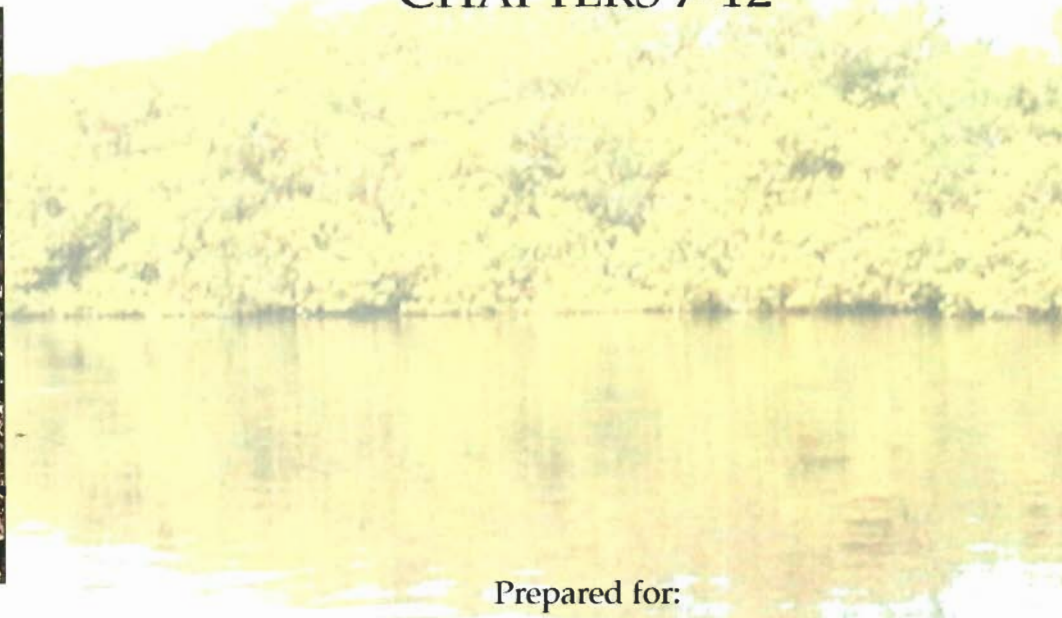




LITTLE MANATEE RIVER WATERSHED MANAGEMENT PLAN

FINAL REPORT
CHAPTERS 7-12



Prepared for:



Hillsborough County
Board of County Commissioners

Prepared by:



JUNE, 2002



06/705-02

LITTLE MANATEE RIVER WATERSHED MANAGEMENT PLAN

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June 2002

John B. Adams, Jr.
06/06/02

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CHAPTER 7

EXISTING WATER QUALITY CONDITIONS

This Chapter provides a description of the existing water quality in the LMR watershed and addresses water quality conditions in streams, lakes, and groundwater. Water quality issues that potentially affect the watershed are discussed and examined with respect to state standards for designated uses.

The Little Manatee River, along with the Alafia River, receives the greatest surface runoff volume in west central Florida. Water quality is generally good in the LMR Watershed, although streamflow and water quality data indicate agricultural runoff, originally pumped from the deep aquifer, contributes to dry season flows and pollutant loadings. Other anthropogenic impacts in the watershed include a diversion to the 4,000-acres off-stream reservoir that supplies cooling water for the Florida Power and Light power plant (the diversion occurs about 3.3 miles upstream of U.S. Highway 301) and the IMC mining operations. The IMC mines are located along the eastern boundary of the watershed and comprise about 6 percent of the land use in the watershed. These facilities have permitted National Pollutant Discharge Elimination System (NPDES) discharges into the LMR system.

Regional natural resource management programs that affect the Little Manatee River are either being implemented or developed through the programs briefly described below:

- Tampa Bay Estuary Program Comprehensive Conservation and Management Plan (CCMP). The Plan was approved by the U.S. Environmental Protection Agency (EPA), Governor Lawton Chiles, and the Tampa Bay Estuary Program (TBEP) Management Conference in early 1997 and is in its early implementation phase.
- Southwest Florida Water Management District (SWFWMD) Surface Water Improvement and Management (SWIM) Plan for Tampa Bay (SWFWMD 1992) addresses water quality, natural systems, land use, and watershed management. Numerous environmental characterization studies and habitat restoration/creation projects have been completed to implement the SWIM Plan.
- SWFWMD Comprehensive Water Management Program for the Little Manatee River. The program was charged with developing a resource management plan. The July 2000 Plan serves as a comprehensive guide to the district in carrying out its water resource management responsibilities.

7.1. REVIEW OF WATER QUALITY DATA AND COMPARISON TO STATE WATER QUALITY STANDARDS

The Little Manatee River has historically good water quality and, of the rivers flowing to Tampa Bay, it is in the best hydrobiological condition (Estevez *et al.* 1991). Both Cockroach Bay and a

large portion of the Little Manatee River have been designated Outstanding Florida Waterbodies by the State of Florida. As such, these waterbodies are afforded the highest level of water quality protection. FDEP has reported water quality in the Little Manatee as *good* (Paulic and Hand 1998) and EPA reported Index of Watershed Indicators for the Little Manatee River as “better quality” and “low vulnerability” (EPA 1999). In addition, 87 miles of the river meet designated uses and the river is not targeted for the upcoming total maximum daily loads (TMDL) program by FDEP (Paulic and Hand 1998).

Several sources of water quality data for the Little Manatee River were identified for the purposes of this characterization (**Table 7-1**). Water quality data from various sources, such as FDEP, the Environmental Protection Commission of Hillsborough County (EPCHC), and the U.S. Geologic Survey (USGS) are examined and the following topics are presented:

- a comparison of water quality in the watershed with state water quality standards;
- a water quality characterization of the Little Manatee River, Cockroach Bay, local lakes; and groundwater;
- an analysis of trends in water quality in the watershed; and
- a summary of pollution sources within the watershed.

Table 7-1. Water quality data for the Little Manatee River (see map for station locations) and the format in which it is available.			
Agency	Period of Record	Water Quality Parameters	Format
EPCHC	1972 - present	BOD, DO, chlorophyll, color, conductivity, depth, metals, N and P species, salinity, TSS, temperature, turbidity	Digital
USGS	variable: 1957 - present	conductivity, pH, temperature, color, DO, metals, ions, TSS, N species, P species, silica.	Digital- USGS web site
EPA/ STORET FDEP/ SWAMP	1984 - present	temperature, pH, TOC, BOD, COD, DO, TSS, color, turbidity, N, P, chlorophyll, TSI	Digital – EPA and FDEP websites
FDEP/FIMP -	1991- present	Data collected as part of monitoring program: temperature, conductivity, N, DO, depth, salinity, turbidity, pH, nutrients, chlorophyll	Digital
SWFWMD	1978 - present	20 lab parameters and 3 field parameters; continuous conductivity and tidal stage	Digital
FDEP/FMRI -	1988 - present	Data collected as part of monitoring program: temperature, conductivity, DO, salinity, turbidity, pH, N, nutrients, chlorophyll	Digital
USF	1989 - 1990	temperature, conductivity, salinity, irradiance, nutrients, POC, chlorophyll	Digital
IMC-Agrico	1995 - present	pH, DO, conductivity, turbidity, TSS, TP, ortho-P, TN, sulfates, chlorophyll	Digital

While the data available are numerous, they were collected with varying objectives, at different spatial and temporal scales, and often using different methods. Because of this, data comparison and combining data from different sources was not considered a valid approach.

7.2 EXISTING WATER QUALITY AND STATE WATER QUALITY STANDARDS

The State of Florida has classified the state's waterbodies according to their use as shown below. For example, Class II Waters should be suitable for shellfish harvesting, Class III Waters should be suitable for recreation (fishing, body contact, etc.). In addition, minimum water quality standards have been established for each class (62-302.530 FAC).

- Class I waters. Drinking water.
- Class II waters. Shellfishing.
- Class III. Recreation, fish and wildlife.
- Class IV. Agricultural use.
- Class V. Industrial use.

In addition, the State has designated specific waterbodies as Outstanding Florida Waters (OFWs). These waterbodies have additional levels of protection beyond water quality standards. Most water quality standards are numerical criteria stated as maximum or minimum chemical concentrations. However, standards for nutrients, for example, do not include numeric criteria. Nutrient standards prohibit significant imbalances to the natural system due to increased nitrogen or phosphorus releases, but do not provide criteria on how to define significant imbalances. The Little Manatee River is classified as a Class III waterbody. The OFW designation applies to the segment from the mouth of the river to the western crossing of the river by S.R. 674, including Hayes, Mill and Bolster Bayous, but excluding South Fork, Ruskin Inlet and all other tributaries.

To assess water quality in streams, FDEP developed a water quality index (WQI) based on conditions of six categories: water clarity (measured as turbidity); dissolved oxygen (DO); oxygen demand [measured as 5-day biochemical oxygen demand (BOD)]; bacteria; nutrient concentration; and biological diversity. Index values correspond to the percentile distribution of stream water quality in the State. The WQI for a stream is the arithmetic average of the six categories. However, by correlation with the USEPA National Profiles Water Quality Index, values were established to categorize the streams as *good*, *fair*, or *poor* water quality. Based on this correlation, ranges for the stream WQI were determined by FDEP as follows:

- 0 to 44 = Good
- 45 to 59 = Fair
- 60 to 90 = Poor

The Florida Water Quality Assessment 305(b) Report is published every two years by FDEP (Hand *et al.* 1996) and contains water quality data for Florida streams in terms of the WQI. The 1996 305(b) Report classifies segments of the LMR as shown in **Table 7-2**.

Table 7-2. Surface water designations for portions of the Little Manatee River reported by Hand <i>et al.</i> (1996). Major subbasin designations in which the FDEP subbasins occur are listed in parentheses.	
FDEP Subbasin	FDEP designation
Lower LMR (Lower Middle LMR)	<i>Good</i> (basins south of the river) <i>Fair</i> (most of basin north of river)
LMR near Wimauma (Upper Middle LMR)	<i>Good</i> (Dug Creek) <i>Fair</i> (remainder of subbasin)
LMR North Fork (Upper LMR)	<i>Good</i> (entire reach)
LMR Ft. Lonesome (IMC mine)	<i>Good</i> (main stem) <i>Fair</i> (mined area of Alderman Creek)
LMR South Fork (LMR South Fork)	<i>Fair</i> (main stem) <i>Good</i> (all tributaries)
Cypress Creek LMR (Upper Middle LMR)	<i>Good</i>
Dug Creek (Upper Middle LMR)	<i>Good</i>
Carlton Branch (Upper Middle LMR)	<i>Good</i>

A review of summarized water quality data in the 305(b) Report (Hand *et al.* 1996) indicates Cockroach Bay has higher turbidity (mean = 7.0 mg/l), lower Secchi depth (0.6 meter), lower dissolved oxygen (4.7 mg/l), higher total nitrogen (TN) (0.99 mg/l), higher total phosphorus (TP) (0.38 mg/l), higher chlorophyll *a* (10 µg/l), higher total coliform bacteria (58 mpn/100 ml), and fecal coliform bacteria (43 mpn/100 ml) than either the adjoining waters of Middle Tampa Bay or Bishops Harbor to the south.

The trophic state index (TSI) is used to rank and classify Florida estuaries according to their chlorophyll *a* levels and nitrogen and phosphorus concentrations. A 10-unit change in the TSI represents a doubling or halving of the algae biomass. A TSI below 50 indicates *good* estuarine water quality, while 50-59 indicates *fair* water quality, and 60-100 is classified as *poor* water quality (Huber *et al.* 1982; Paulic and Hand 1992). TSI values (Huber *et al.* 1982) provide a means of:

- comparing overall trophic conditions between estuaries;
- evaluating the direction and rate of change;
- developing empirical models of trophic conditions as functions of watershed “enrichment” factors; and
- conveying scientific information about water quality to the public.

The TSI reported by FDEP for Cockroach Bay was 56. This value is relatively high compared to other areas of Tampa Bay, but is lower than the TSI calculated in 1992 (64), which was the highest TSI of any named estuarine feature in Tampa Bay at that time. It should be noted that, although pollutant inputs to Cockroach Bay may be elevated relative to other nearby estuarine areas, circulation in Cockroach Bay is very limited, and may well contribute significantly to the lower water quality reported.

Over 4,000 acres in and around Cockroach Bay are classified as Class II waters for shellfish harvesting. However, elevated fecal coliform levels in the bay led to a classification by FDEP inspectors as "approved but temporarily closed" (Paulic and Hand 1994). Additionally, the National Oceanic and Atmospheric Administration (NOAA) Mussel Watch Program identified an increasing trend in lead in Cockroach Bay oyster tissues, based on 1986 to 1990 data (Paulic and Hand 1994).

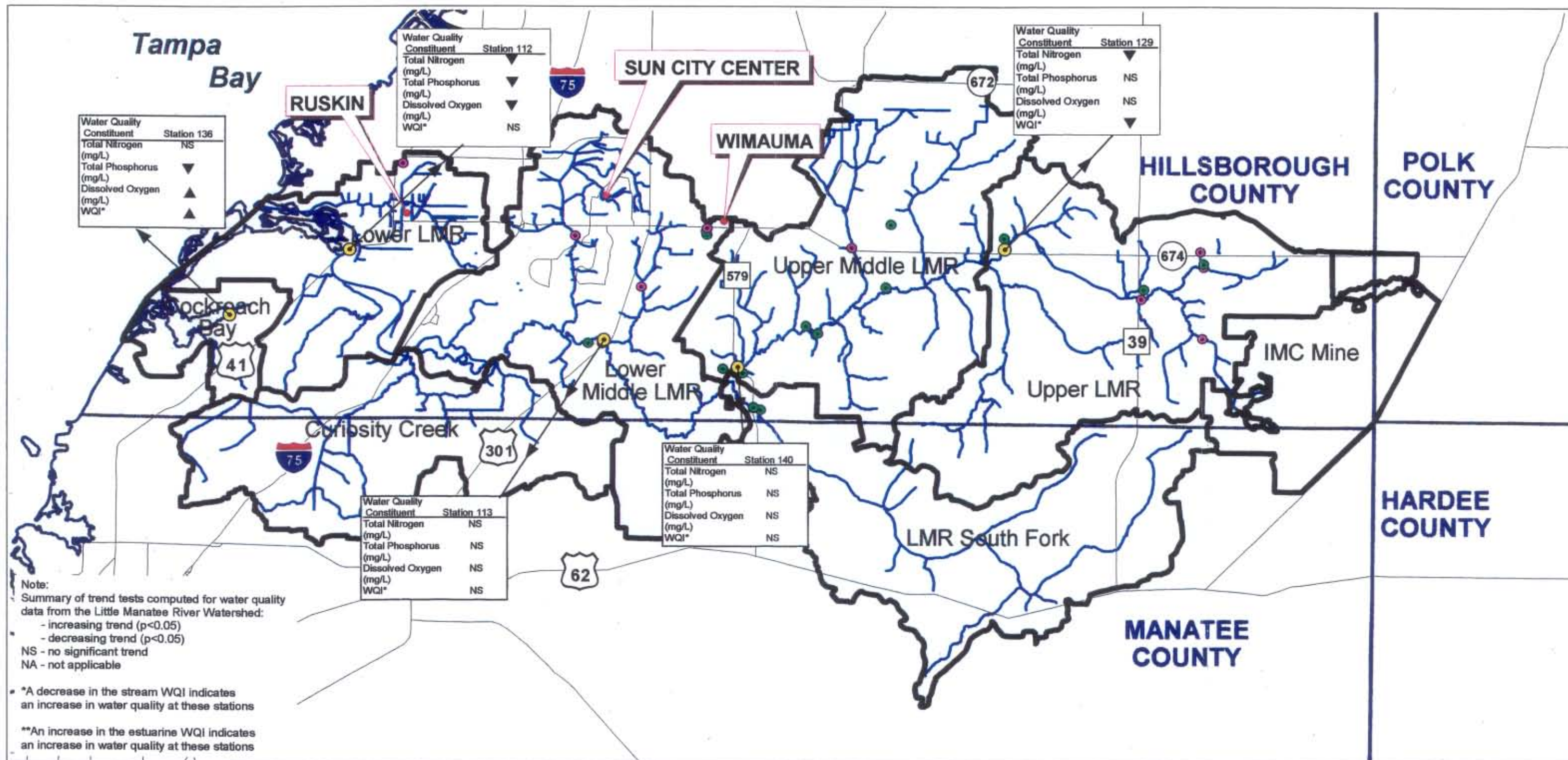
Water quality in the Little Manatee River is considered to range from *good* to *fair*. *Good* water quality is reported for the entire watershed except for the basins adjacent to the main stem and North Fork (Hand *et al.* 1996). There are no severe water quality problems reported, but elevated nutrient and bacteria levels are attributed to agricultural (pesticide and nutrients) and range land (bacteria and nutrients) in the upstream reaches, and on agriculture, septic tanks, package WWTPs, and fish farms in the downstream reaches. Encroaching residential development, agricultural irrigation, and phosphate mining activities are cited as potential threats to water quality in the Little Manatee River in the future.

Sediment quality is also a concern in the LMR Watershed, according to the 1996 305(b) Report (Paulic and Hand 1994). The 1994 305(b) report lists polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyl (PCB), and pesticides as contaminants of concern for Cockroach Bay, based on data obtained from the Florida Coastal Sediment Contaminants Atlas (Seal *et al.* 1994). It should be noted that the contaminants referenced as of concern for oyster tissue and sediment contamination are mostly chemicals that are no longer in use in the United States. Lead has been phased out as a gasoline additive, and PCBs and most persistent pesticides are not in common use. Thus it is possible that levels of these chemicals observed now are residuals from past applications.

7.3 LITTLE MANATEE RIVER AND COCKROACH BAY - EPCHC DATA

The EPCHC has reported monthly water quality observations from five stations in the Little Manatee River and Cockroach Bay from 1974 to present. The locations of these are presented in **Figure 7-1** and listed below:

- Station 136 - located in Cockroach Bay
- Station 112 - located at the U.S. 41 bridge



Department of Public Works
Stormwater Management Section



Monitoring Stations

- Florida Department of Environmental Protection (FDEP)
- Environmental Protection Commission of Hillsborough County (EPCHC)
- US Geological Survey (USGS)

Legend



2 0 2 Miles

September, 2000

- Cities
- Little Manatee River
- County Boundary
- Major Basin Boundary
- Water

Little Manatee River Watershed Management Plan

Figure 7-1 Monitoring Station Locations



- Station 113 - located at the U.S. 301 bridge
- Station 140 - located at the S.R. 579 bridge
- Station 129 - located at the S.R. 674 bridge

The County Streamwatch Program also maintains a station supported by volunteer efforts located at 24th Street.

The long-term monitoring by the EPCHC provides the data necessary to examine long-term temporal patterns in water quality for the Little Manatee River. Salinity, dissolved oxygen (DO), and nutrient data from the EPCHC are reported in the following sections and are also discussed in relation to temporal patterns. EPCHC data were graphed as time series plots and selected parameters were analyzed for trends based on the FDEP Surface Water Ambient Monitoring Program (SWAMP) trend analysis (**Table 7-3**). To identify stream trends, a nonparametric correlation analysis (Spearman's Ranked Correlation) was applied to trend information from eight water quality parameters (bacteria, turbidity, TSS, BOD, DO, Secchi depth, nitrogen, and phosphorus) in addition to the overall WQI. Estuary trend analysis focused on four trophic state parameters (chlorophyll, Secchi depth, nitrogen, and phosphorus) in addition to the TSI.

SWAMP was begun in 1991 to better address the federal and state water quality management and assessment requirements. It was not designed to identify causes of pollution, monitor compliance of point sources, or allow a thorough detailed understanding of an ecosystem, but rather to screen waterbodies to provide a broad assessment of water quality. Information generated from this program would be used to develop total maximum daily loads (TMDLs), identify waterbodies for more detailed studies, and potentially identify waterbodies for restoration and rehabilitation.

All EPCHC stations are sampled monthly. Freshwater sites are sampled just below the surface and estuarine sites are sampled just below the surface, at mid-depth, and just above the bottom.

Salinity

Mean annual salinities at EPCHC Station 136 (Cockroach Bay) range from less than 15 ppt to nearly 25 ppt. These salinities are consistently higher than salinities at Station 112 on the Little Manatee River (located at U.S. 41) where average annual salinities ranging from approximately 6 ppt to 14 ppt. (**Figure 7-2**). Stations 113, 140, and 129, occur in freshwater conditions upstream of tidal influence. The estuarine portion of the Little Manatee River extends approximately 9.9 miles above Shell Point to the upstream extent of the 0.5 ppt isohaline during average low flows (Fernandez 1985). Upstream of the 0.5 ppt isohaline, the system is freshwater.

Figure 7-2 Mean annual salinities (ppt)
at EPCHC stations 112 and 136 in the Little Manatee River (1974-1998)

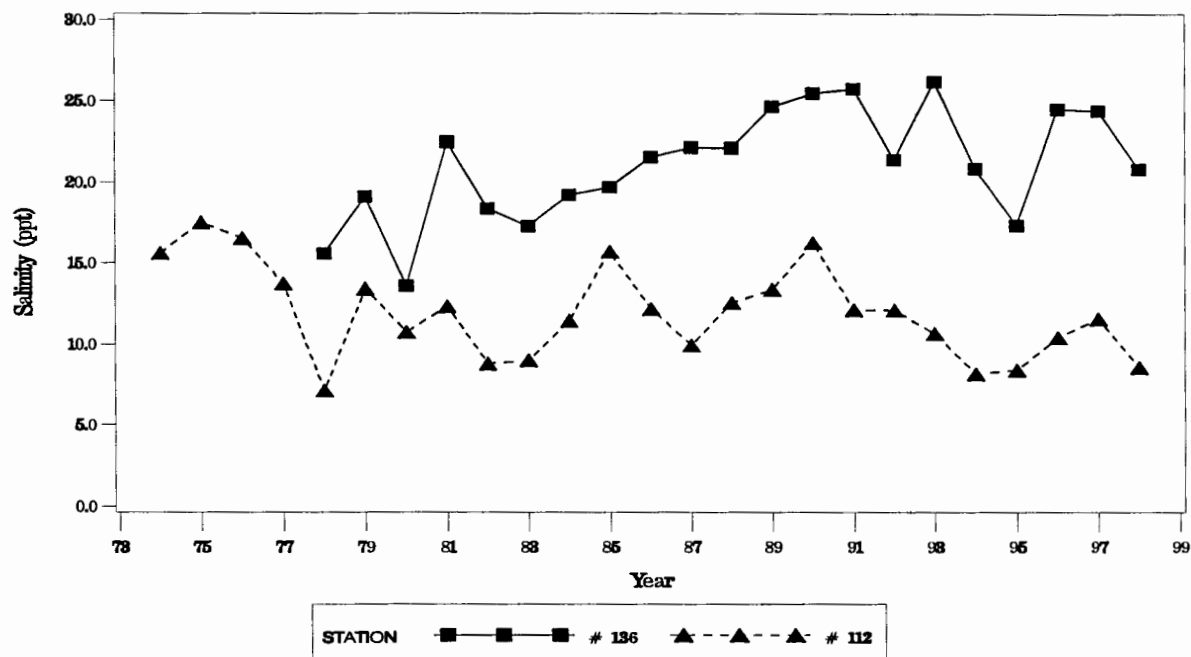


Table 7-3. Summary of trend tests computed for water quality data from the Little Manatee River Watershed. ▲ - increasing trend in water quality ($p < 0.05$); ▼ - decreasing trend in water quality ($p < 0.05$); NS indicates no significant trend; ID – insufficient data; NA – not applicable.					
Water Quality Constituent	Station 112	Station 113	Station 129	Station 136	Station 140
Salinity (ppt, mid-depth)	NS	NA	NA	NS	NA
Total Nitrogen (mg/l)	▼	NS	▼	NS	NS
Total Phosphorus (mg/l)	▼	NS	NS	▼	NS
Chlorophyll <i>a</i> (µg/l)	NS	NS	NS	NS	NS
Total Suspended Solids (mg/l)	NS	NS	NS	ID	▼
Dissolved Oxygen (mg/l)	▼	NS	NS	▲	NS
Conductivity (mid-depth, µmhos/cm)	▼	NS	NS	NS	NS
WQI	NS	NS	▲	▲	NS
TSI	▼	NS	▲	▲	▲

Total Nitrogen and Total Phosphorus

Excessive nutrient enrichment (eutrophication) has been identified by the Tampa Bay Estuary Program (TBEP) as an issue of high priority in the Tampa Bay system overall. Concentrations of the nutrient parameters total nitrogen (TN) and total phosphorus (TP) over the period of record are plotted in **Figures 7-3(a) and (b) and 7-4(a) and (b)**. Trends over time are presented in Table 7-3.

Nitrogen is the limiting nutrient in the LMR watershed, a result of natural phosphate deposits in the watershed and the abundance phosphate in the Little Manatee River and Cockroach Bay. Mean annual TN concentrations for the four Little Manatee River stations (112, 113, 140, and 129) and the Cockroach Bay station (136) exhibited a large TN peak in 1987 when a large storm occurred and another, smaller peak associated with a large storm in 1992. Mean annual TN concentrations at EPCHC stations 112 and 136 ranged from approximately 0.7 mg/l to 1.7 mg/l [Figure 7-3(a)].

Mean values at the estuarine station (112) and the Cockroach Bay station (136) were slightly higher, especially for the last 7 years, when compared with the upstream stations. Mean TN values for the entire period of record were 1.1 for Station 112 and 1.19 for Station 136. Trend

Figure 7-3(a). Mean annual TN concentrations (mg/l)
at EPCHC stations 112 and 136 in the Little Manatee River (1982-1998)

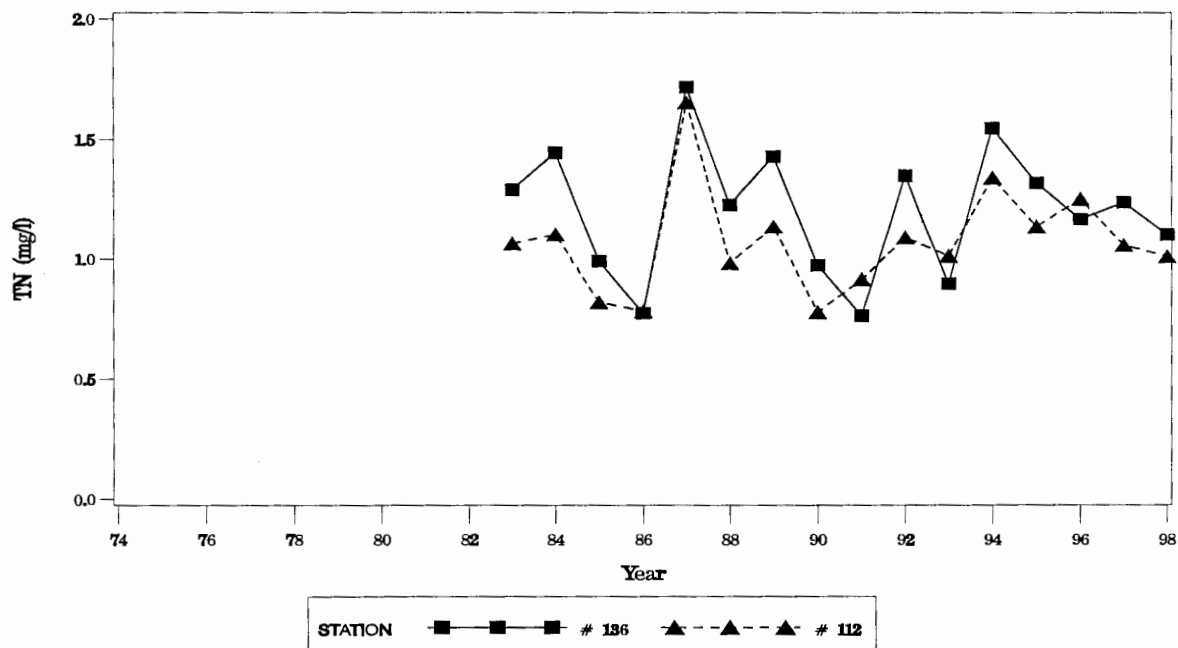


Figure 7-3(b). Mean annual TN concentrations (mg/l)
at EPCHC stations 113, 140 and 129 in the Little Manatee River (1982-1998)

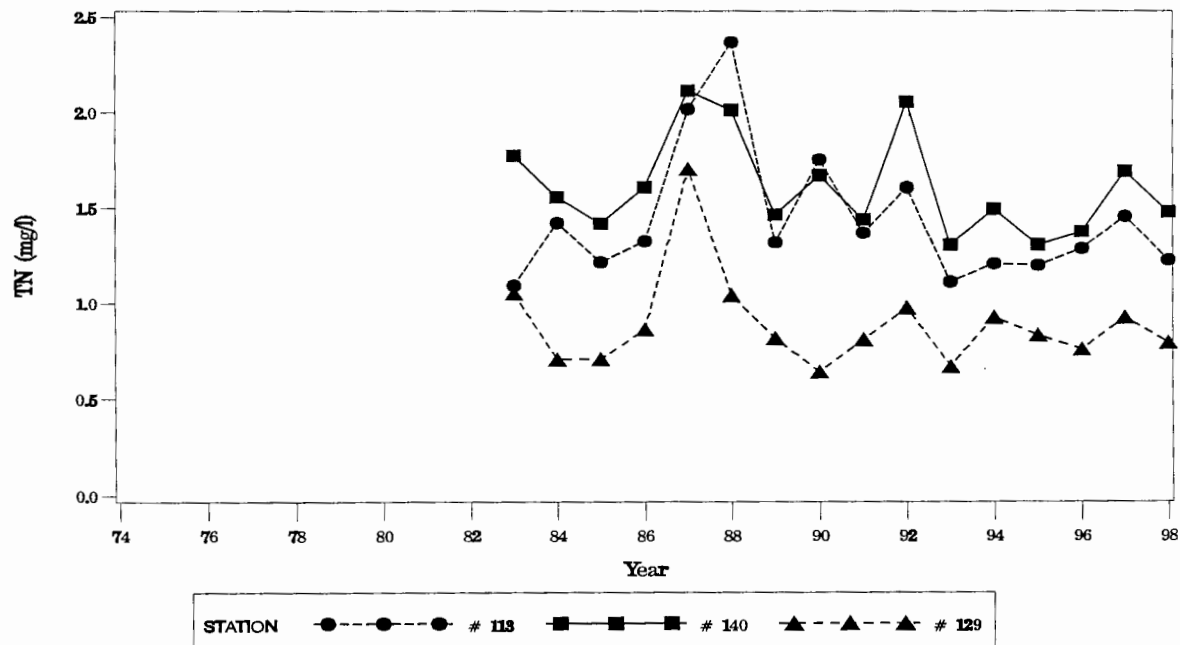


Figure 7-4(a). Mean annual TP concentrations (mg/l)
at EPCHC stations 112 and 136 in the Little Manatee River (1974-1998)

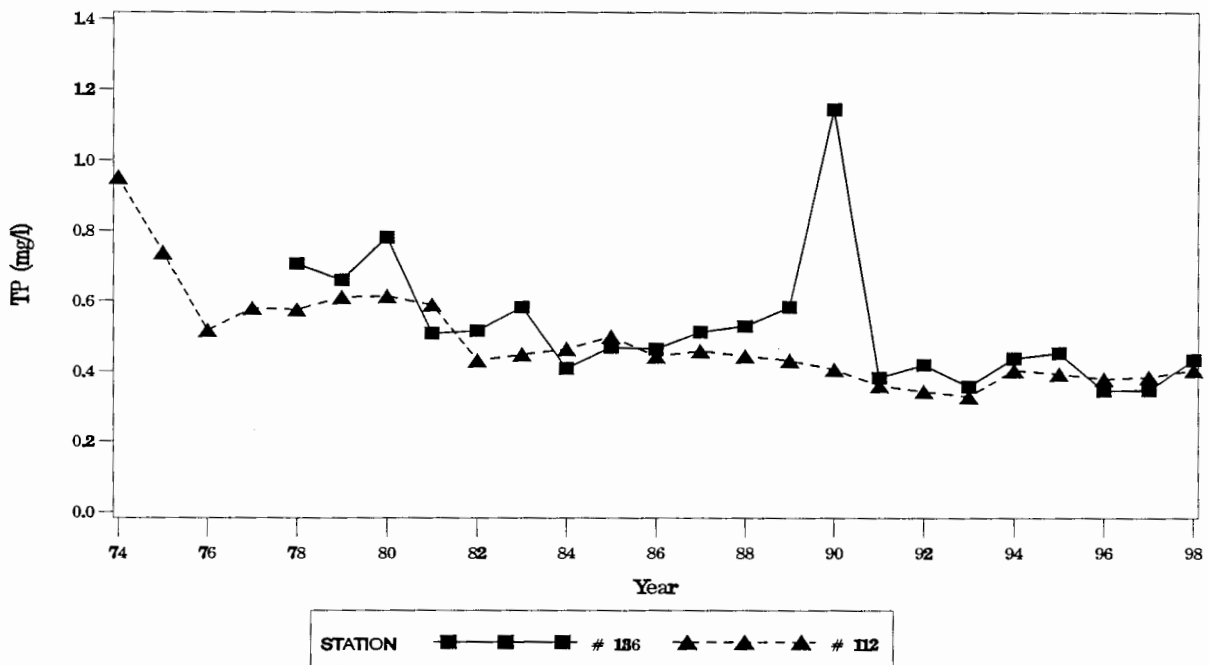
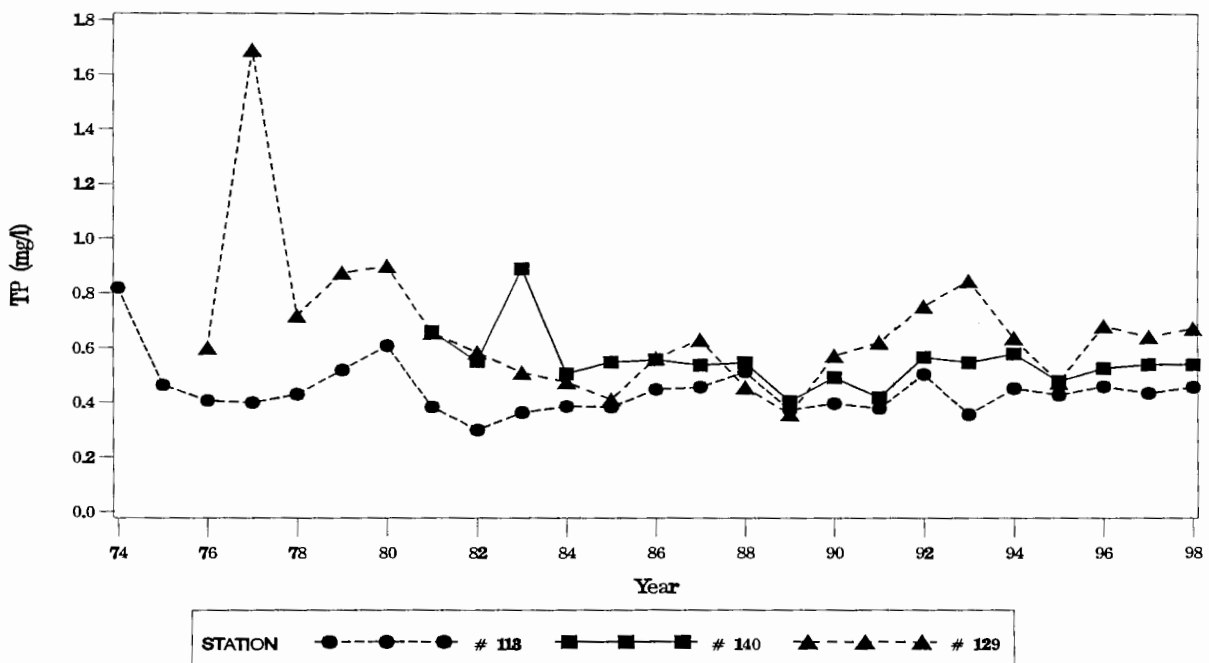


Figure 7-4(b). Mean annual TP concentrations (mg/l)
at EPCHC stations 113, 140 and 129 in the Little Manatee River (1974-1998)



tests over the period of record (Table 7-3) indicated a decrease in mean annual TN values at the downstream Station 112, but not in Cockroach Bay. Overall mean TN values for both stations are considered *fair* values used in calculating TSI for estuaries (Paulic and Hand 1998). TN values greater than 1.2 mg/l are considered characteristic of *poor* water quality.

At the riverine stations, mean TN values for the period of record were 1.4 mg/l at Station 113, 1.6 mg/l at Station 140, and 0.9 mg/l at Station 129. Mean annual TN values were consistently lowest at Station 129, the farthest station upstream [Figure 7-3(b)] and trends in TN concentrations over the period of record also indicated a significant decrease at Station 129 (Table 7-3). Station 129 is located in the northeastern portion of the watershed and includes the Ft. Lonesome area and IMC mining subbasins.

Mean annual TN values at Station 129 are in the upper 30th percentile (0.9 mg/l) of Florida streams, indicating good water quality. In contrast, stations 113 and 140 fall within the 60th to 70th percentile (1.4 – 1.6 mg/l), indicating poorer water quality when compared with most Florida streams.

Nitrogen values in this portion of the watershed were described as reflecting pre-development (natural) conditions in a study of nutrient loading in the Little Manatee Watershed conducted by Flannery *et al.* (1991). These results were largely attributable to the undeveloped and less intense land uses in the northeastern portion of the watershed around Ft. Lonesome, compared with the more intensely developed Upper Middle major subbasin, including the Lake Carlton and Lake Wimauma subbasins. Mean TN values for stations 113 and 140 are consistently higher than for Station 129, ranging from 1.0 mg/l to almost 2.5 mg/l, compared with 0.5 mg/l to 1.7 mg/l at Station 129.

Mean annual TP concentrations and variations in values were lower at stations 136 (Cockroach Bay) and 112 (estuarine). Both stations 136 and 112 on the Little Manatee River had significant decreases in mean annual TP values over the period of record (Table 7-3). Mean annual TP values at Station 136 (Cockroach Bay) ranged from approximately 0.3 to 1.2 mg/l and values at Station 112 ranged from approximately 0.3 to 1.0 mg/l [Figure 7-4(a)]. These TP values fall within the *poor* categories for estuaries in the state.

