FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration

SOUTHWEST DISTRICT • SPRINGS COAST BASIN -
ANCLOTE RIVER/COASTAL PINELLAS COUNTY PLANNING UNIT

FINAL TMDL Report

Fecal Coliform TMDLs for Cedar Creek (Tidal) (WBID 1556) and Cedar Creek (WBID 1556A)

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September 2012

Acknowledgments

This Total Maximum Daily Load (TMDL) analysis could not have been accomplished without significant contributions from staff in the Pinellas County Department of Environment and Infrastructure, the City of Dunedin, FDEP's Watershed Assessment Section, and Watershed Evaluation and TMDL Section. Map production assistance was provided by the Watershed Data Services Section with the FDEP's Division of Environmental Assessment and Restoration.

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TMDL Program

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http://www.dep.state.fl.us/legal/Rules/shared/62-303/62-303.pdf

Florida STORET Program

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

2012 Integrated Report

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

Criteria for Surface Water Quality Classifications

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

Water Quality Status Report: Springs Coast

http://waterwebprod.dep.state.fl.us/basin411/springscoast/status/SpringCst.pdf

Water Quality Assessment Report: Springs Coast

http://waterwebprod.dep.state.fl.us/basin411/springscoast/assessment/G5AS-Springs_Coast-LORES_Merged.pdf

U.S. Environmental Protection Agency

Region 4: TMDLs in Florida

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

National STORET Program

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Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Loads (TMDLs) for fecal coliform bacteria for the tidal and freshwaters segments of Cedar Creek, located in the Springs Coast Basin. These systems were verified as impaired for fecal coliform, and therefore included on the Verified Lists of impaired waters for the Springs Coast Basin that were adopted by Secretarial Order on May 19, 2009 (for the freshwater segment) or February 7, 2012 (for the tidal segment). These TMDLs establish the allowable fecal coliform loading to the Cedar Creek tidal and freshwater segments that would restore the waterbodies so that they meet their 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 Springs Coast Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. Cedar Creek (Tidal) has been identified as WBID 1556, and the freshwater portion of Cedar Creek as WBID 1556A.

Cedar Creek (Tidal) and Cedar Creek are two of 93 waterbody segments in the Springs Coast Basin, Anclote River / Coastal Pinellas County Unit. WBID 1556 is one of 22 waterbody segments in the Springs Coast Basin included on the initial 1998 303(d) list submitted by the Department to the United States Environmental Protection Agency (EPA). The 1998 303(d) list was incorporated into a 1999 Consent Decree between EPA and Earth Justice.

The initial list used data from stations listed in the Department's 1996 305(b) report. The report used best available information at the time to generally characterize the quality of Florida's waters. Some of the delineations of waterbody areas and locations of sampling stations for the 1998 303(d) list were inaccurate due to technical limitations at that time. With the primary goal of providing more accurate assessments, the Department has revised the delineations over time. EPA has labeled the redrawing of WBID boundaries "resegmentation," as the original stations corresponded to specific WBID areas or segments. Resegmented WBIDs are those WBIDs that have been altered from the initial 1998 303(d) Consent Decree or previous cycle boundaries. As a result of the resegmentation process for the Group 4 Basins, there are currently 40 Consent Decree waterbody segments in the Springs Coast Basin, including WBID 1556A. This number is based on the Impaired Waters Rule (IWR, 62-303, F.A.C) Run 44x.

The Cedar Creek watershed is located in the northwest area of Pinellas County and is contained entirely within the City of Dunedin (**Figure 1.1**). In addition to the main channel, the creek has one tributary; both discharge into St. Joseph Sound (**Figure 1.2**), and total approximately 2.1 miles in length. Additional information about the hydrology of this area is available in the *General Hydrology of the Middle Gulf Area, Florida (Report of Investigation No. 56)*, by the US Geological Survey (Cherry et al., 1970).

The areas within the Cedar Creek (Tidal) (WBID 1556) and Cedar Creek (WBID 1556A) WBID boundaries are approximately 0.50 square miles (mi^2) (319 acres) and 1.7 mi^2 (1,074 acres), respectively. These areas are almost completely developed. Major land use types include low and medium density residential, institutional, and commercial lands, with a small portion of recreational/open space.

WBIDs 1556 and 1556A are located in the west-central coastal region of peninsular Florida, in the area identified as the Gulf Coastal Lowlands physiographic region, where soils are poorly drained and the water table is near land surface. Soils in this region are variable, they range from excessively drained sands to moderate or poorly drained soils with a sandy subsoil (USDA, 2006). As a result of extensive changes of the land surface for development, large portions of this area have soils types characterized as Urban Land (SWFWMD, 2002).

Two main aquifers are found in Pinellas County, the surficial aquifer and the Floridan aquifer. The surficial aquifer system consists of undifferentiated sands, shell material, silts and clayey sands of varying thickness (Causseaux, 1985). The principal uses for the surficial aquifer in Pinellas County are irrigation, limited domestic use, and dewatering projects for mining and infrastructure installation (SWFWMD, 2006). The Floridan aquifer system consists primarily of highly permeably carbonate rocks and is separated into two principal zones consisting of the fresh potable water of the Upper Floridan aquifer and the highly mineralized water of the Lower Floridan aquifer (Causseaux, 1985). In Pinellas County, the Upper Floridan aquifer is the principal source of water and is used for industrial, mining, public supply, domestic use, and irrigation purposes, as well as brackish water desalination in coastal communities (SWFWMD, 2006).

An important feature of the area is karst topography. Watersheds located in karst regions are extremely vulnerable to contamination. Many of these karst features infiltrate the water table forming a direct connection between land surface and the underlying aquifer systems, allowing interaction between surface and ground waters (SWFWMD, 2002) increasing the threat of ground water contamination from surface water pollutants (Trommer, 1987). Potential sources of contamination include saltwater encroachment and infiltration of contaminants carried in surface water, direct infiltration of contaminants (chemicals or pesticides applied to or spilled on the land, fertilizer carried in surface runoff), landfills, septic tanks, sewage-plant treatment ponds, and wells used to dispose of stormwater runoff or industrial waste (Miller, 1990).

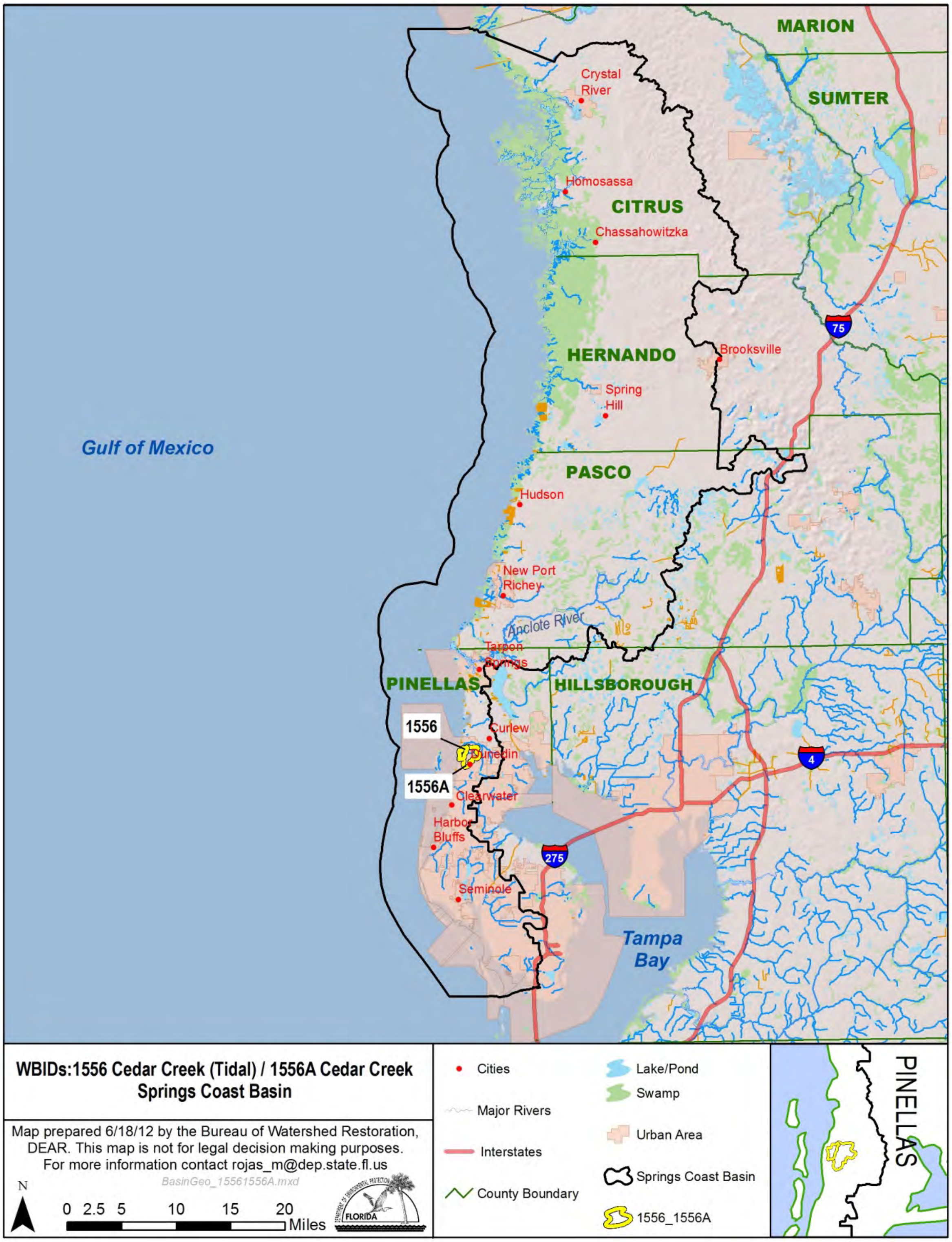

Figure 1.1. Location of the Cedar Creek (Tidal) (WBID 1556) and Cedar Creek (WBID 1556A) WBIDs in the Springs Coast Basin and Major Hydrologic and Geopolitical Features in the Area

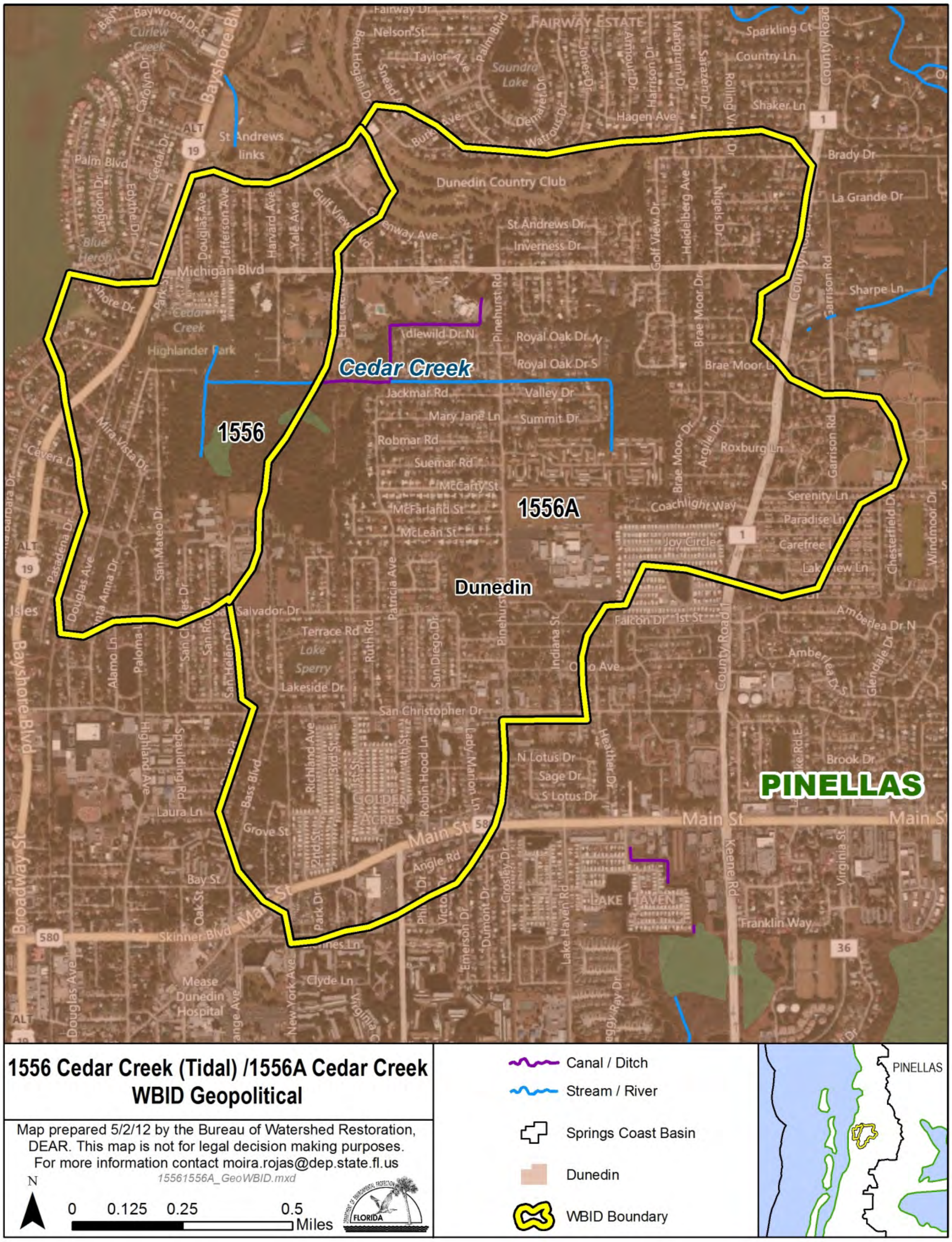

Figure 1.2. Location of the Cedar Creek (Tidal) (WBID 1556) and Cedar Creek (WBID 1556A) WBIDs in Pinellas County

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, Section 403.067, 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.

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 Cedar Creek (Tidal) and Cedar Creek basins. These activities will depend heavily on the active participation of the Southwest Florida Water Management District (SWFWMD), 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 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 22 impaired waterbodies in the Springs Coast Basin on its initial 1998 303(d) list. As a result of the resegmentation process for the Group 4 Basins, there are currently 40 Consent Decree waterbody segments in the Springs Coast Basin (see **Section 1.2**). 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 WBIDs 1556 and 1556A, and has verified that these waterbody segments are impaired for fecal coliform bacteria. Verified impairment was based on the observation that, with a 90 percent confidence level based on binomial distribution, more than 10 percent of values exceeded the assessment threshold of 400 counts per 100 milliliters (counts/100mL) (see **Section 3.2** for details) in these WBIDs.

WBID 1556A was verified as impaired during the Cycle 1 verified period (January 1, 1999 through June 30, 2006) assessment. This impairment was confirmed in the Cycle 2 assessment (January 1, 2004, through June 30, 2011). WBID 1556 was verified as impaired during the Cycle 2 verified period.

Table 2.1 summarizes fecal coliform monitoring results used for verified impairment for the Cycle 1 verified period for WBID 1556A, and **Table 2.2** summarizes fecal coliform results used for verified impairment for the Cycle 2 assessment (based on IWR Run44x data) for both WBID 1556A and 1556. As they better represent the current conditions, results from Run44x for the Cycle 2 verified period were used in the TMDL development process.

Table 2.1. Summary of Fecal Coliform Monitoring Data for Cedar Creek (WBID 1556A) during the Cycle 1 Verified Period (January 1, 1999, through June 30, 2006)

This is a two-column table. Column 1 lists the parameter, and Column 2 lists the Cycle 1 results.

Parameter	Fecal Coliform Cycle 1
Total number of samples	34
IWR-required number of exceedances for the Verified List	7
Number of observed exceedances	16
Number of observed non-exceedances	18
Number of seasons during which samples were collected	4

Table 2.2. Summary of Fecal Coliform Monitoring Data for Cedar Creek (Tidal) (WBID 1556) and Cedar Creek (WBID 1556A) during the Cycle 2 Verified Period (January 1, 2004 through June 30, 2011)

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

Parameter	WBID	
	1556	1556A
Total number of samples	19	34
IWR-required number of exceedances for the Verified List	5	7
Number of observed exceedances	15	25
Number of observed non-exceedances	4	9
Number of seasons during which samples were collected	4	4
Highest observation (counts/100mL)	8,600	8,600
Lowest observation (counts/100mL)	100	80
Median observation (counts/100mL)	920	605
Mean observation (counts/100mL)	2,144	1,258

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)**

Both WBIDs addressed in this report are Class III waterbodies, with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. WBID 1556 is a Class III marine waterbody and WBID 1556A is a Class III freshwater waterbody. The criterion applicable to this TMDL is the Class III (freshwater and marine) 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 (freshwater and marine) 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 this TMDL was not to exceed 400 counts/100mL 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 Cedar Creek (Tidal) and Cedar Creek WBID Boundaries

4.2.1 Point Sources

Wastewater Point Sources

There are no NPDES-permitted wastewater facilities in either the Cedar Creek (Tidal) or Cedar Creek watersheds.

