

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Water Resource Management, Bureau of Watershed Management

CENTRAL DISTRICT • INDIAN RIVER LAGOON BASIN

TMDL Report
Fecal Coliform TMDL for
Crane Creek,
WBIDs 3085 and 3085A

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Websites

Florida Department of Environmental Protection, Bureau of Watershed Management

TMDL Program

<http://www.dep.state.fl.us/water/tmdl/index.htm>

Identification of Impaired Surface Waters Rule

<http://www.dep.state.fl.us/water/tmdl/docs/AmendedIWR.pdf>

STORET Program

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

2006 Integrated Report

[http://www.dep.state.fl.us/water/tmdl/docs/2006 Integrated Report.pdf](http://www.dep.state.fl.us/water/tmdl/docs/2006%20Integrated%20Report.pdf)

Surface Water Quality Standards

<http://www.dep.state.fl.us/legal/rules/shared/62-302/62-302.pdf>

Basin Status Report for the Indian River Lagoon Basin

<http://www.dep.state.fl.us/water/basin411/indianriver/status.htm>

U.S. Environmental Protection Agency

Region 4: Total Maximum Daily Loads in Florida

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

National STORET Program

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

Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Load (TMDL) for fecal coliform bacteria for Crane Creek in the Indian River Lagoon Basin. The creek was verified as impaired for fecal coliform and therefore was included on the Verified List of impaired waters for the Indian River Lagoon Basin that was adopted by Secretarial Order on December 12, 2007. The TMDL establishes the allowable fecal coliform loadings to Crane Creek that would restore the waterbody so that it meets its applicable water quality criterion for fecal coliform.

1.2 Identification of Waterbody

Crane Creek is located in the southeast part of Brevard County. It flows primarily in an easterly direction into the Indian River Lagoon and drains an area of about 18.2 square miles. The Crane Creek watershed is located in the central part of the city of Melbourne, where the majority of land use is highly urbanized. The creek receives water through canal ditches from the urban area. It is divided into two WBIDs, which include a predominantly freshwater segment (WBID 3085) and a predominantly marine segment (WBID 3085A) (**Figure 1.1**). These two parts are connected to each other, and fresh water flows in an easterly direction into the estuary.

For assessment purposes, the Florida Department of Environmental Protection (Department) has divided the Indian River Lagoon Basin into water assessment polygons with a unique **waterbody identification** (WBID) number for each watershed or stream reach. This TMDL addresses the following WBIDs:

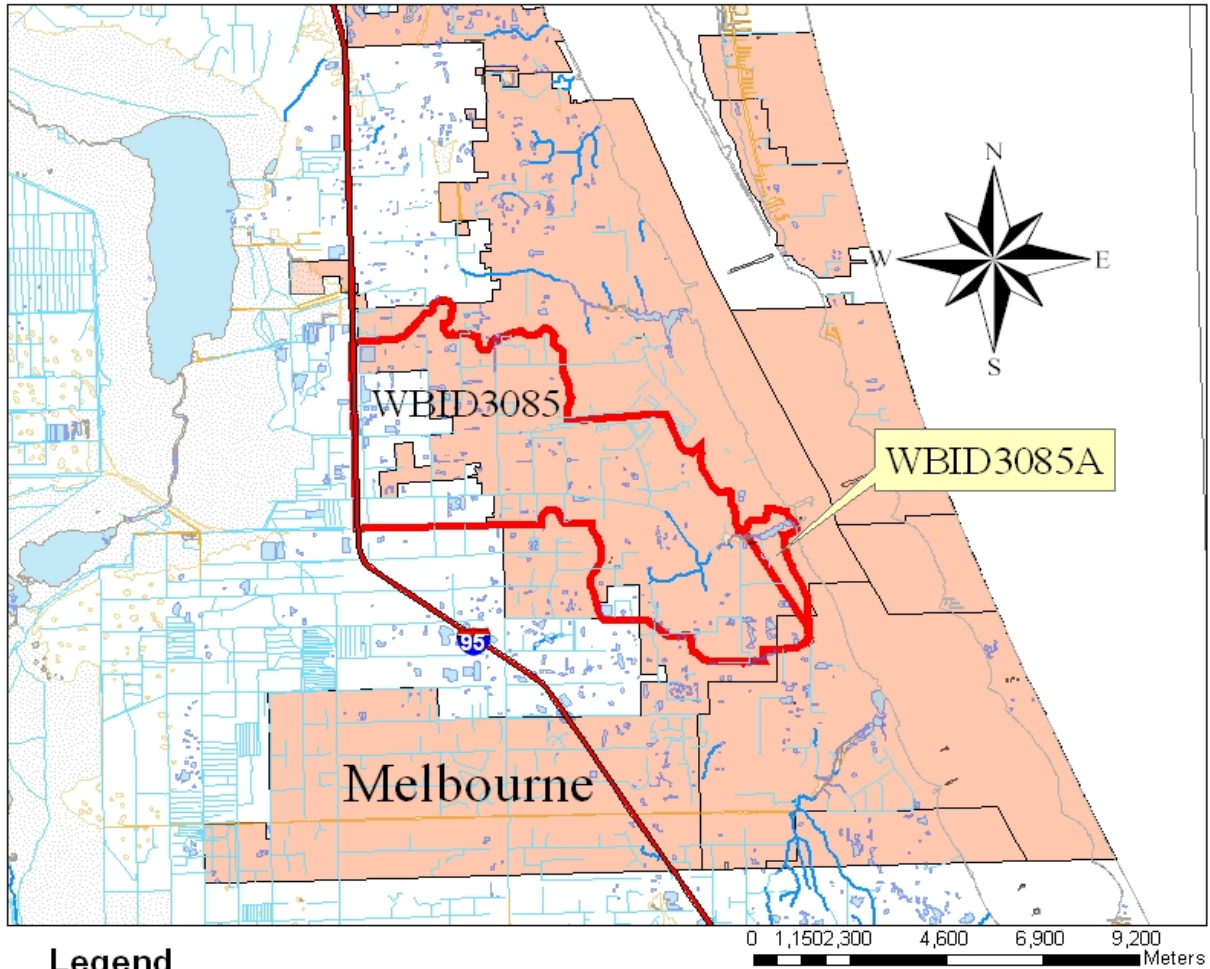
**WBID 3085, Crane Creek (Fresh Water) – for fecal coliform, and
WBID 3085A, Crane Creek (Marine) – for fecal coliform.**

1.3 Background

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

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

Figure 1.1. Location of Crane Creek in Brevard County and Major Hydrological Features in the Area



Legend

Two WBID boundary

City Limits (poly)

NHDFlowline

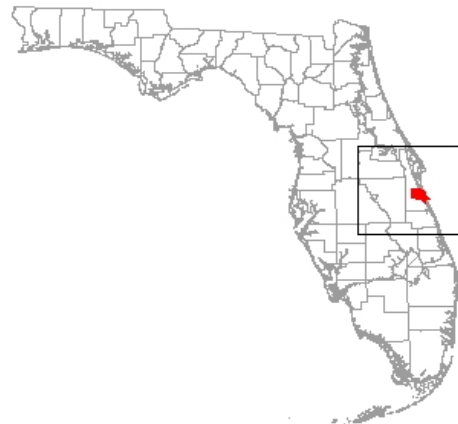
Feature Type

Canal/Ditch

Coastline

Stream/River

FDOT Interstates



This TMDL Report will be followed by the development and implementation of a Basin Management Action Plan, or BMAP, designed to reduce the amount of fecal coliform that caused the verified impairment of Crane Creek. These activities will depend heavily on the active participation of the St. Johns River Water Management District (SJRWMD), local governments, businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDLs for impaired waterbodies.

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rulemaking History

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

Florida's 1998 303(d) list included 26 waterbodies in the Indian River Lagoon Basin. However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rulemaking process, the Environmental Regulation Commission adopted the new methodology as Rule 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001; the rule was modified in 2006 and 2007.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in the Crane Creek watershed and has verified that these waterbody segments are impaired for fecal coliform bacteria. For the freshwater segment of the creek (WBID 3085), the verification of impairment was based on the observations that 49 out of 81 fecal coliform samples collected during the verified period (January 1, 1999, through June 30, 2006) exceeded the applicable fecal water quality criterion (Rule 62-302, F.A.C.). For the marine segment of the creek (WBID 3085A), the verification of impairment was based on the observation that 17 out of 32 fecal coliform samples collected during the verified period exceeded the applicable fecal water quality criterion.

Table 2.1 summarizes the fecal coliform monitoring results for the verified period for each WBID.

Table 2.1. Summary of Fecal Coliform Monitoring Data for Crane Creek During the Verified Period: Freshwater Segment (WBID 3085) and Marine Segment (WBID 3085A)

Waterbody (WBID)	Parameter	Fecal Coliform
Crane Creek (Fresh Water) (3085)	Total number of samples	81
	IWR-required number of exceedances for the Verified List	13
	Number of observed exceedances	49
	Number of observed nonexceedances	32
	Number of seasons during which samples were collected	4
	Highest observation (MPN/100mL)*	6,800
	Lowest observation (MPN/100mL)	4
	Median observation (MPN/100mL)	440
	Mean observation (MPN/100mL)	824
	FINAL ASSESSMENT	Impaired
Crane Creek (Marine) (3085A)	Total number of samples	32
	IWR-required number of exceedances for the Verified List	6
	Number of observed exceedances	17
	Number of observed nonexceedances	15
	Number of seasons during which samples were collected	4
	Highest observation (MPN/100mL)*	20,000
	Lowest observation (MPN/100mL)	83
	Median observation (MPN/100mL)	485
	Mean observation (MPN/100mL)	2,181
	FINAL ASSESSMENT	Impaired

* Most probable number per 100 milliliters.

