SILVER / TWIN LAKES WATERSHED MANAGEMENT PLAN

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EXECUTIVE SUMMARY

The Silver / Twin Lakes watershed drains approximately 0.8 square miles of land located in central Hillsborough County. The watershed is generally bordered by Habana Place and White Trout Lake to the north, Armenia Avenue to the east, Kirby Street to the south and Himes Avenue to the west. The watershed can be further divided into 103 smaller subbasins ranging in size from 1.24 to 50.44 acres. The runoff of the entire watershed ultimately discharges into the Hillsborough River through a collection of ditches originating in Kirby Creek. The watershed can be characterized as urban, being dominated by residential land uses throughout the majority of the area with commercial and other non-residential land uses being found along the main roads of Busch Boulevard and Waters Avenue. Of the total 506 + acres in the watershed, residential land uses constitute the majority of the land uses with about 68.94 % or 348.99 acres. There are no light industrial or extractive / mining land uses to be found within the watershed. For the natural systems, there are no upland areas remaining nor are there any forested wetlands. This study has been broken up into two broad categories, flood control / water quantity and natural systems / water quality. They are generally discussed in the section below.

Chapter one provides a short introduction and describes the project's objectives and organization.

The second chapter, Watershed Description, discusses the many facets of the watershed. These include climate, soils, physiography and hydrology, geology and hydrogeology and existing and future land uses. The geology and hydrogeology portion briefly discusses the Floridan and surficial aquifers. Numerous figures depict these many physical features.

Chapter 3 discusses the Major Conveyance Systems. In this chapter, the major conveyance systems of Silver / Twin Lakes watershed are identified. There are three systems: Little Twin Lake system, Twin Lake system and Silver Lake system. Major water features, such as lakes, ponds, and ditches, in each system are described.

Hydrologic and Hydraulic Model Methods are reviewed in the fourth chapter. Major parameters are introduced. Hillsborough County’s version of the Storm Water Management Model (HCSWMM) is used. In this model, the rainfall-runoff procedure is simulated by the NRCS-CN method, while the hydraulic part is simulated by St. Venant equations, which are solved by the finite difference method.

In chapter 5, Model Calibration and Verification, the procedure of model calibration and verification is discussed. Since there is no observed history information available, the regression method was used to calibrate the peak discharge.

For the Existing Conditions Flood Level of Service chapter, six storm events (2.33 year, 5 year, 10 year, 25 year, 50 year, and 100 year, respectively) are simulated with the model calibrated and verified in chapter 5. The model results were then compared with Hillsborough County flood level of service requirements to find out the Silver / Twin Lake watershed Level of Service or LOS. The results show that this watershed satisfies the requirements of a LOS B for a 25-year storm event.

Chapter 7 describes the Existing Water Quality Conditions. In it, the existing data from LakeWatch and the Environmental Protection Commission of Hillsborough County is presented. The LakeWatch data for Silver and Twin Lakes is discussed in detail with possible explanations for existing readings given. Both lakes are just barely staying within the "good" range for Trophic State Index (TSI), with a slightly improving trend indicated for water quality. Areas of concern for the watershed include the development of lake management plans for the major lakes, additional protection through regulation and education, achievement of Tampa Bay Estuary program goals and bacteriological studies.

The Existing Natural Systems Conditions are summarized in chapter 8. The chapter discusses the condition of the watershed prior to development (pre-1900) and compares it with the watershed as it exists today. Existing community types are described in detail, including what potential plants, animals and listed species are or could be expected to be found. Natural systems areas of concern are habitat loss due to fragmentation and degradation, the introduction of exotic and nuisance species, the relation between the loss of buffers and water quality, the alteration of historic flows to wetlands and restoration of natural systems.

Chapter 9 covers water supply issues. In it, groundwater use is discussed for each of the Southwest Florida Water Management District permits issued in the watershed. Surface water use is briefly addressed, as well. Water supply areas of concern relate to impacts due to withdrawals, aquifer recharge, minimum flows and levels and water reuse and conservation.

The Pollutant Loading and Removal Model (PLRM) is discussed in chapter 10. The model's several components and use is briefly described. The model takes land uses, hydrologic soil groups and land use information to produce individual "elements" that the model uses further. These elements are then subjected to a rainfall amount and run-off coefficients are used to determine the amount of stormwater run-off generated. An event mean concentration is applied to each of these elements and gross pollutant loads are produced. Conversely, a best management practice or BMP can be applied to the same element to produce the net load. A BMP is a pollutant-reducing factor such as a stormwater pond or swale system. The model uses the Environmental Protection Agency's Simple Method to determine non-point pollutant loads. Net pollutant loads by subbasin are computed and summarized in Table 10.4.

Chapter 11 addresses the existing water quality treatment level of service for the watershed. This is another function of the PLRM. The WQTLOS is determined by comparing a particular subbasin's existing net pollutant load against the non-treated pollutant load of the same subbasin assuming that it is 100 % low to medium density residential land use. Ratios are obtained that determine the WQTLOS in terms of % load when compared to the benchmark value.

The Alternative Analysis is done in chapter 13. In this chapter, alternatives were proposed to solve the potential flooding and/or safety problems. The flood control alternatives are:

- regular channel maintenance for the outfalls of Silver and Twin Lakes, and
- culvert replacement on Kirby Creek at Humphrey Street

The water quality control alternatives are:

- creation of bioretention areas around each of the watershed's major lakes.

In chapter 15, the improved level of service (LOS) for the Silver / Twin Lake watershed is discussed based on the alternative analysis and recommendations as described in Chapter 13.

Chapter 16 identifies the final recommended projects along with its estimated budget. Again, these projects are regular channel maintenance of Kirby Creek and Silver Lake outfall and the replacement of the culvert at Humphrey Street.

Chapter 18 is the maintenance plan for the watershed.

The list of final recommendations can be found in chapter 19.

Water Quantity / Flood Control Recommendations

One purpose of the flood control portion of the study is to develop a computer simulation model of the Silver / Twin Lakes watershed under current conditions. The calibrated model is also used to develop a Watershed Management Plan (WMP) for the watershed. The objective of the plan is to determine level of service for existing stormwater infrastructure and to develop alternatives and recommendations for improving the conveyance system to eliminate any flooding situations.

There are three target areas for the recommended improvements in this study based on model prediction, verification of field investigation and public input in the way of complaints received by this section during the El Nino event of 1997/98.

- Regular maintenance of the Silver Lake Outfall system between North Habana Avenue and North Saint Peter Avenue

- Regular, environmentally sensitive maintenance of the Twin Lake Outfall (Kirby Creek) for its entire length within the County portion of the watershed.

- In kind replacement of the 54" RCP on Kirby Creek at Humphrey Street, primarily for reasons of safety.

Water Quality / Natural Systems Recommendations

The water quality / natural systems portion of the plan evaluates the existing conditions for both criteria. Water quality data was gathered primarily from the LakeWatch data that has been collected in the watershed since 1996. Other data reviewed is from the Environmental Protection Commission of Hillsborough County. Their data was compiled from the citizen's complaints that have been generated in the watershed. Review of the LakeWatch and EPC data shows that there is a steady and slight improvement of the water quality of Silver and Twin Lakes. The measure of water quality used is the Trophic State Index (TSI). This system is used to directly compare one waterbody to another using the parameters of chlorophyll a, total phosphorus and total nitrogen. A TSI less than 45 indicates good water quality, between 45 and 60 is fair and greater than 60 is considered poor. For years where the TSI could be calculated, it was in the good range, but on a few occasion the TSI fell into the fair range for both lakes. The water quality appears to be continuing on a trend of slightly improving water quality. Water quality areas of concern are the protection of the watershed's lakes and streams through education and regulation. Low impact development measures should be explored. The County should continue in its efforts to "hold the line" on nitrogen loadings to the Bay.

General Recommendations

1. The plan should be updated on no less than a five-year cycle with public input as an intricate part. This continual updating will allow for the incorporation of the latest information and refinement of existing procedures and projects.

2. The plan should be reviewed and approved by regulatory agencies with jurisdiction in Hillsborough County. These agencies should also be approached for assistance with implementation and enforcement.

3. Retrofitting of existing land uses should be explored. As many of the water quality BMP alternatives presented in Chapter 13 should be used as possible. Bioretention areas

especially should be investigated.

4. All vegetation maintenance activities should be designed to remove the vegetation from the system. Cutting or herbiciding vegetation merely contributes to muck build up and releases nutrients back into the system. Equipment should be purchased or developed to “bag” cut vegetation when mowing ditches or swales where the cut materials may otherwise be transported downstream to a receiving waterbody. Aquatic vegetation management should likewise focus on removal of the vegetation from the system by mechanical harvesting. This will remove nutrients from the system, minimize muck/sediment buildup, and minimize mosquito problems. Efforts should be made to compost these materials and reuse as fertilizer or mulch.

5. Water flow information should be gathered in conjunction with any sampling information collected in Kirby Creek. This will aid in future pollutant loading calculations.

6. This watershed plan should be continuously updated with "As-Builts” submitted electronically by the developer.

Specific Water Quality Recommendations

1. Use the Stream WATERWATCH program to assist in developing land use specific EMCs that can be used to “calibrate” and verify the pollutant loading and removal model. Emphasis should be put on Kirby Creek. This recommendation should be implemented as soon as possible after acceptance of this watershed plan. A minimum of two sites should be chosen.

2. The LAKEWATCH program should continue to expand its monitoring program in the watershed and provide an important water quality and aquatic plant species baseline for this area.

3. The Adopt-A-Pond program has equipment that should be used to aid in specific small-scale restoration programs using their criteria.

4. An inspection system should be implemented as part of the maintenance plan that will aid in the detection of illicit discharges into the County’s stormwater system. This system should be designed to maximize the credits to the County under the Federal Emergency Management Agency’s Community Rating System.

5. A watershed specific septic tank study should be completed which identifies the location of septic tanks, assesses their impacts on water quality, and recommends management

techniques to improve their efficiency. The Planning and Growth Management Department has proposed such a study countywide, and this study should be completed.

6. Assimilative capacity studies should be conducted on lakes in this watershed in order to determine proper regulatory needs for protection of the lakes. Once the assimilative capacity studies are completed, the information should be used to develop a lake management plan for each lake.

Natural Systems

1. Programs such as the Pepper Busters and County's Adopt-A-Pond should be expanded in the watershed to aid in controlling nuisance vegetation. Plants from the Exotic Plant Pest Council's category one list should be targeted. A program should be instituted for single family homeowners, that has as an incentive, free access to dumpsters or special garbage pick-up for large amounts of nuisance vegetation that they have removed.

2. Upland natural systems have been eliminated from the watershed. The agricultural parcel in the watershed should be purchased by the County and a restoration project should be undertaken within five years of the approval of this plan. This area should be restored to the habitat that was originally on the site.

3. Existing areas of natural buffers such as wetland conservation area setbacks should be identified and preserved. Projects similar to the Delaney Creek Restoration project should be explored for Kirby Creek that will take into account the proposed maintenance schedule.

Water Supply

1. Consideration should be given to the aquifer recharge potential when siting stormwater treatment systems. Care should be taken to avoid moving water from an area of high recharge potential to an area of low potential.

2. Water conservation and the use of reclaimed water should be encouraged through educational programs including LAKEWATCH and Stream WATERWATCH.

Pollutant Loading and Reduction Model

1. **Benchmark –** The appropriateness of low / medium density land use is justified; however, the value used to model the loading may have been somewhat low. Some studies have found loadings almost twice as high as those used in the model, but values used were from direct measurements done in Hillsborough County. Using higher

numbers would raise the benchmark and could have the effect of raising some LOSs.

2. **BMPs** – One of the model's shortcomings is that it does not allow the use of multiple BMPs. In addition, literature values for multiple BMPs are extremely difficult to find or extrapolate. Values should be developed for use in the model that can accommodate multiple BMPs.

3. One of the lessons learned in using the PLR model is that impervious surfaces are the main component in the creation of pollutant loads. A method should be developed to track the amount of impervious surface in the watershed. The County has minimal parking requirements for specific land uses that are governed by zoning. The Planning and Growth Management Department should revisit these requirements and do whatever possible to reduce these requirements or amend them to encourage the use of other alternatives where appropriate.

4. Another problem in using the model is in the determination of pollutant loads for future proposed land uses. This drawback is due to the incompatibility in translating the existing land use based on SWFWMD's application of FLUCCS codes into the future land use designations of the Planning Commission, which does not use FLUCCS codes. The Planning Commission should be urged to adopt the FLUCCS code in predicting future land use or develop a system that is directly comparable to FLUCCS. Presently the Planning Commission's system groups diverse land uses such as residential and commercial into mixed urban uses. This should be done prior to the next updating of this portion of the watershed plan.

5. The County should immediately embark on a program to develop as many specific EMC values as possible for land uses to be used in future applications of the model.

Level Of Service

1. To increase the water quality treatment level of service, stormwater ponds built in this watershed should be the Conservation Wet Detention design to maximize pollution load reductions.
2. A project / program should be started within two years of approval of this plan that would create a series of bioretention ponds along the shores of both Silver and Twin Lakes. These lakes are on the verge of passing from the "good" to "fair" range in terms of trophic state index and it will be easier to stop this drop in water quality at this point in time than it will several more years from now.

Revisit Regulations

1. Land Alteration and Landscaping rules should be revised to include larger buffers around wetlands and waterbodies. Studies have demonstrated that larger setbacks provide better protection by allowing some treatment of stormwater run-off prior to its introduction into the receiving waterbody. Variances should be either eliminated or allowed uses should be curtailed. Activities such as grading should not be allowed. Construction and other related activities should also be limited; no impervious areas should be allowed. It has been shown that as little as 10% impervious area within a watershed can have serious detrimental impacts on aquatic ecosystems.

2. One of the projected land use changes in the watershed is the conversion of the agricultural areas to high-density residential housing (greater than 5 units per acre). These housing densities should be reduced around wetlands and waterbodies for the same reason setback variances should be limited. This will have the effect of reducing impervious areas around these sensitive habitats. Studies have shown a wide range of pollutant loading for this land use category. Some of these loadings can approach those expected for more intensive land uses such as institutional and commercial.

3. The flooding caused by the recent El Nino events, primarily in 1998, demonstrated the damage that can be caused by unchecked building in the 25 and 100-year floodplains. Regulations should seek to avoid encroachment into these natural areas and allow them to function as the flood storage areas. By preserving these naturally occurring areas, “free” stormwater functions are provided that saves the County money.

4. Clearly, wet detention times must be increased. Recent studies show that a residence time of 14 days in conjunction with planted littoral areas may be necessary to provide adequate treatment. The SWFWMD should be encouraged to raise their standards, and failing this, the County should implement stricter standards.

5. Sedimentation and erosion has been identified as a significant source of pollutant load in the watershed. PGMD should reassess the need for mass grading of projects over 2 acres. Developers should be encouraged to grade small areas at a time rather than clearing entire project areas at one time. Erosion control techniques should required in all construction plans and then be inspected during construction in addition to the requirement of inspection prior to construction to ensure their continued maximum efficiency and to comply with the County’s National Pollutant Discharge Elimination System (NPDES) permit.

6. Low Impact Development techniques should be required in this watershed to minimize the volume of runoff and therefore the total pollutant load. As part of this recommendation, a team of representatives from the various County and State regulatory agencies as well as the regulated community should be immediately formed to develop a Hillsborough County Low Impact Development Technical Manual and incentives to carry out its recommendations once it has been developed.

7. All CIP’s should include life-cycle costing, a maintenance plan, and mitigation plan if appropriate for the facility. In addition, sediment transport has been a problem in the watershed and sediment control devices, such as sumps, should be incorporated into as many projects as possible.

8. Upon adoption of this plan, all CIP projects should incorporate water quality BMP’s into their design. The type of treatment used shall be based on the LOS parameter contributing the greatest load in the subbasin that the project(s) is being constructed. This aspect should be tracked so that a number of parameters can be addressed with subsequent projects and that a single parameter is not addressed by multiple projects. A matrix or flowchart should be developed that will aid the designers in choosing the appropriate parameter to be addressed and using the best BMP(s) to achieve that goal.

INTRODUCTION

This report was prepared by the Stormwater Management Section of the Hillsborough County Public Works Department to provide a brief overview of existing water quantity and environmental conditions within the Silver / Twin Lakes watershed and to allow for informed decision-making when evaluating specific stormwater projects. Environmental issues associated with the proposed flood control projects and general recommendations to address watershed areas of concern are also discussed.

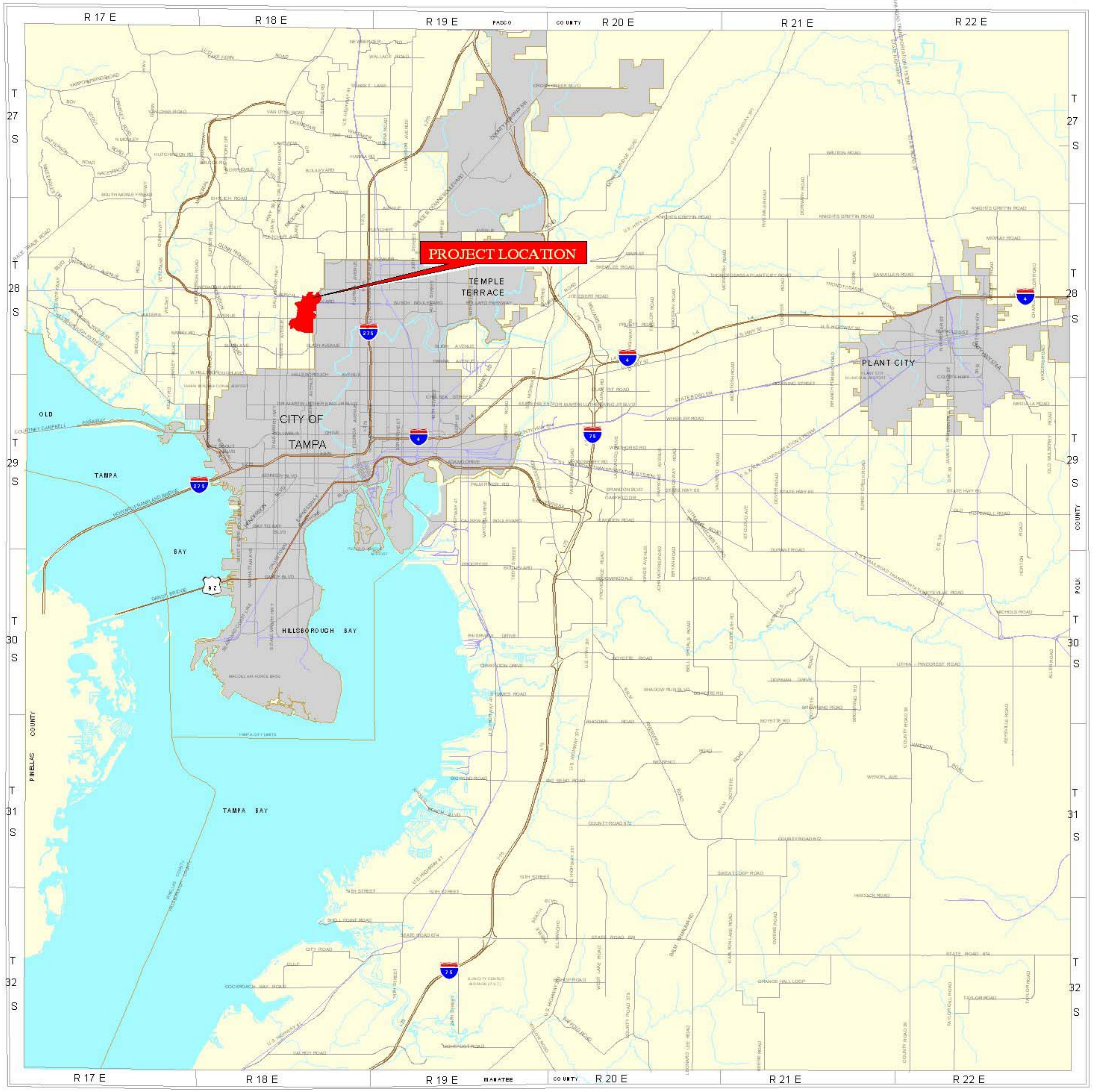
1.1 OVERVIEW

The Silver / Twin Lake watershed is located in central Hillsborough County in an area in which a number of land and water management issues are currently being addressed by state, regional and local government agencies (see **Figure 1-1**). The watershed can be characterized as urban and contains approximately 0.8 square miles or about 506.19 acres. The basin study area is roughly bounded to the north by Habana Place and White Trout Lake, to its eastern side by the Armenia Avenue, along its south side by Kirby Street and on the west side by Himes Avenue. Ultimately, water from this basin discharges into Tampa Bay via the Hillsborough River. This is not a direct connection, but water from the watershed eventually makes it to the river through a series of ditch systems that winds its way through the City of Tampa.

The watershed's climate is subtropical. The basin's soils are fairly evenly divided between well drained and poorly drained soils according to the classification system developed by the United States Soil Conservation Service (SCS) for Hillsborough County. The better drained soils occupy the central and eastern portions of the watershed; while the poorly drained soils are found primarily in the basin's northeastern and southeastern quadrants and in a small pocket surrounding Silver Lake. The Silver / Twin Lake watershed is contained within the Gulf Coast Lowlands portion of the Midpeninsular Zone, one of the three geomorphic divisions of Florida (White 1970). The watershed has 2 major outfalls and 3 major conveyance systems.

Existing land uses within the watershed boundaries are devoted primarily to residential housing with the largest amount being high density. For the most part, commercial land uses are confined to areas immediately adjacent to the two largest roads in the watershed, Busch Boulevard and Waters Avenue. Given the urban nature of the area, not many land use changes will be anticipated for the future. Predicted changes center primarily around the conversion of single family residential land uses into non-residential areas.

Because this area was developed prior to the establishment of the majority of present day



SILVER TWIN LAKE AREA STORMWATER MANAGEMENT MASTER PLAN DECEMBER 2000

LEGEND

- SILVER TWIN LAKE AREA
- MAJOR ROAD
- RAIL ROAD
- MINOR ROAD
- CITY BOUNDARY
- WATER FEATURES

FIGURE 1-1
PROJECT LOCATION MAP

Hillsborough County
Florida

Department of Public Works
Engineering Division
Stormwater Management Section

N

INSERT FIGURE 1-1 LOCATION MAP

environmental laws, very few natural systems exist within the watershed. The majority of these areas can be found surrounding the watershed's lakes. The lack of these natural systems means

few listed species can be expected to be found in the basin. The only expected species will be primarily wading birds, which still have the ability to utilize the wetland areas. No Significant or Essential Upland Habitat as defined by the Hillsborough County Land Development Code (LDC)
exists within the watershed. Those natural areas that do exist have had significant habitat loss due to at least three factors. These are degradation and fragmentation of the areas through development and the introduction of exotic and invasive plants and animals.

In order to better assess the impact of stormwater runoff to these systems, a pollutant loading model has been developed to assist in the pinpointing of trouble spots both in the present and in the future.

While there have been no long term water quality studies on any of the water bodies in the watershed, information for this report was gathered from other types of environmental studies or samplings by governmental agencies. Volunteers for Hillsborough County's LakeWatch program started sampling Silver Lake in 1994 but sampling has only been done on a regular basis since 1996. Twin Lake has also been sampled regularly since 1996. The watershed's two smaller lakes, Lake Dorothea and Hidden Lake do not presently have a LakeWatch volunteer on them.

1.2 PROJECT OBJECTIVES

The objectives for this study were to summarize existing information on flood control and environmental conditions in the Silver / Twin Lakes watershed, identify potential environmental issues associated with proposed flood control projects and to develop general recommendations to address areas of concern within the watershed. The study is, therefore, further subdivided into existing and proposed conditions. The existing conditions chapters 1 through 11 contain a general description of the watershed including physical parameters such as the significant natural features such as lakes, streams, etc.; climate; topography; soils; physiography, hydrology, geology and hydrogeology, and land use. It also allows for at least one public meeting for input on the existing conditions and / or the proposed alternatives. In the proposed conditions chapters 12 through 19 are the alternatives analysis for the projects being proposed as solutions, the proposed level of service and preferred alternatives, recommendations, a maintenance plan and a list of final recommendations. This section also provides for at least one public meeting to present the plan's final recommendations.

1.2.1 Water Quantity Objectives

The plan is divided into two broad areas. The first is the water quantity portion, which includes the use of Hillsborough County's version of the Storm Water Management Model (SWMM). The second portion is on the water quality and natural systems issues and will be discussed in the following section. The SWM model is used to predict flood water levels under various storm events and to provide effective flood control protection for public and private property by identifying flood problem areas and design levels of service for existing and future conditions.

1.2.2 Water Quality / Natural Systems Objectives

Water quality and natural systems are the second portion of the plan. As with the water quantity section of the plan, this component is divided into existing and proposed conditions.

1.2.2.1 Existing Conditions

As part of the existing conditions evaluation, any existing water quality information for the watershed's lakes and streams is collected and analyzed. Information on the natural systems is also gathered. This information includes the Southwest Florida Water Management District's data on the possible habitat types that existed prior to 1900 based on interpretation of soils information; present day floral and faunal communities and listed species. Water supply is another aspect investigated. A GIS-based pollutant loading and removal model is employed to determine annual and seasonal pollutant loading and the existing water quality treatment level of service. There will be at least one meeting that will be used to present all of these findings to the public and give them an opportunity to comment and give other input.

1.2.2.2 Proposed Conditions

Chapters 12 through 19 contain the alternatives analysis for the projects being proposed as solutions, the proposed level of service and preferred alternatives, recommendations, a maintenance plan and a list of final recommendations. This section also provides for at least one more public meeting to present the plan's final recommendations.

1.3 PROJECT ORGANIZATION

This report is organized into nineteen chapters, each of which address specific portions of the study:

! Chapter 1 provides an introduction and an overview of the report along with a list of objectives.

! Chapter 2 provides an overview of the watershed including major environmental features related to stormwater management.

! Chapter 3 describes the basin’s major conveyance systems.

! Chapter 4 explains the Hydraulic / Hydrologic Model Methodology.

! Chapter 5 characterizes the Hydraulic / Hydrologic Model Calibration and Verification.

! Chapter 6 describes the existing conditions flood level of service along with analysis and designations.

! Chapter 7 discusses existing water quality conditions in the watershed.

! Chapter 8 summarizes existing conditions relating to natural systems.

! Chapter 9 discusses existing conditions affecting water supply, including ground and surface water use.

! Chapter 10 discusses the pollutant loading model, its use and results.

! Chapter 11 provides a summary of the existing conditions water quality treatment level of service.

! Chapter 12 provides for a public meeting for input on the existing conditions portion of the watershed management plan.

! Chapter 13 discusses flood control and water quality alternatives.

! Chapter 14 provides for a second public meeting to address issues and concerns raised in the previous meeting.

! Chapter 15 lists the preferred alternatives including the proposed levels of service for flood control and water quality.

! Chapter 16 puts forth flood control and water quality recommendations.

! Chapter 17 provides for the last public meeting for review of the final draft.

! Chapter 18 outlines the maintenance plan for the watershed.

! Chapter 19 includes a list of recommended projects.

Exhibits

! Exhibit 5-1 shows existing connectivity diagrams.

! Exhibit 5-2 illustrates the Thiessen Method / Gauge and sampling locations.

! Exhibit 6-1 contains water surface profiles.

! Exhibit 6-2 gives historic flooding information.

! Exhibit 6-3 provides existing conditions for flood control level of service.

! Exhibit 6-4 defines the 100-year floodplain.

! Exhibit 6-5 (optional) delineates the 25-year floodplain.

! Exhibit 13-1 is the alternatives location map.

! Exhibit 15-1 shows proposed flood control level of service.

! Exhibit 15-2 provides proposed water quality treatment level of service.

Appendices

! Appendix 11-A summarizes water quality by subbasin.

! Appendix 10-B lists runoff coefficients for the Pollutant Loading and Removal Model.

! Appendix 13-A projects cost estimates for project alternatives.

! Appendix 18-A lays out the proposed Monitoring plan.

WATERSHED DESCRIPTION

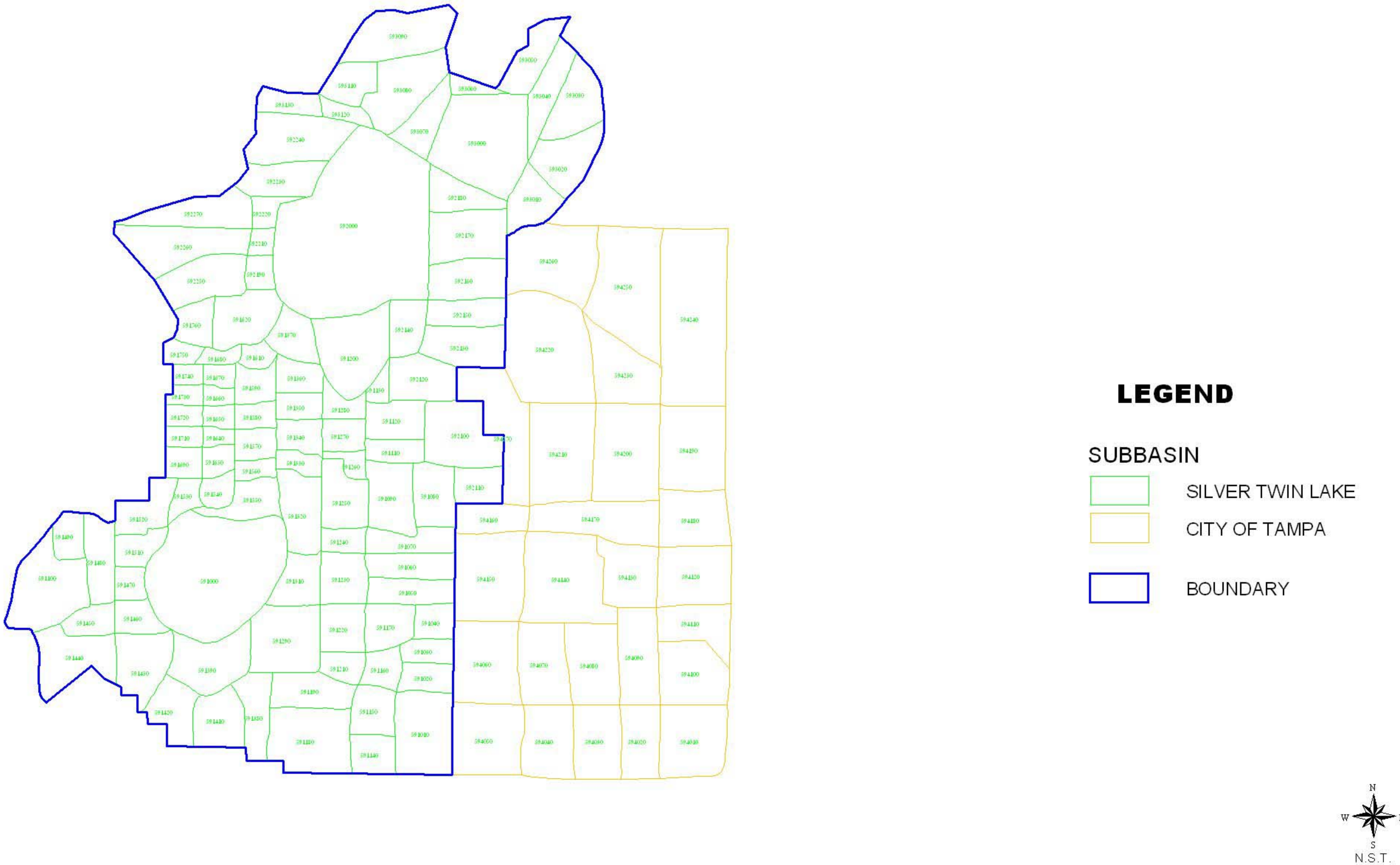
2.1 OVERVIEW

The Silver / Twin Lakes watershed drains an area of approximately 0.8 square miles or 506.19 acres in central Hillsborough County. The watershed can be characterized as urban, being made up primarily of residential land uses. The basin study area is roughly bounded to the north by Orange Grove Drive and White Trout Lake, to its eastern side by the Tampa City limits, along its south side by Kirby Street and on the west side by Dale Mabry Highway. Additionally, several large roads, including Busch Boulevard and Waters and Habana Avenues, bisect the watershed. The basin, shown in **Figure 2-1**, is composed of 103 smaller units or sub-basins ranging in size from 1.24 to 50.44 acres. Topography varies from a high of 78-79 feet National Geodetic Vertical Datum (NGVD) in the northeastern portion of the watershed to a low of about 30 feet NGVD in the area of Silver Lake and is depicted in **Figure 2-2**.

The major natural features of the watershed are Silver and Twin Lakes. Twin Lake, the larger of the two, comprises 27.05 acres of its 50.44 acres drainage basin. Currently no information is available on its maximum, minimum or mean depths. The water surface elevation is about 30 feet NGVD. Silver Lake is the other major waterbody found in the watershed. The lake occupies 18.69 acres of its 30.62 acre basin. The lake's depth varies between 0 to 16 feet, with the lake dropping quickly from 0 to 12 feet in the first 40 meters (131 feet) away from shore. In the northern portion of the lake, bottom depth is around 12 feet with a few pockets at a depth of 14 feet. In the lake's southern portion, the bottom is at about 14 feet with a couple of pockets being 16 feet deep. During the last ten years the water level of the lake has fluctuated between 30 and 32 feet NGVD, with the average depth right around 31 feet.

In addition, two smaller lakes also occur in the watershed. They are Lake Dorothea and Hidden Lake. Dorothea is just barely the larger of the two at 3.19 acres; Hidden Lake is 3.17 acres. The basin for Lake Dorothea is almost 11.5 acres in size while Hidden Lakes' basin is just less than 10 acres in area. Surface water elevation for both lakes is similar as well, around 41 to 42 feet NGVD.

Land uses within the watershed boundaries are not very diverse, with over two thirds of the land uses being dedicated to single family residential. Over 96% of this residential land use is high density. Most areas of commercial land use center around the major roads in the watershed, Busch Boulevard and Waters Avenue. Because of the degree of development, natural systems in the watershed are limited to the areas immediately around the lakes and are composed entirely of wetland systems.



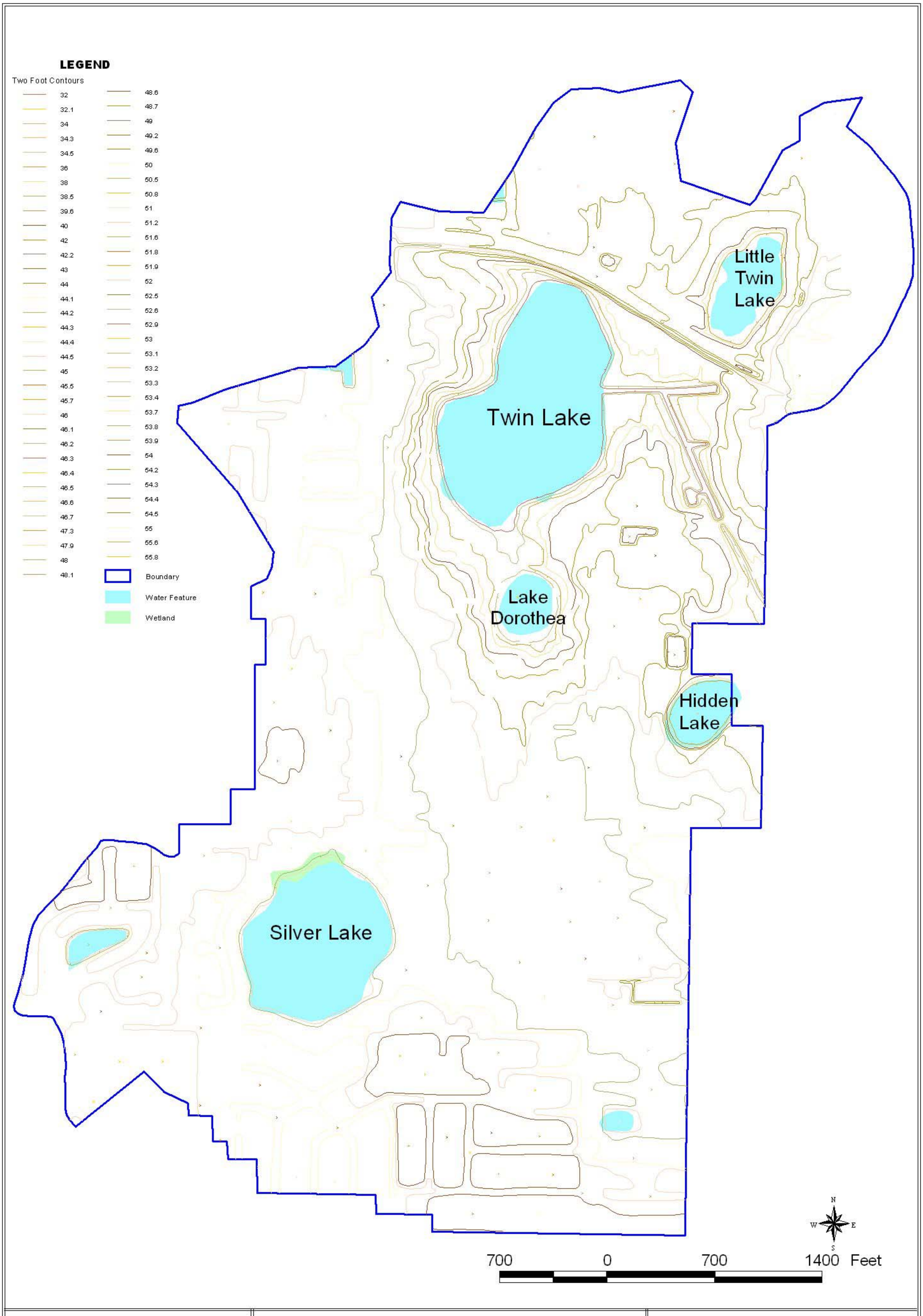
Hillsborough County Florida

Department of Public Works
Engineering Division
Stormwater Management Section

SILVER TWIN LAKE AREA STORMWATER MANAGEMENT MASTER PLAN DECEMBER 2000

FIGURE 2-1

SILVER TWIN LAKE AREA WATERSHED MAP



Hillsborough County
Florida

SILVER TWIN LAKE AREA
STORMWATER MANAGEMENT
MASTER PLAN
JAN. 2001

Public Works Department
Engineering Division
Stormwater Management Section

FIGURE 2-2
WATERSHED TOPOGRAPHY
MAP

INSERT FIGURE 2-2, WATERSHED TOPOGRAPHY

2.2 CLIMATE

The climate of the Silver / Twin Lakes watershed, and for Hillsborough County as a whole can be classified as humid subtropical. Annual average precipitation is around 52.4 inches. Approximately 60% of this total falls during the four month rainy season that extends from June through September. This rainy season also coincides with the occurrence of most tropical storms and hurricanes. Additionally, the conditions are ripe for regular, convective afternoon and evening thunderstorms. These summer events, which can be very localized, are highly variable in both intensity and volume. The larger, normal summer storm events and those associated with tropical systems can cause flooding problems in areas where there are deficiencies in the existing stormwater or other drainage systems.

Winter rainfall is, for the most part, relatively light and is generally associated with the weak cold fronts that descend from the northern part of the country and travel south through the region. However, some of the largest annual single rain events have occurred in the winter months and this is especially true in El Nino years.

The annual mean temperature in Hillsborough County is about 72 °F (Fahrenheit). The mean monthly temperature ranges from a low of approximately 60 °F in January to a high of approximately 82 °F in August. Typically, summer temperatures range from morning lows in the high 70's and low 80's to afternoon highs that can easily reach into the mid-90's, but rarely do they exceed 100 °F. Summer humidity that ranges into the mid to upper 90's can further exacerbate the situation. Conversely, typical winter low temperatures generally range above freezing into the 40's; only occasionally dropping into the low 20's and teens. High temperatures generally reach into the upper 60's or low 70's for most of the season, especially between passages of the cold fronts.

According to the National Weather Service in Ruskin, humidity does not vary as seasonally as temperature and rainfall. The Service keeps daily records for 1 and 7 o’clock A.M. and 1 and 7 o’clock P.M. The 7 A.M. time period generally records the highest humidity with the annual average at 88%, while the 1 P.M. time period records the lowest at an average of 58%.

Evapotranspiration rates vary and limited data are available for analysis. Estimates of 39 inches per year have been reported. Viessman, et al. (1977) reports the figure to be closer to 48 inches per year. Lake evaporation data from Lake Alfred in Polk County is often quoted for use in Hillsborough County and is supplemented by scattered data available from the Lake Padgett weather station. Studies conducted by Tampa Bay Water estimate the lake evaporation rate to average approximately 56 inches per year.

2.3 SOILS

Soil distribution by type is shown in **Figure 2-3**. This information was developed based on Geographical Information Systems (GIS) coverages developed by SWFWMD. Much useful information, such as drainage classification, percent slope, water table depth, permeability, natural vegetation and potential uses for development and agriculture, can be ascertained by consulting the SCS manual for Hillsborough County for each particular soil type.

These soil types can be arranged into four basic groups based on their runoff potential; these types are shown in **Figure 2-4**. The hydrologic groups are commonly used in watershed planning to estimate infiltration rates and moisture capacity. Soil properties that influence the minimum rate of infiltration obtained for a bare soil after prolonged wetting are: depth to seasonally high water table, intake rate and permeability, and depth to a layer or layers that slow or impede water movement. The major soil hydrologic groups are:

! Group A (low runoff potential) soils have high infiltration rates and a high rate of water transmission even when thoroughly wetted. They have typical infiltration rates of 10 inches/hour when dry and 0.50 in./hr. when saturated. Soil types found in the Silver / Twin Lakes watershed that fall into this group include 7 & 9 - Candler fine sands and 53 - Tavares-Millhopper fine sands.

! Group B (moderate runoff potential) soils have moderate infiltration rates when thoroughly wetted and a moderate rate of water transmission. They have typical infiltration rates of 8 inches/hour when dry and 0.40 in./hr. when saturated.

! Group C (moderately high runoff potential) soils have low infiltration rates when thoroughly wetted and a low rate of water transmission. They have typical infiltration rates of 5 inches/hour when dry and 0.25 in./hr. when saturated. Soil types found in the Silver / Twin Lake watershed that fall into this group include 2 – Adamsville fine sand, 47 - Seffner fine sand and 61 - Zolfo fine sand.

! Group D (high runoff potential) soils have very slow infiltration rates when thoroughly wetted and a very low rate of water transmission. They have typical infiltration rates of 3 inches/hour when dry and 0.10 in./hr. when saturated. The only soil type found in the Silver / Twin Lakes watershed within this group is 5 - Basinger, Holopaw and Samsula.

! Dual classifications (e.g. A/D or B/D) can be assigned to soils that exhibit substantially different hydrologic characteristics during the wet and dry seasons. During the wet season, these soils become saturated throughout much of the soil column due to elevated

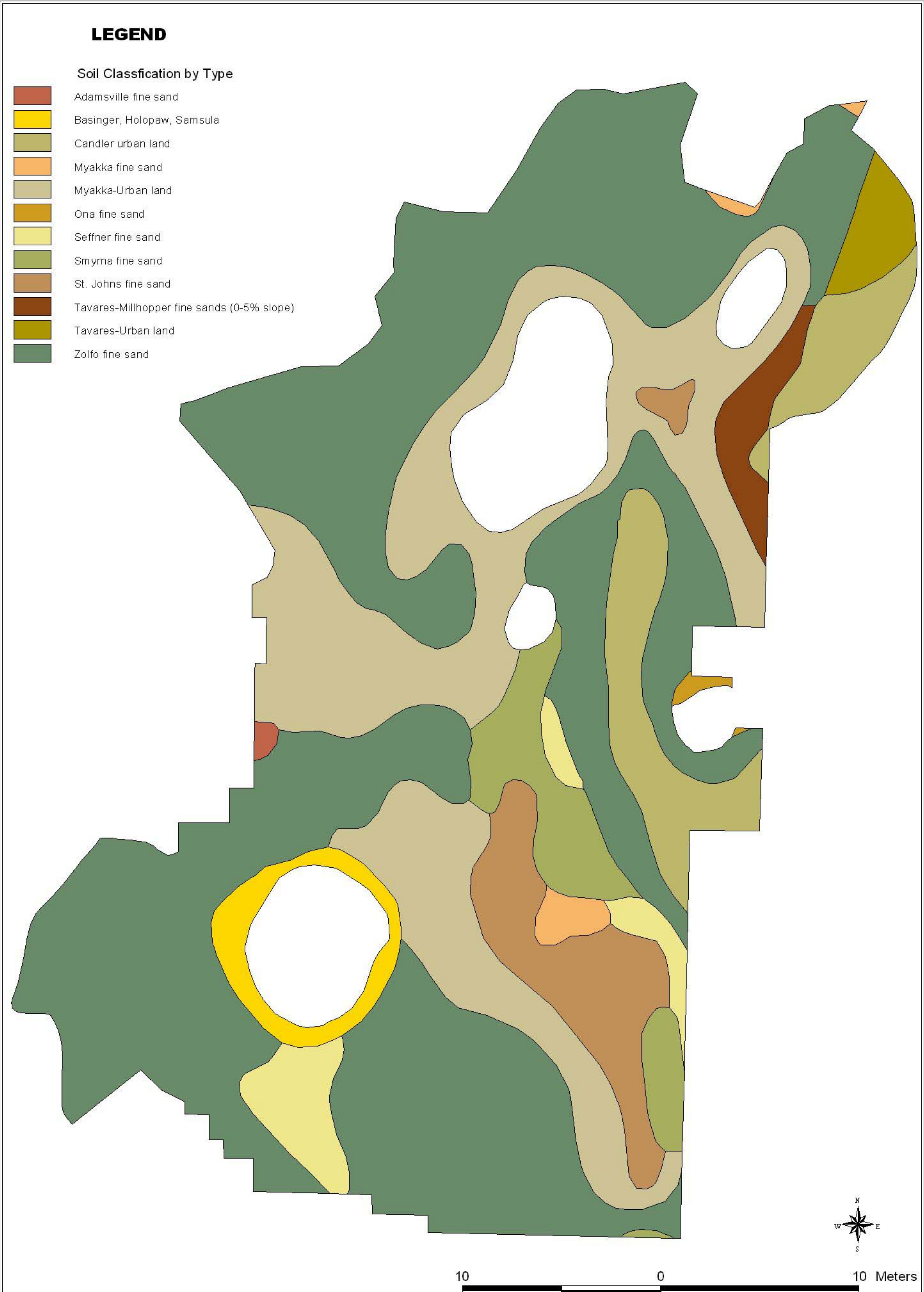


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FIGURE 2-3
SOIL CLASSIFICATION BY TYPE MAP

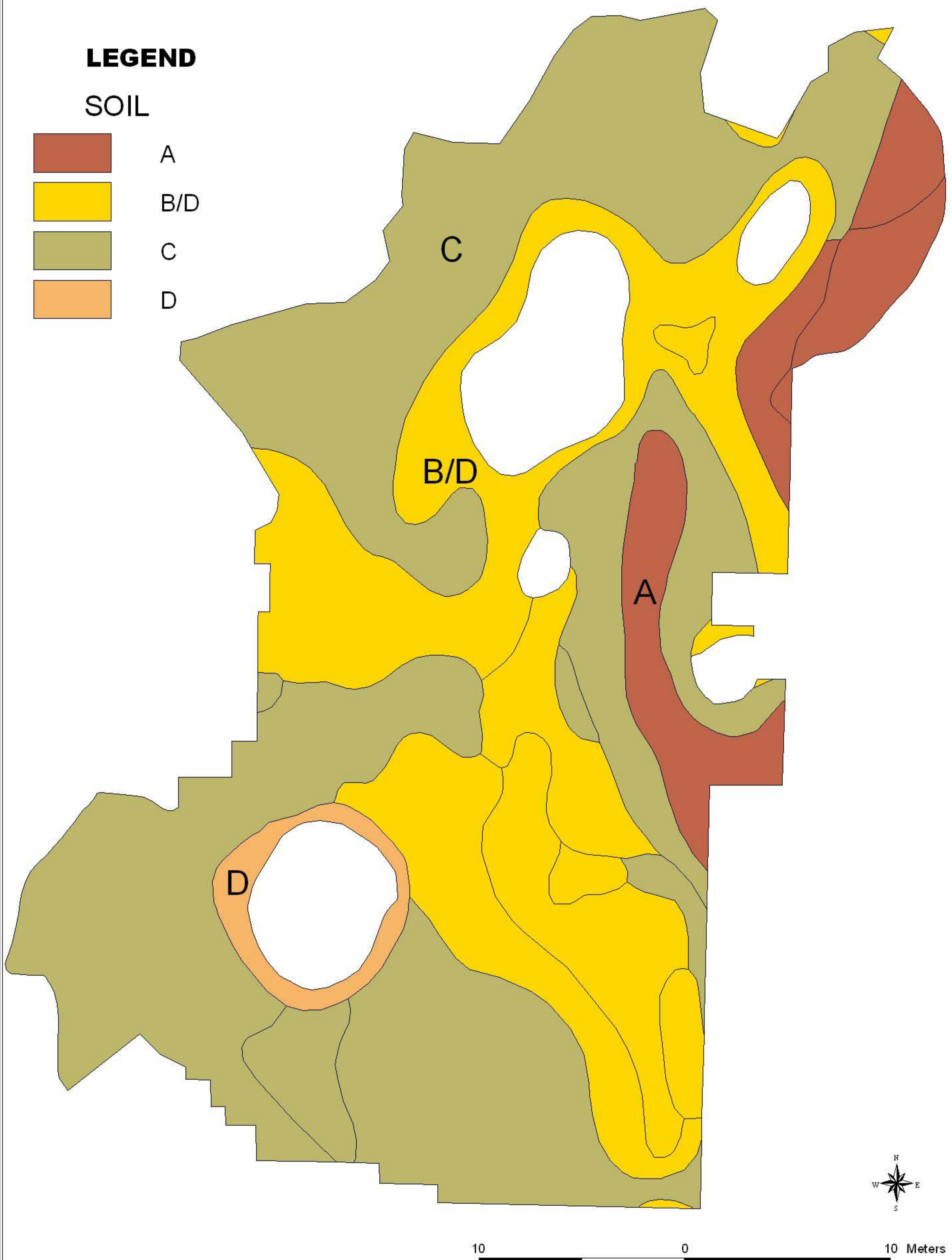

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FIGURE 2-4
SOIL TYPE BY HYDROLOGIC GROUP
MAP

INSERT FIGURE 2-4, Soil type by Hydrologic Group

water table conditions. Infiltration is thus impeded and the soils exhibit Group D infiltration and runoff rates. During the dry season when the water levels recede, infiltration rates increase and runoff rates decline to Group A or Group B levels. Soil types that fall within the B/D classification found within the Silver / Twin Lake watershed are 29 - Myakka fine sand, 32 - Myakka-Urban land complex, 33 - Ona fine sand, 46 - St. Johns fine sand and 52 - Smyrna fine sand.

Soils can also be classified as either hydric or non-hydric, which relates to whether the soils had wetland or upland origins, respectively. Those soils designated as hydric develop under anaerobic conditions in wetland areas and generally contain a large amount of organics. They are poorly to very poorly drained or depressional in nature, and are associated with a high seasonal water table. In contrast, those soils that are non-hydric lack these characteristics and are associated with upland or transitional areas. Soil types with the hydric classification found within the Silver / Twin Lakes watershed are 5 - Basinger, Holopaw and Samsula, and 46 - St. Johns fine sand. All of the other types would be considered non-hydric.

2.4 PHYSIOGRAPHY AND HYDROLOGY

The Silver / Twin Lakes watershed lies within the Gulf Coastal Lowlands physiographic unit as defined by White (1990). This unit is part of the Central or Mid-Peninsular physiographic zone, one of three in Florida. Land elevations in the watershed vary between a high of about 80 feet NGVD in the northern portions of the watershed to a low of around 30 feet NGVD at the surface of Silver Lake. These elevations are shown on **Figure 2-2.**

The watershed has two major outfalls, one for each of the two major lakes in the watershed. These outfalls eventually discharge into the Hillsborough River through a series of interconnected ditches. In addition to these outfalls, there are also two major stormwater conveyance systems within the basin. Again, they are associated with the major lakes in the watershed.

Surface flows are generally from the west to the east or southeast toward the connections with the Hillsborough River following the natural topography within the basin. Hydrologically, surface flows originate for the most part through stormwater runoff with very little influence from groundwater flows.

2.5 GEOLOGY AND HYDROGEOLOGY

The area is underlain by a thick sequence of sedimentary strata divided into an upper zone of unconsolidated sediments and lower zone of consolidated carbonate rock.

At land surface, undifferentiated sediments including silt, sand, and clay form surficial deposits which vary in thickness from less than 10 feet in coastal areas to over 100 feet in paleokarst depressions or in sand ridges. Typical thickness of the surficial deposits varies from 20 to 50 feet. In low lying areas near lakes and streams, thin layers of organic material mix with the surficial deposits. Pleistocene-aged silts and clays form the base of the undifferentiated sediments.

Underlying the unconsolidated material is a series of Tertiary-aged limestones and dolomites that form the carbonate platform of peninsular Florida. The sequence of carbonate rocks includes, in descending order, the following formations: Tampa Member of the of the Arcadia Formation of the Hawthorn Group, Suwannee Limestone, Ocala Group, Avon Park, Oldsmar, and Cedar Key Formations. A lithographic change from limestone and dolomite to a sequence of gypsiferous dolomite begins in the lower portion of the Avon Park Formation and continues into the Oldsmar and Cedar Key Formations. The top of this lithologic change marks the middle confining unit of the Floridan aquifer system. The middle confining unit is generally considered the base of the freshwater production zone of the Upper Floridan aquifer.

The Tampa Member of the Arcadia Formation of the Hawthorn Group is a tan-colored carbonate and sand mixture, which can contain variable amounts of clay. The Tampa Member can be fossiliferous and may also contain phosphate grains and chert. The Tampa Member ranges from 50 to 150 feet in thickness. The Suwannee Limestone consists of two rock types; the upper portion is tan-colored, crystalline limestone containing prominent gastropod and pelecypod molds and the lower portion is cream-colored limestone containing foraminifera and pellets of micrite in a finely crystalline limestone matrix. The Suwannee Limestone varies from 150 to 300 feet in thickness.

The Ocala Group contains a series of limestones that are generally soft, friable, porous and fossiliferous. This unit is late Eocene in age and ranges in thickness from 90 to 300 feet. The Avon Park Formation comprises brown, highly fossiliferous, soft to well-indurated, chalky limestone and a gray to brown, very fine microcrystalline dolomite. The Avon Park Formation ranges from 300 to 500 feet in thickness.

The hydrogeologic flow system of the northern Tampa Bay region contains two distinct groundwater reservoirs: the unconfined surficial aquifer and the semi-confined Upper Floridan aquifer. The Upper Floridan aquifer is under water table conditions in areas where the clay confining layer is discontinuous or absent. A general hydrogeologic cross-section of the Tampa Bay region is shown in **Figure 2-5**.

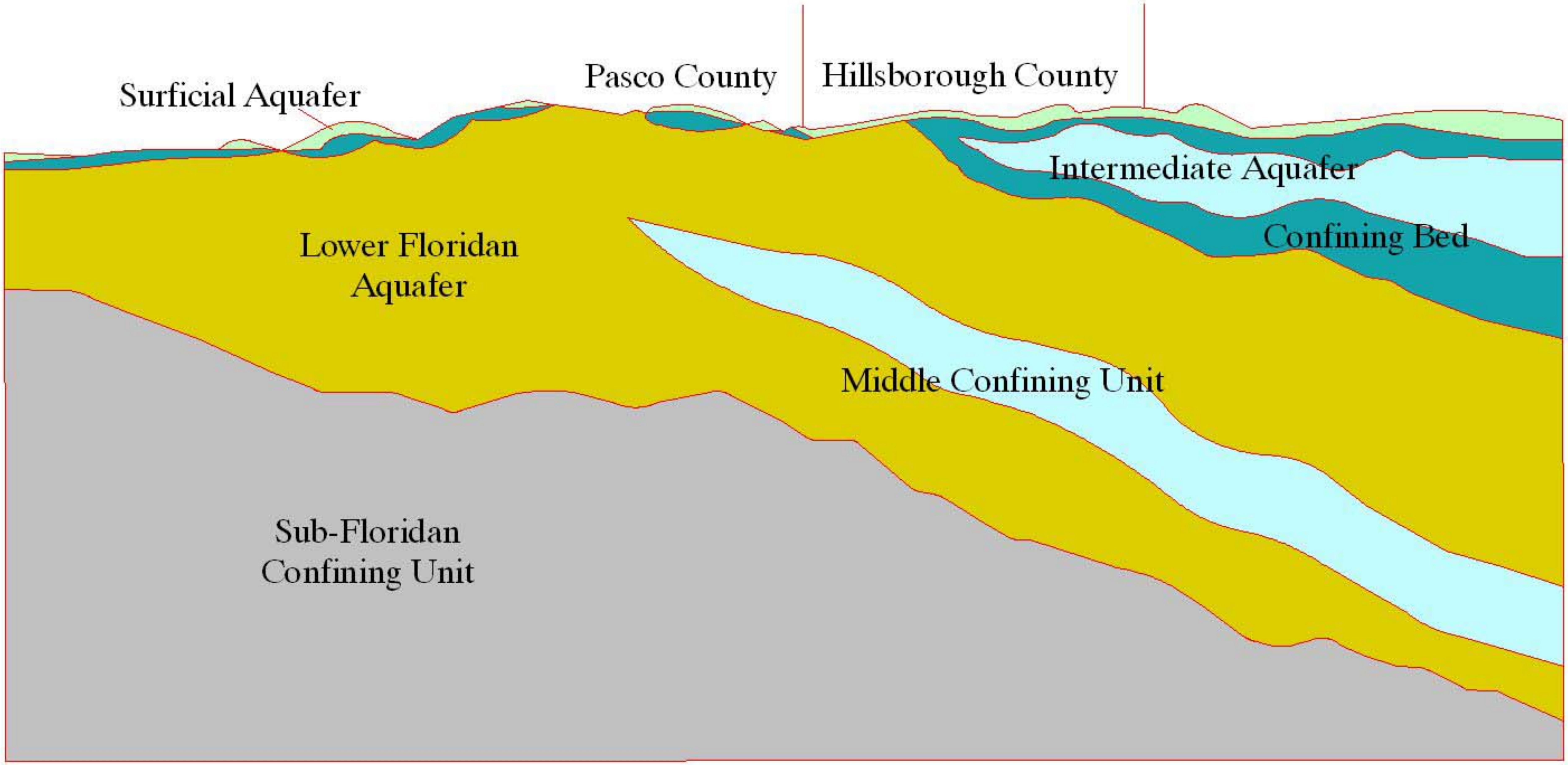

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FIGURE 2-5

SILVER TWIN LAKE AREA
HYDROGEOLOGIC CROSS SECTION
MAP

INSERT FIGURE 2-5, A Representative Hydrogeologic Cross Section

2.5.1 Surficial Aquifer

The surficial aquifer is comprised primarily of unconsolidated deposits of fine-grained sand with an average thickness of 30 feet. Due to the karst geology of the region, thickness of the sand can be highly variable. The depth of the water table ranges from near land surface to several feet below land surface. Rainfall is the primary influence on water table elevation, with annual highs in most years occurring during the end of the wet season (in Sept.- Oct.) and annual lows occurring near the end of the dry season (in May-June). The direction of groundwater flow varies locally and is significantly influenced by the topography of the land surface. The hydraulic gradient (change of elevation per unit length) in the area typically ranges from a few feet per mile to about ten feet per mile. The permeability of the surficial aquifer is generally low and water withdrawn from this aquifer is used most often for lawn irrigation and watering livestock. Surficial aquifer wells typically yield less than 20 gallons per minute.

2.5.2 Semi-Confining Zone

Below the surficial aquifer is a semi-confining unit comprised of clay, silt and sandy clay that has the ability to retard the movement of water between the overlying surficial aquifer and the underlying Upper Floridan aquifer. The confining materials are comprised of blue-green to gray, waxy, plastic, sandy clay and clay. The upper portion of the Arcadia Formation (Hawthorn Group) typically forms the semi-confining layer.

Leakage from the surficial aquifer into the Upper Floridan aquifer occurs by infiltration across the semi-confining layer or through fractures or secondary openings in the semi-confining unit caused by chemical dissolution of the underlying limestone. Due to the highly karstic nature of the geologic system, the clay semi-confining layer can be absent in one area but tens of feet thick just a short distance away. These localized karst features, in which the clay semi-confining layer is breached or missing, significantly increases hydraulic connection between the two aquifers (Hancock and Smith 1996).

2.5.3 Upper Floridan Aquifer

The Upper Floridan aquifer consists of a continuous series of carbonate units that include portions of the Tampa Member of the Arcadia Formation of the Hawthorn Group, Suwannee Limestone, Ocala Limestone and Avon Park Formation. Groundwater within the Upper Floridan aquifer is typically under artesian conditions within the project area.

Near the base of the Avon Park Formation lies the middle confining unit of the Floridan aquifer, an evaporite sequence of very low permeability that is composed of gypsiferous dolomite and dolomitic limestone. The middle confining unit generally delineates the boundary between the freshwater Upper Floridan aquifer and the brine-saturated Lower Floridan aquifer. The evaporites function as a lower confining unit and retard vertical flow across the boundary. In general, the permeability of the Upper Floridan aquifer is moderate in the Tampa Member and Suwannee Limestone, low in the Ocala Limestone and very high in portions of the Avon Park Formation. The limestone and dolomite beds produce significant quantities of water due largely to numerous solution openings along bedding planes and fractures. The Ocala Limestone yields limited amounts of water and may be considered a semi-confining layer within the Upper Floridan aquifer. Overall, the Ocala Limestone tends to act as a semi-confining zone between the overlying Tampa / Suwannee Formations and the underlying Avon Park Formation.

Transmissivity of the Avon Park Formation is very high due to the fractured nature of the dolomite zones.

Ground water flow in the Floridan aquifer originates as rainfall which percolates downward from the surficial aquifer. In areas where the Upper Floridan aquifer outcrops, this recharge can be direct. Recharge rates are generally higher in the northern portion of the County. However, recharge can be highly variable throughout the area, due to karst geology and induced leakage caused by ground-water withdrawals. The regional hydraulic gradient and direction of flow in the Upper Floridan aquifer is generally toward the south and west.

2.6 EXISTING AND FUTURE LAND USE

This information was gathered from two primary sources. The existing land use was determined by using 1995 Southwest Florida Water Management District and Hillsborough County Property Appraiser's information. The future land use information is from the Hillsborough County Planning Commission and reflects the predicted land use for the year 2015.

2.6.1 Existing Land Uses

As stated previously, the Silver / Twin Lakes watershed is fairly homogeneous in terms of land uses, being dominated by residential land uses. The Southwest Florida Water Management District's 1995 Land Use / Land Cover Map is shown in **Figure 2-6.** Additional existing land use information provided by the County's Property Appraiser's Office is illustrated in **Figure 2-7**. **Figure 2-8** shows the Planning Commission's projected land use for the year 2015. Commercial uses are primarily found along the area's main roads – Busch Boulevard and Waters Avenue. As shown in **Figure 2-9**, there are no vested projects or Developments of Regional Impact (DRI) projects within the watershed. Most of the natural and recreation lands

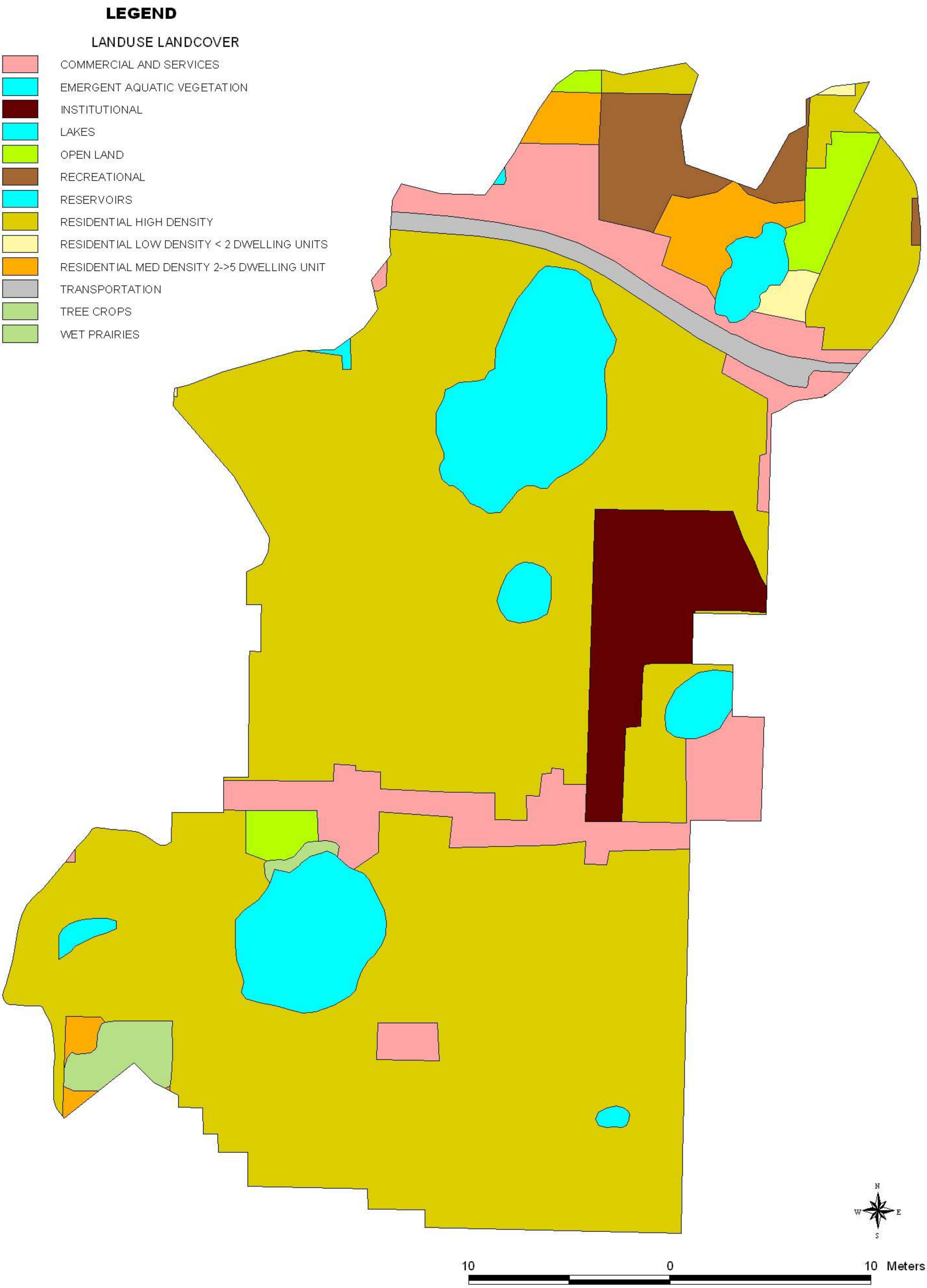

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FIGURE 2-6
1995 LANDUSE/COVER
MAP

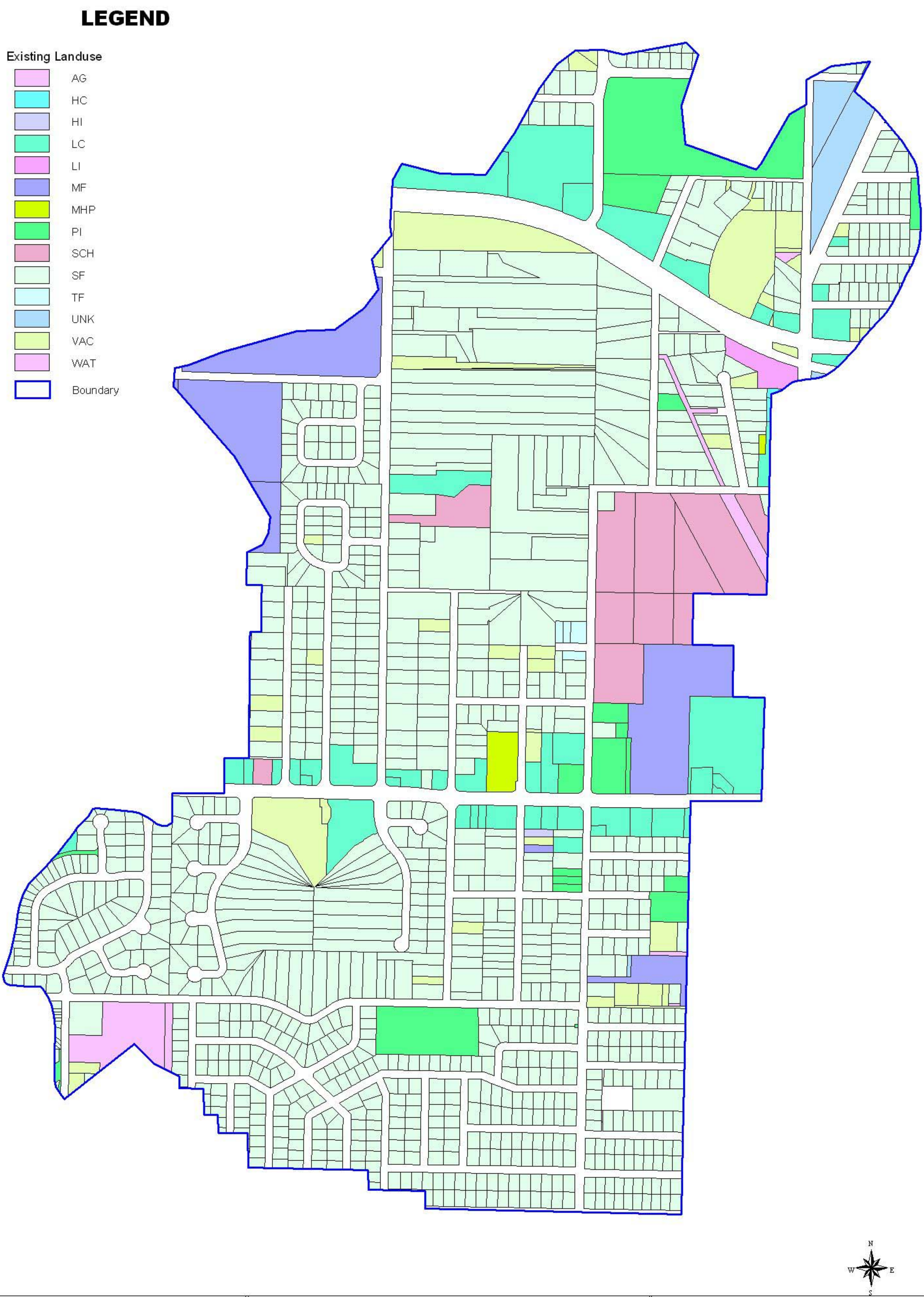

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Figure 2-7
Silver Twin Lake Area
Existing Landuse
Map

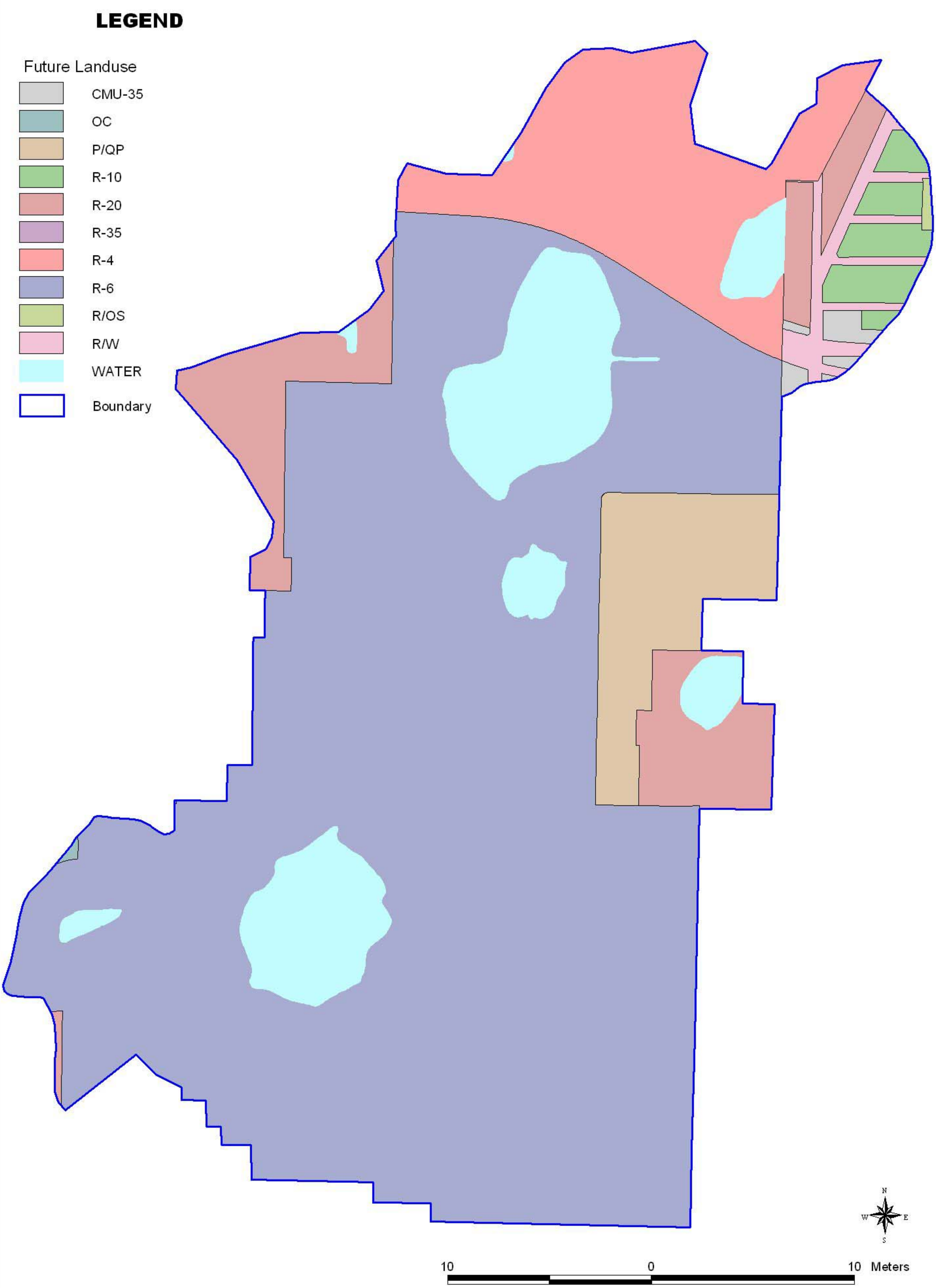

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FIGURE 2-8
FUTURE LANDUSE
MAP

INSERT FIGURE 2-8, Future Land Use – 2015 Planning Commission

are found in proximity to the watershed's lakes. No areas of Significant or Essential Upland Wildlife Habitat exist within the watershed area. The majority of the watershed's residential areas tend to be older subdivisions with little or no stormwater treatment being provided. The lots are typically less than a quarter acre in size.

