FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration

NORTHWEST DISTRICT • CHOCTAWHATCHEE–ST. ANDREW BAY BASINS

FINAL TMDL Report

Fecal Coliform TMDL for Minnow Creek (WBID 130)

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Acknowledgments

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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

2008 305(b) Report

http://www.dep.state.fl.us/water/docs/2008_Integrated_Report.pdf

Criteria for Surface Water Quality Classifications

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

Basin Status Report: Choctawhatchee–St. Andrew Bay

http://www.dep.state.fl.us/water/basin411/csa/status.htm

Water Quality Assessment Report: Choctawhatchee–St. Andrew Bay

http://www.dep.state.fl.us/water/basin411/csa/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 Minnow Creek, located in the Choctawhatchee-St. Andrew Bay Basins. The creek was verified as impaired for fecal coliform, and therefore was included on the Verified List of impaired waters for the Choctawhatchee–St. Andrew Bay Basins that was adopted by Secretarial Order on January 15, 2010. The TMDL establishes the allowable fecal coliform loading to Minnow 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 Choctawhatchee-St. Andrew Bay Basins into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. Minnow Creek is WBID 130.

Minnow Creek is 1 of the 172 waterbody segments in the Choctawhatchee Basin and one of 8 waterbody segments in the basin included on the 1998 303(d) list for Florida. The watershed is located in northwest Jackson County, south of the city of Graceville (**Figure 1.1**).

The headwaters of Minnow Creek are in the northwestern portion of Jackson County. The creek flows southwest for approximately 7.7 miles to Alligator Creek, eventually flowing into Holmes Creek, a principal tributary of the Choctawhatchee River. The creek receives flow from a number of smaller branches (**Figure 1.2**).

The drainage area within the Minnow Creek WBID boundary is approximately 11.89 square miles (mi^2) (7,613 acres) and is predominantly made up of agricultural and forested land. Additional information about this area is available in the Basin Status Report for Choctawhatchee–St. Andrew Bay (Department, 2003).

WBID 130 is located in the Dougherty Karst Plain ecoregion, which occupies a portion of the central Florida panhandle. This ecoregion is comprised of a flat-to-gently-rolling, southwestward sloping plains generally characterized by karst terrain.

The Floridan aquifer is at or near the surface in much of the region. In this area the aquifer is unconfined, allowing water to enter, move through, and discharge from the Floridan aquifer system more readily and rapidly (Miller, 1990). In these unconfined areas, the aquifer is either exposed or is covered by a thin layer of sand or by clayey, residual soil (Miller, 1990).

The karst features in the region allow for the rapid infiltration of surface water into the aquifer systems and offer direct access to the aquifers by natural and anthropogenic pollutants (Scott, 1992). Transport of pollutants in karst terrains is quick and attenuation is limited (Youno et al., 2001). The main sources and causes of groundwater pollution in karst areas fall under four groups municipal, industrial, agricultural and miscellaneous (Youno et al., 2001). Potential sources in predominantly agricultural areas located within karst terrain include organic compounds from the excessive and improper use of fertilizer and pesticides, and nitrate and bacteria from excessive livestock waste (Crawford and Whallon, 1985). In karst terrains with more urbanized areas contaminants associated with urban stormwater runoff (lead, chromium, oil and grease), bacteria from pet wastes, leaky underground storage tanks and septic tanks are potential problems (Crawford and Whallon, 1985). Other sources of potential ground water contamination include unauthorized hazardous waste disposal sites, old landfills, unauthorized dumps, and abandoned wells (ADEM, 2001).

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.

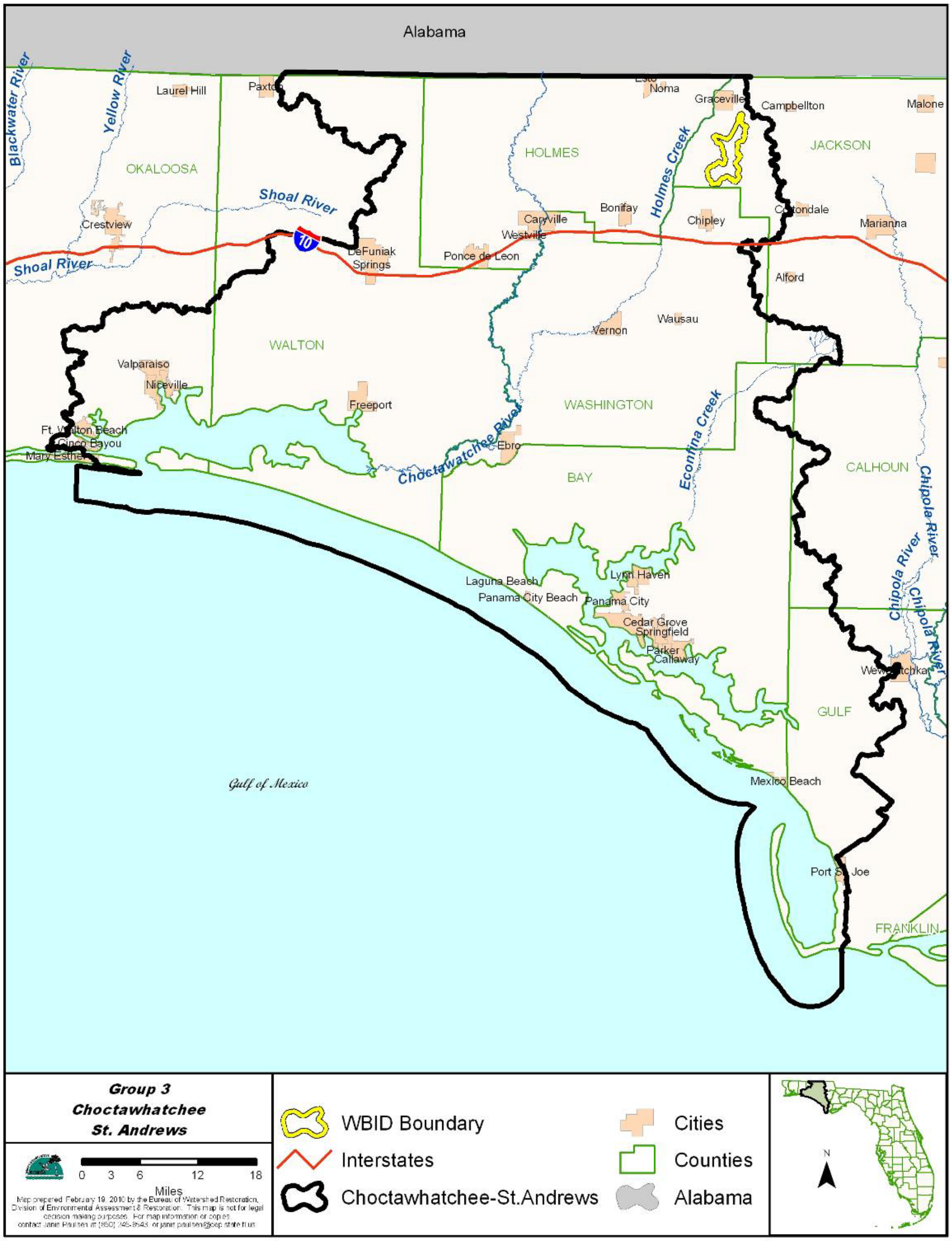

Figure 1.1. Location of the Minnow Creek Watershed (WBID 130) in the Choctawhatchee–St. Andrew Bay Basin and Major Geopolitical and Hydrologic Features in the Area