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)

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

3.2 Applicable Water Quality Standards and Numeric Water Quality Target

Numeric criteria for bacterial quality are expressed in terms of fecal coliform bacteria concentration. The water quality criterion for the protection of Class III 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. During the development of load duration curves for the impaired segments (as described in subsequent chapters), there were insufficient data (fewer than 10 samples in a given month) available to evaluate the geometric mean criterion for fecal coliform bacteria. Therefore, the criterion selected for the TMDLs was not to exceed 400 MPN/100 mL in any sampling event for fecal coliform. The 10 percent exceedance allowed by the water quality criterion for fecal coliform bacteria was not used directly in estimating the target load, but was included in the TMDL margin of safety (as described in subsequent chapters).

Chapter 4: ASSESSMENT OF SOURCES

4.1 Types of Sources

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

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

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

4.2 Potential Sources of Fecal Coliform in the Crane Creek Watershed

4.2.1 Point Sources

Wastewater Point Sources

One NPDES-permitted wastewater facility (Melbourne/Grant Street WWTP, FL0041122) was identified in the Crane Creek watershed. This domestic WWTP is currently permitted under a NPDES wastewater permit. The surface water discharge from the facility is limited to a maximum of 5 days during the mechanical integrity testing of the facility’s underground injection well. The discharge is authorized only during the winter months (November through March). No maximum value is designated in the permit for the discharge rate. For the period from 1999 through 2006, the facility only discharged twice, in March 1999 and March 2004. The discharge

rates were 3.74 million gallons per day (mgd) and 3.7 mgd, and the fecal coliform concentrations were 11 counts/100mL and below the detection limit in 1999 and 2004, respectively. The total fecal coliform load from the facility in March 1999 was 1.56×10^9 counts/day.

According to the permit issued to the facility, any one sample shall not exceed 86 fecal coliform counts/100mL. There is an underground injection well system that is limited to 11.5 mgd AADF (Annual Average Daily Flow), which is the permitted combined treatment capacity of the Melbourne D.B Lee WWTF and Melbourne Grant Street WWTF. There is also an existing slow-rate public access land application system. The existing reuse capacity is 0.5 mgd AADF, with a total anticipated reuse capacity of 1.0 mgd AADF.

Municipal Separate Storm Sewer System Permittees

The stormwater collection systems owned and operated by the city of Melbourne in the Crane Creek watershed are covered by a Phase II NPDES municipal separate storm sewer system (MS4) permit (FLR04E027). The city of Melbourne is the lead permittee for the permit. There was no Phase I MS4 permit identified in the Crane Creek watershed.

4.2.2 Land Uses and Nonpoint Sources

Land Uses

The spatial distribution and acreage of different land use categories were identified using the SJRWMD's year 2004 land use coverage (scale 1:40,000) contained in the Department's geographic information system (GIS) library. Land use categories in the watershed were aggregated using the simplified Level 1 codes and tabulated in **Table 4.1**. **Figure 4.1** shows the acreage of the principal land uses in the watershed.

As shown in **Table 4.1**, the Crane Creek watershed drains about 11,642 acres of land. The dominant land use category is urban (urban and built-up; low-, medium-, and high-density residential; and transportation, communication, and utilities), which accounts for about 67 percent of the total watershed area. Of the 7,792 acres of urban lands, residential land use occupies about 4,133 acres, or about 35.5 percent of the total watershed area. Natural land use areas, which include water/wetlands, upland forest, and barren land, occupy about 2,379 acres, accounting for about 20.4 percent of the total watershed area.

Because no significant conventional point source contributor was identified in the Crane Creek watershed, the primary loadings of fecal coliform into these canals are generated by nonpoint sources or MS4-permitted areas in the watershed. Nonpoint sources of coliform bacteria generally, but not always, come from the coliform bacteria that accumulate on land surfaces and wash off as a result of storm events, the contribution from ground water from sources such as failed septic tanks, and the improper land application of domestic wastewater residuals. Typical nonpoint sources of coliform bacteria include the following:

Table 4.1. Classification of Land Use Categories in the Crane Creek Watershed

Level 1 Code	Land Use	Acreage	% Acreage
1000	Urban and built-up	2,532	21.7%
	Low-density residential	161	1.4%
	Medium-density residential	2,949	25.3%
	High-density residential	1,023	8.8%
2000	Agriculture	210	1.8%
3000	Rangeland	1,261	10.8%
4000	Forest/ rural open	1,240	10.7%
5000	Water	389	3.3%
6000	Wetland	556	4.8%
7000	Barren land	194	1.7%
8000	Transportation, communication, and utilities	1,127	9.7%
	TOTAL	11,642	100.0%

- *Wildlife,*
- *Agricultural animals,*
- *Pets in residential areas,*
- *Onsite sewage treatment and disposal systems (septic tanks),*
- *Land application of domestic wastewater residuals, and*
- *Urban development (outside of Phase I or II MS4 discharges).*

No data were available to specifically identify and quantify the major source(s) of fecal coliform bacteria in the Crane Creek watershed. However, the spatial distribution of fecal coliform across Crane Creek and the timing of high fecal coliform readings in the downstream segment of the creek shed some light on the possible sources of these bacteria. In fact, the land use types in the watershed, especially land use around stations from which water quality samples were collected, provide further information on the potentially important sources for the fecal coliform pollution in the watershed.

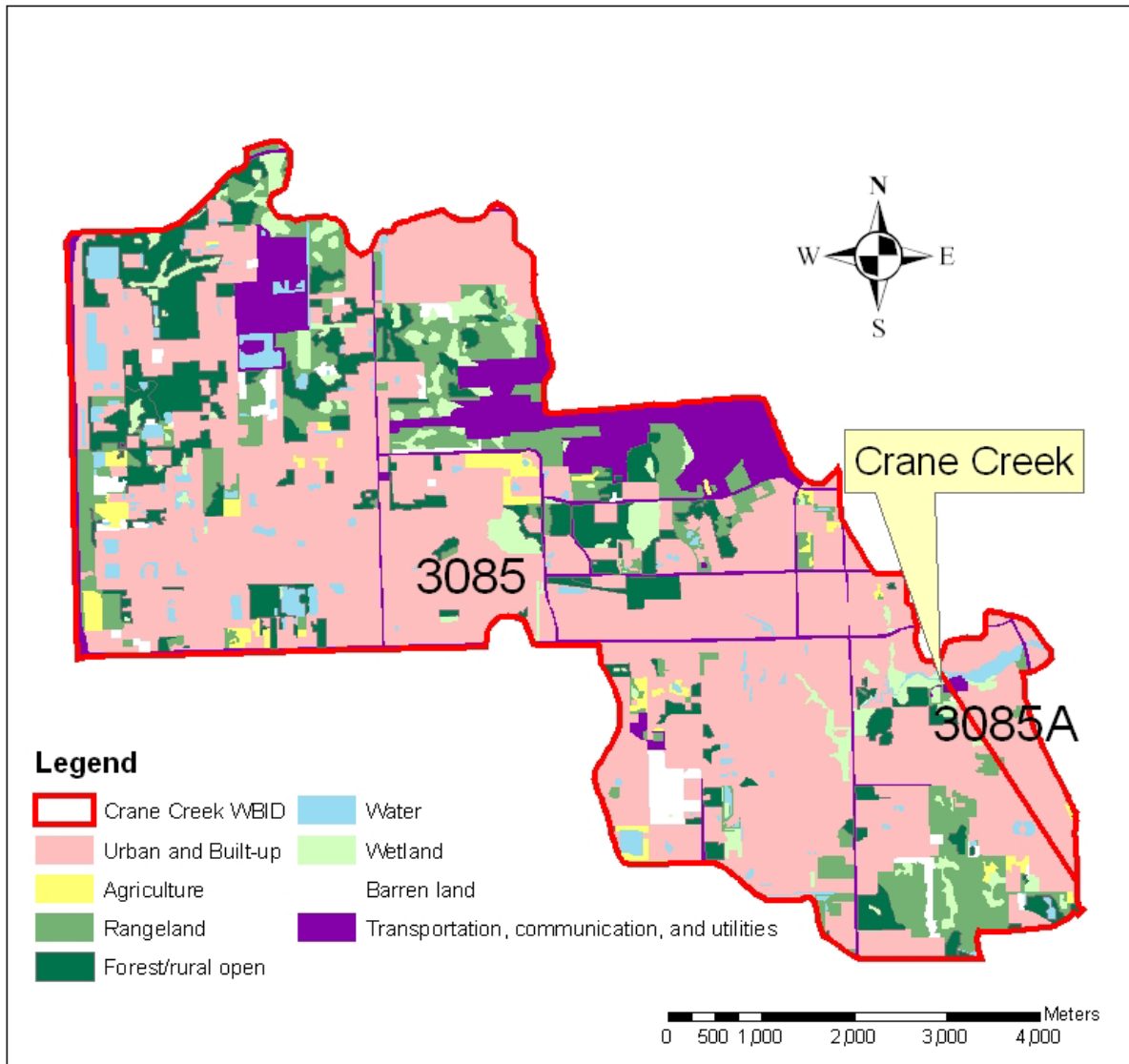


Figure 4.1. Principal Land Uses in Watersheds that Drain to Crane Creek

Figures 4.2 and 4.3 show the fecal coliform concentrations observed in the upstream (WBID 3085) and downstream (WBID 3085A) segments of Crane Creek. In the upstream segment, the concentration of fecal coliform ranged from 4 to 6,800 MPN/100mL, and averaged 848 MPN/100mL during the verified period from 1999 to 2006 (**Figure 4.2**). For the period from 2005 to 2006, fecal coliform concentrations in the upstream segment ranged from 120 to 2,900 MPN/100mL, averaging 673 MPN/100mL. For the downstream segment, fecal coliform data were only collected during 2005 and 2006. The concentration ranged from 83 to 20,000 MPN/100mL, and averaged 2,181 MPN/100mL during the two-year period.