Table 2.1
Existing Land Uses for the Silver / Twin Lakes Watershed
(based on 1995 Southwest Florida Water Management District information)

Land Use Category	Total Acreage	Percent of Total
Low / Medium Density Residential	12.582329662	2.48566
High Density Residential	336.407886992	66.45794
Light Industrial	0.0	0.0
Agricultural	5.122270078	1.01191
Commercial	45.770585551	9.04206
Institutional	26.724157930	5.27940

Highway / Utility	7.297865213	1.44171
Recreational	13.500886268	2.66712
Open Land	4.307721691	0.85099
Extractive (Mining) / Disturbed	0.0	0.0
Upland Forested	0.0	0.0
Wetland Forested	0.0	0.0
Wetland Non-Forested	3.375889037	0.66691
Water	51.10708072	10.0962
TOTAL	506.196673144	99.99986

As can be seen from Table 2.1, of the 506+ acres in the watershed, 442.284 acres or 87.37% of the watershed has been developed. The remaining land uses are composed of a citrus grove, natural wetland areas and open water – lakes and reservoirs.

2.6.2 Future Land Uses

Due to the highly developed nature of the Silver / Twin Lakes watershed, not many changes in land use are predicted by Hillsborough County's Planning Commission projections for the year 2015. The majority of predicted changes will be associated with the agricultural and open land areas and will most likely change over to a mixed urban use of residential and light commercial land uses.

Table 2.2
Future Land Uses Changes for the Silver / Twin Lakes Watershed

Land Use Category	Total Acreage	Percent of Total
Low / Medium Density Residential	53.77	10.64
High Density Residential	370.14	73.22
Light Industrial	0.0	0.0
Agricultural	0.0	0.0
Commercial	0.0*	0.0*
Institutional	28.82	5.70
Highway / Utility	0.0*	0.0*
Recreational	0.0*	0.0*
Open Land	0.0	0.0
Extractive (Mining) / Disturbed	0.0	0.0
Upland Forested	0.0	0.0
Wetland Forested	0.0	0.0
Wetland Non-Forested	0.0*	0.0*

Water	52.79	10.44
TOTAL	505.52	100.00

As can be seen from Table 2.2 above, several land uses that occurred in the existing land use table (**Table 2-1**) are not shown as a future land use. In some cases this is because that land use has been converted to another type. For example, it can be expected that at some point in the future the agriculture use, a citrus grove, will be developed for a residential or similar land use. Open land would fall under this category as well. However, other designations such as commercial and highway utilities are not shown. These land uses, designated by an asterisk (*) still exist in the watershed but, due to the way the Planning Commission compiles their information, they are incorporated into another land use category. For example, the Planning Commission's R-20 category includes commercial land uses, but for the purposes of this table, the R-20 designation has been included in the high density residential category. There is no accurate way to remove the commercial land uses from this designation. Wetlands are treated in a similar manner. With present day wetland protection regulations, it is not likely that the nearly 4 acres of wetland will disappear. However, the Planning Commission does not treat wetlands as a land use; they are a form of land cover. Because of this, again they have been combined into another land use category.

MAJOR CONVEYANCE SYSTEMS

The watershed area is located in central Hillsborough County and contains approximately 0.8 square mile. The study area is bounded by White Trout Lake and Habana Place to the north, Kirby Street to the south, Himes Avenue to the west, and Armenia Avenue to the east (see Figure 3.1). For modeling purpose, the domain is further extended to Albany Street (see Chapter 5 for detail discussion). Land use within the study area consists mainly of single-family residential areas, with scattered multi-family and commercial areas along Waters and Armenia Avenues. The whole system is comprised of three sub-systems: Little Twin Lake system, Twin Lake system, and Silver Lake system. As listed in Table 3.1, there are six major lakes and ponds in this area.

Table 3.1 List of Lakes and Ponds in Silver / Twin Lakes Area

Name	Area (Acres)	Mean Depth (Feet)	Water Level	
			Surface Elev. (NGVD / Feet)	Survey Date
Little Twin Lake	7.67	6.0	34.3	3/31/1960
Twin Lake	29	9.4	32	3/8/1963
Silver Lake	18.12	10.5	43.7	10/24/1966
Lake Dorothea	3.31	8.33	31.43	12/8/1964
Hidden Lake	5	4.0	32.8	N/A
Lago Vista Detention Pond	1.5	3.0	48	N/A

3.1 LITTLE TWIN LAKE SYSTEM

The Little Twin Lake system is located to the north of Busch Boulevard. Stormwater in this area flows into Little Twin Lake via a pipe system flowing from west to east. Under normal condition, the water in Little Twin Lake will evaporate into the air and/or seep into the ground. When the water level in Little Twin Lake is high, part of the water will flow to Kirby Creek of Twin Lake system through a pipe under Busch Blvd. The system's total length about 2,243 ft.

Little Twin Lake

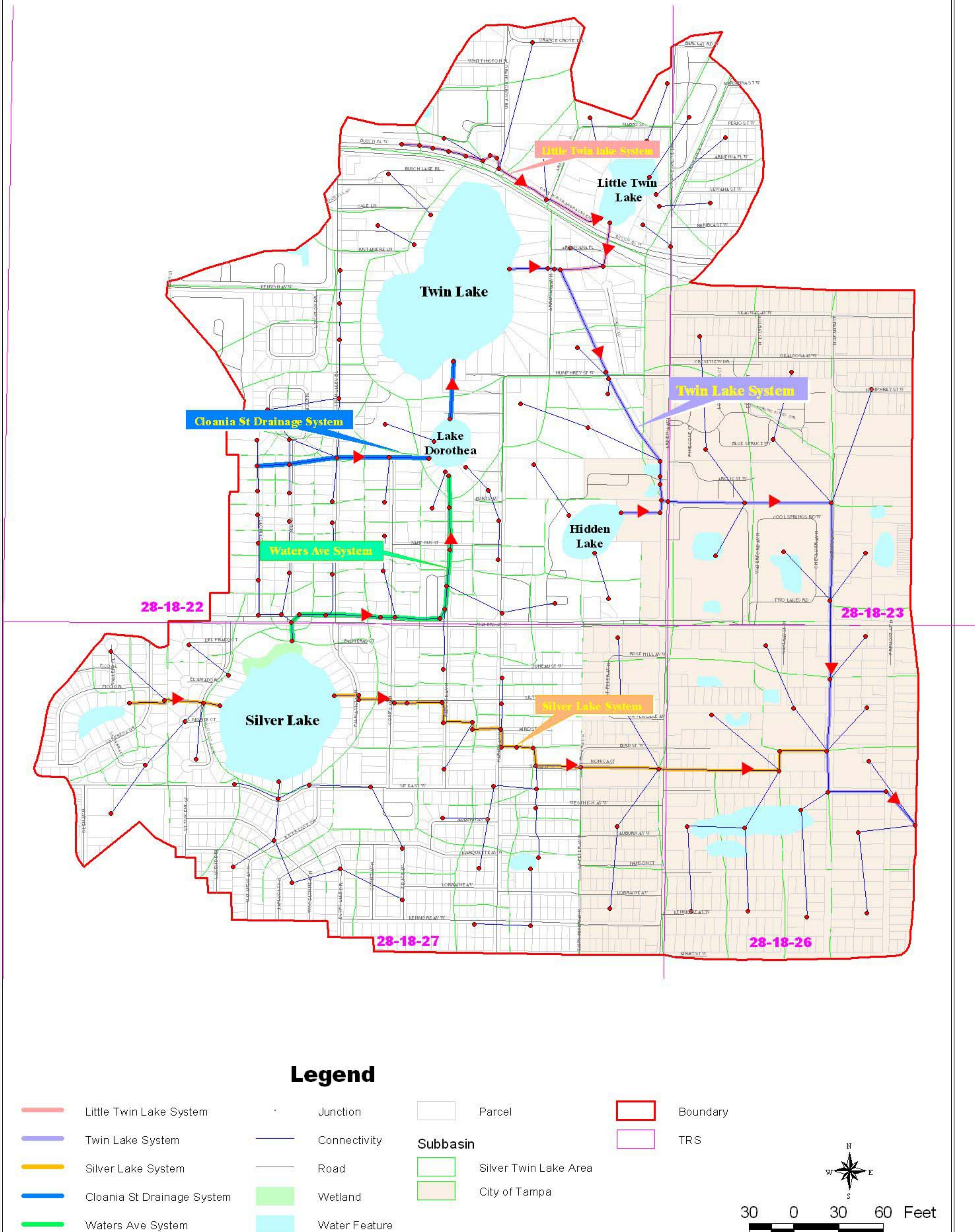

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FIGURE 3-1
MAJOR CONVEYANCE SYSTEM MAP

The Twin Lake system is located between Busch Boulevard and Waters Avenue. Kirby Creek is utilized as the outfall for this system, as well as the stormwater conveyance system to the Hillsborough River.

The upstream portion of this system consists of some storm-sewered areas, with the majority of the system consisting of open ditches with culvert crossings. The watershed section of the west of Armenia Avenue is in Hillsborough County, while the area east of Armenia Avenue is in City of Tampa. The channel within the City of Tampa's reach has been improved,

Twin Lake

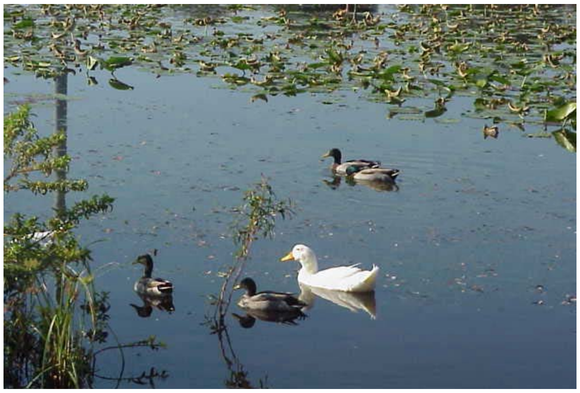
Kirby Creek in City of Tampa

Lake Dorothea

Kirby Creek in Hillsborough County

with the cross-sections being fairly uniform, averaging a depth of 5 feet between the top of bank and channel bottom. It is well maintained.

Lake Dorothea is a small lake located south of Twin Lake and connects to Twin Lake through a natural channel. Hidden Lake is another small lake located near Waters Avenue, which collects stormwater in the Hidden Lake apartment complex. The water then flows to Kirby Creek through a pipe.



Hidden Lake

3.3 SILVER LAKE SYTEM

The Silver Lake system is located to the south of Waters Avenue. Silver Lake has two outfalls: the first is a set of pipes that connects to Lake Dorothea, the second is the Ballard Park Ditch. Under normal conditions, stormwater collected by Silver Lake will flow to Lake Dorothea through a pipe system; when the water level in Silver Lake is higher than 45', its water will be discharged to the Hillsborough River through both outfalls. The Ballard Park ditch also serves as a final stormwater conveyance system for the area east of Silver Lake (approximately 230 acres) to Kirby Creek. The upstream part of this drainage system consists of a combination of storm

Silver Lake

The Ballard Park Ditch

sewered areas and open ditch systems. The Ballard park ditch is characterized by a fairly uniform flat channel in the lower reaches, with two sharp bends located approximately 500 feet upstream of Kirby Creek. The upper reaches consist of a heavily vegetated, steep channel (1.2 percent) with variable cross-sections. The confluence point of the Ballard Park ditch and Kirby Creek is at Albany Street.

The Lago Vista detention pond is located to the west of Silver Lake and collects stormwater in Lago Vista, and the water then flows to Silver Lake through a pipe system.

3.4 OTHER SYSTEMS

3.4.1 Claonia St. Drainage System

Claonia Street drainage system is a sub-system of the Twin Lake system, located west of Lake Dorothea. This system connects Claonia Street with Lake Dorothea through a very small natural swale (the depth is less than 2 feet). Because of the limited capacity of this swale, the area around Claonia Street, May Street, and May Circle area has been historical flood prone. In 2000, this system was improved by Hillsborough County (CIP 47049). Model results show that with the improvements, the flooding problem in this area has been solved.

3.4.2 Waters Avenue System

The Waters Avenue system is a sub-system connecting Twin Lake and Silver Lake. As discussed in 3.2 and 3.3, this system serves to adjust levels between Twin Lake and Silver Lake. Under normal conditions, water flows from Silver Lake to Twin Lake. When Twin Lake's water level is higher than 45 feet and Silver Lake's water level is low, water will flow from Twin Lake to Silver Lake.

HYDRAULIC / HYDROLOGIC MODEL METHODOLOGY

Several computer software products and analysis techniques have been used to develop the current model for all the County watershed studies, including the Silver / Twin Lakes Area watershed (STL). This chapter provides a general description of these methods and approaches.

4.1 GENERAL METHODOLOGY AND DATABASE DEVELOPMENT

The U.S.D.A. Natural Resources Conservation Service (NRCS) – formerly known as the Soil Conservation Service (SCS) – Runoff Curve Number (CN) method was used to generate runoff hydrographs from rainfall data and watershed parameters. This method estimates the expected storm water runoff on the basis of soil and land cover characteristics as well as watershed flow path and slope characteristics. Runoff hydrographs were developed using NRCS Dimensionless Unit Hydrograph method.

Inflow hydrographs were generated at junctions. Discharges were routed through the system using a modified version of the U. S. Environmental Protection Agency (EPA) Storm Water Management Model (SWMM) version 4.31, Hillsborough County version of SWMM. The EXTRAN block of SWMM provides a hydrodynamic channel routing model.

4.2 HYDROLOGY

In the Hillsborough County version of SWMM model, the SCS-CN method, rather than the nonlinear reservoir method, was used to calculate the runoff hydrographs.

4.2.1 SCS-CN Method

The SCS-CN method is one of the most popular methods for computing the volume of surface runoff for a given rainfall event from small watersheds. Kent (1973) described and examined this method in detail. The SCS-CN method is based on the water balance equation and two fundamental hypotheses. The first hypothesis states that the ratio of the actual amount of direct runoff to the maximum potential runoff is equal to the ratio of the amount of actual infiltration to the amount of the potential maximum retention. The second hypothesis states that the amount of initial abstraction is some fraction of the potential maximum retention. Expressed mathematically, the water balance equation and the two hypotheses, respectively, are

$$P = I_a + F + P_E \qquad (4\text{-}1)$$

$$\frac{P_E}{P - I_a} = \frac{F}{S} \qquad (4\text{-}2)$$

$$I_a = \lambda S \qquad (4\text{-}3)$$

where P = total precipitation in inches;

I_a = initial abstraction in inches;

F = cumulative infiltration excluding I_a, in inches;

λ = non-dimensional parameter;

P_E = direct runoff in inches; and

S = potential maximum retention or infiltration in inches.

The current version of the SCS-CN method assumes λ equal to 0.2 for usual practical application. As the initial abstraction component accounts for surface storage, interception, and infiltration before runoff begins, λ can take any value ranging from 0 to 1. Combining (4-1) and (4-2), we can write an equation for P_E as follows:

$$P_E = \frac{(P - I_a)^2}{P - I_a + S} \qquad (4\text{-}4)$$

If λ =0.2, then

$$P_E = \frac{(P - 0.2S)^2}{P + 0.8S} \qquad (4\text{-}5)$$

By studying the relationships of many different watersheds, the SCS further introduced a dimensionless number, *CN*, called a curve number. The curve number and S are related by

$$S = \frac{1000}{CN} - 10 \qquad (4\text{-}6)$$

The curve number is a function of land use, cover, soil classification, hydrologic conditions, and antecedent runoff conditions. The variation in infiltration rates of different soils is incorporated in curve number selection through the classification of soils into four hydrologic soil groups: A, B, C, and D. These groups, representing soils having high, moderate, low, and very low infiltration rates :

Group A soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission (greater than 0.30 in/h).

Group B soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well drained to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.30 in/h).

Group C soils have low infiltration rates when thoroughly wetted and consist mainly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05-0.15 in/h).

Group D soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water shallow soils over nearly impervious material . These soils have a very low rate of water transmission (0-0.05 in/h).

Runoff curve numbers for urban areas, cultivated and other agricultural lands, and arid and semiarid rangelands are shown in Table 4.1.

Table 4.1a Runoff Curve Numbers for Urban Areas*

Cover type and hydrologic condition	Average percentage of impervious area**	Curve numbers for hydrologic soil group			
		A	B	C	D

Fully developed urban areas (vegetation established) Open space (lawns, parks, golf courses, cemeteries, etc.)***					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding Right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch, and basin borders		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town house)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acre	12	46	65	77	82

Table 4.1a (cont'd.) **Runoff Curve Numbers for Urban Areas***

Cover type and hydrologic condition	**Average percentage of impervious area****	**Curve numbers for hydrologic soil group**			
		A	**B**	**C**	**D**
Developing urban areas:					

Newly graded areas (pervious areas only, no vegetation)		77	86	91	94
Idle lands (CNs are determined through the use of cover types similar to those for other agricultural lands.)					

* Average runoff condition, and $I_a = 0.2S$.

** The average percentage of impervious area shown was used to develop the composite CNs. Other assumptions are as follows: Impervious areas are directly connected to the drainage system; impervious areas have a CN of 98; and pervious areas are considered equivalent to open space in good hydrologic condition.

*** CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space cover type.

Table 4.1b Runoff Curve Numbers for Cultivated Agricultural Lands*

Cover type	Treatment**	Hydrologic Condition***	Curve numbers for hydrologic soil group			
			A	B	C	D
Fallow	Bare soil		77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR+CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	64	74	81	85
	C+CR	Poor	69	78	83	87
		Good	64	74	81	85

Table 4.1b (cont'd.) **Runoff Curve Numbers for Cultivated Agricultural Lands***

Cover type	Treatment**	Hydrologic Condition***	Curve numbers for hydrologic soil group			
			A	B	C	D
Row crops (cont'd.)	Contoured and terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+CR	Poor	65	73	79	81

		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR+CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C+CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

* Average runoff condition, and $I_a = 0.2S$.

** Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

*** Hydrologic condition is based on a combination of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes in rotations, (d) percentage of residue cover on the land surface (good $\geq$ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better-than-average infiltration and tend to decrease runoff.

Table 4.1c Runoff Curve Numbers for Other Agriculture Lands[1]

Cover type	Hydrologic condition	Curve numbers for hydrologic soil group			
		A	**B**	**C**	**D**
Pasture, grassland, or range-continuous forage for grazing[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80

Meadow-continuous grass, protected from grazing and generally mowed for hay		30	58	71	78
Brush—brush-weed-grass mixture with brush the major element[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30[4]	48	65	73
Woods—grass combination (orchard or tree farm)[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30[4]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots		59	74	82	86

[1] Average runoff condition, and $I_a = 0.2S$.
[2] Poor: <50% ground cover or heavily grazed with no mulch.
Fair: 50% to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.
[3] Poor: <50% ground cover.
Fair: 50% to 75% ground cover.
Good: > 75% ground cover.
[4] Actual curve number is less than 30; use CN=30 for runoff computations.
[5] CNs shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CNs for woods and pasture.
[6] Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Table 4.1d Runoff Curve Numbers for Arid and Semiarid Rangeland*

Cover Type	Hydrologic condition**	Curve numbers for hydrologic soil group			
		A***	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85

Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosote bush, blackbrush, bursage, paloverde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

*Average runoff condition, and $I_a = 0.2S$. For range in humid regions, use the table for other agriculture lands.

** Poor: <30% ground cover (litter, grass, and brush overstory.
Fair: 30% to 70% ground cover.
Good: > 70% ground cover.

*** Curve numbers for group A have been developed for desert shrub only.

4.2.2 SCS Dimensionless Hydrograph

The SCS dimensionless hydrograph is a synthetic unit hydrograph in which the discharge is expressed by the ratio of discharge Q to peak discharge Q_p and the time by the ratio of time t to the time of rise of the unit hydrograph, T_p. The unit peak discharge is calculated by

$$U_p = \frac{KA}{T_p} \qquad (4\text{-}7)$$

where U_p = unit peak discharge, cfs/inch;

A = drainage are, mile^2;

K = hydrograph shape factor, ranging from 300 for flat swampy areas to 600 in steep terrain. SCS standard K value = 484.

T_p = time to peak, in hours.

$$T_p = \frac{t_r}{2} + t_p \qquad (4\text{-}8)$$

where t_r = storm duration, hours;

t_p = drainage area lag, hours.

$$t_p = 0.6T_c \qquad (4\text{-}9)$$

where T_c = time of concentration, hours.

Figure 4-1 shows the definition of U_p, T_p, for a triangular unit hydrograph used in Hillsborough County version of SWMM model.

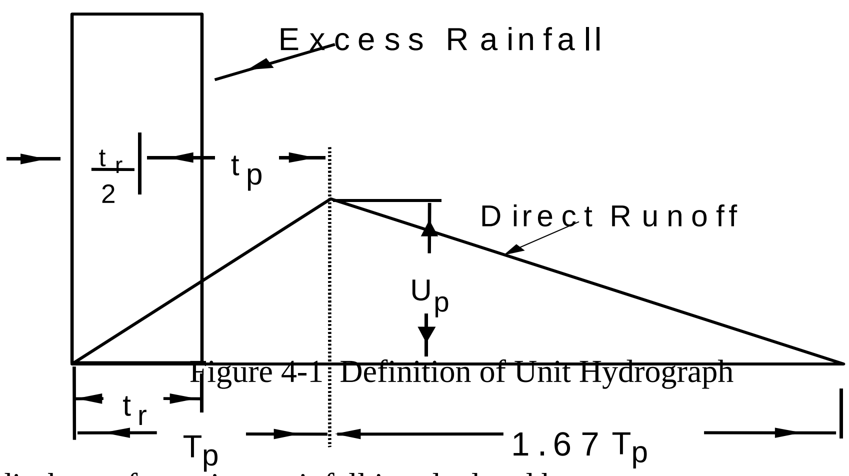


Figure 4-1 Definition of Unit Hydrograph

The peak discharge for a given rainfall is calculated by

$$Q_p = U_p P_E \qquad (4\text{-}10)$$

where Q_p= peak discharge, cfs. P_E is calculated with Equation (4-5).

4.2.3 Model Implementation

The convolution method is used to yield the direct runoff hydrograph. The convolution equation is

$$Q_n = \sum_{m=1}^{n \le M} P_{Em} U_{n-m+1} \qquad (4\text{-}11)$$

where

P_{Em} = excess rainfall of *mth* pulse in inches;

U_{n-m+1} = unit direct runoff at time *n t* of *mth* rainfall pulse, interpolated from Fig. 4.1, cfs/inch;

t = time step, minutes;

Q_n = total runoff at time *n t*, cfs;

M = total pulses of excess rainfall.

4.2.4 Rainfall Depth

Rainfall depths were estimated from isohyetal maps shown in the Southwest Florida Water Management District's (SWFWMD) Environmental Resource Permitting Information Manual. The rainfall depths for the 24 hours duration storm event used in model simulation are as follows:

Table 4.2 Design Storm Events

STORM EVENT PRECIPITATION	24-HOUR DEPTH (in.)
Mean Annual	4.50
5-year	5.50
10-year	7.00
25-year	8.00
50-year	10.0
100-year	11.0

The design storm rainfall distribution used is the SCS 24-Hour Type II Florida-Modified, as required by both SWFWMD and Hillsborough County.

4.2.5 Soil Data, Land Use, and SCS-CN Number Determination

4.2.5.1 Soil Data

SWFWMD Geographic Information System (GIS) soil coverage was used to obtain soil information for the STL watershed. The SWFWMD coverage was developed from data in the SCS *Soil Survey of Hillsborough County, Florida*, 1989. Each soil polygon in the GIS coverage is associated with an attribute that designates its soil identification number. A database table was used to associate soil identification numbers with their corresponding Hydrologic Soil Group (HSG). Hydrologic soil groups in the STL watershed consist of six designations A, B, C, D, B/D, A/D and Water. The HSG A soils have a high infiltration rate and low runoff potential. HSG B soils are moderately well drained and have a moderate infiltration rate. HSG C soils have slow infiltration rates and may contain a layer of fine texture soil, which impedes the downward movement of water. HSG D soils include poorly drained, very silty/clayey/organic soils or soils with high groundwater tables. Dual hydrologic classifications (B/D and A/D) includes soils which have a seasonal high water table but can be drained. The first hydrologic soil group designates the drained condition and the second hydrologic soil group designates the undrained condition of the soil. The hydrologic soil groups used in the analysis were shown in Figure 2-4. It is based on the SWFWMD GIS soil coverage.

4.2.5.2 Land Use

The SWFWMD GIS Land Use Coverage (1995) was used to represent existing conditions land use. The SWFWMD land use coverage is based on 1995 aerial infrared photography. Each land use polygon in the GIS coverage is associated with an attribute that designates a classification from the Florida Land Use Classification System (FLUCS) – also known as the Florida Land Use, Cover and Forms Classification System (FLUCFCS). There has been some development in the STL watershed since 1995 that is not represented in the SWFWMD coverage. As impervious area increases, runoff usually increases. However, SWFWMD has been regulating the quantity of stormwater runoff since 1984. The objective of this regulation is to prevent peak runoff rates under developed conditions from exceeding peak runoff rates associated with predevelopment conditions. The Land Use/Land Cover data used in the analysis are shown in Figure 2-6. SWFWMD uses the ARC/INFO GIS in Unix System, which is compatible to Hillsborough County ARC/INFO GIS performed in Windows NT

Workstation version GIS system.

4.2.5.3 Runoff Curve Numbers

Runoff curve number calculations were based on a GIS intersection of the SWFWMD land use coverage with the SWFWMD soil coverage and with the County subbasin map. The subbasin map was prepared in AutoCAD and exported in DXF format. It was then imported to the County GIS system for overlay with the soil and land use coverages. The resulting GIS polygons are associated with attributes of soil type and FLUCS code. Each soil type was then associated with a hydrologic soil group (A, B, C, or D) as discussed in previous sections, and each FLUCS code was associated with an SCS land use category. A CN value was then assigned to each polygon based on the specific hydrologic soil group and land cover classification. The average area weighted CN value was based on Table 4.1 then computed for each subbasin.

4.2.6 Time-of-Concentration

Time-of-concentration estimates were made by adding the travel time for segments of appropriate flow paths. The methods used for calculating travel times are based on that shown in the Hillsborough County Stormwater Technical Manual, and are summarized as follows:

Overland Flow:	Kinematic Wave Equation
Shallow Concentrated Paved:	SCS equations relating velocity to watercourse slope
Shallow Concentrated Unpaved:	SCS equations relating velocity to watercourse slope
Channel Flow:	Assumed velocity 2 ft/sec
Pipe Flow:	Assumed velocity 3 ft/sec

The selection of Manning's coefficients for the calculation of overland flow travel time is based on Table 4.3.

Table 4.3 Overland Flow Manning's n Values

Basin Type	Recommended value	Range of values
Concrete	0.011	0.01 - 0.013
Asphalt	0.012	0.01 - 0.015
Bare Sand	0.01	0.010 -- 0.016
Graveled Surface	0.012	0.012 - 0.030
Bare Clay-loam (eroded)	0.012	0.012 - 0.033
Fallow (no residue)	0.05	0.006 - 0.16

Chisel Plow (<1/4 tons/acre residue)	0.07	0.006 - 0.17
Chisel Plow (1/4 - 1 tons/acre residue)	0.18	0.07 -- 0.34
Chisel Plow (1 - 3 tons/acre residue)	0.3	0.19 -- 0.47
Chisel Plow (>3 tons/acre residue)	0.4	0.34 -- 0.46
Disk/Harrow (<1/4 tons/acre residue)	0.08	0.008 - 0.41
Disk/Harrow (1/4 -1 tons/acre residue)	0.16	0.10 -- 0.25
Disk/Harrow (1 - 3 tons/acre residue)	0.25	0.14 -- 0.53
Disk/Harrow (>3 tons/acre residue)	0.3	N/A
No Till (<1/4 tons/acre residue)	0.04	0.03 -- 0.07
No Till (1/4 - 1 tons/acre residue)	0.07	0.01 -- 0.13
No Till (1 - 3 tons/acre residue)	0.3	0.16 -- 0.47
Plow (fall)	0.06	0.02 -- 0.10
Coulter	0.1	0.05 -- 0.13
Range (natural)	0.13	0.01 -- 0.32
Range (clipped)	0.08	0.02 -- 0.24
Grass (bluegrass sod)	0.45	0.39 -- 0.63
Short grass prairie	0.15	0.10 -- 0.20
Dense grass	0.24	0.17 -- 0.30
Bermudagrass	0.41	0.30 -- 0.48
Woods	0.45	N/A

4.3 HYDRAULICS

4.3.1 Major Modifications

Hillsborough County has modified the U.S. EPA SWMM 4.31 to compute water surface elevations and discharges at links and nodes shown on the conduit/junction schematic diagram. The SWMM EXTRAN block was used for hydraulic routing. The most significant modifications to EPA SWMM 4.31 included directly integrating the SCS method to generate runoff hydrographs, entrance and exit headloss coefficient, and conduit stretch factor.

The exit headloss coefficient is usually set to 1.0. The entrance headloss coefficient is selected based on Table 4.4.

Other minor changes included the increase of dimensions of a number of key parameters, enhancements of the inputs and the outputs and error trapping. Input enhancements included a provision for specifying reach numbers for orifices and weirs, and another for using elevations rather than depths above invert for weir data. Several output enhancements have been provided including a provision for printing a summary file showing the computed peak discharge values and the computed peak water surface elevations.

Elliptical and arch pipes are included in the current County version SWMM model. Natural channels are represented in EXTRAN as conduits with irregular cross section data. The cross section data is input as ground shots (elevations and stations across the channel) in a format similar to that of HEC-2 (U.S. Army Corps of Engineers) cross section data. EXTRAN uses the cross section data only to obtain the shape geometry. It uses the invert elevations input on the conduit records to determine the channel's slope. A natural channel is, thus, treated as a prismatic conduit with an irregular shape.

Table 4.4 Culvert Entrance Loss Coefficients

Type of Structure and Design of Entrance	Coefficient k_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, square cut end	0.5

Table 4.4 (cont'd.) **Culvert Entrance Loss Coefficients**

Type of Structure and Design of Entrance	Coefficient k_e
Straight headwall	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D) (Indexes 250, 251, 252, 253, 255)	0.2
Mitered to conform to fill slope (Indexes 272, 273, 274)	0.7
End section conforming to fill slope'	0.5
Beveled edges, 33.7^o or 45^o bevels	0.2
Side- or slope-tapered inlet	0.2
Straight sand-cement (Index 258)	0.3
U-type with grate (Index 260)	0.7
U-type (Index 261)	0.5
Winged concrete (Index 266)	0.3

U-type sand-cement (Index 268)	0.5
Flared end concrete (Index 270)	0.5
Side drain, mitered with grate (Index 273)	1.0
<u>Pipe or Pipe-Arch, Corrugated Metal</u>	
Straight endwall--rounded (Radius=1/12 D) (Index 250)	0.2
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls, square-edge	0.5
Mitered to conform to fill slope (Indexes 272, 273, 271)	0.7
End section conforming to fill slope, paved or unpaved*	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
<u>Box, Reinforced Concrete</u>	
Headwall parallel to embankment (no wingwalls)	
Square-edged on three edges	0.5
Rounded on three edges to radius of 1/12 barrel dimension, or beveled edges on three sides (Index 290)	0.2

Table 4.4 (cont'd.) **Culvert Entrance Loss Coefficients**

Type of Structure and Design of Entrance	Coefficient k_e
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwalls at 10° to 25° to barrel, square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square edged at crown	0.7
Side- or slope-tapered inlet	0.2

*End sections conforming to fill slope, made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests, they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections incorporating a closed taper in their design have a superior hydraulic performance.

Note: Entrance head loss, $H_e = K_e \frac{V^2}{2g}$

Reference : USDOT, FHWA, HEC-5 (1965).

4.3.2 Boundary / Initial Conditions

To solve the St. Vennant equations, both boundary and initial conditions are necessary. The boundary conditions are usually given water levels at downstream, steady and/or unsteady. The upstream boundary conditions, water inflows, are determined by hydrology subroutine. The propriety water levels and water discharges are used as initial conditions.

4.3.3 Overflow Weirs

At some roadway crossings, weirs were used to simulate the overtopping of the road. Broad crested weirs were also used to simulate overland flow connections. In some cases, overland flow weirs were used to convey overbank flow, which was modeled as re-entering the channel at a downstream junction point.

4.3.4 Roughness Coefficients

The roughness coefficients for the right, left, and center portions of the channel sections were evaluated separately. In many cases, overbank areas were considered to be storage elements and not considered to have conveyance capability. Manning coefficients for channel sections were taken from several sources, including but not limited to, the HEC-2 water surface profile printouts obtained from FEMA. The values have been adjusted by Hillsborough County staff engineers on the basis of photographs, site visits, and general knowledge of the area. The roughness coefficients may be adjusted as more reliable field information becomes available or as refinements in model calibration occur. Higher roughness values sometimes result in smaller computed discharge values in downstream locations and larger computed water surface elevations in upstream locations. The roughness values are adjusted as part of the calibration efforts.

For some conduits, roughness coefficients were adjusted internally by providing the entrance and exit losses coefficient externally as discussed in 4.3.1.

4.3.5 Numerical Instability

The EXTRAN model solves the St. Vennant equations that describe unsteady flow in channels based on three different numerical methods: explicit finite difference method, implicit finite difference method, and iteration method. In this study, method three, the iteration method was used. The advantages of this method are: 1. Better stability; 2. Faster; and 3. Easier debug. However, this method is still subject to numerical instability caused by accumulated round-off error. It is difficult to predict the conditions that cause numerical instability however. Big time step, short conduit lengths, steep bottom slopes for conduits and low storage at junctions is frequently associated with numerical instability. Achieving numerical stability requires numerous adjustments to the model input data. Such adjustments include the use of equivalent pipes with longer lengths, decrease time step, adjust roughness, and the addition of storage at the junctions.

The equivalent pipe formula used to calculate the adjustments is as follows:

$$n_e = n_p L_p^{1/2} / L_e^{1/2} \qquad (4.12)$$

where;

n_e = Manning roughness of equivalent pipe
L_e = Computed equivalent length
n_p = Actual Manning roughness of the pipe
L_p = Actual length of the pipe

HYDROLOGY AND HYDRAULIC MODEL CALIBRATION AND VERIFICATION

This chapter contains the data collection, hydrological/hydraulic model calibration and verification procedure used for the Silver / Twin lakes Area watershed existing conditions model. The goal of the calibration effort is to develop a hydrological/hydraulic model that reflects observed conditions in the watersheds and that can be used to predict system performance for future events and to evaluate alternative projects in the watershed.

Generally speaking, the calibration process includes simulating a measured event by first adjusting the hydrologic input parameters according to the measured rainfall depth and distribution and then comparing computed water surface elevations and flows to the measured values collected at gage stations. The hydrodynamic model is then adjusted so that computed and measured values more closely match. The model is considered well calibrated when the results of stage, flow, and volume are in reasonable range with the recorded data at the established gauge stations. The model is then adjusted with specific parameters accordingly and verified with data from other storm events. However, for a watershed like Silver / Twin Lakes area where there are no gage stations available, the model calibration is totally different. In this case, model setup is very important. All the parameters, such as Manning's roughness coefficient, SCS curve number, time of concentration, etc., should be carefully chosen based on experience and neighboring watersheds, Sweetwater Creek, Lower Sweetwater Creek, and Curiosity Creek, for example. The model then is calibrated with regression equation results.

5.1 BOUNDARY CONDITIONS

Since there is no observed information available, the free overfall condition is used. The basic assumption of such kind of condition is that for any given discharge, the downstream water depth is always equal to the correspondent critical depth. For a rectangular channel, the critical depth is defined by

$$D_c = \sqrt[3]{\frac{Q^2}{B^2 g}} \qquad (5-1)$$

where D_c = critical water depth, ft;
Q = water discharge, cfs;
B = channel width, ft;

and g = gravity acceleration, feet/second^2 .

The drawback of such kind of boundary condition is that it may underestimate the downstream water level. To minimize the effect of the drawback, the simulation area should be extended to a point far from the interested area. In the present study, Kirby Creek was extended from Armenia Avenue to Albany Street. In the following paragraphs of this section, we will discuss that such kind of extension is big enough.

Assuming that the channel is rectangular with a small slope, based on the energy equation, the effluence length can be calculated by

$$L = \frac{1}{\lambda}[(D_1 - D_c) + \frac{Q^2}{2gB^2}(\frac{1}{D_1^2} - \frac{1}{D_c^2})] \qquad (5-2)$$

where L = effluence length, ft;
B = channel width, ft;
Q = water discharge, cfs;
D_1 = normal water depth under Q, ft;
D_c = critical water depth under Q, ft;
and. - . a coefficient related to Manning's n. From Manning's Law,

$$\lambda = \frac{n^2 \overline{V}^2}{1.486^2 \overline{R}^{4/3}} \qquad (5-3)$$

where n = Manning's roughness coefficient;
$\overline{V}$ = averaged velocity, feet/sec, $\overline{V} = 2Q/(B(D_1 + D_c))$;
and $\overline{R}$ = averaged hydraulic radius, ft,
$\overline{R} = [D_1 B(D_c + 2B) + D_c B(D_1 + B)]/[2(D_c + 2B)(D_1 + 2B)]$

A program in Lahey Fortran 95 as listed below was developed to calculate the required extent length.

Table 5.1 Source Code of Extent Length Calculation

```
Program Extent_Length

Implicit none

Type channel_type
   Real :: Length
   Real :: Width
   Real :: Critical_depth
   Real :: Normal_depth
   Real :: Manning_n
   Real :: discharge
   Real :: slope
end type channel_type

type (channel_type) :: Channel

logical :: not_end_of_calculation = .true.

real :: V_average
real :: R_average
real :: gravity = 32.356, Const_f = 1.486
real :: V_c, V_n, lambt

Character :: temp

do while (not_end_of_calculation)
print *, "Please enter channel information:"
print *, "Channel width = ?"
read(*,*) channel%width
print *, "Channel Manning_n = ?"
read(*,*) channel%Manning_n
print *, "Channel slope = ?"
read(*,*) channel%slope
print *, "Channel discharge = ?"
read(*,*) channel%discharge


channel%critical_depth = (channel%discharge * channel%discharge &
/ (channel%width * channel%width * gravity))**(1.0/3.0)
```

```
     call normal_d(channel%normal_depth,channel%discharge,        &
              channel%manning_n,channel%slope,              &
              channel%width)

     print *, 'normal = ', channel%normal_depth, ' ft'
     print *, 'critical =', channel%critical_depth, ' ft'
     pause

     V_average = 2.0*channel%discharge/(channel%width*            &
             (channel%normal_depth + channel%critical_depth))

     R_average = (channel%normal_depth*channel%width*             &
             (channel%critical_depth + 2.0 * channel%width) +  &
             channel%critical_depth*channel%width*            &
             (channel%normal_depth + 2.0* channel%width))  /   &
            (2.0*(channel%critical_depth + 2.0 * channel%width)&
               *(channel%normal_depth + 2.0* channel%width))

     lambt = channel%manning_n * channel%manning_n * V_average *   &
         V_average/(const_f*const_f*R_average**(4.0/3.0))


    channel%length = ((channel%normal_depth - channel%critical_depth)&
         + channel%discharge*channel%discharge/(2.0*gravity*    &
         channel%width*channel%width)*(1.0/(channel%normal_depth&
         *channel%normal_depth)-1.0/(channel%critical_depth*    &
         channel%critical_depth)))/lambt

    print *, 'Extent length =   ',channel%length,' feet'

    print *, 'Do you want continue? (Y/N) '
    print *, ' '

    read(*,*) temp


    if (temp=='n'.or.temp=='N') then
    not_end_of_calculation = .false.
    endif
```

```
      end do

      END program extent_length

      subroutine normal_d(d,q,n,s,b)

      implicit none

      real :: d,q,n,s,b

      real :: f,a,e
      real :: epsilon = 0.01
      a = q*n/(1.486*sqrt(s))

      d = 0.5

 10      f = (a**3.0*(b+2.0*d)*(b+2.0*d))**(1.0/5.0)/b

      e = d-f

      if (abs(d-f)/d.le.epsilon) then
      return
      else
       if (e>0.0) then
          d = d - 0.1
       else
          d = d + 0.1
       endif
       goto 10
     endif

     end subroutine normal_D
```

Table 5.2 lists the effect lengths of all six design storm events for Kirby Creek of the Silver / Twin lakes watershed.

Table 5.2 Minimum Extent Lengths

Storm Event	Discharge (cfs)	Required Extension (ft)	Comments

Mean Annual	128.1	96	
5 Year	161.4	122	
10 Year	194.4	135	
25 Year	227.2	152	
50 Year	290.6	198	
100 Year	320.3	227	

The channel was actually extended to 2,660 feet in the model, which is much longer than what was required.

5.2 MODEL CALIBRATION

As discussed before, the model was first setup based on experience and surrounding watersheds, such as Sweetwater Creek, Lower Sweetwater Creek, and Curiosity Creek, and then calibrated with regression equation results.

5.2.1 Model Setup

Table 5.3 lists SCS-CN numbers in each sub-basin. Table 5.4 lists, Manning's roughness coefficients in pipes and channels. Table 5.5 lists initial conditions for all lakes and ponds.

Table 5.3 List of Curve Numbers

Basin_ID	Area (Acres)	Curve Number		Basin_ID	Area (Acres)	Curve Number
591000	30.61	95.94		591510	3.26	90.28
591010	10.42	91.23		591520	4.83	92.06
591020	3.32	91		591530	2.11	84.48
591030	2.74	90.97		591540	2.28	92.54
591040	9.98	90.98		591550	5.02	89.94
591050	4.81	90.85		591560	1.74	90.81
591060	4.96	90.39		591570	2.88	90.13

Table 5.3 (cont'd.) **List of Curve Numbers**

Basin_ID	Area (Acres)	Curve Number		Basin_ID	Area (Acres)	Curve Number
591070	4.62	88.29		591580	4.93	81.05
591080	5.71	83.04		591590	3.31	90.54

591090	7.02	91.06	591610	1.74	90.18
591100	11.72	90.98	591620	7.23	90.41
591110	3	83.21	591630	2.09	90.19
591120	2.31	90.93	591640	1.24	90.77
591130	1.37	90.15	591650	14.04	91.62
591140	3.82	90	591660	1.29	91
591150	4.53	90.28	591670	1.55	91
591160	3.08	90.8	591680	1.42	90.86
591170	3.07	90.78	591690	2.55	90
591180	10.44	91	591710	1.71	90.53
591190	5.25	90	591720	12.13	91.51
591200	11.45	92.63	591730	1.54	91
591210	2.73	90	591740	1.36	91
591220	4.72	90.72	591750	1.82	91
591230	5.23	91	591760	3.46	90.86
591240	2.35	91	592000	50.43	95.6
591250	6.09	92.69	592100	9.82	93.46
591260	1.61	91.16	592110	3.78	89.22
591270	3.07	90.81	592120	3.3	90.9
591280	2.53	90.87	592130	6.98	85.19
591290	6.51	91	592140	4.24	76.06
591310	4.81	90.91	592150	4.62	84.15
591320	6.92	92.15	592160	6.66	86.65
591330	2.11	90.3	592170	8.44	86.07
591340	3.26	90.42	592180	4.6	90.72
591350	2.69	91	592190	2.1	90.54
591360	6.25	79.17	592210	17.2	78.05
591370	4.42	90.27	592220	2.05	90
591380	5.93	90	592230	5.67	90.01
591390	8.74	90.23	592240	9.71	90.25
591410	5.99	90	592250	7.57	90.11
591420	5.4	90	592260	13.83	81.05

Table 5.3 (cont'd.) **List of Curve Numbers**

Basin_ID	**Area (Acres)**	**Curve Number**	**Basin_ID**	**Area (Acres)**	**Curve Number**

591430	7.25	89.95	592270	7.33	90.47
591440	9.06	93.99	593000	17.75	88.95
591450	3.11	90	593010	5.21	84.64
591460	3.2	90.08	593020	6.89	77.2
591470	2.24	90.32	593030	6.9	76.28
591480	5.39	90	593040	5.29	74.72
591490	3.02	90	593050	5.48	83.31
593060	1.47	80.41	594100	9.11	91
593070	4.88	87.93	594110	4.67	91
593080	9.41	84.97	594120	9.41	91.04
593090	9.92	82.07	594130	7.74	93.22
593110	4.21	94.16	594140	15.99	92.19
593120	1.9	92.87	594150	13.35	87.64
593130	3.15	93.08	594160	4.64	87.45
594010	8.14	88.53	594170	10.37	93.18
594020	6.21	89.43	594180	8.48	91.5
594030	7.75	89.65	594190	13.96	91.17
594040	11.31	90	594200	1.58	91
594050	10.98	91.12	594210	1.73	91
594060	8.61	80.55	594220	19.3	83.31
594070	11.73	91	594230	8.96	80.11
594080	8.76	93.73	594240	25.62	80.62
594090	8.53	92.16	594250	1.45	90.09
			594260	9.79	89.99
			594270	11.66	91.83

Table 5.4 List of Manning's n

Conduit Type	Manning's n	Note
RCP	0.012	
CMP	0.022-0.025	
Kirby Creek	0.025-0.030	
Dillard Park Ditch	0.025	
Other Natural Ditches	0.040	

Table 5.5 List of Initial Conditions

Name	Area (Acres)	Mean Depth (Feet)	Initial Water Level (Feet)	Comment
Little Twin Lake	7.67	6.0	30.20	
Twin Lake	29	9.4	33.67	
Silver Lake	18.12	10.5	43.0	
Lake Dorothea	3.31	8.33	31.43	
Hidden Lake	5	4.0	31.40	
Lago Vista Detention Pond	1.5	3.0	43.6	

5.2.2 Regression Method

Multiple-regression analysis was used in this study to relate the peak streamflow at selected frequency intervals to various physical and climatic characteristics. Research by Tasker and Stedinger (1989) indicates that generalized least squares (GLS) is appropriate for hydrologic regression. GLS regression takes into consideration the time-sampling error (length of record at each site) and the cross correlation of annual peak streamflows between sites. Bridges (1982) developed a nationwide regression equation to estimate peak discharge under urban conditions. The general form of this equation for region A (Tampa area) is

$$Q_T = CA^{B1}S^{B2}(A_L + 3.0)^{B3} \qquad (5-4)$$

where Q_T = Peak runoff rate for return period T, in cfs;
C = Regression constant;
A = Drainage area, in miles;

S = Channel slope in feet/mile, measured between points 10% and 85% of the distance from the design point to the watershed boundary;
A_L = Surface area of lakes, ponds, and detention and retention basins, expressed as a percentage of the drainage area;
and B1, B2, and B3 = Regression exponents.

For urban drainage areas of less than 10 square miles in the Tampa Bay area, Lopez and Woodham (1983) provide regression equations. The general form for flood frequencies of 2, 5, and 10 years is

$$Q_T = CA^{B1}F^{B2}S^{B3}(A_d - 0.01)^{B4} \qquad (5-5)$$

and for flood frequencies of 25, 50, and 100 years is

$$Q_T = CA^{B1}(13.0 - F)^{B2}S^{B3} \qquad (5-6)$$

where Q_T = Peak runoff rate for return period T, in cfs;
C = Regression constant;
A = Drainage area, in miles;
F = Basin development factor;
S = Channel slope in feet/mile, measured between points 10% and 85% of the distance from the design point to the watershed boundary;
A_d = Surface area of lakes, ponds, and detention and retention basins, expressed as a percentage of the drainage area;
and B1, B2, B3, and B4 = Regression exponents.

All the parameters are available in FDOT drainage manual.

Table 5.6 lists the program for Equation (5-4), and Table 5.7 lists the program for Equations (5-5) and (5-6).

Table 5.6 List of Source Code for Equation (5-4)

```
Program USGS_Regression_Method
Dimension c(8), b1(8), b2(8), b3(8),q(8)
data c/93.4,192,274,395,496,609,779,985/
data b1/0.756,0.722,0.708,0.696,0.690,0.685,0.674,0.668/
data b2/0.268,0.255,0.248,0.240,0.234,0.227,0.205,0.196/
data b3/-0.803,-0.759,-0.738,-0.717,-0.705,-0.695,-0.694,-0.687/
character*3 yr(8)
```

```
   real lk
   data yr/'002','005','010','025','050','100','200','500'/
   open(1,file='regna.dat')
   write(1,*) 'USGS Regression Equation Results for Silver/Twin Lake area'
!    print *, 'please input watershed area in mi**2'
 !   print *, ' '
  !  read(*,*) da
   da=1.3
   print *, 'please input watershed slope in ft/mi'
   print *, ' '
   read(*,*) sl
   print *, 'please input lake percentage %'
   print *,  ' '
   read(*,*)lk
   do I=1,8
   q(i)=c(i)*da**b1(i)*sl**b2(i)*(lk+3.0)**b3(i)
   print *, 'q(',yr(i),')=',q(i)
   write(1,*)'q(',yr(i),')=',q(i)
   pause
   enddo
   close(1)
   end Program USGS_Regression_method
```

Table 5.7 List of Source Code for Equations (5-5) and (5-6)

```
   Program Tampa_Regression_method
   dimension c(6), b1(6), b2(6), b3(6),q(6),b4(6)
   data c/3.72,7.94,12.9,214,245,282/
   data b1/1.07,1.03,1.04,1.13,1.14,1.16/
   data b2/1.05,0.87,0.75,-0.59,-0.55,-0.51/
   data b3/0.77,0.81,0.83,0.73,0.74,0.76/
   data b4/-0.11,-0.10,-0.10,0.0,0.0,0.0/
   character*3 yr(6)
   real lk
   data yr/'002','005','010','025','050','100'/
   open(1,file='regnat.dat')
```

```
   write(1,*) 'Tampa Regression Equation Results for Silver/Twin Lake area'
!    print *, 'please input watershed area in mi**2'
 !   print *, ' '
  !  read(*,*) da
   da=1.3
   print *, 'please input watershed slope in ft/mi'
   print *, ' '
   read(*,*) sl
   print *, 'please input lake percentage %'
   print *,  ' '
   read(*,*) lk
   print *, 'please input basin development factor'
   print *,  ' '
   read(*,*)bdf

   do I=1,6
   q(i)=c(i)*da**b1(i)*bdf**b2(i)*sl**b3(i)*(lk+0.01)**b4(i)
!    if(i>2) q(i)=c(I)*da**b1(i)*(13.-bdf)**b2(i)*sl**b3(i)*(lk+0.01)**b4(i)
   if(I>3) q(i)=c(i)*da**b1(i)*(13.-bdf)**b2(i)*sl**b3(i)

   print *, 'q(',yr(i),')=',q(i)
   write(1,*)'q(',yr(i),')=',q(i)
   pause
   enddo
   close(1)
   end Program Tampa_Regression_Method
```

5.2.3 Calibration Results

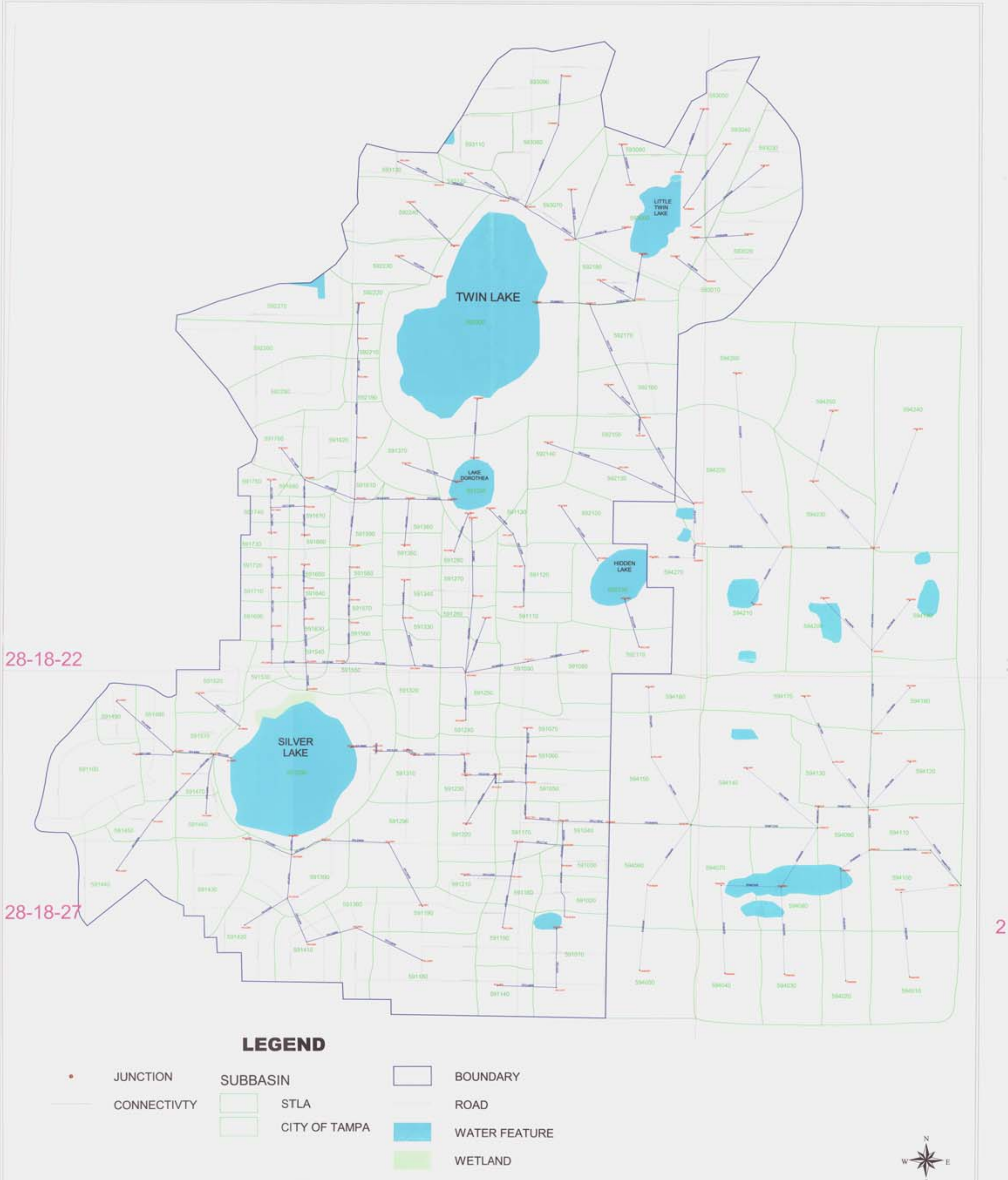
Regression analysis was performed using the programs listed in Table 5.6 and 5.7 for peak streamflow having recurrence intervals of 2, 5, 10, 25, 50, and 100 years, respectively. Similarly, the SWMM model was run for these storm events. Table 5.8 lists the comparisons of SWMM model results with regression method results.

Table 5.8 Comparison of Calibration Results

Event	Peak Discharge at Downstream (cfs)		
	SWMM Model	USGS Equation	Tampa Equation
2.33 Year	128.1	32*	13*
5 Year	161.4	70	30
10 Year	194.4	102	51

25 Year	227.2	152	215
50 Year	290.6	194	277
100 Year	320.3	240	365

* 2-Year event



Hillsborough County
Florida

SILVER TWIN LAKE AREA
STORMWATER MANAGEMENT
MASTER PLAN
JAN. 2001

Public Works Department
Engineering Division
Stormwater Management Section

Exhibit 5-1
Silver Twin Lake Area
Existing Connectivity Diagram
Map

EXISTING CONDITIONS FLOOD LEVEL OF SERVICE

This chapter briefly describes the Flood Control (FC) Level of Service (LOS) methodology used to analyze the Silver / Twin Lakes watershed and then discusses existing conditions FC LOS deficiencies within the study area.

6.1 STANDARD STORM EVENTS

Based on the Hillsborough County Stormwater Management Technical Manual and Southwest Florida Water Management District (SWFWMD) Environmental Resource Permitting Criteria Manual, a standard design storm is defined by total duration, total rainfall depth, and temporal distribution for a specific return period.

There are six standard design storms used to analyze the flooding impacts on Silver / Twin Lakes watershed: the 100-year, 50-year, 25-year, 10-year, 5-year and 2.33-year (mean annual), respectively. The duration and distribution set by SWFWMD criteria are 24 hours, and SCS-type II Florida Modified respectively. Antecedent moisture conditions (AMC-II) are also set by the same SWFWMD criteria. Initial lake elevations used in the HCSWMM model at the start of the design storm event was determined by the inverts of the correspondent outfalls. The total amount of rainfall for a particular frequency was determined based on SWFWMD's rainfall map, which may vary with physical location of watershed. However, considering the small size of the Silver / Twin Lakes watershed, this study assumed uniformly distributed rainfall events. The total rainfalls used for each standard design storm event are listed in Table 6.1.

Table 6.1 - Standard Design Storm Rainfall Intensities

Design Storm	Rainfall Intensity
100-yr/24 hr	11.00 inches
50-yr/24 hr	10.00 inches
25-yr/24 hr	8.00 inches
10-yr/24 hr	7.00 inches
5-yr/24 hr	5.50 inches
2.33-yr/24 hr	4.50 inches

6.2 FLOOD CONTROL LEVEL OF SERVICE DEFINITION

The Hillsborough County Comprehensive Plan, Stormwater Management Element contains definitions for Level of Service flood protection designations. According to these definitions, a storm return period and duration (i.e. 25-year/24-hour) and letter designation (i.e. B) are needed to define the level of flood protection (i.e. 25-year/24-hour level B). The flood level designations contained in the Comprehensive Plan are A, B, C and D. A is the highest level and D is the lowest. However, these criteria are somewhat subjective. Therefore, it is necessary to establish quantitative criteria by which to assign LOS designations. An allowable tolerance that is demographically representative for Hillsborough County before flooding can be classified was assigned to LOS designations A-D as shown in Table 6.2 below. This table contains the interpretation of the Comprehensive Plan definitions used in the LOS analysis herein.

Table 6.2 Level of Service Definition Interpretations

Level	HC Comprehensive Plan Definitions	Master Plan Interpretations
A	No significant street flooding	Street flooding is less than 3"; no site flooding; no structure flooding.
B	No major residential yard flooding	Street flooding is 3" or more above the crown, but less than 6"; site flooding is less than 3"; no structure flooding.
C	No significant structure flooding	Street flooding is 6" or more above the crown, but less than 12"; site flooding is 3" or more, but less than 6"; structure flooding is less than 3".
D	No limitation on flooding	Structure flooding is 3" or more.

As shown in Figure 6-1, the FC LOS designations contained in the Comprehensive Plan contain the assumption that sites are higher than roads and structures are higher than sites. However, this is not always the case. The LOS analysis methodology used herein evaluates road, site and structure landmark elevations independently.

The Comprehensive Plan contains estimated Adopted (existing conditions) and Ultimate (proposed) LOS designations for several watersheds in Hillsborough County. According to the Comprehensive Plan, the 25-year/24-hour level B is the target LOS for the Silver / Twin Lakes watershed.

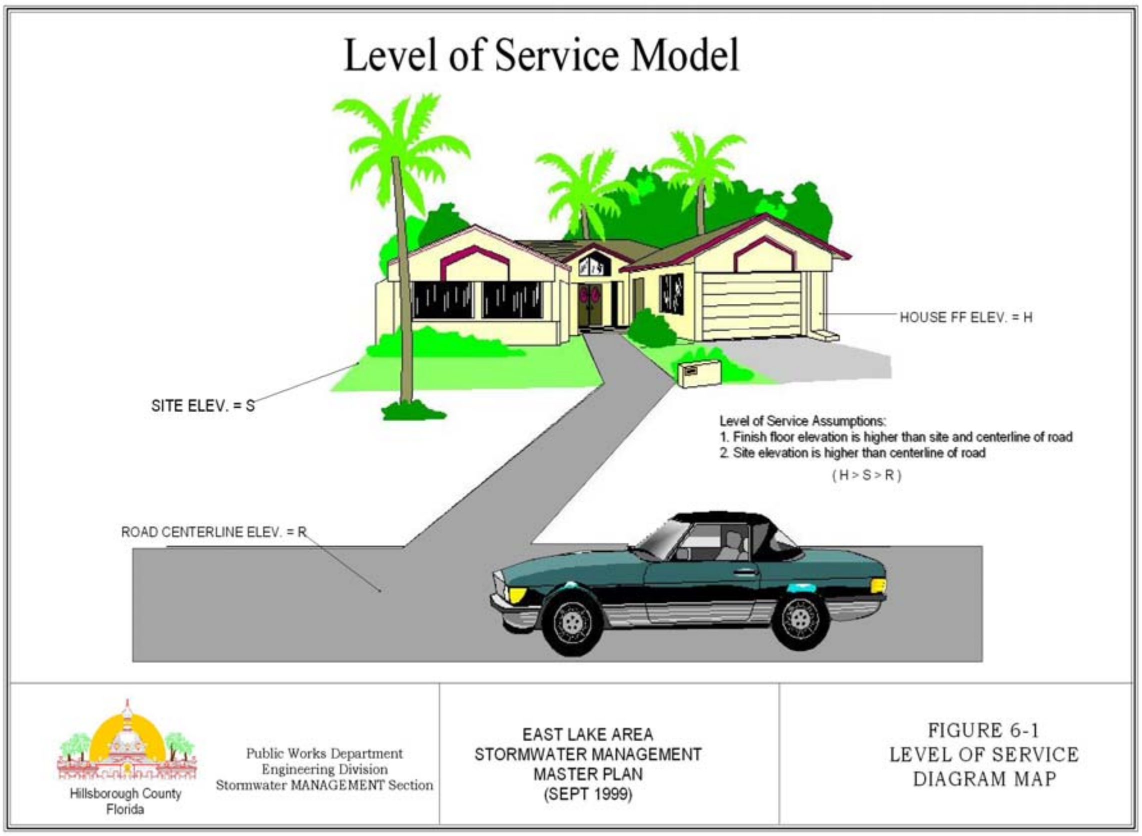


Figure 6-1 Flood Control Level of Service Definition

6.3 ESTABLISHMENT OF LANDMARK ELEVATION

In order to evaluate the FC LOS for a watershed, landmark elevations must first be determined. These elevations refer to landmarks contained in the LOS definitions, including roads, sites and structures. Landmark elevations are established for every subbasin in the watershed. These landmarks then serve as a tool for determining the level of service for the subbasin, and on a broader scale, the system and the watershed. The landmark elevations established for LOS analysis are the critical or lowest landmark elevations in a subbasin. The critical landmark elevations are reflective of the worst case flooding that could occur in a subbasin. These are obtained from survey data and from topographic analysis. Every sub-basin in the watershed is examined for the critical structure, site and road elevation. Table 6.3 contains landmark elevations determined for each Silver / Twin Lake watershed subbasin in the unincorporated portion of Hillsborough County.

6.4 EXISTING CONDITIONS MODEL SIMULATION RESULTS

Figures 6-2 to 6-6 show the simulation results for the major conveyance systems in Silver / Twin Lakes watershed for all six storm events.

6.4.1 Little Twin Lake System

As shown in Figure 6-2, there is no flooding problem identified in this system. The capacity of this drainage system is adequate for the 100-year storm event.

6.4.2 Twin Lake System

The majority of this system is in the City of Tampa. As shown in Figure 6-3, there are no flooding problems identified in unincorporated Hillsborough County. The capacity of this drainage system is sufficient.

6.4.3 Silver Lake Outfall

The major part of this system is made up of either natural or man made ditches. As shown in Figure 6-4, there are no flooding problems identified in this drainage system.

6.4.4 Waters Avenue System

As mentioned in Chapter 3, this system acts as a connection between the Twin Lake and Silver Lake systems. In all six design storm events, water will flow from Silver Lake to Twin Lake. As shown in Figure 6-5, there are no flooding problems identified in this drainage system.

6.4.5 May Street System

As mentioned in Chapter 3, the Claonia Street, May Street, and May Circle area has historically had flooding problems. In 2000, this system was improved by Hillsborough County (CIP 47049). As shown in Figure 6-6, with the improvement, the flooding problem in this area has been solved.

