FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration

NORTHEAST DISTRICT • LOWER ST. JOHNS BASIN

TMDL Report

Fecal Coliform TMDL for Craig Creek (WBID 2297)

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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 : Lower St. Johns

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

Water Quality Assessment Report: Lower St. Johns

http://www.dep.state.fl.us/water/basin411/sj_lower/assessment.htm

U.S. Environmental Protection Agency

Region 4: Total Maximum Daily Loads 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 Craig Creek, located in the Lower St. Johns Basin. The creek was verified as impaired for fecal coliform and therefore was included on the Verified List of impaired waters for the Lower St. Johns Basin that was adopted by Secretarial Order on May 27, 2004. The TMDL establishes the allowable fecal coliform loading to Craig 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 Lower St. Johns Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. Craig Creek is WBID 2297.

Craig Creek is located in central Duval County in northeast Florida, just south and east of the St. Johns River as it makes its turn to the Atlantic Ocean. The creek is situated within the limits of the City of Jacksonville (**Figure 1.1**). It begins just east of Interstate 95 and flows southwest for approximately 0.3 miles before turning and flowing generally west for approximately 1.1 miles and discharging into the St. Johns River. Two other small branches (**Figure 1.2**) contribute to Craig Creek: the eastern branch flows north and joins Craig Creek just as it turns west, and the western branch flows north to join the creek approximately 0.2 miles upstream of the mouth. The drainage area within the Craig Creek WBID boundary is approximately 1 square mile (mi^2) and is highly urbanized. Additional information about the hydrology and geology of this area is available in the Basin Status Report for the Lower St. Johns (Department, 2002).

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 Craig Creek Watershed (WBID 2297) in the Lower St. Johns Basin and Major Geopolitical and Hydrologic Features in the Area

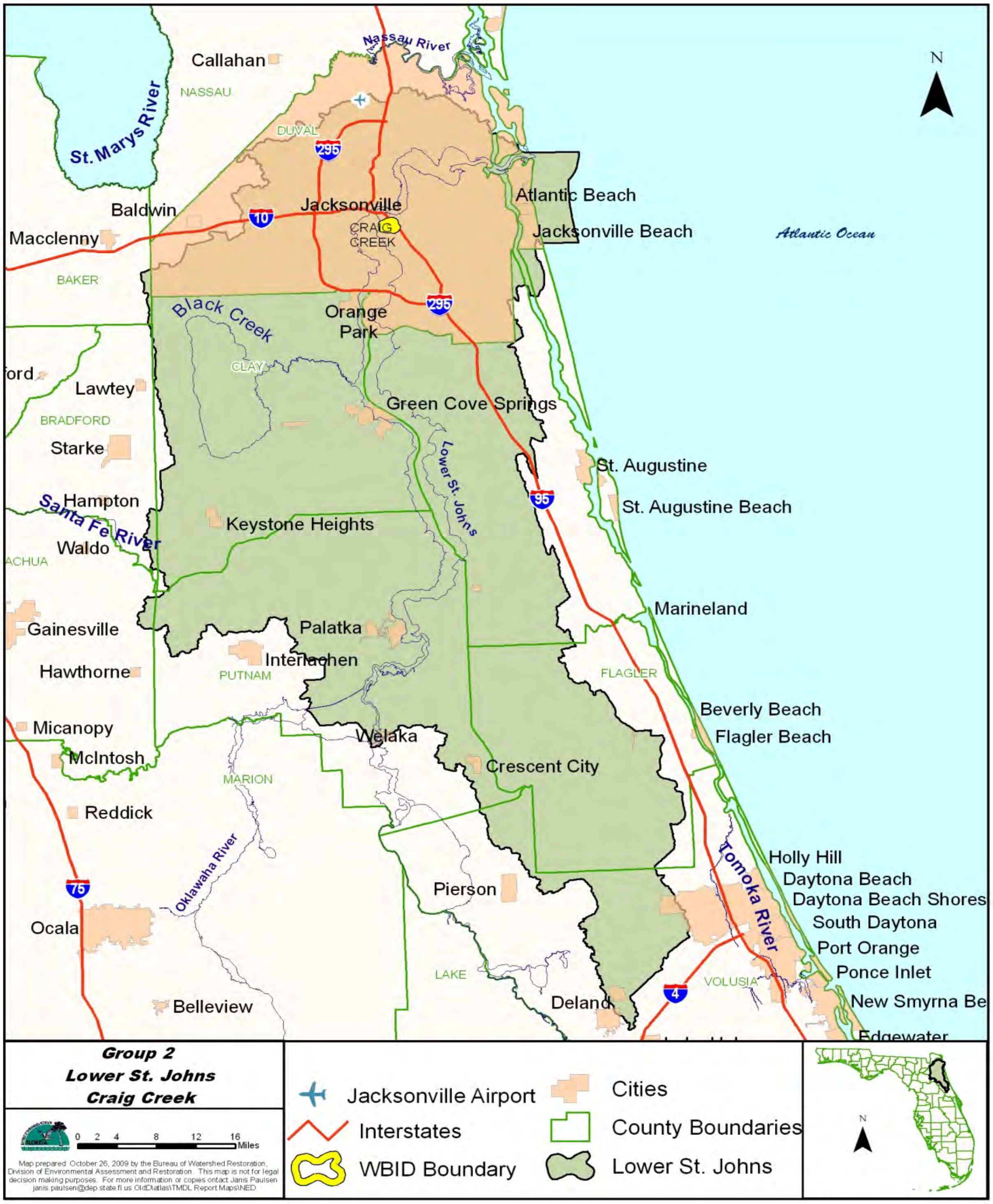
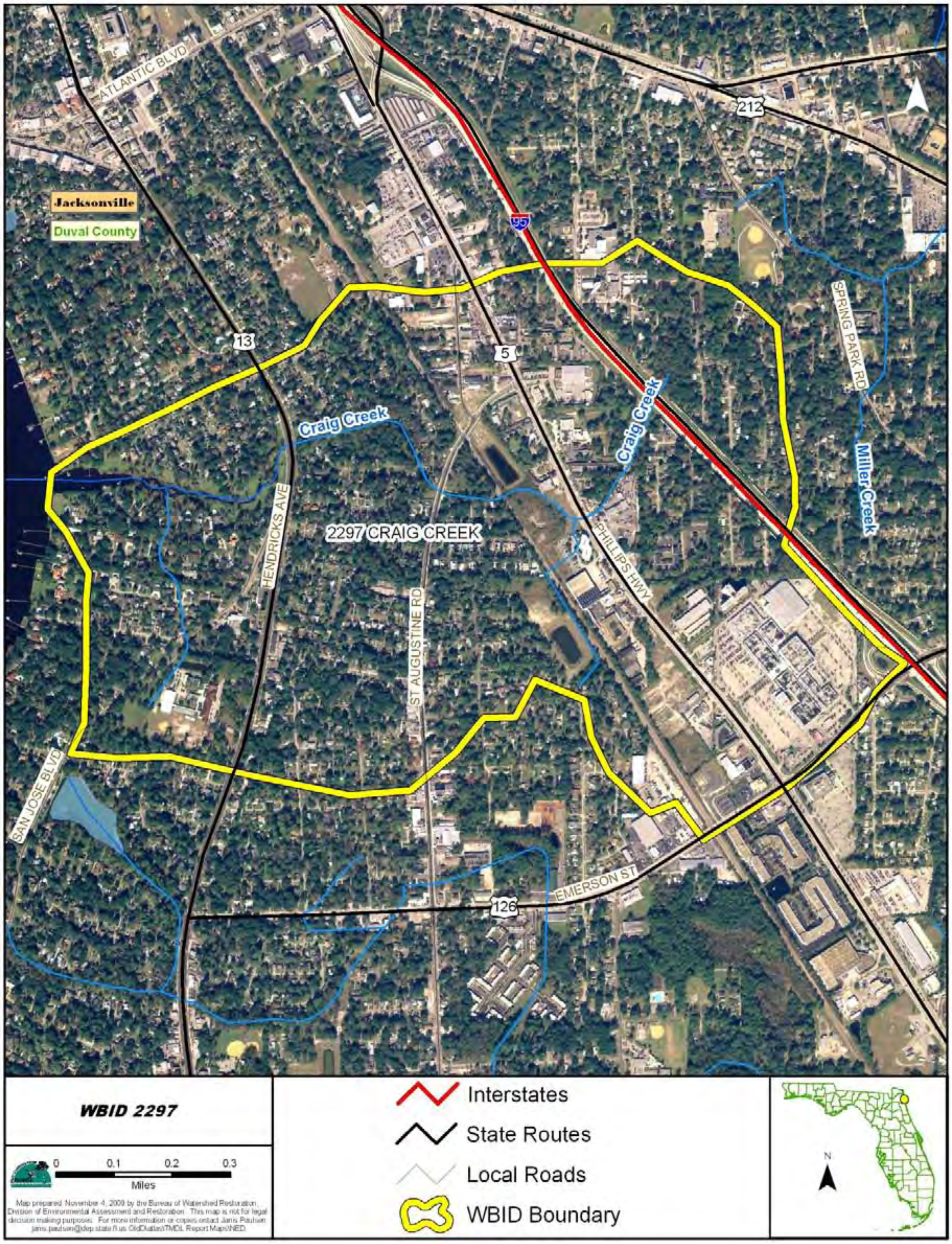