Municipal Separate Storm Sewer System Permittees

One NPDES municipal separate storm sewer systems (MS4) permit covers both WBID 1556 and WBID 1556A, permit FLS000005. Including the City of Dunedin, there are 23 co-permittees included in this permit. **Table 4.1** lists the NPDES MS4 permit, the permit holder and co-permittee covering WBIDs 1556 and 1556A.

Table 4.1. Municipal Separate Storm Sewer System Permits Covering WBIDs 1556 and 1556A

This is a three-column table. Column 1 lists the WBID number, Column 2 lists the permit holder, and Column 3 lists the co-permittee

Permit	Permit Holder	Co-Permittee
FLS000005	Pinellas County	City of Dunedin

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.

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

Land Uses

The spatial distribution and acreage of different land use categories were identified using the SWFWMD's 2009 land use coverage contained in the Department's geographic information system (GIS) library. Land use categories within the Cedar Creek (Tidal) and Cedar Creek WBID boundaries were aggregated using the Florida Land Use Code and Classification System (FLUCCS) expanded Level 1 codes (including low, medium, and high density residential) and tabulated in **Table 4.2**. **Table 4.2** also shows the total area within each WBID. The spatial distribution of the principal land uses within the WBID boundaries is shown in **Figure 4.1.**

Within both WBID boundaries, the dominant land use categories are residential (medium- and high-density), urban built-up, and transportation, which account for approximately 78% and 93% of the total acreage for WBID 1556 and 1556A, respectively. In WBIDs 1556 and 1556A, low impact land use areas, including upland forests, wetlands and water, make up approximately 22% and 7% of the total areas, respectively.

Table 4.2. Classification of Land Use Categories within the Cedar Creek (Tidal) (WBID 1556) and Cedar Creek (WBID 1556A) Boundaries in 2009

This is a six-column table. Column 1 lists the Level 1 land use code, Column 2 lists the land use description, Columns 3-6 list the acreage and the percent acreage land use in each WBID.

Level 1 Code	Land Use	WBID 1556		WBID 1556A	
		Acreage	% Acreage	Acreage	% Acreage
1000	Urban and built-up	50	16%	239	22%
-	Low-density residential	7	2%	0	0%
-	Medium-density residential	6	2%	379	35%
-	High-density residential	182	57%	370	35%
2000	Agriculture	0	0%	0	0%
3000	Rangeland	0	0%	0	0%
4000	Upland forest	24	8%	33	3%
5000	Water	5	2%	13	1%
6000	Wetland	41	13%	25	2%
7000	Barren land	0	0%	0	0%
8000	Transportation, communication, and utilities	4	1%	15	1%
-	**TOTAL**	**319**	**100%**	**1,074**	**100%**

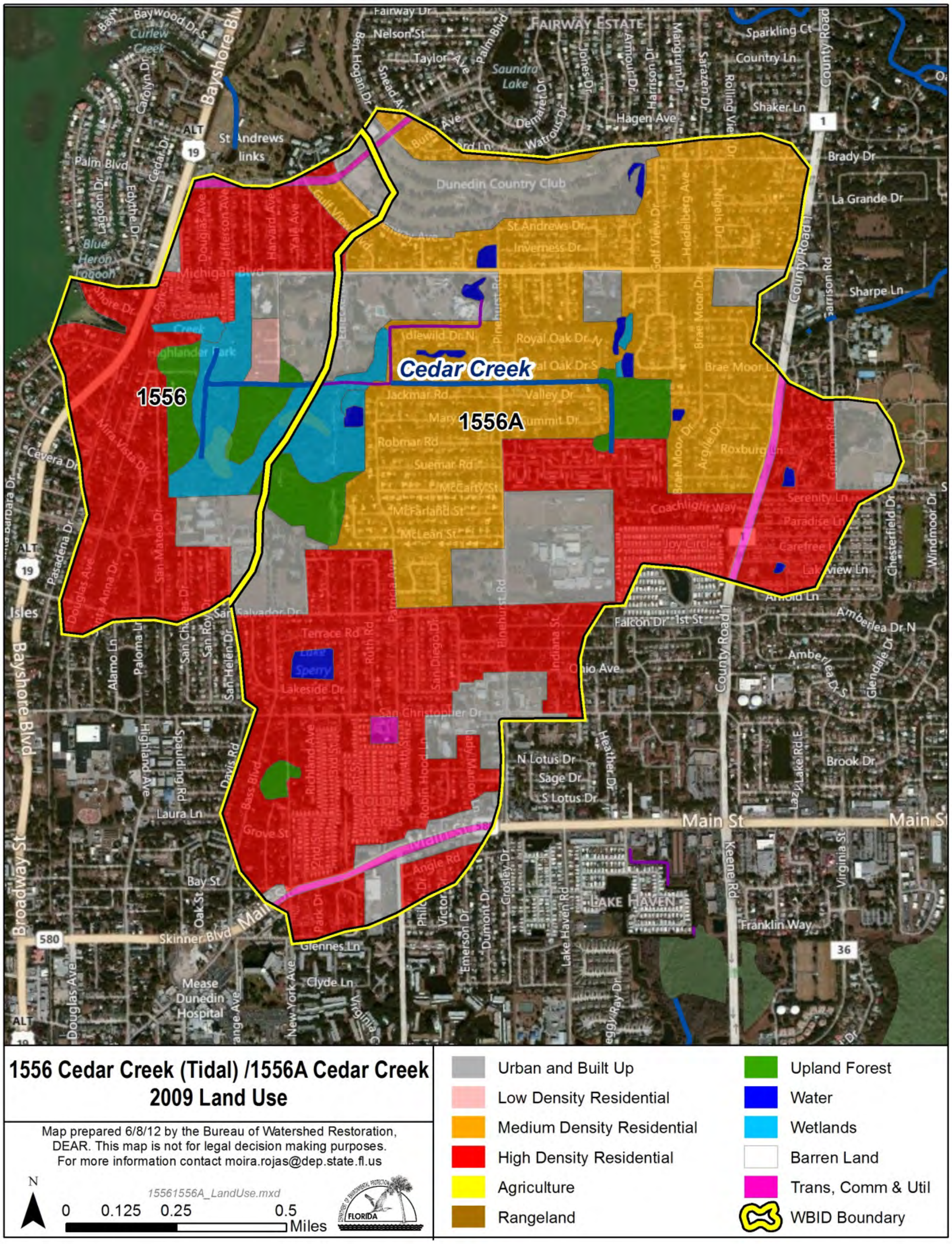

Figure 4.1. Principal Land Uses within the Cedar Creek (Tidal) (WBID 1556) and Cedar Creek (WBID 1556A) Boundaries in 2009

Urban Development

Because the dominant land use categories contributing to nonpoint source pollution are urban land areas – urban and built-up (commercial and services); medium- and high-density residential – possible sources for fecal coliform loadings can include failed septic tanks, sewer line leakages, and pet feces disposed of inappropriately. A preliminary quantification of the fecal coliform loadings from these sources was conducted to demonstrate the relative contributions. **Appendix B** provides detailed load estimates and describes the methods used for the quantification. It should be noted that the information included in **Appendix B** was only used to demonstrate the possible relative contributions from different sources.

Wildlife and Sediments

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

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

The fecal coliform TMDLs for the Cedar Creek (Tidal) and Cedar Creek WBIDs were developed using the "percent reduction" approach. Using this method, the percent reduction needed to meet the applicable criterion is calculated based on the 90th percentile of all measured concentrations collected during the Cycle 2 verified period (January 1, 2004, through June 30, 2011).

Because bacteriological counts in water are not normally distributed, a nonparametric method is more appropriate for the analysis of fecal coliform data (Hunter, 2002). The Hazen method, which uses a nonparametric formula, was used to determine the 90th percentile. 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

Data used to develop these TMDLs were primarily provided by the Department, the Department's Southwest District, and Pinellas County Department of Environment and Infrastructure (DEMI). In addition, data collected for the City of Dunedin's Surface Water Quality Monitoring Program (Sites 10-13) during the Cycle 2 verified period (n=36) were also used in the development of these TMDLs, as well as for the temporal, spatial and critical condition analyses. These data were collected to assist in compliance with the City's NPDES permit. *These data were not available during the Cycle 2 assessment for Group 5 basins and therefore were not used in verifying the fecal coliform impairment of WBIDs 1556 and 1556A.*

All data used in the development of these TMDLs and corresponding analyses were collected during the Cycle 2 verified period (January 1, 2004, through June, 30, 2011). **Table 5.1** lists the stations where fecal coliform data were collected during this time period. **Figure 5.1 shows** the locations of these water quality stations in the Cedar Creek (Tidal) and Cedar Creek.

Table 5.2 summarizes the descriptive statistics for WBIDs 1556 and 1556A for the Cycle 2 verified period fecal coliform results based on IWR Run44x and the additional data provided by the City of Dunedin.

Table 5.1. Stations Where Water Quality Samples Were Collected for Fecal Coliform Data during the Cycle 2 Verified Period (January 1, 2004, through June 30, 2011)

This is a three-column table. Column 1 lists the WBID number, Column 2 lists the station ID and Column 3 lists the agency collecting the data

WBID	Station ID	Agency
1556	21FLTPA 28020228246470	FDEP Southwest District
	21FLTPA 28020278246543	FDEP Southwest District
	21FLTPA 28020818246562	FDEP Southwest District
	21FLTPA 28020928247076	FDEP Southwest District
	21FLPDEM09-02	Pinellas County DEMI
	Site 11 - Cedar Creek at Harvard Avenue Footbridge	City of Dunedin
	Site 13 - Cedar Creek at Alternate US-19	City of Dunedin
1556A	21FLTPA 28021558246025	FDEP Southwest District
	21FLTPA 28020268246032	FDEP Southwest District
	21FLTPA 28020288246345	FDEP Southwest District
	21FLTPA 28020248246475	FDEP Southwest District
	21FLTPA 28020248246185	FDEP Southwest District
	21FLPDEM09-03	Pinellas County DEMI
	21FLGW 35445	FDEP
	Site 10 - Cedar Creek at Jackmar Road	City of Dunedin
	Site 12 - Cedar Creek at South Channel from Lake Sue-Mar	City of Dunedin

Table 5.2. Descriptive Statistics of Fecal Coliform Data for WBIDs 1556 and 1556A for Cycle 2 Verified Period (January 1, 2004 through June 30, 2011)

This is a nine-column table. Column 1 lists the WBID number, and Columns 2-9 list the descriptive statistic and corresponding result.

[1]Coliform counts are #/100mL

WBID	Mean observation[1]	Standard deviation	Median observation[1]	Highest observation[1]	Lowest observation[1]	25% quartile[1]	75% quartile[1]	# of samples
1556	1,606	1,961	540	8,600	9	298	2,800	37
1556A	1,126	1,642	525	8,600	1	263	1,175	51

Figure 5.1. Location of IWR Water Quality Stations with Fecal Coliform Data in Cedar Creek (Tidal) (WBID 1556) and Cedar Creek (WBID 1556A)

Plots of fecal coliform data against time determined there were no significant increasing or decreasing trends (Prob>0.05) during the period of observation (January 1, 2004 through June 30, 2011) in either WBID 1556 or WBID 1556A. **Figures 5.2a** and **5.2b** show the fecal coliform concentration trends observed in Cedar Creek (Tidal) and Cedar Creek during the Cycle 2 verified period.

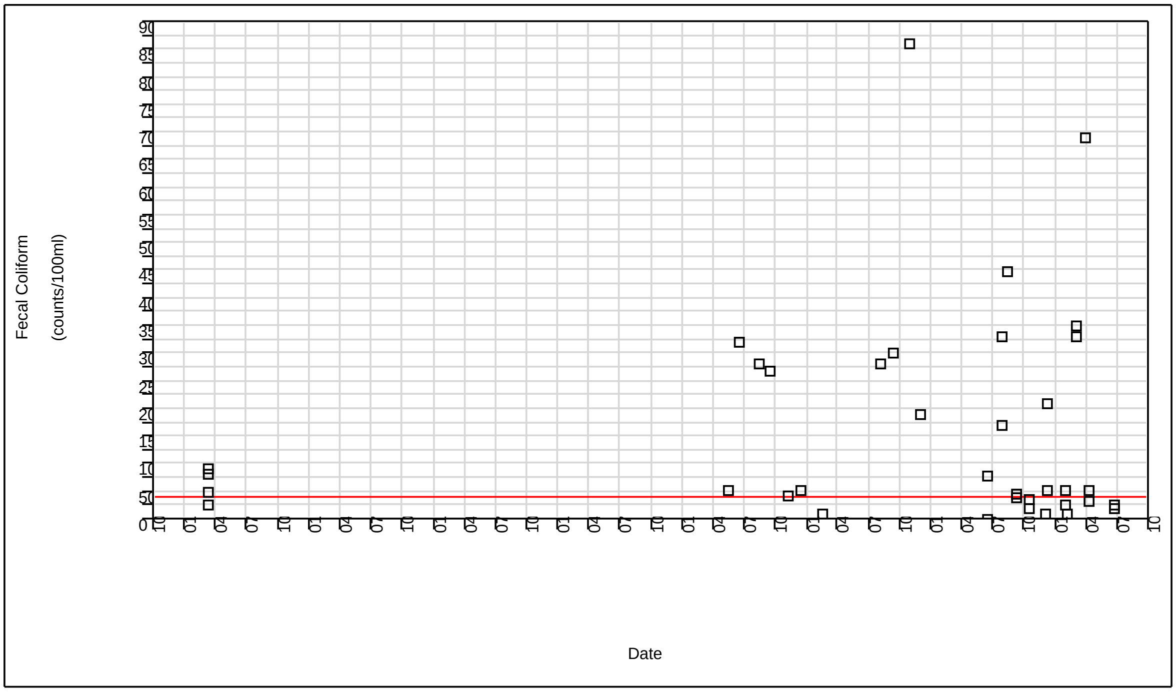

Figure 5.2a. Fecal Coliform Concentration Trends in Cedar Creek (Tidal) (WBID 1556) for the Cycle 2 Verified Period (January 1, 2004 through June 30, 2011)

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

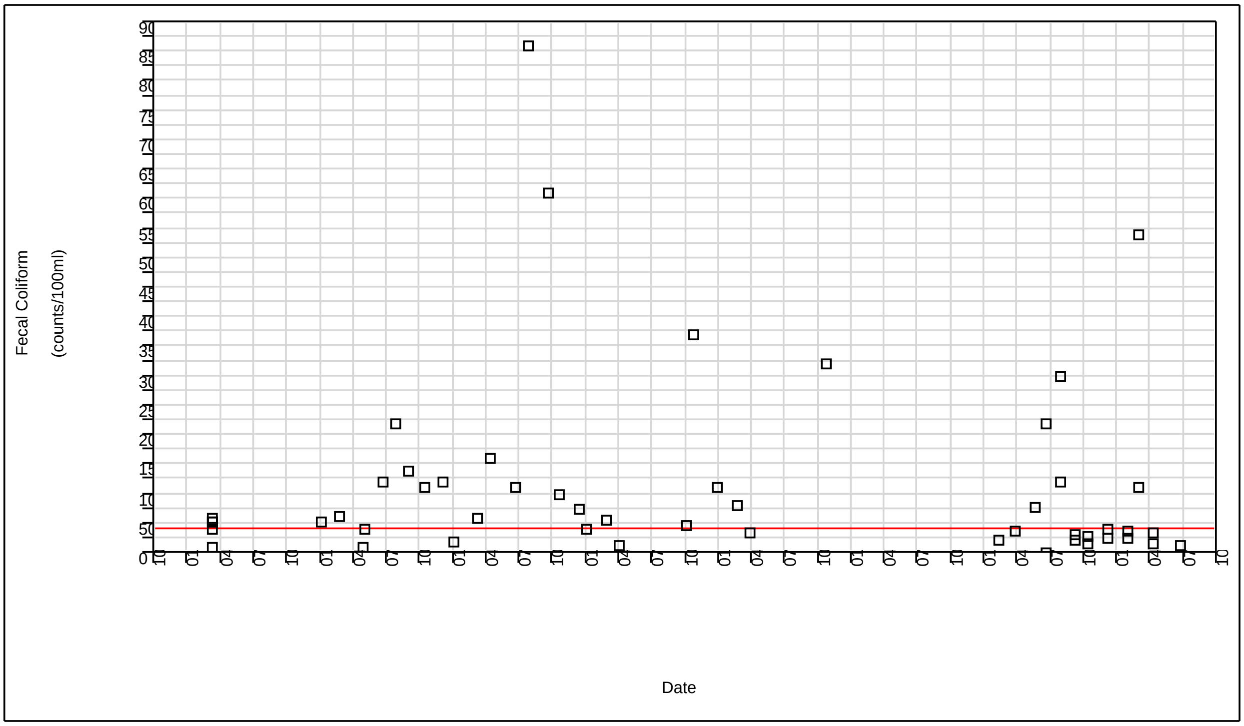

Figure 5.2b. Fecal Coliform Concentration Trends in Cedar Creek (WBID 1556A) for the Cycle 2 Verified Period (January 1, 2004 through June 30, 2011)

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

Temporal Patterns

MONTHLY AND SEASONAL TRENDS

Seasonally, in an impaired water influenced mainly by nonpoint sources, a peak in fecal coliform concentrations and exceedance rates is expected 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 (**Tables 5.3a** to **5.3d**).