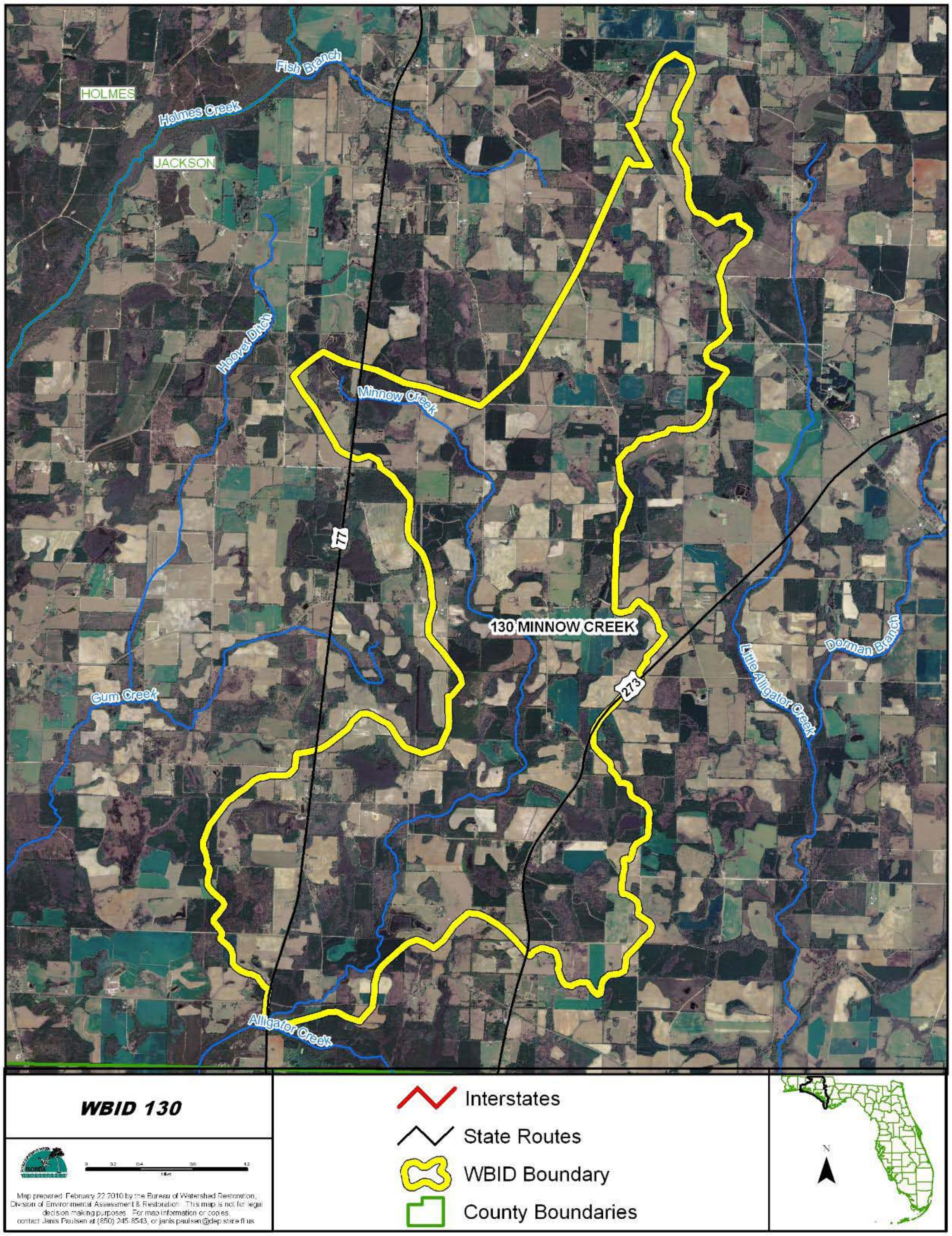

Figure 1.2. Location of Minnow Creek (WBID 130) in Jackson County and Major Hydrologic Features in the Area

This TMDL report will be followed by the development and implementation of a restoration plan designed to reduce the amount of fecal coliform that caused the verified impairment of Minnow Creek. These activities will depend heavily on the active participation of the Northwest Florida Water Management District (NWFWMD), local governments, businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDLs for impaired waterbodies.

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 identified eight impaired waterbodies in the Choctawhatchee River watershed on its 1998 303(d) list. However, the FWRA (Section 403.067, F.S.) stated that all Florida 303(d) lists created before the adoption of the FWRA 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 Minnow Creek and has verified that this waterbody segment is impaired for fecal coliform bacteria. The verified impairment was based on the observation that for 8 out of 18 fecal coliform samples collected during the Cycle 2 verified period (January 1, 2002, through June 30, 2009), more than 10 percent of the values exceeded the assessment threshold of 400 counts per 100 milliliters (counts/100mL) (see **Section 3.2** for details).

Table 2.1 summarizes the fecal coliform monitoring results for the Cycle 2 verified period for Minnow Creek used in developing the TMDL.

Table 2.1. Summary of Fecal Coliform Monitoring Data for Minnow Creek (WBID 130) During the Cycle 2 Verified Period (January 1, 2002, through June 30, 2009)

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

Waterbody (WBID)	Parameter	Fecal Coliform
Minnow Creek (WBID 130)	Total number of samples	18
Minnow Creek (WBID 130)	IWR-required number of exceedances for the Verified List	5
Minnow Creek (WBID 130)	Number of observed exceedances	8
Minnow Creek (WBID 130)	Number of observed nonexceedances	10
Minnow Creek (WBID 130)	Number of seasons during which samples were collected	2
Minnow Creek (WBID 130)	Highest observation (counts/100mL)	3,000
Minnow Creek (WBID 130)	Lowest observation (counts/100mL)	12
Minnow Creek (WBID 130)	Median observation (counts/100mL)	205
Minnow Creek (WBID 130)	Mean observation (counts/100mL)	713

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)**

Minnow Creek is a Class III (fresh) 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 freshwater 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.

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 discernable, 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 Minnow Creek WBID Boundary

4.2.1 Point Sources

Wastewater Point Sources

There are no NPDES-permitted wastewater facilities in the Minnow Creek watershed.

Municipal Separate Storm Sewer System Permittees

There are no NPDES Phase I or Phase II municipal separate storm sewer system (MS4) permits in the Minnow Creek watershed.

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 to accurately quantify 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 NWFWMD's 2004 land use coverage contained in the Department's geographic information system (GIS) library. Land use categories within the Minnow Creek WBID boundary were aggregated using the simplified Level 1 codes 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 WBID boundary is approximately 7,613 acres. The dominant land use categories are agriculture (pastures, crops, hay fields, and groves), which accounts for about 47 percent of the total WBID area, and upland forest land (coniferous and hardwood forests, and pine flatwoods), which accounts for approximately 32 percent of the total WBID area. Urban lands (urban and built-up; low- and mid-density residential; and transportation, communication, and utilities) occupy about 347 acres, or about 5 percent of the total WBID area. Natural land uses, which include upland forests, water, wetlands, and rangeland, occupy about 3,735 acres, accounting for about 49 percent of the total WBID area.

Table 4.1. Classification of Land Use Categories within the Minnow Creek WBID Boundary in 2004

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	4	0.1%
-	Low-density residential	301	3.9%
-	Medium-density residential	25	0.3%
-	High-density residential	-	0.0%
2000	Agriculture	3,531	46.4%
3000	Rangeland	150	2.0%
4000	Upland forest	2,408	31.6%
5000	Water	45	0.6%
6000	Wetland	1,133	14.9%
7000	Barren land	-	0.0%
8000	Transportation, communication, and utilities	16	0.2%
-	**TOTAL**	**7,613**	**100.0%**

