

TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Fecal Coliforms

In

**Horse Creek above Peace River (WBID 1787A),
Myrtle Slough – Freshwater (WBID 1995), Hawthorne
Creek (WBID 1997), and Myrtle Slough – Marine
(WBID 2054)**

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LIST OF ABBREVIATIONS

AWT	Advanced Waste Treatment
BMP	Best Management Practices
BPJ	Best Professional Judgment
CFS	Cubic Feet per Second
DEM	Digital Elevation Model
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
F.A.C.	Florida Administrative Code
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agriculture Statistics Service
NLCD	National Land Cover Data
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSTD	Onsite Sewer Treatment and Disposal Systems
PLRG	Pollutant Load Reduction Goal
Rf3	Reach File 3
RM	River Mile
STORET	STORage RETrieval database
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WBID	Water Body Identification
WLA	Waste Load Allocation
WMP	Water Management Plan
WWTF	Wastewater Treatment Facility

SUMMARY SHEET
Total Maximum Daily Load (TMDL)

1. 303(d) Listed Waterbody Information

State: Florida

Major River Basin: Middle and Lower Peace River

Impaired Waterbody for TMDLs (1998 303(d) List):

WBID	Segment Name	River Basin	County	Constituent(s)
1787A	Horse Creek above Peace River	Peace	Desoto / Hardee / Hillsborough / Manatee / Polk	Fecal Coliforms
1995	Myrtle Slough - Freshwater	Peace	Desoto	Fecal Coliforms
1997	Hawthorne Creek	Peace	Desoto	Fecal Coliforms
2054	Myrtle Slough - Marine	Peace	Desoto	Fecal Coliforms

2. TMDL Endpoints (i.e., Targets) for Class 1 Waters:

Fecal Coliform: Not to exceed 400 MPN/100ml at 95th Percentile was used for all TMDLs

TMDL Endpoints (i.e., Targets) for Class III Waters (fresh and marine):

Fecal Coliform: Not to exceed 400 MPN/100ml at 95th Percentile was used for all TMDLs

3. Fecal Coliform Allocation:

Waterbody	WBID	WLA ¹		LA (% Reduction) ²	TMDL (% Reduction) ²
		Facility (MPN/day)	MS4		
Horse Creek above Peace River	1787A	N/A	41%	41%	41%
Myrtle Slough - Freshwater	1995	N/A	N/A	68%	68%
Hawthorne Creek	1997	N/A	N/A	88%	88%
Myrtle Slough - Marine	2054	N/A	85%	85%	85%

Notes:

1) The WLA is typically separated into the components originating from continuous NPDES facilities (e.g. WWTPs) and from Municipal Separate Storm Sewers (MS4). WLAs are provided because Horse Creek above Peace River and Myrtle Slough - Marine are within MS4 service areas.

2) Overall percent reduction required to achieve the 400 MPN/100 ml fecal coliform criterion. The Margin of Safety is implicit and does not take away from the TMDL value.

3) NA = Not Applicable

4. Endangered Species (yes or blank): Yes

5. EPA Lead on TMDL (EPA or blank): EPA

6. TMDL Considers Point Source, Nonpoint Source, or both: Both

7. NPDES Discharges to surface waters addressed in TMDL: Yes

Name	NPDES #	Discharge Type	Receiving Stream
Charlotte Co. MS4	FLR04E043	MS4	Myrtle Slough - Marine
Hillsborough Co. MS4	FLS000006	MS4	Horse Creek above Peace River
Manatee Co. MS4	FLS000036	MS4	Horse Creek above Peace River
Polk Co. MS4	FLS000015	MS4	Horse Creek above Peace River

**TOTAL MAXIMUM DAILY LOAD (TMDL) FOR FECAL COLIFORMS IN
HORSE CREEK ABOVE PEACE RIVER (WBID 1787A),
MYRTLE SLOUGH – FRESHWATER (WBID 1995),
HAWTHORNE CREEK (WBID 1997),
AND MYRTLE SLOUGH - MARINE (WBID 2054)**

1.0 INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those waterbodies that are not meeting water quality standards. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA, 1991).

The Florida Department of Environmental Protection (FDEP) developed a statewide approach to managing water resources on the basis of natural boundaries, such as river basins, rather than political boundaries. This watershed management approach is the framework FDEP uses for developing and implementing TMDLs. The state's 52 basins are divided into 5 groups. Water quality is assessed in each group on a rotating five-year cycle. FDEP also established five Water Management Districts (WMD) responsible for managing ground and surface water supplies in the counties encompassing their districts. All of the TMDLs WBIDs are Group 3 waterbodies (Figure 1) managed by the Southwest Florida Water Management District (SWFWMD).

For the purpose of planning and management, the WMDs divide their districts into planning units defined as either an individual primary tributary basin or a group of adjacent primary tributary basins with similar characteristics. Horse Creek above Peace River, Myrtle Slough – Freshwater, and Hawthorne Creek are located within the Middle Peace River Planning Unit, which extends from Payne Creek in the north down to the confluence of Horse Creek with the Peace River in the south. Myrtle Slough – Marine is located within the Lower Peace River Planning Unit, which is the area below the Middle Peace Planning Unit just above Charlotte Harbor. Planning units contain smaller, hydrological based units called drainage basins, which are further divided into water segments. A water segment usually contains only one unique waterbody type (stream, lake, canal, etc.) and is typically about five square miles in area. Unique waterbody identification (WBIDs) numbers are assigned to each water segment. The stream segments addressed in this TMDL report are designated WBID 1787A (Horse Creek above Peace River), WBID 1995 (Myrtle Slough - Freshwater), WBID 1997 (Hawthorne Creek) and WBID 2054 (Myrtle Slough - Marine). The locations of these WBIDs are shown in Figure 2.

