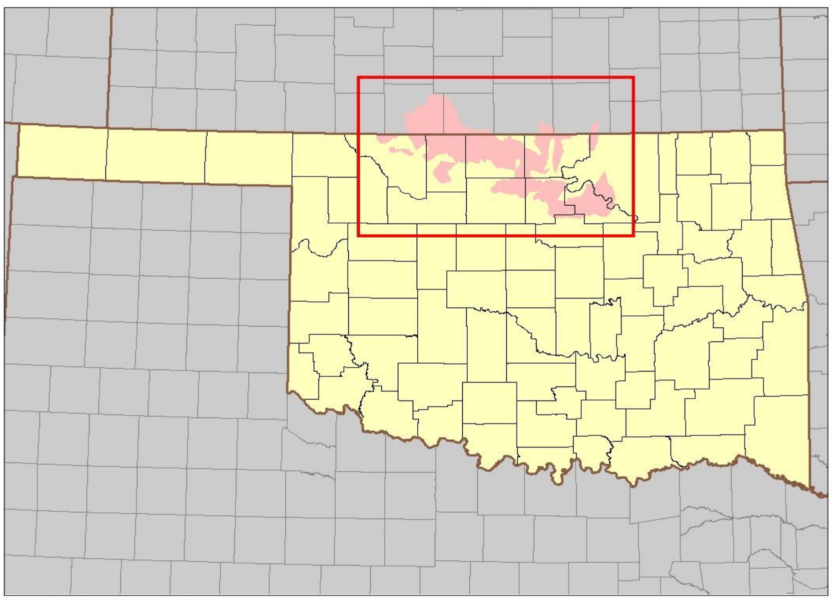
FINAL

BACTERIA AND TURBIDITY TOTAL MAXIMUM DAILY LOADS FOR THE SALT FORK OF THE ARKANSAS RIVER, OKLAHOMA (OK621000, OK621010, OK621100, OK621200, OK621210)



Prepared for:

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

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Prepared by:

PARSONS

SEPTEMBER 2011

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OKWBID

OK621000010010_30, OK621000020130_00, OK621000030010_00, OK621000040010_00, OK621000050010_00, OK621000060010_00, OK621010010010_00, OK621010010090_00, OK621010010160_00, OK621010010230_00, OK621010010270_00, OK621010020010_00, OK621010030010_00, OK621010030030_00, OK621100000010_00, OK621100000010_10, OK621100000100_00, OK621200010200_00, OK621200030010_00, OK621200050010_00, OK621200050010_10, OK621210000050_10, OK621210000270_00

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ACRONYMS AND ABBREVIATIONS

AEMS	Agricultural Environmental Management Service
AES	Aesthetics
AG	Agriculture water supply
ASAE	American Society of Agricultural Engineers
BMP	best management practice
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
DMR	Discharge monitoring report
EWS	Emergency water supply
FISH	Fish consumption
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
NRMSE	Normalized root mean square error
NTU	Nephelometric turbidity unit
OLS	Ordinary least square
O.S.	Oklahoma statute
ODAFF	Oklahoma Department of Agriculture, Food and Forestry
ODEQ	Oklahoma Department of Environmental Quality
OPDES	Oklahoma Pollutant Discharge Elimination System
OSWD	Onsite wastewater disposal
OWRB	Oklahoma Water Resources Board
PBCR	Primary body contact recreation

PPWS	Public and private water supply
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
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WLA	Wasteload allocation
WQM	Water quality monitoring
WQS	Water quality standard
WWAC	Warm water aquatic community
WWTP	Wastewater treatment plant

Executive Summary

This report documents the data and assessment used to establish TMDLs for the pathogen indicator bacteria [fecal coliform, *Escherichia coli (E. coli),* Enterococci] and turbidity for certain waterbodies in the Salt Fork of the Arkansas River basin. 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 (USEPA) guidance, and Oklahoma Department of Environmental Quality (ODEQ) guidance and procedures. ODEQ is required to submit all TMDLs to USEPA for review and approval. Once the USEPA 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 (USEPA 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. The 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 in the Salt Fork of the Arkansas River basin, identified in Table ES-1, that ODEQ 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 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 PBCR or fish and wildlife propagation use designated for each waterbody.

Bacteria: Table ES-2 summarizes water quality data collected during primary contact recreation season from the water quality monitoring (WQM) stations between 1998 and 2009 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 ODEQ 2008 303(d) list (ODEQ 2008). It also includes the new date collected after the data cutoff date for the 2008 303(d) list.

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

WBID	Name	Stream Miles	TMDL Date	Priority	*E. coli*	ENT	FC	Designated Use Primary Body Contact Recreation	Turbidity	Designated Use Warm Water Aquatic Life
OK621000010010_30	Arkansas River, Salt Fork	34.5	2019	4		x		N	x	N
OK621000020130_00	Spring Creek	6.1	2019	4			x	N		
OK621000030010_00	Bois d' Arc Creek	36.9	2019	4	x	x	x	N	x	N
OK621000040010_00	Deer Creek	40.8	2019	4	x	x		N	x	N
OK621000050010_00	Pond Creek	60.2	2019	4	x	x		N	x	N
OK621000060010_00	Crooked Creek	32.9	2019	4		x		N	x	N
OK621010010010_00	Arkansas River, Salt Fork	17.3	2013	2		x		N	x	N
OK621010010090_00	Clay Creek	3.4	2016	3		x		N		
OK621010010160_00	Arkansas River, Salt Fork	15.0	2019	4	x	x	x	N	x	N
OK621010010230_00	Turkey Creek	20.8	2019	4	x	x		N	x	N
OK621010010270_00	Yellowstone Creek	21.8	2019	4		x		N		
OK621010020010_00	Sandy Creek	17.8	2013	2	x	x	x	N		
OK621010030010_00	Medicine Lodge River	13.5	2016	2	x	x		N	x	N
OK621010030030_00	Driftwood Creek	38.8	2019	4	x	x		N	x	N
OK621100000010_00	Chikaskia River	5.4	2016	3	x	x		N	x	N
OK621100000010_10	Chikaskia River	23.1	2016	4		x	x	N	x	N
OK621100000100_00	Bitter Creek	23.3	2019	4	x	x		N	x	N
OK621200010200_00	Arkansas River	37.5	2013	4		x		N	x	N
OK621200030010_00	Black Bear Creek	68.0	2013	2	x	x		N		
OK621200050010_00	Red Rock Creek	37.3	2016	3	x	x		N	x	N
OK621200050010_10	Red Rock Creek	46.1	2019	4	x			N	x	N
OK621210000050_10	Beaver Creek	21.6	2019	4	x	x		N		
OK621210000270_00	Chilocco Creek	16.3	2019	4	x	x		N	x	N

ENT = enterococci; FC = fecal coliform
N = Not attaining; X = Criterion exceeded
Source: 2008 Integrated Report, ODEQ 2008.

Table ES-2 Summary of Indicator Bacteria Samples from Primary Body Contact Recreation Season, 1998-2009

Waterbody ID	Waterbody Name	Indicator	Number of samples	Geometric Mean Concentration (count/100 ml)	Number of samples exceeding single sample criterion	% samples exceeding single sample criterion	2008 303(d)	Notes
OK621000010010_30	Arkansas River, Salt Fork	ENT	33	750	29	88%	X	TMDL required
OK621000020040_00	Wild Horse Creek	EC	8	292	4	50%	X	Insufficient number of samples
		ENT	8	350	7	88%	X	Insufficient number of samples
OK621000020130_00	Spring Creek	EC	6	1070	5	83%	X	Insufficient number of samples
		ENT	6	874	6	100%	X	Insufficient number of samples
		FC	9	782	6	67%	X	TMDL required
OK621000030010_00	Bois d' Arc Creek	EC	22	191	5	23%	X	TMDL required
		ENT	22	191	15	68%	X	TMDL required
		FC	9	1240	5	56%	X	TMDL required
OK621000040010_00	Deer Creek	EC	17	124	4	24%	X	TMDL required
		ENT	17	95	6	35%	X	TMDL required
OK621000050010_00	Pond Creek	EC	17	174	4	24%	X	TMDL required
		ENT	17	289	16	94%	X	TMDL required
OK621000060010_00	Crooked Creek	ENT	15	122	10	67%	X	TMDL required
OK621010010010_00	Arkansas River, Salt Fork	ENT	17	29	2	12%	X	Geomean standard met
OK621010010090_00	Clay Creek	ENT	17	181	11	65%	X	TMDL required
OK621010010160_00	Arkansas River, Salt Fork	EC	39	236	12	31%	X	TMDL required
		ENT	39	1384	37	95%	X	TMDL required
		FC	32	832	24	75%	X	TMDL required
OK621010010230_00	Turkey Creek	EC	21	327	9	43%	X	TMDL required

Waterbody ID	Waterbody Name	Indicator	Number of samples	Geometric Mean Concentration (count/100 ml)	Number of samples exceeding single sample criterion	% samples exceeding single sample criterion	2008 303(d)	Notes
		ENT	21	636	21	100%	X	TMDL required
OK621010010270_00	Yellowstone Creek	ENT	21	91	8	38%	X	TMDL required
OK621010020010_00	Sandy Creek	EC	22	288	9	41%	X	TMDL required
		ENT	22	235	18	82%	X	TMDL required
		FC	8	1413	7	88%	X	TMDL required
OK621010030010_00	Medicine Lodge River	EC	17	247	5	29%	X	TMDL required
		ENT	17	250	13	76%	X	TMDL required
OK621010030030_00	Driftwood Creek	EC	17	176	4	24%	X	TMDL required
		ENT	17	300	13	76%	X	TMDL required
OK621100000010_00	Chikaskia River	EC	17	97	5	29%	X	Geomean standard met
		ENT	17	68	6	35%	X	TMDL required
OK621100000010_10	Chikaskia River	ENT	39	183	21	54%	X	TMDL required
		FC	24	182	8	33%	X	TMDL required
OK621100000010_20	Chikaskia River	ENT					X	No data
OK621100000030_00	Duck Creek	EC	6	122	1	17%	X	Insufficient number of samples
		ENT	6	280	4	67%	X	Insufficient number of samples
OK621100000100_00	Bitter Creek	EC	25	136	4	16%	X	TMDL required
		ENT	25	143	14	56%	X	TMDL required
OK621200010200_00	Arkansas River	ENT	21	187	12	57%	X	TMDL required
OK621200030040_00	Camp Creek	FC	7	409	1	14%	X	Insufficient number of samples
OK621200030270_00	Cow Creek	EC	6	328	1	17%	X	Insufficient number of samples

Waterbody ID	Waterbody Name	Indicator	Number of samples	Geometric Mean Concentration (count/100 ml)	Number of samples exceeding single sample criterion	% samples exceeding single sample criterion	2008 303(d)	Notes
		ENT	6	720	5	83%	X	Insufficient number of samples
OK621200030010_00	Black Bear Creek	EC	18	357	6	33%	X	TMDL required
		ENT	18	357	6	33%	X	TMDL required
		FC	6	581	2	33%	X	Insufficient number of samples
OK621200050010_00	Red Rock Creek	EC	18	390	7	39%	X	TMDL required
		ENT	17	336	11	65%	X	TMDL required
OK621200050010_10	Red Rock Creek	EC	18	357	6	33%	X	TMDL required
OK621200050160_00	Grassy Creek	EC					X	No data
OK621210000030_10	Arkansas River	FC					X	No data
		ENT					X	No data
OK621210000050_10	Beaver Creek	EC	18	357	6	33%	X	TMDL required
		ENT	18	357	6	33%	X	TMDL required
OK621210000270_00	Chilocco Creek	EC	18	357	6	33%	X	TMDL required
		ENT	18	357	6	33%	X	TMDL required

Fecal coliform (FC) water quality criterion = Geometric Mean of 400 counts/100 mL
E. coli (EC) water quality criterion = Geometric Mean of 126 counts/100 mL
Enterococci (ENT) water quality criterion = Geometric Mean of 33 counts/100 mL

The definition of PBCR is 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.*

To implement Oklahoma's WQS for PBCR, the Oklahoma Water Resources Board (OWRB) promulgated Chapter 46, *Implementation of Oklahoma's Water Quality Standards* (OWRB 2008a). 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) Screening levels:

(1) The screening level for fecal coliform shall be a density of 400 colonies per 100 ml.

(2) The screening level for Escherichia coli shall be a density of 235 colonies per 100 ml in streams designated in OAC 785:45 as Scenic Rivers and in lakes, and 406 colonies per 100 ml in all other waters of the state designated as Primary Body Contact Recreation.

(3) The screening level for enterococci shall be a density of 61 colonies per 100 ml in streams designated in OAC 785:45 as Scenic Rivers and in lakes, and 108 colonies per 100 ml in all other waters of the state designated as Primary Body Contact Recreation.

(c) Fecal coliform:

(1) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be fully supported with respect to fecal coliform if the geometric mean of 400 colonies per 100 ml is met and no greater than 25% of the sample concentrations from that waterbody exceed the screening level prescribed in (b) of this Section.

(d) 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, or the sample concentrations from that waterbody taken during the recreation season do not exceed the screening level prescribed in (b) of this Section, or both such conditions exist.

(e) 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, or the sample concentrations from that waterbody taken during the recreation season do not exceed the screening level prescribed in (b) of this Section, or both such conditions exist.

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 2008). Waterbodies placed on the 303(d) list for not supporting the PBCR are the result of individual samples exceeding the instantaneous criteria or the long-term geometric mean of individual samples exceeding the geometric mean criteria for each respective bacterial indicator. Targeting the instantaneous criterion established for the primary contact recreation season (May 1st to September 30th) as the water quality goal for TMDLs corresponds to the basis for 303(d) listing and may be protective of the geometric mean criterion as well as the criteria for the secondary contact recreation season. However, both the instantaneous and geometric mean criteria for *E. coli* and Enterococci will be evaluated as water quality targets to ensure the most protective goal is established for each waterbody.

All TMDLs for fecal coliform must take into account that no more than 25 percent of the samples may exceed the instantaneous numeric criteria. For *E. coli* and Enterococci, no samples may exceed instantaneous criteria. Since the attainability of stream beneficial uses for *E. coli* and Enterococci is based on the compliance of either the instantaneous or a long-term geometric mean criterion, percent reductions goals will be calculated for both criteria. TMDLs will be based on the percent reduction required to meet either the instantaneous or the long-term geometric mean criterion, whichever is less.

If fecal coliform is utilized to establish the TMDL, then the water quality target is the instantaneous water quality criteria (400/100 mL). If *E. coli* is utilized to establish the TMDL, then the water quality target is the instantaneous water quality criterion value (406/100 mL), and the geometric mean water quality target is the geometric mean criterion value (126/100 mL). If Enterococci are utilized to establish the TMDL, then the water quality target is the instantaneous water quality criterion value (108/100 mL) and the geometric mean water quality target is the geometric mean criterion value (33/100 mL). TMDLs for bacteria will incorporate an explicit 10 percent MOS.

After re-evaluating bacteria data for the streams listed in Table ES-1 bacteria TMDLs are not required for the following waterbodies: Wild Horse Creek (OK621000020040_00), Chikaskia River (OK621100000010_20), Duck Creek (OK621100000030_00), Camp Creek (OK621200030040_00), Cow Creek (OK621200030270_00), Grassy Creek (OK621200050160_00), Arkansas River (OK621210000030_10).

Turbidity: 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 water quality data collected from the WQM stations between 1998 and 2009 for turbidity under base flow conditions, which ODEQ considers to be all flows less than the 25th flow exceedance percentile (i.e., the lower 75 percent of flows) Water quality samples collected under flow conditions greater than the 25th flow exceedance percentile (highest flows) were therefore excluded from the data set used for TMDL analysis. Table ES-4 presents a subset of data for TSS samples collected during base flow conditions.

Table ES-3 Summary of Turbidity Samples Collected During Base Flow Conditions, 1998-2009

Waterbody ID	Waterbody Name	WQM Stations	Number of turbidity samples	Number of samples greater than 50 NTU	% samples exceeding criterion	Average Turbidity (NTU)
OK621000010010_30	Arkansas River, Salt Fork	OK621000010010-001AT	11	6	55%	204
OK621000030010_00	Bois d' Arc Creek	OK621000030010C, OK621000030010F	36	6	17%	51
OK621000040010_00	Deer Creek	OK621000040010D	36	12	33%	62
OK621000050010_00	Pond Creek	OK621000050010D	35	18	51%	128
OK621000060010_00	Crooked Creek	OK621000060010C	35	12	34%	64
OK621010010010_00	Arkansas River, Salt Fork	OK621010010010D	40	33	83%	146
OK621010010160_00	Arkansas River, Salt Fork	OK621010010160-001AT	34	22	65%	141
OK621010010230_00	Turkey Creek	OK621010010230G	60	18	30%	46
OK621010030010_00	Medicine Lodge River	OK621010030010D	38	12	32%	87
OK621010030030_00	Driftwood Creek	OK621010030030C	41	16	39%	83
OK621100000010_00	Chikaskia River	OK621100000010B	20	8	40%	45
OK621100000010_10	Chikaskia River	OK621100000010-001AT, OK621100000010M	60	17	28%	68
OK621100000100_00	Bitter Creek	621100-00-0100G	54	17	31%	40
OK621200010200_00	Arkansas River	OK621200010200-001AT	15	3	20%	52
OK621200050010_00	Red Rock Creek	OK621200050010K	31	19	61%	145
OK621200050010_10	Red Rock Creek	OK621200050010M	33	18	55%	111
OK621210000270_00	Chilocco Creek	OK621210-00-0270C	23	6	26%	39

Table ES-4 Summary of TSS Samples During Base Flow Conditions, 1998-2009

Waterbody ID	Waterbody Name	WQM Stations	Number of TSS samples	Average TSS (mg/L)
OK621000010010_30	Arkansas River, Salt Fork	OK621000010010-001AT	0	-
OK621000030010_00	Bois d' Arc Creek	OK621000030010C, OK621000030010F	36	36
OK621000040010_00	Deer Creek	OK621000040010D	36	52
OK621000050010_00	Pond Creek	OK621000050010D	34	79
OK621000060010_00	Crooked Creek	OK621000060010C	33	41
OK621010010010_00	Arkansas River, Salt Fork	OK621010010010D	38	103
OK621010010160_00	Arkansas River, Salt Fork	OK621010010160-001AT	18	220
OK621010010230_00	Turkey Creek	OK621010010230G	59	37
OK621010030010_00	Medicine Lodge River	OK621010030010D	36	72
OK621010030030_00	Driftwood Creek	OK621010030030C	40	65
OK621100000010_00	Chikaskia River	OK621100000010B	18	58
OK621100000010_10	Chikaskia River	OK621100000010-001AT, OK621100000010M	49	107
OK621100000100_00	Bitter Creek	621100-00-0100G	53	45
OK621200010200_00	Arkansas River	OK621200010200-001AT	7	45
OK621200050010_00	Red Rock Creek	OK621200050010K	30	61
OK621200050010_10	Red Rock Creek	OK621200050010M	33	57
OK621210000270_00	Chilocco Creek	OK621210-00-0270C	21	29

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).

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 exceed 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 percent 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-5 provides the results of the waterbody specific regression analysis.

Table ES-5 Regression Statistics and TSS Goals

Waterbody ID	Waterbody Name	R-square	NRMSE	TSS Goal (mg/L)[a]	MOS[b]
OK621000010010_30	Arkansas River, Salt Fork	0.814	12.4%	47	15%
OK621000030010_00	Bois d' Arc Creek	0.860	9.1%	52	10%
OK621000040010_00	Deer Creek	0.863	9.4%	47	10%
OK621000050010_00	Pond Creek	0.933	8.3%	42	10%
OK621000060010_00	Crooked Creek	0.888	8.7%	44	10%
OK621010010010_00	Arkansas River, Salt Fork	0.894	5.4%	41	10%
OK621010010160_00	Arkansas River, Salt Fork	0.880	8.2%	82	10%
OK621010010230_00	Turkey Creek	0.607	17.9%	49	20%
OK621010030010_00	Medicine Lodge River	0.878	9.8%	59	15%
OK621010030030_00	Driftwood Creek	0.904	7.7%	52	10%
OK621100000010_00	Chikaskia River, Lower	0.913	7.9%	57	10%
OK621100000010_10	Chikaskia River, Upper	0.745	14.7%	75	15%
OK621100000100_00	Bitter Creek	0.761	11.6%	61	15%
OK621200010200_00	Arkansas River	0.772	9.7%	80	10%
OK621200050010_00	Red Rock Creek, Lower	0.780	11.1%	35	15%
OK621200050010_10	Red Rock Creek, Upper	0.816	12.3%	38	15%
OK621210000270_00	Chilocco Creek	0.624	14.3%	39	15%

[a] WQ goal minus MOS

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; some plant life 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 are required to monitor for one of the three bacterial indicators (fecal coliform, *E coli*, or Enterococci) and 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 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-6 Summary of Potential Pollutant Sources by Category

Waterbody ID	Waterbody Name	Municipal NPDES Facility	Industrial NPDES Facility	MS4	NPDES No Discharge Facility	CAFO	Mines	Nonpoint Source
OK621000010010_30	Arkansas River, Salt Fork							TSS
OK621000020130_00	Spring Creek							Bacteria
OK621000030010_00	Bois d' Arc Creek							Bacteria, TSS
OK621000040010_00	Deer Creek							Bacteria, TSS
OK621000050010_00	Pond Creek							Bacteria, TSS
OK621000060010_00	Crooked Creek							Bacteria, TSS
OK621010010010_00	Arkansas River, Salt Fork							Bacteria, TSS
OK621010010090_00	Clay Creek							Bacteria
OK621010010160_00	Arkansas River, Salt Fork							Bacteria, TSS
OK621010010230_00	Turkey Creek							Bacteria, TSS
OK621010010270_00	Yellowstone Creek							Bacteria
OK621010020010_00	Sandy Creek							Bacteria
OK621010030010_00	Medicine Lodge River							Bacteria, TSS
OK621010030030_00	Driftwood Creek							Bacteria, TSS
OK621100000010_00	Chikaskia River							Bacteria, TSS

Waterbody ID	Waterbody Name	Municipal NPDES Facility	Industrial NPDES Facility	MS4	NPDES No Discharge Facility	CAFO	Mines	Nonpoint Source
OK621100000010_10	Chikaskia River							Bacteria, TSS
OK621100000100_00	Bitter Creek							Bacteria, TSS
OK621200010200_00	Arkansas River							Bacteria, TSS
OK621200030010_00	Black Bear Creek							Bacteria
OK621200050010_00	Red Rock Creek							Bacteria, TSS
OK621200050010_10	Red Rock Creek							Bacteria, TSS
OK621210000050_10	Beaver Creek							Bacteria
OK621210000270_00	Chilocco Creek							Bacteria, TSS

Facility present in watershed.

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

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 are effective at identifying whether impairments are associated with point or nonpoint sources. 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 bacteria 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);
- sorting the flow data and calculating flow exceedance percentiles for the time period and season of interest;
- 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;
- matching the water quality observations with the flow data from the same date;
- 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 bacteria 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;
- 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 equation); or multiplying the flow by the bacteria indicator concentration to calculate daily loads; then

- plotting the flow exceedance percentiles and daily load observations in a load duration plot.

For bacteria 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 = 400 cfu /100 mL (Fecal coliform); 406 cfu/100 mL (E. coli); or 108 cfu/100 mL (Enterococci)

unit conversion factor = 24,465,525 mL*s / ft3*day

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 4-1***

unit conversion factor = 5.39377 L*s*lb /(ft^3 ****day*mg)***

Historical observations of bacteria, TSS and/or turbidity concentrations are paired with flow data and are plotted as separate LDCs. The fecal coliform load (or the y-value of each point) is calculated by multiplying the fecal coliform concentration (colonies/100 mL) by the instantaneous flow (cubic feet per second[cfs]) at the same site and time, with appropriate volumetric and time unit conversions. Fecal coliform/*E. coli*/Enterococci loads representing exceedance of water quality criteria fall above the water quality criterion line. Likewise, the TSS load (or the y-value of each point) is calculated by multiplying the TSS concentration (measured or converted from turbidity) (mg/L) by the instantaneous flow (cfs) at the same site and time, with appropriate volumetric and time unit conversions. TSS loads representing exceedance of water quality criteria fall above the TMDL line.

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 effluent limitations and water quality.

This definition can be expressed by the following equation:

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

For each waterbody the TMDLs presented in this report are expressed as a percent reduction across the full range of flow conditions. The difference between existing loading and the water quality target is used to calculate the loading reductions required. PRG are calculated for each waterbody and bacterial indicator species as the reductions in load required so no existing instantaneous water quality observations would exceed the water quality target for *E. coli* and Enterococci and no more than 25 percent of the samples exceed the water quality target for fecal coliform.

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. Selection of the appropriate PRG for each waterbody in Table ES-7 is denoted by bold text. The TMDL PRG will be the lesser of that required to meet the geometric mean or instantaneous criteria for *E. coli* and

Enterococci because WQSs are considered to be met if, 1) either the geometric mean of all data is less than the geometric mean criteria, or 2) no samples exceed the instantaneous criteria. The PRGs range from 0 to 96 percent.

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

Waterbody ID	Waterbody Name	Required Reduction Rate				
		FC	EC		ENT	
		Instant-aneous	Instant-aneous	Geo-mean	Instant-aneous	Geo-mean
OK621000010010_30	Arkansas River, Salt Fork				99.0%	**96.0%**
OK621000020130_00	Spring Creek	**71.0%**				
OK621000030010_00	Bois d' Arc Creek	**88.0%**	82.0%	**40.8%**	99.1%	**84.4%**
OK621000040010_00	Deer Creek		82.0%	**8.3%**	98.1%	**68.7%**
OK621000050010_00	Pond Creek		78.0%	**34.7%**	95.0%	**89.7%**
OK621000060010_00	Crooked Creek				92.0%	**75.7%**
OK621010010010_00	Arkansas River, Salt Fork				91.0%	**0.0%**
OK621010010090_00	Clay Creek				95.0%	**83.6%**
OK621010010160_00	Arkansas River, Salt Fork	**80.0%**	95.0%	**57.4%**	99.5%	**97.6%**
OK621010010230_00	Turkey Creek		82.0%	**65.4%**	98.1%	**95.3%**
OK621010010270_00	Yellowstone Creek				96.0%	**67.3%**
OK621010020010_00	Sandy Creek	**95.2%**	94.0%	**60.6%**	95.0%	**87.3%**
OK621010030010_00	Medicine Lodge River		73.0%	**54.1%**	94.5%	**88.1%**
OK621010030030_00	Driftwood Creek		91.0%	**35.4%**	98.2%	**90.1%**
OK621100000010_00	Chikaskia River, Lower		82.0%	**0.0%**	95.2%	**56.0%**
OK621100000010_10	Chikaskia River, Upper	**64.0%**			99.2%	**83.8%**
OK621100000100_00	Bitter Creek		79.0%	**16.6%**	98.1%	**79.2%**
OK621200010200_00	Arkansas River				95.6%	**84.1%**
OK621200030010_00	Black Bear Creek		93.5%	**51.6%**	99.1%	**87.6%**
OK621200050010_00	Red Rock Creek, Lower		95.0%	**70.9%**	99.1%	**91.2%**
OK621200050010_10	Red Rock Creek, Upper		93.0%	**68.3%**		
OK621210000050_10	Beaver Creek		94.0%	**55.4%**	98.6%	**87.6%**
OK621210000270_00	Chilocco Creek		75.0%	**39.1%**	91.0%	**79.2%**

Similarly, percent reduction goals for TSS are calculated as the required overall reduction so that no more than 10 percent of the samples exceed the water quality target for TSS. The PRGs for the seventeen waterbodies included in this TMDL report are summarized in Table ES-8 and range from 43 to 89 percent.

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

Waterbody ID	Waterbody Name	Required Reduction Rate
OK621000010010_30	Arkansas River, Salt Fork	89%
OK621000030010_00	Bois d' Arc Creek	43%
OK621000040010_00	Deer Creek	60%
OK621000050010_00	Pond Creek	82%
OK621000060010_00	Crooked Creek	51%
OK621010010010_00	Arkansas River, Salt Fork	82%
OK621010010160_00	Arkansas River, Salt Fork	85%
OK621010010230_00	Turkey Creek	52%
OK621010030010_00	Medicine Lodge River	67%
OK621010030030_00	Driftwood Creek	70%
OK621100000010_00	Chikaskia River, Lower	44%
OK621100000010_10	Chikaskia River, Upper	54%
OK621100000100_00	Bitter Creek	50%
OK621200010200_00	Arkansas River	51%
OK621200050010_00	Red Rock Creek, Lower	85%
OK621200050010_10	Red Rock Creek, Upper	77%
OK621210000270_00	Chilocco Creek	44%

The TMDL, WLA, LA, and MOS vary with flow condition, and are calculated at every 5^{th} flow interval percentile. The WLA component of each TMDL is the sum of all WLAs within each contributing watershed. The sum of the WLAs can be represented as a single line below the LDC. The LDC and the simple equation of:

$$\textit{Average LA = average TMDL – MOS - } \sum \textit{WLA}$$

can provide an individual value for the LA in counts per day, which represents the area under the TMDL target line and above the WLA line.

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 bacteria TMDLs, an explicit MOS was set at 10 percent.

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 MOS. The selection of MOS is based on the normalized root mean square error (NRMSE) for each waterbody. The explicit MOS ranges from 10 percent to 20 percent.

The bacteria TMDLs established in this report adhere to the seasonal application of the Oklahoma WQS which limits the PBCR use to the period of May 1^{st} through September 30^{th}.

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 5 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

As authorized by Section 402 of the CWA, ODEQ has delegation of the NPDES in Oklahoma, except for certain jurisdictional areas related to agriculture and the oil and gas industry retained by the Oklahoma Department of Agriculture and Oklahoma Corporation Commission, for which the USEPA has retained permitting authority. The NPDES program in Oklahoma is implemented via Title 252, Chapter 606 of the Oklahoma Pollution Discharge Elimination System (OPDES) Act, and in accordance with the agreement between ODEQ and USEPA relating to administration and enforcement of the delegated NPDES program. Implementation of WLAs for point sources is done through permits issued under the OPDES program. The pollutant reduction rates called for in this TMDL report are as high as 99 percent. The ODEQ recognizes that achieving such high reductions will be a challenge, especially since unregulated nonpoint sources are a major cause of both bacteria 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.

SECTION 1
INTRODUCTION

1.1 TMDL Program Background

Section 303(d) of the Clean Water Act (CWA) and U.S. Environmental Protection Agency (USEPA) Water Quality Planning and Management Regulations (40 Code of Federal Regulations [CFR] Part 130) require states to develop total maximum daily loads (TMDLs) for waterbodies not meeting designated uses where technology-based controls are in place. 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 (USEPA 1991).

This report documents the data and assessment used to establish TMDLs for the pathogen indicator bacteria [fecal coliform, *Escherichia coli (E. coli)*, Enterococci] and turbidity for selected waterbodies in the Salt Fork of the Arkansas River basin. (All future references to bacteria in this document imply these three classes of fecal pathogen indicator bacteria 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), USEPA guidance, and Oklahoma Department of Environmental Quality (ODEQ) guidance and procedures. ODEQ is required to submit all TMDLs to USEPA for review and approval. Once the USEPA 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 (USEPA 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. The 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 ODEQ 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, which are presented upstream to downstream, include:

- Arkansas River, Salt Fork (OK621000010010_30),
- Spring Creek (OK621000020130_00),
- Bois d' Arc Creek (OK621000030010_00),
- Deer Creek (OK621000040010_00),
- Pond Creek (OK621000050010_00),
- Crooked Creek (OK621000060010_00),
- Arkansas River, Salt Fork (OK621010010010_00),
- Clay Creek (OK621010010090_00),
- Arkansas River, Salt Fork (OK621010010160_00),
- Turkey Creek (OK621010010230_00),
- Yellowstone Creek (OK621010010270_00),
- Sandy Creek (OK621010020010_00),
- Medicine Lodge River (OK621010030010_00),
- Driftwood Creek (OK621010030030_00),
- Chikaskia River (OK621100000010_00),
- Chikaskia River (OK621100000010_10),
- Bitter Creek (OK621100000100_00),
- Arkansas River (OK621200010200_00),
- Black Bear Creek (OK621200030010_00),
- Red Rock Creek (OK621200050010_00),
- Red Rock Creek (OK621200050010_10),
- Beaver Creek (OK621210000050_10), and
- Chilocco Creek (OK621210000270_00).

Figures 1-1 and 1-2 are location maps showing 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 Upper Salt Fork of the Arkansas River Watersheds Not Supporting Primary Body Contact Recreation or Fish and Wildlife Propagation

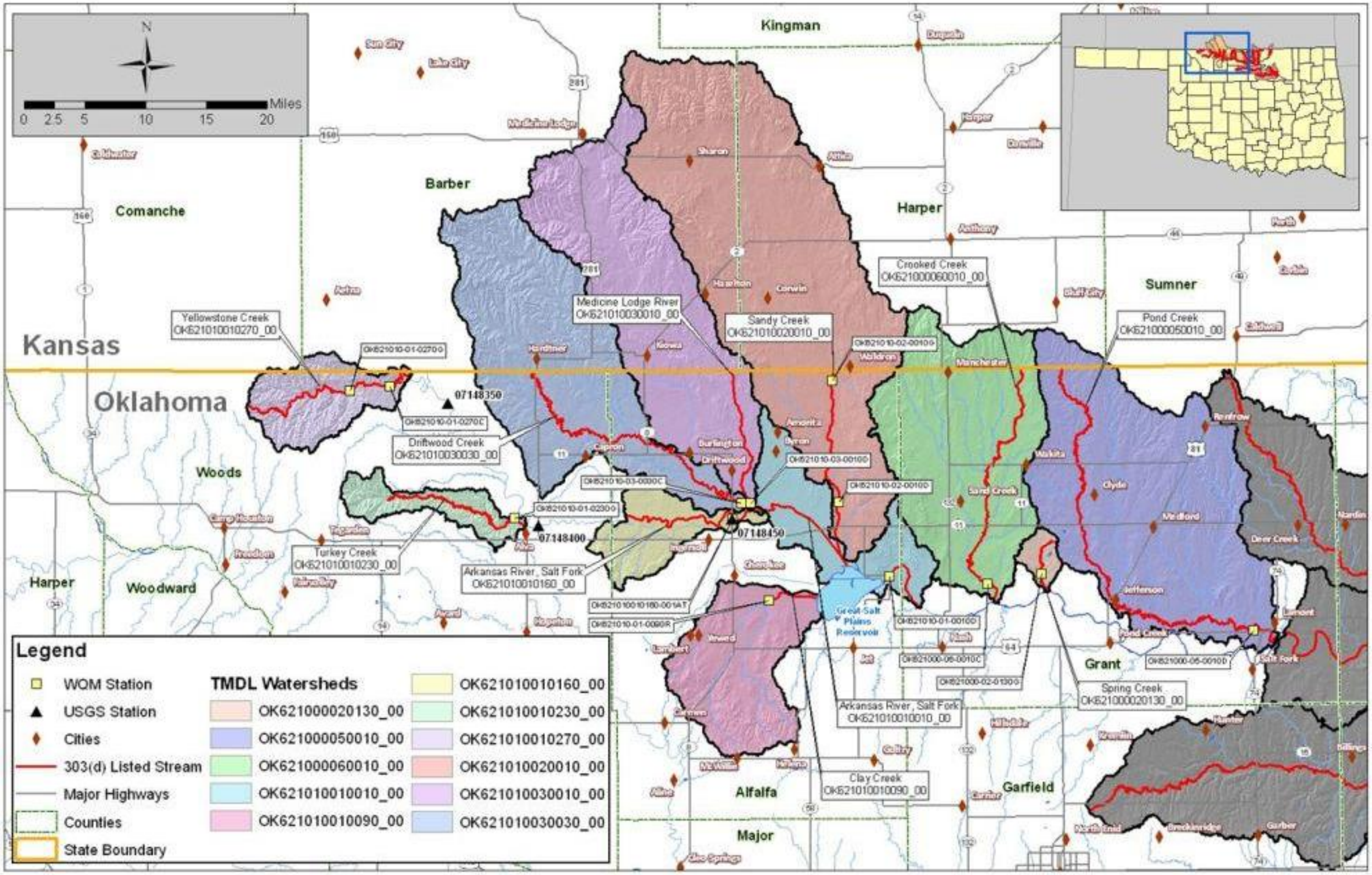
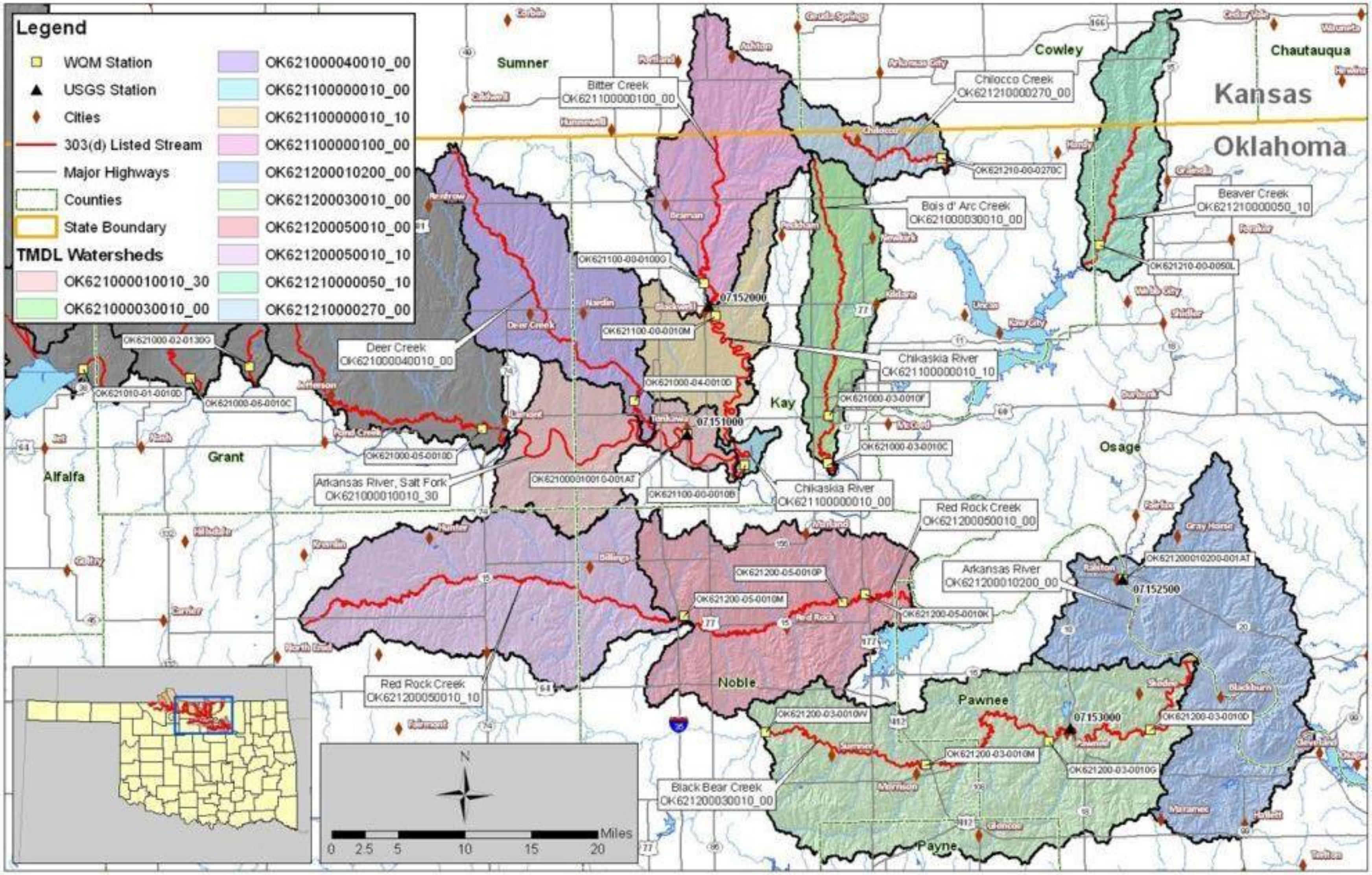


Figure 1-2 Lower Salt Fork of the Arkansas River Watersheds Not Supporting Primary Body Contact Recreation or Fish and Wildlife Propagation Use



Elevated levels of pathogen indicator bacteria or turbidity above the WQS 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 PBCR 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 2008 303(d) Listing Decision

Station ID	Waterbody Name	Description	WBID
OK621000010010-001AT	Arkansas River, Salt Fork	Salt Fork Arkansas River At US77 At Tonkawa, OK	OK621000010010_30
OK621000-02-0130G	Spring Creek	Section 12-26N-7W	OK621000020130_00
OK621000-03-0010C	Bois d'Arc Creek	SE SE SE Section 18-25N-2E	OK621000030010_00
OK621000-03-0010F	Bois d'Arc Creek	NW Section 32-26N-2E	OK621000030010_00
OK621000-04-0010D	Deer Creek	NE NE NW Section 26-26N-2W	OK621000040010_00
OK621000-05-0010D	Pond Creek	SE SE SE Section 35-26N-4W	OK621000050010_00
OK621000-06-0010C	Crooked Creek	NW SW SW Section 8-26N-7W	OK621000060010_00
OK621010-01-0010D	Salt Fork of Arkansas River	NE NE NE Section 11-26N-9W	OK621010010010_00
OK621010-01-0090R	Clay Creek	NE NE NE Section 19-26N-10W	OK621010010090_00
OK621010010160-001AT	Arkansas River, Salt Fork	Salt Fork Arkansas River At SH 58 Near Ingersoll, OK	OK621010010160_00
OK621010-01-0230G	Turkey Creek	SW NW NW Section 14-27N-14W	OK621010010230_00
OK621010-01-0270C	Yellowstone Creek	NW SW NW SECTION 19-29N-15W	OK621010010270_00
OK621010-01-0270G	Yellowstone Creek	SE NW SE SECTION 21-29N-16W	OK621010010270_00
OK621010-02-0010D	Sandy Creek	SW SE SE Section 6-27N-9W	OK621010020010_00
OK621010-02-0010G	Sandy Creek	Section 18-29N-9W	OK621010020010_00
OK621010-03-0010D	Medicine Lodge River	S.B. Section 1-27N-11W	OK621010030010_00
OK621010-03-0030C	Driftwood Creek	SE SW SE Section 2-27N-11W	OK621010030030_00
OK621100-00-0010B	Chickaskia River: Lower	S.B. Section 18-25N-1E	OK621100000010_00
OK621100-00-0010M	Chickaskia River: Upper	NE NE NE Section 9-27N-1W	OK621100000010_10
OK621100-00-0100G	Bitter Creek	SW NW NW Section 11-27N-1W	OK621100000100_00
OK621200010200-001AT	Arkansas River	Arkansas River At SH 18 At Ralston, OK	OK621200010200_00
OK621200-03-0010D	Black Bear Creek: Lower	Sections 31/32 22N-6E	OK621200030010_00
OK621200-03-0010G	Black Bear Creek: Lower	SE NW NE Section 1-21N-4E	OK621200030010_00
OK621200-03-0010M	Black Bear Creek: Lower	W.B. Section 9-21N-3E	OK621200030010_00
OK621200-03-0010W	Black Bear Creek: Upper	NE NE NE Section 32-22N-1E	OK621200030010_00
OK621200-05-0010K	Red Rock Creek: Lower	SW SE Section 3-23N-2E	OK621200050010_00
OK621200-05-0010P	Red Rock Creek: Lower	W.B. Section 16-23N-1E	OK621200050010_00
OK621200-05-0010M	Red Rock Creek: Upper	SW NW NW SECTION 16-23N-1W	OK621200050010_10
OK621210-00-0050L	Beaver Creek	N.B. Section 34-28N-5E	OK621210000050_10
OK621210-00-0270C	Chilocco Creek	W.B. Section 26-29N-3E	OK621210000270_00

1.2 Watershed Description

General. The Salt Fork of the Arkansas River is located in the northern portion of Oklahoma and southern portion of Kansas. The majority of the waterbodies addressed in this report are located in Alfalfa, Garfield, Grant, Kay, Noble, Osage, Pawnee and Woods Counties of Oklahoma. The southern section of Black Bear Creek (OK621200030010_00) is located in Payne County. 34.6 percent of the Study Area is located in Barber, Comanche, Cowley, Harper and Sumner Counties of Kansas. These counties are part of the Prarie Tableland, Cross Timbers Transition, Flint Hills, North Cross Timbers and Osage Cuestas ecoregions of Oklahoma (Woods, A.J, Omerik, J.M., et al 2005).

The watersheds in the Study Area are located in the Northern Shelf and Nemaha Ridge geological provinces (ODEQ 2008). Table 1-2, derived from the 2000 U.S. Census, demonstrates that the counties in which these watersheds are located are sparsely populated (U.S. Census Bureau 2000). Table 1-3 lists the towns and cities located in each watershed.

Table 1-2 County Population and Density

County Name	Population (2000 Census)	Population Density (per square mile)
Oklahoma		
Alfalfa	6,105	7
Garfield	57,813	55
Grant	5,144	5
Kay	48,080	51
Noble	11,411	15
Osage	44,437	19
Pawnee	16,612	28
Payne	68,190	98
Woods	9,089	7
Kansas		
Barber	5,307	5
Comanche	1,967	2
Cowley	36,291	32
Harper	6,536	8
Sumner	25,946	22

Table 1-3 Towns and Cities by Watershed

Waterbody Name	Waterbody ID	Municipalities
Arkansas River, Salt Fork	OK621000010010_30	Tonkawa
Spring Creek	OK621000020130_00	Newkirk, Kildare
Bois d' Arc Creek	OK621000030010_00	
Deer Creek	OK621000040010_00	Deer Creek
Pond Creek	OK621000050010_00	Renfrow, Medford, Jefferson
Crooked Creek	OK621000060010_00	Manchester, Wakita
Arkansas River, Salt Fork	OK621010010010_00	Amorita, Byron
Clay Creek	OK621010010090_00	Lambert
Arkansas River, Salt Fork	OK621010010160_00	
Turkey Creek	OK621010010230_00	
Yellowstone Creek	OK621010010270_00	
Sandy Creek	OK621010020010_00	Sharon, Attica, Hazelton, Waldron
Medicine Lodge River	OK621010030010_00	Kiowa, Burlington
Driftwood Creek	OK621010030030_00	Hardtner, Capron
Chikaskia River	OK621100000010_00	
Chikaskia River	OK621100000010_10	Blackwell
Bitter Creek	OK621100000100_00	Braman
Arkansas River	OK621200010200_00	Ralston, Blackburn, Maramec, Hallett
Black Bear Creek	OK621200030010_00	Skedee, Pawnee, Morrison, Glencoe
Red Rock Creek	OK621200050010_00	Red Rock
Red Rock Creek	OK621200050010_10	Hunter, Billings
Beaver Creek	OK621210000050_10	
Chilocco Creek	OK621210000270_00	

Climate. Table 1-4 summarizes the average annual precipitation for each Oklahoma waterbody in the Study Area. NOAA National Climatic Data Center precipitation data was downloaded from Mesonet from 1971-2000. Annual precipitation for each watershed was calculated using an area weighted average based on Thiessen Polygons for each station. Average annual precipitation values among the watersheds in this portion of Oklahoma range between 24 and 38.7 inches (http://www.mesonet.org/index.php).

Table 1-4 Average Annual Precipitation by Watershed

Waterbody Name	Waterbody ID	Average Annual Precipitation (Inches)
Arkansas River, Salt Fork	OK621000010010_30	35.7
Spring Creek	OK621000020130_00	34.6
Bois d' Arc Creek	OK621000030010_00	37.3
Deer Creek	OK621000040010_00	35.1
Pond Creek	OK621000050010_00	34.4
Crooked Creek	OK621000060010_00	31.6
Arkansas River, Salt Fork	OK621010010010_00	31.3
Clay Creek	OK621010010090_00	31.4
Arkansas River, Salt Fork	OK621010010160_00	30.0
Turkey Creek	OK621010010230_00	27.0
Yellowstone Creek	OK621010010270_00	24.1
Sandy Creek	OK621010020010_00	30.3
Medicine Lodge River	OK621010030010_00	29.3
Driftwood Creek	OK621010030030_00	27.6
Chikaskia River	OK621100000010_00	36.3
Chikaskia River	OK621100000010_10	35.4
Bitter Creek	OK621100000100_00	36.1
Arkansas River	OK621200010200_00	38.7
Black Bear Creek	OK621200030010_00	37.6
Red Rock Creek	OK621200050010_00	36.3
Red Rock Creek	OK621200050010_10	35.5
Beaver Creek	OK621210000050_10	37.9
Chilocco Creek	OK621210000270_00	38.0

Land Use. Tables 1-5a through 1-5d 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 Figure 1-3. The two most dominant land use categories throughout the Study Area are cultivated crops and grasslands/herbaceous. Two watersheds in the Study Area do have a significant percentage of land use classified as Deciduous Forest including Arkansas River (OK621200010200_00) and Black Bear Creek (OK621200030010_00). The Bois d' Arc Creek (OK621000030010_00) watershed has a significant percentage of land use classified as Pasture/Hay. The aggregated total of low, medium, and high intensity developed land account for less than 2 percent of the land use in each watershed, except for Bois d' Arc Creek (OK621000030010_00) which accounts for 4.6 percent. The watersheds targeted for TMDL development in this Study Area range in size from 4,819 acres (Chikaskia River, OK621100000010_00) to 296,734 acres (Sandy Creek, OK621010020010_00).

Figure 1-3 Land Use Map

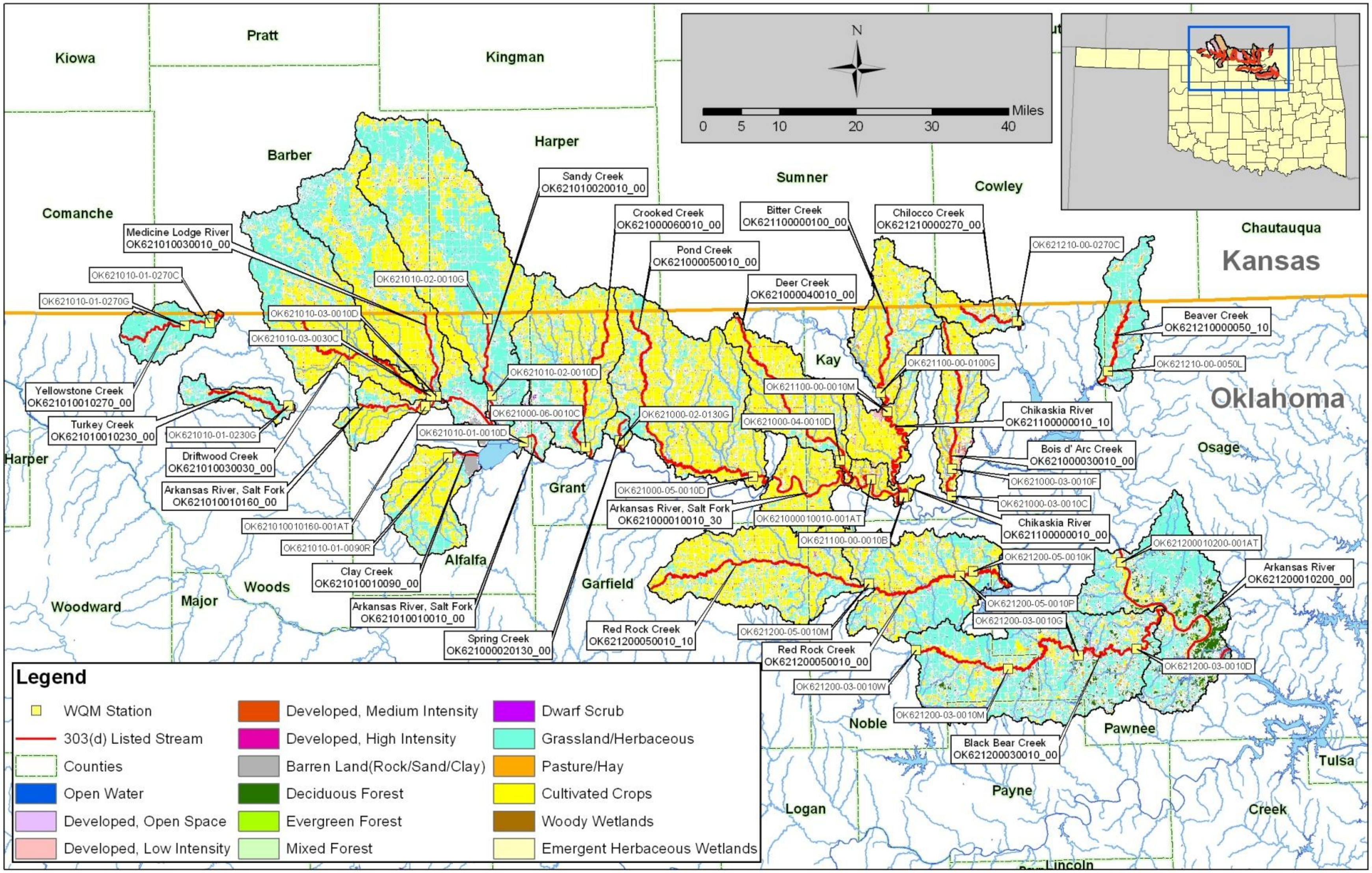


Table 1-5a Land Use Summaries by Watershed

Land Use Category	Watershed					
	Arkansas River, Salt Fork	Spring Creek	Bois d' Arc Creek	Deer Creek	Pond Creek	Crooked Creek
Waterbody ID	**OK621000010010_30**	**OK621000020130_00**	**OK621000030010_00**	**OK621000040010_00**	**OK621000050010_00**	**OK621000060010_00**
Percent of Open Water	1.73%	0.71%	0.32%	0.29%	0.39%	0.29%
Percent of Developed, Open Space	4.74%	3.66%	5.33%	4.29%	4.35%	3.91%
Percent of Developed, Low Intensity	1.22%	0.21%	3.42%	0.26%	0.48%	0.40%
Percent of Developed, Medium Intensity	0.17%	0.00%	0.83%	0.02%	0.06%	0.02%
Percent of Developed, High Intensity	0.03%	0.00%	0.30%	0.00%	0.01%	0.00%
Percent of Barren Land (Rock/Sand/Clay)	0.01%	0.00%	0.01%	0.00%	0.01%	0.01%
Percent of Deciduous Forest	0.80%	0.38%	0.80%	0.25%	0.10%	1.32%
Percent of Evergreen Forest	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Percent of Mixed Forest	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Percent of Shrub/Scrub	0.07%	0.04%	0.17%	0.05%	0.03%	0.59%
Percent of Grassland/Herbaceous	9.18%	50.63%	19.32%	15.53%	27.30%	36.81%
Percent of Pasture/Hay	6.42%	0.00%	10.17%	1.97%	0.35%	0.15%
Percent of Cultivated Crops	71.19%	41.73%	55.87%	74.69%	63.76%	54.65%
Percent of Woody Wetlands	4.10%	1.61%	3.19%	2.36%	2.03%	1.35%
Percent of Emergent Herbaceous Wetlands	0.34%	1.03%	0.27%	0.29%	1.13%	0.49%
Acres Open Water	1,279	54	201	291	826	446
Acres Developed, Open Space	3,501	279	3,370	4,313	9,218	5,959
Acres Developed, Low Intensity	900	16	2,161	257	1,011	617
Acres Developed, Medium Intensity	129	0	522	16	135	33
Acres Developed, High Intensity	24	0	190	0	28	2
Acres Barren Land (Rock/Sand/Clay)	7	0	4	0	22	8
Acres Deciduous Forest	590	29	507	251	206	2,004
Acres Evergreen Forest	3	0	0	0	0	0
Acres Mixed Forest	0	0	0	0	0	8
Acres Shrub/Scrub	48	3	110	52	56	898
Acres Grassland/Herbaceous	6,779	3,862	12,215	15,599	57,917	56,079
Acres Pasture/Hay	4,740	0	6,427	1,976	746	228
Acres Cultivated Crops	52,576	3,183	35,319	75,014	135,253	83,260
Acres Woody Wetlands	3,028	123	2,017	2,373	4,301	2,064
Acres Emergent Herbaceous Wetlands	252	79	170	286	2,397	749
Total (Acres)	**73,856**	**7,628**	**63,213**	**100,428**	**212,118**	**152,355**

Table 1-5b Land Use Summaries by Watershed

Land Use Category	Watershed					
	Arkansas River, Salt Fork	Clay Creek	Arkansas River, Salt Fork	Turkey Creek	Yellowstone Creek	Sandy Creek
Waterbody ID	**OK621010010010_00**	**OK621010010090_00**	**OK621010010160_00**	**OK621010010230_00**	**OK621010010270_00**	**OK621010020010_00**
Percent of Open Water	11.10%	2.20%	2.37%	1.60%	1.04%	0.79%
Percent of Developed, Open Space	3.75%	3.72%	4.14%	3.16%	2.05%	3.54%
Percent of Developed, Low Intensity	0.73%	0.29%	0.25%	0.69%	0.03%	0.22%
Percent of Developed, Medium Intensity	0.03%	0.02%	0.00%	0.04%	0.00%	0.02%
Percent of Developed, High Intensity	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%
Percent of Barren Land (Rock/Sand/Clay)	5.79%	4.82%	0.21%	0.01%	0.00%	0.02%
Percent of Deciduous Forest	2.57%	0.30%	1.13%	2.10%	2.41%	1.81%
Percent of Evergreen Forest	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%
Percent of Mixed Forest	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Percent of Shrub/Scrub	3.06%	0.00%	0.02%	0.00%	0.01%	0.09%
Percent of Grassland/Herbaceous	47.98%	31.57%	25.09%	71.06%	89.47%	57.15%
Percent of Pasture/Hay	0.31%	0.03%	0.04%	0.00%	0.00%	0.09%
Percent of Cultivated Crops	18.17%	56.78%	65.18%	21.04%	4.80%	35.71%
Percent of Woody Wetlands	4.25%	0.03%	1.55%	0.29%	0.18%	0.50%
Percent of Emergent Herbaceous Wetlands	2.24%	0.21%	0.00%	0.00%	0.01%	0.06%
Acres Open Water	6,165	1,703	828	395	437	2,333
Acres Developed, Open Space	2,086	2,880	1,447	779	860	10,497
Acres Developed, Low Intensity	403	225	87	170	11	667
Acres Developed, Medium Intensity	19	14	0	9	0	56
Acres Developed, High Intensity	6	7	0	0	0	6
Acres Barren Land (Rock/Sand/Clay)	3,217	3,725	73	2	0	67
Acres Deciduous Forest	1,426	233	395	519	1,010	5,358
Acres Evergreen Forest	0	14	0	0	0	0
Acres Mixed Forest	0	0	1	0	0	23
Acres Shrub/Scrub	1,701	0	6	1	2	275
Acres Grassland/Herbaceous	26,657	24,426	8,760	17,523	37,500	169,583
Acres Pasture/Hay	171	24	15	0	0	262
Acres Cultivated Crops	10,097	43,931	22,755	5,190	2,014	105,959
Acres Woody Wetlands	2,361	22	542	72	74	1,476
Acres Emergent Herbaceous Wetlands	1,247	159	2	1	5	170
Total (Acres)	**55,557**	**77,364**	**34,911**	**24,660**	**41,913**	**296,734**

Table 1-5c Land Use Summaries by Watershed

Land Use Category	Watershed					
	Medicine Lodge River	Driftwood Creek	Chikaskia River	Chikaskia River	Bitter Creek	Arkansas River
Waterbody ID	**OK621010030010_00**	**OK621010030030_00**	**OK621100000010_00**	**OK621100000010_10**	**OK621100000100_00**	**OK621200010200_00**
Percent of Open Water	1.76%	0.52%	2.99%	1.27%	0.28%	2.78%
Percent of Developed, Open Space	3.82%	3.90%	3.58%	5.35%	5.18%	3.68%
Percent of Developed, Low Intensity	0.36%	0.18%	0.18%	2.76%	0.47%	0.16%
Percent of Developed, Medium Intensity	0.07%	0.02%	0.00%	0.39%	0.03%	0.06%
Percent of Developed, High Intensity	0.01%	0.00%	0.00%	0.07%	0.00%	0.00%
Percent of Barren Land (Rock/Sand/Clay)	0.01%	0.01%	0.09%	0.00%	0.00%	0.04%
Percent of Deciduous Forest	1.22%	0.80%	4.16%	0.55%	0.92%	25.02%
Percent of Evergreen Forest	0.00%	0.00%	0.00%	0.00%	0.00%	0.79%
Percent of Mixed Forest	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Percent of Shrub/Scrub	0.03%	0.00%	0.24%	0.04%	0.00%	0.00%
Percent of Grassland/Herbaceous	36.05%	40.18%	2.10%	9.24%	22.54%	59.59%
Percent of Pasture/Hay	0.16%	0.25%	6.31%	7.92%	6.36%	2.02%
Percent of Cultivated Crops	56.18%	53.93%	70.26%	69.75%	62.28%	5.82%
Percent of Woody Wetlands	0.32%	0.22%	9.86%	2.37%	1.84%	0.00%
Percent of Emergent Herbaceous Wetlands	0.00%	0.00%	0.24%	0.30%	0.09%	0.04%
Acres Open Water	2,921	866	144	706	248	5,082
Acres Developed, Open Space	6,349	6,520	173	2,977	4,562	6,734
Acres Developed, Low Intensity	602	298	9	1,534	414	302
Acres Developed, Medium Intensity	117	25	0	216	30	107
Acres Developed, High Intensity	21	2	0	40	2	9
Acres Barren Land (Rock/Sand/Clay)	23	12	4	2	4	75
Acres Deciduous Forest	2,028	1,334	201	308	812	45,789
Acres Evergreen Forest	7	6	0	0	0	1,450
Acres Mixed Forest	5	2	0	0	0	0
Acres Shrub/Scrub	42	4	11	22	1	0
Acres Grassland/Herbaceous	59,887	67,156	101	5,144	19,840	109,051
Acres Pasture/Hay	259	412	304	4,410	5,598	3,693
Acres Cultivated Crops	93,322	90,130	3,386	38,837	54,825	10,651
Acres Woody Wetlands	536	365	475	1,317	1,620	0
Acres Emergent Herbaceous Wetlands	6	0	12	167	79	73
Total (Acres)	**166,124**	**167,133**	**4,819**	**55,681**	**88,033**	**183,014**

Table 1-5d Land Use Summaries by Watershed

Land Use Category	**Watershed**				
	Black Bear Creek	**Red Rock Creek**	**Red Rock Creek**	**Beaver Creek**	**Chilocco Creek**
Waterbody ID	**OK621200030010_00**	**OK621200050010_00**	**OK621200050010_10**	**OK621210000050_10**	**OK621210000270_00**
Percent of Open Water	0.91%	0.67%	0.68%	0.75%	0.53%
Percent of Developed, Open Space	4.44%	4.78%	4.31%	3.15%	4.69%
Percent of Developed, Low Intensity	0.71%	0.63%	0.30%	0.14%	0.31%
Percent of Developed, Medium Intensity	0.08%	0.31%	0.05%	0.00%	0.04%
Percent of Developed, High Intensity	0.02%	0.07%	0.01%	0.00%	0.00%
Percent of Barren Land (Rock/Sand/Clay)	0.00%	0.00%	0.02%	0.02%	0.00%
Percent of Deciduous Forest	13.25%	4.67%	2.20%	1.57%	5.84%
Percent of Evergreen Forest	0.32%	0.01%	0.09%	0.00%	0.00%
Percent of Mixed Forest	0.00%	0.00%	0.00%	0.00%	0.00%
Percent of Shrub/Scrub	0.00%	0.00%	0.00%	0.00%	0.00%
Percent of Grassland/Herbaceous	62.74%	45.77%	26.76%	77.84%	31.24%
Percent of Pasture/Hay	3.60%	0.39%	0.30%	7.69%	6.25%
Percent of Cultivated Crops	13.94%	42.69%	65.28%	4.26%	48.43%
Percent of Woody Wetlands	0.00%	0.00%	0.00%	4.25%	2.51%
Percent of Emergent Herbaceous Wetlands	0.00%	0.01%	0.00%	0.32%	0.14%
Acres Open Water	2,204	956	1,050	427	163
Acres Developed, Open Space	10,778	6,804	6,625	1,788	1,434
Acres Developed, Low Intensity	1,728	903	466	78	96
Acres Developed, Medium Intensity	191	439	77	0	11
Acres Developed, High Intensity	39	97	16	0	0
Acres Barren Land (Rock/Sand/Clay)	8	2	24	11	0
Acres Deciduous Forest	32,186	6,654	3,379	890	1,787
Acres Evergreen Forest	766	21	133	0	0
Acres Mixed Forest	0	0	0	0	0
Acres Shrub/Scrub	0	0	0	1	0
Acres Grassland/Herbaceous	152,394	65,165	41,145	44,145	9,552
Acres Pasture/Hay	8,736	550	465	4,363	1,911
Acres Cultivated Crops	33,852	60,782	100,379	2,418	14,808
Acres Woody Wetlands	0	4	0	2,410	767
Acres Emergent Herbaceous Wetlands	9	8	0	179	43
Total (Acres)	**242,892**	**142,386**	**153,759**	**56,712**	**30,573**

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 bacteria, 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. However, the flow data from the surrounding USGS gage stations and the instantaneous flow measurement data along 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 and implementation procedures (OWRB 2008). 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 2008). An excerpt of the Oklahoma WQS (Title 785) summarizing the State of Oklahoma Antidegradation Policy is provided in Appendix C. Table 2-1, an excerpt from the 2008 Integrated Report (ODEQ 2008), lists beneficial uses designated for each bacteria and/or turbidity impaired stream segment where at least one TMDL is required. The beneficial uses include:

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

Table 2-2 summarizes the PBCR and WWAC use attainment status and the bacteria 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 bacteria and/or turbidity impairments that affect the PBCR and WWAC-beneficial uses.

The definition of PBCR is 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.*

Table 2-1 Designated Beneficial Uses for TMDL Required Waterbodies in This Report

WBID	Name	AES	AG	WWAC	FISH	PBCR	PPWS	EWS
OK621000010010_30	Arkansas River, Salt Fork	F	F	N	N	N	F	
OK621000020130_00	Spring Creek	F	F	I	X	N		
OK621000030010_00	Bois d' Arc Creek	I	N	N	X	N	I	
OK621000040010_00	Deer Creek	F	N	N	X	N	I	
OK621000050010_00	Pond Creek	I	F	N	X	N	I	
OK621000060010_00	Crooked Creek	F	F	N	X	N	I	
OK621010010010_00	Arkansas River, Salt Fork	I	F	N	X	N	I	
OK621010010090_00	Clay Creek	F	N	N	X	N		F
OK621010010160_00	Arkansas River, Salt Fork	F	N	N	F	N	F	
OK621010010230_00	Turkey Creek	N	N	N	X	N	I	
OK621010010270_00	Yellowstone Creek	F	N	F	X	N	I	
OK621010020010_00	Sandy Creek	F	F	I	X	N	I	
OK621010030010_00	Medicine Lodge River	F	F	N	X	N	I	
OK621010030030_00	Driftwood Creek	F	F	N	X	N	I	
OK621100000010_00	Chikaskia River	I	F	N	X	N	I	
OK621100000010_10	Chikaskia River	I	F	N	N	N	I	
OK621100000100_00	Bitter Creek	I	N	N	X	N	I	
OK621200010200_00	Arkansas River	I	F	N	F	N	I	
OK621200030010_00	Black Bear Creek	I	F	N	N	N	I	
OK621200050010_00	Red Rock Creek	I	N	N	X	N		
OK621200050010_10	Red Rock Creek	I	N	N	X	N		
OK621210000050_10	Beaver Creek	I	F	N	X	N	I	
OK621210000270_00	Chilocco Creek	F	F	N	X	N		

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)

WBID	Name	Stream Miles	TMDL Date	Priority	*E. coli*	ENT	FC	Designated Use Primary Body Contact Recreation	Turbidity	Designated Use Warm Water Aquatic Life
OK621000010010_30	Arkansas River, Salt Fork	34.5	2019	4		x		N	x	N
OK621000020130_00	Spring Creek	6.1	2019	4			x	N		
OK621000030010_00	Bois d' Arc Creek	36.9	2019	4	x	x	x	N	x	N
OK621000040010_00	Deer Creek	40.8	2019	4	x	x		N	x	N
OK621000050010_00	Pond Creek	60.2	2019	4	x	x		N	x	N
OK621000060010_00	Crooked Creek	32.9	2019	4		x		N	x	N
OK621010010010_00	Arkansas River, Salt Fork	17.3	2013	2		x		N	x	N
OK621010010090_00	Clay Creek	3.4	2016	3		x		N		
OK621010010160_00	Arkansas River, Salt Fork	15.0	2019	4	x	x	x	N	x	N
OK621010010230_00	Turkey Creek	20.8	2019	4	x	x		N	x	N
OK621010010270_00	Yellowstone Creek	21.8	2019	4		x		N		
OK621010020010_00	Sandy Creek	17.8	2013	2	x	x	x	N		
OK621010030010_00	Medicine Lodge River	13.5	2016	2	x	x		N	x	N
OK621010030030_00	Driftwood Creek	38.8	2019	4	x	x		N	x	N
OK621100000010_00	Chikaskia River	5.4	2016	3	x	x		N	x	N
OK621100000010_10	Chikaskia River	23.1	2016	4		x	x	N	x	N
OK621100000100_00	Bitter Creek	23.3	2019	4	x	x		N	x	N
OK621200010200_00	Arkansas River	37.5	2013	4		x		N	x	N
OK621200030010_00	Black Bear Creek	68.0	2013	2	x	x		N		
OK621200050010_00	Red Rock Creek	37.3	2016	3	x	x		N	x	N
OK621200050010_10	Red Rock Creek	46.1	2019	4	x			N	x	N
OK621210000050_10	Beaver Creek	21.6	2019	4	x	x		N		
OK621210000270_00	Chilocco Creek	16.3	2019	4	x	x		N	x	N

ENT = enterococci; FC = fecal coliform
N = Not attaining; X = Criterion exceeded
Source: 2008 Integrated Report, ODEQ 2008

To implement Oklahoma's WQS for PBCR, OWRB promulgated Chapter 46, *Implementation of Oklahoma's Water Quality Standards* (OWRB 2008a). 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) Screening levels.

(1) The screening level for fecal coliform shall be a density of 400 colonies per 100 ml.

(2) The screening level for Escherichia coli shall be a density of 235 colonies per 100 ml in streams designated in OAC 785:45 as Scenic Rivers and in lakes, and 406 colonies per 100 ml in all other waters of the state designated as Primary Body Contact Recreation.

(3) The screening level for enterococci shall be a density of 61 colonies per 100 ml in streams designated in OAC 785:45 as Scenic Rivers and in lakes, and 108 colonies per 100 ml in all other waters of the state designated as Primary Body Contact Recreation.

(c) Fecal coliform:

(1) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be fully supported with respect to fecal coliform if the geometric mean of 400 colonies per 100 ml is met and no greater than 25% of the sample concentrations from that waterbody exceed the screening level prescribed in (b) of this Section.

(2) The Primary Body Contact Recreation subcategory designated for a waterbody shall be deemed to be not supported with respect to fecal coliform if the geometric mean of 400 colonies per 100 ml is not met, or greater than 25% of the sample concentrations from that waterbody exceed the screening level prescribed in (b) of this Section, or both such conditions exist.

(d) 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, or the sample concentrations from that waterbody taken during the recreation season do not exceed the screening level prescribed in (b) of this Section, or both such conditions exist.

(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 and any of the sample concentrations from that waterbody taken during the recreation season exceed a screening level prescribed in (b) of this Section.

(e) 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, or the sample concentrations from that waterbody taken during the recreation season do not exceed the screening level prescribed in (b) of this Section, or both such conditions exist.

(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 and any of the sample concentrations from that waterbody taken during the recreation season exceed a screening level prescribed in (b) of this Section.

Compliance with the Oklahoma WQS is based on meeting requirements for all three bacterial indicators. 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 2008).

As stipulated in the WQS, utilization of the geometric mean to determine compliance for any of the three indicator bacteria depends on the collection of five samples within a 30-day period. For most WQM stations in Oklahoma there are insufficient data available to calculate the 30-day geometric mean since most water quality samples are collected once a month. As a result, waterbodies placed on the 303(d) list for not supporting the PBCR are the result of individual samples exceeding the instantaneous criteria or the long-term geometric mean of individual samples exceeding the geometric mean criteria for each respective bacterial indicator. Targeting the instantaneous criterion established for the primary contact recreation season (May 1st to September 30th) as the water quality goal for TMDLs corresponds to the basis for 303(d) listing and may be protective of the geometric mean criterion as well as the criteria for the secondary contact recreation season. However, both the instantaneous and geometric mean criteria for *E. coli* and Enterococci will be evaluated as water quality targets to ensure the most protective goal is established for each waterbody.

A sample quantity exception exists for fecal coliform that allows waterbodies to be listed for nonsupport of PBCR if there are less than 10 samples. The assessment method states that if there are less than 10 samples and the existing sample set already assures a nonsupport determination, then the waterbody should be listed for TMDL development. This condition is true in any case where the small sample set demonstrates that at least three out of six samples exceed the single sample fecal coliform criterion. In this case if four more samples were available to meet minimum of 10 samples, this would still translate to >25 percent exceedance or nonsupport of PBCR (*i.e.*, three out of 10 samples = 33 percent exceedance). For *E. coli* and Enterococci, the 10-sample minimum was used, without exception, in attainment determination.

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:

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 2008a). 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 exceed 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 Bacteria Data Summary

Table 2-3 summarizes water quality data collected during primary contact recreation season from the WQM stations between 1998 and 2009 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 ODEQ 2008 303(d) list (ODEQ 2008). Water quality data from the primary contact recreation seasons are provided in Appendix A. For the data collected between 1998 and 2008, evidence of nonsupport of the PBCR use based on elevated fecal coliform, *E. coli* and Enterococci concentrations was observed in three waterbodies: Bois d' Arc Creek (OK621000030010_00), Arkansas River Salt Fork (OK621010010160_00) and Sandy Creek (OK621010020010_00). Evidence of nonsupport of the PBCR use based on *E. coli* and Enterococci exceedances was observed in eleven waterbodies: Deer Creek (OK621000040010_00), Pond Creek (OK621000050010_00), Turkey Creek (OK621010010230_00), Medicine Lodge River (OK621010030010_00), Driftwood Creek (OK621010030030_00), Chikaskia River (OK621100000010_00), Bitter Creek (OK621100000100_00), Red Rock Creek (OK621200050010_00), Black Bear Creek (OK621200030010_00), Beaver Creek (OK621210000050_10) and Chilocco Creek (OK621210000270_00). Evidence of nonsupport of the PBCR use based only on fecal coliform exceedances was observed in Spring Creek (OK621000020130_00). Evidence of nonsupport of the PBCR use based only on Enterococci exceedances was observed in six waterbodies: Arkansas River Salt Fork (OK621000010010_30), Crooked Creek (OK621000060010_00), Arkansas River Salt Fork (OK621010010010_00), Clay Creek (OK621010010090_00), Yellowstone Creek (OK621010010270_00), and Arkansas River (OK621200010200_00). Red Rock Creek (OK62120005010_10) was listed based on *E. coli* exceedances only.

Due to an insufficient number of samples, no TMDLs are required for the following waterbodies: Wild Horse Creek (OK621000020040_00), Chikaskia River (OK621100000010_20), Duck Creek (OK621100000030_00), Camp Creek (OK621200030040_00), Cow Creek (OK621200030270_00), Grassy Creek (OK621200050160_00), Arkansas River (OK621210000030_10).

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, TSS are used as a surrogate in this TMDL. Therefore, both turbidity and TSS data are presented in this subsection.

Table 2-4 summarizes water quality data collected from the WQM stations between 1998 and 2009 for turbidity. 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, ODEQ considers base flow conditions to be all flows less than the 25th flow exceedance percentile (i.e., the lower 75 percent of flows) which is consistent with the USGS Streamflow Conditions Index (USGS 2007a). Therefore, Table 2-4 was prepared to represent the subset of these data for samples collected during base flow conditions. Water quality samples collected under flow conditions greater than the 25th flow exceedance percentile (highest flows) were therefore excluded from the data set used for TMDL analysis. The data in Table 2-5 were used to support the decision to place all 23 of the waterbodies listed in Table 2-1 on the ODEQ 2008 303(d) list (ODEQ 2008) for nonsupport of the WWAC use based on turbidity levels observed in the waterbody. Table 2-6 summarizes water quality data collected from the WQM stations between 1998 and 2009 for TSS. Table 2-7 presents a subset of these data for samples collected during base flow conditions. In using TSS as a surrogate to support TMDL development at least 10 TSS samples are required to conduct the regression analysis between turbidity and TSS. Water quality data for turbidity and TSS are provided in Appendix A.

Table 2-3 Summary of Indicator Bacteria Samples from Primary Body Contact Recreation Season, 1998-2009

Waterbody ID	Waterbody Name	Indicator	Number of samples	Geometric Mean Concentration (count/100 ml)	Number of samples exceeding single sample criterion	% samples exceeding single sample criterion	2008 303(d)	Notes
OK621000010010_30	Arkansas River, Salt Fork	ENT	33	750	29	88%	X	TMDL required
OK621000020040_00	Wild Horse Creek	EC	8	292	4	50%	X	Insufficient number of samples
		ENT	8	350	7	88%	X	Insufficient number of samples
OK621000020130_00	Spring Creek	EC	6	1070	5	83%	X	Insufficient number of samples
		ENT	6	874	6	100%	X	Insufficient number of samples
		FC	9	782	6	67%	X	TMDL required
OK621000030010_00	Bois d' Arc Creek	EC	22	191	5	23%	X	TMDL required
		ENT	22	191	15	68%	X	TMDL required
		FC	9	1240	5	56%	X	TMDL required
OK621000040010_00	Deer Creek	EC	17	124	4	24%	X	TMDL required
		ENT	17	95	6	35%	X	TMDL required
OK621000050010_00	Pond Creek	EC	17	174	4	24%	X	TMDL required
		ENT	17	289	16	94%	X	TMDL required
OK621000060010_00	Crooked Creek	ENT	15	122	10	67%	X	TMDL required
OK621010010010_00	Arkansas River, Salt Fork	ENT	17	29	2	12%	X	Geomean standard met
OK621010010090_00	Clay Creek	ENT	17	181	11	65%	X	TMDL required
OK621010010160_00	Arkansas River, Salt Fork	EC	39	236	12	31%	X	TMDL required
		ENT	39	1384	37	95%	X	TMDL required
		FC	32	832	24	75%	X	TMDL required

Waterbody ID	Waterbody Name	Indicator	Number of samples	Geometric Mean Concentration (count/100 ml)	Number of samples exceeding single sample criterion	% samples exceeding single sample criterion	2008 303(d)	Notes
OK621010010230_00	Turkey Creek	EC	21	327	9	43%	X	TMDL required
		ENT	21	636	21	100%	X	TMDL required
OK621010010270_00	Yellowstone Creek	ENT	21	91	8	38%	X	TMDL required
OK621010020010_00	Sandy Creek	EC	22	288	9	41%	X	TMDL required
		ENT	22	235	18	82%	X	TMDL required
		FC	8	1413	7	88%	X	TMDL required
OK621010030010_00	Medicine Lodge River	EC	17	247	5	29%	X	TMDL required
		ENT	17	250	13	76%	X	TMDL required
OK621010030030_00	Driftwood Creek	EC	17	176	4	24%	X	TMDL required
		ENT	17	300	13	76%	X	TMDL required
OK621100000010_00	Chikaskia River	EC	17	97	5	29%	X	Geomean standard met
		ENT	17	68	6	35%	X	TMDL required
OK621100000010_10	Chikaskia River	ENT	39	183	21	54%	X	TMDL required
		FC	24	182	8	33%	X	TMDL required
OK621100000010_20	Chikaskia River	ENT					X	No data
OK621100000030_00	Duck Creek	EC	6	122	1	17%	X	Insufficient number of samples
		ENT	6	280	4	67%	X	Insufficient number of samples
OK621100000100_00	Bitter Creek	EC	25	136	4	16%	X	TMDL required
		ENT	25	143	14	56%	X	TMDL required
OK621200010200_00	Arkansas River	ENT	21	187	12	57%	X	TMDL required
OK621200030040_00	Camp Creek	FC	7	409	1	14%	X	Insufficient number of samples

Waterbody ID	Waterbody Name	Indicator	Number of samples	Geometric Mean Concentration (count/100 ml)	Number of samples exceeding single sample criterion	% samples exceeding single sample criterion	2008 303(d)	Notes
OK621200030270_00	Cow Creek	EC	6	328	1	17%	X	Insufficient number of samples
		ENT	6	720	5	83%	X	Insufficient number of samples
OK621200030010_00	Black Bear Creek	EC	18	357	6	33%	X	TMDL required
		ENT	18	357	6	33%	X	TMDL required
		FC	6	581	2	33%	X	Insufficient number of samples
OK621200050010_00	Red Rock Creek	EC	18	390	7	39%	X	TMDL required
		ENT	17	336	11	65%	X	TMDL required
OK621200050010_10	Red Rock Creek	EC	18	357	6	33%	X	TMDL required
OK621200050160_00	Grassy Creek	EC					X	No data
OK621210000030_10	Arkansas River	FC					X	No data
		ENT					X	No data
OK621210000050_10	Beaver Creek	EC	18	357	6	33%	X	TMDL required
		ENT	18	357	6	33%	X	TMDL required
OK621210000270_00	Chilocco Creek	EC	18	357	6	33%	X	TMDL required
		ENT	18	357	6	33%	X	TMDL required

Fecal coliform (FC) water quality criterion = Geometric Mean of 400 counts/100 mL
E. coli (EC) water quality criterion = Geometric Mean of 126 counts/100 mL
Enterococci (ENT) water quality criterion = Geometric Mean of 33 counts/100 mL

Table 2-4 Summary of All Turbidity Samples, 1998-2009

Waterbody ID	Waterbody Name	WQM Stations	Number of turbidity samples	Number of samples greater than 50 NTU	% samples exceeding criterion	Average Turbidity (NTU)
OK621000010010_30	Arkansas River, Salt Fork	OK621000010010-001AT	15	10	67%	185
OK621000030010_00	Bois d' Arc Creek	OK621000030010C, OK621000030010F	59	19	32%	103
OK621000040010_00	Deer Creek	OK621000040010D	40	16	40%	106
OK621000050010_00	Pond Creek	OK621000050010D	41	24	59%	149
OK621000060010_00	Crooked Creek	OK621000060010C	36	12	33%	63
OK621010010010_00	Arkansas River, Salt Fork	OK621010010010D	42	35	83%	157
OK621010010160_00	Arkansas River, Salt Fork	OK621010010160-001AT	35	23	66%	166
OK621010010230_00	Turkey Creek	OK621010010230G	60	18	30%	46
OK621010030010_00	Medicine Lodge River	OK621010030010D	42	14	33%	84
OK621010030030_00	Driftwood Creek	OK621010030030C	41	16	39%	83
OK621100000010_00	Chikaskia River	OK621100000010B	39	22	56%	126
OK621100000010_10	Chikaskia River	OK621100000010-001AT, OK621100000010M	94	40	43%	127
OK621100000100_00	Bitter Creek	621100-00-0100G	63	24	38%	96
OK621200010200_00	Arkansas River	OK621200010200-001AT	29	15	52%	135
OK621200050010_00	Red Rock Creek	OK621200050010K	40	28	70%	194
OK621200050010_10	Red Rock Creek	OK621200050010M	39	24	62%	136
OK621210000270_00	Chilocco Creek	OK621210-00-0270C	40	13	33%	54

Table 2-5 Summary of Turbidity Samples Collected During Base Flow Conditions, 1998-2009

Waterbody ID	Waterbody Name	WQM Stations	Number of turbidity samples	Number of samples greater than 50 NTU	% samples exceeding criterion	Average Turbidity (NTU)	Notes
OK621000010010_30	Arkansas River, Salt Fork	OK621000010010-001AT	11	6	55%	204	TMDL required
OK621000030010_00	Bois d' Arc Creek	OK621000030010C, OK621000030010F	36	6	17%	51	TMDL required
OK621000040010_00	Deer Creek	OK621000040010D	36	12	33%	62	TMDL required
OK621000050010_00	Pond Creek	OK621000050010D	35	18	51%	128	TMDL required
OK621000060010_00	Crooked Creek	OK621000060010C	35	12	34%	64	TMDL required
OK621010010010_00	Arkansas River, Salt Fork	OK621010010010D	40	33	83%	146	TMDL required
OK621010010160_00	Arkansas River, Salt Fork	OK621010010160-001AT	34	22	65%	141	TMDL required
OK621010010230_00	Turkey Creek	OK621010010230G	60	18	30%	46	TMDL required
OK621010030010_00	Medicine Lodge River	OK621010030010D	38	12	32%	87	TMDL required
OK621010030030_00	Driftwood Creek	OK621010030030C	41	16	39%	83	TMDL required
OK621100000010_00	Chikaskia River	OK621100000010B	20	8	40%	45	TMDL required
OK621100000010_10	Chikaskia River	OK621100000010-001AT, OK621100000010M	60	17	28%	68	TMDL required
OK621100000100_00	Bitter Creek	621100-00-0100G	54	17	31%	40	TMDL required
OK621200010200_00	Arkansas River	OK621200010200-001AT	15	3	20%	52	TMDL required
OK621200050010_00	Red Rock Creek	OK621200050010K	31	19	61%	145	TMDL required
OK621200050010_10	Red Rock Creek	OK621200050010M	33	18	55%	111	TMDL required
OK621210000270_00	Chilocco Creek	OK621210-00-0270C	23	6	26%	39	TMDL required

Table 2-6 Summary of All TSS Samples, 1998-2009

Waterbody ID	Waterbody Name	WQM Stations	Number of TSS samples	Average TSS (mg/L)
OK621000010010_30	Arkansas River, Salt Fork	OK621000010010-001AT	1	124[a]
OK621000030010_00	Bois d' Arc Creek	OK621000030010C, OK621000030010F	59	95
OK621000040010_00	Deer Creek	OK621000040010D	40	144
OK621000050010_00	Pond Creek	OK621000050010D	40	84
OK621000060010_00	Crooked Creek	OK621000060010C	34	41
OK621010010010_00	Arkansas River, Salt Fork	OK621010010010D	40	103
OK621010010160_00	Arkansas River, Salt Fork	OK621010010160-001AT	19	267
OK621010010230_00	Turkey Creek	OK621010010230G	59	37
OK621010030010_00	Medicine Lodge River	OK621010030010D	40	72
OK621010030030_00	Driftwood Creek	OK621010030030C	40	65
OK621100000010_00	Chikaskia River	OK621100000010B	37	156
OK621100000010_10	Chikaskia River	OK621100000010-001AT, OK621100000010M	79	168
OK621100000100_00	Bitter Creek	621100-00-0100G	62	116
OK621200010200_00	Arkansas River	OK621200010200-001AT	19	210
OK621200050010_00	Red Rock Creek	OK621200050010K	40	145
OK621200050010_10	Red Rock Creek	OK621200050010M	40	113
OK621210000270_00	Chilocco Creek	OK621210-00-0270C	38	41

[a] Value corresponds to the single measurement.

Table 2-7 Summary of TSS Samples During Base Flow Conditions 1998-2009

Waterbody ID	Waterbody Name	WQM Stations	Number of TSS samples	Average TSS (mg/L)
OK621000010010_30	Arkansas River, Salt Fork	OK621000010010-001AT	0	-
OK621000030010_00	Bois d' Arc Creek	OK621000030010C, OK621000030010F	36	36
OK621000040010_00	Deer Creek	OK621000040010D	36	52
OK621000050010_00	Pond Creek	OK621000050010D	34	79
OK621000060010_00	Crooked Creek	OK621000060010C	33	41
OK621010010010_00	Arkansas River, Salt Fork	OK621010010010D	38	103
OK621010010160_00	Arkansas River, Salt Fork	OK621010010160-001AT	18	220
OK621010010230_00	Turkey Creek	OK621010010230G	59	37
OK621010030010_00	Medicine Lodge River	OK621010030010D	36	72
OK621010030030_00	Driftwood Creek	OK621010030030C	40	65
OK621100000010_00	Chikaskia River	OK621100000010B	18	58
OK621100000010_10	Chikaskia River	OK621100000010-001AT, OK621100000010M	49	107
OK621100000100_00	Bitter Creek	621100-00-0100G	53	45
OK621200010200_00	Arkansas River	OK621200010200-001AT	7	45
OK621200050010_00	Red Rock Creek	OK621200050010K	30	61
OK621200050010_10	Red Rock Creek	OK621200050010M	33	57
OK621210000270_00	Chilocco Creek	OK621210-00-0270C	21	29

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." For the WQM stations requiring bacteria TMDLs in this report, defining the water quality target is somewhat complicated by the use of three different bacterial indicators each with different numeric criterion for determining attainment of PBCR use as defined in the Oklahoma WQSs. An individual water quality target is established for each bacterial indicator since each indicator group must demonstrate compliance with the numeric criteria prescribed in the Oklahoma WQS (OWRB 2008). As previously stated, because available bacteria data were collected on an approximate monthly basis (see Appendix A) instead of at least five samples over a 30–day period, data for these TMDLs are analyzed and presented in relation to both the instantaneous and a long-term geometric mean for each bacterial indicator.

All TMDLs for fecal coliform must take into account that no more than 25 percent of the samples may exceed the instantaneous numeric criteria. For *E. coli* and Enterococci, no samples may exceed the instantaneous criteria. Since the attainability of stream beneficial uses for *E. coli* and Enterococci is based on the compliance of either the instantaneous or a long-term geometric mean criterion, percent reductions goals will be calculated for both criteria. TMDLs will be based on the percent reduction required to meet either the instantaneous or long-term geometric mean criterion, whichever is less.

If fecal coliform is utilized to establish the TMDL, then the water quality target is the instantaneous water quality criteria (400/100 mL). If *E. coli* is utilized to establish the TMDL, then the water quality target is the instantaneous water quality criterion value (406/100 mL), and the geometric mean water quality target is the geometric mean criterion value (126/100 mL). If Enterococci are utilized to establish the TMDL, then the water quality target is the instantaneous water quality criterion value (108/100 mL) and the geometric mean water quality target is the geometric mean criterion value (33/100 mL).

TMDLs for bacteria will incorporate an explicit 10 percent MOS. The allowable bacteria load is derived by using the actual or estimated flow record multiplied by the water quality target. The line drawn through the allowable load data points is the water quality target which represents the maximum load for any given flow that still satisfies the WQS.

An individual water quality target established for turbidity must demonstrate compliance with the numeric criteria prescribed in the Oklahoma WQS (OWRB 2008). 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 percent 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 waterbody 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; some plant life 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 are required to monitor for one of the three bacterial pathogen indicators (fecal coliform, *E. coli*, or Enterococci) and 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 are considered nonpoint sources.

The 2008 Integrated Water Quality Assessment Report (ODEQ 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, rangeland grazing, municipal point source discharges, 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 originating in Kansas (Pond Creek (OK621000050010_00), Crooked Creek (OK621000060010_00), Yellowstone Creek (OK621010010270_00), Sandy Creek (OK621010020010_00), Medicine Lodge River (OK621010030010_00), Driftwood Creek (OK621010030030_00), Bitter Creek (OK621100000100_00), Beaver Creek (OK621210000050_10), and Chilocco Creek (OK621210000270_00)) data were provided and summarized as part of each category. These data were provided to demonstrate that some of the indicator bacteria or TSS loading outside of Oklahoma’s jurisdiction may contribute to nonsupport of the WWAC use in Oklahoma. It is recognized that Oklahoma has no enforcement authority over bacteria or TSS sources originating beyond the Oklahoma state boundary.

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 NPDES-permitted municipal plants are classified as no-discharge facilities. NPDES-permitted facilities classified as point sources that may contribute bacteria or TSS loading include:

- NPDES municipal wastewater treatment plant (WWTP);
- NPDES Industrial WWTP Discharges;
- NPDES 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 coliform 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 ODEQ 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 Biochemical Oxygen Demand (BOD) or Carbonaceous Biochemical Oxygen Demand (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 bacteria loading to surface waters. CAFOs are recognized by USEPA as 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 USEPA NPDES Program, can also contain high fecal coliform bacteria concentrations. Stormwater runoff from MS4 areas, facilities under multi-sector general permits, and NPDES construction stormwater discharges, which are regulated under the USEPA NPDES Program, can contain TSS. 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 the 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 are no NPDES-permitted facilities of any type in the contributing watersheds of Spring Creek (OK621000020130_00), Yellowstone Creek (OK621010010270_00), Sandy Creek (OK621010020010_00), Chikaskia River (OK621100000010_00) and Beaver Creek (OK621210000050_10). The remaining eighteen watersheds in the Study Area have at least one NPDES-permitted facility.

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 9 continuous point source discharging facilities within the Study Area but they are not all sources of concern for bacteria or TSS loading. Eight 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 or 4911 in Table 3-1 discharge organic TSS and therefore are not considered a potential source of turbidity within their respective watershed. There are two active NPDES-permitted industrial facilities operating in the Study Area which are shown in Figures 3-1 and 3-2 and facility information is listed in Table 3-1.

WWTP dischargers for bacteria impaired watersheds were reviewed for availability of Discharge Monitoring Reports (DMR) data. Monthly DMRs for fecal coliform analyses were not available for the City of Tonkawa (OK0021903), City of Newkirk (OK0031968), ONEOK Hydrocarbon, LP – Medford (OK0045306), City of Cherokee (OKG580043) and OG & E - Sooner Generating (OK0035068) because these facilities do not have fecal coliform limits. Therefore it is not possible to provide an adequate evaluation on the performance of these municipal WWTPs with respect to their compliance with fecal coliform permit limits over time for those facilities. One NPDES facility, ONEOK Hydrocarbon, LP - Medford (OK0045306), did not have any DMR data for TSS available. DMR data for the remaining eight facilities are provided in Appendix D.

Table 3-1 Continuous Point Source Discharges in the Study Area

OPDES Permit No.	Name	Receiving Water (Waterbody ID)	Waterbody Name	Facility Type	SIC Code	County	Design Flow (mgd)	Facility ID	Expiration Date	Max. FC cfu/100 mL	Max./Avg. TSS mg/L	Outfall
OK0021903	City of Tonkawa	OK621000010010_30	Arkansas River, Salt Fork	Sewerage System	4952	Kay	0.5	S21012	8/31/5015	NA	135/90	001A
OK0031968	City of Newkirk	OK621000030010_00	Bois d' Arc Creek	Sewerage System	4952	Kay	0.378	S21013	6/30/2009	NA	135/90	001A
OK0045306	ONEOK Hydrocarbon, LP - Medford	OK621000050010_00	Pond Creek	Natural Gas Liquids	1321	Grant	NA	27000040	1/31/2012	NA	NA	004A
OKG580043	City of Cherokee	OK621010010090_00	Clay Creek	Sewerage System	4952	Alfalfa	0.4	S21003	6/30/2011	NA	135/90	001A
OK0031909	City of Blackwell	OK621100000010_10	Chikaskia River	Sewerage System	4952	Kay	1.6	S21102	1/31/2012	400/200	45/30	001A
OK0020761	City of Ralston	OK621200010200_00	Arkansas River	Sewerage System	4952	Pawnee	0.05	S21208	10/31/13	NA	135/90	001A
OK0026654	City of Pawnee	OK621200030010_00	Black Bear Creek	Sewerage System	4952	Pawnee	0.3	S21212	5/31/2012	400/200	45/30	001A
OK0028517	Town of Glencoe	OK621200030010_00	Black Bear Creek	Sewerage System	4952	Payne	0.064	S21213	5/31/2012	400/200	135/90[A], 22.5/15[B]	001A
OK0035068	OG & E - Sooner Generating	OK621200050010_00	Red Rock Creek	Electrical Services	4911	Noble	NA	52000090	4/30/2011	NA	100/30	301A
										NA	100/30	601A

[A] Season 1. The effluent season number of the measurement or violation.
[B] Season 0. The effluent season number of the measurement or violation.
NA = not available.