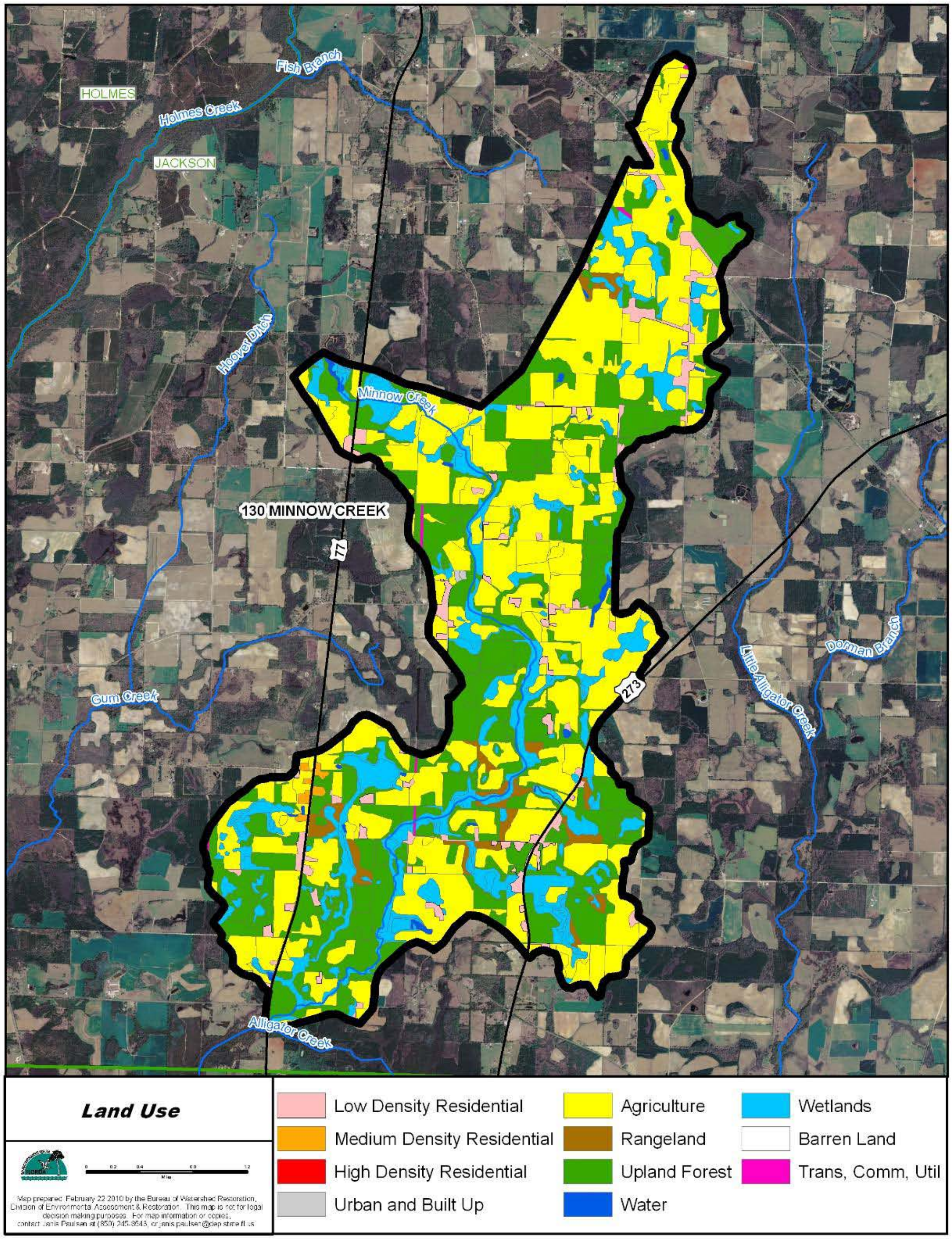

Figure 4.1. Principal Land Uses within the Minnow Creek Watershed (WBID 130) Boundary in 2004

Livestock

Based on the land use distribution listed in **Table 4.1**, a potentially important nonpoint source of coliform includes livestock and other agricultural animals. Agricultural animal waste is associated with various pathogens in streams; these include *E. coli, Salmonella, Giardia, Campylobacter, Shigella, and Cryptosporidiumparvum* (Landry and Wolfe, 1999). Agricultural activities, including runoff from pastureland and cattle in streams, can affect water quality. **Appendix B** provides detailed load estimates and describes the methods used for the quantification.

Urban Development

Although urban land use is not dominant within the Minnow Creek WBID boundary, contributions from residential areas may still be possible sources for fecal coliform loadings due to failed septic tanks and pet feces that are inappropriately disposed of. 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** is only used to demonstrate the possible relative contributions from different sources. The loading estimates were not used in establishing the final TMDL.

Wildlife and Sediments

In addition to livestock, wildlife and sediments could also contribute to the fecal coliform exceedances in the watershed. Wildlife such as birds, raccoons, bobcats, rabbits, deer, and feral hogs have direct access to streams, especially under low-flow conditions, and 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).

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

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

When continuous flow measurements in a watershed are available, a bacteria TMDL can be developed using the load duration curve method, which was developed by the Kansas Department of Health and Environment and provides the allowable daily bacteria load. However, flow data were not available for Minnow Creek; therefore, the fecal coliform TMDL was developed using the "percent reduction" approach. Using this method, the percent reduction needed to meet the applicable criterion was calculated based on the 90th percentile of all measured concentrations collected during the Cycle 2 verified period (January 1, 2002 to June 30, 2009). 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. The EPA Region 4 uses this method in developing fecal coliform TMDLs. The percent reduction of fecal coliform needed to meet the applicable criterion was calculated as described in **Section 5.1.2**.

5.1.1 Data Used in the Determination of the TMDL

The data used to develop this TMDL were provided by the Department (Stations: 21FLPNS 305012408531460, 21FLPNS 305125408530557, 21FLPNS 305301908530266, and 21FLGW 13696). Data were collected equally at Stations 21FLPNS 305012408531460, 21FLPNS 305125408530557, and 21FLPNS 305301908530266, and collected only once at Station 21FLGW 13696. See **Figure 5.1** for the locations of the water quality stations where fecal coliform data were collected for Minnow Creek.

The Cycle 2 verified period includes data collected from January 1, 2002, through June 30, 2009. During this period, 18 fecal coliform samples were collected from 4 sampling stations in WBID 130. Fecal coliform data for Minnow Creek were mostly collected in 2009. As a result, this analysis focuses on fecal coliform data collected in the latter part of the Cycle 2 verified period.

Concentrations ranged from 12 to 3,000 counts/100mL and averaged 713 counts/100mL during the period of observation. **Table 5.1** summarizes the descriptive statistics for the 2002, 2008, and 2009 fecal coliform results. **Figure 5.2** shows the fecal coliform concentration trends observed in Minnow Creek for the period of observation.

