FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration

CENTRAL DISTRICT • MIDDLE ST. JOHNS BASIN

Final TMDL Report

Fecal Coliform TMDL for Gee Creek (WBID 2994A), Soldier Creek Reach (WBID 2986), and Smith Canal (WBID 2962)

David Tyler

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Acknowledgments

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Florida Department of Environmental Protection, Bureau of Watershed Restoration

TMDL Program

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

Identification of Impaired Surface Waters Rule

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

STORET Program

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

2008 Integrated Report

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

Criteria for Surface Water Quality Classifications

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

Basin Status Report for the Middle St. Johns Basin

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

Water Quality Assessment Report for the Middle St. Johns Basin

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

U.S. Environmental Protection Agency

Region 4: Total Maximum Daily Loads in Florida

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

National STORET Program

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

Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Loads (TMDLs) for fecal coliform bacteria for Gee Creek, Soldier Creek Reach (referred to as Soldier Creek throughout this document), and Smith Canal in the Middle St. Johns Basin. These waterbodies were verified as impaired for fecal coliform and therefore were included on the Verified List of impaired waters for the Middle St. Johns Basin that was adopted by Secretarial Order on May 19, 2009. The TMDLs establish the allowable fecal coliform loadings to Gee Creek, Soldier Creek, and Smith Canal that would restore these waterbodies so that they meet their applicable water quality criterion for fecal coliform.

1.2 Identification of Waterbody

Gee Creek, Soldier Creek, and Smith Canal are located in the western portion of Seminole County along the Interstate 4 corridor (**Figure 1.1**), as follows:

- *Soldier Creek (about 4.3 miles long) flows southeast, entering the far western edge of Lake Jesup, where it joins with its sister stream, Gee Creek (about 4.3 miles in length), which flows northeast. Soldier Creek drains an area of about 19 square miles, including a large portion of northern Longwood (approximately 14,000 people) and the outskirts of Lake Mary (about 15,000 people) and Winter Springs (approximately 33,000 people). Soldier Creek comprises mainly residential areas and has fairly extensive wetlands (especially in the downstream section of the creek), of which a large portion is contained within Seminole County's Solider Creek Park.*

- *Gee Creek drains an area of about 10 square miles, including virtually all of the city of Casselberry, plus portions of Longwood and Winter Springs.*

- *Smith Canal (about 4.8 miles in length) flows northwest, entering the St. Johns River approximately 1.4 miles upstream of the outlet to Lake Monroe. The canal drains an area of about 22 square miles, including portions of Sanford (about 51,000 people) and Lake Mary. Gee Creek and Smith Canal comprise mainly residential areas, with sparse patches of wetlands and forested land.*

Additional information about the hydrology and geology of these waterbodies is available in the Basin Status Report for the Middle St. Johns (Florida Department of Environmental Protection [Department], 2003).

For assessment purposes, the Department has divided the Middle St. Johns Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. Gee Creek, Soldier Creek, and Smith Canal are WBIDs 2994A, 2986, and 2962, respectively (**Figure 1.2**).

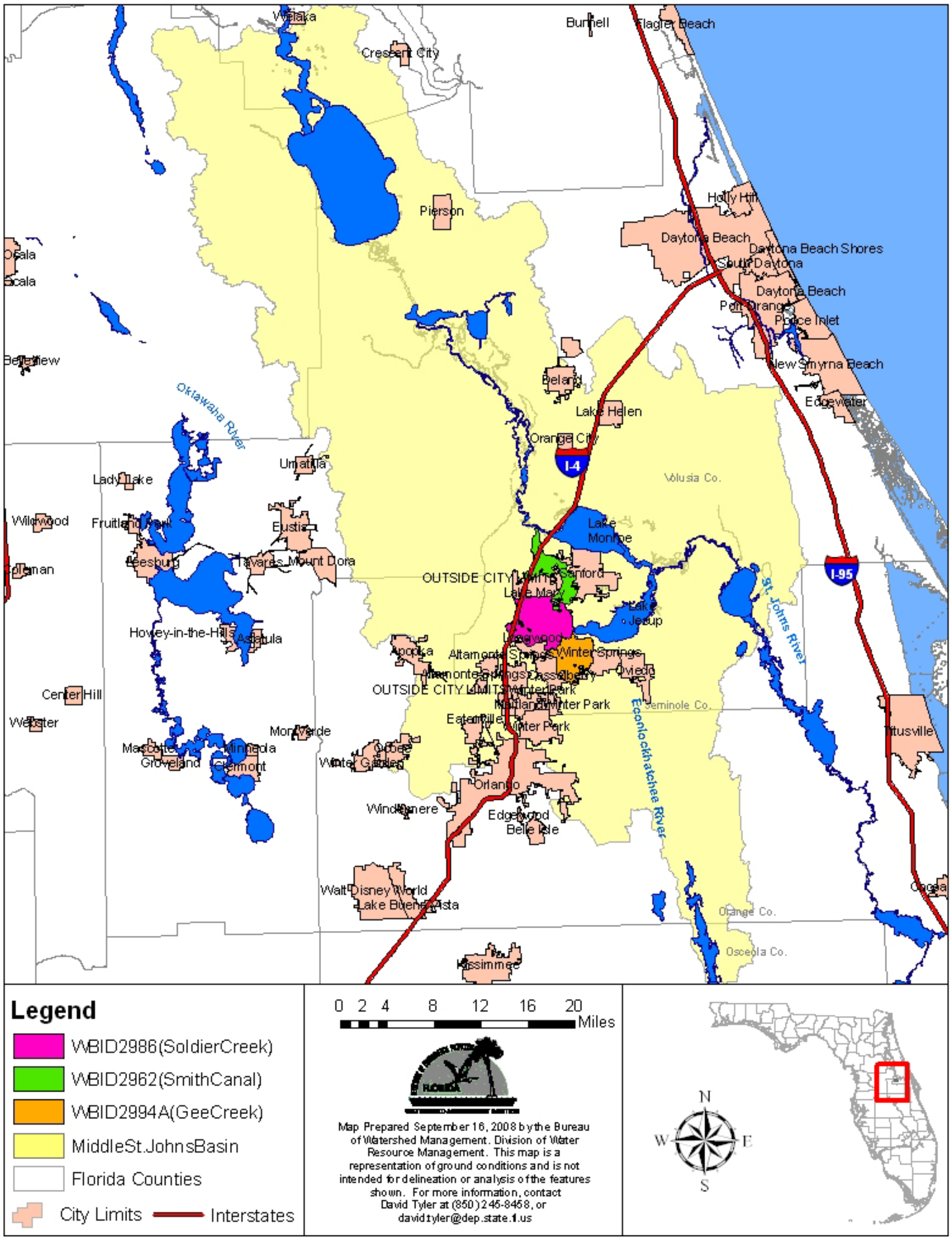


Figure 1.1. Location of the Gee Creek (WBID 2994A), Soldier Creek (WBID 2986), and Smith Canal (WBID 2962) Watersheds in the Middle St. Johns Basin and Major Geopolitical Features in the Area

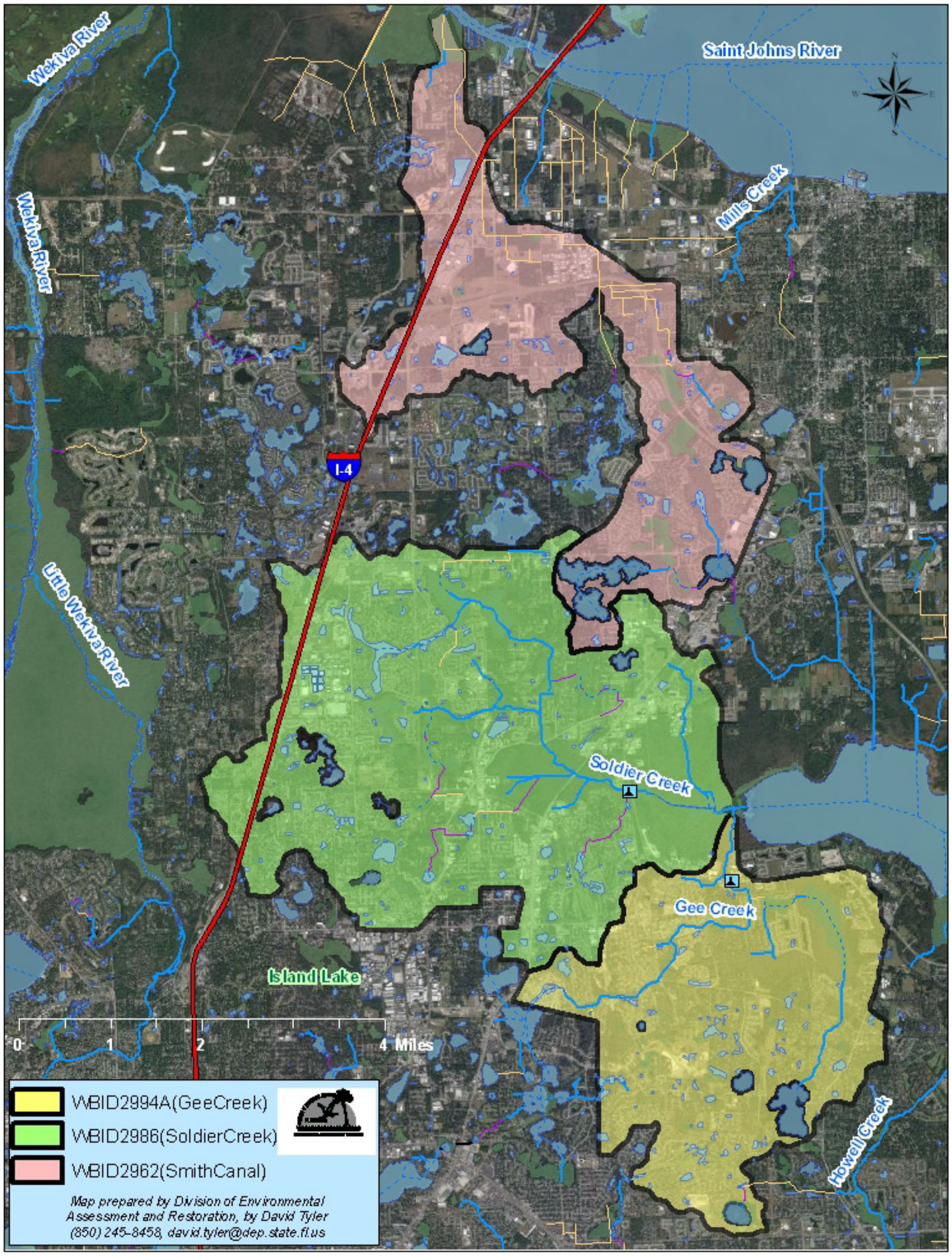


Figure 1.2. Location of the Gee Creek (WBID 2994A), Soldier Creek (WBID 2986), and Smith Canal (WBID 2962) Watersheds in Seminole County and Hydrologic Features in the Area

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.

This TMDL Report will be followed by the development and implementation of a restoration plan, designed to reduce the amount of fecal coliform that caused the verified impairment of Gee Creek, Soldier Creek, and Smith Canal. 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 24 waterbodies in the Middle St. Johns 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 2004 and 2007.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in Gee Creek, Soldier Creek, and Smith Canal and verified the impairments for fecal coliform (**Table 2.1**). **Table 2.2** summarizes the data collected during the verified period (January 1, 2001, through June 30, 2008). As shown in **Table 2.1**, the projected year for the fecal coliform bacteria TMDLs was 2008, but the Settlement Agreement between EPA and Earthjustice, which drives the TMDL development schedule for waters on the 1998 303(d) list, allows an additional nine months to complete the TMDLs. As such, these TMDLs must be adopted and submitted to the EPA by September 30, 2009.

These waterbodies were verified as impaired based on fecal coliform because, using the IWR methodology, more than 10 percent of the values exceeded the Class III freshwater criterion of 400 counts per 100 milliliters (counts/100mL) for fecal coliform: Gee Creek (14 out of 32 samples), Soldier Creek (11 out of 36 samples), and Smith Canal (11 out of 46 samples) in the verified period exceeded the criterion.

The verified impairments were based on data collected by Seminole County and the Department's Central District. **Figure 5.1** shows the WBID locations and STORET stations. **Figures 2.1a, 2.1b,** and **2.1c** display the fecal coliform data collected from 2001 through 2008 for each watershed.

Table 2.1. Verified Impairments for Gee Creek (WBID 2994A), Soldier Creek (WBID 2986), and Smith Canal (WBID 2962)

[1] The TMDLs were scheduled to be completed by December 31, 2008, based on a Consent Decree between the EPA and Earthjustice, but the Consent Decree allows a nine-month extension for completing the TMDL.

