FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration

NORTHEAST DISTRICT • LOWER ST. JOHNS BASIN

# Final TMDL Report

# Fecal Coliform TMDL for Deep Bottom Creek, WBID 2361

**Katrina Sanders**

**June 2009**

# Acknowledgments

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### Florida Department of Environmental Protection, Bureau of Watershed Management

**Total Maximum Daily Load (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 305(b) Report**

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

**Criteria for Surface Water Quality Classifications**

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

**Basin Status Report for the Lower St. Johns Basin**

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

**Water Quality Assessment Report for the Lower St. Johns Basin**

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

### U.S. Environmental Protection Agency

**Region 4: Total Maximum Daily Loads in Florida**

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

**National STORET Program**

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

# Chapter 1: INTRODUCTION

## 1.1 Purpose of Report

This report presents the Total Maximum Daily Load (TMDL) for fecal coliform for Deep Bottom Creek, located in the South Mainstem Planning Unit of the Lower St. Johns Basin. The creek has been verified as impaired for fecal coliform, and was included on the Verified List of impaired waters for the Lower St. Johns Basin that was adopted by Secretarial Order in May 2004. This TMDL establishes the allowable loadings to Deep Bottom Creek that would restore the waterbody so that it meets its applicable water quality criterion for fecal coliform.

## 1.2 Identification of Waterbody

Deep Bottom Creek, located in Duval County in northeast Florida, has a drainage area of about 1.91 square miles ($mi^2$). A direct tributary of the St. Johns River (**Figures 1.1** and **1.2**), it is approximately 2.04 miles long and is a second-order stream.

The Deep Bottom Creek watershed is located towards the southeast corner of Duval County, along the eastern bank of the St. Johns River near where it is crossed by Interstate 295 (I-295). I-295 also crosses the southern portion of the Deep Bottom Creek watershed, which encompasses a moderately populated part of Duval County. Additional information about the creek's hydrology and geology are available in the Water Quality Assessment Report for the Lower St. Johns Basin (Florida Department of Environmental Protection [Department], 2004).

For assessment purposes, the Department has divided the Lower St. Johns Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. Deep Bottom Creek consists of one segment, WBID 2361 (**Figure 1.2**), which this TMDL addresses.

Deep Bottom Creek is part of the South Mainstem Planning Unit. Planning units are groups of smaller watersheds (WBIDs) that are part of a larger basin unit, in this case the Lower St. Johns Basin. The South Mainstem Planning Unit consists of 53 WBIDs. **Figure 1.3** shows the location of these WBIDs, Deep Bottom Creek's location in the planning unit, and a list of the other WBIDs in the planning unit.

## Figure 1.1. Location of Deep Bottom Creek, WBID 2361, and Major Geopolitical Features in the Lower St. Johns Basin

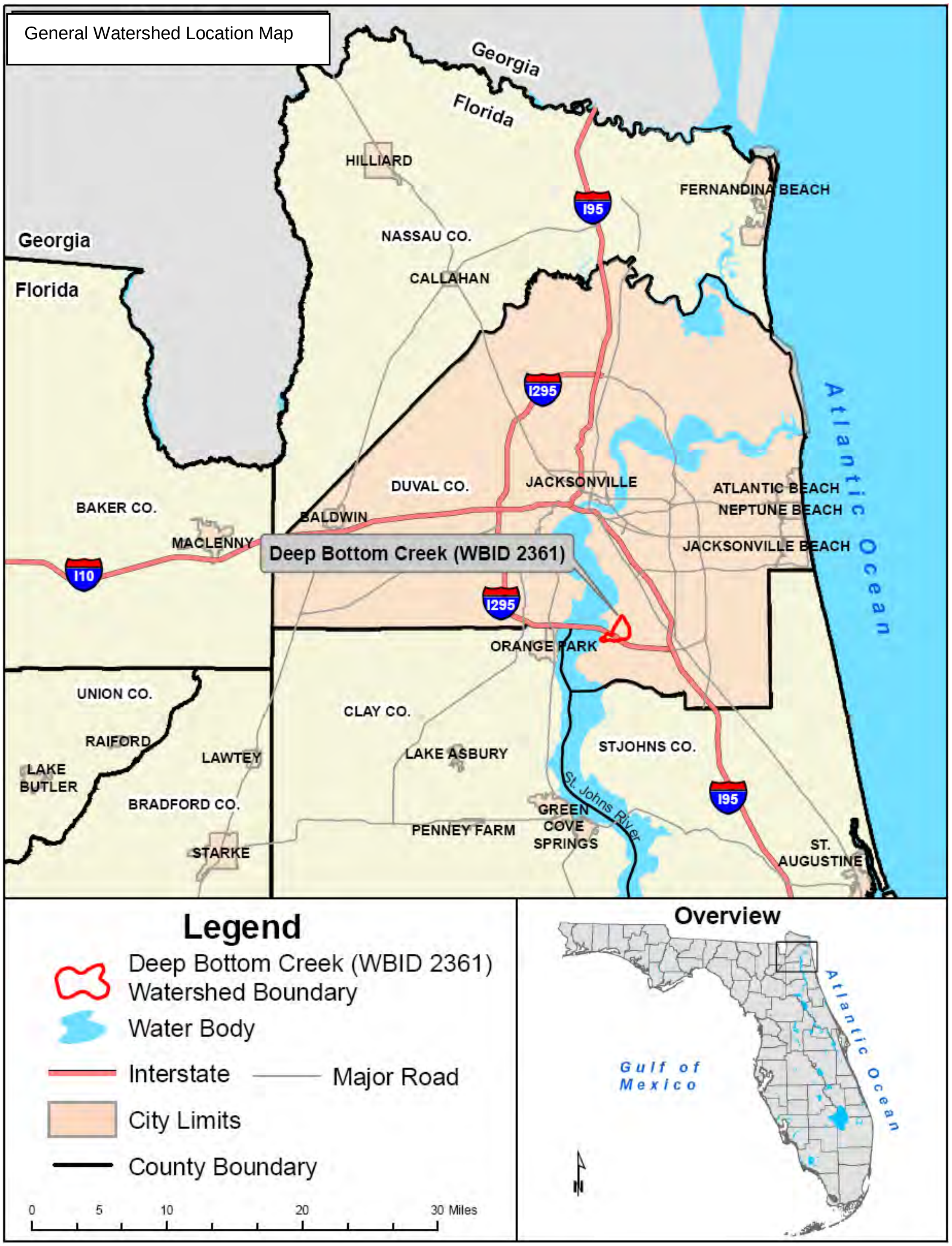
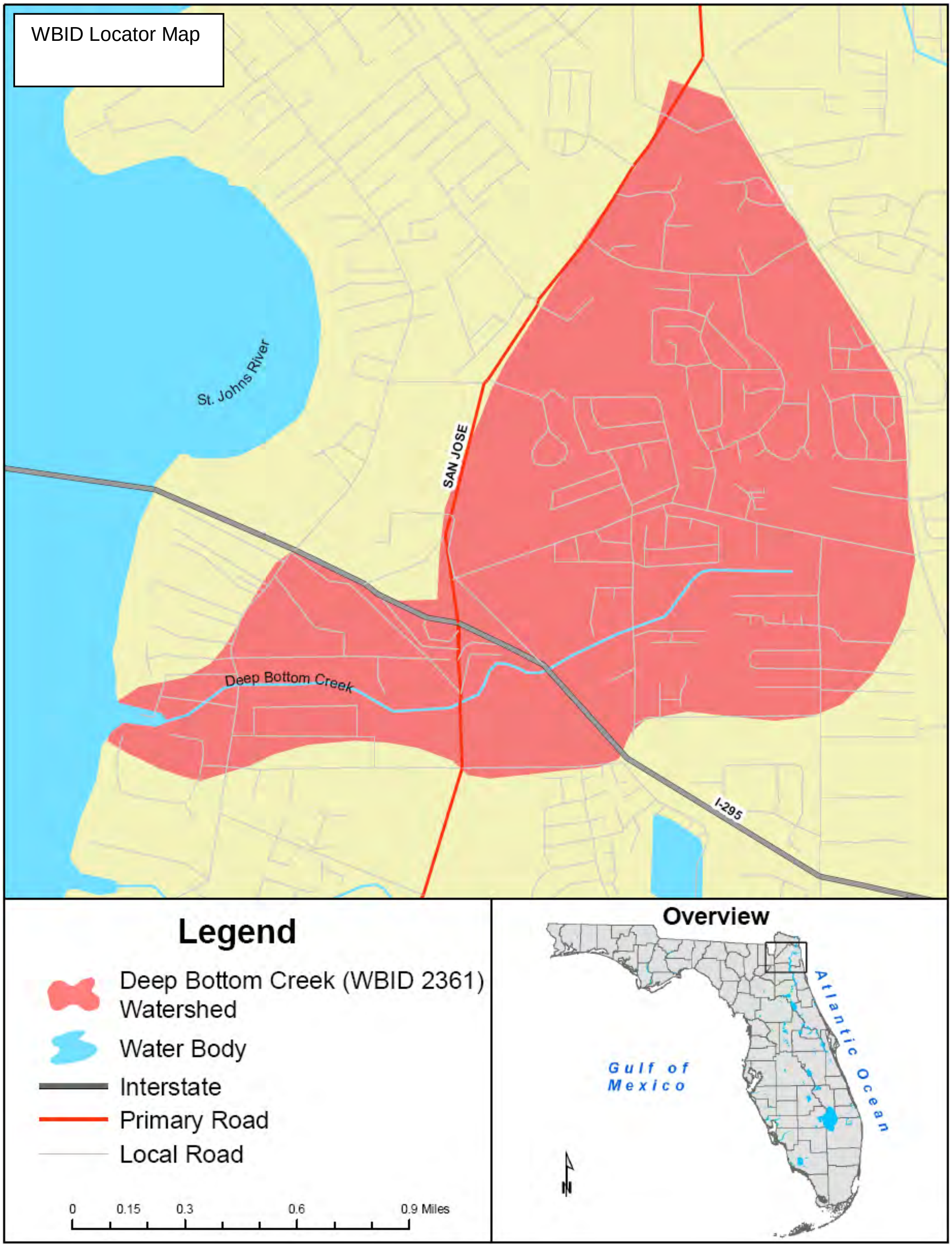
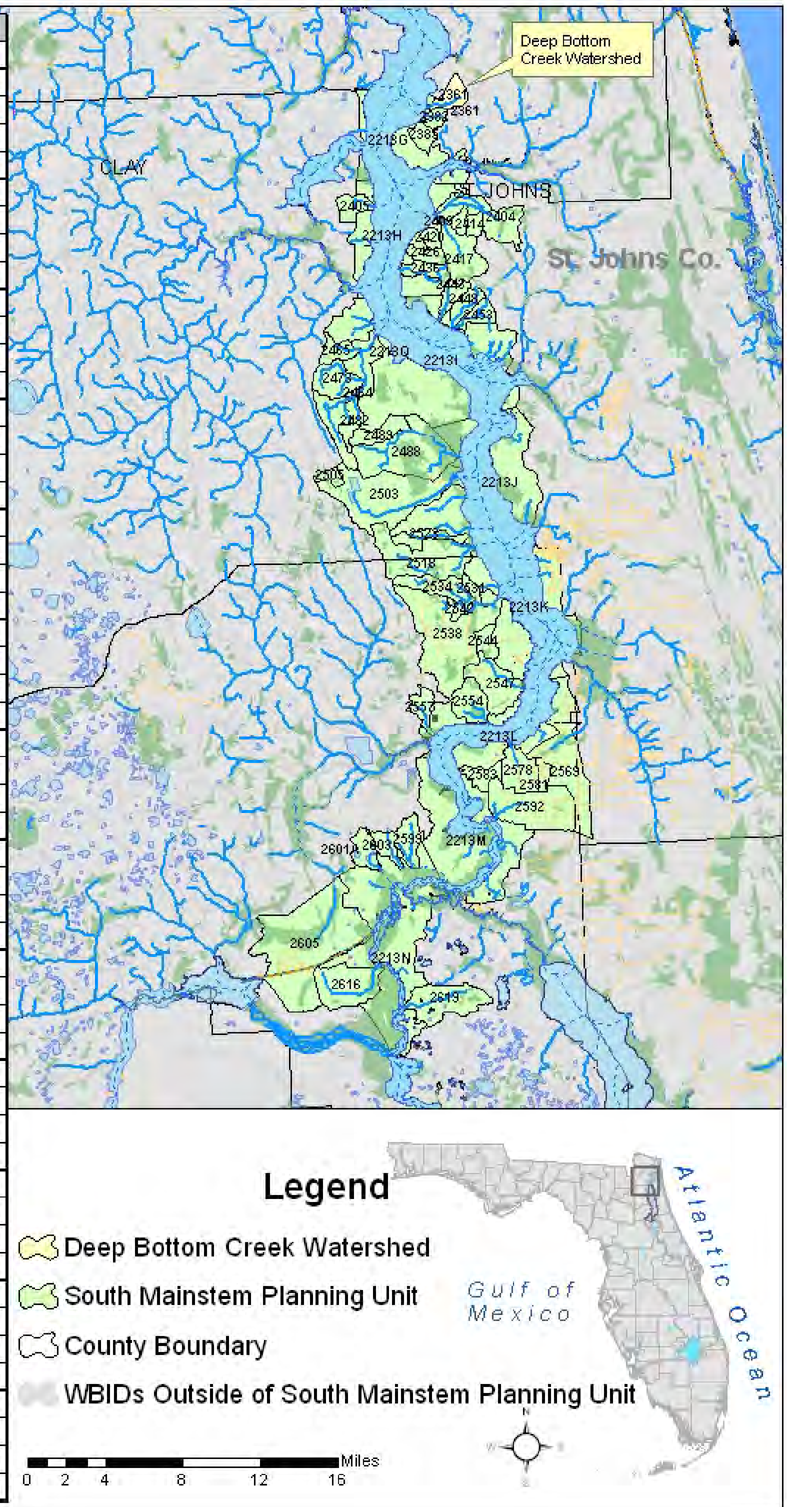


Figure 1.2. Overview of Deep Bottom Creek, WBID 2361



## Figure 1.3. WBIDs in the South Mainstem Planning Unit

| WBID | NAME |
|---|---|
| 2213G | STJ RIV AB DOCTOR LAKE |
| 2213H | STJ RIV AB JULINGTON C |
| 2213I | STJ RIV AB BLACK CK |
| 2213J | STJ RIV AB PALMO CK |
| 2213K | STJ RIV AB TOCOI |
| 2213L | STJ RIV AB FEDERAL PT |
| 2213M | STJ RIV AB RICE CK |
| 2213N | STJ RIV AB DUNNS CK |
| 2213Q | GREEN COVE SPRINGS |
| 2361 | DEEP BOTTOM CREEK |
| 2382 | UNNAMED DRAIN |
| 2385 | MANDARIN DRAIN |
| 2404 | CUNNINGHAM CREEK |
| 2405 | PETERS BRANCH |
| 2409 | BIG LIGE BRANCH |
| 2414 | LITTLE LIGE BRANCH |
| 2417 | MILL CREEK |
| 2420 | UNNAMED BRANCH |
| 2426 | UNNAMED BRANCH |
| 2436 | KENTUCKY BRANCH |
| 2443 | ORANGE GROVE BRANCH |
| 2448 | KENDALL CREEK |
| 2453 | PETTY BRANCH |
| 2464 | GOVERNOR CREEK |
| 2465 | UNNAMED BRANCH |
| 2473 | UNNAMED BRANCH |
| 2482 | UNNAMED BRANCH |
| 2488 | WALKILL CREEK |
| 2489 | UNNAMED BRANCH |
| 2503 | CLARKES CREEK |
| 2505 | MINED AREA |
| 2518 | UNNAMED CREEK |
| 2523 | UNNAMED DITCH |
| 2531 | UNNAMED SLOUGH |
| 2534 | UNNAMED SLOUGH |
| 2538 | CEDAR CREEK |
| 2542 | UNNAMED SLOUGH |
| 2544 | UNNAMED SLOUGH |
| 2547 | MASON BRANCH |
| 2554 | FISH CREEK |
| 2557 | MOCCASIN CREEK |
| 2569 | WEST RUN INTERCEPTER D |
| 2578 | DOG BRANCH |
| 2581 | UNNAMED DITCHES |
| 2583 | COW BRANCH |
| 2592 | MILL BRANCH |
| 2599 | TWOMILE CREEK |
| 2601 | ROUND LAKE |
| 2601A | ROUND LAKE OUTLET |
| 2603 | DUVALL BRANCH |
| 2605 | CROSS FLORIDA BARGE CA |
| 2616 | CAMP BRANCH |
| 2619 | ACOSTA CREEK |



## 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 Basin Management Action Plan, or BMAP, to reduce the amount of fecal coliform that caused the verified impairment of Deep Bottom Creek. These activities will depend heavily on the active participation of the St. Johns River Water Management District (SJRWMD), city of Jacksonville, Jacksonville Electric Authority (JEA), local 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) a list of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant causing impairment of these 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.]), and the state's 303(d) list is amended annually to include basin updates.