Mean annual TP concentrations did not change significantly at the three upstream stations for the period of record (Table 7-3). Except for a peak in 1977 (1.7 mg/l), average TP values ranged from 0.3 to 0.9 at these upstream stations [Figure 7-4(b)]. The highest average TP concentrations for the period of record were reported at upstream stations 129 and 140.

TP values at the upstream stations are higher than 70 percent of TP values reported for Florida streams (Hand *et al.* 1996). Concentrations at the three upstream sites are high for surface waters, but reflect high background levels of phosphorus from the Bone Valley geologic formation underlying the Little Manatee River. Particulate phosphorus values have been reported to be lowest for the northeastern portion of the basin, and again likely a result of less

intense land uses in this portion of the watershed and the commensurately small amount of urban use and crop lands (9 percent) (Flannery *et al.* 1991).

Chlorophyll *a*

Annual average chlorophyll *a* concentrations generally correspond to annual rainfall as a result of increased nutrient loading associated with increased rainfall and stormwater runoff. High chlorophyll *a* concentrations generally represent high nutrient loading and long residence times more characteristic of channeled streams and lakes in urban areas. In Cockroach Bay, mean annual chlorophyll *a* concentrations were relatively high, ranging from approximately 10 µg/l to nearly 35 µg/l and were similar to those reported for Hillsborough Bay (EPCHC 1997). Station 112, however, had a mean chlorophyll *a* concentration of 7.7 for the period of record, and a range of approximately 5 µg/l –11 µg/l over the period of record [see **Figure 7-5(a)**]. These chlorophyll values are considered to represent *good* to *fair* water quality conditions when compared with other Florida estuaries.

Upstream stations 113, 140, and 129, as well as the downstream station (112) had lower values with higher variation when compared with the Cockroach Bay (136) station (see Figure 7-5(b)). Mean annual chlorophyll *a* concentrations at Station 129 (farthest upstream) ranged from 1 µg/l to 16 µg/l, except for a large storm peak in 1977. The overall mean for Station 129 was 7.7 µg/l compared with a mean of 3.5 µg/l at Station 140, farther downstream. Mean annual chlorophyll *a* values ranged from 0.6 µg/l at Station 129, to 0.9 µg/l at Station 113, and 1.8 µg/l at Station 140 in 1997.

These values are consistent with trends in other water quality parameters which indicate better water quality associated with less intense land uses above Station 129, and increasing loads farther downstream due to more agriculture and row crops. No significant trends in chlorophyll *a* were found at any of the EPCHC monitoring stations.

Total Suspended Solids

Mean annual concentrations of total suspended solids (TSS) ranged from less than five to nearly 60 mg/l at the downstream and Cockroach Bay stations [**Figure 7-6(a)**]. Data were unavailable beyond 1989 for the downstream and Cockroach Bay stations and data from Station 136 were insufficient to detect whether or not any changes were significant.

At the three upstream stations [**Figure 7-6(b)**], mean annual TSS values were much lower and less variable when compared with the downstream and Cockroach Bay stations. Mean TSS values were below 10 mg/l at stations 140 and 129, although values ranged from approximately two to nearly 20 mg/l at Station 113. Relative to other Florida streams, these TSS values fall within the upper 70 percent in terms of TSS for stations 140 and 129. In contrast, mean annual TSS values at Station 113 exceeded 90 percent of Florida streams, ranking it among the worst in terms of TSS.

Figure 7-5(a). Mean annual Chlorophyll a concentrations (ug/l)
at EPCHC stations 112 and 136 in the Little Manatee River (1974-1998)

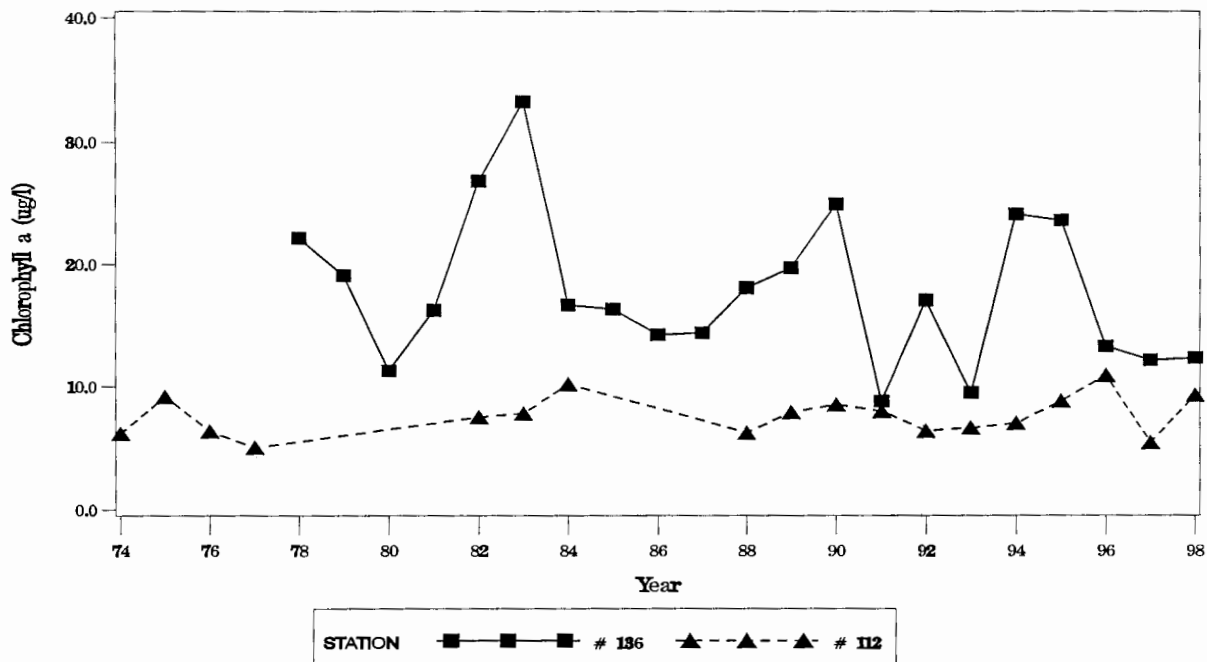


Figure 7-5(b). Mean annual Chlorophyll a concentrations (ug/l)
at EPCHC stations 113, 140 and 129 in the Little Manatee River (1974-1998)

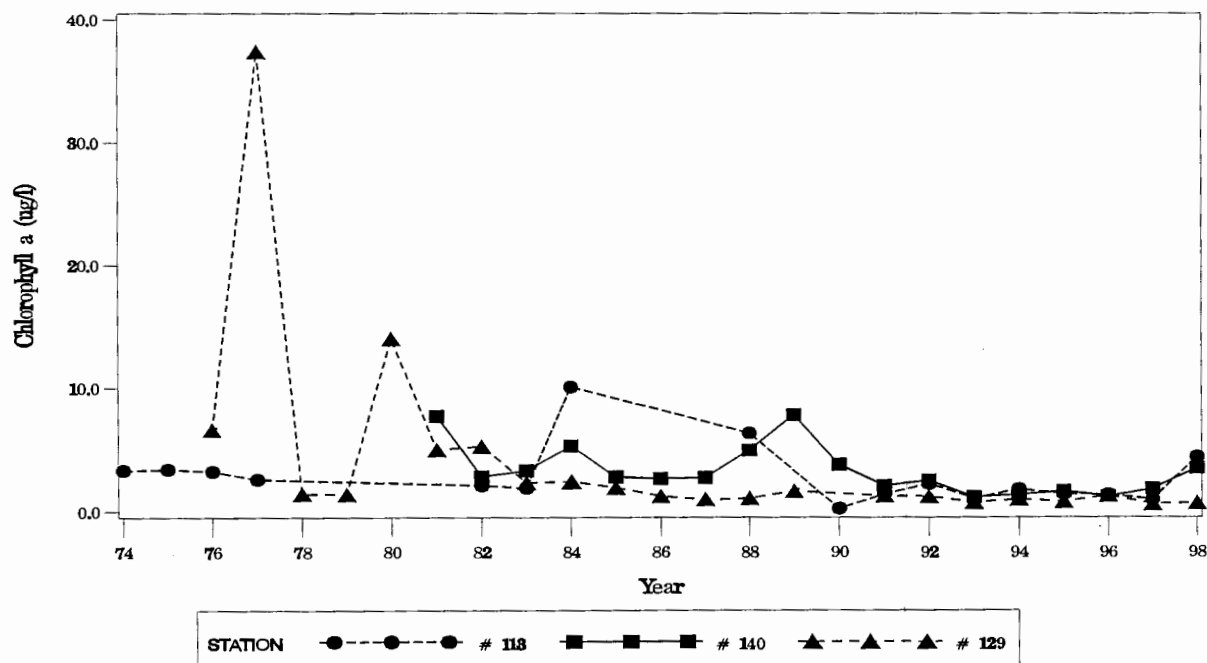


Figure 7-6(a). Mean annual TSS concentrations (mg/l)
at EPCHC stations 112 and 136 in the Little Manatee River (1974-1989)

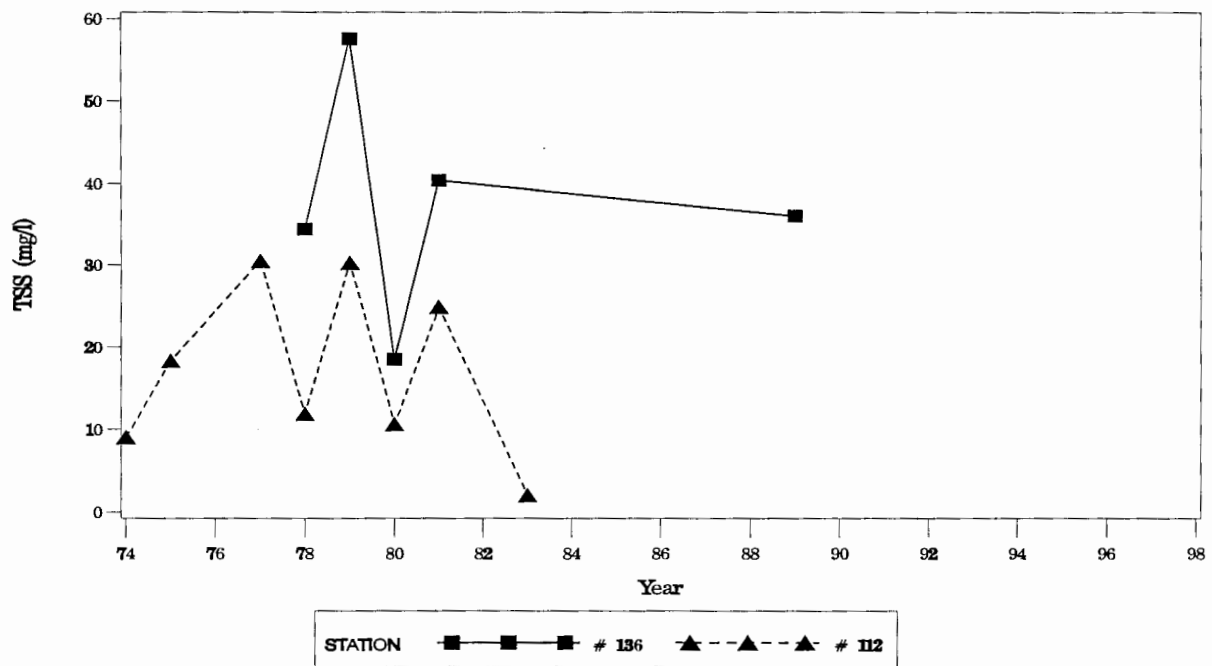
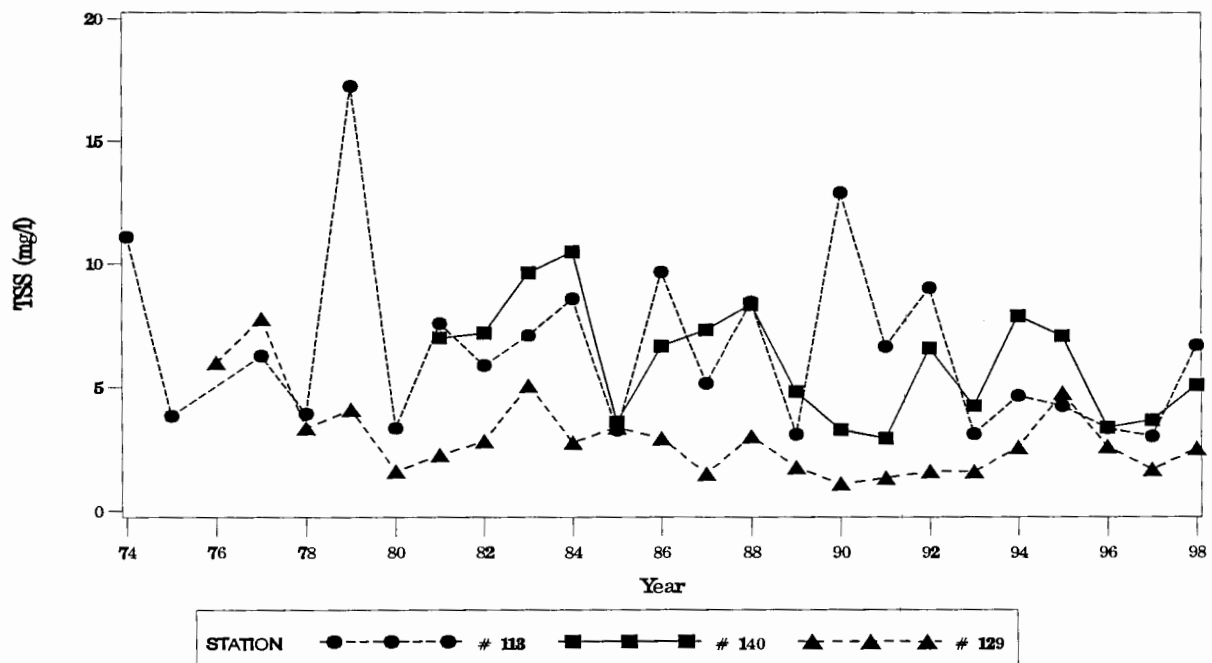


Figure 7-6(b). Mean annual TSS concentrations (mg/l)
at EPCHC stations 113, 140 and 129 in the Little Manatee River (1974-1998)



A significant decrease in TSS occurred only at Station 140, located at the SR 579 bridge. Mean annual TSS values were consistently lower at Station 129. These values reflect generally better water quality conditions of the relatively undeveloped northeastern portion of the watershed in comparison with the Sun City, Wimauma, and Cypress Creek portions of the watershed where stormwater and agricultural runoff and associated increases in particulate matter are greater.

Dissolved Oxygen and Biological Oxygen Demand

DO is a function of several factors, including organic substances, oxygen demand and rate of uptake of benthic deposits, photosynthesis and respiration by plankton, water temperature, freshwater input, and tidal exchange. Mean annual DO values at the downstream and Cockroach Bay stations in the Little Manatee River ranged from 4 to 7 mg/l [**Figure 7-7(a)**] and were similar to values for lower, middle, and old Tampa Bay (EPCHC 1997). These values are low when compared to the median value of 4.0 mg/l in Florida waters (Paulic and Hand 1998) and 5.0 mg/l criteria for Class III waters in Florida, and may result from excessive loadings of particulate carbon and nitrogen, depending on the amount of microbial activity. However, naturally occurring processes in highly colored Florida waters, and estuaries in general, can contribute to low DO values.

Mean annual DO values were consistently greater for upstream stations 113, 140, and 129 [**Figure 7-7(b)**] when compared with the downstream and Cockroach Bay stations and ranged from 5.8 mg/l to 8.5 mg/l at these stations, although there was a peak of 10 mg/l at Station 140 in 1981. These values are consistent with the information that the upper reaches of the Little Manatee River have relatively high DO due to narrow streambed and relatively high flow rates that promote oxygenation of the water. DO values (mg/l) in Hillsborough County waters, depending on temperature and salinity, are about 7-8 mg/l at 100 percent saturation and indicate a normal healthy system (EPCHC 1997).

Total and Fecal Coliforms

Mean annual total coliform bacteria concentrations for downstream Station 112 and Cockroach Bay (136) are presented in **Figure 7-8(a)**. Among all the EPCHC stations, Station 112 had the lowest overall concentrations for the period of record, with only three mean annual concentrations exceeding 2,000 colonies/100ml for the period of record. Mean annual concentrations were generally below 1500 colonies/100ml, with the exception of 1992 (almost 3000 colonies/100ml) and 1978 and 1979 (greater than 4000 colonies/100ml) and were comparable to values reported for Hillsborough Bay (EPCHC 1997).

Data for the three upstream river sites are presented in **Figure 7-8(b)**. Values were generally lower for the upstream Station 129 when compared with farther downstream, stations 113 and 140, and ranged from approximately 1000 to nearly 15,000 colonies/100/ml. The variability in counts among the three sites was large, although peaks were consistent among years for all stations. State standards for total coliform concentrations set a limit of 1000/100 ml for Class III

Figure 7-7(a). Mean annual DO concentrations (mg/l)
at EPCHC stations 112 and 136 in the Little Manatee River (1974-1998)

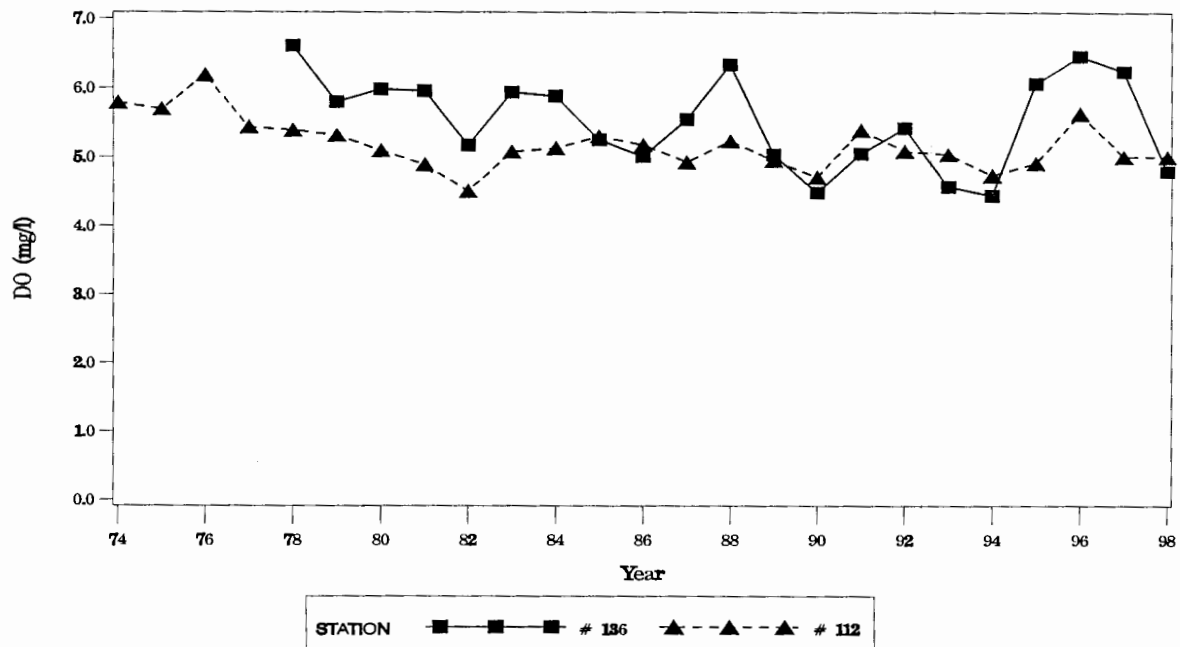


Figure 7-7(b). Mean annual DO concentrations (mg/l)
at EPCHC stations 113, 140 and 129 in the Little Manatee River (1974-1998)

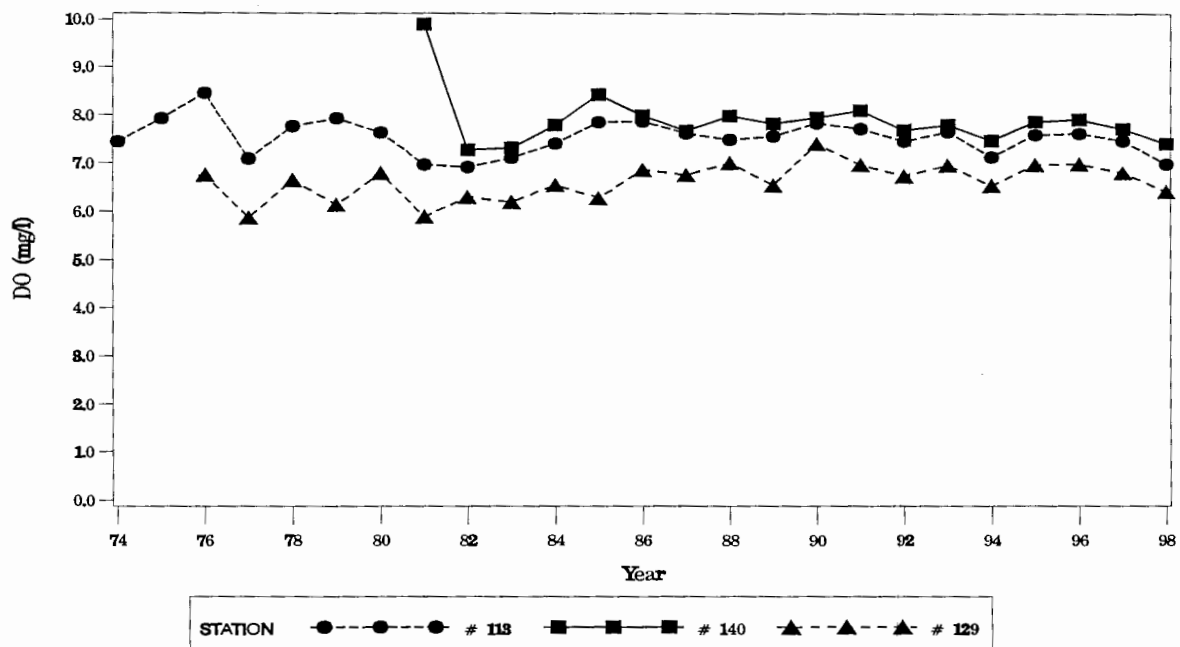


Figure 7-8(a). Mean annual total coliforms (# colonies/100 ml)
at EPCHC stations 112 and 136 in the Little Manatee River (1974-1998)

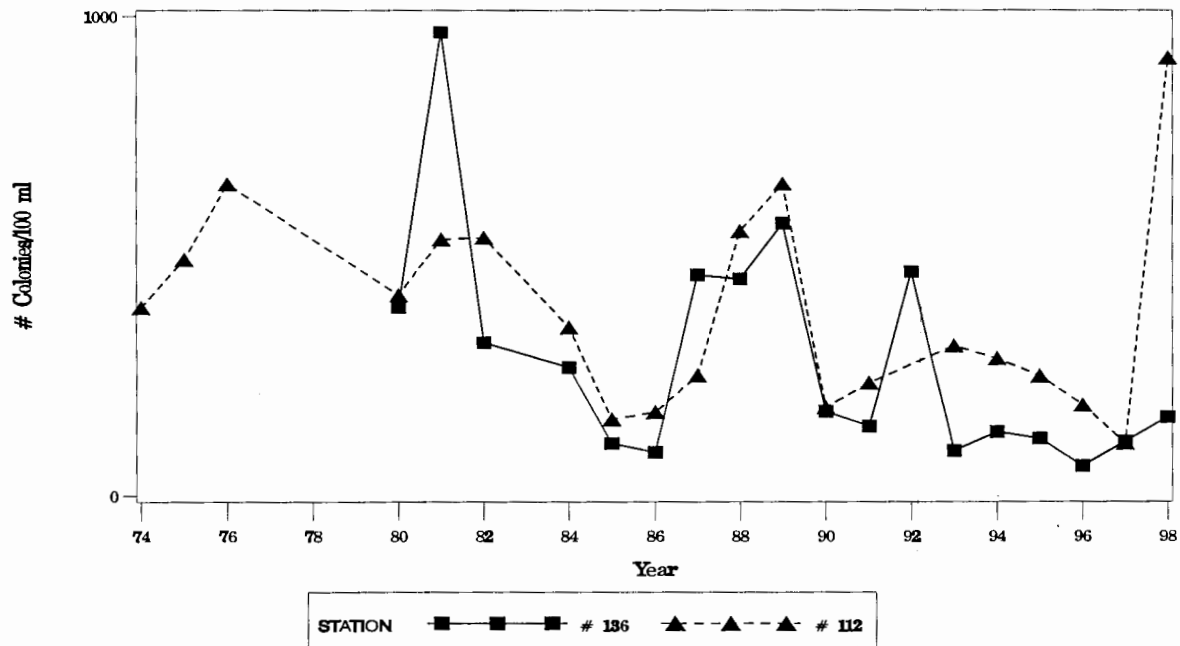
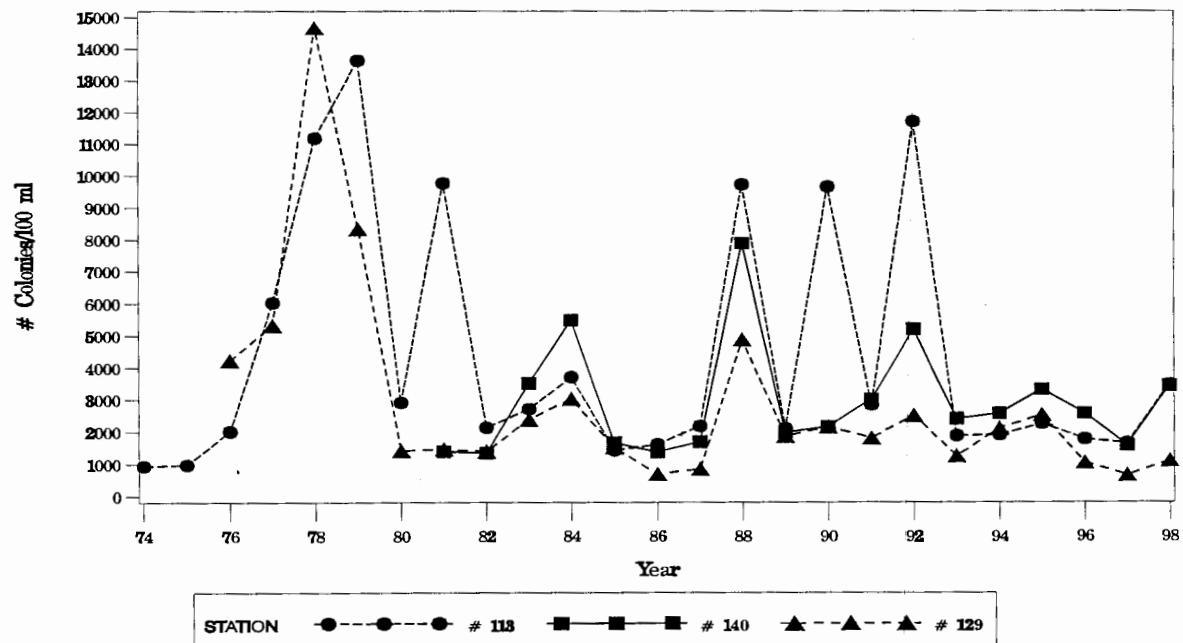


Figure 7-8(b). Mean annual total coliforms (# colonies/100 ml)
at EPCHC stations 113, 140 and 129 in the Little Manatee River (1974-1998)



waters. Data from these stations exhibited a distinct peak in 1988, typical for a large storm year. Station 113 consistently exhibited the highest total coliform levels, with six annual counts over 8,000 colonies/100ml.

Mean annual total coliform concentrations in the Little Manatee River watershed are characteristically high due to bacterial contamination associated with pasture and other agricultural runoff in the watershed, as well as some urban stormwater runoff in the lower portion of the watershed. River and stream total coliform concentrations are closer to sources of bacterial contamination and show a greater response due to the localized nature of the runoff. High bacterial counts in upper reaches of tributaries can be attributed to pasture runoff, while urban stormwater runoff is generally responsible for high bacterial counts in the lower reaches (EPCHC 1997). As for previous water quality parameters examined, the best water quality occurred at Station 129, where the watershed has the lowest intensity land uses.

Fecal coliform bacteria concentrations in Cockroach Bay appear to have declined over the period of record with only one annual average count of over 300/100ml since 1984 [Figure 7-9(a)]. Mean values exceeded the state standard (200/100 ml) several times over the period of record, most notably in 1979, 1981, 1983, and 1992. Like the mean total coliform values, fecal coliform values at the upstream stations had greater variability over the period of record, although maximum values were not any higher when compared to Cockroach Bay. Fecal coliform peaks were also consistent with peaks in TSS [Figure 7-9(b)]. This may be explained by the fact that high TSS obscures bacterial presence and decontamination efforts are not completely successful with high TSS loads (EPCHC 1997).

Conductivity

Mean annual conductivity values at the five EPCHC monitoring stations are plotted in Figure 7-10(a) and 7-10(b). Conductivity values were consistently higher in Cockroach Bay, Station 136, when compared with downstream Station 112, although values decreased significantly over the period of record only at Station 112, and are consistent with differences in salinities between the two stations. Average conductivity values ranged from approximately 15,000 to nearly 30,000 $\mu\text{mhos/cm}$ at Station 112, compared with approximately 20,000 to over 40,000 $\mu\text{mhos/cm}$ at Station 136.

Average conductivity values at upstream stations 113, 140, and 129 were near or at 400 $\mu\text{mhos/cm}$ for the past several years, and may be an indication of groundwater influence on the stream flow. Sulfate concentrations at Station 113 have increased as well, rising from near 60 mg/l during the late 1970s to near 90 mg/l since 1990. Conductivity values showed a significant increase over the period of record at Station 140 and suggest the strong influence of runoff from agriculture and row crops in this portion of the basin. Conductivities at Station 129 showed no significant trends over the period of record and are consistent with previous indications of the good water quality at this upstream station. Sulfate concentrations are another potential indicator of groundwater influence in surface water.

Figure 7-9(a). Mean annual total fecal coliforms (# colonies/100 ml)
at EPCHC stations 112 and 136 in the Little Manatee River (1974-1998)

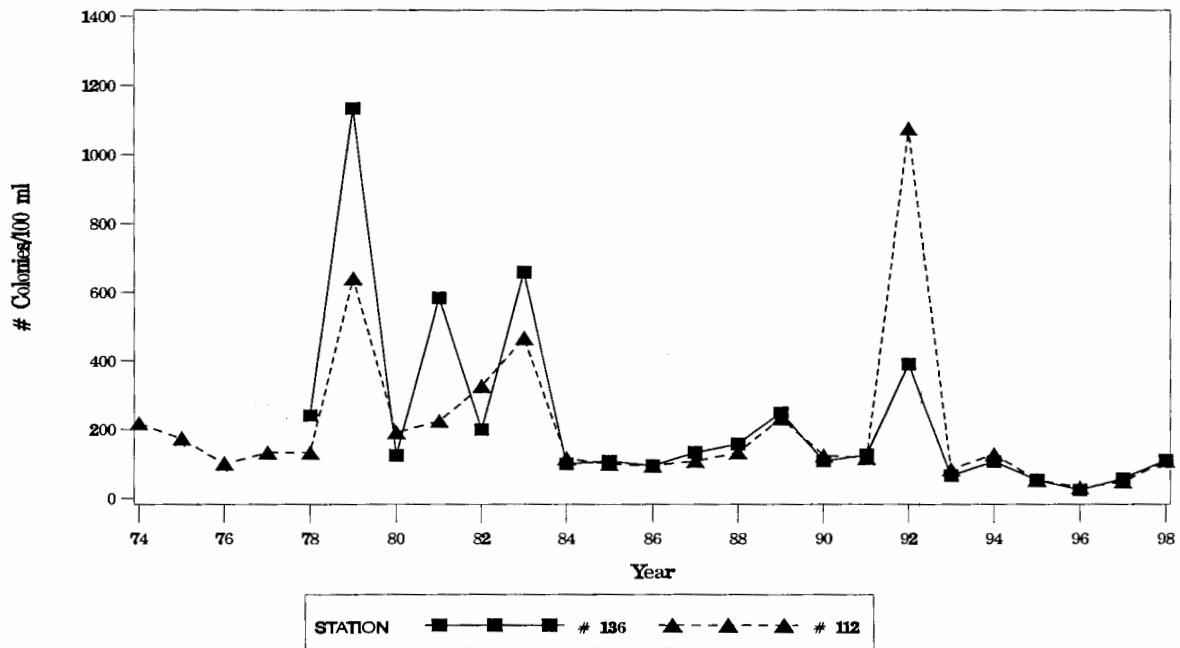


Figure 7-9(b). Mean annual total fecal coliforms (# colonies/100 ml)
at EPCHC stations 113, 140 and 129 in the Little Manatee River (1974-1998)

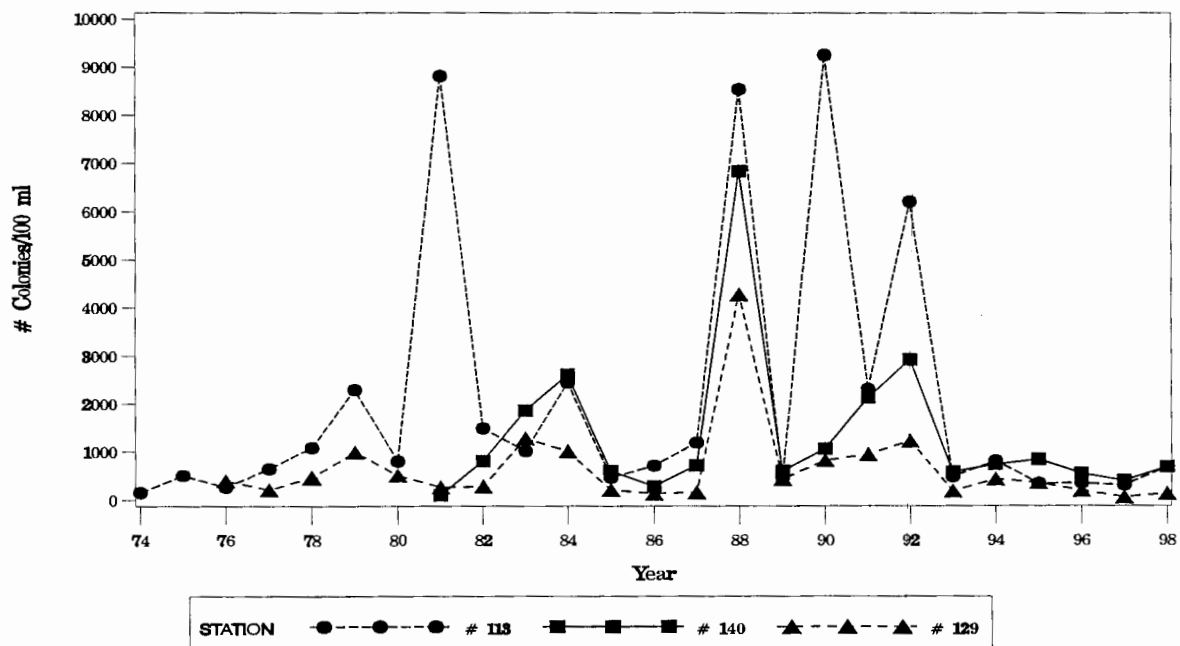


Figure 7-10(a). Mean annual conductivity (umhos/cm)
at EPCHC stations 112 and 136 in the Little Manatee River (1974-1998)

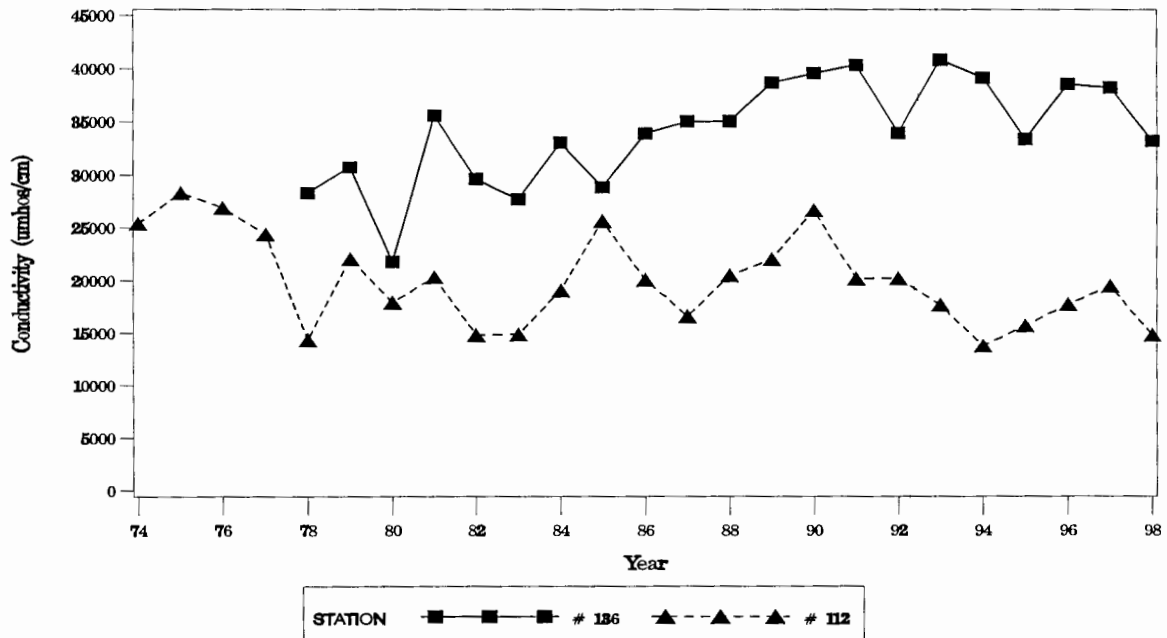
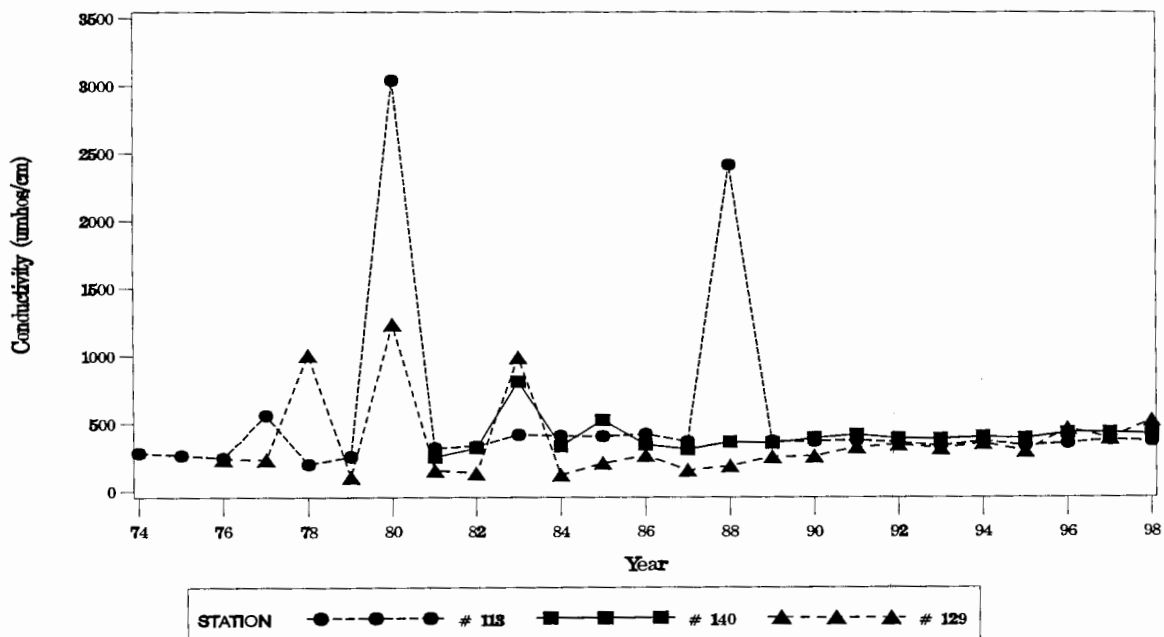


Figure 7-10(b). Mean annual conductivity (umhos/cm)
at EPCHC stations 113, 140 and 129 in the Little Manatee River (1974-1998)



Groundwater generally has higher conductivity levels when compared with ambient surface water, and this parameter is often used to identify surface waterbodies with significant groundwater inputs such as spring inputs. Groundwater conductivity levels can also be used to indicate anthropogenic effects on surface waterbodies. Increased conductivity may indicate increasing groundwater flows in the Little Manatee River, which may in turn be the result of irrigation water from a groundwater source flowing off-site to a surface waterbody, or the introduction of groundwater into the surface water systems through mining operations.