The WBIDs addressed in this report are located in an environment of humid southern temperate to subtropical climatic zones, with frosts/freezing temperatures occurring at least once a year. The average mean daily temperature is 70°F, with mean summer temperatures in the low 80s and mean winter temperatures in the upper 50s. Average annual rainfall is approximately 53 inches, with two-thirds of rainfall occurring between June and September. Rainfall variability, both seasonally and from year to year, is high. The Gulf of Mexico is the prevailing factor affecting climate in this area; Gulf waters influence winter cold fronts and high summer temperatures (SWFWMD, 2002).

Cedar Creek (Tidal) (WBID 1556)

The highest quarterly exceedance rate and highest quarterly average fecal coliform concentration were observed during the third quarter, the rainy and warmer season (89% and 2,404 counts/100mL, respectively). The lowest exceedance rate was observed during the second quarter, the cooler and drier season (50%). Episodic exceedances in fecal coliform concentrations occurred throughout the period of observation (2004-2011). With the exception of February, fecal coliform exceedances were observed in the Cedar Creek (Tidal) basin in all the other months in which measured fecal coliform concentrations were available. The highest monthly average fecal coliform concentration was observed in August (3,367 counts/100mL). **Tables 5.3a** and **5.3b** summarize the monthly and seasonal fecal coliform averages and percent exceedances, respectively, for data collected for the Cycle 2 verified period for this WBID.

Table 5.3a. Summary Statistics of Fecal Coliform Data for All Stations in Cedar Creek (Tidal) (WBID 1556) by Month during the Cycle 2 Verified Period (January 1, 2004 through June 30, 2011)

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

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

Month	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
January	2	250	520	385	385	1	50
February	2	100	110	105	105	0	0
March	7	275	6900	920	2316	6	86
April	2	320	540	430	430	1	50
May	1	540	540	540	540	1	100
June	5	9	3200	250	888	2	40
July	2	1700	3300	2500	2500	2	100
August	3	2800	4500	2800	3367	3	100
September	4	380	3000	1580	1635	3	75
October	3	200	8600	350	3050	1	33
November	1	430	430	430	430	1	100
December	5	106	2100	540	1035	4	80

Table 5.3b. Summary Statistics of Fecal Coliform Data for All Stations in Cedar Creek (Tidal) (WBID 1556) by Season during the Cycle 2 Verified Period (January 1, 2004 through June 30, 2011)

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

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

Season	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
Quarter 1	11	100	6,900	520	1,563	7	64
Quarter 2	8	9	3,200	430	730	4	50
Quarter 3	9	380	4,500	2,800	2,404	8	89
Quarter 4	9	106	8,600	530	1,640	6	67

Cedar Creek (WBID 1556A)

Elevated fecal coliform concentrations and exceedance rates greater than 40% were observed during all quarters, The highest quarterly exceedance rate and highest quarterly average fecal coliform concentration were observed during the third quarter, the rainy and warmer season (75% and 2,880 counts/100mL, respectively). Episodic exceedances in fecal coliform concentrations occurred throughout the period of observation (2004-2011). Fecal coliform exceedances were observed in the Cedar Creek basin in all months in which measured fecal coliform concentrations were available, with the highest monthly average fecal coliform concentration and exceedance rate observed in July (3,750 counts/100mL and 100%, respectively). **Tables 5.3c** and **5.3d** summarize the monthly and seasonal fecal coliform averages and percent exceedances, respectively, for data collected for the Cycle 2 verified period for this WBID.

Table 5.3c. Summary Statistics of Fecal Coliform Data for All Stations in Cedar Creek (WBID 1556A) by Month during the Cycle 2 Verified Period (January 1, 2004 through June 30, 2011)

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

[1] Coliform counts are #/100mL.
[2] Exceedances represent values above 400 counts/100mL.
- = No data

Month	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
January	5	170	520	360	342	1	20
February	4	220	800	595	553	3	75
March	10	85	5400	520	992	7	70
April	5	80	1600	160	462	1	20
May	2	400	760	580	580	1	50
June	5	1	2200	1100	926	3	60
July	4	1200	8600	2600	3750	4	100
August	0	-	-	-	-	-	-
September	4	220	6100	860	2010	2	50
October	7	140	3700	1000	1410	5	71
November	0	-	-	-	-	-	-
December	5	260	1200	730	738	3	60

Table 5.3d. Summary Statistics of Fecal Coliform Data for All Stations in Cedar Creek (WBID 1556A) by Season during the Cycle 2 Verified Period (January 1, 2004 through June 30, 2011)

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

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

Season	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
Quarter 1	19	85	5,400	510	728	11	58
Quarter 2	12	1	2,200	375	675	5	42
Quarter 3	8	220	8,600	1,800	2,880	6	75
Quarter 4	12	140	3,700	865	1,130	8	67

Using rainfall data collected at the Tampa International Airport by the CLimate Information for Management and Operational Decisions (CLIMOD) system of the Southeast Regional Climate Center (available http://acis.sercc.com/), it was possible to compare monthly rainfall with monthly fecal coliform exceedance rates, as well as average quarterly rainfall with average quarterly fecal coliform exceedance rates at all stations (**Figures 5.3a** to **5.3d**).

Cedar Creek (Tidal) (WBID 1556)

The impact of rainfall on monthly and quarterly exceedances in WBID 1556 is inconclusive. During the Cycle 2 verified period, monthly exceedance rates occurred independently of rainfall, and exceedances were recorded during low and high rainfall periods (**Figure 5.3a**). Exceedance rates generally follow the rainfall pattern on the quarterly basis (**Figure 5.3b**). The occurrence of higher exceedance rates during wet seasons is an indication that in WBID 1556 high rainfall serves to negatively impact water quality in this basin.

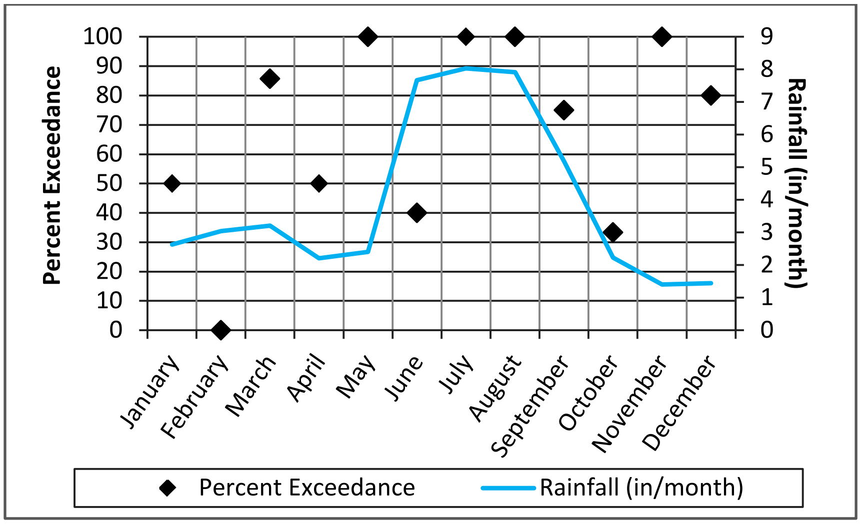

Figure 5.3a. Fecal Coliform Exceedances and Rainfall at All Stations in WBID 1556 by Month during the Cycle 2 Verified Period (January 1, 2004 through June 30, 2011)

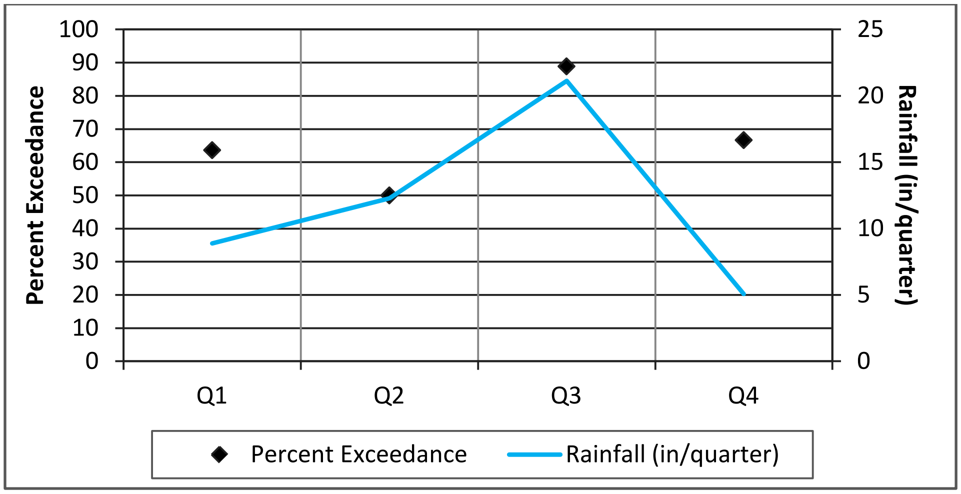

Figure 5.3b. Fecal Coliform Exceedances and Rainfall at All Stations in WBID 1556 by Season during the Cycle 2 Verified Period (January 1, 2004 through June 30, 2011)

Cedar Creek (WBID 1556A)

The impact of rainfall on monthly and quarterly exceedances in WBID 1556A is also inconclusive. As was the case for WBID 1556, during the Cycle 2 verified period, monthly exceedance rates occurred independently of rainfall, and exceedances were recorded during lower and higher rainfall periods (**Figure 5.3c** and **Figure 5.3d**). The occurrence of higher exceedance rates during wet seasons is an indication that in WBID 1556A high rainfall serves to negatively impact water quality in this basin.

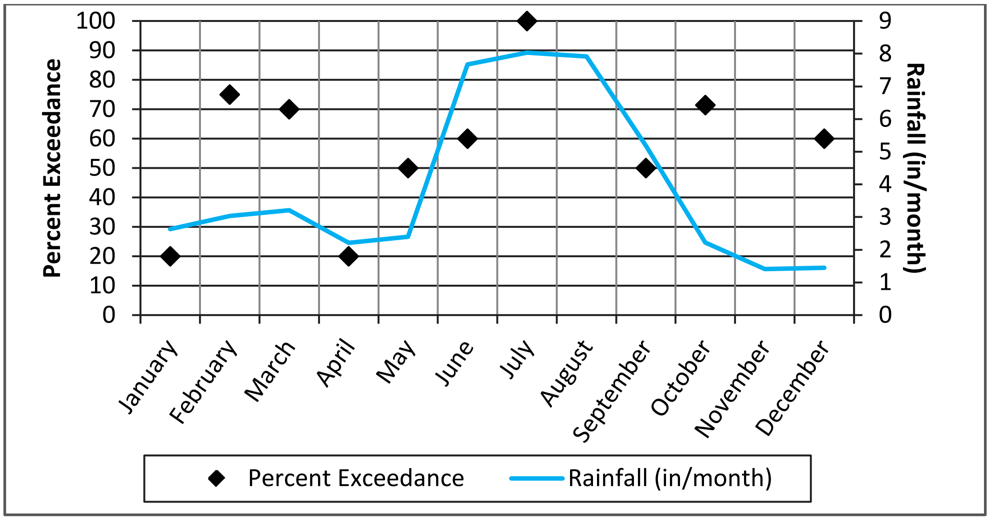

Figure 5.3c. Fecal Coliform Exceedances and Rainfall at All Stations in WBID 1556A by Month during the Cycle 2 Verified Period (January 1, 2004 through June 30, 2011)

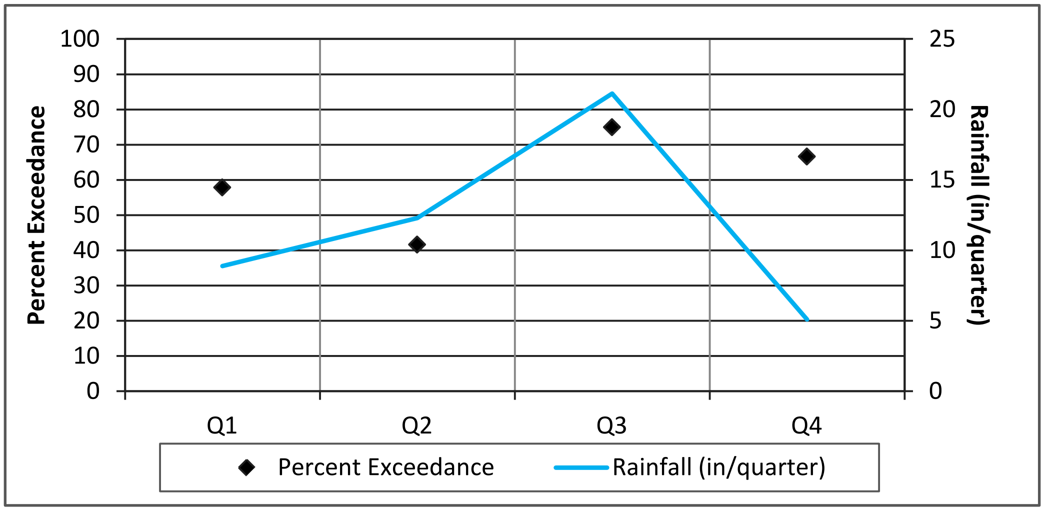

Figure 5.3d. Fecal Coliform Exceedances and Rainfall at All Stations in WBID 1556A by Season during the Cycle 2 Verified Period (January 1, 2004 through June 30, 2011)

Period of Record Trend

Although a plot of historical fecal coliform data against time revealed no significant (Prob > 0.05) increasing or decreasing trend for the entire period of record in the Cedar Creek (Tidal) and Cedar Creek WBIDs (1991-2011 and 2004-2010, respectively) (**Figures 5.4a** and **5.4b**), fecal coliform concentrations that exceed the criteria are frequently recorded in these WBIDs. Many of these samples are collected during periods of small or no rainfall, indicating that exceeding concentrations may not be a consequence of stormwater discharges, but rather other local sources.

Since 2006, the City of Dunedin has been working on the Cedar Creek Restoration Plan to improve stormwater treatment, increase drainage capacity and provide enhanced protection against erosion and flooding within the Cedar Creek basin. In addition, the SWFWMD has been working with Pinellas County and the City of Dunedin on stormwater improvement projects aimed at water quality and flood control in the Cedar Creek watershed. These projects, located within WBIDs 1556 and 1556A, should improve the water quality of runoff and potentially reduce fecal coliform concentrations in Cedar Creek.

