

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Water Resource Management, Bureau of Watershed Management

CENTRAL DISTRICT • MIDDLE ST. JOHNS RIVER BASIN

TMDL Report

Fecal Coliform and Total Coliform TMDLs for Crane Strand Drain and Crane Strand (WBID 3014 and 3023)

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August 16, 2005

Acknowledgments

This study could not have been accomplished without significant contributions from staff in the Florida Department of Environmental Protection's Central District Office and Watershed Assessment Section. Eric Pluchino, Rob Renk, David Sharr, George Jackson, Nathan Bailey, Ann Stansel, Courtney Modlin, and Rob McTear all contributed greatly, helping in the intensive survey of the Crane Strand and Crane Strand Drain. Rob van DenAkker from Orange County Environmental Protection Department and Kim Ornberg, Gloria Eby, and Donald McKenna from Seminole County provided the Department with the sanitary sewer line coverage for the project area and many valuable insights about possible sources of coliform bacteria pollution in the basin.

Editorial assistance provided by Daryll Joyner, Jan Mandrup-Poulsen, and Ann Stansel.

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Web sites

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>

2002 305(b) Report

http://www.dep.state.fl.us/water/docs/2002_305b.pdf

Criteria for Surface Water Quality Classifications

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

Basin Status Report for the Tampa Bay Tributaries Basin

http://www.dep.state.fl.us/water/tmdl/stat_rep.htm

Allocation Technical Advisory Committee (ATAC) Report

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

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 and total coliform bacteria for Crane Strand Drain and Crane Strand in the Middle St. Johns River Basin. These streams were verified as impaired for fecal coliform and total coliform bacteria, and therefore were included on the Verified List of impaired waters for the Middle St. Johns River basin that was adopted by Secretarial Order on May 27, 2004. The TMDL establishes the allowable fecal coliform and total coliform loadings to Crane Strand Drain and Crane Strand that would restore the waterbody so that it meets its applicable water quality criteria for fecal and total coliform.

1.2 Identification of Waterbody

Crane Strand Drain and Crane Strand are located in the northern part of Orange County and drain to the Little Econlockhatchee River (**Figure 1.1**). Crane Strand (WBID 3023, also known as the E4 canal), is a man-made canal system that flows primarily in an easterly direction into the Little Econlockhatchee River and drains an area of about 18.0 square miles. Crane Strand Drain (WBID 3014) is part of the Crane Strand drainage basin located in the northwest of Crane Strand and drains the surface runoff in a north to south direction into the C4 canal. Other basins that drain into Crane Strand include Lake Baldwin Outfall (WBID 3023A), located west of Crane Strand Drain, and Azalea Park Canal (WBID 3025), located south of Crane Strand. The City of Winter Park is located in the northwest portion of the Crane Strand basin and the City of Orlando is located in the southwest. The C4 canal is channelized along its entire length from near the Arcadia Acres weir to its outfall to the Little Econ River at Econ Trail and drains a highly urbanized area. More detailed information about the Crane Strand can be found in the “Little Econlockhatchee River Basin Stormwater Management Master Plan (final report)” by Orange County (2001).

For assessment purposes, the Department has divided the Middle St. Johns River 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 3014, Crane Strand Drain – for fecal coliform and total coliform
WBID 3023, Crane Strand – for fecal coliform and total coliform.

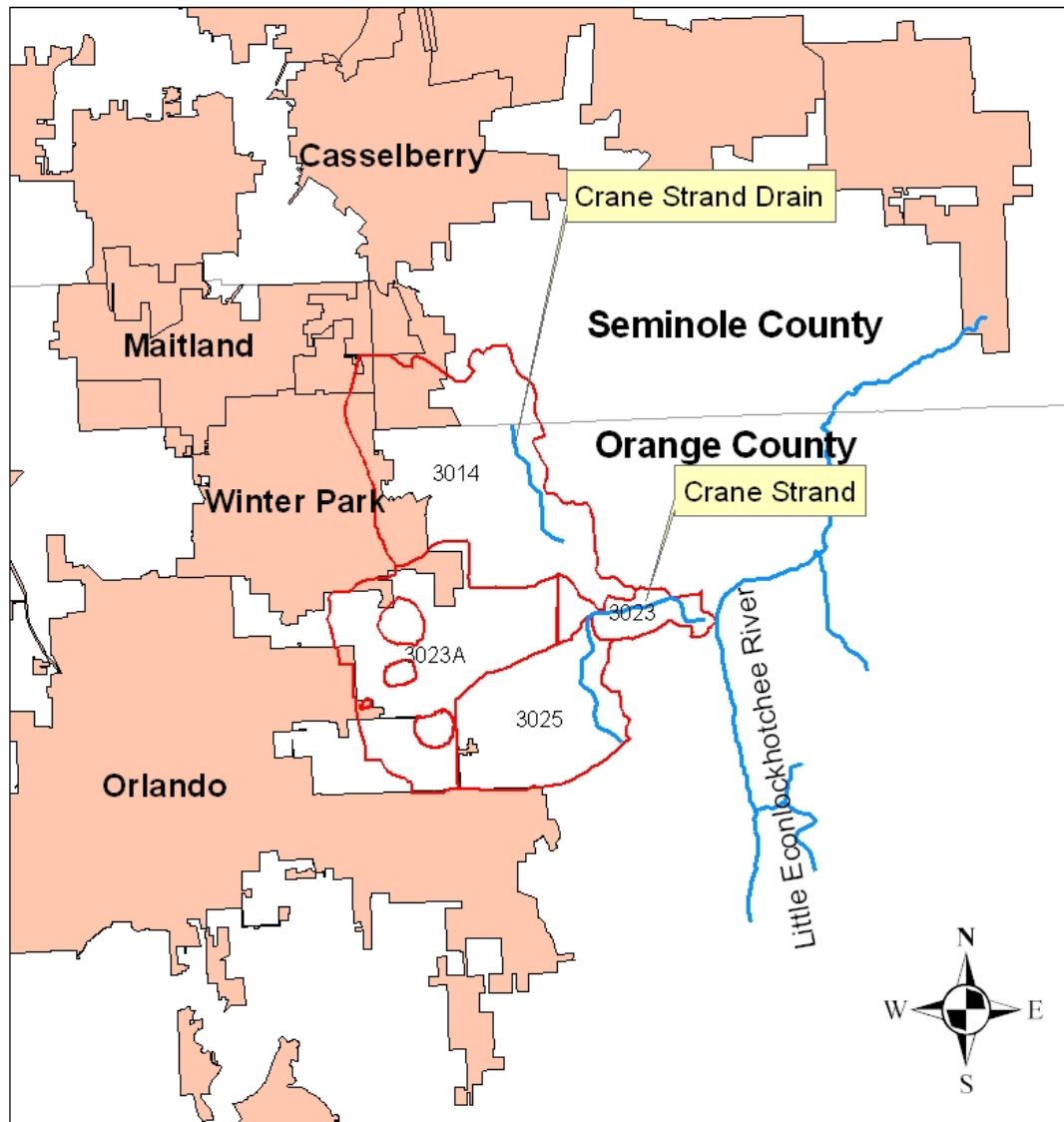
1.3 Background

This report was developed as part of the Florida Department of Environmental Protection’s (Department) 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. TMDLs provide important water quality restoration goals that will guide restoration activities.

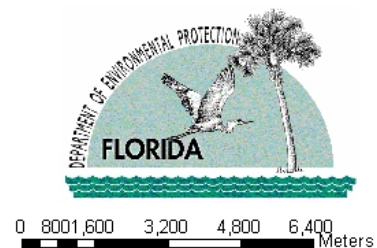
This TMDL Report will be followed by the development and implementation of a Basin Management Action Plan, or BMAP, designed to reduce the amount of fecal coliform and total coliform that caused the verified impairment of Crane Strand Drain and Crane Strand. These activities will depend heavily on the active participation of 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.

