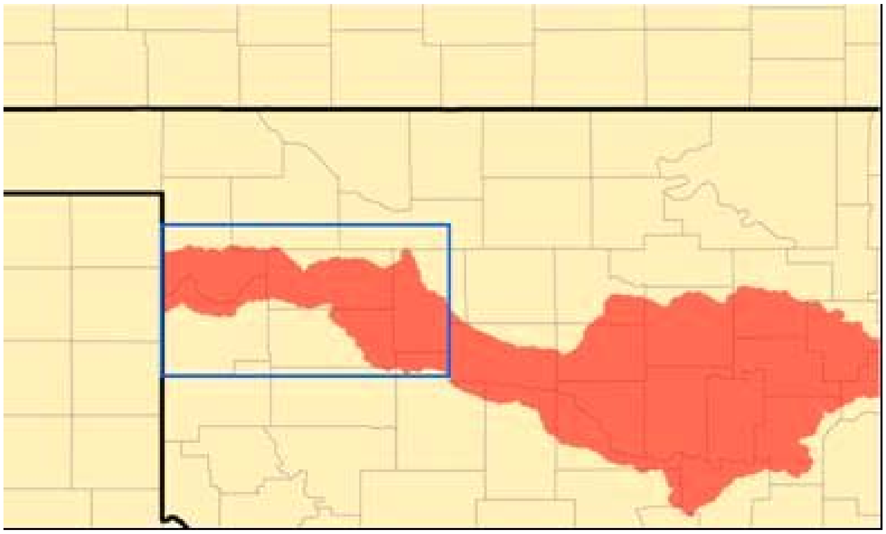
FINAL

BACTERIA TOTAL MAXIMUM DAILY LOADS FOR CANADIAN RIVER, OKLAHOMA (OKWBID 52062)



Prepared for:

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

Prepared by:

PARSONS

SEPTEMBER 2006

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SEPTMEBER 2006

Oklahoma Department of Environmental Quality: FY05/06 106 Carryover Grant (I006400-03)
Project 13 – Bacteria TMDL Development

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ACRONYMS AND ABBREVIATIONS

AEMS	Agricultural Environmental Management Services
ASAE	American Society of Agricultural Engineers
BMP	best management practice
CAFO	Concentrated Animal Feeding Operation
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
LA	Load allocation
LDC	Load duration curve
mg	Million gallons
mgd	Million gallons per day
ml	Milliliter
MOS	Margin of safety
MS4	Municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
O.S.	Oklahoma statutes
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
PRG	Percent reduction goal
SSO	Sanitary sewer overflow
TMDL	Total maximum daily load
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WLA	Wasteload allocation
WQM	Water quality monitoring
WQS	Water quality standard
WWTP	Wastewater treatment plant

Executive Summary

This report documents the data and assessment used to establish total maximum daily loads (TMDL) for the pathogen indicator bacteria fecal coliform, *Escherichia coli (E. coli),* or *Enterococci* for certain waterbodies in the Canadian River Basin. The data and assessment are in accordance with requirements of Section 303(d) of the Clean Water Act, 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 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.

The purpose of this report is to establish pollutant load allocations for indicator bacteria 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.

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

1.1 Problem Identification and Water Quality Target

A decision was made to place the Canadian River waterbodies (OKWBID 52062) in Table E-1 on the ODEQ 2002 303(d) list because evidence of nonsupport of primary body contact recreation (PBCR) was observed.

Table ES-1 Excerpt from the 2002 Integrated Report – Comprehensive Waterbody Assessment Category List

Oklahoma Waterbody ID	NAME	Stream Miles	Category	TMDL Date	Primary Body Contact Recreation	Warm Water Aquatic Community
OK520620010010	Canadian River	41.98	5	2008	N	I
OK520620010120	Bear Creek	6.07	5	2008	N	I
OK520620020010	Canadian River	38.52	5	2005	N	I
OK520620020090	Trail Creek	14.34	5	2008	N	I
OK520620030020	Lone Creek	13.18	5	2008	N	I
OK520620030050	Red Trail Creek	7.95	5	2008	N	N
OK520620030110	Red Creek	12.34	5	2008	N	I
OK520620040050	Hackberry Creek	16.49	5	2008	N	I
OK520620050160	Commission Creek	12.51	5	2008	N	I
OK520620060010	Deer Creek	55.73	5	2005	N	I

A = Attaining I = Insufficient Data N = Not Attaining X = Not Assessed

Source: 2002 Integrated Report, ODEQ 2002

The consistent percentage of water quality criterion exceedances at most water quality monitoring (WQM) stations, regardless of bacteria indicator, suggests that the temporal and spatial severity of bacteria loading is significant and chronic. In general, exceedances of *Enterococci* criteria were more frequent than those of *E. coli* or fecal coliform. The TMDLs in this report only address the PBCR-designated use.

The definition of PBCR is summarized by the following excerpt from Chapter 45 of the Oklahoma WQSs.

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

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

Oklahoma's numeric criteria to protect the PBCR beneficial use are (OWRB 2004):

(1) Coliform Bacteria: The bacteria of the fecal coliform group shall not exceed a monthly geometric mean of 200/100 ml, as determined by multiple-tube fermentation or membrane filter procedures based on a minimum of not less than five (5) samples collected over a period of not more than thirty (30) days. Further, in no more than 10% of the total samples during any thirty (30) day period shall the bacteria of the fecal coliform group exceed 400/100 ml.

(2) Escherichia coli (E. coli): E. coli shall not exceed a monthly geometric mean of 126/100 ml based upon a minimum of not less than five (5) samples collected over a period of not more than thirty (30) days. No sample shall exceed a 75% one-sided confidence level of 235/100 ml in lakes and high use waterbodies and the 90% one-sided confidence level of 406/100 ml in all other Primary Body Contact Recreation beneficial use areas.

(3) Enterococci: Enterococci shall not exceed a monthly geometric mean of 33/100 ml based upon a minimum of not less than five (5) samples collected over a period of not more than thirty (30) days. No sample shall exceed a 75% one-sided confidence level of 61/100 ml in lakes and high use waterbodies and the 90% one-sided confidence level of 108/100 ml in all other Primary Body Contact Recreation beneficial use areas.

Compliance with Oklahoma WQS is based on meeting requirements of one of the three bacteria indicators. However, 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 2004).

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 the instantaneous criteria for each of the three bacteria indicators. Targeting the instantaneous criterion as the water quality goal for TMDLs corresponds to the basis for 303(d) listing and is expected to be protective of the geometric mean criterion as well. Furthermore, these TMDLs must take into account that no more than 10 percent of the samples may exceed the instantaneous numeric criteria.

1.2 Pollutant Source Assessment

NPDES-permitted facilities are absent from most of the watersheds in the study area, and most point sources are relatively minor and for the most part, tend to meet instream water quality criteria in their effluent. Thus, nonpoint sources are considered to be the major origin of bacteria loading in each watershed. Nonpoint source bacteria loading to the receiving streams of each waterbody emanate from a number of different sources. The data analysis and the load duration curves (LDC) demonstrate that exceedances at the WQM stations are the result of a variety of nonpoint source loading. The load allocations (LA), calculated as the difference between the TMDL, the margin of safety (MOS), and the wasteload allocation (WLA), for each WQM station are presented in Table ES-2.

1.3 using Load Duration curves to Develop TMDLs

The TMDL calculations presented in this report are derived from LDCs. LDCs facilitate rapid development of TMDLs and as a TMDL development tool, are effective in identifying whether impairments are associated with point or nonpoint sources.

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 treatment plant effluents would dominate the base flow of the impaired water.

LDCs display the maximum allowable load over the complete range of flow conditions by a line using the calculation of flow multiplied by the 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.

1.4 TMDL Calcuations

As indicated above, the bacteria TMDLs for the 303(d)-listed WQM stations 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 uncertainty 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 WQM station the TMDLs presented in this report are expressed as a percent reduction across the full range of flow conditions (See Table ES-2). The TMDL, WLA, LA, and MOS vary with flow condition, and can be calculated for any flow value. The WLA component of each TMDL is the sum of all WLAs within the contributing watershed of each WQM station. The sum of the WLAs can be represented as a single line below the LDC. The LDC and the simple equation of:

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

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. Percent reductions necessary to achieve the water quality target are also provided for all WQM stations as another acceptable representation of the TMDL.

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 uncertainty associated with calculating the allowable fecal coliform pollutant loading to ensure WQSs are attained. For the explicit MOS the water quality target was set at 10 percent lower than the water quality criterion for each pathogen which equates to 360 cfu/100 ml, 365.4 cfu/100 ml, and 97.2/100 ml for fecal coliform, *E. coli*, and *Enterococci*, respectively. The net effect of the TMDL with MOS is that the assimilative capacity or allowable pollutant loading of each waterbody is slightly reduced. These TMDLs incorporate an explicit MOS by using a curve representing 90 percent of the TMDL as the average MOS. There are other conservative elements utilized in these TMDLs that can be recognized as an implicit MOS such as:

The use of in stream bacteria concentrations to estimate existing loading; and
The highest PRG for nonpoint sources.

This conservative approach to establishing the MOS will ensure that both the 30-day geometric mean and instantaneous bacteria standards can be achieved and maintained.

Table ES-2 TMDL Summaries and Percent Reductions Required

WQM Station	Indicator Bacteria Species	WLA† (cfu/day)	LA† (cfu/day)	MOS† (cfu/day)	TMDL† (cfu/day)	Percent Reduction
OK520620010010G	Fecal Coliform	0	7.93E+11	8.81E+10	8.81E+11	**84%**
OK520620010120G	Enterococci	0	4.76E+08	5.28E+07	5.28E+08	**98%**
OK520620020010-00 AT	Enterococci	3.60E+08	1.77E+11	1.97E+10	1.97E+11	**96%**
OK520620020090G	Enterococci	0	4.76E+08	5.28E+07	5.28E+08	**90%**
OK520620030020C	Enterococci	0	2.38E+08	2.64E+07	2.64E+08	**89%**
OK520620030050G	Enterococci	0	2.38E+06	2.64E+05	2.64E+06	**98%**
OK520620030110G	Enterococci	0	2.38E+08	2.64E+07	2.64E+08	**81%**
OK520620040050D	Enterococci	0	4.76E+08	5.28E+07	5.28E+08	**81%**
OK520620050160C	Enterococci	0	2.38E+08	2.64E+07	2.64E+08	**51%**
OK520620060010F	Enterococci	8.74E+09	5.31E+10	6.87E+09	6.87E+10	**82%**

† Derived for illustrative purposes at the median flow value

1.5 Reasonable Assurance

As authorized by Section 402 of the CWA, ODEQ has delegation of the National Pollutant Discharge Elimination System (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 point source WLAs is done through permits issued under the OPDES program

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 (TMDL) 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 in-stream 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),* or *Enterococci* for certain waterbodies in the Canadian River Basin. The data and assessment will be 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 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 (LA) necessary to meet the WQS established for a waterbody based on the relationship between pollutant sources and in-stream water quality conditions. A TMDL consists of a wasteload allocation (WLA), 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 uncertainty 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 loadings 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, tribes, and local, state, and federal government agencies.

This TMDL report focuses on ten waterbodies that ODEQ placed in Category 5 of the 2002 Integrated Report (303(d) list) for nonsupport of primary body contact recreation (PBCR): OK520620010010 (Canadian River), OK520620010120 (Bear Creek), 520620020010 (Canadian River), OK520620020090 (Trail Creek), OK520620030020 (Lone Creek), OK520620030050 (Red Trail Creek), OK520620030110 (Red Creek), OK520620040050

(Hackberry Creek), OK520620050160 (Commission Creek), and OK520620060010 (Deer Creek).

Figure 1-1 is a location map showing these Oklahoma waterbodies and their contributing watersheds. This map also displays the 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.

Elevated levels of pathogen indicator bacteria in aquatic environments indicate that a receiving water is contaminated with human or animal feces and an indication that a potential health risk exists for individuals exposed to the water and results in the requirement that a TMDL be developed. The TMDLs established in this report are a necessary step in the process to develop the bacteria loading controls needed to restore the primary contact recreation use designated for each waterbody. Table 1-1 provides a description of the locations of the WQM stations on the 303(d)-listed waterbodies.

Table 1-1 Water Quality Monitoring Stations used for 2002 303(d) Listing Decision

Water Body Name	WQM Station	WQM Station Location Description
Canadian River	OK520620010010K	Canadian River northeast of Hydro, OK
	OK520620010010G	Canadian River Site # 6 near Bridgeport, OK
	OK520620010010P	Canadian River east of Thomas
	OK520620010010S	Canadian River Site # 3 at SH 33 northeast of Thomas
Bear Creek	OK520620010120G	Bear Creek at State Highway 58
Canadian River	OK520620020010_001AT	Canadian River at US 183 at Taloga, OK
Trail Creek	OK520620020090G	Trail Creek at Dewey County Rd. E0730
Lone Creek	OK520620030020C	Lone Creek at Dewey County Rd. D0765
Red Trail Creek	OK520620030050G	Red Trail Creek at State Highway 34
Red Creek	OK520620030110G	Red Creek at Dewey County Rd. E0720
Hackberry Creek	OK520620040050D	Hackberry Creek at Ellis County Rd. N1950
Commission Creek	OK520620050160C	Commission Creek at Ellis County Rd. N1730
Deer Creek	OK520620060010F	Deer Creek near Hydro, OK

1.2 Watershed Description

General. The Canadian River Basin is located in the western portion of Oklahoma. Headwaters of the Canadian River originate in New Mexico and cross the Texas Panhandle before entering Oklahoma. The Canadian River meanders eastward and accepts drainage from dozens of tributaries. The tributaries addressed in this TMDL Report include Bear Creek, Trail Creek, Lone Creek, Red Trail Creek, Red Creek**,** Hackberry Creek, Commission Creek, and Deer Creek. These waterbodies are located in the following counties: Blaine, Caddo, Custer, Dewey, and Ellis. These counties are part of the Central Great Plains ecoregion.

Land Use. Table 1-2 summarizes the acreages and the associated percentages of the land use categories within the contributing watersheds upstream of each WQM station. The land use/land cover data were derived from the U.S. Geological Survey (USGS) National Land Cover Dataset (USGS 2005). The land use is displayed in Figure 1-2.

The dominant land use throughout the study area is grassland. The second most prevalent land use in each watershed is cropland (row crops and small grains). Small cities are located in some of the watersheds, however, urban land use categories account for less than one percent of the land use in each watershed.

Climate. Average annual precipitation values in this portion of Oklahoma counties range between 26 and 31 inches (Oklahoma Climate Survey 2005).

Table 1-2 Land Use Summary by Watershed

Landuse Category	WQM Station									
	OK520620010010	OK520620010120	OK520620020010	OK520620020090	OK520620030020	OK520620030050	OK520620030110	OK520620040050	OK520620050160	OK520620060010
Open water	1	0.16	0.66	0.24	0.37	0.31	0.14	0.13	0.59	0.22
Low Intensity Residential	0.23	0.05	0.19	0	0	0	0	0	0.15	0.53
High Intensity Residential	0.03	0	0.02	0	0	0	0	0	0.01	0.5
High Intensity Commercial/Industrial/Transportation	0.08	0.18	0.01	0	0	0.12	0	0	0.1	0.45
Bare Rock/Sand/Clay	0.04	0.12	0.09	0	0.05	0.02	0.08	0.14	0.24	0.03
Quarries/Strip Mines/Gravel Pits	0	0	0	0	0	0	0	0	0	0
Transitional	0.14	0	0	0	0	0	0	0	0	0
Deciduous Forest	3.6	1.68	1.39	1.51	0.03	0.1	0.08	0.08	0.02	1.23
Evergreen Forest	8.59	7.52	10.67	9.18	19.19	2.3	6.3	0.47	0.08	1.27
Mixed Forest	0.78	0.52	1.41	1.52	1.72	0.72	1.39	0.21	0.04	0.26
Deciduous Shrubland	4.29	3.14	13.02	20.99	16.8	14.48	28.16	13.04	24.41	1.68
Grassland/Herbaceous	30.68	22.43	38.45	50.97	57.18	64.26	57.11	80.17	58.72	20.29
Pasture/Hay	7.4	4.26	2.71	1.32	0.13	0.5	0.35	0.41	0.67	6.26
Row Crops	12.48	33.93	7.46	2.25	0.49	1.17	2.24	3.4	7.11	14.87
Small Grains	29.96	25.98	23.68	12.01	4.05	16.02	4.15	1.96	7.72	52.39
Bare Soil	0	0	0	0	0	0	0	0	0	0
Other Grasses (Urban/recreational; e.g. parks and golf courses)	0.01	0	0	0	0	0	0	0	0	0.01
Woody Wetlands	0.03	0	0	0	0	0	0	0	0	0
Emergent Herbaceous Wetlands	0.49	0.02	0.24	0	0	0	0	0	0.15	0
Acres OpenWater	1,920	22	1,488	72	69	32	12	86	749	457
Acres Low Intensity Residential	373	7	437	0	0	0	0	0	195	1,132
Acres High Intensity Residential	44	0	47	0	0	0	0	0	12	1,065
Acres High Intensity Commercial/Industrial/Transportation	133	25	12	0	0	12	0	0	126	964
Acres Bare Rock/Sand/Clay	64	17	200	0	10	2	7	99	304	69
Acres Quarries/Strip Mines/Gravel Pits	0	0	0	0	0	0	0	0	0	0
Acres Transitional	227	0	0	0	0	0	0	0	0	0
Acres Deciduous Forest	5,906	232	3,136	445	5	10	7	54	27	2,609
Acres Evergreen Forest	14,075	1,043	24,019	2,711	3,590	237	571	324	94	2,701
Acres Mixed Forest	1,282	72	3,175	450	321	74	126	143	47	551
Acres Deciduous Shrubland	7,033	435	29,292	6,198	3,143	1,495	2,550	9,000	31,199	3,561
Acres Grassland/Herbaceous	50,271	3,109	86,534	15,049	10,700	6,632	5,172	55,324	75,063	43,041
Acres Pasture/Hay	12,128	591	6,106	390	25	52	32	282	855	13,289
Acres Row Crops	20,458	4,702	16,778	665	91	121	203	2,348	9,086	31,540
Acres Small Grains	49,105	3,600	53,298	3,546	759	1,653	376	1,349	9,862	111,158
Acres Bare Soil	0	0	0	0	0	0	0	0	0	0
Acres Other Grasses (Urban/recreational; e.g. parks, lawns)	15	0	7	0	0	0	0	0	0	25
Acres Woody Wetlands	42	0	0	0	0	0	0	0	2	0
Acres Emergent Herbaceous Wetlands	801	2	531	0	0	0	0	0	198	2
Total (Acres)	**163,878**	**13,858**	**225,061**	**29,524**	**18,713**	**10,322**	**9,056**	**69,009**	**127,822**	**212,164**

Figure 1-1 Location Map for the Canadian River, Bear Creek, Trail Creek, Lone Creek, Red Trail Creek, Red Creek, Hackberry Creek, Commission Creek, and Deer Creek Watersheds

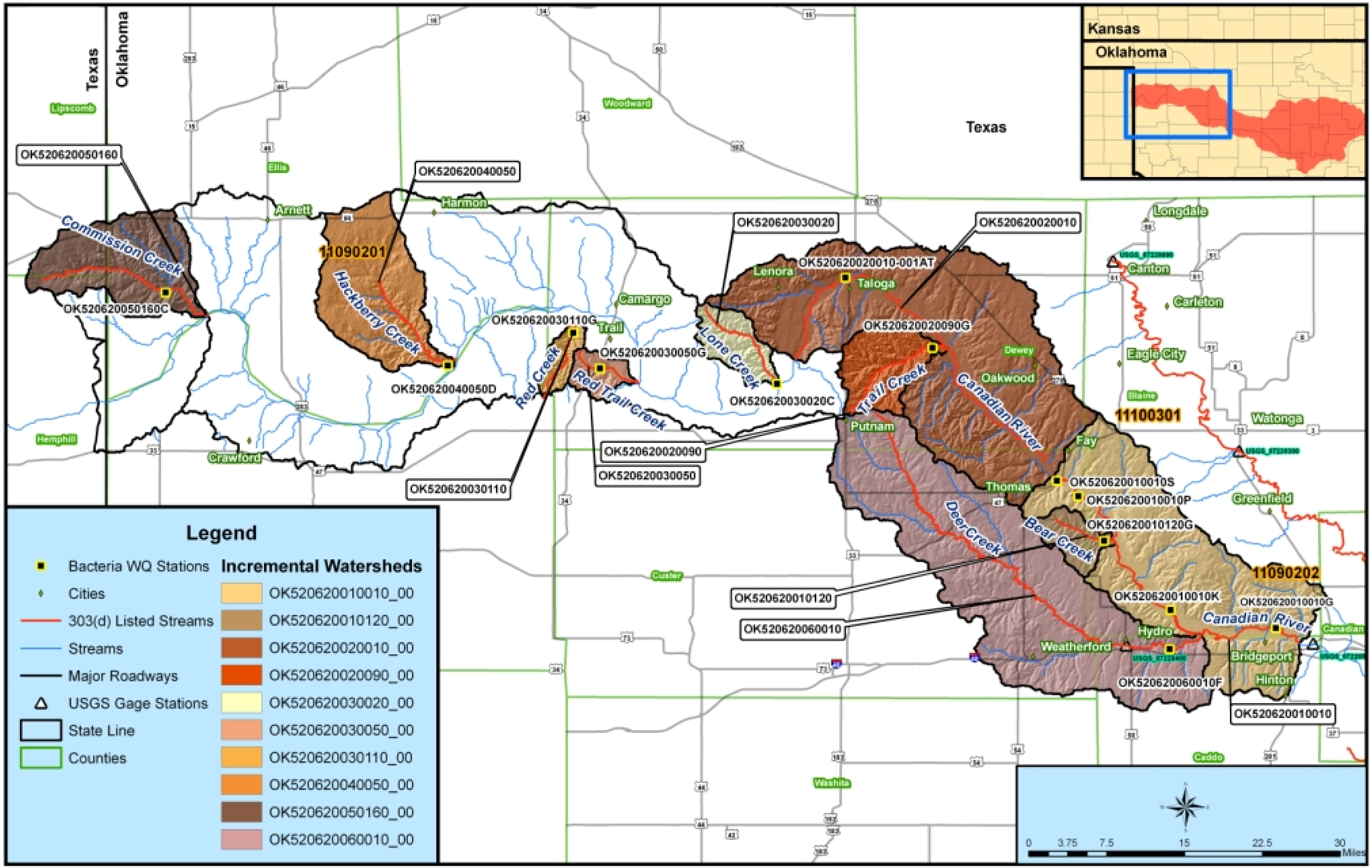
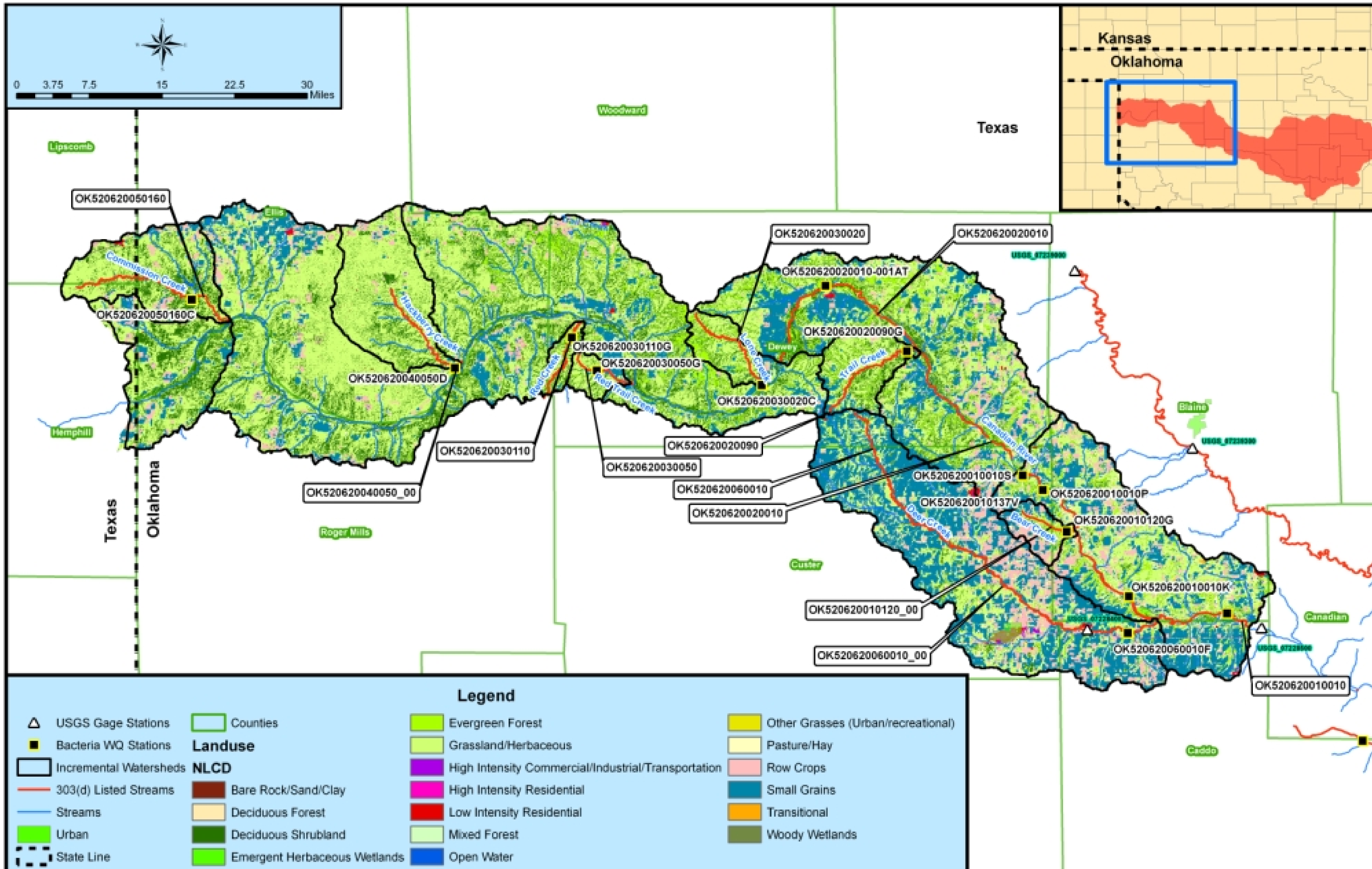


Figure 1-2 Land Use Map by Watershed



SECTION 2
PROBLEM IDENTIFICATION AND WATER QUALITY TARGET

2.1 Oklahoma Water Quality Standards

Title 785 of the Oklahoma Administrative Code authorizes the Oklahoma Water Resources Board (OWRB) to promulgate Oklahoma's water quality standards (OWRB 2004). The OWRB has statutory authority and responsibility concerning establishment of state water quality standard, as provided for 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.* [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 2004). The beneficial uses designated for the Canadian River, Bear Creek, Trail Creek, Lone Creek, Red Trail Creek, Red Creek, Hackberry Creek, Commission Creek, and Deer Creek include PBCR, public/private water supply, warm water aquatic community, industrial water supply, agricultural water supply, and aesthetics. The TMDLs in this report only address the PBCR-designated use. Table 2-1 summarizes the beneficial use attainment status for the 10 waterbodies of the study area as summarized in Appendix B of the 2002 Integrated Report (ODEQ 2002).

Table 2-1 Excerpt from the 2002 Integrated Report – Comprehensive Waterbody Assessment Category List

Oklahoma Waterbody ID	NAME	Stream Miles	Category	TMDL Date	Primary Body Contact Recreation	Warm Water Aquatic Community
OK520620010010	Canadian River	41.98	5	2008	N	I
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Source: 2002 Integrated Report, ODEQ 2002

The definition of PBCR is summarized by the following excerpt from Chapter 45 of the Oklahoma WQSs.

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

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

Oklahoma's numeric criteria to protect the PBCR beneficial use are (OWRB 2004):

(1) Coliform Bacteria: The bacteria of the fecal coliform group shall not exceed a monthly geometric mean of 200/100 ml, as determined by multiple-tube fermentation or membrane filter procedures based on a minimum of not less than five (5) samples collected over a period of not more than thirty (30) days. Further, in no more than 10% of the total samples during any thirty (30) day period shall the bacteria of the fecal coliform group exceed 400/100 ml.

(2) Escherichia coli (E. coli): E. coli shall not exceed a monthly geometric mean of 126/100 ml based upon a minimum of not less than five (5) samples collected over a period of not more than thirty (30) days. No sample shall exceed a 75% one-sided confidence level of 235/100 ml in lakes and high use waterbodies and the 90% one-sided confidence level of 406/100 ml in all other Primary Body Contact Recreation beneficial use areas.

(3) Enterococci: Enterococci shall not exceed a monthly geometric mean of 33/100 ml based upon a minimum of not less than five (5) samples collected over a period of not more than thirty (30) days. No sample shall exceed a 75% one-sided confidence level of 61/100 ml in lakes and high use waterbodies and the 90% one-sided confidence level of 108/100 ml in all other Primary Body Contact Recreation beneficial use areas.

Compliance with Oklahoma WQS is based on meeting requirements of one of the three bacteria indicators. However, 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 2004).

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, most waterbodies placed on the 303(d) list for not supporting the PBCR are the result of individual samples exceeding criteria, also known as instantaneous or single sample criterion. Targeting the instantaneous criterion as the water quality goal for TMDLs corresponds to the basis for 303(d) listing and is expected to be protective of the geometric mean criterion as well.

2.2 Problem Identification

Table 2-2 summarizes water quality data collected during primary contact recreation season from the WQM stations between 1997 and 2003 for each indicator bacteria. The 1997 to 2001 subset of this data was used to support the decision to place the Canadian River waterbodies on the ODEQ 2002 303(d) list (ODEQ 2002). Water quality data from the primary and secondary contact recreation seasons are provided in Appendix A. For the data collected between 1997 and 2003, evidence of nonsupport of the PBCR use based on fecal coliform concentrations was observed in five waterbodies: OK520620010010, OK520620010120, OK520620020090, OK520620030050, and OK520620030110. Evidence of nonsupport of the PBCR use based on *E. coli* and *Enterococci* concentrations was observed in all waterbodies with the exception of OK520620010010, where they were not measured.

The consistent percentage of water quality criterion exceedances at most WQM sites, regardless of bacteria indicator, suggests that the temporal and spatial severity of bacteria loading is significant and chronic. In general, exceedances of *Enterococci* criteria were more frequent than those of *E. coli* or fecal coliform.

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 TMDLs in this report, defining the water quality target is somewhat complicated by the use of three different bacteria indicators with three different numeric criterion for determining attainment of PBCR use as defined in the Oklahoma WQSs. 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 the instantaneous criteria for each of the three bacteria indicators. Furthermore, these TMDLs must take into account that no more than 10 percent of the samples may exceed the instantaneous numeric criteria. For *E.coli* and *Enterococcus*, 10% exceedance is allowable when standards state that "no samples will exceed criteria". Rather than propose TMDL calculations for all bacteria indicators at each WQM station, water quality targets for TMDL development will be driven by one indicator for each waterbody based on the bacteria indicator that is the most conservative (*i.e.,* warrants the largest percent reduction). Furthermore, the water quality target for each waterbody will incorporate an explicit 10 percent MOS. For example, if fecal coliform is utilized to establish the TMDL, then the water quality target is 360 organisms per 100 milliliters (mL), 10 percent lower than the instantaneous water quality criteria of 400/ 100 mL. For *E. coli* the water quality target is 365 organisms/ 100 mL which is 10 percent lower than the criterion value (406/ 100 L). For *Enterococci* the water quality target is 97/ 100 mL, which is 10 percent lower than the criterion value (108/ 100 mL). This conservative approach will be protective of both the instantaneous and 30-day geometric mean criteria.

This water quality target will be used to determine the allowable bacteria load which is derived by using the actual or estimated flow record multiplied by the instream criteria minus a 10 percent MOS. 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.

Table 2-2 Summary of Indicator Bacteria Samples from Primary Contact Recreation Season, 1997-2003

WQM Station	Waterbody Name	Indicator Bacteria	Single Sample Water Quality Criterion	Geometric Mean Concentration (count/100ml)	Number of Samples	Number of Samples Exceeding Criterion	% of Samples Exceeding Criterion
OK520620010010K	Canadian River	FC	400	436	6	2	33%
OK520620010010G		FC	400	693	9	6	67%
OK520620010010P		FC	400	344	6	2	33%
OK520620010010S		FC	400	359	9	3	33%
OK520620010120G	Bear Creek	EC	406	461	6	2	33%
		ENT	108	1142	6	6	100%
		FC	400	1455	7	5	71%
OK520620020010_001AT	Canadian River	EC	406	53	16	1	6%
		ENT	108	129	16	7	44%
		FC	400	94	16	3	19%
OK520620020090G	Trail Creek	EC	406	200	12	4	33%
		ENT	108	208	11	10	91%
		FC	400	191	7	3	43%
OK520620030020C	Lone Creek	EC	406	529	8	3	38%
		ENT	108	263	8	7	88%
OK520620030050G	Red Trail Creek	EC	406	306	5	3	60%
		ENT	108	858	5	5	100%
		FC	400	609	6	5	83%
OK520620030110G	Red Creek	EC	406	84	5	1	20%
		ENT	108	190	5	3	60%
		FC	400	487	7	3	43%
OK520620040050D	Hackberry Creek	EC	406	367	6	4	67%
		ENT	108	256	6	5	83%
OK520620050160C	Commission Creek	EC	406	158	8	1	13%
		ENT	108	142	8	6	75%
OK520620060010F	Deer Creek	EC	406	193	8	4	50%
		ENT	108	90	8	4	50%

SECTION 3
POLLUTANT SOURCE ASSESSMENT

A 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.

Point sources are permitted through the National Pollutant Discharge Elimination System (NPDES) program. NPDES-permitted facilities that discharge treated wastewater are required to monitor for one of the three bacteria indicators (fecal coliform, *E coli*, or *Enterococci*) in accordance with its permit. Nonpoint sources are diffuse sources that typically cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources may involve land activities that contribute bacteria 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 following discussion describes what is known regarding point and nonpoint sources of bacteria in the impaired watersheds.

3.1 NPDES-Permitted Facilities

Under 40CFR, §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 loading include:

1. NPDES municipal wastewater treatment plants (WWTP);
2. NPDES municipal no-discharge WWTP;
3. NPDES municipal separate storm sewer discharge (MS4s); and
4. NPDES Concentrated Animal Feeding Operation (CAFO).

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. 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. Stormwater runoff from MS4 areas, which is now regulated under the USEPA NPDES Program, can also contain high fecal coliform bacteria concentrations. However, there are no urbanized areas designated as MS4s within this study area. CAFOs are designated by USEPA as significant sources of pollution, and may have the potential to cause serious impacts to water quality if not properly managed.

There are no NPDES permitted facilities of any type in the contributing watershed of Commission Creek, Hackberry Creek, Red Creek, Red Trail Creek, Lone Creek, Trail Creek, and Bear Creek.

Three of the watersheds in the study area OK520620020010-00 (Canadian River Upstream), OK520620020010-00 (Canadian River Downstream), and OK520620060010-00 (Deer Creek) have continuous point source discharges.

3.1.1 Continuous Point Source Discharges

The locations of the NPDES permitted facilities which discharge wastewater to surface waters addressed in these TMDLs are shown in Figure 3-1 and are listed in Table 3-1.

Table 3-1 Point Source Discharges in the Study Area

NPDES	Name	Receiving Water	SIC Code	County	Design Flow (mgd)
OK0038971	City of Thomas Public Works Authority	520620020010 Canadian River	Sewerage Systems	Custer	0.088
OK0034886	Dewey Co. Rural Water District No. 1	520620020010 Canadian River	Sewerage Systems	Dewey	N/A
OK0021563	Weatherford Public Works Authority	520620060010 Deer Creek	Sewerage Systems	Custer	1.998
OK0028185	City of Hydro	520620060010 Deer Creek	Sewerage Systems	Caddo	0.14
OK0041785	Imation / Kodak Polychrome Graphics	520620060010 Deer Creek	Photographic Equipment & Supplies	Custer	N/A
OK0032107	Mid-Continent Pipeline Co. - Putnam	520620060010 Deer Creek	Crude Petroleum & Natural Gas	Dewey	N/A

N/A = not available

Discharge Monitoring Reports (DMR) were used to determine the number of fecal coliform analyses performed from 2000 through 2005, the maximum concentration during this period, the number of violations occurring when the monthly geometric mean concentration exceeded 200 cfu/100 ml, and the number of violations when a daily maximum concentration exceeded 400 cfu/100 ml. DMR data for fecal coliform were only available for the Weatherford Public Works Authority and the City of Hydro (see Appendix B). These data indicate that there are no violations occurring at the Weatherford Public Works Authority. However, the City of Hydro wastewater treatment plant discharge violated permit limits for fecal coliform from May through September 2005, with monthly geometric mean concentrations ranging from 340 organisms/100 ml to 1475/100 ml. This facility reported no discharge from 2001 through April 2005.

3.1.2 NPDES No-Discharge Facilities and SSOs

There are eight NPDES-permitted no-discharge facilities within the study area. The locations of these facilities are shown in Figure 3-1, and are listed in Table 3-2. For the purposes of these TMDLs, it is assumed that no-discharge facilities do not contribute bacteria loading to the Canadian River and its tributaries. However, it is possible the wastewater collection systems associated with those WWTPs could be a source of bacteria loading, or that discharges may occur during large rainfall events that exceed the systems' storage capacity.

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

Facility	Facility ID	County	Facility Type	Type	Watershed
Arnett WWTP	S20601	Ellis	Lagoon	Municipal	OK520620010010 Canadian River
Dewey RWSD #2	S20644	Dewey	Lagoon	Municipal	OK520620020010 Canadian River
Oakwood WWTP	S20605	Dewey	Lagoon	Municipal	OK520620020010 Canadian River
Seiling WWTP	S20524	Dewey	Lagoon	Municipal	OK520620020010 Canadian River
Dolphin Industries	WD86-013	Custer	N/A	Industrial	OK520620010120 Bear Creek
Country East MHP	S20673	Custer	Lagoon	Municipal	OK520620060010 Deer Creek
Dolese Weatherford Batch Plant	OKG11T003	Custer	N/A	Industrial	OK520620060010 Deer Creek
Harrall's Meats	CW71-002	Custer	N/A	Industrial	OK520620060010 Deer Creek

Sanitary sewer overflows (SSO) from wastewater collection systems, although infrequent, can be a major source of fecal coliform 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 over the last 6 years 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. There were 46 SSOs, ranging from 10 to 2800 gallons, reported by the Weatherford Public Works Authority (OK0021563) between June 2002 and August 2004. The reported SSOs in the Canadian River watershed are provided in Appendix B.

3.1.3 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 for CAFOs can include animal waste discharges to waters of the state and failure to properly operate wastewater lagoons. According to ODAFF, there are no reported historic performance problems from the CAFOs in this region.

Figure 3-1 below depicts the locations of the 7 CAFOs located in the study area. Table 3-3 lists the CAFOs located in the study area. Commission Creek, Hackberry Creek, Red Creek, Red Trail Creek, Lone Creek, Trail Creek, and Bear Creek have no CAFOs within their contributing watershed.

Table 3-3 NPDES-Permitted CAFOs in the Study Area

NPDES ID	OKG010037	OKG010086	OKU000443	OKG010033	OKG010150	OKG010161	OKU000371
CAFO Name	Dobbins Ranch LLC	CK Cattle Co.	5-D Swine, Inc.	Chain Feedlot, Inc.	Purvine Farms, Inc.	Smith Ranch	Land O' Lakes Inc.
City	Thomas	Custer	Custer	Oakwood	Fay	Taloga	Fort Dodge
County	Custer	Custer	Custer	Dewey	Dewey	Dewey	Caddo
Type of Facility	Beef Cattle	Beef Cattle	Swine	Beef Cattle	Beef Cattle	Beef Cattle	Swine
# Animals	4000	N/A	2520	1300	750	250	2296

N/A = data not available

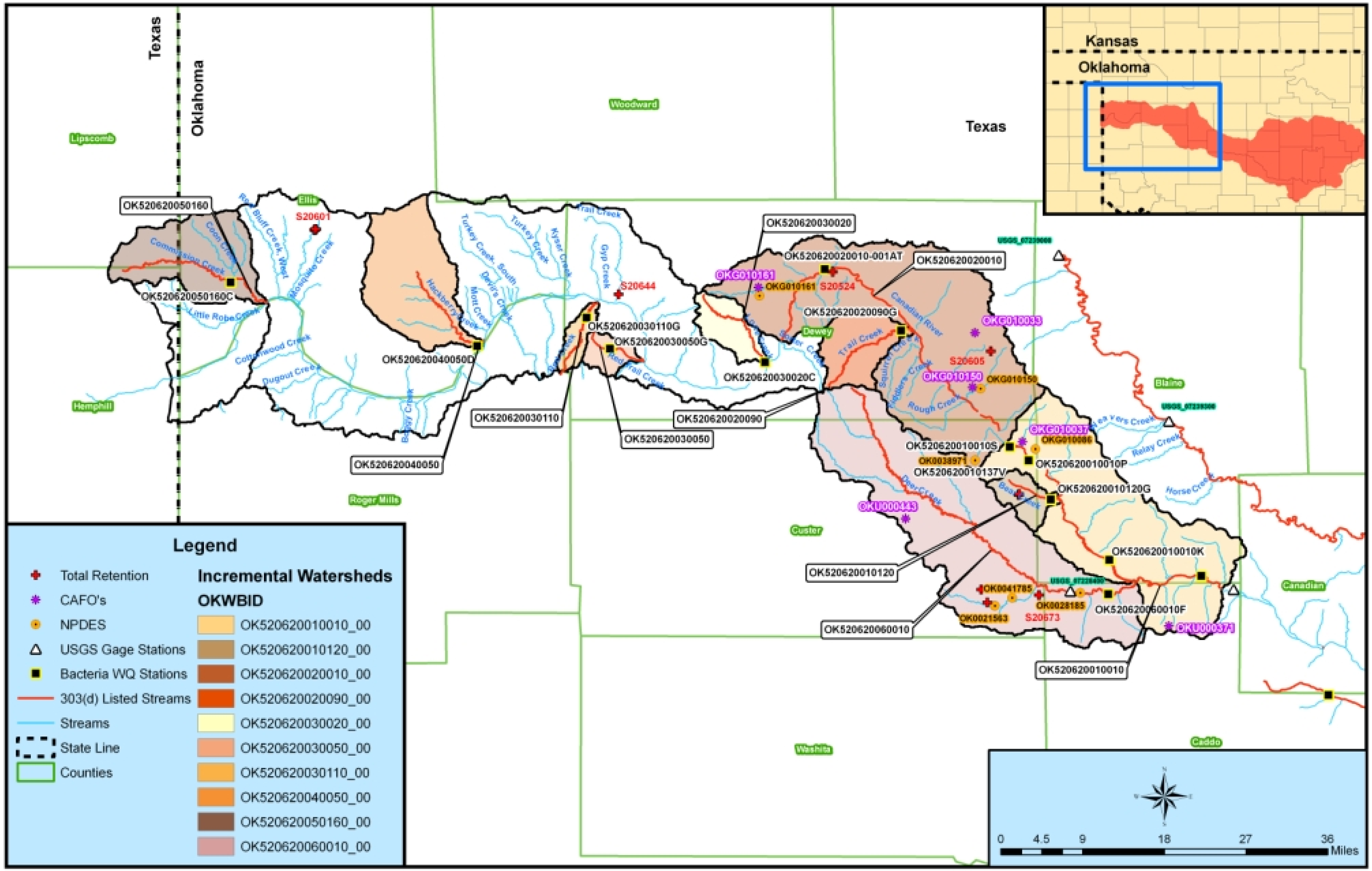
3.2 Nonpoint Sources

Nonpoint sources include those sources that cannot be identified as entering the waterbody at a specific location. Bacteria originate from rural, suburban, and urban areas. The following section describes possible major nonpoint sources contributing fecal coliform in the Canadian River, Bear Creek, Trail Creek, Lone Creek, Red Trail Creek, Red Creek, Hackberry Creek, Commission Creek, and Deer Creek watersheds.