Heavy rains may also increase groundwater infiltration to streams and result in natural increases in conductivity. Surface water with no groundwater inputs may have conductance readings in the range of 100 up to 400 $\mu\text{mhos/cm}$. Groundwater from the Floridan aquifer typically has conductivity levels of 400 to over 1000 $\mu\text{mhos/cm}$.

Trophic State Index and Water Quality Index: Estuaries

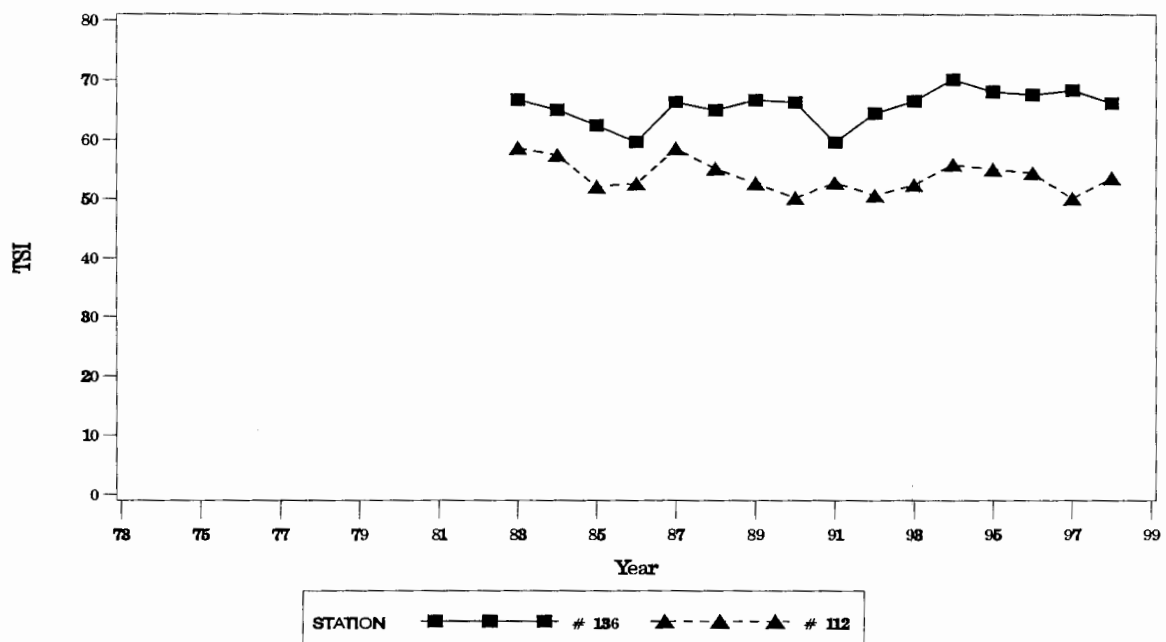
As indicated previously, TSI ranges are different for freshwater and estuarine systems. Stations 112 and 136 are located in the estuarine portion of the watershed. Mean annual TSI values at Station 112 showed a significant decrease over the period of record and ranged from approximately 50 to just under 60, still within the *fair* water quality range (**Figure 7-11**). Mean annual TSIs for stations 112 and 136 were 53.8, and 65.5, respectively, indicating *fair* water quality in the downstream station and *poor* water quality in Cockroach Bay. Cockroach Bay, however, had a significant increase in mean annual TSI value, indicating decreasing water quality. Values for Cockroach ranged from approximately 60 to 70, indicating *poor* water quality, as described by Hand *et al.* (1996).

The EPCHC has developed a WQI intended only for Tampa Bay, which includes only stations 112 and 136. The index is based on six categories of water quality including clarity, dissolved oxygen, oxygen-demanding substances, bacteria, nutrients, and biological diversity. Index values are based on raw data (e.g., annual averages) from a particular sampling location and converted to values ranging from 0 to 99 for the six categories. Each categorical value corresponds to the percentile distribution of water quality data collected from streams throughout Florida. An overall score is generated based on the average of any of the six categories for which data is available, however, the index is more reliable as more categories are used. TSI values are scored as follows:

- 0 to <70 = Poor
- 70 to 79 = Fair
- 80 to 89 = Good
- 90 to 100 = Excellent

Estuarine WQIs were calculated for EPCHC Station 112 in the lower Little Manatee River and Station 136 in Cockroach Bay. Mean annual WQI values averaged 65.1 at Station 112 and 55.8 at Station 136 (**Figure 7-12(a)**). Both these values indicate *poor* water quality at these estuarine

Figure 7-11 Mean annual TSI values
at EPCHC stations 112 and 136 in the Little Manatee River (1974-1998)



sites. While Station 112 is an estuarine station, WQI values at this station were consistently lower than values at Station 136 and were more consistent with upstream stations 113, 140, and 136 (**Figure 7-12(b)**). Station 136, however, exhibited a trend of significantly increasing estuarine WQI values, indicating increasing water quality in Cockroach Bay (Table 7-3).

Water Quality Index: Streams

Mean annual FDEP WQI values at Station 129 since 1989 indicate *good* water quality based on FDEP criteria. For the period of record, mean annual WQI values ranged from approximately 40 to just over 60 at Station 129, although there was a significant trend of decreasing WQI and increasing water quality (Figure 7-11 and Table 7-3). Remaining stream stations 113 and 140 had similar ranges in mean annual WQI values but were consistently higher when compared with Station 129 since 1986.

These data, combined with evidence of increased dry season stream flow and land use activities in the upper LMR watershed, suggest that activities such as agriculture may be introducing substantial amounts of groundwater into the Little Manatee River. While this in itself is not necessarily harmful, resulting increases in stream flows or changes in chemical balances may affect downstream biological communities.

7.4 GROUNDWATER

Groundwater quality trends within the LMR watershed are similar to those experienced in many coastal areas of southwest Florida. Generally, as the population has increased during the last 50 years, there has been an increase in groundwater supply demand and development, resulting in saltwater intrusion into the drinking water aquifers. The water quality parameters generally used to assess the migration of the saltwater interface are chloride, total dissolved solids (TDS) and sulfate. The drinking water standards for chloride and sulfates are 250 milligrams per liter and for TDS is 500 milligrams per liter. Exceeding a drinking water standard at a sampling point for any of the three parameters usually indicates lateral or vertical migration of the saltwater interface has occurred.

Site-specific data from USGS groundwater monitoring wells in southern Hillsborough County indicate the variability in chloride concentrations in the Little Manatee River watershed (Trommer 1993). Chloride concentrations in one intermediate aquifer system well have remained virtually unchanged in 18 years, while chloride concentrations in another intermediate aquifer system well 4 miles farther south have increased. Two upper Floridan aquifer system wells are located 2 miles south of the first well. Chloride concentrations in both wells have increased, one from 40 to 250 mg/l and the other from 600 mg/l to more than 1,500 mg/l. All three wells with increased chloride concentrations were located down gradient of agricultural areas and the saltwater intrusion resulting from nearby long term pumping for irrigation may be the cause of the increases.

Figure 7-12(a). Mean annual WQI values
at EPCHC stations 112 and 136 in the Little Manatee River (1974-1998)

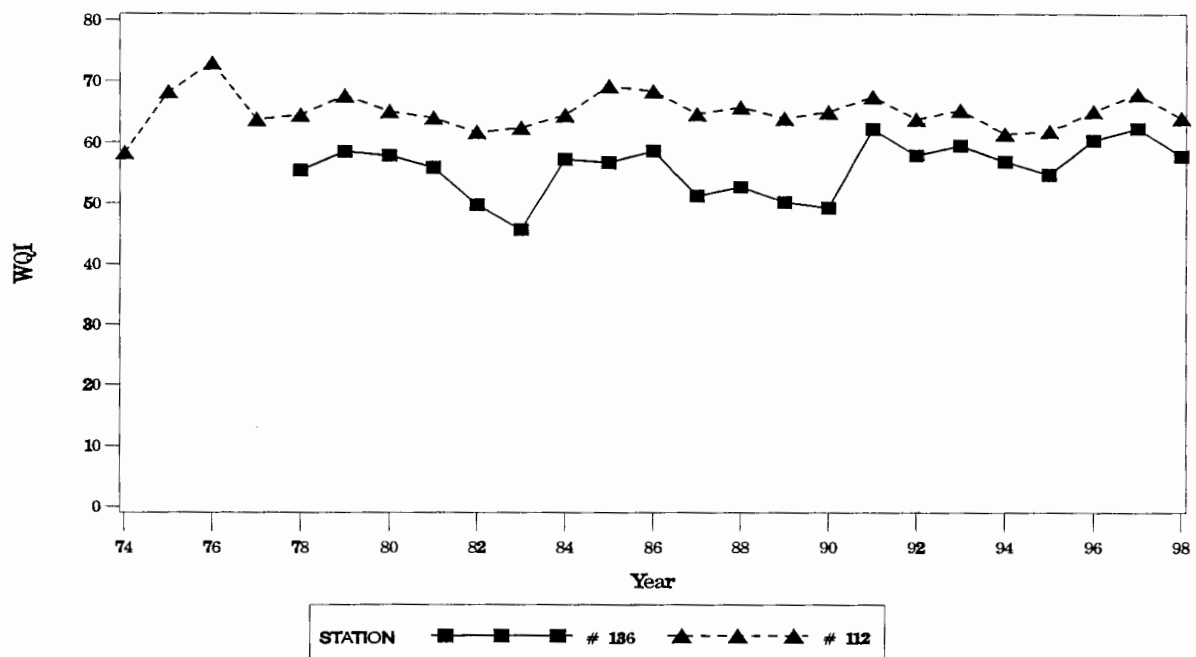
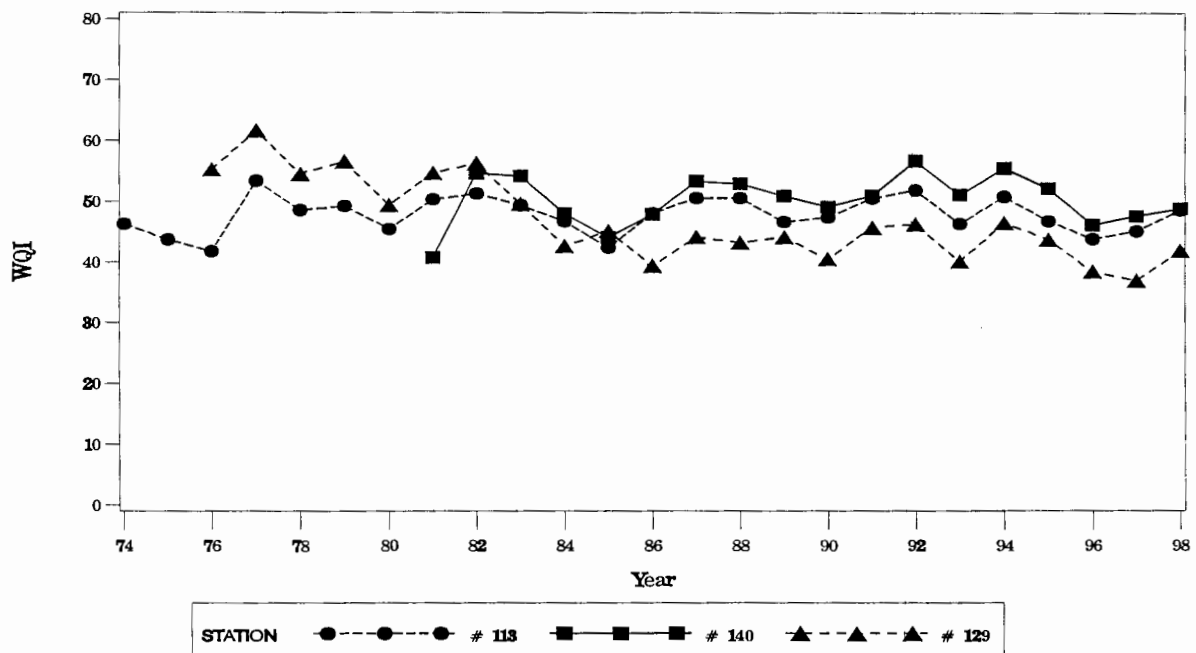


Figure 7-12(b). Mean annual WQI values
at EPCHC stations 113, 140 and 129 in the Little Manatee River (1974-1998)



USGS data indicate that intermediate aquifer system groundwater within only the eastern portion of the Little Manatee River watershed is suitable for potable consumption. USGS water quality data from the upper Floridan aquifer system indicate that groundwater within the western third of the LMR watershed is unfit for potable consumption. Nonpotable uses of groundwater such as crop irrigation and phosphate mine dewatering are not limited by potable drinking water standards. Many crops, in fact, can tolerate TDS levels in groundwater above 1,000 mg/l.

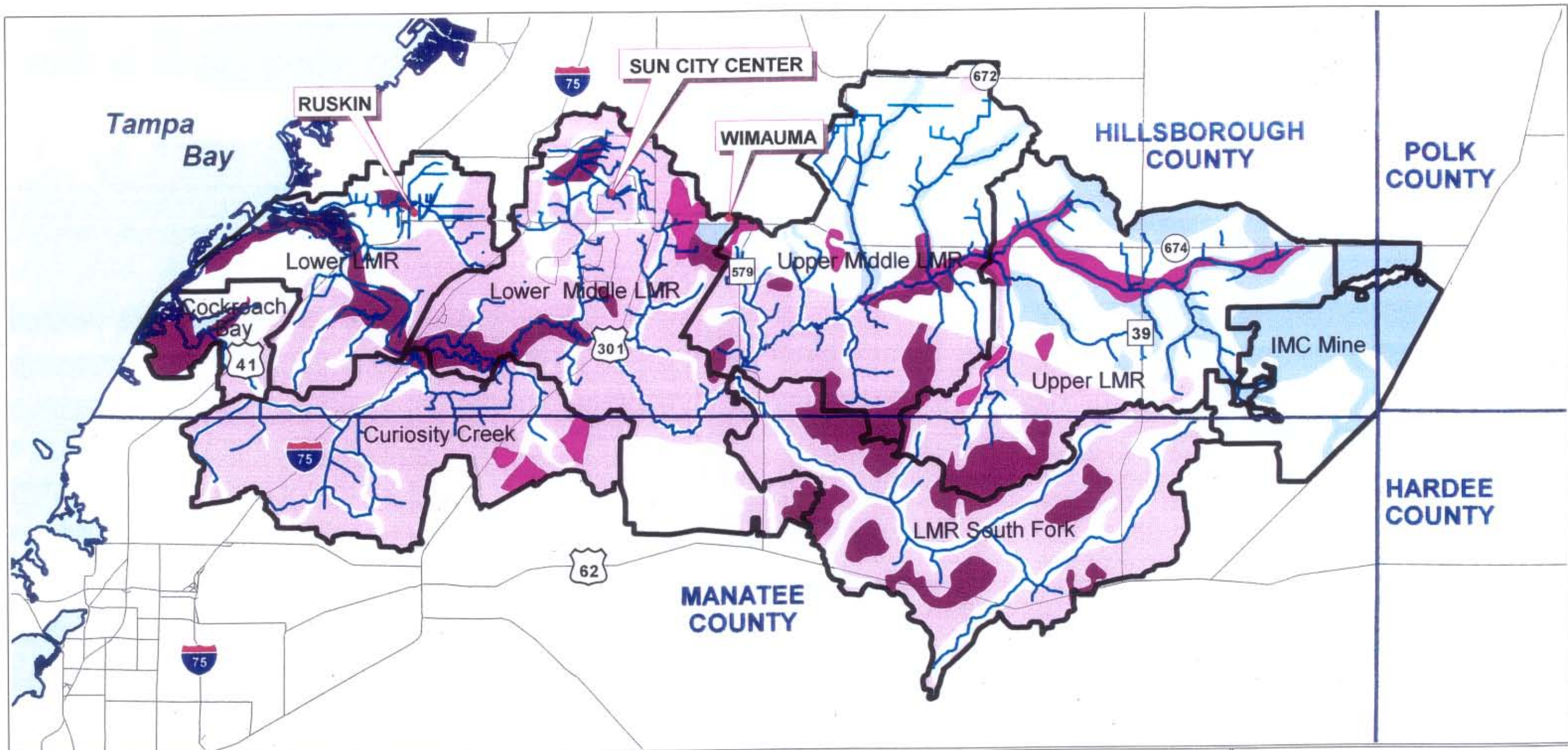
A data set developed by the USEPA has been used to evaluate groundwater pollution potential. The method, termed DRASTIC, evaluates seven parameters, including: depth to water, net recharge, aquifer media, soil media, topography, impact of the vadose zone, and hydraulic conductivity. The results are presented in map form and provide an illustration of areas with varying DRASTIC values and associated potential for groundwater contamination. Based on this, the LMR watershed has generally low DRASTIC values (i.e. low potential for groundwater contamination) (**Figure 7-13**). It should be noted that the DRASTIC index is independent of actual sources of pollution and does not necessarily mean that groundwater contamination is occurring. In certain cases, the methodology has been found to over estimate pollution potential, such as for wetlands in the Hillsborough River basin and coastal discharge areas elsewhere in the SWFWMD (SWFWMD 1999).

Groundwater quality can be impacted through wells that connect different aquifer units. If these wells are inactive or not properly plugged and abandoned, groundwater from one aquifer unit can enter another and alter the water quality. This is especially a problem in coastal areas where poor quality groundwater from the upper Floridan aquifer system can migrate upward through open bore holes into the intermediate aquifer system because of the natural hydraulic gradient. A sufficient number of these problem wells may affect groundwater at a regional level. The coastal portion of the LMR watershed includes some of the highest concentrations of these cross-connecting wells. The occurrence of these wells may in part explain the relatively poor groundwater quality of the intermediate aquifer system in the LMR watershed.

7.5 LAKES

There are seven named lakes in the Little Manatee River watershed in Hillsborough County: Lake Simmons, Lake Wimauma, Lake Carlton, Lake Parrish, Middle Lake, North Lake, and South Lake. Only Carlton Lake and Lake Wimauma are natural lakes. Lake Parrish is approximately 4,000 acres in size and serves as a cooling reservoir constructed and used by the Florida Power Corporation for plant cooling. None of these lakes are monitored by FDEP, EPCHC or any other local, state, or federal agency. Information on the lakes was obtained from the Hillsborough County Lake Atlas: Watershed Navigator (2000), and TSI values for Lake Wimauma and Lake Simmons are listed in **Table 7-4**. In addition, water quality data are presently being collected for Lake Carlton as part of this project.

The TSI index, described previously, is used to rank and classify Florida lakes according to trophic state and represents an average of the main physical, chemical, and biological expressions of the trophic state concept. TSI values are classified differently for lakes when compared with



Department of Public Works
Stormwater Management Section



Increasing Pollution Potential

Legend



2 0 2 Miles

September, 2000

- Cities
- ~ Little Manatee River
- County Boundary
- Major Basin Boundary
- Water

**Little Manatee River
Watershed Management Plan**

Figure 7-13
DRASTIC Mapping

PBSJ

estuaries. A TSI below 60 indicates *good* lake water quality (compared to below 50 for an estuary), while 60-69 indicates *fair* water quality (50-59 for an estuary), and 70-100 is classified as *poor* water quality (compared to 60-100 for an estuary) (Huber *et al.* 1982; Paulic and Hand 1992). Trophic State Index (TSI) values (Huber *et al.* 1982) provide a means of:

- comparing overall trophic conditions between lakes,
- evaluating the direction and rate of change,
- developing empirical models of trophic conditions as functions of watershed “enrichment” factors, and
- conveying scientific information about lake water quality to the public.

Wimauma lakes region is a closed basin and receives runoff from surrounding urban and agricultural land uses. Lake Wimauma and the neighboring Lake Carlton are located in the eastern portion of the watershed and are characterized as clear, acidic, low nutrient, small waterbodies. The soils in this area are a mix of alkaline and acid sands. Other clear, acidic, oligotrophic lakes within the region are not known. Historic TSI value for Lake Wimauma (44) indicates very good water quality, although only three samples have been analyzed. Lake Carlton is presently undergoing water quality sampling although no data are available to date.

Lake Simmons is actually one of the water retention areas in the community of Sun City in the northern part of the watershed. It receives runoff from the surrounding residential and recreational (golf course) land uses. Based on 38 water quality samples collected from 1996 to 2000, this waterbody has a TSI of 49 and is considered to have *good* water quality. It is smaller and has much lower water quality when compared with Lake Wimauma farther east, likely a result of both the geology underlying the lake as well as the increased runoff from the streets of the community.

Table 7-4. Name, size, and water quality condition of lakes in the Little Manatee River Watershed (a TSI \leq 59 is considered good).				
Lake	Acres	TSI	Drainage Area	Description
Wimauma	135.5	44	0.8 mi ²	Clear, acidic, low nutrients.
Lake Simmons	No data	49	No data	Slightly acidic, but generally eutrophic with dark water.

7.6 WATER QUALITY ISSUES/AREAS OF CONCERN

Water quality issues and areas of concern in the Little Manatee River watershed include:

- groundwater pumping for agricultural applications and commensurate impacts to groundwater levels as well as stormwater runoff, and saltwater intrusion;

- future expansion of phosphate mining industry into the central portion of the watershed along the Little Manatee River and associated impacts to surface water runoff; and
- increased urbanization and associated increases in impervious surfaces and commensurate increases in stormwater runoff.

Groundwater pumping for agricultural applications and the subsequent decrease in water levels in the aquifer is a concern in the LMR watershed due to saltwater intrusion. In addition, the transport of pesticides, nutrients, and sediments from agricultural fields during storms and following irrigation negatively impact the health of the streams and river in the watershed. Water quality data indicate the greatest nutrient and pollutant loadings from the most intense land uses in the watershed, largely row crops. In fact, pollutant loads downstream from row crops and urban areas were found to be greater than loadings downstream from IMC mining areas during this study (Section 7.1.2, above) and in other studies (Flannery *et al.* 1991).

The expansion of the phosphate industry into the eastern portion of the Little Manatee River watershed will result in significant loss of habitat and natural areas that buffer impacts of stormwater runoff and accompanying pollutants to the river. While reclamation and restoration efforts and successes have improved, these natural areas take years to reclaim as natural vegetation communities, and hundreds of years for forests to mature. In addition, the industry brings with it the threat of toxic spills into the rivers and streams of the watershed and commensurate fish and wildlife impacts. For example, in November, 1994, nearly 500 million gallons of water from an IMC-Agrico clay settling pond flooded into the Alafia River in eastern Hillsborough County when a clay settling-pond dam failed at the Hopewell Mine. The water flooded Keyville in eastern Hillsborough County and a plume muddied the Alafia River for two days.

While the threat of spills remains, permitting restricts discharges from mining activities. Interestingly, a study completed by Flannery *et al.* (1991) found no evidence of pollutant discharge by the IMC mines into the Ft. Lonesome watershed, even though IMC has a NPDES-permitted mine discharge to Alderman's Creek in the extreme southeast headwaters of the river. Mean values for specific conductance, nitrate-nitrite, turbidity, pH, and particulate carbon and nitrogen were lowest for the Ft. Lonesome subbasin, which drains the mined areas in the LMR watershed. Flannery *et al.* (1991) concluded that although water quality at the Ft. Lonesome station has been impacted to some degree, during their study, this portion of the watershed represented the water quality of a natural stream in the basin and can be viewed somewhat as a control site.

Groundwater use is also an environmental concern for mining activities. Although the mining industry uses about 95 percent recycled water today, it still consumes about 30 billion gallons or deep well water annually.

Urbanization is not the problem in the Little Manatee watershed that it is in other parts of Hillsborough County. Urban areas are limited to the middle and lower reaches (i.e., Wimauma,

Sun City, Sun City Center, Ruskin), and encompass only about 13 percent of the basin area. However, these communities, combined with future development, increase the pollution potential to wetlands, streams, the river and bay. The extent of future development in the watershed was presented in Chapter 2.

CHAPTER 8

EXISTING NATURAL SYSTEMS

8.1 OVERVIEW

Although the LMR watershed has relatively little urbanization in comparison with other watersheds draining to Tampa Bay, agriculture and phosphate mining are conspicuous throughout the watershed. The downstream reaches of the Little Manatee River and Cockroach Bay are surrounded by predominantly row crops and residential with scattered commercial and industrial land uses. Farther upstream urban development includes high density residential associated with the community of Sun City, and Lake Wimauma. The distribution of row crops is extensive in the major basins. The upper reaches of the Little Manatee River include primarily agricultural and crop lands, whereas phosphate mining dominates the far eastern portion of the watershed.

As a result of the relatively undeveloped conditions in the watershed, natural systems are more extensive when compared with other watersheds in the Tampa Bay region and make up approximately 33 percent of the existing land cover in the LMR watershed (**Table 8-1**). Combined upland communities, including pine flatwoods, scrubby flatwoods, and scrub, make up nearly twenty percent of the watershed (Flannery *et al.* 1991). The largest natural vegetation category, however, is wetlands forest (12.6 percent), which is associated primarily with stream and river channels. Herbaceous wetlands are scattered throughout the basin, and in combination with estuarine wetlands, comprise less than five percent of the watershed. Because of the importance of natural communities in providing habitat for fish and wildlife, this chapter provides descriptions of the natural systems that characterize the watershed, the associated species of interest, and habitat issues of concern in the watershed.

A map of habitat, based on GAP coverages (Cox *et al.* 1994) is provided in **Figure 8-1**. In it, natural habitats are mapped for the watershed, based on vegetation type rather than land use. As a result, the number of habitats identified is much more numerous when compared with land use and land cover (Chapter 2) and illustrates the diversity of habitat in the LMR watershed. In addition, ELAPP (Environmental Lands and Protection Program), parks and other public lands are mapped in **Figure 8-2** and greenway systems and significant wildlife habitat are mapped in **Figure 8-3**. Much of the conservation and greenways lands correspond to wetlands associated with the Little Manatee River.

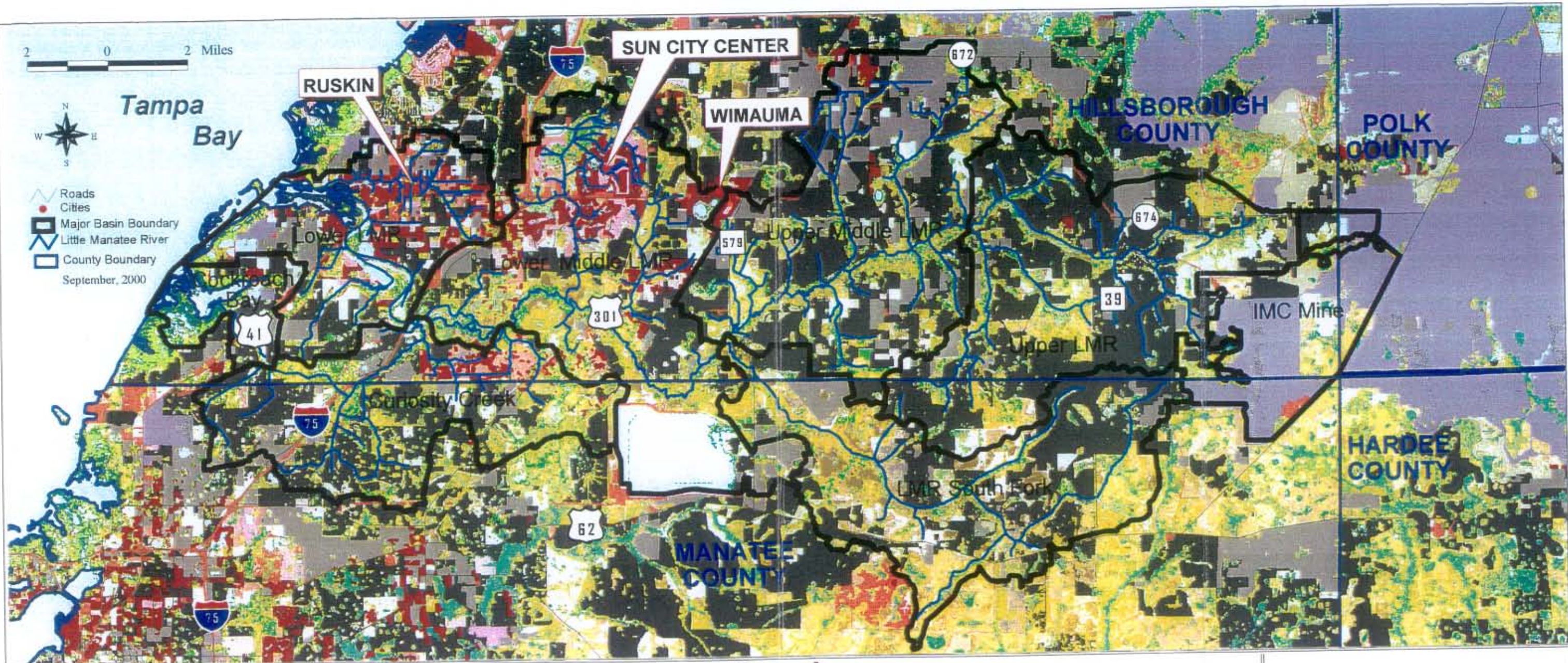
Many habitats in the watershed have been or will be disturbed due to mining, urban development, and exotic species expansion. These components were integrated and used to develop a map of habitat that can be considered stressed and/or sensitive, based on surrounding conditions (**Figure 8-4**). A buffer, one-quarter mile wide, was designated around each natural

land use polygon in the watershed. "Stressed conditions," including urban, exotic, and disturbed areas, were identified in the buffers.

Table 8-1. Acres of developed and undeveloped land uses in the LMR watershed and percent of the watershed each makes up, based on FLUCCCS.

Land Use	Acres in Watershed	% of Watershed
Undeveloped Land Uses		
Herbaceous	288.7	0.2%
Shrub and Brushland	12,685.1	8.1%
Mixed Rangeland	167.8	0.1%
Upland Coniferous Forests	898.1	0.6%
Pine Flatwoods	6,730.3	4.3%
Upland Hardwood Forests	269.9	0.2%
Hardwood - Conifer Mixed	6,256.2	4.0%
Tree Plantations	781.9	0.5%
Bay Swamps	5.3	0.0%
Public Lands	1,585.8	1.0%
Streams and Lake Swamps (Bottomland)	11,389.2	7.3%
Wetland Coniferous Forests	13.6	0.0%
Cypress	774.9	0.5%
Wetland Forested Mixed	3,162.5	2.0%
Vegetated Non-Forested Wetlands	0.2	0.0%
Freshwater Marshes	3,453.9	2.2%
Saltwater Marshes	632.3	0.4%
Wet Prairies	1,239.7	0.8%
Emergent Aquatic Vegetation	205.6	0.1%
Non-Vegetated	1.1	0.0%
Tidal Flats	800.3	0.5%
Shorelines	23.0	0.0%
Total Undeveloped Lands	51,365	33.0
Streams and Waterways	68.3	0.0%
Lakes	82.1	0.1%
Reservoirs	4,973.9	3.2%
Bays and Estuaries	1,495.6	1.0%
Intermittent Ponds	2.4	0.0%
Total Water	6,622.3	4.3
Total Developed Land Uses	97,818.8	62.8
Total of all Lands	155,806.6	100.0%

FLUCCS = Florida Land Use/Cover Classification System



Department of Public Works
Stormwater Management Section



- Ag/Confined Feeding Operation/
Specialty Farms
- Ag/Groves/Ornamental
- Agriculture
- Bare soil/Clearcut
- Bay/Gum/Cypress Ecological Complex
- Black Mangrove Forest
- Black Mangrove Woodland
- Black needle Rush Marsh
- Brazilian Pepper Shrubland
- Broad-leaved Evergreen and Mixed
Evergreen/Cold-deciduous Shrubland
Compositional Group
- Buttonwood Woodland
- Casuarina Compositional Complex
- Cattail Marsh Compositional Group
- Coastal Strand
- Cypress Forest Compositional Group
- Dry Prairie Ecological Complex
- Dwarf Cypress Prairie
- Dwarf Mangrove Ecological Complex
- Extractive
- Flooded/Saturated Broad-leaved
Evergreen/Mixed Evergreen-Cold
deciduous Shrubland Compositional Group

Legend

- Forb Emergent Marsh
- Gallberry/Saw Palmetto Compositional Group
- Graminoid Dry Prairie Ecological Complex
- Graminoid Emergent Marsh Compositional Group
- Groundsel-tree/Marsh Elder Tidal Shrubland
- Live Oak Woodland
- Loblolly Bay Forest
- Maidencane Marsh
- Mesic-Hydric Live Oak/ Sabal
Palm Ecological Complex
- Mesic-Xeric Mixed Pine/Oak/Hickory
Forest Ecological Complex
- Mixed Evergreen-Cold-deciduous Hardwood Forest
- Mixed Mangrove Forest Formation
- Mixed Mangrove Woodland
- Muhly Grass Marsh
- Open water
- Pasture/Grassland/Agriculture
- Pavement, Roadside
- Periphyton
- Recreation
- Red Mangrove Forest
- Red Mangrove Woodland
- Salt Marsh Ecological Complex

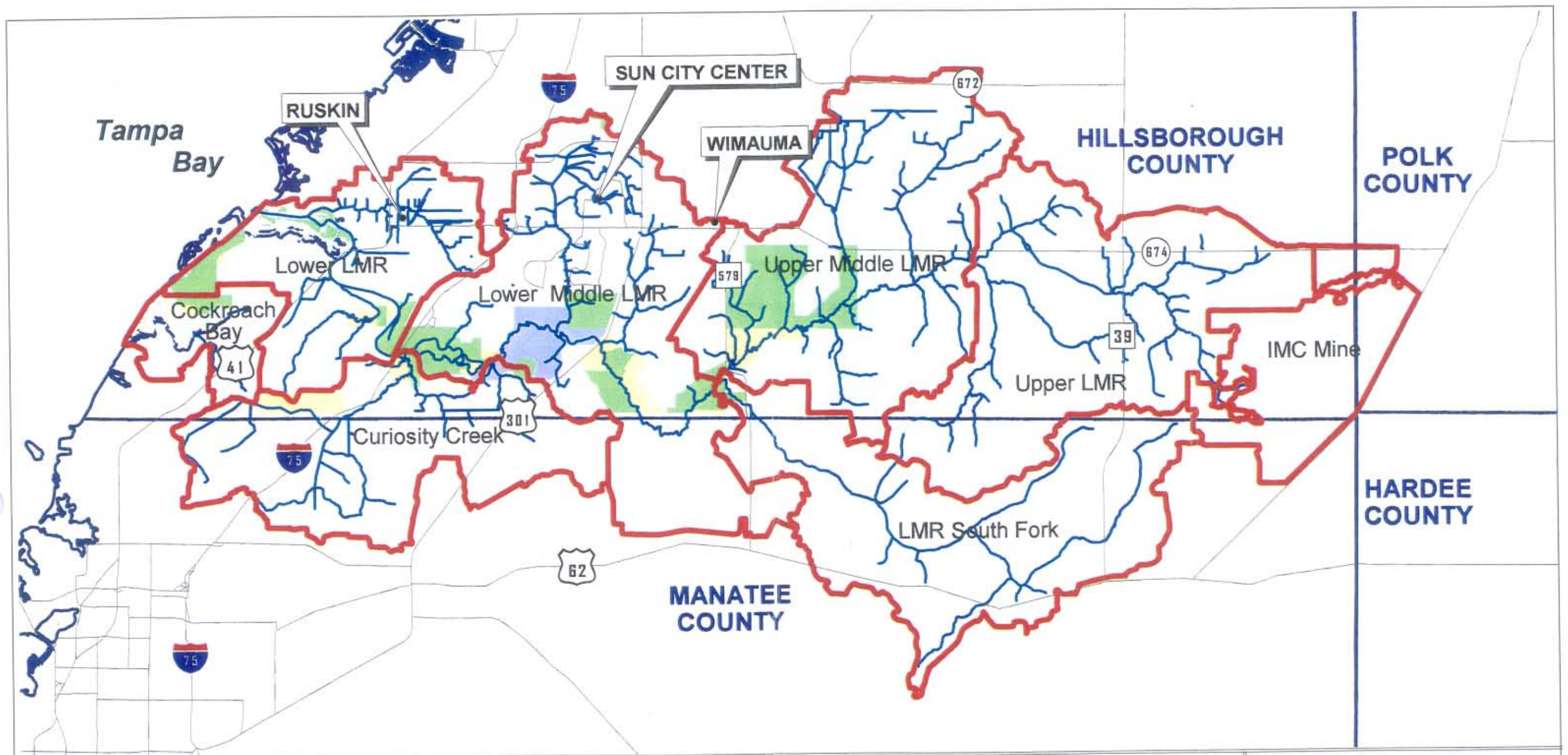
- Saltmarsh Cordgrass Marsh
- Saltmeadow Cordgrass/Salt Grass Salt Marsh
- Saltwort/ Glasswort Ecological Complex
- Sand Cordgrass Grassland
- Sand Pine Forest
- Sandhill Ecological Complex
- Saturated-Flooded Cold-deciduous
shrubland Ecological Complex
- Sawgrass Marsh
- Sea Oats Dune Grassland
- Semi-deciduous Tropical/Subtropical Swamp Forest
- South Florida Slash Pine Forest
- South Florida Slash Pine Woodland
- Spikerush Marsh
- St. Johns Wort Shrubland Compositional Group
- Swamp Forest Compositional Group
- Temperate Wet Prairie
- Urban
- Urban Open/Others
- Urban Residential
- Water lily or Floating Leaved Vegetation
- Wiregrass Grassland
- Xeric Scrubland
- Xeric-Mesic Live Oak Ecological Complex