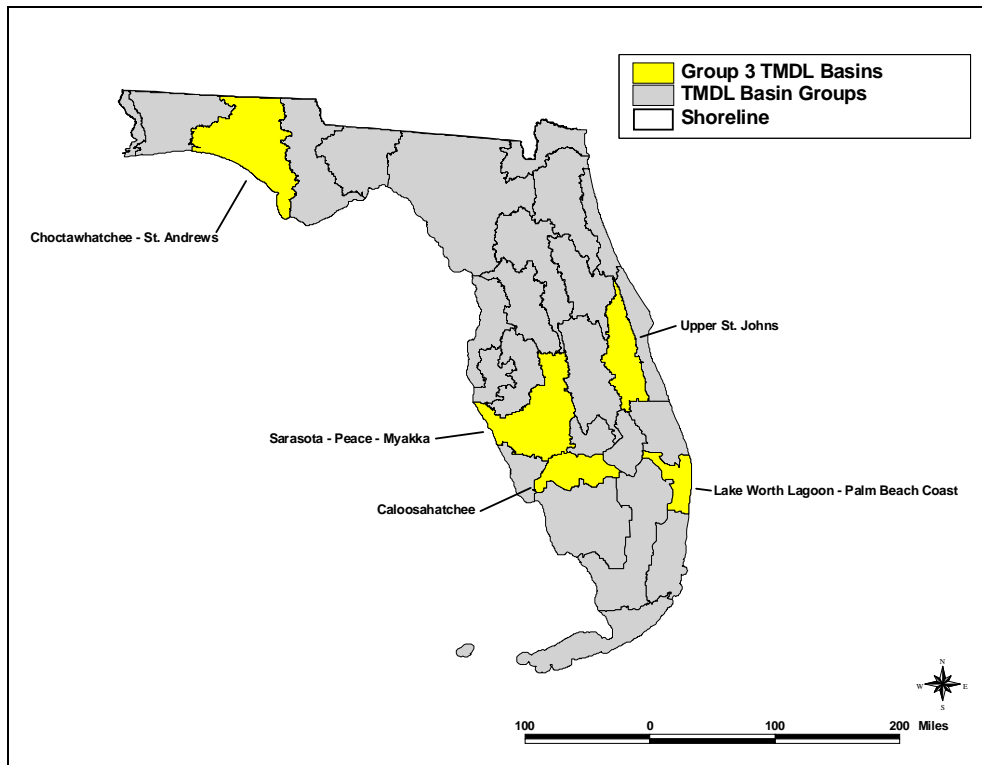


Figure 1 FDEP Group 3 TMDL Basins

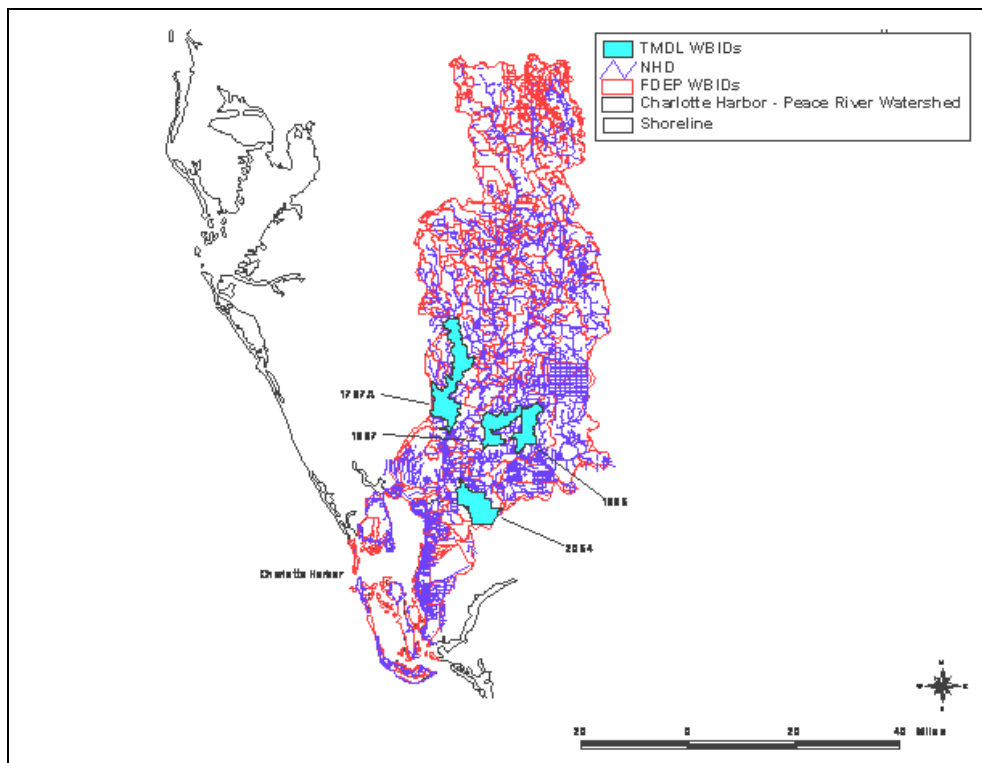


Figure 2 Peace River Basin

2.0 PROBLEM DEFINITION

To determine the status of surface water quality in the state of Florida, chemical data, biological data, and fish consumption advisories were evaluated for potential impairments. Florida's process for determining levels of water quality impairment is described in the Identification of Impaired Surface Waters Rule (IWR), in Section 62-303 of the Florida Administrative Code (FAC). The IWR defines threshold criteria for determining if a waterbody should be added to the state's planning list of potentially impaired waters. Once a waterbody is on the planning list, additional data and information are collected and assessed to determine if the water should be included on the state's verified list of water quality impairments.

Florida's final 1998 Section 303(d) verified list identified Myrtle Slough - Marine (WBID 2054) as potentially not supporting water quality standards (WQS) due to elevated concentrations of fecal coliforms. Horse Creek above Peace River (WBID 1787A), Myrtle Slough – Freshwater (WBID 1995), and Hawthorne Creek (WBID 1997) were all on the planning list, but not yet verified. Fecal coliform bacteria are present in large numbers in the intestinal tracts of humans and other warm-blooded animals. With the exception of *Escherichia Coli*, most fecal coliform bacteria do not cause disease by themselves. However, high numbers of them in a waterbody indicate the presence of fecal material, and therefore the likely presence of other bacteria that are pathogenic. A 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998) established a schedule by which EPA is committed to developing TMDLs. Since FDEP has not yet verified the fecal coliform impairments in these waterbodies, EPA is responsible for assessing all readily available water quality data to determine whether TMDLs should be developed for them.

The format of the remainder of this report is as follows: Section 3.0 is a general description of the impaired watersheds; Section 4.0 describes the water quality standards and target criteria; and Section 5.0 describes the data and source assessments, as well as the approach used to develop the TMDL.

3.0 WATERSHED DESCRIPTION

Horse Creek above Peace River (WBID 1787A) is a direct tributary to the Lower Peace River, and is located in Desoto, Hardee, Hillsborough, Manatee and Polk Counties, FL (Figure 3). The creek and its tributaries, which include Brushy Creek, Buzzard Roost Creek, and Lettis Creek, drain approximately 568 km² (219 mi²). The majority of the watershed is agriculture (45 percent), with an even mix of cropland and pastureland, tree crops, and open land. Wetlands make up the second largest land use with 18 percent. The urban, residential, and extractive lands, which take up just over 12 percent of the total land use, are primarily low density residential. There are no known NPDES-permitted discharges in the Horse Creek Watershed. The Horse Creek above Peace River watershed is within the Hillsborough County MS4 (FLS000006), Manatee County MS4 (FL000036), and Polk County MS4 (FL000015) service areas.

Myrtle Slough - Freshwater (WBID 1995) is a direct tributary to Prairie Creek, which flows to the Lower Peace River, and is located in Desoto County, FL (Figure 4). The Creek drains approximately 64 km² (25 mi²). The majority of the land in the watershed is comprised of agriculture (47 percent), with cropland and pastureland accounting for almost all of this. Wetlands (27 percent) and upland nonforested (19 percent) are the other land uses that dominate the watershed. There is very little urban area in the watershed, with the total being just under one percent. There are no known NPDES-permitted discharges or MS4 permits in the Myrtle Slough – Freshwater watershed.

Hawthorne Creek (WBID 1997) is a direct tributary to Joshua Creek, and ultimately the Peace River, and is located in Desoto County, FL (Figure 5). The Creek drains approximately 103 km² (40 mi²). The dominant land use in the watershed is agriculture, with tree crops and other timber related activities making up most of this land (81 percent). The urban, residential, and extractive lands, which make up just under five percent, are primarily low density residential. Wetlands make up roughly 10 percent of the total land in the watershed. There are no known NPDES-permitted discharges or MS4 permits in the Hawthorne Creek watershed.

Myrtle Slough – Marine (WBID 2054) is a direct tributary to Prairie Creek, and ultimately the Lower Peace River, and is located in Charlotte County, FL (Figure 6). Myrtle Slough - Marine drains approximately 92 km² (36 mi²). The dominant land uses in the watershed are upland nonforested and forest, with each accounting for approximately 33 percent of the total land. Wetlands make up 19 percent of the total land. Urban, residential, and extractive lands make up less than 1 percent of the total land for the entire watershed. There is an MS4 permit located in the Myrtle Slough watershed. The Charlotte County MS4 (FLR04E043) covers the entire watershed.

Table 1 Land use Distribution for the Impaired WBIDs

Impaired Waterbody	WBID(s)	Unit ²	Urban Residential & Built-Up	Agriculture	Upland Nonforested	Forest	Water	Wetlands	Disturbed & Barren Land	Transportation & Utilities	Total
Horse Creek above Peace River	1787A, 1787B, 1826, 1836, 1838, 1852, 1884, 1904, 1915, 1933, 1934, 1939, 1944, 1957, 1986, 1939A	Km ²	68.6	255.9	61.1	76.1	1.1	104.3	0.1	0.8	568.1
		percent	12.1	45.0	10.8	13.4	0.2	18.4	0.0	0.1	100.0
Myrtle Slough - Freshwater	1995	Km ²	0.5	29.7	12.0	3.9	0.4	17.2	0.0	0.0	63.7
		percent	0.8	46.6	18.8	6.1	0.6	27.0	0.0	0.0	100.0
Hawthorne Creek	1997, 2001	Km ²	4.6	83.1	2.3	1.9	0.6	9.6	0.0	0.4	102.5
		percent	4.5	81.1	2.3	1.8	0.6	9.4	0.0	0.4	100.0
Myrtle Slough - Marine	2054	Km ²	0.8	8.5	31.0	30.6	0.3	19.2	0.3	1.0	91.7
		percent	0.9	9.2	33.8	33.4	0.3	20.9	0.3	1.1	100.0

Notes:

1. Land use data are based on 2006 SWFWMD land cover features categorized according to the Florida Land Use and Cover Classification System (FLUCCS). The features were photo interpreted from 2006 one-foot color infrared digital aerial photographs at the 1:12,000 scale. Areas in the table represent the watershed draining to the impaired segment.
2. Km²= square kilometers.
3. The urban/residential and built-up category includes commercial, industrial and extractive uses.
4. The upland nonforested category includes shrub and brushland.