6.5 COMPARISON OF COMPUTED RESULTS AND LANDMARK ELEVATIONS

Using the flood protection LOS designation criteria contained in Table 6.2, the landmark elevations for each subbasin are compared to the computed results of the hydraulic model. In general, the computed result for the most downstream junction was used for comparison with landmark elevations. Table 6.3 contains the difference between established landmark elevations and computed water surface elevations and Level of Service analysis for the 2.33-year/24-hour, 5-year/24-hour, 10-year/24-hour, 25-year/24-hour storm events, and 100-year/24-hour storm events, respectively . There is no structure flooding, site flooding, and road flooding identified in the watershed under the conditions of a 25-year/24-hour storm event.

Table 6.3 Level of Service Analysis

SILVER/TWIN LAKE WATERSHED (Existing Conditions) EXISTING LEVEL OF SERVICE Level of Service Analysis											**Flood Level Designations**				
		Landmark Elevations			Water Surface Elevations										
Story Board	Subbasin	Road	Site	Struct	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**50-YR**	**100-yr**	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**100-yr**
	591000	45.50	46.00	47.00	43.62	44.25	44.88	45.56	46.81	47.28	A	A	A	B	D
	591010	45.00	46.00	47.00	40.75	41.31	41.73	42.08	42.67	42.93	A	A	A	A	D
	591020	45.00	45.40	46.00	37.52	38.24	38.71	39.06	39.66	39.92	A	A	A	A	D

Table 6.3 (cont'd.) **Level of Service Analysis**

SILVER/TWIN LAKE WATERSHED (Existing Conditions) EXISTING LEVEL OF SERVICE Level of Service Analysis											**Flood Level Designations**				
		Landmark Elevations			Water Surface Elevations										
Story Board	Subbasin	Road	Site	Struct	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**50-YR**	**100-yr**	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**100-yr**
	591030	43.00	44.00	45.00	36.59	37.53	38.02	38.36	38.92	39.16	A	A	A	A	D
	591040	45.50	46.00	47.00	34.44	34.95	35.42	35.81	36.48	36.75	A	A	A	A	D
	591050	44.50	45.00	45.50	37.70	37.87	38.01	38.45	39.36	39.96	A	A	A	A	D
	591060	45.60	46.00	46.60	40.58	41.06	41.39	41.69	42.23	42.50	A	A	A	A	D
	591070	47.00	47.40	48.00	40.69	41.17	41.52	41.82	42.38	42.65	A	A	A	A	D
	591080	999.00	999.00	999.00	48.13	48.16	48.18	48.20	48.24	48.26	E	E	E	E	E
	591090	46.10	46.50	46.80	37.93	38.44	39.12	39.83	41.29	42.12	A	A	A	A	D
	591100	50.00	51.60	52.00	45.78	46.38	46.99	47.60	48.80	49.33	A	A	A	A	D
	591110	47.90	48.80	49.00	48.25	48.26	48.26	48.27	48.29	48.29	B	B	B	B	D
	591120	999.00	999.00	999.00	47.19	47.19	47.19	47.19	47.19	47.19	E	E	E	E	E
	591130	999.00	999.00	999.00	45.10	45.11	45.13	45.14	45.16	45.18	E	E	E	E	E
	591140	49.70	50.00	51.00	44.96	44.97	44.98	44.99	45.01	45.01	A	A	A	A	D
	591150	50.60	51.00	51.50	46.77	46.78	46.79	46.80	46.82	46.83	A	A	A	A	D
	591160	44.00	46.50	47.00	36.03	36.56	37.18	37.78	38.72	38.99	A	A	A	A	D
	591170	43.20	44.00	45.00	35.81	36.28	36.73	37.11	37.75	38.02	A	A	A	A	D
	591180	50.00	53.20	54.00	50.14	50.88	51.42	53.27	54.73	54.96	B	B	B	B	D
	591190	52.30	53.00	53.50	52.27	52.28	52.29	52.29	53.25	53.32	A	A	A	A	D
	591200	40.00	41.00	42.00	34.51	34.83	35.02	35.18	35.47	35.57	A	A	A	A	D
	591210	49.50	50.00	50.50	43.25	43.26	43.27	43.27	43.28	43.29	A	A	A	A	D
	591220	999.00	999.00	999.00	48.28	48.29	48.30	48.31	48.33	48.34	E	E	E	E	E

Table 6.3 (cont'd.) **Level of Service Analysis**

SILVER/TWIN LAKE WATERSHED (Existing Conditions) EXISTING LEVEL OF SERVICE Level of Service Analysis											**Flood Level Designations**				
		Landmark Elevations			Water Surface Elevations										
Story Board	Subbasin	Road	Site	Struct	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**50-YR**	**100-yr**	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**100-yr**
	591230	42.40	43.00	43.40	39.28	39.45	39.62	39.85	40.98	41.84	A	A	A	A	D
	591240	43.00	44.60	45.00	41.25	41.27	41.28	41.29	42.08	43.06	A	A	A	A	D
	591250	43.00	44.90	45.00	38.17	38.69	39.52	40.39	42.07	43.06	A	A	A	A	D
	591260	45.00	45.90	46.00	37.78	38.33	39.03	39.79	41.26	42.08	A	A	A	A	D
	591270	43.80	45.00	45.00	36.13	37.08	37.62	38.08	39.09	39.63	A	A	A	A	D
	591280	41.00	41.50	42.00	35.36	35.93	36.31	36.61	37.25	37.56	A	A	A	A	D
	591290	999.00	999.00	999.00	52.12	52.14	52.16	52.18	53.26	53.35	E	E	E	E	E
	591310	47.70	48.00	49.00	42.56	42.59	42.64	42.81	43.19	43.41	A	A	A	A	D
	591320	45.00	45.50	46.00	41.02	41.40	42.53	43.81	46.04	46.82	A	A	A	A	D
	591330	45.00	45.50	46.00	45.19	45.20	45.21	45.23	46.04	46.81	B	B	B	B	D
	591340	47.10	48.00	50.00	47.16	47.17	47.18	47.19	47.20	47.21	B	B	B	B	D
	591350	45.10	45.90	46.00	44.05	44.42	44.77	45.13	46.11	46.59	A	A	A	B	D
	591360	45.70	46.00	47.10	44.02	44.38	44.72	45.08	46.04	46.56	A	A	A	A	D
	591370	999.00	45.00	46.00	45.28	45.29	45.31	45.32	45.34	45.35	C	C	C	C	D
	591380	49.40	52.30	53.00	50.14	50.90	51.45	53.23	54.71	54.88	B	B	B	D	D
	591390	999.00	999.00	999.00	49.15	49.91	50.45	51.54	52.92	53.07	E	E	E	E	E
	591410	999.00	999.00	999.00	50.14	50.91	51.46	53.18	54.80	54.78	E	E	E	E	E
	591420	999.00	999.00	999.00	50.47	50.82	51.31	52.91	54.22	54.37	E	E	E	E	E
	591430	999.00	999.00	999.00	50.10	50.89	51.26	51.67	53.02	53.21	E	E	E	E	E
	591440	999.00	999.00	999.00	52.51	52.53	52.55	52.56	52.59	52.60	E	E	E	E	E

Table 6.3 (cont'd.) **Level of Service Analysis**

SILVER/TWIN LAKE WATERSHED (Existing Conditions)	**Flood**

EXISTING LEVEL OF SERVICE	Level of Service Analysis										**Level Designations**				
		Landmark Elevations			Water Surface Elevations										
Story Board	Subbasin	Road	Site	Struct	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**50-YR**	**100-yr**	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**100-yr**
	591450	50.00	52.00	53.00	50.44	50.46	50.48	50.49	50.53	50.54	B	B	B	B	D
	591460	999.00	999.00	999.00	54.26	54.27	54.27	54.28	54.30	54.30	E	E	E	E	E
	591470	50.00	50.30	51.00	49.16	49.18	49.20	49.22	49.41	49.68	A	A	A	A	D
	591480	52.50	52.50	53.00	45.97	46.81	47.80	48.74	49.44	49.71	A	A	A	A	D
	591490	52.20	53.00	53.50	52.85	52.86	52.86	52.87	52.88	52.89	B	B	B	B	D
	591510	50.00	50.50	51.00	45.86	46.68	47.64	48.62	49.38	49.66	A	A	A	A	D
	591520	50.80	51.00	51.50	50.88	50.90	50.91	50.92	50.94	50.95	B	B	B	B	D
	591530	50.00	50.50	51.00	50.92	51.68	52.64	52.81	52.92	53.35	C	D	D	D	D
	591540	51.00	52.00	53.00	44.16	44.69	45.64	46.41	47.66	48.34	A	A	A	A	D
	591550	49.00	49.50	50.00	43.27	43.89	44.98	46.05	47.53	48.14	A	A	A	A	D
	591560	48.90	49.00	50.00	43.28	43.91	45.00	46.07	47.55	48.16	A	A	A	A	D
	591570	999.00	999.00	999.00	51.43	51.96	52.40	52.87	53.72	54.10	E	E	E	E	E
	591580	999.00	999.00	999.00	51.38	51.90	52.35	52.81	53.66	54.03	E	E	E	E	E
	591590	49.90	51.30	52.00	47.98	48.85	49.65	50.14	50.95	51.34	A	A	A	B	D
	591610	49.20	50.00	51.00	46.88	47.09	47.28	47.45	47.77	47.92	A	A	A	A	D
	591620	999.00	999.00	999.00	51.26	51.98	52.71	53.41	54.68	55.28	E	E	E	E	E
	591630	51.00	51.00	51.00	49.11	49.14	49.17	49.20	49.82	50.35	A	A	A	A	D
	591640	51.00	51.00	51.00	50.10	50.13	50.15	50.18	50.23	50.39	A	A	A	A	D
	591650	999.00	999.00	999.00	51.19	51.21	51.24	51.27	51.31	51.33	E	E	E	E	E
	591660	51.00	51.00	51.00	50.04	50.05	50.08	50.11	50.15	50.17	A	A	A	A	D

Table 6.3 (cont'd.) **Level of Service Analysis**

SILVER/TWIN LAKE WATERSHED (Existing Conditions)	**Flood**

EXISTING LEVEL OF SERVICE Level of Service Analysis											Level Designations				
		Landmark Elevations			Water Surface Elevations										
Story Board	Subbasin	Road	Site	Struct	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**50-YR**	**100-yr**	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**100-yr**
	591670	50.40	51.00	51.40	49.69	50.03	50.08	50.11	50.15	50.16	A	A	A	A	D
	591680	52.00	53.40	54.00	50.10	50.10	50.10	50.11	50.15	50.17	A	A	A	A	D
	591690	54.10	55.00	55.00	50.93	51.69	52.66	52.85	52.96	53.40	A	A	A	A	D
	591710	54.00	54.00	54.00	50.95	51.70	52.66	52.85	52.96	53.40	A	A	A	A	D
	591720	53.00	53.00	53.00	51.18	51.71	52.67	52.85	52.99	53.43	A	A	A	A	D
	591730	52.00	52.00	52.00	51.05	51.05	51.06	51.07	51.08	51.08	A	A	A	A	D
	591740	999.00	999.00	999.00	49.85	50.06	50.10	50.13	50.17	50.18	E	E	E	E	E
	591750	53.00	53.00	53.00	51.04	51.04	51.05	51.05	51.06	51.07	A	A	A	A	D
	591760	50.00	51.00	52.00	50.07	50.08	50.09	50.12	50.16	50.17	B	B	B	B	D
	592000	999.00	999.00	999.00	33.02	33.37	33.72	34.05	34.76	35.12	E	E	E	E	E
	592100	40.00	40.00	42.00	32.42	32.66	32.90	33.14	33.60	33.82	A	A	A	A	D
	592110	999.00	999.00	999.00	46.81	46.83	46.85	46.86	46.89	46.90	E	E	E	E	E
	592120	999.00	999.00	999.00	45.27	45.28	45.29	45.30	45.32	45.33	E	E	E	E	E
	592130	999.00	999.00	999.00	40.13	40.16	40.18	40.21	40.25	40.27	E	E	E	E	E
	592140	45.00	46.90	47.00	43.89	43.92	43.93	43.95	43.99	44.00	A	A	A	A	D
	592150	40.00	41.00	42.00	40.08	40.09	40.10	40.12	40.14	40.15	B	B	B	B	D
	592160	37.80	40.00	41.00	37.11	37.13	37.14	37.16	37.19	37.20	A	A	A	A	D
	592170	999.00	999.00	999.00	40.12	40.14	40.16	40.17	40.21	40.22	E	E	E	E	E
	592180	999.00	999.00	999.00	40.91	40.93	40.94	40.96	40.99	41.00	E	E	E	E	E
	592190	999.00	999.00	999.00	51.48	52.31	53.15	53.94	55.39	56.07	E	E	E	E	E

Table 6.3 (cont'd.) **Level of Service Analysis**

SILVER/TWIN LAKE WATERSHED (Existing Conditions)	**Flood**

EXISTING LEVEL OF SERVICE	Level of Service Analysis										**Level Designations**				
		Landmark Elevations			Water Surface Elevations										
Story Board	Subbasin	Road	Site	Struct	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**50-YR**	**100-yr**	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**100-yr**
	592210	999.00	999.00	999.00	52.29	53.22	54.17	55.05	56.64	57.36	E	E	E	E	E
	592220	999.00	999.00	999.00	52.32	53.25	54.21	55.09	56.67	57.40	E	E	E	E	E
	592230	44.80	45.00	46.00	44.89	44.91	44.92	44.93	44.96	44.97	B	B	B	B	D
	592240	47.50	45.00	45.00	44.92	44.94	44.96	44.97	45.00	45.02	A	A	A	A	D
	592250	999.00	999.00	999.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	E	E	E	E	E
	592260	999.00	999.00	999.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	E	E	E	E	E
	592270	999.00	999.00	999.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	E	E	E	E	E
	593000	40.00	40.00	40.00	34.07	35.02	35.84	36.53	37.83	38.42	A	A	A	A	D
	593010	47.80	47.80	47.80	45.08	45.09	45.11	45.12	45.14	45.15	A	A	A	A	D
	593020	999.00	999.00	999.00	44.69	44.71	44.73	44.74	44.78	44.79	E	E	E	E	E
	593030	999.00	999.00	999.00	45.31	45.34	45.36	45.38	45.42	45.44	E	E	E	E	E
	593040	999.00	999.00	999.00	45.19	45.21	45.23	45.25	45.28	45.29	E	E	E	E	E
	593050	999.00	999.00	999.00	44.12	44.14	44.16	44.18	44.22	44.23	E	E	E	E	E
	593060	999.00	999.00	999.00	43.65	43.66	43.67	43.68	43.70	43.70	E	E	E	E	E
	593070	40.00	41.20	43.00	35.92	36.20	36.24	36.53	37.83	38.42	A	A	A	A	D
	593080	40.00	42.00	43.00	38.37	39.13	39.73	40.23	41.11	41.52	A	A	A	B	D
	593090	999.00	999.00	999.00	47.06	47.10	47.12	47.15	47.20	47.23	E	E	E	E	E
	593110	999.00	999.00	999.00	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	E	E	E	E	E
	593120	40.00	42.00	43.00	38.97	39.75	40.14	40.49	41.32	41.71	A	A	B	B	D
	593130	45.00	45.00	45.00	42.03	42.15	42.28	42.83	44.13	44.47	A	A	A	A	D

Table 6.3 (cont'd.) **Level of Service Analysis**

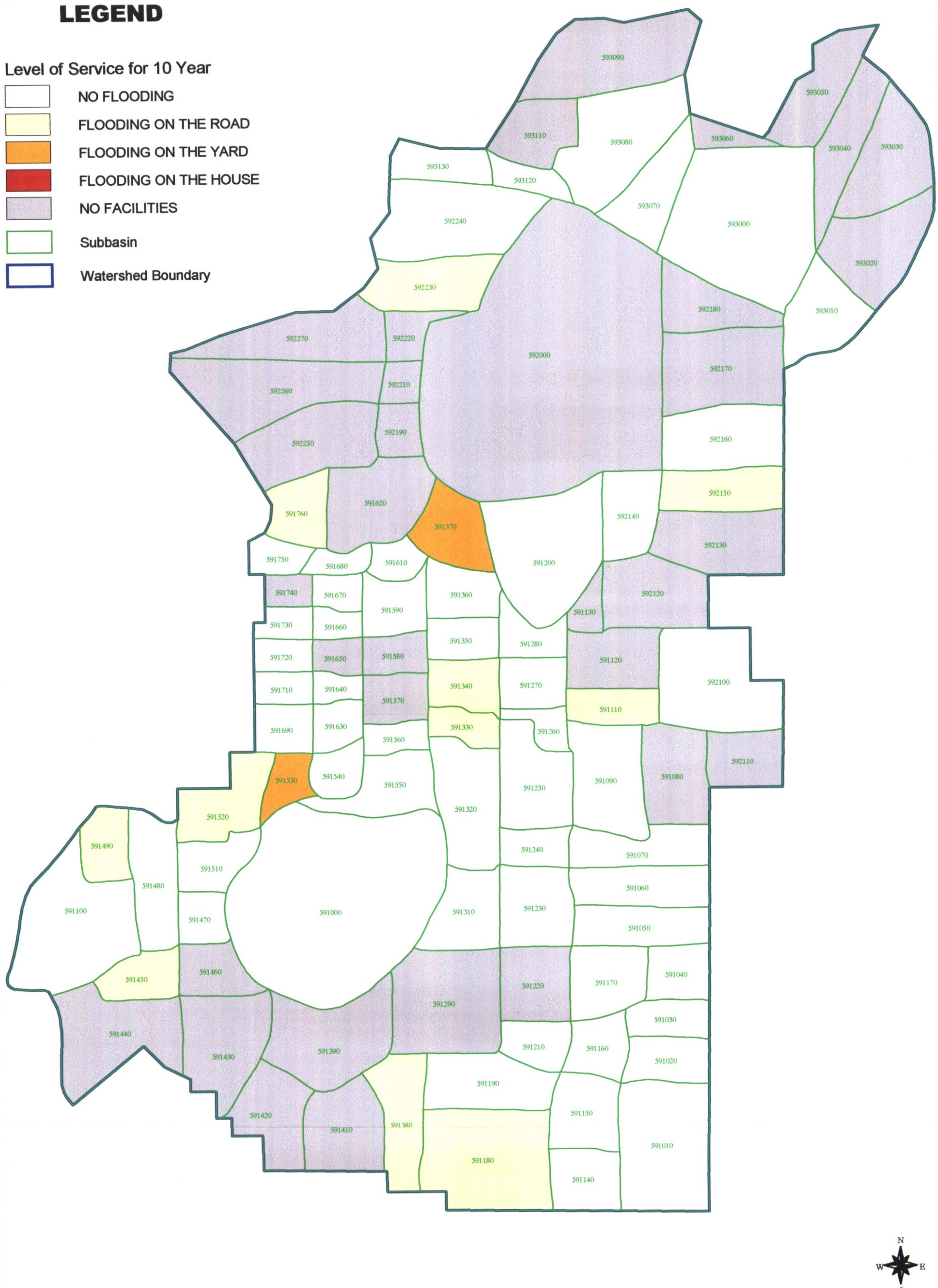
SILVER/TWIN LAKE WATERSHED (Existing Conditions)	**Flood**

EXISTING LEVEL OF SERVICE Level of Service Analysis											**Level Designations**				
		Landmark Elevations			Water Surface Elevations										
Story Board	Subbasin	Road	Site	Struct	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**50-YR**	**100-yr**	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**100-yr**
	594010	999.00	999.00	999.00	30.04	30.05	30.06	30.06	30.07	30.08	E	E	E	E	E
	594020	999.00	999.00	999.00	33.34	33.34	33.35	33.35	33.36	33.37	E	E	E	E	E
	594030	999.00	999.00	999.00	37.64	37.65	37.65	37.66	37.67	37.68	E	E	E	E	E
	594040	999.00	999.00	999.00	37.65	37.65	37.66	37.67	37.68	37.69	E	E	E	E	E
	594050	999.00	999.00	999.00	47.95	47.95	47.96	47.97	47.98	47.99	E	E	E	E	E
	594060	999.00	999.00	999.00	46.07	46.08	46.09	46.10	46.12	46.13	E	E	E	E	E
	594070	999.00	999.00	999.00	36.68	36.69	36.70	36.71	36.73	36.74	E	E	E	E	E
	594080	999.00	999.00	999.00	34.12	34.14	34.15	34.17	34.20	34.21	E	E	E	E	E
	594090	999.00	999.00	999.00	30.37	30.38	30.39	30.40	30.41	30.42	E	E	E	E	E
	594100	999.00	999.00	999.00	29.57	29.58	29.59	29.60	29.62	29.63	E	E	E	E	E
	594110	999.00	999.00	999.00	29.53	29.54	29.54	29.54	29.55	29.56	E	E	E	E	E
	594120	999.00	999.00	999.00	26.95	26.96	26.97	26.97	26.99	26.99	E	E	E	E	E
	594130	999.00	999.00	999.00	25.15	25.50	25.81	26.10	26.61	26.83	E	E	E	E	E
	594140	999.00	999.00	999.00	30.07	30.08	30.40	30.84	31.58	31.89	E	E	E	E	E
	594150	999.00	999.00	999.00	45.97	45.98	45.99	46.00	46.02	46.03	E	E	E	E	E
	594160	999.00	999.00	999.00	46.03	46.03	46.04	46.04	46.05	46.06	E	E	E	E	E
	594170	999.00	999.00	999.00	25.76	25.76	25.81	26.10	26.61	26.83	E	E	E	E	E
	594180	999.00	999.00	999.00	26.85	26.86	26.86	26.87	26.88	26.96	E	E	E	E	E
	594190	999.00	999.00	999.00	28.26	28.27	28.28	28.31	28.58	28.69	E	E	E	E	E
	594200	999.00	999.00	999.00	28.22	28.22	28.22	28.30	28.57	28.69	E	E	E	E	E

Table 6.3 (cont'd.) **Level of Service Analysis**

SILVER/TWIN LAKE WATERSHED (Existing Conditions)	**Flood**

EXISTING LEVEL OF SERVICE	Level of Service Analysis										**Level Designations**				
		Landmark Elevations			Water Surface Elevations										
Story Board	Subbasin	Road	Site	Struct	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**50-YR**	**100-yr**	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**100-yr**
	594210	999.00	999.00	999.00	32.12	32.12	32.12	32.12	32.13	32.22	E	E	E	E	E
	594220	999.00	999.00	999.00	32.18	32.19	32.21	32.22	32.24	32.26	E	E	E	E	E
	594230	999.00	999.00	999.00	32.04	32.05	32.06	32.07	32.08	32.09	E	E	E	E	E
	594240	999.00	999.00	999.00	32.06	32.07	32.08	32.09	32.11	32.12	E	E	E	E	E
	594250	999.00	999.00	999.00	32.21	32.22	32.22	32.22	32.23	32.23	E	E	E	E	E
	594260	999.00	999.00	999.00	32.55	32.56	32.56	32.57	32.58	32.59	E	E	E	E	E
	594270	999.00	999.00	999.00	32.10	32.31	32.49	32.69	33.12	33.30	E	E	E	E	E



Hillsborough County
Florida

SILVER TWIN LAKE AREA STORMWATER MANAGEMENT MASTER PLAN SEPTEMBER 2001

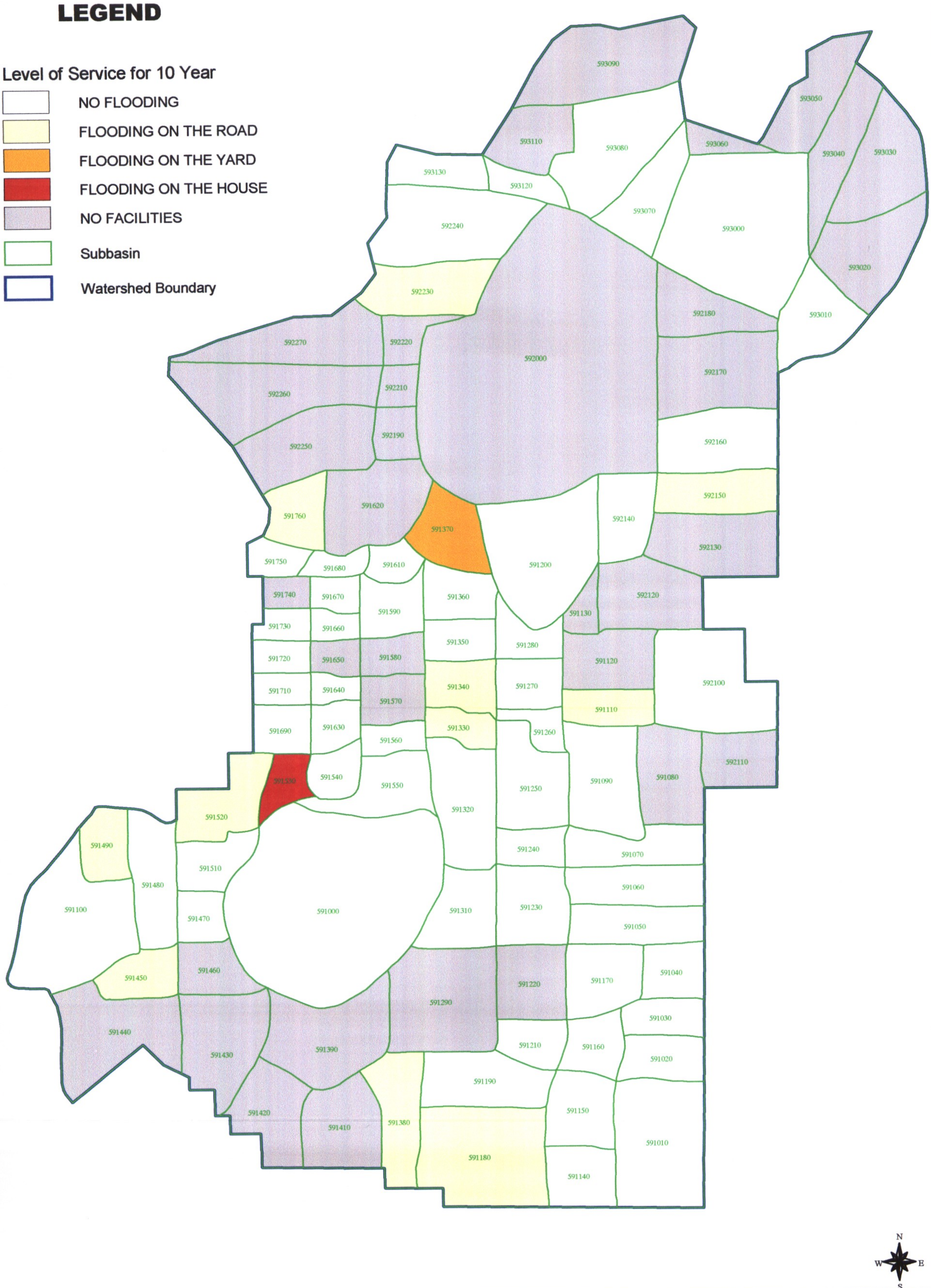
Public Works Department
Engineering Division
Stormwater Management Section

Figure 6-3A
Existing Condition
Level of Service 2.33 Yr. 24Hr.

LEGEND

Level of Service for 10 Year

- NO FLOODING
- FLOODING ON THE ROAD
- FLOODING ON THE YARD
- FLOODING ON THE HOUSE
- NO FACILITIES
- Subbasin
- Watershed Boundary



Hillsborough County
Florida

SILVER TWIN LAKE AREA STORMWATER MANAGEMENT MASTER PLAN SEPTEMBER 2001

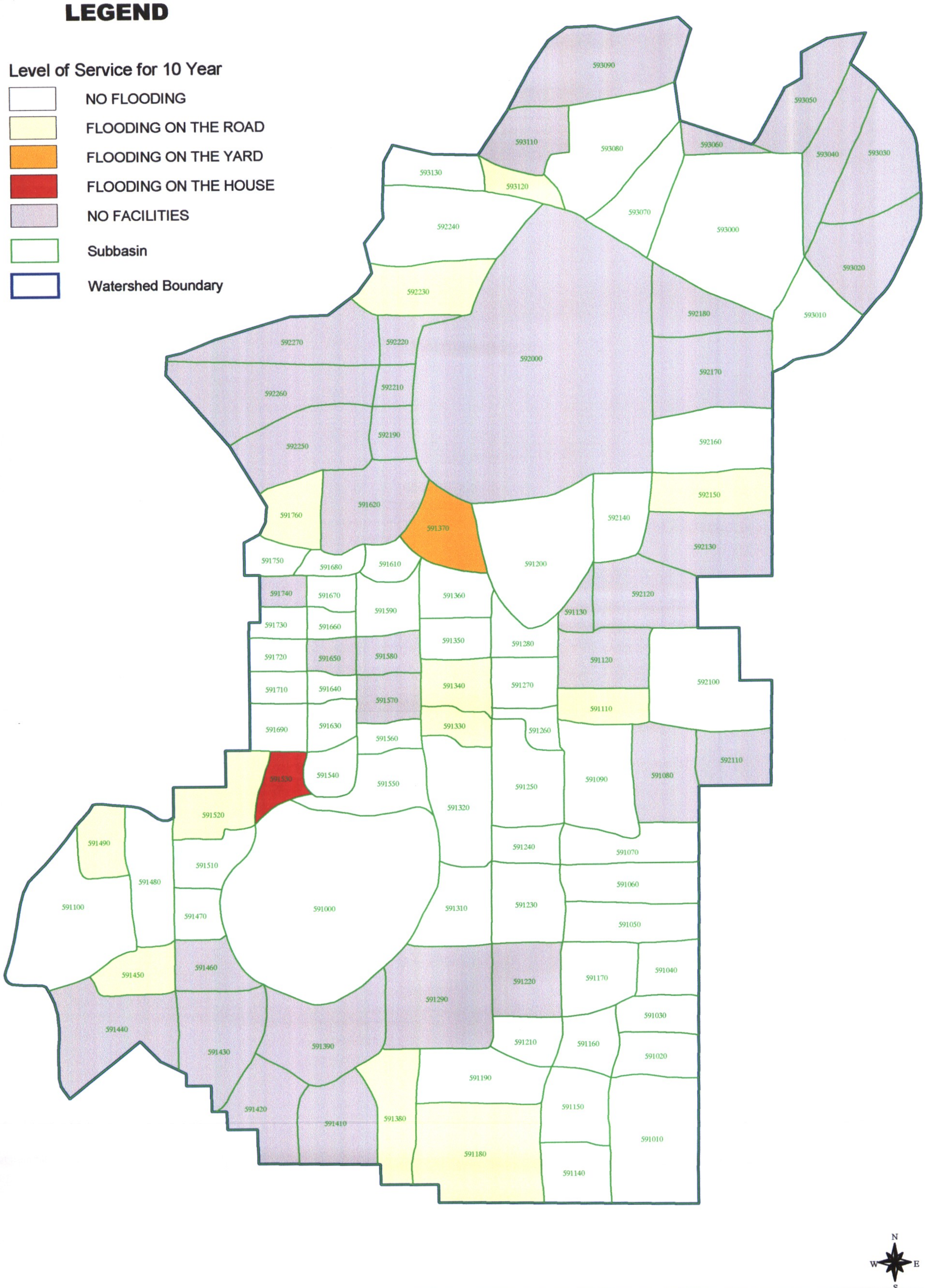
Public Works Department
Engineering Division
Stormwater Management Section

Figure 6-3B
Existing Condition
Level of Service 5 Yr. 24Hr.

LEGEND

Level of Service for 10 Year

- NO FLOODING
- FLOODING ON THE ROAD
- FLOODING ON THE YARD
- FLOODING ON THE HOUSE
- NO FACILITIES
- Subbasin
- Watershed Boundary



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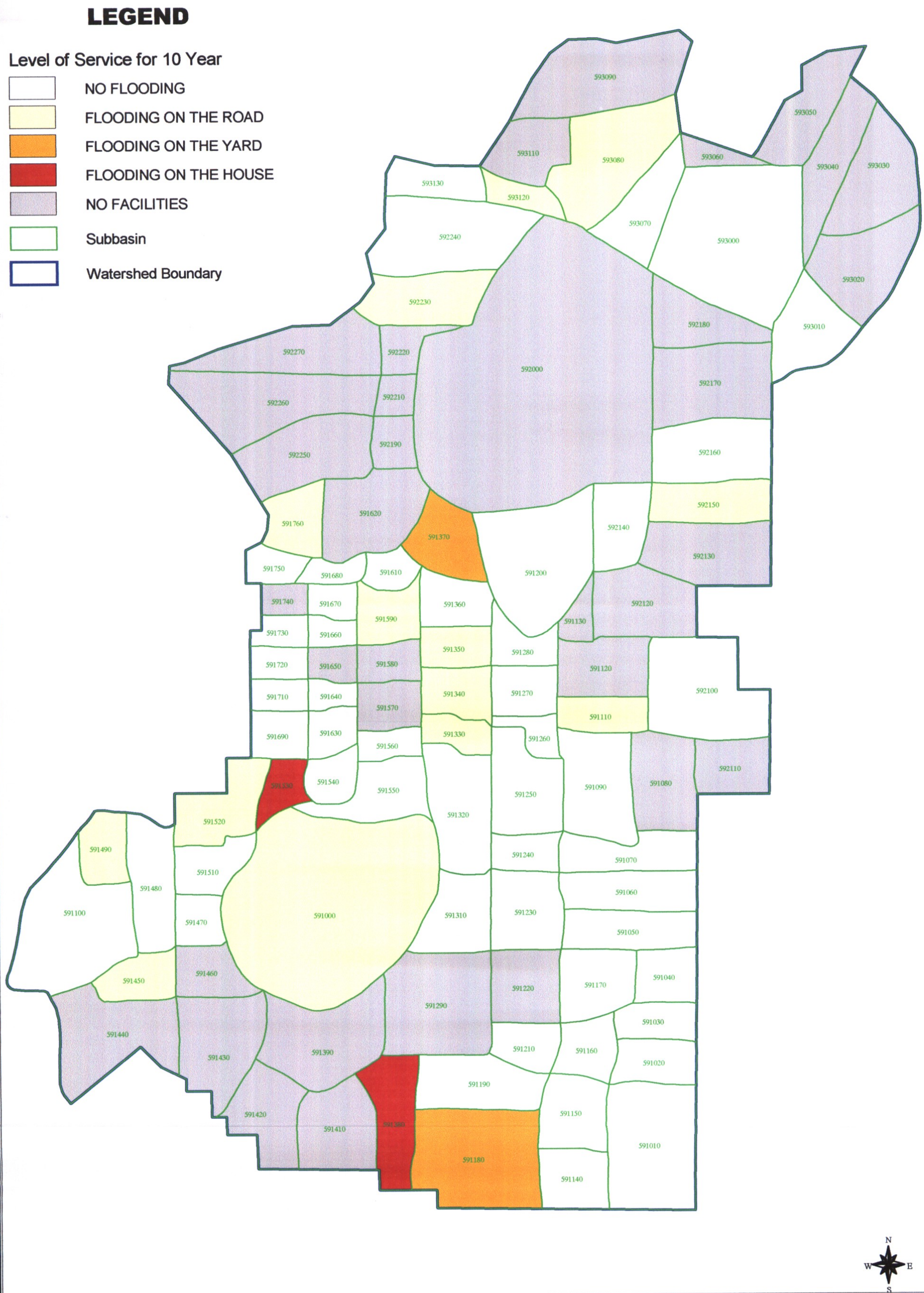
SILVER TWIN LAKE AREA STORMWATER MANAGEMENT MASTER PLAN SEPTEMBER 2001

Public Works Department
Engineering Division
Stormwater Management Section

Figure 6-3C
Existing Condition
Level of Service 10 Yr. 24Hr.



Hillsborough County
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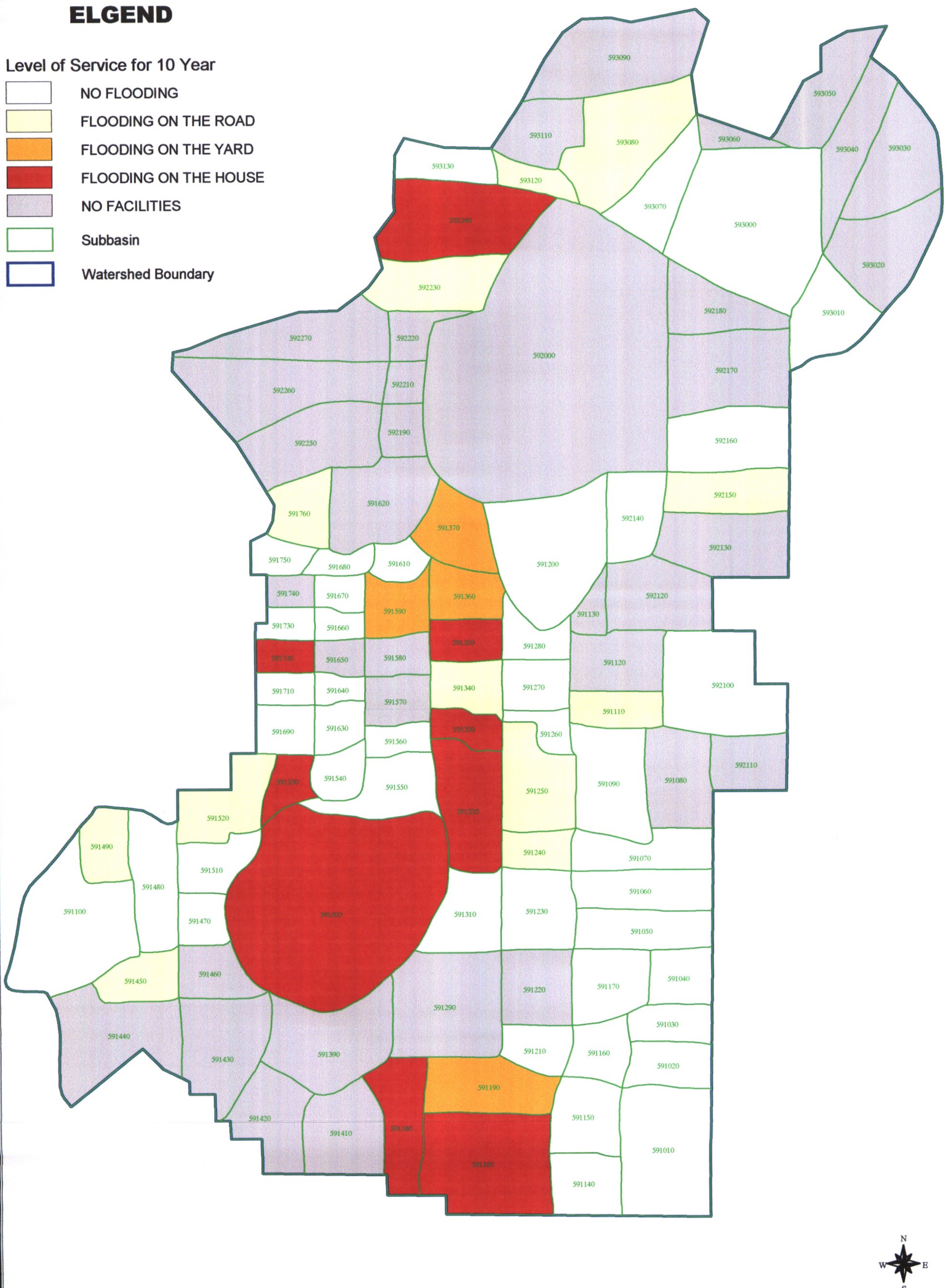
SILVER TWIN LAKE AREA
STORMWATER MANAGEMENT
MASTER PLAN
SEPTEMBER 2001

Public Works Department
Engineering Division
Stormwater Management Section

Figure 6-3D
Existing Condition
Level of Service 25 Yr. 24Hr.

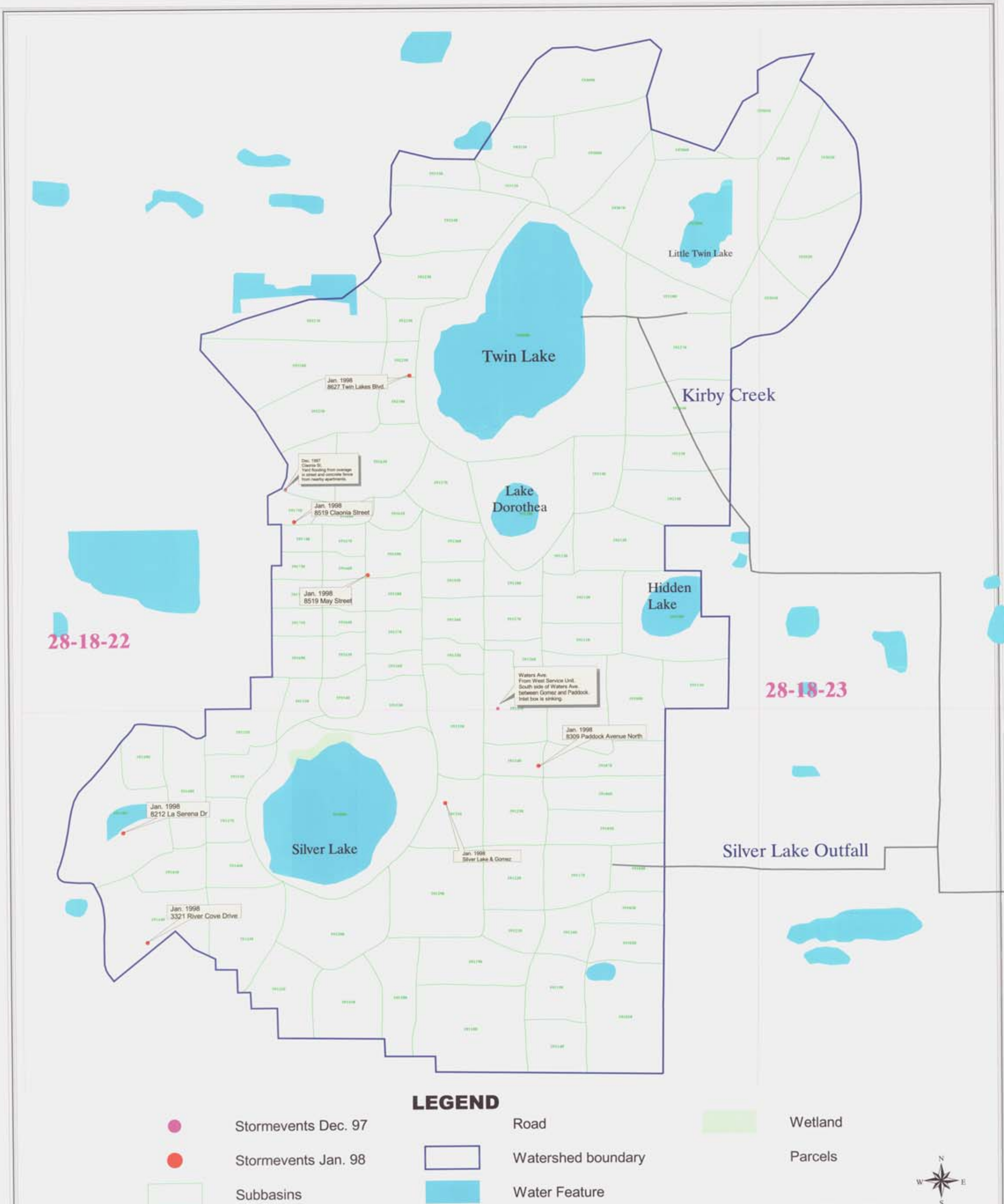


Hillsborough County
Florida

SILVER TWIN LAKE AREA STORMWATER MANAGEMENT MASTER PLAN SEPTEMBER 2001

Public Works Department
Engineering Division
Stormwater Management Section

Figure 6-3E
Existing Condition
Level of Service 100 Yr. 24Hr.



Hillsborough County
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SILVER TWIN LAKE AREA STORMWATER MANAGEMENT MASTER PLAN SEPTEMBER 2001

Public Works Department
Engineering Division
Stormwater Management Section

Exhibit 6-2
Silver Twin Lake Area
Historic Flooding Location
Map

EXISTING WATER QUALITY CONDITIONS

7.1 OVERVIEW

As previously shown in **Table 2.1** in Chapter 2, there are very few wetland areas left in the Silver / Twin Lakes watershed area. Lakes and the man-made reservoir contribute about 10.09% of the watershed's total acreage and constitute the main bulk of the basin's natural systems. The major natural surface water features in the watershed are Silver and Twin Lakes. In addition to these two lakes, there are several smaller lakes, none of which total more than 10 acres. They are, in order of descending size in acres, Little Twin Lake, Hidden Lake and Lake Dorothea.

The federal Clean Water Act (CWA), as amended, provides the framework for water quality management throughout the United States. As overall goals, the CWA calls for the restoration and maintenance of "fishable and swimmable" waters for all citizens. Federal and state regulations developed to implement the act have therefore focused on providing water quality conditions necessary to support viable fish and wildlife populations and protect human health. Water quality standards that include: (1) designated uses; (2) numeric and narrative water quality criteria, and (3) an antidegradation policy, have been the primary tools used in the national management effort.

Designated Uses, such as potable water supply, shellfish harvesting, wildlife propagation and recreational contact, are identified at the state level (e.g. Ch. 62-302.400, Florida Administrative Code or F.A.C.) through a formal rulemaking process, and are established for all waterbodies within the state's jurisdiction.

Water quality criteria, which describe the specific water quality conditions necessary to achieve designated uses, are also established by rulemaking at the state level (e.g. Ch. 62-302.530, F.A.C.). Criteria adopted by the state must be consistent with minimum federal standards set by the U.S. EPA. Presently, the EPA is working through DEP to establish TMDLs to be used on a statewide basis.

Anti-degradation policy, which is implemented by state and federal regulatory agencies through the permitting process, holds that all existing uses of a waterbody (including those that may exceed the designated uses) should be maintained. For example, regulatory agencies will seek to maintain the existing condition when that condition is higher than the minimum for a fishable and swimmable waterway unless important economic and social goals require otherwise.

All lakes within the Silver / Twin Lakes watershed are considered to be Class III Florida waters. This designation allows for human recreation and the "propagation and maintenance of a healthy, well-balanced population of fish and wildlife" (Chapter 62-302.400 F.A.C.).

7.2 LAKES

Several lakes exist within the Silver / Twin Lakes watershed. They are distributed fairly evenly throughout the basin. Silver and Twin Lakes are the largest, with the remainder all being less than 5 acres in size. According to the SWFWMD, Twin Lake ranks about 72nd in size of all the lakes and major borrow pits found in Hillsborough County. Silver Lake ranks about 116th. All the basin's lakes have undergone numerous man-induced changes through the years due to the progressively urban nature of the land uses that surround them. Many of these changes could have been avoided or substantially delayed, had the watershed not been developed prior to the majority of most environmental and stormwater regulations. This has resulted in the accelerated eutrophication of many of these lakes.

7.2.1 Data and Assessment Methods

The only water quality data that has been regularly collected within the watershed has come from the University of Florida's LAKEWATCH program in which Hillsborough County participates. Unfortunately, this monitoring has either not been carried out for an extended period or the sampling has been interrupted due to a change of LAKEWATCH volunteers on a particular lake. These lakes include only Silver and Twin. The condition of these waterbodies is a watershed area of concern. The Environmental Protection Commission of Hillsborough County has also taken a few samples on the watershed's lakes through the years as a result of citizen's complaints.

Trained volunteers perform monthly sampling for the LAKEWATCH program. These volunteers measure Secchi disk depth for water clarity along with chlorophyll *a* and general water chemistry indicators. These samples are taken on three permanently located sites on the lake. The samples are immediately frozen and shipped to a laboratory at the University of Florida for analysis. The lab provides measurements of total phosphorus, total nitrogen and chlorophyll *a* using FDEP approved methods. This sampling is to be carried out within a specified eleven day period each month. Other information, such as bathymetry, lake stage and depth, vegetative and animal surveys and general water chemistry are also collected from a subset of lakes. These surveys are carried out by the Hillsborough County Lake Management Program (LaMP), which usually samples between 30 and 50 lakes each year.

FDEP recommends the use of the Florida Trophic Site Index (TSI) to characterize water quality conditions in lakes based on nutrient and chlorophyll concentrations (Hand et. al 1990, 1996). The index approach was initially developed by Carlson (1977), who used three water quality indicators (total phosphorus concentration, chlorophyll concentration, and Secchi disk depth) to summarize trophic state conditions. Carlson=s index was constructed so that a 10 unit change in index value represented a doubling or halving of chlorophyll concentration (an indicator of algal biomass). The Florida TSI developed by FDEP is based on the same rationale, but has been modified from Carlson=s original formula. It includes the concentration of total nitrogen (TN) as an additional trophic state indicator and the indicator of Secchi depth has been dropped. The Secchi depth was dropped from the calculation of TSI values (Hand et. al. 1996) because FDEP found that interpretation of Secchi depth data in many Ablackwater≅ (tannic) Florida waterbodies can be problematic due to reduction of water column transparency from naturally elevated concentrations of dissolved organic matter (DOM), algal cells or other sources of turbidity.

The components of the Trophic State Index are calculated as follows (Hand et. al. 1990):

$TSI_{CHLa} = 16.8 + (14.4 \text{ x } \ln[\text{Chl } a])$

$TSI_{TP} = 18.6 + \ln([TP] \text{ x } 1000) - 18.4$

$TSI_{TN} = 56 + (19.8 \text{ x } \ln[TN])$

$TSI_{SECCHI} = 60 - (30 \text{ x } \ln[SD])$

where:

[Chl *a*] = annual average chlorophyll a concentration in *u*g/l

[TP] = annual average total phosphorus concentration in mg/l

[TN] = annual average total nitrogen concentration in mg/l

[SD] = annual average Secchi disk depth in meters

$\ln = \log_e$

An overall index value (TSI_{avg}) can be obtained by averaging the component values. FDEP recommends the following interpretation of calculated TSI_{avg} values for lakes (Hand et. al. 1990, 1996):

Lake TSI_{avg}	FDEP Water Quality Characterization
< 60	AGood≅
60 - 69	AFair≅
> 69	APoor≅

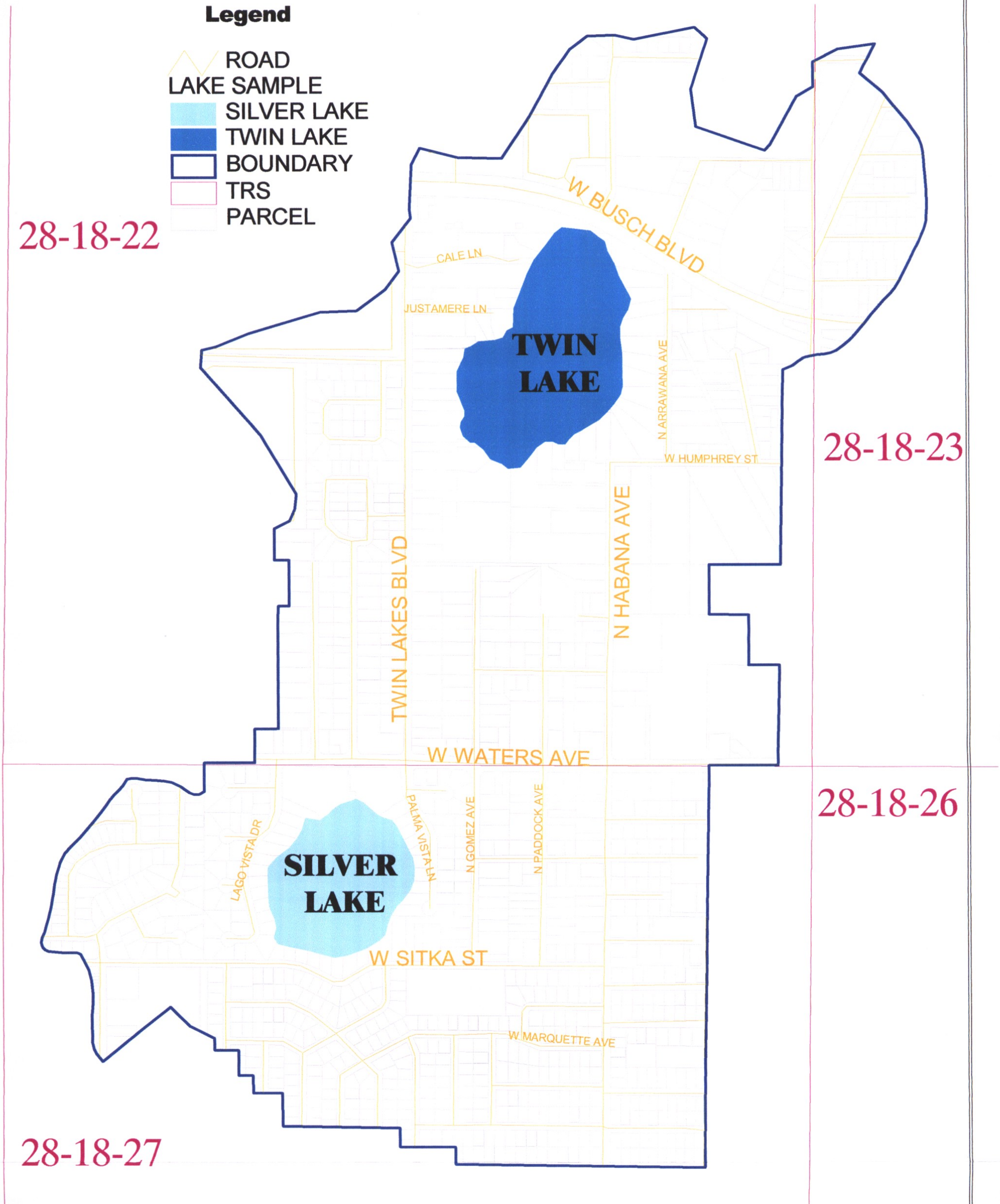
LAKEWATCH and other physical information for the lakes in the Silver / Twin Lakes watershed is summarized in **Table 7.1** and includes surface area, mean depth, lake volume and annual average TSI, when available.

During the time of sampling, the annual average TSI has been rated as Agood≅ for both Silver and Twin Lakes. **Figure 7-1** shows the location of the lakes being samples.

Table 7.1
Summary of lake data for the Silver / Twin Lakes Watershed

LAKE NAME	AVAILABLE LAKEWATCH DATA	SURFACE AREA (acres)	MEAN DEPTH (ft)	LAKE VOLUME (gallons)	ANNUAL AVERAGE TSI
Dorothea	N/A	3.19	N/A	N/A	N/A
Hidden	N/A	3.17	N/A	N/A	N/A
Little Twin	N/A	4.28	N/A	N/A	N/A
Silver	11/96-10/00*	18.69	N/A	N/A	56.8
Twin	11/96-12/01*	27.05	9.4	87,139,008	58.3

* denotes not all months are available; there are gaps in the data



Hillsborough County
Florida

SILVER TWIN LAKE AREA
STORMWATER MANAGEMENT
MASTER PLAN
SEPTEMBER 2001

Public Works Department
Engineering Division
Stormwater Management Section

Figure 7-1
Silver Twin Lake Area
Location of LakeWatch
Sampled Lakes

7.2.1.1 Silver Lake

As shown in **Table 7.1** above, Silver Lake is the second largest lake in the watershed and ranks 116th in size on SWFWMD's list of the Hillsborough County's lakes and large borrow pits. It is in the southwestern portion of the watershed and occupies the lowest topographic point in the basin. The lake's water level in years with normal rainfall is at about 30 feet NGVD. With the exception of the northern edge, the lake is ringed by high density single family residential land uses. On the northern end is a small commercial area adjacent to Waters Avenue. This area also contains one of the few areas of wetland found within the watershed. **Table 7.2** below summarizes the LAKEWATCH sampling data for the lake for the time period between 11/30/96 and 10/01/00. Within this timeframe, 13 gaps in the data exist when monthly samples were not taken. The normal LAKEWATCH parameters were sampled for: Secchi depth, total nitrogen, total phosphorus and chlorophyll *a*. As discussed above, these parameters are used to determine the lake's Trophic State Index.

Table 7.2 Summary of LAKEWATCH Sampling Data for Silver Lake *

Lake Name	Date	Secchi (ft)	Total Nitrogen	Total Phosphorus	Chl-*a*
Silver	11/30/96	4	1.25	0.042	---
Silver	01/21/97	---	1.29	0.055	0.125
Silver	02/08/97	1.33	3.45	0.117	0.314
Silver	03/02/97	1.83	1.92	0.056	0.048
Silver	04/13/97	4.67	1.61	0.032	0.019
Silver	05/27/97	5	0.77	0.028	0.015
Silver	07/05/97	4	0.70	0.030	0.017
Silver	09/22/97	1.67	1.37	0.026	0.222
Silver	10/13/97	2.83	1.23	0.040	0.030
Silver	02/14/98	5.1	0.81	0.068	0.023
Silver	03/15/98	1.5	1.59	0.094	0.122
Silver	03/31/98	4.5	1.05	0.046	0.026
Silver	05/03/98	5.5	0.72	0.033	0.009
Silver	06/14/98	2.16	1.44	0.053	0.067
Silver	08/18/98	2.5	0.84	0.038	0.026
Silver	09/20/98	4	0.94	0.042	0.049
Silver	11/15/98	5	0.98	0.031	---
Silver	01/31/99	5	0.80	0.037	0.028

Table 7.2 (cont'd) **Summary of LAKEWATCH Sampling Data for Silver Lake ***

Lake Name	Date	Secchi (ft)	Total Nitrogen	Total Phosphorus	Chl-*a*
Silver	02/28/99	3	1.31	0.041	0.042
Silver	03/28/99	3	0.93	0.032	0.020
Silver	04/25/99	6	0.66	0.033	0.008
Silver	05/31/99	6.17	0.69	0.028	0.016
Silver	07/15/99	4	0.86	0.035	0.023
Silver	08/15/99	4.33	0.85	0.026	0.022
Silver	09/28/99	4.12	0.79	0.034	0.025
Silver	10/31/99	3.4	0.91	0.030	0.027
Silver	11/03/99	---	0.79	0.030	---
Silver	12/31/99	7.2	0.84	0.040	0.019
Silver	01/30/00	6.83	0.65	0.026	0.013
Silver	02/29/00	4	0.94	0.036	0.031
Silver	04/02/00	2.77	1.03	0.038	0.029
Silver	04/30/00	2.86	0.98	0.035	0.025
Silver	06/10/00	5	0.80	0.056	0.015
Silver	08/13/00	4.5	0.72	0.042	0.028
Silver	10/01/00	4	1.07	0.038	0.036

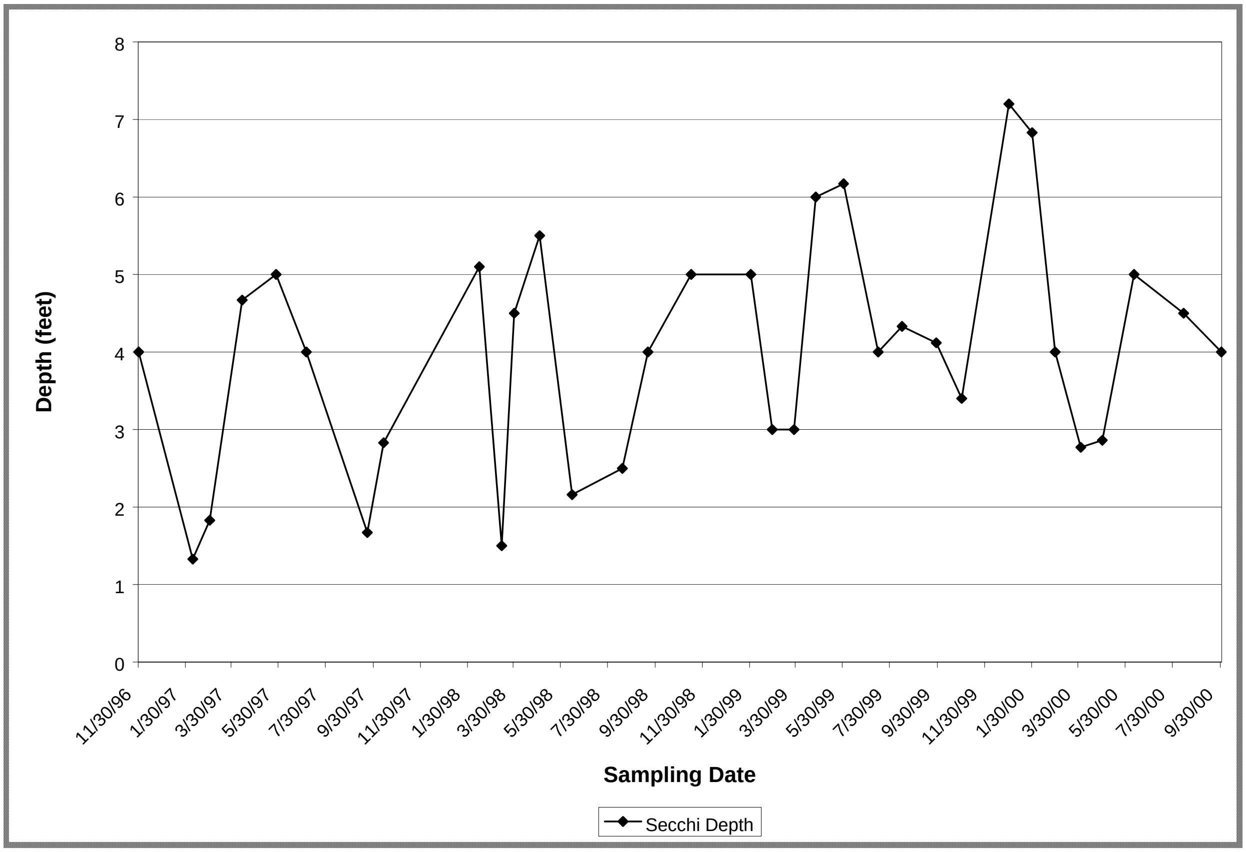
* This data is the daily average for the Lake taken at three sampling locations

LAKEWATCH Data

A Secchi disc is a device used to measure the degree of light penetration though a body of water such as a lake, stream or pond. This light penetration is generally an indication of the amount of suspended matter in the water. These particles may be inorganic, such as silt, or of an organic origin such as particles of decaying plants or living algae. The disc is approximately 20 cm. (8 inches) in diameter and is divided into quarters, with alternating black and white portions It is attached to a cord that has been marked at measured intervals - one foot, one inch, etc.

A measurement is obtained by lowering the disc into the water column and taking a reading as the disc disappears. The disc is then raised until it reappears. An average of these two readings can then be made. This process is repeated and all measurements are then averaged together. Measurements should be taken in the shade of vegetation, next to a dock or on the shady side of the boat. Surface distortions can affect the reading. To compensate, viewing the disc through a glass bottomed bucket or similar device will eliminate surface distortion.

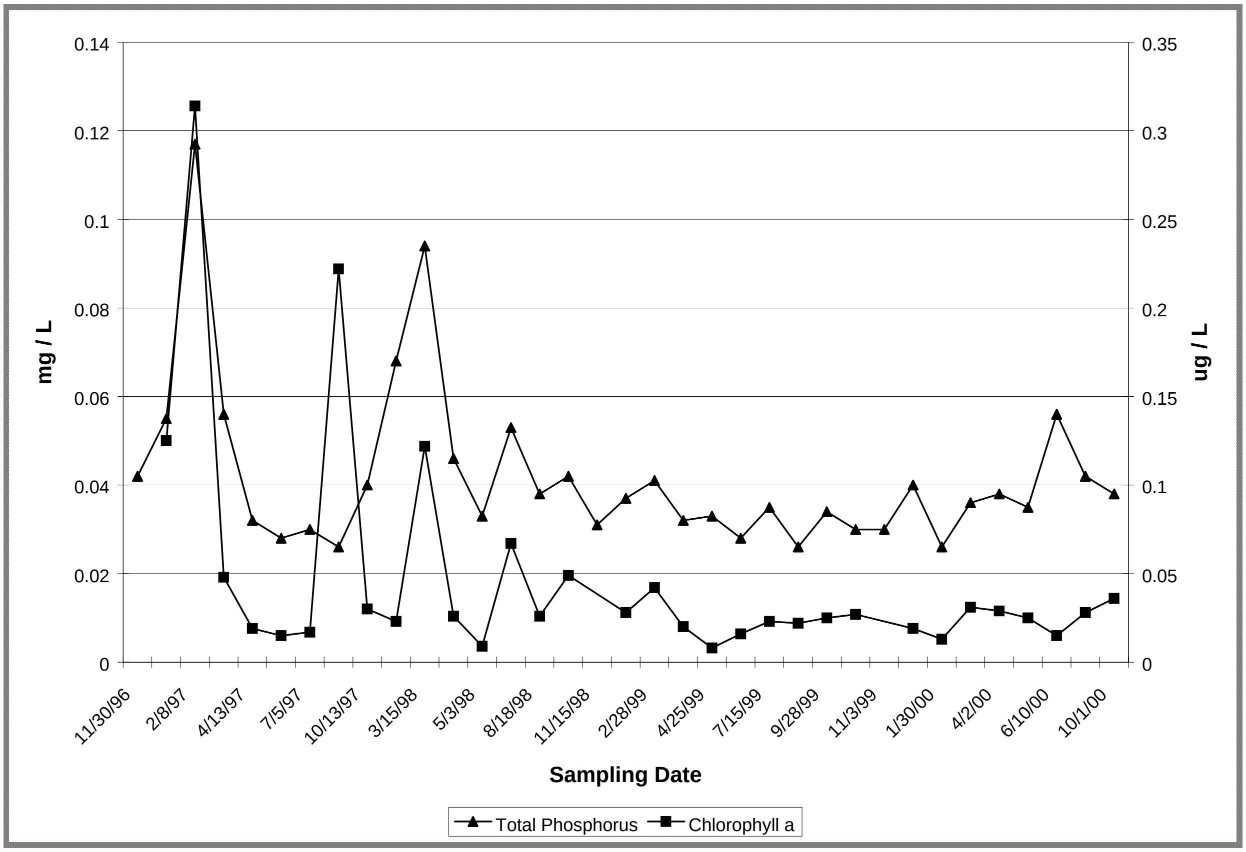
Figure 7-2
Summary of LAKEWATCH Secchi Depth Sampling Results



The average Secchi depth for Silver Lake is 4.3 feet with a minimum reading of 1.3 feet and a maximum reading of 12.8 feet. As can be seen from the LAKEWATCH data, the Secchi depth for Silver Lake is getting better or, in other words, the lake's water clarity is improving. The explanation for this improvement could be for a number or combination of reasons. It should be remembered; however, that the available data is extremely limited and this could be the part of a larger pattern that will not be discernable with the information provided. The first possible explanation is that the readings were at their worst during the El Nino event in late 1997 and early 1998. At this time, inflows to the lake were at their maximum and these flows could easily have stirred up bottom sediments and suspended them in the water column. The opposite would be true during the following drought years where inflows were at a minimum.

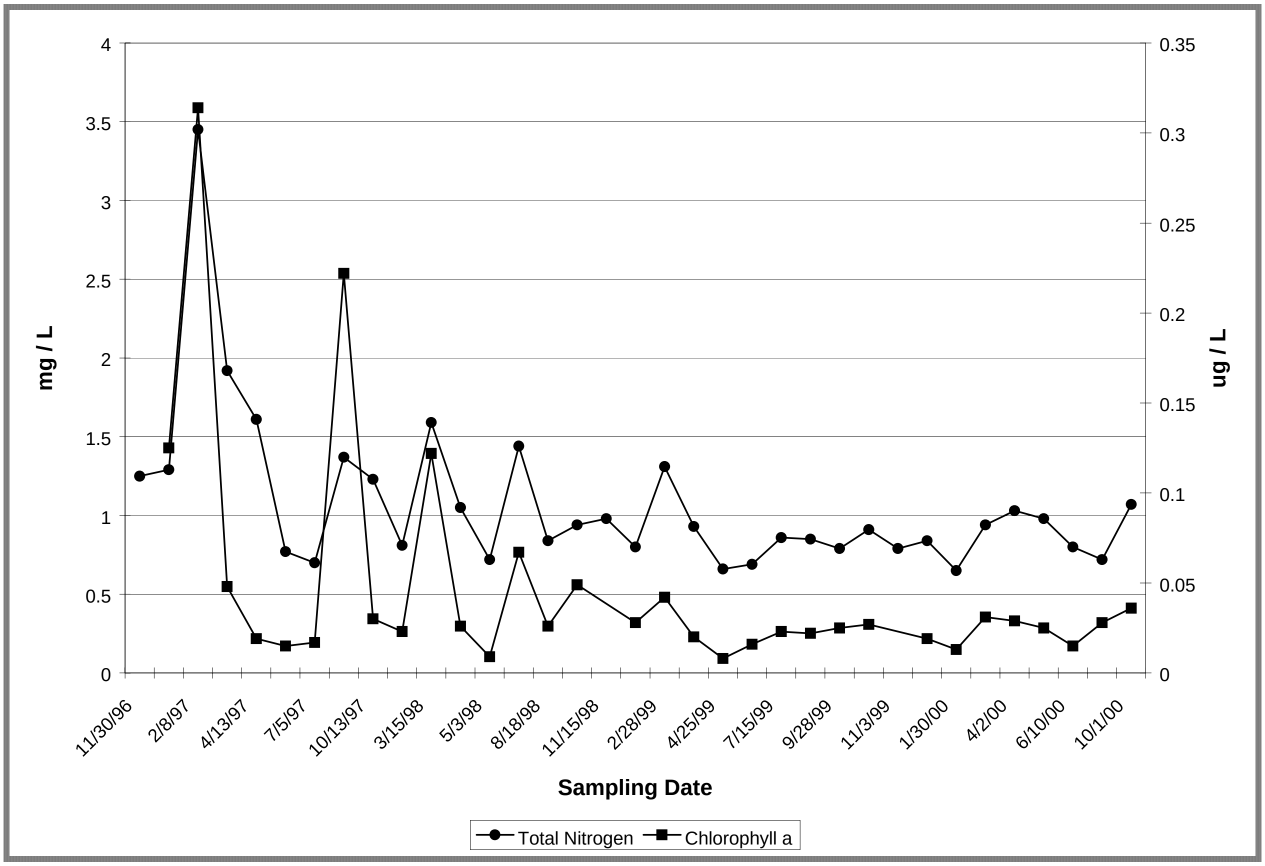
Related to these flows is the input of nutrients into the lake via stormwater run-off. As can be seen from **Figure 7-3**, with an increase in total phosphorus, there is a corresponding increase in chlorophyll *a*.