Parameter Causing Impairment	Priority for TMDL Development	Projected Year for TMDL Development[1]
Fecal Coliform	Low	2008

Table 2.2. Summary of Fecal Coliform Data for Gee Creek (WBID 2994A), Soldier Creek (2986), and Smith Canal (2962) During the Verified Period (January 1, 2001, through June 30, 2008)

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

Waterbody	Total Number of Samples	IWR-required Number of Exceedances for the Verified List[12]	Number of Observed Exceedances[1]	Number of Observed Nonexceedances[1]	Number of Seasons Data were Collected	Mean[2]	Median[2]	Min[2]	Max[2]
Soldier Creek	36	7	11	25	4	356	290	40	1,360
Gee Creek	32	7	14	18	4	915	350	2	7,600
Smith Canal	46	8	11	35	4	379	200	1	1,730

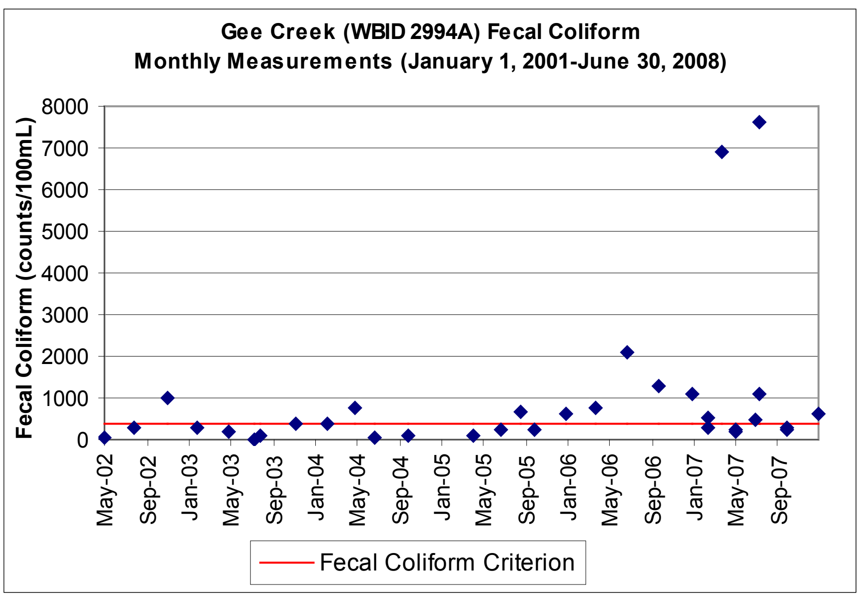


Figure 2.1a. Fecal Coliform Measurements for Gee Creek (WBID 2994A) During the Verified Period (January 1, 2001, through June 30, 2008)

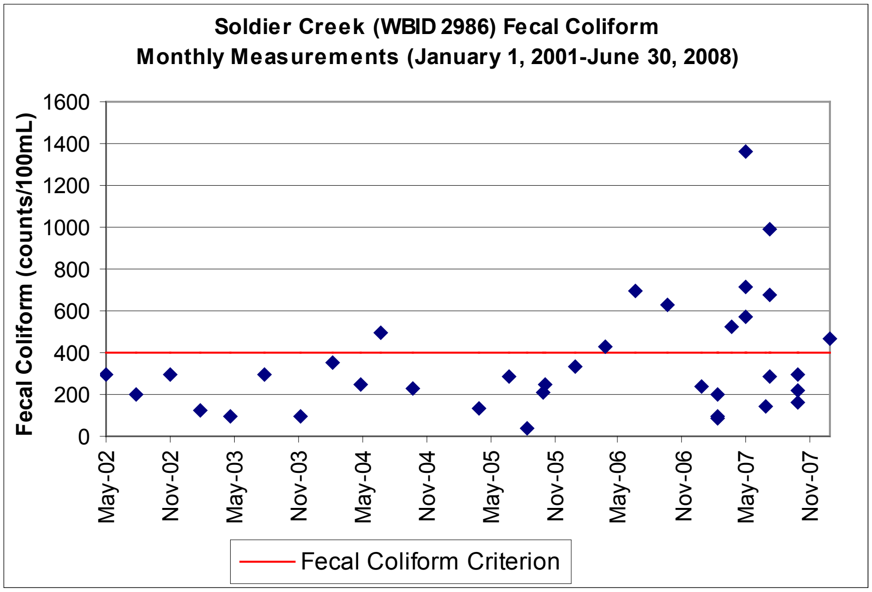


Figure 2.1b. Fecal Coliform Measurements for Soldier Creek (WBID 2986) During the Verified Period (January 1, 2001, through June 30, 2008)

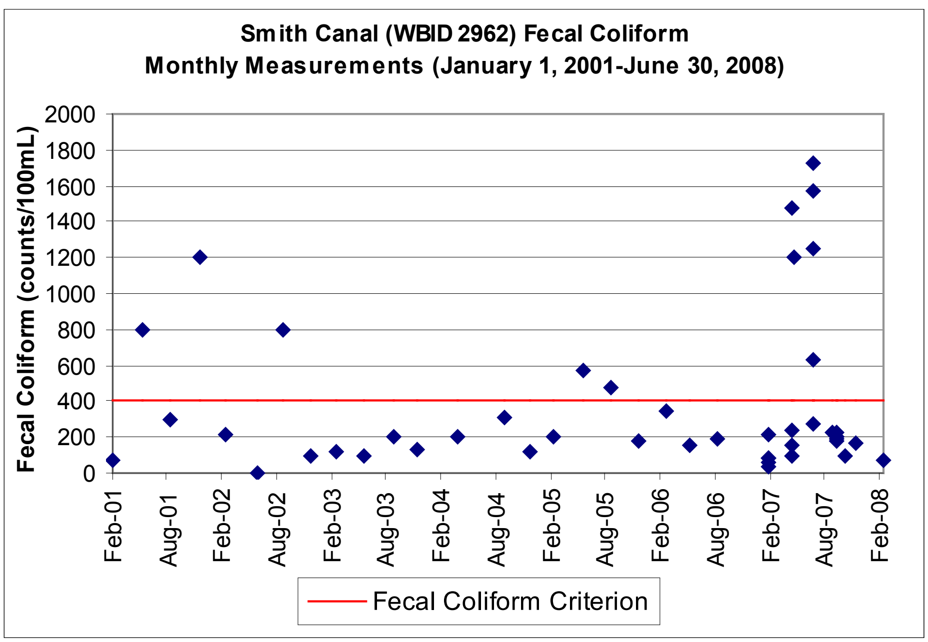


Figure 2.1c. Fecal Coliform Measurements for Smith Canal (WBID 2962) During the Verified Period (January 2001–June 2008)

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)**

Gee Creek, Soldier Creek, and Smith Canal are Class III waterbodies, with a designated use of recreation, propagation, and the maintenance of a healthy, well-balanced population of fish and wildlife. The criterion applicable to these TMDLs 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 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 the TMDLs (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/100mL in any sampling event for fecal coliform. The 10 percent exceedance allowed by the water quality criterion for fecal coliform bacteria was not used directly in estimating the target load, but was included in the TMDLs' margin of safety (as described in subsequent chapters).

Chapter 4: ASSESSMENT OF SOURCES

4.1 Types of Sources

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

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

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

4.2 Potential Sources of Fecal Coliform in the Gee Creek, Soldier Creek, and Smith Canal Watersheds

4.2.1 Point Sources

There are two NPDES-permitted facilities (CEMEX–Sanford Concrete Batch Plant, Permit No. FLG110320; and Rinker Materials–Sanford Concrete Batch Plant, Permit No. FLG110598) located near Smith Canal, and one NPDES-permitted facility (Sprague Electronics Ground Water Remediation Industrial Wastewater, Permit No. FL0171565) in the Soldier Creek watershed. However, these facilities' discharges do not contribute fecal coliform bacteria to surface water.

Municipal Separate Storm Sewer System Permittees

The stormwater collection systems owned and operated by Seminole County with the Florida Department of Transportation (FDOT) District 5 and co-permittees (cities of Casselberry, Winter Springs, Longwood, Lake Mary, and Sanford) are covered by a Phase I NPDES municipal separate storm sewer system (MS4) permit (FLS000038). There are no Phase II MS4 permits identified for Gee Creek, Soldier Creek, or Smith Canal.

4.2.2 Land Uses and Nonpoint Sources

Nonpoint source pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. Nonpoint pollution is caused by rainfall moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even underground sources of drinking water (EPA, 1994). Potential nonpoint sources of coliform include loadings from surface runoff, wildlife, livestock, pets, leaking septic tanks, and leaking sewer lines.

The load duration curve analysis described in detail in Chapter 5 sheds some light on possible nonpoint sources of fecal coliform in the Gee Creek and Soldier Creek watersheds. According to **Figures 5.3a** and **5.3b** (in Chapter 5), all of the fecal coliform exceedances occurred in several flow duration zones: “Mid-range,” “Dry,” and “Low” conditions.

As no major point sources were identified discharging fecal coliform into Gee Creek, Soldier Creek, and Smith Canal, an exceedance under dry weather conditions could be considered as stemming primarily from baseflow, which carries the pollutant from the surficial aquifer. Baseflow pollution could result from many different sources, including failed septic tanks and leaking sewer systems, which are covered in more detail later in this chapter. The watersheds are mainly residential, and irrigation from lawns could carry fecal coliform from pet feces into surficial ground water, or an irrigation system could discharge directly into the stream if it is improperly constructed.

Wildlife such as birds, raccoons, bobcats, rabbits, and occasionally deer could also contribute to the fecal coliform exceedances in all three watersheds—especially Soldier Creek, which has a considerable amount of vegetated habitat in the southern downstream portion of the watershed. These animals have direct access to the stream, especially under low-flow conditions. **Figure 4.1** shows significant amounts of vegetative canopy along a portion of Soldier Creek, upstream from Station 21FLCEN 20010937.

Figure 4.1. Vegetation Shading Soldier Creek (Looking Upstream from Station 21FLCEN 20010937)

Land Uses

The spatial distribution and acreage of different land use categories were identified using the SJRWMD's 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 **Tables 4.1a, 4.1b,** and **4.1c**. **Figure 4.2** shows the principal land uses in each watershed.

As shown in **Tables 4.1a, 4.1b,** and **4.1c,** the Gee Creek, Soldier Creek, and Smith Canal watersheds drain about 6,419, 11,738, and 6,337 acres of land, respectively. The dominant land use category for the Gee Creek, Soldier, Creek, and Smith Canal watersheds is urban land (urban and built-up; low-, medium-, and high-density residential; and transportation, communication, and utilities), which accounts for 70, 66, and 57 percent, of the watersheds' total areas, respectively. Natural land uses for the Gee Creek, Soldier Creek, and Smith Canal watersheds, including water/wetlands, upland forest, and barren land, occupy about 30 percent of the total watershed area.

Table 4.1a. Classification of Land Use Categories for the Gee Creek Watershed (WBID 2994A) in 2004

- = Empty cell

Level 1 Code	Land Use	Acreage	% Acreage
1000	Urban and Built-up	601	9.37%
1100	Low-density Residential	389	6.06%
1200	Medium-density Residential	2,775	43.23%
1300	High-density Residential	533	8.31%
2000	Agriculture	65	1.01%
3000	Rangeland	107	1.67%
4000	Forest/Rural Open	426	6.63%
5000	Water	209	3.25%
6000	Wetlands	1,116	17.39%
7000	Barrenland	14	0.22%
8000	Transportation, Communication, and Utilities	183	2.86%
-	**Total:**	**6,419**	**100%**

Table 4.1b. Classification of Land Use Categories for the Soldier Creek Watershed (WBID 2986) in 2004

- = Empty cell

Level 1 Code	Land Use	Acreage	% Acreage
1000	Urban and Built-up	2,163	18.43%
1100	Low-density Residential	661	5.63%
1200	Medium-density Residential	2,934	25.00%
1300	High-density Residential	1,247	10.63%
2000	Agriculture	317	2.70%
3000	Rangeland	215	1.83%
4000	Forest/Rural Open	597	5.09%
5000	Water	374	3.19%
6000	Wetlands	2,456	20.93%
7000	Barrenland	2	0.02%
8000	Transportation, Communication, and Utilities	770	6.56%
-	**Total:**	**11,738**	**100%**

Table 4.1c. Classification of Land Use Categories for the Smith Canal Watershed (WBID 2962) in 2004

- = Empty cell

Level 1 Code	Land Use	Acreage	% Acreage
1000	Urban and Built-up	912	14.39%
1100	Low-density Residential	218	3.45%
1200	Medium-density Residential	1,014	16.00%
1300	High-density Residential	842	13.29%
2000	Agriculture	243	3.84%
3000	Rangeland	617	9.74%
4000	Forest/Rural Open	835	13.18%
5000	Water	296	4.67%
6000	Wetlands	673	10.61%
7000	Barrenland	36	0.57%
8000	Transportation, Communication, and Utilities	652	10.28%
-	**Total:**	**6,337**	**100%**

Urban Development

Pets (especially dogs) could be a significant source of coliform pollution through surface runoff in the Gee Creek, Soldier Creek, and Smith Canal watersheds. In addition to pets, other animal fecal coliform contributors commonly seen in urban areas include rats, pigeons, and sometimes raccoons.

Studies report that up to 95 percent of the fecal coliform found in urban stormwater can come from 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 streptococcus bacteria. Trial et al. (1993) also reported that cats and dogs were the primary source of fecal coliform in urban watersheds. Using bacteria source tracking techniques, Watson (2002) found that the amount of fecal coliform bacteria contributed by dogs in Stevenson Creek in Clearwater, Florida, was as important as that from septic tanks.