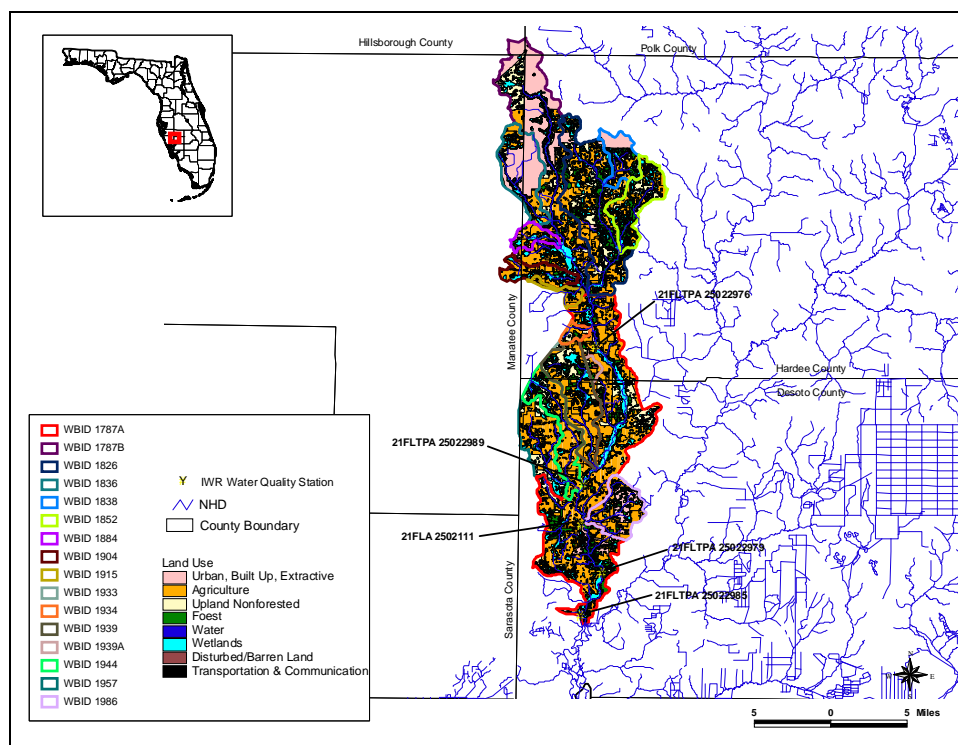


Figure 3 Land Use and Location of Sampling Stations in WBID 1787A

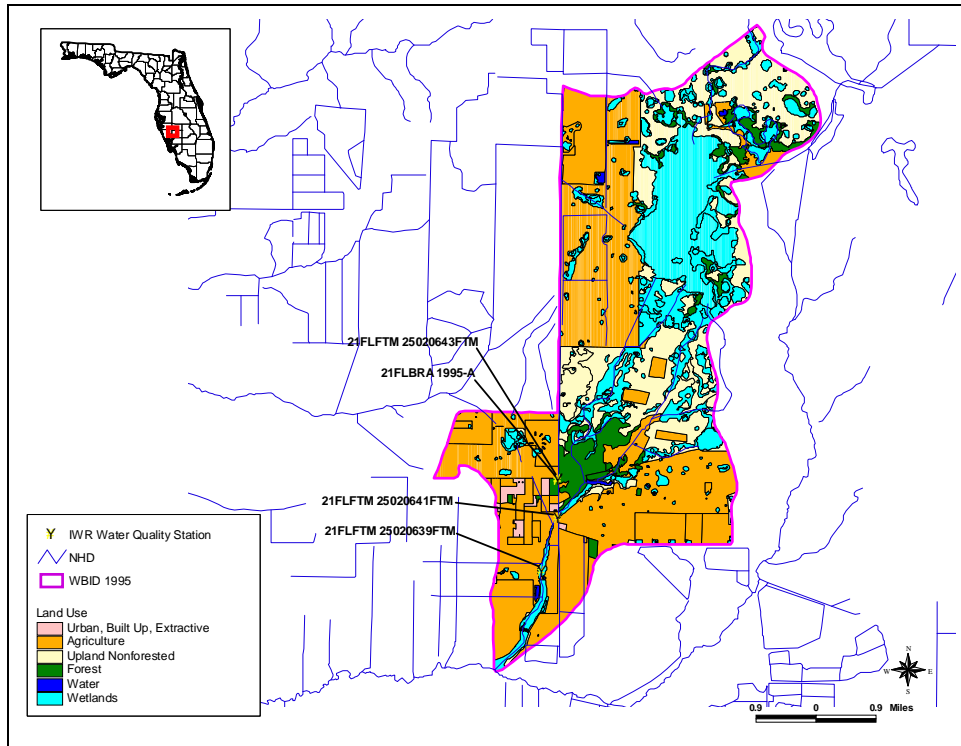


Figure 4 Land Use and Locations of Sampling Stations in WBID 1995

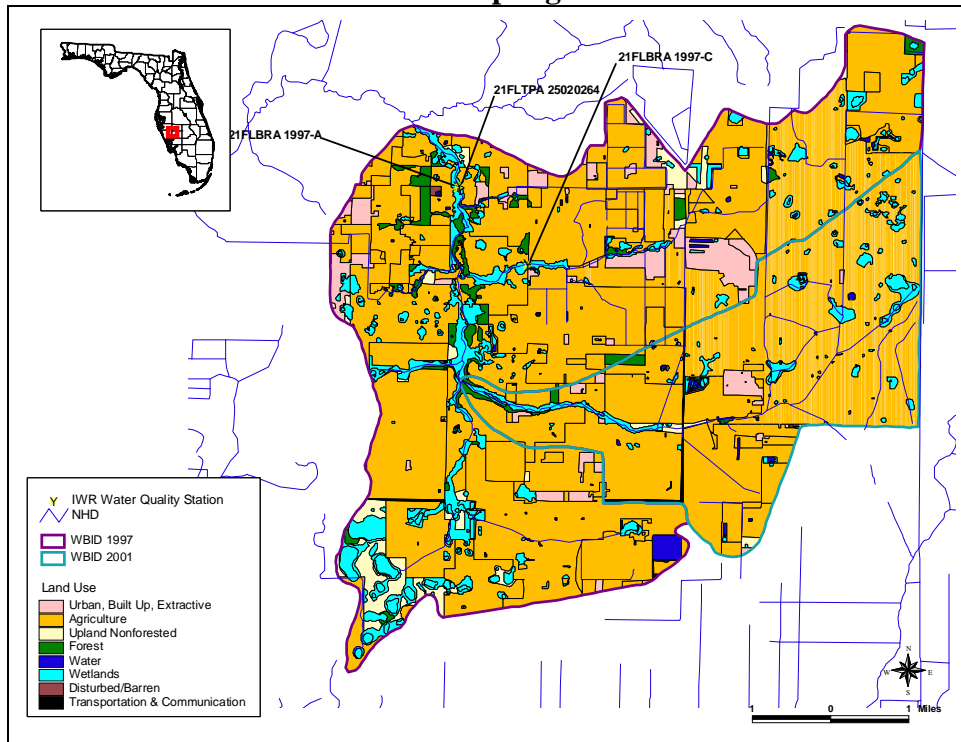


Figure 5 Land Use and Locations of Sampling Stations in WBID 1997

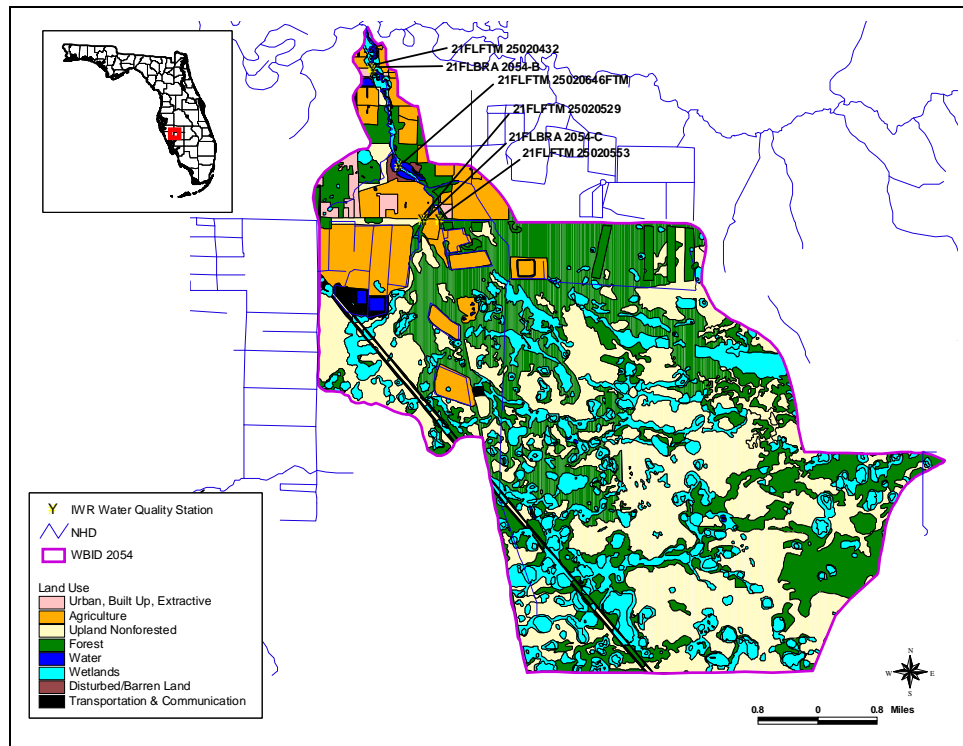


Figure 6 Land Use and Locations of Sampling Stations in WBID 2054

4.0 WATER QUALITY STANDARD AND TARGET INFORMATION

WBID 1995 is a Class I waterbody. WBIDs 1787A and 1997 are Class III freshwater streams. WBID 2054 is a Class III Marine waterbody. The designated uses of Class I waters include recreation, and propagation and maintenance of a healthy, well-balanced population of fish and wildlife, as well as the provision that the water is used for drinking water purposes. The designated uses of Class III fresh and marine waters include recreation, and propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The water quality criteria for protection of Class I and III waters are established by the State of Florida in the Florida Administrative Code (FAC), Section 62-302.530. The individual criteria should be considered in conjunction with other provisions in water quality standards that apply to all waters, including Section 62-302.500 FAC [Surface Waters: Minimum Criteria, General Criteria], unless alternative or more stringent criteria are specified in FAC Section 62-302.530. In addition, unless otherwise stated, all criteria express the maximum not to be exceeded at any time. The specific criteria addressed in this TMDL document are provided in the following section.

Fecal Coliform Bacteria (Class I Waters)

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. Monthly averages shall be expressed as geometric means based on a minimum of 5 samples taken over a 30-day period.

