FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration

NORTHWEST DISTRICT • PERDIDO RIVER AND BAY BASIN

FINAL TMDL Report

Fecal Coliform TMDL for Brushy Creek (WBID 4)

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Websites

Florida Department of Environmental Protection, Bureau of Watershed Restoration

TMDL Program
http://www.dep.state.fl.us/water/tmdl/index.htm
Identification of Impaired Surface Waters Rule
http://www.dep.state.fl.us/legal/Rules/shared/62-303/62-303.pdf

Florida STORET Program

http://www.dep.state.fl.us/water/storet/index.htm

2012 Integrated Report

http://www.dep.state.fl.us/water/docs/2012_integrated_report.pdf

Criteria for Surface Water Quality Classifications

http://www.dep.state.fl.us/water/wqssp/classes.htm

Waer Quality Status Report : Perdido River and Bay
http://www.dep.state.fl.us/water/basin411/perdido/status.htm
Water Quality Assessment Report: Perdido River and Bay
http://www.dep.state.fl.us/water/basin411/perdido/assessment.htm

U.S. Environmental Protection Agency

Region 4: TMDLs in Florida

http://www.epa.gov/region4/water/tmdl/florida/

National STORET Program

http://www.epa.gov/storet/

Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Load (TMDL) for fecal coliform bacteria for Brushy Creek, located in the Perdido River and Bay Basin. This waterbody was verified as impaired for fecal coliform, and therefore was included on the Verified List of impaired waters for the Perdido River and Bay Basin that was adopted by Secretarial Order in December 2007. The TMDL establishes the allowable fecal coliform loading to Brushy Creek that would restore the waterbody so that it meets its applicable water quality criterion for fecal coliform.

1.2 Identification of Waterbody

For assessment purposes, the Florida Department of Environmental Protection (Department) has divided the Perdido River and Bay Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. Brushy Creek is WBID 4.

Brushy Creek, a tributary of the Perdido River, is a 24-mile-long creek that runs through Alabama and Florida. The headwaters of the creek rise on the east side of Atmore, Alabama, and flow generally in a southerly direction. The creek discharges into the Perdido River. Brushy Creek is located in the northwestern portion of Escambia County, in northwest Florida (**Figure 1.1**). The Brushy Creek watershed is rural, with the primary land uses being silviculture and farming (**Figure 1.2**). Additional information about the hydrology and geology of this area is available in the Water Quality Status Report for the Perdido River and Bay Basin (Department 2006).

1.3 Background

This report was developed as part of the Department’s watershed management approach for restoring and protecting state waters and addressing TMDL Program requirements. The watershed approach, which is implemented using a cyclical management process that rotates through the state’s 52 river basins over a 5-year cycle, provides a framework for implementing the TMDL Program–related requirements of the 1972 federal Clean Water Act and the 1999 Florida Watershed Restoration Act (FWRA) (Chapter 99-223, Laws of Florida).

A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet water quality standards, including its applicable water quality criteria and its designated uses. TMDLs are developed for waterbodies that are verified as not meeting their water quality standards. They provide important water quality restoration goals that will guide restoration activities.

A TMDL report is followed by the development and implementation of a restoration plan designed to reduce the amount of fecal coliform that caused the verified impairment of a waterbody. These activities depend heavily on the active participation of local governments, businesses, citizens, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions of fecal coliform and achieve the established TMDLs for impaired waterbodies.

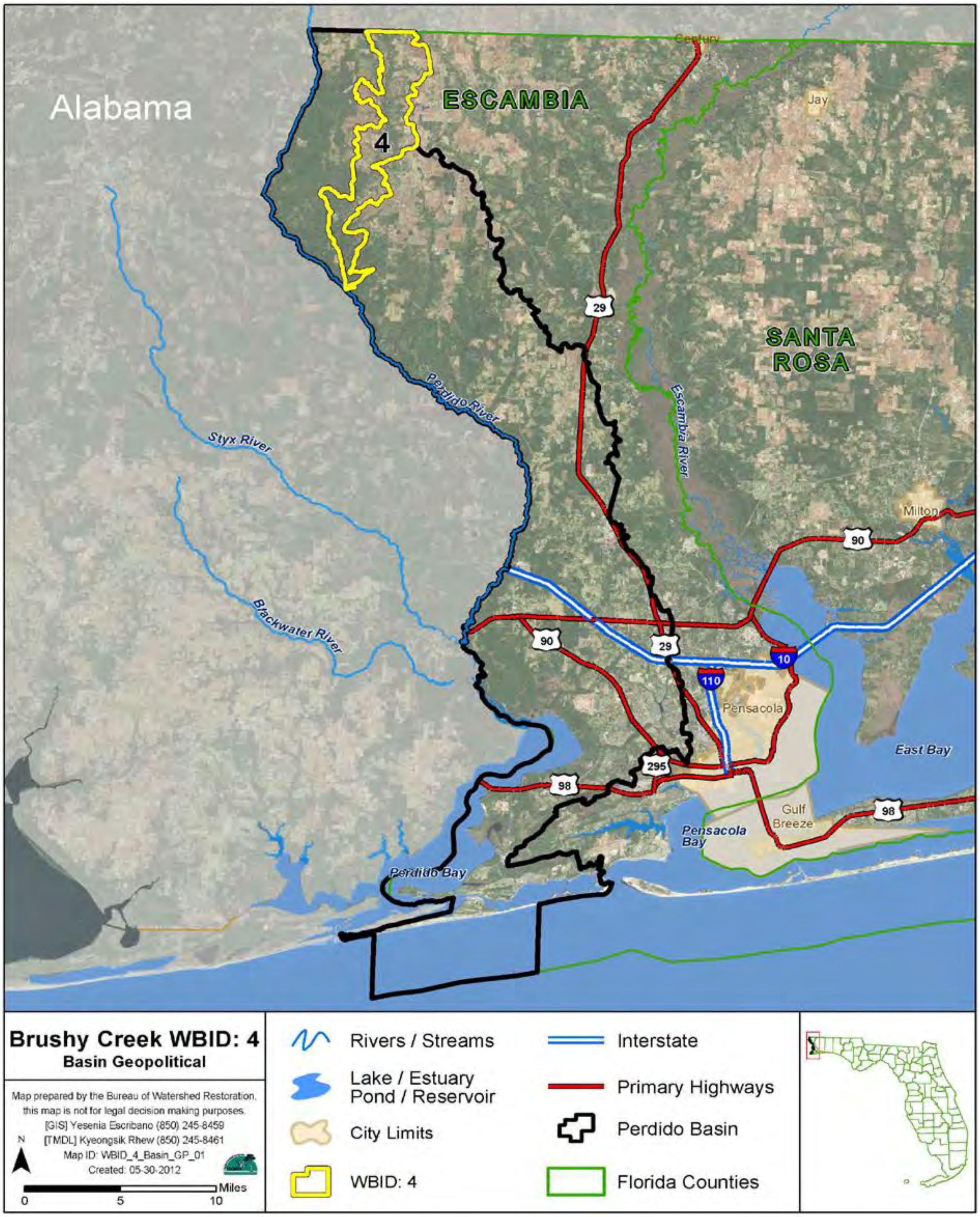


Figure 1.1. Location of the Brushy Creek (WBID 4) Watershed in the Perdido River and Bay Basin and Major Geopolitical and Hydrologic Features in the Area

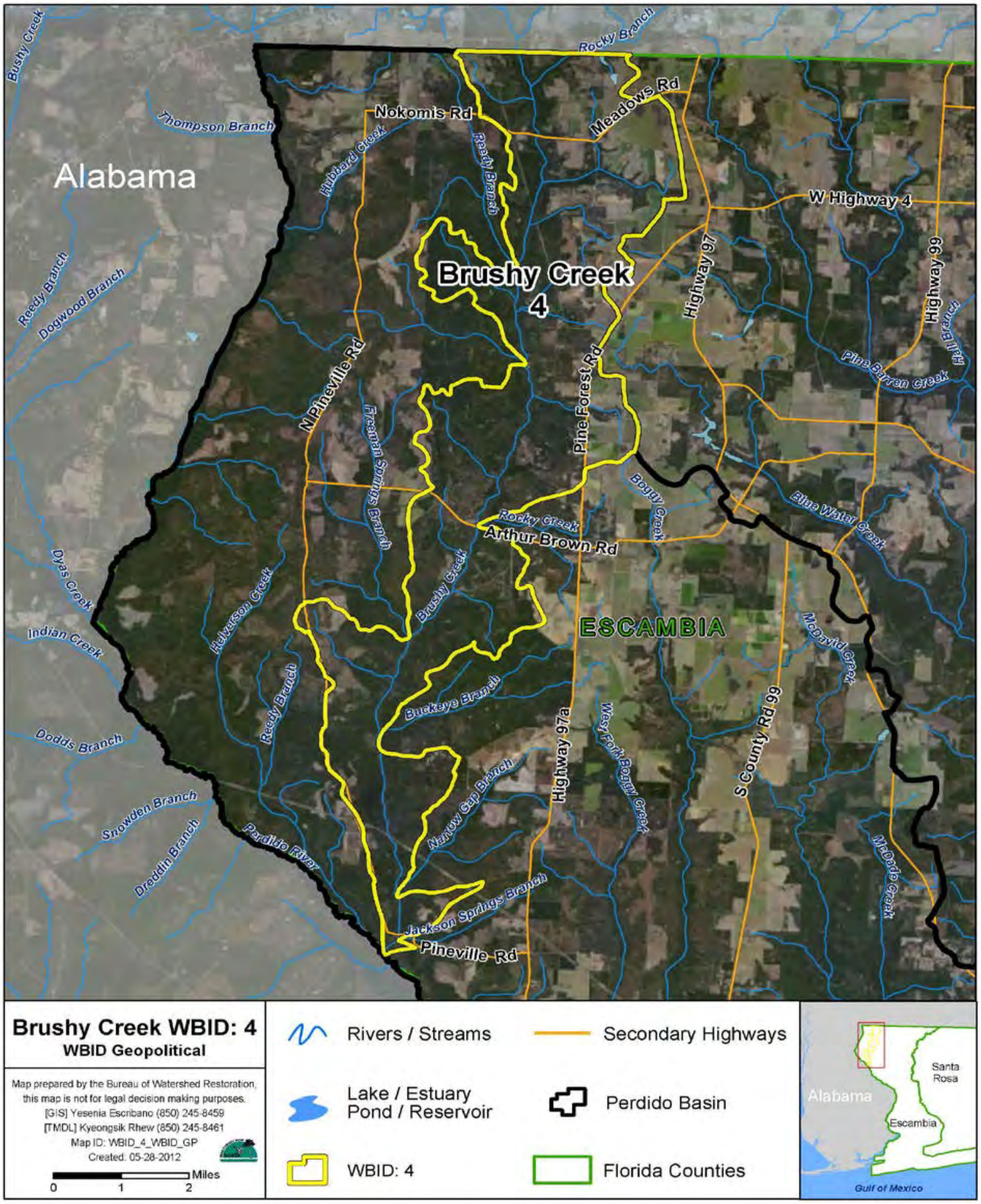


Figure 1.2. Detailed View of the Brushy Creek (WBID 4) Watershed and Major Geopolitical and Hydrologic Features in the Area

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rulemaking History

Section 303(d) of the federal Clean Water Act requires states to submit to the U.S. Environmental Protection Agency (EPA) lists of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant causing the impairment of listed waters on a schedule. The Department has developed such lists, commonly referred to as 303(d) lists, since 1992. The list of impaired waters in each basin, referred to as the Verified List, is also required by the FWRA (Subsection 403.067[4], Florida Statutes [F.S.]); the state's 303(d) list is amended annually to include basin updates.