Figure 1.1: Location of Crane Strand Drain and Crane Strand and major geopolitical features around these basins



Legend

- WBIDs draining to Crane Strand
- Channels
- City Limits (poly)
- Florida Counties with Shoreline (areas)



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 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 22 waterbodies in the Middle St. Johns River 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 Chapter 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in the Crane Strand Drain and Crane Strand watershed and has verified that these canals are impaired for fecal coliform and total coliform bacteria. For Crane Strand Drain, the verification of impairment was based on the observations that 7 out of 28 fecal coliform samples and 5 out of 20 total coliform samples collected during the verified period (January 1, 1996 through June 30, 2003) exceeded applicable fecal and total coliform water quality criteria (FAC 62-302). For Crane Strand, the verification of impairment was based on the observation that 10 out of 20 fecal coliform samples and 10 out of 20 total coliform samples collected during the verified period exceeded applicable fecal and total coliform water quality criteria. **Table 2.1** summarizes the fecal coliform and total coliform monitoring results for the verified period for each WBID.

It should be noted that Crane Strand Drain (WBID 3014) and Crane Strand (WBID 3023) were not listed as impaired for coliforms on the 1998 303(d) list. Waterbodies verified as impaired through the IWR process that were not previously on the 1998 303(d) list are usually given a low priority for TMDL development. However, Crane Strand Drain (WBID 3014) was also verified as impaired for low dissolved oxygen (DO), with BOD identified as the causative pollutant. Because the coliform bacteria impairment was the only other impairment verified through the IWR process for this waterbody, the Department advanced the timetable to develop the coliform bacteria TMDL together with the DO TMDL in 2005. By doing this, the intensive surveys and the collection of information on the possible sources of pollutants for both low DO and elevated bacteria could be conducted at the same time.

Crane Strand (WBID 3023) was not on the 1998 303(d) either. The only parameter verified through the IWR process for this waterbody was the coliform impairment. Theoretically, the bacteria TMDL for this waterbody could be developed in 2008. However, as Crane Strand Drain directly discharges into Crane Strand and the two waterbody segments were considered integral parts of a single system, the coliform bacteria TMDL for Crane Strand (WBID 3023) was developed together with the coliform TMDL for Crane Strand Drain.

Table 2.1. Summary of Fecal Coliform Monitoring Data for Crane Strand Drain (WBID 3014) and Crane Strand (WBID 3023)

Waterbody (WBID)	Parameter	Fecal Coliform	Total Coliform
Crane Strand Drain (3014)	Total number of samples	28	20
	IWR required number of exceedances for the verified list	6	5
	Number of observed exceedances	7	5
	Number of observed nonexceedances	21	15
	Number of seasons during which samples were collected	4	4
	Highest observation (MPN/100mL)*	5800	21000
	Lowest observation (MPN/100 mL)	22	320
	Median observation (MPN/100 mL)	220	1339
	Mean observation (MPN/100 mL)	592	2437
	FINAL ASSESSMENT	Impaired	Impaired
Crane Strand (3023)	Total number of samples	20	20
	IWR required number of exceedances for the verified list	5	5
	Number of observed exceedances	10	10
	Number of observed nonexceedances	10	10
	Number of seasons during which samples were collected	4	4
	Highest observation (MPN/100mL)*	6,000	16,300
	Lowest observation (MPN/100 mL)	10	40
	Median observation (MPN/100 mL)	335	1,605
	Mean observation (MPN/100 mL)	909	2,624
	FINAL ASSESSMENT	Impaired	Impaired

* Most probable number per 100 milliliters.

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criteria 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 Crane Strand Drain and Crane Strand are Class III waterbodies, with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The criteria applicable to this TMDL are the Class III criteria for fecal and total coliform.

3.2 Applicable Water Quality Standards and Numeric Water Quality Target

Numeric criteria for bacterial quality are expressed in terms of fecal coliform and total coliform bacteria concentrations. The water quality criteria for protection of Class III waters, as established by Chapter 62-302, F.A.C., state 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.

Total Coliform Bacteria:

The MPN or MF per 100 milliliters (mL) shall be less than or equal to 1,000 as a monthly average nor exceed 1,000 in more than 20 percent of the samples examined during any month; and less than or equal to 2,400 at any time.

The criteria state 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 stream (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 either fecal coliform or total coliform bacteria. Therefore, the criteria selected for the TMDLs were not to exceed 400 MPN/100 mL in any sampling event for fecal coliform and not to exceed 2,400 MPN/100mL in any sampling event for total 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 and Total Coliform in Crane Strand Drain and Crane Strand basins

4.2.1 Point Sources

Three NPDES permitted wastewater facilities were identified in the Crane Strand basin. These include L-3 Communications Link, Simulation, and Training (FLRNEE059), Kaman Dayron, Inc. (FLRNEE296), and Cemex/Goldenrod Concrete Batch Plant (FLG110401). All these facilities are currently permitted under NPDES generic permits, which do not require routine monitoring. The nature of these businesses, which include electricity, machinery, equipment, supplies, ammunition for small arms, and a concrete batch plant, indicate that they will not discharge a significant amount of fecal or total coliform bacteria into ambient waters.

Municipal Separate Storm Sewer System Permittees

The stormwater collection systems owned and operated by Orange County and the City of Winter Park in the Crane Strand Drain and Crane Strand basins are covered by a Phase I NPDES municipal separate storm sewer system (MS4) permit. Orange County is the lead permittee. There are no Phase II permittees identified in these basins.

4.2.2 Land Uses and Nonpoint Sources

Land Uses

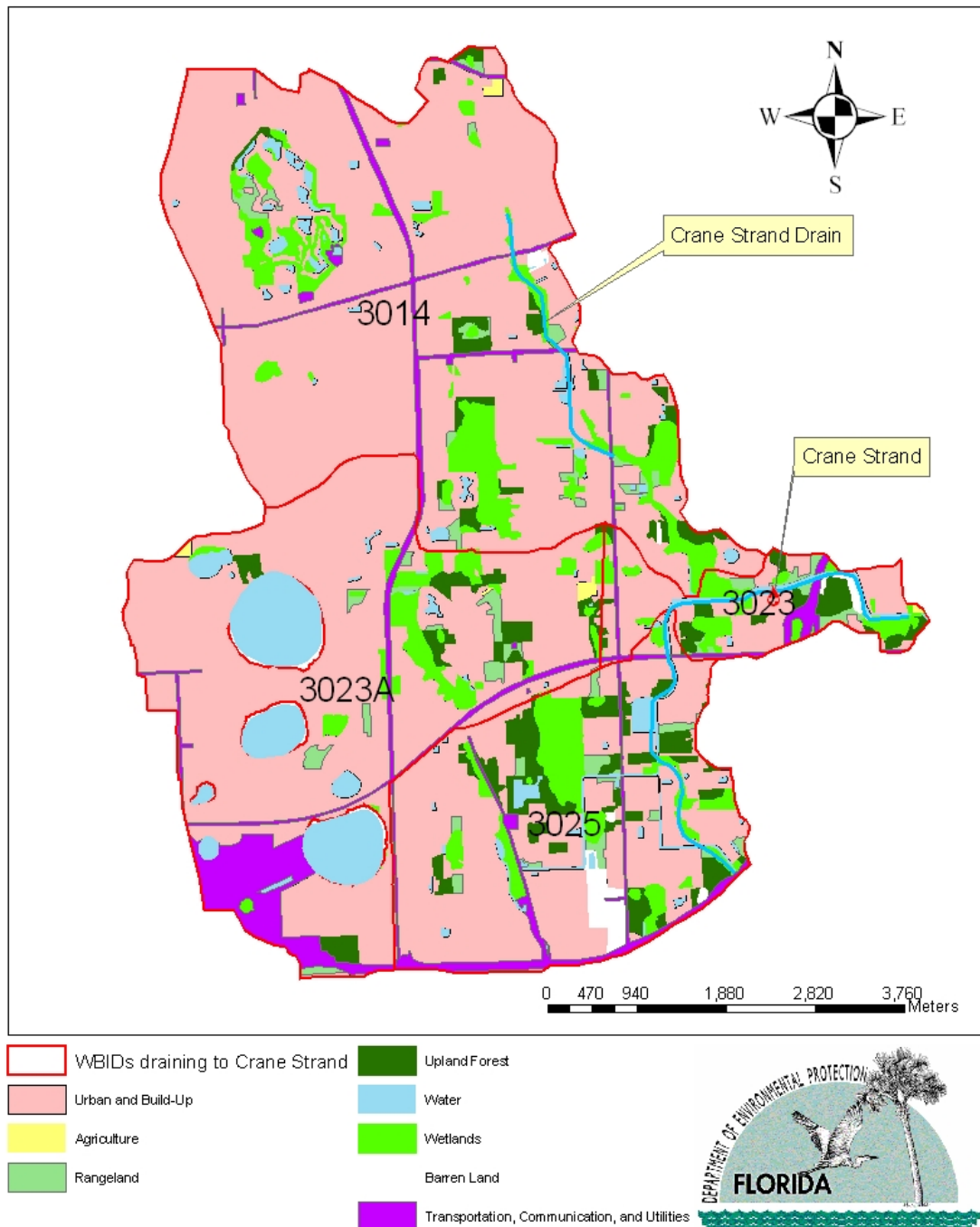
The spatial distribution and acreage of different land use categories were identified using the SJRWMD's year 2000 land use coverage (scale 1:40,000) contained in the Department's geographic information system (GIS) library. Land use categories in the watershed were aggregated using the simplified Level 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 Strand Drain and Crane Strand basins drain about 11,367 acres of land (including the land areas in WBID 3023A and WBID 3025, which discharge into Crane Strand). The dominant land use category is the urban land (urban and build-up, low, medium, and high density residential, and transportation, communication, and utilities), which accounts for about 80 percent of the total basin area. Of the 9,101 acres of urban lands, residential area occupies about 5,092 acres, or about 45 percent of the total basin area. Natural land use areas, which include water/wetlands and upland forest, occupy about 1,878 acres, accounting for about 17 percent of the total basin area.