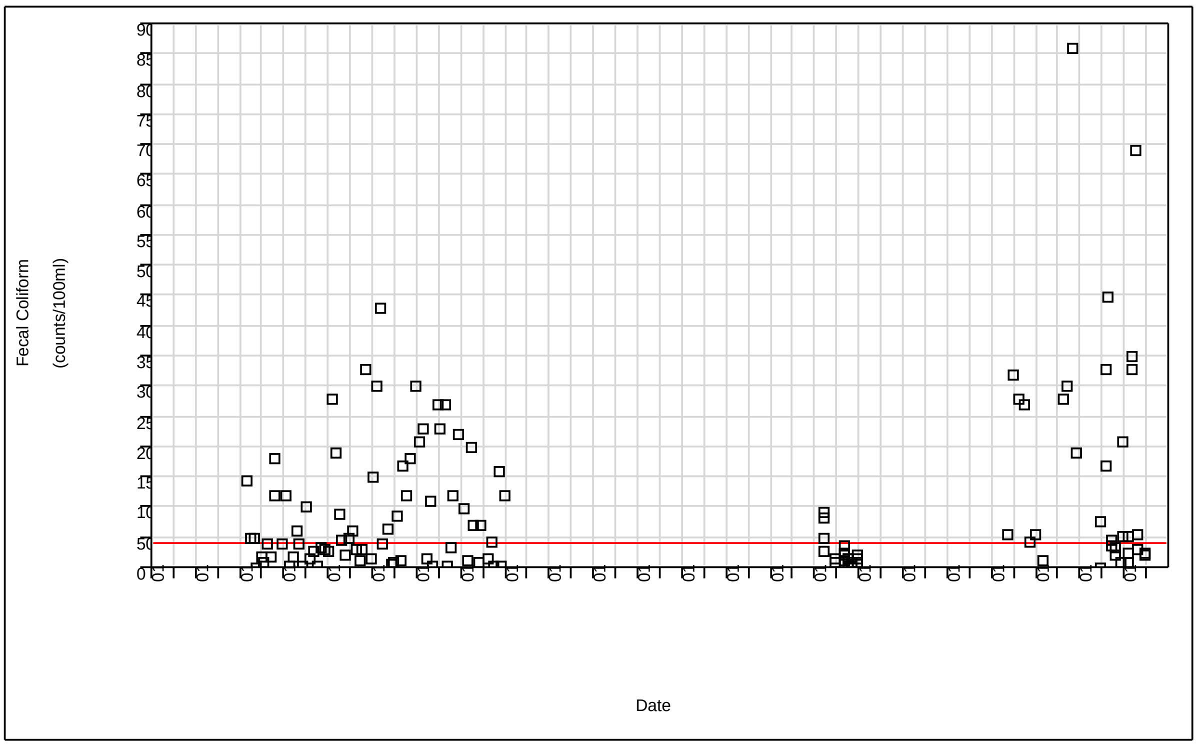

Figure 5.4a. Fecal Coliform Concentration Trends at Cedar Creek (Tidal) (WBID 1556) for the Entire Period of Record (1991-2011)

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

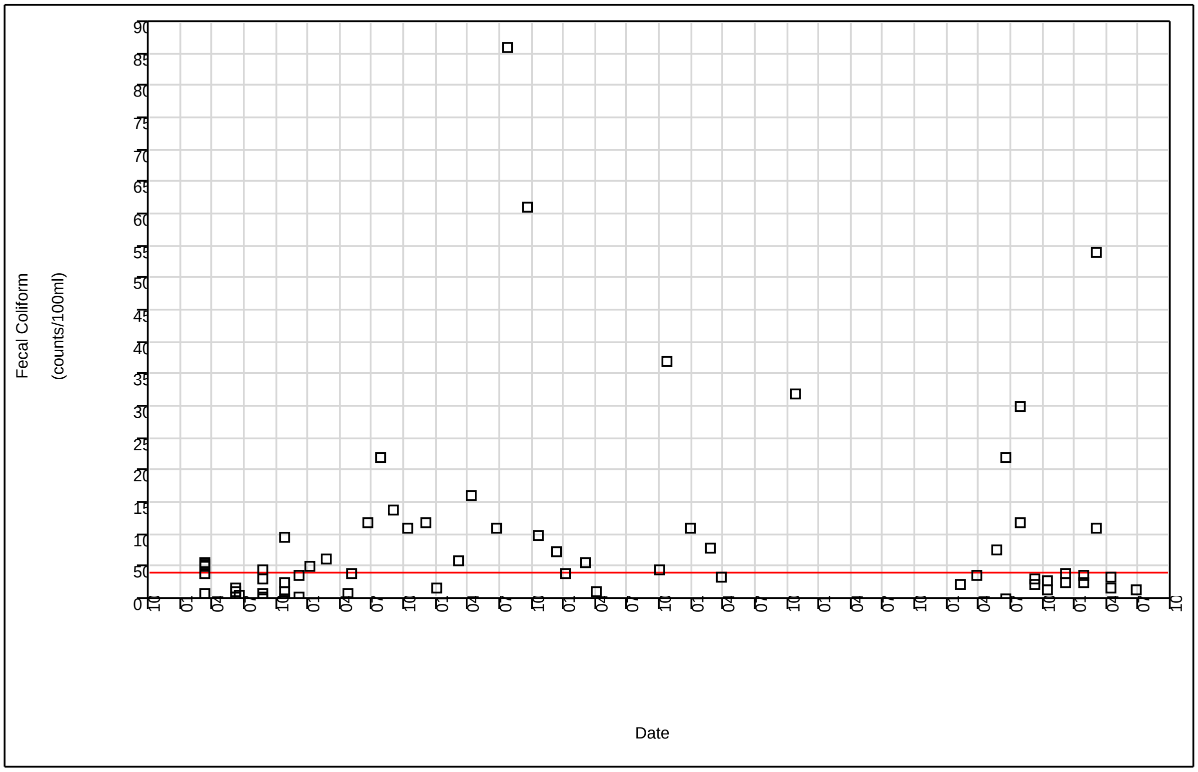

Figure 5.4b. Fecal Coliform Concentration Trends at Cedar Creek (WBID 1556A) for the Entire Period of Record (2004-2011)

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

Spatial Patterns

Fecal coliform data from the Cycle 2 verified period (January 1, 2004–June 30, 2011) were analyzed to detect spatial trends (**Figures 5.5a** to **5.5b**). Stations are displayed from upstream to downstream. **Figure 5.6** shows the spatial distribution of the principal land uses and the locations of the water quality stations within each WBID.

Cedar Creek (Tidal) (WBID 1556)

Fecal coliform concentrations that exceeded the State criteria where observed in six of the seven sampling stations within the WBID (**Figures 5.5a**). The highest exceedance rates were recorded at Stations 21FLTPA 28020228246470, 21FLTPA 28020278246543 and 21FLTPA 28020818246562 (100%); however, only one sample was collected at each of these stations. Station 21FLPDEM09-02, which had the highest number of samples (n=15), had an exceedance rate of 80% and the highest fecal coliform concentration recorded in the WBID (8,600 counts/100mL). Samples at five of the seven stations exceeded the single sample maximum criterion of 800 counts/100mL (**Table 5.4a**). All sampling stations are located on the main channel of Cedar Creek.

With the exception of Station 21FLTPA 28020928247076 and Site 13, which are surrounded primarily by high-density residential areas, land use surrounding all other stations in the WBID is predominantly classified as wetland hardwood forest (stream and lake swamps), with small low-density areas in the vicinity. Most stations are located in the vicinity of Hammock Park, a 85-acre mixed-hardwood forest. The park is a low, swampy area with rich, mucky soils.

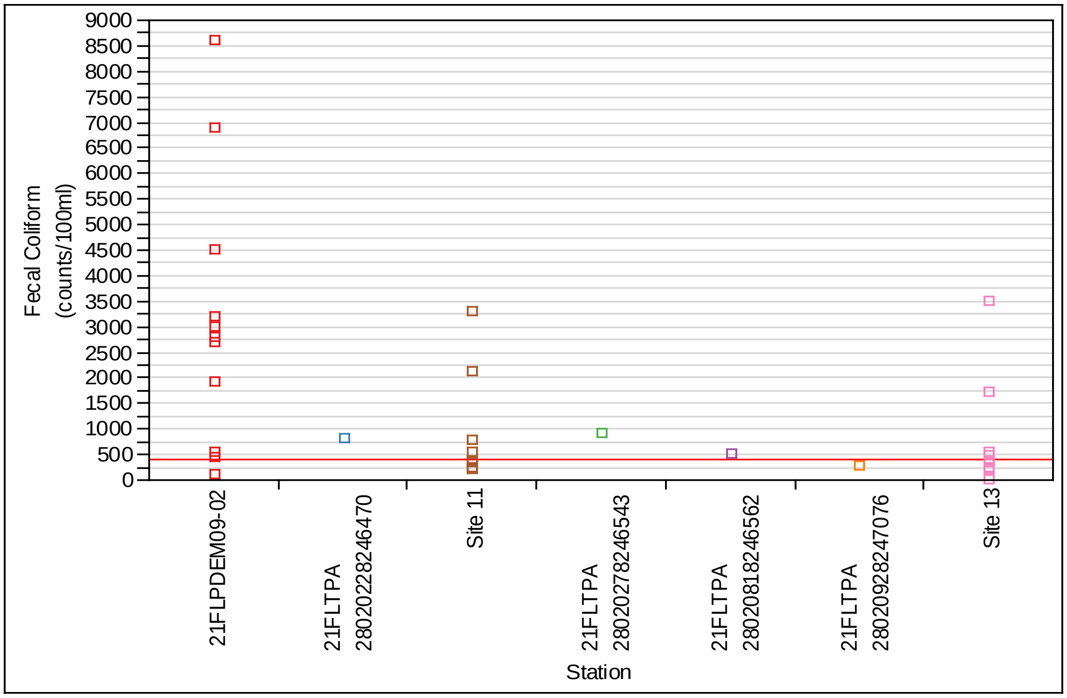

Figure 5.5a. Spatial Fecal Coliform Concentration Trends in Cedar Creek (Tidal) (WBID 1556) by Station during the Cycle 2 Verified Period (January 1, 2004 through June 30, 2011)

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

Table 5.4a. Station Summary Statistics of Fecal Coliform Data for Cedar Creek (Tidal) (WBID 1556) during the Cycle 2 Verified Period (January 1, 2004 through June 30, 2011)

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

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

Station	Period of Observation	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
21FLPDEM09-02	2008-2011	15	100	8600	2700	2548	12	80
21FLTPA 28020228246470	2004	1	820	820	820	820	1	100
21FLTPA 28020278246543	2004	1	920	920	920	920	1	100
21FLTPA 28020818246562	2004	1	500	500	500	500	1	100
21FLTPA 28020928247076	2004	1	275	275	275	275	0	0
Site 11	2010-2011	9	210	3300	540	1244	5	56
Site 13	2010-2011	9	9	3500	460	832	5	56

Cedar Creek (WBID 1556A)

Fecal coliform concentrations that exceeded the State criteria where observed in eight of the nine sampling stations within the WBID (**Figures 5.5b**). The highest exceedance rates were recorded at Stations 21FLTPA 28020248246185, 21FLTPA 28020248246475, 21FLTPA 28020268246032 and 21FLTPA 28020288246345 (100%); however, only one sample was collected at each of these stations. Station 21FLPDEM09-03, which had the highest number of samples (n=28), had an exceedance rate of 71% and the highest fecal coliform concentration recorded in the WBID (8,600 counts/100mL). Samples at four of the nine stations exceeded the single sample maximum criterion of 800 counts/100mL (**Table 5.4b**).

With the exception of Stations 21FLTPA 28020248246475, 21FLTPA 28020268246032 and Site 12, which are surrounded primarily by wetland or upland hardwood forest areas, land use surrounding all other stations in the WBID is predominantly classified as medium-density residential.

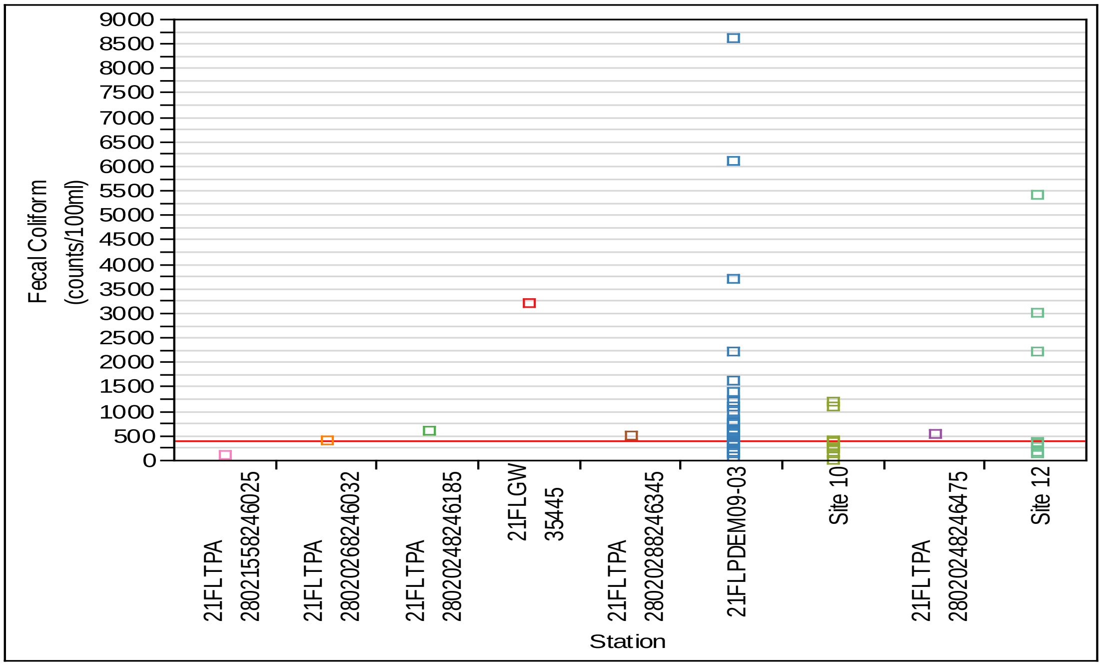

Figure 5.5b. Spatial Fecal Coliform Concentration Trends in Cedar Creek (WBID 1556A) by Station during the Cycle 2 Verified Period (January 1, 2004 through June 30, 2011)

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

Table 5.4b. Station Summary Statistics of Fecal Coliform Data for Cedar Creek (WBID 1556A) during the Cycle 2 Verified Period (January 1, 2004 through June 30, 2011)

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

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

Station	Period of Observation	Number of Samples	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances
21FLGW 35445	2008	1	3200	3200	3200	3200	1	100
21FLPDEM09-03	2005-2010	28	80	8600	745	1338	20	71
21FLTPA 28020248246185	2004	1	580	580	580	580	1	100
21FLTPA 28020248246475	2004	1	530	530	530	530	1	100
21FLTPA 28020268246032	2004	1	410	410	410	410	1	100
21FLTPA 28020288246345	2004	1	510	510	510	510	1	100
21FLTPA 28021558246025	2004	1	85	85	85	85	0	0
Site 10	2010-2011	9	1	1200	270	437	2	22
Site 12	2010-2011	8	140	5400	340	1480	3	38

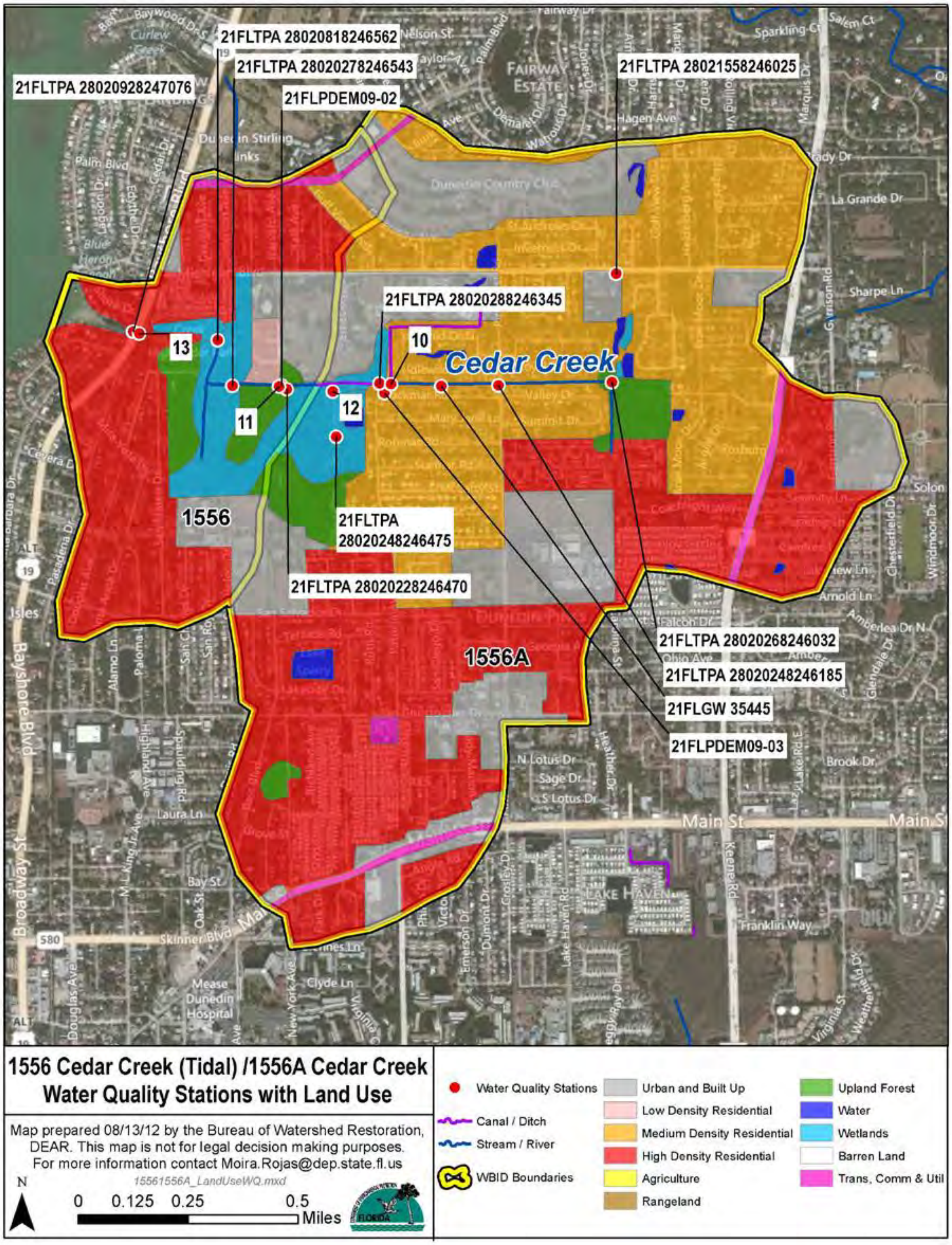

Figure 5.6. Principal Land Uses and Location of IWR Water Quality Stations with Fecal Coliform Data in WBIDs 1556 and 1556A

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 by contributing to exceedances during dry weather. The critical condition for point source loading typically occurs during periods of low stream flow, when dilution is minimized.