Figure 3-1 Locations of NPDES-Permitted Facilities in the Study Area

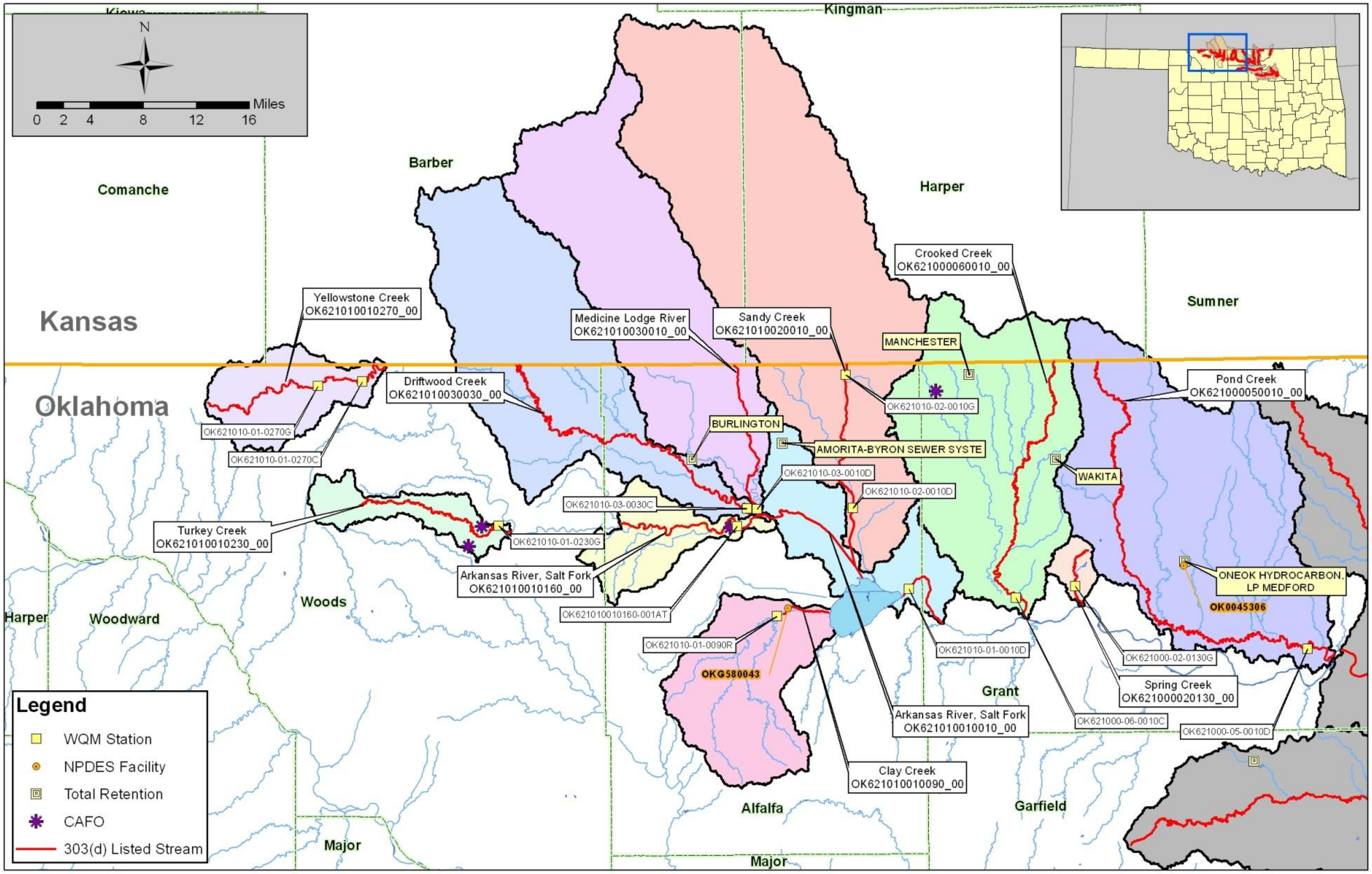
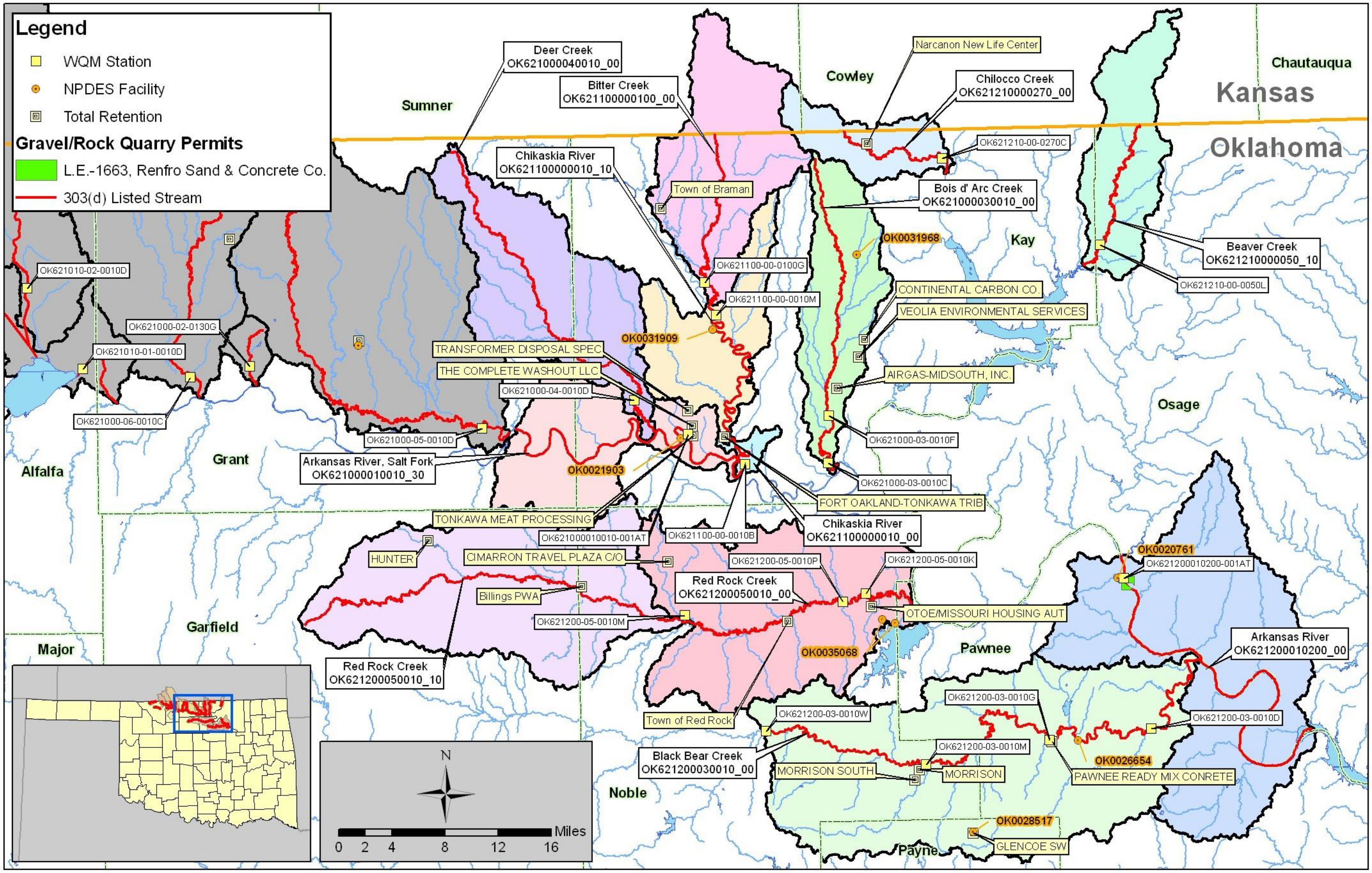


Figure 3-2 Locations of NPDES-Permitted Facilities in the Study Area



3.1.2 NPDES No-Discharge Facilities and Sanitary Sewer Overflows

For the purposes of these TMDLs, it is assumed that no-discharge facilities do not contribute indicator bacteria or TSS loading. However, it is possible the wastewater collection systems associated with these no-discharge facilities could be a source of indicator bacteria loading, or that discharges from the wastewater plant may occur during large rainfall events that exceed the systems' storage capacities. There are 24 municipal or industrial no-discharge facilities in the Study Area which are listed in Table 3-2. The no-discharge facilities located in Arkansas River, Salt Fork (OK621000010010_30), Bois d' Arc Creek (OK621000030010_00), Pond Creek (OK621000050010_00), Crooked Creek (OK621000060010_00), Arkansas River, Salt Fork (OK621010010010_00), Chikaskia River (OK621100000010_10), Medicine Lodge River (OK621010030010_00), Driftwood Creek (OK621010030030_00), Bitter Creek (OK621100000100_00), Black Bear Creek (OK621200030010_00), Red Rock Creek (OK621200050010_00), Red Rock Creek (OK621200050010_10) and Chilocco Creek (OK621210000270_00) watersheds could be a contributing to the elevated levels of instream indicator bacteria loading.

Sanitary sewer overflows (SSO) from wastewater collection systems, although infrequent, can be a major source of indicator bacteria 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 USEPA, primarily through enforcement and fines. While not all sewer overflows are reported, ODEQ has some data on SSOs available. SSOs were reported between 1990 and 2011. During that period, 427 overflows were reported ranging from 0 to 12 million gallons (mg). Table 3-3 summarizes the SSO occurrences by NPDES facility. SSO data are provided in Appendix E.

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

Facility	Facility ID	County	Facility Type	Type	Waterbody ID	Waterbody Name
Tonkawa Meat Processing	CW72-121	Kay	Total retention	Industrial	OK621000010010_30	Arkansas River, Salt Fork
The Complete Washout	WD97-010	Kay	Total retention	Industrial	OK621000010010_30	Arkansas River, Salt Fork
Airgas-Midsouth, Inc.	WD82-043	Kay	Total retention	Industrial	OK621000030010_00	Bois d' Arc Creek
Continental Carbon Co	W-69-015	Kay	Total retention	Industrial	OK621000030010_00	Bois d' Arc Creek
Veolia Environmental Services	WD84-023	Kay	Total retention	Industrial	OK621000030010_00	Bois d' Arc Creek
Koch Medford Frac Facility	WD84-034	Grant	Total retention	Industrial	OK621000050010_00	Pond Creek
Manchester WWTP	21015	Grant	Lagoon (total retention)	Municipal	OK621000060010_00	Crooked Creek
Wakita WWTP	21006	Grant	Lagoon (total retention)	Municipal	OK621000060010_00	Crooked Creek
Amorita-Byron Sewer System Authority	21024	Alfalfa	Lagoon (total retention)	Municipal	OK621010010010_00	Arkansas River, Salt Fork
Burlington WWTP	21002	Alfalfa	Lagoon (total retention)	Municipal	OK621010030010_00	Medicine Lodge River
Burlington WWTP	21002	Alfalfa	Lagoon (total retention)	Municipal	OK621010030030_00	Driftwood Creek
Transformer Disposal Special.	WD91-026	Kay	Total retention	Industrial	OK621100000010_10	Chikaskia River
Fort Oakland-Tonkawa Tribal Auth WWTP	21021	Kay	Lagoon (total retention)	Municipal	OK621100000010_10	Chikaskia River
Braman WWTP	21101	Kay	Lagoon (total retention)	Municipal	OK621100000100_00	Bitter Creek
Morrison North WWTP	21211	Noble	Lagoon (total retention)	Municipal	OK621200030010_00	Black Bear Creek
Morrison South WWTP	21218	Noble	Lagoon (total retention)	Municipal	OK621200030010_00	Black Bear Creek
Pawnee Ready Mix Concrete & Sup	OKG11T004	Pawnee	Total retention	Industrial	OK621200030010_00	Black Bear Creek
Glencoe SW WWTP	21239	Payne	Lagoon (total retention)	Municipal	OK621200030010_00	Black Bear Creek
Otoe/Missouri Tribe Housing Authority	21244	Noble	Lagoon (total retention)	Municipal	OK621200050010_00	Red Rock Creek
Red Rock PWA WWTP	21220	Noble	Lagoon (total retention)	Municipal	OK621200050010_00	Red Rock Creek

Facility	Facility ID	County	Facility Type	Type	Waterbody ID	Waterbody Name
Cimarron Travel Plaza WWTP	21240	Noble	Lagoon (total retention)	Municipal	OK621200050010_00	Red Rock Creek
Hunter WWTP	21203	Garfield	Lagoon (total retention)	Municipal	OK621200050010_10	Red Rock Creek
Billings Lagoon WWTP	21204	Noble	Lagoon (total retention)	Municipal	OK621200050010_10	Red Rock Creek
Narconon Chilocco Ctr WWTP	21216	Kay	Lagoon (total retention)	Municipal	OK621210000270_00	Chilocco Creek

Table 3-3 Sanitary Sewer Overflow (SSO) Summary

Facility Name	NPDES Permit No.	Receiving Water	Facility ID	Number of Occurrences	Date Range		Amount (Gallons)	
					From	To	Min	Max
City of Cherokee	OKG580043	OK621010010090_00	S21003	11	8/4/1995	8/17/2010	0	6,500
City of Tonkawa	OK0021903	OK621000010010_30	S21012	29	9/26/1996	6/14/2010	48	50,000
City of Newkirk	OK0031968	OK621000030010_00	S21013	65	8/3/1993	6/9/2008	0	20,000
City of Blackwell	OK0031909	OK621100000010_10	S21102	74	3/18/1992	1/30/2011	0	12,000,000
City of Ralston	OK0020761	OK621200010200_00	S21208	2	2/28/1996	6/20/2005	35,000	35,000
City of Pawnee	OK0026654	OK621200030010_00	S21212	244	3/20/1990	3/7/2011	5	2,000,000
Town of Glencoe	OK0028517	OK621200030010_00	S21213	2	4/19/1995	6/29/2007	0	9,500

3.1.3 NPDES Municipal Separate Storm Sewer Discharge

Phase I MS4

In 1990 the USEPA 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 (USEPA 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 are no Phase I MS4 permits 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 MS4 permit for small communities in Oklahoma became effective on February 8, 2005. Ponca City [Bois d' Arc Creek (OK621000030010_00)] is the only municipality in the Study Area designated by USEPA for inclusion in the Phase II Stormwater Program. There are no Phase II MS4s in any other sub-watersheds in the study area. The permit information for Ponca City MS4 is as follows:

- Permit #: OKR040030
- Expiration date: 02/07/2010

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 nonpermitted communities show existing loads of fecal coliform bacteria at levels greater than the State's instantaneous standards. ODEQ 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/.

3.1.4 Concentrated Animal 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 Act, AEMS works with producers and concerned citizens to ensure that animal waste does not impact the waters of the state. 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 2005). 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 2005). CAFOs are considered no-discharge facilities.

CAFOs are designated by USEPA as significant sources of pollution, and may have the potential to cause serious impacts to water quality if not managed properly. Potential problems from CAFOs can include unauthorized discharges of bacteria or nutrient loads to waters of the state and failure to properly operate wastewater lagoons. CAFOs are not considered a source of TSS loading. The location of each CAFO is shown in Figure 3-1 and is listed in Table 3-4.

Regulated CAFOs within the Study Area operate under state CAFO licenses issued and overseen by ODAFF and NPDES permits by USEPA. 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 bacteria loads and achieve progress toward meeting the specified reduction goals must be implemented. This provision will be forwarded to USEPA and ODAFF for follow up.

Table 3-4 NPDES-Permitted CAFOs in Study Area

ODAFF Owner ID	USEPA Facility	ODAFF ID	ODAFF License Number	Max # of Slaughter Feeder Cattle units at Facility	Max # of Horse Units at Facility	Total # of Animal Units at Facility	County	Waterbody ID and Waterbody Name
AGN031785	OKG010032	82	1372	1000		1000	Grant	OK621000060010_00, Crooked Creek
AGN007153	OKG010217	52	3	10,000		10,000	Alfalfa	OK621010010160_00, Arkansas River, Salt Fork
WQ0000015	OKU000355	54	1481	2,500	1000	3,500	Woods	OK621010010230_00, Turkey Creek
AGN035658	OKG010194	265	1479	2,000		2,000	Woods	OK621010010230_00, Turkey Creek

3.1.5 Stormwater Permits Construction Activities

A general stormwater permit (OKR10) is required by the ODEQ 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 (ODEQ 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 construction permits are summarized in Table 3-5.

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 ODEQ. 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 (ODEQ 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 3-6 summarizes data from the Oklahoma Department of Mines and provides the permitted mining acres for each of the quarries located within the Study Area. The locations of these quarries are shown in Figures 3-1 and 3-2. However, none of the three facilities has a discharge permit which indicates that none of them actually discharge. ODEQ's records show that Arbuckle Materials in Pawnee submitted an application for a new Rock, Sand and Quarry general permit in 2007. ODEQ determined that no permit was required for the facility because the facility operates completely outside of the wetted perimeter of a water body and the facility is to be total retention only.

3.1.7 Section 404 permits

Section 404 of the 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). USEPA reviews and provides comments on each permit application to make sure it adequately protects water quality and complies with applicable guidelines. Both USACE and USEPA 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 CWA 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
Northern Oklahoma College Allied Health Education Communications Bldg.	Kay	7352	10/23/2007	OK621000010010_30	Tonkawa Creek	4
ODOT JP #24140(04)	Kay	9107		OK621000010010_30	Arkansas River, Salt Fork	23.27
Spec Bldg #2	Kay	6736	10/23/2007	OK621000030010_00	Bois D'Arc Creek	1
First National Bank Of Oklahoma	Kay	7615	3/13/2008	OK621000030010_00	Unnamed Tributary To Bois D'Arc Creek	1
Packrat Storage	Kay	8685	1/19/2008	OK621000030010_00	Unnamed Tributary Of Bois D'Arc Creek	2
Encompass Tool Building	Kay	8804	3/13/2008	OK621000030010_00	Bois D' Arc Creek	2.32
Ponca City Aquatic & Family Center YMCA	Kay	9079		OK621000030010_00	Bois D'Arc Creek	46
Ash Street-Street Improvements	Kay	9181	6/17/2008	OK621000030010_00	Tributary M To Bois D'Arc Creek	1.25
Packrat Storage	Kay	8685	1/19/2008	OK621000030010_00	Unnamed Tributary Of Bois D'Arc Creek	2
Ponca City Aquatic & Family Center YMCA	Kay	9079		OK621000030010_00	Bois D'Arc Creek	46
ODOT JP #22655(04)	Grant	7746	10/8/2007	OK621000040010_00	Deer Creek	4
ODOT JP #22892(04)	Grant	8652	1/19/2008	OK621000060010_00	Crooked Creek	3
ODOT JP #18989(04)	Woods	7869	1/11/2008	OK621010010230_00	Turkey Creek	2.88
OK/KS State Line To Brinks, OK Capacity Improvement Project	Woods	6104		OK621010030030_00	Mule Creek, Little Mule Creek, Driftwood Creek	142
BNSF Railway	Woods	7311	1/18/2008	OK621010030030_00	Capron Creek North	1.25
ODOT JP #18711(04)	Alfalfa	8222	10/30/2007	OK621010030030_00	Driftwood Creek	-
ODOT Jp #15593(04)	Kay	6766	2/11/2008	OK621100000010_10	Stink Creek	35
ODOT JP #24084(04)	Kay	8110	1/18/2008	OK621100000010_10	Stink Creek	3.6
Blackwell Elementary School	Kay	8670	3/6/2008	OK621100000010_10	Chikaskia River	15
ODOT JP #20340(06)	Kay	7902	1/18/2008	OK621100000100_00	Dry Creek	26
ODOT JP #21556(04)	Pawnee	8216	10/24/2007	OK621200030010_00	Black Bear Creek	1
ODOT JP #22353(04)	Noble	8467	11/8/2007	OK621200030010_00	Long Branch Creek	4

Company Name	County	Permit ID	Date Issued	Waterbody ID	Receiving Water (Permit)	Estimated Acres
Le Place Commercial Development	Noble	9208		OK621200030010_00	Unnamed Tributary Of Spring Creek	6
Yearling RV Park	Noble	8116	1/10/2008	OK621200050010_00	Red Rock Creek	4
ODOT JP #23222(04)	Noble	8231	9/27/2007	OK621200050010_00	Ceres Creek	6
ODOT JP #12317(04)	Noble	8498	11/8/2007	OK621200050010_00	Red Rock Creek	38
ODOT JP #23222(04)	Noble	8231	9/27/2007	OK621200050010_00	Ceres Creek	6
Shale Pit Project	Garfield	7170	1/19/2008	OK621200050010_10	Red Rock Creek	5
ODOT JP #20246 (04)	Noble	8208	9/27/2007	OK621200050010_10	Red Rock Creek	20
85 Car Unit Train Expansion	Garfield	9083		OK621200050010_10	Skeleton Creek	43

Table 3-6 Rock, Sand and Gravel Quarries

Company Name	County	Permit ID	Product	Permitted Acres	Permit Issue Date	Permit Renewal Date	Mining Expiration Date	Waterbody ID
Renfro Sand & Concrete Co.	Pawnee	L.E.-1663	Sand & Gravel	3	9/1/1998	8/31/2008	8-31-2008	OK621200010200_00
Arbuckle Materials, Inc. (Pawnee)	Pawnee	L.E.-2212-A	Sand, Gravel, & Clay	77	4/1/2007	3/31/2009	3-31-… (Life Expectancy)	OK621200050010_00
412 Dozer Service, Inc.	Grant	X08-1161	Shale	3	9/1/2007		8-31-2008	OK621000060010_00

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 a state's instantaneous standards. A study under USEPA'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 (USEPA 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 existing loads of fecal coliform bacteria at levels greater than the State's instantaneous standards. The specific requirements for bacteria control in a MS4 permit can be found in Appendix F. Appendix F 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 bacteria 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 (ODEQ 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 bacteria TMDLs it is important to identify the potential for bacteria contributions from wildlife by watershed. Wildlife is naturally attracted to riparian corridors of streams and rivers. With direct access to the stream channel, wildlife can be a concentrated source of bacteria 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 bacteria 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 percent 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 3-7 in cfu/day provides a relative magnitude of loading in each watershed.

Table 3-7 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
OK621000010010_30	Arkansas River, Salt Fork	73,856	917	0.012	458
OK621000020130_00	Spring Creek	7,628	109	0.014	55
OK621000030010_00	Bois d' Arc Creek	63,213	712	0.011	356
OK621000040010_00	Deer Creek	100,428	1,330	0.013	665
OK621000050010_00	Pond Creek	212,118	2,917	0.014	1,459
OK621000060010_00	Crooked Creek	152,355	1,842	0.012	921
OK621010010010_00	Arkansas River, Salt Fork	55,557	805	0.014	403
OK621010010090_00	Clay Creek	77,364	1,125	0.015	562
OK621010010160_00	Arkansas River, Salt Fork	34,911	496	0.014	248
OK621010010230_00	Turkey Creek	24,660	269	0.011	134
OK621010010270_00	Yellowstone Creek	41,913	410	0.010	205
OK621010020010_00	Sandy Creek	296,734	953	0.003	476
OK621010030010_00	Medicine Lodge River	166,124	696	0.004	348
OK621010030030_00	Driftwood Creek	167,133	979	0.006	490
OK621100000010_00	Chikaskia River	4,819	54	0.011	27
OK621100000010_10	Chikaskia River	55,681	626	0.011	313
OK621100000100_00	Bitter Creek	88,033	647	0.007	323
OK621200010200_00	Arkansas River	183,014	3,002	0.016	1,501
OK621200030010_00	Black Bear Creek	242,892	3,640	0.015	1,820
OK621200050010_00	Red Rock Creek	142,386	1,810	0.013	905
OK621200050010_10	Red Rock Creek	153,759	1,281	0.008	641
OK621210000050_10	Beaver Creek	30,573	564	0.018	282
OK621210000270_00	Chilocco Creek	56,712	235	0.004	118

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 bacteria 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 bacteria sources include:

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

Table 3-8 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 3-8 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 impaired waterbodies or 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 3-8. 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 bacteria 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 in Table 3-9. 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. Cattle again appear to represent the most likely commercially raised farm animal source of fecal bacteria.

Table 3-8 Livestock and Manure Estimates by Watershed

Waterbody ID	Waterbody Name	Cattle & Calves	Dairy Cows	Hogs & Pigs	Chickens	Sheep & Lambs	Horses & Ponies	Turkeys	Ducks	Geese	Acres of Manure Application
OK621000010010_30	Arkansas River, Salt Fork	5,663	4	41	107	506	122	1	6	0	98
OK621000020130_00	Spring Creek	568	0	2	4	26	6	0	0	0	7
OK621000030010_00	Bois d' Arc Creek	4,485	1	51	139	650	126	1	7	0	98
OK621000040010_00	Deer Creek	7,344	1	46	108	579	117	1	7	0	117
OK621000050010_00	Pond Creek	16,314	3	57	123	704	169	0	11	0	211
OK621000060010_00	Crooked Creek	13,799	8	44	133	442	173	0	6	0	177
OK621010010010_00	Arkansas River, Salt Fork	8,328	0	42	41	89	170	0	0	0	99
OK621010010090_00	Clay Creek	12,626	0	64	60	100	268	0	0	0	149
OK621010010160_00	Arkansas River, Salt Fork	5,559	0	27	26	42	115	0	0	0	70
OK621010010230_00	Turkey Creek	2,901	0	6	9	7	36	0	0	0	71
OK621010010270_00	Yellowstone Creek	4,788	0	9	15	11	60	0	0	1	121
OK621010020010_00	Sandy Creek	38,323	48	78	466	239	610	0	0	6	679
OK621010030010_00	Medicine Lodge River	18,080	0	42	69	80	272	0	0	5	472
OK621010030030_00	Driftwood Creek	18,364	0	39	64	67	258	0	0	4	482
OK621100000010_00	Chikaskia River	342	0	4	11	50	10	0	1	0	8
OK621100000010_10	Chikaskia River	3,944	1	45	122	571	111	1	6	0	86
OK621100000100_00	Bitter Creek	5,639	31	210	189	665	137	1	10	1	185
OK621200010200_00	Arkansas River	20,684	39	51	412	243	829	3	19	6	362
OK621200030010_00	Black Bear Creek	29,506	119	201	789	514	1,648	20	42	16	611
OK621200050010_00	Red Rock Creek	18,924	25	54	164	145	614	21	11	8	11
OK621200050010_10	Red Rock Creek	21,703	131	69	319	367	802	8	16	2	365
OK621210000050_10	Beaver Creek	5,496	35	171	111	80	74	1	4	1	83
OK621210000270_00	Chilocco Creek	2,161	12	86	70	229	52	1	4	0	56

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

Waterbody ID	Waterbody Name	Cattle & Calves	Dairy Cows	Hogs & Pigs	Chickens	Sheep & Lambs	Horses & Ponies	Turkeys	Ducks	Geese	Total
OK621000010010_30	Arkansas River, Salt Fork	588,997	410	445	15	6,068	51	0	16	5	596,007
OK621000020130_00	Spring Creek	59,054	0	22	1	312	2	0	0	0	59,393
OK621000030010_00	Bois d' Arc Creek	466,491	127	552	19	7,795	53	0	18	0	475,055
OK621000040010_00	Deer Creek	763,790	69	495	15	6,944	49	0	18	0	771,381
OK621000050010_00	Pond Creek	1,696,629	289	619	17	8,445	71	0	26	6	1,706,102
OK621000060010_00	Crooked Creek	1,435,096	834	479	18	5,304	73	0	15	18	1,441,837
OK621010010010_00	Arkansas River, Salt Fork	866,139	0	450	6	1,070	71	0	0	0	867,736
OK621010010090_00	Clay Creek	1,313,143	0	696	8	1,199	113	0	0	0	1,315,159
OK621010010160_00	Arkansas River, Salt Fork	578,104	0	295	4	504	48	0	0	2	578,957
OK621010010230_00	Turkey Creek	301,710	0	65	1	81	15	0	0	15	301,888
OK621010010270_00	Yellowstone Creek	497,956	0	100	2	131	25	0	0	30	498,244
OK621010020010_00	Sandy Creek	3,985,554	4,831	840	63	2,865	256	0	0	295	3,994,705
OK621010030010_00	Medicine Lodge River	1,880,369	18	449	9	960	114	0	0	239	1,882,158
OK621010030030_00	Driftwood Creek	1,909,808	0	423	9	804	108	0	0	206	1,911,357
OK621100000010_00	Chikaskia River	35,618	10	42	1	595	4	0	0	0	36,272
OK621100000010_10	Chikaskia River	410,191	112	486	17	6,854	47	0	15	0	417,721
OK621100000100_00	Bitter Creek	586,442	3,139	2,269	26	7,984	58	0	24	51	599,992
OK621200010200_00	Arkansas River	2,151,106	3,967	554	56	2,916	348	0	47	288	2,159,282
OK621200030010_00	Black Bear Creek	3,068,666	12,008	2,167	107	6,164	692	2	103	767	3,090,676
OK621200050010_00	Red Rock Creek	1,968,083	2,539	587	22	1,737	258	2	27	382	1,973,636
OK621200050010_10	Red Rock Creek	2,257,124	13,271	742	43	4,403	337	1	38	94	2,276,053
OK621210000050_10	Beaver Creek	571,551	3,532	1,847	15	964	31	0	11	61	578,012
OK621210000270_00	Chilocco Creek	224,789	1,218	925	9	2,742	22	0	9	19	229,733

3.2.3 Failing Onsite Wastewater Disposal Systems and Illicit Discharges

ODEQ 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 (ODEQ 2004). OSWD systems and illicit discharges can be a source of bacteria loading to streams and rivers. Bacteria 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 discharges to creeks through springs and seeps.

To estimate the potential magnitude of OSWDs fecal bacteria 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 (U.S. Census Bureau 2000). 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 tracking 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 1995 American Housing Survey conducted by the U.S. Census Bureau estimates that, nationwide, 10 percent of occupied homes with OSWD systems experience malfunctions during the year (U.S. Census Bureau 1995). A study conducted by Reed, Stowe & Yanke, LLC (2001) reported that approximately 12 percent of the OSWD systems in east Texas and 8 percent 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 3-10 summarizes estimates of sewered and unsewered households for each watershed in the Study Area.

Table 3-10 Estimates of Sewered and Unsewered Households

Waterbody ID	Waterbody Name	Public Sewer	Septic Tank	Other Means	Housing Units	% Sewered
OK621000010010_30	Arkansas River, Salt Fork	1,680	155	11	1,846	91%
OK621000020130_00	Spring Creek	0	15	0	15	0%
OK621000030010_00	Bois d' Arc Creek	4,369	421	10	4,800	91%
OK621000040010_00	Deer Creek	76	256	4	336	23%
OK621000050010_00	Pond Creek	797	310	17	1,125	71%
OK621000060010_00	Crooked Creek	210	224	0	434	48%
OK621010010010_00	Arkansas River, Salt Fork	6	183	5	194	3%
OK621010010090_00	Clay Creek	440	92	2	534	82%
OK621010010160_00	Arkansas River, Salt Fork	31	68	1	100	31%
OK621010010230_00	Turkey Creek	92	47	6	146	63%
OK621010010270_00	Yellowstone Creek	0	36	0	36	0%
OK621010020010_00	Sandy Creek	284	466	24	774	37%
OK621010030010_00	Medicine Lodge River	1,005	293	12	1,309	77%
OK621010030030_00	Driftwood Creek	169	200	6	375	45%
OK621100000010_00	Chikaskia River	9	54	1	63	14%
OK621100000010_10	Chikaskia River	2,700	283	15	2,998	90%
OK621100000100_00	Bitter Creek	158	266	21	445	36%
OK621200010200_00	Arkansas River	372	836	14	1,222	30%
OK621200030010_00	Black Bear Creek	1,677	1,302	29	3,007	56%
OK621200050010_00	Red Rock Creek	179	292	8	479	37%
OK621200050010_10	Red Rock Creek	499	362	20	881	57%
OK621210000050_10	Beaver Creek	26	82	6	114	23%
OK621210000270_00	Chilocco Creek	31	221	5	257	12%

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

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

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

The average of number of people per household was calculated to be 2.53 for counties in the Study Area (U.S. Census Bureau 2000). 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 3-11.

Table 3-11 Estimated Fecal Coliform Load from OSWD Systems

Waterbody ID	Waterbody Name	Acres	Septic Tank	# of Failing Septic Tanks	Estimated Loads from Septic Tanks (x 10^9 counts/day)
OK621000010010_30	Arkansas River, Salt Fork	73,856	155	12	83
OK621000020130_00	Spring Creek	7,628	15	1	8
OK621000030010_00	Bois d' Arc Creek	63,213	421	34	226
OK621000040010_00	Deer Creek	100,428	256	20	137
OK621000050010_00	Pond Creek	212,118	310	25	166
OK621000060010_00	Crooked Creek	152,355	224	18	120
OK621010010010_00	Arkansas River, Salt Fork	55,557	183	15	98
OK621010010090_00	Clay Creek	77,364	92	7	49
OK621010010160_00	Arkansas River, Salt Fork	34,911	68	5	37
OK621010010230_00	Turkey Creek	24,660	47	4	25
OK621010010270_00	Yellowstone Creek	41,913	36	3	20
OK621010020010_00	Sandy Creek	296,734	466	37	250
OK621010030010_00	Medicine Lodge River	166,124	293	23	157
OK621010030030_00	Driftwood Creek	167,133	200	16	107
OK621100000010_00	Chikaskia River	4,819	54	4	29
OK621100000010_10	Chikaskia River	55,681	283	23	152
OK621100000100_00	Bitter Creek	88,033	266	21	143
OK621200010200_00	Arkansas River	183,014	836	67	448
OK621200030010_00	Black Bear Creek	242,892	1,302	104	698
OK621200050010_00	Red Rock Creek	142,386	292	23	156
OK621200050010_10	Red Rock Creek	153,759	362	29	194
OK621210000050_10	Beaver Creek	30,573	82	7	44
OK621210000270_00	Chilocco Creek	56,712	221	18	118

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 bacteria loading. On average 37.2 percent of the nation's households own dogs and 32.4 percent 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 2000), dog and cat populations can be estimated for each watershed. Table 3-12 summarizes the estimated number of dogs and cats for the watersheds of the Study Area.

Table 3-12 Estimated Numbers of Pets

Waterbody ID	Waterbody Name	Dogs	Cats
OK621000010010_30	Arkansas River, Salt Fork	791	892
OK621000020130_00	Spring Creek	9	10
OK621000030010_00	Bois d' Arc Creek	2,573	2,903
OK621000040010_00	Deer Creek	156	176
OK621000050010_00	Pond Creek	501	565
OK621000060010_00	Crooked Creek	235	265
OK621010010010_00	Arkansas River, Salt Fork	104	117
OK621010010090_00	Clay Creek	208	235
OK621010010160_00	Arkansas River, Salt Fork	121	136
OK621010010230_00	Turkey Creek	96	109
OK621010010270_00	Yellowstone Creek	23	26
OK621010020010_00	Sandy Creek	522	588
OK621010030010_00	Medicine Lodge River	332	375
OK621010030030_00	Driftwood Creek	155	175
OK621100000010_00	Chikaskia River	28	32
OK621100000010_10	Chikaskia River	1,566	1,767
OK621100000100_00	Bitter Creek	192	217
OK621200010200_00	Arkansas River	634	715
OK621200030010_00	Black Bear Creek	1,711	1,930
OK621200050010_00	Red Rock Creek	289	326
OK621200050010_10	Red Rock Creek	411	464
OK621210000050_10	Beaver Creek	102	115
OK621210000270_00	Chilocco Creek	200	225

Table 3-13 provides an estimate of the fecal coliform load 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 3-13 Estimated Fecal Coliform Daily Production by Pets ($x10^9$ counts/day)

Waterbody ID	Waterbody Name	Dogs	Cats	Total
OK621000010010_30	Arkansas River, Salt Fork	2,609	482	3,091
OK621000020130_00	Spring Creek	30	6	36
OK621000030010_00	Bois d' Arc Creek	8,492	1,568	10,060
OK621000040010_00	Deer Creek	516	95	611
OK621000050010_00	Pond Creek	1,652	305	1,957
OK621000060010_00	Crooked Creek	776	143	920
OK621010010010_00	Arkansas River, Salt Fork	343	63	406
OK621010010090_00	Clay Creek	687	127	814
OK621010010160_00	Arkansas River, Salt Fork	398	74	472
OK621010010230_00	Turkey Creek	318	59	376
OK621010010270_00	Yellowstone Creek	76	14	91
OK621010020010_00	Sandy Creek	1,721	318	2,039
OK621010030010_00	Medicine Lodge River	1,096	202	1,298
OK621010030030_00	Driftwood Creek	513	95	607
OK621100000010_00	Chikaskia River	93	17	110
OK621100000010_10	Chikaskia River	5,168	954	6,122
OK621100000100_00	Bitter Creek	634	117	751
OK621200010200_00	Arkansas River	2,092	386	2,478
OK621200030010_00	Black Bear Creek	5,645	1,042	6,687
OK621200050010_00	Red Rock Creek	953	176	1,129
OK621200050010_10	Red Rock Creek	1,357	251	1,608
OK621210000050_10	Beaver Creek	338	62	400
OK621210000270_00	Chilocco Creek	659	122	781

3.3 Summary of Bacteria Sources

There are no continuous, permitted point sources of bacteria in the Crooked Creek (OK621000060010_00), Arkansas River, Salt Fork (OK621010010010_00), Medicine Lodge River (OK621010030010_00), Driftwood Creek (OK621010030030_00), Bitter Creek (OK621100000100_00), Red Rock Creek (OK621200050010_10), Chilocco Creek (OK621210000270_00), Arkansas River, Salt Fork (OK621010010160_00), Turkey Creek (OK621010010230_00), Deer Creek (OK621000040010_00), Spring Creek (OK621000020130_00), Yellowstone Creek (OK621010010270_00), Sandy Creek(OK621010020010_00), Chikaskia River (OK621100000010_00) and Beaver Creek (OK621210000050_10) watersheds which require bacteria TMDLs; therefore, nonsupport of PBCR use in these watersheds is caused by nonpoint sources of bacteria only. The Black Bear Creek (OK621200030010_00) and Chikaskia River (OK621100000010_10) watersheds each have one continuous point source dischargers which contributes bacteria, but the available data suggests that the proportion of bacteria from point sources is minor. CAFOs maybe contributing bacteria loading in Crooked Creek, Arkansas River, Salt Fork (OK621010010160_00) and Turkey Creek watersheds. The various nonpoint sources are considered to be the major source of bacteria loading in each watershed that requires a TMDL for bacteria.

Table 3-14 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 bacteria concentrations in each watershed. 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 bacteria source tracking studies around the nation demonstrate that wild birds and mammals represent a major source of the fecal bacteria found in streams.

Table 3-14 Summary of Fecal Coliform Load Estimates from Nonpoint Sources to Land Surfaces ($x10^9$ counts/day)

Waterbody ID	Waterbody Name	All Livestock	Pets	Deer	Estimated Loads from Septic Tanks
OK621000010010_30	Arkansas River, Salt Fork	596,007	3,091	458	83
OK621000020130_00	Spring Creek	59,393	36	55	8
OK621000030010_00	Bois d' Arc Creek	475,055	10,060	356	226
OK621000040010_00	Deer Creek	771,381	611	665	137
OK621000050010_00	Pond Creek	1,706,102	1,957	1,459	166
OK621000060010_00	Crooked Creek	1,441,837	920	921	120
OK621010010010_00	Arkansas River, Salt Fork	867,736	406	403	98
OK621010010090_00	Clay Creek	1,315,159	814	562	49
OK621010010160_00	Arkansas River, Salt Fork	578,957	472	248	37
OK621010010230_00	Turkey Creek	301,888	376	134	25
OK621010010270_00	Yellowstone Creek	498,244	91	205	20
OK621010020010_00	Sandy Creek	3,994,705	2,039	476	250
OK621010030010_00	Medicine Lodge River	1,882,158	1,298	348	157
OK621010030030_00	Driftwood Creek	1,911,357	607	490	107
OK621100000010_00	Chikaskia River	36,272	110	27	29
OK621100000010_10	Chikaskia River	417,721	6,122	313	152
OK621100000100_00	Bitter Creek	599,992	751	323	143
OK621200010200_00	Arkansas River	2,159,282	2,478	1,501	448
OK621200030010_00	Black Bear Creek	3,090,676	6,687	1,820	698
OK621200050010_00	Red Rock Creek	1,973,636	1,129	905	156
OK621200050010_10	Red Rock Creek	2,276,053	1,608	641	194
OK621210000050_10	Beaver Creek	578,012	400	282	44
OK621210000270_00	Chilocco Creek	229,733	781	118	118

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.

Of the 17 watersheds in the Study Area that require turbidity TMDLs, two of them, Pond Creek (OK621000050010_00) and Red Rock Creek (OK621200050010_00), have industrial permitted sources of TSS that will necessitate a WLA. Twelve of the watersheds have other permitted activities such as construction and/or mining that contribute some TSS loading. Therefore, nonsupport of WWAC use in the all but one watershed 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:

$$\textbf{TMDL} = \Sigma\ \textbf{WLA} + \Sigma\ \textbf{LA} + \textbf{MOS}$$

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. Thus, the allowable pollutant load that can be allocated to point and nonpoint sources can then be defined as the TMDL minus the MOS.

40 CFR, §130.2(1), states that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures. For fecal coliform, *E. coli*, or Enterococci bacteria, TMDLs are expressed as colony-forming units (cfu) per day, where possible, or as a percent reduction goal (PRG), and represent the maximum one-day load the stream can assimilate while still attaining the WQS. 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 TSS 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 from 1998 to 2008 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:

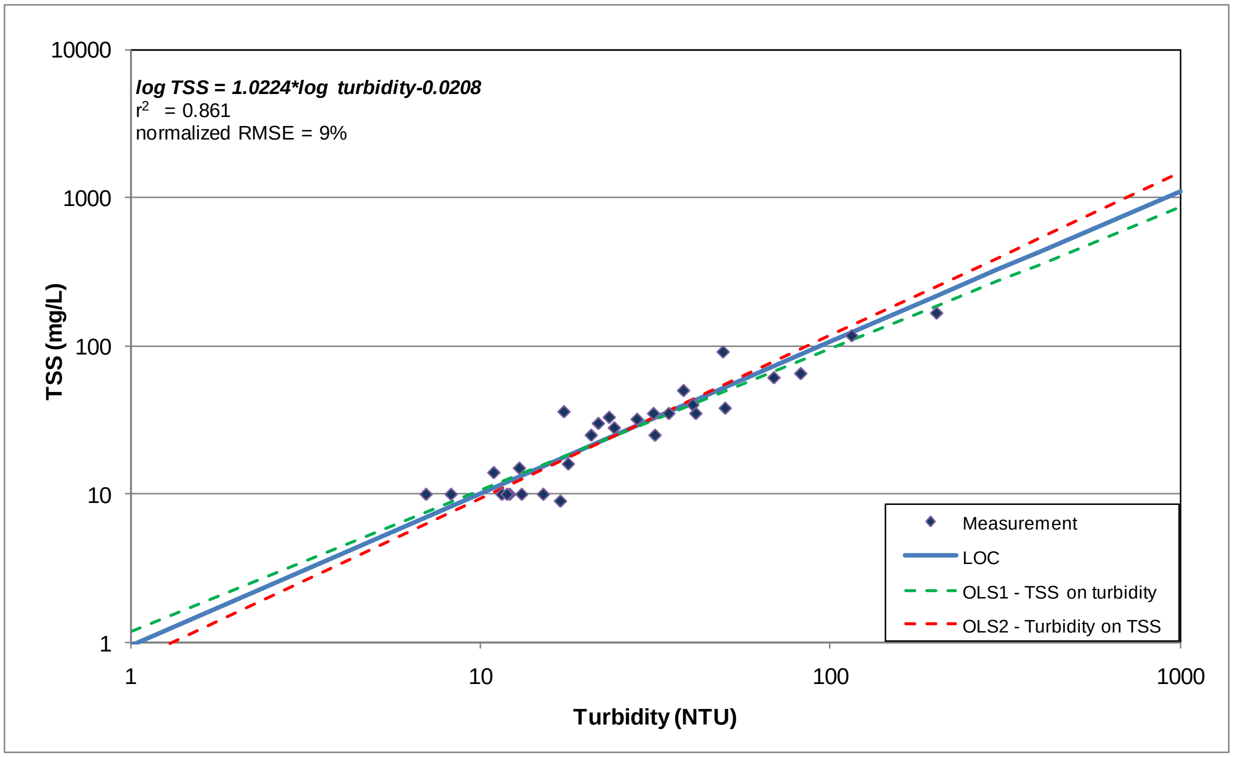
$$m1 = \sqrt{m \cdot m'} = sign[r] \cdot \frac{s_y}{s_x}$$

where *m*1 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 (*b*1) is subsequently found by fitting the line with the LOC slope through the point (mean turbidity, mean TSS). Figure 4-1 shows an example of the correlation between TSS and turbidity, along with the LOC and the OLS lines.

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 9 which means the root mean square error (RMSE) is 9% 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.

Figure 4-1 Linear Regression for TSS-Turbidity for Bois d'Arc Creek (OK621000030010_00)



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 segment is provided 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 are effective at identifying 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 bacteria 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.

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 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 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-four 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, which is numbered from 0 to 100 percent, and may or may not be logarithmic. The lowest measured flow occurs at an exceedance frequency of 100 percent indicating that flow has equaled or exceeded this value 100 percent of the time, while the highest measured flow is found at an exceedance frequency of 0 percent. The median flow occurs at a flow exceedance frequency of 50 percent. The flow exceedance percentiles for each waterbody addressed in this report are provided in Appendix B.

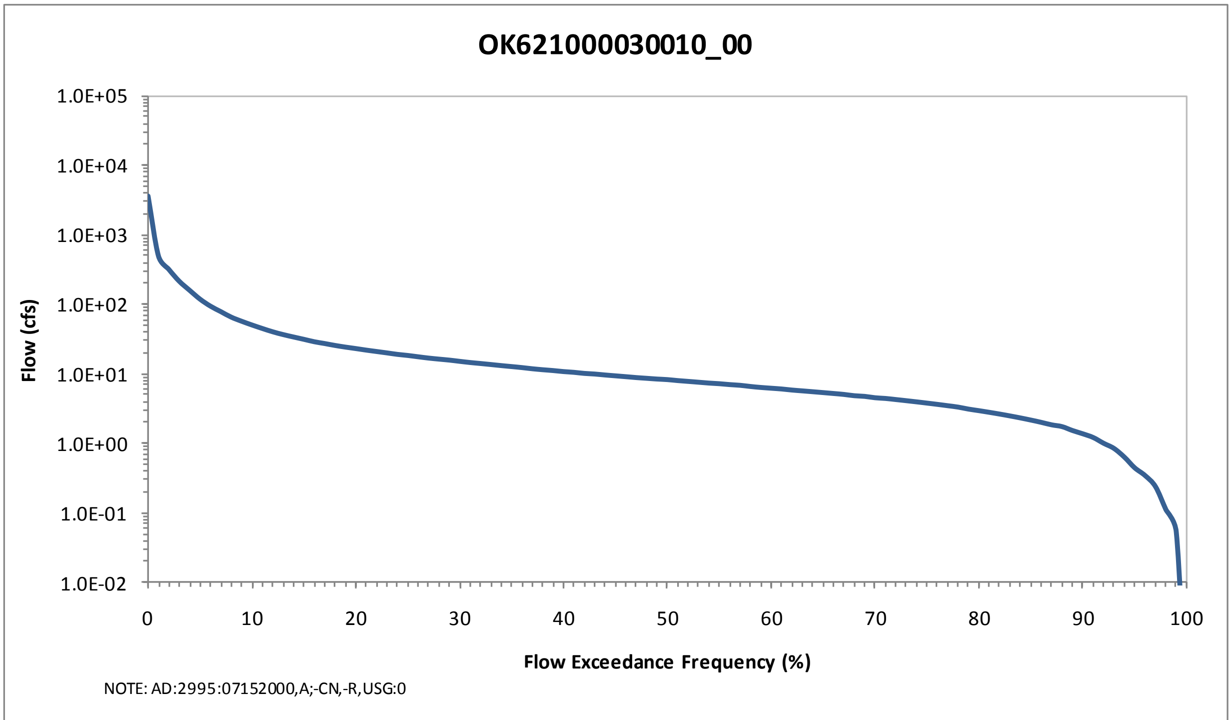
While the number of observations required to develop a flow duration curve is not rigorously specified, a flow duration curve is usually based on more than 1 year of observations, and encompasses inter-annual and seasonal variation. Ideally, the drought of record and flood of record are included in the 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 bacteria, 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 percent and downward at a frequency near 100 percent, 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 percent. 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 Bois d'Arc Creek (OK621000030010_00)



Flow duration curves for each impaired waterbody in the Study Area are provided in Section 5.2.

4.4 Estimating Existing Loading

A key step in the use of LDCs for TMDL development is the estimation of existing instream loads. 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 bacteria 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 Bacteria LDCs. LDCs are similar in appearance to flow duration curves; however, for bacteria the ordinate is expressed in terms of a bacteria load in cfu/day, and for TSS the ordinate is expressed in terms of a load in lbs/day. The curve represents the single sample water quality criterion for fecal coliform (400 cfu/100 mL), *E. coli*

(406 cfu/100 mL), or Enterococci (108 cfu/100 mL) expressed in terms of a load through multiplication by the continuum of flows historically observed at the site. 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 for the time period and season of interest;
- 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 bacteria 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;
- 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 bacteria 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 = 400 cfu /100 mL (Fecal coliform); 406 cfu/100 mL (E. coli); or 108 cfu/100 mL (Enterococci)

unit conversion factor = 24,465,525 mL*s / ft3*day

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) = $\boldsymbol{WQ_{goal}}$ **** flow (cfs) * unit conversion factor***

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

unit conversion factor = 5.39377 $\boldsymbol{L*s*lb /(ft^3*day*mg)}$

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 equal or exceed the measured or estimated flow. Historical observations of bacteria, TSS and/or turbidity concentrations are paired with flow data and are plotted as separate LDCs. The fecal coliform load (or the y-value of each point) is calculated by multiplying the fecal coliform concentration (colonies/100 mL) by the instantaneous flow (cfs) at the same site and time, with appropriate volumetric and time unit conversions. Fecal coliform/*E. coli*/Enterococci loads representing exceedance of water quality criteria fall above the water quality criterion line. Likewise, the TSS load (or the y-value of each point) is calculated by multiplying the TSS concentration (measured or converted from turbidity) (mg/L) by the instantaneous flow (cfs) at the same site and time, with appropriate volumetric and time unit conversions. TSS loads representing exceedance of water quality criteria fall above the

TMDL line. Regarding bacteria data, it is noted that only those flows and water quality samples observed in the months comprising the primary contact recreation season are used to generate the LDCs. It is inappropriate to compare single sample bacteria observations and instantaneous or daily flow durations to a 30-day geometric mean water quality criterion in the LDC.

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 and runoff influence may be observed with low or moderate flows.

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 bacteria TMDLs in this report, an explicit MOS of 10 percent was selected. The 10 percent MOS has been used in other approved bacteria 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 bacteria 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 USEPA 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. TMDLs can be expressed in terms of maximum allowable concentrations, or as different maximum loads allowable under different flow conditions, rather than single maximum load values. For bacteria TMDLs a concentration-based approach meets the requirements of 40 CFR, 130.2(i) for expressing TMDLs “in terms of mass per time, toxicity, or other appropriate measures” and is consistent with USEPA’s Protocol for Developing Pathogen TMDLs (USEPA 2001). 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. WLAs may be set to zero in cases of watersheds with no existing or planned continuous permitted point sources. For watersheds with permitted point sources, NPDES permit limits are used to derive WLAs. 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 watershed. Using this information bacteria and TSS WLAs can be calculated using a mass balance approach as shown in the equations below.

WLA for bacteria:

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

Where:

WQS = 200 cfu /100 mL (Fecal coliform); 126 cfu/100 mL (E. coli); or 33 cfu/100 mL (Enterococci)

flow (10^6 gal/day) = permitted flow

unit conversion factor = 37,854,120-10^6gal/day

WLA for TSS:

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

Where:

WQ goal is provided in Table 5-1;

flow (10^6 gal/day) = permitted flow or average monthly flow

unit conversion factor = 8.3445 L*lb/(gal*mg)

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, USEPA regulations and guidance recommend expressing NPDES permit limits for MS4s as BMPs.

LAs can be calculated under different flow conditions as the water quality target load minus the WLA. The LA is represented by the area under the LDC but above the WLA. 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 bacteria TMDLs, if there are no permitted MS4s in the Study Area, WLA_MS4 is set to zero. When there are permitted MS4s in a watershed, 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 cases 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 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 water quality standards at the end-of-pipe and, therefore, no WLA reduction would be required. 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.

Step 6: Estimate LA Load Reduction. After existing loading estimates are computed for each pollutant, nonpoint load reduction estimates for each waterbody are calculated by using the difference between estimated existing loading and the allowable load expressed by the LDC (TMDL-MOS). This difference is expressed as the overall PRG for the impaired waterbody. For fecal coliform the PRG, which ensures that no more than 25 percent of the samples exceed the TMDL based on the instantaneous criteria, allocates the loads in manner that is also protective of the geometric mean criterion. For *E. coli* and Enterococci, because WQSs are considered to be met if 1) either the geometric mean of all data is less than the geometric mean criteria, or 2) no sample exceeds the instantaneous criteria, the TMDL PRG will be the lesser of that required to meet the geometric mean or instantaneous criteria. For turbidity, the PRG is the load reduction that ensures that no more than 10 percent of the samples under flow-base conditions exceed the TMDL.

SECTION 5
TMDL CALCULATIONS

5.1 Surrogate TMDL Target for Turbidity

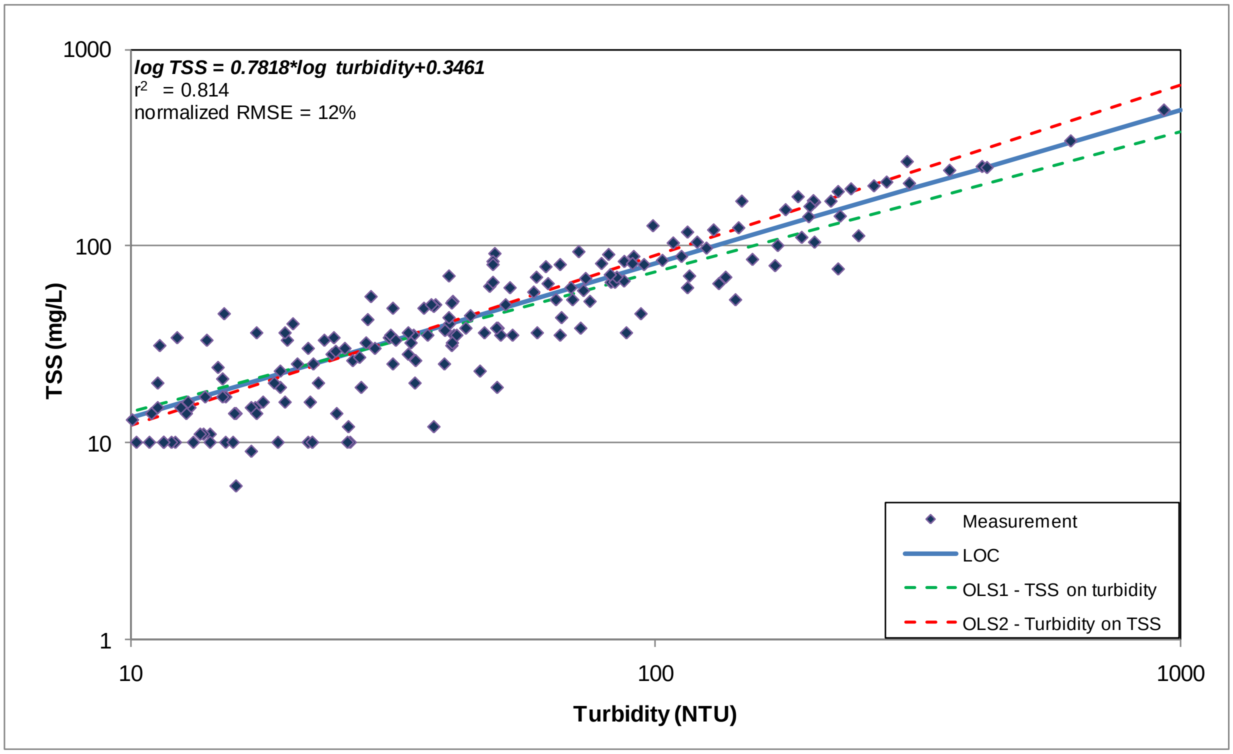
Using the LOC method described in Section 4.1, correlations between TSS and turbidity were developed for establishing the statistics of the regressions and the resultant TSS goals provided in Table 5-1. The regression analysis for each impaired waterbody in the Study Area using the LOC method is displayed in Figures 5-1 through 5-17.

Table 5-1 Regression Statistics and TSS Goals

Waterbody ID	Waterbody Name	R-square	NRMSE	TSS Goal (mg/L)[a]	MOS[b]
OK621000010010_30	Arkansas River, Salt Fork	0.814	12.4%	47	15%
OK621000030010_00	Bois d' Arc Creek	0.860	9.1%	52	10%
OK621000040010_00	Deer Creek	0.863	9.4%	47	10%
OK621000050010_00	Pond Creek	0.933	8.3%	42	10%
OK621000060010_00	Crooked Creek	0.888	8.7%	44	10%
OK621010010010_00	Arkansas River, Salt Fork	0.894	5.4%	41	10%
OK621010010160_00	Arkansas River, Salt Fork	0.880	8.2%	82	10%
OK621010010230_00	Turkey Creek	0.607	17.9%	49	20%
OK621010030010_00	Medicine Lodge River	0.878	9.8%	59	15%
OK621010030030_00	Driftwood Creek	0.904	7.7%	52	10%
OK621100000010_00	Chikaskia River, Lower	0.913	7.9%	57	10%
OK621100000010_10	Chikaskia River, Upper	0.745	14.7%	75	15%
OK621100000100_00	Bitter Creek	0.761	11.6%	61	15%
OK621200010200_00	Arkansas River	0.772	9.7%	80	10%
OK621200050010_00	Red Rock Creek, Lower	0.780	11.1%	35	15%
OK621200050010_10	Red Rock Creek, Upper	0.816	12.3%	38	15%
OK621210000270_00	Chilocco Creek	0.624	14.3%	39	15%

[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 Arkansas River, Salt Fork (OK621000010010_30)



Note: Regression for reach OK621000010010_30 was developed using data for the 8-digit watershed (11060004) due to the lack of reach-specific TSS-turbidity paired data.

Figure 5-2 Linear Regression for TSS-Turbidity for Bois d'Arc Creek (OK621000030010_00)

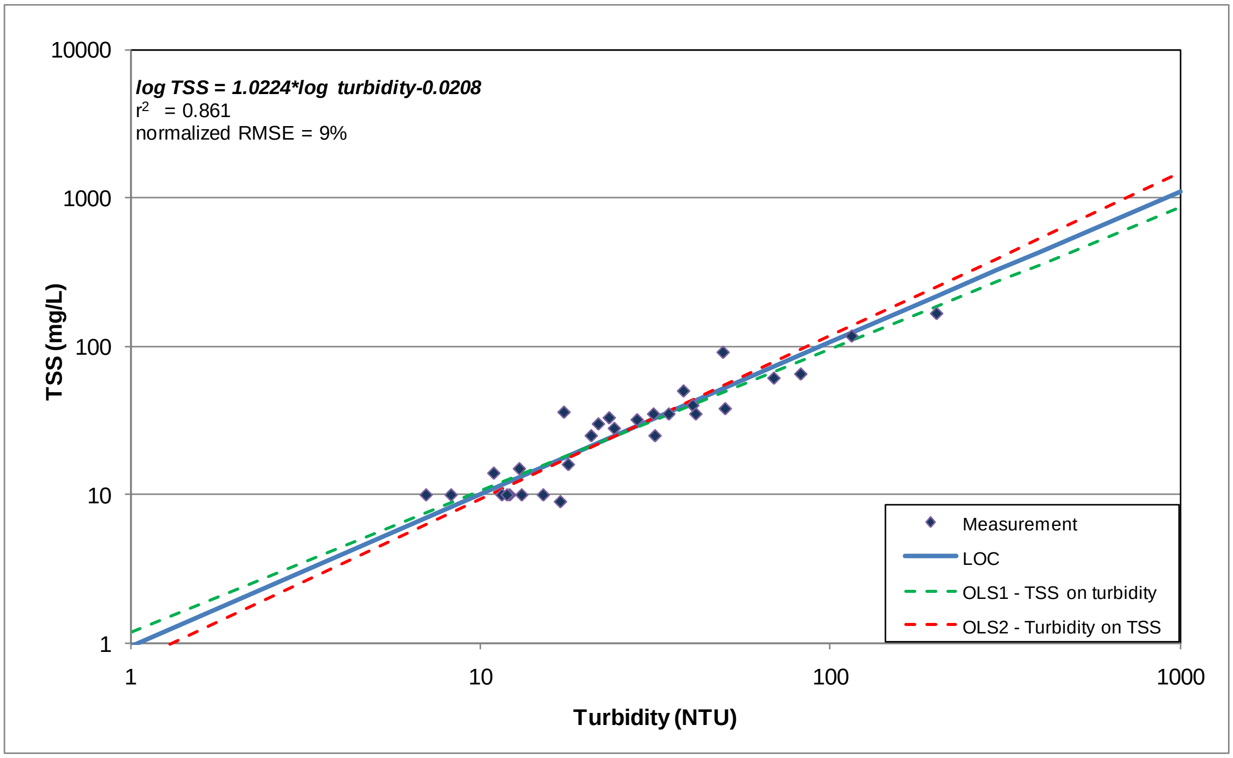


Figure 5-3 Linear Regression for TSS-Turbidity for Deer Creek (OK621000040010_00)

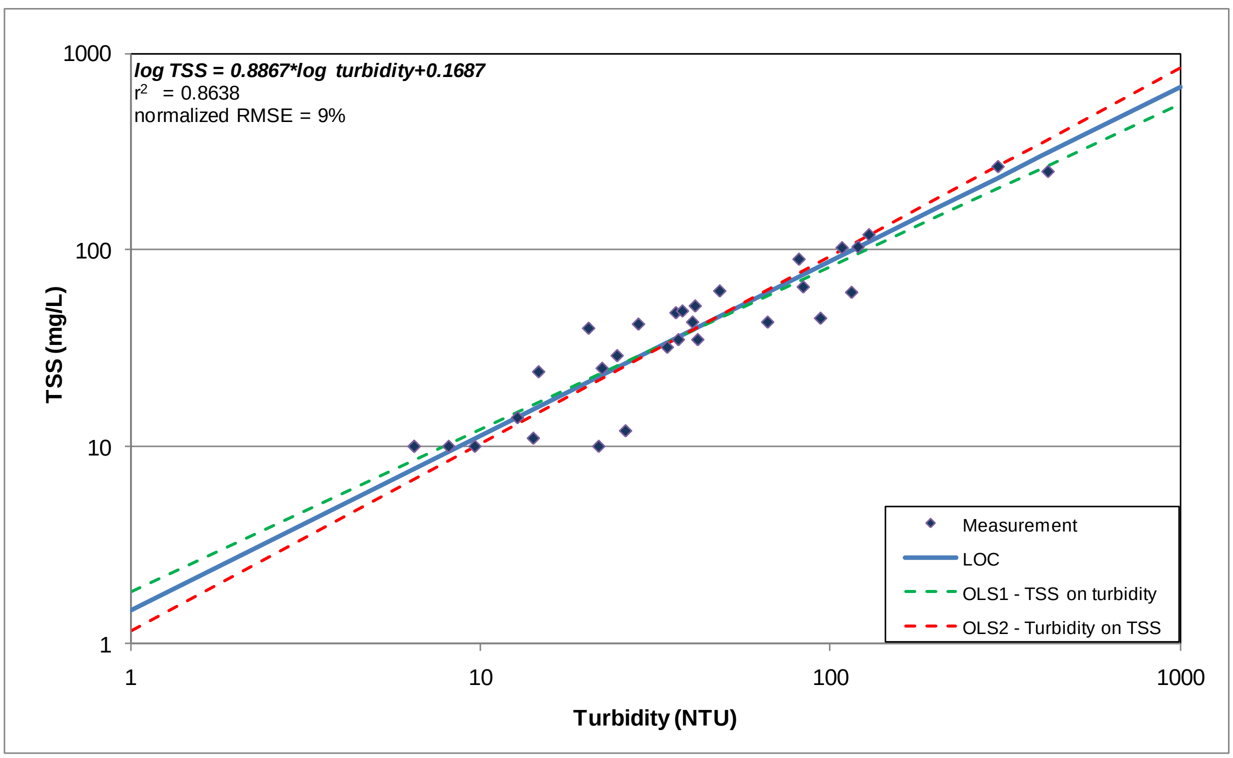


Figure 5-4 Linear Regression for TSS-Turbidity for Pond Creek (OK621000050010_00)

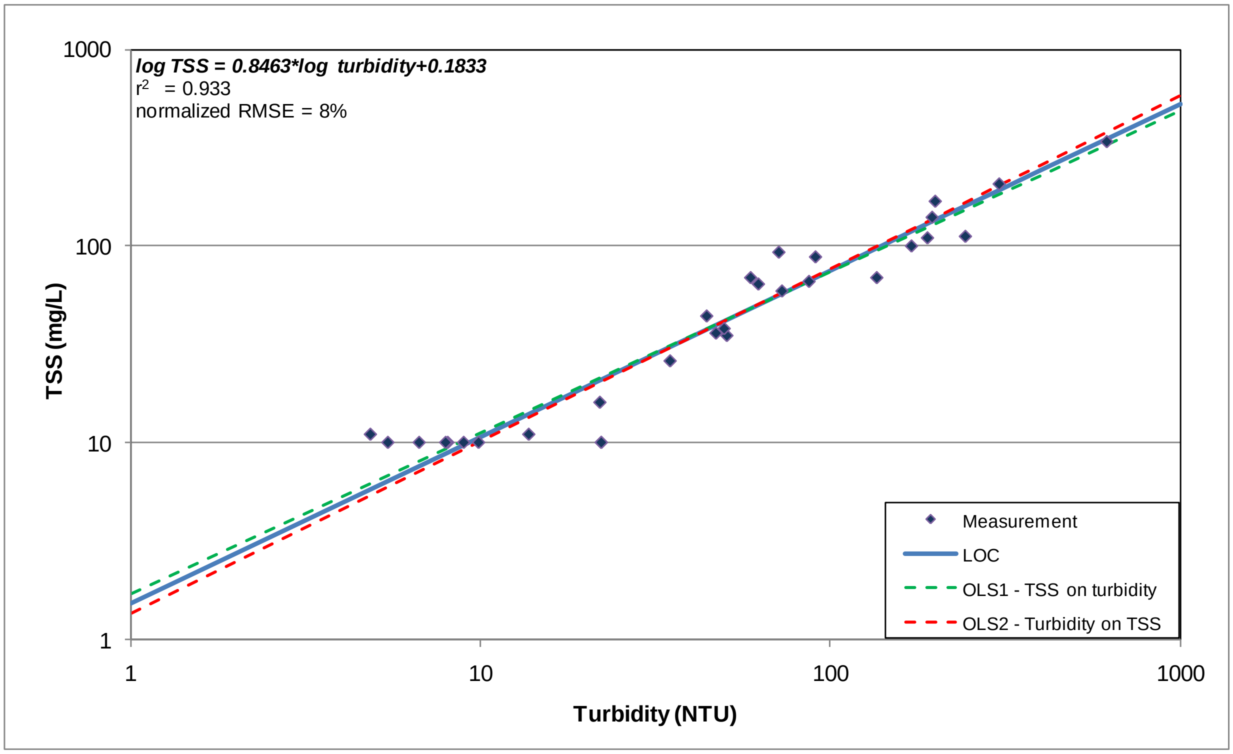


Figure 5-5 Linear Regression for TSS-Turbidity for Crooked Creek (OK621000060010_00)

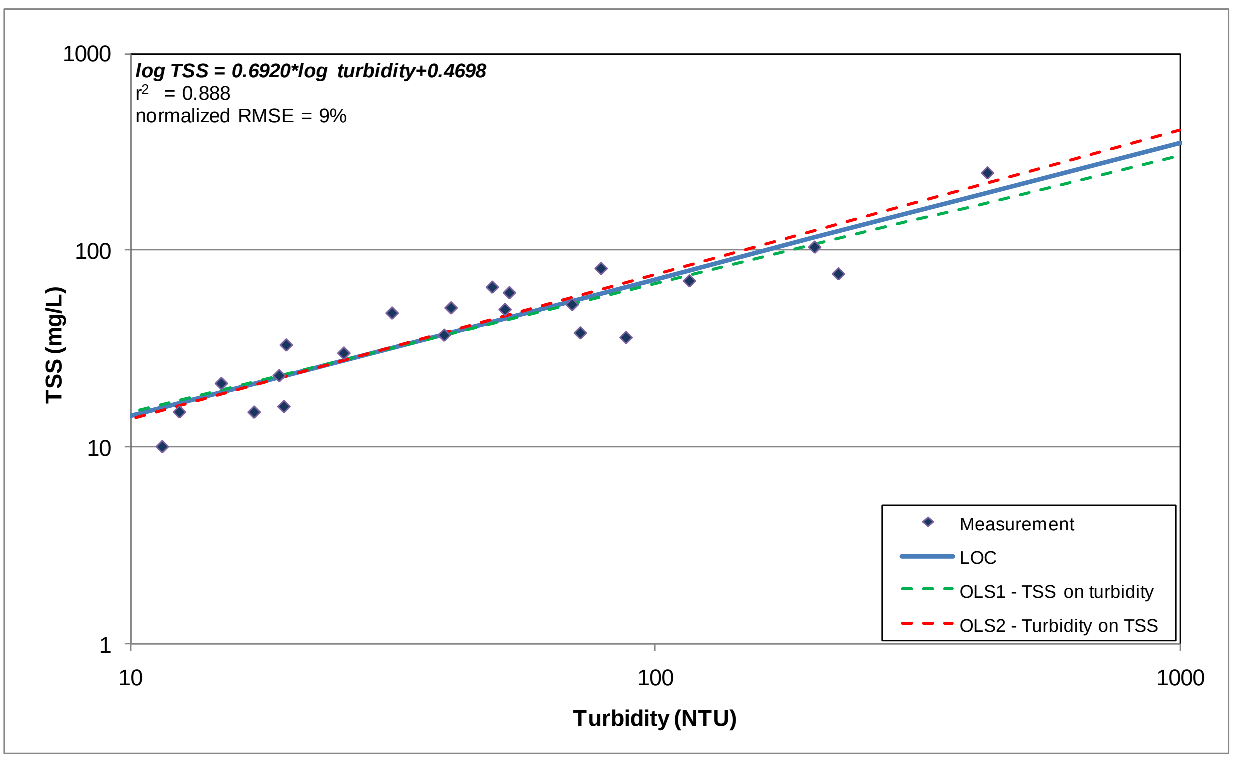


Figure 5-6 Linear Regression for TSS-Turbidity for the Arkansas River, Salt Fork (OK621010010010_00)

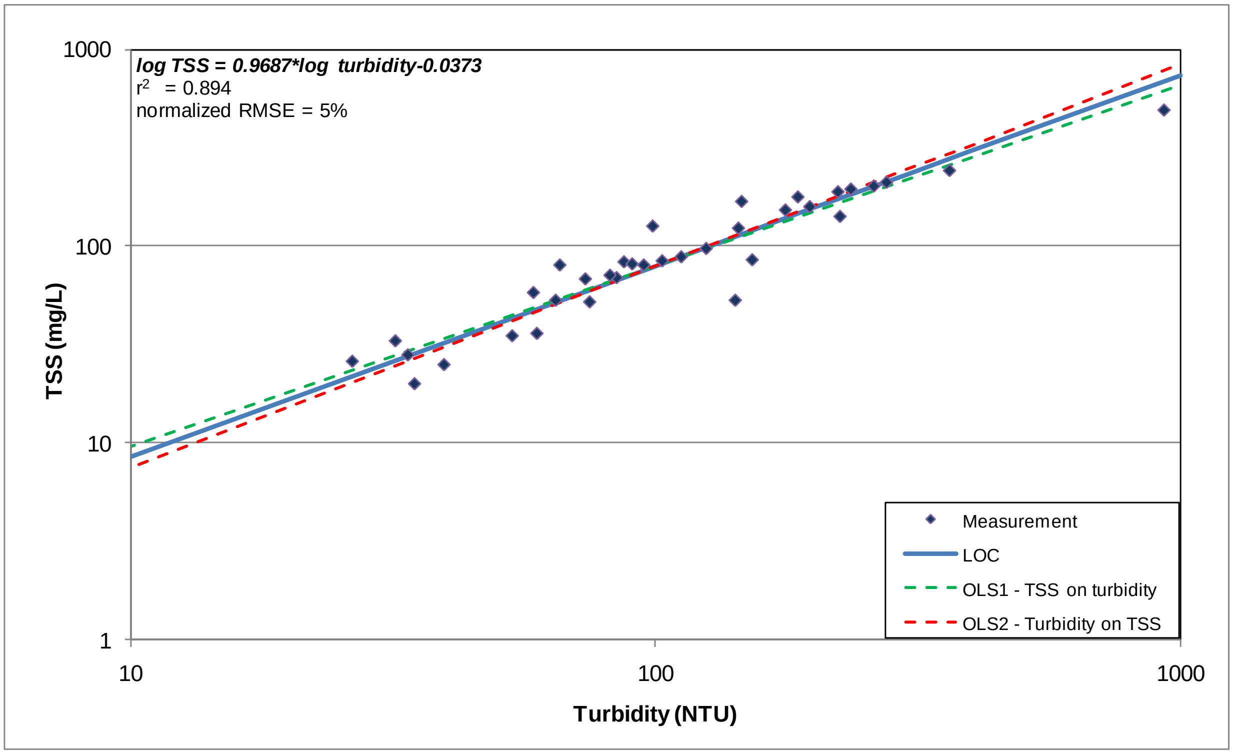


Figure 5-7 Linear Regression for TSS-Turbidity for Arkansas River, Salt Fork (OK621010010160_00)

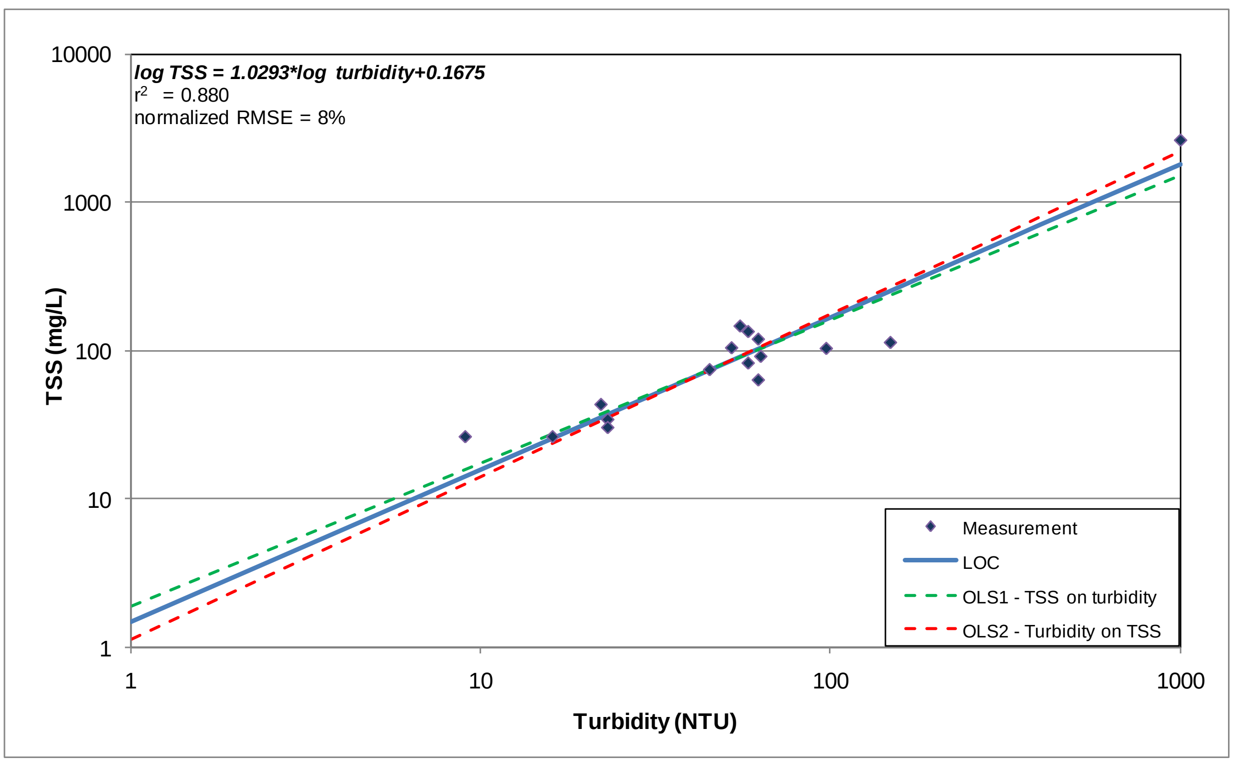


Figure 5-8 Linear Regression for TSS-Turbidity for Turkey Creek (OK621010010230_00)

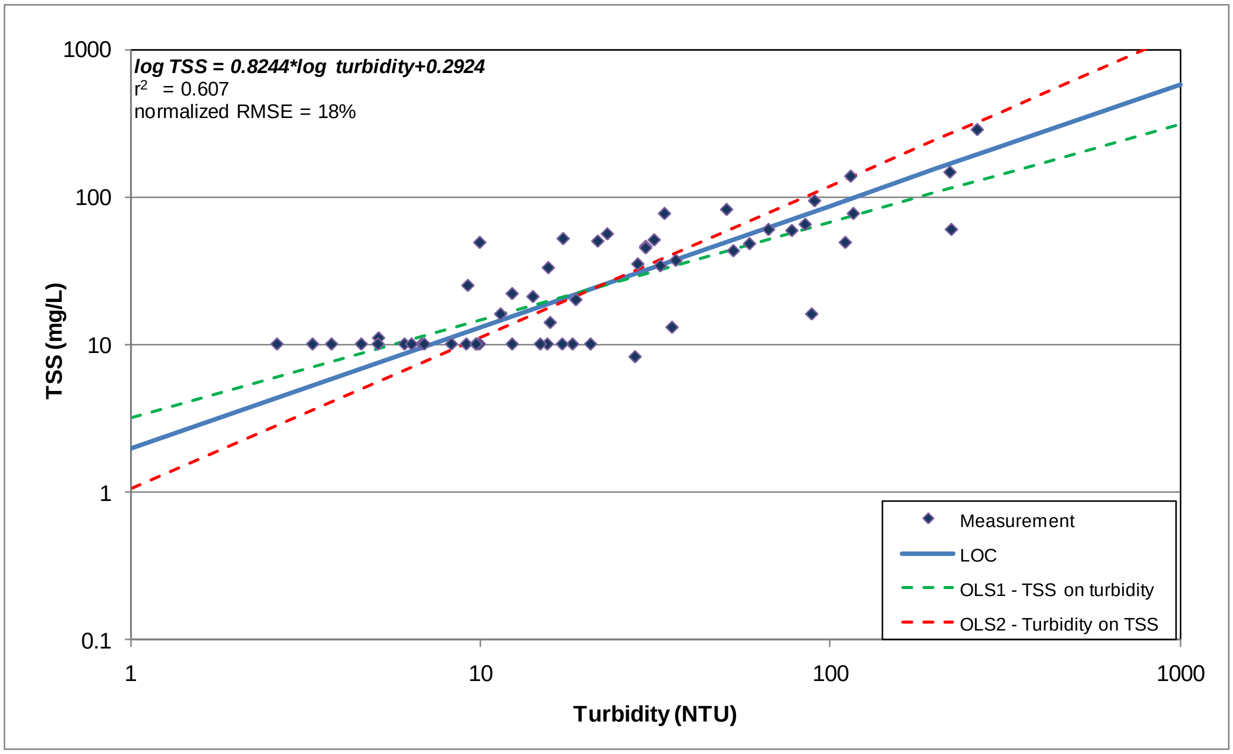


Figure 5-9 Linear Regression for TSS-Turbidity for Medicine Lodge River (OK621010030010_00)

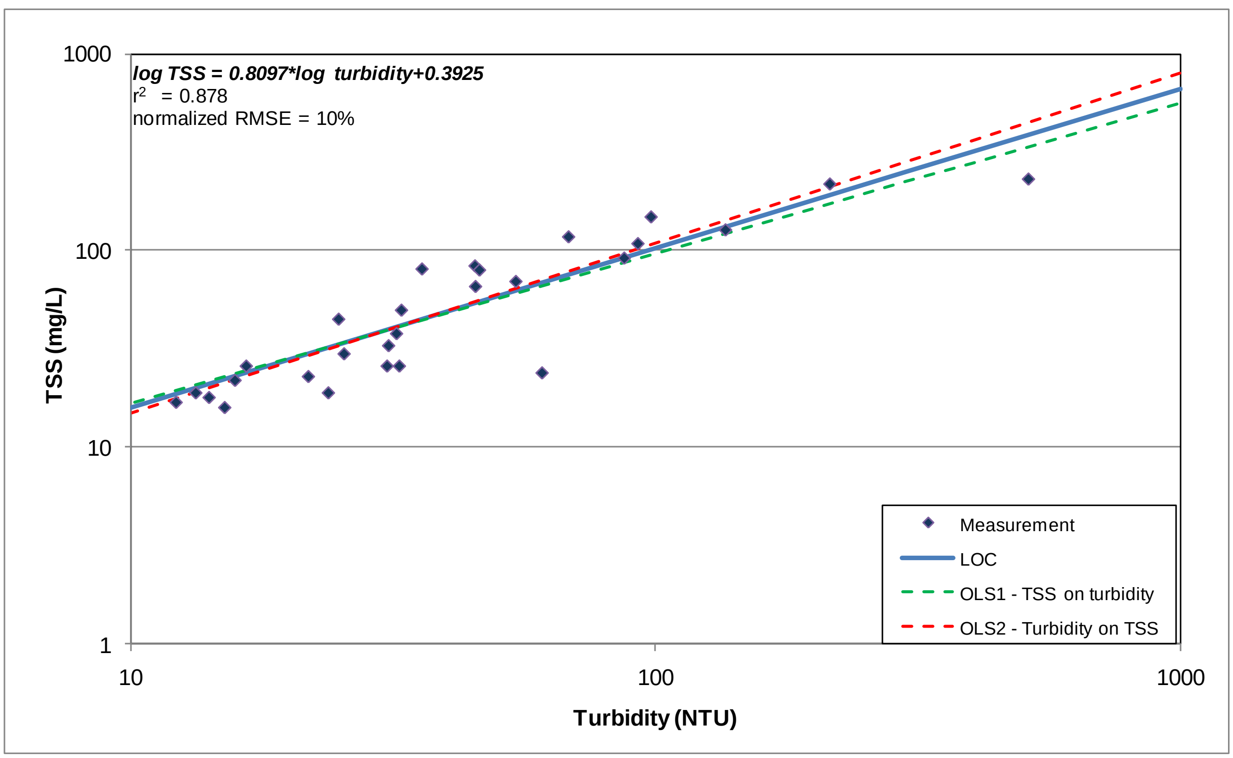


Figure 5-10 Linear Regression for TSS-Turbidity for Driftwood Creek (OK621010030030_00)

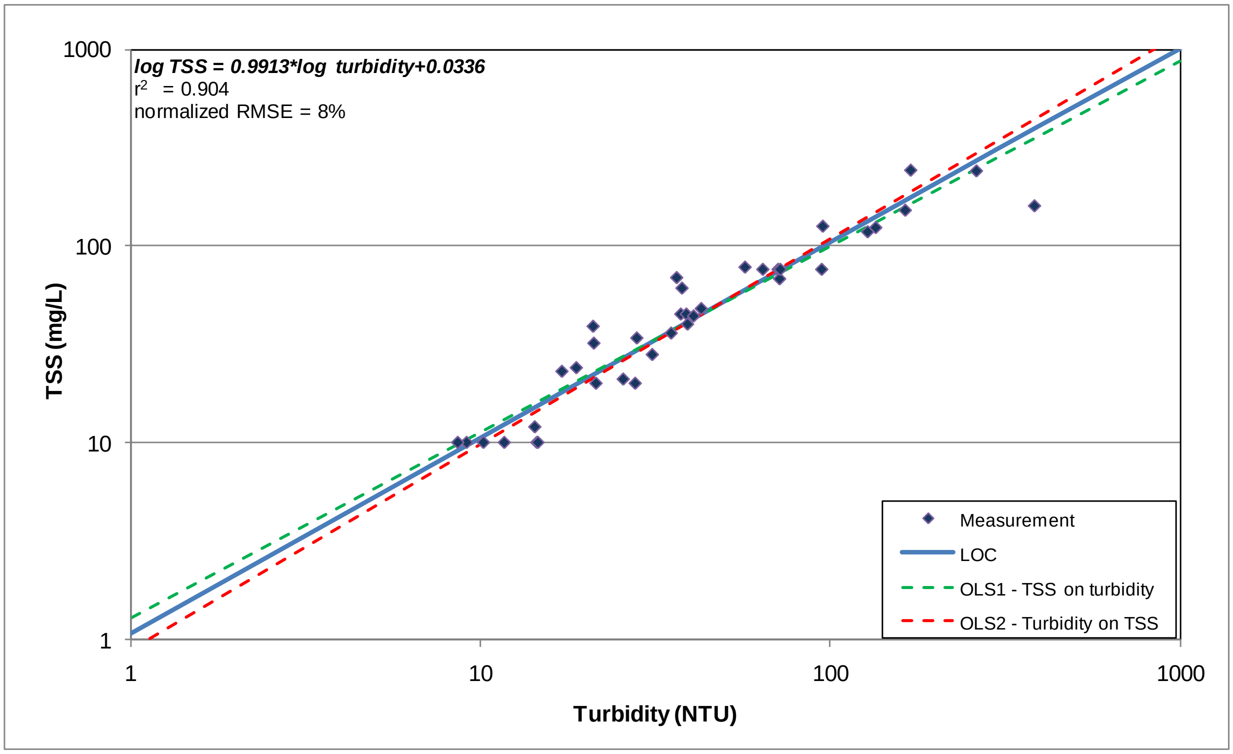


Figure 5-11 Linear Regression for TSS-Turbidity for Chikaskia River, Lower (OK621100000010_00)

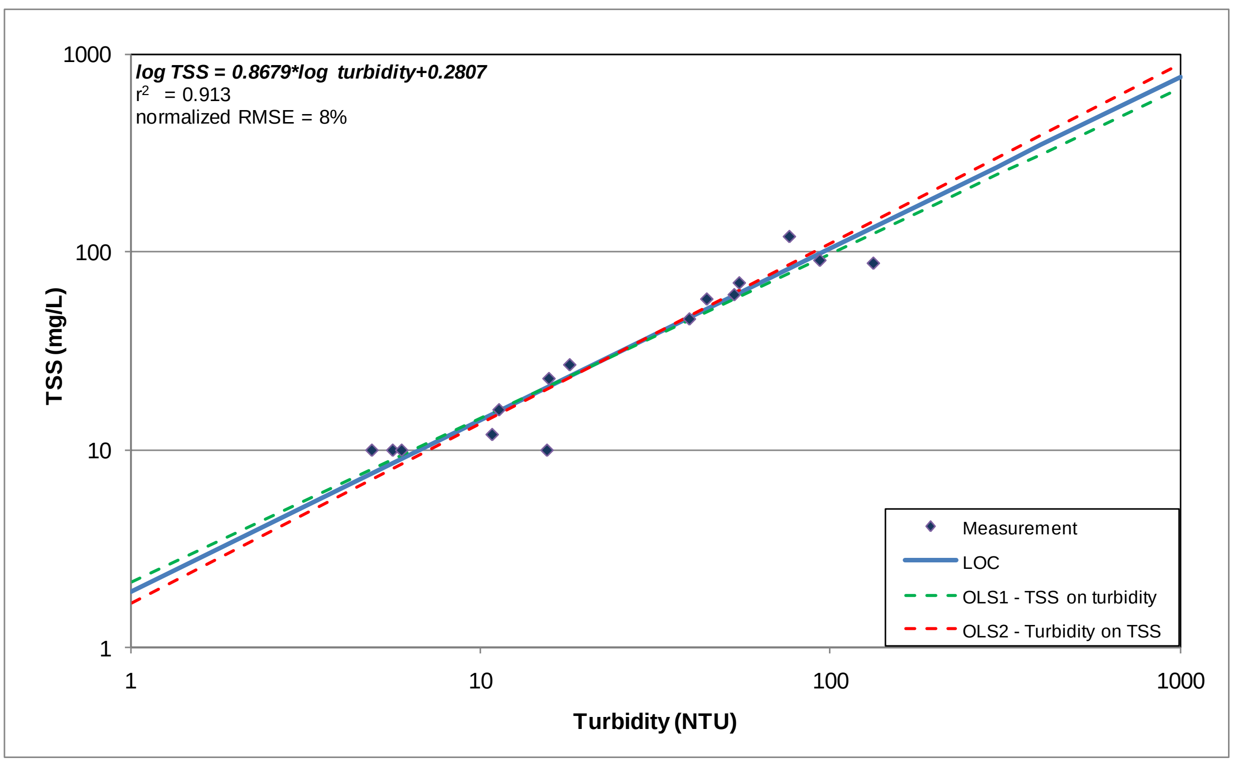


Figure 5-12 Linear Regression for TSS-Turbidity for Chikaskia River, Upper (OK621100000010_10)

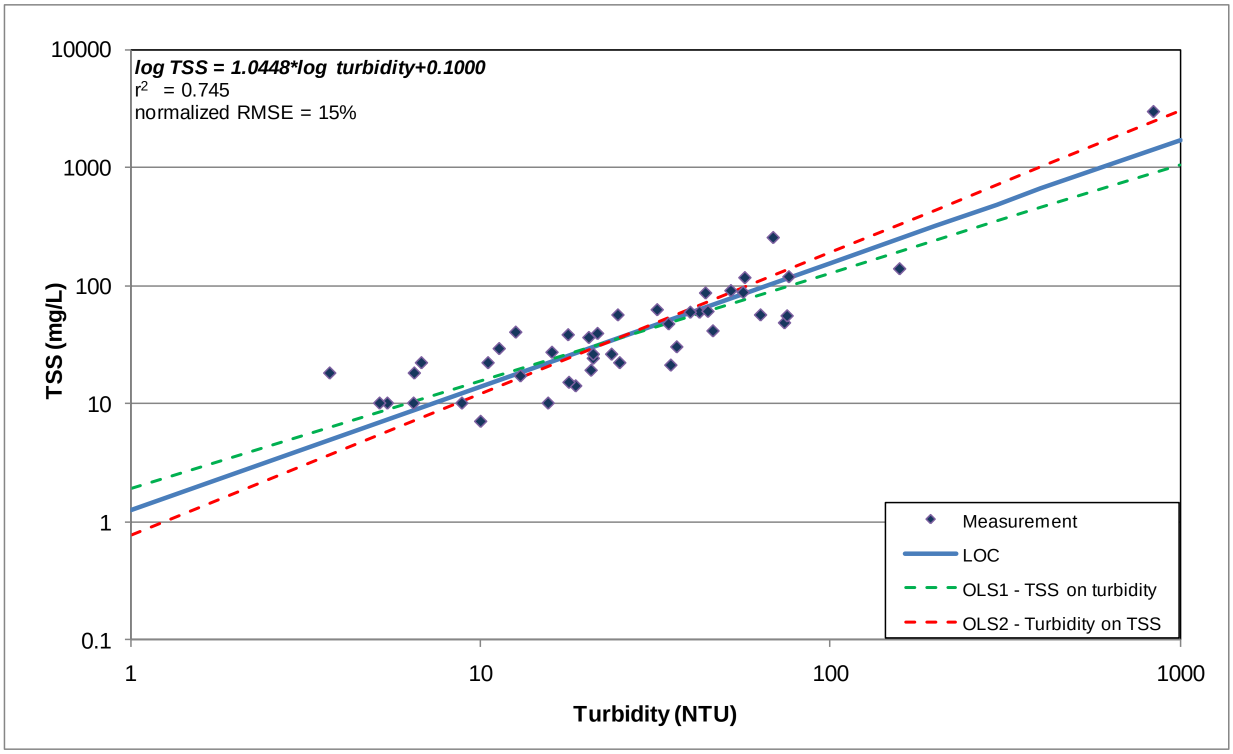


Figure 5-13 Linear Regression for TSS-Turbidity for Bitter Creek (OK621100000100_00)