Florida's 1998 303(d) list included 52 waterbodies and 15 parameters in the Lower 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 rule-making 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; the rule was amended in 2006 and 2007.

## 2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in Deep Bottom Creek and has verified that the creek is impaired for fecal coliform based on data in the Department's IWR database. **Tables 2.1** through **2.3** provide summary results for fecal coliform data for the verification period (which for Group 2 waters was January 1, 1996, to June 30, 2003), by month, season, and year, respectively. There is a 92.31 percent overall exceedance rate for fecal coliform in Deep Bottom Creek during the verified period, with a total of 26 samples, ranging from 204 to 11,000 counts per 100 milliliters (counts/100mL).

Exceedances occurred in all months in which samples were collected, with 100 percent exceedance rates occurring in January, March, May, August, September, October, and November (**Table 2.1**). All months had exceedance rates greater than or equal to 66.67 percent, except February (no samples), June (no samples), and December (no samples). Sample size for each month is small, with all months having 5 or fewer samples, making interpretation difficult.

When aggregating data by season, the winter and fall seasons demonstrated the highest percentages of exceedances (both 100.00 percent). The winter season had the second lowest amount of rainfall, and the fall season had the lowest (**Table 2.2**). Due to the small sample size, it is not clear whether the exceedances are directly associated with rainfall events, nonpoint sources, point sources, or seasonal variation.

After examining the yearly data, exceedance rates are very high in 1996, and from 1998 to 2001 (100.00 percent) (**Table 2.3**). Sample size is small, with only 1 sample in 1996, 3 samples in 1998, 7 in 1999, and 4 in 2000 and 2001, making it difficult to verify potential trends.

There are 3 sampling sites where historical data were collected during the verified period (January 1, 1996, to June 30, 2003). The city of Jacksonville collected 22 samples and the Department collected 4. **Section 5.1** discusses sampling stations further.

### Table 2.1. Summary of Fecal Coliform Data by Month for the Verified Period (January 1, 1996–June 30, 2003), WBID 2361

| Month | N | Minimum | Maximum | Median | Mean | Number of Exceedances | % Exceedances | Mean Precipitation |
|---|---|---|---|---|---|---|---|---|
| January | 5 | 472 | 4,000 | 2,200 | 2,056 | 5 | 100.00 | 2.55 |
| February | 0 | - | - | - | - | - | - | 2.82 |
| March | 3 | 870 | 1,800 | 1,400 | 1,357 | 3 | 100.00 | 4.26 |
| April | 5 | 340 | 2,200 | 900 | 1,048 | 4 | 80.00 | 2.79 |
| May | 1 | 1,700 | 1,700 | 1,700 | 1,700 | 1 | 100.00 | 1.61 |
| June | 0 | - | - | - | - | - | - | 6.18 |
| July | 3 | 204 | 5,000 | 3,000 | 2,735 | 2 | 66.67 | 6.36 |
| August | 2 | 3,000 | 11,000 | 7,000 | 7,000 | 2 | 100.00 | 6.97 |
| September | 1 | 967 | 967 | 967 | 967 | 1 | 100.00 | 10.01 |
| October | 4 | 1,100 | 9,000 | 2,550 | 3,800 | 4 | 100.00 | 3.74 |
| November | 2 | 7,000 | 8,000 | 7,500 | 7,500 | 2 | 100.00 | 1.81 |
| December | 0 | - | - | - | - | - | - | 3.46 |

- = No data available for February, June, and December.
Coliform counts are #/100mL.
Exceedances represent values above 400 counts/100mL.
Mean precipitation is for Jacksonville International Airport (JIA) in inches.

### Table 2.2. Summary of Fecal Coliform Data by Season for the Verified Period (January 1, 1996–June 30, 2003), WBID 2361

| Season | N | Minimum | Maximum | Median | Mean | Number of Exceedances | % Exceedances | Mean Precipitation |
|---|---|---|---|---|---|---|---|---|
| Winter | 8 | 472 | 4,000 | 1,600 | 1,794 | 8 | 100.00 | 9.62 |
| Spring | 6 | 340 | 2,200 | 950 | 1,157 | 5 | 83.33 | 10.58 |
| Summer | 6 | 204 | 11,000 | 3,000 | 3,862 | 5 | 83.33 | 23.34 |
| Fall | 6 | 1,100 | 9,000 | 5,000 | 5,033 | 6 | 100.00 | 9.01 |

Coliform counts are #/100mL.
Exceedances represent values above 400 counts/100mL.
Mean precipitation is for JIA in inches.

## Table 2.3. Summary of Fecal Coliform Data by Year for the Verified Period (January 1, 1996–June 30, 2003), WBID 2361

| Year | N | Minimum | Maximum | Median | Mean | Number of Exceedances | % Exceedances | Mean Precipitation |
|---|---|---|---|---|---|---|---|---|
| 1996 | 1 | 8,000 | 8,000 | 8,000 | 8,000 | 1 | 100.00 | 60.63 |
| 1997 | 0 | - | - | - | ,- | - | - | 57.27 |
| 1998 | 3 | 1,700 | 5,000 | 3,000 | 3,233 | 3 | 100.00 | 56.72 |
| 1999 | 7 | 870 | 11,000 | 1,800 | 3,996 | 7 | 100.00 | 42.44 |
| 2000 | 4 | 2,200 | 7,000 | 2,600 | 3,600 | 4 | 100.00 | 39.77 |
| 2001 | 4 | 1,000 | 4,000 | 2,050 | 2,275 | 4 | 100.00 | 49.14 |
| 2002 | 5 | 204 | 2,100 | 801 | 909 | 4 | 80.00 | 54.72 |
| 2003 | 2 | 340 | 610 | 475 | 475 | 1 | 50.00 | 27.36 |

- = No data available for February.
Coliform counts are #/100mL.
Exceedances represent values above 400 counts/100mL.
Total precipitation is for JIA in inches.

# 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)** |

Deep Bottom Creek is a Class III fresh waterbody, with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criterion applicable to the impairment addressed by this TMDL is for fecal coliform.

## 3.2 Applicable Water Quality Standards and Numeric Water Quality Target

### *3.2.1 Fecal Coliform Criterion*

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

> ***Fecal Coliform Bacteria:***
>
> *The most probable number (MPN) or membrane filter (MF) counts per 100 mL of fecal coliform bacteria shall not exceed a monthly average of 200, nor exceed 400 in 10 percent of the samples, nor exceed 800 on any one day.*

The criterion states that monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period. However, there are insufficient data (fewer than 10 samples in a given month) available to evaluate the geometric mean criterion for fecal coliform bacteria. Therefore, the criterion selected for the TMDL is that samples shall not exceed 400 counts/100mL.

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

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

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

## 4.2 Potential Sources of Coliform in the Deep Bottom Creek Watershed

### *4.2.1 Point Sources*

There is currently one permitted wastewater facility located in the Deep Bottom Creek watershed, but it does not discharge inside the watershed (**Figure 4,1**). This facility, the Mandarin Water Reclamation Facility (FL0023493), discharges to the St. Johns River.

#### Municipal Separate Storm Sewer System Permittees

The city of Jacksonville and Florida Department of Transportation (FDOT) District 2 are copermittees for a Phase I NPDES municipal separate storm sewer system (MS4) permit (FLS000012) that covers the Deep Bottom Creek watershed. Responsibility for the permit is shared among FDOT and the cities of Jacksonville, Neptune Beach, and Atlantic Beach.

**Figure 4.2** shows the stormwater infrastructure of the watershed. Outfalls represent points where a conveyance of stormwater discharges into a separate stormwater system through a channelized or natural waterway. Inlets are a component of the stormwater system located

Figure 4.1. Permitted Discharge Facilities in the Deep Bottom Creek Watershed, WBID 2361

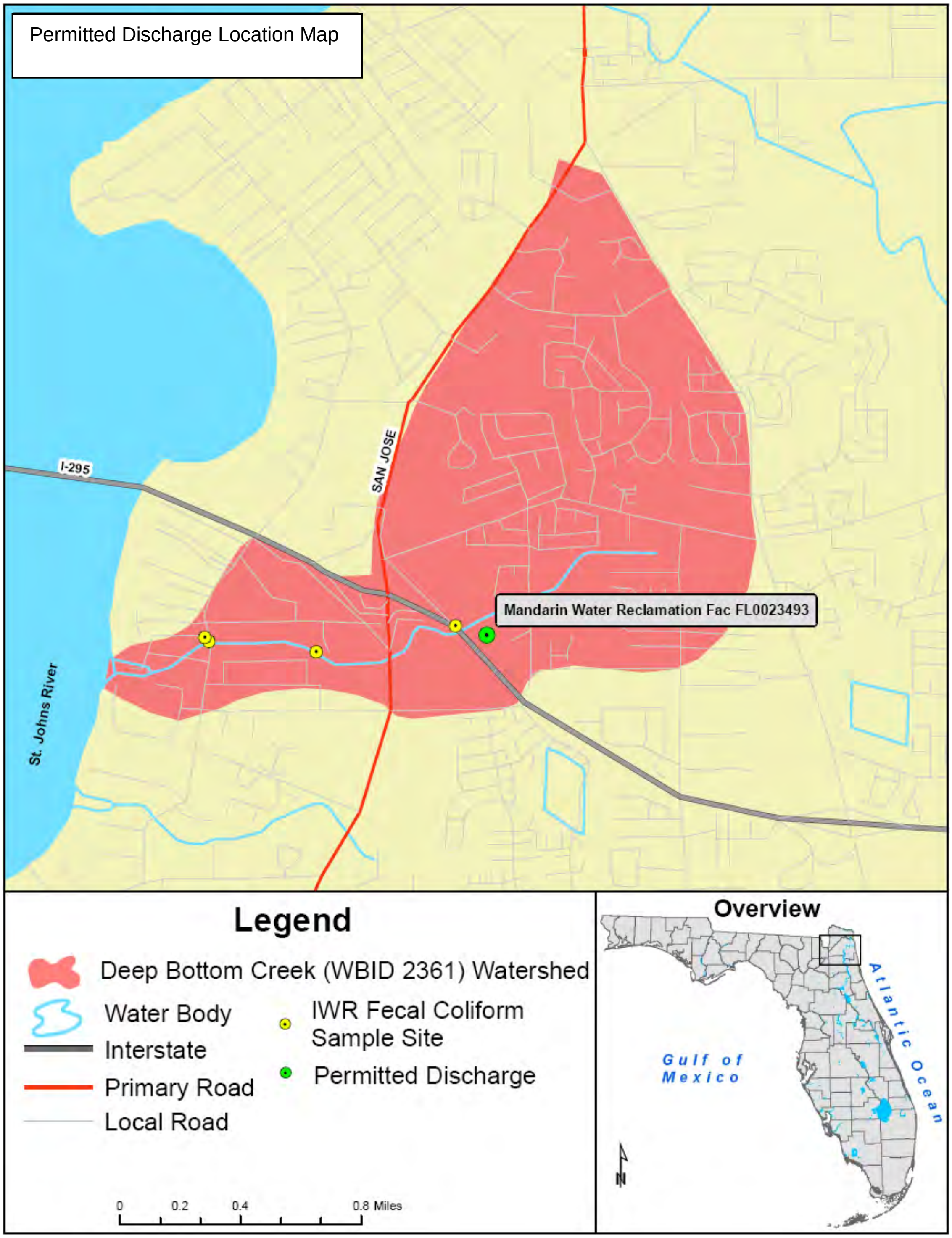
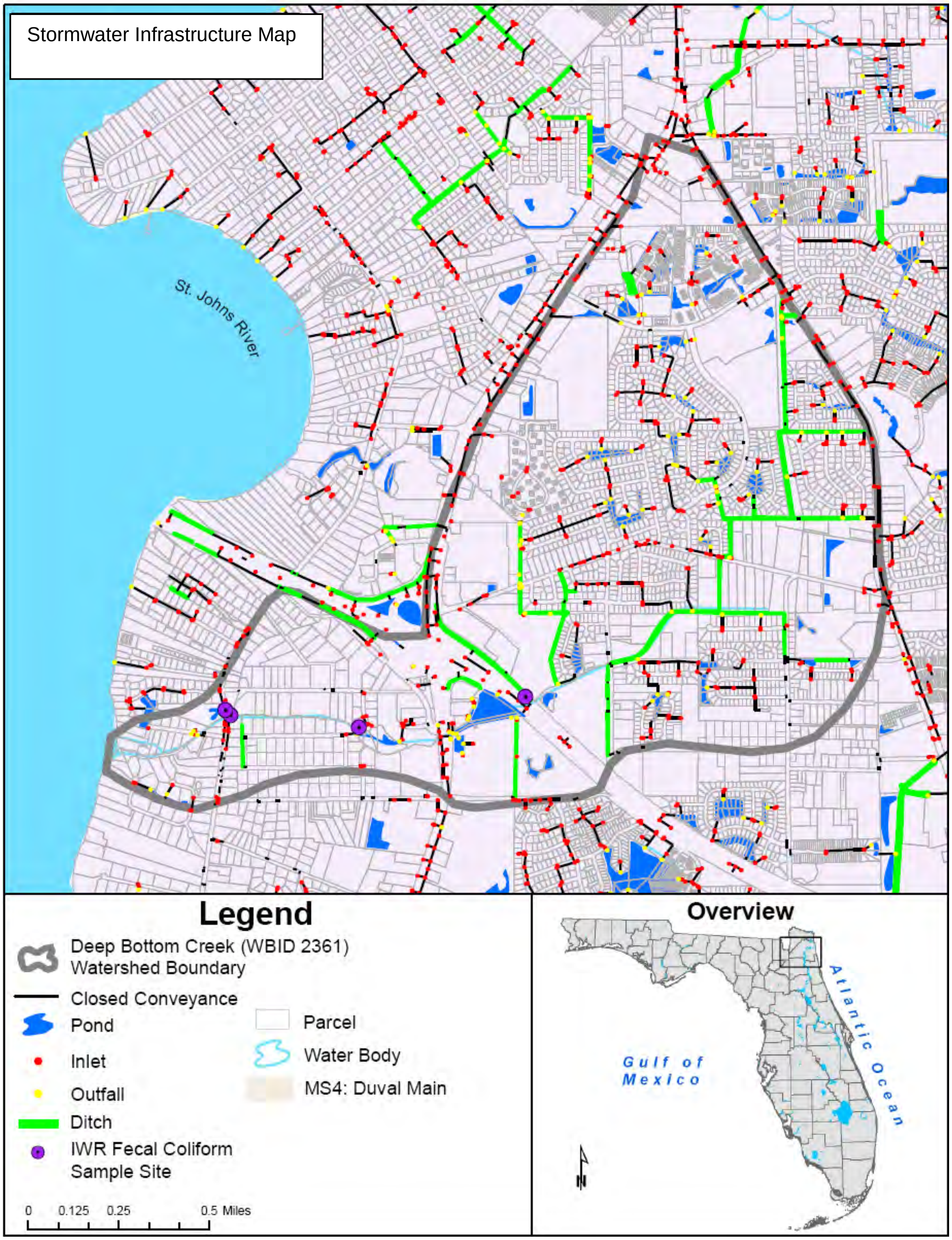


Figure 4.2. Stormwater Infrastructure in the Deep Bottom Creek Watershed, WBID 2361



along the curbed edge of paved surfaces or the low point of an area to provide for the collection of stormwater runoff, access for inspection and maintenance, pipe junctions, sediment traps, or conflicts with other utilities (K. Grable, personal communication, October 16, 2008). In the Deep Bottom Creek watershed, there are 100 outfalls and 413 inlets.

### *4.2.2 Land Uses and Nonpoint Sources*

Additional coliform loadings to Deep Bottom Creek are generated from nonpoint sources in the watershed. Potential nonpoint sources of coliform include loadings from surface runoff, agriculture, wildlife, pets, leaking or overflowing sewer lines, and leaking septic tanks.

#### Land Uses

The spatial distribution and acreage of different land use categories were identified using the 2004 land use coverage contained in the Department's Geographic Information System (GIS) library, initially provided by the SJRWMD. Land use categories and acreages in the watershed were aggregated using the Level 3 codes tabulated in **Table 4.1. Figure 4.3** shows the principal Level 3 land uses in the watershed.

The Deep Bottom Creek watershed covers an area of 1.91 $mi^2$. As **Table 4.1** shows, most of the land in the watershed is covered by impacted areas (approximately 1,119 acres, or 91 percent) composed mostly of residential (61.23 percent) and commercial and services (16.73 percent). The largest single land use is medium-density residential (34.00 percent), followed by low-density residential (17.09 percent) and commercial and services (16.73 percent).