These sources include wildlife, agricultural activities and domesticated animals, land application fields, urban runoff, failing onsite wastewater disposal (OSWD) systems and domestic pets. As previously stated, there are no NPDES-permitted facilities in Commission Creek, Hackberry Creek, Red Creek, Red Trail Creek, Lone Creek, and Trail Creek watersheds, therefore, non-support of PBCR use is caused by nonpoint sources of bacteria only.

Bacteria associated with urban runoff can emanate from humans, wildlife, livestock, 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). BMPs such as buffer strips and proper disposal of domestic animal waste reduce bacteria loading to waterbodies.

Figure 3-1 Locations of NPDES-Permitted Facilities in the Canadian River Watershed (OK52062)



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 1999 to 2003 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 both watersheds. Table 3-4 provides the estimated number of deer for the Canadian River, Bear Creek, Trail Creek, Lone Creek, Red Trail Creek, Red Creek, Hackberry Creek, Commission Creek, and Deer Creek watersheds.

Table 3-4 Estimated Deer Populations

OKWBID	Deer
OK520620010010 Canadian River	1,121
OK520620020010 Canadian River	1,588
OK520620010120 Bear Creek	79
OK520620020090 Trail Creek	213
OK520620030020 Lone Creek	135
OK520620030050 Red Trail Creek	74
OK520620030110 Red Creek	66
OK520620040050 Hackberry Creek	384
OK520620050160 Commission Creek	558
OK520620060010 Deer Creek	1,348

According to a livestock study conducted by ASAE (the American Society of Agricultural Engineers), 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 for deer provided in Table 3-5 in cfu/day provides a relative magnitude of loading in each watershed.

Table 3-5 Estimated Fecal Coliform Production for Deer

Category	Watershed Area (acres)	Wild Deer Population	Estimated Wild Deer per acre	Fecal Production (cfu/day) of Deer Population
OK520620010010 Canadian River	163,804	1,121	0.007	5.60E+11
OK520620010120 Bear Creek	13,841	79	0.006	3.93E+10
OK520620020010 Canadian River	225,021	1,588	0.007	7.94E+11
OK520620020090 Trail Creek	29,508	213	0.007	1.06E+11
OK520620030020 Lone Creek	18,713	135	0.007	6.75E+10
OK520620030050 Red Trail Creek	10,316	74	0.007	3.72E+10
OK520620030110 Red Creek	9,097	66	0.007	3.29E+10
OK520620040050 Hackberry Creek	69,013	384	0.006	1.92E+11
OK520620050160 Commission Creek	66,278	558	0.008	2.79E+11
OK520620060010 Deer Creek	212,269	1,348	0.006	6.74E+11

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 fecal bacteria loading. Agricultural activities of greatest concern are typically those associated with livestock operations (Drapcho and Hubbs 2002):

Processed livestock manure is often applied to fields as fertilizer, and can contribute to fecal bacteria loading to waterbodies if washed into streams by runoff.

Livestock grazing in pastures deposit manure containing fecal bacteria onto land surfaces. These bacteria may be washed into waterbodies by runoff.

Livestock often have direct access to waterbodies and can provide a concentrated source of fecal bacteria loading directly into streams.

Table 3-6 provides estimated numbers of selected livestock by watershed based on the 2002 USDA county agricultural census data (USDA 2002). The estimated livestock populations in Table 3-6 were derived by using the percentage of the watershed within each county. Because the watersheds are generally much smaller than the counties, and livestock are not evenly distributed across counties or constant with time, these are rough estimates only. Beef cattle are clearly the most abundant species of livestock in the study area. Since cattle often have direct access to tributaries of the Canadian River, Bear Creek, Trail Creek, Lone Creek, Red Trail Creek, Red Creek, Hackberry Creek, Commission Creek, and Deer Creek, the potential for concentrated loading of bacteria may be high.

Detailed information is not available to describe or quantify the relationship between instream concentrations of bacteria and land application of manure from livestock. The estimated acreage by watershed where manure was applied in 2002 is also shown in Table 3-6. These estimates are also based on the county level reports from the 2002 USDA county agricultural census, and contain all of the same uncertainties as the livestock populations. Despite the lack of specific data, for the purpose of these TMDLs, land application of livestock manure is considered a potential source of bacteria loading to the Canadian River watershed.

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 livestock populations and the fecal coliform production rates from ASAE, an estimate of fecal coliform production from each group of livestock was calculated in each watershed of the study area in Table 3-7. 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 livestock source of fecal bacteria.

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.

Table 3-6 Livestock and Manure Estimates by Watershed

OKWBID	Cattle & Calves-all	Dairy Cows	Horses & Ponies	Goats	Sheep & Lambs	Hogs & Pigs	Ducks & Geese	Chickens & Turkeys	Acres of Manure Application
OK520620010010	20,878	98	206	37	116	538	10	24	353
OK520620010120	1,607	12	20	5	28	2	2	8	54
OK520620020010	20,070	89	229	89	243	73	13	231	211
OK520620020090	2,889	12	32	13	32	12	2	35	20
OK520620030020	1,712	7	19	8	19	7	1	21	12
OK520620030050	1,281	5	14	6	14	5	1	16	9
OK520620030110	877	4	11	4	9	4	0	10	6
OK520620040050	5,005	37	63	7	34	977	0	21	77
OK520620050160	4,752	22	56	5	21	586	0	15	68
OK520620060010	27,438	176	372	86	463	1,077	36	160	864

Table 3-7 Fecal Coliform Production Estimates for Selected Livestock (number/day)

OKWBID	Cattle & Calves-all	Dairy Cows	Horses & Ponies	Goats	Sheep & Lambs	Hogs & Pigs	Ducks & Geese	Chickens & Turkeys
OK520620010010	2.E+15	1.E+13	9.E+10	N/A	1.E+12	6.E+12	2.E+10	3.E+09
OK520620010120	2.E+14	1.E+12	8.E+09	N/A	3.E+11	2.E+10	5.E+09	1.E+09
OK520620020010	2.E+15	9.E+12	1.E+11	N/A	3.E+12	8.E+11	3.E+10	3.E+10
OK520620020090	3.E+14	1.E+12	1.E+10	N/A	4.E+11	1.E+11	5.E+09	5.E+09
OK520620030020	2.E+14	7.E+11	8.E+09	N/A	2.E+11	8.E+10	2.E+09	3.E+09
OK520620030050	1.E+14	5.E+11	6.E+09	N/A	2.E+11	5.E+10	2.E+09	2.E+09
OK520620030110	9.E+13	4.E+11	5.E+09	N/A	1.E+11	4.E+10	0.E+00	1.E+09
OK520620040050	5.E+14	4.E+12	3.E+10	N/A	4.E+11	1.E+13	0.E+00	3.E+09
OK520620050160	5.E+14	2.E+12	2.E+10	N/A	3.E+11	6.E+12	0.E+00	2.E+09
OK520620060010	3.E+15	2.E+13	2.E+11	N/A	6.E+12	1.E+13	9.E+10	2.E+10

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 8 percent of the OSWD systems in the Texas Panhandle (adjacent to the study area) 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 3-8 summarizes estimates of sewered and unsewered households for each watershed in the study area.

Table 3-8 Estimates of Sewered and Unsewered Households

WATERBODY	Public Sewer	Septic Tank or Cesspool	Other Means	Housing Units	% Sewered
OK520620010010_00	826	426	15	1,252	66
OK520620010120_00	93	35	2	128	73
OK520620020010_00	568	437	23	1,005	57
OK520620020090_00	47	35	2	82	57
OK520620030020_00	33	24	1	57	58
OK520620030050_00	26	20	1	46	57
OK520620030110_00	17	14	1	31	56
OK520620040050_00	49	65	4	114	43
OK520620050160_00	102	133	5	235	43
OK520620060010_00	3,706	884	60	4,590	81

For the purpose of estimating fecal coliform loading in watersheds, an OSWD failure rate of 8 percent was used. Using this 8 percent failure rate, calculations were 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 2.44 for counties in the study area (U.S. Census Bureau 2000). Approximately 70 gallons of wastewater was 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 published reports (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 3-9.

Table 3-9 Estimated Fecal Coliform Load from OSWD Systems

WATERBODY	Acres	Septic Tank or Cesspool	# of Failing Septic Tanks	Estimated loads from septic tanks (counts/day)
OK520620010010	163,804	426	34	2.2E+11
OK520620010120	13,841	35	3	1.8E+10
OK520620020010	225,021	437	35	2.3E+11
OK520620020090	29,508	35	3	1.8E+10
OK520620030020	18,713	24	2	1.2E+10
OK520620030050	10,316	20	2	1.0E+10
OK520620030110	9,097	14	1	7.2E+09
OK520620040050	69,013	65	5	3.3E+10
OK520620050160	66,278	133	11	6.9E+10
OK520620060010	212,269	884	71	4.6E+11

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 nationally, there are 0.58 dogs per household and 0.66 cats per household (American Veterinary Medical Association 2004). 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 3-10 summarizes the estimated number of dogs and cats for the watersheds of the study area.

Table 3-10 Estimated Numbers of Pets

Waterbody ID	Dogs	Cats
OK520620010010	735	836
OK520620010120	75	85
OK520620020010	596	679
OK520620020090	49	56
OK520620030020	34	39
OK520620030050	27	31
OK520620030110	19	21
OK520620040050	68	78
OK520620050160	140	159
OK520620060010	2,698	3,070

Table 3-11 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 3-11 Estimated Fecal Coliform Daily Production by Pets

Waterbody	Dogs	Cats	Total
OK520620010010	2.4E+12	4.5E+11	2.9E+12
OK520620010120	2.5E+11	4.6E+10	2.9E+11
OK520620020010	2.0E+12	3.7E+11	2.3E+12
OK520620020090	1.6E+11	3.0E+10	1.9E+11
OK520620030020	1.1E+11	2.1E+10	1.3E+11
OK520620030050	8.9E+10	1.7E+10	1.1E+11
OK520620030110	6.3E+10	1.1E+10	7.4E+10
OK520620040050	2.2E+11	4.2E+10	2.7E+11
OK520620050160	4.6E+11	8.6E+10	5.5E+11
OK520620060010	8.9E+12	1.7E+12	1.1E+13

3.3 Summary of Bacteria Sources

NPDES-permitted facilities are absent from most of the watersheds in the study area, and most point sources are relatively minor and for the most part tend to meet instream water quality criteria in their effluent. Thus, nonpoint sources are considered to be the major origin of bacteria loading in each watershed. Table 3-12 summarizes the suspected sources of bacteria loading in each impaired watershed.

Table 3-12 Estimated Major Source of Bacteria Loading by Watershed

Waterbody	Name	Point Sources	Nonpoint Sources	Major Source
OK520620010010	Canadian River	Yes	Yes	Nonpoint
OK520620010120	Bear Creek	No	Yes	Nonpoint
OK520620020010	Canadian River	Yes	Yes	Nonpoint
OK520620020090	Trail Creek	No	Yes	Nonpoint
OK520620030020	Lone Creek	No	Yes	Nonpoint
OK520620030050	Red Trail Creek	No	Yes	Nonpoint
OK520620030110	Red Creek	No	Yes	Nonpoint
OK520620040050	Hackberry Creek	No	Yes	Nonpoint
OK520620050160	Commission Creek	No	Yes	Nonpoint
OK520620060010	Deer Creek	Yes	Yes	Nonpoint

Table 3-13 below provides a summary of the estimated fecal coliform loads in cfu/day for the four major nonpoint source categories (livestock, pets, deer and septic tanks) that are contributing 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 have demonstrated that wild birds and mammals, represent a major source of the fecal bacteria found in streams.

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. Also, the structural properties of some manures, such as cow patties, may limit their washoff into streams by runoff. In contrast, malfunctioning septic tank effluent may be present in pools on the surface, or in shallow groundwater, which may enhance its conveyance to streams.

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

Waterbody	Livestock	Pets	Deer	Malfunctioning septic tanks
OK520620010010	2.0E+15	2.9E+12	5.6E+11	2.2E+11
OK520620010120	2.0E+14	2.9E+11	3.9E+10	1.8E+10
OK520620020010	2.0E+15	2.3E+12	7.9E+11	2.3E+11
OK520620020090	3.0E+14	1.9E+11	1.1E+11	1.8E+10
OK520620030020	2.0E+14	1.3E+11	6.8E+10	1.2E+10
OK520620030050	1.0E+14	1.1E+11	3.7E+10	1.0E+10
OK520620030110	9.0E+13	7.4E+10	3.3E+10	7.2E+09
OK520620040050	5.1E+14	2.7E+11	1.9E+11	3.3E+10
OK520620050160	5.1E+14	5.5E+11	2.8E+11	6.9E+10
OK520620060010	3.0E+15	1.1E+13	6.7E+11	4.6E+11

SECTION 4
TECHNICAL APPROACH AND METHODS

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

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

The WLA is the proportion of the TMDL allocated to existing and future point sources. The LA is the portion of the TMDL allocated to nonpoint sources and 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*, TMDLs are expressed as cfu per day where possible, or as a percent reduction goal (PRG), and represent the maximum 1-day load the stream can assimilate while still attaining the WQS.

4.1 Using Load Duration Curves to Develop TMDLs

The TMDL calculations presented in this report are derived from load duration curves (LDCs). 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 four following steps which are described in Subsections 4.2 through 4.4 below:

i) Preparing flow duration curves for gaged and ungaged WQM stations;
ii) Estimating existing bacteria loading in the receiving water using ambient water quality data;
iii) Using LDCs to identify the critical condition which will dictate loading reductions necessary to attain WQS; and
iv) Interpreting LDCs to derive TMDL elements – WLA, LA, MOS, and PRG

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 treatment plant effluents would dominate the base flow of the impaired water.

LDCs display the maximum allowable load over the complete range of flow conditions by a line using the calculation of flow multiplied by the 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.

4.2 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. 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. The more complex approach used here also considered watershed differences in rainfall, land use, and the hydrologic properties of soil that govern runoff and retention. More than one upstream flow gage may also be considered. A more detailed explanation of the methods for estimating flow at ungaged WQM stations is provided in Appendix C.

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 WQM station addressed in this report are provided in Appendix C.

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 2005a).

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.

Figures 4-1 through 4-10 are flow duration curves for each impaired waterbody. The flow duration curve for Deer Creek was based on measured flows from 1960 to 1980 at USGS gage station 07228400 (Deer Creek at Hydro, Oklahoma). This gage was inactivated in 1980. The flow duration curves for the other nine waterbodies were estimated using USGS gage station 07228500, located on the Canadian River at Bridgeport, Oklahoma, just downstream of the study area. The flow period used for USGS gage station 07228500 was from 1965 (the date of impoundment of the Canadian River at Lake Meredith) to 2004. The stepped characteristic displayed in some of the flow duration curve is caused by extremely low flow conditions typical of small intermittent streams.

Figure 4-1 Flow Duration Curve for the Canadian River (Waterbody 520620020010) During PBCR Season

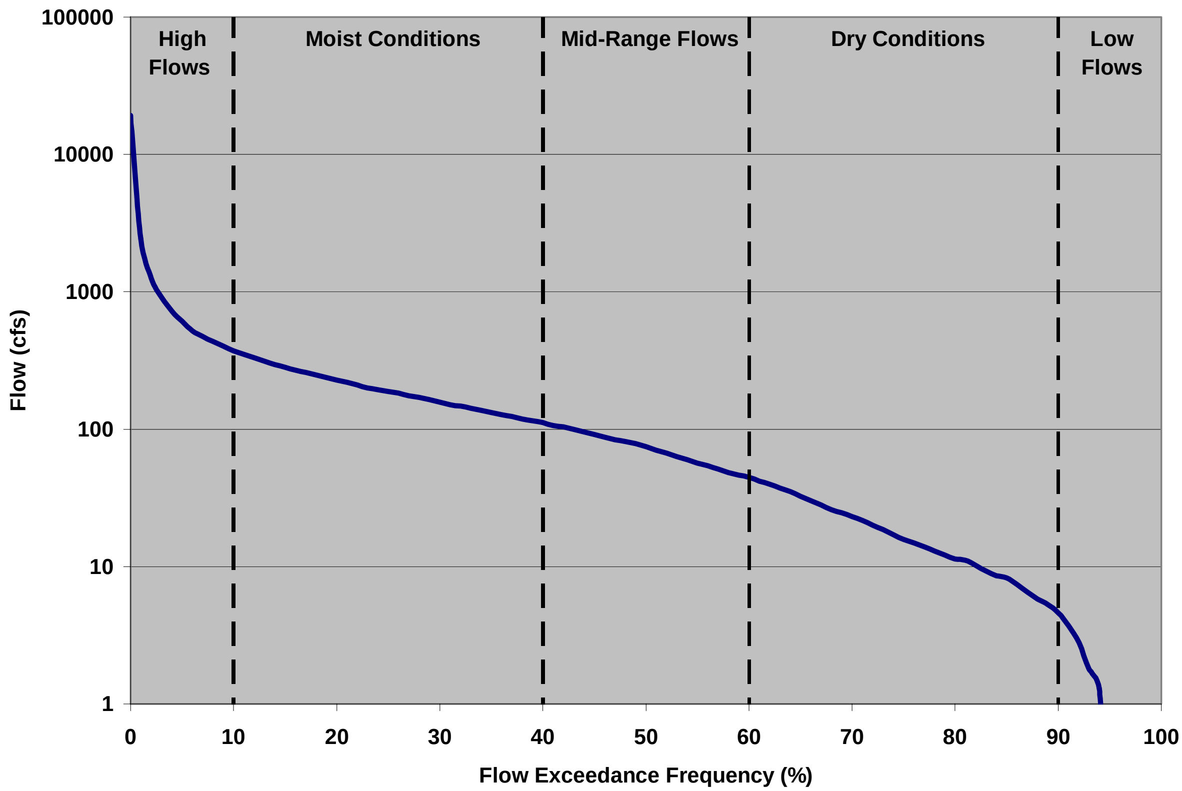
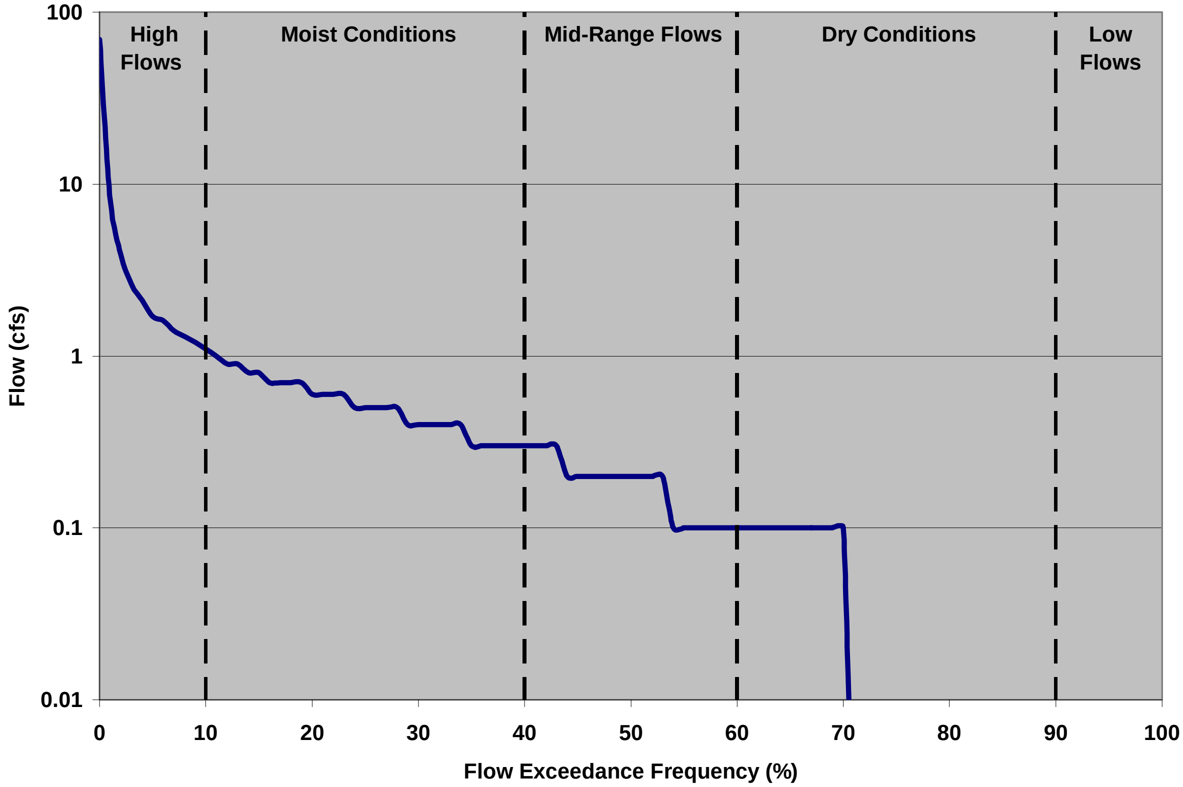


Figure 4-2 Flow Duration Curve for Bear Creek During PBCR Season



Note: The stepped curve is caused by extremely low flow conditions near the limit of quantitation, as well as data rounding conventions.

Figure 4-3 Flow Duration Curve for the Canadian River (Waterbody 520620010010) During PBCR Season

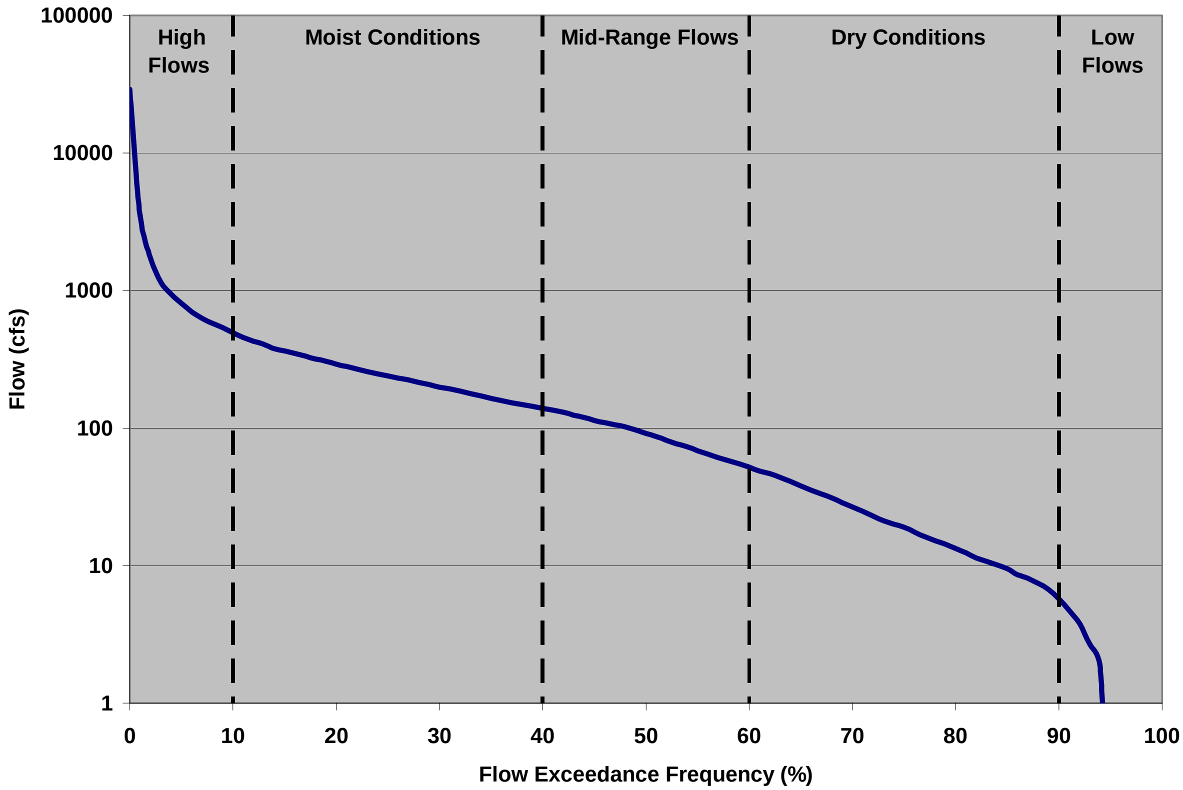
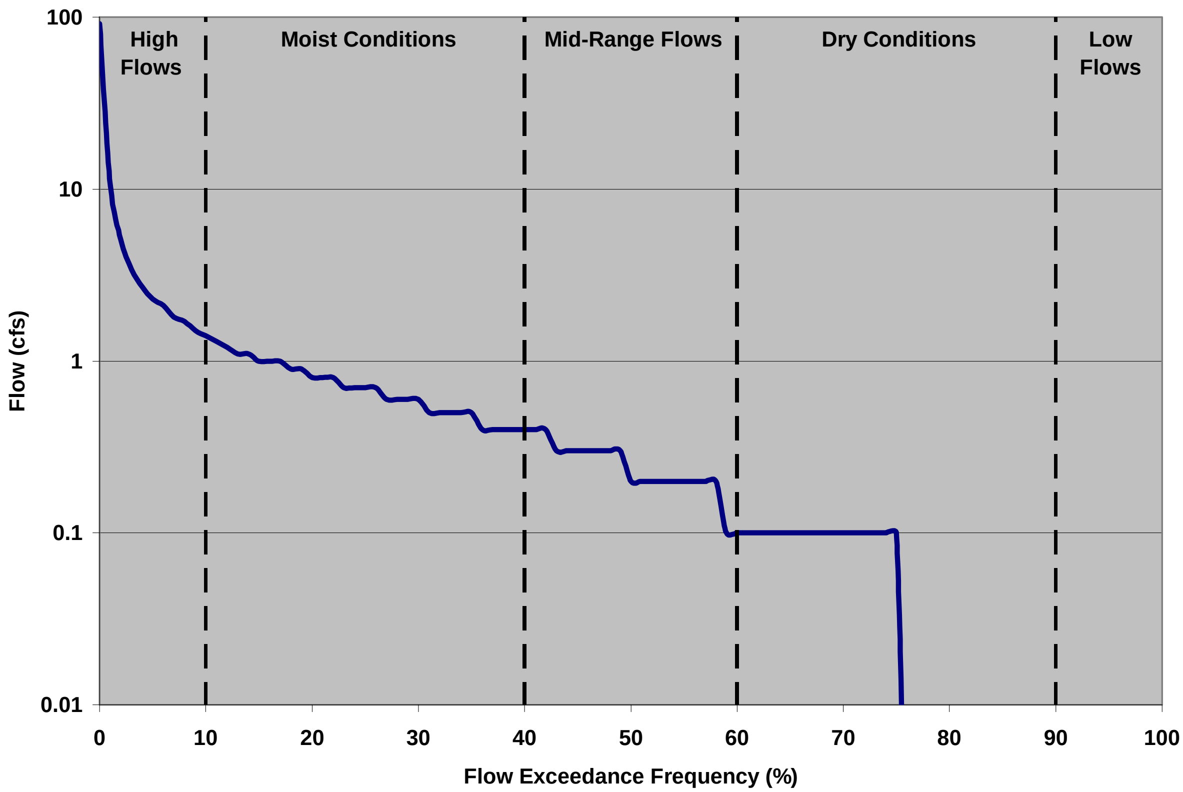
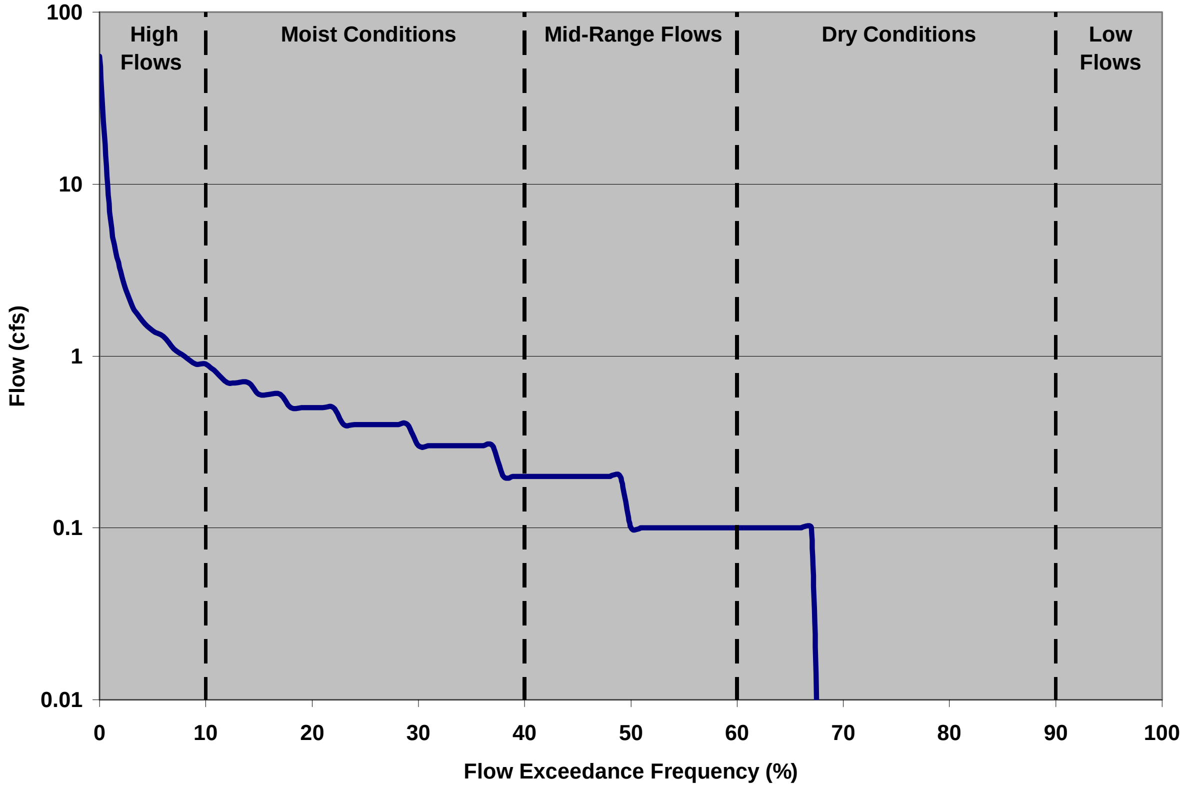


Figure 4-4 Flow Duration Curve for Trail Creek During PBCR Season



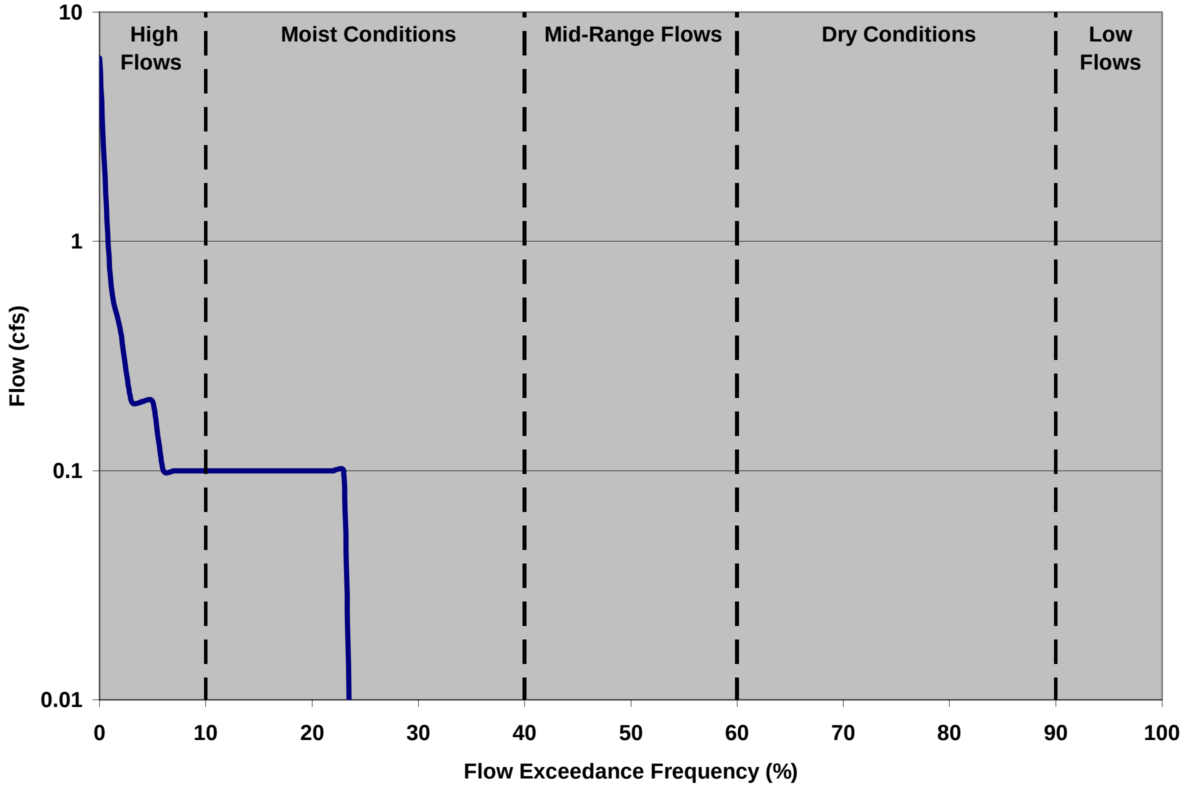
Note: The stepped curve is caused by extremely low flow conditions near the limit of quantitation, as well as data rounding conventions.

Figure 4-5 Flow Duration Curve for Lone Creek During PBCR Season



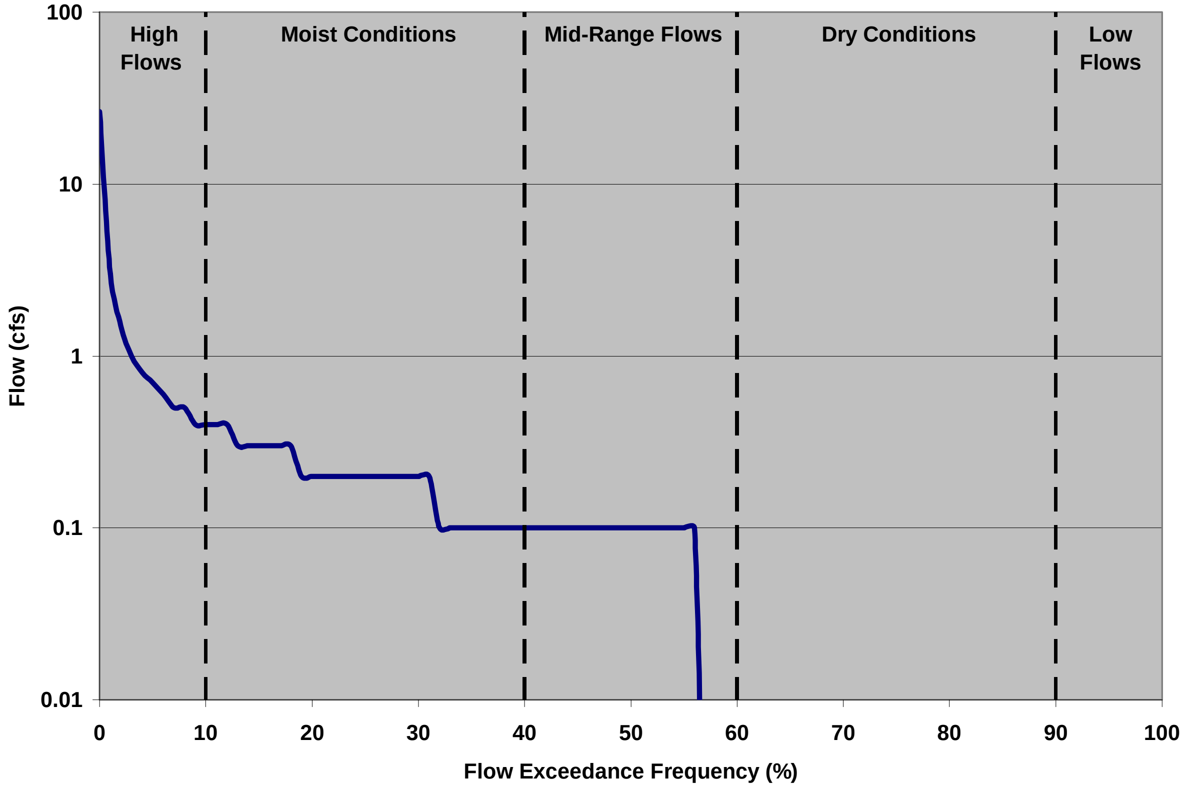
Note: The stepped curve is caused by extremely low flow conditions near the limit of quantitation, as well as data rounding conventions.

Figure 4-6 Flow Duration Curve for Red Trail Creek During PBCR Season



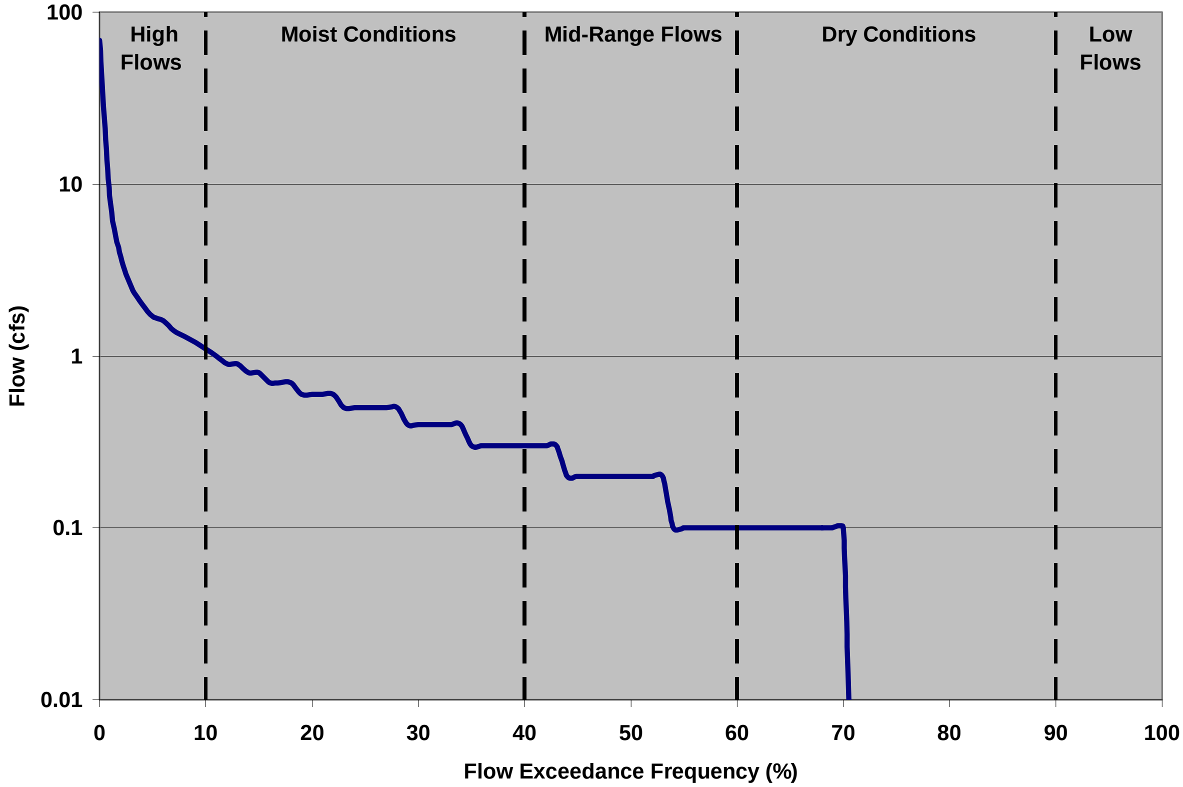
Note: The stepped curve is caused by extremely low flow conditions near the limit of quantitation, as well as data rounding conventions.