Concentrations of fecal coliform in May 2006 were especially high. Most of the data points collected in this sampling event were higher than 10,000 MPN/100 mL (**Figure 4.3**). The Department continues to collect more samples to confirm if these data are representative of the fecal coliform concentration in the downstream section.

Figure 4.2. Monthly Change in Fecal Coliform Concentrations at Station 21FLGW 3508 in WBID 3805

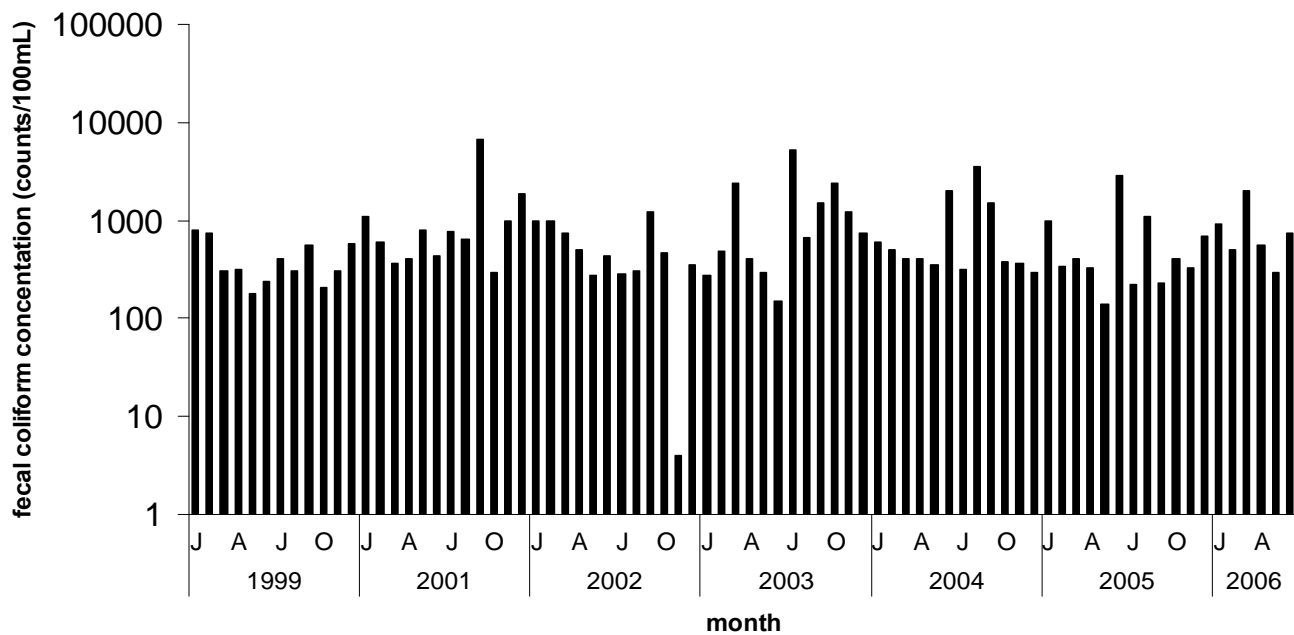
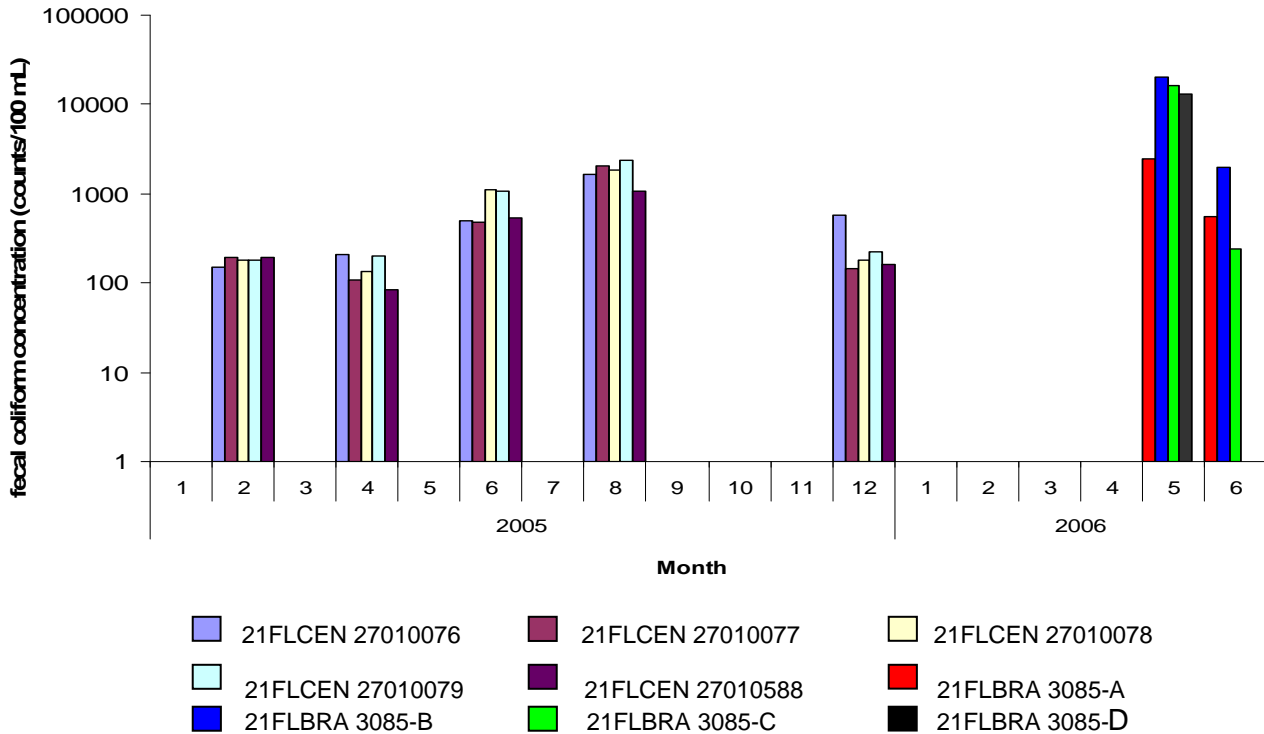


Figure 4.3. Spatial and Temporal Trends in Fecal Concentrations at Stations in WBID 3085A



Pets

Pets (especially dogs) could be a significant source of coliform pollution through surface runoff in the Crane Creek watershed. 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 for 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 those 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 one dog. A single gram of dog feces contains about 23 million fecal coliform bacteria (van der Wel, 1995). Unfortunately, statistics show that about 40 percent

of American dog owners do not pick up their dogs' feces. **Table 4.2** shows the fecal coliform concentrations of the surface runoff measured in two urban areas (Bannerman et al., 1993; Steuer et al., 1997). While the bacteria levels differed widely in the two studies, both indicated that residential lawns, driveways, and streets were the major source areas for bacteria.

Table 4.2. Concentrations (Geometric Mean Colonies per 100 mL) of Fecal Coliform from Urban Source Areas (Steuer et al., 1997; Bannerman et al., 1993)

Geographic Location	Marquette, MI	Madison, WI
Number of storms sampled	12	9
Commercial parking lot	4,200	1,758
High-traffic street	1,900	9,627
Medium-traffic street	2,400	56,554
Low-traffic street	280	92,061
Commercial rooftop	30	1,117
Residential rooftop	2,200	294
Residential driveway	1,900	34,294
Residential lawns	4,700	42,093
Basin outlet	10,200	175,106

The number of dogs in the Crane Creek watershed is not known. Therefore, the statistics produced by APPMA were used in this analysis to estimate the possible fecal coliform loads contributed by dogs. The total human population in the Crane Creek watershed, calculated based on the Tiger Track 2000 data (Department's GIS library) was 26,047. According to the U.S. Census Bureau, there was an average of 2.35 people per household in Brevard County in 2000. This gives about 11,084 households in the entire watershed. Assuming that 40 percent of the households in this area have one dog, the total number of dogs in the watershed is about 4,434.