Table 4.1. Classification of land use categories for the Crane Strand basin

Level 1 Code	Land Use	Acreage	Percent Acreage
1000	Urban and Build-Up	3311	29.1%
	Low-density residential	199	1.8%
	Medium-density residential	1878	16.5%
	High-density residential	3014	26.5%
2000	Agriculture	24	0.2%
3000	Rangeland	278	2.4%
7000	Barren land	88	0.8%
8000	Transportation, communication, and utilities	697	6.1%
4000	Forest/rural open	602	5.3%
5000/6000	Water/wetland	1276	11.2%
	TOTAL	11367	100.0%

Figure 4.1. Principal Land Uses in basins that drains to Crane Strand Drain and Crane Strand



Source Assessment

Because no traditional point sources were identified in the Crane Strand Drain and Crane Strand basins, the primary loadings of fecal coliform and total 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, and 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:

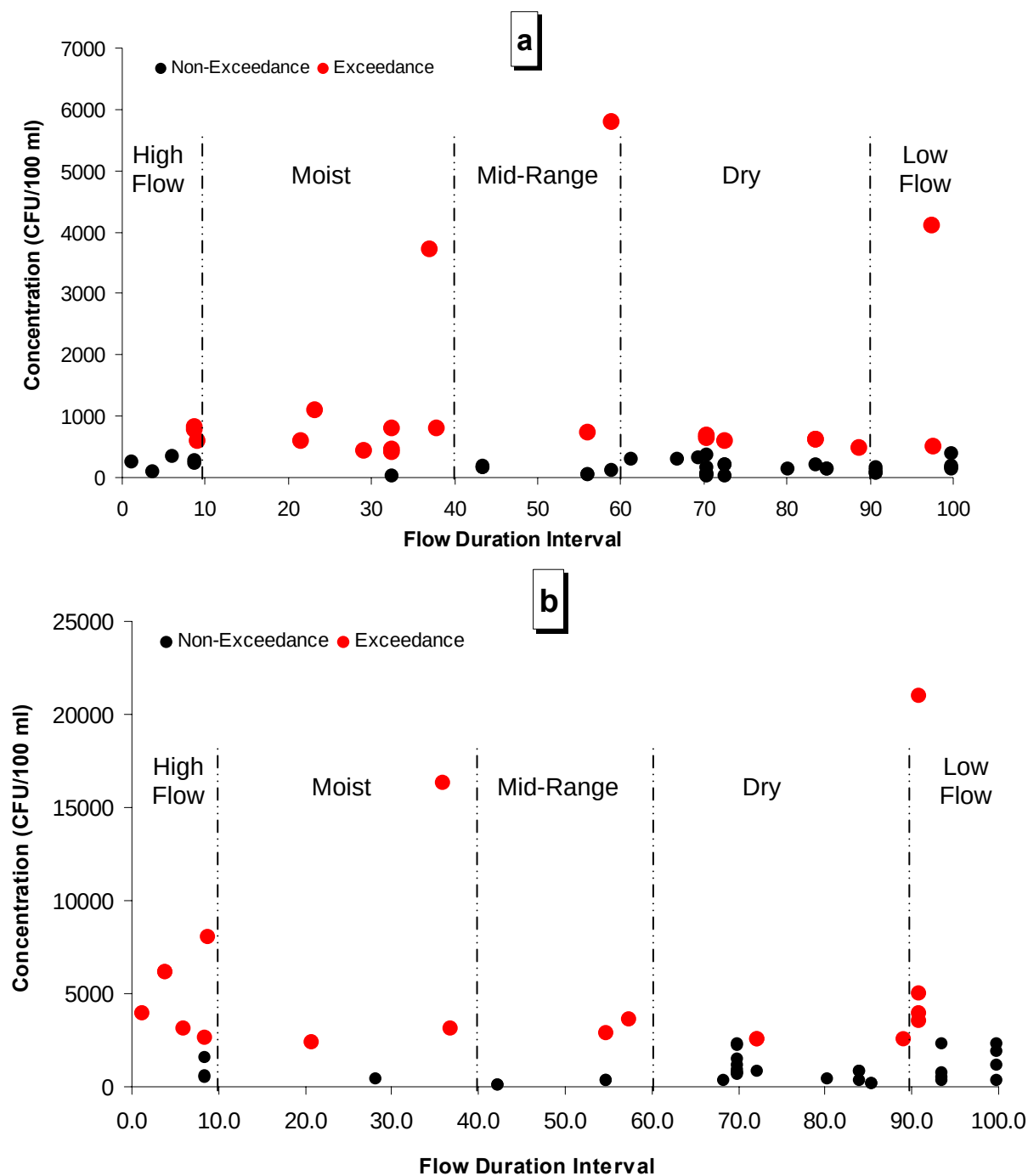
- Wildlife,
- Agricultural animals,
- Pets in residential areas,
- Onsite sewage treatment and disposal systems (septic tanks),
- Land application of domestic wastewater residuals, and
- Urban development (outside of Phase I or II MS4 discharges).

No data were available to specifically identify and quantify the major source(s) of fecal and total coliform bacteria in the Crane Strand Drain and Crane Strand basins. However, the relationship between the frequency at which fecal and total coliform measurements exceed the water quality criteria and the landuse types in these basins, especially the landuse around the station from which water quality samples were collected, shed light on what might be the potentially important sources for the fecal and total coliform pollution in the Crane Strand basin.

Figure 4.2a and b show concentrations of fecal and total coliform at different flow regimes, respectively. Because flow measurements were only available for the Crane Strand basin, fecal and total coliform concentrations from the Crane Strand Drain were combined with the fecal and total coliform concentrations from the Crane Strand basin and plotted against the flow duration using the Crane Strand flow measurements (see Chapter 5 for additional information about the flow duration curves). As these graphs show, when the flow duration ranking is lower than 40%, 9 of the 15 fecal coliform samples exceeded 400 MPN/100 ml, which is about a 60% exceedance rate. However, when the flow duration ranking is higher than 40%, the exceedance rate decreases to about 31%, with only 8 among 26 fecal coliform samples exceeding 400 MPN/100 ml. A similar trend was observed for total coliform. When the flow duration ranking is lower than 40%, 8 out of 11 samples exceed the total coliform criteria, which is about a 73% exceedance rate. However, when the flow duration ranking is higher than 40%, only 8 out of 25 samples exceeded the total coliform criteria (23% exceedance rate). For both fecal and total coliform, the percent exceedance significantly increases when the flow ranking is lower than 40%, which indicates that high frequency of exceedances appear under high flow conditions, which in turn suggests that the exceedances are mainly associated either with the surface runoff or high ground water table.

