of any specified pollutant from any point source discharge existing as of June 11, 1989, shall be prohibited in any waterbody or watershed designated in Appendix A of OAC 785:45 with the limitation "SWS". Any discharge of any pollutant to a waterbody designated "SWS" which would, if it occurred, lower existing water quality shall be prohibited. Provided however, new point source discharges or increased load of any specified pollutant from a discharge existing as of June 11, 1989, may be approved by the permitting authority in circumstances where the discharger demonstrates to the satisfaction of the permitting authority that such new discharge or increased load will result in maintaining or improving the water quality in both the direct receiving water, if designated SWS, and any downstream waterbodies designated SWS.

(c) Stormwater discharges. Regardless of subsections (a) and (b) of this Section, point source discharges of stormwater to waterbodies and watersheds designated "HQW" and "SWS" may be approved by the permitting authority.

(d) Nonpoint source discharges or runoff. Best management practices for control of nonpoint source discharges or runoff should be implemented in watersheds of waterbodies designated "HQW" or "SWS" in Appendix A of OAC 785:45.

785:46-13-5. Tier 3 protection; prohibition against degradation of water quality in outstanding resource waters

(a) General. New point source discharges of any pollutant after June 11, 1989, and increased load of any pollutant from any point source discharge existing as of June 11, 1989, shall be prohibited in any waterbody or watershed designated in Appendix A of OAC 785:45 with the limitation "ORW" and/or "Scenic River", and in any waterbody located within the watershed of any waterbody designated with the limitation "Scenic River". Any discharge of any pollutant to a waterbody designated "ORW" or "Scenic River" which would, if it occurred, lower existing water quality shall be prohibited.

(b) Stormwater discharges. Regardless of 785:46-13-5(a), point source discharges of stormwater from temporary construction activities to waterbodies and watersheds designated "ORW" and/or "Scenic River" may be permitted by the permitting authority. Regardless of 785:46-13-5(a), discharges of stormwater to waterbodies and watersheds designated "ORW" and/or "Scenic River" from point sources existing as of June 25, 1992, whether or not such stormwater discharges were permitted as point sources prior to June 25, 1992, may be permitted by the permitting authority; provided, however, increased load of any pollutant from such stormwater discharge shall be prohibited.

(c) Nonpoint source discharges or runoff. Best management practices for control of nonpoint source discharges or runoff should be implemented in watersheds of waterbodies designated "ORW" in Appendix A of OAC 785:45, provided, however, that development of conservation plans shall be required in sub-watersheds where discharges or runoff from nonpoint sources are identified as causing or significantly contributing to degradation in a waterbody designated "ORW".

(d) LMFO's. No licensed managed feeding operation (LMFO) established after June 10, 1998 which applies for a new or expanding license from the State Department of Agriculture after March 9, 1998 shall be located...[w]ithin three (3) miles of any designated scenic river area as specified by the Scenic Rivers Act in 82 O.S. Section 1451 and following, or [w]ithin one (1) mile of a waterbody [2:9-210.3(D)] designated in Appendix A of OAC 785:45 as "ORW".

785:46-13-6. Protection for Appendix B areas

(a) General. Appendix B of OAC 785:45 identifies areas in Oklahoma with waters of recreational and/or ecological significance. These areas are divided into Table 1, which includes national and state parks, national forests, wildlife areas, wildlife management areas and wildlife refuges; and Table 2, which includes areas which contain threatened or endangered species listed as such by the federal government pursuant to the federal Endangered Species Act as amended.

(b) Protection for Table 1 areas. New discharges of pollutants after June 11, 1989, or increased loading of pollutants from discharges existing as of June 11, 1989, to waters within the boundaries of areas listed in Table 1 of Appendix B of OAC 785:45 may be approved by the permitting authority under such conditions as ensure that the recreational and ecological significance of these waters will be maintained.

(c) Protection for Table 2 areas. Discharges or other activities associated with those waters within the boundaries listed in Table 2 of Appendix B of OAC 785:45 may be restricted through agreements between appropriate regulatory agencies and the United States Fish and Wildlife Service. Discharges or other activities in such areas shall not substantially disrupt the threatened or endangered species inhabiting the receiving water.

(d) Nonpoint source discharges or runoff. Best management practices for control of nonpoint source discharges or runoff should be implemented in watersheds located within areas listed in Appendix B of OAC 785:45.

APPENDIX D

SANITARY SEWER OVERFLOWS DATA

Sanitary Sewer Overflows (SSO) Data since 2005

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Muskogee	S20415	1/18/2005	100	Stopped Main	W & D	Flushed	Manhole
Muskogee	S20415	1/24/2005	50	Stopped Main	C & D	Flushing	Manhole
Muskogee	S20415	2/3/2005	100	Stopped Main	W & D	Flushed	Manhole
Muskogee	S20415	2/3/2005	100	Blockage	W & D	Flushing	Manhole
Muskogee	S20415	2/8/2005	50,000	Broken Force Main	Disinfected	Replaced Pipe	Pipe
Muskogee	S20415	2/9/2005	300	Line On Residential L.S. Broke	C & D	Replaced Line	Lift Station
Muskogee	S20415	5/31/2005	100	Blockage	W & D		Manhole
Muskogee	S20415	6/16/2005	100	Blockage	W & D	Flushed	Manhole
Muskogee	S20415	8/4/2005	100	Roots	W & D	Unstopped	Manhole
Muskogee	S20415	10/11/2005	1,000	Cracked Line	Flushing	Repair	Pipe
Muskogee	S20415	10/18/2005	5,000	Contractor Broke Force Main	W & D	Repaired	Pipe
Muskogee	S20415	10/21/2005	45,000	Broken Main	C & D	Replaced Pipe	Pipe
Muskogee	S20415	12/28/2005	500	Pipe & Pillar Support Broke	W & D	Repairs	Pipe
Muskogee	S20415	1/9/2006	100	Stopped Main	W & D	Flushed	Pipe
Muskogee	S20415	1/24/2006	200	Blockage	W & D	Cleared	Pipe
Muskogee	S20415	1/31/2006	2,000	Blockage	W & D	Flushed	Manhole
Muskogee	S20415	1/31/2006	500	Blockage	C & D	Flushed	Manhole
Muskogee	S20415	2/15/2006	200	Blockage	W & D	Cleared	Manhole
Muskogee	S20415	2/21/2006	10	Bockage	W & D	Flushed	
Muskogee	S20415	3/20/2006	500	Blockage	W & D	Cleared	Manhole
Muskogee	S20415	4/18/2006	1,000	Outfall Line Has Hole In It	C & D	Repaired	Pipe
Muskogee	S20415	5/8/2006	100	Blockage	W & D	Cleaned	Manhole
Muskogee	S20415	5/17/2006	1,000	Blockage	W & D	Cleared	Pipe
Muskogee	S20415	6/12/2006	100	Blockage	W & D	Cleared	Manhole
Muskogee	S20415	6/19/2006	1,000	Blockage	W & D	Rooted	Manhole
Muskogee	S20415	10/4/2006	50	Stopped Main	W & D	Flushed	Pipe
Muskogee	S20415	12/18/2006	10	Blockage	W & D	Flushed	Pipe
Muskogee	S20415	1/29/2007	100	Stopped Main	W & D	Rooted	Manhole
Muskogee	S20415	2/14/2007	500	Blockage	C & D	Cleared	Manhole
Muskogee	S20415	2/26/2007	50	Stoppage	W & D		Pipe
Muskogee	S20415	3/21/2007	3,000	Cracked Pipe	After Repairs	Repairs	Pipe
Muskogee	S20415	3/27/2007	50	Hole In Pipe	Cleaned After Repair	Repair	Pipe
Muskogee	S20415	3/30/2007	500	Cracked Pipe	None Until Repairs	Repairs	Pipe
Muskogee	S20415	4/26/2007	100	Stopped Main	C & D	Rooted	Pipe
Muskogee	S20415	5/7/2007	5,000	Rain			Manhole
Muskogee	S20415	5/7/2007	5,000	Rain			Manhole
Muskogee	S20415	1/18/2005	100	Stopped Main	W & D	Flushed	Manhole
Muskogee	S20415	1/24/2005	50	Stopped Main	C & D	Flushing	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Muskogee	S20415	5/7/2007	2,000	Rain			
Muskogee	S20415	6/8/2007	200	Stopped Main	W & D	Rooted	Manhole
Muskogee	S20415	6/11/2007	100	Repairs Are Weeping	Clean & Treat	Repair	Pipe
Muskogee	S20415	6/11/2007	100	Repairs	Washed	To Be Completed	Pipe
Muskogee	S20415	6/13/2007	5,000	Overflow	Washed	Cleared	Manhole
Muskogee	S20415	6/20/2007	1,000	Rain	Washed	Cleared	Manhole
Muskogee	S20415	6/27/2007	5,000	Rain			Manhole
Muskogee	S20415	6/27/2007	7,000	Rain			Manhole
Muskogee	S20415	6/27/2007	5,000	Rain			Manhole
Muskogee	S20415	7/2/2007	100,000	Holes In Pipe	C & D	Repairs	Pipe
Muskogee	S20415	7/12/2007	75,000	Rain	C & D	Repairs	Pipe
Muskogee	S20415	7/12/2007	75,000	Rain	C & S	Repairs	Pipe
Muskogee	S20415	7/31/2007	500,000	Broken Main	W & D	Contracted Out	Pipe
Muskogee	S20415	7/31/2007	750,000	Broken Pipe	W & D	Contracted Out	Pipe
Muskogee	S20415	7/31/2007	500,000	Broken Main	W & D	Repaired	Pipe
Muskogee	S20415	7/31/2007	750,000	Broken Pipe	W & D	Repaired Pipe	Pipe
Muskogee	S20415	8/6/2007	10,000	Debris	W & D	Seal Mh Lid	Manhole
Muskogee	S20415	8/10/2007	30,000	Broken Pipe	W & D	Repair	Pipe
Muskogee	S20415	8/10/2007	30,000	Broken Pipe	Flush & Disinfect	Repair	Pipe
Muskogee	S20415	8/10/2007	30,000	Broken Pipe	C & D	Repaired	Pipe
Muskogee	S20415	8/29/2007	5,000	Stopped Main	C & D	Cleaned Line	Manhole
Muskogee	S20415	9/26/2007	1,000	Plugged Line	C & D	Cleaned	Manhole
Muskogee	S20415	11/21/2007	2,000	Stopped Main	Open Hydrant	Clean Line	Pipe
Muskogee	S20415	11/28/2007	500	Grease	C & D	Cleaned	Manhole
Muskogee	S20415	12/3/2007	2,000	Stopped Main	Washed	Cleaned	Manhole
Muskogee	S20415	1/13/2008	100	Stoppage	C & D	Root Line	Pipe
Muskogee	S20415	1/23/2008	1,000	Blockage	C & D	Root & Clean	Manhole
Muskogee	S20415	1/25/2008	10,000	Stopped Main	Flush Area	Root Line	Manhole
Muskogee	S20415	1/29/2008	5,000	Hole In Pipe	C & D	Repair	Pipe
Muskogee	S20415	1/30/2008	10,000	Hole In Pipe	C & D	Repair	Pipe
Muskogee	S20415	2/5/2008	2,000	Rain Water	W & D	Clean	Manhole
Muskogee	S20415	2/6/2008	30,000	Repairs Did Not Hold	C & D	Repair	Pipe
Muskogee	S20415	2/6/2008	30,000	Repairs Did Not Hold	C & D	Repaired	Pipe
Muskogee	S20415	2/25/2008	10,000	Broken Pipe	C & D	Repair	Pipe
Muskogee	S20415	2/25/2008	10,000	Broken Pipe	C & D	Repaired	Pipe
Muskogee	S20415	2/27/2008	8,000	Broken Main	C & D	Repairing	Pipe
Muskogee	S20415	2/27/2008	7,000	L.S Turned Off To Repair Pipe	C & D	Repaired Pipe	Lift Station
Muskogee	S20415	3/3/2008	30,000	Rain	C & D		Manhole
Muskogee	S20415	5/7/2007	2,000	Rain			

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Muskogee	S20415	3/4/2008	1,000	Gravel	C & D		Manhole
Muskogee	S20415	3/18/2008	500	High Water Due To Heavy Rains	Cleaned & Disinfected Area		Lift Station
Muskogee	S20415	3/18/2008	4000	High Water/Rain	Will Clean & Disinfect Once Bypass Is Complete		Lift Station
Muskogee	S20415	3/18/2008	2500	High Water Due To Rain	Will Clean & Disinfect Once Bypass Is Complete		Lift Station
Muskogee	S20415	3/18/2008	80000	High Water Due To Rain	Will Clean & Disinfect Once Bypass Is Complete		Manhole
Muskogee	S20415	3/18/2008	30000	High Water Due To Heavy Rain	Will Clean & Disinfect Once Bypass Complete		Manhole
Muskogee	S20415	3/18/2008	4000	High Water Due To Heavy Rain	Cleaned & Disinfected Area		Lift Station
Muskogee	S20415	3/18/2008	2500	High Water Due To Heavy Rain	Cleaned & Disinfected		Lift Station
Muskogee	S20415	3/18/2008	30000	High Water Due To Rain	Cleaned And Disinfected		Manhole
Muskogee	S20415	3/18/2008	80,000	High Water Due To Heavy Rain	Cleaned & Disinfected		Manhole
Muskogee	S20415	3/24/2008	1,000	Paper	C & D	Cleaned	Manhole
Muskogee	S20415	3/26/2008	3,000	Blockage	C & D	Cleaned	Manhole
Muskogee	S20415	4/2/2008	20,000	Contractor HIT MH	C & D		Manhole
Muskogee	S20415	5/7/2008	20,000	Rain	Cleaned & Disinfected Area		Manhole
Muskogee	S20415	5/8/2008	50000	Deteriated Line	Area Will Be Disinfected	Line Will Be Fixed	Pipe
Muskogee	S20415	5/27/2008	83,000	Leak At Base Of M.H. Ring Lid	C & D	Repair	Manhole
Muskogee	S20415	5/27/2008	8,000	Rain	Cleaned And Disinfected Surrounding Area		Manhole
Muskogee	S20415	5/27/2008	10,000	Rain	Cleaned And Disinfected Surrounding Area		Manhole
Muskogee	S20415	5/27/2008	15000	The Main Line Was Stopped Up	Cleaned & Disinfected Surrounding Area	Flush	Manhole
Muskogee	S20415	5/27/2008	446,000	Several Holes In Line East Of M.M #8	Will Clean & Disinfect Area Once Repairs Are Completed	Repairs	Pipe
Muskogee	S20415	5/27/2008	446000	Several Holes In Line East Of Mh#8	Cleaned And Disinfected Area	Holes Have Been Repaired	Pipe
Muskogee	S20415	6/1/2008	25000	Rain	Cleaned & Disinfected Area		Manhole
Muskogee	S20415	6/1/2008	40000	Rain	Cleaned & Disinfected Area		Manhole
Muskogee	S20415	6/1/2008	200	Busted Hole In House Line	C & D	Repaired By Homeowner	Pipe
Muskogee	S20415	6/2/2008	5000	Broken Line	Will Clean & Disinfect Area Once Repairs Are Complete	REPAIR LINE	Manhole
Muskogee	S20415	6/2/2008	5000	Broken Down Line	Will Clean Area Once Repairs Are Complete	REPAIR LINE	Manhole
Muskogee	S20415	6/2/2008	5,000	Broke Down Line	Wash Area	Repaired	Manhole
Muskogee	S20415	6/20/2008	30,000	Rain	C & D		Lift Station

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Muskogee	S20415	6/20/2008	45,000	Rain	C & D		Lift Station
Muskogee	S20415	6/20/2008	18,000	Rain	C & D		Lift Station
Muskogee	S20415	6/20/2008	40,000	Rain	C & D		Manhole
Muskogee	S20415	6/20/2008	60,000	Rain	C & D		Manhole
Muskogee	S20415	6/20/2008	60,000	Rain	C & D		Manhole
Muskogee	S20415	6/20/2008	40,000	Rains	C & D		Manhole
Muskogee	S20415	6/23/2008	30,000	Deteriorated Line	C & D	Repairs	Pipe
Muskogee	S20415	7/7/2008	50	Stopped Main	C & D	Cleared	Pipe
Muskogee	S20415	8/19/2008	3,000	Broken Pipe	C & D	Repair	Pipe
Muskogee	S20415	9/17/2008	20,000	Blockage	W & D	Cleaned	Manhole
Muskogee	S20415	9/18/2008	30,000	Broken Pipe	Cleaned & Disinfected Area	Repair	Pipe
Muskogee	S20415	9/18/2008	30,000	Repairing Line West Of MH # 11	Cleaned & Disinfected Area		Manhole
Muskogee	S20415	9/19/2008	2500	Repairs Did Not Completely Hold	Will Clean And Disinfect When Repairs Are Done	Will Repair Pipe	Pipe
Muskogee	S20415	9/19/2008	2,500	Repairs Failed	C & D	Repairs	Pipe
Muskogee	S20415	11/14/2008	200	Blockage	C & D	Cleaned	Manhole
Muskogee	S20415	11/14/2008	200	Blockage	C 7 D	Cleaned	Manhole
Muskogee	S20415	11/17/2008	20,000	Main Line Stopped Up	Disinfected Area & Washed Down Area	Cleaned Line From Mh	Manhole
Muskogee	S20415	12/12/2008	1,800	Tree Roots	C & D	Root & Clean	Manhole
Muskogee	S20415	12/30/2008	10000	Main Sewer Line Was Stopped Up	Cleaned & Disinfected	Flushed Line	Manhole
Muskogee	S20415	2/9/2009	25,000	Stopped Line	C & D	Flushed	Manhole
Muskogee	S20415	2/11/2009	1800	Sewer Line Broke	Cleaned And Disinfected	Repaired Sewer Line	Manhole
Muskogee	S20415	3/2/2009	2000	Level Control System Failed At Lift Station	C&D	Repaired Lift Station	Manhole
Muskogee	S20415	3/13/2009	15,000	Sewer Line Hit While Repairing	Washed	Repaired	Pipe
Muskogee	S20415	3/17/2009	80,000	Stopped Main	C & D	Rooted	Manhole
Muskogee	S20415	3/17/2009	80,000	Stoppage	C & D	Rooted	Manhole
Muskogee	S20415	3/19/2009	10	Breaker Turned Off	W & D	Explain To Homeowner Not To Turn Off	Lift Station
Muskogee	S20415	3/20/2009	35,000	Stoppage	C & S	Flushed	Manhole
Muskogee	S20415	4/14/2009	5,000	Sewer Line Hit While Repairing	Washed	Repaired	Pipe
Muskogee	S20415	5/3/2009	700	Stopped Main	C & D	Flushed	Manhole
Muskogee	S20415	5/18/2009	7,000	Stopped Main	W & D	Cleaned	Manhole
Muskogee	S20415	5/26/2009	3,000	Stopped Main	W & D	Flushed	Manhole
Muskogee	S20415	5/27/2009	1,000	Power Failure	W & D	Restore	Manhole
Muskogee	S20415	6/3/2009	150,000	Leaking From Pipe	W & D	Repairs	Pipe
Muskogee	S20415	6/9/2009	1,500	Broken Pipe	C & D	Repairs	Pipe
Muskogee	S20415	6/9/2009	1,500	Broken Pipe	C & D	Repaired Pipe	Pipe
Muskogee	S20415	6/15/2009	50,000	Blockage	C & D	Flushed	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Muskogee	S20415	7/10/2009	1,500	Stopped Main	C & D	Flushed	Pipe
Muskogee	S20415	7/25/2009	100	Main Sewer Line Stopped Up	Washed & Disinfected Area	Flushed & Cleaned Line	Manhole
Muskogee	S20415	7/29/2009	1000	Line Stopped Up Between MH 14 And MH 15	Cleaned & Flushed Line	Flushed Line	Manhole
Muskogee	S20415	8/14/2009	10,000	Line Tapped In Storm Sewer Line	C & D	Reroute Line	Pipe
Muskogee	S20415	8/16/2009	10,000	Broken Main	C & D	Repair	Pipe
Muskogee	S20415	8/26/2009	1,500	Stopped Line	W & D	Flushed	Manhole
Muskogee	S20415	9/7/2009	4,000	Stopped Main	W & D	Flushed	Manhole
Muskogee	S20415	9/10/2009	2,000	L.S. Down	Disinfect	Reset Starters	Lift Station
Muskogee	S20415	9/14/2009	3,000	Electrical Problems	C & D	Repaired	Lift Station
Muskogee	S20415	9/17/2009	10,000	Broken Main	C & D	Replaced Main	Pipe
Muskogee	S20415	9/30/2009	50,000	Malfunction	C & D	Repaired	Lift Station
Muskogee	S20415	10/8/2009	1,000,000.00	High Flow & Pump Failure	C & D	Repair	Lift Station
Muskogee	S20415	10/8/2009	15,000	Stopped Line	Cleaned		Manhole
Muskogee	S20415	10/9/2009	85,000	Rain	C & D		Manhole
Muskogee	S20415	10/9/2009	85,000	Rain	C & D		Manhole
Muskogee	S20415	10/14/2009	200,000	Force Main Break	C & D	Repairing	Pipe
Muskogee	S20415	10/17/2009	1,000	Gravity Line Broke	C & D	Repaired	Pipe
Muskogee	S20415	10/19/2009	500	Stopped Main	W & D	Flushed	Manhole
Muskogee	S20415	11/20/2009	30,000	Rain	W & D		Manhole
Muskogee	S20415	11/20/2009	50,000	High Water Flow	W & D		Manhole
Muskogee	S20415	11/20/2009	30,000	Rain	W & D		Manhole
Muskogee	S20415	12/9/2009	14,000	Line Stoppage	W & S	Flushed	Lift Station
Muskogee	S20415	12/22/2009	5,000	Stopped Main	W & S	Flushed	Manhole
Muskogee	S20415	12/29/2009	20,000	Previous Repairs Did Not Hold	C & D	Repairing Main	Pipe
Muskogee	S20415	12/31/2009	800	Blockage	W & S	Flushed	Pipe
Muskogee	S20415	1/18/2010	7,500	Stopped Main	C & D	Cleared	Manhole
Muskogee	S20415	1/29/2010	375,000	Broken Main	W & D	Repair	Pipe
Muskogee	S20415	2/1/2010	2,000	Pump Failure	W & D	Back Flushed Pump	Lift Station
Muskogee	S20415	2/10/2010	400	Stopped Main	W & D	Flushed	Pipe
Muskogee	S20415	2/11/2010	400	Blockage	Washed	Flushed	Pipe
Muskogee	S20415	2/19/2010	15,000	Line Stopped	C & S	Flushed & Rooted	Manhole
Muskogee	S20415	2/23/2010	1,500	Pump Line Broke While Repairing	Running Water	Repair	Lift Station
Muskogee	S20415	2/28/2010	15,000	Clogged Pump	Flush & Disinfect	Clear	Lift Station
Muskogee	S20415	3/10/2010	200	Blockage	W & D	Flushed	Manhole
Muskogee	S20415	3/22/2010	7,000	Blockage	Washed	Flushed	Manhole
Muskogee	S20415	3/22/2010	9,000	Blockage	Washed	Rooted	Manhole
Muskogee	S20415	3/22/2010	12,000	High Water Flow			Manhole
Muskogee	S20415	3/23/2010	3,000	Grease & Debris	Washed	Cleaned	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Muskogee	S20415	4/1/2010	50	Breaker Tripped	Washed	Reset Breaker	Lift Station
Muskogee	S20415	4/5/2010	500	Blockage	C & D	Flushed	Pipe
Muskogee	S20415	4/7/2010	100	Blockage	W & D	Flushed	Manhole
Muskogee	S20415	4/7/2010	500	Blockage	W & D	Flushed	Manhole
Muskogee	S20415	4/16/2010	30,000	Blockage	C & D	Cleaned	Manhole
Muskogee	S20415	4/27/2010	10,000	Broken Pipe	W & D	Repair	Pipe
Muskogee	S20415	5/3/2010	35,000	Stopped Line	C & S	Flushed	Manhole
Muskogee	S20415	5/3/2010	35,000	Main Stoppage	W & S	Flushed	Manhole
Muskogee	S20415	5/12/2010	1,200	Stopped Main	W & D	Cleaned Main	Manhole
Muskogee	S20415	5/13/2010	10,000	Power Outage	C & D	Replaced Thermostat In Generator	Lift Station
Muskogee	S20415	5/17/2010	5,000	Stopped Main	C & D	Cleaned	Pipe
Muskogee	S20415	5/19/2010	8,000	Rain	C & D		Lift Station
Muskogee	S20415	5/23/2010	20,000	Blockage	C & D	Flushed	Pipe
Muskogee	S20415	5/26/2010	10,000	L.S. Power Failure	W & D	Reset Motors	Pipe
Muskogee	S20415	6/9/2010	1,000	Stopped Main	C & D	Flushed	Pipe
Muskogee	S20415	6/11/2010	65,000	Sewer Blockage	W & D	Camera & Repair	Pipe
Muskogee	S20415	6/11/2010	100	Stopped Sewer	Cleaned	Flushed	Manhole
Muskogee	S20415	6/26/2010	10,000	L.S. Motor Tripped	C & D	Reset Motors	Pipe
Muskogee	S20415	7/6/2010	2,000	Blockage	W & D	Flushed	Manhole
Muskogee	S20415	7/10/2010	10,000	Blockage	C & D	Flushed	Manhole
Muskogee	S20415	7/27/2010	15000	Main Line Stopped Up	W & D	Flushed	Pipe
Muskogee	S20415	8/11/2010	500	Unmarked Valve	Disinfect	Marked Valve	Lift Station
Muskogee	S20415	8/12/2010	500	Unmarked Valve	Disinfect	Marked Valve	Lift Station
Muskogee	S20415	9/24/2010	500	Stoppage	W & D	Flushed	Manhole
Muskogee	S20415	9/30/2010	10,000	Broken Main	None	Repair	Pipe
Muskogee	S20415	9/30/2010	10,000	Broken Main & Storm Drain Line	None	Repair	Pipe
Muskogee	S20415	10/1/2010	700	Contractor Causing Break	C & D	Repair	Pipe
Muskogee	S20415	10/7/2010	300	Blockage	C & D	Flushed	Pipe
Muskogee	S20415	10/21/2010	1,000	Broken Main	C & D	Repaired	Pipe
Muskogee	S20415	10/21/2010	1,000	Stoppage	W & D	Flushed	Manhole
Muskogee	S20415	11/18/2010	500	Stoppage	W & D	Flushed	Pipe
Muskogee	S20415	11/20/2010	500	Blockage	W & D	Flushed	Manhole
Muskogee	S20415	11/22/2010	1,000	Blockage	W & D	Flushed	Pipe
Muskogee	S20415	11/23/2010	500,000	Pump Failure	W & D	Repaired	Pipe
Muskogee	S20415	11/23/2010	500,000	Pump Failure At L.S.	W & D	Repair	Pipe
Muskogee	S20415	11/30/2010	1,000	Line Stoppage	W & D	Cleaned	Manhole
Muskogee	S20415	12/8/2010	200	Stopped Line	C & D	Flushed	Manhole
Muskogee	S20415	12/15/2010	300	Stopped Main	W & D	Flushed	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Muskogee	S20415	1/3/2011	1,000	Stopped Sewer	W & D	Flushed	Manhole
Muskogee	S20415	1/19/2011	500	Stopped Line	W & S	Flushed	Manhole
Muskogee	S20415	2/22/2011	30,000	Broken Main	W & D	Repair	Pipe
Muskogee	S20415	2/24/2011	120,000				
Muskogee	S20415	2/27/2011	1,000	Blockage	W & D	Cleared	Manhole
Muskogee	S20415	2/28/2011	500	Stopped Line	C & D	Flush	Manhole
Muskogee	S20415	3/8/2011	1,000	No Trench Was Cut Out	C & D	Cut Trench Line	Manhole
Muskogee	S20415	3/10/2011	2,000	Stopped Line	C & D	Flushed	Manhole
Muskogee	S20415	3/11/2011	1,000	Stopped Line	C & D	Flushed	Manhole
Muskogee	S20415	3/20/2011	500	Main Sewer Line Stopped Up	Cleaned Main Sewer Line	Cleaned	Pipe
Muskogee	S20415	3/22/2011	8000	Main Sewer Line Stopped Up	Cleaned Main Sewer Line		Pipe
Muskogee	S20415	4/6/2011	2,000	Stoppage	C & D	Flushed	Manhole
Muskogee	S20415	4/20/2011	2,000	Stopped Line	C & D	Cleaned	Manhole
Muskogee	S20415	4/21/2011	200	Stopped Main	C & D	Flushed	Manhole
Muskogee	S20415	4/21/2011	18,000	Rain	C & D	None	Lift Station
Muskogee	S20415	4/24/2011	288,889	Power Failure	C & D	Reset Pumps	Lift Station
Muskogee	S20415	4/24/2011	25,000	Rain	C & D	None	Lift Station
Muskogee	S20415	4/24/2011	6,000	Rain	C & D	None	Lift Station
Muskogee	S20415	4/24/2011	10,000	Rain	C & D	None	Lift Station
Muskogee	S20415	4/25/2011	720,000	Station Under Water	C & D	Pumping	Lift Station
Muskogee	S20415	4/25/2011	30,000	Rain	C & D	None	Manhole
Muskogee	S20415	4/25/2011	60,000	Rain	C & D	None	Manhole
Muskogee	S20415	4/25/2011	400	Line Stopped	C & D	Flushed	Manhole
Muskogee	S20415	4/25/2011	1,500	Rain	C & D	None	Manhole
Muskogee	S20415	4/25/2011	1,500	Rain	C & D	None	Manhole
Muskogee	S20415	4/25/2011	1,500	Rain	C & D	None	Manhole
Muskogee	S20415	4/26/2011	1,000	Stopped Main	W & D	Flushed	Manhole
Muskogee	S20415	4/28/2011	2,000	Stopped Main	C & D	Flushed	Manhole
Muskogee	S20415	5/5/2011	12,000	Blockage	C & D	Flushed	Manhole
Muskogee	S20415	5/8/2011	2,000	Blockage	C & D	Flushed	Manhole
Muskogee	S20415	5/13/2011	12,000	Blockage	C & D	Flushed	Manhole
Muskogee	S20415	5/15/2011	70,000	Blockage	C & D	Flushed	Manhole
Muskogee	S20415	5/20/2011	20,000	Rain	C & D		Lift Station
Muskogee	S20415	5/20/2011	20,000	Rain	C & D		Lift Station
Muskogee	S20415	5/23/2011	30,000	Rain	C & D	None	Lift Station
Muskogee	S20415	5/23/2011	20,000	Rain	C & D	None	Lift Station
Muskogee	S20415	5/23/2011	20,000	Rain	C & D	None	Lift Station
Muskogee	S20415	5/23/2011	22,000	Rain	C & D	None	Lift Station
Muskogee	S20415	5/24/2011	3,000	Stopped Line	C & D	Flushed	Pipe