According to the waste production rate for dogs and the fecal coliform counts per gram of dog wastes listed in **Table 4.3**, and assuming that 40 percent of dog owners do not pick up dog feces, the total waste produced by dogs and left on the land surface in residential areas would be 798,300 grams/day. The total produced by dogs would be 1.76×10^{12} counts/day of fecal coliform. It should be noted that this load only represents the fecal coliform load created in the watershed 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 4.3. Dog Population Density, Wasteload, and Fecal Coliform Density (Weiskel et al., 1996)

Type	Population density (an/household)	Wasteload (g/an-day)	Fecal coliform density (fecal coliform/g)
Dog	0.4**	450	2,200,000

** Number from APPMA.

Septic Tanks

Septic tanks are another potentially important source of coliform pollution in urban watersheds. When properly installed, most of the coliform from septic tanks should be removed within 50 meters of the drainage field (Minnesota Pollution Control Agency, 1999). However, in areas with a relatively high ground water table, the drainfield can be flooded during the rainy season, and coliform bacteria can pollute the surface water through stormwater runoff.

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

A rough estimate of fecal coliform loads from failed septic tanks in the Crane Creek watershed can be made using **Equation 4.1**:

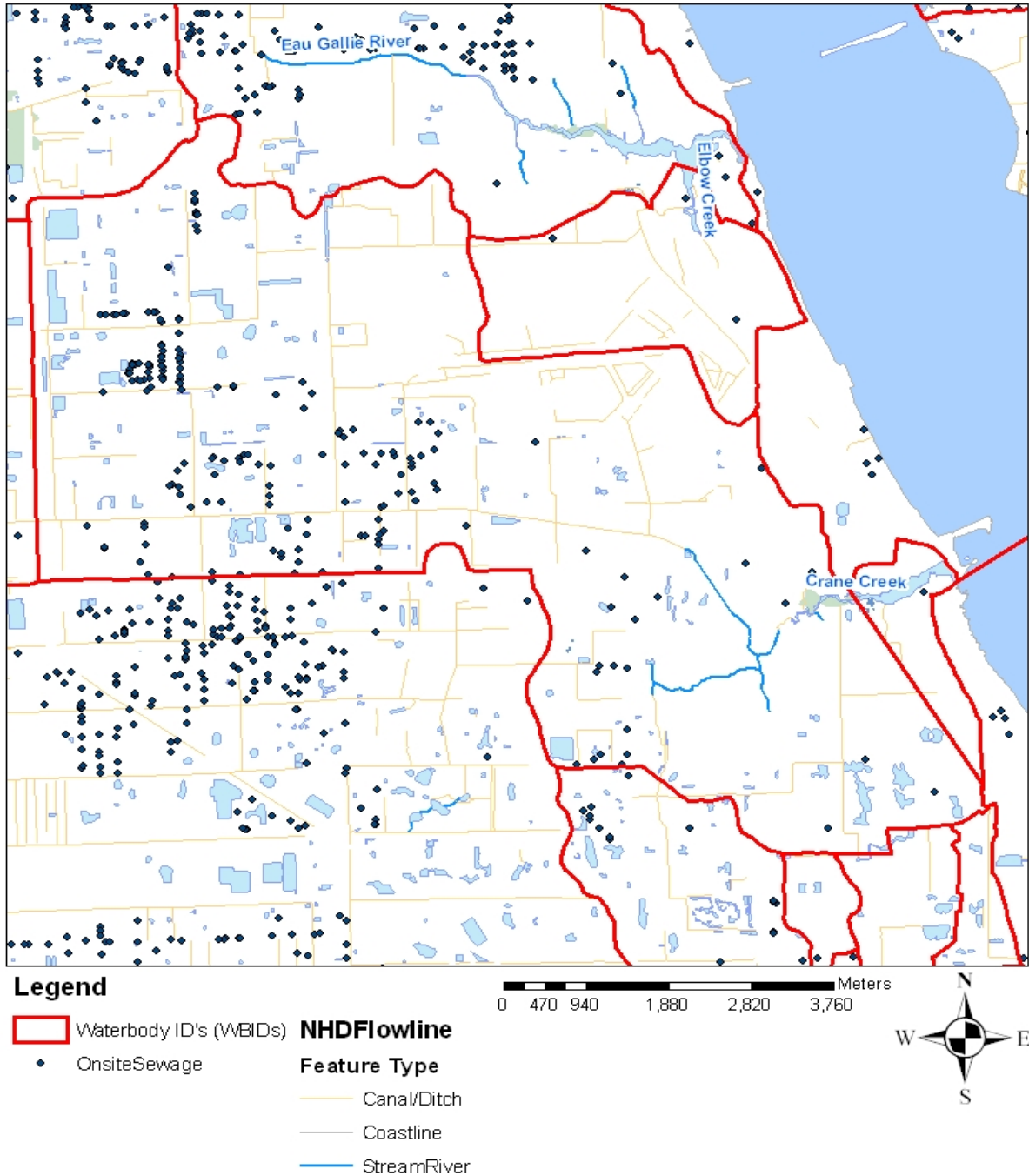
$$L = 37.85 * N * Q * C * F \quad \text{Equation 4.1}$$

Where,

- L* is the fecal coliform daily load (counts/day),
- N* is the total number of septic tanks in the area (septic tanks),
- Q* is the discharge rate for each septic tank,
- C* is the fecal coliform concentration for the septic tank discharge, and
- F* is the septic tank failure rate.

Based on 2007 Florida Department of Health (FDOH) onsite sewage GIS coverage (<http://www.doh.state.fl.us/environment/programs/EhGis/EhGisDownload.htm>), about 212 housing units (*N*) were identified as being on septic tanks in the Crane Creek watershed (**Figure 4.4**). The discharge rate from each septic tank (*Q*) was calculated by multiplying the average household size by the per capita wastewater production rate per day. Based on the information published by the Census Bureau, the average household size for Brevard County is about 2.35 people/household. The same population density was assumed for the Crane Creek watershed. A commonly cited value for per capita wastewater production rate is 70 gallons/day/person (EPA, 2001). The commonly cited concentration (*C*) for septic tank discharge is 1×10^6 counts/100mL for fecal coliform (EPA, 2001).

Figure 4.4. Distribution of Onsite Sewage Disposal Systems (Septic Tanks) in the Crane Creek Watershed



No measured septic tank failure rate data were available for the watershed at the time this TMDL was developed. Therefore, the failure rate was derived from the number of septic tank and septic tank repair permits for the county published by FDOH (<http://www.doh.state.fl.us/environment/OSTDS/statistics/ostdsstatistics.htm>). The number of septic tanks in the county was calculated assuming that none of the installed septic tanks will be removed after being installed (**Table 4.4**). The reported number of septic tank repair permits was also obtained from the FDOH Website (**Table 4.4**). Based on this information, a discovery rate of failed septic tanks for each year between 2000 and 2005 was calculated and listed in **Table 4.4**.

Based on **Table 4.4**, the average annual septic tank failure discovery rate for Brevard County is about 0.34%. Assuming that failed septic tanks are not discovered for about 5 years, the estimated annual septic tank failure rate is about 5 times the discovery rate, which is equal to 1.7 percent. Based on **Equation 4.1**, the estimated fecal coliform loading from failed septic tanks in the Crane Creek watershed is about 2.2×10^{10} counts/day.

Table 4.4. Estimated Septic Tank Numbers and Septic Tank Failure Rates for Brevard County, 2000-05

	2000	2001	2002	2003	2004	2005	Average
New installation (septic tanks)	1,455	1,774	142	1,515	1,715	3,039	1,607
Accumulated installation (septic tanks)	77,357	78,812	80,586	80,728	82,243	83,958	80,614
Repair permit (septic tanks)	427	407	131	275	234	183	276
Failure discovery rate (%)	0.55	0.52	0.16	0.34	0.28	0.22	0.34
Failure rate (%)*	2.8	2.6	0.8	1.7	1.4	1.1	1.7

* Failure rate is 5 times the failure discovery rate.

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.

Figures 4.5 and **4.6** show the general land uses and locations of fecal coliform sampling stations along the upstream and the downstream segments of Crane Creek, respectively. The watershed largely comprises urban areas, and the dominant urban land use is medium-density residential. The SJRWMD's 1988 land use GIS coverage indicates that the general area was covered by medium-density residential about 20 years ago.

When this TMDL was developed, no information on sewer line coverage was available to the Department, and so it was difficult to determine with certainty whether the entire area was sewered. Typically, the medium-density residential areas are sewered to avoid too-high septic tank density. If the medium-density residential areas shown in **Figures 4.5** and **4.6** are sewered, as these residential areas are more than 20 years old, sewer line leakage could be a significant source of the fecal pollution.

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 in the Crane Creek watershed can be made using **Equation 4.2**.

$$L = 37.85 * N * Q * C * F \qquad \text{Equation 4.2}$$

Where,

- L* is the fecal coliform daily load (counts/day);
- N* is the number of households using sanitary sewer in the watershed;
- Q* is the discharge rate for each household;
- C* is the fecal coliform concentration for domestic wastewater discharge, and
- F* is the sewer line leakage rate.