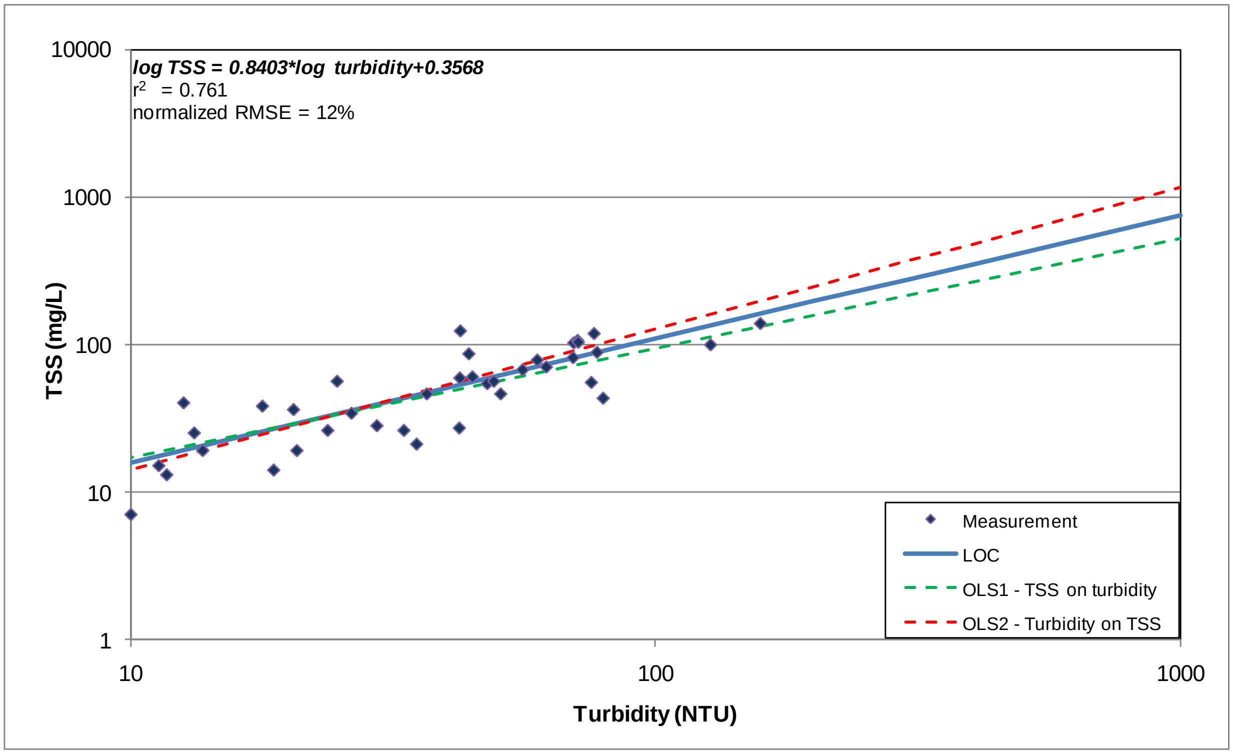


Figure 5-14 Linear Regression for TSS-Turbidity for Arkansas River (OK621200010200_00)

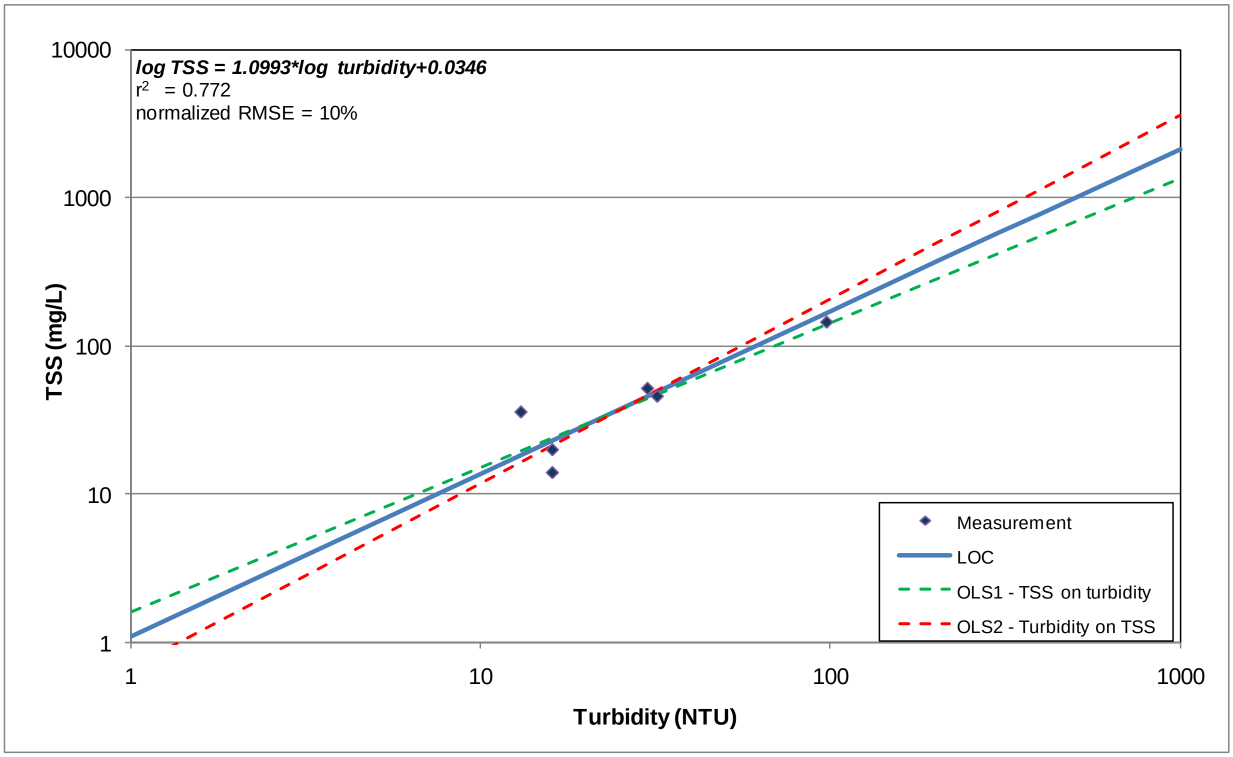


Figure 5-15 Linear Regression for TSS-Turbidity for Red Rock Creek, Lower (OK621200050010_00)

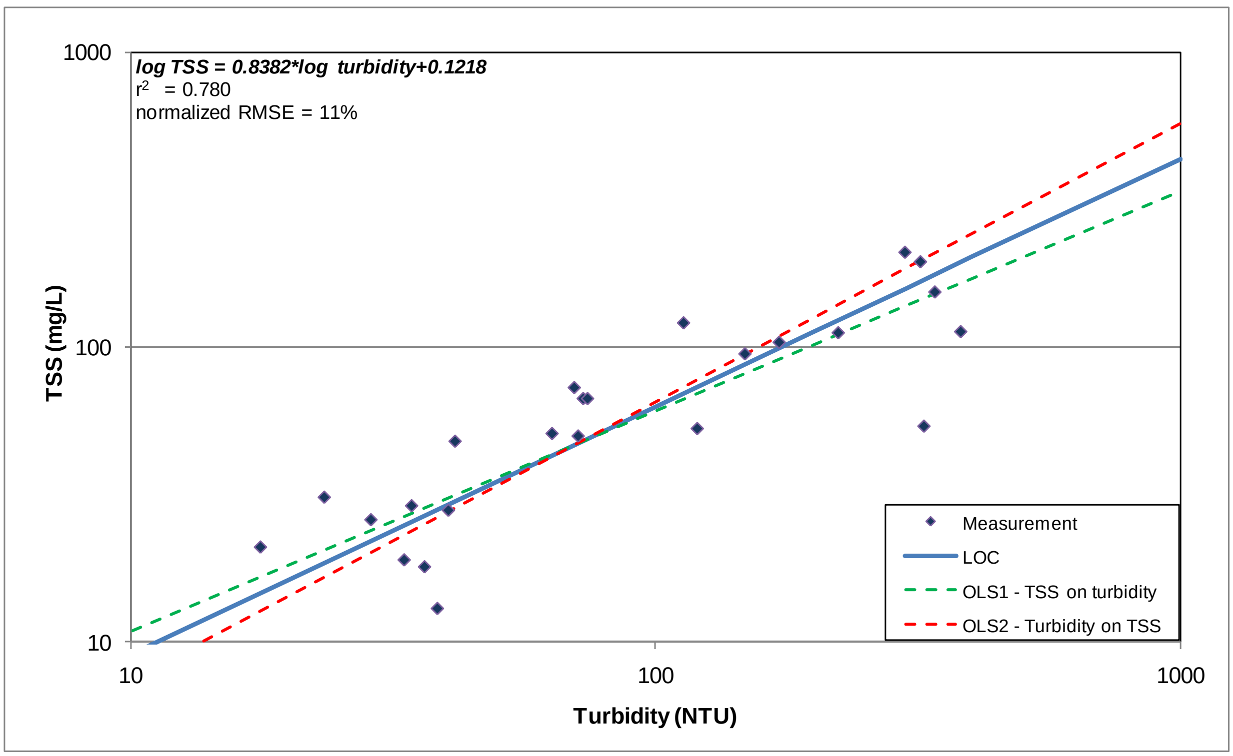


Figure 5-16 Linear Regression for TSS-Turbidity for Red Rock Creek, Upper (OK621200050010_10)

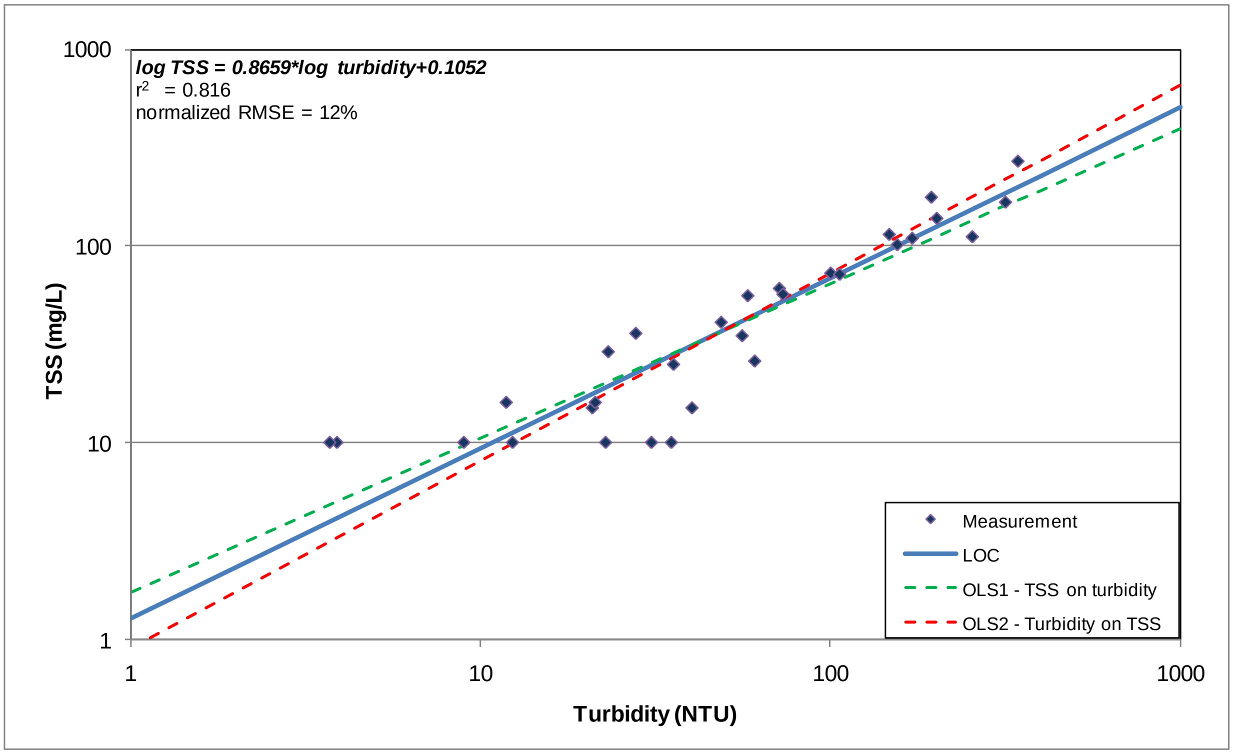
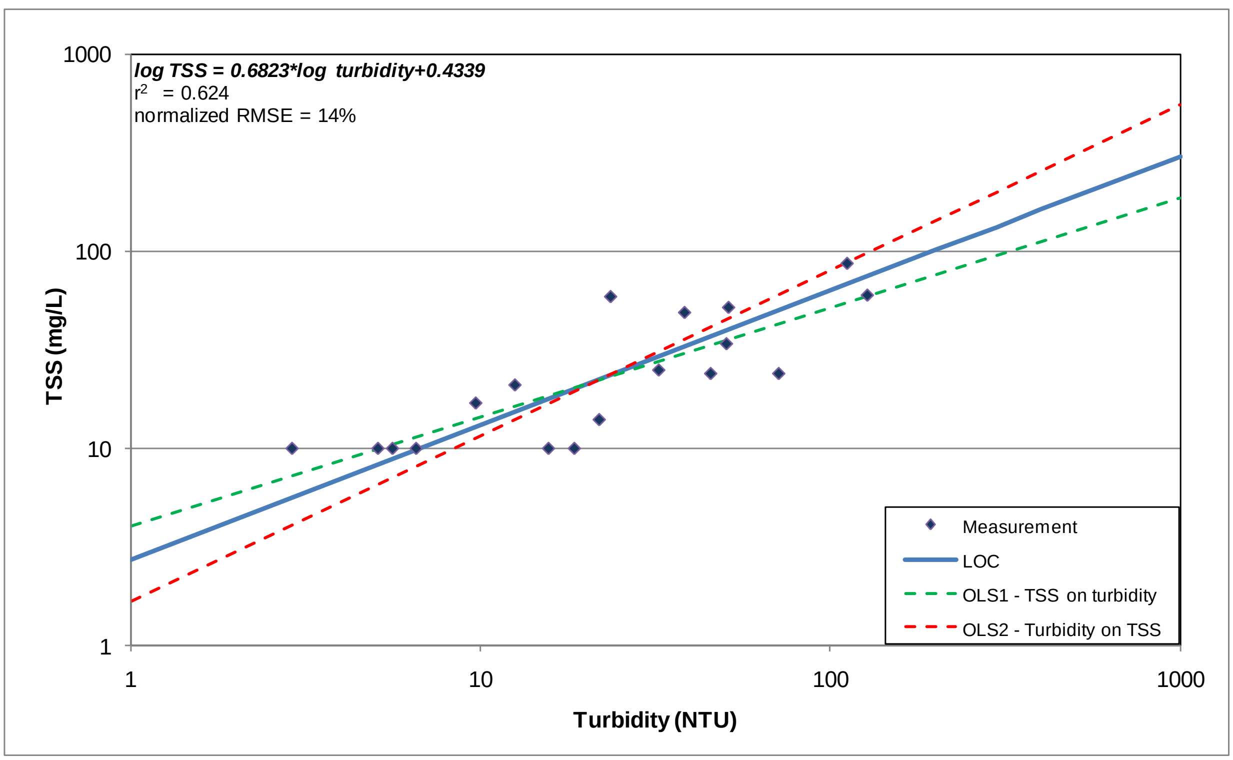


Figure 5-17 Linear Regression for TSS-Turbidity for Chilocco Creek (OK621210000270_00)



5.2 Flow Duration Curves

Following the same procedures described in Section 4.3, a flow duration curve for each waterbody in the Study Area was developed and shown in Figure 5-18 through Figure 5-40.

Figure 5-18 Flow Duration Curve for Arkansas River, Salt Fork (OK621000010010_30)

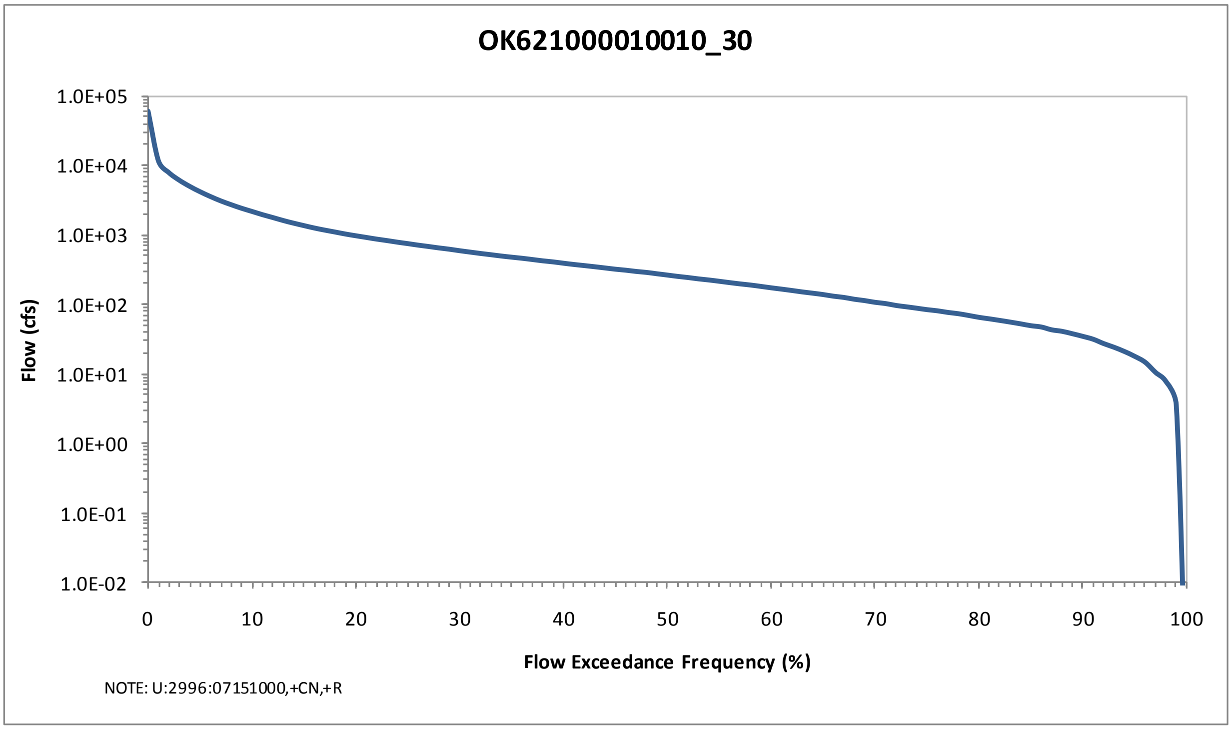


Figure 5-19 Flow Duration Curve for Spring Creek (OK621000020130_00)

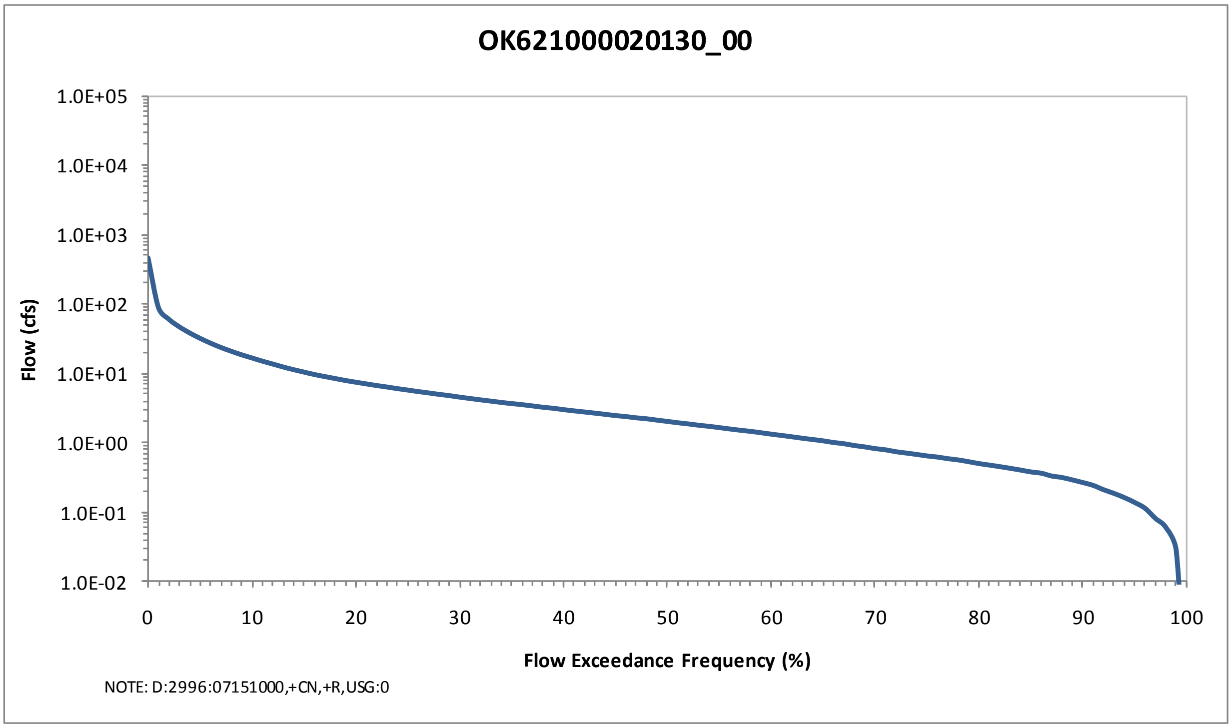


Figure 5-20 Flow Duration Curve for Bois d'Arc Creek (OK621000030010_00)

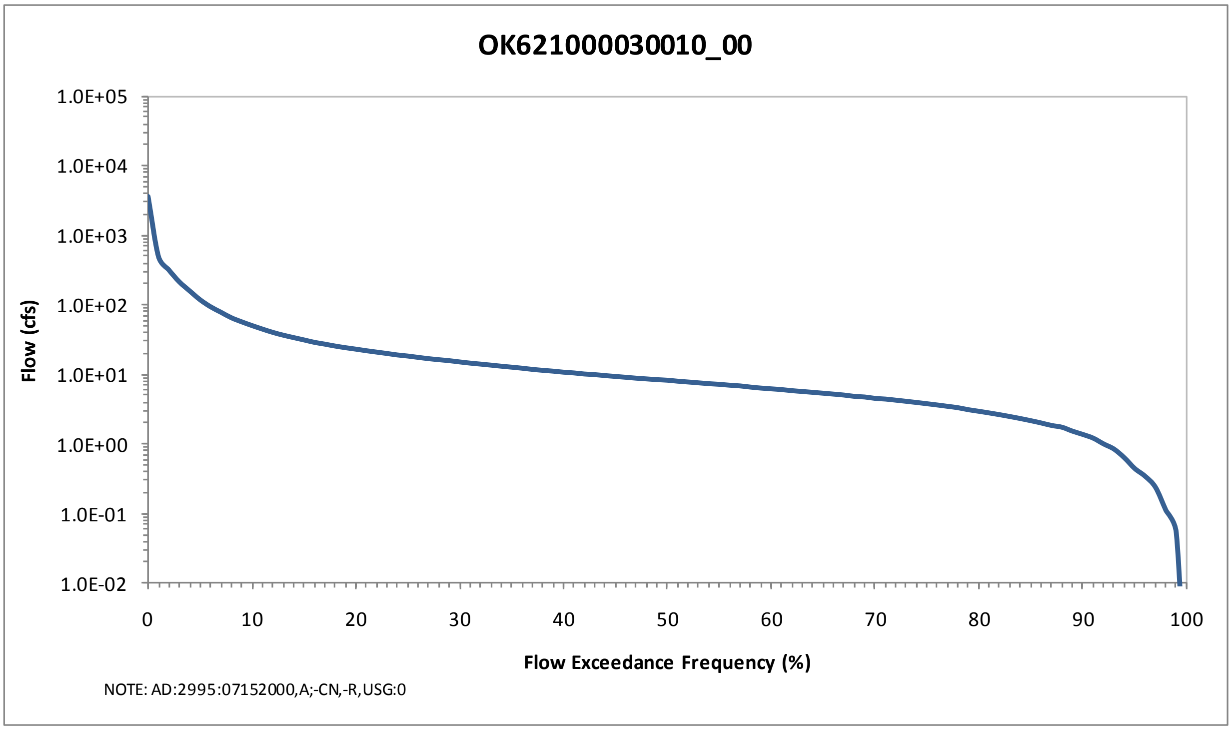


Figure 5-21 Flow Duration Curve for Deer Creek (OK621000040010_00)

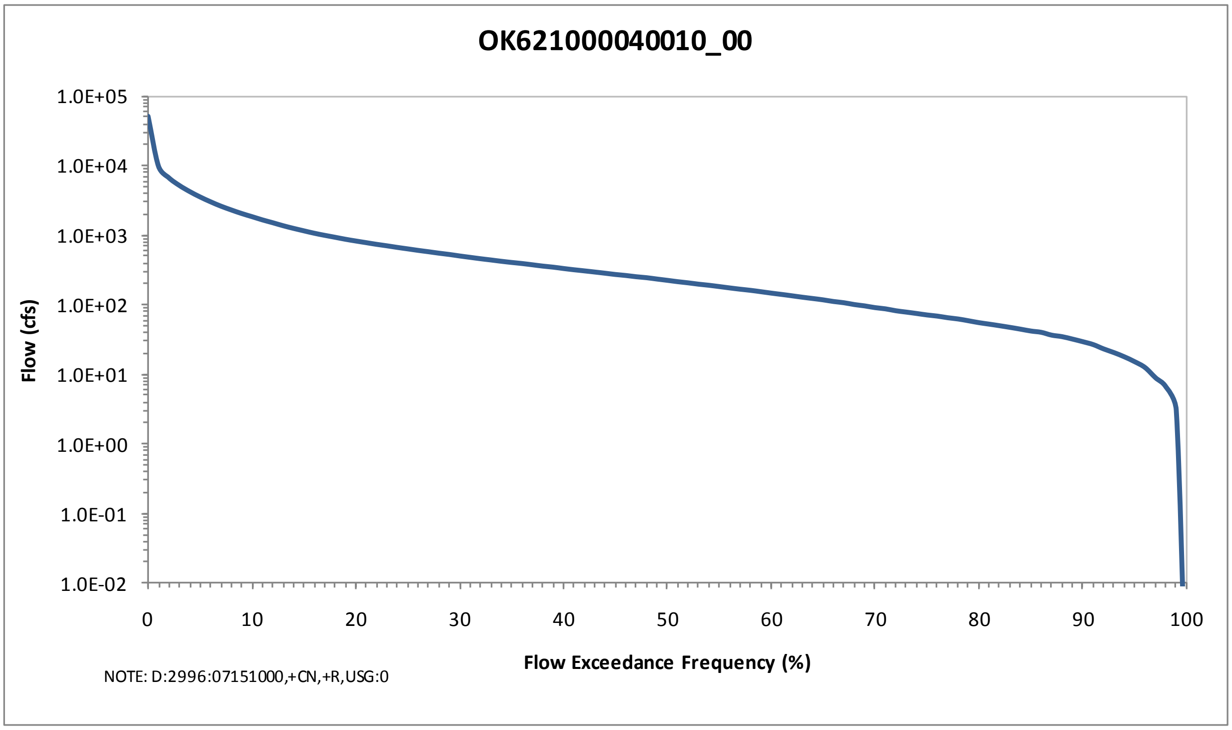


Figure 5-22 Flow Duration Curve for Pond Creek (OK621000050010_00)

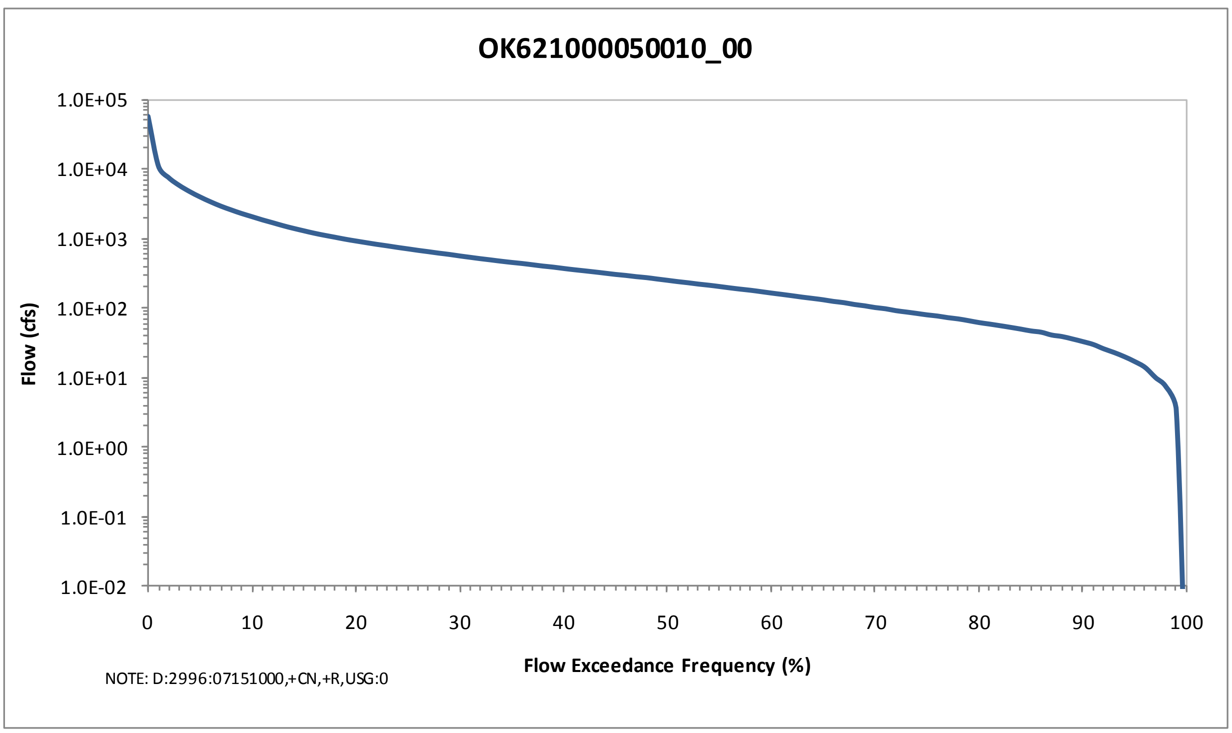


Figure 5-23 Flow Duration Curve for Crooked Creek (OK621000060010_00)

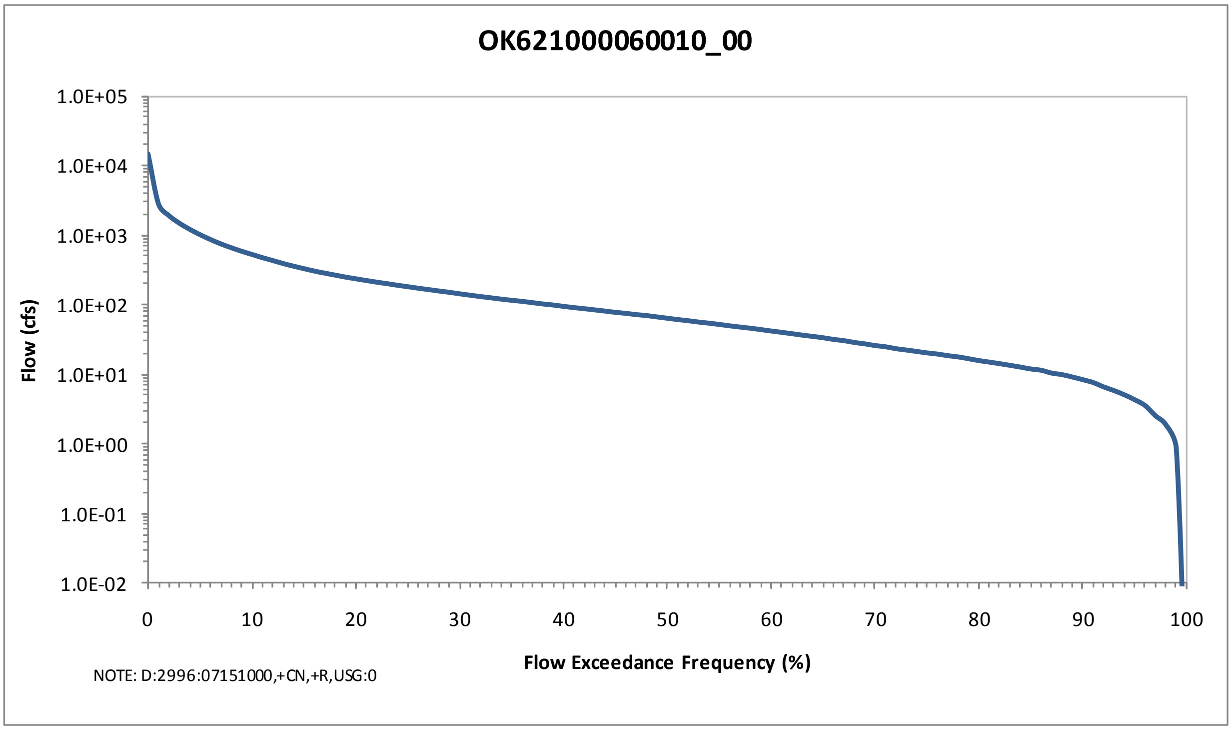


Figure 5-24 Flow Duration Curve for Arkansas River, Salt Fork (OK621010010010_00)

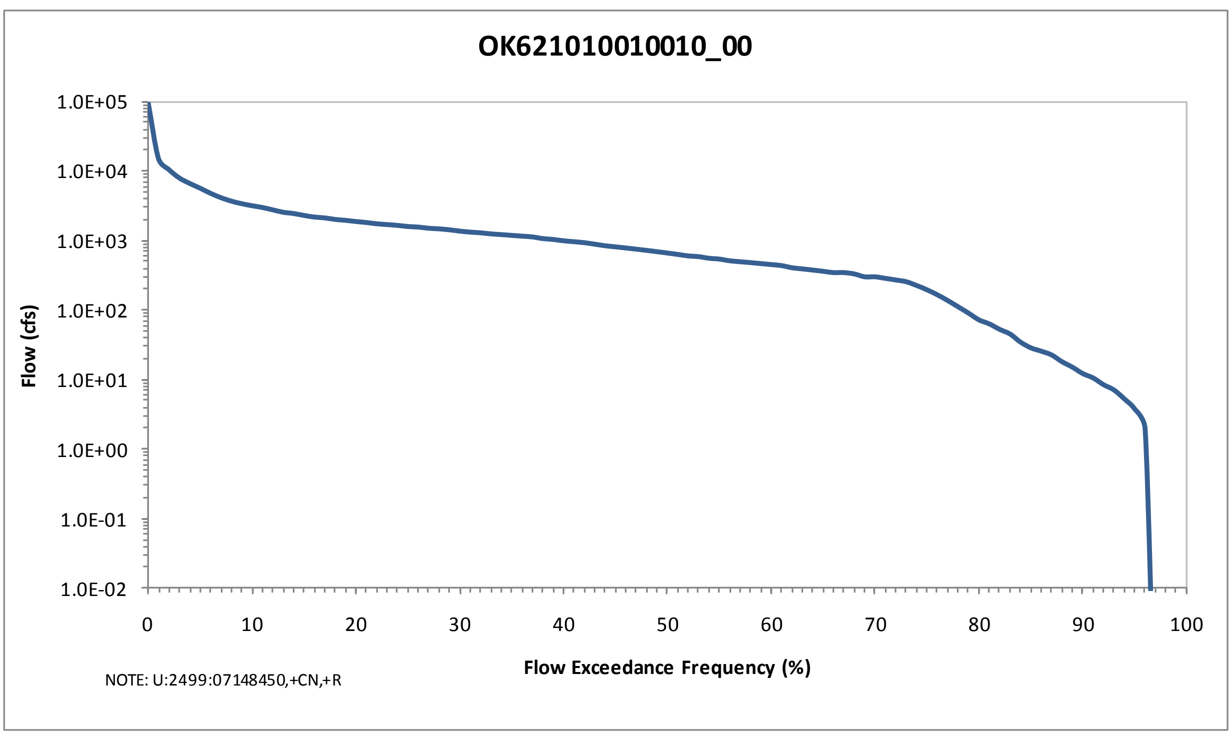


Figure 5-25 Flow Duration Curve for Clay Creek (OK621010010090_00)

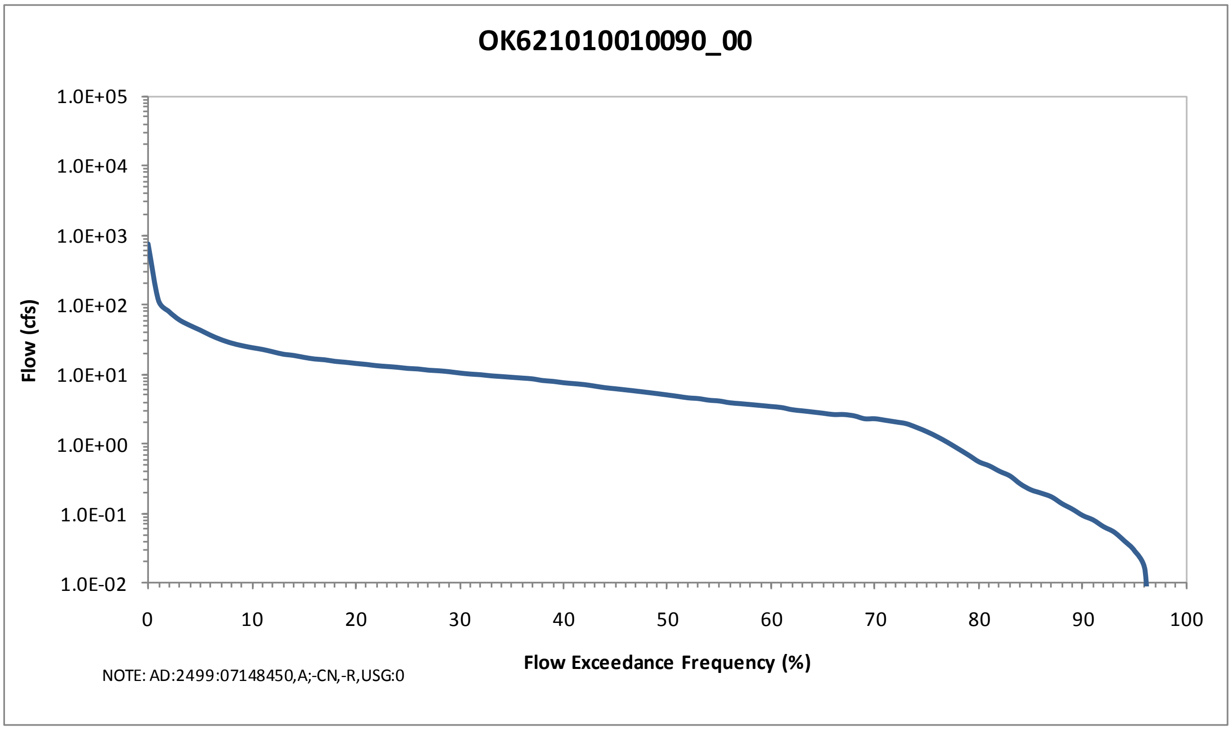


Figure 5-26 Flow Duration Curve for Arkansas River, Salt Fork (OK621010010160_00)

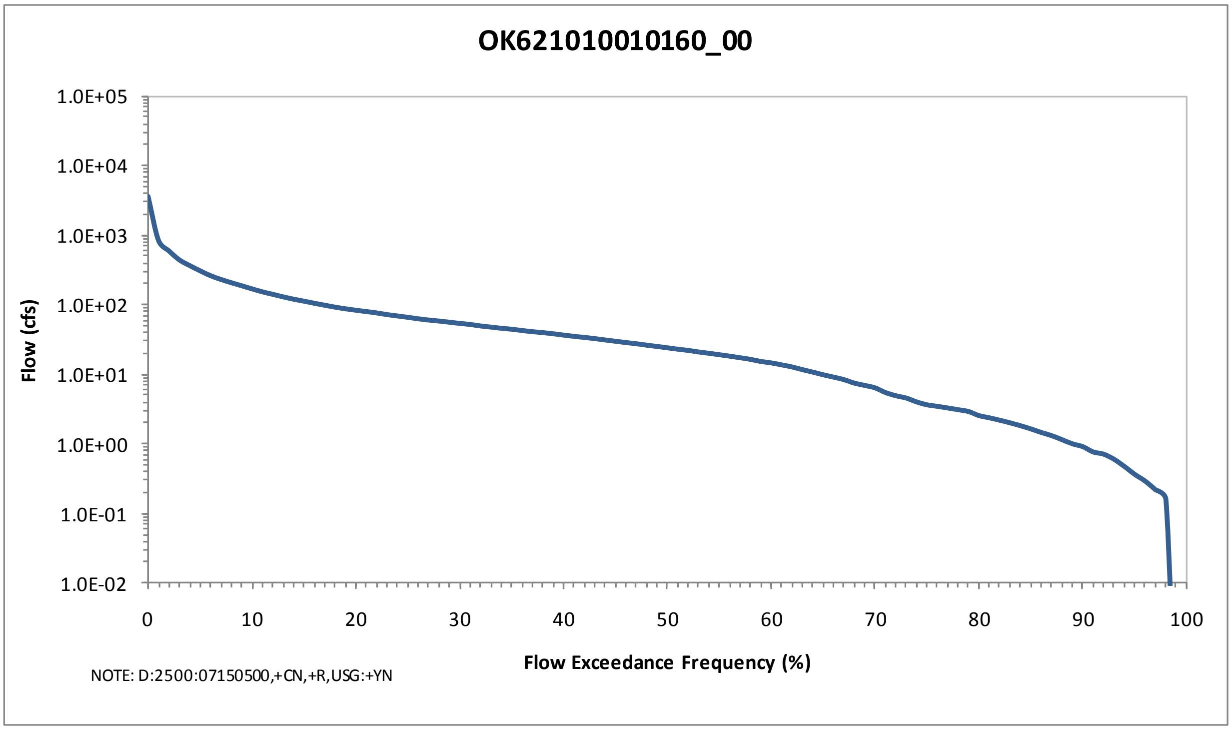


Figure 5-27 Flow Duration Curve for Turkey Creek (OK621010010230_00)

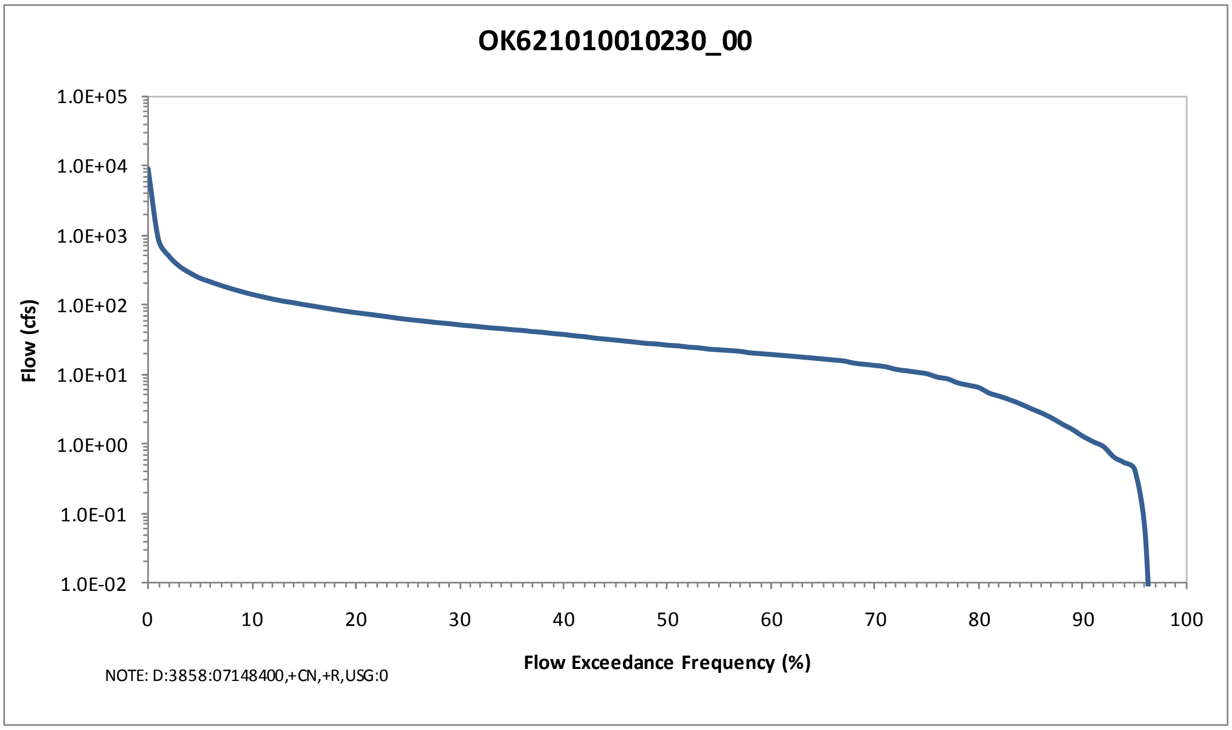


Figure 5-28 Flow Duration Curve for Yellowstone Creek (OK621010010270_00)

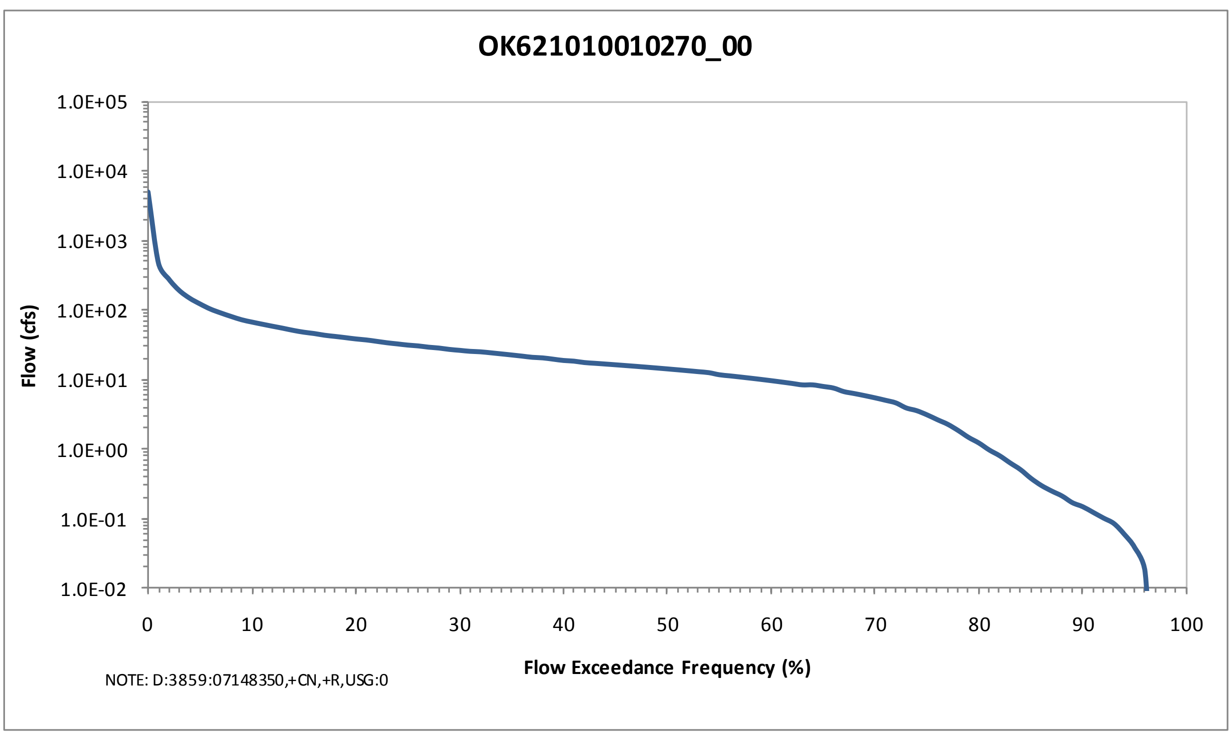


Figure 5-29 Flow Duration Curve for Sandy Creek (OK621010020010_00)

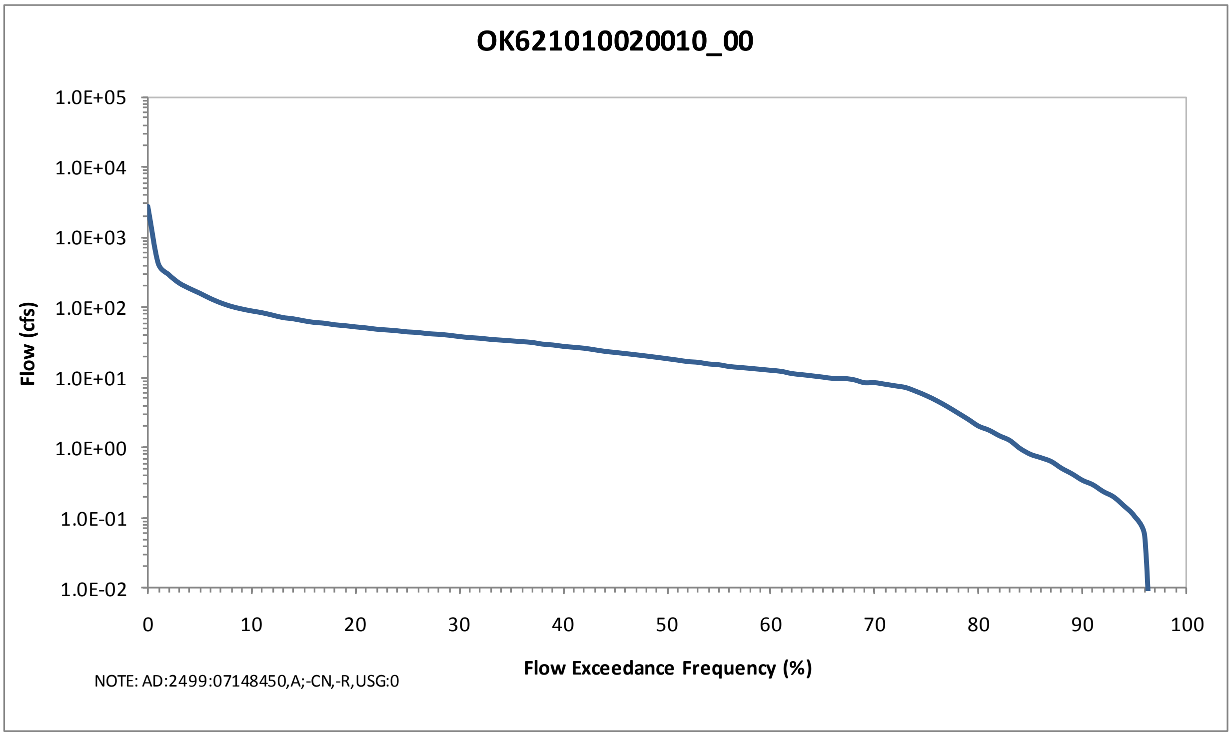


Figure 5-30 Flow Duration Curve for Medicine Lodge River (OK621010030010_00)

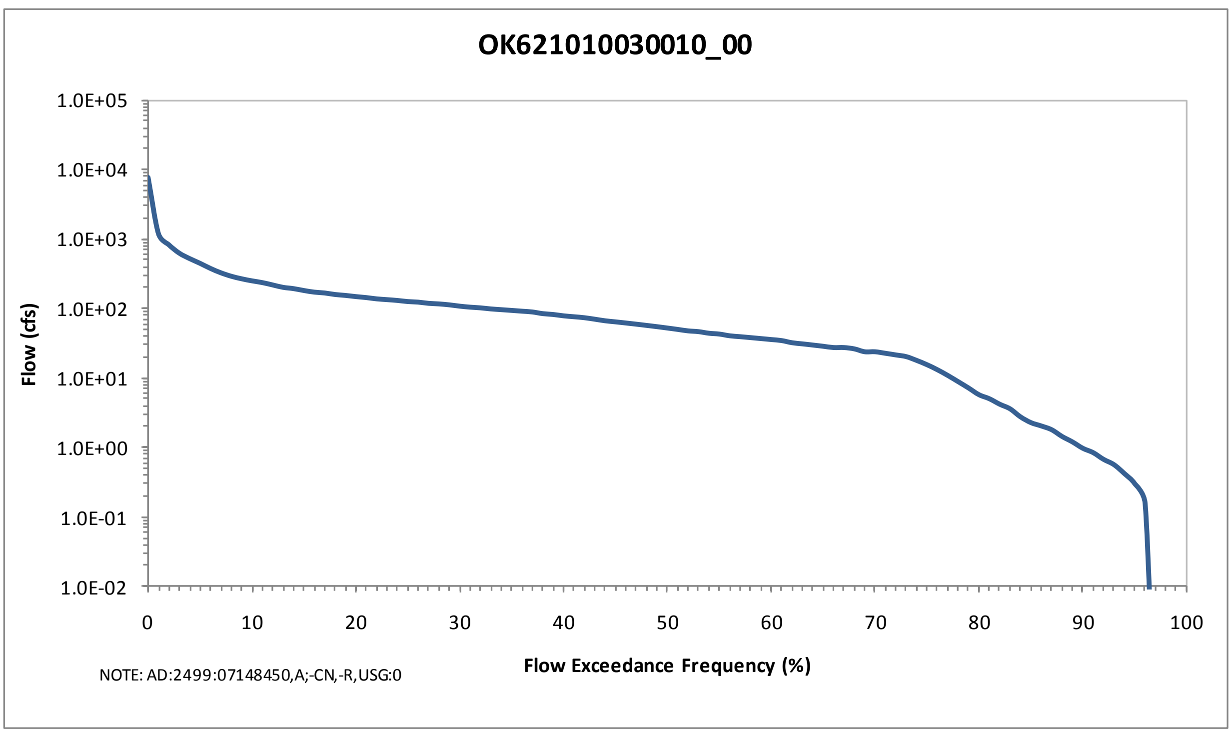


Figure 5-31 Flow Duration Curve for Driftwood Creek (OK621010030030_00)

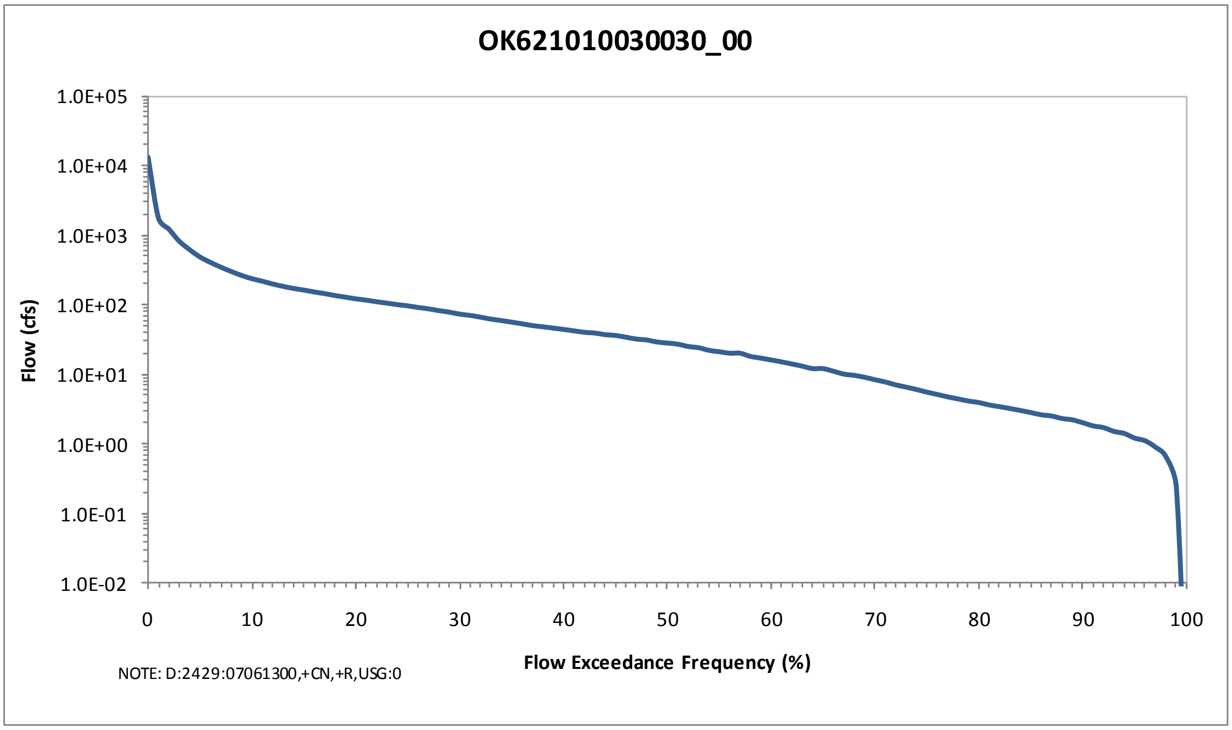


Figure 5-32 Flow Duration Curve for Chikaskia River, Lower (OK621100000010_00)

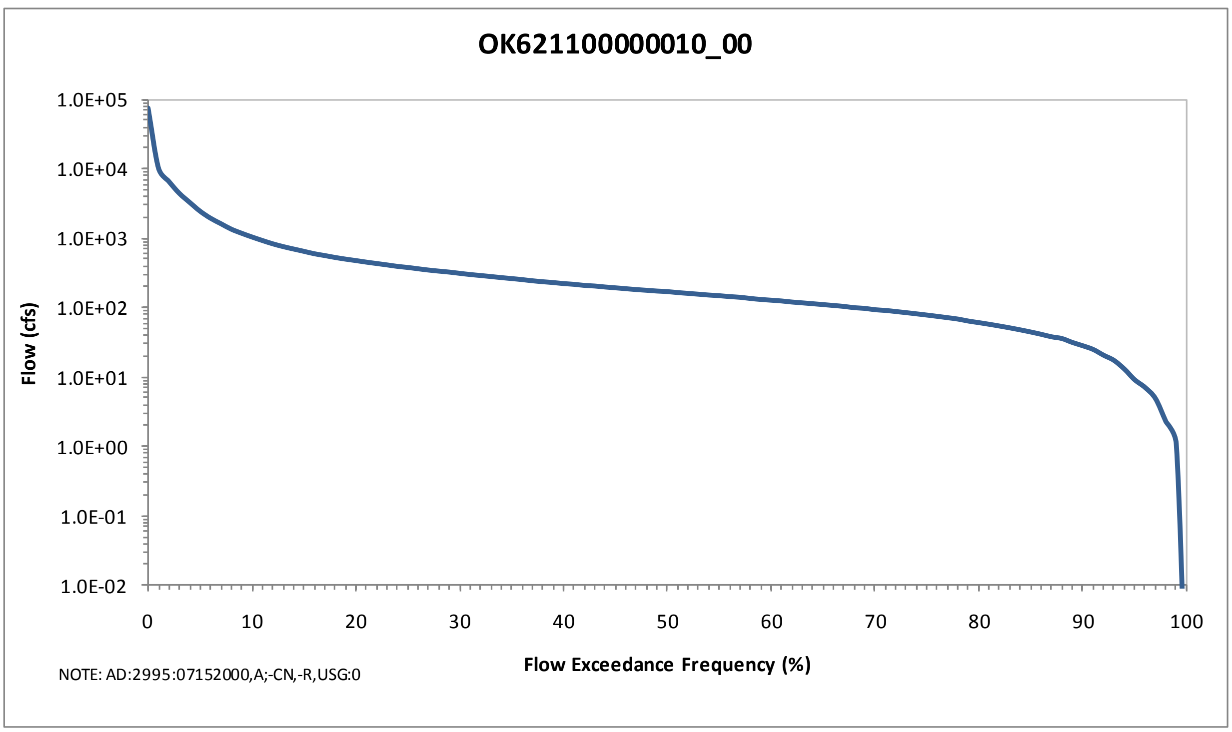


Figure 5-33 Flow Duration Curve for Chikaskia River, Upper (OK621100000010_10)

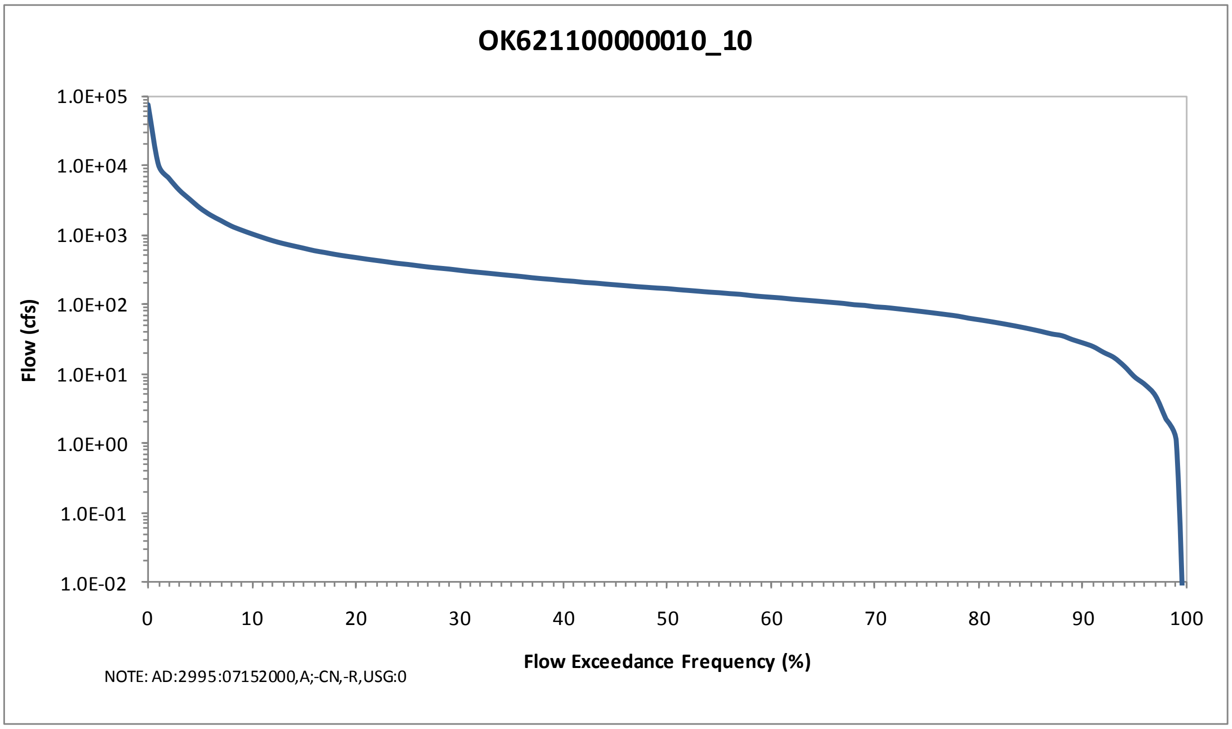


Figure 5-34 Flow Duration Curve for Bitter Creek (OK621100000100_00)

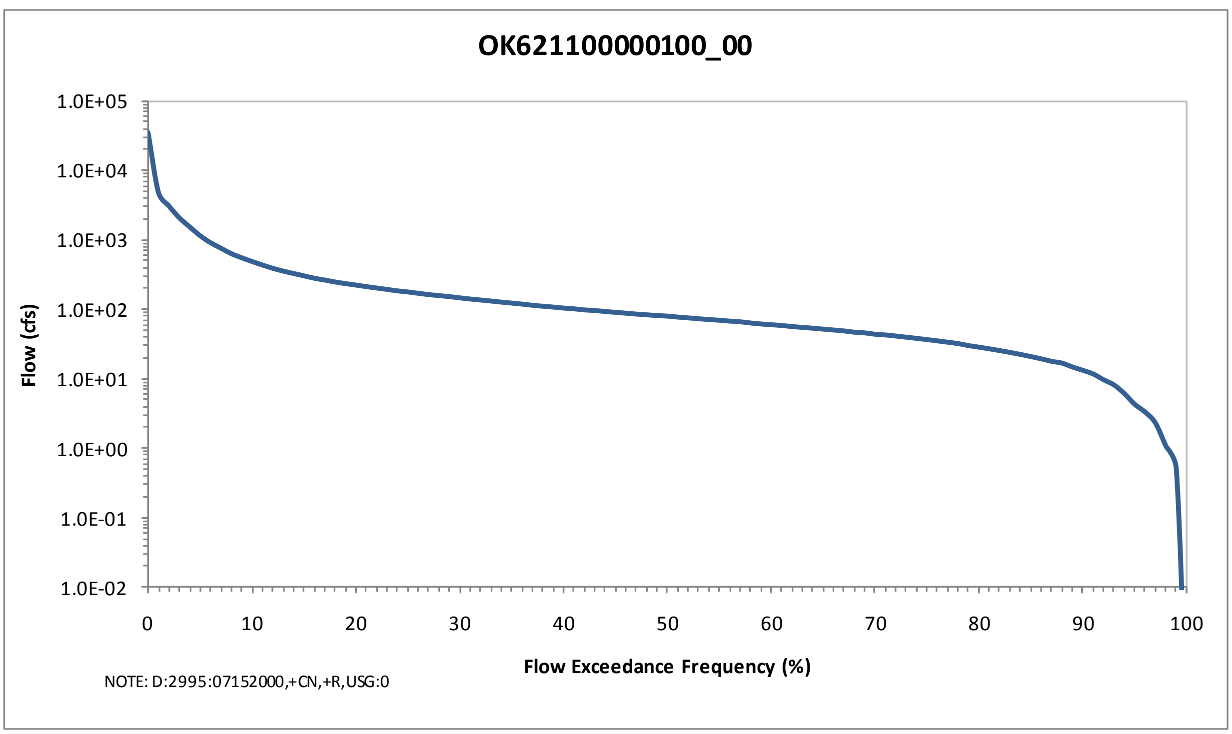


Figure 5-35 Flow Duration Curve for Arkansas River (OK621200010200_00)

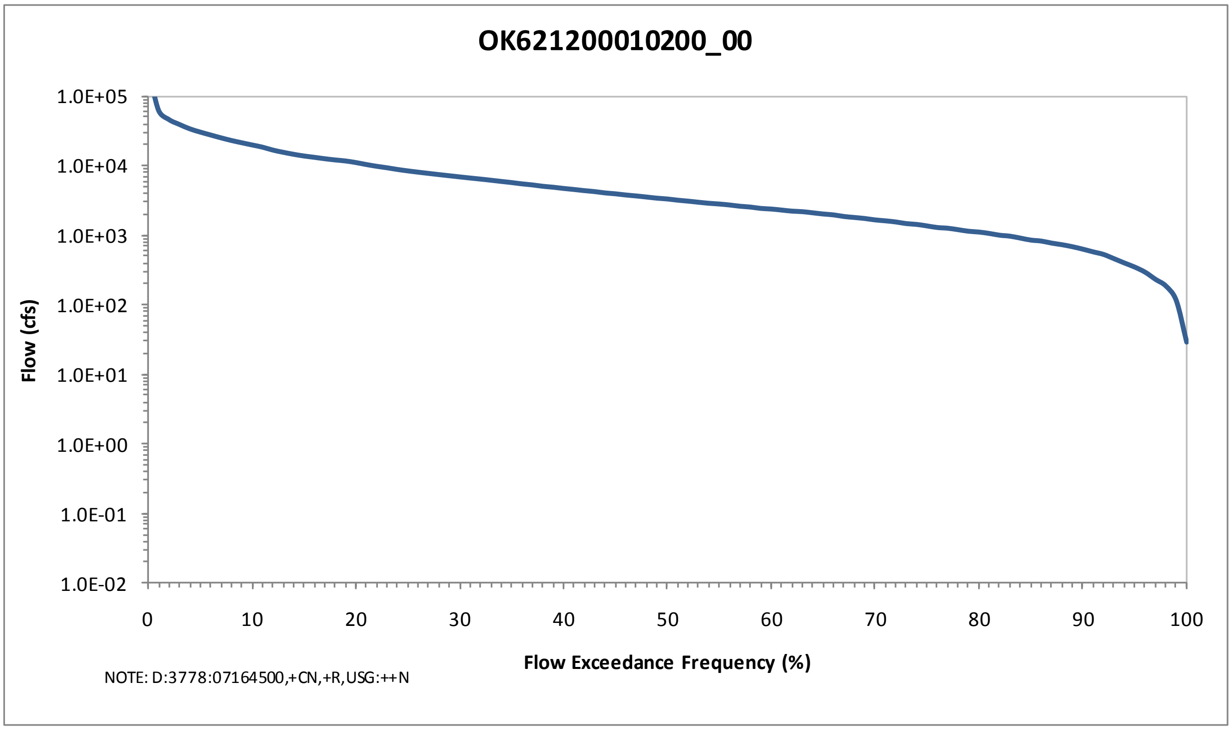


Figure 5-36 Flow Duration Curve for Black Bear Creek (OK621200030010_00)

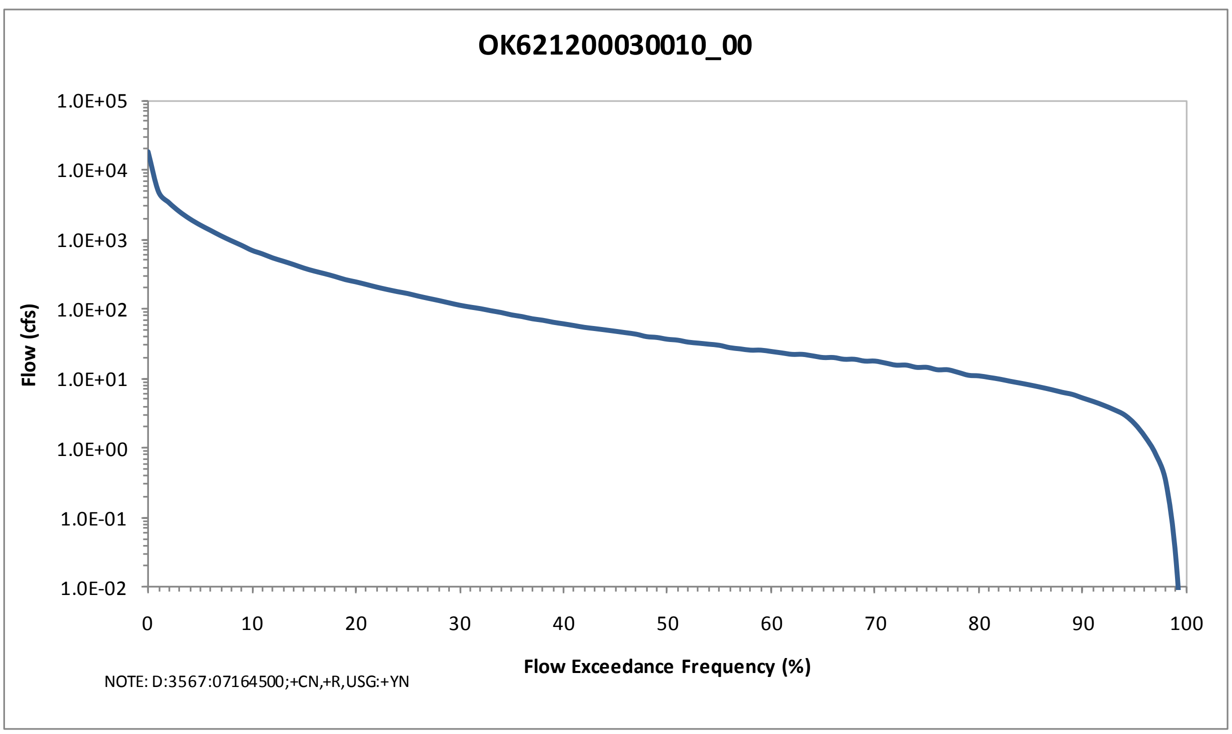


Figure 5-37 Flow Duration Curve for Red Rock Creek, Lower (OK621200050010_00)

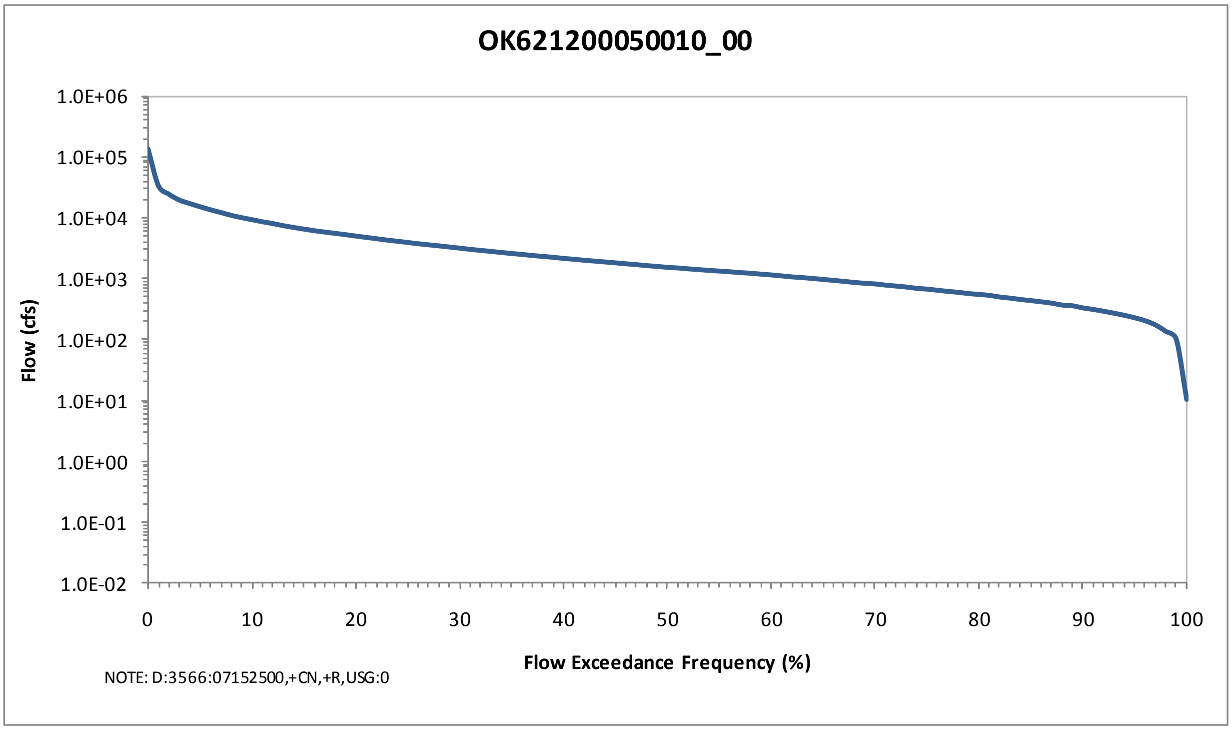


Figure 5-38 Flow Duration Curve for Red Rock Creek, Upper (OK621200050010_10)

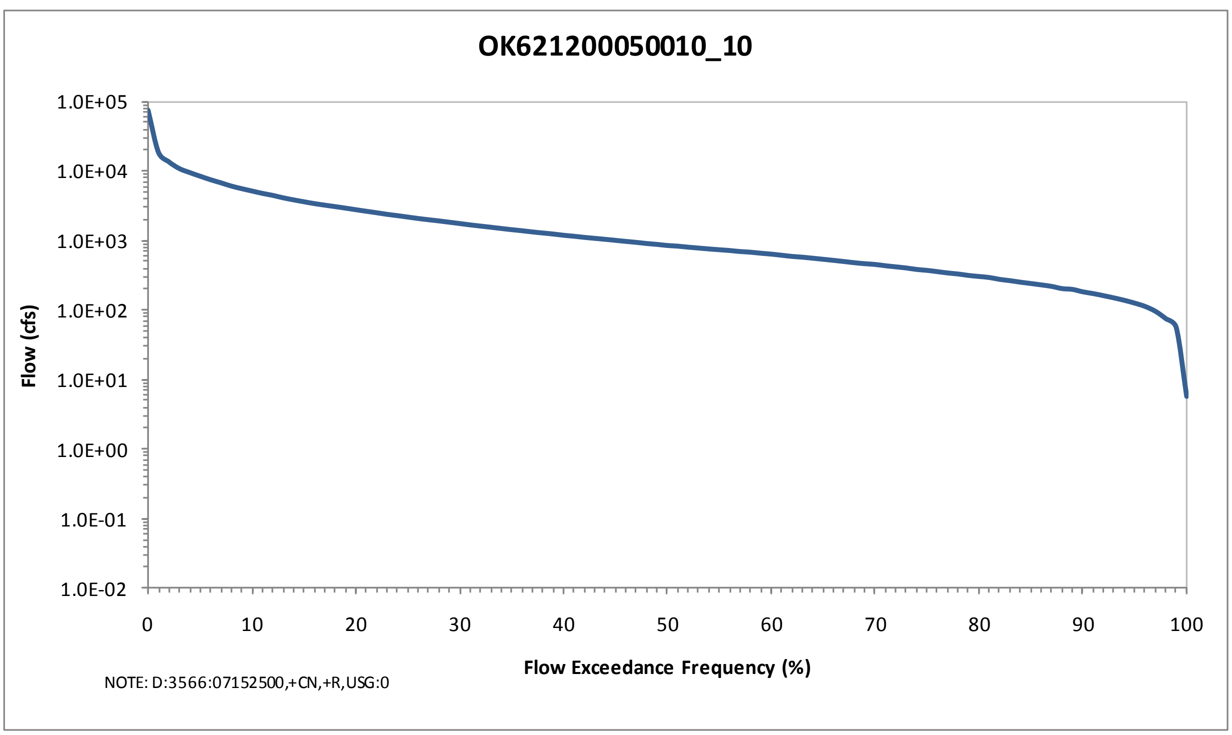


Figure 5-39 Flow Duration Curve for Beaver Creek (OK621210000050_10)

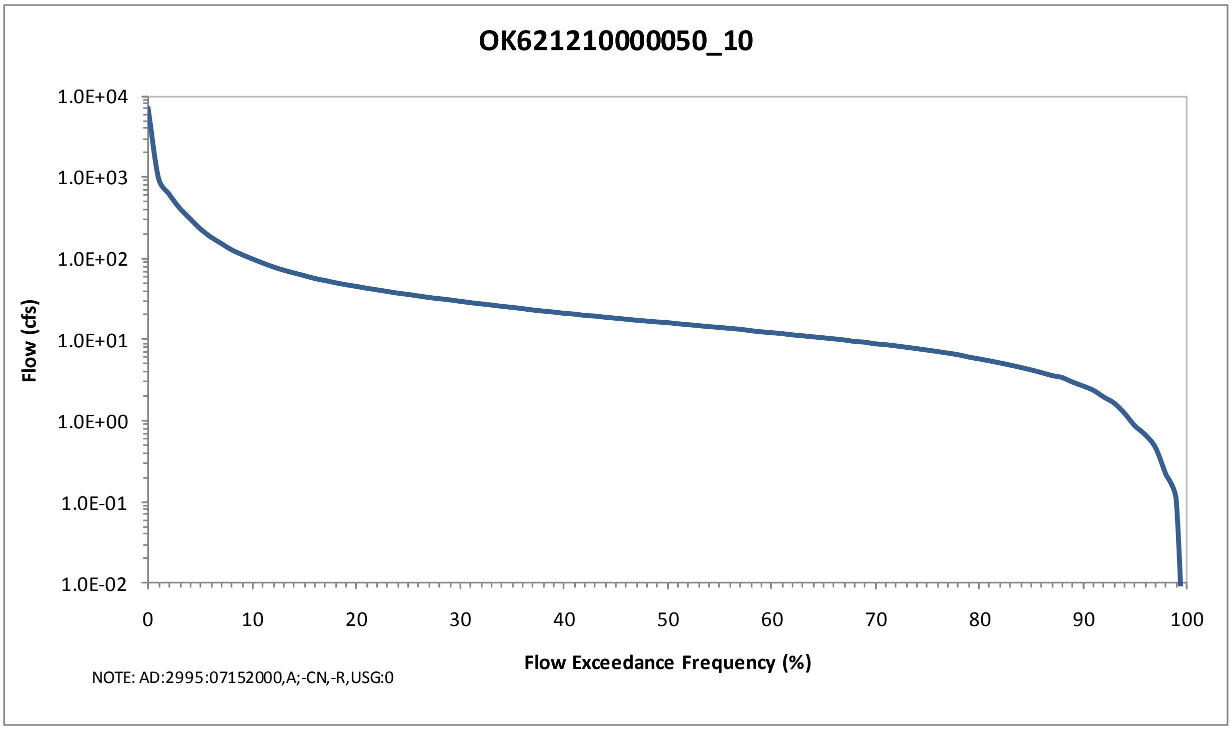
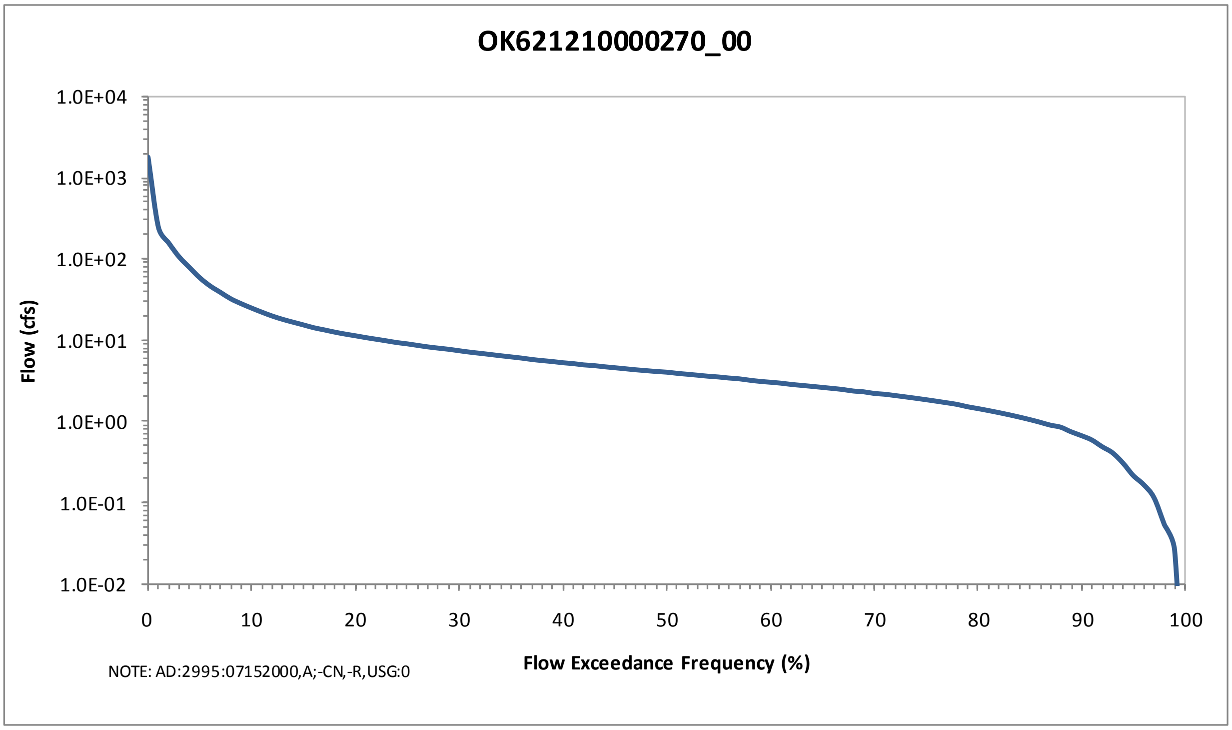


Figure 5-40 Flow Duration Curve for Chilocco Creek (OK621210000270_00)



5.3 Estimated Loading and Critical Conditions

USEPA 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.

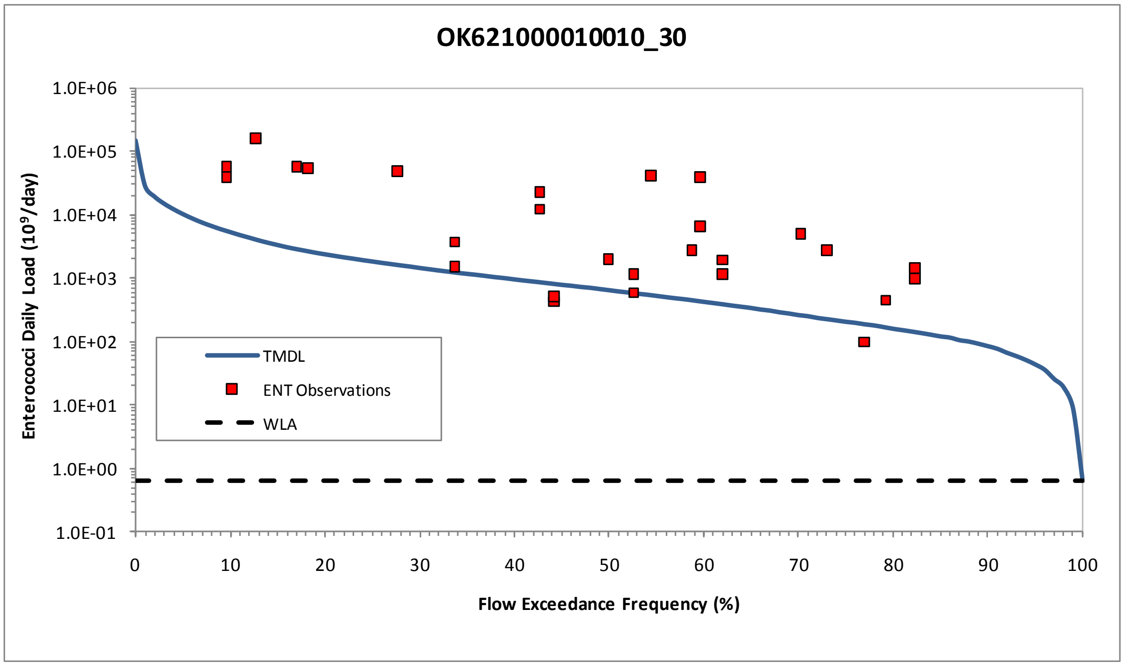
Bacteria LDC: To calculate the bacteria load, the flow rate at each flow exceedance percentile is multiplied by a unit conversion factor (*24,465,525 mLs / ft^3 day*) and the criterion specific to each bacterial indicator. This calculation produces the maximum bacteria load in the stream without exceeding the instantaneous standard over the range of flow conditions. The allowable bacteria (fecal coliform, *E. coli*, or Enterococci) 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 bacteria load.

To estimate existing loading, bacteria observations for the primary contact recreation season (May 1st through September 30th) from 2002 to 2009 are paired with the flows measured or estimated in that waterbody on the same date. Pollutant loads are then calculated by multiplying the measured bacteria concentration by the flow rate and the unit conversion factor of *24,465,756 mLs / ft^3 day*. The associated flow exceedance percentile is then obtained from the tables provided in Appendix B. The observed bacteria loads are then added to the LDC plot as points. These points represent individual ambient water quality samples of bacteria. Points above the LDC indicate the bacteria instantaneous standard was exceeded at the time of sampling. Conversely, points under the LDC indicate the sample met the WQS.

The bacteria LDCs developed for each impaired waterbody (representing the primary contact recreation season using data from 1998 through 2008) are shown in Figures 5-41 through 5-82. 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.

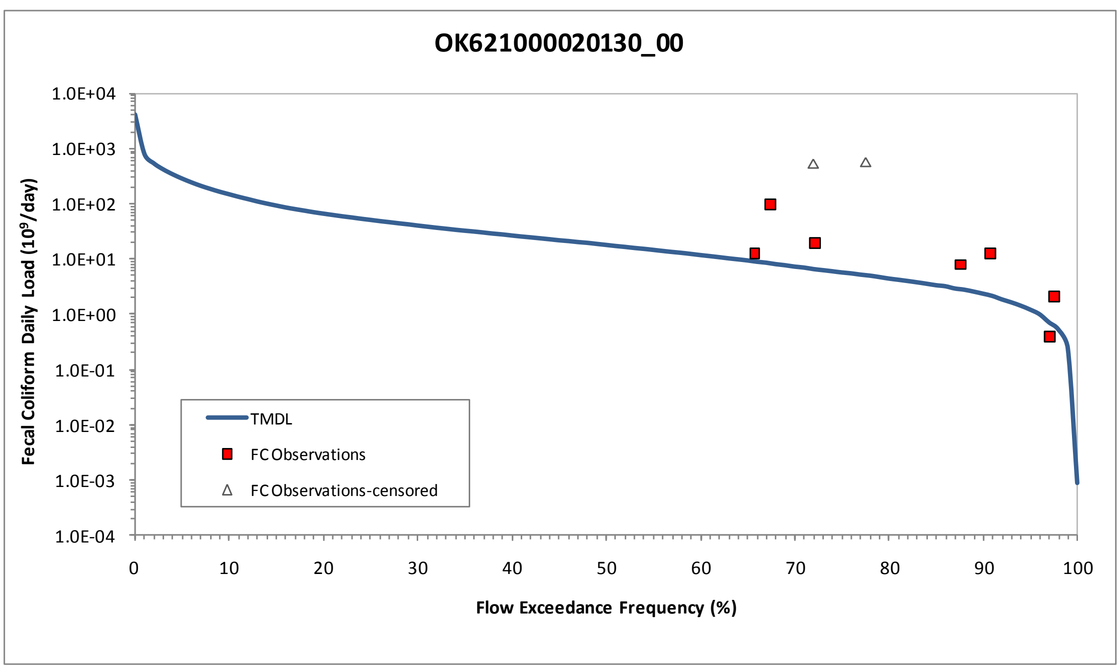
The LDC for the Salt Fork of the Arkansas River (Figure 5-41) is based on Enterococci bacteria measurements collected during primary contact recreation season at WQM station OK621000010010-001AT. The LDC indicates that levels of Enterococci exceed the instantaneous water quality criterion under all flow conditions.

Figure 5-41 Load Duration Curve for Enterococci in Arkansas River, Salt Fork (OK621000010010_30)



The LDC for Spring Creek (Figure 5-42) is based on fecal coliform bacteria measurements collected during primary contact recreation season at WQM station OK621000020130G. The LDC indicates that levels of fecal coliform exceed the instantaneous water quality criterion under low and moderate flow conditions.

Figure 5-42 Load Duration Curve for Fecal Coliform in Spring Creek (OK621000020130_00)



The LDCs for Bois d'Arc Creek (Figures 5-43, 5-44, and 5-45) are based on *E. coli*, Enterococci and fecal coliform measurements during primary contact recreation season at WQM station OK621000030010C. The LDCs indicate that levels of the three indicators exceed the instantaneous water quality criteria under high and moderate flow conditions.

Figure 5-43 Load Duration Curve for *E. coli* in Bois d'Arc Creek (OK621000030010_00)

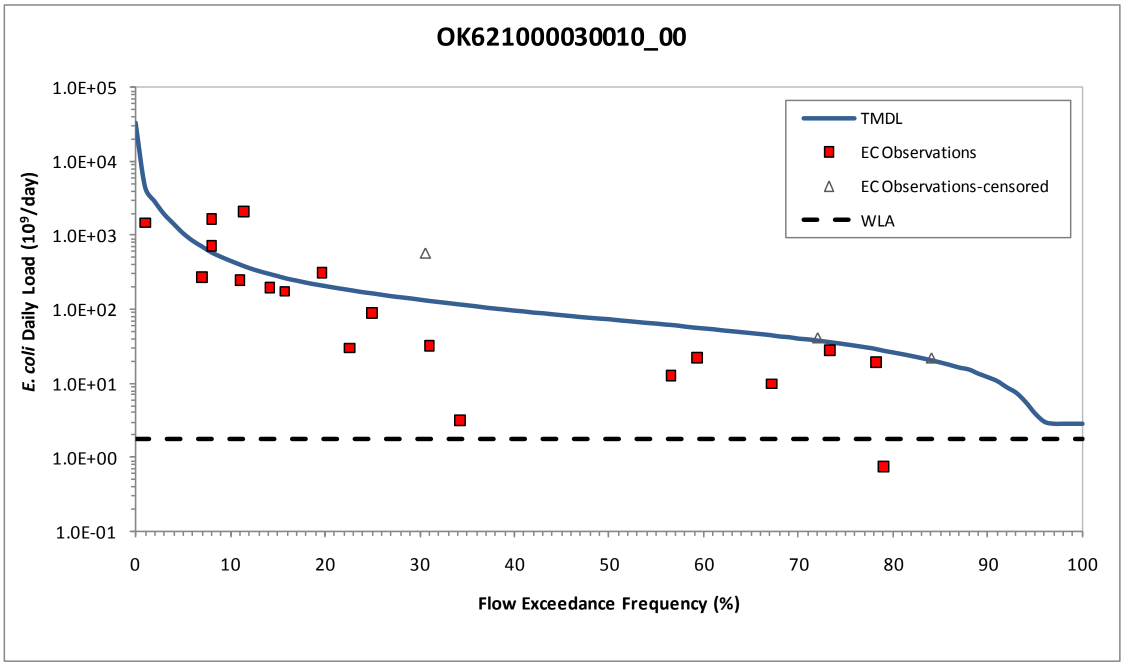


Figure 5-44 Load Duration Curve for Enterococci in Bois d'Arc Creek (OK621000030010_00)

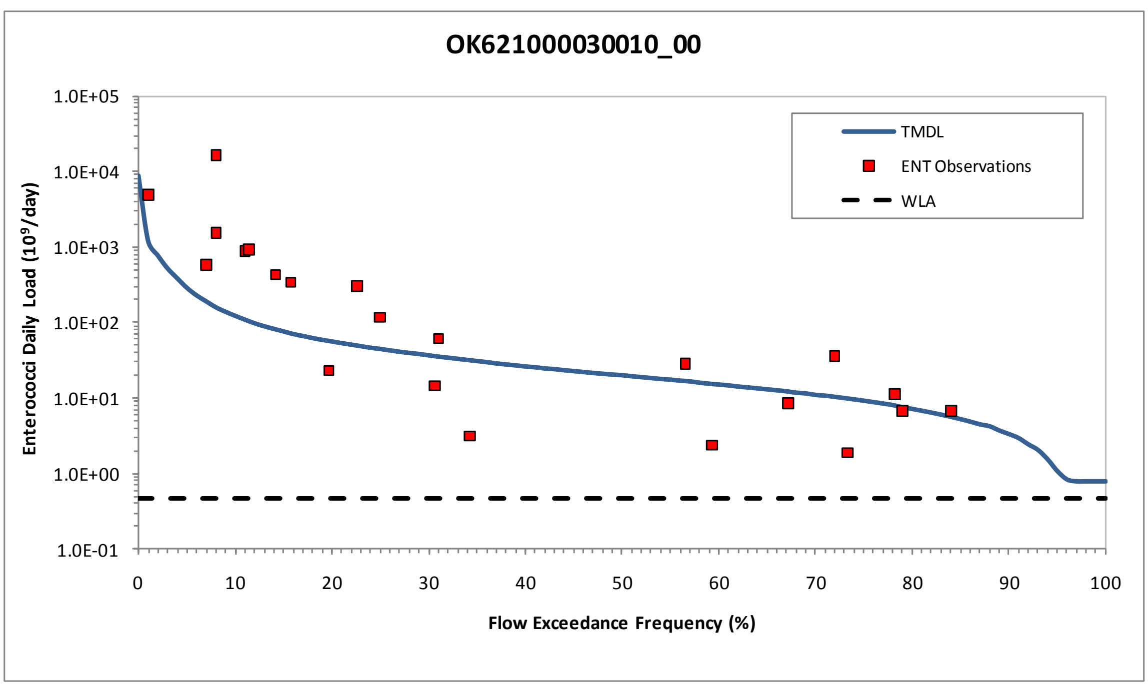
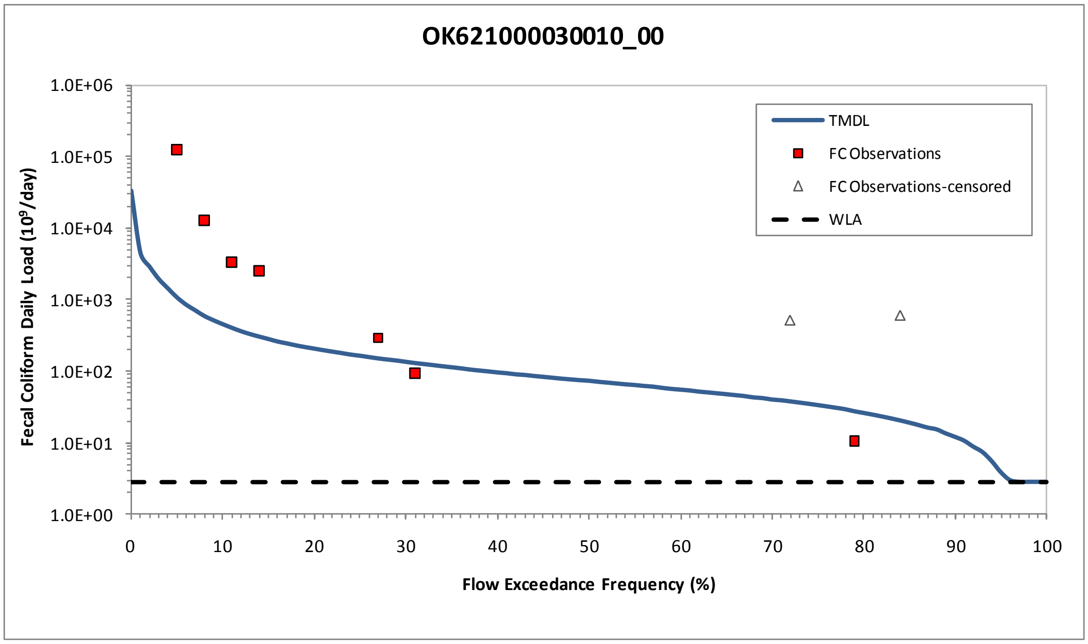


Figure 5-45 Load Duration Curve for Fecal Coliform in Bois d'Arc Creek (OK621000030010_00)



The LDCs for Deer Creek (Figure 5-46 and 5-47) are based on *E. coli* and Enterococci measurements during primary contact recreation season at WQM station OK621000040010D. The LDCs indicate that *E. coli* and Enterococci levels occasionally exceed the instantaneous water quality criteria under low flow conditions.