According to the American Pet Products Manufacturers Association (APPMA), about 4 out of 10 U.S. households include at least 1 dog. A single gram of dog feces contains about 23 million fecal coliform bacteria (Van der Wel, 1995). Unfortunately, statistics show that about 40 percent of American dog owners do not pick up their dogs' feces.

Table 4.2 shows the fecal coliform concentrations of surface runoff measured in two urban areas (Bannerman et al., 1993; Steuer et al., 1997). While bacteria levels were widely different in the two studies, both indicated that residential lawns, driveways, and streets were the major source areas for bacteria.

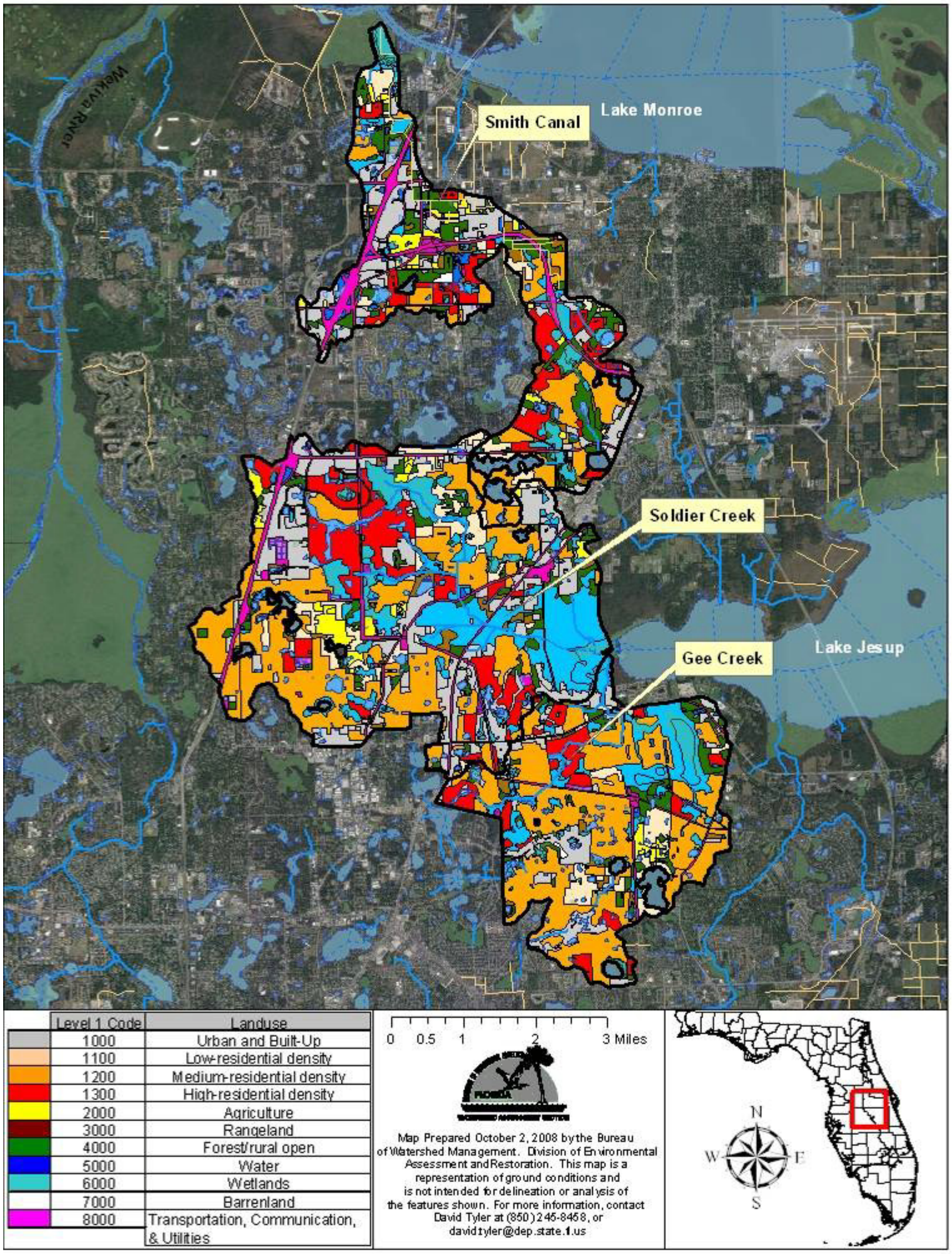


Figure 4.2. Principal Land Uses in the Gee Creek (WBID 2994A), Soldier Creek, (WBID 2986), and Smith Canal (WBID 2962) Watersheds in 2004

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

Geographic Location	Marquette, Michigan	Madison, Wisconsin
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 Gee Creek, Soldier Creek, and Smith Canal watersheds is not known. Therefore, this analysis used the statistics produced by APPMA to estimate the possible fecal coliform loads contributed by dogs. The human population in the Gee Creek, Soldier Creek, and Smith Canal watersheds calculated from the census track using Tiger Track 2000 data (the Department's GIS library) was approximately 20,358, 35,680, and 11,587, respectively. According to the U.S. Census Bureau, there were 2.59 people per household in Seminole County in 2000. This results in an estimated 7,860, 13,776, and 4,474 households in the Gee Creek, Soldier Creek, and Smith Canal watersheds, respectively. Assuming that 40 percent of the households in this area have 1 dog, the total number of dogs in the Gee Creek, Soldier Creek, and Smith Canal watersheds is about 3,144, 5,510, and 1,790, respectively.

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 of residential areas is 577,080 grams/day. The total fecal coliform produced by dogs in the Gee Creek, Soldier Creek, and Smith Canal watersheds is 1.25×10^{12}, 2.18×10^{12}, and 7.01×10^{11} counts/day, respectively.

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

Table 4.3. Dog Population Density, Wasteload, and Fecal Coliform Density

* Number from APPMA.
Source: Weiskel et al., 1996.

Type	Population density (#/household)	Wasteload (grams/day)	Fecal coliform density (fecal coliform/gram)
Dog	0.4*	450	2,200,000

Septic Tanks

Septic tanks are another potentially important source of coliform pollution in urban watersheds. When properly installed, most of the coliform from septic tanks should be removed within 50 meters of the drainage field (Minnesota Pollution Control Agency, 1999). However, in areas with a relatively high ground water table, the 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 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 each watershed can be made using **Equation 4.1**:

$$L = 37.85 * N * Q * C * F \qquad \textbf{(Equation 4.1)}$$

Where:

L is the fecal coliform daily load (counts/day);
N is the total number of septic tanks in the watershed (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 (available: http://www.doh.state.fl.us/environment/programs/EhGis/EhGisDownload.htm), about 353, 1,308, and 337 housing units (*N*) were identified as being on septic tanks in the Gee Creek, Soldier Creek, and Smith Canal watersheds, respectively (**Figure 4.3**). 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 U.S. Census Bureau, the average household size for Seminole County is about 2.59 people/household. The same population density was assumed for the Gee Creek, Solider Creek, and Smith Canal watersheds. 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 $1x10^6$ counts/100mL for fecal coliform (EPA, 2001).

No measured septic tank failure rate data were available for the three watersheds when this TMDL analysis was conducted. Therefore, the failure rate was derived from the number of septic tank and septic tank repair permits for Seminole County published by FDOH (available: 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**).

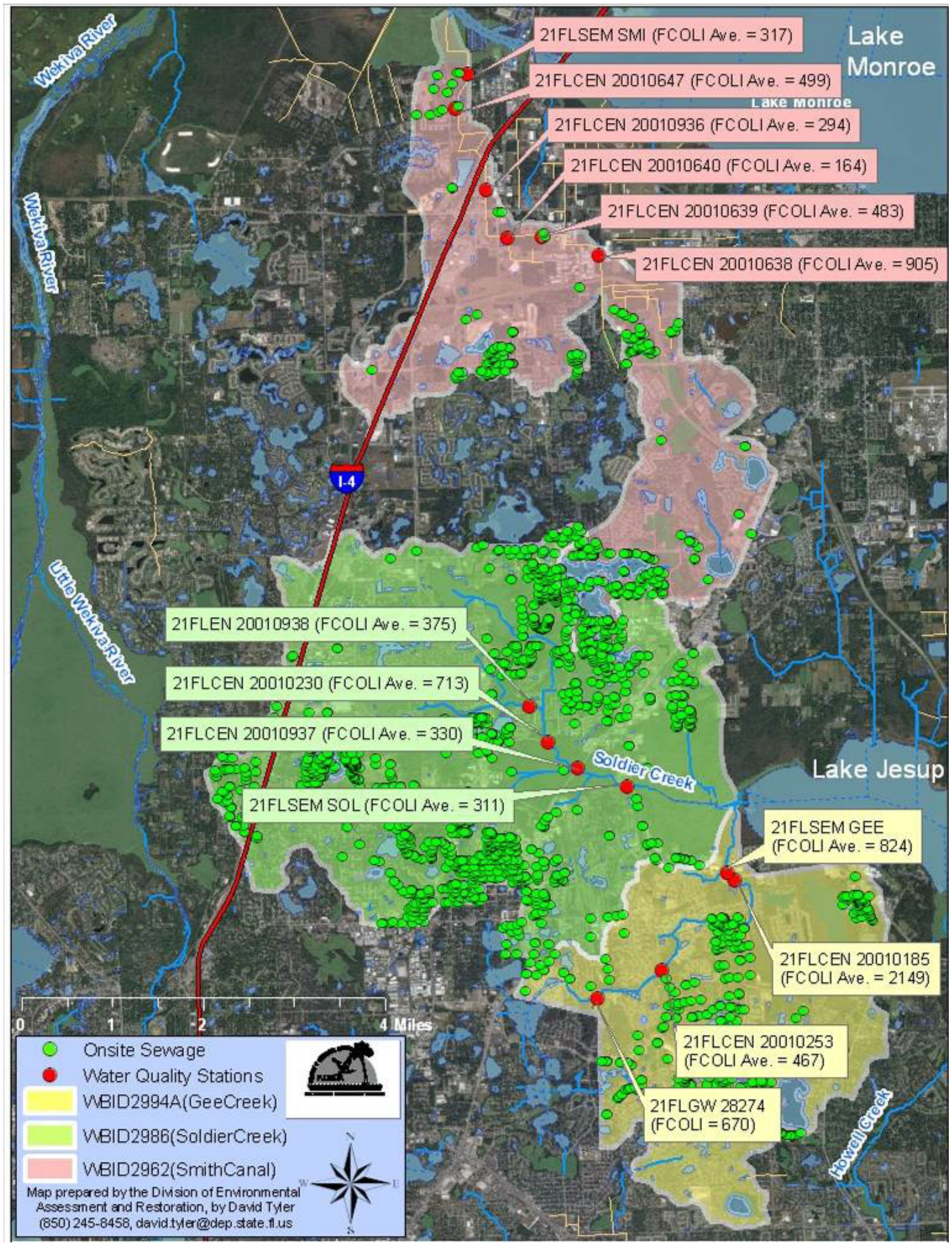


Figure 4.3. Distribution of Onsite Sewage Systems (Septic Tanks) in the Gee Creek (WBID 2994A), Soldier Creek (WBID 2986), and Smith Canal (WBID 2962) Watersheds

Based on this information, a discovery rate of failed septic tanks for each year between 2001 and 2006 was calculated and listed in **Table 4.4**. Using the table, the average annual septic tank failure discovery rate for Seminole County is about 1.07 percent. Assuming that failed septic tanks are not discovered for about 5 years, the estimated annual septic tank failure rate is about 5 times the discovery rate, or 5.3 percent. Based on **Equation 4.1**, the estimated fecal coliform loading from failed septic tanks in the Gee Creek, Soldier Creek, and Smith Canal watersheds is approximately 1.28 x 10^{11}, 4.76 x 10^{11}, and 1.23 x 10^{11} counts/day, respectively.

Table 4.4. Estimated Septic Numbers and Septic Failure Rates for Seminole County, 2001–06

- = Empty cell
[1] The failure rate is 5 times the failure discovery rate.

-	2002	2003	2004	2005	2006	2007	Average
New installation (septic tanks)	310	278	199	259	296	205	258
Accumulated installation (septic tanks)	38,226	38,536	38,814	39,013	39,272	39,568	38,905
Repair permit (septic tanks)	463	425	349	409	412	432	415
Failure discovery rate (%)	1.21	1.10	0.90	1.05	1.05	1.09	1.07
Failure rate (%)[1]	6.1	5.5	4.5	5.2	5.2	5.5	5.3

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.

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 the typical fecal coliform concentration 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 Gee Creek, Soldier Creek, and Smith Canal watersheds 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 the domestic wastewater discharge; and
F is the sewer line leakage rate.

The number of households (N) in the Gee Creek, Soldier Creek, and Smith Canal watersheds using the sewer line are 7,507, 12,468, and 4,137 (total households minus septic tank households), respectively. The discharge rate through the sewer line from each household (Q)

was calculated by multiplying the average household size (2.59 people) by the per capita wastewater production rate per day (70 gallons). The commonly cited concentration (*C*) for domestic wastewater is $1x10^6$ counts/100mL for fecal coliform (EPA, 2001). Of the total number of households using the sewer line, 0.5 percent (*F*) was assumed as the sewer line leakage rate (Culver et al., 2002). Based on **Equation 4.2**, the estimated fecal coliform loading from sewer line leakage in the Gee Creek, Soldier Creek, and Smith Canal watersheds is about 2.6×10^{11}, 4.3×10^{11}, and 1.4×10^{11} counts/day, respectively.

