For Public Comment, April 2008

One Total Maximum Daily Load for Bacteria in Peach Creek

For Segment Number 1803C

Prepared by the:

Chief Engineer's Office, Water Programs, TMDL Section
TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

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Total Maximum Daily Load Program
Texas Commission on Environmental Quality
MC-203
P.O. Box 13087
Austin, Texas 78711-3087

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The preparation of this report was financed in part through grants from
the U.S. Environmental Protection Agency.

This document is based on large part on the report titled
"Final Modeling Report for Fecal Coliform TMDL Development for
Peach Creek, Segment 1803C,"
by James Miertschin & Associates, Inc.

Contents

Executive Summary 1

Introduction 1

Problem Definition 2

Designated Uses and Water Quality Standards 4

Description of Watershed 4

- Climate 4
- Economy 5
- Geology and Hydrogeology 5
- Soils 6
- Land Use 7

Assessment of Pollutant Sources 7

- Data and Information Inventory 7
- Water Quality Monitoring 8
  - Water Quality Data 8
  - Stream Flow and Weather Data 9
- Critical Condition 11
- Consideration of Seasonal Variations 11

Endpoint Identification 11

Source Identification 12

- Point Sources 12
- Nonpoint Sources 12
  - Failing Septic Systems 14
  - Leaking Wastewater Infrastructure 15
  - Livestock and WAFs 15
  - Wildlife and Feral Animals 17

Linkage Analysis 18

- Bacterial Source Tracking 19

Pollutant Load Allocation 21

- TMDL Calculation 21
- Allocation Scenario Development 21
  - Wasteload Allocations 22
  - Load Allocations 23

Margin of Safety 24

TMDL Summary 24

Public Participation 25

Implementation and Reasonable Assurances 26

- Implementation Processes to Address the TMDL 26

References 28

Figures

Figure 1: TMDL Watershed 3
Figure 2: Land Use for Study Area 6
Figure 3: Peach Creek Sampling Stations 8
Figure 4: Fecal Coliform Sampling Results at CR 353 10
Figure 5: *E. coli* Sampling Results at CR 353 10
Figure 6: Mechanism of Nonpoint Source Loading 13
Figure 7: Septic System Density and Number by Subbasin, 1990 14
Figure 8: Comparison of Fecal Coliform Sources for Peach Creek 19

Tables

Table 1: Land Use Types and Areas 7
Table 2: Bacteria Data for Peach Creek (1996-2004) 9
Table 3: Point Sources 13
Table 4: Livestock Population Estimates 16
Table 5: TCEQ Permitted CAFOs in Segment 1803C Watershed 16
Table 6: Fecal Coliform Production Rates for Livestock and Wildlife 17
Table 7: Estimated Inventory of Wildlife in Peach Creek Watershed 18
Table 8: BST Sampling Station 20
Table 9: WLAs for Fecal Coliform in Impaired Reach (10^6 cfu/day) 22
Table 10: LAs for Fecal Coliform in Impaired Reach (10^6 cfu/day) 23
Table 11: Summary of Fecal Coliform TMDL for Impaired Reach (10^6 cfu/day) 24
Table 12: Summary of *E. coli* TMDL for Impaired Reach (10^6 cfu/day) 25

One Total Maximum Daily Load for Bacteria in Peach Creek

Executive Summary

This document describes a project developed to address water quality impairments related to bacteria in Peach Creek (Segment 1803C). Peach Creek is 66 miles long, and has a watershed of 885 square miles, located primarily in Gonzales, Caldwell, Bastrop, and Fayette Counties. Peach Creek was first identified as impaired for recreational use in the 2000 *Texas Water Quality Inventory and 303(d) List* (TCEQ 2000). This impairment continued and was identified on subsequent lists (2004, draft 2006).

The goal for this total maximum daily load (TMDL) project is to determine the maximum bacteria loading the stream can receive and still allow support of the contact recreation use. Elevated levels of indicator bacteria such as Escherichia coli (*E. coli*), although not generally pathogenic, indicate the potential risk to public health. The criteria for support of the contact recreation use are based on indicator bacteria rather than direct measurements of pathogens.

The standards for water quality are defined in the *Texas Surface Water Quality Standards* (Chapter 307 of the Texas Administrative Code, Title 30). The criteria for assessing attainment of the contact recreation use are expressed as the number of colony forming units (cfu) of bacteria per hundred milliliters (100 mL) of water. For *E. coli* the number of colony forming units may not exceed 394 cfu/100 mL in a single sample, nor 126 cfu/100 mL as a geometric mean of all samples over a range of time.

Based on analysis of the load allocation scenario, a 47 to 100 percent reduction in nonpoint source loading is required for Peach Creek. This will include reductions in direct and indirect (storm runoff-related) nonpoint source loading. No reduction is required for point sources. However, a wasteload allocation has been assigned to point sources, which requires municipal wastewater treatment facilities (WWTFs) to maintain adequate levels of disinfection.

Introduction

Section 303(d) of the federal Clean Water Act requires all states to identify waters that do not meet, or are not expected to meet, applicable water quality standards. The compilation of impaired water bodies is known as the 303(d) list. For each Category 5a listed water body, states must develop a TMDL for each pollutant that contributes to impairment. The Texas Commission on Environmental Quality (TCEQ) is responsible for ensuring that TMDLs are developed for impaired surface waters in Texas.

In simple terms, a TMDL is like a budget that determines the amount of a particular pollutant that a water body can receive and still meet applicable water quality standards. In other words, TMDLs are the best possible estimates of the assimilative capacity of the water body for a pollutant under consideration. A TMDL is commonly expressed as a

load with units of mass per period of time, but may be expressed in other ways. For bacteria TMDLs, loads are typically expressed as the number of cfu per period of time. TMDLs must also estimate how much the pollutant load must be reduced from current levels in order to achieve water quality standards.

The TMDL Program is a major component of Texas' overall process for managing surface water quality. The Program addresses impaired or threatened streams, reservoirs, lakes, bays and estuaries (water bodies), inside or bordering on the state of Texas. The primary objective of the TMDL Program is to restore and maintain the beneficial uses-such as drinking water supply, recreation, support of aquatic life, and fishing-of impaired water bodies. This TMDL addresses impairments to the contact recreation use due to elevated indicator bacteria in Peach Creek.

Section 303(d) of the Clean Water Act and the implementing regulations of the US Environmental Protection Agency (EPA) (40 Code of Federal Regulations, Part 130) describe the statutory and regulatory requirements for acceptable TMDLs. The EPA provides further direction for developing TMDLs in its *Guidance for Water Quality-Based Decisions: The TMDL Process* (USEPA 1991). This TMDL document has been prepared in accordance with those regulations and guidelines. The TCEQ must consider certain elements in developing a TMDL; they are described in the following sections:

- Problem Definition
- Endpoint Identification
- Source Analysis
- Seasonal Variation
- Linkage between Sources and Receiving Waters
- Margin of Safety
- Pollutant Load Allocation
- Public Participation
- Implementation and Reasonable Assurance

This document is based on the "Final Modeling Report for Fecal Coliform TMDL Development for Peach Creek, Segment 1803C" prepared for the TCEQ by James Miertschin & Associates, Inc. (JMA 2006).

In accordance with the *Memorandum of Agreement between the TCEQ and the Texas State Soil and Water Conservation Board (TSSWCB) Regarding TMDLs, Implementation Plans (I-Plans), and Watershed Protection Plans*, the Board approved this TMDL report on Month, Day, Year. The commission adopted this document on Month, Day, Year. Upon EPA approval, this TMDL will become an update to the state's Water Quality Management Plan.

Problem Definition

This document describes a project developed to address water quality impairments related to bacterial indicators for pathogens in Peach Creek (Segment 1803C).

Peach Creek was identified as impaired for bacteria in the 2000 *Texas Water Quality Inventory and 303(d) List* (TCEQ 2000). This impairment continued and was identified on subsequent lists (2004, draft 2006).