The number of households (*N*) that are tied to sewer lines is 10,881 (total households minus the households using septic tanks) in the Crane Creek watershed. The discharge rate through sewers from each household (*Q*) was calculated by multiplying the average household size (2.35) by the per capita wastewater production rate per day (70 gallons). The commonly cited concentration (*C*) for domestic wastewater is 1×10^6 counts/100mL for fecal coliform (EPA, 2001). The contribution of fecal coliform through sewer line leakage was assumed to be 0.5 percent of the total sewage loading created from the population not on septic tanks (Culver et al., 2002). Based on **Equation 4.2**, the estimated fecal coliform loading from sewer line leakage in the watershed is about 3.4×10^{11} counts/day.

Wildlife

Wildlife is another possible source of fecal and total coliform bacteria in the Crane Creek watershed. As shown in **Figure 4.1**, there are wetland areas along Crane Creek, and these are likely habitats for small wildlife such as rabbits and raccoons. For highly urbanized areas, birds and rats could also be important contributors to bacterial pollution.

Figure 4.5. Land Use and Fecal Coliform Sampling Stations in WBID 3085

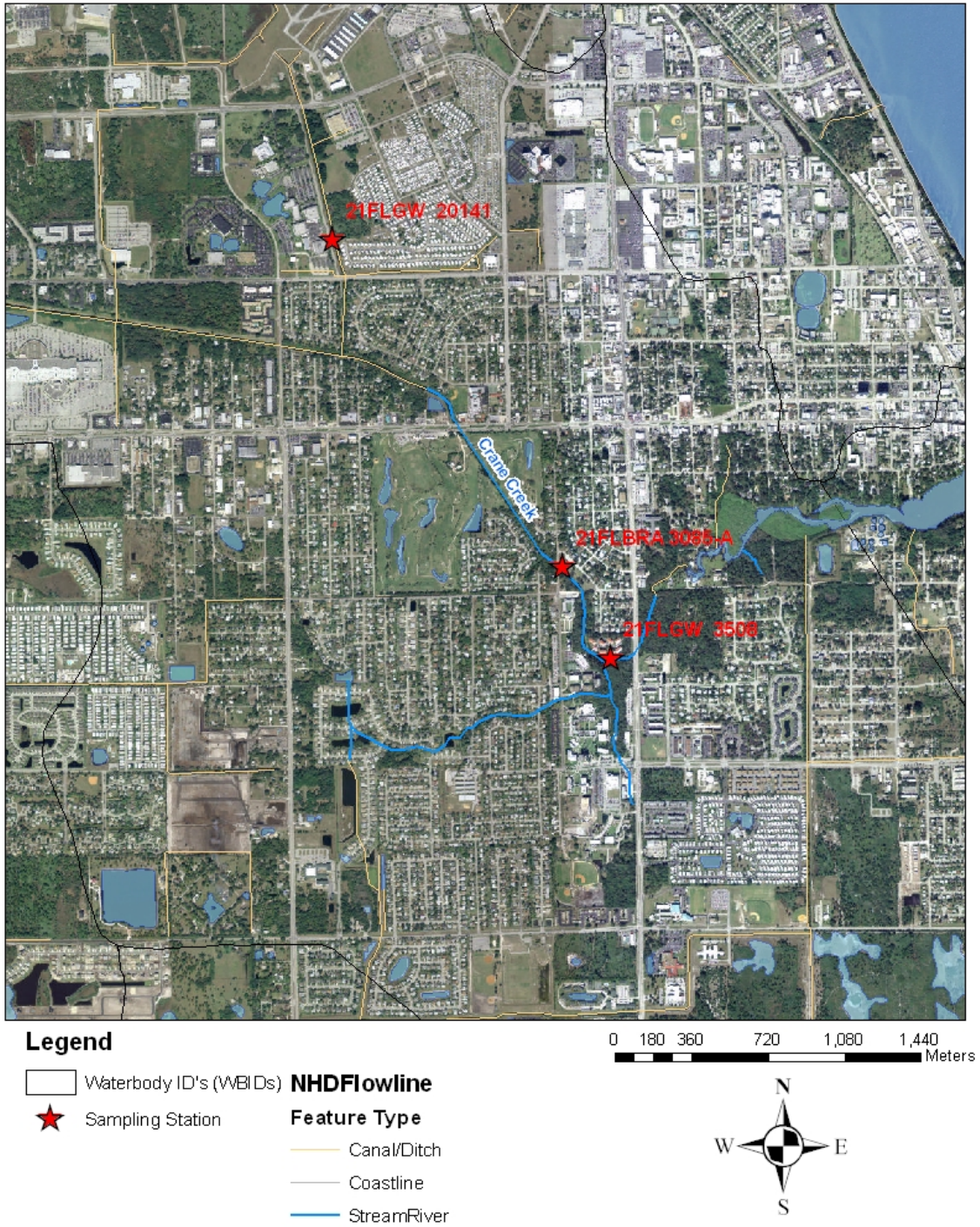






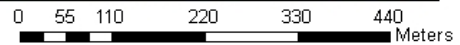


Figure 4.6. Land Use and Fecal Coliform Sampling Stations in WBID 3085A



Legend

- | | | |
|---|--------------------------|--|
|  | Waterbody ID's (WBIDs) | NHDFlowline |
|  | Sampling Station in 2005 | Feature Type |
|  | Sampling Station in 2006 |  Canal/Ditch |
| | |  Coastline |
| | |  Stream/River |



Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

The methodology used for this TMDL is the load duration curve. Also known as the “Kansas Approach” because it was developed by the state of Kansas, this method has been well documented in the literature, with improved modifications used by EPA Region 4. Basically, the method relates the pollutant concentration to the flow of the stream, in order to establish the existing loading capacity and the allowable pollutant load (TMDL) under a spectrum of flow conditions. It then determines the maximum allowable pollutant load and load reduction requirement based on the analysis of the critical flow conditions. This method requires four steps to develop the TMDL and establish the required load reduction:

1. *Develop the flow duration curve,*
2. *Develop the load duration curve for both the allowable load and existing loading,*
3. *Define the critical conditions, and*
4. *Establish the needed load reduction by comparing the existing loading with the allowable load under critical conditions.*

5.1.1 Data Used in the Determination of the TMDL

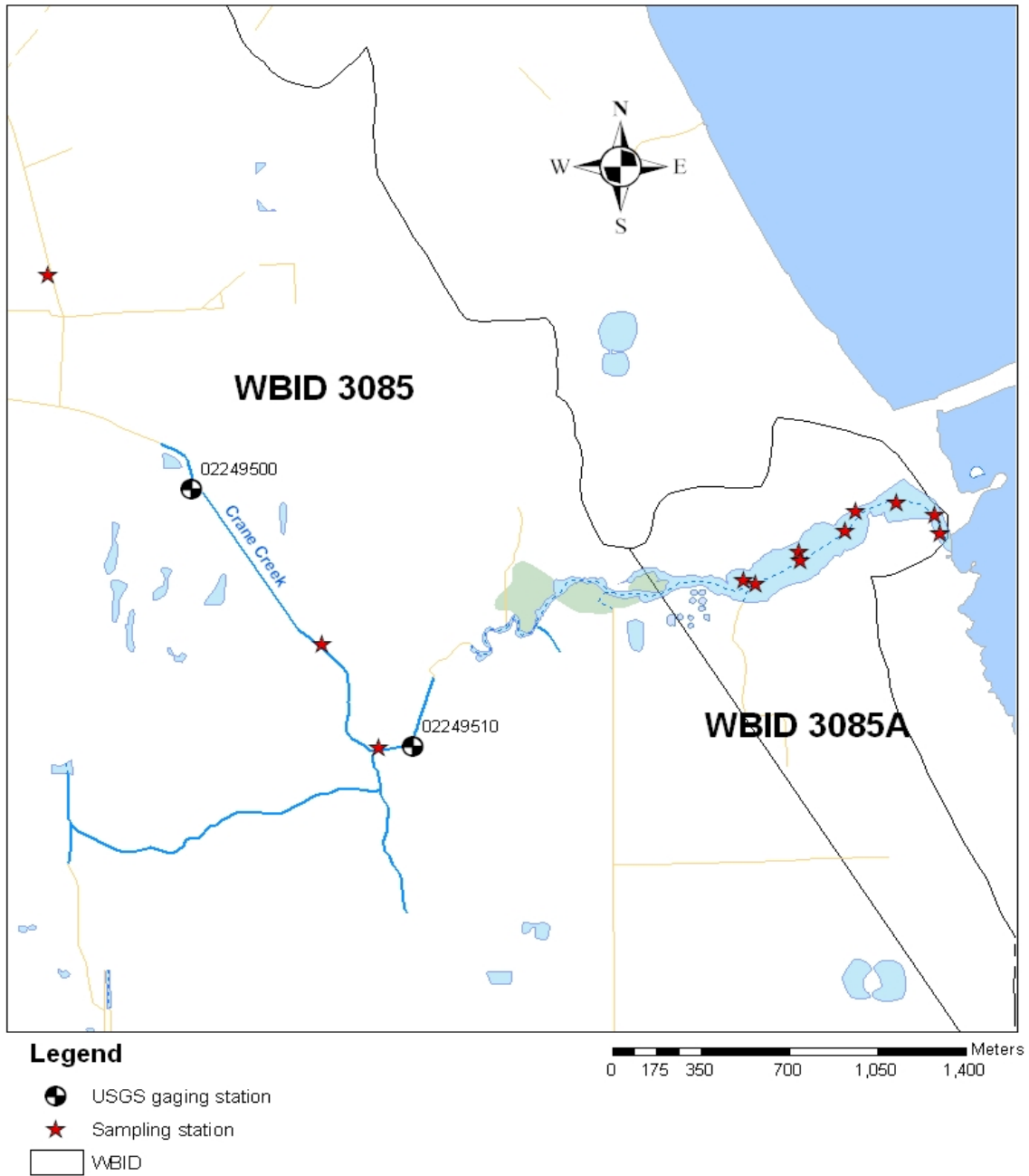
Fecal coliform concentration and flow measurements were required to estimate both the allowable pollutant load and existing loading to Crane Creek. **Figure 5.1** shows the locations of the water quality sites from which fecal coliform data were collected and the U.S. Geological Survey (USGS) gaging stations (Stations 02249500 and 02249510) from which the flow measurements were taken. This analysis used fecal coliform data collected during the Verified Period (January 1, 1999, through June 30, 2006). During the Verified Period, a total of 81 fecal coliform samples was collected from 3 sampling stations in WBID 3085, and 32 fecal samples were collected from 9 stations located in WBID 3085A. Also, samples collected in August and December 2007 were used in calculating the TMDL. Data used for this TMDL report were provided by the Department’s Central District office, the SJRWMD, and Biological Research Association (BRA).