Figure 1.2. Detailed View of the Craig Creek Watershed (WBID 2297) in Duval County



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. For Craig Creek, Basin Management Action Plan (BMAP) efforts are under way. These activities depend heavily on the active participation of the local governments, businesses, citizens, and other stakeholders. The Department is currently working with these organizations and individuals to undertake or continue reductions of fecal coliform 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. In April 2001, after a long rulemaking process, the Environmental Regulation Commission adopted a formal methodology for water quality assessment in ambient waters as Rule 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), per the requirement in the FWRA (Section 403.067, F.S). The verified fecal coliform impairment in Craig Creek was based on the assessment procedures defined in this rule.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in Craig Creek and has verified that this waterbody segment is impaired for fecal coliform bacteria. The creek was first verified impaired for fecal coliform in the Department's Cycle 1 assessment (January 1, 1996, through June 30, 2003). The impairment was confirmed based on the result of the Cycle 2 assessment (January 1, 2001, through June 30, 2008). The initial verified impairment was based on the observation that 20 out of 24 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 57 out of 69 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 Craig 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 during the Cycle 2 verified period were used in the TMDL development. **Table 2.2** summarizes the fecal coliform monitoring results used to develop the TMDL.

Table 2.2 indicates that on some occasions very high fecal coliform concentrations have been observed in Craig Creek. The mean and median concentrations indicate that, in addition to periodic extreme fecal coliform concentrations, the concentration in the creek is often above the water quality criterion of 400 counts/100mL.

Table 2.1. Summary of Fecal Coliform Monitoring Data for Craig Creek (WBID 2297) During the Cycle 1 Verified Period (January 1, 1996–June 30, 2003) and Cycle 2 Verified Period (January 1, 2001–June 30, 2008)

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

- = Empty cell/no data

Waterbody (WBID)	Parameter	Cycle 1 Fecal Coliform	Cycle 2 Fecal Coliform
Craig Creek (2297)	Total number of samples	24	69
Craig Creek (2297)	IWR-required number of exceedances for the Verified List	5	11
Craig Creek (2297)	Number of observed exceedances	20	57
Craig Creek (2297)	Number of observed nonexceedances	4	12
-	**FINAL ASSESSMENT**	**Impaired**	**Impaired**

Table 2.2. Summary of Fecal Coliform Monitoring Data for Craig Creek (WBID 2297) During the Cycle 2 Verified Period (January 1, 2001–June 30, 2008)

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 2 results.

Waterbody (WBID)	Parameter	Fecal Coliform
Craig Creek (2297)	Total number of samples	69
Craig Creek (2297)	Number of observed exceedances	57
Craig Creek (2297)	Number of observed nonexceedances	12
Craig Creek (2297)	Number of seasons during which samples were collected	4
Craig Creek (2297)	Highest observation (counts/100mL)	96,000
Craig Creek (2297)	Lowest observation (counts/100mL)	20
Craig Creek (2297)	Median observation (counts/100mL)	2,233
Craig Creek (2297)	Mean observation (counts/100mL)	6,757

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)**

Craig Creek is a Class III (fresh) waterbody, with a designated use of recreation, propagation, and the 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) waterbodies, 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 percent 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 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, including 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 Craig Creek WBID Boundary

4.2.1 Point Sources

Wastewater Point Sources

There are no NPDES-permitted facilites located or that discharge within the Craig Creek WBID boundary.

Municipal Separate Storm Sewer System Permittees

A Phase I NPDES municipal separate storm sewer system (MS4) permits cover Craig Creek. The City of Jacksonville and Florida Department of Transportation (FDOT) District 2 are copermittees for Permit Number FLS000012.

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 they create high fecal coliform loadings, and specifying the relative contributions from these sources. Depending on the land use distribution in a given watershed, nonpoint sources in urban areas often include failed septic tanks, leaking sewer lines, and pet feces. For a watershed dominated by agricultural land uses, fecal coliform loadings can come from runoff from areas with animal feeding operations or direct animal access to receiving waters.

In addition to these anthropogenic sources, birds and other wildlife can 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 in the Craig Creek Watershed

The spatial distribution and acreage of different land use categories were identified using the St. Johns River Water Management District's (SJRWMD) 2004 land use coverage contained in the Department's geographic information system (GIS) library. Land use categories within the Craig 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 Craig Creek WBID boundary is about 641 acres. The dominant land use category is urban land (urban and built-up; low-, medium-, and high-density residential; and transportation, communication, and utilities), which accounts for about 98 percent of the total WBID area. Of the 626 acres of urban lands, residential land use occupies about 356 acres, or about 56 percent of the total WBID area. Natural land uses, which include water, wetlands, upland forest, and barren land, occupy about 15 acres, accounting for about 2 percent of the total WBID area.

Because the dominant land use within the Craig Creek WBID boundary is urban, the most likely sources of the fecal coliform loadings to the creek are failed septic tanks, sewer line leakage, and pet feces. The preliminary quantification of the fecal coliform loadings from these sources was conducted to demonstrate the relative contributions of each source. **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. The loading estimates were not used in establishing the final TMDL.