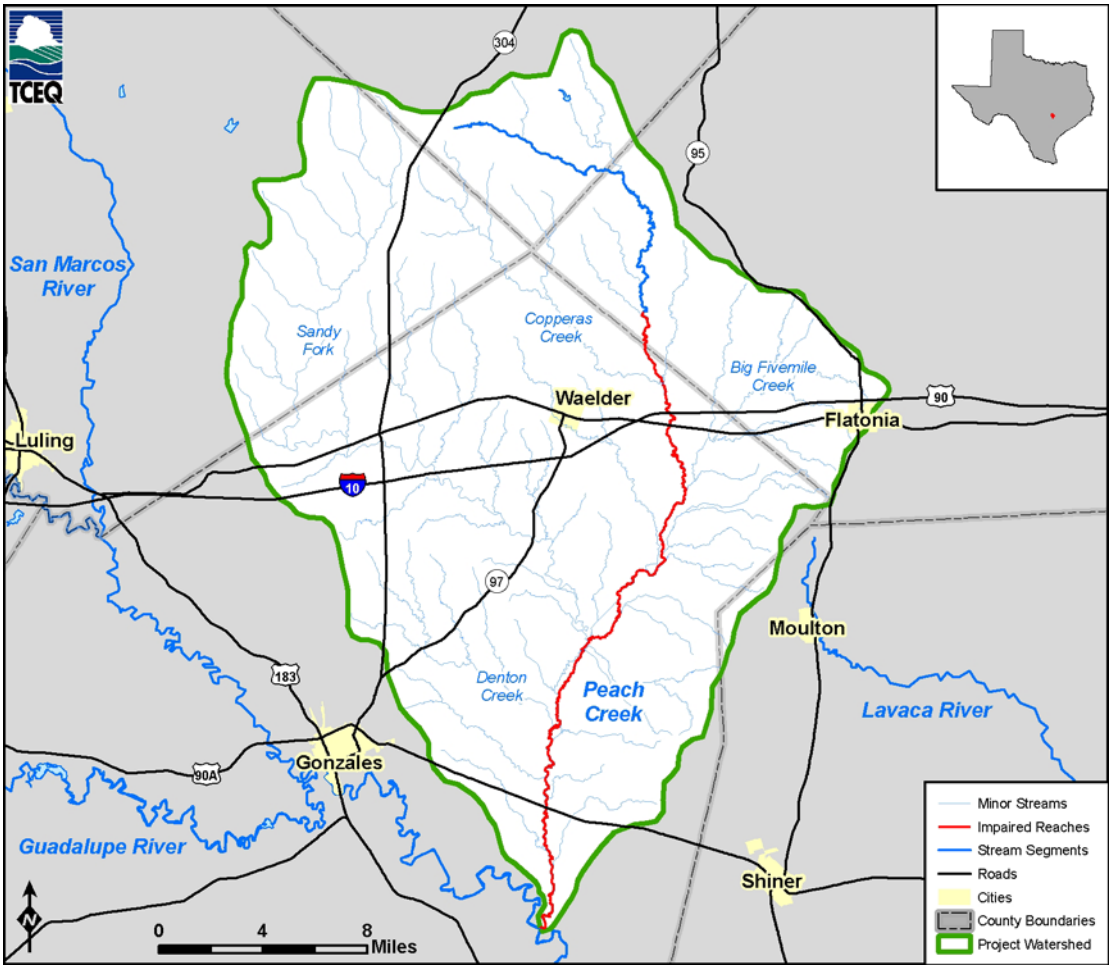

Figure 1: TMDL Watershed

Based on the 2000, 2002, and 2004 303(d) Lists, only a portion of the segment, Assessment Unit (AU) _01, defined as the lower 25 miles of water body, was found to be impaired. However, according to the draft 2006 *Texas Water Quality Inventory and 303(d) List*, AU_03, defined as from approximately 1.2 miles downstream of FM (Farm to Market) 1680 in Gonzales County to confluence with Elm Creek in Fayette County, was also listed as impaired. AU_02 is not impaired, and is defined as the remainder water body, or furthest upstream reach. In total, approximately 35 miles of Peach Creek have been designated as impaired. A map of the study area is presented in Figure 1.

In response to the listing, the TCEQ initiated an investigation to identify possible point and nonpoint sources of bacteria and to quantify the appropriate reductions necessary to comply with established water quality standards (presented in the following section). Possible sources and/or causes of contamination include:

- discharges from wastewater treatment facilities
- storm water runoff from the urban and non-urban landscape
- leaking sewer infrastructure
- wildlife and other warm-blooded animal deposition
- failing septic systems
- pet and livestock deposition

Designated Uses and Water Quality Standards

Segment 1803C is designated for contact recreation and aquatic life uses. The *Texas Surface Water Quality Standards* (TCEQ 2000) provide numeric and narrative criteria to evaluate attainment of designated uses. *E. coli* is the preferred indicator bacteria for assessing the contact recreation use in freshwater, but fecal coliform bacteria may also be used since it was the preferred indicator in the past. The numeric criteria defined in the Standards for support of the contact recreation use are as follows.

- *E. coli*
  - The geometric mean of *E. coli* should not exceed 126 cfu/100 mL
  - Single samples of *E. coli* should not exceed 394 cfu/100 mL more than 25 percent of the time
- Fecal coliform
  - The geometric mean of fecal coliform should not exceed 200 cfu/100 mL
  - Single samples of fecal coliform should not exceed 400 cfu/100 mL more than 25 percent of the time

Description of Watershed

Peach Creek is 66 miles long and flows through Bastrop, Fayette, and Gonzales Counties before reaching its confluence with the Guadalupe River (Segment 1803). The largest tributary of Peach Creek is Sandy Fork, which begins in Caldwell County. The drainage area of Peach Creek is approximately 885 square miles, and is located predominantly in Gonzales, Caldwell, Fayette, and Bastrop Counties. A relatively small portion of the drainage area is located inside Lavaca County. A map of the study area is presented in Figure 1.

Climate

The Gulf of Mexico is the principal source of moisture that drives precipitation in the study area. The amount of precipitation that falls is influenced by the distance from the Gulf of Mexico and by topography. The study area is located primarily within the South Central Texas climatic division.

The climate of the region is classified as humid subtropical. Summers are usually hot and humid, while winters are often mild and dry. The hot weather is rather persistent from late May through September, accompanied by prevailing southeasterly winds. The cool season, beginning about the first of November and extending through March, is typically

the driest season of the year as well. Winters are typically short and mild, with most of the precipitation falling as drizzle or light rain.

The climate is dominated by proximity to the Gulf of Mexico and characterized by prevailing southeasterly winds. During the long humid summers, high daytime temperatures are common in the study area. Although mean annual temperatures are basically uniform throughout the region, there are some marked seasonal variations.

As with the rest of the interior of the State, maximum precipitation periods in the study area are typically late spring (May) and early autumn (September). Winter and summer periods are typically low precipitation periods. The maximum precipitation period in May is driven by the buildup of water vapor from the Gulf of Mexico from the prevailing winds from the south. Precipitation is caused by late season cold air migrations, warm season thunderstorms, and spring low-pressure troughs. In September, cold air converges with moisture-laden southerly winds and late season convective thunderstorms drive the precipitation. It is not unusual for hurricanes to affect rainfall in the early autumn period. Summer drought conditions are common in the study area, due to strong high-pressure cells that result in lengthy dry spells. Mean annual precipitation in the watershed ranges from 34 to 37 inches per year.

Economy

The study watershed includes the corners of Gonzales, Caldwell, Lavaca, Fayette, and Bastrop Counties, with the Gonzales County portion being by far the largest. Flatonia, located partially within the study watershed in Fayette County, is the largest city in the study area and had an estimated population in 2000 of 1,377 (US Census 2006). Waelder, located in the center of the watershed in Gonzales County, had an estimated population of 947 in 2000 (US Census 2006).

Agribusiness is the most important component of the local economy. Poultry and cattle are the primary types of livestock raised in the watershed. Rangeland is the dominant land use in the watershed. Harvested crops, such as grains and pecans, are grown in a small portion of the region's farmland (TSHA 2001; USDA 2002). Other natural resources in the region include clay, sand, and gravel mines; oil and gas production; and uranium production.

Geology and Hydrogeology

Tertiary period geologic formations underlie the Peach Creek watershed. These formations typically consist of sandstones formed through fluvial processes. The formations dip gently toward the Gulf of Mexico.

Groundwater in the area is primarily associated with the Queen City and Carrizo-Wilcox aquifer systems. The Queen City Aquifer underlies most of the watershed. The outcrop zone of this aquifer includes the portions of the watershed inside Bastrop, Caldwell, and northwestern Gonzales County. The aquifer is made up of sand and loose sandstone and is usually less than 500 feet in thickness. The Carrizo-Wilcox Aquifer downdip zone underlies the Queen City Aquifer throughout most of the study watershed. The thickness of

sand and gravel layers in the Carrizo-Wilcox aquifer range from less than 200 feet to 3,000 feet in thickness (Ashworth 1995).

Soils

Soil conditions vary significantly throughout the study area. Gonzales County, alone, includes over 75 different soil types and 19 underlying geological formations, making it the most diverse county of the state (TSHA 2001). Soils in the study area can range from clays to sands and typically have moderate to low permeability.