Hydrologic conditions were analyzed using rainfall. A flow duration curve–type chart that would normally be applied to flow events was created using precipitation data from the CLIMOD Tampa International Airport 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 for both WBIDs were derived based on these percentile ranges and are presented in **Table 5.5**. Three-day (the day of and 2 days prior to sampling) precipitation accumulations were used in the analysis (**Tables 5.6a** and **5.6b** and **Figures 5.7a** and **5.7b**).

Table 5.5. Precipitation Event Ranges for Rainfall Data for WBIDs 1556 and 1556A

This is a seven-column table. Column 1 lists WBID, Column 2 lists rainfall periods of records, Columns 3- 6 list the event range (in in/3-Day).

WBID	Rainfall Period of Record	Precipitation Event				
		Extreme	Large	Medium	Small	None/Not Measurable
1556	1970-2011	>1.82"	1.22" - 1.82"	0.1" - 1.22"	0.01" - 0.1"	<0.01"
1556A	1970-2011	>1.82"	1.22" - 1.82"	0.1" - 1.22"	0.01" - 0.1"	<0.01"

Cedar Creek (Tidal) (WBID 1556)

Historical data show that fecal coliform exceedances occurred over all hydrologic conditions. Percentages of exceedances greater than 50% occurred after all sampled events. The highest percentage of exceedances occurred after periods of extreme precipitation (100%); however, this period also had the fewest number of samples collected (N=1). The lowest percentage of exceedances occurred after periods of none or not measurable precipitation (56%).

Given that exceedance rates and exceeding concentrations followed all of the sampled precipitation events and that, other than MS4s, there are no traditional point source dischargers that would contribute to observed levels fecal coliform bacteria within the Cedar Creek (Tidal) WBID boundary, it can be assumed that various nonpoint sources are a major contributing factor to high fecal coliform concentrations in the WBID. While the lowest percentage of exceedances occurred after periods of no or little rainfall, the exceedance rate is considered significant and is an indication that local sources are contributing to elevated fecal coliform concentrations. **Table 5.6a** and **Figure 5.7a** show fecal coliform data by hydrologic condition.

As fecal coliform exceedances occurred in all the of the precipitation intervals the target fecal coliform reduction calculated in the following section and shown in **Table 5.7a** is applicable under all rainfall conditions in the Cedar Creek (Tidal) watershed.

Table 5.6a. Summary of Fecal Coliform Data for Cycle 2 Verified Period (January 1, 2004 through June 30, 2011) by Hydrologic Condition for Cedar Creek (Tidal) (WBID 1556)

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

Precipitation Event	Event Range (in/3-Day)	Total Samples	Number of Exceedances	% Exceedances	Number of Non-exceedances	% Non-exceedances
Extreme	>1.82"	1	1	100%	0	0%
Large	1.22" - 1.82"	3	2	67%	1	33%
Medium	0.1" - 1.22"	11	9	82%	2	18%
Small	0.01" - 0.1"	6	4	67%	2	33%
None/ Not Measurable	<0.01"	16	9	56%	7	44%

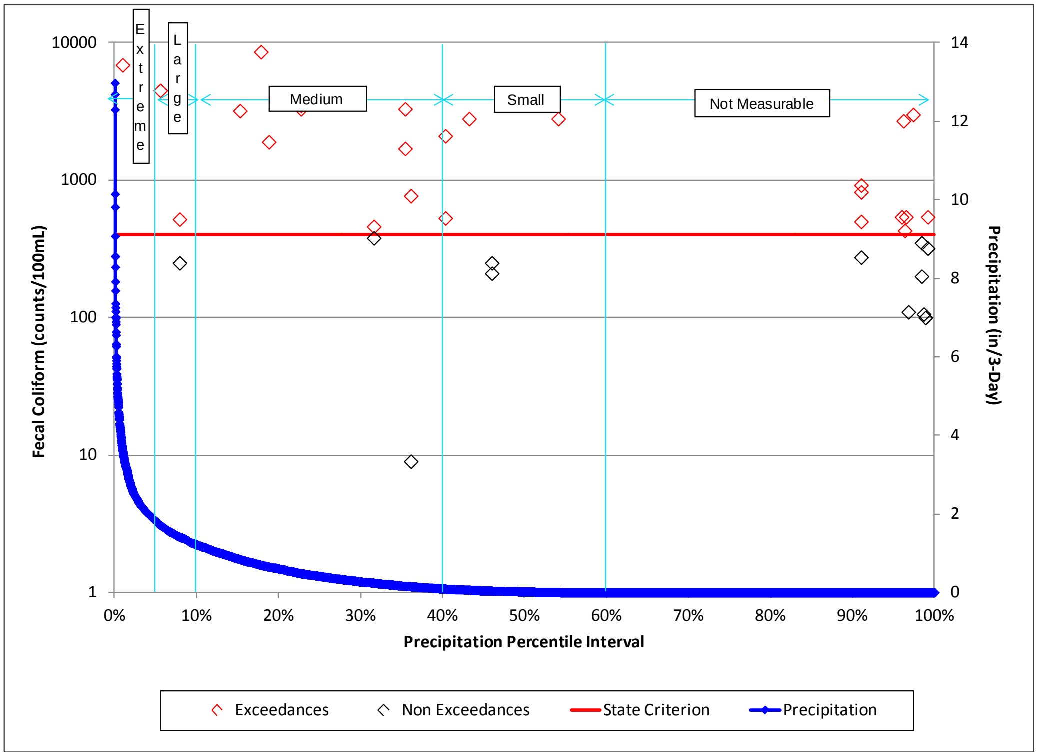

Figure 5.7a. Fecal Coliform Data for Cycle 2 Verified Period (January 1, 2004 through June 30, 2011) by Hydrologic Condition for Cedar Creek (Tidal) (WBID 1556)

Cedar Creek (WBID 1556A)

Historical data show that fecal coliform exceedances occurred over all hydrologic conditions during which samples were collected. The highest percentage of exceedances occurred after periods of medium precipitation (68%) and the lowest percentage of exceedances occurred after periods of small precipitation (20%). A relatively high percentage of exceedances occurred after periods of none or non-measurable precipitation (63%).

Given that exceedance rates and exceeding concentrations followed all of the sampled precipitation events and that, other than MS4s, there are no traditional point source dischargers that would contribute to observed levels fecal coliform bacteria within the Cedar Creek WBID boundary, it can be assumed that various nonpoint sources are a major contributing factor to high fecal coliform concentrations in the WBID. That exceedance rates of 20% and greater occurred after all sampled precipitation events, indicates that both nonpoint sources (that are rainfall dependent) and local sources (that are rainfall independent) are major contributing factors to elevated fecal coliform concentrations. **Table 5.6b** and **Figure 5.7b** show fecal coliform data by hydrologic condition

As fecal coliform exceedances occurred in all the of the sampled precipitation intervals the target fecal coliform reduction calculated in the following section and shown in **Table 5.7b** is applicable under all rainfall conditions in the Cedar Creek watershed.

Table 5.6b. Summary of Fecal Coliform Data for Cycle 2 Verified Period (January 1, 2004 through June 30, 2011) by Hydrologic Condition for Cedar Creek (WBID 1556A)

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

Precipitation Event	Event Range (in/3-Day)	Total Samples	Number of Exceedances	% Exceedances	Number of Non-exceedances	% Non-exceedances
Extreme	>1.82"	0	-	-	-	-
Large	1.22" - 1.82"	3	1	33%	2	67%
Medium	0.1" - 1.22"	19	13	68%	6	32%
Small	0.01" - 0.1"	5	1	20%	4	80%
None/ Not Measurable	<0.01"	24	15	63%	9	38%

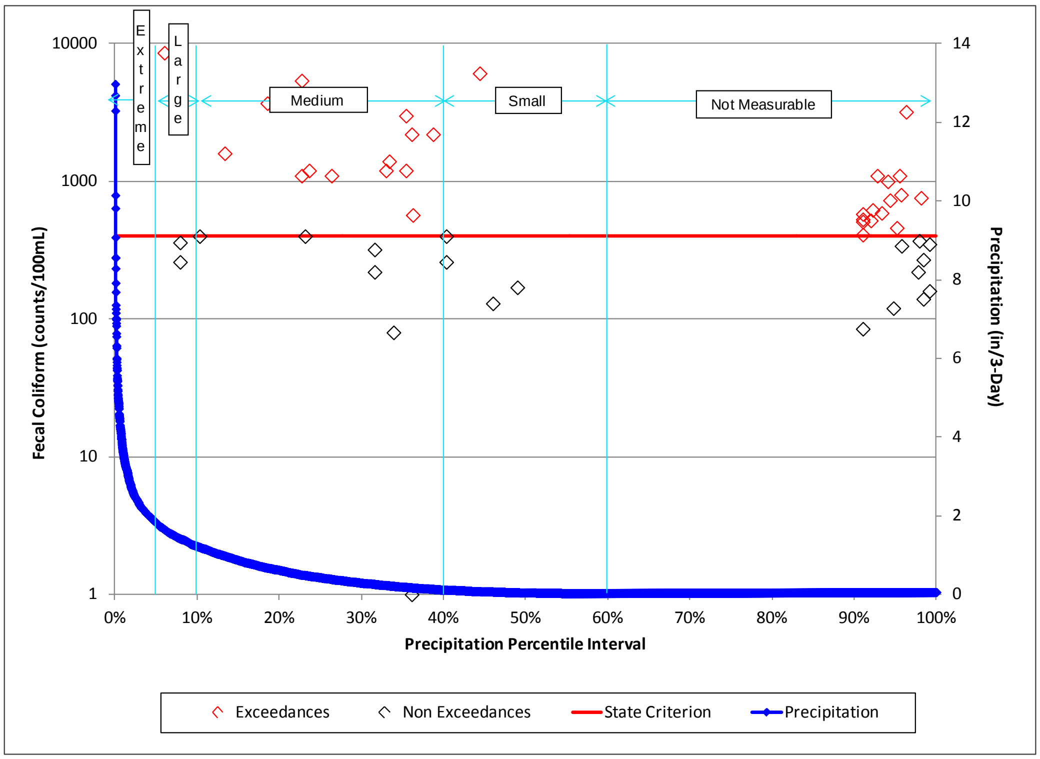

Figure 5.7b. Fecal Coliform Data for Cycle 2 Verified Period (January 1, 2004 through June 30, 2011) by Hydrologic Condition for Cedar Creek (WBID 1556A)

5.1.3 TMDL Development Process

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

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

Formula 1

Using the Hazen method for estimating percentiles, as described in Hunter (2002), the existing condition concentration was defined as the 90th percentile of all the fecal coliform data collected during the Cycle 2 verified period (January 1, 2004, to June 30, 2011). 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 (**Tables 5.6a** and **5.6b**), 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; data for WBID 1556 are used as an example.

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

Formula 3

Where:

- *C_{lower} is the fecal coliform concentration corresponding to the percentile lower than the 90th percentile (in this case, 3,300 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, 88%), or 90% – 88% = 2%.*
- *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, 88 and 91 percent, respectively (**Table 5.6a**). Next, the fecal coliform concentrations corresponding to the lower and upper percentile values were identified (3,300 and 3,500 counts/100mL, respectively) (**Table 5.6a**). 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., 91% – 88% =3 percentile unit difference). R was then calculated as R = (3,500 – 3,300) / (91% – 88%) = 66.7.

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 = 3,300 + (2*66.7) = 3,433 counts/100mL).

Using **Formula 1**, the percent reduction for the period of observation (January 1, 2004, to June 30, 2011) was calculated as 88 percent for Cedar Creek (Tidal) (i.e., % reduction needed = [(3,433 –400) / 3,433]*100 = 88%).

Tables 5.6a and **5.6b** show 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 5.7a. Calculation of Fecal Coliform Reductions for Cedar Creek (Tidal) (WBID 1556) 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 concentration (counts/100mL), Column 4 lists the rank of fecal coliform concentration, and Column 5 lists the percentile of the fecal concentration distribution.

- = Empty cell/no data

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
Site 13	06/16/10	9	1	1%
21FLPDEM09-02	2/1/2011	100	2	4%
21FLPDEM09-02	12/2/2010	106	3	7%
21FLPDEM09-02	2/17/2009	110	4	9%
Site 13	10/13/10	200	5	12%
Site 11	06/22/11	210	6	15%
Site 11	01/27/11	250	7	18%
Site 13	06/22/11	250	8	20%
21FLTPA 28020928247076	3/8/2004	275	9	23%
Site 13	04/11/11	320	10	26%
Site 11	10/13/10	350	11	28%
Site 11	09/07/10	380	12	31%
21FLPDEM09-02	11/5/2008	430	13	34%
Site 13	09/07/10	460	14	36%
21FLTPA 28020818246562	3/8/2004	500	15	39%
Site 13	01/27/11	520	16	42%
Site 13	12/07/10	530	17	45%
21FLPDEM09-02	5/14/2008	540	18	47%
21FLPDEM09-02	12/15/2008	540	19	50%
Site 11	04/11/11	540	20	53%
Site 11	06/16/10	770	21	55%
21FLTPA 28020228246470	3/8/2004	820	22	58%
21FLTPA 28020278246543	3/8/2004	920	23	61%
Site 13	07/28/10	1700	24	64%
21FLPDEM09-02	12/2/2009	1900	25	66%
Site 11	12/07/10	2100	26	69%
21FLPDEM09-02	9/16/2008	2700	27	72%
21FLPDEM09-02	8/12/2008	2800	28	74%
21FLPDEM09-02	8/3/2009	2800	29	77%
21FLPDEM09-02	9/10/2009	3000	30	80%
21FLPDEM09-02	6/17/2008	3200	31	82%
Site 11	03/02/11	3300	32	85%
Site 11	**07/28/10**	**3300**	**33**	**88%**
Site 13	**03/02/11**	**3500**	**34**	**91%**
21FLPDEM09-02	8/10/2010	4500	35	93%
21FLPDEM09-02	3/29/2011	6900	36	96%
21FLPDEM09-02	10/28/2009	8600	37	99%
-	-	-	Existing condition concentration–90th percentile (counts/100mL)	3,433
-	-	-	Allowable concentration (counts/100mL)	400
-	-	-	Final percent reduction	88

Note: Boldface type indicates concentration used in percent reduction calculations

Table 5.7b. Calculation of Fecal Coliform Reductions for Cedar Creek (WBID 1556A) 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 concentration (counts/100mL), Column 4 lists the rank of fecal coliform concentration, and Column 5 lists the percentile of fecal concentration distribution.