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Muskogee	S20415	5/24/2011	3,000	Stopped Line	C & D	Flushed	Pipe
Muskogee	S20415	6/1/2011	1,000	Broken Pipe	C & D	Repair	Pipe
Muskogee	S20415	6/1/2011	1,000	Broken Pipe	C & D	Repair	Pipe
Muskogee	S20415	6/14/2011	15,000	Stopped Line	C & D	Flushed	Manhole
Muskogee	S20415	6/14/2011	15,000	Stopped Main	C & D	Flushed	Manhole
Muskogee	S20415	6/27/2011	400	Line Stoppage	C & D	Cleared	Pipe
Muskogee	S20415	7/2/2011	100	Broken Force Main	C & D	Repair	Pipe
Muskogee	S20415	7/7/2011	200	Broken Pipe	C & D	Repair	Pipe
Muskogee	S20415	7/14/2011	200	Valve Open In Meter Can	W & D	Closed Valve	Pipe
Muskogee	S20415	7/20/2011	50,000	Broken Bubbler Line @ Station & Bad High Water Alarm Float	C & D	Repaired	Lift Station
Muskogee	S20415	7/27/2011	40,000	Pump Hole Out To Repair	C & D	Repair Line	Pipe
Muskogee	S20415	7/28/2011	50,000	Fix Pipe Hole	W & D	Replaced Pipe	Pipe
Muskogee	S20415	7/29/2011	60,000	Broken Pipe	Running Fire Hydrant	Repair Section Of Line	Pipe
Muskogee	S20415	8/13/2011	2,000	Sewer Stoppage	W & D	Flushed	Manhole
Muskogee	S20415	8/13/2011	10,000	Sewer Stoppage	W & D	Flushed	Pipe
Muskogee	S20415	8/21/2011	7,000	Stopped Line	W & D	Flushed	Manhole
Muskogee	S20415	9/7/2011	1,000	Grinder Pump Failed	C & D	Install New Pump	Lift Station
Muskogee	S20415	9/8/2011	1,000	Line Stoppage	C & D	Cleared	Pipe
Muskogee	S20415	9/12/2011	100	Stoppage	C & D	Repaired	Pipe
Muskogee	S20415	10/6/2011	85,000	Broken Main	C & D	Repair	Pipe
Muskogee	S20415	10/6/2011	85,000	Broken Main	C & D	Repair	Pipe
Muskogee	S20415	10/14/2011	50,000	Broken Force Main	C & D	Repair	Pipe
Muskogee	S20415	10/28/2011	500	Stopped Main	C & D	Flushed	Pipe
Muskogee	S20415	10/31/2011	500	Stopped Main	C & D	Cleared	Manhole
Muskogee	S20415	11/8/2011	15,000	Rainfall	C & D	None	Manhole
Muskogee	S20415	11/8/2011	20,000	Rainfall	C & D	None	Manhole
Muskogee	S20415	11/21/2011	500,000	Hole In Line & Blockage	W & D	Flushed & Repaired	Pipe
Muskogee	S20415	12/17/2011	60,000	Stopped Main	C & D	Flushed	Manhole
Muskogee	S20415	12/19/2011	2,000	Stopped Main	C & D	Flushed	Manhole
Muskogee	S20415	12/20/2011	2,500	Stopped Main	C & D	Rooted Line	Manhole
Muskogee	S20415	12/27/2011	6000	Main Sewer Line Stopped Up	Cleaned & Flushed Main Sewer Line	Cleaned & Disinfected Area	Manhole
Muskogee	S20415	12/27/2011	800	Main Sewer Line Stopped Up.	Cleaned & Disinfected Area.	Cleaned & Flushed Main Sewer Line.	Pipe
Muskogee	S20415	12/30/2011	1,000	Stopped Main	C & D	Flushed	Manhole
Muskogee	S20415	1/9/2012	600	Stopped Main	W & D	Flushed	Manhole
Muskogee	S20415	1/18/2012	1,000	Valve Broken	W & D	Repair	Pipe
Muskogee	S20415	1/24/2012	300	Stopped Main	W & S	Flushed	Pipe
Muskogee	S20415	1/25/2012	60,000	Rainfall	Disinfect	Checked Pumps	Manhole
Muskogee	S20415	1/25/2012	2,000	Stopped Main	W & D	Flushed	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Muskogee	S20415	1/25/2012	500	Stopped Main	W & D	Flushed	Manhole
Muskogee	S20415	1/25/2012	1,000	Stopped Main	Washed	Flushed	Manhole
Muskogee	S20415	1/25/2012	500	Cleaned Line	W & D	Cleaned	Manhole
Muskogee	S20415	2/3/2012	20,000	Stopped Main	C & D	Flushed	Manhole
Webbers Falls	S20428	6/1/2008	100.00	Pump Failure	Cleaned	Replace	Manhole
Warner	S20420	5/24/2009	120,000	Cleaning Clarifiers	None	Contact City Engineer	Lagoon/Basin
Warner	S20420	5/30/2009	120,000	Cleaning Clarifiers	None	Applied For Discharge Permit	Lagoon/Basin
Warner	S20420	10/9/2009	200	I&I	Cleaned	None	Manhole
Warner	S20420	1/21/2010		Rain	Washed	None Yet	Manhole
Warner	S20420	4/25/2011	1,000	Flooding	Pumped	Check On I&I	Manhole
Warner	S20420	7/10/2011	5,000	Stopped Main	Cleaned	Cleared	Pipe
Warner	S20420	8/18/2011	2,000	Stopped Main		Cleaned Out	Manhole
Warner	S20420	8/29/2011	75	Blockage	Washed	Cleared Out	Manhole
Warner	S20420	11/8/2011	4,000	Stopped Main	None	Cleaned	Manhole
Warner	S20420	11/15/2011	1,000	Stopped Main	Cleaned By Ron-Co		Manhole
Checotah	S20418	8/13/2005		Power Surge	Treated	Restore	Lift Station
Checotah	S20418	1/9/2006	80,000	Busted Pipe	Flushed	Repair	Pipe
Checotah	S20418	5/6/2006	30,000	Rain	Oxygen Stabilizer	Searching For I&I	Lift Station
Checotah	S20418	10/6/2006	110,000	Pump Burnout	O2 Stabilizer	Replaced	Lift Station
Checotah	S20418	11/30/2006	20,000	I&I	Oxygen Stabilizer	Searching For I&I	Lift Station
Checotah	S20418	1/16/2007	1,400	Generator Failed	Clean	Repair	Manhole
Checotah	S20418	1/16/2007	3,500	Generator Failure	Clean	Restore	Manhole
Checotah	S20418	1/20/2007	62,000	Power Failure	C & D	Restore	Lift Station
Checotah	S20418	2/13/2007	8,500	Rain	C & S	Smoke Testing	Manhole
Checotah	S20418	5/7/2007	40,000	I&I	Oxygen Stabilizer	Clear	Manhole
Checotah	S20418	5/7/2007	35,000	I&I	Treated Area	Monitoring	Lift Station
Checotah	S20418	6/11/2007	3,000	I&I	Lime		Manhole
Checotah	S20418	6/15/2007					
Checotah	S20418	6/15/2007	25,000	I&I	Limed	Check Main	Manhole
Checotah	S20418	6/15/2007	50,000	I&I	Oxygen Stabilizer		Lift Station
Checotah	S20418	6/15/2007	12,000	I&I	Limed	Patching Holes	Manhole
Checotah	S20418	6/15/2007	4,100	I&I	Limed	Smoke Test	Manhole
Checotah	S20418	6/18/2007	5,000	Rains	Lime	Looking For Clog	Manhole
Checotah	S20418	6/18/2007	28,000	I&I	Limed	Repairing	Lift Station
Checotah	S20418	6/20/2007	28,000	Rain	Lime	Patching Holes & Capping Lines	Manhole
Checotah	S20418	6/20/2007	31,000	Rain	Lime	Maintenance	Lift Station
Checotah	S20418	6/20/2007	15,000	Rain	Lime	Repairing Holes	Manhole
Checotah	S20418	6/26/2007		Rains	Lime	Searching With Dye	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Checotah	S20418	6/26/2007	3,000	I&I	Lime	Dye	Manhole
Checotah	S20418	6/26/2007	40,000	I&I	Lime	Dye	Lift Station
Checotah	S20418	6/26/2007	7,000	I&I/ Pumps Burned	Limed	Repair	Lift Station
Checotah	S20418	6/27/2007	3,000	I&I	Lime	Searching For I&I	Manhole
Checotah	S20418	6/28/2007	20,000	I&I	Lime	Dye	Manhole
Checotah	S20418	6/28/2007	30,000	I&I	Oxygen Stabilizer	Dye	Manhole
Checotah	S20418	6/28/2007	70,000	I&I	Oxygen Stabilizer	Dyeing	Lift Station
Checotah	S20418	7/1/2007	10,000	Rains	Oxygen Stabilizer	Smoke Test	Manhole
Checotah	S20418	7/1/2007	30,000	I&I	Lime	Looking For I&I	Manhole
Checotah	S20418	7/2/2007	62,000	I&I	Lime	Looking For I&I	Lift Station
Checotah	S20418	7/2/2007	3,500	I&I	Lime	Looking For I&I	Manhole
Checotah	S20418	7/10/2007	51,000	Rain	Lime	Looking For I&I	Lift Station
Checotah	S20418	7/10/2007	4,000	I&I	Lime	Searching For I&I	Manhole
Checotah	S20418	7/10/2007	13,000	I&I	Lime		Manhole
Checotah	S20418	7/10/2007	32,000	I&I	Lime		Manhole
Checotah	S20418	7/12/2007	60,000	Rain	Lime	Looking For I&I	Manhole
Checotah	S20418	7/12/2007	10,000	Rain	Lime		Manhole
Checotah	S20418	7/12/2007	10,000	Rain	Hydrogen Peroxide		MANHOLE
Checotah	S20418	7/12/2007	20,000	Rain	Peroxide		Manhole
Checotah	S20418	7/12/2007	100,000	I&I	Lime		Lift Station
Checotah	S20418	7/12/2007	30,000	Rain	Peroxide		Manhole
Checotah	S20418	7/12/2007	20,000	Rain	Peroxide		Manhole
Checotah	S20418	7/13/2007	2,000	Rain	Peroxide		Manhole
Checotah	S20418	7/13/2007	5,000	Rain	Peroxide		Manhole
Checotah	S20418	7/13/2007	20,000	Rain	Peroxide		Manhole
Checotah	S20418	7/13/2007	19,000	I&I	Lime		Manhole
Checotah	S20418	10/10/2007	85	Ants In Control Box	Oxygen Stabilizer	Sprayed	Lift Station
Checotah	S20418	2/16/2008		Motor Burnout	Lime	Repair	Lift Station
Checotah	S20418	2/17/2008	1,300	Rains	Lime	Jetter	Manhole
Checotah	S20418	3/3/2008					
Checotah	S20418	3/3/2008	1,500	I&I	Lime	Locating I&I	Manhole
Checotah	S20418	3/3/2008	1,500	Rain	Lime	Locate I&I	Manhole
Checotah	S20418	3/3/2008	1,500	Rain	Lime	Locate I&I	Manhole
Checotah	S20418	3/3/2008	10,000	I&I	Lime	Locate I&I	Lift Station
Checotah	S20418	3/3/2008	1,500	I&I	Lime	Locate I&I	Manhole
Checotah	S20418	3/3/2008	1,500	Rain	Lime	Locate I&I	Manhole
Checotah	S20418	3/17/2008	25,000	Rain	Lime	Locating I&I	Manhole
Checotah	S20418	3/17/2008	15,000	Rain	Lime	Locate I&I	Manhole
Checotah	S20418	3/17/2008	48,000	Rain	Lime	Locate I&I	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Checotah	S20418	3/17/2008	45,000	Rain	Lime	Locate I&I	Manhole
Checotah	S20418	3/17/2008	80,000	Rain	Lime	Locate I&I	Lift Station
Checotah	S20418	3/18/2008	8,000	Rain	Lime	Locate I&I	Manhole
Checotah	S20418	3/18/2008	10,000	Rain	Lime	Locate I&I	Manhole
Checotah	S20418	3/18/2008	6,000	Rain	Lime	Locate I&I	Manhole
Checotah	S20418	3/18/2008	15,000	Rain	Lime	Locate I&I	Manhole
Checotah	S20418	4/10/2008	20,000	Rain	C & D	Looking For I&I	Manhole
Checotah	S20418	4/10/2008	7,500	Rain	W & D		Manhole
Checotah	S20418	4/10/2008	8,000	Rain			MANHOLE
Checotah	S20418	4/10/2008	12,000	Rain	W & D		Manhole
Checotah	S20418	4/10/2008	40,000	Rain	W & D		Manhole
Checotah	S20418	4/10/2008	38,000	Rain	W & D		Manhole
Checotah	S20418	4/10/2008	5,000	Rain	W & D		Manhole
Checotah	S20418	4/10/2008	12,000	Rain	W & D		Manhole
Checotah	S20418	4/10/2008	70,000	Rain	W & D		Lift Station
Checotah	S20418	5/27/2008	55,000	Pump Failure	C & S	Repaired	Manhole
Checotah	S20418	6/10/2008	10,000	Rain	Oxygen Stabilizer	Smoke Test	Lift Station
Checotah	S20418	6/10/2008	5,000	I&I	Stabilizer	Locating I&I	Manhole
Checotah	S20418	6/10/2008	6,000	Rain	Stabilzer	Locate I&I	Manhole
Checotah	S20418	12/30/2008	2,000	Blockage	C & S	Remove	Pipe
Checotah	S20418	4/15/2009	50,000	Blockage	Lime	Jetter	Pipe
Checotah	S20418	5/6/2009		Rain	Lime		
Checotah	S20418	5/14/2009	19,000	Rains	Lime	Smoke Testing	Lift Station
Checotah	S20418	9/15/2009	15,000	I&I	Lime	Looking For I&I	Lift Station
Checotah	S20418	9/15/2009	4,000	I&I	Lime	Find Problem	Manhole
Checotah	S20418	9/15/2009	4,000	I&I	Lime	Find Problem	Manhole
Checotah	S20418	9/15/2009	4,000	I&I	Lime	Find Problem	Manhole
Checotah	S20418	10/9/2009	100,000	Rain	Lime	Searching I&I	Lift Station
Checotah	S20418	10/9/2009	10,000	I&I	Lime		Manhole
Checotah	S20418	10/9/2009	6,000	I&I	Lime		Manhole
Checotah	S20418	10/9/2009	6,000	I&I	Lime		Manhole
Checotah	S20418	10/9/2009	20,000	I&I	Lime		Manhole
Checotah	S20418	10/9/2009	20,000	I&I	Lime		Manhole
Checotah	S20418	10/9/2009	4,000	I&I	Lime		Manhole
Checotah	S20418	10/13/2009	3,000	Rain	Lime	Searching I&I	Lift Station
Checotah	S20418	12/24/2009	2,500	Pump Failure	Cleaned	Repair	Manhole
Checotah	S20418	5/19/2010	15,000	Rain	Lime		Manhole
Checotah	S20418	5/19/2010	10,000	Rain	Lime		Manhole
Checotah	S20418	5/19/2010	7,500	Rain	Lime		Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Checotah	S20418	5/19/2010	2,000	I&I	Limed	Flushed	Manhole
Checotah	S20418	5/19/2010	10,000	I&I	Lime	New L.S.	Manhole
Checotah	S20418	5/19/2010	30,000	I&I	Lime		Manhole
Checotah	S20418	5/19/2010	150,000	I&I	Lime	New System	Lift Station
Checotah	S20418	5/19/2010	30,000	I&I	Lime	New System	Manhole
Checotah	S20418	7/13/2010	3,500	Blockage	Lime	Flushed	Manhole
Checotah	S20418	7/21/2010	60,000	Contractor Mistake	Lime	Replaced	Pipe
Checotah	S20418	10/25/2010	28,000	Blockage	Lime	Flushed	Pipe
Checotah	S20418	12/28/2010	20	Collar Slipped On Main	Lime	Repair	Pipe
Checotah	S20418	12/28/2010	1,000	Pump Failure	Oxygen Stabilizer	Repair Pump	Lift Station
Checotah	S20418	1/26/2011	1,300	Electrical Problems	Lime	Called Electrician	Lift Station
Checotah	S20418	4/24/2011		I&I	Lime		Manhole
Checotah	S20418	4/24/2011		I&I	Lime		Manhole
Checotah	S20418	4/24/2011		I&I	Lime		Manhole
Checotah	S20418	4/24/2011		I&I	Stabilizer	Find Problem	Manhole
Checotah	S20418	4/24/2011		I&I	Stabilizer	Looking For I&I	Manhole
Checotah	S20418	4/24/2011		Rain	Stabilizer	Seek Problem	Manhole
Checotah	S20418	4/24/2011		Rain	Stabilizer	Seek Problem	Manhole
Checotah	S20418	4/24/2011		Rain	Stabilizer	Locate I&I	Manhole
Checotah	S20418	4/24/2011		I&I	Stabilizer	Working On New System	Manhole
Checotah	S20418	4/24/2011		I&I	Lime		Manhole
Checotah	S20418	4/25/2011	50,000	Rain	Clean	Repair Problems	Manhole
Checotah	S20418	4/27/2011	4,000	Pump Failure In Rain	Cleaned	Replace	Manhole
Checotah	S20418	4/27/2011	15,000	I&I	Oxygen Stabilizer	New Station	Lift Station
Checotah	S20418	4/27/2011	5,000	I&I	Stabilizer	New Lines	Manhole
Checotah	S20418	4/27/2011	5,000	I&I	Stabilizer	Smoke Test	Manhole
Checotah	S20418	6/20/2011	30	Lift Station Down	Oxygen Stabilizer	Repair	Lift Station
Checotah	S20418	8/24/2011	125	Panel Failure	Lime	Reset Panel	Lift Station
Checotah	S20418	11/7/2011	2,000	I&I	C & D	Reduce I&I	Manhole
Checotah	S20418	11/8/2011	25,000	Rain	C & D	Work On System	Manhole
Checotah	S20418	11/8/2011	3,500	Rain	Treated	Larger L.S.	Manhole
Checotah	S20418	11/8/2011	1,000	Rain	Treated	Larger L.S.	Manhole
Checotah	S20418	11/8/2011	1,300	Rains	Treated	Larger Main	Manhole
Checotah	S20418	11/8/2011	1,600	Rains	Treated	Larger Mains	Manhole
Checotah	S20418	1/20/2012	500	Blockage	Oxygen stabilizer	Jetted	Manhole
Checotah	S20418	2/3/2012	1,000	I&I	Oxygen stabilizer	Locate I&I	Manhole
Checotah	S20418	2/3/2012	1,000	Rain	Oxygen		Manhole
Checotah	S20418	2/3/2012	1,000	Rain			Manhole
Checotah	S20418	2/3/2012	1,000	Rain			Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Checotah	S20418	2/6/2012	5,000	Rain			Lift Station
Checotah	S20418	7/13/2010	3,500	Blockage	Lime	Flushed	Manhole
Checotah	S20418	7/21/2010	60,000	Contractor Mistake	Lime	Replaced	Pipe
Checotah	S20418	10/25/2010	28,000	Blockage	Lime	Flushed	Pipe
Checotah	S20418	12/28/2010	20	Collar Slipped On Main	Lime	Repair	Pipe
Checotah	S20418	12/28/2010	1,000	Pump Failure	Oxygen stabilizer	Repair Pump	Lift Station
Checotah	S20418	1/26/2011	1,300	Electrical Problems	Lime	Called Electrician	Lift Station
Checotah	S20418	4/24/2011		I&I	Lime		MANHOLE
Checotah	S20418	4/25/2011	50,000	Rain	Clean	Repair Problems	Manhole
Checotah	S20418	4/27/2011	4,000	Pump Failure In Rain	Cleaned	Replace	Manhole
Checotah	S20418	4/27/2011	15,000	I&I	Oxygen stabilizer	New Station	Lift Station
Checotah	S20418	4/27/2011	5,000	I&I	Stabilizer	New Lines	Manhole
Checotah	S20418	4/27/2011	5,000	I&I	Stabilizer	Smoke Test	Manhole
Checotah	S20418	6/20/2011	30	Lift Station Down	Oxygen stabilizer	Repair	Lift Station
Checotah	S20418	8/24/2011	125	Panel Failure	LIME	Reset Panel	Lift Station
Checotah	S20418	11/7/2011	2,000	I&I	C & D	Reduce I&I	Manhole
Checotah	S20418	11/8/2011	25,000	Rain	C & D	Work On System	Manhole
Checotah	S20418	11/8/2011	3,500	Rain	Treated	Larger L.S.	Manhole
Checotah	S20418	11/8/2011	1,000	Rain	Treated	Larger L.S.	Manhole
Checotah	S20418	11/8/2011	1,300	Rains	Treated	Larger Main	Manhole
Checotah	S20418	11/8/2011	1,600	Rains	Treated	Larger Mains	Manhole
Checotah	S20418	1/20/2012	500	Blockage	Oxygen stabilizer	Jetted	Manhole
Checotah	S20418	2/3/2012	1,000	I&I	Oxygen stabilizer	Locate I&I	Manhole
Checotah	S20418	2/3/2012	1,000	Rain	Oxygen		Manhole
Checotah	S20418	2/3/2012	1,000	Rain			Manhole
Checotah	S20418	2/3/2012	1,000	Rain			Manhole
Checotah	S20418	2/6/2012	5,000	Rain			Lift Station
Broken Arrow	S20409	1/6/2005	5,760	Grease	C & D	Cleared	Manhole
Broken Arrow	S20409	1/6/2005		Grease	C & D	Cleared	
Broken Arrow	S20409	1/8/2005		Roots	C & D	Cleared	
Broken Arrow	S20409	1/21/2005	30,000	Firewood In Mh	HTH	Cleared	Manhole
Broken Arrow	S20409	1/29/2005		Cleaning Operation	C & D	Pending Investigation	
Broken Arrow	S20409	4/19/2005		Cleaning Operation	Cleaned	Investigate	
Broken Arrow	S20409	5/31/2005	2,040	Root	C & D	Cleared	Manhole
Broken Arrow	S20409	6/6/2005	1,000	Pump Malfunction	HTH	Cleared	Lift station
Broken Arrow	S20409	6/6/2005	5,000	Power Outage	HTH		Lift station
Broken Arrow	S20409	7/30/2005	20,000	Roots & Logs	Flushed	Removed	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Broken Arrow	S20409	8/6/2005	8,000	Debris		Flushed	Manhole
Broken Arrow	S20409	8/10/2005	162	Roots	C & D	Cleared	
Broken Arrow	S20409	9/9/2005	40,000	Power Outage	Cleaning	Replaced Fuse	Lift Station
Broken Arrow	S20409	9/18/2005	30,000	Bad Breaker On #2 Pump	HTH	Replace Breaker	Lift Station
Broken Arrow	S20409	10/18/2005	4,829	Construction Work	C & D	Repaired	Manhole
Broken Arrow	S20409	11/8/2005	510	Grease	C & D	Cleared	Manhole
Broken Arrow	S20409	11/13/2005	300,000	L.S. Malfunction	HTH	Restore	Lift station
Broken Arrow	S20409	12/17/2005		Roots	C & D	Cleared	
Broken Arrow	S20409	1/8/2006	5,000	Malfunction	HTH	Repair	Lift station
Broken Arrow	S20409	1/9/2006	8,685	Debris	C & D	Cleared	Manhole
Broken Arrow	S20434	1/16/2006	1,000	Grease	Cleaned	Cleared	Manhole
Broken Arrow	S20409	3/4/2006	5,790	Roots	C & D	Cleared	Manhole
Broken Arrow	S20409	3/27/2006	5,000	Pump Failure	HTH	Replace	Lift Station
Broken Arrow	S20409	4/5/2006		Root	C & D	Cleared	
Broken Arrow	S20409	5/9/2006	10,000	Contractor Error	Washed	Contacted Company	Manhole
Broken Arrow	S20409	7/19/2006	10,000	Rags	HTH	Clean Off Floats	Lift Station
Broken Arrow	S20409	7/29/2006	2,000	Grease & Rags	HTH	Flushed	Manhole
Broken Arrow	S20409	9/1/2006	15,000	L.S. Malfunction	Flush Fire Hydrant	Repair	Lift Station
Broken Arrow	S20409	1/25/2007	5,000	Contractor Hit Main	HTH		Lift Station
Broken Arrow	S20409	2/6/2007	1,000	L.S. Down	HTH	Replace Coupling	Lift Station
Broken Arrow	S20409	3/30/2007	1,000	Rain & Malfunction	HTH		Head Works
Broken Arrow	S20409	5/7/2007	3,000	Rain	HTH		Lift Station
Broken Arrow	S20409	7/23/2007	3,000	Pump Failure	Clean	Replace	Lift Station
Broken Arrow	S20409	8/17/2007	500	Power Failure	Cleaned	Replace Breakers	Lift Station
Broken Arrow	S20409	10/24/2007	2,000	L.S. Down - Construction	HTH		Manhole
Broken Arrow	S20409	10/31/2007	10,000	Sewer Line Hit	HTH		Pipe
Broken Arrow	S20409	12/10/2007	115,000	Power Loss	HTH		Lift Station
Broken Arrow	S20409	12/10/2007	140,000	Power Loss	HTH		Lift Station
Broken Arrow	S20409	12/10/2007	11,760	Power Loss	HTH		Lift Station
Broken Arrow	S20409	12/10/2007	642,000	Power Loss	HTH		Lift Station
Broken Arrow	S20409	12/10/2007	813,000	Power Loss	HTH		Lift Station
Broken Arrow	S20409	12/10/2007	10,000	Power Loss	HTH		Lift Station