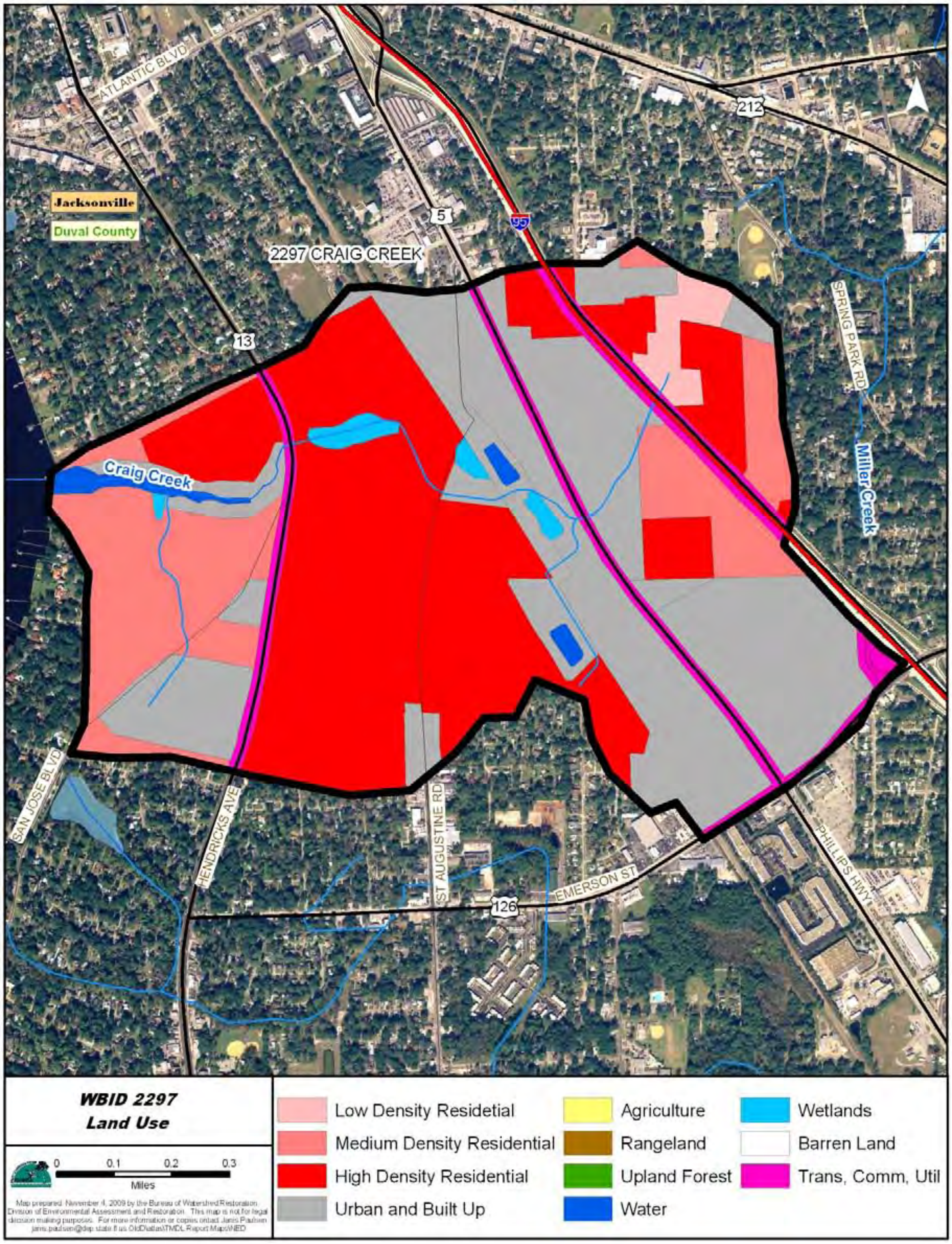
Table 4.1. Classification of Land Use Categories within the Craig Creek WBID Boundary in 2004

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	228	35.6%
-	Low-density residential	12	1.9%
-	Medium-density residential	105	16.4%
-	High-density residential	239	37.3%
2000	Agriculture	0	0.0%
3000	Rangeland	0	0.0%
4000	Upland forest	0	0.0%
5000	Water	8	1.2%
6000	Wetland	7	1.1%
7000	Barren land	0	0.0%
8000	Transportation, communication, and utilities	42	6.6%
-	**TOTAL**	**641**	**100.1%**

Figure 4.1. Principal Land Uses within the Craig Creek WBID Boundary in 2004



Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

When continuous flow measurements in a watershed are available and are not tidally influenced, 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 daily bacteria load. However, flow data were not available for Craig Creek, and so the fecal coliform TMDL was developed using the "percent reduction" approach. Using this method, the percent reduction needed to meet the applicable criterion is calculated for each value above the criterion, and then a median percent reduction is calculated.

5.1.1 Data Used in the Determination of the TMDL

All data used for this TMDL report were provided by the Department's Northeast District office and the City of Jacksonville. The data were included in Run_37 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. During this period, a total of 69 fecal coliform samples were collected from three sampling stations in WBID 2297.

Figure 5.2 shows the fecal coliform concentrations observed in Craig Creek. These ranged from 20 to 96,000 counts/100mL and averaged 6,757 counts/100mL during the Cycle 2 verified period. The data from sampling station 21FLJXWQSS63 (January 29, 2001, to November 29, 2007) (**Figure 5.3**) were used to obtain long-term annual and seasonal fecal coliform averages and percent exceedances (**Table 5.1**). No long-term temporal trends were observed. Episodic peak fecal coliform concentrations occurred throughout the period of observation, and the average concentration in the creek neither increased nor decreased over the period of observation. Seasonally, it is not uncommon to observe a peak in fecal coliform concentrations and exceedance rates during the third quarter (summer, July–September), when conditions are rainy and warm, and lower concentrations and exceedance rates in the first and fourth quarters (winter, January–March; and fall, October–December), when conditions are drier and colder. While the highest percent exceedances, mean concentration, and median concentration did occur during the third quarter, fecal coliform concentrations and exceedance rates were very high during each quarter.

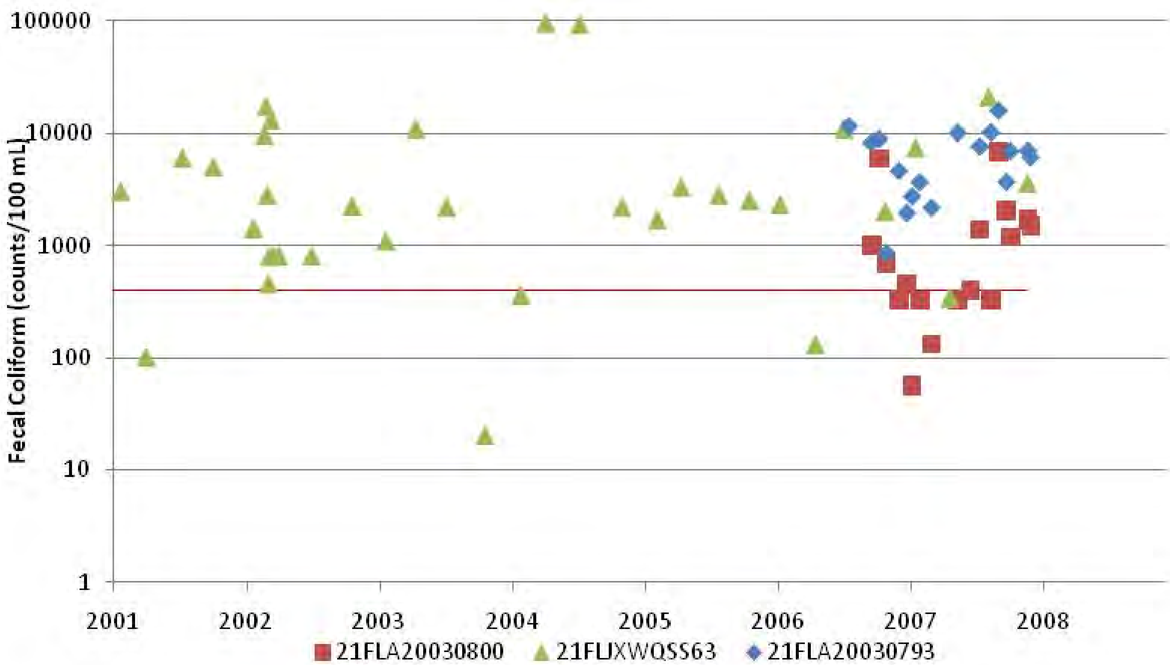
Using rainfall data collected at Jacksonville International Airport (available: http://climod.meas.ncsu.edu/), it was possible to compare annual total rainfall between 2001 and 2007 with annual fecal coliform exceedance rates for the same period, and long-term (2001–07) average quarterly total rainfall with long-term (2001–07) average quarterly fecal coliform exceedance rates at Station 21FLJXWQSS63 (**Figures 5.4** and **5.5**). Again, while peak fecal coliform concentrations commonly coincide with or follow periods of increased rainfall, a clear relationship between rainfall and percent exceedances was not observed in Craig Creek.