Pets (especially dogs) could be a significant source of coliform pollution through the surface runoff in Crane Strand Drain and Crane Strand basins. These two basins are largely urban areas (Table 4.1),

Figure 4.2. Exceedance of fecal and total coliform bacterial over water quality criteria under different flow regimes. A: Fecal coliform concentration; B: Total coliform concentration. The red dots represent counts that exceed the water quality criteria. The black dots represent counts that do not exceed the water quality criteria.



and the dominant urban landuse is residential. Studies report that up to 95% of the fecal coliform found in urban stormwater can come from nonhuman origins (Alderiso et al, 1996 and 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 Oliveri (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 coliforms 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 American Pet Products Manufacturers Association (APPPMA), 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 showed that about 40% of American dog owners do not pick up their dog's 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 level were widely different 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 Coliforms from Urban Source Areas (Steuer et al., 1997; Bannerman et al., 1993)

Geographic location	Marquette, MI	Madison, WI
Number of storms sampled	12	9
Commerical 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

In addition to pets, some other animal fecal coliform contributors commonly seen in urban areas include rats, pigeons, and sometimes, raccoons.

The number of dogs in Crane Strand Drain and Crane Strand basins is not known. Therefore, the statistics produced by APPMA was used in this study to estimate the possible fecal coliform loads contributed by dogs. According to the United States Census bureau, the number of households in Orange County in 2000 was 336,286. According to SJRWMD 2000 landuse GIS coverage, the total residential area in Orange County was about 88,667 acres. This gives a household density of about 3.79 households/acre residential area. According to **Table 4.1**, Crane Strand Drain and Crane Strand basins have about 5,091 acres of residential area. This gives about 19,309 households in the entire study basin. Assuming that 40% of the households in this area have one dog, the total number of dogs in the project basin is about 7,723 dogs. 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% of the dog owners do not pick up dog feces, the total waste produced by dogs and left on the land surface of residential area would be

1,390,215 grams. The total fecal coliform produced by dogs would be 3.06×10^{12} /day fecal coliform. It should be noted that this load only represented the fecal coliform load created in the watershed and was not intended to be used to represent a part of the existing load that reached the receiving waterbody. The fecal coliform load that eventually reaches the receiving waterbody could be significantly less than this value due to the attenuation in the overland transport.

Table 4.3. Dog population density, waste load, and fecal coliform density.

Type	Population density (an/household)	Waste load (g/an-day)	Fecal coliform density (fecal coliform/g)
Dog (Weiskel et al. 1996)	0.4**	450	2,200,000

** Number from APPMA.

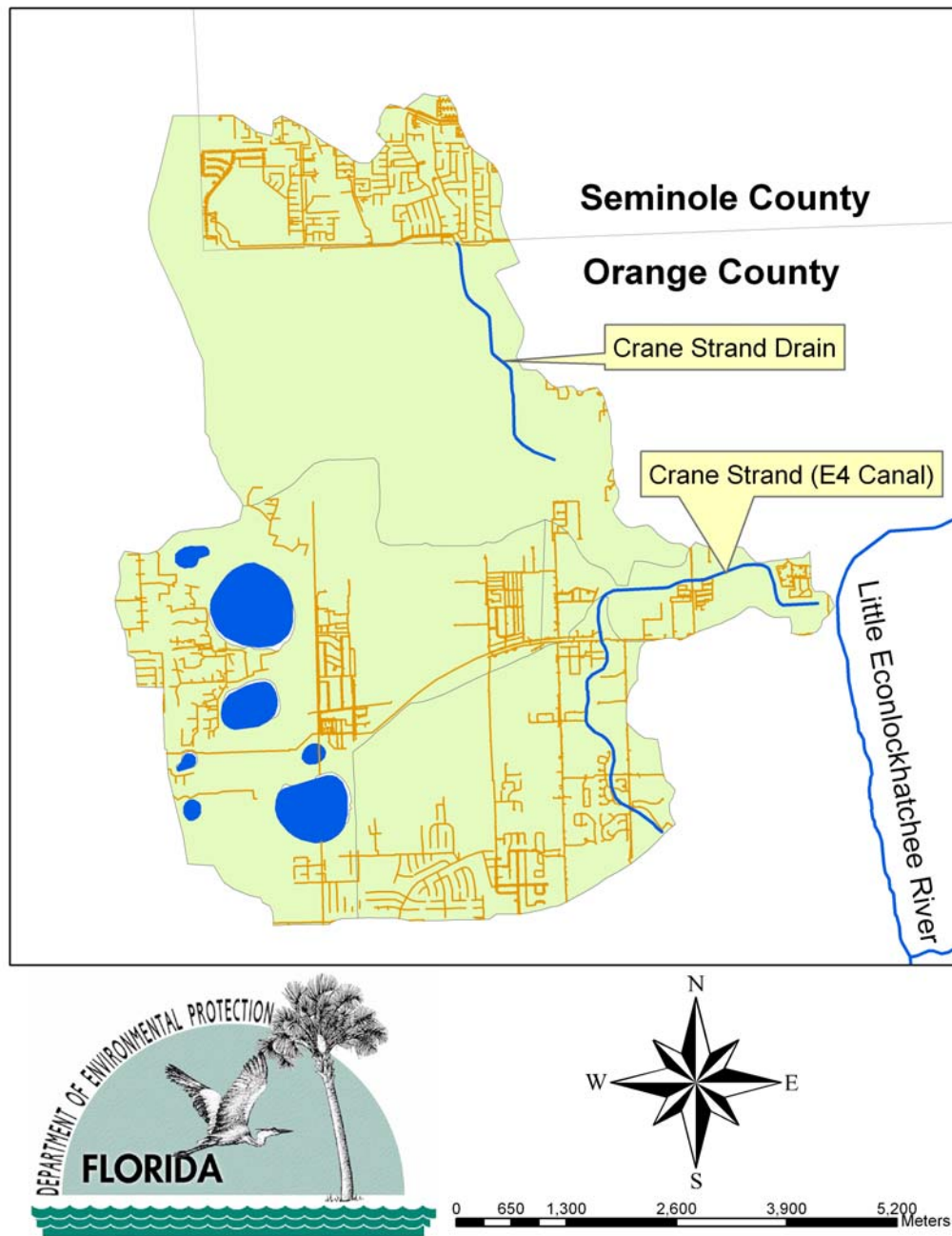
Septic tanks are another potentially important source of coliform pollution in urban watersheds. When properly installed, most of the coliform from septic tanks should be removed within 50 meters of the drainage field (Minnesota Pollution Control Agency, 1999). However, in areas with a relatively high ground water table, the drainage field can be flooded during the rainy season and coliform bacteria can pollute the surface water through storm 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 go into the well and once the polluted water is used to irrigate lawns, coliform bacteria may get to the land surface and wash into surface waters during the rainy season.

Sanitary sewer overflows (SSO) 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, little comprehensive data are available to quantify SSO frequency and bacteria loads in most watersheds. The Association of Metropolitan Sewage Agencies (AMSA, 1994) estimates that about 140 overflows occur per one thousand miles of sanitary sewer lines each year (1,000 miles of sewer serves a population of about 250,000). The AMSA survey also found that 15 to 35% of sewer lines were over capacity and could potentially overflow during storms.

Figure 4.2A and B show that exceedances also exist under low flow conditions, although in a decreased exceedance frequency. These exceedances could be caused by septic tank failures or sewer line leakages that interact with the ground water. Ground water pollution influences the stream water quality mainly through baseflow.