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

The TMDL methodology used for Gee Creek and Soldier Creek 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 the 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 TMDLs and establish the required load reductions:

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.*

There is no flow gage located in Smith Canal; therefore, the fecal coliform TMDL calculation was developed using the "percent reduction" approach. For this method, the percent reduction needed to meet the applicable criterion is calculated for each value above the criterion, and then a median percent reduction is calculated.

5.1.1 Data Used in the Determination of the TMDLs

Fecal coliform concentration and flow measurements were used to estimate both the allowable coliform loads and existing coliform loads. **Figure 5.1** shows the locations of the water quality sites where fecal coliform data were collected and the U.S. Geological Survey (USGS) gaging stations where the flow measurements were taken. **Figures 2.1a, 2.1b,** and **2.1c** display the data for fecal coliform used in this analysis. Data used for this TMDL report were mainly provided by Seminole County and the Department's Central District, from the following stations:

- *Gee Greek (Stations: 21FLCEN 20010 - 185 and 253, 21FLSEM GEE, and 21FLGW 28274);*
- *Soldier Creek (Stations: 21FLCEN 20010 – 230, 937, and 938, and 21FLSEM SOL); and*
- *Smith Canal (Stations: 21FLCEN 20010 – 638, 639, 640, 647, and 936, and 21FLSEM SMI).*

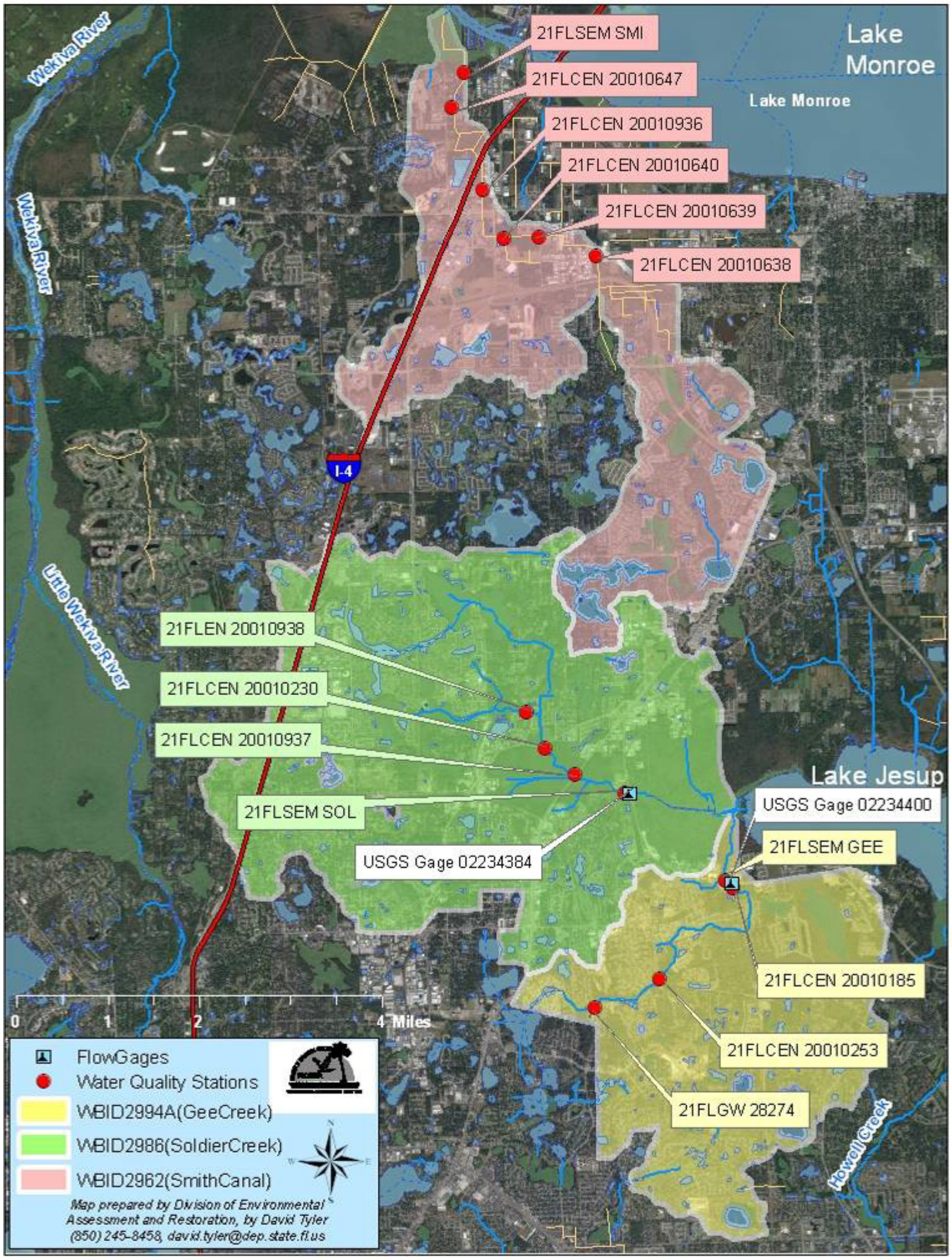


Figure 5.1. Locations of Water Quality Stations and USGS Gaging Stations Where Water Quality Data and Flow Measurements Were Collected for This Report

5.1.2 TMDL Development Process for Gee Creek and Soldier Creek

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.

The range of flows from the USGS flow gage was divided into "flow zones." The concept of zones is adopted from Cleland (August 15, 2002). The purpose of the zones is to demarcate hydrologic conditions between drought and peak flood into flow ranges such as low, dry, average, moist, and high. Expressing the flows in terms of frequency of recurrence (duration) allows a linkage of exceedances of the criterion to specific flow intervals and durations. Following Cleland's approach (September 2003), the Department selected the following flow zones: "High" (0–10), "Moist"(11–40), "Mid-range" (41–60), "Dry" (61–90), and "Low" (91–100).

Figures 5.2a and **5.2b** show the flow duration curves for USGS Gages 02234400 (located in Longwood, FL between water quality stations 21FLCEN 20010185 and 21FLSEM GEE, about 0.83 miles upstream of Soldier Creek's confluence with Lake Jesup) and 02234384 (located in Longwood, FL near water quality station 21FLSEM SOL, about 1.3 miles upstream of Lake Jesup). The period of record used for the flow duration analysis for Gages 02234384 and 02234400 was October 1, 1986, to September 8, 2008, and August 12, 1985, to September 8, 2008, respectively.

Using the flows from the flow duration curve, load duration curves for fecal coliform bacteria (**Figures 5.3a** and **5.3b**) were calculated using the following equations:

(observed flow) x (conversion factor) x (state criteria) = ([parameter quantity]/day or daily load) (Equation 5.1)

(observed flow) x (conversion factor) x (coliform measurement) (Equation 5.2)

Equation 5.1 yields the load duration curve or allowable load curve, shown as the fecal coliform target line in **Figures 5.3a** and **5.3b**. Using **Equation 5.1** (above), tables of fecal coliform loads **(Tables 5.1a** and **5.1b)** were calculated, substituting the observed coliform exceedances for the state criterion value yielding the existing load (**Equation 5.2**). All the fecal coliform observations were then plotted, and it was noted where the samples were in relation to the allowable load curve (above or below the curve). Those above the curve are noted as exceedances to the state criterion and are indicated by a red square.

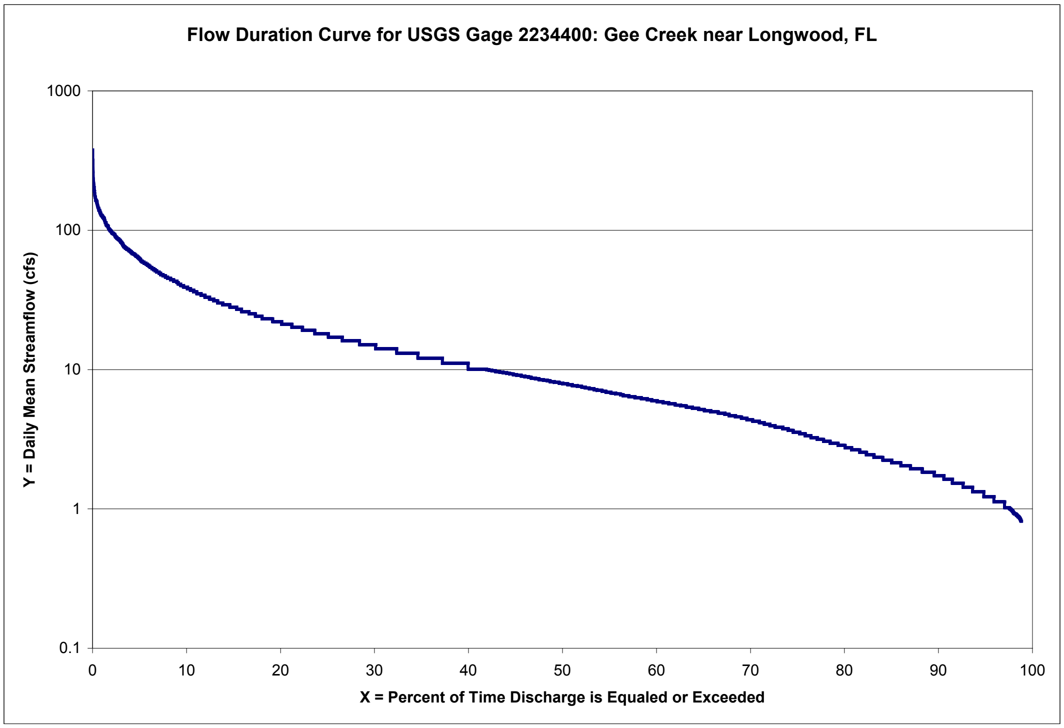


Figure 5.2a. Flow Duration Curve for USGS Gage 02234400 (1985–2008)

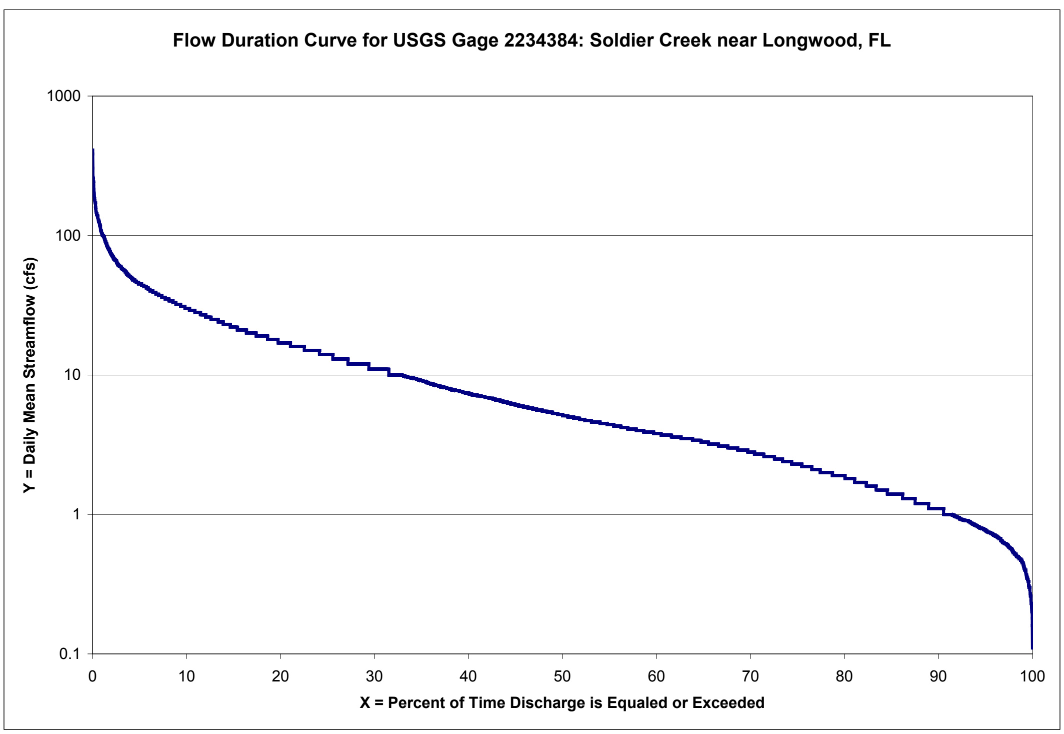


Figure 5.2b. Flow Duration Curve for USGS Gage 02234384 (1986–2008)