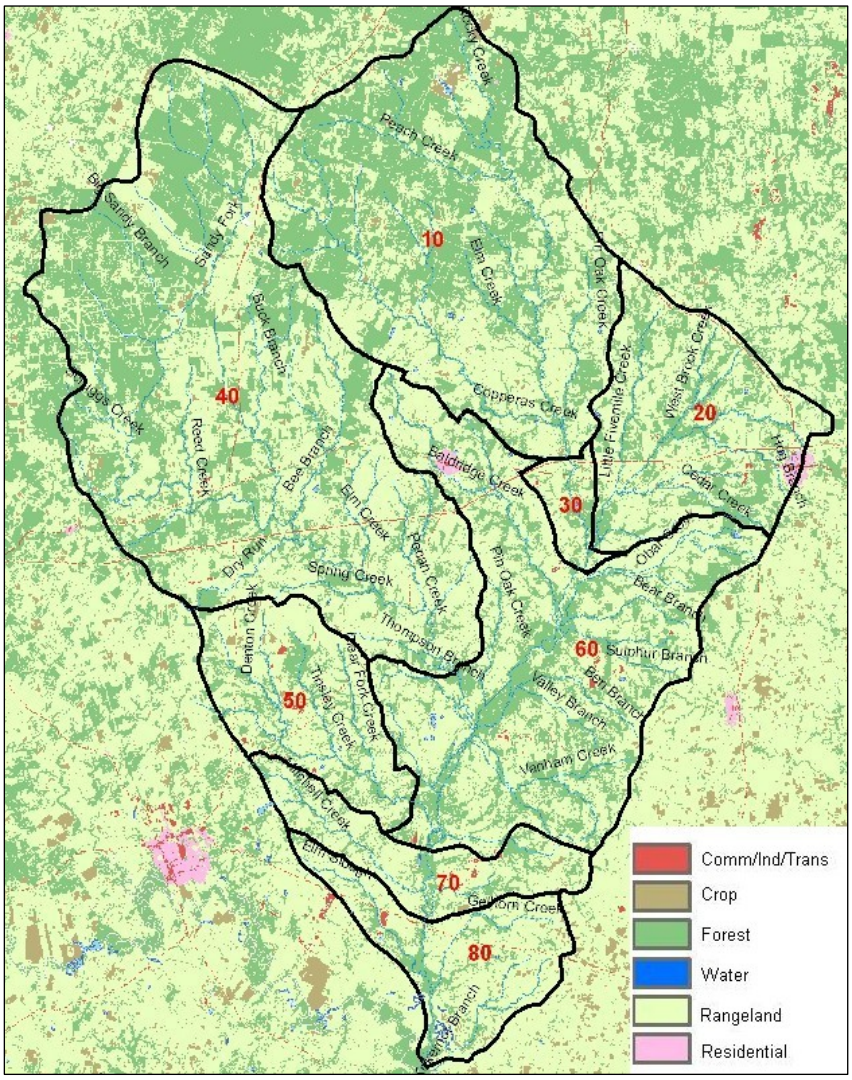

Figure 2: Land Use for Study Area

*Red numbers represent stream catchments

Land Use

Land use data for the watershed were based on the United States Geological Survey National Land Cover Dataset (USGS NLCD). Derived from the early to mid-1990s Landsat Thematic Mapper satellite data, the NLCD is a land-cover classification scheme applied consistently over the United States. The spatial resolution of the data is 30 meters and mapped in the Albers Conic Equal Area projection, NAD 83. Land use for the watershed is shown in Figure 2, areas and percentages are shown in Table 1.

Table 1: Land Use Types and Areas

Land Use Type	Area	Percent of Total
Forest	118,932	38.3%
Crop/Pastureland	4,739	1.5%
Rangeland	184,181	59.4%
Residential	554	0.2%
Comm/Ind/Trans	1,869	0.6%
Total	310,275	100%

Assessment of Pollutant Sources

The data used to assess sources affecting the impaired segment are discussed in the following sections. The inventory of data and information is outlined, along with monitoring, water quality, stream flow, and meteorological data.

Data and Information Inventory

A wide range of data and information was used in the development of the TMDL. Categories of data used include the following:

- Hydrographic data that describe the physical conditions of the stream, such as the stream reach network and connectivity, and the stream channel depth, width, slope, and elevation.
- Watershed physiographic data that describe the watershed's physical conditions such as topography, soils, and land use.
- Data and information related to the use of, and activities in, the watershed that can be used in the identification of potential bacterial sources.
- Environmental monitoring data that describe stream flow and water quality conditions in the stream.

Water Quality Monitoring

The Guadalupe-Blanco River Authority (GBRA) is responsible for coordinating the Clean Rivers Program's monitoring activities in the Peach Creek Watershed for inclusion in the TCEQ's Surface Water Quality Monitoring (SWQM) program database. Data collected by GBRA and other entities have been used to assess the segment for compliance with water quality standards. Figure 3 shows the locations, names, and numbers for stations where significant bacteria sampling occurred throughout the period 1996-2004. Also shown are the locations of WWTFs with their TCEQ permit numbers.

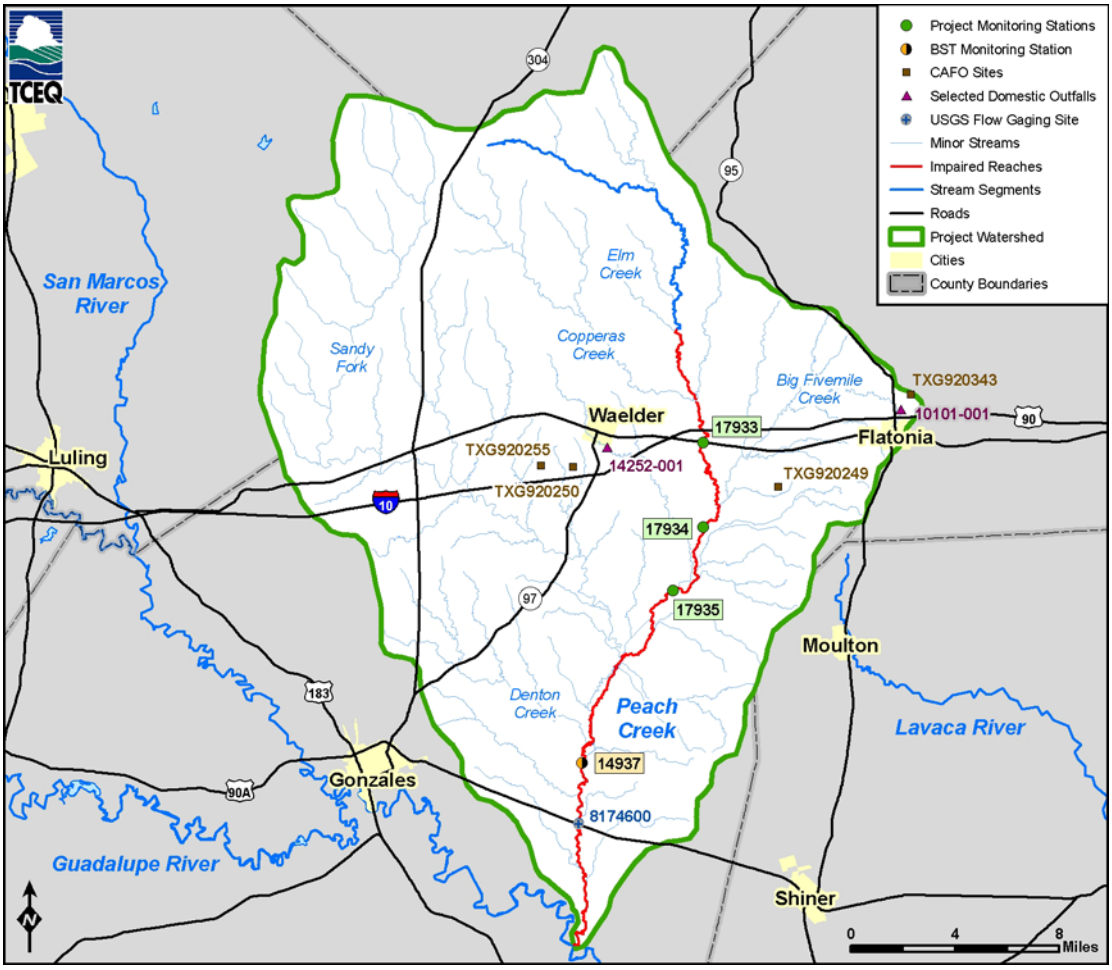

Figure 3: Peach Creek Sampling Stations

Water Quality Data

Review of the available water quality data reinforced earlier assessments, which concluded that the segment contains elevated levels of bacteria. Table 2 summarizes the available data for fecal coliform and *E. coli* sampling. The table includes the number of samples collected, the number of samples that exceeded the grab sample criterion, and the geometric mean of the sampled concentrations.

To summarize the water quality of Peach Creek, a single station with the majority of available data was selected for presentation in this section of the report to illustrate typical conditions. Fecal coliform bacteria monitoring data for Peach Creek station 14937 at CR 353 for the period 1996-2004 are displayed in Figure 4. A plot of *E. coli* bacteria concentrations for the same station is displayed in Figure 5 for the years 1996-2004. Also shown are flow records for the USGS gage at US Hwy 90A (#08174600), which was inactive prior to October of 2000. It was observed that higher counts are typically associated with runoff conditions.

Table 2: Bacteria Data for Peach Creek (1996-2004)

		E. coli			**Fecal Coliform**		
TCEQ Station	**Location**	**No. Samples**	**No. Exceed**	**Geomean (cfu/100mL)**	**No. Samples**	**No. Exceed**	**Geomean (cfu/100mL)**
14937	CR 353	112	29	184	67	21	259
17935	FM 397	8	1	188	4	0	157
17934	FM 1680	9	1	115	5	2	244
17933	US 90	9	3	172	5	2	322

Stream Flow and Weather Data

Stream flow and precipitation records are necessary to calibrate watershed and water quality models, calculate loadings of pollutants from point and nonpoint sources, characterize transport processes, and evaluate impacts of pollutant loadings.