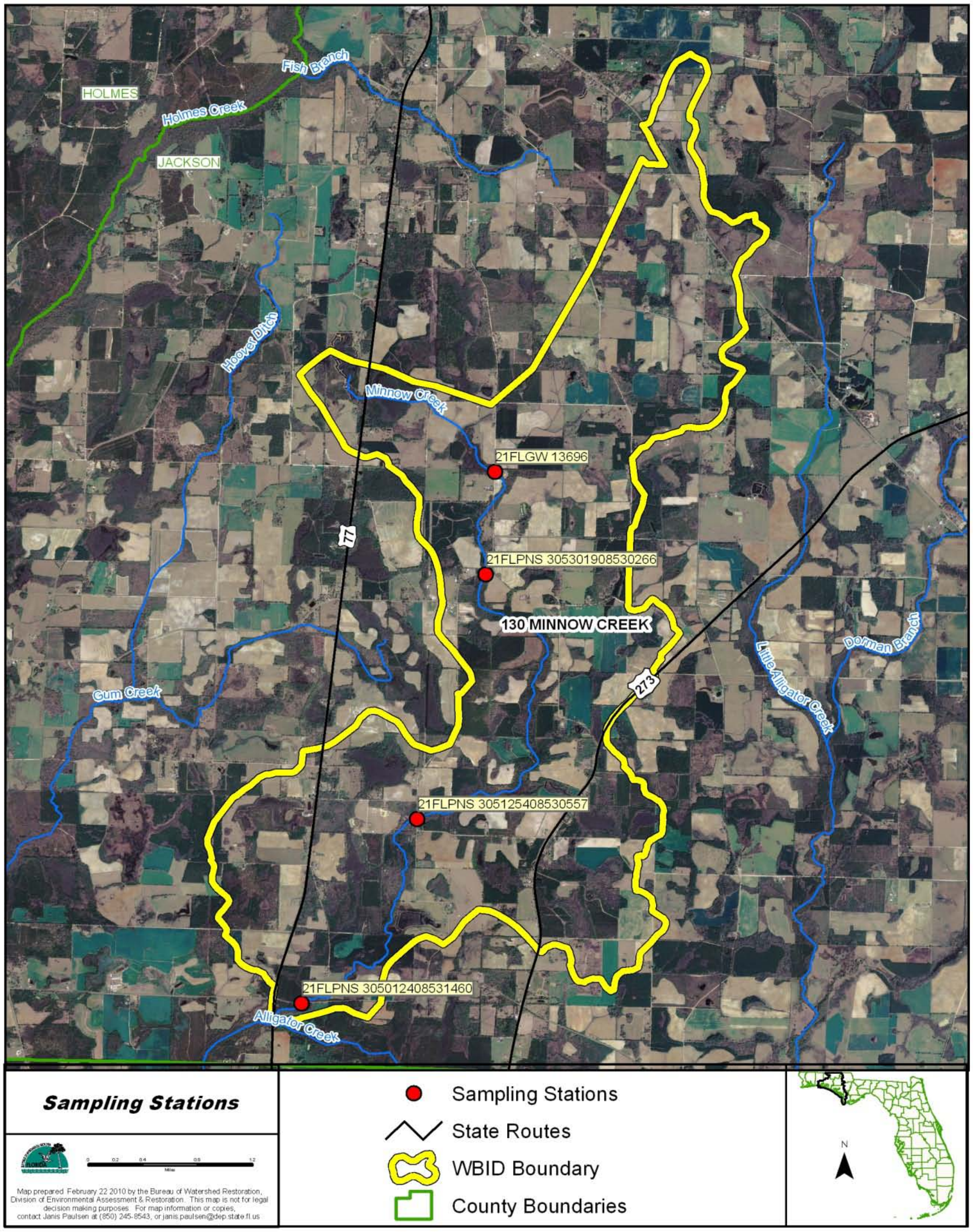

Figure 5.1. Location of Water Quality Stations with Fecal Coliform Data in Minnow Creek (WBID 130)

Table 5.1. Descriptive Statistics of Fecal Coliform Data for Minnow Creek (WBID 130) for 2002, 2008, and 2009

This is a two-column table. Column 1 lists the descriptive statistic, and Column 2 lists the result.

Descriptive Statistic	Result
Mean observation (counts/100mL)	713
Standard deviation	887
Median observation (counts/100mL)	205
Highest observation (counts/100mL)	3,000
Lowest observation (counts/100mL)	12
25% quartile	83
75% quartile	1,225
Number of samples	18

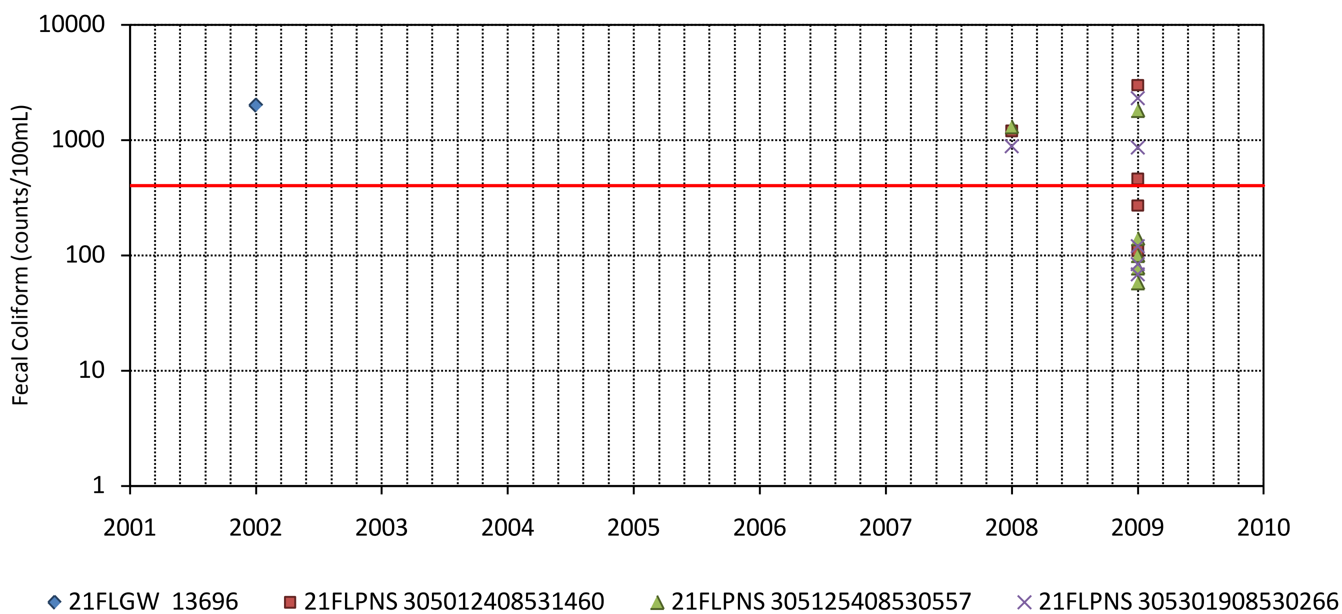

Figure 5.2. Fecal Coliform Concentration Trends in Minnow Creek (WBID 130) during the Cycle 2 Verified Period for Data Collected in 2002, 2008, and 2009

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

Temporal Patterns

As the majority of fecal coliform concentration data were collected in 2009 (n=14), except for 1 sample in 2002 and 3 samples in 2008, a typical seasonal trend could not be established with certainty. However, episodic peak fecal coliform concentrations were observed throughout the 2009 sampling season.

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 occur in the first and fourth quarters (winter, January–March; and fall, October–December), when conditions are drier and colder. Given that samples were collected only during the first and second quarters, it cannot be confirmed whether this seasonal variation is found in Minnow Creek. However, contrary to common seasonal observations, the highest fecal coliform concentrations, as well as the second highest exceedance rates, were observed during the first quarter (January) and second quarter (April). **Tables 5.2a** and **5.2b** summarize monthly and seasonal fecal coliform averages and percent exceedances, respectively, for data associated with the verified period for this WBID (2002, 2008, and 2009).

Table 5.2a. Summary Statistics of Fecal Coliform Data for all Stations in Minnow Creek (WBID 130) by Month during the Cycle 2 Verified Period (2002–09)

This is an eight-column table. Column 1 lists the year, 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.

- = Empty cell/no data
[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	3	880	1,300	1,200	1,126	3	100%
February	3	68	460	78	202	1	33%
March	6	58	270	115	130	0	0%
April	4	12	3,000	2,050	1,778	3	75%
May	2	100	860	480	480	1	50%
June	-	-	-	-	-	-	-
July	-	-	-	-	-	-	-
August	-	-	-	-	-	-	-
September	-	-	-	-	-	-	-
October	-	-	-	-	-	-	-
November	-	-	-	-	-	-	-
December	-	-	-	-	-	-	-

Table 5.2b. Summary Statistics of Fecal Coliform Data for all Stations in Minnow Creek (WBID 130) by Season during the Cycle2 Verified Period (2002–09)

This is an eight-column table. Column 1 lists the year, 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.

- = Empty cell/no data
[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	12	58	1,300	130	397	4	33%
Quarter 2	6	12	3,000	1,330	1,345	4	67%

Using rainfall data collected at the Chipley climate station (available: http://climod.meas.ncsu.edu/) it was possible to compare monthly rainfall in 2009 (the year with the most samples collected) with monthly fecal coliform exceedance rates for the same period (**Figure 5.3**). Peak fecal coliform concentrations are commonly observed to coincide with, or follow, periods of increased rainfall; this trend was observed in Minnow Creek on several occasions. In 2008 and 2009, high fecal coliform concentrations were correlated with 3-day precipitation (extreme and medium precipitation events) at all 3 stations sampled. For example, when 3-day precipitation was 3.35 inches (for a sampling event on April 14, 2009), fecal coliform concentrations were 3,000, 1,800, and 2,300 counts/100mL at Stations 21FLPNS 305012408531460, 21FLPNS 305125408530557, and 21FLPNS 305301908530266, respectively (**Section 5.1.2**).