Florida's 1998 303(d) list included 13 waterbodies in the Perdido River and Bay Basin. However the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new science –based methodology to identify impaired waters. After a long rulemaking process, the Environmental Regulation Commission adopted the new methodology as Rule 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001; the rule was modified in 2006 and 2007.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in Brushy Creek and has verified that this waterbody segment is impaired for fecal coliform bacteria. Brushy Creek was initially assessed during the Cycle 1 verified period (January 1, 1999, through June 30, 2006). Because a fecal coliform TMDL was not developed following the Cycle 1 listing, the creek was reassessed for the Cycle 2 verified period (January 1, 2004, through June 30, 2011). The initial verified impairment was based on the observation that 30 out of 137 fecal coliform samples collected during the Cycle 1 verified period exceeded the assessment threshold of 400 counts per 100 milliliters (counts/100mL) (see **Section 3.2** for details). The verified impairment was reaffirmed when 18 out of 93 fecal coliform samples collected during the Cycle 2 verified period exceeded the assessment threshold.

Table 2.1 summarizes the fecal coliform monitoring results for the Cycle 1 and Cycle 2 verified periods for Brushy Creek. To ensure that the fecal coliform TMDL was developed based on current conditions in the creek and that recent trends in the creek's water quality were adequately captured, monitoring data gathered during the Cycle 2 verified period were used in the TMDL development. **Table 2.2** summarizes the fecal coliform monitoring results during the Cycle 2 verified period.

Table 2.1. Summary of Fecal Coliform Monitoring Data for Brushy Creek During the Cycle 1 Verified Period (January 1, 1999–June 30, 2006) and Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

This is a four-column table. Column 1 lists the WBID name and number, Column 2 lists the parameter, Column 3 lists the corresponding Cycle 1 results, and Column 4 lists corresponding Cycle 1 results

- = Empty cell/no data

Parameter	Cycle 1 Fecal Coliform	Cycle 2 Fecal Coliform
Total number of samples	137	93
IWR-required number of exceedances for the Verified List	19	14
Number of observed exceedances	30	18
Number of observed nonexceedances	107	75
FINAL ASSESSMENT	**Impaired**	**Impaired**

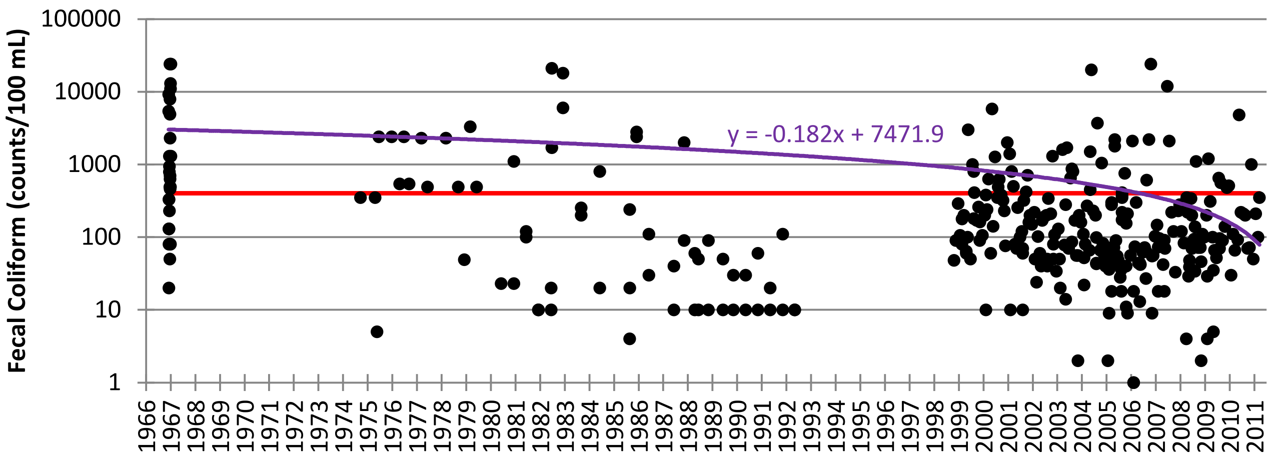
Table 2.2. Summary of Fecal Coliform Monitoring Data for Brushy Creek During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

This is a three-column table. Column 1 lists the WBID name and number, Column 2 lists the parameter, and Column 3 lists the corresponding Cycle 2 results

Parameter	Fecal Coliform
Total number of samples	93
Number of observed exceedances	18
Number of observed nonexceedances	75
Number of seasons during which samples were collected	4
Highest observation (counts/100mL)	24,000
Lowest observation (counts/100mL)	2
Median observation (counts/100mL)	110
Mean observation (counts/100mL)	947

2.3 Period of Record Trend

Historical fecal coliform data collection began in 1966 and continued to 2011 in Brushy Creek. Fecal coliform concentrations ranged from 1 to 24,000 counts/100mL and averaged 970 counts/100mL. Plotting the period of record (historical) fecal coliform data by time for Brushy Creek (Prob> F = 0.0001) revealed a significant decreasing trend (**Figure 2.1**).



Note: The red line indicates the target concentration (400 counts/100mL).

Figure 2.1. Fecal Coliform Concentration Trends in Brushy Creek for the Period of Record (1966–2011)

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criterion Applicable to the TMDL

Florida's surface waters are protected for five designated use classifications, as follows:

Class I	**Potable water supplies**
Class II	**Shellfish propagation or harvesting**
Class III	**Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife**
Class IV	**Agricultural water supplies**
Class V	**Navigation, utility, and industrial use (there are no state waters currently in this class)**

Brushy Creek is a Class III waterbody, with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The criterion applicable to this TMDL is the Class III criterion for fecal coliform.

3.2 Applicable Water Quality Standards and Numeric Water Quality Target

Numeric criteria for bacterial quality are expressed in terms of fecal coliform bacteria concentration. The water quality criterion for the protection of Class III fresh waters, as established by Rule 62-302, F.A.C., states the following:

Fecal Coliform Bacteria:

The most probable number (MPN) or membrane filter (MF) counts per 100 mL of fecal coliform bacteria shall not exceed a monthly average of 200, nor exceed 400 in 10 percent of the samples, nor exceed 800 on any one day.

The criterion states that monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period. There were insufficient data (fewer than 10 samples in a given month) available to evaluate the geometric mean criterion for fecal coliform bacteria. Therefore, the criterion selected for the TMDL was not to exceed 400 counts/100mL in any sampling event for fecal coliform. The 10% exceedance allowed by the water quality criterion for fecal coliform bacteria was not used directly in estimating the target load, but was included in the TMDL margin of safety (as described in subsequent chapters).

Chapter 4: ASSESSMENT OF SOURCES

4.1 Types of Sources

An important part of the TMDL analysis is the identification of pollutant source categories, source subcategories, or individual sources of pollutants in the impaired waterbody and the amount of pollutant loadings contributed by each of these sources. Sources are broadly classified as either “point sources” or “nonpoint sources.” Historically, the term “point sources” has meant discharges to surface waters that typically have a continuous flow via a discernible, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) are examples of traditional point sources. In contrast, the term “nonpoint sources” was used to describe intermittent, rainfall-driven, diffuse sources of pollution associated with everyday human activities, including runoff from urban land uses, agriculture, silviculture, and mining; discharges from failing septic systems; and atmospheric deposition.

However, the 1987 amendments to the Clean Water Act redefined certain nonpoint sources of pollution as point sources subject to regulation under the EPA’s National Pollutant Discharge Elimination System (NPDES) Program. These nonpoint sources included certain urban stormwater discharges, such as those from local government master drainage systems, construction sites over five acres, and a wide variety of industries (see **Appendix A** for background information on the federal and state stormwater programs).

To be consistent with Clean Water Act definitions, the term “point source” will be used to describe traditional point sources (such as domestic and industrial wastewater discharges) and stormwater systems requiring an NPDES stormwater permit when allocating pollutant load reductions required by a TMDL (see **Section 6.1**). However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES stormwater discharges and non-NPDES stormwater discharges, and as such, this source assessment section does not make any distinction between the two types of stormwater.

4.2 Potential Sources of Fecal Coliform within the Brushy Creek WBID Boundary

4.2.1 Point Sources

Wastewater Point Sources

No NPDES-permitted facilities are located in or discharge within the Brushy Creek WBID boundary.

Municipal Separate Storm Sewer System Permittees

There are no NPDES municipal separate storm sewer system (MS4) permits covering the Brushy Creek watershed. Therefore, all the load reduction goes to the load allocation for nonpoint sources.

4.2.2 Land Uses and Nonpoint Sources

Accurately quantifying the fecal coliform loadings from nonpoint sources requires identifying nonpoint source categories, locating the sources, determining the intensity and frequency at which these sources create high fecal coliform loadings, and specifying the relative contributions from these sources. Depending on the land use distribution in a given watershed, frequently cited nonpoint sources in urban areas include failed septic tanks, leaking sewer lines, and pet feces. For a watershed dominated by agricultural land uses, fecal coliform loadings can come from the runoff from areas with animal feeding operations or direct animal access to receiving waters.

In addition to the sources associated with anthropogenic activities, birds and other wildlife can also act as fecal coliform contributors to receiving waters. While detailed source information is not always available for accurately quantifying the fecal coliform loadings from different sources, land use information can provide some hints on the potential sources of observed fecal coliform impairment.

Land Uses

The spatial distribution and acreage of different land use categories were identified using the Northwest Florida Water Management District's (NWFWMD) 2009–10 land use coverage contained in the Department's geographic information system (GIS) library. Land use categories within the Brushy Creek WBID boundary were aggregated using the Florida Land Use Code and Classification System (FLUCCS) expanded Level 1 codes (including low-, medium-, and high-density residential) and tabulated in **Table 4.1**. **Figure 4.1** shows the spatial distribution of the principal land uses within the WBID boundary.