Figure 4-7 Flow Duration Curve for Red Creek During PBCR Season



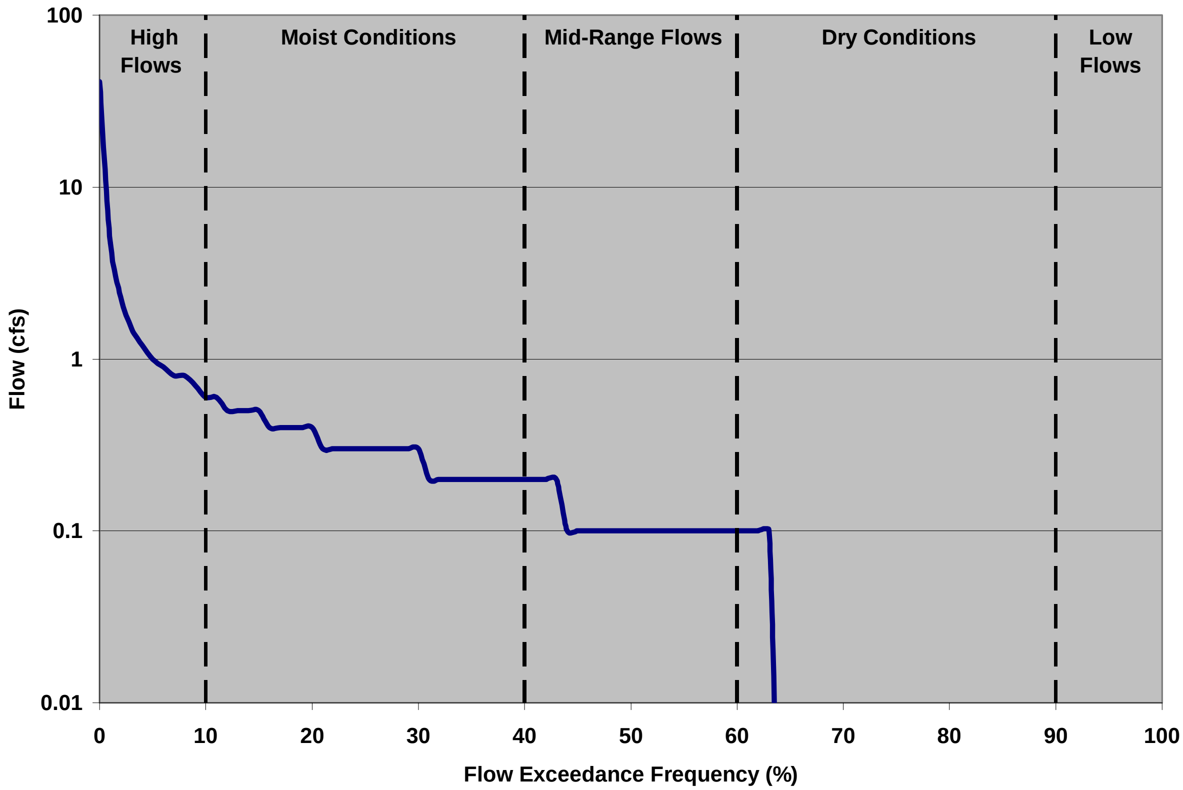
Note: The stepped curve is caused by extremely low flow conditions near the limit of quantitation, as well as data rounding conventions.

Figure 4-8 Flow Duration Curve for Hackberry Creek During PBCR Season



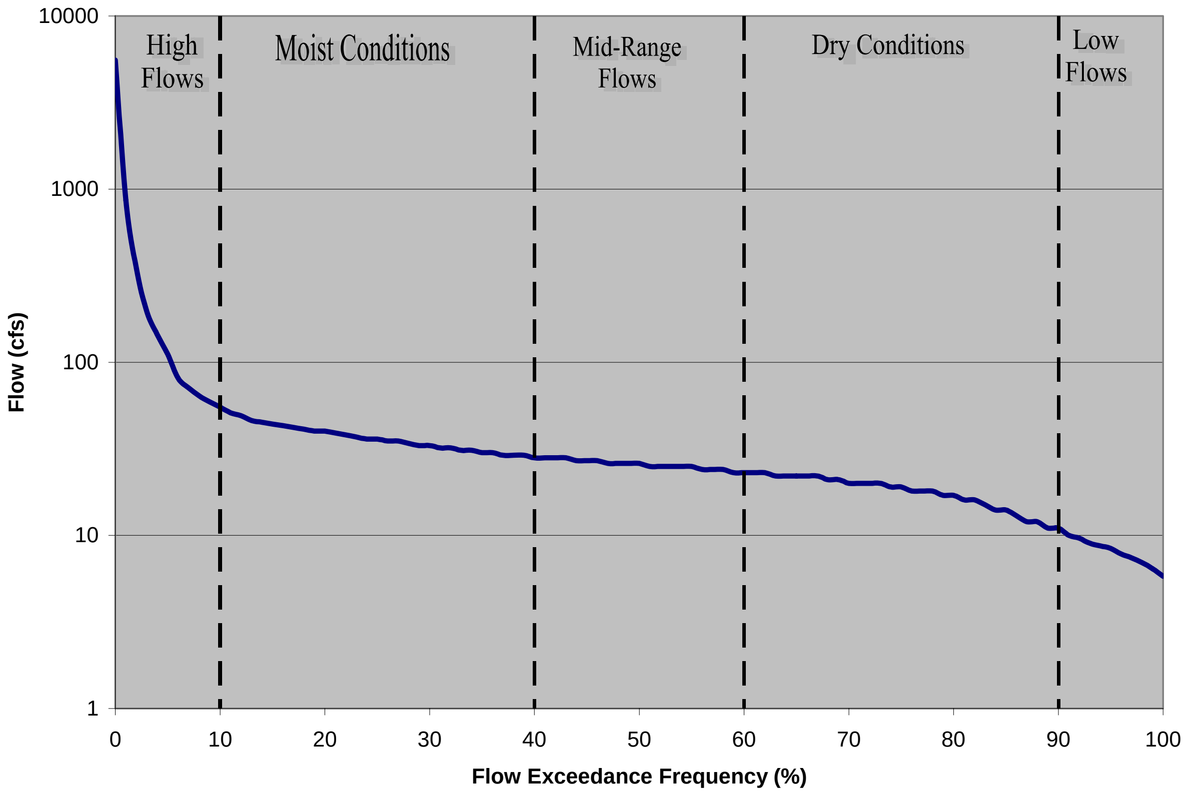
Note: The stepped curve is caused by extremely low flow conditions near the limit of quantitation, as well as data rounding conventions.

Figure 4-9 Flow Duration Curve for Commission Creek During PBCR Season



Note: The stepped curve is caused by extremely low flow conditions near the limit of quantitation, as well as data rounding conventions.

Figure 4-10 Flow Duration Curve for Deer Creek During PBCR Season



Flow duration curves can be subdivided into hydrologic condition classes to facilitate the diagnostic and analytical uses of flow and LDCs. The hydrologic classification scheme utilized in this application is similar to that described by Cleland (2003):

Table 4-1 Hydrologic Classification Scheme

Flow Duration Interval	Hydrologic Condition Class
0-10%	High flows
10-40%	Moist Conditions
40-60%	Mid-Range Conditions
60-90%	Dry Conditions
90-100%	Low Flows

Flow duration curves are generated using an ODEQ automated application referred to as the bacteria LDC toolbox. A step-by-step procedure on how to generate flow duration curves and flow exceedance percentiles are provided in Appendix C.

The USGS National Water Information System serves as the primary source of flow measurements for the application. 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 application. 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 grab measurements collected at the same site and time. When available, these instantaneous flow measurements were used in lieu of the daily average flow to calculate instantaneous bacteria loads.

4.3 Estimating Current Point and Nonpoint Loading

Another key step in the use of LDCs for TMDL development is the estimation of existing bacteria loading from point and nonpoint sources and the display of this loading in relation to the TMDL. In Oklahoma, WWTPs that discharge treated sanitary wastewater must meet the state WQSs for fecal bacteria at the point of discharge. However, for TMDL analysis it is necessary to understand the relative contribution of WWTPs to the overall pollutant loading and its general compliance with required effluent limits. The monthly bacteria load for continuous point source dischargers is estimated by multiplying the monthly average flow rates by the monthly geometric mean using a conversion factor. Data necessary for this calculation were extracted from each point source's available discharge monitoring reports from 1997 through 2005. The 90th percentile value of the monthly loads was used to express the estimated existing point source load in counts/day. The current pollutant loading from each permitted point source discharge is calculated using the equation below.

Point Source Loading = monthly average flow rates (mgd) * geometric mean of corresponding fecal coliform concentration * unit conversion factor

Where:

unit conversion factor = 37,854,120 100-ml/million gallons (mg)

It is difficult to estimate current nonpoint loading due to lack of specific water quality and flow information that would assist in estimating the relative proportion of non-specific sources within the watershed. Therefore, existing instream loads were used as a conservative surrogate for nonpoint loading. Existing instream loads were calculated as the 90th percentile of measured fecal coliform concentrations under each hydrologic condition class multiplied by the flow rate under various flow conditions.

4.4 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 bacteria loading 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, the ordinate is expressed in terms of a bacteria load in cfu per day (cfu/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 this 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;

matching the water quality observations with the flow data from the same date;

multiplying the flow by the water quality parameter concentration to calculate daily loads; then

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

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: WQC = 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

The flow exceedance frequency (x-value of each point) is obtained by looking up the historical exceedance frequency of the measured flow, in other words, the percent of historical observations that equal or exceed the measured flow. Historical observations of bacteria concentration are paired with flow data and are plotted on the LDC. 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) 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.

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 fecal coliform 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: Develop LDCs with MOS. An LDC depicting slightly lower estimates than the TMDL is developed to represent the TMDL with MOS. The MOS may be defined explicitly or implicitly. A typical explicit approach would reserve some fraction of the TMDL (*e.g.,* 10%) 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 the TMDLs in this report, an explicit MOS of 10 percent of the TMDL value (10% of the instantaneous water quality criterion) has been selected to slightly reduce assimilative capacity in the watershed. The MOS at any given percent flow exceedance, therefore, is defined as the difference in loading between the TMDL and the TMDL with MOS.

Step 3: Calculate WLA. As previously stated, the pollutant load allocation for point sources is defined by the WLA. 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 permitted stormwater discharges as point source discharges and, therefore, part of the WLA.

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. This 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).

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, wasteloads may be derived from NPDES permit limits. A WLA may be calculated for each active NPDES wastewater discharger using a mass balance approach as shown in the equation below. The permitted average flow rate used for each point source discharge and the water quality criterion concentration are used to estimate the WLA for each wastewater facility. All WLA values for each subwatershed are then summed to represent the total WLA for the watershed.

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

Where: WQC = 400 cfu /100 ml (Fecal coliform); 406 cfu/100 ml (E. coli); or 108 cfu/100 ml (Enterococci)

flow (mgd) = permitted flow or design flow (if unavailable)

unit conversion factor = 37,854,120 100-ml/mg

Step 4: Calculate LA. 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 – MOS - ∑WLA

However, to express the LA as an individual value, the LA is derived using the equation above but at the median point of the hydrologic condition class requiring the largest percent reduction as displayed in the LDCs provided in Appendix D. Thus, an alternate method for expressing the LA is to calculate a PRG for fecal coliform. LAs are calculated as percent reductions from current estimated loading levels required to meet water quality criteria.

Step 5: Estimate WLA Load Reduction. The WLA load reduction was not calculated as it was assumed that the continuous dischargers (NPDES permitted WWTPs) are adequately regulated under existing permits and, therefore, no WLA reduction would be required.

Step 6: Estimate LA Load Reduction. After existing loading estimates are computed for the three different hydrologic condition classes, nonpoint load reduction estimates for each WQM station are calculated by using the difference between estimated existing loading and the LDC (TMDL). This difference is expressed as a PRG and the hydrologic condition class with the largest percent reduction is selected as the critical condition and the overall PRG for the impaired waterbody.

SECTION 5
TMDL CALCULATIONS

5.1 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 water quality parameters. To accomplish this, available instream WQM data were evaluated with respect to flows and magnitude of water quality criteria exceedance using LDCs. While any given WQM station may be placed on the 303(d) list for exceedances of one or more of the three bacteria indicators, a TMDL will only be derived for one bacteria indicator based on whichever indicator necessitates the largest PRG to achieve WQS. For example, as summarized in Section 2, Bear Creek (OK520620010120G) has exceedances of the fecal coliform, *E. coli*, and *Enterococci* criteria (ODEQ 2004a). To determine which bacteria indicator for this WQM station will dictate the TMDL calculations, the critical conditions for each bacteria indicator must be derived to identify which bacteria indicator necessitates the largest PRG to achieve WQS.

To calculate the bacteria load at the WQS, the flow rate at each flow exceedance percentile is multiplied by a unit conversion factor (*24,465,525 ml*s / ft^3*day*) and the criterion specific to each bacteria indictor. 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 through October) from 1997 to 2003 are paired with the flows measured or estimated at the same site on the same date. Pollutant loads are then calculated by multiplying the measured bacteria concentration by the flow rate and a unit conversion factor of *24,465,525 ml*s / ft^3*day*. The associated flow exceedance percentile is then matched with the measured flow from the tables provided in Appendix C. 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 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 for each WQM site and bacterial indicator species as the percent reductions in load required in order that no more than 10% of the existing water quality observations would exceed the water quality target (i.e., the water quality criterion minus the MOS).

After existing loading and percent reductions are calculated for each bacteria indicator, the largest percent reduction required dictates the indicator bacteria species and WQM station that will be used to derive the TMDL for each waterbody. This is because for the contact recreation use to be supported, criteria for each indicator species must be met at each WQM station in the waterbody. Table 5-1 presents the percent reductions necessary for each bacteria indicator at each of the WQM stations in the project area. Based on this table, the TMDL for Canadian River segment OK520620010010 will be based on the LDC for fecal coliform at station OK520620010010G, and for all other waterbodies the TMDL PRGs will be based on *Enterococci*. It appears that the water quality criterion for *Enterococci* is generally the most difficult to attain.

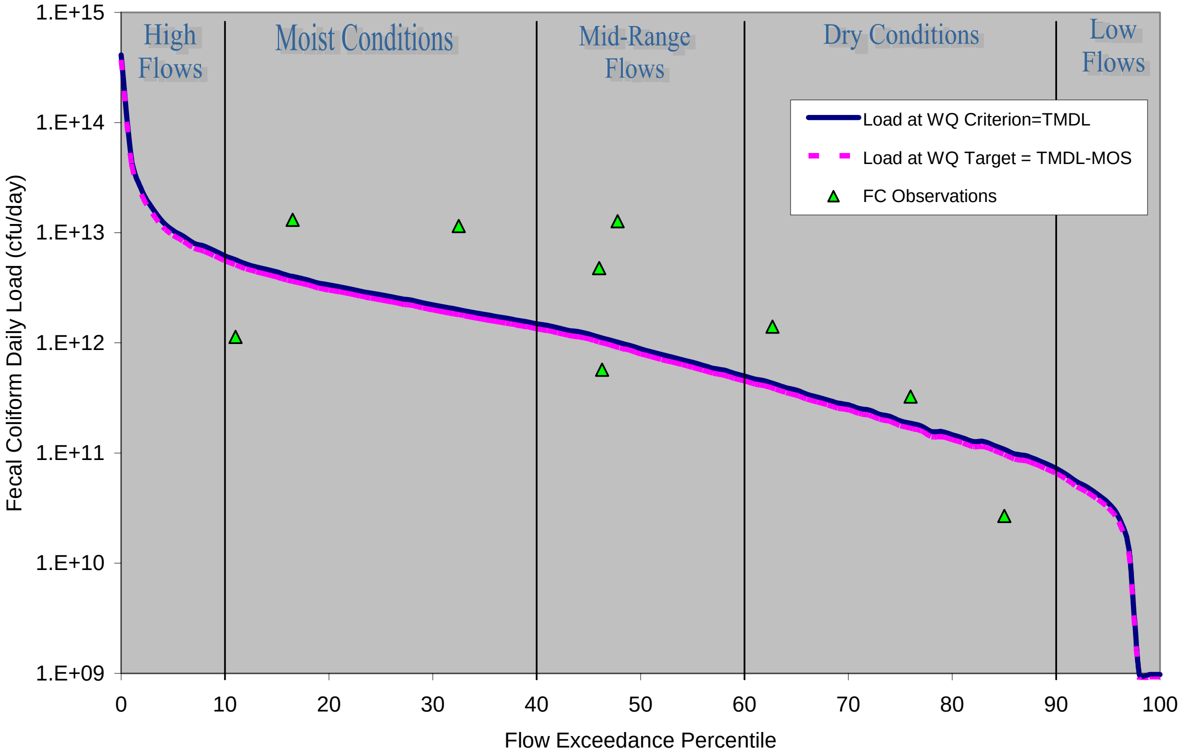
Table 5-1 TMDL Percent Reductions Required to Meet Water Quality Standards for WQM Stations in the Canadian River Watershed

Waterbody ID	WQM Station	Waterbody Name	Percent Reduction Required		
			FC	EC	ENT
OK520620010010	OK520620010010G	Canadian River	84%	NA[1]	NA[1]
OK520620010010	OK520620010010K	Canadian River	72%	NA[1]	NA[1]
OK520620010010	OK520620010010P	Canadian River	60%	NA[1]	NA[1]
OK520620010010	OK520620010010S	Canadian River	72%	NA[1]	NA[1]
OK520620010120	OK520620010120G	Bear Creek	93%	13%	98%
OK520620020010	OK520620020010-001AT	Canadian River	82%	NA[2]	96%
OK520620020090	OK520620020090G	Trail Creek	13%	41%	90%
OK520620030020	OK520620030020C	Lone Creek	NA[1]	72%	89%
OK520620030050	OK520620030050G	Red Trail Creek	67%	29%	98%
OK520620030110	OK520620030110G	Red Creek	55%	0%	81%
OK520620040050	OK520620040050D	Hackberry Creek	NA[1]	62%	81%
OK520620050160	OK520620050160C	Commission Creek	NA[1]	0%	51%
OK520620060010	OK520620060010F	Deer Creek	NA[1]	78%	82%

[1] Monitoring data insufficient to determine attainment status
[2] Not Impaired

LDCs for each waterbody (for the contact recreation season from 1997 through 20003) for the WQM stations and indicator bacteria species with the largest PRGs, are shown in Figures 5-1 through 5-10. They indicate that actual fecal coliform and *Enterococci* loads are exceeding the instantaneous load of the WQS during all flow conditions, indicative of nonpoint sources. The LDCs for other WQM stations and indicator bacteria, those that the TMDLs are <u>not</u> based on, are provided in Appendix D.

Figure 5-1 Load Duration Curve for Fecal Coliform in the Canadian River at Station OK520620010010G



* there is no wasteload allocation for this waterbody

Figure 5-2 Load Duration Curve for *Enterococci* in the Canadian River at Station OK520620020010-001AT

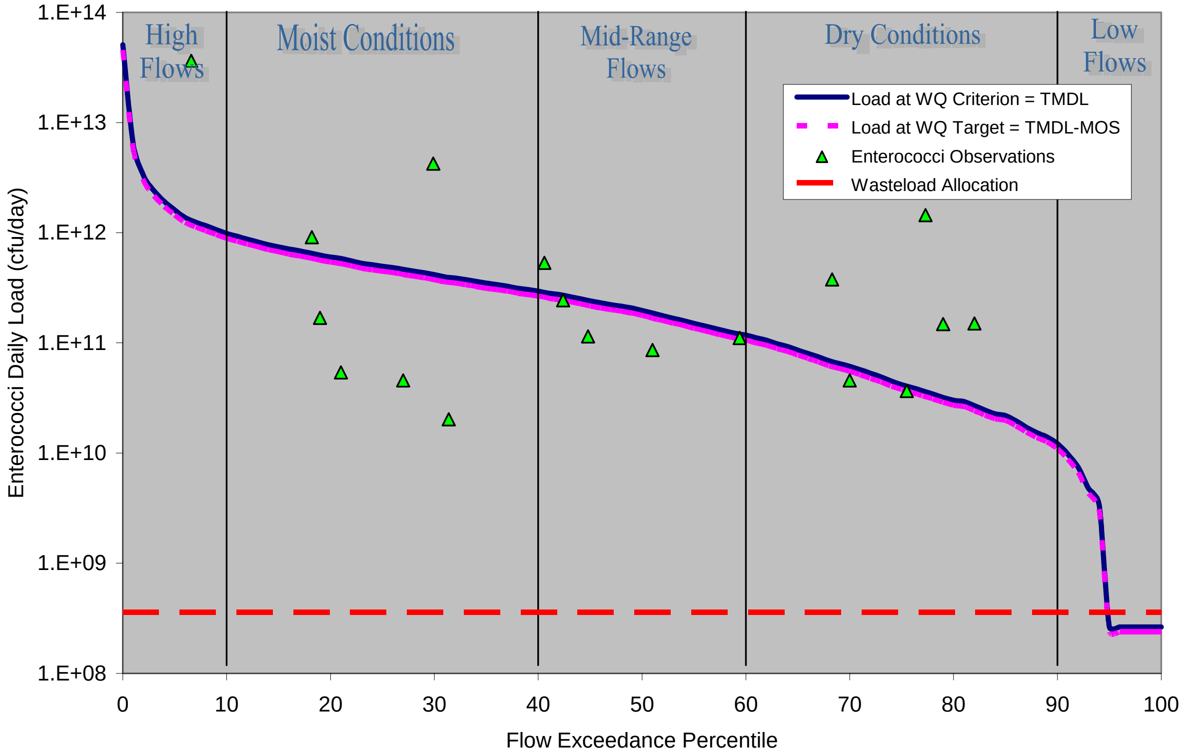
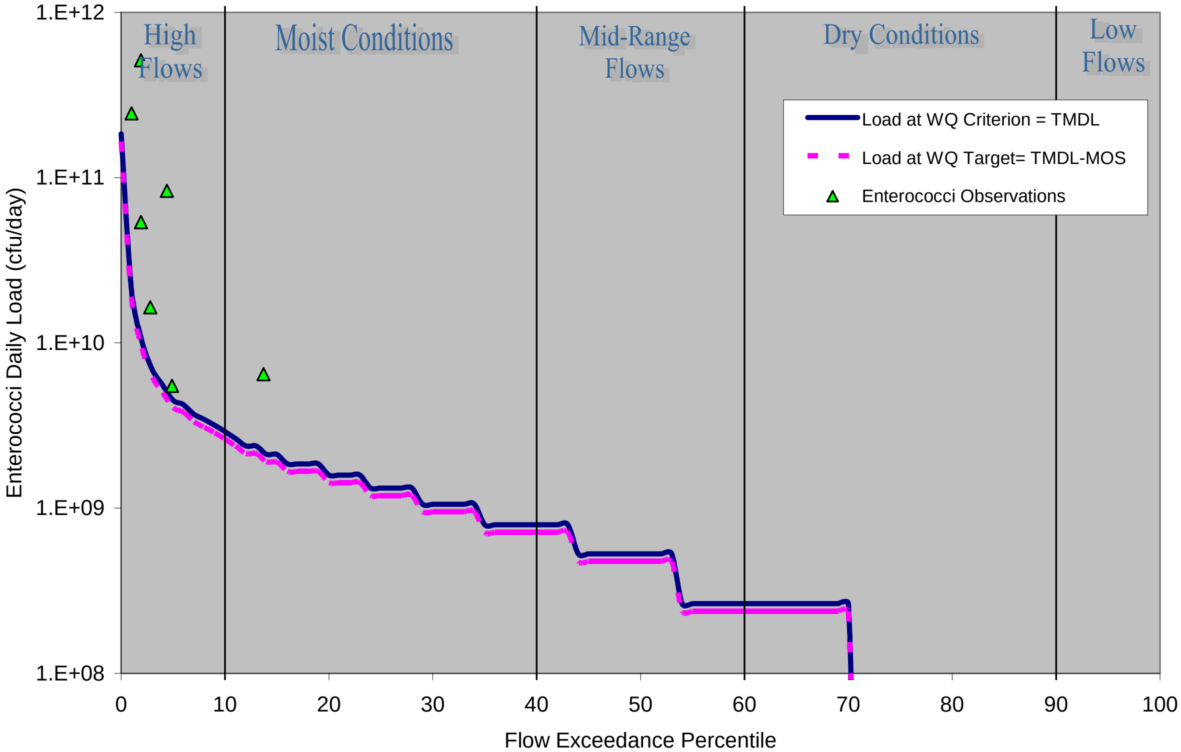
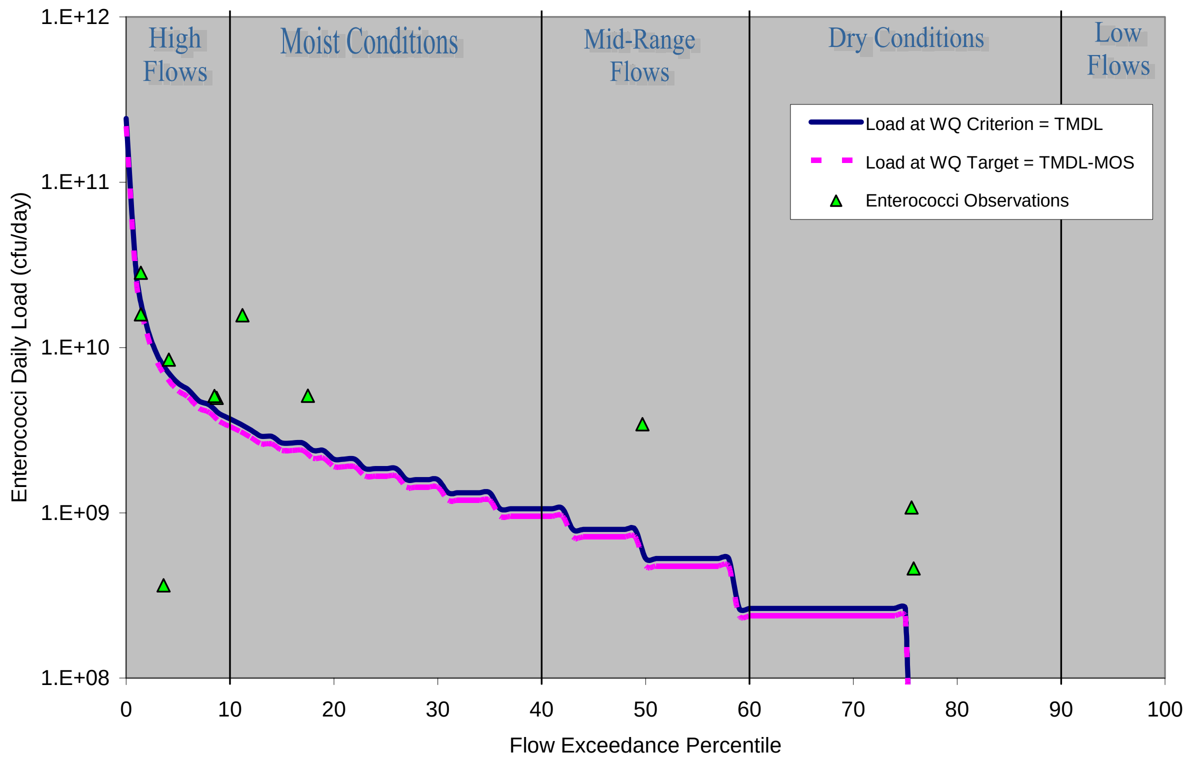


Figure 5-3 Load Duration Curve for *Enterococci* in Bear Creek at Station OK520620010120G



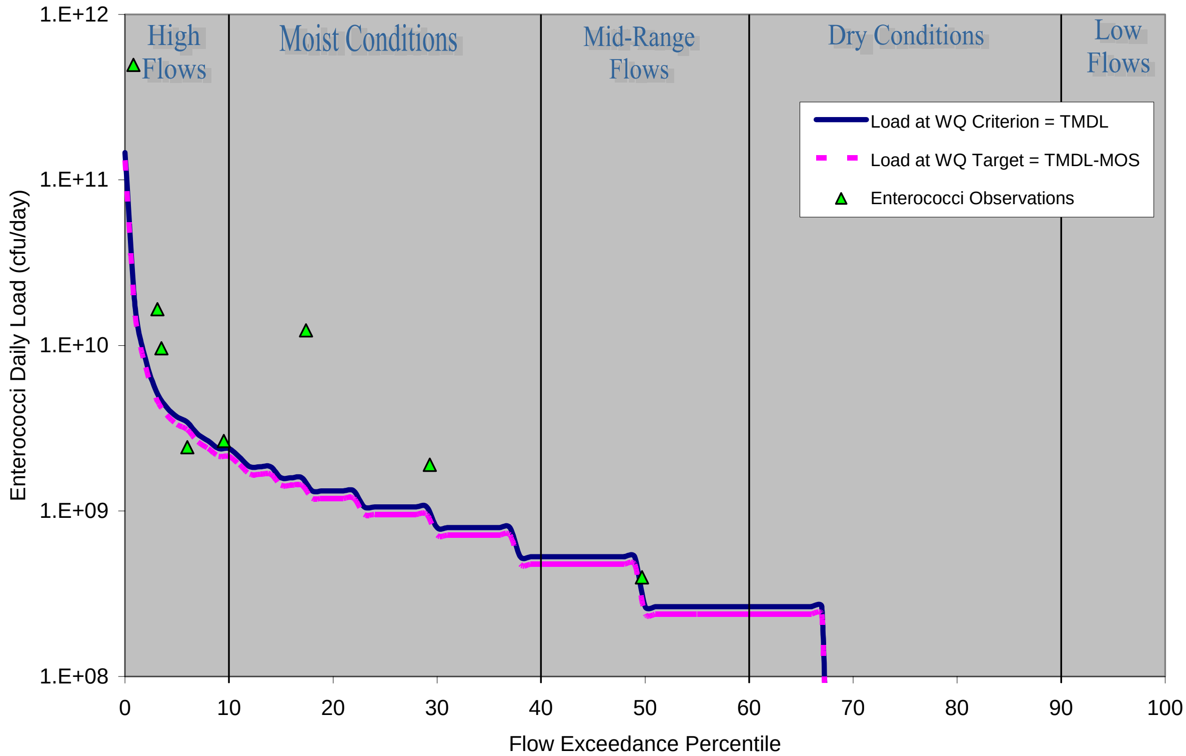
* there is no wasteload allocation for this waterbody

Figure 5-4 Load Duration Curve for *Enterococci* in Trail Creek at Station OK520620020090G



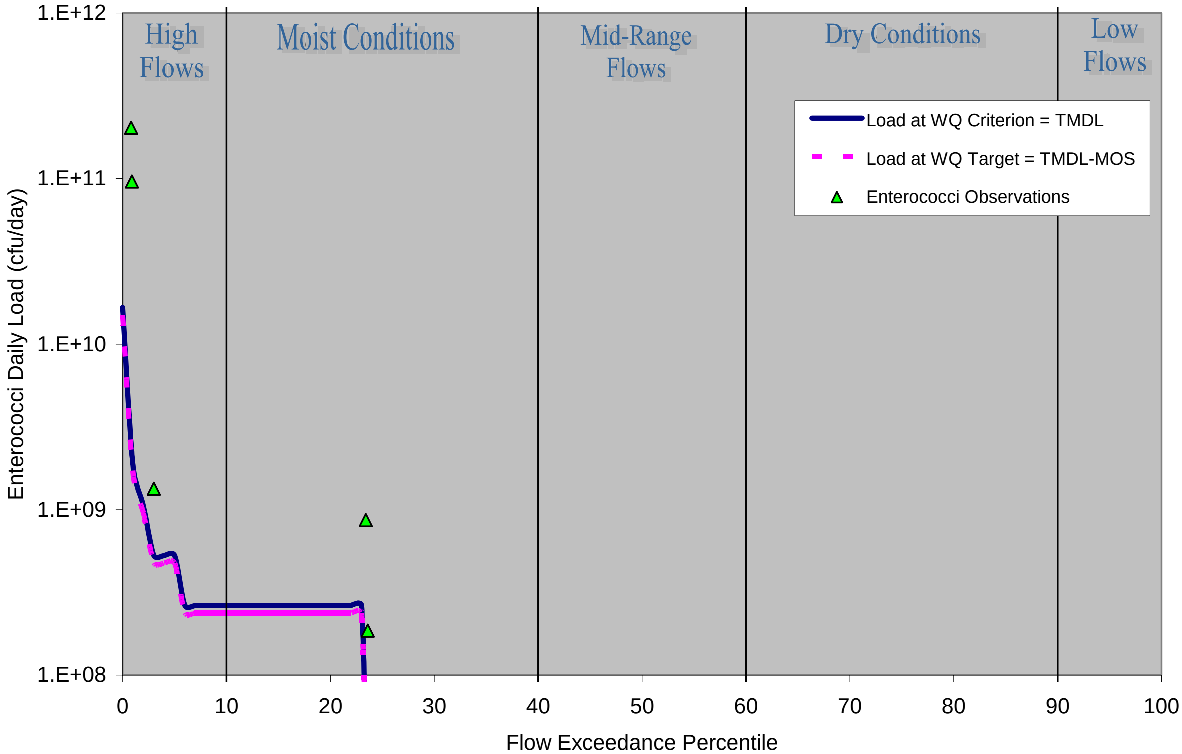
* there is no wasteload allocation for this waterbody

Figure 5-5 Load Duration Curve for *Enterococci* in Lone Creek at Station OK520620030020C



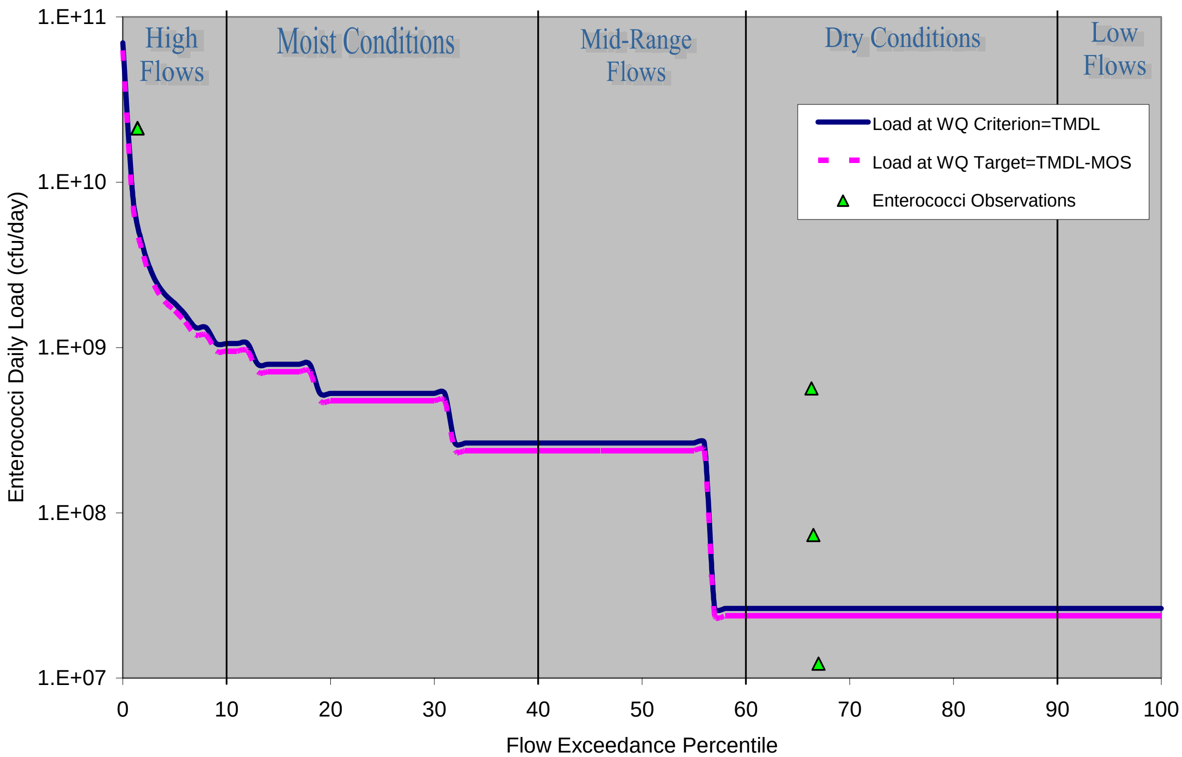
* there is no wasteload allocation for this waterbody

Figure 5-6 Load Duration Curve for *Enterococci* in Red Trail Creek at Station OK520620030050G



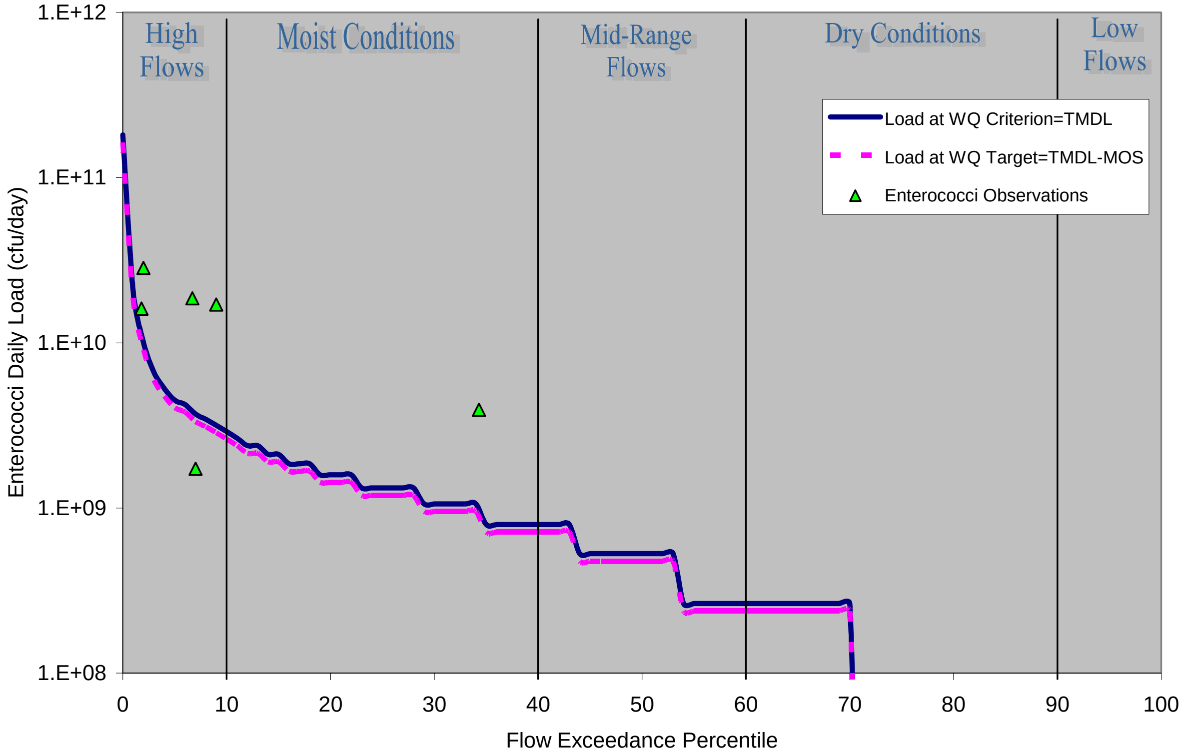
* there is no wasteload allocation for this waterbody

Figure 5-7 Load Duration Curve for *Enterococci* in Red Creek at Station OK520620030110G



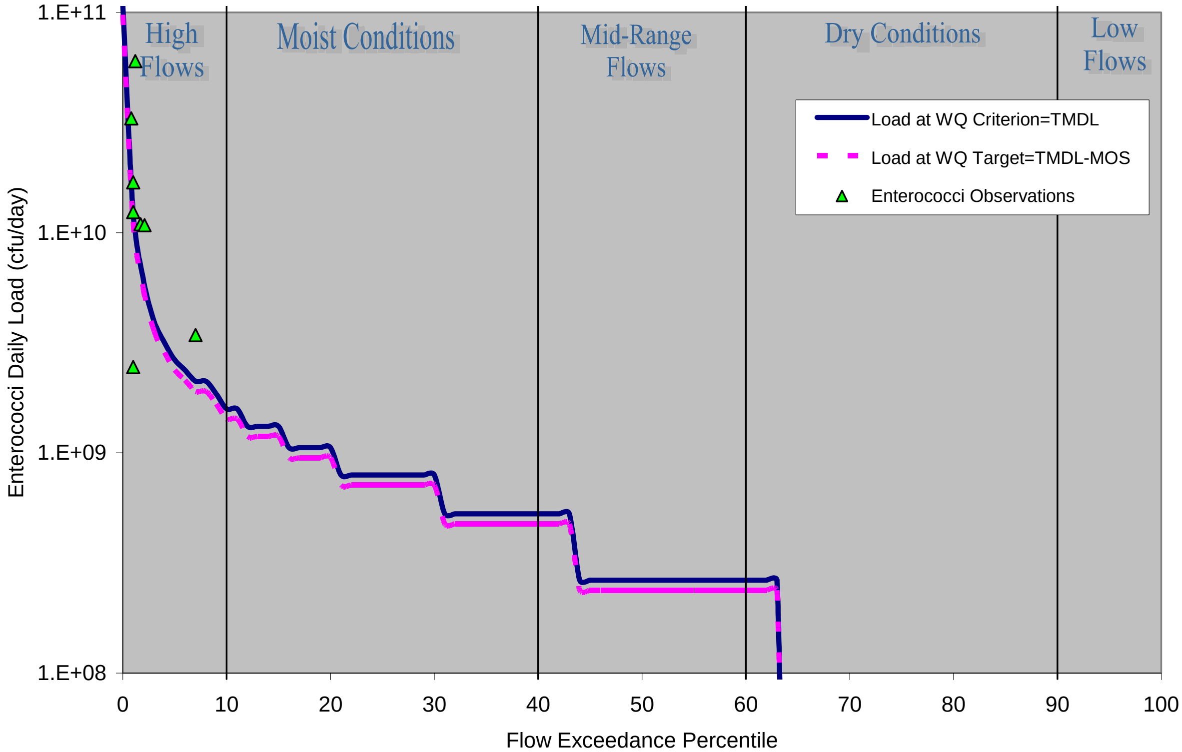
* there is no wasteload allocation for this waterbody

Figure 5-8 Load Duration Curve for *Enterococci* in Hackberry Creek at Station OK520620040050D



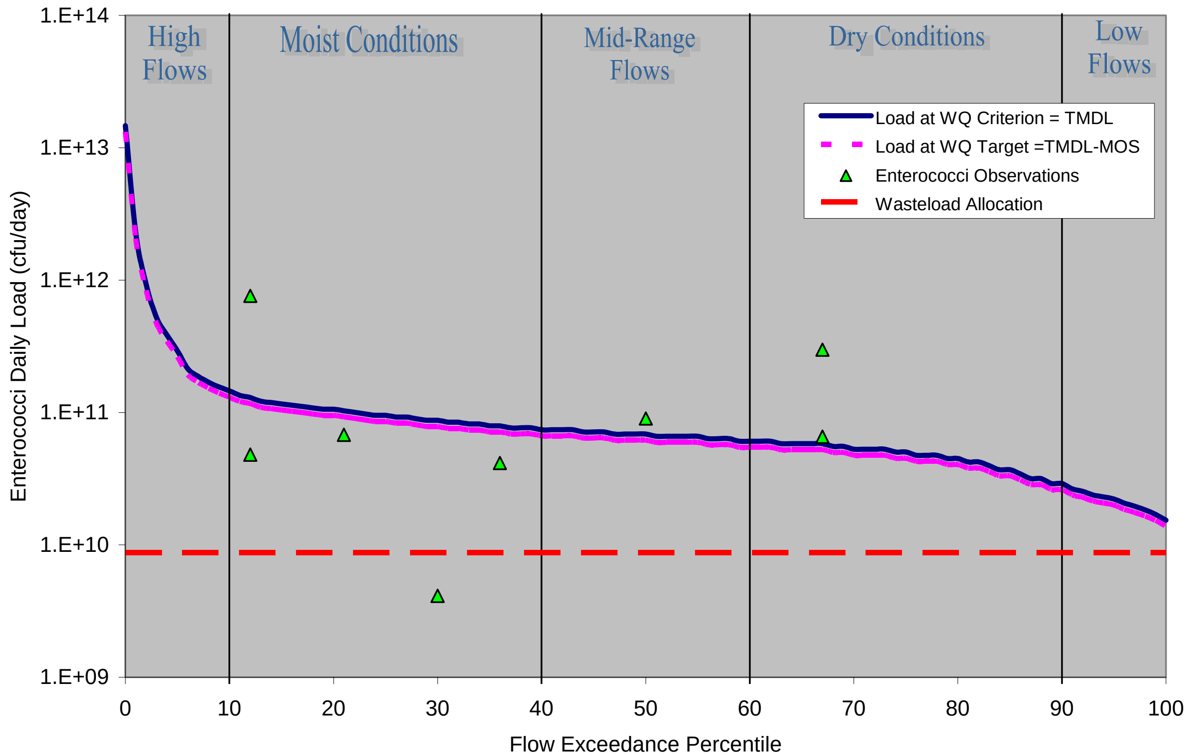
* there is no wasteload allocation for this waterbody

Figure 5-9 Load Duration Curve for *Enterococci* in Commission Creek at Station OK520620050160C



* there is no wasteload allocation for this waterbody

Figure 5-10 Load Duration Curve for *Enterococci* in Deer Creek at Station OK520620060010F



5.2 Waste Load Allocation

NPDES permitted facilities are allocated a daily wasteload calculated as their permitted daily average discharge flow rate multiplied by the instream single-sample water quality criterion. In other words, the facilities are required to meet instream criteria in their discharge. Table 5-2 summarizes the WLA of the NPDES-permitted facilities within the Canadian River watershed. The WLA for each facility is derived from the following equation:

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

Where:

WQS = 108, 400, and 406 cfu/100ml for Enterococci, fecal coliform, and E. coli respectively

flow (cfs) = permitted flow

unit conversion factor = 37,854,120 100-ml/mg

Table 5-2 Wasteload Allocations for NPDES Permitted Facilities

Waterbody ID	NPDES Permit Number	Flow	Wasteload Allocation (cfu/day)		
			Fecal Coliform	*E. coli*	*Enterococci*
OK520620020010 Canadian River	OK0038971	0.09	1.33E+09	1.35E+09	3.60E+08
OK520620060010 Deer Creek	OK0021563	2.00	3.03E+10	3.07E+10	8.17E+09
	OK0028185	0.14	2.12E+09	2.15E+09	5.72E+08

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.