No direct information regarding the distribution of septic tanks in the basin was available to the Department when this study was conducted. However, the Orange County Environmental Protection Department provided a GIS coverage showing locations of the sanitary sewer lines in Orange County. The Crane Strand Drain and Crane Strand basins are highly urbanized, and

Figure 4.3. Location of sanitary sewer lines in the study area



the majority of the residential areas are covered by sanitary sewer lines (Figure 4.3). Septic tank leakage may not be the most important source of fecal and total coliform bacteria in this basin. Based on the GIS coverage provided by the Orange County, the total length of the sanitary sewer line within the boundary of the study basin is about 96 miles. Using AMSA's estimate of 140 SSO per 1000 miles per year, the possible sewer line leakage frequency for the study basin is about 14 per year. Although 14 SSO is not a large number, depending on the scale and time length before a given leakage is fixed, the bacteria loading from the leakage could be significant, especially if the sewer line is located adjacent to a receiving water

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

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 and total coliform concentrations and flow measurements were required to estimate both the allowable pollutant load and existing loading to Crane Strand. **Figure 5.1** shows the locations of the water quality sites from which fecal coliform and total coliform data were collected and the U.S. Geological Survey (USGS) gauging station from which the flow measurements were taken. Fecal and total coliform data collected during the Verified Period (1996 through 2003) were used in this study. Some data collected by the Department in a 2005 intensive survey were also added to the data set. A total of 33 fecal coliform and 24 total coliform samples were collected from 5 sampling stations in Crane Strand Drain, and 26 fecal and total coliform samples were collected from one station located in Crane Strand. Data used for this TMDL report were mainly provided by the Department's intensive survey, the Department's Central District office, Orange County, and Seminole County.

Because flow measurements were only available from a USGS gauging station located on Crane Strand (E4 canal), fecal coliform measurements from the five sites in the Crane Strand Drain basin were combined with the fecal coliform measurements from the site on Crane Strand, and a single fecal coliform TMDL was developed for Crane Strand Drain and Crane Strand. A combination of the data from the two basins was also applied to total coliforms and a single total coliform TMDL was developed for both the Crane Strand Drain and Crane Strand basins. **Table 2.2** provides a statistical summary of fecal and total coliform measurements in Crane Strand. **Figures 5.2a** and **5.2b** show the seasonal trends for fecal and total coliform concentrations from various sampling sites in the verified period (1996 through 2003) and the

Figure 5.1. Locations of Water Quality Stations and USGS Gauging Station from which Water Quality Data and Flow Measurements Were Collected for This Report

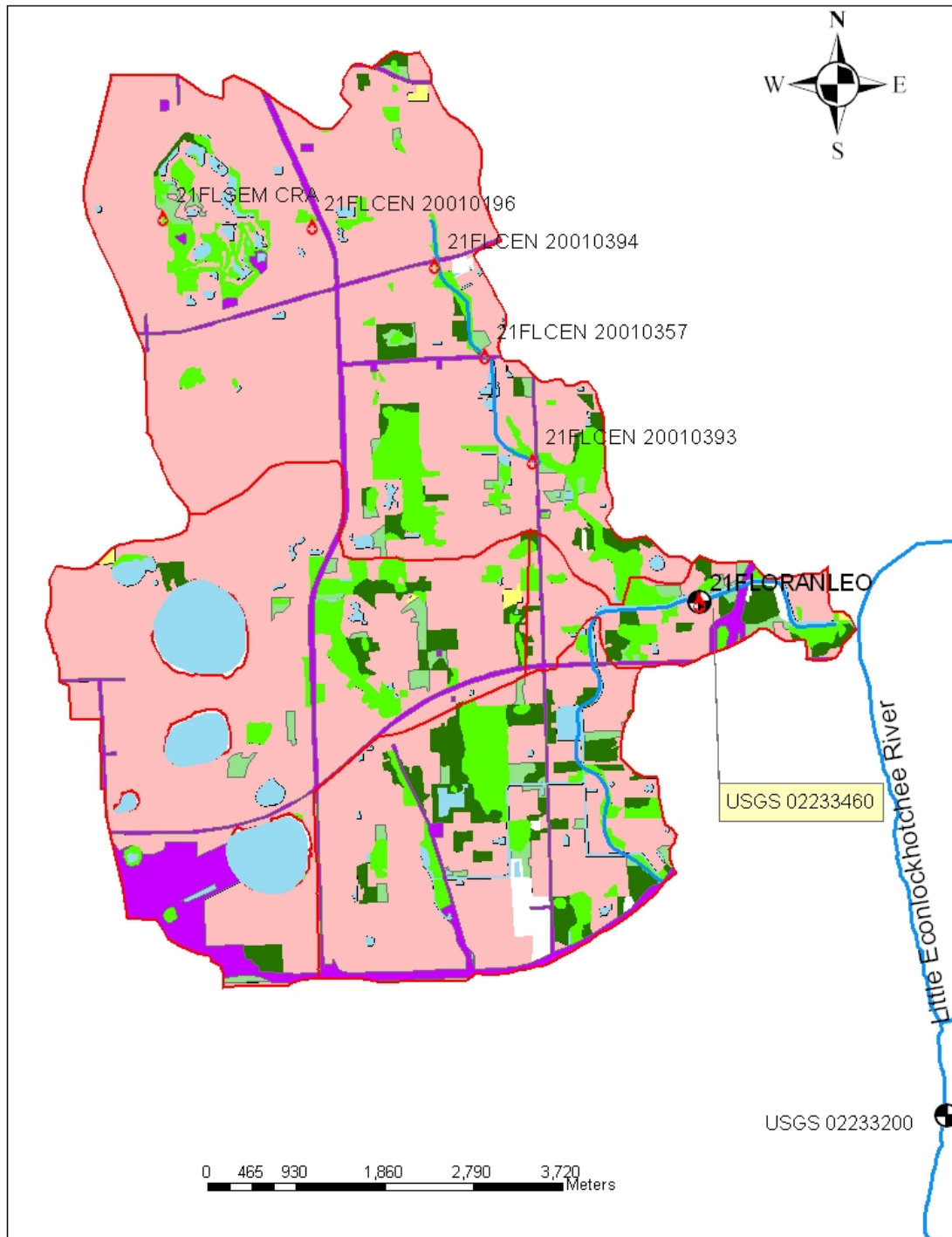


Figure 5.2a. Trend of Fecal Coliform Concentrations in Crane Strand Drain and Crane Strand. The LEO station is located in Crane Strand. All the other stations are located in Crane Strand Drain