Figure 5-46 Load Duration Curve for *E. coli* in Deer Creek (OK621000040010_00)

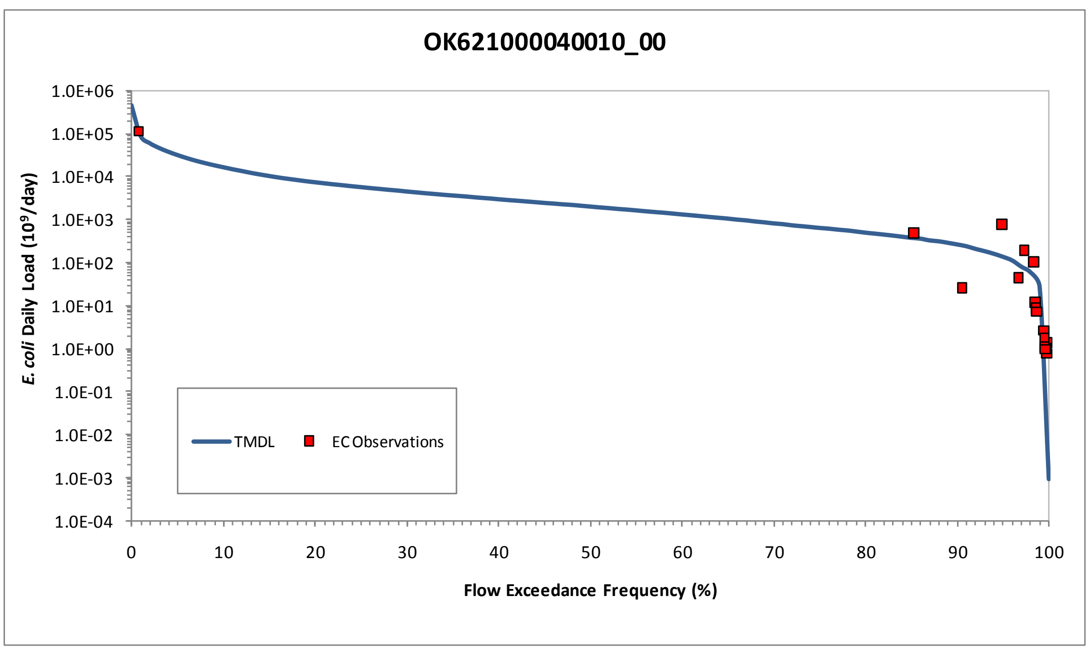
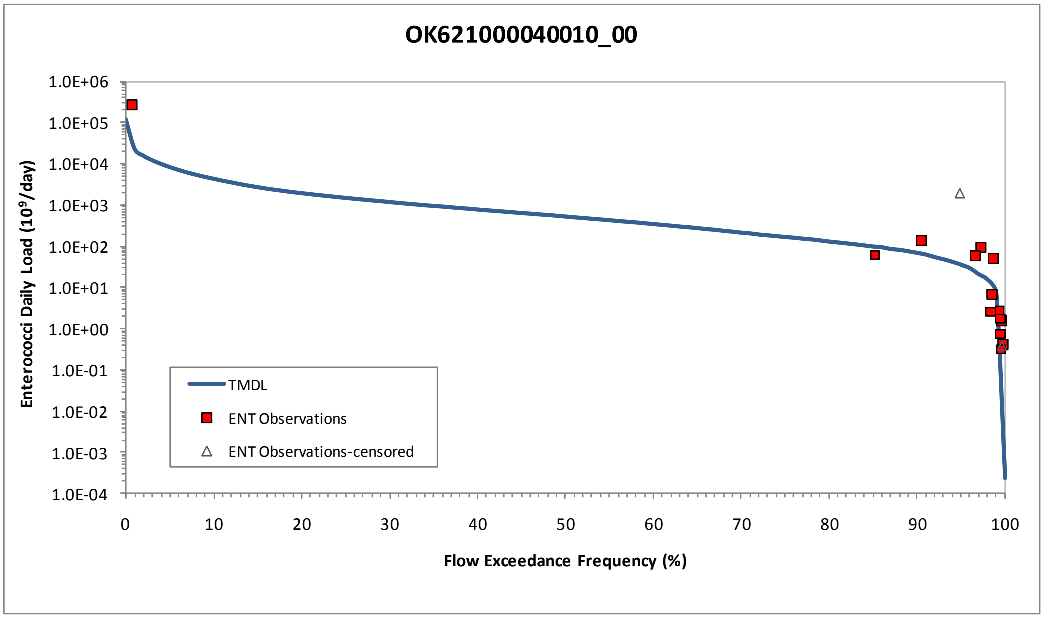


Figure 5-47 Load Duration Curve for Enterococci in Deer Creek (OK621000040010_00)



The LDCs for Pond Creek (Figures 5-48 and 5-49) are based on *E. coli* and Enterococci bacteria measurements collected during primary contact recreation season at WQM station OK621000050010D. The LDCs indicate that levels of *E. coli* occasionally exceed the instantaneous water quality criterion under low and moderate flow conditions, while Enterococci levels exceed the instantaneous water quality criterion under a wide range of hydrologic conditions, indicative of loading from both point and nonpoint sources.

Figure 5-48 Load Duration Curve for *E. coli* in Pond Creek (OK621000050010_00)

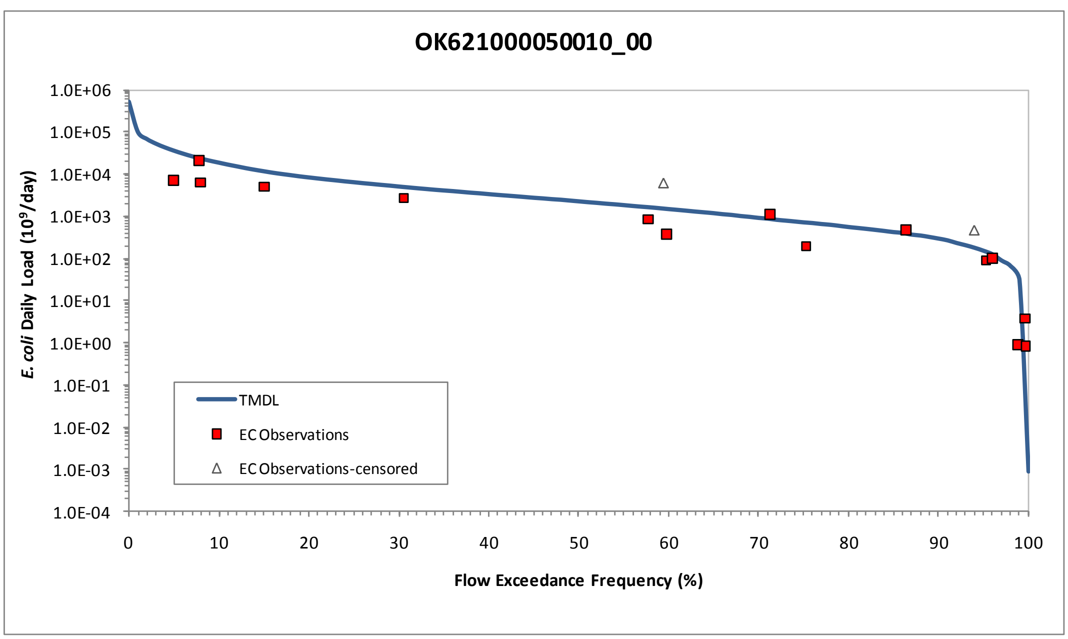
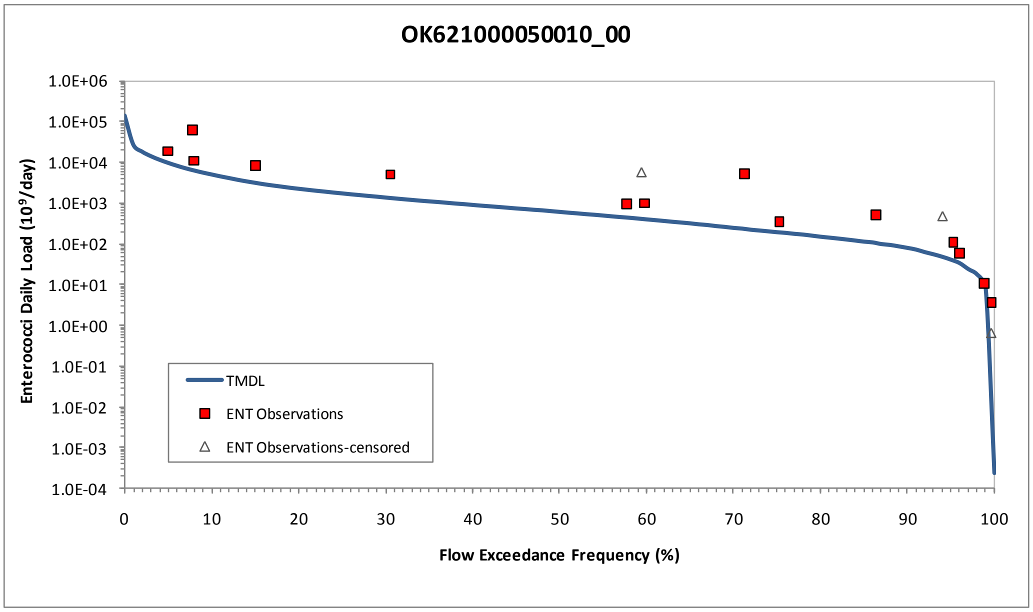
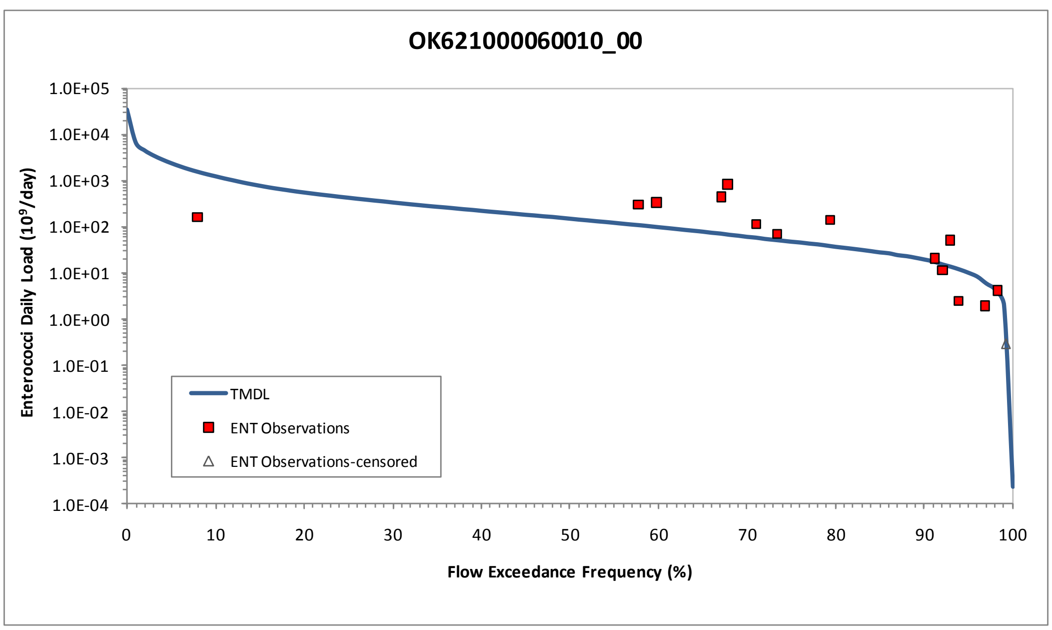


Figure 5-49 Load Duration Curve for Enterococci in Pond Creek (OK621000050010_00)



The LDC for Crooked Creek (Figures 5-50) is based on Enterococci measurements during primary contact recreation season at WQM station OK621000060010C. The LDC indicates that Enterococci levels exceed the instantaneous water quality criterion under moderate and low flow conditions.

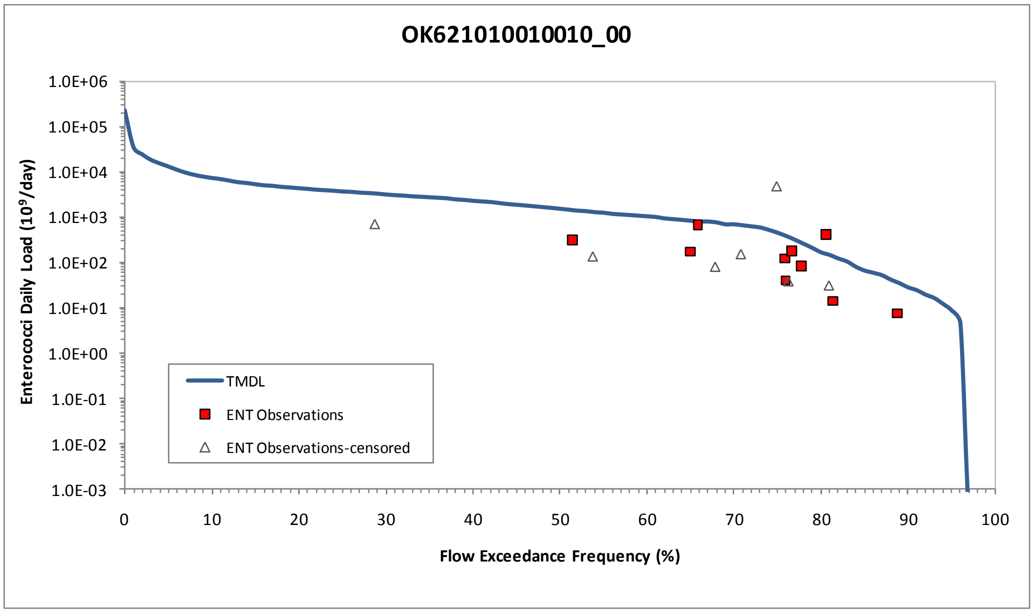
Figure 5-50 Load Duration Curve for Enterococci in Crooked Creek (OK62100060010_00)



The LDC for the Salt Fork of the Arkansas River (Figure 5-51) is based on Enterococci measurements during primary contact recreation season at WQM station OK621010010010D.

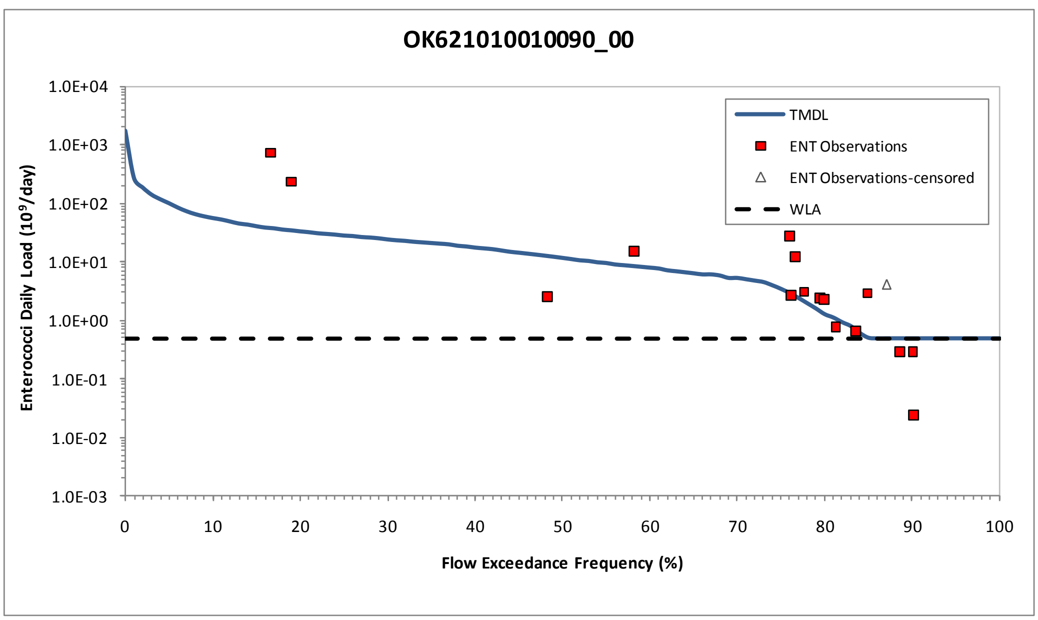
The LDC indicates that Enterococci levels occasionally exceed the instantaneous water quality criterion under moderate flow conditions.

Figure 5-51 Load Duration Curve for Enterococci in Arkansas River, Salt Fork (OK621010010010_00)



The LDC for Clay Creek is shown in Figure 5-52. It is based on Enterococci measurements during primary contact recreation season at WQM station OK621010010090R. The LDC indicates that Enterococci levels exceed the instantaneous water quality criterion under high and moderate flow conditions, indicative of loading from nonpoint sources.

Figure 5-52 Load Duration Curve for Enterococci in Clay Creek (OK621010010090_00)



The LDCs for the Salt Fork of the Arkansas River are shown in Figure 5-53 for *E. coli*, 5-54 for Enterococci, and 5-55 for fecal coliform. They are based on bacteria indicator measurements during primary contact recreation season at WQM station OK621010010160-001AT. The LDCs indicate that levels of all three indicators exceed the instantaneous water quality criteria under moderate and low flow conditions.

Figure 5-53 Load Duration Curve for *E. Coli* in Arkansas River, Salt Fork (OK621010010160_00)

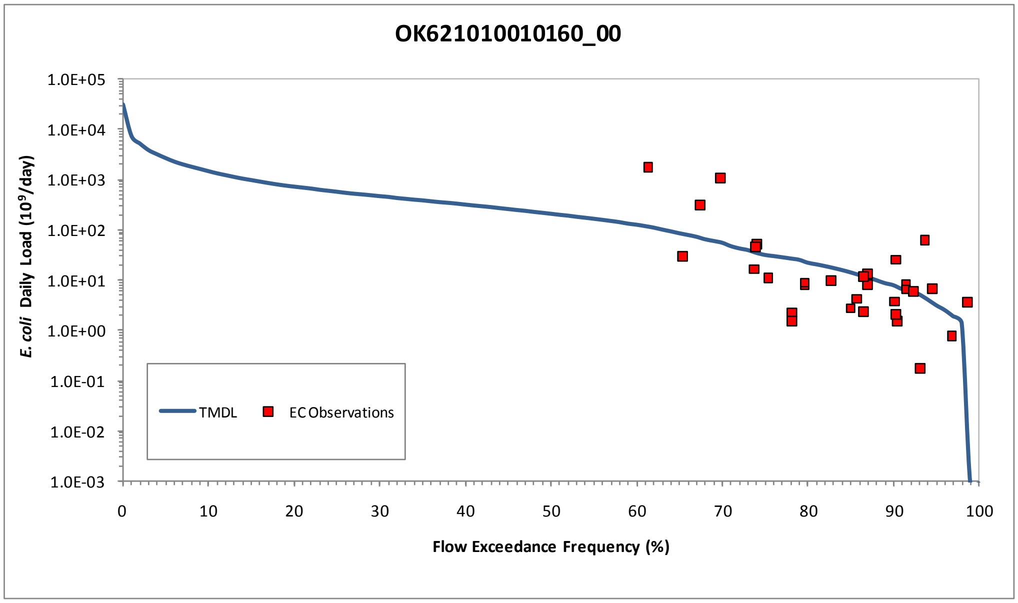


Figure 5-54 Load Duration Curve for Enterococci in Arkansas River, Salt Fork (OK621010010160_00)

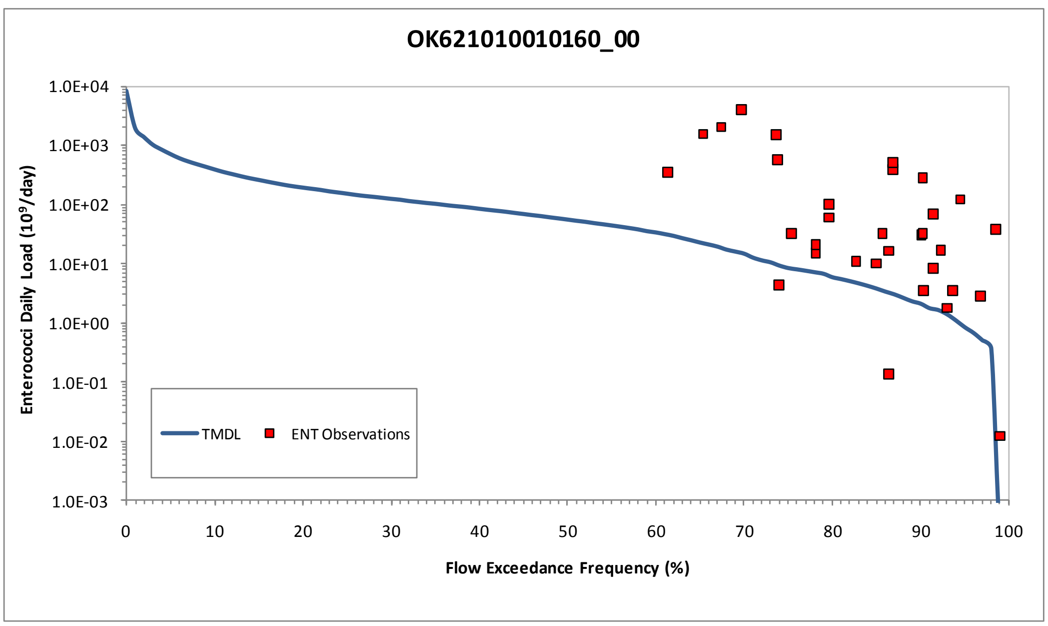
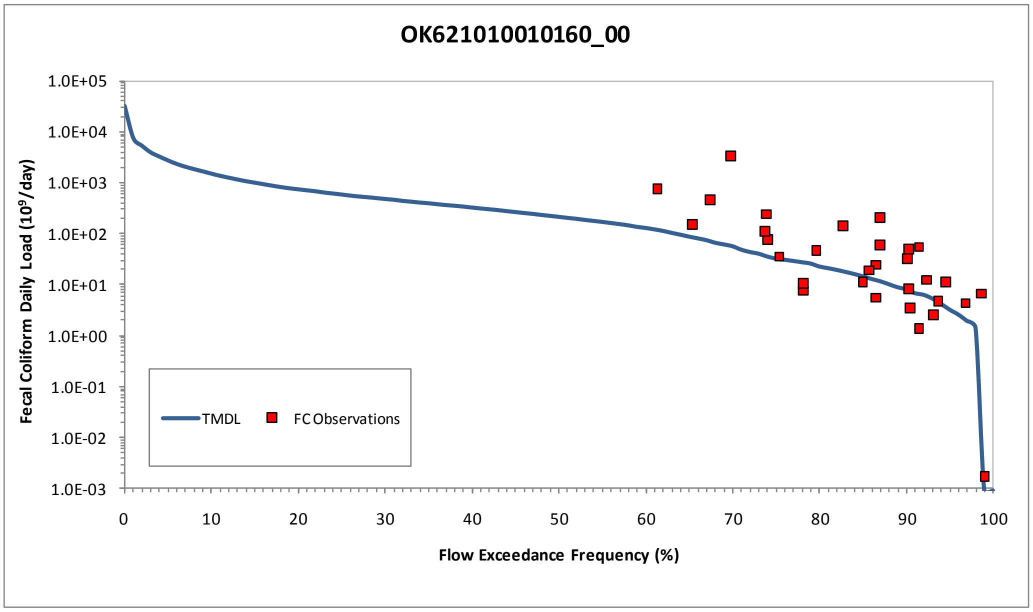


Figure 5-55 Load Duration Curve for Fecal Coliform in Arkansas River, Salt Fork (OK621010010160_00)



The LDCs for Turkey Creek are shown in Figure 5-56 for *E. coli* and 5-57 for Enterococci. They are based on bacteria indicator measurements during primary contact recreation season at WQM station OK621010010230G. The LDCs indicate that levels of both indicators exceed the instantaneous water quality criteria under all flow conditions, indicative of point and nonpoint loadings.

Figure 5-56 Load Duration Curve for *E. Coli* in Turkey Creek (OK621010010230_00)

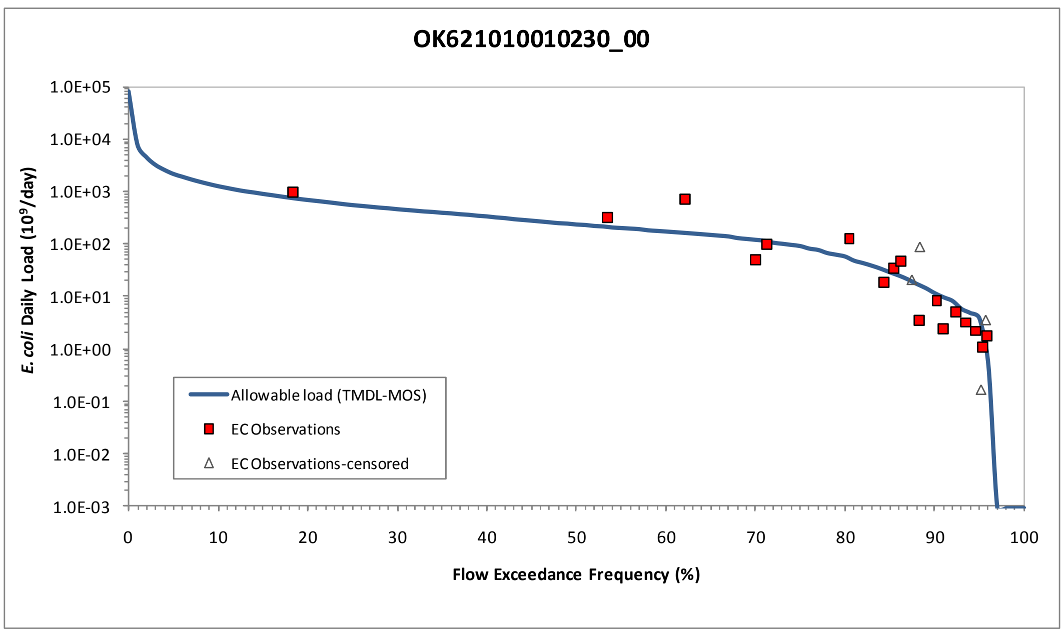
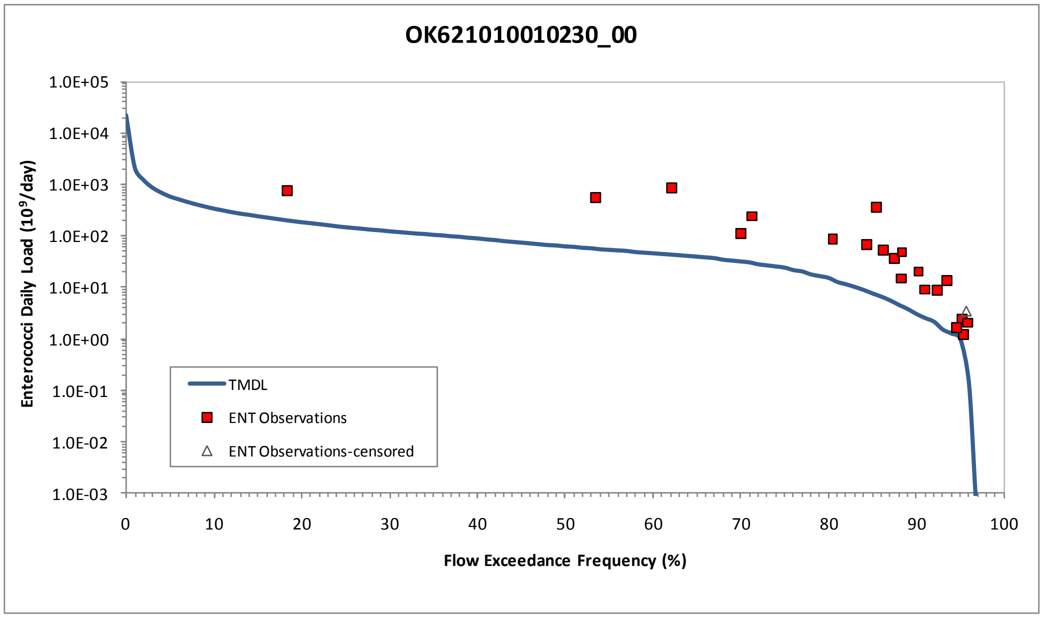
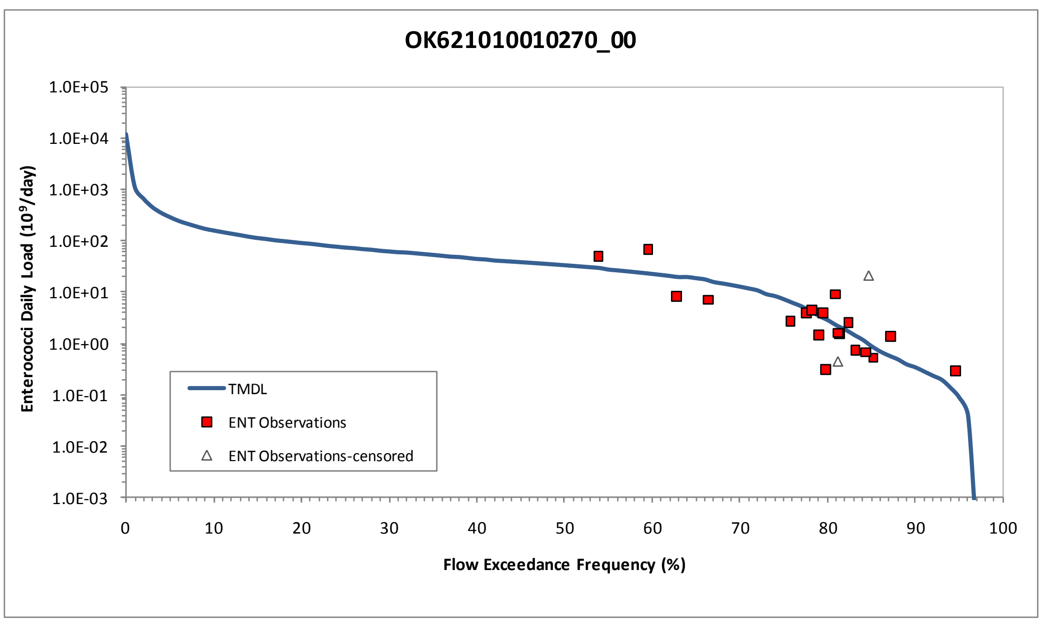


Figure 5-57 Load Duration Curve for Enterococci in Turkey Creek (OK621010010230_00)



The LDC for Yellowstone Creek is shown in Figure 5-58. It is based on Enterococci measurements during primary contact recreation season at WQM station OK621010010270G. The LDC indicates that Enterococci levels exceed the instantaneous water quality criterion under moderate and low flow conditions.

Figure 5-58 Load Duration Curve for Enterococci in Yellowstone Creek (OK621010010270_00)



The LDCs for Sandy Creek are shown in Figure 5-59 for *E. coli*, 5-60 for Enterococci, and 5-61 for fecal coliform. They are based on bacteria indicator measurements during primary contact recreation season at WQM stations OK621010020010D and OK621010020010G. The LDCs indicate that levels of all three indicators exceed the instantaneous water quality criteria under all flow conditions.

Figure 5-59 Load Duration Curve for *E. Coli* in Sandy Creek (OK621010020010_00)

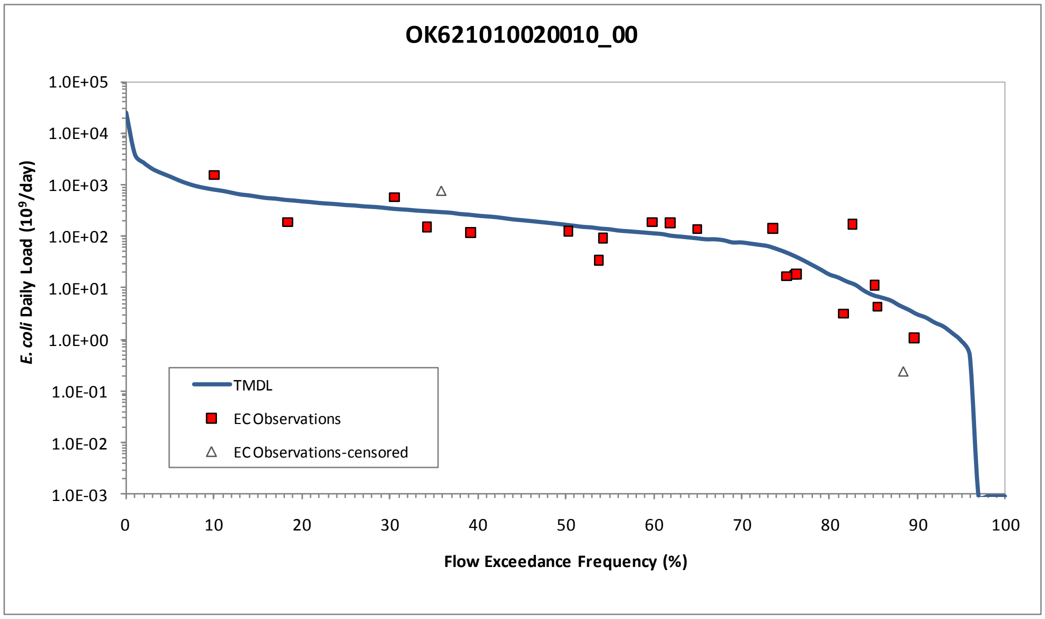


Figure 5-60 Load Duration Curve for Enterococci in Sandy Creek (OK621010020010_00)

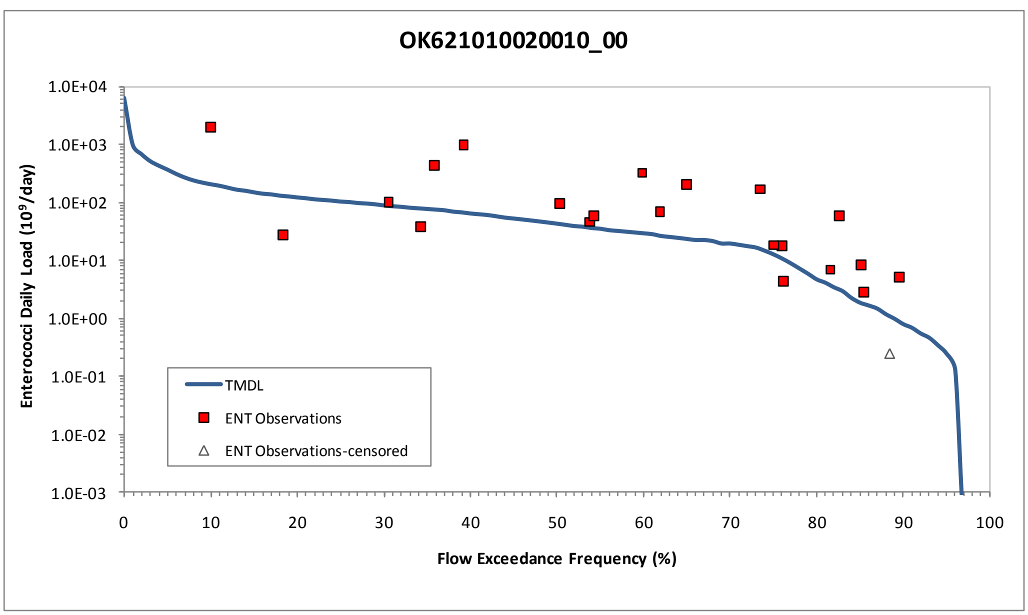
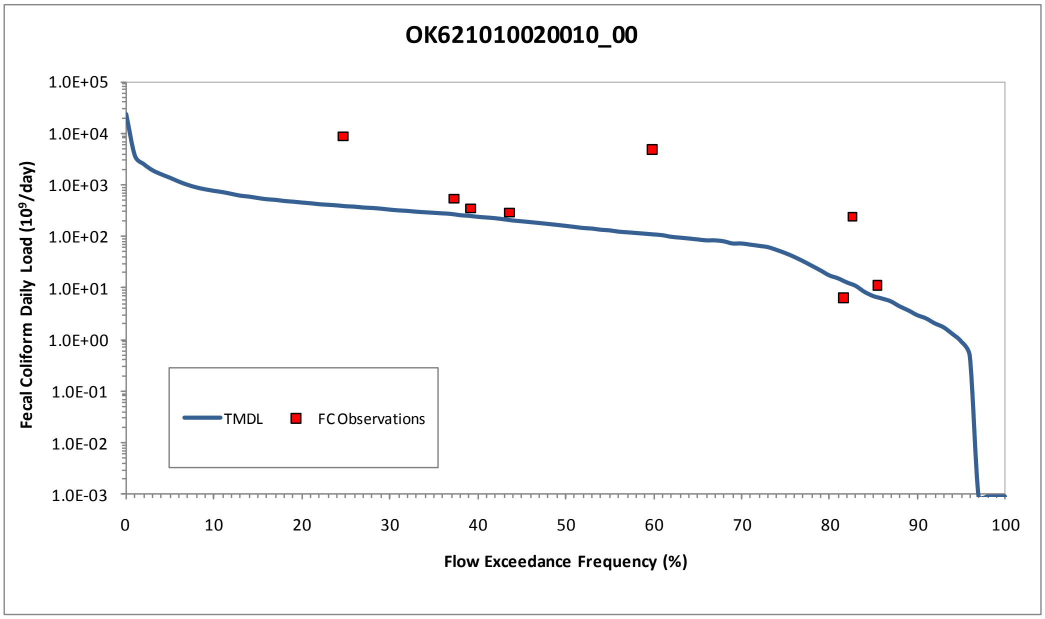


Figure 5-61 Load Duration Curve for Fecal Coliform in Sandy Creek (OK621010020010_00)



The LDCs for Medicine Lodge River (Figures 5-62 and 5-63) are based on *E. coli* and Enterococci measurements during primary contact recreation season at WQM station OK621010030010D. The LDCs indicate that *E. coli* and Enterococci levels exceed the instantaneous water quality criteria under all flow conditions.

Figure 5-62 Load Duration Curve for *E. coli* in Medicine Lodge River (OK621010030010_00)

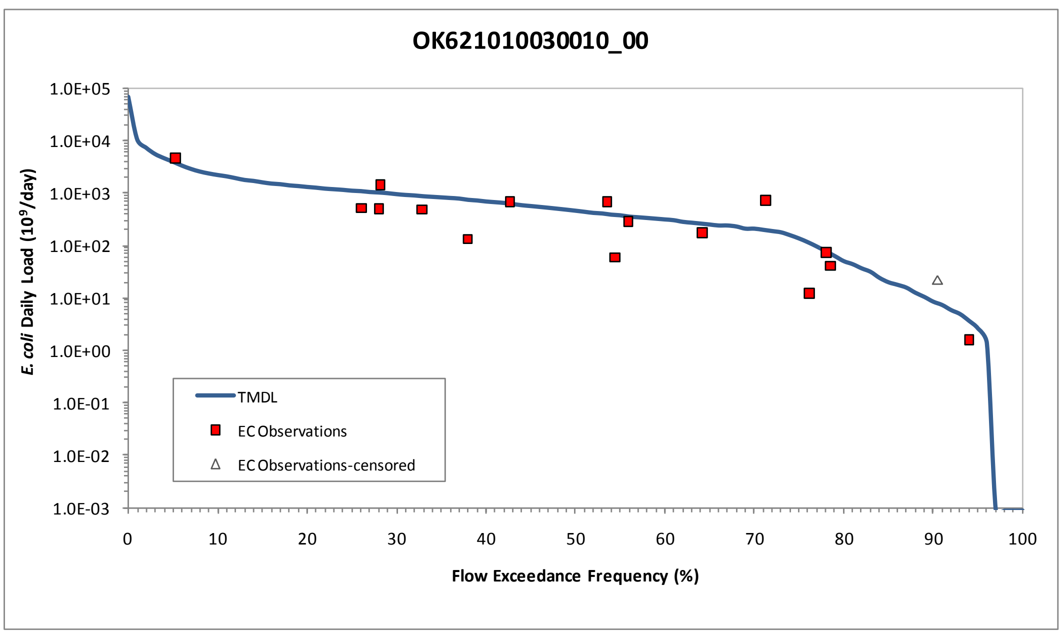
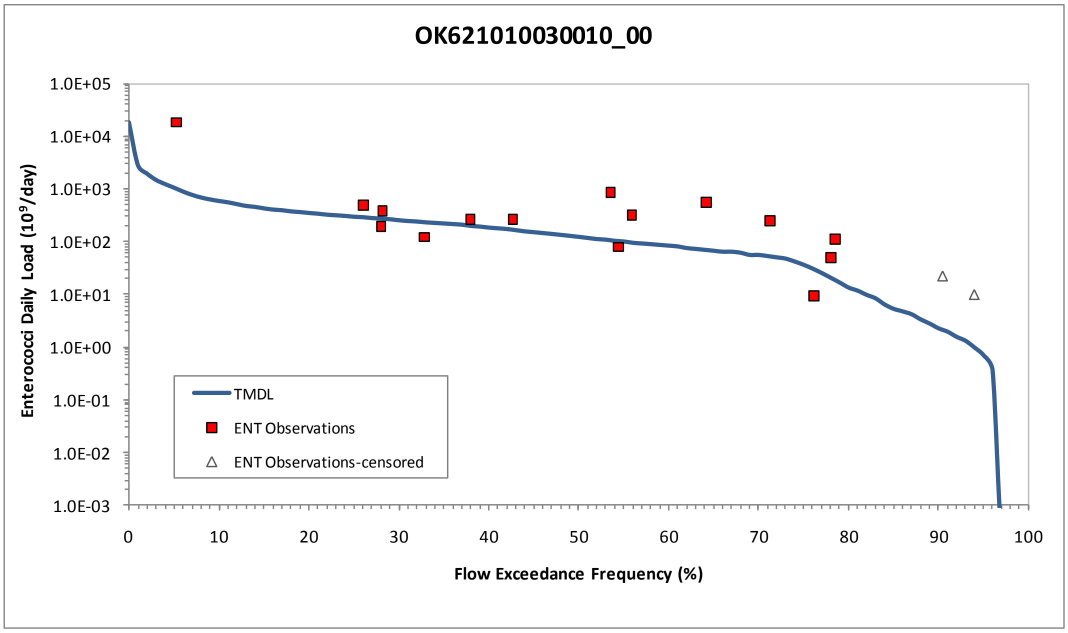


Figure 5-63 Load Duration Curve for Enterococci in Medicine Lodge River (OK621010030010_00)



The LDCs for Driftwood Creek (Figures 5-64 and 5-65) are based on *E. coli* and Enterococci bacteria measurements collected during primary contact recreation season at WQM station OK621010030030C. The LDCs indicate that levels of both indicators occasionally exceed the instantaneous water quality criteria under low and moderate flow conditions.

Figure 5-64 Load Duration Curve for E. coli in Driftwood Creek (OK621010030030_00)

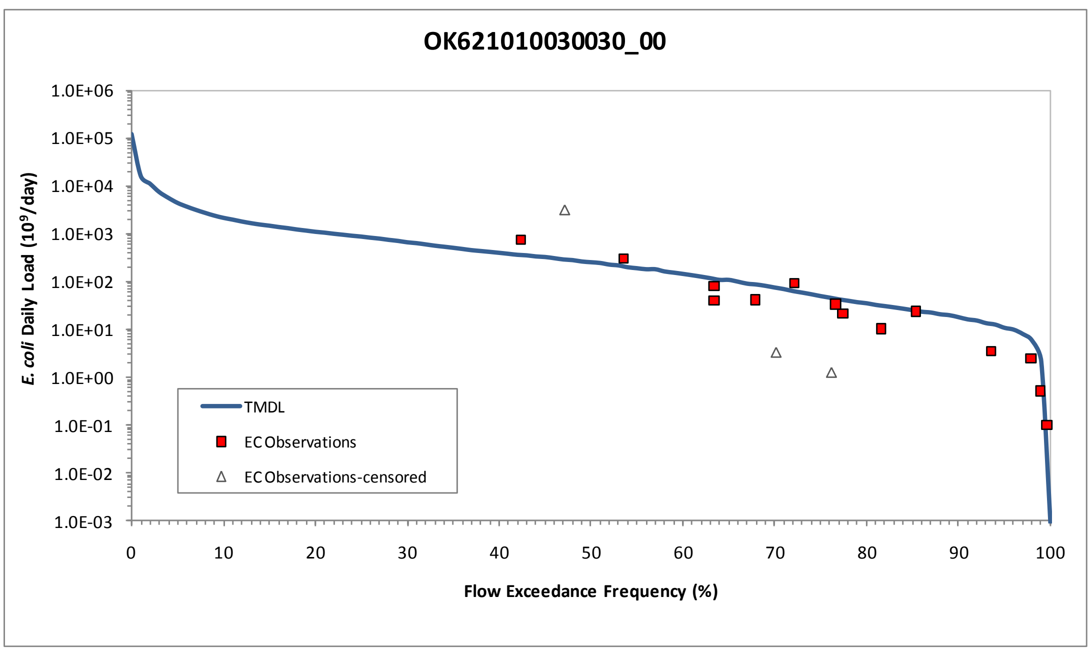
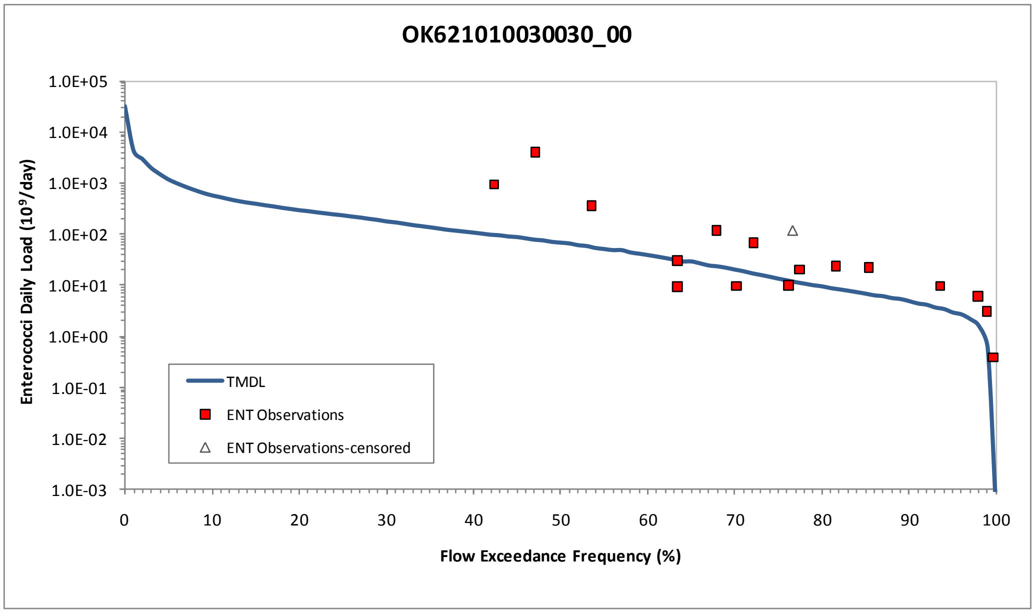


Figure 5-65 Load Duration Curve for Enterococci in Driftwood Creek (OK621010030030_00)



The LDCs for Chikaskia River, Lower (Figures 5-66 and 5-67) are based on *E. coli* and Enterococci measurements during primary contact recreation season at WQM station OK621100-00-0010M. The LDCs indicate that *E. coli* and Enterococci levels exceed the instantaneous water quality criteria under high and moderate flow conditions, indicative of nonpoint source loadings.

Figure 5-66 Load Duration Curve for *E. coli* in Chikaskia River, Lower (OK621100000010_00)

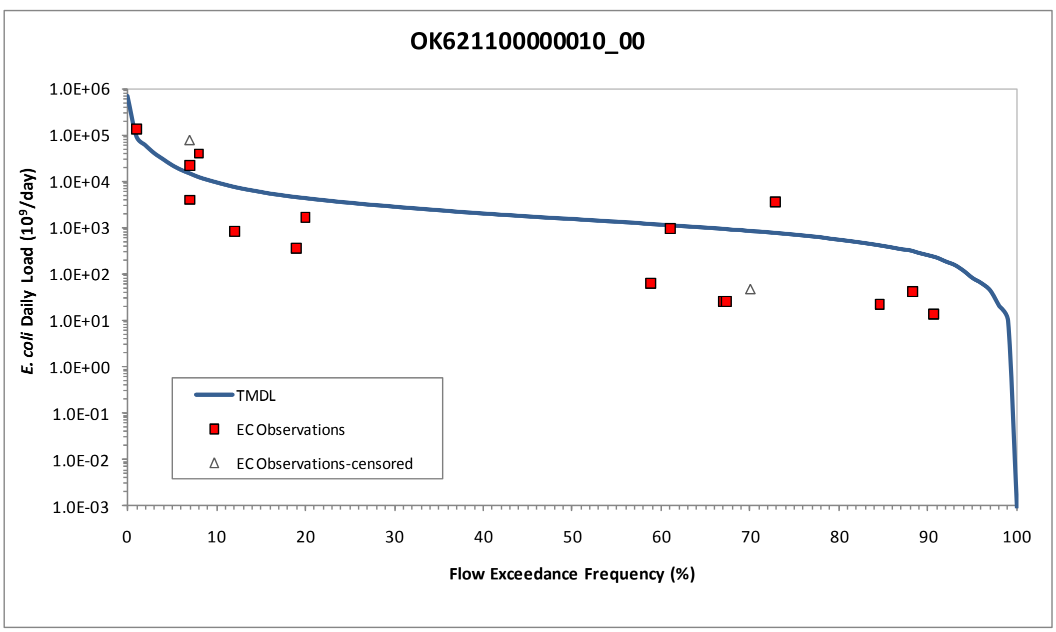
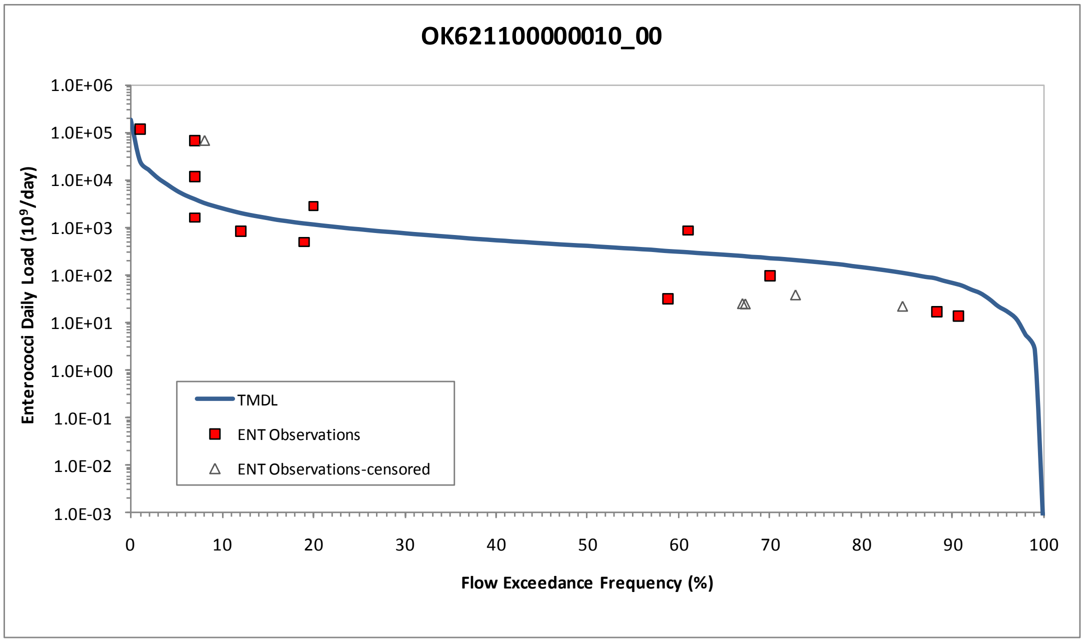


Figure 5-67 Load Duration Curve for Enterococci in Chikaskia River, Lower (OK621100000010_00)



The LDCs for Chikaskia River, Upper (Figures 5-68 and 5-69) are based on Enterococci and fecal coliform bacteria measurements collected during primary contact recreation season at WQM stations OK621100000010-001AT and OK621100000010B. The LDCs indicate that levels of both indicators exceed the instantaneous water quality criteria under high and moderate flow conditions, indicative of nonpoint source loadings.

Figure 5-68 Load Duration Curve for Enterococci Chikaskia River, Upper (OK621100000010_10)

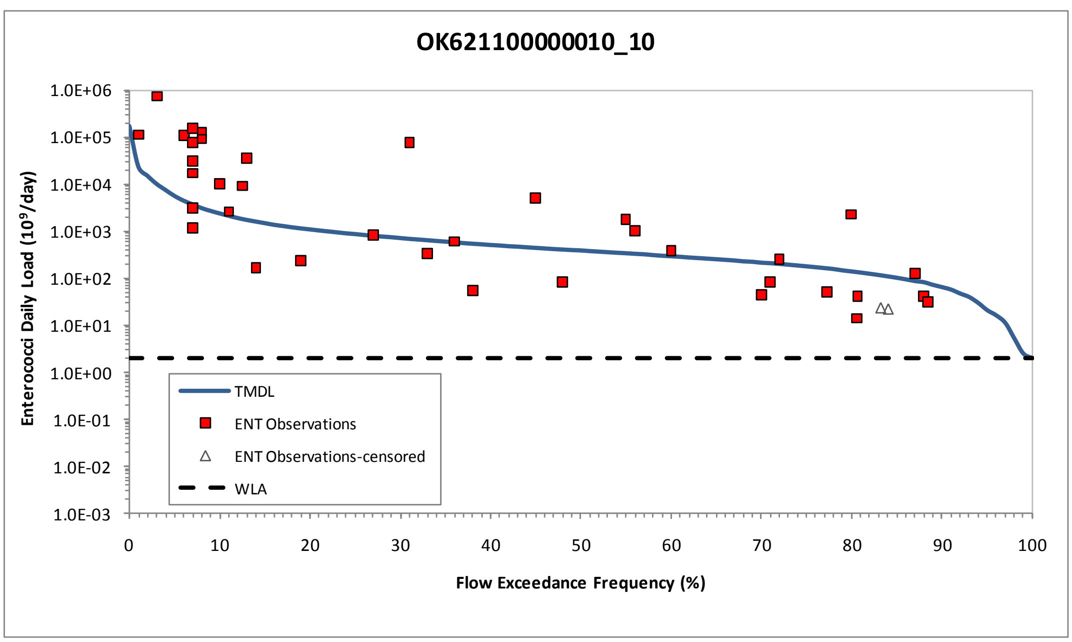
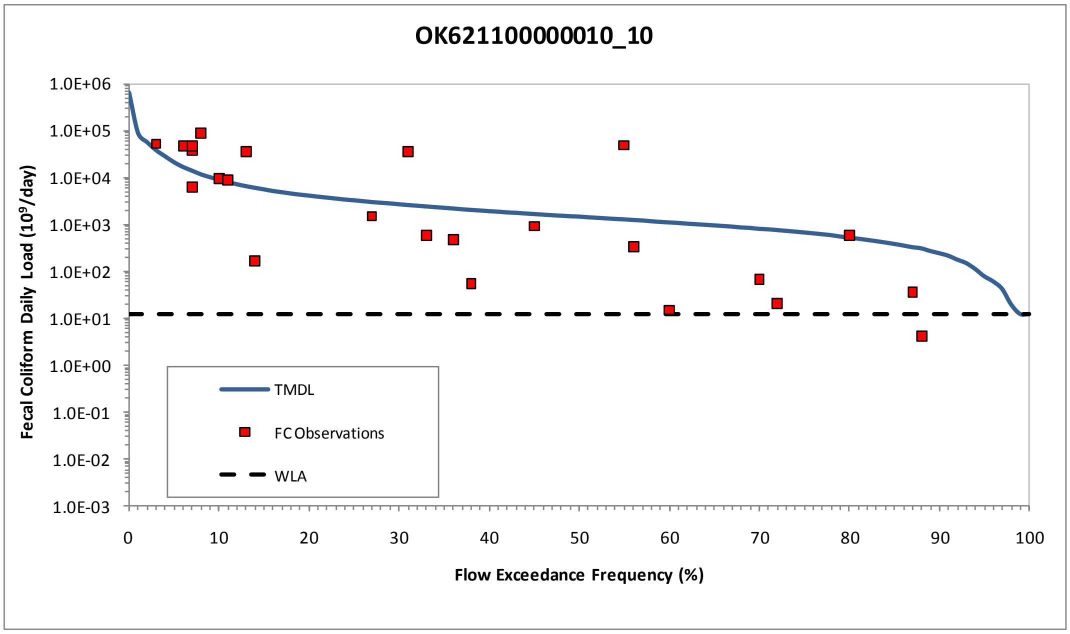


Figure 5-69 Load Duration Curve for Fecal Coliform in Chikaskia River, Upper (OK621100000010_10)



The LDCs for Bitter Creek are shown in Figure 5-70 for *E. coli* and 5-71 for Enterococci. They are based on bacteria indicator measurements during primary contact recreation season at WQM station OK621100000100G. The LDCs indicate that levels of *E. coli* exceed the instantaneous water quality criterion under moderate and low flow conditions, while the Enterococci criterion is exceeded under all flow conditions.

Figure 5-70 Load Duration Curve for *E. Coli* in Bitter Creek (OK621100000100_00)

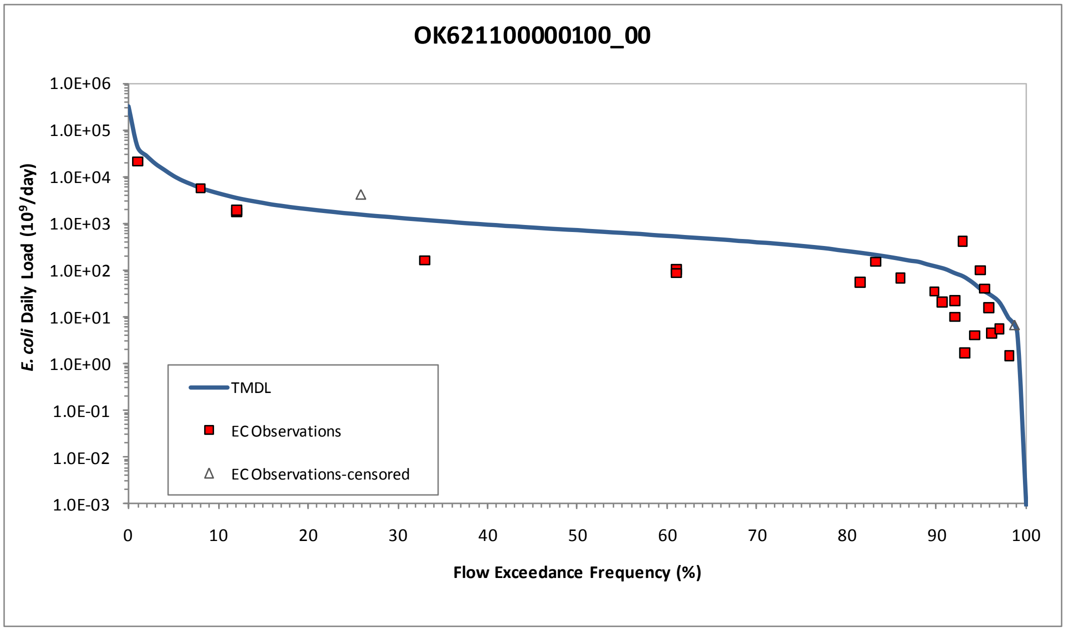
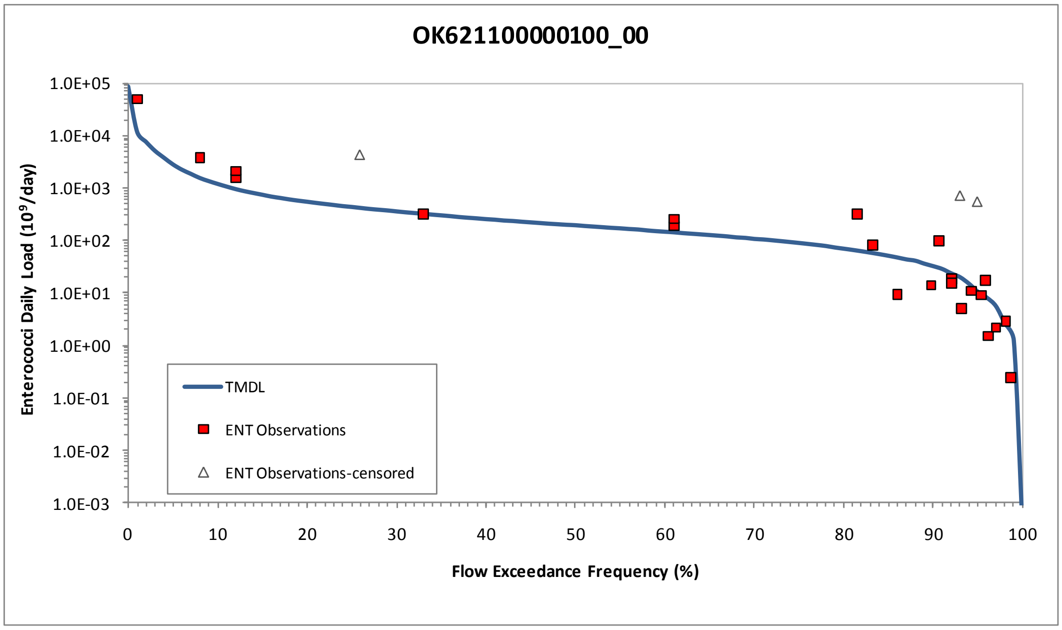
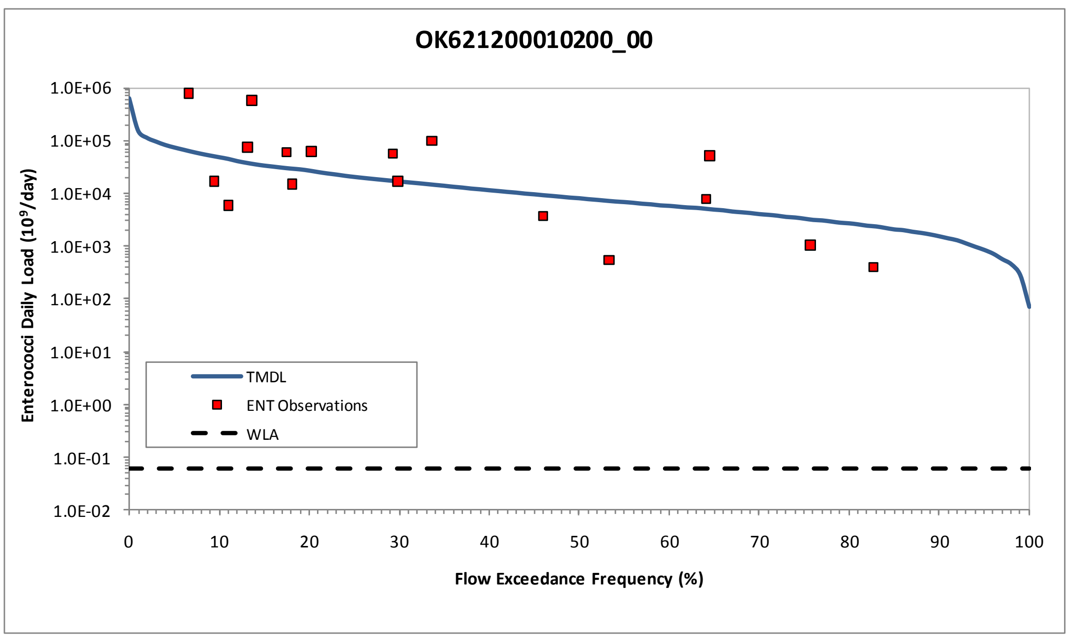


Figure 5-71 Load Duration Curve for Enterococci in Bitter Creek (OK621100000100_00)



The LDC for the Arkansas River is shown in Figure 5-72. It is based on Enterococci measurements during primary contact recreation season at WQM station OK621200010200-001AT. The LDC indicates that levels of Enterococci exceed the instantaneous water quality criteria under high and moderate flow conditions, indicative of nonpoint loadings.

Figure 5-72 Load Duration Curve for Enterococci in the Arkansas River (OK621200010200_00)



The LDCs for Black Bear Creek (Figures 5-73 and 5-74) are based on *E. coli and* Enterococci measurements during primary contact recreation season at WQM stations OK621200-03-0010G, OK621200-03-0010M, and OK621200-03-0010W. The LDCs indicate that levels of *E. coli* and Enterococci exceed the instantaneous water quality criteria under all flow conditions.

Figure 5-73 Load Duration Curve for *E. coli* in Black Bear Creek (OK621200030010_00)

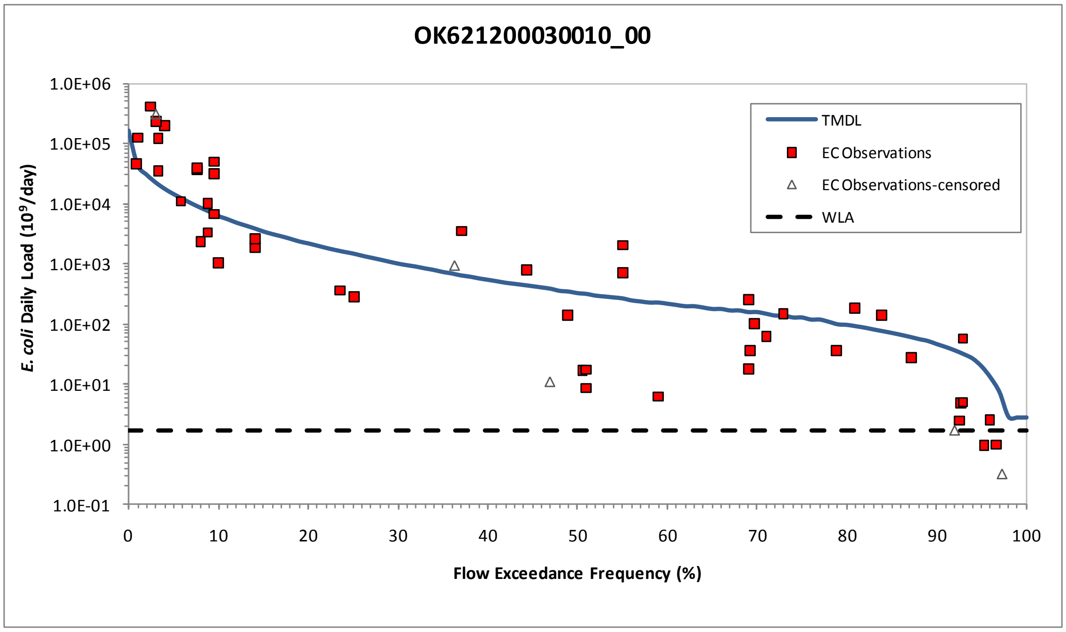
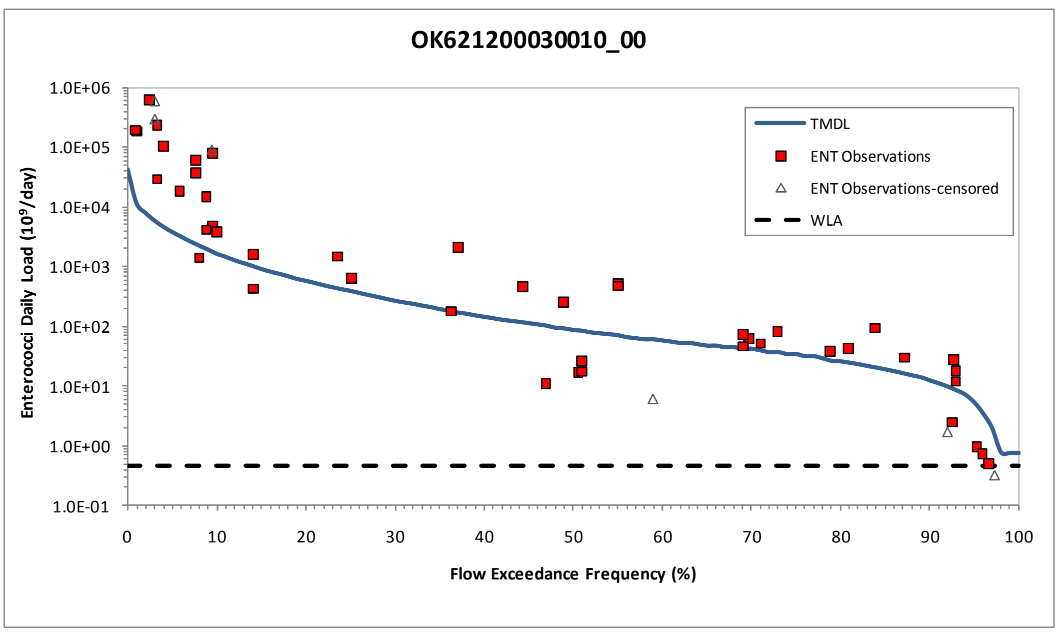


Figure 5-74 Load Duration Curve for Enterococci in Black Bear Creek (OK621200030010_00)



The LDCs for Red Rock Creek, Lower are shown in Figure 5-75 for *E. coli* and 5-76 for Enterococci. They are based on bacteria indicator measurements during primary contact recreation season at WQM station OK621200-05-0010K. The LDCs indicate that levels of both indicators exceed the instantaneous water quality criteria primarily under high flow conditions, indicative of nonpoint source loadings.

Figure 5-75 Load Duration Curve for *E. Coli* in Red Rock Creek, Lower (OK621200050010_00)

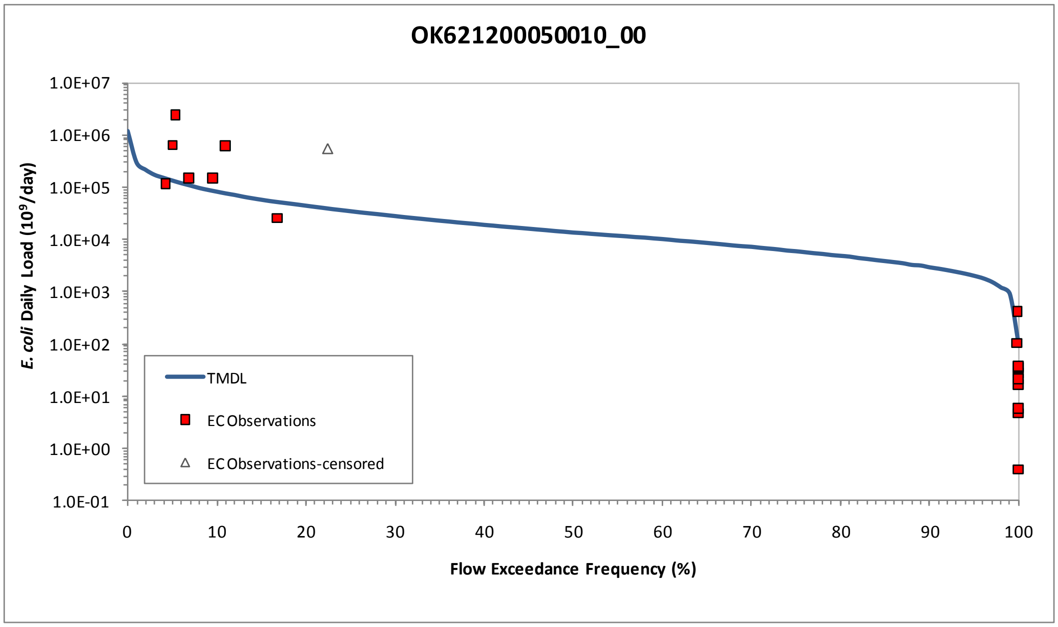
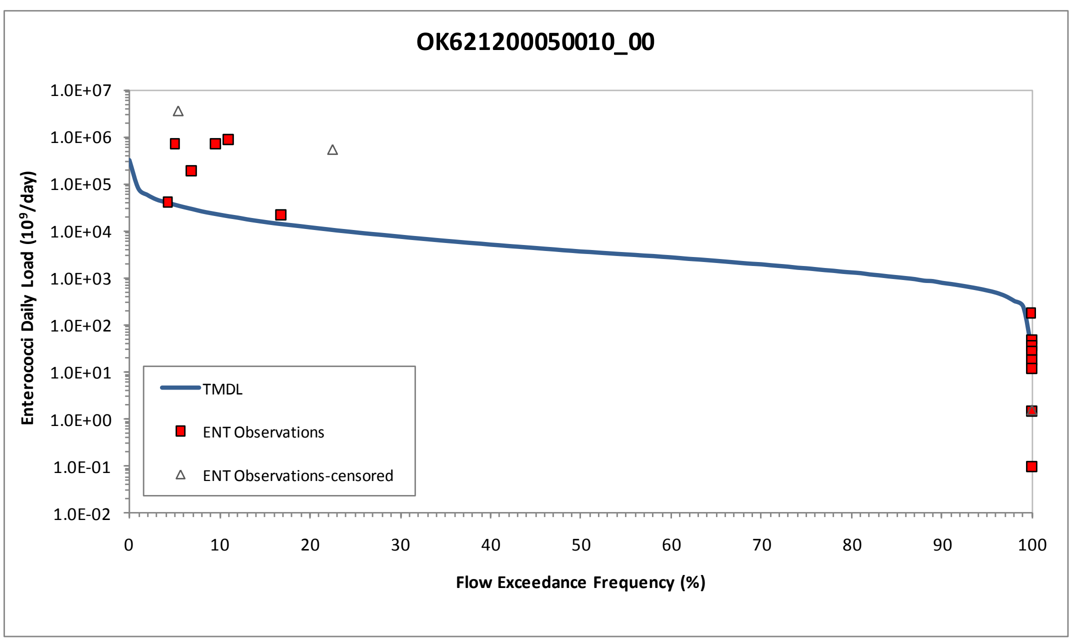
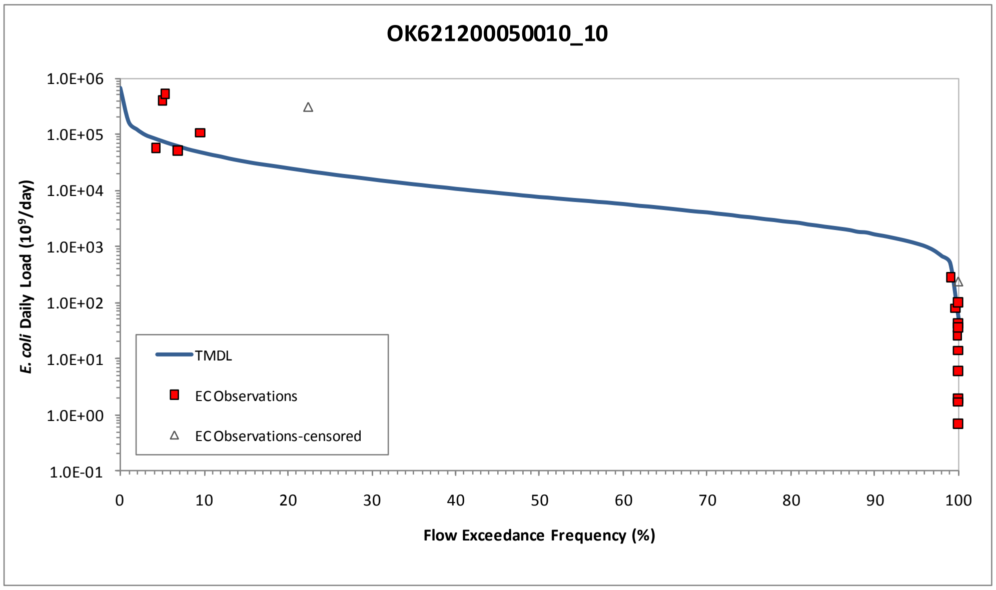


Figure 5-76 Load Duration Curve for Enterococci in Red Rock Creek, Lower (OK621200050010_00)



The LDC for the Red Rock Creek, Upper is shown in Figure 5-77. It is based on *E. coli* measurements during primary contact recreation season at WQM station OK621200-05-0010M. The LDC indicates that levels of *E. coli* exceed the instantaneous water quality criteria mainly under high flow conditions, indicative of nonpoint loadings.

Figure 5-77 Load Duration Curve for *E. coli* in Red Rock Creek, Upper (OK621200050010_10)



The LDCs for Beaver Creek, Lower are shown in Figure 5-78 for *E. coli* and 5-79 for Enterococci. They are based on bacteria indicator measurements during primary contact recreation season at WQM station OK621210-00-0050L. The LDCs indicate that levels of both indicators exceed the instantaneous water quality criteria under all flow conditions.

Figure 5-78 Load Duration Curve for *E. Coli* in Beaver Creek (OK621210000050_10)

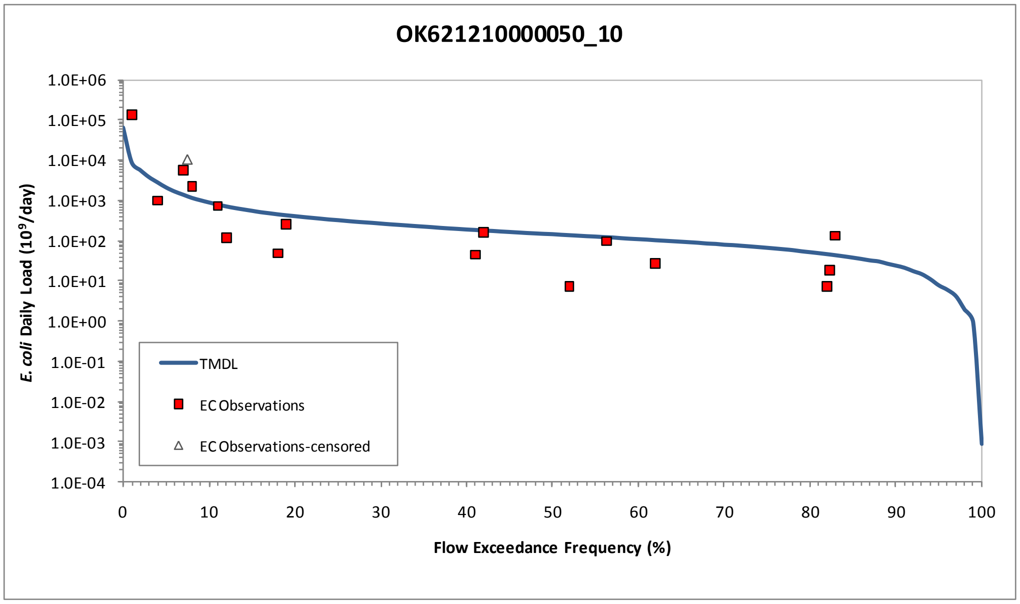
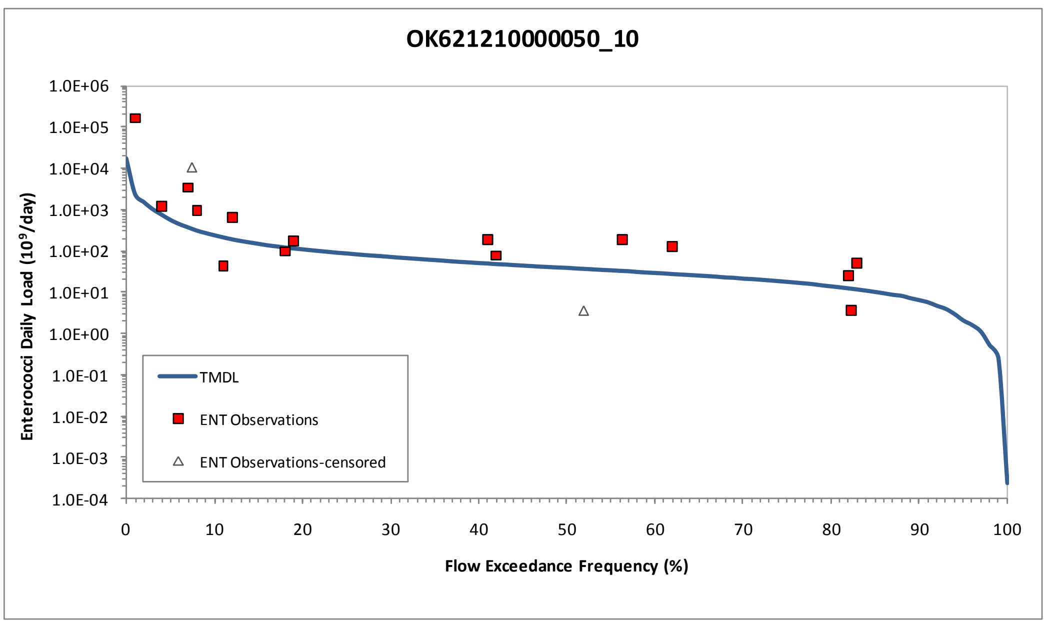


Figure 5-79 Load Duration Curve for Enterococci in Beaver Creek (OK621210000050_10)



The LDCs for Chilocco Creek, Lower are shown in Figure 5-80 for *E. coli* and 5-81 for Enterococci. They are based on bacteria indicator measurements during primary contact recreation season at WQM station OK621210-00-0270C. The LDCs indicate that levels of both indicators exceed the instantaneous water quality criteria under all flow conditions.

Figure 5-80 Load Duration Curve for *E. Coli* in Chilocco Creek (OK621210000270_00)

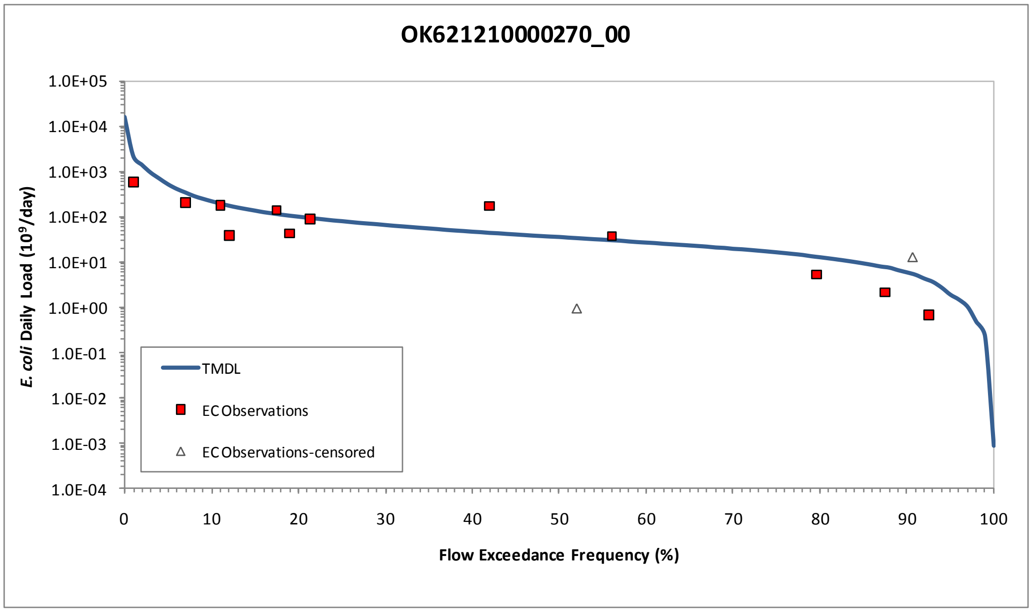
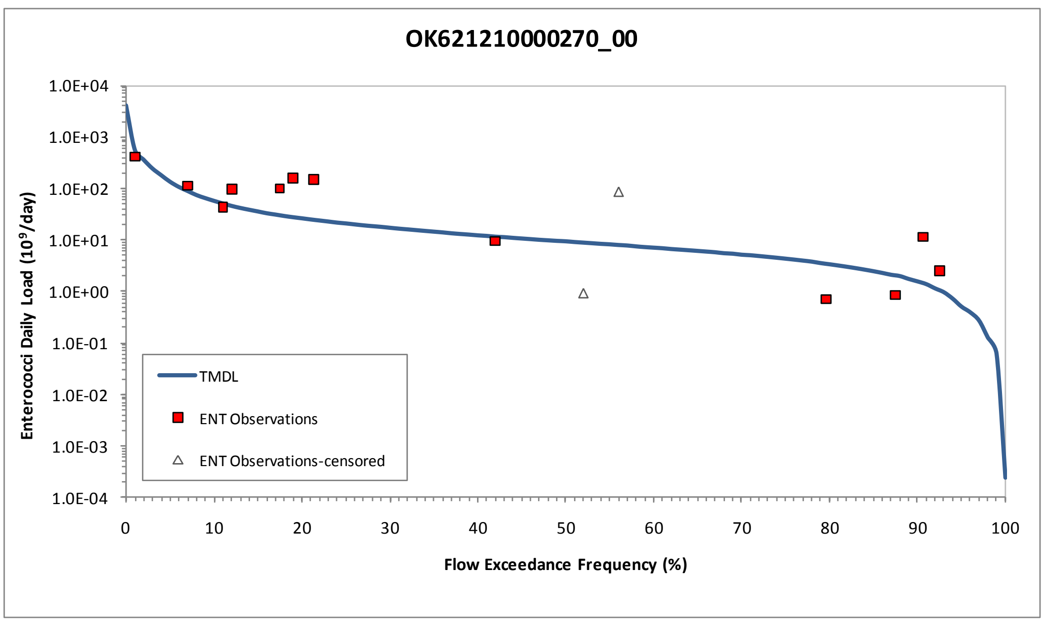


Figure 5-81 Load Duration Curve for Enterococci in Chilocco Creek (OK621210000270_00)



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 2009 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.