- = Empty cell/no data

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
Site 10	06/16/10	1	1	1%
21FLPDEM09-03	4/25/2005	80	2	3%
21FLTPA 28021558246025	3/9/2004	85	3	5%
21FLPDEM09-03	4/3/2007	120	4	7%
Site 10	06/22/11	130	5	9%
Site 12	10/13/10	140	6	11%
Site 12	04/11/11	160	7	13%
21FLPDEM09-03	1/4/2006	170	8	15%
21FLPDEM09-03	2/8/2010	220	9	17%
Site 10	09/07/10	220	10	19%
Site 10	01/27/11	260	11	21%
Site 12	12/07/10	260	12	23%
Site 10	10/13/10	270	13	25%
Site 12	09/07/10	320	14	26%
21FLPDEM09-03	3/26/2008	340	15	28%
Site 10	04/11/11	350	16	30%
Site 12	01/27/11	360	17	32%
21FLPDEM09-03	3/24/2010	370	18	34%
21FLPDEM09-03	1/3/2007	400	19	36%
21FLPDEM09-03	5/2/2005	400	20	38%
Site 10	12/07/10	400	21	40%
21FLTPA 28020268246032	3/9/2004	410	22	42%
21FLPDEM09-03	10/1/2007	460	23	44%
21FLTPA 28020288246345	3/9/2004	510	24	46%
21FLPDEM09-03	1/4/2005	520	25	48%
21FLTPA 28020248246475	3/9/2004	530	26	50%
21FLPDEM09-03	2/28/2007	570	27	52%
21FLTPA 28020248246185	3/9/2004	580	28	54%
21FLPDEM09-03	3/6/2006	590	29	56%
21FLPDEM09-03	2/22/2005	620	30	58%
21FLPDEM09-03	12/12/2006	730	31	60%
21FLPDEM09-03	5/20/2010	760	32	62%
21FLPDEM09-03	2/21/2008	800	33	64%
21FLPDEM09-03	10/19/2006	1000	34	66%
21FLPDEM09-03	6/20/2006	1100	35	68%
21FLPDEM09-03	10/12/2005	1100	36	70%
21FLPDEM09-03	12/27/2007	1100	37	72%
Site 10	03/02/11	1100	38	74%
21FLPDEM09-03	6/20/2005	1200	39	75%
21FLPDEM09-03	12/1/2005	1200	40	77%
Site 10	07/28/10	1200	41	79%
21FLPDEM09-03	9/1/2005	1400	42	81%

Station	Date	Fecal Coliform Concentration (MPN/100mL)	Rank	Percentile by Hazen Method
21FLPDEM09-03	4/11/2006	1600	43	83%
21FLPDEM09-03	7/27/2005	2200	44	85%
Site 12	06/16/10	2200	45	87%
Site 12	**07/28/10**	**3000**	**46**	**89%**
21FLGW 35445	**10/21/2008**	**3200**	**47**	**91%**
21FLPDEM09-03	10/23/2007	3700	48	93%
Site 12	03/02/11	5400	49	95%
21FLPDEM09-03	9/18/2006	6100	50	97%
21FLPDEM09-03	7/24/2006	8600	51	99%
-	-	-	Existing condition concentration–90th percentile (counts/100mL)	3100
-	-	-	Allowable concentration (counts/100mL)	400
-	-	-	Final percent reduction	87

Note: Boldface type indicates concentration used in percent reduction calculations

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:

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

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

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

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 TMDLs for Cedar Creek (Tidal) and Cedar Creek are expressed as a percent reduction, and represent the maximum daily fecal coliform load the streams can assimilate without exceeding the fecal coliform criterion (**Table 6.1**).

6.2 Load Allocation

Based on a percent reduction approach, the LA for percent reduction in fecal coliform from nonpoint sources for each WBID is presented in **Table 6.1**. 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

There are no NPDES-permitted wastewater facilities in either the Cedar Creek (Tidal) or Cedar Creek watersheds.

It should be noted 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 future 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 percent reduction in current fecal coliform loading for each WBID is presented in **Table 6.1**.

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 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.

Table 6.1. TMDL Components for Fecal Coliform in WBIDs 1556 and 1556A

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.

[1] N/A = Not applicable

WBID	Waterbody Name	Parameter	TMDL (counts/100mL)	WLA for Wastewater (counts/100mL)	WLA for NPDES Stormwater (% reduction)	LA (% reduction)	MOS
1556	Cedar Creek (Tidal)	Fecal coliform	400	N/A[1]	88	88	Implicit
1556A	Cedar Creek	Fecal coliform	400	N/A[1]	87	87	Implicit

Chapter 7: TMDL IMPLEMENTATION

7.1 Basin Management Action Plan

Following the adoption of these TMDLs 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 these TMDLs, 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.

The Department has released a guidance document developed from the Department's experiences in collaborating with local stakeholders during BMAP efforts around the state (http://www.dep.state.fl.us/water/watersheds/docs/fcg_toolkit.pdf). The document provides local stakeholders useful information for identifying sources of fecal coliform bacteria in their watersheds and examples of management actions to address these sources. Tools such as the guidance document will 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. The estimates were based on the best information available to the Department when the calculation was made. The numbers provided do not represent the actual loadings from the sources.

Pets

Pets (especially dogs) could be a significant source of coliform pollution through surface runoff within the WBID boundaries. 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 WBID boundaries is unknown. Therefore, the statistics produced by APPMA were used in these analyses to estimate the possible fecal coliform loads contributed by dogs.

Using information from the Florida Department of Revenue's (DOR) 2010 Cadastral tax parcel and ownership coverage contained in the Department's geographic information system (GIS) library, residential parcels were identified using DOR's land use codes. The final number of households within each WBID boundary was calculated by adding the number of residential units on the parcels for all improved residential land use codes. The estimated number of households within each of the WBID boundaries is shown in **Table B.1**.

Table B.1 also shows the estimated number of dogs within each WBID boundary, assuming that 40 percent of the households in these areas have 1 dog; the total waste produced (grams/day) by dogs and left on the land surface in residential areas in the WBIDs, assuming that 40 percent of dog owners do not pick up their dogs' feces; and the total load of fecal coliform produced by dogs (counts/day) within each WBID boundary.

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

Table B.2 shows the waste production rate for a dog (450 grams/animal/day) and the fecal coliform counts per gram of dog waste (2,200,000 counts/gram).

Table B.1. Estimated Number of Households and Dogs, Waste Produced (grams/day) by Dogs Left on the Land Surface and Total Load of Fecal Coliform (counts/day) Produced by Dogs within each WBID Boundary

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

WBID	# Households	# Dogs	Waste Produced Left on Land Surface (grams/day)	Loading (counts/day)
1556	872	349	62,784	1.38E+11
1556A	3,312	1,325	238,464	5.25E+11

Table B.2. Dog Population Density, Wasteload and Fecal Coliform Density Based on the Literature (Weiskel et al., 1996)

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

- = Empty cell/no data
* Number from APPMA

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

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. Therefore, in this report, the possible fecal coliform load contributed by sewer line leakage was estimated based on an empirical leakage rate of 0.5 percent of the total raw sewage (Culver et al., 2002) created within the WBIDs by the households connected to the sewer system.

The estimated number of properties connected to the sewer system was based on data obtained from the Florida Department of Health's (FDOH) ongoing inventory of wastewater treatment and disposal method for developed properties. Using information from the DOR's 2010 Cadastral tax parcel and ownership coverage, residential parcels were identified using DOR's land use codes. The final number of households within each WBID boundary was calculated by adding the number residential units on the parcels for all improved residential land use codes (see **Table B.1**). **Table B.3** shows the estimated number of households *(N)* within the WBID boundaries served by sewer systems.

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 WBID boundaries 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 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 (100mL/gallon).

The discharge rate through sewers from each household (*Q*) was calculated by multiplying the average household size for Pinellas County (2.21) (U.S. Census Bureau 2010) by the per capita wastewater production rate per day (70 gallons/day/person). The commonly cited concentration (*C*) for domestic wastewater is $1x10^6$ counts/100 mL 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.1**, the approximate fecal coliform loading from sewer line leakage in each the WBID is summarized in **Table B.3.**

Table B.3. Estimated Number of Households Served by Sanitary Sewers and Estimated Fecal Coliform Loading from Sewer Line Leakage within each WBID Boundary

This is a three-column table. Column 1 lists the WBID number, Column 2 lists the number of households served by sanitary sewers, Column 3 lists the sanitary sewer loading

WBID	# of Households Served by Sanitary Sewers	Sanitary Sewer (counts/day)
1556	872	2.6E+10
1556A	3,312	9.7E+10

Septic Tanks

Based on information obtained from the FDOH onsite sewage data, all housing units within the WBID boundaries are served by sewer systems.

Wildlife

Wildlife (deer, birds, raccoons) is another possible source of fecal coliform bacteria within the Cedar Creek (Tidal) and Cedar Creek WBID boundaries. However, as these represent natural inputs, no reductions are assigned to these sources by these TMDLs.

Appendix C: TMDL Public Comments for Fecal Coliform TMDLs

September 24, 2012

Robert DiSpirito
City Manager
City of Dunedin
Post Office Box 1348
Dunedin, Florida 34967-1348

Re: Response to Comments from the City of Dunedin Comments on Draft TMDLs for Springs Coast Basin – Curlew Creek Freshwater Segment (WBID 1538A), Cedar Creek Tidal (WBID 1556) and Fresh (WBID 1556A)

Dear Mr. Dispirito:

Thank you for your comments regarding our recently proposed Total Maximum Daily Load (TMDL) reports for fecal coliform in the Springs Coast basin. The Department appreciates the time and effort you put into reviewing these draft TMDLs. This letter is in response to your comment letter dated July 23, 2012. Below are the comments from the City of Dunedin and our responses to these comments:

City of Dunedin Comments:

1. In February, 2010, the city of Dunedin implemented a continuing surface water quality monitoring program at 13 sites throughout the City. The program monitors water quality in Curlew Creek, in Cedar Creek and in Stevenson Creek. Attached is a copy of a summary report, dated June 5, 2012, which presents both the details of accumulated water quality data and an indication of conditions observed at each site at the time of sampling. We consider these data to be more credible because they better reflect current conditions for development and for sanitary sewer vs. septage service.

2. We consider these data to be much more appropriate for TMDL and other water quality assessment purposes, than data compiled before February 2010.

FDEP Response:

The Department appreciates receiving the monitoring data provided by the City of Dunedin. While we agree these data better reflect current conditions, several analyses comparing data collected by the Department's Southwest District and Pinellas County Department of Environment and Infrastructure (DEMI) and the data collected for the City's continuing surface water quality monitoring program show that the magnitudes and variations of fecal coliform concentrations between the datasets are similar to each other, which adds to the Department's confidence in the data used in the TMDL development for WBIDs 1538A, 1556 and 1556A. See figures below:

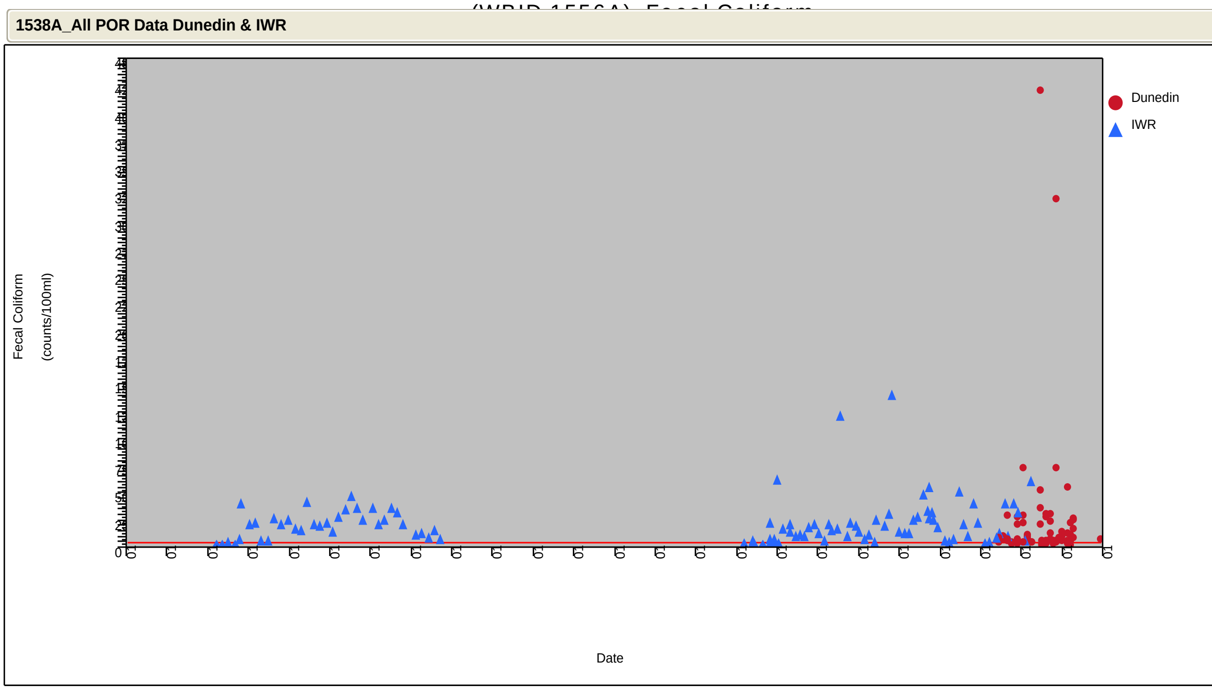

Figure 1. Fecal Coliform Concentration Trends at Curlew Creek Freshwater Segment (WBID 1538A) for the Entire Period of Record (1991-2012). Data collected by the Department's Southwest District and DEMI are presented in blue. Data collected for Dunedin's continuing surface water quality monitoring program are presented in red. The red line indicates the target concentration (400 counts/100mL).

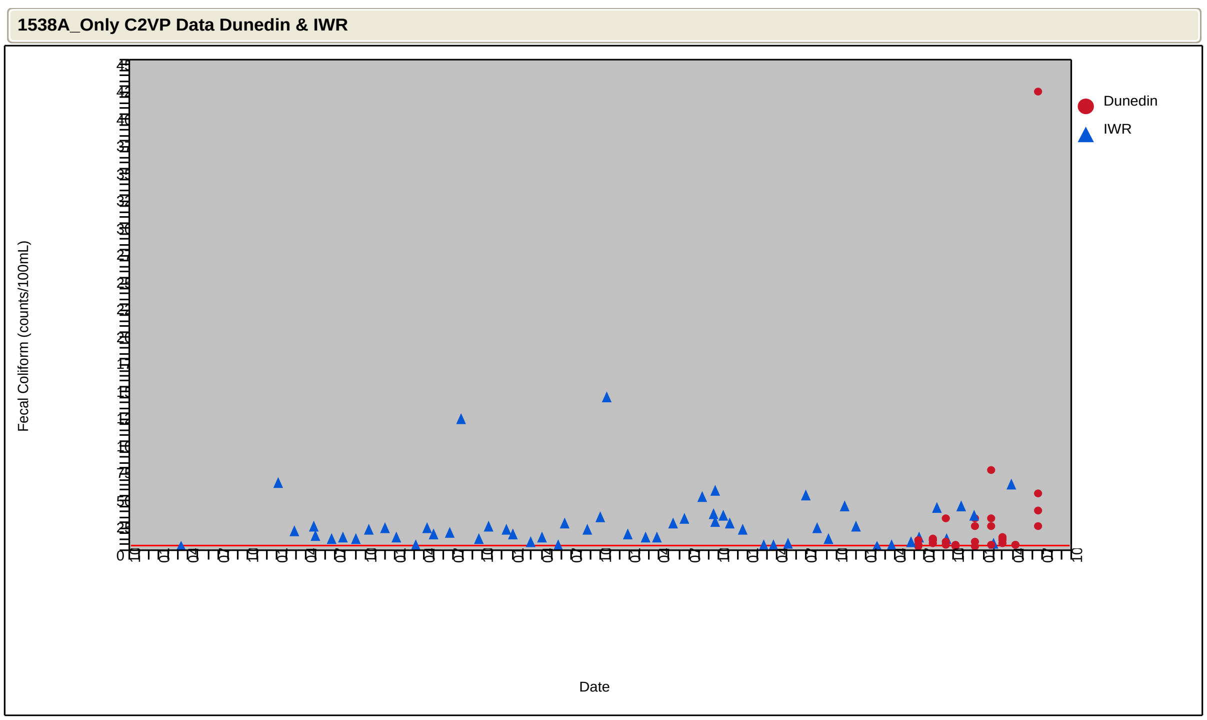

Figure 2. Fecal coliform concentration trends at Curlew Creek Freshwater Segment (WBID 1538A) during the Cycle 2 Verified Period (January 1, 2004 to June 30, 2011). Data collected by the Department's Southwest District and DEMI are presented in blue. Data collected for Dunedin's continuing surface water quality monitoring program are presented in red. The red line indicates the target concentration (400 counts/100mL).