Figure 7-3
Silver Lake Total Phosphorus versus Chlorophyll *a*



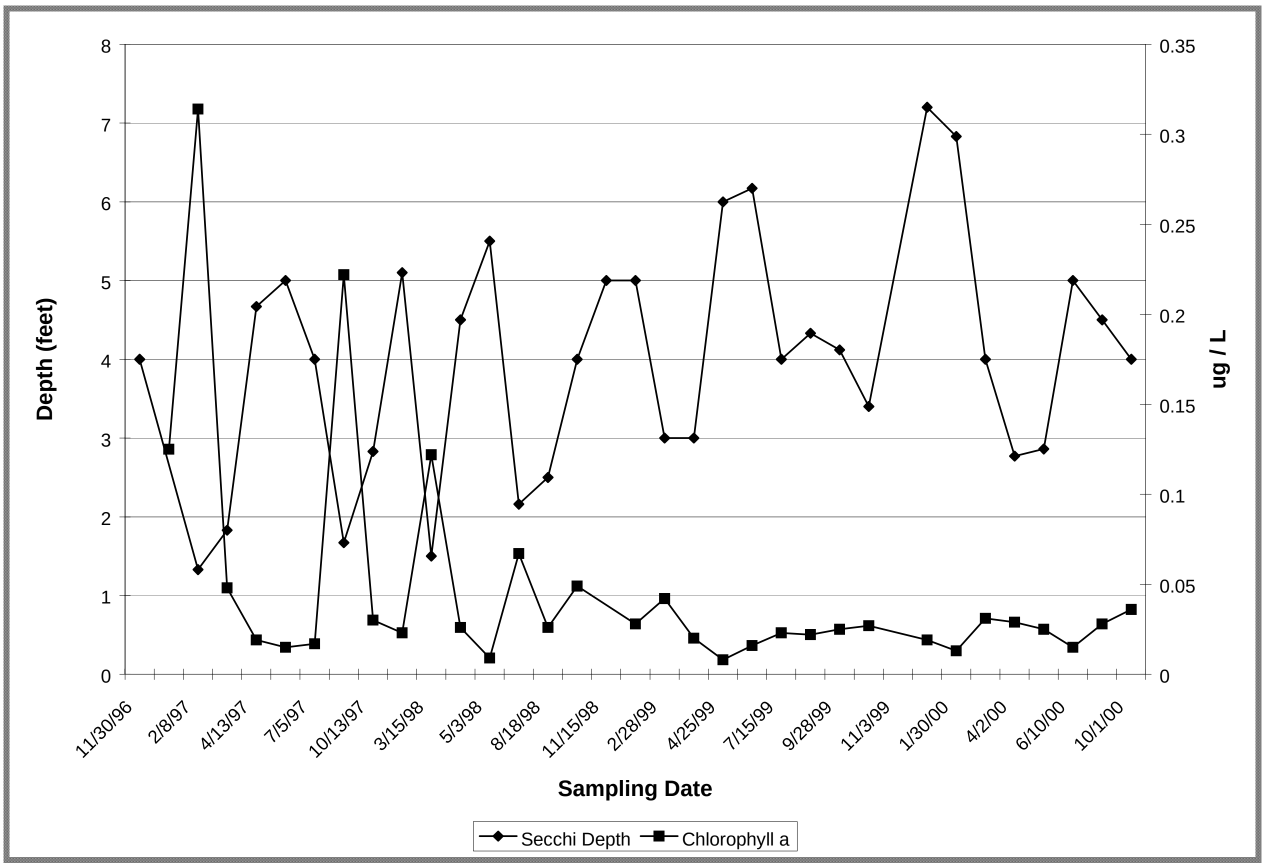
An even better result is given when total nitrogen is plotted against chlorophyll *a*. See **Figure 7-4** below:

Figure 7-4
Silver Lake Total Nitrogen versus Chlorophyll *a*



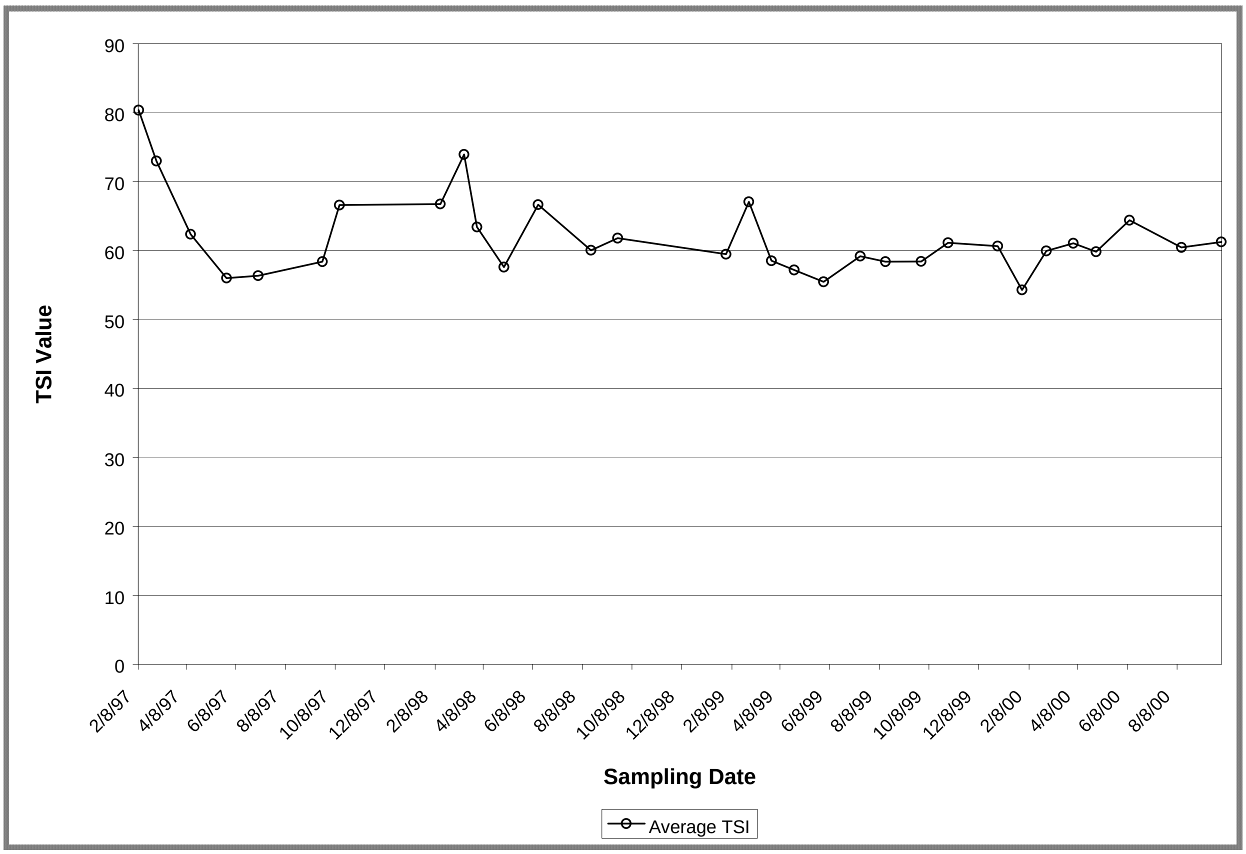
Another reason can be seen in the following **figure 7-5**, which shows the Secchi depth plotted against chlorophyll *a*. This is close to a classic correlation of chlorophyll *a* and water clarity. As can be seen from the figure, water clarity is highest when chlorophyll *a* (suspended particles) is at a minimum. The reverse is generally true as well. This graph is related to figures 7-3 and figure 7-4 above. Nitrogen and phosphorus are two of the main nutrients essential for the growth and reproduction of algae. When these constituents enter the lake in large amounts, as during the El Nino or other large storm events, and there is little macrophytic plant coverage on the lake to assimilate them, the algae in the lake will bloom and begin to take up all the excess nutrients. This cycle will continue until something comes along to break it. This generally requires some type of human intervention, as the algae will outcompete all but the most competitive vascular plants. This generally includes nuisance vegetation such as southern cattails or exotic vegetation such as primrose willow, hydrilla or torpedograss. Unfortunately, given the common practices of wanting an uninterrupted view of the lake and access to the water, the vast majority of this macrophytic vegetation has been removed and not allowed to become re-established. It has been replaced primarily by lawn grasses which cannot perform the same useful functions as the native vegetation once did. To add further to this lack of vegetation, fifty grass carp were introduced into the lake in June 1996 to control the aquatic plant known as coontail. But the carp will not limit themselves to just this one plant and in the situation where they have eaten all or most of the target species, they will move on to eat other vegetation, some of which may be desirable. In some situations, when the fish have eliminated all sources of food in a waterbody, the fish will resort to clipping off pieces of the lawn grasses that overhang the edges of the water.

Figure 7-5
Silver Lake Secchi Depth vs. Chlorophyll *a*



Finally, as with its component parts shown in the figures above, the TSI for Silver Lake is trending toward improvement. But remember, this is a limited amount of data collected in a very short time period. It may not reflect the “normal”, long-term condition of the lake. This is especially true since during the timeframe in which the sampling occurs, the area has experience both drought and a rather large El Nino / La Nina event. For the data to be more meaningful, LAKEWATCH sampling must continue through many more years and unfortunately through many more cycles of normal weather, drought and El Nino. During this short timeframe the values has fluctuated from a high of 89.19 in February 1997 to a low of 43.55 a year later in February 1998. The average Trophic State Index value of the LAKEWATCH data supplied for this study is 57.62. **Figure 7-6** below graphically represents the Trophic State Index for the lake between 1997 and 2000.

Figure 7-6
Silver Lake Trophic State Index*



* Values are daily averages taken at the three LAKEWATCH sites on the lake

7.2.1.2 Twin Lake

As shown in **Table 7.1** above, Twin Lake is the largest lake in the watershed and 72nd in size on SWFWMD's list of the Hillsborough County's lakes and large borrow pits. It is in the north central third of the watershed. The lake's water level in years with normal rainfall is at about 31 feet NGVD. The lake is completely ringed by high-density single family residential land uses. **Table 7.3** below summarizes the LAKEWATCH sampling data for the lake for the time period between 11/23/96 and 12/21/00. Within this timeframe, 14 gaps in the data exist when monthly samples were not taken. As with Silver Lake, the normal LAKEWATCH parameters were sampled for: Secchi depth, total nitrogen, total phosphorus and chlorophyll *a*. As discussed above, these parameters are used to determine the lake's Trophic State Index.

Table 7.3 Summary of LAKEWATCH Sampling Data for Twin Lake*

Lake Name	Date	Secchi (ft)	Total Nitrogen	Total Phosphorus	Chlorophyll-*a*
Twin	11/23/96	3	0.92	0.026	0.026
Twin	12/29/96	3	0.79	0.023	0.017
Twin	01/25/97	4.4	0.65	0.024	0.016
Twin	02/28/97	4.1	0.62	0.021	0.013
Twin	03/15/97	3.2	0.78	0.024	0.022
Twin	04/20/97	3.6	0.78	0.026	0.022
Twin	06/06/97	3	0.96	0.026	0.032
Twin	10/04/97	4	0.87	0.028	0.034
Twin	01/31/98	5	0.69	0.029	0.024
Twin	02/28/98	6.2	0.57	0.041	0.014
Twin	03/29/98	4.5	0.83	0.037	0.030
Twin	05/09/98	6	0.64	0.025	0.010
Twin	07/03/98	5	0.81	0.016	0.016
Twin	07/12/98	4	0.72	0.019	0.022
Twin	10/31/98	2.8	0.61	0.024	0.019
Twin	11/28/98	3.3	0.69	0.024	0.023
Twin	12/27/98	3.4	0.72	0.027	0.026
Twin	03/10/99	4.5	0.82	0.026	0.024
Twin	04/30/99	4	0.84	0.026	0.024
Twin	05/31/99	4.7	0.72	0.020	0.013
Twin	06/12/99	2.8	0.84	0.015	0.020
Twin	07/14/99	3.7	0.84	0.018	0.019

Table 7.3 (cont'd.) **Summary of LAKEWATCH Sampling Data for Twin Lake***

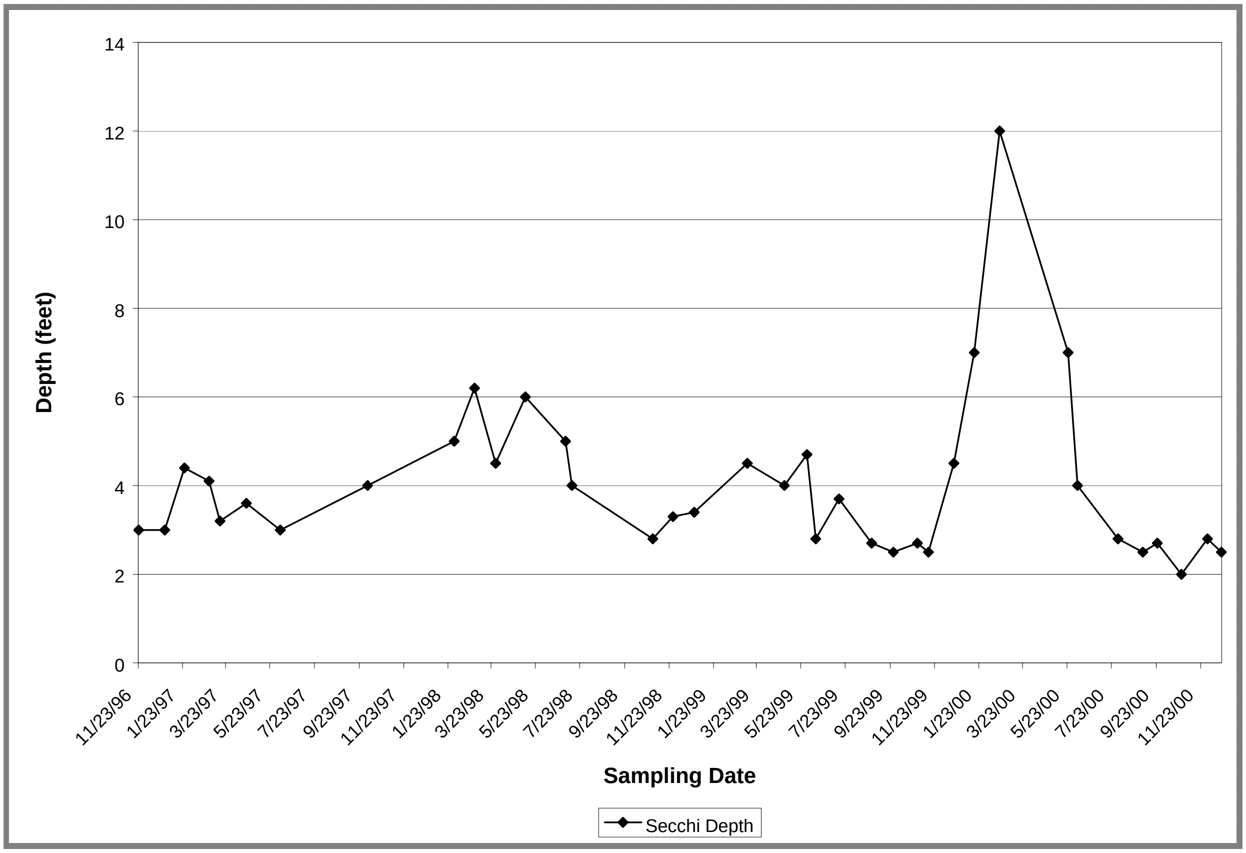
Lake Name	Date	Secchi (ft)	Total Nitrogen	Total Phosphorus	Chlorophyll-*a*
Twin	08/28/99	2.7	0.71	0.018	0.017
Twin	09/27/99	2.5	0.75	0.024	0.032
Twin	10/30/99	2.7	0.77	0.025	0.027
Twin	11/14/99	2.5	0.77	0.024	0.028
Twin	12/19/99	4.5	0.88	0.030	0.011
Twin	01/16/00	7	0.71	0.025	---
Twin	02/20/00	12	0.67	0.016	---
Twin	05/24/00	7	0.87	0.019	---
Twin	06/06/00	4	1.02	0.023	---
Twin	08/01/00	2.8	0.99	0.026	0.030
Twin	09/04/00	2.5	1.07	0.028	0.041
Twin	09/24/00	2.7	0.88	0.027	0.035
Twin	10/27/00	2	0.88	0.024	0.026
Twin	12/02/00	2.8	0.94	0.027	0.031
Twin	12/21/00	2.5	0.72	0.030	0.035

* This data is the daily average for the Lake taken at three sampling locations

LAKEWATCH Data

In reviewing **Figure 7-7** below, the most striking feature is the large spike seen in the first few months of 2000. Rainfall records indicate this was one of the driest periods in the past couple of decades. As discussed in the previous section on Silver Lake, this spike could be due to the fact that there were little, if any, inflows into the lake with the associated stirring of bottom sediments and nutrient input. In addition, algae are usually at its lowest concentrations in the winter due primarily to the cold weather.

Figure 7-7
Summary of LAKEWATCH Secchi Depth Sampling Results



As with Silver Lake, there is quite a correlation seen in **Figure 7-8** below, which compares the Total Phosphorus concentration versus the concentration of Chlorophyll *a*. The only anomalies are the two chlorophyll spikes that actually precede the spikes for total phosphorus in the first part of 1998 and 2000. To further confuse matters, the spikes occur in the winter, which would not normally be expected.

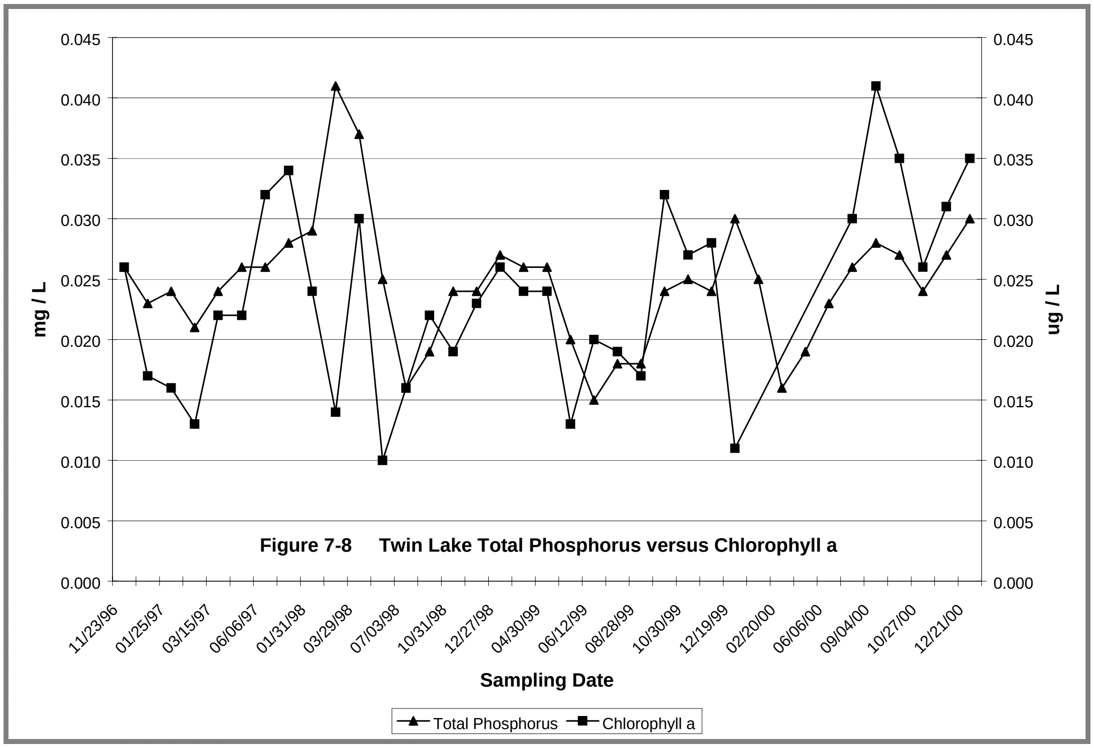


Figure 7-8 Twin Lake Total Phosphorus versus Chlorophyll a

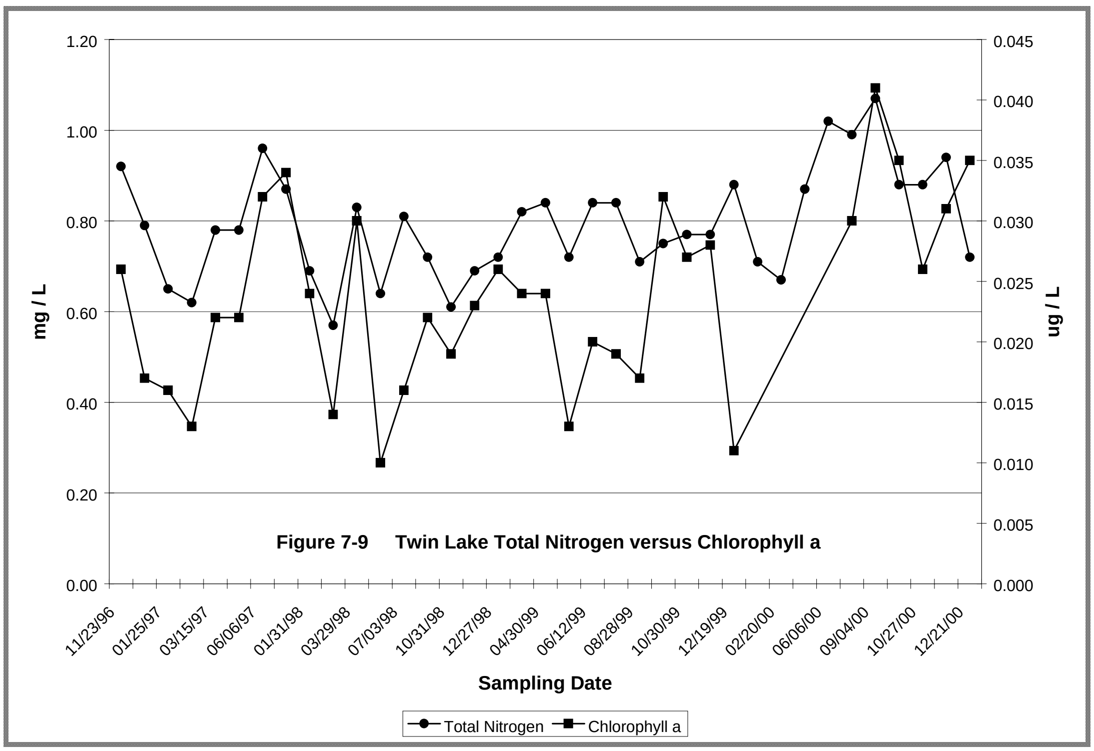
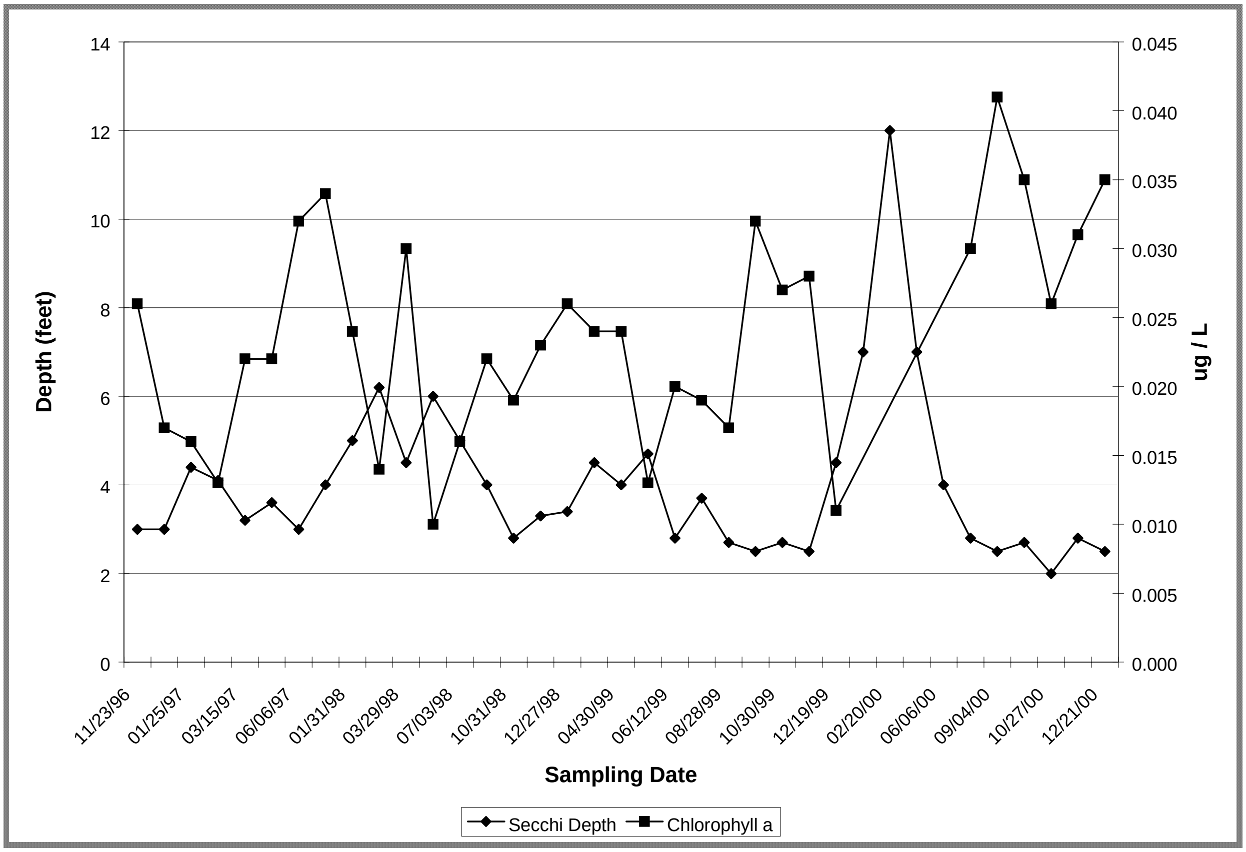


Figure 7-9 Twin Lake Total Nitrogen versus Chlorophyll a

As with Silver Lake, the correlation is much better when plotting Total Nitrogen against Chlorophyll *a*. This is illustrated in **Figure 7-9**, above.

Figure 7-10
Twin Lake Secchi Depth versus Chlorophyll *a*

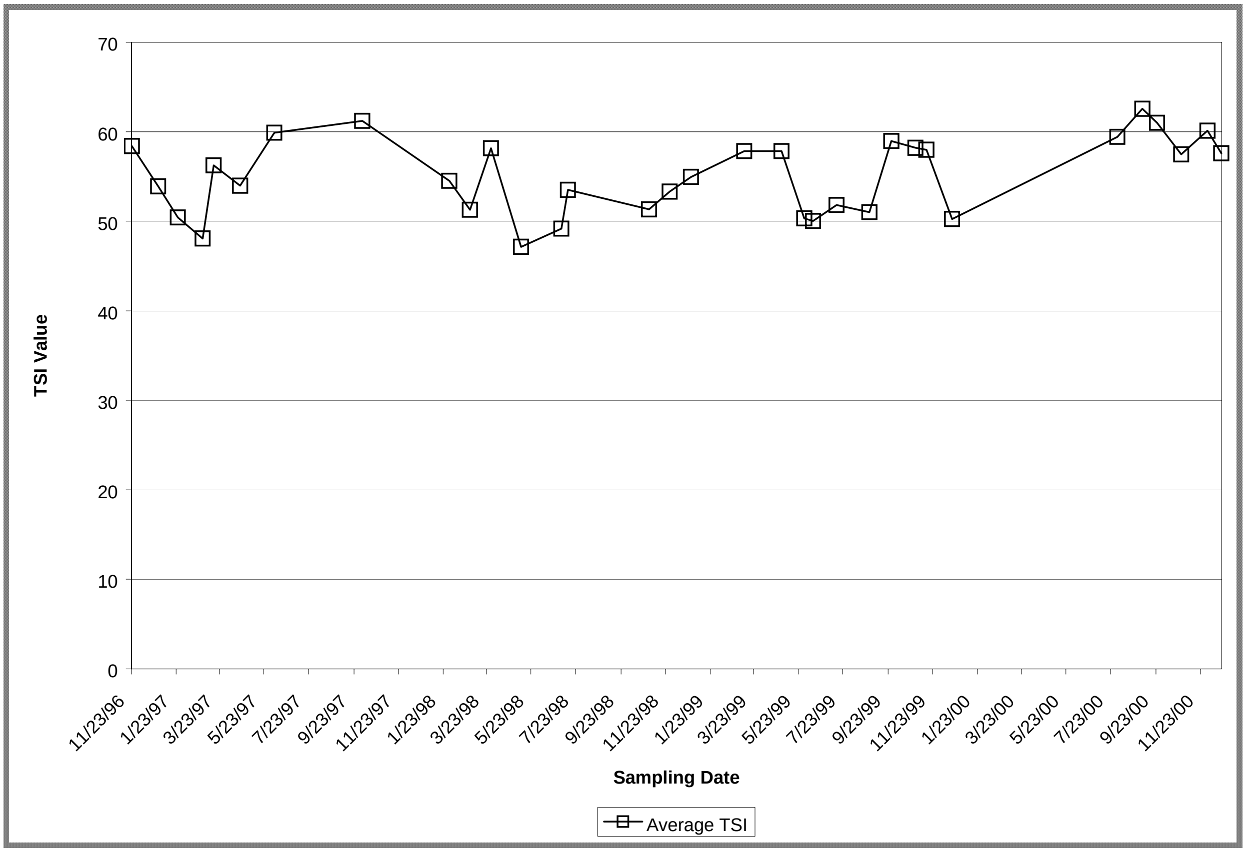


As with the Silver Lake information, when Secchi depth is plotted against chlorophyll *a* for Twin Lake, there is a direct inverse correlation between depth and chlorophyll concentration. Again, as chlorophyll concentration is decreased, Secchi depth increases.

Finally, the Trophic State Index for Twin Lake is very similar to that discussed above for Silver Lake. Again, the TSI for Twin Lake is slowly trending toward improvement. But, this is a limited amount of data collected in a very short time period and may not reflect the long-term condition of the lake. The timeframe in which the sampling occurs, includes both drought and a large El Nino / La Nina event. For the data to be more meaningful, LAKEWATCH sampling must continue through many more years and many more cycles of normal weather, drought and El Nino. During this short timeframe the values has fluctuated from a high of 62.55 in

September 2000 to a low of 47.14 in May 1998. The average Trophic State Index value of the LAKEWATCH data supplied for this study is 55.08. **Figure 7-11** below reflects the lakes daily TSI averages from the lake's three sampling locations.

Figure 7-11
Twin Lake Trophic State Index



When compared to the graph of Silver Lake's TSI, Twin Lake's Trophic State Index has not varied near as much, holding within a range of 15 points. In comparison, Silver Lake has ranged over 45 points. As with the rest of the data, this is difficult to interpret given the short range of data.

Environmental Protection Commission Data

The Environmental Protection Commission of Hillsborough County has collected monthly water samples from various locations in the County since 1972 for estuarine systems and 1973 for freshwater habitats. These locations include creeks, rivers, Tampa Bay and Lake

Thonotosassa and presently totals 92 locations. Twenty-eight parameters are tested including physical, chemical and biological factors. Physical measurements include parameters such as water and air temperature, pH, conductivity and turbidity. Chemical factors monitored are parameters like ions and metals. Biological measurements include BOD, chlorophyll and coliform counts. Unfortunately, none of these sites occur in the watershed. EPC only does water sampling in the basin as a result of citizen's complaints. Data from EPC's sampling information is reflected below in **Tables 7.4a through 7.4f.** While the data here is scant, some general information can be demonstrated with it.

Table 7.4a
Data for EPC Water Quality Sampling Sites in Little Twin Lake
(Physical Parameters)

Year	Date	Sample #	Turbidity	Secchi Depth	Water Temp.			Air Temp.	Conductivity			pH			Diss. Oxygen			Salinity		
					Top	Mid	Bot		Top	Mid	Bot	Top	Mid	Bot	Top	Mid	Bot	Top	Mid	Bot
			JTU	inches	ºC			ºC	umhos / cm						mg / L			parts / thousand		
1981	4/15	---	262	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1993	4/13	#1	---	VB	23.7	23.1	23.0	30.5	0.147	0.148	0.148	7.0	7.0	7.0	6.1	6.0	5.6	0.1	0.1	0.1
	4/13	#2	---	72	24.4	23.0	22.3	30.5	0.147	0.148	0.147	7.0	7.0	6.8	6.7	6.2	3.3	0.1	0.1	0.1
	4/13	#3	---	VB	24.4	23.3	23.1	30.5	0.147	0.148	0.153	7.0	6.9	6.9	6.4	5.4	5.3	0.1	0.1	0.1
	4/13	#4	---	60	25.0	23.4	23.1	30.5	0.147	0.148	0.150	7.0	6.8	6.7	6.6	4.0	3.3	0.1	0.1	0.1
	4/13	#5	---	VB	24.5	23.5	23.3	30.5	0.147	0.147	0.160	7.0	7.0	6.9	6.9	6.6	4.5	0.1	0.1	0.1

Dissolved Oxygen

Tables 7.4a, 7.4c and 7.4e, contain information on dissolved oxygen (DO). This is a general measure of surface water health. Oxygen is introduced into water by either direct diffusion across the air / water surface interface or by photosynthesis in plants. Animals such as fishes, insects and other invertebrates deplete DO by taking it in during respiration. The decomposition of organic matter also uses dissolved oxygen. For Class III freshwaters, DO "shall not be less than 5.0 mg/L". Depending on the salinity and temperature, 100% saturation for dissolved oxygen generally ranges between 7 and 8 mg/L. A value of 4 to 5 mg/L is generally accepted as being the minimum requirement for a healthy and diverse animal population, even though some organisms, such as certain larval insects, can survive in lower concentrations. Their presence is routinely used as an indicator of low DO content and/or water pollution. However, blackwater or spring-fed streams are naturally low in dissolved oxygen. A high DO can indicate an elevated level of photosynthesis, usually by algae and phytoplankton, and is a common characteristic of many hypereutrophic systems. **Table 7.2a** shows that DO from the April 1993 event in Little Twin Lake is a little lower than the average range for lakes, but top and mid depth water sample only goes below the State's 5 mg/L standard once. Bottom samples drop below the standard in 3 of the 5 samples. This is not unusual for a bottom sample.

For the samples for Twin Lake in 1987 and 1989, reflected in **Table 7.4c**, the DO is higher than the standard for all but on of the top and mid depth samples. However, the bottom sample drops precipitously in terms of DO. Several of the sampling sites had readings over 8 mg/L. The most likely explanation for this is that there was a high concentration of algae in the lake at least at the time of the sampling, possibly a bloom. The low readings at the bottom would seem to reinforce this explanation. As the short-lived organisms died, they would sink to the bottom, where their decomposition would use up most of the available oxygen. This is related to Biological Oxygen Demand, which is discussed in more detail below.

Biological Oxygen Demand

Another measure of oxygen is Biological Oxygen Demand or BOD. Data on BOD is found in **Tables 7.4b, 7.4d and 7.4f**. For Class III waters, BOD "shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each class and, in no case, shall it be great enough to produce nuisance conditions". BOD is defined as "the quantity of oxygen utilized by a mixed population of microorganisms in the aerobic oxidation of the organic matter in a sample (generally one liter) for a particular length of time (usually 5 days) at a particular temperature." The range of possible readings can vary considerably. Water from an exceptionally clear lake might show a BOD of less than 2 ml/L of water. Raw sewage may give readings in the hundreds and food-processing wastes may be in the thousands. If there is a large quantity of organic waste in the water supply, there will also be large amounts of bacteria present working on decomposing this waste. The demand for oxygen will be high and correspondingly, so will the BOD level. As the waste is consumed or dispersed through the water, BOD levels will begin to decline. Nitrates and phosphates in a body of water can contribute to high BOD levels. Because nitrates and phosphates are plant nutrients, they can cause plant life and algae to grow quickly. When this happen, they also die quickly and contribute to the organic waste in the water, which is then decomposed by bacteria. This results in a high BOD level. When BOD levels are high, dissolved oxygen (DO) levels decrease due to the fact that the oxygen that is available in the water is being consumed by the bacteria. Since less dissolved oxygen is available in the water, fish and other aquatic organisms may not survive.

Table 7.4b
Annual Averages For EPC Water Quality Sampling Sites in Little Twin Lake
(Biological and Chemical Parameters)

Year	Date	BOD.5	Coliform		Phosphorus		Nitrogen			
		mg / L	Total	Fecal	Ortho	Total	Kjeldahl	NH_3N	NO_3 / NO_2	Total
			# / 100 ml		mg / L		mg / L			
1987	1/25 (S)	---	5900	3800	---	---	---	---	---	---
	1/25 (W)	---	3900	670	---	---	---	---	---	---
	1/25 (N)	---	4600	1600	---	---	---	---	---	---
	1/25 (E)	---	6000	2000	---	---	---	---	---	---
	10/19	---	70	10	---	---	---	---	---	---
	12/15	1.21	210	50	---	0.03	0.48	---	<0.01	---
1993	4/13	1.8	---	6	<0.01	<.04	0.59	<0.03	0.003	0.593
	8/30 #1	2.44	>46000	46000	0.14	0.39	1.44	0.04	0.140	1.58
	8/30 #2	3.54	17000	13000	0.02	0.14	0.19	0.10	0.077	0.267
	8/30 #3	2.75	10000	10000	0.04	0.07	0.41	0.11	0.078	0.488

This type of decomposition is one of the most common causes of fish kills in Hillsborough County lakes. This is especially lethal when combined with high water temperatures that depresses the concentration of available oxygen in the water to begin with.

Table 7.4c
Data For EPC Water Quality Sampling Sites in Twin Lake
(Physical Parameters)

Year	Date	Sample #	Secchi Depth	Water Temperature			Air Temp.	Conductivity			pH			Dissolved Oxygen			Salinity		
				Top	Mid	Bot		Top	Mid	Bot	Top	Mid	Bot	Top	Mid	Bot	Top	Mid	Bot
			inches	ºC			ºC	umhos / cm						mg / L			parts / thousand		
1987	9/15	#1	42	30.1	29.6	29.1	34.0	0.245	0.235	0.242	8.2	7.6	6.8	9.0	8.4	0.3	---	---	---
	9/15	#2	42	30.2	29.7	29.2	34.0	0.237	0.238	0.233	8.7	8.0	8.5	10.9	9.0	3.2	---	---	---
	9/15	#3	---	30.5	29.4	29.1	36.0	0.273	0.275	0.269	6.8	6.8	6.7	4.1	3.4	6.4	---	---	---
1989	6/8	---	54	31.0	30.5	27.2	---	0.252	0.252	0.254	8.4	8.2	6.8	8.3	8.4	0.3	0.1	0.1	0.1
	10/17	#1	---	29.9	28.2	27.4	---	0.20	0.20	0.20	8.1	7.5	7.4	9.0	8.4	2.0	---	---	---
	10/17	#2	---	29.9	28.2	27.5	---	0.20	0.20	0.20	8.0	7.6	7.4	8.7	8.3	3.4	---	---	---

Coliform Bacteria

Information on coliform bacteria is found in **Tables 7.4b, 7.4d and 7.4f**. Coliform bacteria are measure in two broad groups - total and fecal. Total coliform measure is the "count of the number of coliform bacteria found in a culture of a sample of water".

Table 7.4d
Data For EPC Water Quality Sampling Sites in Twin Lake
(Biological and Chemical Parameters)

Year	Date	Sample #	BOD.5	Coliform		Phosphorus		Nitrogen			
			mg / L	Total	Fecal	Ortho	Total	Organic	Kjeldahl	NH_3N	NO_3 / NO_2
				# / 100 ml		mg / L		mg / L			
1975	1/7	---	---	6100	6000	---	---	---	---	---	---
	---	---	---	---	---	---	---	---	---	---	---
1987	4/23	---	---	40	40	---	---	---	---	---	---
	7/20	---	---	300	130	---	---	---	---	---	---
	9/15	#1	3.8	90	50	---	0.02	---	1.73	0.17	<0.01
	9/15	#2	3.0	70	30	---	0.03	---	1.98	0.15	0.01
	9/15	#3	2.4	4000	2000	---	---	---	---	---	---
1989	6/12	---	4.0	320	380	---	---	---	---	---	---
	10/17	#1	1.75	50	60	---	0.02	---	0.48	0.05	0.01
	10/17	#2	1.45	130	90	---	0.03	---	0.56	0.05	0.04
1990	6/14	---	---	450	470	---	---	---	---	---	---
1993	6/8	---	---	40	40	---	---	---	---	---	---

Coliforms are bacteria found in the gut of warm-blooded animals and are excreted with feces. They are a general indicator of the possible presence of pathogenic organisms. In contrast, fecal coliforms (mostly *Escherichia coli*) are only found in mammals. They too are excreted in feces and on therefore a direct indicator of leaky septic or sewage treatment systems or domestic animal operations. Both these indicators are measure in MPN or Most Probable Number/100 ml of water. For Class III freshwaters, total coliforms must be: $\leq$ 1000 MPN on a monthly average; not exceed 1000 in more than 20% of the monthly sample or $\leq$ 2,400 for any daily sample. This last standard was exceeded in both Little Twin Lake (table 7.2b) and Lake Dorothea (table 7.2f) the majority of the time, 7 of 9 and 4 of 7 samples, respectively. Remembering there is a limited amount of data, this would seem to indicate at least during the sampling dates, there may have been leaky septic or sewage systems in the immediate area. There are no dairy or other domestic livestock operations within the watershed. Total coliforms were more "normal" in Twin Lake where there were only 2 exceedences of State standards in the 11 samples taken.

Table 7.4e
Data For EPC Water Quality Sampling Sites in Lake Dorothea
(Physical Parameters)

Year	Date	Turbidity	Water Temperature			Conductivity			pH			Dissolved Oxygen			Salinity		
			Top	Mid	Bot	Top	Mid	Bot	Top	Mid	Bot	Top	Mid	Bot	Top	Mid	Bot
		NTU	ºC			umhos / cm						mg / L			parts / thousand		
1991	5/28	4.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1993	6/8 #1	---	29.7	29.5	29.3	0.370	0.372	0.380	7.0	6.9	6.9	1.9	1.7	1.2	0.2	0.2	0.2
	6/8 #2	---	31.0	30.5	27.2	0.252	0.252	0.252	8.4	8.2	6.8	8.3	8.4	0.3	---	---	---

Fecal coliforms in Class III freshwaters MPN counts "shall not exceed a monthly average of 200, nor exceed 400 in 10% of the samples, nor exceed 800 on any daily sample. Monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30 day

Table 7.4f
Data For EPC Water Quality Sampling Sites in Lake Dorothea
(Biological & Chemical Parameters)

Year	Date	BOD.5	Coliform		Phosphorus		Nitrogen				
		mg / L	Total	Fecal	Ortho	Total	Organic	Kjeldahl	NH_3N	NO_3 / NO_2	Total
			# / 100 ml		mg / L		mg / L				
1973	8/24	---	3150	<100	---	---	---	---	---	---	---
1987	9/15	2.4	4000	2000	---	0.02	---	1.86	0.25	0.07	---
	10/19	---	70	<10	---	---	---	---	---	---	---
1988	1/25	---	2800	800	---	---	---	---	---	---	---
	12/15	1.02	170	80	---	0.02	---	0.52	---	0.16	---
1993	6/8 #1	---	4000	900	---	---	---	---	---	---	---
	6/8 #2	---	40	40	---	---	---	---	---	---	---

period. The fecal coliform exceedences were exactly the same as the total coliforms with one exception. This occurred on Lake Dorothea where there were only 2 instead of 4 exceedences of State standards in the 7 samples taken.

Nutrients

The two nutrients sampled for by the EPC in the watershed are phosphorus and nitrogen. Neither have a concentration limit set upon them for State water quality standards; however, in Chapter 62-302.530, they are "limited as needed to prevent violations of other standards contained in this chapter. Man-induced nutrient enrichment (total nitrogen or total phosphorus) shall be considered degradation in relation to the provisions of Sections 62-302.300, 62-302.700 and 62-4.242 F.A.C." Both phosphorus and nitrogen enter the water from run-off containing animal wastes, excess fertilizers, and wastewater effluent. They are the two main nutrients responsible for plant growth and reproduction, especially in algae. Each is measure in organic and inorganic forms and are usually combined to give a "total" concentration. In addition, they can occur in water in both particulate and dissolved forms, which makes it challenging to remove it from the water column. Particulates are vastly easier to remove than dissolved forms.

7.3 STREAMS

Kirby Creek is the only stream feature in the watershed and it has been greatly altered through the years. The stream is now highly channelized to assist in flood control. This, however, decreases the amount of water treatment that the creek can perform because the water is flowing faster and because it is cleaned on a somewhat regular basis, there is little vegetation. Unfortunately, most of the vegetation that does exist is made up of nuisance and exotic species. Stream water quality is impacted primarily by non-point sources all along its length. No water quality information is available for this waterbody. Parameters of concern are dissolved oxygen, coliforms, lead concentration, nutrients, turbidity and biological oxygen demand.

7.3.1. Data and Assessment Methods

As with the lake sampling, EPC does not sample in Kirby Creek unless it is in response to citizen's complaints. There have been no complaints, and therefore, no samples have been taken in Kirby Creek. It is also unfortunate that there are no United States Geological Service (USGS) gaging stations within the watershed. These stations generally just measure water flows and do not normally collect water quality data.

Just as lake water quality can be compared by using the TSI values, the water quality of a stream can be measured by the Water Quality Index or WQI. The WQI (Hand et. al. 1990, 1996) is a measure based on a combination of no more than six water quality indicators water clarity, dissolved oxygen, oxygen-demanding substances, bacteria, nutrients and biological diversity. These indicators can have multiple constituents, that is, more than one factor can be used to determine the indicator=s value. Phosphorus and nitrogen both fall into the category of a nutrient indicator. Therefore, data availability will determine the constituents used for determining the Index. For each measured constituent, the raw data, in either a daily, weekly or monthly form, is converted into annual averages. These averages are then converted to percentiles using a database developed by FDEP. The information for this database is established by information on 2,000 Florida stream monitoring locations. These percentile values are then averaged to generate the WQI, which can range from a low of 10 (best quality) to over 90 (worst quality). This final averaging process ignores categories that have no available data. The WQI can be calculated from 1 or more of the six indicator categories; however, the more indicators used, the more reliable the determination will be (Hand et. al. 1990, 1996).

Hand et. al. (1996) provide the following summary of the WQI. AThe Florida Water-Quality Index has several advantages over previous measures. First, since it is based on the percentile distribution of Florida stream data, it is tailored to Florida. Second, the index uses the most important measures of water quality in Florida: clarity, dissolved oxygen, oxygen-demanding substances, nutrients, bacteria, and biological diversity. Third, it is simple to understand and calculate and does not require a mainframe computer or any complex data transformations or averaging schemes. Finally, the index nicely identifies areas of good fair, and poor water quality that correspond to professional and public opinion.≅ FDEP recommends the following interpretation of WQI values, based on an analysis of Florida stream data and the US EPA National Profiles Water-Quality Index (Hand et. al. 1996):

Stream WQI	FDEP Water Quality Characterization
< 45	AGood≅
45 – 60	AFair≅
> 60	APoor≅

7.4 WATER QUALITY ISSUES / AREAS OF CONCERN

Management of natural lakes and streams has been identified as a specific area of concern for the Silver / Twin Lakes Watershed. Proper management of these waterbodies includes the protection of lakes and streams exhibiting good water quality characteristics as well as restoration of waterbodies with degraded water quality.

7.4.1 Lakes

While it is hard to determine the overall water quality of the lakes in the Silver / Twin Lakes watershed due to the limited amount of data collected thus far, there can be no doubt that continued changes toward more intensive land uses within the watershed will have detrimental impacts on these natural waterbodies. These impacts result from practices such as inadequately treated stormwater, septic system discharges, the removal of native vegetation from shorelines and the over-use of fertilizers and pesticides on residential lots.

Protection of lakes should be encouraged through regulation and education. Current regulations should be evaluated to see if they are meeting expectations. Community access for boating and swimming and discouraging hardening of the shoreline by walls or ramps should be explored. Sewer infrastructure should be extended to decrease the need for septic systems. Education should emphasis the worth of native wetland vegetation in relation to lake health and explain the value of setbacks and buffers. Citizens and citizens groups should be encouraged to develop whole lake management plans as opposed to the separate, single residential lot approach that prevails today. It is clear that some sort of incentive is needed to encourage single family homeowners to be more sensitive to the conditions of their lakes. The LAKEWATCH program should continue to be expanded to increase the amount of data collected so trends in water quality and aquatic plant management can be assessed.

7.4.2 Streams

Stream water quality is adversely impacted by primarily and nonpoint source pollutant discharges. Kirby Creek discharges into Tampa Bay via the Hillsborough River. The Tampa Bay Estuary Program has set various water quality and habitat management goals for the Bay. The TBEP is a partnership of federal, state and local governmental agencies working with various private groups which has adopted several stormwater related goals for each watershed.

! AHold the line≅ on nitrogen loading to Tampa Bay and its major segments to 1992-94 average levels. This will serve as a baseline to measure improvements from. This measure should encourage the regrowth of an additional 12,350 acres of seagrasses and restore seagrass acreage to 1950's levels. Between 1950 and 1980 around 19,000 acres or about half the seagrasses in the Bay were lost.

! Toxic contaminants in the Bay that result from stormwater run-off is another concern. The TBEP seeks to protect the relatively clean areas of the Bay from further contamination and minimize the risk to humans and wildlife in those areas of the Bay that are already impacted.

- Another type of contamination is bacterial and results from sanitary sewer overflows and/or septic tank discharges that occur primarily in times of heavy rains. This impacts the use of the Bay for swimming and shellfish harvesting.

- Freshwater inflows for the Bay and its lower reaches is also critical to the health of the Bay. Stormwater detention and retention play an important part in this flow of water, where both timing and quantity are important. Presently, minimum flows and levels for most of the major waterbodies in the County are being developed by the Southwest Florida Water Management District. Related to this is the issue of impervious surfaces; it is a goal to reduce these surfaces and therefore reduce stormwater run-off.

Stormwater has been identified as a significant source of both nutrients and toxic pollutants in the Tampa Bay watershed (TBEP 1996). Almost half (45%) of the nitrogen loading into the Bay results from stormwater run-off as does approximately 60% of the metals chromium, lead, zinc and mercury. Discharge of microbial contaminants is one of the main concerns. As previously stated, fecal coliforms are hosted by warm-blooded animals and their presence in the watershed are a result of numerous sources:

- Leaky sanitary sewer lines or lift stations

- Deficient or failing septic systems

- Stormwater run-off from feedlots or dairies that has not been adequately treated (not applicable to this watershed).

- Unpermitted surface water discharges from private wastewater treatment plants or other industries.

A plan needs to be developed in conjunction with state and local environmental agencies to restore Kirby Creek back to some semblance of the natural system that it once was, while retaining the ability for maintenance activities recognizing that it has been altered over the years as an intricate part of the watershed's stormwater management system.

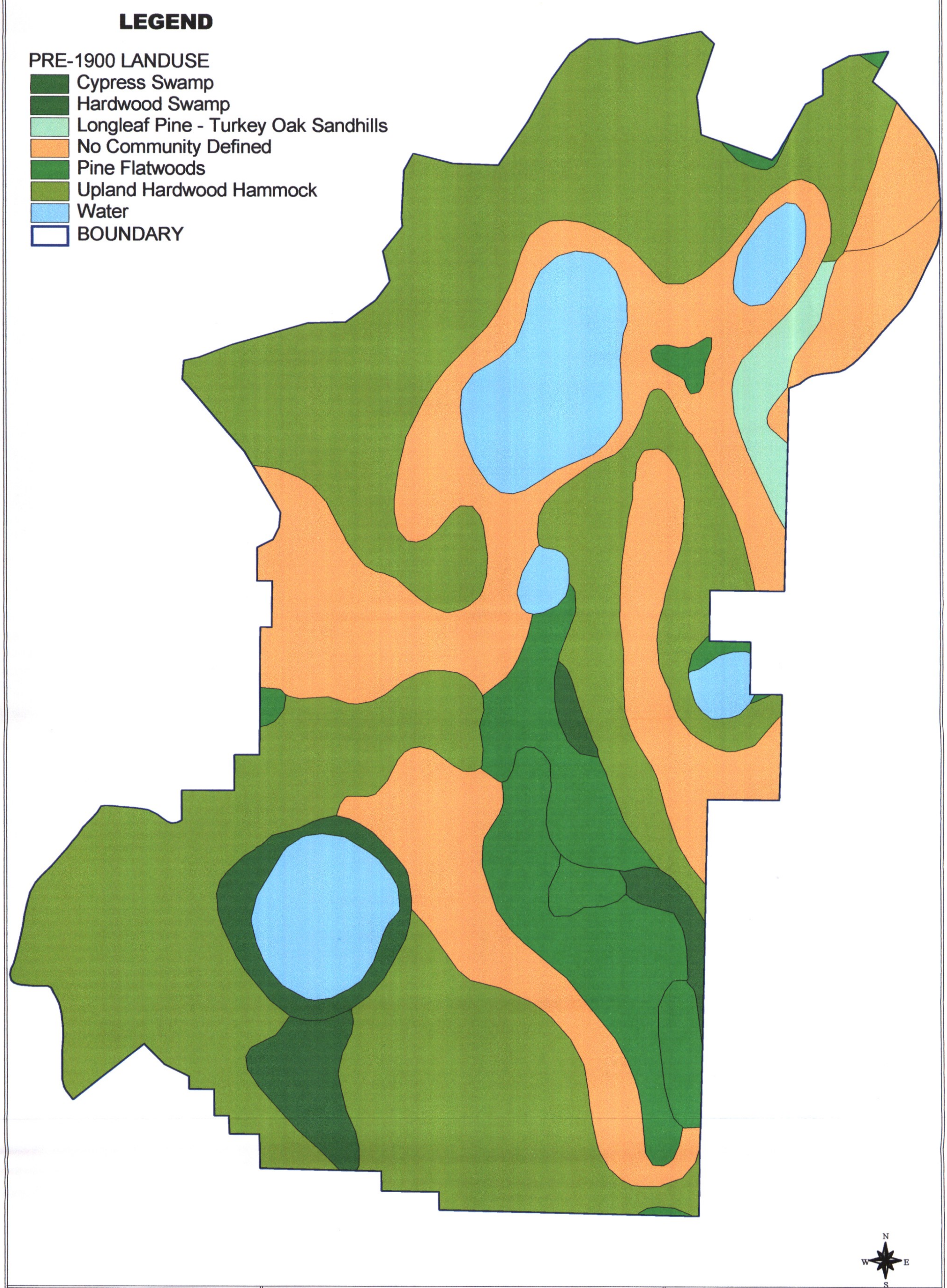
EXISTING NATURAL SYSTEMS CONDITIONS

8.1 OVERVIEW

There are extremely few areas of natural systems left in the Silver / Twin Area watershed This is most likely due to its proximity to the City of Tampa which meant that the watershed was developed early, prior to most types of environmental permitting. Loss of natural systems and habitats to development commonly results in the degradation of water quality, an increase in run-off volumes and timing and a decrease in populations of aquatic and upland wildlife (Schueler 1994). These decreases in wildlife are due to the variation in water levels and timing and by the sedimentation that usually accompanies increased flows. Another type of natural system alteration is the change in fire regime. Fire is an intricate part of maintaining system health and in some cases maintaining the system. Many of the upland systems, especially those in which pine trees are a major component, need fire for a couple of reasons. Some pinecones will not open until they are exposed to a certain heat level or are burned. In addition, pines are adapted to regular, light fires which will eliminate most hardwoods such as oaks but does not affect the pines. In the same way, some wetland systems remain non-forested because regular fires will kill any encroaching trees or shrubs, while leaving the fire adapted herbaceous vegetation to resprout or reseed. Included in the goals of watershed management is the protection of these remaining natural areas and the restoration or creation of natural areas to levels that will be able to properly treat stormwater run-off. This in turn will increase the natural systems' water quality and biodiversity by providing more suitable wildlife habitat. Also, a decrease in run-off volume will increase stream channel stability and decrease stream bank erosion (Schueler 1994).

8.2 HISTORIC HABITAT TYPES

This section uses information generated by the Southwest Florida Water Management District and attempts to reflect the possible land cover for the watershed prior to 1900. It was produced using data from historic aerial photographs and the 1988 and 1958 Soils Conservation Service's Soil Survey of Hillsborough County. The information developed is not intended to be used for planning purposes, but is just an approximation of the most likely land cover types. It can accurately give coverage or acreage for general land cover types such as uplands or wetlands, but its reliability decreases when trying to determine if the wetland is a shallow grass pond or a freshwater marsh. The information can be useful in determining the best area to try to restore the different natural systems types.



Hillsborough County
Florida

**SILVER TWIN LAKE AREA
STORMWATER MANAGEMENT
MASTER PLAN
JAN. 2001**

Public Works Department
Engineering Division
Stormwater Management Section

**Figure 8-1
Silver Twin Lake Area
Historic Soil
Pre 1900 Landuse**

It makes more sense to try to re-establish an area of sand pine scrub on a parcel on which it has historically occurred on rather than trying to "force" it to grow on a parcel that did not support this community in the past and would be better suited for another type of ecosystem. The historic land coverage is shown in **Figure 8-1**. **Table 8.1** summarizes the historic land use, its FLUCCS equivalent and the percent coverage of the watershed for that cover type.

Table 8.1
Historic Land Cover Types

HISTORIC COVER TYPE	ACRES	% COVER	FLUCCS EQUIVALENT
Longleaf Pine - Turkey Oak Hills	8.08	1.44	412 - Longleaf Pine - Xeric Oaks
Oak Hammock	274.18	48.91	427 - Live Oak
South Florida Flatwoods	54.47	9.72	411 - Pine Flatwoods
Wetland Hardwood Hammocks	14.99	2.67	617 - Mixed Wetland Hardwoods
Freshwater Marsh and Pond	10.30	1.84	641 - Freshwater Marsh
Water	51.21	9.14	520 - Lakes
No Community Defined	147.33	26.28	N/A
UPLAND SUBTOTAL	336.73	60.07	
WETLAND SUBTOTAL	76.50	13.65	
UNDEFINED SUBTOTAL	147.33	26.28	
GRAND TOTAL	**560.56**	**100.00**	

8.2.1 Historic Upland Communities

Of the community types identified, uplands constituted about 337 acres or approximately 60 % of the pre-1900 watershed. As a general rule, these are the first areas that are developed in most watersheds. Well-drained soils containing sandhills prime real estate for the establishment of citrus groves, as well as other types of agriculture and residential areas. Pine flatwoods are also easily developed without too much alteration to soils or hydrology, as are the upland hardwood hammocks.

8.2.1.1 Longleaf Pine - Turkey Oak Hills

This community type can be found throughout Florida, but is more common in central Florida and areas of the panhandle. The ecosystem's size can vary widely and can include a few other habitat types, especially small isolated wetlands. This community type can be found in hilly areas with nearly level to strong slopes. The soils are moderately well to excessively drained, deep, somewhat acid in pH, and usually coarse textured. In the historic watershed this habitat type occupied around 8 acres or 1.44 %. It could have occurred on Candler-Urban complex (9), Tavares-Millhopper fine sands (53) or Tavares-Urban complex (55) soils.

There are two main vegetational types found within this community. The first type has a canopy dominated by scattered longleaf pine (*Pinus palustris*). These areas typically are the more mature, natural sites that have not been logged and/or their fire regime has no been altered. If the area has been logged or the fire regime is altered, the second community that results is typically dominated by turkey oak (*Quercus laevis*). In addition to these canopy species, bluejack oak (*Quercus incana*) is a commonly found tree in this habitat type. Various herbaceous and woody species can be found in the understory, which frequently contains numerous areas of bare ground. A shrub story is not commonly found in this community, but where it occurs, it could contain saw palmetto (*Serenoa repens*) and wax myrtle (*Myrica cerifera*). Ground cover can consist of numerous species in the aster family including asters - *Aster* species, blazing stars - *Liatris* species, elephant's foot - *Elephantopus* species and golden-asters, *Chrysopsis* species; numerous plants from the bean family including butterfly peas - *Centrosema* and *Clitoria* species; partridge pea - *Cassia* species, beggarweed - *Desmodium* species and indigoes - *Baptisia* species. Other plants that can also be found are bracken fern (*Pteridum aquilinum*) and various milkweeds - *Asclepias* species and various grasses that include dropseed - *Sporobolus* species, panic grasses - *Panicum* species and indiangrass (*Sorghastrum nutans*).

Animals found in this community are usually adapted to conditions of high temperature and lack of water. Many are burrowing species or use the burrows of other animals, or have a nocturnal lifestyle so that they can avoid the heat of the day and conserve water. Frequently found mammals include fox squirrel (*Sciurus niger*), pocket gopher (*Geomys floridana*) and white-tailed deer (*Odecoileus virginianus*). Birds could include wild turkey (*Meleagris gallopavo*), northern bobwhite (*Colinus virginianus*) and eastern towhee (*Pipilo erthrophthalmus*). Commonly occurring reptiles would have included gopher turtle (*Gopherus polyphemus*), indigo snake (*Drymarchon corias*) and fence lizard (*Scleroporus undulatus*).

8.2.1.2 South Florida Flatwoods

This community type can be found throughout south and central Florida and, when combined with its northern counterpart, is probably the most common ecosystem in the state. Most areas of this type are very large in size and can include other habitat types, especially wetlands. Flatwoods can be found on nearly level land. The soils are poorly to somewhat poorly drained, deep, somewhat acid in pH, and usually coarse textured. In the historic watershed this ecosystem covered approximately 55 acres or 9.7 %. This type could have occurred on

Adamsville fine sand (2), Myakka fine sand (29), Myakka-Urban land complex (32), Ona fine sand (33) or Smyrna fine sand (52) soils.

Fire and water control the vegetation of this community. As with other pine dominated ecosystems, this one is maintained by fire which precludes the establishment of hardwoods. On the other hand, due to the relatively high water table, especially during the summer, there are can be slight differences in vegetational types found. These vary with the wetness or dryness of the location. Generally, the wetter areas contain less trees and less saw palmetto. The canopy is dominated by slash pine (*Pinus elliottii*), with scattered live oak (*Quercus virginiana*). The shrub layer is usually dominated by saw palmetto with gallberry (*Ilex glabra*) and wax myrtle as minor components along with tarflower (*Befaria racemosa*) and blueberries – *Vaccinium* species mixed in. Various herbaceous and woody species can be found in the groundcover, which is typically dominated by grasses such as bluestems – *Andropogon* and *Schizachyrium* species, switchgrasses and threeawns – *Aristida* species.

Due to the patchy nature of other included vegetative communities within the flatwoods ecosystem, there is a good diversity of animals that can be found. The ecotones or areas between the different systems provide good nesting sites and areas for food and cover. Typical animals include white-tailed deer, armadillo (*Dasypus novemcincutus*), eastern cottontail (*Sylvilagus floridanus*), and raccoon (*Procyon lotor*). Birds could include Bachman's sparrow (*Aimophila aestivalis*), wild turkey, pine warbler (*Dendroica pinus*), and red-bellied woodpecker (*Melanerpes carolinus*). Commonly occurring reptiles and amphibians would have included eastern diamondback rattlesnake (*Crotalus adamanteus*), black racer (*Coluber constrictor*) and pinewoods treefrog (*Hyla fumeralis*).

8.2.1.3 Upland Hardwood Hammock

This community type is commonly found in north central Florida and less in the north or west portion of the state. Most areas of this community are usually smaller in size, generally less than a few hundred acres and can include other habitat types such as wetlands. This is considered the climax community type for Florida and most of the southeastern United States. Once attained, this community will be self-sustaining, provided it is not altered by humans or catastrophic natural occurrences such as hurricanes or wildfire.

This community occurs on rolling terrain with nearly level to strongly sloping land. The soils are typically deep, somewhat poorly to well drained and generally coarse textured. Historically, this habitat occupied almost half the watershed's area at 48.91 % or 275 acres. It could have occurred on the following soils: Adamsville fine sand (2), Seffner fine sand (47), Tavares-Millhopper fine sand (53), Tavares-Urban land complex (55) or Zolfo fine sand (61).

The canopy is dominated by oaks, primarily live and laurel (*Quercus laurifolia*), pignut hickory (*Carya glabra*), slash pine, southern magnolia (*Magnolia grandiflora*) and sweetgum (*Liquidambar styracaflua*). Because this is a climax community and typically has a dense canopy, the subcanopy layer can be quite sparse in large areas. Where vegetation does exist it could have contained American beautyberry (*Callicarpa americana*), waxmyrtle and coral bean (*Erythrina herbacea*). The groundcover is also sparse but could have contained asters, switchgrasses, various greenbriers – *Smilax* species, poison ivy (*Toxicodendron radicans*) and partridge berry (*Mitchellia repens*).

Due to the stability of this habitat, many animals can be found and many of those will be large mammals. Typical animals include white-tailed deer, cotton rat, gray squirrel, bobcat (*Lynx rufus*) and raccoon. Because of the food generated by the various trees and plants, this habitat type is very important for migratory songbirds and could include myrtle warbler (*Dendroica coronata*), summer tanager (*Piranga rubra*), Chuck-will's-widow (*Caprimulgus carolinianus*) and various woodpeckers. Normally occurring reptiles and amphibians would have included eastern diamondback rattlesnake, indigo snake, southern ring-necked snake (*Diadophis punctatus*), and southern toad (*Bufo terrestris*).

8.2.2 Historic Wetland Communities

Of the community types identified, wetlands constituted about 76.50 acres or about 13.65% of the pre-1900 watershed. As opposed to the uplands, these are usually the last areas that are developed in most watersheds. This is generally due to the cost of filling the wetlands and / or because of wetland protection regulations. Poorly-drained muck soils are not good for much other than agriculture crops that need this type of rich soils. Within the watershed, these wetlands can be broadly divided into forested and non-forested areas.

8.2.2.1 Freshwater Marsh and Pond

This community type is commonly found scattered throughout Florida and ranges in size from a few to hundreds, or even thousands, of acres. Like the upland pine communities, this ecosystem is somewhat dependent on fire to maintain its non-forested condition. The herbaceous plants are adapted to occasional fire that will keep hardwoods from overgrowing the system. These herbs are dominated by grasses, sedges and rushes that are able to withstand inundation for two or more months during the summer and then dry out for the majority of the winter season. Within the state, these marshes can be divided into eight main groups, defined by the type of vegetation that dominates each of them. These include pickerelweed (*Pontederia cordata*), sawgrass (*Cladium jamaicense*), arrowhead (*Sagittaria* species), fire flag (*Thalia geniculata*), cattail (*Typha* species), spikerush (*Eleocharis* species), bulrush (*Scirpus* species) and maidencane (*Panicum hemitomon*).

This community occurs on nearly level to depressional land. The soils are typically very poorly drained and generally coarse textured or organic materials underlain by clay or sand. In the historic watershed, this community occupied around 2% or 10.3 acres. It could have occurred on Basinger, Holopaw and Samsula soils (5).

Rarely do these systems have a tree component associated with them. In the majority of the cases where tree species are involved, there will be one or a few black gums found in the pond's center. Occasionally, a red maple (*Acer rubra*) or sweetbay magnolia (*Magnolia virginiana*) is found instead. Shrubs too, are generally not found but when present, they consist mainly of buttonbush (*Cephalanthus occidentalis*) or elderberry (*Sambucus canadensis*). Groundcover would be the main component of this ecosystem and is composed of grasses such as switchgrasses (various *Panicum* species), paspalums (*Paspalum* species), foxtails (*Setaria* species), lovegrasses (*Eragrostis* species) and bluestems (*Andropogon* species). Plants in the sedge family would include flatsedges (*Cyperus* species), beakrushes (*Rhynchospora* species), sedges (*Carex* species) and bulrushes (*Scirpus* species). Rushes would include numerous members of the *Juncus* family.

Typical animals include white-tailed deer, cotton rat, gray squirrel, bobcat, wild hog (*Sus scrofa*) and raccoon. These habitats are important feeding areas for long-legged wading birds such as herons, egrets, ibis and wood stork. Marshbirds such as rails, moorhens, blackbirds, bitterns and gallinules use these areas for breeding purposes. The ephemeral type of this wetland is also an important breeding area for many amphibians that take advantage of these areas that have no fish to prey on their eggs and young.

8.2.2.2 Wetland Hardwood Hammock

This community type is commonly found scattered throughout Florida with the exception of the Central Florida Ridge. Some areas of this community can be smaller in size, but like cypress systems, those areas associated with riverine floodplains can be quite large. Like its upland counterpart, this is considered a climax community type for Florida and most of the southeastern United States. Once attained, this community will be self-sustaining, provided it is left unaltered by humans or catastrophic natural occurrences such as hurricanes or wildfire.

This community occurs on level to nearly level land. The soils are typically deep, poorly to somewhat poorly drained and generally underlain with loamy subsoils. Surface soils are usually sandy in nature. This habitat occupied around 15 acres or 2.76 % of the watershed. In the historic watershed, it would have occurred primarily on Basinger, Holopaw and Samsula soils (5).