#### Population

According to the U.S. Census Bureau, census block population densities in the Deep Bottom Creek watershed in the year 2000 ranged from 0 to 28,169 people/$mi^2$ (0 to 44 people/acre), with an average of 2,939 people/$mi^2$ (4.59 people/acre) in the watershed (**Figure 4.4**). Based on calculations using data on number of people per household size, the estimated population in the watershed is 5,544, with an average household size of 2.26 people (see **Table 4.2**). The Census Bureau reports that, for all of Duval County, the total population for 2000 was 778,879, with 329,778 total housing units and an average occupancy rate of 92.1 percent (303,747 occupied housing units).

For all of Duval County, the Bureau reported a housing density of approximately 426 housing units/$mi^2$ (which equates to just under 1 housing unit/acre [0.67]). This places Duval County seventh in housing densities and population in Florida (U.S. Census Bureau Website, 2007). The estimated average housing density in Deep Bottom Creek is 1,303 housing units/$mi^2$ (which equates to just under 2.04 housing units/acre), based on population, which is 3 times that of Duval County.

## Table 4.1. Classification of Land Use Categories in the Deep Bottom Creek Watershed, WBID 2361

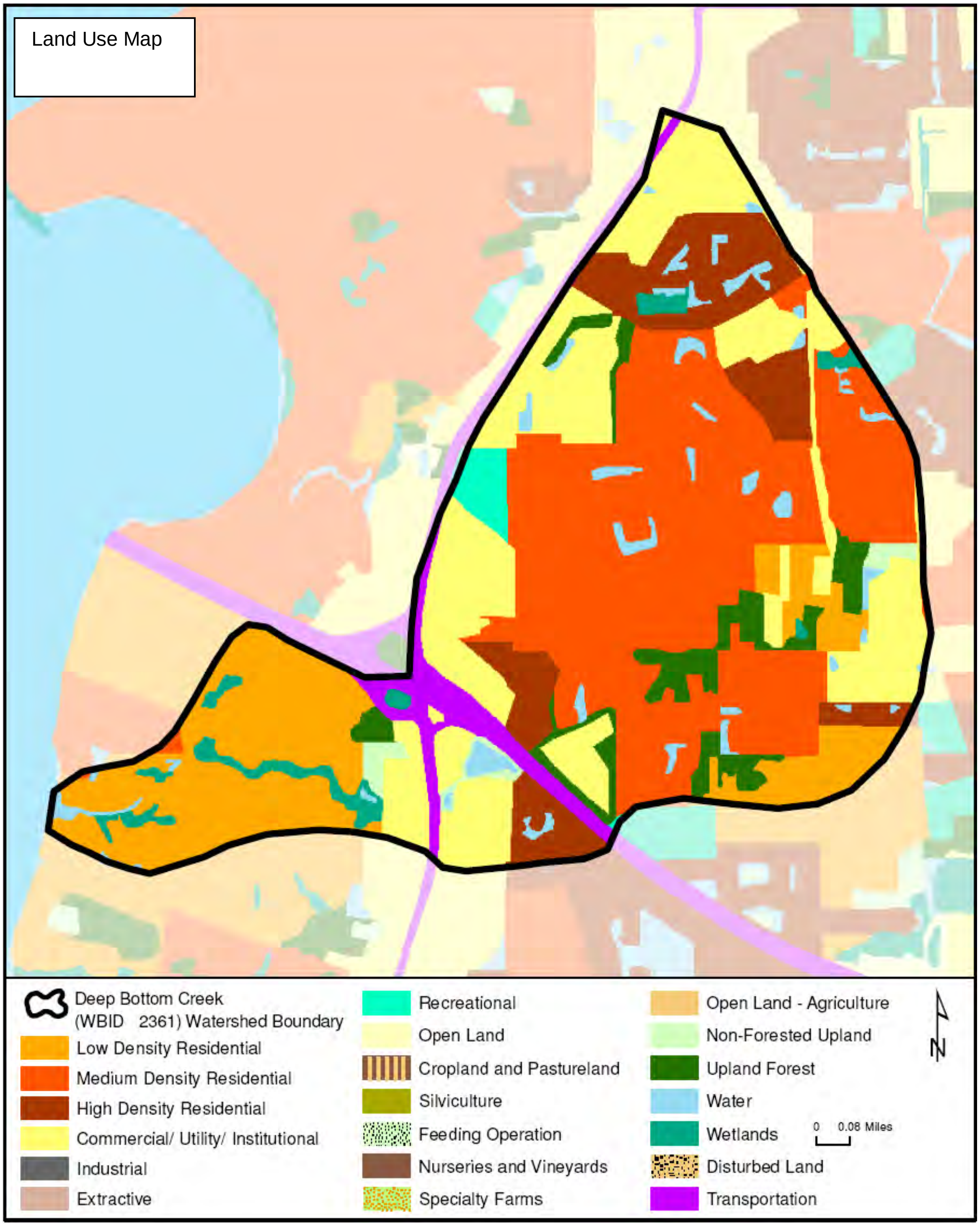
| Level 3 Land Use Code | Attribute | Area (acres) | % of Total Land Use |
|---|---|---|---|
| 1100 | Residential, low density–less than 2 dwelling units/acre | 209.01 | 17.09 |
| 1200 | Residential, medium density–2-5 dwelling units/acre | 415.86 | 34.00 |
| 1300 | Residential, high density–6 or more dwelling units/acre | 124.14 | 10.15 |
| 1400 | Commercial and services | 204.65 | 16.73 |
| 1700 | Institutional | 49.13 | 4.02 |
| 1850 | Parks and zoos | 0.61 | 0.05 |
| 1860 | Community recreational facilities | 13.84 | 1.13 |
| 3100 | Herbaceous upland nonforested | 7.50 | 0.61 |
| 3200 | Shrub and brushland (wax myrtle or saw palmetto, occasionally scrub) | 5.19 | 0.42 |
| 4110 | Pine flatwoods | 47.71 | 3.90 |
| 4340 | Upland mixed coniferous/hardwood | 14.64 | 1.20 |
| 5100 | Streams and waterways | 2.75 | 0.22 |
| 5300 | Reservoirs–pits, retention ponds, dams | 37.12 | 3.03 |
| 6170 | Mixed wetland hardwoods | 22.05 | 1.80 |
| 6300 | Wetland forested mixed | 3.06 | 0.25 |
| 6410 | Freshwater marshes | 1.06 | 0.09 |
| 6430 | Wet prairies | 0.62 | 0.05 |
| 8140 | Roads and highways (divided 4-lanes with medians) | 41.32 | 3.38 |
| 8310 | Electrical power facilities | 2.77 | 0.23 |
| 8320 | Electrical power transmission lines | 7.03 | 0.57 |
| 8340 | Sewage treatment | 13.21 | 1.08 |
| | **TOTAL:** | **1,223.28** | **100.00** |

## Table 4.2. Estimated Average Household Size in the Deep Bottom Creek Watershed, WBID 2361

| Household Size* | Number of Households | % of Total | Number of People |
|---|---|---|---|
| 1-person household | 828 | 33.69 | 828 |
| 2-person household | 788 | 32.06 | 1,576 |
| 3-person household | 416 | 16.91 | 1,248 |
| 4-person household | 284 | 11.56 | 1,136 |
| 5-person household | 103 | 4.19 | 515 |
| 6-person household | 30 | 1.21 | 180 |
| 7-or-more-person household | 9 | 0.37 | 64 |
| **TOTAL:** | **2,458** | **100.00** | **5,547*** |
| | | **AVERAGE HOUSEHOLD SIZE:** | **2.26** |

*Individual values for number of people per household size have been rounded to the nearest whole number, while total number of people remains based on unrounded values.
Data from U.S. Census Bureau Website, 2007, based on the Duval County blocks present in the Deep Bottom Creek watershed.

## Figure 4.3. Principal Level 3 Land Uses in the Deep Bottom Creek Watershed, WBID 2361, in 2004



## Figure 4.4. Population Density in the Deep Bottom Creek Watershed, WBID 2361, in 2000

### Septic Tanks

Approximately 78 percent of Duval County residences are connected to a wastewater treatment plant, while the rest use septic tanks (JEA Water and Sewer Expansion Authority [WSEA] septic files) (PBS&J, 2007). The Florida Department of Health (FDOH) reports that as of fiscal year 2006–07, there were 90,292 permitted septic tanks in Duval County and for fiscal years 1991 to 2007 (missing 1992–93), 6,278 permits for repairs were issued, or an average of approximately 419 repairs annually countywide (FDOH Website, 2007).

The Department obtained septic tank repair permit data from JEA for its service area, which includes the Deep Bottom Creek watershed. These data are more watershed specific than the countywide FDOH data. Included are septic tank repair permit records issued from March 1990 to March 2004, areas serviced by a WWTF, and areas where large numbers of failing septic tanks are present. **Figure 4.5** presents this information in map form. The data show there were 34 permits for repairs issued during this time in the watershed, or an average of 2.43 repairs per year. If this average is rounded up to 3 (to allow for those septic tanks where failures may not be known or have not been repaired), and using an estimate of 70 gallons/day/person (EPA, 2001), a loading of 1.80 x 1010 fecal coliform counts/day is derived. **Table 4.3** shows these estimations.

As shown in the map (depicted in yellow), the southwestern end of the Deep Bottom Creek watershed is in a septic tank phase-out area (an area with the highest priority to be sewered due to high septic tank failure rates). It can be seen from the map that this area is where most of the repair permits were issued from March 1990 to March 2004. The Deep Bottom Creek watershed area is serviced by the Mandarin WWTF.

#### Table 4.3. Estimated Annual Fecal Coliform Loading from Failed Septic Tanks in the Deep Bottom Creek Watershed, WBID 2361

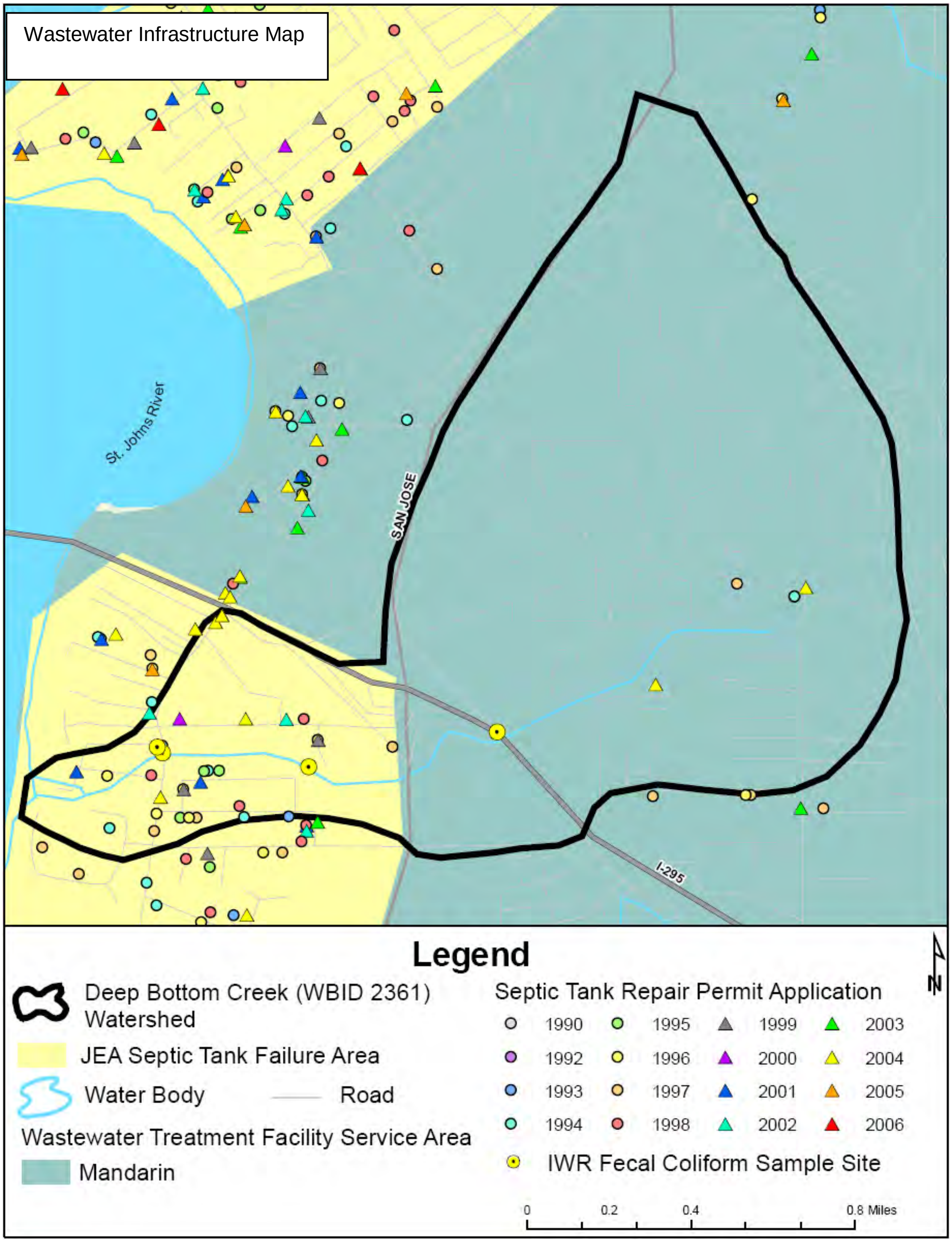
| Total Number of Repair Permits in WBID 2361 (March 1990–March 2004)[1] | Number of Tank Failures/ Year (Total Repair Permits/ Number of Years) | Number of Tank Failures/Year, Rounded Up To Allow for Unknown or Unrepaired Failures | Estimated Load from Failed Tanks (counts/mL)[2] | Gallons/ Person/ Day[2] | Estimated Number of Persons per Household[3] | Estimated Daily Load from Failing Tanks (counts/day) | Estimated Yearly Load from Failing Tanks (counts/yr) |
|---|---|---|---|---|---|---|---|
| 34 | 2.43 | 3 | 1.00E+04 | 70 | 2.26 | 1.80E+10 | 6.56E+12 |

[1] Based on septic tank repair permits issued in the watershed from March 1990 to March 2004 (JEA information); see text.

[2] EPA, 2001.

[3] From U.S Census Bureau; see **Table 4.2** for more information on this estimate.

Figure 4.5. Septic Tank Repair Permits Issued for the Deep Bottom Creek Watershed, WBID 2361, 1990–2006



## 4.3 Source Summary

### *4.3.1 Agriculture*

According to the Florida Department of Agriculture and Consumer Services' (FDACS) 2006 survey (FDACS Website, 2007), there are about 8,000 cows in Duval County. Assuming that improved pastures are primarily used to raise cattle, there are approximately 8,734 acres of land on which cows reside in Duval County, consisting of improved pastures (8,238 acres), cattle-feeding operations (337 acres), and dairies (159 acres). Using this information, there is approximately 1 cow per acre of land on which cows reside in Duval County. However, according to Level 3 land use data, no agricultural areas have been identified in the Deep Bottom Creek watershed, and therefore there are no potential fecal coliform loadings from cattle.

### *4.3.2 Pets*

The Department has been unable to obtain information on the number of dogs in the Deep Bottom Creek watershed; however, estimates can be made based on dog ownership statistics from the American Veterinary Medical Association (AVMA). Based on U.S. Census Bureau data, there are an estimated 2,458 households in the watershed, and AVMA estimates that there are 0.58 dogs per household (AVMA Website, 2005). Using this information, there are approximately 1,426 dogs in the Deep Bottom Creek watershed, representing a potential fecal coliform loading of 7.13 x $10^{12}$ counts per day (**Table 4.4**).

Table 4.4. Estimated Loading from Dogs in the Deep Bottom Creek Watershed, WBID 2361

| Estimated Number of Households in WBID 2361 | Estimated Dog:Household Ratio[1] | Estimated Number of Dogs in WBID 2361 | Estimated Fecal Coliform (counts/dog/day[2]) | Estimated Fecal Coliform (counts/day) | Estimated Fecal Coliform (counts/year) |
|---|---|---|---|---|---|
| 2,458 | 0.58 | 1,426 | 5.00E+09 | 7.13E+12 | 2.60E+15 |

[1] From AVMA, which states the original source to be the *U.S. Pet Ownership and Demographics Sourcebook,* 2002.

[2] EPA, 2001.

### *4.3.3 Leaking or Overflowing Wastewater Collection Systems*

As noted previously, about 78 percent of households in Duval County are connected to a wastewater facility. Assuming that this countywide average applies to the 2,458 households in the Deep Bottom Creek watershed, approximately 1,917 households are connected to a wastewater facility. Given that there are 2.26 people per household in the watershed, each producing a 70-gallon-per-person-per-day discharge (EPA, 2001), a daily flow of approximately 1.15 x $10^6$ liters (L) is transported through the collection system. The EPA (Davis, 2002) suggests that a 5 percent leakage rate from collection systems is a realistic estimate. Based on this rate and EPA values for fecal coliform in raw sewage (2001), the potential loadings of fecal coliform from leaking sewer lines are 2.87 x $10^{12}$ counts/day (**Table 4.5**).