Figures 5-82 through Figure 5-98 show the TSS LDCs developed for the seventeen waterbodies addressed in this TMDL report. Data in the figures demonstrate that for most waterbodies, 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 5-82 Load Duration Curve for Total Suspended Solids in Arkansas River, Salt Fork (OK621000010010_30)

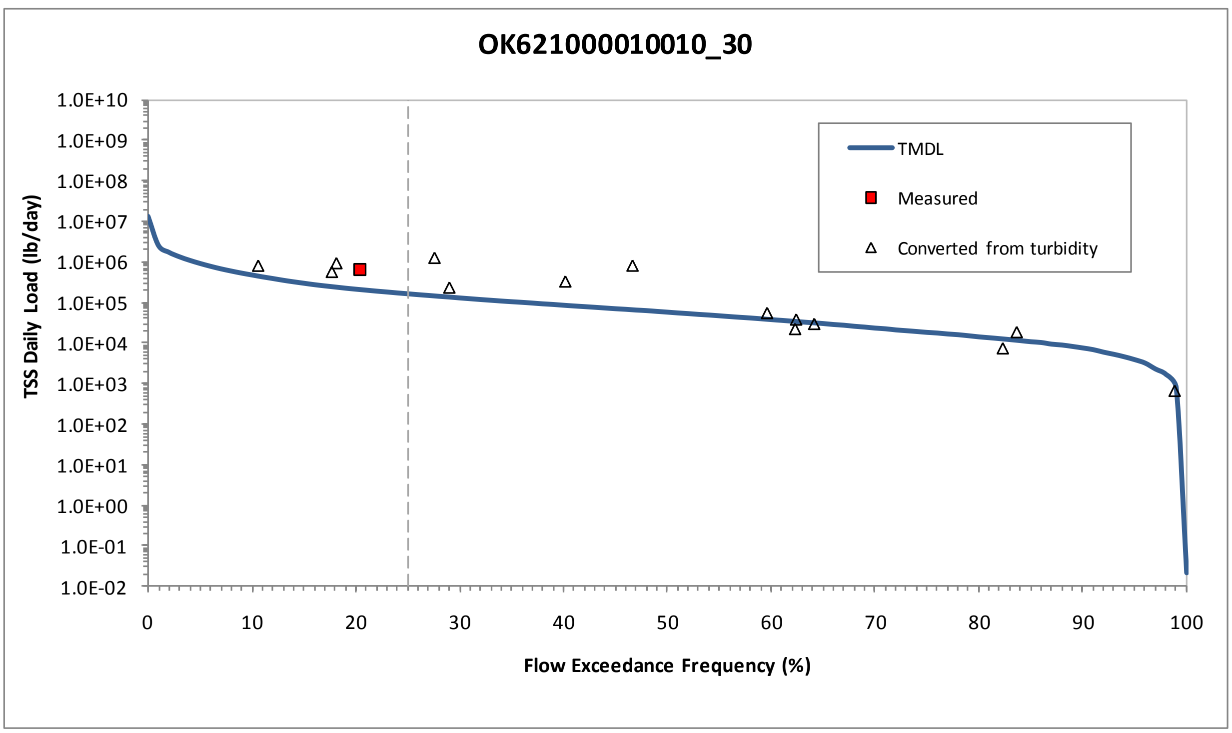


Figure 5-83 Load Duration Curve for Total Suspended Solids in Bois d'Arc Creek (OK621000030010_00)

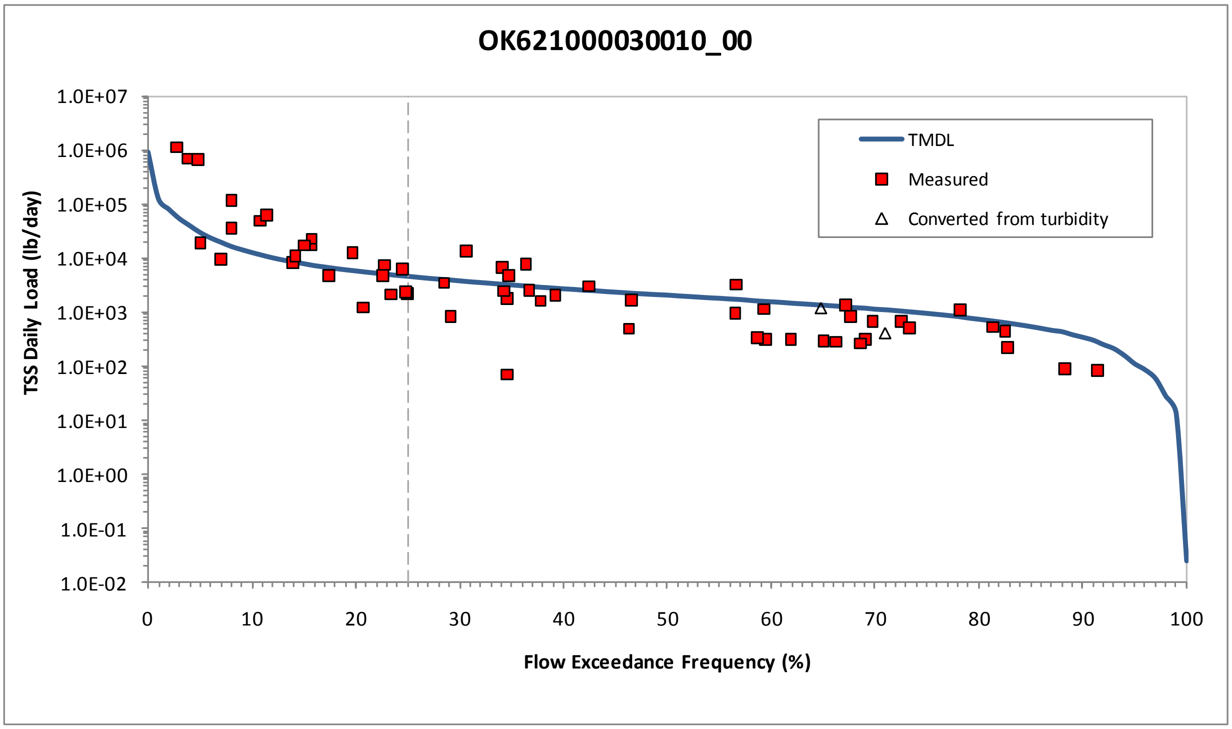


Figure 5-84 Load Duration Curve for Total Suspended Solids in Deer Creek (OK621000040010_00)

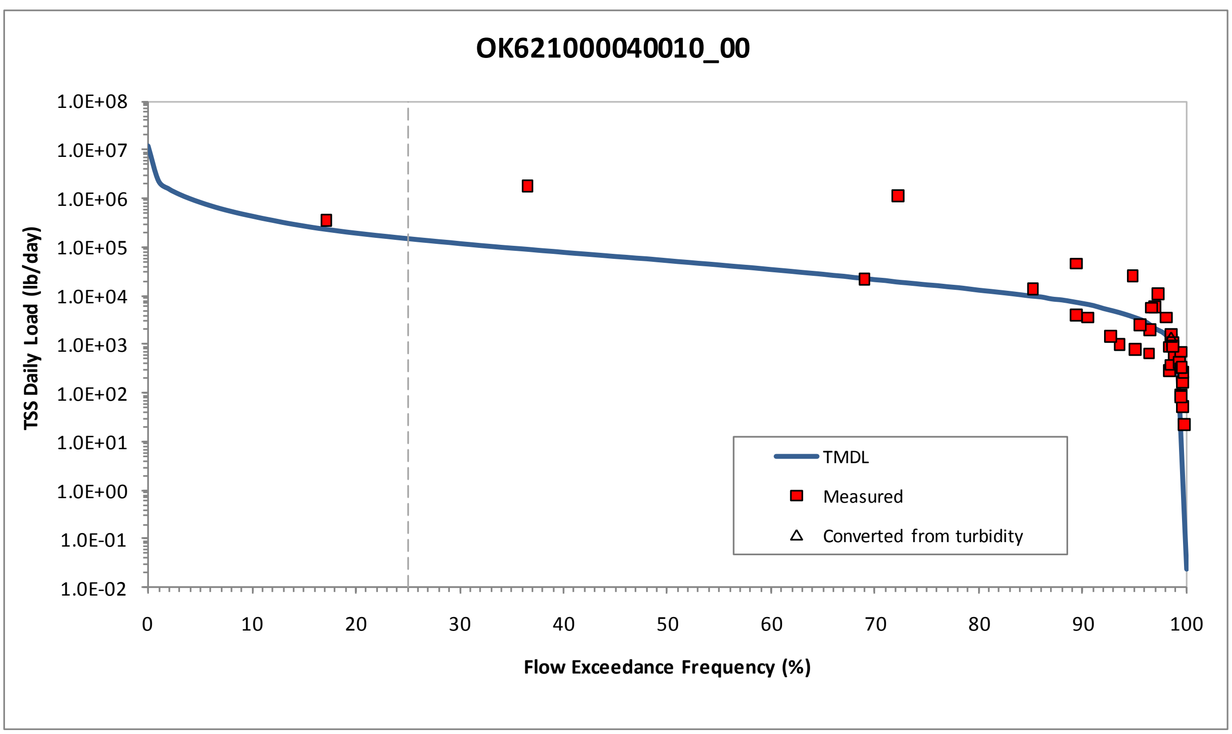


Figure 5-85 Load Duration Curve for Total Suspended Solids in Pond Creek (OK621000050010_00)

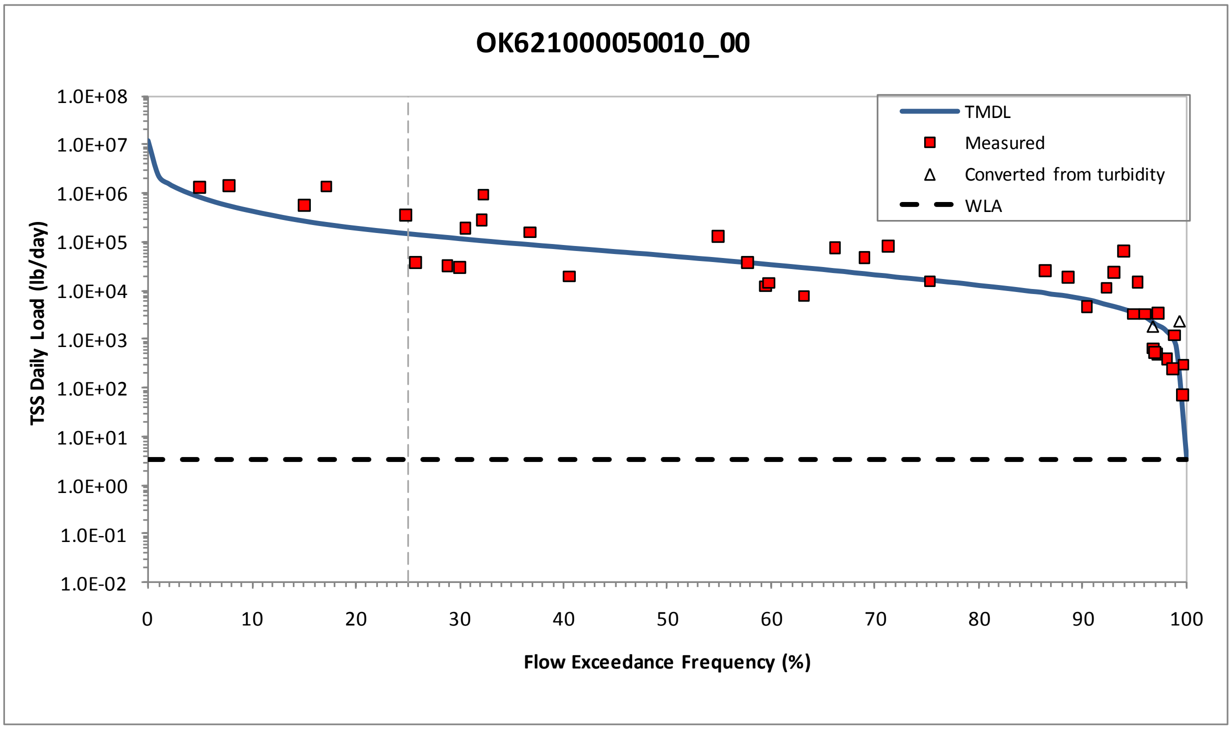


Figure 5-86 Load Duration Curve for Total Suspended Solids in Crooked Creek (OK621000060010_00)

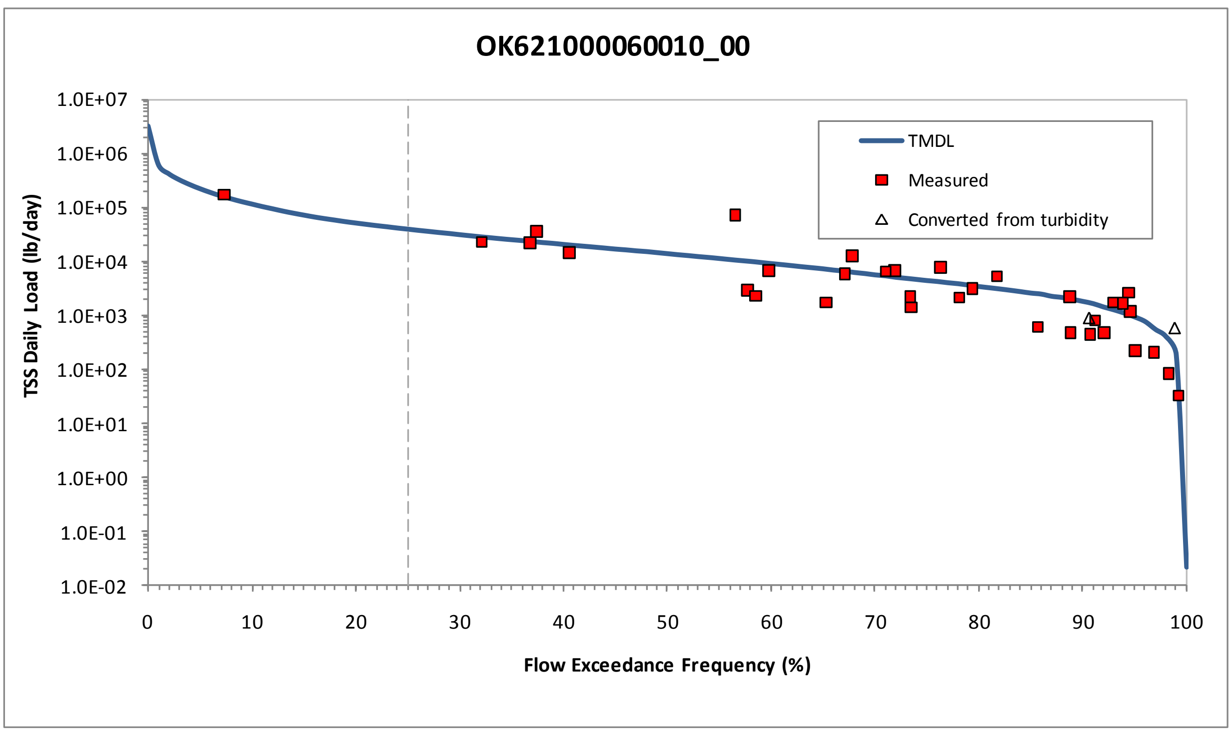


Figure 5-87 Load Duration Curve for Total Suspended Solids in Arkansas River, Salt Fork (OK621010010010_00)

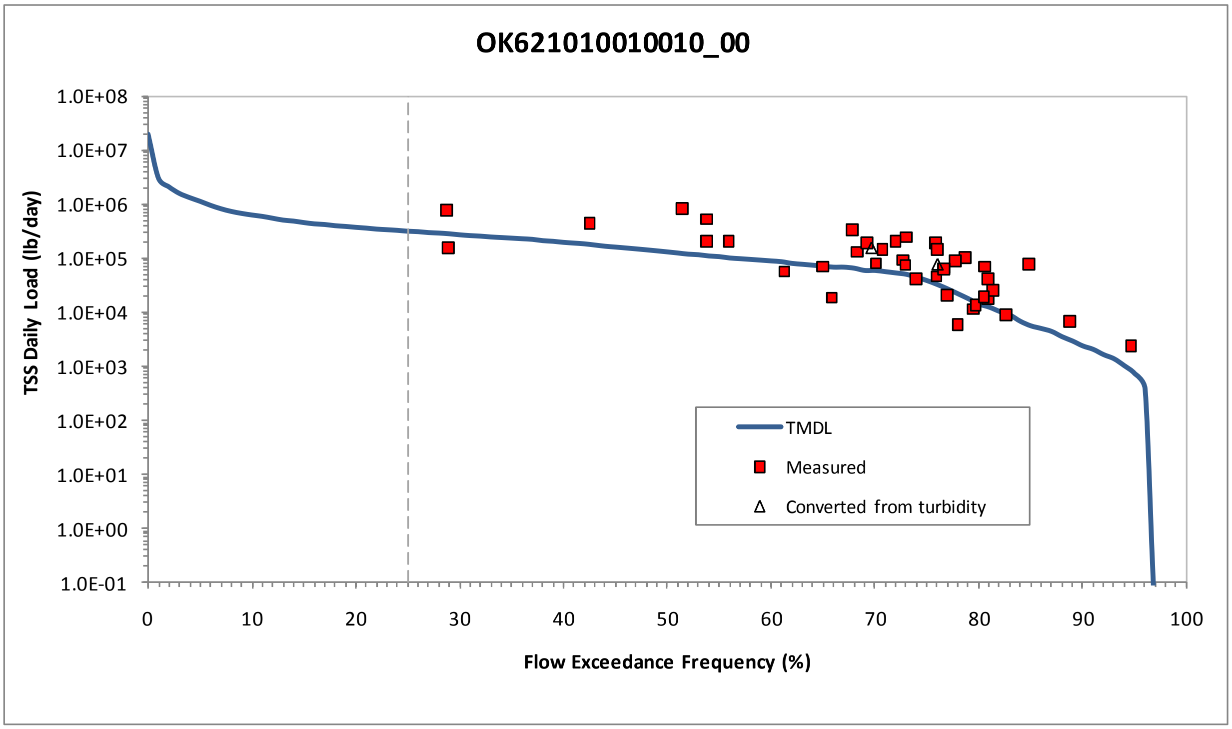


Figure 5-88 Load Duration Curve for Total Suspended Solids in Arkansas River, Salt Fork (OK621010010160_00)

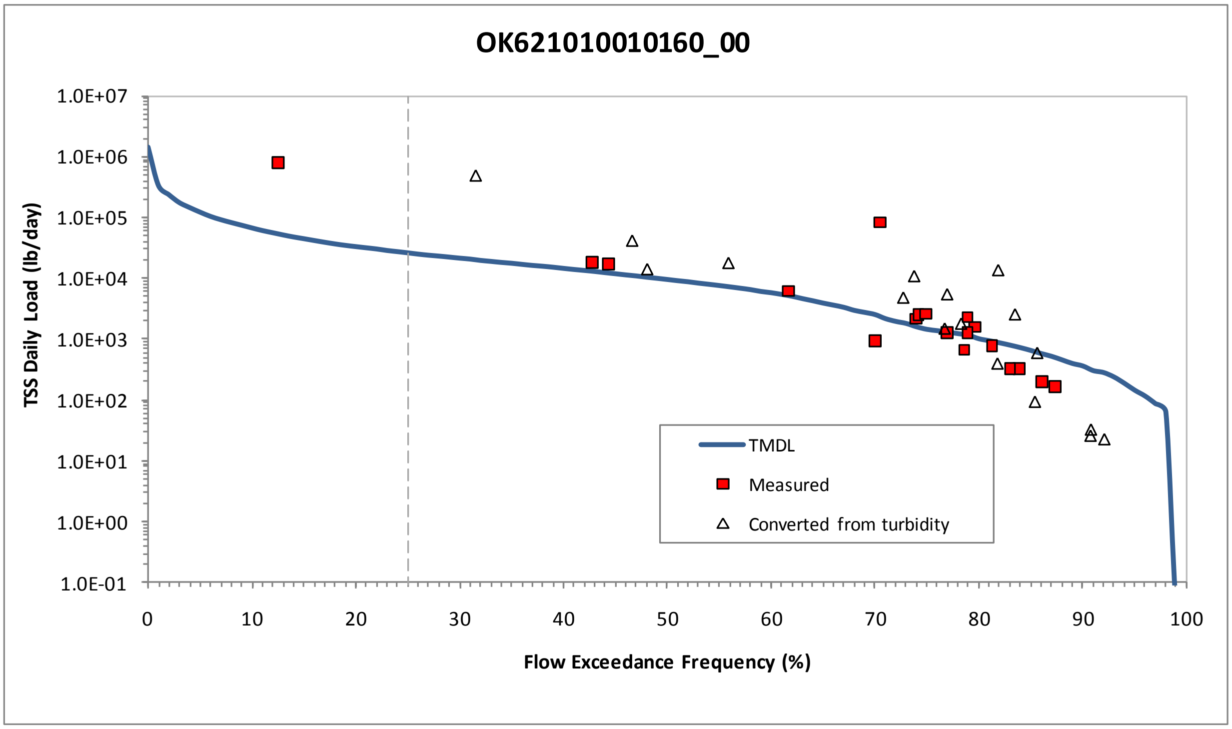


Figure 5-89 Load Duration Curve for Total Suspended Solids in Turkey Creek (OK621010010230_00)

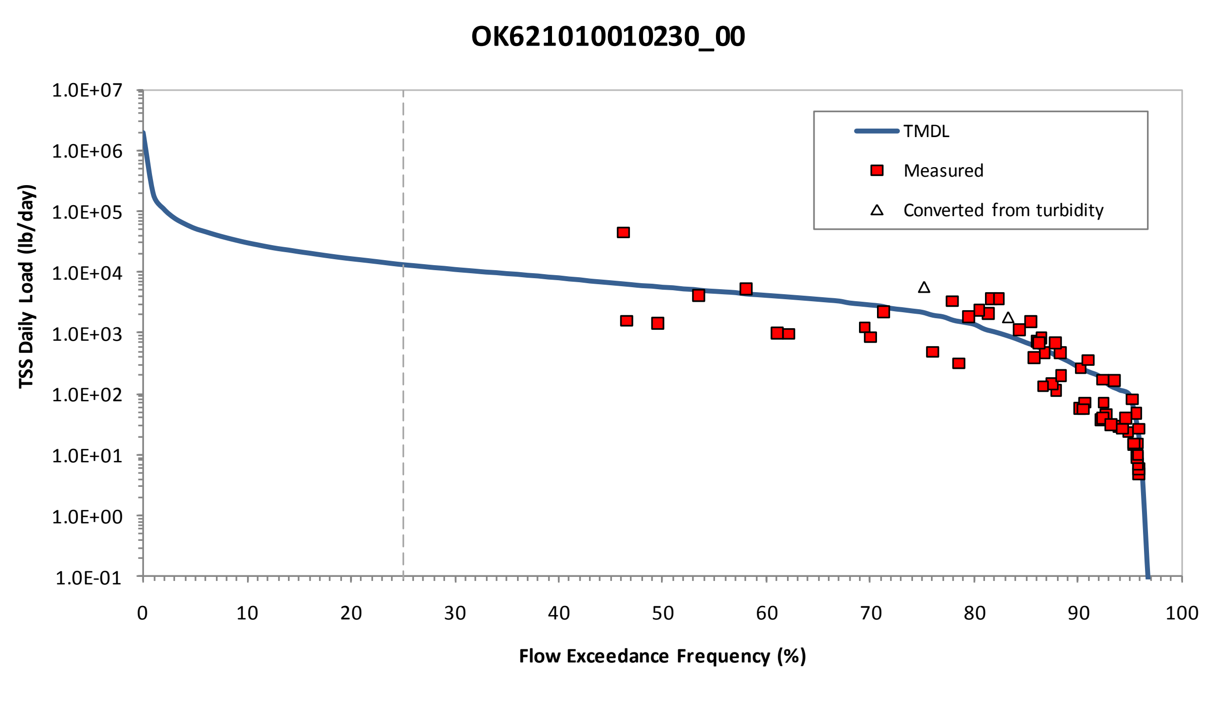


Figure 5-90 Load Duration Curve for Total Suspended Solids in Medicine Lodge River (OK621010030010_00)

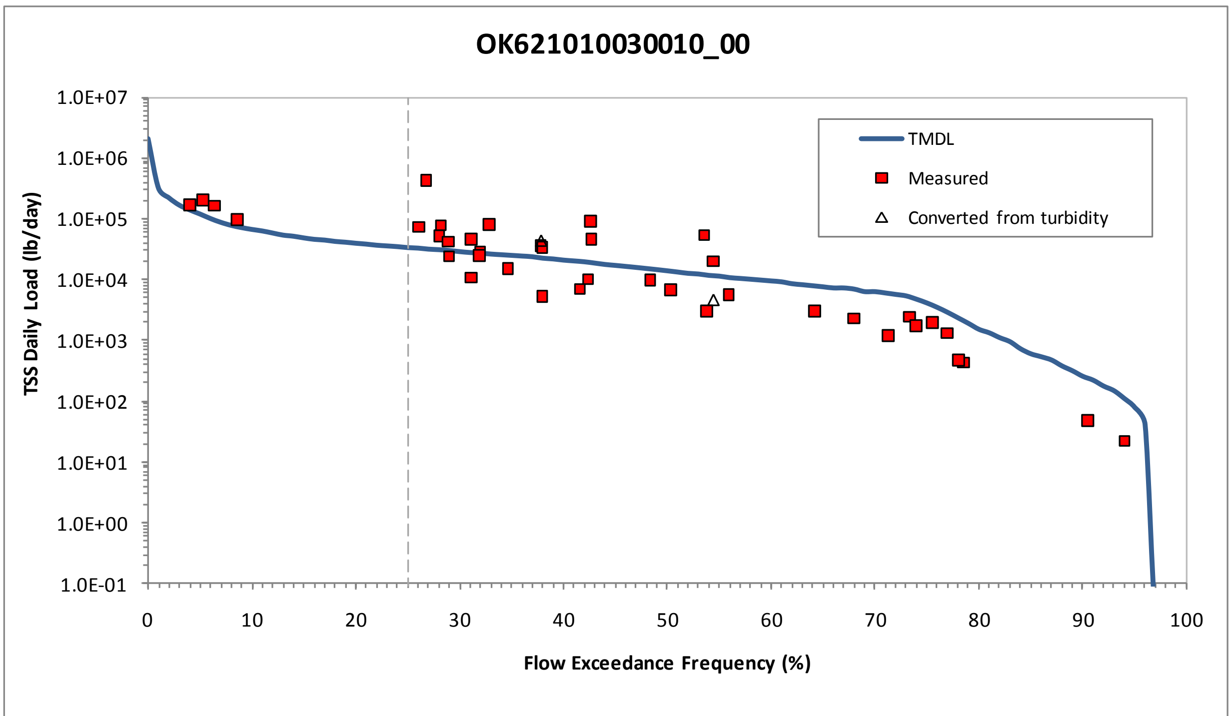


Figure 5-91 Load Duration Curve for Total Suspended Solids in Driftwood Creek (OK621010030030_00)

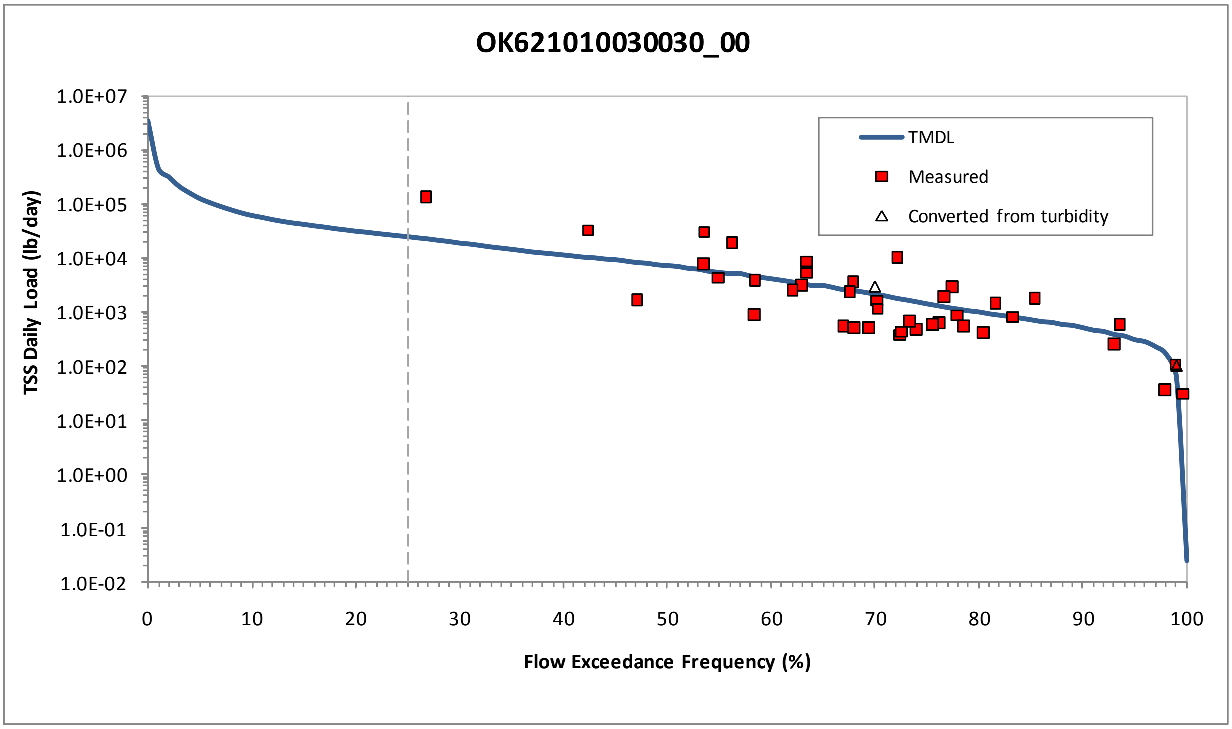


Figure 5-92 Load Duration Curve for Total Suspended Solids in Chikaskia River, Lower (OK621100000010_00)

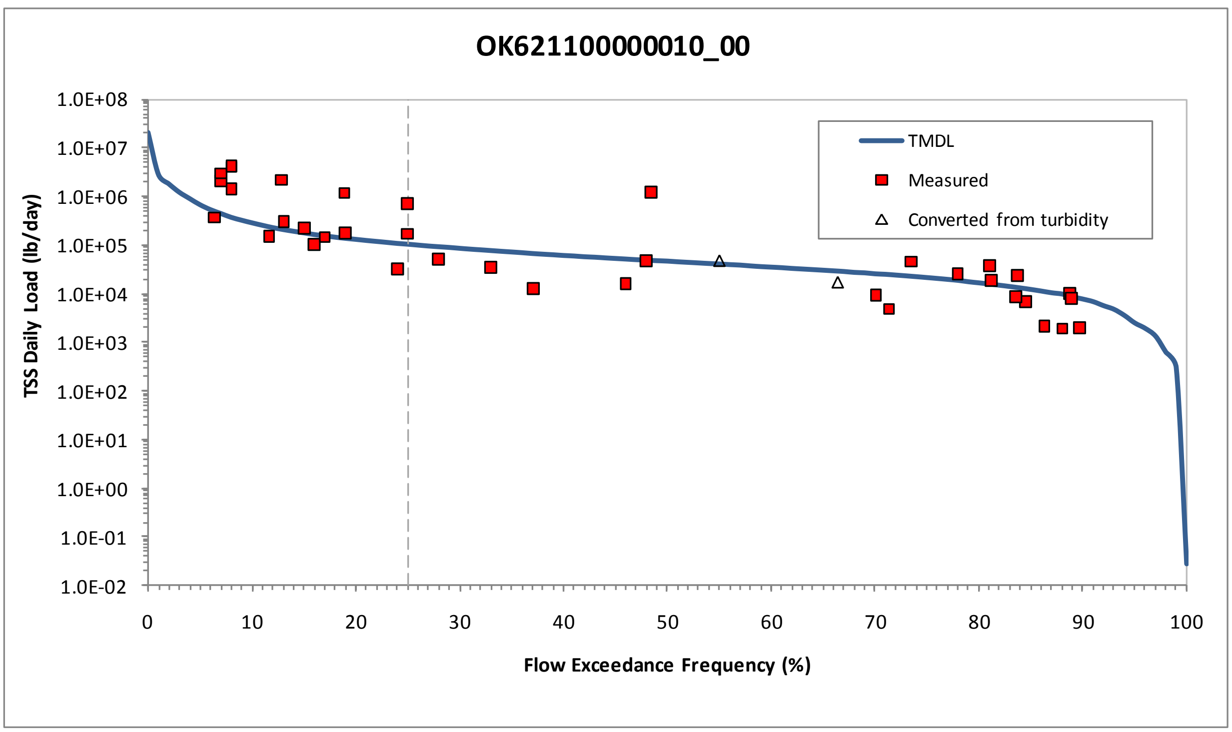


Figure 5-93 Load Duration Curve for Total Suspended Solids in Chikaskia River, Upper (OK621100000010_10)

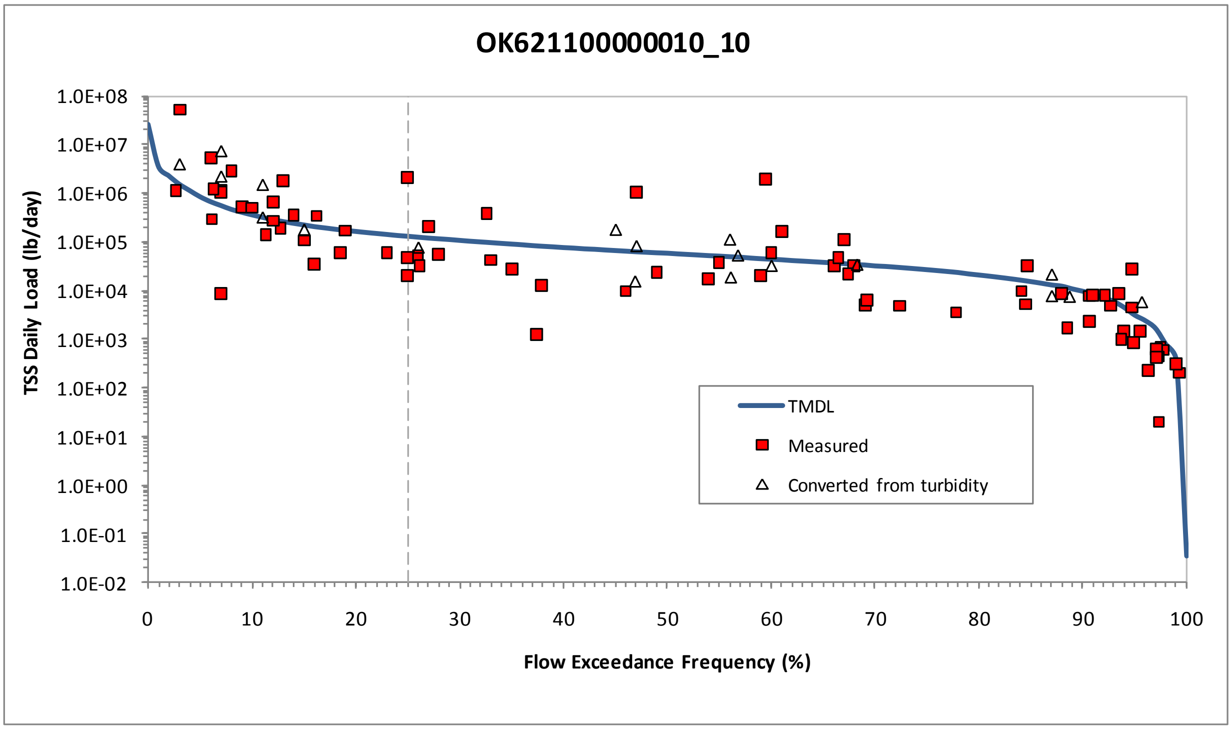


Figure 5-94 Load Duration Curve for Total Suspended Solids in Bitter Creek (OK621100000100_00)

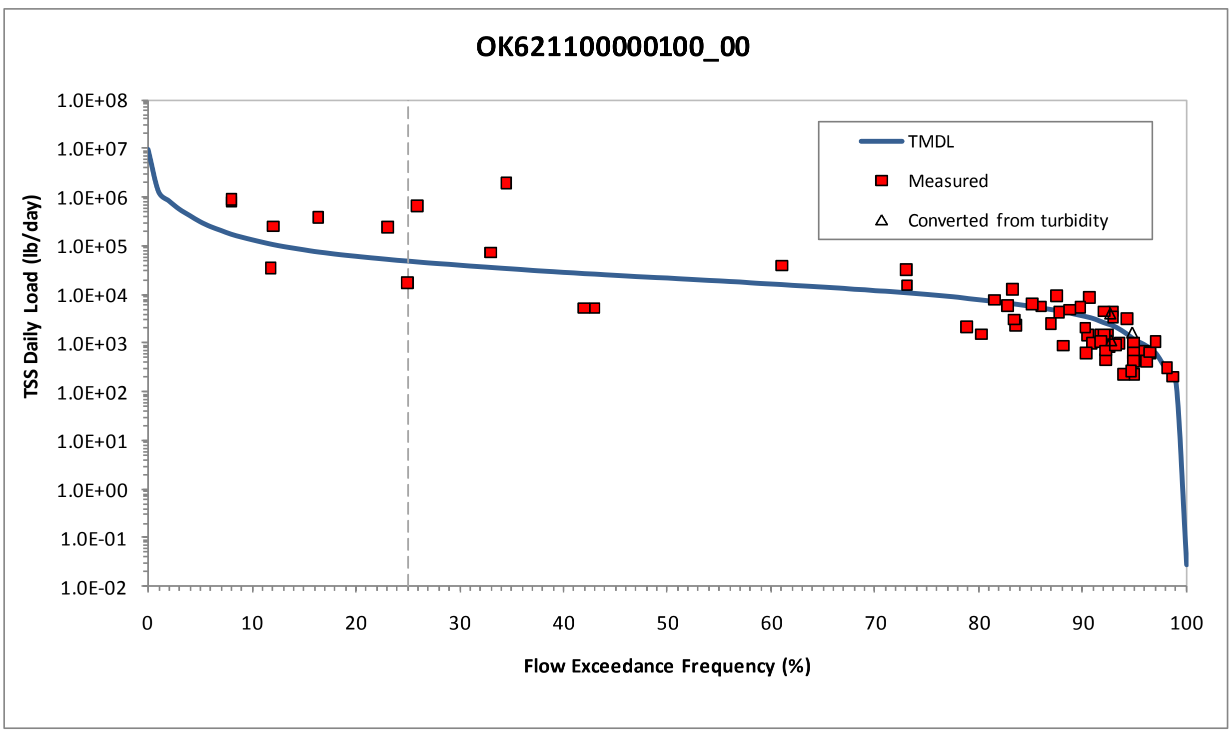


Figure 5-95 Load Duration Curve for Total Suspended Solids in the Arkansas River (OK621200010200_00)

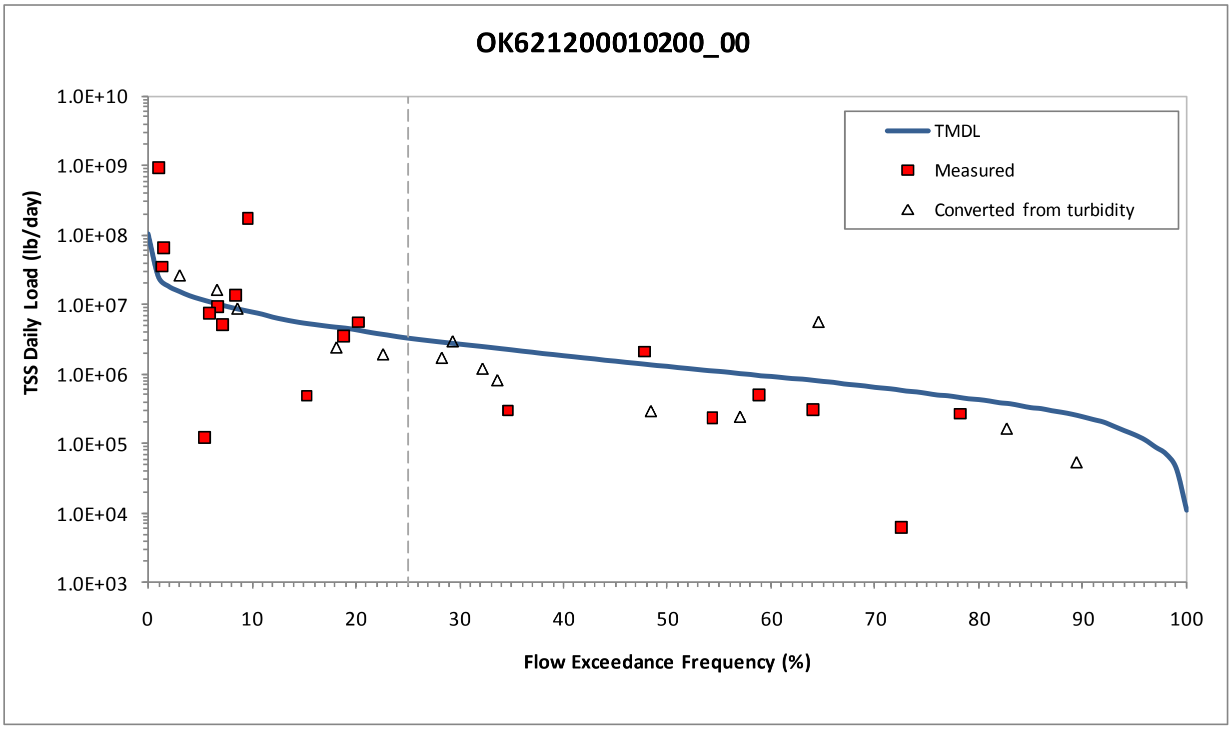


Figure 5-96 Load Duration Curve for Total Suspended Solids in Red Rock Creek, Lower (OK621200050010_00)

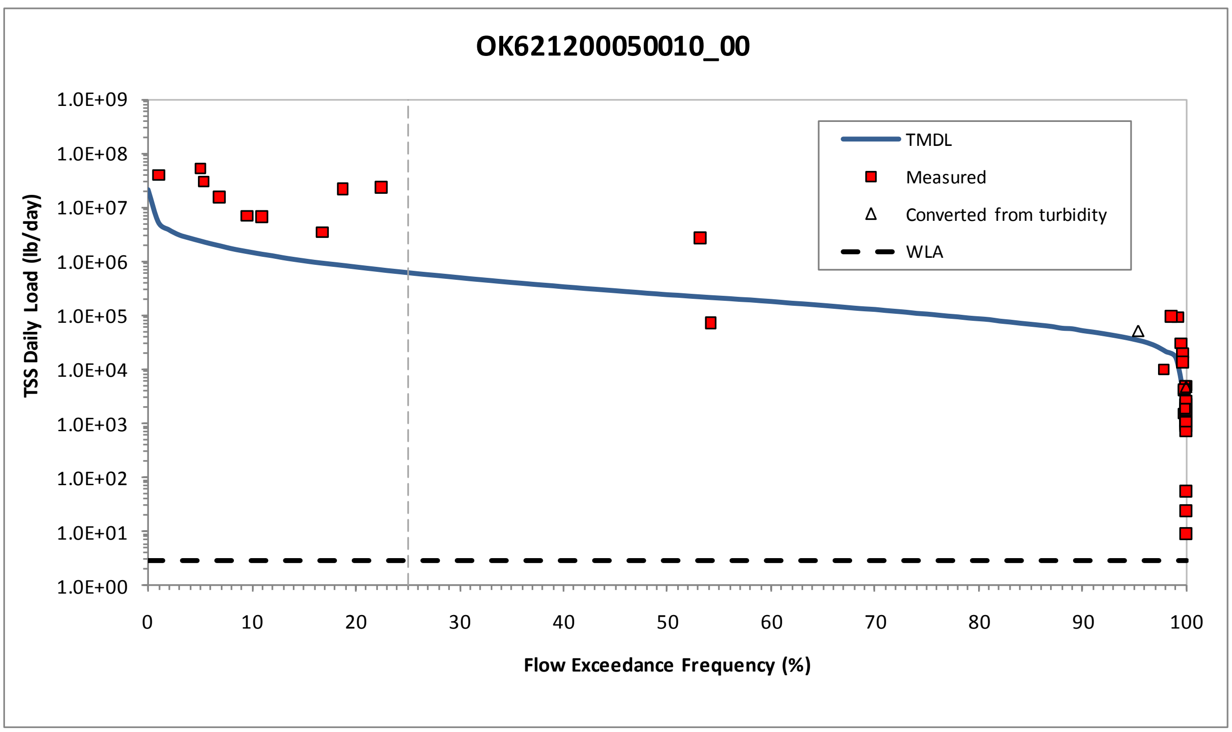


Figure 5-97 Load Duration Curve for Total Suspended Solids in Red Rock Creek, Upper (OK621200050010_10)

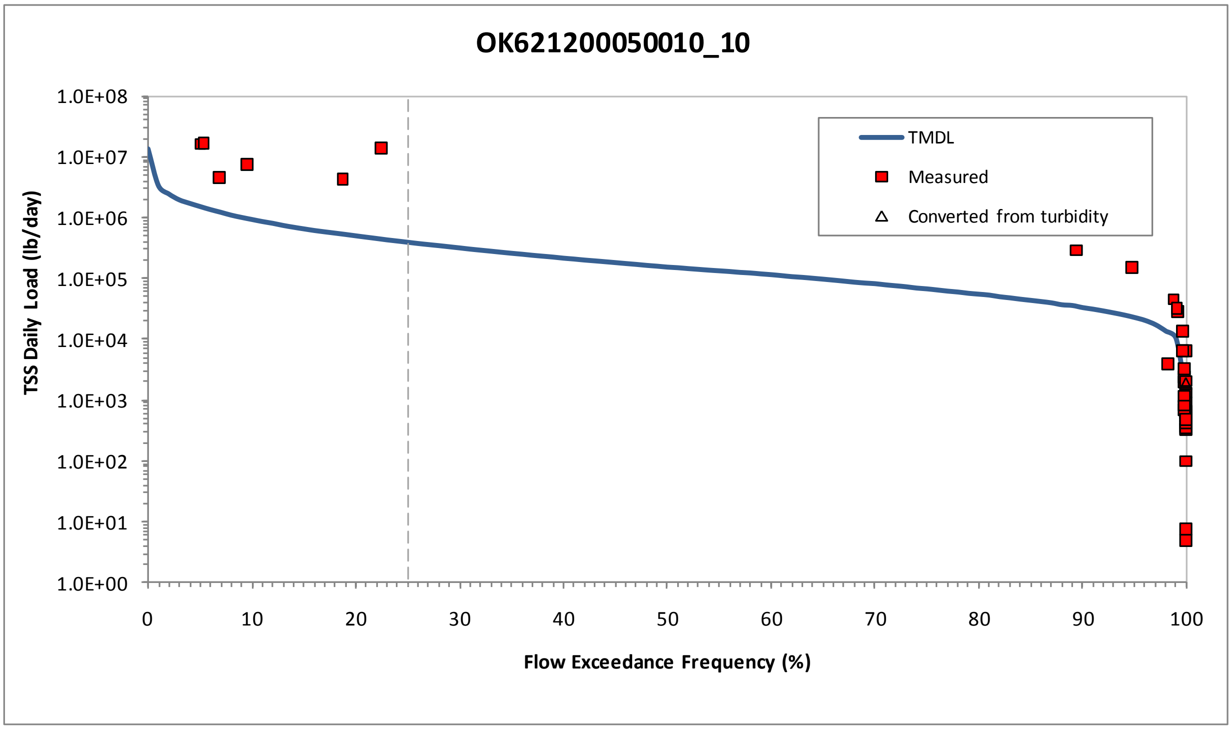
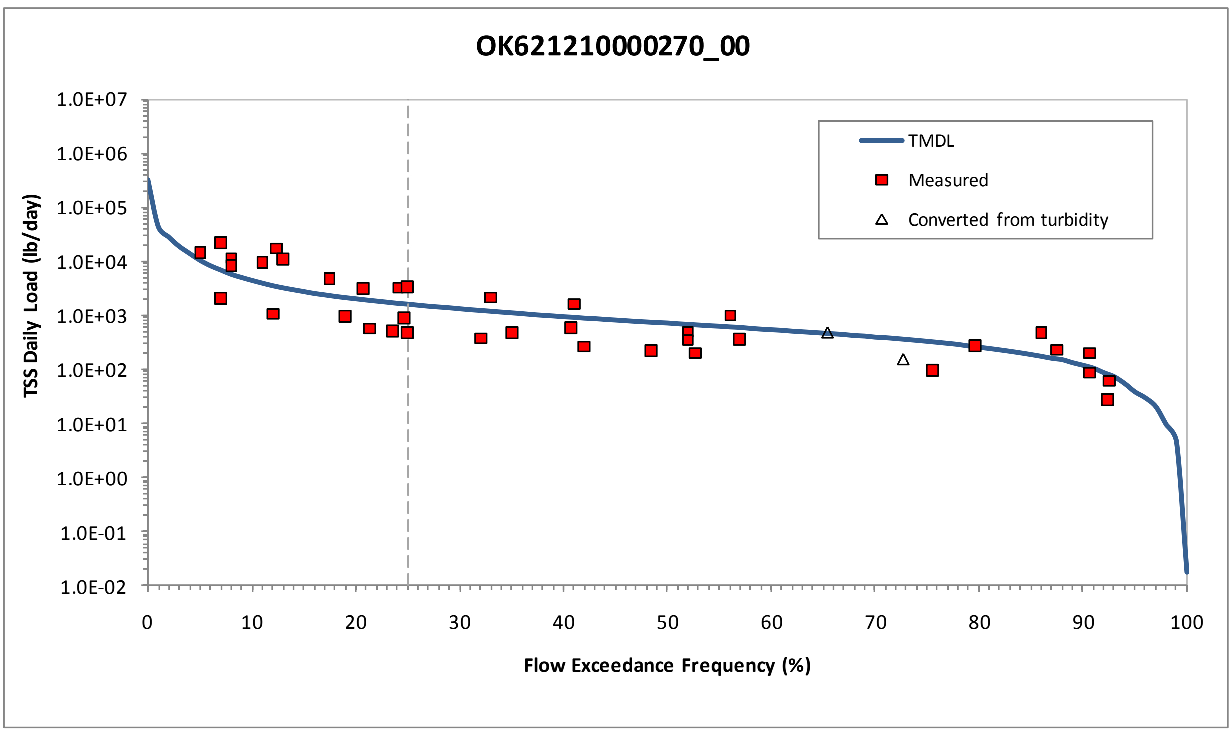


Figure 5-98 Load Duration Curve for Total Suspended Solids in Chilocco Creek (OK621210000270_00)



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 water quality target can also be calculated under different flow conditions. The difference between existing loading and the water quality target 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 between the concentrations of samples and verifying that no more than a fixed percent of the samples exceed the water quality target concentration. PRG are calculated for each watershed and bacterial indicator species as the reductions in load required so no existing instantaneous water quality observations would exceed the water quality targets for *E. coli* and Enterococci and no more than 25 percent of the samples exceed the water quality target for fecal coliform. This is because for the PBCR use to be supported, criteria for each bacterial indicator must be met in each impaired waterbody. 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 0 to 96 percent.

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

Waterbody ID	Waterbody Name	Required Reduction Rate				
		FC	EC		ENT	
		Instant-aneous	Instant-aneous	Geo-mean	Instant-aneous	Geo-mean
OK621000010010_30	Arkansas River, Salt Fork				99.0%	**96.0%**
OK621000020130_00	Spring Creek	**71.0%**				
OK621000030010_00	Bois d' Arc Creek	**88.0%**	82.0%	**40.8%**	99.1%	**84.4%**
OK621000040010_00	Deer Creek		82.0%	**8.3%**	98.1%	**68.7%**
OK621000050010_00	Pond Creek		78.0%	**34.7%**	95.0%	**89.7%**
OK621000060010_00	Crooked Creek				92.0%	**75.7%**
OK621010010010_00	Arkansas River, Salt Fork				91.0%	**0.0%**
OK621010010090_00	Clay Creek				95.0%	**83.6%**
OK621010010160_00	Arkansas River, Salt Fork	**80.0%**	95.0%	**57.4%**	99.5%	**97.6%**
OK621010010230_00	Turkey Creek		82.0%	**65.4%**	98.1%	**95.3%**
OK621010010270_00	Yellowstone Creek				96.0%	**67.3%**
OK621010020010_00	Sandy Creek	**95.2%**	94.0%	**60.6%**	95.0%	**87.3%**
OK621010030010_00	Medicine Lodge River		73.0%	**54.1%**	94.5%	**88.1%**
OK621010030030_00	Driftwood Creek		91.0%	**35.4%**	98.2%	**90.1%**
OK621100000010_00	Chikaskia River, Lower		82.0%	**0.0%**	95.2%	**56.0%**
OK621100000010_10	Chikaskia River, Upper	**64.0%**			99.2%	**83.8%**
OK621100000100_00	Bitter Creek		79.0%	**16.6%**	98.1%	**79.2%**
OK621200010200_00	Arkansas River				95.6%	**84.1%**
OK621200030010_00	Black Bear Creek		93.5%	**51.6%**	99.1%	**87.6%**
OK621200050010_00	Red Rock Creek, Lower		95.0%	**70.9%**	99.1%	**91.2%**
OK621200050010_10	Red Rock Creek, Upper		93.0%	**68.3%**		
OK621210000050_10	Beaver Creek		94.0%	**55.4%**	98.6%	**87.6%**
OK621210000270_00	Chilocco Creek		75.0%	**39.1%**	91.0%	**79.2%**

Similarly, percent reduction goals for TSS are calculated as the required overall reduction so that no more than 10 percent of the samples exceed the water quality target for TSS. The PRGs for the seventeen waterbodies included in this TMDL report are summarized in Table 5-3 and range from 43 to 89 percent.

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

Waterbody ID	Waterbody Name	Required Reduction Rate
OK621000010010_30	Arkansas River, Salt Fork	89%
OK621000030010_00	Bois d' Arc Creek	43%
OK621000040010_00	Deer Creek	60%
OK621000050010_00	Pond Creek	82%
OK621000060010_00	Crooked Creek	51%
OK621010010010_00	Arkansas River, Salt Fork	82%
OK621010010160_00	Arkansas River, Salt Fork	85%
OK621010010230_00	Turkey Creek	52%
OK621010030010_00	Medicine Lodge River	67%
OK621010030030_00	Driftwood Creek	70%
OK621100000010_00	Chikaskia River, Lower	44%
OK621100000010_10	Chikaskia River, Upper	54%
OK621100000100_00	Bitter Creek	50%
OK621200010200_00	Arkansas River	51%
OK621200050010_00	Red Rock Creek, Lower	85%
OK621200050010_10	Red Rock Creek, Upper	77%
OK621210000270_00	Chilocco Creek	44%

5.4 Wasteload Allocation

5.4.1 Indicator Bacteria

For bacteria 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 sub-watersheds in study area. Six stream segments contain permitted discharge facilities and need WLAs. The WLA for each facility discharging to a bacteria-impaired reach is derived from the following equation:

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

Where:

WQS = 33, 200, and 126 cfu/100 mL for Enterococci, fecal coliform, and E. coli respectively

flow (10^6 gal/day) = permitted flow

unit conversion factor = 37,854,120-10^6gal/day

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 WQM station, then the WLA is zero. Compliance with the WLA will be achieved by adhering to the fecal coliform limits and disinfection requirements of NPDES permits. 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 bacteria levels. In the future, all point source dischargers which are assigned a wasteload allocation but do not currently have a bacteria 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 bacteria 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	NPDES Permit No.	Name	Design Flow (mgd)	Dis-infection	FC Limits (cfu/100 ml)	Expiration Date
OK621000010010_30	OK0021903	City of Tonkawa[1,2]	0.5	No	No limits	8/31/15
OK621000030010_00	OK0031968	City of Newkirk[2]	0.378	No	No limits	6/30/09
OK621010010090_00	OKG580043	City of Cherokee[2]	0.4	No	No limits	6/30/11
OK621100000010_10	OK0031909	City of Blackwell	1.6	Yes	200/400	1/31/12
OK621200010200_00	OK0020761	City of Ralston	0.05	Yes	200/400	10/31/13
OK621200030010_00	OK0026654	City of Pawnee	0.3	Yes	200/400	5/31/12
	OK0028517	Town of Glencoe[2]	0.064	No	No limits	5/31/12

1 City of Tonkawa does not discharge between May 1 and October 31.
2 Lagoon System

Table 5-4a shows wasteload allocations for continuously discharging facilities and for each impaired bacteria indicator. The wasteload allocations for City of Tonkawa were not included because the city does not discharge between May 1 and October 31.

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

Waterbody ID	NPDES Permit No.	Name	Design Flow (mgd)	Bacteria Indicator	Wasteload Allocations (cfu/100 ml)
OK621000030010_00	OK0031968	City of Newkirk	0.378	FC	2.86E+09
				EC	1.80E+09
				ENT	4.72E+08
OK621010010090_00	OKG580043	City of Cherokee	0.4	ENT	5.00E+08
OK621100000010_10	OK0031909	City of Blackwell	1.6	FC	1.21E+10
				ENT	2.00E+09
OK621200010200_00	OK0020761	City of Ralston	0.05	ENT	6.25E+07

OK621200030010_00	OK0026654	City of Pawnee	0.3	EC	1.43E+09
				ENT	3.75E+08
	OK0028517	Town of Glencoe	0.064	EC	3.05E+08
				ENT	8.00E+07

Permitted stormwater discharges are considered point sources. Ponca City is the only city with an MS4 permit within the Study Area. The WLA for the Ponca City MS4 permit was calculated as the LA times the fraction of a given watershed covered by such permit.

WLA_{MS4}= (TMDL-MOS-WLA)*% watershed covered by MS4

Where: TMDL = total maximum daily load at a given flow, as calculated using LDCs

MOS = explicit margin of safety (10% for this study)

WLA = waste load allocation for permitted WWTPs as defined previously

The WLA_{MS4} for Ponca City was therefore derived from the percentage of the Bois d' Arc Creek watershed covered by the MS4 permit. For the remaining 22 watersheds the WLA for MS4 is zero.

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. Table 5-5 summarizes the WLA for the NPDES-permitted facilities within the Salt Fork of the Arkansas River Study Area. The WLA for each facility is derived as follows:

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

Where: WQ goal = waterbody-specific water quality goal as summarized in Table 4-1

flow (10^6 gal/day) = average monthly flow

unit conversion factor = 8.3445 L*lb/(10^6 gal * mg)

Table 5-5 Total Suspended Solids Wasteload Allocations for NPDES-Permitted Facilities

Waterbody ID	Instream TSS Criteria (mg/L)	NPDES Permit No.	Name	Average Monthly Flow (mgd)	Wasteload Allocation (lb/day)
OK621000050010_00	42	OK0045306	ONEOK Hydrocarbon, LP - Medford	0.01[a]	3.5
OK621200050010_00	35	OK0035068	OG & E – Sooner Generating	0.01[a]	2.9

[a] Self-reported flow data are not available. Flow was assumed as 0.01 MGD for calculating the WLA.

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 percent of TSS loading is reserved as part of the WLA.

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 ODEQ a BMP-based turbidity reduction plan which should include all practicable turbidity control techniques. The turbidity reduction plan must be approved by ODEQ 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 bacteria 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 percent 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 bacteria 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 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.

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 bacteria TMDLs, an explicit MOS was set at 10 percent.

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 MOS. The selection of MOS is based on the NRMSE for each waterbody. The explicit MOS ranges from 10 percent to 20 percent. Table 5-6 shows the MOS for each waterbody.

Table 5-6 Explicit Margin of Safety for Total Suspended Solids TMDLs

Waterbody ID	Waterbody Name	NRMSE	Margin of Safety
OK621000010010_30	Arkansas River, Salt Fork	12.4%	15%
OK621000030010_00	Bois d' Arc Creek	9.1%	10%
OK621000040010_00	Deer Creek	9.4%	10%
OK621000050010_00	Pond Creek	8.3%	10%
OK621000060010_00	Crooked Creek	8.7%	10%
OK621010010010_00	Arkansas River, Salt Fork	5.4%	10%
OK621010010160_00	Arkansas River, Salt Fork	8.2%	10%
OK621010010230_00	Turkey Creek	17.9%	20%
OK621010030010_00	Medicine Lodge River	9.8%	15%
OK621010030030_00	Driftwood Creek	7.7%	10%
OK621100000010_00	Chikaskia River, Lower	7.9%	10%
OK621100000010_10	Chikaskia River, Upper	14.7%	15%
OK621100000100_00	Bitter Creek	11.6%	15%
OK621200010200_00	Arkansas River	9.7%	10%
OK621200050010_00	Red Rock Creek, Lower	11.1%	15%
OK621200050010_10	Red Rock Creek, Upper	12.3%	15%
OK621210000270_00	Chilocco Creek	14.3%	15%

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 effluent limitations and water quality.

This definition can be expressed by the following equation:

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

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 5^{th} flow interval percentile. Table 5-7 and 5-8 summarize the TMDL, WLA, LA and MOS loadings at the 50% flow percentile. Tables 5-9 through 5-49 summarize the allocations for indicator bacteria and Tables 5-50 to 5-66 present the allocations for TSS.

Table 5-7 Summaries of Bacteria TMDLs

Waterbody ID	Stream Name	Pollutant	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)	TMDL (cfu/day)
OK621000010010_30	Arkansas River, Salt Fork	ENT	6.25E+08	0	6.32E+11	7.03E+10	7.03E+11
OK621000020130_00	Spring Creek	FC	0	0	1.8E+10	2E+09	2.00E+10
OK621000030010_00	Bois d' Arc Creek	FC	2.86E+09	2.28E+09	6.81E+10	8.14E+09	8.14E+10
OK621000030010_00	Bois d' Arc Creek	EC	1.80E+09	2.35E+09	7.02E+10	8.26E+09	8.26E+10
OK621000030010_00	Bois d' Arc Creek	ENT	4.72E+08	6.25E+08	1.87E+10	2.2E+09	2.20E+10
OK621000040010_00	Deer Creek	EC	0	0	2.01E+12	2.23E+11	2.23E+12
OK621000040010_00	Deer Creek	ENT	0	0	5.34E+11	5.93E+10	5.93E+11
OK621000050010_00	Pond Creek	EC	0	0	2.25E+12	2.5E+11	2.50E+12
OK621000050010_00	Pond Creek	ENT	0	0	5.99E+11	6.66E+10	6.66E+11
OK621000060010_00	Crooked Creek	ENT	0	0	1.49E+11	1.66E+10	1.66E+11
OK621010010010_00	Arkansas River, Salt Fork	ENT	0	0	1.55E+12	1.72E+11	1.72E+12
OK621010010090_00	Clay Creek	ENT	5.00E+08	0	1.14E+10	1.32E+09	1.32E+10
OK621010010160_00	Arkansas River, Salt Fork	FC	0	0	2.07E+11	2.3E+10	2.30E+11
OK621010010160_00	Arkansas River, Salt Fork	EC	0	0	5.6E+10	6.22E+09	6.22E+10
OK621010010160_00	Arkansas River, Salt Fork	ENT	0	0	2.1E+11	2.34E+10	2.34E+11
OK621010010230_00	Turkey Creek	EC	0	0	2.32E+11	2.58E+10	2.58E+11
OK621010010230_00	Turkey Creek	ENT	0	0	6.18E+10	6.86E+09	6.86E+10

Waterbody ID	Stream Name	Pollutant	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)	TMDL (cfu/day)
OK621010010270_00	Yellowstone Creek	ENT	0	0	3.41E+10	3.78E+09	3.78E+10
OK621010020010_00	Sandy Creek	FC	0	0	1.62E+11	1.8E+10	1.80E+11
OK621010020010_00	Sandy Creek	EC	0	0	1.64E+11	1.82E+10	1.82E+11
OK621010020010_00	Sandy Creek	ENT	0	0	4.37E+10	4.85E+09	4.85E+10
OK621010030010_00	Medicine Lodge River	EC	0	0	4.72E+11	5.24E+10	5.24E+11
OK621010030010_00	Medicine Lodge River	ENT	0	0	1.25E+11	1.39E+10	1.39E+11
OK621010030030_00	Driftwood Creek	EC	0	0	2.5E+11	2.78E+10	2.78E+11
OK621010030030_00	Driftwood Creek	ENT	0	0	6.66E+10	7.4E+09	7.40E+10
OK621100000010_00	Chikaskia River, Lower	EC	0	0	1.52E+12	1.69E+11	1.69E+12
OK621100000010_00	Chikaskia River, Lower	ENT	0	0	4.04E+11	4.49E+10	4.49E+11
OK621100000010_10	Chikaskia River, Upper	FC	1.21E+10	0	1.44E+12	1.61E+11	1.61E+12
OK621100000010_10	Chikaskia River, Upper	ENT	2.00E+09	0	3.9E+11	4.36E+10	4.36E+11
OK621100000100_00	Bitter Creek	EC	0	0	7.16E+11	7.96E+10	7.96E+11
OK621100000100_00	Bitter Creek	ENT	0	0	1.9E+11	2.12E+10	2.12E+11
OK621200010200_00	Arkansas River	ENT	6.25E+07	0	7.9E+12	8.77E+11	8.77E+12
OK621200030010_00	Black Bear Creek	EC	1.74E+09	0	3.25E+11	3.63E+10	3.63E+11
OK621200030010_00	Black Bear Creek	ENT	4.55E+08	0	8.64E+10	9.65E+09	9.65E+10
OK621200050010_00	Red Rock Creek, Lower	EC	0	0	1.36E+13	1.51E+12	1.51E+13
OK621200050010_00	Red Rock Creek, Lower	ENT	0	0	3.62E+12	4.03E+11	4.03E+12
OK621200050010_10	Red Rock Creek, Upper	EC	0	0	7.71E+12	8.56E+11	8.56E+12
OK621210000050_10	Beaver Creek	EC	0	0	1.44E+11	1.6E+10	1.60E+11
OK621210000050_10	Beaver Creek	ENT	0	0	3.82E+10	4.25E+09	4.25E+10
OK621210000270_00	Chilocco Creek	EC	0	0	3.59E+10	3.99E+09	3.99E+10
OK621210000270_00	Chilocco Creek	ENT	0	0	9.55E+09	1.06E+09	1.06E+10

Table 5-8 Summaries of TSS TMDLs

Waterbody ID	Stream Name	Pollutant	WLA_{WWTP} (lbs/day)	WLA_{growth} (lbs/day)	LA (lbs/day)	MOS (lbs/day)	TMDL (lbs/day)
OK621000010010_30	Arkansas River, Salt Fork	TSS	0	678	56,959	10,171	67,808
OK621000030010_00	Bois d' Arc Creek	TSS	0	23	2,076	233	2,333
OK621000040010_00	Deer Creek	TSS	0	573	51,028	5,733	57,335
OK621000050010_00	Pond Creek	TSS	3	568	50,568	5,682	56,822
OK621000060010_00	Crooked Creek	TSS	0	150	13,312	1,496	14,957
OK621010010010_00	Arkansas River, Salt Fork	TSS	0	1,425	126,844	14,252	142,521
OK621010010160_00	Arkansas River, Salt Fork	TSS	0	105	9,316	1,047	10,468
OK621010010230_00	Turkey Creek	TSS	0	69	5,458	1,382	6,909
OK621010030010_00	Medicine Lodge River	TSS	0	167	14,015	2,503	16,684
OK621010030030_00	Driftwood Creek	TSS	0	79	7,018	789	7,885
OK621100000010_00	Chikaskia River, Lower	TSS	0	522	46,466	5,221	52,209
OK621100000010_10	Chikaskia River, Upper	TSS	0	667	56,042	10,007	66,716
OK621100000100_00	Bitter Creek	TSS	0	263	22,097	3,946	26,306
OK621200010200_00	Arkansas River	TSS	0	14,297	1,272,435	142,970	1,429,702
OK621200050010_00	Red Rock Creek, Lower	TSS	3	2,888	242,548	43,313	288,751
OK621200050010_10	Red Rock Creek, Upper	TSS	0	1,753	147,289	26,302	175,344
OK621210000270_00	Chilocco Creek	TSS	0	8	713	127	849

Table 5-9 Enterococci TMDL Calculations for Arkansas River, Salt Fork (OK621000010010_30)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	61,029	1.61E+14	0	0	1.45E+14	1.61E+13
5	4,223	1.12E+13	0	0	1.01E+13	1.12E+12
10	2,196	5.80E+12	0	0	5.22E+12	5.80E+11
15	1,373	3.63E+12	0	0	3.27E+12	3.63E+11
20	980	2.59E+12	0	0	2.33E+12	2.59E+11
25	755	1.99E+12	0	0	1.79E+12	1.99E+11
30	597	1.58E+12	0	0	1.42E+12	1.58E+11
35	481	1.27E+12	0	0	1.14E+12	1.27E+11
40	394	1.04E+12	0	0	9.36E+11	1.04E+11
45	323	8.54E+11	0	0	7.69E+11	8.54E+10
50	266	7.03E+11	0	0	6.33E+11	7.03E+10
55	216	5.72E+11	0	0	5.15E+11	5.72E+10
60	174	4.60E+11	0	0	4.14E+11	4.60E+10
65	139	3.68E+11	0	0	3.31E+11	3.68E+10
70	108	2.85E+11	0	0	2.57E+11	2.85E+10
75	84	2.23E+11	0	0	2.01E+11	2.23E+10
80	65	1.73E+11	0	0	1.56E+11	1.73E+10
85	50	1.31E+11	0	0	1.18E+11	1.31E+10
90	35	9.21E+10	0	0	8.29E+10	9.21E+09
95	18	4.74E+10	0	0	4.27E+10	4.74E+09
100	0.3	6.95E+08	0	0	6.26E+08	6.95E+07

Table 5-10 Fecal Coliform TMDL Calculations for Spring Creek (OK621000020130_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	468	4.58E+12	0	0	4.12E+12	4.58E+11
5	32	3.17E+11	0	0	2.85E+11	3.17E+10
10	17	1.65E+11	0	0	1.48E+11	1.65E+10
15	11	1.03E+11	0	0	9.26E+10	1.03E+10
20	8	7.35E+10	0	0	6.61E+10	7.35E+09
25	6	5.66E+10	0	0	5.10E+10	5.66E+09
30	5	4.47E+10	0	0	4.03E+10	4.47E+09
35	4	3.61E+10	0	0	3.25E+10	3.61E+09
40	3	2.95E+10	0	0	2.66E+10	2.95E+09
45	2.5	2.42E+10	0	0	2.18E+10	2.42E+09
50	2.0	2.00E+10	0	0	1.80E+10	2.00E+09
55	1.7	1.62E+10	0	0	1.46E+10	1.62E+09
60	1.3	1.31E+10	0	0	1.18E+10	1.31E+09
65	1.1	1.05E+10	0	0	9.41E+09	1.05E+09
70	0.8	8.08E+09	0	0	7.27E+09	8.08E+08
75	0.6	6.33E+09	0	0	5.70E+09	6.33E+08
80	0.5	4.91E+09	0	0	4.42E+09	4.91E+08
85	0.4	3.72E+09	0	0	3.35E+09	3.72E+08
90	0.3	2.61E+09	0	0	2.35E+09	2.61E+08
95	0.1	1.35E+09	0	0	1.21E+09	1.35E+08
100	0	0	0	0	0	0

Table 5-11 *E. coli* TMDL Calculations for Bois d'Arc Creek (OK621000030010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	3,680	3.66E+13	1.80E+09	1.07E+12	3.18E+13	3.66E+12
5	120	1.19E+12	1.80E+09	3.48E+10	1.04E+12	1.19E+11
10	51	5.07E+11	1.80E+09	1.47E+10	4.39E+11	5.07E+10
15	32	3.15E+11	1.80E+09	9.12E+09	2.72E+11	3.15E+10
20	23	2.31E+11	1.80E+09	6.69E+09	2.00E+11	2.31E+10
25	19	1.84E+11	1.80E+09	5.31E+09	1.59E+11	1.84E+10
30	15	1.51E+11	1.80E+09	4.36E+09	1.30E+11	1.51E+10
35	13	1.27E+11	1.80E+09	3.65E+09	1.09E+11	1.27E+10
40	11	1.08E+11	1.80E+09	3.09E+09	9.22E+10	1.08E+10
45	9	9.36E+10	1.80E+09	2.67E+09	7.98E+10	9.36E+09
50	8	8.26E+10	1.80E+09	2.35E+09	7.02E+10	8.26E+09
55	7	7.21E+10	1.80E+09	2.04E+09	6.10E+10	7.21E+09
60	6	6.21E+10	1.80E+09	1.75E+09	5.23E+10	6.21E+09
65	5	5.37E+10	1.80E+09	1.51E+09	4.50E+10	5.37E+09
70	5	4.52E+10	1.80E+09	1.26E+09	3.76E+10	4.52E+09
75	4	3.79E+10	1.80E+09	1.05E+09	3.12E+10	3.79E+09
80	3	2.95E+10	1.80E+09	8.01E+08	2.39E+10	2.95E+09
85	2	2.16E+10	1.80E+09	5.71E+08	1.70E+10	2.16E+09
90	1	1.37E+10	1.80E+09	3.41E+08	1.02E+10	1.37E+09
95	0.4	4.42E+09	1.80E+09	7.05E+07	2.10E+09	4.42E+08
100	0.3	3.28E+09	1.80E+09	3.72E+07	1.11E+09	3.28E+08

Table 5-12 Enterococci TMDL Calculations for Bois d'Arc Creek (OK621000030010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	3,680	9.72E+12	4.72E+08	2.84E+11	8.47E+12	9.72E+11
5	120	3.18E+11	4.72E+08	9.25E+09	2.76E+11	3.18E+10
10	51	1.35E+11	4.72E+08	3.92E+09	1.17E+11	1.35E+10
15	32	8.37E+10	4.72E+08	2.43E+09	7.24E+10	8.37E+09
20	23	6.16E+10	4.72E+08	1.78E+09	5.32E+10	6.16E+09
25	19	4.90E+10	4.72E+08	1.41E+09	4.22E+10	4.90E+09
30	15	4.03E+10	4.72E+08	1.16E+09	3.46E+10	4.03E+09
35	13	3.39E+10	4.72E+08	9.72E+08	2.90E+10	3.39E+09
40	11	2.87E+10	4.72E+08	8.21E+08	2.45E+10	2.87E+09
45	9	2.49E+10	4.72E+08	7.11E+08	2.12E+10	2.49E+09
50	8	2.20E+10	4.72E+08	6.25E+08	1.87E+10	2.20E+09
55	7	1.92E+10	4.72E+08	5.44E+08	1.62E+10	1.92E+09
60	6	1.65E+10	4.72E+08	4.66E+08	1.39E+10	1.65E+09
65	5	1.43E+10	4.72E+08	4.01E+08	1.20E+10	1.43E+09
70	5	1.20E+10	4.72E+08	3.36E+08	1.00E+10	1.20E+09
75	4	1.01E+10	4.72E+08	2.79E+08	8.32E+09	1.01E+09
80	3	7.84E+09	4.72E+08	2.13E+08	6.37E+09	7.84E+08
85	2	5.74E+09	4.72E+08	1.52E+08	4.54E+09	5.74E+08
90	1	3.64E+09	4.72E+08	9.08E+07	2.71E+09	3.64E+08
95	0.4	1.18E+09	4.72E+08	1.90E+07	5.67E+08	1.18E+08
100	0.3	8.72E+08	4.72E+08	1.01E+07	3.02E+08	8.72E+07

Table 5-13 Fecal Coliform TMDL Calculations for Bois d'Arc Creek (OK621000030010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	3,680	3.60E+13	2.86E+09	1.05E+12	3.14E+13	3.60E+12
5	120	1.18E+12	2.86E+09	3.42E+10	1.02E+12	1.18E+11
10	51	4.99E+11	2.86E+09	1.45E+10	4.32E+11	4.99E+10
15	32	3.10E+11	2.86E+09	8.95E+09	2.67E+11	3.10E+10
20	23	2.28E+11	2.86E+09	6.56E+09	1.96E+11	2.28E+10
25	19	1.81E+11	2.86E+09	5.20E+09	1.55E+11	1.81E+10
30	15	1.49E+11	2.86E+09	4.26E+09	1.27E+11	1.49E+10
35	13	1.25E+11	2.86E+09	3.57E+09	1.06E+11	1.25E+10
40	11	1.06E+11	2.86E+09	3.01E+09	8.97E+10	1.06E+10
45	9	9.22E+10	2.86E+09	2.60E+09	7.76E+10	9.22E+09
50	8	8.14E+10	2.86E+09	2.28E+09	6.81E+10	8.14E+09
55	7	7.10E+10	2.86E+09	1.98E+09	5.91E+10	7.10E+09
60	6	6.11E+10	2.86E+09	1.69E+09	5.05E+10	6.11E+09
65	5	5.29E+10	2.86E+09	1.45E+09	4.33E+10	5.29E+09
70	5	4.46E+10	2.86E+09	1.21E+09	3.60E+10	4.46E+09
75	4	3.73E+10	2.86E+09	9.96E+08	2.97E+10	3.73E+09
80	3	2.90E+10	2.86E+09	7.54E+08	2.25E+10	2.90E+09
85	2	2.12E+10	2.86E+09	5.27E+08	1.57E+10	2.12E+09
90	1	1.35E+10	2.86E+09	3.00E+08	8.96E+09	1.35E+09
95	0.4	4.35E+09	2.86E+09	3.42E+07	1.02E+09	4.35E+08
100	0.3	3.23E+09	2.86E+09	1.46E+06	4.36E+07	3.23E+08

Table 5-14 *E. coli* TMDL Calculations for Deer Creek (OK621000040010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	51,507	5.12E+14	0	0	4.60E+14	5.12E+13
5	3,565	3.54E+13	0	0	3.19E+13	3.54E+12
10	1,854	1.84E+13	0	0	1.66E+13	1.84E+12
15	1,158	1.15E+13	0	0	1.04E+13	1.15E+12
20	827	8.21E+12	0	0	7.39E+12	8.21E+11
25	637	6.33E+12	0	0	5.70E+12	6.33E+11
30	503	5.00E+12	0	0	4.50E+12	5.00E+11
35	406	4.04E+12	0	0	3.63E+12	4.04E+11
40	332	3.30E+12	0	0	2.97E+12	3.30E+11
45	273	2.71E+12	0	0	2.44E+12	2.71E+11
50	225	2.23E+12	0	0	2.01E+12	2.23E+11
55	183	1.81E+12	0	0	1.63E+12	1.81E+11
60	147	1.46E+12	0	0	1.31E+12	1.46E+11
65	118	1.17E+12	0	0	1.05E+12	1.17E+11
70	91	9.03E+11	0	0	8.13E+11	9.03E+10
75	71	7.08E+11	0	0	6.37E+11	7.08E+10
80	55	5.49E+11	0	0	4.94E+11	5.49E+10
85	42	4.16E+11	0	0	3.74E+11	4.16E+10
90	29	2.92E+11	0	0	2.63E+11	2.92E+10
95	15	1.50E+11	0	0	1.35E+11	1.50E+10
100	0	0	0	0	0	0

Table 5-15 Enterococci TMDL Calculations for Deer Creek (OK621000040010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	51,507	1.36E+14	0	0	1.22E+14	1.36E+13
5	3,565	9.42E+12	0	0	8.48E+12	9.42E+11
10	1,854	4.90E+12	0	0	4.41E+12	4.90E+11
15	1,158	3.06E+12	0	0	2.75E+12	3.06E+11
20	827	2.19E+12	0	0	1.97E+12	2.19E+11
25	637	1.68E+12	0	0	1.52E+12	1.68E+11
30	503	1.33E+12	0	0	1.20E+12	1.33E+11
35	406	1.07E+12	0	0	9.66E+11	1.07E+11
40	332	8.78E+11	0	0	7.90E+11	8.78E+10
45	273	7.21E+11	0	0	6.48E+11	7.21E+10
50	225	5.93E+11	0	0	5.34E+11	5.93E+10
55	183	4.83E+11	0	0	4.34E+11	4.83E+10
60	147	3.89E+11	0	0	3.50E+11	3.89E+10
65	118	3.11E+11	0	0	2.80E+11	3.11E+10
70	91	2.40E+11	0	0	2.16E+11	2.40E+10
75	71	1.88E+11	0	0	1.70E+11	1.88E+10
80	55	1.46E+11	0	0	1.31E+11	1.46E+10
85	42	1.11E+11	0	0	9.96E+10	1.11E+10
90	29	7.77E+10	0	0	6.99E+10	7.77E+09
95	15	4.00E+10	0	0	3.60E+10	4.00E+09
100	0	0	0	0	0	0

Table 5-16 E. coli TMDL Calculations for Pond Creek (OK621000050010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	57,800	5.74E+14	0	0	5.17E+14	5.74E+13
5	4,000	3.97E+13	0	0	3.58E+13	3.97E+12
10	2,080	2.07E+13	0	0	1.86E+13	2.07E+12
15	1,300	1.29E+13	0	0	1.16E+13	1.29E+12
20	928	9.22E+12	0	0	8.30E+12	9.22E+11
25	715	7.10E+12	0	0	6.39E+12	7.10E+11
30	565	5.61E+12	0	0	5.05E+12	5.61E+11
35	456	4.53E+12	0	0	4.08E+12	4.53E+11
40	373	3.71E+12	0	0	3.33E+12	3.71E+11
45	306	3.04E+12	0	0	2.74E+12	3.04E+11
50	252	2.50E+12	0	0	2.25E+12	2.50E+11
55	205	2.04E+12	0	0	1.83E+12	2.04E+11
60	165	1.64E+12	0	0	1.48E+12	1.64E+11
65	132	1.31E+12	0	0	1.18E+12	1.31E+11
70	102	1.01E+12	0	0	9.12E+11	1.01E+11
75	80	7.95E+11	0	0	7.15E+11	7.95E+10
80	62	6.16E+11	0	0	5.54E+11	6.16E+10
85	47	4.67E+11	0	0	4.20E+11	4.67E+10
90	33	3.28E+11	0	0	2.95E+11	3.28E+10
95	17	1.69E+11	0	0	1.52E+11	1.69E+10
100	0.02	1.99E+08	0	0	1.79E+08	1.99E+07

Table 5-17 Enterococci TMDL Calculations for Pond Creek (OK621000050010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	57,800	1.53E+14	0	0	1.37E+14	1.53E+13
5	4,000	1.06E+13	0	0	9.51E+12	1.06E+12
10	2,080	5.50E+12	0	0	4.95E+12	5.50E+11
15	1,300	3.43E+12	0	0	3.09E+12	3.43E+11
20	928	2.45E+12	0	0	2.21E+12	2.45E+11
25	715	1.89E+12	0	0	1.70E+12	1.89E+11
30	565	1.49E+12	0	0	1.34E+12	1.49E+11
35	456	1.20E+12	0	0	1.08E+12	1.20E+11
40	373	9.86E+11	0	0	8.87E+11	9.86E+10
45	306	8.09E+11	0	0	7.28E+11	8.09E+10
50	252	6.66E+11	0	0	5.99E+11	6.66E+10
55	205	5.42E+11	0	0	4.88E+11	5.42E+10
60	165	4.36E+11	0	0	3.92E+11	4.36E+10
65	132	3.49E+11	0	0	3.14E+11	3.49E+10
70	102	2.70E+11	0	0	2.43E+11	2.70E+10
75	80	2.11E+11	0	0	1.90E+11	2.11E+10
80	62	1.64E+11	0	0	1.47E+11	1.64E+10
85	47	1.24E+11	0	0	1.12E+11	1.24E+10
90	33	8.72E+10	0	0	7.85E+10	8.72E+09
95	17	4.49E+10	0	0	4.04E+10	4.49E+09
100	0.02	5.28E+07	0	0	4.76E+07	5.28E+06

Table 5-18 Enterococci TMDL Calculations for Crooked Creek (OK621000060010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	14,389	3.80E+13	0	0	3.42E+13	3.80E+12
5	996	2.63E+12	0	0	2.37E+12	2.63E+11
10	518	1.37E+12	0	0	1.23E+12	1.37E+11
15	324	8.55E+11	0	0	7.70E+11	8.55E+10
20	231	6.10E+11	0	0	5.49E+11	6.10E+10
25	178	4.70E+11	0	0	4.23E+11	4.70E+10
30	141	3.72E+11	0	0	3.34E+11	3.72E+10
35	114	3.00E+11	0	0	2.70E+11	3.00E+10
40	93	2.45E+11	0	0	2.21E+11	2.45E+10
45	76	2.01E+11	0	0	1.81E+11	2.01E+10
50	63	1.66E+11	0	0	1.49E+11	1.66E+10
55	51	1.35E+11	0	0	1.21E+11	1.35E+10
60	41	1.09E+11	0	0	9.77E+10	1.09E+10
65	33	8.68E+10	0	0	7.81E+10	8.68E+09
70	25	6.71E+10	0	0	6.04E+10	6.71E+09
75	20	5.26E+10	0	0	4.74E+10	5.26E+09
80	15	4.08E+10	0	0	3.67E+10	4.08E+09
85	12	3.09E+10	0	0	2.78E+10	3.09E+09
90	8	2.17E+10	0	0	1.95E+10	2.17E+09
95	4	1.12E+10	0	0	1.01E+10	1.12E+09
100	0	0	0	0	0	0

Table 5-19 Enterococci TMDL Calculations for Arkansas River, Salt Fork (OK621010010010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	96,887	2.56E+14	0	0	2.30E+14	2.56E+13
5	5,591	1.48E+13	0	0	1.33E+13	1.48E+12
10	3,121	8.25E+12	0	0	7.42E+12	8.25E+11
15	2,263	5.98E+12	0	0	5.38E+12	5.98E+11
20	1,849	4.89E+12	0	0	4.40E+12	4.89E+11
25	1,568	4.14E+12	0	0	3.73E+12	4.14E+11
30	1,346	3.56E+12	0	0	3.20E+12	3.56E+11
35	1,169	3.09E+12	0	0	2.78E+12	3.09E+11
40	976	2.58E+12	0	0	2.32E+12	2.58E+11
45	799	2.11E+12	0	0	1.90E+12	2.11E+11
50	651	1.72E+12	0	0	1.55E+12	1.72E+11
55	533	1.41E+12	0	0	1.27E+12	1.41E+11
60	444	1.17E+12	0	0	1.06E+12	1.17E+11
65	355	9.38E+11	0	0	8.44E+11	9.38E+10
70	296	7.82E+11	0	0	7.04E+11	7.82E+10
75	192	5.08E+11	0	0	4.57E+11	5.08E+10
80	71	1.88E+11	0	0	1.69E+11	1.88E+10
85	28	7.43E+10	0	0	6.68E+10	7.43E+09
90	12	3.17E+10	0	0	2.85E+10	3.17E+09
95	4	9.77E+09	0	0	8.79E+09	9.77E+08
100	0	0	0	0	0	0

Table 5-20 Enterococci TMDL Calculations for Clay Creek (OK621010010090_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	742	1.96E+12	5.00E+08	0	1.76E+12	1.96E+11
5	43	1.13E+11	5.00E+08	0	1.01E+11	1.13E+10
10	24	6.32E+10	5.00E+08	0	5.64E+10	6.32E+09
15	17	4.58E+10	5.00E+08	0	4.07E+10	4.58E+09
20	14	3.74E+10	5.00E+08	0	3.32E+10	3.74E+09
25	12	3.17E+10	5.00E+08	0	2.81E+10	3.17E+09
30	10	2.72E+10	5.00E+08	0	2.40E+10	2.72E+09
35	9	2.37E+10	5.00E+08	0	2.08E+10	2.37E+09
40	7	1.98E+10	5.00E+08	0	1.73E+10	1.98E+09
45	6	1.62E+10	5.00E+08	0	1.41E+10	1.62E+09
50	5	1.32E+10	5.00E+08	0	1.14E+10	1.32E+09
55	4	1.08E+10	5.00E+08	0	9.20E+09	1.08E+09
60	3	8.98E+09	5.00E+08	0	7.58E+09	8.98E+08
65	3	7.19E+09	5.00E+08	0	5.97E+09	7.19E+08
70	2	5.99E+09	5.00E+08	0	4.89E+09	5.99E+08
75	1	3.89E+09	5.00E+08	0	3.00E+09	3.89E+08
80	1	1.44E+09	5.00E+08	0	7.94E+08	1.44E+08
85	0.2	5.69E+08	5.00E+08	0	1.23E+07	5.69E+07
90	0.2	5.69E+08	5.00E+08	0	1.23E+07	5.69E+07
95	0.2	5.69E+08	5.00E+08	0	1.23E+07	5.69E+07
100	0.2	5.69E+08	5.00E+08	0	1.23E+07	5.69E+07

Table 5-21 *E. coli* TMDL Calculations for Arkansas River, Salt Fork (OK621010010160_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	3,529	3.51E+13	0	0	3.16E+13	3.51E+12
5	301	2.99E+12	0	0	2.69E+12	2.99E+11
10	166	1.64E+12	0	0	1.48E+12	1.64E+11
15	110	1.09E+12	0	0	9.85E+11	1.09E+11
20	82	8.11E+11	0	0	7.30E+11	8.11E+10
25	65	6.41E+11	0	0	5.77E+11	6.41E+10
30	53	5.24E+11	0	0	4.72E+11	5.24E+10
35	43	4.32E+11	0	0	3.89E+11	4.32E+10
40	36	3.56E+11	0	0	3.20E+11	3.56E+10
45	29	2.90E+11	0	0	2.61E+11	2.90E+10
50	24	2.34E+11	0	0	2.10E+11	2.34E+10
55	19	1.86E+11	0	0	1.67E+11	1.86E+10
60	14	1.42E+11	0	0	1.27E+11	1.42E+10
65	10	9.56E+10	0	0	8.60E+10	9.56E+09
70	6	6.20E+10	0	0	5.58E+10	6.20E+09
75	4	3.54E+10	0	0	3.19E+10	3.54E+09
80	2.5	2.48E+10	0	0	2.23E+10	2.48E+09
85	1.6	1.59E+10	0	0	1.43E+10	1.59E+09
90	0.9	8.85E+09	0	0	7.97E+09	8.85E+08
95	0.4	3.54E+09	0	0	3.19E+09	3.54E+08
100	0	0	0	0	0	0

Table 5-22 Enterococci TMDL Calculations for Arkansas River, Salt Fork (OK621010010160_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	3,529	9.33E+12	0	0	8.39E+12	9.33E+11
5	301	7.96E+11	0	0	7.16E+11	7.96E+10
10	166	4.38E+11	0	0	3.94E+11	4.38E+10
15	110	2.91E+11	0	0	2.62E+11	2.91E+10
20	82	2.16E+11	0	0	1.94E+11	2.16E+10
25	65	1.70E+11	0	0	1.53E+11	1.70E+10
30	53	1.39E+11	0	0	1.25E+11	1.39E+10
35	43	1.15E+11	0	0	1.03E+11	1.15E+10
40	36	9.47E+10	0	0	8.52E+10	9.47E+09
45	29	7.72E+10	0	0	6.95E+10	7.72E+09
50	24	6.22E+10	0	0	5.60E+10	6.22E+09
55	19	4.95E+10	0	0	4.45E+10	4.95E+09
60	14	3.77E+10	0	0	3.39E+10	3.77E+09
65	10	2.54E+10	0	0	2.29E+10	2.54E+09
70	6	1.65E+10	0	0	1.48E+10	1.65E+09
75	4	9.42E+09	0	0	8.48E+09	9.42E+08
80	2.5	6.59E+09	0	0	5.93E+09	6.59E+08
85	1.6	4.24E+09	0	0	3.81E+09	4.24E+08
90	0.9	2.35E+09	0	0	2.12E+09	2.35E+08
95	0.4	9.42E+08	0	0	8.48E+08	9.42E+07
100	0	0	0	0	0	0

Table 5-23 Fecal Coliform TMDL Calculations for Arkansas River, Salt Fork (OK621010010160_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	3,529	3.45E+13	0	0	3.11E+13	3.45E+12
5	301	2.95E+12	0	0	2.65E+12	2.95E+11
10	166	1.62E+12	0	0	1.46E+12	1.62E+11
15	110	1.08E+12	0	0	9.70E+11	1.08E+11
20	82	7.99E+11	0	0	7.19E+11	7.99E+10
25	65	6.31E+11	0	0	5.68E+11	6.31E+10
30	53	5.16E+11	0	0	4.65E+11	5.16E+10
35	43	4.26E+11	0	0	3.83E+11	4.26E+10
40	36	3.51E+11	0	0	3.16E+11	3.51E+10
45	29	2.86E+11	0	0	2.57E+11	2.86E+10
50	24	2.30E+11	0	0	2.07E+11	2.30E+10
55	19	1.83E+11	0	0	1.65E+11	1.83E+10
60	14	1.40E+11	0	0	1.26E+11	1.40E+10
65	10	9.42E+10	0	0	8.48E+10	9.42E+09
70	6	6.11E+10	0	0	5.49E+10	6.11E+09
75	4	3.49E+10	0	0	3.14E+10	3.49E+09
80	2.5	2.44E+10	0	0	2.20E+10	2.44E+09
85	1.6	1.57E+10	0	0	1.41E+10	1.57E+09
90	0.9	8.72E+09	0	0	7.85E+09	8.72E+08
95	0.4	3.49E+09	0	0	3.14E+09	3.49E+08
100	0	0	0	0	0	0

Table 5-24 *E. coli* TMDL Calculations for Turkey Creek (OK621010010230_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	9,010	8.95E+13	0	0	8.05E+13	8.95E+12
5	240	2.38E+12	0	0	2.14E+12	2.38E+11
10	140	1.39E+12	0	0	1.25E+12	1.39E+11
15	100	9.90E+11	0	0	8.91E+11	9.90E+10
20	76	7.58E+11	0	0	6.82E+11	7.58E+10
25	61	6.05E+11	0	0	5.45E+11	6.05E+10
30	51	5.05E+11	0	0	4.55E+11	5.05E+10
35	43	4.32E+11	0	0	3.89E+11	4.32E+10
40	37	3.69E+11	0	0	3.32E+11	3.69E+10
45	31	3.05E+11	0	0	2.75E+11	3.05E+10
50	26	2.58E+11	0	0	2.32E+11	2.58E+10
55	22	2.21E+11	0	0	1.99E+11	2.21E+10
60	19	1.90E+11	0	0	1.71E+11	1.90E+10
65	16	1.63E+11	0	0	1.47E+11	1.63E+10
70	13	1.32E+11	0	0	1.18E+11	1.32E+10
75	10	1.00E+11	0	0	9.00E+10	1.00E+10
80	6	6.32E+10	0	0	5.69E+10	6.32E+09
85	3	3.16E+10	0	0	2.84E+10	3.16E+09
90	1	1.26E+10	0	0	1.14E+10	1.26E+09
95	0.4	4.16E+09	0	0	3.74E+09	4.16E+08
100	0	0	0	0	0	0

Table 5-25 Enterococci TMDL Calculations for Turkey Creek (OK621010010230_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	9,010	2.38E+13	0	0	2.14E+13	2.38E+12
5	240	6.33E+11	0	0	5.70E+11	6.33E+10
10	140	3.70E+11	0	0	3.33E+11	3.70E+10
15	100	2.63E+11	0	0	2.37E+11	2.63E+10
20	76	2.02E+11	0	0	1.81E+11	2.02E+10
25	61	1.61E+11	0	0	1.45E+11	1.61E+10
30	51	1.34E+11	0	0	1.21E+11	1.34E+10
35	43	1.15E+11	0	0	1.03E+11	1.15E+10
40	37	9.80E+10	0	0	8.82E+10	9.80E+09
45	31	8.12E+10	0	0	7.31E+10	8.12E+09
50	26	6.86E+10	0	0	6.18E+10	6.86E+09
55	22	5.88E+10	0	0	5.29E+10	5.88E+09
60	19	5.04E+10	0	0	4.54E+10	5.04E+09
65	16	4.34E+10	0	0	3.91E+10	4.34E+09
70	13	3.50E+10	0	0	3.15E+10	3.50E+09
75	10	2.66E+10	0	0	2.39E+10	2.66E+09
80	6	1.68E+10	0	0	1.51E+10	1.68E+09
85	3	8.40E+09	0	0	7.56E+09	8.40E+08
90	1	3.36E+09	0	0	3.02E+09	3.36E+08
95	0.4	1.11E+09	0	0	9.96E+08	1.11E+08
100	0	0	0	0	0	0

Table 5-26 Enterococci TMDL Calculations for Yellowstone Creek (OK621010010270_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	5,096	1.35E+13	0	0	1.21E+13	1.35E+12
5	124	3.27E+11	0	0	2.94E+11	3.27E+10
10	68	1.79E+11	0	0	1.61E+11	1.79E+10
15	48	1.28E+11	0	0	1.15E+11	1.28E+10
20	39	1.02E+11	0	0	9.21E+10	1.02E+10
25	32	8.35E+10	0	0	7.51E+10	8.35E+09
30	27	7.01E+10	0	0	6.31E+10	7.01E+09
35	23	6.01E+10	0	0	5.41E+10	6.01E+09
40	19	5.01E+10	0	0	4.51E+10	5.01E+09
45	16	4.34E+10	0	0	3.91E+10	4.34E+09
50	14	3.78E+10	0	0	3.41E+10	3.78E+09
55	12	3.12E+10	0	0	2.80E+10	3.12E+09
60	10	2.56E+10	0	0	2.30E+10	2.56E+09
65	8	2.11E+10	0	0	1.90E+10	2.11E+09
70	5	1.45E+10	0	0	1.30E+10	1.45E+09
75	3	8.24E+09	0	0	7.41E+09	8.24E+08
80	1	3.23E+09	0	0	2.90E+09	3.23E+08
85	0.4	1.00E+09	0	0	9.01E+08	1.00E+08
90	0.1	3.89E+08	0	0	3.51E+08	3.89E+07
95	0.04	1.00E+08	0	0	9.01E+07	1.00E+07
100	0	0	0	0	0	0

Table 5-27 *E. coli* TMDL Calculations for Sandy Creek (OK621010020010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	2,735	2.72E+13	0	0	2.44E+13	2.72E+12
5	158	1.57E+12	0	0	1.41E+12	1.57E+11
10	88	8.75E+11	0	0	7.88E+11	8.75E+10
15	64	6.35E+11	0	0	5.71E+11	6.35E+10
20	52	5.18E+11	0	0	4.67E+11	5.18E+10
25	44	4.40E+11	0	0	3.96E+11	4.40E+10
30	38	3.77E+11	0	0	3.40E+11	3.77E+10
35	33	3.28E+11	0	0	2.95E+11	3.28E+10
40	28	2.74E+11	0	0	2.46E+11	2.74E+10
45	23	2.24E+11	0	0	2.02E+11	2.24E+10
50	18	1.82E+11	0	0	1.64E+11	1.82E+10
55	15	1.49E+11	0	0	1.34E+11	1.49E+10
60	13	1.24E+11	0	0	1.12E+11	1.24E+10
65	10	9.95E+10	0	0	8.96E+10	9.95E+09
70	8	8.29E+10	0	0	7.47E+10	8.29E+09
75	5	5.39E+10	0	0	4.85E+10	5.39E+09
80	2	1.99E+10	0	0	1.79E+10	1.99E+09
85	1	7.88E+09	0	0	7.09E+09	7.88E+08
90	0.3	3.36E+09	0	0	3.02E+09	3.36E+08
95	0.1	1.04E+09	0	0	9.33E+08	1.04E+08
100	0	0	0	0	0	0

Table 5-28 Enterococci TMDL Calculations for Sandy Creek (OK621010020010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	2,735	7.23E+12	0	0	6.50E+12	7.23E+11
5	158	4.17E+11	0	0	3.75E+11	4.17E+10
10	88	2.33E+11	0	0	2.10E+11	2.33E+10
15	64	1.69E+11	0	0	1.52E+11	1.69E+10
20	52	1.38E+11	0	0	1.24E+11	1.38E+10
25	44	1.17E+11	0	0	1.05E+11	1.17E+10
30	38	1.00E+11	0	0	9.04E+10	1.00E+10
35	33	8.72E+10	0	0	7.84E+10	8.72E+09
40	28	7.28E+10	0	0	6.55E+10	7.28E+09
45	23	5.96E+10	0	0	5.36E+10	5.96E+09
50	18	4.85E+10	0	0	4.37E+10	4.85E+09
55	15	3.97E+10	0	0	3.57E+10	3.97E+09
60	13	3.31E+10	0	0	2.98E+10	3.31E+09
65	10	2.65E+10	0	0	2.38E+10	2.65E+09
70	8	2.21E+10	0	0	1.99E+10	2.21E+09
75	5	1.43E+10	0	0	1.29E+10	1.43E+09
80	2	5.30E+09	0	0	4.77E+09	5.30E+08
85	1	2.10E+09	0	0	1.89E+09	2.10E+08
90	0.3	8.94E+08	0	0	8.04E+08	8.94E+07
95	0.1	2.76E+08	0	0	2.48E+08	2.76E+07
100	0	0	0	0	0	0

Table 5-29 Fecal Coliform TMDL Calculations for Sandy Creek (OK621010020010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	2,735	2.68E+13	0	0	2.41E+13	2.68E+12
5	158	1.54E+12	0	0	1.39E+12	1.54E+11
10	88	8.62E+11	0	0	7.76E+11	8.62E+10
15	64	6.25E+11	0	0	5.63E+11	6.25E+10
20	52	5.11E+11	0	0	4.60E+11	5.11E+10
25	44	4.33E+11	0	0	3.90E+11	4.33E+10
30	38	3.72E+11	0	0	3.35E+11	3.72E+10
35	33	3.23E+11	0	0	2.91E+11	3.23E+10
40	28	2.70E+11	0	0	2.43E+11	2.70E+10
45	23	2.21E+11	0	0	1.99E+11	2.21E+10
50	18	1.80E+11	0	0	1.62E+11	1.80E+10
55	15	1.47E+11	0	0	1.32E+11	1.47E+10
60	13	1.23E+11	0	0	1.10E+11	1.23E+10
65	10	9.81E+10	0	0	8.83E+10	9.81E+09
70	8	8.17E+10	0	0	7.35E+10	8.17E+09
75	5	5.31E+10	0	0	4.78E+10	5.31E+09
80	2	1.96E+10	0	0	1.77E+10	1.96E+09
85	1	7.76E+09	0	0	6.99E+09	7.76E+08
90	0.3	3.31E+09	0	0	2.98E+09	3.31E+08
95	0.1	1.02E+09	0	0	9.19E+08	1.02E+08
100	0	0	0	0	0	0