Source: US Geological Survey, Biological Resources Division

Little Manatee River Watershed Management Plan

Figure 8-1
Natural Habitat





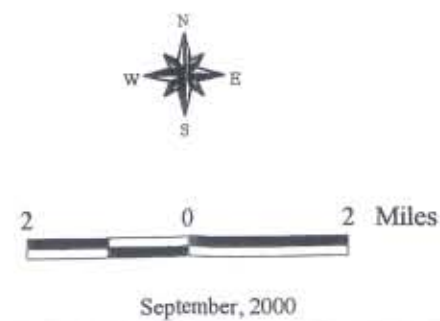
Department of Public Works
Stormwater Management Section



ELAPP

- Acquired Site Area
- Approved Site Area
- Other Public Land

Legend

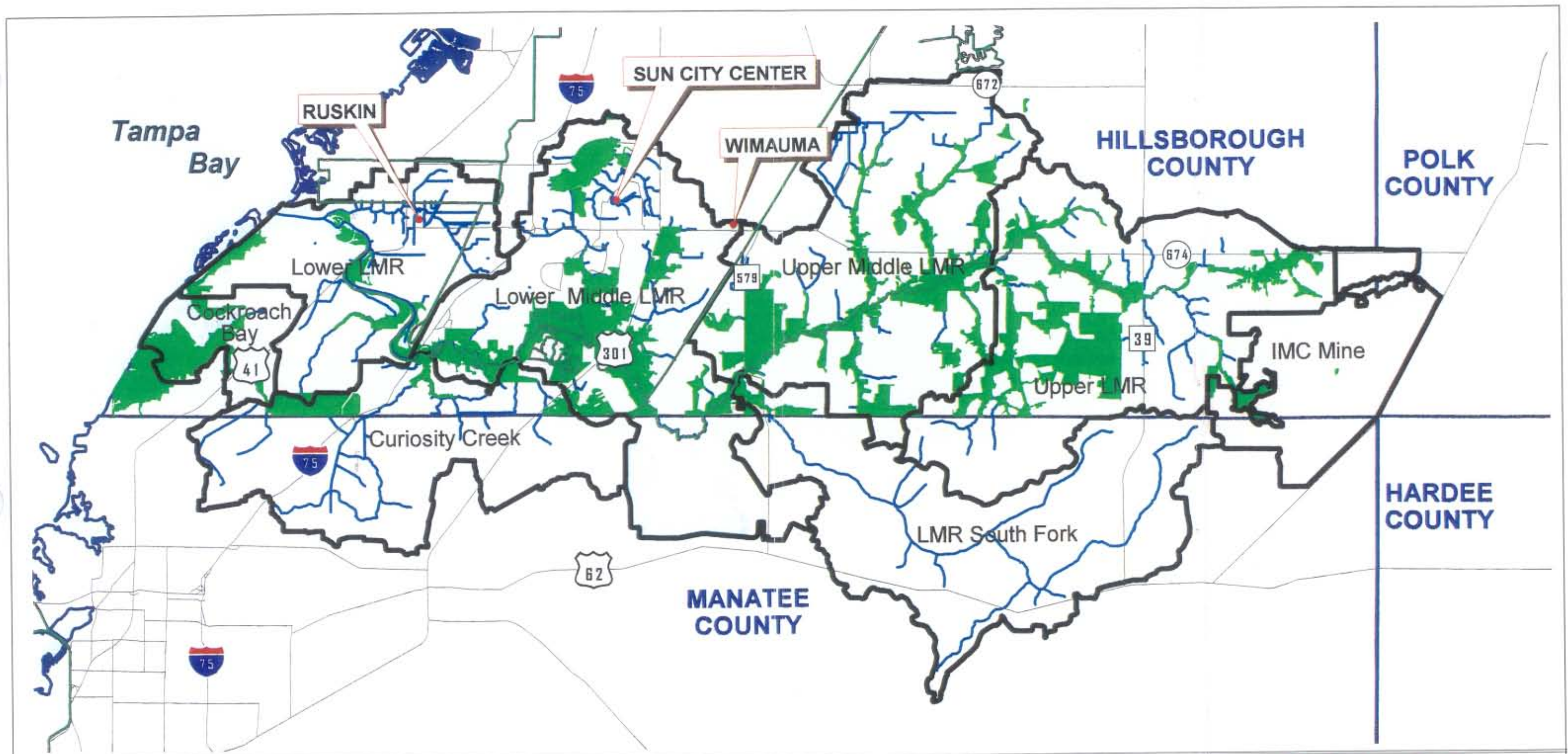


- Cities
- Little Manatee River
- County Boundary
- Major Basin Boundary

**Little Manatee River
Watershed Management Plan**

**Figure 8-2
ELAPP, Parks,
& Other Public Lands**

PBSJ



Department of Public Works
Stormwater Management Section



- | | | |
|---|------------------------------|----------------------|
| • | Cities | Water |
| — | Roads | Major Basin Boundary |
| — | Little Manatee River | |
| — | Greentrails | |
| ■ | Significant Wildlife Habitat | |

Legend



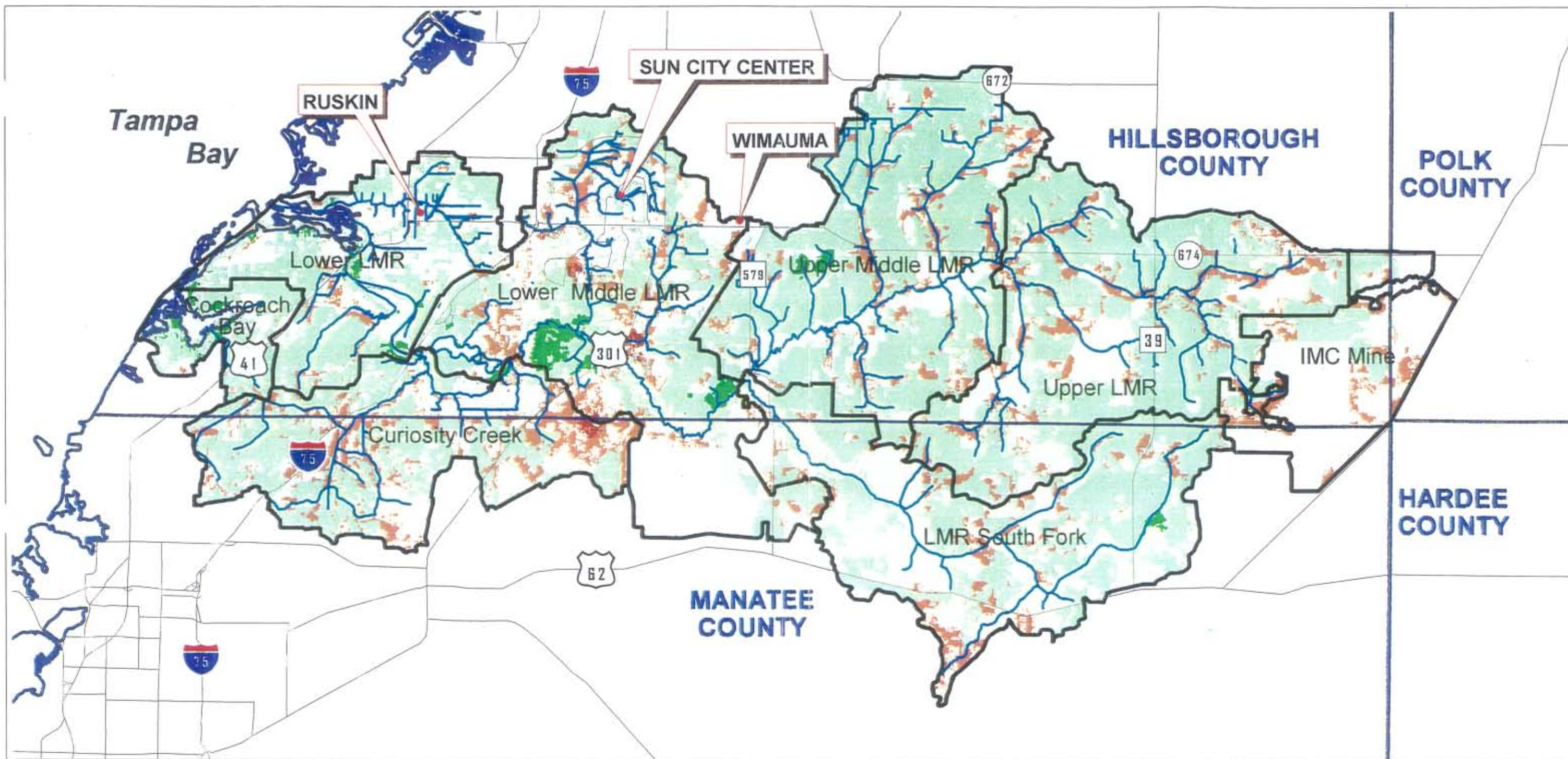
2 0 2 Miles

September, 2000

Little Manatee River Watershed Management Plan

Figure 8-3
Greenways and
Significant Wildlife Habitat

PBSJ



Department of Public Works
Stormwater Management Section



 Less Sensitive


 More Sensitive

Legend



2 0 2 Miles

September, 2000

-  Cities
-  Little Manatee River
-  County Boundary
-  Major Basin Boundary
-  Water

**Little Manatee River
Watershed Management Plan**

Figure 8-4
Sensitive Habitat

PBSJ

A natural area was designated as “stressed” depending on how many times the stressed conditions occurred in adjacent lands. Adjacent conservation lands reduces the “stress” to a habitat. For example, a hardwood swamp surrounded in part by urban land uses, but also adjacent to mining (disturbed) areas and areas with exotic species, would be considered the “stressed” in this classification scheme. A similar natural area with adjacent conservation lands would be considered less sensitive or less “stressed.” Conservation areas were considered “stressed/sensitive” only if they were in proximity to or included exotic species, disturbed areas, mining, or urban land uses. Habitat polygons were assigned “points” based on the nature of surrounding land cover and land use practices, including proximity to or inclusion of:

- conservation areas;
- urban development;
- exotic species;
- disturbed areas; and
- future development.

These criteria were included in a matrix and used to calculate a sensitivity score for the habitat area. An example of the matrix is presented in **Table 8-2**. A score of 1 indicates lands adjacent to the targeted habitat area (polygon) meet the criteria; a score of 0 indicates the criteria were not met in adjacent polygon(s). The more criteria met, the higher the total score, and the greater the stress/sensitivity assigned to the targeted habitat polygon. A total of 82,617 habitat polygons were analyzed.

Table 8-2. Matrix example for sensitivity/stress scores.						
Habitat Polygon	Criteria Polygons					Total Score
	Conservation Area	Urban development	Exotic species	Disturbed area	Future development	
1	1	1	1	1	1	5
2	0	1	1	1	1	4
3	0	0	0	0	0	0
4	0	1	1	0	0	2
5	1	1	0	0	1	3

In Figure 8-4, areas in red are identified as most sensitive/stressed due to potential or existing impacts of surrounding or internal land uses or practices. Stressed or sensitive habitat in the eastern portion of the basin is easily identified as natural areas within existing mining land uses, which include exotic species cover, mining disturbance, dewatering, and adjacent high intensity land use (mining) and disturbed areas. Designated sensitive habitats also occurred in the east-central portion of the watershed, on either side of U.S. 301. In these cases the stressed habitats were associated primarily with urban and residential development around Sun City and Wimauma, as well as surrounding croplands. Exotic species and disturbance are not the predominant characteristics impacting habitat in this portion of the watershed.

Areas with the “least stress” were identified in Cockroach Bay and along the Little Manatee River channel and tributaries. These areas are closely associated with conservation areas and future protection of such areas is likely dependent on the continued protection and acquisition of natural lands, such as those presented in the integrated Conservation Plan Map (**Figure 8-5**). Both existing and future conservation and public lands are included as part of the integrated Conservation Plan Map in an effort to further identify important habitat in the LMR watershed.

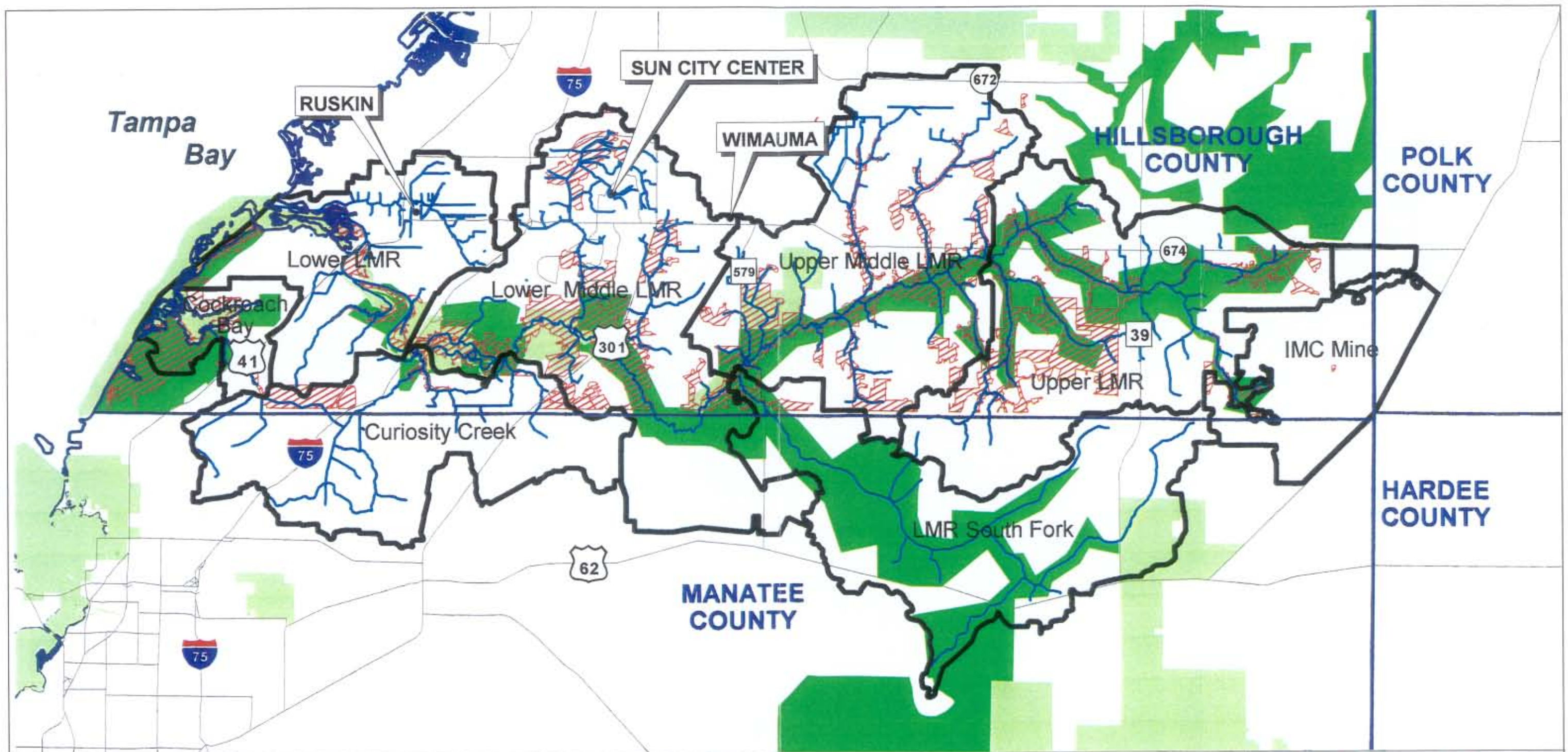
The Little Manatee River is tidally influenced from its mouth to approximately one mile upstream of U.S. 301 (Fernandez 1985). The stream width varies from approximately 4,000 feet at Shell Point at the mouth of the river to 400 feet at U.S. 41, and narrows to 40 - 150 feet at U.S. 301.

Salinity is an important factor in the distribution of submerged aquatic vegetation (Zieman 1982), emergent vegetation (Odum *et al.* 1984; Latham *et al.* 1994), benthic infauna (Estevez *et al.* 1984), and fish species distributions (Peebles *et al.* 1991) in riverine and estuarine systems. In addition, community interactions in these saline habitats are controlled less by biological processes, such as predation and competition, than by physical factors, such as salinity changes. Thus, the estuarine habitat often serves as a physically stressful but highly productive sanctuary for developing stages of offshore fish and often provides critical nursery habitats for important recreational and commercial fish populations in the bay.

At the upstream extent of the tidal influence in the Little Manatee River, salinities are low and many plants and animals are sensitive to increases in salinity, while in the lower reaches of the river, average salinities are high and characteristic plant and animal populations are more sensitive to decreases in salinities. For example, insects, freshwater fishes, and many species of freshwater plants, such as sawgrass, duck potato, bulrushes, and spike rushes occur in low salinity upstream river reaches. Along the downstream reaches, marine fishes and benthos occur in combination with salt-tolerant plant communities limited to few species, including mangroves, saltmarshes, and seagrasses.





In addition to organisms that spend their entire life cycles in estuarine systems - such as shellfish and spotted sea trout - many marine species migrate in or off shore during larval and juvenile stages. Many commercially important species, such as oysters, penaeid shrimp, blue crabs, and various finfishes are euryhaline and survive rapidly changing conditions of salinity and other habitat variables (euryhaline organisms tolerate a wide range in salinities). These species use the abundant food resources of coastal systems while remaining relatively free from predation by the stenohaline marine forms offshore and the inshore freshwater predators (stenohaline organisms tolerate a very narrow range of salinities).

The vegetation and wildlife resources in the estuarine and freshwater wetlands and the uplands in the LMR watershed are discussed in the following sections.



Department of Public Works
Stormwater Management Section




-  Greenway System
-  Existing Conservation Lands
-  Proposed Conservation Lands
-  Water

Legend



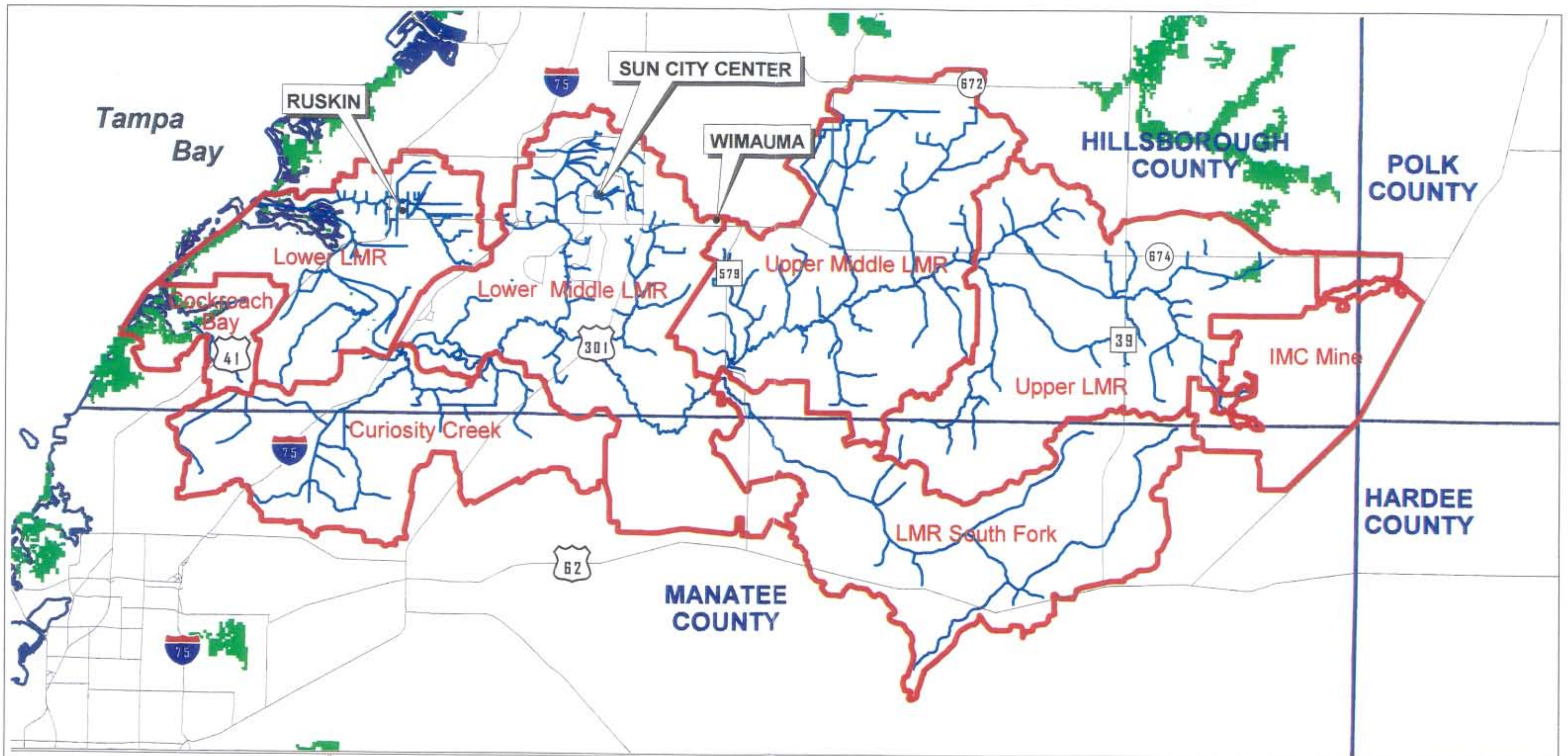
September, 2000

-  Cities
-  Little Manatee River
-  County Boundary
-  Major Basin Boundary

**Little Manatee River
Watershed Management Plan**

**Figure 8-5
Integrated
Conservation Plan**

PBSJ



Department of Public Works
Stormwater Management Section



 Strategic Habitat
Conservation Areas *


* Source: Florida Fish and
Wildlife Conservation Commission

Legend



2 0 2 Miles

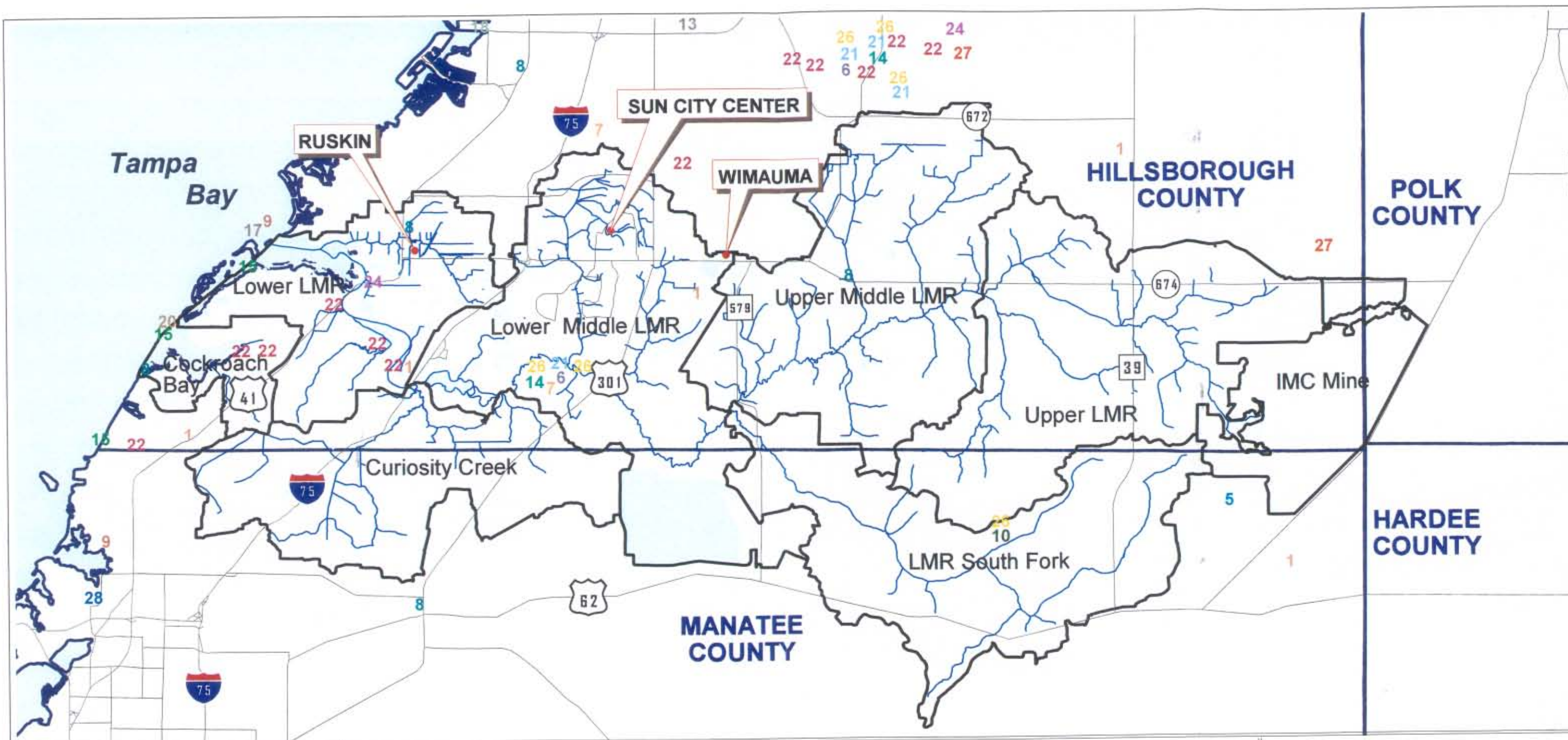
September, 2000

-  Water
-  Cities
-  Little Manatee River
-  County Boundary
-  Major Basin Boundary

**Little Manatee River
Watershed Management Plan**

Figure 8-6
Critical Habitat

PBS&J



Department of Public Works
Stormwater Management Section



- 1 BALD EAGLE
- 2 BLACK SKIMMER
- 3 BROWN PELICAN
- 4 CASPIAN TERN
- 5 CHAPMAN'S SKELETONGRASS
- 6 CURTISS' MILKWEED
- 7 EASTERN DIAMONDBACK RATTLESNAKE
- 8 EASTERN INDIGO SNAKE
- 9 ESTUARINE TIDAL SWAMP
- 10 FLORIDA MOUSE
- 11 FLORIDA PINE SNAKE
- 12 FLORIDA SCRUB-JAY
- 13 GEOLOGICAL FEATURE

Legend

- 14 GOPHER TORTOISE
- 15 HAIRY BEACH SUNFLOWER
- 16 LEAST TERN
- 17 MANATEE
- 18 MANATEE AGGREGATION SITE
- 19 MARINE TIDAL SWAMP
- 20 NECKLACE POD
- 21 NODDING PINWEED
- 22 RARE/ENDANGERED PLANT
- 23 ROYAL TERN
- 24 SAND BUTTERFLY PEA
- 25 SANDWICH TERN

September, 2000

- 26 SCRUB
- 27 SPOON-FLOWER
- 28 XERIC HAMMOCK
- Water
- Cities
- Little Manatee River
- County Boundary
- Major Basin Boundary



2 0 2 Miles

Little Manatee River Watershed Management Plan

Figure 8-7
Species & Habitat
Occurrence

PBSJ

8.2 UPLAND VEGETATION COMMUNITIES

Upland communities in the LMR watershed include long leaf pine and flatwoods communities, as well as hammocks and scrub (Figure 8-1). Historically, long leaf pine and associated shrubs and grasses were the dominant vegetation occurring on the well drained, deep sands in the watershed. Most of the original forests that once occurred throughout Hillsborough County, including the LMR watershed, have been cleared and converted to agriculture, except for a few areas within the forested flood plain and swamps. Most are characterized by well drained and somewhat poorly drained soils that were converted to farming (e.g., vegetables, citrus) or pasture. Long leaf pine communities cleared but not converted to agriculture have since regenerated, but are now dominated by stands of turkey oak (*Quercus laevis*), and bluejack oak (*Q. incana*), with live oak in wetter areas. Dominant vegetation in well drained sands includes oak (*Quercus* spp.), hickory (*Carya* spp.), magnolia (*Magnolia* spp.), long leaf pine (*Pinus palustris*), and often a dense undergrowth of shrubs and grasses.

Aerial photographic interpretation of portions of Hillsborough County within the Alafia River and LMR watershed (Dames & Moore 1975) identified uplands dominated by agricultural fields (active and inactive), mixed hardwoods, pine/oak mix, pine flatwoods, and oak-deciduous mix. The dominant plant species in the old field habitat are grasses that support grazing or other agricultural practices. Mixed hardwoods have primarily an oak overstory. The remaining habitat types are mixes of pine and oak. Cypress (*Taxodium* spp.) domes or heads are also an important vegetation component within the watershed.

8.2.1 Pine Flatwoods

As the name implies, pine flatwoods are dominated by one or more of the following species of pine: *Pinus palustris* (longleaf pine), *P. elliotii* (slash pine), and *P. serotina* (pond pine). Other tree species commonly found include numerous species of oak (*Quercus* spp.), sweet gum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), ash (*Fraxinus* spp.) and cabbage palm (*Sabal palmetto*). Although the density of the tree canopy varies significantly between locations, the typical pine flatwoods canopy is generally open.

Pine flatwoods communities occur on somewhat poorly drained and dark soils. Species composition includes slash pine, oak, hickory, saw palmettos, and wiregrass as well as other grasses. Pine flatwoods communities within the LMR watershed have largely been replaced by agricultural uses and to a lesser extent urban development. Remnant and regenerated flatwoods communities within agricultural old fields are characterized by slash pine (*Pinus elliotii*), saw palmetto (*Serenoa repens*), gallberry (*Ilex glabra*), rusty lyonia (*Lyonia ferruginea*), wax myrtle (*Myrica cerifera*), and wiregrass (*Aristida stricta*).

Pine flatwoods are ranked as “demonstrably secure” in Florida by Florida Natural Areas Inventory (FNAI 1999) and encompass a sizable portion of the project area. Pine flatwoods are

protected by the Hillsborough County Land Development Code and are to be restored and managed whenever possible. The flatwoods are “characterized by low, flat topography; poorly drained and nutrient-poor, acidic, sandy soils; and an open woodland vegetation with a pine overstory and a variable shrub and herb layer” (Abrahamson and Hartnett 1990).

Some abandoned agricultural fields have succeeded to plant communities dominated by broom sedge, oaks, and pines. Many of these old fields have also been invaded by exotic nuisance plant species such as Brazilian pepper and melaleuca. A few areas have been replanted in pines.

Understory species of the pine flatwoods include saw palmetto (*Serenoa repens*), fetterbush (*Lyonia lucida*), gallberry (*Ilex glabra*), staggerbush (*Lyonia fruticosa*), wax myrtle (*Myrica cerifera*), dwarf live oak (*Quercus minima*), and tarflower (*Befaria racemosa*). Density of the shrub layer in a pine flatwoods community varies greatly, but is often high when present.

Fire has historically been one of the strongest influences on the flatwoods ecosystems. Variation in the periodicity and extent of fire is frequently credited with the large variation in vegetation associations of flatwoods communities. Frequent fire in flatwoods results in a more open canopy and sparse shrub layer, allowing the development of an herbaceous layer, especially wiregrass (*Aristida* spp.). Frequent fires can sometimes result in the absence of a tree and/or shrub layer, one of the factors maintaining the dry prairie ecosystem. Herbaceous species common to the dry prairie include mostly grasses -- wiregrass (*Aristida berychiana*) (formerly *A. Stricta*), bottlebush three awn (*Aristida spiciformis*), arrowfeather (*Aristida purpurescens*), broomsedge (*Andropogon virginicus*), love grasses (*Eragrostis* spp.), and other grasses and herbaceous species. Dry prairie occasionally contains saw palmetto and scattered shrubs.

Because of its low topography, poor nutrient content of the soils, and poor drainage, flatwoods have not historically been used extensively for agriculture or development. However, they were used extensively for grazing, lumber, pulpwood, and the production of resin and turpentine

These practices have had various effects on the structure and health of the ecosystem. Because of the extent of flatwoods forests (about 33 percent of the southeastern U.S.), the impact of even the most destructive lumber harvest resulted in damage to only a small percentage of the total ecosystem. Land drainage techniques have increased the use of this ecosystem, but unfortunately, the attitude remains that we still have abundant acreage in healthy flatwoods forests and dry prairies.

In fact, none of the original (pre-Columbus), virgin flatwoods ecosystem remains in the state of Florida and the secondary forests are decreasing at an ever-increasing rate. Drainage, chemical fertilization techniques, and the increased population growth in the state have resulted in demands on this land for urban developments and agriculture. In addition, because of the increasing encroachment of urban development on flatwoods communities in all parts of the state, fire suppression has been the rule in many parts of the state, leading to drastic alterations of this fire dependent ecosystem.

Mesic flatwoods, or scrubby flatwoods, occur on moderately well-drained sandy substrates with a mixture of organic material, often with a hard pan. Under natural conditions, these communities are characterized by occasional fire and dominant vegetation includes longleaf pine or slash pine with scrub oaks and wiregrass understory.

In the LMR watershed, well drained soils that have not been cleared for agricultural uses or urban development presently support scrubby flatwoods communities. Vegetation within this community includes longleaf pine (*P. palustris*), slash pine (*P. elliotii*), sand pine (*P. clausa*), sand live oak (*Q. geminata*), Chapman's oak (*Q. chapmanii*), myrtle oak (*Q. myrtifolia*), saw palmetto (*S. repens*), staggerbush (*L. fruticosa*), and wiregrass (*A. stricta*). Lichens (*Cladonia* spp.) and spike moss (*Selaginella arenicola*) are also commonly present within this community.

8.2.2 Hammocks

Despite the diversity of tree species in Florida's hammocks, there are a number of species which are exceptionally common. These species often occur under a limited range of hydrological conditions in any one area, often in either the xeric, mesic, or hydric hammock, but rarely in all three (Platt and Schwartz 1990). Common to all three hydrological conditions in most parts of the state is the live oak. In southern parts of the state, the sabal palm (*S. palmetto*) is a common tree species found in all hydrologic conditions. Hickory (*Carya glabra*) is also common in many hammocks through out the state, as is sweet gum (*L. styraciflua*). In northern forests, the white oak (*Q. alba*), beech (*Fagus grandiflora*), spruce pine (*P. glabra*), and laurel oak (*Q. hemisphaerica*) reach the southernmost limits of their range in mesic to xeric hammocks. Tulip tree (*Liriodendron tulipifera*), tupelo (*Nyssa sylvatica*), and loblolly pine (*P. taeda*) are common species in the northern hydric hammocks.

Sabal palm and live oak often achieve dominance in some of the more hydric forests like those of Myakka River State Park. Sweetbay magnolia (*Magnolia virginiana*), water oak (*Q. nigra*), slash pine, American elm (*Ulmus americana*), and sweet gum are common species in the more mesic to hydric hammocks. Hickory, magnolia, long leaf pine, and red bay (*Persea borbonia*) are more common in mesic to xeric hammocks. Understory species include: holly (*Ilex* spp.), wax myrtle, ironwood (*Carpinus caroliniana*), saw palmetto, black cherry (*Prunus serotina*), loblolly bay (*Gordonia lasianthus*), red maple, swamp bay (*Persea palustris*), red mulberry (*Morus rubra*), viburnum (*Viburnum obovatum*), and olive (*Osmanthus americanus*), to name a few. Additionally, the hammocks of central and southern Florida often include numerous ground cover species and vascular epiphytes (common only to tropical areas of the globe).

8.2.3 Scrub

Scrub communities are considered imperiled in Florida by the Florida Natural Areas Inventory (FNAI) because of rarity or vulnerability to extinction due to natural or anthropogenic factors.

Scrub communities occur on old dunes with deep fine sand substrates and are characterized by rare or occasional burns (20-80 years). Scrub vegetation is characterized by sand pine, scrub oak and other oak species, rosemary, saw palmetto, and grasses.

Scrub is a xeric shrub community usually dominated by shrubby oaks and/or Florida rosemary (*Ceratiola ericoides*), often with an overstory of pine. However, scrub communities consist of more than just sand pine. There are also common associations such as oak scrub, rosemary scrub, slash pine scrub, and sometimes coastal scrub and scrubby flatwoods. The scrub community occurs at relatively high elevations, on well-drained, infertile, sandy soils. Scrub communities are adapted to and maintained by infrequent fires, probably occurring once every 10-100 years.

Perhaps the greatest difference between the pine flatwoods communities and both the scrub and high pine communities is the higher elevations on which the latter two develop. Higher elevation results in better drained soils. The higher elevations have made the scrub and high pine habitat highly desirable for development as a result of the added protection from flooding. From citrus farm and golf course use, Florida's scrub and high pine communities are disappearing at a rapid rate.