Flow measurements from the USGS gaging station located in the upstream Crane Creek segment were used for this analysis. Fecal coliform measurements obtained from all the stations in both WBIDs were combined in the load duration analysis, and a single fecal coliform TMDL was developed for all of Crane Creek. Flow measurements from USGS gaging stations located in the downstream segment of the creek (Stations 02249512 and 02249518) were not used because of the tidal fluctuations.

The sampling site on Crane Creek (Site ID: 21FLGW 3508) has data for all four seasons from 1999 through 2006, except for 2000 (**Figure 4.2**). No data were available for fecal coliform bacteria in 2000. All data collected from sites located in the marine segment of the creek were

collected in 2005 and 2006 (**Figure 4.3**). These data showed no obvious seasonal pattern for fecal coliform bacteria.

Figure 5.1. Locations of Water Quality Stations and USGS Gaging Stations in WBIDs 3085 and 3085A



5.1.2 TMDL Development Process

Develop the Flow Duration Curve

The first step in the development of load duration curves is to create *flow duration curves*. A flow duration curve displays the cumulative frequency distribution of daily flow data over the period of record. The duration curve relates flow values measured at a monitoring station to the percent of time the flow values were equalled or exceeded. Flows are ranked from low, which are exceeded nearly 100 percent of the time, to high, which are exceeded less than 1 percent of the time.

This TMDL report used flow measurements from the USGS gaging stations located at Crane Creek (Stations 02249500 and 02249510). There were both flow and gage height measurements at Station 02249500, but the data records only covered the period from February 2003 to December 2007. Thus no data had been collected for a significant portion of the verified period. Station 02249510 is located downstream of Station 02249500. It only has gage height measurements, but its period of record is January 1999 to December 2007. Therefore, the stage data from Station 02249510 were used to extend the stage records of Station 02249500 for the period from January 1999 through February 2003. The flow rates of Station 02249500 for this period were then derived based on the flow rate–stage relationship of this station.

The relationship of gage height measurements between the two stations from January 2003 to December 2007 was derived through linear correlation analysis, and a correlation equation between the two sets of gage height data was derived from the analysis (**Figure 5.2**). The gage height at Station 2249500 from January 1999 to January 2003 was extrapolated using the equation and the measured gage heights at Station 02249510. To determine the gauge height–flow rate relation for Station 02249500, gage height and water flow measurements were correlated, and a correlation equation was developed (**Figure 5.3**).

Water flows from January 1999 to January 2003 at Station 02249500 were then estimated using the gage height–flow correlation equation and the gage heights estimated based on the gage height correlation between the two stations. The gage height and flow measurements from both USGS gaging stations were downloaded from the USGS Florida Integrated Science Center water resources Website (<http://fl.water.usgs.gov>). The flow duration curve for Crane Creek was developed based on a mixed flow dataset, which includes both measured data when they were available and the estimated data when the measured data were not available.

The flow duration curve was created by using the percentile function and the flow record to generate the flow at a given duration interval. For example, at the 90th duration interval, the percentile function calculates the flow that is equal or exceeded 90 percent of the time. **Figure 5.4** shows the flow duration curves for Crane Creek generated from the measured flow and estimated flow using regression analysis. Flows toward the right side of the plot are exceeded in greater frequency and are indicative of low-flow conditions. Flows on the left side of the plot represent high flows and occur less frequently.

Figure 5.2. Relationship of Gage Heights between USGS Gaging Stations 02249500 and 02249510

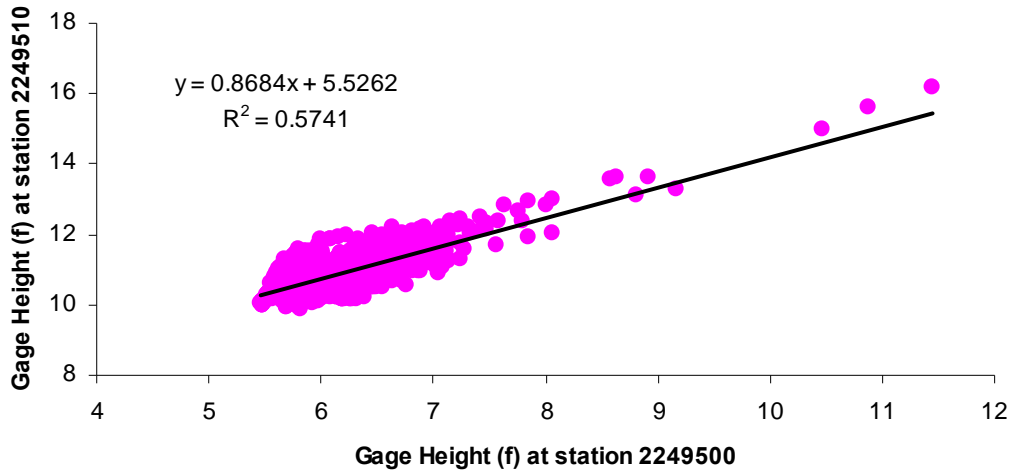
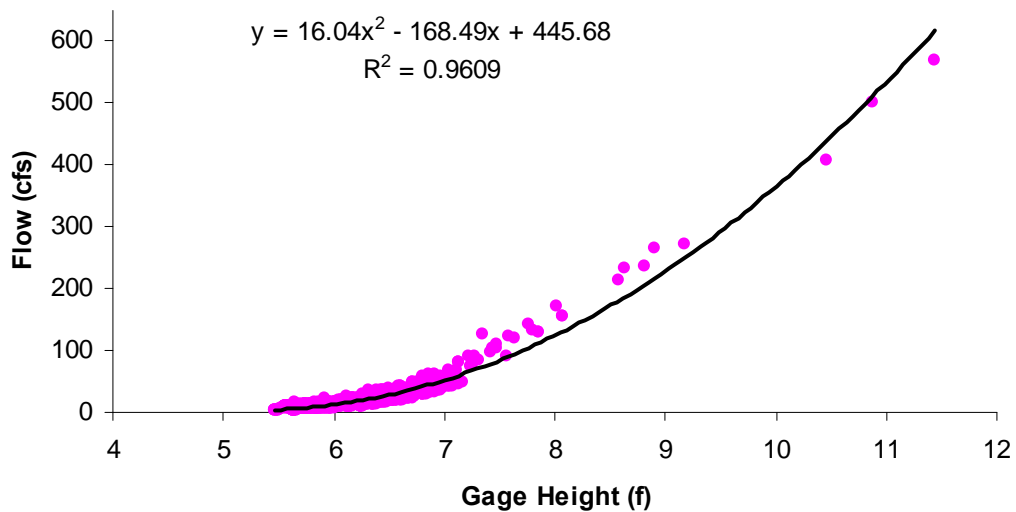
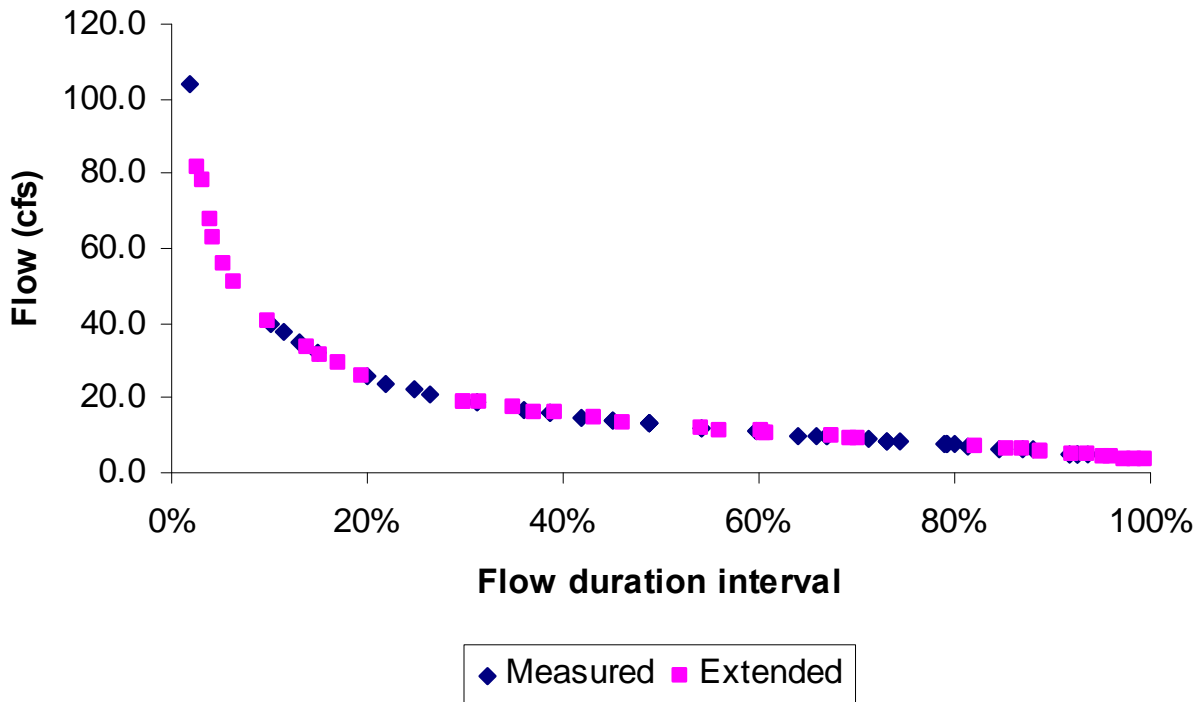