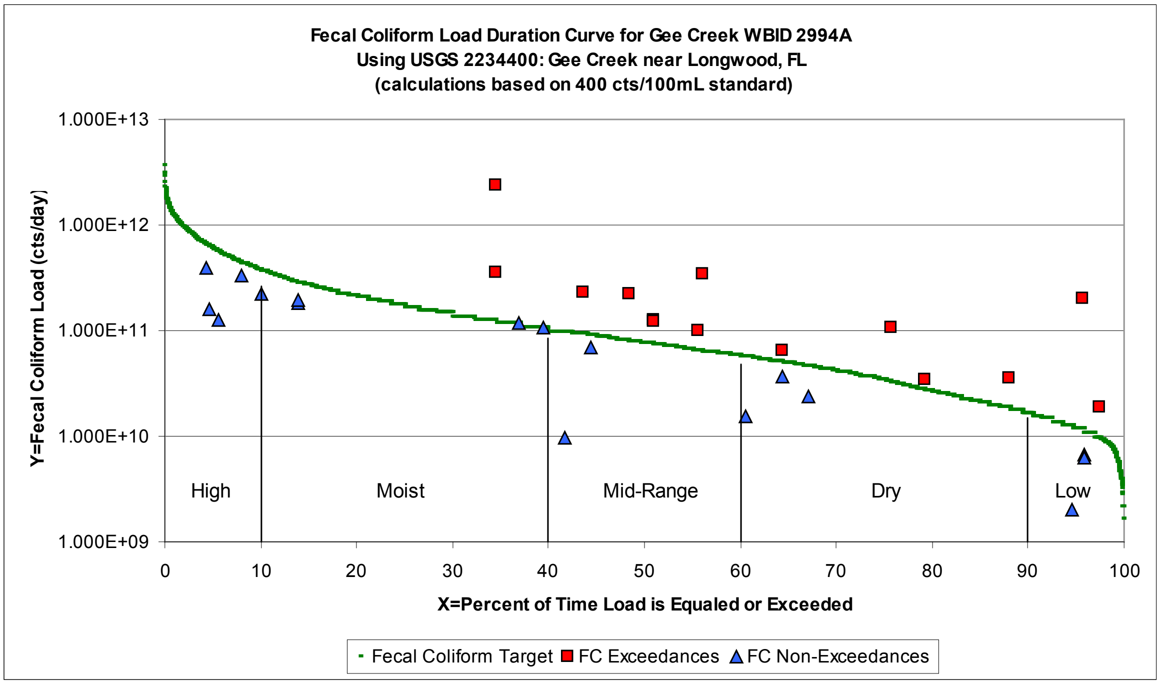


Figure 5.3a. Load Duration Curve for Fecal Coliform in Gee Creek (WBID 2994A)

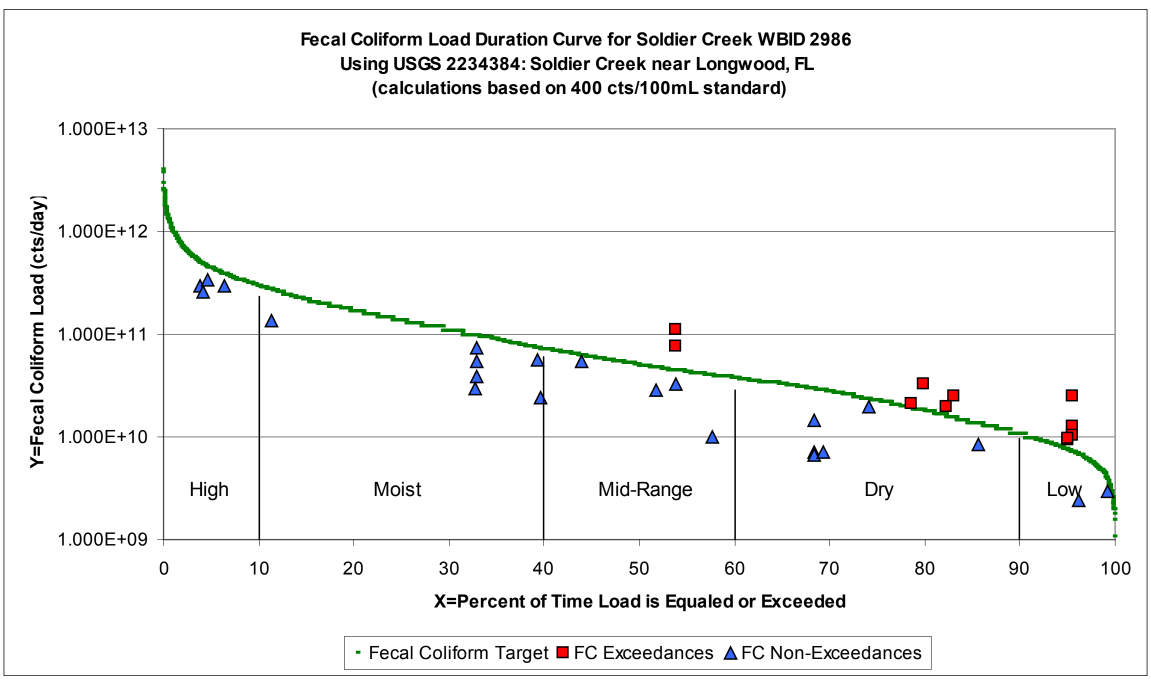


Figure 5.3b. Load Duration Curve for Fecal Coliform in Soldier Creek (WBID 2986)

Table 5.1a. Observed Fecal Coliform Data for Calculating Exceedances to the State Criterion for Gee Creek (WBID 2994A)

cfs = cubic feet per second

Station Number	Date	Time	Flow (cfs)	% of Time Discharge Is Equaled or Exceeded (X)	Fecal Coliform (counts/100mL)	Fecal Coliform Load (counts/day) (Y)
21FLSEM GEE	7/9/2007	0	2.90	79.269%	480	3.406E+10
21FLCEN 20010185	2/21/2007	848	5.20	64.413%	515	6.553E+10
21FLSEM GEE	1/10/2006	0	6.70	55.553%	620	1.016E+11
21FLSEM GEE	1/8/2008	0	7.70	50.987%	640	1.206E+11
21FLGW 28274	8/29/2005	1110	7.70	50.950%	670	1.262E+11
21FLSEM GEE	4/6/2006	0	1.90	88.092%	760	3.533E+10
21FLSEM GEE	5/10/2004	1130	1.00	97.384%	760	1.860E+10
21FLSEM GEE	11/13/2002	0	9.50	43.571%	1,000	2.325E+11
21FLCEN 20010253	7/23/2007	1226	13.00	34.576%	1,100	3.499E+11
21FLSEM GEE	1/10/2007	0	8.30	48.346%	1,100	2.234E+11
21FLSEM GEE	10/3/2006	0	3.40	75.765%	1,300	1.082E+11
21FLSEM GEE	7/5/2006	0	6.60	56.120%	2,100	3.391E+11
21FLSEM GEE	4/2/2007	0	1.20	95.731%	6,900	2.026E+11
21FLCEN 20010185	7/23/2007	1208	13.00	34.576%	7,600	2.417E+12

Table 5.1b. Observed Fecal Coliform Data for Calculating Exceedances to the State Criterion for Soldier Creek (WBID 2986)

Station Number	Date	Time	Flow (cfs)	Percent of Time Discharge Is Equaled or Exceeded (X)	Fecal Coliform (counts/100mL)	Fecal Coliform Load (counts/day) (Y)
21FLSEM SOL	4/6/2006	0	2.00	78.534%	430	2.104E+10
21FLSEM SOL	1/8/2008	0	1.70	82.243%	470	1.955E+10
21FLSEM SOL	7/6/2004	1040	0.77	95.005%	500	9.420E+09
21FLSEM SOL	4/2/2007	0	0.76	95.117%	520	9.670E+09
21FLCEN 20010938	5/14/2007	1235	0.74	95.529%	570	1.032E+10
21FLSEM SOL	10/3/2006	0	1.60	83.129%	630	2.466E+10
21FLCEN 20010938	7/23/2007	1117	4.60	53.896%	680	7.654E+10
21FLSEM SOL	7/5/2006	0	1.90	79.870%	700	3.254E+10
21FLCEN 20010937	5/14/2007	1205	0.74	95.529%	710	1.286E+10
21FLCEN 20010230	7/23/2007	1057	4.60	53.896%	990	1.114E+11
21FLCEN 20010230	5/14/2007	1219	0.74	95.529%	1,360	2.463E+10

As noted previously, values on the load duration curve can generally be grouped by hydrologic conditions to identify the most likely potential sources. Exceedances falling into the 10th through 40th percentile flows are typically associated with moist conditions when stormwater loads are the most likely source, and exceedances falling into the 60th through 90th percentiles are typically associated with dry conditions when point sources are likely the dominant source. As shown in **Figures 5.1a** and **5.1b**, the majority of fecal coliform exceedances in Gee Creek and Soldier Creek are concentrated within the 40th to 100th percentile of flow. Because no major point source was identified in Gee Creek or Soldier Creek, the exceedances occurring in the low-flow condition imply a contribution from baseflow. As discussed earlier, this could result from leaking septic tanks or sewer lines, lawn irrigation, and wild animals.

Tables 5.2a and **5.2b** depict the allowable fecal coliform bacteria load for peak flow, low flow, and 5-percentile increments in flow. **Tables 5.2a** and **5.2b** were created by taking the Nth percentile flow (flow rank in the table) from the measured flow data and multiplying each percentile flow by the fecal coliform criterion of 400 counts/100mL and converting into bacteria counts/day. This conversion was accomplished by multiplying the criterion by [(28317/100)*60*60*24]. The factor 28317/100 converts counts/100mL into counts per cubic foot.

Table 5.2a. Fecal Coliform Loads for Gee Creek (WBID 2994A)

- = Empty cell/no data

Flow Rank	Flow Rank (%)	Flow (cfs)	Allowable Fecal Coliform Load (counts/day)	Flow Conditions
0.017%	-	377.0	3.69E+12	Peak
0.100%	-	217.7	2.13E+12	-
0.274%	-	173.0	1.69E+12	1-day
1%	1	127.0	1.24E+12	-
5%	5	62.0	6.07E+11	-
10%	10	39.0	3.82E+11	-
15%	15	28.0	2.74E+11	-
20%	20	22.0	2.15E+11	-
25%	25	18.0	1.76E+11	-
30%	30	15.0	1.47E+11	-
35%	35	12.0	1.17E+11	-
40%	40	10.0	9.79E+10	-
45%	45	9.1	8.91E+10	-
50%	50	7.9	7.68E+10	-
55%	55	6.8	6.65E+10	-
60%	60	5.9	5.77E+10	-
65%	65	5.1	4.99E+10	-
70%	70	4.3	4.21E+10	-
75%	75	3.5	3.43E+10	-
80%	80	2.8	2.74E+10	-
85%	85	2.1	2.07E+10	-
90%	90	1.7	1.66E+10	-
95%	95	1.2	1.17E+10	-
99%	99	0.8	7.34E+09	-
100%	100	0.0	3.91E+08	Low

Table 5.2b. Fecal Coliform Loads for Soldier Creek (WBID 2962)

- = Empty cell/no data

Flow Rank	Flow Rank (%)	Flow (cfs)	Allowable Fecal Coliform Load (counts/day)	Flow Conditions
0.017%	-	411.0	4.02E+12	Peak
0.100%	-	242.9	2.38E+12	-
0.274%	-	172.0	1.68E+12	1-day
1%	1	102.0	9.98E+11	-
5%	5	45.0	4.40E+11	-
10%	10	30.0	2.94E+11	-
15%	15	22.0	2.15E+11	-
20%	20	17.0	1.66E+11	-
25%	25	14.0	1.37E+11	-
30%	30	11.0	1.08E+11	-
35%	35	9.1	8.91E+10	-
40%	40	7.4	7.24E+10	-
45%	45	6.1	5.97E+10	-
50%	50	5.2	5.04E+10	-
55%	55	4.4	4.31E+10	-
60%	60	3.8	3.72E+10	-
65%	65	3.3	3.23E+10	-
70%	70	2.8	2.74E+10	-
75%	75	2.3	2.25E+10	-
80%	80	1.9	1.86E+10	-
85%	85	1.4	1.37E+10	-
90%	90	1.1	1.08E+10	-
95%	95	0.8	7.54E+09	-
99%	99	0.4	4.31E+09	-
100%	100	0.1	1.08E+09	Low

Finally, the percent reduction in loading needed for compliance with the state criterion was calculated. For the purposes of this TMDL, the critical periods for Gee Creek occurred in the "Moist" (10–40), "Mid-range" (40–60), "Dry" (60–90), and "Low" (90–100) flow zones, while Soldier Creek's critical periods were the "Mid-range" (40–60) and "Low" (90–100) flow zones. The critical periods are the flow intervals where the majority of the criterion exceedances occurred, as shown in **Figures 5.3a** and **5.3b**. Therefore, separate TMDL components were calculated to reflect the critical flow zones (**Tables 5.3a** and **5.3b**). This calculation involved both the median of allowable loads, which previously were calculated using percentile increments of 5, 25, 50, 75, and 95 as the median of the zones, and the median of the existing load based on measured exceedances computed for each critical zone. The needed reduction of daily load was completed using **Equation 5.3**:

$$\frac{\text{(existing load)} - \text{(allowable load)}}{\text{(existing load)}} \times 100 \qquad \text{(Equation 5.3)}$$

Table 5.3a. Fecal Coliform Percent Reductions Required for Different Flow Zones for Gee Creek (WBID 2994A)

N/A – Not applicable

Gee Creek	High (0–10)	Moist (10–40)	Mid-range (40–60)	Dry (60–90)	Low (90–100)
TMDL (allowed load)	N/A	1.76E+11	7.68E+10	3.43E+10	1.17E+10
Existing Load	N/A	1.38E+12	1.75E+11	5.04E+10	1.11E+11
% Reduction	N/A	87%	56%	71%	89%

Table 5.3b. Fecal Coliform Percent Reductions Required for Different Flow Zones for Soldier Creek (WBID 2986)

N/A – Not applicable

Soldier Creek	High (0–10)	Moist (10–40)	Mid-range (40–60)	Dry (60–90)	Low (90–100)
TMDL (allowed load)	N/A	N/A	5.04E+10	N/A	7.54E+09
Existing Load	N/A	N/A	9.40E+10	N/A	1.03E+10
% Reduction	N/A	N/A	46%	N/A	27%

5.1.3 TMDL Development Process for Smith Canal

As described in **Section 5.1**, the percent reduction needed to meet the fecal coliform criterion was determined for each individual exceedance using the following equation:

$$\frac{[\text{measured exceedance} - \text{criterion}]*100}{\text{measured exceedance}} \qquad \text{(Equation 5.4)}$$

The fecal coliform TMDL was calculated as the median of the percent reductions needed over the data range where exceedances occurred (see **Table 5.4** for data). As noted in the next section, most of the exceedances occurred in the summer months, and the median percent reduction for this period was 67 percent.