Scrub communities occupy well to excessively well drained soils, (white sand) and are dominated by sand pine (*P. clausa*) with an evergreen oak understory. In the absence of fire, these communities are dominated by oaks and are termed "oak scrubs." Oaks that characterize scrub communities include scrub live oak, myrtle oak, scrub oak, and Chapman's oak. Shrub layers are generally open with saw palmetto, rusty lyonia, and Florida rosemary. Ground cover is sparse and generally includes gopher apple (*Licania michauxii*), beak rush (*Rynchospora megalocarpa*), milk pea (*Galactia* spp), and various grasses including (*Andropogon floridanum*) and (*Panicum* spp.). Lichens such as reindeer moss and the relatively rare spike moss are also present.

8.3 WETLAND AND AQUATIC VEGETATION COMMUNITIES

The Little Manatee River has extensive areas of oligohaline and freshwater wetland habitat (Figure 8-1). The vegetation composition of these systems ranges from marine seagrasses and coastal mangrove forests at the mouth of the river to the freshwater floodplain forest along the tributaries of the upper portions of the watershed. Of these, the coastal resources along the lower portion of the watershed are considered critical wetland resources and provide nursery habitat for many fish species. The change in salinity in the lower river and the gradual change in wetland communities that result from the influence of this salinity variation are important factors affecting the productivity of these wetland communities.

Peebles and Flannery (1992), in their study of fish nursery use of the Little Manatee River, identified six segments in the tidal river, based on shoreline physiography and vegetation (Table

8-3). The vegetation communities along the gradient of the downstream estuary to the upstream freshwater river are described in the following sections.

Fewer emergent species occur in these saline environments, e.g., mangroves (*Rhizophora mangle*, *Avicennia germinans*, and *Laguncularia racemosa*) and cordgrass (*Spartina alterniflora*), when compared with freshwater conditions. The presence of these species is not a result of their preference for higher salinity; rather, it is a result of intolerance of these conditions by most other species. Common emergent wetland and coastal plant species occurring along the lower, saline portions, of the Little Manatee River are listed in **Table 8-4**.

Table 8-3. River mile locations and characteristics of oligohaline sampling locations (depth and surface salinity are presented as means with ranges in parentheses) (Peebles and Flannery 1992).			
River Mile	Depth (Feet)	Salinity (‰)	Description
8.8	6.2 (3.2-8.2)	0.8 (0.0-4.5)	braided channel, sloughs, marsh, hammocks dominant vegetation: black rush, cattail, leather fern, saw palmetto, wax myrtle, red cedar, pine, sabal palm
6.4	6.2 (3.2-9.8)	3.3 (0.0-14.0)	channel bordered by low bluffs on south bank, marsh-rimmed embayment on north dominant vegetation: black rush, saw palmetto, sabal palm, pine, oak, Australian pine
4.4	5.6 (4.3-6.6)	6.7 (0.0-19.0)	channel bordered by low bluffs on north bank, low, marshy ground on south dominant vegetation: black rush, Brazilian pepper, saw palmetto, sabal palm, pine, red mangrove
2.4	7.5 (5-10.8)	11.6 (0.0-24.0)	channel bordered by municipal development on north bank, mangrove swamp on south dominant vegetation: red mangrove, black mangrove, oak
0.0	6.2 (3.3-9.8)	17.9 (1.0-30.0)	braided channel bordered by municipal development on north bank, mangrove swamp on south, oyster growth near shoreline dominant vegetation: red mangrove, shoal grass
-2.4	9.8 (6.6-12.5)	25.8 (13.0-34.0)	open bay with sand bottom

Some exotic plant species occur along the lower river, the most abundant of which is Brazilian pepper. Exotic species are often found under conditions in which the native vegetation has been disturbed, providing a foothold for exotics, which then remain at the expense of native species.

8.3.1 Phytoplankton

Salinity, to a large extent, influences the seasonal and spatial variations in phytoplankton species composition and community characteristics within the estuarine systems, including the Little Manatee River. Phytoplankton were studied by Vargo between January 1988 and 1989 in the Little Manatee River and Tampa Bay. The study demonstrated that diatoms and microflagellates were the numerically dominant group of phytoplankton in both the river and bay. Microflagellates dominated more frequently in riverine sampling stations, particularly at intermediate salinity zones between 12 and 18 ppt. The seasonal phytoplankton cycle in the river for the total size fraction displays a relative consistency in chlorophyll concentration between 5 and 10 ug/l for most of the year with the maximum occurring in June. Late summer and fall values display a general decrease toward the winter minima. Species present in the samples included the blue-green algae *Schizothrix*, and the diatoms *Skeletonema costatum* and *Thalassiosira sp.* Vargo also concluded that nitrogen addition to the Little Manatee River and Tampa Bay results in dramatically increased diatom populations.

Table 8-4. List of emergent wetland and coastal plant species along the lower Manatee River.

Common Name	Scientific Name
black needle rush	<i>Juncus roemarianus</i>
softstem bulrush	<i>Scirpus validus</i>
duck potato	<i>Sagittaria lancifolia</i>
Sawgrass	<i>Cladium jamaicense</i>
Cattail	<i>Typha domingensis</i>
leather fern	<i>Acrostichum danaeifolium</i>
salt bush	<i>Baccharis halimifolia</i>
red mangrove	<i>Rhizophora mangle</i>
white mangrove	<i>Laguncularia racemosa</i>
black mangrove	<i>Avicennia germinans</i>
saltmarsh cordgrass	<i>Spartina alterniflora</i>
marsh hay cordgrass	<i>Spartina patens</i>

8.3.2 Mangroves

The mangrove communities along the shoreline within the mouth of the Little Manatee River, Cockroach Bay, and Little Cockroach Bay consist of fringe and overwash mangrove communities dominated by red (*Rhizophora mangle*), black (*Avicennia germinans*), or white (*Laguncularia racemosa*) mangroves. Some of these areas have been transected by mosquito ditches and canals. Overwash mangrove forests are completely inundated by daily tides. The salinity and velocity of water in overwash forests are higher than in fringe forests along shorelines of the bay and tributaries such as the Little Manatee River. The latitude of Tampa Bay

is near the northern limit of mangroves and low-temperature stress is common for mangroves in Tampa Bay. The mangrove forests fringing Tampa Bay have been described as scrub marsh because of repetitive freeze damage (Estevez and Mosura 1985). Lugo and Snedeker (1974) and Odum *et al.* (1982) have described types of mangrove forest based on the influence of environmental factors, appearance of the vegetation, and community dynamics.

A botanical survey along the Little Manatee River between February 1982 and May 1983 (Fernandez 1985) was used to compare vegetation among these salinity zones. Relatively few plants were found to occur in the high salinity environment. Between river miles 0 (the mouth of the river) and 2.5, the river channel includes numerous islands and mangroves (primarily *Rhizophora mangle*) which dominate the relatively undeveloped shorelines. Only four out of 32 species, including black mangrove, buttonwood (*Conocarpus erecta*), white mangrove, and red mangrove, were found in the high salinity zone (never <10 ppt). The majority of species (26 species) were found at lower salinities (always <10 ppt zone) and 15 species occurred at intermediate salinities (sometimes <10 ppt).

8.3.3 Seagrasses

A variety of submerged macrophyte communities are found within Cockroach Bay, Little Cockroach Bay, and the mouth of the Little Manatee River. *Halodule wrightii* (shoal grass), *Thalassia testudinum* (turtle grass), and *Syringodium filiforme* (manatee grass) are found along the gradients of depth, turbidity, and wave energy within these areas. A variety of macroalgae is also present, both on the unconsolidated sediments and on submerged hard substrates.

Seagrasses are an important component of the Tampa Bay ecosystem in that they provide habitat for many species of wildlife. Losses of seagrasses are often a result of reduction in water clarity due to physical impacts such as dredging. In addition to water clarity, nutrient inputs and resulting epiphyte growth on seagrass blades may shade the seagrass and kill or stress it. The health and presence of seagrasses are an effective measure of the health of the estuary and alterations in freshwater flows that may impair the recovery of seagrasses should be addressed (Ries 1993).

The seagrasses of south and central Florida tolerate salinity fluctuations, although all species have optimal ranges of salinity and may exhibit leaf loss and decreased growth outside these ranges. Near the river mouth in high salinity areas, inshore species turtle grass and *Ruppia maritima* are common. Shoal grass is considered the most euryhaline seagrass. *Ruppia* is a freshwater species tolerant of some salinities, and extends farther upstream in the low salinity areas and mixes with *Vallisneria*, another salinity tolerant freshwater species. Near the usual limit of salt penetration, submersed plant diversity increases as *Vallisneria* species intermix with obligate freshwater species, such as *Najas* sp., *Ceratophyllum* sp., and *Hydrilla verticillata*. Rooted aquatic weeds such as *Hydrilla* only become common in tidal reaches of spring runs where salt influx is prevented by constant freshwater discharge.

Water quality parameters other than salinity influence submerged aquatic plant distribution, abundance, and conditions. These parameters include turbidity, color, hardness, and pH. Long-term losses of submerged aquatic vegetation, and more specifically seagrasses, have been identified as a region-wide concern on the west coast of Florida. Increased nutrients, turbidity, or other light-attenuating substances have generally been proposed as causes of decline in cover.

8.3.4 Salt Barrens

The plant community and ecology of salt barren/high marsh habitats (i.e., saltern, salt prairie) within Tampa Bay were reviewed by Lewis and Estevez (1988). These communities occur at elevations landward of the mangrove forest, in an area normally inundated by tides only once or twice a month. The salt water pools in these areas fill with seawater and the water eventually evaporates. Because of the residual salt accumulation, soil salinities in salt barrens may exceed 100 ppt. Plant species which occupy this habitat are uniquely salt tolerant. These halophytic species typically include *Sesuvium portulaca* (sea purslane), *Salicornia virginica* (glasswort), *Batis maritima* (saltwort), *Borrchia frutescens* (sea oxeye daisy), *Limonium carolinianum* (sea lavender), and salt tolerant grasses (*Distichlis spicata* and *Paspalum virgatum*). Carlton (1975) provides a description of these and other halophytic plant species common to Florida saltwater wetlands.

Salt barrens are a class of emergent vegetation habitat that have been targeted by the Tampa Bay Estuary Program (TBEP) as a living resource target for protection and restoration. Approximately 1,312 acres of salt barrens habitat exist within and adjoining Cockroach Bay.

8.3.5 Saltwater and Freshwater Marshes

Saltwater marshes are intertidal plant communities that form the transition between terrestrial and marine ecosystems. These saltmarshes, located along the downstream portion of the LMR, are highly productive (Odum *et al.* 1984), a result of freshwater nutrient and organic input, tidal fluctuation, rainfall and river flow variation, as well as basic physiographic and biological features. Phytoplankton, periphyton, and vascular plants all add to the productivity of the saltmarshes. As emergent vegetation habitat, salt marshes have been targeted by the TBEP as a living resource target for protection and restoration. Approximately 430 acres of salt marsh habitat exist within the Cockroach Bay Aquatic Preserve (PBS&J 1999).

Along with mangroves, saltmarshes make up most of the vegetation at the mouth of the river. The two dominant plant species comprising the saltmarshes are:

- smooth cordgrass (*Spartina alterniflora*), and
- black rush (*Juncus roemerianus*).

The saltwater marshes in the Little Manatee River are dominated by black needle rush and saltmarsh cordgrass upstream of U.S. 41 to upstream of I-75 along the river edge. Cordgrass fringes are generally monospecific, although saltmarsh aster (*A. tenuifolia*) and black rush may be interspersed. Black rush stands occur at higher elevations when compared with cordgrass and are subjected to shorter and less frequent flooding.

Between river miles 2.5 and 7.5, the river is confined to a single channel, although the river widens into relatively large tidal embayments in three areas along the channel. Saltmarshes, dominated by black rush are the dominant vegetation along the shores of these embayments. In addition, the channel meanders along this stretch of the river and bluffs occur alternately on the outside of the river bends on opposite banks of the channel. Narrow bands of intertidal wetlands occur along the low-lying shorelines within this reach.

Brackish vegetation habitat is primarily limited to areas where salinities range between 0 and 15 ppt, and include both emergent and submergent forms. Submerged brackish species *Vallisneria neotropicalis* and *Ruppia maritima* are actually freshwater plants tolerant of low salinities. *Sagittaria subulata* is common in dense mats along creeks and is often exposed at low tides.

Freshwater marshes begin east of I-75, at approximately river mile 10. These marshes are dominated by freshwater species, primarily cattail (*Typha latifolia*) and leather fern (*Acrostichum danaeifolium*). Freshwater marshes may also include sawgrass (*Cladium jamaicense*), duck potato (*Sagittaria lancifolia*), morning glory (*Ipomoea sagittata*), and bulrush (*Scirpus validus*) along the channel banks. Water hyacinths (*Eichhornia crassipes*) were present along the north bank. While plants in tidal freshwater marshes, where salinities are greater than 0.5 ppt, are tolerant of low salinities and fluctuating water levels, seed germination is difficult. Saltmarsh and brackish marsh species, however, vegetatively expand and are not limited by seed viability.

Between river miles 7.5 and 10, the Little Manatee River becomes braided watercourses with shorelines dominated by brackish wetland species (primarily cattail, leather fern, sawgrass, and black rush). Upstream of river mile 10, the river returns to form one channel with freshwater aquatic vegetation such as *Nuphar luteum* (spatterdock) and *Hydrocotyle umbellata* becoming more common. Hardwood forests border the river in areas upstream of river mile 9.3.

8.3.6 Forested Wetlands

Floodplain forest begins to dominate the river bank in areas upstream of river mile 10 and the 0.5 ppt isohaline (Fernandez 1985). These communities are alluvial, on substrates of sand, silt, clay, and organics, and may be occasionally or seasonally inundated. The forested floodplain may be dominated by hardwoods, as in the case of bottomland hardwoods, or by coniferous cypress domes.

The palustrine forested category includes all freshwater (containing less than 0.5 parts per thousand ocean-derived salts) wetlands dominated by woody vegetation greater than 20 feet in height (Cowardin *et al.* 1979). Floodplain wetlands, locally called bottomland hardwoods, make up the predominant portion of this category. Water regimes range from brief periodic flooding to near permanent inundation. For example, communities dominated by oaks (*Quercus* spp.) along with pop ash (*Fraxinus caroliniana*), sweet gum and ironwood (*Carpinus caroliniana*) are subject to spring and winter flooding. Old river scars and oxbows vegetated by cypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*) may be flooded nearly continuously. Forested wetland communities with intermediate degrees of flooding are an extensive part of the bottomland hardwood spectrum. Important species of the intermediate zones include willows (*Salix* spp.), maples (*Acer* spp.), and water hickory (*Carya aquatica*).

In addition to bottomland hardwoods, non-alluvial forested wetlands cover large acreages. These include pine (*Pinus* spp.) dominated savannas and wet pine flatwoods, hydric hammocks, bay (*Magnolia virginiana*, *Gordonia lasianthus*, and *Persea borbonia*) heads; and cypress or gum (*Nyssa sylvatica* var. *biflora*) ponds.

These habitats include formerly forested wetlands that have been cleared, burned or otherwise impacted but are still wetland and are now experiencing regrowth. Also within this category are shrub-dominated wetlands vegetated by species such as hollies (*Ilex* spp.), bays, fetterbushes (*Lyonia lucida* and *Leucothoe racemosa*), accreting river point bars, backwaters of ponds and reservoirs, and sand or gravel pits vegetated by buttonbush (*Cephalanthus occidentalis*), and willows.

Vegetation within these hardwood forests also includes red maple, popash, black gum, sweetgum, bald cypress, sweet bay, cabbage palm and Carolina willow (*Salix caroliniana*). Shrubs and vines make up the understory and groundcover vegetation. Shrub species include fetterbush, and wax myrtle, while vines include smilax (*Smilax laurifolia*), poison ivy (*Toxicodendron radicans*), and muscadine grape vine (*Vitis* spp.). Various ferns, herbaceous wetland species, and epiphytes also occur in the wetland hardwood systems.

8.3.7 Hydric Hammock

Hydric hammock communities occur in low, flat, wet sites where the limestone is near the surface and where the hydroperiod allows for 60 days per year inundation. Hydric hammocks are characterized by hardwood and cabbage palm in addition to understory vegetation. Plant species include slash pine, live oak, cabbage palm, and hickory. Understory vegetation includes shrub species such as beauty berry (*Callicarpa americana*), saw palmetto, sparkleberry (*Vaccinium arboreum*), and blackhaw (*Viburnum obovatum*). Herbaceous vegetation is generally sparse, although ferns and epiphytes are usually present.

8.4 WILDLIFE

A diverse assemblage of fauna inhabits the various terrestrial and aquatic habitats within the Little Manatee River and watershed. Since 35 percent of the watershed remains in upland native habitat, terrestrial wildlife species that adapt well to human activities predominate. Conversely, the coastal estuarine areas of Cockroach Bay and the lower Little Manatee River are considered regionally significant habitat areas that support a wide variety of fish and birds. These areas include the seagrasses and coastal mangroves that serve as nurseries for marine and avian species that inhabit the larger west coast of the Gulf of Mexico.

8.4.1 Mammals

Terrestrial wildlife that inhabit the various eco-systems within the watershed include those species that are common to central Florida. The Florida Natural Areas Inventory and Florida Fish and Wildlife Conservation Commission (FFWCC) listings identify the mammals occurring in the areas including: opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), big brown bat (*Eptesicus fuscus*), Florida mouse (*Peromyscus floridanus*), oldfield mouse (*Peromyscus polionotus*), nine-banded armadillo (*Dasypus novemcinctus*), march rabbit (*Sylvilagus palustris*), eastern cottontail rabbit (*Sylvilagus floridanus*), Sherman's fox squirrel (*Sciurus niger shermani*), river otter (*Lutra canadensis*), bobcat (*Lynx rufus*), red fox (*Vulpes vulpes*), white-tail deer (*Odocoileus virginianus*), and wild pig (*Sus scrofa*). This listing includes both common and listed species.

Mammals occurring in flatwoods include the cotton mouse (*Peromyscus gossypinus*), grey fox (*Urocyon cinereoargenteus*), and large mammals such as white-tailed deer (*Odocoileus virginianus*), black bear (*Ursus americanus*), and the endangered Florida panther (*Felis concolor coryi*).

Two marine mammals occupy estuarine and riverine habitats within the watershed. These include the manatee (*Trichechus manatus*) and bottle-nosed dolphin (*Tursiops truncatus*).

8.4.2 Birds

A wide variety of bird species exist within the Little Manatee River and Cockroach Bay area because of the combination of climate, habitat, and the proximity of the region to a major migratory route. Long (1975) lists 89 species of birds as permanent, winter or summer residents, or as transients to the area. Many of the bird species use the habitats associated with the bay for nesting and raising young and/or feeding on fish and invertebrates by wading in the shallow waters or diving in the deeper waters.

The state listed Florida scrub jay (*Aphelocoma coerulescens coerulescens*) is common in scrub habitat in Florida, and its occurrence is documented in the watershed. The prospect of reintroducing this species is referenced within the Little Manatee State Recreation Area's Unit Management Plan. The listed Florida burrowing owl (*Speotyto cunicularia floridana*) also occurs in Hillsborough County and in the LMR watershed. In flatwoods, bird species include pine warbler (*Dendroica pinus*) and great horned owl (*Bubo virginianus*) (Abrahamson and Hartnett 1990).

Odum *et al.* (1982) divided the mangrove avifauna into six groups based on similarities in methods of procuring food. These groups (guilds) are wading birds, probing shorebirds, floating and diving waterbirds, aerially searching birds, birds of prey, and arboreal birds. Wading birds include herons, egrets, ibises, bitterns, and spoonbills. Probing shorebirds include rails, stilts, sandpipers, and willets. Floating and diving birds include ducks, grebes, loons, cormorants, and gallinules. Aerially searching birds include gulls, terns, kingfisher, black skimmer, and fish crow. Birds of prey include hawks, falcons, vultures, and owls. Arboreal birds include the mangrove cuckoo, woodpeckers, flycatchers, thrushes, vireos, warblers, blackbirds, and sparrows.

The shallow areas next to mangroves provide foraging and resting habitat for wading bird species (e.g., herons, ibis, egrets, wood storks, roseate spoonbill), probing birds, and floating and diving birds. The wading bird species (vireos, warblers, mangrove cuckoo, osprey, and yellow-crowned night heron) nest, or may be expected to nest, in the mangrove fringe and mangrove islands in the estuarine portion of the Little Manatee River. The eastern shoreline and islands of Tampa Bay have been shown to be nesting and foraging habitat for several aerially searching birds (e.g. laughing gulls).

8.4.3 Reptiles and Amphibians

The scrub and scrub flatwoods communities in the watershed support gopher tortoise (*Gopherus polyphemus*), Florida scrub lizard (*Sceloporus woodi*), sand skink (*Neoseps reynoldsi*), and the blue-tailed mole skink (*Eumeces egregius liviidus*). Reptile and amphibian species of pine flatwoods include pine woods tree frog (*Hyla femoralis*), gopher tortoise (*Gopherus polyphemus*), oak toad (*Bufo quercicus*), eastern diamondback rattlesnake (*Crotalus adamanteus*), black racer (*Coluber constrictor*). The gopher tortoise, itself a species of special concern, also shares its home with several species, including the crawfish, the gopher frog, eastern indigo snake, and several other listed species.

8.4.4 Fish

Comp (1985) prepared a list of 203 fish species that have been collected in Tampa Bay. He believed that only 125 species could be considered common in habitats and 10 or fewer species usually made up the majority of fish caught in sampling programs. The ten most common fish

caught include tidewater silverside (*Menidia peninsulae*), bay anchovy (*Anchoa mitchilli*), scaled sardine (*Harengula jaguana*), striped mullet (*Mugil cephalus*), pinfish (*Lagodon rhomboides*), longnose killifish (*Fundulus similis*), spot (*Leiostomus xanthurus*), silver perch (*Bairdiella chrysoura*), silver jenny (*Eucinostomus gula*), and code goby (*Gobiosoma robustum*). Comp (1985) emphasized that this list is biased because the standard gear used in sampling programs tends to capture smaller, less mobile species. These species are typically the main food source for larger, more predatory fishes. Many of the species in this category are of importance to recreational and commercial fisheries and include *Megalops atlanticus* (tarpon), *Centropomus undecimalis* (snook), *Rachycentron canadum* (cobia), *Cynoscion nebulosus* (spotted seatrout), *C. arenarius* (sand seatrout), and various shark species (Lewis and Estevez 1988).

Killam *et al.* (1992) reviews the basic life histories of several fish species found within Tampa Bay. Many of the species demonstrate a habitat preference for the types of habitats found in Cockroach Bay. Spotted seatrout, silver perch, and *Microgobius gulosus* (clown goby) prefer areas characterized by submerged aquatic vegetation. *Sciaenops ocellatus* (red drum), snook, striped mullet, juvenile tarpon, and spot prefer the backwater mangrove areas and tidal rivers.

FDEP conducts monthly sampling of Cockroach Bay and the Little Manatee River through its Fisheries-Independent Monitoring Program. In the 1996 sampling program summary, the most common fish species recorded in Tampa Bay rivers (data from the lower Alafia, Little Manatee, and Manatee rivers are analyzed together) were *Anchoa* (anchovy) species, *Penaeus duorarum* (shrimp), and *Menticirrhus americanus* (whiting) (FDEP 1996). These species were also among the most commonly encountered in the in-bay samples.

Peebles and Flannery (1992) completed a two-year fish sampling program in the lower Little Manatee River to characterize the use of the area as fish spawning and nursery habitat and to assess the influence of land-based activities and processes on these functions. The findings indicated that the tidal portions of the Little Manatee River are used year-round as nursery habitat by estuarine dependent fishes, with larval species richness being highest during spring and summer. Larval and juvenile fish within the Little Manatee River were sampled, and it was found that the tidal portion of the river was heavily used as nursery habitat by an economically important assemblage of fishes.

Most of the larger species of fish that were collected were not spawned within the Little Manatee River; they migrated there as postlarvae or young juveniles. The spawning locations of those species were located between Tampa Bay proper (e.g., spotted seatrout, sand seatrout, silver perch, kingfishes, bay anchovy) and the Gulf of Mexico on the intercontinental shelf or beyond (e.g., striped mullet, spot). The assemblage of young, marine-derived fishes that concentrate in the tidal Little Manatee River includes the bay anchovy, menhaden, common snook, red drum, striped mullet, sand seatrout, southern kingfish, spot, skiliffish, naked goby, code goby, clown goby, hogchoker, line sole, and two or more species of mojarra.

From stomach analysis and sampling within the river, Pebbles and Flannery (1992) found that the food resources used by the young fishes within the tidal river were closely linked to the benthic community. The tidal river supports large numbers of benthically-associated macroinvertebrates including mysids, amphipods, and harpacticoid copepods which are important food items for the young fishes. The benthic productivity within the river is supported by the large amounts of dissolved and particulate organic carbon imported into the tidal river from the watershed.

8.4.5 Shellfish

Peebles and Flannery (1992), in their study of fish nursery use of the Little Manatee River, considered oyster growth moderate to extensive along the shoreline between river miles 0 (the mouth of the river) and 2.5, where sea grasses (primarily *Halodule wrightii* and *Thalassia testudinum*) occur on the shallow (<3 ft) sandy flats near the mouth of the river and mangroves dominate the shoreline.

Oyster beds exist within the tidal areas of Cockroach Bay and the mouth of the Little Manatee River. These beds are both habitat and potential fisheries. The primary oyster indigenous in Tampa Bay is the American oyster (*Crassostrea virginica*). Oysters tend to form aggregations on a variety of substrates, e.g., dead oyster shells, mangrove roots. These beds, reefs, or bars are usually limited to the mid-intertidal zone where minimum inundation and heat determine the upper limit to growth and predation determines the lower limit (FDNR 1987). Bahr and Lanier (1981) provide a comprehensive discussion of the oyster reef community which consists of invertebrates and some resident fishes.

Oysters are filter feeders feeding directly on suspended particulate matter in the water column. In doing this, they can biodeposit large quantities of suspended sediment; however, they can also concentrate pollutants (FDNR 1987; Lewis and Estevez 1988). Killam *et al.* (1992) provide a historic review of the oyster fishery in Tampa Bay. The oyster fishery in Tampa Bay has declined to near nonexistence because of man's activities around the bay (e.g, dredge and fill, stormwater runoff).

In 1983, the FDEP (formerly Florida Department of Natural Resources) temporarily closed the waters of the preserve to shellfishing due to increased coliform levels. FDEP released a draft report in 1990 that resulted in "prohibited status" for the eastern one-third of Cockroach Bay and the mouth of the Little Manatee River and a "conditionally restricted" for the rest of the aquatic preserve (Lewis Environmental Services, Inc. 1992). Shellfish harvesting within Cockroach Bay remains prohibited.

The northern and southern quahog (*Mercenaria mercenaria* and *M. campechiensis*, respectively) (i.e., hard clams) and the bay scallop (*Argopecten irradians*) are present within Tampa Bay. The hard clam fishery, reviewed in more detail in Killam *et al.* (1992), is small and primarily

recreational. According to local scientists, the bay scallop has been absent from Tampa Bay since the 1960s because of degraded water quality (Coastal Environmental, Inc. 1994). Because of recent observed improvements in water quality, local researchers believe that the water quality conditions in the bay may support a re-establishment of viable bay scallop populations and have introduced juvenile scallops into Tampa Bay.

A survey of the seagrass beds and surrounding areas in the bay for scallops was performed in 1993; the design and results are reviewed in Coastal Environmental, Inc. (1994). Six scallops were found in the survey; none were found in the Cockroach Bay area. During the 1996 and 1997 scallop surveys, however, over 70 were found bay-wide but the Cockroach Bay area was not sampled during those years.

8.4.6 Zooplankton

The University of South Florida, Department of Marine Sciences studied the zooplankton of the Little Manatee River Estuary from 1988 to 1990 (Rast *et al.* 1991). Night samples from six river stations within the lower 8.8 miles of the river identified sixty-seven (67) taxonomic categories of zooplankton. Dominant species included *copepod nauplii*, five groups of adult copepods, rotifers and larvae of polychaetes, mollusks and decapods. *Copepod nauplii* were the most numerous organism at all stations and comprised a major portion of the biomass at the river stations. Along with *nauplii*, the calanoid copepod *Acartia tonsa*, the cyclopoid copepod *Oithona colcarva*, benthic harpacticoid copepod, and polychaete and pelecypod larvae comprised 96 percent of the numbers and 86 percent of the biomass for the combined river stations. During periods of low river flow when salinity in the river stations was similar in value to the bay, zooplankton numbers and biomass at the lower river stations were similar in value to the bay. Conversely, high flow periods reduced zooplankton numbers within the river especially at the upriver stations. The assemblage of zooplankton in the bay was generally more diverse and contained a higher percentage of meroplanktonic larvae of benthic invertebrates.

A number of studies have demonstrated that most of the dominant zooplankton found in this study serve as important food items for larval or juvenile fish.

8.5 DESIGNATED CRITICAL HABITAT AND STRATEGIC HABITAT CONSERVATION AREAS

As development pressures increase in Florida coastal counties, habitat areas are rapidly disappearing or being degraded. Dwindling coastal habitat areas are important to many rare species including sea turtles, shorebirds, plovers, and migratory birds. Protecting strategic habitat areas by designating them as conservation lands is one way to preserve some components of coastal Florida's wildlife, threatened plant species, and rare plant communities. The Florida Game and Freshwater Fish Commission (FGFWFC), now Florida Fish and Wildlife

Conservation Commission (FFWCC), produced recommendations for minimum conservation goals for declining wildlife species and rare plant and animal species (Cox *et al.* 1994).

Strategic Habitat Conservation Areas (SHCAs) delineate habitat areas in Florida that should be conserved if key components of the biological diversity in the state are to be maintained. Using habitat and distribution maps, public land boundaries, and literature-based density estimates, Cox *et al.* (1994) developed maps of under-represented species that were merged into a single statewide map of SHCAs. Conservation areas were identified for rare communities (e.g. scrub, pine rocklands), rare plants, wading birds, and bat caves were included in the strategic habitat conservation areas. Strategic habitat conservation areas show lands needed to meet minimum conservation goals (Cox *et al.* 1994).

A map of SHCAs in the LMR watershed area is presented in **Figure 8-6**. Florida's system of publicly owned conservation lands covers 4.54 million acres in coastal counties and represents a foundation for the protection of ecologically sensitive and important communities and species. An additional 2.35 million acres in coastal counties are proposed Strategic Habitat Conservation Areas.

Regional maps of hot spots of biodiversity have also been mapped by Cox *et al.* (1994). Individual habitat maps for 44 focal species and rare natural communities highlight potential habitat and serve as indicator species of biological diversity in Florida.

8.6 LISTED SPECIES

Species designated as endangered, threatened, or of special concern on state and federal lists and other species categorized by other agencies as deserving special protection or consideration in the watershed are listed in **Table 8-5**. In addition, the Florida Natural Areas Inventory (FNAI), as part of The Nature Conservancy, maps occurrences of sensitive and listed species and these are presented in **Figure 8-7**. All of the species are representative of critical habitat which occurs in the LMR watershed and Cockroach Bay. Cox *et al.* (1994) selected the mangrove cuckoo (*Coccyzus minor*) and Wilson's plover (*Charadrius wilsonia*) as focal species representative of habitats requiring conservation.

In the coastal areas of the watershed, Wilson's plovers forage along exposed salt flats and sandy open areas in close proximity to open water, coastal strand, saltmarsh, and mangroves. Wilson's plovers are found in coastal areas around Florida. Within the Cockroach Bay area, significant foraging habitat would include the high marsh (salt barren) and intertidal sandy areas. Other important bird species known or expected to exist in the area include the black whiskered vireo, the gray kingbird, and the prairie warbler (Paul 1997). The Cockroach Bay Aquatic Preserve area is categorized as having a "high overlap" of critical coastal habitats for listed species by Cox *et al.* (1994). Listed bird species in the flatwoods community include the red-cockaded woodpecker, crested caracara, and Florida sandhill crane.

The distribution of the four species of sea turtles found within Tampa Bay (loggerhead (*Caretta caretta caretta*), green (*Chelonia mydas mydas*), Kemp's ridley (*Lepidochelys kemp*i), and hawksbill (*Eretmochelys imbricata imbricata*)) is presented in Meylan *et al.* (1996). The bay serves as habitat for several life stages of marine turtles including foraging adults, foraging juveniles and subadults, and, in specific locations nesting females. The aquatic preserve contains potential foraging habitats for the adults, juveniles, and subadults.

The distribution of the West Indian manatee (*Trichechus manatus*) within Tampa Bay is reviewed from available data in Weigle (1996). From aerial survey data collected between 1987 and 1994 and field surveys, sightings and mortality counts of the West Indian manatee can be summarized for Cockroach Bay and the Little Manatee River. Manatees are commonly seen in the Little Manatee River, where they feed and calve.

The diamondback terrapin is another species of concern for the Cockroach Bay Aquatic Preserve. This coastal reptile has been designated as "rare" by the Florida Committee on Rare and Threatened Plants and Animals (Moler 1992). The local variants of this species, the ornate diamondback and mangrove terrapins, are characteristic of the Florida Gulf coast and Atlantic Coast, but have a limited distribution.

Diamondback terrapins have been observed locally on the Alafia Bank, in Terra Ceia Bay, on Tarpon Key, and are frequently found in commercial crab traps in the Cockroach Bay and Little Manatee River area. A study of the incidental capture of diamondback terrapin by crab pots in South Carolina (Bishop 1983) found that blue crab traps may account for the majority of adult terrapin mortality. The study also found that male captures outnumbered females by greater than 2:1 (perhaps because large females could not enter the traps), and over 80 percent of the captures occurred during April and May in a wide range of salinities and temperatures.

Table 8-5. Endangered and Threatened Species Identified within the LMR watershed and Cockroach Bay area of Hillsborough County, Florida (FNAI 2000).

Common Name	Scientific Name	FWCC	USFWS
Amphibians & Reptiles			
American alligator	<i>Alligator mississippiensis</i>	LS	T(S/A)
Loggerhead turtle	<i>Caretta caretta</i>	LT	LT
Green turtle	<i>Chelonia mydas</i>	LE	LE
American crocodile	<i>Crocodylus acutus</i>	LE	LE
Leatherback turtle	<i>Dermochelys coriacea</i>	LE	LE
Eastern indigo snake	<i>Drymarchon corais couperi</i>	LT	LT
Gopher tortoise	<i>Gopherus polyphemus</i>	LS	N
Kemp's ridley turtle	<i>Lepidochelys kemp</i>	LE	LE
Florida pine snake	<i>Pituophis melanoleucus mugitus</i>	LS	N
Suwannee cooter	<i>Pseudemys concinna suwanniensis</i>	LS	N
Short-tailed snake	<i>Stilosoma extenuatum</i>	LT	N
Florida gopher frog	<i>Rana capito aesopus</i>	LS	N
Birds			
Roseate spoonbill	<i>Ajaia ajaia</i>	LS	N
Florida scrub jay	<i>Aphelocoma coerulescens</i>	LT	LT
Limpkin	<i>Aramus quarauna</i>	LS	N
Snowy plover	<i>Charadrius alexandrinus</i>	LT	N
Piping plover	<i>Charadrius melodus</i>	LT	LT
Little blue heron	<i>Egretta caerulea</i>	LS	N
Reddish egret	<i>Egretta rufescens</i>	LS	N
Snowy egret	<i>Egretta thula</i>	LS	N
Tricolored heron	<i>Egretta tricolor</i>	LS	N
Peregrine falcon	<i>Falco peregrinus</i>	LE	E(S/A)
Southeastern American kestrel	<i>Falco sparverius paulus</i>	LT	N
Florida sandhill crane	<i>Grus canadensis pratensis</i>	LT	N
American oystercatcher	<i>Haematopus palliatus</i>	LS	N
Bald eagle	<i>Haliaeetus leucocephalus</i>	LT	LT
Wood stork	<i>Mycteria americana</i>	LE	LE
Osprey	<i>Pandion haliaetus</i>	LS	N
Brown pelican	<i>Pelecanus occidentalis</i>	LS	N
Black skimmer	<i>Rynchops niger</i>	LS	N
Florida burrowing owl	<i>Speotyto cunicularia floridana</i>	LS	N
Least tern	<i>Sterna antillarum</i>	LT	N
White ibis	<i>Eudocimus albus</i>	LS	N
Mammals			
Florida mouse	<i>Podomys floridanus</i>	LS	N

Table 8-5. Endangered and Threatened Species Identified within the LMR watershed and Cockroach Bay area of Hillsborough County, Florida (FNAI 2000).			
Common Name	Scientific Name	FWCC	USFWS
Sherman's fox squirrel	<i>Sciurus niger shermani</i>	LS	N
West Indian manatee	<i>Trichechus manatus</i>	LE	LE
Plants			
Brittle maidenhair fern	<i>Adiantum tenerum</i>	LE	N
Curtiss' milkweed	<i>Asclepias curtissii</i>	LE	N
Auricled spleenwort	<i>Asplenium auritum</i>	LE	N
Florida bonamia	<i>Bonamia grandiflora</i>	LE	LT
Hand fern	<i>Cheiroglossa palmata</i>	LE	N
Pygmy fringe tree	<i>Chionanthus pygmaeus</i>	LE	LE
Florida golden aster	<i>Chrysopsis floridana</i>	LE	LE
Tampa vervain	<i>Glandularia tampensis</i>	LE	N
Nodding pinweed	<i>Lechea cernua</i>	LT	N
Pine pinweed	<i>Lechea divaricata</i>	LE	N
Wild coco	<i>Pteroglossapis ecristata</i>	LT	N
Chaffseed	<i>Schwalbea americana</i>	LE	LE
Broad-leaved nodding-caps	<i>Triphora latifolia</i>	LE	N
Rain lily	<i>Zephyranthes simpsonii</i>	LT	N

FWCC - Florida Wildlife Conservation Commission

USFWS - U.S. Fish and Wildlife Service

LS - Listed as Species of Special Concern

LE- Listed as Endangered

LT - Listed as Threatened

T(S/A) - Threatened due to similarity of appearance

E(S/A) - Endangered due to similarity of appearance

N - Not listed

8.7 NATURAL SYSTEMS ISSUES/AREAS OF CONCERN

Habitat restoration, exotic species, loss of habitat to development and mining, impacts of agricultural and urban runoff, and potential spills due to shipping are areas of concern in the LMR watershed. Acquisition and management of publicly owned lands, including coordinated planning between holdings (i.e. aquatic preserve, Tampa Electric Company (TECO) lands, Environmental Land Acquisition and Protection Program (ELAPP), State Recreation Area) are intended to protect and conserve natural areas in the watershed. These issues are discussed below.