The geometric mean criteria reflect chronic or long-term water quality conditions, whereas the 400 and 800 values reflect acute or short-term conditions. To determine the impairment status of the streams, available data were assessed against both components of the acute criteria. It was not possible to assess against the geometric mean criteria in any WBID due to insufficient data. The 400 MPN/100 ml criterion was selected as the endpoint for the TMDL, since this resulted in more stringent reductions.

Fecal Coliform Bacteria (Class III Waters- Fresh and Marine)

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. Monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period.

The geometric mean criteria reflect chronic or long-term water quality conditions, whereas the 400 and 800 values reflect acute or short-term conditions. To determine the impairment status of the streams, available data were assessed against both components of the acute criteria. It was not possible to assess against the geometric mean criteria in any WBID due to insufficient data. The 400 MPN/100 ml criterion was selected as the endpoint for all TMDLs, since this resulted in more stringent reductions.

5.0 FECAL COLIFORM TMDL

This section of the report details the development of the fecal coliform TMDLs. Fecal coliform bacteria are frequently used as indicators of fecal contamination since they are abundant in the intestines and feces of animals and people.

5.1 Water Quality Assessment and Deviation from Target

FDEP maintains ambient monitoring stations throughout the basin and allows public access to the monitoring results via the internet in their IWR database. Data collected at monitoring stations within the impaired WBID and reported in IWR Run 35 were used in the analysis. Tables 2, 4, 6 and 8 provide a list of these monitoring stations. Monitoring results are tabulated in Appendix A. Results having laboratory data qualifiers were used in the TMDL analysis in accordance with Appendix A. A summary of fecal coliform monitoring data collected at each station for each WBID is provided in Tables 3, 5, 7, and 9.

Violations of the fecal coliform criteria often occur in response to rainfall events. Precipitation data collected at a nearby USGS Gage and plotted with the fecal coliform results to identify conditions when violations occurred (see Figures 7-10). In most instances, exceedances of the criteria occur in response to rain events while at other times exceedances occur during dry conditions. Implementation of these TMDLs should address controlling nonpoint sources during both wet and dry weather conditions.

Table 2 Monitoring Stations in WBID 1787A

Station ID	Station Name	# of Observations	Start Date	End Date
21FLA 25020111	Horse Creek SR 72 Bridge	5	1/16/1997	4/13/1998
21FLFTM 25020111	Horse Creek SR 72 Bridge	2	4/11/2001	6/4/2001
21FLTPA 25022976	H6 - Horse Creek	3	6/5/2000	9/13/2000
21FLTPA 25022979	H10 - Horse Creek	3	6/7/2000	2/28/2001
21FLTPA 25022985	H17 - Horse Creek	3	6/7/2000	2/26/2001
21FLTPA 25022989	H21 - Horse Creek	1	9/13/2000	9/13/2000

Table 3 Summary of Fecal Coliform Monitoring Data in WBID 1787A

Station ID	% Samples >400 MPN/100ml	% Samples >800 MPN/100ml	Minimum Concentration	Maximum Concentration
21FLA 25020111	40	20	100	1060
21FLFTM 25020111	50	0	100	580
21FLTPA 25022976	0	0	1	180
21FLTPA 25022979	0	0	1	75
21FLTPA 25022985	0	0	12	130
21FLTPA 25022989	0	0	85	85

Table 4 Monitoring Stations in WBID 1995

Station ID	Station Name	# of Observations	Start Date	End Date
21FLBRA 1995-A	1995 - Myrtle Slough - End of Pine Island Rd	2	4/8/2008	4/15/2008
21FLFTM 25020639FTM	Myrtle Slough Site 2 WBID 1995, at Nichols RD, Desoto County	5	9/30/2003	5/24/2004
21FLFTM 25020641FTM	Myrtle Slough Site 1 WBID1995, at Culvert Under Pine Island Street	4	11/5/2003	5/24/2004
21FLFTM 25020643FTM	Myrtle Slough Site 4 WBID1995, at Canal at Corner of Pine Island	4	11/5/2003	5/24/2004

Table 5 Summary of Fecal Coliform Monitoring Data in WBID 1995

Station ID	% Samples >400 MPN/100ml	% Samples >800 MPN/100ml	Minimum Concentration	Maximum Concentration
21FLBRA 1995-A	0	0	25	52
21FLFTM 25020639FTM	40	40	80	1400
21FLFTM 25020641FTM	25	25	60	1140
21FLFTM 25020643FTM	0	0	90	340

Table 6 Monitoring Stations in WBID 1997

Station ID	Station Name	# of Observations	Start Date	End Date
21FLBRA 1997-A	1997 - Hawthorne Creek - Crossing on 760A	2	4/8/2008	5/12/2008
21FLBRA 1997-C	1997 - Hawthorne Creek - Crossing on Airport Road	1	4/8/2008	4/8/2008
21FLTPA 25020264	TP124 - Hawthorne Creek	2	3/30/1999	3/30/1999

Table 7 Summary of Fecal Coliform Monitoring Data in WBID 1997

Station ID	% Samples >400 MPN/100ml	% Samples >800 MPN/100ml	Minimum Concentration	Maximum Concentration
21FLBRA 1997-A	100	50	540	2000
21FLBRA 1997-C	100	0	650	650
21FLTPA 25020264	100	100	1340	3700

Table 8 Monitoring Stations in WBID 2054

Station ID	Station Name	# of Observations	Start Date	End Date
21FLBRA 2054-A	2054 - Myrtle Slough - Crossing on 74 near P.G. Farms	1	4/24/2008	4/24/2008
21FLBRA 2054-B	2054 - Myrtle Slough - Crossing on Washington Loop Rd	3	4/1/2008	5/24/2008
21FLBRA 2054-C	2054 - Myrtle Slough - on 74 after Happy Hollow	2	4/1/2008	4/24/2008
21FLFTM 25020432	Myrtle Slough at SR764	5	9/30/2003	5/24/2004
21FLFTM 25020529	Myrtle Slough, West Fork at SR74	5	9/30/2003	5/24/2004
21FLFTM 25020553	Myrtle Slough, East Branch Below CR 74	5	9/30/2003	5/24/2004
21FLFTM 25020646FTM	Myrtle Slough WBID 2054 - Site 5 @ Desrosier Bros Property	1	5/24/2004	5/24/2004

Table 9 Summary of Fecal Coliform Monitoring Data in WBID 2054

Station ID	% Samples >400 MPN/100ml	% Samples >800 MPN/100ml	Minimum Concentration	Maximum Concentration
21FLBRA 2054-A	100	100	2600	2600
21FLBRA 2054-B	33	0	65	580
21FLBRA 2054-C	100	100	2000	4800
21FLFTM 25020432	0	0	10	300
21FLFTM 25020529	80	20	80	1000
21FLFTM 25020553	20	20	40	900
21FLFTM 25020646FTM	0	0	10	10

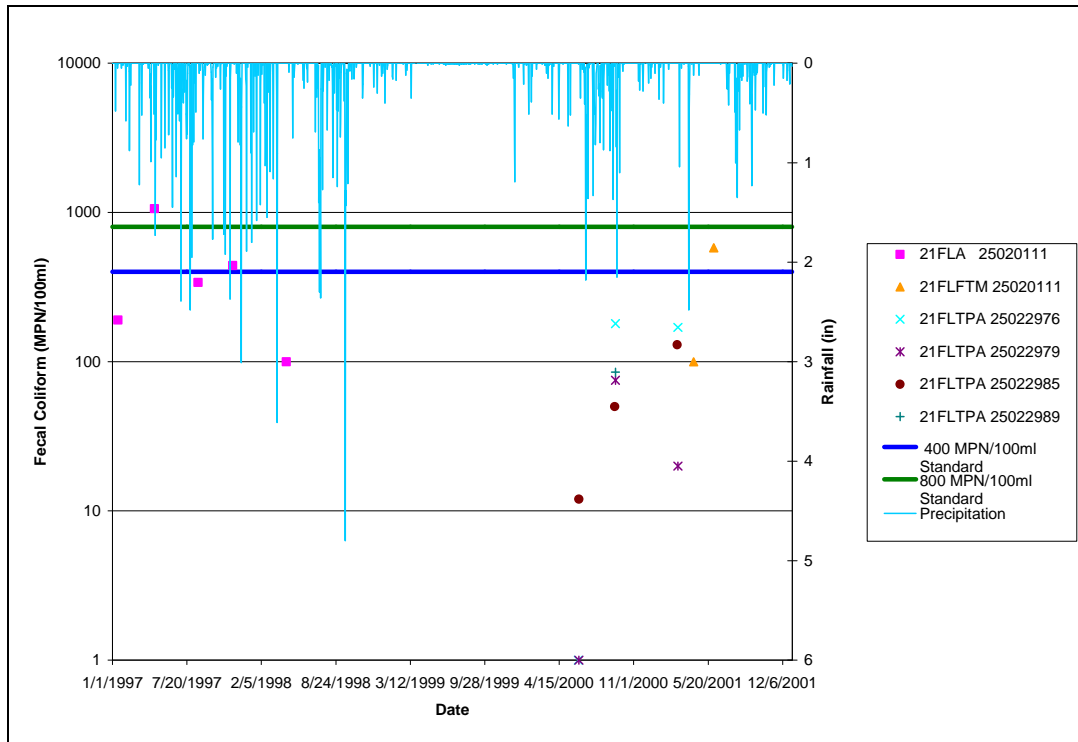


Figure 7 Comparison of Fecal Coliform Concentrations in Horse Creek above Peace River and Rainfall at USGS02394650 – Peace River at Bartow, FL