### Table 4.5. Estimated Loading from Wastewater Collection Systems in the Deep Bottom Creek Watershed, WBID 2361

| Estimated Number of Homes on Central Sewer in WBID 2361 | Estimated Daily Flow (L) | Daily Leakage (L) | Raw Sewage (counts/ 100 mL) | Estimated Fecal Coliform (counts/day) | Estimated Fecal Coliform (counts/year) |
|---|---|---|---|---|---|
| 1917 | 1.15E+06 | 5.74E+04 | 5.00E+06 | 2.87E+12 | 1.05E+15 |

**Table 4.6** summarizes the various estimates from potential sources. It is important to note that this is not a complete list (for example, wildlife is missing), and that the potential loadings are estimated. Proximity to the waterbody, rainfall frequency and magnitude, soil types, drainage features, and temperature are just a few of the factors that could influence and determine the actual loadings from these sources that reach Deep Bottom Creek. In addition, the tidal exchange between the Lower St. Johns River and many of its tributaries, including Deep Bottom Creek, also contributes to the fecal coliform loading in the watershed. However, WBID 2213G, the portion of the Lower St Johns into which Deep Bottom Creek flows, is not impaired by fecal coliform.

### Table 4.6. Summary of Estimated Annual Potential Coliform Loading from Various Sources in the Deep Bottom Creek Watershed, WBID 2361

| Source | Fecal Coliform (counts/year) |
|---|---|
| Septic Tanks | $6.56 \times 10^{12}$ |
| Agriculture | 0.00 |
| Dogs | $2.60 \times 10^{15}$ |
| Collection Systems | $1.05 \times 10^{15}$ |

# Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

## 5.1 Determination of Loading Capacity

The methodology used for this TMDL was the “percent reduction” methodology. The Department generally prefers to use the load duration curve or “Kansas” method for coliform TMDLs, but this method could not be used because there are no stream gauging stations on Deep Bottom Creek. To determine the TMDL, the percent reduction that would be required for each of the exceedances to meet the applicable criterion was determined. The median value of all of these reductions for fecal coliform determined the overall required reduction, and this is therefore the TMDL.

### *5.1.1 Data Used in the Determination of the TMDL*

The following five sampling stations on Deep Bottom Creek have historical fecal coliform observations (**Figure 5.1**):

- *Deep Bottom Creek at Scott Mill Road (STORET ID: 21FLJXWQSS18);*
- *Deep Bottom Creek at Scott Mill Road (STORET ID: 21FLA20030595);*
- *Deep Bottom Creek at I-295 (STORET ID: 21FLA20030596);*
- *Deep Bottom Creek at Cheatham Trail (STORET ID: 21FLA20030592); and*
- *Deep Bottom Creek at Woods of Mandarin 3200 Hartley Road (STORET ID: 21FLA20030850).*

The first station at Scott Mill Road (21FLJXWQSS18), monitored by the city of Jacksonville, is located at Scott Mill Road approximately 0.07 miles north of its intersection with Lynnhaven Road. The second station at Scott Mill Road (21FLA20030595) is monitored by the Department’s Northeast District, and is located at Scott Mill Road approximately 0.06 miles northeast of its intersection with Lynnhaven Road. The Department’s Northeast District also monitors the other three stations: the I-295 station is located approximately 0.05 miles southeast of the northbound exit ramp from the interstate; the station at Cheatham Trail is located approximately 0.03 miles west of the road’s dead end; and the station at Hartley Road is situated about 0.04 miles southwest of the intersection of San Jose Road and Plummer Cove Road.

**Table 5.1** shows data collection information for each station, and **Figure 5.1** shows the locations of the sample sites. **Table 5.2** shows observed historical data analysis, and **Appendix B** contains all the historical fecal coliform observations from the sites for the planning and verified periods for the Lower St. Johns Basin. **Figure 5.2** shows the historical observations visually over time. The stations exhibited the following overall percent exceedance rates: 94.74 percent at Scott Mill Road (STORET ID: 21FLJXWQSS18); 75.00 percent at Scott Mill Road (STORET ID: 21FLA20030595); 100 percent at I-295; 100 percent at Cheatham Trail; and 50 percent at Hartley Road (**Table 5.2**).

## Table 5.1. Sampling Station Summary for Deep Bottom Creek, WBID 2361

| Station | STORET ID | Station Owner | Years With Data | Number of Samples |
|---|---|---|---|---|
| Deep Bottom Creek at Woods of Mandarin 3200 Hartley Road | 21FLA 20030850 | Department, Northeast District | 2007 | 2 |
| Deep Bottom Creek at Cheatham Trail | 21FLA 20030592 | Department, Northeast District | 1999, 2002, 2007 | 5 |
| Deep Bottom Creek at I-295 | 21FLA 20030596 | Department, Northeast District | 1999 | 1 |
| Deep Bottom Creek at Scott Mill Road | 21FLJX WQSS18 | City of Jacksonville | 1991–96, 1998–2007 | 57 |
| Deep Bottom Creek at Scott Mill Road | 21FLA 20030595 | Department, Northeast District | 1999, 2007 | 4 |

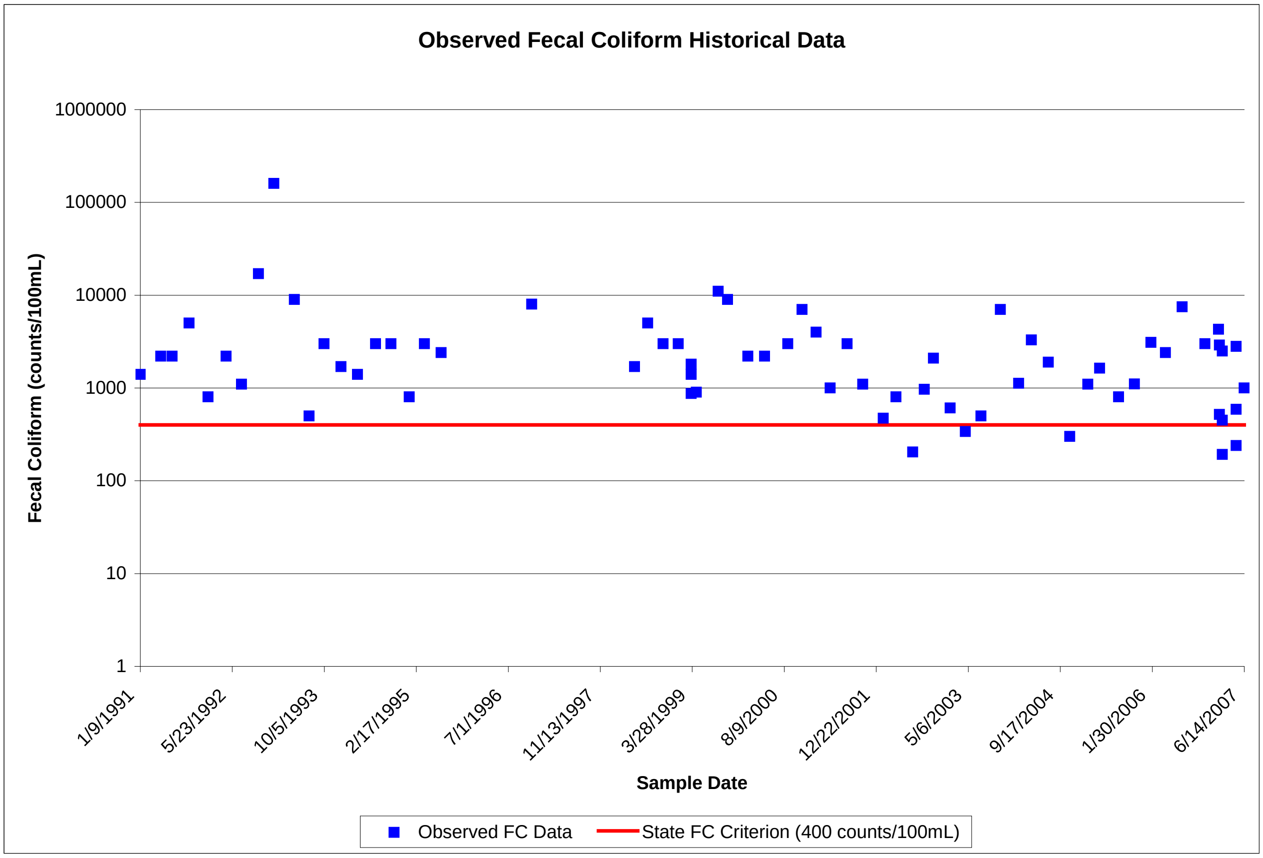
## Table 5.2. Statistical Summary of All Historical Data for Deep Bottom Creek, WBID 2361

| Station | STORET ID | Number of Samples | Minimum | Maximum | Median | Mean | Exceedances | % Exceedances |
|---|---|---|---|---|---|---|---|---|
| Deep Bottom Creek at Woods of Mandarin 3200 Hartley Road | 21FLA 20030850 | 2 | 192 | 2,800 | 1,496 | 1,496 | 1 | 50.00 |
| Deep Bottom Creek at Cheatham Trail | 21FLA 20030592 | 5 | 450 | 1,400 | 590 | 785.4 | 5 | 100.00 |
| Deep Bottom Creek at I-295 | 21FLA 20030596 | 1 | 870 | 870 | 870 | 870 | 1 | 100.00 |
| Deep Bottom Creek at Scott Mill Road | 21FLJX WQSS18 | 57 | 204 | 160,000 | 2,200 | 5,779 | 54 | 94.74 |
| Deep Bottom Creek at Scott Mill Road | 21FLA 20030595 | 4 | 240 | 2,900 | 2,150 | 1,860 | 3 | 75.00 |

Coliform concentrations are counts/100mL.

Figure 5.1. Historical Sample Sites in Deep Bottom Creek, WBID 2361

Figure 5.2. Historical Fecal Coliform Observations for Deep Bottom Creek, WBID 2361, 1991–2007




### 5.1.2 TMDL Development Process

Due to the lack of supporting flow information, a simple calculation was performed to determine the needed reduction. Exceedances of the state criterion were compared with the criterion of 400 counts/100mL. For each individual exceedance, an individual required reduction was calculated using the following:

$$\frac{[(\text{observed value}) - (\text{state criterion})] \times 100}{(\text{observed value})}$$

After the individual results were calculated, the median of the individual values was calculated, which is 82 percent. This means that in order to meet the state criterion of 400 counts/100mL, an 82 percent reduction in current loading is necessary, and this is therefore the TMDL for Deep Bottom Creek. **Table 5.3** shows the annual summaries of exceedances used to determine the TMDL by year, and **Table 5.4** shows the individual exceedances used in calculating the TMDL for Deep Bottom Creek.

### Table 5.3. Annual Summary of Fecal Coliform Exceedances Used To Develop the TMDL for Deep Bottom Creek, WBID 2361

| Year | Number of Exceedances | Minimum | Maximum | Median | Mean |
|---|---|---|---|---|---|
| 1991 | 4 | 1,400 | 5,000 | 2,200 | 2,700 |
| 1992 | 4 | 800 | 17,000 | 1,650 | 5,275 |
| 1993 | 4 | 500 | 160,000 | 6,000 | 43,125 |
| 1994 | 4 | 1,400 | 3,000 | 2,350 | 2,275 |
| 1995 | 3 | 800 | 3,000 | 2,400 | 2,067 |
| 1996 | 1 | 8,000 | 8,000 | 8,000 | 8,000 |
| 1998 | 3 | 1,700 | 5,000 | 3,000 | 3,233 |
| 1999 | 7 | 870 | 11,000 | 1,800 | 3,996 |
| 2000 | 4 | 2,200 | 7,000 | 2,600 | 3,600 |
| 2001 | 4 | 1,000 | 4,000 | 2,050 | 2,275 |
| 2002 | 4 | 472 | 2,100 | 884 | 1,085 |
| 2003 | 3 | 500 | 7,000 | 610 | 2,703 |
| 2004 | 3 | 1,120 | 3,300 | 1,900 | 2,107 |
| 2005 | 4 | 800 | 1,635 | 1,103 | 1,160 |
| 2006 | 4 | 2,400 | 7,500 | 3,050 | 4,000 |
| 2007 | 8 | 450 | 4,300 | 1,750 | 1,883 |

Coliform counts are #/100mL and represent years for which exceedances exist.

### Table 5.4. Calculation of Reductions for the Fecal Coliform TMDL for Deep Bottom Creek, WBID 2361

| Sample Date | Location | Observed Value (Exceedance) (counts/100mL) | Required % Reduction |
|---|---|---|---|
| 1/9/1991 | Deep Bottom Creek at Scott Mill Rd | 1,400 | 71.43 |
| 5/1/1991 | Deep Bottom Creek at Scott Mill Rd | 2,200 | 81.82 |
| 7/1/1991 | Deep Bottom Creek at Scott Mill Rd | 2,200 | 81.82 |
| 10/1/1991 | Deep Bottom Creek at Scott Mill Rd | 5,000 | 92.00 |
| 1/13/1992 | Deep Bottom Creek at Scott Mill Rd | 800 | 50.00 |
| 4/20/1992 | Deep Bottom Creek at Scott Mill Rd | 2,200 | 81.82 |
| 7/13/1992 | Deep Bottom Creek at Scott Mill Rd | 1,100 | 63.64 |
| 10/12/1992 | Deep Bottom Creek at Scott Mill Rd | 17,000 | 97.65 |
| 1/4/1993 | Deep Bottom Creek at Scott Mill Rd | 160,000 | 99.75 |
| 4/26/1993 | Deep Bottom Creek at Scott Mill Rd | 9,000 | 95.56 |
| 7/15/1993 | Deep Bottom Creek at Scott Mill Rd | 500 | 20.00 |
| 10/4/1993 | Deep Bottom Creek at Scott Mill Rd | 3,000 | 86.67 |
| 1/4/1994 | Deep Bottom Creek at Scott Mill Rd | 1,700 | 76.47 |
| 4/4/1994 | Deep Bottom Creek at Scott Mill Rd | 1,400 | 71.43 |
| 7/11/1994 | Deep Bottom Creek at Scott Mill Rd | 3,000 | 86.67 |
| 10/3/1994 | Deep Bottom Creek at Scott Mill Rd | 3,000 | 86.67 |

| Sample Date | Location | Observed Value (Exceedance) (counts/100mL) | Required % Reduction |
|---|---|---|---|
| 1/10/1995 | Deep Bottom Creek at Scott Mill Rd | 800 | 50.00 |
| 4/3/1995 | Deep Bottom Creek at Scott Mill Rd | 3,000 | 86.67 |
| 7/3/1995 | Deep Bottom Creek at Scott Mill Rd | 2,400 | 83.33 |
| 11/6/1996 | Deep Bottom Creek at Scott Mill Rd | 8,000 | 95.00 |
| 5/19/1998 | Deep Bottom Creek at Scott Mill Rd | 1,700 | 76.47 |
| 7/29/1998 | Deep Bottom Creek at Scott Mill Rd | 5,000 | 92.00 |
| 10/21/1998 | Deep Bottom Creek at Scott Mill Rd | 3,000 | 86.67 |
| 1/11/1999 | Deep Bottom Creek at Scott Mill Rd | 3,000 | 86.67 |
| 3/22/1999 | Deep Bottom Creek AT I-295 | 870 | 54.02 |
| 3/22/1999 | Deep Bottom Cr at Cheatham Tr | 1,400 | 71.43 |
| 3/22/1999 | Deep Bottom Creek at Scott Mill Rd | 1,800 | 77.78 |
| 4/20/1999 | Deep Bottom Creek at Scott Mill Rd | 900 | 55.56 |
| 8/16/1999 | Deep Bottom Creek at Scott Mill Rd | 11,000 | 96.36 |
| 10/6/1999 | Deep Bottom Creek at Scott Mill Rd | 9,000 | 95.56 |
| 1/25/2000 | Deep Bottom Creek at Scott Mill Rd | 2,200 | 81.82 |
| 4/24/2000 | Deep Bottom Creek at Scott Mill Rd | 2,200 | 81.82 |
| 8/29/2000 | Deep Bottom Creek at Scott Mill Rd | 3,000 | 86.67 |
| 11/14/2000 | Deep Bottom Creek at Scott Mill Rd | 7,000 | 94.29 |
| 1/29/2001 | Deep Bottom Creek at Scott Mill Rd | 4,000 | 90.00 |
| 4/16/2001 | Deep Bottom Creek at Scott Mill Rd | 1,000 | 60.00 |
| 7/17/2001 | Deep Bottom Creek at Scott Mill Rd | 3,000 | 86.67 |
| 10/10/2001 | Deep Bottom Creek at Scott Mill Rd | 1,100 | 63.64 |
| 1/29/2002 | Deep Bottom Creek at Scott Mill Rd | 472 | 15.25 |
| 4/8/2002 | Deep Bottom Creek at Scott Mill Rd | 801 | 50.06 |
| 9/10/2002 | Deep Bottom Cr at Cheatham Tr | 967 | 58.63 |
| 10/29/2002 | Deep Bottom Creek at Scott Mill Rd | 2,100 | 80.95 |
| 1/28/2003 | Deep Bottom Creek at Scott Mill Rd | 610 | 34.43 |
| 7/15/2003 | Deep Bottom Creek at Scott Mill Rd | 500 | 20.00 |
| 10/28/2003 | Deep Bottom Creek at Scott Mill Rd | 7,000 | 94.29 |
| 2/4/2004 | Deep Bottom Creek at Scott Mill Rd | 1,120 | 64.29 |
| 4/13/2004 | Deep Bottom Creek at Scott Mill Rd | 3,300 | 87.88 |
| 7/14/2004 | Deep Bottom Creek at Scott Mill Rd | 1,900 | 78.95 |
| 2/14/2005 | Deep Bottom Creek at Scott Mill Rd | 1,100 | 63.64 |
| 4/19/2005 | Deep Bottom Creek at Scott Mill Rd | 1,635 | 75.54 |
| 8/1/2005 | Deep Bottom Creek at Scott Mill Rd | 800 | 50.00 |
| 10/26/2005 | Deep Bottom Creek at Scott Mill Rd | 1,106 | 63.83 |
| 1/23/2006 | Deep Bottom Creek at Scott Mill Rd | 3,100 | 87.10 |
| 4/12/2006 | Deep Bottom Creek at Scott Mill Rd | 2,400 | 83.33 |
| 7/12/2006 | Deep Bottom Creek at Scott Mill Rd | 7,500 | 94.67 |
| 11/13/2006 | Deep Bottom Creek at Scott Mill Rd | 3,000 | 86.67 |