8.7.1 Exotic and Invasive Plants

As a result of disturbance and habitat degradation, wetlands can be invaded by aggressive, highly-tolerant, non-native vegetation, such as purple loosestrife (*Lythrum salicaria*), water

hyacinth (*Eichornia crassipes*), and salvinia (*Salvinia molesta*), or can be dominated by a monoculture of cattails (*Typha spp.*) or common reed (*Phragmites spp.*) (McColligan and Kraus 1988; Weller 1981; Mitsch and Gosselink 1996). Particularly in constructed wetlands, including restored wetlands, non-native and tolerant native species may outcompete other species leading to a reduction in species diversity.

Non-native species may be introduced intentionally. For example, water hyacinth has been noted for its ability to sequester nutrients and is used for wastewater purification (Mitsch and Gosselink 1996). Water hyacinth and similar species can rapidly fill a wetland and are a threat to water quality in some areas.

The proliferation of exotic or nuisance plant species within the watershed is a continuing problem. The most common exotic species include Brazilian pepper (*Schinus terebinthifolius*), Australian pine (*Casuarina equisetifolia*), melaleuca (*Malaleuca quinenervia*), and cogon grass (*Imperata cylindrica*). Other species are also present although their infestation is less extensive. These include air potato (*Dioscorea bulbifera*), skunk vine (*Paederia foetida*), and cattails (*Typha spp.*). All of these plants have been identified as nuisance species by the Florida Exotic Pest Plant Council (FEPPC). These plants displace native species and tend to dominate natural ecosystems by becoming mono-cultures.

Australian pine have colonized the urban fringe, fallow agricultural fields and disturbed areas within the coastal areas of Cockroach Bay and the mouth of the Little Manatee River. Brazilian pepper and melaleuca have gained a foothold within disturbed areas, specifically on the fringe of agricultural fields, fallow fields, and along road right-of-ways. Cogon grass was imported for use as a pasture grass and now proliferates within improved pasture and agricultural lands within the watershed. Eradication programs for these exotic species have been initiated within the Cockroach Bay Aquatic Preserve, on TECO lands to the south of the Preserve, and on Hillsborough County ELAPP lands throughout the watershed. Control of these species requires diligent and persistent efforts due to their aggressive growth and colonization characteristics.

8.7.2 Management of Publicly Owned Lands

Watershed management actions should support the management objectives of the publicly owned conservation lands within the watershed. These lands include the Little Manatee River State Recreation Area, Hillsborough County ELAPP land holdings, Cockroach Bay Aquatic Preserve, and the TECO Port Manatee Planning Area. In addition, coordination of planning objectives and actions between the conservation management groups charged with the management of these lands would benefit the watershed.

8.7.3 Mitigation of Potential Impact from Shipping Spills in Tampa Bay

Due to its location, the Little Manatee River and Cockroach Bay are particularly susceptible to damage caused by large marine fuel spills. Tampa Bay is home to five major seaports, a growing cruise ship industry and numerous power plants. Businesses depend on shipping to deliver fuels and chemicals. More than 4,000 ships enter Tampa Bay every year, transporting petroleum products and chemicals needed by area businesses. The mouth of the Little Manatee River is approximately 2,300 yards east of the main shipping channel, and is situated between Port Manatee and Big Bend port terminals. The Cockroach Bay area and the tidal portions of Little Manatee River are therefore vulnerable to spills from both ports and spills originating within shipping lanes.

Federal law requires that commercial shippers and port facilities plan to accommodate the cleanup of worst-case scenario oil and fuel spills. However, large spills can require that additional equipment and personnel be brought to the area. That makes effective advanced planning and coordination essential so that appropriate equipment can be deployed rapidly.

8.7.4 Impacts of Agriculture in the Watershed

Agriculture encompasses nearly 50 percent of the land use in the LMR watershed and is associated with water quality problems due to excessive pumping and runoff. Historically, agriculture has been the major factor in freshwater and estuarine wetland loss and degradation. Although the passage of the Food Security Act of 1985 "Swampbuster" provision prevented the conversion of wetlands to agricultural production, certain exempted activities performed in wetlands can degrade wetlands:

- harvesting food, fiber, or forest products;
- minor drainage;
- maintenance of drainage ditches;
- construction and maintenance of irrigation ditches;
- construction and maintenance of farm or forest roads;
- maintenance of dams, dikes, and levees;
- direct and aerial application of damaging pesticides (herbicides, fungicides, insecticides, fumigants); and
- ground water withdrawals.

These activities can alter wetlands hydrology, water quality, and species composition. Excessive amounts of fertilizers and animal waste reaching wetlands in runoff from agricultural operations, including confined animal facilities, can cause eutrophication.

If best management practices are used and careful monitoring occurs, silviculture and timber removal may only minimally affect some wetland functions. Habitat and community structure, however, still may be seriously degraded. Drainage, clearing, haul road construction, rutting, and ditching of forested wetlands, all may affect wetlands in some way, although the impact may only be temporary. Since timber removal generally occurs in 20-50 year rotations, careful harvest may not be a permanent threat to wetlands.

Adverse effects of timber harvest can include a rise in water table due to harvesting activities. Impacts include: a decrease in transpiration, soil disturbance, compaction by heavy equipment, sedimentation and erosion from logging decks, skid trails, roads, and ditches. Drainage and altered hydrology from ditching, draining, and road construction also result in a rise in the water table in these areas (Shepard 1994). By applying best management practices, hydrology and biogeochemical processes of wetlands may be altered for only one to three years following timber harvest (Shepard 1994).

In addition to direct losses of wetlands to agriculture, pesticides and fertilizers used during silvicultural operations can enter wetlands through runoff as well as through deposition from aerial application. Fertilizers may contribute to eutrophication of wetlands.

Pasture lands and associated grazing livestock can degrade wetlands on which they occur. As vegetation is reduced, stream banks can be destroyed by sloughing and erosion. Stream bank destabilization and erosion then cause downstream sedimentation (Kent 1994). Sedimentation reduces stream and lake capacity, resulting in decreased water supply, irrigation water, flood control, hydropower production, water quality, and impairment of aquatic life and wetland habitat (USEPA 1993).

The overgrazing of livestock depleting vegetation from riparian areas causes increased water temperatures and erosion and gully formation, prevents runoff filtration, and eliminates food and cover for fish and wildlife (USEPA 1993b). Also, cattle traffic may cause dens and burrows to collapse along with high nutrient inputs from urea and manure. The economic losses attributed to the reduced quality and quantity of water and habitat from overgrazing of riparian wetland vegetation is more than \$200 million in the United States (USEPA 1993). However, if stocking of livestock is well managed, grazing can coexist with wetlands, benefiting farmers and increasing habitat diversity.

8.7.5 Impacts of Phosphate Mining in the Eastern Portion of the Watershed

Florida phosphate mining dates back to the first hardrock deposits found near Hawthorne in Alachua County in 1883. Phosphate mining involves stripping off the top layer of earth and piling it in rows to get to the layers of phosphate below. Following mining activities, reclamation occurs. Eventually, sand will fill the dredged rows, the rows of earth will be bulldozed flat, the land will be contoured and then replanted. Early mining was accomplished with wheelbarrows, picks and shovels followed by mule-drawn scrapers. Steam shovels and centrifugal pumps

mounted on barges were also used to mine the river-pebble phosphate deposits in the Peace River. River-pebble mining ended in 1908. Draglines, the current mining tool, came into use with the dawn of electricity and diesel power in the 1920s and 1930s.

The FDEP Bureau of Mine Reclamation administers programs for the reclamation and restoration of lands mined for phosphate, limestone, heavy materials, sand and clay (Chapters 211 and 378, Florida Statutes). The Mine Reclamation Program has played an integral role in reconnecting the central Florida region with an integrated habitat network.

In 1975, reclamation laws came into effect which require that lands impacted by mining operations be reclaimed. Environmental Protection Commission of Hillsborough County (EPCHC) works together with phosphate mining companies to ensure that those wetlands impacted by mining activities are restored to a functional quality equal to or better than pre-mining conditions. In 1978, the Florida Legislature created the Florida Institute of Phosphate Research (FIPR). One of the goals of FIPR is to conduct reclamation research, including restoration of hydrologic functions and balances of surface and groundwater systems.

Phosphate mining has resulted in the loss of thousands of acres of wetlands in central Florida (Mitsch and Gosselink 1996) and future land use in the LMR watershed includes approximately one third phosphate mining, while further expansion is planned in the eastern portion of the watershed. Acid drainage from active and abandoned mines causes extensive ecological damage. Unlike in the Alafia River, there are no gypsum stacks or phosphate processing activities in the LMR watershed, although there are clay settling ponds.

Phosphate mining displaces habitat and reclamation efforts occur over many years and may affect wetlands directly through the mining of the wetlands themselves. If wetlands are lost due to mining activities, the beneficial characteristics of wetlands are lost as well. This could potentially affect water quality and sediment deposition in addition to destruction of wetland habitat. Wetlands are home to wading birds, fish, amphibians, and other animals. Loss of wetland habitat means loss of the plants and animals living there, which may also affect other animals down the food chain.

Mining activities also affect wetlands indirectly, by altering the natural hydrology or by releasing sediment and particle-laden waters (turbid discharge) into the wetlands and waterways. Mining may disconnect wetlands from natural water sources or from outfall structures which discharge excess water out of the wetland. Many wetland plants cannot survive if the conditions are too dry or are too wet. Therefore, alteration of the hydrology may result in loss of beneficial wetland vegetation.

Increased turbidity within the water column due to discharges or spills during mining may affect the amount of light reaching vegetation below the surface. Increases in turbidity may result in mortality of the aquatic plants which provide habitat and food for other organisms. The staff of the EPCHC work together with the phosphate industry to develop and utilize best-management

practices to minimize detrimental effects. For example, the hydrology of wetlands adjacent to mining activities is maintained through methods such as recharge ditches to rehydrate wetlands, or outfall structures to prevent flooding in wetland systems that are not normally inundated with water. In addition, the Hillsborough County Phosphate Mining Ordinance permits no mining within the 25-year floodplain, so that waterways such as the Hillsborough, Alafia, and Little Manatee Rivers will retain some protection from mining activities.

8.7.6 Seagrass Restoration Efforts

The previously described submerged and emergent aquatic vegetation communities described above have experienced a historical decline in acreage within the larger Tampa Bay area (Janicki *et al.* 1995; Lewis and Coastal 1995). Within Middle Tampa Bay, 4,100 acres of seagrasses have been targeted for restoration (Janicki *et al.* 1995); however, in most cases, restoration cannot occur without water quality improvements that result in increased light penetration.

Protection and restoration targets for the emergent wetland vegetation communities are discussed in *Setting Priorities for Tampa Bay Protection and Restoration: Restoring the Balance* (Lewis and Coastal 1995). Baywide, tidal marsh (i.e., black needle rush marsh) and salt barrens have experienced substantially greater losses than have mangrove and saltmarsh (i.e., smooth cordgrass marsh). Greater bayward encroachment has occurred from urban and agricultural development into these habitats. Middle Tampa Bay presently includes the greatest proportion of mangrove/saltmarsh habitat (5,061 acres) and salt barren habitat (533 acres) of all of the bay segments. Tidal marsh communities, however, have been depleted significantly within the Middle Tampa Bay segment, with approximately 737 acres remaining for preservation and 874 acres targeted for restoration.

Chapter 9

WATER SUPPLY

Water supply issues in the LMR watershed include groundwater use, surface water use, development of alternative water supplies, and establishment of minimum flows and levels. The south and central regions of Hillsborough County, including the LMR watershed, are served primarily by a well field in the Lithia area and the current most important water supply issue is the decline of water levels in the aquifers. This, in turn, can reduce the potential availability of water for public, agricultural, and industrial use and can result in significant environmental impacts. Alternative water supply sources are being developed in the Tampa Bay region as part of an approach to reduce/supplement existing groundwater supplies and alleviate pressure on the aquifers.

Water projects currently being developed in the Tampa Bay region to address future water supply include diverting flows from the Alafia and Hillsborough rivers, as well as the Tampa Bypass Canal, coupled with the construction of a reservoir in the Alafia River watershed. In addition, a desalination facility to be located adjacent to the Tampa Electric Company (TECO) Big Bend plant in southern Hillsborough County is currently under study. The Tampa Bay Water Master Water Plan has no water supply facilities planned within the LMR watershed.

9.1 GROUNDWATER

The following paragraphs describe both current groundwater use and describe in more detail the groundwater-related issues in the LMR watershed.

9.1.1 Groundwater Use

Agricultural interests are by volume the greatest permitted users of groundwater resources within the LMR watershed. Water Use Permits (WUPs) are required for all entities that use groundwater amounts in excess of 100,000 gallons-per-day (gpd) or have water supply wells 6-inches or greater in diameter. Non-permitted groundwater uses within the watershed include small diameter wells (less than 6 inches) that are used primarily for residential potable water supply and both residential and commercial irrigation. Currently, records are not available to accurately estimate the groundwater volume used by non-permitted users.

Within the LMR watershed, permitted users account for approximately 102 mgd of groundwater withdrawals primarily from the intermediate aquifer system and upper Floridan aquifer system. The greatest concentration of wells is in the western portion of the watershed, and conversely the greatest quantity of groundwater withdrawals occurs in the central and southeastern portions. Groundwater withdrawals in the southeastern portion of the watershed are primarily used for phosphate mining and associated activities. Groundwater withdrawals throughout the remainder of the area are principally due to agriculture.

Water use permits in the Little Manatee Watershed are mapped on **Figure 9-1** and listed in **Appendix F**. Agricultural uses make up approximately 85 million gallons per day (mgd) of the groundwater withdrawals, comprising 83% of the total permitted groundwater quantity within the LMR watershed. Other permitted groundwater uses include recreational, public water supply, mining and private water supply.

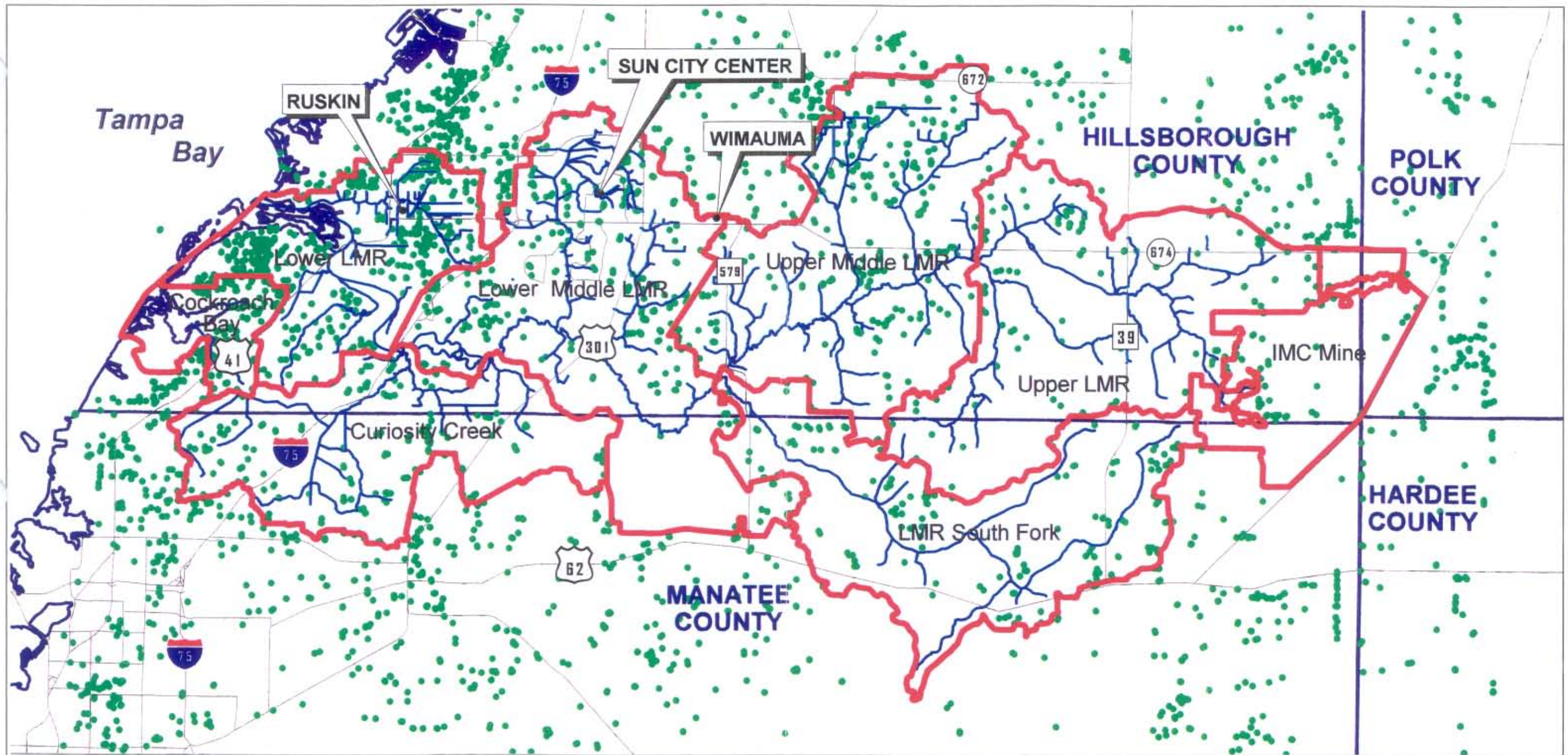
9.1.2 Groundwater Issues

The combination of thick confining beds and large withdrawals from the Upper Floridan aquifer in areas south of central Hillsborough and north central Polk counties has resulted in large declines in the potentiometric surface of the upper Floridan aquifer over a relatively large area (Ryder 1985). Long-term trends in water levels in the upper Floridan aquifer have also been correlated with annual departures from long-term averages. While seasonal variations in water levels correlate well with seasonal variations in rainfall, groundwater pumping exacerbates fluctuations. For example, it has been reported that the nearly steady decline in water levels in the middle 1970s can be attributed to increased ground water withdrawals (Ryder 1985).

According to data published by the USGS (1985), there has been a decrease in the potentiometric surface of approximately 20 feet near the LMR watershed coastline and as much as 40 feet in the eastern portion of the watershed. Additional groundwater development since the mid 1980s has probably increased the decline in the potentiometric surface of the upper Floridan aquifer system. Excessive groundwater pumping for agricultural applications and mining activities, as well as alterations in sheet flow and drainage patterns as a result of urban development, agriculture, mining, and other developed land uses have contributed to a decline in aquifer levels.

Although the confining layer of the Hawthorn Group (Peace River Formation) generally protects surface water features such as wetlands, lakes, and streams from the effect of declines in groundwater levels, wetlands that lie within the areas of greatest groundwater withdrawals are most likely to be adversely impacted by declining groundwater levels. Wetlands located directly south of Wimauma and in the southeastern portion of the LMR watershed appear to be most at risk.

Groundwater resources within the LMR watershed are regulated and managed by the SWFWMD. Water Use Caution Areas (WUCAs) were established by SWFWMD to provide additional protective measures where the water resources had been adversely impacted by groundwater withdrawals. In addition, to further stabilize groundwater declines and the associated water resource problems within WUCAs, SWFWMD also designated several Most Impacted Areas, which restrict the development of new fresh groundwater supplies. The entire Little Manatee River watershed lies within the designated Most Impacted Area of the Eastern Tampa Bay Water Use Caution Area. Existing WUPs for the use of groundwater resources



Department of Public Works
Stormwater Management Section



- Well *
- Cities
- Little Manatee River

* Source: SWFWMD

Legend



2 0 2 Miles

September, 2000

- County Boundary
- Major Basin Boundary
- Water

**Little Manatee River
Watershed Management Plan**

**Figure 9-1
Permitted
Groundwater Wells**

PBSJ

within a Most Impacted Area are renewable but new WUPs for groundwater use are only issued for the use of brackish groundwater resources.

An important regulatory issue related to the WUCAs concerns the establishment of the Southern Water Use Caution Area (SWUCA). Recently, an appeals court ruled in favor of SWFWMD in the historic SWUCA case (September 2000). SWUCA rules were intended to combat saltwater intrusion into the Floridan aquifer, to stabilize lake levels in Polk and Highlands counties, and to limit regulatory impacts on the region's economy and existing legal users. SWUCA encompasses eight counties – DeSoto, Hardee, Manatee, Sarasota, southern Hillsborough County, and portions of Polk, Highlands and Charlotte counties within the District.

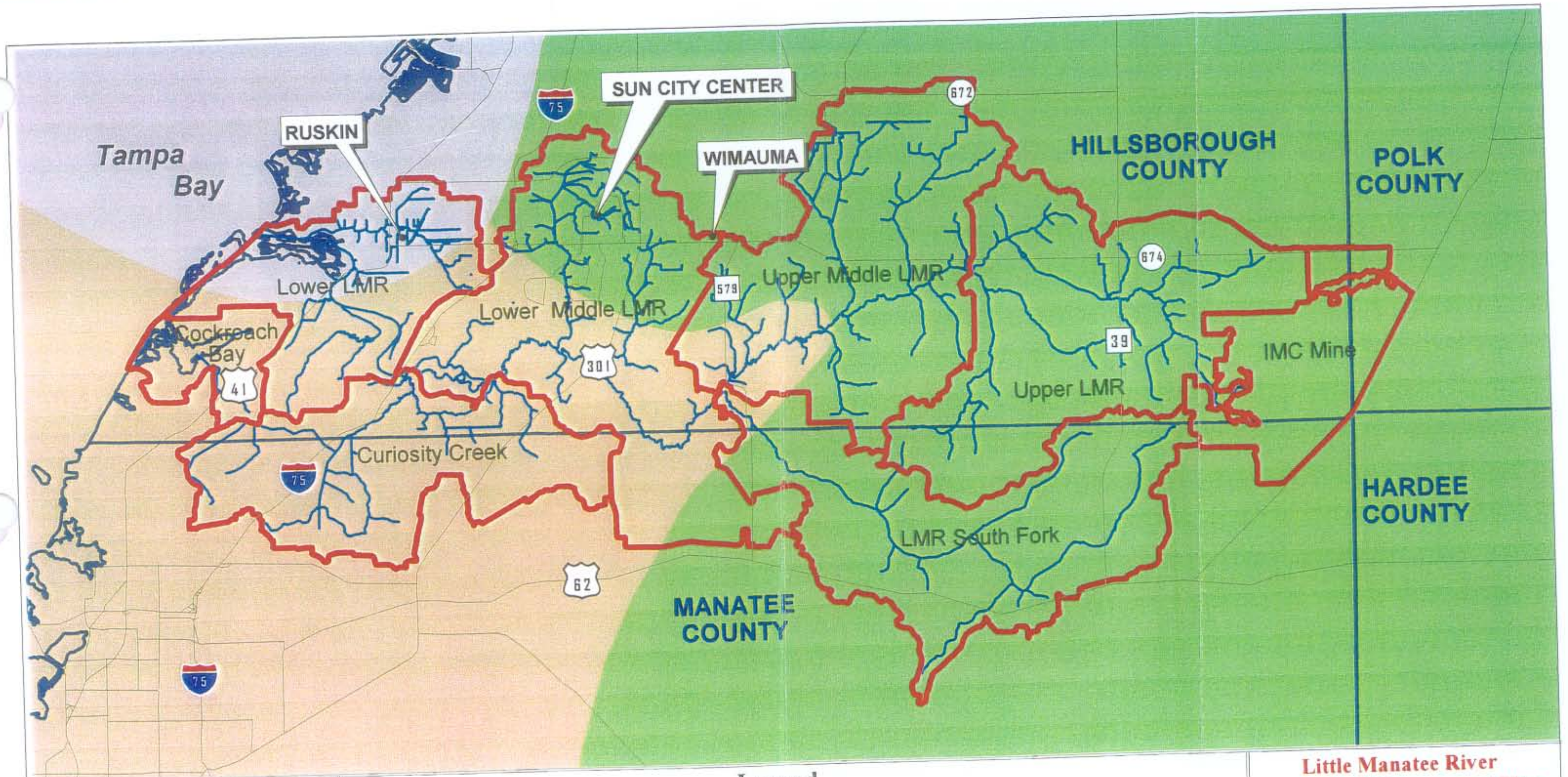
Following the SWFWMD Governing Board approval of the SWUCA rules in November 1994, petitions were filed challenging them. More than 70 issues were covered in the court's Final Order, and the SWFWMD prevailed on a significant majority. However, the Final Order invalidated several important SWUCA rules, and subsequently, the SWFWMD filed an appeal. The Appellate Court's ruling in favor of the SWFWMD may also be appealed to the state Supreme Court under limited circumstances.

Another problem associated with excessive groundwater withdrawals, especially in coastal communities, is saltwater intrusion (Mahon 1989). In nature, the freshwater-saltwater interface is gradual and its location depends on the pore characteristics of the aquifer and the hydraulic pressure. Increasing the stress on the groundwater system results in lowering of the potentiometric surface, with a resulting displacement of the interface inland into freshwater aquifers. This may be exacerbated in the LMR watershed, because, as shown in **Figure 9-2**, recharge rates in the eastern portions of the watershed are less than 1 inch/year, while the far northwestern portion discharges at a rate of 1 to 5 inches/year. The southwest portion of the LMR watershed shows discharge rates of less than 1 inch/year, which is comparable to the recharge rates on the east.

With this level of protection and by properly managing the resources through, for example, the preferential use of brackish groundwater, the potential for an overall improvement in groundwater quality in the watershed is much greater.

9.2 SURFACE WATER

Currently, the use of surface water for water supply is not significant in the LMR. However, as indicated previously, as dictated by state law, alternate water supplies are being explored and developed as demands for fresh water supplies increase in the Tampa Bay area. Some of these supplies may include the use of water from the LMR.



Department of Public Works
Stormwater Management Section



Aquifer Recharge and Discharge
(inches per year)

- Discharge/ 1 To 5
- Discharge/ Less Than 1
- Recharge/ Less Than 1

Legend



2 0 2 Miles

September, 2000

- Cities
- Little Manatee River
- County Boundary
- Major Basin Boundary
- Water

Little Manatee River
Watershed Management Plan

Figure 9-2
Aquifer
Recharge/ Discharge

PBSJ

Flow and rainfall data were evaluated as part of this study to present a preliminary evaluation of the use of LMR water as a potential water source. The period of flow record, 1939 through 1999, at USGS station 2300500 near Wimauma was analyzed to determine if there has been any long-term changes in flow patterns at the LMR. A flow duration curve is included as **Figure 9-3**. This figure indicates, for example, that the 50th percentile average daily flow is approximately 60 cfs.

In addition, as shown in **Figure 9-4**, cumulative average daily flow values follow with small deviations a single best-fit line for the entire period of record. This is an indication that flows passing the USGS station have remained constant over the years. Therefore, there would be a high reliability of success when establishing a range of flows that could be diverted from the river for water supply purposes. However, the figure also shows some periodic variations. For example, flow was slightly lower than normal between 1986 and 1994, but has increased to normal levels since that time.

The reliability of river flow depends to a large degree on available rainfall. An analysis of rainfall patterns in the LMR watershed was also conducted by examining the cumulative rainfall curve. The USGS gauge 86880 near Parrish data were used for this analysis. As described in Chapter 5, data at this station were also used as the basis for the hydrologic model calibration conducted as part of this project. **Figure 9-5** indicates that rainfall has remained relatively constant over the 55 year period of record from 1944 through 2000.

9.3 MINIMUM FLOWS AND LEVELS

Water Management Districts in Florida have been assigned the task of establishing “minimum flows and levels” (MFLs), which are directed to establish the amount of water that is needed in a lake, river, or aquifer to maintain adequate ecological conditions. In that sense, MFLs could also be defined as flows that can be withdrawn from a waterbody without causing significant harm to its current uses. The establishment of MFLs is an essential planning tool, and it may provide the basis of issuing water use permits and conserving water resources in the region.

The statutory directive for MFLs was included in the Water Resources Act enacted by the Florida Legislature in 1972 and Section 373.042, F.S., which directs each water management district to establish MFLs for surface water bodies, watercourses, and aquifers within their respective jurisdictions. The SWFWMD, like the other districts in the state, has not yet established MFLs for many watercourses and lakes, including the LMR, or any of the aquifers within its boundaries. While MFLs can provide a baseline against which the cumulative effect of water withdrawals can be measured, the establishment of a minimum flow or level for any particular waterbody or course can be an immensely complicated task.

Figure 9-3 Flow Duration Curve at USGS Gauge 2300500 LMR near Wimauma

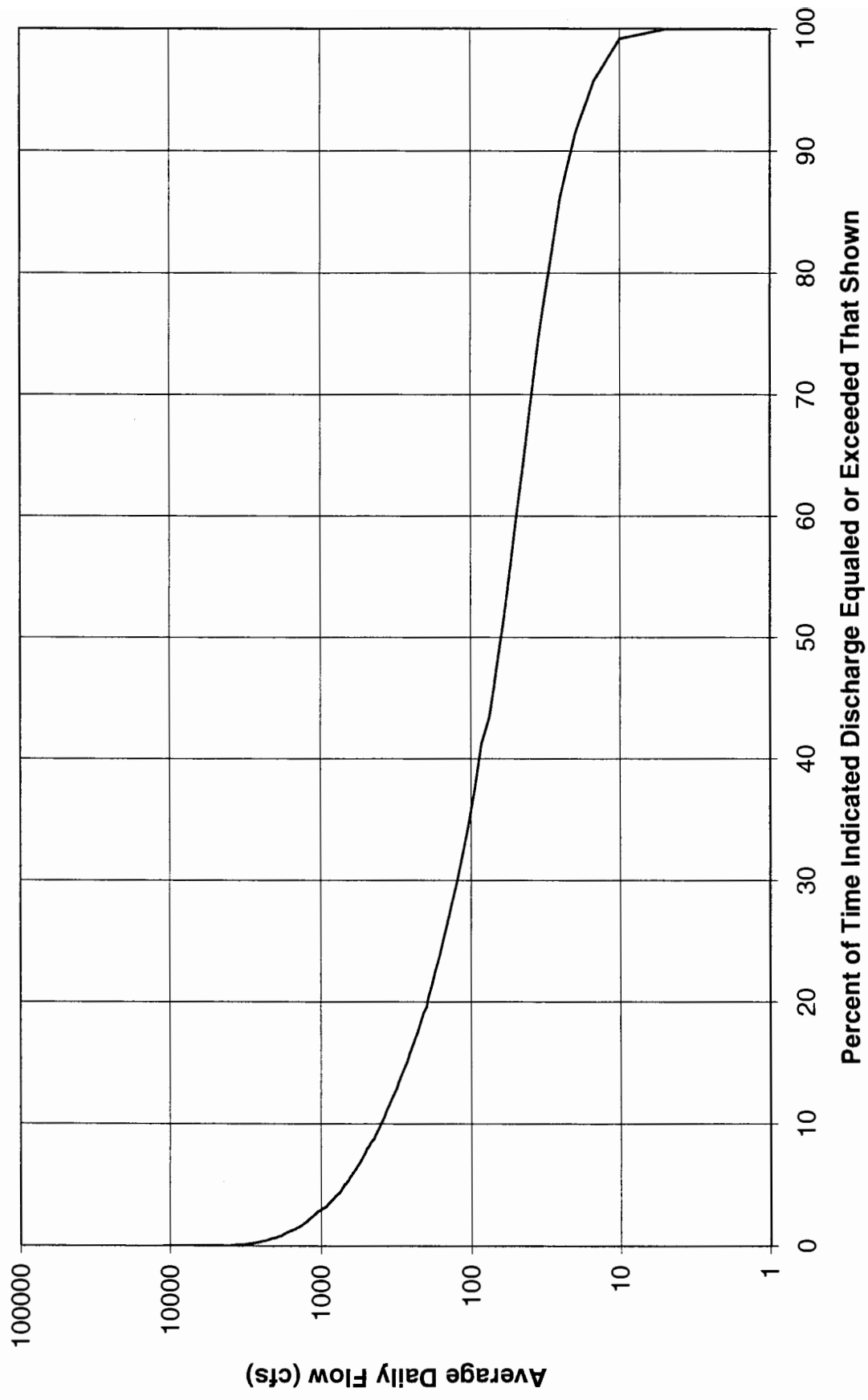


Figure 9-4 Cumulative Average Daily Flow at USGS Gauge 2300500 LMR near Wimauma

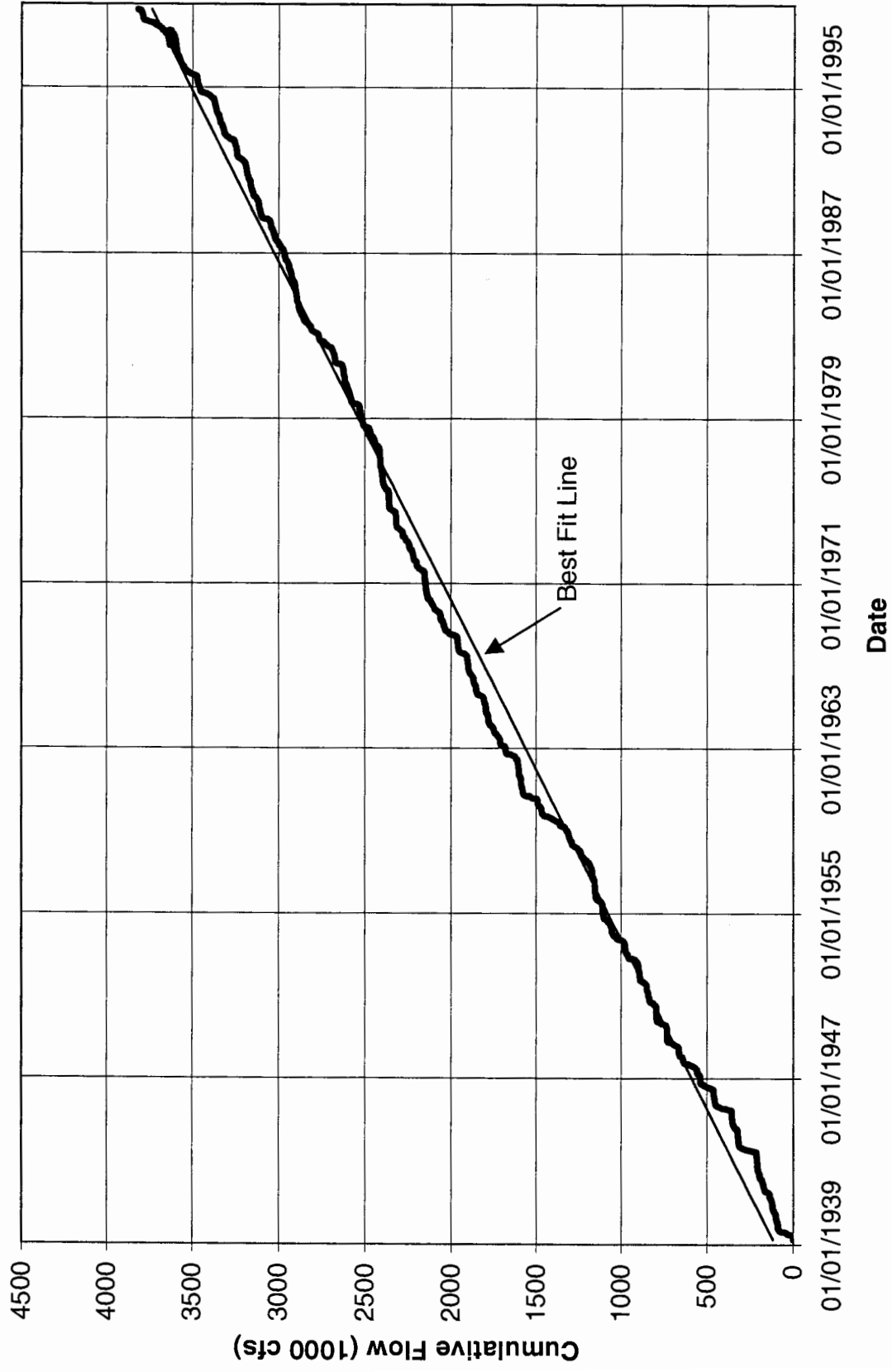
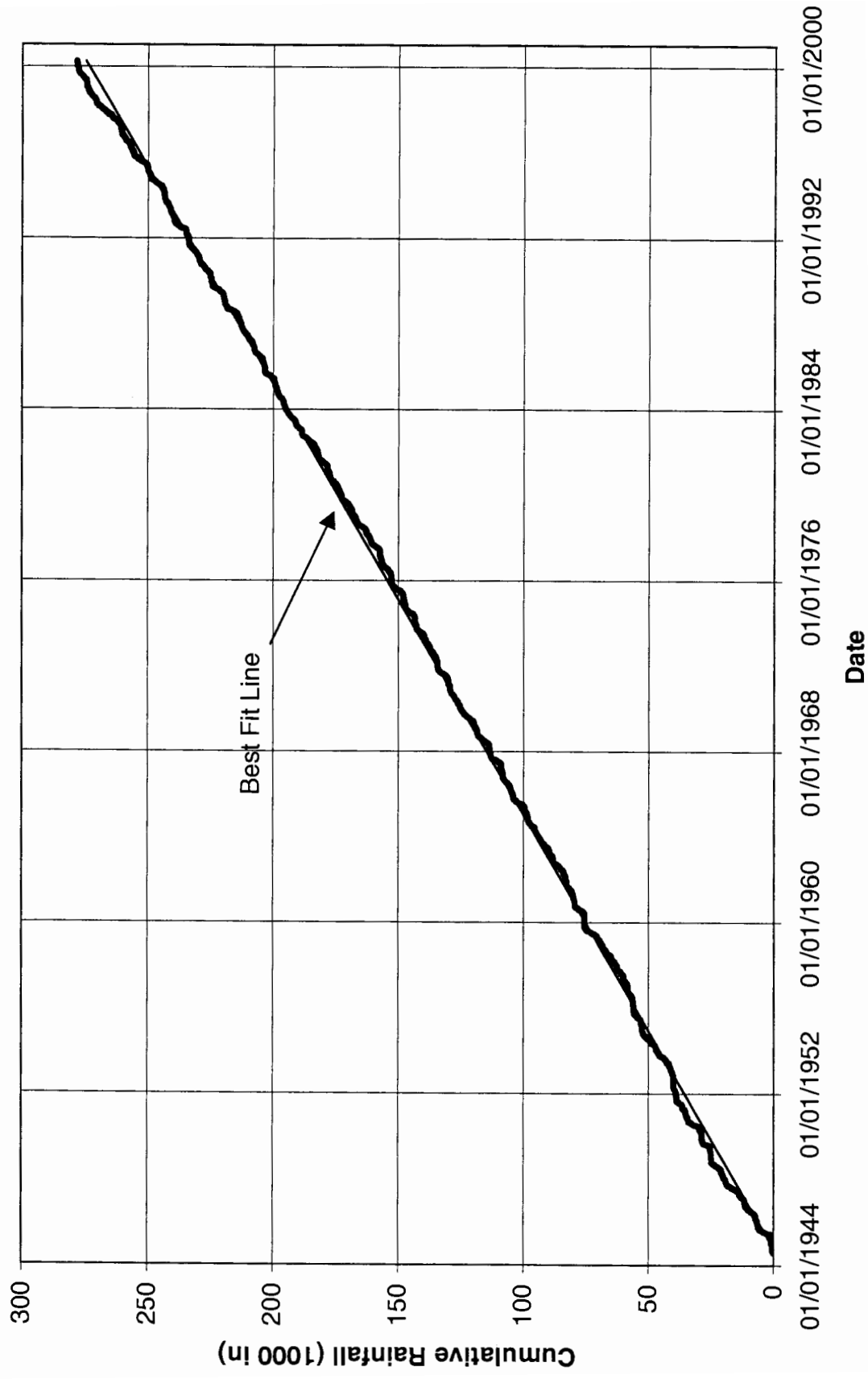


Figure 9-5 Cumulative Rainfall at USGS Gauge 86880 LMR near Parrish



9.4 OTHER ALTERNATIVE WATER SUPPLY SOURCES

In addition to the existing groundwater sources and the potential surface water supply projects, the Tampa Bay region is in the process of implementing projects that consider other potential sources of water supply. Some of these supplies include desalinated water (which Hillsborough and Pasco already use), treated wastewater, continued conservation, and/or increased reclaimed water use. The use of alternative water supplies intends to:

- Reduce well field pumping (reduce environmental stress);
- Provide a safe, sustainable, environmentally-sensitive, drought-proof and cost-effective water supply;
- Decrease reliance on rainfall; and
- Increase use of desalinated water, the best quality water in the world (according to the United States Environmental Protection Agency).