5.1.4 Critical Conditions/Seasonality

The critical conditions for coliform loadings in a given watershed depend on the existence of point sources and land use patterns in the watershed. Typically, the critical condition for nonpoint sources is an extended dry period, followed by a rainfall runoff event. During wet weather periods, coliform bacteria that have built up on the land surface under dry weather conditions are washed off by rainfall, resulting in wet weather exceedances. However, significant nonpoint source contributions could also occur under dry weather conditions without any major surface runoff event. This usually happens when nonpoint sources contaminate the surficial aquifer and coliform bacteria are brought into the receiving waters through baseflow. The critical condition for point source loading typically occurs during periods of low stream flow, when dilution is minimized.

There were no flow gages to derive a flow duration curve for Smith Canal; therefore, rainfall data were compared with the measured fecal coliform data for each waterbody. Measurements were sorted by month and season (the calendar year was divided into quarters) to determine

Table 5.4. Calculation of Percent Reduction in Fecal Coliform Necessary To Meet the Water Quality Standard of 400 Colonies/100mL in Smith Canal (WBID 2962)

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

Date	Station	Fecal Coliform Exceedances[1, 2]	Fecal Coliform Target[1]	% Reduction
9/14/2005	21FLSEM SMI	480	400	17%
6/16/2005	21FLSEM SMI	570	400	30%
7/23/2007	21FLCEN 20010936	630	400	37%
6/7/2001	21FLSEM SMI	800	400	50%
9/17/2002	21FLSEM SMI	800	400	50%
12/12/2001	21FLSEM SMI	1,200	400	67%
5/21/2007	21FLSEM SMI	1,200	400	67%
7/23/2007	21FLCEN 20010647	1,250	400	68%
5/14/2007	21FLCEN 20010638	1,480	400	73%
7/23/2007	21FLCEN 20010639	1,570	400	75%
7/23/2007	21FLCEN 20010638	1,730	400	77%
-	-	-	**Median % Reduction:**	**67%**

whether there was a temporal pattern of exceedances. Monthly rainfall data from Sanford (087977) were also obtained and included in the analysis. **Tables 5.5a** and **5.5b** present summary statistics by month and season, respectively, for fecal coliform measurements (*Winter*: January–March; *Spring*: April–June; *Summer*: July–September; *Fall*: October–December). Fecal coliform exceedances occurred mainly in the summer months for Smith Canal, implying potential fecal coliform bacteria sources during surface runoff events. **Figure 5.4** shows this information graphically. The highest fecal coliform averages for all stations (except Station 21FLSEM SMI, which did not have any data in July) occurred in July, further validating potential nonpoint source loading during the summer months.

For Gee Creek, the fecal coliform bacteria exceedances occurred in the “Moist” (10–40), “Mid–Range” (40–60), “Dry” (60–90), and “Low” (90–100) flow zone conditions (**Figure 5.3a**), while Soldier Creek’s fecal coliform bacteria exceedances occurred in the “Mid-range” (40–60) and “Low” (90–100) flow zones (**Figure 5.3b**). Because no major point sources were identified in these watersheds, exceedances in these flow zone conditions are considered to be from nonpoint sources. Furthermore, for TMDL purposes the Department used the median percent reduction value from the “Moist” (10–40), “Mid-range” (40–60), “Dry” (60–90), and “Low” (90–100) flow zones to represent the percent reduction for Gee Creek, and the median percent reduction value from the “Mid-range” (40–60) and “Low” (90–100) flow zones for Soldier Creek (**Table 6.1**).

During major rain events, all three waterbodies rise quite quickly (according to the Department’s Central District and Seminole County staff), resulting in a "flushing" effect, as they receive excess and direct runoff (especially Smith Canal) from the roads they flow under (**Figures 5.5** through **5.7**).

Table 5.5a. Summary Statistics of Fecal Coliform Data for Smith Canal (WBID 2962), by Month

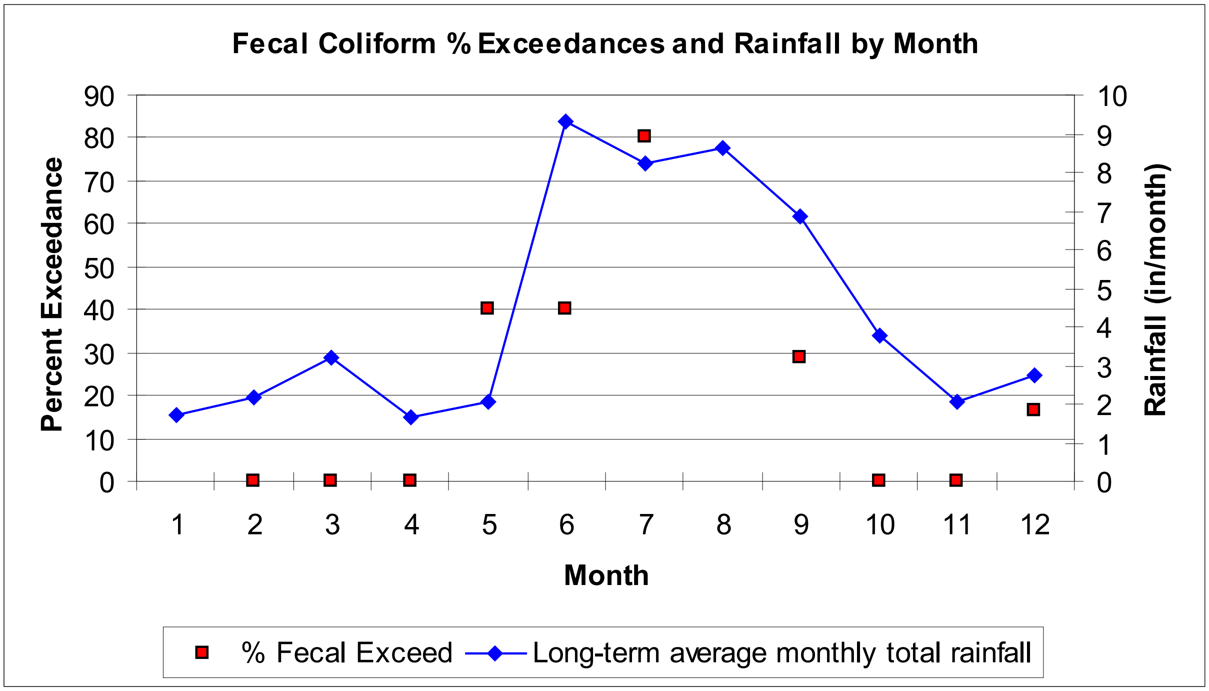
\- = Empty cell/no data
[1] Coliform counts are #/100mL.
[2] Exceedances represent values above 400 counts/100mL.

Month	Number of Cases	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances of Cases	Rainfall Mean (inches)
1	-	-	-	-	-	-	-	1.69
2	6	35	210	77.5	90	0	0.00%	2.16
3	5	120	350	205	220	0	0.00%	3.22
4	1	200	200	200	200	0	0.00%	1.66
5	5	96	1,480	235	632	2	40.00%	2.08
6	5	1	800	150	324	2	40.00%	9.33
7	5	270	1,730	1,250	1,090	4	80.00%	8.25
8	-	-	-	-	-	-	-	8.61
9	7	190	800	300	359	2	28.57%	6.84
10	5	183	230	200	201	0	0.00%	3.79
11	1	90	90	90	90	0	0.00%	2.04
12	6	100	1,200	150	317	1	16.67%	2.73

Table 5.5b. Summary Statistics of Fecal Coliform Data for Smith Canal (WBID 2962), by Season

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

Season	Number of Cases	Minimum[1]	Maximum[1]	Median[1]	Mean[1]	Number of Exceedances[2]	% Exceedances of Cases	Total Rainfall Mean (inches)
1	12	35	350	141	155	0	0.00%	7.07
2	15	1	1,480	200	385	4	26.67%	13.07
3	13	190	1,730	775	724	6	54.29%	23.70
4	6	90	1,200	150	202	1	5.56%	8.56



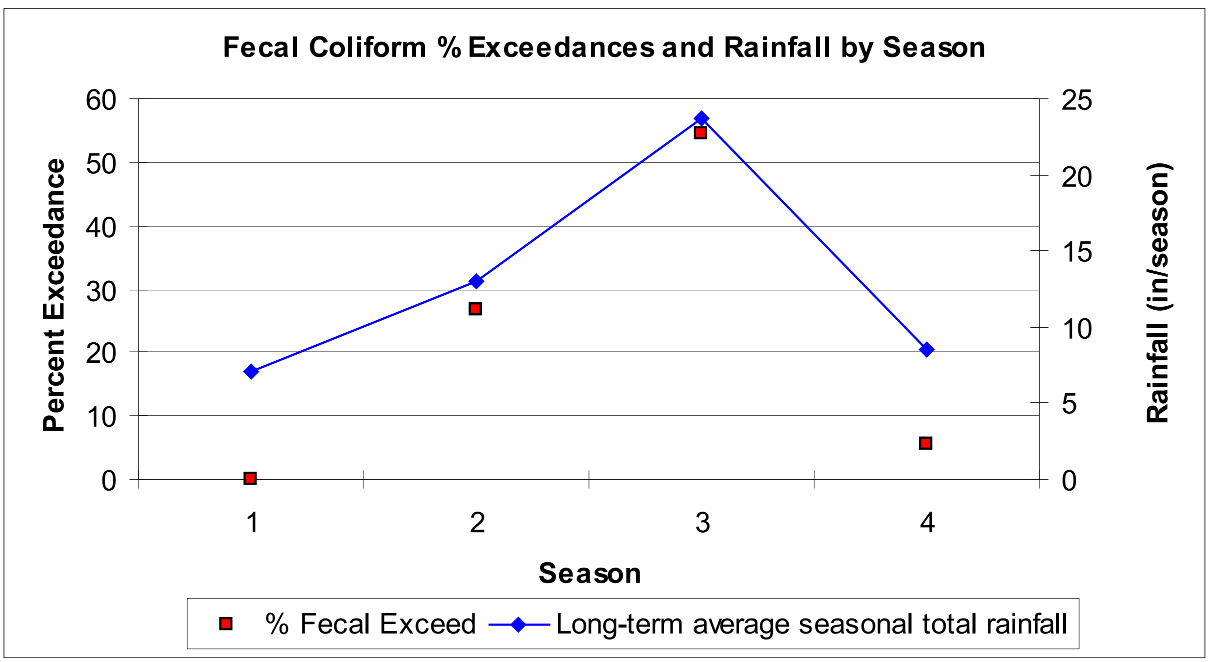


Figure 5.4. Fecal Coliform Exceedances and Rainfall for Smith Canal (WBID 2962), by Month and Season, 2000–07

Figure 5.5. Stormwater Drain Flowing into Smith Canal at Station 21FLCEN 20010638