Permitted stormwater discharges are considered as point sources. However, there is no permitted stormwater discharges in the study watershed.

5.3 Load Allocation

As discussed in Section 3, nonpoint source bacteria loading to the receiving streams of each waterbody emanate from a number of different sources. The data analysis and the LDCs demonstrate that exceedances at the WQM stations are the result of a variety of nonpoint source loading. The LAs for each stream segment are calculated as the difference between the TMDL, MOS, and WLA as follows:

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

Where TMDL can be calculated based on the bacteria standards and flow rate in the stream.

5.4 Seasonal Variability

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs account for seasonal variation in watershed conditions and pollutant loading. The 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 through September 30. Seasonal variation was also accounted for in these TMDLs by using more than 5 years of water quality data by using the longest period of USGS flow records when estimating flows to develop flow exceedance percentiles.

5.5 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 uncertainty associated with calculating the allowable fecal coliform pollutant loading to ensure WQSs are attained. USEPA guidance allows for use of implicit or explicit expressions of the MOS, or both. When conservative assumptions are used in development of the TMDL, or conservative factors are used in the calculations, the MOS is implicit. When a specific percentage of the TMDL is set aside to account for uncertainty, then the MOS is considered explicit.

For the explicit MOS the water quality target was set at 10 percent lower than the water quality criterion for each pathogen which equates to 360 cfu/100 ml, 365.4 cfu/100 ml, and 97.2/100 ml for fecal coliform, *E. coli*, and *Enterococci,* respectively. The net effect of the TMDL with MOS is that the assimilative capacity or allowable pollutant loading of each waterbody is slightly reduced. These TMDLs incorporate an explicit MOS by using a curve representing 90 percent of the TMDL as the average MOS. The MOS at any given percent flow exceedance, therefore, can be defined as the difference in loading between the TMDL and the TMDL with MOS. For consistency, the explicit MOS at each WQM station will be expressed as a numerical value derived from the same critical condition as the largest load reduction goal (see Table 5-3).

There are other conservative elements utilized in these TMDLs that can be recognized as an implicit MOS such as:

The use of in stream bacteria concentrations to estimate existing loading; and

The highest PRG for nonpoint sources.

This conservative approach to establishing the MOS will ensure that both the 30-day geometric mean and instantaneous bacteria standards can be achieved and maintained.

5.6 TMDL Calculations

The bacteria TMDLs for the 303(d)-listed WQM stations 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 uncertainty 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 stream segment the TMDLs presented in this report are expressed as a percent reduction across the full range of flow conditions. The TMDL, WLA, LA, and MOS will vary with flow condition, and are calculated at every 5% flow interval (Table 5-3 through 5-32). The TMDL for Deer Creek is expressed graphically with annotations in Figure 5-11. For illustrative purposes, the TMDL, WLA, LA, and MOS are calculated for the median flow at each site in Table 5-3. The WLA component of each TMDL is the sum of all WLAs within the contributing watershed of each WQM station. The sum of the WLAs can be represented as a single line below the LDC. The LDC and the simple equation of:

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

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. Percent reductions necessary to achieve the water quality target are also provided for all WQM stations as another acceptable representation of the TMDL. Appendix D presents the LDCs for the WQM stations on the Canadian River, Bear Creek, Trail Creek, Lone Creek, Red Trail Creek, Red Creek, Hackberry Creek, Commission Creek, and Deer Creek depicting the TMDL, MOS, and WLA (if applicable).

Figure 5-11 Annotated TMDL for Enterococci in Deer Creek

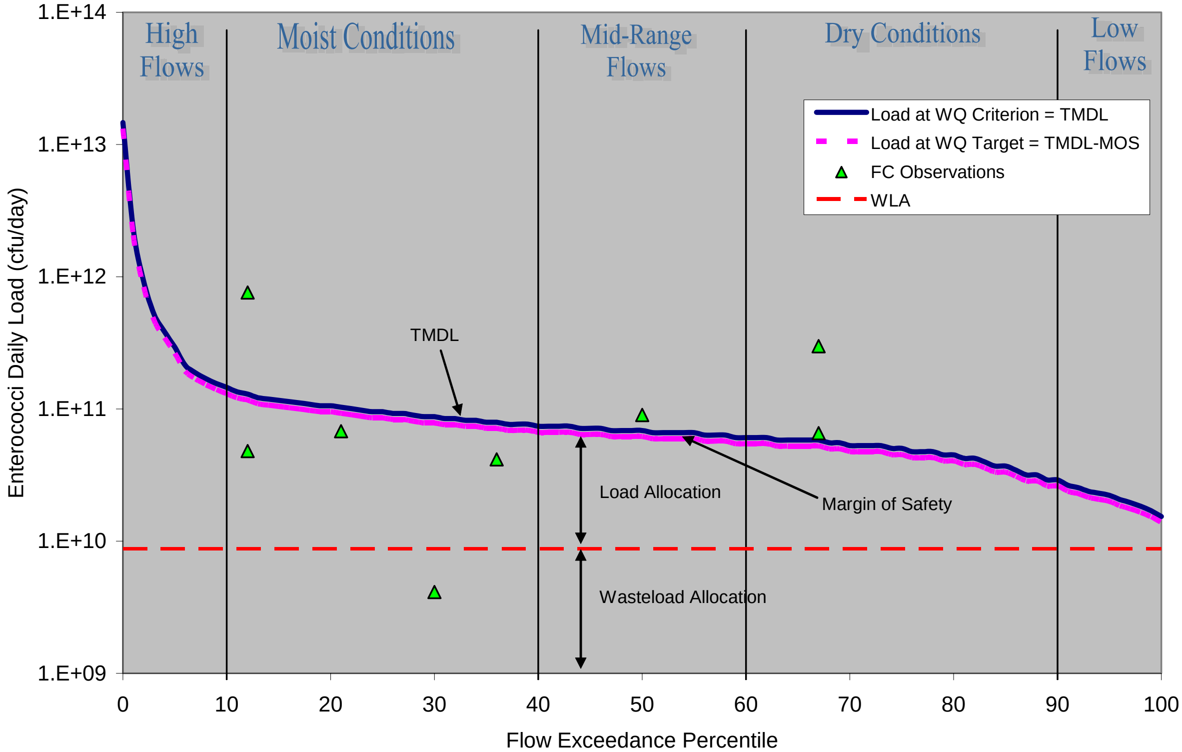


Table 5-3 Fecal Coliform TMDL Calculations for Canadian River (OK520620010010)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	42100.0	4.12E+14	1.33E+09	3.71E+14	4.12E+13
5	1070.0	1.05E+13	1.33E+09	9.42E+12	1.05E+12
10	629.0	6.16E+12	1.33E+09	5.54E+12	6.16E+11
15	450.0	4.40E+12	1.33E+09	3.96E+12	4.40E+11
20	343.0	3.36E+12	1.33E+09	3.02E+12	3.36E+11
25	279.0	2.73E+12	1.33E+09	2.46E+12	2.73E+11
30	226.0	2.21E+12	1.33E+09	1.99E+12	2.21E+11
35	185.0	1.81E+12	1.33E+09	1.63E+12	1.81E+11
40	152.0	1.49E+12	1.33E+09	1.34E+12	1.49E+11
45	123.0	1.20E+12	1.33E+09	1.08E+12	1.20E+11
50	90.0	8.81E+11	1.33E+09	7.91E+11	8.81E+10
55	68.0	6.65E+11	1.33E+09	5.98E+11	6.65E+10
60	51.0	4.99E+11	1.33E+09	4.48E+11	4.99E+10
65	38.0	3.72E+11	1.33E+09	3.33E+11	3.72E+10
70	28.0	2.74E+11	1.33E+09	2.45E+11	2.74E+10
75	20.0	1.96E+11	1.33E+09	1.75E+11	1.96E+10
80	15.0	1.47E+11	1.33E+09	1.31E+11	1.47E+10
85	11.0	1.08E+11	1.33E+09	9.56E+10	1.08E+10
90	7.4	7.24E+10	1.33E+09	6.38E+10	7.24E+09
95	3.6	3.52E+10	1.33E+09	3.04E+10	3.52E+09
100	0.0	N/A	N/A	N/A	N/A

Table 5-4 E. Coli TMDL Calculations for Canadian River (OK52062010010)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	42100.0	4.18E+14	1.35E+09	3.76E+14	4.18E+13
5	1070.0	1.06E+13	1.35E+09	9.56E+12	1.06E+12
10	629.0	6.25E+12	1.35E+09	5.62E+12	6.25E+11
15	450.0	4.47E+12	1.35E+09	4.02E+12	4.47E+11
20	343.0	3.41E+12	1.35E+09	3.06E+12	3.41E+11
25	279.0	2.77E+12	1.35E+09	2.49E+12	2.77E+11
30	226.0	2.24E+12	1.35E+09	2.02E+12	2.24E+11
35	185.0	1.84E+12	1.35E+09	1.65E+12	1.84E+11
40	152.0	1.51E+12	1.35E+09	1.36E+12	1.51E+11
45	123.0	1.22E+12	1.35E+09	1.10E+12	1.22E+11
50	90.0	8.94E+11	1.35E+09	8.03E+11	8.94E+10
55	68.0	6.75E+11	1.35E+09	6.07E+11	6.75E+10
60	51.0	5.07E+11	1.35E+09	4.55E+11	5.07E+10
65	38.0	3.77E+11	1.35E+09	3.38E+11	3.77E+10
70	28.0	2.78E+11	1.35E+09	2.49E+11	2.78E+10
75	20.0	1.99E+11	1.35E+09	1.77E+11	1.99E+10
80	15.0	1.49E+11	1.35E+09	1.33E+11	1.49E+10
85	11.0	1.09E+11	1.35E+09	9.70E+10	1.09E+10
90	7.4	7.35E+10	1.35E+09	6.48E+10	7.35E+09
95	3.6	3.58E+10	1.35E+09	3.08E+10	3.58E+09
100	0.0	N/A	N/A	N/A	N/A

Table 5-5 Enterococci TMDL Calculations for Canadian River (OK52062010010)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	42100.0	1.11E+14	3.60E+08	1.00E+14	1.11E+13
5	1070.0	2.83E+12	3.60E+08	2.54E+12	2.83E+11
10	629.0	1.66E+12	3.60E+08	1.50E+12	1.66E+11
15	450.0	1.19E+12	3.60E+08	1.07E+12	1.19E+11
20	343.0	9.06E+11	3.60E+08	8.15E+11	9.06E+10
25	279.0	7.37E+11	3.60E+08	6.63E+11	7.37E+10
30	226.0	5.97E+11	3.60E+08	5.37E+11	5.97E+10
35	185.0	4.89E+11	3.60E+08	4.40E+11	4.89E+10
40	152.0	4.02E+11	3.60E+08	3.61E+11	4.02E+10
45	123.0	3.25E+11	3.60E+08	2.92E+11	3.25E+10
50	90.0	2.38E+11	3.60E+08	2.14E+11	2.38E+10
55	68.0	1.80E+11	3.60E+08	1.61E+11	1.80E+10
60	51.0	1.35E+11	3.60E+08	1.21E+11	1.35E+10
65	38.0	1.00E+11	3.60E+08	9.00E+10	1.00E+10
70	28.0	7.40E+10	3.60E+08	6.62E+10	7.40E+09
75	20.0	5.28E+10	3.60E+08	4.72E+10	5.28E+09
80	15.0	3.96E+10	3.60E+08	3.53E+10	3.96E+09
85	11.0	2.91E+10	3.60E+08	2.58E+10	2.91E+09
90	7.4	1.96E+10	3.60E+08	1.72E+10	1.96E+09
95	3.6	9.51E+09	3.60E+08	8.20E+09	9.51E+08
100	0.0	N/A	N/A	N/A	N/A

Table 5-6 Fecal Coliform TMDL Calculations for Bear Creek (OK52062010120)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	69.3	6.78E+11	0	6.10E+11	6.78E+10
5	1.7	1.66E+10	0	1.50E+10	1.66E+09
10	1.1	1.08E+10	0	9.69E+09	1.08E+09
15	0.8	7.83E+09	0	7.05E+09	7.83E+08
20	0.6	5.87E+09	0	5.28E+09	5.87E+08
25	0.5	4.89E+09	0	4.40E+09	4.89E+08
30	0.4	3.91E+09	0	3.52E+09	3.91E+08
35	0.3	2.94E+09	0	2.64E+09	2.94E+08
40	0.3	2.94E+09	0	2.64E+09	2.94E+08
45	0.2	1.96E+09	0	1.76E+09	1.96E+08
50	0.2	1.96E+09	0	1.76E+09	1.96E+08
55	0.1	9.79E+08	0	8.81E+08	9.79E+07
60	0.1	9.79E+08	0	8.81E+08	9.79E+07
65	0.1	9.79E+08	0	8.81E+08	9.79E+07
70	0.1	9.79E+08	0	8.81E+08	9.79E+07
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-7 E. Coli TMDL Calculations for Bear Creek (OK52062010120)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	69.3	6.88E+11	0	6.20E+11	6.88E+10
5	1.7	1.69E+10	0	1.52E+10	1.69E+09
10	1.1	1.09E+10	0	9.83E+09	1.09E+09
15	0.8	7.95E+09	0	7.15E+09	7.95E+08
20	0.6	5.96E+09	0	5.36E+09	5.96E+08
25	0.5	4.97E+09	0	4.47E+09	4.97E+08
30	0.4	3.97E+09	0	3.58E+09	3.97E+08
35	0.3	2.98E+09	0	2.68E+09	2.98E+08
40	0.3	2.98E+09	0	2.68E+09	2.98E+08
45	0.2	1.99E+09	0	1.79E+09	1.99E+08
50	0.2	1.99E+09	0	1.79E+09	1.99E+08
55	0.1	9.93E+08	0	8.94E+08	9.93E+07
60	0.1	9.93E+08	0	8.94E+08	9.93E+07
65	0.1	9.93E+08	0	8.94E+08	9.93E+07
70	0.1	9.93E+08	0	8.94E+08	9.93E+07
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-8 Enterococci TMDL Calculations for Bear Creek (OK52062010120)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	69.3	1.83E+11	0	1.65E+11	1.83E+10
5	1.7	4.49E+09	0	4.04E+09	4.49E+08
10	1.1	2.91E+09	0	2.62E+09	2.91E+08
15	0.8	2.11E+09	0	1.90E+09	2.11E+08
20	0.6	1.59E+09	0	1.43E+09	1.59E+08
25	0.5	1.32E+09	0	1.19E+09	1.32E+08
30	0.4	1.06E+09	0	9.51E+08	1.06E+08
35	0.3	7.93E+08	0	7.13E+08	7.93E+07
40	0.3	7.93E+08	0	7.13E+08	7.93E+07
45	0.2	5.28E+08	0	4.76E+08	5.28E+07
50	0.2	5.28E+08	0	4.76E+08	5.28E+07
55	0.1	2.64E+08	0	2.38E+08	2.64E+07
60	0.1	2.64E+08	0	2.38E+08	2.64E+07
65	0.1	2.64E+08	0	2.38E+08	2.64E+07
70	0.1	2.64E+08	0	2.38E+08	2.64E+07
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-9 Fecal Coliform TMDL Calculations for Canadian River (OK520620020010)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	19224.1	1.88E+14	1.33E+09	1.69E+14	1.88E+13
5	525.2	5.14E+12	1.33E+09	4.62E+12	5.14E+11
10	351.1	3.44E+12	1.33E+09	3.09E+12	3.44E+11
15	275.7	2.70E+12	1.33E+09	2.43E+12	2.70E+11
20	231.8	2.27E+12	1.33E+09	2.04E+12	2.27E+11
25	203.8	1.99E+12	1.33E+09	1.79E+12	1.99E+11
30	181.1	1.77E+12	1.33E+09	1.59E+12	1.77E+11
35	158.1	1.55E+12	1.33E+09	1.39E+12	1.55E+11
40	139.3	1.36E+12	1.33E+09	1.23E+12	1.36E+11
45	123.5	1.21E+12	1.33E+09	1.09E+12	1.21E+11
50	108.7	1.06E+12	1.33E+09	9.56E+11	1.06E+11
55	93.9	9.19E+11	1.33E+09	8.26E+11	9.19E+10
60	81.3	7.96E+11	1.33E+09	7.15E+11	7.96E+10
65	67.3	6.59E+11	1.33E+09	5.91E+11	6.59E+10
70	54.7	5.35E+11	1.33E+09	4.80E+11	5.35E+10
75	39.9	3.90E+11	1.33E+09	3.50E+11	3.90E+10
80	26.3	2.57E+11	1.33E+09	2.30E+11	2.57E+10
85	17.8	1.74E+11	1.33E+09	1.55E+11	1.74E+10
90	11.6	1.14E+11	1.33E+09	1.01E+11	1.14E+10
95	5.8	5.68E+10	1.33E+09	4.98E+10	5.68E+09
100	0.0	N/A	N/A	N/A	N/A

Table 5-10 E. Coli TMDL Calculations for Canadian River (OK520620020010)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	19224.1	1.91E+14	1.35E+09	1.72E+14	1.91E+13
5	525.2	5.22E+12	1.35E+09	4.69E+12	5.22E+11
10	351.1	3.49E+12	1.35E+09	3.14E+12	3.49E+11
15	275.7	2.74E+12	1.35E+09	2.46E+12	2.74E+11
20	231.8	2.30E+12	1.35E+09	2.07E+12	2.30E+11
25	203.8	2.02E+12	1.35E+09	1.82E+12	2.02E+11
30	181.1	1.80E+12	1.35E+09	1.62E+12	1.80E+11
35	158.1	1.57E+12	1.35E+09	1.41E+12	1.57E+11
40	139.3	1.38E+12	1.35E+09	1.24E+12	1.38E+11
45	123.5	1.23E+12	1.35E+09	1.10E+12	1.23E+11
50	108.7	1.08E+12	1.35E+09	9.70E+11	1.08E+11
55	93.9	9.33E+11	1.35E+09	8.38E+11	9.33E+10
60	81.3	8.08E+11	1.35E+09	7.25E+11	8.08E+10
65	67.3	6.68E+11	1.35E+09	6.00E+11	6.68E+10
70	54.7	5.43E+11	1.35E+09	4.88E+11	5.43E+10
75	39.9	3.96E+11	1.35E+09	3.55E+11	3.96E+10
80	26.3	2.61E+11	1.35E+09	2.34E+11	2.61E+10
85	17.8	1.77E+11	1.35E+09	1.58E+11	1.77E+10
90	11.6	1.15E+11	1.35E+09	1.02E+11	1.15E+10
95	5.8	5.76E+10	1.35E+09	5.05E+10	5.76E+09
100	0.0	N/A	N/A	N/A	N/A

Table 5-11. Enterococci TMDL Calculations for Canadian River (OK52062020010)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	19224.1	5.08E+13	3.60E+08	4.57E+13	5.08E+12
5	525.2	1.39E+12	3.60E+08	1.25E+12	1.39E+11
10	351.1	9.28E+11	3.60E+08	8.35E+11	9.28E+10
15	275.7	7.28E+11	3.60E+08	6.55E+11	7.28E+10
20	231.8	6.12E+11	3.60E+08	5.51E+11	6.12E+10
25	203.8	5.38E+11	3.60E+08	4.84E+11	5.38E+10
30	181.1	4.79E+11	3.60E+08	4.30E+11	4.79E+10
35	158.1	4.18E+11	3.60E+08	3.76E+11	4.18E+10
40	139.3	3.68E+11	3.60E+08	3.31E+11	3.68E+10
45	123.5	3.26E+11	3.60E+08	2.93E+11	3.26E+10
50	108.7	2.87E+11	3.60E+08	2.58E+11	2.87E+10
55	93.9	2.48E+11	3.60E+08	2.23E+11	2.48E+10
60	81.3	2.15E+11	3.60E+08	1.93E+11	2.15E+10
65	67.3	1.78E+11	3.60E+08	1.60E+11	1.78E+10
70	54.7	1.45E+11	3.60E+08	1.30E+11	1.45E+10
75	39.9	1.05E+11	3.60E+08	9.45E+10	1.05E+10
80	26.3	6.95E+10	3.60E+08	6.22E+10	6.95E+09
85	17.8	4.70E+10	3.60E+08	4.20E+10	4.70E+09
90	11.6	3.07E+10	3.60E+08	2.72E+10	3.07E+09
95	5.8	1.53E+10	3.60E+08	1.34E+10	1.53E+09
100	0.0	N/A	N/A	N/A	N/A

Table 5-12 Fecal Coliform TMDL Calculations for Trail Creek (OK520620020090)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	91.7	8.97E+11	0	8.08E+11	8.97E+10
5	2.3	2.25E+10	0	2.03E+10	2.25E+09
10	1.4	1.37E+10	0	1.23E+10	1.37E+09
15	1.0	9.79E+09	0	8.81E+09	9.79E+08
20	0.8	7.83E+09	0	7.05E+09	7.83E+08
25	0.7	6.85E+09	0	6.17E+09	6.85E+08
30	0.6	5.87E+09	0	5.28E+09	5.87E+08
35	0.5	4.89E+09	0	4.40E+09	4.89E+08
40	0.4	3.91E+09	0	3.52E+09	3.91E+08
45	0.3	2.94E+09	0	2.64E+09	2.94E+08
50	0.2	1.96E+09	0	1.76E+09	1.96E+08
55	0.2	1.96E+09	0	1.76E+09	1.96E+08
60	0.1	9.79E+08	0	8.81E+08	9.79E+07
65	0.1	9.79E+08	0	8.81E+08	9.79E+07
70	0.1	9.79E+08	0	8.81E+08	9.79E+07
75	0.1	9.79E+08	0	8.81E+08	9.79E+07
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-13 E. Coli TMDL Calculations for Trail Creek (OK520620020090)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	91.7	9.11E+11	0	8.20E+11	9.11E+10
5	2.3	2.28E+10	0	2.06E+10	2.28E+09
10	1.4	1.39E+10	0	1.25E+10	1.39E+09
15	1.0	9.93E+09	0	8.94E+09	9.93E+08
20	0.8	7.95E+09	0	7.15E+09	7.95E+08
25	0.7	6.95E+09	0	6.26E+09	6.95E+08
30	0.6	5.96E+09	0	5.36E+09	5.96E+08
35	0.5	4.97E+09	0	4.47E+09	4.97E+08
40	0.4	3.97E+09	0	3.58E+09	3.97E+08
45	0.3	2.98E+09	0	2.68E+09	2.98E+08
50	0.2	1.99E+09	0	1.79E+09	1.99E+08
55	0.2	1.99E+09	0	1.79E+09	1.99E+08
60	0.1	9.93E+08	0	8.94E+08	9.93E+07
65	0.1	9.93E+08	0	8.94E+08	9.93E+07
70	0.1	9.93E+08	0	8.94E+08	9.93E+07
75	0.1	9.93E+08	0	8.94E+08	9.93E+07
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-14 Enterococci TMDL Calculations for Trail Creek (OK520620020090)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	91.7	2.42E+11	0	2.18E+11	2.42E+10
5	2.3	6.08E+09	0	5.47E+09	6.08E+08
10	1.4	3.70E+09	0	3.33E+09	3.70E+08
15	1.0	2.64E+09	0	2.38E+09	2.64E+08
20	0.8	2.11E+09	0	1.90E+09	2.11E+08
25	0.7	1.85E+09	0	1.66E+09	1.85E+08
30	0.6	1.59E+09	0	1.43E+09	1.59E+08
35	0.5	1.32E+09	0	1.19E+09	1.32E+08
40	0.4	1.06E+09	0	9.51E+08	1.06E+08
45	0.3	7.93E+08	0	7.13E+08	7.93E+07
50	0.2	5.28E+08	0	4.76E+08	5.28E+07
55	0.2	5.28E+08	0	4.76E+08	5.28E+07
60	0.1	2.64E+08	0	2.38E+08	2.64E+07
65	0.1	2.64E+08	0	2.38E+08	2.64E+07
70	0.1	2.64E+08	0	2.38E+08	2.64E+07
75	0.1	2.64E+08	0	2.38E+08	2.64E+07
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-15 Fecal Coliform TMDL Calculations for Lone Creek (OK520620030020)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	55.3	5.41E+11	0	4.87E+11	5.41E+10
5	1.4	1.37E+10	0	1.23E+10	1.37E+09
10	0.9	8.81E+09	0	7.93E+09	8.81E+08
15	0.6	5.87E+09	0	5.28E+09	5.87E+08
20	0.5	4.89E+09	0	4.40E+09	4.89E+08
25	0.4	3.91E+09	0	3.52E+09	3.91E+08
30	0.3	2.94E+09	0	2.64E+09	2.94E+08
35	0.3	2.94E+09	0	2.64E+09	2.94E+08
40	0.2	1.96E+09	0	1.76E+09	1.96E+08
45	0.2	1.96E+09	0	1.76E+09	1.96E+08
50	0.1	9.79E+08	0	8.81E+08	9.79E+07
55	0.1	9.79E+08	0	8.81E+08	9.79E+07
60	0.1	9.79E+08	0	8.81E+08	9.79E+07
65	0.1	9.79E+08	0	8.81E+08	9.79E+07
70	0.0	N/A	N/A	N/A	N/A
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-16 E. Coli TMDL Calculations for Lone Creek (OK520620030020)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	55.3	5.49E+11	0	4.94E+11	5.49E+10
5	1.4	1.39E+10	0	1.25E+10	1.39E+09
10	0.9	8.94E+09	0	8.05E+09	8.94E+08
15	0.6	5.96E+09	0	5.36E+09	5.96E+08
20	0.5	4.97E+09	0	4.47E+09	4.97E+08
25	0.4	3.97E+09	0	3.58E+09	3.97E+08
30	0.3	2.98E+09	0	2.68E+09	2.98E+08
35	0.3	2.98E+09	0	2.68E+09	2.98E+08
40	0.2	1.99E+09	0	1.79E+09	1.99E+08
45	0.2	1.99E+09	0	1.79E+09	1.99E+08
50	0.1	9.93E+08	0	8.94E+08	9.93E+07
55	0.1	9.93E+08	0	8.94E+08	9.93E+07
60	0.1	9.93E+08	0	8.94E+08	9.93E+07
65	0.1	9.93E+08	0	8.94E+08	9.93E+07
70	0.0	N/A	N/A	N/A	N/A
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-17 Enterococci TMDL Calculations for Lone Creek (OK520620030020)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	55.3	1.46E+11	0	1.32E+11	1.46E+10
5	1.4	3.70E+09	0	3.33E+09	3.70E+08
10	0.9	2.38E+09	0	2.14E+09	2.38E+08
15	0.6	1.59E+09	0	1.43E+09	1.59E+08
20	0.5	1.32E+09	0	1.19E+09	1.32E+08
25	0.4	1.06E+09	0	9.51E+08	1.06E+08
30	0.3	7.93E+08	0	7.13E+08	7.93E+07
35	0.3	7.93E+08	0	7.13E+08	7.93E+07
40	0.2	5.28E+08	0	4.76E+08	5.28E+07
45	0.2	5.28E+08	0	4.76E+08	5.28E+07
50	0.1	2.64E+08	0	2.38E+08	2.64E+07
55	0.1	2.64E+08	0	2.38E+08	2.64E+07
60	0.1	2.64E+08	0	2.38E+08	2.64E+07
65	0.1	2.64E+08	0	2.38E+08	2.64E+07
70	0.0	N/A	N/A	N/A	N/A
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-18 Fecal Coliform TMDL Calculations for Red Trail Creek (OK520620030050)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	6.3	6.17E+10	0	5.55E+10	6.17E+09
5	0.2	1.96E+09	0	1.76E+09	1.96E+08
10	0.1	9.79E+08	0	8.81E+08	9.79E+07
15	0.1	9.79E+08	0	8.81E+08	9.79E+07
20	0.1	9.79E+08	0	8.81E+08	9.79E+07
25	0.0	N/A	N/A	N/A	N/A
30	0.0	N/A	N/A	N/A	N/A
35	0.0	N/A	N/A	N/A	N/A
40	0.0	N/A	N/A	N/A	N/A
45	0.0	N/A	N/A	N/A	N/A
50	0.0	N/A	N/A	N/A	N/A
55	0.0	N/A	N/A	N/A	N/A
60	0.0	N/A	N/A	N/A	N/A
65	0.0	N/A	N/A	N/A	N/A
70	0.0	N/A	N/A	N/A	N/A
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-19 E. Coli TMDL Calculations for Red Trail Creek (OK520620030050)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	6.3	6.26E+10	0	5.63E+10	6.26E+09
5	0.2	1.99E+09	0	1.79E+09	1.99E+08
10	0.1	9.93E+08	0	8.94E+08	9.93E+07
15	0.1	9.93E+08	0	8.94E+08	9.93E+07
20	0.1	9.93E+08	0	8.94E+08	9.93E+07
25	0.0	N/A	N/A	N/A	N/A
30	0.0	N/A	N/A	N/A	N/A
35	0.0	N/A	N/A	N/A	N/A
40	0.0	N/A	N/A	N/A	N/A
45	0.0	N/A	N/A	N/A	N/A
50	0.0	N/A	N/A	N/A	N/A
55	0.0	N/A	N/A	N/A	N/A
60	0.0	N/A	N/A	N/A	N/A
65	0.0	N/A	N/A	N/A	N/A
70	0.0	N/A	N/A	N/A	N/A
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-20 Enterococci TMDL Calculations for Red Trail Creek (OK520620030050)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	6.3	1.66E+10	0	1.50E+10	1.66E+09
5	0.2	5.28E+08	0	4.76E+08	5.28E+07
10	0.1	2.64E+08	0	2.38E+08	2.64E+07
15	0.1	2.64E+08	0	2.38E+08	2.64E+07
20	0.1	2.64E+08	0	2.38E+08	2.64E+07
25	0.0	N/A	N/A	N/A	N/A
30	0.0	N/A	N/A	N/A	N/A
35	0.0	N/A	N/A	N/A	N/A
40	0.0	N/A	N/A	N/A	N/A
45	0.0	N/A	N/A	N/A	N/A
50	0.0	N/A	N/A	N/A	N/A
55	0.0	N/A	N/A	N/A	N/A
60	0.0	N/A	N/A	N/A	N/A
65	0.0	N/A	N/A	N/A	N/A
70	0.0	N/A	N/A	N/A	N/A
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-21 Fecal Coliform TMDL Calculations for Red Creek (OK520620030110)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	26.4	2.58E+11	0	2.33E+11	2.58E+10
5	0.7	6.85E+09	0	6.17E+09	6.85E+08
10	0.4	3.91E+09	0	3.52E+09	3.91E+08
15	0.3	2.94E+09	0	2.64E+09	2.94E+08
20	0.2	1.96E+09	0	1.76E+09	1.96E+08
25	0.2	1.96E+09	0	1.76E+09	1.96E+08
30	0.2	1.96E+09	0	1.76E+09	1.96E+08
35	0.1	9.79E+08	0	8.81E+08	9.79E+07
40	0.1	9.79E+08	0	8.81E+08	9.79E+07
45	0.1	9.79E+08	0	8.81E+08	9.79E+07
50	0.1	9.79E+08	0	8.81E+08	9.79E+07
55	0.1	9.79E+08	0	8.81E+08	9.79E+07
60	0.0	N/A	N/A	N/A	N/A
65	0.0	N/A	N/A	N/A	N/A
70	0.0	N/A	N/A	N/A	N/A
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-22 E. Coli TMDL Calculations for Red Creek (OK520620030110)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	26.4	2.62E+11	0	2.36E+11	2.62E+10
5	0.7	6.95E+09	0	6.26E+09	6.95E+08
10	0.4	3.97E+09	0	3.58E+09	3.97E+08
15	0.3	2.98E+09	0	2.68E+09	2.98E+08
20	0.2	1.99E+09	0	1.79E+09	1.99E+08
25	0.2	1.99E+09	0	1.79E+09	1.99E+08
30	0.2	1.99E+09	0	1.79E+09	1.99E+08
35	0.1	9.93E+08	0	8.94E+08	9.93E+07
40	0.1	9.93E+08	0	8.94E+08	9.93E+07
45	0.1	9.93E+08	0	8.94E+08	9.93E+07
50	0.1	9.93E+08	0	8.94E+08	9.93E+07
55	0.1	9.93E+08	0	8.94E+08	9.93E+07
60	0.0	N/A	N/A	N/A	N/A
65	0.0	N/A	N/A	N/A	N/A
70	0.0	N/A	N/A	N/A	N/A
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-23 Enterococci TMDL Calculations for Red Creek (OK520620030110)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	26.4	6.98E+10	0	6.28E+10	6.98E+09
5	0.7	1.85E+09	0	1.66E+09	1.85E+08
10	0.4	1.06E+09	0	9.51E+08	1.06E+08
15	0.3	7.93E+08	0	7.13E+08	7.93E+07
20	0.2	5.28E+08	0	4.76E+08	5.28E+07
25	0.2	5.28E+08	0	4.76E+08	5.28E+07
30	0.2	5.28E+08	0	4.76E+08	5.28E+07
35	0.1	2.64E+08	0	2.38E+08	2.64E+07
40	0.1	2.64E+08	0	2.38E+08	2.64E+07
45	0.1	2.64E+08	0	2.38E+08	2.64E+07
50	0.1	2.64E+08	0	2.38E+08	2.64E+07
55	0.1	2.64E+08	0	2.38E+08	2.64E+07
60	0.0	N/A	N/A	N/A	N/A
65	0.0	N/A	N/A	N/A	N/A
70	0.0	N/A	N/A	N/A	N/A
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-24 Fecal Coliform TMDL Calculations for Hackberry Creek (OK520620040050)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	68.7	6.72E+11	0	6.05E+11	6.72E+10
5	1.7	1.66E+10	0	1.50E+10	1.66E+09
10	1.1	1.08E+10	0	9.69E+09	1.08E+09
15	0.8	7.83E+09	0	7.05E+09	7.83E+08
20	0.6	5.87E+09	0	5.28E+09	5.87E+08
25	0.5	4.89E+09	0	4.40E+09	4.89E+08
30	0.4	3.91E+09	0	3.52E+09	3.91E+08
35	0.3	2.94E+09	0	2.64E+09	2.94E+08
40	0.3	2.94E+09	0	2.64E+09	2.94E+08
45	0.2	1.96E+09	0	1.76E+09	1.96E+08
50	0.2	1.96E+09	0	1.76E+09	1.96E+08
55	0.1	9.79E+08	0	8.81E+08	9.79E+07
60	0.1	9.79E+08	0	8.81E+08	9.79E+07
65	0.1	9.79E+08	0	8.81E+08	9.79E+07
70	0.1	9.79E+08	0	8.81E+08	9.79E+07
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-25 E. Coli TMDL Calculations for Hackberry Creek (OK520620040050)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	68.7	6.82E+11	0	6.14E+11	6.82E+10
5	1.7	1.69E+10	0	1.52E+10	1.69E+09
10	1.1	1.09E+10	0	9.83E+09	1.09E+09
15	0.8	7.95E+09	0	7.15E+09	7.95E+08
20	0.6	5.96E+09	0	5.36E+09	5.96E+08
25	0.5	4.97E+09	0	4.47E+09	4.97E+08
30	0.4	3.97E+09	0	3.58E+09	3.97E+08
35	0.3	2.98E+09	0	2.68E+09	2.98E+08
40	0.3	2.98E+09	0	2.68E+09	2.98E+08
45	0.2	1.99E+09	0	1.79E+09	1.99E+08
50	0.2	1.99E+09	0	1.79E+09	1.99E+08
55	0.1	9.93E+08	0	8.94E+08	9.93E+07
60	0.1	9.93E+08	0	8.94E+08	9.93E+07
65	0.1	9.93E+08	0	8.94E+08	9.93E+07
70	0.1	9.93E+08	0	8.94E+08	9.93E+07
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-26 Enterococci TMDL Calculations for Hackberry Creek (OK520620040050)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	68.7	1.82E+11	0	1.63E+11	1.82E+10
5	1.7	4.49E+09	0	4.04E+09	4.49E+08
10	1.1	2.91E+09	0	2.62E+09	2.91E+08
15	0.8	2.11E+09	0	1.90E+09	2.11E+08
20	0.6	1.59E+09	0	1.43E+09	1.59E+08
25	0.5	1.32E+09	0	1.19E+09	1.32E+08
30	0.4	1.06E+09	0	9.51E+08	1.06E+08
35	0.3	7.93E+08	0	7.13E+08	7.93E+07
40	0.3	7.93E+08	0	7.13E+08	7.93E+07
45	0.2	5.28E+08	0	4.76E+08	5.28E+07
50	0.2	5.28E+08	0	4.76E+08	5.28E+07
55	0.1	2.64E+08	0	2.38E+08	2.64E+07
60	0.1	2.64E+08	0	2.38E+08	2.64E+07
65	0.1	2.64E+08	0	2.38E+08	2.64E+07
70	0.1	2.64E+08	0	2.38E+08	2.64E+07
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-27 Fecal Coliform TMDL Calculations for Commission Creek (OK520620050160)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	41.0	4.01E+11	0	3.61E+11	4.01E+10
5	1.0	9.79E+09	0	8.81E+09	9.79E+08
10	0.6	5.87E+09	0	5.28E+09	5.87E+08
15	0.5	4.89E+09	0	4.40E+09	4.89E+08
20	0.4	3.91E+09	0	3.52E+09	3.91E+08
25	0.3	2.94E+09	0	2.64E+09	2.94E+08
30	0.3	2.94E+09	0	2.64E+09	2.94E+08
35	0.2	1.96E+09	0	1.76E+09	1.96E+08
40	0.2	1.96E+09	0	1.76E+09	1.96E+08
45	0.1	9.79E+08	0	8.81E+08	9.79E+07
50	0.1	9.79E+08	0	8.81E+08	9.79E+07
55	0.1	9.79E+08	0	8.81E+08	9.79E+07
60	0.1	9.79E+08	0	8.81E+08	9.79E+07
65	0.0	N/A	N/A	N/A	N/A
70	0.0	N/A	N/A	N/A	N/A
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-28 E. Coli TMDL Calculations for Commission Creek (OK520620050160)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	41.0	4.07E+11	0	3.67E+11	4.07E+10
5	1.0	9.93E+09	0	8.94E+09	9.93E+08
10	0.6	5.96E+09	0	5.36E+09	5.96E+08
15	0.5	4.97E+09	0	4.47E+09	4.97E+08
20	0.4	3.97E+09	0	3.58E+09	3.97E+08
25	0.3	2.98E+09	0	2.68E+09	2.98E+08
30	0.3	2.98E+09	0	2.68E+09	2.98E+08
35	0.2	1.99E+09	0	1.79E+09	1.99E+08
40	0.2	1.99E+09	0	1.79E+09	1.99E+08
45	0.1	9.93E+08	0	8.94E+08	9.93E+07
50	0.1	9.93E+08	0	8.94E+08	9.93E+07
55	0.1	9.93E+08	0	8.94E+08	9.93E+07
60	0.1	9.93E+08	0	8.94E+08	9.93E+07
65	0.0	N/A	N/A	N/A	N/A
70	0.0	N/A	N/A	N/A	N/A
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-29 Enterococci TMDL Calculations for Commission Creek (OK520620050160)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	41.0	1.08E+11	0	9.75E+10	1.08E+10
5	1.0	2.64E+09	0	2.38E+09	2.64E+08
10	0.6	1.59E+09	0	1.43E+09	1.59E+08
15	0.5	1.32E+09	0	1.19E+09	1.32E+08
20	0.4	1.06E+09	0	9.51E+08	1.06E+08
25	0.3	7.93E+08	0	7.13E+08	7.93E+07
30	0.3	7.93E+08	0	7.13E+08	7.93E+07
35	0.2	5.28E+08	0	4.76E+08	5.28E+07
40	0.2	5.28E+08	0	4.76E+08	5.28E+07
45	0.1	2.64E+08	0	2.38E+08	2.64E+07
50	0.1	2.64E+08	0	2.38E+08	2.64E+07
55	0.1	2.64E+08	0	2.38E+08	2.64E+07
60	0.1	2.64E+08	0	2.38E+08	2.64E+07
65	0.0	N/A	N/A	N/A	N/A
70	0.0	N/A	N/A	N/A	N/A
75	0.0	N/A	N/A	N/A	N/A
80	0.0	N/A	N/A	N/A	N/A
85	0.0	N/A	N/A	N/A	N/A
90	0.0	N/A	N/A	N/A	N/A
95	0.0	N/A	N/A	N/A	N/A
100	0.0	N/A	N/A	N/A	N/A