Other water supply options that may be available in the LMR watershed include:

- Aquifer storage and recovery;
- Use of the Florida Power & Light cooling reservoir; or
- Use of abandoned phosphate mined areas.

Reclaimed water is not an option at the present time in southern Hillsborough County due to the low quantity of reuse water available and the lack of existing infrastructure on which to base a supply system. Industrial and commercial users could, however, reduce water uses through water audits, improved Best Management Practices (BMPs), and appropriate pilot projects, such as exploring the feasibility of closed loop systems for cooling water. Research technologies that use less water during mining operations may be examined and applied. Also, the use of expanded recycling methods could be investigated. The use of stormwater as a source of supply is also an available option for supplementing irrigation systems. However, its use as a source of public water supply must be carefully evaluated in terms of compliance with water treatment rules, including, if applicable, requirements for the groundwater under the influence of surface water rule. Finally, the implementation of water conservation programs is a factor that should be actively and constantly pursued.

CHAPTER 10

POLLUTANT LOADING MODEL

10.1 OVERVIEW

Documented and potential sources of water pollution in the LMR watershed include nonpoint sources, point sources, septic tanks, atmospheric deposition, and septic sludge and wastewater residuals. Some minor sources, such as groundwater, may also contribute to the overall loading to the river.

An approach that has been used by federal and state regulatory agencies to quantify the amount of pollutants discharged into a waterbody is to estimate the average annual and seasonal pollutant loads. Pollution loads in the LMR watershed were estimated using the Pollutant Loading and Removal Model previously developed by the Hillsborough County Public Works/Stormwater Management Environmental Team (1999). The model uses land use, rainfall, soils and pollutant event mean concentrations (EMC) data to estimate pollutant loads and levels of treatment by subbasins in the watershed. GIS coverages of land use and hydrologic soil characteristics were intersected with subbasin delineations to provide runoff characteristics. **Figure 10-1** is a flow diagram showing the pollutant loading model components.

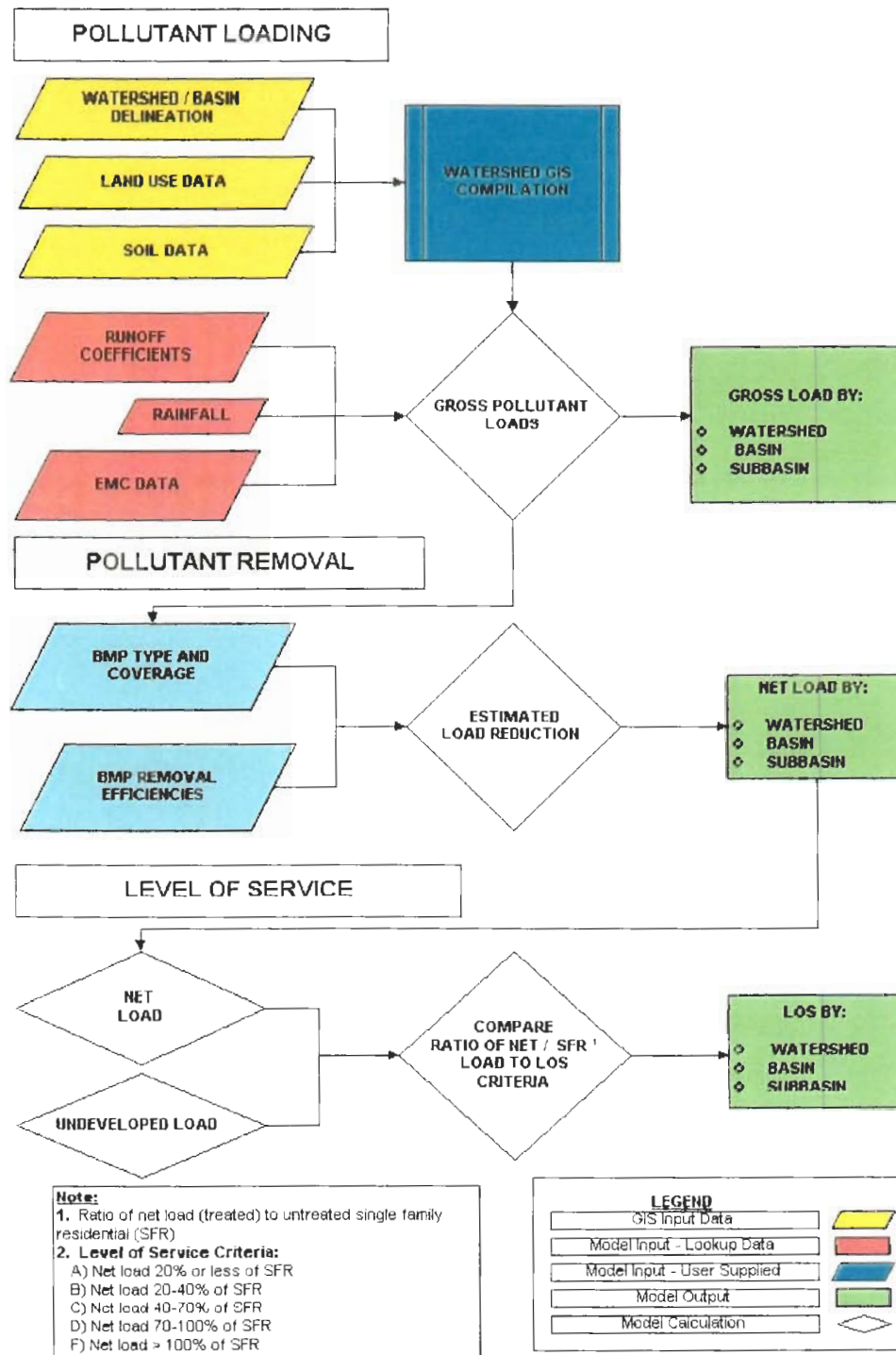
The model was also developed to evaluate expected future pollutant conditions based on potential improvements or alternatives within a watershed.

10.2 POLLUTANT LOADING AND REMOVAL MODEL

The Pollutant Loading and Removal Model has three main components outlined below:

- Calculation of gross pollutant loads. The gross pollutant load for each subbasin is calculated as the product of runoff volume and stormwater EMC for each selected pollutant. Runoff volume is determined based on total annual or seasonal rainfall and the area's hydrologic conditions. In terms of concentrations, EMC values were identified based on previous stormwater studies performed by Hillsborough County and other available data. Hillsborough County EMC values were measured as part of the County's National Pollutant Discharge Elimination System (NPDES) permit for stormwater discharges.
- Estimation of net loads based on existing treatment. Net pollutant loads are the actual amount of pollutant reaching the receiving waterbodies once the effects of stormwater runoff treatment are considered. They are calculated based on the estimated removal efficiency and occurrence of treatment facilities by land use within each subbasin.

Figure 10-1
Little Manatee River Watershed Management Plan
Pollutant Loading Model Flow Diagram



- Evaluation of levels of treatment. Levels of treatment for each subbasin are estimated using a comparison of existing net loads to a benchmark condition pollutant evaluation. The pollutant load benchmark used for comparison is untreated low/medium density residential land use for the entire watershed.

The model calculates loads for a total of 12 different parameters (pollutants) including:

- 5-Day Biological Oxygen Demand (BOD₅)
- Total Suspended Solids (TSS)
- Total Kjeldahl Nitrogen (TKN)
- Nitrate + Nitrite (NO₃+NO₂)
- Total Nitrogen
- Total Phosphorus
- Total Dissolved Phosphorus
- Oil and Grease
- Cadmium
- Copper (Cd)
- Zinc (Zn)
- Lead (Pb)

10.2.1 Land Use

The percent of impervious land surface is typically based on Land Use and Land Cover Classification System (FLUCCS) and commensurate uses. For example, transportation land uses include roads and highways and proportionately more impervious surfaces (and greater runoff), when compared with forested uplands or other natural areas. The percent of impervious surface can then be used as a factor to determine the volume of runoff expected from within a watershed. The 1995 Florida Land Use, Cover and Forms Classification System (FLUCFCS) (FDOT 1995) coverages provided by the SWFWMD were used to identify and quantify land uses in each subbasin. For pollutant loading estimates, land use classes were aggregated to correspond with Hillsborough County's current NPDES permit. The aggregated land use categories evaluated for the model are listed in **Table 10-1**.

Aggregated land uses, acres, and percentage of the Little Manatee River Watershed of each are listed in Table 10-1. Agriculture makes up nearly 50 percent of the land use in the watershed, followed by wetland forest, which encompasses only 11 percent of the land cover in the watershed. No other land use makes up more than 10 percent of the watershed.

10.2.2 Soil Characteristics and Runoff Coefficients

Soil type is another important component of runoff calculations because of the variation in the infiltration capacity among soils. In addition, the distribution of soils can vary significantly throughout a watershed. Hydrologic soils groups are typically used to classify soils based on runoff potential. Runoff volume calculations were based on the application of runoff coefficients by soil and land use type. Runoff coefficients used in this analysis for annual pollutant load calculations are consistent with those used by Hillsborough county for the NPDES permitting process and are summarized in **Appendix H**. PBS&J conducted a preliminary computation of seasonal rainfall/runoff coefficients by application of a methodology that is based on the

Table 10-1. Acres of aggregated land uses and percent of watershed each makes up.		
Land Use	Acres	Percent
Agricultural	76,986	49%
Commercial	611	0%
Extractive (Mining)/Disturbed	9,631	6%
High Density Residential	2,269	1%
Highway/Utility	1,301	1%
Institutional	140	0%
Light Industrial	148	0%
Low/Medium Density Residential	4,789	3%
Open Land	14,170	9%
Recreational	1,177	1%
Upland Forest	14,793	9%
Water	6,619	4%
Wetland Forest	16,841	11%
Wetland Non-Forested	6,333	4%
Total	155,806	100%

annual rainfall/runoff data provided by Hillsborough County for the assessment of annual pollutant loads. The methodology consisted of the following steps:

- The hourly rainfall data at the Tampa International Airport NOAA station was used to identify the rainfall events that have occurred during the period of record (48 years). A rainfall event was defined as a continued period of rainfall that may include dry periods of less than 12 hours.
- The SCS methodology was used to calculate the expected runoff volume resulting from each rainfall event. The total expected runoff was divided by the total amount of rainfall accumulated during the period to obtain the corresponding rainfall/runoff coefficient.
- Per the SCS method, expected runoff is a function of the curve number (CN). The CN associated with each land use/soils combination in the water quality model was “calibrated” to replicate the annual rainfall/runoff coefficient provided by the County.
- The calibrated CNs for the entire period of record (annual average) were then assumed to correspond to runoff flows occurring during average antecedent moisture conditions (AMCs). It should be mentioned that the results of the “calibration” indicated that calculated average condition CNs were generally higher than the values reported in the literature. Therefore, the county’s coefficients may be overestimating actual mean annual runoff volumes.

- Values of CN for seasonal conditions were assumed to correspond to calculated deviations from average and wet AMCs, per the SCS methodology. The seasonal CNs were then applied to the corresponding rainfall events over the period of record to determine expected seasonal runoff volumes for every land use category included in the water quality model. Various model runs were required to determine the point at which the sum of the seasonal loads closely approximated the annual loads. The summer season was assumed to correspond to the period June through September.
- The seasonal runoff coefficients corresponding to each land use category were determined by the ratio of total expected seasonal runoff by total rainfall over the period of record.

Table 10-2 shows the average and seasonal runoff coefficients applied in the analysis conducted herein. It should be noted that the values of the annual or seasonal coefficients have not been calibrated with actual field conditions. Therefore, it would be desirable to adjust them in the future as more data become available.

10.2.3 Basin Delineation

For the hydrologic analyses described earlier in Chapter 4, the LMR watershed was divided into eight major subbasins and 716 subbasins, making up the 155,806 acre watershed. These same subbasins were used in the pollutant loading model by combining hydrologic and runoff water quality characteristics.

10.2.4 Pollutant Concentrations

The parameters applied for the pollutant loading analysis were those required for NPDES permitting of stormwater discharges for Hillsborough County. The annual load of a specific constituent generated from each basin during cumulative annual rainfall events was calculated as the product of the annual runoff volume times the corresponding event mean concentration (EMC). The EMC is the mean concentration of a chemical parameter expected in the stormwater runoff discharged from a particular land use category during a typical (average) storm event. The calculated constituent mass represents the pollutant load.

For watershed analyses in Hillsborough County, the EMC values reported in the Hillsborough County NPDES permit applications for stormwater discharges and supporting documents were used, if available. For land use categories or parameters not reported by Hillsborough County, EMC data from other studies in Florida were used. EMC values were available for many land uses for numerous pollutants, including: five-day biological oxygen demand (BOD₅), total suspended solids (TSS), total kjeldahl nitrogen (TKN), nitrite plus nitrate (NO₂+NO₃), total nitrogen (TN), total and dissolved phosphorus (TP and TDP), oil and grease, cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn).

Table 10-2. Annual and seasonal runoff coefficients by land use and soil type.

Land Use	Annual				Summer				Winter			
	A	B	C	D	A	B	C	D	A	B	C	D
Agricultural	0.150	0.233	0.318	0.400	0.118	0.190	0.269	0.348	0.168	0.266	0.350	0.431
Commercial	0.450	0.549	0.651	0.750	0.390	0.477	0.576	0.705	0.651	0.567	0.669	0.771
Extractive (Mining) / Disturbed	0.050	0.050	0.050	0.050	0.040	0.040	0.040	0.040	0.050	0.061	0.061	0.061
High Density Residential	0.500	0.566	0.634	0.700	0.433	0.495	0.563	0.635	0.634	0.583	0.654	0.725
Highway/Utility	0.500	0.599	0.701	0.800	0.433	0.524	0.636	0.743	0.701	0.622	0.726	0.817
Institutional	0.450	0.549	0.651	0.750	0.390	0.477	0.576	0.705	0.651	0.567	0.669	0.771
Light Industrial	0.500	0.599	0.701	0.800	0.433	0.524	0.636	0.743	0.701	0.622	0.726	0.817
Low/Medium Density Residential	0.267	0.322	0.379	0.430	0.218	0.279	0.324	0.370	0.379	0.354	0.412	0.458
Open Land	0.100	0.166	0.234	0.300	0.078	0.132	0.193	0.253	0.234	0.187	0.267	0.333
Recreational	0.100	0.166	0.234	0.300	0.078	0.132	0.193	0.253	0.234	0.187	0.267	0.333
Upland Forest	0.050	0.050	0.050	0.050	0.040	0.040	0.040	0.040	0.050	0.061	0.061	0.061
Water	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Wetland Forest	0.100	0.100	0.100	0.100	0.078	0.078	0.078	0.078	0.100	0.118	0.118	0.118
Wetland Non- Forested	0.200	0.200	0.200	0.200	0.160	0.160	0.160	0.160	0.200	0.228	0.228	0.228

EMC values used to estimate pollutant loads are summarized in **Table 10-3**. Literature reviews previously performed by Hillsborough County for the Northwest Hillsborough and Pemberton/Baker Creek watershed reports in 1999 included comparisons of EMC values in Hillsborough County to other Florida and national studies. Summaries of those findings for each parameter are provided in **Table 10-4**.

10.2.5 Existing Stormwater Treatment

The type and extent of best management practices (BMPs) providing pollutant removal were also examined and used to estimate net loads from each basin. BMP coverage data were developed for each aggregate land use within each subbasin based on field surveys and photointerpretation of digital orthophotography provided by the SWFWMD. BMPs used to reduce loads generated by various land uses included wet ponds, percolation ponds (dry retention basins), grassed swales, and infiltration trenches.

For each land use within a subbasin, a percent cover of the area treated by a particular BMP was estimated. Load removal was then calculated based on removal efficiencies supplied with the model. BMP removal efficiencies are listed in **Table 10-5(a)** for sediments and nutrients and **Table 10-5(b)** for grease and oil and metals, by BMP. Most BMPs identified in the watershed were wet detention ponds and drainage swales associated with transportation (I-75, US 301, US 41). Several large wet detention ponds were constructed within the last decade by the FDOT to

Table 10-3. EMC values by parameter for land use categories under existing conditions stormwater pollution model Hillsborough County Public Works / Stormwater Management.

Land Use	NPDES Conventional WQ (mg/l)								Cd
	BOD ₅	TSS	TKN	NO ₃ +NO ₂	TN	TP	TDP	Oil and Grease	
Low/Medium Density Residential	1.00	19.00	1.082	0.281	1.363	0.401	0.282	1.080	0.001
High Density Residential	2.60	29.00	1.368	0.679	2.047	1.337	0.552	1.073	0.001
Light Industrial	2.87	18.20	2.088	0.187	2.275	0.332	0.187	3.663	0.001
Agricultural	18.30	12.70	2.167	0.803	2.970	2.349	1.223	0.500	0.013
Commercial	2.67	22.92	1.645	0.387	2.032	0.279	0.157	0.650	0.001
Institutional	2.67	22.92	1.645	0.387	2.032	0.279	0.157	0.650	0.001
Highway/Utility	24.00	261.00	2.990	1.140	4.130	0.120	0.300	0.400	0.040
Recreational	3.80	11.10	2.090	0.508	2.598	0.050	0.130	0.900	0.007
Open Land	3.80	11.10	2.090	0.508	2.598	0.050	0.130	0.900	0.001
Extractive (Mining)/Disturbed	28.94	13.20	3.500	0.030	3.530	0.194	0.134	0.900	0.001
Upland Forest	0	0	0	0	0	0	0	0	0
Wetland Forest	0	0	0	0	0	0	0	0	0
Wetland Non-Forested	0	0	0	0	0	0	0	0	0
Water	0	0	0	0	0	0	0	0	0

Table 10-4. Summaries of comparisons of pollutant values in Hillsborough County to other Florida and national studies.	
Parameter	Summary of Findings
BOD ₅	Tends to be lower, or similar, than those found in other areas in Florida, except for agriculture. The agriculture EMC for BOD ₅ is approximately five times larger than other values reported in Florida. In general, Hillsborough County agricultural land use EMCs for a number of parameters tend to be much higher than those reported elsewhere in Florida. Low levels of organic matter may reflect the low organic matter typically present in Florida soils.
Nitrogen	Hillsborough County data indicate that total nitrogen EMCs for agricultural land use are 74 percent higher than that for low/medium family residential uses. Residential land uses tends to have higher loadings in Florida and Hillsborough County than nationally due to the increased application of lawn fertilizer by homeowners and golf course managers. Slightly higher TKN and TP values for multi-family sites may reflect more intensive landscape maintenance for these land uses. Commercial land uses also have nitrogen values that are higher than national averages. This may reflect primarily atmospheric deposition, as studies in Florida have shown that commercial sites produce elevated nitrogen loads even if little green area is present.
TSS	Data for Hillsborough County are comparable to other Florida locations and lower than U.S. averages. TSS results from soil erosion, with construction sites a major contributor along with agricultural practices. Additional primary sources of TSS include vehicle emissions and atmospheric deposition.
Phosphorus	Hillsborough County data indicate that total phosphorus EMCs for agricultural land use are 586 percent higher than that for low/medium family residential uses. However, the EMC for total phosphorus is six times as high as the average EMC found for various agricultural sites in Florida. This situation makes agriculture one of the main contributors of nutrient loadings. Phosphorous runoff tends to be lower in Florida than the U.S. average, although data from Hillsborough County studies differ somewhat. Phosphorus runoff from residential and commercial land uses is higher than Florida average, while runoff from industrial land uses is similar to Florida and national averages.
Lead	Lead levels are lower than other locations in Florida and across the U.S. Relatively low concentrations may reflect fate and transport characteristics of the particular systems sampled and/or decreased emissions due to the use of unleaded gasoline.
Copper	Copper data for Hillsborough County are higher than other locations in Florida, but similar to the nationwide average. Relatively high values were observed for residential land uses. Transportation-related activities, particularly releases from brake linings, have been identified as primary sources for copper. Copper is also a common element in algaecides and fungicides, and many fertilizers contain copper.
Zinc	Zinc data are much lower for Hillsborough County and Florida in general than the rest of the U.S. Sources of zinc include industrial processes, transportation-related activities, atmospheric deposition and fertilizers. Relatively low zinc concentrations may reflect fate and transport characteristics of the particular systems sampled and/or the presence of fewer industrial processing facilities in Hillsborough County than other parts of the U.S.

treat roadway improvement projects. Wet detention ponds were found in newer residential areas constructed in the late 1980s and early 1990s after rules requiring on-site storage and treatment of runoff were enacted by the State of Florida.

An example of a community with numerous treatment ponds is Sun City, in contrast with the community of Ruskin, where there are few or no treatment ponds or swales. A smaller number of percolation ponds and grass swales were also observed, primarily along transportation corridors. No infiltration trenches were identified within the watershed based on field surveys.

Table 10-5 (a). Percent Removal by Pollutant for BMP Types Stormwater Pollutant Loading and Removal Model Hillsborough County Public Works/Stormwater Management.

BMP ID	Description	BOD ₅	TSS	TKN	NO ₃ +NO ₂	TN	TP	TDP
1	Wet-detention	60% ¹	85% ¹	30% ¹	80% ¹	30% ¹	65% ¹	80% ³
2	Percolation	80% ¹	80% ¹	80% ¹	80% ¹	80% ¹	80% ¹	80% ³
3	Infiltration Trench		75% ³				60% ³	
4	Grass Swale		60% ³	10% ³	15% ³	10%	20% ³	

Note:

1. Harper, 1995. "Pollutant Removal Efficiencies for Typical Stormwater Management Systems in Florida." Stormwater Research Conference, 1995.
2. Kadlec, R.H. and R.L. Knight, 1996. "Treatment Wetlands." CTC Press, Inc. Boca Raton, Florida.
3. Parson ES, 1999

Table 10-5(b). Percent Removal by Pollutant for BMP Types Stormwater Pollutant Loading and Removal Model Hillsborough County Public Works / Stormwater Management.

BMP ID	Description	Oil and Grease	Cd	Cu	Pb	Zn
1	Wet-detention	35% ²	75% ²	65% ¹	75% ¹	85%
2	Percolation	80% ³	80% ³	80% ¹	80% ¹	80%
3	Infiltration Trench				65% ³	65%
4	Grass Swale				70% ³	60%

Note:

4. Harper, 1995. "Pollutant Removal Efficiencies for Typical Stormwater Management Systems in Florida." Stormwater Research Conference, 1995.
5. Kadlec, R.H. and R.L. Knight, 1996. "Treatment Wetlands." CTC Press, Inc. Boca Raton, Florida.
6. Parson ES, 1999

10.3 POLLUTANT LOADS

The EPA Simple Method is used in the spreadsheet model to calculate pollutant loads. Using the EPA method, gross non-point source pollutant loads are calculated using the following formula:

$$L_i = (0.227)(P)(CF)(Rv_i)(C_i)(A_i)$$

where:

- L_i = annual pollutant load per basin (lb/yr);
- P = annual average precipitation (in/yr);
- Rv_i = weighted average runoff coefficient based on impervious area;
- C_i = event mean concentration of pollutant (mg/l);
- A_i = catchment area contributing to outfall (acres); and
- CF = correction factor for storms that do not produce runoff
(assumed $CF=0.9$, 10 percent of storms do not produce runoff).

The runoff value was calculated as the product of the annual rainfall amount and the corresponding weighted land use and soil runoff coefficients for a given subbasin. A correction factor of 0.9 was applied to rainfall to account for the numerous small rainfall events (possibly less than 0.1 inch) that occur throughout the year.

These events are small enough that no runoff is created. The annual contribution of each subbasin in terms of stormwater runoff volume was then calculated by multiplying the runoff coefficient by the average annual rainfall volume for the Tampa Bay area (52.4 inches). The rainfall volume used to calculate average annual runoff was therefor 47.16 inches ($52.4 \times 0.9 = 47.16$).

10.3.1 Gross Pollutant Loads

As indicated previously, estimates of gross pollutant loads were calculated for each subbasin using the 1995 land use and hydrologic soils information. These calculations were performed assuming no stormwater treatment occurred within any of the 716 subbasins. Gross annual and seasonal pollutant loadings of conventional pollutants (BOD5, suspended solids and nutrients) for each of the eight major subbasins are listed in **Tables 10-6(a)** through **10-6(c)**. Gross annual and seasonal loadings of oil and grease and metals are listed for each major subbasin in **Tables 10-7(a)** through **10-7(c)**. Results indicated that, as opposed of rainfall for which wet season volume accounts for 60 percent of the total annual amount, annual wet season gross pollutant loads amount to approximately 70 percent of the total.

Table 10-6(a). Gross annual pollutant loading for conventional pollutants in the LMR watershed by major subbasin.

Basin ID	Area (acres)	BOD5 (lbs/yr)	TSS (lbs/yr)	TKN (lbs/yr)	NO3+NO2 (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)	TDP (lbs/yr)
Cockroach Bay	4,490	95,721	161,834	12,290	4,513	16,802	11,656	6,102
Curiosity Creek	18,800	594,873	1,099,830	79,573	28,188	107,761	68,254	36,690
IMC Mine	10,440	186,684	110,229	25,288	2,673	27,961	5,870	3,398
LMR South Fork	24,633	797,775	664,835	107,122	37,653	144,775	98,590	52,171
Lower Middle LMR	28,353	614,331	1,991,298	107,392	38,886	146,278	78,070	41,001
Lower LMR	14,535	406,739	1,078,012	63,943	21,680	85,623	47,900	25,952
Upper LMR	27,288	997,413	764,337	130,297	45,696	175,993	123,042	64,855
Upper Middle LMR	27,261	1,045,123	809,341	132,588	47,742	180,330	132,645	69,613
Total	155,801	4,738,658	6,679,717	658,493	227,030	885,523	566,028	299,781

Table 10-6(b). Gross winter pollutant loading for conventional pollutants in the LMR watershed by major subbasin.

Basin ID	Area (acres)	BOD5 (lbs/yr)	TSS (lbs/yr)	TKN (lbs/yr)	NO3+NO2 (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)	TDP (lbs/yr)
Cockroach Bay	4,490	31,150	54,931	4,012	1,475	5,487	3,780	1,979
Curiosity Creek	18,800	193,974	372,745	25,954	9,197	35,151	22,120	11,906
IMC Mine	10,440	59,059	34,946	8,000	858	8,858	1,893	1,093
LMR South Fork	24,633	259,907	217,073	34,810	12,249	47,059	32,134	17,000
Lower Middle LMR	28,353	202,657	681,573	35,613	12,941	48,554	25,793	13,531
Lower LMR	14,535	133,395	368,398	21,143	7,162	28,306	15,643	8,489
Upper LMR	27,288	324,684	248,736	42,322	14,863	57,184	40,095	21,128
Upper Middle LMR	27,261	339,686	263,512	43,067	15,512	58,580	43,131	22,634
Total	155,801	1,544,514	2,241,916	214,920	74,257	289,178	184,590	97,760

Table 10-6(c). Gross summer pollutant loading for conventional pollutants in the LMR watershed by major subbasin.

Basin ID	Area (acres)	BOD5 (lbs/yr)	TSS (lbs/yr)	TKN (lbs/yr)	NO3+NO2 (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)	TDP (lbs/yr)
Cockroach Bay	4,490	64,985	104,751	8,305	3,045	11,349	7,933	4,152
Curiosity Creek	18,800	402,955	711,677	53,821	19,069	72,890	46,606	25,013
IMC Mine	10,440	134,468	78,395	18,104	1,828	19,932	4,052	2,350
LMR South Fork	24,633	539,158	447,356	72,461	25,460	97,921	66,637	35,265
Lower Middle LMR	28,353	409,431	1,266,658	70,881	25,558	96,439	51,900	27,306
Lower LMR	14,535	273,840	691,771	42,671	14,473	57,143	32,418	17,541
Upper LMR	27,288	677,071	518,044	88,454	30,987	119,441	83,435	43,979
Upper Middle LMR	27,261	708,489	547,121	89,828	32,351	122,179	89,916	47,187
Total	155,801	3,210,398	4,365,772	444,524	152,771	597,295	382,898	202,793

Table 10-7(a). Gross pollutant loading for oil and grease and metals in the LMR watershed by major subbasin.

Basin ID	Area (acres)	Oil and Grease (lbs/yr)	Cd (lbs/yr)	Cu (lbs/yr)	Pb (lbs/yr)	Zn (lbs/yr)
Cockroach Bay	4,490	3,461	74	249	325	248
Curiosity Creek	18,800	21,819	473	1,461	2,461	1,588
IMC Mine	10,440	7,010	33	91	12	75
LMR South Fork	24,633	27,958	558	1,741	284	833
Lower Middle LMR	28,353	42,539	519	2,225	4,122	3,068
Lower LMR	14,535	25,085	333	1,195	2,278	1,613
Upper LMR	27,288	33,277	688	2,153	179	955
Upper Middle LMR	27,261	33,739	737	2,338	198	1,042
Total	155,801	194,888	3,415	11,452	9,859	9,422

Table 10-7(b). Gross pollutant loading for oil and grease and metals in the LMR watershed by major subbasin.

Basin ID	Area (acres)	Oil and Grease (lbs/yr)	Cd (lbs/yr)	Cu (lbs/yr)	Pb (lbs/yr)	Zn (lbs/yr)
Cockroach Bay	4,490	1,138	24	82	114	85
Curiosity Creek	18,800	7,133	156	480	856	540
IMC Mine	10,440	2,217	11	29	4	24
LMR South Fork	24,633	9,065	182	568	96	273
Lower Middle LMR	28,353	14,242	173	746	1,432	1,054
Lower LMR	14,535	8,403	110	397	793	553
Upper LMR	27,288	10,787	224	702	59	311
Upper Middle LMR	27,261	10,964	239	760	65	339
Total	155,801	63,948	1,119	3,765	3,419	3,179

Table 10-7(c). Gross pollutant loading for oil and grease and metals in the LMR watershed by major subbasin.

Basin ID	Area (acres)	Oil and Grease (lbs/yr)	Cd (lbs/yr)	Cu (lbs/yr)	Pb (lbs/yr)	Zn (lbs/yr)
Cockroach Bay	4,490	2,313	50	167	204	160
Curiosity Creek	18,800	14,741	318	982	1,540	1,023
IMC Mine	10,440	4,999	23	62	8	52
LMR South Fork	24,633	18,928	377	1,176	183	559
Lower Middle LMR	28,353	27,747	342	1,449	2,578	1,941
Lower LMR	14,535	16,551	222	792	1,426	1,030
Upper LMR	27,288	22,593	466	1,460	119	647
Upper Middle LMR	27,261	22,833	499	1,584	132	704
Total	155,801	130,705	2,297	7,671	6,191	6,117

10.3.2 Net Pollutant Loads

Estimates of net pollutant loads were subsequently calculated for each subbasin using stormwater treatment BMP coverage file (**Appendix D**). These data were used to compare untreated versus treated runoff conditions in the watershed. Net annual and seasonal pollutant loadings of suspended solids and nutrients for each of the major subbasins are listed in **Tables 10-8(a)** through **10-8(c)**. Net loadings of oil and grease and metals are listed for each major subbasin in **Tables 10-9(a)** through **10-9(c)**.

Summaries of gross and net annual loads for conventional pollutants, as well as for oil and grease and heavy metals are shown in **Tables 10-10(a)** and **10-10(b)**. Summaries for summer loads are shown in **Tables 10-11(a)** and **10-11(b)**, whereas summaries for winter loads are presented in **Tables 10-12(a)** and **10-12(b)**. Based on model results, load reductions were greatest for the metals lead (Pb) and zinc (Zn) and total suspended solids (TSS). The annual reduction in annual zinc loadings was 40 percent, more than twice that of lead (17 percent reduction) and total suspended solids (16 percent reduction). None of the nutrients examined exhibited load reductions of more than 2 percent.

Loading results can be explained in part by land uses in the basins and treatment efficiencies. Examples of pollutants generated in urban areas include: sediment from development and new construction; oil, grease, and toxic chemicals from automobiles; nutrients and pesticides from lawns; viruses and bacteria from failing septic systems; road salts; and heavy metals. Sediments and solids constitute the largest volume of pollutant loads to receiving waters in urban areas and transport nutrients and other pollutants to waterbodies.

High loads of lead may be a result of leaded gasoline residues on roads and in soils. These pollutants are lightly bound to sediments. Zinc commonly occurs in high concentrations due to its occurrence in many industrial and residential uses. Zinc is a common component of urban runoff due to its use as a rust preventative in iron-containing metals.

Nutrients and TSS loadings are high where agricultural uses dominate the landscape and treatment is absent. In agricultural areas, these loads are exacerbated by the addition of fertilizers and pesticides. Nutrients and pesticides from turf management and gardening in the more urbanized areas and communities add to total phosphorus and nitrogen loads in the watershed. While wet detention basins to detain runoff and allow for settling of pollutants associated with sediments and reduction of nutrients through biological processes are often effective, high runoff can exceed the capacity of the treatment pond and result in high loads.

Oil and grease and the remaining metals (cadmium and copper) exhibited no more than 2 percent reductions in loadings to the watershed due to treatment removal efficiencies. In addition, the loadings for these metals and nutrients were much higher in the Curiosity Creek, Lower Middle, the Lower, and the Middle LMR basins where most of the development has

Table 10-8(a). Net annual pollutant loading for conventional pollutants in the LMR watershed by major subbasin.								
Basin ID	Area (acres)	BOD5 (lbs/yr)	TSS (lbs/yr)	TKN (lbs/yr)	NO3+NO2 (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)	TDP (lbs/yr)
Cockroach Bay	4,490	95,721	151,585	12,270	4,501	16,775	11,654	6,102
Curiosity Creek	18,800	592,555	804,921	78,769	27,784	106,651	68,201	36,661
IMC Mine	10,440	101,166	54,970	20,117	2,554	22,745	5,249	2,870
LMR South Fork	24,633	797,775	664,835	107,122	37,653	144,775	98,590	52,171
Lower Middle LMR	28,353	605,484	1,511,295	104,527	37,053	142,573	77,248	40,274
Lower LMR	14,535	401,096	852,924	62,514	20,816	83,767	47,247	25,423
Upper LMR	27,288	990,945	757,753	129,862	45,653	175,541	122,956	64,781
Upper Middle LMR	27,261	1,045,046	807,283	132,547	47,713	180,277	132,612	69,585
Total	155,801	4,629,789	5,605,566	647,728	223,727	873,106	563,758	297,866

Table 10-8(b). Net summer pollutant loading for conventional pollutants in the LMR watershed by major subbasin.								
Basin ID	Area (acres)	BOD5 (lbs/yr)	TSS (lbs/yr)	TKN (lbs/yr)	NO3+NO2 (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)	TDP (lbs/yr)
Cockroach Bay	4,490	31,150	51,387	4,005	1,471	5,477	3,779	1,979
Curiosity Creek	18,800	193,173	270,051	25,674	9,057	34,765	22,102	11,896
IMC Mine	10,440	32,184	17,580	6,375	821	7,219	1,698	928
LMR South Fork	24,633	259,907	217,073	34,810	12,249	47,059	32,134	17,000
Lower Middle LMR	28,353	199,787	515,284	34,663	12,334	47,323	25,519	13,291
Lower LMR	14,535	131,496	290,231	20,658	6,871	27,675	15,426	8,312
Upper LMR	27,288	322,650	246,610	42,184	14,848	57,041	40,067	21,104
Upper Middle LMR	27,261	339,660	262,826	43,054	15,503	58,562	43,120	22,624
Total	155,801	1,510,007	1,871,043	211,422	73,154	285,122	183,844	97,134

Table 10-8(c). Net winter pollutant loading for conventional pollutants in the LMR watershed by major subbasin.								
Basin ID	Area (acres)	BOD5 (lbs/yr)	TSS (lbs/yr)	TKN (lbs/yr)	NO3+NO2 (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)	TDP (lbs/yr)
Cockroach Bay	4,490	64,985	98,319	8,292	3,038	11,333	7,932	4,152
Curiosity Creek	18,800	401,508	527,652	53,320	18,817	72,198	46,573	24,995
IMC Mine	10,440	71,847	37,931	14,317	1,741	16,113	3,597	1,963
LMR South Fork	24,633	539,158	447,356	72,461	25,460	97,921	66,637	35,265
Lower Middle LMR	28,353	403,510	965,265	69,004	24,353	94,015	51,355	26,821
Lower LMR	14,535	270,161	550,245	41,746	13,910	55,943	31,985	17,189
Upper LMR	27,288	672,342	513,406	88,139	30,958	119,116	83,375	43,928
Upper Middle LMR	27,261	708,438	545,742	89,800	32,332	122,144	89,894	47,167
Total	155,801	3,131,948	3,685,916	437,080	150,609	588,782	381,349	201,481

Table 10-9(a). Net annual pollutant loading for oil and grease and metals in the LMR watershed by major subbasin.