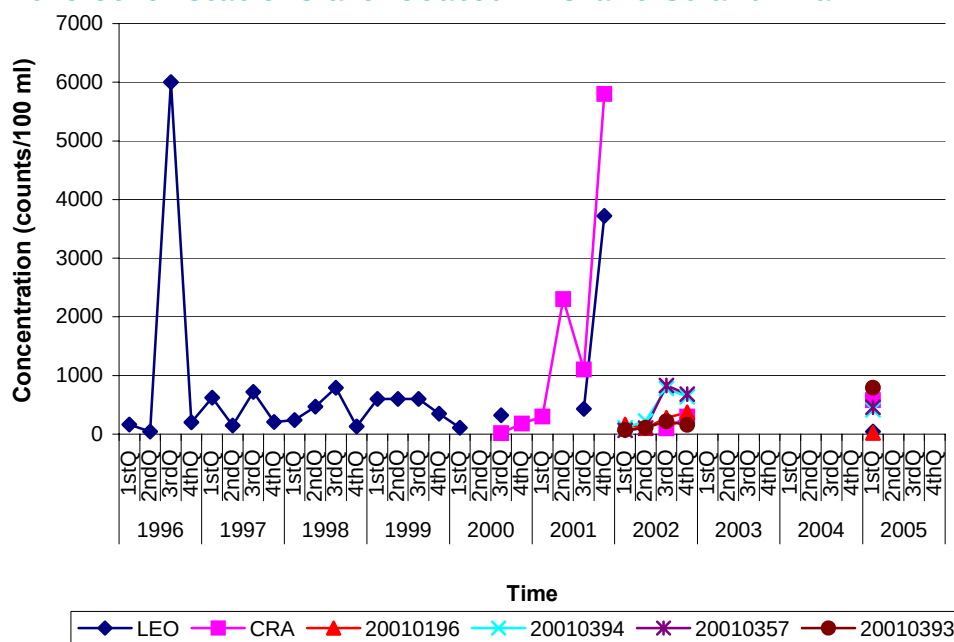
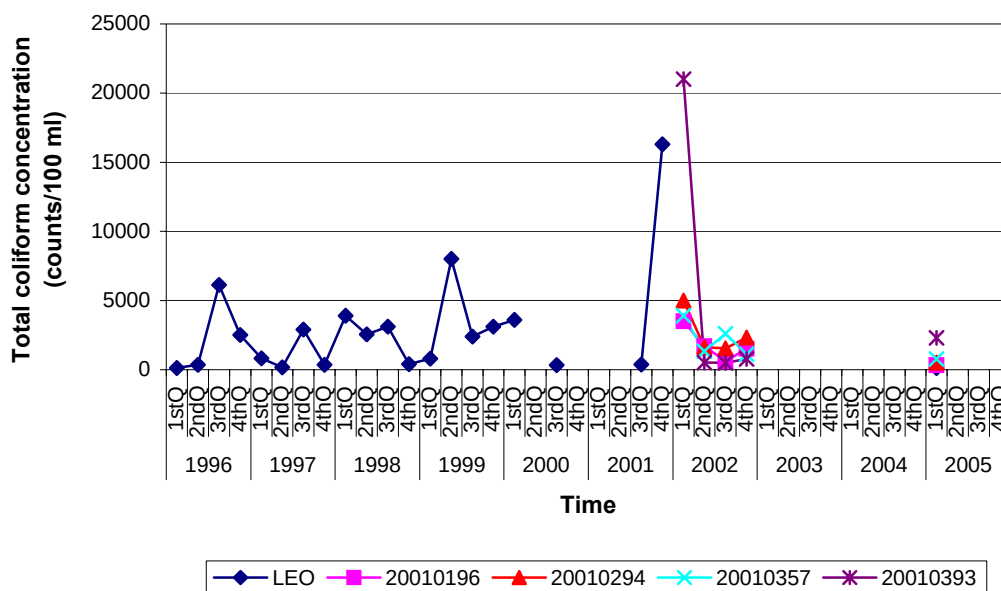


Figure 5.2b. Trend of Total Coliform Concentrations in Crane Strand Drain and Crane Strand. The LEO station is located in Crane Strand. All the other stations are located in Crane Strand Drain



results from the Department's intensive survey in 2005. The sampling site on Crane Strand (Site ID: LEO) has data for all four seasons from 1996 through 1999 and data for two seasons in 2000 and 2001. Most data collected from sites located in Crane Strand Drain were collected in 2002. For both fecal and total coliform bacteria, no obvious seasonal pattern was shown by these data. Fecal coliform concentrations from most sites stay below 1000 counts/100 ml. Peak values higher than 1000 counts/100 ml were observed in several occasions. However, the 6000 counts/100 ml observed at LEO site in the 3rd quarter of 1996 was considered unreliable because the total coliform count observed at the same time at the same station was 6,125 counts/100ml. Therefore, when the fecal coliform TMDL was developed, the 6000 counts/100 ml observed at LEO site in 1996 was excluded.

Flow measurements from a USGS gauging station located at Crane Strand (Station 02233460: Crane Strand at Banner Dam, Winter Park, Florida) were used in this TMDL report. Because the flow record from this station (from November of 2001 through April of 2005) did not cover the entire period during which the water quality samples were collected (especially the period from 1996 through 2000), flow measurements from a nearby USGS gauging station located in the upper reach of Little Econlockhatchee River (Station 02233200: Little Econlockhatchee River Tributary at St. HWY 15A near Orlando) were used in this study to extend the flow data from USGS Station 02233460 using the "Move. 1" statistical routine, which is discussed in detail in the following section. Flow measurements from both USGS gauging stations were downloaded from USGS water resource website (<http://fl.water.usgs.gov>). The flow duration curve for Crane Strand was developed based on a mixed flow data set, which includes both measured data when they were available, and the "Move. 1" estimated data when the measured data were not available. **Figure 5.1** shows the location of USGS gauging stations used in this study.

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 equaled 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.

As mentioned in the previous section, because the flow measurements collected at USGS Gauging Station 02233460 did not completely cover the period during which the water quality data were collected, the flow data set from the station was extrapolated using the "Move.1" statistical routine (Hirsch, 1982) based on the flow measurement collected from a nearby gauging station on a tributary to the Little Econlockhatchee River (USGS 02233200). The flow record of this station covers the period from October 1, 1959, through September 30, 2003. "Move.1" extends the flow data set using the following equation:

$$Y = \text{mean}(Y) + \frac{\text{stdev}(Y)}{\text{stdev}(X)} * (X - \text{mean}(X)) \quad (1)$$

Where:

- Y is the simulated daily flow for Crane Strand,
- Mean(Y) is the average logarithmic daily flow over the period of record for Crane Strand,
- Stdev(Y) is the standard deviation of the daily flow over the period of record for Crane Strand,
- X is the measured daily flow for the tributary of Little Econlockhatchee River,
- Mean(X) is the average logarithmic daily flow over the period of record for the tributary of Little Econlockhatchee River, and
- Stdev(X) is the standard deviation of the daily flow over the period of record for the tributary of Little Econlockhatchee River.

Table 5.1 shows the means and standard deviations of the logarithmic flow measurements for Crane Strand and the tributary of the Little Econlockhatchee River. Means and standard deviations for both Crane Strand and the tributary were calculated based on the flow measurements for November 15, 2001 through September 30, 2003. During this period, both flow stations had flow measurements.

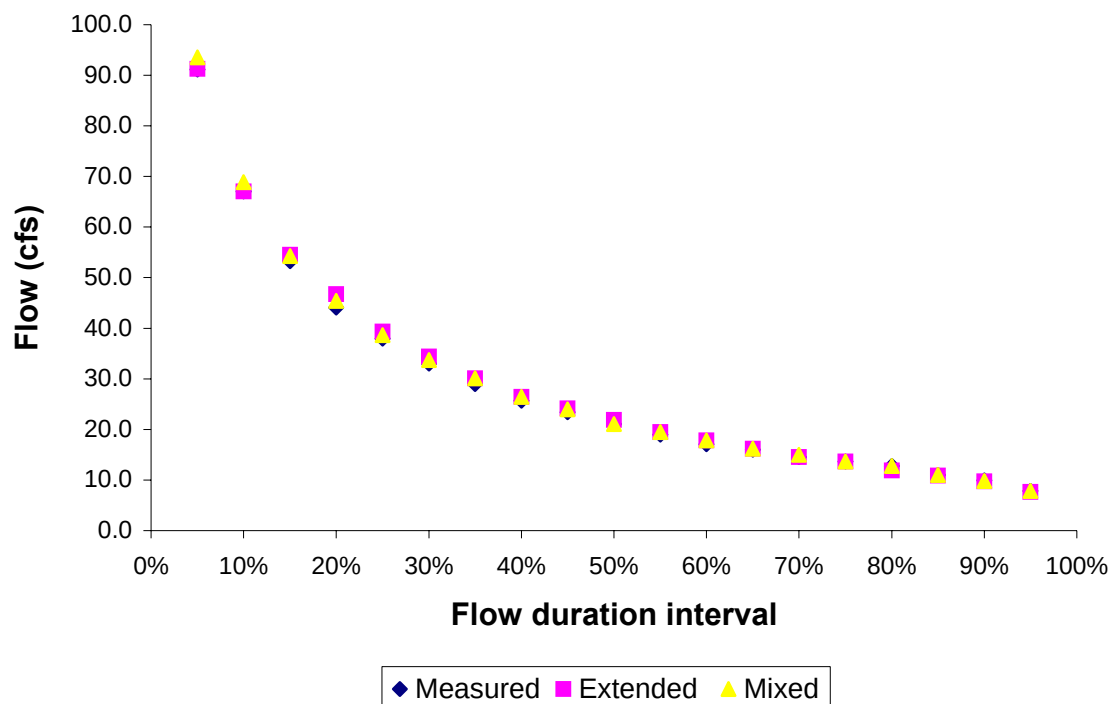
Table 5.1. Means and Standard Deviations of the Logarithmic Flow Measurements for Crane Strand (Y) and the tributary of Little Econlockhatchee River (X)

	Log flow of the tributary of Little Econlockhatchee River (X)	Log Crane Strand Flow (Y)
Mean	1.44	1.41
Stdev	0.40	0.33
$\frac{stdev(Y)}{stdev(X)}$	0.822	

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 5.3** shows the flow duration curves for Crane Strand generated from the measured flow and estimated flow using “Move. 1.” 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.