Oaks, primarily live, laurel and water (*Quercus niger*), red maple, slash pine, cabbage palm, sweetbay magnolia (*Magnolia virginiana*), and sweetgum dominate the canopy. Since this is a climax community and typically has a dense canopy, the subcanopy layer can be quite sparse in large areas. Where vegetation does exist it could have contained waxmyrtle, coral bean, saw palmetto, dwarf palmetto (*Sabal minor*) and sparkleberry (*Vaccinium arboretum*) along with saplings of the canopy species. Groundcover could also be sparse but could have contained asters, switchgrasses, various greenbriers, trumpet creeper and numerous species of ferns.

Due to the stable habitat, many animals can be found and many of them will be large mammals. Typical animals include white-tailed deer, cotton rat, gray squirrel, bobcat, wild hog and raccoon. Historically, this area would have been prime habitat for the Florida black bear (*Ursus americanus*) and the Florida panther (*Felix concolor*). Because the large variety of trees and plants that generate a large supply of food, this habitat type is very important for migratory songbirds and could include myrtle warbler, red-eyed vireo, scarlet tanager, and various woodpeckers. Normally occurring reptiles and amphibians would have included eastern diamondback rattlesnake, indigo snake, various watersnakes and numerous frogs and toads.

8.2.2.3 Open Water

This ecological type is found in throughout Florida and includes natural lakes, ponds and seasonal water features. The size of these communities can vary from a few hundred square feet to hundreds of acres.

Because of the varied nature of the community, there is no typical landscape or soil type associated with open water. They commonly occur in almost all of the system types discussed in the previous sections. Water covered a little over 51 acres or 9% of the watershed.

Vegetation on the immediate edge of the system will vary with the type of community the open water is found in. In the open water itself numerous aquatic plants could be found including waterlilies (*Nymphea* species), pondweeds (*Potamogeton* species), various spikerushes, lemon bacopa (*Bacopa caroliniana*) and bladderworts (*Utricularia* species).

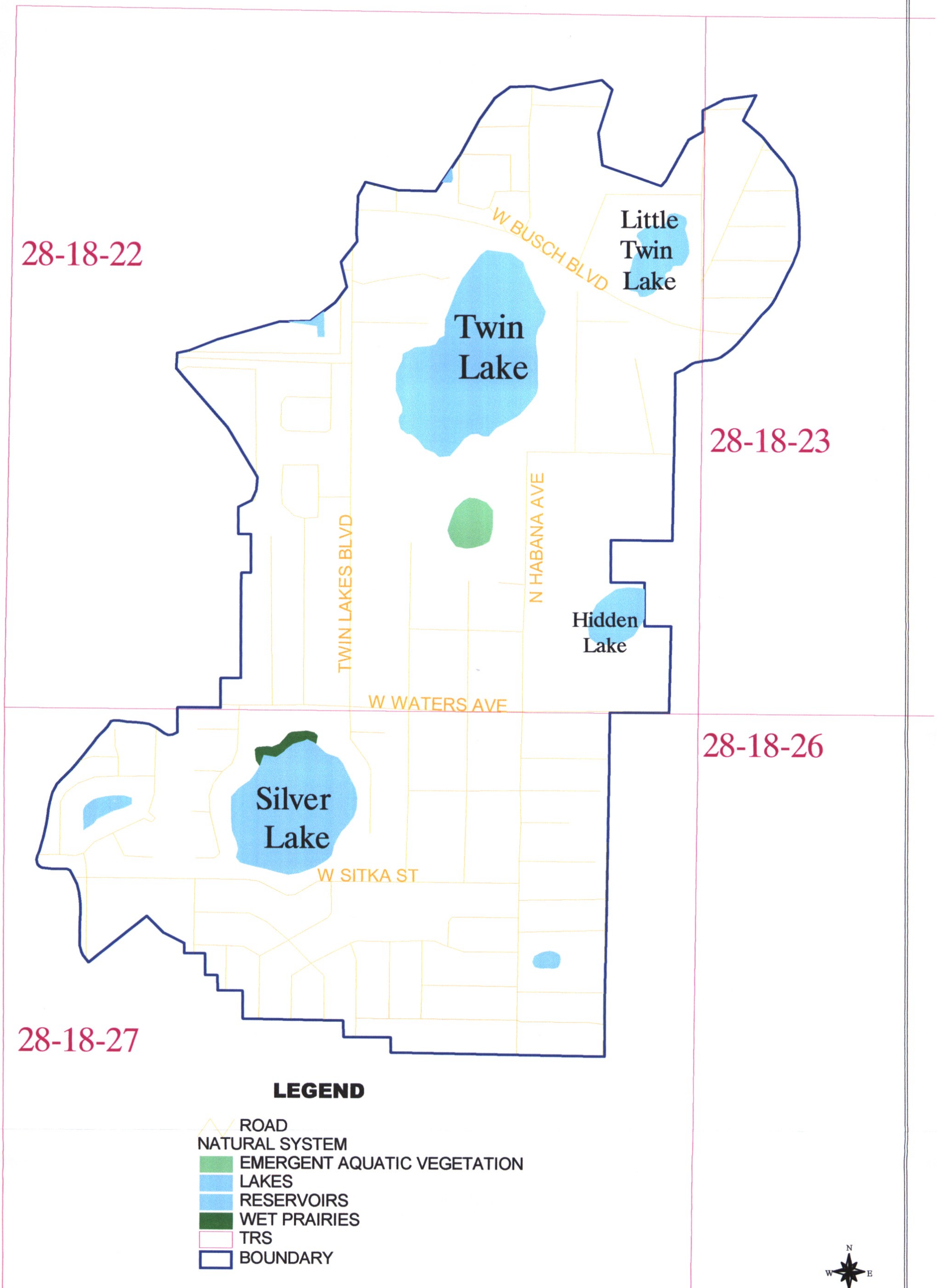
Mammals found in this habitat are generally the same as those found in adjacent habitats and use the open water as a source of drinking water or an area to breed. Birds would also be typical of the areas of open water with shorebirds and long-legged waders along with gulls and terns. Reptiles would include watersnakes, numerous species of turtles and the American alligator (*Alligator mississippiensis*). This habitat serves as an important area in the life cycle of many amphibians such as frogs, toads and salamanders.

8.3 EXISTING HABITAT TYPES

Degradation caused by the impacts to these natural systems affects the quality of life of all the citizens in, and in many cases, outside the watershed. These impacts may affect potable water supply, recreational resources and quite possibly the climate of the Tampa Bay area. It is therefore in the best interest of the community to preserve, enhance and restore natural systems within the watershed to historic or near historic levels. If natural systems are to be preserved, the first step has to be the identification and quantification of each system. Next, issues and areas of concern must be identified for each of the systems involved and from their possible solutions for improvements can then be explored. This section identifies the remaining wetland systems in the Silver / Twin Lakes Area watershed; all the historic upland areas have been developed in one way or the other. The chapter also describes the flora and fauna that can be expected to occur in each of the habitat types. **Figure 8-2** depicts the natural systems that can be found in the basin.

Only 10.0225 % or 56.24003 acres of the watershed's 561^{+} acres have not yet been developed. This acreage includes only wetlands and open water, no upland natural systems remain. Of this total, 51.21 acres or 9.14 % of the watershed is considered open water and consists of lakes and reservoirs. These two components represent 93.9938 % of the natural systems area. Wetland acreage comprises 3.37733 % of the natural systems area and 6.0052 % of the total watershed area. Wetlands have undergone a 58.17 % decrease from a historic high of 76.50 acres to a low of 3.38 acres. This information is summarized and further broken down in **Table 8.2** below.

Of these losses, residential land uses have contributed the most with over two-thirds or 68.94 % or 348.99 acres converted from natural systems. Combined commercial, institutional, light industrial and highway / utility land uses have destroyed 15.76 % of the original watershed area or 79.79 acres. Not too surprising in such a highly developed area, agricultural land uses only transformed 1.01 % of the watershed area or 5.12 acres. However, it must be keep in mind that most of the residential and other developed areas have been converted from agricultural uses. Open land use, undeveloped land in the urban landscape, accounts for only 4.31 acres or less than 1 % of the watershed's losses. Finally, 2.67 % of the watershed or a little over 13.50 acres have been converted to recreational land uses.



Hillsborough County
Florida

SILVER TWIN LAKE AREA
STORMWATER MANAGEMENT
MASTER PLAN
JAN. 2001

Public Works Department
Engineering Division
Stormwater Management Section

Figure 8-2
Silver Twin Lake Area Existing Natural System Map

INSERT FIGURE 8-2, EXISTING HABITAT TYPES

Table 8.2
Existing Natural Systems Land Cover Distribution in the Silver / Twin Lakes Watershed

FLUCCS CODE	LAND COVER TYPE	ACRES	% OF NATURAL SYSTEMS	% OF WATERSHED
	Upland Subtotals	***0.0***	***0.0***	***0.0***
520	Lakes	51.26	91.15	9.14
530	Reservoirs	1.598	2.84	0.28
	Water Subtotals	***52.86***	***93.99***	***9.42***
643	Wet Prairies	0.93	1.65	0.16
644	Freshwater Marsh	2.45	4.36	0.44
	Wetland Subtotal	***3.38***	***6.01***	***0.60***

TOTAL		**56.24**	**100.00**	**10.02**

8.3.1 Existing Upland Habitat Types

No upland habitats, outside of residential lawns, exist within the watershed; all have been converted to “improved” land uses. **Table 8.3** below summarizes the historic natural systems acreages versus the existing acreages and depicts the percent change for each system type.

8.3.2 Open Water

This is type of non-vegetated “wetland”. Most of the open water portions of lakes, ponds, swamps, etc. do not qualify as wetlands under the state’s definition (see section 8.3.1.4. below) These areas fall under the category of Waters of the State and would receive protection under those regulations as surface waters.

This land use category is generally defined as those areas that are predominately or persistently cover with water and if linear in nature must be at least χ mile (660 feet) wide or, if extended, cover at least 40 acres. FLUCCS codes do not routinely classify waterbodies that are ten acres or less. Open water occupies 52.86 acres in the Silver / Twin Lakes watershed and is composed of natural lakes and reservoirs / borrow pits. As shown in **Table 8.2** above, this amounts to almost 94 % of the natural systems or a little over 9.4 % of the basin’s total area. This habitat type has had a minimal net increase in the watershed from a historic low of 51.21 acres to the present day total of 52.86 acres. This represents an increase of only 0.03 % and could be the difference in mapping methods rather than a true gain in acreage for the watershed. The one true increase is in the reservoir category where a 1.6 acres pond was created since the historic information was collected. A reservoir is defined as an open waterbody with a control structure on it. These are almost always man-made.

Table 8.3
Land Cover Changes in the Silver / Twin Lakes Watershed

AGGREGATE TYPE	LAND COVER TYPE	HISTORIC ACRES	EXISTING ACRES	% CHANGE
UPLANDS	Longleaf Pine - Turkey Oak Hills	8.08	0.0	-100
	Pine Flatwoods	54.47	0.0	-100
	Upland Hardwood Forest	274.18	0.0	-100
	Subtotal	**336.73**	**0.0**	**-100**
WETLANDS	Hardwood Hammock	14.99	0.0	-100

	Freshwater Marshes	10.30	2.45	-76.21
	Wet Prairies	0.0	0.93	N/A
	Subtotal	**25.29**	**3.38**	**-86.63**
OPEN WATER	Lakes	51.21	51.26	+0.0009
	Reservoirs	0.0	1.60	N/A
	Subtotal	**51.26**	**52.86**	**+0.03**
UNDEFINED	Undefined Community	**147.33**	**N/A**	**N/A**
203.57* acres	**TOTAL**	**413.38***	**56.24****	**-86.39****

* Total of all **bolded** subtotals
** Does not included undefined lands (open land); only a total of uplands, wetlands and water.

8.3.2.1 Lakes

This habitat type is characterized as large, non-flowing, natural areas of permanent water. As discussed in the previous section, the FLUCCS system separates the vegetated portion of a lake into a separate wetland category depending on the species composition. As discussed in the previous chapter, there are several lakes contained in the watershed and they are the dominant natural systems features in the basin. Twin Lake is the largest at 27.05 acres with a basin about twice that size. Next in size is Silver Lake at 18.69 acres in a 30 acre basin. These lakes serve as important areas for the wildlife of the watershed. In addition to these lakes are the three almost equally sized Little Twin Lake, Lake Dorothea and Hidden Lake. All are just over 3 acres in size. Within the watershed lakes occupy 52.86 acres which translates into almost 94 % of the natural systems area and close to 10 % of the total watershed area. According to the historical data, there has been a 0.03 % increase in the areal coverage of lakes from the pre-1900 figure of 51.21 acres. This gain is due primarily to the creation of a small 1.6 acre borrow pit in the watershed.

Trees that can be expected to be found include pond cypress, Coastal Plains willow, laurel oak, red maple, live oak, sweet gum and slash pine. Shrubs include primrose willow, Mexican seedbox - *Ludwigia octovalvis*, wax myrtle and saltbush. Herbaceous vegetation includes cattails, umbrella pennywort, sacred lotus - *Nelumbo nucifera*, spatterdock, fragrant waterlily - *Nymphaea odorata*, pickerelweed and duck potato.

Mammals found in this habitat are generally the same as those found in adjacent habitats and use the open water as a source of drinking water or an area to breed. Given the developed nature of the watershed, there would be no large mammals expected to occur. Raccoon and opossum would be the largest and both are highly adaptable to urban habitats. Otherwise, mammals would be limited to small rodents, such as gray squirrel, and various rats and mice. Birds would also be typical of the areas of open water with shorebirds and long-legged waders along with gulls and terns. Reptiles would include watersnakes and numerous species of turtles. The American alligator (*Alligator mississippiensis*) was reported in Twin Lake in 1998. This habitat serves as an important area in the life cycle of many amphibians such as frogs, toads and salamanders.

8.3.2.2 Reservoirs

Reservoirs form a minor component of the watershed's natural systems. In this basin there are two small ponds totaling 1.6 acres. Both these ponds appear to be stormwater ponds within apartment complexes in the northwest corner of the watershed. They may have originally been used as a source of fill for the pads of the buildings as well. They cover about 2.84 % of the natural systems area and 0.28 % of the total watershed area.

Floral and faunal components will be similar to those found within the watershed's lakes.

8.3.3 Wetlands

Wetlands are those areas, typically associated with topographic lows and a water table at or near the soils surface, where there is sufficient hydrologic regime to support, in most cases, aquatic or hydrophytic flora. However, unvegetated wetlands can exist in the form of alluvial or tidal flats. Wetland areas with permanent pools of open water are considered water by FLUCCS and are not included in this category.

The definition of a wetland for the State of Florida as found in 373.019 (17) Florida Statutes reads "*… those areas that are inundated or saturated by surface water or ground water at a frequency and a duration sufficient to support, and under normal circumstance do support, a prevalence of vegetation typically adapted for life in saturated soils. Soils present in wetlands generally are classified as hydric or alluvial, or possess characteristics that are associated with reducing soil conditions. The prevalent vegetation in wetlands generally consists of facultative or obligate hydrophytic macrophytes that are typically adapted to areas having soil conditions described above. These species due to morphological, physiological, or reproductive adaptation, have the ability to grow, reproduce or persist in aquatic environments or anaerobic soil conditions. Florida wetlands generally include swamps, marshes, bayheads, bogs, cypress domes and strands, sloughs, wet prairies, riverine swamps and marshes, hydric seepage slopes, tidal marshes, mangrove swamps and other similar areas. Florida wetlands generally do not include longleaf or slash pine flatwoods with an understory dominated by saw palmetto.*" As can be seen from **Table 8.3**, over 86 % of the watershed's wetlands have been developed since 1900; from a high of 25.29 acres down to the present-day total of only 3.39.

8.3.3.1 Non-Forested Wetlands

While forested wetland areas can be important for large mammals and migratory birds, these non-forested wetlands, particularly the ephemeral isolated systems, can be very important in the breeding cycle of many amphibians. This is due to the fact that they dry out during the winter, effectively eliminating fish from the system. In this predator reduced environment their larvae have a better chance of survival.

FRESHWATER MARSHES

This community type constitutes the largest amount of wetland acreage in the watershed at 2.45 acres. In terms of percent coverage, this equates to 4.36 % of the natural systems area and 0.44 % of the total watershed area. These marshes can be further categorized depending on the dominant vegetative type. The determination is similar to forested areas; if 66 % or more of an individual plant species dominates the area, the marsh can be characterized as that type of marsh. For example if it contains 66 % or more cattails, it will be designated as a cattail marsh. As stated in the historic section for this community, there are eight major types that can be found. Within the watershed, all of this habitat type is found within Lake Dorothea and is classified as a cattail marsh.

Again, the highly urban nature of the watershed is going to restrict the types of animals that will be able to use this habitat. As with the open water systems, mammals will be limited primarily to small rodents, opossum and raccoons. Birds also will be limited to those species that are able to adapt to urban environs - northern mockingbird, blue jay, northern cardinal, red-winged blackbird, common and boat-tailed grackles, house sparrows, mourning and Eurasian collared doves and rock pigeons. Urban adapted reptiles will be limited to species such as the black racer and eastern legless lizard. Amphibians will be exotic species such as the Cuban treefrog, greenhouse treefrog and the giant marine toad and native species such as the American toad.

WET PRAIRIE

This predominately grassy habitat occupies 0.93 acres on the northwest corner of Silver Lake. Natural systems coverage amounts to 1.65 %; while, total watershed area coverage comes to only 0.16 %. The main feature that separates this type from freshwater marsh is the relatively drier conditions and shorter vegetation.

There are few if any trees associated with wet prairies and those would be found along the fringe with the exception of the odd tupelo in areas of longer standing water. Shrubs would be limited to buttonbush, St. Johnsworts, *Ludwigias* and wax myrtle. Herbaceous vegetation would include meadowbeauties, various grasses and sedges, marsh pinks – *Sabatia* species, yellow-eyed grasses – *Xyris* species and sundews.

Animals would be similar to those found in freshwater marshes.

8.4 LISTED SPECIES WITHIN THE WATERSHED

Listed species are those flora and fauna protected by federal and state regulations which prohibit certain activities that might harm these species or their habitats. In 1973 the federal government, in order to protect these plants and animals, passed the Endangered Species Act. The United States Fish and Wildlife Service (USFWS) is responsible for federal enforcement and administers protection for plants under 50 CFR 23 and for animals under 50 CFR 17. Listed plants and animals are divided into two categories at the federal level, endangered and threatened.

Federally listed endangered species are defined as Aany species which is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary (of the Interior or Commerce) to constitute a pest whose protection under the provisions of this Act would present an overwhelming and overriding risk to man.≅

Federally listed threatened species are those plants and animals Awhich are likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

The state of Florida has similar protections that are administered by Florida Fish and Wildlife Conservation Commission for animals and by the Florida Department of Agriculture and Consumer Services (ACS) for plants. Animals are placed into three categories - endangered, threatened and species of special concern and are protected by Rules 39-27.003, 39-27.004 and 39-27.005 respectively.

State listed endangered animals are those Afish and wildlife naturally occurring in Florida, whose prospects of survival are in jeopardy due to modification or loss of habitat; overutilization for commercial, sporting, scientific, or educational purposes; disease; predation; inadequacy of regulatory mechanisms; or other natural or manmade factors affecting its continued existence.≅

State listed threatened animals are defined as Afish and wildlife naturally occurring in Florida which may not be in immediate danger of extinction, but which exists in such small populations as to become endangered if it is subjected to increased stress as a result of further modification of its environment.≅

State listed species of special concern are those Afaunal species that warrant special protection, recognition or consideration because it has an inherent significant vulnerability to habitat modification, environmental alteration, human disturbance, or substantial human exploitation which, in the foreseeable future, may result in its becoming a threatened species; may already meet certain criteria for designation as a threatened species but for which conclusive data are limited or lacking; may occupy such an unusually vital and essential ecological niche that should it decline significantly in numbers or distribution other species would be adversely affected to a significant degree; or has not sufficiently recovered from past population depletion.≅

Plants are similarly divided into endangered, threatened and commercially exploited and fall under Chapter 5B-40.

State listed endangered plants include those species Anative to the state that are in imminent danger of extinction within the state, the survival of which is unlikely if the causes of a decline in the number of plants continue, and includes all species determined to be endangered or threatened pursuant to the federal Endangered Species Act of 1973, as amended, Pub. L. No. 93-205 (87 Statute 884)≅.

State listed threatened plants refer to Aspecies native to the state that are in rapid decline in the number of plants within the state, but which have not so decreased in such number as to cause them to be endangered.≅

State listed commercially exploited plants encompass those Aspecies native to the state which are subject to being removed in significant numbers from native habitats in the state and sold or transported for sale.≅

A list of the flora and fauna that could potentially be found or has been observed in the Silver / Twin Lakes watershed is summarized in **Tables 8.4a & b**. The tables also summarize the habitat types in which those species were, or could be expected to be, found. Habitat loss and fragmentation from development has been the main factor in driving these plants and animals toward extinction, with the introduction of exotic and nuisance species and commercial exploitation playing a lesser role. Species listed in **bold type** were observed during one or more of the field visits to the watershed and the column bearing the bold A**X**≅ is the habitat type in which those species were observed.

Table 8.4a

Listed Flora Potentially Found/Observed in the Silver / Twin Lakes Watershed

		STATUS[1]		HABITAT PREFERENCE[2]			
Common Name	**Scientific Name**	**FL**	**FED**	**L**	**R**	**FM**	**WP**
Bearded Grass Pink	*Calopogon barbatus*	T	---				X
Catesby's or Pine Lily	*Lilium catesbaei*	T	---				X
Nodding Clubmoss	*Lycopodium cernuum*	CE	---				X
Cinnamon Fern	*Osmunda cinnamomea*	CE	---			**X**	X
Royal Fern	*Osmunda regalis*	CE	---	**X**		X	
Blue-flowered Bladderwort	*Pinguicula caerulea*	T	---				
Yellow-flowered Bladderwort	*Pinguicula lutea*	T	---				
Rain Lily	*Zephyranthes atamasco*	T	---				

Table 8.4b
Listed Fauna Potentially Found and / or Observed in the Silver / Twin Lakes Watershed

		STATUS[1]		HABITAT PREFERENCE [2]			
Common Name	**Scientific Name**	**FL**	**FED**	**L**	**R**	**WP**	**FM**
Reptiles							
American Alligator	*Alligator mississippiensis*	SSC	T/SA	**X**			
Birds							
Roseate Spoonbill	*Ajaia ajaja*	SSC	---	X		X	X
Limpkin	*Aramus guarauna*	SSC	---	X			X
Little Blue Heron	*Egretta caerulea*	SSC	---	**X**	X	X	X
Snowy Egret	*Egretta thula*	SSC	---	X	X	X	X
Tricolored Heron	*Egretta tricolor*	SSC	---	**X**		X	X
White Ibis	*Eudocimus albus*	SSC	---	**X**		X	X
Southeastern Kestrel	*Falco sparverius paulus*	T	---	X		X	
Sandhill Crane	*Grus canadensis*	T	---	X		X	X
Bald Eagle	*Haliaeetus leucocephalus*	T	T	X			
Wood Stork	*Mycteria americana*	E	E	X			X
Brown Pelican	*Pelecanus occidentalis*	SSC	---	X			

Least Tern	*Sterna anatillarum*	T	---	X			

STATUS[1] **- FL** = Florida Fish & Wildlife Conservation Commission; **FED** = United States Fish and Wildlife Service; **E** = Endangered; **T** = Threatened; **T/SA** = Threatened / Similarity of Appearance; **SSC** = Species of Special Concern and **CE** = Commercially Exploited

Habitat Preference[2] **- L** - Lakes; **R -** Reservoirs; **FM** - Freshwater Marshes; and **WP** - Wet Prairies

Some of these species are not always limited to those habitats listed in these tables. As more and more suitable habitat is altered or destroyed, many species will utilize less than ideal habitat as a substitute. For instance, sandhill cranes use large, grassy open areas to forage in. This includes pastureland and other open spaces which are not included in the tables above. “Florida” kestrels, the listed subspecies of the Southeastern kestrel, are notorious for hanging out around Little League baseball fields and golf courses. They need habitats where the grass stays low enough for them to easily find their primary prey - grasshoppers. Golf courses and ball fields are a good substitute for the grasslands they once used. Rain lilies also need open grassy areas for suitable habitat and because of this, this species is most commonly found in residential yards and other similar areas. Finally, roadside ditches function much like streams and lakeshores in terms of feeding habitat for many of the long-legged wading birds like herons, egrets, ibis and storks. This is especially true for wood storks. They feed primarily by touch and prefer their food items to be concentrated in areas of low water. Roadside ditches with their alternating water regimes of flow and no flow, depending on storm events, mimics the seasonal drawdowns of the ponds and streams this species depends on as a source of food.

8.5 PROTECTED LANDS WITHIN THE WATERSHED

There are numerous mechanisms for preserving land in the watershed. On the state level, Florida Forever / Preservation 2000 is the most recent initiative on buying and preserving vital habit. These programs were preceded in 1979 by the establishment of the Conservation and Recreational Lands (CARL) program and in 1981 by the development of both the Save Our Coast (SOC) and Save Our Rivers (SOR) programs. On the County level, the Environmental Lands Acquisition and Protection Program (ELAPP) serves a similar function in land preservation to that of the state.

Other mechanisms protect certain habitat types. Since 1984, Florida has protected its valuable wetlands through State law. This has been done most recently when the State rewrote its wetland regulations that went into effect in July 1994. Both the Department of Environmental Regulation and the state’s Water Management District use these regulations to protect wetlands.

Hillsborough County is one of the few counties in the state that has additional wetland protection through local government. This is accomplished through the Rules of Hillsborough County, Chapter 1-11 - the Wetland Rule. In addition to wetland protection, the County has provisions written in the Land Development Code to protect vital upland habitat, as well. This is carried out under the Upland Habitat Ordinance that divides environmentally sensitive uplands into two categories. The first is termed Significant Wildlife Habitat and has the potential for use by listed species. The second is Essential Wildlife Habitat which are habitats on which listed species have been observed.

8.5.1 ELAPP Sites

This program was established in 1987 and its primary purpose is to acquire, preserve and manage environmentally sensitive lands. Public use is permitted on select parcels. The program is under the County's Parks and Recreation Department with an advisory board composed of concerned private citizens and County staff. Unfortunately, due to the highly developed nature of the watershed, ELAPP has not purchased any properties within the watershed nor does it presently have any parcels in the basin under consideration.

8.5.2 Significant And Essential Wildlife Habitat

This program was established in 1992 and recognizes the importance of protecting vital upland habitats in a manner similar to the County's Wetland Rule. Significant wildlife habitat is defined by the Hillsborough County Land Development Code (LDC) as "Contiguous stands of natural plant communities which have the potential to support healthy and diverse populations of wildlife and which have been identified in the Florida Game and Freshwater Fish Commission Natural Systems and Land Use Inventory for Hillsborough County." These are those upland areas that have the potential for supporting listed plant and animal species. Essential wildlife habitat is defined by the LDC as "Land or water bodies which, through the provision of habitat, are necessary to maintain populations of endangered or threatened species or species of special concern." These are lands on which listed species have been found. There are no areas of Significant and Essential Wildlife habitat to be found in the watershed.

8.6 NATURAL SYSTEMS ISSUES/AREAS OF CONCERN

This section discusses the major issues of concern for the natural systems in the watershed and describes specific problems with respect to these issues. These issues have been identified as habitat loss through fragmentation and degradation, the introduction of exotic species, the loss of buffers against water quality impacts, and the alteration of flow into wetland systems. These issues are described in more detailed in the following paragraphs.

8.6.1 Loss of Habitat as a Result of Fragmentation and Degradation

Two of the main reasons for habitat loss within the Silver / Twin Lakes watershed are fragmentation and degradation of the existing habitats. Fragmentation is the slicing up of large pieces of habitat or entire ecosystems into smaller Aislands≅ which themselves are frequently subject to further fragmentation. Generally, these islands contain wetlands that were to cost prohibitive to fill prior to wetland protection rules and regulations or were not allowed to be impacted by regulatory agencies. The same may be true for some green spaces that are now required as part of present day zoning requirements. As the spaces between these Aislands≅ are filled with development, the lack of greenways or corridors prevents most wildlife from recolonizing one area from another until the habitatσ value is near zero. Another aspect of this process is what has come to be termed the Aedge effect≅. In this scenario, the edges in and around the habitat increases, which makes less large areas of deep habitat that is required for the breeding success of some wildlife, especially certain species of songbirds. If these species do not feel they are inside a large enough area of suitable habitat, they will move on to a more appropriate area. Additionally, this increase in edge also allows greater access by predators. In some cases, it has been demonstrated that the decline in population of some deep woods dwelling songbirds, such as vireos and warblers, is the result of parasitism by the brown-headed cowbird. Cowbirds are normally found in grasslands and other similar open habitats, but with an increase in edges, it is not difficult for them to penetrate into breeding habitat of these songbirds that were previously too deep in the forest for the cowbirds to reach. This Aedge effect≅ can be a two-sided sword however as some species such as wild turkey, northern bobwhite and white-tailed deer seem to benefit from it.

Degradation of the remaining habitat can occur in various ways. As stated above, many of the natural systems in the watershed are dependent on a regime of fire to maintain the status quo of the systems. If coniferous habitats are not subjected to frequent light fires, hardwoods will gain a foothold and the system will, through natural succession, become a hardwood system. In the same way, if fire is suppressed in a wet prairie or freshwater marsh, trees and shrubs will become established and the area will transition into a forested system. In areas of development it is increasingly difficult to burn and maintain these fire dependent habitats. Another type of degradation is through alteration of the hydrologic regime of a system, especially wetlands. As run-off is captured by treatment systems, the frequency and duration of water being delivered into the system is altered and this can lead to changes in the vegetative composition of wetland plant species, which in turn affects the wildlife usage of the system. The removal of vegetation can impact a system both directly or indirectly. The direct impact can be the outright removal of habitat. More subtle impacts occur when trees or floating vegetation are removed from a lake or stream, which can result in a rise in water temperature. The same effect has been observed in the soils of terrestrial habitats. The removal of groundcover can result in increased erosion and sedimentation and a lessening of the stormwater treatment ability of the system. Other types of degradation can result from the inappropriate recreation use of an area. Wetlands can be favorite spots for off road Amud-boggers≅. Illegal dumping or discharges can also lead to degradation, both direct and indirect.

8.6.2. Introduction of Exotic Species

With the advent of relatively easy access to virtually any part of the planet, the problem of invasion by exotic plant and animal species has become a serious issue for the Silver / Twin Lakes watershed and the state of Florida. Given Florida=s mild climate and abundant rain, close to one-third of the state=s flora are exotic plants. Some of these were introduced intentionally; Punktree - *Melaleuca quinquenervia*, was brought in to assist in the draining of wetland because it has a high rate of transpiration. Brazilian pepper was first introduced as an ornamental because of its bright red berries, which are prevalent in the winter (the austral summer) especially during the Christmas season. Australian pines - *Casuarina* species, and cogongrass - *Imperata cylindrica*, were brought in for agricultural purposes, as a windbreak and groundcover, respectively. Others, such as water hyacinth - *Eichhornia crassipes*, hydrilla - *Hydrilla verticillata*, and primrose willow - *Ludwigia peruviana* cost the state and private homeowners millions of dollars annually to control in lakes, streams and wetlands. Vines, such as air potato - *Dioscorea bulbifera* and skunk vine - *Paederia foetida*, are quickly overgrowing forested systems and out competing native vines such as grapes and catbriers - *Smilax* species, that are relied on by wildlife for winter forage. It has been estimated that at least 40,000 acres in Florida have been overgrown by the Japanese and Old World climbing ferns - *Lygodium japonicum* and *L. microphyllum*, respectively. Most of this acreage is in South Florida and the floodplain of the Apalachicola River. But the extremes of these two sites demonstrate just how adaptable this species is. The Exotic Pest Plant Council of Florida, established in 1993, has compiled a listing of most of the exotic species found in the state and has ranked them in three different categories based on their propensity to become invasive or nuisance and the amount of damage that can or has been done.

Plants are not the only aliens in our environment. Feral animals, cats, pigs and dogs, decimate plant and wildlife populations. This is especially true of the feral hogs which can destroy large areas of wetland vegetation while rooting for food. Nutria, *Myocastor coypus*, a large South American rodent, was originally farmed in Louisiana and escaped from captivity during flooding that resulted from hurricanes in the 1940's. It has since made its way to Florida and is destructive to wetland habitats with its voracious appetite and vigorous burrowing. Two amphibians, the cane or giant marine toad - *Bufo marinus*, and the Cuban treefrog - *Osteopilus septentrionalis*, affect our domestic and wild animals in various ways. The cane toad eats virtually anything that will fit into its mouth from insects to small mammals to birds.

In addition, the cane toad is also very toxic because it possesses rather large parotoid glands which holds a milky poison which can easily kill any small animal that tries to eat it. The Cuban treefrog predates directly on our native treefrogs and compete with them for breeding space. Introduced birds like the European starling - *Sturnella vulgaris*, house sparrow - *Passer domesticus*, and rock dove - *Columba livia*, compete directly with native species that occupy the same ecological niche. The starling and sparrow have been attributed to the decline of the eastern bluebird - *Sialia sialis*, by out competing the bluebird for suitable nesting habitat.

Controlling these exotic species in an urban environment can be difficult. Vacant lands can become refugia for these species; a place to re-invade from once the eradication process is over. In addition, many of these species, especially the plants, are pioneer species, which specialize in colonizing areas that have been cleared of vegetation. So clearing an area may just encourage the same or different species to re-establish themselves in the same area. Another example of the Aedge effect≅ is shown with some plants like primrose willow which are very good at colonizing cleared edges of wetlands and from there penetrating toward the interior. Other species can be resistant to many or all herbicides and therefore require vast amounts of labor intensive removal. Clearly this is one of the major problems to the natural systems in the watershed.

8.6.3 The Loss of Buffers Against Water Quality Impacts

The presence of buffers is of extreme importance along the edges of wetland systems. These buffers provide a variety of functions. In terms of water quality, several direct and indirect results can be observed. The vegetation in these buffers helps to maintain water quality by slowing down velocities allowing particulates to settle out of the water column. This increased residence time also allows the plants to remove more nutrients and other pollutant from the water. Erosion and sedimentation is lessened by the vegetation ability to stabilize wetland banks and bottoms. If large areas of buffer exist, such as a floodplain, the volume of water stored can prevent damage to roads and other structures. These areas also moderate the velocity and flow of water thus minimizing scouring in flowing systems. In coastal areas buffering against wave action, especially during hurricanes or tropical storms, can again save large amounts of money. These savings are two-fold. The first is the direct savings by the prevention of flooding while the second is indirect in that costly seawalls or rip-rap will not be needed.

Another indirect benefit is to wildlife. These vegetated areas can serve as important greenway corridors that will allow for the flow of plants and animals between otherwise isolated areas of habitat. The larger the corridor is, the larger the type of animal will be that can utilize it. This relates to the edge effect that has already been discussed in this chapter. It has been hypothesized that some greenways are used as reference points for migrating animals (Primack, 1993).

8.6.4 The Alteration of Flows to Wetland Systems

With the advent of modern stormwater treatment techniques, one of the drawbacks is the change in water regime for many wetland systems. This can be through the reduction of historic flows or by increasing them. Most stormwater systems are built to retain water for the treatment process, usually done by vegetation. Now, water that historically flowed directly into a wetland is held back. This water may or may not reach the wetland. Some of the water is lost through transpiration of the vegetation or directly via evaporation. Still more is lost through percolation into the ground. This amount can be small in the case of a traditional detention pond or large in the case of an infiltration or retention pond where virtually all the water will go into the ground. The timing of the delivery of water is also related to this. Many streams rely on periodic flushing of built up sediments by large storm events. This is prevented when a stormwater system now moderates the flow of water by releasing it more gradually than it would under unaltered conditions. Conversely, an increase in the impervious surfaces in a basin can increase the historic flows into a wetland, even if it goes through a stormwater system and water is lost as described above. This is due to the sheer magnitude of run-off that creates “new” water that now reaches the wetland but which would not have been generated if the area was in its natural state. An increase in water in wetlands is not always a good thing. Cypress trees depend on a “dry” season for their seeds to germinate. While they will remain viable for a period of time in water, they must have dry land to be able to root and grow. Many amphibians depend on the timing of rainpool development for their successful breeding. Too much water can result in a permanent pond that may be used by fish; too little water and the pond may dry up before the larvae will be able to fully develop.

8.6.5 Restoration of Natural Systems

While the four issue discussed above are pertinent to the watershed, the primary focus on natural systems in the basin should be restoration of natural systems. This is going to be very difficult due to the very reason that these systems no longer exist. Since the watershed is so highly developed, there are little, if any, lands available in the watershed to restore. The main possibility is the only remaining bit of agricultural area in the basin, a single orange grove, and the shores of the watershed’s lakes and the banks of its only creek. Developed land will be extremely expensive to purchase and even if it can be acquired, large tracts are needed to provide any useful benefits. It is not likely that a parcel wedged in between two commercial tracts will be able to support a viable population of plants or animals. This may be easier to some degree in a residential setting, where there is already some habitat value, but it will still be very difficult.

WATER SUPPLY

9.1 OVERVIEW

Water is supplied in the Tampa Bay area through both ground and surface water. Of the two, groundwater provides the main supply for Hillsborough County including the Silver / Twin Lakes (STL) Watershed. Within Hillsborough County, groundwater supplies at least three-quarters of the water used, with only the City of Tampa currently relying on surface water for part of its public water supply. For the rest of the County, water is supplied from groundwater through both private and public wells. The public groundwater supply is managed by Tampa Bay Water (TBW). This entity was formed in 1998 from its predecessor, the West Coast Regional Water Supply Authority (WCRWSA). Between the years of 1960 and 1993, public supply water use in the Tampa Bay area has increased by over 400 percent, from 60 million gallons per day (mgd) to over 251 mgd. Within Hillsborough County alone, water demand for all uses in 1995 was approximately 252 mgd. Water use has begun to stabilize due to the practices of water conservation and reuse, however demand projections from the Southwest Florida Water Management District (SWFWMD) estimate that total water use within Hillsborough County will increase to over 321 mgd in the year 2020. Providing an adequate water supply for our ever-increasing population while trying to protect the environment has become one of the greatest challenges facing our region.

Watershed management issues that are related to water supply and that are being considered in this report include: a) ground and surface water use, b) aquifer recharge, c) impacts due to water withdrawals, d) minimum flows and levels, and e) water conservation. Following is a discussion of these issues.

9.2 GROUNDWATER USE

The Silver / Twin Lakes Watershed lies within what is known as the Southern Groundwater Basin (SGWB). The SGWB is located from approximately Central Pasco County down to the northern end of Lee County and from the coastline over to approximately U.S. Highway 27 in Highlands and Polk Counties. This is an area in which the boundaries act as a barrier to groundwater flow (i.e. groundwater does not flow to or from adjacent basins). Groundwater within the SGWB accumulates from recharge due to rainfall. The groundwater system in this area is composed of three aquifers, the shallow surficial, intermediate, and deeper Floridan. The surficial aquifer is made up of sand and variable amounts of organic matter and clay, and is used mostly for some domestic and irrigation purposes. The intermediate aquifer between the Floridan and surficial consists of sand, clay, phosphatic sand and clay, and limestone, but it thins and disappears to the north into northern Hillsborough County and is not a significant supply source in this watershed. The primary water source is the Floridan aquifer, which consists of thick layers of limestone that can produce large quantities of water for public, agricultural, and industrial use.

Water use is divided into permitted uses and non-permitted uses. Water Use Permits (WUP's) are issued by the SWFWMD for significant uses that meet one of the following thresholds:

1. Total withdrawal capacity from any source or combination of sources is greater than or equal to 1,000,000 gallons per day (gpd).
2. Annual average withdrawal from any source or combined sources is greater than or equal to 100,000 gpd.
3. Withdrawal is from a well having an outside diameter of six inches or more at the surface.
4. Withdrawal is from a surface water body and the outside diameter of the withdrawal pipe or the sum of the outside diameters of the withdrawal pipes is four inches or greater.

The following table summarizes WUP's issued within the STL Watershed.

Table 9.1 Water Use Permits in the Silver / Twin Lakes Watershed Based on SWFWMD Permit Data

Permit Number	Permittee	Predominant Use	Average Use (gpd)	Peak Mo. Use (gpd)	Expiration Date
004028	Forest Hills Athletic Complex	Recreational	17,900	58,700	March 28, 2004
006527	Lincoln Garden LLC*	Agricultural	3000	9700	September 3, 2009
009219	Post Apartment Homes, Lmt.*	Recreational	26,000	69,000	November 4, 2008

* Only a portion of the amount permitted is withdrawn from points within the watershed.

Based on the SWFWMD permit data, there are 3 water use permits within the STL Watershed, all of which are for groundwater withdrawals. One is for agricultural use, and the remaining two are for recreational use. The total average amount permitted for public supply that is located within the watershed is 0 gallons per day (gpd). Other total average amounts permitted include 3,000 gpd for agriculture, 0 gpd for industrial/commercial, and 43,900 gpd for recreational use for a total average amount permitted within the STL Watershed of 15,633 gpd.

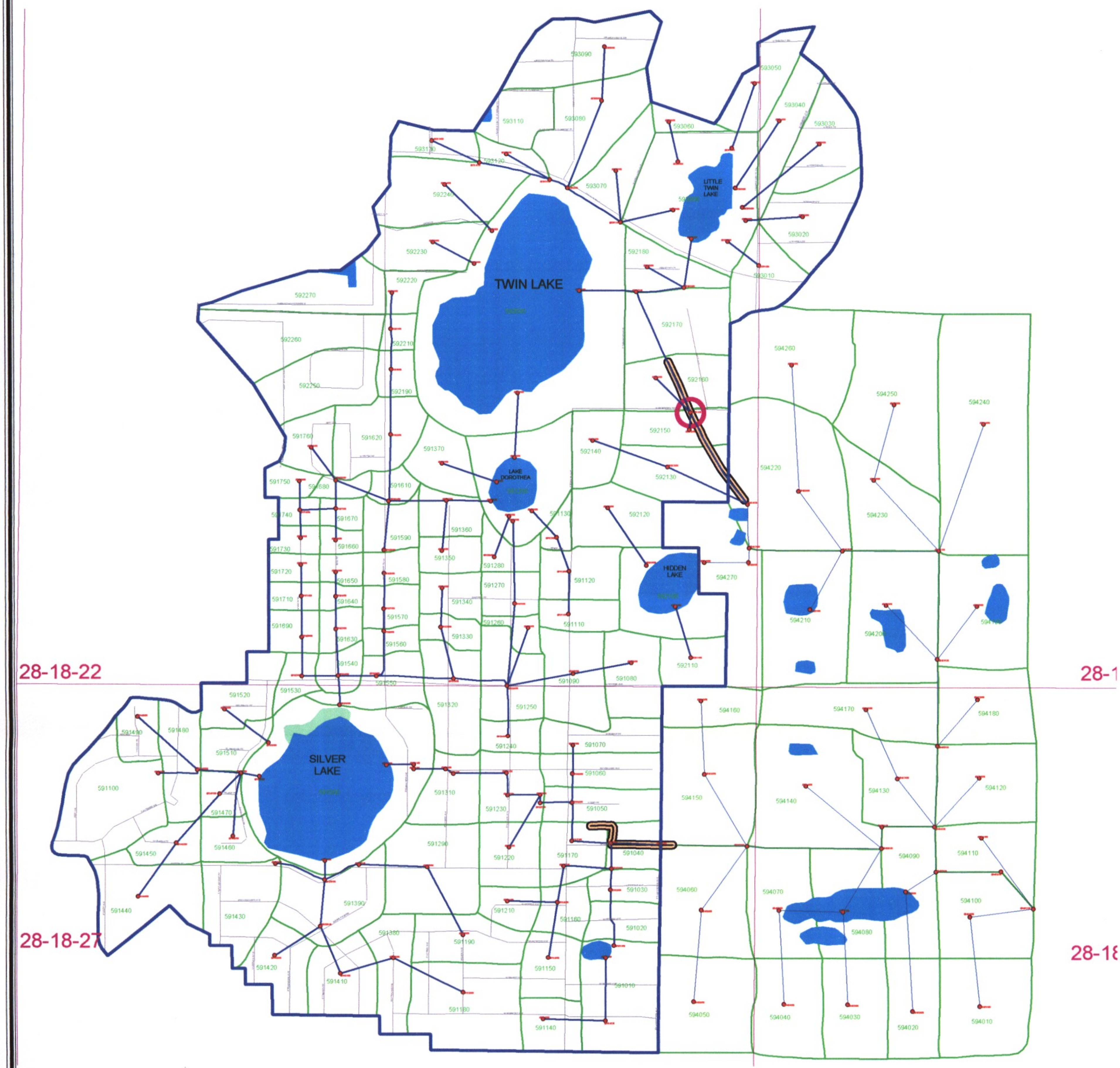
Figure 9-1 shows the locations of the water use permits.

9.3 SURFACE WATER USE

Based on available permit data, it does not appear that there are any permitted surface water withdrawals from any of the streams or water bodies within the Silver / Twin Lakes Watershed. In fact, within the Tampa Bay area, the use of surface water for public water supply has been limited mainly to the use of the Hillsborough River as the main supply for the City of Tampa. Recently though, due to the recognition of adverse environmental impacts from groundwater pumping, and subsequent requirements to reduce the amount of pumping from wellfields, alternative supply sources including new surface water supplies are now part of Tampa Bay Water's Master Water Plan. However, none of the proposed surface water supply sources are located within the Silver / Twin Lakes Watershed. Given the relatively small scale of the streams and water bodies within the STL Watershed, it is unlikely that any significant public surface water supply development would occur in this watershed.

9.4 WATER SUPPLY ISSUES / AREAS OF CONCERN

As stated above, watershed management issues related to water supply include impacts due to withdrawals, aquifer recharge, minimum flows and levels, and water reuse and conservation. These items are discussed in the following paragraphs.



LEGEND

- JUNCTION
- CONNECTIVTY
- CULVERT REPLACEMENT
- DITCH MAINTENANCE
- DITCH MAINTENANCE
- BOUNDARY
- Water Feature
- WETLAND

N W E S

Hillsborough County
Florida

SILVER TWIN LAKE AREA STORMWATER MANAGEMENT MASTER PLAN SEPTEMBER 2001

Public Works Department
Engineering Division
Stormwater Management Section

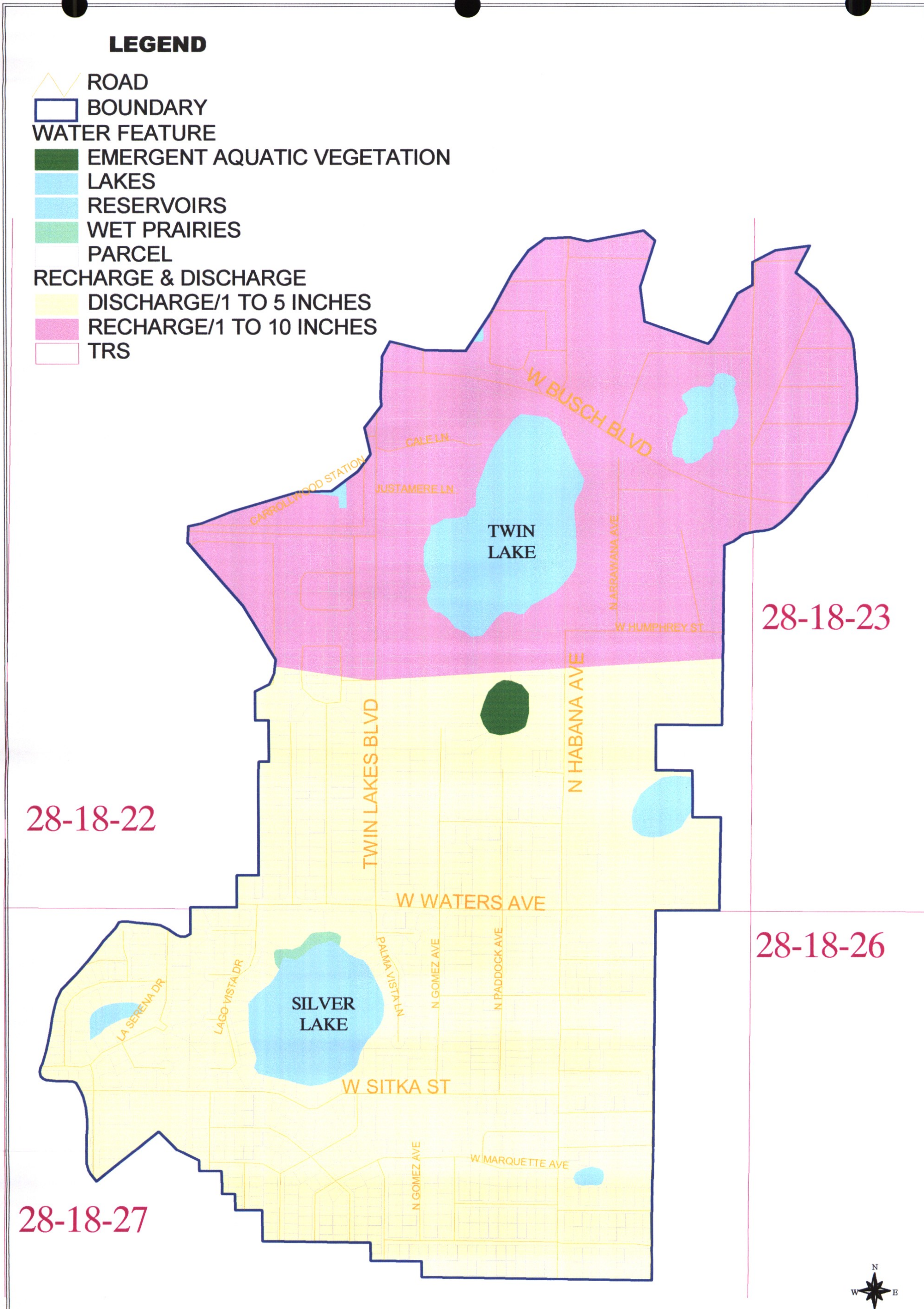
Figure 19-1
Silver Twin Lake Area
Location of final recommended project
Map

9.4.1. Aquifer Recharge

Aquifer recharge refers to the replenishment of groundwater in an aquifer through infiltration of rainwater or from flow from an adjacent aquifer. Recharge generally occurs in areas that are topographically higher than surrounding areas, and where the hydraulic gradient causes flow into the aquifer. Recharge for the surficial aquifer is directly related to rainfall. This means annual high water levels in the surficial aquifer generally occur in September-October with the end of the rainy season and conversely annual lows follow the end of the dry season in April-May.

Recharge to the Upper Floridan aquifer occurs in the upper or northern half of the watershed, and is considered to be moderate based on a study by Aucott (1988) that discusses general variations in recharge to and discharge from the Floridan aquifer system. The lower or southern half of the watershed is considered to be a discharge zone for the Floridan aquifer, which is to be expected due to the low surface elevation and proximity to the coast. Figure 9-2 shows these general variations in recharge/discharge in the STL Watershed.

Several factors influence the amount of recharge in both aquifers. One of the most obvious is the amount of impervious area found in the watershed. This will prevent or reduce the amount of water that is able to penetrate into the soil and from there into one or both aquifers. Closely related to impervious area, is the treatment of stormwater run-off from these areas. In older developed areas the run-off from impervious areas is not captured and treated by stormwater systems, but is directed toward the Bay in as quick and direct a manner as possible. This effectively removes the stormwater from being able to infiltrate into the ground and contribute to recharging the aquifer. If the water is captured by a stormwater system, it may be transported from an area of relatively high recharge potential to one of low potential. Consideration of these factors should be given when locating and designing future stormwater projects.



Hillsborough County
Florida

**SILVER TWIN LAKE AREA
STORMWATER MANAGEMENT
MASTER PLAN
SEPTEMBER 2001**

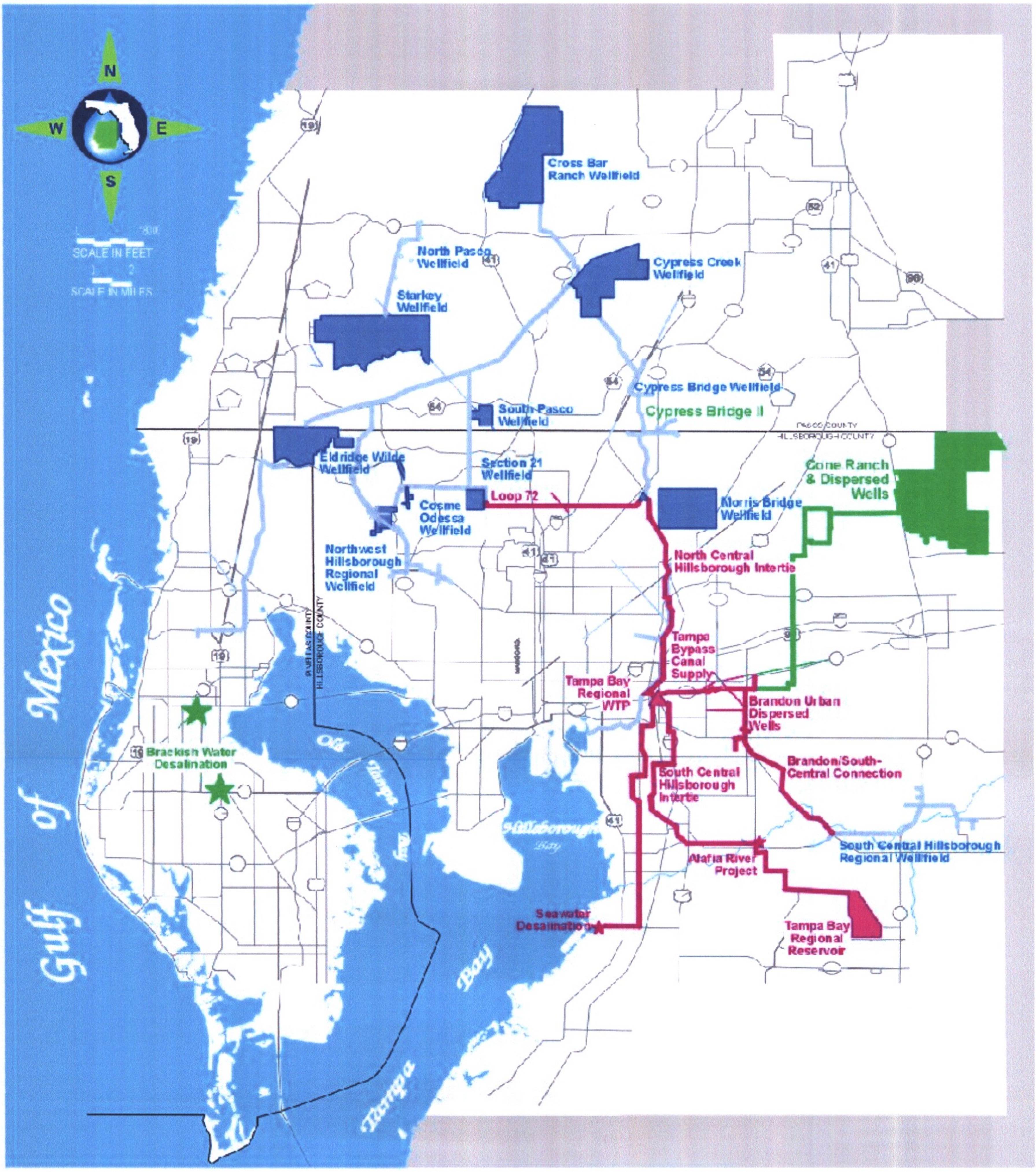
Public Works Department
Engineering Division
Stormwater Management Section

**Figure 9-2
Silver Twin Lake Area
Recharge to and Discharge From
the Floridan Aquifer**

9.4.2. Impacts Due to Water Withdrawals

Withdrawal of water due to groundwater or surface water pumping can have adverse impacts on the environment and on other water users. Because groundwater is the main source of water in our region, impacts from water withdrawals are most commonly related to groundwater pumping. During the mid to late 1980's, declining hydrologic conditions were observed in the eastern Tampa Bay area including the STL Watershed. In response to this, the SWFWMD designated the area as the Northern Tampa Bay Water Use Caution Area (NTB WUCA) in 1989, and implemented specific water use permitting rules for this area to better manage future withdrawals

One common type of impact due to groundwater withdrawal is the dewatering of wetlands and declining lake levels due to the lowering of the water table. This has occurred in the northwest area of Hillsborough County from years of significant pumping at several public supply wellfields that has negatively impacted wetlands and several lakes in the area. These environmental impacts sparked several years of disputes between the WCRWSA, its member governments, and the SWFWMD. In 1998 in order to try and resolve the impacts to the water resources, the WCRWSA was reorganized into what is now Tampa Bay Water, and all parties approved the Northern Tampa Bay New Water Supply and Ground-Water Withdrawal Reduction Agreement known as the "Partnership Agreement". The key objectives of the agreement are the development of new water supply sources other than groundwater, a phased reduction in existing pumping, the end of litigation, and financial assistance from the SWFWMD in the development of new water supplies. Also as part of the reorganization and agreement, the member governments sold all their active well fields to TBW. This ownership allows TBW to manage the total water supply in a more environmentally sensitive way. The idea is to rotate pumping, allowing one or more of the wellfields to "rest" and letting the groundwater in the area to recover. If it is found that one or more wellfields are adversely affecting wetlands or groundwater, they can be taken off-line. Those wellfields that were "resting" can be put back on-line and allow the water table to recover in the areas of impact. In order to make this concept work, TBW has established a loop system to link all existing water supplies and will link future projects into the loop as well. Also, TBW is required to reduce groundwater pumping from 11 wellfields in the northern Tampa Bay region from approximately 158 million gallons per day (mgd) down to 121 mgd by the end of 2002, and down to 90 mgd by the end of 2007. In conjunction with these reductions, alternative water supply sources are to be developed to provide 85 mgd of new water supply by the end of 2007. Figure 9-3 illustrates Tampa Bay Water's Master Water Plan projects within Hillsborough County. None of the proposed new water supply sources projects are located within the STL Watershed.



LEGEND

- Approved Facilities (red line)
- Proposed Facilities (green line)
- Existing Facilities (light blue line)
- Approved Facilities (dark blue)

Hillsborough County
Florida

**SILVER TWIN LAKE AREA
STORMWATER MANAGEMENT
MASTER PLAN
SEPT. 2001**

Public Works Department
Engineering Division
Stormwater Management Section

**Figure 9-3
Tampa Bay Water
Existing & Proposed Regional Water use
Facilities map**

Another impact due to groundwater withdrawals is known as saltwater intrusion. Underlying the fresh groundwater in the Floridan aquifer there is saltwater. The transition zone where the groundwater changes from freshwater to saltwater is referred to as the saltwater interface. The farther inland you go from the coast, the deeper the saltwater interface occurs (usually several hundred to over one thousand feet deep). When fresh groundwater is pumped out of the Floridan aquifer, the deeper salt water can move in to take its place causing the saltwater interface to slowly move upward and farther inland. This saltwater intrusion has been occurring in the Tampa Bay area for several decades. The movement of the saltwater is a slow process, usually on the order of one foot per year or less, although in some areas it is occurring at a faster rate.

In southern Hillsborough County along the east coast of Tampa Bay, saltwater intrusion is becoming an increasing problem. Unless all groundwater pumping in the area is completely stopped, the saltwater will continue to slowly move inward and upward within the aquifer. However, doing away with groundwater withdrawals is not realistic, but there are possibilities for controlling the problem. By injecting freshwater (potable, reclaimed, or possibly treated stormwater) into the aquifer, the movement of the saltwater interface can be slowed and possibly stopped.

9.4.3. Minimum Flows and Levels

In 1996, the Florida Legislature directed the state’s five water management districts to set schedules to “establish minimum flows and levels for watercourses in their respective districts.” The SWFWMD was subsequently required to set the flows and levels for surface waters and aquifers in Hillsborough, Pasco and Pinellas Counties, “below which significant harm to the water resources or ecology of the state or region” would occur. Subsequently, a committee composed of District staff, local government representatives and interested citizens, was formed to define “significant harm”. This Technical Advisory Committee was further broken down into subcommittees to reach a consensus on the methodologies for setting the minimum flows and levels (MFL's) for aquifers, lakes and wetlands. The term significant harm now equates to “significant change”.

The SWFWMD adopted an MFL rule in November 1998, but due to challenges by various parties, the rule did not go into effect until early 2000. This rule established minimum levels for several lakes in the northern Tampa Bay region, including northwest Hillsborough County, and also established a minimum flow for the Hillsborough River. A priority list and schedule for establishing future MFL’s within the SWFWMD is being developed that includes establishing a minimum level for the Floridan aquifer within the Northern Water Use Caution Area, however none of the proposed lakes or streams on the list are located within the STL Watershed.

9.4.4 Water Conservation

Over the past thirty years, our region has experienced increasing growth and development as more and more people have moved into the area. Along with the ever-increasing growth, of course, comes a greater demand on services including the need for more water. Because of the recognition of environmental degradation due to increasing water use, the need for water conservation has become more and more important. Hillsborough County has a variety of water conservation programs currently in place. These include an increasing use of reclaimed water, a low-flow toilet rebate program, lawn watering restrictions, and a public outreach and education program to promote awareness of the importance of water conservation. An increasing awareness of the need for water conservation on the part of the general public and private industry, and the implementation of the above programs has helped to decrease the per capita daily water use in Hillsborough County from approximately 146 gallons per day in 1989 to about 103 gallons per day in 1996.

One area where there is potential for increased conservation efforts in the STL Watershed is the use of reclaimed water. Currently there are no reclaimed water sites in the STL Watershed, and there are not any sites proposed in the near future. In the future, as the South-Central Hillsborough County Reclaimed Water Plan is updated, sites within this area should be considered for inclusion in the plan. Additionally, the County should continue to promote water conservation efforts, and provide information to the public on the importance of conserving what is arguably our most important resource.

POLLUTANT LOADING AND REMOVAL MODEL

10.1 OVERVIEW

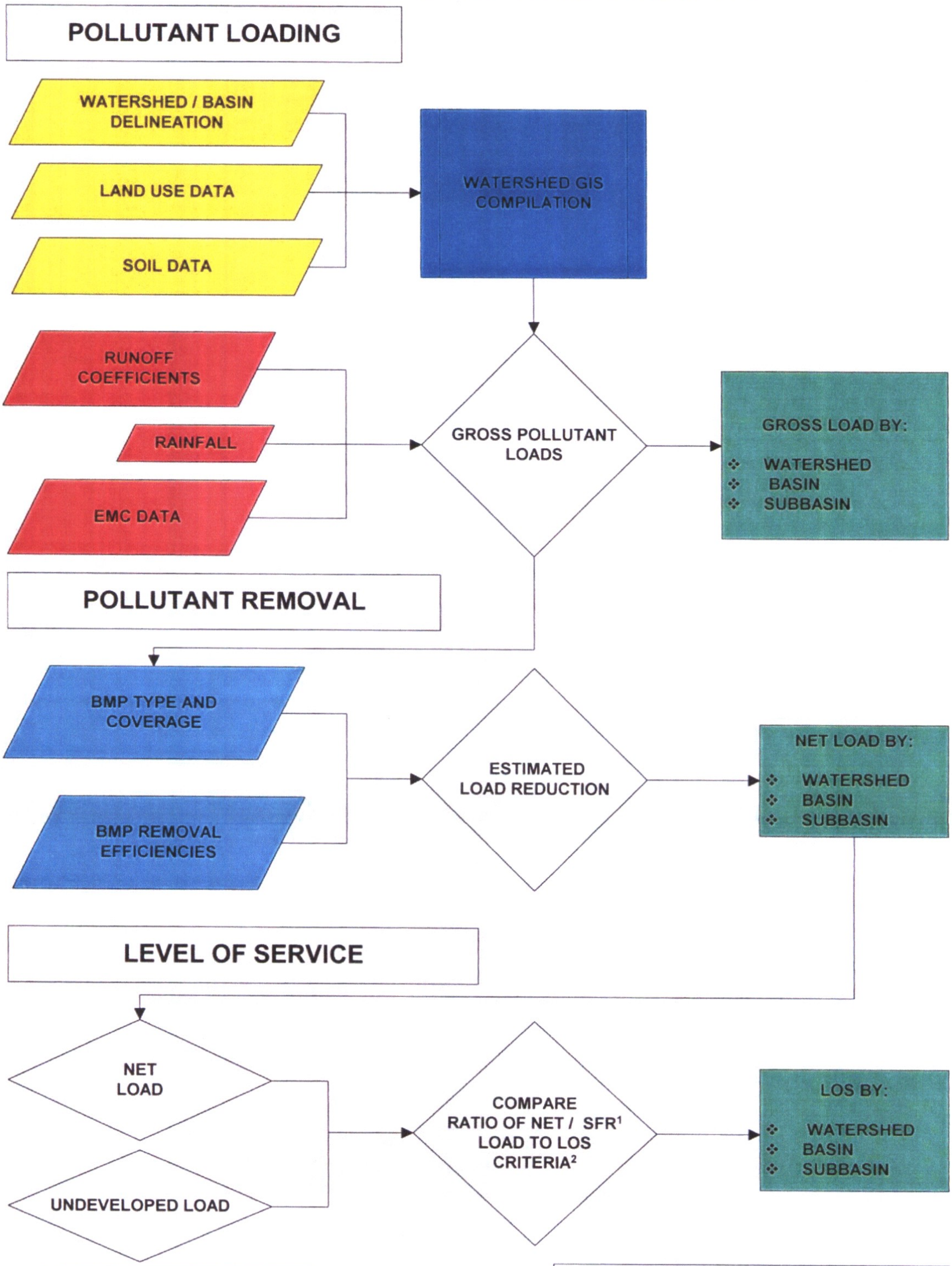
Development in Hillsborough County has been proceeding steadily throughout the last decade. This is especially true in the northwest and northcentral portions of the County, as well as the Brandon area. In 1998, the County contracted Parsons Engineering Sciences, Inc. to assist in the development of a qualitative pollutant loading and removal model (PLRM) to be used as a tool in the County's watershed management plans, in order to better evaluate the water quality impacts that may result from this development and to assist in the establishment of a water quality treatment level of service. The model's purpose is to qualitatively assess the amount of pollutant loading and use that information to determine a water quality treatment level of service for a given area; these areas can be an entire watershed, subwatershed, subbasin or even a catchment area.

Two versions of the model were considered prior to its development, both a GIS based and spreadsheet based program. It was decided to base the model on spreadsheets, which can be worked from the Excel© spreadsheet program. The spreadsheet concept was chosen due to its ease of use and because it does not need special equipment or software. To allow use in the Excel© program, the model was written in VisualBasic© code and includes various input or editing screens to facilitate its use. Since land uses will almost certainly change in the future, the model was made so that new data can be incorporated into the model as it becomes available.

10.2 MODEL INPUT DATA

There are three main components of the PLRM. Gross pollutant loads can be determined in the first component. This is most easily accomplished with a GIS program such as ArcView©. An initial input file is created by forming an intersection of soil and land use data in conjunction with the subbasin delineations. This information is combined with run-off coefficients, rainfall amounts and event mean concentration (EMC) information to develop an annual average pollutant load for each subbasin. By applying best management practices information to these same areas, a net loading, the second component, can be calculated. Finally as part of the third component, the water quality treatment level of service (WQTLOS) can be determined by comparing the net load versus a benchmark standard, in this case low or medium density residential land use without stormwater treatment. This WQTLOS can be determined on a watershed, basin or subbasin level. The operation of the model is shown in the flowchart **Figure 10-1**.

HILLSBOROUGH COUNTY STORMWATER MANAGEMENT
WATER QUALITY MODEL SCHEMATIC



Note:

1. Ratio of net load (treated) to untreated single family residential (SFR)
2. **Level of Service Criteria:**
   - A) Net load 20% or less of SFR
   - B) Net load 20-40% of SFR
   - C) Net load 40-70% of SFR
   - D) Net load 70-100% of SFR
   - F) Net load > 100% of SFR

LEGEND

- GIS Input Data
- Model Input - Lookup Data
- Model Input - User Supplied
- Model Output
- Model Calculation

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STORMWATER MANAGEMENT
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**Figure 10-1
Silver Twin Lake Area
Water Quality Model Schematic**

10.2.1 Land Use

The PLRM uses the SWFWMD's 1995 land use coverage, which is based on the Florida Land Use and Cover Classification System (FLUCCS) codes. The land use is a general indicator of the amount of impervious surface area to be found within a given parcel of land and this can be used to gauge the amount of run-off that might be generated for each rainfall event using predetermined run-off coefficients that the model has incorporated into one of its look-up tables.

For the purposes of this model, land use categories were aggregated to correspond with those in Hillsborough County's NPDES permit. These aggregated land use categories are:

- low / medium density residential
- high density residential
- light industrial
- agricultural
- commercial
- institutional
- highway / utility
- recreational
- open land
- extractive (mining) / disturbed
- upland forest
- wetland forest
- wetland non-forested

See **Table 2.1** for a summary of the existing aggregated land uses in the Silver / Twin Lakes watershed.

10.2.2 Soil Characteristics

Here, soils are divided into their hydrologic soils group. As previously discussed in Chapter 2, there are four main hydrologic soil groups based on their infiltration rates and soil moisture capacities. These groups are:

Group A - low run-off potential

Group B - moderately low run-off potential

Group C - moderately high run-off potential

Group D - high run-off potential

In addition, the infiltration rate of some soils changes, depending on the time of year and soil saturation. In this case a dual designation can be assigned such as A/D or B/D. In this dual designation, the first letter indicates the infiltration rate during the dry season. Here, a soil may act like an A or B class soil with higher infiltration rates. The second letter indicates the infiltration rate during the wet season where the soil will have a slower infiltration rate and, therefore in these two examples, act more like a D class soil.