As shown in **Table 4.1**, the total area within the Brushy Creek WBID boundary is about 16,959 acres. The dominant land use category is upland forest, which accounts for about 48% of the total watershed area. Urban lands—including urban and built-up; low- and medium-density residential; and transportation, communication, and utilities—make up about 3% of the total area. Agricultural land use accounts for 17%. Low-impact land uses, including rangeland, upland forest, water, wetland, and barren land, occupy 80% of the watershed area.

Because no conventional point sources were identified in the Brushy Creek watershed, the primary loadings of fecal coliform to the creek are generated by nonpoint sources or MS4-permitted areas in the watershed. Runoff from agriculture could be another source, in addition to failed septic tanks and pet feces, because the watershed is in a rural area. A preliminary quantification of the fecal coliform loadings from these sources was conducted to demonstrate the relative contributions. **Appendix B** provides detailed load estimates and describes the methods used for the quantification. It should be noted that the information included in **Appendix B** was only used to demonstrate the possible relative contributions from different sources. These loading estimates were not used in establishing the final TMDL.

Wildlife and Sediments

Wildlife and sediments could also contribute to fecal coliform exceedances in each watershed. Wildlife such as rabbits, birds, and raccoons have direct access to the waterbody and can deposit their feces directly into the water. Wildlife also deposit coliform bacteria with their feces onto land surfaces, where they can be transported during storm events to nearby streams. Studies have shown that fecal coliform bacteria can survive and reproduce in streambed sediments and can be resuspended in surface water when conditions are right (Jamieson *et al.* 2005; Solo-Gabriele *et al.* 2002).

Current source identification methodologies cannot quantify the exact amount of fecal coliform loading from wildlife and/or sediment sources.

Table 4.1. Classification of Land Use Categories within the Brushy Creek WBID Boundary

This is a four-column table. Column 1 lists the Level 1 land use code, Column 2 lists the land use, Column 3 lists the acreage, and Column 4 lists the percent acreage.

- = Empty cell/no data

Level 1 Code	Land Use	Acreage	% Acreage
1000	Urban and built-up	8	0.0%
-	Low-density residential	351	2.1%
-	Medium-density residential	3	0.0%
-	High-density residential	-	-
2000	Agriculture	2,944	17.4%
3000	Rangeland	833	4.9%
4000	Upland forest	8,051	47.5%
5000	Water	67	0.4%
6000	Wetland	4,553	26.8%
7000	Barren land	5	0.0%
8000	Transportation, communication, and utilities	144	0.8%
-	**TOTAL**	**16,959**	**100.0%**

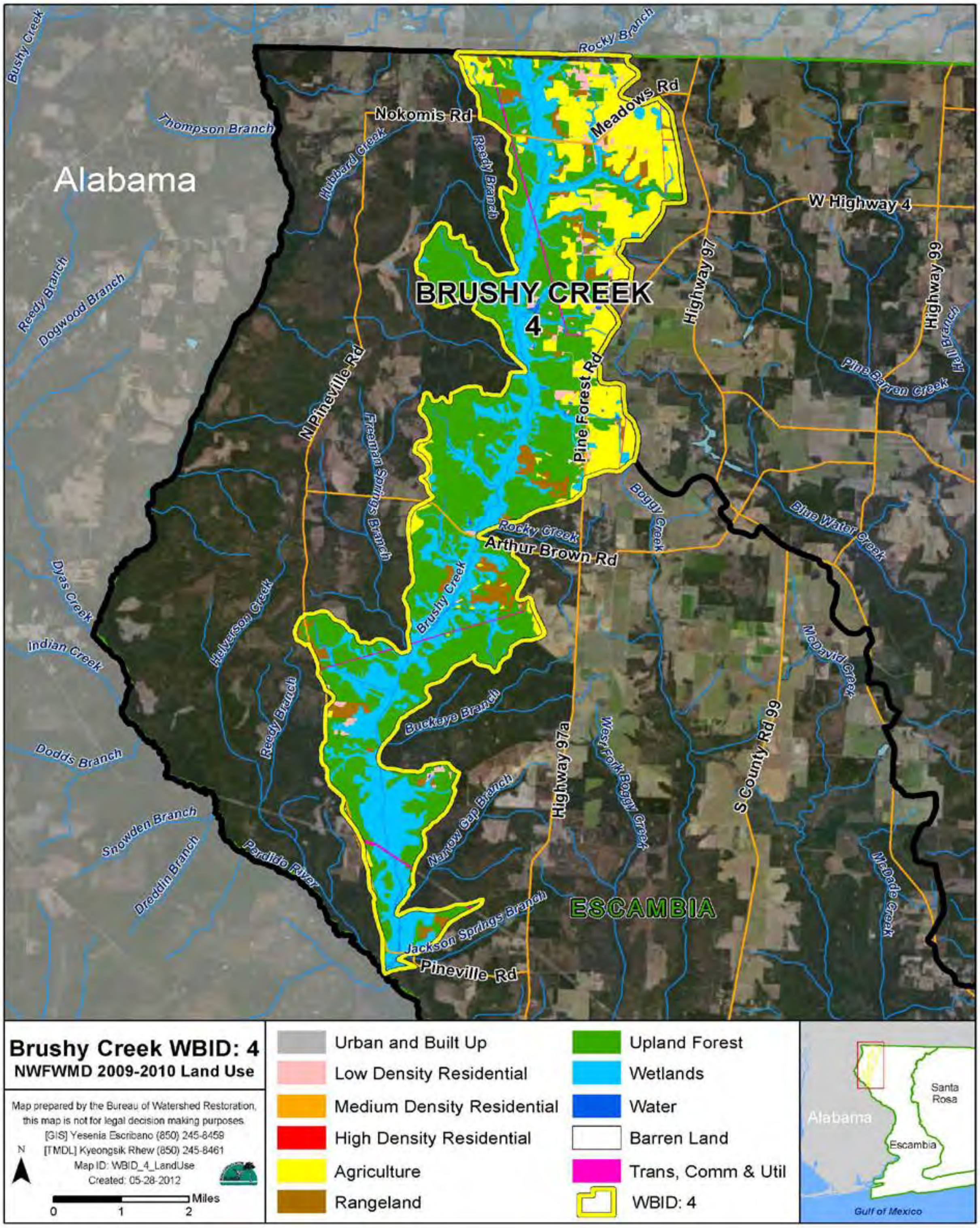


Figure 4.1. Principal Land Uses within the Brushy Creek WBID Boundary in 2009–10

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

The fecal coliform TMDL was developed using the Hazen method, which is a percent reduction approach. Using this method, the percent reduction needed to meet the applicable criterion is calculated based on the 90th percentile of all measured concentrations collected during the Cycle 2 verified period (January 1, 2004, through June 30, 2011). Because bacteriological counts in water are not normally distributed, a nonparametric method is more appropriate for the analysis of fecal coliform data (Hunter 2002). The Hazen method, which uses a nonparametric formula, was used to determine the 90th percentile value. The percent reduction of fecal coliform needed to meet the applicable criterion was calculated as described in **Section 5.1.3**.

5.1.1 Data Used in the Determination of the TMDL

All data used for this TMDL report were provided by the Department. The data were included in Run_44 of the Department's IWR database. **Figure 5.1** shows the locations of the water quality sites where fecal coliform data were collected. This analysis used fecal coliform data collected during the Cycle 2 verified period (January 1, 2004, through June 30, 2011) to represent more accurately the current conditions. During this period, a total of 93 fecal coliform samples were collected from 8 water quality stations in Brushy Creek.

Figure 5.2 shows the fecal coliform concentrations observed in Brushy Creek. These ranged from 2 to 24,000 counts/100mL and averaged 947 counts/100mL during the Cycle 2 verified period. Plotting fecal coliform data by time for Brushy Creek only during the Cycle 2 verified period revealed no increasing or decreasing trend (Prob > F = 0.1860).