To ensure that the final flow data set was as accurate as possible, measured flow was used whenever there was a measured record. This created a mixed data set that includes both the “Move. 1” predicted flow and measured flow. **Figure 5.3** demonstrates that the flow duration curves created based on measured, extended, and mixed data sets are very similar. In creating the load duration curve, this TMDL report used the flow duration interval based on the mixed data set.

Figure 5.3. Flow Duration Curve for Crane Strand



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 or total 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:

$$\text{Allowable load} = (\text{observed flow}) \times (\text{conversion factor}) \times (\text{state criteria}) \quad (2)$$

$$\text{Existing loading} = (\text{observed flow}) \times (\text{conversion factor}) \times (\text{coliform measurement}) \quad (3)$$

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 in-stream fecal coliform or total 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 geometric mean, 400 MPN/100mL and 2,400 MPN/100 mL were used as target criteria for fecal coliform and total coliform, respectively. **Figures 5.4a and 5.4b** show both the allowable loads and the existing loads over the flow duration ranking for Crane Strand. 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 criteria.

As shown in **Figures 5.4a and 5.4b**, exceedances of the fecal coliform and total coliform criteria in Crane Strand and Crane Strand Drain occur across the entire span of the flow record. In general, exceedances on the right side of the curve typically occur during low-flow events, which implies 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 having 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 Strand Drain and Crane Strand, the exceedance frequency is higher at high flow conditions but the exceedances occur across the entire span of the flow conditions. Because exceedances occur throughout the flow record, there is no critical flow condition, and 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 and total coliform load reductions required to achieve water quality criteria were 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:

$$\text{Load reduction} = \frac{\text{Existing loading} - \text{Allowable loading}}{\text{Existing loading}} \times 100\% \quad (4)$$

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 ($R^2 = 0.7047$) and total coliform loading ($R^2 = 0.6543$). Therefore, power functions were used to predict the existing loads corresponding to the flow recurrence intervals used by the *Allowable loading*. The following are the power equations developed for fecal coliform and total coliform:

$$\text{For fecal coliform: } Y = 3E + 13X^{-1.1125} \quad (5)$$

$$\text{For total coliform: } Y = 3E + 13X^{-0.7171} \quad (6)$$

Where:

X is the flow recurrence interval between the 10th and 90th percentile and

Y is the predicted *Existing loading* for fecal coliform (Equation 5) and total coliform (Equation 6).

Figures 5.4a and **5.4b** show the trend lines and power equations for both fecal and total coliform bacteria. After the trend lines were developed, they were 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, and the final percent reduction needed was the median of these values. The TMDL and percent reductions were calculated as the median of all the loads and percent reductions calculated at the various recurrence intervals between the 10th and 90th percentile. **Tables 5.2a** and **5.2b**, respectively, show the calculation of the TMDL and percent reductions for fecal coliform and total coliform in Crane Strand Drain and Crane Strand.

Table 5.2a. Calculation of TMDL and Percent Reduction for Fecal Coliform in Crane Strand Drain and Crane Strand basins, WBID 3014 and 3023

Interval	Allowable Load (counts/day)	Existing Load ¹ (counts/day)	Percent Reduction
90	9.69E+10	2.01E+11	51.8
85	1.08E+11	2.14E+11	49.6
80	1.25E+11	2.29E+11	45.3
75	1.34E+11	2.46E+11	45.6
70	1.42E+11	2.66E+11	46.5
65	1.57E+11	2.89E+11	45.7
60	1.67E+11	3.15E+11	47.1

55	1.86E+11	3.48E+11	46.5
50	2.06E+11	3.86E+11	46.6
45	2.29E+11	4.34E+11	47.3
40	2.51E+11	4.95E+11	49.2
35	2.84E+11	5.75E+11	50.6
30	3.23E+11	6.82E+11	52.6
25	3.71E+11	8.35E+11	55.6
20	4.31E+11	1.07E+12	59.7
15	5.21E+11	1.47E+12	64.7
10	6.56E+11	2.32E+12	71.7
Median	2.06E+11	3.86E+11	49.2

Table 5.2b. Calculation of TMDL and Percent Reduction for Total Coliform in Crane Strand Drain and Crane Strand, WBID 3014 and 3023

Interval	Allowable Load (counts/day)	Existing Load ¹ (counts/day)	Percent Reduction
90	5.81E+11	1.19E+12	51.2
85	6.47E+11	1.24E+12	47.8
80	7.52E+11	1.30E+12	42.0
75	8.03E+11	1.36E+12	40.8
70	8.53E+11	1.43E+12	40.1
65	9.39E+11	1.50E+12	37.5
60	1.00E+12	1.59E+12	37.1
55	1.12E+12	1.69E+12	34.2
50	1.24E+12	1.81E+12	31.8
45	1.37E+12	1.96E+12	29.8
40	1.51E+12	2.13E+12	29.2
35	1.70E+12	2.34E+12	27.3
30	1.94E+12	2.62E+12	25.9
25	2.23E+12	2.98E+12	25.3
20	2.59E+12	3.50E+12	26.1
15	3.13E+12	4.30E+12	27.3
10	3.94E+12	5.75E+12	31.6
Median	1.24E+12	1.81E+12	31.8

Figure 5.4a. Load Duration Curves for Allowable Load and Existing Loading Capacity of Fecal Coliform