The Craig Creek fecal coliform data were also analyzed to detect spatial trends. Fecal coliform data from September 2006 through December 2007 at Stations 21FLA20030800 (upstream) and 21FLJXWQSS63/21FLA20030793 (downstream) were analyzed (**Figure 5.6**). Data from downstream stations 21FLJXWQSS63 and 21FLA20030793 were combined because these were at the same location on Hendricks Avenue.

While high fecal coliform concentrations were observed throughout the creek, concentrations were lower at the upstream station compared with the downstream station (**Table 5.2**). At upstream station 21FLA20030800, roughly 14 percent of the data were greater than or equal to 5,000 counts/100mL, compared with 45 percent at downstream stations 21FLJXWQSS63/ 21FLA20030793. Lower fecal coliform concentrations in the upstream portions of the creek may indicate lower loadings to the upstream portions compared with loadings to the downstream portions of Craig Creek.

Figure 5.1. Location of Water Quality Stations in Craig Creek (WBID 2297)

Figure 5.2. Fecal Coliform Concentrations in Craig Creek (WBID 2297) during the Cycle 2 Verified Period



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

Figure 5.3. Fecal Coliform Concentrations at Station 21FLJXWQSS63 in Craig Creek (WBID 2297) during the Cycle 2 Verified Period

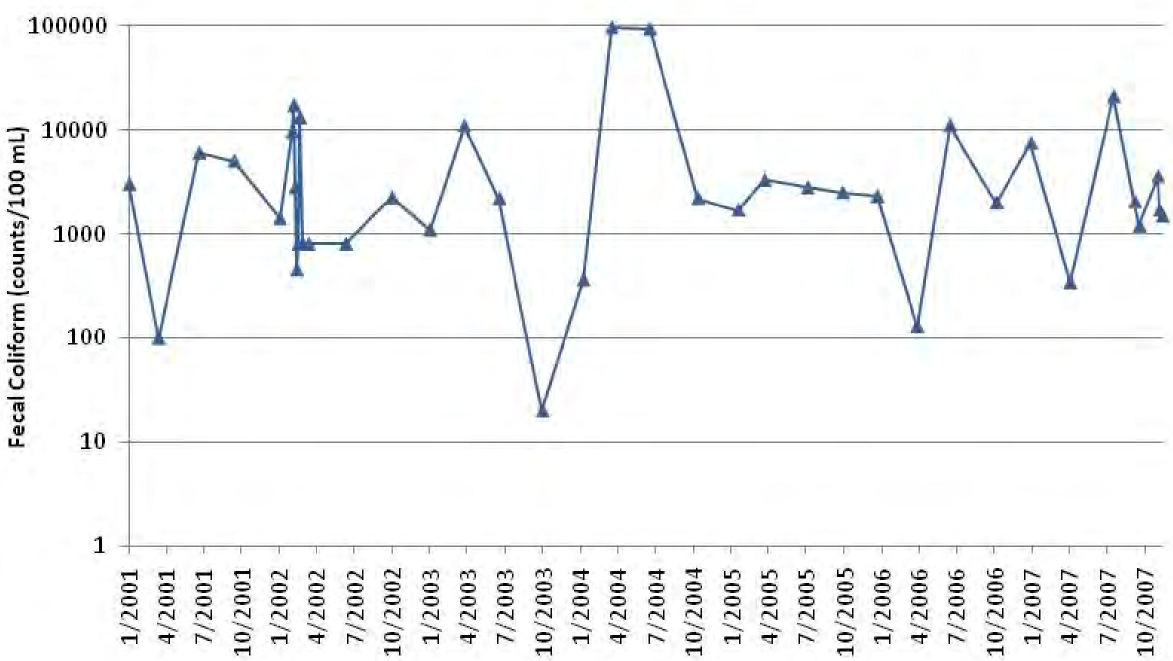


Table 5.1a. Summary Statistics of Fecal Coliform Data at Station 21FLJXWQSS63 in Craig Creek (WBID 2297) by Year during the Cycle 2 Verified Period

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.

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

Year	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
2001	4	100	6,000	4,000	3,525	3	75%
2002	11	452	17,200	1,410	4,545	11	100%
2003	4	20	11,000	1,645	3,578	3	75%
2004	4	360	96,000	47,600	47,890	3	75%
2005	4	1,700	3,300	2,650	2,575	4	100%
2006	4	130	11,000	2,150	3,858	3	75%
2007	4	340	21,000	5,525	8,098	3	75%

Table 5.1b. Summary Statistics of Fecal Coliform Data at Station 21FLJXWQSS63 in Craig Creek (WBID 2297) by Season during the Cycle 2 Verified Period

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	14	360	17,200	2,000	4,433	13	93%
Quarter 2	7	100	96,000	801	15,953	4	57%
Quarter 3	7	801	93,000	6,000	19,543	7	100%
Quarter 4	7	20	5,000	2,233	2,508	6	86%

Figure 5.4. Fecal Coliform Exceedances and Rainfall at Station 21FLJXWQSS63 in Craig Creek (WBID 2297) by Year during the Cycle 2 Verified Period

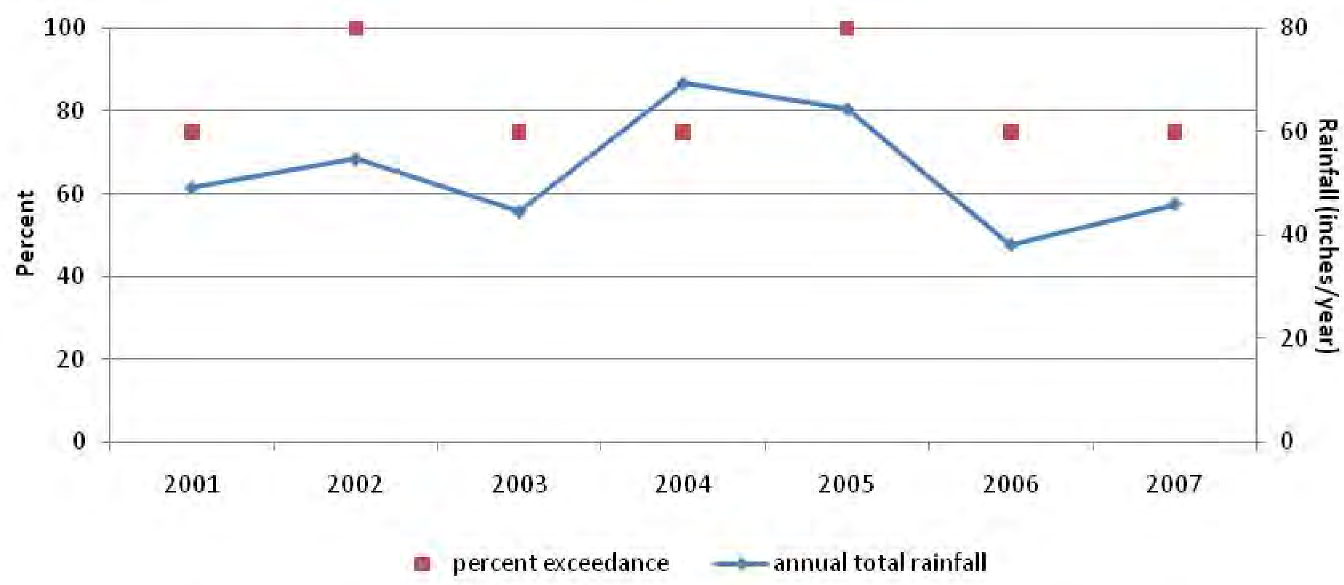


Figure 5.5. Fecal Coliform Exceedances and Rainfall at Station 21FLJXWQSS63 in Craig Creek (WBID 2297) by Season during the Cycle 2 Verified Period