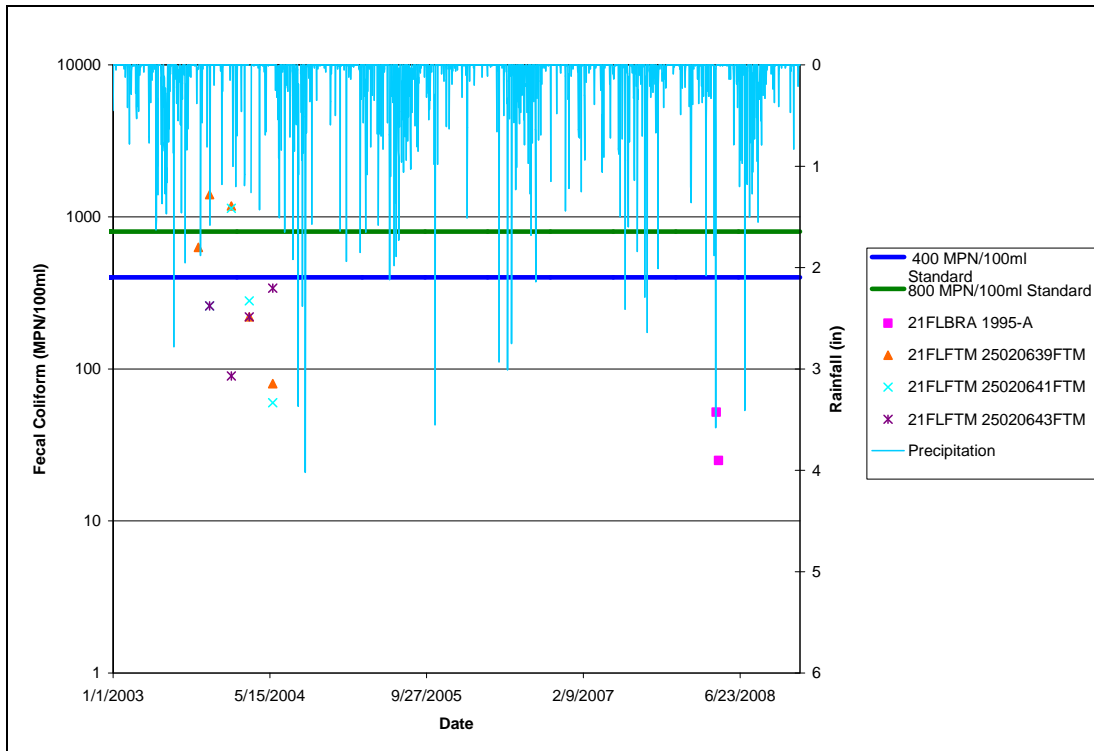


Figure 8 Comparison of Fecal Coliform Concentrations in Myrtle Slough – Freshwater at USGS02394650 – Peace River at Bartow, FL

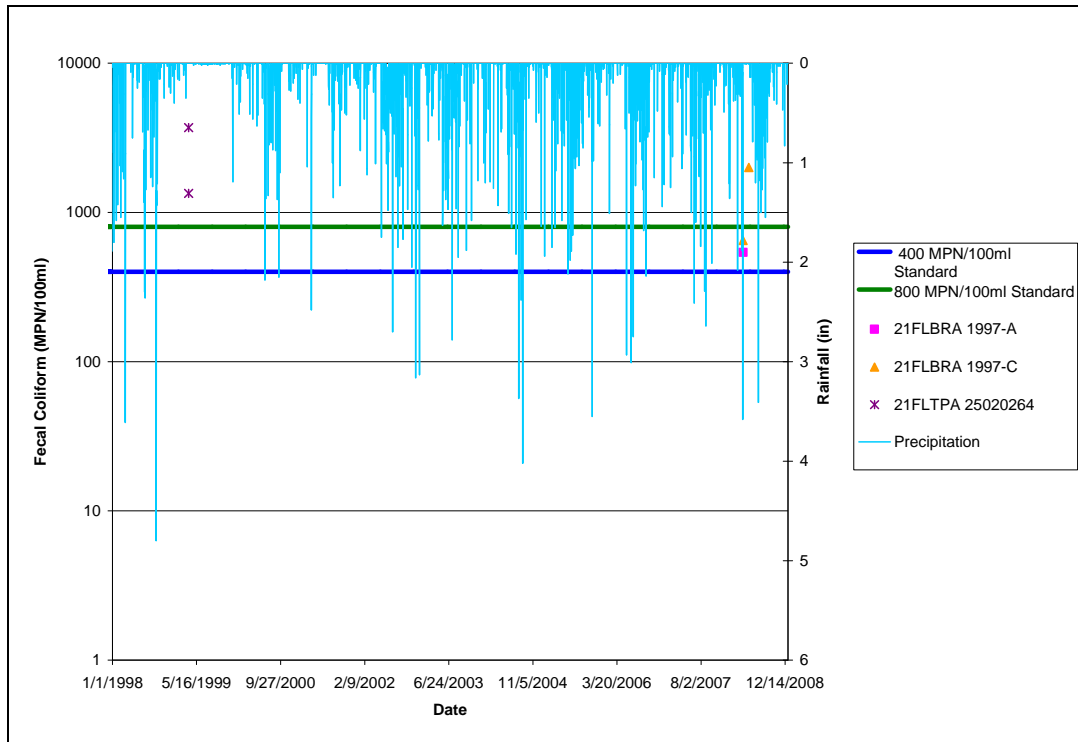


Figure 9 Comparison of Fecal Coliform Concentrations in Hawthorne Creek at USGS02394650 – Peace River at Bartow, FL

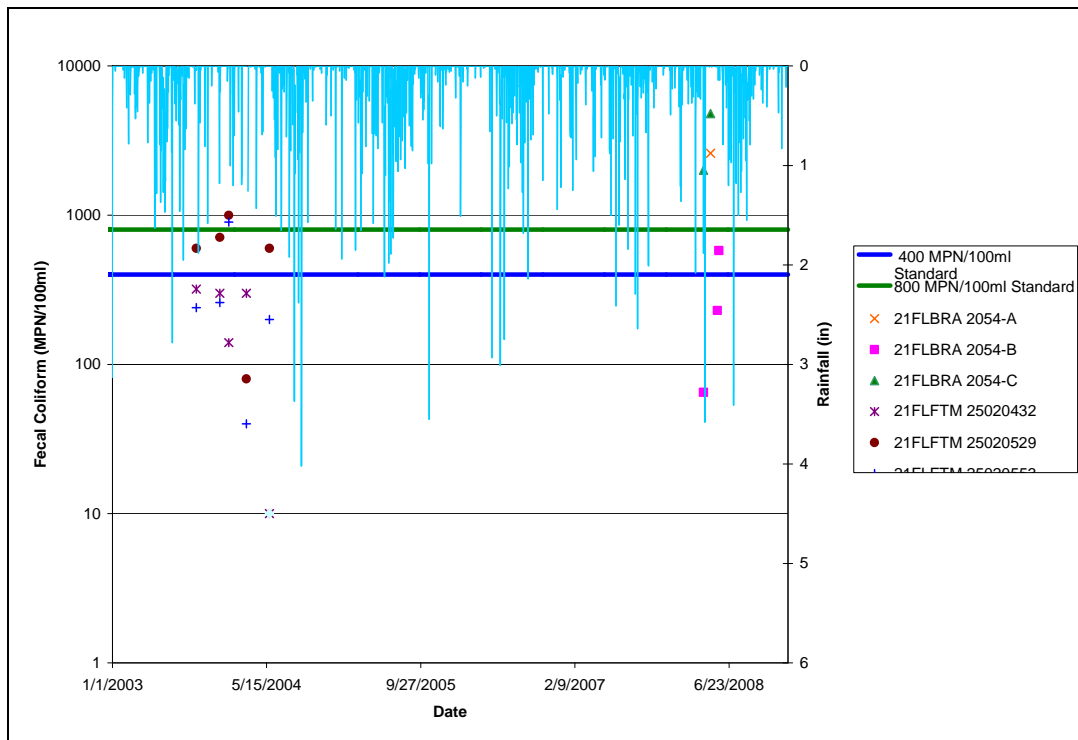


Figure 10 Comparison of Fecal Coliform Concentrations in Myrtle Slough – Marine at USGS02394650 – Peace River at Bartow, FL

5.2 Source Assessment

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of coliform bacteria in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either point or non-point sources.

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities discharging treated sanitary wastewater or stormwater (i.e., Phase I or II MS4 discharges) are considered primary point sources of coliform. It is important to note that MS4 discharges are actually urban stormwater collection systems, and operate in a different manner than industrial or municipal discharges.