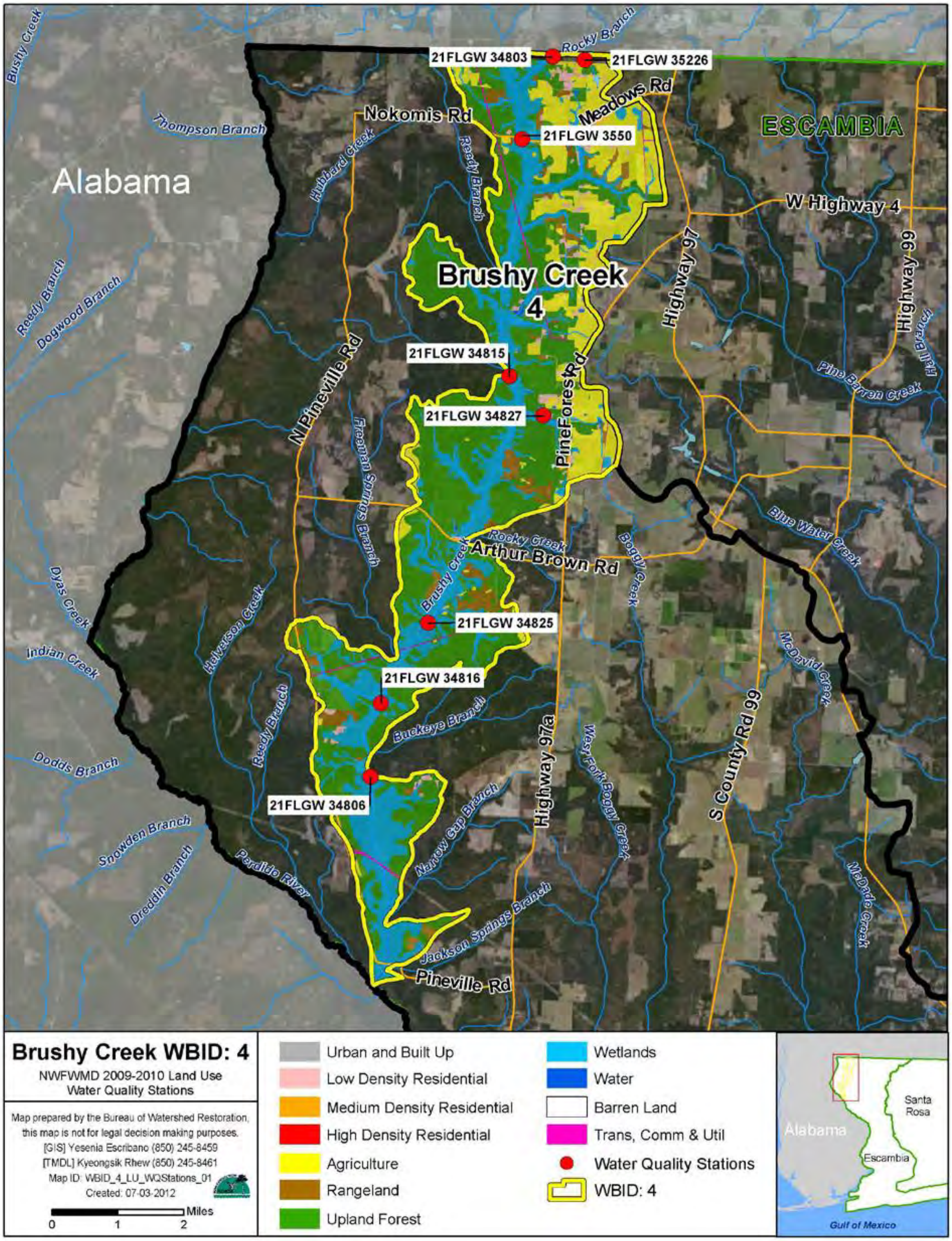
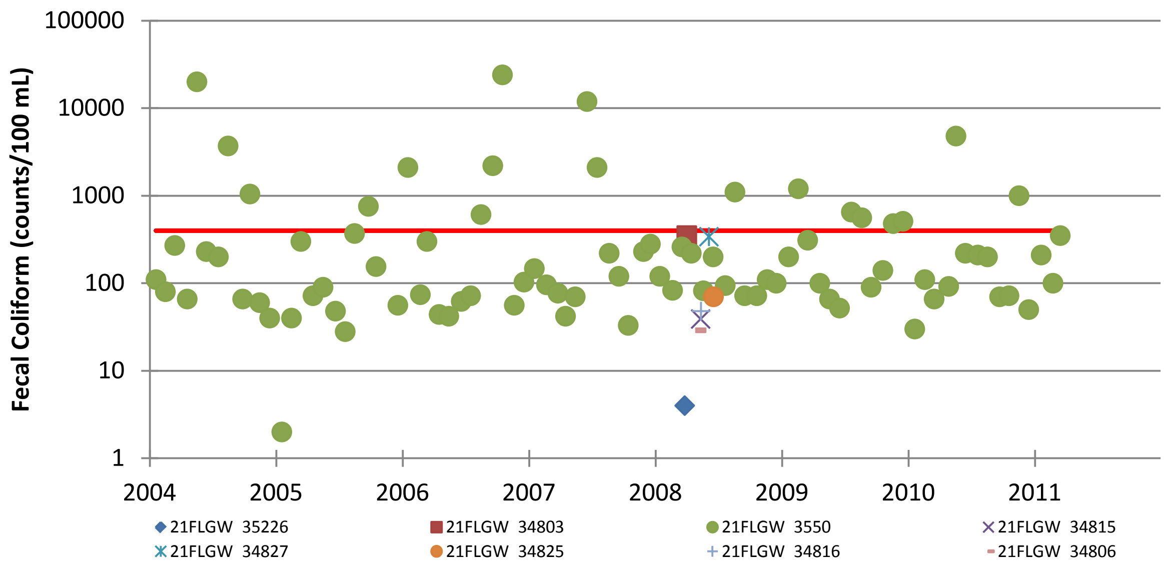


Figure 5.1. Location of Water Quality Stations in Brushy Creek



Note: The red line indicates the target concentration (400 counts/100mL).

Figure 5.2. Trends in Fecal Coliform Concentrations in Brushy Creek During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

Temporal Patterns

Monthly and Seasonal Trends

Seasonally, a peak in fecal coliform concentrations and exceedance rates is commonly observed during the third quarter (summer, July–September), when conditions are rainy and warm, and lower concentrations and exceedance rates are observed in the first quarter (winter, January–March), when conditions are drier and colder. In general, such a relationship was found for exceedance rates in Brushy Creek, but not for the fecal coliform concentration. Mean fecal coliform concentrations were highest in the second and fourth quarters (**Table 5.1b** and **Figure 5.3b**).

Using rainfall data collected at Pensacola Regional Airport (Climate Information for Management and Operational Decisions [CLIMOD] website 2008), it was possible to compare average quarterly total rainfall with long-term (2004 through 2011) average monthly and quarterly fecal coliform exceedance rates at all stations (**Figures 5.3a** and **5.3b**). Rainfall differences among months were relatively small, but the months from August to October were wetter than the other months. Seasonal differences in rainfall were also small, and the third quarter was typically wettest.

The highest quarterly exceedance rate was observed in the third quarter (38%), and the highest quarterly average fecal coliform concentration was observed during the second quarter (1,458 counts/100mL). The lowest exceedance rate was observed during the first quarter (8%). Episodic exceedances in fecal coliform concentrations occurred throughout the Cycle 2 verified period (2004 through 2011). Except for March and April, fecal coliform exceedances were observed in Brushy Creek in all months. The highest monthly average fecal coliform concentration was observed in October (3,645 counts/100mL). **Tables 5.1a** and **5.1b** summarize the monthly and seasonal fecal coliform average and percent exceedances, respectively, during the Cycle 2 verified period for this watershed.

The influence of rainfall on monthly and quarterly exceedances in Brushy Creek is inconclusive, as during the Cycle 2 verified period, monthly exceedance rates do not appear to be correlated with monthly rainfall.

Table 5.1a. Summary Statistics of Fecal Coliform Data for All Stations in Brushy Creek by Month During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

This is an eight-column table. Column 1 lists the month, Column 2 lists the number of samples, Column 3 lists the minimum coliform count/100mL, Column 4 lists the maximum count, Column 5 lists the median count, Column 6 lists the mean count, Column 7 lists the number of exceedances, and Column 8 lists the percent exceedances.

[1] Coliform counts are #/100mL.
[2] Exceedances represent values above 400 counts/100mL

Month	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
January	8	2	2,100	134	365	1	13%
February	8	40	1,200	90	223	1	13%
March	9	4	350	270	215	0	0%
April	9	29	350	72	113	0	0%
May	9	39	20,000	70	2,804	2	22%
June	9	48	11,900	200	1,458	1	11%
July	7	28	2,100	200	479	2	29%
August	7	200	3,700	560	966	4	57%
September	7	66	2,200	90	482	2	29%
October	7	33	24,000	140	3,645	2	29%
November	6	56	1,000	170	323	2	33%
December	7	40	510	100	163	1	14%

Table 5.1b. Summary Statistics of Fecal Coliform Data for All Stations in Brushy Creek by Season During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

This is an eight-column table. Column 1 lists the season, Column 2 lists the number of samples, Column 3 lists the minimum coliform count/100mL, Column 4 lists the maximum count, Column 5 lists the median count, Column 6 lists the mean count, Column 7 lists the number of exceedances, and Column 8 lists the percent exceedances.

[1] Coliform counts are #/100mL.
[2] Exceedances represent values above 400 counts/100mL

Season	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
Quarter 1	25	2	2,100	110	266	2	8%
Quarter 2	27	29	20,000	72	1,458	3	11%
Quarter 3	21	28	3,700	210	642	8	38%
Quarter 4	20	33	24,000	107	1,430	5	25%

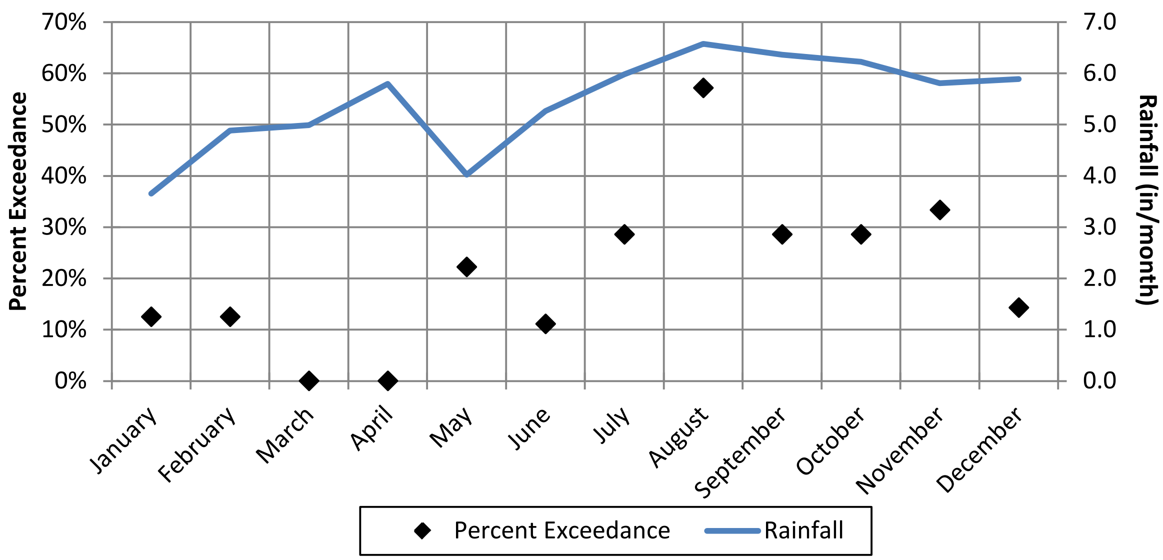


Figure 5.3a. Fecal Coliform Exceedances and Rainfall at All Stations in Brushy Creek by Month During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

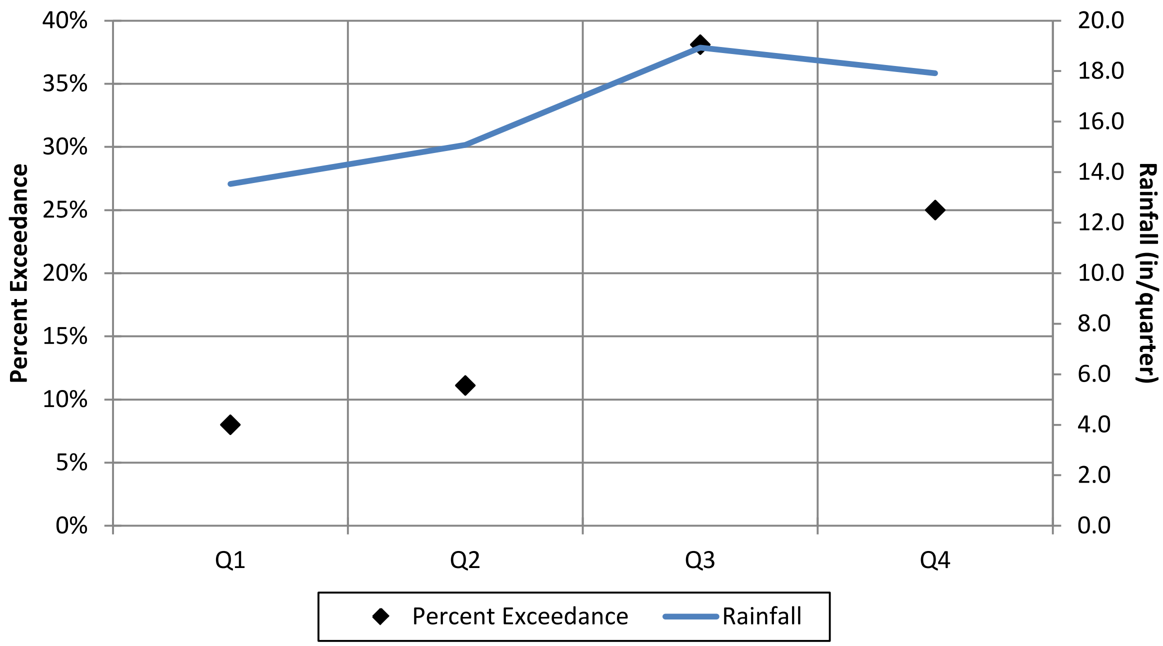


Figure 5.3b. Fecal Coliform Exceedances and Rainfall at All Stations in Brushy Creek by Season During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

Spatial Patterns

Fecal coliform data from the Cycle 2 verified period (January 1, 2004, through June 30, 2011) were analyzed to detect spatial trends in the data (**Table 5.2** and **Figure 5.4**). Stations are displayed from upstream to downstream (from left to right) (**Figure 5.4**).