For Peach Creek, daily flow data are available at the USGS gage at US Hwy 90A (#08174600) for the period of October 2000 to the present. Prior to October of 2000, the gage was inactive. There are no other flow-gauging stations in the watershed.

Precipitation data employed in the present study were obtained from the National Weather Service (NWS). Records of daily rainfall for the NWS cooperative stations in Jeddo, Flatonia, and Gonzales were the primary source of data for modeling. The data from these daily rainfall stations were disaggregated using hourly rainfall data, primarily from gages in Austin, San Antonio, and Victoria (based on proximity and availability of data).

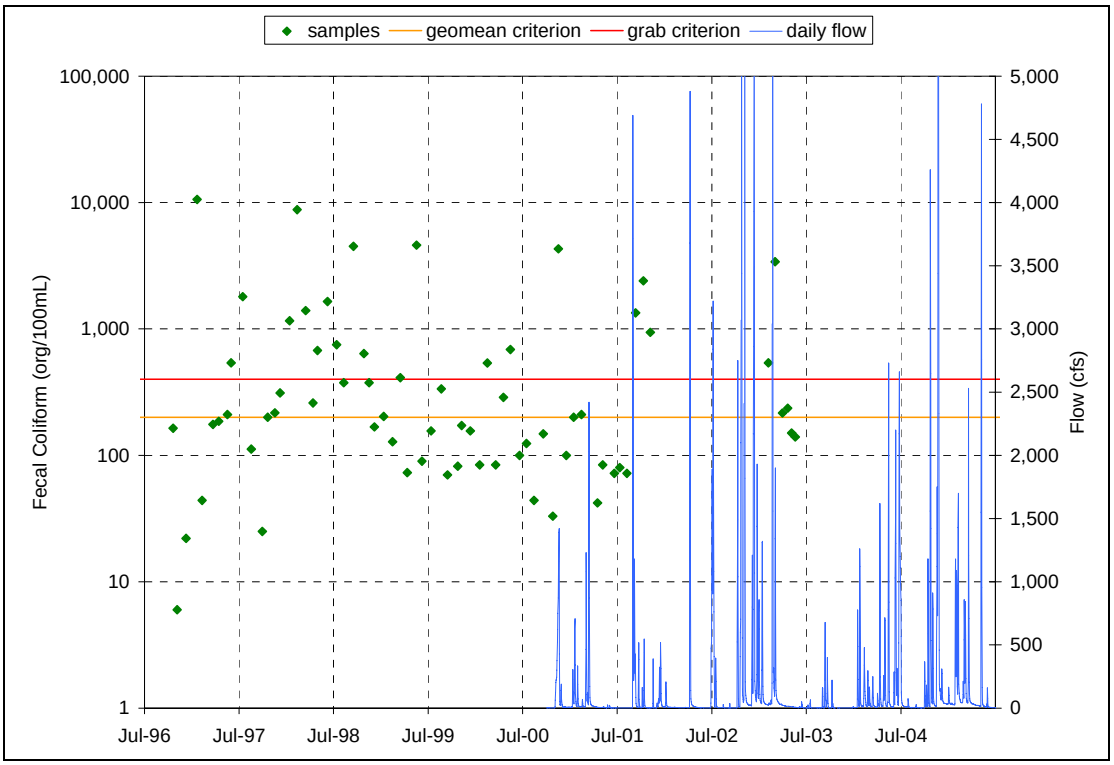

Figure 4: Fecal Coliform Sampling Results at CR 353

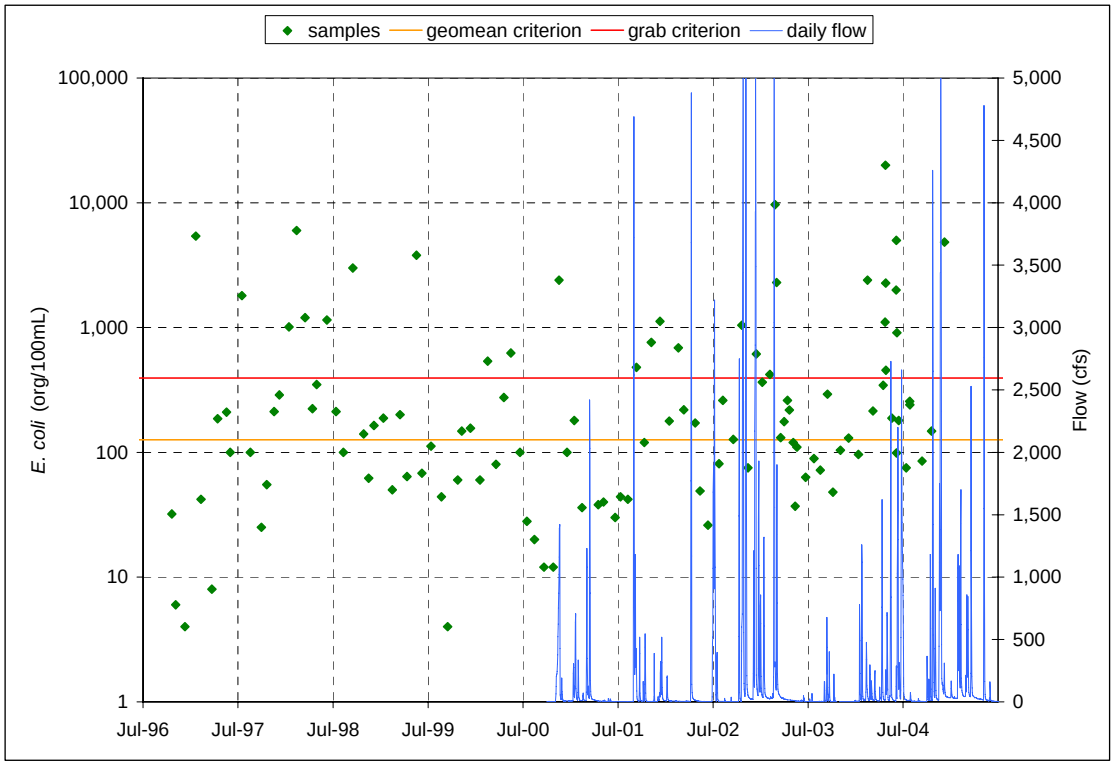

Figure 5: *E. coli* Sampling Results at CR 353

Critical Condition

Federal regulations in 40 CFR 130.7(c)(1) require TMDLs to take into account critical conditions for stream flow, loadings, and water quality parameters. The intent of this requirement is to ensure that the water quality is protected during times when it is most vulnerable. The critical condition is considered the "worst case scenario" of environmental conditions for the study segments. If the TMDL is developed so that the water quality targets are met under the critical condition, then the water quality targets are most likely to be met under all other conditions as well. Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and help in identifying the actions that may have to be undertaken to meet the water quality standards.

Highest average bacteria concentrations typically occur under runoff conditions during periods of frequent rainfall. To quantify this effect, bacteria samples from the historical database were classified as either runoff or baseflow samples. Samples were typically classified as runoff-related if they were collected during periods of rising or rapidly receding flow. This analysis was important for calibrating the water quality model, as well as for determining critical conditions. For the primary monitoring station at CR 353, the median baseflow and runoff-related fecal coliform concentrations were determined to be 157 and 1682 cfu/100mL, respectively.

For the present analysis, simulations were conducted for the period 2001-2004. Through simulation of this multi-year period, all potential flow conditions are explicitly considered in development of the TMDL. The modeling period includes typical high flow and low flow periods throughout the study area watersheds, which encompass any critical conditions that must be accounted for. The critical condition may vary year to year and season to season, depending upon the unique combination of rainfall, streamflow, temperature, and bacteria loadings from variable sources at any point in time. For the period of simulation in this analysis, for example, the most critical condition was represented as the 91-day period with the highest simulated geometric mean bacteria concentration, which occurred in the spring of 2004.

Consideration of Seasonal Variations

Exceedances currently occur throughout the impaired segments irrespective of season. The water quality model accounts for seasonal effects by including temporal variations in climatic patterns, water temperature, and loading rates for some of the bacteria sources. Climatic variations have the greatest influence on bacteria levels in the streams, with periods of chronic wet weather typically resulting in the highest average bacteria concentrations.

Endpoint Identification

TMDLs must identify a quantifiable water quality target for each constituent that causes a body of water to appear on the 303(d) list. These water quality targets are based on the

Texas Surface Water Quality Standards (TCEQ 2000). The numeric criteria defined in the Standards for support of the contact recreation use are as follows.

- *E. coli*
  - The geometric mean of *E. coli* should not exceed 126 cfu/100 mL
  - Single samples of *E. coli* should not exceed 394 cfu/100 mL more than 25 percent of the time

The model was developed for fecal coliform simulation (as opposed to *E. coli* simulation) because most of the scientific literature regarding sources was in terms of fecal coliform at the time of model development. However, the final allocation has been expressed in terms of *E. coli*.

Source Identification

Pollutants may come from several sources, both point and nonpoint. The possible sources of bacteria in the impaired segments are discussed in this section.