Table 5-30 Fecal Coliform TMDL Calculations for Deer Creek (OK520620060010)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	5560.0	5.44E+13	3.24E+10	4.89E+13	5.44E+12
5	110.9	1.09E+12	3.24E+10	9.44E+11	1.09E+11
10	55.0	5.38E+11	3.24E+10	4.52E+11	5.38E+10
15	44.0	4.31E+11	3.24E+10	3.55E+11	4.31E+10
20	40.0	3.91E+11	3.24E+10	3.20E+11	3.91E+10
25	36.0	3.52E+11	3.24E+10	2.85E+11	3.52E+10
30	33.0	3.23E+11	3.24E+10	2.58E+11	3.23E+10
35	30.0	2.94E+11	3.24E+10	2.32E+11	2.94E+10
40	28.0	2.74E+11	3.24E+10	2.14E+11	2.74E+10
45	27.0	2.64E+11	3.24E+10	2.05E+11	2.64E+10
50	26.0	2.54E+11	3.24E+10	1.97E+11	2.54E+10
55	25.0	2.45E+11	3.24E+10	1.88E+11	2.45E+10
60	23.0	2.25E+11	3.24E+10	1.70E+11	2.25E+10
65	22.0	2.15E+11	3.24E+10	1.61E+11	2.15E+10
70	20.0	1.96E+11	3.24E+10	1.44E+11	1.96E+10
75	19.0	1.86E+11	3.24E+10	1.35E+11	1.86E+10
80	17.0	1.66E+11	3.24E+10	1.17E+11	1.66E+10
85	14.0	1.37E+11	3.24E+10	9.09E+10	1.37E+10
90	11.0	1.08E+11	3.24E+10	6.45E+10	1.08E+10
95	8.4	8.22E+10	3.24E+10	4.16E+10	8.22E+09
100	5.8	5.68E+10	3.24E+10	1.87E+10	5.68E+09

Table 5-31 E. Coli TMDL Calculations for Deer Creek (OK520620060010)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	5560.0	5.52E+13	3.29E+10	4.97E+13	5.52E+12
5	110.9	1.10E+12	3.29E+10	9.59E+11	1.10E+11
10	55.0	5.46E+11	3.29E+10	4.59E+11	5.46E+10
15	44.0	4.37E+11	3.29E+10	3.60E+11	4.37E+10
20	40.0	3.97E+11	3.29E+10	3.25E+11	3.97E+10
25	36.0	3.58E+11	3.29E+10	2.89E+11	3.58E+10
30	33.0	3.28E+11	3.29E+10	2.62E+11	3.28E+10
35	30.0	2.98E+11	3.29E+10	2.35E+11	2.98E+10
40	28.0	2.78E+11	3.29E+10	2.17E+11	2.78E+10
45	27.0	2.68E+11	3.29E+10	2.08E+11	2.68E+10
50	26.0	2.58E+11	3.29E+10	2.00E+11	2.58E+10
55	25.0	2.48E+11	3.29E+10	1.91E+11	2.48E+10
60	23.0	2.28E+11	3.29E+10	1.73E+11	2.28E+10
65	22.0	2.19E+11	3.29E+10	1.64E+11	2.19E+10
70	20.0	1.99E+11	3.29E+10	1.46E+11	1.99E+10
75	19.0	1.89E+11	3.29E+10	1.37E+11	1.89E+10
80	17.0	1.69E+11	3.29E+10	1.19E+11	1.69E+10
85	14.0	1.39E+11	3.29E+10	9.23E+10	1.39E+10
90	11.0	1.09E+11	3.29E+10	6.55E+10	1.09E+10
95	8.4	8.34E+10	3.29E+10	4.22E+10	8.34E+09
100	5.8	5.76E+10	3.29E+10	1.90E+10	5.76E+09

Table 5-32 Enterococci TMDL Calculations for Deer Creek (OK520620060010)

Percentile	Flow (cfs)	TMDL (cfu/day)	WLA† (cfu/day)	LA (cfu/day)	MOS (cfu/day)
0	5560.0	1.47E+13	8.74E+09	1.32E+13	1.47E+12
5	110.9	2.93E+11	8.74E+09	2.55E+11	2.93E+10
10	55.0	1.45E+11	8.74E+09	1.22E+11	1.45E+10
15	44.0	1.16E+11	8.74E+09	9.59E+10	1.16E+10
20	40.0	1.06E+11	8.74E+09	8.64E+10	1.06E+10
25	36.0	9.51E+10	8.74E+09	7.69E+10	9.51E+09
30	33.0	8.72E+10	8.74E+09	6.97E+10	8.72E+09
35	30.0	7.93E+10	8.74E+09	6.26E+10	7.93E+09
40	28.0	7.40E+10	8.74E+09	5.78E+10	7.40E+09
45	27.0	7.13E+10	8.74E+09	5.55E+10	7.13E+09
50	26.0	6.87E+10	8.74E+09	5.31E+10	6.87E+09
55	25.0	6.61E+10	8.74E+09	5.07E+10	6.61E+09
60	23.0	6.08E+10	8.74E+09	4.60E+10	6.08E+09
65	22.0	5.81E+10	8.74E+09	4.36E+10	5.81E+09
70	20.0	5.28E+10	8.74E+09	3.88E+10	5.28E+09
75	19.0	5.02E+10	8.74E+09	3.64E+10	5.02E+09
80	17.0	4.49E+10	8.74E+09	3.17E+10	4.49E+09
85	14.0	3.70E+10	8.74E+09	2.45E+10	3.70E+09
90	11.0	2.91E+10	8.74E+09	1.74E+10	2.91E+09
95	8.4	2.22E+10	8.74E+09	1.12E+10	2.22E+09
100	5.8	1.53E+10	8.74E+09	5.05E+09	1.53E+09

5.7 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 the 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 2002a). The CPP can be viewed from ODEQ's website at http://www.deq.state.ok.us/WQDnew/pubs/2002_cpp_final.pdf. Table 5-33 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 5-33 Partial List of Oklahoma Water Quality Management Agencies

Agency	Web Link
Oklahoma Conservation Commission	**http://www.okcc.state.ok.us/WQ/WQ_home.htm**
Oklahoma Department of Wildlife Conservation	**http://www.wildlifedepartment.com/watchabl.htm**
Oklahoma Department of Agriculture, Food, and Forestry	**http://www.oda.state.ok.us/water-home.htm**
Oklahoma Water Resources Board	**http://www.owrb.state.ok.us/quality/index.php**

Nonpoint source pollution is addressed by the Oklahoma Conservation Commission. 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 AEMS, provides CAFO operators the necessary tools and information to deal with the manure and wastewater animals produce so streams, lakes, ponds, and ground water 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 98%. The DEQ recognizes that achieving such high reductions may not be realistic, especially since unregulated nonpoint sources are a major cause of the impairment. The high reduction rates are not uncommon for pathogen impaired waters. Similar reduction rates are often found in other pathogen TMDLs around the nation. The suitability of the current criteria for pathogens and the beneficial uses of the receiving stream should be reviewed. For example, Kansas DEQ has proposed to exclude certain high flow conditions during which pathogen standards will not apply, although that exclusion was not approved by the EPA. Additionally, EPA has been conducting new epidemiology studies and may develop new recommendations for pathogen criteria in the near future.

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

- Removing the Primary Body Contact Recreation use: This revision would require documentation in a Use Attainability Analysis that the use is not existing 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 EPA 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 EPA studies that could result in revisions to their recommendations are on-going. 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 methodology such as that found in EPA guidance.

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

SECTION 6
PUBLIC PARTICIPATION

Federal regulations require EPA to notify the public and seek comment concerning TMDLs that they prepare. These TMDLs were developed under contract to ODEQ, and EPA has held a public review period seeking comments, information and data from the public and any other interested parties. The notice for the public review period was published in the Federal Register on August 11, 2006, and the review period closed on September 11, 2006.

Written comments were received during the public notice period from the Oklahoma Conservation Commission, Oklahoma Farm Bureau, and Tinker Air Force Base. The comments and response will be included in a separate report, which will include comments on similar TMDLs with the same public review period. The final TMDLs will be incorporated in Oklahoma's Water Quality Management Plan.

SECTION 7
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APPENDIX A
AMBIENT WATER QUALITY BACTERIA DATA – 1997 TO 2003

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacteria Indicator	Criteria (#/100ml)
OK520620010010G	Canadian River	9/8/1997	200	FC	400
OK520620010010G	Canadian River	9/22/1997	1700	FC	400
OK520620010010G	Canadian River	10/6/1997	200	FC	SBCR
OK520620010010G	Canadian River	10/20/1997	200	FC	SBCR
OK520620010010G	Canadian River	11/3/1997	<200	FC	SBCR
OK520620010010G	Canadian River	11/17/1997	200	FC	SBCR
OK520620010010G	Canadian River	12/1/1997	200	FC	SBCR
OK520620010010G	Canadian River	12/15/1997	20	FC	SBCR
OK520620010010G	Canadian River	12/29/1997	80	FC	SBCR
OK520620010010G	Canadian River	1/12/1998	80	FC	SBCR
OK520620010010G	Canadian River	1/26/1998	80	FC	SBCR
OK520620010010G	Canadian River	2/9/1998	400	FC	SBCR
OK520620010010G	Canadian River	2/22/1998	80	FC	SBCR
OK520620010010G	Canadian River	3/9/1998	700	FC	SBCR
OK520620010010G	Canadian River	3/23/1998	200	FC	SBCR
OK520620010010G	Canadian River	4/6/1998	<200	FC	SBCR
OK520620010010G	Canadian River	4/20/1998	230	FC	SBCR
OK520620010010G	Canadian River	5/4/1998	80	FC	400
OK520620010010G	Canadian River	5/18/1998	1300	FC	400
OK520620010010G	Canadian River	6/1/1998	2300	FC	400
OK520620010010G	Canadian River	6/15/1998	5000	FC	400
OK520620010010G	Canadian River	6/29/1998	1300	FC	400
OK520620010010G	Canadian River	7/27/1998	700	FC	400
OK520620010010G	Canadian River	8/10/1998	<200	FC	400
OK520620010010K	Canadian River	9/8/1997	200	FC	400
OK520620010010K	Canadian River	9/22/1997	200	FC	400
OK520620010010K	Canadian River	10/6/1997	200	FC	SBCR
OK520620010010K	Canadian River	10/20/1997	<200	FC	SBCR
OK520620010010K	Canadian River	11/3/1997	400	FC	SBCR
OK520620010010K	Canadian River	11/17/1997	<200	FC	SBCR
OK520620010010K	Canadian River	12/1/1997	200	FC	SBCR
OK520620010010K	Canadian River	12/15/1997	110	FC	SBCR
OK520620010010K	Canadian River	12/29/1997	<200	FC	SBCR
OK520620010010K	Canadian River	1/12/1998	40	FC	SBCR
OK520620010010K	Canadian River	1/26/1998	170	FC	SBCR
OK520620010010K	Canadian River	2/9/1998	<200	FC	SBCR
OK520620010010K	Canadian River	2/22/1998	40	FC	SBCR
OK520620010010K	Canadian River	3/9/1998	800	FC	SBCR
OK520620010010K	Canadian River	3/23/1998	800	FC	SBCR
OK520620010010K	Canadian River	4/6/1998	200	FC	SBCR
OK520620010010K	Canadian River	4/20/1998	300	FC	SBCR
OK520620010010K	Canadian River	5/4/1998	220	FC	400
OK520620010010K	Canadian River	5/18/1998	1,300	FC	400
OK520620010010K	Canadian River	6/1/1998	200	FC	400

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacteria Indicator	Criteria (#/100ml)
OK520620010010K	Canadian River	6/15/1998	3,000	FC	400
OK520620010010P	Canadian River	9/8/1997	400	FC	400
OK520620010010P	Canadian River	9/22/1997	3000	FC	400
OK520620010010P	Canadian River	10/6/1997	<200	FC	SBCR
OK520620010010P	Canadian River	10/20/1997	<200	FC	SBCR
OK520620010010P	Canadian River	11/3/1997	<200	FC	SBCR
OK520620010010P	Canadian River	11/17/1997	<200	FC	SBCR
OK520620010010P	Canadian River	12/1/1997	<200	FC	SBCR
OK520620010010P	Canadian River	12/15/1997	20	FC	SBCR
OK520620010010P	Canadian River	12/29/1997	80	FC	SBCR
OK520620010010P	Canadian River	1/12/1998	230	FC	SBCR
OK520620010010P	Canadian River	1/26/1998	<20	FC	SBCR
OK520620010010P	Canadian River	2/9/1998	<200	FC	SBCR
OK520620010010P	Canadian River	2/22/1998	300	FC	SBCR
OK520620010010P	Canadian River	3/9/1998	1300	FC	SBCR
OK520620010010P	Canadian River	3/23/1998	<200	FC	SBCR
OK520620010010P	Canadian River	4/6/1998	<200	FC	SBCR
OK520620010010P	Canadian River	4/20/1998	220	FC	SBCR
OK520620010010P	Canadian River	5/4/1998	90	FC	400
OK520620010010P	Canadian River	5/18/1998	170	FC	400
OK520620010010P	Canadian River	6/1/1998	<200	FC	400
OK520620010010P	Canadian River	6/15/1998	900	FC	400
OK520620010010S	Canadian River	9/8/1997	400	FC	400
OK520620010010S	Canadian River	9/22/1997	2300	FC	400
OK520620010010S	Canadian River	10/6/1997	<200	FC	SBCR
OK520620010010S	Canadian River	10/20/1997	<200	FC	SBCR
OK520620010010S	Canadian River	11/3/1997	400	FC	SBCR
OK520620010010S	Canadian River	11/17/1997	200	FC	SBCR
OK520620010010S	Canadian River	12/1/1997	200	FC	SBCR
OK520620010010S	Canadian River	12/15/1997	60	FC	SBCR
OK520620010010S	Canadian River	12/29/1997	<20	FC	SBCR
OK520620010010S	Canadian River	1/12/1998	70	FC	SBCR
OK520620010010S	Canadian River	1/26/1998	40	FC	SBCR
OK520620010010S	Canadian River	2/9/1998	<200	FC	SBCR
OK520620010010S	Canadian River	2/22/1998	80	FC	SBCR
OK520620010010S	Canadian River	3/9/1998	1300	FC	SBCR
OK520620010010S	Canadian River	3/23/1998	<200	FC	SBCR
OK520620010010S	Canadian River	4/6/1998	200	FC	SBCR
OK520620010010S	Canadian River	4/20/1998	40	FC	SBCR
OK520620010010S	Canadian River	5/4/1998	170	FC	400
OK520620010010S	Canadian River	5/18/1998	80	FC	400
OK520620010010S	Canadian River	6/1/1998	400	FC	400
OK520620010010S	Canadian River	6/15/1998	1300	FC	400
OK520620010010S	Canadian River	6/29/1998	220	FC	400
OK520620010010S	Canadian River	7/27/1998	700	FC	400

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacteria Indicator	Criteria (#/100ml)
OK520620010010S	Canadian River	8/10/1998	<200	FC	400
OK520620010120G	Bear Creek	7/31/2000	226	EC	406
OK520620010120G	Bear Creek	9/5/2000	3,282	EC	406
OK520620010120G	Bear Creek	12/19/2000	134	EC	SBCR
OK520620010120G	Bear Creek	1/29/2001	426	EC	SBCR
OK520620010120G	Bear Creek	3/6/2001	727	EC	SBCR
OK520620010120G	Bear Creek	4/10/2001	3,654	EC	SBCR
OK520620010120G	Bear Creek	5/15/2001	354	EC	406
OK520620010120G	Bear Creek	6/19/2001	333	EC	406
OK520620010120G	Bear Creek	7/24/2001	420	EC	406
OK520620010120G	Bear Creek	8/28/2001	260	EC	406
OK520620010120G	Bear Creek	11/6/2001	50	EC	SBCR
OK520620010120G	Bear Creek	7/31/2000	1,700	ENT	108
OK520620010120G	Bear Creek	9/5/2000	10,000	ENT	108
OK520620010120G	Bear Creek	12/19/2000	500	ENT	SBCR
OK520620010120G	Bear Creek	1/29/2001	5,000	ENT	SBCR
OK520620010120G	Bear Creek	3/6/2001	1,000	ENT	SBCR
OK520620010120G	Bear Creek	4/10/2001	500	ENT	SBCR
OK520620010120G	Bear Creek	5/15/2001	1,100	ENT	108
OK520620010120G	Bear Creek	6/19/2001	800	ENT	108
OK520620010120G	Bear Creek	7/24/2001	380	ENT	108
OK520620010120G	Bear Creek	8/28/2001	390	ENT	108
OK520620010120G	Bear Creek	11/6/2001	5	ENT	SBCR
OK520620010120G	Bear Creek	5/22/2000	500	FC	400
OK520620010120G	Bear Creek	6/26/2000	1,000	FC	400
OK520620010120G	Bear Creek	7/31/2000	240	FC	400
OK520620010120G	Bear Creek	9/5/2000	41,000	FC	400
OK520620010120G	Bear Creek	12/19/2000	220	FC	SBCR
OK520620010120G	Bear Creek	1/29/2001	230	FC	SBCR
OK520620010120G	Bear Creek	3/6/2001	300	FC	SBCR
OK520620010120G	Bear Creek	4/10/2001	4,100	FC	SBCR
OK520620010120G	Bear Creek	5/15/2001	5,000	FC	400
OK520620010120G	Bear Creek	6/19/2001	1,700	FC	400
OK520620010120G	Bear Creek	8/28/2001	330	FC	400
OK520620010120G	Bear Creek	11/6/2001	150	FC	SBCR
OK520620020010_001AT	Canadian River	6/15/1999	185	EC	406
OK520620020010_001AT	Canadian River	7/13/1999	10	EC	406
OK520620020010_001AT	Canadian River	9/15/1999	5,172	EC	406
OK520620020010_001AT	Canadian River	5/9/2000	132	EC	406
OK520620020010_001AT	Canadian River	6/13/2000	86	EC	406
OK520620020010_001AT	Canadian River	7/19/2000	41	EC	406
OK520620020010_001AT	Canadian River	5/2/2001	143	EC	406
OK520620020010_001AT	Canadian River	6/19/2001	5	EC	406
OK520620020010_001AT	Canadian River	5/14/2002	20	EC	406
OK520620020010_001AT	Canadian River	6/12/2002	20	EC	406

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacteria Indicator	Criteria (#/100ml)
OK520620020010_001AT	Canadian River	7/17/2002	10	EC	406
OK520620020010_001AT	Canadian River	8/14/2002	169	EC	406
OK520620020010_001AT	Canadian River	5/12/2003	20	EC	406
OK520620020010_001AT	Canadian River	5/27/2003	10HT	EC	406
OK520620020010_001AT	Canadian River	6/16/2003	253	EC	406
OK520620020010_001AT	Canadian River	6/30/2003	10HT	EC	406
OK520620020010_001AT	Canadian River	7/21/2003	31	EC	406
OK520620020010_001AT	Canadian River	9/8/2003	10	EC	406
OK520620020010_001AT	Canadian River	6/15/1999	10	ENT	108
OK520620020010_001AT	Canadian River	7/13/1999	5	ENT	108
OK520620020010_001AT	Canadian River	9/15/1999	2,300	ENT	108
OK520620020010_001AT	Canadian River	5/9/2000	30	ENT	108
OK520620020010_001AT	Canadian River	6/13/2000	160	ENT	108
OK520620020010_001AT	Canadian River	7/19/2000	40	ENT	108
OK520620020010_001AT	Canadian River	5/2/2001	1,000	ENT	108
OK520620020010_001AT	Canadian River	6/19/2001	40	ENT	108
OK520620020010_001AT	Canadian River	5/14/2002	60	ENT	108
OK520620020010_001AT	Canadian River	6/12/2002	80	ENT	108
OK520620020010_001AT	Canadian River	7/17/2002	50	ENT	108
OK520620020010_001AT	Canadian River	8/14/2002	500	ENT	108
OK520620020010_001AT	Canadian River	5/12/2003	50	ENT	108
OK520620020010_001AT	Canadian River	5/27/2003	200HT	ENT	108
OK520620020010_001AT	Canadian River	6/16/2003	3,000	ENT	108
OK520620020010_001AT	Canadian River	6/30/2003	10HT	ENT	108
OK520620020010_001AT	Canadian River	7/21/2003	600	ENT	108
OK520620020010_001AT	Canadian River	9/8/2003	600	ENT	108
OK520620020010_001AT	Canadian River	6/15/1999	100	FC	400
OK520620020010_001AT	Canadian River	7/13/1999	5	FC	400
OK520620020010_001AT	Canadian River	9/15/1999	2,400	FC	400
OK520620020010_001AT	Canadian River	5/9/2000	70	FC	400
OK520620020010_001AT	Canadian River	6/13/2000	150	FC	400
OK520620020010_001AT	Canadian River	7/19/2000	100	FC	400
OK520620020010_001AT	Canadian River	5/2/2001	2,000	FC	400
OK520620020010_001AT	Canadian River	6/19/2001	40	FC	400
OK520620020010_001AT	Canadian River	5/14/2002	10	FC	400
OK520620020010_001AT	Canadian River	6/12/2002	400	FC	400
OK520620020010_001AT	Canadian River	7/17/2002	10	FC	400
OK520620020010_001AT	Canadian River	8/14/2002	400	FC	400
OK520620020010_001AT	Canadian River	5/12/2003	10	FC	400
OK520620020010_001AT	Canadian River	5/27/2003	50HT	FC	400
OK520620020010_001AT	Canadian River	6/16/2003	600	FC	400
OK520620020010_001AT	Canadian River	6/30/2003	70HT	FC	400
OK520620020010_001AT	Canadian River	9/8/2003	10	FC	400
OK520620020090G	Trail Creek	7/31/2000	41	EC	406
OK520620020090G	Trail Creek	9/5/2000	416	EC	406

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacteria Indicator	Criteria (#/100ml)
OK520620020090G	Trail Creek	11/14/2000	314	EC	SBCR
OK520620020090G	Trail Creek	12/19/2000	373	EC	SBCR
OK520620020090G	Trail Creek	1/30/2001	10	EC	SBCR
OK520620020090G	Trail Creek	3/6/2001	31	EC	SBCR
OK520620020090G	Trail Creek	4/10/2001	3,654	EC	SBCR
OK520620020090G	Trail Creek	6/19/2001	74	EC	406
OK520620020090G	Trail Creek	7/24/2001	195	EC	406
OK520620020090G	Trail Creek	8/27/2001	1,040	EC	406
OK520620020090G	Trail Creek	10/2/2001	230	EC	SBCR
OK520620020090G	Trail Creek	11/6/2001	30	EC	SBCR
OK520620020090G	Trail Creek	4/23/2002	350	EC	SBCR
OK520620020090G	Trail Creek	5/29/2002	350	EC	406
OK520620020090G	Trail Creek	7/9/2002	140	EC	406
OK520620020090G	Trail Creek	8/6/2002	610	EC	406
OK520620020090G	Trail Creek	9/10/2002	300	EC	406
OK520620020090G	Trail Creek	10/15/2002	20	EC	406
OK520620020090G	Trail Creek	4/8/2003	60	EC	SBCR
OK520620020090G	Trail Creek	5/13/2003	470	EC	406
OK520620020090G	Trail Creek	6/17/2003	190	EC	406
OK520620020090G	Trail Creek	7/31/2000	<10	ENT	108
OK520620020090G	Trail Creek	9/5/2000	1,100	ENT	108
OK520620020090G	Trail Creek	11/14/2000	900	ENT	SBCR
OK520620020090G	Trail Creek	12/19/2000	8,000	ENT	SBCR
OK520620020090G	Trail Creek	1/30/2001	400	ENT	SBCR
OK520620020090G	Trail Creek	3/6/2001	160	ENT	SBCR
OK520620020090G	Trail Creek	4/10/2001	500	ENT	SBCR
OK520620020090G	Trail Creek	6/19/2001	300	ENT	108
OK520620020090G	Trail Creek	7/24/2001	940	ENT	108
OK520620020090G	Trail Creek	8/27/2001	500	ENT	108
OK520620020090G	Trail Creek	10/2/2001	370	ENT	SBCR
OK520620020090G	Trail Creek	11/6/2001	100	ENT	SBCR
OK520620020090G	Trail Creek	4/23/2002	140	ENT	SBCR
OK520620020090G	Trail Creek	5/29/2002	140	ENT	108
OK520620020090G	Trail Creek	7/9/2002	130	ENT	108
OK520620020090G	Trail Creek	8/6/2002	610	ENT	108
OK520620020090G	Trail Creek	9/10/2002	220	ENT	108
OK520620020090G	Trail Creek	10/15/2002	220	ENT	SBCR
OK520620020090G	Trail Creek	4/8/2003	60	ENT	SBCR
OK520620020090G	Trail Creek	5/13/2003	130	ENT	108
OK520620020090G	Trail Creek	6/17/2003	130	ENT	108
OK520620020090G	Trail Creek	5/22/2000	100	FC	400
OK520620020090G	Trail Creek	6/26/2000	1,700	FC	400
OK520620020090G	Trail Creek	7/31/2000	70	FC	400
OK520620020090G	Trail Creek	9/5/2000	<10	FC	400
OK520620020090G	Trail Creek	11/14/2000	500	FC	SBCR

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacteria Indicator	Criteria (#/100ml)
OK520620020090G	Trail Creek	12/19/2000	100	FC	SBCR
OK520620020090G	Trail Creek	1/30/2001	<10	FC	SBCR
OK520620020090G	Trail Creek	3/6/2001	40	FC	SBCR
OK520620020090G	Trail Creek	4/10/2001	16,000	FC	SBCR
OK520620020090G	Trail Creek	6/19/2001	200	FC	400
OK520620020090G	Trail Creek	7/24/2001	480	FC	400
OK520620020090G	Trail Creek	8/27/2001	1,630	FC	400
OK520620020090G	Trail Creek	10/2/2001	580	FC	SBCR
OK520620020090G	Trail Creek	11/6/2001	85	FC	SBCR
OK520620030020C	Lone Creek	8/14/2001	155	EC	406
OK520620030020C	Lone Creek	9/18/2001	71,600	EC	406
OK520620030020C	Lone Creek	10/23/2001	1,010	EC	SBCR
OK520620030020C	Lone Creek	4/23/2002	80	EC	SBCR
OK520620030020C	Lone Creek	5/29/2002	160	EC	406
OK520620030020C	Lone Creek	7/9/2002	280	EC	406
OK520620030020C	Lone Creek	8/6/2002	520	EC	406
OK520620030020C	Lone Creek	9/10/2002	180	EC	406
OK520620030020C	Lone Creek	10/15/2002	120	EC	SBCR
OK520620030020C	Lone Creek	4/8/2003	200	EC	SBCR
OK520620030020C	Lone Creek	5/13/2003	1,320	EC	406
OK520620030020C	Lone Creek	6/17/2003	100	EC	406
OK520620030020C	Lone Creek	8/14/2001	125	ENT	108
OK520620030020C	Lone Creek	9/18/2001	1,310	ENT	108
OK520620030020C	Lone Creek	10/23/2001	320	ENT	SBCR
OK520620030020C	Lone Creek	4/23/2002	260	ENT	SBCR
OK520620030020C	Lone Creek	5/29/2002	210	ENT	108
OK520620030020C	Lone Creek	7/9/2002	330	ENT	108
OK520620030020C	Lone Creek	8/6/2002	900	ENT	108
OK520620030020C	Lone Creek	9/10/2002	210	ENT	108
OK520620030020C	Lone Creek	10/15/2002	80	ENT	SBCR
OK520620030020C	Lone Creek	4/8/2003	30	ENT	SBCR
OK520620030020C	Lone Creek	5/13/2003	90	ENT	108
OK520620030020C	Lone Creek	6/17/2003	120	ENT	108
OK520620030020C	Lone Creek	9/18/2001	600	FC	400
OK520620030050G	Red Trail Creek	7/31/2000	74	EC	406
OK520620030050G	Red Trail Creek	11/14/2000	259	EC	SBCR
OK520620030050G	Red Trail Creek	12/19/2000	86	EC	SBCR
OK520620030050G	Red Trail Creek	1/30/2001	20	EC	SBCR
OK520620030050G	Red Trail Creek	3/6/2001	52	EC	SBCR
OK520620030050G	Red Trail Creek	4/10/2001	852	EC	SBCR
OK520620030050G	Red Trail Creek	5/14/2001	>520	EC	406
OK520620030050G	Red Trail Creek	6/19/2001	512	EC	406
OK520620030050G	Red Trail Creek	7/24/2001	305	EC	406
OK520620030050G	Red Trail Creek	8/28/2001	450	EC	406
OK520620030050G	Red Trail Creek	10/2/2001	1730	EC	SBCR

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacteria Indicator	Criteria (#/100ml)
OK520620030050G	Red Trail Creek	11/6/2001	1630	EC	SBCR
OK520620030050G	Red Trail Creek	7/31/2000	260	ENT	108
OK520620030050G	Red Trail Creek	11/14/2000	9000	ENT	SBCR
OK520620030050G	Red Trail Creek	12/19/2000	6000	ENT	SBCR
OK520620030050G	Red Trail Creek	1/30/2001	7000	ENT	SBCR
OK520620030050G	Red Trail Creek	3/6/2001	500	ENT	SBCR
OK520620030050G	Red Trail Creek	4/10/2001	1100	ENT	SBCR
OK520620030050G	Red Trail Creek	5/14/2001	4,000	ENT	108
OK520620030050G	Red Trail Creek	6/19/2001	4,000	ENT	108
OK520620030050G	Red Trail Creek	7/24/2001	590	ENT	108
OK520620030050G	Red Trail Creek	8/28/2001	190	ENT	108
OK520620030050G	Red Trail Creek	10/2/2001	530	ENT	SBCR
OK520620030050G	Red Trail Creek	11/6/2001	100	ENT	SBCR
OK520620030050G	Red Trail Creek	5/22/2000	1,100	FC	400
OK520620030050G	Red Trail Creek	6/26/2000	1,400	FC	400
OK520620030050G	Red Trail Creek	7/31/2000	200	FC	400
OK520620030050G	Red Trail Creek	11/14/2000	160	FC	SBCR
OK520620030050G	Red Trail Creek	12/19/2000	90	FC	SBCR
OK520620030050G	Red Trail Creek	1/30/2001	50	FC	SBCR
OK520620030050G	Red Trail Creek	3/6/2001	30	FC	SBCR
OK520620030050G	Red Trail Creek	4/10/2001	1100	FC	SBCR
OK520620030050G	Red Trail Creek	5/14/2001	500	FC	400
OK520620030050G	Red Trail Creek	6/19/2001	500	FC	400
OK520620030050G	Red Trail Creek	8/28/2001	660	FC	400
OK520620030050G	Red Trail Creek	10/2/2001	1880	FC	SBCR
OK520620030050G	Red Trail Creek	11/6/2001	1680	FC	SBCR
OK520620030110G	Red Creek	9/5/2000	10	EC	406
OK520620030110G	Red Creek	10/9/2000	546	EC	SBCR
OK520620030110G	Red Creek	11/14/2000	20	EC	SBCR
OK520620030110G	Red Creek	12/19/2000	10	EC	SBCR
OK520620030110G	Red Creek	1/30/2001	31	EC	SBCR
OK520620030110G	Red Creek	3/6/2001	<10	EC	SBCR
OK520620030110G	Red Creek	4/10/2001	364	EC	SBCR
OK520620030110G	Red Creek	5/14/2001	122	EC	406
OK520620030110G	Red Creek	6/19/2001	52	EC	406
OK520620030110G	Red Creek	7/24/2001	145	EC	406
OK520620030110G	Red Creek	8/28/2001	450	EC	406
OK520620030110G	Red Creek	10/2/2001	200	EC	SBCR
OK520620030110G	Red Creek	11/6/2001	140	EC	SBCR
OK520620030110G	Red Creek	9/5/2000	50	ENT	108
OK520620030110G	Red Creek	10/9/2000	1500	ENT	SBCR
OK520620030110G	Red Creek	11/14/2000	120	ENT	SBCR
OK520620030110G	Red Creek	12/19/2000	60	ENT	SBCR
OK520620030110G	Red Creek	1/30/2001	300	ENT	SBCR
OK520620030110G	Red Creek	3/6/2001	30	ENT	SBCR

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacteria Indicator	Criteria (#/100ml)
OK520620030110G	Red Creek	4/10/2001	400	ENT	SBCR
OK520620030110G	Red Creek	5/14/2001	500	ENT	108
OK520620030110G	Red Creek	6/19/2001	500	ENT	108
OK520620030110G	Red Creek	7/24/2001	60	ENT	108
OK520620030110G	Red Creek	8/28/2001	330	ENT	108
OK520620030110G	Red Creek	10/2/2001	410	ENT	SBCR
OK520620030110G	Red Creek	11/6/2001	210	ENT	SBCR
OK520620030110G	Red Creek	5/22/2000	400	FC	400
OK520620030110G	Red Creek	6/26/2000	800	FC	400
OK520620030110G	Red Creek	9/5/2000	3300	FC	400
OK520620030110G	Red Creek	10/9/2000	400	FC	SBCR
OK520620030110G	Red Creek	11/14/2000	50	FC	SBCR
OK520620030110G	Red Creek	12/19/2000	20	FC	SBCR
OK520620030110G	Red Creek	1/30/2001	10	FC	SBCR
OK520620030110G	Red Creek	3/6/2001	10	FC	SBCR
OK520620030110G	Red Creek	4/10/2001	700	FC	SBCR
OK520620030110G	Red Creek	5/14/2001	200	FC	400
OK520620030110G	Red Creek	6/19/2001	190	FC	400
OK520620030110G	Red Creek	7/24/2001	270	FC	400
OK520620030110G	Red Creek	8/28/2001	600	FC	400
OK520620030110G	Red Creek	10/2/2001	120	FC	SBCR
OK520620030110G	Red Creek	11/6/2001	270	FC	SBCR
OK520620040050D	Hackberry Creek	8/14/2001	105	EC	406
OK520620040050D	Hackberry Creek	9/18/2001	1,120	EC	406
OK520620040050D	Hackberry Creek	10/23/2001	100	EC	SBCR
OK520620040050D	Hackberry Creek	4/23/2002	320	EC	SBCR
OK520620040050D	Hackberry Creek	5/29/2002	950	EC	406
OK520620040050D	Hackberry Creek	7/9/2002	440	EC	406
OK520620040050D	Hackberry Creek	10/15/2002	160	EC	SBCR
OK520620040050D	Hackberry Creek	4/8/2003	30	EC	SBCR
OK520620040050D	Hackberry Creek	5/13/2003	100	EC	406
OK520620040050D	Hackberry Creek	6/17/2003	500	EC	406
OK520620040050D	Hackberry Creek	8/14/2001	435	ENT	108
OK520620040050D	Hackberry Creek	9/18/2001	520	ENT	108
OK520620040050D	Hackberry Creek	10/23/2001	120	ENT	SBCR
OK520620040050D	Hackberry Creek	4/23/2002	250	ENT	SBCR
OK520620040050D	Hackberry Creek	5/29/2002	140	ENT	108
OK520620040050D	Hackberry Creek	7/9/2002	310	ENT	108
OK520620040050D	Hackberry Creek	10/15/2002	100	ENT	SBCR
OK520620040050D	Hackberry Creek	4/8/2003	30	ENT	SBCR
OK520620040050D	Hackberry Creek	5/13/2003	50	ENT	108
OK520620040050D	Hackberry Creek	6/17/2003	580	ENT	108
OK520620040050D	Hackberry Creek	9/18/2001	1,340	FC	400
OK520620050160C	Commission Creek	8/14/2001	40	EC	406
OK520620050160C	Commission Creek	9/18/2001	620	EC	406

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacteria Indicator	Criteria (#/100ml)
OK520620050160C	Commission Creek	10/23/2001	140	EC	SBCR
OK520620050160C	Commission Creek	4/23/2002	10	EC	SBCR
OK520620050160C	Commission Creek	5/29/2002	270	EC	406
OK520620050160C	Commission Creek	7/9/2002	280	EC	406
OK520620050160C	Commission Creek	8/6/2002	180	EC	406
OK520620050160C	Commission Creek	9/10/2002	70	EC	406
OK520620050160C	Commission Creek	10/15/2002	20	EC	SBCR
OK520620050160C	Commission Creek	4/8/2003	15	EC	SBCR
OK520620050160C	Commission Creek	5/13/2003	120	EC	406
OK520620050160C	Commission Creek	6/17/2003	140	EC	406
OK520620050160C	Commission Creek	8/14/2001	150	ENT	108
OK520620050160C	Commission Creek	9/18/2001	580	ENT	108
OK520620050160C	Commission Creek	10/23/2001	120	ENT	SBCR
OK520620050160C	Commission Creek	4/23/2002	80	ENT	SBCR
OK520620050160C	Commission Creek	5/29/2002	130	ENT	108
OK520620050160C	Commission Creek	7/9/2002	90	ENT	108
OK520620050160C	Commission Creek	8/6/2002	200	ENT	108
OK520620050160C	Commission Creek	9/10/2002	200	ENT	108
OK520620050160C	Commission Creek	10/15/2002	200	ENT	SBCR
OK520620050160C	Commission Creek	4/8/2003	15	ENT	SBCR
OK520620050160C	Commission Creek	5/13/2003	20	ENT	108
OK520620050160C	Commission Creek	6/17/2003	200	ENT	108
OK520620050160C	Commission Creek	9/18/2001	930	FC	400
OK520620060010F	Deer Creek	8/14/2001	55	EC	406
OK520620060010F	Deer Creek	9/18/2001	7800	EC	406
OK520620060010F	Deer Creek	10/23/2001	50	EC	SBCR
OK520620060010F	Deer Creek	4/22/2002	10	EC	SBCR
OK520620060010F	Deer Creek	5/28/2002	540	EC	406
OK520620060010F	Deer Creek	7/9/2002	650	EC	406
OK520620060010F	Deer Creek	8/6/2002	80	EC	406
OK520620060010F	Deer Creek	9/9/2002	<10	EC	406
OK520620060010F	Deer Creek	10/14/2002	20	EC	SBCR
OK520620060010F	Deer Creek	4/7/2003	<10	EC	SBCR
OK520620060010F	Deer Creek	5/12/2003	20	EC	406
OK520620060010F	Deer Creek	6/16/2003	1620	EC	406
OK520620060010F	Deer Creek	8/14/2001	55	ENT	108
OK520620060010F	Deer Creek	9/18/2001	610	ENT	108
OK520620060010F	Deer Creek	10/23/2001	20	ENT	SBCR
OK520620060010F	Deer Creek	4/22/2002	10	ENT	SBCR
OK520620060010F	Deer Creek	5/28/2002	40	ENT	108
OK520620060010F	Deer Creek	7/9/2002	70	ENT	108
OK520620060010F	Deer Creek	8/6/2002	120	ENT	108
OK520620060010F	Deer Creek	9/9/2002	140	ENT	108
OK520620060010F	Deer Creek	10/14/2002	<20	ENT	SBCR
OK520620060010F	Deer Creek	4/7/2003	<10	ENT	SBCR

WQM Station	Water Body Name	Date	Bacteria Concentration (#/100ml)	Bacteria Indicator	Criteria (#/100ml)
OK520620060010F	Deer Creek	5/12/2003	<10	ENT	108
OK520620060010F	Deer Creek	6/16/2003	540	ENT	108
OK520620060010F	Deer Creek	9/18/2001	10	FC	400

EC = E. coli; ENT = enterococci; FC = fecal coliform

SBCR indicates secondary body contact recreation, applicable from October 1 to April 30, for which numeric criteria are not specified

APPENDIX B
NPDES PERMIT DISCHARGE MONITORING REPORT DATA – 1997 TO 2005

Appendix B

NPDES Permit Discharge Monitoring Report Data 1997-2005

Permit	Monthly Average Concentration (cfu/100ml)	Daily Maximum Concentration (cfu/100ml)	Outfall	Report Date	Parameter Code	Parameter	Monthly Average Flow (MGD)	Monthly Maximum Flow (MGD)	Paramet er Code	Parameter
OK0021563	50	64	1	5/31/1999	74055	FC	0.893	1.089	50050	Flow
OK0021563	63.6	122	1	6/30/1999	74055	FC	0.92	1.212	50050	Flow
OK0021563	66.5	88	1	7/31/1999	74055	FC	0.94	1.225	50050	Flow
OK0021563	92	136	1	8/31/1999	74055	FC	0.957	1.087	50050	Flow
OK0021563	41.2	76	1	9/30/1999	74055	FC	0.924	1.119	50050	Flow
OK0021563	70.6	155	1	5/31/2000	74055	FC	0.76	0.977	50050	Flow
OK0021563	34.5	52	1	6/30/2000	74055	FC	0.866	1.266	50050	Flow
OK0021563	60	132	1	7/31/2000	74055	FC	0.929	1.216	50050	Flow
OK0021563	51	82	1	8/31/2000	74055	FC	0.926	1.165	50050	Flow
OK0021563	43.5	74	1	9/30/2000	74055	FC	0.915	1.038	50050	Flow
OK0021563	50	84	1	5/31/2001	74055	FC	0.995	1.263	50050	Flow
OK0021563	46.75	68	1	6/30/2001	74055	FC	0.9906	1.182	50050	Flow
OK0021563	66	106	1	7/31/2001	74055	FC	1.051	1.294	50050	Flow
OK0021563	53.6	72	1	8/31/2001	74055	FC	0.938	1.302	50050	Flow
OK0021563	50	104	1	9/30/2001	74055	FC	0.877	1.079	50050	Flow
OK0021563	46.4	68	1	5/31/2002	74055	FC	0.85	1.054	50050	Flow
OK0021563	106.5	224	1	6/30/2002	74055	FC	0.888	1.04	50050	Flow
OK0021563	38.8	64	1	7/31/2002	74055	FC	1.118	1.141	50050	Flow
OK0021563	31.5	70	1	8/31/2002	74055	FC	0.903	1.103	50050	Flow
OK0021563	23	44	1	9/30/2002	74055	FC	0.757	1.023	50050	Flow
OK0021563	32	36	1	5/31/2003	74055	FC	0.7869	0.925	50050	Flow
OK0021563	75	128	1	6/30/2003	74055	FC	0.8468	1.054	50050	Flow
OK0021563	65	106	1	7/31/2003	74055	FC	0.764	0.994	50050	Flow
OK0021563	30	32	1	8/31/2003	74055	FC	0.874	1.047	50050	Flow
OK0021563	43	54	1	9/30/2003	74055	FC	0.952	1.081	50050	Flow
OK0021563	54	84	1	5/31/2004	74055	FC	0.783	0.916	50050	Flow
OK0021563	49	62	1	6/30/2004	74055	FC	0.8645	1.063	50050	Flow
OK0021563	31	36	1	7/31/2004	74055	FC	0.8176	1.083	50050	Flow
OK0021563	40	46	1	8/31/2004	74055	FC	0.923	1.14	50050	Flow
OK0021563	25	32	1	9/30/2004	74055	FC	0.8669	1.035	50050	Flow
OK0028185			1	5/31/1998	74055	FC	0	0	50050	Flow
OK0028185			1	6/30/1998	74055	FC	0	0	50050	Flow
OK0028185			1	7/31/1998	74055	FC	0	0	50050	Flow
OK0028185			1	8/31/1998	74055	FC	0	0	50050	Flow
OK0028185			1	9/30/1998	74055	FC	0	0	50050	Flow
OK0028185			1	5/31/1999	74055	FC	0	0	50050	Flow
OK0028185			1	6/30/1999	74055	FC	0	0	50050	Flow
OK0028185			1	7/31/1999	74055	FC	0	0	50050	Flow
OK0028185			1	8/31/1999	74055	FC	0	0	50050	Flow
OK0028185			1	9/30/1999	74055	FC	0	0	50050	Flow
OK0028185			1	5/31/2000	74055	FC	0	0	50050	Flow
OK0028185			1	6/30/2000	74055	FC	0	0	50050	Flow
OK0028185			1	7/31/2000	74055	FC	0	0	50050	Flow