Fecal coliform concentrations that exceeded the state criterion were only observed in 1 of the 8 sampling stations within the WBID (**Table 5.2** and **Figure 5.4**). Station 21FLGW 3550, which is located in the upstream portion of the waterbody, had 92% of the samples collected from 2004 to 2011, and 18 of 86 samples exceeded the criterion. This station, which is surrounded by wetlands, upland forest, and agricultural (mostly hayfield) land uses, receives runoff from the city of Atmore, Alabama. Only 7 samples out of 93 were collected from the 7 other stations (i.e., 1 sample from each water quality station), making it hard to say anything about spatial patterns in the watershed.

Table 5.2. Station Summary Statistics of Fecal Coliform Data for Brushy Creek During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

This is a nine-column table. Column 1 lists the station, Column 2 lists the period of observation, Column 3 lists the number of samples, Column 4 lists the minimum count/100mL, Column 5 lists the maximum count/100mL, Column 6 lists the median count, Column 7 lists the mean count, Column 8 lists the number of exceedances, and Column 9 lists the percent exceedances.

[1] Coliform counts are #/100mL.
[2] Exceedances represent values above 400 counts/100mL.

Station	Period of Observation	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
21FLGW 35226	2008	1	4	4	4	4	0	0.0%
21FLGW 34803	2008	1	350	350	350	350	0	0.0%
21FLGW 3550	2004–11	86	2	24,000	110	1,014	18	20.9%
21FLGW 34815	2008	1	39	39	39	39	0	0.0%
21FLGW 34827	2008	1	340	340	340	340	0	0.0%
21FLGW 34825	2008	1	70	70	70	70	0	0.0%
21FLGW 34816	2008	1	48	48	48	48	0	0.0%
21FLGW 34806	2008	1	29	29	29	29	0	0.0%

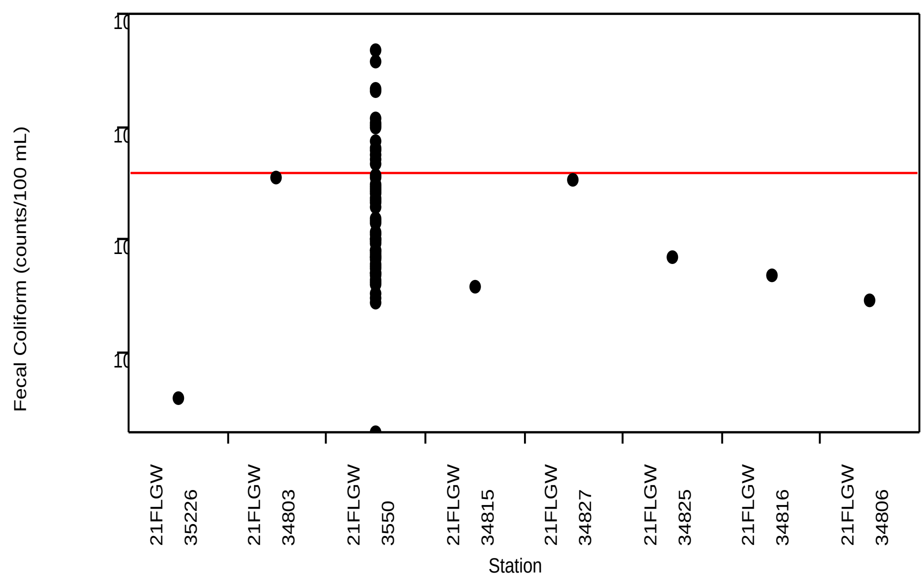


Figure 5.4. Spatial Fecal Coliform Concentration Trends in Brushy Creek by Station During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

5.1.2 Critical Condition

The critical condition for coliform loadings in a given watershed depends on many factors, including the presence of point sources and the land use pattern in the watershed. Typically, the critical condition for nonpoint sources is an extended dry period followed by a rainfall runoff event. During the wet weather period, rainfall washes off coliform bacteria that have built up on the land surface under dry conditions, resulting in the wet weather exceedances. However, significant nonpoint source contributions can also appear under dry conditions without any major surface runoff event. This usually happens when nonpoint sources contaminate the surficial aquifer, and fecal coliform bacteria are brought into the receiving waters through baseflow. In addition, the fecal coliform contribution of wildlife with direct access to the receiving water can be more noticeable during dry weather, by contributing to exceedances. The critical condition for point source loading typically occurs during periods of low stream flow, when dilution is minimized.

Hydrologic conditions were analyzed using rainfall in Brushy Creek. A loading curve–type chart that would normally be applied to flow events was created using precipitation data from Pensacola Regional Airport. The chart was divided in the same manner as if flow were being analyzed, where extreme precipitation events represent the upper percentiles (0–5th percentile), followed by large precipitation events (5th–10th percentile), medium precipitation events (10th–40th percentile), small precipitation events (40th–60th percentile), and no recordable precipitation events (60th–100th percentile). Three-day (the day of and 2 days prior to sampling) precipitation accumulations were used in the analysis (**Table 5.3** and **Figure 5.5**).

Data show that fecal coliform exceedances occurred over all hydrologic conditions. The highest percentage of exceedances (75%) occurred after large precipitation events, but this period also had the fewest samples (n=3). It is difficult to draw conclusions with so few samples representing large precipitation events. However, if extreme, large, and medium precipitation events are combined due to small sample size, exceedance rates appear still high (32.4%), indicating that nonpoint sources are probably a major contributing factor. The exceedance rate for a “no measurable precipitation” event is not insignificant, reaching 6%. These exceedances might be an indication that local sources are contributing to elevated fecal coliform concentrations. **Table 5.3** and **Figure 5.5** show fecal coliform data by hydrologic condition.

Table 5.3. Summary of Fecal Coliform Data for Brushy Creek by Hydrologic Condition During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

This is a seven-column table. Column 1 lists the type of precipitation event, Column 2 lists the event range (in inches), Colum 3 lists the total number of samples, Column 4 lists the number of exceedances, Column 5 lists the percent exceedances, Column 6 lists the number of nonexceedances, and Column 7 lists the percent nonexceedances.

Precipitation Event	Event Range (inches)	Total Samples	Number of Exceedances	% Exceedances	Number of Nonexceedances	% Nonexceedances
Extreme	>2.47"	4	1	25.0%	3	75.0%
Large	1.66" - 2.47"	3	2	66.7%	1	33.3%
Medium	0.19" - 1.66"	27	8	29.6%	19	70.4%
Small	0.01" - 0.19"	11	4	36.4%	7	63.6%
None/ Not Measurable	<0.01"	48	3	6.3%	45	93.8%

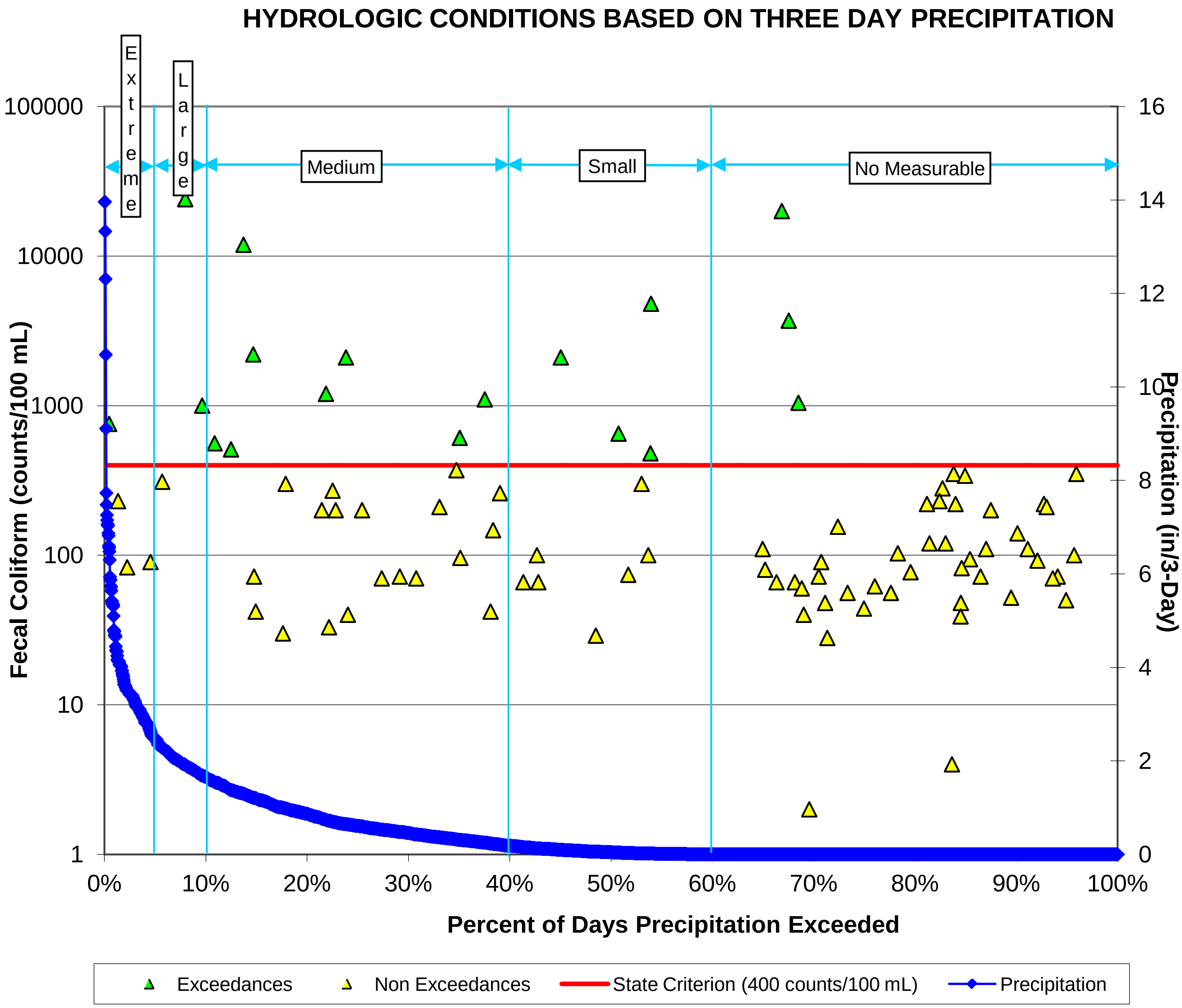


Figure 5.5. Fecal Coliform Data for Brushy Creek by Hydrologic Condition During the Cycle 2 Verified Period (January 1, 2004–June 30, 2011)