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Broken Arrow	S20409	12/10/2007	147,000	Power Loss	HTH		Lift Station
Broken Arrow	S20409	12/10/2007	103,000	Power Loss	HTH		Lift Station
Broken Arrow	S20409	12/10/2007	18,200	Ice Storm	Wash		Lift Station
Broken Arrow	S20409	12/10/2007	24,500	Ice Storm	HTH		Lift Station
Broken Arrow	S20409	12/10/2007	294,000	Ice Storm	HTH		Lift Station
Broken Arrow	S20409	12/10/2007	1000000.00	Ice Storm	HTH		Lift Station
Broken Arrow	S20409	12/11/2007	2000000.00	Power Outage	HTH		Lift Station
Broken Arrow	S20409	12/11/2007	66,000	Power Loss	HTH		Lift Station
Broken Arrow	S20409	12/11/2007	42,000	Ice Storm	HTH		Lift Station
Broken Arrow	S20409	4/10/2008	5,000	Rain	HTH	Checking MH's	
Broken Arrow	S20409	7/10/2008	8,000	Bad Fuse	C & S	Replace Fuse	Lift Station
Broken Arrow	S20409	7/11/2008	4,000	Blown Fuse	C & S	Replace Bad Motor	Lift Station
Broken Arrow	S20409	7/27/2008	6,000	Blown Fuse	HTH	Replace	Lift Station
Broken Arrow	S20409	9/4/2008	6,000	Blockage	Cleaned	Cleared	Pipe
Broken Arrow	S20409	9/25/2008	11,808	Leak	C & S	Repair	Lift Station
Broken Arrow	S20409	9/30/2008		Blown Fuse		Repair	
Broken Arrow	S20409	9/30/2008	15,000	Blown Fuse	C & S	Replace Fuse	Lift Station
Broken Arrow	B20409	2/11/2009	25,000	Rain	HTH	Checking MH's	Lift Station
Broken Arrow	B20409	2/11/2009	15,000	Rain	HTH		Lift Station
Broken Arrow	S20409	9/22/2009	50,000	Rain/Blockage	C & S	Clean & Repair	Head Works
Broken Arrow	A20409	10/22/2009	5,000	Rain	C & S	Monitoring	Lift Station
Broken Arrow	S20409	10/31/2009	3,000	Grease 7 Roots	C & S	Root Cutting	Manhole
Broken Arrow	A20409	11/16/2009	17,000	Power Outage	C & S	Restoring	Lift Station
Broken Arrow	S20409	3/17/2010	100,000	Power Left Off	HTH	Turn Power On	Lift Station
Broken Arrow	S20409	5/20/2010	30,000	Rags In Bar Screen	HTH	Adjust Alarm Level	Head Works
Broken Arrow	B20434	6/6/2010	2,000	Roots	C & S	Jetted	Pipe
Broken Arrow	S20409	9/27/2010	1,000	Sand In Line	HTH	Jetted	Manhole
Broken Arrow	S20409	9/28/2010	8,400	Equipment Failure	Cleaning	Turn Off Valve	Manhole
Broken Arrow	S20409	10/4/2010		Contractor Cleaning	Cleaning	Investigate	
Broken Arrow	S20409	10/4/2010		Contractor Cleaning	Cleaned	Investigate	
Broken Arrow	S20409	10/4/2010		Contractor Cleaning	Cleaned	Investigate	
Broken Arrow	S20409	11/6/2010	10,000	L.S. Down	HTH & Flush Hydrants	Restore	Lift Station

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Broken Arrow	B20434	11/26/2010	25,000	Grease & Debris	C & S	Cleared	Manhole
Broken Arrow	S20409	5/27/2011	468,900	Line Washed Out	HTH	Repair	Pipe
Broken Arrow	A20409	12/10/2011	2,000	Line Collapsed	HTH	Replace	Manhole
Broken Arrow	S20409	12/27/2011	3500	Pso Fuse Tripped On One Leg Of Supply Line	Water Seems To Have Dried Up	New Generator Has Been Installed	Lift Station
Tulsa	S20409	5/29/2006	4,053	Root	C & D	Cleared	Manhole
Tulsa	S20409	6/18/2006		Grease	Cleaned	Cleared	
Tulsa	S20409	6/18/2006		Grease	Cleaned	Cleared	
Tulsa	S20409	6/18/2006		Grease	Cleaned	Cleared	
Tulsa	S20409	6/27/2006		Root	C & D	Cleared	Manhole
Tulsa	S20409	7/28/2006		Roots	Cleaned	Cleared	
Tulsa	S20409	10/28/2006	672	Grease	C & D	Cleared	Manhole
Tulsa	S20409	10/29/2006	696	Grease	C & D	Cleared	
Tulsa	S20409	11/3/2006		Vandalism	C & D	Cleared	Manhole
Tulsa	S20409	11/6/2006		Cleaning Crew	Cleaned		
Tulsa	S20409	12/3/2006	112	Grease	C & D	Cleared	
Tulsa	S20409	2/23/2007	480	Grease	C & D	Cleared	
Tulsa	S20409	2/23/2007		Grease	Cleaned	Cleared	
Tulsa	S20409	3/7/2007		Roots	Cleaned	Cleared	
Tulsa	S20409	5/7/2007		Rain			
Tulsa	S20409	5/7/2007	38,208	Rain			
Tulsa	S20409	5/7/2007	81,192	Rain			
Tulsa	S20409	5/7/2007	81,192	Rain			
Tulsa	S20409	5/7/2007	180,262	Rain			
Tulsa	S20409	5/7/2007	56,225	Rain			
Tulsa	S20409	5/7/2007	393,120	Rain			
Tulsa	S20409	5/7/2007	624,950	Rain			
Tulsa	S20409	5/7/2007		Rain		Monitor	
Tulsa	S20409	5/7/2007	1000000	Rain	Clean	Monitor	
Tulsa	S20409	5/7/2007	750,770	Rain	Cleaned	Monitor	
Tulsa	S20409	5/7/2007	721,119	Rain	Cleaned		
Tulsa	S20409	5/7/2007	1,677	Rain	Clean		
Tulsa	S20409	5/7/2007	280,489	Rain	Cleaned		
Tulsa	S20409	5/7/2007		Rain	Cleaned		
Tulsa	S20409	5/7/2007	173,250	Rain	Cleaned	Monitor	
Tulsa	S20409	5/7/2007	636,900	Rain	Clean	Monitor	
Tulsa	S20409	5/7/2007	111,747	Rain	Cleaned		
Tulsa	S20409	5/7/2007	99,280	Rain	Cleaned		
Tulsa	S20409	5/7/2007	99,280	Rain	Cleaned		

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa	S20409	5/7/2007	99,280	Rain	Cleaned		
Tulsa	S20409	5/7/2007	368,550	Rain	Cleaned		
Tulsa	S20409	5/7/2007	1300000	Rain	Clean		
Tulsa	S20409	5/7/2007	93,912	Rain	Cleaned		
Tulsa	S20409	5/7/2007		Rain	Cleaned		
Tulsa	S20409	5/7/2007	43,520	Rain	Cleaned		
Tulsa	S20409	5/7/2007		Rain	Cleaned		
Tulsa	S20409	5/20/2007		Grease	C & D	Cleared	
Tulsa	S20409	7/11/2007	345	Grease	Cleaned	Cleared	
Tulsa	S20409	12/11/2007	1000000	Power Loss	C & D	Restore	Manhole
Tulsa	S20409	1/8/2008		Root	Cleaned	Cleared	
Tulsa	S20409	2/27/2008		Debris	C & D	Cleaned	Manhole
Tulsa	S20409	11/21/2008	2,160	Debris	C & D	Cleaned	Manhole
Coweta	S20410	2/10/2005	5,000	Broken Pipe	Lime	Repaired	Pipe
Coweta	S20410	2/22/2005	20,000	Busted Line	Limed	Replace	Pipe
Coweta	S20410	2/22/2005	70,000	Soap & Grease From Rain	Limed	Repaired Line	Manhole
Coweta	S20410	3/21/2005	90,000	Rain	C & S		Manhole
Coweta	S20410	6/7/2005	2,000	Constructing New Line	Limed	Install Line	Manhole
Coweta	S20410	7/19/2005	5,000	Blockage	Limed	Maintenance	Manhole
Coweta	S20410	12/14/2005	500	Roots & Soap	Limed	Maintenance List	Manhole
Coweta	S20410	1/2/2006	40	Roots	C & S	Maintenance	
Coweta	S20410	1/3/2006	100	Blockage	Limed	Jetted	Manhole
Coweta	S20410	1/10/2006	150	Soap	Limed	Maintenance List	Manhole
Coweta	S20410	3/25/2006	100	Blockage	Limed	Maintenance	Manhole
Coweta	S20410	5/1/2006	5,000	Rain	Limed	Maintenance	Manhole
Coweta	S20410	6/18/2006	1,700	Malfunction	Cleaned	Check Regularly	Manhole
Coweta	S20410	6/21/2006	200	Malfunction	Limed	Check Often	Manhole
Coweta	S20410	11/9/2006	2,000	Soap	Washed	Maintenance Cleaning	Manhole
Coweta	S20410	12/6/2006	7,000	Frozen Bar Screen	Cleaned	Maintenance	Head Works
Coweta	S20410	12/9/2006	100	Soap	C & S	Maintenance	Manhole
Coweta	S20410	12/30/2006	2,000	Rains	Limed	Maintenance	Pipe
Coweta	S20410	1/4/2007	2,000	Breaker Went Off At L.S.	C & S	Checked Daily	Lift Station
Coweta	S20410	2/22/2007	1,000	Paper, Towels, Rags & Soap	C & S	Jetted	
Coweta	S20410	3/9/2007	50	Soap & Trash	Limed	Maintenance	Pipe
Coweta	S20410	4/16/2007	25,000	Debris	W & D	Maintenance	Manhole
Coweta	S20410	4/25/2007	500	Paper Towels & Soap	Limed	Preventive Maintenance	Pipe
Coweta	S20410	5/9/2007	1,000	I&I			Manhole
Coweta	S20410	5/13/2007	100	Roots & Trash		Dig Out Roots	Manhole
Coweta	S20410	5/14/2007	1,000	Backup	Limed	Maintenance	

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Coweta	S20410	6/1/2007	2,000	Roots	Lime	Maintenance	
Coweta	S20410	6/5/2007	7,000	Wood	Limed	Maintenance	
Coweta	S20410	6/23/2007	50,000	Rain	Lime	Jetter	Manhole
Coweta	S20410	6/27/2007	20,000	Rain	Lime	Jetted	Lift Station
Coweta	S20410	6/27/2007	65,000	Rains	Lime	Jetted	
Coweta	S20410	7/6/2007	100	Pump Failure	C & S	Check L.S.	Manhole
Coweta	S20410	7/13/2007	20,000	Rain	C & S	Maintenance	Manhole
Coweta	S20410	7/25/2007	100	Roots	Limed	Maintenance	
Coweta	S20410	8/6/2007	500	Soap, Grease & Roots	C & S	Maintenance	Manhole
Coweta	S20410	8/9/2007	1,000	Roots & Grease	C & S	Maintenance	Manhole
Coweta	S20410	8/11/2007	50,000	Tap On Main Broke	C & S	Check Main	Pipe
Coweta	S20410	8/21/2007	10,000	Roots	C & S	Maintenance	Manhole
Coweta	S20410	10/9/2007	200	Soap & Roots	Lime	Maintenance List	Pipe
Coweta	S20410	10/9/2007	200	Grease & Soap	Lime	Maintenance	
Coweta	S20410	10/15/2007	50,000	Debris	Limed	Maintenance List	Manhole
Coweta	S20410	11/3/2007	1,000	Malfunction	C & D	Repair	Lift Station
Coweta	S20410	11/9/2007	1,000	Worn Pipe	Limed	Repair	Pipe
Coweta	S20410	12/13/2007	30,000	Soap & Rags	Lime	Maintenance	Manhole
Coweta	S20410	1/7/2008	1,000	Roots & Trash	Lime	Rodded	Manhole
Coweta	S20410	2/5/2008	500	Soap	Lime	Maintenance Schedule	Manhole
Coweta	S20410	2/11/2008	500	Trash	Lime	Jetted	Manhole
Coweta	S20410	2/20/2008	10,000	Roots	C & S	Jetted	Pipe
Coweta	S20410	2/28/2008	1,000	Paper Towels	C & S	Maintenance List	Manhole
Coweta	S20410	3/17/2008		Roots, Soap & Paper	Lime	Maintenance Schedule	Manhole
Coweta	S20410	3/18/2008	60,000	Rain	Lime	Maintenance	Manhole
Coweta	S20410	3/18/2008	5,000	Rain & Debris	Lime	Maintenance	Manhole
Coweta	S20410	3/18/2008	60,000	Rain	Lime	Maintenance	Manhole
Coweta	S20410	3/18/2008	1,000	Rain, Soap & Paper	Lime	Maintenance	Manhole
Coweta	S20410	4/1/2008	10,000	Rain	Limed	Jetted	Manhole
Coweta	S20410	4/1/2008	50,000	Rain	Lime	Jetted	Manhole
Coweta	S20410	4/1/2008	50,000	Rain	Lime	Jetted	Manhole
Coweta	S20410	4/1/2008	5,000	Rain	Lime	Maintenance List	Pipe
Coweta	S20410	4/1/2008	10,000	Rain	Lime	Clean	Manhole
Coweta	S20410	4/20/2008	2,000	Blockage	Lime	Maintenance Schedule	
Coweta	S20410	8/24/2008	1,500	Blockage	Limed	Maintenance List	Manhole
Coweta	S20410	8/26/2008	100	Toilet Paper & Grease	Lime	Jetted	
Coweta	S20410	9/4/2008	10	Roots	C & D	Root Cutter	
Coweta	S20410	9/5/2008		Grease & Sludge	Lime	Maintenance List	Manhole
Coweta	S20410	9/12/2008	20,000	Grease, Rage & Roots	Lime	Maintenance	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Coweta	S20410	9/16/2008	500	L.S. Breaker Malfunction	Lime	Check	Manhole
Coweta	S20410	9/22/2008	20,000	Pump Failure At L.S.	Lime	Check Everyday	Manhole
Coweta	S20410	9/29/2008		Pump Failure	C & S	Check	Manhole
Coweta	S20410	10/7/2008	1,000	Blockage	Lime	Maintenance List	Manhole
Coweta	S20410	10/9/2008	500	Blockage	Lime	Maintenance List	Pipe
Coweta	S20410	11/24/2008	5,000	Broken Line	Limed		Pipe
Coweta	S20410	12/10/2008	500	Broken Main	Lime	Repair	Manhole
Coweta	S20410	12/13/2008	1,000	Paper Towels	C & S	Maintenance List	Pipe
Coweta	S20410	2/3/2009	500	Soap & Roots	Limed	Maintenance List	Manhole
Coweta	S20410	3/4/2009		Grease & Sludge	Pumped	Jetted	Manhole
Coweta	S20410	3/31/2009		Mechanical	Cleaned		Lagoon/Basin
Coweta	S20410	5/4/2009	25,000	Deris	Lime	Maintenance	Manhole
Coweta	S20410	5/14/2009	20,000	Storm	Lime	Repair	Manhole
Coweta	S20410	5/17/2009	10,000	Rain	Limed	Maintenance	Manhole
Coweta	S20410	6/3/2009	1,000	Blockage	Lime	Jetted	Manhole
Coweta	S20410	6/16/2009	500	Soap & Grease	Limed	Jetted	Manhole
Coweta	S20410	6/24/2009	1,000	Soap & Grease	C & S	Maintenance	Manhole
Coweta	S20410	9/10/2009	500	Rain	Lime		Manhole
Coweta	S20410	9/22/2009	75	Limb In Creek Hitting Main	Lime	Repair	Pipe
Coweta	S20410	10/9/2009	1,000	Rain	Limed	Maintenance	Manhole
Coweta	S20410	10/28/2009	100	Stopped Main	Cleaned		Pipe
Coweta	S20410	10/29/2009	500	Rain	Limed	Maintenance	Pipe
Coweta	S20410	11/4/2009	500	Stopped Main	Cleaned	Maintenance List	Pipe
Coweta	S20410	2/11/2010	10	Grease	Lime	Maintenance	Lift Station
Coweta	S20410	2/16/2010	25	Grease	Limed	Maintenance List	Manhole
Coweta	S20410	2/23/2010	100	Grease, Rags & Paper	Lime	Jet Rodding	Manhole
Coweta	S20410	4/7/2010	>50	Pvc Pipe Broke By Kids	Lime	Replace	Pipe
Coweta	S20410	3/30/2011	50	Blockage	Limed	Rodded	
Coweta	S20410	4/13/2011	350	Grease	C & S	Jetted	Manhole
Coweta	S20410	4/25/2011	500	Rains	Lime	Maintenance List	Manhole
Coweta	S20410	4/28/2011	100	Grease	Lime	Maintenance	Manhole
Coweta	S20410	5/3/2011	200	Contractor Error	Limed	Repaired	Lift Station
Coweta	S20410	7/6/2011	>350	Leak In Pump Hose	None	Replace	Lagoon/Basin
Coweta	S20410	9/6/2011	400	Tripped Breaker	Limed	Check Breaker Often	Manhole
Coweta	S20410	10/25/2011	450	Grease	C & S	Jetted	Manhole
Coweta	S20410	11/8/2011	50	Rain	Limed	Jetted	Manhole
Coweta	S20410	11/21/2011	1,000	Stopped Main	C & S	Jetted	Manhole
Coweta	S20410	11/21/2011	750	Rain	C & S	Jetted	Manhole
Coweta	S20410	1/9/2012	1,000	Grease	Limed	Jett More Often	Pipe