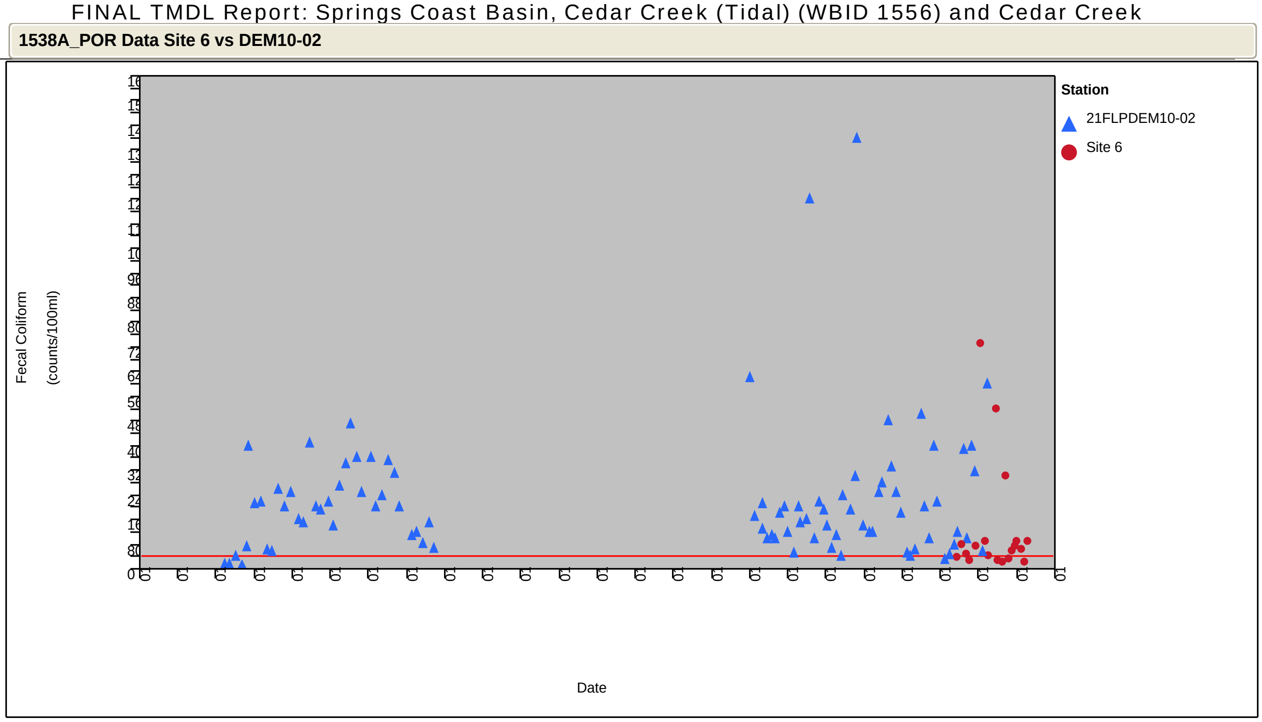

Figure 3. Fecal coliform concentration trends at co-located stations in the Curlew Creek Freshwater Segment (WBID 1538A) during the entire period of record (1991-2012). Data collected by the DEMI are presented in blue. Data collected for Dunedin's continuing surface water quality monitoring program are presented in red. The red line indicates the target concentration (400 counts/100mL).

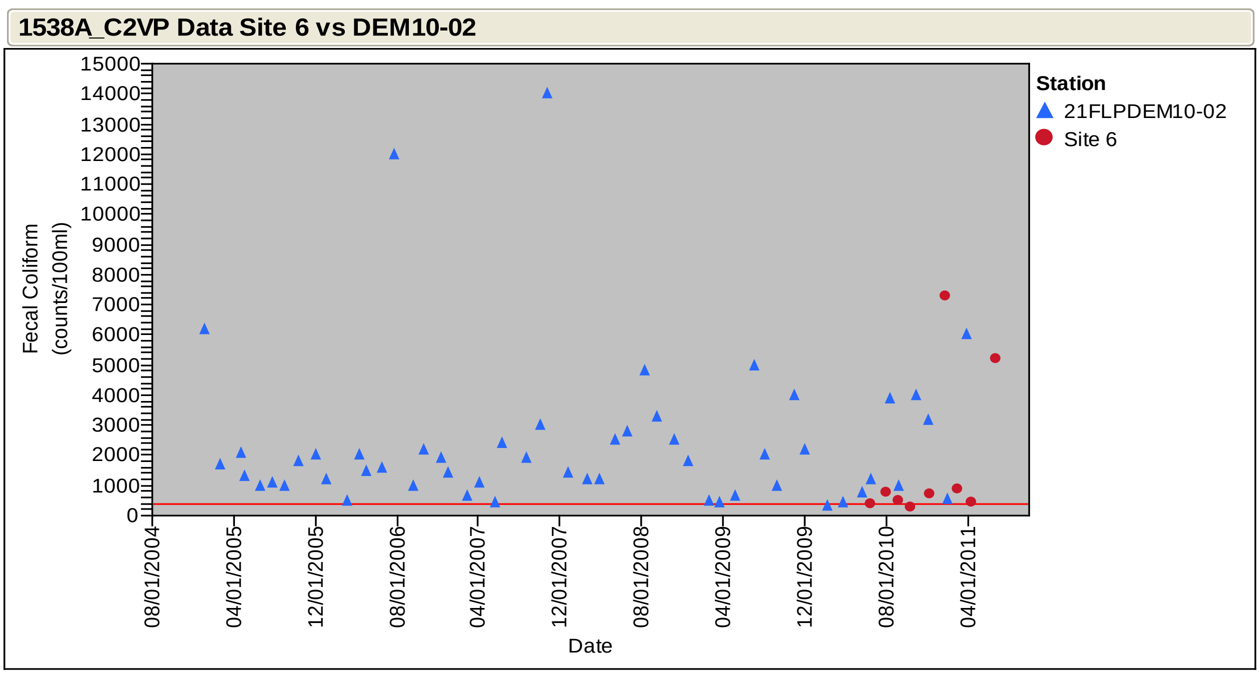

Figure 4. Fecal coliform concentration trends at co-located stations in the Curlew Creek Freshwater Segment (WBID 1538A) during the Cycle 2 Verified Period (January 1, 2004 to June 30, 2011). Data collected by DEMI are presented in blue. Data collected for Dunedin's continuing surface water quality monitoring program are presented in red. The red line indicates the target concentration (400 counts/100mL).

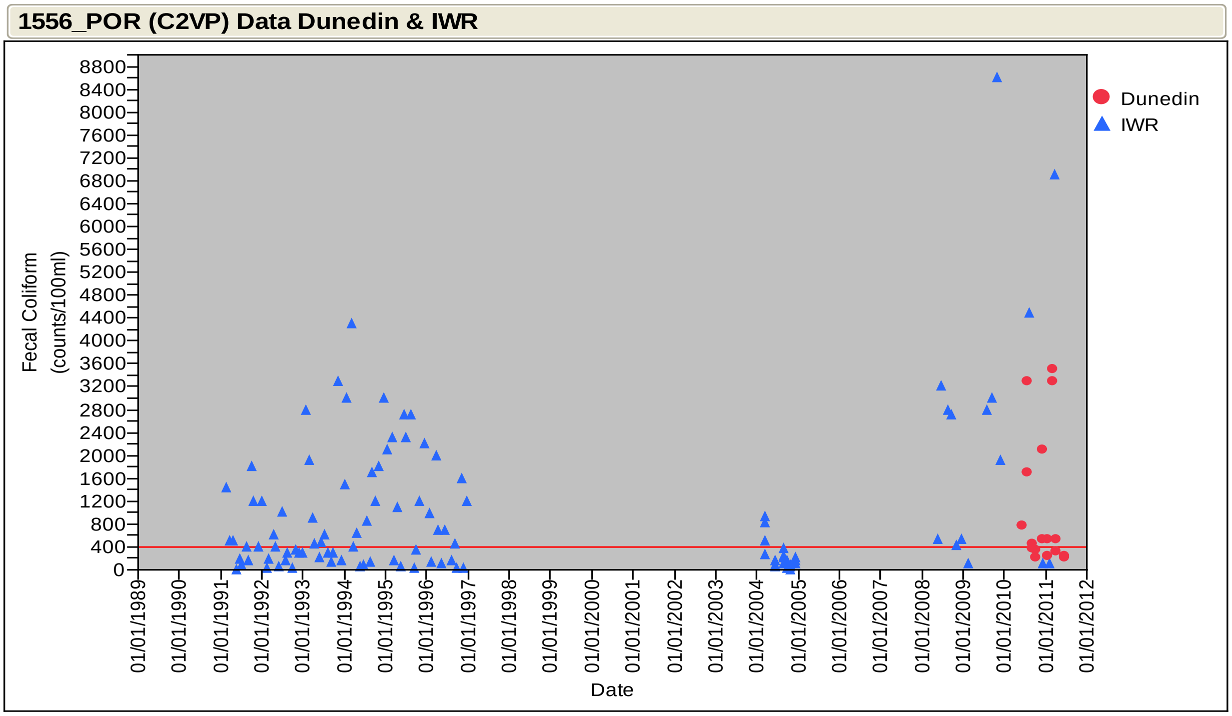

Figure 5. Fecal coliform concentration trends at Cedar Creek (Tidal) (WBID 1556) for the entire period of record (1991-2011). Data collected by the Department's Southwest District and DEMI are presented in blue. Data collected for Dunedin's continuing surface water quality monitoring program are presented in red. The red line indicates the target concentration (400 counts/100mL).

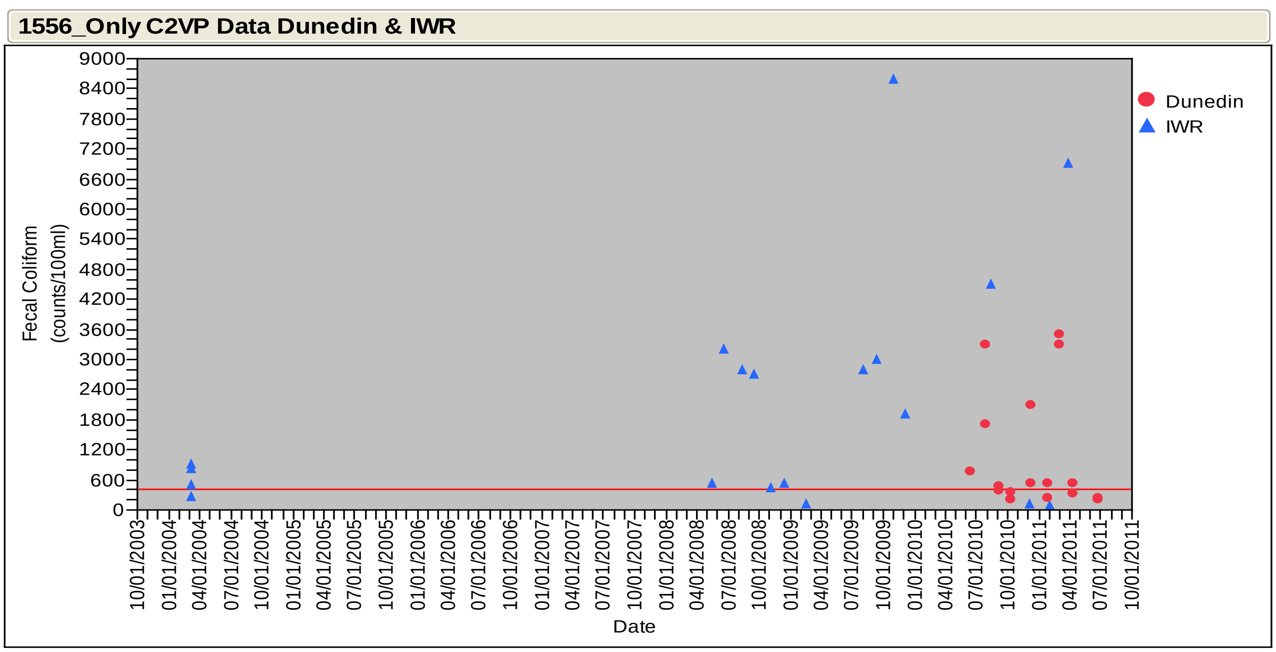

Figure 6. Fecal coliform concentration trends at Cedar Creek (Tidal) (WBID 1556) during the Cycle 2 Verified Period (January 1, 2004 to June 30, 2011). Data collected by the Department's Southwest District and DEMI are presented in blue. Data collected for Dunedin's continuing surface water quality monitoring program are presented in red. The red line indicates the target concentration (400 counts/100mL).

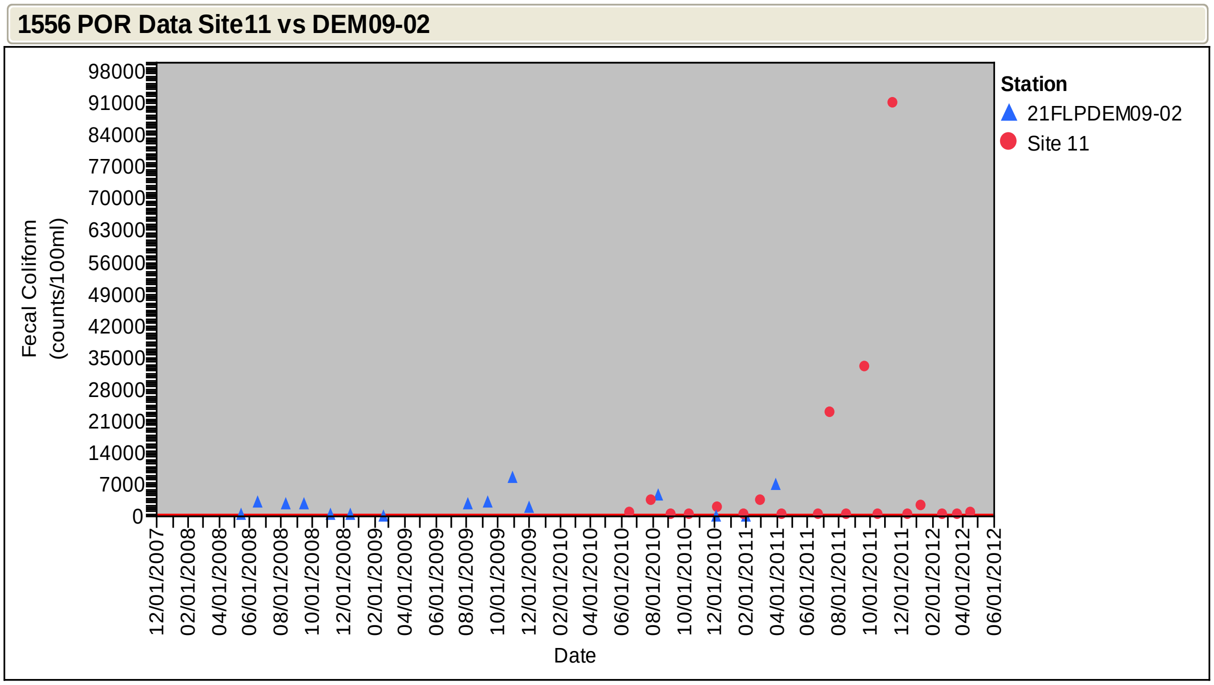

Figure 7. Fecal coliform concentration trends at co-located stations in Cedar Creek (Tidal) (WBID 1556) during the entire period of record (1991-2012). Data collected by the DEMI are presented in blue. Data collected for Dunedin's continuing surface water quality monitoring program are presented in red. The red line indicates the target concentration (400 counts/100mL).

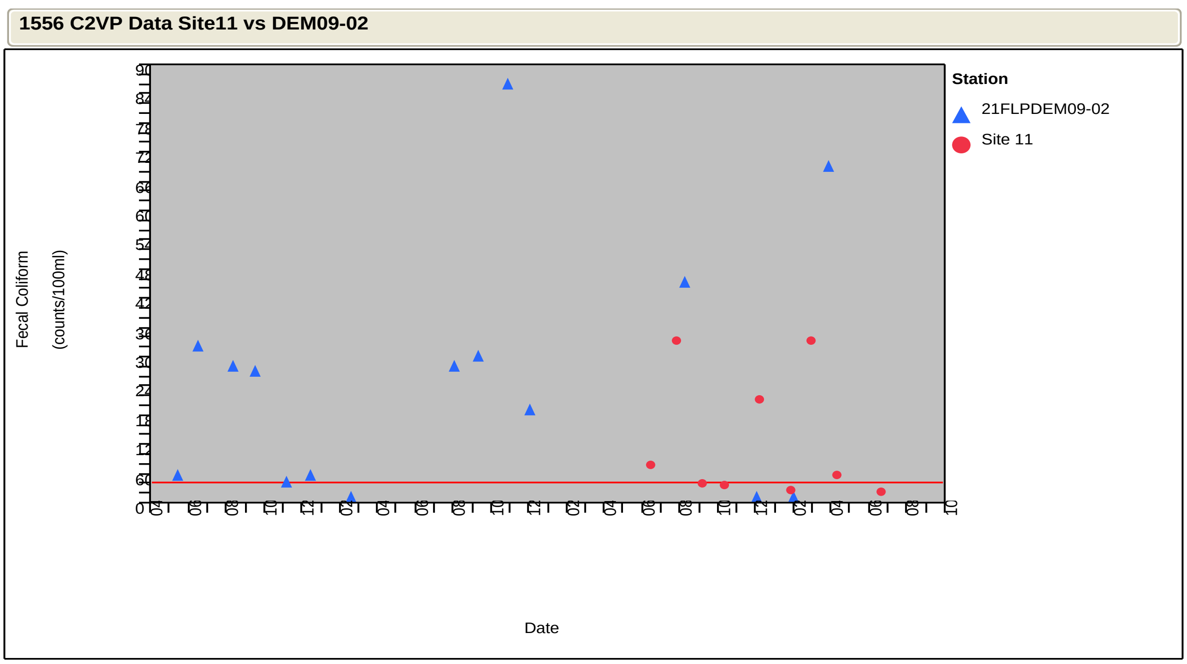

Figure 8. Fecal coliform concentration trends at co-located stations in Cedar Creek (Tidal) (WBID 1556) during the Cycle 2 Verified Period (January 1, 2004 to June 30, 2011). Data collected by DEMI are presented in blue. Data collected for Dunedin's continuing surface water quality monitoring program are presented in red. The red line indicates the target concentration (400 counts/100mL).