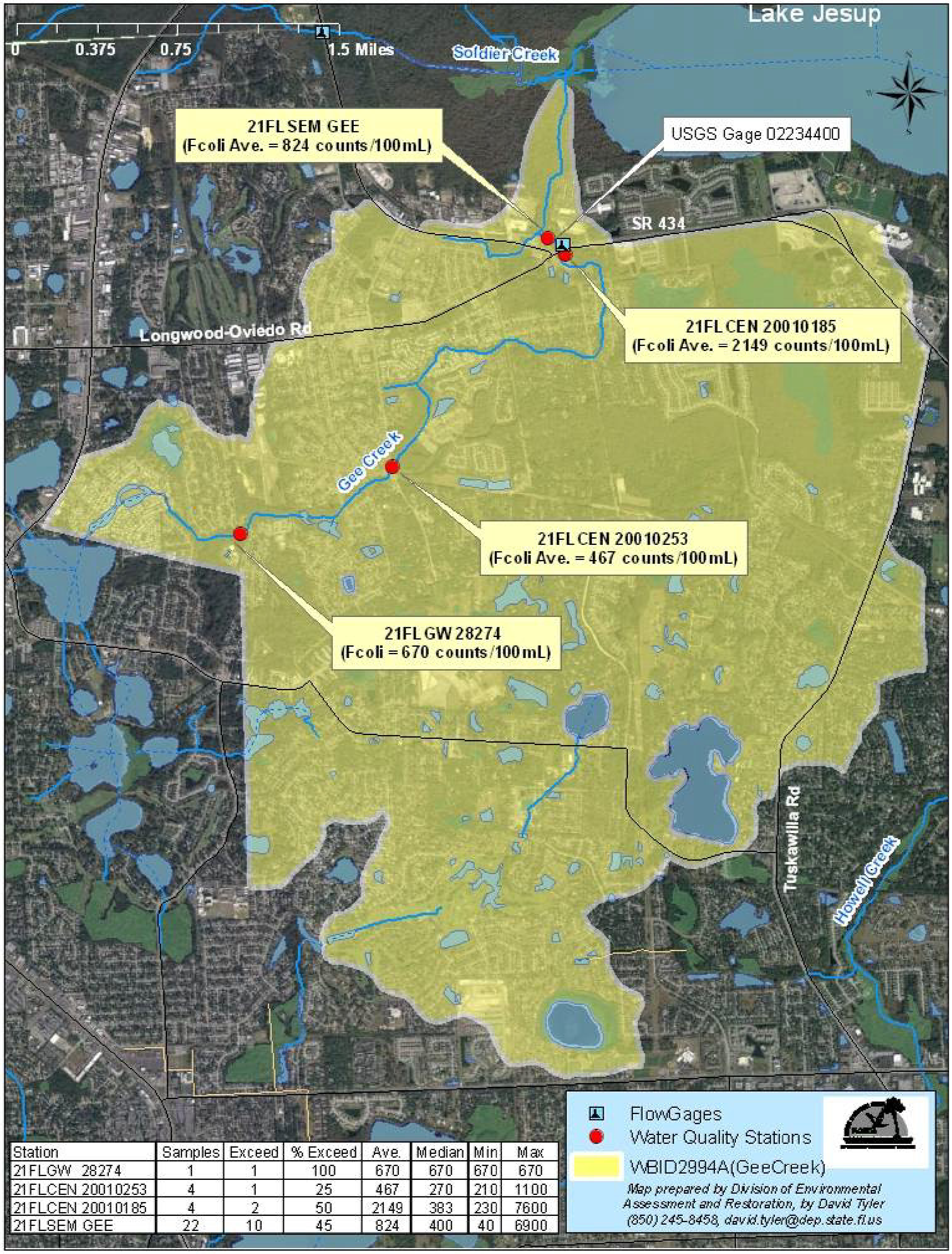
Figure 5.6. Stormwater Drain Flowing into Soldier Creek at Station 21FLCEN 20010264

Figure 5.7. Stormwater Drain Flowing into Gee Creek at Station 21FLCEN 20010185

5.1.5 Spatial and Temporal Patterns

Gee Creek

There are 4 stations in Gee Creek with fecal coliform data (**Figure 5.8**). All 4 stations have exceedances, with Stations 21FLCEN 20010185, 21FLCEN 20010253, and 21FLGW 28275 (note that 21FLGW 28275 only had 1 sample) having all their exceedances in the summer months. Station 21FLSEM GEE has fecal coliform data (22 samples) from May 2002 to January 2008, with no apparent temporal pattern. However, more recent data show a worsening trend in the fecal coliform data, with 8 exceedances out of 8 samples from January 2006 to January 2008 (**Figure 5.9**). The two farthest downstream stations (21FLCEN 20010185 and 21FLSEM GEE) have the highest fecal coliform averages for the creek; however, more data collection is recommended from all 4 stations to make any detailed source assessment. The major land use surrounding Station 21FLSEM GEE is low-density residential, while Station 21FLCEN 20010185 is surrounded by mixed coniferous and hardwoods, with a medium-density residential area just upstream.



Station	Samples	Exceed	% Exceed	Ave.	Median	Min	Max
21FLGW 28274	1	1	100	670	670	670	670
21FLCEN 20010253	4	1	25	467	270	210	1100
21FLCEN 20010185	4	2	50	2149	383	230	7600
21FLSEM GEE	22	10	45	824	400	40	6900

Figure 5.8. Fecal Coliform Station Averages and Summary Statistics for Gee Creek (WBID 2994A)

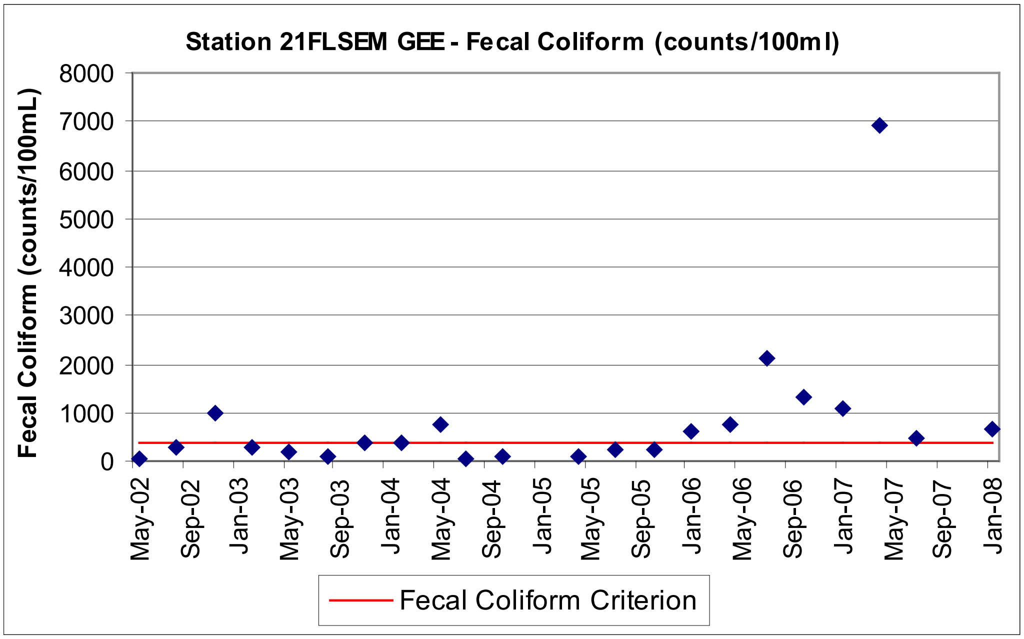
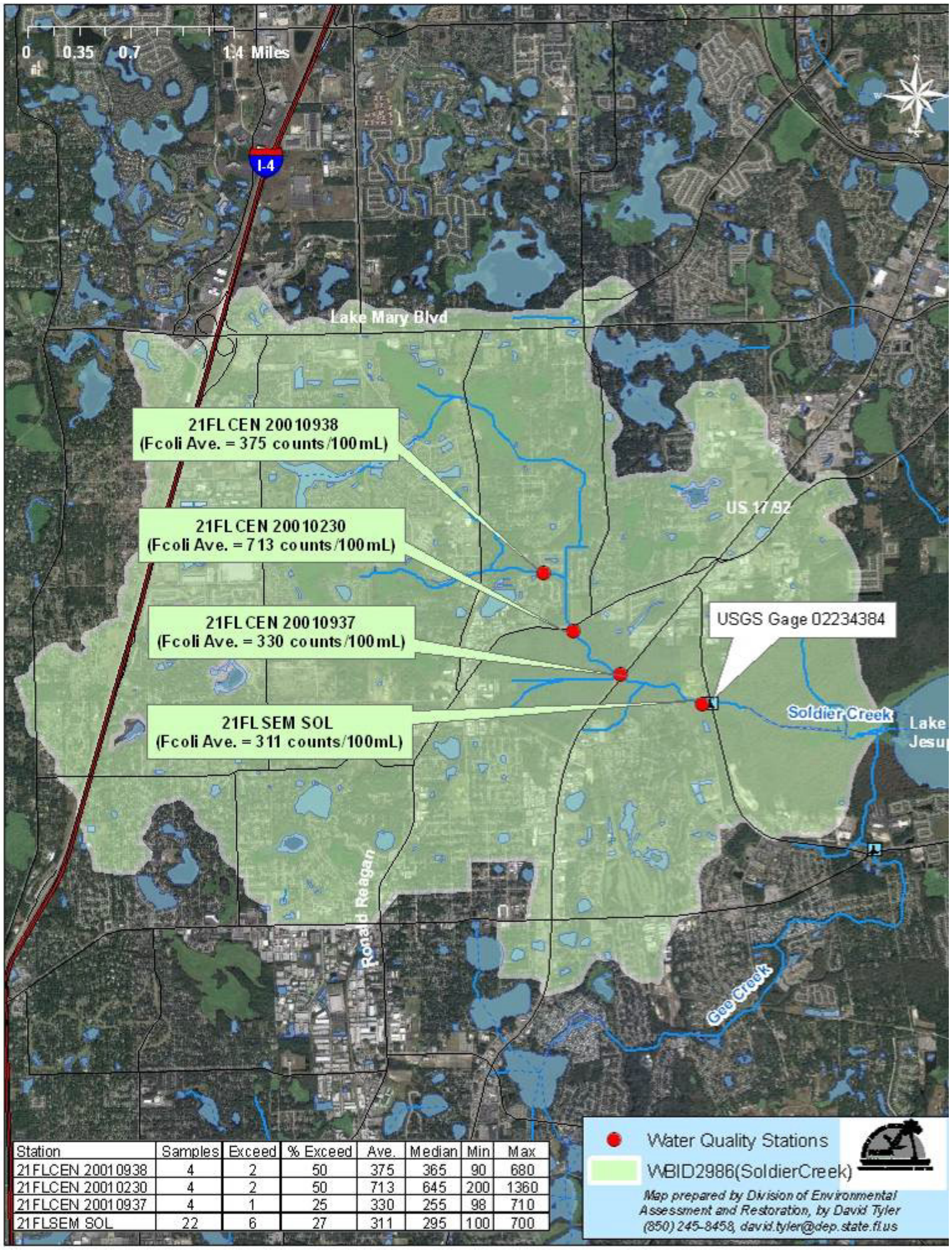


Figure 5.9. Temporal Trend of Fecal Concentration at Station 21FLSEM GEE (Gee Creek, WBID 2994A)

Soldier Creek

There are 4 stations in Soldier Creek with fecal coliform data (**Figure 5.10**). All 4 stations have exceedances, with all the exceedances at Stations 21FLCEN 20010938, 21FLCEN 20010230, and 21FLCEN 20010937 occurring in the summer months. Station 21FLSEM SOL has fecal coliform data (22 samples) from May 2002 to January 2008, with no apparent temporal pattern. However, more recent data also show a worsening trend in the fecal coliform data, with 5 exceedances out of 8 samples from January 2006 to January 2008 (**Figure 5.11**). Station 21FLCEN 20010230 has the overall highest fecal coliform average among all the stations, and just upstream of the station is a high-density residential area, which potentially could be providing runoff into the creek.



Station	Samples	Exceed	% Exceed	Ave.	Median	Min	Max
21FLCEN 20010938	4	2	50	375	365	90	680
21FLCEN 20010230	4	2	50	713	645	200	1360
21FLCEN 20010937	4	1	25	330	255	98	710
21FLSEM SOL	22	6	27	311	295	100	700

Figure 5.10. Fecal Coliform Station Averages and Summary Statistics for Soldier Creek (WBID 2986)

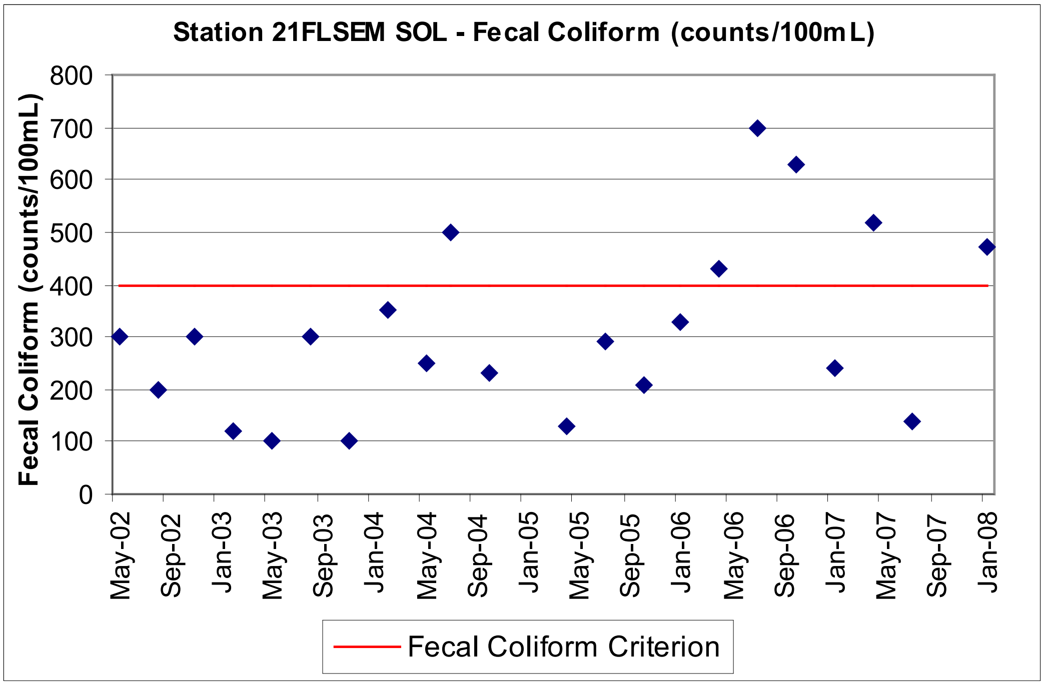


Figure 5.11. Temporal Trend of Fecal Concentration at Station 21FLSEM SOL (Soldier Creek, WBID 2986)

Smith Canal

There are 6 stations in Smith Canal with fecal coliform data (**Figure 5.12**). All 6 stations have exceedances (except Station 21FLCEN 20010640), with Stations 21FLCEN 20010647, 21FLCEN 20010936, 21FLCEN 20010639, and 21FLCEN 20010638 having all their exceedances in the summer months. Station 21FLSEM SMI has fecal coliform data (27 samples) from February 2001 to March 2008, with no apparent temporal pattern. Station 21FLCEN 20010638 has the overall highest fecal coliform average among all the stations, and has a noticeable stormwater drain (see **Figure 5.5**) providing runoff to the canal.