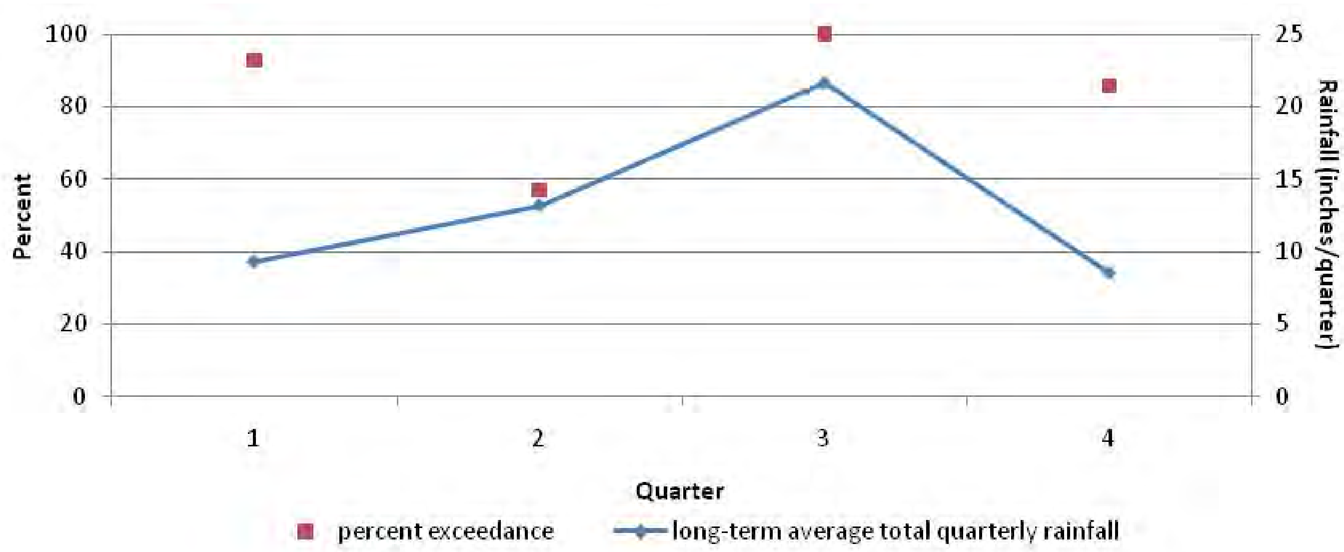


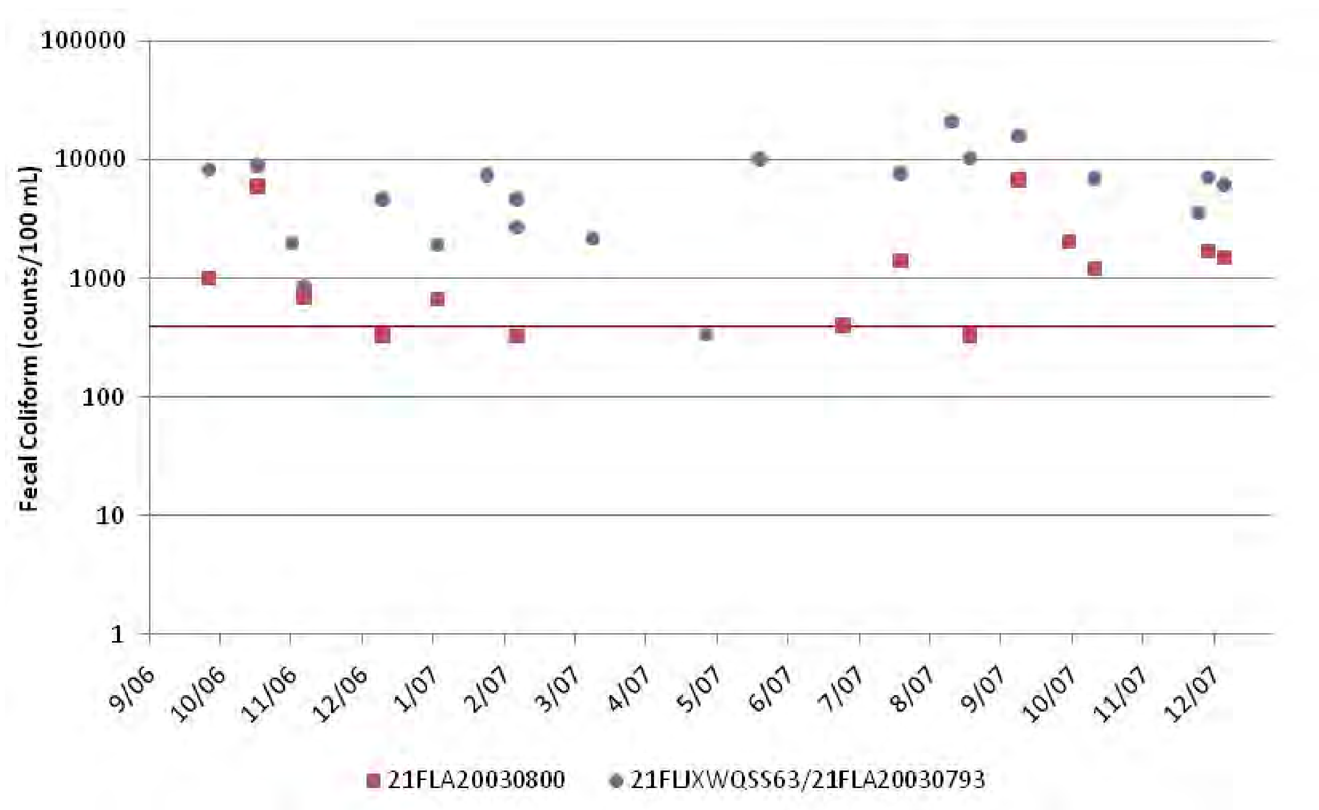
Table 5.2. Station Summary Statistics of Fecal Coliform Data for Craig Creek (WBID 2297), September 2006–December 2007

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	Maximum[1]	Mean[1]	Median[1]	Number of Exceedances[2]	% Exceedances
21FLA20030800	9/06-12/07	14	6,800	1,742	1,100	10	71%
21FLJXWQSS63/ 21FLA20030793	9/06-12/07	20	21,000	6,665	6,600	19	95%

Figure 5.6. Spatial Fecal Coliform Concentration Trends in Craig Creek (WBID 2297), September 2006–December 2007



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

5.1.2 TMDL Development Process

Due to the lack of supporting information, mainly flow data, a simple reduction calculation was performed to determine the needed reduction. Exceedances of the state criterion were compared with that criterion. For each individual exceedance, an individual required reduction was calculated using the following:

$$\textbf{Load reduction} = \frac{\textbf{Existing loading} - \textbf{Allowable loading}}{\textbf{Existing loading}} \times \textbf{100\%}$$

After the individual results were calculated, the median of the individual values was calculated. **Table 5.3** shows the individual reduction calculations for fecal coliform. The median reduction was 87 percent.