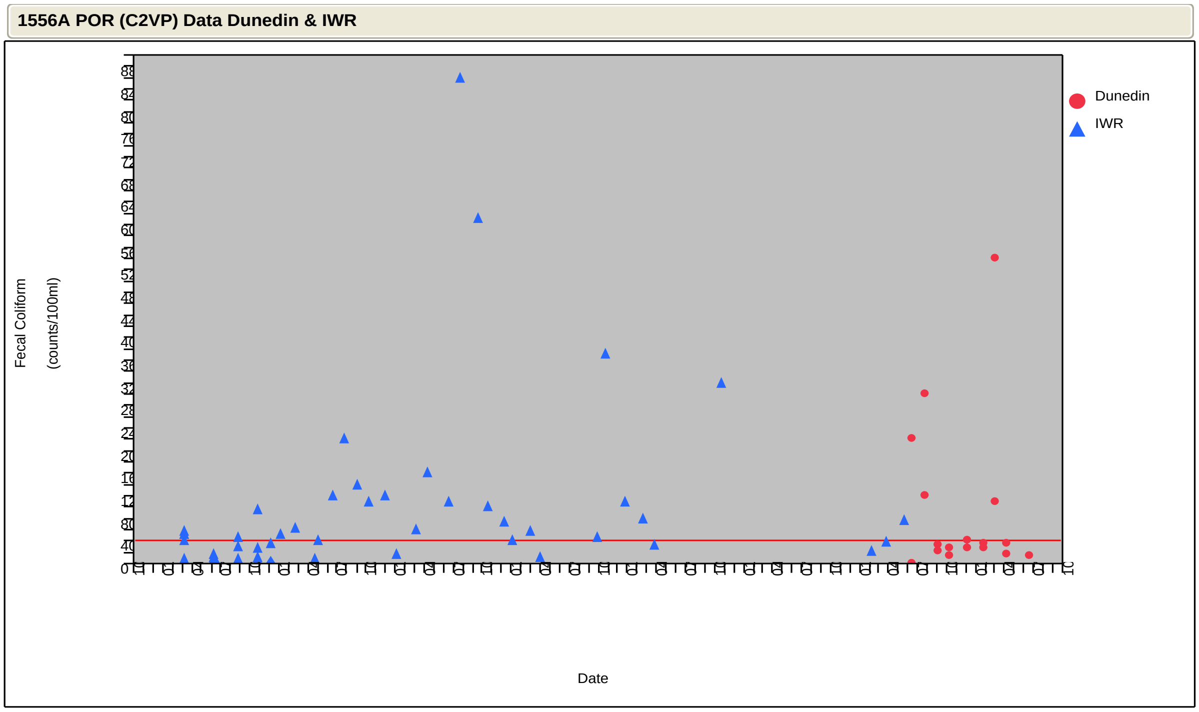

Figure 9. Fecal coliform concentration trends at Cedar Creek (WBID 1556A) for the entire period of record (2004-2011). Data collected by the Department's Southwest District and DEMI are presented in blue. Data collected for Dunedin's continuing surface water quality monitoring program are presented in red. The red line indicates the target concentration (400 counts/100mL).

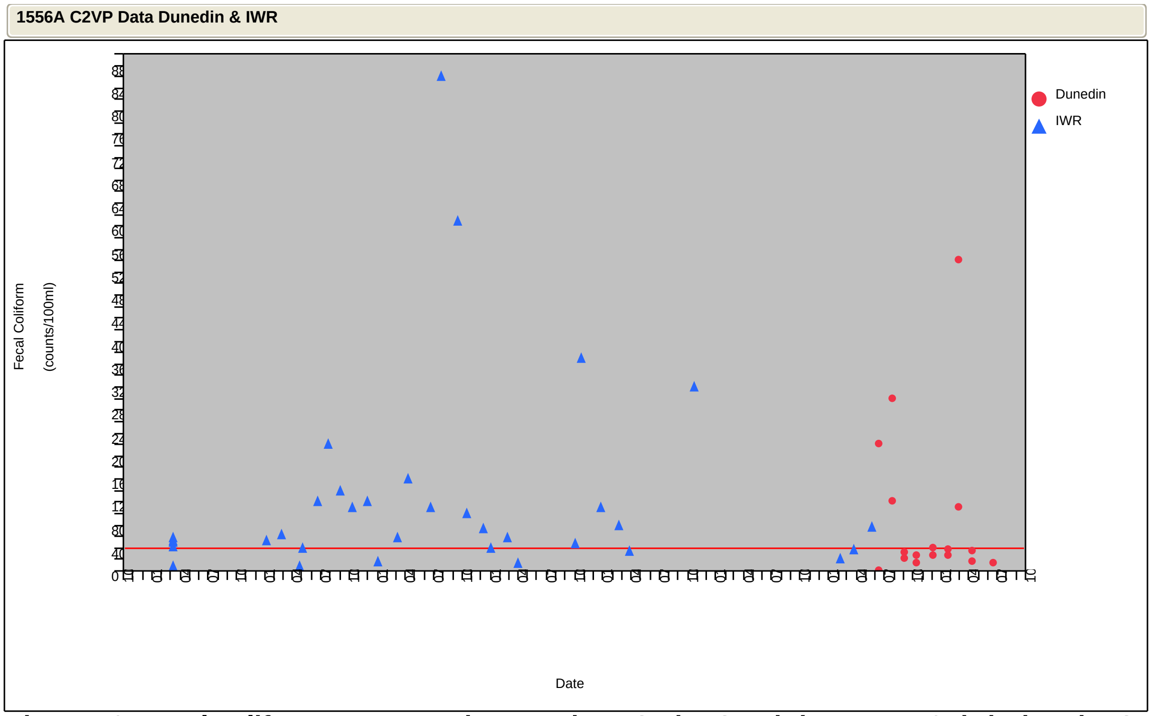

Figure 10. Fecal coliform concentration trends at Cedar Creek (WBID 1556A) during the Cycle 2 Verified Period (January 1, 2004 to June 30, 2011). Data collected by the Department's Southwest District and DEMI are presented in blue. Data collected for Dunedin's continuing surface water quality monitoring program are presented in red. The red line indicates the target concentration (400 counts/100mL).

1556A POR Data Site10 vs DEM09-03 & 21FLTPA 28020288246345

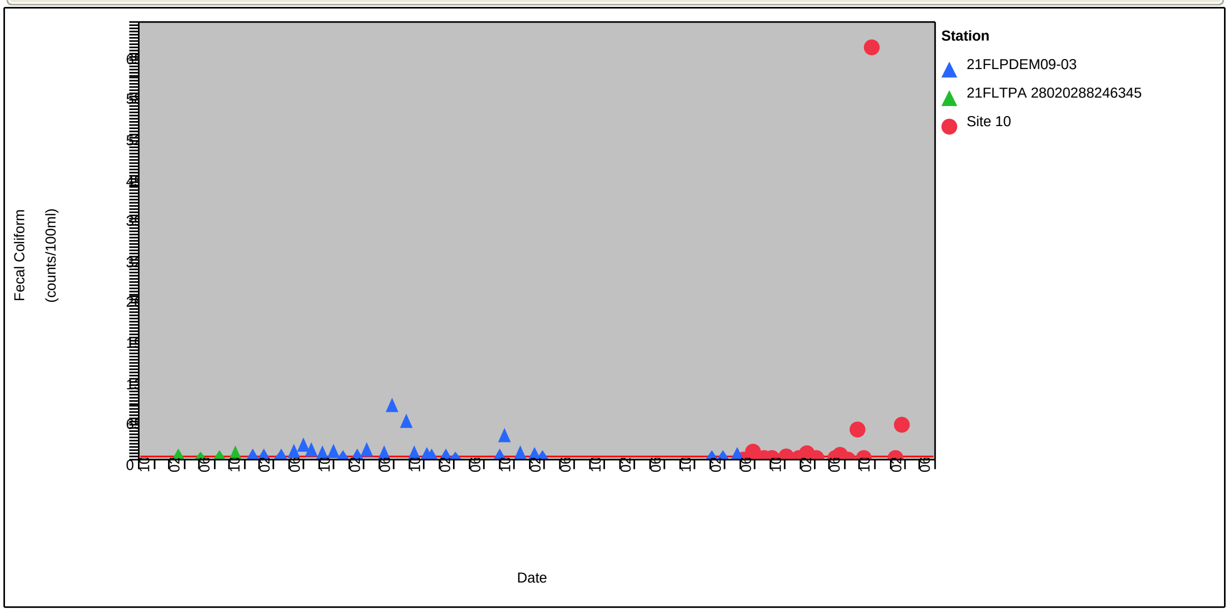

Figure 11. Fecal coliform concentration trends at co-located stations in Cedar Creek (WBID 1556A) during the entire period of record (2004-2012). Data collected by the Department's Southeast District are presented in green. Data collected by DEMI are presented in blue. Data collected for Dunedin's continuing surface water quality monitoring program are presented in red. The red line indicates the target concentration (400 counts/100mL).

1556A C2VP Data Site10 vs DEM09-03 & 21FLTPA 28020288246345

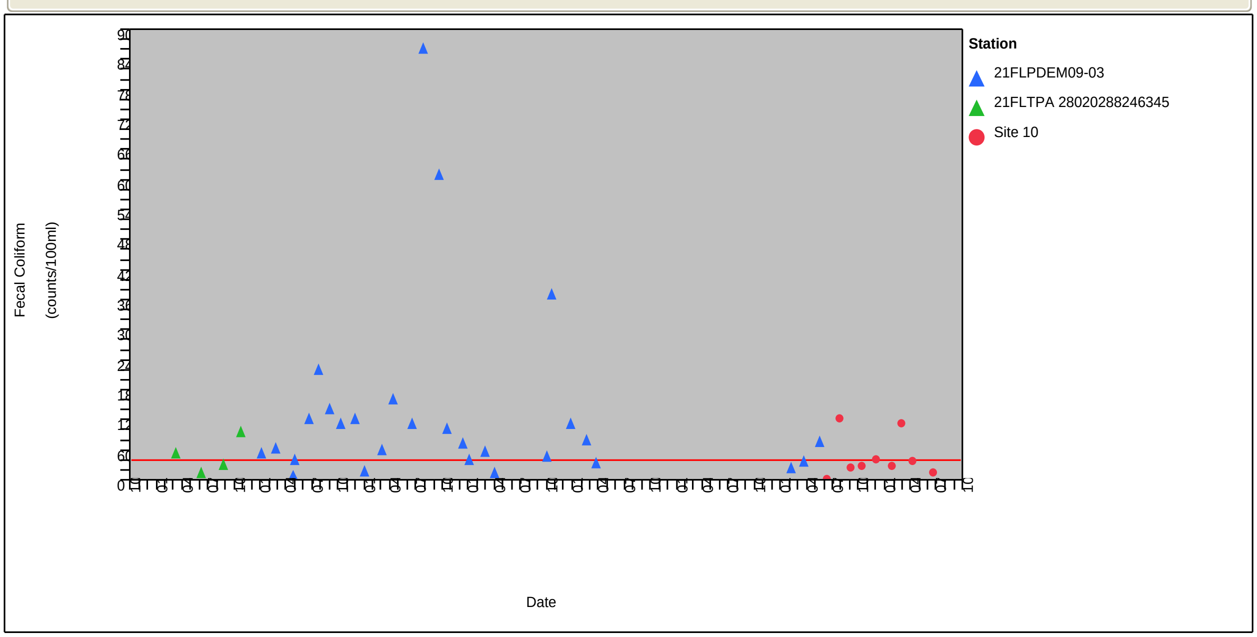

Figure 12. Fecal coliform concentration trends at co-located stations in Cedar Creek (WBID 1556A) during the Cycle 2 Verified Period (January 1, 2004 to June 30, 2011). Data collected by the Department's Southeast District are presented in green. Data collected by DEMI are presented in blue. Data collected for Dunedin's continuing surface water quality monitoring program are presented in red. The red line indicates the target concentration (400 counts/100mL).

City of Dunedin Comment:

3. Fecal coliform data compiled since February 2011 indicate counts ranging from about 200 to in excess of 20,000 counts per 100 ml. The data indicate regular excursions above the allowable standard and indicate a need for fecal coliform control and reduction. However, there is not sufficient information with which to conclude or recommend that stormwater discharges must be subject to a 90% reduction in fecal coliforms. We consider that a BMAP should, at least, initially confirm actual sources and source loads before developing an expectation of percentage reductions.

FDEP Response:
The data used for the percent reduction calculations were all collected during the Cycle 2 verified period (January 1, 2004 through June 30, 2011) and include data from STORET collected by the Department's Southwest District and Pinellas County Department of Environment and Infrastructure (DEMI), data collected for the City of Dunedin's Surface Water Quality Monitoring Program and data collected by the Mid-County WWTF. Based on available data for WBIDs 1538A, 1556 and 1556A percent reductions of 90%, 88% and 87%, respectively, are required for each waterbody. However, the focus on restoration and implementation of the TMDL should be on meeting the state criterion of 400 counts/100mL, rather than the percent reduction.

Following the adoption of these TMDLs by rule, the next phase of the TMDL process is the development of the Basin Management Action Plan (BMAP), or the TMDL implementation plan. The Department will determine the best course of action regarding the implementation. The Department will work with stakeholders throughout the process of creating the TMDL implementation plan for potential source identification, to ensure that the appropriate source assessment tools are used, that management actions are sufficient to address the potential sources, and that the completed plan includes the necessary actions to achieve the TMDL.

As your letter suggests, the BMAP process will include walking the watershed of impaired waters, identifying possible sources that cause the observed exceedances (failed septic tanks, leaking sewer lines, inappropriate disposal of wastes from domestic animals, etc.), and getting these sources fixed. To clarify, a BMAP is an implementation plan for adopted TMDLs. In other words, the BMAP stage comes after the TMDL stage. We agree with you that, identifying and confirming actual sources is an indispensible part of the BMAP development.

City of Dunedin Comment:

4. We concur that uncollected pet wastes, septage discharges, sanitary sewer overflows and wildlife wastes are likely sources of fecal coliform in both Curlew Creek and Cedar Creek. However, absent more site specific information, the report computations of the potential magnitudes of these likely sources should not be considered as anything more than illustrative. As with issue 2, we consider that a BMAP should initially confirm actual sources and source loads before developing an expectation of load reductions.

FDEP Response:
The Department conducted a preliminary quantification of the fecal coliform loadings from potential sources (pet waste, septic tanks and sanitary sewer overflows) provided in detail in Appendix B of the fecal coliform TMDL reports. As is mentioned in the report, it should be noted that this information is only used to illustrate the relative contribution from each of these potential sources, but is not used for the final load reduction estimation.

Again, thank you very much for your time and effort in reviewing our TMDLs. We hope to continuously working with you to improve the quality of our TMDLs and restore Florida waters.
Please contact me at Jan.Mandrup-Poulsen@dep.state.fl.us if you have any further comments.

Sincerely,

Jan Mandrup-Poulsen, Environmental Administrator
Watershed Evaluation and TMDL Section
Florida Department of Environmental Protection

Florida Department of Environmental Protection
Division of Environmental Assessment and Restoration
Bureau of Watershed Restoration
2600 Blair Stone Road
Tallahassee, Florida 32399-2400