| Sample Date | Location | Observed Value (Exceedance) (counts/100mL) | Required % Reduction |
|---|---|---|---|
| 1/25/2007 | Deep Bottom Creek at Scott Mill Rd | 4,300 | 90.70 |
| 1/30/2007 | Deep Bottom Creek at Scott Mill Rd | 2,900 | 86.21 |
| 1/30/2007 | Deep Bottom Cr at Cheatham Tr | 520 | 23.08 |
| 2/15/2007 | Deep Bottom Cr at Cheatham Tr | 450 | 11.11 |
| 2/15/2007 | Deep Bottom Creek at Scott Mill Rd | 2,500 | 84.00 |
| 5/1/2007 | Deep Bottom Cr at Cheatham Tr | 590 | 32.20 |
| 5/1/2007 | Deep Bottom Cr @ Woods of Mandarin 3200 Hartley Rd | 2,800 | 85.71 |
| 6/14/2007 | Deep Bottom Creek at Scott Mill Rd | 1,000 | 60.00 |
| | **MEDIAN:** | **2,200** | **81.82** |

### *5.1.3 Critical Conditions/Seasonality*

Exceedances in Deep Bottom Creek cannot be associated with flows, as no flow data are available in the watershed. Therefore, the effects of flow under various conditions cannot be determined or considered as a critical condition.

**Appendix B** provides historical fecal coliform observations in Deep Bottom Creek. Coliform data are presented by month, season, and year to determine whether certain patterns are evident in the dataset.

A nonparametric test (Kruskal-Wallis) was applied to the fecal coliform dataset to determine whether there were significant differences among months or seasons. At an alpha (α) level of 0.05, there were no significant differences (**Appendices C** and **D**). It is very difficult to evaluate possible patterns among months due to the small sample sizes; the range in monthly observations for fecal coliform varies from 0 to 5 samples in a given month (**Table 2.1**). January, March, May, August, September, October, and November all had exceedance rates of 100 percent, while April and July had the lowest exceedance rates at 80 and 66.67 percent, respectively. Grouping observations by season increased sample sizes for statistical comparison, as seen in **Table 2.2**, but sample size is still relatively small (between 6 and 8 samples). Winter and fall demonstrated the greatest percentage of exceedances (100 percent) and spring and summer exhibited the lowest (83.33 percent). **Appendix E** presents comparisons by station and season.

A factor that could contribute to these monthly or seasonal differences is the pattern of rainfall. Rainfall records for JIA (**Appendix F** illustrates rainfall from 1990 to 2008) were used to determine rainfall amounts associated with individual sampling dates. Rainfall recorded on the day of sampling (1D), the cumulative total for the day of and the previous 2 days (3D), the cumulative total for the day of and the previous 6 days (7D), and the cumulative total for the day of and 29 days prior (30D) were all paired with the respective coliform observation based on date. A Spearman correlation matrix was generated that summarized the simple correlation coefficients between the various rainfall and coliform values (**Appendix G**). The simple correlations (r values in the Spearman correlation table) between both fecal coliform and the various rainfall totals were all positive, suggesting that as rainfall (and possible runoff) increased, the number of coliform increased.

Simple linear regressions were performed between coliform observations and rainfall totals to determine whether any of the relationships were significant at an α level of 0.05. None of the $r^2$ values between fecal coliform and all of the various precipitation intervals was significant (see **Appendix H**). A table of historical monthly average rainfall (**Appendix I**) indicates that monthly rainfall totals increase in June, peak in September, and by October return to the levels observed in January through May. **Appendix J** includes a graph of annual rainfall from 1955 to 2008 versus the long-term average (52.56 inches) over this period. The beginning of the verified period, 1996, through 1998 represented above-average rainfall years, while 1999 to 2001 were below average, and 2002 was again above average. Below-average rainfall occurred again during 2003, returning to above-average rainfall in 2004 and 2005. The years 2006 to 2008 were below average. Data exceedances occurred almost all of the time, making it difficult to correlate them to rainfall patterns.

As shown in **Table 2.3,** exceedances do not appear to follow the same pattern as rainfall. The highest percentage of exceedances was seen in 1996 (100 percent; 1 sample), 1998 (100 percent; 3 samples), 1999 (100 percent; 7 samples), 2000 (100 percent; 4 samples), and 2001 (100 percent; 4 samples). In 1996, there was above-average rainfall, while 1999, 2000, and 2001 were below-average rainfall years. The lowest percentage of exceedances was observed in 2002 (80 percent; 5 samples) and 2003 (50 percent; 2 samples). In 2001, there was above-average rainfall, and 2003 was a below-average rainfall year. A trend with rainfall cannot really be established, and again this is probably attributable to small sample size, between 0 and 7 samples per year.

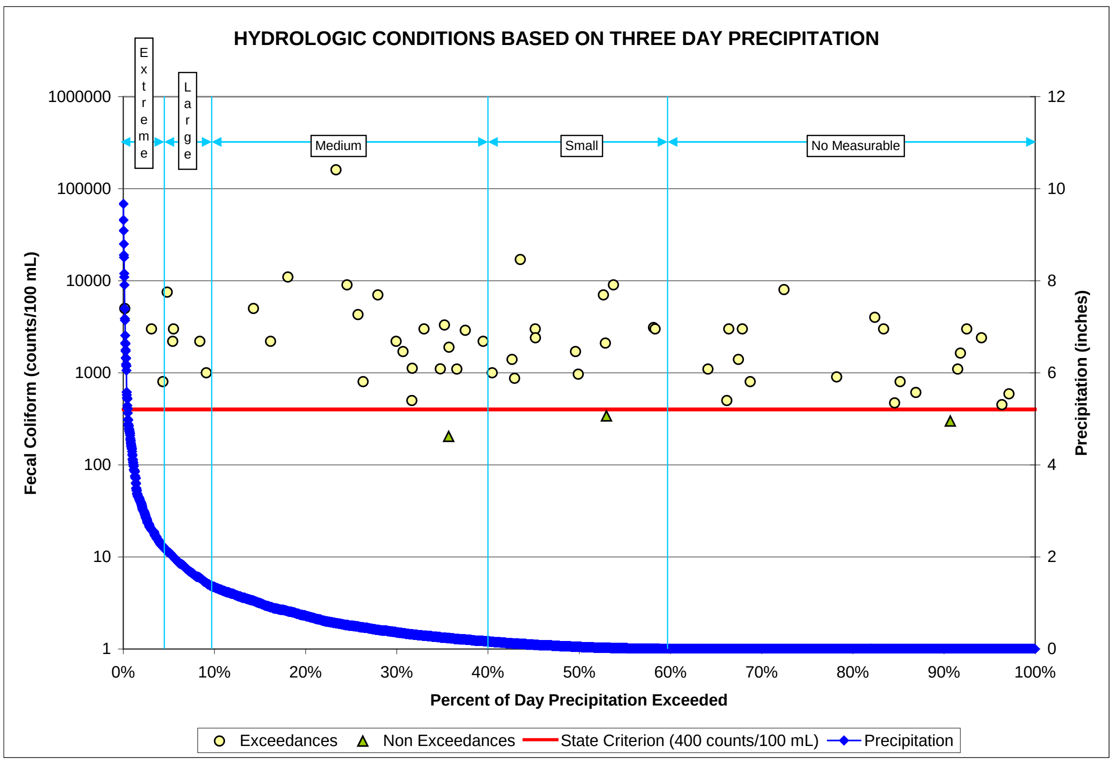
As no flow data were available, hydrologic conditions were analyzed using rainfall. A loading curve–type chart that would normally be applied to flow events was created using precipitation data from JIA from 1990 to 2008. The chart was divided in the same manner as if flow were being analyzed, where extreme precipitation events represent the upper percentiles (0 to $5^{th}$ percentile), followed by large precipitation events ($5^{th}$ to $10^{th}$ percentile), medium precipitation events ($10^{th}$ to $40^{th}$ percentile), small precipitation events ($40^{th}$ to $60^{th}$ percentile), and no recordable precipitation events ($60^{th}$ to $100^{th}$ percentile). The analysis used 3-day (the day of and 2 days prior to sampling) precipitation accumulations (**Figure 5.3**).

Data show that fecal coliform exceedances occurred over all hydrologic conditions for which data exist; therefore, no one season or flow condition is more critical than another. The lowest percentage of exceedances occurred during periods of small precipitation events (93.33 percent), and the highest percentage (100.00 percent) during large and extreme precipitation events. Large numbers of exceedances occur when there is little or no precipitation, indicating that ground water contributions with elevated coliform levels could be affecting the waterbody as well. A pattern could become clearer if more samples were collected, especially following extreme and large rainfall events. **Table 5.5** summarizes data and hydrologic conditions. **Figure 5.3** depicts the same data.

## Table 5.5. Summary of Fecal Coliform Data by Hydrologic Condition

| Precipitation Event | Event Range (inches) | Total Samples | Number of Exceedances | % Exceedances | Number of Nonexceedances | % Nonexceedances |
|---|---|---|---|---|---|---|
| Extreme | >2.1" | 4 | 4 | 100.00% | 0 | 0.00% |
| Large | 1.33" - 2.1" | 4 | 4 | 100.00% | 0 | 0.00% |
| Medium | 0.18" - 1.33" | 18 | 17 | 94.44% | 1 | 5.56% |
| Small | 0.01" - 0.18" | 16 | 15 | 93.75% | 1 | 6.25% |
| None/No Measurable | <0.01" | 20 | 19 | 95.00% | 1 | 5.00% |

## Figure 5.3. Fecal Coliform Data by Hydrologic Condition Based on Rainfall



# 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 TMDL for Deep Bottom Creek is expressed in terms of both counts/100mL and percent reduction, and represents the maximum daily fecal coliform load the creek can assimilate and maintain the fecal coliform criterion (**Table 6.1**).

Table 6.1. TMDL Components for Deep Bottom Creek, WBID 2361

| WBID | Parameter | TMDL (counts/100mL) | WLA | | LA (% reduction) | MOS |
|---|---|---|---|---|---|---|
| | | | Wastewater (colonies/day) | NPDES Stormwater | | |
| 2361 | Fecal Coliform | 400 | N/A | 82% | 82% | Implicit |

N/A – Not applicable

## 6.2 Load Allocation

A fecal coliform reduction of 82 percent is required from nonpoint sources. It should be noted that the load allocation includes loading from stormwater discharges that are not part of the NPDES Stormwater Program.

## 6.3 Wasteload Allocation

Currently, there are no permitted NPDES wastewater discharges in the watershed. Any new potential discharger is expected to comply with the Class III criterion for fecal coliform bacteria as well as the TMDL value, and therefore is not allowed to exceed 200 counts/100mL as a monthly average, 400 counts/100mL in more than 10 percent of the samples, or 800 counts/100mL at any given time.

### *6.3.1 NPDES Wastewater Discharges*

As mentioned previously, there are no permitted wastewater facilities with a permit to discharge into the Deep Bottom Creek watershed. Any new potential discharger is expected to comply with the Class III criterion for fecal coliform bacteria as well as the TMDL value, and therefore is not allowed to exceed 200 counts/100mL as a monthly average, 400 counts/100mL in more than 10 percent of the samples, or 800 counts/100mL at any given time.

### *6.3.2 NPDES Stormwater Discharges*

The Deep Bottom Creek watershed, located in Duval County, falls under Phase I MS4 Permit FLS000012, with the city of Jacksonville and FDOT District 2 as copermittees. The wasteload allocation for this permit is an 82 percent reduction in current anthropogenic fecal coliform loading from the MS4. It should be noted that any MS4 permittee is only responsible for reducing the loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction.

## 6.4 Margin of Safety

Consistent with the recommendations of the Allocation Technical Advisory Committee (Department, 2001), an implicit MOS was used in the development of this TMDL by not allowing any exceedances of the state criterion, even though the actual criterion allows for 10 percent exceedances over the fecal coliform criterion of 400 counts/100mL.

# 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, or BMAP, for the TMDL. The first BMAP for the tributaries to the Lower St. Johns River will address the 10 worst-case impairments in the 55 tributaries impaired for fecal coliform. Any future BMAPs will address additional subsets of the tributaries listed for fecal coliform.

In addition to addressing failing septic tanks, the BMAP may include some sort of public education program about pet waste cleanup. As **Table 4.4** shows, potential impacts from dogs in the watershed could be significant. If pet owners are educated on the potential impacts their pets are having on Deep Bottom Creek, and they are inclined to take action, this could potentially decrease a source load. When considering the significance of seven-day rainfall, this could be a potentially significant load to the stream.

Through the implementation of projects, activities, and additional source assessments in the BMAP, stakeholders expect the following outcomes:

- *Improved water quality trends in the tributaries of the Lower St. Johns River, which will also help improve water quality in the main stem of the river;*
- *Decreased loading of the target pollutant (fecal coliform);*
- *Enhanced public awareness of pollutant sources, pollutant impacts on water quality, and corresponding corrective actions;*
- *Enhanced understanding of basin hydrology, water quality, and pollutant sources; and*
- *The ability to evaluate management actions, estimate their benefits, and identify additional pollutant sources.*

### *7.1.1 Determination of Worst-Case WBIDs*

The initial determination of the worst-case WBIDs uses a ranking method that establishes the severity of bacterial contamination based on the number of exceedances of fecal coliform colony counts—i.e., the number of total fecal coliform samples in a waterbody during the period of record to indicate how many samples are over 800, 5,000, and 10,000 colony counts. A combined rank is then created based on the number of exceedances in each category. The WBIDs are sorted from worst to best to provide a guideline for assessment priorities, with the worst-case waterbody ranked first. Future BMAPs will continue to address the worst-case waters first, using the ranking method.

### *7.1.2 Identification of Probable Sources*

#### Tributary Pollutant Assessment Project

Initial sampling for the study on the six initial WBIDs of highest concern began July 26, 2005, and was completed on February 1, 2006. The final deliverable (the *Tributary Pollutant Assessment Project Manual*) was submitted to JEA on June 1, 2006, and became available for public review and comment on June 16, 2006. Four types of fecal indicators (fecal coliform, *E. coli*., *Enterococci*, and coliphages) were studied. *Enterococcus faecalis* was also studied in an attempt to further identify potential sources of sewage, and samples were checked for human/ruminant primers.

The executive summary submitted to the Department by JEA and PBS&J is attached as **Appendix K**. The results of the study will be used to help guide the identification of restoration projects during BMAP development.

#### Technical Reports

In an effort to address the known impairments in the Lower St. Johns tributaries, the Department contracted with Post, Buckley, Schuh & Jernigan (PBS&J) to develop technical reports that describe and interpret the water quality, spatial, and geographic data from the Department, Duval County Health Department, city of Jacksonville, and JEA. The reports analyze the available data to identify the most probable sources of fecal coliform, which fall into five main categories, as follows: (1) stormwater, (2) onsite sewage treatment and disposal systems (OSTDS), (3) sewer infrastructure, (4) nonpoint sources such as pet waste, and (5) natural background such as wildlife. These reports were peer reviewed by technical stakeholders in the basin, who also provided additional input based on their knowledge of the tributaries.