Table 5-30 *E. coli* TMDL Calculations for Medicine Lodge River (OK621010030010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	7,853	7.80E+13	0	0	7.02E+13	7.80E+12
5	453	4.50E+12	0	0	4.05E+12	4.50E+11
10	253	2.51E+12	0	0	2.26E+12	2.51E+11
15	183	1.82E+12	0	0	1.64E+12	1.82E+11
20	150	1.49E+12	0	0	1.34E+12	1.49E+11
25	127	1.26E+12	0	0	1.14E+12	1.26E+11
30	109	1.08E+12	0	0	9.75E+11	1.08E+11
35	95	9.41E+11	0	0	8.47E+11	9.41E+10
40	79	7.86E+11	0	0	7.07E+11	7.86E+10
45	65	6.43E+11	0	0	5.79E+11	6.43E+10
50	53	5.24E+11	0	0	4.72E+11	5.24E+10
55	43	4.29E+11	0	0	3.86E+11	4.29E+10
60	36	3.57E+11	0	0	3.22E+11	3.57E+10
65	29	2.86E+11	0	0	2.57E+11	2.86E+10
70	24	2.38E+11	0	0	2.14E+11	2.38E+10
75	16	1.55E+11	0	0	1.39E+11	1.55E+10
80	6	5.72E+10	0	0	5.14E+10	5.72E+09
85	2	2.26E+10	0	0	2.04E+10	2.26E+09
90	1	9.65E+09	0	0	8.68E+09	9.65E+08
95	0.3	2.98E+09	0	0	2.68E+09	2.98E+08
100	0	0	0	0	0	0

Table 5-31 Enterococci TMDL Calculations for Medicine Lodge River (OK621010030010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	7,853	2.07E+13	0	0	1.87E+13	2.07E+12
5	453	1.20E+12	0	0	1.08E+12	1.20E+11
10	253	6.68E+11	0	0	6.02E+11	6.68E+10
15	183	4.85E+11	0	0	4.36E+11	4.85E+10
20	150	3.96E+11	0	0	3.56E+11	3.96E+10
25	127	3.36E+11	0	0	3.02E+11	3.36E+10
30	109	2.88E+11	0	0	2.59E+11	2.88E+10
35	95	2.50E+11	0	0	2.25E+11	2.50E+10
40	79	2.09E+11	0	0	1.88E+11	2.09E+10
45	65	1.71E+11	0	0	1.54E+11	1.71E+10
50	53	1.39E+11	0	0	1.25E+11	1.39E+10
55	43	1.14E+11	0	0	1.03E+11	1.14E+10
60	36	9.50E+10	0	0	8.55E+10	9.50E+09
65	29	7.60E+10	0	0	6.84E+10	7.60E+09
70	24	6.34E+10	0	0	5.70E+10	6.34E+09
75	16	4.12E+10	0	0	3.71E+10	4.12E+09
80	6	1.52E+10	0	0	1.37E+10	1.52E+09
85	2	6.02E+09	0	0	5.42E+09	6.02E+08
90	1	2.57E+09	0	0	2.31E+09	2.57E+08
95	0.3	7.92E+08	0	0	7.13E+08	7.92E+07
100	0	0	0	0	0	0

Table 5-32 *E. coli* TMDL Calculations for Driftwood Creek (OK621010030030_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	13,200	1.31E+14	0	0	1.18E+14	1.31E+13
5	484	4.81E+12	0	0	4.33E+12	4.81E+11
10	236	2.34E+12	0	0	2.11E+12	2.34E+11
15	162	1.61E+12	0	0	1.45E+12	1.61E+11
20	121	1.20E+12	0	0	1.08E+12	1.20E+11
25	96	9.54E+11	0	0	8.58E+11	9.54E+10
30	73	7.25E+11	0	0	6.53E+11	7.25E+10
35	56	5.56E+11	0	0	5.01E+11	5.56E+10
40	44	4.37E+11	0	0	3.93E+11	4.37E+10
45	36	3.58E+11	0	0	3.22E+11	3.58E+10
50	28	2.78E+11	0	0	2.50E+11	2.78E+10
55	21	2.09E+11	0	0	1.88E+11	2.09E+10
60	16	1.59E+11	0	0	1.43E+11	1.59E+10
65	12	1.19E+11	0	0	1.07E+11	1.19E+10
70	8	8.24E+10	0	0	7.42E+10	8.24E+09
75	6	5.46E+10	0	0	4.92E+10	5.46E+09
80	4	3.87E+10	0	0	3.49E+10	3.87E+09
85	3	2.78E+10	0	0	2.50E+10	2.78E+09
90	2	1.99E+10	0	0	1.79E+10	1.99E+09
95	1	1.19E+10	0	0	1.07E+10	1.19E+09
100	0	0	0	0	0	0

Table 5-33 Enterococci TMDL Calculations for Driftwood Creek (OK621010030030_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	13,200	3.49E+13	0	0	3.14E+13	3.49E+12
5	484	1.28E+12	0	0	1.15E+12	1.28E+11
10	236	6.24E+11	0	0	5.61E+11	6.24E+10
15	162	4.28E+11	0	0	3.85E+11	4.28E+10
20	121	3.20E+11	0	0	2.88E+11	3.20E+10
25	96	2.54E+11	0	0	2.28E+11	2.54E+10
30	73	1.93E+11	0	0	1.74E+11	1.93E+10
35	56	1.48E+11	0	0	1.33E+11	1.48E+10
40	44	1.16E+11	0	0	1.05E+11	1.16E+10
45	36	9.51E+10	0	0	8.56E+10	9.51E+09
50	28	7.40E+10	0	0	6.66E+10	7.40E+09
55	21	5.55E+10	0	0	4.99E+10	5.55E+09
60	16	4.23E+10	0	0	3.80E+10	4.23E+09
65	12	3.17E+10	0	0	2.85E+10	3.17E+09
70	8	2.19E+10	0	0	1.97E+10	2.19E+09
75	6	1.45E+10	0	0	1.31E+10	1.45E+09
80	4	1.03E+10	0	0	9.27E+09	1.03E+09
85	3	7.40E+09	0	0	6.66E+09	7.40E+08
90	2	5.28E+09	0	0	4.76E+09	5.28E+08
95	1	3.17E+09	0	0	2.85E+09	3.17E+08
100	0	0	0	0	0	0

Table 5-34 *E. coli* TMDL Calculations for Chikaskia River, Lower (OK621100000010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	75,285	7.48E+14	0	0	6.73E+14	7.48E+13
5	2,459	2.44E+13	0	0	2.20E+13	2.44E+12
10	1,043	1.04E+13	0	0	9.33E+12	1.04E+12
15	648	6.43E+12	0	0	5.79E+12	6.43E+11
20	477	4.73E+12	0	0	4.26E+12	4.73E+11
25	379	3.77E+12	0	0	3.39E+12	3.77E+11
30	312	3.10E+12	0	0	2.79E+12	3.10E+11
35	262	2.60E+12	0	0	2.34E+12	2.60E+11
40	222	2.21E+12	0	0	1.99E+12	2.21E+11
45	193	1.92E+12	0	0	1.72E+12	1.92E+11
50	170	1.69E+12	0	0	1.52E+12	1.69E+11
55	148	1.47E+12	0	0	1.33E+12	1.47E+11
60	128	1.27E+12	0	0	1.14E+12	1.27E+11
65	110	1.10E+12	0	0	9.88E+11	1.10E+11
70	93	9.25E+11	0	0	8.33E+11	9.25E+10
75	78	7.75E+11	0	0	6.97E+11	7.75E+10
80	61	6.03E+11	0	0	5.42E+11	6.03E+10
85	44	4.41E+11	0	0	3.97E+11	4.41E+10
90	28	2.80E+11	0	0	2.52E+11	2.80E+10
95	9	9.04E+10	0	0	8.13E+10	9.04E+09
100	0	0	0	0	0	0

Table 5-35 Enterococci TMDL Calculations for Chikaskia River, Lower (OK621100000010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	75,285	1.99E+14	0	0	1.79E+14	1.99E+13
5	2,459	6.50E+12	0	0	5.85E+12	6.50E+11
10	1,043	2.76E+12	0	0	2.48E+12	2.76E+11
15	648	1.71E+12	0	0	1.54E+12	1.71E+11
20	477	1.26E+12	0	0	1.13E+12	1.26E+11
25	379	1.00E+12	0	0	9.02E+11	1.00E+11
30	312	8.24E+11	0	0	7.42E+11	8.24E+10
35	262	6.93E+11	0	0	6.23E+11	6.93E+10
40	222	5.87E+11	0	0	5.28E+11	5.87E+10
45	193	5.09E+11	0	0	4.59E+11	5.09E+10
50	170	4.49E+11	0	0	4.04E+11	4.49E+10
55	148	3.92E+11	0	0	3.53E+11	3.92E+10
60	128	3.38E+11	0	0	3.04E+11	3.38E+10
65	110	2.92E+11	0	0	2.63E+11	2.92E+10
70	93	2.46E+11	0	0	2.22E+11	2.46E+10
75	78	2.06E+11	0	0	1.85E+11	2.06E+10
80	61	1.60E+11	0	0	1.44E+11	1.60E+10
85	44	1.17E+11	0	0	1.06E+11	1.17E+10
90	28	7.44E+10	0	0	6.70E+10	7.44E+09
95	9	2.40E+10	0	0	2.16E+10	2.40E+09
100	0	0	0	0	0	0

Table 5-36 Enterococci TMDL Calculations for Chikaskia River, Upper (OK621100000010_10)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	72,992	1.93E+14	2.00E+09	0	1.74E+14	1.93E+13
5	2,384	6.30E+12	2.00E+09	0	5.67E+12	6.30E+11
10	1,011	2.67E+12	2.00E+09	0	2.40E+12	2.67E+11
15	628	1.66E+12	2.00E+09	0	1.49E+12	1.66E+11
20	462	1.22E+12	2.00E+09	0	1.10E+12	1.22E+11
25	368	9.71E+11	2.00E+09	0	8.72E+11	9.71E+10
30	302	7.99E+11	2.00E+09	0	7.17E+11	7.99E+10
35	254	6.72E+11	2.00E+09	0	6.02E+11	6.72E+10
40	215	5.69E+11	2.00E+09	0	5.10E+11	5.69E+10
45	187	4.94E+11	2.00E+09	0	4.43E+11	4.94E+10
50	165	4.36E+11	2.00E+09	0	3.90E+11	4.36E+10
55	144	3.80E+11	2.00E+09	0	3.40E+11	3.80E+10
60	124	3.27E+11	2.00E+09	0	2.93E+11	3.27E+10
65	107	2.83E+11	2.00E+09	0	2.53E+11	2.83E+10
70	90	2.39E+11	2.00E+09	0	2.13E+11	2.39E+10
75	76	2.00E+11	2.00E+09	0	1.78E+11	2.00E+10
80	59	1.55E+11	2.00E+09	0	1.38E+11	1.55E+10
85	43	1.14E+11	2.00E+09	0	1.00E+11	1.14E+10
90	27	7.22E+10	2.00E+09	0	6.29E+10	7.22E+09
95	9	2.33E+10	2.00E+09	0	1.90E+10	2.33E+09
100	1	3.67E+09	2.00E+09	0	1.31E+09	3.67E+08

Table 5-37 Fecal Coliform TMDL Calculations for Chikaskia River, Upper (OK621100000010_10)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	72,992	7.14E+14	1.21E+10	0	6.43E+14	7.14E+13
5	2,384	2.33E+13	1.21E+10	0	2.10E+13	2.33E+12
10	1,011	9.90E+12	1.21E+10	0	8.90E+12	9.90E+11
15	628	6.15E+12	1.21E+10	0	5.52E+12	6.15E+11
20	462	4.52E+12	1.21E+10	0	4.06E+12	4.52E+11
25	368	3.60E+12	1.21E+10	0	3.23E+12	3.60E+11
30	302	2.96E+12	1.21E+10	0	2.65E+12	2.96E+11
35	254	2.49E+12	1.21E+10	0	2.23E+12	2.49E+11
40	215	2.11E+12	1.21E+10	0	1.88E+12	2.11E+11
45	187	1.83E+12	1.21E+10	0	1.63E+12	1.83E+11
50	165	1.61E+12	1.21E+10	0	1.44E+12	1.61E+11
55	144	1.41E+12	1.21E+10	0	1.26E+12	1.41E+11
60	124	1.21E+12	1.21E+10	0	1.08E+12	1.21E+11
65	107	1.05E+12	1.21E+10	0	9.31E+11	1.05E+11
70	90	8.84E+11	1.21E+10	0	7.83E+11	8.84E+10
75	76	7.40E+11	1.21E+10	0	6.54E+11	7.40E+10
80	59	5.76E+11	1.21E+10	0	5.06E+11	5.76E+10
85	43	4.21E+11	1.21E+10	0	3.67E+11	4.21E+10
90	27	2.67E+11	1.21E+10	0	2.28E+11	2.67E+10
95	9	8.63E+10	1.21E+10	0	6.56E+10	8.63E+09
100	1	1.36E+10	1.21E+10	0	1.31E+08	1.36E+09

Table 5-38 *E. coli* TMDL Calculations for Bitter Creek (OK621100000100_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	35,459	3.52E+14	0	0	3.17E+14	3.52E+13
5	1,158	1.15E+13	0	0	1.04E+13	1.15E+12
10	491	4.88E+12	0	0	4.39E+12	4.88E+11
15	305	3.03E+12	0	0	2.73E+12	3.03E+11
20	224	2.23E+12	0	0	2.01E+12	2.23E+11
25	179	1.77E+12	0	0	1.60E+12	1.77E+11
30	147	1.46E+12	0	0	1.31E+12	1.46E+11
35	123	1.23E+12	0	0	1.10E+12	1.23E+11
40	105	1.04E+12	0	0	9.35E+11	1.04E+11
45	91	9.02E+11	0	0	8.12E+11	9.02E+10
50	80	7.96E+11	0	0	7.16E+11	7.96E+10
55	70	6.94E+11	0	0	6.25E+11	6.94E+10
60	60	5.98E+11	0	0	5.38E+11	5.98E+10
65	52	5.17E+11	0	0	4.65E+11	5.17E+10
70	44	4.36E+11	0	0	3.92E+11	4.36E+10
75	37	3.65E+11	0	0	3.28E+11	3.65E+10
80	29	2.84E+11	0	0	2.55E+11	2.84E+10
85	21	2.08E+11	0	0	1.87E+11	2.08E+10
90	13	1.32E+11	0	0	1.19E+11	1.32E+10
95	4	4.26E+10	0	0	3.83E+10	4.26E+09
100	0	0	0	0	0	0

Table 5-39 Enterococci TMDL Calculations for Bitter Creek (OK621100000100_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	35,459	9.37E+13	0	0	8.43E+13	9.37E+12
5	1,158	3.06E+12	0	0	2.75E+12	3.06E+11
10	491	1.30E+12	0	0	1.17E+12	1.30E+11
15	305	8.06E+11	0	0	7.26E+11	8.06E+10
20	224	5.93E+11	0	0	5.34E+11	5.93E+10
25	179	4.72E+11	0	0	4.25E+11	4.72E+10
30	147	3.88E+11	0	0	3.49E+11	3.88E+10
35	123	3.26E+11	0	0	2.94E+11	3.26E+10
40	105	2.76E+11	0	0	2.49E+11	2.76E+10
45	91	2.40E+11	0	0	2.16E+11	2.40E+10
50	80	2.12E+11	0	0	1.90E+11	2.12E+10
55	70	1.85E+11	0	0	1.66E+11	1.85E+10
60	60	1.59E+11	0	0	1.43E+11	1.59E+10
65	52	1.38E+11	0	0	1.24E+11	1.38E+10
70	44	1.16E+11	0	0	1.04E+11	1.16E+10
75	37	9.71E+10	0	0	8.74E+10	9.71E+09
80	29	7.55E+10	0	0	6.79E+10	7.55E+09
85	21	5.53E+10	0	0	4.97E+10	5.53E+09
90	13	3.51E+10	0	0	3.15E+10	3.51E+09
95	4	1.13E+10	0	0	1.02E+10	1.13E+09
100	0	0	0	0	0	0

Table 5-40 Enterococci TMDL Calculations for Arkansas River (OK621200010200_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	261,000	6.90E+14	6.25E+07	0	6.21E+14	6.90E+13
5	30,500	8.06E+13	6.25E+07	0	7.25E+13	8.06E+12
10	19,900	5.26E+13	6.25E+07	0	4.73E+13	5.26E+12
15	13,800	3.65E+13	6.25E+07	0	3.28E+13	3.65E+12
20	11,100	2.93E+13	6.25E+07	0	2.64E+13	2.93E+12
25	8,420	2.22E+13	6.25E+07	0	2.00E+13	2.22E+12
30	6,900	1.82E+13	6.25E+07	0	1.64E+13	1.82E+12
35	5,720	1.51E+13	6.25E+07	0	1.36E+13	1.51E+12
40	4,710	1.24E+13	6.25E+07	0	1.12E+13	1.24E+12
45	3,940	1.04E+13	6.25E+07	0	9.37E+12	1.04E+12
50	3,320	8.77E+12	6.25E+07	0	7.90E+12	8.77E+11
55	2,810	7.42E+12	6.25E+07	0	6.68E+12	7.42E+11
60	2,380	6.29E+12	6.25E+07	0	5.66E+12	6.29E+11
65	2,020	5.34E+12	6.25E+07	0	4.80E+12	5.34E+11
70	1,660	4.39E+12	6.25E+07	0	3.95E+12	4.39E+11
75	1,360	3.59E+12	6.25E+07	0	3.23E+12	3.59E+11
80	1,110	2.93E+12	6.25E+07	0	2.64E+12	2.93E+11
85	851	2.25E+12	6.25E+07	0	2.02E+12	2.25E+11
90	630	1.66E+12	6.25E+07	0	1.50E+12	1.66E+11
95	348	9.20E+11	6.25E+07	0	8.27E+11	9.20E+10
100	29	7.66E+10	6.25E+07	0	6.89E+10	7.66E+09

Table 5-41 *E. coli* TMDL Calculations for Black Bear Creek (OK621200030010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	18,260	1.81E+14	1.74E+09	0	1.63E+14	1.81E+13
5	1,616	1.60E+13	1.74E+09	0	1.44E+13	1.60E+12
10	695	6.90E+12	1.74E+09	0	6.21E+12	6.90E+11
15	386	3.84E+12	1.74E+09	0	3.45E+12	3.84E+11
20	245	2.43E+12	1.74E+09	0	2.18E+12	2.43E+11
25	166	1.65E+12	1.74E+09	0	1.48E+12	1.65E+11
30	113	1.12E+12	1.74E+09	0	1.01E+12	1.12E+11
35	82	8.13E+11	1.74E+09	0	7.30E+11	8.13E+10
40	61	6.05E+11	1.74E+09	0	5.42E+11	6.05E+10
45	48	4.73E+11	1.74E+09	0	4.24E+11	4.73E+10
50	37	3.63E+11	1.74E+09	0	3.25E+11	3.63E+10
55	30	2.97E+11	1.74E+09	0	2.65E+11	2.97E+10
60	24	2.42E+11	1.74E+09	0	2.16E+11	2.42E+10
65	20	1.98E+11	1.74E+09	0	1.76E+11	1.98E+10
70	18	1.76E+11	1.74E+09	0	1.57E+11	1.76E+10
75	14	1.43E+11	1.74E+09	0	1.27E+11	1.43E+10
80	11	1.08E+11	1.74E+09	0	9.52E+10	1.08E+10
85	8	7.91E+10	1.74E+09	0	6.95E+10	7.91E+09
90	5	5.17E+10	1.74E+09	0	4.48E+10	5.17E+09
95	2	2.20E+10	1.74E+09	0	1.81E+10	2.20E+09
100	0.3	3.18E+09	1.74E+09	0	1.12E+09	3.18E+08

Table 5-42 Enterococci TMDL Calculations for Black Bear Creek (OK621200030010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	18,260	4.82E+13	4.55E+08	0	4.34E+13	4.82E+12
5	1,616	4.27E+12	4.55E+08	0	3.84E+12	4.27E+11
10	695	1.84E+12	4.55E+08	0	1.65E+12	1.84E+11
15	386	1.02E+12	4.55E+08	0	9.18E+11	1.02E+11
20	245	6.46E+11	4.55E+08	0	5.81E+11	6.46E+10
25	166	4.39E+11	4.55E+08	0	3.94E+11	4.39E+10
30	113	2.98E+11	4.55E+08	0	2.68E+11	2.98E+10
35	82	2.16E+11	4.55E+08	0	1.94E+11	2.16E+10
40	61	1.61E+11	4.55E+08	0	1.44E+11	1.61E+10
45	48	1.26E+11	4.55E+08	0	1.13E+11	1.26E+10
50	37	9.65E+10	4.55E+08	0	8.64E+10	9.65E+09
55	30	7.90E+10	4.55E+08	0	7.06E+10	7.90E+09
60	24	6.43E+10	4.55E+08	0	5.74E+10	6.43E+09
65	20	5.26E+10	4.55E+08	0	4.69E+10	5.26E+09
70	18	4.68E+10	4.55E+08	0	4.17E+10	4.68E+09
75	14	3.80E+10	4.55E+08	0	3.38E+10	3.80E+09
80	11	2.87E+10	4.55E+08	0	2.53E+10	2.87E+09
85	8	2.11E+10	4.55E+08	0	1.85E+10	2.11E+09
90	5	1.37E+10	4.55E+08	0	1.19E+10	1.37E+09
95	2	5.85E+09	4.55E+08	0	4.81E+09	5.85E+08
100	0.3	8.46E+08	4.55E+08	0	3.06E+08	8.46E+07

Table 5-43 *E. coli* TMDL Calculations for Red Rock Creek, Lower (OK621200050010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	133,729	1.33E+15	0	0	1.20E+15	1.33E+14
5	15,096	1.50E+14	0	0	1.35E+14	1.50E+13
10	9,237	9.18E+13	0	0	8.26E+13	9.18E+12
15	6,473	6.43E+13	0	0	5.79E+13	6.43E+12
20	4,977	4.94E+13	0	0	4.45E+13	4.94E+12
25	3,902	3.88E+13	0	0	3.49E+13	3.88E+12
30	3,150	3.13E+13	0	0	2.82E+13	3.13E+12
35	2,571	2.55E+13	0	0	2.30E+13	2.55E+12
40	2,137	2.12E+13	0	0	1.91E+13	2.12E+12
45	1,806	1.79E+13	0	0	1.61E+13	1.79E+12
50	1,523	1.51E+13	0	0	1.36E+13	1.51E+12
55	1,324	1.31E+13	0	0	1.18E+13	1.31E+12
60	1,144	1.14E+13	0	0	1.02E+13	1.14E+12
65	965	9.59E+12	0	0	8.63E+12	9.59E+11
70	813	8.08E+12	0	0	7.27E+12	8.08E+11
75	669	6.64E+12	0	0	5.98E+12	6.64E+11
80	547	5.43E+12	0	0	4.89E+12	5.43E+11
85	433	4.30E+12	0	0	3.87E+12	4.30E+11
90	329	3.27E+12	0	0	2.94E+12	3.27E+11
95	226	2.25E+12	0	0	2.02E+12	2.25E+11
100	10	1.03E+11	0	0	9.24E+10	1.03E+10

Table 5-44 Enterococci TMDL Calculations for Red Rock Creek, Lower (OK621200050010_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	133,729	3.53E+14	0	0	3.18E+14	3.53E+13
5	15,096	3.99E+13	0	0	3.59E+13	3.99E+12
10	9,237	2.44E+13	0	0	2.20E+13	2.44E+12
15	6,473	1.71E+13	0	0	1.54E+13	1.71E+12
20	4,977	1.32E+13	0	0	1.18E+13	1.32E+12
25	3,902	1.03E+13	0	0	9.28E+12	1.03E+12
30	3,150	8.32E+12	0	0	7.49E+12	8.32E+11
35	2,571	6.79E+12	0	0	6.11E+12	6.79E+11
40	2,137	5.65E+12	0	0	5.08E+12	5.65E+11
45	1,806	4.77E+12	0	0	4.29E+12	4.77E+11
50	1,523	4.03E+12	0	0	3.62E+12	4.03E+11
55	1,324	3.50E+12	0	0	3.15E+12	3.50E+11
60	1,144	3.02E+12	0	0	2.72E+12	3.02E+11
65	965	2.55E+12	0	0	2.29E+12	2.55E+11
70	813	2.15E+12	0	0	1.93E+12	2.15E+11
75	669	1.77E+12	0	0	1.59E+12	1.77E+11
80	547	1.44E+12	0	0	1.30E+12	1.44E+11
85	433	1.14E+12	0	0	1.03E+12	1.14E+11
90	329	8.69E+11	0	0	7.82E+11	8.69E+10
95	226	5.97E+11	0	0	5.38E+11	5.97E+10
100	10	2.73E+10	0	0	2.46E+10	2.73E+09

Table 5-45 *E. coli* TMDL Calculations for Red Rock Creek, Upper (OK621200050010_10)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	75,685	7.52E+14	0	0	6.77E+14	7.52E+13
5	8,544	8.49E+13	0	0	7.64E+13	8.49E+12
10	5,228	5.19E+13	0	0	4.67E+13	5.19E+12
15	3,663	3.64E+13	0	0	3.27E+13	3.64E+12
20	2,817	2.80E+13	0	0	2.52E+13	2.80E+12
25	2,208	2.19E+13	0	0	1.97E+13	2.19E+12
30	1,783	1.77E+13	0	0	1.59E+13	1.77E+12
35	1,455	1.45E+13	0	0	1.30E+13	1.45E+12
40	1,209	1.20E+13	0	0	1.08E+13	1.20E+12
45	1,022	1.02E+13	0	0	9.14E+12	1.02E+12
50	862	8.56E+12	0	0	7.71E+12	8.56E+11
55	749	7.44E+12	0	0	6.70E+12	7.44E+11
60	648	6.43E+12	0	0	5.79E+12	6.43E+11
65	546	5.43E+12	0	0	4.88E+12	5.43E+11
70	460	4.57E+12	0	0	4.12E+12	4.57E+11
75	378	3.76E+12	0	0	3.38E+12	3.76E+11
80	309	3.07E+12	0	0	2.77E+12	3.07E+11
85	245	2.43E+12	0	0	2.19E+12	2.43E+11
90	186	1.85E+12	0	0	1.66E+12	1.85E+11
95	128	1.27E+12	0	0	1.14E+12	1.27E+11
100	6	5.81E+10	0	0	5.23E+10	5.81E+09

Table 5-46 *E. coli* TMDL Calculations for Beaver Creek (OK621210000050_10)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	7,115	7.07E+13	0	0	6.36E+13	7.07E+12
5	232	2.31E+12	0	0	2.08E+12	2.31E+11
10	99	9.79E+11	0	0	8.81E+11	9.79E+10
15	61	6.08E+11	0	0	5.47E+11	6.08E+10
20	45	4.47E+11	0	0	4.03E+11	4.47E+10
25	36	3.56E+11	0	0	3.20E+11	3.56E+10
30	29	2.93E+11	0	0	2.64E+11	2.93E+10
35	25	2.46E+11	0	0	2.21E+11	2.46E+10
40	21	2.08E+11	0	0	1.88E+11	2.08E+10
45	18	1.81E+11	0	0	1.63E+11	1.81E+10
50	16	1.60E+11	0	0	1.44E+11	1.60E+10
55	14	1.39E+11	0	0	1.25E+11	1.39E+10
60	12	1.20E+11	0	0	1.08E+11	1.20E+10
65	10	1.04E+11	0	0	9.34E+10	1.04E+10
70	9	8.75E+10	0	0	7.87E+10	8.75E+09
75	7	7.32E+10	0	0	6.59E+10	7.32E+09
80	6	5.69E+10	0	0	5.13E+10	5.69E+09
85	4	4.17E+10	0	0	3.75E+10	4.17E+09
90	3	2.64E+10	0	0	2.38E+10	2.64E+09
95	1	8.54E+09	0	0	7.69E+09	8.54E+08
100	0	0	0	0	0	0

Table 5-47 Enterococci TMDL Calculations for Beaver Creek (OK621210000050_10)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	7,115	1.88E+13	0	0	1.69E+13	1.88E+12
5	232	6.14E+11	0	0	5.53E+11	6.14E+10
10	99	2.61E+11	0	0	2.34E+11	2.61E+10
15	61	1.62E+11	0	0	1.46E+11	1.62E+10
20	45	1.19E+11	0	0	1.07E+11	1.19E+10
25	36	9.47E+10	0	0	8.52E+10	9.47E+09
30	29	7.79E+10	0	0	7.01E+10	7.79E+09
35	25	6.55E+10	0	0	5.89E+10	6.55E+09
40	21	5.55E+10	0	0	4.99E+10	5.55E+09
45	18	4.82E+10	0	0	4.33E+10	4.82E+09
50	16	4.25E+10	0	0	3.82E+10	4.25E+09
55	14	3.71E+10	0	0	3.34E+10	3.71E+09
60	12	3.19E+10	0	0	2.87E+10	3.19E+09
65	10	2.76E+10	0	0	2.48E+10	2.76E+09
70	9	2.33E+10	0	0	2.09E+10	2.33E+09
75	7	1.95E+10	0	0	1.75E+10	1.95E+09
80	6	1.51E+10	0	0	1.36E+10	1.51E+09
85	4	1.11E+10	0	0	9.98E+09	1.11E+09
90	3	7.03E+09	0	0	6.33E+09	7.03E+08
95	1	2.27E+09	0	0	2.05E+09	2.27E+08
100	0	0	0	0	0	0

Table 5-48 *E. coli* TMDL Calculations for Chilocco Creek (OK621210000270_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	1,778	1.77E+13	0	0	1.59E+13	1.77E+12
5	58	5.77E+11	0	0	5.19E+11	5.77E+10
10	25	2.45E+11	0	0	2.20E+11	2.45E+10
15	15	1.52E+11	0	0	1.37E+11	1.52E+10
20	11	1.12E+11	0	0	1.01E+11	1.12E+10
25	9	8.90E+10	0	0	8.01E+10	8.90E+09
30	7	7.32E+10	0	0	6.59E+10	7.32E+09
35	6	6.15E+10	0	0	5.54E+10	6.15E+09
40	5.2	5.21E+10	0	0	4.69E+10	5.21E+09
45	4.6	4.52E+10	0	0	4.07E+10	4.52E+09
50	4.0	3.99E+10	0	0	3.59E+10	3.99E+09
55	3.5	3.48E+10	0	0	3.13E+10	3.48E+09
60	3.0	3.00E+10	0	0	2.70E+10	3.00E+09
65	2.6	2.59E+10	0	0	2.33E+10	2.59E+09
70	2.2	2.19E+10	0	0	1.97E+10	2.19E+09
75	1.8	1.83E+10	0	0	1.65E+10	1.83E+09
80	1.4	1.42E+10	0	0	1.28E+10	1.42E+09
85	1.0	1.04E+10	0	0	9.38E+09	1.04E+09
90	0.7	6.61E+09	0	0	5.95E+09	6.61E+08
95	0.2	2.13E+09	0	0	1.92E+09	2.13E+08
100	0	0	0	0	0	0

Table 5-49 Enterococci TMDL Calculations for Chilocco Creek (OK621210000270_00)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA_{WWTP} (cfu/day)	WLA_{MS4} (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	1,778	4.70E+12	0	0	4.23E+12	4.70E+11
5	58	1.53E+11	0	0	1.38E+11	1.53E+10
10	25	6.51E+10	0	0	5.86E+10	6.51E+09
15	15	4.04E+10	0	0	3.64E+10	4.04E+09
20	11	2.97E+10	0	0	2.68E+10	2.97E+09
25	9	2.37E+10	0	0	2.13E+10	2.37E+09
30	7	1.95E+10	0	0	1.75E+10	1.95E+09
35	6	1.64E+10	0	0	1.47E+10	1.64E+09
40	5.2	1.39E+10	0	0	1.25E+10	1.39E+09
45	4.6	1.20E+10	0	0	1.08E+10	1.20E+09
50	4.0	1.06E+10	0	0	9.55E+09	1.06E+09
55	3.5	9.26E+09	0	0	8.34E+09	9.26E+08
60	3.0	7.98E+09	0	0	7.18E+09	7.98E+08
65	2.6	6.90E+09	0	0	6.21E+09	6.90E+08
70	2.2	5.81E+09	0	0	5.23E+09	5.81E+08
75	1.8	4.87E+09	0	0	4.38E+09	4.87E+08
80	1.4	3.79E+09	0	0	3.41E+09	3.79E+08
85	1.0	2.77E+09	0	0	2.49E+09	2.77E+08
90	0.7	1.76E+09	0	0	1.58E+09	1.76E+08
95	0.2	5.68E+08	0	0	5.11E+08	5.68E+07
100	0	0	0	0	0	0

Table 5-50 Total Suspended Solids TMDL Calculations for Arkansas River, Salt Fork (OK621000010010_30)

Percentile	Flow (cfs)	TMDL (lb/day)	WLA (lb/day)		LA (lb/day)	MOS (lb/day)
			WWTP	Future growth		
0	61,029	NA	NA	NA	NA	NA
5	4,223	NA	NA	NA	NA	NA
10	2,196	NA	NA	NA	NA	NA
15	1,373	NA	NA	NA	NA	NA
20	980	NA	NA	NA	NA	NA
25	755	192,393	0	1,924	161,610	28,859
30	597	152,031	0	1,520	127,706	22,805
35	481	122,701	0	1,227	103,069	18,405
40	394	100,367	0	1,004	84,309	15,055
45	323	82,339	0	823	69,165	12,351
50	266	67,808	0	678	56,959	10,171
55	216	55,162	0	552	46,336	8,274
60	174	44,398	0	444	37,295	6,660
65	139	35,519	0	355	29,836	5,328
70	108	27,446	0	274	23,055	4,117
75	84	21,527	0	215	18,082	3,229
80	65	16,683	0	167	14,014	2,502
85	50	12,647	0	126	10,623	1,897
90	35	8,880	0	89	7,459	1,332
95	18	4,574	0	46	3,842	686
100	0.3	68	0	1	57	10

NA = Not Applicable

Table 5-51 Total Suspended Solids TMDL Calculations for Bois d'Arc Creek (OK621000030010_00)

Percentile	Flow (cfs)	TMDL (lb/day)	WLA (lb/day)		LA (lb/day)	MOS (lb/day)
			WWTP	Future growth		
0	3,680	NA	NA	NA	NA	NA
5	120	NA	NA	NA	NA	NA
10	51	NA	NA	NA	NA	NA
15	32	NA	NA	NA	NA	NA
20	23	NA	NA	NA	NA	NA
25	19	5,201	0	52	4,629	520
30	15	4,279	0	43	3,809	428
35	13	3,596	0	36	3,200	360
40	11	3,046	0	30	2,711	305
45	9	2,645	0	26	2,354	264
50	8	2,333	0	23	2,076	233
55	7	2,036	0	20	1,812	204
60	6	1,753	0	18	1,561	175
65	5	1,516	0	15	1,349	152
70	5	1,278	0	13	1,137	128
75	4	1,070	0	11	952	107
80	3	832	0	8	741	83
85	2	609	0	6	542	61
90	1	386	0	4	344	39
95	0.4	125	0	1	111	12
100	0.3	93	0	1	82	9

NA = Not Applicable

Table 5-52 Total Suspended Solids TMDL Calculations for Deer Creek (OK621000040010_00)

Percentile	Flow (cfs)	TMDL (lb/day)	WLA (lb/day)		LA (lb/day)	MOS (lb/day)
			WWTP	Future growth		
0	51,507	NA	NA	NA	NA	NA
5	3,565	NA	NA	NA	NA	NA
10	1,854	NA	NA	NA	NA	NA
15	1,158	NA	NA	NA	NA	NA
20	827	NA	NA	NA	NA	NA
25	637	162,676	0	1,627	144,782	16,268
30	503	128,548	0	1,285	114,408	12,855
35	406	103,749	0	1,037	92,336	10,375
40	332	84,864	0	849	75,529	8,486
45	273	69,621	0	696	61,962	6,962
50	225	57,335	0	573	51,028	5,733
55	183	46,641	0	466	41,511	4,664
60	147	37,541	0	375	33,411	3,754
65	118	30,032	0	300	26,729	3,003
70	91	23,207	0	232	20,654	2,321
75	71	18,201	0	182	16,199	1,820
80	55	14,106	0	141	12,554	1,411
85	42	10,693	0	107	9,517	1,069
90	29	7,508	0	75	6,682	751
95	15	3,868	0	39	3,442	387
100	0	0	0	0	0	0

NA = Not Applicable

Table 5-53 Total Suspended Solids TMDL Calculations for Pond Creek (OK621000050010_00)

Percentile	Flow (cfs)	TMDL (lb/day)	WLA (lb/day)		LA (lb/day)	MOS (lb/day)
			WWTP	Future growth		
0	57,800	NA	NA	NA	NA	NA
5	4,000	NA	NA	NA	NA	NA
10	2,080	NA	NA	NA	NA	NA
15	1,300	NA	NA	NA	NA	NA
20	928	NA	NA	NA	NA	NA
25	715	161,221	3	1,612	143,483	16,122
30	565	127,398	3	1,274	113,381	12,740
35	456	102,820	3	1,028	91,507	10,282
40	373	84,105	3	841	74,850	8,411
45	306	68,998	3	690	61,405	6,900
50	252	56,822	3	568	50,568	5,682
55	205	46,224	3	462	41,136	4,622
60	165	37,205	3	372	33,109	3,720
65	132	29,764	3	298	26,486	2,976
70	102	22,999	3	230	20,466	2,300
75	80	18,039	3	180	16,051	1,804
80	62	13,980	3	140	12,439	1,398
85	47	10,598	3	106	9,428	1,060
90	33	7,441	3	74	6,619	744
95	17	3,833	3	38	3,408	383
100	0.02	5	3	0	1	0

NA = Not Applicable

Table 5-54 Total Suspended Solids TMDL Calculations for Crooked Creek (OK621000060010_00)

Percentile	Flow (cfs)	TMDL (lb/day)	WLA (lb/day)		LA (lb/day)	MOS (lb/day)
			WWTP	Future growth		
0	14,389	NA	NA	NA	NA	NA
5	996	NA	NA	NA	NA	NA
10	518	NA	NA	NA	NA	NA
15	324	NA	NA	NA	NA	NA
20	231	NA	NA	NA	NA	NA
25	178	42,437	0	424	37,769	4,244
30	141	33,534	0	335	29,846	3,353
35	114	27,065	0	271	24,088	2,706
40	93	22,139	0	221	19,703	2,214
45	76	18,162	0	182	16,164	1,816
50	63	14,957	0	150	13,312	1,496
55	51	12,167	0	122	10,829	1,217
60	41	9,793	0	98	8,716	979
65	33	7,835	0	78	6,973	783
70	25	6,054	0	61	5,388	605
75	20	4,748	0	47	4,226	475
80	15	3,680	0	37	3,275	368
85	12	2,790	0	28	2,483	279
90	8	1,959	0	20	1,743	196
95	4	1,009	0	10	898	101
100	0	0	0	0	0	0

NA = Not Applicable

Table 5-55 Total Suspended Solids TMDL Calculations for the Arkansas River, Salt Fork (OK621010010010_00)

Percentile	Flow (cfs)	TMDL (lb/day)	WLA (lb/day)		LA (lb/day)	MOS (lb/day)
			WWTP	Future growth		
0	96,887	NA	NA	NA	NA	NA
5	5,591	NA	NA	NA	NA	NA
10	3,121	NA	NA	NA	NA	NA
15	2,263	NA	NA	NA	NA	NA
20	1,849	NA	NA	NA	NA	NA
25	1,568	343,347	0	3,433	305,578	34,335
30	1,346	294,760	0	2,948	262,336	29,476
35	1,169	255,890	0	2,559	227,743	25,589
40	976	213,782	0	2,138	190,266	21,378
45	799	174,912	0	1,749	155,672	17,491
50	651	142,521	0	1,425	126,844	14,252
55	533	116,608	0	1,166	103,781	11,661
60	444	97,174	0	972	86,484	9,717
65	355	77,739	0	777	69,188	7,774
70	296	64,782	0	648	57,656	6,478
75	192	42,109	0	421	37,477	4,211
80	71	15,548	0	155	13,838	1,555
85	28	6,154	0	62	5,477	615
90	12	2,624	0	26	2,335	262
95	4	810	0	8	721	81
100	0	0	0	0	0	0

NA = Not Applicable

Table 5-56 Total Suspended Solids TMDL Calculations for the Arkansas River, Salt Fork (OK621010010160_00)

Percentile	Flow (cfs)	TMDL (lb/day)	WLA (lb/day)		LA (lb/day)	MOS (lb/day)
			WWTP	Future growth		
0	3,529	NA	NA	NA	NA	NA
5	301	NA	NA	NA	NA	NA
10	166	NA	NA	NA	NA	NA
15	110	NA	NA	NA	NA	NA
20	82	NA	NA	NA	NA	NA
25	65	28,708	0	287	25,550	2,871
30	53	23,474	0	235	20,891	2,347
35	43	19,350	0	193	17,221	1,935
40	36	15,940	0	159	14,186	1,594
45	29	13,006	0	130	11,575	1,301
50	24	10,468	0	105	9,316	1,047
55	19	8,327	0	83	7,411	833
60	14	6,344	0	63	5,646	634
65	10	4,282	0	43	3,811	428
70	6	2,776	0	28	2,470	278
75	4	1,586	0	16	1,412	159
80	2.5	1,110	0	11	988	111
85	1.6	714	0	7	635	71
90	0.9	397	0	4	353	40
95	0.4	159	0	2	141	16
100	0	0	0	0	0	0

NA = Not Applicable

Table 5-57 Total Suspended Solids TMDL Calculations for Turkey Creek (OK621010010230_00

Percentile	Flow (cfs)	TMDL (lb/day)	WLA (lb/day)		LA (lb/day)	MOS (lb/day)
			WWTP	Future growth		
0	9,010	NA	NA	NA	NA	NA
5	240	NA	NA	NA	NA	NA
10	140	NA	NA	NA	NA	NA
15	100	NA	NA	NA	NA	NA
20	76	NA	NA	NA	NA	NA
25	61	16,216	0	162	12,811	3,243
30	51	13,537	0	135	10,694	2,707
35	43	11,563	0	116	9,134	2,313
40	37	9,871	0	99	7,798	1,974
45	31	8,178	0	82	6,461	1,636
50	26	6,909	0	69	5,458	1,382
55	22	5,922	0	59	4,679	1,184
60	19	5,076	0	51	4,010	1,015
65	16	4,371	0	44	3,453	874
70	13	3,525	0	35	2,785	705
75	10	2,679	0	27	2,117	536
80	6	1,692	0	17	1,337	338
85	3	846	0	8	668	169
90	1	338	0	3	267	68
95	0.4	111	0	1	88	22
100	0	0	0	0	0	0

NA = Not Applicable

Table 5-58 Total Suspended Solids TMDL Calculations for Medicine Lodge River (OK621010030010_00)

Percentile	Flow (cfs)	TMDL (lb/day)	WLA (lb/day)		LA (lb/day)	MOS (lb/day)
			WWTP	Future growth		
0	7,853	NA	NA	NA	NA	NA
5	453	NA	NA	NA	NA	NA
10	253	NA	NA	NA	NA	NA
15	183	NA	NA	NA	NA	NA
20	150	NA	NA	NA	NA	NA
25	127	40,193	0	402	33,762	6,029
30	109	34,506	0	345	28,985	5,176
35	95	29,955	0	300	25,163	4,493
40	79	25,026	0	250	21,022	3,754
45	65	20,476	0	205	17,200	3,071
50	53	16,684	0	167	14,015	2,503
55	43	13,651	0	137	11,466	2,048
60	36	11,375	0	114	9,555	1,706
65	29	9,100	0	91	7,644	1,365
70	24	7,584	0	76	6,370	1,138
75	16	4,929	0	49	4,141	739
80	6	1,820	0	18	1,529	273
85	2	720	0	7	605	108
90	1	307	0	3	258	46
95	0.3	95	0	1	80	14
100	0	0	0	0	0	0

NA = Not Applicable

Table 5-59 Total Suspended Solids TMDL Calculations for Driftwood Creek (OK621010030030_00)

Percentile	Flow (cfs)	TMDL (lb/day)	WLA (lb/day)		LA (lb/day)	MOS (lb/day)
			WWTP	Future growth		
0	13,200	NA	NA	NA	NA	NA
5	484	NA	NA	NA	NA	NA
10	236	NA	NA	NA	NA	NA
15	162	NA	NA	NA	NA	NA
20	121	NA	NA	NA	NA	NA
25	96	27,035	0	270	24,062	2,704
30	73	20,558	0	206	18,297	2,056
35	56	15,771	0	158	14,036	1,577
40	44	12,391	0	124	11,028	1,239
45	36	10,138	0	101	9,023	1,014
50	28	7,885	0	79	7,018	789
55	21	5,914	0	59	5,263	591
60	16	4,506	0	45	4,010	451
65	12	3,379	0	34	3,008	338
70	8	2,337	0	23	2,080	234
75	6	1,549	0	15	1,379	155
80	4	1,098	0	11	977	110
85	3	789	0	8	702	79
90	2	563	0	6	501	56
95	1.2	338	0	3	301	34
100	0	0	0	0	0	0

NA = Not Applicable

Table 5-60 Total Suspended Solids TMDL Calculations for Chikaskia River, Lower (OK621100000010_00)

Percentile	Flow (cfs)	TMDL (lb/day)	WLA (lb/day)		LA (lb/day)	MOS (lb/day)
			WWTP	Future growth		
0	75,285	NA	NA	NA	NA	NA
5	2,459	NA	NA	NA	NA	NA
10	1,043	NA	NA	NA	NA	NA
15	648	NA	NA	NA	NA	NA
20	477	NA	NA	NA	NA	NA
25	379	116,390	0	1,164	103,587	11,639
30	312	95,773	0	958	85,238	9,577
35	262	80,475	0	805	71,623	8,048
40	222	68,171	0	682	60,673	6,817
45	193	59,193	0	592	52,682	5,919
50	170	52,209	0	522	46,466	5,221
55	148	45,558	0	456	40,547	4,556
60	128	39,240	0	392	34,924	3,924
65	110	33,919	0	339	30,188	3,392
70	93	28,599	0	286	25,453	2,860
75	78	23,943	0	239	21,309	2,394
80	61	18,622	0	186	16,574	1,862
85	44	13,634	0	136	12,135	1,363
90	28	8,646	0	86	7,695	865
95	9	2,793	0	28	2,486	279
100	0	0	0	0	0	0

NA = Not Applicable

Table 5-61 Total Suspended Solids TMDL Calculations for Chikaskia River, Upper (OK621100000010_10)

Percentile	Flow (cfs)	TMDL (lb/day)	WLA (lb/day)		LA (lb/day)	MOS (lb/day)
			WWTP	Future growth		
0	72,992	NA	NA	NA	NA	NA
5	2,384	NA	NA	NA	NA	NA
10	1,011	NA	NA	NA	NA	NA
15	628	NA	NA	NA	NA	NA
20	462	NA	NA	NA	NA	NA
25	368	148,730	0	1,487	124,933	22,310
30	302	122,384	0	1,224	102,802	18,358
35	254	102,836	0	1,028	86,383	15,425
40	215	87,113	0	871	73,175	13,067
45	187	75,640	0	756	63,538	11,346
50	165	66,716	0	667	56,042	10,007
55	144	58,217	0	582	48,902	8,733
60	124	50,143	0	501	42,120	7,522
65	107	43,344	0	433	36,409	6,502
70	90	36,545	0	365	30,698	5,482
75	76	30,596	0	306	25,701	4,589
80	59	23,797	0	238	19,989	3,570
85	43	17,423	0	174	14,635	2,613
90	27	11,049	0	110	9,281	1,657
95	9	3,570	0	36	2,998	535
100	0	0	0	0	0	0

NA = Not Applicable

Table 5-62 Total Suspended Solids TMDL Calculations for Bitter Creek (OK621100000100_00)

Percentile	Flow (cfs)	TMDL (lb/day)	WLA (lb/day)		LA (lb/day)	MOS (lb/day)
			WWTP	Future growth		
0	35,459	NA	NA	NA	NA	NA
5	1,158	NA	NA	NA	NA	NA
10	491	NA	NA	NA	NA	NA
15	305	NA	NA	NA	NA	NA
20	224	NA	NA	NA	NA	NA
25	179	58,644	0	586	49,261	8,797
30	147	48,255	0	483	40,535	7,238
35	123	40,548	0	405	34,060	6,082
40	105	34,349	0	343	28,853	5,152
45	91	29,825	0	298	25,053	4,474
50	80	26,306	0	263	22,097	3,946
55	70	22,955	0	230	19,282	3,443
60	60	19,771	0	198	16,608	2,966
65	52	17,090	0	171	14,356	2,564
70	44	14,410	0	144	12,104	2,161
75	37	12,064	0	121	10,134	1,810
80	29	9,383	0	94	7,882	1,407
85	21	6,870	0	69	5,771	1,030
90	13	4,356	0	44	3,659	653
95	4	1,407	0	14	1,182	211
100	0	0	0	0	0	0

NA = Not Applicable

Table 5-63 Total Suspended Solids TMDL Calculations for Arkansas River (OK621200010200_00)

Percentile	Flow (cfs)	TMDL (lb/day)	WLA (lb/day)		LA (lb/day)	MOS (lb/day)
			WWTP	Future growth		
0	261,000	NA	NA	NA	NA	NA
5	30,500	NA	NA	NA	NA	NA
10	19,900	NA	NA	NA	NA	NA
15	13,800	NA	NA	NA	NA	NA
20	11,100	NA	NA	NA	NA	NA
25	8,420	3,625,930	0	36,259	3,227,078	362,593
30	6,900	2,971,368	0	29,714	2,644,518	297,137
35	5,720	2,463,221	0	24,632	2,192,267	246,322
40	4,710	2,028,282	0	20,283	1,805,171	202,828
45	3,940	1,696,694	0	16,967	1,510,058	169,669
50	3,320	1,429,702	0	14,297	1,272,435	142,970
55	2,810	1,210,079	0	12,101	1,076,970	121,008
60	2,380	1,024,907	0	10,249	912,167	102,491
65	2,020	869,879	0	8,699	774,192	86,988
70	1,660	714,851	0	7,149	636,217	71,485
75	1,360	585,661	0	5,857	521,238	58,566
80	1,110	478,003	0	4,780	425,422	47,800
85	851	366,469	0	3,665	326,157	36,647
90	630	271,299	0	2,713	241,456	27,130
95	348	149,860	0	1,499	133,376	14,986
100	29	12,488	0	125	11,115	1,249

NA = Not Applicable

Table 5-64 Total Suspended Solids TMDL Calculations for Red Rock Creek, Lower (OK621200050010_00)

Percentile	Flow (cfs)	TMDL (lb/day)	WLA (lb/day)		LA (lb/day)	MOS (lb/day)
			WWTP	Future growth		
0	133,729	NA	NA	NA	NA	NA
5	15,096	NA	NA	NA	NA	NA
10	9,237	NA	NA	NA	NA	NA
15	6,473	NA	NA	NA	NA	NA
20	4,977	NA	NA	NA	NA	NA
25	3,902	739,516	3	7,395	621,190	110,927
30	3,150	597,100	3	5,971	501,561	89,565
35	2,571	487,349	3	4,873	409,370	73,102
40	2,137	405,035	3	4,050	340,227	60,755
45	1,806	342,320	3	3,423	287,546	51,348
50	1,523	288,751	3	2,888	242,548	43,313
55	1,324	250,861	3	2,509	210,720	37,629
60	1,144	216,890	3	2,169	182,185	32,533
65	965	182,919	3	1,829	153,649	27,438
70	813	154,175	3	1,542	129,504	23,126
75	669	126,737	3	1,267	106,456	19,011
80	547	103,611	3	1,036	87,030	15,542
85	433	82,052	3	821	68,921	12,308
90	329	62,323	3	623	52,349	9,348
95	226	42,855	3	429	35,996	6,428
100	10	1,960	3	20	1,643	294

NA = Not Applicable

Table 5-65 Total Suspended Solids TMDL Calculations for Red Rock Creek, Upper (OK621200050010_10)

Percentile	Flow (cfs)	TMDL (lb/day)	WLA (lb/day)		LA (lb/day)	MOS (lb/day)
			WWTP	Future growth		
0	75,685	NA	NA	NA	NA	NA
5	8,544	NA	NA	NA	NA	NA
10	5,228	NA	NA	NA	NA	NA
15	3,663	NA	NA	NA	NA	NA
20	2,817	NA	NA	NA	NA	NA
25	2,208	449,070	0	4,491	377,219	67,361
30	1,783	362,588	0	3,626	304,574	54,388
35	1,455	295,942	0	2,959	248,591	44,391
40	1,209	245,957	0	2,460	206,604	36,894
45	1,022	207,873	0	2,079	174,614	31,181
50	862	175,344	0	1,753	147,289	26,302
55	749	152,335	0	1,523	127,961	22,850
60	648	131,706	0	1,317	110,633	19,756
65	546	111,077	0	1,111	93,305	16,662
70	460	93,622	0	936	78,643	14,043
75	378	76,961	0	770	64,647	11,544
80	309	62,917	0	629	52,851	9,438
85	245	49,826	0	498	41,854	7,474
90	186	37,846	0	378	31,790	5,677
95	128	26,024	0	260	21,860	3,904
100	5.9	1,190	0	12	1,000	179

NA = Not Applicable

Table 5-66 Total Suspended Solids TMDL Calculations for Chilocco Creek (OK621210000270_00)

Percentile	Flow (cfs)	TMDL (lb/day)	WLA (lb/day)		LA (lb/day)	MOS (lb/day)
			WWTP	Future growth		
0	1,778	NA	NA	NA	NA	NA
5	58	NA	NA	NA	NA	NA
10	25	NA	NA	NA	NA	NA
15	15	NA	NA	NA	NA	NA
20	11	NA	NA	NA	NA	NA
25	9	1,892	0	19	1,590	284
30	7	1,557	0	16	1,308	234
35	6	1,308	0	13	1,099	196
40	5.2	1,108	0	11	931	166
45	4.6	962	0	10	808	144
50	4.0	849	0	8	713	127
55	3.5	741	0	7	622	111
60	3.0	638	0	6	536	96
65	2.6	551	0	6	463	83
70	2.2	465	0	5	391	70
75	1.8	389	0	4	327	58
80	1.4	303	0	3	254	45
85	1.0	222	0	2	186	33
90	0.7	141	0	1	118	21
95	0.2	45	0	0	38	7
100	0	0	0	0	0	0

NA = Not Applicable

5.9 Reasonable Assurances

ODEQ 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 provide reasonable assurance that the pollutant reductions as required by these TMDLs can be achieved and water quality can be restored to maintain designated uses. ODEQ'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 (ODEQ 2006). The CPP can be viewed from ODEQ's website at http://www.deq.state.ok.us/WQDnew/pubs.html Table 5-67 provides a partial list of the state partner agencies ODEQ will collaborate with to address point and nonpoint source reduction goals established by TMDLs.

Table 5-67 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/watchabl.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

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 USEPA and the National Resources Conservation Service of the USDA, 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.

As authorized by Section 402 of the CWA, the ODEQ has delegation of the NPDES Program in Oklahoma, except for certain jurisdictional areas related to agriculture and the oil and gas industry retained by State Department of Agriculture and Oklahoma Corporation Commission, for which the USEPA has retained permitting authority. The NPDES Program in Oklahoma is implemented via Title 252, Chapter 606 of the Oklahoma Pollution Discharge Elimination System (OPDES) Act and in accordance with the agreement between ODEQ and USEPA relating to administration and enforcement of the delegated NPDES Program. Implementation of point source WLAs is done through permits issued under the OPDES program.

The reduction rates called for in this TMDL report are as high as 96 percent. The ODEQ recognizes that achieving such high reductions will be a challenge, especially since unregulated nonpoint sources are a major cause of both bacteria 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 USEPA. Additionally, USEPA 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 bacteria 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 are based on USEPA guidelines (See 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 USEPA studies that could result in revisions to their recommendations are ongoing. The use of the three indicators specified in Oklahoma's standards should be evaluated. The numeric criteria values should also be evaluated using a risk-based method such as that found in USEPA guidance.

Unless or until the WQSs are revised and approved by USEPA, 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.

SECTION 6
PUBLIC PARTICIPATION

The Salt Fork of the Arkansas Bacterial and Turbidity TMDL Report was sent to other related State agencies and local government agencies for peer review and then submitted to EPA to be Preliminarily Reviewed on June 16, 2011. EPA completed their review on July 7, 2011. On July 15, 2011 a public notice about the Salt Fork of the Arkansas Bacterial and Turbidity TMDL Report was posted on the DEQ webpage at http://www.deq.state.ok.us/wqdnew/index.htm and was sent to persons on the DEQ contact list who either have requested all notices or live in the watershed of interest. In addition, the public notice was sent to local newspapers and/or other publications in the watershed area affected by this TMDL.

The public was given a 45-day opportunity to review the Salt Fork of the Arkansas Bacterial and Turbidity TMDL Report, submit comments to DEQ, and/or request a public meeting. The public comment period ended on August 30, 2011. DEQ received one comment from Quang Pham at the Oklahoma Department of Agriculture, Food and Forestry (ODAFF) during the public comment period. The response to his comment can be found in Appendix G, and the changes were incorporated into this TMDL Report. There were no requests for a public meeting.

SECTION 7
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APPENDIX A
Ambient Water Quality Data

Table A-1 Bacteria Data - 1998 to 2008

Waterbody ID	WQM Station	Date	FC[1]	EC[1]	ENT[1]
OK621000010010_30	OK621000010010-001AT	05/09/2001		85	3000
OK621000010010_30	OK621000010010-001AT	06/04/2001	390	96	2000
OK621000010010_30	OK621000010010-001AT	06/06/2001		96	2000
OK621000010010_30	OK621000010010-001AT	07/09/2001	20	20	600
OK621000010010_30	OK621000010010-001AT	07/09/2001		20	600
OK621000010010_30	OK621000010010-001AT	08/06/2001	10	10	1000
OK621000010010_30	OK621000010010-001AT	08/06/2001		10	1000
OK621000010010_30	OK621000010010-001AT	09/10/2001	370	41	700
OK621000010010_30	OK621000010010-001AT	05/15/2002	10	10	9000
OK621000010010_30	OK621000010010-001AT	05/15/2002		10	9000
OK621000010010_30	OK621000010010-001AT	05/15/2002		10	9000
OK621000010010_30	621000010010-01	05/15/2002	10	10	1500
OK621000010010_30	621000010010-01	06/02/2002	10		
OK621000010010_30	OK621000010010-001AT	07/10/2002	10	10	1900
OK621000010010_30	OK621000010010-001AT	08/28/2002	10	10	300
OK621000010010_30	OK621000010010-001AT	08/28/2002		10	300
OK621000010010_30	OK621000010010-001AT	08/28/2002		10	300
OK621000010010_30	621000010010-01	08/28/2002	190	20	120
OK621000010010_30	OK621000010010-001AT	09/25/2002	500	318	500
OK621000010010_30	621000010010-01	09/25/2002	500	146	300
OK621000010010_30	621000010010-01	05/03/2004	200	52	700
OK621000010010_30	621000010010-01	05/03/2004	1000	110	1000
OK621000010010_30	621000010010-01	06/01/2004	200	31	300
OK621000010010_30	621000010010-01	06/15/2004	10	10	200
OK621000010010_30	621000010010-01	06/15/2004	100	10	100
OK621000010010_30	621000010010-01	06/21/2004	3500	235	7700
OK621000010010_30	621000010010-01	07/06/2004	7300	1130	3900
OK621000010010_30	621000010010-01	07/19/2004	40	41	1400
OK621000010010_30	621000010010-01	07/19/2004	200	41	2600
OK621000010010_30	621000010010-01	08/09/2004	70	30	1200
OK621000010010_30	621000010010-01	08/23/2004	70	10	52
OK621000010010_30	621000010010-01	08/23/2004	110	20	63
OK621000010010_30	621000010010-01	09/13/2004	10	10	52
OK621000010010_30	621000010010-01	09/28/2004	20	10	265
OK621000020130_00	OK621000020130G	05/16/2000	500		
OK621000020130_00	OK621000020130G	06/20/2000	1200		
OK621000020130_00	OK621000020130G	07/25/2000	1000		
OK621000020130_00	OK621000020130G	08/29/2000	200	763	14000
OK621000020130_00	OK621000020130G	05/08/2001	2000	2142	3000
OK621000020130_00	OK621000020130G	06/12/2001	4200	3654	2000
OK621000020130_00	OK621000020130G	07/23/2001	>300	610	185
OK621000020130_00	OK621000020130G	08/20/2001	>300	>400	110
OK621000020130_00	OK621000020130G	09/24/2001	1210	1030	260
OK621000030010_00	OK621000030010C	05/16/2000	700		
OK621000030010_00	OK621000030010C	06/20/2000	3000		

Waterbody ID	WQM Station	Date	FC[1]	EC[1]	ENT[1]
OK621000030010_00	OK621000030010C	07/25/2000	42000		
OK621000030010_00	OK621000030010C	08/29/2000	140	10	90
OK621000030010_00	OK621000030010C	05/08/2001	8000	1017	10000
OK621000030010_00	OK621000030010C	06/12/2001	3000	223	800
OK621000030010_00	OK621000030010C	07/23/2001	>300	>400	345
OK621000030010_00	OK621000030010C	08/20/2001	>300	>400	120
OK621000030010_00	OK621000030010C	09/24/2001	260	90	170
OK621000030010_00	OK621000030010C	07/22/2002		300	20
OK621000030010_00	OK621000030010C	08/26/2002		>1600	40
OK621000030010_00	OK621000030010C	09/30/2002		140	15
OK621000030010_00	OK621000030010C	06/03/2003		1980	870
OK621000030010_00	OK621000030010C	08/12/2003		240	140
OK621000030010_00	OK621000030010C	09/25/2003		240	470
OK621000030010_00	OK621000030010C	06/02/2004		80	70
OK621000030010_00	OK621000030010C	05/29/2007		440	960
OK621000030010_00	OK621000030010C	06/25/2007		140	300
OK621000030010_00	OK621000030010C	07/03/2007		120	400
OK621000030010_00	OK621000030010C	07/30/2007		200	260
OK621000030010_00	OK621000030010C	09/10/2007		60	600
OK621000030010_00	OK621000030010C	05/12/2008		540	40
OK621000030010_00	OK621000030010C	06/24/2008		240	520
OK621000030010_00	OK621000030010C	07/29/2008		70	160
OK621000030010_00	OK621000030010C	08/25/2008		10	10
OK621000040010_00	OK621000040010D	07/22/2002		130	40
OK621000040010_00	OK621000040010D	08/26/2002		800	20
OK621000040010_00	OK621000040010D	09/30/2002		40	60
OK621000040010_00	OK621000040010D	06/03/2003		100	60
OK621000040010_00	OK621000040010D	07/08/2003		60	60
OK621000040010_00	OK621000040010D	08/12/2003		40	<20
OK621000040010_00	OK621000040010D	09/23/2003		970	480
OK621000040010_00	OK621000040010D	06/02/2004		50	50
OK621000040010_00	OK621000040010D	05/29/2007		2000	>5000
OK621000040010_00	OK621000040010D	06/25/2007		80	60
OK621000040010_00	OK621000040010D	07/03/2007		220	520
OK621000040010_00	OK621000040010D	07/30/2007		30	20
OK621000040010_00	OK621000040010D	09/10/2007		180	240
OK621000040010_00	OK621000040010D	05/12/2008		480	60
OK621000040010_00	OK621000040010D	06/24/2008		40	220
OK621000040010_00	OK621000040010D	07/29/2008		70	500
OK621000040010_00	OK621000040010D	08/25/2008		30	10
OK621000050010_00	OK621000050010D	07/29/2002		>1600	>1500
OK621000050010_00	OK621000050010D	09/03/2002		120	<20
OK621000050010_00	OK621000050010D	05/06/2003		440	480
OK621000050010_00	OK621000050010D	06/09/2003		420	1900
OK621000050010_00	OK621000050010D	07/14/2003		10	115
OK621000050010_00	OK621000050010D	08/18/2003		40	170
OK621000050010_00	OK621000050010D	09/22/2003		>1000	>1000

Waterbody ID	WQM Station	Date	FC[1]	EC[1]	ENT[1]
OK621000050010_00	OK621000050010D	06/07/2004		230	285
OK621000050010_00	OK621000050010D	06/05/2007		320	960
OK621000050010_00	OK621000050010D	07/09/2007		70	190
OK621000050010_00	OK621000050010D	07/23/2007		100	170
OK621000050010_00	OK621000050010D	08/06/2007		300	170
OK621000050010_00	OK621000050010D	09/18/2007		190	210
OK621000050010_00	OK621000050010D	05/20/2008		200	370
OK621000050010_00	OK621000050010D	06/24/2008		160	260
OK621000050010_00	OK621000050010D	07/29/2008		90	240
OK621000050010_00	OK621000050010D	09/03/2008		100	180
OK621000060010_00	OK621000060010C	09/03/2002		20	<20
OK621000060010_00	OK621000060010C	05/06/2003		900	200
OK621000060010_00	OK621000060010C	06/09/2003		440	1160
OK621000060010_00	OK621000060010C	07/14/2003		130	120
OK621000060010_00	OK621000060010C	08/18/2003		<10	30
OK621000060010_00	OK621000060010C	09/22/2003		530	330
OK621000060010_00	OK621000060010C	06/05/2007		460	360
OK621000060010_00	OK621000060010C	07/09/2007		70	110
OK621000060010_00	OK621000060010C	07/23/2007		110	10
OK621000060010_00	OK621000060010C	08/06/2007		20	80
OK621000060010_00	OK621000060010C	09/18/2007		60	270
OK621000060010_00	OK621000060010C	05/20/2008		530	20
OK621000060010_00	OK621000060010C	06/24/2008		380	600
OK621000060010_00	OK621000060010C	07/29/2008		180	330
OK621000060010_00	OK621000060010C	09/03/2008		110	110
OK621010010010_00	OK621010010010D	07/29/2002		30	80
OK621010010010_00	OK621010010010D	09/03/2002		<20	<20
OK621010010010_00	OK621010010010D	05/06/2003		40	20
OK621010010010_00	OK621010010010D	06/09/2003		20	<20
OK621010010010_00	OK621010010010D	07/14/2003		<10	10
OK621010010010_00	OK621010010010D	08/18/2003		<10	20
OK621010010010_00	OK621010010010D	09/22/2003		40	30
OK621010010010_00	OK621010010010D	06/07/2004		70	30
OK621010010010_00	OK621010010010D	06/05/2007		40	20
OK621010010010_00	OK621010010010D	07/09/2007		10	<10
OK621010010010_00	OK621010010010D	07/23/2007		<10	<10
OK621010010010_00	OK621010010010D	08/06/2007		<10	<10
OK621010010010_00	OK621010010010D	09/18/2007		30	250
OK621010010010_00	OK621010010010D	05/20/2008		<10	10
OK621010010010_00	OK621010010010D	06/24/2008		<20	<20
OK621010010010_00	OK621010010010D	07/29/2008		<10	50
OK621010010010_00	OK621010010010D	09/23/2008		10	>1000
OK621010010090_00	OK621010010090R	07/30/2002		1920	650
OK621010010090_00	OK621010010090R	09/04/2002		<20	140
OK621010010090_00	OK621010010090R	05/06/2003		60	20
OK621010010090_00	OK621010010090R	06/09/2003		500	1840
OK621010010090_00	OK621010010090R	07/14/2003		40	70

Waterbody ID	WQM Station	Date	FC[1]	EC[1]	ENT[1]
OK621010010090_00	OK621010010090R	08/18/2003		<10	120
OK621010010090_00	OK621010010090R	09/22/2003		250	>1000
OK621010010090_00	OK621010010090R	06/08/2004		>500	100
OK621010010090_00	OK621010010090R	06/05/2007		520	900
OK621010010090_00	OK621010010090R	07/09/2007		180	180
OK621010010090_00	OK621010010090R	07/23/2007		20	90
OK621010010090_00	OK621010010090R	08/07/2007		80	160
OK621010010090_00	OK621010010090R	09/17/2007		100	90
OK621010010090_00	OK621010010090R	05/20/2008		370	170
OK621010010090_00	OK621010010090R	06/24/2008		380	540
OK621010010090_00	OK621010010090R	07/29/2008		190	460
OK621010010090_00	OK621010010090R	09/02/2008		40	10
OK621010010160_00	OK621010010160-001AT	06/01/1999	1900	4611	900
OK621010010160_00	OK621010010160-001AT	07/06/1999	540	364	30
OK621010010160_00	OK621010010160-001AT	08/02/1999	200	85	5
OK621010010160_00	OK621010010160-001AT	09/07/1999	520	6630	380
OK621010010160_00	OK621010010160-001AT	05/17/2000	300	73	270
OK621010010160_00	OK621010010160-001AT	06/20/2000	380	122	350
OK621010010160_00	OK621010010160-001AT	07/26/2000	2600	177	200
OK621010010160_00	OK621010010160-001AT	08/23/2000	730	130	480
OK621010010160_00	OK621010010160-001AT	09/20/2000	1600	865	9000
OK621010010160_00	OK621010010160-001AT	05/08/2001	1700	324	4000
OK621010010160_00	OK621010010160-001AT	06/05/2001	700	116	900
OK621010010160_00	OK621010010160-001AT	06/05/2001		116	900
OK621010010160_00	OK621010010160-001AT	06/05/2001		116	900
OK621010010160_00	621010010160-01	06/05/2001	700	132	1500
OK621010010160_00	OK621010010160-001AT	07/10/2001	300	20	210
OK621010010160_00	OK621010010160-001AT	07/10/2001		20	210
OK621010010160_00	OK621010010160-001AT	08/07/2001	700	202	5000
OK621010010160_00	OK621010010160-001AT	08/07/2001		202	5000
OK621010010160_00	OK621010010160-001AT	09/24/2001	2000	228	1900
OK621010010160_00	OK621010010160-001AT	09/24/2001		228	1900
OK621010010160_00	OK621010010160-001AT	05/14/2002	15000	4884	18000
OK621010010160_00	OK621010010160-001AT	06/05/2002	1800	1222	8000
OK621010010160_00	OK621010010160-001AT	07/10/2002	1400	823	15000
OK621010010160_00	OK621010010160-001AT	08/27/2002	2000	272	13000
OK621010010160_00	OK621010010160-001AT	08/27/2002		272	13000
OK621010010160_00	OK621010010160-001AT	08/27/2002		272	13000
OK621010010160_00	621010010160-01	08/27/2002	7000	443	17000
OK621010010160_00	OK621010010160-001AT	09/24/2002	4000	581	5000
OK621010010160_00	621010010160-01	09/24/2002	100	474	600
OK621010010160_00	OK621010010160-001AT	05/06/2003	100	30	200
OK621010010160_00	621010010160-01	05/06/2003	140	20	280
OK621010010160_00	OK621010010160-001AT	05/26/2003	500	97	5000
OK621010010160_00	OK621010010160-001AT	06/10/2003	800	121	11000
OK621010010160_00	OK621010010160-001AT	07/01/2003	900	422	600
OK621010010160_00	OK621010010160-001AT	07/08/2003	200	86	200

Waterbody ID	WQM Station	Date	FC[1]	EC[1]	ENT[1]
OK621010010160_00	OK621010010160-001AT	08/05/2003	3000	1497	17000
OK621010010160_00	OK621010010160-001AT	08/12/2003	1100	520	1500
OK621010010160_00	OK621010010160-001AT	09/09/2003	500	121	1900
OK621010010160_00	OK621010010160-001AT	09/16/2003	600	132	1000
OK621010010230_00	OK621010010230G	05/16/2000	200		
OK621010010230_00	OK621010010230G	07/25/2000	8000		
OK621010010230_00	OK621010010230G	08/28/2000	400	235	1000
OK621010010230_00	OK621010010230G	05/15/2001	300	472	5000
OK621010010230_00	OK621010010230G	06/18/2001	1500	243	600
OK621010010230_00	OK621010010230G	07/24/2001	380	155	345
OK621010010230_00	OK621010010230G	08/21/2001		>400	720
OK621010010230_00	OK621010010230G	09/24/2001	350	160	180
OK621010010230_00	OK621010010230G	07/30/2002		1630	1975
OK621010010230_00	OK621010010230G	09/04/2002		<20	300
OK621010010230_00	OK621010010230G	05/06/2003		80	340
OK621010010230_00	OK621010010230G	06/10/2003		220	780
OK621010010230_00	OK621010010230G	07/15/2003		>2000	1100
OK621010010230_00	OK621010010230G	08/19/2003		90	340
OK621010010230_00	OK621010010230G	09/22/2003		560	970
OK621010010230_00	OK621010010230G	06/08/2004		195	145
OK621010010230_00	OK621010010230G	06/04/2007		720	820
OK621010010230_00	OK621010010230G	07/10/2007		890	620
OK621010010230_00	OK621010010230G	07/23/2007		480	380
OK621010010230_00	OK621010010230G	08/07/2007		340	820
OK621010010230_00	OK621010010230G	09/17/2007		>1000	>1000
OK621010010230_00	OK621010010230G	05/19/2008		280	480
OK621010010230_00	OK621010010230G	06/23/2008		740	880
OK621010010270_00	OK621010010270G	05/23/2000	5000		
OK621010010270_00	OK621010010270G	06/27/2000	600		
OK621010010270_00	OK621010010270G	07/24/2000	21000		
OK621010010270_00	OK621010010270G	08/28/2000	140	20	70
OK621010010270_00	OK621010010270G	05/15/2001	300	85	80
OK621010010270_00	OK621010010270G	06/18/2001	100	20	40
OK621010010270_00	OK621010010270G	07/24/2001	400	260	375
OK621010010270_00	OK621010010270G	08/21/2001	305	280	230
OK621010010270_00	OK621010010270G	09/25/2001	510	300	100
OK621010010270_00	OK621010010270G	07/30/2002		760	290
OK621010010270_00	OK621010010270G	09/04/2002		<20	60
OK621010010270_00	OK621010010270G	05/06/2003		380	<20
OK621010010270_00	OK621010010270G	06/09/2003		20	120
OK621010010270_00	OK621010-01-0270C	07/14/2003		30	<2000
OK621010010270_00	OK621010-01-0270C	08/18/2003		<10	250
OK621010010270_00	OK621010-01-0270C	09/22/2003		170	50
OK621010010270_00	OK621010-01-0270C	06/08/2004		155	70
OK621010010270_00	OK621010-01-0270C	06/04/2007		310	40
OK621010010270_00	OK621010-01-0270C	07/10/2007		230	160
OK621010010270_00	OK621010-01-0270C	07/23/2007		30	150

Waterbody ID	WQM Station	Date	FC[1]	EC[1]	ENT[1]
OK621010010270_00	OK621010-01-0270C	08/07/2007		480	40
OK621010010270_00	OK621010-01-0270C	09/17/2007		130	60
OK621010010270_00	OK621010-01-0270C	05/19/2008		110	10
OK621010010270_00	OK621010-01-0270C	06/23/2008		80	40
OK621010020010_00	OK621010020010G	05/16/2000	500		
OK621010020010_00	OK621010020010G	06/20/2000	700		
OK621010020010_00	OK621010020010G	07/25/2000	8000		
OK621010020010_00	OK621010020010G	08/29/2000	7400	5298	1800
OK621010020010_00	OK621010020010G	05/08/2001	15000	578	1000
OK621010020010_00	OK621010020010G	06/12/2001	500	171	1400
OK621010020010_00	OK621010020010G	07/23/2001	620	235	155
OK621010020010_00	OK621010020010G	09/24/2001	165	83	180
OK621010020010_00	OK621010020010G	07/29/2002		650	250
OK621010020010_00	OK621010020010G	09/03/2002		<20	<20
OK621010020010_00	OK621010020010G	05/06/2003		160	160
OK621010020010_00	OK621010020010G	06/10/2003		880	1020
OK621010020010_00	OK621010-02-0010D	07/15/2003		300	230
OK621010020010_00	OK621010-02-0010D	08/15/2003		110	530
OK621010020010_00	OK621010-02-0010D	09/23/2003		>1000	555
OK621010020010_00	OK621010-02-0010D	06/07/2004		185	45
OK621010020010_00	OK621010-02-0010D	06/05/2007		560	840
OK621010020010_00	OK621010-02-0010D	07/09/2007		90	120
OK621010020010_00	OK621010-02-0010D	07/23/2007		170	40
OK621010020010_00	OK621010-02-0010D	08/06/2007		140	20
OK621010020010_00	OK621010-02-0010D	09/18/2007		580	420
OK621010020010_00	OK621010-02-0010D	05/19/2008		630	110
OK621010020010_00	OK621010-02-0010D	06/23/2008		720	920
OK621010020010_00	OK621010-02-0010D	07/28/2008		270	170
OK621010020010_00	OK621010-02-0010D	09/02/2008		130	140
OK621010030010_00	OK621010030010D	07/29/2002		1330	460
OK621010030010_00	OK621010030010D	09/03/2002		60	80
OK621010030010_00	OK621010030010D	05/06/2003		180	70
OK621010030010_00	OK621010030010D	06/10/2003		430	1710
OK621010030010_00	OK621010030010D	07/15/2003		210	570
OK621010030010_00	OK621010030010D	08/19/2003		>1000	>1000
OK621010030010_00	OK621010030010D	09/23/2003		270	300
OK621010030010_00	OK621010030010D	06/07/2004		380	145
OK621010030010_00	OK621010030010D	06/04/2007		620	760
OK621010030010_00	OK621010030010D	07/10/2007		170	160
OK621010030010_00	OK621010030010D	07/23/2007		40	30
OK621010030010_00	OK621010030010D	08/06/2007		60	120
OK621010030010_00	OK621010030010D	09/18/2007		240	750
OK621010030010_00	OK621010030010D	05/19/2008		200	50
OK621010030010_00	OK621010030010D	06/23/2008		520	140
OK621010030010_00	OK621010030010D	07/28/2008		350	230
OK621010030010_00	OK621010030010D	09/02/2008		160	>1000
OK621010030030_00	OK621010030030C	07/29/2002		>4000	5150

Waterbody ID	WQM Station	Date	FC[1]	EC[1]	ENT[1]
OK621010030030_00	OK621010030030C	09/03/2002		<20	60
OK621010030030_00	OK621010030030C	05/06/2003		260	100
OK621010030030_00	OK621010030030C	06/10/2003		780	980
OK621010030030_00	OK621010030030C	07/15/2003		100	280
OK621010030030_00	OK621010030030C	08/19/2003		80	480
OK621010030030_00	OK621010030030C	09/23/2003		150	360
OK621010030030_00	OK621010030030C	06/07/2004		490	350
OK621010030030_00	OK621010030030C	06/04/2007		540	640
OK621010030030_00	OK621010030030C	07/10/2007		180	510
OK621010030030_00	OK621010030030C	07/23/2007		<10	80
OK621010030030_00	OK621010030030C	08/06/2007		130	30
OK621010030030_00	OK621010030030C	09/18/2007		360	340
OK621010030030_00	OK621010030030C	05/19/2008		190	180
OK621010030030_00	OK621010030030C	06/23/2008		120	280
OK621010030030_00	OK621010030030C	07/28/2008		290	>1000
OK621010030030_00	OK621010030030C	09/02/2008		50	190
OK621100000010_00	OK621100-00-0010M	07/22/2002		50	20
OK621100000010_00	OK621100-00-0010M	08/26/2002		1880	<20
OK621100000010_00	OK621100-00-0010M	09/30/2002		20	20
OK621100000010_00	OK621100-00-0010M	06/03/2003		140	240
OK621100000010_00	OK621100-00-0010M	07/08/2003		10	<10
OK621100000010_00	OK621100-00-0010M	08/12/2003		20	<20
OK621100000010_00	OK621100-00-0010M	09/23/2003		>2000	1660
OK621100000010_00	OK621100-00-0010M	06/02/2004		10	<10
OK621100000010_00	OK621100-00-0010M	05/29/2007		1200	>2000
OK621100000010_00	OK621100-00-0010M	06/25/2007		100	300
OK621100000010_00	OK621100-00-0010M	07/03/2007		540	460
OK621100000010_00	OK621100-00-0010M	07/30/2007		30	40
OK621100000010_00	OK621100-00-0010M	09/10/2007		<20	40
OK621100000010_00	OK621100-00-0010M	05/12/2008		540	40
OK621100000010_00	OK621100-00-0010M	06/24/2008		40	40
OK621100000010_00	OK621100-00-0010M	07/29/2008		320	280
OK621100000010_00	OK621100-00-0010M	08/25/2008		20	10
OK621100000010_10	OK621100000010-001AT	06/07/1999	380	285	410
OK621100000010_10	OK621100000010-001AT	07/06/1999	160	110	30
OK621100000010_10	OK621100000010-001AT	08/25/1999	14000	9804	500
OK621100000010_10	OK621100000010-001AT	09/07/1999	5	10	130
OK621100000010_10	OK621100000010-001AT	05/17/2000	180	63	100
OK621100000010_10	OK621100000010-001AT	06/21/2000	1030	496	2300
OK621100000010_10	OK621100000010-001AT	07/26/2000	2700	2247	3800
OK621100000010_10	OK621100000010-001AT	08/23/2000	30	10	20
OK621100000010_10	OK621100000010-001AT	09/18/2000	5	10	50
OK621100000010_10	OK621100000010-001AT	05/09/2001	400	195	120
OK621100000010_10	OK621100000010-001AT	06/06/2001	500	275	7000
OK621100000010_10	OK621100000010-001AT	07/11/2001	100	5	300
OK621100000010_10	OK621100000010-001AT	08/08/2001	40	10	140
OK621100000010_10	OK621100000010-001AT	09/24/2001	5100	839	11000

Waterbody ID	WQM Station	Date	FC[1]	EC[1]	ENT[1]
OK621100000010_10	OK621100000010-001AT	05/15/2002	1000	448	800
OK621100000010_10	OK621100000010-001AT	07/10/2002	10	20	120
OK621100000010_10	OK621100000010B	07/22/2002		130	30
OK621100000010_10	OK621100000010B	08/26/2002		>1600	40
OK621100000010_10	OK621100000010-001AT	08/28/2002	200	30	1100
OK621100000010_10	OK621100000010-001AT	09/25/2002	400	61	1600
OK621100000010_10	OK621100000010B	09/30/2002		<20	<20
OK621100000010_10	OK621100000010B	06/03/2003		270	480
OK621100000010_10	OK621100000010B	07/08/2003		20	40
OK621100000010_10	OK621100-00-0010B	08/12/2003		60	<20
OK621100000010_10	OK621100-00-0010B	09/23/2003		>2000	1960
OK621100000010_10	621100000010-01	05/03/2004	2000	173	2000
OK621100000010_10	621100000010-01	05/04/2004	10	10	10
OK621100000010_10	621100000010-01	06/01/2004	90	10	50
OK621100000010_10	OK621100-00-0010B	06/02/2004		30	10
OK621100000010_10	621100000010-01	06/15/2004	80	20	100
OK621100000010_10	621100000010-01	06/16/2004	10	10	10
OK621100000010_10	621100000010-01	06/21/2004	1200	459	3900
OK621100000010_10	OK621100-00-0010B	05/29/2007		850	2850
OK621100000010_10	OK621100-00-0010B	06/25/2007		220	440
OK621100000010_10	OK621100-00-0010B	07/03/2007		420	460
OK621100000010_10	OK621100-00-0010B	07/30/2007		10	20
OK621100000010_10	OK621100-00-0010B	09/10/2007		10	20
OK621100000010_10	OK621100-00-0010B	05/12/2008		300	80
OK621100000010_10	OK621100-00-0010B	08/25/2008		20	30
OK621100000100_00	OK621100000100G	05/16/2000	400		
OK621100000100_00	OK621100000100G	06/20/2000	1500		
OK621100000100_00	OK621100000100G	07/25/2000	5000		
OK621100000100_00	OK621100000100G	08/29/2000	490	183	210
OK621100000100_00	OK621100000100G	05/08/2001	400	63	300
OK621100000100_00	OK621100000100G	06/12/2001	400	84	500
OK621100000100_00	OK621100000100G	07/23/2001	>300	425	95
OK621100000100_00	OK621100000100G	08/20/2001	>300	>400	15
OK621100000100_00	OK621100000100G	09/24/2001	80	60	120
OK621100000100_00	OK621100000100G	07/22/2002		60	20
OK621100000100_00	OK621100000100G	08/26/2002		900	>5000
OK621100000100_00	OK621100000100G	09/30/2002		140	20
OK621100000100_00	OK621100000100G	06/03/2003		1730	>3000
OK621100000100_00	OK621100000100G	07/08/2003		30	80
OK621100000100_00	OK621100000100G	08/12/2003		100	40
OK621100000100_00	OK621100000100G	09/23/2003		>1000	>1000
OK621100000100_00	OK621100000100G	06/02/2004		50	100
OK621100000100_00	OK621100000100G	05/29/2007		360	240
OK621100000100_00	OK621100000100G	06/25/2007		100	40
OK621100000100_00	OK621100000100G	07/03/2007		180	420
OK621100000100_00	OK621100000100G	07/30/2007		110	90
OK621100000100_00	OK621100000100G	09/10/2007		40	60

Waterbody ID	WQM Station	Date	FC[1]	EC[1]	ENT[1]
OK621100000100_00	OK621100000100G	05/12/2008		260	140
OK621100000100_00	OK621100000100G	06/24/2008		180	160
OK621100000100_00	OK621100000100G	06/24/2008		200	220
OK621100000100_00	OK621100000100G	07/29/2008		70	130
OK621100000100_00	OK621100000100G	07/29/2008		60	180
OK621100000100_00	OK621100000100G	08/25/2008		10	30
OK621200010200_00	OK621200010200-001AT	05/17/2000	140	146	50
OK621200010200_00	OK621200010200-001AT	06/21/2000	40	337	360
OK621200010200_00	OK621200010200-001AT	07/26/2000	800	120	2200
OK621200010200_00	OK621200010200-001AT	08/23/2000	60	5	10
OK621200010200_00	OK621200010200-001AT	09/18/2000	5	5	40
OK621200010200_00	OK621200010200-001AT	05/09/2001	200	121	1000
OK621200010200_00	OK621200010200-001AT	06/06/2001	70	20	1600
OK621200010200_00	OK621200010200-001AT	06/06/2001		20	1600
OK621200010200_00	OK621200010200-001AT	07/11/2001	5	5	80
OK621200010200_00	OK621200010200-001AT	08/08/2001	10	10	20
OK621200010200_00	OK621200010200-001AT	08/08/2001		10	20
OK621200010200_00	OK621200010200-001AT	09/24/2001		132	200
OK621200010200_00	OK621200010200-001AT	05/08/2002	300	85	500
OK621200010200_00	OK621200010200-001AT	05/08/2002		85	500
OK621200010200_00	OK621200010200-001AT	07/09/2002	10	10	20
OK621200010200_00	OK621200010200-001AT	08/26/2002	6000	291	1300
OK621200010200_00	OK621200010200-001AT	08/26/2002		291	1300
OK621200010200_00	OK621200010200-001AT	09/23/2002	4000	332	300
OK621200010200_00	621200010200-01	05/03/2004	3000	288	200
OK621200010200_00	621200010200-01	06/01/2004	80	20	40
OK621200010200_00	621200010200-01	06/21/2004	100	20	100
OK621200030010_00	OK621200-03-0010G	05/20/1998	230		
OK621200030010_00	OK621200-03-0010G	05/26/1998	>16000		
OK621200030010_00	OK621200-03-0010G	06/17/1998	1300		
OK621200030010_00	OK621200-03-0010G	07/23/1998	<200		
OK621200030010_00	OK621200-03-0010G	08/17/1998	<200		
OK621200030010_00	OK621200-03-0010G	09/21/1998	<200		
OK621200030010_00	OK621200-03-0010D	07/23/2002		720	170
OK621200030010_00	OK621200-03-0010M	07/23/2002		580	180
OK621200030010_00	OK621200-03-0010W	08/05/2002		70	20
OK621200030010_00	OK621200-03-0010D	08/27/2002		2100	1250
OK621200030010_00	OK621200-03-0010M	08/27/2002		3000	700
OK621200030010_00	OK621200-03-0010W	09/03/2002		<20	<20
OK621200030010_00	OK621200-03-0010W	09/30/2002		100	
OK621200030010_00	OK621200-03-0010D	06/03/2003		1110	790
OK621200030010_00	OK621200-03-0010M	06/03/2003		270	170
OK621200030010_00	OK621200-03-0010W	06/03/2003		340	190
OK621200030010_00	OK621200-03-0010W	07/07/2003		50	120
OK621200030010_00	OK621200-03-0010D	07/08/2003		130	140
OK621200030010_00	OK621200-03-0010M	07/08/2003		50	290
OK621200030010_00	OK621200-03-0010W	08/11/2003		<20	<20

Waterbody ID	WQM Station	Date	FC[1]	EC[1]	ENT[1]
OK621200030010_00	OK621200-03-0010D	08/12/2003		20	20
OK621200030010_00	OK621200-03-0010M	08/12/2003		40	20
OK621200030010_00	OK621200-03-0010W	09/15/2003		670	440
OK621200030010_00	OK621200-03-0010D	09/16/2003		670	390
OK621200030010_00	OK621200-03-0010M	09/16/2003		730	210
OK621200030010_00	OK621200-03-0010W	06/01/2004		30	30
OK621200030010_00	OK621200-03-0010D	06/08/2004		>500	95
OK621200030010_00	OK621200-03-0010M	06/08/2004		160	135
OK621200030010_00	OK621200-03-0010M	05/29/2007		1450	1500
OK621200030010_00	OK621200-03-0010W	05/29/2007		1550	2400
OK621200030010_00	OK621200-03-0010D	05/30/2007		1050	1550
OK621200030010_00	OK621200-03-0010D	06/26/2007		360	260
OK621200030010_00	OK621200-03-0010M	06/26/2007		2700	4300
OK621200030010_00	OK621200-03-0010W	06/26/2007		1700	>5000
OK621200030010_00	OK621200-03-0010D	07/03/2007		260	1100
OK621200030010_00	OK621200-03-0010M	07/25/2007		160	710
OK621200030010_00	OK621200-03-0010W	07/25/2007		490	200
OK621200030010_00	OK621200-03-0010M	07/30/2007		80	330
OK621200030010_00	OK621200-03-0010W	07/30/2007		150	270
OK621200030010_00	OK621200-03-0010D	08/06/2007		<10	10
OK621200030010_00	OK621200-03-0010M	09/10/2007		3900	>10000
OK621200030010_00	OK621200-03-0010W	09/10/2007		>5000	>5000
OK621200030010_00	OK621200-03-0010D	09/11/2007		4000	2100
OK621200030010_00	OK621200-03-0010W	05/12/2008		320	540
OK621200030010_00	OK621200-03-0010D	05/13/2008		100	60
OK621200030010_00	OK621200-03-0010M	06/16/2008		2100	4100
OK621200030010_00	OK621200-03-0010W	06/16/2008		600	500
OK621200030010_00	OK621200-03-0010D	06/17/2008		5600	8300
OK621200030010_00	OK621200-03-0010D	06/24/2008		60	220
OK621200030010_00	OK621200-03-0010M	07/21/2008		180	40
OK621200030010_00	OK621200-03-0010W	07/21/2008		250	150
OK621200030010_00	OK621200-03-0010D	07/22/2008		70	160
OK621200030010_00	OK621200-03-0010D	08/26/2008		10	<10
OK621200030010_00	OK621200-03-0010M	08/26/2008		20	30
OK621200030010_00	OK621200-03-0010W	08/26/2008		10	20
OK621200030010_00	OK621200-03-0010D	09/29/2008		20	20
OK621200030010_00	OK621200-03-0010M	09/30/2008		50	130
OK621200030010_00	OK621200-03-0010W	09/30/2008		170	180
OK621200050010_00	OK621200-05-0010K	05/20/1998	70		
OK621200050010_00	OK621200-05-0010K	05/26/1998	>16000		
OK621200050010_00	OK621200-05-0010K	06/17/1998	200		
OK621200050010_00	OK621200-05-0010K	07/23/1998	200		
OK621200050010_00	OK621200-05-0010K	08/17/1998	<200		
OK621200050010_00	OK621200-05-0010K	09/21/1998	<200		
OK621200050010_00	OK621200-05-0010K	08/05/2002		940	400
OK621200050010_00	OK621200-05-0010K	09/03/2002		60	<20
OK621200050010_00	OK621200-05-0010K	09/30/2002		164	

Waterbody ID	WQM Station	Date	FC[1]	EC[1]	ENT[1]
OK621200050010_00	OK621200-05-0010K	06/03/2003		150	100
OK621200050010_00	OK621200-05-0010K	07/07/2003		160	330
OK621200050010_00	OK621200-05-0010K	08/11/2003		80	20
OK621200050010_00	OK621200-05-0010K	09/15/2003		200	595
OK621200050010_00	OK621200-05-0010K	06/01/2004		230	240
OK621200050010_00	OK621200-05-0010K	05/29/2007		1750	1950
OK621200050010_00	OK621200-05-0010K	06/26/2007		650	3000
OK621200050010_00	OK621200-05-0010K	07/25/2007		290	100
OK621200050010_00	OK621200-05-0010K	07/31/2007		2950	4150
OK621200050010_00	OK621200-05-0010K	09/10/2007		>5000	>5000
OK621200050010_00	OK621200-05-0010K	05/12/2008		500	640
OK621200050010_00	OK621200-05-0010K	06/16/2008		6800	>10000
OK621200050010_00	OK621200-05-0010K	07/21/2008		180	150
OK621200050010_00	OK621200-05-0010K	08/25/2008		140	10
OK621200050010_00	OK621200-05-0010K	09/30/2008		130	100
OK621200050010_10	OK621200-05-0010M	08/05/2002		>1600	240
OK621200050010_10	OK621200-05-0010M	09/03/2002		120	240
OK621200050010_10	OK621200-05-0010M	09/30/2002		100	
OK621200050010_10	OK621200-05-0010M	06/03/2003		260	170
OK621200050010_10	OK621200-05-0010M	07/07/2003		50	120
OK621200050010_10	OK621200-05-0010M	08/11/2003		220	20
OK621200050010_10	OK621200-05-0010M	09/15/2003		80	320
OK621200050010_10	OK621200-05-0010M	06/01/2004		240	310
OK621200050010_10	OK621200-05-0010M	05/29/2007		1900	1900
OK621200050010_10	OK621200-05-0010M	06/26/2007		800	3850
OK621200050010_10	OK621200-05-0010M	07/25/2007		250	120
OK621200050010_10	OK621200-05-0010M	07/30/2007		150	90
OK621200050010_10	OK621200-05-0010M	09/10/2007		>5000	>5000
OK621200050010_10	OK621200-05-0010M	05/12/2008		300	620
OK621200050010_10	OK621200-05-0010M	06/16/2008		2600	3700
OK621200050010_10	OK621200-05-0010M	07/21/2008		220	90
OK621200050010_10	OK621200-05-0010M	08/25/2008		220	230
OK621200050010_10	OK621200-05-0010M	09/30/2008		800	150
OK621210000050_10	OK621210-00-0050L	07/23/2002		1120	440
OK621210000050_10	OK621210-00-0050L	08/27/2002		340	160
OK621210000050_10	OK621210-00-0050L	06/02/2003		>3000	>3000
OK621210000050_10	OK621210-00-0050L	07/07/2003		20	<10
OK621210000050_10	OK621210-00-0050L	08/11/2003		60	200
OK621210000050_10	OK621210-00-0050L	09/22/2003		130	160
OK621210000050_10	OK621210-00-0050L	06/01/2004		150	30
OK621210000050_10	OK621210-00-0050L	05/29/2007		720	310
OK621210000050_10	OK621210-00-0050L	06/25/2007		1520	920
OK621210000050_10	OK621210-00-0050L	07/30/2007		220	150
OK621210000050_10	OK621210-00-0050L	09/10/2007		280	540
OK621210000050_10	OK621210-00-0050L	05/13/2008		340	20
OK621210000050_10	OK621210-00-0050L	06/17/2008		5800	6900
OK621210000050_10	OK621210-00-0050L	06/24/2008		60	340