Spatial Patterns

Fecal coliform data from 2009 for Stations 21FLPNS 305301908530266 (upstream), 21FLPNS 305125408530557 (midstream) and 21FLPNS 305012408531460 (downstream) were analyzed to detect spatial trends in the data. Spatially, high fecal coliform concentrations were observed at all three stations, with the highest concentration recorded at Station 21FLPNS 305012408531460, the most downstream station (**Figure 5.4** and **Table 5.3**). Land use adjacent to this station is classified as wetland forested, coniferous plantations, and pine flatwoods (**Figure 5.5**). However, signs of direct livestock access have been observed in the creek, potentially coming from the improved pastureland area east of the station (**Figure 5.6**).

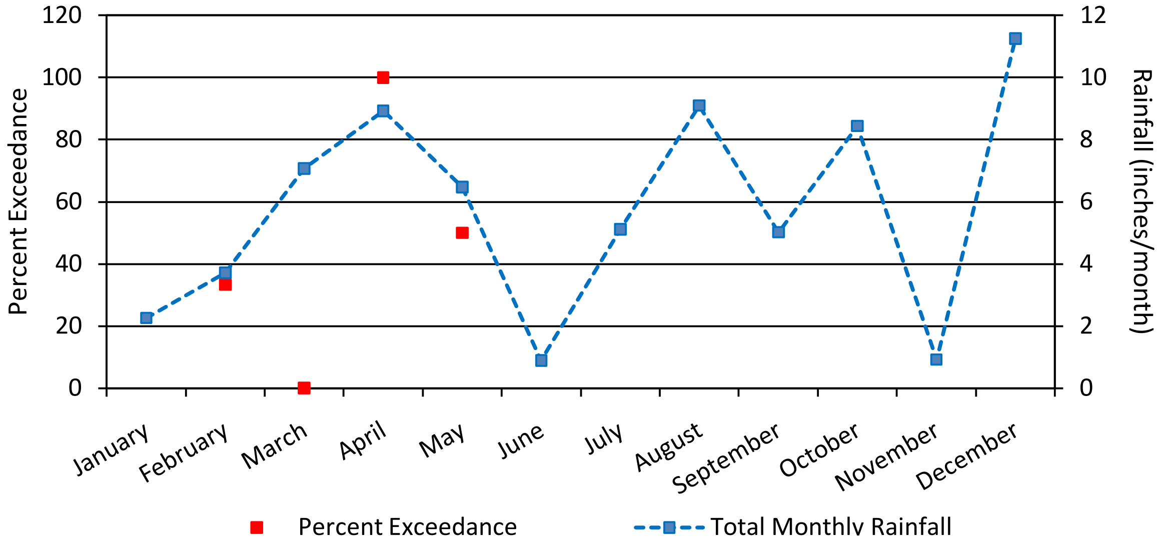

Figure 5.3. Fecal Coliform Exceedances and Rainfall at all Stations in Minnow Creek (WBID 130) by Month during the 2009 Sampling Season

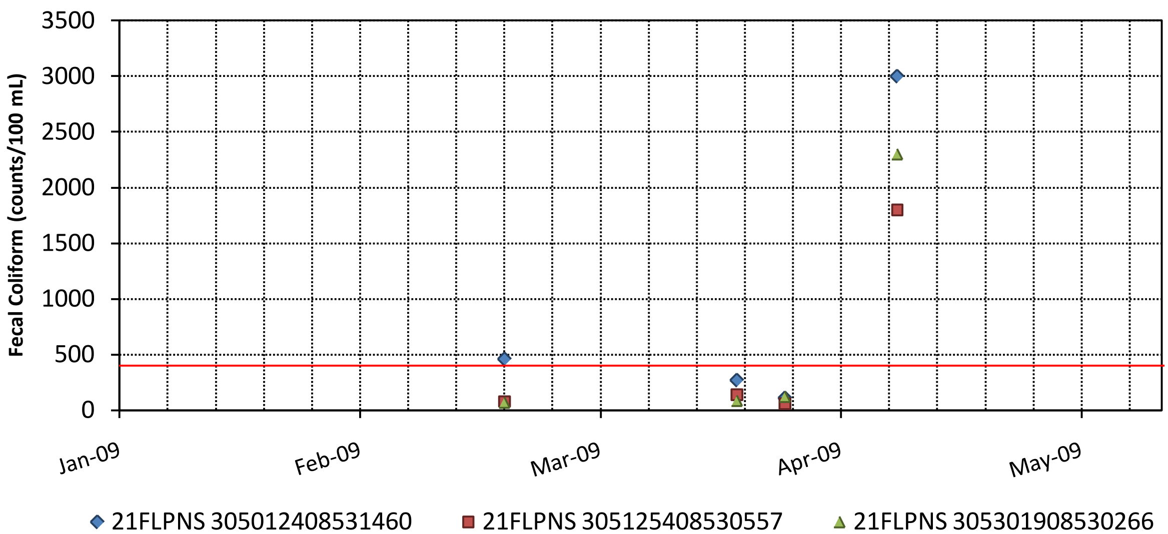

Figure 5.4. Spatial Fecal Coliform Concentration Trends in Minnow Creek (WBID 130) in 2009

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

Table 5.3. Station Summary Statistics of Fecal Coliform Data for Minnow Creek (WBID 130) in 2009

This is an eight-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 maximum count/100mL, Column 5 lists the mean count, Column 6 lists the median 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

Station	Period of Observation	Number of Samples	Minimum[1]	Maximum[1]	Mean[1]	Median[1]	Number of Exceedances[2]	% Exceedances
21FLPNS 305012408531460	2009	4	110	3,000	365	960	2	50%
21FLPNS 305125408530557	2009	5	58	1,800	100	435	1	20%
21FLPNS 305301908530266	2009	5	68	2,300	120	686	2	40%

Figure 5.5. Pine Flatwoods Adjacent to Minnow Creek Station 21FLPNS 305012408531460, Chipley, Florida

Figure 5.6. Minnow Creek (Facing South) at Station 21FLPNS 305012408531460, Chipley, Florida. Livestock Pastureland Area Is Located Downstream.

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.

As no current flow data were available, hydrologic conditions were analyzed using rainfall. Instead, a loading curve–type chart that would normally be applied to flow events was created using precipitation data from the Chipley climate station. 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). Event precipitation ranges were derived based on these percentiles. Extreme events were determined as those with rainfall greater than 2.11 inches; large events, 1.55 to 2.11 inches; medium events, 0.19 to 1.55 inches; small events, 0.01 to 0.19 inches; and nonmeasurable events, less than 0.01 inch. Three-day (the day of and 2 days prior to sampling) precipitation accumulations were used in the analysis (**Table 5.4** and **Figure 5.7**).

Historical data show that fecal coliform exceedances occurred over extreme, medium, and not measurable precipitation events. Given that no samples were collected during large and small precipitation events, it can only be assumed, and not generalized, that fecal coliform exceedances occur over all hydrologic conditions.

The highest percentage of exceedances (100 percent) occurred after extreme precipitation events; but, this period also had the fewest samples (n=3). Exceedances were also observed in samples collected after medium precipitation events (50 percent exceedances). The lowest percentage of exceedances occurred after periods of no measurable precipitation (14.3 percent). The fact that the highest exceedance rates occurred after extreme and medium precipitation events, rather than after periods of little or no rainfall, indicates that nonpoint sources are probably a major contributing factor. However, while the lowest percentage of exceedances occurred after periods of little or no rainfall, the exceedance rate is significant, and could also indicate nonpoint sources of fecal coliform pollution to Minnow Creek.

That there are no point sources located in or discharging to Minnow Creek indicate that nonpoint sources such as baseflow, which contributes to the creek's flow during dry conditions, have been impacted by failed septic tanks. In addition, direct animal access could be another possible source. The high rates of exceedances and episodic extreme fecal coliform concentrations that occurred after all categories of sampled precipitation events indicate that various nonpoint sources likely contribute fecal coliform pollution to Minnow Creek. **Table 5.4** and **Figure 5.7** show fecal coliform data by hydrologic condition.