10.2.3 Run-off Coefficient

Run-off volume calculations are based on the application of run-off coefficients to the intersection of each soil and land use type. The values assigned to the run-off coefficients were based on those obtained from NPDES permit studies conducted in Hillsborough County. Most of the coefficients, listed by land use, can be found in the FDOT drainage manual. Run-off coefficients used by the PLRM are summarized in **Table 10.1** below.

Table 10.1
Run-off Coefficients for Pollutant Loading and Removal Model

Land Use	Hydrologic Soil Group	Run-off Coefficient
Low / Medium Density Residential	A	0.267
	B/D	0.322
	C	0.379
	D	0.430
High Density Residential	A	0.500
	B/D	0.566
	C	0.634
	D	0.700
Light industrial or Highway / Utility	A	0.500
	B/D	0.599
	C	0.701
	D	0.800

Table 10.1 - cont'd.
Run-off Coefficients for Pollutant Loading and Removal Model

Land Use	Hydrologic Soil Group	Run-off Coefficient
Agricultural	A	0.150
	B/D	0.233
	C	0.318
	D	0.400
Commercial or Institutional	A	0.450
	B/D	0.549
	C	0.651
	D	0.750
Recreational or Open land	A	0.100
	B/D	0.166
	C	0.234
	D	0.300
Extractive (Mining) / Disturbed or Upland Forested	A	0.050
	B/D	0.050
	C	0.050
	D	0.050
Wetland Forested or Wetland Non-Forested	A	0.200
	B/D	0.200
	C	0.200
	D	0.200

10.2.4 Subbasin Delineations

The Silver / Twin Lakes watershed was broken down into 103 smaller subbasins in order to be better able to compare the hydrologic, hydraulic and run-off water quality characteristics. These subbasins range in size between 1.24 and 50.44 acres, depending on the land use and configuration of any stormwater system. These subbasins can also be aggregated into larger areas (basins or watersheds) for a broader view.

10.2.5 Event Mean Concentrations

The event mean concentration or EMC specifies the average concentration of a given pollutant measured in run-off during storm events for a given land use and is calculated by flow weighting each pollutant sample measured. For the purposes of the PLRM, the pollutants chosen are those which are monitored for the County's NPDES permit. These constituents and their related EMC's are found in **Table 10.2**. By multiplying a particular EMC by the annual run-off volume, an annual average pollutant load can be determined. These EMC values were derived from various sources. Many of the values are reported in the County's NPDES permit. All other values were compiled from other, appropriate Florida studies. With the exception of nitrogen for residential land uses and nitrogen and phosphorus for agricultural land uses, the EMC's used are similar to or lower than EMC's for other parts of Florida and the nation. Copper in the County was higher than other parts of Florida but lower than national measurements. Total nitrogen and total phosphorus measurements were found to be much higher than residential land uses - 74 and 586 percent, respectively. The total nitrogen EMC is similar to other agricultural locations in Florida; however, the total phosphorus data was 6 times the Florida norm.

10.2.6 Best Management Practices (BMP) Information

The final input data needed centers on the BMPs existing within the watershed's subbasins. The type of BMP and its percent coverage for each land use within each subbasin is determined using current aerial photography, such as the colored orthophoto quads or blue line aerials; specific site data or permits and/or actual field inspections. The BMP types and their removal efficiencies are shown in **Table 10.3**. This information is needed in calculating the net pollutant loading. The BMP file must be in a specific format, which can be generated by the model.

Table 10.2
Event Mean Concentration (EMC) Values by Land Use
(Source - Parsons Engineering Sciences)

Land Use	NPDES Conventional Water Quality Parameters (mg/L)																NPDES Metals (mg/L)							
	BOD_5		TSS		TKN		NO_3+NO_2		TN		TP		TDP		Oil/Grease		Cd		Cu		Pb		Zn	
Low/Med Density Residential	1.0	e	19		1.082		0.281		1.36	g	0.401		0.282		1.08		0.001	e	0.013		0.008		0.022	
High Density Residential	2.6		29		1.368		0.679		2.04	g	1.337		0.552		1.073		0.001	e	0.047		0.006		0.058	
Light Industrial	2.87		18.2		2.088		0.187		2.27	g	0.332		0.187		3.663		0.001	e	0.024		0.006		0.096	
Agriculture	18.3		12.7		2.167		0.803		2.97	g	2.349		1.223		0.5	e	0.013		0.041		0.003	e	0.017	
Commercial – Office	2.62		36.5		2.207		0.171		2.37	g	0.305		0.182		0.793		0.001	e	0.014		0.003	e	0.036	
Commercial – Retail	2.72		9.33		1.083		0.603		1.68	g	0.253		0.132		0.5	e	0.001	e	0.021		0.005		0.015	
Commercial – Combined	2.67		22.92		1.65		0.39		2.03	g	0.28		0.16		0.65		0.001		0.02		0.004		0.03	
Institutional	2.67	f	22.92	f	1.65	f	0.39	f	2.03	g	0.28	f	0.16	f	0.65	f	0.001	f	0.02	f	0.004	f	0.03	f
Highway / Utility	24	a	261	a	2.99	a	1.140	a	4.13	g	0.120	a	0.300	d	0.4	d	0.040	a	0.103	a	0.960	a	0.410	a
Recreational	3.8	b	11.1	b	2.09	b	0.508	b	2.59	g	0.050	b	0.13	c	0.9	d	0.007	b	0.041	b	0.006	b	0.004	b
Open Land	3.8	f	11.1	f	2.09	f	0.03	c	2.59	g	0.19	c	0.13	f	0.9	f	0.0003	c	0.001	c	0.001	c	0.006	
Extractive (Mining) / Disturbed	28.94	c	13.2	c	3.50	c	0.03	c	3.53	g	0.19	c	0.13	c	0.9	d	0.0003	c	0.001	c	0.001	c	0.006	c
Upland Forested	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h
Wetland Forest	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h
Wetland Non-forested	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h

<u>Note:</u>

All EMC values without footnotes were obtained from samples collected for the Hillsborough Co. NPDES Permit Application (1993)
For parameters not detected in all samples, EMC's were calculated using in half the reporting limit for nondetects.
For pollutants not reported by Hillsborough County (1993), additional sources were used as noted:

- a. Average values used by Hillsborough County (1994) (from Smith and Lord (1990), provided in Wanielista and Yousef (1993)
- b. Literature value reported as EMC in Hillsborough County (1994)
- c. Calculated value from Sarasota County stormwater sample
- d. Orange County, 1993
- e. Surrogate based on ½ DL for values reported as BDL
- f. EMC's for open land use were assumed to be less than or equal to EMC's for recreational land use
- g. Total nitrogen (TN) estimated as the sum of NH3 + organic N (TKN) + oxidized N (NO2+NO3)
- h. EMC's for upland forest, wetland forest and non-forested wetland were assumed to be zero for benchmark comparison

EMC's reported as representative of agricultural land use were used for all subcategories of agricultural land use (e.g. pastures, crops and groves)

Table 10.3
Estimated BMP Removal Efficiencies
(Source - Parsons Engineering Sciences)

BMP Type	BOD_5	TSS	TKN	$NO3 + NO_2$	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
Wet Detention	60%	85%	30%	80%	30%	65%	80%	35%	75%	65%	75%	85%
Percolation	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Infiltration Trench		75%				60%						
Grass Swale		60%	10%	15%	10%	20%						

Harper, H. H. 1995. "Pollutant removal efficiencies for typical stormwater management systems in Florida"

Kadlec, R. H and R. L. Knight, 1996. "Treatment Wetlands" CTC Press, Inc. Boca Raton, Florida

USEPA, 1993 "Guidance specifying management measures for sources of nonpoint pollution in coastal waters"

Parsons Engineering Science, 1999

10.3 DETERMINATION OF GROSS AND NET POLLUTANT LOADS

This model uses the EPA Simple Method to determine non-point pollutant loads. This is done according to the formula - $L_I = (0.277)(P)(CF)(R_{VI})(C_I)(A_I)$; where

L_I	=	the annual pollutant load per basin in pounds per year
P	=	the annual average precipitation in inches per year
CF	=	the correction factor for storms not producing run-off; assumed to be 0.9
R_{VI}	=	the weighted average runoff coefficient based on impervious area
C_I	=	the event mean concentration of pollutant in milligrams per liter; and
A_I	=	the catchment area contributing to the outfall in acres

The first step in the process of determining the gross pollutant load is the creation of an input data file. This is in the form of a GIS export file that contains the intersection of subbasin, soil and land use coverage. The resulting file lists areas referred to as elements, in acres, for every combination of land use and hydrologic soils group in each subbasin. The data input file is added to the model and the model's run-off coefficient, rainfall and EMC data can then be applied to this file. The gross pollutant loads are determined on the watershed, basin and subbasin level. In the determination of the net pollutant load, the model is run a second time using the same data as in the gross load determination, but here the BMP coverage file is applied.

Table 10.4 summarizes the net pollutant loads.

10.4 DETERMINATION OF WATER QUALITY LEVEL OF SERVICE

The WQTLOS has been developed to aid in the comparison of existing or proposed water quality standards to pollutant loading goals. The low to medium single family residential land use, without stormwater treatment has been selected as the benchmark for this comparison. The model calculates the net pollutant load for each pollutant based on land use and BMP practices. It also calculates the gross load for each pollutant assuming 100% of the subbasin is in low to medium single-family residential land use. Next, the ratio of net to gross load is determined. The LOS is then determined for each subbasin based on the criteria listed below. This LOS is designated by the letters A through F with A being the highest and F the lowest LOS.

LOS A, net load equivalent to 20% or less of untreated single family residential. This level generally applies to undisturbed natural systems or areas with stormwater treatment facilities that can remove pollutants down to the level of undisturbed 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% of untreated single family residential. This level applies to those areas built to present day SWFWMD standards of 80% removal and assumes that the facility has been properly designed and maintained.

LOS C, net load equivalent to between 40% and 70% of untreated single family residential. This level would apply to areas which were built to present day standards but the facility was poorly designed or maintained. It would also apply to properly designed and maintained systems built prior to present day standards.

LOS D, net load equivalent to between 70% and 100% of untreated single family residential. This level would apply to those subbasins with minimal treatment.

LOS F, net load equivalent to or greater than 100% of untreated single family residential. This level would apply to those subbasins having no or inadequate stormwater treatment of an area producing larger pollutant loads per unit area than typical residential land uses.

Table 10.4 Summary of Net Pollutant Loads by Subbasin for the Silver / Twin Lakes Watershed

Subbasin ID	Watershed	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
591000	Silver Twin Lake	219.697	2314.03	117.117	54.2229	171.34	101.222	42.3591	86.198	0.08287	3.59506	0.47078	4.47183
591010	Silver Twin Lake	159.276	1776.54	83.8036	41.5955	125.399	81.9045	33.8155	65.7319	0.06126	2.87922	0.36756	3.55308
591020	Silver Twin Lake	51.9624	579.581	27.3402	13.5702	40.9104	26.7207	11.032	21.4445	0.01999	0.93932	0.11991	1.15916
591030	Silver Twin Lake	42.9635	479.209	22.6054	11.2201	33.8255	22.0932	9.12149	17.7307	0.01652	0.77665	0.09915	0.95842
591040	Silver Twin Lake	174.732	1846.19	95.5508	40.9831	136.534	73.4523	30.9531	65.3408	0.06681	2.69749	0.37085	3.38739
591050	Silver Twin Lake	76.5165	853.453	40.2594	19.9826	60.242	39.3471	16.245	31.5778	0.02943	1.38318	0.17658	1.70691
591060	Silver Twin Lake	82.2101	916.958	43.2551	21.4695	64.7246	42.2749	17.4538	33.9275	0.03162	1.48611	0.18972	1.83392
591070	Silver Twin Lake	73.5677	819.357	38.7504	19.1579	57.9083	37.6383	15.5469	30.2814	0.02829	1.32447	0.16939	1.63514
591080	Silver Twin Lake	83.62	865.37	46.3652	18.792	65.1572	32.2554	13.7281	30.0741	0.0319	1.20949	0.17176	1.53093
591090	Silver Twin Lake	118.23	1086.99	70.3595	20.3916	90.7511	23.81	11.2449	33.5246	0.04458	1.09725	0.19982	1.48615
591100	Silver Twin Lake	74.2678	310.195	68.4564	9.67087	102.304	33.2515	7.8484	49.679	0.01785	1.17007	0.10688	0.61907
591110	Silver Twin Lake	48.8939	489.031	27.7072	10.2204	37.9277	16.1525	7.01263	16.4671	0.01859	0.63107	0.09508	0.81088
591120	Silver Twin Lake	36.3458	405.395	19.1235	9.49184	28.6153	18.6901	7.71649	14.9996	0.01398	0.65702	0.08387	0.81079
591130	Silver Twin Lake	23.9586	267.23	12.6059	6.25687	18.8628	12.3202	5.08659	9.88751	0.00921	0.4331	0.05529	0.53446
591140	Silver Twin Lake	66.8611	745.758	35.1792	17.461	52.6403	34.382	14.1951	27.5931	0.02572	1.20864	0.15429	1.49152
591150	Silver Twin Lake	76.9638	858.442	40.4948	20.0994	60.5942	39.5771	16.34	31.7624	0.0296	1.39127	0.17761	1.71688
591160	Silver Twin Lake	49.4355	551.396	26.0107	12.9103	38.921	25.4213	10.4955	20.4017	0.01901	0.89364	0.11408	1.10279
591170	Silver Twin Lake	49.1964	548.729	25.8849	12.8478	38.7327	25.2983	10.4448	20.303	0.01892	0.88932	0.11353	1.09746
591180	Silver Twin Lake	198.075	2209.3	104.218	51.7281	155.946	101.856	42.0529	81.7441	0.07618	3.58059	0.4571	4.4186
591190	Silver Twin Lake	91.9538	1025.64	48.3819	24.0141	72.396	47.2855	19.5225	37.9486	0.03537	1.66224	0.2122	2.05128
591200	Silver Twin Lake	149.081	1662.83	78.4395	38.9331	117.373	76.662	31.651	61.5245	0.05734	2.69492	0.34403	3.32565
591210	Silver Twin Lake	47.6963	531.997	25.0956	12.4561	37.5516	24.5269	10.1263	19.6839	0.01834	0.8622	0.11007	1.06399
591220	Silver Twin Lake	76.2564	850.553	40.1226	19.9147	60.0373	39.2134	16.1898	31.4704	0.02933	1.37848	0.17598	1.70111
591230	Silver Twin Lake	81.8585	913.037	43.0702	21.3777	64.4478	42.0942	17.3792	33.7824	0.03148	1.47975	0.1889	1.82607
591240	Silver Twin Lake	36.8045	410.511	19.3648	9.61163	28.9764	18.926	7.81387	15.1889	0.01416	0.66531	0.08493	0.82102
591250	Silver Twin Lake	94.9755	942.44	54.0845	19.5139	73.5984	30.1798	13.1738	31.4932	0.03608	1.19221	0.18234	1.53788
591260	Silver Twin Lake	25.4886	279.378	13.584	6.43394	20.0179	12.3221	5.11737	10.1949	0.00978	0.43868	0.05727	0.54416
591270	Silver Twin Lake	49.0783	547.411	25.8227	12.817	38.6397	25.2376	10.4197	20.2542	0.01888	0.88718	0.11326	1.09482
591280	Silver Twin Lake	40.1313	447.618	21.1152	10.4804	31.5957	20.6367	8.52018	16.5619	0.01544	0.72545	0.09261	0.89524
591290	Silver Twin Lake	73.1328	815.713	38.4791	19.0989	57.5781	37.6072	15.5267	30.1814	0.02813	1.32202	0.16877	1.63143
591310	Silver Twin Lake	75.9974	847.663	39.9863	19.847	59.8333	39.0802	16.1348	31.3635	0.02923	1.3738	0.17538	1.69533
591320	Silver Twin Lake	109.529	1121.97	61.1369	24.0928	85.2297	40.4088	17.292	38.6326	0.04174	1.53248	0.22134	1.94798
591330	Silver Twin Lake	35.8096	399.414	18.8413	9.35181	28.1932	18.4144	7.60265	14.7783	0.01377	0.64733	0.08264	0.79883
591340	Silver Twin Lake	54.4591	607.428	28.6539	14.2222	42.876	28.0045	11.5621	22.4748	0.02095	0.98445	0.12567	1.21486
591350	Silver Twin Lake	42.1328	469.943	22.1684	11.0032	33.1715	21.666	8.94512	17.3879	0.0162	0.76163	0.09723	0.93989

Table 10.4 Summary of Net Pollutant Loads by Subbasin for the Silver / Twin Lakes Watershed

Subbasin ID	Watershed	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
591360	Silver Twin Lake	99.6424	860.149	61.2664	14.6542	75.9206	11.1359	6.13138	24.5675	0.03736	0.67364	0.15078	0.97452
591370	Silver Twin Lake	75.2107	838.888	39.5724	19.6416	59.214	38.6756	15.9678	31.0389	0.02893	1.35958	0.17356	1.67778
591380	Silver Twin Lake	103.922	1159.13	54.6791	27.1397	81.8187	53.44	22.0635	42.8879	0.03997	1.87859	0.23982	2.31826
591390	Silver Twin Lake	154.917	1727.92	81.5103	40.4572	121.967	79.6632	32.8901	63.9331	0.05958	2.80043	0.3575	3.45584
591410	Silver Twin Lake	104.995	1171.1	55.2438	27.42	82.6638	53.9919	22.2914	43.3308	0.04038	1.898	0.2423	2.34221
591420	Silver Twin Lake	94.6807	1056.05	49.8166	24.7262	74.5428	48.6877	20.1014	39.074	0.03642	1.71153	0.21849	2.11211
591430	Silver Twin Lake	128.204	1413.76	66.823	33.1442	99.9672	65.3283	26.9932	52.3115	0.04981	2.29299	0.29249	2.8268
591440	Silver Twin Lake	353.998	703.286	61.4548	24.067	85.5218	59.5866	29.7547	29.1003	0.24306	1.37081	0.17094	1.15318
591450	Silver Twin Lake	54.4035	606.838	28.6267	14.2078	42.8345	27.9755	11.5505	22.4544	0.02093	0.98343	0.12557	1.21362
591460	Silver Twin Lake	56.2571	627.483	29.5999	14.6918	44.2916	28.9291	11.9438	23.2169	0.02164	1.01695	0.12982	1.25497
591470	Silver Twin Lake	39.9405	445.491	21.0149	10.4306	31.4455	20.5387	8.47969	16.4832	0.01536	0.722	0.09217	0.89098
591480	Silver Twin Lake	83.1484	874.73	46.7317	20.7275	69.9268	42.2716	16.8506	36.2644	0.03089	1.48599	0.18534	1.74946
591490	Silver Twin Lake	37.0153	339.137	23.6491	8.28572	35.3872	18.3546	6.73596	18.0038	0.01271	0.64522	0.07627	0.67827
591510	Silver Twin Lake	58.01	646.065	30.525	15.1345	45.6595	29.7715	12.295	23.9196	0.0223	1.04655	0.13363	1.29163
591520	Silver Twin Lake	75.7829	694.78	44.4213	13.6702	58.0915	17.2327	7.97311	22.3892	0.02832	0.74827	0.12901	0.99953
591530	Silver Twin Lake	24.7194	161.382	14.5352	3.58104	18.1163	2.08868	1.35881	6.10723	0.00823	0.11322	0.02617	0.17264
591540	Silver Twin Lake	38.8303	328.068	23.7367	5.74717	29.4838	4.393	2.42347	9.64133	0.0144	0.25856	0.05732	0.37391
591550	Silver Twin Lake	85.661	880.822	46.9427	19.6889	66.6316	34.4431	14.615	31.4741	0.0324	1.26782	0.17572	1.59733
591560	Silver Twin Lake	30.3096	323.765	16.4507	7.26831	23.719	13.3031	5.57969	11.5661	0.0116	0.48371	0.06544	0.60507
591570	Silver Twin Lake	49.6703	554.015	26.1342	12.9716	39.1058	25.542	10.5454	20.4986	0.0191	0.89789	0.11462	1.10803
591580	Silver Twin Lake	78.0781	757.649	45.0644	15.2676	60.332	22.078	9.80641	24.7623	0.02959	0.90328	0.1445	1.17922
591590	Silver Twin Lake	54.6226	609.252	28.7399	14.2649	43.0048	28.0886	11.5968	22.5423	0.02101	0.98741	0.12605	1.2185
591610	Silver Twin Lake	29.8596	333.049	15.7107	7.79794	23.5087	15.3547	6.33942	12.3228	0.01148	0.53977	0.06891	0.6661
591620	Silver Twin Lake	121.111	1350.85	63.7231	31.6286	95.3517	62.2791	25.7128	49.9816	0.04658	2.18932	0.27949	2.70171
591630	Silver Twin Lake	36.7875	405.518	19.5249	9.38983	28.9148	18.1504	7.52299	14.8654	0.01413	0.64344	0.08338	0.79678
591640	Silver Twin Lake	20.0034	223.115	10.5249	5.22396	15.7488	10.2864	4.24687	8.25525	0.00769	0.3616	0.04616	0.44623
591650	Silver Twin Lake	27.1027	302.299	14.2602	7.07797	21.3382	13.937	5.75411	11.1851	0.01042	0.48993	0.06254	0.6046
591660	Silver Twin Lake	20.1846	225.136	10.6202	5.27128	15.8915	10.3795	4.28534	8.33002	0.00776	0.36488	0.04658	0.45027
591670	Silver Twin Lake	24.2525	270.509	12.7606	6.33364	19.0942	12.4714	5.149	10.0088	0.00933	0.43841	0.05597	0.54102
591680	Silver Twin Lake	22.6022	252.101	11.8922	5.90265	17.7949	11.6227	4.79862	9.32775	0.00869	0.40858	0.05216	0.5042
591690	Silver Twin Lake	44.6296	497.792	23.482	11.6552	35.1372	22.9499	9.47521	18.4183	0.01717	0.80677	0.10299	0.99558
591710	Silver Twin Lake	28.2415	315.001	14.8594	7.37537	22.2347	14.5226	5.99588	11.655	0.01086	0.51052	0.06517	0.63
591720	Silver Twin Lake	24.7367	275.909	13.0153	6.46008	19.4754	12.7204	5.25179	10.2086	0.00951	0.44716	0.05708	0.55182
591730	Silver Twin Lake	24.104	268.852	12.6824	6.29484	18.9772	12.395	5.11746	9.94752	0.00927	0.43573	0.05562	0.5377
591740	Silver Twin Lake	21.2402	236.91	11.1756	5.54696	16.7226	10.9224	4.50946	8.76567	0.00817	0.38396	0.04902	0.47382

Table 10.4 Summary of Net Pollutant Loads by Subbasin for the Silver / Twin Lakes Watershed

Subbasin ID	Watershed	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
591750	Silver Twin Lake	28.4189	316.98	14.9527	7.4217	22.3744	14.6139	6.03355	11.7283	0.01093	0.51373	0.06558	0.63396
591760	Silver Twin Lake	54.9877	613.325	28.932	14.3603	43.2923	28.2764	11.6743	22.693	0.02115	0.99401	0.12689	1.22665
592000	Silver Twin Lake	492.715	5461.14	211.307	103.093	314.399	192.334	80.6621	155.943	0.34268	7.2543	5.64011	10.3611
592100	Silver Twin Lake	107.558	1064.53	61.3471	21.9741	83.3211	33.7368	14.7538	35.4834	0.04085	1.33775	0.20563	1.72789
592110	Silver Twin Lake	49.1889	422.396	30.3226	7.13364	37.4562	5.14285	2.89401	11.9816	0.01843	0.32258	0.07373	0.47005
592120	Silver Twin Lake	52.269	583	27.5015	13.6502	41.1518	26.8783	11.0971	21.571	0.0201	0.94486	0.12062	1.166
592130	Silver Twin Lake	117.092	1027.49	71.4077	17.9766	89.3843	15.7535	8.20439	29.971	0.04396	0.86661	0.18245	1.22821
592140	Silver Twin Lake	63.2191	550.383	38.7074	9.50799	48.2154	7.80787	4.16831	15.8936	0.02372	0.44828	0.09713	0.64141
592150	Silver Twin Lake	74.0912	679.066	44.1668	12.6829	56.8497	14.5826	6.92008	20.8692	0.02793	0.6781	0.12456	0.9208
592160	Silver Twin Lake	102.434	1121.64	54.6311	25.8058	80.4369	49.34	20.4983	40.8972	0.03932	1.75793	0.2298	2.18127
592170	Silver Twin Lake	127.405	1394.64	66.9575	31.5858	98.5433	60.1638	25.0221	49.9155	0.05204	2.15392	0.37807	2.70151
592180	Silver Twin Lake	234.107	2546.15	50.7239	21.6706	72.3945	25.573	12.5419	23.7166	0.32291	1.6629	7.3837	4.2018
592190	Silver Twin Lake	34.6217	386.165	18.2163	9.04159	27.2579	17.8035	7.35045	14.2881	0.01332	0.62585	0.0799	0.77233
592210	Silver Twin Lake	25.1429	280.44	13.229	6.56617	19.7952	12.9293	5.33803	10.3763	0.00967	0.45451	0.05802	0.56088
592220	Silver Twin Lake	35.8556	399.928	18.8656	9.36383	28.2294	18.4381	7.61242	14.7973	0.01379	0.64816	0.08274	0.79986
592230	Silver Twin Lake	99.1935	1106.39	52.191	25.9048	78.0958	51.0083	21.0595	40.9364	0.03815	1.79311	0.22891	2.21278
592240	Silver Twin Lake	339.168	3717.99	103.4	47.8361	151.237	76.6589	33.6887	64.6857	0.37143	3.4828	7.86512	6.52119
592250	Silver Twin Lake	130.969	1460.8	68.9096	34.203	103.113	67.3481	27.8056	54.0497	0.05037	2.36751	0.30224	2.92161
592260	Silver Twin Lake	171.249	1910.43	90.128	44.7232	134.851	88.0564	36.3606	70.7028	0.06589	3.09543	0.39544	3.82015
592270	Silver Twin Lake	48.7822	204.104	44.9381	6.37005	67.2332	21.9475	5.17917	32.7379	0.01173	0.77151	0.07044	0.40808
593000	Silver Twin Lake	303.783	3376.92	95.5703	27.2055	122.776	18.8123	14.5334	50.621	0.41054	1.67368	8.89041	4.83925
593010	Silver Twin Lake	229.215	2406.72	51.4521	16.4511	67.9032	9.07054	6.30294	16.1839	0.32082	1.18051	7.34417	3.65769
593020	Silver Twin Lake	94.6215	1051.47	50.0257	24.5258	74.5514	47.9553	19.8507	38.9106	0.03669	1.69088	0.21808	2.08826
593030	Silver Twin Lake	93.1508	1020.63	49.0648	24.0424	73.1073	46.7837	19.3795	38.0505	0.0375	1.65714	0.21203	2.03111
593040	Silver Twin Lake	49.9256	207.817	27.763	7.549	35.312	3.93561	2.9652	13.566	0.01447	0.12882	0.03166	0.21812
593050	Silver Twin Lake	68.7277	557.935	37.4348	14.6005	52.0353	21.96	9.96222	24.4847	0.05727	0.98768	0.1389	0.97351
593060	Silver Twin Lake	10.5714	57.5373	6.69627	1.65746	8.35374	0.78211	0.77247	3.90164	0.01808	0.11772	0.02734	0.04586
593070	Silver Twin Lake	188.273	1894.37	51.0114	14.5645	65.5759	6.31409	5.31738	18.0751	0.26125	0.99769	5.45431	2.75342
593080	Silver Twin Lake	160.022	1164.13	74.0046	17.9877	92.4682	7.33901	5.93049	28.7169	0.19593	1.16828	1.99123	1.40539
593090	Silver Twin Lake	96.0923	827.363	59.2243	19.5775	78.8018	25.4971	13.2845	40.3011	0.09153	1.23325	0.25165	1.21655
593110	Silver Twin Lake	75.5191	648.499	46.5538	10.9522	57.506	7.89576	4.44313	18.3951	0.0283	0.49525	0.1132	0.72166
593120	Silver Twin Lake	136.266	1414.98	25.3171	6.69127	33.5929	1.43728	1.8512	5.58526	0.21459	0.59745	5.10919	2.20988
593130	Silver Twin Lake	189.137	1933.29	38.9675	9.38781	51.2818	2.34183	2.63732	9.27313	0.2921	0.83507	6.93488	3.01316

10.5 ADDITIONAL FEATURES AND UTILITIES

Features

The model can be programmed two different ways. The first way is through a series of dialog boxes that guide the user through the steps in setting up and executing a pollutant-loading scenario. The second way is by directly inputting the required information into the Manager sheet of the model. This second option is also a good way to check the input information prior to running the model.

The model contains various look-up tables including literature references for the BMP information, both general and single family residential run-off coefficients, general and single family residential event mean concentrations and examples of pollutant loading, LOS and Manager sheets.

Also included are a user's manual and a very brief help section that explains how to execute a scenario and gives formatting hints.

A report option allows easy access to output files for executed scenarios and level of service.

Utilities

The model has the capability to create a template for inputting BMP coverage information. This is important because the subbasin ID numbers and land use spellings must be identical in the input and BMP files in order for the model to produce the correct loadings. If the numbers and spellings are not identical, the model will treat them as different categories and the resulting information will not be an accurate accounting of the pollutant loads.

Land uses can be reaggregated according to FLUCCS codes to have the required land use categories. After reaggregation, all identically numbered subbasins must be regrouped together, if they were separated from each other during the reaggregation process.

Adding Data

Data can be added to the EMC, run-off coefficient, land use aggregation and watershed listings; however, new worksheets must be formatted exactly like the existing sheet.

WATER QUALITY TREATMENT LEVEL OF SERVICE

11.1 OVERVIEW

The determination of a water quality treatment level of service (WQTLOS) is one of the latest tools to be applied to watershed management. Designating levels of service has been done routinely for years in such different areas as traffic volume or flood control, of which, water quality has sometimes been a component. Assigning levels of service allows for the comparison of existing or proposed conditions against a standard. In this case the standard will be the low to medium density residential land use without stormwater treatment. One of the difficulties in trying to establish a WQLOS is that numerous parameters are measured. In this case, twelve different water quality elements can be chosen from. They are:

- BOD - biological oxygen demand
- TSS - total suspended solids
- TKN - total Kjeldahl nitrogen
- NO_3 + NO_2 - nitrates and nitrites
- TN - total nitrogen
- TP - total phosphorus
- TDP - total dissolved phosphorus
- Oil and Grease
- Cd - cadmium
- Cu - copper
- Pb - lead
- Zn - zinc

In determining the overall LOS for a particular basin, it is problematic to try to average parameters or to focus on just one or two parameters. A basin could have good water quality in terms of most or all but one of these parameters, but may have dangerous levels of one parameter such as lead, so care must be taken when choosing parameter(s).

For the purposes of this study, two parameters were chosen – total nitrogen and total suspended solids. Total nitrogen was chosen for several reasons. This is the one of the most difficult constituent to remove from stormwater, with an average removal rate of about 30% using a typical wet detention pond built and maintained to present day standards and assuming a 3 day residence time (Harper, 1995). Wet detention at this level of treatment will also remove at least 60% of the remaining ten pollutants with the exception of oil and grease and Kjeldahl nitrogen, which have approximately 35% and 30% removal rates, respectively. Another reason for choosing nitrogen is that it is also the target of the Tampa Bay Estuary Program’s plan to improve the water quality of Tampa Bay and restore seagrasses to historic levels. Governments within the Tampa Bay watershed have already agreed to "hold the line" on this pollutant. Ideally, as many compounds as possible should be removed on the subbasin level prior to reaching the Bay, rather than letting them impact the Bay and then trying to remove them. One of the ways of doing this is by increased residence times, which at the same time should increase the removal rates of the other pollutants accordingly. Particulates such as TSS and the various metals will have longer to settle out of the water column and the other pollutants will have a longer residence time to be acted on by biological or chemical means. It has been found that some pollutants such as metals and pathogens adhere to the TSS particles and would be removed with them. This is the reason for choosing TSS as the second WQTLOS parameter. Pathogens are not normally considered in LOS determinations and increased residence times would be one way to increase their removal, as well. The existing water quality treatment level of service for these two parameters are shown in figures 11A and 11B below.

11.2 WATER QUALITY TREATMENT LEVEL OF SERVICE DEFINITIONS

The WQTLOS is determined by using the Pollutant Loading and Removal Model to compare a particular subbasin' existing net pollutant load against the non-treated pollutant load of the same subbasin, assuming that its land use coverage is 100% single family low to medium density. This is done by calculating the ratio of net load to the gross load and then applying the criteria listed below.

LOS A, net load equivalent to 20% or less of untreated single family residential. This level generally applies to undisturbed natural systems or areas with stormwater treatment facilities going above and beyond present day treatment standards by removing pollutants down to the level of undisturbed natural systems. Areas of low to medium density land uses with 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% of untreated single family residential. This level applies to those areas built to present day SWFWMD standards of 80% removal and assumes that the facility has been properly designed and maintained.

LOS C, net load equivalent to between 40% and 70% of untreated single family residential. This level would apply to areas which were built to present day standards but the facility was poorly designed or maintained. It could also apply to properly designed and maintained systems built prior to present day standards.

LOS D, net load equivalent to between 70% and 100% of untreated single family residential. This level would apply to those subbasins with minimal treatment.

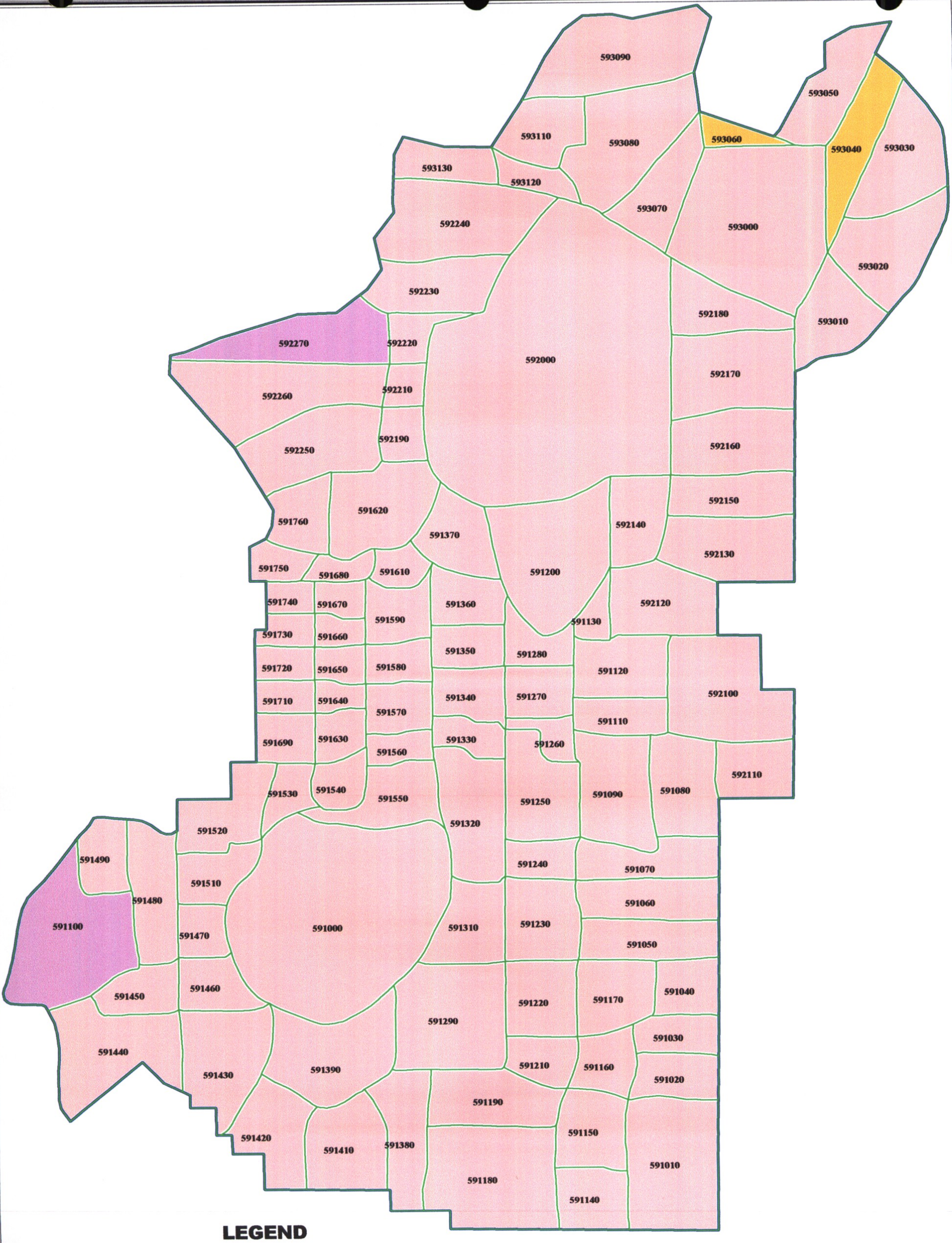
LOS F, net load equivalent to or greater than 100% of untreated single family residential. This level would apply to subbasins with no or inadequate treatment of an area producing large pollutant loads per unit area when compared to the low to medium density residential land use standard.

11.3 RESULTS

Water quality treatment level of service for the Silver / Twin Lakes watershed by subbasins is summarized in Exhibit 11-A. As can be seen from this information, the majority of the subbasins, in the majority of the parameters used, are at level of service D and F. The only exceptions to this pattern are those subbasins that have high density residential or commercial land uses with adequate stormwater treatment or have a large component of the subbasin in either recreational or open land use.

Of the 103 subbasins in this subwatershed, none of the basins attained level of service A, B, C or D across the board for each parameter. In addition to this, there was not a single subbasin that had less than 4 LOS F for the twelve parameters. There were 77 subbasins that had LOS F for all parameters and another 8 more that had LOS F for all but one parameter. In all of the latter cases, the remaining LOS level was D. Conversely, only one LOS A was recorded in the parameter of lead (Pb). This was in subbasin 593040, which was composed primarily of the open land use category. This was the subbasin with the highest scores - 1 A, 7 C's and only 4 F's. Next in line was subbasin 591100 with 3 B's, 2 C's, 2 D's and 5 F's. This subbasin contained primarily treated high-density single-family land uses. Similar to this was another treated high-density single-family basin (592270) with 3 B's, 2 C's and 6 F's. Somewhat surprisingly, a treated commercial subbasin, 591530, had the next best rating with 1 B, 3 C's, 2 D's and 6 F's. Finally, subbasin 593060 had 2 B's, 4 C's and 6 F's. This subbasin was composed primarily of untreated recreational and low to medium density single family land uses.

When looking at the parameters of TSS and TN, the LOS is not any better. As shown in figure 11 A, for the parameter of TSS, all but 4 of the 103 subbasins scored a non-F LOS. For TN, figure 11 B depicts that there were no non-F LOS scores; 103 out of 103 subbasins scored LOS F.



LEGEND

- Subbasin
- Watershed Boundary

Water Quality LOS

- LOS B = netload equivalent to between 20% & 40% of untreated single family residential.
- LOS C = net load equivalent to between 40% & 70% of untreated single family residential.
- LOS F = net load equivalent to or greater than 100% of untreated single family residential.

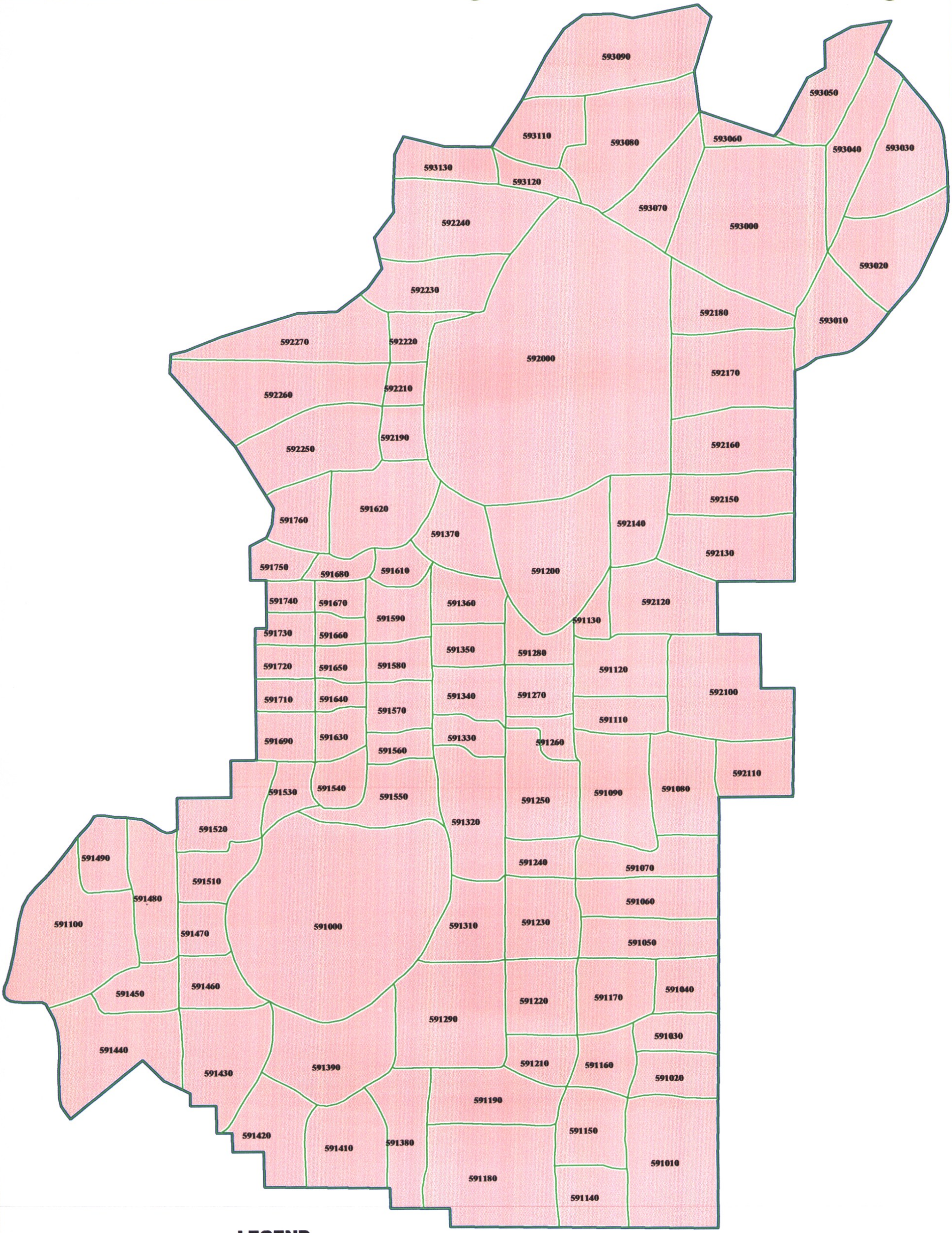
N W E S

Hillsborough County
Florida

SILVER TWIN LAKE AREA STORMWATER MANAGEMENT MASTER PLAN SEPTEMBER 2001

Public Works Department
Engineering Division
Stormwater Management Section

Figure 11A
Existing Water Quality Level of Service (TSS) Map



LEGEND

Subbasin

Watershed Boundary

Water Quality LOS

LOS F = netload equivalent to or greater than 100% of untreated single family residential.

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Florida

SILVER TWIN LAKE AREA STORMWATER MANAGEMENT MASTER PLAN SEPTEMBER 2001

Public Works Department
Engineering Division
Stormwater Management Section

Figure 11B
Existing Water Quality Level of Service (TN) Map

The upper portion of Table 11.1a below summarizes how many subbasins met a particular treatment level of service for a given parameter. The lower portion gives same information as a percentage of the total amount of subbasins. As can be seen from the table, Biological Oxygen Demand (BOD) treatment level of service is the worst with all 103 subbasins scoring LOS F. On the other end of the scale is Total Dissolved Phosphorus (TDP) where 5.8 % of the subbasins achieved LOS C and 7.8 achieved LOS D.

Table 11.1 Treatment Level of Service Summary for Each Parameter by Subbasin for the Silver / Twin Lakes Watershed

	BOD	TSS	TKN	NO_3 $+NO_2$	TN	TP	TDP	Oil & Grease	Cd	Cu	Pb	Zn
# LOSA	0	0	0	0	0	0	0	0	0	0	1	0
# LOS B	0	2	0	0	0	1	0	0	0	0	3	1
# LOS C	0	2	0	0	0	5	6	6	1	1	3	3
# LOS D	0	0	1	2	0	2	8	9	2	0	13	1
# LOS F	103	99	102	101	103	95	89	88	100	102	83	98
TOTAL	**103**	**103**	**103**	**103**	**103**	**103**	**103**	**103**	**103**	**103**	**103**	**103**
% LOS A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
% LOS B	0.0	1.9	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	2.9	1.0
% LOS C	0.0	1.9	0.0	0.0	0.0	4.9	5.8	5.8	1.0	1.0	2.9	2.9
% LOS D	0.0	0.0	1.0	1.9	0.0	1.9	7.8	8.7	1.9	0.0	12.6	1.0
% LOS F	100.0	96.2	99.0	98.1	100.0	92.2	86.4	85.5	97.1	99.0	80.6	95.1
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Again, it should be remembered that the subbasin LOS is determined by comparing each subbasin against the untreated low to medium density single family residential Abenchmark≅. Because of this, it will be almost impossible for any basin with non-residential land uses to achieve a high LOS without the incorporation of extra or extraordinary stormwater treatment system(s). Even most of the residential areas in the watershed do not have treatment facilities because they were developed prior to the establishment of any standards for water quality.

Exhibit 11-A Summary of the Existing Water Quality Treatment Level of Service by Subbasin

Subbasin ID	Watershed	BOD_5	TSS	TKN	NO_3 $+NO_2$	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
591000	Silver Twin Lake	F	F	D	F	F	F	F	C	D	F	C	F
591010	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591020	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591030	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591040	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591050	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591060	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591070	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591080	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591090	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	D	F
591100	Silver Twin Lake	F	B	F	D	F	F	C	D	B	F	B	C
591110	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591120	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591130	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591140	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591150	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591160	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591170	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591180	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591190	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591200	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591210	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591220	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591230	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591240	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591250	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591260	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591270	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591280	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591290	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591310	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591320	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591330	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591340	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591350	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591360	Silver Twin Lake	F	F	F	F	F	F	D	F	F	F	D	F
591370	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591380	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591390	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591410	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591420	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591430	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591440	Silver Twin Lake	F	F	F	F	F	F	F	D	F	F	C	F
591450	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591460	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591470	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591480	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F

Exhibit 11-A Summary of the Existing Water Quality Treatment Level of Service by Subbasin

Subbasin ID	Watershed	BOD_5	TSS	TKN	NO_3 $+NO_2$	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
591490	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	D	F
591510	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591520	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	D	F
591530	Silver Twin Lake	F	F	F	F	F	C	C	C	D	F	B	D
591540	Silver Twin Lake	F	F	F	F	F	F	D	D	F	F	D	F
591550	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591560	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591570	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591580	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591590	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591610	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591620	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591630	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591640	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591650	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591660	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591670	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591680	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591690	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591710	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591720	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591730	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591740	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591750	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
591760	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
592000	Silver Twin Lake	F	F	F	F	F	F	F	D	F	F	F	F
592100	Silver Twin Lake	F	F	F	F	F	F	F	D	F	F	D	F
592110	Silver Twin Lake	F	F	F	F	F	F	D	F	F	F	D	F
592120	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
592130	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	D	F
592140	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	D	F
592150	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	D	F
592160	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
592170	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
592180	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
592190	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
592210	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
592220	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
592230	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
592240	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
592250	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
592260	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
592270	Silver Twin Lake	F	B	F	D	F	F	C	F	B	F	B	C
593000	Silver Twin Lake	F	F	F	F	F	D	D	D	F	F	F	F
593010	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
593020	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F

Exhibit 11-A Summary of the Existing Water Quality Treatment Level of Service by Subbasin

Subbasin ID	Watershed	BOD_5	TSS	TKN	NO_3 $+NO_2$	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
593030	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	F	F
593040	Silver Twin Lake	F	C	F	F	F	C	C	C	C	C	A	C
593050	Silver Twin Lake	F	F	F	F	F	F	F	F	F	F	D	F
593060	Silver Twin Lake	F	C	F	F	F	B	C	C	F	F	C	B
593070	Silver Twin Lake	F	F	F	F	F	D	D	D	F	F	F	F
593080	Silver Twin Lake	F	F	F	F	F	C	C	D	F	F	F	F
593090	Silver Twin Lake	F	F	F	F	F	F	F	D	F	F	D	F
593110	Silver Twin Lake	F	F	F	F	F	F	D	F	F	F	D	F
593120	Silver Twin Lake	F	F	F	F	F	C	D	C	F	F	F	F
593130	Silver Twin Lake	F	F	F	F	F	C	D	C	F	F	F	F

PUBLIC INPUT / PUBLIC MEETING

The public is a major stakeholder in the watershed planning process. In many cases, they are the source of much historic information. Toward that end, the public meeting was held on January 22, 2002 in the cafeteria of the Twin Lakes Elementary School. The intent of the meeting was to gather any additional information that may have been missed during the process, as well as to involve the public in the watershed's projects by informing them of what was being proposed by the County.

County staff present at the meeting included:

Bernadette Cooper - Meeting Secretary
David Glicksberg - Senior Hydrologist
Kelly Holland - Project Manager / Environmental Scientist
Martin Montalvo - Meeting Facilitator
Andy Morris - West Service Unit Representative
Patrick Murphy - Public Relations Specialist
Dr. Junshan Su - Project Engineer / Professional Engineer

The meeting started at 6:30 PM and lasted until 9:00 PM. A total of 46 people attended the meeting. Mr. Montalvo started the meeting by giving a brief description of the watershed planning process and of the plan itself. The public was then invited to ask questions and view the poster size boards depicting various information on the watershed. These included:

1) the watershed overlain onto 1938, 1985 and 2000 aerial photographs
2) a map depicting the various flood complaints that had been received by the County during the 1997-8 El Nino Event. It also depicts past and future CIP projects.
3) a map showing the flood Level of Service for a 25 Year / 24 Hour storm event
4) a graphic illustrating the Trophic State Index for Silver and Twin Lakes from the years 1997 to 2000.

Eighteen comment sheets were received at the end of the meeting with an additional comment sent in the day after the meeting. These comments were responded to either by phone or letter. In addition, staff visited eight sites on January 31, 2002 to investigate some of the comments.

The following pages include the project summary sheet that was given out at the meeting, the attendance sheets, all comment forms received both at the meeting and after it and finally a copy of any written comments that went back in reply to citizens' comment.

Hillsborough County
Florida

Office of the County Administrator
Daniel A. Kleman

THE SILVER - TWIN LAKES WATERSHED MANAGEMENT PLAN

Presented by
Your Stormwater Management Section

January 22, 6:30 p.m. at Twin Lakes Elementary School

Project Manager:	**Kelly Holland**
Project Design Engineer:	**Junshan Su, Ph.D. P.E.**
Recording Engineer:	**Abraham Adger**
Meeting Secretary:	**Bernadette Cooper**
Road & Street West Unit:	**Doug Beam or Andy Morris**
Moderator:	**Martin Montalvo**

Introduction:

County staff will be presenting information relative to this project and receiving community input. In order to convey the information in an efficient manner and maximize the use of your time, it is respectfully requested that all questions and comments be held until the end of the presentation. Everyone will have a chance to be heard. We will gladly stay as late as it takes to answer your questions and hear all your comments. Please write down your comments as we go along. At the end of our presentation ample time will be available to answer any questions and receive comments and suggestions

This document, the meeting summary, provides a brief history of the project and what the goals of this meeting are. Included with this handout are two additional documents. These documents are the Glossary and List of Abbreviations and the Proposed Projects Comment Sheet. The Glossary and List of Abbreviations has been provided in order to define and alleviate any confusion that may be involved with the use of technical and scientific terms. If any term should arise that has not been listed within this document, please do not hesitate to ask us to clarify. The Proposed Project Comment Sheet allows you, the citizen, to provide feedback regarding the project that will be presented here this evening.

Project History:

The Silver - Twin Lakes Watershed Management Plan is one of seventeen plans that the County has developed to identify and address flood control, natural systems and water quality issues throughout unincorporated Hillsborough County. These plans are part of the accelerated stormwater program put in place by the Board of County Commissioners to address the widespread flooding that occurred in 1997-98 El Nino event, as well as to improve water quality in the lakes and streams within Hillsborough County and ultimately Tampa Bay.

Funding Source:

This project is funded as part of the Capital Improvement Program (CIP). This funding is collected with your real estate taxes as a stormwater fee and transferred into the CIP fund.

Project Description:

The Silver - Twin Lakes Watershed area is generally bounded by Himes Avenue to the west, Habana Place and White Trout Lake to the north, Kirby Street to the south, and Armenia Avenue to the east. In-house staff completed this project. It was begun in August 2000 and completed in October 2001. The plan includes a review of existing flood control, water quality and natural systems conditions in the watershed and uses computer models to simulate flooding in response to various storm events and to estimate pollutant loading within the watershed. Problem areas are identified and then alternative solutions are proposed and evaluated. Finally, recommendations are made for projects to be constructed as well as for maintenance of the stormwater system and monitoring of the water quality in the watershed.

In order to facilitate the development of this plan, this public meeting will be used to provide information and obtain feedback from area residents and other interested persons regarding the work being done.

Hillsborough County is endeavoring to reduce the flooding problems and improve water quality in the Silver - Twin Lakes Watershed area. The development of the watershed management plan for this area will help to address these issues with the input received tonight and at the previous public meetings.

We thank everyone for their attendance tonight and for any comments and/or suggestions that are given.

BOARD OF COUNTY COMMISSIONERS
Stacey L. Easterling
Pat Frank
Chris Hart
Jim Norman
Jan K. Platt
Thomas Scott
Ronda Storms

Hillsborough County
Florida

Office of the County Administrator
Daniel A. Kleman

Deputy County Administrator
Patricia Bean

Assistant County Administrators
Kathy C. Harris
Edwin Hunzeker
Anthony Shoemaker

SILVER/TWIN LAKES WATERSHED MANAGEMENT PLAN
SIGN-IN SHEET

Presented by Stormwater Management Section
Tuesday, January 22, 2002
Twin Lakes Elementary School, 8507 N. Habana Avenue

Please print your name, address and telephone number:

1. ALICE DUNCAN 8906 N ARRAWANA 935-7906
2. BROOKS DUNCAN " " "
3. Maril Martinez 3117 W. River Cove Dr. 932-8013
4. R A Roberts 8418 Twin Lake Bl 933-1747
5. [illegible] 8504 Twin Lakes 932-3435
6. Robert [illegible] Leonard 8701 Twin Lks 933-2582
7. M/M C.P. MARRONE 2814 W Humphrey St Tampa 935-5676
8. M/M Don Wellman 8016 Paddock Ave T 932-9415
9. Frank Sierra 8015 Lago Vista Dr. 9334344
10. STAN YABCZANKA 8922 OKEN AVE. 935-3711
11. Yvonne & Mel Marrone 8907 N Arrawana 935-7908
12. ALEY AWAD 306 E. Jackson 224-7835
13. Mike & Jamie Whitlow 2801 W. Humphrey [illegible]

Post Office Box 1110 · Tampa, Florida 33601
Web Site: www.hillsboroughcounty.org

14. SUSAN BROWN 2810 Silver Lake Ave Tpa 813 932-4064

15. Mae L. Tedrick 8908 N. Arrawana Dr 813 935-7907

16. [illegible] + Bill Rose 8911 N. Arrawana Ave Tpa 932-6744

17. [illegible] + Gary [illegible] 8643 Twin Lakes 932-4747

18. Robert Leonard + [illegible] B. Leonard

19. TOM MORENO 8905 N. ARRAWANA AVE TAMPA

20. BRIAN BRANTLEY 8717 TWIN LAKES 935-3595

21. JACK SMELT 3205 W. SITKA ST 935 0097

22. Douglas W. Beam WSU 554-5006

23. RON BUTTON 3306 EL MONTE CT 33614 933-275[illegible]

24.

25.

26.

27.

28.

29.

30.

31.

32.

33.

34.

35.

36.

Rath-

37. Booker Short 8925 N Arrawana Av 932 4193

38. John Robertson 8631 Twin Lakes Blvd. Tampa 33614

39. Anne Marie Seegers 2711 W. Humphrey St 33614

40. M/M Robert C Clauser 3409 W. Kenyon Ave 33614

41. Bill [illegible] 7017 [illegible] 33614

42. Teresa Simmons 3005 Cale Ln Tampa FL 33614

43. Clinton N Simmons 3005 Cale Ln Tampa FL 33614

44. John + Joy Albano 2806 Silver Lake Av Tpa Fl 336[illegible]

45. JUSANNAH E MILLER 8516 N HABANA AVE TPA 3361[illegible]

46. Linda + Jim Kilcullen 8612 [illegible] Cir. TPA 33614

47. TED + SUE STROHM 2811 W. SITKA ST TPA 3361[illegible]

48. Chris Thayer 2923 W. Sligh Ave 33614

49. (Representing Louis Perna)

50. JUAN DAVIS 8637 Twin Lakes Blvd

51. SUSIE ADAMS 8926 N. ARRAWANA

52.

53.

54.

55.

56.

57.

58.

59.

HILLSBOROUGH COUNTY
FLORIDA

Silver/Twin Lakes Watershed Management Plan
Comment Form

Name: SUSAN E BROWN
Address: 2810 Silver Lake Ave
TAMPA FL 33614
E-mail: BROWNSE@prodigy.net

The information received from talking with the project staff was helpful:
(very) 1 2 3 4 (5) (not very)

#26358

Were your questions / concerns addressed? Yes ☒ No ☐

Please provide us with any additional comments regarding the Silver/Twin Lakes Watershed Management Plan, or any other comments or concerns.

exact location
address

SINCE HOUSING DEVELOPMENT LATE 19[illegible]

CONTINUOUS BACK YARD FLOODING AT THE SOUTH END of my property. County owned EASMENT RUNS EAST AND WEST behind 2805, 2810, 2820?

HAVE MADE PREVIOUS COMPLAINTS

PLEASE MAKE A SITE VISIT.

BEHIND my residence AT 2810 Silver Lake Ave there is A RAIN & LAKE flooding which originates because of a trapped water flow. The EASEMENT behind the house west of 2810 and the residence EAST of 2810 is restricted due to the culvert pipe being at a higher level, forcing its flow to be backed up into the yard. The COUNTY HAS NOT MAINTAINED the EASEMENT, which has resulted in TREE AND plant FOLIAGE which Adds to the overall problem.

Please return form to:
Dr. Junshan Su, Sr. Engineer, Stormwater Management Section
Bernadette W. Cooper, Public Relations/Information Specialist II
Public Works Department Stormwater Management Section
P.O. Box 1110, 23rd Floor, Tampa, FL 33601
or fax to: 813-272-5320

HILLSBOROUGH COUNTY
FLORIDA

Silver/Twin Lakes Watershed Management Plan
Comment Form

Name: Robert C Clausen
Address: 3409 W. Kenyon Ave
Tampa Fl 33614-1638
E-mail: ____________________

The information received from talking with the project staff was helpful: 26366

(very) 1 (2) 3 4 5 (not very)

Were your questions / concerns addressed? Yes ☐ No ☐ N.A.

Please provide us with any additional comments regarding the Silver/Twin Lakes Watershed Management Plan, or any other comments or concerns.

the Question I have was if After All the digging Along Twin Lake Ave. is done. will the street be paved completely.

If Not, Why Not?

Please return form to:
Dr. Junshan Su, Sr. Engineer, Stormwater Management Section
Bernadette W. Cooper, Public Relations/Information Specialist II
Public Works Department Stormwater Management Section
P.O. Box 1110, 23rd Floor, Tampa, FL 33601
or fax to: 813-272-5320

HILLSBOROUGH COUNTY
FLORIDA

Silver/Twin Lakes Watershed Management Plan
Comment Form

Name: William G Corristan 813 935 4248
Address: 8017 Lago Vista Dr
Tampa 33614
E-mail: billcorr@netzero.net

The information received from talking with the project staff was helpful: #26276
(very) 1 2 3 4 5 (not very)

Were your questions / concerns addressed? Yes ❑ No ❑

Please provide us with any additional comments regarding the Silver/Twin Lakes Watershed Management Plan, or any other comments or concerns.

I have lived on Lake Silver for more Than 20 years.

There are at least 7 storm sewers into The lake, one beside my lot.

The lake is silting and needs many yards of sand removed at each inflow.

The lake is very clear when we haven't had much rain. Rain brings murky water and Thick algae for weeks after a good rain as well as all kinds of Trash and garbage.

How can you and I improve The quality of The water in Lake Silver.

Please return form to:
Dr. Junshan Su, Sr. Engineer, Stormwater Management Section
Bernadette W. Cooper, Public Relations/Information Specialist II
Public Works Department Stormwater Management Section
P.O. Box 1110, 23rd Floor, Tampa, FL 33601
or fax to: 813-272-5320

HILLSBOROUGH COUNTY
FLORIDA

CLIFTON STREET DRAINAGE IMPROVEMENTS
Comment Form

Name: Juan Davis
Address: 8637 Twin Lakes Blvd
Tampa 33614

The information received from talking with the project staff was helpful:
(very) (1) 2 3 4 5 (not very)

Were your questions / concerns addressed? Yes ☑ No ☐ #27273

Please provide us with any additional comments regarding the Clifton Street Drainage Improvements.

Good Planning job.

Note: Many "out of line" questions & comments are brought up during these meetings. Presenters should be better prepared to dismiss questions and comments not pertaining to meeting agenda.

Please return form to:
[Remy Ogunsola]
Public Works Department/Stormwater Management Section
P.O. Box 1110
Tampa, FL 33601
** or fax to: 813-272-5320

HILLSBOROUGH COUNTY
FLORIDA

CLIFTON STREET DRAINAGE IMPROVEMENTS
Comment Form

Name: Jim & Linda Kilcullen
Address: 3613 May Circle
Tampa, Fl, 33614 932-9467

The information received from talking with the project staff was helpful:
(very) 1 2 3 4 5 (not very)

#26387

Were your questions / concerns addressed? Yes ❑ No ❑

Please provide us with any additional comments regarding the Clifton Street Drainage Improvements.

Please mail us a copy of the handout from the meeting on 1/22 at Twin Lakes School concerning the Silver-Twin Lakes Watershed Mgm Plan.

Please return form to:
[Remy Ogunsola]
Public Works Department/Stormwater Management Section
P.O. Box 1110
Tampa, FL 33601
** or fax to: 813-272-5320

HILLSBOROUGH COUNTY
FLORIDA

Silver/Twin Lakes Watershed Management Plan
Comment Form

Name: CARMELO Marrone
Address: 2814 West HUMPHREY ST
TAMPA, Florida 33614
E-mail:

26342

The information received from talking with the project staff was helpful:
(very) 1 2 3 4 5 (not very)

Were your questions / concerns addressed? Yes ☐ No ☐

Please provide us with any additional comments regarding the Silver/Twin Lakes Watershed Management Plan, or any other comments or concerns.

My concern is to protect the Lake from polluted water from drain-off. LAST year they planned to do just that I haven't heard anything different. Why don't you bury the water AND SAVE IT for drought times?

Please return form to:
Dr. Junshan Su, Sr. Engineer, Stormwater Management Section
Bernadette W. Cooper, Public Relations/Information Specialist II
Public Works Department Stormwater Management Section
P.O. Box 1110, 23rd Floor, Tampa, FL 33601
or fax to: 813-272-5320

Hillsborough County
Florida

Office of the County Administrator
Daniel A. Kleman

February 8, 2002

Mr. and Mrs. C.P. Marrone
2814 West Humphrey Street
Tampa, FL 33614

Dear Mr. and Mrs. Marrone,

Thank you for attending the recent public meeting to discuss the Silver - Twin Lakes Watershed Management Plan and its associated stormwater projects. We appreciate that you have taken the time to make additional comments.

You specifically asked about 1) the proposed project from last year in the Twin Lakes area and 2) about the possibility of storing stormwater underground for reuse later.

1) As we discussed by phone on January 28, the project you referred to on Twin Lakes was cancelled.

2) The use of stormwater storage underground is in general a good idea, but it is difficult in practice. One of the main problems in terms of the Floridan aquifer is isolating the stormwater from "cleaner" drinking water. If the stormwater can be treated to near drinking water quality there is no problem. However, if we do this then there is no real need to store it; we should use it and save our groundwater. If this water could be isolated in rock "vaults", we could then extract it at our leisure, treat it and use it. But there are few areas in Central Florida where this could be done. The limestone that underlies most of Florida is extremely porous and has been called a rock sponge. One of the main uses of stormwater injection as it is called is to prevent the intrusion of salt water into our drinking water. As we draw water out of the aquifer, especially in coastal areas, it is replaced by salt water. By injecting stormwater, this intrusion can be checked or slowed; but again treated stormwater is preferred. As we discussed on the phone, there has been some experimentation with the creation of "bubbles" of stormwater within some of these areas of saltwater. The difference in densities of the two types of water keeps them fairly separate. The stormwater can then be extracted in times of need, treated and reused. I am sure this will be an issue in the coming years that will be investigated further. Hopefully we will be

HILLSBOROUGH COUNTY
FLORIDA

Silver/Twin Lakes Watershed Management Plan
Comment Form

Name: Mel Marrone
Address: 8907 N Arrawana Ave
Tampa FL 33614
E-mail: m.marrone@verizon.net

The information received from talking with the ~~project staff~~ was helpful:
(very) 1 2 3 4 (5) (not very)

#26329

Were your questions / concerns addressed? Yes ☐ No ☒

Please provide us with any additional comments regarding the Silver/Twin Lakes Watershed Management Plan, or any other comments or concerns.

Intersection of Humphrey & Habana floods [illegible]

We live on the canal that runs off of Twin Lake. The canal has less than 2 feet of water when it used to have 6 to 8 feet of water - Water that used to flow now doesn't.

~~[illegible]~~

Maintaining the water quality of Twin Lake is our major concern.

Please return form to:
Dr. Junshan Su, Sr. Engineer, Stormwater Management Section
Bernadette W. Cooper, Public Relations/Information Specialist II
Public Works Department Stormwater Management Section
P.O. Box 1110, 23rd Floor, Tampa, FL 33601
or fax to: 813-272-5320

Hillsborough County
Florida

Office of the County Administrator
Daniel A. Kleman

February 8, 2002

Mr. Mel Marrone
8907 North Arrawana Avenue
Tampa, FL 33614

Dear Mr. Marrone,

Thank you for attending the recent public meeting to discuss the Silver - Twin Lakes Watershed Management Plan and its associated stormwater projects. We were disappointed to find that we did not do a good job answering the questions you had, but we appreciate that you have taken the time to make additional comments.

In your comments, you indicated that 1) water flows in the canal coming out of Twin Lakes have been reduced and 2) the maintenance of water quality in Twin Lakes is your major concern.

1) Service Request # 26239 was initiated with our Roadway Maintenance Unit. They will schedule an inspection of the area. Please refer to this number in any future communications with the County.

2) Since the meeting focused primarily on the three flood control projects, hopefully this letter will more fully explain the water quality aspects of the plan. Many of the final recommendations of the plan directly affect water quality of the lakes in the watershed. I have included that chapter of the plan for your information. You will see that many of them are not projects that can be constructed. The only water quality project of that sort that was recommended by the plan was the one we discussed in the meeting which called for a series of small bioretention ponds to treat stormwater run-off prior to its entry into the lake. This could be done by property owners around the lake on a strictly voluntary basis. Other recommendations call for changes in the way new developments are permitted, the way maintenance is done by removing the material where now it is usually left in place, a study of septic tanks in the watershed and upland restoration along with many others.

HILLSBOROUGH COUNTY
FLORIDA

Silver/Twin Lakes Watershed Management Plan
Comment Form

Name: Maril Martinez
Address: 3117 W. River Cove Dr.
Tampa, FL 33614-2828
E-mail: MAMbuse51@AOL.COM

932-8013

#26272

The information received from talking with the project staff was helpful:
(very) 1 2 3 4 5 (not very)

Were your questions / concerns addressed? Yes ❑ No ❑

Please provide us with any additional comments regarding the Silver/Twin Lakes Watershed Management Plan, or any other comments or concerns.

3117 W. River Cove Dr.
(1) Corner of River Cove and Woodlynne Ave. Floods when there is a heavy rain. The water frequently covers the road from the intersection to my house which is the second from the corner and is knee deep or higher.

(2) West end of Sitka at Himes Ave. frequently floods during heavy rains and is sometimes not passable.

(3) West end of Kirby at Himes Ave - same concern as #2

Please return form to:
Dr. Junshan Su, Sr. Engineer, Stormwater Management Section
Bernadette W. Cooper, Public Relations/Information Specialist II
Public Works Department Stormwater Management Section
P.O. Box 1110, 23rd Floor, Tampa, FL 33601
or fax to: 813-272-5320

HILLSBOROUGH COUNTY
FLORIDA

Silver/Twin Lakes Watershed Management Plan
Comment Form

Name: SUSANNAH E MILLER
Address: 8516 N HABANA AVE
TAMPA, FL 33614
E-mail:

#262275

The information received from talking with the project staff was helpful:
(very) 1 2 (3) 4 5 (not very)

Were your questions / concerns addressed? Yes ☐ No ☐

Please provide us with any additional comments regarding the Silver/Twin Lakes Watershed Management Plan, or any other comments or concerns.

MY CONCERN IS MORE WATER CLARITY + FILTERING OF STREET RUN OFF SO TRASH DOESN'T GO INTO MY LAKE (LAKE DORATHEA)
A DRAIN GOES UNDER MY PROPERTY + I HAVE TO SCOOP UP PLASTIC BAGS, STRAWS ETC.
ALSO ¶ TURBITITY OF LAKE.