Waterbody ID	WQM Station	Date	FC[1]	EC[1]	ENT[1]
OK621210000050_10	OK621210-00-0050L	07/22/2008		90	370
OK621210000050_10	OK621210-00-0050L	08/26/2008		100	460
OK621210000050_10	OK621210-00-0050L	09/29/2008		40	80
OK621210000270_00	OK621210-00-0270C	07/23/2002		>800	690
OK621210000270_00	OK621210-00-0270C	08/27/2002		1440	80
OK621210000270_00	OK621210-00-0270C	07/07/2003		<10	<10
OK621210000270_00	OK621210-00-0270C	08/11/2003		100	40
OK621210000270_00	OK621210-00-0270C	09/22/2003		60	230
OK621210000270_00	OK621210-00-0270C	05/29/2007		340	590
OK621210000270_00	OK621210-00-0270C	06/25/2007		220	120
OK621210000270_00	OK621210-00-0270C	07/03/2007		100	70
OK621210000270_00	OK621210-00-0270C	07/30/2007		150	560
OK621210000270_00	OK621210-00-0270C	09/10/2007		440	320
OK621210000270_00	OK621210-00-0270C	05/13/2008		340	80
OK621210000270_00	OK621210-00-0270C	06/24/2008		80	200
OK621210000270_00	OK621210-00-0270C	07/29/2008		430	>1000
OK621210000270_00	OK621210-00-0270C	08/25/2008		150	20

FC = fecal coliform (STORET Code: 31610); EC = *E. coli* (STORET Code: 31609); ENT = enterococci (STORET Code: 31649)

[1] Units = counts/100 mL

Table A-2 Turbidity and Total Suspended Solids Data - 1998 to 2009

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621000010010_30	OK621000010010-001AT	11/13/2000	92	124	high
OK621000010010_30	OK621000010010-001AT	02/07/2001	80		low
OK621000010010_30	OK621000010010-001AT	03/07/2001	86		high
OK621000010010_30	OK621000010010-001AT	04/04/2001	118		high
OK621000010010_30	OK621000010010-001AT	05/09/2001	645		low
OK621000010010_30	OK621000010010-001AT	06/06/2001	231		high
OK621000010010_30	OK621000010010-001AT	07/11/2001	46		low
OK621000010010_30	OK621000010010-001AT	08/08/2001	20		low
OK621000010010_30	OK621000010010-001AT	10/03/2001	72		low
OK621000010010_30	OK621000010010-001AT	02/06/2002	27		low
OK621000010010_30	OK621000010010-001AT	03/13/2002	23		low
OK621000010010_30	OK621000010010-001AT	04/10/2002	37		low
OK621000010010_30	OK621000010010-001AT	05/15/2002	63		low
OK621000010010_30	OK621000010010-001AT	06/05/2002	1000		low
OK621000010010_30	OK621000010010-001AT	08/28/2002	228		low
OK621000030010_00	OK621000030010F	05/16/2000	49.3	91	low
OK621000030010_00	OK621000030010F	06/20/2000	56.5	755	high
OK621000030010_00	OK621000030010F	07/25/2000	582	196	high
OK621000030010_00	OK621000030010F	08/29/2000	17.3	36	low
OK621000030010_00	OK621000030010F	10/03/2000	17.8	16	low
OK621000030010_00	OK621000030010F	11/06/2000	829	950	high
OK621000030010_00	OK621000030010F	12/11/2000	16.9	9	low
OK621000030010_00	OK621000030010F	01/22/2001	21.4	1	low
OK621000030010_00	OK621000030010F	02/26/2001	>1000	830	high
OK621000030010_00	OK621000030010F	04/02/2001	24.1	28	low
OK621000030010_00	OK621000030010F	05/08/2001	627	81	low
OK621000030010_00	OK621000030010F	06/12/2001	82.2	65	low
OK621000030010_00	OK621000030010F	07/23/2001	28	32	low
OK621000030010_00	OK621000030010F	08/20/2001	10.9	14	low
OK621000030010_00	OK621000030010F	09/24/2001	21.7	30	low
OK621000030010_00	OK621000030010F	10/29/2001	12.1	<10	low
OK621000030010_00	OK621000030010F	12/10/2001	12.9	15	low
OK621000030010_00	OK621000030010F	01/14/2002	15.1	<10	low
OK621000030010_00	OK621000030010F	02/19/2002	31.5	25	low
OK621000030010_00	OK621000030010F	03/25/2002	40.4	40	low
OK621000030010_00	OK621000030010C	07/22/2002	73.7	25	low
OK621000030010_00	OK621000030010C	08/26/2002	201	166	low
OK621000030010_00	OK621000030010C	09/30/2002	23.3	33	low

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621000030010_00	OK621000030010C	11/04/2002	53.1	68	high
OK621000030010_00	OK621000030010C	12/03/2002	8.23	<10	low
OK621000030010_00	OK621000030010C	01/14/2003	6.47	32	low
OK621000030010_00	OK621000030010C	02/19/2003	34.5	35	low
OK621000030010_00	OK621000030010C	03/24/2003	115	117	low
OK621000030010_00	OK621000030010C	04/28/2003	64.8	112	high
OK621000030010_00	OK621000030010C	06/03/2003	467	266	high
OK621000030010_00	OK621000030010C	08/12/2003	68.9	61	low
OK621000030010_00	OK621000030010C	09/25/2003	24.5	141	high
OK621000030010_00	OK621000030010C	10/21/2003	45	44	high
OK621000030010_00	OK621000030010C	12/02/2003	11.5	<10	low
OK621000030010_00	OK621000030010C	01/05/2004	2.23	<10	low
OK621000030010_00	OK621000030010C	02/09/2004	17.6	20	high
OK621000030010_00	OK621000030010C	03/15/2004	50	38	low
OK621000030010_00	OK621000030010C	04/26/2004	107	29	high
OK621000030010_00	OK621000030010C	06/02/2004	38	50	low
OK621000030010_00	OK621000030010C	10/21/2004	18.1		low
OK621000030010_00	OK621000030010C	05/29/2007	60.2	102	high
OK621000030010_00	OK621000030010C	06/25/2007	28.2	22	high
OK621000030010_00	OK621000030010C	07/30/2007	20.4	22	high
OK621000030010_00	OK621000030010C	09/04/2007	40.7		low
OK621000030010_00	OK621000030010C	09/10/2007	38.5	43	high
OK621000030010_00	OK621000030010C	10/07/2007		56	low
OK621000030010_00	OK621000030010C	10/15/2007	41.6	63	high
OK621000030010_00	OK621000030010C	11/13/2007	20.7	25	low
OK621000030010_00	OK621000030010C	12/17/2007	61.3	<10	high
OK621000030010_00	OK621000030010C	01/22/2008	6.98	<10	low
OK621000030010_00	OK621000030010C	03/03/2008	77.7	101	high
OK621000030010_00	OK621000030010C	04/07/2008	27.2	33	high
OK621000030010_00	OK621000030010C	05/12/2008	115	99	high
OK621000030010_00	OK621000030010C	06/24/2008	40.2	59	high
OK621000030010_00	OK621000030010C	07/29/2008		24	low
OK621000030010_00	OK621000030010C	08/25/2008	41.2	35	low
OK621000030010_00	OK621000030010C	11/18/2008	11.9	<10	low
OK621000030010_00	OK621000030010C	12/30/2008	13.1	<10	low
OK621000030010_00	OK621000030010C	02/10/2009	23.5	23	high
OK621000030010_00	OK621000030010C	03/10/2009	31.2	35	low
OK621000030010_00	OK621000030010C	04/14/2009	443	323	high
OK621000040010_00	OK621000040010D	07/22/2002	26.1	<10	low

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621000040010_00	OK621000040010D	08/26/2002	84.1	<10	low
OK621000040010_00	OK621000040010D	09/30/2002	24.5	29	low
OK621000040010_00	OK621000040010D	11/04/2002	93.7	45	low
OK621000040010_00	OK621000040010D	12/03/2002	6.42	<10	low
OK621000040010_00	OK621000040010D	01/14/2003	6.37	32	low
OK621000040010_00	OK621000040010D	02/19/2003	12.7	14	low
OK621000040010_00	OK621000040010D	03/24/2003	129	120	low
OK621000040010_00	OK621000040010D	04/28/2003	108	103	low
OK621000040010_00	OK621000040010D	06/03/2003	36.1	48	low
OK621000040010_00	OK621000040010D	07/08/2003	41	52	low
OK621000040010_00	OK621000040010D	08/12/2003	48.2	62	low
OK621000040010_00	OK621000040010D	09/23/2003	420	252	low
OK621000040010_00	OK621000040010D	10/21/2003	66.1	43	low
OK621000040010_00	OK621000040010D	12/02/2003	6.43	<10	low
OK621000040010_00	OK621000040010D	01/05/2004	2.9	<10	low
OK621000040010_00	OK621000040010D	02/09/2004	41.7	35	low
OK621000040010_00	OK621000040010D	03/15/2004	34.1	32	low
OK621000040010_00	OK621000040010D	04/26/2004	302	267	low
OK621000040010_00	OK621000040010D	06/02/2004	81.3	90	low
OK621000040010_00	OK621000040010D	05/29/2007	385	311	high
OK621000040010_00	OK621000040010D	06/25/2007	83.6	65	low
OK621000040010_00	OK621000040010D	07/30/2007	20.3	40	low
OK621000040010_00	OK621000040010D	09/10/2007	120	104	low
OK621000040010_00	OK621000040010D	09/18/2007	58.4		low
OK621000040010_00	OK621000040010D	10/07/2007	40.3	43	low
OK621000040010_00	OK621000040010D	10/15/2007	>1000	2655	high
OK621000040010_00	OK621000040010D	11/13/2007	14.1	11	low
OK621000040010_00	OK621000040010D	12/17/2007	21.7	<10	low
OK621000040010_00	OK621000040010D	01/22/2008	9.59	<10	low
OK621000040010_00	OK621000040010D	03/03/2008	481	880	high
OK621000040010_00	OK621000040010D	04/07/2008	36.7	35	low
OK621000040010_00	OK621000040010D	05/12/2008	115	61	low
OK621000040010_00	OK621000040010D	06/24/2008	22.2	25	low
OK621000040010_00	OK621000040010D	07/29/2008		49	low
OK621000040010_00	OK621000040010D	08/25/2008	37.7	49	low
OK621000040010_00	OK621000040010D	11/18/2008	8.07	<10	low
OK621000040010_00	OK621000040010D	12/30/2008	25.9	12	low
OK621000040010_00	OK621000040010D	02/10/2009	14.6	24	low
OK621000040010_00	OK621000040010D	03/10/2009	28.2	42	low

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621000040010_00	OK621000040010D	04/14/2009	144	67	high
OK621000050010_00	OK621000050010D	07/29/2002		14	low
OK621000050010_00	OK621000050010D	08/07/2002	350		low
OK621000050010_00	OK621000050010D	09/03/2002	183	10	low
OK621000050010_00	OK621000050010D	10/07/2002	783	112	high
OK621000050010_00	OK621000050010D	11/12/2002	50.6	35	low
OK621000050010_00	OK621000050010D	12/09/2002	8.92	<10	low
OK621000050010_00	OK621000050010D	01/21/2003	13.7	11	low
OK621000050010_00	OK621000050010D	03/12/2003	34.8	26	low
OK621000050010_00	OK621000050010D	03/31/2003	71.3	93	low
OK621000050010_00	OK621000050010D	05/06/2003	190	110	low
OK621000050010_00	OK621000050010D	06/09/2003	196	140	low
OK621000050010_00	OK621000050010D	07/14/2003	72.8	59	low
OK621000050010_00	OK621000050010D	08/18/2003	62.3	64	low
OK621000050010_00	OK621000050010D	09/22/2003	>1000	613	low
OK621000050010_00	OK621000050010D	10/27/2003	22.1	<10	low
OK621000050010_00	OK621000050010D	12/08/2003	4.82	11	low
OK621000050010_00	OK621000050010D	01/12/2004	5.41	<10	low
OK621000050010_00	OK621000050010D	02/17/2004	244	112	low
OK621000050010_00	OK621000050010D	03/22/2004	90.8	88	low
OK621000050010_00	OK621000050010D	04/19/2004	59.2	69	low
OK621000050010_00	OK621000050010D	06/07/2004	200	169	low
OK621000050010_00	OK621000050010D	06/05/2007	210	101	high
OK621000050010_00	OK621000050010D	07/09/2007	84.7	60	high
OK621000050010_00	OK621000050010D	08/06/2007	44.3	44	low
OK621000050010_00	OK621000050010D	08/09/2007	35.8		low
OK621000050010_00	OK621000050010D	09/18/2007	49.7	38	low
OK621000050010_00	OK621000050010D	10/07/2007	48.9	83	low
OK621000050010_00	OK621000050010D	10/23/2007	620	340	low
OK621000050010_00	OK621000050010D	11/27/2007	6.65	<10	low
OK621000050010_00	OK621000050010D	01/08/2008	171	100	low
OK621000050010_00	OK621000050010D	02/05/2008	305	207	low
OK621000050010_00	OK621000050010D	03/11/2008	136	69	low
OK621000050010_00	OK621000050010D	04/15/2008	213	90	high
OK621000050010_00	OK621000050010D	05/20/2008	87	66	low
OK621000050010_00	OK621000050010D	06/24/2008	75.1	79	high
OK621000050010_00	OK621000050010D	07/29/2008	21.9	16	low
OK621000050010_00	OK621000050010D	09/03/2008	47.1	36	low
OK621000050010_00	OK621000050010D	11/18/2008	9.84	<10	low

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621000050010_00	OK621000050010D	12/30/2008	8.03	<10	low
OK621000050010_00	OK621000050010D	02/10/2009	7.92	<10	low
OK621000050010_00	OK621000050010D	03/09/2009	22.1	<10	low
OK621000050010_00	OK621000050010D	04/14/2009	249	227	high
OK621000060010_00	OK621000060010C	08/08/2002	220		low
OK621000060010_00	OK621000060010C	09/03/2002	214	<10	low
OK621000060010_00	OK621000060010C	10/07/2002	223	76	low
OK621000060010_00	OK621000060010C	11/12/2002	15	45	low
OK621000060010_00	OK621000060010C	03/12/2003	19.2	23	low
OK621000060010_00	OK621000060010C	03/31/2003	40.8	51	low
OK621000060010_00	OK621000060010C	05/06/2003	69.4	53	low
OK621000060010_00	OK621000060010C	06/09/2003	78.8	81	low
OK621000060010_00	OK621000060010C	07/14/2003	14.9	21	low
OK621000060010_00	OK621000060010C	08/18/2003	17.2	15	low
OK621000060010_00	OK621000060010C	09/22/2003	51.7	50	low
OK621000060010_00	OK621000060010C	10/27/2003	6.35	<10	low
OK621000060010_00	OK621000060010C	12/08/2003	3.12	<10	low
OK621000060010_00	OK621000060010C	01/12/2004	4.91	<10	low
OK621000060010_00	OK621000060010C	02/17/2004	429	249	low
OK621000060010_00	OK621000060010C	06/05/2007	87.9	36	low
OK621000060010_00	OK621000060010C	07/09/2007	19.6	16	low
OK621000060010_00	OK621000060010C	08/06/2007	12.4	15	low
OK621000060010_00	OK621000060010C	08/09/2007	16		low
OK621000060010_00	OK621000060010C	09/18/2007	37.7	12	low
OK621000060010_00	OK621000060010C	10/23/2007	201	104	low
OK621000060010_00	OK621000060010C	11/27/2007	6.75	<10	low
OK621000060010_00	OK621000060010C	01/08/2008	19.8	33	low
OK621000060010_00	OK621000060010C	02/05/2008	31.5	48	low
OK621000060010_00	OK621000060010C	03/11/2008	71.9	38	low
OK621000060010_00	OK621000060010C	04/15/2008	116	70	low
OK621000060010_00	OK621000060010C	05/20/2008	52.7	61	low
OK621000060010_00	OK621000060010C	06/24/2008	39.6	37	low
OK621000060010_00	OK621000060010C	07/29/2008	25.5	30	low
OK621000060010_00	OK621000060010C	09/03/2008	11.5	<10	low
OK621000060010_00	OK621000060010C	10/20/2008	32.5	45	high
OK621000060010_00	OK621000060010C	11/18/2008	4.87	<10	low
OK621000060010_00	OK621000060010C	12/30/2008	3.64	<10	low
OK621000060010_00	OK621000060010C	02/10/2009	9.03	<10	low
OK621000060010_00	OK621000060010C	03/09/2009	7.39	30	low

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621000060010_00	OK621000060010C	04/14/2009	48.9	65	low
OK621010010010_00	OK621010010010D	06/25/2002	148		low
OK621010010010_00	OK621010010010D	07/29/2002	343	<10	low
OK621010010010_00	OK621010010010D	09/03/2002	142	53	low
OK621010010010_00	OK621010010010D	10/07/2002	591	77	high
OK621010010010_00	OK621010010010D	11/12/2002	176	108	high
OK621010010010_00	OK621010010010D	12/09/2002	26.4	26	low
OK621010010010_00	OK621010010010D	01/21/2003	31.9	33	low
OK621010010010_00	OK621010010010D	03/12/2003	33.7	28	low
OK621010010010_00	OK621010010010D	03/31/2003	112	88	low
OK621010010010_00	OK621010010010D	05/06/2003	364	241	low
OK621010010010_00	OK621010010010D	06/09/2003	125	97	low
OK621010010010_00	OK621010010010D	07/14/2003	65.7	80	low
OK621010010010_00	OK621010010010D	08/18/2003	95	80	low
OK621010010010_00	OK621010010010D	09/22/2003	276	210	low
OK621010010010_00	OK621010010010D	10/27/2003	103	84	low
OK621010010010_00	OK621010010010D	12/08/2003	73.5	68	low
OK621010010010_00	OK621010010010D	01/12/2004	58.5	58	low
OK621010010010_00	OK621010010010D	02/17/2004	34.7	20	low
OK621010010010_00	OK621010010010D	03/22/2004	177	152	low
OK621010010010_00	OK621010010010D	04/19/2004	261	201	low
OK621010010010_00	OK621010010010D	06/07/2004	225	141	low
OK621010010010_00	OK621010010010D	06/05/2007	59.4	36	low
OK621010010010_00	OK621010010010D	07/09/2007	84.3	69	low
OK621010010010_00	OK621010010010D	08/06/2007	223	188	low
OK621010010010_00	OK621010010010D	08/20/2007	113		low
OK621010010010_00	OK621010010010D	09/18/2007	236	194	low
OK621010010010_00	OK621010010010D	10/07/2007	934	488	low
OK621010010010_00	OK621010010010D	10/23/2007	144	123	low
OK621010010010_00	OK621010010010D	11/27/2007	64.5	53	low
OK621010010010_00	OK621010010010D	01/08/2008	187	177	low
OK621010010010_00	OK621010010010D	02/05/2008	87.1	83	low
OK621010010010_00	OK621010010010D	03/11/2008	146	168	low
OK621010010010_00	OK621010010010D	04/15/2008	98.8	126	low
OK621010010010_00	OK621010010010D	05/20/2008	74.9	52	low
OK621010010010_00	OK621010010010D	06/24/2008	153	85	low
OK621010010010_00	OK621010010010D	07/29/2008	90.3	81	low
OK621010010010_00	OK621010010010D	09/03/2008	19.6	36	low
OK621010010010_00	OK621010010010D	11/18/2008	39.5	25	low

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621010010010_00	OK621010010010D	12/30/2008	53.3	35	low
OK621010010010_00	OK621010010010D	02/10/2009	197	158	low
OK621010010010_00	OK621010010010D	03/09/2009	40.4	<10	low
OK621010010010_00	OK621010010010D	04/14/2009	81.9	71	low
OK621010010160_00	OK621010010160-001AT	12/01/1998	91.3	28	low
OK621010010160_00	OK621010010160-001AT	01/19/1999	45	74	low
OK621010010160_00	OK621010010160-001AT	02/08/1999	97	103	low
OK621010010160_00	OK621010010160-001AT	03/07/1999	22	43	low
OK621010010160_00	OK621010010160-001AT	04/05/1999	1000	1100	high
OK621010010160_00	OK621010010160-001AT	07/06/1999		102	low
OK621010010160_00	OK621010010160-001AT	08/02/1999	62	63	low
OK621010010160_00	OK621010010160-001AT	09/07/1999	16	26	low
OK621010010160_00	OK621010010160-001AT	10/18/1999	23	34	low
OK621010010160_00	OK621010010160-001AT	11/15/1999	23	30	low
OK621010010160_00	OK621010010160-001AT	12/13/1999	63	91	low
OK621010010160_00	OK621010010160-001AT	01/31/2000	148	113	low
OK621010010160_00	OK621010010160-001AT	02/22/2000	62	119	low
OK621010010160_00	OK621010010160-001AT	03/22/2000	164		low
OK621010010160_00	OK621010010160-001AT	04/17/2000	52	104	low
OK621010010160_00	OK621010010160-001AT	05/15/2000	55	146	low
OK621010010160_00	OK621010010160-001AT	06/20/2000	58	134	low
OK621010010160_00	OK621010010160-001AT	07/24/2000	1000	2650	low
OK621010010160_00	OK621010010160-001AT	08/21/2000	9	26	low
OK621010010160_00	OK621010010160-001AT	09/19/2000	4		low
OK621010010160_00	OK621010010160-001AT	11/13/2000	58	82	low
OK621010010160_00	OK621010010160-001AT	02/06/2001	67		low
OK621010010160_00	OK621010010160-001AT	03/06/2001	115		low
OK621010010160_00	OK621010010160-001AT	04/03/2001	51		low
OK621010010160_00	OK621010010160-001AT	05/08/2001	283		low
OK621010010160_00	OK621010010160-001AT	06/05/2001	185		low
OK621010010160_00	OK621010010160-001AT	08/07/2001	4		low
OK621010010160_00	OK621010010160-001AT	09/11/2001	5		low
OK621010010160_00	OK621010010160-001AT	10/02/2001	45		low
OK621010010160_00	OK621010010160-001AT	02/05/2002	645		low
OK621010010160_00	OK621010010160-001AT	03/12/2002	147		low
OK621010010160_00	OK621010010160-001AT	04/09/2002	64		low
OK621010010160_00	OK621010010160-001AT	05/14/2002	1000		low
OK621010010160_00	OK621010010160-001AT	06/05/2002	109		low
OK621010010160_00	OK621010010160-001AT	07/09/2002	7.5		low

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621010010160_00	OK621010010160-001AT	08/27/2002	21		low
OK621010010230_00	OK621010010230G	05/16/2000	33.5	77	low
OK621010010230_00	OK621010010230G	06/19/2000	50.4	82	low
OK621010010230_00	OK621010010230G	07/25/2000	114	138	low
OK621010010230_00	OK621010010230G	08/28/2000	23	56	low
OK621010010230_00	OK621010010230G	10/03/2000	29.6	46	low
OK621010010230_00	OK621010010230G	11/13/2000	21.6	50	low
OK621010010230_00	OK621010010230G	12/18/2000	5.11	11	low
OK621010010230_00	OK621010010230G	01/29/2001	11.4	16	low
OK621010010230_00	OK621010010230G	03/05/2001	27.6	8.2	low
OK621010010230_00	OK621010010230G	04/09/2001	17.2	52	low
OK621010010230_00	OK621010010230G	05/15/2001	89.9	94	low
OK621010010230_00	OK621010010230G	06/06/2001	91.5		low
OK621010010230_00	OK621010010230G	06/18/2001	28.1	35	low
OK621010010230_00	OK621010010230G	07/24/2001	73.8	12	low
OK621010010230_00	OK621010010230G	08/21/2001	35.2	13	low
OK621010010230_00	OK621010010230G	09/24/2001	12.3	10	low
OK621010010230_00	OK621010010230G	11/05/2001	6.79	<10	low
OK621010010230_00	OK621010010230G	12/10/2001	3.31	<10	low
OK621010010230_00	OK621010010230G	01/14/2002	9.81	<10	low
OK621010010230_00	OK621010010230G	02/19/2002	9.69	<10	low
OK621010010230_00	OK621010010230G	03/25/2002	15.5	<10	low
OK621010010230_00	OK621010010230G	06/27/2002	18.3	<10	low
OK621010010230_00	OK621010010230G	07/30/2002		<10	low
OK621010010230_00	OK621010010230G	09/04/2002	29.6	45	low
OK621010010230_00	OK621010010230G	10/08/2002	221	60	low
OK621010010230_00	OK621010010230G	11/13/2002	36.1	37	low
OK621010010230_00	OK621010010230G	12/10/2002	8.25	<10	low
OK621010010230_00	OK621010010230G	01/22/2003	6.06	<10	low
OK621010010230_00	OK621010010230G	03/12/2003	14.8	<10	low
OK621010010230_00	OK621010010230G	04/01/2003	9.19	25	low
OK621010010230_00	OK621010010230G	05/06/2003	58.6	48	low
OK621010010230_00	OK621010010230G	06/10/2003	77.4	59	low
OK621010010230_00	OK621010010230G	07/15/2003	14.1	21	low
OK621010010230_00	OK621010010230G	08/19/2003	66.4	60	low
OK621010010230_00	OK621010010230G	09/22/2003	15.6	33	low
OK621010010230_00	OK621010010230G	10/27/2003	9.94	49	low
OK621010010230_00	OK621010010230G	12/08/2003	5.09	<10	low
OK621010010230_00	OK621010010230G	01/12/2004	220	<10	low

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621010010230_00	OK621010010230G	02/17/2004	4.56	<10	low
OK621010010230_00	OK621010010230G	03/23/2004	20.6	<10	low
OK621010010230_00	OK621010010230G	04/20/2004	219	147	low
OK621010010230_00	OK621010010230G	06/08/2004	88.2	16	low
OK621010010230_00	OK621010010230G	06/04/2007	110	49	low
OK621010010230_00	OK621010010230G	07/10/2007	116	77	low
OK621010010230_00	OK621010010230G	07/17/2007	131		low
OK621010010230_00	OK621010010230G	08/07/2007	32.6	34	low
OK621010010230_00	OK621010010230G	09/17/2007	18.7	20	low
OK621010010230_00	OK621010010230G	10/22/2007	9.92	<10	low
OK621010010230_00	OK621010010230G	11/26/2007	2.62	<10	low
OK621010010230_00	OK621010010230G	01/07/2008	6.35	<10	low
OK621010010230_00	OK621010010230G	02/04/2008	6.9	<10	low
OK621010010230_00	OK621010010230G	03/10/2008	9.1	<10	low
OK621010010230_00	OK621010010230G	04/14/2008	15.8	14	low
OK621010010230_00	OK621010010230G	05/19/2008	52.7	43	low
OK621010010230_00	OK621010010230G	06/23/2008	31.3	51	low
OK621010010230_00	OK621010010230G	10/06/2008	84.5	65	low
OK621010010230_00	OK621010010230G	11/17/2008	9.71	<10	low
OK621010010230_00	OK621010010230G	12/29/2008	3.75	<10	low
OK621010010230_00	OK621010010230G	02/09/2009	12.3	22	low
OK621010010230_00	OK621010010230G	03/10/2009	17.1	<10	low
OK621010010230_00	OK621010010230G	04/13/2009	262	286	low
OK621010030010_00	OK621010030010D	06/26/2002	14.4		low
OK621010030010_00	OK621010030010D	07/29/2002	332	<10	low
OK621010030010_00	OK621010030010D	09/03/2002	87.2	92	low
OK621010030010_00	OK621010030010D	10/07/2002	514	232	low
OK621010030010_00	OK621010030010D	11/12/2002	31	33	low
OK621010030010_00	OK621010030010D	12/09/2002	32.5	26	low
OK621010030010_00	OK621010030010D	01/21/2003	23.8	19	low
OK621010030010_00	OK621010030010D	03/12/2003	32.1	38	low
OK621010030010_00	OK621010030010D	04/01/2003	54.2	83	high
OK621010030010_00	OK621010030010D	05/06/2003	45.3	84	low
OK621010030010_00	OK621010030010D	06/10/2003	76.3	86	high
OK621010030010_00	OK621010030010D	07/15/2003	3.19	10	low
OK621010030010_00	OK621010030010D	08/19/2003	2.94	10	low
OK621010030010_00	OK621010030010D	09/23/2003	60.8	24	low
OK621010030010_00	OK621010030010D	10/28/2003	30.8	26	low
OK621010030010_00	OK621010030010D	12/09/2003	15.1	16	low

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621010030010_00	OK621010030010D	01/13/2004	45.4	66	low
OK621010030010_00	OK621010030010D	02/18/2004	44.2	58	high
OK621010030010_00	OK621010030010D	03/22/2004	35.9	81	low
OK621010030010_00	OK621010030010D	04/19/2004	25.5	30	low
OK621010030010_00	OK621010030010D	06/07/2004	68.3	118	low
OK621010030010_00	OK621010030010D	06/04/2007	215	219	low
OK621010030010_00	OK621010030010D	07/10/2007	92.6	109	low
OK621010030010_00	OK621010030010D	08/06/2007	54.2	70	low
OK621010030010_00	OK621010030010D	08/27/2007	89.3		low
OK621010030010_00	OK621010030010D	09/18/2007	13.3	19	low
OK621010030010_00	OK621010030010D	10/23/2007	9.4	12	low
OK621010030010_00	OK621010030010D	11/27/2007	12.2	17	low
OK621010030010_00	OK621010030010D	01/07/2008	46.2	80	low
OK621010030010_00	OK621010030010D	02/05/2008	32.8	50	low
OK621010030010_00	OK621010030010D	03/10/2008	16.6	26	low
OK621010030010_00	OK621010030010D	04/15/2008	24.9	45	low
OK621010030010_00	OK621010030010D	05/19/2008	98.1	149	low
OK621010030010_00	OK621010030010D	06/23/2008	136	128	low
OK621010030010_00	OK621010030010D	07/28/2008	7.35	<10	low
OK621010030010_00	OK621010030010D	09/02/2008	2.57	<10	low
OK621010030010_00	OK621010030010D	10/07/2008	>1000	659	low
OK621010030010_00	OK621010030010D	11/17/2008	21.8	23	low
OK621010030010_00	OK621010030010D	12/30/2008	14.1	18	low
OK621010030010_00	OK621010030010D	02/10/2009	15.8	22	low
OK621010030010_00	OK621010030010D	03/09/2009	8.02	11	low
OK621010030010_00	OK621010030010D	04/13/2009	44.2	65	high
OK621010030030_00	OK621010030030C	06/26/2002	76.9		low
OK621010030030_00	OK621010030030C	07/29/2002		10	low
OK621010030030_00	OK621010030030C	09/03/2002	37.4	45	low
OK621010030030_00	OK621010030030C	10/07/2002	384	160	low
OK621010030030_00	OK621010030030C	11/12/2002	38.8	45	low
OK621010030030_00	OK621010030030C	12/09/2002	9.13	<10	low
OK621010030030_00	OK621010030030C	01/21/2003	10.2	<10	low
OK621010030030_00	OK621010030030C	03/12/2003	21	39	low
OK621010030030_00	OK621010030030C	04/01/2003	37.7	61	low
OK621010030030_00	OK621010030030C	05/06/2003	95.3	126	low
OK621010030030_00	OK621010030030C	06/10/2003	164	152	low
OK621010030030_00	OK621010030030C	07/15/2003	64.2	76	low
OK621010030030_00	OK621010030030C	08/19/2003	71	76	low

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621010030030_00	OK621010030030C	09/23/2003	45.7	10	low
OK621010030030_00	OK621010030030C	10/28/2003	35.1	36	low
OK621010030030_00	OK621010030030C	12/09/2003	21.4	20	low
OK621010030030_00	OK621010030030C	01/13/2004	17.1	23	low
OK621010030030_00	OK621010030030C	02/18/2004	28	34	low
OK621010030030_00	OK621010030030C	03/22/2004	14.5	<10	low
OK621010030030_00	OK621010030030C	04/19/2004	42.8	48	low
OK621010030030_00	OK621010030030C	06/07/2004	170	243	low
OK621010030030_00	OK621010030030C	06/04/2007	262	241	low
OK621010030030_00	OK621010030030C	07/10/2007	71.7	68	low
OK621010030030_00	OK621010030030C	08/06/2007	57.1	78	low
OK621010030030_00	OK621010030030C	08/21/2007	83.8		low
OK621010030030_00	OK621010030030C	09/18/2007	135	124	low
OK621010030030_00	OK621010030030C	10/23/2007	31	28	low
OK621010030030_00	OK621010030030C	11/27/2007	14.3	12	low
OK621010030030_00	OK621010030030C	01/07/2008	18.8	24	low
OK621010030030_00	OK621010030030C	02/04/2008	14.6	<10	low
OK621010030030_00	OK621010030030C	03/10/2008	25.6	21	low
OK621010030030_00	OK621010030030C	04/15/2008	40.7	44	low
OK621010030030_00	OK621010030030C	05/19/2008	128	118	low
OK621010030030_00	OK621010030030C	06/23/2008	72	76	low
OK621010030030_00	OK621010030030C	07/28/2008	94.6	76	low
OK621010030030_00	OK621010030030C	09/02/2008	36.4	69	low
OK621010030030_00	OK621010030030C	10/07/2008	829	277	low
OK621010030030_00	OK621010030030C	11/17/2008	27.7	20	low
OK621010030030_00	OK621010030030C	12/30/2008	8.61	<10	low
OK621010030030_00	OK621010030030C	02/10/2009	11.7	<10	low
OK621010030030_00	OK621010030030C	03/09/2009	21.1	32	low
OK621010030030_00	OK621010030030C	04/13/2009	39.1	40	low
OK621100000010_00	OK621100000010B	07/22/2002	55	70	low
OK621100000010_00	OK621100000010B	08/26/2002	152	20	low
OK621100000010_00	OK621100000010B	09/30/2002	18	27	low
OK621100000010_00	OK621100000010B	11/04/2002	133	88	low
OK621100000010_00	OK621100000010B	12/03/2002	5.61	<10	low
OK621100000010_00	OK621100000010B	01/14/2003	7.76	32	low
OK621100000010_00	OK621100000010B	02/19/2003	15.5	<10	low
OK621100000010_00	OK621100000010B	03/24/2003	492	437	high
OK621100000010_00	OK621100000010B	04/28/2003	228	200	high
OK621100000010_00	OK621100000010B	06/03/2003	486	533	high

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621100000010_00	OK621100000010B	07/08/2003	44.4	58	low
OK621100000010_00	OK621100000010B	08/12/2003	93.5	91	low
OK621100000010_00	OK621100000010B	09/23/2003	>1000	1321	high
OK621100000010_00	OK621100000010B	10/21/2003	41.7	37	high
OK621100000010_00	OK621100000010B	12/02/2003	5.95	<10	low
OK621100000010_00	OK621100000010B	01/05/2004	4.89	<10	low
OK621100000010_00	OK621100000010B	02/09/2004	26.5	33	high
OK621100000010_00	OK621100000010B	03/15/2004	73	73	high
OK621100000010_00	OK621100000010B	06/02/2004	76.5	120	low
OK621100000010_00	OK621100000010B	10/20/2004	24.5		low
OK621100000010_00	OK621100000010B	05/29/2007	489.1	556	high
OK621100000010_00	OK621100000010B	06/25/2007	166	242	high
OK621100000010_00	OK621100000010B	07/30/2007	54.2	65	high
OK621100000010_00	OK621100000010B	09/10/2007	62.2	49	high
OK621100000010_00	OK621100000010B	10/15/2007	39.6	46	low
OK621100000010_00	OK621100000010B	11/13/2007	10.8	12	low
OK621100000010_00	OK621100000010B	12/17/2007	76.1	341	low
OK621100000010_00	OK621100000010B	01/22/2008	11.3	16	low
OK621100000010_00	OK621100000010B	03/03/2008	69.5	84	high
OK621100000010_00	OK621100000010B	04/07/2008	24.9	28	high
OK621100000010_00	OK621100000010B	05/12/2008	256	341	high
OK621100000010_00	OK621100000010B	08/25/2008	53.2	61	low
OK621100000010_00	OK621100000010B	10/07/2008	53.4	63	high
OK621100000010_00	OK621100000010B	11/18/2008	38.8	32	high
OK621100000010_00	OK621100000010B	12/30/2008	55.8	48	high
OK621100000010_00	OK621100000010B	02/10/2009	12.3	15	high
OK621100000010_00	OK621100000010B	03/10/2009	15.7	23	low
OK621100000010_00	OK621100000010B	04/14/2009	369	571	high
OK621100000010_00	OK621100000010B	08/13/2009	56		low
OK621100000010_10	OK621100000010-001AT	01/20/1999	21	24	low
OK621100000010_10	OK621100000010-001AT	02/08/1999	56	86	high
OK621100000010_10	OK621100000010-001AT	03/07/1999	16	27	low
OK621100000010_10	OK621100000010-001AT	04/05/1999	588	536	high
OK621100000010_10	OK621100000010-001AT	05/05/1999		464	high
OK621100000010_10	OK621100000010-001AT	06/07/1999	123	92	high
OK621100000010_10	OK621100000010-001AT	07/06/1999		1	high
OK621100000010_10	OK621100000010-001AT	08/25/1999	74	48	low
OK621100000010_10	OK621100000010-001AT	09/07/1999	52	90	low
OK621100000010_10	OK621100000010-001AT	10/18/1999	25	22	low

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621100000010_10	OK621100000010-001AT	11/15/1999	21	26	low
OK621100000010_10	OK621100000010-001AT	12/13/1999	269	154	high
OK621100000010_10	OK621100000010-001AT	01/31/2000		1	low
OK621100000010_10	OK621100000010-001AT	02/22/2000		1	low
OK621100000010_10	OK621100000010-001AT	03/22/2000	161		high
OK621100000010_10	OK621100000010-001AT	05/16/2000	57	116	low
OK621100000010_10	OK621100000010M	05/16/2000	44	86	low
OK621100000010_10	OK621100000010-001AT	06/20/2000	74	96	high
OK621100000010_10	OK621100000010M	06/20/2000	158	138	low
OK621100000010_10	OK621100000010-001AT	07/24/2000	758	2250	high
OK621100000010_10	OK621100000010M	07/25/2000	20.4	36	low
OK621100000010_10	OK621100000010-001AT	08/22/2000	32	62	low
OK621100000010_10	OK621100000010M	08/29/2000	17.8	38	low
OK621100000010_10	OK621100000010-001AT	09/20/2000	26		low
OK621100000010_10	OK621100000010M	10/03/2000	12.6	40	low
OK621100000010_10	OK621100000010M	11/06/2000	841	2980	low
OK621100000010_10	OK621100000010-001AT	11/14/2000	25	28	high
OK621100000010_10	OK621100000010M	12/11/2000	10	7	low
OK621100000010_10	OK621100000010M	01/22/2001	6.77	22	low
OK621100000010_10	OK621100000010-001AT	02/07/2001	27		low
OK621100000010_10	OK621100000010M	02/26/2001	1000	260	low
OK621100000010_10	OK621100000010-001AT	03/06/2001	43		high
OK621100000010_10	OK621100000010M	04/02/2001	18.7	14	low
OK621100000010_10	OK621100000010-001AT	04/04/2001	35		high
OK621100000010_10	OK621100000010M	05/08/2001	76.2	118	low
OK621100000010_10	OK621100000010-001AT	05/09/2001	189		high
OK621100000010_10	OK621100000010M	06/05/2001	90.8		low
OK621100000010_10	OK621100000010-001AT	06/06/2001	107		high
OK621100000010_10	OK621100000010M	06/12/2001	75.3	55	low
OK621100000010_10	OK621100000010-001AT	07/11/2001	94		low
OK621100000010_10	OK621100000010M	07/23/2001	35	21	low
OK621100000010_10	OK621100000010-001AT	08/08/2001	69		low
OK621100000010_10	OK621100000010M	08/20/2001	24.7	56	low
OK621100000010_10	OK621100000010M	09/24/2001	42.3	59	low
OK621100000010_10	OK621100000010-001AT	10/03/2001	32		low
OK621100000010_10	OK621100000010M	10/29/2001	23.7	26	low
OK621100000010_10	OK621100000010M	12/10/2001	6.46	18	low
OK621100000010_10	OK621100000010M	01/14/2002	3.7	18	low
OK621100000010_10	OK621100000010-001AT	02/06/2002	11		low

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621100000010_10	OK621100000010M	02/19/2002	20.7	19	low
OK621100000010_10	OK621100000010-001AT	03/13/2002	16		low
OK621100000010_10	OK621100000010M	03/25/2002	44.7	60	low
OK621100000010_10	OK621100000010-001AT	04/10/2002	56		low
OK621100000010_10	OK621100000010-001AT	05/15/2002	509		high
OK621100000010_10	OK621100000010M	07/22/2002	34.5	47	low
OK621100000010_10	OK621100000010M	07/23/2002	42.8		low
OK621100000010_10	OK621100000010M	08/26/2002	139	12	low
OK621100000010_10	OK621100000010-001AT	08/28/2002	111		low
OK621100000010_10	OK621100000010M	09/30/2002	63.2	56	low
OK621100000010_10	OK621100000010M	11/04/2002	66.7	21	high
OK621100000010_10	OK621100000010M	12/03/2002	8.84	<10	low
OK621100000010_10	OK621100000010M	01/14/2003	5.41	<10	low
OK621100000010_10	OK621100000010M	02/19/2003	17.9	15	low
OK621100000010_10	OK621100000010M	03/24/2003	147	111	high
OK621100000010_10	OK621100000010M	04/28/2003	98.6	85	high
OK621100000010_10	OK621100000010M	06/03/2003	891	543	high
OK621100000010_10	OK621100000010M	07/08/2003	39.8	59	low
OK621100000010_10	OK621100000010M	08/12/2003	21.6	39	low
OK621100000010_10	OK621100000010M	08/13/2003	29.1		low
OK621100000010_10	OK621100000010M	09/23/2003	>1000	1114	high
OK621100000010_10	OK621100000010M	10/21/2003	28.4	29	high
OK621100000010_10	OK621100000010M	12/02/2003	6.43	<10	low
OK621100000010_10	OK621100000010M	01/05/2004	5.14	<10	low
OK621100000010_10	OK621100000010M	02/09/2004	36.5	30	high
OK621100000010_10	OK621100000010M	03/15/2004	43.1	48	high
OK621100000010_10	OK621100000010M	04/26/2004	398	43	high
OK621100000010_10	OK621100000010M	06/02/2004	56.4	87	low
OK621100000010_10	OK621100000010M	05/29/2007	482	402	high
OK621100000010_10	OK621100000010M	06/25/2007	177	137	high
OK621100000010_10	OK621100000010M	07/30/2007	36.7	65	high
OK621100000010_10	OK621100000010M	09/10/2007	46.2	41	low
OK621100000010_10	OK621100000010M	10/15/2007	84.7	202	high
OK621100000010_10	OK621100000010M	11/13/2007	10.5	22	low
OK621100000010_10	OK621100000010M	12/17/2007	39.1	<10	low
OK621100000010_10	OK621100000010M	01/22/2008	15.6	<10	low
OK621100000010_10	OK621100000010M	03/03/2008	>1000	1066	high
OK621100000010_10	OK621100000010M	04/07/2008	31.9	32	high
OK621100000010_10	OK621100000010M	05/12/2008	163	122	high

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621100000010_10	OK621100000010M	06/24/2008	58.4	62	high
OK621100000010_10	OK621100000010M	07/29/2008	68.7	254	low
OK621100000010_10	OK621100000010M	08/25/2008	36.4	30	low
OK621100000010_10	OK621100000010M	10/07/2008	19.5	32	high
OK621100000010_10	OK621100000010M	11/18/2008	23.3	11	high
OK621100000010_10	OK621100000010M	12/30/2008	21.8	22	high
OK621100000010_10	OK621100000010M	02/10/2009	13	17	low
OK621100000010_10	OK621100000010M	03/10/2009	11.3	29	low
OK621100000010_10	OK621100000010M	04/14/2009	135	126	high
OK621100000010_10	OK621100000010M	08/13/2009	43.7		low
OK621100000100_00	621100-00-0100G	05/16/2000	44	86	low
OK621100000100_00	621100-00-0100G	06/20/2000	158	138	low
OK621100000100_00	621100-00-0100G	07/25/2000	20.4	36	low
OK621100000100_00	621100-00-0100G	08/29/2000	17.8	38	low
OK621100000100_00	621100-00-0100G	10/03/2000	12.6	40	low
OK621100000100_00	621100-00-0100G	11/06/2000	841	2980	high
OK621100000100_00	621100-00-0100G	12/11/2000	10	7	low
OK621100000100_00	621100-00-0100G	01/22/2001	6.77	22	low
OK621100000100_00	621100-00-0100G	02/26/2001	>1000	260	high
OK621100000100_00	621100-00-0100G	04/02/2001	18.7	14	low
OK621100000100_00	621100-00-0100G	05/08/2001	76.2	118	low
OK621100000100_00	621100-00-0100G	06/05/2001	90.8		low
OK621100000100_00	621100-00-0100G	06/12/2001	75.3	55	low
OK621100000100_00	621100-00-0100G	07/23/2001	35	21	low
OK621100000100_00	621100-00-0100G	08/20/2001	24.7	56	low
OK621100000100_00	621100-00-0100G	09/24/2001	42.3	59	low
OK621100000100_00	621100-00-0100G	10/29/2001	23.7	26	low
OK621100000100_00	621100-00-0100G	12/10/2001	6.46	18	low
OK621100000100_00	621100-00-0100G	01/14/2002	3.7	18	low
OK621100000100_00	621100-00-0100G	02/19/2002	20.7	19	low
OK621100000100_00	621100-00-0100G	03/25/2002	44.7	60	low
OK621100000100_00	621100-00-0100G	07/22/2002	33.1	26	low
OK621100000100_00	621100-00-0100G	07/23/2002	54.2		low
OK621100000100_00	621100-00-0100G	08/26/2002	79.3	43	low
OK621100000100_00	621100-00-0100G	09/30/2002	47.7	54	low
OK621100000100_00	621100-00-0100G	11/04/2002	50.6	46	low
OK621100000100_00	621100-00-0100G	12/03/2002	4.67	42	low
OK621100000100_00	621100-00-0100G	01/14/2003	3.76	<10	low
OK621100000100_00	621100-00-0100G	02/19/2003	4.82	<10	low

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621100000100_00	621100-00-0100G	03/24/2003	36.6	46	low
OK621100000100_00	621100-00-0100G	04/28/2003	69.7	102	low
OK621100000100_00	621100-00-0100G	06/03/2003	55.7	67	low
OK621100000100_00	621100-00-0100G	07/08/2003	70.9	106	low
OK621100000100_00	621100-00-0100G	08/12/2003	77.2	88	low
OK621100000100_00	621100-00-0100G	09/23/2003	>1000	713	high
OK621100000100_00	621100-00-0100G	10/21/2003	42.2	27	low
OK621100000100_00	621100-00-0100G	12/02/2003	4	<10	low
OK621100000100_00	621100-00-0100G	01/05/2004	7.6	<10	low
OK621100000100_00	621100-00-0100G	02/09/2004	126	26	low
OK621100000100_00	621100-00-0100G	03/15/2004	49.1	56	low
OK621100000100_00	621100-00-0100G	04/26/2004	392	236	high
OK621100000100_00	621100-00-0100G	06/02/2004	71.1	103	low
OK621100000100_00	621100-00-0100G	05/29/2007	169	234	high
OK621100000100_00	621100-00-0100G	06/25/2007	61.8	70	low
OK621100000100_00	621100-00-0100G	07/30/2007	26.3	34	low
OK621100000100_00	621100-00-0100G	09/10/2007	69.5	81	low
OK621100000100_00	621100-00-0100G	10/15/2007	29.4	28	low
OK621100000100_00	621100-00-0100G	11/13/2007	13.7	19	low
OK621100000100_00	621100-00-0100G	12/17/2007	39.1	<10	low
OK621100000100_00	621100-00-0100G	01/22/2008	6.63	<10	low
OK621100000100_00	621100-00-0100G	03/03/2008	29.8	18	high
OK621100000100_00	621100-00-0100G	04/07/2008	11.3	15	low
OK621100000100_00	621100-00-0100G	05/12/2008	127	99	low
OK621100000100_00	621100-00-0100G	06/24/2008	139	120	high
OK621100000100_00	621100-00-0100G	06/24/2008	59.4	78	low
OK621100000100_00	621100-00-0100G	07/29/2008	42.4	123	low
OK621100000100_00	621100-00-0100G	07/29/2008		28	low
OK621100000100_00	621100-00-0100G	08/05/2008	19.8		low
OK621100000100_00	621100-00-0100G	08/25/2008	13.2	25	low
OK621100000100_00	621100-00-0100G	10/07/2008		24	low
OK621100000100_00	621100-00-0100G	11/18/2008	6.98	<10	low
OK621100000100_00	621100-00-0100G	12/30/2008	11.7	13	low
OK621100000100_00	621100-00-0100G	02/10/2009	6.89	<10	low
OK621100000100_00	621100-00-0100G	03/10/2009	15.8	16	high
OK621100000100_00	621100-00-0100G	04/14/2009	283	263	high
OK621200010200_00	OK621200010200-001AT	12/01/1998	1119	82	high
OK621200010200_00	OK621200010200-001AT	01/20/1999	16	14	low
OK621200010200_00	OK621200010200-001AT	02/09/1999	210	59	high

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621200010200_00	OK621200010200-001AT	03/07/1999		10	high
OK621200010200_00	OK621200010200-001AT	04/06/1999		1	low
OK621200010200_00	OK621200010200-001AT	05/17/1999		1	high
OK621200010200_00	OK621200010200-001AT	06/08/1999	227	128	high
OK621200010200_00	OK621200010200-001AT	07/06/1999		364	high
OK621200010200_00	OK621200010200-001AT	08/03/1999	52	56	high
OK621200010200_00	OK621200010200-001AT	09/08/1999	98	146	low
OK621200010200_00	OK621200010200-001AT	10/19/1999	32	46	low
OK621200010200_00	OK621200010200-001AT	11/16/1999	30	52	low
OK621200010200_00	OK621200010200-001AT	12/14/1999	316	232	high
OK621200010200_00	OK621200010200-001AT	05/16/2000	57	168	high
OK621200010200_00	OK621200010200-001AT	06/21/2000	155	148	high
OK621200010200_00	OK621200010200-001AT	07/25/2000	659	2350	high
OK621200010200_00	OK621200010200-001AT	08/22/2000	13	36	low
OK621200010200_00	OK621200010200-001AT	09/20/2000	15		low
OK621200010200_00	OK621200010200-001AT	10/17/2000	16	20	low
OK621200010200_00	OK621200010200-001AT	11/14/2000	58	82	high
OK621200010200_00	OK621200010200-001AT	02/07/2001	42		low
OK621200010200_00	OK621200010200-001AT	03/07/2001	74		high
OK621200010200_00	OK621200010200-001AT	04/04/2001	64		high
OK621200010200_00	OK621200010200-001AT	05/09/2001	25		low
OK621200010200_00	OK621200010200-001AT	06/06/2001	87		high
OK621200010200_00	OK621200010200-001AT	07/11/2001	38		high
OK621200010200_00	OK621200010200-001AT	08/08/2001	25		low
OK621200010200_00	OK621200010200-001AT	10/03/2001	35		low
OK621200010200_00	OK621200010200-001AT	02/06/2002	36		high
OK621200010200_00	OK621200010200-001AT	03/13/2002	13		low
OK621200010200_00	OK621200010200-001AT	04/10/2002	16		low
OK621200010200_00	OK621200010200-001AT	05/08/2002	71		low
OK621200010200_00	OK621200010200-001AT	08/26/2002	330		low
OK621200050010_00	OK621200050010K	08/05/2002	670	<10	low
OK621200050010_00	OK621200050010K	09/03/2002	382	113	low
OK621200050010_00	OK621200050010K	09/30/2002	524	29	low
OK621200050010_00	OK621200050010K	11/04/2002	299	210	low
OK621200050010_00	OK621200050010K	12/02/2002	23.3	31	low
OK621200050010_00	OK621200050010K	01/14/2003	29.3	<10	low
OK621200050010_00	OK621200050010K	02/18/2003	28.6	26	low
OK621200050010_00	OK621200050010K	03/24/2003	325	207	high
OK621200050010_00	OK621200050010K	04/28/2003	172	104	low

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621200050010_00	OK621200050010K	06/03/2003	113	121	low
OK621200050010_00	OK621200050010K	07/07/2003	223	112	low
OK621200050010_00	OK621200050010K	08/11/2003	63.4	51	low
OK621200050010_00	OK621200050010K	08/15/2003	64		low
OK621200050010_00	OK621200050010K	09/15/2003	69.9	73	low
OK621200050010_00	OK621200050010K	10/20/2003	320	195	low
OK621200050010_00	OK621200050010K	12/01/2003	325	54	low
OK621200050010_00	OK621200050010K	01/05/2004	33.1	19	low
OK621200050010_00	OK621200050010K	02/09/2004	148	95	low
OK621200050010_00	OK621200050010K	03/15/2004	341	154	low
OK621200050010_00	OK621200050010K	04/19/2004	41.4	48	low
OK621200050010_00	OK621200050010K	06/01/2004	72.7	67	low
OK621200050010_00	OK621200050010K	01/22/2007	9.57	10	low
OK621200050010_00	OK621200050010K	05/29/2007	495	648	high
OK621200050010_00	OK621200050010K	06/26/2007	152	135	high
OK621200050010_00	OK621200050010K	07/31/2007	160	141	high
OK621200050010_00	OK621200050010K	09/10/2007		1008	high
OK621200050010_00	OK621200050010K	10/16/2007	120	53	low
OK621200050010_00	OK621200050010K	11/13/2007	34.2	29	low
OK621200050010_00	OK621200050010K	12/17/2007	38.3	13	low
OK621200050010_00	OK621200050010K	03/03/2008	841	765	high
OK621200050010_00	OK621200050010K	04/07/2008	478	362	high
OK621200050010_00	OK621200050010K	05/12/2008	254	232	high
OK621200050010_00	OK621200050010K	06/16/2008	340	381	high
OK621200050010_00	OK621200050010K	07/21/2008	206	108	high
OK621200050010_00	OK621200050010K	08/06/2008	117		low
OK621200050010_00	OK621200050010K	08/25/2008	71.1	50	low
OK621200050010_00	OK621200050010K	09/30/2008	40.2	28	low
OK621200050010_00	OK621200050010K	11/04/2008	36.2	18	low
OK621200050010_00	OK621200050010K	12/14/2008		10	low
OK621200050010_00	OK621200050010K	02/02/2009	7.93	<10	low
OK621200050010_00	OK621200050010K	03/03/2009	17.6	21	low
OK621200050010_00	OK621200050010K	04/06/2009	74.1	67	low
OK621200050010_10	OK621200050010M	08/05/2002	440	<10	low
OK621200050010_10	OK621200050010M	09/03/2002	316	168	low
OK621200050010_10	OK621200050010M	09/30/2002	495	29	low
OK621200050010_10	OK621200050010M	11/04/2002	201	139	low
OK621200050010_10	OK621200050010M	12/02/2002	11.8	16	low
OK621200050010_10	OK621200050010M	01/14/2003	23.1	29	low

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621200050010_10	OK621200050010M	02/18/2003	12.3	<10	low
OK621200050010_10	OK621200050010M	03/24/2003	262	212	high
OK621200050010_10	OK621200050010M	04/28/2003	155	102	low
OK621200050010_10	OK621200050010M	06/03/2003	194	178	low
OK621200050010_10	OK621200050010M	07/07/2003	171	110	low
OK621200050010_10	OK621200050010M	08/11/2003	71.3	61	low
OK621200050010_10	OK621200050010M	09/15/2003	100	73	low
OK621200050010_10	OK621200050010M	10/20/2003	40.1	15	low
OK621200050010_10	OK621200050010M	12/01/2003	22.7	10	low
OK621200050010_10	OK621200050010M	01/05/2004	48.6	41	low
OK621200050010_10	OK621200050010M	02/09/2004	60.6	26	low
OK621200050010_10	OK621200050010M	03/15/2004	254	112	low
OK621200050010_10	OK621200050010M	04/19/2004	27.7	36	low
OK621200050010_10	OK621200050010M	06/01/2004	106	72	low
OK621200050010_10	OK621200050010M	05/29/2007	405	352	high
OK621200050010_10	OK621200050010M	06/26/2007	208	259	high
OK621200050010_10	OK621200050010M	07/30/2007	57.9	56	low
OK621200050010_10	OK621200050010M	09/10/2007		1051	high
OK621200050010_10	OK621200050010M	10/16/2007	55.8	35	low
OK621200050010_10	OK621200050010M	11/13/2007	35.5	25	low
OK621200050010_10	OK621200050010M	12/17/2007	30.7	<10	low
OK621200050010_10	OK621200050010M	01/22/2008	8.92	<10	low
OK621200050010_10	OK621200050010M	03/03/2008	298	266	high
OK621200050010_10	OK621200050010M	04/07/2008	343	272	low
OK621200050010_10	OK621200050010M	05/12/2008	194	122	high
OK621200050010_10	OK621200050010M	06/16/2008	299	384	high
OK621200050010_10	OK621200050010M	07/08/2008			high
OK621200050010_10	OK621200050010M	07/21/2008	147	115	low
OK621200050010_10	OK621200050010M	08/06/2008	63.1		low
OK621200050010_10	OK621200050010M	08/25/2008	73	57	low
OK621200050010_10	OK621200050010M	09/30/2008	20.8	15	low
OK621200050010_10	OK621200050010M	11/04/2008	21.2	16	low
OK621200050010_10	OK621200050010M	12/15/2008		<10	low
OK621200050010_10	OK621200050010M	02/02/2009	3.87	<10	low
OK621200050010_10	OK621200050010M	03/03/2009	3.69	<10	low
OK621200050010_10	OK621200050010M	04/06/2009	35	10	low
OK621210000270_00	OK621210-00-0270C	07/23/2002	45.5	24	low
OK621210000270_00	OK621210-00-0270C	08/27/2002	39.2	<10	low
OK621210000270_00	OK621210-00-0270C	10/01/2002	112	87	low

Waterbody ID	WQM Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow Condition
OK621210000270_00	OK621210-00-0270C	11/05/2002	137	19	low
OK621210000270_00	OK621210-00-0270C	12/02/2002	18.5	<10	low
OK621210000270_00	OK621210-00-0270C	01/15/2003	23.5	59	low
OK621210000270_00	OK621210-00-0270C	02/18/2003	21.8	14	low
OK621210000270_00	OK621210-00-0270C	03/25/2003	193	106	high
OK621210000270_00	OK621210-00-0270C	04/28/2003	173	66	high
OK621210000270_00	OK621210-00-0270C	07/07/2003	71.3	24	low
OK621210000270_00	OK621210-00-0270C	08/11/2003	38.3	49	low
OK621210000270_00	OK621210-00-0270C	09/22/2003	32.3	25	low
OK621210000270_00	OK621210-00-0270C	10/20/2003	14.3	55	low
OK621210000270_00	OK621210-00-0270C	10/30/2003	10.4		low
OK621210000270_00	OK621210-00-0270C	12/01/2003	5.06	<10	low
OK621210000270_00	OK621210-00-0270C	01/06/2004	2.87	<10	low
OK621210000270_00	OK621210-00-0270C	02/09/2004	225	170	high
OK621210000270_00	OK621210-00-0270C	03/15/2004	39.4	113	high
OK621210000270_00	OK621210-00-0270C	04/26/2004	3.71	46	high
OK621210000270_00	OK621210-00-0270C	05/29/2007	38.6	<10	high
OK621210000270_00	OK621210-00-0270C	06/25/2007	19	<10	high
OK621210000270_00	OK621210-00-0270C	07/30/2007	14.7	15	high
OK621210000270_00	OK621210-00-0270C	09/10/2007	64.5	68	high
OK621210000270_00	OK621210-00-0270C	10/15/2007	20.3	65	high
OK621210000270_00	OK621210-00-0270C	11/13/2007	9.65	17	low
OK621210000270_00	OK621210-00-0270C	12/17/2007	15.6	<10	low
OK621210000270_00	OK621210-00-0270C	01/23/2008	6.51	<10	low
OK621210000270_00	OK621210-00-0270C	03/03/2008	119	70	high
OK621210000270_00	OK621210-00-0270C	04/07/2008	43.6	53	high
OK621210000270_00	OK621210-00-0270C	05/13/2008	125	82	high
OK621210000270_00	OK621210-00-0270C	06/24/2008	12.9	<10	high
OK621210000270_00	OK621210-00-0270C	07/29/2008	51.2	52	low
OK621210000270_00	OK621210-00-0270C	08/05/2008	44		low
OK621210000270_00	OK621210-00-0270C	08/25/2008	50.5	34	low
OK621210000270_00	OK621210-00-0270C	10/07/2008	12.5	21	low
OK621210000270_00	OK621210-00-0270C	11/18/2008	5.57	<10	low
OK621210000270_00	OK621210-00-0270C	12/30/2008	8.43	<10	high
OK621210000270_00	OK621210-00-0270C	02/10/2009	12.8	18	high
OK621210000270_00	OK621210-00-0270C	03/10/2009	128	60	low
OK621210000270_00	OK621210-00-0270C	04/14/2009	154	48	high

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 timeseries, 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 timeseries 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:

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

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

WBID	OK621000010010_30	OK621000020130_00	OK621000030010_00	OK621000040010_00	OK621000050010_00	OK621000060010_00	OK621010010010_00	OK621010010090_00	OK621010010160_00	OK621010010230_00	OK621010010270_00	OK621010020010_00	OK621010030010_00	OK621010030030_00	OK621100000010_00	OK621100000010_10	OK621100000100_00	OK621200010200_00	OK621200030010_00	OK621200050010_00	OK621200050010_10	OK621210000050_00	OK621210000270_00
ProjGage	2996	2996	2995	2996	2996	2996	2499	2499	2499	3858	3859	2499	2499	2499	2995	2995	2995	3566	3567	3566	3566	2995	2995
Area (sq. mile)	95.29399044	11.23941537	56.47254676	80.14669219	108.2271834	50.91597839	87.30315597	32.47852914	24.73118188	38.92389705	66.06446598	188.9634007	199.0374133	80.68760851	7.582591499	75.72356989	48.44400954	72.7581937	142.5799794	65.49762811	152.2641612	67.37253072	47.97048041
CN	79.2048	70.3577	80.6088	81.7678	78.848	78.247	69.8968	80.9984	69.8211	71.9255	67.3117	64.0915	70.6613	75.0337	82.4851	82.4161	80.3431	60.5692	70.3238	75.4036	79.4815	74.5552	76.5343
Rain (inch)	35.4655624	33.256651	36.943831	34.24313375	33.997795	32.36103	31.18634575	30.696787	29.87266325	27.915526	26.393321	31.03681825	30.16231925	29.2184172	36.126317	35.6362295	35.569578	39.44152593	38.41037718	36.41656146	35.34388857	38.2040948	37.178053
ProjType	U	D	A	D	D	D	U	A	D	D	D	A	A	D	A	A	D	U	U	D	D	A	A
NN	27033	27033	26850	27033	27033	27033	2586	2586	20454	15894	12419	2586	2586	12691	26850	26850	26850	30681	from black bear	30686	30686	26850	26850
QAQC	U:2996:07151000,+CN,+R	D:2996:07151000,+CN,+R,USG:0	AD:2995:07152000,A;-CN,-R,USG:0	D:2996:07151000,+CN,+R,USG:0	D:2996:07151000,+CN,+R,USG:0	D:2996:07151000,+CN,+R,USG:0	U:2499:07148450,+CN,+R	AD:2499:07148450,A;-CN,-R,USG:0	D:2500:07150500,+CN,+R,USG:+YN	D:3858:07148400,+CN,+R,USG:0	D:3859:07148350,+CN,+R,USG:0	AD:2499:07148450,A;-CN,-R,USG:0	AU:2499:07148450,A;-CN,-R	D:2429:07061300,+CN,+R,USG:0	AU:2995:07152000,A;-CN,-R	AU:2995:07152000,A;-CN,-R	D:2995:07152000,+CN,+R,USG:0	D:3778:07164500,+CN,+R,USG:++N	0	D:3566:07152500,+CN,+R,USG:0	D:3566:07152500,+CN,+R,USG:0	AD:2995:07152000,A;-CN,-R,USG:0	AD:2995:07152000,A;-CN,-R,USG:0
Percentile	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	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	61028.58	467.70	3680.24	51507.22	57800.00	14388.67	96887.42	742.18	3529.31	9009.85	5096.17	2734.79	7852.89	13200.00	75285.02	72991.56	35458.68	261000.00	18260.10	133728.80	75684.88	7115.49	1778.24
1	11720.02	89.82	503.05	9891.53	11100.00	2763.22	14939.89	114.44	825.29	858.59	480.14	421.70	1210.90	1760.00	10290.76	9977.26	4846.87	63100.00	4869.36	33225.41	18804.18	972.62	243.07
2	7961.17	61.01	322.48	6719.11	7540.00	1877.00	10339.59	79.20	582.87	499.25	282.18	291.85	838.04	1220.00	6596.92	6395.95	3107.10	46200.00	3386.42	24264.20	13732.51	623.50	155.82
3	6187.33	47.42	217.64	5222.01	5860.00	1458.78	7839.75	60.05	433.14	356.68	193.74	221.29	635.42	817.00	4452.11	4316.48	2096.91	39300.00	2523.21	19438.93	11001.62	420.79	105.16
4	5047.00	38.68	160.98	4259.59	4780.00	1189.93	6538.05	50.08	358.28	286.20	149.94	184.55	529.92	617.00	3293.04	3192.72	1551.00	34000.00	1980.94	17026.30	9636.17	311.24	77.78
5	4223.43	32.37	120.20	3564.51	4000.00	995.76	5591.37	42.83	301.24	239.56	123.82	157.82	453.19	484.00	2458.95	2384.04	1158.15	30500.00	1615.74	15096.19	8543.81	232.41	58.08
6	3600.48	27.59	95.32	3038.75	3410.00	848.88	4718.64	36.15	256.68	212.00	104.45	133.19	382.45	405.00	1949.83	1890.43	918.35	27700.00	1350.14	13441.82	7607.50	184.29	46.06
7	3114.78	23.87	79.43	2628.83	2950.00	734.37	4082.59	31.27	226.37	188.15	91.82	115.24	330.90	346.00	1624.86	1575.36	765.30	25200.00	1128.81	12132.10	6866.26	153.57	38.38
8	2745.23	21.04	66.19	2316.93	2600.00	647.24	3638.83	27.87	203.20	169.07	81.71	102.71	294.93	300.00	1354.05	1312.80	637.75	23100.00	958.38	10891.32	6164.03	127.98	31.98
9	2439.03	18.69	57.72	2058.51	2310.00	575.05	3342.99	25.61	183.60	153.17	73.28	94.36	270.95	263.00	1180.73	1144.76	556.11	21400.00	821.15	9995.20	5656.86	111.60	27.89
10	2196.18	16.83	50.99	1853.55	2080.00	517.79	3121.11	23.91	165.59	139.92	67.81	88.10	252.97	236.00	1043.16	1011.38	491.32	19900.00	694.99	9236.94	5227.72	98.59	24.64
11	1974.45	15.13	45.38	1666.41	1870.00	465.52	2943.60	22.55	150.08	129.32	63.18	83.09	238.58	217.00	928.33	900.05	437.24	18500.00	618.63	8547.62	4837.59	87.74	21.93
12	1794.96	13.76	40.67	1514.92	1700.00	423.20	2721.72	20.85	138.14	119.78	58.96	76.82	220.60	198.00	831.93	806.58	391.83	16800.00	541.16	7996.16	4525.49	78.63	19.65
13	1626.02	12.46	37.07	1372.34	1540.00	383.37	2514.64	19.26	127.09	111.83	55.17	70.98	203.82	183.00	758.27	735.17	357.14	15600.00	485.83	7375.77	4174.37	71.67	17.91
14	1488.76	11.41	34.21	1256.49	1410.00	351.00	2411.09	18.47	117.64	106.00	51.38	68.06	195.42	171.00	699.77	678.45	329.59	14600.00	434.92	6893.24	3901.28	66.14	16.53
15	1372.62	10.52	31.67	1158.47	1300.00	323.62	2263.17	17.34	110.16	99.64	48.43	63.88	183.43	162.00	647.78	628.04	305.10	13800.00	386.23	6472.75	3663.30	61.22	15.30
16	1267.03	9.71	29.23	1069.35	1200.00	298.73	2144.84	16.43	102.85	94.34	46.33	60.54	173.84	152.00	597.95	579.73	281.63	13200.00	349.71	6093.62	3448.73	56.51	14.12
17	1182.56	9.06	27.54	998.06	1120.00	278.81	2085.67	15.98	96.25	89.04	43.80	58.87	169.05	144.00	563.28	546.12	265.30	12600.00	320.94	5790.32	3277.08	53.24	13.30
18	1108.65	8.50	25.84	935.68	1050.00	261.39	1982.12	15.18	90.37	84.27	42.12	55.95	160.65	135.00	528.62	512.52	248.98	12100.00	292.16	5514.59	3121.03	49.96	12.49
19	1037.91	7.95	24.46	875.98	983.00	244.71	1922.96	14.73	85.56	80.03	40.43	54.28	155.86	128.00	500.46	485.21	235.71	11700.00	263.39	5245.76	2968.88	47.30	11.82
20	979.84	7.51	23.30	826.97	928.00	231.02	1849.00	14.16	81.64	76.32	38.75	52.19	149.86	121.00	476.62	462.10	224.49	11100.00	244.57	4976.92	2816.73	45.05	11.26
21	927.04	7.10	22.13	782.41	878.00	218.57	1789.83	13.71	78.07	73.14	37.48	50.52	145.07	116.00	452.79	439.00	213.26	10400.00	224.65	4728.76	2676.28	42.80	10.70
22	877.42	6.72	21.13	740.53	831.00	206.87	1715.87	13.14	74.69	69.96	35.80	48.43	139.07	110.00	432.21	419.05	203.57	9810.00	205.84	4501.29	2547.54	40.85	10.21
23	835.18	6.40	20.18	704.88	791.00	196.91	1671.49	12.80	70.59	66.78	34.11	47.18	135.48	105.00	412.71	400.14	194.39	9340.00	190.35	4273.81	2418.80	39.01	9.75
24	791.89	6.07	19.22	668.35	750.00	186.70	1627.12	12.46	67.56	63.60	32.85	45.93	131.88	100.00	393.22	381.24	185.20	8830.00	177.07	4087.69	2313.46	37.16	9.29
25	754.94	5.79	18.53	637.16	715.00	177.99	1567.95	12.01	64.53	60.95	31.59	44.26	127.08	96.00	379.13	367.58	178.57	8420.00	166.00	3901.57	2208.13	35.83	8.96
26	717.98	5.50	17.74	605.97	680.00	169.28	1538.37	11.78	61.50	58.83	30.75	43.42	124.69	91.00	362.88	351.83	170.92	8070.00	152.72	3722.35	2106.69	34.30	8.57
27	686.31	5.26	17.00	579.23	650.00	161.81	1479.20	11.33	59.00	56.71	29.48	41.75	119.89	87.00	347.72	337.13	163.77	7750.00	141.65	3570.70	2020.86	32.86	8.21
28	654.63	5.02	16.42	552.50	620.00	154.34	1449.61	11.10	57.04	54.59	28.64	40.92	117.49	82.00	335.80	325.57	158.16	7450.00	131.69	3432.83	1942.84	31.74	7.93
29	627.18	4.81	15.89	529.33	594.00	147.87	1405.24	10.76	54.90	53.00	27.38	39.66	113.90	78.00	324.97	315.07	153.06	7170.00	121.73	3288.08	1860.91	30.71	7.68
30	596.56	4.57	15.25	503.49	565.00	140.65	1346.07	10.31	52.76	50.88	26.53	37.99	109.10	73.00	311.97	302.47	146.94	6900.00	112.88	3150.21	1782.89	29.49	7.37
31	570.16	4.37	14.67	481.21	540.00	134.43	1301.69	9.97	50.98	49.29	25.69	36.74	105.50	70.00	300.06	290.92	141.32	6650.00	106.24	3012.35	1704.86	28.36	7.09
32	544.82	4.18	14.19	459.82	516.00	128.45	1272.11	9.74	48.48	47.70	25.27	35.91	103.11	66.00	290.31	281.46	136.73	6420.00	100.71	2895.16	1638.54	27.44	6.86
33	522.65	4.01	13.71	441.11	495.00	123.22	1227.73	9.40	46.70	46.11	24.43	34.65	99.51	62.00	280.56	272.01	132.14	6180.00	94.07	2784.87	1576.12	26.52	6.63
34	500.48	3.84	13.24	422.39	474.00	118.00	1198.15	9.18	44.92	45.05	23.59	33.82	97.11	59.00	270.81	262.56	127.55	5940.00	88.53	2674.58	1513.70	25.60	6.40
35	481.47	3.69	12.81	406.35	456.00	113.52	1168.57	8.95	43.49	43.46	22.74	32.98	94.71	56.00	262.14	254.16	123.47	5720.00	81.89	2571.18	1455.18	24.78	6.19
36	464.58	3.56	12.39	392.10	440.00	109.53	1138.98	8.72	41.71	42.40	21.90	32.15	92.32	53.00	253.48	245.76	119.39	5480.00	77.47	2481.57	1404.46	23.96	5.99
37	445.57	3.41	11.91	376.06	422.00	105.05	1109.40	8.50	40.11	40.81	21.06	31.31	89.92	50.00	243.73	236.30	114.79	5290.00	71.93	2385.06	1349.84	23.04	5.76
38	426.57	3.27	11.54	360.02	404.00	100.57	1050.23	8.05	38.86	39.75	20.64	29.64	85.12	48.00	236.15	228.95	111.22	5060.00	68.61	2302.34	1303.03	22.32	5.58
39	411.78	3.16	11.23	347.54	390.00	97.09	1020.65	7.82	37.43	38.16	19.80	28.81	82.73	46.00	229.65	222.65	108.16	4900.00	64.19	2226.52	1260.11	21.70	5.42
40	393.83	3.02	10.86	332.39	373.00	92.85	976.27	7.48	35.83	37.10	18.95	27.56	79.13	44.00	222.06	215.30	104.59	4710.00	60.87	2136.90	1209.40	20.99	5.25
41	378.00	2.90	10.59	319.02	358.00	89.12	946.69	7.25	34.40	35.51	18.53	26.72	76.73	42.00	216.65	210.05	102.04	4550.00	57.55	2067.97	1170.39	20.48	5.12
42	364.27	2.79	10.22	307.44	345.00	85.88	917.10	7.03	33.15	34.45	17.69	25.89	74.33	40.00	209.06	202.70	98.47	4380.00	54.23	1992.15	1127.47	19.76	4.94
43	350.54	2.69	10.01	295.85	332.00	82.65	872.73	6.69	31.91	32.86	17.27	24.63	70.74	39.00	204.73	198.50	96.43	4240.00	52.01	1930.11	1092.36	19.35	4.84
44	336.82	2.58	9.69	284.27	319.00	79.41	828.35	6.35	30.48	31.80	16.85	23.38	67.14	37.00	198.23	192.19	93.37	4060.00	49.80	1868.07	1057.25	18.74	4.68
45	323.09	2.48	9.43	272.69	306.00	76.18	798.77	6.12	29.23	30.74	16.43	22.55	64.74	36.00	192.82	186.94	90.82	3940.00	47.59	1806.03	1022.14	18.22	4.55
46	312.53	2.40	9.16	263.77	296.00	73.69	769.18	5.89	27.98	29.68	16.00	21.71	62.34	34.00	187.40	181.69	88.26	3790.00	45.37	1743.99	987.02	17.71	4.43
47	299.86	2.30	8.90	253.08	284.00	70.70	739.60	5.67	26.92	28.62	15.58	20.88	59.95	32.00	181.98	176.44	85.71	3670.00	43.16	1688.84	955.81	17.20	4.30
48	290.36	2.23	8.68	245.06	275.00	68.46	710.01	5.44	25.67	27.56	15.16	20.04	57.55	31.00	177.65	172.24	83.67	3540.00	39.84	1626.80	920.70	16.79	4.20
49	277.69	2.13	8.47	234.37	263.00	65.47	680.43	5.21	24.60	27.03	14.74	19.21	55.15	29.00	173.32	168.04	81.63	3410.00	38.73	1578.55	893.39	16.38	4.09
50	266.08	2.04	8.31	224.56	252.00	62.73	650.85	4.99	23.53	25.97	14.32	18.37	52.75	28.00	170.07	164.89	80.10	3320.00	36.52	1523.41	862.18	16.07	4.02

WBID	OK621000010010_30	OK621000020130_00	OK621000030010_00	OK621000040010_00	OK621000050010_00	OK621000060010_00	OK621010010010_00	OK621010010090_00	OK621010010160_00	OK621010010230_00	OK621010010270_00
ProjGage	2996	2996	2995	2996	2996	2996	2499	2499	2499	3858	3859
Area (sq. mile)	95.29399044	11.23941537	56.47254676	80.14669219	108.2271834	50.91597839	87.30315597	32.47852914	24.73118188	38.92389705	66.06446598
CN	79.2048	70.3577	80.6088	81.7678	78.848	78.247	69.8968	80.9984	69.8211	71.9255	67.3117
Rain (inch)	35.4655624	33.256651	36.943831	34.24313375	33.997795	32.36103	31.18634575	30.696787	29.87266325	27.915526	26.393321
ProjType	U	D	A	D	D	D	U	A	D	D	D
NN	27033	27033	26850	27033	27033	27033	2586	2586	20454	15894	12419
QAQC	U:2996:07151000, +CN,+R	D:2996:07151000, +CN,+R,USG:0	AD:2995:0715200 0,A;-CN,-R,USG:0	D:2996:07151000, +CN,+R,USG:0	D:2996:07151000,+CN,+R ,USG:0	D:2996:07151000, +CN,+R,USG:0	U:2499:07148450, +CN,+R	AD:2499:0714845 0,A;-CN,-R,USG:0	D:2500:07150500, +CN,+R,USG:+YN	D:3858:07148400, +CN,+R,USG:0	D:3859:07148350, +CN,+R,USG:0
Percentile	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)
51	254.46	1.95	8.05	214.76	241.00	59.99	621.26	4.76	22.46	25.44	13.90
52	244.96	1.88	7.84	206.74	232.00	57.75	591.68	4.53	21.57	24.38	13.48
53	234.40	1.80	7.63	197.83	222.00	55.26	576.89	4.42	20.50	23.85	13.06
54	225.95	1.73	7.41	190.70	214.00	53.27	547.30	4.19	19.61	22.79	12.64
55	216.45	1.66	7.25	182.68	205.00	51.03	532.51	4.08	18.72	22.26	11.79
56	206.95	1.59	7.04	174.66	196.00	48.79	502.93	3.85	17.82	21.73	11.37
57	198.50	1.52	6.88	167.53	188.00	46.80	488.14	3.74	16.93	21.20	10.95
58	191.11	1.46	6.62	161.29	181.00	45.06	473.34	3.63	16.04	20.14	10.53
59	182.66	1.40	6.41	154.17	173.00	43.07	458.55	3.51	14.97	19.61	10.11
60	174.22	1.34	6.25	147.04	165.00	41.07	443.76	3.40	14.26	19.08	9.69
61	166.83	1.28	6.09	140.80	158.00	39.33	428.97	3.29	13.37	18.55	9.27
62	159.43	1.22	5.88	134.56	151.00	37.59	399.38	3.06	12.48	18.02	8.84
63	152.04	1.17	5.72	128.32	144.00	35.85	384.59	2.95	11.41	17.49	8.42
64	145.71	1.12	5.56	122.98	138.00	34.35	369.80	2.83	10.52	16.96	8.42
65	139.37	1.07	5.40	117.63	132.00	32.86	355.01	2.72	9.63	16.43	8.00
66	131.98	1.01	5.24	111.39	125.00	31.12	340.22	2.61	8.91	15.90	7.58
67	126.70	0.97	5.08	106.94	120.00	29.87	340.22	2.61	8.20	15.37	6.74
68	119.31	0.91	4.87	100.70	113.00	28.13	325.42	2.49	7.31	14.31	6.32
69	114.03	0.87	4.77	96.24	108.00	26.89	295.84	2.27	6.77	13.78	5.90
70	107.70	0.83	4.55	90.90	102.00	25.39	295.84	2.27	6.24	13.25	5.48
71	103.47	0.79	4.45	87.33	98.00	24.40	281.05	2.15	5.35	12.72	5.05
72	97.14	0.74	4.29	81.98	92.00	22.90	266.26	2.04	4.81	11.66	4.63
73	92.92	0.71	4.13	78.42	88.00	21.91	251.46	1.93	4.46	11.13	3.92
74	88.69	0.68	3.97	74.85	84.00	20.91	221.88	1.70	3.92	10.60	3.58
75	84.47	0.65	3.81	71.29	80.00	19.92	192.30	1.47	3.56	10.07	3.12
76	81.30	0.62	3.65	68.62	77.00	19.17	162.71	1.25	3.39	9.01	2.65
77	77.08	0.59	3.49	65.05	73.00	18.17	134.61	1.03	3.21	8.48	2.27
78	73.91	0.57	3.34	62.38	70.00	17.43	109.46	0.84	3.03	7.42	1.85
79	69.69	0.53	3.12	58.81	66.00	16.43	88.75	0.68	2.85	6.89	1.47
80	65.46	0.50	2.97	55.25	62.00	15.43	71.00	0.54	2.50	6.36	1.22
81	62.30	0.48	2.81	52.58	59.00	14.69	62.13	0.48	2.32	5.30	0.97
82	59.13	0.45	2.65	49.90	56.00	13.94	51.77	0.40	2.14	4.77	0.80
83	55.96	0.43	2.49	47.23	53.00	13.19	44.38	0.34	1.96	4.24	0.63
84	52.79	0.40	2.33	44.56	50.00	12.45	34.02	0.26	1.78	3.71	0.51
85	49.63	0.38	2.17	41.88	47.00	11.70	28.10	0.22	1.60	3.18	0.38
86	47.51	0.36	2.01	40.10	45.00	11.20	25.15	0.19	1.43	2.76	0.30
87	43.29	0.33	1.85	36.54	41.00	10.21	22.19	0.17	1.28	2.33	0.25
88	41.18	0.32	1.75	34.75	39.00	9.71	17.75	0.14	1.12	1.91	0.21
89	38.01	0.29	1.54	32.08	36.00	8.96	14.79	0.11	0.98	1.59	0.17
90	34.84	0.27	1.38	29.41	33.00	8.21	11.98	0.09	0.89	1.27	0.15
91	31.68	0.24	1.22	26.73	30.00	7.47	10.35	0.08	0.75	1.06	0.12
92	27.45	0.21	1.01	23.17	26.00	6.47	8.28	0.06	0.70	0.90	0.10
93	24.28	0.19	0.85	20.50	23.00	5.73	6.95	0.05	0.59	0.64	0.08
94	21.12	0.16	0.64	17.82	20.00	4.98	5.18	0.04	0.46	0.53	0.06
95	17.95	0.14	0.44	15.15	17.00	4.23	3.70	0.03	0.36	0.42	0.04
96	14.78	0.11	0.34	12.48	14.00	3.49	1.92	0.01	0.29	0.05	0.02
97	10.56	0.08	0.24	8.91	10.00	2.49	0.00	0.00	0.21	0.00	0.00
98	7.81	0.06	0.11	6.59	7.40	1.84	0.00	0.00	0.16	0.00	0.00
99	3.59	0.03	0.05	3.03	3.40	0.85	0.00	0.00	0.00	0.00	0.00
100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

WBID	OK621010020010_00	OK621010030010_00	OK621010030030_00	OK621100000010_00	OK621100000010_10	OK621100000100_00	OK621200010200_00	OK621200030010_00	OK621200050010_00	OK621200050010_10	OK621210000050_00	OK621210000270_00
ProjGage	2499	2499	2499	2995	2995	2995	3566	3567	3566	3566	2995	2995
Area (sq. mile)	188.9634007	199.0374133	80.68760851	7.582591499	75.72356989	48.44400954	72.7581937	142.5799794	65.49762811	152.2641612	67.37253072	47.97048041
CN	64.0915	70.6613	75.0337	82.4851	82.4161	80.3431	60.5692	70.3238	75.4036	79.4815	74.5552	76.5343
Rain (inch)	31.03681825	30.16231925	29.2184172	36.126317	35.6362295	35.569578	39.44152593	38.41037718	36.41656146	35.34388857	38.2040948	37.178053
ProjType	A	A	D	A	A	D	U	U	D	D	A	A
NN	2586	2586	12691	26850	26850	26850	30681	from black bear	30686	30686	26850	26850
QAQC	AD:2499:0714845 0,A;-CN,-R,USG:0	AU:2499:0714845 0,A;-CN,-R	D:2429:07061300, +CN,+R,USG:0	AU:2995:07152000, A;-CN,-R	AU:2995:07152000, A;-CN,-R	D:2995:07152000, +CN,+R,USG:0	D:3778:07164500 ,+CN,+R,USG:++ N	0	D:3566:07152500, +CN,+R,USG:0	D:3566:07152500, +CN,+R,USG:0	AD:2995:07152000 ,A;-CN,-R,USG:0	AD:2995:0715200 0,A;-CN,-R,USG:0
Percentile	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)	Q (cfs)
51	17.54	50.35	27.00	164.65	159.64	77.55	3190.00	35.41	1488.94	842.68	15.56	3.89
52	16.70	47.96	25.00	160.32	155.44	75.51	3090.00	33.20	1440.69	815.37	15.15	3.79
53	16.28	46.76	24.00	155.99	151.23	73.47	2980.00	32.09	1399.33	791.96	14.74	3.68
54	15.45	44.36	22.00	151.65	147.03	71.43	2880.00	30.99	1357.97	768.55	14.33	3.58
55	15.03	43.16	21.00	148.40	143.88	69.90	2810.00	29.88	1323.50	749.05	14.03	3.51
56	14.20	40.76	20.00	144.07	139.68	67.86	2720.00	27.67	1289.04	729.54	13.62	3.40
57	13.78	39.56	20.00	140.82	136.53	66.33	2610.00	26.56	1247.68	706.13	13.31	3.33
58	13.36	38.37	18.00	135.40	131.28	63.77	2540.00	25.45	1220.10	690.53	12.80	3.20
59	12.94	37.17	17.00	131.07	127.08	61.73	2430.00	25.45	1178.74	667.12	12.39	3.10
60	12.53	35.97	16.00	127.82	123.93	60.20	2380.00	24.35	1144.28	647.61	12.08	3.02
61	12.11	34.77	15.00	124.57	120.78	58.67	2300.00	23.24	1102.92	624.21	11.77	2.94
62	11.27	32.37	14.00	120.24	116.58	56.63	2220.00	22.13	1061.56	600.80	11.36	2.84
63	10.86	31.17	13.00	116.99	113.43	55.10	2180.00	22.13	1033.99	585.19	11.06	2.76
64	10.44	29.97	12.00	113.74	110.28	53.57	2100.00	21.03	999.52	565.69	10.75	2.69
65	10.02	28.77	12.00	110.49	107.12	52.04	2020.00	19.92	965.05	546.18	10.44	2.61
66	9.60	27.58	11.00	107.24	103.97	50.51	1960.00	19.92	930.59	526.67	10.14	2.53
67	9.60	27.58	10.00	103.99	100.82	48.98	1860.00	18.81	896.12	507.17	9.83	2.46
68	9.19	26.38	9.60	99.66	96.62	46.94	1800.00	18.81	861.65	487.66	9.42	2.35
69	8.35	23.98	9.00	97.49	94.52	45.92	1740.00	17.71	834.08	472.06	9.21	2.30
70	8.35	23.98	8.30	93.16	90.32	43.88	1660.00	17.71	813.40	460.35	8.80	2.20
71	7.93	22.78	7.70	90.99	88.22	42.86	1610.00	16.60	778.94	440.84	8.60	2.15
72	7.52	21.58	7.00	87.74	85.07	41.33	1550.00	15.49	751.36	425.24	8.29	2.07
73	7.10	20.38	6.50	84.49	81.92	39.80	1470.00	15.49	723.79	409.63	7.99	2.00
74	6.26	17.98	6.00	81.24	78.77	38.26	1430.00	14.39	689.32	390.13	7.68	1.92
75	5.43	15.59	5.50	77.99	75.62	36.73	1360.00	14.39	668.64	378.42	7.37	1.84
76	4.59	13.19	5.10	74.74	72.47	35.20	1290.00	13.28	641.07	362.82	7.06	1.77
77	3.80	10.91	4.70	71.49	69.32	33.67	1260.00	13.28	613.50	347.21	6.76	1.69
78	3.09	8.87	4.40	68.24	66.17	32.14	1200.00	12.17	592.82	335.51	6.45	1.61
79	2.51	7.19	4.10	63.91	61.96	30.10	1140.00	11.07	565.25	319.91	6.04	1.51
80	2.00	5.75	3.90	60.66	58.81	28.57	1110.00	10.85	546.63	309.37	5.73	1.43
81	1.75	5.04	3.60	57.41	55.66	27.04	1060.00	10.29	528.02	298.84	5.43	1.36
82	1.46	4.20	3.40	54.16	52.51	25.51	1000.00	9.74	496.31	280.89	5.12	1.28
83	1.25	3.60	3.20	50.91	49.36	23.98	968.00	9.07	475.63	269.19	4.81	1.20
84	0.96	2.76	3.00	47.66	46.21	22.45	908.00	8.52	452.20	255.92	4.50	1.13
85	0.79	2.28	2.80	44.41	43.06	20.92	851.00	7.97	432.90	245.00	4.20	1.05
86	0.71	2.04	2.60	41.16	39.91	19.39	824.00	7.41	413.59	234.08	3.89	0.97
87	0.63	1.80	2.50	37.91	36.76	17.86	770.00	6.86	393.60	222.76	3.58	0.90
88	0.50	1.44	2.30	35.75	34.66	16.84	730.00	6.31	366.03	207.16	3.38	0.84
89	0.42	1.20	2.20	31.41	30.46	14.80	683.00	5.87	356.38	201.70	2.97	0.74
90	0.34	0.97	2.00	28.16	27.31	13.27	630.00	5.20	328.81	186.09	2.66	0.67
91	0.29	0.84	1.80	24.91	24.16	11.73	576.00	4.65	310.20	175.56	2.35	0.59
92	0.23	0.67	1.70	20.58	19.95	9.69	529.00	4.09	289.52	163.85	1.95	0.49
93	0.20	0.56	1.50	17.33	16.80	8.16	460.00	3.54	268.84	152.15	1.64	0.41
94	0.15	0.42	1.40	13.00	12.60	6.12	399.00	2.99	248.16	140.45	1.23	0.31
95	0.10	0.30	1.20	9.10	8.82	4.29	348.00	2.21	226.10	127.96	0.86	0.21
96	0.05	0.16	1.10	7.04	6.83	3.32	294.00	1.44	202.66	114.70	0.67	0.17
97	0.00	0.00	0.89	4.87	4.73	2.30	232.00	0.82	172.33	97.53	0.46	0.12
98	0.00	0.00	0.65	2.27	2.21	1.07	186.00	0.32	135.11	76.47	0.22	0.05
99	0.00	0.00	0.24	1.08	1.05	0.51	115.00	0.02	100.64	56.96	0.10	0.03
100	0.00	0.00	0.00	0.00	0.00	0.00	29.00	0.00	10.34	5.85	0.00	0.00

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
NPDES Discharge Monitoring Report Data

NPDES No.	Outfall	Monitoring Date	Max TSS Concentration (mg/L)	Average TSS Concentration (mg/L)	Max FC Concentration (cfu/100ml)	Average FC Concentration (cfu/100ml)	Maximum Flow (MGD)	Average Flow (MGD)
OK0020761	001	05/31/2008	28	28	51	51	0.040104	0.036787
OK0021903	001	01/31/2003	46	34			0.71	0.27
OK0021903	001	02/28/2003	46	43			0.39	0.162
OK0021903	001	03/31/2003	48	41.75			0.39	0.208
OK0021903	001	02/29/2004	30	60			0.3	0.3
OK0021903	001	03/31/2004	20	40			0.3	0.3
OK0021903	001	04/30/2004	56	52			0.3	0.3
OK0021903	001	11/30/2004	31	62			0.43	0.34
OK0021903	001	12/31/2004	27	54			0.47	0.35
OK0021903	001	01/31/2005	22	44			0.44	0.3
OK0021903	001	02/28/2005	38.35	76.7			0.7	0.47
OK0021903	001	03/31/2005	56	53			473	346
OK0021903	001	11/30/2005	6.25	25			0.51	0.31
OK0021903	001	12/31/2005	7.5	15			576	404
OK0021903	001	01/31/2006	3.5	7			0.48	0.45
OK0021903	001	02/28/2006	65	13			0.53	0.46
OK0021903	001	03/31/2006	3.5	7			0.56	0.49
OK0021903	001	11/30/2006	48	48			0.35	0.3
OK0021903	001	12/31/2006	60	57.5			0.198	0.172
OK0021903	001	01/31/2007	60	48			0.19	0.18
OK0021903	001	02/28/2007	38	34			0.195	0.187
OK0021903	001	03/31/2007	49	43.5			0.19	0.18
OK0021903	001	11/30/2007	30	30			0.45	0.3
OK0021903	001	12/31/2007	38	38			0.48	0.47
OK0021903	001	01/31/2008	45.5	45.5			0.5	0.25
OK0021903	001	02/29/2008	26.5	26.5			0.35	0.268
OK0021903	001	03/31/2008	14	14			0.35	0.29
OK0026654	001	01/31/1998	12	11.5	15	9	0.448	0.338
OK0026654	001	02/28/1998	12	10.5	6	3	0.34	0.267
OK0026654	001	03/31/1998	12	11	360	180	0.489	0.353
OK0026654	001	04/30/1998	32	23	0	0	0.484	0.326
OK0026654	001	05/31/1998	14	13	0	0	0.411	0.313
OK0026654	001	06/30/1998	16	15	0	0	0.286	0.233
OK0026654	001	07/31/1998	15	13.5	0	0	0.278	0.195
OK0026654	001	08/31/1998	12	11.5	0	0	0.236	0.19
OK0026654	001	09/30/1998	16	14	280	140	0.378	0.218
OK0026654	001	10/31/1998	14	12.5	450	225	0.447	0.2
OK0026654	001	11/30/1998	0.18	0.14	0	0	0.46	0.23
OK0026654	001	12/31/1998	14	12	3	2	38.7	0.263
OK0026654	001	01/31/1999	10	9.6	0	0	0.54	0.27
OK0026654	001	02/28/1999	14	14	4	3	0.469	0.317
OK0026654	001	03/31/1999	18	14	200	126	0.52	0.38
OK0026654	001	04/30/1999	13	12.5	0	0	0.54	0.322