Permit	Monthly Average Concentration (cfu/100ml)	Daily Maximum Concentration (cfu/100ml)	Outfall	Report Date	Parameter Code	Parameter	Monthly Average Flow (MGD)	Monthly Maximum Flow (MGD)	Paramet er Code	Parameter
OK0028185			1	8/31/2000	74055	FC	0	0	50050	Flow
OK0028185			1	9/30/2000	74055	FC	0	0	50050	Flow
OK0028185			1	5/31/2001	74055	FC	0	0	50050	Flow
OK0028185			1	6/30/2001	74055	FC	0	0	50050	Flow
OK0028185			1	7/31/2001	74055	FC	0	0	50050	Flow
OK0028185			1	8/31/2001	74055	FC	0	0	50050	Flow
OK0028185			1	9/30/2001	74055	FC	0	0	50050	Flow
OK0028185			1	5/31/2002	74055	FC	0	0	50050	Flow
OK0028185			1	6/30/2002	74055	FC	0	0	50050	Flow
OK0028185			1	7/31/2002	74055	FC	0	0	50050	Flow
OK0028185			1	8/31/2002	74055	FC	0	0	50050	Flow
OK0028185			1	9/30/2002	74055	FC	0	0	50050	Flow
OK0028185			1	5/31/2003	74055	FC	0	0	50050	Flow
OK0028185			1	6/30/2003	74055	FC	0	0	50050	Flow
OK0028185			1	7/31/2003	74055	FC	0	0	50050	Flow
OK0028185			1	8/31/2003	74055	FC	0	0	50050	Flow
OK0028185			1	9/30/2003	74055	FC	0	0	50050	Flow
OK0028185			1	5/31/2004	74055	FC	0	0	50050	Flow
OK0028185			1	6/30/2004	74055	FC	0	0	50050	Flow
OK0028185			1	7/31/2004	74055	FC	0	0	50050	Flow
OK0028185			1	8/31/2004	74055	FC	0	0	50050	Flow
OK0028185			1	9/30/2004	74055	FC	0	0	50050	Flow
OK0028185	1175	1320	1	5/31/2005	74055	FC	0	0	50050	Flow
OK0028185	1380	2380	1	6/30/2005	74055	FC	0	0	50050	Flow
OK0028185	340	360	1	7/31/2005	74055	FC	0	0	50050	Flow
OK0028185	1470	2620	1	8/31/2005	74055	FC	0	0	50050	Flow
OK0028185	1290	1740	1	9/30/2005	74055	FC	0	0	50050	Flow

APPENDIX C
ESTIMATED FLOW EXCEEDANCE PERCENTILES

Appendix C

Estimated Flow Exceedance Percentiles by WQM Station (cfs)

Flows projected from USGS gage stations

	OK520620020010-001AT	OK520620010010G	OK520620010010K	OK520620010010P	OK520620010010S	OK520620010120G	OK520620020090G	OK520620030020C	OK520620030050G	OK520620030110G	OK520620040050D	OK520620050160C	OK520620060010F
USGS Gage Reference	07228500	07228500	07228500	07228500	07228500	07228500	07228500	07228500	07228500	07228500	07228500	07228500	7228400
Watershed Area (sq. mile)	23,978	24,892	24,444	24,310	24,281	20.6	45.1	29.2	4.2	10.7	107.4	56.1	310.5
NRCS Curve Number	64	65	65	64	64	75	67	63	64	71	55	59	76
Average Annual Rainfall (inch)	18.3	18.7	18.5	18.4	18.4	30.4	28.8	27.8	26.4	26.4	25.2	23.8	30.1
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)**
0	19224	42100	29001	25499	24857	69	92	55	6.3	26	69	41	5560
1	1872	4770	3479	3093	3018	7.9	10.4	6.3	0.7	3.0	7.8	4.7	864
2	1059	2480	1728	1562	1524	3.9	5.1	3.1	0.4	1.5	3.8	2.3	352
3	766	1700	1154	1061	1045	2.6	3.4	2	0.2	1	2.5	1.5	196
4	622	1280	941	862	847	2.1	2.7	1.6	0.2	0.8	2	1.2	145
5	525	1070	806	748	736	1.7	2.3	1.4	0.2	0.7	1.7	1	111
6	471	950	701	635	622	1.6	2.1	1.3	0.1	0.6	1.6	0.9	81
7	436	822	625	573	562	1.4	1.8	1.1	0.1	0.5	1.4	0.8	71
8	403	769	578	525	514	1.3	1.7	1	0.1	0.5	1.3	0.8	64
9	373	700	537	490	481	1.2	1.5	0.9	0.1	0.4	1.2	0.7	59
10	351	629	493	453	444	1.1	1.4	0.9	0.1	0.4	1.1	0.6	55
11	332	580	456	421	413	1	1.3	0.8	0.1	0.4	1	0.6	51
12	316	533	428	393	386	0.9	1.2	0.7	0.1	0.4	0.9	0.5	49
13	301	500	407	370	363	0.9	1.1	0.7	0.1	0.3	0.9	0.5	46
14	289	475	378	350	344	0.8	1.1	0.7	0.1	0.3	0.8	0.5	45
15	276	450	363	334	329	0.8	1	0.6	0.1	0.3	0.8	0.5	44
16	264	420	348	320	315	0.7	1	0.6	0.1	0.3	0.7	0.4	43
17	256	400	334	308	302	0.7	1	0.6	0.1	0.3	0.7	0.4	42
18	247	380	318	292	288	0.7	0.9	0.5	0.1	0.3	0.7	0.4	41
19	239	357	305	282	277	0.7	0.9	0.5	0.1	0.2	0.6	0.4	40
20	232	343	291	270	265	0.6	0.8	0.5	0.1	0.2	0.6	0.4	40
21	226	330	280	260	255	0.6	0.8	0.5	0.1	0.2	0.6	0.3	39
22	220	316	268	247	243	0.6	0.8	0.5	0.1	0.2	0.6	0.3	38
23	214	302	257	237	233	0.6	0.7	0.4	0.1	0.2	0.5	0.3	37
24	210	290	248	230	226	0.5	0.7	0.4	0	0.2	0.5	0.3	36
25	204	279	240	221	218	0.5	0.7	0.4	0	0.2	0.5	0.3	36
26	199	268	232	214	211	0.5	0.7	0.4	0	0.2	0.5	0.3	35
27	194	256	224	207	204	0.5	0.6	0.4	0	0.2	0.5	0.3	35
28	191	249	215	199	196	0.5	0.6	0.4	0	0.2	0.5	0.3	34
29	185	236	207	190	188	0.4	0.6	0.4	0	0.2	0.4	0.3	33
30	181	226	199	184	181	0.4	0.6	0.3	0	0.2	0.4	0.3	33
31	177	217	193	179	176	0.4	0.5	0.3	0	0.2	0.4	0.2	32
32	172	209	186	172	169	0.4	0.5	0.3	0	0.1	0.4	0.2	32
33	167	200	178	165	164	0.4	0.5	0.3	0	0.1	0.4	0.2	31
34	162	192	172	159	157	0.4	0.5	0.3	0	0.1	0.4	0.2	31
35	158	185	165	154	152	0.3	0.5	0.3	0	0.1	0.3	0.2	30
36	154	178	159	148	146	0.3	0.4	0.3	0	0.1	0.3	0.2	30
37	151	172	153	142	140	0.3	0.4	0.3	0	0.1	0.3	0.2	29
38	147	165	148	138	136	0.3	0.4	0.2	0	0.1	0.3	0.2	29
39	143	159	144	134	132	0.3	0.4	0.2	0	0.1	0.3	0.2	29
40	139	152	139	130	129	0.3	0.4	0.2	0	0.1	0.3	0.2	28
41	136	147	135	126	124	0.3	0.4	0.2	0	0.1	0.3	0.2	28
42	133	140	130	121	119	0.3	0.4	0.2	0	0.1	0.3	0.2	28
43	129	133	124	115	114	0.3	0.3	0.2	0	0.1	0.3	0.2	28
44	126	129	119	110	109	0.2	0.3	0.2	0	0.1	0.2	0.1	27
45	124	123	114	106	104	0.2	0.3	0.2	0	0.1	0.2	0.1	27
46	121	115	110	102	100	0.2	0.3	0.2	0	0.1	0.2	0.1	27
47	117	109	106	99	97	0.2	0.3	0.2	0	0.1	0.2	0.1	26
48	115	102	102	94	93	0.2	0.3	0.2	0	0.1	0.2	0.1	26
49	112	97	97	91	89	0.2	0.3	0.2	0	0.1	0.2	0.1	26
50	109	90	92	86	85	0.2	0.2	0.1	0	0.1	0.2	0.1	26
51	106	85	87	81	80	0.2	0.2	0.1	0	0.1	0.2	0.1	25
52	103	80	82	76	75	0.2	0.2	0.1	0	0.1	0.2	0.1	25
53	100	76	77	72	71	0.2	0.2	0.1	0	0.1	0.2	0.1	25
54	97	72	73	69	68	0.1	0.2	0.1	0	0.1	0.1	0.1	25
55	94	68	68	64	64	0.1	0.2	0.1	0	0.1	0.1	0.1	25
56	91	64	65	61	60	0.1	0.2	0.1	0	0.1	0.1	0.1	24
57	89	60	61	58	57	0.1	0.2	0.1	0	0	0.1	0.1	24
58	86	58	58	55	54	0.1	0.2	0.1	0	0	0.1	0.1	24
59	84	54	55	52	52	0.1	0.1	0.1	0	0	0.1	0.1	23
60	81	51	52	50	49	0.1	0.1	0.1	0	0	0.1	0.1	23
61	78	48	49	46	46	0.1	0.1	0.1	0	0	0.1	0.1	23
62	75	46	47	44	43	0.1	0.1	0.1	0	0	0.1	0.1	23
63	72	43	44	42	42	0.1	0.1	0.1	0	0	0.1	0.1	22
64	70	40	41	39	39	0.1	0.1	0.1	0	0	0.1	0	22
65	67	38	38	36	36	0.1	0.1	0.1	0	0	0.1	0	22
66	65	35	35	34	33	0.1	0.1	0.1	0	0	0.1	0	22
67	62	33	33	31	31	0.1	0.1	0.1	0	0	0.1	0	22
68	60	31	31	29	29	0.1	0.1	0	0	0	0.1	0	21
69	57	29	29	27	27	0.1	0.1	0	0	0	0.1	0	21
70	55	28	27	26	26	0.1	0.1	0	0	0	0.1	0	20
71	52	26	25	24	24	0	0.1	0	0	0	0	0	20
72	49	25	23	22	22	0	0.1	0	0	0	0	0	20

	OK520620020010-001AT	OK520620010010G	OK520620010010K	OK520620010010P	OK520620010010S	OK520620010120G	OK520620020090G	OK520620030020C	OK520620030050G	OK520620030110G	OK520620040050D	OK520620050160C	OK520620060010F
USGS Gage Reference	07228500	07228500	07228500	07228500	07228500	07228500	07228500	07228500	07228500	07228500	07228500	07228500	7228400
Watershed Area (sq. mile)	23,978	24,892	24,444	24,310	24,281	20.6	45.1	29.2	4.2	10.7	107.4	56.1	310.5
NRCS Curve Number	64	65	65	64	64	75	67	63	64	71	55	59	76
Average Annual Rainfall (inch)	18.3	18.7	18.5	18.4	18.4	30.4	28.8	27.8	26.4	26.4	25.2	23.8	30.1
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)**
73	47	23	21	20	20	0	0.1	0	0	0	0	0	20
74	43	22	20	18.9	18.8	0	0.1	0	0	0	0	0	19
75	40	20	19	17.9	17.6	0	0.1	0	0	0	0	0	19
76	36	19	17.6	16.7	16.3	0	0	0	0	0	0	0	18
77	33	18	16.2	15.1	15.1	0	0	0	0	0	0	0	18
78	32	16	15.2	14.4	14.2	0	0	0	0	0	0	0	18
79	29	16	14.3	13.6	13.3	0	0	0	0	0	0	0	17
80	26	15	13.3	12.4	12.2	0	0	0	0	0	0	0	17
81	25	14	12.4	11.8	11.7	0	0	0	0	0	0	0	16
82	23	13	11.4	11.3	11.2	0	0	0	0	0	0	0	16
83	22	13	10.7	10.4	10.4	0	0	0	0	0	0	0	15
84	20	12	10.1	9.4	9.4	0	0	0	0	0	0	0	14
85	18	11	9.5	8.7	8.5	0	0	0	0	0	0	0	14
86	17	10	8.6	8.3	8.2	0	0	0	0	0	0	0	13
87	15	9.7	8.1	7.5	7.5	0	0	0	0	0	0	0	12
88	14	9	7.4	6.8	6.7	0	0	0	0	0	0	0	12
89	13	8.2	6.7	6.2	6.1	0	0	0	0	0	0	0	11
90	12	7.4	5.7	5.6	5.5	0	0	0	0	0	0	0	11
91	10	6.5	4.7	4.2	4.1	0	0	0	0	0	0	0	10
92	9.3	5.6	3.8	3.6	3.5	0	0	0	0	0	0	0	9.6
93	8.4	5	2.7	2.4	2.3	0	0	0	0	0	0	0	9
94	7.2	4.3	1.9	1.8	1.7	0	0	0	0	0	0	0	8.7
95	5.8	3.6	0	0	0	0	0	0	0	0	0	0	8.4
96	4.8	2.7	0	0	0	0	0	0	0	0	0	0	7.8
97	3.6	1.4	0	0	0	0	0	0	0	0	0	0	7.4
98	2.2	0	0	0	0	0	0	0	0	0	0	0	6.9
99	0.9	0	0	0	0	0	0	0	0	0	0	0	6.4
100	0	0	0	0	0	0	0	0	0	0	0	0	5.8

Appendix C
General Methodology for Estimating Flow at WQM Stations

A flow duration curve will be developed using existing USGS measured flow where the data exist at the same location as the Oklahoma WQM station, or by estimating flow for WQM stations with no corresponding flow record. Flow data to support flow duration curves and load duration curves will be derived for each Oklahoma WQM station in the following priority:

v) In cases where a USGS flow gage coincides with, or occurs within one-half mile upstream or downstream of the Oklahoma WQM station.

a. If simultaneous daily flow data matching the water quality sample 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 gage. First, the most appropriate nearby stream gage is identified. All flow data are first log-transformed to linearize the data because flow data are highly skewed. Linear regressions are then developed between 1) daily streamflow at the gage to be filled/extended, and 2) streamflow at all gages within 95 miles that have at least 300 daily flow measurements on matching dates. The station with the best flow relationship, as indicated by the highest r-squared value, is selected as the index gage. R-squared indicates the fraction of the variance in flow explained by the regression. The regression is then used to estimate flow at the gage to be filled/extended from flow at the index station. Flows will not be estimated based on regressions with r-squared values less than 0.25, even if that is the best regression. In some cases, it will be necessary to fill/extend flow records from two or more index gages. The flow record will be filled/extended to the extent possible based on the best index gage (highest r-squared value), and remaining gaps will be filled from the next best index gage (second highest r-squared value), and so forth.

vi) In the case no coincident flow data are available for a WQM station, but flow gage(s) are present upstream and/or downstream, flows will be estimated for the WQM station from an upstream or downstream gage using a watershed area ratio method derived by delineating subwatersheds, and relying on the National Resources Conservation Service (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 (NED) 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 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 Table 7. 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 20 Feb 2004).

Table C-1 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 Low Intensity Residential	54	70	80	85
22 High Intensity Residential	77	85	90	92
23 Commercial/Industrial/Transportation	89	92	94	95
31 Bare Rock/Sand/Clay	25	25	25	25
32 Quarries/Strip Mines/Gravel Pits	0	0	0	0
33 Transitional	75	80	85	90
41 Deciduous Forest	37	48	57	63
42 Evergreen Forest	45	48	73	80
43 Mixed Forest	43	65	76	82
51 Shrubland	40	51	63	70
61 Orchards/Vineyards/Other	55	69	78	83
71 Grasslands/Herbaceous	40	51	63	70
81 Pasture/Hay	35	56	70	77
82 Row Crops	64	75	82	85
83 Small Grains	64	75	82	85
84 Fallow	40	51	63	70
85 Urban/Recreational Grasses	49	69	79	84
91 Woody Wetlands	100	100	100	100
92 Emergent Herbaceous Wetlands	100	100	100	100

d. Flow at the ungaged site is calculated from the gaged site. The NRCS runoff curve number equation is:

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

where:

Q = runoff (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:

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

e. 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, P_{gaged}. 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:

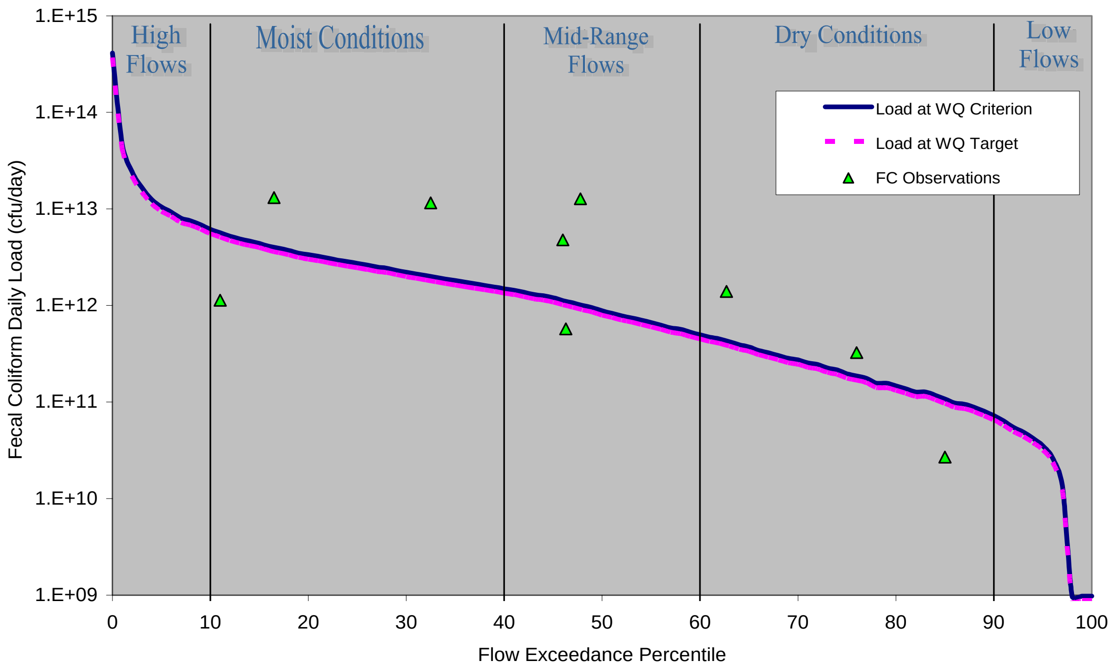
$$P_{ungaged} = P_{gaged}\left(\frac{M_{ungaged}}{M_{gaged}}\right) \qquad (5)$$

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.

vii) 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.

APPENDIX D
LDCS FOR ADDITIONAL SITES AND INDICATOR BACTERIA

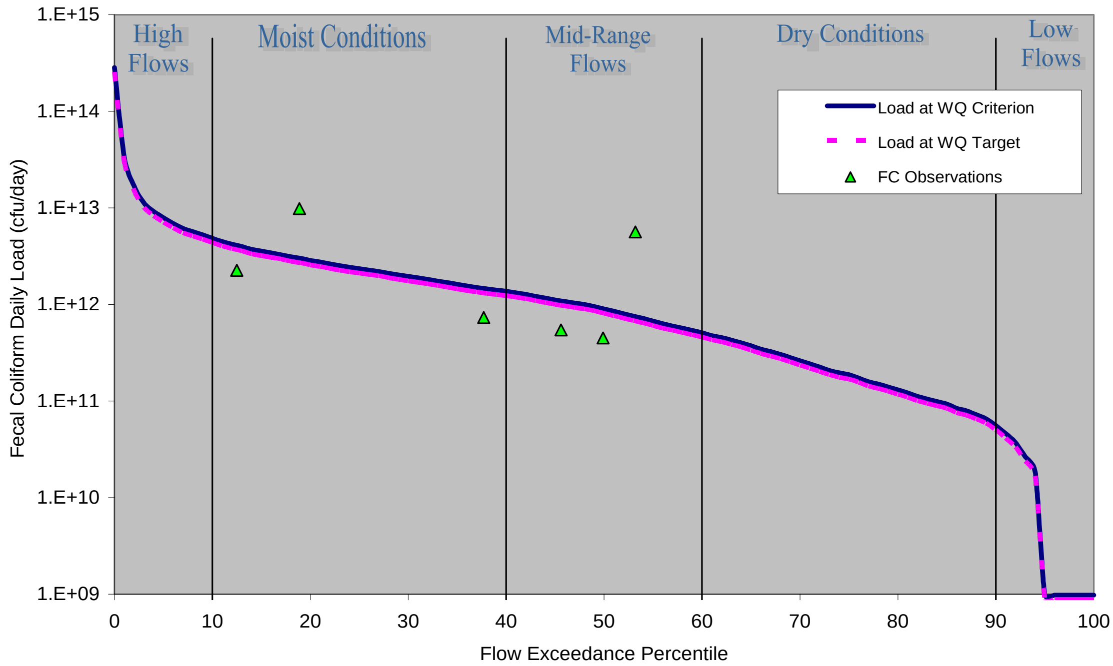
Load Duration Curve for Fecal Coliform in the Canadian River at Station OK520620010010G



Load Duration Curve Data for Fecal Coliform in the Canadian River at Station OK520620010010G

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620010010G	9/8/1997	5.73E+11	46.30	200	117
OK520620010010G	9/22/1997	4.78E+12	46.00	1700	115
OK520620010010G	5/4/1998	1.14E+12	11.00	80	580
OK520620010010G	5/18/1998	1.31E+13	16.50	1300	412
OK520620010010G	6/1/1998	1.15E+13	32.50	2300	205
OK520620010010G	6/15/1998	1.27E+13	47.80	5000	104
OK520620010010G	6/29/1998	1.40E+12	62.70	1300	44
OK520620010010G	7/27/1998	3.25E+11	76.00	700	19
OK520620010010G	8/10/1998	2.69E+10	85.00	100	11

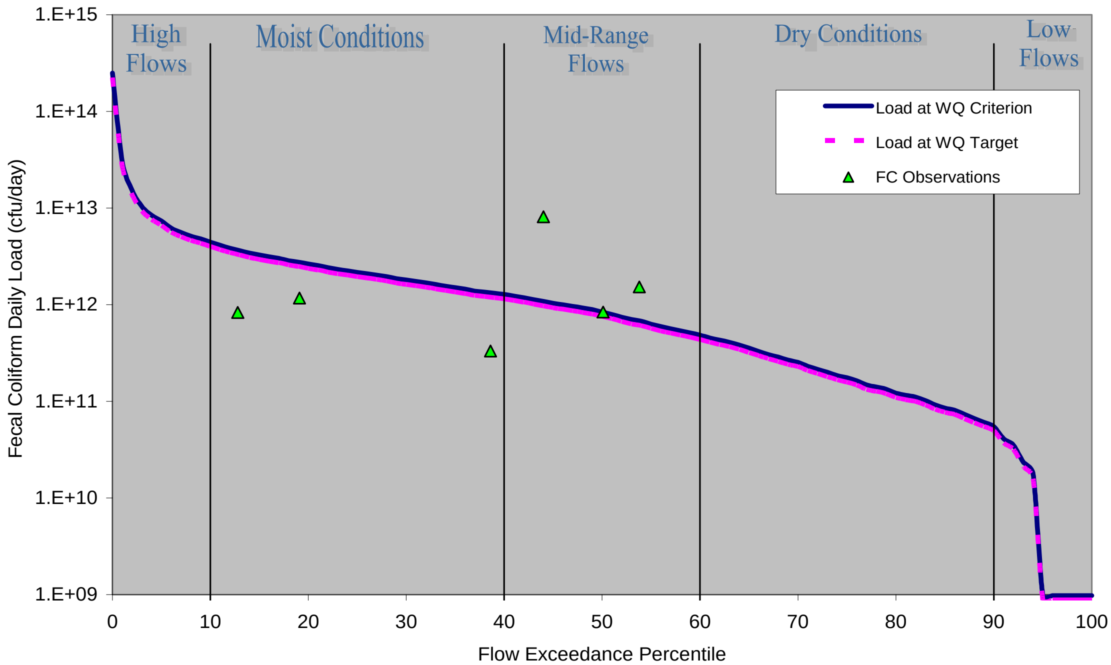
Load Duration Curve for Fecal Coliform in the Canadian River at Station OK520620010010K



Load Duration Curve Data for Fecal Coliform in the Canadian River at Station OK520620010010K

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620010010K	9/8/1997	4.51E+11	49.9	200	92
OK520620010010K	9/22/1997	5.46E+11	45.6	200	112
OK520620010010K	5/4/1998	2.25E+12	12.5	220	418
OK520620010010K	5/18/1998	9.80E+12	18.9	1,300	308
OK520620010010K	6/1/1998	7.34E+11	37.7	200	150
OK520620010010K	6/15/1998	5.62E+12	53.2	3,000	77

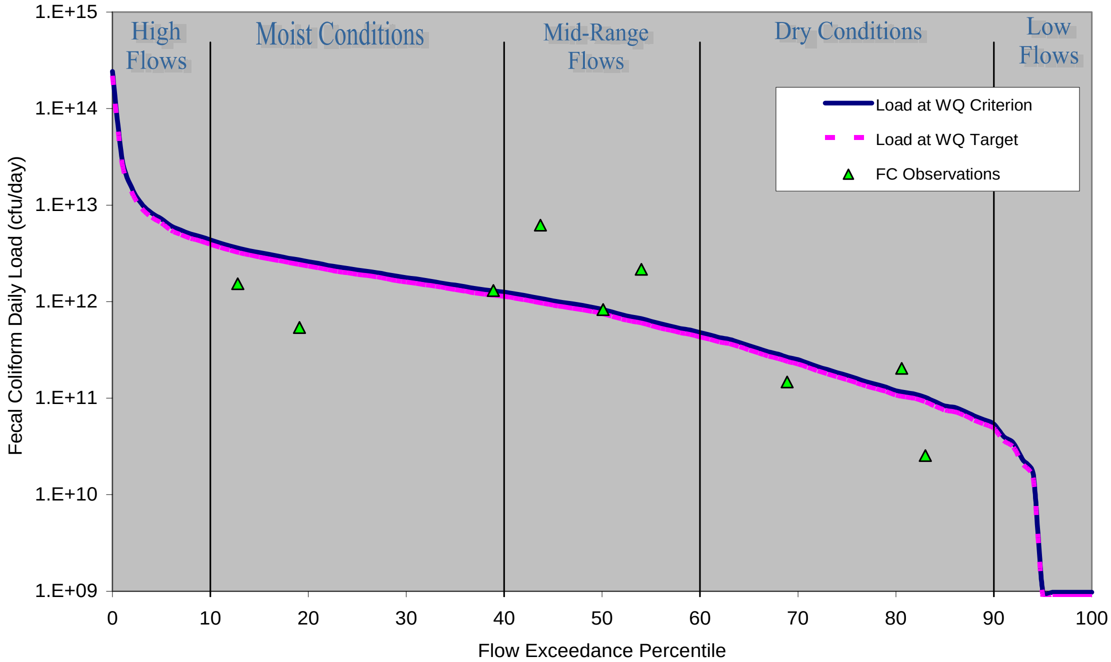
Load Duration Curve for Fecal Coliform in the Canadian River at Station OK520620010010P



Load Duration Curve Data for Fecal Coliform in the Canadian River at Station OK520620010010P

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620010010P	9/8/1997	8.37E+11	5.01E+01	400	85.5
OK520620010010P	9/22/1997	8.12E+12	4.40E+01	3000	110.6
OK520620010010P	5/4/1998	8.29E+11	1.28E+01	90	376.7
OK520620010010P	5/18/1998	1.17E+12	1.91E+01	170	281.3
OK520620010010P	6/1/1998	3.32E+11	3.86E+01	100	135.5
OK520620010010P	6/15/1998	1.53E+12	5.38E+01	900	69.4

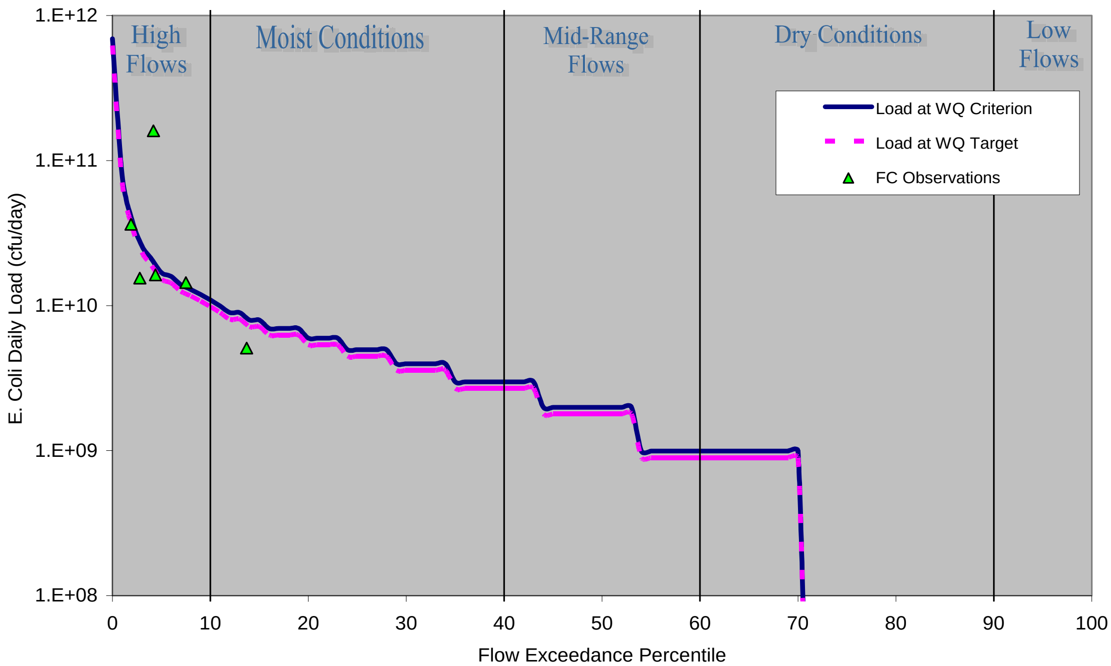
Load Duration Curve for Fecal Coliform in the Canadian River at Station OK520620010010S



Load Duration Curve Data for Fecal Coliform in the Canadian River at Station OK520620010010S

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620010010S	9/8/1997	8.25E+11	5.01E+01	400	84.3
OK520620010010S	9/22/1997	6.21E+12	4.37E+01	2300	110.4
OK520620010010S	5/4/1998	1.53E+12	1.28E+01	170	369
OK520620010010S	5/18/1998	5.40E+11	1.91E+01	80	276
OK520620010010S	6/1/1998	1.30E+12	3.89E+01	400	133
OK520620010010S	6/15/1998	2.17E+12	5.40E+01	1300	68.1
OK520620010010S	6/29/1998	1.47E+11	6.89E+01	220	27.3
OK520620010010S	7/27/1998	2.04E+11	8.06E+01	700	11.9
OK520620010010S	8/10/1998	2.54E+10	8.30E+01	100	10.4

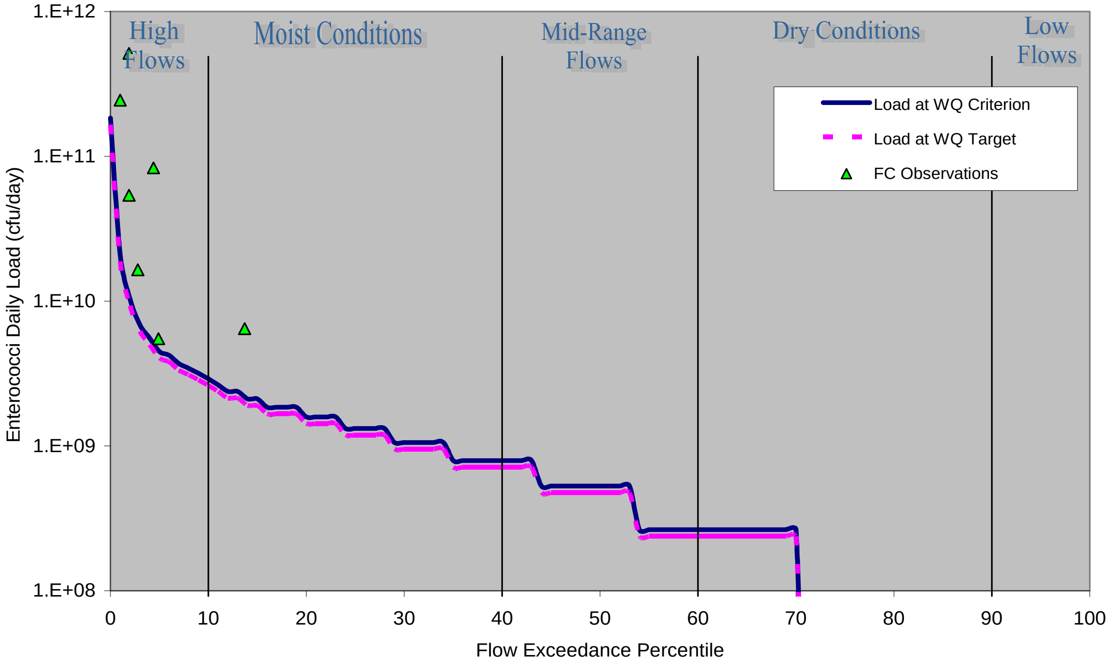
Load Duration Curve for *E. coli* in Bear Creek at Station OK520620010120G



Load Duration Curve Data for *E. coli* in Bear Creek at Station OK520620010120G

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620010120G	7/31/2000	1.55E+10	2.80E+00	226	3
OK520620010120G	9/5/2000	1.61E+11	4.20E+00	3,282	2
OK520620010120G	5/15/2001	3.64E+10	1.90E+00	354	4
OK520620010120G	6/19/2001	1.63E+10	4.40E+00	333	2
OK520620010120G	7/24/2001	1.44E+10	7.50E+00	420	1
OK520620010120G	8/28/2001	5.09E+09	1.37E+01	260	1

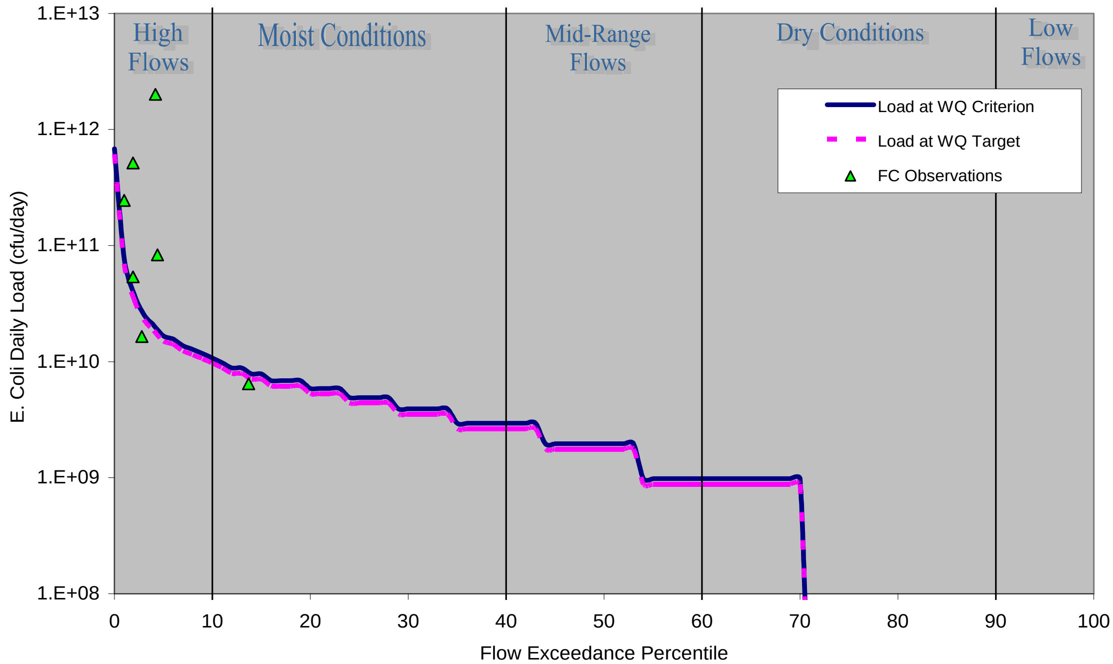
Load Duration Curve for *Enterococci* in Bear Creek at Station OK520620010120G



Load Duration Curve Data for *Enterococci* in Bear Creek at Station OK520620010120G

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620010120G	5/22/2000	5.38E+10	1.90E+00	500	4
OK520620010120G	6/26/2000	2.45E+11	1.00E+00	1,000	10
OK520620010120G	7/31/2000	1.64E+10	2.80E+00	240	3
OK520620010120G	9/5/2000	2.01E+12	4.20E+00	41,000	2
OK520620010120G	5/15/2001	5.14E+11	1.90E+00	5,000	4
OK520620010120G	6/19/2001	8.32E+10	4.40E+00	1,700	2
OK520620010120G	8/28/2001	6.46E+09	1.37E+01	330	1
OK520620010120G	11/6/2001	5.50E+09	4.90E+00	150	2

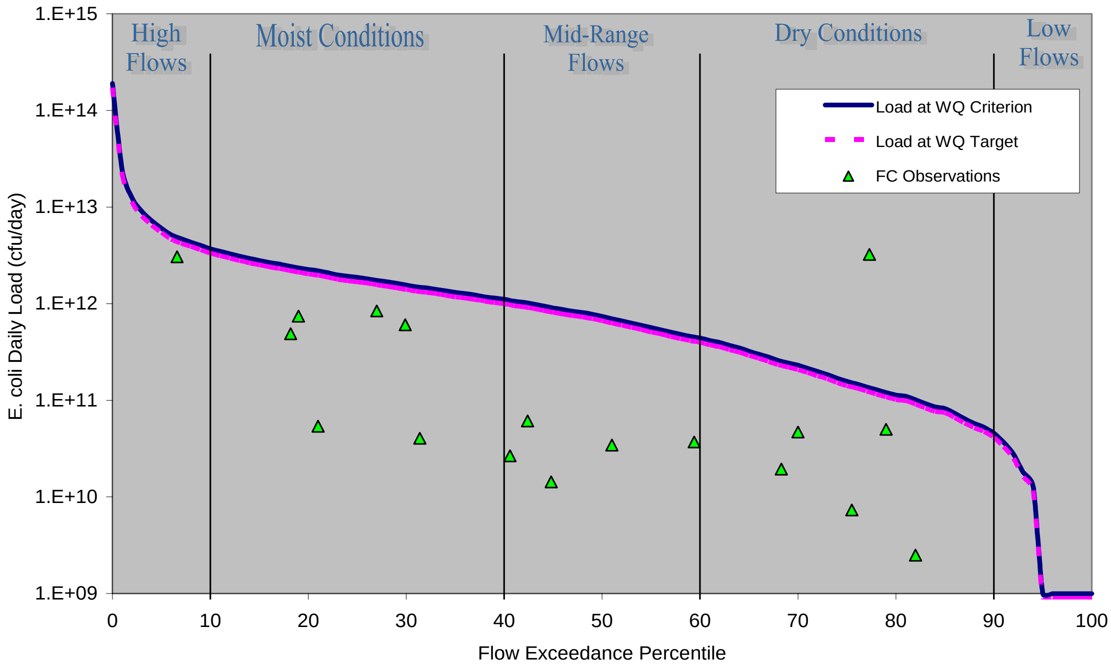
Load Duration Curve for Fecal Coliform in Bear Creek at Station OK520620010120G



Load Duration Curve Data for Fecal Coliform in Bear Creek at Station OK520620010120G

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620010120G	5/22/2000	5.38E+10	1.90	500	4
OK520620010120G	6/26/2000	2.45E+11	1.00	1,000	10
OK520620010120G	7/31/2000	1.64E+10	2.80	240	3
OK520620010120G	9/5/2000	2.01E+12	4.20	41,000	2
OK520620010120G	5/15/2001	5.14E+11	1.90	5,000	4
OK520620010120G	6/19/2001	8.32E+10	4.40	1,700	2
OK520620010120G	8/28/2001	6.46E+09	13.70	330	1