### *7.1.3 Issues To Be Addressed in Future Watershed Management Cycles*

The BMAP process identified the following items that should be addressed in future watershed management cycles to ensure that future BMAPs use the most accurate information:

1. ***Source Identification—****Sources of fecal coliform impairment are particularly difficult to trace. For this reason, the BMAP includes source identification studies as management actions.*
2. ***Septic Tanks—****The Department is implementing a study,* Evaluation of Septic Tank Influences on Nutrient Loading to the Lower St. Johns River Basin and Its Tributaries, *to better understand the nutrient and bacteria loading from septic tanks via ground water by monitoring conditions at representative sites. The study seeks to answer questions on potential OSTDS impacts and the attenuation of nitrogen, phosphorus, and bacteria (fecal coliform) by soil, under the range of conditions that represent typical OSTDS sites near impaired surface waters. It will also document the nutrients and bacteria in the receiving Lower St. Johns tributaries at each site. The results will provide information about the relative contribution of fecal coliform from septic tanks located near the impaired tributaries.*

3. *GIS Information—During the BMAP process, the available GIS data, which provide a basis for some of the source analyses, have improved. As more information becomes available, the updated GIS database for the tributaries will be utilized to aid in source identification. This information will include determining the spatial locations for private wastewater systems and infrastructure, collecting jurisdictional or systemwide programs and activities on a WBID scale for future reporting and assessment, and systematically updating all GIS information databases used to compile the BMAP.*

### *7.1.4 BMAP Implementation*

The BMAP requires that all stakeholders implement their projects to achieve reductions as soon as practicable. However, the full implementation of the BMAP will be a long-term process. While some of the projects and activities in the BMAP are recently completed or currently ongoing, several projects will require more time to design, secure funding, and construct. Although funding the projects could be an issue, funding limitations do not affect the requirement that every entity must implement the activities listed in the BMAP.

Since BMAP implementation is a long-term process, the TMDL targets established for the Lower St. Johns Basin will not be achieved in the next five years. It may take even longer for the tributaries to respond to reduced loadings and fully meet applicable water quality standards. Regular follow-up and continued coordination and communication among the stakeholders will be essential to ensure the implementation of management strategies and the assessment of their incremental effects. Any additional management actions required to achieve TMDLs, if necessary, will be developed as part of BMAP follow-up.

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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 the stormwater flood control requirements of the state's water management districts, along with wetland protection requirements, into the Environmental Resource Permit regulations

Chapter 62-40, F.A.C., also requires the 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.

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 Stormwater Permitting Program to designate certain stormwater discharges as "point sources" of pollution. The EPA promulgated regulations and began implementing the Phase I NPDES Stormwater Program in 1990. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific standard industrial classification (SIC) codes, construction sites disturbing 5 or more acres of land, and master drainage systems of local governments with a population above 100,000, which are better known as municipal separate storm sewer systems (MS4s). However, because the master drainage systems of most local governments in Florida are interconnected, the EPA has implemented Phase 1 of the MS4 permitting program on a countywide basis, which brings in all cities (incorporated areas), Chapter 298 urban water control districts, and the FDOT throughout the 15 counties meeting the population criteria. EPA authorized the Department to implement the NPDES Stormwater Program (except for tribal lands) in October 2000.

An important difference between the federal 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 focuses 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 10,000 people. The revised rules require that these additional activities obtain permits by 2003. While these urban stormwater discharges are now technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility, as are other point sources of pollution, such as domestic and industrial wastewater discharges. It should be noted that all MS4 permits issued in Florida include a reopener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.

## Appendix B: Historical Fecal Coliform Observations in Deep Bottom Creek, WBID 2361

| Date | Station | Location | Fecal Coliform (counts/100mL) | Remark Code |
|---|---|---|---|---|
| 1/9/1991 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 1,400 | |
| 5/1/1991 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 2,200 | |
| 7/1/1991 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 2,200 | |
| 10/1/1991 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 5,000 | |
| 1/13/1992 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 800 | |
| 4/20/1992 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 2,200 | |
| 7/13/1992 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 1,100 | |
| 10/12/1992 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 17,000 | |
| 1/4/1993 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 160,000 | L |
| 4/26/1993 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 9,000 | |
| 7/15/1993 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 500 | |
| 10/4/1993 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 3,000 | |
| 1/4/1994 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 1,700 | |
| 4/4/1994 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 1,400 | |
| 7/11/1994 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 3,000 | |
| 10/3/1994 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 3,000 | |
| 1/10/1995 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 800 | |
| 4/3/1995 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 3,000 | |
| 7/3/1995 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 2,400 | |
| 11/6/1996 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 8,000 | |
| 5/19/1998 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 1,700 | |
| 7/29/1998 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 5,000 | |
| 10/21/1998 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 3,000 | |
| 1/11/1999 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 3,000 | |
| 3/22/1999 | 21FLA 20030592 | Deep Bottom Cr at Cheatham Tr | 1,400 | |
| 3/22/1999 | 21FLA 20030595 | Deep Bottom Creek at Scott Mill Rd | 1,800 | |
| 3/22/1999 | 21FLA 20030596 | Deep Bottom Creek at I-295 | 870 | |
| 4/20/1999 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 900 | |
| 8/16/1999 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 11,000 | |
| 10/6/1999 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 9,000 | |
| 1/25/2000 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 2,200 | |
| 4/24/2000 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 2,200 | |
| 8/29/2000 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 3,000 | |
| 11/14/2000 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 7,000 | |
| 1/29/2001 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 4,000 | |
| 4/16/2001 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 1,000 | |
| 7/17/2001 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 3,000 | |

| Date | Station | Location | Fecal Coliform (counts/100mL) | Remark Code |
|---|---|---|---|---|
| 10/10/2001 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 1,100 | |
| 1/29/2002 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 472 | |
| 4/8/2002 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 801 | |
| 7/8/2002 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 204 | |
| 9/10/2002 | 21FLA 20030592 | Deep Bottom Cr at Cheatham Tr | 967 | |
| 10/29/2002 | 21FLJXWQSS18 | Deep Bottom Creek at Scott Mill Rd | 2,100 | |
| 1/28/2003 | SS18 | Deep Bottom Creek at Scott Mill Rd | 610 | |
| 4/21/2003 | SS18 | Deep Bottom Creek at Scott Mill Rd | 340 | |
| 7/15/2003 | SS18 | Deep Bottom Creek at Scott Mill Rd | 500 | |
| 10/28/2003 | SS18 | Deep Bottom Creek at Scott Mill Rd | 7,000 | |
| 2/4/2004 | SS18 | Deep Bottom Creek at Scott Mill Rd | 1,120 | |
| 4/13/2004 | SS18 | Deep Bottom Creek at Scott Mill Rd | 3,300 | |
| 7/14/2004 | SS18 | Deep Bottom Creek at Scott Mill Rd | 1,900 | |
| 11/8/2004 | SS18 | Deep Bottom Creek at Scott Mill Rd | 300 | |
| 2/14/2005 | SS18 | Deep Bottom Creek at Scott Mill Rd | 1,100 | |
| 4/19/2005 | SS18 | Deep Bottom Creek at Scott Mill Rd | 1,635 | |
| 8/1/2005 | SS18 | Deep Bottom Creek at Scott Mill Rd | 800 | |
| 10/26/2005 | SS18 | Deep Bottom Creek at Scott Mill Rd | 1,106 | |
| 1/23/2006 | SS18 | Deep Bottom Creek at Scott Mill Rd | 3,100 | |
| 4/12/2006 | SS18 | Deep Bottom Creek at Scott Mill Rd | 2,400 | |
| 7/12/2006 | SS18 | Deep Bottom Creek at Scott Mill Rd | 7,500 | |
| 11/13/2006 | SS18 | Deep Bottom Creek at Scott Mill Rd | 3,000 | |
| 1/25/2007 | SS18 | Deep Bottom Creek at Scott Mill Rd | 4,300 | |
| 1/30/2007 | 21FLA 20030592 | Deep Bottom Cr at Cheatham Tr | 520 | |
| 1/30/2007 | 21FLA 20030595 | Deep Bottom Creek at Scott Mill Rd | 2,900 | |
| 2/15/2007 | 21FLA 20030592 | Deep Bottom Cr at Cheatham Tr | 450 | |
| 2/15/2007 | 21FLA 20030595 | Deep Bottom Creek at Scott Mill Rd | 2,500 | |
| 2/15/2007 | 21FLA 20030850 | Deep Bottom Cr @ Woods of Mandarin 3200 Hartley Rd | 192 | A |
| 5/1/2007 | 21FLA 20030592 | Deep Bottom Cr at Cheatham Tr | 590 | |
| 5/1/2007 | 21FLA 20030595 | Deep Bottom Creek at Scott Mill Rd | 240 | |
| 5/1/2007 | 21FLA 20030850 | Deep Bottom Cr @ Woods of Mandarin 3200 Hartley Rd | 2,800 | |
| 6/14/2007 | SS18 | Deep Bottom Creek at Scott Mill Rd | 1,000 | |

Shaded cells indicate values that exceed the state criterion of 400 counts/100mL.

**NOTE:** Some samples are represented in the table as an average of duplicates (i.e., same date and location), per the IWR, for TMDL determination.

**Remark Code:**

A Value reported is the mean of two or more determinations.

L Off-scale high.

# Appendix C: Kruskal–Wallis Analysis of Fecal Coliform Observations versus Season in Deep Bottom Creek, WBID 2361

Categorical values encountered during processing are:
SEASON$ (4 levels)
FALL, SPRING, SUMMER, WINTER

Kruskal-Wallis One-Way Analysis of Variance for 69 cases
Dependent variable is FCCTS100ML
Grouping variable is SEASON$

| Group | Count | Rank Sum |
|---|---|---|
| FALL | 14 | 667.000 |
| SPRING | 18 | 554.500 |
| SUMMER | 15 | 528.000 |
| WINTER | 22 | 665.500 |

Kruskal-Wallis Test Statistic = 7.603
Probability is 0.055 assuming Chi-square distribution with 3 df

# Appendix D: Kruskal – Wallis Analysis of Fecal Coliform Observations versus Month in Deep Bottom Creek, WBID 2361

Categorical values encountered during processing are:
MONTH (11 levels)
1, 2, 3, 4, 5, 6, 7,
8, 9, 10, 11

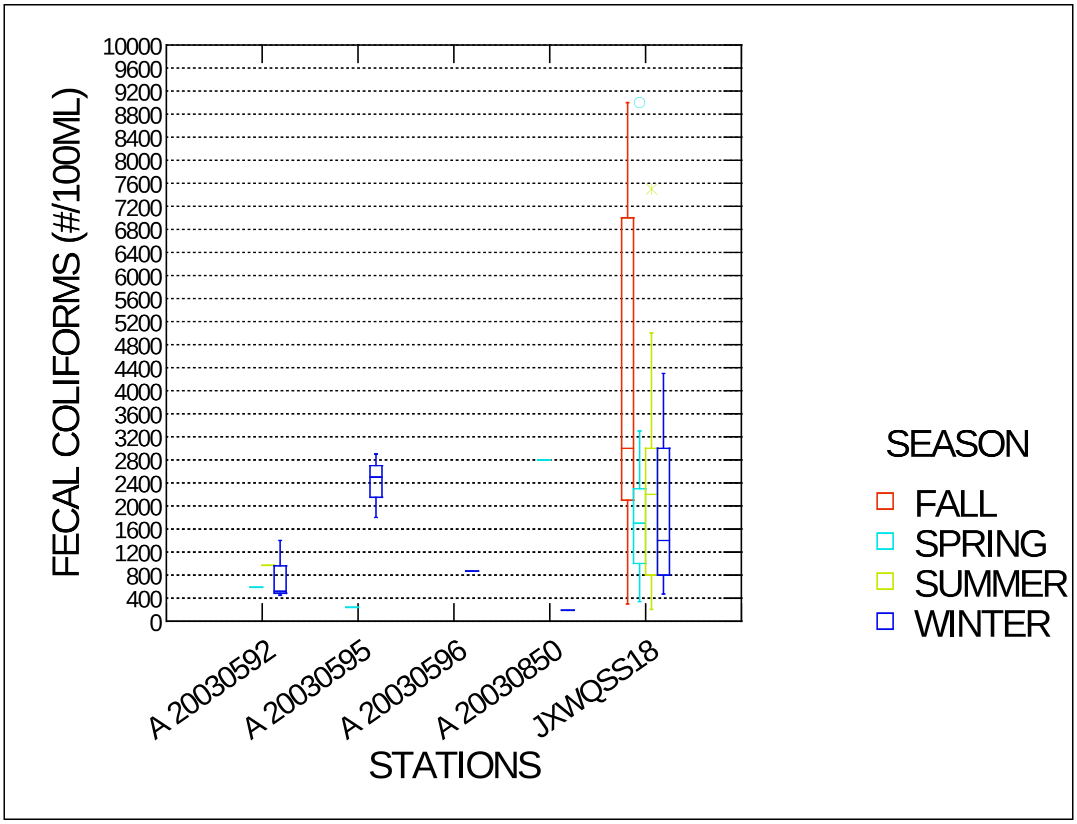
Kruskal-Wallis One-Way Analysis of Variance for 69 cases
Dependent variable is FCCTS100ML
Grouping variable is MONTH

| Group | Count | Rank Sum |
|---|---|---|
| 1 | 14 | 488.500 |
| 2 | 5 | 99.000 |
| 3 | 3 | 78.000 |
| 4 | 12 | 406.500 |
| 5 | 5 | 127.500 |
| 6 | 1 | 20.500 |
| 7 | 11 | 378.000 |
| 8 | 3 | 131.000 |
| 9 | 1 | 19.000 |
| 10 | 10 | 487.500 |
| 11 | 4 | 179.500 |

Kruskal-Wallis Test Statistic = 12.064
Probability is 0.281 assuming Chi-square distribution with 10 df

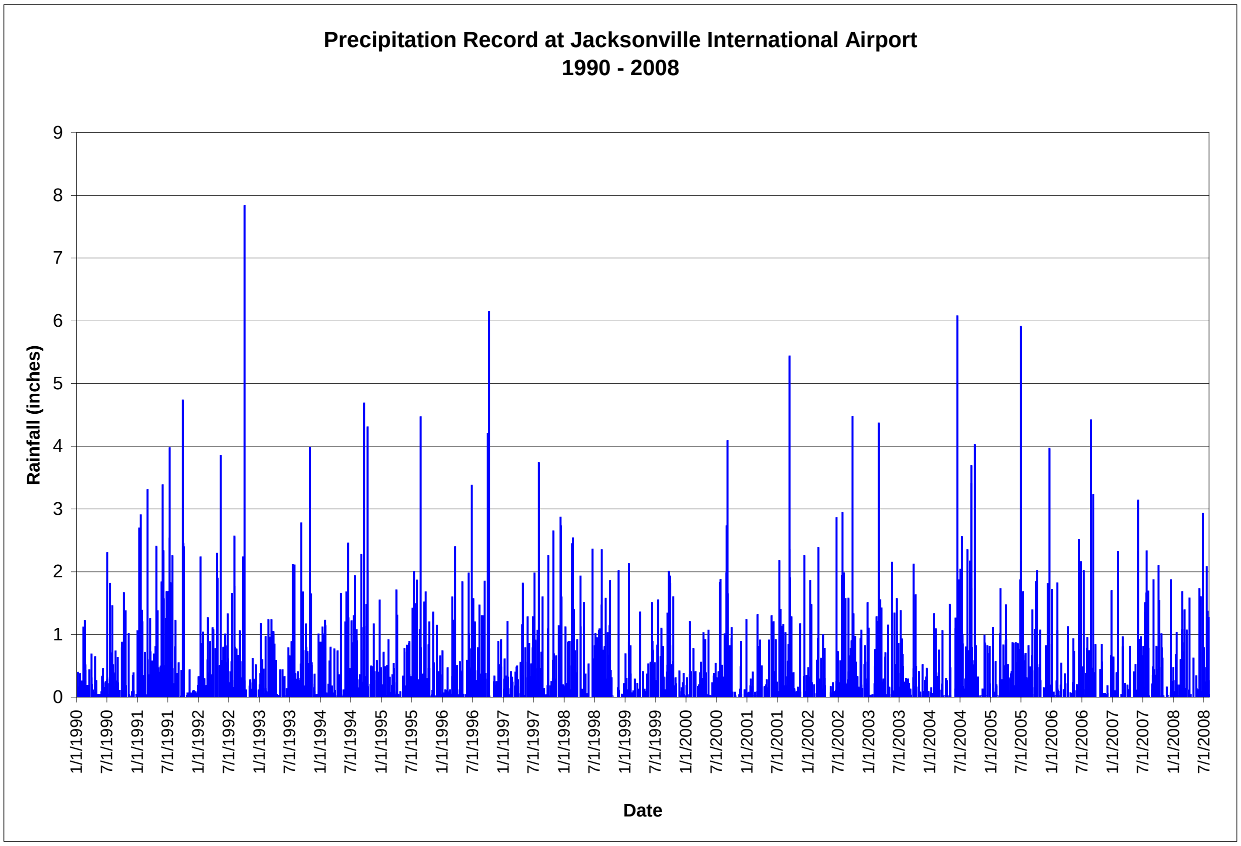
## Appendix E: Chart of Fecal Coliform Observations by Season and Station in Deep Bottom Creek, WBID 2361