Table 5.4. Summary of Historical Fecal Coliform Data by Hydrologic Condition for Minnow Creek (WBID 130)

This is a seven-column table. Column 1 lists the type of precipitation event, Column 2 lists the event range (in inches), Column 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 Non-exceedances	% Non-exceedances
Extreme	>2.11"	3	3	100%	0	0%
Large	1.55" - 2.11"	0	0	0	0	0
Medium	0.19" - 1.55"	8	4	50%	4	0%
Small	0.01" - 0.19"	0	0	0	0	0
None/ Not Measurable	<0.01"	7	1	14.3%	6	85.7%

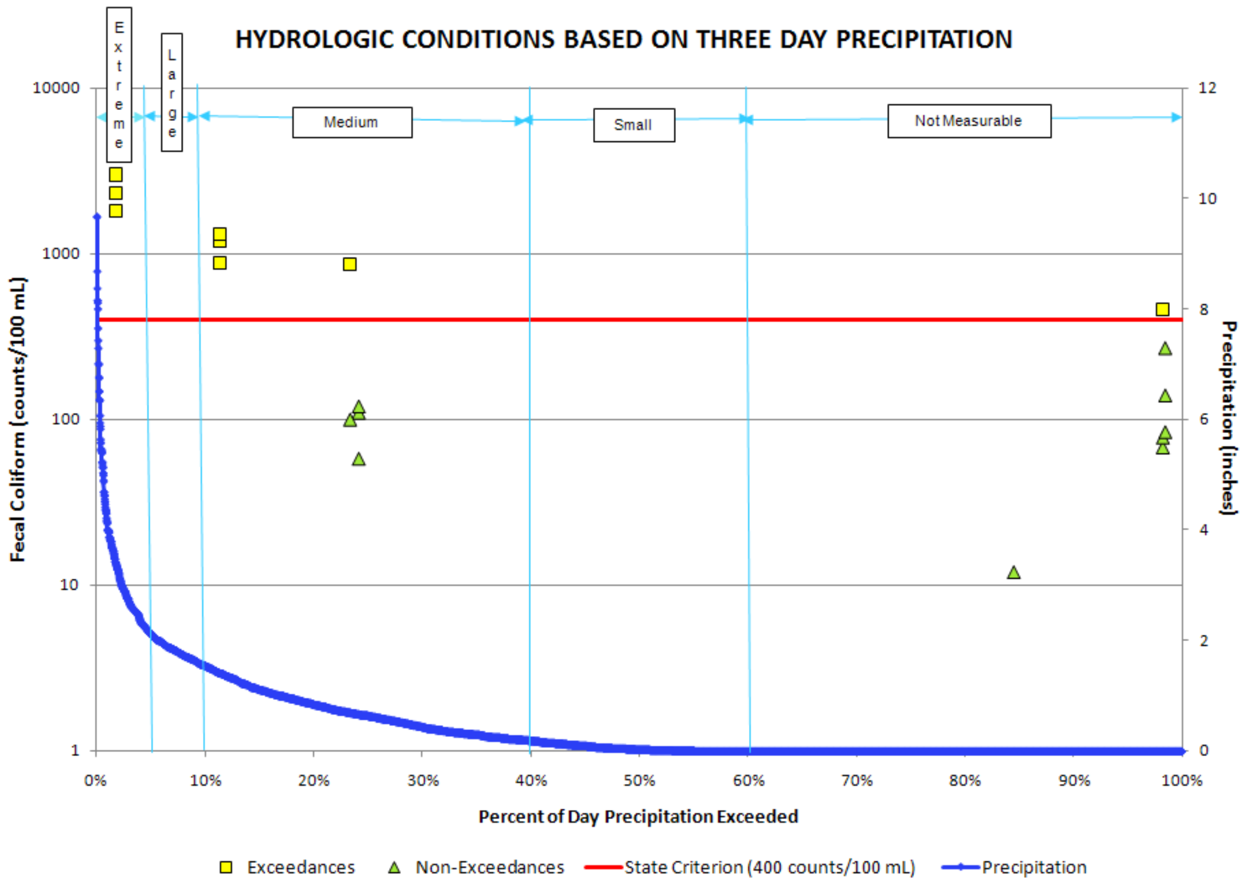

Figure 5.7. Historical Fecal Coliform Data by Hydrologic Condition for Minnow Creek (WBID 130)

As fecal coliform exceedances occurred following all sampled categories of precipitation events—extreme, large, and not-measurable—the target fecal coliform reduction calculated in the following section and shown in Table 5.5 is applicable under all rainfall conditions in Minnow Creek.

5.1.3 TMDL Development Process

Due to the lack of supporting information, mainly flow data, 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 pollutant load was calculated by comparing the existing concentrations and target concentration using **Formula 1**:

$$\text{Needed \% Reduction} = \frac{\text{Existing } 90^{\text{th}} \text{ Percentile Concentration-Allowable Concentration}}{\text{Existing } 90^{\text{th}} \text{ Percentile Concentration}} \times 100 \qquad \textbf{Formula 1}$$

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, 2002, to June 30, 2009). The 90th percentile is also called the 10 percent exceedance event. 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 5.5**), and **Formula 2** is used to determine the percentile value of each data point.

$$\text{Percentile} = \frac{\text{Rank} - 0.5}{\text{Total Number of Samples Collected}}$$ **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.

$$90^{\text{th}}\ \text{Percentile Concentration} = C_{\text{lower}} + (P_{90\text{th}} * R)$$ **Formula 3**

Where:

> *C_{lower} is the fecal coliform concentration corresponding to the percentile lower than the 90th percentile, in this case, 1,800 counts/100mL.*
>
> *P_{90th} is the percentile difference between the 90th percentile and the percentile number immediately lower than the 90th percentile (in this case, 86%), which is 90% – 86% = 4%*
>
> *R is a ratio defined as R= (fecal coliform concentration $_{upper}$ – fecal coliform concentration $_{lower}$) / (percentile $_{upper}$ – percentile $_{lower}$)*

To calculate *R*, the percentile values below and above the 90th percentile were identified, in this case, 86 and 92 percent, respectively (**Table 5.5**). Next, the fecal coliform concentrations corresponding to the lower and upper percentile values were identified (1,800 and 2,300 counts/100mL, respectively) (**Table 5.5**). The fecal coliform concentration difference between the lower and higher percentiles was then calculated and divided by the unit percentile. The unit percentile difference is the difference between the lower and upper percentiles (e.g., 92% – 86% = 6 percentile unit difference). R was then calculated as R = (2,300 – 1,800)/(92% – 86%) = 83.

The C_{lower}, P_{90th}, and *R* were substituted into **Formula 3** to calculate the 90th percentile fecal coliform concentration (i.e., 90th Percentile Concentration = 1,800 + (4*83) = 2,133 counts/100mL).

Using **Formula 1**, the percent reduction for the period of observation (January 1, 2002, to June 30, 2009) was calculated as 81 percent for Minnow Creek (i.e., % reduction needed = [(2,133 – 400)/2,133]*100 = 81%).

Table 5.5 shows the individual fecal coliform data, the ranks, the percentiles for each individual data, the existing 90th percentile concentration, the allowable concentration (400 counts/100mL), and the percent reduction needed to meet the applicable water quality criterion for fecal coliform.

Table 5.5. Calculation of Fecal Coliform Reductions for the Minnow Creek (WBID 130) TMDL Based on the Hazen Method

This is a five-column table. Column 1 lists the station, Column 2 lists the sampling date, Column 3 lists the fecal coliform exceedance concentration (MPN/100mL), Column 4 lists the rank, and Column 5 lists the percentile by the Hazen method.