NPDES No.	Outfall	Monitoring Date	Max TSS Concentration (mg/L)	Average TSS Concentration (mg/L)	Max FC Concentration (cfu/100ml)	Average FC Concentration (cfu/100ml)	Maximum Flow (MGD)	Average Flow (MGD)
OK0026654	001	05/31/1999	15	14.5	0	0	0.522	0.324
OK0026654	001	06/30/1999	17	16.5	79	40	0.476	0.341
OK0026654	001	07/31/1999	16	14	16	12	0.49	0.28
OK0026654	001	08/31/1999	8	6.5	5	5	0.26	0.177
OK0026654	001	09/30/1999	8	6.5	8	5	0.344	0.218
OK0026654	001	10/31/1999	13	12	1	1	0.34	0.194
OK0026654	001	11/30/1999	13	12	2	2	0.23	0.2
OK0026654	001	12/31/1999	15	14.5	100	51	0.48	0.24
OK0026654	001	01/31/2000	12	11.4	50	25	0.26	0.192
OK0026654	001	02/29/2000	18	15	100	100	0.28	0.197
OK0026654	001	03/31/2000	14	13.5	230	115	0.36	0.27
OK0026654	001	04/30/2000	16	14	80	80	0.35	0.288
OK0026654	001	05/31/2000	12	10	50	50	0.26	0.19
OK0026654	001	06/30/2000	18	16	60	30	0.264	0.222
OK0026654	001	07/31/2000	18	16	0	0	0.268	0.211
OK0026654	001	08/31/2000	14	12	0	0	0.22	0.19
OK0026654	001	09/30/2000	11	11	0	0	0.21	0.182
OK0026654	001	10/31/2000	18	16	200	200	0.288	0.177
OK0026654	001	11/30/2000	15	13.5	4	2	0.368	0.198
OK0026654	001	12/31/2000	13	12	0	0	0.198	0.135
OK0026654	001	01/31/2001	14	13	0	0	0.307	0.198
OK0026654	001	02/28/2001	14	13.5	35	21	0.373	0.261
OK0026654	001	03/31/2001	10	7.5	21	12	0.302	0.266
OK0026654	001	04/30/2001	11	10	41	20	0.297	0.231
OK0026654	001	05/31/2001	16	14	56	29	0.55	0.221
OK0026654	001	06/30/2001	13	12	1	1	0.344	0.225
OK0026654	001	07/31/2001	17	15.5	10	6	0.217	0.197
OK0026654	001	08/31/2001	13	12	11	5	0.225	0.168
OK0026654	001	09/30/2001	8	6.5	8	4	0.249	0.183
OK0026654	001	10/31/2001	14	13.5	1	1	0.2	0.182
OK0026654	001	11/30/2001	12	11.5	0	0	0.285	0.192
OK0026654	001	12/31/2001	14	12.5	27	16	0.279	0.195
OK0026654	001	01/31/2002	14	12.5	0	0	0.38	0.205
OK0026654	001	02/28/2002	32	23	300	150	0.279	0.225
OK0026654	001	03/31/2002	14	13.5	100	70	0.376	0.238
OK0026654	001	04/30/2002	12	11.5	0	0	0.357	0.23
OK0026654	001	05/31/2002	20	19	0	0	0.366	0.246
OK0026654	001	06/30/2002	19	18.5	0	0	0.355	0.251
OK0026654	001	07/31/2002	18	16.5	1	1	0.288	0.231
OK0026654	001	08/31/2002	19	17	4	4	0.496	0.277
OK0026654	001	09/30/2002	12	10.5	2	1	0.446	0.294
OK0026654	001	10/31/2002	16	14	96	88	0.366	0.266
OK0026654	001	11/30/2002	12	10	25	13	0.317	0.252

NPDES No.	Outfall	Monitoring Date	Max TSS Concentration (mg/L)	Average TSS Concentration (mg/L)	Max FC Concentration (cfu/100ml)	Average FC Concentration (cfu/100ml)	Maximum Flow (MGD)	Average Flow (MGD)
OK0026654	001	12/31/2002	16	12	46	23	0.399	0.267
OK0026654	001	01/31/2003	16	14	100	100	0.399	0.285
OK0026654	001	02/28/2003	13	12	3	2	0.236	0.206
OK0026654	001	03/31/2003	19	17	460	230	0.55	0.31
OK0026654	001	04/30/2003	14	13	88	44	0.353	0.283
OK0026654	001	05/31/2003	16	12	150	75	0.331	0.246
OK0026654	001	06/30/2003	22	20	20	19	0.4	0.277
OK0026654	001	07/31/2003	12	11	120	80	0.3	0.254
OK0026654	001	08/31/2003	13	12	110	63	0.456	0.26
OK0026654	001	09/30/2003	15	14.5	0	0	0.265	0.376
OK0026654	001	10/31/2003	26	20.5	36	18	0.5	0.285
OK0026654	001	11/30/2003	13	12	310	159	0.468	0.27
OK0026654	001	12/31/2003	12	11.5	1	0	0.444	0.271
OK0026654	001	01/31/2004	13	12.5	24	12	0.448	0.313
OK0026654	001	02/29/2004	14	13.5	36	30	0.442	0.325
OK0026654	001	03/31/2004	11	10	89	74	0.58	0.39
OK0026654	001	04/30/2004	8	6.5	830	288	0.496	0.35
OK0026654	001	05/31/2004	22	18	370	27	0.422	0.275
OK0026654	001	06/30/2004	9	5.5	2	2	0.483	0.304
OK0026654	001	07/31/2004	20	13	15	10	0.51	0.292
OK0026654	001	08/31/2004	70	34.3	66,000	13,200	0.356	0.289
OK0026654	001	09/30/2004	13	12.5	16	6	0.325	0.24
OK0026654	001	10/31/2004	13	12.5			0.595	0.371
OK0026654	001	11/30/2004	15	9.8	53	10	0.61	0.46
OK0026654	001	12/31/2004	14	14	27	7	0.54	0.379
OK0026654	001	01/31/2005	16	14.5	510	32	0.7	0.41
OK0026654	001	02/28/2005	18	14.5	2	2	0.51	0.357
OK0026654	001	03/31/2005	14	13	2	2	0.295	0.26
OK0026654	001	04/30/2005	14	14	4	3	0.317	0.257
OK0026654	001	05/31/2005	18	16	500	31	0.437	0.285
OK0026654	001	06/30/2005	23	18.5	2	3	0.468	0.316
OK0026654	001	07/31/2005	18	16.5	6	3		0.31
OK0026654	001	08/31/2005	16	15	12	9	0.414	0.312
OK0026654	001	09/30/2005	17	16	50	10	0.41	0.312
OK0026654	001	10/31/2005	18	17	2,000	63	0.391	0.334
OK0026654	001	11/30/2005	19	17.5	2	2	0.32	0.3
OK0026654	001	12/31/2005	22	19	0	0	0.32	0.277
OK0026654	001	01/31/2006	22	20.5	2	2	0.368	0.267
OK0026654	001	02/28/2006	15	13	41	5	0.327	0.273
OK0026654	001	03/31/2006	17	17	1,000	435	0.446	0.317
OK0026654	001	04/30/2006			16,000	6,812	0.478	0.346
OK0026654	001	05/31/2006			32,000	10,276	0.457	0.357
OK0026654	001	06/30/2006			28,000	290	0.399	0.339

NPDES No.	Outfall	Monitoring Date	Max TSS Concentration (mg/L)	Average TSS Concentration (mg/L)	Max FC Concentration (cfu/100ml)	Average FC Concentration (cfu/100ml)	Maximum Flow (MGD)	Average Flow (MGD)
OK0026654	001	07/31/2006			16	6	0.448	0.287
OK0026654	001	08/31/2006			27	21	0.34	0.266
OK0026654	001	09/30/2006			2	1	0.344	0.289
OK0026654	001	10/31/2006	38	27	275	60	0.314	0.253
OK0026654	001	11/30/2006	6	6	50	35	0.362	0.278
OK0026654	001	12/31/2006	12	12	200	85	0.413	0.307
OK0026654	001	01/31/2007	10	8	13	9	0.466	0.3763
OK0026654	001	02/28/2007	17	9.5	2	1	0.53	0.434
OK0026654	001	03/31/2007	10	6.5	41	14	0.623	0.519
OK0026654	001	04/30/2007	8	21.5	93	59	0.645	0.589
OK0026654	001	05/31/2007	9.7	6.3	5,700	282	0.656	0.4025
OK0026654	001	06/30/2007	8.5	7.25	4,300	415	0.334	0.257
OK0026654	001	07/31/2007	5.5	5	16	7	0.316	0.264
OK0026654	001	08/31/2007	3	2.75	1	1	0.2856	0.1205
OK0026654	001	09/30/2007	5	4.5	7	5	0.3085	0.18923
OK0026654	001	10/31/2007	22	15.75			0.2993	0.1932
OK0026654	001	11/30/2007	4	3			0.2655	0.1551
OK0026654	001	12/31/2007	6	4.5			0.36	0.2426
OK0026654	001	01/31/2008	12	11.5			0.2475	0.2054
OK0026654	001	02/29/2008	13	10.25			0.3147	0.1798
OK0026654	001	03/31/2008	7.5	6.5			0.3018	0.207
OK0026654	001	04/30/2008	5	10.77			0.2883	0.2274
OK0026654	001	05/31/2008	10	8	28	15	0.3119	0.2457
OK0026654	001	06/30/2008	8	7	54	22	0.3107	0.2771
OK0028517	001	01/31/1998	30	30			0.086	0.059
OK0028517	001	02/28/1998	54	54			0.063	0.059
OK0028517	001	03/31/1998	53	53			0.061	0.054
OK0028517	001	04/30/1998	64	64			0.052	0.048
OK0028517	001	05/31/1998	77	77			28.4	48
OK0028517	001	10/31/1998	85	85			49.1	86.4
OK0028517	001	11/30/1998	56	56			0.308	0.214
OK0028517	001	12/31/1998	61	61			0.024	0.019
OK0028517	001	02/28/1999	46	46			0.61	0.37
OK0028517	001	05/31/1999	77	77			0.25	0.2
OK0028517	001	07/31/1999	87	87			0.025	0.019
OK0028517	001	11/30/1999	62	62			0.205	0.205
OK0028517	001	02/29/2000	48	48			0.0225	0.037
OK0028517	001	03/31/2000	59	59			0.0262	0.037
OK0028517	001	04/30/2000	83	83			0.0487	0.037
OK0028517	001	05/31/2000	140	140			0.375	0.2625
OK0028517	001	06/30/2000	120	120			0.01875	0.037
OK0028517	001	07/31/2000	120	120			0.0375	0.0375
OK0028517	001	08/31/2000	61	61			0.0375	0.0375

NPDES No.	Outfall	Monitoring Date	Max TSS Concentration (mg/L)	Average TSS Concentration (mg/L)	Max FC Concentration (cfu/100ml)	Average FC Concentration (cfu/100ml)	Maximum Flow (MGD)	Average Flow (MGD)
OK0028517	001	10/31/2000	110	110			0.0375	0.0375
OK0028517	001	11/30/2000	97	97			0.0375	0.0375
OK0028517	001	12/31/2000	69	69			0.0375	0.0375
OK0028517	001	01/31/2001	64	64			0.0375	0.0375
OK0028517	001	02/28/2001	35	35			0.0375	0.0375
OK0028517	001	03/31/2001	50	50			0.0375	0.0375
OK0028517	001	04/30/2001	89	89			0.0375	0.0375
OK0028517	001	05/31/2001	100	100			0.0375	0.0375
OK0028517	001	06/30/2001	71	71			0.0375	0.0375
OK0028517	001	07/31/2001	72	72			0.0375	0.0375
OK0028517	001	11/30/2001	84	84			0.0375	0.0375
OK0028517	001	12/31/2001	60	60			0.0375	0.0375
OK0028517	001	01/31/2002	42	42			0.0375	0.0375
OK0028517	001	02/28/2002	34	34			0.0375	0.0375
OK0028517	001	03/31/2002	18	18			0.0375	0.0375
OK0028517	001	04/30/2002	88	88			0.0375	0.0375
OK0028517	001	05/31/2002	90	90			0.0375	0.0375
OK0028517	001	06/30/2002	63	63			0.0375	0.0375
OK0028517	001	09/30/2002	73	73			0.0375	0.0375
OK0028517	001	10/31/2002	69	69			0.0375	0.0375
OK0028517	001	11/30/2002	74	74			0.0375	0.0375
OK0028517	001	12/31/2002	59	59			0.0375	0.0375
OK0028517	001	01/31/2003	55	55			0.0375	0.0375
OK0028517	001	02/28/2003	54	54			0.0375	0.0375
OK0028517	001	03/31/2003	43	43			0.0375	0.0375
OK0028517	001	04/30/2003	84	84			0.0375	0.0375
OK0028517	001	05/31/2003	110	110			0.0375	0.0375
OK0028517	001	06/30/2003	96	96			0.0375	0.0375
OK0028517	001	07/31/2003	38	38			0.0375	0.0375
OK0028517	001	10/31/2003	46	46			0.0375	0.0375
OK0028517	001	11/30/2003	46	46			0.0375	0.0375
OK0028517	001	12/31/2003	36	36			0.0375	0.0375
OK0028517	001	01/31/2004	32	32			0.0375	0.0375
OK0028517	001	02/29/2004	35	35			0.0375	0.0375
OK0028517	001	03/31/2004	30	30			0.0375	0.0375
OK0028517	001	04/30/2004	57	57			0.0375	0.0375
OK0028517	001	05/31/2004	80	80			0.0375	0.0375
OK0028517	001	06/30/2004	70	70			0.0375	0.0375
OK0028517	001	07/31/2004	50	50			0.0375	0.0375
OK0028517	001	08/31/2004	28	28			0.0375	0.0375
OK0028517	001	09/30/2004	58	58			0.0375	0.0335
OK0028517	001	10/31/2004	62	62			0.0375	0.0375
OK0028517	001	11/30/2004	76	76			0.0375	0.0375

NPDES No.	Outfall	Monitoring Date	Max TSS Concentration (mg/L)	Average TSS Concentration (mg/L)	Max FC Concentration (cfu/100ml)	Average FC Concentration (cfu/100ml)	Maximum Flow (MGD)	Average Flow (MGD)
OK0028517	001	12/31/2004	31	31			0.0375	0.0375
OK0028517	001	01/31/2005	33	33			0.0445	0.0445
OK0028517	001	02/28/2005	33	33			0.064	0.064
OK0028517	001	03/31/2005	29	29			0.064	0.064
OK0028517	001	04/30/2005	69	69			0.064	0.064
OK0028517	001	05/31/2005	49	49			0.064	0.064
OK0028517	001	06/30/2005	56	56			0.064	0.064
OK0028517	001	07/31/2005	86	86			0.064	0.064
OK0028517	001	09/30/2005	52	52	9,500	1,233	0.064	0.064
OK0028517	001	10/31/2005	100	100			0.064	0.064
OK0028517	001	11/30/2005	80	80			0.064	0.064
OK0028517	001	01/31/2006	92	92			0.064	0.064
OK0028517	001	02/28/2006	110	110			0.064	0.064
OK0028517	001	04/30/2006	140	140			0.064	0.064
OK0028517	001	05/31/2006	110	110			0.064	0.064
OK0028517	001	01/31/2007	80	80			0.064	0.064
OK0028517	001	02/28/2007	54	54			0.064	0.064
OK0028517	001	04/30/2007	78	78			0.064	0.064
OK0028517	001	05/31/2007	92	92			0.064	0.064
OK0028517	001	06/30/2007	84	84	430	72	0.064	0.064
OK0028517	001	07/31/2007	48	48	78	46	0.064	0.064
OK0028517	001	08/31/2007	66	66	7	3	0.064	0.064
OK0028517	001	09/30/2007	35	35	32	1	0.064	0.064
OK0028517	001	10/31/2007	85	85			0.064	0.064
OK0028517	001	11/30/2007	88	88			0.064	0.064
OK0028517	001	12/31/2007	65	65			0.064	0.064
OK0028517	001	01/31/2008	45	45			0.064	0.064
OK0028517	001	02/29/2008	78	78			0.064	0.064
OK0028517	001	03/31/2008	96	96			0.064	0.064
OK0028517	001	04/30/2008	77.5	77.5			0.064	0.064
OK0028517	001	05/31/2008	55.5	55.5	38	38	0.064	0.064
OK0031909	001	01/31/1998	18	15			2.41	1.41
OK0031909	001	02/28/1998	24	16.5			1.31	1.215
OK0031909	001	03/31/1998	55	31.4			4.975	1.947
OK0031909	001	04/30/1998	29	25.8			2.816	1.5
OK0031909	001	05/31/1998	24	20.3	290	39	2.316	1.363
OK0031909	001	06/30/1998	42	22.6	310	16	1.773	1.245
OK0031909	001	08/31/1998	5.5	4.3	295	13	1.152	1.003
OK0031909	001	09/30/1998	9	5.5	339	37	1.569	0.925
OK0031909	001	10/31/1998	11	9.4			4.739	1.628
OK0031909	001	11/30/1998	37	19.1			5.011	2
OK0031909	001	12/31/1998	9	8			2.455	1.486
OK0031909	001	01/31/1999	11	9.3			4.467	1.397

NPDES No.	Outfall	Monitoring Date	Max TSS Concentration (mg/L)	Average TSS Concentration (mg/L)	Max FC Concentration (cfu/100ml)	Average FC Concentration (cfu/100ml)	Maximum Flow (MGD)	Average Flow (MGD)
OK0031909	001	02/28/1999	28	15.3			2.418	1.598
OK0031909	001	03/31/1999	10	8.5			2.784	1.78
OK0031909	001	04/30/1999	17	13.3			4.896	2.316
OK0031909	001	05/31/1999	17	12.8	297	185	4.15	1.924
OK0031909	001	06/30/1999	31	22	303	97	4.809	2.482
OK0031909	001	07/31/1999	14	10.5	363	249	4.864	2.092
OK0031909	001	08/31/1999	10	7.7	14	5	2.222	1.28
OK0031909	001	09/30/1999	7.5	7.1	9	4	1.877	1.223
OK0031909	001	10/31/1999	8	7.3			1.3	1.07
OK0031909	001	11/30/1999	12	9.6			1.183	1.051
OK0031909	001	12/31/1999	10	8.3			1.988	1.223
OK0031909	001	01/31/2000	11	9.5			1.128	1.075
OK0031909	001	02/29/2000	14	10.7			2.03	1.127
OK0031909	001	03/31/2000	25	19.8			4.08	1.864
OK0031909	001	04/30/2000	27	16.1			1.906	1.592
OK0031909	001	05/31/2000	17	14.2	357	21	2.155	1.368
OK0031909	001	06/30/2000	15	14	47	18	2	1.418
OK0031909	001	07/31/2000	14	12	5	3	1.739	1.24
OK0031909	001	08/31/2000	10	9.4	150	17	1.11	1.012
OK0031909	001	09/30/2000	12	10.6	370	9	1.084	0.895
OK0031909	001	10/31/2000	13	10.5			1.397	0.941
OK0031909	001	11/30/2000	10	8.4			1.714	1.072
OK0031909	001	12/31/2000	11	8.1			1.02	0.97
OK0031909	001	01/31/2001	14	10.4			1.907	1.133
OK0031909	001	02/28/2001	22	14.3			3.686	1.343
OK0031909	001	03/31/2001	15	11.1			1.378	1.172
OK0031909	001	04/30/2001	12	9.8			1.288	1.094
OK0031909	001	05/31/2001	15	11.1	62	13	1.8	1.128
OK0031909	001	06/30/2001	13	9.5	343	156	1.409	0.982
OK0031909	001	07/31/2001	8	6.2	183	6	0.936	0.814
OK0031909	001	08/31/2001	5.5	4.6	36	9	0.808	0.677
OK0031909	001	09/30/2001	8	6.3	380	48	0.837	0.711
OK0031909	001	10/31/2001	7.5	6.5			0.88	0.747
OK0031909	001	11/30/2001	8	7			0.89	0.722
OK0031909	001	12/31/2001	9	6.9			0.868	0.752
OK0031909	001	01/31/2002	7	5.9			1.099	0.754
OK0031909	001	02/28/2002	11	9.5			1.011	0.765
OK0031909	001	03/31/2002	8	7.1			1.001	0.808
OK0031909	001	04/30/2002	16	10.4			1.065	0.836
OK0031909	001	05/31/2002	12	10.6	185	5	2.674	0.932
OK0031909	001	06/30/2002	12	8	8	3	2.323	1.069
OK0031909	001	07/31/2002	10	8.9	37	4	1.306	0.775
OK0031909	001	08/31/2002	15	10.2	54	3	1.014	0.701

NPDES No.	Outfall	Monitoring Date	Max TSS Concentration (mg/L)	Average TSS Concentration (mg/L)	Max FC Concentration (cfu/100ml)	Average FC Concentration (cfu/100ml)	Maximum Flow (MGD)	Average Flow (MGD)
OK0031909	001	09/30/2002	8.5	6	302	16	1.668	0.743
OK0031909	001	10/31/2002	32	14			3.172	0.901
OK0031909	001	11/30/2002	16	12			0.795	0.718
OK0031909	001	12/31/2002	11	9.5			0.898	0.731
OK0031909	001	01/31/2003	10	9			0.834	0.68
OK0031909	001	02/28/2003	13	11			0.724	0.589
OK0031909	001	03/31/2003	20	14.8			2.801	1
OK0031909	001	04/30/2003	22	17			1.397	0.922
OK0031909	001	05/31/2003	17	11.9	590	38	2.124	0.871
OK0031909	001	06/30/2003	22	17.3	27	10	1.575	0.799
OK0031909	001	07/31/2003	14	12.2	8	4	0.717	0.551
OK0031909	001	08/31/2003	12	8.9	1,200	36	1.281	0.517
OK0031909	001	09/30/2003	12	7.7	720	14	1.617	0.648
OK0031909	001	10/31/2003	12	8.8			1.619	0.7
OK0031909	001	11/30/2003	13	12.5			0.751	0.617
OK0031909	001	12/31/2003	18	12.2			0.8	0.628
OK0031909	001	01/31/2004	16	14			1.699	0.695
OK0031909	001	02/29/2004	20	14.3			0.98	0.739
OK0031909	001	03/31/2004	24	19.2			2.761	0.959
OK0031909	001	04/30/2004	41	25.5			2.442	0.938
OK0031909	001	05/31/2004	42	26.3	340	6	1.57	0.775
OK0031909	001	06/30/2004	16	11.8	44,000	70	1.584	0.846
OK0031909	001	07/31/2004	38	17	1	1	1.584	0.846
OK0031909	001	08/31/2004	11	7.1	26	4	1.264	0.699
OK0031909	001	09/30/2004	10	7.4	18,900	44	0.708	0.562
OK0031909	001	10/31/2004	15	10			1.483	0.728
OK0031909	001	11/30/2004	13	11.5			1.658	0.928
OK0031909	001	12/31/2004	13	10.5			0.975	0.748
OK0031909	001	01/31/2005	16	12			2.789	0.997
OK0031909	001	02/28/2005	14	12			1.249	0.94
OK0031909	001	03/31/2005	16	13			1.579	0.922
OK0031909	001	04/30/2005	20	17.3			0.916	0.757
OK0031909	001	05/31/2005	16	12.5	23	7	0.993	0.625
OK0031909	001	06/30/2005	16	13	28	7	1.985	0.727
OK0031909	001	07/31/2005	27	15.9	120	4	1.541	0.595
OK0031909	001	08/31/2005	17	10	1,300	6	1.768	0.682
OK0031909	001	09/30/2005	8	7.4	< 1	< 1	0.837	0.555
OK0031909	001	10/31/2005	18	8.8			0.964	0.555
OK0031909	001	11/30/2005	16	13.2			0.588	0.498
OK0031909	001	12/31/2005	19	15.5			0.595	0.506
OK0031909	001	01/31/2006	16	12			0.71	0.51
OK0031909	001	02/28/2006	20	17			0.677	0.487
OK0031909	001	03/31/2006	16	12.3			1.111	0.587

NPDES No.	Outfall	Monitoring Date	Max TSS Concentration (mg/L)	Average TSS Concentration (mg/L)	Max FC Concentration (cfu/100ml)	Average FC Concentration (cfu/100ml)	Maximum Flow (MGD)	Average Flow (MGD)
OK0031909	001	04/30/2006	22	14.3			2.433	0.654
OK0031909	001	05/31/2006	26	20.4	6	2	1.417	0.702
OK0031909	001	06/30/2006	32	20	5	1	0.702	0.506
OK0031909	001	07/31/2006	21	17.3	39	1	0.732	0.399
OK0031909	001	08/31/2006	26	10.6	23	4	0.728	0.405
OK0031909	001	09/30/2006	14	8.5	< 1	< 1	0.695	0.403
OK0031909	001	10/31/2006	14	10.8			0.695	0.424
OK0031909	001	11/30/2006	17	9			0.763	0.468
OK0031909	001	12/31/2006	10	5.3			0.763	0.582
OK0031909	001	01/31/2007	17	10.3			0.778	0.506
OK0031909	001	02/28/2007	16	12.5			0.86	0.56
OK0031909	001	03/31/2007	10	9			6.926	1.225
OK0031909	001	04/30/2007	18	11.3			2.866	1.33
OK0031909	001	05/31/2007	7.5	6.5	< 1	< 1	2.514	0.982
OK0031909	001	06/30/2007	6	5.5	< 1	< 1	5.145	1.437
OK0031909	001	07/31/2007	20	14	21	5	4.327	1.579
OK0031909	001	08/31/2007	17	13.5	33	6	1.464	0.902
OK0031909	001	09/30/2007	13	8.3	< 1	< 1	1.21	0.81
OK0031909	001	10/31/2007	7	5.5			2.345	0.928
OK0031909	001	11/30/2007	4	3.5			1.013	0.831
OK0031909	001	12/31/2007	19	12.5			1.938	0.992
OK0031909	001	01/31/2008	6	5.5			2.387	0.962
OK0031909	001	02/29/2008	9	8.5			1.659	1.139
OK0031909	001	03/31/2008	17	11.3			2.159	1.19
OK0031909	001	04/30/2008	33	26.3			2.894	1.409
OK0031909	001	05/31/2008	14.5	12.3	< 1	< 1	3.481	1.571
OK0031909	001	06/30/2008	10	8	< 1	< 1	3.669	2.027
OK0031968	001	01/31/1999	100	90			1.032	0.235
OK0031968	001	02/28/1999	79	68			1.005	0.459
OK0031968	001	03/31/1999	120	96			1.033	0.781
OK0031968	001	11/30/1999	140	120			1.008	0.209
OK0031968	001	12/31/1999	320	187			1.032	0.45
OK0031968	001	01/31/2000	320	192			1.032	0.205
OK0031968	001	02/29/2000	100	94			0.571	0.333
OK0031968	001	03/31/2000	100	95			0.528	0.323
OK0031968	001	03/31/2001	42	2			1.2	0.848
OK0035068	301	01/31/1998	9	6			2.304	2.24
OK0035068	301	02/28/1998	9	7			2.608	2.332
OK0035068	301	03/31/1998	9	8			2.64	2.528
OK0035068	301	04/30/1998	11	10			2.448	2.312
OK0035068	301	05/31/1998	12	8			2.496	2.456
OK0035068	301	06/30/1998	16	13			2.304	2.272
OK0035068	301	07/31/1998	31	21			2.064	2

NPDES No.	Outfall	Monitoring Date	Max TSS Concentration (mg/L)	Average TSS Concentration (mg/L)	Max FC Concentration (cfu/100ml)	Average FC Concentration (cfu/100ml)	Maximum Flow (MGD)	Average Flow (MGD)
OK0035068	301	08/31/1998	15	14			2.96	2.704
OK0035068	301	09/30/1998	21	17			2.208	2.136
OK0035068	301	10/31/1998	15	13			2.304	2.192
OK0035068	301	11/30/1998	8	6			2.424	1.896
OK0035068	301	12/31/1998	7	6			2.912	2.608
OK0035068	301	01/31/1999	5	5			2.416	2.416
OK0035068	301	02/28/1999	7	6			2.848	2.839
OK0035068	301	03/31/1999	7	6			2.72	2.72
OK0035068	301	04/30/1999	16	13			2.912	2.496
OK0035068	301	05/31/1999	16	12			2.48	2.24
OK0035068	301	06/30/1999	16	15			2.608	2.512
OK0035068	301	07/31/1999	21	18			2.688	2.496
OK0035068	301	08/31/1999	21	16			2.56	2.432
OK0035068	301	09/30/1999	22	20			2.304	2.232
OK0035068	301	10/31/1999	14	12			2.176	1.496
OK0035068	301	11/30/1999	9	7			1.888	0.983
OK0035068	301	12/31/1999	< 4	< 4			2.544	2.512
OK0035068	301	01/31/2000	5	5			2.368	2.368
OK0035068	301	02/29/2000	7	< 6			2.72	0.801
OK0035068	301	03/31/2000	12	9			2.32	2.28
OK0035068	301	04/30/2000	10	10			2.304	2.304
OK0035068	301	05/31/2000	13	11			2.72	2.384
OK0035068	301	06/30/2000	22	20			2.78	2.66
OK0035068	301	07/31/2000	20	17			2.432	2.368
OK0035068	301	08/31/2000	21	17			2.56	2.368
OK0035068	301	09/30/2000	24	20			2.128	2.064
OK0035068	301	10/31/2000	15	14			2.224	2.2
OK0035068	301	11/30/2000	9	< 6			2.304	2.212
OK0035068	301	12/31/2000	< 4	< 4			2.224	2.172
OK0035068	301	01/31/2001	< 4	< 4			2.88	2.592
OK0035068	301	02/28/2001	5	< 4			2.176	2.112
OK0035068	301	03/31/2001	9	7			2.352	2.416
OK0035068	301	04/30/2001	16	12			2.304	2.264
OK0035068	301	05/31/2001	16	14			2.368	2.12
OK0035068	301	06/30/2001	12	12			2.304	2.272
OK0035068	301	07/31/2001	20	18			2.368	2.272
OK0035068	301	08/31/2001	20	16			2.176	2.024
OK0035068	301	09/30/2001	14	14			2.56	2.52
OK0035068	301	10/31/2001	19	17			2.848	2.64
OK0035068	301	11/30/2001	10	8			2.48	2.24
OK0035068	301	12/31/2001	8	< 6			2.48	2.424
OK0035068	301	01/31/2002	4	< 4			2.66	2.476
OK0035068	301	02/28/2002	6	< 5			1.872	0.069

NPDES No.	Outfall	Monitoring Date	Max TSS Concentration (mg/L)	Average TSS Concentration (mg/L)	Max FC Concentration (cfu/100ml)	Average FC Concentration (cfu/100ml)	Maximum Flow (MGD)	Average Flow (MGD)
OK0035068	301	03/31/2002	11	< 5			2.96	0.22
OK0035068	301	04/30/2002	12	11			2.784	0.158
OK0035068	301	05/31/2002	16	13			2.368	0.192
OK0035068	301	06/30/2002	21	16			1.264	0.524
OK0035068	301	07/31/2002	18	16			2.128	2.064
OK0035068	301	08/31/2002	18	17			2.592	2.384
OK0035068	301	09/30/2002	16	14			2.48	2.328
OK0035068	301	10/31/2002	19	14			2.672	2.555
OK0035068	301	11/30/2002	42	24			2.176	2.12
OK0035068	301	12/31/2002	5	4			2.416	1.904
OK0035068	301	01/31/2003	< 4	< 4			2.56	2.341
OK0035068	301	02/28/2003	6	5			2.208	2.128
OK0035068	301	03/31/2003	8	8			3.04	2.86
OK0035068	301	04/30/2003	17	10			2.56	1.904
OK0035068	301	05/31/2003	17	14			2.624	2.216
OK0035068	301	06/30/2003	14	13			2.241	2.113
OK0035068	301	07/31/2003	20	17			2.176	2.095
OK0035068	301	08/31/2003	14	13			2.128	2.064
OK0035068	301	09/30/2003	26	22			2.368	2.261
OK0035068	301	10/31/2003	15	14.5			2.56	2.52
OK0035068	301	11/30/2003	8.5	7.8			2.304	2.192
OK0035068	301	12/31/2003	5.5	5.3			2.248	2.156
OK0035068	301	01/31/2004	9	6			2.48	2.384
OK0035068	301	02/29/2004	4	4			2.944	2.944
OK0035068	301	03/31/2004	6	5.3			2.304	2.212
OK0035068	301	04/30/2004	15	14			2.368	2.283
OK0035068	301	05/31/2004	18	15			2.176	2.08
OK0035068	301	06/30/2004	21	18.5			2.208	2.184
OK0035068	301	07/31/2004	22	20			2.176	2.176
OK0035068	301	08/31/2004	20	18			2.224	2.16
OK0035068	301	09/30/2004	20	20			2.592	2.592
OK0035068	301	10/31/2004	24	19			2.176	1.552
OK0035068	301	11/30/2004	12	8.8			1.2	1.176
OK0035068	301	12/31/2004	8.5	6.3			1.392	1.24
OK0035068	301	01/31/2005	4	4			1.28	1.28
OK0035068	301	02/28/2005	9.5	< 6.8			1.24	1.224
OK0035068	301	03/31/2005	14	9.8			1.152	1.12
OK0035068	301	04/30/2005	10	10			1.024	1.024
OK0035068	301	05/31/2005	16	14.5			1.416	1.224
OK0035068	301	06/30/2005	16	16			1.088	1.088
OK0035068	301	07/31/2005	19	19			1.088	1.088
OK0035068	301	08/31/2005	16	15.5			1.184	1.152
OK0035068	301	09/30/2005	24	24			1.088	1.088

NPDES No.	Outfall	Monitoring Date	Max TSS Concentration (mg/L)	Average TSS Concentration (mg/L)	Max FC Concentration (cfu/100ml)	Average FC Concentration (cfu/100ml)	Maximum Flow (MGD)	Average Flow (MGD)
OK0035068	301	10/31/2005	22	18.5			1.216	1.12
OK0035068	301	11/30/2005	10	10			0.944	0.944
OK0035068	301	12/31/2005	< 4	< 4			1.336	1.176
OK0035068	301	01/31/2006	< 4	< 4			1.28	1.2
OK0035068	301	02/28/2006	< 4	< 4			0.768	0.768
OK0035068	301	03/31/2006	11	11			1.152	1.152
OK0035068	301	04/30/2006	10	10			1.336	1.26
OK0035068	301	05/31/2006	19	14			1.4	1.324
OK0035068	301	06/30/2006	15	15			1.24	1.24
OK0035068	301	07/31/2006	20	20			1.152	1.152
OK0035068	301	08/31/2006	17	14.5			1.392	1.302
OK0035068	301	09/30/2006	16	16			1.216	1.216
OK0035068	301	10/31/2006	16	16			1.176	1.176
OK0035068	301	11/30/2006	6.5	6.5			1.152	1.152
OK0035068	301	12/31/2006	5	4.5			2.688	1.669
OK0035068	301	01/31/2007	9	< 6.5			1.064	1.064
OK0035068	301	02/28/2007	< 4	< 4			1.064	0.986
OK0035068	301	03/31/2007	22	14			1.088	1.012
OK0035068	301	04/30/2007	13	11.5			1.12	0.961
OK0035068	301	05/31/2007	26	18			0.968	0.916
OK0035068	301	06/30/2007	28	18.3			1.056	1.044
OK0035068	301	07/31/2007	25	21.5			1.088	1.088
OK0035068	301	08/31/2007	25	25			1.24	1.24
OK0035068	301	09/30/2007	19	17.5			1.056	1.048
OK0035068	301	10/31/2007	48	25.3			1.936	1.544
OK0035068	301	11/30/2007	5	5			0.704	0.704
OK0035068	301	12/31/2007	6	< 5			1.337	1.176
OK0035068	301	01/31/2008	< 5	< 4.5			1.34	1.278
OK0035068	301	02/29/2008	4.1	< 4.1			1.36	1.32
OK0035068	301	03/31/2008	16	11.3			2.416	1.784
OK0035068	301	04/30/2008	14	12.8			1.76	1.413
OK0035068	301	05/31/2008	12	11.8				
OK0035068	301	06/30/2008	25	25			1.3	1.29
OK0035068	601	Outfall 601						
OK0035068	601	03/31/1998	31	10			4.32	3.646
OK0035068	601	04/30/1998	8	6			4.32	4.21
OK0035068	601	08/31/1998	5	< 5			4.32	4.212
OK0035068	601	09/30/1998	< 4	< 4			4.32	3.69
OK0035068	601	11/30/1998	6	6			4.32	4.122
OK0035068	601	12/31/1998	6	5			4.32	4.17
OK0035068	601	05/31/1999	7	< 5			4.32	4.2
OK0035068	601	06/30/1999	7	< 5			4.32	4.2
OK0035068	601	09/30/1999	11	< 6			4.32	3.93

NPDES No.	Outfall	Monitoring Date	Max TSS Concentration (mg/L)	Average TSS Concentration (mg/L)	Max FC Concentration (cfu/100ml)	Average FC Concentration (cfu/100ml)	Maximum Flow (MGD)	Average Flow (MGD)
OK0035068	601	03/31/2000	5	< 4			4.32	3.64
OK0035068	601	04/30/2000	5	< 4			4.32	4.23
OK0035068	601	08/31/2000	< 4	< 4			4.32	4.118
OK0035068	601	03/31/2001	5	4			4.32	4.13
OK0035068	601	04/30/2001	4	< 4			4.32	4.005
OK0035068	601	05/31/2001	12	< 9			4.32	3.728
OK0035068	601	06/30/2001	5	5			4.32	4.013
OK0035068	601	07/31/2001	5	5			0.558	0.558
OK0035068	601	08/31/2001	< 4	< 4			3.06	2.484
OK0035068	601	05/31/2002	7	< 5			4.32	4.186
OK0035068	601	06/30/2002	8	< 5			4.32	4.131
OK0035068	601	09/30/2002	4	< 4			4.32	4
OK0035068	601	10/31/2002	< 4	< 4			4.32	4.045
OK0035068	601	02/28/2003	4	< 4			4.32	4.32
OK0035068	601	03/31/2003	< 4	< 4			4.32	4.18
OK0035068	601	05/31/2003	< 4	< 4			4.32	3.9
OK0035068	601	06/30/2003	6	< 5			4.32	4.05
OK0035068	601	08/31/2003	7	< 5			4.32	4.08
OK0035068	601	02/29/2004	5.5	4.5			4.32	4.09
OK0035068	601	03/31/2004	8	< 4.9			4.32	4.32
OK0035068	601	04/30/2004	9.5	< 5.4			4.32	4.3
OK0035068	601	08/31/2004	4	< 4			4.32	4.17
OK0035068	601	11/30/2004	< 4	< 4			4.32	3.969
OK0035068	601	03/31/2005	< 4	< 4			4.32	4.21
OK0035068	601	04/30/2005	8	8			4.32	4.053
OK0035068	601	06/30/2006	< 4	< 4			4.32	3.78
OK0035068	601	03/31/2007	< 4	< 4			3.24	0.525
OK0035068	601	04/30/2007	4	4			3.24	3.117
OK0035068	601	05/31/2007	18	18			3.24	3.19
OK0035068	601	06/30/2007	4	4			3.24	3.104
OK0035068	601	07/31/2007	4	4			3.24	3.19
OK0035068	601	08/31/2007	4	4			3.24	0.274
OK0035068	601	10/31/2007	< 4	< 4			3.24	2.831
OK0035068	601	11/30/2007	4.5	4.5			3.24	3.05
OK0035068	601	04/30/2008	4.5	4.3			3.24	3.072
OK0035068	601	05/31/2008	< 4	< 4			3.24	3.2
OK0035068	601	06/30/2008	5	5			3.24	2.943
OKG580043	001	01/31/2005	84	73			0.286	0.139
OKG580043	001	02/28/2005	64	62			0.104	0.077
OKG580043	001	03/31/2005	70	67			0.181	0.143
OKG580043	001	04/30/2005	84	74			0.051	0.051
OKG580043	001	05/31/2005	88	86			0.051	0.022
OKG580043	001	06/30/2005	120	120			0.586	0.201

NPDES No.	Outfall	Monitoring Date	Max TSS Concentration (mg/L)	Average TSS Concentration (mg/L)	Max FC Concentration (cfu/100ml)	Average FC Concentration (cfu/100ml)	Maximum Flow (MGD)	Average Flow (MGD)
OKG580043	001	07/31/2005	110	72			0.051	0.036
OKG580043	001	08/31/2005	170	160			0.286	0.084
OKG580043	001	09/30/2005	180	175			0.286	0.047
OKG580043	001	10/31/2005	170	160			0.181	0.097
OKG580043	001	11/30/2005	170	170			0.181	0.126
OKG580043	001	12/31/2005	85	73			0.104	0.066
OKG580043	001	01/31/2006	100	99			0.104	0.056
OKG580043	001	02/28/2006	90	90			0.051	0.051
OKG580043	001	03/31/2006	98	97			0.181	0.086
OKG580043	001	06/30/2007	100	93			0.074	0.051
OKG580043	001	07/31/2007	91	86.5			0.074	0.032
OKG580043	001	08/31/2007	96	96			0.018	0.018
OKG580043	001	09/30/2007	36	36			0.00001	0.0001
OKG580043	001	02/29/2008	112	110			0.117	0.03
OKG580043	001	03/31/2008	108	102			0.117	0.05
OKG580043	001	06/30/2008	86	86			0.315	0.109

Note: Red highlights show permit limit exceedances for TSS and FC. Facility permit limits are shown in Table 3-1.

APPENDIX E
ODEQ Sanitary Sewer Overflow Data – 1990 to 2011

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
BLACKWELL	S21102		0.00	WWTP				POWER OUTAGE
BLACKWELL	S21102		0.00			X		
BLACKWELL	S21102		0.00	"B" ST. & E. FERGUSON				RAIN & FLOODING
BLACKWELL	S21102		0.00	6TH & LEGION DR.				LINE BREAK
BLACKWELL	S21102		0.00					
BLACKWELL	S21102		0.00	1200 BLK. W. DULAN	1,000	X		
BLACKWELL	S21102	3/18/1992	8.00	MH 1/4 MILE UPSTREAM OF THE SEWER PLANT		X		Several inches of rain and infiltration/inflow
BLACKWELL	S21102	10/18/1992		5TH AND DEWEY	5000	X		LINE BREAKAGE
BLACKWELL	S21102	6/21/1993	0.00	5TH AND DEWEY	0	X		LINE BREAKAGE
BLACKWELL	S21102	6/10/1995	48.00	PLANT FLOODED	12000000	X		RAIN
BLACKWELL	S21102	9/26/1996	72.00	SEWER PLANT AREA & 15 SQ. BLKS. OF THE TOWN	0	X		CKICKASKIA RIVER FLOODED
BLACKWELL	S21102	4/15/1997	80.00		100,000			BLOCKAGE
BLACKWELL	S21102	5/26/1997	1.00					BLOCKAGE
BLACKWELL	S21102	5/26/1997	1.00		>50			SEWER BLOCKAGE
BLACKWELL	S21102	5/29/1997		L.S. IN WEST CITY				GASKET LEAK
BLACKWELL	S21102	7/17/1997		MH ON 6TH ST. BETWEEN BRIDGE & PADON AVE.				RAIN
BLACKWELL	S21102	12/29/1997	2.00	LEGION PARK	6,000	X		PUMP FAILURE
BLACKWELL	S21102	1/27/1998	2.50	WEST SIDE OF TOWN	>200,000			ROOTS
BLACKWELL	S21102	7/11/1998		124 N. 5TH	100	X		STOPPED MAIN
BLACKWELL	S21102	8/25/1998		44TH ST. WW PUMP STATION	1,500	X		PUMP MALFUNCTION
BLACKWELL	S21102	10/2/1998		WWP	100,000	X		RAIN
BLACKWELL	S21102	10/30/1998		25 CITY SQUARE BLOCKS				FLOODING
BLACKWELL	S21102	12/11/1998	1.00	44TH ST. PUMP STATION	1,500	X		PUMP FAILURE
BLACKWELL	S21102	2/5/1999	3.00	BIBLE HOLINESS CHURCH				
BLACKWELL	S21102	3/28/1999	23.00	L.S. #1	87,000			RAIN

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
BLACKWELL	S21102	3/29/1999	23.00	L.S.#1 E. OF SIXTH ST. & S. OF DOOLIN AVE.	87,000			L.S. MALFUNCTION
BLACKWELL	S21102	6/19/1999	5.50		200,000			RAIN
BLACKWELL	S21102	7/1/1999		WWTP	200,000			POWER OUTAGE
BLACKWELL	S21102	2/4/2000		MH S.E. OF CITY				ROOTS
BLACKWELL	S21102	2/24/2000		WWTP	30,000			PUMP MALFUNCTION
BLACKWELL	S21102	5/8/2001	1.50	HWY 11 W. OF CITY AT 44TH & 29TH	1,000	X		CONTRACTOR ERROR
BLACKWELL	S21102	5/9/2001	0.70	900 BLK. N. "A" & "B"	55	X		STOPPAGE
BLACKWELL	S21102	12/11/2001	0.00	N.E. QUADRANT OF CITY		X		DAMAGED SEWER LINES
BLACKWELL	S21102	2/2/2002	3.50	WWTP	2,300			POWER OUTAGE
BLACKWELL	S21102	3/26/2002	0.70	1400BLK. OF SOUTH "E" ST. FROM "E" & COOLIDGE	500	X		ROOTS
BLACKWELL	S21102	9/14/2002	0.20	44TH & DOOLIN	500	X		POWER FAILURE
BLACKWELL	S21102	8/19/2003	0.00	WWTP - 220 W. LAWRENCE			X	LINE SURCHARGED
BLACKWELL	S21102	9/2/2003	3.00	WWTP	100		X	OVERFLOW
BLACKWELL	S21102	1/18/2004	9.50	LEGION SEWER L.S.	3,000	X		POWER FAILURE
BLACKWELL	S21102	3/4/2004	20.00	"E" & SANTE FE;"B" & FURGUSON;5TH AT DEWEY & MCKINLEY	1 MILLN	X		RAIN
BLACKWELL	S21102	4/20/2004	3.60	SOUTH "E" ST. MH	50,000	X		RAIN
BLACKWELL	S21102	6/3/2004	0.50	PLANT	100		X	BLOCKAGE
BLACKWELL	S21102	6/21/2004	3.00	LEGION SEWER L.S.	5,000	X		PUMP FAILURE
BLACKWELL	S21102	8/15/2004	3.00	PLANT	500		X	OVERFLOW
BLACKWELL	S21102	8/21/2004	4.00	8TH & SANTE FE	500	X		BLOCKAGE
BLACKWELL	S21102	8/21/2004	4.00	1000 BLK OF W. OKLAHOMA	100	X		BLOCKAGE
BLACKWELL	S21102	9/12/2004	0.50	8TH & SANTE FE	50	X		BLOCKAGE
BLACKWELL	S21102	9/14/2004	0.00	LEGION ST. & DOOLIN AVE		X		HOLE IN PIPE
BLACKWELL	S21102	9/21/2004	2.00	800 BLK. W. SANTE FE	500	X		LEAK IN PIPE

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
BLACKWELL	S21102	2/25/2005	2.50	19TH & 20TH N. OF BRIDGE ST.	6,000	X		ROOTS
BLACKWELL	S21102	3/28/2005	0.00	PLANT	300		X	OVERFLOW
BLACKWELL	S21102	6/22/2005	2.50	S. 3RD & SOUTHWEST BLVD.	1,500	X		CONTRACTOR ERROR
BLACKWELL	S21102	7/4/2005	4.00	44TH ST. L.S.	450	X		POWER OUTAGE
BLACKWELL	S21102	12/10/2005	1.00	8TH AT COLLEGE & LINCOLN	2,000	X		BLOCKED MAIN
BLACKWELL	S21102	7/20/2006	1.00	LEGION DR. & FRISCO	3,000	X		STOPPED MAIN
BLACKWELL	S21102	12/15/2006	0.70	S. 8TH AT SANTE FE & COLLEGE	200			BLOCKAGE
BLACKWELL	S21102	3/30/2007	1.00	FULTON ST. & 1ST	1,500	X		I&I
BLACKWELL	S21102	3/30/2007	1.00	1ST AT FULTON & FLORENCE ST.	500	X		I&I
BLACKWELL	S21102	3/30/2007	2.00	"B" ST. & FURGESON AVE.	5,000	X		I&I
BLACKWELL	S21102	3/30/2007	2.00	BRADEN PROPERTY	5,000	X		I&I
BLACKWELL	S21102	6/30/2007	9.00	SOUTH "B" ST. & EAST FERGUSON	46,000	X		RAIN
BLACKWELL	S21102	6/30/2007	28.50	300 BLK. N. 5TH	17,000	X		RAIN
BLACKWELL	S21102	6/30/2007	28.50	100 BLK. S. 5TH	10,000	X		RAIN
BLACKWELL	S21102	6/30/2007	33.00	SOUTH "E" ST. IN PASTURE AT OLD BREWER PROPERTY	96,000	X		RAIN
BLACKWELL	S21102	5/27/2008	36.00	S. "B" ST. & E. FURGUSON	2,500	X		RAIN
BLACKWELL	S21102	6/6/2008	10.00	"B" & FERGUSON	120	X		RAIN
BLACKWELL	S21102	6/9/2008	7.00	1ST & FULTON	22,800	X		RAIN
BLACKWELL	S21102	6/9/2008	20.00	"B" ST. & FERGUSON	36,000	X		RAIN
BLACKWELL	S21102	6/9/2008	20.00	SOUTH SANTA FE & "E" ST.	48,000	X		RAIN
BLACKWELL	S21102	10/25/2008	0.50	BRAUMS L.S.	200	X		POWER OUTAGE
BLACKWELL	S21102	3/19/2009	18.00	HWY 11 & 44TH ST.	27,000	X		CONTRACTOR ERROR
BLACKWELL	S21102	5/19/2010	10.00	"B" ST. & FERGUSON	148,000	X		RAIN
BLACKWELL	S21102	6/14/2010	6.00	"B" & E. FERGUSON	27,000	X		RAIN
BLACKWELL	S21102	1/30/2011	1.50	903 ROBIN RD.	20	X		ROOTS

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
CHEROKEE	S21003		0.00					
CHEROKEE	S21003	8/4/1995	0.00	EAST 5TH	0	X		RAIN I/I
CHEROKEE	S21003	4/22/1996	3.00	CHEROKEE LAGOON HEAD SECTION, NOT RUN OFF	3000	X		PUMP STATION FAILED
CHEROKEE	S21003	4/14/1999		5TH & FLORIDA S. SIDE OF ROAD	6,500	X		FLOOD WATER
CHEROKEE	S21003	9/11/2000	0.50	WWTP	1,000	X		POWER OUTAGE
CHEROKEE	S21003	12/15/2002	20.00	LAGOON	3,000	X		PUMPS OVERLOAD
CHEROKEE	S21003	9/12/2008	0.00	5TH & FLORIDA		X		RAIN
CHEROKEE	S21003	8/11/2009	0.00	WWTP	1,250		X	PUMP FAILURE
CHEROKEE	S21003	9/13/2009	24.00	WWTP	<1,000		X	RAIN
CHEROKEE	S21003	10/8/2009	0.00	54TH & FLORIDA		X		RAIN
CHEROKEE	S21003	8/17/2010	0.00	E. 5TH & S. ILLINOIS			X	RAIN
GLENCOE - NW	S21213	4/19/1995	0.00	LIFT STATION	0	X		LIGHTING STRIKE
GLENCOE - NW	S21213	11/10/1999		LAGOONS	5 MILLN		X	LAGOON MAINTENANCE
GLENCOE - NW	S21213	6/29/2007	8.00	PLANT	9,500		X	RAIN
NEWKIRK	S21013		8.00	LIFT STATION #1				RAIN
NEWKIRK	S21013	8/3/1993	0.00	LAGOONS SEEPING	0	X	X	CONSTRUCTION DAMAGE
NEWKIRK	S21013	11/20/1994	2.00	LIFT STATION IN SW PART OF TOWN	0	X		HYDROLIC OVERLOAD AT LIFT STATION
NEWKIRK	S21013	3/12/1995	3.00	#1 LIFT STATION	0	X		RAIN I/I
NEWKIRK	S21013	3/15/1995	5.00	6TH AND PINE LIFT STATION	0	X		PUMP LOCKED UP
NEWKIRK	S21013	4/29/1995	11.00	HIWAY 77 & COUNTY ROAD	0	X		RAIN I/I
NEWKIRK	S21013	6/3/1995	20.00	LIFT STATION	0	X		RAIN I/I
NEWKIRK	S21013	6/8/1995	24.00	LIFT STATION #1	0	X		RAIN I/I
NEWKIRK	S21013	8/2/1995	1.00	LIFT STATION	20000	X		RAIN I/I
NEWKIRK	S21013	9/26/1996	8.00	HWY 77 COUNTY ROAD	0	X		RAIN

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
NEWKIRK	S21013	9/26/1996	8.00	8TH ST. BETWEEN CHESTNUT & PINE		X		RAIN
NEWKIRK	S21013	9/26/1996	8.00	SOUTH ST. BETWEEN MAIN & ELM		X		RAIN
NEWKIRK	S21013	9/26/1996	8.00	ACADEMY BETWEEN PECKHAM HWY & 7TH ST.		X		RAIN
NEWKIRK	S21013	9/26/1996	8.00	PEACH ST. BETWEEN 7TH & 8TH		X		RAIN
NEWKIRK	S21013	9/26/1996	8.00	2 ON PECKHAM HWY BETWEEN MAGNOLIA & CEDAR		X		RAIN
NEWKIRK	S21013	11/3/1996	1.00	E. 6TH ST. & E. 8TH ST. BETWEEN PINE & CHESTNUT	0	X		SANDBAG LOST IN SEWER LINE WHILE SMOKE TESTING
NEWKIRK	S21013	11/16/1996	10.00	HWY 77 & COUNTY ROAD		X		RAIN
NEWKIRK	S21013	11/16/1996	10.00	8TH ST. BETWEEN CHESTNUT & PINE				RAIN
NEWKIRK	S21013	11/16/1996	10.00	9TH & CHESTNUT				RAIN
NEWKIRK	S21013	11/16/1996	10.00	SOUTH ST. BETWEEN MAIN & ELM				RAIN
NEWKIRK	S21013	11/16/1996	10.00	PEACH ST. BETWEEN 7TH & 8TH				RAIN
NEWKIRK	S21013	11/16/1996	10.00	ACADEMY BETWEEN 7TH & PECKHAM HWY.				RAIN
NEWKIRK	S21013	12/10/1996	13.00	1/2 MILE S.W. OF NEWKIRK		X		BROKEN MAIN
NEWKIRK	S21013	12/21/1996	4.00	HWY 77-COUNTY ROAD		X		MALFUNCTION
NEWKIRK	S21013	2/20/1997	8.00	E. 8-PINE/CHESTNUT;9TH-ELM/PINE;S. ST-MAIN/ELM;PEACH-7TH/8TH				
NEWKIRK	S21013	4/11/1997	8.50	HWY 77 & COUNTY RD.				RAIN
NEWKIRK	S21013	8/15/1997		RETENTION LAGOONS		X		LAGOONS ARE FULL
NEWKIRK	S21013	8/19/1997	40.00	L.S.	2,000			
NEWKIRK	S21013	8/19/1997	0.50	HWY 77 & COUNTY RD.	2,000	X		PUMP FAILURE
NEWKIRK	S21013	3/16/1998	8.00	9TH BETWEEN CHESTNUT & ELM/S. BETWEEN MAIN & ELM		X		RAIN

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
NEWKIRK	S21013	3/16/1998	8.00	ACADEMY BETWEEN 7TH & 8TH		X		RAIN
NEWKIRK	S21013	7/8/1998	2.00	8 & CHESTNUT/9 & PINE/S. & MAIN/ACEDEMY BETW. PECKHAM & 7TH				RAIN
NEWKIRK	S21013	8/30/1998	0.10	L.S.	500	X		PUMP FAILURE
NEWKIRK	S21013	9/22/1998	1.00	MH'S IN VARIOUS PLACES IN CITY		X		RAIN
NEWKIRK	S21013	10/2/1998	4.00	MH'S IN CITY		X		RAIN
NEWKIRK	S21013	10/4/1998	5.00	MH'S IN CITY		X		RAIN
NEWKIRK	S21013	10/11/1998	0.40	L.S. #1		X		POWER FAILURE
NEWKIRK	S21013	10/31/1998	6.00	MH'S		X		RAIN
NEWKIRK	S21013	11/24/1998	0.20	HWY 77 & COUNTY SHED RD.	700	X		AIR PUMP FAILURE
NEWKIRK	S21013	1/30/1999	3.00	VARIOUS MANHOLES				
NEWKIRK	S21013	4/14/1999	3.00	8TH ST/ACADEMY & PECKHAM HWY/9TH & CHESTNUT/S. AT MAIN & 9TH				RAIN
NEWKIRK	S21013	5/23/1999	2.00	8TH AT CHESTNUT & PINE,7TH & ACADEMY & PECKHAM HWY.				
NEWKIRK	S21013	6/2/1999		LAGOONS				RAINS
NEWKIRK	S21013	6/19/1999	1.00	8TH AT CHESTNUT & PINE-ACADEMY & PECKHAM HWY/CHESTNUT & 9TH				
NEWKIRK	S21013	6/24/1999	6.70	LIFT STATION #1		X		RAIN
NEWKIRK	S21013	7/1/1999		LAGOONS				RAINS
NEWKIRK	S21013	7/1/1999	4.00	8TH AT CHESNUT & PINE-ACADEMY & HWY & 7TH		X		RAIN
NEWKIRK	S21013	3/15/2000	0.50	BETWEEN 7TH & PECKHAM RD.		X		RAIN
NEWKIRK	S21013	6/21/2000	3.00	8TH AT S. CHESTNUT & PINE/PECKHAM HWY & 7TH		X		RAIN
NEWKIRK	S21013	6/21/2000		SOUTH ST. AT MAIN & ELM		X		RAIN
NEWKIRK	S21013	2/24/2001	4.00	SOUTH ST AT MAIN & ELM & CHESTNUT & PINE		X		RAIN

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
NEWKIRK	S21013	5/24/2002	2.00	8TH ST. BETWEEN CHESTNUT & PINE, PECKHAM HWY & 7TH; S. ST.		X		RAIN
NEWKIRK	S21013	6/12/2002	0.00	MAIN & ELM, CHESTNUT & PINE, PECKHAM HWY & 7TH		X		RAIN
NEWKIRK	S21013	11/13/2002	2.00	HWY 77 - COUNTY RD.		X		ELECTRICAL FAILURE
NEWKIRK	S21013	11/20/2002	1.00	HWY 77 - COUNTY RD.		X		ELECTRICAL OUTAGE
NEWKIRK	S21013	3/4/2004	8.00	SOUTH ST. & ELM;PECKHAM AT APPLE & ACADEMY;8TH & 9TH AT PINE		X		RAIN
NEWKIRK	S21013	4/27/2004	0.30	6TH ST L.S.		X		PUMP FAILURE
NEWKIRK	S21013	9/22/2005	0.50	LIFT STATION #1		X		MALFUNCTION
NEWKIRK	S21013	3/20/2007	10.00	LIFT STATION #1		X		RAIN
NEWKIRK	S21013	3/20/2007	10.00	SOUTH ST. & ELM; PECKHAM ST. AT APPLE & ACADEMY		X		RAIN
NEWKIRK	S21013	3/20/2007	10.00	6TH & 8TH AT PINE & CHESTNUT; ACADEMY AT 7TH & PECKHAM		X		RAIN
NEWKIRK	S21013	3/20/2007	10.00	12TH & PLEAST VIEW RD.		X		RAIN
NEWKIRK	S21013	6/29/2007	5.00	#1 L.S; SOUTH ST. & ELM; PECKHAM AT APPLE & ACADEMY;		X		RAIN
NEWKIRK	S21013	6/29/2007	5.00	6TH & 8TH ST. AT PINE & CHESTNUT; ACADEMY AT 7TH & PECKHAM;		X		RAIN
NEWKIRK	S21013	6/29/2007	5.00	12TH & PLEAST VIEW RD.		X		RAIN
NEWKIRK	S21013	6/9/2008	0.60	PECKHAM ST. @ APPLE & ACADEMY		X		STORMS
PAWNEE	S21212		0.00	PECAN GROVE MOTEL UNDER PARKING LOT				
PAWNEE	S21212		0.00	8TH & ILLINOIS ST.	1,500	X		RAIN
PAWNEE	S21212		0.00	8TH ST. LIFT STATION				RAIN
PAWNEE	S21212		0.00	8TH ST. L.S.				

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
PAWNEE	S21212		0.00	205 PECAN ST.	20,000			BREAKER SHUT OFF
PAWNEE	S21212		0.00					
PAWNEE	S21212		0.00	PLANT			X	POWER FAILURE
PAWNEE	S21212		0.00					
PAWNEE	S21212		0.00					
PAWNEE	S21212		0.00					
PAWNEE	S21212		0.00	LAGOONS				
PAWNEE	S21212		0.00					RAIN
PAWNEE	S21212		0.00					
PAWNEE	S21212		0.00					
PAWNEE	S21212		0.00					
PAWNEE	S21212		0.00					RAIN
PAWNEE	S21212		0.00					FLOODING
PAWNEE	S21212		0.00	BEHIND DANNY T'S				
PAWNEE	S21212		0.00	S.W. OF 8TH ST. L.S.				FLOODING
PAWNEE	S21212			ALLEY				
PAWNEE	S21212		0.00	LAGOON				RAIN
PAWNEE	S21212		0.00	N. OF TOWN @ BATH HOUSE				LINE BREAK
PAWNEE	S21212	3/20/1990		BLACK BEAR CREEK				HEAVY RAINFALL
PAWNEE	S21212	3/21/1990		NORTH SIDE OF HWY 64				CREEK CUT INTO INTERCEPTOR LINE AND MANHOLE.
PAWNEE	S21212	6/5/1990		INFLUENT LINE TO WASTEWATER PLANT	5			FLOODING OF THE CREEK CAUSED BYPASS FROM SEWER LINE WASHOUT
PAWNEE	S21212	10/11/1990		LIFT STA				PUMP FAILURE
PAWNEE	S21212	9/10/1991		Lift Station		x		Lift Station Down
PAWNEE	S21212	6/9/1992	13.00	BLUE HAWK & PECAN STREETS		X		LIGHTING STRIKE

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
PAWNEE	S21212	5/9/1993	48.00	PLANT SHUT DOWN	2000000	X		PLANT FLOODED
PAWNEE	S21212	10/2/1994	5.00	PECAN AND LONE CHIEF	1000	X		ROOT STOPPAGE
PAWNEE	S21212	12/30/1994	2.00	AT PLANT	500	X		PUMP FAILURE
PAWNEE	S21212	7/27/1995	1.00	9TH AND DENVER	100	X		LINE STOPPAGE
PAWNEE	S21212	8/2/1995	1.00	808 DENVER	300	X		LINE STOPPAGE
PAWNEE	S21212	9/7/1995	1.00	8TH AND PARK LIFT STATION	50	X		ONE PUMP WENT PUT COULDN'T HANDLE THE LOAD
PAWNEE	S21212	2/29/1996	1.00	8TH AND HARRISON	1000	X		LINE STOPPAGE
PAWNEE	S21212	2/29/1996	1.00	MANHOLE @ 8TH & HARRISON	1000	X		LINE PLUGGED
PAWNEE	S21212	4/29/1996	0.00	WWTP	50000	X	X	OPERATIONAL ERROR AT SLUDGE BEDS
PAWNEE	S21212	9/19/1996	1.00	4TH & FORREST	1000	X		DUE TO CONSTRUCTION
PAWNEE	S21212	9/19/1996	1.00	9TH & DENVER	500	X		DUE TO CONSTRUCTION
PAWNEE	S21212	12/1/1997	1.00	BETWEEN 5TH & 6TH ST.	1,000			
PAWNEE	S21212	3/11/1998		5TH & ELM	1000	X		MAINSEWER LINE STOPPED UP
PAWNEE	S21212	4/13/1998	24.00	8TH & BOULDER LIFT STATION	20000	X		PUMP BROKE
PAWNEE	S21212	4/13/1998	23.00	8TH AND BOULDER LIFT STATION	20000			PUMP PROBLEMS
PAWNEE	S21212	8/23/1998	24.00	8TH & BOULDER L.S.	15,000	X		PUMPS MALFUNCTION
PAWNEE	S21212	10/13/1998	24.00	8TH & BOULDER	20,000			PUMP FAILURE
PAWNEE	S21212	3/16/2001	36.00	ALLEY AT 2ND & 3RD & ILLINOIS & KANSAS	10,000	X		LINE STOPPAGE
PAWNEE	S21212	8/17/2001		6TH & BLACKBEAR	60,000	X		COLLAPSED PIPE
PAWNEE	S21212	8/22/2001		6TH & BLACKBARREL				
PAWNEE	S21212	2/28/2002	0.00	9TH & ILLINOIS ST.	60,000	X		CRACK IN LINE
PAWNEE	S21212	12/11/2002	0.00					
PAWNEE	S21212	10/24/2003	6.00	PLANT	50,000		X	PUMP FAILURE

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
PAWNEE	S21212	8/9/2005	4.00	4TH NASH - 4TH ST. LIFT STATION	1,000	X		BLOCKAGE
PAWNEE	S21212	8/12/2005	2.00	4TH ST. LIFT STATION	500	X		DEBRIS
PAWNEE	S21212	8/15/2005	6.00	4TH ST. LIFT STATION	1,000	X		PUMP FAILURE
PAWNEE	S21212	8/30/2005	11.00	9TH & RIDGE RD.	500	X		PUMP FAILURE
PAWNEE	S21212	8/31/2005	1.00	8TH & BOULDER	500	X		PUMP FAILURE
PAWNEE	S21212	12/29/2005	1.00	5TH & DENVER	100	X		BLOCKAGE
PAWNEE	S21212	1/13/2006	1.00	OAK & ASH W. OF 7TH	500	X		RAGS
PAWNEE	S21212	1/15/2006	5.00	820 ASH	500	X		RAGS
PAWNEE	S21212	1/21/2006	1.50	5TH & DENVER	100	X		ROOTS
PAWNEE	S21212	2/8/2006	0.50	E. OF HWY 64 BEHIND DANNY T'S	500	X		ROOTS
PAWNEE	S21212	4/18/2006	16.50	FIELD EAST OF 903 KANSAS	500	X		BROKEN MANHOLE
PAWNEE	S21212	5/1/2006	2.50	8TH & ILLINOIS	500	X		BLOCKAGE
PAWNEE	S21212	8/28/2006	14.00	EAST OF BLACK BEAR L.S.	300	X		STOPPED MAIN
PAWNEE	S21212	9/24/2006	3.00	HWY 18 @ PAWNEE PARTS PLUS	50	X		STOPPED MAIN
PAWNEE	S21212	10/4/2006	24.00	BLACK BEAR CREEK	50,000		X	SYSTEM UPSET
PAWNEE	S21212	10/31/2006	2.50	HWY 64 & HWY 18	5	X		CLOGGED LINE
PAWNEE	S21212	11/7/2006	0.50	PAWNEE BILL RD. & 9TH ST.	6	X		DEBRIS
PAWNEE	S21212	11/7/2006	1.50	1315 8TH ST. AT 9TH & 7TH & ASH ST.	30	X		TOILET PAPER
PAWNEE	S21212	11/8/2006	1.00	HARRISON & 5TH IN COURT HOUSE LAWN	9	X		BLOCKAGE
PAWNEE	S21212	11/19/2006	1.00	5TH & DENVER	45	X		DEBRIS
PAWNEE	S21212	11/23/2006	2.00	BLACK BEAR L.S.	75	X		LINE STOPPED
PAWNEE	S21212	11/25/2006	1.00	9TH & HARRISON	75	X		STOPPAGE
PAWNEE	S21212	12/5/2006	22.00	8TH ST L.S.	200	X		ELECTRICAL PROBLEM
PAWNEE	S21212	12/11/2006	2.10	8TH PARK	60	X		DEBRIS & ROOTS

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
PAWNEE	S21212	12/16/2006	7.00	BLACKBEAR L.S.	550	X		ROOTS & DEBRIS
PAWNEE	S21212	12/18/2006	1.00	601 9TH ST.	15	X		PAPER & DEBRIS
PAWNEE	S21212	12/24/2006	1.00	PECAN ST. NEAR L.S.	25	X		DEBRIS
PAWNEE	S21212	1/8/2007	0.70	700 ILLINOIS ST.	11	X		LID POPPED OFF
PAWNEE	S21212	1/17/2007	0.00	BLACKBEAR L.S.	10	X		FROZEN
PAWNEE	S21212	1/28/2007	0.00	S. OF PLANT AT HWY 18	250	X		OVERFLOW
PAWNEE	S21212	2/1/2007	1.00	PLANT	150	X		PLUGGED LINE
PAWNEE	S21212	2/13/2007	1.30	6TH & SYCAMORE	20	X		TRASH & DEBRIS
PAWNEE	S21212	2/25/2007	1.50	5TH & DENVER	55	X		PAPER & ROOTS
PAWNEE	S21212	2/26/2007	0.50	4TH ST. LIFT STATION	45	X		PUMP FAILURE
PAWNEE	S21212	2/28/2007	2.50	8TH & ASH	100	X		BROKEN FLOAT
PAWNEE	S21212	3/3/2007	0.00	8TH ST. L.S. AT ASH & BOULDER	150	X		DAMAGED FLOAT
PAWNEE	S21212	3/9/2007	2.00	501 6TH	125	X		BLOCKAGE
PAWNEE	S21212	3/10/2007	0.70	8TH ST. L.S.	65	X		MALFUNCTION
PAWNEE	S21212	3/12/2007	1.50	8TH ST. AT DENVER & ELM	450			JUNK IN LINES
PAWNEE	S21212	3/19/2007	1.50	213 ASH	15	X		DEBRIS
PAWNEE	S21212	3/19/2007	70.50	711 ELM	500	X		SEWER WAS MOVED AND NOT RECONNECTED
PAWNEE	S21212	3/20/2007	0.00	ALLEY BEHIND 710 DENVER	500	X		SADDLE HAS COME UNDONE
PAWNEE	S21212	3/27/2007	0.70	PLANT	55	X		OVERFLOW
PAWNEE	S21212	3/27/2007	0.70	PLANT	55	X		UNMONITORED
PAWNEE	S21212	3/29/2007	12.00	PLANT	50,000	X		RAIN
PAWNEE	S21212	4/1/2007	5.00	213 ASH	500	X		RAIN
PAWNEE	S21212	4/2/2007	7.00	PLANT	20,000	X		OVERFLOW
PAWNEE	S21212	4/7/2007	2.00	5TH & DENVER	75	X		ROOTS
PAWNEE	S21212	4/9/2007	0.50	9TH & RIDGE RD.	55	X		ELECTRICAL PROBLEMS
PAWNEE	S21212	4/10/2007	172.00	114 KANSAS ST.	300	X		TOWELS

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
PAWNEE	S21212	4/20/2007	2.50	PLANT	55	X		OVERFLOW
PAWNEE	S21212	4/30/2007	4.00	LIFT STATION	300	X		PUMP MALFUNCTION
PAWNEE	S21212	5/1/2007	3.00	8TH ST ALLEY AT ASH & BOULDER	1,800	X		RAIN
PAWNEE	S21212	5/2/2007	1.50	8TH ST ALLEY LIFT STATION	950	X		RAIN
PAWNEE	S21212	5/2/2007	1.00	9TH ST. RIDGE RD.	2,000	X		BAD FLOATS
PAWNEE	S21212	5/3/2007	0.50	8TH ST. ALLEY BY LIFT STATION	625	X		RAIN
PAWNEE	S21212	5/7/2007	24.00	BLACK BEAR L.S.	40,000	X		FLOODING
PAWNEE	S21212	5/9/2007	24.00	PLANT	225,000	X		RAIN
PAWNEE	S21212	5/10/2007	24.00	BLACKBEAR L.S.	40,000	X		RAIN
PAWNEE	S21212	5/10/2007	24.00	WWTP	200,000	X		RAIN
PAWNEE	S21212	5/11/2007	24.00	PLANT	10,000	X		RAIN
PAWNEE	S21212	5/11/2007	24.00	BLACK BEAR LIFT STATION	10,000	X		RAIN
PAWNEE	S21212	5/12/2007	24.00	BLACBEAR L.S.	750	X		RAIN
PAWNEE	S21212	5/12/2007	24.00	PLANT	6,000	X		RAIN
PAWNEE	S21212	5/13/2007	18.80	BLACKBEAR L.S.	750	X		RAIN
PAWNEE	S21212	5/13/2007	0.00	PLANT	1,700	X		RAIN
PAWNEE	S21212	5/14/2007	5.50	PLANT	150	X		RAIN
PAWNEE	S21212	5/24/2007	8.30	8TH ST. L.S.	2,550	X		RUNOFF
PAWNEE	S21212	5/27/2007	0.00	8TH & ILLINOIS	20,000	X		RAIN
PAWNEE	S21212	5/27/2007	0.00	BLACK BEAR L.S.	50,000	X		RAIN
PAWNEE	S21212	5/27/2007	0.00	PLANT	125,000		X	RAIN
PAWNEE	S21212	5/28/2007	24.00	BLACK BEAR L.S.	45,000	X		RAIN
PAWNEE	S21212	5/28/2007	0.00	PLANT ACROSS STREET	80,000	X		RAIN
PAWNEE	S21212	5/28/2007	1.50	4TH ST. L.S.	1,500	X		MALFUNCTION
PAWNEE	S21212	5/30/2007	19.00	BLACK BEAR L.S.	45,000	X		RAIN
PAWNEE	S21212	5/30/2007	22.00	PLANT	60,000	X		RAIN
PAWNEE	S21212	5/31/2007	24.00	PLANT	125,000	X		RAIN

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
PAWNEE	S21212	6/1/2007	24.00	PLANT ACROSS STREET FROM LAGOON	175,000	X		RAIN
PAWNEE	S21212	6/1/2007	12.30	8TH & ILLINOIS ST.	12,000	X		RAIN
PAWNEE	S21212	6/1/2007	24.00	BLACK BEAR L.S.	50,000	X		RAIN
PAWNEE	S21212	6/2/2007	24.00	BLACK BEAR L.S.	55,000	X		RAIN
PAWNEE	S21212	6/2/2007	24.00	PLANT	260,000	X		RAIN
PAWNEE	S21212	6/3/2007	12.00	BLACK BEAR L.S.	5,500	X		RAIN
PAWNEE	S21212	6/3/2007	24.00	PLANT	4,000	X		RAIN
PAWNEE	S21212	6/4/2007	24.00	PLANT	35,000	X		RAIN
PAWNEE	S21212	6/5/2007	4.50	PLANT	600	X		RAIN
PAWNEE	S21212	6/13/2007	1.50	7TH & DENVER AREA	20	X		BLOCKAGE
PAWNEE	S21212	6/15/2007	24.00	PLANT	175,000	X		RAIN
PAWNEE	S21212	6/17/2007	24.00	PLANT	125,000	X		RAIN
PAWNEE	S21212	6/18/2007	24.50	BLACK BEAR L.S.	23,000	X		RAIN
PAWNEE	S21212	6/18/2007	19.50	WWTP	26,000	X		RAIN
PAWNEE	S21212	6/19/2007	0.00	BLACK BEAR L.S.				
PAWNEE	S21212	6/20/2007	24.00	8TH ST. LIFT STATION	13,000	X		RAIN
PAWNEE	S21212	6/20/2007	24.00	PLANT	225,000	X		RAIN
PAWNEE	S21212	6/20/2007	0.00	BLACK BEAR L.S.	62,000	X		RAIN
PAWNEE	S21212	6/21/2007	7.00	BLACK BEAR L.S.	2,500	X		RAIN
PAWNEE	S21212	6/21/2007	24.00	PLANT	225,000	X		RAIN
PAWNEE	S21212	6/22/2007	24.00	ACROSS STREET FROM PLANT	250,000	X		RAIN
PAWNEE	S21212	6/23/2007	24.00	PLANT	55,000	X		RAIN
PAWNEE	S21212	6/24/2007	24.00	PLANT	6,500	X		RAIN
PAWNEE	S21212	6/25/2007	5.50	PLANT	1,500	X		RAIN
PAWNEE	S21212	6/26/2007	24.00	ACROSS STREET FROM PLANT	260,000	X		RAIN
PAWNEE	S21212	6/26/2007	24.00	BLACK BEAR L.S.	5,000	X		RAIN
PAWNEE	S21212	6/27/2007	24.00	BLACK BEAR L.S.	67,000	X		RAIN

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
PAWNEE	S21212	6/27/2007	24.00	8TH ST L.S. @ ASH & BOULDER	30,000	X		RAIN
PAWNEE	S21212	6/27/2007	24.00	PLANT	300,000	X		RAIN
PAWNEE	S21212	6/28/2007	0.00	8TH & ILLINOIS	27,000	X		RAIN
PAWNEE	S21212	6/28/2007	0.00	YELLOWHORSE DR. LIFT STATION AREA	27,000	X		RAIN
PAWNEE	S21212	6/28/2007	0.00	ALLEY ON 4TH ST. BEHIND CLICKS STEAK HOUSE	27,000	X		RAIN
PAWNEE	S21212	6/28/2007	24.00	NEXT TO BLACK BEAR L.S.	77,000	X		RAIN
PAWNEE	S21212	6/28/2007	24.00	ACROSS STREET FROM PLANT	400,000	X		RAIN
PAWNEE	S21212	6/28/2007	24.00	ALLEY AT ASH & BOULDER ON 8TH ST.	40,000	X		RAIN
PAWNEE	S21212	6/28/2007	0.00	NEXT TO DANNY T'S ON HWY 64		X		RAIN
PAWNEE	S21212	6/28/2007	0.00	DANNY T'S ON HWY 64/18		X		RAIN
PAWNEE	S21212	6/29/2007	3.80	NEXT TO 8TH ST L.S.	13,000	X		RAIN
PAWNEE	S21212	6/29/2007	24.00	ACROSS FROM WWTP	350,000	X		RAIN
PAWNEE	S21212	6/29/2007	24.00	NEXT TO DANNY T'S & HWY 64/18		X		RAIN
PAWNEE	S21212	6/29/2007	24.00	NEXT TO BLACK BEAR L.S.	65	X		RAIN
PAWNEE	S21212	6/30/2007	24.00	ACROSS FROM WWTP	325,000	X		RAIN
PAWNEE	S21212	6/30/2007	24.00	NEXT TO BLACK BEAR L.S.	62.,000	X		RAIN
PAWNEE	S21212	7/1/2007	24.00	NEXT TO BLACK BEAR L.S.	67,000	X		RAIN
PAWNEE	S21212	7/1/2007	24.00	ACROSS FROM WWTP	375,000	X		RAIN
PAWNEE	S21212	7/1/2007	24.00	NEXT TO DANNY T'S & HWY64/18		X		RAIN
PAWNEE	S21212	7/2/2007	24.00	NEXT TO BLACK BEAR L.S.	67,000	X		RAIN
PAWNEE	S21212	7/2/2007	24.00	DANNY T'S & HWY 18/64		X		RAIN
PAWNEE	S21212	7/2/2007	24.00	ACROSS FROM WWTP	375,000	X		RAIN
PAWNEE	S21212	7/3/2007	24.00	ACROSS FROM WWTP	225,000	X		RAIN
PAWNEE	S21212	7/3/2007	17.50	NEXT TO BLACK BEAR L.S.	27,000	X		RAIN
PAWNEE	S21212	7/4/2007	24.00	ACROSS FROM WWTP	275,000	X		RAIN

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
PAWNEE	S21212	7/5/2007	24.00	ACROSS FROM WWTP	250,000	X		RAIN
PAWNEE	S21212	7/6/2007	24.00	ACROSS FROM WWTP	2,500	X		RAIN
PAWNEE	S21212	7/7/2007	7.00	ACROSS FROM WWTP	250	X		RAIN
PAWNEE	S21212	7/12/2007	2.00	8TH & ILLINOIS	1,200	X		RAIN
PAWNEE	S21212	7/12/2007	24.00	ACROSS FROM WWTP	125,000	X		RAIN
PAWNEE	S21212	7/12/2007	24.00	NEXT TO BLACK BEAR L.S.	45,000	X		RAIN
PAWNEE	S21212	7/13/2007	24.00	ACROSS FROM WWTP	200,000	X		RAIN
PAWNEE	S21212	7/13/2007	0.00	WWTP	33,000		X	POWER FAILURE
PAWNEE	S21212	7/13/2007	0.00	8TH & ILLINOIS	2,500	X		RAIN
PAWNEE	S21212	7/13/2007	24.00	NEXT TO BLACK BEAR L.S.	45,000	X		RAIN
PAWNEE	S21212	7/14/2007	0.80	4TH ST. & HILCREST	250	X		CONTACTOR KICKED OFF
PAWNEE	S21212	7/14/2007	24.00	BLACK BEAR L.S.	55,000	X		RAIN
PAWNEE	S21212	7/14/2007	24.00	ACROSS FROM WWTP	120,000	X		RAIN
PAWNEE	S21212	7/15/2007	23.50	BLACK BEAR L.S.	25,000	X		RAIN
PAWNEE	S21212	7/15/2007	24.00	ACROSS FROM WWTP	55,000	X		RAIN
PAWNEE	S21212	7/16/2007	11.20	ACROSS FROM WWTP	1,700	X		RAIN
PAWNEE	S21212	7/17/2007	0.00	205 PECAN ST.	20,000	X		BREAKERS KICKED OFF
PAWNEE	S21212	8/1/2007	1.00	205 PECAN ST. L.S.	100	X		PLUGGED LINE
PAWNEE	S21212	8/2/2007	0.00	NEXT TO DANNY T'S ON HWY 64/18	200,000	X		HOLE IN LINE
PAWNEE	S21212	9/3/2007	0.00	WWTP	20,000	X		FORGOT TO TURN OFF
PAWNEE	S21212	9/7/2007	0.00	8TH & ILLINOIS	25,000	X		RAIN
PAWNEE	S21212	9/7/2007	0.00	PLANT	90,000		X	RAIN WATER
PAWNEE	S21212	10/22/2007	0.00	PLANT	200,000	X		RAIN
PAWNEE	S21212	11/15/2007	24.00	EAST UNDER HWY SOUTH OF DANNY T'S	500	X		ROOTS
PAWNEE	S21212	11/16/2007	24.00	UNDER HWY S. OF DANNY T'S	500	X		ROOTS

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
PAWNEE	S21212	11/17/2007	24.00	HWY S. OF DANNY T'S	500	X		ROOTS
PAWNEE	S21212	11/18/2007	24.00	HWY S. OF DANNY T'S	500	X		ROOTS
PAWNEE	S21212	11/19/2007	24.00	HWY S. OF DANNY T'S	500	X		ROOTS
PAWNEE	S21212	11/20/2007	24.00	HWY S. OF DANNY T'S	500	X		ROOTS
PAWNEE	S21212	11/25/2007	17.00	WWTP	325,000		X	RAIN
PAWNEE	S21212	11/26/2007	0.00	PLANT	300,000			
PAWNEE	S21212	12/4/2007	1.50	6TH & ASH	100	X		DIAPERS, TOWELS, ETC.
PAWNEE	S21212	1/30/2008	2.50	7TH & DENVER	30	X		STOPPAGE
PAWNEE	S21212	2/8/2008	2.00	316 HILLCREST	100	X		ROOTS & RAGS
PAWNEE	S21212	2/9/2008	142.00	LAGOONS ACROSS HWY FROM SEWER	1,000	X		PUMP FAILURE
PAWNEE	S21212	2/17/2008	22.40	LAGOON ACROSS FROM PLANT	2,000	X		RAIN
PAWNEE	S21212	2/19/2008	0.00	PLANT				
PAWNEE	S21212	2/27/2008	50.20	8TH ST. L.S.	500	X		ROOTS
PAWNEE	S21212	3/9/2008	23.50	1105 5TH ST.	100	X		ROOTS & DEBRIS
PAWNEE	S21212	3/12/2008	4.30	5TH & DENVER	50	X		ROOTS & DEBRIS
PAWNEE	S21212	5/15/2008	5.30	9TH & RIDGE RD.				ELECTRICAL PROBLEMS
PAWNEE	S21212	6/5/2008	1.30	205 PECAN ST.	500	X		LIFT STATION DOWN
PAWNEE	S21212	8/7/2008	0.40	715 ELM ST.	100	X		ROOTS & DEBRIS
PAWNEE	S21212	8/20/2008	8.00	8TH ST L.S.	500	X		PUMP FAILURE
PAWNEE	S21212	8/21/2008	1.00	5TH & DENVER	50	X		BLOCKAGE
PAWNEE	S21212	11/9/2008	24.00	8TH ST. L.S.	100	X		MALFUNCTION
PAWNEE	S21212	12/5/2008	0.70	7TH & DENVER	20	X		STOPPAGE
PAWNEE	S21212	12/15/2008	4.00	7TH & DENVER	25	X		BLOCKAGE
PAWNEE	S21212	1/10/2009	22.50	525 4TH ST.	30	X		SOLIDS
PAWNEE	S21212	2/2/2009	1.60	5TH & HARRISON	200	X		STOPPAGE
PAWNEE	S21212	2/9/2009	0.50	705 & 711 GRANITE	25	X		ROOTS
PAWNEE	S21212	2/11/2009	2.00	310 FOREST	35	X		STOPPAGE

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
PAWNEE	S21212	2/26/2009	1.70	5TH & DENVER	50	X		ROOTS
PAWNEE	S21212	3/24/2009	20.80	WWTP	250,000		X	POWER SURGE
PAWNEE	S21212	4/19/2009	10.00	4TH ST. LIFT STATION	200	X		PUMP FAILURE
PAWNEE	S21212	5/12/2009	1.00	7TH & DENVER	25	X		STOPPED LINE
PAWNEE	S21212	5/12/2009	1.00	8TH & DENVER, N. OF HIGH SCHOOL	50	X		STOPPED LINE
PAWNEE	S21212	5/25/2009	32.30	8TH ST. L.S.	25,000	X		L.S. PUMP FAILURE
PAWNEE	S21212	8/1/2009	0.00					
PAWNEE	S21212	8/2/2009	0.00	8TH ST. L.S.	200	X		HOLE IN PIPE
PAWNEE	S21212	8/3/2009	1.00	3 BLKS. S. OF HIGH SCHOOL	20	X		BLOCKAGE
PAWNEE	S21212	9/17/2009	0.50	7TH & 8TH ON GRANITE	20			BLOCKAGE
PAWNEE	S21212	3/15/2010	1.50	WWTP	50			VALVE LEFT ON
PAWNEE	S21212	5/21/2010	2.00	LAGOON	25,000	X		RAIN
PAWNEE	S21212	6/14/2010	2.00	WWTP - 8TH & ILLINOIS	150	X		RAIN
PAWNEE	S21212	12/2/2010	2.00	8TH & ILLINOIS				BLOCKAGE
PAWNEE	S21212	12/7/2010	0.00	400 KANSAS	15	X		BLOCKAGE
PAWNEE	S21212	3/7/2011	0.50	705 GRANITE	8	X		BLOCKAGE
RALSTON	S21208	2/28/1996	0.00	N. FOURTH ST.	35000	X		PIPE BREAK & PLUGGED DOWNSTREAM
RALSTON	S21208	6/20/2005	0.00	LIFT STATION		X		PUMP FAILURE
TONKAWA	S21012		0.00		200			
TONKAWA	S21012		0.00					RAIN
TONKAWA	S21012		0.00					
TONKAWA	S21012		0.00					
TONKAWA	S21012		0.00	PLANT				
TONKAWA	S21012		0.00	PLANT				
TONKAWA	S21012		0.00	PLANT	>MILLN			
TONKAWA	S21012		0.00					RAIN

Facility Name	Facility ID	Date	Duration (hrs)	Location	Amount (gallons)	Raw	Treated	Cause
TONKAWA	S21012		0.00	PLANT				DISCHARGING
TONKAWA	S21012		0.00	PLANT				RAINS
TONKAWA	S21012		0.00					
TONKAWA	S21012		0.00					
TONKAWA	S21012		0.00					FLOODING
TONKAWA	S21012		0.00					SHUT DOWN
TONKAWA	S21012	9/26/1996	4.00	4TH & ???	48			RAINS
TONKAWA	S21012	1/11/1999		WEST DIKE OF LAGOON INTO SALT FORK RIVER			X	OVERFLOW LAGOON
TONKAWA	S21012	1/11/1999		WAST DIKE OF LAGOON			X	OVERFLOW
TONKAWA	S21012	3/22/1999		LAGOON			X	SNOW
TONKAWA	S21012	4/23/1999		1/2 MILE W. OF HWY 77 INTO RIVER/E. END OF LAGOON INTO DITCH			X	RAINS
TONKAWA	S21012	7/29/1999		PROPERTY 1/8 MILE S. OF SALT FORK RIVER				
TONKAWA	S21012	6/13/2001	7.00	1111 S. TONKAWA LAGOON	50,000	X		SEWER LINE HIT BY CONTRACTOR
TONKAWA	S21012	3/8/2004	0.50	MAIN & RIEVERA L.S.	<1,000	X		POWER FAILURE
TONKAWA	S21012	7/28/2005	0.00	PLANT	4,000	X		IRRIGATION SYSTEM DOWN
TONKAWA	S21012	6/19/2006	0.00	100 RIVERA ST.	10,000	X		PUMP FAILURE
TONKAWA	S21012	7/2/2006	3.00	100 RIVERA ST.	50,000	X		PUMP FAILURE
TONKAWA	S21012	8/29/2006	0.30	EAST NORTH AVE. & 44TH ST.	200	X		LIFT STATION DOWN
TONKAWA	S21012	6/13/2007	0.00	PLANT				RAIN
TONKAWA	S21012	6/29/2007	0.00					FLOOD WATERS
TONKAWA	S21012	6/14/2010	50.00	100 BLK. SOUTH 5TH		X		RAIN

APPENDIX F
STORM WATER PERMITTING REQUIREMENTS AND PRESUMPTIVE BEST MANAGEMENT PRACTICES (BMPS) APPROACH

Appendix F

Storm water 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 storm water pollution prevention plan (SWPPP) to implement any requirements of the total maximum daily load (TMDL) allocation. [See 40 CFR §130.]

Storm water 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 storm water 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 storm water permits which is based on BMPs. "The interim permitting approach uses best management practices (BMPs) in first-round storm water 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 storm water 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 storm water 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 bacteria 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 bacteria 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. The Oklahoma Conservation Commission has developed a watershed plan for this segment of the North Canadian River that should facilitate these actions.

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

ENTITIES	PHASE 1 / PHASE 2 MS4	PERMIT #	EXPIRATION DATE
Ponca City	Phase 2 MS4	OKR040030	02/07/2010

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 bacteria 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 bacteria controls in the future.

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 Bacteria Reduction Plan

Permittees shall submit an approvable Bacteria 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 bacteria 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 storm water 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 storm water contributed (if applicable) by pets, recreational and exhibition livestock, and zoos;
e. Investigation and implementation of BMPs that prevent additional storm water bacteria 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 storm water 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 storm water sampling and other

measures intended to specifically identify bacterial pollution sources and high priority areas for bacteria reductions.

i. Periodic evaluation of the effectiveness of the bacteria 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 Bacteria Monitoring Program

Permittees may participate in a coordinated regional bacteria 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 3 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 Bacteria Reduction Plan and monitoring program. The TMDL implementation report shall document relevant actions taken by the permittee that affect MS4 storm water 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 storm water BMP, and improve the overall aesthetics of a storm water 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 storm water 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		

BEST MANAGEMENT PRACTICE	IMPAIRMENT SOURCE		REPORTED EFFICIENCY	NOTE
	AGRICULTURE	URBAN		
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		
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	X	X		

BEST MANAGEMENT PRACTICE	IMPAIRMENT SOURCE		REPORTED EFFICIENCY	NOTE
	AGRICULTURE	URBAN		
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.				
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		
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		X		

BEST MANAGEMENT PRACTICE	IMPAIRMENT SOURCE		REPORTED EFFICIENCY	NOTE
	AGRICULTURE	URBAN		
acceptable manner.				
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 storm water 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 storm water facility that includes a permanent pool of water and, therefore, is normally wet even during non-rainfall periods. Inflows from storm water 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
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]	

BEST MANAGEMENT PRACTICE	IMPAIRMENT SOURCE		REPORTED EFFICIENCY	NOTE
	AGRICULTURE	URBAN		
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	X	X		

BEST MANAGEMENT PRACTICE	IMPAIRMENT SOURCE		REPORTED EFFICIENCY	NOTE
	AGRICULTURE	URBAN		
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.				
Wetland development/enhancement: The construction of a wetland for the treatment of animal waste runoff or storm water runoff. Wetlands improve water quality by removing nutrients from animal waste or sediments and nutrients from storm water 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 BestManagement Practice Categories and Pollutant Removal Efficiencies (2003); USDA (2003); DCR (1999); DEQ/DCR (2001).

2 Barrett,M.E.,ComplyingwiththeEdwardsAquiferRules:TechnicalGuidanceonBestManagementPractices,TexasNaturalResourceConservationCommissionReportRG-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 G
Responses to Comments

Appendix G
Responses to Comments

Comments from Quang Pham at Oklahoma Department of Agriculture, Food and Forestry (ODAFF) received on July 19, 2011:

Comments #1: Sub-section 3.1.1, page 3.3, second paragraph: The reason why the DMRs of the municipal wastewater treatment facilities do not have data on bacteria should be explained (i.e. those are lagoons and no bacteria tests are required to be run).

Response #1: the sentence "because these facilities do not have fecal coliform limits" was added to the paragraph.

Comment #2: Table 3-4, page 3-12, NPDES Permitted CAFOs in Study Area:

- First Facility (OKG010032): Max. No. of Slaughter …, and Total Number of Animal Units are both 1,000 instead of 500;
- 3rd Facility (OKU000355): Max No. of Slaughter….are 2,500 cows (instead of 1,500) and 500 horses; Total Number of Animal Units is 3,500 instead of 1,500.

Response #2: Table 3-4 was modified according to the comments.

Comment #3: Table 3-9, page 3-21, Fecal Coliform Production Estimates for commercially Raised Farm Animals: generated by Ducks in Spring Creek watershed and in Ark. River, Salt Fork watershed were both shown as 1 x 10 E+9; while numbers of ducks in these watersheds were 0, as shown on Table 3-8, page 3-20.

Response #3: The discrepancy was caused by round-up errors since the table was generated using spreadsheet. The discrepancy was corrected in Table 3-9.