Point Sources

Point sources, such as municipal WWTFs, can contribute bacteria loads to surface water streams through effluent discharges. These facilities are permitted through the Texas Pollutant Discharge Elimination System (TPDES) program that is managed by the TCEQ. Five active permitted point sources have been identified in the Peach Creek watershed, as listed in Table 3.

Two point sources located in the study watershed may contribute bacteria: the City of Flatonia and the City of Waelder WWTFs. Permitted point sources that process wastewater associated with fecal matter are typically required to provide disinfection. Both the Flatonia and Waelder WWTFs include facultative lagoon systems. These treatment facilities do not include chemical disinfection processes. Twenty-one days detention time within the pond system, where bacteria are degraded by solar radiation and other natural processes, substantially reduces bacteria (numbers/count). This type of pond system is usually required to monitor effluent for fecal coliform.

According to the Waelder Facility permit, effluent fecal coliform levels must be measured once each month, but there is no maximum discharge concentration stipulated by the permit. At the Flatonia facility, fecal coliform samples must be collected five times each week and the average value may not exceed 200 cfu/100 mL, according to the facility's permit. The locations of these two point source dischargers are shown in Figure 3.

Nonpoint Sources

In the Peach Creek watershed, both urban and rural nonpoint sources of fecal coliform bacteria were considered in the present analysis. Nonpoint source (NPS) loading enters the impaired segment through distributed, unspecific locations. Nonpoint sources can enter the impaired stream through two pathways: directly (not storm water) or indirectly (storm water). Nonpoint sources generally include background loads, failing septic sys-

tems, livestock production, animal deposition, and leaking wastewater infrastructure. Each of these sources can result in either direct or indirect NPS pollution. Figure 6 illustrates methods of NPS loading.

Table 3: Point Sources

Permittee	Daily Avg. Flow	TCEQ Permit #
City of Waelder – WWTF	0.12 MGD*	14252
City of Flatonia – WWTF	0.25 MGD*	10101
Southern Clay Products, Inc. - US 90 clay mine	-	1925
Southern Clay Products, Inc. - Elm Grove clay mine	-	3405
Aqua WSC - Delhi iron removal water treatment plant	-	14361

* Million Gallons per Day

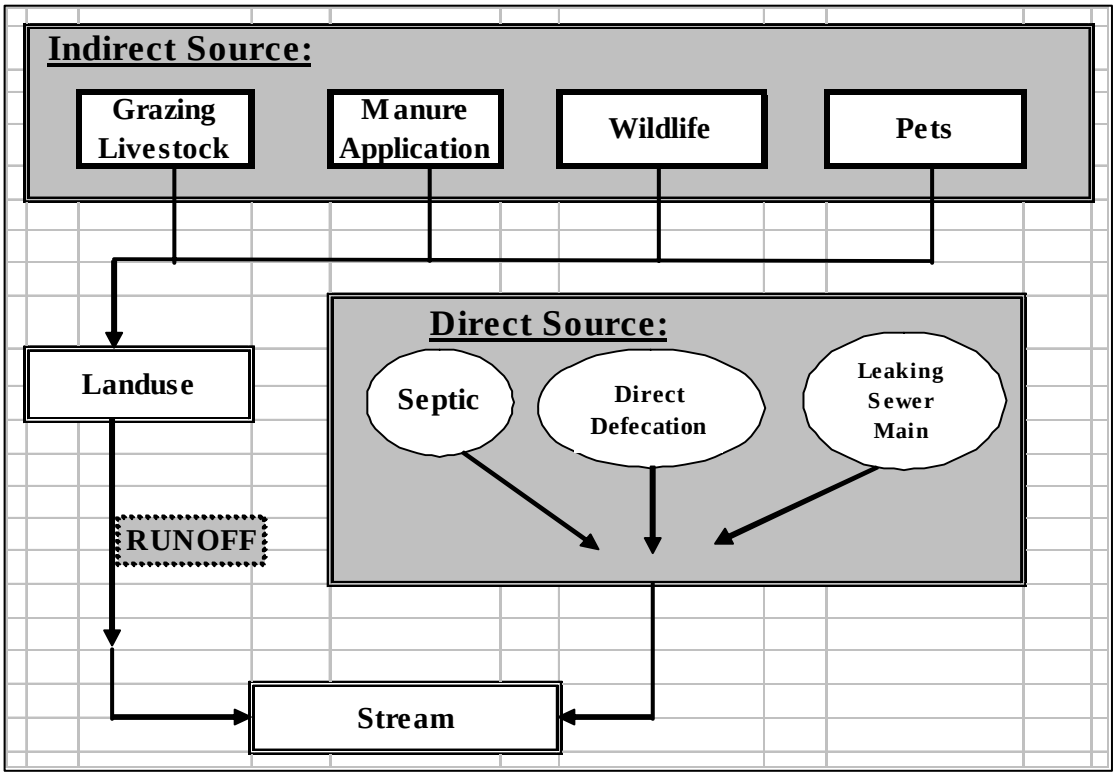

Figure 6: Mechanism of Nonpoint Source Loading

Failing Septic Systems

Private residential sewage treatment systems (septic systems) typically consist of one or more septic tanks and a drainage or distribution field. A septic system failure can occur via two mechanisms. First, drainfield failures, broken pipes, or overloading could result in uncontrolled, direct discharges to the streams. Such failures could occur in reaches with older homes located near a watercourse or in remote areas. As a second mechanism, an overloaded drainfield could experience surfacing of effluent, and the pollutants would then be available for surface accumulation and subsequent washoff under runoff conditions.

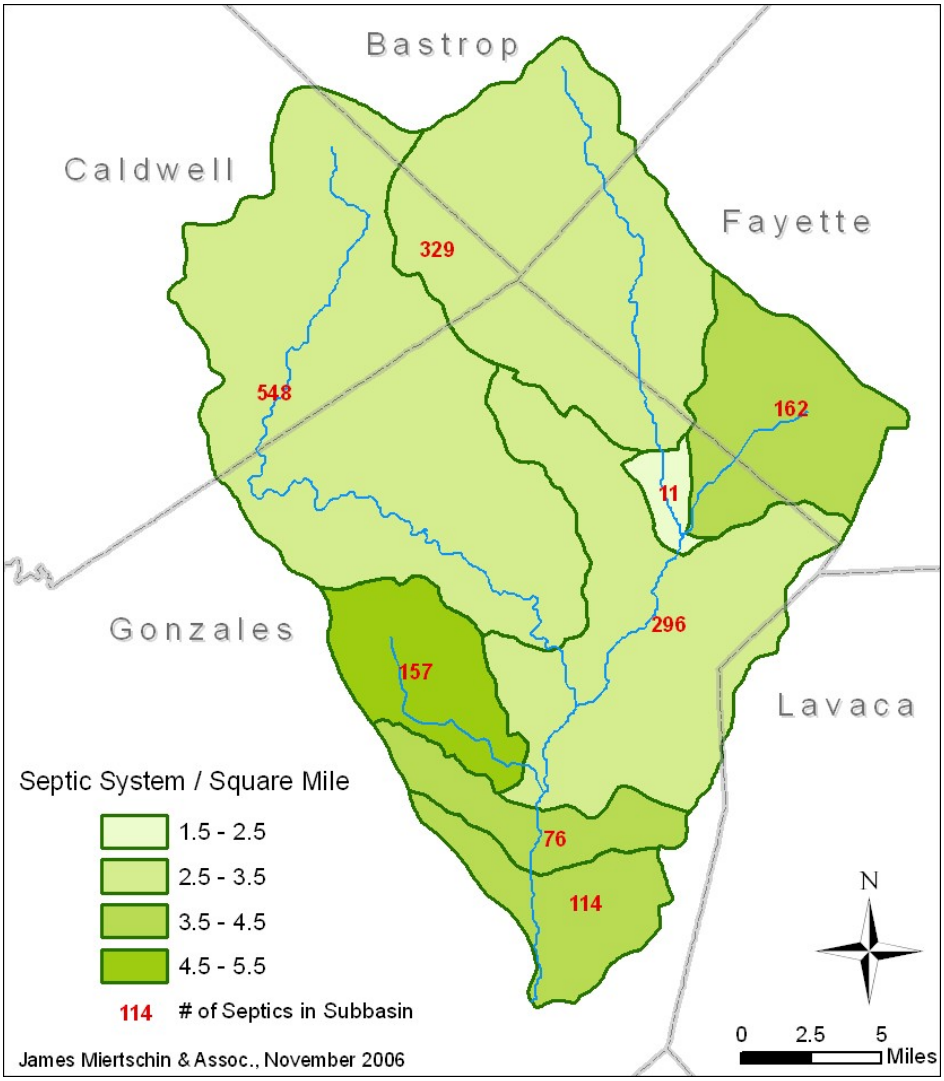

Figure 7: Septic System Density and Number by Subbasin, 1990

The number of septic systems in the study area was estimated using information from the 1990 U.S. Census, which included a question regarding the means of household sewage disposal (US Census 2006). Unfortunately, this question was not posed in the 2000 Census. Based on the 1990 data, the number of septic systems (and other non-sewered sys-

tems) in the study area was estimated by intersecting the geographic census block-groups with the study area watershed. The spatial distribution of these systems is shown in Figure 7. From 1990 to 2000, the total number of septic systems was estimated to have increased from 1,694 to 2,202.