Of 69 cases, 3 were excluded by making graph range less than data range.




| Station | STORET ID |
|---|---|
| Deep Bottom Creek at Woods of Mandarin 3200 Hartley Road | 21FLA 20030850 |
| Deep Bottom Creek at Cheatham Trail | 21FLA 20030592 |
| Deep Bottom Creek at I-295 | 21FLA 20030596 |
| Deep Bottom Creek at Scott Mill Road | 21FLJX WQSS18 |
| Deep Bottom Creek at Scott Mill Road | 21FLA 20030595 |

## Appendix F: Chart of Rainfall for JIA, 1990–2008

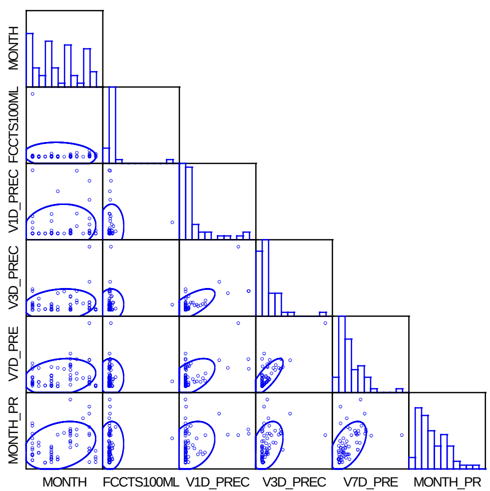


## Appendix G: Spearman Correlation Matrix Analysis for Precipitation and Fecal Coliform in Deep Bottom Creek, WBID 2361

Spearman correlation matrix

| | MONTH | FCCTS100ML | V1D_PREC | V3D_PREC | V7D_PRE |
|---|---|---|---|---|---|
| MONTH | 1.000 | | | | |
| FCCTS100ML | 0.243 | 1.000 | | | |
| V1D_PREC | 0.194 | 0.344 | 1.000 | | |
| V3D_PREC | 0.057 | 0.244 | 0.524 | 1.000 | |
| V7D_PRE | 0.106 | 0.184 | 0.275 | 0.597 | 1.000 |
| MONTH_PR | 0.252 | 0.126 | 0.315 | 0.497 | 0.658 |

| | MONTH_PR |
|---|---|
| MONTH_PR | 1.000 |




Number of observations: 69

# Appendix H: Analysis of Fecal Coliform Observations and Precipitation in Deep Bottom Creek, WBID 2361

## FECAL COLIFORM DATA VERSUS DAY OF SAMPLING PRECIPITATION

Dep Var: FCCTS100ML N: 69 Multiple R: 0.054 Squared multiple R: 0.003

Adjusted squared multiple R: 0.000 Standard error of estimate: 19271.074

| Effect | Coefficient | Std Error | Std Coef | Tolerance | t | P(2 Tail) |
|---|---|---|---|---|---|---|
| CONSTANT | 4566.973 | 2514.311 | 0.000 | . | 1.816 | 0.074 |
| V1D_PREC | 3176.724 | 7203.127 | 0.054 | 1.000 | 0.441 | 0.661 |

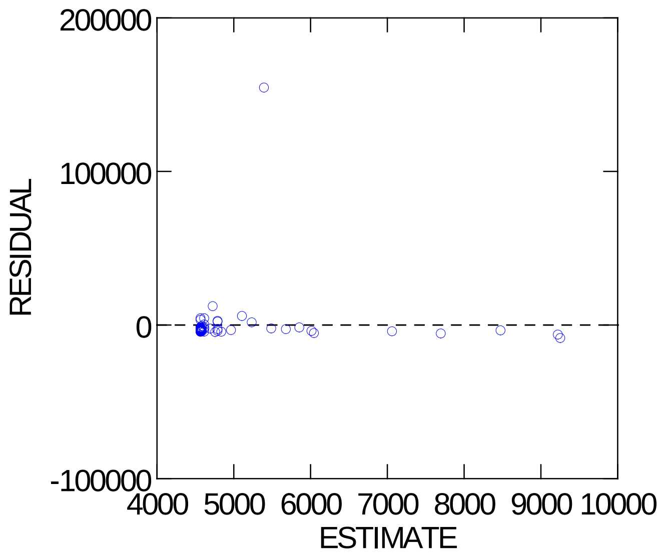
Analysis of Variance

| Source | Sum-of-Squares | df | Mean-Square | F-ratio | P |
|---|---|---|---|---|---|
| Regression | 7.22318E+07 | 1 | 7.22318E+07 | 0.194 | 0.661 |
| Residual | 2.48821E+10 | 67 | 3.71374E+08 | | |

*** WARNING ***
Case 4 has large leverage (Leverage = 0.182)
Case 5 has large leverage (Leverage = 0.266)
Case 9 is an outlier (Studentized Residual = 52.916)
Case 33 has large leverage (Leverage = 0.262)

Durbin-Watson D Statistic 1.758
First Order Autocorrelation 0.121

Plot of residuals against predicted values



## FECAL COLIFORM DATA VERSUS DAY OF SAMPLING AND 2 DAYS PRIOR PRECIPITATION

Dep Var: FCCTS100ML   N: 69   Multiple R: 0.015   Squared multiple R: 0.000

Adjusted squared multiple R: 0.000   Standard error of estimate: 19296.712

| Effect | Coefficient | Std Error | Std Coef | Tolerance | t | P(2 Tail) |
|---|---|---|---|---|---|---|
| CONSTANT | 4827.264 | 2671.319 | 0.000 | . | 1.807 | 0.075 |
| V3D_PREC | 408.273 | 3220.707 | 0.015 | 1.000 | 0.127 | 0.900 |

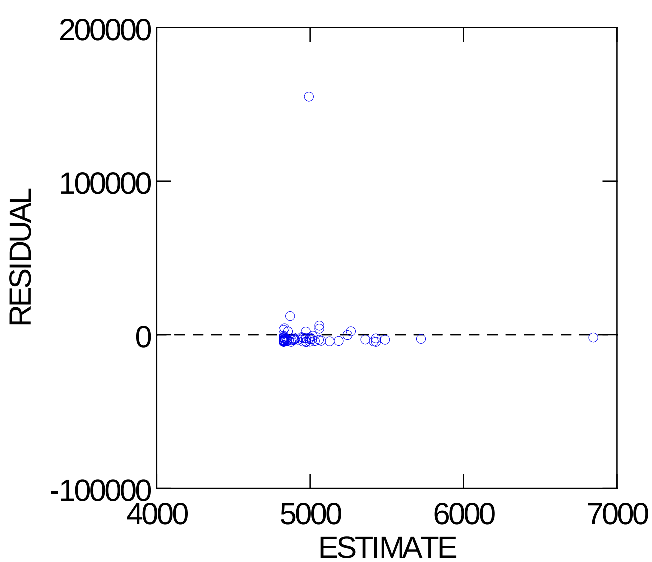
Analysis of Variance

| Source | Sum-of-Squares | df | Mean-Square | F-ratio | P |
|---|---|---|---|---|---|
| Regression | 5983652.547 | 1 | 5983652.547 | 0.016 | 0.900 |
| Residual | 2.49483E+10 | 67 | 3.72363E+08 | | |

*** WARNING ***
Case 4 has large leverage (Leverage = 0.588)
Case 9 is an outlier (Studentized Residual = 53.241)

Durbin-Watson D Statistic 1.763
First Order Autocorrelation 0.118

Plot of residuals against predicted values



## FECAL COLIFORM DATA VERSUS DAY OF SAMPLING AND 6 DAYS PRIOR PRECIPITATION

Dep Var: FCCTS100ML N: 69 Multiple R: 0.041 Squared multiple R: 0.002

Adjusted squared multiple R: 0.000 Standard error of estimate: 19283.014

| Effect | Coefficient | Std Error | Std Coef | Tolerance | t | P(2 Tail) |
|---|---|---|---|---|---|---|
| CONSTANT | 5672.893 | 3086.080 | 0.000 | . | 1.838 | 0.070 |
| V7D_PRE | -857.374 | 2569.765 | -0.041 | 1.000 | -0.334 | 0.740 |

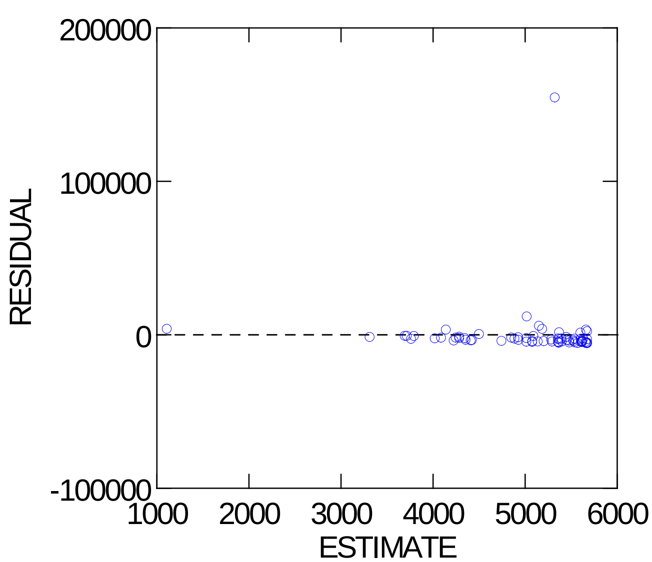
Analysis of Variance

| Source | Sum-of-Squares | df | Mean-Square | F-ratio | P |
|---|---|---|---|---|---|
| Regression | 4.13908E+07 | 1 | 4.13908E+07 | 0.111 | 0.740 |
| Residual | 2.49129E+10 | 67 | 3.71835E+08 | | |

*** WARNING ***
Case 4 has large leverage (Leverage = 0.380)
Case 9 is an outlier (Studentized Residual = 53.005)

Durbin-Watson D Statistic 1.774
First Order Autocorrelation 0.113

Plot of residuals against predicted values



## FECAL COLIFORM DATA VERSUS DAY OF SAMPLING AND 29 DAYS PRIOR PRECIPITATION

Dep Var: FCCTS100ML N: 69 Multiple R: 0.074 Squared multiple R: 0.005

Adjusted squared multiple R: 0.000 Standard error of estimate: 19246.099

| Effect | Coefficient | Std Error | Std Coef | Tolerance | t | P(2 Tail) |
|---|---|---|---|---|---|---|
| CONSTANT | 3094.734 | 3892.104 | 0.000 | . | 0.795 | 0.429 |
| MONTH_PR | 473.317 | 779.178 | 0.074 | 1.000 | 0.607 | 0.546 |

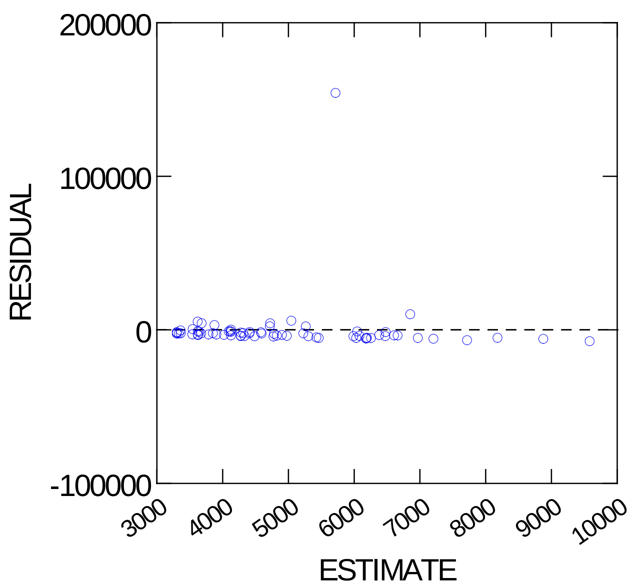
Analysis of Variance

| Source | Sum-of-Squares | df | Mean-Square | F-ratio | P |
|---|---|---|---|---|---|
| Regression | 1.36683E+08 | 1 | 1.36683E+08 | 0.369 | 0.546 |
| Residual | 2.48176E+10 | 67 | 3.70412E+08 | | |

*** WARNING ***
Case 3 has large leverage (Leverage = 0.168)
Case 9 is an outlier (Studentized Residual = 52.970)

Durbin-Watson D Statistic 1.770
First Order Autocorrelation 0.114

Plot of residuals against predicted values



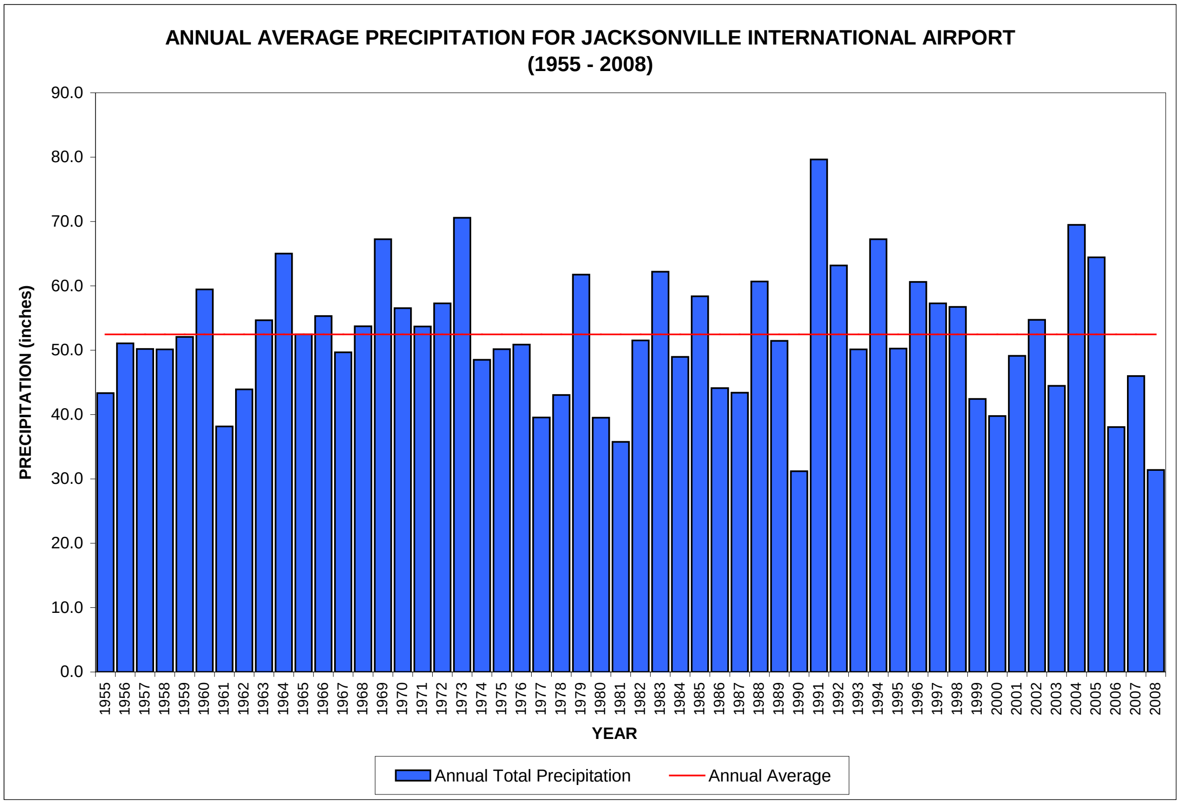
## Appendix I: Monthly and Annual Precipitation from JIA, 1955–2008