HOW DO I GET TO BE A VOLUNTEER TO COLLECT DATA ON MY LAKE

Please return form to:
Dr. Junshan Su, Sr. Engineer, Stormwater Management Section
Bernadette W. Cooper, Public Relations/Information Specialist II
Public Works Department Stormwater Management Section
P.O. Box 1110, 23rd Floor, Tampa, FL 33601
or fax to: 813-272-5320

Hillsborough County
Florida

Office of the County Administrator
Daniel A. Kleman

February 8, 2002

Ms. Susannah E. Miller
8516 North Habana Avenue
Tampa, FL 33614

Dear Ms. Miller,

Thank you for attending the recent public meeting to discuss the Silver - Twin Lakes Watershed Management Plan and its associated stormwater projects. We also appreciate that you have taken the time to make additional comments.

Your comments were concerning 1) water clarity and 2) filtering the water flowing into the lake.

1) As we discussed in the public meeting, since most of the watershed was developed prior to environmental and stormwater regulations, there is little, if any, treatment of the rain run-off. Numerous substances are being brought into the lake as this water flows over the land. These include fertilizers and pesticides that have been applied to residential and commercial lawns and green spaces as well as nutrients like phosphorus and nitrogen in the form of lawn clippings; fallen leaves, twigs and large branches; and paper trash. All of these, except for the pesticides, can serve as fertilizer for plants in the lake. If there were a healthy population of large plants in the lake, they would take up these substances. As a general rule, these plants called macrophytes should cover 60% or more of the lakeshore. In the case of your lake, the algae are the dominant plants and they "bloom" when this nutrient rich water reaches them. If they become too numerous, when they die, their decomposition by bacteria can use up most of the oxygen in the water and cause fish kills.

Another possibility affecting water clarity may be that a strong inflow of water could be stirring up the sediments in the bottom of the lake, as it is relatively shallow. These sediments act as a trap or "sink" for all the nutrients that the plants and algae do not take up. If these nutrients are resuspended into the water column, they can also cause algal blooms. Cold weather is one of the few natural controls for algae and you may have noticed that during a cold winter or during an extreme cold snap, the lake will suddenly clear up.

2) There are many things that can be done to help improve the water quality of the lake. As a private citizen living on the lake, you can plant your lakeshore with native wetland vegetation and encourage your neighbors to do the same. Try to limit the fertilizer and pesticides you use on your lawn and leave a

HILLSBOROUGH COUNTY
FLORIDA

Silver/Twin Lakes Watershed Management Plan
Comment Form

Name: TOM MORENO
Address: 8905 NORTH ARRAWANA AVE
TAMPA 33614
E-mail: NINETYSIX.TEARS@VERIZON.NET

The information received from talking with the project staff was helpful:
(very) 1 2 3 4 5 (not very)

#26332

Were your questions / concerns addressed? Yes ☐ No ☒

Please provide us with any additional comments regarding the Silver/Twin Lakes Watershed Management Plan, or any other comments or concerns.

I AM CONCERNED ABOUT THE FEEDER CANAL FROM W. HUMPHREY TO TWIN LAKE. THIS CANAL IS OVERGROWN, BLOCKED, HAS ALMOST NO WATER FLOW.

THIS CANAL NEEDS TO BE ~~CLE~~ CLEANED TO ALLOW THE WATER TO FLOW.

IN THE PAST 5 YEARS THE WATER LEVEL HAS DROPPED TO THE POINT THAT IT IS ALMOST DRY DURING EARLY SUMMER, CONTRIBUTING TO EVEN GREATER OVERGROWTH DURING THE SUMMER.

MY PROPERTY HAS A SMALL POND OFF THE CANAL WHICH HAS BEEN TRANSFORMED FROM A TWO FOOT DEEP POND TO A TWO INCH DEEP MARSH.

Please return form to:
Dr. Junshan Su, Sr. Engineer, Stormwater Management Section
Bernadette W. Cooper, Public Relations/Information Specialist II
Public Works Department Stormwater Management Section
P.O. Box 1110, 23rd Floor, Tampa, FL 33601
or fax to: 813-272-5320

HILLSBOROUGH COUNTY
FLORIDA

TWIN LAKES

~~CLIFTON STREET~~ DRAINAGE IMPROVEMENTS
Comment Form

Name: LUIS M. PERNA
Address: 2705 W. HUMPHREY ST
TAMPA, FL. 33614

#26270

The information received from talking with the project staff was helpful:
(very) (1) 2 3 4 5 (not very)

Were your questions / concerns addressed? Yes ☑ No ☐

Please provide us with any additional comments regarding the ~~Clifton Street~~ TWIN LAKES Drainage Improvements.

DID A GREAT JOB.

QUESTION -
HOW MANY STORM WATER PIPES CURRENTLY DRAIN INTO TWIN LAKE?

Please return form to:
[Remy Ogunsola]
Public Works Department/Stormwater Management Section
P.O. Box 1110
Tampa, FL 33601
** or fax to: 813-272-5320

Hillsborough County
Florida

Office of the County Administrator
Daniel A. Kleman

February 8, 2002

Mr. Luis M. Perna
2705 West Humphrey Street
Tampa, FL 33614

Dear Mr. Perna,

Thank you for attending the recent public meeting to discuss the Silver - Twin Lakes Watershed Management Plan and its associated stormwater projects. We also appreciate that you were satisfied with the staff presentation and made additional comments.

Your question was how many stormwater pipes presently drain into Twin Lakes. I have included two (2) copies of an aerial photograph from our current stormwater inventory that depicts there are no direct stormwater inflows into the lake. Any water entering the lake is primarily from overland flow.

On this photograph, the pink or fuscia lines indicate roads; the red dots are structures such as end or head walls; the blue lines are pipes and culverts; and the black and blue dashed lines are open ditches.

In the lower left hand corner is Silver Lake and you can see that there is a culvert with a headwall on the north side of the lake. This is depicted by the blue line ending in a red dot.

√

HILLSBOROUGH COUNTY
FLORIDA

Silver/Twin Lakes Watershed Management Plan
Comment Form

Name: R. A. Roberts
Address: 8418 Twin Lake Blvd.
Tpa 33614-1728
E-mail: ____________________

The information received from talking with the project staff was helpful: 26334.
(very) 1 2 3 4 5 (not very)

Were your questions / concerns addressed? Yes ☐ No ☐

Please provide us with any additional comments regarding the Silver/Twin Lakes Watershed Management Plan, or any other comments or concerns.

ref: South end of Twin Lakes Blvd
Pipes under driveways have not been changed – drainage ditches are still open and clog up – Road shoulders wash in to open ditches — We have always had flooding in This area will 18" pipes be changed and ditches filled in?

Robert A. Roberts
933-1747

Please return form to:
Dr. Junshan Su, Sr. Engineer, Stormwater Management Section
Bernadette W. Cooper, Public Relations/Information Specialist II
Public Works Department Stormwater Management Section
P.O. Box 1110, 23rd Floor, Tampa, FL 33601
or fax to: 813-272-5320

#26262

HILLSBOROUGH COUNTY
FLORIDA

Silver/Twin Lakes Watershed Management Plan
Comment Form

Name: John Robertson
Address: 8631 Twin Lakes Blvd.
Tampa, FL 33614
E-mail: johnr@ij.net

Also part of Florida Lakewatch for Twin Lake.

The information received from talking with the project staff was helpful:
(very) 1 2 3 4 (5) (not very)

Were your questions / concerns addressed? Yes ☒ No ☐

Please provide us with any additional comments regarding the Silver/Twin Lakes Watershed Management Plan, or any other comments or concerns.

- Please expedite Kirby Creek Culvert Repl. & Channel Maint. Project to restore flow to Twin Lake (proper outflow).
- Advise acceleration of septic system impact study & Hillsborough Co. providing sewer services to take septic system loading out of system.
- Expedite availability of Watershed Mgmt. Plan on internet or provide CD.
- Proj. No. 47049 and 49233 eliminated the requirement for Proj. No. 40027 because flow was greatly decreased to that section of Twin Lakes Blvd. (i.e. North of Arctic St. to Busch Blvd.) Deepen existing ditch adjacent to concrete privacy wall surrounding Layton subdivision and add swales or weir type structure for water flow prior to reaching Twin Lake. Do not attempt to add additional pipes directing flow to Twin Lake.

Please return form to:
Dr. Junshan Su, Sr. Engineer, Stormwater Management Section
Bernadette W. Cooper, Public Relations/Information Specialist II
Public Works Department Stormwater Management Section
P.O. Box 1110, 23rd Floor, Tampa, FL 33601
or fax to: 813-272-5320

↓ Reverse

HILLSBOROUGH COUNTY
FLORIDA

Silver/Twin Lakes Watershed Management Plan
Comment Form

Name: Iris/William Rose
Address: 8911 N. Arrawana Ave
Tampa FL 33614
E-mail: IBROSEFLA@aol.com

#26330

The information received from talking with the project staff was helpful:
(very) 1 (2) 3 4 5 (not very)

Were your questions / concerns addressed? Yes ☑ No ☐

Please provide us with any additional comments regarding the Silver/Twin Lakes Watershed Management Plan, or any other comments or concerns.

Our biggest concern is the canal behind our home which receives its water from Twin Lake. We need to know that a culvert will be placed at the bridge on Humphrey to accommodate flow of water from the lake, through the canal & proceed to the Hillsborough River which is where we have been told it ends up.

Please return form to:
Dr. Junshan Su, Sr. Engineer, Stormwater Management Section
Bernadette W. Cooper, Public Relations/Information Specialist II
Public Works Department Stormwater Management Section
P.O. Box 1110, 23rd Floor, Tampa, FL 33601
or fax to: 813-272-5320

HILLSBOROUGH COUNTY
FLORIDA

Silver/Twin Lakes Watershed Management Plan
Comment Form

Name: Anne Marie Seegers
Address: 2711 W. Humphrey St
Tampa, Fl 33614
E-mail: ASEEGERS10@AOL.COM

The information received from talking with the project staff was helpful:
(very) 1 (2) 3 4 5 (not very)

#26364

Were your questions / concerns addressed? Yes ☑ No ☐

Please provide us with any additional comments regarding the Silver/Twin Lakes Watershed Management Plan, or any other comments or concerns.

Every heavy rain results in the corner of Habana and Humphrey St. flooding. Cars are unable or concerned about driving at this intersection. This has been a problem as long as I have lived at that intersection - 19 yrs. It is a very serious problem. Many cars stall. Please address this problem.

Please return form to:
Dr. Junshan Su, Sr. Engineer, Stormwater Management Section
Bernadette W. Cooper, Public Relations/Information Specialist II
Public Works Department Stormwater Management Section
P.O. Box 1110, 23rd Floor, Tampa, FL 33601
or fax to: 813-272-5320

HILLSBOROUGH COUNTY
FLORIDA

Ruth & **Silver/Twin Lakes Watershed Management Plan**
Comment Form

Name: Booker Short
Address: 8925 N Arrawana Av
932 4193
E-mail:

The information received from talking with the project staff was helpful:
(very) (1) 2 3 4 5 (not very)

#26277

Were your questions / concerns addressed? Yes ☒ No ❑

Please provide us with any additional comments regarding the Silver/Twin Lakes Watershed Management Plan, or any other comments or concerns.

I would like to see water quality made a higher priority.

Please return form to:
Dr. Junshan Su, Sr. Engineer, Stormwater Management Section
Bernadette W. Cooper, Public Relations/Information Specialist II
Public Works Department Stormwater Management Section
P.O. Box 1110, 23rd Floor, Tampa, FL 33601
or fax to: 813-272-5320

Hillsborough County
Florida

Office of the County Administrator
Daniel A. Kleman

February 8, 2002

Ruth and Booker Short
8925 North Armenia Avenue
Tampa, FL 33614

Dear Mr. and Mrs. Short,

Thank you for attending the recent public meeting to discuss the Silver - Twin Lakes Watershed Management Plan and its associated stormwater projects. We also appreciate that you were satisfied with the staff presentation and made additional comments.

Your concern was that you would like to see water quality made a higher priority.

While it is true that flood control is typically our main focus, water quality and natural systems are also a high priority. Our projects are usually designed to have multiple purposes such as flood control and water quality improvements. At worst, they are designed so that they do not degrade water quality. That is why almost half of the plan is dedicated to the two issues of water quality and habitat. One of the major challenges of the Silver - Twin Lakes Watershed is one we discussed many times in the public meeting. That is that the watershed was developed prior to present-day environmental and stormwater permitting and there are no real areas where we can purchase land to create stormwater ponds or regional treatment facilities. This limits us to only being able to do retrofittings in older areas or adding water treatment features to new projects.

The focus of the meeting was on the "constructable" projects listed in the plan. However, many of the water quality recommendations of the plan are not projects that are built. I have included the final recommendations chapter for your information. These recommendations are many and varied and are divided into structural and non-structural types. The structural recommendations proposed projects that can actually be built or constructed. The non-structural recommendations include things such as education, pollution source reduction and permitting. When you read the recommendations chapter, you will see that it includes general recommendations that can apply to all watersheds, the small retention ponds we discussed in the meeting and revisiting existing stormwater and environmental regulations, among others. All of these recommendations will help to improve the water quality within the watershed.

HILLSBOROUGH COUNTY
FLORIDA

CLIFTON STREET DRAINAGE IMPROVEMENTS
Comment Form

#26360

Name: JACK A. SMELT
Address: 3205 W. SITKA ST
TAMPA FL 33614

The information received from talking with the project staff was helpful:
(very) 1 2 3 (4) 5 (not very)

Were your questions / concerns addressed? Yes ☐ No ☐

Please provide us with any additional comments regarding the Clifton Street Drainage Improvements.

Silver Lake - Sitka St
Will Drainage Ruin the Silver Lake. - Some Drainage
Have Caused Algae in Lake
Some People Might Be Fertilize Too Much.
Also - Dach? From North Are Causing Algae in Silver Lake

- I Do not Have Drainage Problem at my Home -

Hope the Lake Will Not Be Polluted -

Jack Smelt

Please return form to:
[Remy Ogunsola]
Public Works Department/Stormwater Management Section
P.O. Box 1110
Tampa, FL 33601
** or fax to: 813-272-5320

Hillsborough County
Florida

Office of the County Administrator
Daniel A. Kleman

February 8, 2002

Mr. Jack A. Smelt
3205 West Sitka Street
Tampa, FL 33614

Dear Mr. Smelt,

Thank you for attending the recent public meeting to discuss the Silver - Twin Lakes Watershed Management Plan and its associated stormwater projects. We also appreciate that you have taken the time to make additional comments and allowed us to provide you with more information.

Your comments were similar to many others on the lakes in the watershed - pollutants entering the lakes through stormwater and causing algal blooms.

As we discussed in the public meeting, since most of the watershed was developed prior to environmental and stormwater regulations, there is little, if any, treatment of the rain run-off. Numerous substances are being brought into the lake as this water flows over the land. These include fertilizers and pesticides that have been applied to residential and commercial lawns and green spaces as well as nutrients like phosphorus and nitrogen in the form of lawn clippings; fallen leaves, twigs and large branches; and paper trash. All of these, except for the pesticides, can serve as fertilizer for plants in the lake. If there were a healthy population of large plants in the lakes, these substances would be taken up by them. As a general rule, these plants called macrophytes should cover 60% or more of the lakeshore. In the case of your lake, the algae are the dominant plants and they "bloom" when this nutrient rich water reaches them.

Another possibility is that a strong inflow of water through some or all of the pipes could be stirring up the sediments in the bottom of the lake, as it is relatively shallow. These sediments act as a trap or "sink" for all the nutrients that the plants do not take up. If these nutrients are resuspended into the water column, they can also cause algal blooms. Cold weather is one of the few natural controls for algae and you may have noticed that during a cold winter or during an extremely cold snap, the lake will suddenly clear up. But again, the best way to control the algae is to have the lake dominated by macrophytes. These plants will take up most of the nutrients and prevent the algae from reaching the levels you now see.

There are many things we, as the County and you as a private citizen, can do to help improve the water quality of the lake. As a private citizen if you live on the lake, you can plant your lakeshore with native

HILLSBOROUGH COUNTY
FLORIDA

#20268

CLIFTON STREET DRAINAGE IMPROVEMENTS
Comment Form

Name: STAN YABCZANKA
Address: 8922 OREN AVE
935-3711

The information received from talking with the project staff was helpful:
(very) 1 (2) 3 4 5 (not very)

Were your questions / concerns addressed? Yes ☐ No ☑ - Somewhat.

Please provide us with any additional comments regarding the Clifton Street Drainage Improvements.

I Live on The CANAL system EAST of Twin Lake. I have seasonal flooding in my yard of approximately 6" to 8" over the seawall when we go through several days to weeks of repeated Rains.

I Think most of the drainage network is sufficient if kept clean.

I also believe that a regular (Herbicide or Algicide) could be Reasonable solution without the expense of mechanized cleaning.

If A site inspection is conducted of This AREA it would be appreciated if I could be notified to point out particulars of The AREA with my over 20 years experience AS A Resident.

THANKS

[signature]

Please return form to:
[Remy Ogunsola]
Public Works Department/Stormwater Management Section
P.O. Box 1110
Tampa, FL 33601
** or fax to: 813-272-5320

January 23, 2002

Mr Jonshan Su, PhD
Hillsborough County Engineering Div
Stormwater Management
601 E. Kennedy Blvd
22nd Fl, P.O. Box 1110
Tampa, Fl 33601

Dear Sir;

Per our conversation on 1/22/02 at the Silver Lake- Twin Lake Watershed Conference at the Twin Lakes Elementary School, enclosed you will find copies of the plan presented to me by your department regarding filling in a section of the drainage ditch in front of my home at 8418 Twin Lakes Blvd. On two different occasions, I was given permission to fill the ditch at my own expense according to pre- approved plans.
This has always been out of the question for me since I am a very senior citizen on a limited incpme.
Respectfully request you, or someone else with authority visit my street and notice that just two homes have open ditches- mine and my neighbor whose address is 8510 Twin Lakes Blvd.

Our section of roadway has no shoulder to speak of, and when the Road Department builds it up, in washes down in to the ditch with a heavy rain. Incidentally, my driveway and my neighbors still have 12 inch pipe. The project called for increasing the size of these pipes for everyone.

Respectfully request you or someone else in authority visit the site and evaluate the situation. I pay just as much stormwater taxes as the rest of the folks on my street, and would like to get just as much consideration.

Respectfully,

Robert A. Roberts

813-933-1747

Robert A. Roberts, Sr.
8418 Twin Lakes Blvd.
Tampa, FL 33614-1728

Important County Phone Numbers:

Community Relations Coordinator:	(813) 272-5275
Planning and Growth Management:	(813) 272-5920
Public Works/Engineering Division:	(813) 272-5912
Road & Street West Service Unit:	(813) 554-5006
Stormwater Management Section:	(813) 272-5912
SWFWMD	(800) 423-1476
Tampa Regulatory Office	(813) 985-7481
Water Resource Team:	(813) 301-7206

THANKS FOR HELPING US SERVE YOU BETTER
Your Stormwater Management Section

Permit No. 311

R. A. ROBERTS
(Name of Applicant)

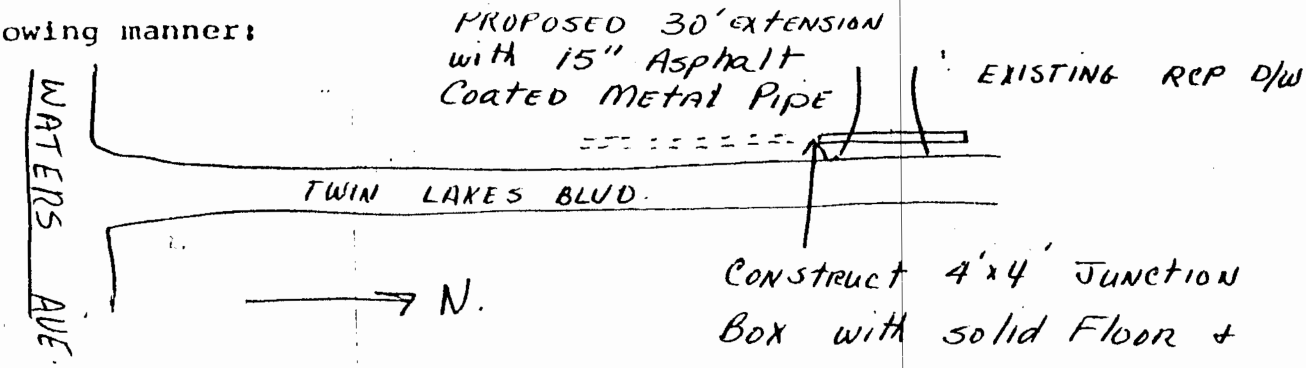
of 8418 TWIN LAKES BLVD. TAMPA, FLA 33614
(Address)

hereinafter termed the applicant, requests permission for the construction of driveway(s) on Hillsborough County right of way at the following location:

County Road Name TWIN LAKES Blvd. S ___ T ___ R ___ Mtc.Unit No. 2

Nearest Intersection WATERS AVE.

in the following manner:



as shown on the attached sketch.

Using culverts meeting D.O.T. specifications as per F.D.O.T. standard specifications for Road & Bridge Construction 1977.

The driveway(s) will be constructed in accordance with Hillsborough County Subdivision Regulations, sec. 5.13-H.

The applicant will save and keep Hillsborough County harmless from any and all damages, claims, or injuries that may occur by reason of this construction of said facility.

... and obligates himself to conform to the above

ALTERNATIVE ANALYSIS

This chapter describes the alternative analysis. As discussed in Chapter 6, there is no existing flooding problems in the Silver / Twin Lakes watershed. The alternatives discussed below are to solve the potential flooding, water quality, and natural system problems.

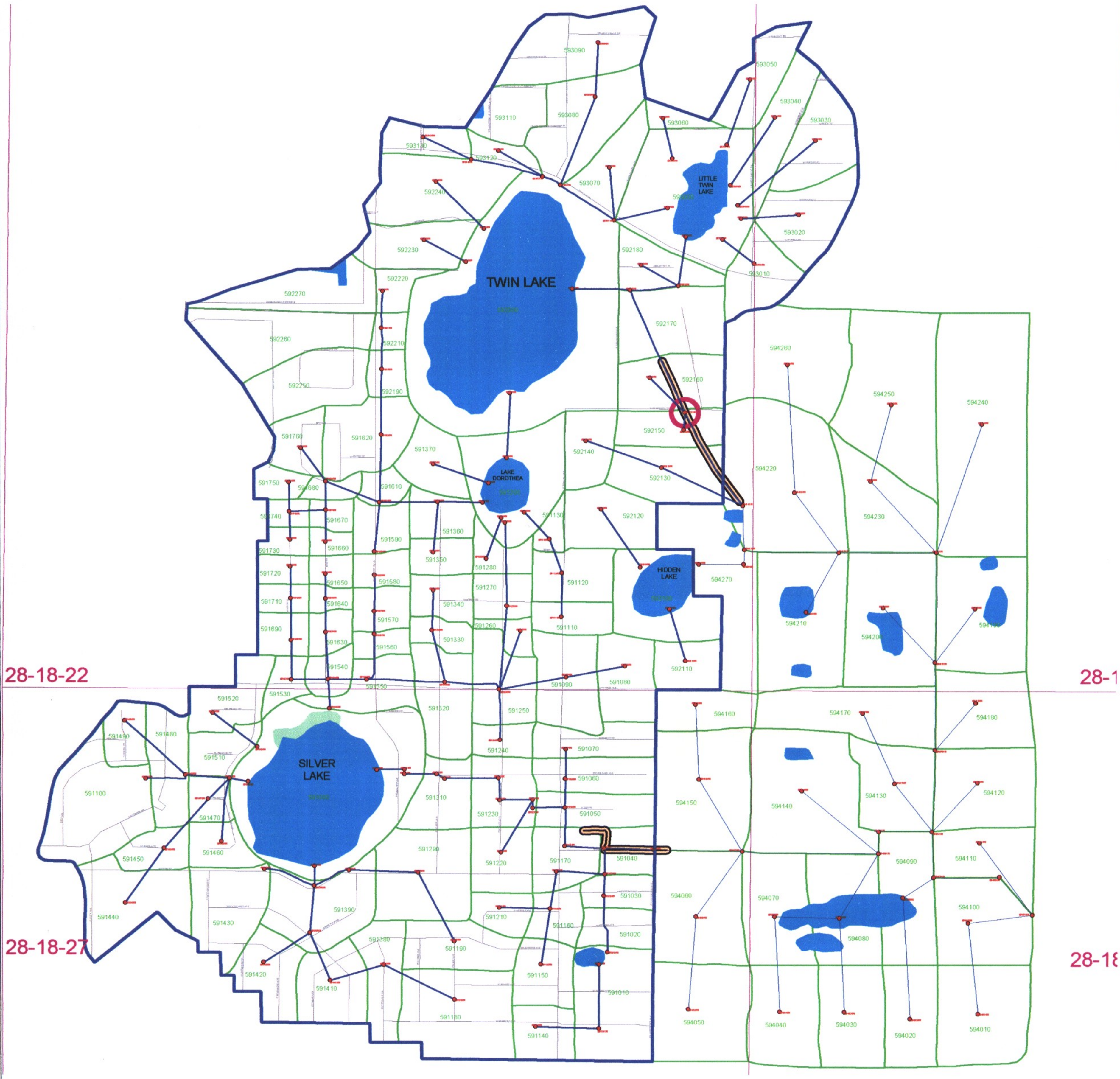
13.1 SILVER LAKE OUTFALL

As described in Chapter 3, upstream of this system is consist of a series of pipes. The alternative for this system is the regular maintenance (clean once a year) of the downstream ditch from N. Habana Avenue to N. Saint Peter Avenue. Figures 13-1 to 13-2 shows the existing condition in year 2000 of this ditch.

Figure 13-1 Ditch South of W. Bird Street

Figure 13-2 Ditch North of W. Sitka Street

The total length of maintenance is ft (see Figure 13.3)



LEGEND

•	JUNCTION		DITCH MAINTENANCE		Water Feature
	CONNECTIVTY		DITCH MAINTENANCE		WETLAND
	CULVERT REPLACEMENT		BOUNDARY		

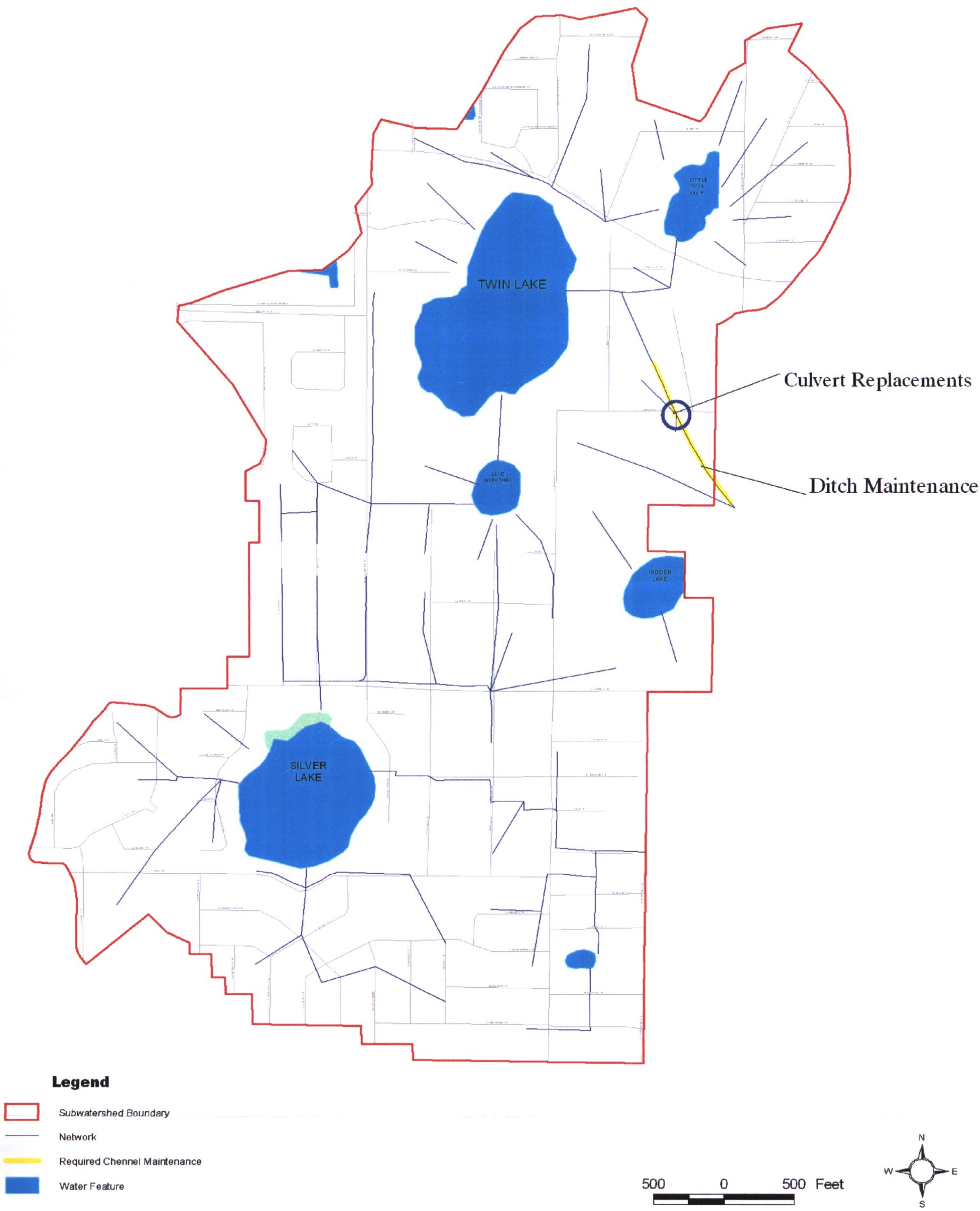
N W E S

Hillsborough County
Florida

SILVER TWIN LAKE AREA STORMWATER MANAGEMENT MASTER PLAN SEPTEMBER 2001

Public Works Department
Engineering Division
Stormwater Management Section

Figure 13-1
Silver Twin Lake Area Alternatives Location Map



SILVER TWIN LAKE WATERSHED MANAGEMENT PLAN
FIGURE 13-3
TWIN LAKE OUTFALL
ALTERNATIVE LOCATION MAP

Department of Public Works
Engineering Division
Stormwater Management Section

July 2001

Hillsborough County
Florida

(insert figure 13-3)

13.2 TWIN LAKE OUTFALL

13.2.1 Kirby Creek

The portion of Kirby Creek found within Hillsborough County is heavily vegetated (see figures 13-4 to 13-7). These plants will slow the water's flow within the creek as well as increase the water level in Twin Lake. The maintenance (clean once a year) length, as shown in Figure 13-7, is about ft. The goal of this maintenance shall be to remove nuisance and exotic vegetation and to re-establish self sustaining populations of desirable vegetation able to assist in water quality treatment. Maintenance shall be done in accordance with the maintenance plan found in this document and with all applicable federal, state and local environmental permitting.

Figure 13-4 Kirby Creek near Arrawana Avenue

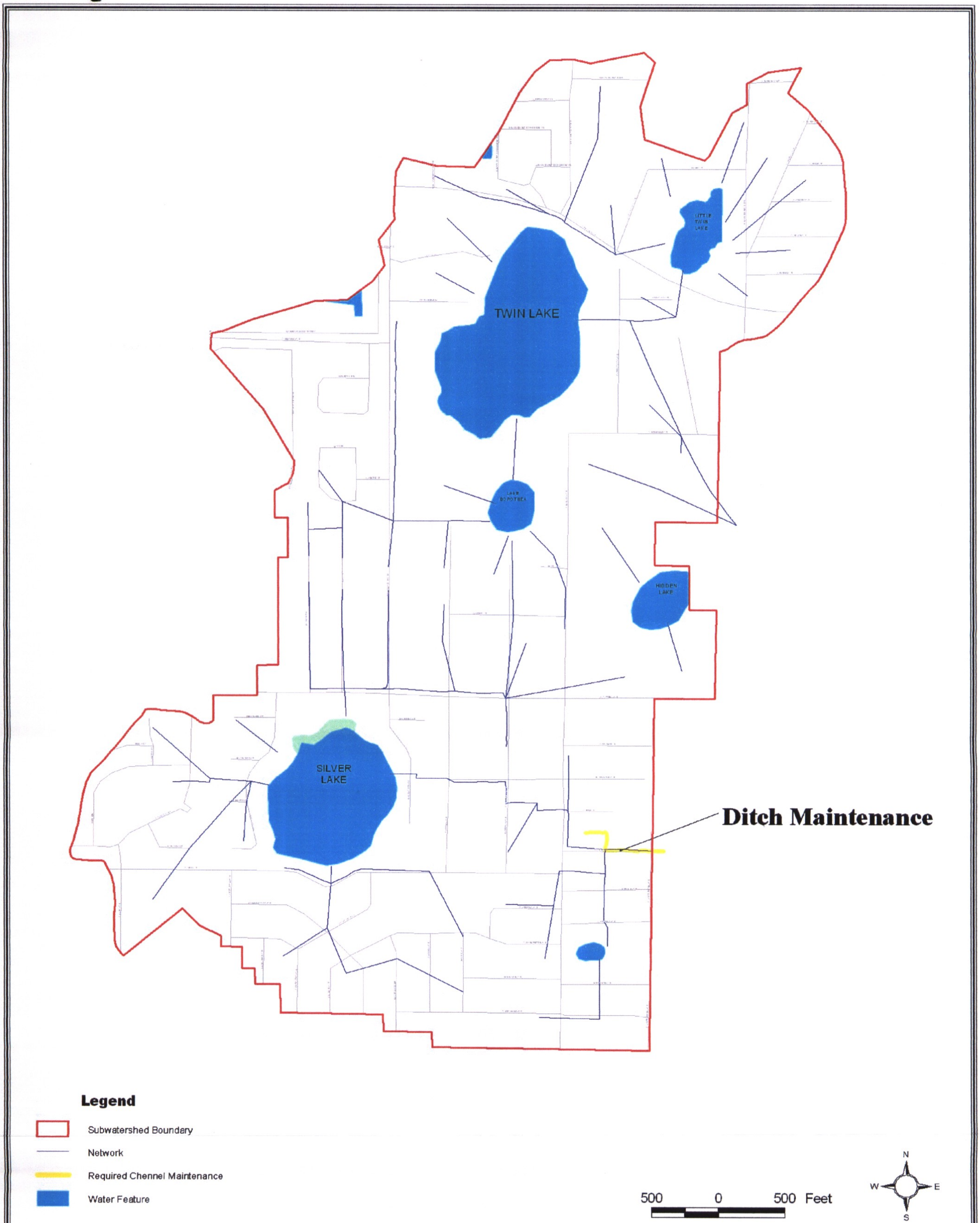
Figure 13-5 Kirby Creek at Humphrey St. (Facing Upstream)

Figure 13-6 Kirby Creek at Humphrey St. (facing downstream)

13.1.1 Culvert at Humphrey Street

From flooding point of view, this culvert is big enough. However, this CMP culvert has been heavily corroded (Figure 13-7), and needs to be replaced with a 54" RCP for safety reasons.

Figure 13-7 Culvert at Humphrey Street



SILVER TWIN LAKE WATERSHED MANAGEMENT PLAN
FIGURE 13-8
SILVER LAKE OUTFALL
ALTERNATIVE LOCATION MAP

Department of Public Work
Engineering Division
Stormwater Management Section

July 2001

Hillsborough County
Florida

(Insert Figure 13-8)

13.3 WATER QUALITY ALTERNATIVES

13.3.1 Structural Alternatives

Structural stormwater best management practices are, as the name implies, those systems that can be constructed. The best example of a structural stormwater BMP is a stormwater pond. Since the majority of the watershed was developed during the period prior to the requirement for stormwater treatment, retrofitting or use of existing areas must be focused on. The alternative(s) used must be carefully matched to the physical constraints of the area or site or with the type of pollutant(s) desired for removal.

13.3.1.1 Regional Stormwater Facilities

Normally, stormwater treatment occurs on the particular parcel of land that generates the runoff. In contrast to this, regional stormwater facilities treat stormwater that has been gathered from more than one site and transported to the facility, generally through a series of pipes and/or ditches. These areas can contain detention or retention ponds or more advanced systems such as alum treatment facilities. Regional facilities should be designed to allow for multiple uses such as open / green space, recreation, groundwater recharge, reuse, etc. The facilities should be designed as to allow enough land to have sufficient slope to have planted littoral shelves if wet detention is used.

13.3.1.2 Use of Existing Conditions

Wherever possible, the natural contours of the land should be used to convey stormwater. This will reduce erosion and sedimentation and in most parts of the County where slopes are gentle, the reduced velocities will allow for filtration and infiltration.

Wetlands

Existing wetlands can be used to attenuate stormwater as long as hydroperiods are not drastically altered. However, care must be taken to bleed off excess water as soon as possible, especially for herbaceous wetlands that are usually sensitive to prolonged inundation. Sediment sumps are usually required to prevent excess sedimentation. This will lessen the need for maintenance dredging. This option is especially desirable when the storage of stormwater will lead to the rehydration of a dewatered wetland. Wetlands are analogous to vegetated wet detention ponds, but can usually be more aesthetically pleasing and can serve as quality habitat for wildlife.

Grassed Swales and Overland Flow

These BMP types use existing vegetation to slow velocities. This will allow particulates, such as sediments and metals, to drop out of the water column and increase residence time to allow for better nutrient uptake. In general, they are situated above the water table to allow for some percolation as well. Grass swales can be made more efficient with the use of check dams to further slow velocities. Overland flow must take physical and biological aspects into account. The type of vegetation used must be able to stand limited inundation and the dry periods between use. Soils must likewise by suited to prevent erosion. Slope will also come into play with respect to soil erosion. A disadvantage of both of these BMPs is that they have the potential to use up large, linear parcels of land

13.3.1.3 Buffers

Vegetative strips are the most commonly used buffers. Their placement in sensitive areas, such as between roadways and stormwater ponds, can greatly reduce the amount of sediment that enters the system. These buffers serve multiple purposes such as stabilization, capture of sediment, some filtering capacity, wildlife habitat and aesthetics. As with stormwater ponds, swales should be designed to have 4:1 or gentler slopes to allow for adequate plant coverage and to reduce erosion and sedimentation.

13.3.1.4 Pervious Concrete and Tuft Block

The use of pervious pavement or materials such as turf block on the edges of impervious area can also perform some of the same function as buffers. They are especially important when looking at groundwater recharge, since water is allowed to penetrate the soil rather than being discharged to a receiving waterbody. Pervious concrete has regular maintenance requirements such as sweeping, vacuuming or pressure washing to prevent clogging. Materials such as turf block and other similar systems provide infiltration through the interstitial areas in the gridwork. This type of BMP does not clog as readily as pervious concrete. Both BMPs have similar characteristics. Percolation can be enhanced by placing a layer of gravel underneath them, as well as by placing them in well-drained soils situated above the high water table. Neither is good in areas that are used by heavy equipment.

13.3.1.5 Chemical Treatment

The most common of these types of treatments is with the use of alum; however, types of iron or ferric compounds can also be used. In this system, the pollutants are removed by flocculation. The coagulant is introduced into the system and forms a precipitate that binds with it many different chemicals, particles and even microbial pathogens. This treatment can occur either on or off line. It has been found to be one of the most effective methods of pollutant removal with efficiencies at or above 90% for most pollutants. Nitrogen is, unfortunately, one of the few parameters that is not readily removed by alum treatment. One of the drawbacks of this type of treatment is toxicity and its effects on flora and fauna. Because of these problems, alum should only be used in cases where all other options have proved to be unsuccessful.

13.3.1.6 Solid / Liquid Separation Structures

This type of technology is used primarily to remove gross pollutants such as litter, debris and coarse sediments by passing the flow through a series of baffles and chambers designed to settle out the target materials. Litter is defined as human created materials such as paper, cloth, metals, etc.. Debris is naturally occurring, organic materials such as leaves, branches and yard waste. Coarse sediments are inorganic particles such as sand and other soils. These types of systems have proven to be very effective in this regard, provided they are adequately maintained. Removal efficiencies for pollutants other than gross pollutants typically runs less than 30%. To offset this drawback, some systems add or rely upon a series of filters and / or activated charcoal to remove dissolved pollutants. These structures can also reduce the flows in the stormwater system and large storms that exceed the design capacities can bypass the treatment and even resuspend previously captured materials. It is recommended that these types of systems be employed in all future County construction projects in the watershed.

13.3.1.7 Detention and Retention Ponds

These two BMP types are the most common stormwater treatment options in use. Detention ponds, as the name implies, are used to temporarily store or detain water until it can percolate into the ground. Like many of the previous BMPs, soils should be porous and the water table low. Vegetation should be able to take periods of inundation and drought. Fine sediments can reduce percolation rates and sedimentation rates can be high. Retention ponds hold or retain water and generally have some permanent pool. Created stormwater wetlands serve the same functions. Because they are commonly planted or have vegetated littoral shelves, they can provide some wildlife habitat. These types of BMP can be either in-line or off-line systems. Both require regular maintenance, but this can be reduced with the installation of a sediment sump. Multi-use facilities, similar to those discussed with the regional treatment facilities can be designed, usually on a smaller scale. It is recommended that in the subbasins immediately surrounding the watershed’s lakes, the possibility be explored on placing small bioretention ponds around the lakes’ edges to provide water quality treatment.

13.3.1.8 Filtration Systems

These areas are similar to retention ponds in that water is allowed to percolate into the ground, and from there into the groundwater. They most commonly are in the form of a pond, trench or pipe. All use gravel or sand as the filtration / percolation medium, sometimes underlain with some type of filter mat. Sediment sumps or some other type of BMP are helpful in reducing sedimentation that leads to clogging. Clogging is a major concern and routine maintenance is required. As with the other types of percolation BMPs, the water table must be low and soils must be porous.

13.3.2 Non-structural Alternatives

As the alternative to structural BMPs, non-structural alternatives do not require construction. They generally center on pollution source reduction by various means.

13.3.2.1 Maintenance

This aspect is almost as important as the construction of the BMP. In facilities which contain underdrain filtration systems, it has been observed that regular maintenance must be perform on an almost monthly basis or the system may actually become an exporter of pollutants, such as nitrogen, pathogens and/or phosphorus (Harper, et. al. 1999). Vegetation in stormwater ponds has maximum treatment when the plants are in the growing stage and this levels off after they have matured. In addition, some plants such as cattails can add large amounts of organics and muck as they decompose in the pond.

13.3.2.2 Education

Another important type of source control is education. This will inform the public as to the results of their actions and are especially important in reducing gross pollutants. Various programs exist in this arena, water quality monitoring programs like the County's Lake Management Program (LaMP) and Stream WATERWATCH; clean up programs, such as Coastal Cleanups; festivals and Earth Day events, xeriscaping and gardening programs and school programs. It is recommended that lake management plans be developed for, at a minimum, Silver and Twin Lakes. These lakes are on the verge of passing out of the "good" TSI range and into only the "fair" range. If the problem is addressed soon, it could save much time and effort in the future.

13.3.2.3 Preventative or Source Reduction Measures

These measures can be as varied as street sweeping, litter control laws, facilities inspections, proper use of chemicals and the elimination of illicit discharges. Street sweeping serves a dual purpose in that it removes pollutant prior to introduction into the system and it prevents clogging of the system as well. To be effective, sweeping must be done on a regular basis, preferably between major storm events. Litter control laws and facilities inspections can be used to decrease or eliminate the source inputs. . While they are "constructed" BMP's, again the idea is to reduce the run-off and therefore the pollutant load. Included in this category are cisterns, rooftop holding areas and rainbarrels. For specific pollutants such as pathogens, frequent inspection of septic systems can prevent illicit discharges. Removing the septic tanks and placing the land use on sanitary sewers or small "package plants" can further reduce these discharges, again as long as the system is regularly inspected and maintained. Programs can be taken advantage of such as the one in which repetitively flooded structures can be removed using Federal Emergency Management Agency's (FEMA) incentives. Simply removing the structures and associated septic systems, if any, can go a long way to reducing loading. If a stormwater treatment system is constructed in addition to structure removal, the reduction can be further increased.

13.3.2.4 Planted Vegetation

Re-establishment of vegetation in both uplands and wetlands is another alternative method. This alternative is similar to preserving existing vegetative buffers and serves all the same purposes including reduction in velocity, direct nutrient removal, soil stabilization and erosion prevention, capture of sediment and the creation of wildlife habitat. This can be done in upland areas to create a buffer or in wetlands and waterbodies to provide treatment.

13.3.2.5 Habitat Preservation

The simple act of preserving natural areas, both uplands and wetlands, like many of the other options in this chapter can serve a dual purpose. The first is that the preservation will provide treatment of stormwater run-off and prevent erosion / sedimentation in the case of both uplands and wetlands. Of course, wetlands will provide a greater role in treatment. The second is a form of source reduction by preventing the land to go into a more intensive land use that would increase pollutant loads.

Many of these alternatives must be applied on a case by case basis and will be recommended in the following chapters.

PUBLIC INPUT (2ND MEETING)

This second public meeting is intended to be a continuation of the watershed process, involving all the affected parties in the watershed. Information gathered during the first public meeting will have been incorporated into the plan to the largest extent possible and a series of alternatives developed to alleviate issues discovered or documented in the watershed. These alternatives are then presented to the public for their comment and opinion. At the time of publication of this report, the second meeting was not held. Prior to the initiation of the final recommendations, it is anticipated that a series of meetings will be held to incorporate public comment into the design or implementation of all recommendations.

PROPOSED LEVEL OF SERVICE

This chapter discusses the improved level of service (LOS) for both flood control and water quality treatment for the Silver / Twin Lake Area watershed based on the alternative analysis and recommendations as described in Chapter 13.

15.1 PROPOSED FLOOD CONTROL LEVEL OF SERVICE

As defined in the Stormwater Management Element of Hillsborough County Comprehensive plan, one of the goals of this report is to achieve an ultimate LOS for the Silver / Twin Lake Area Watershed (i.e., 25-yr/24 hour/level B). As discussed in Chapter 6, the Level Of Service for Silver / Twin Lake area under existing condition is already satisfy this goal, i.e., the LOS of most of sub-basins are "A", and few of them are "B".

15.2 PROPOSED WATER QUALITY TREATMENT LEVEL OF SERVICE

The water quality treatment level of service is not currently defined in any governmental law or rule, nor is it addressed in the Hillsborough County Comprehensive Plan. In this watershed, the single family low to medium density residential land use is being employed as the standard for comparison. It was felt that this is the best compromise to use. Natural systems were initially investigated for use as the benchmark; however, the resulting LOS would have been skewed downward because these systems, in general, provide treatment rather than creating pollutant loads. If a more intensive land use, such as commercial or industrial, were used, the results would have been shifted towards a higher LOS due to the large amount of pollutant load generated by these land uses. This is due primarily to the amount of impervious surfaces that generate large amounts of run-off. Level of service “C” will be the target WQTLOS for the Silver / Twin Lake Area watershed.

As can be seen from the existing water quality treatment level of service discussion in Chapter 11, for the two parameters chosen, total phosphorus and total nitrogen, the level of service is well below the target of “C”. In all subbasins, the LOS was “F” for the parameter of TN and only four of the subbasins for the parameter of TSS met or exceeded the target. In this case two subbasins met the target and two exceeded it with LOS “B”.

The proposed treatment alternative is to place a small bioretention pond on each parcel in each of the subbasins that feed into four of the natural lakes found in the watershed - Silver, Twin, Little Twin and Dorothea. If it is assumed that each pond will treat 50% of the parcel's stormwater run-off and have the same treatment ability of a wet detention pond, the treatment is still inadequate. As can be seen for the parameter of TSS in **Figure 15A**, only two changes to the WQTLOS were effected. Both of these were for the subbasins that Silver and Twin Lakes are found in. In Twin Lake's immediate subbasin, 592000, the LOS was raised from an "F" to a "D". It was raised from an "F" to a "C" in Silver Lake's primary subbasin - 591000. As seen in **Figure 15B** for the parameter of TN, only one of the twenty-eight subbasins had a change in WQTLOS. This was in Silver Lake's primary subbasin 591000 where it rose from an "F" to a "D".

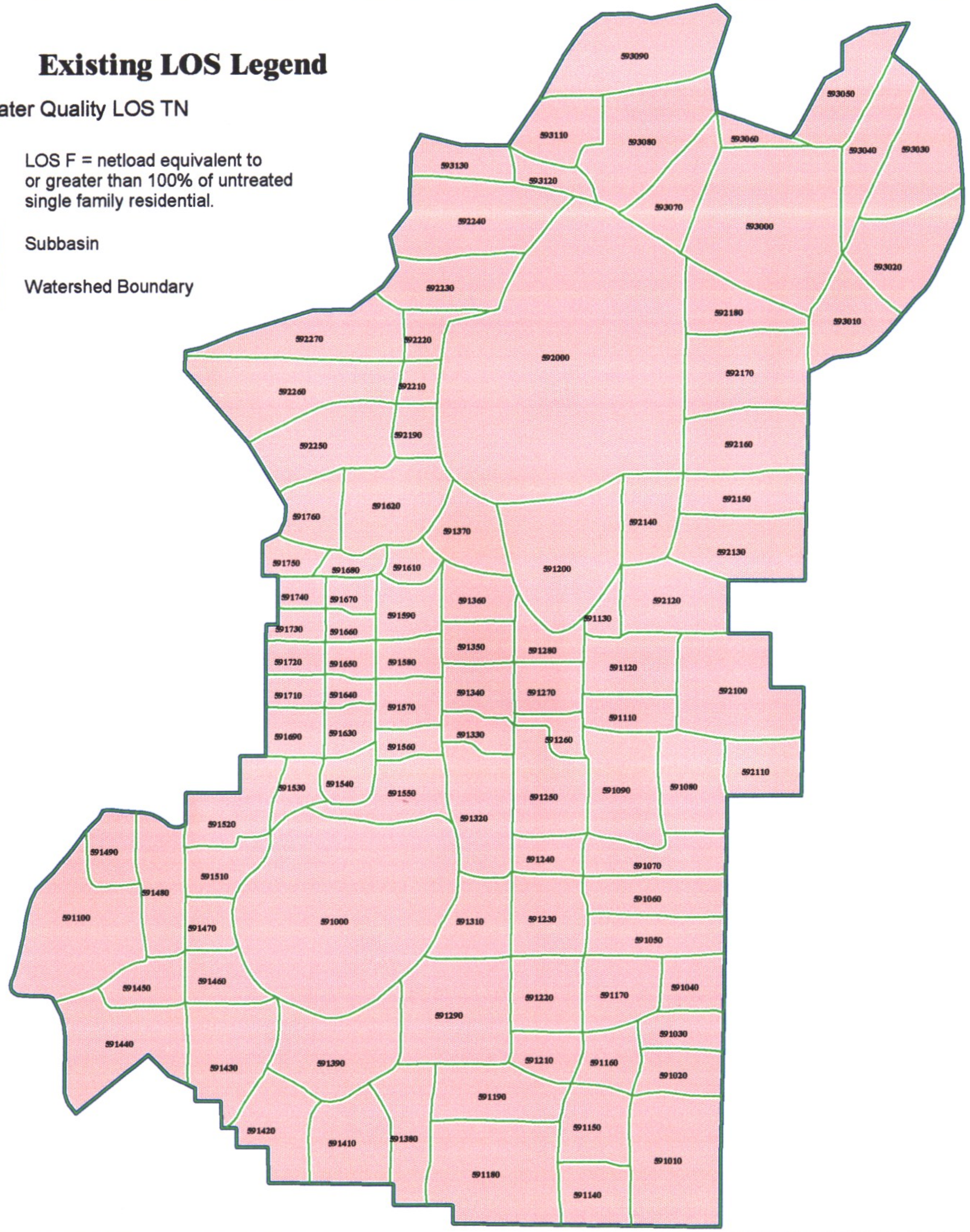
It is clear from this exercise that more stringent measures will need to be taken to raise the WQTLOS to the target of "C". However, even if this project is undertaken and does not raise the level of service, it will still greatly reduce the amount of pollutant loading into these lakes. Table 15.1 below summarizes the amount of each pollutant that will be reduced by implementing this project.

Subbasin	BOD_5	TSS	TKN	NO_3+ NO_2	TN	TP	TDP	Oil & Grease	Cd	Cu	Pb	Zn
591000	64.851	975.998	16.775	21.558	24.723	32.791	16.890	14.781	0.031	1.162	0.175	1.892
591130	7.1876	113.5728	1.8909	2.5027	2.8294	4.0041	2.0346	1.7303	0.0035	0.1408	0.0207	0.2271
591200	44.724	706.701	11.766	15.573	17.606	24.915	12.660	10.767	0.0215	0.876	0.129	1.413
591280	12.039	190.238	3.167	4.192	4.739	6.707	3.408	2.898	0.006	0.236	0.035	0.381
591290	21.940	346.678	5.772	7.640	8.637	12.222	6.211	5.282	0.011	0.430	0.063	0.693
591310	22.799	360.257	5.998	7.939	8.975	12.701	6.454	5.489	0.011	0.447	0.066	0.720
591320	32.859	476.836	9.171	9.637	12.785	13.133	6.917	6.761	0.016	0.498	0.083	0.828
591350	12.640	199.726	3.325	4.401	4.976	7.041	3.578	3.043	0.006	0.248	0.037	0.400
591360	29.893	365.563	9.190	5.862	11.388	3.619	2.453	4.299	0.014	0.219	0.057	0.414
591370	22.563	356.528	5.936	7.857	8.882	12.570	6.387	5.432	0.011	0.442	0.065	0.713
591390	46.475	734.367	12.227	16.183	18.295	25.890	13.156	11.188	0.022	0.910	0.134	1.469
591430	38.461	600.846	10.024	13.258	14.995	21.232	10.797	9.155	0.019	0.745	0.110	1.201
591460	16.982	266.680	4.440	5.877	6.644	9.402	4.778	4.063	0.008	0.331	0.049	0.533
591470	11.982	189.333	3.152	4.172	4.717	6.675	3.392	2.885	0.006	0.235	0.035	0.379
591510	17.403	274.578	4.579	6.054	6.849	9.676	4.918	4.186	0.008	0.340	0.050	0.549
591520	22.735	295.282	6.663	5.468	8.714	5.601	3.189	3.918	0.011	0.243	0.048	0.425
591620	36.333	574.113	9.559	12.651	14.303	20.241	10.285	8.747	0.018	0.712	0.105	1.148
592000	147.673	2319.270	31.653	41.210	47.106	62.493	32.254	27.270	0.128	2.357	2.115	4.402
592140	18.966	233.913	5.806	3.803	7.232	2.538	1.667	2.781	0.009	0.146	0.036	0.273
592160	30.730	476.698	8.195	10.322	12.066	16.036	8.199	7.157	0.015	0.571	0.086	0.927
592170	38.221	592.723	10.044	12.634	14.782	19.553	10.009	8.735	0.020	0.700	0.142	1.148
592180	70.232	1082.116	7.609	8.668	10.859	8.311	5.017	4.150	0.121	0.540	2.769	1.786
592190	10.387	164.120	2.733	3.617	4.089	5.786	2.940	2.500	0.005	0.203	0.030	0.328
592210	7.543	119.187	1.984	2.627	2.969	4.202	2.135	1.816	0.004	0.148	0.022	0.238
592220	10.757	169.969	2.830	3.746	4.234	5.992	3.045	2.589	0.005	0.211	0.031	0.339
592230	29.758	470.215	7.829	10.362	11.714	16.578	8.424	7.164	0.014	0.582	0.086	0.940
592240	101.750	1580.147	15.510	19.134	22.686	24.914	13.476	11.320	0.139	1.132	2.949	2.772
593000	91.135	1435.189	14.336	10.882	18.416	6.114	5.813	8.859	0.154	0.544	3.334	2.057
Silver	296.382	4520.8544	78.7999	97.7845	115.332	149.32	76.7016	67.7062	0.1418	5.3397	0.8127	8.6899
Twin	483.385	7548.5581	97.9432	124.971	144.807	184.11	95.7835	81.4491	0.4686	7.1564	8.3344	14.0292
Little Twin	91.135	1435.1890	14.3355	10.8822	18.4164	6.114	5.8134	8.8587	0.1540	0.5439	3.3339	2.0567
Dorothea	148.012	2166.2408	41.0813	44.1909	57.6529	61.394	32.1882	30.9508	0.0706	2.3064	0.3790	3.8203
TOTAL	**1018.91**	**15670.842**	**232.160**	**277.829**	**336.208**	**400.94**	**210.487**	**188.9648**	**0.8349**	**15.346**	**12.860**	**28.5961**

Existing LOS Legend

Water Quality LOS TN

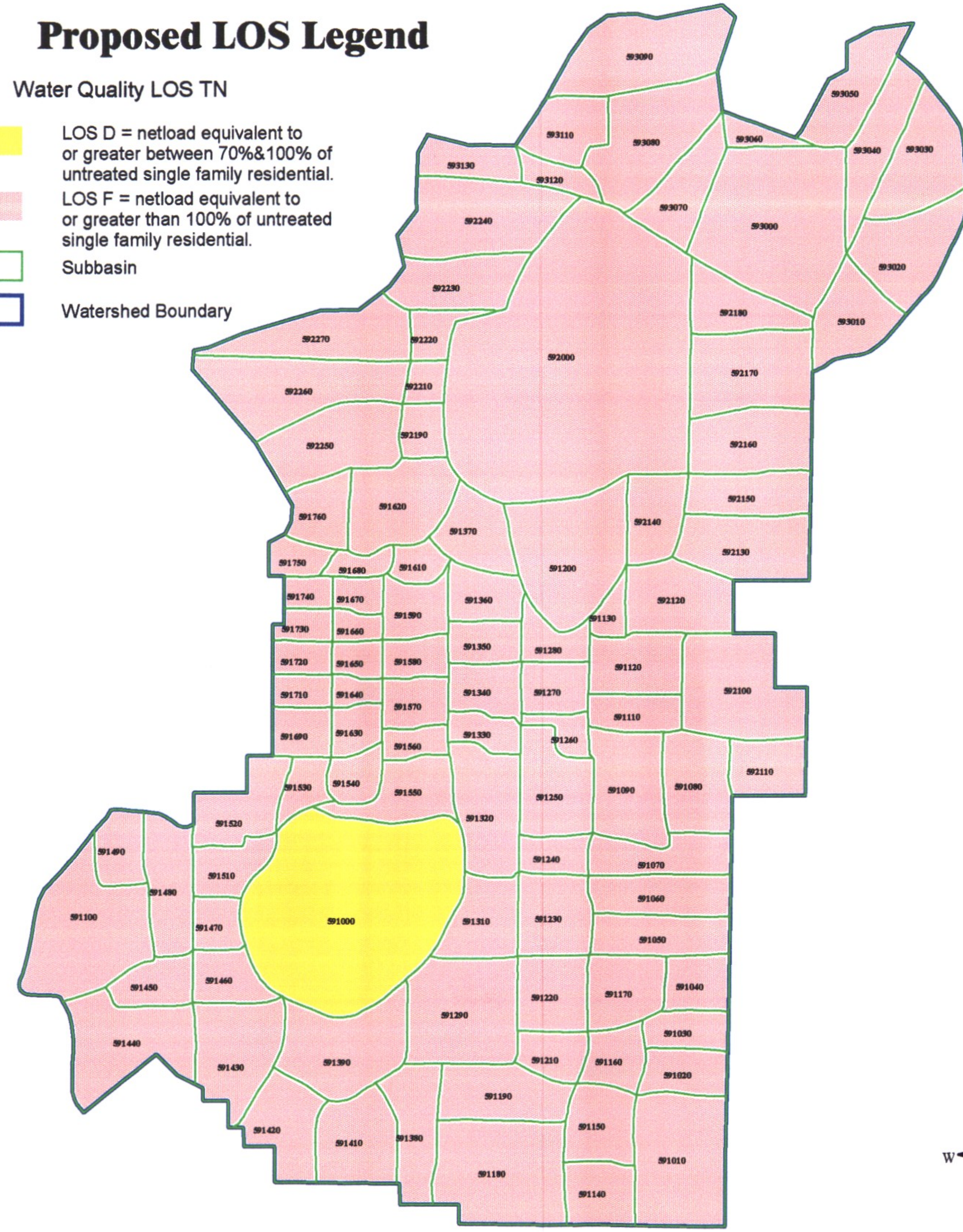
- LOS F = netload equivalent to or greater than 100% of untreated single family residential.
- Subbasin
- Watershed Boundary



Proposed LOS Legend

Water Quality LOS TN

- LOS D = netload equivalent to or greater between 70%&100% of untreated single family residential.
- LOS F = netload equivalent to or greater than 100% of untreated single family residential.
- Subbasin
- Watershed Boundary



N.T.S

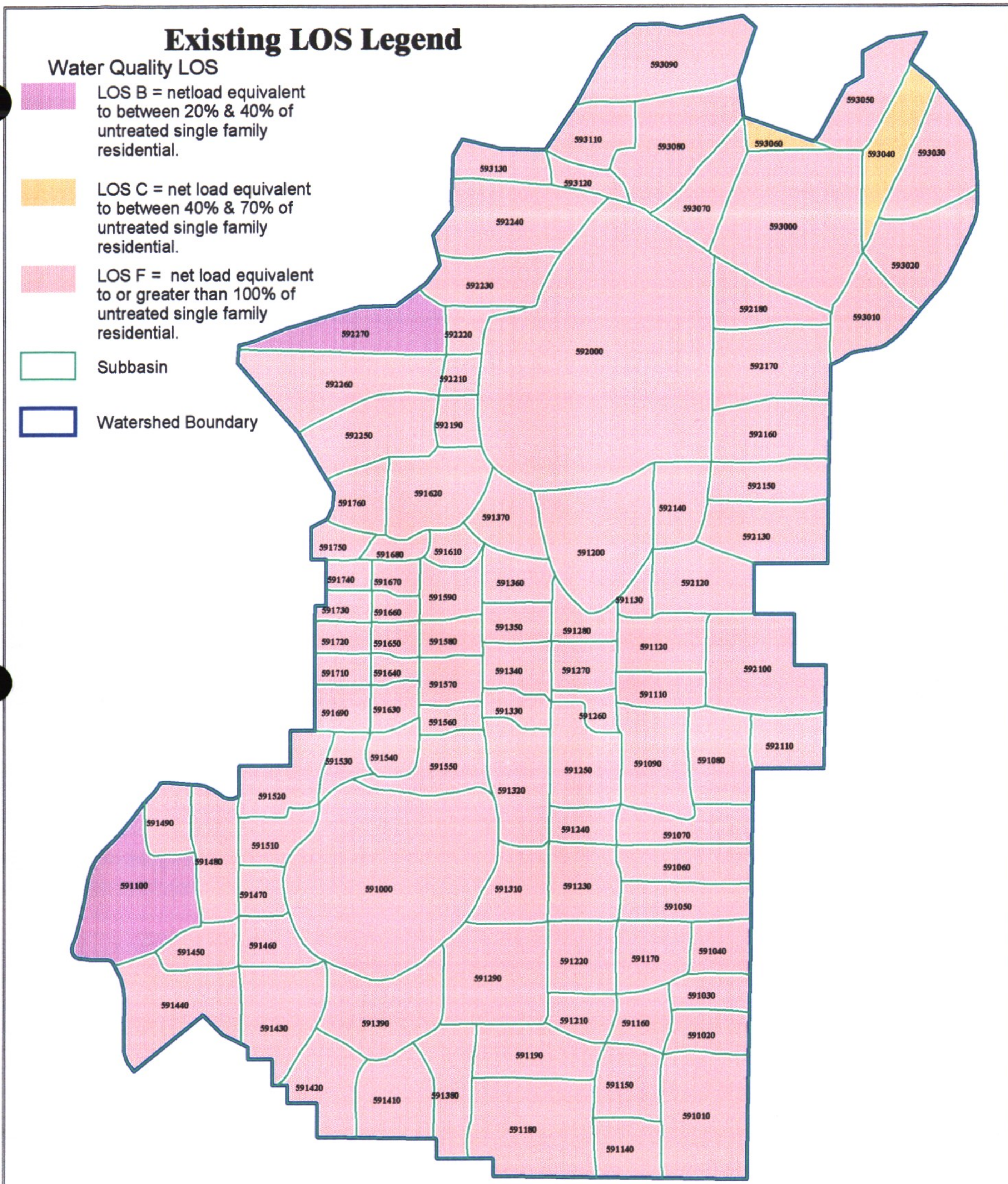
Hillsborough County Florida

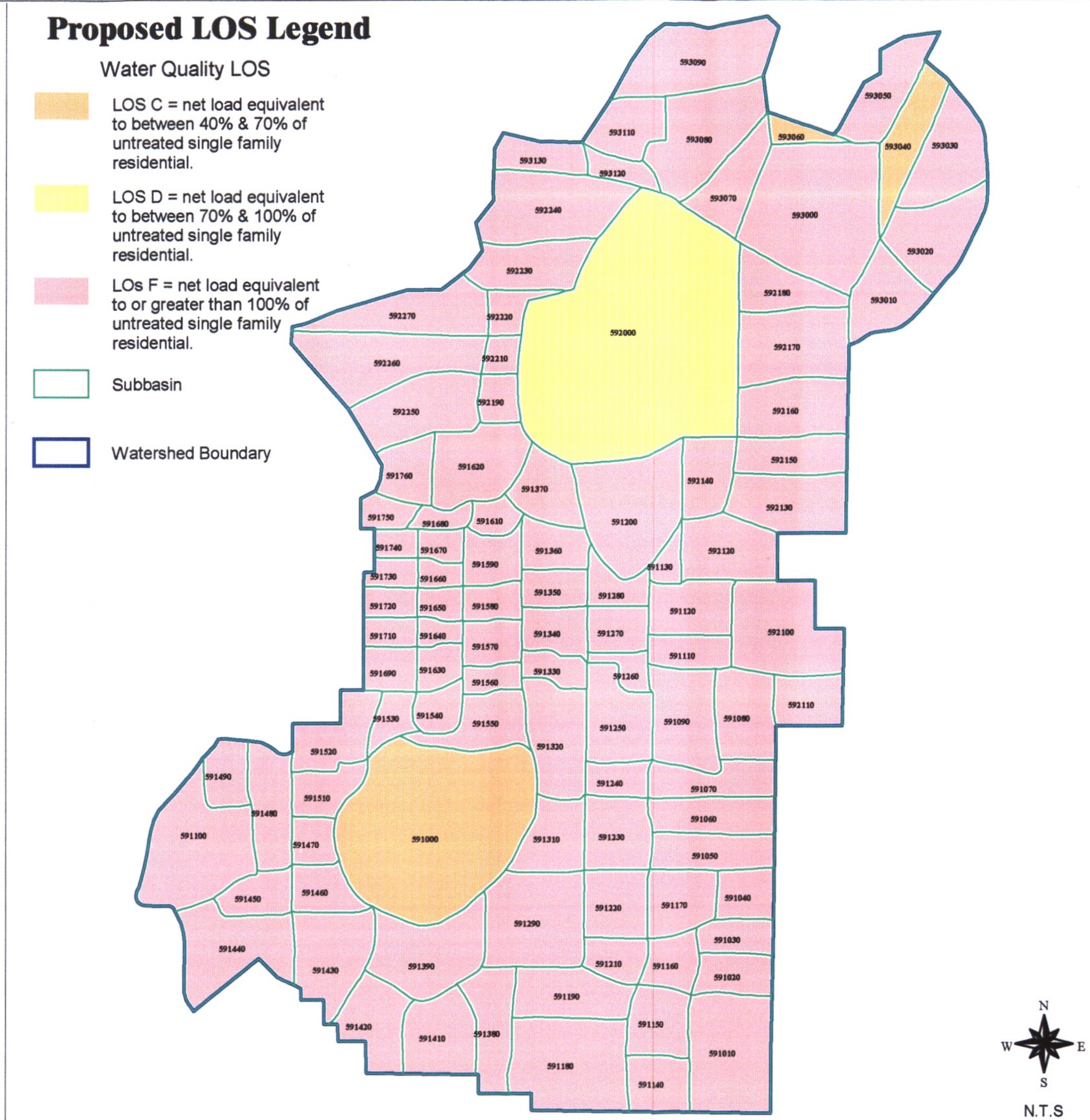
Department of Public Works
Engineering Division
Stormwater Management Section

SILVER/TWIN LAKE STORMWATER MANAGEMENT MASTER PLAN (SEPT 2001)

FIGURE 15A

Proposed Water Quality Level of Service (TN) Map





Hillsborough County
Florida

Department of Public Works
Engineering Division
Stormwater Management Section

SILVER TWIN LAKE
STORMWATER MANAGEMENT
MASTER PLAN
(SEPT 2001)

FIGURE 15B

Propoesd Water Quality Level of Service(TSS) Map

RECOMMENDATIONS

16.1 FLOOD CONTROL

Flooding problem areas and their recommended solutions have been identified and described in this chapter. **Figure 16-1** shows the locations of all recommended projects. Proposed project information includes planning-level structures and non-structures scenario solutions associated with costs and benefits analysis. Planning-level costs are the cost of the improvement based on non-detailed quantity estimates. All estimates are based primarily on SWFMWD contour maps, aerial maps, and limited survey data. Unit costs utilized in developing planning-level costs were taken from Construction Contract History, FDOT State Estimates Office, Engineering Support Services, July 1995 through June 1996. The criteria used to evaluate the technical feasibility of each of the proposed projects are contained in Chapter 13, Alternatives Analysis.