5.1.3 TMDL Development Process

A simple reduction calculation was performed to determine the reduction in fecal coliform concentration necessary to achieve the concentration target (400 counts/100mL). The percent reduction needed to reduce the pollutant load was calculated by comparing the existing concentrations and target concentration using **Formula 1**:

$$\textbf{Needed \% reduction} = \frac{\textbf{Existing 90th percentile concentration} - \textbf{Allowable concentration}}{\textbf{Existing 90th percentile concentration}} \times \textbf{100\%} \qquad \textbf{Formula 1}$$

Using the Hazen method for estimating percentiles, as described in Hunter (2002), the existing condition concentration was defined as the 90th percentile of all the fecal coliform data collected during the Cycle 2 verified period (January 1, 2004, to June 30, 2011). This will result in a target condition that is consistent with the state bacteriological water quality assessment threshold for Class III waters.

In applying this method, all of the available data are ranked (ordered) from the lowest to the highest (**Table 5.4**), and **Formula 2** is used to determine the percentile value of each data point:

$$\textbf{Percentile} = \frac{\textbf{Rank - 0.5}}{\textbf{Total Number of Samples Collected}} \qquad \textbf{Formula 2}$$

If none of the ranked values is shown to be the 90th percentile value, then the 90th percentile number (used to represent the existing condition concentration) is calculated by interpolating between the two data points adjacent (above and below) to the desired 90th percentile rank using **Formula 3,** as described below:

$$\textbf{90}^{th}\textbf{ percentile concentration} = C_{lower} + (P90^{th} * R) \qquad \textbf{Formula 3}$$

Where:

C_{lower} is the fecal coliform concentration corresponding to the percentile lower than the 90th percentile;

P_{90th} is the percentile difference between the 90th percentile and the percentile number immediately lower than the 90th percentile; and

R is a ratio defined as R = (fecal coliform concentration $_{upper}$ – fecal coliform concentration $_{lower}$) / (percentile $_{upper}$ – percentile $_{lower}$).

Table 5.4 presents the individual fecal coliform data, the ranks, the percentiles for each individual datum, the existing 90th percentile concentration (1,100 counts/100mL), the allowable concentration (400 counts/100mL), and the percent reduction needed to meet the applicable water quality criterion for fecal coliform. The needed reduction was calculated as 64%.

$$\textbf{Needed \% reduction} = \frac{\textbf{1100} - \textbf{400}}{\textbf{1100}} \times \textbf{100\%}$$

Table 5.4. Calculation of Fecal Coliform Reductions for the Brushy Creek TMDL Based on the Hazen Method

This is a five-column table. Column 1 lists the station, Column 2 lists the sample collection date, Column 3 lists the fecal coliform existing concentration (counts/100mL), Column 4 lists the concentration rank, and Column 5 lists the concentration percentile.

Note: The row with boldface type and yellow highlighting indicates the 90th percentile.
- = Empty cell/no data

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
21FLGW 3550	1/19/2005	2	1	1%
21FLGW 35226	3/27/2008	4	2	2%
21FLGW 3550	7/21/2005	28	3	3%
21FLGW 34806	4/29/2008	29	4	4%
21FLGW 3550	1/20/2010	30	5	5%
21FLGW 3550	10/16/2007	33	6	6%
21FLGW 34815	5/12/2008	39	7	7%
21FLGW 3550	12/15/2004	40	8	8%
21FLGW 3550	2/16/2005	40	9	9%
21FLGW 3550	5/16/2006	42	10	10%
21FLGW 3550	4/18/2007	42	11	11%
21FLGW 3550	4/18/2006	44	12	12%
21FLGW 3550	6/23/2005	48	13	13%
21FLGW 34816	5/13/2008	48	14	15%
21FLGW 3550	12/15/2010	50	15	16%
21FLGW 3550	6/17/2009	52	16	17%
21FLGW 3550	12/20/2005	56	17	18%
21FLGW 3550	11/21/2006	56	18	19%
21FLGW 3550	11/16/2004	60	19	20%
21FLGW 3550	6/21/2006	62	20	21%
21FLGW 3550	4/21/2004	66	21	22%
21FLGW 3550	9/28/2004	66	22	23%
21FLGW 3550	5/19/2009	66	23	24%
21FLGW 3550	3/17/2010	66	24	25%
21FLGW 3550	5/16/2007	70	25	26%
21FLGW 3550	9/22/2010	70	26	27%
21FLGW 34825	6/18/2008	70	27	28%
21FLGW 3550	4/19/2005	72	28	30%
21FLGW 3550	7/18/2006	72	29	31%
21FLGW 3550	9/16/2008	72	30	32%
21FLGW 3550	10/21/2008	72	31	33%
21FLGW 3550	10/19/2010	72	32	34%
21FLGW 3550	2/23/2006	74	33	35%

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
21FLGW 3550	3/27/2007	77	34	36%
21FLGW 3550	2/18/2004	80	35	37%
21FLGW 3550	5/20/2008	82	36	38%
21FLGW 3550	2/21/2008	83	37	39%
21FLGW 3550	5/18/2005	90	38	40%
21FLGW 3550	9/16/2009	90	39	41%
21FLGW 3550	4/28/2010	92	40	42%
21FLGW 3550	7/22/2008	94	41	44%
21FLGW 3550	2/22/2007	96	42	45%
21FLGW 3550	12/16/2008	100	43	46%
21FLGW 3550	4/21/2009	100	44	47%
21FLGW 3550	2/23/2011	100	45	48%
21FLGW 3550	12/19/2006	103	46	49%
21FLGW 3550	1/22/2004	110	47	50%
21FLGW 3550	11/20/2008	110	48	51%
21FLGW 3550	2/18/2010	110	49	52%
21FLGW 3550	9/19/2007	120	50	53%
21FLGW 3550	1/15/2008	120	51	54%
21FLGW 3550	10/20/2009	140	52	55%
21FLGW 3550	1/18/2007	147	53	56%
21FLGW 3550	10/18/2005	155	54	58%
21FLGW 3550	7/20/2004	200	55	59%
21FLGW 3550	6/17/2008	200	56	60%
21FLGW 3550	1/21/2009	200	57	61%
21FLGW 3550	8/18/2010	200	58	62%
21FLGW 3550	7/21/2010	210	59	63%
21FLGW 3550	1/20/2011	210	60	64%
21FLGW 3550	8/22/2007	220	61	65%
21FLGW 3550	4/15/2008	220	62	66%
21FLGW 3550	6/15/2010	220	63	67%
21FLGW 3550	6/15/2004	230	64	68%
21FLGW 3550	11/29/2007	230	65	69%
21FLGW 3550	3/19/2008	260	66	70%
21FLGW 3550	3/16/2004	270	67	72%
21FLGW 3550	12/19/2007	280	68	73%
21FLGW 3550	3/15/2005	300	69	74%
21FLGW 3550	3/14/2006	300	70	75%
21FLGW 3550	3/17/2009	310	71	76%
21FLGW 34827	6/5/2008	340	72	77%

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
21FLGW 34803	4/2/2008	350	73	78%
21FLGW 3550	3/16/2011	350	74	79%
21FLGW 3550	8/17/2005	370	75	80%
21FLGW 3550	11/19/2009	480	76	81%
21FLGW 3550	12/17/2009	510	77	82%
21FLGW 3550	8/20/2009	560	78	83%
21FLGW 3550	8/17/2006	609	79	84%
21FLGW 3550	7/21/2009	650	80	85%
21FLGW 3550	9/26/2005	755	81	87%
21FLGW 3550	11/17/2010	1,000	82	88%
21FLGW 3550	10/19/2004	1,045	83	89%
21FLGW 3550	**8/19/2008**	**1,100**	**84**	**90%**
21FLGW 3550	2/18/2009	1,200	85	91%
21FLGW 3550	1/18/2006	2,100	86	92%
21FLGW 3550	7/18/2007	2,100	87	93%
21FLGW 3550	9/20/2006	2,200	88	94%
21FLGW 3550	8/17/2004	3,700	89	95%
21FLGW 3550	5/19/2010	4,800	90	96%
21FLGW 3550	6/19/2007	11,900	91	97%
21FLGW 3550	5/19/2004	20,000	92	98%
21FLGW 3550	10/18/2006	24,000	93	99%
-	**-**	**-**	**Existing condition concentration-90th percentile (counts/100mL)**	**1,100**
-	**-**	**-**	**Allowable concentration (counts/100mL)**	**400**
-	**-**	**-**	**Final % reduction**	**64%**

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. A TMDL is expressed as the sum of all point source loads (wasteload allocations, or WLAs), nonpoint source loads (load allocations, or LAs), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

TMDL = $\sum \square WLAs + \sum \square LAs + MOS$

As discussed earlier, the WLA is broken out into separate subcategories for wastewater discharges and stormwater discharges regulated under the NPDES Program:

TMDL $\cong \sum \square WLAs_{\textbf{wastewater}} + \sum \square WLAs_{\textbf{NPDES Stormwater}} + \sum \square LAs + MOS$

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (1) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is also accounted for within the LA, and (2) TMDL components can be expressed in different terms (for example, the WLA for stormwater is typically expressed as a percent reduction, and the WLA for wastewater is typically expressed as mass per day).

WLAs for stormwater discharges are typically expressed as “percent reduction” because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges also differs from the permitting of most wastewater point sources. Because stormwater discharges cannot be centrally collected, monitored, and treated, they are not subject to the same types of effluent limitations as wastewater facilities, and instead are required to meet a performance standard of providing treatment to the “maximum extent practical” through the implementation of best management practices (BMPs).

This approach is consistent with federal regulations (40 CFR § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or other appropriate measure. The TMDL for Brushy Creek is expressed in terms of counts/100mL and percent reduction, and represents the maximum daily fecal coliform load the stream can assimilate without exceeding the fecal coliform criterion (**Table 6.1**).