Table 5.3. Calculation of Fecal Coliform Reductions for the Craig Creek (WBID 2297) TMDL

This is a five-column table. Column 1 lists the date, Column 2 lists the sampling station, Column 3 lists the fecal coliform exceedance concentration (counts/100mL), Column 4 lists the target concentration (counts/100mL), and Column 5 lists the percent reduction.

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Date	Sampling Station	Fecal Coliform Exceedance Concentration (counts/100mL)	Fecal Coliform Target (counts/100mL)	% Reduction
1/29/2001	21FLJXWQSS63	3,000	400	86.67%
7/17/2001	21FLJXWQSS63	6,000	400	93.33%
10/10/2001	21FLJXWQSS63	5,000	400	92.00%
1/29/2002	21FLJXWQSS63	1,410	400	71.63%
2/28/2002	21FLJXWQSS63	9,600	400	95.83%
3/4/2002	21FLJXWQSS63	17,200	400	97.67%
3/7/2002	21FLJXWQSS63	2,800	400	85.71%
3/11/2002	21FLJXWQSS63	452	400	11.50%
3/14/2002	21FLJXWQSS63	800	400	50.00%
3/18/2002	21FLJXWQSS63	13,100	400	96.95%
3/25/2002	21FLJXWQSS63	800	400	50.00%
4/8/2002	21FLJXWQSS63	801	400	50.06%
7/8/2002	21FLJXWQSS63	801	400	50.06%
10/28/2002	21FLJXWQSS63	2,233	400	82.09%
1/28/2003	21FLJXWQSS63	1,090	400	63.30%
4/21/2003	21FLJXWQSS63	11,000	400	96.36%
7/15/2003	21FLJXWQSS63	2,200	400	81.82%
4/13/2004	21FLJXWQSS63	96,000	400	99.58%
7/14/2004	21FLJXWQSS63	93,000	400	99.57v
11/8/2004	21FLJXWQSS63	2,200	400	81.82%

Date	Sampling Station	Fecal Coliform Exceedance Concentration (counts/100mL)	Fecal Coliform Target (counts/100mL)	% Reduction
2/14/2005	21FLJXWQSS63	1,700	400	76.47%
4/19/2005	21FLJXWQSS63	3,300	400	87.88%
8/1/2005	21FLJXWQSS63	2,800	400	85.71%
10/25/2005	21FLJXWQSS63	2,500	400	84.00%
1/17/2006	21FLJXWQSS63	2,300	400	82.61%
7/12/2006	21FLJXWQSS63	11,000	400	96.36%
7/27/2006	21FLA 20030793	11,660	400	96.57%
9/27/2006	21FLA 20030800	1,000	400	60.00%
9/27/2006	21FLA 20030793	8,333	400	95.20%
10/18/2006	21FLA 20030800	6,000	400	93.33%
10/18/2006	21FLA 20030793	9,000	400	95.56%
11/2/2006	21FLJXWQSS63	2,000	400	80.00%
11/7/2006	21FLA 20030800	700	400	42.86%
11/7/2006	21FLA 20030793	867	400	53.86%
12/11/2006	21FLA 20030793	4,667	400	91.43%
1/2/2007	21FLA 20030800	448	400	10.71%
1/2/2007	21FLA 20030793	1,971	400	79.71%
1/17/2007	21FLA 20030793	2,771	400	85.56%
1/25/2007	21FLJXWQSS63	7,450	400	94.63%
2/7/2007	21FLA 20030793	3,700	400	89.19%
3/12/2007	21FLA 20030793	2,200	400	81.82%
5/23/2007	21FLA 20030793	10,200	400	96.08%
7/23/2007	21FLA 20030800	1,400	400	71.43%
7/23/2007	21FLA 20030793	7,700	400	94.81%
8/14/2007	21FLJXWQSS63	21,000	400	98.10%
8/22/2007	21FLA 20030793	10,333	400	96.13%
9/12/2007	21FLA 20030800	6,800	400	94.12%
9/12/2007	21FLA 20030793	16,000	400	97.50%
10/4/2007	21FLA 20030800	2,040	400	80.39%
10/4/2007	21FLA 20030793	3,731	400	89.28%
10/15/2007	21FLA 20030800	1,200	400	66.67%
10/15/2007	21FLA 20030793	7,000	400	94.29%
11/29/2007	21FLJXWQSS63	3,600	400	88.89%
12/3/2007	21FLA 20030800	1,700	400	76.47%
12/3/2007	21FLA 20030793	7,100	400	94.37%
12/10/2007	21FLA 20030800	1,500	400	73.33%
12/10/2007	21FLA 20030793	6,200	400	93.55%
-	-	-	**Median % Reduction**	**86.67%**

5.1.3 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. A loading curve–type chart that would normally be applied to flow events was created using precipitation data from Jacksonville International Airport instead. 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 5.4** and **Figure 5.7**).

Historical data show that fecal coliform exceedances occurred over all hydrologic conditions, except for large precipitation events for which no samples were collected. The exceedance rate was 100% for extreme precipitation events, but few samples were collected under this condition. However, very high exceedance rates (higher than 80%) also occurred after all other precipitation events: medium, small, and not measurable. The very high exceedance rates and concentrations following all precipitation events, as well as the lack of point source dischargers within the Craig Creek WBID boundary other than permitted stormwater point sources (i.e., MS4 systems), indicate that various nonpoint sources likely contribute fecal coliform pollution to Craig Creek in runoff after precipitation events and in baseflow during dry periods with little rainfall. Baseflow contributes to creek flow during dry conditions and can be impacted by failed septic tanks and leaking sewer infrastructure. **Table 5.4** and **Figure 5.7** show fecal coliform data by hydrologic condition.

As fecal coliform exceedances occurred following all categories of precipitation events, except for large precipitation events when no samples were collected, the target fecal coliform reduction calculated in the previous section and shown in **Table 5.3** is applicable under all rainfall conditions in Craig Creek.