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Coweta	S20410	2/7/2012	7,000	Grease & Paper Towels/ Sludge	Limed	Jetted	Manhole
Haikey Creek	S20434	7/8/2008		Broken Main	C & D	Cleared	Manhole
Haikey Creek	S20434	7/13/2008	1500000	Broken Main	Cleaning	Pump Around	Pipe
Haikey Creek	S20434	7/13/2008		Construction Work	Cleaned		
Haikey Creek	S20434	12/11/2008		Grease	C & D	Cleared	Manhole
Haikey Creek	S20434	3/2/2009	4,439	Roots	Cleaned	Cleared	Manhole
Haikey Creek	S20434	3/2/2009	3,128	Roots	C & D	Cleared	Manhole
Haikey Creek	S20434	4/9/2009	690	Grease	Cleaned	Cleared	
Haikey Creek	S20434	8/16/2009	4,641	Grease	C & D	Cleared	Manhole
Haikey Creek	S20434	8/21/2009	1,920	Debris	C & D	Cleared	Manhole
Haikey Creek	S20434	9/30/2009		Broken Main	C & D	Repair	
Haikey Creek	S20434	12/1/2009	323	Root	C & D	Cleared	Manhole
Haikey Creek	S20434	12/10/2009	720	Roots	C & D	Cleared	Manhole
Haikey Creek	S20434	1/15/2010		Contractor Cleaning	Cleaned	Investigate	
Haikey Creek	S20434	1/21/2010		Broken Main	Cleaning	Pending	Pipe
Haikey Creek	S20434	1/21/2010		Broken Main	Cleaning	Pending	Pipe
Haikey Creek	S20434	2/5/2010		Contractor Cleaning	Cleaned	Investigate	
Haikey Creek	S20434	3/8/2010		Broken Main	C & D	Cleared	
Haikey Creek	S20434	3/10/2010		Broken Main	Contractor Cleaned	Cleared	
Haikey Creek	S20434	3/23/2010		Grease	Cleaned	Cleared	
Haikey Creek	S20434	3/27/2010	560	Grease	C & D	Cleared	
Haikey Creek	S20434	1/17/2007	1,000				
Haikey Creek	S20434	5/7/2007					
Haikey Creek	S20434	5/7/2007					
Haikey Creek	S20434	6/27/2007		Overflow			Manhole
Haikey Creek	S20434	3/18/2008		Rain	C & D		Lift Station
Haikey Creek	S20434	4/8/2008		Rain			Manhole
Haikey Creek	S20434	4/9/2008		Overload			Manhole
Haikey Creek	S20434	5/4/2008	56	Root Stoppage	Cleaned & Deodorized	Cleared	
Haikey Creek	S20434	5/7/2008					
Haikey Creek	S20434	5/7/2008		Rain	C & D		Lift Station
Haikey Creek	S20434	5/7/2008		Rain	C & S		Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Haikey Creek	S20434	5/27/2008		Rain			Manhole
Haikey Creek	S20434	5/27/2008	880	Broken Main	Cleaned	Repair	
Haikey Creek	S20434	6/9/2008		Rain			
Haikey Creek	S20434	8/15/2008		Broken Main	Cleaned By Resident	CLEANED LINE	
Haikey Creek	S20434	8/15/2008		Broken Main	Cleaned By Resident	CLEANED LINE	
Haikey Creek	S20434	8/15/2008		Broken Line	Cleaned By Resident	CLEANED LINE	
Haikey Creek	S20434	3/28/2009		Rain/Snow	Limed	Repair	Lift Station
Haikey Creek	S20434	3/29/2009		Rain/Snow	Lime		Manhole
Haikey Creek	S20434	4/29/2009		Rain			Lift Station
Haikey Creek	S20434	5/2/2009					Lift Station
Haikey Creek	S20434	9/21/2009		Rain			Manhole
Haikey Creek	S20434	10/7/2009					
Haikey Creek	S20434	10/14/2009					
Haikey Creek	S20434	7/24/2010		Line Break			
Haikey Creek	S20434	1/24/2011					
Haikey Creek	S20434	2/22/2011	500	Construction Problems	Soaked Into Ground	Repairs	
Haikey Creek	S20434	2/22/2011	500				
Haikey Creek	S20434	3/30/2011	1,000	Air Relief Valve Failure		Replace	Lift Station
Haikey Creek	S20434	8/1/2011	500	Leak	Pumped	Repairs	Manhole
Haikey Creek	S20434	10/6/2011					
Haikey Creek	S20434	10/24/2011	50	Tanker Flipped Over			
Haikey Creek	S20434	11/6/2011					
Haikey Creek	S20434	3/31/2010		Contractor Cleaning	Cleaned	Investigate	
Haikey Creek	S20434	4/12/2010	850	Roots	C & D	Cleared	Manhole
Haikey Creek	S20434	4/22/2010	690	Grease	C & D	Cleared	
Haikey Creek	S20434	6/10/2010		Debris	C & D	Cleared	
Haikey Creek	S20434	6/29/2010		Debris	Cleaned	Cleared	
Haikey Creek	S20434	8/14/2010	213	Root	C & D	Cleared	
Haikey Creek	S20434	10/25/2010		Root	C & D	Cleared	
Haikey Creek	S20434	11/14/2010	5,430	Roots	C & D	Cleared	Manhole
Haikey Creek	S20434	12/21/2010	7,680	Broken Main	Cleaning	Cleaned	Pipe
Haikey Creek	S20434	1/26/2011	960	Root	C & D	Cleared	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Haikey Creek	S20434	2/2/2011	8,160	Grease	Cleaned	Cleared	Manhole
Haikey Creek	S20434	4/7/2011		Debris	C & D	Cleared	Manhole
Haikey Creek	S20434	4/15/2011		Cleaned Line	Cleaned By Owner	Cleaned	
Haikey Creek	S20434	4/25/2011	2,040	Root	Cleaned	Cleared	Manhole
Haikey Creek	S20434	4/28/2011		Rain	Cleaned	Study	
Haikey Creek	S20434	11/22/2011	690	Broken Main	C & D	Cleared	
Haikey Creek	S20434	11/23/2011	1,728	Root	C & D	Cleared	Manhole
Haikey Creek	S20434	1/19/2012	14,160	Broken Main	Cleaning	Setup Pump	Manhole
Haikey Creek	S20434	1/19/2012	14,160	Broken Main	Cleaning	Setup Pump	Manhole
Haikey Creek	S20434	1/20/2012		Cleaning Crew	Cleaned By Resident	Investigate	
Tulsa	S20402	1/1/2005		Roots	C & D	Cleared	Manhole
Tulsa	S20402	1/3/2005	36,600	Debris	C & D	Cleared	Manhole
Tulsa	S20402	1/5/2005	2,040	Roots	C & D	Cleared	
Tulsa	S20402	1/5/2005	2,040	Roots	Cleaned	Cleared	
Tulsa	S20402	1/6/2005	10,275	Grease	C & D	Cleared	
Tulsa	S20402	1/11/2005	1,200	Grease	C & D	Cleared	Manhole
Tulsa	S20402	1/29/2005	8,160	Roots	W & D	Cleared	Manhole
Tulsa	S20402	2/8/2005		Roots	C & D	Cleared	
Tulsa	S20402	2/8/2005	510	Broken Main	C & D	Repaired Line	Manhole
Tulsa	S20402	2/10/2005		Roots	C & D	Cleared	
Tulsa	S20402	2/28/2005	960	Roots	C & D	Cleared	
Tulsa	S20402	3/15/2005	34.1	Grease	C & D	Cleared	
Tulsa	S20402	3/23/2005	120	Debris	W & D	Cleared	
Tulsa	S20402	3/25/2005	6,680	Grease	C & D	Cleared	Manhole
Tulsa	S20402	3/31/2005		Cleaning Operation	Cleaned		
Tulsa	S20402	4/6/2005	25,050	Broken Main	C & D	Repaired	Manhole
Tulsa	S20402	4/6/2005		Broken Main	C & D	Repaired Line	
Tulsa	S20402	4/11/2005	1,020	Grease	C & D	Cleared	Manhole
Tulsa	S20402	4/18/2005	110,400	Broken Main	Cleaning	Repair Line	Pipe
Tulsa	S20402	5/14/2005		Power Outage			
Tulsa	S20402	6/19/2005	9,686	Grease	C & D	Cleared	Manhole
Tulsa	S20402	6/20/2005	16,898	Broken Main	Cleaning	Repaired	Pipe
Tulsa	S20402	7/10/2005		Root	Cleaned	Cleared	
Tulsa	S20402	7/11/2005	179,400	Broken Main	C & D	Repaired	Pipe
Tulsa	S20402	7/23/2005	2,400	Vandalism	C & D	Cleared	Manhole
Tulsa	S20402	7/26/2005		Construction Work	Cleaning	Cleared	
Tulsa	S20402	8/29/2005	720	Grease	C & D	Cleared	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa	S20402	9/18/2005	1,152	Grease	C & D	Cleared	Manhole
Tulsa	S20402	9/18/2005	1,152	Grease	C & D	Cleared	Manhole
Tulsa	S20402	11/1/2005	1,360	Grease	C & D	Cleared	Manhole
Tulsa	S20402	11/10/2005		Grease	Cleaned	Cleared	
Tulsa	S20402	11/15/2005	179	Roots	Cleaned	Cleared	
Tulsa	S20402	11/17/2005		Debris	C & D	Cleared	Manhole
Tulsa	S20402	11/17/2005		Debris	Cleaned	Cleared	
Tulsa	S20402	11/22/2005		Grease	Cleaned	Cleared	
Tulsa	S20402	11/22/2005	9.35	Roots	C & D	Cleared	
Tulsa	S20402	12/2/2005	3,264	Grease	C & D	Cleared	Manhole
Tulsa	S20402	12/2/2005	3,264	Grease	C & D	Cleared	Manhole
Tulsa	S20402	12/5/2005	255	Grease	C & D	Cleared	Manhole
Tulsa	S20402	12/15/2005	15.58	Debris	C & D	Cleared	
Tulsa	S20402	12/22/2005	6,885	Broken Main	Cleaned	Repair	Manhole
Tulsa	S20402	12/22/2005	1,122	Broken Main	Cleaned	Repair	
Tulsa	S20402	1/3/2006	3,944	Debris	C & D	Cleared	Manhole
Tulsa	S20402	1/5/2006	1,680	Grease	Cleaned & Flushed	Cleared	
Tulsa	S20402	1/11/2006		Root	C & D	Cleared	
Tulsa	S20402	1/17/2006		Grease	C & D	Cleared	
Tulsa	S20402	1/21/2006	12,240	Grease	C & D	Cleared	Manhole
Tulsa	S20402	1/23/2006		Root	C & D	Cleared	Manhole
Tulsa	S20402	1/26/2006	2,160	Roots	C & D	Cleared	Manhole
Tulsa	S20402	1/26/2006		Root	Cleaned	Cleared	Manhole
Tulsa	S20402	1/26/2006		Roots	Cleaned	Cleared	
Tulsa	S20402	1/29/2006	4,676	Grease	C & D	Cleared	Manhole
Tulsa	S20402	2/8/2006		Roots	C & D	Cleared	
Tulsa	S20402	2/9/2006	912	Root	C & D	Cleared	Manhole
Tulsa	S20402	2/9/2006	9.35	Roots	C & D	Cleared	
Tulsa	S20402	2/11/2006	1,035	Roots	C & D	Cleared	
Tulsa	S20402	2/14/2006	480	Roots	Flushed & Deoderized	Cleared	Manhole
Tulsa	S20402	2/15/2006		Debris	Cleaned	Cleared	
Tulsa	S20402	2/20/2006		Grease	C & D	Cleared	
Tulsa	S20402	2/21/2006	42	Roots	C & D	Cleared	
Tulsa	S20402	2/22/2006	25.71	Roots	C & D	Cleared	
Tulsa	S20402	2/23/2006		Cleaning Crew	C & D	Pending	
Tulsa	S20402	2/23/2006		Cleaning Crew	Cleaned	Pending	
Tulsa	S20402	2/23/2006		Grease	C & D	Cleared	
Tulsa	S20402	3/1/2006	2,720	Grease	C & D	Cleared	
Tulsa	S20402	3/16/2006		Root	C & D	Cleared	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa	S20402	3/28/2006		Roots	Cleaned	Cleared	Pipe
Tulsa	S20402	3/31/2006		Grease	C & D	Cleared	
Tulsa	S20402	3/31/2006	5,790	Grease	C & D	Cleared	Manhole
Tulsa	S20402	3/31/2006	8,190	Grease	C & D	Cleared	Manhole
Tulsa	S20402	4/7/2006	672	Grease	C & D	Cleared	Manhole
Tulsa	S20402	4/20/2006	2,895	Grease	C & D	Cleared	Manhole
Tulsa	S20402	4/22/2006	11,580	Vandalism	C & D	Cleared	Manhole
Tulsa	S20402	4/24/2006	230	Roots	C & D	Cleared	
Tulsa	S20402	5/1/2006	7,264	Broken Main	Cleaning	Repair	Pipe
Tulsa	S20402	5/5/2006	896	Grease	C & D	Cleared	
Tulsa	S20402	5/12/2006		Debris	Cleaned By Resident	CLEARED	
Tulsa	S20402	5/22/2006		Construction Work	Cleaned By Owner	Counseled Contractor	Manhole
Tulsa	S20402	5/24/2006		Grease	C & D	Cleared	
Tulsa	S20402	6/7/2006		Debris	Cleaned By Owner	CLEARED	
Tulsa	S20402	6/7/2006	5,010	Debris	C & D	Cleared	Manhole
Tulsa	S20402	6/13/2006	2.8	Roots	Cleaned	Cleared	
Tulsa	S20402	6/14/2006	2,895	Roots	Cleaned	Cleared	Manhole
Tulsa	S20402	6/17/2006		Construction Work	Cleaned	Monitored Line	
Tulsa	S20402	6/17/2006		Construction Work	Cleaned	Monitored	
Tulsa	S20402	6/22/2006	2,992	Rain	C & D	Monitored	
Tulsa	S20402	6/22/2006		Rain	C & D	Monitored Line	
Tulsa	S20402	6/23/2006		Rain	Cleaned	Monitored Line	
Tulsa	S20402	6/23/2006		Rain	Cleaned	Monitored Line	
Tulsa	S20402	7/10/2006		Grease	Cleaned	Cleared	
Tulsa	S20402	7/14/2006	1,920	Grease	C & D	Cleared	
Tulsa	S20402	7/20/2006	249.3	Grease	Cleaned	Cleared	
Tulsa	S20402	7/20/2006		Grease	Cleaned	Cleared	
Tulsa	S20402	7/28/2006	552	Debris	C & D	Cleared	Manhole
Tulsa	S20402	7/28/2006	2,832	Defective	C & D	Cleared	Manhole
Tulsa	S20402	7/28/2006		Defective Manhole	Cleaned	Cleared	Manhole
Tulsa	S20402	8/12/2006	322	Debris	C & D	Cleared	
Tulsa	S20402	8/24/2006		Grease	C & D	Cleared	
Tulsa	S20402	8/25/2006	368	Debris	Cleaning	Cleared	
Tulsa	S20402	8/25/2006	12,558	Debris	Cleaning	Cleared	Manhole
Tulsa	S20402	8/25/2006	12,558	Debris	Cleaned	Cleared	Manhole
Tulsa	S20402	9/12/2006		Schedule Cleaning	C & D	Cleared	
Tulsa	S20402	9/13/2006	112	Grease	C & D	Cleared	
Tulsa	S20402	10/3/2006	632	Grease	C & D	Cleared	
Tulsa	S20402	10/6/2006	3,375	Grease	C & D	Cleared	

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa	S20402	10/12/2006	12.46	Grease	Cleaned	Cleared	
Tulsa	S20402	10/17/2006		Roots	C & D	Cleared	
Tulsa	S20402	10/19/2006		Grease	C & D	Cleared	Pipe
Tulsa	S20402	10/24/2006	4,320	Root	C & D	Cleared	Manhole
Tulsa	S20402	11/8/2006	2,895	Grease	C & D	Cleared	Manhole
Tulsa	S20402	11/10/2006		Root	Cleaned	Cleared	
Tulsa	S20402	11/14/2006	152	Debris	Flushed & Deoderized	Cleared	Pipe
Tulsa	S20402	11/19/2006	2,393	Root	Cleaned	Cleared	
Tulsa	S20402	11/20/2006	2,895	Grease	C & D	Cleared	Manhole
Tulsa	S20402	11/30/2006		Vandalism	Cleaned	Cleared	
Tulsa	S20402	12/4/2006	1,392	Grease	C & D	Cleared	Manhole
Tulsa	S20402	12/6/2006	672	Roots	C & D	Cleared	Manhole
Tulsa	S20402	12/12/2006	1,000	Malfunction		REPAIR	CLARIFIER
Tulsa	S20402	12/13/2006		Roots	Cleaned	Cleared	
Tulsa	S20402	12/13/2006		Roots	Cleaned	Cleared	
Tulsa	S20402	12/18/2006	4,080	Roots	C & D	Cleared	Manhole
Tulsa	S20402	12/25/2006	152	Root	Cleaned	Cleared	
Tulsa	S20402	12/30/2006	480	Roots	C & D	Cleared	
Tulsa	S20402	1/1/2007	480	Grease	C & D	Cleared	Manhole
Tulsa	S20402	1/1/2007	80	Grease	C & D	Cleared	
Tulsa	S20402	1/2/2007	230	Grease	C & D	Cleared	
Tulsa	S20402	1/7/2007	5,790	Grease	C & D	Cleared	Manhole
Tulsa	S20402	1/11/2007		Debris	C & D	Cleared	
Tulsa	S20402	1/11/2007	111.89	Debris	Cleaned	Cleared	
Tulsa	S20402	1/11/2007	405.4	Debris	Cleaned	Cleared	
Tulsa	S20402	1/24/2007		Debris	Cleaned	Cleared	
Tulsa	S20402	1/29/2007		Roots	Cleaned	Cleared	
Tulsa	S20402	1/30/2007		Broken Main	C & D	Cleared	
Tulsa	S20402	2/3/2007		Root	Cleaned	Cleared	
Tulsa	S20402	2/4/2007		Grease	Cleaned	Cleared	
Tulsa	S20402	2/10/2007	240	Root	C & D	Cleared	
Tulsa	S20402	2/23/2007	240	Roots	C & D	Cleared	
Tulsa	S20402	2/23/2007	255	Roots	C & D	Cleared	Manhole
Tulsa	S20402	2/28/2007		Broken Main	C & D	Cleared	
Tulsa	S20402	3/2/2007	12,672	Broken Main	Cleaning	Repaired Line	Manhole
Tulsa	S20402	3/17/2007	240	Root	C & D	Cleared	Manhole
Tulsa	S20402	3/19/2007		Vandalism	C & D	Cleared	Manhole
Tulsa	S20402	3/29/2007	1,930	Root	C & D	Cleared	Manhole
Tulsa	S20402	3/29/2007	2,730	Root	C & D	Cleared	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa	S20402	3/30/2007	12,285	Root	C & D	Cleared	Manhole
Tulsa	S20402	3/30/2007		Root	Cleaned	Cleared	
Tulsa	S20402	3/31/2007	80	Grease	C & D	Cleared	
Tulsa	S20402	4/13/2007		Malfunction			Digester
Tulsa	S20402	4/24/2007	32,640	Grease	C & D	Cleared	Manhole
Tulsa	S20402	4/26/2007	1,776	Root	Cleaned	Cleared	
Tulsa	S20402	4/27/2007	3,315	Broken Main	Cleaning	Repair	Pipe
Tulsa	S20402	5/3/2007		Root	Cleaned	Cleared	
Tulsa	S20402	5/3/2007	37,442	Rain	Clean	Monitor	Manhole
Tulsa	S20402	5/4/2007	480	Root	C & D	Cleared	Manhole
Tulsa	S20402	5/7/2007		Rain	Cleaned	Monitored	
Tulsa	S20402	5/7/2007	2,244	Rain	Cleaned	Monitored	
Tulsa	S20402	5/7/2007	78.56	Rain	Cleaned	Monitored	
Tulsa	S20402	5/8/2007	5,000	Rain			
Tulsa	S20402	5/8/2007	32	Rain	Clean		Manhole
Tulsa	S20402	5/8/2007		Grease	Clean		
Tulsa	S20402	5/9/2007		Rain	Cleaned	Monitored	Manhole
Tulsa	S20402	5/9/2007		Rain	Cleaned	Monitored	Manhole
Tulsa	S20402	5/9/2007	3,822	Broken Main	C & D	Cleared	Manhole
Tulsa	S20402	5/9/2007		Rain	Cleaned	Monitored	Manhole
Tulsa	S20402	5/12/2007		Debris	C & D	Cleared	Manhole
Tulsa	S20402	5/14/2007		Cleaning Crew	Cleaned	Investigation	
Tulsa	S20402	5/14/2007		Debris	C & D	Cleared	Manhole
Tulsa	S20402	5/15/2007		Broken Main	Cleaned	Repair	
Tulsa	S20402	5/26/2007		Debris	Cleaned	Cleared	
Tulsa	S20402	5/30/2007		Broken Main	C & D	Cleaning Crew	Pipe
Tulsa	S20402	6/1/2007	8,106	Grease	C & D	Cleared	Manhole
Tulsa	S20402	6/5/2007	800	Root	C & D	Cleared	
Tulsa	S20402	6/5/2007		Cleaning Crew	Cleaned	Monitored	
Tulsa	S20402	6/12/2007	10,920	Rain	Cleaning	Monitor	Manhole
Tulsa	S20402	6/17/2007	5,344	Grease	C & D	Cleared	Manhole
Tulsa	S20402	6/20/2007		Rain	Cleaned	Monitored	
Tulsa	S20402	6/20/2007	26,544	Rain	Cleaned	Monitored	
Tulsa	S20402	6/20/2007	135,408	Rain	Clean	Monitored	Manhole
Tulsa	S20402	6/20/2007	750	Roots	C & D	Cleared	
Tulsa	S20402	6/20/2007		Roots	C & D	Cleared	
Tulsa	S20402	6/20/2007		Rain	C & D	Monitored	
Tulsa	S20402	6/20/2007	25,200	Rain	Clean	Monitored	Manhole
Tulsa	S20402	6/20/2007	25,200	Rain	Cleaned	Monitored	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa	S20402	6/27/2007		Rain	Clean	Monitor	
Tulsa	S20402	6/27/2007	165,165	Rain	Cleaned	Monitor	Manhole
Tulsa	S20402	6/27/2007	104,060	Rain	Cleaned	Monitor	Manhole
Tulsa	S20402	6/27/2007	43,425	Rain	Cleaned	Monitor	Manhole
Tulsa	S20402	6/27/2007		Rain	F & D	Monitor	
Tulsa	S20402	6/28/2007	337,006	Rain	Clean	Monitor	Manhole
Tulsa	S20402	7/13/2007	12,285	Broken Main	C & D	Cleared	Manhole
Tulsa	S20402	7/19/2007	200	Overflow	Cleaned		Digester
Tulsa	S20402	7/19/2007		Broken Main	Cleaned	Repair	
Tulsa	S20402	7/27/2007	200,000.00	Broken Main	Cleaned		Pipe
Tulsa	S20402	7/30/2007	22,300	Broken Main	Cleaning	Repaired	
Tulsa	S20402	8/1/2007		Root	C & D	Cleared	
Tulsa	S20402	8/16/2007		Grease	Cleaned	Cleared	
Tulsa	S20402	9/8/2007		Rain			
Tulsa	S20402	9/9/2007		Rain	Cleaning	Monitored	
Tulsa	S20402	9/10/2007		Rain	Cleaned	Monitored	
Tulsa	S20402	9/13/2007		Debris	Cleaned	Cleared	
Tulsa	S20402	9/17/2007	8,878	Grease	C & D	Cleared	Manhole
Tulsa	S20402	9/17/2007	15,364	Grease	C & D	Cleared	Manhole
Tulsa	S20402	9/17/2007		Roots	C & D	Cleared	
Tulsa	S20402	9/23/2007	685.67	Broken Main	Cleaned	Cleared	
Tulsa	S20402	9/26/2007		Broken Main	C & D	Cleared	
Tulsa	S20402	9/29/2007		Grease	Cleaned	Cleared	
Tulsa	S20402	10/3/2007	476	Root	C & D	Cleared	
Tulsa	S20402	10/11/2007		Roots	C & D	Cleared	
Tulsa	S20402	10/11/2007		Roots	C & D	Cleared	
Tulsa	S20402	10/13/2007	105.97	Root	Cleaned	Cleared	
Tulsa	S20402	10/18/2007		Grease	C & D	Cleared	
Tulsa	S20402	10/21/2007		Root	Cleaned	Cleared	
Tulsa	S20402	11/6/2007	5,385	Broken Main	Cleaned	Investigate	
Tulsa	S20402	11/7/2007		Broken Main	Cleaned	Repair	
Tulsa	S20402	11/7/2007	897	Broken Main	Cleaned	Repair	
Tulsa	S20402	11/10/2007	2,715	Broken Main	Cleaned	Cleared	
Tulsa	S20402	11/15/2007	1,122	Root	C & S	Cleared	
Tulsa	S20402	11/27/2007		Roots	Cleaned	Cleared	
Tulsa	S20402	12/4/2007	1,200	Root	C & D	Cleared	Manhole
Tulsa	S20402	12/9/2007		Grease	C & D	Cleared	
Tulsa	S20402	12/11/2007	16,653	Debris	C & D	Cleared	Manhole
Tulsa	S20402	12/11/2007	4,200,000.00	Power Loss			Lift Station