Non-point sources of coliform are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not always, involve accumulation of bacteria on land surfaces and wash off as a result of storm events. Typical non-point sources of coliform include:

- Wildlife
- Agricultural animals
- Onsite Sewer Treatment and Disposal Systems (septic tanks)
- Urban development (outside of Phase I or II MS4 discharges)

A geographic information system (GIS) tool was used to display, analyze, and compile available information to characterize potential bacteria sources in the impaired WBID. This information includes land use, point source dischargers, soil types and characteristics, population data (human and livestock), and stream characteristics.

5.2.1 Point Sources

5.2.1.1 Permitted Facilities

A TMDL wasteload allocation (WLA) is given to NPDES permitted facilities discharging to surface waters within an impaired watershed. Facilities that dispose of wastewater by means other than a surface water discharge, such as spray irrigation or underground injection wells, typically treat wastewater to less stringent secondary standards. These facilities would be considered in the load allocation for nonpoint sources. There are currently no facilities permitted to discharge in the four TMDL WBIDs.

5.2.1.2 Municipal Separate Storm Sewer Systems Permits

The 1987 amendments to the Clean Water Act designated certain stormwater discharges as point sources requiring NPDES stormwater permits. The regulated activities involve Municipal Separate Storm Sewer Systems (MS4s), construction sites over one acre, and specific industrial operations. Although these types of stormwater discharges are now considered point sources with respect to permitting and TMDLs, they behave similarly to nonpoint sources in that they are driven by rainfall-runoff processes leading to the intermittent discharge of pollutants from land use activities in response to storms.

According to 40 CFR 122.26(b)(8), an MS4 is defined as “a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):

- (i) Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law)...including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the Clean Water Act that discharges into waters of the United States.
- (ii) Designed or used for collecting or conveying stormwater;
- (iii) Which is not a combined sewer; and
- (iv) Which is not part of a Publicly Owned Treatment Works.

In 1990, EPA developed rules establishing Phase I of the NPDES stormwater program, designed to prevent harmful pollutants washed into MS4s by stormwater runoff, or dumped directly into them, from being delivered to local waterbodies. Phase I of the program required operators of “medium” and “large” MS4s (generally serving populations of 100,000 or more) to implement a stormwater management program as a means of controlling polluted discharges. Approved stormwater management programs for medium and large MS4s are required to address a variety of water quality related issues including roadway runoff management, municipal owned operations, and hazardous waste treatment, etc. Because the master drainage systems of most local governments in Florida are interconnected, EPA implemented Phase 1 of the MS4 permitting program on a countywide basis, which brings in all cities, Chapter 298 urban water control districts, and the Florida Department of Transportation throughout the 15 counties meeting the population criteria.

Phase II of the NPDES stormwater rule extended coverage to certain “small” MS4s and to construction sites between one and five acres. Small MS4s are defined as any municipal stormwater collection system that does not meet the criteria of a medium or large MS4 covered by Phase I. Only a select subset of small MS4s requires an NPDES stormwater permit. These “regulated small MS4s” include those located in “urbanized areas” as defined by the Bureau of Census, and other small MS4s designated by NPDES permitting authorities.

In October 2000, US EPA authorized FDEP to implement the NPDES stormwater program in all areas of Florida except Indian tribal lands. FDEP’s authority to administer the NPDES program

is set forth in Section 403.0885, FS. The three major components of NPDES stormwater regulations are:

- MS4 permits that are issued to entities that own and operate master stormwater systems, primarily local governments. Permittees are required to implement comprehensive stormwater management programs designed to reduce the discharge of pollutants from the MS4 to the maximum extent practicable.
- Stormwater associated with industrial activities, which is regulated primarily by a multisector general permit that covers various types of industrial facilities. Regulated industrial facilities must obtain NPDES stormwater permit coverage and implement appropriate pollution prevention techniques to reduce contamination of stormwater.
- Construction activity general permits for projects that ultimately disturb one or more acres of land and which require the implementation of stormwater pollution prevention plans to provide for erosion and sediment control during construction.

The Horse Creek above Peace River watershed is within the Hillsborough County MS4 (FLS000006), Manatee County MS4 (FL000036), and Polk County MS4 (FL000015) service areas. Myrtle Slough - Marine (WBID 2054) is within the Charlotte County MS4 (FLR04E043) service area.

5.2.2 Nonpoint Sources

5.2.2.1 Agriculture

Agriculture is a potential source of coliform delivery to streams, including runoff of manure from pastureland and cropland, and direct animal access to streams. WBID 1787A has 51 percent of its land categorized as agriculture, WBID 1995 has 47 percent agriculture, WBID 1997 has 81 percent agriculture, and WBID 2054 has 9 percent agriculture (Table 1 and Figures 3-6).

The USDA National Agricultural Statistics Service (NASS) compiles Census of Agriculture data by county for virtually every facet of U.S. agriculture (USDA NASS, 2007). The “Census of Agriculture Act of 1997” (Title 7, United States Code, Section 2204g) directs the Secretary of Agriculture to conduct a census of agriculture on a 5-year cycle collecting data for the years ending in 2 and 7. Livestock inventories from the 2007 Census of Agriculture reports for each County are listed in Table 10. Cattle and goats are the predominate livestock in the area of concern.

Table 10 Livestock Inventory by County (NASS, 2007)

County	Cattle	Broiler Chickens	Goats	Hogs	Llamas	Sheep
Charlotte	26,937	252	255	46	N/A	16
Desoto	72,442	N/A	348	105	N/A	265
Hardee	85,680	N/A	231	142	N/A	23
Hillsborough	59,000	151	2,157	110	57	581
Manatee	11,293	100	254	N/A	N/A	N/A
Polk	100,000	872	1,853	208	NA	NA

5.2.2.2 Wildlife

Wildlife deposit bacteria in their feces onto land surfaces where it can be transported during storm events to nearby streams, or they may deposit their feces directly into the water body or stream. Bacteria loads from wildlife is generally assumed background, since the contribution from this source is small relative to the load from urban and agricultural areas; however, due to the significant presence of wetlands and other prime habitat for wild animals in all WBIDs, it should be considered as a possibility for a greater loading than background. Water fowl (e.g., herons, ducks, geese, loons) often frequent storm-water ponds and other bodies of water. Depending on the number of birds, the contributions of fecal coliform could result in stream concentrations above the criteria.

5.2.2.3 Onsite Sewerage Treatment and Disposal Systems (Septic Tanks)

Onsite sewage treatment and disposal systems (OSTDs) including septic tanks are commonly used where providing central sewer is not cost effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTD is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, OSTDs can be a source of nutrients (nitrogen and phosphorus), pathogens, and other pollutants to both ground water and surface water. Very little land use in any of the WBIDs other than WBID 1787A are urban, where septic tanks would generally be located. Even so, septic tanks still could potentially be a source of fecal coliform bacteria.

The State of Florida Department of Health publishes septic tanks data on a county by county basis (www.doh.state.fl.us/environment/ostds/statistics/ostdsstatistics.htm). Table 11 summarizes the cumulative number of septic systems installed since the 1970 census. The data does not reflect septic tanks removed from service.

Table 11 County Estimates of Septic System Installations

County	Septic Systems (1970-2008)
Charlotte	42,078
Desoto	10,314
Hardee	8,632
Hillsborough	106,542
Manatee	36,257
Polk	117,747

5.2.2.4 Urban Development

Urban land uses include residential, industrial, extractive and commercial categories. Fecal coliform loading from urban areas (whether within an MS4 jurisdiction or not) is attributable to multiple sources including stormwater runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals.

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 outlined in Chapter 403 of the Florida Statutes (FS), was established as a technology-based program that relies upon the implementation of Best Management Practices (BMPs) that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, FAC.

Florida's stormwater program is unique in having a performance standard for older stormwater systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older stormwater management systems shall be reduced as needed to restore or maintain the beneficial uses of water" (Section 62-40-.432 (5) (c), FAC).

In 1994, state legislation created the Environmental Resource Permitting program to consolidate stormwater quantity, stormwater quality, and wetlands protection into a single permit. Presently, the majority of environmental resource permits are issued by the state's water management districts, although DEP continues to issue permits for specific projects.

Nonstructural and structural BMPs are an integral part of Florida's stormwater programs. Nonstructural BMPs, often referred to as "source controls", are those that can be used to prevent the generation of NPS pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimizing impervious surfaces. Technology-based structural BMPs are used to mitigate the increased stormwater peak discharge rate, volume, and pollutant loadings that accompany urbanization.

There are a few areas with low density residential development, primarily in WBID 1787A. There are MS4 permittees within WBIDs 1787A and 2054. It is possible that some of the fecal coliform bacteria are coming into the stream in WBID 1787A are from septic tanks, and the MS4 could be contributing runoff in both WBIDs 1787A and 2054. This should be studied as a possible means for fecal coliform bacteria to enter the stream.

5.3 Analytical Approach

The approach for calculating coliform TMDLs depends on the number of water quality samples and the availability of flow data. When long-term records of water quality and flow data are not available, the TMDL is expressed as a percent reduction. Load duration curves are used to develop TMDLs when significant data are available to develop a relationship between flow and concentration. Flow measurements are not available for any WBIDs, nor were sufficient information available to estimate flow. Complicating flow estimation matters more, there are large areas of wetlands in all WBIDs. Hydrologically speaking, wetland soils behave differently than other types of soils. Ultimately it was determined that the TMDL should be expressed as a percent reduction.