Basin ID	Area (acres)	Oil and Grease (lbs/yr)	Cd (lbs/yr)	Cu (lbs/yr)	Pb (lbs/yr)	Zn (lbs/yr)
Cockroach Bay	4,490	3,461	74	249	281	232
Curiosity Creek	18,800	21,780	470	1,451	1,211	1,125
IMC Mine	10,440	5,458	30	88	8	50
LMR South Fork	24,633	27,958	558	1,741	284	833
Lower Middle LMR	28,353	41,338	507	2,166	2,257	2,347
Lower LMR	14,535	24,195	326	1,161	1,455	1,264
Upper LMR	27,288	33,103	687	2,152	177	950
Upper Middle LMR	27,261	33,691	737	2,337	197	1,039
Total	155,801	190,985	3,388	11,344	5,871	7,840

Table 10-9(b). Net summer pollutant loading for oil and grease and metals in the LMR watershed by major subbasin.

Basin ID	Area (acres)	Oil and Grease (lbs/yr)	Cd (lbs/yr)	Cu (lbs/yr)	Pb (lbs/yr)	Zn (lbs/yr)
Cockroach Bay	4,490	1,138	24	82	99	79
Curiosity Creek	18,800	7,119	154	476	420	379
IMC Mine	10,440	1,729	10	28	3	16
LMR South Fork	24,633	9,065	182	568	96	273
Lower Middle LMR	28,353	13,849	169	727	783	804
Lower LMR	14,535	8,102	108	386	506	432
Upper LMR	27,288	10,731	224	701	59	310
Upper Middle LMR	27,261	10,948	239	760	65	339
Total	155,801	62,681	1,110	3,729	2,030	2,630

Table 10-9(c). Net winter pollutant loading for oil and grease and metals in the LMR watershed by major subbasin.

Basin ID	Area (acres)	Oil and Grease (lbs/yr)	Cd (lbs/yr)	Cu (lbs/yr)	Pb (lbs/yr)	Zn (lbs/yr)
Cockroach Bay	4,490	2,313	50	167	176	150
Curiosity Creek	18,800	14,717	315	976	760	734
IMC Mine	10,440	3,863	20	60	6	34
LMR South Fork	24,633	18,928	377	1,176	183	559
Lower Middle LMR	28,353	26,946	335	1,409	1,413	1,490
Lower LMR	14,535	15,968	217	769	912	811
Upper LMR	27,288	22,470	466	1,459	118	643
Upper Middle LMR	27,261	22,801	499	1,583	131	703
Total	155,801	128,007	2,279	7,599	3,701	5,124

Table 10-10(a). Summary of annual pollutant loading for conventional pollutants in the LMR watershed by major subbasin.

Area (acres)	BOD5 (lbs/yr)	TSS (lbs/yr)	TKN (lbs/yr)	NO3+NO2 (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)	TDP (lbs/yr)
Gross Load	4,738,658	6,679,717	658,493	227,030	885,523	566,028	299,781
Net Load	4,629,789	5,605,566	647,728	223,727	873,106	563,758	297,866
Current Removal	108,869	1,074,151	10,765	3,303	12,417	2,269	1,915
% Removed	2%	16%	2%	1%	1%	0%	1%

Table 10-10(b). Summary of annual pollutant loading for oil and grease and metals in the LMR watershed by major subbasin.

Loadings	Oil and Grease (lbs/yr)	Cd (lbs/yr)	Cu (lbs/yr)	Pb (lbs/yr)	Zn (lbs/yr)
Gross Load	194,888	3,415	11,452	9,859	9,422
Net Load	190,985	3,388	11,344	5,871	7,840
Current Removal	3,902	27	109	3,988	1,581
% Removed	2%	1%	1%	40%	17%

Table 10-11(a). Summary of summer pollutant loading for conventional pollutants in the LMR watershed by major subbasin.

Area (acres)	BOD5 (lbs/yr)	TSS (lbs/yr)	TKN (lbs/yr)	NO3+NO2 (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)	TDP (lbs/yr)
Gross Load	3,210,398	4,365,772	444,524	152,771	597,295	382,898	202,793
Net Load	3,131,948	3,685,916	437,080	150,609	588,782	381,349	201,481
Current Removal	78,450	679,856	7,445	2,162	8,514	1,549	1,312
% Removed	2%	16%	2%	1%	1%	0%	1%

Table 10-11(b). Summary of summer pollutant loading for oil and grease and metals in the LMR watershed by major subbasin.

Loadings	Oil and Grease (lbs/yr)	Cd (lbs/yr)	Cu (lbs/yr)	Pb (lbs/yr)	Zn (lbs/yr)
Gross Load	130,705	2,297	7,671	6,191	6,117
Net Load	128,007	2,279	7,599	3,701	5,124
Current Removal	2,698	18	72	2,490	993
% Removed	2%	1%	1%	40%	16%

Table 10-12(a). Summary of winter pollutant loading for conventional pollutants in the LMR watershed by major subbasin.

Area (acres)	BOD5 (lbs/yr)	TSS (lbs/yr)	TKN (lbs/yr)	NO3+NO2 (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)	TDP (lbs/yr)
Gross Load	1,544,514	2,241,916	214,920	74,257	289,178	184,590	97,760
Net Load	1,510,007	1,871,043	211,422	73,154	285,122	183,844	97,134
Current Removal	34,507	370,873	3,498	1,104	4,056	745	626
% Removed	2%	17%	2%	1%	1%	0%	1%

Table 10-12(b). Summary of winter pollutant loading for oil and grease and metals in the LMR watershed by major subbasin.

Loadings	Oil and Grease (lbs/yr)	Cd (lbs/yr)	Cu (lbs/yr)	Pb (lbs/yr)	Zn (lbs/yr)
Gross Load	194,888	3,415	11,452	9,859	9,422
Net Load	190,985	3,388	11,344	5,871	7,840
Current Removal	3,903	27	108	3,988	1,582
% Removed	2%	1%	1%	40%	17%

occurred. These basins combined accounted for less than 60 percent of the land area in the watershed. These basins also accounted for approximately 57 percent of the TSS loadings, but nearly 75 percent of the total zinc loadings.

Heavy metals and pesticides, in solution or adhered to sediments, are discharged to surface waters by sources including wastewater effluent and surface runoff. In addition, oils and grease are leaked onto road surfaces from car and truck engines, spilled at fueling stations, and discarded directly onto pavement or into storm sewers instead of being taken to recycling stations.

These pollutants degrade water quality and can harm aquatic life by interfering with photosynthesis, respiration, growth, and reproduction. In more urban settings, such as Sun City and Ruskin, pollutant loads due to metals, oils and grease associated with highway and industrial use are high due to increased impervious surfaces, automobiles, and other intense land uses such as light industrial and commercial. Considerable effort is being directed to minimizing anthropogenic inputs of metals because many aquatic organisms are sensitive to metals such as copper, nickel and zinc.

10. 4 OTHER SOURCES OF POLLUTION

As indicated previously, other sources of pollution in the watershed include nonpoint and point sources, septic tanks, atmospheric deposition, and septic sludge and wastewater residuals.

Nonpoint source pollution is addressed here as nutrients and contaminants entering a receiving waterbody through stormwater runoff. Nonpoint source loadings originate from both urban and agricultural land use activities. Nonpoint source pollutants may include those applied in the watershed (fertilizer, pesticides), by-products of urban or agricultural activities (automobile fluids, animal waste, lawn clippings and other organic detritus, etc.), or atmospheric deposition (discussed below).

10.4.1 Point Sources

Point source pollution to the LMR watershed includes domestic wastewater treatment plants (WWTP) and industrial facilities. There are no point sources in the Cockroach Bay watershed, but several domestic and industrial facilities operate in the vicinity. No domestic WWTP regularly discharges effluent directly to surface waters, but the Hawaiian Isles WWTP is located directly adjacent to the north shore of Cockroach Bay and uses a percolation pond to treat and dispose of its effluent.

Industrial sites in the watershed include the Florida Power and Light (FP&L) Point Manatee Electric Generating Station and the IMC-Agrico Four Corners Mine, both of which discharge to the Little Manatee River. FP&L has two point source discharges into the South Fork of the Little Manatee River, consisting of seepage from Lake Parrish, with mixing zones for iron and pH (acidity). IMC-Agrico has NPDES-permitted mine discharge to Alderman's Creek in the extreme southeast headwaters of the river.

The largest and only publicly owned domestic WWTP that discharges effluent in the watershed is the Hillsborough County South Regional facility. This facility is located just outside the watershed boundary, north of SR 674 and west of I-75, but discharges most of its treated effluent (averaging approximately two mgd) within the watershed. The plant was upgraded to advanced wastewater treatment (AWT) in 1992, and is permitted for wet weather surface discharge to Tampa Bay. Under normal circumstances, however, all effluent is reused at industrial facilities (TECO's Big Bend Power Generating Station) or sprayed on golf courses and roadway medians for landscaping irrigation. Point sources in the LMR watershed are listed in **Table 10-13**.

10.4.2 Septic Tanks

Properly constructed and maintained septic tanks provide domestic wastewater treatment and pose little environmental threat in the proper setting. However, they may contribute to groundwater and surface water pollution if:

- they are improperly sized, located or constructed;
- they are not maintained and periodically cleaned; and/or
- a large number of septic tanks exist at relatively high density.

Table 10-13. Point sources located in the LMR watershed. Average discharge is for the period 1992 – 1994.

Facility Name	Domestic or Industrial	Average discharge (mgd)	Effluent Discharge Method*	Comments
FP&L Point Manatee Station	I	2.2	SD	Cooling pond seepage and wet weather gate openings only.
IMC-Agrico Four Corners Mine	I	2.1	SD	NPDES mine discharge is periodic.
South County Regional WWTP	D	2.2	IR, I, SD	Surface discharge in wet weather only. Public.
Hawaiian Isle Trailer Park	D		PP	Privately-owned.
Chula Vista MHP	D	0.016	PP	Privately-owned.
Neptune MHP	D	0.015	PP	Privately-owned.
Hide-a Way Campground	D	0.013	PP	Privately-owned.
Holiday Palms RV Park	D	0.005	PP	Privately-owned.
Manatee RV Park	D	0.013	PP	Privately-owned.
Moorings at Manatee	D	0.017	PP	Privately-owned.
Little Manatee River MH Park	D	0.007	PP	Privately-owned.
Little Manatee Isles MH Park	D	0.009	PP	Privately-owned.
Interstate I-75 Rest Area	D	0.008	DF	Privately-owned.
IMC Four Corners Mine WWTP	D	0.004	PP	Package plant at the mine.

NOTE: Effluent discharge methods: SD = surface discharge, IR = spray irrigation, PP = percolation pond, DF = drain field, I = industrial reuse.

The Florida Department of Health and Rehabilitative Services standards (Chapter 10D-6, Florida Administrative Code) limit the number of septic tanks that may be used per acre, designate the minimum distance to a surface waterbody or potable well from a septic tank, and specify that the seasonal high water table must be no less than two feet below the bottom of the drain field. Proper maintenance and cleaning include pumping out septic tanks every three to five years. If all these criteria are met, effluent can be expected to be treated properly and have no impact on a receiving water.

Septic tanks have in the past been located in inappropriate areas, improperly constructed, and not maintained. Even though the Florida Department of Health and Rehabilitation provides effective implementation of rules for new septic tanks, older units may not meet the current standards.

Additionally, no local or state regulations require the periodic maintenance and cleaning of septic tanks, and cleaning and maintaining is not always practiced on a regular and voluntary basis.

Septic tanks have been identified as a potential cause of high fecal coliform bacteria counts in coastal and inland waters and were cited as probable contributors to the high bacteria levels that prompted the conditional closing of the south Hillsborough County Class II shellfish harvesting area, which includes the lower LMR. It must be noted, however, that few data exist to directly link septic tanks to specific water quality and public health problems.

Results from various field monitoring programs have been mixed regarding the potential for septic tank contamination of surrounding areas. An investigation by EPCHC in 1990 failed to identify septic tanks as the source of elevated coliform bacteria within the Cockroach Bay Aquatic Preserve. The Pinellas County Department of Environmental Management (PCDEM) collected groundwater samples adjacent to older septic tanks in the Allen's Creek system and did not find elevated bacteria or nutrient levels (Espiritu-Anderson *et al.* 1996). In addition, extensive field monitoring in the Turkey Creek basin near concentrations of septic tanks (Anderson and Belanger 1993) was not conclusive regarding the purported widespread groundwater contamination due to nutrients or bacteria. Groundwater and surface water sampling in residential canal communities in Port Charlotte by Ardaman & Associates, Inc. *et al.* (1995) found elevated nitrogen levels in groundwater adjacent to the canals, although bacteria contamination in the surface water or groundwater was not investigated.

Although it is difficult to obtain adequate data to examine septic tank contamination, it must be assumed there is potential for groundwater and surface water contamination from septic tanks. A study sponsored by SWFWMD SWIM (Ayres Associates 1995) estimated TN and TP loads from septic tanks within major drainage systems in the Tampa Bay Watershed. Ayres Associates (1995) estimated nitrogen loads from septic tanks delivered to the LMR to be on the order of 10 tons per year (annual load for 1990). In contrast, the estimated net TN loading from nonpoint sources in the watershed according to the pollutant loading model estimates was 400 tons per year. Bacterial loading from septic tanks was not addressed by Ayres Associates (1995).

An inventory of septic tanks within the watershed was included in a 1991 assessment of potential pollutant sources in the watershed by SWFWMD. For that inventory, sanitary sewer service areas were delineated, and all homes and businesses within the service area were assumed to be on-line. This is not a totally valid assumption, because Hillsborough County does not have a mandatory connection ordinance. That is, even if a sanitary sewer collection line is accessible, a homeowner is under no obligation to connect to it unless the site is inappropriate for septic tank use. After the service areas were identified, all homes and businesses outside the service area limits were counted using 1"=200' aerial photographs. All these homes were assumed to use septic tanks. The number of homes and businesses using septic tanks were tallied and reported as the number per square mile. Septic tank densities ranged from near zero per square mile in the eastern portion of the watershed to over 500 per square mile in Ruskin. The total number of

septic tanks identified using these methods was estimated to be 4,768. Using similar techniques, septic tanks in the Cockroach Bay watershed were estimated to total 107.

The majority of the septic tanks (approximately 3,700) were located in the lower LMR basin, in and around Ruskin. Over 300 septic tanks were identified in the LMR near Wimauma. Information obtained from the Hillsborough County Engineering Services staff (Hillsborough County 1997) revealed that the sanitary sewer collection system has not been expanded since the 1991 inventory, so the current number of septic tanks in the LMR watershed has likely not changed significantly over the past eight years.

Tests for trends in fecal coliforms have shown no significant differences over time at any of the EPCHC stations (Chapter 7). Based on these results, and estimates of nitrogen loading, it is not likely that septic tanks contribute significantly to nutrient loading in the LMR, although high concentrations of septic tanks in small areas (such as Ruskin) may result in localized surface water impacts. Bacteria tend to become bound to soil particles after a short distance if septic tanks are functioning properly, so if there are impacts, they likely originate from failed septic tanks in homes or businesses close to the river.

10.4.3 Atmospheric Deposition

Atmospheric deposition is the delivery of pollutants to a waterbody or watershed through rainfall (wetfall) or through gaseous exchange and particulate fallout (dryfall). Atmospheric deposition can contribute to surface water pollutant loadings through direct deposition to open waterbodies, and through deposition onto the land surface, where some of the material becomes entrained in stormwater runoff.

Although atmospheric sources are suspected as a significant contributor to nonpoint source loadings, this relationship is not well established. However, recent TBEP studies have indicated that atmospheric deposition is a significant source of nutrient loading to Tampa Bay, contributing almost 30 percent of the TN and slightly over 30 percent of the TP from direct deposition to the open water alone (Zarbock *et al.* 1996), in addition to significant amounts of contaminants (Frithsen *et al.* 1995). In that case, the atmospheric deposition loads are accounted for by the EMC values used to estimate nonpoint source loads, with the exception of the load deposited directly in open water.

The average annual TN load to Middle Tampa Bay for the period 1992-1994 was estimated at approximately 306 tons/year (Zarbock *et al.* 1996). Based on the 306 ton load to Middle Tampa Bay's 115-square mile area, an order-of-magnitude estimate of the annual atmospheric deposition load to the open water is approximately 16 tons/year, or about 4 percent of the TN loading for the LMR watershed. This small contribution is mainly a function of the relatively small open water area of the Cockroach Bay Aquatic Preserve.

Sources of atmospheric deposition loads include stationary (power plants, industrial sites, WWTP, etc.) and mobile (automobiles) sources. It has been estimated that the ratio of stationary to mobile contributions to local atmospheric emissions, which contribute to local deposition, is approximately 70:30 in the Tampa Bay area, almost the reverse of the national average (PBS&J 1999). However, proportions of atmospheric loading originating locally and imported from distant sources, potentially hundreds of miles away, cannot be estimated. It should also be noted that the Little Manatee River/Cockroach Bay system is located close to the TECO Big Bend site and the FP&L Point Manatee electric generating stations. Developing methods of identifying local and distant sources of atmospheric deposition loading is a current topic of research in Florida and across the country.

10.4.4 Septic Sludge and Wastewater Residuals

Septic sludge and wastewater residuals are from septic tank and WWTP operations and are typically disposed of by land spreading on agricultural land, usually pasture or range. Ayres Associates (1995) completed a study for SWFWMD SWIM program in which the potential nutrient loading to surface water bodies resulting from current sludge spreading practices in the Tampa Bay area were calculated. Two wastewater residual sites and one septic waste application site located in the LMR watershed were identified as inactive after 1993. Three active wastewater residual application sites were also found in the watershed in the Wimauma area. Potential loadings to surface waters from these sites were classified as medium, based on five relative loading classifications. This suggests that bio-solids application in the LMR watershed probably contributes to nutrient loadings. Although the magnitude of that application has not been estimated, the load is expected to be small when compared with nonpoint loads.

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CHAPTER 11

WATER QUALITY TREATMENT LEVEL OF SERVICE

11.1 OVERVIEW

Based on the results of the pollutant loading and removal model (Chapter 10), a water quality treatment level of service was established for each subbasin within the LMR watershed. The results of this analysis can be used to assign priorities at a subbasin level for the implementation of water quality improvement alternatives in the watershed.

Water quality treatment levels of service (LOS) were applied to this watershed study to provide comparisons of existing and proposed stormwater treatment conditions to pollutant loading goals. A pollutant load reduction goal was previously established for the Tampa Bay Watershed by the Tampa Bay Estuary Program (TBEP) (formerly the Tampa Bay National Estuary Program [TBNEP]). A reduction goal for nitrogen has been targeted as a priority due to the identification of nitrogen as the limiting nutrient for phytoplankton growth in the bay.

Excess nitrogen can stimulate algal growth and lead to reduced light penetration through the water column and subsequent shading and death of seagrasses. The nitrogen reduction goal is based on loads generated by several potential inputs including point sources, atmospheric deposition, and non-point source runoff from various land uses. The intent of the management effort by TBEP is to protect water quality and, ultimately, valuable natural resources in the bay (Tampa Bay National Estuary Program 1996). Currently, the goal for the Tampa Bay watershed is to maintain or decrease levels of nitrogen loads as development continues.

The modeling effort in this study focuses only on land use as a basis for evaluating pollutant loads. For comparison purposes, pollutant loads based on stormwater runoff from single family (low to medium density) residential land use were selected as the standard for comparison. In this manner, the calculation of pollutant loads is similar with the concept of standard residential unit (SRU) sometimes used for stormwater utility assessments.

The steps in the identification of a water quality treatment level of service designation for each subbasin are listed below.

1. Net pollutant loads were calculated for each pollutant of interest based on 1995 land uses and existing stormwater treatment BMPs (described in Chapter 10).
2. Benchmark pollutant loads were calculated for each pollutant based on the assumption that 100 percent of the watershed area was developed for low/medium residential land uses and there is no existing treatment.
3. Ratios of net load/gross load were calculated.

4. Criteria described below were applied to each subbasin and pollutant to determine the LOS for the subbasin.

Based on the following ranges, water quality LOS criteria were defined as a score from A through F:

- **LOS A**, net load equivalent to 20 percent or less of untreated single family residential. A LOS equal to A for a subbasin would indicate the presence of a high percentage of undisturbed natural systems, or high percentages of developed areas treated with BMPs capable of removing pollution levels to those representing natural systems. Areas where typical land uses (residential) exhibit stormwater treatment levels above the minimum required per 62-40.432(5) F.A.C. (Water Policy) would also receive LOS A.
- **LOS B**, net load equivalent to between 20 and 40 percent of untreated single family residential areas. A LOS equal to B would indicate the presence of BMPs with removal efficiencies consistent with those representing adequately designed and maintained conditions and a relatively even mix of developed and natural land uses.
- **LOS C**, net load equivalent to between 40 and 70 percent of untreated single family residential areas. A LOS equal to C would indicate the presence of treatment systems showing removal efficiencies consistent with those representing average to poorly maintained conditions and a greater percentage of developed versus natural land uses.
- **LOS D**, net load equivalent to between 70 and 100 percent of untreated single family residential areas. A LOS equal to D would indicate minimal treatment of sub-basin discharges and a relatively high percentage of developed land uses.
- **LOS F**, net load equal to or greater than 100 percent of untreated single family residential areas. A LOS equal to F would indicate no treatment for sub-basin discharges, or the presence of extensive areas of land uses producing larger pollution loads per unit area than typical residential land uses.

11.2 WATER QUALITY TREATMENT LEVELS OF SERVICE AND POLLUTANT LOAD CALCULATIONS

As indicated previously, benchmark pollutant loads were calculated for each pollutant based on the assumption that 100 percent of the watershed area was developed for low/medium residential land uses and no existing stormwater treatment existed in any of the subbasins. A summary of LOS and net loads for the entire basin is provided in **Table 11-1(a)** and **11-1(b)**.

Based on the difference between net loads (Table 10-7) and untreated single family gross loads (LOS Loads), reduction of pollutant loads from current land use conditions to simply achieve the benchmark water quality LOS conditions (low/medium density residential with no stormwater

treatment) would be high for nearly all 12 parameters. The smallest increase in treatment would be required for oil and grease (28 percent) while the largest would be required for BOD-5 (735 percent). Nine of the 12 parameters would require reductions up to 150 percent, including nitrogen. Considering existing stormwater BMP removal efficiencies, achieving these goals would require an extremely aggressive implementation program.

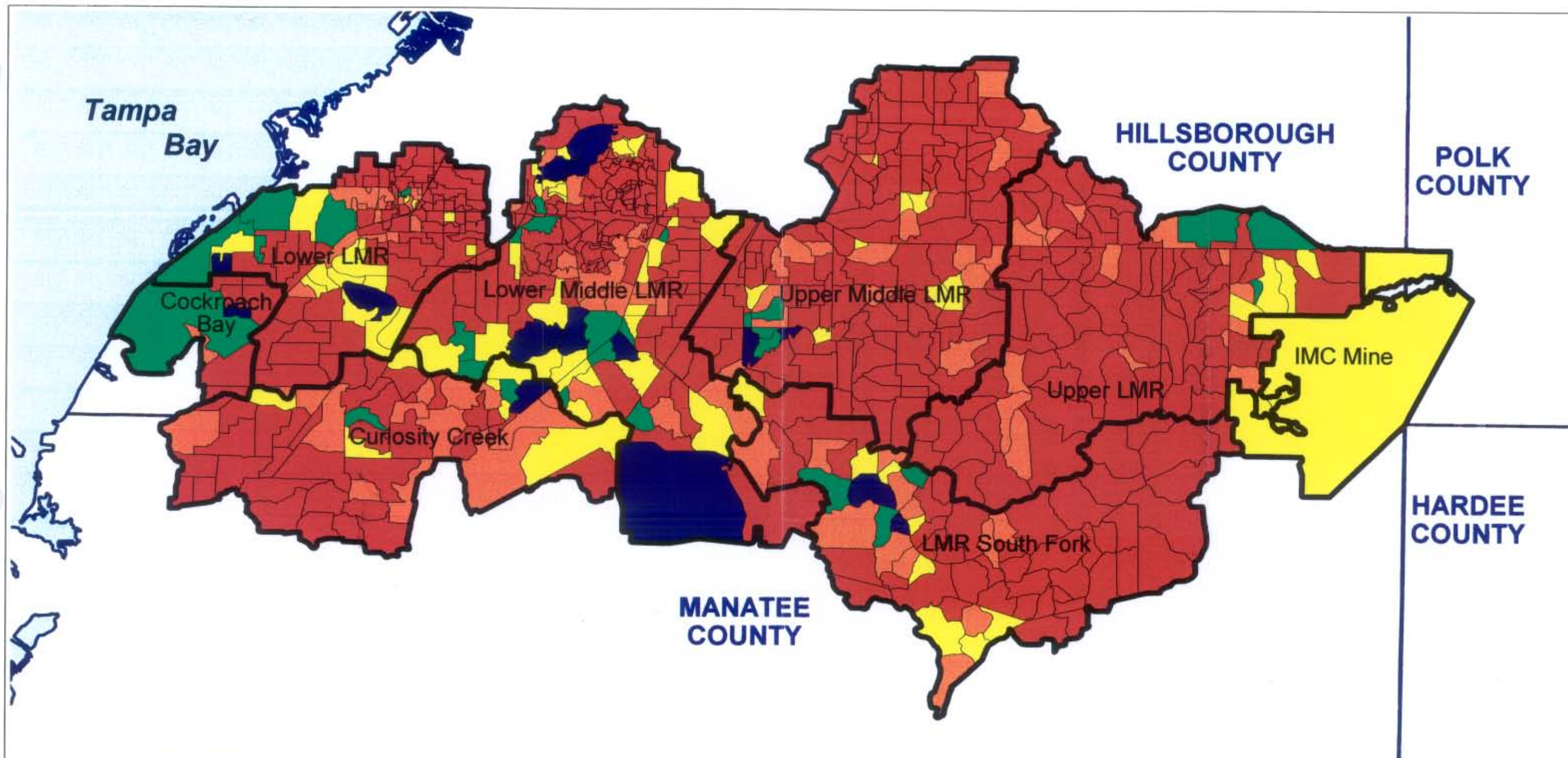
Table 11-1(a). Estimated water quality LOS (low/medium density residential, untreated) loads and percent reductions needed to equal LOS loads.							
Load	BOD5 (lbs/yr)	TSS (lbs/yr)	TKN (lbs/yr)	NO3+NO2 (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)	TDP (lbs/yr)
LOS Loads	630,249	11,974,727	681,929	177,100	859,029	252,730	177,730
Net Loads	4,629,789	5,605,566	647,728	223,727	873,106	563,758	297,866
Reduction needed to achieve LOS	735%	47%	95%	126%	102%	223%	168%

Table 11-1(b). Estimated water quality LOS (low/medium density residential, untreated) loads and percent reductions needed to equal LOS loads.					
Load	Oil and Grease (lbs/yr)	Cd (lbs/yr)	Cu (lbs/yr)	Pb (lbs/yr)	Zn (lbs/yr)
LOS Loads	680,669	630	8,193	5,042	13,865
Net Loads	190,985	3,388	11,344	5,871	7,840
Reduction needed to achieve LOS	28%	538%	138%	116%	57%

11.3 WATER QUALITY TREATMENT LEVELS OF SERVICE SCORES

The water quality LOS designations based on a comparison of existing land use conditions (net loads) to the low/medium density residential benchmark are listed in **Appendix E**. Overall LOS scores for the major subbasins in the LMR watershed are listed in **Table 11-2** and mapped in **Figure 11-1**. BOD-5 was ranked F in all subbasins, followed closely by phosphorus and cadmium, each with seven of eight subbasins receiving an F LOS value. The most frequent LOS score was F for all parameters combined (Figure 11-1, Table 11-2) which indicates that pollutant loads from existing conditions were equal to or higher than that of untreated residential land use. These results reflect the dominant agriculture land use throughout the watershed.

In addition, there is a conspicuous absence of treatment throughout the urban areas in the watershed, with the exception of Sun City and some of the newer developments. Interestingly, the northeastern portion of the watershed, where water quality in the Little Manatee River is



Department of Public Works
Stormwater Management Section



Water Quality LOS



Legend



2 0 2 Miles

September, 2000

County Boundary
Major Basin Boundary

Little Manatee River
Watershed Management Plan

Figure 11-1
Existing Water Quality
Treatment
Level of Service

PBS&J

considered good and indicative of less intense land use and more natural conditions, (see Chapter 7 for discussion), the treatment level of service remains low.

Of the eight major subbasins, there was a total of 53 F from a possible 96 scores (12 pollutants and eight major subbasins). Only TSS, oil and grease, and zinc pollutant parameters did not score an “F” in any of the eight subbasins.

The second highest reduction required to meet LOS goals was calculated for TP, which was exceeded only by 5 day BOD. The estimated water quality LOS reduction for TN loads was estimated to be 102 percent, compared with 223 percent for TP and 735 percent for 5 day BOD. TSS and TKN had the lowest LOS reductions among nutrients (47 percent and 95 percent, respectively), followed by NO₃+NO₂ (126 percent), and TDP (168 percent).

Of the eight major subbasins, six received “F” LOS ranks for eight of the 12 parameters examined. The IMC mining subbasin and Cockroach Bay were the only major subbasins to receive any “A” scores. Cockroach Bay ranked “A” for only oil and grease, while the mining subbasin scored “A” for TSS, oil and grease, as well as copper, lead and zinc.

Although there are few lakes in the LMR watershed, Lakes Wimauma and Carlton occur in closed subbasins and, based on the model, these areas are assumed to receive relatively high pollutant loads with little to no treatment and no flushing. As a result, continued loading to these surface waters could result in significant water quality degradation in the future if remediation measures are not implemented.

Importantly, the IMC mine and Cockroach Bay exhibited the best LOS rankings in the watershed and these results are somewhat consistent with previous studies in which water quality in the Ft. Lonesome area is considered good and water quality in Cockroach Bay is improving.

The predominance of F scores in the basins is a result of relatively high EMC values for relatively higher intensity land uses when compared with single family residential with no treatment. In addition, the large area of agriculture in the watershed (> 50 percent) characterizes the majority of the basins and also receives little or no treatment. As a result, LOS scores, which are based on the ratio between the loads in the target basin and single family residential loads, are high for most basins in the watershed. Higher runoff volumes characterize higher intensity land uses such as high density residential, commercial, and industrial. LOS scores reflect the difference between the higher intensity land uses and single family residential runoff volumes for nearly all land uses.

The pollutant examined are of concern in the Tampa Bay region as they relate directly to water quality, clarity, and public health goals established through the TBEP Comprehensive Conservation Management Plan (1996).

Table 11-2. Overall LOS scores among major subbasins.

Basin ID	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
Cockroach Bay	F	C	C	D	C	F	F	A	F	D	F	C
Curiosity Creek	F	C	D	F	F	F	F	B	F	F	F	C
IMC Mine	F	A	C	B	C	B	B	A	D	A	A	A
LMR South Fork	F	B	F	F	F	F	F	B	F	F	B	B
Lower Middle LMR	F	C	D	F	D	F	F	B	F	F	F	D
Lower LMR	F	D	D	F	F	F	F	B	F	F	F	D
Upper LMR	F	B	F	F	F	F	F	B	F	F	B	B
Upper Middle LMR	F	B	F	F	F	F	F	B	F	F	B	C

Efforts to reduce loading of these pollutants to the Little Manatee River, surrounding lakes, and groundwater should be incorporated into future management activities for the watershed. These efforts should include:

- implementation and enforcement of stormwater best management practices (BMPs - wet detention ponds, baffle boxes, etc.);
- source reduction (e.g., education programs for home and business owners concerning the need to reduce fertilizers and illicit discharges);
- improved wastewater treatment practices (extending centralized sewer systems to areas treated by on-site disposal systems or septic tanks); and
- restoration/conservation of natural lands and riparian buffer areas to reduce current and future pollutant loads.

CHAPTER 12

PUBLIC INPUT (FIRST MEETING)

12.1 MEETING MINUTES

The First Public Meeting for the Little Manatee River Watershed Management Plan was held on October 12, 2000 from 6:30 pm to 8:30 pm at the Ruskin Elementary School Cafeteria. The purposes of the meeting included:

- Acquainting local residents with the project objectives;
- Working with residents to identify issues that will help formulate solutions;
- Informing residents of methods to participate in development of the plan; and
- Gathering and sharing information with surrounding communities.

The overall meeting followed an “open-house” format. Citizens were greeted at the door and were given a brief overview of the meeting format. Handout materials included a project fact sheet, frequently asked questions, relevant contact information and comment forms. A brief introduction to the audience announcing the team and meeting format was given once most of the meeting attendees arrived. Several project displays regarding flood protection, water quality, water supply, conservation, and habitat issues were set up to address specific questions or concerns in the watershed. A brief video discussing the goals of the watershed and providing general information was presented.

Following the presentation an open discussion took place in order to allow questions and comments regarding the overall project objectives. The goal of the open discussion was to more clearly communicate the project objectives and to help the project team discover any new problem areas or possible solutions. The meeting also included individual breakout sessions where the public has an opportunity to review displays and discuss problems and potential solutions one-on-one. A total of 43 attendees signed in on the forms provided to document attendance at the First Public Meeting. The Hillsborough County meeting notice, meeting agenda, sign-in-sheets, handouts and public comment forms are included in **Appendix K**.

12.2 COMMENTS AND RECOMMENDATIONS

Comments from citizens regarding observations on flooding, water quality or habitat issues were encouraged. The comment form was designed for the public to give any additional comments or concerns they felt needed to be addressed. Listed below is a summary of the written comments received through comment forms distributed at the First Public Meeting. A response to how the

LMRWMP addressed each comment is also presented below.

Comment: *Flooding problem on West Shellpoint Road, west of Janie Street West.*

Response: Flooding improvement projects have been proposed on Shellpoint Road as part of Project 3.1. Secondary drainage should also improve as a result of implementing this project.

Comment: *Yard flooding problem at the corner of 5th Street SW and Dickman Drive SW.*

Response: Proposed projects will reduce peak stages throughout the watershed. However, those projects will not significantly improve conditions created by tidal surges within the floodplain. It is generally not cost-effective to provide drainage relief for low-lying, tidally influenced area through increased drainage conveyance. Assistance is available through programs such as flood proofing or property relocation. Improved system maintenance, which is also addressed as part of this project, will also increase conveyance of floodwaters. . To assess some of the problems, the computer model was developed to simulate the system under a high tide condition.

Comment: *Development activities create drainage problems for surrounding residents.*

Response: Hillsborough County and the Southwest Florida Water Management District (SWFWMD) permit new construction activities in the watershed. Current permitting requires that post-construction peak discharge rate for the 25-year, 24-hour storm event must be less than or equal to the pre-construction conditions. Prior to current regulations, upstream and downstream impacts may not have been adequately addressed. The computer model created as part of this project will allow regulators to ensure that no impacts occur upstream or downstream of proposed new developments.

Comment: *Flooding problems exist from high tides or tidal surges.*

Response: Proposed projects will reduce peak stages throughout the watershed. However, those projects will not significantly improve conditions created by tidal surges within the floodplain. It is generally not cost-effective to provide drainage relief for low-lying, tidally influenced area through increased drainage conveyance. Assistance is available through programs such as flood proofing or property relocation. Improved system maintenance, which is also addressed as part of this project, will also increase conveyance of floodwaters. . To assess some of the problems, the computer model was developed to simulate the system under a high tide condition.

Comment: *Improve maintenance of existing systems to decrease flooding problems.*

Response: Maintenance of the existing systems has been reviewed as part of the watershed plan. An operations and maintenance plan for the system and recommendations for improvement are in Appendix G of the final report and discussed at the final public meeting.

Comment: *Restore and maintain public lands.*

Response: Conceptual restoration and acquisition project alternatives have been proposed as part of the watershed plan. The plan shall include proposals to continue identification and acquisition of Environmental Lands Acquisition and Protection Program (ELAPP) lands under the existing program. Acquisitions should continue to focus on purchases that are adjacent to the river and tributaries. Acquisitions should focus on wildlife corridors and connections among existing acquisitions. An operations and maintenance plan of the system is outlined in Appendix G of the final report.

Comment: *Maintain Cockroach Bay Aquatic Preserve*

Response: The watershed plan encourages continued protection of Cockroach Bay through the *Cockroach Bay Aquatic Preserve Management Plan* (Southwest Florida Water Management District, 1997).

Comment: *Remove exotic species.*

Response: Removal of exotic species, replacement with native species, followed by maintenance is proposed on Environmental Lands Acquisition and Protection Program (ELAPP) lands and specifically for proposed projects natural systems projects described in Chapter 13.

Comment: *Keep Little Manatee pristine and natural.*

Response: Requirement of a 100-foot buffer along river and primary stream channels to protect the river from agriculture and development impacts is proposed as part of the watershed plan.

Comment: *Establish minimum flow levels.*

Response: The Southwest Florida Water Management District has been assigned the task of establishing minimum flow levels, which are directed to establish the amount of water that is needed in a lake, river, or aquifer to maintain adequate ecological conditions.

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