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa	S20402	12/12/2007	2,400	Power Failure	C & D	Restore	
Tulsa	S20402	12/12/2007	720,000.00	Power Loss			Lift Station
Tulsa	S20402	12/17/2007		Debris	C & D	Cleared	
Tulsa	S20402	12/31/2007		Broken Main	C & D	Cleared	
Tulsa	S20402	1/1/2008		Root	C & D	Cleared	Manhole
Tulsa	S20402	1/2/2008		Broken Main	C & D	Cleared	
Tulsa	S20402	1/4/2008		Root	Cleaned	Cleared	
Tulsa	S20402	1/7/2008	13,216	Root	C & D	Cleared	Manhole
Tulsa	S20402	1/9/2008	5,983	Broken Main	C & D	Cleared	Manhole
Tulsa	S20402	1/9/2008		Broken Main	Cleaned	Cleared	
Tulsa	S20402	1/10/2008		Root	C & D	Cleared	Manhole
Tulsa	S20402	1/10/2008		Root	Cleaned	Cleared	
Tulsa	S20402	1/11/2008	442	Broken Main	C & D	Repair	Manhole
Tulsa	S20402	1/24/2008		Debris	C & D	Cleared	Manhole
Tulsa	S20402	2/9/2008		Debris	C & D	Cleared	
Tulsa	S20402	2/13/2008	1,000	Debris	C & D	Cleared	
Tulsa	S20402	2/17/2008		Root	C & D	Cleared	
Tulsa	S20402	2/25/2008	4,080	Grease	Cleaned	Cleared	Manhole
Tulsa	S20402	2/26/2008	720	Root	C & D	Cleaned	Manhole
Tulsa	S20402	3/1/2008		Debris	C & D	Cleaned	
Tulsa	S20402	3/1/2008		Debris	C 7 D	Cleaned	
Tulsa	S20402	3/1/2008	240	Debris	C & D	Cleaned	
Tulsa	S20402	3/3/2008	360	Root	C & D	Cleaned	
Tulsa	S20402	3/5/2008		Construction Work	Cleaned By Contractor	Notified Engineer	
Tulsa	S20402	3/5/2008	72,630	Construction Work	Cleaning	Notified Engineer	Manhole
Tulsa	S20402	3/5/2008		Broken Main	C & D	Repair	
Tulsa	S20402	3/11/2008	720	Broken Main	C & D	Repair	
Tulsa	S20402	3/17/2008	360	Debris	C & D	Cleaned	
Tulsa	S20402	3/18/2008		Root	C & D	Cleared	
Tulsa	S20402	3/18/2008	13,200	Broken Main	Cleaning	Repair	Manhole
Tulsa	S20402	3/18/2008	640	Root	C & D	Cleared	
Tulsa	S20402	3/18/2008	12,750	Rain	Cleaning	Monitor	Manhole
Tulsa	S20402	3/18/2008	12,750	Rain	Cleaning	Monitor	Manhole
Tulsa	S20402	3/18/2008	509,520	Rain	Cleaning	Monitor	Manhole
Tulsa	S20402	3/18/2008	42,400	Rain	Cleaning	Monitor	
Tulsa	S20402	3/18/2008	124,248	Rain	Cleaning	Monitor	Manhole
Tulsa	S20402	3/18/2008		Rain	Cleaned	Monitor	
Tulsa	S20402	3/18/2008		Rain	Cleaned	Monitor	
Tulsa	S20402	3/20/2008		Root	Cleaned By Resident	Cleared	

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa	S20402	3/20/2008		Root	C & D	Cleared	Manhole
Tulsa	S20402	3/20/2008		Debris	C & D	Cleared	
Tulsa	S20402	3/20/2008		Rain	C & D	Monitor	Manhole
Tulsa	S20402	3/21/2008	480	Broken Main	C & D	Repair	
Tulsa	S20402	3/21/2008	2,040	Grease	C & D	Cleared	Manhole
Tulsa	S20402	3/22/2008		Debris	C & D	Cleared	Manhole
Tulsa	S20402	3/26/2008		Rain	C & D	Monitor	Manhole
Tulsa	S20402	4/1/2008		Grease Stoppage	Deodorized		
Tulsa	S20402	4/2/2008		Root Stoppage	Cleaned	Cleaned Line	
Tulsa	S20402	4/6/2008	4,095	Root	C & D	Cleared	Manhole
Tulsa	S20402	4/8/2008	196,105	Rain	Clean	Study	Manhole
Tulsa	S20402	4/8/2008	1,870	Rain	Clean	Study	
Tulsa	S20402	4/8/2008		Rain	Cleaned	Study	
Tulsa	S20402	4/8/2008	66,800	Rain	Clean	Study	Manhole
Tulsa	S20402	4/8/2008	146.64	Rain	Cleaned	Study	
Tulsa	S20402	4/8/2008	502,320	Rain	Cleaned	Study	Manhole
Tulsa	S20402	4/8/2008		Rain	Cleaned	Study	Manhole
Tulsa	S20402	4/8/2008		Rain	Cleaned	Study	
Tulsa	S20402	4/8/2008		Rain	Cleaned	Study	
Tulsa	S20402	4/8/2008	54,600	Rain	Cleaned	Study	Manhole
Tulsa	S20402	4/8/2008		Rain	Cleaned	Study	Manhole
Tulsa	S20402	4/8/2008		Rain	Cleaned	Study	Manhole
Tulsa	S20402	4/8/2008	7.48	Rain	Cleaned	Study	
Tulsa	S20402	4/9/2008	139,400	Rain	Follow Up Cleaning	On Going Study	Manhole
Tulsa	S20402	4/9/2008	139,400	Rain	Cleaned	Monitor	Manhole
Tulsa	S20402	4/10/2008	401,310	Rain	Cleaning	Study	Manhole
Tulsa	S20402	4/10/2008		Rain	Cleaned	Study	
Tulsa	S20402	4/10/2008		Rain	Cleaned	Study	
Tulsa	S20402	4/10/2008		Rain	Cleaned	Study	
Tulsa	S20402	4/10/2008		Rain	Cleaned	Study	
Tulsa	S20402	4/10/2008	1,122	Rain	Cleaned	Study	
Tulsa	S20402	4/10/2008	298,185	Rain	Cleaned	Study	Manhole
Tulsa	S20402	4/10/2008		Rain	Cleaned	Study	
Tulsa	S20402	4/10/2008	779.17	Rain	Cleaned	Study	
Tulsa	S20402	4/10/2008	84,375	Rain	Cleaning	Study	
Tulsa	S20402	4/10/2008	556,110	Rain	Cleaning	Study	Manhole
Tulsa	S20402	4/10/2008	14.96	Rain	Cleaned	Study	
Tulsa	S20402	4/10/2008		Rain	C & D	Study	Manhole
Tulsa	S20402	4/11/2008	Unknown	Rain	Cleaned & Deodorized		Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa	S20402	4/14/2008		Rain	C & D	Study	Manhole
Tulsa	S20402	4/19/2008		Debris	C & D	Cleared	
Tulsa	S20402	4/21/2008		Broken Main	C & D	Cleared	
Tulsa	S20402	4/21/2008		Broken Main	C & D	Cleared	
Tulsa	S20402	4/24/2008		Rain	Cleaned	Study	
Tulsa	S20402	4/24/2008		Rain	C & D	Study	
Tulsa	S20402	4/24/2008	120	Broken Main	C & D	Repair	
Tulsa	S20402	4/24/2008		Rain	Cleaned	Study	
Tulsa	S20402	4/25/2008		Construction Work	Cleaned	Pump Area	Manhole
Tulsa	S20402	4/25/2008	690	Broken Main	C & D	Repair	
Tulsa	S20402	4/25/2008	240	Broken Main	C & D	Repair	
Tulsa S.	S20402	5/8/2008	1440	Broken Main	C&D	Schedule Repair	
Tulsa S.	S20402	5/8/2008		Debris Stoppage	Cleaned By Resident	INVESTIGATE	
Tulsa S.	S20402	5/9/2008	4080	Vandalism	C&D	Cleaned Out Mh	Manhole
Tulsa S.	S20402	5/12/2008		Rain	C&D	On Going Study	Manhole
Tulsa S.	S20402	5/24/2008	5,040	Root Stoppage	Cleaned & Deodorized	Cleaned Line	Manhole
Tulsa S.	S20402	5/27/2008		Broken Main	Cleaned	Repair	
Tulsa S.	S20402	5/27/2008		Rain	Cleaned & Deodorized	Refer To Engineering	
Tulsa S.	S20402	5/27/2008	26520	Rain	Cleaned & Deodorized	Refer To Engineering	Manhole
Tulsa S.	S20402	5/27/2008		Rain	Cleaned & Deodorized	Refer To Engineering	Manhole
Tulsa S.	S20402	5/27/2008		Rain	Follow Up Cleaning	Refer To Engineering	
Tulsa S.	S20402	5/27/2008	1930	Debris Stoppage	Cleaned & Deodorized	Cleaned Line	Manhole
Tulsa S.	S20402	5/27/2008		Rain	Cleaned & Deodorized	Refer To Engineering	Manhole
Tulsa S.	S20402	5/28/2008		Rain	Cleaned & Deodorized	Refer To Engineering	Manhole
Tulsa S.	S20402	5/28/2008	2016	Root Stoppage	Cleaned & Deodorized	Cleaned Line	Manhole
Tulsa S.	S20402	5/28/2008		Rain	Cleaned & Deodorized	Refer To Engineering	
Tulsa S.	S20402	5/30/2008	139230	Broken Main	Follow Up Cleaning	Repair Line	
Tulsa S.	S20402	6/1/2008		Rain	Cleaned & Deodorized	Refer To Engineering	
Tulsa S.	S20402	6/1/2008	3400	Rain	Cleaned & Deodorized	Refer To Engineering	Manhole
Tulsa S.	S20402	6/1/2008		Rain	Cleaned By Resident	Refer To Engineering	
Tulsa S.	S20402	6/1/2008		Rain	Follow Up Cleaning	Refer To Engineering	Manhole
Tulsa S.	S20402	6/2/2008		Rain	Cleaned		
Tulsa	S20402	6/2/2008		Rain	C & D	Monitor	Manhole
Tulsa	S20402	6/2/2008	1,000,000.00	Equipment Failure	Cleaning	Cleaned	Manhole
Tulsa S.	S20402	6/3/2008	12,285	Equipment Failure	Cleaned	Repaired	Manhole
Tulsa S.	S20402	6/9/2008	16032	Rain	Follow Up Cleaning	Refer To Engineering	

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa S.	S20402	6/9/2008		Rain			
Tulsa S.	S20402	6/9/2008	2603.04	Rain	Follow Up Cleaning	Refer To Engineering	
Tulsa S.	S20402	6/9/2008		Rain	Follow Up Cleaning	Refer To Engineering	
Tulsa S.	S20402	6/9/2008		Rain	Follow Up Cleaning	Refer To Engineering	
Tulsa S.	S20402	6/9/2008		Rain	Follow Uo Cleaning	Refer To Engineering	
Tulsa S.	S20402	6/9/2008	3740	Rain	Cleaned & Deodorized	Refer To Engineering	
Tulsa S.	S20402	6/9/2008	520560	Rain	Follow Up Cleaning	Refer To Engineering	Manhole
Tulsa S.	S20402	6/9/2008	65.45	Rain	Follow Up Cleaning	Refer To Engineering	
Tulsa S.	S20402	6/9/2008		Rain	Follow Up Cleaning	Refer To Engineering	
Tulsa S.	S20402	6/9/2008		Rain	Follow Up Cleaning	Refer To Engineering	
Tulsa S.	S20402	6/9/2008	478.72	Grease Stoppage	Follow Up Cleaning	Cleaned Line	
Tulsa S.	S20402	6/9/2008	466378	Rain	Follow Up Cleaning	Refer To Engineering	Manhole
Tulsa S.	S20402	6/9/2008	10072	Equipment Failure	Cleaned & Deodorized	Cleaned Equipment	
Tulsa S.	S20402	6/9/2008	216098	Rain	Follow Up Cleaning	Refer To Engineering	Manhole
Tulsa S.	S20402	6/9/2008	26220	Rain	Follow Up Cleaning	Refer To Engineering	
Tulsa S.	S20402	6/9/2008	28290	Rain	Follow Up Cleaning	Refer To Engineering	
Tulsa S.	S20402	6/9/2008	51360	Debris Stoppage	Follow Up Cleaning	Clean Lines	Manhole
Tulsa S.	S20402	6/9/2008		Rain	Follow Up Cleaning	Refer To Engineering	
Tulsa S.	S20402	6/9/2008	48636	Rain	Follow Up Cleaning	Refer To Engineering	Manhole
Tulsa S.	S20402	6/9/2008	304.5	Rain	Follow Up Cleaning	Refer To Engineering	
Tulsa S.	S20402	6/9/2008	16032	Rain	Follow Up Cleaning	Refer To Engineering	
Tulsa S.	S20402	6/9/2008	96693	Rain	Follow Up Cleaning	Refer To Engineering	Manhole
Tulsa S.	S20402	6/9/2008	96693	Rain	Follow Up Cleaning	Refer To Engineering	Manhole
Tulsa S.	S20402	6/9/2008	96693	Rain	Follow Up Cleaning	Refer To Engineering	Manhole
Tulsa S.	S20402	6/9/2008	50566	Rain	Follow Up Cleaning	Refer To Engineering	Manhole
Tulsa S.	S20402	6/9/2008	18000	Rain	Cleaned By Resident	Refer To Engineering	
Tulsa S.	S20402	6/9/2008	141141	Rain	Follow Up Cleaning	Refer Engineering	Manhole
Tulsa S.	S20402	6/9/2008		Rain	Follow Up Cleaning	Refer To Engineering	Manhole
Tulsa S.	S20402	6/9/2008	72520	Rain	Follow Up Cleaning	Refer To Engineering	
Tulsa S.	S20402	6/9/2008	1250000	Rain	Follow Up Cleaning	Refer To Engineering	
Tulsa S.	S20402	6/9/2008	160320	Rain	Follow Up Cleaning	Refer To Engineering	Manhole
Tulsa S.	S20402	6/9/2008		Rain	Follow Up Cleaning	Refer To Engineering	Manhole
Tulsa S.	S20402	6/9/2008	62560	Rain	Follow Up Cleaning	Refer To Engineering	

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa	S20402	6/9/2008	430860	Rain	Follow Up Cleaning	Refer To Engineering	Manhole
Tulsa S.	S20402	6/10/2008	7200	Grease Stoppage	Cleaned & Deodorized	Cleaned Line	Manhole
Tulsa S.	S20402	6/10/2008		Grease Stoppage	Cleaned & Deodorized	Cleaned Line	
Tulsa S.	S20402	6/10/2008	163800	Rain	Follow Up Cleaning	Refer To Engineering	Manhole
Tulsa S.	S20402	6/11/2008		Rain	C & D	Refer To Engineering	Manhole
Tulsa S.	S20402	6/12/2008		Rain	Cleaned & Deodorized	Refer To Engineering	Manhole
Tulsa S.	S20402	6/16/2008	49680	Rain	Follow Up Cleaning	Refer To Engineering	Manhole
Tulsa S.	S20402	6/16/2008		Rain	Cleaned & Deodorized	Refer To Engineering	Manhole
Tulsa S.	S20402	6/16/2008	360	Root Stoppage	Cleaned & Deodorized	Cleaned Line	
Tulsa S.	S20402	6/17/2008		High Flows			
Tulsa S.	S20402	6/18/2008		Rain	Cleaned & Deodorized	Refer To Engineering	Manhole
Tulsa S.	S20402	6/18/2008		Rain	Cleaned & Deodorized	Refer To Engineering	Manhole
Tulsa	S20402	6/25/2008	720	Grease	C & D	Cleaned	Manhole
Tulsa S.	S20402	6/30/2008		Rain	Cleaned & Deodorized	Cleaned Line	Manhole
Tulsa S.	S20402	7/1/2008		Construction Work	Follow Up Cleaning	Secure Discharge Hose	Manhole
Tulsa	S20402	7/11/2008	57,330	Equipment Failure	C & D		Manhole
Tulsa	S20402	7/13/2008	49,665	Equipment Failure	C & D	Refer To SWWTP	Manhole
Tulsa S.	S20402	7/14/2008		Truck Spill	Cleaned		
Tulsa	S20402	7/22/2008	2,160	Grease	C & D	Cleared	Manhole
Tulsa S.	S20402	7/27/2008		Vandalism	Follow Up Cleaning	Repaired Equipment	Pipe
Tulsa	S20402	8/2/2008		Rain	Cleaned	Refer To Engineering	
Tulsa	S20402	8/18/2008	500	Broken Main	Cleaning	Repaired	Pipe
Tulsa	S20402	8/20/2008		Contractor Cleaning	Cleaned	Investigate	
Tulsa	S20402	8/26/2008		Cleaning Crew	Cleaned	Investigate	
Tulsa	S20402	9/5/2008	1,920	Debris	C & D	Cleaned	Manhole
Tulsa S.	S20402	9/9/2008		Debris Stoppage	Cleaned & Deodorized	Cleaned Line	
Tulsa S.	S20402	9/12/2008	46,320	Broken Main	Cleaned & Deodorized	Repaired	
Tulsa S.	S20402	9/14/2008	720	Root Stoppage	C&D	Cleaned Main Line	
Tulsa	S20402	9/23/2008		Equipment Failure	Cleaned	Pulled Plug In Mh	
Tulsa	S20402	10/6/2008		Grease	Cleaned	Cleared	
Tulsa	S20402	10/10/2008	2,004	Grease	C & D	Cleared	Manhole
Tulsa S.	S20402	10/29/2008	1152	Debris Stoppage	Cleaned & Deodorized	Cleaned Line	Manhole
Tulsa	S20402	11/14/2008		Root	Cleaned		
Tulsa S.	S20402	11/25/2008	2720	Root Stoppage	Cleaned & Deodorized	Cleaned Line	Manhole
Tulsa	S20402	12/1/2008	720	Debris	C & D	Cleaned	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa	S20402	12/1/2008	720	Roots	C & D	Cleared	Manhole
Tulsa S.	S20402	12/2/2008	480	Root Stoppage	Cleaned & Deodorized	Cleaned Line	Manhole
Tulsa S.	S20402	12/2/2008	200	Root Stoppage	Cleaned	Cleaned Line	
Tulsa S.	S20402	12/10/2008		Broken Line	Cleaned & Deodorized	Cleaned Line	
Tulsa S.	S20402	12/10/2008		Broken Main	Cleaned & Deodorized	Cleaned Line	
Tulsa	S20402	12/13/2008	240	Debris	C & D	Cleared	Manhole
Tulsa	S20402	12/13/2008		Root	C & D	Cleared	
Tulsa	S20402	12/15/2008		Grease	C & D	Cleared	
Tulsa	S20402	12/18/2008	560	Broken Main	C & D	Schedule Repair	
Tulsa	S20402	12/26/2008		Broken Main	C & D	Repair	Pipe
Tulsa	S20402	12/28/2008		Grease	C & D	Cleaned	Manhole
Tulsa	S20402	1/3/2009		Broken Main	Cleaning	Repair	
Tulsa S.	S20402	1/8/2009		Debris Stoppage	Cleaned & Deodorized	Cleaned Line	Cleanout
Tulsa - S.	S20402	1/8/2009	100	Failed Valve			
Tulsa	S20402	1/10/2009		Debris	C & D	Cleared	Manhole
Tulsa	S20402	1/12/2009		Debris	C & D	Cleared	
Tulsa	S20402	1/30/2009		Debris	Cleaned	Cleared	
Tulsa	S20402	2/2/2009	3,360	Debris	Cleaning	Cleared	Manhole
Tulsa	S20402	2/3/2009		Roots	C & D	Cleared	
Tulsa S.	S20402	2/6/2009		Root Stoppage	Cleaned & Deodorized	Cleaned Line	
Tulsa	S20402	2/17/2009		Broken Main	Cleaning	Repaired Main	Pipe
Tulsa	S20402	2/17/2009	4,185	Broken Main	Cleaning	Repaired	Pipe
Tulsa S.	S20402	3/1/2009	1488	Debris Stoppage	C&D	Cleaned Line	Manhole
Tulsa S.	S20402	3/1/2009		Debris Stoppage	C&D	Cleaned Line	Manhole
Tulsa S.	S20402	3/3/2009	160	Debris Stoppage	C&D	Cleaned Line	
Tulsa S.	S20402	3/9/2009		Debris Stoppage	Cleaned & Deodorized	Cleaned Line	
Tulsa S.	S20402	3/11/2009		Grease Stoppage	Cleaned By Owner	Cleaned Line	
Tulsa	S20402	3/16/2009		Debris	C & D	Cleared	Manhole
Tulsa	S20402	3/24/2009		Grease	C & D	Cleared	
Tulsa	S20402	3/28/2009	8,078	Broken Main	Cleaned	Repair	
Tulsa	S20402	3/28/2009	560	Broken Main	C & D	Repair	
Tulsa	S20402	3/28/2009	650	Grease	C & D	Cleaned	
Tulsa	S20402	3/29/2009	1,350	Broken Main	C & D	Repair	
Tulsa - S.	S20402	3/30/2009	1,100	Scum Pit Overflow			
Tulsa	S20402	3/30/2009	672	Broken Main	C & D	Cleaned	
Tulsa	S20402	3/30/2009	592	Broken Main	C & D		
Tulsa	S20402	4/3/2009	2,880	Debris	C & D	Cleared	Manhole
Tulsa	S20402	4/7/2009	1,000	Spill			Digester

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa	S20402	4/12/2009	1,280	Broken Main	C & D	Set Up Pump	
Tulsa	S20402	4/13/2009	1,104	Debris	C & D	Cleared	Manhole
Tulsa S.	S20402	5/4/2009		Rain	C&D	On Going Study	Manhole
Tulsa S.	S20402	5/6/2009		Rain	C& D	On Going Study	Manhole
Tulsa - S.	S20402	5/13/2009		Grease	C & D	Cleared	Manhole
Tulsa - S.	S20402	5/14/2009		Rain	Cleaned	Remove Plug	
Tulsa - S.	S20402	5/15/2009	2,040	Debris	C & D	Cleared	Manhole
Tulsa - S.	S20402	6/4/2009	240	Roots	C & D	Cleaned	Manhole
Tulsa - S.	S20402	6/26/2009		Construction Work	Cleaned	Cut Outtap	
Tulsa - S.	S20402	7/8/2009		Root	C & D	Cleared	Manhole
Tulsa S.	S20402	7/21/2009		Broken Main	C & D	Cleared	
Tulsa - S.	S20402	8/17/2009	2,240	Broken Main	C & D	Repair	Pipe
Tulsa - S.	S20402	8/18/2009	2,880	Broken Main	C & D	Repair	Pipe
Tulsa - S.	S20402	8/20/2009	300	Grit Liquid Spill			
Tulsa - S.	S20402	8/23/2009	200	Spill	Cleaning		Digester
Tulsa - S.	S20402	9/11/2009	1,440	Grease	C & D	Cleared	Manhole
Tulsa - S.	S20402	9/15/2009		Contractor Cleaning	C & D	Investigation	
Tulsa - S.	S20402	9/15/2009		Power Failure	C & D	Restored Power	Lift Station
Tulsa - S.	S20402	9/21/2009		Rain			
Tulsa - S.	S20402	9/21/2009	2,880	Debris	Cleaning	Cleared	Manhole
Tulsa - S.	S20402	9/21/2009	84,045	Rain	Clean	Monitor	Manhole
Tulsa - S.	S20402	9/21/2009	16,380	Power Failure	Clean	Restore	Manhole
Tulsa - S.	S20402	9/21/2009		Rain	Clean	Monitor	
Tulsa - S.	S20402	9/21/2009	13,600	Rain	C & D	Monitor	Manhole
Tulsa - S.	S20402	9/21/2009		Rain	Cleaned	Monitor	
Tulsa - S.	S20402	9/21/2009		Rain	Cleaned	Monitor	
Tulsa - S.	S20402	9/21/2009		Rain	Clean	Monitor	
Tulsa - S.	S20402	9/21/2009		Rain	Clean	Monitor	Manhole
Tulsa - S.	S20402	9/21/2009	214,785	Rain	Clean	Monitor	
Tulsa - S.	S20402	9/22/2009	690,000	Broken Main	Cleaned & Flushed		Pipe
Tulsa - S.	S20402	9/22/2009		Rain	C & D	Monitor	
Tulsa - S.	S20402	9/22/2009	34,500	Broken Main	Cleaning		Pipe
Tulsa - S.	S20402	9/23/2009	112	Broken Main	C & D	Cleared	
Tulsa - S.	S20402	9/23/2009	238	Broken Main	C & D	Cleared	Manhole
Tulsa - S.	S20402	9/23/2009		Rain	W & D	Monitor	
Tulsa - S.	S20402	9/29/2009		Rain	C & D	Monitor	
Tulsa - S.	S20402	10/4/2009	5,760	Broken Main	Cleaning	Cleared	Pipe
Tulsa - S.	S20402	10/5/2009	7.104	Broken Main	Cleaning	Repair	Pipe
Tulsa - S.	S20402	10/26/2009		Overflow			