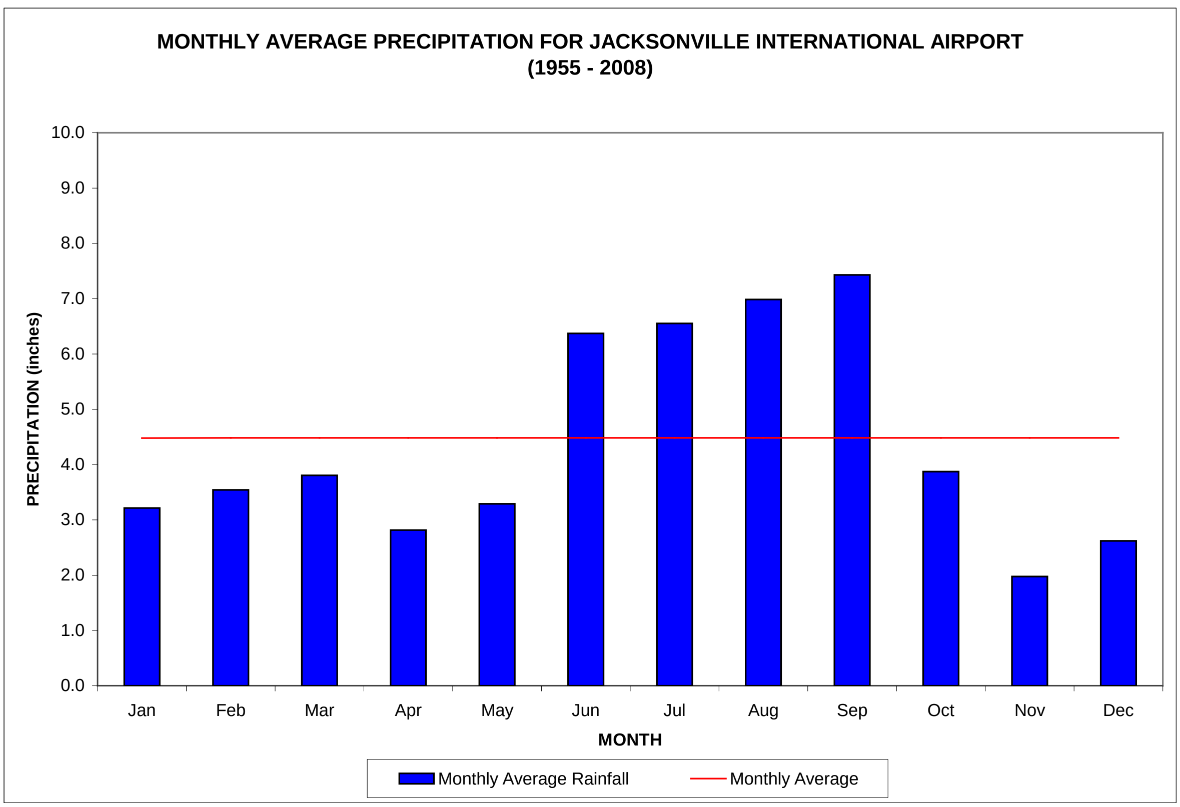
| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1955 | 3.1 | 2.46 | 1.66 | 1.5 | 4.51 | 2.7 | 5.53 | 3.85 | 10.6 | 5.36 | 1.9 | 0.2 | **43.33** |
| 1956 | 2.9 | 2.94 | 0.81 | 2.33 | 3.98 | 7.87 | 8.25 | 5.24 | 2.89 | 13.4 | 0.4 | 0 | **51.08** |
| 1957 | 0.3 | 1.69 | 3.87 | 1.61 | 5.25 | 7.1 | 12.3 | 3.3 | 8.33 | 3.5 | 1.6 | 1.3 | **50.18** |
| 1958 | 3.4 | 3.74 | 3.38 | 8.24 | 3.79 | 3.96 | 4.37 | 4.67 | 4.75 | 5.07 | 2 | 2.8 | **50.14** |
| 1959 | 3 | 5.22 | 9.75 | 2.65 | 9.2 | 2.94 | 4.51 | 2.86 | 5.67 | 3.12 | 2.2 | 1 | **52.08** |
| 1960 | 2.1 | 5.17 | 6.94 | 3.54 | 1.18 | 4.7 | 16.2 | 6.5 | 8.57 | 2.95 | 0.1 | 1.5 | **59.45** |
| 1961 | 2.9 | 4.85 | 1.17 | 4.16 | 3.06 | 5.27 | 3.48 | 10.6 | 1.02 | 0.27 | 0.9 | 0.5 | **38.15** |
| 1962 | 2.2 | 0.52 | 3.1 | 2.36 | 1.12 | 8.22 | 6.31 | 10.1 | 4.37 | 1.13 | 2.1 | 2.5 | **43.9** |
| 1963 | 5.4 | 6.93 | 2.23 | 1.75 | 1.74 | 12.5 | 6.47 | 4.95 | 4.88 | 1.53 | 2.7 | 3.6 | **54.66** |
| 1964 | 7.3 | 6.55 | 1.76 | 4.65 | 4.8 | 4.67 | 6.12 | 5.63 | 10.3 | 5.09 | 3.3 | 4.8 | **65.03** |
| 1965 | 0.7 | 5.5 | 3.91 | 0.95 | 0.94 | 9.79 | 2.71 | 9.58 | 11 | 1.75 | 1.9 | 3.8 | **52.47** |
| 1966 | 4.6 | 5.97 | 0.71 | 2.25 | 10.4 | 7.74 | 11.1 | 3.88 | 5.94 | 1.38 | 0.2 | 1.1 | **55.3** |
| 1967 | 3.1 | 4.35 | 0.81 | 2 | 1.18 | 12.9 | 5.22 | 12.3 | 1.8 | 1.13 | 0.2 | 4.7 | **49.68** |
| 1968 | 0.8 | 3.05 | 1.2 | 0.99 | 2.17 | 12.3 | 6.84 | 16.2 | 2.68 | 5.09 | 1.3 | 1.1 | **53.72** |
| 1969 | 0.8 | 3.39 | 4.23 | 0.34 | 3.78 | 5.12 | 5.89 | 15.1 | 10.3 | 9.81 | 4.6 | 3.9 | **67.26** |
| 1970 | 4.2 | 8.85 | 9.98 | 1.77 | 1.84 | 2.65 | 7.6 | 11 | 3.2 | 3.95 | 0 | 1.6 | **56.55** |
| 1971 | 2 | 2.55 | 2.41 | 4.07 | 1.9 | 5.52 | 5.07 | 12.8 | 4.17 | 6.46 | 0.8 | 5.9 | **53.69** |
| 1972 | 5.8 | 3.48 | 4.43 | 2.98 | 8.26 | 6.75 | 3.15 | 9.76 | 2.6 | 4.46 | 4.2 | 1.4 | **57.29** |
| 1973 | 4.6 | 5.07 | 10.2 | 11.6 | 5.33 | 4.1 | 5.45 | 7.49 | 7.86 | 4.08 | 0.4 | 4.3 | **70.57** |
| 1974 | 0.3 | 1.28 | 3.47 | 1.53 | 4.14 | 5.53 | 9.83 | 11.2 | 8.13 | 0.34 | 1 | 1.7 | **48.52** |
| 1975 | 3.5 | 2.58 | 2.46 | 5.78 | 7 | 5.21 | 6.36 | 6.23 | 5.24 | 3.63 | 0.4 | 1.8 | **50.15** |
| 1976 | 2.3 | 1.05 | 3.41 | 0.63 | 10 | 4.26 | 5.41 | 6.37 | 8.56 | 1.63 | 2.4 | 4.8 | **50.87** |
| 1977 | 3 | 3.24 | 1.03 | 1.76 | 3.07 | 2.65 | 1.97 | 7.26 | 7.45 | 1.68 | 3.1 | 3.4 | **39.56** |
| 1978 | 4.6 | 4.17 | 2.83 | 2.24 | 9.18 | 2.62 | 6.67 | 2.39 | 4.4 | 1.26 | 0.8 | 1.8 | **43.04** |
| 1979 | 6.3 | 3.75 | 1 | 4.18 | 7.54 | 5.91 | 4.67 | 4.78 | 17.8 | 0.25 | 3.6 | 2 | **61.76** |
| 1980 | 2.6 | 1.06 | 6.83 | 3.91 | 3.02 | 4.59 | 5.29 | 3.97 | 3.03 | 2.69 | 2.3 | 0.2 | **39.53** |
| 1981 | 0.9 | 4.53 | 5.41 | 0.32 | 1.48 | 3.31 | 2.46 | 6.47 | 1.22 | 1.35 | 4.9 | 3.4 | **35.77** |
| 1982 | 3 | 1.67 | 4.26 | 3.6 | 3.55 | 8.06 | 3.81 | 6.93 | 9.32 | 3.37 | 1.9 | 2 | **51.52** |
| 1983 | 7.2 | 4.27 | 8.46 | 4.65 | 1.38 | 6.86 | 6.11 | 4.63 | 4.61 | 4.29 | 3.3 | 6.4 | **62.19** |
| 1984 | 2.1 | 4.67 | 5.77 | 3.14 | 1.46 | 4.76 | 6.01 | 3.78 | 12.3 | 1.53 | 3.3 | 0.1 | **48.96** |
| 1985 | 1.1 | 1.45 | 1.26 | 2.76 | 2.08 | 3.71 | 6.33 | 8.93 | 16.8 | 8.34 | 2.1 | 3.6 | **58.39** |
| 1986 | 4.2 | 4.72 | 5.44 | 0.93 | 2.13 | 2.53 | 3.27 | 9.6 | 1.99 | 1.8 | 2.9 | 4.7 | **44.1** |
| 1987 | 4.1 | 6.47 | 6.27 | 0.14 | 0.75 | 4.18 | 4.4 | 4.48 | 7.13 | 0.3 | 5 | 0.2 | **43.39** |
| 1988 | 6.4 | 6.08 | 2.65 | 3.44 | 1.35 | 3.71 | 4.5 | 8.48 | 16.4 | 2.35 | 4.3 | 1.1 | **60.68** |
| 1989 | 1.7 | 1.77 | 2.14 | 2.79 | 1.55 | 3.66 | 8.98 | 9.16 | 14.4 | 1.39 | 0.5 | 3.4 | **51.45** |
| 1990 | 1.8 | 4.07 | 1.59 | 1.34 | 0.18 | 1.59 | 6.53 | 3.81 | 2.6 | 4.54 | 1.2 | 1.9 | **31.2** |
| 1991 | 10 | 1.52 | 7.33 | 6.31 | 9.35 | 11.7 | 15.9 | 3.48 | 6.2 | 6.36 | 0.7 | 0.6 | **79.63** |
| 1992 | 5.8 | 2.64 | 4.09 | 5.33 | 5.97 | 7.04 | 3.32 | 10.8 | 7.33 | 8.34 | 1.9 | 0.7 | **63.18** |
| 1993 | 3.9 | 2.89 | 5.98 | 0.85 | 1.6 | 2.52 | 7.54 | 2.96 | 7.6 | 8.84 | 3.6 | 1.9 | **50.12** |
| 1994 | 6.6 | 0.92 | 2.14 | 1.51 | 3.15 | 14 | 8.26 | 3.29 | 9.79 | 10.2 | 3.5 | 3.9 | **67.26** |
| 1995 | 1.9 | 2.07 | 3.67 | 1.77 | 1.77 | 5.35 | 9.45 | 9.93 | 5.41 | 3.53 | 3.2 | 2.2 | **50.25** |

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1996 | 1.1 | 1.11 | 6.83 | 2.85 | 0.72 | 11.4 | 4.2 | 7.83 | 8.49 | 11.5 | 1.4 | 3.2 | **60.63** |
| 1997 | 2.9 | 1.28 | 1.84 | 4.56 | 3.43 | 6.33 | 7.69 | 8.24 | 3.97 | 4.84 | 2.4 | 9.8 | **57.27** |
| 1998 | 3.5 | 11.1 | 2.64 | 4.71 | 0.96 | 2.95 | 7.29 | 10.1 | 7.65 | 3.01 | 2.4 | 0.4 | **56.72** |
| 1999 | 4.6 | 1.7 | 0.4 | 1.92 | 1.02 | 7.75 | 3.56 | 3.51 | 13 | 3.24 | 0.8 | 0.9 | **42.44** |
| 2000 | 2.8 | 1.17 | 1.79 | 2.6 | 1.15 | 2.43 | 5.69 | 7.38 | 11.6 | 0.23 | 1.6 | 1.4 | **39.77** |
| 2001 | 0.9 | 0.68 | 5.48 | 0.62 | 2.56 | 5.59 | 8.31 | 3.58 | 16 | 0.81 | 1.4 | 3.1 | **49.14** |
| 2002 | 4.5 | 0.82 | 4.38 | 2.41 | 0.47 | 6.24 | 7.8 | 8.14 | 9.31 | 2.58 | 2.7 | 5.4 | **54.72** |
| 2003 | 0.1 | 4.66 | 10.7 | 2.63 | 2.54 | 6.75 | 7.33 | 1.83 | 3.04 | 2.98 | 0.7 | 1.2 | **44.47** |
| 2004 | 1.6 | 4.47 | 1.36 | 2.02 | 1.24 | 17.2 | 8.6 | 9.85 | 16.3 | 1.32 | 2.9 | 2.7 | **69.47** |
| 2005 | 1.9 | 3.56 | 3.67 | 4.53 | 3.51 | 14.8 | 7.37 | 4.43 | 5.76 | 6.49 | 1.1 | 7.4 | **64.44** |
| 2006 | 2.30 | 3.91 | 0.68 | 1.22 | 2.01 | 7.25 | 3.97 | 7.08 | 4.55 | 1.81 | 0.39 | 2.90 | **38.07** |
| 2007 | 2.29 | 2.40 | 2.22 | 1.02 | 1.12 | 6.68 | 9.48 | 3.57 | 5.44 | 8.85 | 0.17 | 2.74 | **45.98** |
| 2008 | 2.63 | 5.22 | 3.50 | 2.34 | 0.66 | 8.21 | 8.83 | | | | | | **31.39** |
| **AVG** | **3.21** | **3.54** | **3.81** | **2.82** | **3.29** | **6.37** | **6.55** | **6.99** | **7.43** | **3.87** | **1.98** | **2.62** | **52.47** |

Rainfall is in inches, and represents data from JIA.

## Appendix J: Annual and Monthly Average Precipitation at JIA, 1955–2008



## Appendix K: Executive Summary of Tributary Pollution Assessment Project

***Note:*** *This appendix contains the executive summary of the Tributary Pollution Assessment Project (TPAP) submitted to the Department by JEA and PBS&J. The six phases detailed in the methodology development and evaluation section have already been completed as of the date of this TMDL. In place of the public workshop mentioned in the section describing Phase 6, the* Tributary Pollution Assessment Manual *was presented to the Jacksonville Waterways Commission on February 1, 2007.*

The Tributary Pollution Assessment Project involves developing and evaluating a methodology for conducting tributary pollution assessments for listed water bodies in the Duval County area, as referenced in the Reasonable Assurance (RA) Plan. Duval County has approximately 100 tributary Water Body IDs (WBIDs), i.e. small to large tributaries of the St. Johns River, identified by the State. The RA Plan provides reasonable assurance that the fecal coliform levels of the 51 top-ranked WBIDs will be reduced sufficiently to restore them to their designated use for recreation. The 51 WBIDs are grouped into four priority groups in the RA Plan.

PBS&J was contracted by JEA to develop a methodology for conducting tributary pollution assessments for sources of fecal coliform contamination in the listed tributaries. This methodology will be field-verified by conducting sanitary surveys of selected tributary water body segments, and revised based on lessons learned from this process. The final product of this endeavor will be a *Tributary Pollution Assessment Manual* that can be used as a blueprint for conducting sanitary surveys.

The Tributary Pollution Assessment Project is a continuation of the effort started under the RA Plan. The RA Plan participants have been brought together to form the Tributary Assessment Team (TAT). The TAT will serve as an advisory committee to the PBS&J Project Team throughout the development of the *Tributary Pollution Assessment Manual*. The TAT is composed of representatives from:

- JEA
- City of Jacksonville Environmental Quality Division
- City of Jacksonville Public Works Department
- Duval County Health Department
- Florida Department of Environmental Protection
- St. Johns Riverkeeper
- Water and Sewer Expansion Authority
- US Army Corps of Engineers

Other representatives (from these and additional entities) may be included in the TAT activities in varying roles, as relevant.

Our approach for developing and evaluating a methodology for conducting tributary pollution assessments is divided into six major phases including:

1) Pre-planning;
2) Planning;
3) Development of *Tributary Pollution Assessment Manual*;

4) Evaluation of Methodology/Manual by Conducting Sanitary Surveys;
5) Summary Report; and
6) Public Workshop.

The Pre-Planning phase (Phase I) entailed four main goals:

1) to obtain and review all documents included in the RA Plan;
2) to develop categories for tributary classification and categorize the 51 priority WBIDs;
3) to overlay each WBID onto land use, infrastructure, and historical sampling maps to begin assessing probable sources and migration pathways; and
4) to develop the *Draft Work Plan*.

The Planning phase (Phase II) begins with the organization and initial meeting of the Tributary Assessment Team (TAT) with the ultimate goal of finalizing the *Work Plan*.

The Development of the *Tributary Pollution Assessment Manual* phase (Phase III) primarily involves the formulation of the assessment methodology for each tributary category described in the Pre-Planning phase, the use of a decision tree to determine which assessment methodology corresponds to each of the highest-ranked WBIDs, and the establishment of a model monitoring plan for each tributary category. This phase will be completed upon submitting the *Manual* to the TAT for review.

The next phase, Evaluation of Methodology/Manual by Conducting Sanitary Surveys (Phase IV), entails field-verification of the methodology described in the *Draft Tributary Pollution Assessment Manual* for the highest ranked water bodies for each category (or as determined to ensure adequate geographical representation of the study area) and applying the results to recommend generic corrective actions and revise the methodology, if necessary. The outcome of this phase would be the *Tributary Pollution Assessment Manual.*

The final two phases, Summary Report (Phase V) and Public Workshop (Phase VI), would entail providing a summary of the results of the tributary pollution assessments, including a discussion of lessons learned and site-specific corrective actions, to JEA and presenting the results from the *Tributary Pollution Assessment Manual* to the public. The final phase would also include a written summary of public input received at the workshop.

For additional information, please contact: Don Deis, PBS&J Project Manager, at (904) 363-8442 or drdeis@pbsj.com.

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