Table 6.1. TMDL Components for Fecal Coliform in Brushy Creek

This is a six-column table. Column 1 lists the parameter, Column 2 lists the TMDL (counts/100mL), Column 3 lists the WLA for wastewater (counts/100mL), Column 4 lists the WLA for NPDES stormwater (percent reduction), Column 5 lists the LA (percent reduction), and Column 6 lists the MOS.

N/A – Not applicable

Parameter	TMDL (counts/100mL)	WLA for Wastewater (counts/100mL)	WLA for NPDES Stormwater (% reduction)	LA (% reduction)	MOS
Fecal coliform	400	N/A	N/A	64%	Implicit

6.2 Load Allocation

A fecal coliform reduction of 64% is needed from nonpoint sources in the Brushy Creek watershed. It should be noted that the LA includes loading from stormwater discharges regulated by the Department and the water management districts that are not part of the NPDES Stormwater Program (see **Appendix A**).

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

No NPDES-permitted wastewater facilities are permitted to discharge within the Brushy Creek WBID boundary. The state already requires all NPDES point source dischargers to meet bacteria criteria at the end of the pipe. It is the Department's current practice not to allow mixing zones for bacteria. Any point sources that may discharge in the WBID in the future will also be required to meet end-of-pipe standards for coliform bacteria.

6.3.2 NPDES Stormwater Discharges

There are no NPDES MS4 permits covering the Brushy Creek watershed. Therefore, all the load reduction goes to the load allocation for nonpoint sources

6.4 Margin of Safety

Consistent with the recommendations of the Allocation Technical Advisory Committee (Department 2001), an implicit MOS was used in the development of this TMDL by not subtracting contributions from natural sources and sediments when the percent reduction was calculated. This makes the estimation of human contribution more stringent and therefore adds to the MOS.

Chapter 7: TMDL IMPLEMENTATION

7.1 Basin Management Action Plan

Following the adoption of this TMDL by rule, the Department will determine the best course of action regarding its implementation. Depending on the pollutant(s) causing the waterbody impairment and the significance of the waterbody, the Department will select the best course of action leading to the development of a plan to restore the waterbody. Often this will be accomplished cooperatively with stakeholders by creating a Basin Management Action Plan, referred to as the BMAP. BMAPs are the primary mechanism through which TMDLs are implemented in Florida (see Subsection 403.067[7], F.S.). A single BMAP may provide the conceptual plan for the restoration of one or many impaired waterbodies.

If the Department determines that a BMAP is needed to support the implementation of this TMDL, a BMAP will be developed through a transparent, stakeholder-driven process intended to result in a plan that is cost-effective, technically feasible, and meets the restoration needs of the applicable waterbodies. Once adopted by order of the Department Secretary, BMAPs are enforceable through wastewater and municipal stormwater permits for point sources and through BMP implementation for nonpoint sources. Among other components, BMAPs typically include the following:

- *Water quality goals (based directly on the TMDL);*
- *Refined source identification;*
- *Load reduction requirements for stakeholders (quantitative detailed allocations, if technically feasible);*
- *A description of the load reduction activities to be undertaken, including structural projects, nonstructural BMPs, and public education and outreach;*
- *A description of further research, data collection, or source identification needed in order to achieve the TMDL;*
- *Timetables for implementation;*
- *Implementation funding mechanisms;*
- *An evaluation of future increases in pollutant loading due to population growth;*
- *Implementation milestones, project tracking, water quality monitoring, and adaptive management procedures; and*
- *Stakeholder statements of commitment (typically a local government resolution).*

BMAPs are updated through annual meetings and may be officially revised every five years. Completed BMAPs in the state have improved communication and cooperation among local stakeholders and state agencies; improved internal communication within local governments; applied high-quality science and local information in managing water resources; clarified the obligations of wastewater point source, MS4, and non-MS4 stakeholders in TMDL implementation; enhanced transparency in the Department's decision making; and built strong relationships between the Department and local stakeholders that have benefited other program areas.

7.2 Other TMDL Implementation Tools

However, in some basins, and for some parameters, particularly those with fecal coliform impairments, the development of a BMAP using the process described above will not be the most efficient way to restore a waterbody, such that it meets its designated uses. This is because fecal coliform impairments result from the cumulative effects of a multitude of potential sources, both natural and anthropogenic. Addressing these problems requires good old-fashioned detective work that is best done by those in the area.

A multitude of assessment tools is available to assist local governments and interested stakeholders in this detective work. The tools range from the simple (such as Walk the WBIDs and GIS mapping) to the complex (such as bacteria source tracking). Department staff will provide technical assistance, guidance, and oversight of local efforts to identify and minimize fecal coliform sources of pollution. Based on work in the Lower St Johns River Tributaries and Hillsborough Basins, the Department and local stakeholders have developed a logical process and tools to serve as a foundation for this detective work.

In the near future, the Department will be releasing these tools to assist local stakeholders with the development of local implementation plans to address fecal coliform impairments. In such cases, the Department will rely on these local initiatives as a more cost-effective and simplified approach to identify the actions needed to put in place a road map for restoration activities, while still meeting the requirements of Subsection 403.067(7), F.S.

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Appendices

Appendix A: Background Information on Federal and State Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Rule 62-40, F.A.C. In 1994, the Department's stormwater treatment requirements were integrated with the stormwater flood control requirements of the water management districts, along with wetland protection requirements, into the Environmental Resource Permit (ERP) regulations.

Rule 62-40, F.A.C., also requires the state's water management districts to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a Surface Water Improvement and Management (SWIM) plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, they have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka.

In 1987, the U.S. Congress established Section 402(p) as part of the federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES permitting program to designate certain stormwater discharges as "point sources" of pollution. The EPA promulgated regulations and began implementing the Phase I NPDES Stormwater Program in 1990. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific standard industrial classification (SIC) codes, construction sites disturbing 5 or more acres of land, and the master drainage systems of local governments with a population above 100,000, which are better known as MS4s. However, because the master drainage systems of most local governments in Florida are interconnected, the EPA implemented Phase I of the MS4 permitting program on a countywide basis, which brought in all cities (incorporated areas), Chapter 298 urban water control districts, and Florida Department of Transportation (FDOT) throughout the 15 counties meeting the population criteria. The Department received authorization to implement the NPDES Stormwater Program in 2000.

An important difference between the federal NPDES and the state's Stormwater/ERP Programs is that the NPDES Program covers both new and existing discharges, while the state's program focuses on new discharges only. Additionally, Phase II of the NPDES Program, implemented in 2003, expands the need for these permits to construction sites between 1 and 5 acres, and to local governments with as few as 1,000 people. While these urban stormwater discharges are now technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility, as are other point sources of pollution such as domestic and industrial wastewater discharges. It should be noted that all MS4 permits issued in Florida include a reopener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.

Appendix B: Estimates of Fecal Coliform Loadings from Potential Sources

The Department has provided these estimations for informational purposes only and did not use them to calculate the TMDL. They are intended to give the public a general idea of the relative importance of each source in the waterbody. The estimates were based on the best information available to the Department when the calculation was made. The numbers provided do not represent actual loadings from the sources.

Agriculture

In the Level 3 land use category, 11 agricultural codes were identified in the Brushy Creek watershed. Row crop, the largest agricultural category, represented 1,260 acres. Hayfield, the second largest, represented approximately 769 acres. Field crop, the third largest, represented approximately 357 acres. Improved pasture, the fourth largest, represented approximately 257 acres. Assuming that the improved pasture is primarily used to raise cattle, there is 1 beef cow per 3 acres, and beef cattle produce 1×10^{11} fecal coliform counts/cow/day; this could represent potential fecal coliform loadings of 8.6×10^{12} counts/day (**Table B.1)**.

Table B.1. Estimated Agricultural Loading in the Brushy Creek Watershed

This is a five-column table. Column 1 lists the improved pasture acreage, Column 2 lists the number of beef cattle per three acres, Column 3 lists the estimated number of cattle, Column 4 lists the estimated fecal coliform density per cow, and Column 5 lists the fecal coliform load.

Improved Pasture Acreage	Beef Cattle per Three Acres	Estimated Number of Cattle	Estimated Fecal Coliform (counts/cow/day)	Estimated Fecal Coliform Load (counts/day)
257	1	86	1×10^{11}	8.6×10^{12}

Pets

Pets (especially dogs) could be a significant source of coliform pollution through surface runoff within the Brushy Creek WBID boundary. Studies report that up to 95% of the fecal coliform found in urban stormwater can have nonhuman origins (Alderiso *et al.* 1996; Trial *et al.* 1993).

The most important nonhuman fecal coliform contributors appear to be dogs and cats. In a highly urbanized Baltimore catchment, Lim and Olivieri (1982) found that dog feces were the single greatest source of fecal coliform and fecal strep bacteria. Trial *et al.* (1993) also reported that cats and dogs were the primary source of fecal coliform in urban subwatersheds. Using bacteria source tracking techniques, it was found in Stevenson Creek in Clearwater, Florida, that the amount of fecal coliform bacteria contributed by dogs was as important as that from septic tanks (Watson 2002).

According to the American Pet Products Manufacturers Association (APPMA), about 4 out of 10 U.S. households include at least 1 dog. A single gram of dog feces contains about 2.2 million fecal coliform bacteria (Weiskel *et al.* 1996). Unfortunately, statistics show that about 40% of American dog owners do not pick up their dogs' feces. The number of dogs within the Brushy Creek WBID boundary is not known. Therefore, the statistics produced by APPMA were used in this analysis to estimate the possible fecal coliform loads contributed by dogs.

Using information from the Florida Department of Revenue's (DOR) 2009 Cadastral tax parcel and ownership coverage contained in the Department's GIS library, residential parcels were identified using DOR's residential land use codes. The final number of households within the WBID boundary was calculated by adding the number of residential units on the parcels for all improved residential land use codes. The estimated number of households within the WBID boundary is 110 (**Table B.2)**.

Table B.3 shows the waste production rate for a dog (450 grams/animal/day) and the fecal coliform counts per gram of dog waste (2,200,000 counts/gram). **Table B.2** also shows the estimated number of dogs within the WBID boundary, assuming that 40% of the households in these areas have 1 dog and the total waste produced (grams/day) by dogs and left on the land surface in residential areas in the WBID, assuming that 40% of dog owners do not pick up their dogs' feces. The estimated fecal coliform loading produced by dogs (counts/day) within the WBID boundary is about 1.74×10^{10} counts/day.

It should be noted that this load only represents the fecal coliform load created in the WBID and is not intended to be used to represent a part of the existing load that reaches the receiving waterbody. The fecal coliform load that eventually reaches the receiving waterbody could be significantly less than this value due to attenuation in overland transport.