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa - S.	S20402	10/29/2009	8,160	Rain	Cleaning	Monitor	Manhole
Tulsa - S.	S20402	10/29/2009		Rain	Cleaning	Monitor	Manhole
Tulsa - S.	S20402	10/29/2009		Rain	Cleaned	Monitor	
Tulsa - S.	S20402	10/30/2009		Rain	C & D	Monitor	Manhole
Tulsa - S.	S20402	11/1/2009		Rain	C & D	Monitor	
Tulsa - S.	S20402	11/5/2009	300	Sludge From Backwash	Cleaned		
Tulsa - S.	S20402	11/8/2009		Debris	Cleaned	Cleared	
Tulsa - S.	S20402	12/26/2009	2,400	Debris	C & D	Cleared	Manhole
Tulsa - S.	S20402	12/28/2009	75	Root	C & D	Cleaned	
Tulsa - S.	S20402	1/5/2010	320	Grease	C & D	Cleared	
Tulsa - S.	S20402	1/5/2010	1,920	Grease	C & D	Cleared	Manhole
Tulsa - S.	S20402	1/11/2010	4,473.04	Broken Main	C & D	Cleared	
Tulsa - S.	S20402	1/16/2010		Root	C & D	Cleared	
Tulsa - S.	S20402	1/17/2010		Root	C & D	Cleared	Manhole
Tulsa - S.	S20402	1/21/2010	3,555	Grease	C & D	Cleared	
Tulsa - S.	S20402	2/4/2010		Broken Main	Cleaned		
Tulsa - S.	S20402	2/5/2010	1,610	Grease	C & D	Cleared	
Tulsa - S.	S20402	2/5/2010	9,555	Grease	C & D	Cleared	Manhole
Tulsa - S.	S20402	2/9/2010		Roots	C & D	Cleared	Manhole
Tulsa - S.	S20402	2/10/2010	16,320	Debris	C & D	Cleared	Manhole
Tulsa - S	S20402	2/22/2010	160	Debris	Cleaned	Cleared	
Tulsa - S.	S20402	2/25/2010	2,730	Grease	C & D	Cleaned	Manhole
Tulsa - S.	S20402	3/2/2010	5,790	Cleaning Crew	C & D	Cleared	Manhole
Tulsa - S.	S20402	3/25/2010	1,152	Grease	C & D	Cleared	
Tulsa - S.	S20402	4/9/2010	249.33	Broken Main	Cleaning	Cb	
Tulsa - S.	S20402	4/13/2010	720	Grease	C & D	Cleared	Manhole
Tulsa - S.	S20402	4/23/2010	200	Sludge			
Tulsa - S.	S20402	5/15/2010		Grease	C & D	Cleared	
Tulsa - S	S20402	5/20/2010		Rain	Cleaning	Monitored	
Tulsa - S	S20402	5/21/2010		Rain	C & D	Cleared	
Tulsa - S	S20402	5/21/2010		Rain	C & D	Monitored	Manhole
Tulsa - S	S20402	5/22/2010	960	Grease	C & D	Cleared	Manhole
Tulsa - S	S20402	5/24/2010		Rain	C & D	Cleared	Manhole
Tulsa - S	S20402	6/4/2010		Grease	Cleaned	Cleared	
Tulsa - S	S20402	6/8/2010		Grease	Cleaned	Cleared	
Tulsa - S	S20402	6/14/2010	52,440	Rain	Cleaning	Study	Manhole
Tulsa - S	S20402	6/14/2010		Rain	Cleaning	Study	
Tulsa - S	S20402	6/16/2010		Roots	C & D	Cleared	
Tulsa - S	S20402	6/19/2010		Rain	C & D	Study	

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa - S	S20402	6/21/2010		Rain	C & D	Study	Manhole
Tulsa - S	S20402	6/22/2010		Roots	C & D	Cleared	Manhole
Tulsa - S	S20402	7/6/2010		Root	C & D	Cleared	
Tulsa - S	S20402	7/8/2010	111,890	Rain	Cleaning	Study	Manhole
Tulsa - S	S20402	7/8/2010		Rain	C & D	Study	
Tulsa - S	S20402	7/8/2010	44,390	Rain	Cleaned	Study	Manhole
Tulsa - S	S20402	7/8/2010	86,172	Rain	Cleaned	Study	Manhole
Tulsa - S	S20402	7/9/2010	353,190	Rain	None	Study	Manhole
Tulsa - S	S20402	7/13/2010		Rain	Cleaned	Study	
Tulsa S.	S20402	7/22/2010		Rain Overload	C&D	On Going Study	Manhole
Tulsa - S	S20402	7/30/2010	1,120	Grease	C & D	Cleared	
Tulsa - S	S20402	7/30/2010	6,680	Grease	C & D	Cleared	Manhole
Tulsa - S	S20402	8/2/2010		Root	C & D	Cleared	Manhole
Tulsa - S	S20402	8/6/2010	79,800	Broken Main	Cleaning	Cleared	Pipe
Tulsa - S	S20402	8/9/2010	67,200	Broken Pipe	Deoderized	Cleared	Pipe
Tulsa - S	S20402	8/10/2010	42,000	Broken Pipe	Cleaned	Repair	Pipe
Tulsa - S.	S20402	8/19/2010		Grease	C & D	Cleared	
Tulsa - S.	S20402	8/23/2010		Debris	C & D	Cleared	
Tulsa - S	S20402	9/2/2010	595	Grease	C & D	Cleared	Manhole
Tulsa - S	S20402	9/2/2010	765	Grease	C & D	Cleared	Manhole
Tulsa - S.	S20402	9/9/2010					
Tulsa - S	S20402	10/9/2010		Debris	C & D	Cleared	
Tulsa - S	S20402	10/18/2010		Vandalism	Cleaned	Cleared	
Tulsa - S	S20402	10/18/2010		Vandalism	Cleaned	Cleared	
Tulsa - S	S20402	10/20/2010		Grease	Cleaned	Cleared	
Tulsa - S	S20402	10/20/2010	5,790	Grease	C & D	Cleared	Manhole
Tulsa - S	S20402	10/28/2010	1,920	Debris	C & D	Cleared	Manhole
Tulsa - S	S20402	11/6/2010	480	Broken Main	C & S	Flushed	Pipe
Tulsa - S.	S20402	11/15/2010	1,365	Broken Main	Cleaned	Flushed	Pipe
Tulsa - S	S20402	11/23/2010					DIGESTER
Tulsa - S	S20402	11/24/2010	7,720	Debris	C & D	Cleared	Manhole
Tulsa - S	S20402	12/1/2010		Root	C & D	Cleared	
Tulsa - S	S20402	12/9/2010	24,570	Root	C & D	Cleared	Manhole
Tulsa - S	S20402	12/16/2010	9,600	Grease	Cleaned	Cleared	
Tulsa - S	S20402	12/16/2010	1,920	Grease	C & D	Cleared	
Tulsa - S	S20402	12/24/2010	3,360	Debris	Cleaned	Cleared	
Tulsa - S	S20402	12/25/2010	5,790	Root	C & D	Cleared	Manhole
Tulsa - S	S20402	1/6/2011	200	Vandalism	C & D	Cleared	
Tulsa - S	S20402	1/7/2011		Broken Main	C & D	Cleared	Pipe

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa - S	S20402	1/10/2011		Debris	C & D	Cleared	
Tulsa - S	S20402	1/11/2011		Debris	C & D	Cleared	
Tulsa - S	S20402	1/14/2011	2,160	Grease	Cleaned	Cleared	Manhole
Tulsa - S	S20402	1/18/2011		Root	C & D	Cleared	
Tulsa - S	S20402	1/21/2011	1,320	Broken Main	Cleaned	Repair	Pipe
Tulsa - S	S20402	1/22/2011	4,304	Grease	C & D	Cleared	
Tulsa - S	S20402	1/23/2011	720	Grease	C & D	Cleared	Manhole
Tulsa - S	S20402	1/24/2011	320	Root	C & D	Cleared	
Tulsa - S	S20402	1/24/2011	240	Grease	C & D	Cleared	Manhole
Tulsa - S	S20402	1/28/2011	1,994	Root	Cleaned	Cleared	
Tulsa - S	S20402	2/10/2011	6,358	Debris	Cleaned	Cleared	
Tulsa - S	S20402	2/13/2011		Grease	Cleaned	Cleared	
Tulsa - S.	S20402	2/24/2011	9,000	Construction			
Tulsa - S	S20402	2/24/2011		Contractor Error			
Tulsa - S.	S20402	2/26/2011		Roots	C & D	Cleared	
Tulsa - S.	S20402	3/3/2011		Roots	Cleaning	Cleared	
Tulsa - S.	S20402	3/5/2011	6,750	Grease	C & D	Cleared	
Tulsa - S	S20402	3/11/2011		Grease	C & D	Cleared	Manhole
Tulsa - S	S20402	3/18/2011	720	Grease Stoppage	C&D	Cleaned Line	
Tulsa - S	S20402	3/18/2011	1440	Grease Stoppage	C&D	Cleaned Line	Manhole
Tulsa - S	S20402	3/18/2011	Unknown	Grease Stoppage	C&D	Cleaned Line	Manhole
Tulsa - S	S20402	3/18/2011	480	Grease Stoppage	C&D	Cleaned Line	Manhole
Tulsa - S	S20402	3/18/2011	720	Grease	C & D	Cleared	
Tulsa - S	S20402	3/18/2011	1,440	Grease	C & D	Cleared	Manhole
Tulsa - S	S20402	3/18/2011		Grease	C & D	Cleared	Manhole
Tulsa - S	S20402	3/18/2011	480	Grease	C & D	Cleared	Manhole
Tulsa - S	S20402	3/20/2011	120	Debris Stoppage	C&D	Cleaned Line	
Tulsa - S	S20402	3/20/2011	120	Debris	C & D	Cleared	
Tulsa - S.	S20402	3/24/2011					
Tulsa - S	S20402	3/24/2011	2,160	Debris	Cleaning	Cleared	Manhole
Tulsa - S	S20402	3/25/2011	2,880	Broken Main	Cleaning	Repair	Manhole
Tulsa - S.	S20402	3/31/2011		Debris	C & D	Cleared	Manhole
Tulsa - S	S20402	3/31/2011		Debris	C & D	Cleared	Manhole
Tulsa - S	S20402	4/6/2011		Grease	C & D	Cleared	
Tulsa - S.	S20402	4/12/2011	36,800	Broken Main	C & D	Cleared	Pipe
Tulsa - S	S20402	4/25/2011	1,440	Rain	Cleaned	Study	
Tulsa - S	S20402	4/25/2011	1462.34	Rain	Cleaned	Study	
Tulsa - S	S20402	4/25/2011	1,200	Rain	C & D	Study	Manhole
Tulsa - S	S20402	4/25/2011	1,200	Rain	C & D	Study	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa - S	S20402	4/26/2011		Grease	C & D	Cleared	
Tulsa - S	S20402	4/26/2011		Roots	Cleaned	Cleared	
Tulsa - S	S20402	4/28/2011	4,095	Grease	C & D	Cleared	Manhole
Tulsa - S	S20402	4/28/2011		Debris	Cleaned	Cleared	
Tulsa - S.	S20402	5/3/2011	690	Root	C & D	Cleared	
Tulsa - S.	S20402	5/5/2011	2,304	Grease	C & D	Cleared	Manhole
Tulsa - S	S20402	5/17/2011	289	Grease	C & D	Cleared	Manhole
Tulsa - S	S20402	5/17/2011	289	Grease	C & D	Cleared	Manhole
Tulsa - S	S20402	6/7/2011	81,000	Construction	None		Clarifier
Tulsa - S	S20402	6/11/2011	5,490	Construction Work	Cleaning	Reconnect Service	
Tulsa - S	S20402	6/13/2011	7,920	Broken Main	Diluted By Creek	Repair	Pipe
Tulsa - S	S20402	6/21/2011	120	Grease	C & D	Cleared	
Tulsa - S	S20402	6/21/2011	720	Grease	C & D	Cleared	Manhole
Tulsa - S	S20402	6/26/2011	500	Broken Main	Cleaning	Repaired Line	Pipe
Tulsa - S	S20402	6/27/2011	500	Broken Main	Cleaning	Repaired Line	Pipe
Tulsa - S	S20402	7/2/2011	960	Grease	C & D	Cleared	
Tulsa - S	S20402	7/12/2011		Broken Main	Cleaning	Repaired	
Tulsa - S	S20402	7/12/2011		Broken Main	Cleaning	Repaired	
Tulsa - S	S20402	7/28/2011	240	Root	Flushed & Deoderized	Cleared	
Tulsa - S	S20402	7/31/2011	1,440	Roots	Flushed & Deodorized	Cleaned	Manhole
Tulsa - S	S20402	7/31/2011		Root	C & D	Cleared	
Tulsa - S	S20402	8/3/2011		Debris	Cleaned By Resident	Cleared	
Tulsa - S	S20402	8/11/2011		Construction Work	Cleaning	Cleared	
Tulsa - S	S20402	8/15/2011		Debris	C & D	Cleared	Manhole
Tulsa - S	S20402	8/19/2011		Debris	Cleaned	Cleared	
Tulsa - S	S20402	8/20/2011		Debris	Cleaned	Cleared	
Tulsa - S	S20402	8/20/2011	25,920	Debris	C & D	Cleared	Manhole
Tulsa - S	S20402	8/20/2011	25,920	Debris	Cleaned Basement	Cleaned	Manhole
Tulsa - S	S20402	9/8/2011	1,920	Broken Main	Cleaning	Repair Line	Pipe
Tulsa - S	S20402	9/13/2011		Debris	C & D	Cleared	
Tulsa - S	S20402	10/3/2011		Broken Main	Cleaning	Cleaned	Pipe
Tulsa - S	S20402	10/4/2011	1,296	Debris	C & D	Cleared	Manhole
Tulsa - S	S20402	10/6/2011	912	Debris	C & D	Cleared	Manhole
Tulsa - S	S20402	10/28/2011	480	Root	C & D	Cleared	
Tulsa - S	S20402	11/16/2011		Debris	C & D	Cleared	Manhole
Tulsa - S	S20402	12/8/2011		Root	C & D	Cleared	
Tulsa - S	S20402	12/11/2011	480	Root	C & D	Cleared	
Tulsa - S	S20402	12/24/2011	1440	Root Stoppage	C&D	Cleaned Line	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Tulsa - S	S20402	12/26/2011	299	Root Stoppage	C & D	Cleaned Line	
Tulsa - S	S20402	1/6/2012		Root	C & D	Cleared	
Tulsa - S	S20402	1/10/2012	5,760	Root	C & D	Cleared	Manhole
Tulsa - S	S20402	1/10/2012	960	Roots	C & D	Cleared	
Tulsa - S	S20402	1/10/2012		Roots	C & D	Cleared	
Tulsa - S	S20402	1/12/2012	2,040	Grease	C & D	Cleared	Manhole
Tulsa - S	S20402	1/13/2012	2,856	Root	C & D	Cleared	Manhole
Tulsa - S	S20402	1/15/2012		Root	C & D	Cleared	
Jenks	S20403	12/12/2006		Contractor Hit MH		REPAIRS	Manhole
Jenks	S20403	3/19/2008	1,000	Damaged Pipe	C & D	Repair	Manhole
Jenks	S20403	2/6/2009	2,500	Pipe Filling Failed	Disinfect	Repair Pipe	Pipe
Jenks	S20403	12/27/2009	1000000	Collapsed Line	HTH	New Construction	Lift Station
Jenks	S20403	6/29/2010	2,000	Pump Failure	C & D	New Pumps Ordered	Lift Station
Jenks	S20403	7/11/2010	5,000	Collapsed Line	Cleaned		Manhole
Jenks	S20403	7/16/2010	50,000	Broken Main	C & D	To Repair	Pipe
Jenks	S20403	10/21/2010		Lift Station Clogged	C & S	Reset Pumps	Manhole
Jenks	S20403	11/7/2010		Lift Station Down	C & S	Pumped Back	Manhole
Jenks	S20403	1/24/2011	2,000	L.S. Down	W & D	Replaced Pump	Lift Station
Jenks	S20403	2/24/2011	700	Rain	Bleached	Manually Turn On Pumps	Manhole
Jenks	S20403	2/27/2011	5,000	Busted Main	Cleaned	Repair	Pipe
Jenks	S20403	5/9/2011	1,700	Power Failure	Diluting	Restore	Lift Station
Jenks	S20403	7/5/2011	200	Rags & Wipes	C & S	Cleared	Lift Station
Jenks	S20403	8/30/2011	2,500	Power Failure	Flushing	Repair	Manhole
Jenks	S20403	10/5/2011	150	Toilet Paper & Grease	C & D	Jet Rodded	Manhole
Jenks	S20403	11/14/2011	2,000	Power Surge @ L.S.	Treated	Reset Breaker	Manhole
Jenks	S20403	1/5/2012	55	Overflow	Limed	Monitoring Closely	Drying Beds
Jenks	S20403	2/4/2012	75	Blockage	Treated	Pumped	Manhole
Jenks	S20403	2/9/2012	75	L.S. Malfunction	C & D	Repair	Manhole
Bixby - S	S20407	4/20/2005	30	Electrical Problem	Limed	Replaced & Repair	Lift Station
Bixby - S	S20407	1/3/2006	150	Pump Failure	C & D	Repair	Lift Station
Bixby - S	S20407	1/7/2006	50	L.S. Malfunction	Disinfect	Repaired	Lift Station
Bixby - S	S20407	1/19/2006	50	Grease	C & S	Jetted	
Bixby - S	S20407	9/25/2006	800	Malfunction	Disinfect	Reset	Lift Station
Bixby - S	S20407	2/24/2007		Rags	Limed	Jetted	Manhole
Bixby - S	S20407	5/4/2007	300	L.S. Down	C & D	Restore	Manhole
Bixby - S	S20407	6/1/2007		Pumps Failure		Repair	Lift Station
Bixby - S	S20407	6/23/2007	10	Lift Station Malfunction	C & D	Repaired	Lift Station
Bixby - S	S20407	10/30/2007	500	Ruptured Main	C & D	Repair	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Bixby - S	S20407	11/2/2007	30	Contractor Error	C & D	Remarked Lines	
Bixby - S	S20407	11/27/2007	20	Defective Coupling On Main	C & D	Replaced	Manhole
Bixby - S	S20407	12/8/2007	30	Pump Failure	C & D	Cleaned	Lift Station
Bixby - S	S20407	12/12/2007		Ice Storm	C & D	Generator	Lift Station
Bixby - S	S20407	12/12/2007	100	Ice Storm	C & D	Generator	Lift Station
Bixby - S	S20407	12/16/2007	800	Ice Storm	C & D	Replaced Heaters	Lift Station
Bixby - S	S20407	4/23/2008	55	Blockage	C & D	Jetted	Manhole
Bixby - S	S20407	10/30/2008		Roots	C & D	Removed	
Bixby - S	S20407	12/23/2008	500	Hit By Contractors	C & D	Remarked Main	
Bixby - S	S20407	6/10/2009	200	Contractor Error	C & D	Updated Maps	Pipe
Bixby - S	S20407	6/11/2009	300	Pump Failure	C & D	Reset Pump	Lift Station
Bixby - S	S20407	7/13/2009	60	Constructor Error	C & D		Pipe
Bixby - S	S20407	9/4/2009		Vehicle Accident	C & D	Removed Arv	
Bixby - S	S20407	1/15/2010	25	Blockage	C & D	Jetted	Pipe
Bixby - S	S20407	2/16/2010	50	Lift Station Down	C & D	Repairs	Manhole
Bixby - S	S20407	6/12/2010		Pumps Clogged With Rags	Disinfect	Cleared	Manhole
Bixby - S	S20407	6/18/2010	500	Blown Breaker	Sanitary Spray	Replace Breaker	
Bixby - S	S20407	7/10/2010	300	Broken Sewer Tap	C & D	Cap Tap	Pipe
Bixby - S	S20407	7/13/2010	150	Clogged Valve	C & D	Cleared Valve	Manhole
Bixby - S	S20407	7/13/2010		Pump Clogged With Rags	C & D	Cleared	Manhole
Bixby - S	S20407	10/26/2010	100	Power Outage	C & D	Reset Power	Manhole
Glenpool	S20430	2/20/2005	250	Grease	C & S	Rodded	Manhole
Glenpool	S20430	5/9/2005	200	Blockage	Limed	Remove	Manhole
Glenpool	S20430	7/25/2005	500	Electrical Problems	Limed		Manhole
Glenpool	S20430	8/3/2005	200	Grease	Limed	Rodded	
Glenpool	S20430	10/10/2005	250	L.S. Down	C & S	Repair	Manhole
Glenpool	S20430	12/17/2005	720	Roots & Grease	C & S	Rodded	Manhole
Glenpool	S20430	10/11/2006	100	Roots	Limed	Flushed	Manhole
Glenpool	S20430	4/16/2007	200	Pump Tripped	Limed	Reset	Lift Station
Glenpool	S20430	5/7/2007		Rain	Pumped To Lagoon		Lift Station
Glenpool	S20430	6/1/2007	200	Power Outage	Lime	Restore	Lift Station
Glenpool	S20430	12/10/2007		Power Outage			Lift Station
Glenpool	S20430	12/10/2007		Power Outage	Limed	Talked To Power Company	Lift Station
Glenpool	S20430	1/2/2008		Clogged Screen	Lime	Ordered New Screens	Lift Station
Glenpool	S20430	1/17/2008		Construction Error	Lime	Repairs	Pipe
Glenpool	S20430	12/29/2008		Loss Of Power Due To Storm	Limed Area/Bypass Pump		Lift Station
Glenpool	S20430	3/13/2009	500	Broken Prv	Cleaned W/ Lime & Chlorine	Raise Valve Box Above Grade	Pipe
Glenpool	S20430	5/30/2009	300	Malfunction	C & S	Repairs	Lift Station