- = Empty cell/no data

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
21FLGW 13696	4/30/2002	12	1	3%
21FLPNS 305125408530557	3/31/2009	58	2	8%
21FLPNS 305301908530266	2/24/2009	68	3	14%
21FLPNS 305125408530557	2/24/2009	78	4	19%
21FLPNS 305301908530266	3/25/2009	84	5	25%
21FLPNS 305125408530557	5/20/2009	100	6	31%
21FLPNS 305012408531460	3/31/2009	110	7	36%
21FLPNS 305301908530266	3/31/2009	120	8	42%
21FLPNS 305125408530557	3/25/2009	140	9	47%
21FLPNS 305012408531460	3/25/2009	270	10	53%
21FLPNS 305012408531460	2/24/2009	460	11	58%
21FLPNS 305301908530266	5/20/2009	860	12	64%
21FLPNS 305301908530266	1/17/2008	880	13	69%
21FLPNS 305012408531460	1/17/2008	1,200	14	75%
21FLPNS 305125408530557	1/17/2008	1,300	15	81%
21FLPNS 305125408530557	4/14/2009	1,800	16	86%
21FLPNS 305301908530266	4/14/2009	2,300	17	92%
21FLPNS 305012408531460	4/14/2009	3,000	18	97%
-	**-**	**-**	**Existing condition concentration– 90th percentile (counts/100mL)**	**2,133**
-	**-**	**-**	**Allowable concentration (counts/100mL)**	**400**
-	**-**	**-**	**Final % reduction**	**81%**

A data distribution analysis identified one outlier (3,000 counts/100mL) (**Figure 5.8**). Communication with the data providers provided no evidence that sampling or data quality concerns were associated with this result; therefore, there is no reasonable justification for removing this extreme value for the final percent reduction calculation. The final percent reduction number is not being extremely biased or distorted by the outlier present in the data set.

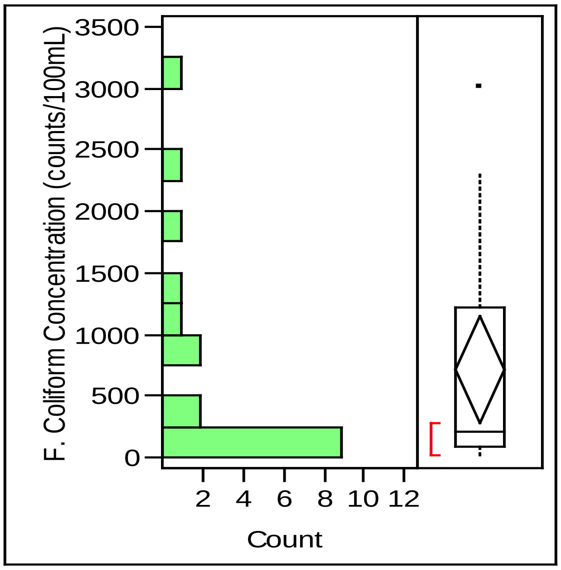

Figure 5.8. Histogram and Box Plot of Fecal Coliform Results for Cycle 2 Verified Period Data

Note: Outliers are identified as points on the right.

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:

$$\textbf{TMDL} = \sum \textbf{WLAs} + \sum \textbf{LAs} + \textbf{MOS}$$

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

$$\textbf{TMDL} \cong \sum \textbf{WLAs}_{\textbf{wastewater}} + \sum \textbf{WLAs}_{\textbf{NPDES Stormwater}} + \sum \textbf{LAs} + \textbf{MOS}$$

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (a) 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 (b) 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 Minnow Creek is expressed in terms of counts/day 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 Minnow Creek (WBID 130)

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	81%	Implicit

6.2 Load Allocation

Based on a percent reduction approach, the LA is an 81 percent reduction in fecal coliform from nonpoint sources. 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 were identified within the Minnow Creek WBID boundary.

It should be note that the state requires all NPDES-permitted wastewater 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 Phase I or Phase II MS4 permits in the Minnow Creek watershed. It should be noted that any future MS4 permittee is only responsible for reducing the anthropogenic loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction.

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.

Many assessment tools are 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 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 the Florida Department of Transportation 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/environmental resource permitting programs is that the NPDES Program covers both new and existing discharges, while the state's program focus 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 provides these estimates for informational purposes only and did not use them to calculate the TMDL. These estimates are intended to give the public a general idea of the relative importance of each source in the waterbody. They 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.

Pets

Pets (especially dogs) could be a significant source of coliform pollution through surface runoff within the Minnow Creek WBID boundary. Studies report that up to 95 percent 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 (van der Wel, 1995). Unfortunately, statistics show that about 40 percent of American dog owners do not pick up their dogs' feces. The number of dogs within the Minnow 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 obtained from the Jackson County Property Appraiser's Office website (available: http://www.qpublic.net/cgi-bin/jackson_display.cgi?KEY=01-5N-13-0000-0040-0000) and data obtained from the Florida Department of Health (FDOH) to calculate the number of properties in residential land use areas within the Minnow Creek WBID boundary, the number of households within the WBID boundary was estimated to be approximately 159. The next section describes the data provided by FDOH. Assuming that 40 percent of the households in this area have 1 dog, there are about 64 dogs within the WBID.

Assuming that 40 percent of dog owners do not pick up their dogs' feces, the total waste produced by dogs and left on the land surface in residential areas in the WBID is approximately 11,448 grams/day. The total load produced by dogs is about 2.52×10^{10} counts/day of fecal coliform. 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.1** 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) based on the literature, and estimates of waste and fecal coliform loads within the Minnow Creek WBID boundary.

Table B.1. Dog Population Density, Wasteload, and Fecal Coliform Density Based on the Literature (Weiskel et al., 1996)

This is a five-column table. Column 1 lists the animal type (dog), Column 2 lists the population density, Column 3 lists the total number of dogs, Column 4 lists the wasteload, and Column 5 lists the fecal coliform density.

- = Empty cell/no data
* Number from APPMA

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

Livestock

The presence of livestock and other agricultural animals can result in high loading rates of pathogens to soils and waters. Livestock with direct access to the receiving water can contribute to exceedances during wet and dry weather conditions. Problems with grazing animals and pathogen loading rates derive primarily from animal density (Hubbard et al., 2004). At low animal densities, concerns relate primarily to livestock having free access to waterbodies, where they can directly deposit urine and manure (Hubbard et al., 2004). At high animal densities, concerns relate to the large amounts of urine and feces that are deposited in relatively small areas, increasing the probability of nutrients and pathogens being transported to surface waterbodies via surface runoff, or entering ground water (Hubbard et al., 2004). A major potential source of bacteria loading within the Minnow Creek WBID is grazing livestock, primarily cattle (approximately 47 percent of the WBID is specifically categorized as Level 1 agricultural land use).

The estimated fecal coliform loads from livestock for the Minnow Creek WBID were derived from the EPA document, *Protocol for developing pathogen TMDLs: Source assessment* (2001). Data from the U.S. Department of Agriculture (USDA) (2007) were used to obtain the number of livestock for Jackson County, and data from the NWFWMD's 2004 land use coverage were used to obtain total pastureland areas for the county. Livestock counts and pasture areas were used to determine livestock densities (e.g., number of cows per acre of pastureland) for Jackson County, assuming that livestock are evenly distributed over pasture areas within the county.

Pasture areas of the WBID were used with the livestock density for the county to obtain livestock counts within the WBID. **Table B.2** summarizes pastureland acreage estimated for Jackson County and WBID 130 in 2007, as well as the livestock densities per acre of pastureland estimated for the county. **Table B.3** summarizes cattle populations in Jackson County and estimates the livestock population for WBID 130.

Table B.3 also includes an estimate of fecal coliform loads produced by cattle in the WBID. These loads were obtained based on the cattle densities estimated for the WBID and the fecal coliform counts that the American Society of Agricultural Engineers (ASAE) (1998) estimates for fecal indicator concentrations for cattle (1×10^{11} counts/day). The total fecal coliform load produced by cattle in the Minnow Creek WBID is about 7.29×10^{13} counts/day.

Table B.2. Summary of Pastureland Acreage in Jackson County and WBID 130, and Livestock Densities per Acre of Pastureland for Jackson County and WBID 130

This is a three-column table. Column 1 lists the geographic area, Column 2 lists the acres of pastureland, and Column 3 lists the cattle per acre of pastureland.

*Assumed to be the same as that of Jackson County

Geographic Area	Acres of Pastureland	Livestock (cattle) per Acre of Pastureland
Jackson County	57,789	0.93
Minnow Creek (WBID 130)	780	0.93*

Table B.3. Summary of Livestock Populations in Jackson County and WBID 130, and Livestock Waste Estimates for WBID 130

This is a four-column table. Column 1 lists the type of livestock, Column 2 lists the livestock population in Jackson County in 2007, and Column 3 lists the estimated livestock population in WBID 130 in 2007.