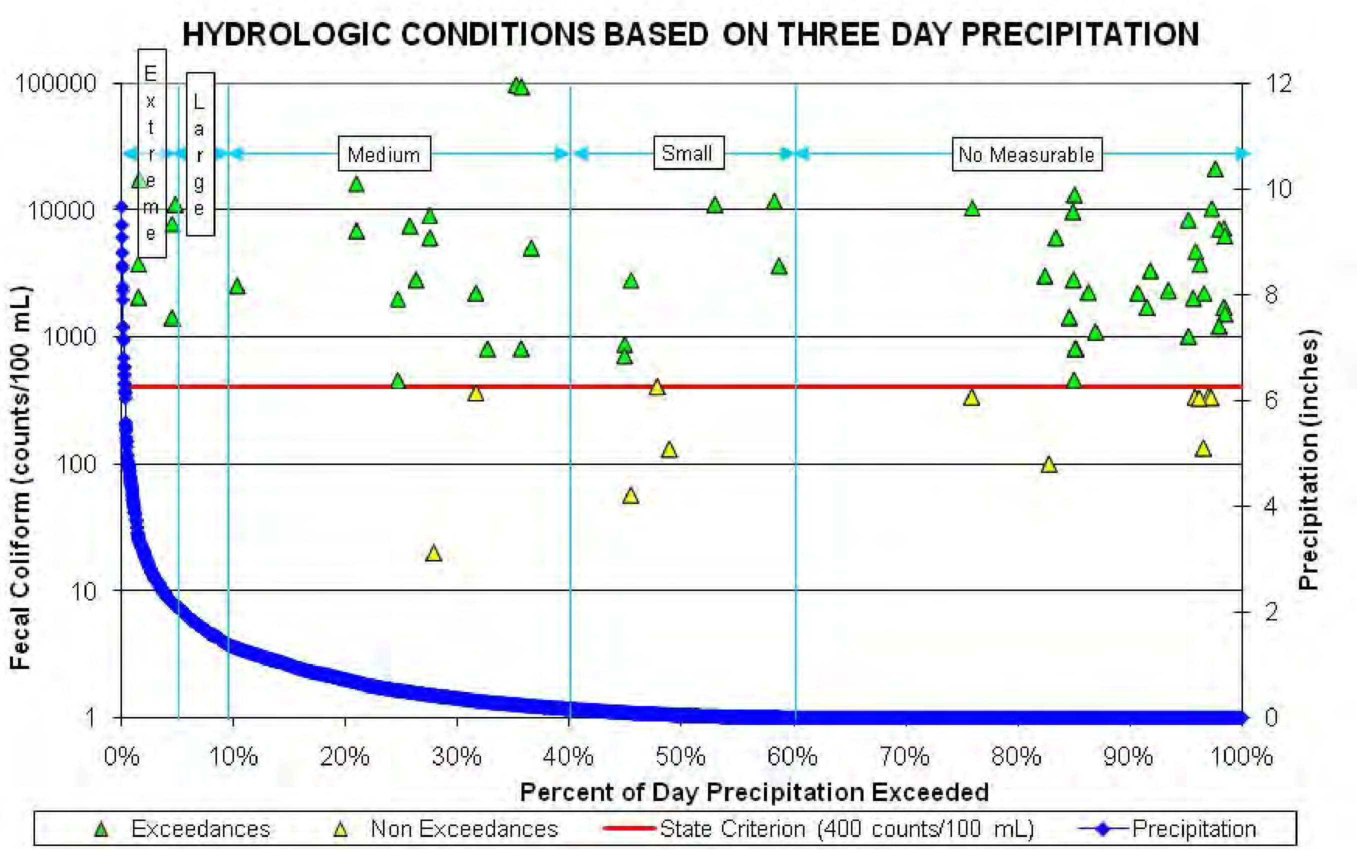
Table 5.4. Summary of Historical Fecal Coliform Data by Hydrologic Condition

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.

N/A = Not applicable

Precipitation Event	Event Range (inches)	Total Samples	Number of Exceedances	% Exceedances	Number of Non-exceedances	% Non-exceedances
Extreme	>2.1"	6	6	100.00%	0	0.00%
Large	1.33" - 2.1"	0	0	N/A	0	N/A
Medium	0.18" - 1.33"	17	15	88.24%	2	11.76%
Small	0.01" - 0.18"	9	6	66.67%	3	33.33%
None/ Not Measurable	<0.01"	37	30	81.08%	7	18.92%

Figure 5.7. Historical Fecal Coliform Data by Hydrologic Condition



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:

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

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

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

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (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 Craig 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 Craig Creek (WBID 2297)

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	87%	87%	Implicit

6.2 Load Allocation

Based on a percent reduction approach, the load allocation is an 87 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 permitted to discharge within the Craig 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

The WLA for stormwater discharges with an MS4 permit is an 87 percent reduction in current fecal coliform loading for WBID 2297. It should be noted that any 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 allowing any exceedances of the state criterion, even though intermittent natural exceedances of the criterion would be expected and would be taken into account when determining impairment. Additionally, the TMDL calculated for fecal coliform was based on meeting the water quality criterion of 400 counts/100mL without any exceedances, while the actual criterion allows for 10 percent exceedances over the fecal coliform criterion.

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 the Hillsborough Basin, 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 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/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 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.

Additional information about the potential fecal coliform sources in this area is available in the technical report for the Craig Creek watershed (PBS&J, 2008).

Pets

Pets (especially dogs) could be a significant source of coliform pollution through surface runoff within the Craig 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 23 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 Craig 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 Duval County Property Appraiser's Office website (available: http://www.coj.net/Departments/Property+Appraiser/default.htm) and data obtained from the Florida Department of Health (FDOH), the number of households in residential land use areas within the Craig Creek WBID boundary was estimated to be 1,454. The next section describes the data provided by FDOH. Property data from the Duval County Property Appraiser's Office were used to determine the number of households in apartment complexes, mobile home parks, duplexes, and other multiple household residential sites within the WBID boundary. Assuming that 40 percent of the households in this area have 1 dog, there are about 582 dogs in the WBID.

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). 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 is approximately 104,700 grams/day. The total produced by dogs is about 2.3×10^{11} 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. Dog Population Density, Wasteload, and Fecal Coliform Density (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, in 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.

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 Craig 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 inventorying the use of onsite treatment and disposal systems (i.e., septic tanks) by determining the methods of wastewater disposal for developed property sites statewide, 123 housing units *(N)* within the Craig Creek WBID boundary are known or believed 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 Craig Creek WBID boundary, 25 properties are known to use septic tanks and 90 are estimated to use septic systems. Because the probability that these 90 estimated septic tank properties are in fact served by septic tanks ranges from 56 to 98 percent, all 115 properties were assumed to be served by septic tanks for the purposes of this report.

Information from the Duval County Property Appraiser's Office was used to determine that some of the properties with septic systems within the Craig Creek WBID boundary contained duplexes, townhouses, or multiple homes, and therefore had multiple households. Information obtained from the Property Appraiser's website indicated that 3 of the residential properties served by septic systems contained a total of 11 units. The number of households served by septic systems within the WBID boundary was estimated to be 123 (115 – 3 + 11). 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 Duval County is about 2.51 people/household. The same population densities were assumed within the Craig 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/100 mL 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 Duval County based on FDOH's septic tank inventory and the number of septic tank repair permits issued in Duval County, as published by FDOH (available: http://www.doh.state.fl.us/environment/OSTDS/statistics/ostdsstatistics.htm). The cumulative number of septic tanks in Duval 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, and assuming that none of the installed septic tanks will be removed after being installed (**Table B.2**). 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 the table.

Based on **Table B.2**, the average annual septic tank failure discovery rate is about 0.47 percent for Duval 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 2.4 percent. Based on **Equation B.1**, the estimated fecal coliform loading from failed septic tanks within the Craig Creek WBID boundary is about 2.0×10^{10} counts/day.