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Glenpool	S20430	6/26/2010	100	Grease	Limed	Rodded	Manhole
Glenpool	S20430	9/9/2010	500	Power Outage	C & S	Restore	Lift Station
Glenpool	S20430	9/9/2010	200,000	Pump Failure	C & S	Restore	Head Works
Glenpool	S20430	4/13/2011	400	Grease	Limed	Jet Rodder	Manhole
Glenpool	S20430	7/20/2011	400	Blockage	Limed	Jetted	
Glenpool	S20430	7/21/2011	150	Transformer Malfunction	Limed	Repair	
Glenpool	S20430	11/14/2011	4,000	Grease	Limed	Upgrade System	Manhole
Glenpool	S20430	10/10/2006	100	Paper & Grease	C & D	Cleaned	Manhole
Mounds	S20431	5/17/2002	5,000	Rains	C & S	Line Replacement	Manhole
Mounds	S20431	10/9/2003	8,000	Rain	C & S	Line Repair	Manhole
Mounds	S20431	6/2/2007	2,000	Obstruction	C & S	Shut Off For Repair	
Mounds	S20431	1/3/2008	100	Leaking Line	C & S	Repair	Pipe
Mounds	S20431	3/4/2010	300	Blockage	Sprayed	Replace	Pipe
Bixby - N	S20438	7/21/2006	100	Malfunction	C & D	Restore	Lift Station
Bixby - N	S20438	8/25/2006	500	Plugged Line	C & D	Jetted	
Bixby - N	S20438	3/24/2007	100	L.S. Power Failure	Limed	Restore	Lift Station
Bixby - N	S20438	4/3/2007	1,000	Contractor Error	C & D	Repaired	Manhole
Bixby - N	S20438	5/13/2007	1,000	L.S. Down	Limed	Reset	Lift Station
Bixby - N	S20438	5/14/2007	500	Tripped Breaker	C & D	Reset	Lift Station
Bixby - N	S20438	6/2/2007	1	L.S. Malfunction	C & D	Repair	Lift Station
Bixby - N	S20438	6/5/2007	5	Rags	C & D	Cleared Valve	
Bixby - N	S20438	7/21/2007	500	Plugged Line	C & D	Jetted	Manhole
Bixby - N	S20438	10/3/2007	100	Ruptured Main	C & D	Repair	Manhole
Bixby - N	S20438	10/26/2007	50	Roots	C & D	Jetted	Manhole
Bixby - N	S20438	11/1/2007		Construction	C & D	Repair	Manhole
Bixby - N	S20438	12/12/2007	100	Ice Storm	C & D	Generator	Lift Station
Bixby - N	S20438	12/19/2007	600	Relief Valve Open	C & D	Repairs	
Bixby - N	S20438	1/1/2008	150	Lift Station Down	C & D	Pumped	Manhole
Bixby - N	S20438	1/19/2008		Collapsed Line	C & D	Repair	
Bixby - N	S20438	3/1/2008	50	Blockage	C & D	Jetted	Manhole
Bixby - N	S20438	3/2/2008	200	Grease	C & D	Degreaser	Manhole
Bixby - N	S20438	4/13/2008	100	Pumps Damaged By Lightning	C & D	Replace	
Bixby - N	S20438	6/19/2008	300	Blockage	C & D	Jetted	
Bixby - N	S20438	9/14/2008	500	Power Failure	C & D	Reset	Lift Station
Bixby - N	S20438	10/3/2008	35	Malfunction In Valve	C & D	Cleaned Valve	
Bixby - N	S20438	12/7/2008	300	Debris	C & D	Inspected	
Bixby - N	S20438	12/27/2008		Power Failure	C & D	Reset Pumps	
Bixby - N	S20438	1/13/2009	150	Power Failure	C & D	Reset	Lift Station
Bixby - N	S20438	3/24/2009	100	Plugged Line		Jetted	

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Bixby - N	S20438	4/12/2009	60	Power Failure	C & D	Restore	Lift Station
Bixby - N	S20438	4/19/2009	200	Power Failure	C & D	Restore	Lift Station
Bixby - N	S20438	7/13/2009	70	Control Panel Malfunction	C & D	Install Temp. Shade	Lift Station
Bixby - N	S20438	8/23/2009	150	Power Failure	C & D	Reset Breaker	Manhole
Bixby - N	S20438	8/25/2009	100	Float Switch Defective	C & D	Replaced	Manhole
Bixby - N	S20438	8/30/2009	50	Lift Station Down	C & D	Reset Pumps	Manhole
Bixby - N	S20438	3/24/2010	400	Tree Roots	C & D	Removed	Manhole
Bixby - N	S20438	4/6/2010	300	Grease & Rags	C & D	Jetted	Manhole
Bixby - N	S20438	7/3/2010	150	Tripped Breaker	C & D	Reset	Manhole
Bixby - N	S20438	7/24/2010	250	Malfunction	C & D	Repairs	Lift Station
Bixby - N	S20438	9/20/2010	500	Malfunction	C & D	Repair	
Bixby - N	S20438	1/14/2011	100	Lift Station Down	Disinfect	Reset Pumps	Lift Station
Bixby - N	S20438	3/7/2011	250	Blockage	C & D	Jetted	Manhole
Bixby - N	S20438	3/24/2011	300	Line Blockage	C & D	Jetted	Manhole
Bixby - N	S20438	11/28/2011	100	Power Loss	C & D		Manhole
Bixby - N	S20438	7/21/2006	41	11/28/2011	1.00	1000.00	
Sand Springs	S20457	1/31/2005	30,000	Roots	C & S	Root Cutter	Manhole
Sand Springs	S20457	7/8/2005	10,000	Contractor Error	HTH	Repair Main	
Sand Springs	S20457	8/31/2005	250,000	Grease & Roots	HTH	Root Cut Line	Manhole
Sand Springs	S20457	11/1/2005	100,000	Rocks	C & S	Removed	Manhole
Sand Springs	S20457	3/11/2006	5,000	Pump Failure	C & S	Repairing	Lift Station
Sand Springs	S20457	7/2/2006	25,000	Line Collapsed	HTH	Repairing	
Sand Springs	S20457	1/30/2007	15,000	Root		Rodded	Manhole
Sand Springs	S20457	5/7/2007	180,000	Rain	HTH	Project Started	Manhole
Sand Springs	S20457	5/7/2007	20,000	Rain	HTH		
Sand Springs	S20457	5/7/2007	150,000	Rain	HTH		Manhole
Sand Springs	S20457	5/7/2007	40,000	Rain	HTH	Project	Manhole
Sand Springs	S20457	6/1/2007	100,000	Line Blown	C & S	Talking To Contractor	Manhole
Sand Springs	S20457	7/24/2007	1.2 Mill	Broken Main	HTH	Monitor & Repair	Pipe
Sand Springs	S20457	8/24/2007	10,000	Rags & Debris	HTH	Monitor & Rodded	Manhole
Sand Springs	S20457	12/10/2007	7,500	Ice Storm	HTH	Restore	Lift Station
Sand Springs	S20457	12/10/2007	4,000	Ice Storm	HTH	Restore	Lift Station
Sand Springs	S20457	12/10/2007	2,000	Ice Storm	HTH	Restore	Lift Station
Sand Springs	S20457	12/10/2007	7,500	Ice Storm	HTH	Restore	Lift Station
Sand Springs	S20457	12/10/2007	10,000	Ice Storm	HTH	Restore	Lift Station
Sand Springs	S20457	12/10/2007	35,000	Ice Storm	HTH	Restore	Lift Station

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Sand Springs	S20457	12/11/2007	1,500	Power Loss	HTH	Restore	Lift Station
Sand Springs	S20457	2/26/2008	21,600	Rags & Debris	HTH	Rodded	Manhole
Sand Springs	S20457	4/10/2008	10,000	Rain	Cleaned	Rehab	Manhole
Sand Springs	S20457	6/1/2008	3,200	Rain	HTH	Monitor	Manhole
Sand Springs	S20457	6/1/2008	3,200	Power Outages	HTH	Monitor	Manhole
Sand Springs	S20457	6/1/2008	3,200	Power Outages	HTH	Monitor	Manhole
Sand Springs	S20457	6/1/2008	3,200	Power Outages	HTH	Monitor	Manhole
Sand Springs	S20457	6/15/2008	75,000	Vandalism	HTH	Sealed Lid	Manhole
Sand Springs	S20457	6/15/2008	22,800	Rain	HTH	Monitor	Manhole
Sand Springs	S20457	6/18/2008	18,900	Rains	HTH	Monitor	Manhole
Sand Springs	S20457	9/29/2008	10	Grease	C & S	Rodded	Manhole
Sand Springs	S20457	10/8/2008	64,840	Plug Failed	Rodded	Resealed Plug	Pipe
Sand Springs	S20457	10/27/2008	1,000	Contractor Error		Follow Specific Guidelines	Pipe
Sand Springs	S20457	10/27/2008	1,000	Contractor Error			Pipe
Sand Springs	S20457	12/3/2008	5,000	Grease & Roots	C & S	Rodded	Manhole
Sand Springs	S20457	12/11/2008	30,000	Vandalized Mh	C & D	Secure Mh	Manhole
Sand Springs	S20457	12/17/2008	125	Contractor Error - Pipe Unplugged		Plug Installed	Pipe
Sand Springs	S20457	6/30/2009	350	Preventive Rodded Mh's	C & D	Monitor Mh's	Manhole
Sand Springs	S20457	9/21/2009	300	Rain	C & D	Line Study Project	Manhole
Sand Springs	S20457	9/21/2009	400	Rain	C & D	Inspection	Lift Station
Sand Springs	S20457	9/24/2009	2,620	Line Break	C & D	Monitor Lines	Pipe
Sand Springs	S20457	10/7/2009	340	Collapsed Main	C & D	Replace	Manhole
Sand Springs	S20457	10/29/2009	1,500	Rain	C & D	Line Study Project	Manhole
Sand Springs	S20457	11/20/2009	350	Pipe Break From Erosion	W & D	Repair	Pipe
Sand Springs	S20457	1/30/2010	1,500	Line Collapsed & Roots	W & D	Video & Repair	Manhole
Sand Springs	S20457	2/12/2010	600	Line Break	C & D	Repair	Pipe
Sand Springs	S20457	3/11/2010	600	Grease	W & D	Rodded	Manhole
Sand Springs	S20457	3/16/2010	200	Line Collapsed & Roots	C & D	Rodded	Manhole
Sand Springs	S20457	6/14/2010	4,650	Rain In Rv Park	C & D	Notify Owners Of Rv Park	Lift Station
Sand Springs	S20457	8/2/2010	500	Line Collapsed	C & D	Repair	
Sand Springs	S20457	2/3/2011	940	Grease	C & D	Rodded & Degreaser	Manhole
Sand Springs	S20457	2/7/2011	600	Grease	C & D	Rodded & Degreaser	Manhole
Sand Springs	S20457	2/15/2011	360	Roots	C & D	Rodded & Vac	Manhole
Sand Springs	S20457	2/22/2011	450	Roots & Grease	C & D	Rodded	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Sand Springs	S20457	8/14/2011	4,500	Roots	Washed	Rehab Project	Manhole
Sand Springs	S20457	9/11/2011	270	Roots	C & D	Rodded	Manhole
Sand Springs	S20457	10/4/2011	150	Line Collapsed	C & D	Replaced	Pipe
Sand Springs	S20457	10/27/2011	90	Roots	C & D	Root Saw	Manhole
Sand Springs	S20457	11/4/2011	360,000	Main Separation	Hth	Repair By Contractor	Pipe
Sand Springs	S20457	11/16/2011	6,000	Grease, Roots & Rocks	Hth	Rodded & Monitored	Manhole
Sand Springs	S20457	11/21/2011	2,400	Solids Buildup	Hth	Rooted	Manhole
Sand Springs	S20457	11/29/2011	200	Solids Buildup	Hth	Rooted	Manhole
Sand Springs	S20457	12/1/2011	1,500	Line Break	Hth	Rooted	Manhole
Sand Springs	S20457	1/11/2012	3,240	Roots	Hth	Rooted	Manhole
Rogers RSD #1	S21521	2/26/2006	150	Malfunction	None	None	Lift Station
Rogers RSD #1	S21521	12/10/2007	10,000	Power Off			Lift Station
Rogers RSD #1	S21521	12/10/2007	5,000	Power Outage			Lift Station
Rogers RSD #1	S21521	12/10/2007	5,000	Power Outage		Generator	Lift Station
Rogers RSD #1	S21521	12/10/2007	10,000	Power Out		Generator	Lift Station
Rogers RSD #1	S21521	12/14/2007	1,000	Power Out			Lift Station
Rogers RSD #1	S21521	4/9/2008		Rain	None	None	Lift Station
Rogers RSD #1	S21521	4/9/2008		Rain			Lift Station
Rogers RSD #1	S21521	4/12/2008	5,000	Busted Main			Lift Station
Rogers RSD #1	S21521	3/31/2010	500	Power Failure	Lime		Manhole
Rogers RSD #1	S21521	12/12/2011	1,000	Malfunction	Limed	Flushed	Lift Station
Claremore	S21506	2/5/2006	10,000	Electrical Malfunction	Cleaned	Repairs	Manhole
Claremore	S21506	9/23/2006	10,000	Bell Failure	C & S	Replaced	Pipe
Claremore	S21506	1/22/2007	5,000	Toilet Paper	C & D	Jet Rodded	Manhole
Claremore	S21506	5/7/2007	5,000	Roots & Rain	C & S	Removed Roots	Manhole
Claremore	S21506	5/7/2007	30,000	Rain	Treated	Address I&I Issues	Lift Station
Claremore	S21506	5/9/2007	50,000	Leak	Treated	Repair	Lagoon/Basin
Claremore	S21506	6/4/2007	3,000	Valve Failure	C & S	Repaired	Lift Station
Claremore	S21506	6/23/2007	2,000	Rain	Washed Away	Smoke Testing	Manhole
Claremore	S21506	6/23/2007	1,500	Rain	Washed	Smoke Test	Manhole
Claremore	S21506	6/23/2007	2,000	Rain	Washed	Smoke Test	Manhole
Claremore	S21506	6/23/2007	2,500	Rain	Washed	Smoke Test	Manhole
Claremore	S21506	6/23/2007	1,200	Rain	Washed	Smoke Test	Manhole
Claremore	S21506	6/23/2007	3,000	Rain	Washed	Smoke Test	Manhole
Claremore	S21506	6/25/2007	500,000	Rain	C & S	None	Lagoon/Basin

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Claremore	S21506	6/25/2007	30,000	Leak	C & S	Repair	Lagoon/Basin
Claremore	S21506	9/20/2007	3,000	Unknown	C & S	Jetted	Manhole
Claremore	S21506	9/27/2007	1,000	Line Break	C & S	Repaired	Pipe
Claremore	S21506	10/4/2007	10,000	Paper Towels	C & S	Rodded	Manhole
Claremore	S21506	12/11/2007	10,000	Ice Storm	Lime	Repaired	Manhole
Claremore	S21506	12/11/2007	10,000	Ice Storm	Limed	Repaired	Manhole
Claremore	S21506	12/11/2007	10,000	Ice Storm	Lime	Repair	Manhole
Claremore	S21506	3/19/2008	20,000	Debris	Limed	Repair	Head Works
Claremore	S21506	3/20/2008	30,000	Leak At MH	C & S	Inspect & Repair	Lagoon/Basin
Claremore	S21506	3/20/2008	50,000	Leak	C & S	Reinspected	Lagoon/Basin
Claremore	S21506	4/8/2008	10,000	Rain	Lime	Smoke Testing	Manhole
Claremore	S21506	4/8/2008	10,000	Rain	C & S	Smoke Testing	Manhole
Claremore	S21506	4/8/2008	10,000	Rain	C & S	Smoke Testing	Manhole
Claremore	S21506	6/9/2008	13,920	Rain	C & S	Fixing I&I Problems	Manhole
Claremore	S21506	6/9/2008	17,400	Rain	C & S	Repair	Manhole
Claremore	S21506	6/9/2008	17,400	Rain	C & S	Repair	Manhole
Claremore	S21506	6/9/2008	17,400	Rain	C & S	Repair	Manhole
Claremore	S21506	6/9/2008	6.96	Rain	C & S	Repair	Manhole
Claremore	S21506	6/9/2008	50,000	Leak In Joint	Treated	Repaired	Lagoon/Basin
Claremore	S21506	6/9/2008	15,000	Leaks	Treated	Repaired	Lagoon/Basin
Claremore	S21506	6/16/2008	10,440	Rain	C & S	Repairing	Manhole
Claremore	S21506	6/16/2008	8,700	Rain	C & S	Repairing	Manhole
Claremore	S21506	6/16/2008	8,700	Rain	C & S	Repair	Manhole
Claremore	S21506	6/16/2008	17,400	Rain	C & S	Repair	Manhole
Claremore	S21506	6/16/2008	8,700	Rain	C & S	Repair	Manhole
Claremore	S21506	6/16/2008	15,660	Rain	C & S	Repair	Manhole
Claremore	S21506	6/16/2008	17,400	Rain	C & S	Repair	Manhole
Claremore	S21506	9/21/2008	1,000	L.S. Failure	C & S	Repaired	Pipe
Claremore	S21506	9/23/2008	4,000	Line Crushed By Contractors	C & S	Completed	Pipe
Claremore	S21506	12/4/2008	5,000	Grease	C & S	Grease Trap Service	Manhole
Claremore	S21506	1/30/2009	2,000	Mh Lid Fell Into MH	C & S	Replace Lid	Manhole
Claremore	S21506	2/11/2009	500	Rain	C & S	Looking For Source	Manhole
Claremore	S21506	3/7/2009	50	Grease & Mop Head	C & S		Pipe
Claremore	S21506	5/1/2009	10,000	Rain	Cleaned	Repairing I&I	Manhole
Claremore	S21506	5/1/2009	6,000	Rain	Cleaned	Repairing	Manhole
Claremore	S21506	5/1/2009	6,000	Rain	Cleaned	Repairing	Manhole
Claremore	S21506	5/1/2009	12,000	Rain	Cleaned	Repairing	Manhole
Claremore	S21506	5/1/2009	9,000	Rain	Cleaned	Repairing	Manhole
Claremore	S21506	5/1/2009	15,000	Rain	Cleaned	Repairing	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Claremore	S21506	9/21/2009	500	Grease	C & S	Degrease	Manhole
Claremore	S21506	9/21/2009	800	Rain	C & S	Replace Lines	Manhole
Claremore	S21506	9/21/2009	1,000	Clothing	C & S	Cleared	Manhole
Claremore	S21506	10/2/2009	10,000	Vandalism	Sanitized	Secured	Lift Station
Claremore	S21506	10/5/2009	56,000	Pump Failure	C & S	Replace & Repair	Manhole
Claremore	S21506	10/25/2009	150	Grease & Baby Wipes	C & S	Cleaned	Manhole
Claremore	S21506	11/19/2009	5,000	Broken Pipe	C & S	Repaired	Manhole
Claremore	S21506	12/24/2009	10,000	Bar Screen Full Of Rags	C & S	Clear	Head Works
Claremore	S21506	2/21/2010	100	Rain	C & S	Divert Flow To Feb	Clarifier
Claremore	S21506	2/23/2010	5,000	Rags	C & S	Cleaned	Manhole
Claremore	S21506	1/26/2011	2,500	Blockage	C & S	Cleared	Manhole
Claremore	S21506	2/15/2011	2,000	Diaper	C & S	Contacted Veterans Hospital	Manhole
Claremore	S21506	2/18/2011		Overflow	C & D	New Plant Under Construction	Lagoon/Basin
Claremore	S21506	2/22/2011	1,500	Roots	C & S	Removed	Manhole
Claremore	S21506	4/5/2011	500	Electrical Problem	Lime	Reset	
Claremore	S21506	6/2/2011		Electrical Overload	Disinfects	Repair	Head Works
Claremore	S21506	7/26/2011	200	Valve Was Not Closed	Lime	Close Valve	
Claremore	S21506	10/17/2011		Power Failure	Limed	Restore	
Claremore	S21506	12/7/2011	3,500	Grease	C & S	More Frequent Inspections	Lift Station
Claremore	S21506	2/4/2012	1,000	Rain	Disinfect	Need Operator	Head Works
Chouteau	S21624	1/4/2005	10,000	Rain	C & S	Repair	Lift Station
Chouteau	S21624	1/4/2005	3000000	Rain			
Chouteau	S21624	2/7/2005	770,914	Rain			
Chouteau	S21624	4/6/2005	1000000	Rain			
Chouteau	S21624	12/30/2006	658,517	Rain	None	None	
Chouteau	S21624	7/7/2008	100	Power Failure	Bleached	Repair	Lift Station
Chouteau	S21624	7/9/2008	1,000	Rain	C & S	None	Manhole
Chouteau	S21624	7/12/2008	2,000	Rain	C & S		Lift Station
Chouteau	S21624	7/12/2008	1,000	Rain	Bleach		Manhole
Chouteau	S21624	8/23/2008	4,000	Power Outage	Bleached	Restore	Lift Station
Chouteau	S21624	8/31/2008	2,000	Lightning Storm	C & D		Lift Station
Chouteau	S21624	11/25/2008	1,000	Blockage	None		Manhole
Chouteau	S21624	6/18/2009	2,500	Pump Failure	C & S		Lift Station
Chouteau	S21624	9/9/2009	2,000	Rain	Bleached	Replacing Pipe	Manhole
Chouteau	S21624	1/5/2010	3,000	Construction	C & S	Replacing Line	Lift Station
Chouteau	S21624	1/6/2010	1,500	Construction	C & S	Replacing Line	Lift Station
Chouteau	S21624	2/17/2010	2,000	Malfunction	Bleach	More Attention	Lift Station
Chouteau	S21624	7/23/2010	1,000	Pump Not Turned Back On After Maintenance	C & S	Remember	Manhole

Facility Name	Facility ID	Bypass Date	Amount (Gallons)	Cause	Cleanup	Preventive	Type of Source
Chouteau	S21624	12/21/2010	25,000	Basin Overflowed From Valve Failure	None	Replace Valve	Lagoon
Chouteau	S21624	4/25/2011	4,000	Rain	Bleach		Manhole
Chouteau	S21624	4/25/2011	2,000	Rain	Bleach	None	Lift Station

APPENDIX E

STORMWATER PERMITTING REQUIREMENTS AND PRESUMPTIVE BEST MANAGEMENT PRACTICES (BMP) APPROACH

Stormwater permitting Requirements and Presumptive Best Management Practices (BMPs) Approach

A. BACKGROUND

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

Stormwater discharges are highly variable both in terms of flow and pollutant concentration, and the relationships between discharges and water quality can be complex. For municipal stormwater discharges in particular, the current use of system-wide permits and a variety of jurisdiction-wide BMPs, including educational and programmatic BMPs, does not easily lend itself to the existing methodologies for deriving numeric water quality-based effluent limitations. These methodologies were designed primarily for process wastewater discharges which occur at predictable rates with predictable pollutant loadings under low flow conditions in receiving waters.

EPA has recognized these problems and developed permitting guidance for stormwater permits. [See "Interim Permitting Approach for Water Quality-Based Effluent Limitations in Stormwater Permits" (EPA-833-D-96-00, Date published: 09/01/1996)] Due to the nature of stormwater discharges, and the typical lack of information on which to base numeric water quality-based effluent limitations (expressed as concentration and mass), EPA recommends an interim permitting approach for NPDES stormwater permits which is based on BMPs. "The interim permitting approach uses best management practices (BMPs) in first-round stormwater permits, and expanded or better-tailored BMPs in subsequent permits, where necessary, to provide for the attainment of water quality standards." (*ibid.*)

A monitoring component is also included in the recommended BMP approach. "Each storm water permit should include a coordinated and cost-effective monitoring program to gather necessary information to determine the extent to which the permit provides for attainment of applicable water quality standards and to determine the appropriate conditions or limitations for subsequent permits." (*ibid.*)

This approach was further elaborated in a guidance memo issued in 2002. [See Memorandum from Robert Wayland, Director of OWOW and James Hanlon, Director of OWM to Regional Water Division Directors: "Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit requirements Based on Those WLAs " (Date published: 11/22/2002)] "The policy outlined in this memorandum affirms the appropriateness of an iterative, adaptive management BMP approach, whereby permits include effluent limits (e.g., a combination of structural and non-structural BMPs) that address stormwater discharges, implement mechanisms to evaluate the performance of such controls, and make adjustments (i.e., more stringent controls or specific BMPs) as necessary to protect water quality. …… If it is determined that a BMP approach (including an iterative BMP approach) is appropriate to meet the stormwater component of the TMDL, EPA recommends that the TMDL reflect this." This BMP-based approach to stormwater sources in TMDLs is also recognized and described in the most recent EPA guidance. [See "TMDLs To Stormwater Permits Handbook" (DRAFT), EPA, November 2008] This TMDL adopts the EPA recommended approach and relies on appropriate BMPs for implementation. No numeric effluent limitations are required or anticipated for municipal stormwater discharge permits.

B. SPECIFIC SWMP/SWPPP REQUIREMENTS

As noted in Section 3 of this report, Oklahoma Pollutant Discharge Elimination System (OPDES)-permitted facilities and non-point sources (e.g., wildlife, agricultural activities and domesticated animals, land application fields, urban runoff, failing onsite wastewater disposal system, and domestic pets) could contribute to exceedances of the water quality criteria. In particular, stormwater runoff from the Phase 1 and 2 Municipal Separate Storm Sewer Systems (MS4s) is likely to contain elevated bacterial concentrations. Permits for these discharges must comply with the provisions of this TMDL. Table E-1 provides a list of Phase 1 and 2 MS4s that are affected by this bacterial TMDL report.

Agricultural activities and other nonpoint sources of bacteria are unregulated. Voluntary measures and incentives should be used and encouraged wherever possible and such sources should strive to attain the reduction goals established in this TMDL.