Generally, only septic systems near streams have a high likelihood of contributing bacteria to the surface water. For this study, a riparian corridor of 300 feet (total width) was applied to all perennial steams in the study area. The overall watershed septic system density was applied to these corridor areas to obtain an estimate of near-stream septic systems. Of these systems, only a small percentage would be expected to be failing. According to a report by Reed, Stowe, and Yank (2001), about 12 percent of the septic systems in the study area are chronically malfunctioning. For this analysis, only the potential direct discharging from failing septic systems were considered in the model. Fecal coliform loadings were calculated based upon a septic system fecal density of 10,000 cfu/100mL (EPA 2001). According to US Census data, the average household in the study area includes about 2.7 people.

Leaking Wastewater Infrastructure

Leaking wastewater sewer lines are difficult to detect, but are a potentially significant source of bacteria, especially in urbanized areas where most residences are served by a central collection system. As with failing septic systems, only wastewater lines located close to streams have a high potential to act as bacterial sources. However, wastewater lines, especially large collector lines, tend to be installed along creeks and streams because the elevation profile along the waterway channel provides an economical arrangement for the gravity transport of collected sewage. In general, wastewater lines will only leak when their hydraulic grade line is higher than that of the stream to which they parallel. Also, sewers will typically only leak if they become cracked or are improperly installed. There were an estimated 1,019 sanitary sewer connections within two cities (Flatonia and Waelder) in the watershed in 1990.

Livestock and WAFs

Livestock population estimates for Gonzales, Fayette, Caldwell, and Bastrop Counties were based upon the federal 2002 Census of Agriculture (USDA 2002), TCEQ CAFO (Confined Animal Feedlot Operations) permit records (Frazier 2005), and TSSWCB Water Quality Management Plan (WQMP) records (TSSWCB 2005). The types of livestock explicitly included in the present analysis were cattle, horses/donkeys, sheep/goats, hogs, and chickens. The census data were used to determine the density of livestock (except chickens) for each county; then the watershed totals were obtained based upon the representative county areas associated with the watershed. Chicken populations for each subwatershed were estimated from data provided by the TCEQ and Gonzales County Soil and Water Conservation District. The populations were assigned to one of two land use categories in the model, namely, waste application field (WAF) 1 and WAF2. WAF1 represents land surfaces that receive litter applications. WAF2 represents land surfaces that receive sprinkler waste application. Animal population estimates for the watershed are presented in Table 4. Other types of livestock had small populations compared to the

major livestock species listed above, and therefore, the fecal loads from these other animal groups were assumed to be negligible.

Grazing animals contribute fecal coliform bacteria to the land surface that are subsequently available for washoff to surface waters during storm events. Also, livestock can deposit fecal material directly into the stream. Fecal coliform bacteria production rates for livestock are displayed in Table 6. For the present study, all of the data regarding manure production rates and fecal coliform density were based upon values reported in literature (EPA 2001) (ASAE 2003).

Table 4: Livestock Population Estimates

Animal Type	Number of Animals
Cattle & Calves	65,457
Swine	629
Sheep	546
Horses & Donkeys	1,346
Chickens	8,527,610

Non-grazing animals considered in the present analysis were chickens in various types of production facilities. The chickens are confined in covered facilities where they are grown or employed in laying eggs. Chicken litter (waste) is collected in the various facilities. In the smaller growing operations, litter is generally scraped and typically stockpiled before it is land applied on waste application fields. In the egg-laying facilities, litter is scraped or washed to lagoons for storage and treatment, after which lagoon wastewater is land-applied via sprinkler irrigation. Thus, the litter from the chicken facilities is ultimately applied in solid or liquid form to WAFs. Once applied to the WAFs, the waste is subject to washoff from the land surface under runoff conditions. Egg-laying CAFO facilities located in the watershed are presented in Table 5.

Table 5: TCEQ Permitted CAFOs in Segment 1803C Watershed

Permit Name	Permit Number	Permitted Poultry
Cal-Maine – Klesel Farm	TXG920249	2,394,000
Cal-Maine – Complex 1	TXG920250	1,297,416
Cal-Maine – Complex 2	TXG920255	1,680,192
Cal-Maine – Farm 19	TXG920343	456,000

Wildlife and Feral Animals

Representative wildlife species were included in the modeling analysis as potential sources of bacteria. The predominant wildlife species to be included in the modeling analysis were determined by wildlife biologists on the project team based on their experience, literature (Davis and Schmidly 1994; TPWD 2004), site visits, and consultation with Texas Parks and Wildlife Department staff (Cain 2004). The key species included deer, raccoons, opossums, feral hogs, and ducks/geese. Of course, numerous other species of animal inhabit the watershed, but the species selected in the present analysis were chosen based upon population and fecal production potential (see Table 6). The population of each wildlife species was developed using estimated population densities per square mile of habitat and the total area of suitable habitat available in each subwatershed. This wildlife inventory is shown in Table 7.

Table 6: Fecal Coliform Production Rates for Livestock and Wildlife

Animal	Fecal Coliform (10^9 cfu/day) (count/animal/day)
Dairy Cow	101
Beef Cow	104
Hog	11
Sheep	12
Horse	0.4
Chicken	0.1
Turkey*	0.09
Duck	2.43
Opossums	0.1
Deer	0.5
Feral Hogs	11
Raccoon	0.1

*domestic

As with livestock, a general estimate of the overall load contribution from wildlife is needed. Since wildlife populations cannot be precisely known, all loading parameters that represent wildlife were subject to adjustment in the model calibration process. There are two mechanisms considered for bacteria loadings from wildlife to be transported to the stream segment. First, wildlife deposit waste on land surfaces that accumulates and is subsequently available for washoff with runoff. Second, wildlife may deposit waste directly into the stream.

Table 7: Estimated Inventory of Wildlife in Peach Creek Watershed

Animal	Number
Ducks	125
Deer	4,732
Raccoons	18,927
Opossums	75,707
Feral Hogs	9,463

Linkage Analysis

Establishing the relationship between instream water quality targets and the source loadings of bacteria is a critical component of TMDL development. It allows for the evaluation of management options that will achieve the desired water quality endpoint. The link can be established through a variety of techniques, ranging from qualitative assumptions based on scientific principles to sophisticated mathematical modeling techniques. In the development of a TMDL for Peach Creek, the relationship was defined through computer modeling based upon data collected throughout the watershed. Monitored flow and water quality data were used to verify that the relationships developed through modeling were accurate.

The Hydrologic Simulation Program - Fortran (HSPF) water quality model was selected as the modeling framework to simulate existing conditions and to perform TMDL allocations. The HSPF model is a continuous simulation model for watershed hydrology and water quality. The model can account for both point and nonpoint source loadings in the watershed. HSPF includes simulation of the receiving stream that receives mass loadings from the watershed.

In order to develop a representative linkage between the sources and the water quality response in the stream in the Peach Creek watershed, model parameters were adjusted to accurately represent hydrology and streamflow as well as fecal coliform bacteria loading and instream concentrations. Hydrologic parameters in the model were set and adjusted based upon available soils, land use, topography, and streamflow data.

Calibration of the water quality model entailed adjustment of bacteria-related parameters to achieve agreement of the simulated model results with the observed fecal coliform measurements. Several parameters were available for adjustment in the model. The model was calibrated for both baseflow and runoff conditions.

The bacterial loads associated with the model calibration can be readily examined in terms of load originating from the land use categories and point sources embodied in the analysis. Comparisons of simulated loads for Peach Creek are compared graphically in Figure 8. The loads presented are the existing total annual average loads that enter the

impaired stream, contributed by the various sources. The loads do not account for decay that occurs as the bacteria travel downstream.

For the study reach, the largest presumed source of fecal coliform bacteria is rangeland. This is attributable to the fact that rangeland is the largest land use category in terms of acreage. Therefore, there is more land available for bacteria deposition and run-off. The next largest contribution is estimated to be forest, and the third largest source is waste application fields. The urban areas and WAFs have relatively small acreages but their assumed loading parameters are relatively large. WAFs are fields where manure from livestock production activities is applied in solid or liquid form.