Figure B.1. Distribution of Properties Served by Septic Tanks and Sewer Systems in the Residential Land Use Areas within the Craig Creek WBID Boundary

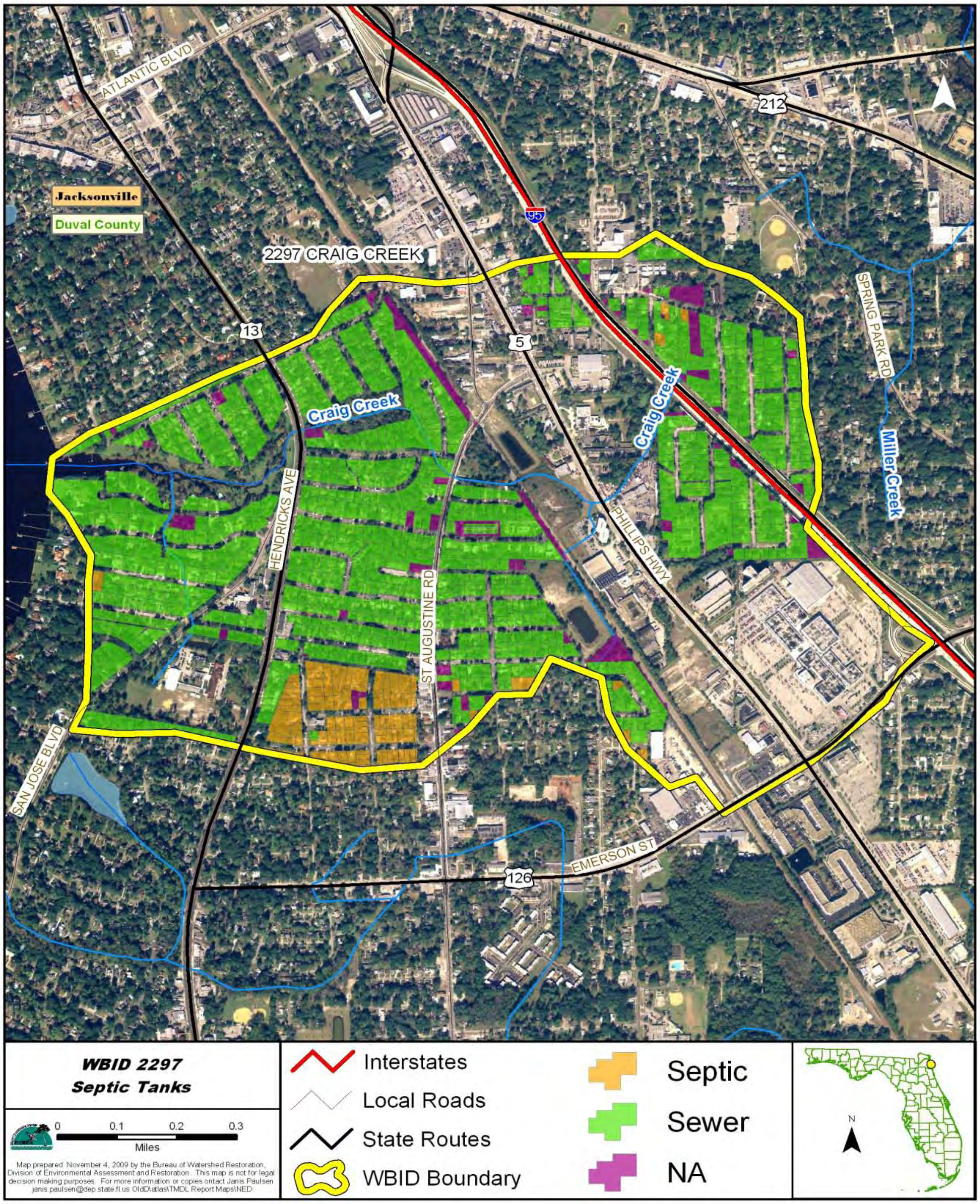

Table B.2. Estimated Number of Septic Tank and Septic Tank Failure Rate for Duval County, 2001–08

This is a 10-column table. Column 1 lists the parameter, Columns 2 through 9 list the estimate for each year from 2001 to 2008, respectively, and Column 10 lists the average.

- = Empty cell/no data
* Failure rate is 5 times the failure discovery rate.

Parameter	2001	2002	2003	2004	2005	2006	2007	2008	Average
Number of new septic tank installations	381	359	459	373	487	598	576	-	462
Cumulative total number of septic tanks	64,885	65,266	65,625	66,084	66,457	66,944	67,542	68,118	-
Number of septic tank repair permits issued	344	369	369	324	226	249	269	-	307
Failure discovery rate (%)	0.53%	0.57%	0.56%	0.49%	0.34%	0.37%	0.40%	-	0.47%
Failure rate (%)*	2.7%	2.9%	2.8%	2.5%	1.7%	1.9%	2.0%	-	2.4%

Sanitary Sewer Overflows

Sanitary sewer overflows (SSOs) can also be a potential source of fecal bacteria pollution. Human sewage can be introduced into surface waters even when storm and sanitary sewers are separated. Leaks and overflows are common in many older sanitary sewers where capacity is exceeded, high rates of infiltration and inflow occur (i.e., outside water gets into pipes, reducing capacity), frequent blockages occur, or sewers are simply falling apart due to poor joints or pipe materials. Power failures at pumping stations are also a common cause of SSOs. The greatest risk of an SSO occurs during storm events; however, few comprehensive data are available to quantify SSO frequency and bacteria loads in most watersheds.

The number of properties connected to the sewer system was also based on data obtained from FDOH's ongoing inventory of wastewater treatment and disposal method for developed properties. As for septic tanks, if there was not enough information to determine with certainty whether a property was sewered, the probability that the property was served by a septic tank was determined. If that probability was low (less than 50 percent), the property was estimated to be served by a sewer system.

Within the Craig Creek WBID boundary, 837 properties are known to be served by sewer systems, and 217 are estimated to be served by sewer systems. The probability that these 217 properties are in fact served by septic tanks is 49 percent or less for each of these properties. Thus all 1,054 properties were assumed to be served by sewer systems for the purposes of this report.

Information from the Duval County Property Appraiser's Office was used to determine that some of the properties connected to the sewer system within the Craig Creek WBID boundary were apartment complexes or properties with multiple houses, and therefore had multiple households. Information obtained from the Property Appraiser's website indicated that 10 of the sewered residential properties contained a total of 287 units. The number of households connected to the sewer system within the WBID boundary was estimated to be 1,331 (1,054 –

10 + 287). Fecal coliform loading from sewer line leakage can be calculated based on the number of people in the watershed, typical per household generation rates, and typical fecal coliform concentrations in domestic sewage, assuming a leakage rate of 0.5 percent (Culver et al., 2002). Based on this assumption, a rough estimate of fecal coliform loads from leaks and SSOs within the Craig Creek WBID boundary can be made using **Equation B.2**.

$$L = 37.85 * N * Q * C * F \qquad \textbf{Equation B.2}$$

Where:

L is the fecal coliform daily load (counts/day);
N is the number of households using sanitary sewer in the WBID;
Q is the discharge rate for each household (gallons/day);
C is the fecal coliform concentration for domestic wastewater (counts/100mL);
F is the sewer line leakage rate; and
37.85 is a conversion factor (100 mL/gallon).

The number of households *(N)* within the Craig Creek WBID boundary that are served by sewer systems is 1,331. The discharge rate through sewers from each household (*Q*) was calculated by multiplying the average household size (2.51) by the per capita wastewater production rate per day (70 gallons/day/person). The commonly cited concentration (*C*) for domestic wastewater is 1×10^6 counts/100mL for fecal coliform (EPA, 2001). The contribution of fecal coliform through sewer line leakage was assumed to be 0.5 percent of the total sewage loading created from the population not on septic tanks (Culver et al., 2002). Based on **Equation B.2**, the estimated fecal coliform loading from sewer line leakage in the WBID is about 4.4×10^{10} counts/day.

Wildlife

Wildlife is another possible source of fecal coliform bacteria. Upland forested areas, wetlands, rangeland, and some agricultural areas serve as habitat for wildlife. As shown in **Figure 4.1**, the small amount of wetlands within the Craig Creek WBID boundary does border or is close to the creek. These areas likely serve as habitat for wildlife that has the potential to contribute fecal coliform to the creek.

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