Figure 5.3. Relationship between Water Flow and Gage Height at Station 02249500



To ensure that the final flow dataset was as accurate as possible, measured flow was used whenever there was a measured record. This created a mixed dataset that included both the regression predicted flow and measured flow. **Figure 5.4** demonstrates that the flow duration curves created based on measured and mixed datasets are very similar. In creating the load duration curve, this TMDL analysis used the flow duration interval based on the mixed dataset.

Figure 5.4. Flow Duration Curve for Crane Creek



Develop the Load Duration Curves for Both the Allowable Load and Existing Loading Capacity

Flow duration curves are transformed into load duration curves by multiplying the flow values along the flow duration curve by the fecal coliform concentration and the appropriate conversion factors. The final results of the load are typically expressed as MPN per day. The following equations were used to calculate the allowable loads and the existing loading:

$$\text{Allowable load} = (\text{observed flow}) \times (\text{conversion factor}) \times (\text{state criteria}) \quad (1)$$

$$\text{Existing loading} = (\text{observed flow}) \times (\text{conversion factor}) \times (\text{coliform measurement}) \quad (2)$$

On the load duration curve, allowable and existing loads are plotted against the flow duration ranking. The allowable load was calculated based on the water quality criterion and flow values from the flow duration curve, and the line drawn through the data points representing the allowable load is called the target line. The existing loads are based on the instream fecal coliform concentrations measured during ambient monitoring and an estimate of flow in the stream at the time of sampling.

As noted previously, because insufficient data were collected to evaluate the fecal coliform monthly geometric mean, 400 MPN/100mL was used as the target criterion for fecal coliform. **Figure 5.5** shows both the allowable loads and the existing loads over the flow duration ranking for Crane Creek. The points of the existing load that were higher than the allowable load at a given flow duration ranking were considered an exceedance of the criterion.

As shown in **Figure 5.5**, exceedances of the fecal coliform criterion in Crane Creek occurred across the entire span of the flow record. In general, exceedances on the right side of the curve typically occur during low-flow events, implying a contribution from either point sources or baseflow, which could come from the load from failed septic tanks and sewer line leakage that interact with surface water. The exceedances that appear on the left side of the curve usually represent loading from stormwater-related sources. In this case, the potential sources may include contributions from pets such as dogs and cats, wild animals, failed septic tanks, and sewer line leakage.

Define the 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, wildlife with direct access to the receiving water can contribute to the exceedance during dry weather. The critical condition for point source loading typically occurs during periods of low stream flow, when dilution is minimized.

For Crane Creek, the exceedance frequency is evenly distributed across the entire span of the flow conditions, and exceedances also occur in the same way. Because exceedances occur throughout the flow record, no critical condition was defined in this TMDL. The Department used the flow records and water quality data available for the 10th to 90th percentile flow duration interval for the TMDL analysis. Flow conditions that were exceeded less than 10 percent of the time were not used because they represent abnormally high-flow events, and flow conditions occurring greater than 90 percent of the time were not used because they are extreme low-flow events.

Establish the Needed Load Reduction by Comparing the Existing Load with the Allowable Load under the Critical Condition

The fecal coliform load reduction required to achieve the water quality criterion was established by comparing the existing loading with the allowable load at each flow recurrence interval between the 10th and 90th percentile (in increments of 5 percent). The actual needed load reduction was calculated using the following equation:

$$\text{Load reduction} = \frac{\text{Existing loading} - \text{Allowable loading}}{\text{Existing loading}} \times 100\% \quad (3)$$

The *Allowable loading* at each recurrence interval was calculated as the product of the water quality criterion and the flow corresponding to the given recurrence interval. To calculate the *Existing loading*, a trend line was fitted to the loads that exceeded the *Allowable loading*. Several types of trend lines were examined, and power functions were found to have the highest correlation coefficient for both fecal coliform loading ($R^2 = 0.4355$). Therefore, power functions were used to predict the existing loads corresponding to the flow recurrence intervals used by the *Allowable loading*. The following power equation was developed for fecal coliform:

$$\text{For fecal coliform: } Y = 4E + 12X^{-0.6737} \quad (4)$$

Where:

X is the flow recurrence interval between the 10th and 90th percentile, and
Y is the predicted *Existing loading* for fecal coliform (**Equation 4**).

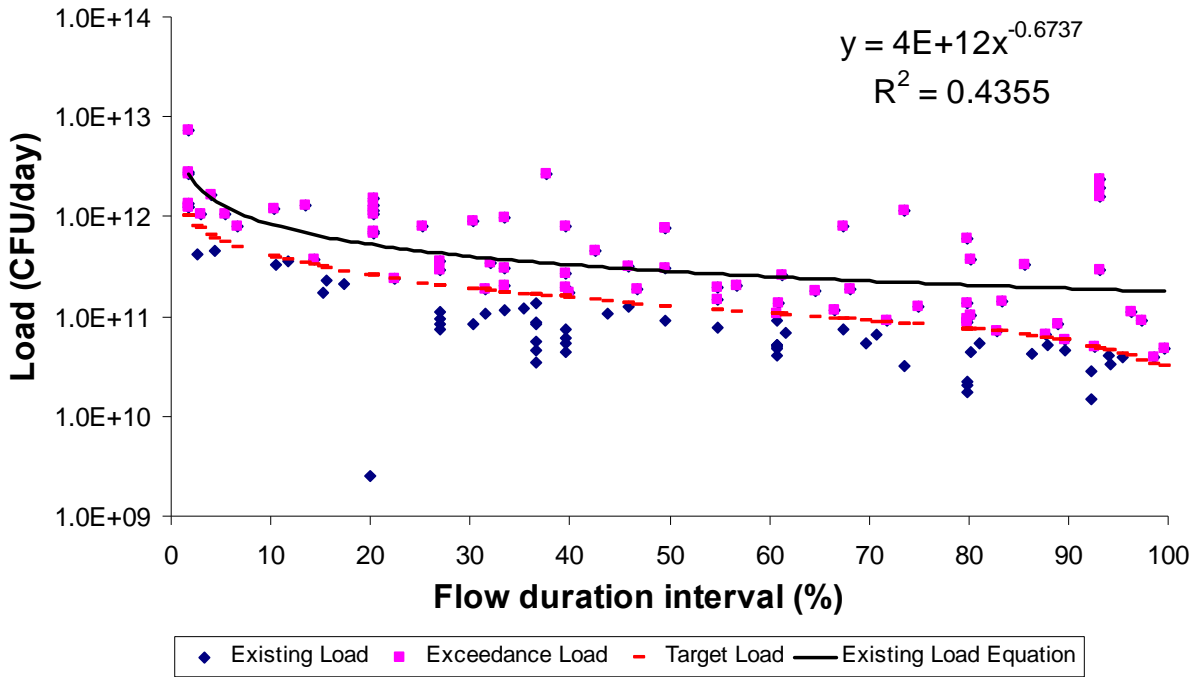
Figure 5.5 shows the trend line and power equation for fecal coliform bacteria exceedances. After the trend line was developed, it was used to determine the median percent reduction required to achieve the numeric criterion. At each recurrence interval between the 10th and 90th percentile (in increments of 5 percent), the equation of the trend line was used to estimate the *Existing loading*.