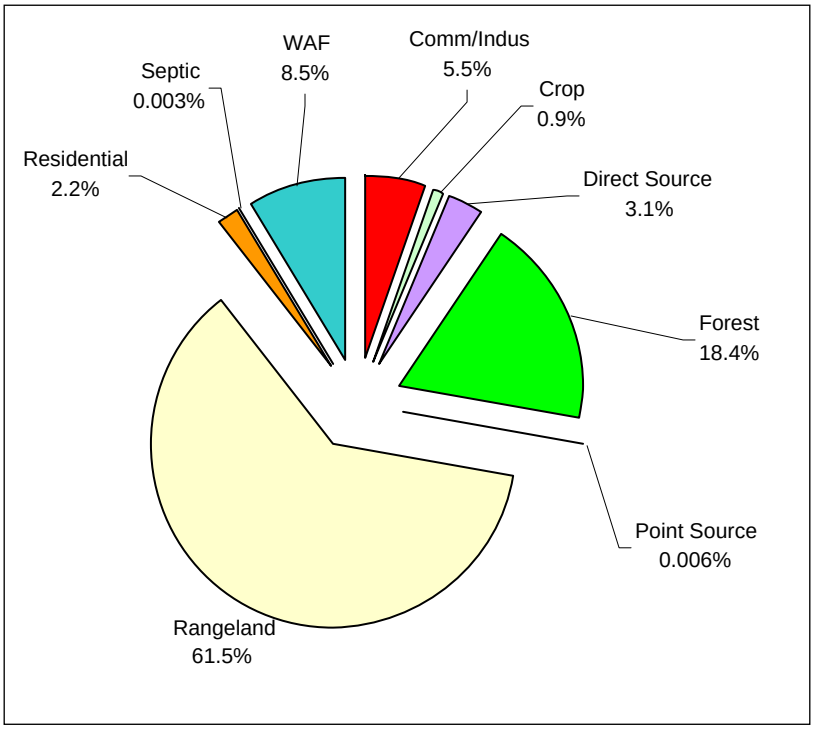

Figure 8: Comparison of Fecal Coliform Sources for Peach Creek

Bacterial Source Tracking

Watercourses can be adversely affected by many different sources of microbial pollution. In a given watershed, the primary potential sources of microbial pollution include human and animal populations, as well as soil and plants as secondary sources. During the past decade, several methods have been proposed for identifying the sources of microbial pollution in the environment. Bacterial Source Tracking (BST) was attempted as a tool to identify possible sources of bacteria. BST can be useful in the development of TMDLs as part of the source assessment, load allocation, and in the development of an I-Plan to target specific sources of bacteria entering a respective water body. For this project, BST was used to identify the presence of sources.

Currently, several research groups and commercial laboratories conduct source tracking and source identification studies using a variety of different methods and target organ-

isms (EPA 2005). The methodologies that have been used to determine the sources of microbial contamination in the environment include phenotypic-based methods such as antibiotic resistance analysis (ARA), and genotypic-based methods such as ribotyping, pulsed field gel electrophoresis (PFGE), polymerase chain reaction (PCR) based methods, and many others. ARA and ribotyping have been used far more than other BST methods, and are more developed with respect to their application to water quality studies.

Available BST methods were evaluated and two genetic fingerprinting methods were selected to meet the needs of this study: enterobacterial repetitive intergenic consensus sequence polymerase chain reaction (ERIC-PCR) and automated ribotyping (RiboPrinting). All BST laboratory work was conducted by the Texas A&M El Paso Agricultural Research and Extension Center (EP AREC) (Di Giovanni and Casarez, 2006). The source identification portion of the method relies on generating genetic fingerprints of *E. coli* strains isolated from the water body sites and comparing the fingerprints to those of *E. coli* strains isolated from potential sources of fecal pollution.

The BST process involves two primary steps. First, a library of the genetic fingerprints of known sources is created. This was accomplished through the field collection of fecal matter samples from animals within the Peach Creek watershed. To achieve a higher rate of collect classification, a combined TCEQ-TSSWCB library utilizing fecal matter samples from other study watersheds was employed. As data were gathered, they were sent to EP AREC to be analyzed and added to the library of fingerprints. The genetic fingerprints are prepared by applying restriction enzymes (*Hin*d III) to the ribosomal RNA of bacteria.

The second step required that bacteria of unknown origin (*E. coli* isolates), collected in ambient water samples, be compared to the fingerprints in the library to determine source classification. For this project, ambient samples were collected at one station listed in Table 8.

Table 8: BST Sampling Station

Station No.	Location Description
14937	Peach Creek at CR 353

EP AREC employed two methods for comparison and classification of DNA fingerprints. First, the Bionumerics statistics software (Applied Maths, Austin, Texas) was used to assign a probable match between each isolate from the water samples and the isolates from the fecal source library. The second method was a visual assessment of each individual band, or DNA fingerprint, generated throughout the study. Only isolate matches with a confidence level of 85 percent or more were accepted as probable matches in the classification protocol for this TMDL. This conservative cut-off criterion was designed to avoid misclassification errors.

The classification results indicate that the predominant sources of *E. coli* in the watershed include non-avian wildlife, cattle, other non-avian livestock, sewage, and avian wildlife. Overall BST results are presented as follows:

- 29% of the isolates originated from non-avian wildlife
- 22% of the isolates originated from cattle
- 12% of the isolates originated from other non-avian livestock
- 11% of the isolates originated from sewage
- 8% of the isolates originated from pets
- 7% of the isolates originated from avian wildlife
- 1% of the isolates originated from avian livestock
- 10% of the isolates were indeterminate

The bacterial source composition results from the present study appear to be reasonable. The three predominant sources identified were non-avian wildlife, cattle, and other non-avian livestock. However, since samples were collected within a limited timeframe from only one sampling location within a large geographic area, these results must be interpreted with caution.

Pollutant Load Allocation

TMDL Calculation

TMDLs are the sum of the individual waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources and natural background conditions, and a margin of safety (MOS). The TMDL equation has historically been written as follows:

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

where… $\sum WLA$ = Sum of Wasteload Allocations (Point Source Allocation)
$\sum LA$ = Sum of Load Allocations (Nonpoint Source Allocation)
MOS = Margin of Safety

In this equation, the "wasteload allocation" and "load allocation" represent the maximum allowable point and nonpoint source contributions, respectively. The margin of safety is included to account for any uncertainty concerning the relationship between effluent limitations and water quality.

Allocation Scenario Development

Several scenarios for best management practice (BMP) application were examined in order to assess various loading reduction scenarios. The scenarios constitute various combinations of BMPs applied to the bacteria loads that emanate from the watersheds that contribute to the stream. In the model, this was accomplished for washoff-based loadings by application of a module that allows the user to adjust the percent loading removed, by land use category. Direct sources of loadings were adjusted in the model with appropriate multipliers to effect reductions.

Wasteload Allocations

In the Peach Creek watershed, there are two point source discharges that may discharge bacteria. These sources are the Flatonia and Waelder WWTFs. Both of these facilities utilize facultative lagoons to achieve wastewater disinfection. Instead of a chemical disinfection process, 21 days detention time within the pond system, where bacteria are degraded by solar radiation and other natural processes, substantially reduces bacteria (numbers/count). These types of treatment facilities may not be able to provide sufficient hydraulic retention time under conditions of rainfall-induced peak flows. Therefore, there is no mechanism for controlling the concentration of bacteria they may discharge in this type of treatment system unless influent hydraulic loading is controlled.

Based on self-reported data, the bacteria loads leaving the WWTFs are negligible compared to the much larger nonpoint sources. The point source loads account for just 0.006 percent of the total annual average stream load, and just 0.2 percent of directly discharging loads (non-washoff loads). Furthermore, the bacteria concentrations measured in the effluent from these facilities are typically well below the bacteria criteria associated with the contact recreation use. For these reasons, no reduction in point source loading has been prescribed. Table 9 summarizes the WLA for point sources.

Table 9: WLAs for Fecal Coliform in Impaired Reach (10^6 cfu/day)

Point Source	Existing Load	Percent Reduction	WLA*
City of Flatonia WWTF	388	0	1893
City of Waelder WWTF	291	0	908
		Total WLA (cfu/day) =	**2801**

*permitted flow x water quality standard

It is the TCEQ's intention to implement these individual WLAs through the permitting process as either monitoring requirements or effluent limitations. However, there may be a more economical or technically feasible means of achieving the goal of improved water quality, and circumstances may warrant changes in individual WLAs after this TMDL is adopted. Therefore, these individual WLAs are non-binding until implemented via a separate TPDES permitting action which may involve a TCEQ "Water Quality Management Plan Update." Regardless, all permitting actions will demonstrate compliance with the TMDL.

The commission understands that this TMDL is, by definition, the total of the sum of the wasteload allocation, the sum of the load allocation, and the margin of safety. Changes to individual WLAs may be necessary in the future in order to accommodate growth or other changing conditions. These changes to individual WLAs do not ordinarily require a revision of the actual TMDL and will be accommodated through the TCEQ's WQMP update process. Any future changes to effluent limitations will be addressed through the permitting process and by updating the WQMP.

Load Allocations

Load allocations for nonpoint sources include land-based washoff loadings and direct discharge nonpoint source loadings. The land-based loadings originate via washoff of bacteria from land surfaces in the watersheds of the impaired reach under rainfall runoff conditions. The direct discharge nonpoint source loadings represent direct deposition from animals (including wildlife, livestock, and pets), and potentially leaking wastewater collection mains.

The LA component of the TMDL incorporates background loadings within the impaired reach, which include aspects of both the land-based source loadings and the direct source loadings. Specifically, the background load from wildlife is included as deposition of bacteria onto land surfaces that is subject to subsequent washoff under rainfall runoff conditions, and as direct deposition into receiving streams.

The LA is determined as shown in Table 10. Here, existing loads and allocated loads are inventoried. The total LA for nonpoint sources is shown in the table. This total LA was the result of summation of the various individual LAs, based on hypothetical removals applied to corresponding existing loads.