5.3.1 Percent Reduction Approach for Fecal Coliform TMDL Development

The percent reduction required to meet the TMDL endpoint is based on the following equation:

$$\% \text{Reduction} = \left(\frac{[existing] - [criterion]}{[existing]} \right) \times 100$$

Where:

% Reduction = percent reduction

[existing] = existing concentration

[criterion] = criterion concentration (i.e. target)

Since the water quality standard for fecal coliform bacteria states that up to 10 percent of samples are allowed to exceed a concentration of 400 MPN/100 ml, the existing condition of the waterbody should be represented using a percentile slightly higher than the 90th, in order to ensure that less than 10 percent of the values exceed the criterion. A 90th percentile concentration implies that 90 percent of the measured values are lower than this concentration, and 10 percent are higher. For these TMDLs, the 95th percentile of fecal coliform measurements for each waterbody was calculated and compared against a target of 400 MPN/100 ml. This would meet the water quality standard and provide a margin of safety by ensuring that only 5 percent of the data exceed a concentration of 400 MPN/100 ml. Percent reductions were also calculated using the maximum concentration measured in each WBID to represent the existing condition and the 800 MPN/100 ml criterion as the target. The larger of the two percent reduction values was selected as the TMDL. For all TMDL calculations, the existing conditions are represented by the 95th percentile fecal coliform concentration, and percent reductions are calculated to meet the 400 MPN/100 ml acute criterion, since that resulted in higher reduction.

There are many formulas for calculating percentiles and these can be found in text books on statistics. The Hazen formula was used to calculate the 95th percentile, as it is recommended in Hunter's Applied Microbiology (2002) article on bacteria in water. Application of the Hazen formula to data collected in all WBIDs is provided in Appendix A.

5.4 Development of Total Maximum Daily Loads

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be represented as the sum of all point source loads (WLA), nonpoint source loads (LA), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$a$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measure. The fecal coliform TMDLs for the four WBIDs are expressed as percent reductions.

5.4.1 Critical Conditions

The critical condition for nonpoint source coliform loading is an extended dry period followed by a rainfall runoff event. During the dry weather period, coliforms build up on the land surface, and are washed off by rainfall. The critical condition for point source loading occurs during periods of low stream flow when dilution is minimized. Water quality data have been collected during both time periods. Most violations occur in response to rain events; however, this is not always the case as all four WBIDs violated the standard during both wet and dry periods. Critical conditions are accounted for in the analyses by using the entire period of record of measured water quality data available for each WBID, and by using the largest percent reduction to represent the pollutant reduction required year-round, for the entire watershed. By achieving this reduction, water quality standards should be achieved during all other time periods.

5.4.2 Existing Conditions

Existing conditions represent the current water quality conditions of a waterbody. Existing conditions are being conservatively represented using the 95th percentile of measured concentrations. Fecal coliform samples collected in each WBID, as well as the 95th percentile and percent reduction required to meet the TMDL target, are shown in Tables 12 through 15.

Table 12 Fecal Coliform Measurements in Horse Creek above Peace River (WBID 1787A)

WBID	Date	Station	Result	Rcode
1787A	1/16/1997	21FLA 25020111	190	
1787A	4/24/1997	21FLA 25020111	1060	
1787A	8/19/1997	21FLA 25020111	340	
1787A	11/20/1997	21FLA 25020111	440	
1787A	4/13/1998	21FLA 25020111	100	B
1787A	6/5/2000	21FLTPA 25022976	1	
1787A	6/7/2000	21FLTPA 25022979	1	
1787A	6/7/2000	21FLTPA 25022985	12	
1787A	9/11/2000	21FLTPA 25022985	50	
1787A	9/13/2000	21FLTPA 25022979	75	
1787A	9/13/2000	21FLTPA 25022989	85	
1787A	9/13/2000	21FLTPA 25022976	180	
1787A	2/26/2001	21FLTPA 25022985	130	
1787A	2/28/2001	21FLTPA 25022979	20	
1787A	2/28/2001	21FLTPA 25022976	170	
1787A	4/11/2001	21FLFTM 25020111	100	B
1787A	6/4/2001	21FLFTM 25020111	580	
95th Percentile Fecal Coliform Concentration			676	
Percent Reduction to meet TMDL Target			41	

Table 13 Fecal Coliform Measurements in Myrtle Slough – Freshwater (WBID 1995)

WBID	Date	Station	Result	Rcode
1995	9/30/2003	21FLFTM 25020639FTM	630	J
1995	11/5/2003	21FLFTM 25020641FTM	260	B
1995	11/5/2003	21FLFTM 25020643FTM	260	B
1995	11/5/2003	21FLFTM 25020639FTM	1400	J
1995	1/13/2004	21FLFTM 25020643FTM	90	
1995	1/13/2004	21FLFTM 25020641FTM	1140	
1995	1/13/2004	21FLFTM 25020639FTM	1180	
1995	3/10/2004	21FLFTM 25020639FTM	220	
1995	3/10/2004	21FLFTM 25020643FTM	220	
1995	3/10/2004	21FLFTM 25020641FTM	280	
1995	5/24/2004	21FLFTM 25020641FTM	60	
1995	5/24/2004	21FLFTM 25020639FTM	80	
1995	5/24/2004	21FLFTM 25020643FTM	340	
1995	4/8/2008	21FLBRA 1995-A	52	
1995	4/15/2008	21FLBRA 1995-A	25	
95th Percentile Fecal Coliform Concentration			1246	
Percent Reduction to meet TMDL Target			68	

Table 14 Fecal Coliform Measurements in Hawthorne Creek (WBID 1997)

WBID	Date	Station	Result	Rcode
1997	36249	21FLTPA 25020264	1340	
1997	36249	21FLTPA 25020264	3700	
1997	39546	21FLBRA 1997-A	540	
1997	39546	21FLBRA 1997-C	650	B
1997	39580	21FLBRA 1997-A	2000	
95th Percentile Fecal Coliform Concentration			3360	
Percent Reduction to meet TMDL Target			88	

Table 15 Fecal Coliform Measurements in Myrtle Slough – Marine (WBID 2054)

WBID	Date	Station	Result	Rcode
2054	9/30/2003	21FLFTM 25020553	240	
2054	9/30/2003	21FLFTM 25020432	320	
2054	9/30/2003	21FLFTM 25020529	600	L
2054	12/15/2003	21FLFTM 25020553	260	
2054	12/15/2003	21FLFTM 25020432	300	
2054	12/15/2003	21FLFTM 25020529	710	J
2054	1/13/2004	21FLFTM 25020432	140	
2054	1/13/2004	21FLFTM 25020553	900	
2054	1/13/2004	21FLFTM 25020529	1000	
2054	3/10/2004	21FLFTM 25020553	40	
2054	3/10/2004	21FLFTM 25020529	80	
2054	3/10/2004	21FLFTM 25020432	300	
2054	5/24/2004	21FLFTM 25020432	10	
2054	5/24/2004	21FLFTM 25020646FTM	10	
2054	5/24/2004	21FLFTM 25020553	200	
2054	5/24/2004	21FLFTM 25020529	600	
2054	4/1/2008	21FLBRA 2054-B	65	
2054	4/1/2008	21FLBRA 2054-C	2000	
2054	4/24/2008	21FLBRA 2054-A	2600	
2054	4/24/2008	21FLBRA 2054-C	4800	
2054	5/16/2008	21FLBRA 2054-B	230	
2054	5/21/2008	21FLBRA 2054-B	580	
95th Percentile Fecal Coliform Concentration			2570	
Percent Reduction to meet TMDL Target			85	

5.5 Margin of Safety

TMDLs shall include a margin of safety (MOS) that takes into account any lack of knowledge about the pollutant loading and in-stream water quality. In this case the lack of knowledge concerns the data, and how well it represents the true water quality. There are two methods for incorporating a MOS in the analysis: 1) implicitly incorporate the MOS using conservative assumptions to develop allocations; or 2) explicitly specify a portion of the TMDL as the MOS

and use the remainder for allocations. In all four TMDLs, an implicit MOS was used by targeting reductions that will result in no more than 5 percent of the samples exceeding a concentration of 400 MPN/100 ml even though the standard requires less than 10 percent exceedance. It should be noted, that in the case of all four TMDLs, a very large portion of the reductions will need to come from non point sources.

5.6 TMDL Determination

The TMDL values represent the maximum daily load the stream can assimilate and maintain water quality standards. The TMDL was determined from the percent reductions required to meet the daily 800 MPN/100 ml WQS and the 400 MPN/100 ml WQS not to be exceeded in more than 10 percent of the samples for Class I and III waters. The TMDL reductions that are required to meet both components of the acute criteria are summarized in Table 16.

Table 16 TMDL Summary

WBID	Parameter	WLA ¹		Load Allocation (% Reduction) ²	TMDL (% Reduction) ²
		WWTP (MPN/Day)	MS4		
1787A	Fecal Coliform	N/A	41%	41% Reduction	41% Reduction
1995	Fecal Coliform	N/A	N/A	68% Reduction	68% Reduction
1997	Fecal Coliform	N/A	N/A	88% Reduction	88% Reduction
2054	Fecal Coliform	N/A	85%	85% Reduction	85% Reduction

Notes:

- 1) The WLA is typically separated into the components originating from continuous NPDES facilities (e.g. WWTPs) and from Municipal Separate Storm Sewers (MS4). WLAs are provided because Horse Creek above Peace River and Myrtle Slough - Marine are within an MS4.
- 2) Overall percent reduction required to achieve the 400 MPN/100 ml fecal coliform criterion. The Margin of Safety is implicit and does not take away from the TMDL value.
- 3) N/A = Not Applicable

5.6.1 Waste Load Allocation

Only NPDES-permitted facilities discharging directly into streams and MS4-permitted urban areas are assigned a WLA. WLAs are expressed separately for municipal and industrial facilities (e.g., WWTPs) and MS4 areas as the former discharge during all weather conditions whereas the latter discharge in response to storm events.