The percent reduction required to achieve the target load was then calculated at each interval using **Equation (3)**. The TMDL and percent reductions were calculated as the median of all the *allowable loads* (1.23E+11 counts/day) and percent reductions calculated at the various recurrence intervals between the 10th and 90th percentile. **Table 5.1** shows the calculation of the TMDL and percent reductions for fecal coliform in Crane Creek.

Table 5.1. Calculation of TMDL and Percent Reduction for Fecal Coliform in the Crane Creek Watershed, WBIDs 3085 and 3085A

Interval	Allowable Load (counts/day)	Existing Load (counts/day)	Percent Reduction
90	5.59E+10	1.93E+11	71.0
85	6.65E+10	2.01E+11	67.3
80	7.44E+10	2.09E+11	64.4
75	8.20E+10	2.18E+11	62.4
70	8.99E+10	2.29E+11	60.7
65	9.59E+10	2.40E+11	60.1
60	1.08E+11	2.54E+11	57.5
55	1.17E+11	2.69E+11	56.3
50	1.23E+11	2.87E+11	57.2
45	1.37E+11	3.08E+11	55.5
40	1.53E+11	3.33E+11	54.2
35	1.69E+11	3.65E+11	53.7
30	1.86E+11	4.05E+11	53.9
25	2.15E+11	4.57E+11	52.9
20	2.54E+11	5.32E+11	52.1
15	3.13E+11	6.45E+11	51.5
10	4.00E+11	8.48E+11	52.8
Median	1.23E+11	2.87E+11	56.3

Figure 5.5. Load Duration Curves for Allowable Load and Existing Loading Capacity of Fecal Coliform



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:

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

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

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

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 Crane Creek are expressed in terms of MPN/day and percent reduction, and represent the maximum daily fecal coliform load the stream can assimilate without exceeding the fecal coliform criterion (**Table 6.1**).

Table 6.1. TMDL Components for Fecal Coliform in the Crane Creek Watershed, WBIDs 3085 and 3085A

Parameter	TMDL (colonies/day)	WLA		LA (% reduction)	MOS
		Wastewater (colonies/day)	NPDES Stormwater (% reduction)		
Fecal coliform	1.23E+11	1.21E+10 *	56.3%	56.3 %	Implicit

* Discharge from the WWTP is only allowed during the maximum five-day mechanical integrity test as defined in the permit.

6.2 Load Allocation

Based on a loading duration curve approach similar to that developed by Kansas (Stiles, 2002), the load allocation is a 56.3 percent reduction in fecal coliform from nonpoint sources. It should be noted that the LA includes loading from stormwater discharges regulated by the Department and the water management districts that are not part of the NPDES stormwater program (see **Appendix A**).

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

One NPDES-permitted wastewater facility with fecal coliform limits was identified in the Crane Creek watershed: the city of Melbourne Grant Street WWTP (FL0041122). The state already requires all NPDES point source dischargers to meet the bacteria criterion at the end of the pipe. It is the Department's current practice not to allow mixing zones for bacteria.

These requirements will also be applied to any possible future point sources that may discharge in the watershed to meet end-of-pipe standards for coliform bacteria. Based on the wastewater permit issued to this facility, the facility is only allowed to discharge to surface water for a maximum of 5 days when a mechanical integrity test is conducted. According to the Department's Permit Compliance System database, the facility only discharged twice (March 1999 and March 2004) during the verified period. The discharge rates were 3.74 mgd and 3.7 mgd, and the fecal coliform concentrations were 11 counts/100mL and below the detection limit in 1999 and 2004, respectively.

Since the fecal coliform concentration in the discharge did not exceed the limit concentration described in the permit to the facility (86 counts/100mL) and the target concentration for this TMDL (400 counts/100mL), the Department suggests that the facility keep its existing discharge load limitation, which is 1.21×10^{10} counts/day (assuming 3.72 mgd, which is an average of 2 discharge rates and 86 fecal coliform counts/100mL) for a maximum of 5 days during the mechanical integrity test.

6.3.2 NPDES Stormwater Discharges

The WLA for stormwater discharges for the city of Melbourne's Phase II MS4 permit is a 56.3 percent reduction in current fecal coliform. 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. For fecal coliform, an implicit MOS was inherently incorporated by using 400 MPN/100mL of fecal coliform as the water quality target for individual samples, instead of setting the criterion as no more than 10 percent of the samples exceeding 400 MPN/100mL. For a fecal coliform TMDL, using the load duration curve method to develop the TMDL assumes there is no instream decay of fecal coliform bacteria after the watershed loading reaches the receiving waterbody, while in reality fecal coliform loadings could diminish through processes such as death, grazing, and deposition. Therefore, the load duration curve method tends to underestimate allowable fecal coliform loading that a given waterbody receives and is therefore more conservative in establishing the TMDL. In addition, the correlation lines fitting through only the existing loadings that exceeded the allowable loadings could overestimate the actual existing loading, which makes the estimation of percent load reduction required more conservative and adds to the MOS.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Basin Management Action Plan

Following the adoption of this TMDL by rule, the next step in the TMDL process is to develop an implementation plan for the TMDL, referred to as the BMAP. This document will be a component of the BMAP for the Indian River Lagoon Basin. It will be developed over the next year in cooperation with local stakeholders, who will attempt to reach a consensus on detailed allocations and on how load reductions will be accomplished. The BMAP will include, among other things:

- *Appropriate load reduction allocations among the affected parties,*
- *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,*
- *Confirmed and potential funding mechanisms,*
- *Any applicable signed agreement(s),*
- *Local ordinances defining actions to be taken or prohibited,*
- *Any applicable local water quality standards, permits, or load limitation agreements,*
- *Milestones for implementation and water quality improvement, and*
- *Implementation tracking, water quality monitoring, and follow-up measures.*

An assessment of progress toward the BMAP milestones will be conducted every five years, and revisions to the plan will be made as appropriate, in cooperation with basin stakeholders.

References

- Alderiso, K., D. Wait and M. Sobsey. 1996. Detection and characterization of make-specific RNA coliphages in a New York City Reservoir to distinguish between human and nonhuman sources of contamination. In: *Proceedings of a Symposium on New York City Water Supply Studies*, J.J. McDonnell et al. (eds.). TPS-96-2. Herndon, Virginia: American Water Resources Association.
- Association of Metropolitan Sewerage Agencies. 1994. *Separate sanitary sewer overflows: What do we currently know?* Washington, D.C.
- Bannerman, R., D. Owens, R. Dodds, and N. Hornewer. 1993. Sources of pollutants in Wisconsin Stormwater. *Water Science and Technology* 28(3-5): 241-259.
- Culver T.B, Y. Jia, R. TiKoo, J. Simsic, and R. Garwood. 2002. *Development of the Total Maximum Daily Load (TMDL) for fecal coliform bacteria in Moore's Creek, Albemarle County, Virginia*. Virginia Department of Environmental Quality.
- Florida Administrative Code. *Rule 62-302, Surface water quality standards*.
- Florida Administrative Code. *Rule 62-303, Identification of impaired surface waters*.
- Florida Department of Environmental Protection. February 2001. *A report to the Governor and the Legislature on the allocation of Total Maximum Daily Loads in Florida*. Tallahassee, Florida: Bureau of Watershed Management.
- Florida Department of Health Website. 2008. Available: <http://www.doh.state.fl.us/environment/programs/EhGis/EhGisDownload.htm> and <http://www.doh.state.fl.us/environment/OSTDS/statistics/ostdsstatistics.htm>.
- Florida Watershed Restoration Act. *Chapter 99-223, Laws of Florida*.
- Minnesota Pollution Control Agency. 1999. *Effect of septic systems on ground water quality*. Ground Water and Assessment Program. Baxter, Minnesota.
- Lim, S., and V. Olivieri. 1982. *Sources of microorganisms in urban runoff*. Johns Hopkins School of Public Health and Hygiene. Baltimore, Maryland: Jones Falls Urban Runoff Project.
- Steuer, J., W. Selbig, N. Hornewer, and J. Prey. 1997. *Sources of contamination in an urban basin in Marquette, Michigan, and an analysis of concentrations, loads, and data quality*. USGS Water Resources Investigation Report 97-4242. Middleton, Michigan.
- Stiles, T.C. November 2002. *Incorporating hydrology in determining TMDL endpoints and allocations*. National TMDL Science and Policy 2002—WEF Specialty Conference. Phoenix, Arizona.

- Trial, W. et al. 1993. Bacterial source tracking: studies in an urban Seattle watershed. *Puget Sound Notes*. 30: 1-3.
- U.S. Environmental Protection Agency. January 2001. *Protocol for developing pathogen TMDLs*. Washington, D.C.: Office of Water. EPA 841-R-00-002.
- U.S. Geological Survey, Florida Integrated Science Center Water Resources Website. 2008. Available: <http://fl.water.usgs.gov>.
- Van der Wel, B. 1995. Dog pollution. *The Magazine of the Hydrological Society of South Australia*, 2(1) 1.
- Watson, T. June 6, 2002. Dog waste poses threat to water. *USA Today*.
- Weiskel, P.K., B.L Howes, and G.R. Heufflder. 1996. Coliform contamination of a coastal embayment: Sources and transport pathway. *Environmental Science and technology* 1872-1881.

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 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, stormwater PLRGs 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 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.



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