Table E-1. MS4 Permits affected by this TMDL Report

Entity	Permit No.	MS4 Phase	Date Issued
City of Bixby	OKR040042	Phase 2 MS4	12/8/2005
City of Broken Arrow	OKR040001	Phase 2 MS4	11/21/2005
City of Claremore	OKR040028	Phase 2 MS4	10/31/2005
City of Coweta	OKR040009	Phase 2 MS4	3/3/2006
City of Muskogee	OKR040013	Phase 2 MS4	11/14/2005
City of Jenks	OKR040024	Phase 2 MS4	12/8/2005
City of Sand Springs	OKR040017	Phase 2 MS4	11/30/2005
City of Sapulpa	OKR040018	Phase 2 MS4	10/27/2006
City of Tulsa[1]	OKS000201	Phase 1 MS4	11/14/2005

[1] Co-permittee with ODOT and OTA

The provisions of this appendix apply only to OPDES/NPDES regulated stormwater discharges. Regulated CAFOs within the watershed operate under NPDES permits issued and overseen by EPA. In order to comply with this TMDL, those CAFO permits in the watershed and their associated management plans must be reviewed. Further actions to reduce bacterial loads and achieve progress toward meeting the specified reduction goals must be implemented. This provision will be forwarded to EPA, as the responsible permitting agency, for follow up.

To ensure compliance with the TMDL requirements under the permit, stormwater permittees must develop strategies designed to achieve progress toward meeting the reduction goals established in the TMDL. Relying primarily upon a Best Management Practices (BMP) approach, permittees should take advantage of existing information on BMP performance and select a suite of BMPs appropriate to the local community that are expected to result in progress toward meeting the reduction goals established in the TMDL. The permittee should provide guidance on BMP installation and maintenance, as well as a monitoring and/or inspection schedule.

Table E–2 provides a summary description of some BMPs with reported effectiveness in reducing bacteria. Permittees may choose different BMPs to meet the permit requirements, as long as the permittees demonstrate that these practices will result in progress toward attaining water quality standards.

As noted above, when a BMP approach is selected a coordinated monitoring program is necessary to establish the effectiveness of the selected BMPs and demonstrate progress toward attaining water quality standards. The monitoring results should be used to refine bacterial controls in the future. With nine permitted entities in the watershed, it is likely that a cooperative monitoring program would be more cost effective than nine individual programs. Individual permittees are not required to participate in a coordinated program and are free to develop their own program if desired.

After EPA approval of the final TMDL, existing MS4 permittees will be notified of the TMDL provisions and schedule. Industrial stormwater permittees are not expected to be a significant source of bacteria. But if any are identified, similar actions will be required.

Compliance with the following provisions will constitute compliance with the requirements of this TMDL.

1. Develop a Bacterial Reduction Plan

Permittees shall submit an approvable Bacterial Reduction Plan to the DEQ within 12 months of notification. Unless disapproved by the Director within 60 days of submission, the plan shall be approved and then implemented by the permittee. This plan shall, at a minimum, include the following:

a. Consideration of ordinances or other regulatory mechanisms to require bacterial pollution control, as well enforcement procedures for noncompliance;

b. Evaluation of the existing SWMP in relation to TMDL reduction goals;

c. An evaluation to identify potential significant sources of bacteria entering your MS4. Develop (or modify an existing program as necessary) and implement a program to reduce the discharge of bacteria in municipal stormwater contributed by any other significant source identified in the source identification evaluation

d. Educational programs directed at reducing bacterial pollution. Implement a public education program to reduce the discharge of bacteria in municipal stormwater contributed (if applicable) by pets, recreational and exhibition livestock, and zoos;

e. Investigation and implementation of BMPs that prevent additional stormwater bacterial pollution associated with new development and re-development;

f. Develop (or modify an existing program as necessary) and implement a program to reduce the discharge of bacteria in municipal stormwater contributed by areas within your MS4 served by on-site wastewater treatment systems

g. Implementation of BMPs applicable to bacteria. Table E-2 below presents summary information on some BMPs that may be considered. Permittees are not limited to BMPs on this list and should select BMPs appropriate to the local community that are expected to result in progress toward meeting the reduction goals established in the TMDL.

h. Modifications to the dry weather field screening and illicit discharge detection and elimination provisions of the SWMP to consider stormwater sampling and other measures intended to specifically identify bacterial pollution sources and high priority areas for bacterial reductions.

i. Periodic evaluation of the effectiveness of the bacterial reduction plan to ensure progress toward attainment of water quality standards.

j. An implementation schedule leading to modification of the SWMP and full implementation of the plan within 3 years of notification.

2. Develop or Participate In a Bacterial Monitoring Program

Permittees may participate in a coordinated regional bacterial monitoring program or develop their own individual program. The monitoring program should be designed to establish the effectiveness of the selected BMPs and demonstrate progress toward achieving the reduction goals of the TMDL and eventual attainment of water quality standards.

a. Within 18 months of notification, the permittee shall prepare and submit to the DEQ either a TMDL monitoring plan or a commitment to participate in a coordinated regional monitoring program. Unless disapproved by the Director within 60 days of submission, the plan shall be approved and then implemented by the permittee. The plan or program shall include:

    (1) A detailed description of the goals, monitoring, and sampling and analytical methods;

    (2) A list and map of the selected TMDL monitoring sites;

    (3) The frequency of data collection to occur at each station or site;

    (4) The parameters to be measured, as appropriate for and relevant to the TMDL;

    (5) A Quality Assurance Project Plan that complies with EPA requirements [EPA Requirements for QA Project Plans (QA/R-5)]

b. The monitoring program shall be fully implemented within three years of notification.

3. Annual Reporting

The permittee shall include a TMDL implementation report as part of their annual report. The TMDL implementation report shall include the status and actions taken by the permittee to implement the Bacterial Reduction Plan and monitoring program. The TMDL implementation report shall document relevant actions taken by the permittee that affect MS4 stormwater discharges to the waterbody segments that are the subject of the TMDL. This TMDL implementation report also shall identify the status of any applicable TMDL implementation schedule milestones.

Table E–2. Some BMPs Applicable to Bacteria

BEST MANAGEMENT PRACTICE	Impairment Source		Reported Efficiency	Note
	Agriculture	Urban		
Animal waste management: A planned system designed to manage liquid and solid waste from livestock and poultry. It improves water quality by storing and spreading waste at the proper time, rate and location.	X		75 %[1]	
Artificial wetland/rock reed microbial filter: A long shallow hydroponic plant/rock filter system that treats polluted waste and wastewater. It combines horizontal and vertical flow of water through the filter, which is filled with aquatic and semi-aquatic plants and microorganisms and provides a high surface area of support media, such as rocks or crushed stone.	X	X		
Compost facility: Treating organic agricultural wastes in order to reduce the pollution potential to surface and ground water. The composting facility must be constructed, operated and maintained without polluting air and/or water resources.	X	X		Permit may be needed
Conservation landscaping: The placement of vegetation in and around stormwater management BMPs. Its purpose is to help stabilize disturbed areas, enhance the pollutant removal capabilities of stormwater BMP, and improve the overall aesthetics of a stormwater BMP.		X		
Diversions: Establishing a channel with a supporting ridge on the lower side constructed along the general land slope which improves water quality by directing nutrient and sediment laden water to sites where it can be used or disposed of safely.	X	X		
Drain Inlet Inserts: A proprietary BMP that is generally easily installed in a drain inlet or catch basin to treat stormwater runoff. Three basic types of inlet insert are available, the tray type, bag type and basket type. The tray type allows flow to pass through filter media residing in a tray located around the perimeter of the inlet.	X	X	5%[2]	
Dry detention pond/basin: Detention ponds/basins that have been designed to temporarily detain stormwater runoff. These ponds fill with stormwater and release it over a period of a few days. They can also be used to provide flood control by including additional flood detention storage.	X	X	40%[2] 51%[3] 88% [4]	
Earthen embankments: A raised impounding structure made from compacted soil. It is appropriate for use with infiltration, detention, extended-detention or retention facilities.	X	X		
Drip irrigation: An irrigation method that supplies a slow, even application of low-pressure water through polyethylene tubing running from supply line directly to a plant's base. Water soaks into the soil gradually, reducing runoff and evaporation (i.e., salinity). Transmission of nutrients and pathogens spread by splashing water and wet foliage created by overhead sprinkler irrigation is greatly reduced. Weed growth is minimized, thereby reducing herbicide applications. Vegetable farming and virtually every type of landscape situation can benefit from the use of drip irrigation.	X	X		

BEST MANAGEMENT PRACTICE	Impairment Source		Reported Efficiency	Note
	Agriculture	Urban		
Fencing: A constructed barrier to livestock, wildlife or people. Standard or conventional (barbed or smooth wire), suspension, woven wire, or electric fences consist of acceptable fencing designs to control the animal(s) or people of concern and meet the intended life of the practice.	X		75%[1]	
Filtration (e.g., sand filters): Intermittent sand filters capture, pre-treat to remove sediments, store while awaiting treatment, and treat to remove pollutants (by percolation through sand media) the most polluted stormwater from a site. Intermittent sand filter BMPs may be constructed in underground vaults, in paved trenches within or at the perimeter of impervious surfaces, or in either earthen or concrete open basins.	X	X	30%[1] 55%[2] 37%[4]	
Infiltration Basin: A vegetated open impoundment where incoming stormwater runoff is stored until it gradually infiltrates into the soil strata. While flooding and channel erosion control may be achieved within an infiltration basin, they are primarily used for water quality enhancement.		X	50%[1]	
Infiltration Trench: A shallow, excavated trench backfilled with a coarse stone aggregate to create an underground reservoir. Stormwater runoff diverted into the trench gradually infiltrates into the surrounding soils from the bottom and sides of the trench. The trench can be either an open surface trench or an underground facility.		X	50%[1]	
Irrigation water management: The process of determining and controlling the volume, frequency, and application rate of irrigation water in a planned, efficient manner. An irrigation system adapted for site conditions (soil, slope, crop grown, climate, water quantity and quality, etc.) must be available and capable of applying water to meet the intended purpose(s).	X	X		
Lagoon pump out: A waste treatment impoundment made by constructing an embankment and/or excavating a pit or dugout in order to biologically treat waste (such as manure and wastewater) and thereby reduce pollution potential by serving as a treatment component of a waste management system.	X	X		
Land-use conversion: BMPs that involve a change in land use in order to retire land contributing detrimentally to the environment. Some examples of BMPs with associated land use changes are: Conservation Reserve Program (CRP) - cropland to pasture; Forest conservation - pervious urban to forest; Forest/grass buffers - cropland to forest/pasture; Tree planting - cropland/pasture to forest; and Conservation tillage – conventional tillage to conservation tillage.	X	X		
Limit livestock access: Excluding livestock from areas where grazing or trampling will cause erosion of stream banks and lowering of water quality by livestock activity in or adjacent to the water. Limitation is generally accomplished by permanent or temporary fencing. In addition, installation of an alternative water source away from the stream has been shown to reduce livestock access.	X			
Litter control: Litter includes larger items and particulates deposited on street surfaces, such as paper, vegetation residues, animal feces, bottles and broken glass, plastics and fallen leaves. Litter-control programs can reduce the amount of deposition of pollutants by as much as 50%, and may be an effective measure of controlling pollution by storm runoff.		X		

BEST MANAGEMENT PRACTICE	Impairment Source		Reported Efficiency	Note
	Agriculture	Urban		
Livestock water crossing facility: Providing a controlled crossing for livestock and/or farm machinery in order to prevent streambed erosion and reduce sediment.	X		100%[1]	
Manufactured BMP systems: Structural measures which are specifically designed and sized by the manufacturer to intercept stormwater runoff and prevent the transfer of pollutants downstream. They are used solely for water quality enhancement in urban and ultra-urban areas where surface BMPs are not feasible.	X	X		
Onsite treatment system installation: Conventional onsite wastewater treatment and disposal system (onsite system) consists of three major components: a septic tank, a distribution box, and a subsurface soil absorption field (consisting of individual trenches). This system relies on gravity to carry household waste to the septic tank, move effluent from the septic tank to the distribution box, and distribute effluent from the distribution box throughout the subsurface soil absorption field. All of these components are essential for a conventional onsite system to function in an acceptable manner.		X		
Porous pavement: An alternative to conventional pavement, it is made from asphalt (in which fine filler fractions are missing) or modular or poured-in concrete pavements. Its use allows rainfall to percolate through it to the sub-base, providing storage and enhancing soil infiltration that can be used to reduce runoff and combined sewer overflows. The water stored in the sub-base then gradually infiltrates the subsoil.		X	50%[1]	
Proper site selection for animal feeding facility: Establishing or relocating confined feeding facilities away from environmentally vulnerable areas such as sinkholes, streams, and rivers in order to reduce or eliminate the amount of pollutant runoff reaching these areas.	X			
Rain garden/bio-retention basin: Rain gardens are landscaped gardens of trees, shrubs, and plants located in commercial or residential areas in order to treat stormwater runoff through temporary collection of the water before infiltration. They are slightly depressed areas into which stormwater runoff is channeled by pipes, curb openings, or gravity.		X	40%[1]	
Range and pasture management: Systems of practices to protect the vegetative cover on improved pasture and native rangelands. It includes practices such as seeding or reseeding, brush management (mechanical, chemical, physical, or biological), proper stocking rates and proper grazing use, and deferred rotational systems.	X		50%[1]	
Wet retention ponds/basins: A stormwater facility that includes a permanent pool of water and, therefore, is normally wet even during non-rainfall periods. Inflows from stormwater runoff may be temporarily stored above this permanent pool.	X	X	32%[1] 70%[4]	
Riparian buffer zones: A protection method used along streams to reduce erosion, sedimentation, and the pollution of water from agricultural non-point sources.	X	X	43–57%[1]	Forested buffer w/o incentive payment

BEST MANAGEMENT PRACTICE	Impairment Source		Reported Efficiency	Note
	Agriculture	Urban		
Septic system pump-out: A typical septic system consists of a tank that receives waste from a residence or business, and a drain field or subsurface absorption system consisting of a series of percolation lines for the disposal of the liquid effluent. Solids (sludge) that remain after decomposition by bacteria in the tank must be pumped out periodically.		X	5%[1]	
Sewer line maintenance (e.g., sewer flushing): Sewer flushing during dry weather is designed to periodically remove solids that have deposited on the bottom of the sewer and the biological slime that grows on the walls of combined sewers during periods of low-flow. Flushing is especially necessary in sewer systems that have low grades which has resulted in velocities during low-flow periods that fall below those needed for self-cleaning.		X		
Stream bank protection and stabilization (e.g., riprap, gabions): Stabilizing shoreline areas that are being eroded by landscaping, constructing bulkheads, riprap revetments, gabion systems, or establishing vegetation.	X	X	40-75%[1]	40 % w/o fencing; 75 % w/fencing
Street sweeping: The practice of passing over an impervious surface, usually a street or a parking lot, with a vacuum or a rotating brush for the purpose of collecting and disposing of accumulated debris, litter, sand and sediments. In areas with defined wet and dry seasons, sweeping prior to the wet season is likely to be beneficial; following snowmelt and heavy leaf fall are also opportune times.		X		
Terrace: An earth embankment, or a combination ridge and channel, constructed across the field slope. Terraces can be used when there is a need to conserve water, excessive runoff is a problem, and the soils and topography are such that terraces can be constructed and farmed with reasonable effort.	X	X		
Vegetated filter strip: A densely vegetated strip of land engineered to accept runoff from upstream development as overland sheet flow. It may adopt any naturally vegetated form, from grassy meadow to small forest. The purpose of a vegetated filter strip is to enhance the quality of stormwater runoff through filtration, sediment deposition, infiltration and absorption.	X	X	<30% [3]	
Waste system/storage (e.g., lagoons, litter shed): Waste treatment lagoons biologically treat liquid waste to reduce the nutrient and BOD content. Lagoons must be emptied and their contents disposed of properly.	X	X	80–100%[1]	
Water treatment (e.g., disinfection, flocculation, carbon filter system): Physical, chemical and/or biological processes used to treat concentrated discharges. Physical-chemical processes that have been demonstrated to effectively treat discharge include sedimentation, vortex separation, screening (e.g., fine-mesh screening), and sand-peat filters. Chemical additives used to enhance separation of particles from liquid include chemical coagulants such as lime, alum, ferric chloride, and various polyelectrolytes. Biological processes that have been demonstrated to effectively treat discharges include contact stabilization, biodiscs, oxidation ponds, aerated lagoons, and facultative lagoons.	X	X		

BEST MANAGEMENT PRACTICE	Impairment Source		Reported Efficiency	Note
	Agriculture	Urban		
Wetland development/enhancement: The construction of a wetland for the treatment of animal waste runoff or stormwater runoff. Wetlands improve water quality by removing nutrients from animal waste or sediments and nutrients from stormwater runoff.	X	X	30%[1] 78%[4]	Including creation and restora-tion

Sources

1 BMP Efficiencies Chesapeake Bay Watershed Model (PhaseIV) August 1999; Draft FC and Nitrate TMDL IP for Dry River (2001); EPA (1998); EPA (1999b); Novotny (1994); Storm Water Best Management Practice Categories and Pollutant Removal Efficiencies (2003); USDA (2003); DCR (1999); DEQ/DCR (2001).

2 Barrett, M.E.,Complying with the Edwards Aquifer Rules: Technical Guidance on Best Management Practices, Texas Natural Resource Conservation Commission Report RG-348, June (1999).

3 The Expected Pollutant Removal (Percent) Data Adapted from US EPA, 1993C.

4 National Pollutant Removal Performance Database, Version 3, September, 2007

APPENDIX F

RESPONSE TO COMMENTS

Comment from okiebass

I would like to see the man power for full time inspectors for residential properties. People cheat on perk test all the time, once they pass sewage just runs out in the fields. Property south of Davis Field to Elm Grove road and south to the river will not perk. People just let sewage run in creeks that flow to the Arkansas River. It's not hard to spot. Unless you have aerobic system or lagoon in this area sewage is contaminating creeks ponds and the river. I know I have lived out here a long time. I know we don't have the man power at least have the one that pass the system come back and check to see if it's working.

Response

Thank you for your concern about the quality of Oklahoma's waters.

The inspections of septic systems and illicit discharges are beyond the scope of this TMDL. However, DEQ does have an enforcement program for failing septic systems and illicit discharges. Suspected septic tank problems and illegal discharges are investigated by the Environmental Complaints and Local Services Division (ECLS) to whom your comment has been forwarded.

To report an environmental complaint, you can either call the DEQ hotline at 1-800-522-0206 or file a complaint on-line at: https://applications.deq.ok.gov/OnlineComplaints/. *If you want to receive updates concerning your complaint, you can leave them your name, mailing address, and phone number on the online form. This enables the DEQ investigators to contact you for additional facts and provide you feedback on the investigation. Upon request, ECLS will keep this information confidential, which will protect your identity and contact information from release on public records, unless ordered released by a District Court. If this is your preference, check the box to the left of "Confidential". Of course, please feel free to remain anonymous.*

Regardless of the nature of the situation, or whether or not you choose to leave contact information, please rest assured that DEQ will seriously consider the information and that we appreciate that you took the time to inform us of your concerns.

Comment from Paul Moore, Tulsa

Please accept this message as an expression of support for the recommended levels of improvement in the Draft. I am particularly supportive of improvements to the Arkansas River water quality as I live and recreate near that river. Improvement of the water quality is critical if fisheries and human recreation are to be encouraged by new development in the Arkansas River.

Response

Thank you for your comment.

Comment from Andrew Qualls-NRCS-CD, Muskogee, OK (comment was summarized)

I was just looking at the NPDES/Storm water TMDLs that were being established with the likely intent of being applied to agriculture in the Verdigris and Arkansas River watersheds and noting that the "default" cause for impairment based on ODEQ assessment was "livestock" for body contact impairment related to coli form type bacteria in many areas where livestock is produced and some of that have very little livestock production.

With the ongoing assessment of "impaired" water systems across the country, it will become necessary to recognize all of the sources of impairment and the relative amount of "movement" into water systems under a wide variety of environmental conditions.

When compared to other states I recognize that there are many occasions where the "cause of impairment" was/is listed as "unknown" and I commend those involved in the establishment of TMDLs that took the approach of recognizing the broad range of possible non-point sources including natural sources of bacterial and turbidity contamination in those watersheds.

While the surface application of poultry litter is technically indirectly related to "livestock", the application of raw poultry litter applied in Muskogee County in 2010 and 2011 seem to be excessive and would need to be addressed in TMDLs that are established. Based on years of personal observation, under certain weather conditions/events, poultry litter is much more mobile than livestock (on pasture) wastes and in normal precipitation years.

I realize that the establishment of TMDLs for all watersheds (currently ongoing by EPA and state Environmental agencies) are merely the baseline for further regulation under CWA storm water rules and that current BMPs are accepted as sufficient for current CWA accepted practices but once these TMDLs are applied to agricultural areas, the road to any corrections is long and tedious and will eventually have to consider the millions of pounds per year of raw poultry waste being applied in these areas as well as other sources of contamination including tens of thousands of waterfowl that use these same areas.

Hopefully ongoing studies (establishment of TMDLs) are being done in such a manner as to allow the extraction or consideration of various sources of pollutants including tens of thousands of waterfowl and relocation of millions of pounds of raw litter from the daily loads and maximums being established so that true and beneficial remedial practices could be implemented to benefit water quality and sustain beneficial and necessary agricultural activities.

In addition, it seems that it would be beneficial to establish what the natural or background loads for these contaminants addressed by the TMDLs would be from other sources if no livestock, litter applications and waterfowl were present so that actual loads from various sources could be established as mobility of livestock on pasture is not the same as surface application of litter and "direct deposit" by waterfowl.

Response

Section 3 of this report researches and evaluates all justifiable sources of bacteria and turbidity. Cattle produce much more fecal coliform per day than poultry which means that livestock are much more likely to be the source of the bacteria which is impairing the *waterbodies. So although a watershed may have very little "livestock", each livestock animal would generate much more bacteria than the same number of poultry would in that same watershed.*

The Oklahoma Department of Agriculture, Food and Forestry (ODAFF) is the State agency in charge of protecting the State's soils and waters from animal waste. In writing this report, DEQ worked with ODAFF to ensure that the number of permitted CAFO or PFO facilities listed in Table 3-4 is correct. In addition, Table 3-7 provides estimated numbers of non-permitted livestock per watershed based on the 2007 U.S. Department of Agriculture's (USDA) county agricultural census data (USDA 2007). The estimated populations of commercially raised farm animal in Table 3-7 were derived by using the percentage of the watershed within each county. Because the watersheds are generally much smaller than the counties, and commercially raised farm animals are not evenly distributed across counties or constant with time, these are rough estimates only.

Although Section 3.1.4 mentions poultry litter, the amount of poultry litter that is land applied is not addressed in this Report. The ODAFF Agricultural Environmental Management Services (AEMS) was created to help develop, coordinate and oversee environmental policies and programs and to work with producers and concerned citizens to protect the Oklahoma environment from animals, poultry and their wastes. Located in AEMS is the Poultry Waste Applicators Program. This program administs and enforces the provisions of the Oklahoma Poultry Waste Applicators Certification Act. The Poultry Waste Applicators Program ensures standards for the application of poultry waste, the certification of applicators of poultry waste, recertification of applicators, and ensure that best management practices are followed as provided in the Act.

Under the Oklahoma Poultry Waste Applicators Certification Act, PFOs are required to develop an Animal Waste Management Plan (AWMP) or an equivalent document, such as a Nutrient Management Plan (NMP). These plans should describe how litter will be stored and applied properly in order to protect the water quality of streams and lakes located in the watershed. In order to comply with this TMDL, the registered PFOs in the watershed and their associated management plans must be reviewed.

For more information about any AEMS program (such as poultry litter, PFOs, and CAFOs) visit: http://www.oda.state.ok.us/aems/index.htm#complaints. *For complaints about these topics, contact the ODAFF Complaint Hotline at (800) 235-9877. This phone is staffed between the hours of 7:30 a.m. and 5:00 p.m. After business hours you may leave a message on the Voice Mail or if there is an emergency you will need to follow the instructions on the Voice Mail.*

Thank you for comments and your recommendations would be taken into advisement.

Comment from Richard Smith, INCOG (paraphrased)

INCOG offers the following comments on the report titled: "Bacteria and Turbidity Total Maximum Daily Loads for the Arkansas-Verdigris River Area, Oklahoma (OK120400, OK120410, OK120420, OK121500, and OK121600)"

1. There is a mis-identification in Table 2-4 for Snake Creek TSS TMDL. WBID OK120400020190_00 is Elk Creek, Snake Creek is WBID OK120410010220_00.
2. The Appendix for bacterial implementation strategy for permitted MS4s is missing, probably should be Appendix E in this report.

Response

The Water Body Identification (WBID) numbers in Table 2-4 for Snake Creek and Cloud Creek have now been corrected.

*The Appendix you referenced "*Storm Water Permitting Requirements and Presumptive Best Management Practices (BMPs) Approach*" was inadvertently omitted. It has now been added to this TMDL Report as "Appendix E".*