Table 10: LAs for Fecal Coliform in Impaired Reach (10^6 cfu/day)

Nonpoint Source	Existing Load	Percent Reduction	LA
Washoff NPS	11,068,123	47.4	5,825,328
Direct Discharge NPS	350,576	47.4	184,514
Septic System NPS	317	100	0
		Total LA (cfu/day) =	**6,009,842**

The selection of BMP control measures to address reductions in loading from nonpoint sources will be developed during the implementation phase of the TMDL with participation from stakeholders. For washoff sources, the different land use categories will dictate the most promising BMPs for both urban and non-urban areas. In this analysis, the 47 percent reduction in washoff nonpoint sources has been applied to the entire watershed, irrespective of land use. During the TMDL implementation phase, stakeholders will have the option to recommend and prescribe different percent reductions to different types of land uses and to specific sources, so long as these various reductions result in an overall washoff load reduction of at least 47 percent.

The category of septic system loads is modeled separately from the direct nonpoint category, but they are both similar in that they represent sources of bacteria that are discharged continuously to the stream and that are not associated with rainfall runoff. Based on the estimation of septic system loads performed in this study, these loads are expected to be negligible when compared to direct nonpoint loads. However, TCEQ regulations do

not allow septic systems to fail and discharge to waters of the State. Therefore, a 100 percent reduction in septic nonpoint source load is part of the required reduction.

Margin of Safety

The MOS is a required component of the TMDL to account for any uncertainty concerning the relationship between effluent limitations and water quality. According to EPA guidance (EPA 1991), the MOS can be incorporated into the TMDL using two methods:

- Implicitly incorporating the MOS using conservative model assumptions to develop allocations; or
- Explicitly specifying a portion of the TMDL as the MOS and using the remainder for allocations.

This TMDL has an implicit MOS which reflects conservative factors incorporated into the TMDL development process. The most important factor was the simulation of bacteria concentrations on a daily basis and the subsequent use of a 91-day period for assessing model results. The 91-day period is based on quarterly sampling on an annual basis, which is consistent with TCEQ methodology. TCEQ typically uses a seven-year period for assessing compliance with Water Quality Standards.

TMDL Summary

Table 11 summarizes the TMDL fecal coliform loading allocations for Peach Creek. The WLA includes all of the allocated point sources and the LA is comprised of unpermitted washoff sources, direct nonpoint sources, septic sources, and various background sources.

In order to achieve the bacteria TMDL for Peach Creek, reductions in washoff loadings from land use areas will be required, along with reductions in direct nonpoint sources, as described in detail in the preceding sections.

Table 11: Summary of Fecal Coliform TMDL for Impaired Reach (10^6 cfu/day)

	TMDL	WLA	LA
Peach Creek	6,012,643	2801	6,009,842

The proposed TMDL is expected to be protective for Texas water quality criteria for *E. coli*. A ratio of 0.63 was applied in the present study to convert fecal coliform to *E. coli*. This ratio is based on comparison of the criterion for *E. coli* compared to the criterion for fecal coliform (126/200 = 0.63). Similar ratios have been observed in the Peach Creek watershed, and have been reported in other studies. Therefore, development of a TMDL to achieve compliance with a fecal coliform concentration of 200 cfu/100 mL should be protective down to an *E. coli* concentration of 126 cfu/100mL (200x0.63 = 126). Table 12 summarizes the TMDL results for *E. coli*.

Table 12: Summary of *E. coli* TMDL for Impaired Reach (10^6 cfu/day)

	TMDL	WLA	LA
Peach Creek	3,787,965	1765	3,786,200

Public Participation

The TCEQ maintains an inclusive public participation process and from the inception of the investigation, the project team sought to ensure that stakeholders were informed and involved. The project team also recognized that communication and comments from the stakeholders in the watershed would strengthen the project and its implementation.
An official steering committee of stakeholders was established. Notices of meetings were posted on the TMDL program's web calendar. Two weeks prior to scheduled meetings, media releases were initiated and steering committee stakeholders were formally invited to attend. To ensure that absent stakeholders and the public were informed of past meetings and pertinent material, a project web page was established to provide meeting summaries, presentations, ground rules, and a list of official steering committee stakeholders. The project web page is available at: <www.tceq.state.tx.us/implementation/water/tmdl/34-peachcreek_group.html>.

Throughout the term of the project, from 2002 to 2007, five meetings were held. At each meeting, the project team received and responded to a number of questions and comments. The objectives of the first meeting in September of 2002 were to:

- Introduce the project team and summarize the public participation process.
- Define what the project intended to accomplish.
- Provide information on TMDL process.
- Review of historical data and monitoring results.

The objectives of the second stakeholder meeting in August of 2003 were to:

- Inform the stakeholders on the status of work being performed on the project.
- Discuss the next phases.

The objectives of the third stakeholder meeting in August of 2004 were to:

- Inform the stakeholders on the status of work being performed on the project.
- Discuss modeling phase results.
- Discuss the next phases.

The objectives of the fourth stakeholder meeting in October of 2005 were to:

- Inform the stakeholders on the status of work being performed on the project.
- Discuss modeling phase results.
- Discuss implementation strategies.

The objectives of the fifth stakeholder meeting in October of 2007 were to:

- Discuss outstanding issues, such as the Bacteria TMDL Task Force Report, water quality standards, on-site sewage facilities (OSSFs), and wildlife
- Discuss the next phase of the project, specifically release of the draft TMDL report for public comment and TCEQ adoption/EPA approval

Implementation and Reasonable Assurances

The TMDL development process involves the preparation of two documents

1) a TMDL, which determines the amount of pollutant a water body can receive and continue to meet applicable water quality standards, and
2) an I-Plan, which is a detailed description and schedule of regulatory and voluntary management measures necessary to achieve the pollutant reductions identified in the TMDL. It is the policy of the commission and of the TSSWCB to develop I-Plans for all TMDLs adopted by the State, and to assure the plans are implemented. I-Plans are not subject to EPA approval.

During TMDL implementation, the State works with stakeholders to develop the management strategies needed to restore water quality to an impaired water body. This information is summarized in the TMDL I-Plan, which is separate from the TMDL document. Preparation of the I-Plan for Segment 1803C will begin upon Commission approval of the TMDL. The I-Plan will detail any activities such as mitigation measures, permit actions, best management practices, and additional sampling and monitoring determined to be necessary to restore water quality.

Implementation Processes to Address the TMDL

Together, a TMDL and a TMDL I-Plan direct the correction of unacceptable water quality conditions that exist in an impaired surface water body in the state. A TMDL broadly identifies the pollutant load goal after assessment of existing conditions and the impact on those conditions from probable or known sources. A TMDL identifies a total loading from the combination of point sources and nonpoint sources that would allow attainment of the established water quality standard.

A TMDL I-Plan specifically identifies required or voluntary implementation actions that will be taken to achieve the pollutant loading goals of the TMDL. Regulatory actions identified in the I-Plan could include:

- adjustment of an effluent limitation in a wastewater permit,
- a schedule for the elimination of a certain pollutant source,
- identification of any nonpoint source discharge that would be regulated as a point source,
- a limitation or prohibition for authorizing a point source under a general permit, or
- a required modification to a storm water management program (SWMP) and pollution prevention plan (PPP).

Strategies to optimize compliance and oversight are identified in an I-Plan when necessary. Such strategies may include monitoring and reporting of effluent discharge quality to evaluate and verify loading trends, adjustment of an inspection frequency, a response protocol to public complaints, and escalation of an enforcement remedy to require corrective action of a regulated entity contributing to an impairment.

The TMDL document and the underlying assumptions, model scenarios, and assessment results are not and should not be interpreted as required effluent limitations, pollutant load reductions that will be applied to specific permits, or any other regulatory action necessary to achieve attainment of the water quality standard. The I-Plan developed by stakeholders and approved by the State, will direct implementation efforts to certain sources contributing to the impaired water.

The I-Plan will be developed through effective coordination with stakeholders affected by or interested in the goals of the TMDL. In determining which sources need to accomplish what reductions, the I-Plan may consider factors such a:

- cost and/or feasibility,
- current availability or likelihood of funding,
- existing or planned pollutant reduction initiatives such as watershed-based protection plans,
- whether a source is subject to an existing regulation,
- the willingness and commitment of a regulated or unregulated source, and
- a host of additional factors.

Ultimately, the I-Plan will identify the commitments and requirements to be implemented through specific permit actions and other means.

The TSSWCB is the lead agency in Texas responsible for planning, implementing, and managing programs and practices for preventing and abating agricultural and silvicultural nonpoint sources of water pollution (Texas Agriculture Code §201.026). In collaboration with local soil and water conservation districts, the TSSWCB works with landowners to develop and implement water quality management plans on agricultural or silvicultural lands. A TSSWCB-certified water quality management plan is a site-specific plan that includes appropriate land treatment practices, production practices, management measures, and technologies that are based on criteria established by the USDA Natural Resources Conservation Service. Water quality management plans are designed to achieve a level of pollution prevention or abatement determined by the TSSWCB to be consistent with state water quality standards.

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