Table B.2. Estimated Number of Households and Dogs, Waste Produced (grams/day) by Dogs Left on the Land Surface, and Total Load of Fecal Coliform (counts/day) Produced by Dogs within the Brushy Creek WBID Boundary

This is a five-column table. Column 1 lists the WBID number, Column 2 lists the number of households, Column 3 lists the number of dogs, Column 4 lists the waste produced left on land, and Column 5 lists the fecal coliform loading.

WBID	Number of Households	Number of Dogs	Waste Produced Left on Land Surface (grams/day)	Loading (counts/day)
4	110	44	7,920	1.74×10^{10}

Table B.3. Dog Population Density, Wasteload, and Fecal Coliform Density Based on the Literature (Weiskel *et al.* 1996)

This is a four-column table. Column 1 lists the animal type (dog), Column 2 lists the population density, Column 3 lists the wasteload, and Column 4 lists the fecal coliform density.

* Number from APPMA

Type	Population Density (animals/household)	Wasteload (grams/animal-day)	Fecal Coliform Density (counts/gram)
Dog	0.4*	450	2,200,000

Septic Tanks

Septic tanks are another potentially important source of coliform pollution in urban watersheds. When properly installed, most of the coliform from septic tanks should be removed within 50 meters of the drainage field (Minnesota Pollution Control Agency 1999). However, the physical properties of an aquifer, such as thickness, sediment type (sand, silt, and clay), and location play a large part in determining whether contaminants from the land surface will reach the ground water (USGS 2010). The risk of contamination is greater for unconfined (water table) aquifers than for confined aquifers because they usually are nearer to the land surface and lack an overlying confining layer to impede the movement of contaminants (USGS 2010).

Sediment type (sand, silt, and clay) also determines the risk of contamination in a particular watershed. According to the USGS (2010), "Porosity, which is the proportion of a volume of rock or soil that consists of open spaces, tells us how much water rock or soil can retain. Permeability is a measure of how easily water can travel through porous soil or bedrock. Soil and loose sediments, such as sand and gravel, are porous and permeable. They can hold a lot of water, and it flows easily through them. Although clay and shale are porous and can hold a lot of water, the pores in these fine-grained materials are so small that water flows very slowly through them. Clay has a low permeability."

Also, the risk of contamination is increased for areas with a relatively high ground water table. The drain field can be flooded during the rainy season, resulting in ponding, and coliform bacteria can pollute surface water through stormwater runoff. Additionally, in these circumstances, a high water table can result in coliform bacteria pollution reaching the receiving waters through baseflow.

Septic tanks may also cause coliform pollution when they are built too close to irrigation wells. Any well that is installed in the surficial aquifer system will cause a drawdown. If the septic tank system is built too close to the well (e.g., less than 75 feet), the septic tank discharge will be within the cone of influence of the well. As a result, septic tank effluent may enter the well, and once the polluted water is used to irrigate lawns, coliform bacteria may reach the land surface and wash into surface waters through stormwater runoff.

A rough estimate of fecal coliform loads from failed septic tanks within the Brushy Creek WBID boundary can be made using **Equation B.1**:

$$L = 37.85 * N * Q * C * F \qquad \textbf{Equation B.1}$$

Where:

L is the fecal coliform daily load (counts/day);
N is the number of households using septic tanks in the WBID;
Q is the discharge rate for each septic tank (gallons/day);
C is the fecal coliform concentration for the septic tank discharge (counts/100mL);
F is the septic tank failure rate; and
37.85 is a conversion factor (100mL/gallon).

Based on the Florida Department of Health's (FDOH) 2012 onsite sewage GIS coverage contained in the Department's GIS library, about 51 households were identified as being on active septic tanks in the Brushy Creek watershed (**Figure B.1** and **Table B.4**). The discharge rate from each septic tank (*Q*) was calculated by multiplying the average household size by the per capita wastewater production rate per day. Based on the information published by the Census Bureau, the average household size for Escambia County is about 2.44 people/household (U.S. Census Bureau website 2006–10). The same population densities were assumed within the WBID boundary. A commonly cited value for per capita wastewater production rate is 70 gallons/day/person (EPA 2001). The commonly cited concentration (*C*) for septic tank discharge is 1×10^6 counts/100mL for fecal coliform (EPA 2001).

No measured septic tank failure rate data were available for the WBID when this TMDL was developed. Therefore, the failure rate was derived from the number of septic tanks in Escambia County based on FDOH's septic tank inventory and the number of septic tank repair permits issued in Escambia County, as published by FDOH (FDOH website 2010). The cumulative number of septic tanks in Escambia County on an annual basis was calculated by subtracting the number of issued septic tank installation permits for each year from the current number of septic tanks in the county based on FDOH's 2009–10 inventory, assuming that none of the installed septic tanks will be removed after being installed (**Table B.5**). The reported number of septic tank repair permits was also obtained from the FDOH website. Based on **Table B.5**, the average annual septic tank failure discovery rate is about 0.72% for Escambia County. Assuming that failed septic tanks are not discovered for about 5 years, the estimated annual septic tank failure rate is about 5 times the discovery rate, or 3.59%. Based on **Equation B.1**, the estimated fecal coliform loading from failed septic tanks within the Brushy Creek WBID boundary is about 1.2×10^{10} counts/day (**Table B.4**).

Table B.4. Estimated Number of Households Using Septic Tanks and Estimated Septic Tank Loading within the Brushy Creek WBID Boundary

This is a three-column table. Column 1 lists the WBID number, Column 2 lists the number of households with a septic tank, and Column 3 lists the septic tank loading.

WBID	Number of Households Using Septic Tanks	Septic Tanks (counts/day)
4	51	1.2×10^{10}

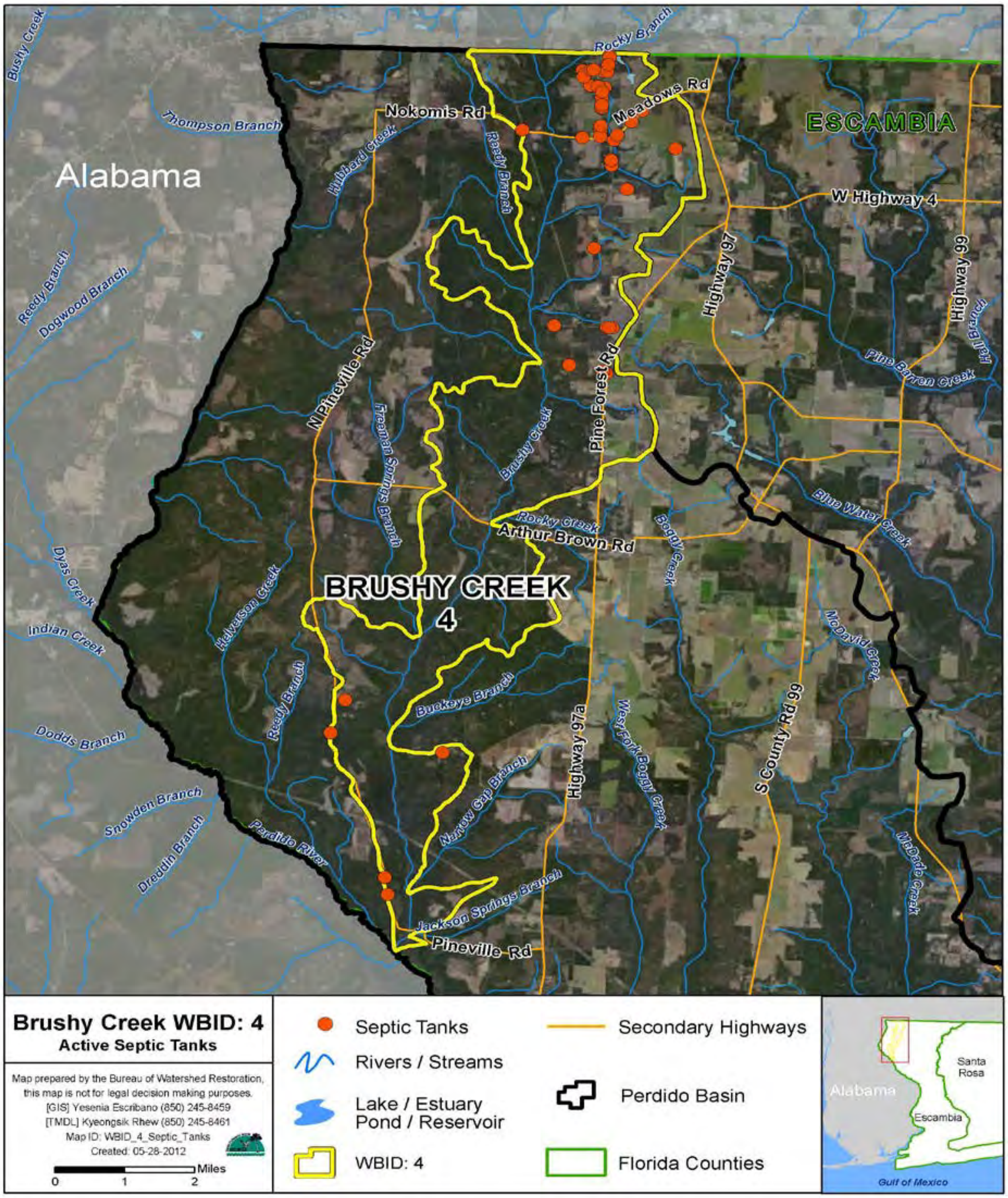

Figure B.1. Distribution of Onsite Sewage Disposal Systems (Septic Tanks) in the Residential Land Use Areas within the Brushy Creek WBID Boundary

Table B.5. Estimated Number of Septic Tanks and Septic Tank Failure Rates for Escambia County, 2003–10

This is a 10-column table. Column 1 lists the parameter, Columns 2 through 9 list the estimate for each year from 2003 to 2010, respectively, and Column 10 lists the average.

[1] The failure rate is 5 times the failure discovery rate.

Year	2003	2004	2005	2006	2007	2008	2009	2010	Average
Number of new septic tank installations	365	272	390	436	314	238	161	146	290
Cumulative total number of septic tanks	67,489	67,761	68,151	68,587	68,901	69,139	69,300	69,446	68,597
Number of septic tank repair permits issued	733	612	507	533	413	408	477	252	492
Failure discovery rate (%)	1.09%	0.90%	0.74%	0.78%	0.60%	0.59%	0.69%	0.36%	0.72%
Failure rate (%)[1]	5.43%	4.52%	3.72%	3.89%	3.00%	2.95%	3.44%	1.81%	3.59%

Wildlife

Wildlife is another possible source of fecal coliform bacteria within the Brushy Creek WBID boundary. However, as these represent natural inputs, no reductions are assigned to these sources by this TMDL.

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