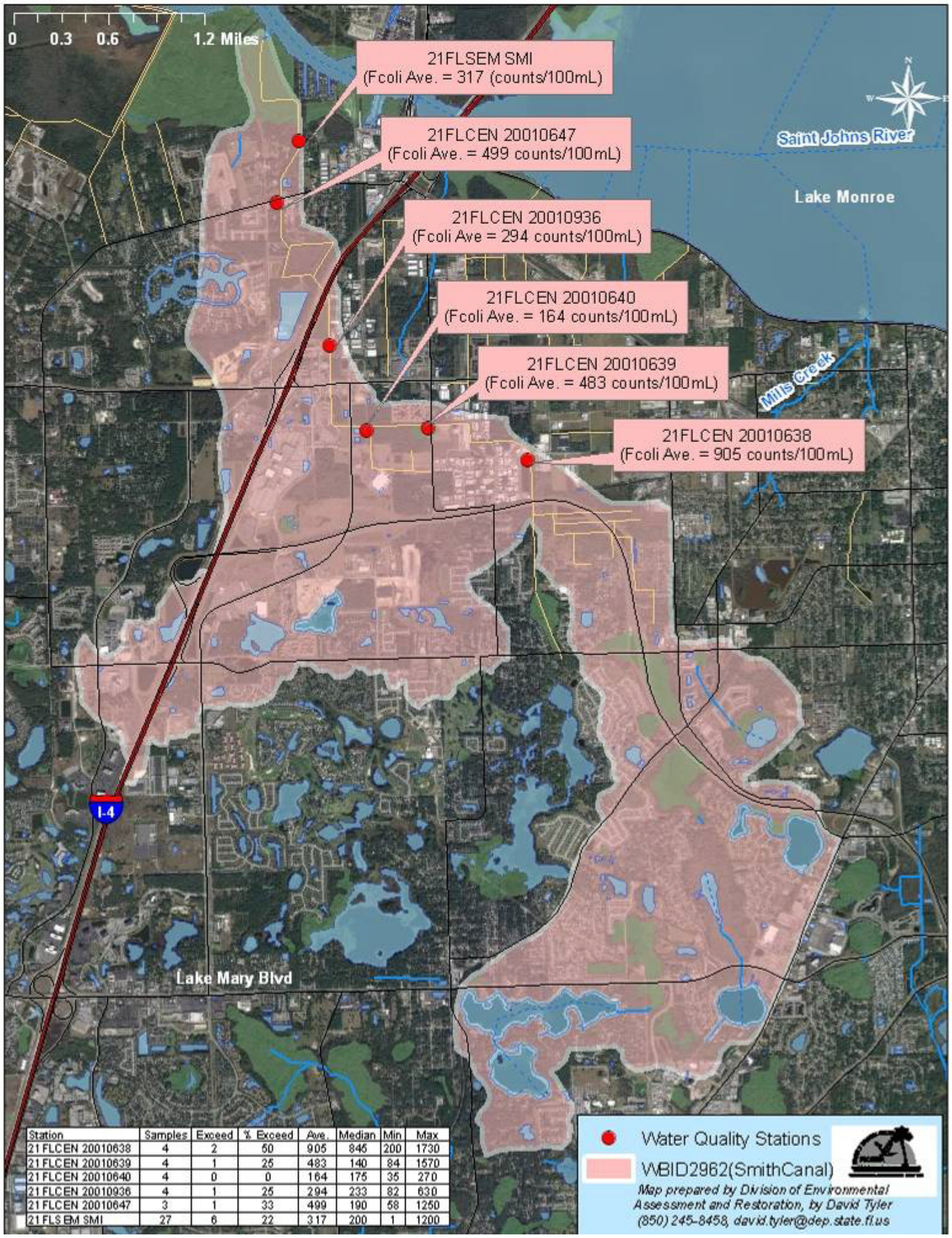


Figure 5.12. Fecal Coliform Station Averages and Summary Statistics for Smith Canal (WBID 2962)

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. A TMDL is expressed as the sum of all point source loads (wasteload allocations, or WLAs), nonpoint source loads (load allocations, or LAs), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

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

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

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

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (a) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is also accounted for within the LA, and (b) TMDL components can be expressed in different terms (for example, the WLA for stormwater is typically expressed as a percent reduction, and the WLA for wastewater is typically expressed as mass per day).

WLAs for stormwater discharges are typically expressed as “percent reduction” because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges also differs from the permitting of most wastewater point sources. Because stormwater discharges cannot be centrally collected, monitored, and treated, they are not subject to the same types of effluent limitations as wastewater facilities, and instead are required to meet a performance standard of providing treatment to the “maximum extent practical” through the implementation of best management practices (BMPs).

This approach is consistent with federal regulations (40 CFR § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or **other appropriate measure**. The TMDLs for Gee Creek and Soldier Creek are expressed in terms of counts/day and percent reduction, while the TMDL for Smith Canal is expressed in terms of a percent reduction. These TMDLs represent the maximum daily fecal coliform loads the streams can assimilate and maintain the fecal coliform criterion (**Table 6.1**).

Table 6.1. TMDL Components for Fecal Coliform in Gee Creek (WBID 2994A), Soldier Creek (WBID 2986), and Smith Canal (WBID 2962)

N/A – Not applicable.

WBID	Parameter	Zone	TMDL (counts/day)	WLA Wastewater (counts/day)	WLA NPDES Stormwater (% reduction)	LA (% reduction)	MOS
2994A	Fecal Coliform	Moist/Mid-Range/Dry/Low	5.63E +10	N/A	79%	79%	Implicit
2986	Fecal Coliform	Mid-Range/Low	2.87E +10	N/A	37%	37%	Implicit
2962	Fecal Coliform	N/A	400 #/100mL	N/A	67%	67%	Implicit

6.2 Load Allocation

A fecal coliform reduction of 79, 37, and 67 percent for Gee Creek, Soldier Creek, and Smith Canal, respectively, is needed from nonpoint sources. It should be noted that the LA includes loading from stormwater discharges regulated by the Department and the water management districts that are not part of the NPDES Stormwater Program (see **Appendix A**).

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

No NPDES-permitted wastewater facilities with fecal coliform limits were identified in Gee Creek, Soldier Creek, and Smith Canal. The state already requires all NPDES point source dischargers to meet bacteria criteria at the end of the pipe. It is the Department's current practice not to allow mixing zones for bacteria. Any point sources that may discharge in the watershed in the future will also be required to meet end-of-pipe standards for coliform bacteria.

6.3.2 NPDES Stormwater Discharges

The WLA for stormwater discharges with an MS4 permit is a 79, 37, and 67 percent reduction in current fecal coliform for Gee Creek (WBID 2994A), Soldier Creek (WBID 2986), and Smith Canal (WBID 2962), respectively. It should be noted that any MS4 permittee is only responsible for reducing the anthropogenic loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction.

6.4 Margin of Safety

Consistent with the recommendations of the Allocation Technical Advisory Committee (Department, 2001), an implicit MOS was used in the development of this TMDL by meeting the water quality criterion of 400 colonies/100mL, while the actual criterion allows for a 10 percent exceedance over that level.

Chapter 7: TMDL IMPLEMENTATION

TMDL Implementation

Following the adoption of this TMDL by rule, the Department will determine the best course of action regarding its implementation. Depending upon the pollutant(s) causing the waterbody impairment and the significance of the waterbody, the Department will select the best course of action leading to the development of a plan to restore the waterbody. Often this will be accomplished cooperatively with stakeholders by creating a Basin Management Action Plan, referred to as the BMAP. Basin Management Action Plans are the primary mechanism through which TMDLs are implemented in Florida [see Subsection 403.067(7) F.S.]. A single BMAP may provide the conceptual plan for the restoration of one or many impaired waterbodies.

If the Department determines a BMAP is needed to support the implementation of this TMDL, a BMAP will be developed through a transparent stakeholder-driven process intended to result in a plan that is cost-effective, technically feasible, and meets the restoration needs of the applicable waterbodies. Once adopted by order of the Department Secretary, BMAPs are enforceable through wastewater and municipal stormwater permits for point sources and through BMP implementation for nonpoint sources. Among other components, BMAPs typically include:

- Water quality goals (based directly on the TMDL);
- Refined source identification;
- Load reduction requirements for stakeholders (quantitative detailed allocations, if technically feasible);
- A description of the load reduction activities to be undertaken, including structural projects, nonstructural BMPs, and public education and outreach;
- A description of further research, data collection, or source identification needed in order to achieve the TMDL;
- Timetables for implementation;
- Implementation funding mechanisms;
- An evaluation of future increases in pollutant loading due to population growth;
- Implementation milestones, project tracking, water quality monitoring, and adaptive management procedures; and
- Stakeholder statements of commitment (typically a local government resolution).

BMAPs are updated through annual meetings and may be officially revised every five years. Completed BMAPs in the state have improved communication and cooperation among local stakeholders and state agencies, improved internal communication within local governments, applied high-quality science and local information in managing water resources, clarified obligations of wastewater point source, MS4 and non-MS4 stakeholders in TMDL implementation, enhanced transparency in DEP decision-making, and built strong relationships between DEP and local stakeholders that have benefited other program areas.

However, in some basins, and for some parameters, particularly those with fecal coliform impairments, the development of a BMAP using the process described above will not be the most efficient way to restore a waterbody, such that it meets its' designated uses. Why? Because fecal coliform impairments result from the cumulative effects of a multitude of potential sources, both natural and anthropogenic. Addressing these problems requires good old fashioned detective work that is best done by those in the area. There are a multitude of assessment tools that are available to assist local governments and interested stakeholders in this detective work. The tools range from the simple – such as Walk the WBIDs and GIS mapping - to the complex such as Bacteria Source Tracking. Department staff will provide technical assistance, guidance, and oversight of local efforts to identify and minimize fecal coliform sources of pollution. Based on work in the Lower St Johns River tributaries and the Hillsborough River basin, the Department and local stakeholders have developed a logical process and tools to serve as a foundation for this detective work. In the near future, the Department will be releasing these tools to assist local stakeholders with the development of local implementation plans to address fecal coliform impairments. In such cases, the Department will rely on these local initiatives as a more cost-effective and simplified approach to identify the actions needed to put in place a roadmap for restoration activities, while still meeting the requirements of Chapter 403.067(7), F.S.

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Appendices

Appendix A: Background Information on Federal and State Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Rule 62-40, F.A.C. In 1994, the Department's stormwater treatment requirements were integrated with the stormwater flood control requirements of the water management districts, along with wetland protection requirements, into the Environmental Resource Permit regulations.

Rule 62-40, F.A.C., also requires the state's water management districts to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a Surface Water Improvement and Management (SWIM) plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, 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 the master drainage systems of local governments with a population above 100,000, which are better known as MS4s. However, because the master drainage systems of most local governments in Florida are interconnected, the EPA implemented Phase I of the MS4 permitting program on a countywide basis, which brought in all cities (incorporated areas), Chapter 298 urban water control districts, and the FDOT throughout the 15 counties meeting the population criteria. The Department received authorization to implement the NPDES Stormwater Program in 2000.

An important difference between the federal NPDES and the state's stormwater/environmental resource permitting programs is that the NPDES Program covers both new and existing discharges, while the state's program focus on new discharges only. Additionally, Phase II of the NPDES Program, implemented in 2003, expands the need for these permits to construction sites between 1 and 5 acres, and to local governments with as few as 1,000 people. While these urban stormwater discharges are now technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility, as are other point sources of pollution such as domestic and industrial wastewater discharges. It should be noted that all MS4 permits issued in Florida include a reopener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.

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