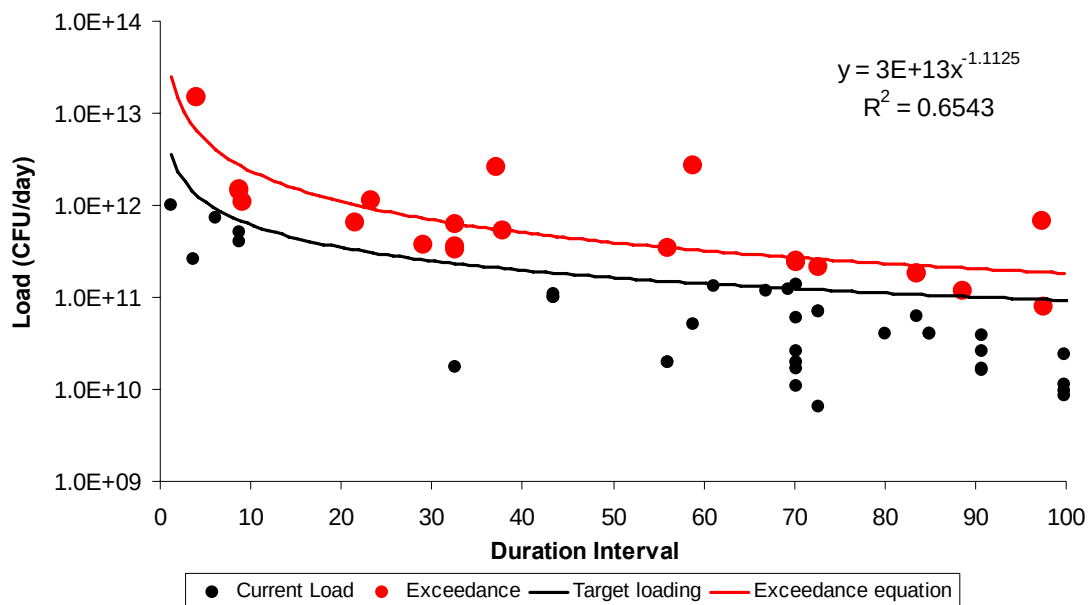
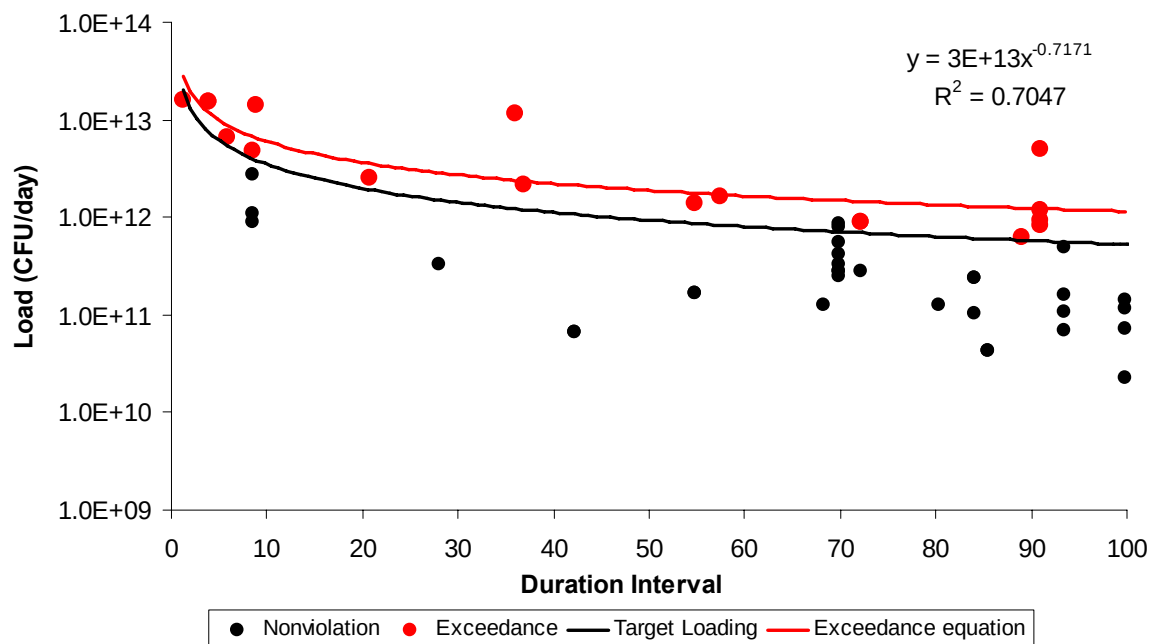


Figure 5.4b. Load Duration Curves for Allowable Load and Existing Loading Capacity of Total Coliform



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 (Waste Load 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 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**. TMDLs for Crane Strand and Crane Strand Drain are expressed in terms of MPN/day and percent reduction, and represent the maximum daily fecal coliform and total coliform loads the stream can assimilate and maintain the fecal coliform criterion (**Table 6.1**).

Table 6.1. TMDL Components for Fecal Coliform and Total Coliform in Crane Strand Drain and Crane Strand basins, WBID 3014 and 3023

Parameter	TMDL (colonies/day)	WLA		LA (percent reduction)	MOS
		Wastewater (colonies/day)	NPDES Stormwater (percent reduction)		
Fecal coliform	2.06×10^{11}	N/A	49.2%	49.2 %	Implicit
Total coliform	1.24×10^{12}	N/A	31.8%	31.8%	Implicit

6.2 Load Allocation (LA)

Based on a loading duration curve approach similar to that developed by Kansas (Stiles, 2002), the load allocation is a 49.2 percent reduction in fecal coliforms from nonpoint sources and a 31.8 percent reduction in total coliforms 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 (WLA)

6.3.1 NPDES Wastewater Discharges

No NPDES-permitted wastewater facilities with fecal and total coliform limits were identified in the Crane Strand Drain and Crane Strand basins. The state of Florida already requires all NPDES point source dischargers to meet bacteria criteria at the end of pipe. It is the Department's current practice to not 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.

6.3.2 NPDES Stormwater Discharges

The WLA for stormwater discharges with an MS4 permit is a 49.2 percent and 31.8 percent reduction in current fecal coliform and total coliform loadings, respectively. It should be noted that any MS4 permittee will only be 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 (MOS)

Consistent with the recommendations of the Allocation Technical Advisory Committee (Florida Department of Environmental Protection, February 2001), an implicit margin of safety (MOS) was used in the development of this TMDL. For fecal coliform, an implicit MOS was inherently incorporated by using 400 MPN/100 mL of fecal coliform as the water quality target for individual samples, instead of setting the criteria as that no more than 10 percent of the samples exceeding 400 MPN/100 mL. For both fecal coliform and total coliform TMDLs, using the load duration curve method to develop TMDL assumes there is no in-stream decay of fecal or total coliform bacteria after the watershed loading reaches to the receiving waterbody, while in reality fecal and total coliform loadings could diminish through processes including death, grazing, and deposition. Therefore, the load duration curve method tends to underestimate allowable fecal and total coliform loadings 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, which will be a component of the Basin Management Action Plan (BMAP) for the Middle St. Johns River Basin. This document will be developed over the next year in cooperation with local stakeholders and will attempt to reach consensus on more detailed allocations and on how load reductions will be accomplished. The BMAP will include the following:

- Appropriate allocations among the affected parties,
- A description of the load reduction activities to be undertaken,
- Timetables for project implementation and completion,
- Funding mechanisms that may be utilized,
- Any applicable signed agreement,
- Local ordinances defining actions to be taken or prohibited,
- Local water quality standards, permits, or load limitation agreements, and
- Monitoring and follow-up measures.

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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 Chapter 62-40, F.A.C. In 1994, the department's stormwater treatment requirements were integrated with stormwater flood control requirements of the water management districts, along with wetland protection requirements, into the Environmental Resource Permit regulations.

Chapter 62-40 also requires the state's water management districts (WMDs) to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a 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. No PLRG has been developed for Newnans Lake at the time this study was conducted.

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 implementation of 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 five or more acres of land, and master drainage systems of local governments with a population above 100,000, which are better known as municipal separate storm sewer systems (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 fifteen 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 one and five 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 similar to 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 re-opener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.

Appendix B: Comments from the United States Environmental Protection Agency (EPA) and responses from the Florida Department of Environmental Protection (DEP) on the Fecal and Total Coliform TMDLs for Crane Strand Drain and Crane Strand

1. EPA comments: Need to fix page 4 regarding the causative pollutant for DO impairment. Currently the document reads “.... Verified for DO with xx identified as the causative pollutant.”

DEP Response: Text revised in the report.

2. EPA comment: In the source assessment, only pets are given an existing fecal coliform load. This load of 3.06E+11 counts/day is about 80% of the existing load for the entire WBID (i.e., 3.86E+11 counts/day, see Table 5.2.a). The TMDL load for the WBID is 2.06E+11 counts/day would require a reduction from pet waste. In the absence of loads for other nonpoint sources, suggest removing the load assigned to pet waste.

DEP Response: It should be noted that the fecal coliform loads presented in the source assessment only represented the fecal coliform load that can be potentially created in the watershed and was not intended to be used to represent the existing load that reached the receiving waterbody. The purpose of watershed loading estimation is to roughly characterize the relative importance of loading from different sources. The fecal coliform load that eventually reaches the receiving waterbody could be significantly less than the load created in the watershed due to the attenuation in the overland transport. In addition, even after the fecal coliform load reaches the receiving water, it will usually diminish through other processes such as death, grazing, and deposition before being measured. This is why fecal and total coliform loads created in the watershed are different from the fecal and total coliform loads calculated by multiplying the in-stream fecal and total coliform concentrations by the stream flow. These two different types of loading are not directly comparable.

3. EPA comment: May want to add the disclaimer requiring any future point sources that may discharge in the watershed to meet end-of-pipe standards for fecal and total coliform.

DEP response: A disclaimer added on page 28, section 6.3.1, of the report per EPA's suggestion.

4. **EPA comment:** In the Margin of Safety, decay is implicit in the analysis as the TMDL is based on instream samples that have undergone decay and dilution. It's probably not exactly correct to assume the analysis does not take into account decay.

DEP response: The language is removed.



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