[1] USDA, 2007

Livestock Type	Livestock in Jackson County in 2007[1]	Estimated Livestock in WBID 130 in 2007	Fecal Coliform Density (counts/day)
Cattle	54,021	729	7.29×10^{13}

Septic Tanks

Septic tanks are another potentially important source of coliform pollution in urban watersheds. 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 groundwater (USGS, 2010). The risk of contamination is greater for unconfined (water-table) aquifers than for confined aquifers because they usually are nearer to 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. "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 (USGS, 2010)."

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 the 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.

In addition, watersheds located in karst regions are extremely vulnerable to contamination. Karst terrain is characterized by springs, caves, sinkholes, and a unique hydrogeology that results in aquifers that are highly productive (USGS, 2010). In comparsion to non-karst areas, the springs, caves, sinkholes, etc act as direct pathways for pollutants to enter waterbodies.

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 Minnow 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 data obtained from FDOH, which is currently undertaking a project to inventory the use of onsite treatment and disposal systems (i.e., septic tanks) by determining the methods of wastewater disposal for developed property sites statewide, 159 housing units *(N)* within the Minnow Creek WBID boundary are known or thought to be using septic tanks to treat their domestic wastewater (**Figure B.1**). FDOH's parcel data were obtained from the Florida Department of Revenue 2008 tax roll. FDOH's wastewater disposal data were obtained from county Environmental Health Departments, wastewater treatment facilities, Department domestic wastewater treatment permits, existing county and city inventories, and other available information.

If there was not enough information to determine with certainty whether a property used a septic system, FDOH employed a probability model to analyze the characteristics of the property and estimate the probability that the property was served by a septic tank. Within the Minnow Creek WBID boundary, 29 properties are known to use septic tanks and 130 are estimated to use septic systems. Because the probability that these 130 estimated septic tank properties are in fact served by septic tanks was 99 percent, all 159 properties were assumed to be served by septic tanks for the purposes of this report. 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 Jackson County is about 2.44 people/household. The same population densities were assumed within the Minnow Creek 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 Jackson County based on FDOH's septic tank inventory and the number of septic tank repair permits issued in the county as published by FDOH (available: http://www.doh.state.fl.us/environment/OSTDS/statistics/ostdsstatistics.htm). The cumulative number of septic tanks in Jackson 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 2008–09 inventory, assuming that none of the installed septic tanks will be removed after being installed (**Table B.4**). The reported number of septic tank repair permits was also obtained from the FDOH website. Based on this information, the annual discovery rates of failed septic tanks were calculated and listed in **Table B.4.**

Based on **Table B.4**, the average annual septic tank failure discovery rate is approximately 0.53 percent for Jackson 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 2.65 percent for Jackson County. Based on **Equation B.1**, the estimated fecal coliform loading from failed septic tanks within the Minnow Creek WBID boundary is about 2.73×10^{10} counts/day.

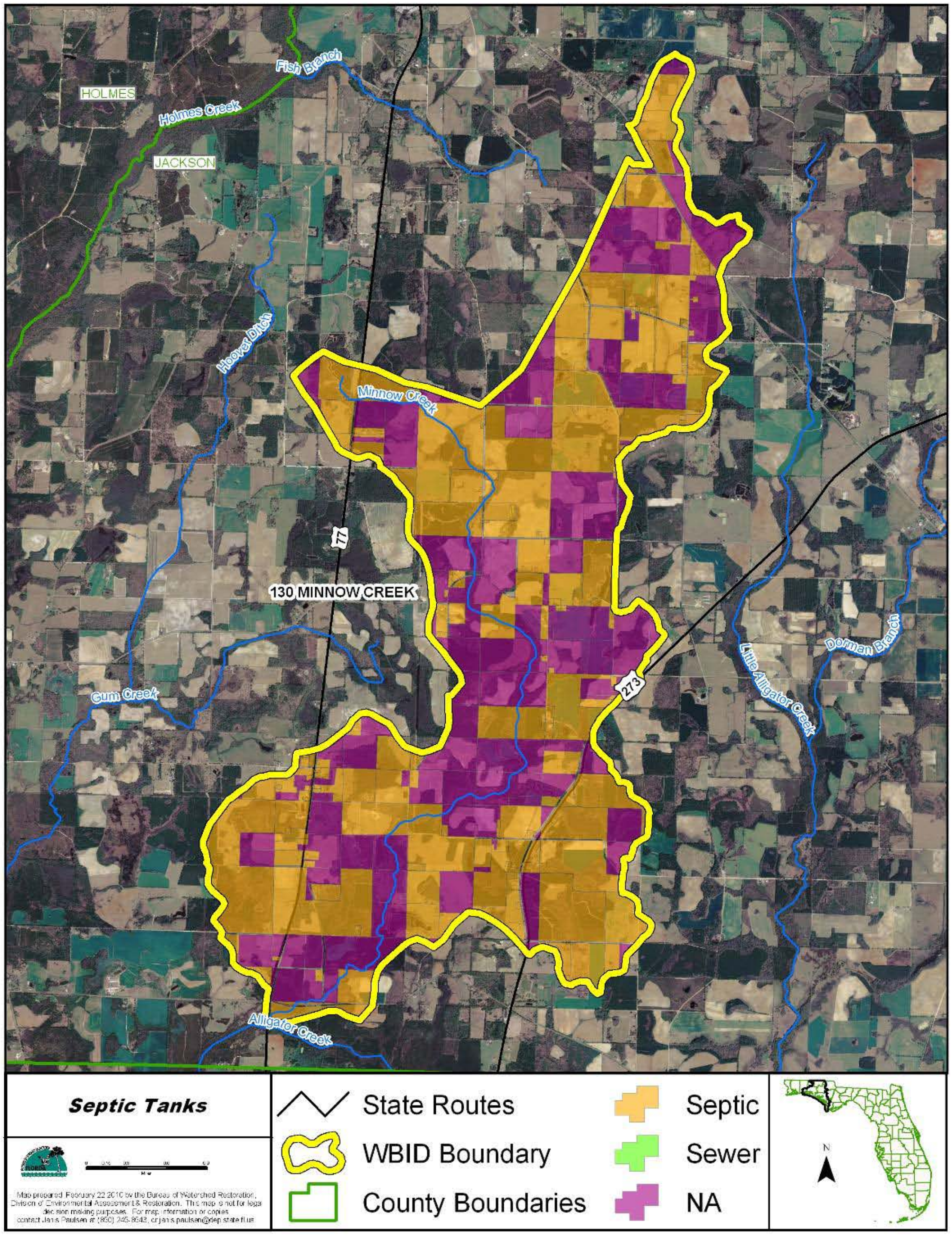

Figure B.1. Distribution of Onsite Sewage Disposal Systems (Septic Tanks) in the Residential Land Use Areas within the Minnow Creek WBID Boundary

Table B.4. Estimated Number of Septic Tanks and Septic Tank Failure Rates for Jackson County, 2002–08

This is an eight-column table. Column 1 lists the type of statistic, Columns 2 through 7 list the estimate for each year from 2002 to 2007, respectively, and Column 8 lists the average.

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

Descriptive Statistic	2002	2003	2004	2005	2006	2007	Average
New installations (septic tanks)	208	189	160	259	317	270	234
Accumulated installations (septic tanks)	15,704	15,912	16,101	16,261	16,520	16,837	16,222.5
Repair permits (septic tanks)	118	96	46	93	80	82	86
Failure discovery rate (%)	0.75%	0.60%	0.29%	0.57%	0.48%	0.49%	0.53%
Failure rate (%)[1]	3.76%	3.02%	1.43%	2.86%	2.42%	2.44%	2.65%

Wildlife

Wildlife is another possible source of fecal coliform bacteria within the Minnow Creek WBID boundary. As shown in **Figure 4.1**, wetland areas border Minnow Creek and several of its contributing branches within the WBID boundary. Additionally, rangeland (dry prairie, shrub, and brushland) and upland forested areas are close to the creek. These areas likely serve as habitat for wildlife that has the potential to contribute fecal coliform to the creek. However, as these represent natural inputs, this TMDL analysis does not assign any reductions to these sources.

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