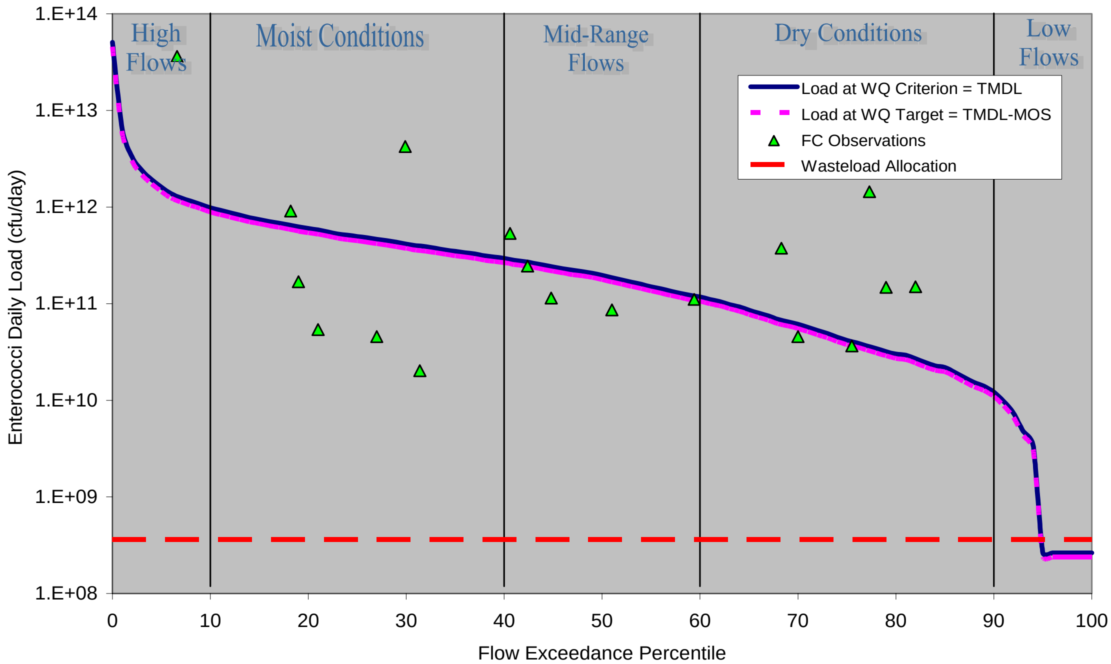
Load Duration Curve for *E. coli* in the Canadian River at Station OK520620020010_001AT



Load Duration Curve Data for *E. coli* in the Canadian River at Station OK520620020010_001AT

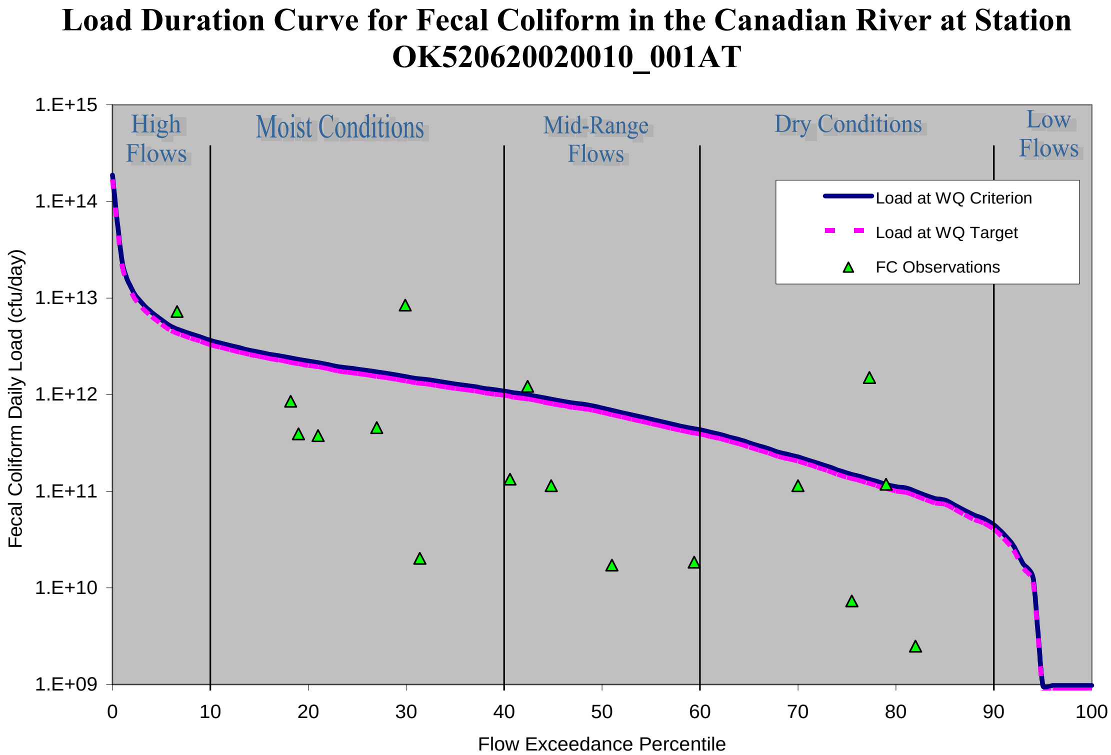
Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620020010_001AT	6/15/1999	8.43E+11	2.70E+01	185	186
OK520620020010_001AT	7/13/1999	4.05E+10	3.14E+01	10	166
OK520620020010_001AT	9/15/1999	3.24E+12	7.73E+01	5,172	26
OK520620020010_001AT	5/9/2000	7.43E+11	1.90E+01	132	230
OK520620020010_001AT	6/13/2000	4.90E+11	1.82E+01	86	233
OK520620020010_001AT	7/19/2000	4.68E+10	7.00E+01	41	47
OK520620020010_001AT	5/2/2001	6.05E+11	2.99E+01	143	173
OK520620020010_001AT	6/19/2001	1.43E+10	4.48E+01	5	117
OK520620020010_001AT	5/14/2002	3.70E+10	5.94E+01	20	76
OK520620020010_001AT	6/12/2002	6.12E+10	4.24E+01	20	125
OK520620020010_001AT	7/17/2002	7.32E+09	7.55E+01	10	30
OK520620020010_001AT	8/14/2002	5.00E+10	7.90E+01	169	12
OK520620020010_001AT	5/12/2003	3.44E+10	5.10E+01	20	70
OK520620020010_001AT	5/27/2003	2.67E+10	4.06E+01	10	109
OK520620020010_001AT	6/16/2003	3.06E+12	6.60E+00	253	495
OK520620020010_001AT	6/30/2003	5.38E+10	2.10E+01	10	220
OK520620020010_001AT	7/21/2003	1.94E+10	6.83E+01	31	26
OK520620020010_001AT	9/8/2003	2.50E+09	8.20E+01	10	10

Load Duration Curve for *Enterococci* in the Canadian River at Station OK520620020010_001AT



Load Duration Curve Data for *Enterococci* in the Canadian River at Station OK520620020010_001AT

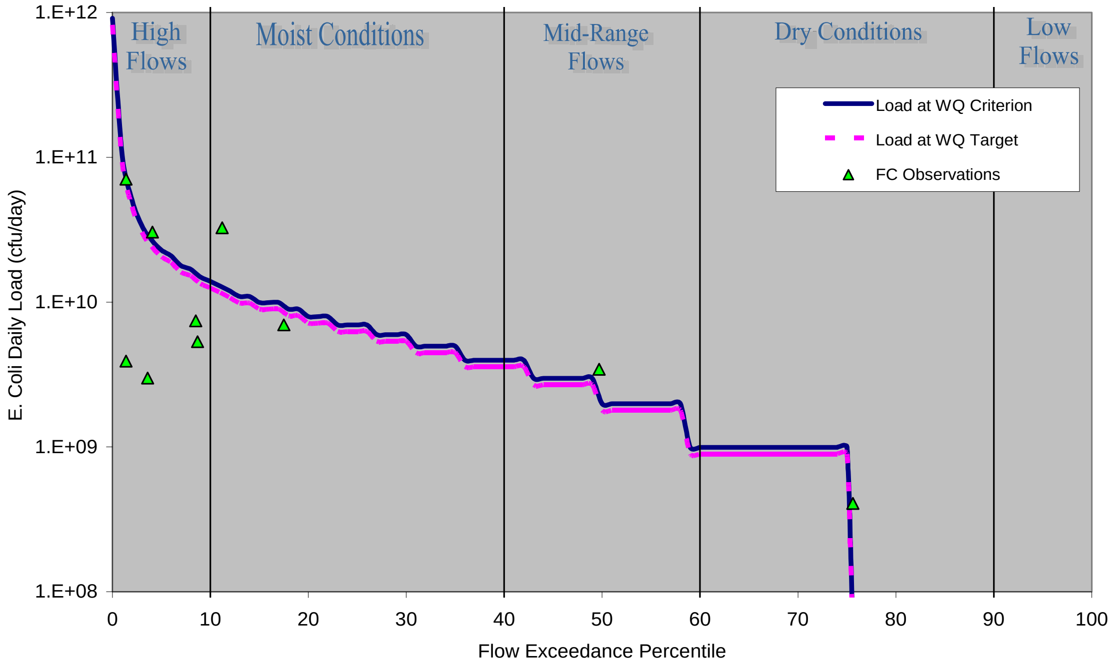
Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620020010_001AT	6/15/1999	4.56E+10	2.70E+01	10	186
OK520620020010_001AT	7/13/1999	2.02E+10	3.14E+01	5	166
OK520620020010_001AT	9/15/1999	1.44E+12	7.73E+01	2,300	26
OK520620020010_001AT	5/9/2000	1.69E+11	1.90E+01	30	230
OK520620020010_001AT	6/13/2000	9.12E+11	1.82E+01	160	233
OK520620020010_001AT	7/19/2000	4.57E+10	7.00E+01	40	47
OK520620020010_001AT	5/2/2001	4.23E+12	2.99E+01	1,000	173
OK520620020010_001AT	6/19/2001	1.15E+11	4.48E+01	40	117
OK520620020010_001AT	5/14/2002	1.11E+11	5.94E+01	60	76
OK520620020010_001AT	6/12/2002	2.45E+11	4.24E+01	80	125
OK520620020010_001AT	7/17/2002	3.66E+10	7.55E+01	50	30
OK520620020010_001AT	8/14/2002	1.48E+11	7.90E+01	500	12
OK520620020010_001AT	5/12/2003	8.61E+10	5.10E+01	50	70
OK520620020010_001AT	5/27/2003	5.33E+11	4.06E+01	200	109
OK520620020010_001AT	6/16/2003	3.63E+13	6.60E+00	3,000	495
OK520620020010_001AT	6/30/2003	5.38E+10	2.10E+01	10	220
OK520620020010_001AT	7/21/2003	3.76E+11	6.83E+01	600	26
OK520620020010_001AT	9/8/2003	1.50E+11	8.20E+01	600	10


Load Duration Curve for Fecal Coliform in the Canadian River at Station OK520620020010_001AT
1.E+15
1.E+14
1.E+13
1.E+12
1.E+11
1.E+10
1.E+09
Fecal Coliform Daily Load (cfu/day)
0
10
20
30
40
50
60
70
80
90
100
Flow Exceedance Percentile
High Flows
Moist Conditions
Mid-Range Flows
Dry Conditions
Low Flows
Load at WQ Criterion
Load at WQ Target
FC Observations

Load Duration Curve Data for Fecal Coliform in the Canadian River at Station OK520620020010_001AT

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620020010_001AT	6/15/1999	4.56E+11	2.70E+01	100	186
OK520620020010_001AT	7/13/1999	2.02E+10	3.14E+01	5	166
OK520620020010_001AT	9/15/1999	1.50E+12	7.73E+01	2,400	26
OK520620020010_001AT	5/9/2000	3.94E+11	1.90E+01	70	230
OK520620020010_001AT	6/13/2000	8.55E+11	1.82E+01	150	233
OK520620020010_001AT	7/19/2000	1.14E+11	7.00E+01	100	47
OK520620020010_001AT	5/2/2001	8.47E+12	2.99E+01	2,000	173
OK520620020010_001AT	6/19/2001	1.15E+11	4.48E+01	40	117
OK520620020010_001AT	5/14/2002	1.85E+10	5.94E+01	10	76
OK520620020010_001AT	6/12/2002	1.22E+12	4.24E+01	400	125
OK520620020010_001AT	7/17/2002	7.32E+09	7.55E+01	10	30
OK520620020010_001AT	8/14/2002	1.18E+11	7.90E+01	400	12
OK520620020010_001AT	5/12/2003	1.72E+10	5.10E+01	10	70
OK520620020010_001AT	5/27/2003	1.33E+11	4.06E+01	50	109
OK520620020010_001AT	6/16/2003	7.27E+12	6.60E+00	600	495
OK520620020010_001AT	6/30/2003	3.77E+11	2.10E+01	70	220
OK520620020010_001AT	9/8/2003	2.50E+09	8.20E+01	10	10

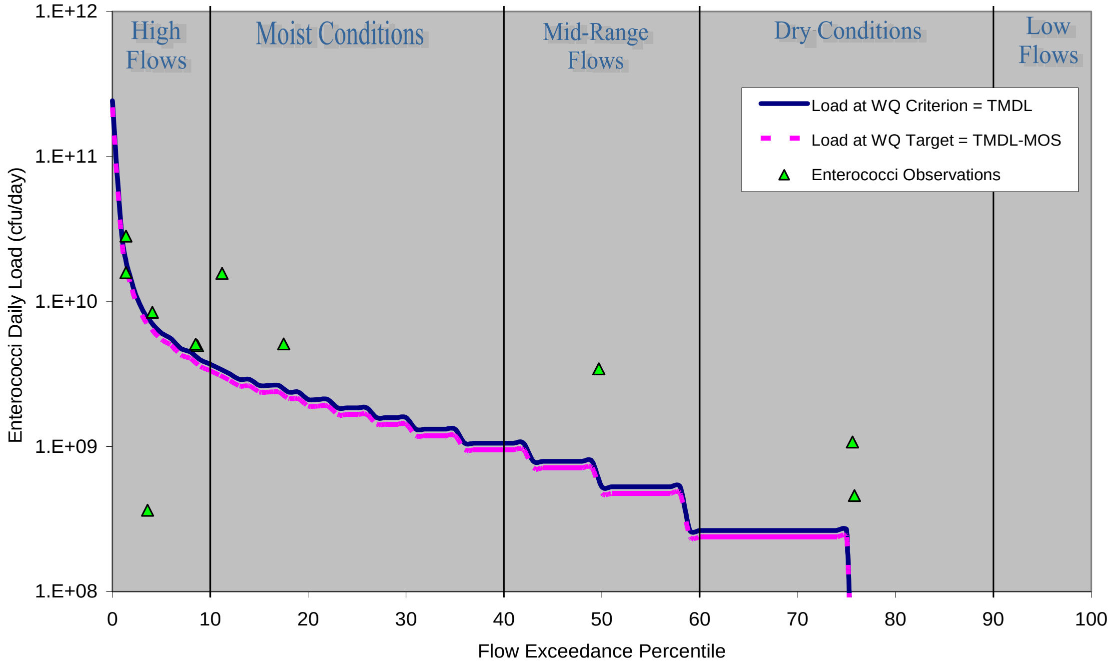
Load Duration Curve for *E. coli* in Trail Creek at Station OK520620020090G



Load Duration Curve Data for *E. coli* in Trail Creek at Station OK520620020090G

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620020090G	7/31/2000	2.99E+09	3.60E+00	41	3
OK520620020090G	9/5/2000	4.07E+08	7.56E+01	416	0
OK520620020090G	6/19/2001	3.91E+09	1.40E+00	74	2
OK520620020090G	7/24/2001	9.54E+07	7.58E+01	195	0
OK520620020090G	8/27/2001	3.26E+10	1.12E+01	1,040	1
OK520620020090G	5/29/2002	7.07E+10	1.40E+00	350	8
OK520620020090G	7/9/2002	5.34E+09	8.70E+00	140	2
OK520620020090G	8/6/2002	3.43E+09	4.97E+01	610	0
OK520620020090G	9/10/2002	6.97E+09	1.75E+01	300	1
OK520620020090G	5/13/2003	3.05E+10	4.10E+00	470	3
OK520620020090G	6/17/2003	7.44E+09	8.50E+00	190	2

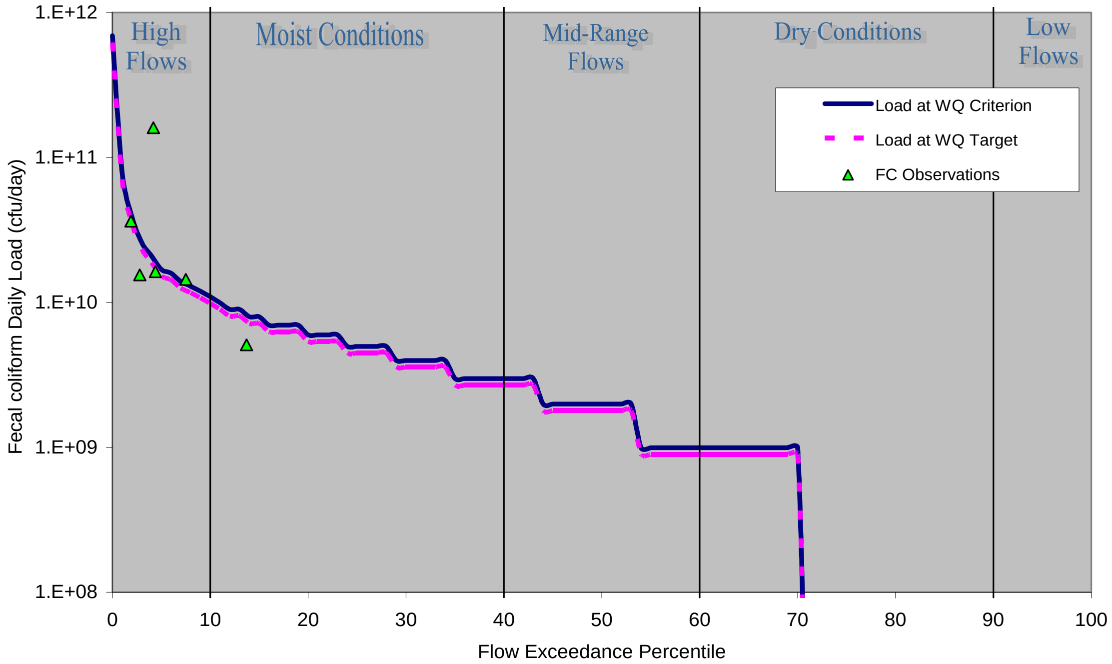
Load Duration Curve for *Enterococci* in Trail Creek at Station OK520620020090G



Load Duration Curve Data for *Enterococci* in Trail Creek at Station OK520620020090G

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620020090G	7/31/2000	3.65E+08	3.60E+00	5	3
OK520620020090G	9/5/2000	1.08E+09	7.56E+01	1,100	0
OK520620020090G	6/19/2001	1.59E+10	1.40E+00	300	2
OK520620020090G	7/24/2001	4.60E+08	7.58E+01	940	0
OK520620020090G	8/27/2001	1.57E+10	1.12E+01	500	1
OK520620020090G	5/29/2002	2.83E+10	1.40E+00	140	8
OK520620020090G	7/9/2002	4.96E+09	8.70E+00	130	2
OK520620020090G	8/6/2002	3.43E+09	4.97E+01	610	0
OK520620020090G	9/10/2002	5.11E+09	1.75E+01	220	1
OK520620020090G	5/13/2003	8.43E+09	4.10E+00	130	3
OK520620020090G	6/17/2003	5.09E+09	8.50E+00	130	2

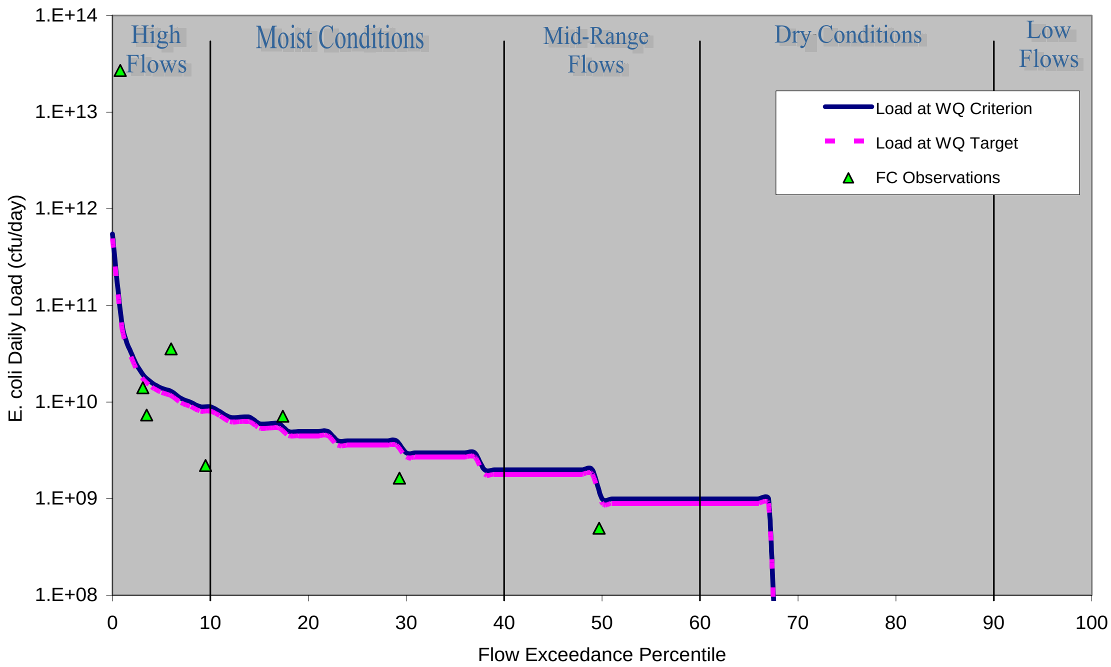
Load Duration Curve for Fecal Coliform in Trail Creek at Station OK520620020090G



Load Duration Curve Data for Fecal Coliform in Trail Creek at Station OK520620020090G

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620020090G	7/31/2000	1.55E+10	2.80E+00	226	3
OK520620020090G	9/5/2000	1.61E+11	4.20E+00	3,282	2
OK520620020090G	5/15/2001	3.64E+10	1.90E+00	354	4
OK520620020090G	6/19/2001	1.63E+10	4.40E+00	333	2
OK520620020090G	7/24/2001	1.44E+10	7.50E+00	420	1
OK520620020090G	8/28/2001	5.09E+09	1.37E+01	260	1

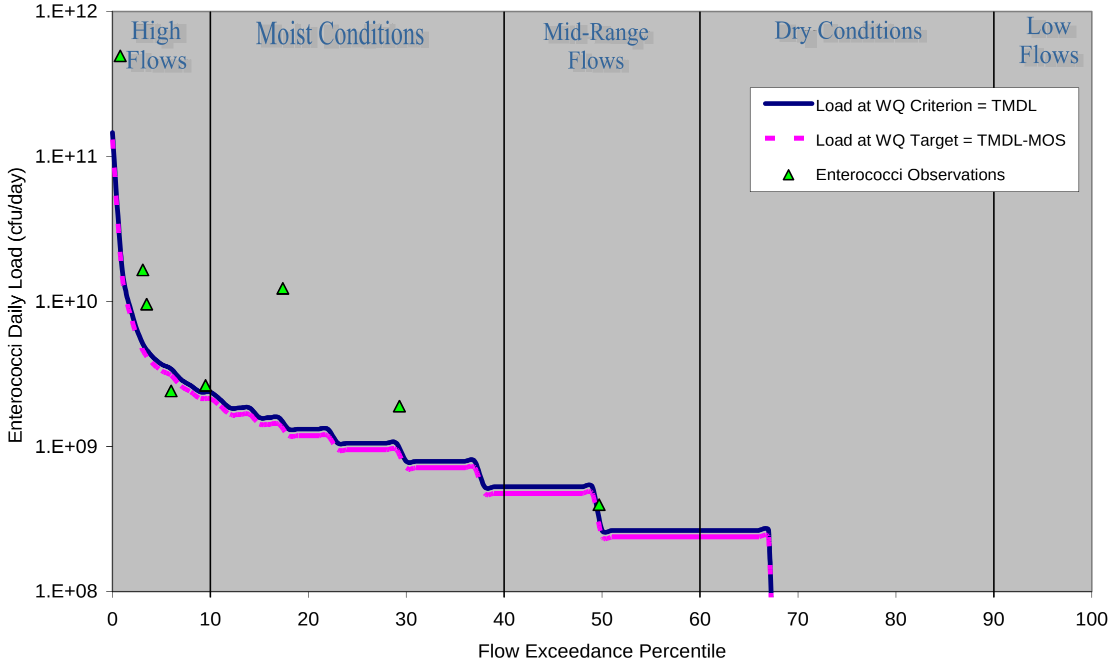
Load Duration Curve for *E. coli* in Lone Creek at Station OK520620030020C



Load Duration Curve Data for *E. coli* in Lone Creek at Station OK520620030020C

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620030020C	8/14/2001	4.93E+08	4.97E+01	155	0
OK520620030020C	9/18/2001	2.71E+13	8.00E-01	71,600	15
OK520620030020C	5/29/2002	7.32E+09	3.50E+00	160	2
OK520620030020C	7/9/2002	1.40E+10	3.10E+00	280	2
OK520620030020C	8/6/2002	7.12E+09	1.74E+01	520	1
OK520620030020C	9/10/2002	1.63E+09	2.93E+01	180	0
OK520620030020C	5/13/2003	3.55E+10	6.00E+00	1,320	1
OK520620030020C	6/17/2003	2.20E+09	9.50E+00	100	1

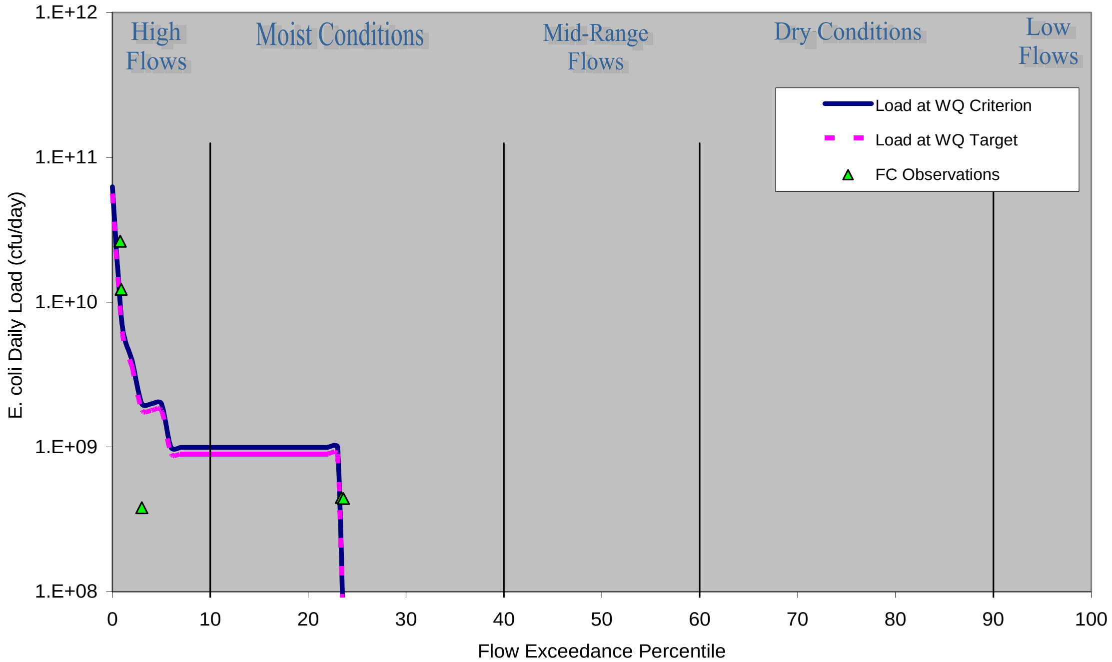
Load Duration Curve for *Enterococci* in Lone Creek at Station OK520620030020C



Load Duration Curve Data for *Enterococci* in Lone Creek at Station OK520620030020C

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620030020C	8/14/2001	3.98E+08	4.97E+01	125	0
OK520620030020C	9/18/2001	4.95E+11	8.00E-01	1,310	15
OK520620030020C	5/29/2002	9.61E+09	3.50E+00	210	2
OK520620030020C	7/9/2002	1.66E+10	3.10E+00	330	2
OK520620030020C	8/6/2002	1.23E+10	1.74E+01	900	1
OK520620030020C	9/10/2002	1.90E+09	2.93E+01	210	0
OK520620030020C	5/13/2003	2.42E+09	6.00E+00	90	1.1
OK520620030020C	6/17/2003	2.64E+09	9.50E+00	120	0.9

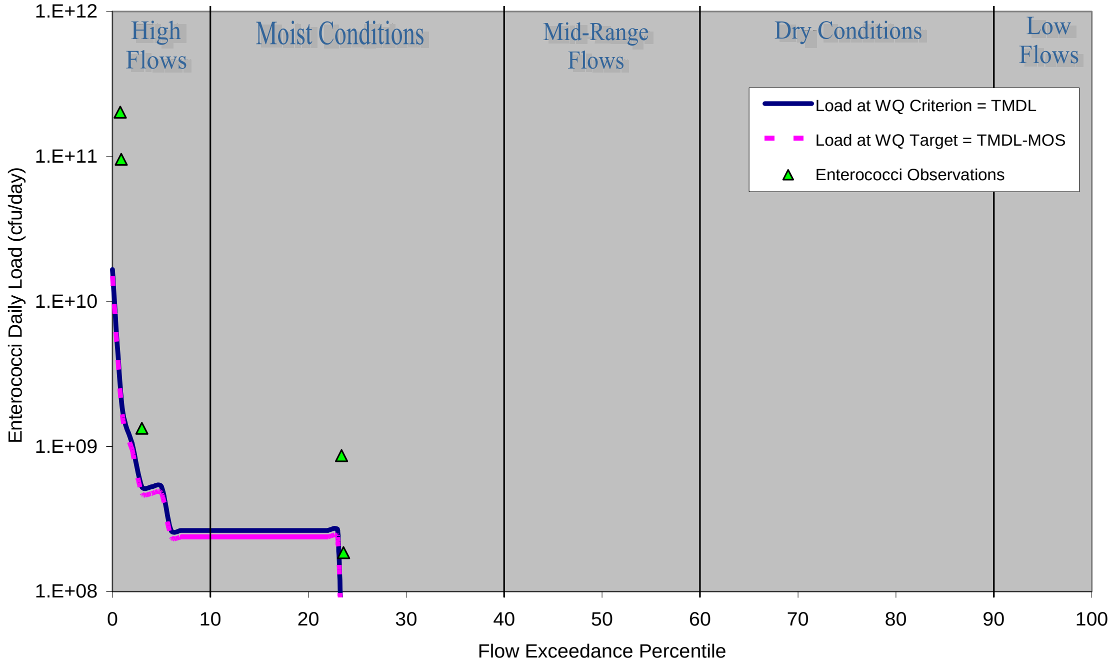
Load Duration Curve for *E. coli* in Red Trail Creek at Station OK520620030050G



Load Duration Curve Data for *E. coli* in Red Trail Creek at Station OK520620030050G

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620030050G	7/31/2000	3.80E+08	3.00E+00	74	0
OK520620030050G	5/14/2001	2.63E+10	8.00E-01	520	2
OK520620030050G	6/19/2001	1.23E+10	9.00E-01	512	1
OK520620030050G	7/24/2001	4.48E+08	2.34E+01	305	0
OK520620030050G	8/28/2001	4.40E+08	2.36E+01	450	0

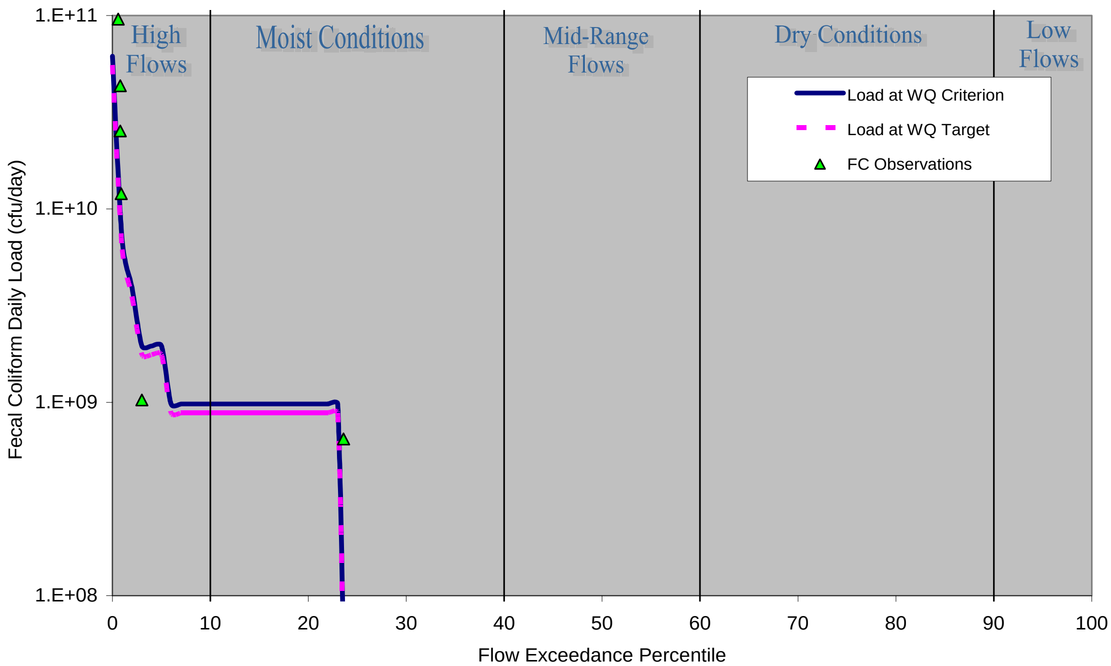
Load Duration Curve for *Enterococci* in Red Trail Creek at Station OK520620030050G



Load Duration Curve Data for *Enterococci* in Red Trail Creek at Station OK520620030050G

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620030050G	7/31/2000	1.34E+09	3.00E+00	260	0
OK520620030050G	5/14/2001	2.03E+11	8.00E-01	4,000	2
OK520620030050G	6/19/2001	9.59E+10	9.00E-01	4,000	1
OK520620030050G	7/24/2001	8.66E+08	2.34E+01	590	0
OK520620030050G	8/28/2001	1.86E+08	2.36E+01	190	0

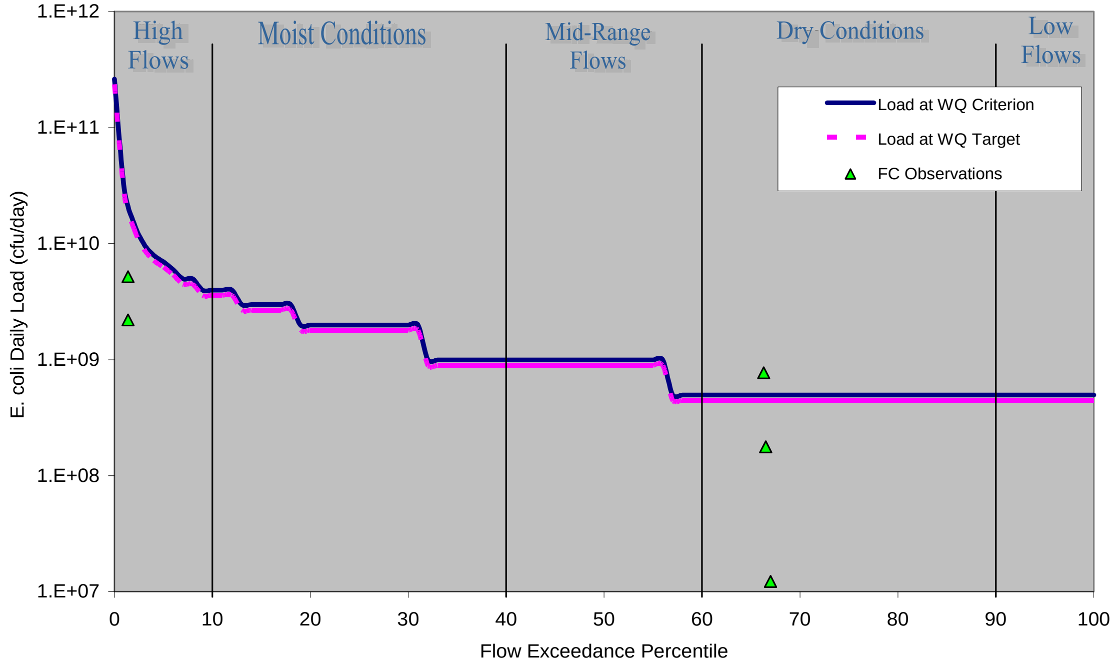
Load Duration Curve for Fecal Coliform in Red Trail Creek at Station OK520620030050G



Load Duration Curve Data for Fecal Coliform in Red Trail Creek at Station OK520620030050G

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620030050G	5/22/2000	4.33E+10	8.00E-01	1,100	2
OK520620030050G	6/26/2000	9.59E+10	6.00E-01	1,400	3
OK520620030050G	7/31/2000	1.03E+09	3.00E+00	200	0
OK520620030050G	5/14/2001	2.53E+10	8.00E-01	500	2
OK520620030050G	6/19/2001	1.20E+10	9.00E-01	500	1
OK520620030050G	8/28/2001	6.46E+08	2.36E+01	660	0

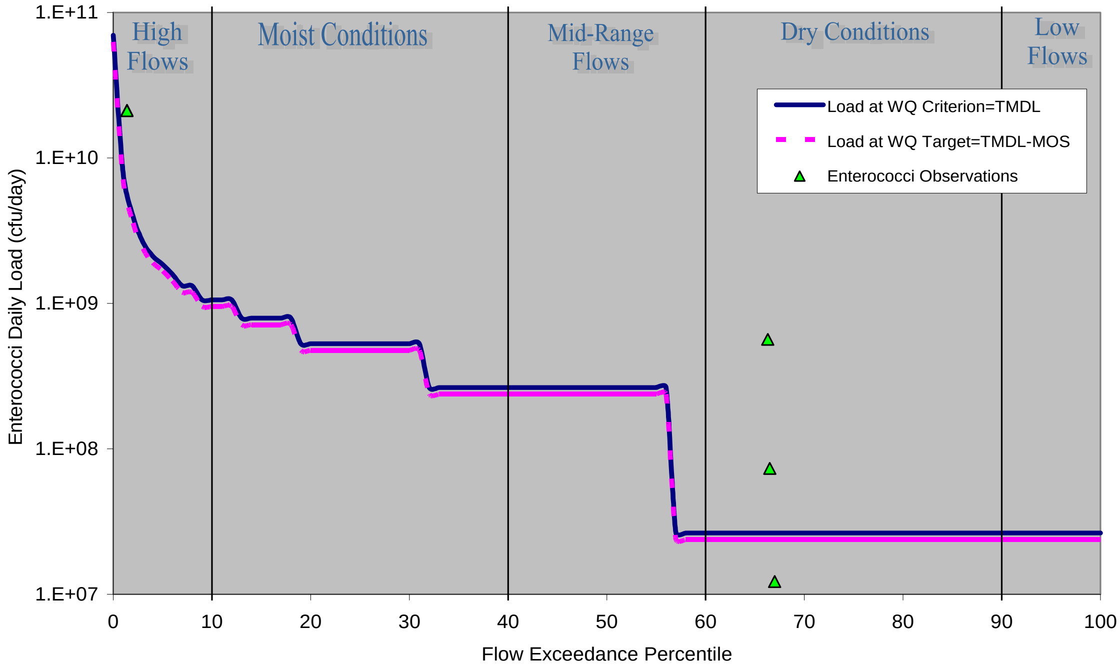
Load Duration Curve for *E. coli* in Red Creek at Station OK520620030110G



Load Duration Curve Data for *E. coli* in Red Creek at Station OK520620030110G

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620030110G	9/5/2000	1.22E+07	6.70E+01	10	0
OK520620030110G	5/14/2001	5.19E+09	1.40E+00	122	2
OK520620030110G	6/19/2001	2.20E+09	1.40E+00	52	2
OK520620030110G	7/24/2001	1.77E+08	6.65E+01	145	0
OK520620030110G	8/28/2001	7.71E+08	6.63E+01	450	0

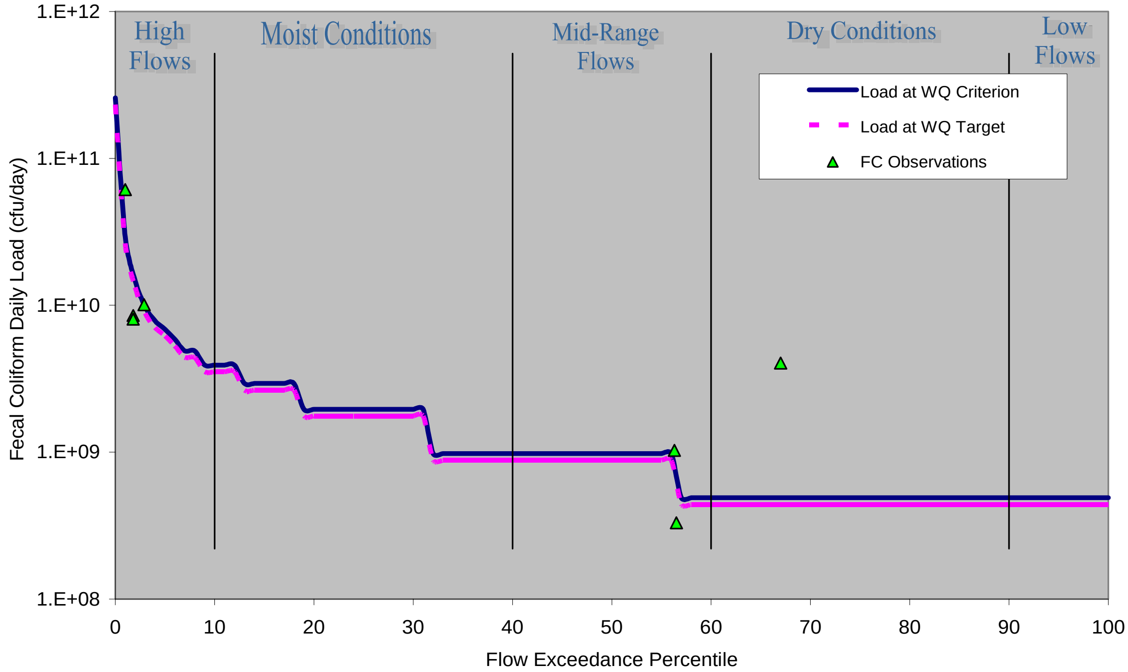
Load Duration Curve for *Enterococci* in Red Creek at Station OK520620030110G