All WBIDS are not currently affected by any NPDES permits. Horse Creek above Peace River (1787A) and Myrtle Slough – Marine (WBID 2054) are affected by MS4 permits. The MS4s that are located within the boundary of the watershed will be responsible for reducing its WLA by the percentage specified in the TMDL table. However, the MS4 permittee will only be responsible for reducing the anthropogenic loads associated with stormwater outfalls it owns or over which it otherwise has responsible control.

5.6.2 Load Allocations

There are two modes of transport for nonpoint source coliform bacteria loading into the stream. First, fecal coliform loading from failing septic systems and animals in the stream are considered direct sources of coliform to the stream, since they are independent of precipitation. The second mode involves coliform loadings resulting from accumulation on land surfaces transported to streams during storm events. Thus, according to this data, the load allocation reductions for all WBIDs should target both direct sources (i.e., failing septic tanks, domesticated animals and livestock in the stream) and rain events since the violations occur during both wet and dry periods.

5.6.3 Seasonal Variation

Seasonality was addressed by using all water quality data associated with the impaired WBID, which was collected during multiple seasons, and where possible over several years. Data for Horse Creek above Peace River was collected throughout 1997 thru 2001, throughout different times during the years. Data for Myrtle Slough – Freshwater was collected throughout 2003, 2004, and 2008 at various times throughout the years. Data for Hawthorne Creek was collected in 1999 and 2008 with there only being a total of 5 measurements, all of which occurred during the spring. Data for Myrtle Slough – Marine was collected in 2003, 2004, and 2008, with measurements occurring throughout different times of the year.

5.7 Recommendations

It is recommended that flow be measured at the time of sampling so that loads can be calculated. Determining the source of bacteria in waterbodies is the initial step to implementing a coliform TMDL. FDEP employs the Basin Management Action Plan (B-MAP) as the mechanism for developing strategies to accomplish the necessary load reductions. Components of a B-MAP are:

- Allocations among stakeholders
- Listing of specific activities to achieve reductions
- Project initiation and completion timeliness
- Identification of funding opportunities
- Agreements
- Local ordinances
- Local water quality standards and permits
- Follow-up monitoring

REFERENCES

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APPENDIX A: WATER QUALITY DATA ANALYSIS

Table A-1 Guide to Water Quality Remark Codes (Rcode column in data tables)

Remark Code	Definition	Use in TMDL
A	Value reported is mean of two or more samples	Data included in analysis as reported
B	Result based on colony counts outside the acceptable range	Data included in analysis as reported
E	Extra sample taken in compositing process	Data included as average
I	The value reported is less than the practical quantification limit and greater than or equal to the method detection limit.	Data included in analysis as reported
J	Estimated. Value shown is not a result of analytical measurement.	Data included in analysis as reported
K	Off-scale low. Actual value not known, but known to be less than value shown	Data included in analysis as reported
L	Off-scale high. Actual value not known, but known to be greater than value shown	Data included in analysis as reported
Q	Sample held beyond normal holding time	Data used in analysis – holding samples on ice slows the metabolism of the organisms resulting in no appreciable growth. Actual concentration is expected to be at least as high as the value reported.
T	Value reported is less than the criteria of detection	Data included in analysis if the reported value is below criteria; otherwise, reported value is not used in the analysis
U	Material was analyzed for but not detected. Value stored is the limit of detection.	Data not included in analysis
<	NAWQA – actual value is known to be less than the value shown	Data included in analysis
Z	Too many colonies were present to count (TNTC), the numeric value represents the filtration volume	Data not included in analysis

Table A-2 Fecal Coliform Data and Percentiles for WBID 1787A

Date	Station	Result	Rcode	Rank	Percentile by Hazen Method
6/5/2000	21FLTPA 25022976	1		1	3
6/7/2000	21FLTPA 25022979	1		1	3
6/7/2000	21FLTPA 25022985	12		3	15
2/28/2001	21FLTPA 25022979	20		4	21
9/11/2000	21FLTPA 25022985	50		5	26
9/13/2000	21FLTPA 25022979	75		6	32
9/13/2000	21FLTPA 25022989	85		7	38
4/13/1998	21FLA 25020111	100	B	8	44
4/11/2001	21FLFTM 25020111	100	B	8	44
2/26/2001	21FLTPA 25022985	130		10	56
2/28/2001	21FLTPA 25022976	170		11	62
9/13/2000	21FLTPA 25022976	180		12	68
1/16/1997	21FLA 25020111	190		13	74
8/19/1997	21FLA 25020111	340		14	79
11/20/1997	21FLA 25020111	440		15	85
6/4/2001	21FLFTM 25020111	580		16	91
4/24/1997	21FLA 25020111	1060		17	97

Table A-3 Water Quality Data and Percentiles for WBID 1995

Date	Station	Result	Rcode	Rank	Percentile by Hazen Method
4/15/2008	21FLBRA 1995-A	25		1	3
4/8/2008	21FLBRA 1995-A	52		2	10
5/24/2004	21FLFTM 25020641FTM	60		3	17
5/24/2004	21FLFTM 25020639FTM	80		4	23
1/13/2004	21FLFTM 25020643FTM	90		5	30
3/10/2004	21FLFTM 25020639FTM	220		6	37
3/10/2004	21FLFTM 25020643FTM	220		6	37
11/5/2003	21FLFTM 25020641FTM	260	B	8	50
11/5/2003	21FLFTM 25020643FTM	260	B	8	50
3/10/2004	21FLFTM 25020641FTM	280		10	63
5/24/2004	21FLFTM 25020643FTM	340		11	70
9/30/2003	21FLFTM 25020639FTM	630	J	12	77
1/13/2004	21FLFTM 25020641FTM	1140		13	83
1/13/2004	21FLFTM 25020639FTM	1180		14	90
11/5/2003	21FLFTM 25020639FTM	1400	J	15	97

Table A-4 Water Quality Data and Percentiles for WBID 1997

Date	Station	Result	Rcode	Rank	Percentile by Hazen Method
4/8/2008	21FLBRA 1997-A	540		1	10
4/8/2008	21FLBRA 1997-C	650	B	2	30
3/30/1999	21FLTPA 25020264	1340		3	50
5/12/2008	21FLBRA 1997-A	2000		4	70
3/30/1999	21FLTPA 25020264	3700		5	90

Table A-5 Water Quality Data and Percentiles for WBID 2054

Date	Station	Result	Rcode	Rank	Percentile by Hazen Method
5/24/2004	21FLFTM 25020432	10		1	2
5/24/2004	21FLFTM 25020646FTM	10		1	2
3/10/2004	21FLFTM 25020553	40		3	11
4/1/2008	21FLBRA 2054-B	65		4	16
3/10/2004	21FLFTM 25020529	80		5	20
1/13/2004	21FLFTM 25020432	140		6	25
5/24/2004	21FLFTM 25020553	200		7	30
5/16/2008	21FLBRA 2054-B	230		8	34
9/30/2003	21FLFTM 25020553	240		9	39
12/15/2003	21FLFTM 25020553	260		10	43
12/15/2003	21FLFTM 25020432	300		11	48
3/10/2004	21FLFTM 25020432	300		11	48
9/30/2003	21FLFTM 25020432	320		13	57
5/21/2008	21FLBRA 2054-B	580		14	61
9/30/2003	21FLFTM 25020529	600	L	15	66
5/24/2004	21FLFTM 25020529	600		15	66
12/15/2003	21FLFTM 25020529	710	J	17	75
1/13/2004	21FLFTM 25020553	900		18	80
1/13/2004	21FLFTM 25020529	1000		19	84
4/1/2008	21FLBRA 2054-C	2000		20	89
4/24/2008	21FLBRA 2054-A	2600		22	98
4/24/2008	21FLBRA 2054-C	4800		23	100

In this TMDL the Hazen formula was used since it is recommended in Hunter's Applied Microbiology (2002) article concerning bacteria in water. To calculate the percentile associated with the sample concentrations the data are first sorted by concentration, lowest to highest. A ranking is assigned to each sample, with the lowest concentration having a rank of 1 and the highest concentration having a rank equivalent to the total number of samples collected. The percentile is calculated as follows:

$$\text{Percentile} = (\text{Rank} - 0.5) / (\text{total number of samples collected})$$

For example, for WBID 2054 on December 15, 2003 a fecal coliform concentration of 260 MPN/100ml was measured at station 21FLFTM 25020553. This concentration ranks number 10 out of 23 samples collected in Horse Creek above Peace River. The associated percentile is calculated as:

$$\text{Percentile} = (10 - 0.5) / 23 = 0.43 = 43\%$$

This implies that 43 percent of the time the instream concentration is less than 260 MPN/100ml.