Load Duration Curve Data for *Enterococci* in Red Creek at Station OK520620030110G

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620030110G	9/5/2000	1.22E+07	6.70E+01	50	0
OK520620030110G	5/14/2001	2.13E+10	1.40E+00	500	2
OK520620030110G	6/19/2001	2.12E+10	1.40E+00	500	2
OK520620030110G	7/24/2001	7.34E+07	6.65E+01	60	0
OK520620030110G	8/28/2001	5.65E+08	6.63E+01	330	0

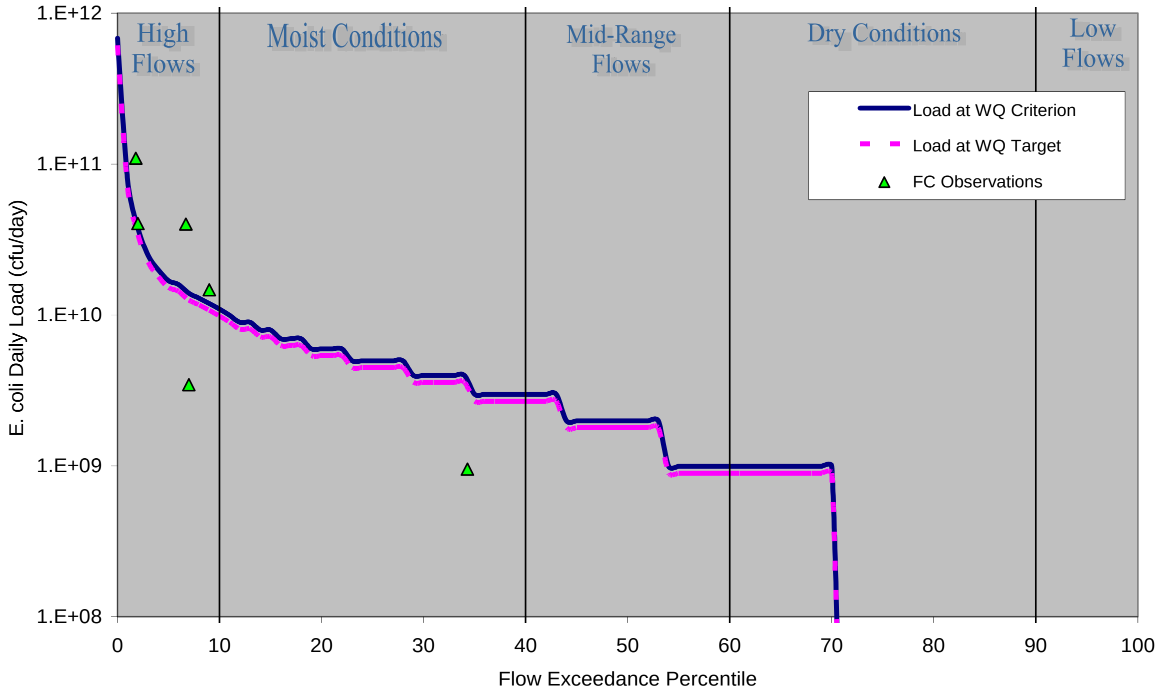
Load Duration Curve for Fecal Coliform in Red Creek at Station OK520620030110G



Load Duration Curve Data for Fecal Coliform in Red Creek at Station OK520620030110G

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620030110G	5/22/2000	1.01E+10	2.90E+00	400	1
OK520620030110G	6/26/2000	6.13E+10	1.00E+00	800	3
OK520620030110G	9/5/2000	4.04E+09	6.70E+01	3300	0
OK520620030110G	5/14/2001	8.51E+09	1.80E+00	200	2
OK520620030110G	6/19/2001	8.04E+09	1.80E+00	190	2
OK520620030110G	7/24/2001	3.30E+08	5.65E+01	270	0
OK520620030110G	8/28/2001	1.03E+09	5.63E+01	600	0

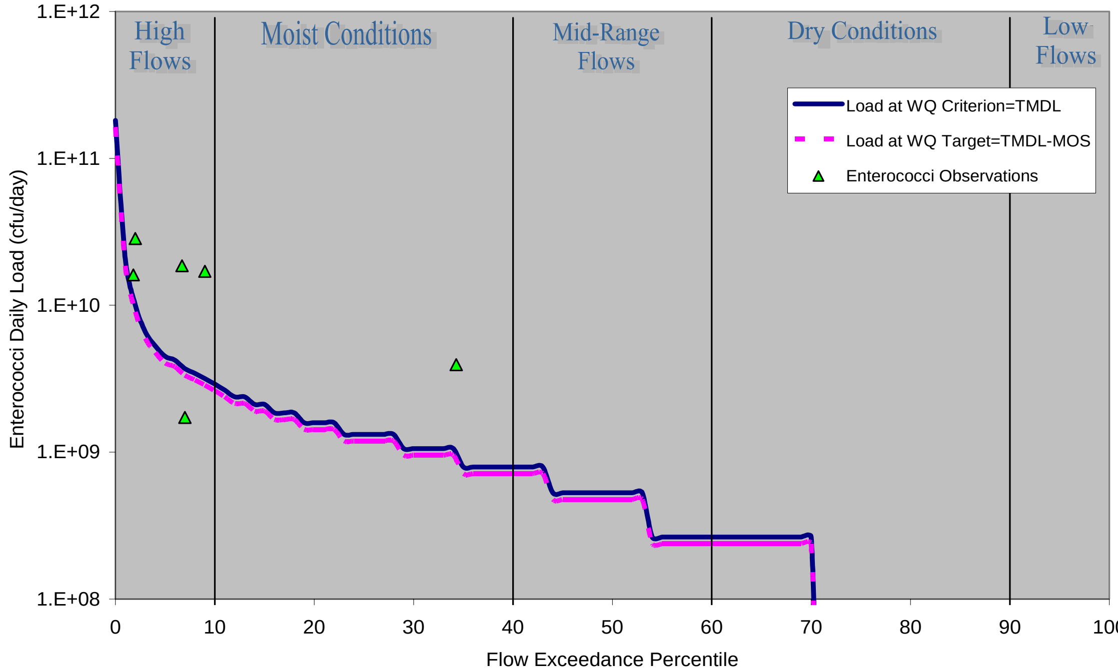
Load Duration Curve for *E. coli* in Hackberry Creek at Station OK520620040050D



Load Duration Curve Data for *E. coli* in Hackberry Creek at Station OK520620040050D

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620040050D	8/14/2001	9.50E+08	3.43E+01	105	0
OK520620040050D	9/18/2001	4.00E+10	6.70E+00	1,120	1
OK520620040050D	5/29/2002	1.09E+11	1.80E+00	950	4.7
OK520620040050D	7/9/2002	4.04E+10	2.00E+00	440	3.75
OK520620040050D	5/13/2003	3.45E+09	7.00E+00	100	1.41
OK520620040050D	6/17/2003	1.47E+10	9.00E+00	500	1.2

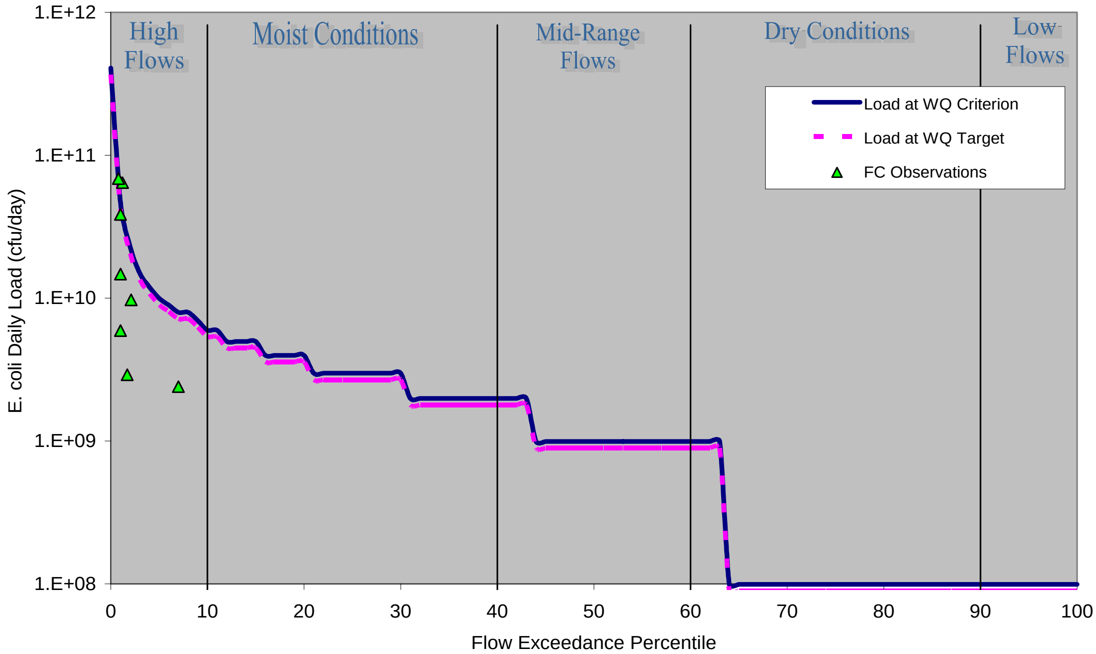
Load Duration Curve for *Enterococci* in Hackberry Creek at Station OK520620040050D



Load Duration Curve Data for *Enterococci* in Hackberry Creek at Station OK520620040050D

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620040050D	8/14/2001	3.94E+09	3.43E+01	435	0
OK520620040050D	9/18/2001	1.86E+10	6.70E+00	520	1
OK520620040050D	5/29/2002	1.61E+10	1.80E+00	140	4.7
OK520620040050D	7/9/2002	2.84E+10	2.00E+00	310	3.75
OK520620040050D	5/13/2003	1.72E+09	7.00E+00	50	1.41
OK520620040050D	6/17/2003	1.70E+10	9.00E+00	580	1.2

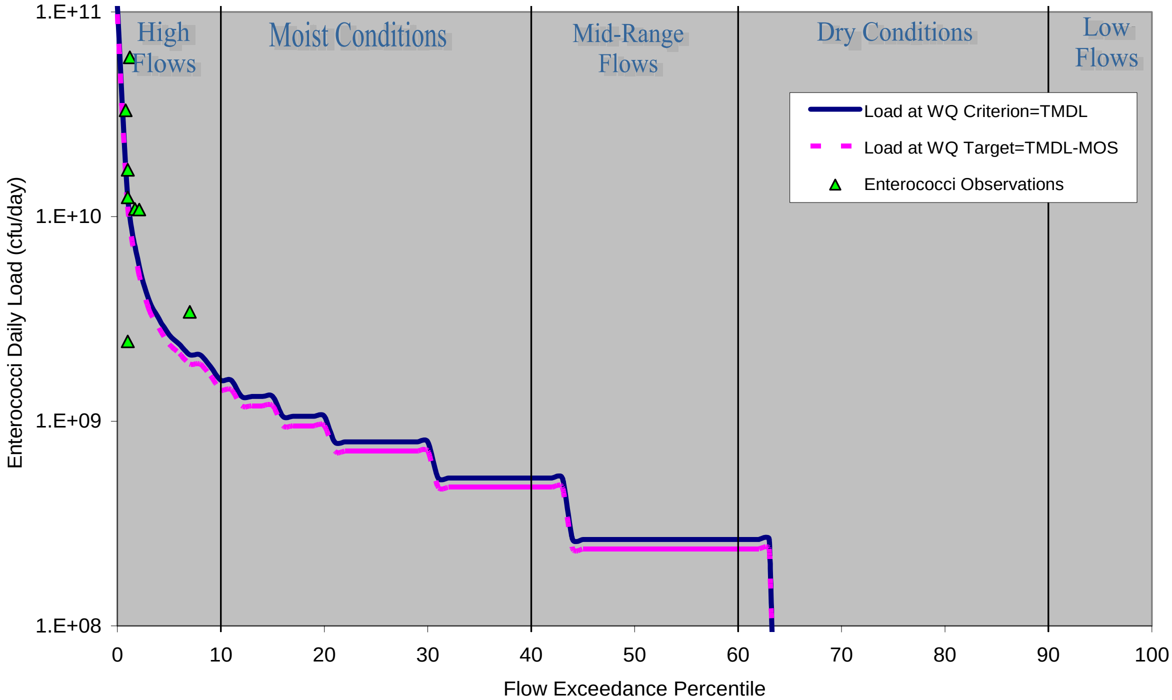
Load Duration Curve for *E. coli* in Commission Creek at Station OK520620050160C



Load Duration Curve Data for *E. coli* in Commission Creek at Station OK520620050160C

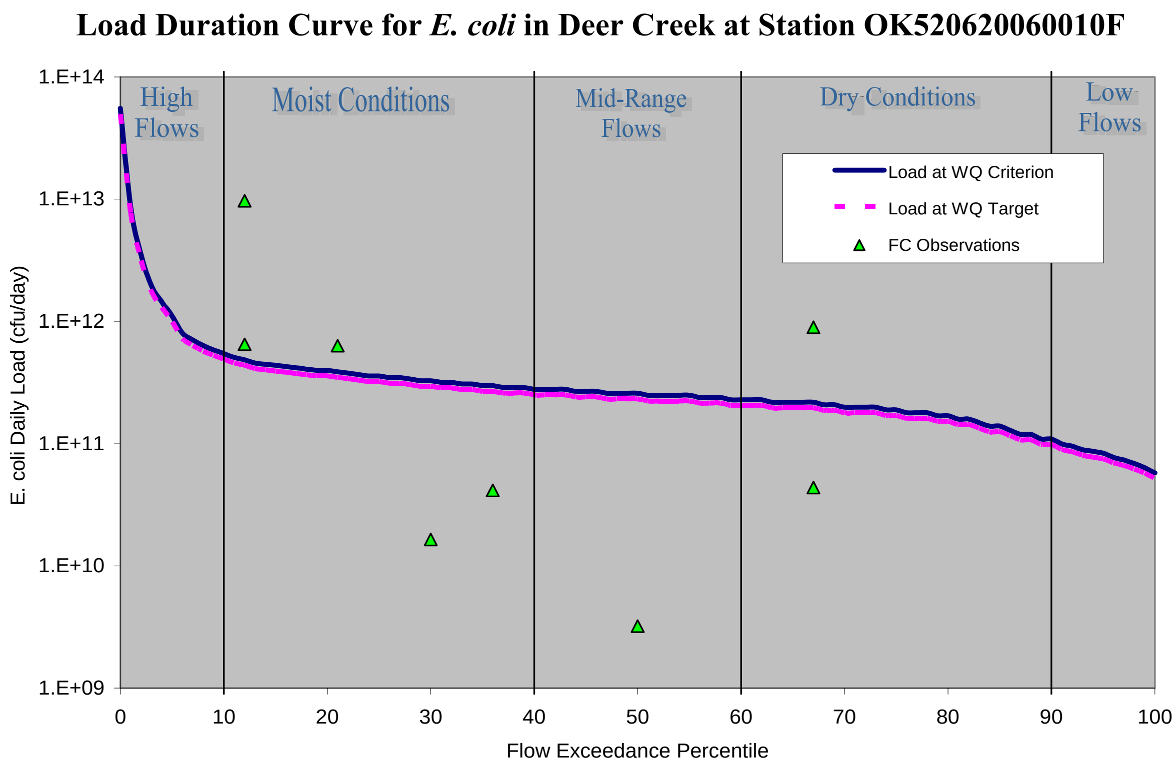
Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620050160C	8/14/2001	2.91E+09	1.70E+00	40	3
OK520620050160C	9/18/2001	6.42E+10	1.20E+00	620	4
OK520620050160C	5/29/2002	6.86E+10	8.00E-01	270	10.38
OK520620050160C	7/9/2002	3.86E+10	1.00E+00	280	5.63
OK520620050160C	8/6/2002	9.73E+09	2.10E+00	180	2.21
OK520620050160C	9/10/2002	5.93E+09	1.00E+00	70	3.46
OK520620050160C	5/13/2003	1.47E+10	1.00E+00	120	5.02
OK520620050160C	6/17/2003	2.40E+09	7.00E+00	140	0.7

Load Duration Curve for *Enterococci* in Commission Creek at Station OK520620050160C



Load Duration Curve Data for *Enterococci* in Commission Creek at Station OK520620050160C

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620050160C	8/14/2001	1.09E+10	1.70E+00	150	2.97
OK520620050160C	9/18/2001	6.00E+10	1.20E+00	580	4.23
OK520620050160C	5/29/2002	3.30E+10	8.00E-01	130	10.38
OK520620050160C	7/9/2002	1.24E+10	1.00E+00	90	5.63
OK520620050160C	8/6/2002	1.08E+10	2.10E+00	200	2.21
OK520620050160C	9/10/2002	1.69E+10	1.00E+00	200	3.46
OK520620050160C	5/13/2003	2.46E+09	1.00E+00	20	5.02
OK520620050160C	6/17/2003	3.43E+09	7.00E+00	200	0.7

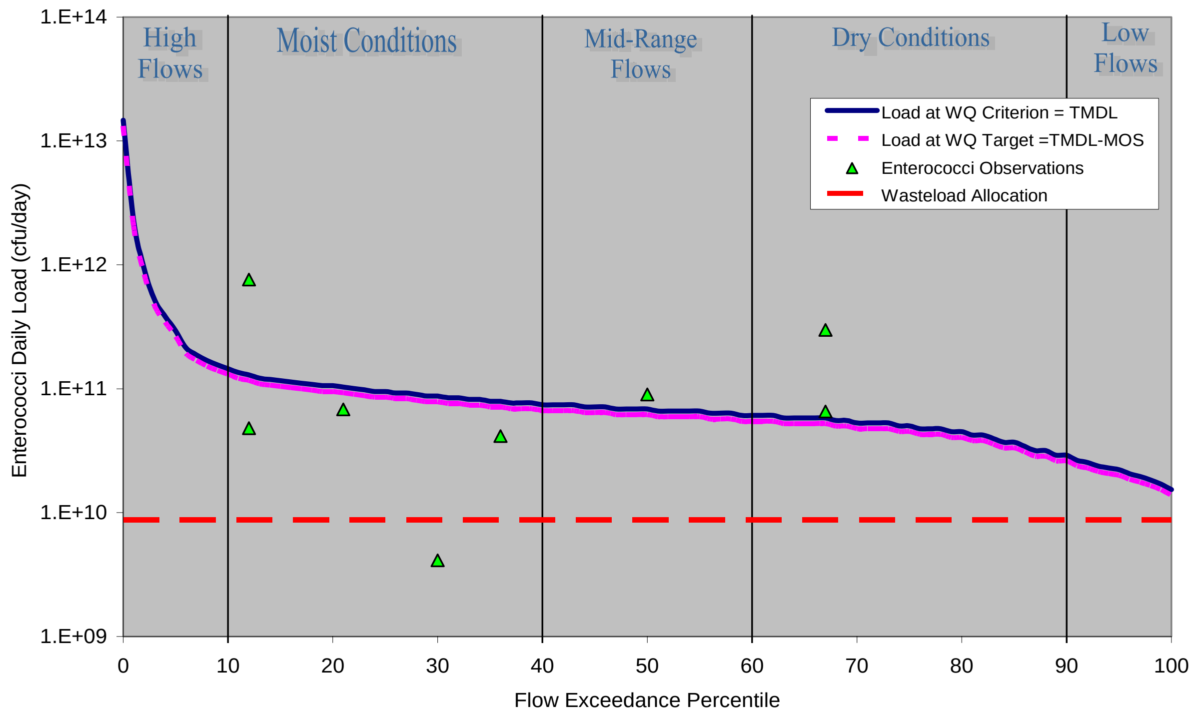


Load Duration Curve for *E. coli* in Deer Creek at Station OK520620060010F
High Flows
Moist Conditions
Mid-Range Flows
Dry Conditions
Low Flows
Load at WQ Criterion
Load at WQ Target
FC Observations
E. coli Daily Load (cfu/day)
1.E+14
1.E+13
1.E+12
1.E+11
1.E+10
1.E+09
0
10
20
30
40
50
60
70
80
90
100
Flow Exceedance Percentile

Load Duration Curve Data for *E. coli* in Deer Creek at Station OK520620060010F

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620060010F	8/14/2001	4.15E+10	36.00	55	30.86
OK520620060010F	9/18/2001	9.72E+12	12.00	7800	50.93
OK520620060010F	5/28/2002	6.49E+11	12.00	540	49.15
OK520620060010F	7/9/2002	6.32E+11	21.00	650	39.71
OK520620060010F	8/6/2002	4.37E+10	67.00	80	22.35
OK520620060010F	9/9/2002	3.21E+09	50.00	10	26.25
OK520620060010F	5/12/2003	1.65E+10	30.00	20	33.65
OK520620060010F	6/16/2003	8.96E+11	67.00	1620	22.6

Load Duration Curve for *Enterococci* in Deer Creek at Station OK520620060010F



Load Duration Curve Data for *Enterococci* in Deer Creek at Station OK520620060010F

Station ID	Start Date	Load	Qfrequency	Result Value	Flow
OK520620060010F	8/14/2001	4.15E+10	36.00	55	30.86
OK520620060010F	9/18/2001	7.60E+11	12.00	610	50.93
OK520620060010F	5/28/2002	4.81E+10	12.00	40	49.15
OK520620060010F	7/9/2002	6.80E+10	21.00	70	39.71
OK520620060010F	8/6/2002	6.56E+10	67.00	120	22.35
OK520620060010F	9/9/2002	8.99E+10	50.00	140	26.25
OK520620060010F	5/12/2003	4.12E+09	30.00	10	33.65
OK520620060010F	6/16/2003	2.99E+11	67.00	540	22.6

APPENDIX E
STATE OF OKLAHOMA ANTIDEGRADATION POLICY

Appendix E
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.

Response to Comments

on

Draft Total Maximum Daily Loads

for the

Upper Canadian River Watershed

and

Turkey Creek Watershed

Comment Period August 11, 2006 – September 11, 2006

Prepared by: USEPA Region 6

September 25, 2006

Upper Canadian River Watershed TMDL (23 TMDLs)

Turkey Creek Watershed TMDL (7 TMDLs)

Comment Period: August 11, 2006 – September 11, 2006

1. Memorandum for Diane Smith (EPA) from Mel A. McFarland (Tinker Air Force Base) dated August 24, 2006.

2. Letter from Gill (Tinker Air Force Base) to Craig (Oklahoma Department of Environmental Quality) dated July 20, 2006.

3. Comments submitted by Tinker Air Force Base for the August 23rd Public Meeting on the Proposed Upper Canadian River Watershed TMDLS

4. Memorandum for Diane Smith (EPA) from Cathy R. Sheirman (Tinker Air Force Base) dated August 31, 2006.

5. Memorandum for Diane Smith (EPA) from Mel Mc Farland (Tinker Air Force Base) dated September 11, 2006.

6. Letter received from Cloxin (Oklahoma Conservation Commission) to Smith (EPA) dated September 11, 2006.

7. Comments received form Oklahoma Farm Bureau (Peak) to Smith (EPA) dated September 11, 2006.

Memorandum to Diane Smith (EPA) from Mel A. McFarland (Tinker Air Force Base) dated August 24, 2006, and Memorandum for Diane Smith (EPA) from Cathy R. Sheirman (Tinker Air Force Base) dated August 31, 2006.

1. The commenter objects to the use of load-duration methodology and the process used by EPA for developing TMDLs in Oklahoma.

Response: The TMDL calculations presented in this report are derived from load duration curves. Load duration curves 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 load duration curve methodology has been used successfully on a National and Regional level for a wide range of pollutants. Nationally over 4000 TMDLs for bacteria have been developed using the load duration curve and other methodologies. Region 6 has established TMDLs for bacteria using the LDC methodology in Louisiana and Arkansas.

2. The commenter states that although the TMDL in question does not impact them directly, the commenter is concerned about EPA's use of the load-duration curve methodology to develop the TMDL.

3. The commenter refers to a letter sent to the Oklahoma Department of Environmental Quality in response to the draft TMDL for the North Canadian River. The commenter states it opposes the draft TMDLs for the same reasons outlined in the referenced letter and that EPA take the actions requested in the letter.

Response: The issues raised in the letter will be addressed in subsequent responses.

4. Commenter states that because the load duration curve method as used in Oklahoma is based on estimates, only one station with stream gage records was used to develop the TMDLs, the TMDLs do not consider background sources, identify specific sources, differentiate between human and animal sources of bacteria, and do not link the sources to actual sources levels of pathogens, the TMDLS are not based on sound science and should not be established.

Response: The requirements for TMDLs are outlined at 40 CFR 130.7. EPA has determined that the load duration curve methodology does meet the requirements of the regulations and TMDLs have been developed nationwide using the load duration curve methodology for bacteria. A TMDL is required to consider point sources (Waste Load Allocation) and non point sources (Load Allocation). Identification of specific individual sources in these categories is not required. EPA agrees that the information the commenter has mentioned would be beneficial and could be developed as the TMDL is implemented. The TMDL establishes the amount of loading of a particular pollutant that a waterbody can assimilate without violating the state's water quality standards.

5. The commenter states that there are processes to involve various stakeholders in determining the individual sources of bacteria in the watershed and that the TMDL does not do this.

Response: As stated in response to the previous comment, the TMDL establishes the loading of a pollutant that a given waterbody can assimilate without violating the state's water quality standards. After a TMDL has been established for a pollutant, stakeholder groups can be formed to determine how to implement the TMDL and restore the watershed to meeting the state's water quality standards.

8. The commenter requests that there be a moratorium on establishing TMDLs in Oklahoma using the load-duration methodology.

Response: As stated in previous responses, EPA believes that the load duration curve methodology is appropriate for developing TMDLs for pathogens in Oklahoma.

9. The commenter raised a number of process and procedure concerns used to establish TMDLs in Oklahoma.

a. The commenter stated that EPA did not meet the requirements of 40 CFR Part 25 in regards to public meetings. 40 CFR 25.5(b) and (c) require that an agency holding a public meeting must give notice of the meeting at least thirty days prior to the meeting and make documents available to the public for review thirty days prior to the meeting. The commenter cited the Federal Register Notice of the draft TMDLs and public meeting was published on August 11, 2006, and the public meetings were held on August 25 and 26, 2006.

Response: EPA acknowledges that it did not give public notice of the meeting thirty days before the meeting. However, the meeting that EPA held was an informal meeting to inform the public about the content of the proposed TMDLs. The administrative requirement for EPA to establish a TMDL only requires EPA to give public notice of the TMDL and respond to any comments raised by the public during the comment period; EPA is not required to hold a public meeting.

b. The commenter stated that EPA's Federal Register Notice was defective because it did not mention the meeting agenda, time or location. In addition, EPA's website did not contain any information about the public meeting and due to this the commenter was not able to adequately prepare for the public meeting.

Response: As mentioned in the previous response, EPA's administrative procedures do not require that the agency hold a public meeting pursuant to 40 CFR 25.5 as part of the public participation process when establishing TMDLs.

c. The commenter expressed concern about the length of the public comment period being too short. The commenter stated that EPA should follow the requirements of Oklahoma's Continuing Planning Process (CPP) which require a thirty day comment period after a public meeting has been held.

Response: EPA again reiterates that it is following its public participation requirements pursuant to federal regulations which allow for a thirty day comment period.

d. The commenter stated that EPA is interfering in a delegated state program and that EPA was doing this in order to meet EPA's internal deadlines.

Response: The commenter implies that the TMDL program is a delegated state program. The TMDL regulations and numerous legal actions taken against EPA have established that EPA has the ultimate responsibility for ensuring that TMDLs are established in a timely manner. EPA and the State of Oklahoma have jointly agreed that EPA would establish the bacteria TMDLs for the Upper Canadian River and Turkey Creek watersheds.

Letter from Gill (Tinker Air Force Base) to Craig (Oklahoma Department of Environmental Quality) dated July 20, 2006

The following comments were submitted on the draft TMDL for pathogens on the North Canadian River prepared by ACOG.

1. Commenter stated that the public record reflects that the TMDL will be implemented without adequate background source analysis or MS4 monitoring.

Response: The bacteria TMDLs for the Upper Canadian River and the Turkey Creek watersheds do not have an implementation component. Identification of background sources and loadings is not a required element of a TMDL. The level of information the commenter suggests that is needed for preparation of the calculation of the maximum allowable load meeting the water quality standard is not required. The information suggested by the commenter is more appropriate for a detailed implementation plan. The assimilative capacity of the stream is allocated between point and nonpoint sources. The allocation to point and nonpoint sources is the responsibility of the State, under the Water Quality Management Plan.

2. Commenter states that the goals for reduction are unattainable and that the TMDL will impose unnecessary and increasingly expensive BMPs without regard to hardship or likelihood of success.

Response: Percent reduction is informational in nature. The TMDL sets the load, not specific BMPs. The TMDL review criteria have no provisions for establishing loads based on expense or hardship. This comment addresses implementation which is not part of the TMDLs that are being established.

3. The commenter expresses a concern that unless background levels of pathogens are considered in the TMDL mandated BMPs and reduction goals the commenter and other MS4 permit holders impacted by the TMDL will be required to fund additional clean-up of pathogens from sources over which they have no control.

Response: The impaired segments do not include any MS4 permittees and therefore the question is moot in regard to these TMDLs. EPA established TMDLs may contain references to specific BMPs as a guide to be used in implementing the TMDL. Although, EPA regulations do not require that implementation be included in the TMDL report, EPA strongly supports TMDLs that do include an implementation component. Additionally, EPA notes that a permittee is only required to demonstrate that their discharge will meet the water quality standard criteria or their individual wasteload allocation and is not responsible for the clean-up of discharges that the permittee has no control over.

5. The commenter states that the proposal is not in compliance with Oklahoma statutes or Federal Water Pollution Control Act.

Response: The TMDLs are being established by EPA and meet the requirements of the Clean Water Act, which makes the Oklahoma statues and CPP moot.

6. The commenter raised concerns about Oklahoma's administrative procedures in regards to establishing TMDLs.

Response: The comment is moot due to the fact that EPA is following Federal administrative procedures in establishing the TMDLs.

Comments submitted by Tinker Air Force Base during the August 23rd Public Meeting on the Proposed Upper Canadian River Watershed TMDLS

1. The commenter questions if the background levels of bacteria in the Canadian River are being exceeded prior to entering Oklahoma.

Response: Segment 520620050010_00 is the first segment of the Canadian River in Oklahoma and is not listed on the 2002 303(d) list as being impaired for pathogens. The next downstream segment is 520620040010_00 and it is also not listed on the 2002 303(d) list for pathogens. Segment 520620030010_00 the next downstream segment is listed on the 2002 303(d) list as being impaired by pathogens.

2. The commenter states that the waterbodies designated use is inappropriate and should be based on land use. The commenter states that primary or secondary body contact recreation uses are inappropriate.

Response: The designated uses of the waterbodies are determined by the State of Oklahoma. The state has determined that the waterbodies have a use of primary contact recreation. The State of Oklahoma does have procedures for removing and changing uses for waterbodies. EPA refers the commenter to the Oklahoma Water Resources Board for further information on this process.

3. Commenter questioned the statement “only a small fraction of these fecal coliform are expected to represent loading into waterbodies,” referring to the sources listed in (Tables 3-6, 3-7). The commenter notes that the watersheds are primarily agricultural and no evidence was presented to support this assertion.

Response: Tables 3-6 and 3-7 give estimates of the magnitude of the loading in the watersheds from livestock. This information is presented for informational purposes only; the loadings in the TMDL were derived from the sample data collected in the waterbodies.

4. The commenter states the assumption that all septic tanks were considered to be failing is not a reasonable assumption.

Response: The information on septic tanks was again for informational purposes only. The actual TMDLs were calculated from sample data collected in the waterbodies.

5. Commenter states that urban/suburban rates of pet ownership are only gross estimates of pets in rural areas which tend to have more dogs and cats per capita.

Response: Comment noted.

6. Commenter questions if it is valid to assume that the entire fecal load from dogs and cats reaches the waterbodies in question.

Response: Table 3-13 gives an estimate of the possible magnitude of the loadings from pets. As stated in previous responses, the TMDL is based on the actual sample data collected in each waterbody.

7. The commenter suggests that Table 3-13 has too many assumptions to be even remotely accurate.

Response: As stated in our responses the estimated loadings in Table 3-13 were not used to calculate the TMDLs. Table 3-13 is an attempt to identify sources of pollution that may need to be addressed during the implementation of the TMDLs.

8. The commenter states that there are no valid stream gage stations in the watershed to base the watersheds' flow duration curves on. Real flow data is required to calculate pathogen loads. The commenter questions if the primary body contact recreation use is correct given the extremely low flows of a number of the waterbodies.

Response: Flow duration curves were estimated from measured data from just downstream of segment 520620020010_00 and from stream gage data from a station on Deer Creek. The use of data from other waterbodies to develop flow curves for a waterbody has been used by EPA and state agencies to develop TMDLs in the absence of flow data for the impaired waterbody. EPA again defers to the Oklahoma Water Resources Board on the issue of the appropriateness of the primary body contact recreation use designation for the waterbodies.

9. The commenter states that flow data from downstream of the study area was used to develop the TMDLs and has asked why the draft report does not contain a flow curve for the monitoring station and if there is any monitoring data available for that site.

Response: A flow curve for the monitoring station was not deemed to be necessary for the project and therefore was not prepared. USGS gage 07228500 is located in segment OK520610020150_00 which has been placed on the on 2002 303(d) list as being impaired by pathogens. The development of a TMDL for this segment is beyond the scope of this report; however EPA expects a pathogen TMDL to be developed for this segment in the future.

10. Commenter states that due to the lack of actual stream gage data in the watersheds, identification of the actual sources of the impairment, the use of literature assumptions and other gross assumptions, the waterbodies should not have been classified as Category 5 waterbodies.

Response: The waterbodies were placed in Category 5 based on actual measurements and monitoring data collected from the specific streams, not assumptions. The decision to place the waterbodies in question on the 303(d) list was reviewed by EPA and the public. This information and subsequent data that has been developed was considered in the process of establishing these TMDLs.

Memorandum to Diane Smith (EPA) from Mel Mc Farland (Tinker Air Force Base) dated September 11, 2006.

1. The commenter mentions the letter sent from Miguel Flores (EPA) to Jon Craig (ODEQ) and has included it as an attachment. The commenter states that the letter indicates EPA is taking over the public participation process for these TMDLs, and that EPA will establish these TMDLs in place of action by ODEQ. The stated reason for this action is to complete the TMDL process by 30 Sep 2006, a deadline internal to EPA.

Response: The letter states that Oklahoma had committed to establishing 38 TMDLs by September 30, 2006, and had, to date, only established 2 TMDLs and that Oklahoma indicated that it would not be able to meet its commitment of establishing 38 TMDLs by September 30, 2006. EPA strongly believes that significant progress in establishing TMDLs in Oklahoma needs to be made this fiscal year. Due to these reasons and not a desire to avoid public participation EPA chose to establish these 30 TMDLs.

2. The commenter states that EPA is deliberately avoiding public participation by taking this action.

Response: As stated above, EPA has determined that significant progress in establishing TMDLs in Oklahoma needs to be made by September 30, 2006, and that in order for progress to be made, EPA has chosen to establish the TMDLs in question.

3. Such action is contrary to federal case law. The court in Environmental Defense Fund, Inc. v. Costle, 657 F.2d 275 (D.C.Cir. 1981), interpreted subsections (c)(1),(c)(2)(A) and (c)(4)(b) of Section 303 of the Clean Water Act (CWA), 33U.S.C. Section 1313(c)(1), (c)(2)(A) and (c)(4)(B)(copy of case attached). Those sections require the states to set water quality standards, and submit them to EPA for review, but they also allow EPA to set water quality standards where new or revised standards are necessary to meet the requirements of Subchapter III. The court stated as follows:

[I]t is logical that EPA should refrain from acting until the states have completed an initial effort to update the standards as they deem appropriate. Environmental Defense Fund v. Costle, 657 F.2d 275 at 294 (footnote omitted).

Although the court was examining subsection (c) of Section 303, the analysis is equally applicable to subsection (d) which immediately follows. This portion of Section 303 requires states to, among other things, establish TMDLs and submit them to EPA for review. The state of Oklahoma is making progress toward establishing TMDLs for the Canadian River or Turkey Creek. The EPA letter reflects that the TMDLS for these watersheds are already in draft form and that EPA has them in hand. Paragraph three of the letter states:

Region 6 has recently draft TMDL reports addressing impairments for pathogens and/or turbidity in Upper Canadian River and the Turkey Creek watersheds from DEQ.

Since Oklahoma is making adequate progress toward establishing TMDLs for these watersheds, under Costle, EPA should refrain from acting until Oklahoma has completed its initial effort to establish these TMDLs.

Response: The commenter has stated its opinion that Oklahoma is making adequate progress toward establishing the TMDLs in question. EPA does not concur with this opinion. In the letter quoted by the commenter, EPA noted that the state of Oklahoma informed EPA that the state would not be able to meet its commitment to EPA to establish the TMDLs by the date agreed to by both agencies of September 30, 2006, and because of this reason EPA would proceed with establishing the TMDLs.

The commenter cites the court decision on Costle which states that EPA should refrain from acting to establish water quality standards in lieu of the state. The commenter suggests that this decision based on Section 303 (c) of the Clean Water Act is applicable to Section 303 (d) of the Clean Water Act. EPA does not concur with this conclusion and EPA has and continues to establish TMDLs for impaired waters in both Arkansas and Louisiana.

4. This action is also contrary to stated Congressional policy. As the court in Costle noted:

This [Section 101(b) of the CWA] recognizes the Congressional policy of placing "primary" responsibility with the state "to prevent, reduce, and eliminate" water pollution. Id,

Response: The commenter states that EPA's actions are contrary to Congressional policy. EPA does not concur. The commenter cites that primary responsibility has been give to the states to prevent, reduce and eliminate water pollution. The TMDLs in question establish the maximum loading for each waterbody in the report and partition the loading between point and non point sources; they do not prevent, reduce or eliminate water pollution. The implementation of the TMDLs, which will be the state's responsibility, will prevent, reduce and eliminate water pollution.

5. Under the facts set out in this memorandum, EPA does not have the statutory authority to establish TMDLs in place of Oklahoma. A comparison of subsections (c) and (d) of Section 303 reveals why. Subsection (c) provides for the states to review, modify and adopt water quality standards and submit them for review to EPA, and subsection (c)(4)(B) has an additional provision for EPA to set water quality standards in <u>any</u> case where EPA determines a new or revised standard is necessary. However, subsections (d)(1)(C) and (d)(2) require the states to set TMDLs and submit them to EPA for approval. Subsection (d)(2) allows EPA to establish TMDLs in place of a state <u>only</u> when it has disapproved a TMDL. There is no language in the Federal Register notice for these TMDLs or in the EPA letter that disapproves Oklahoma's draft TMDLs for the Upper Canadian or Turkey Creek watersheds. Rather, EPA intends to establish these same draft TMDLs as final. Thus, EPA has not disapproved Oklahoma's draft TMDLs and has not statutory authority to take over the public participation process or to establish the TMDLs for these watersheds.

Response: EPA does not concur that EPA can <u>only</u> establish a TMDL after it has disapproved a TMDL. Subsection (d)(2) requires EPA to establish a load if the agency has disapproved the load. The word <u>only</u> does not appear in the statute. EPA has established TMDLs in other Region 6 states without having disapproved the TMDL.

Oklahoma has only submitted the TMDLs in question to EPA for technical review and not final approval.

The state of Oklahoma has not submitted comments objecting to this EPA action. In fact, EPA has received a letter from the Oklahoma Conservation Commission expressing their support for the TMDLs.

Letter received from Cloxin (Oklahoma Conservation Commission) to Smith (EPA) dated September 11, 2006

1. The commenter expressed his support of EPA establishing the TMDLs for the Upper Canadian River and the Turkey Creek Watershed

Response: EPA appreciates the comment of interest, and support of these TMDLs.

Comments received form Oklahoma Farm Bureau (Peak) to Smith (EPA) dated September 11, 2006.

UPPER CANADIAN RIVER WATERSHED AND TURKEY CREEK WATERSHED TMDLS

1. Oklahoma Farm Bureau points out that there is an incorrect statement on page 5-46 of the Upper Canadian River Watershed and page 46 of the Turkey Watershed TMDLs. The statement in question is "Nonpoint source pollution is regulated by the Oklahoma Conservation Commission." The commenter states that the Oklahoma Department of Agriculture Food and Forestry has jurisdiction over nonpoint source runoff from agricultural crop production, agricultural services, livestock production, silviculture, feed yards, livestock markets and animal waste. Other nonpoint source jurisdiction is divided among the Oklahoma Department of Environmental Quality, Oklahoma Corporation Commission, and the Department of Mines.

The Oklahoma Conservation Commission (OCC) is responsible for the monitoring, evaluation and assessment of waters to determine the condition of streams and rivers being impacted by nonpoint source pollution. The OCC is the technical lead agency for nonpoint source categories as defined in Section 319 of the federal Clean Water Act or other subsequent federal or state nonpoint source programs, except for activities related to industrial and municipal storm water or as otherwise provided by state law.

Response: The final report has been changed to reflect this comment.

2. Oklahoma Farm Bureau does not concur that TMDLs must be based on attainment of the current standards. They're concerned that when waterbodies in remote areas of the state with sparse population are labeled as impaired, either the beneficial use may be inappropriate, and/or the standard is questionable. For example, in some areas of the Upper Canadian watershed the biggest contributors of bacteria to the waterbodies will be wildlife and cattle.

They support Use Attainability Analyses (UAA) being performed on the creeks in the Upper Canadian River watershed and the Turkey Creek Watershed to verify whether Primary Body Contact Recreation is the appropriate beneficial. They request that UAAs be performed for:

Upper Canadian River		Turkey Creek	
OK520620010120	Bear Creek	OK620910060010	Turkey Creek
OK520620020090	Trail Creek	OK620910060020	Little Turkey Creek
OK520620030020	Lone Creek	OK620910060030	Buffalo Creek
OK520620030050	Red Trail Creek	OK620910060110	Clear Creek
OK520620030110	Red Creek		
OK520620040050	Hackberry Creek		
OK520620050160	Commission Creek		
OK520620060010	Deer Creek		

Response: The revision of the Oklahoma Water Quality Standards to address the issues raised by the commenter is beyond the scope of the proposed action. We support UAAs being done to verify if Primary Body Contact Recreation is the appropriate beneficial use, however, that also is an action outside the scope of the proposed action. EPA refers the commenter to the Oklahoma Water Resources Board for further information on this process. Finally, EPA’s regulations and procedures require that TMDLs be developed to meet the current water quality standard and cannot be based on a less stringent standard.