Recommended projects will be presented and discussed in the sequences of the major conveyance systems as described in the previous Chapters. These projects are:

Silver Lake Outfall

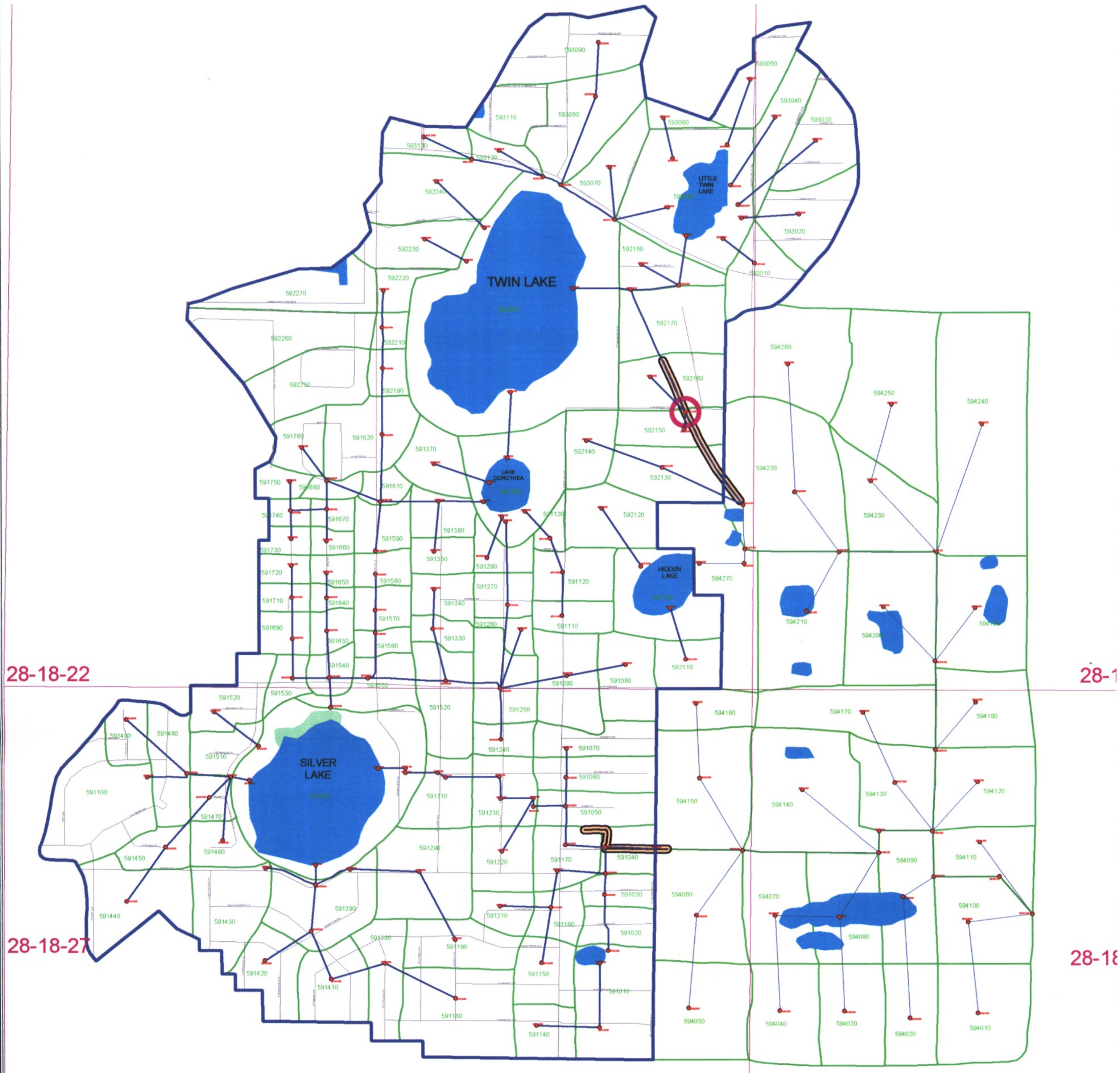
1. Channel Maintenance

Twin Lake Outfall

1. Channel Maintenance
2. Culvert Replacement at Humphrey Street

16.1.1 Silver Lake Outfall

As discussed in Chapter 13, the recommendation for this system is the channel maintenance (clean once a year) of the downstream ditch from N. Habana Avenue to N. Saint Peter Avenue. The total maintenance length is about 900 feet (Figure 16-1).



LEGEND

JUNCTION	DITCH MAINTENANCE	Water Feature
CONNECTIVTY	DITCH MAINTENANCE	WETLAND
CULVERT REPLACEMENT	BOUNDARY	

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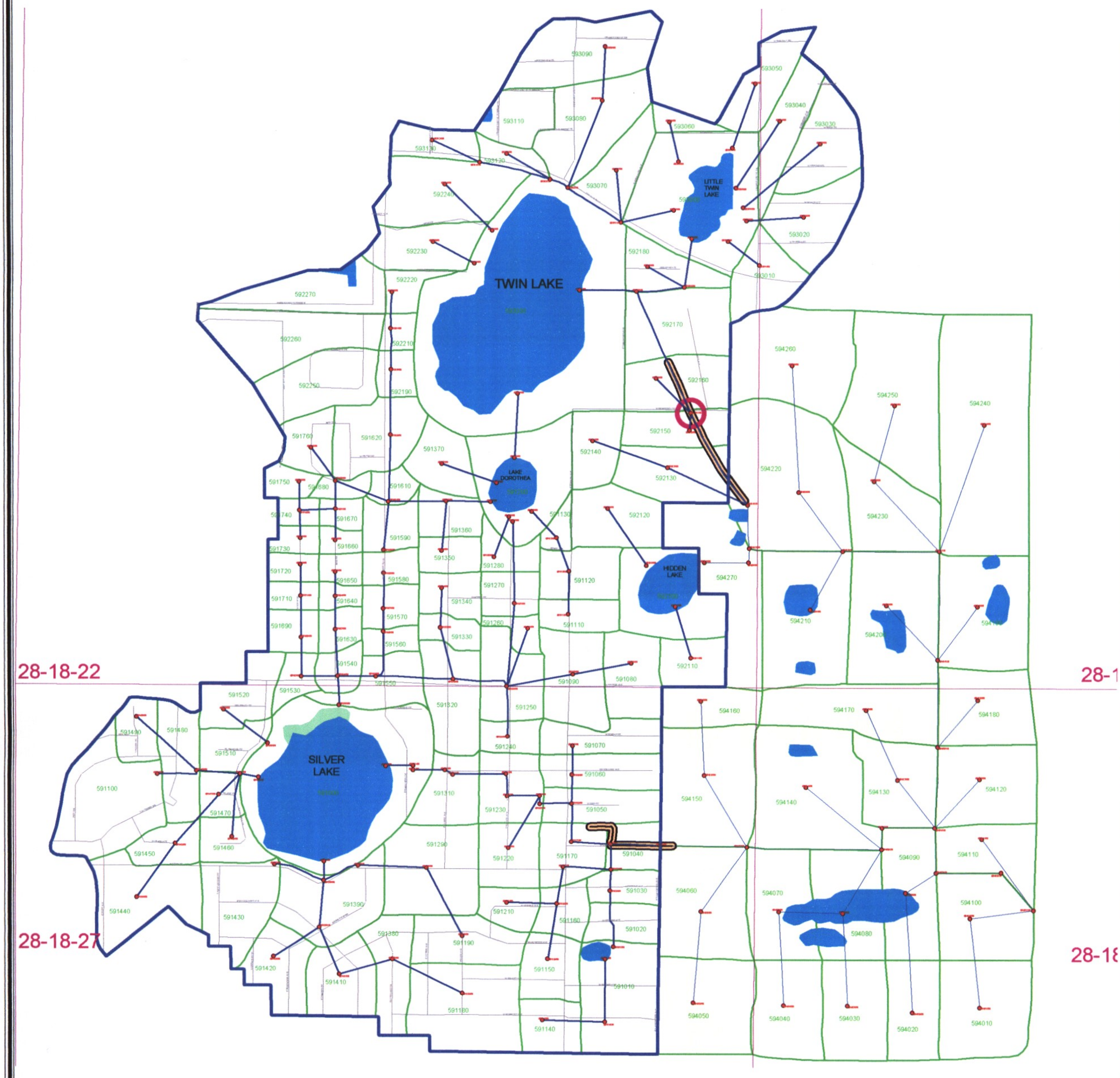
Hillsborough County
Florida

SILVER TWIN LAKE AREA STORMWATER MANAGEMENT MASTER PLAN SEPTEMBER 2001

Public Works Department
Engineering Division
Stormwater Management Section

Figure 16-1
Silver Twin Lake Area
Location of recommended project Map



LEGEND

•	JUNCTION		DITCH MAINTENANCE		Water Feature
	CONNECTIVTY		DITCH MAINTENANCE		WETLAND
	CULVERT REPLACEMENT		BOUNDARY		

Hillsborough County
Florida

SILVER TWIN LAKE AREA STORMWATER MANAGEMENT MASTER PLAN SEPTEMBER 2001

Public Works Department
Engineering Division
Stormwater Management Section

Figure 16-2
Silver Twin Lake Area Maintenance length Map

(Insert Figure 16-2)

16.1.2 Twin Lake Outfall

As discussed in Chapter 13, the recommendation for this system is channel maintenance and culvert replacement.

16.1.2.1 Channel Maintenance

County part of Kirby Creek is heavily vegetated (see figures 13-4 to 13-7). The vegetation will slowdown the flow and increase the water level in Twin Lake. The recommended maintenance (clean once a year) length, as shown in Figure 16-2 above, is about 1,513 ft.

16.1.2.2 Culvert Replacement

The culvert at Humphrey Street is big enough for 25-year storm event. However, this CMP culvert has been heavily corroded (Figure 13-7), and needs to be replaced with a 54" RCP for safety reasons. Table 16-1 lists the cost for this replacement.

Table 16-1 Recommended Capital Improvement Projects Construction Cost Estimates

PROJECT NAME:	Silver / Twin Lakes Watershed							
CIP/CIT No.	48502							
WORCS BID ITEM NO.	FDOT INDEX NO	ITEM DESCRIPTION	UNIT	ESTIMATED QUANTITIES	COUNTY UNIT PRICE			WORCS TOTAL PER PAY ITEM
1	101-1	MOBILIZATION $10,000 - $24,999	LS	1	$1,204.14	$1,204.14	$1,500.00	$1,500.00
*	102-1	MAINTENANCE OF TRAFFIC $10,000.00 TO $49,999.00	LS	1	$1,376.16	$1,376.16		
9		SURVEY CREW	PD	1	$600.00	$600.00	$600.00	$600.00
19	104-13	SILT FENCE (STAKED)	LF	100	$1.71	$171.45	$1.50	$150.00

Table 16-1 (cont'd.) **Recommended Capital Improvement Projects Construction Cost Estimates**

PROJECT NAME:	Silver / Twin Lakes Watershed
CIP/CIT No.	48502

WORCS BID ITEM NO.	FDOT INDEX NO	ITEM DESCRIPTION	UNIT	ESTIMATED QUANTITIES	COUNTY UNIT PRICE			WORCS TOTAL PER PAY ITEM
35	285-704	BASE OPTIONAL Group 4 (Specify material and thickness)	SY	45	$17.74	$798.08	$11.00	$495.00
66	331-72-16	ASPH. CONC. TYPE S (1 3/4)"	SY	45	$10.20	$459.00	$12.75	$573.75
236	430-12-342	PIPE CONC. CULV (CLASS III) (54" CD)	LF	40	$91.00	$3,640.00	$85.00	$3,400.00
376	430-982-242	MITERED END SECTION (CONC. PIPE ROUND) (54" CD)	EA	2	$2,740.00	$5,480.00	$2,963.83	$5,927.66
488	530-3-4	RIPRAP (RUBBLE) (DITCH LINING)	TN	3	$48.71	$146.13	$54.08	$162.24
493	550-2	FENCING, TYPE B	LF	200	$13.49	$2,698.00	$8.09	$1,618.00
542	570-9	WATER FOR GRASS	MG	0.1	$50.00	$5.00	$38.63	$3.86
545	575-1-1	SODDING (BAHIA)	SY	50	$2.78	$139.00	$3.09	$154.50
554	N/A	PROJECT SIGN	EA	2	$679.57	$1,359.14	$50.00	$100.00

Table 16-1 (cont'd.) **Recommended Capital Improvement Projects Construction Cost Estimates**

PROJECT NAME:	Silver / Twin Lakes Watershed
CIP/CIT No.	48502

WORCS BID ITEM NO.	FDOT INDEX NO	ITEM DESCRIPTION	UNIT	ESTIMATED QUANTITIES	COUNTY UNIT PRICE			WORCS TOTAL PER PAY ITEM
NEGOTIATED ITEMS(NOT IN WORCS CONTRACT)MULTIPLIER DOES NOT APPLY								
N/I	110-1-1	CLEARING & GRUBBING	AC	0.1	$14,962.12	$1,496.21		$0.00
N/I	110-3	STRUCTURES REMOVAL OF EXISTING (CULVERT)	CY	90	$9.00	$810.00		$0.00
*** - INDICATES THAT MAINT. OF TRAFFIC IS INCLUDED IN THE CONST. IN THE *WORCS CONTRACT***								
N/I - INDICATES ITEMS NOT COVERED UNDER *WORCS CONTRACT*, PRICE NEGOTIATION REQUIRED								
ENGINEERING COST ESTIMATE STORMWATER MANAGEMENT SECTION								
BY:	**XXXXXXXXX**	HC COUNTY WORCS PROJECTS < 50k USE 92% MULTIPLIER, > 50k USE 90% MULTIPLIER (NW COUNTY NOT INCLUDED) (ENTER 1 IN BOX TO THE RIGHT)	1		COUNTY'S CONTINGENCIES (10%)=			***$13,510.21***
DATE:	**9/21/01**	HC COUNTY WORCS PROJECTS < 50k USE 100.8% MULTIPLIER, > 50k USE 97.9% MULTIPLIER NW COUNTY (ENTER 1 IN BOX TO THE RIGHT)	0		TOTAL =	**$21,760.54**	HC COUNTY WORCS MULTIPLIER NW COUNTY	***$0.00***

16.2 WATER QUALITY / NATURAL SYSTEMS RECOMMENDATIONS

16.2.1 General Recommendations

1. The plan should be updated on no less than a five-year cycle with public input as an intricate part. This constant updating will allow the incorporation the latest information

and refinement of existing procedures and projects.

2. The plan should be reviewed and approved by regulatory agencies with jurisdiction in Hillsborough County. They should also be approached for implementation and enforcement.

3. Retrofitting of existing land uses should be explored. As many of the water quality BMP alternatives presented in Chapter 13 should be used as possible. Bioretention areas especially should be investigated.

4. All vegetation maintenance activities should be designed to remove the vegetation from the system. Cutting or herbiciding vegetation merely contributes to muck build up and releases nutrients back into the system. Equipment should be purchased or developed to "bag" cut vegetation when mowing ditches or swales where the cut materials may otherwise be transported downstream to a receiving waterbody. Aquatic vegetation management should likewise focus on removal of the vegetation from the system by mechanical harvesting. This will remove nutrients from the system, minimize muck/sediment buildup, and minimize mosquito problems. Efforts should be made to compost these materials and reuse as fertilizer or mulch.

5. Water flow information should be gathered in conjunction with any sampling information collected in Kirby Creek. This will aid in future pollutant loading calculations.

6. This watershed plan should be continuously updated with "As-Builts" submitted electronically by the developer.

16.2.2 Water Quality Recommendations

1. Use the STREAMWATCH program to assist in developing land use specific EMCs that can be used to "calibrate" and verify the pollutant loading and removal model. Emphasis should be put on Kirby Creek. This recommendation should be implemented as soon as possible after acceptance of this watershed plan. A minimum of two sites should be chosen.

2. The LAKEWATCH program should continue to expand its monitoring program in the watershed and provide an important water quality and aquatic plant species baseline for this area.

3. The Adopt-A-Pond program has equipment that should be used to aid in specific small-scale restoration programs using their criteria.

4. Upon completion of the stormwater inventory, an inspection system should be added to the maintenance plan that will aid in the detection of illicit discharges into the County's stormwater system. This system should be designed to maximize the credits to the County under the Community Rating System.

5. A watershed specific septic tank study should be completed which identifies the location of septic tanks, assesses their impacts on water quality, and recommends management techniques to improve their efficiency. The Planning and Growth Management Department has proposed such a study countywide, and this study should be completed

6. Assimilative capacity studies should be conducted on lakes in this watershed in order to determine proper regulatory needs for protection of the lakes. Once the assimilative capacity studies are completed, the information should be used to develop a lake management plan for each lake.

16.2.3 Natural Systems

1. Programs such as the Pepper Busters and County's Adopt-A-Pond should be expanded in the watershed to aid in controlling nuisance vegetation. Plants from the EPPC's category one list should be targeted. A program should be instituted for single family homeowners, that has as an incentive, free access to dumpsters or special garbage pick-up for large amounts of nuisance vegetation that they have removed.

2. Upland natural systems have been eliminated from the watershed. The agricultural parcel in the watershed should be purchased by the County and a restoration project should be undertaken within five years of the approval of this plan. This area should be restored to the habitat that was originally on the site.

3. Existing areas of natural buffers such as wetland conservation area setbacks should be identified and preserved. Projects similar to the Delaney Creek Restoration project should be explored for Kirby Creek that will take into account the proposed maintenance schedule.

16.2.4 Water Supply

1. Consideration should be given to the aquifer recharge potential when siting stormwater

treatment systems. Care should be taken to avoid moving water from an area of high recharge potential to an area of low potential.

2. Water conservation and the use of reclaimed water should be encouraged through educational programs including LAKEWATCH and StreamwaterWatch.

16.2.5 Pollutant Loading and Reduction Model

1. **Benchmark –** The appropriateness of low / medium density land use is justified; however, the value used to model the loading may have been somewhat low. Some studies have found loadings almost twice as high as those used in the model, but values used were from direct measurements done in Hillsborough County. Using higher numbers would raise the benchmark and could have the effect of raising some LOSs.

2. **BMPs –** One of the model's shortcomings is that it does not allow the use of multiple BMPs. In addition, literature values for multiple BMPs are extremely difficult to find or extrapolate.

3. One of the lessons learned in using the PLR model is that impervious surfaces are the main component in the creation of pollutant loads. A method should be developed to track the amount of impervious surface in the watershed. The County has minimal parking requirements for specific land uses that are governed by zoning. The Planning and Growth Management Division should revisit these requirements and do whatever possible to reduce these requirements or amend them to encourage the use of other alternatives where appropriate.

4. Another problem in using the model is in the determination of pollutant loads for future proposed land uses. This drawback is due to the incompatibility in translating the existing land use based on SWFWMD's application of FLUCCS codes into the future land use designations of the Planning Commission, which does not use FLUCCS codes. The Planning Commission should be urged to adopt the FLUCCS code in predicting future land use or develop a system that is directly comparable to FLUCCS. Presently the Planning Commission's system groups diverse land uses such as residential and commercial into mixed urban uses. This should be done prior to the next updating of this portion of the watershed plan.

5. The County should immediately embark on a program to develop as many specific EMC values as possible for land uses to be used in future applications of the model.

16.2.6 Level Of Service

1. To increase the water quality treatment level of service, stormwater ponds built in this watershed should be the Conservation Wet Detention design to maximize pollution load reductions.

2. A project / program should be started within two years of approval of this plan that would create a series of bioretention ponds along the shores of both Silver and Twin Lakes. These lakes are on the verge of passing from the "good" to "fair" range in terms of trophic state index and it will be easier to stop this drop in water quality at this point in time than it will several more years from now.

16.2.7 Revisit Regulations

1. Land Alteration and Landscaping rules should be revised to include larger buffers around wetlands and waterbodies. Studies have demonstrated that larger setbacks provide better protection by allowing some treatment of stormwater run-off prior to its introduction into the receiving waterbody. Variances should be either eliminated or allowed uses should be curtailed. Activities such as grading should not be allowed. Construction and other related activities should also be limited; no impervious areas should be allowed. It has been shown that as little as 10% impervious area within a watershed can have serious detrimental impacts on aquatic ecosystems.

2. One of the projected land use changes in the watershed is the conversion of the agricultural areas to high-density residential housing (greater than 5 units per acre). These housing densities should be reduced around wetlands and waterbodies for the same reason setback variances should be limited. This will have the effect of reducing impervious areas around these sensitive habitats. Studies have shown a wide range of pollutant loading for this land use category. Some of these loadings can approach those expected for more intensive land uses such as institutional and commercial.

3. The flooding caused by the recent El Nino events, primarily in 1998, demonstrated the damage that can be caused by unchecked building in the 25 and 100-year floodplains. Regulations should seek to avoid encroachment into these natural areas and allow them to function as the flood storage areas. By preserving these naturally occurring areas, "free" stormwater functions are provided that saves the County money.

4. Clearly, wet detention times must be increased. Recent studies show that a residence time of 14 days in conjunction with planted littoral areas may be necessary to provide

adequate treatment. The SWFWMD should be encouraged to raise their standards, and failing this, the County should implement stricter standards.

5. Sedimentation and erosion has been identified as a significant source of pollutant load in the watershed. PGMD should reassess the need for mass grading of projects over 2 acres. Developers should be encouraged to grade small areas at a time rather than clearing entire project areas at one time. Erosion control techniques should required in all construction plans and then be inspected during construction in addition to the requirement of inspection prior to construction to ensure their continued maximum efficiency.

6. Low Impact Development techniques should be required in this watershed to minimize the volume of runoff and therefore the total pollutant load. As part of this recommendation, a team of representatives from the various County and State regulatory agencies as well as the regulated community should be immediately formed to develop a Hillsborough County Low Impact Development Technical Manual and incentives to carry out its recommendations once it has been developed.

7. All CIP's should include life-cycle costing, a maintenance plan, and mitigation plan if appropriate for the facility. In addition, sediment transport has been a problem in the watershed and sediment control devices, such as sumps, should be incorporated into as many projects as possible.

8. Upon adoption of this plan, all CIP projects should incorporate water quality BMP's into their design. The type of treatment used shall be based on the LOS parameter contributing the greatest load in the subbasin that the project(s) is being constructed. This aspect should be tracked so that a number of parameters can be addressed with subsequent projects and that a single parameter is not addressed by multiple projects. A matrix or flowchart should be developed that will aid the designers in choosing the appropriate parameter to be addressed and using the best BMP(s) to achieve that goal.

PUBLIC INPUT (3RD MEETING)

The third and final public meeting is intended to be a continuation of the watershed planning process, involving all the affected parties in the watershed. Recommendations from the public gathered during the second public meeting will have been incorporated into the plan to the largest extent possible and a series of final recommendations developed for implementation. These final recommendations are then presented to the public for their comment and opinion. At the time of publication of this report, the final public meeting was not held. Prior to the initiation of the final recommendations, it is anticipated that a series of meetings will be held to incorporate public comment into the design or implementation of all recommendations.

MAINTENANCE PLAN

18.1 BACKGROUND INFORMATION

18.1.1 Terms and Definitions

18.1.1.1 Maintenance

The term, "maintenance," can mean a variety of things. In the context of this Maintenance Plan, maintenance is defined as that collection of activities required to keep a component, system, infrastructure asset, or facility functioning as it was originally designed and constructed to function. As such, maintenance focuses on activities that will maintain function in preference to appearance.

Routine maintenance is a term that refers to scheduled, programmed maintenance – sometimes called proactive or preventive maintenance. The County tries to closely schedule Routine Maintenance, although emergencies and weather can cause problems with scheduling. Examples of routine maintenance services include:

- Herbicide Spraying
- Preventive components such as vegetation mowing
- Palliative components such as filling erosion gullies

Extraordinary maintenance is a response to an unanticipated, deteriorated condition. It is possible to effectively schedule some extraordinary maintenance activities, when primarily the result of observed, long-term deterioration. Sometimes the deterioration is not easily seen and the condition is unobserved until the problem is serious enough to repair or replace (such as damage from an underground pipe failure). Examples of extraordinary maintenance services include:

- Responding to incident reports
- Repair, replacement, or rehabilitation not otherwise scheduled
- "Good Neighbor" response to flooding emergencies

Repair, rehabilitation, and replacement activities may be either routine or extraordinary maintenance. However, renovation activities, such as a significant change in a culvert size or the construction of a detention area, are usually capital improvement projects; especially, if of such a size as to require an external contractor to accomplish.

18.1.1.2 Life-cycle Cost

The system life-cycle cost approach recognizes that the cost of infrastructure consists of various components, such as the following:

- Initial construction cost
- Periodic maintenance cost
- Rehabilitation cost
- Replacement cost
- Historic trends in the value of goods and services

The general notion, of life-cycle cost, is important to consider when preparing a maintenance plan. For example, the general trend is for routine maintenance costs to drop, after a major rehabilitation or repair. Being lowest immediately after initial construction is also common for such costs. Also, it is possible to spend a bit more for the initial construction by specifying materials and details that have proven to have low periodic maintenance costs, long replacement periods, or low rehabilitation costs.

Historic trends are generally for increasing costs. This is due to several factors such as the following:

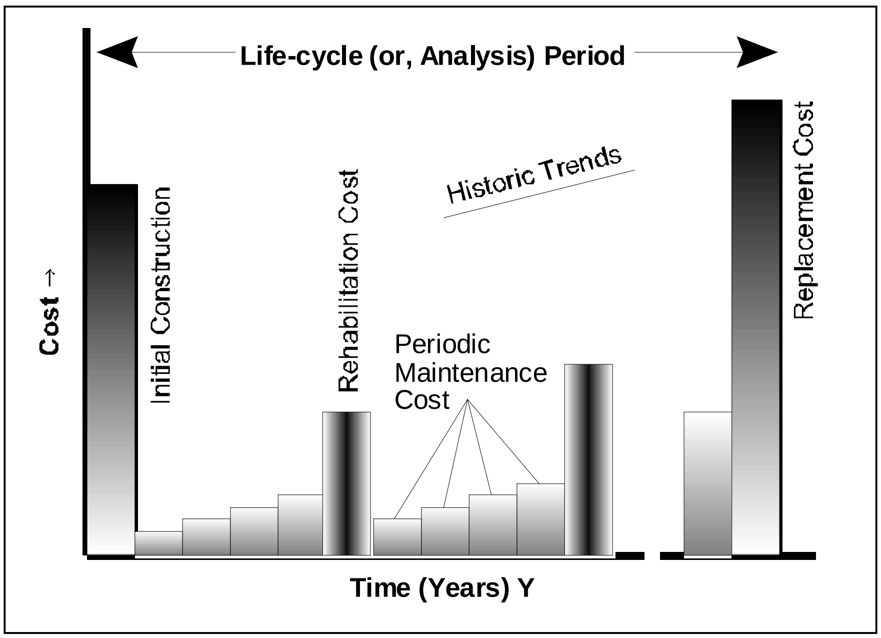
- Inflation – for example, in cost of money, materials, and labor
- System aging – requiring more effort to achieve the same performance (i.e., level of service)
- Technological enhancements – consider increases in performance made possible by new materials, methods, or systems
- Changing regulatory requirements – such as, requiring aquatic weed control when not an original project requirement

- Adding functional requirements – for example, adding a public boat ramp where there was none before

- Increased or enhanced performance standards – such as, adding flood management (such as increased level of service (LOS) definition) to an agricultural drainage project.

The relationships between these cost components is illustrated in Figure 18-1.

Figure 18-1 Life-cycle Cost Components



18.1.1.3 Deterioration

Deterioration is a loss of function, or functional characteristic, of an essential element of the stormwater management infrastructure. While County activities include structure operation for stormwater management, especially during flooding situations, the majority of maintenance activities are directed at coping with infrastructure deterioration. Through routine maintenance, it is possible to maximize the useful life of the infrastructure. Through extraordinary maintenance, it is possible to restore a lost or reduced function of an element of the infrastructure.

There are many different factors that contribute to Infrastructure Deterioration and that are beyond the control of the County. These are summarized below.

Corrosion. All common construction materials corrode or lose material due to chemical interaction with the environment. Some materials appear to last longer than others. Corrugated metal culvert pipes are especially susceptible to corrosion, even if galvanized and coated with asphalt, especially in well-aerated water that contains dissolved salt. This condition is very common near the coastline of Hillsborough County. The most common corrosion of steel pipes is in the wet-dry and splash zones (i.e., mostly on the top and side of the pipe). Corrosion is often seen before it becomes so serious a problem that the culvert pipe collapses. Sometimes the corrosion happens behind a coating or on the soil side of the pipe and goes unseen until collapse happens.

Mechanical systems, such as pumps, electrical controls, in addition to common construction materials, such as culverts, are susceptible to galvanic or induced electric current corrosion. Small differences in the chemistry of the soil, water, or deposited salts can considerably accelerate the corrosion rate. Pump impellers, for example, are particularly susceptible to saltwater corrosion. As it happens, very tiny changes in pump impeller dimensions greatly affects the capacity of the pump to move water.

Fatigue. Fatigue is a weakening of a material from repeated, cyclic application of a load. This is very common with roadway cross drains that are subject to frequent, high wheel loads (i.e., along well-traveled roads and shallow culverts). There are very few external, warning signs of fatigue. When the strength of the culvert has gotten sufficiently low, it simply collapses without any advance warning.

Wear. Structural components, such as operable slide gates, wear due to friction and abrasion during operations. Mechanical systems such as stormwater pumps are subject to abrasion from the suspended matter in stormwater. Consistent with the need to minimize wear and to minimize the amount of oil and grease that enters stormwater runoff, it is necessary to periodically lubricate structures and test the operation of mechanical systems such as pumps.

Erosion and Sedimentation. Erosion and sedimentation are opposite sides of the same coin. Erosion is the removal of material (in this case, soil) while sedimentation is its movement and deposition at a different location. All land areas, including streams, erode and deposit in varying amounts. When the amount of soil that moves into a stream reach equals the amount that moves out of the reach, the reach is in equilibrium.

The ideal situation is an equilibrium channel configuration that also meets stormwater level of service criteria, environmental permit requirements, and navigational requirement, if any. Simply removing sedimentation can actually accelerate channel erosion by upsetting the equilibrium between erosion and sedimentation. Therefore, it is necessary to manage erosion at the same time as removing sedimentation.

The capability of a channel to convey water is directly related to the channel geometry (i.e., depth, width, side slopes, and bed slope) and to the type of material that lines the sides and bottom (i.e., soil, grass, concrete, etc.).

Erosion happens throughout a drainage basin as a result of natural conditions and constructed alterations. In engineering, this is commonly expressed in the form of the "Uniform Soil Loss Equation," which relates erosion rate in a basin or watershed to soil types, land slope, land use practices, erosion control practices, rainfall patterns, and similar factors. The County cannot control the majority of the factors that influence erosion, beyond the physical conditions in the drainage canals themselves. Therefore, the erosion rate within a given watershed can change over time and without warning, producing an increase in the sedimentation rate in the channel.

The County has an active erosion management program in place. Vegetation management, including mowing, hand-cutting, and a reduction in herbicide application, are major components of the bank and channel erosion management program. Bank and channel stabilization (i.e., concrete slabs, riprap, articulated blocks and mats, etc.) and hard-lining are constructed in problem areas and are inspected as a part of the mowing program. When damaged areas are discovered, repairs are scheduled.

Unanticipated Structural Damage. When mowing, running over unseen gullies can cause the mower deck to "scalp" the grass, exposing bare soil to rainfall or flowing water. Sometimes a culvert may have a heavier load placed over it than it was designed to support. The culvert may settle or move, or it may open up a gap at the joints between pipe sections, or it could fracture and collapse. Also, soil conditions may be such that differential settlement happens over a long period of time. Collapse of culvert pipes or sewer lines that did not apparently have adequate bedding or cover are common. When this happens, repairs are programmed as soon as practical.

Fouling. Fouling happens when biological growth, such as algae or barnacles, coats, covers, or blocks a structure and reduces its effectiveness. Continued monitoring and routine maintenance minimize the risk from fouling. The public is encouraged to avoid using the canals to dispose of yard waste and trimmings that can decompose and provide nutrients to encourage biological growth.

Junk and Debris Removal. Even with a continuing public education program to not dispose of junk and debris in the canals, it is necessary to frequently remove junk and debris to prevent it moving through the system as flotsam and possibly blocking culverts and water management structures. Removing junk and debris also removes habitat opportunities for undesirable wildlife.

Latent or Hidden Defects. Some of these problems happen as the result of latent defects showing up some time after the initial construction. Latent defects can come from either the original construction material having a small, undetected flaw, or from poor quality control during the fabrication or installation of the construction materials. As defects are identified, repairs are programmed as soon as practical or, if failure does not seem immediate, monitor their condition.

18.2 SILVER / TWIN LAKES WATERSHED ASSETS

The Silver / Twin Lakes Watershed includes a primary channel drainage system that receives and conveys discharge from numerous secondary and local stormwater systems to Tampa Bay via the Hillsborough River. Hillsborough County manages a considerable list of assets associated with the entire watershed's drainage system. Various improvements to the drainage system have been recommended, which will add to the asset list.

The continued operation and maintenance of these assets is necessary to maintain the expected stormwater and water quality (i.e., performance) levels of service provided by the drainage system. In addition, these day-to-day (i.e., routine or scheduled) and incident response (i.e., extraordinary) maintenance activities are creditable to the County's overall rating under the Federal Emergency Management Agency's Flood Insurance Administration Community Rating System.

In Hillsborough County, the County's Roadway Maintenance Division, which has divided the County into four service areas: North, South, East, and West. Each service area performs the various maintenance activities for stormwater structures located within their boundaries. The Silver / Twin Lakes Watershed falls within of the West Service Area.

18.3 COORDINATION WITH FEMA FIA's CRS PROGRAM

18.3.1 Background

The Federal Emergency Management Agency (FEMA) promotes community-level management of emergencies (such as: flooding, windstorm, etc.). A separate initiative within FEMA, called the Flood Insurance Administration (FIA), administers the national flood insurance program. Communities are rated for insurance purposes using the Community Rating System (CRS).

The CRS program encourages communities to undertake 18 different activities that FEMA recognizes as methods to reduce hazard (in this case, flood) damages. These activities are organized into creditable activities that include:

- Public Information
- Mapping and Regulation
- Flood Damage Reduction
- Flood Preparedness.

Maintenance of the stormwater management system (FEMA calls this the "drainage system") is a creditable activity under the CRS program.

18.3.2 CRS Program Coordination

The County maintenance is responsible for several tasks under the FEMA heading of "Activity 540, Drainage System Maintenance." The following is an abbreviated response, item by item, to the Drainage System Maintenance Program requirements. In some cases, reference is made to other sections of this document. The terminology comes from the CRS Coordinator's Manual.

18.3.2.1 Activity 540, Drainage System Maintenance

a. Channel and basin Debris Removal (CDR)

1. Inspections of the system are conducted at least once a year. Storm events in the County are frequent, especially during the wet season from May through November. Whenever unusually prolonged rain events happen, or potentially damaging single rainfall events occur, it is customary to visually inspect the primary drainage system to check for debris and flotsam blockages, structural failures, or erosion failures. Any observed deficiencies are reported and programmed for maintenance response.

2. An important component of the maintenance activities relating to this CRS activity is the incident response process. Any citizen may report any concern with the drainage system, including channel and basin debris removal. All incident reports are assigned to a supervisor to investigate and respond. If an inspection identifies a need for maintenance, repair, or rehabilitation, the problem is reported and evaluated for inclusion in the routine or scheduled maintenance programs. If the problem is in a basin that has not yet been improved, the condition is reported to the County's stormwater staff, and the feasibility of interim repairs is considered. In these ways, any identified maintenance need receives an appropriate response.

3. County maintenance maintains lists, both informally and formally, of problem structures or areas. These areas receive frequent monitoring during prolonged or intense rainfall events to ensure that flooding can be kept as minimal as feasible.

4. The County has an ongoing, capital improvements program (CIP) that funds improvements to the drainage system. Program management of the CIP is outside of the County Maintenance Operations.

b. 1. The County has regulations that prohibit in-stream dumping of yard and industrial debris.

2. Literature on this subject is distributed. Storm drain markers and area maps are distributed to voluntary groups. Regulations are explained to citizens when inspecting incident reports, if appropriate to the reported problem.

c. 1. The County has regulations protecting coastal areas from activities that can accelerate erosion. The State of Florida also has the Coastal Zone Protection Program. County Maintenance does not specifically manage coastal erosion protection maintenance programs, unless damage is found to adversely impact freshwater discharges from the drainage system.

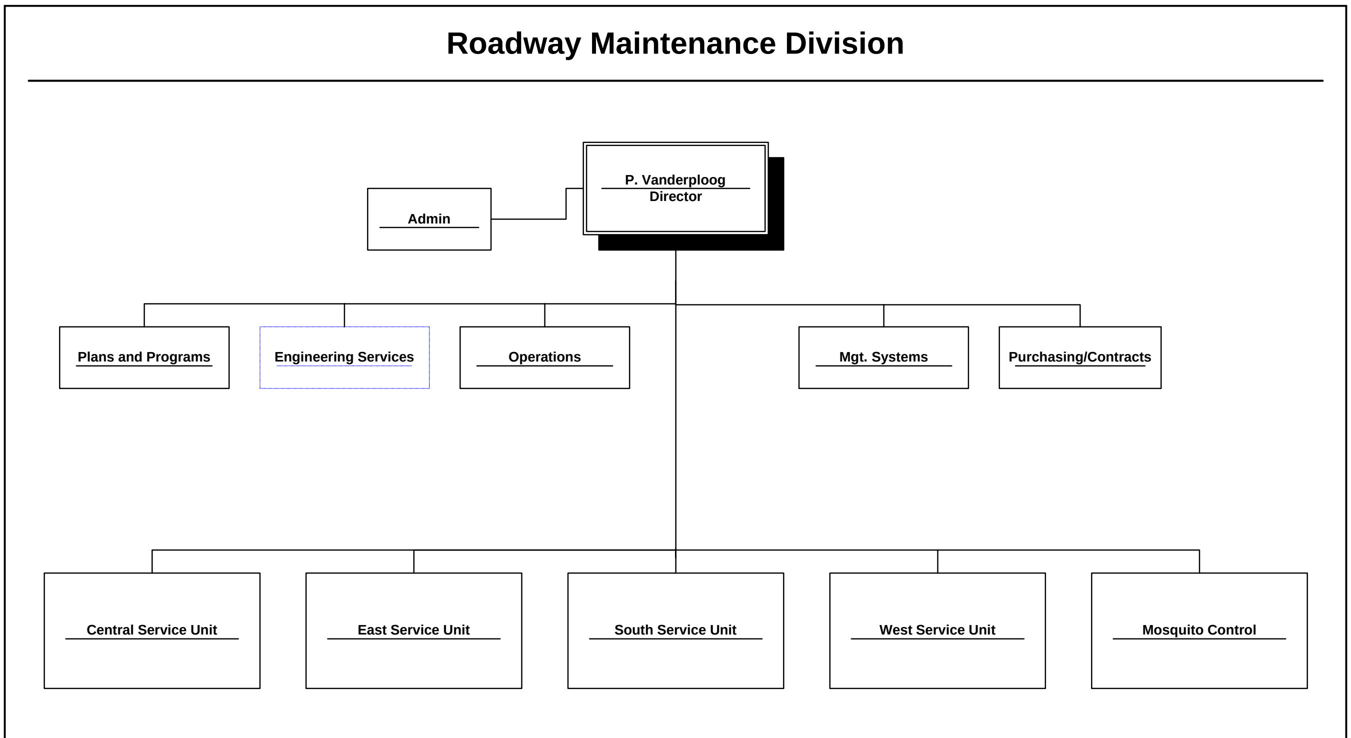
18.3.2.2 Impact Adjustment Credit

County maintenance's authority and responsibility extends to the entire jurisdictional area of the County. Undeveloped areas deliberately receive less frequent maintenance than the developed and populated areas. Maintenance is not improvement. Where the basin CIP program is not yet complete, the existing system is maintained to its most feasible condition until such time as it can be repaired or rehabilitated.

18.3.2.3 Activity 540 Documentation

1. Responsibility. Responsibility for drainage system maintenance rests with the Director of the Roadway Maintenance Division. As shown on the Organization Chart, Figure 18-2, the Director may delegate responsibility and authority to subordinates, for specific maintenance or inspection activities.

Figure 18-2 Organization Chart



2. Description of Community's Drainage System.

3. Inspection Processes. Copies of inspection and incident response forms are kept in County maintenance files, and are available for examination.

4. Debris Removal Procedures. Procedure descriptions are maintained in County maintenance records, and are available for examination.

5. Records. The records that document inspections and debris removal are kept in County maintenance files, and are available for examination.

18.4 CURRENT MAINTENANCE PROGRAM ELEMENTS

The stormwater system, or drainage, maintenance program is driven by established maintenance schedules, incident driven inspections, routine inspections and requests generated from residents of the County. These activities are consolidated into three program components:

- Routine, or scheduled, and drainage conveyance system, or on-condition, maintenance
- Drainage incident response, or extraordinary, maintenance
- Major facilities rehabilitation, which is usually scheduled but based on-condition

18.4.1 Routine and Drainage Conveyance System Maintenance

The ongoing routine and drainage conveyance system maintenance program is a proactive process that is responsible for the periodic maintenance of the existing stormwater management facilities throughout the County to assure that existing facilities meet their intended level of service (i.e., performance).

Routine and drainage conveyance system maintenance activities conducted by the County include:

- Repair or replacement of damaged or deteriorated cross-drain and side-drain pipe culverts and box culverts (on-condition)
- Cleaning and removal of flow-obstructing debris and silt from cross-drain and side-drain pipe culverts, storm sewers and box culverts (on-condition)
- Repair or replacement of damaged, deteriorated, or inadequate catch basin inlets and manholes (on-condition)
- Clean and remove trash, rocks, silt and debris from catch basin inlets and manholes (on-condition)
- Install new pipe culverts (scheduled)

- Construct small drainage structures (scheduled)
- Cleaning and reshaping canals and off-system drainage ditches using specialized equipment such as Menzi Muck All Terrain Excavator (on-condition)
- Roadside ditch cleaning and reshaping using Gradalls and similar equipment (scheduled)
- Limited access mowing using specialized equipment or hand labor (scheduled)

18.4.2 Extraordinary (Drainage Incident Response) Maintenance

A substantial portion of the County’s operation of the maintenance program is extraordinary in that maintenance actions are initiated in response to inspector observations (on-condition but of a high priority and not suitable to a scheduled maintenance approach), citizen complaints and extreme weather/flooding conditions. Drainage incident maintenance is intended to provide an effective, short-term response to reported drainage incidents or complaints.

Upon receipt of a complaint or observation of a problem, a County inspector investigates and prepares a work effort report. The inspector’s report will identify whether or not the County is authorized to resolve the problem, provides an estimate of the level of effort required and assesses the safety factors involved, such as the roadway integrity. This report is reviewed and assessed by supervisory staff and a priority level is assigned. Table 18-A.1 lists the various priority codes in use and designates the time frame goal for completion of the work. The priority code sets the deadline for resolution by the County.

Table 18-A.1 Drainage Incident Priority Codes

Priority Code	Response Time Goal
00	No Priority (no action taken)
01	Immediate Response
02	2 Hours
03	5 Hours
04	24 Hours
05	1 Working Day

06	3 Working Days
07	5 Working Days
08	Within 1 Week
09	Within 2 Weeks
98	As per schedule
99	To be scheduled

County staff has estimated that 80% of their available resources are utilized performing extraordinary maintenance work as the result of incident responses. This leaves only 20% of the County's resources available to perform the routine or scheduled maintenance activities.

18.4.3 Major Facilities Rehabilitation

The major facilities maintenance program involves replacing, rehabilitating, or retrofitting facilities to achieve design condition performance, erosion control and slope stabilization, filter cleanup and rehabilitation, and removal of accumulated silt. This program is a routine or scheduled maintenance activity of existing stormwater facilities on a prioritized basis. Key work activities in this program include:

- Sediment removal
- Reconstruction of ditch cross-sections and profiles
- Repair, rehabilitation and reconstruction of storm sewers
- Repair, rehabilitation and reconstruction of stormwater control structures

18.4.4 Work Tracking System

Hillsborough County Roadway Maintenance Division has recently upgraded to a new version of their work tracking system, Hansen Version 7 Enterprise Solution from Hansen Information Technologies. Through the Hansen system's activity definition, users may describe work requirements for performing tasks at varying levels of detail. Each activity definition is used to describe the work requirements for the job at hand.

Hansen uses an activity-based costing system, which is intended as a management tool instead of an accounting method. It essentially combines two different cost statements. The first cost statement reflects the basic cost groups by cost center. The second provides a deeper breakdown by activity minus non-productive time. Ultimately, the cost of a unit quantity of activities performed can be determined. The County can use Hansen's activity-based costing methods to help determine and justify their budgetary requirements.

Preventive maintenance schedules may also be created for both asset groups and individual assets within the Hansen system. The system can then develop reports that summarize the costs associated with a specific group of work orders. The Hansen system upgrade was extensive and is still in the implementation stages. Once fully integrated into the County's operations, it will provide the ability to generate detailed reports regarding the management of the maintenance function. This information should assist the County to improve maintenance unit operations and in determining the optimal distribution of staff, effort and equipment.

18.5 OVERALL PROGRAM ASSESSMENT

The current maintenance program is approximately 80% extraordinary maintenance. Comparison to other county's programs shows that this is not unusually high. However, it does point out that the vast majority of the cost, in terms of labor, equipment and materials, expended by the County is in response to complaints at the expense of planned maintenance activities. This reduces overall efficiency and can introduce quality control issues such as by using available trades and equipment and not necessarily the most appropriate to the task at hand.

The County does not have an accurate inventory or map of the facilities it is responsible for maintaining. Currently, it does not have a published set of maintenance standards. A maintenance management plan is under development. The current maintenance program is heavily reliant upon the institutional knowledge and experience of its staff.

The County is currently developing a facilities maintenance inventory and accompanying stormwater system mapping. This inventory is anticipated to include ditches, canals, ponds, culverts, bridges, cross drains, side drains, control structures and other facilities maintained by the County. State, Federal and railroad rights-of-way and drainage components will be included in the mapping, but shown with a different color or line type to indicate non-County owned/maintained facilities. Currently, the County has compiled a database of canals and ponds with information regarding the maintenance frequency/type, ownership, current condition and location.

For each County facility listed in the inventory, the collected information and data should include (at a minimum):

- Description

- Location
- Last inspection date
- Last maintenance date
- Scheduled inspection interval
- Scheduled maintenance interval
- Current condition
- Scheduled repair, rehabilitation or replacement

The inventory will become a valuable tool for scheduling of maintenance activities, performance of regular system inspections, identifying unit costs, and development of annual budgets. Problem areas could be more readily identified and scheduled maintenance performed. This would assist the County in improving overall operational effectiveness.

Following the development of the facilities inventory, the County should attempt to identify the appropriate inspection and maintenance intervals. Estimates based on environmental and construction permit conditions, staff experience, or recommended standards can be used initially, with modifications made as site specific knowledge is developed. However, these scheduled maintenance activities should be coordinated and, where duplicative operations happen, critically examined to look for labor, equipment and materials scheduling efficiencies.

18.6 FINDINGS, ISSUES, RECOMMENDATIONS

18.6.1 Findings

The following key findings were made during the development of this maintenance plan:

- Approximately 80% of the County's operation is extraordinary, rather than routine or scheduled maintenance. The County is frequently inundated with phone calls regarding maintenance of adjacent systems whenever and wherever maintenance crews are observed to be working
- The County is having difficulty filling open positions, resulting in staff resources below budgeted levels

- A more user-friendly maintenance system needs to be developed to ensure the completeness, accuracy and integrity of the maintenance performance data

- A detailed maintenance facility inventory is needed

- Defined maintenance standards are needed

- Improvements in equipment inventory, maintenance records, as related to equipment operating hours or cycles, are needed to identify failing equipment and justify the need for new or additional equipment

- Several Menzi Muck All Terrain Excavators are reportedly old and unreliable. As a highly used and frequently depended on piece of equipment, replacement may be justified

- Non-County owned facilities are not being sufficiently maintained by those responsible.

18.6.2 Issues

18.6.2.1 Acceptance of Aging Stormwater Systems for Maintenance

Recent new land developments, that have had their stormwater management and drainage systems transferred to the County for operation and maintenance, have shown unexpected evidence of accelerated aging.

18.6.2.2 Use of Stormwater Infrastructure Beyond Design Service Life

This is particularly an issue for culverts and bridge-culverts where long-term contact with soil and water can cause deterioration. Also, changes in climate and environmental conditions can alter the rate of deterioration. For example, the Florida Department of Transportation suggests the following design service life (i.e., average years to perforation), under ideal conditions (no chemical attack, no galvanic or induced electric current corrosion, no mechanical damage, abrasion, etc.), for 16-gage (gauge), galvanized, steel culvert pipe:

- With soil-water acidity of 7.0 (pH) and resistivity of 50,000 (ohm/cm) .... 50 years

- With soil-water acidity of 6.0 (pH) and resistivity of 3,000 (ohm/cm) .... 20 years

For comparison, typical values for seawater are an acidity of 8.0 (pH) and resistivity of a few hundred ohm/cm. Solutions with a pH of 7.0 are considered neutral; 6.0 pH is acidic; and, 8.0 pH is alkaline. Solutions with a low resistivity have a higher concentration of dissolved salts (dissolved salts conduct electricity and result in lower resistivity values). The above figures follow common sense where one expects to see more deterioration when the pipe is in an environment that is either acid or salty or both.

18.6.2.3 Public Access and Risk

It seems logical to permit public access to the public right-of-way associated with the County stormwater system. Normal and adequate, routine maintenance that meets the stormwater level of service requirements may still have minor gullies, woody vegetation cut off near ground level (but, protruding above ground), steep channel side-slopes, deep water pools in channel, and other physical hazards. In addition, the public has a tendency to "modify" the public right-of-way for their convenience (such as adding a platform to sit or stand on while fishing, etc.), which creates hazards for work crews and equipment.

18.6.2.4 Public Perception

Each person (i.e., public) has his or her own perception about what is an acceptable level of maintenance. Many understand that the canals can look somewhat "rough" and not have any loss of conveyance capacity (that is, they will provide the design stormwater level of service). Many Incident Reports come from individuals who expect the County facilities to be a visual and architectural amenity to their property.

18.6.2.5 Inadequate Access for Crews and Equipment

Many areas of the County stormwater management facilities lack access suitable for the safe passage of crews and equipment. In some cases, crews and small tools for hand-clearing are used when equipment would be much more efficient and cost-effective. Where it is possible to locate a willing landowner, a permanent maintenance easement is secured at no cost to the County. However, there are several areas where this has not been possible and some areas where effective maintenance is virtually impossible.

18.6.2.6 Technological Innovation

It is important to continue to look for ways to improve service. For example, as a direct result of experience with metal pipe corrosion and deterioration, only reinforced concrete or high-density polyethylene (HDPE) culvert pipes, or similar long service life materials, are being used on County projects.

18.6.2.7 Public Policy and Regulatory Changes

Public policy and regulatory changes will continue to create funding challenges affecting County stormwater system maintenance. Examples of this include National Point Discharge Elimination System (NPDES) and Phase II FDEP regulatory requirements. There are also opportunities for improved efficiency through changes in public policy, rules, regulations, and laws in Hillsborough County

18.6.2.8 Primary Versus Secondary Drainage Systems

A primary drainage system is the canal or culvert pipe that drains a whole basin or watershed to a main system. A secondary drainage system conveys water to the primary system. Main systems discharge to a receiving body such as Tampa Bay. All drainage systems are branched, to greater or lesser degrees, like a tree. In that case, the trunk is the primary drainage system and the branches and twigs make up the secondary drainage system.

A failure in a primary drainage system may cause deep and prolonged flooding to a large portion of the basin or watershed. On the other hand, a failure in a secondary drainage system may cause flooding, but usually only of a shallow or intermittent nature, and very localized. Because of resource limitations, smaller, secondary drainage systems such as side and back lot-line swales are typically the responsibility of the property owner; however, County policy is not clear on this point.

18.6.2.9 Repair, Replacement, and Rehabilitation of Existing Stormwater Systems

In response to Incident Reports, repair, replacement, and rehabilitation projects are handled as extraordinary maintenance. However, doing so often places demands on a fiscal year's budget, in terms of both dollars and staff time, resulting in scheduling problems for the remaining routine maintenance activities.

18.6.2.10 Dollar Limits on Repair and Rehabilitation Projects

Extraordinary maintenance requiring wholesale replacements of aging stormwater systems are frequently discovered during inspections of Incident Reports. These projects may results in unanticipated demands on County maintenance capacity (e.g., limits placed by available funding).

18.6.2.11 Inadequate Maintenance of Non-County Systems

System maintenance that should fall to homeowners associations is generally not being done in an adequate manner. By policy, the County does not maintain private stormwater systems, but will step in where situations happen that affect County-owned and maintained systems.

18.6.2.12 County Ownership and Right-of-way Unclear

In the past, the County has had trouble identifying County rights-of-way and easements. As a result, maintenance activities were often performed on non-County owned systems. The County staff now attempt to establish ownership before performing maintenance through coordination with the County's Real Estate Department. The County's current policy is to only perform maintenance on County-owned facilities.

18.6.2.13 Maintenance Standards

The County is currently in the process of developing a set of maintenance standards, but this information was not available for review or summary here. These standards will relate the typical work tasks performed by the County to system performance-related standards (e.g., percent of culvert sediment accretion, etc.), establishing unit quantities for equipment, staff, and production rates. This document will be essential to assessing on-condition situations and scheduling labor, equipment and materials. The successful implementation of the Hansen system should help provide valuable information for the continued revision and updating of this document.

18.6.2.14 Response Prioritization Process

Whether thought of as a triage approach or whatever, resource limitations compared with uncertain demands require a system of prioritization to ensure that the critical functions of the stormwater management system will be maintained and that the risk to the public, in terms of loss of life and property, is minimal. For example, in areas where a system rehabilitation is recommended to improve a stormwater or water quality level of service deficiency, maintenance activities should remain palliative and as necessary to minimize risk to life and property. Another example would be a blocked 12-inch diameter driveway culvert when compared to a fallen tree blocking a headwall in the main creek system – the first can wait while the second could cause considerable flooding.

18.6.2.15 Driveway Culverts

A significant number of drainage incident response events are related to unblocking, repairing, or replacing private driveway culverts. Equally important, there are frequent debates with property owners over the aesthetics of the replacement installation. Considering that the basic driveway culvert primarily benefits the homeowner, it would seem that the maintenance of the driveway and driveway culvert should be the homeowner's responsibility.

18.6.3 Recommendations

- Develop a maintenance features inventory and mapping system to help plan and schedule maintenance activities. This inventory should include ditches, canals, ponds, culverts, bridges, cross drains, side drains, control structures and other stormwater system related facilities maintained by the County. In addition, state, Federal and railroad rights-of-way and related drainage components should be included in the mapping, but shown with a different color or line type to indicate non-County facilities.

- Records of inspection and maintenance should be incorporated into the inventory system

- Increase the County's efforts to fully staff the budgeted and approved positions at the County.

- Conversion to the updated Hansen system should be done with an adequate quality assurance process, to ensure the accuracy and precision of the data.

- The County Road Maintenance Division should consider developing a lease program to stock additional equipment to be shared between the County Maintenance Units. A County lease program would permit rapid deployment of backup equipment, and thereby reducing the amount of downtime currently experienced at the Maintenance Units.

- Revise the set of maintenance standards for the activities the County performs. This should be done in conjunction with the Hansen system.

- Investigate the methodology for recording the inventory of equipment, including maintenance records and operating hours or cycles for each piece of equipment. This will help identify failing equipment and justify the need for new/additional equipment. The need for new/additional equipment should be re-evaluated annually.

- Continue and expand the public education programs pertaining to the maintenance zones and the scheduling of maintenance. By informing the public about scheduled maintenance, maintenance standards, and identifying the zones of maintenance, the number of complaints will be reduced.

- Aggressively enforce the requirements of the County's MS4 NPDES permit, regarding illicit discharges. Public education, combined with an effective inspection and detection program can help to reduce the frequency of these discharges. Consider developing an in-house training program to help maintenance crews better report illicit discharges so that they can be investigated as a part of the incident response process.

- Continue to regularly monitor facilities not owned by the County and formally notify the responsible entities of the need to perform maintenance (such as: FDOT, railroad, etc.). The monitored facilities and contact information for each should be included in the County's facility inventory.

- Continue to observe and note the occurrence of failing infrastructure (such as: culverts, headwalls, ditches, water control structures, mitigation areas, etc.) and schedule them for maintenance. In other words, make reasonable efforts to advance on-condition maintenance activities from extraordinary to scheduled maintenance.

- Develop a work need survey report form or reporting process to identify maintenance needs that may be observed during routine maintenance or scheduled inspections.
- Continue to develop recommended maintenance standards.

LIST OF FINAL RECOMMENDATIONS

19.1 FLOOD CONTROL

Flooding problem areas and their recommended solutions have been identified and described in this chapter. **Figure 19-1** shows the locations of all recommended projects. Proposed project information includes planning-level structures and non-structures scenario solutions associated with costs and benefits analysis. Planning-level costs are the cost of the improvement based on non-detailed quantity estimates. All estimates are based primarily on SWFMWD contour maps, aerial maps, and limited survey data. Unit costs utilized in developing planning-level costs were taken from Construction Contract History, FDOT State Estimates Office, Engineering Support Services, July 1995 through June 1996. The criteria used to evaluate the technical feasibility of each of the proposed projects are contained in Chapter 13, Alternatives Analysis.

Recommended projects will be presented and discussed in the sequences of the major conveyance systems as described in the previous Chapters. These projects are:

Silver Lake Outfall

1. Channel Maintenance

Twin Lake Outfall

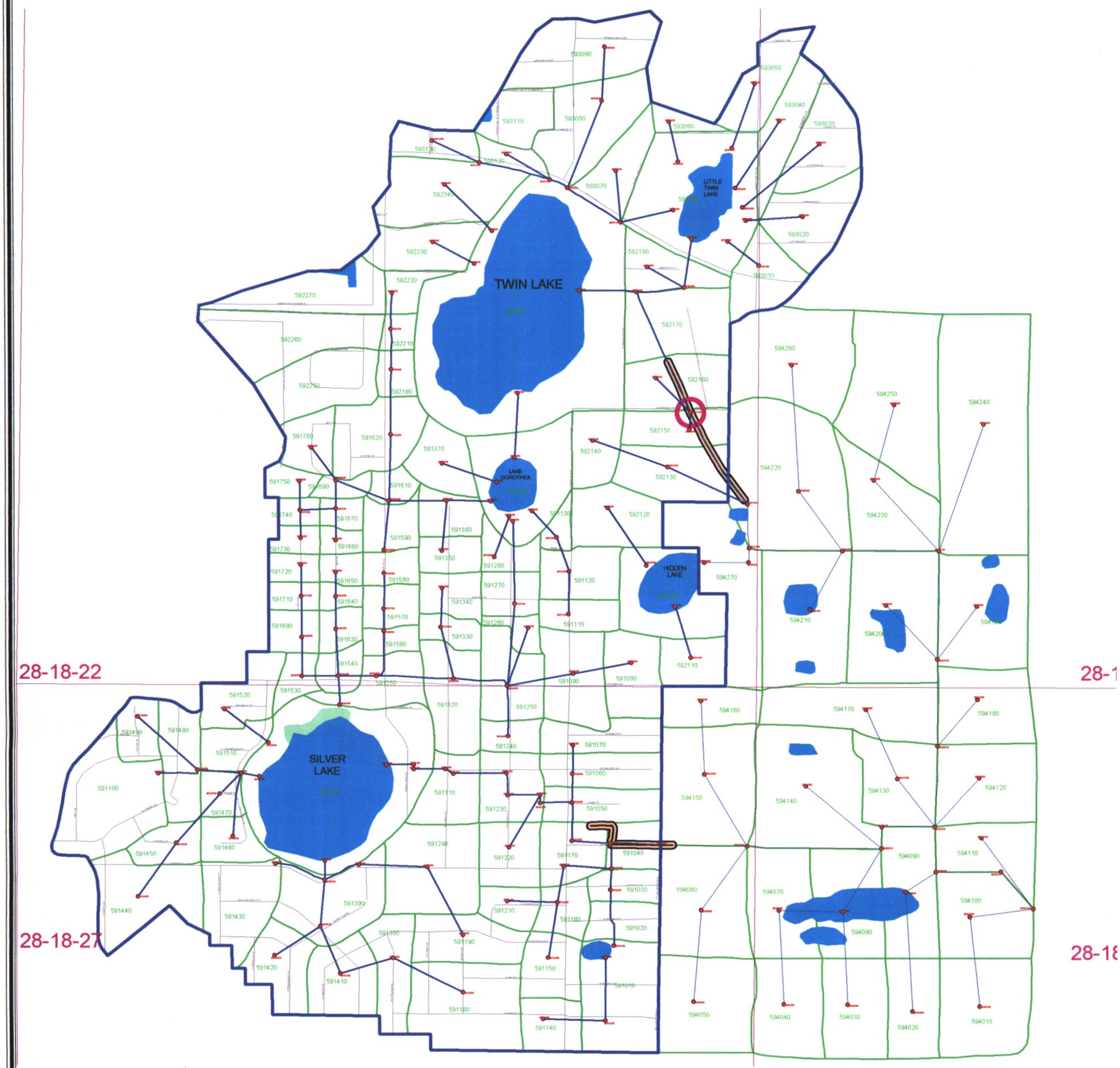
1. Channel Maintenance
2. Culvert Replacement at Humphrey Street

19.1.1 Silver Lake Outfall

As discussed in Chapter 13, the recommendation for this system is the channel maintenance (clean once a year) of the downstream ditch from N. Habana Avenue to N. Saint Peter Avenue. The total maintenance length is about 900 feet .

19.1.2 Twin Lake Outfall

As discussed in Chapter 13, the recommendation for this system is channel maintenance and culvert replacement.



LEGEND

- JUNCTION
- CONNECTIVTY
- CULVERT REPLACEMENT
- DITCH MAINTENANCE
- DITCH MAINTENANCE
- BOUNDARY
- Water Feature
- WETLAND

Hillsborough County
Florida

SILVER TWIN LAKE AREA
STORMWATER MANAGEMENT
MASTER PLAN
SEPTEMBER 2001

Public Works Department
Engineering Division
Stormwater Management Section

Figure 19-1
Silver Twin Lake Area
Location of final recommended project
Map

INSERT FIGURE 19-1

19.1.2.1 Channel Maintenance

County part of Kirby Creek is heavily vegetative (see figures 13-4 to 13-7). The vegetation will slowdown the flow and increase the water level in Twin Lake. The recommended maintenance (clean once a year) length, as shown in Figure 16-2, is about 1,513 ft.

19.1.2.2 Culvert Replacement

The Culvert at Humphrey Street is big enough for 25-year storm event. However, this CMP culvert has been heavily corroded (Figure 13-7), and needs to be replaced with a 54" RCP for safety purpose. Table 16-1 lists the cost for this replacement.

Table 19-1 Recommended Capital Improvement Projects Construction Cost Estimates

PROJECT NAME:				***Silver / Twin Lakes Watershed***				
CIP/CIT No.		48502						
WORCS BID ITEM NO.	**FDOT INDEX NO**	**ITEM DESCRIPTION**	**UNIT**	**ESTIMATED QUANTITIES**	**COUNTY UNIT PRICE**			**WORCS TOTAL PER PAY ITEM**
1	101-1	MOBILIZATION $10,000 - $24,999	LS	1	$1,204.14	$1,204.14	$1,500.00	$1,500.00
*	102-1	MAINTENANCE OF TRAFFIC $10,000.00 TO $49,999.00	LS	1	$1,376.16	$1,376.16		
9		SURVEY CREW	PD	1	$600.00	$600.00	$600.00	$600.00
19	104-13	SILT FENCE (STAKED)	LF	100	$1.71	$171.45	$1.50	$150.00
35	285-704	BASE OPTIONAL Group 4 (Specify material and thickness)	SY	45	$17.74	$798.08	$11.00	$495.00

Table 19-1 (cont'd.) **Recommended Capital Improvement Projects Construction Cost Estimates**

PROJECT NAME:		*Silver / Twin Lakes Watershed*						
CIP/CIT No.		48502						
WORCS BID ITEM NO.	**FDOT INDEX NO**	**ITEM DESCRIPTION**	**UNIT**	**ESTIMATED QUANTITIES**	**COUNTY UNIT PRICE**			**WORCS TOTAL PER PAY ITEM**
66	331-72-16	ASPH. CONC. TYPE S (1 3/4)"	SY	45	$10.20	$459.00	$12.75	$573.75
236	430-12-342	PIPE CONC. CULV (CLASS III) (54" CD)	LF	40	$91.00	$3,640.00	$85.00	$3,400.00
376	430-982-242	MITERED END SECTION (CONC. PIPE ROUND) (54" CD)	EA	2	$2,740.00	$5,480.00	$2,963.83	$5,927.66
488	530-3-4	RIPRAP (RUBBLE) (DITCH LINING)	TN	3	$48.71	$146.13	$54.08	$162.24
493	550-2	FENCING, TYPE B	LF	200	$13.49	$2,698.00	$8.09	$1,618.00
542	570-9	WATER FOR GRASS	MG	0.1	$50.00	$5.00	$38.63	$3.86
545	575-1-1	SODDING (BAHIA)	SY	50	$2.78	$139.00	$3.09	$154.50
554	N/A	PROJECT SIGN	EA	2	$679.57	$1,359.14	$50.00	$100.00
		NEGOTIATED ITEMS (NOT IN WORCS CONTRACT) MULTIPLIER DOES NOT APPLY						

Table 19-1 (cont'd.) **Recommended Capital Improvement Projects Construction Cost Estimates**

PROJECT NAME:					***Silver / Twin Lakes Watershed***			
CIP/CIT No.	48502							
WORCS BID ITEM NO.	**FDOT INDEX NO**	**ITEM DESCRIPTION**	**UNIT**	**ESTIMATED QUANTITIES**	**COUNTY UNIT PRICE**			**WORCS TOTAL PER PAY ITEM**
N/I	110-1-1	CLEARING & GRUBBING	AC	0.1	$14,962.12	$1,496.21		$0.00
N/I	110-3	STRUCTURES REMOVAL OF EXISTING (CULVERT)	CY	90	$9.00	$810.00		$0.00
*** - INDICATES THAT MAINT. OF TRAFFIC IS INCLUDED IN THE CONST. IN THE *WORCS CONTRACT***								
N/I - INDICATES ITEMS NOT COVERED UNDER *WORCS CONTRACT*, PRICE NEGOTIATION REQUIRED								

ENGINEERING COST ESTIMATE STORMWATER MANAGEMENT SECTION							
BY:	**XXXXXXXXX**	HC COUNTY WORCS PROJECTS < 50k USE 92% MULTIPLIER, > 50k USE 90% MULTIPLIER (NW COUNTY NOT INCLUDED) (ENTER 1 IN BOX TO THE RIGHT)	1	COUNTY'S CONTINGENCIES (10%)=			***$13,510.21***
DATE:	**9/21/01**	HC COUNTY WORCS PROJECTS < 50k USE 100.8% MULTIPLIER, > 50k USE 97.9% MULTIPLIER NW COUNTY (ENTER 1 IN BOX TO THE RIGHT)	0	**TOTAL =**	**$21,760.54**	HC COUNTY WORCS MULTIPLIER NW COUNTY	***$0.00***

19.2 WATER QUALITY / NATURAL SYSTEMS RECOMMENDATIONS

19.2.1 General Recommendations

1. The plan should be updated on no less than a five-year cycle with public input as an intricate part. This constant updating will allow the incorporation the latest information and refinement of existing procedures and projects.

2. The plan should be reviewed and approved by regulatory agencies with jurisdiction in Hillsborough County. They should also be approached for implementation and enforcement.

3. Retrofitting of existing land uses should be explored. As many of the water quality BMP alternatives presented in Chapter 13 should be used as possible. Bioretention areas especially should be investigated.

4. All vegetation maintenance activities should be designed to remove the vegetation from the system. Cutting or herbiciding vegetation merely contributes to muck build up and releases nutrients back into the system. Equipment should be purchased or developed to "bag" cut vegetation when mowing ditches or swales where the cut materials may otherwise be transported downstream to a receiving waterbody. Aquatic vegetation management should likewise focus on removal of the vegetation from the system by mechanical harvesting. This will remove nutrients from the system, minimize muck/sediment buildup, and minimize mosquito problems. Efforts should be made to compost these materials and reuse as fertilizer or mulch.

5. Water flow information should be gathered in conjunction with any sampling information collected in Kirby Creek. This will aid in future pollutant loading calculations.

6. This watershed plan should be continuously updated with "As-Builts" submitted electronically by the developer.

19.2.2 Water Quality Recommendations

1. Use the STREAMWATCH program to assist in developing land use specific EMCs that can be used to "calibrate" and verify the pollutant loading and removal model. Emphasis should be put on Kirby Creek. This recommendation should be implemented as soon as

possible after acceptance of this watershed plan. A minimum of two sites should be chosen.

2. The LAKEWATCH program should continue to expand its monitoring program in the watershed and provide an important water quality and aquatic plant species baseline for this area.

3. The Adopt-A-Pond program has equipment that should be used to aid in specific small-scale restoration programs using their criteria.

4. Upon completion of the stormwater inventory, an inspection system should be added to the maintenance plan that will aid in the detection of illicit discharges into the County's stormwater system. This system should be designed to maximize the credits to the County under the Community Rating System.

5. A watershed specific septic tank study should be completed which identifies the location of septic tanks, assesses their impacts on water quality, and recommends management techniques to improve their efficiency. The Planning and Growth Management Department has proposed such a study countywide, and this study should be completed

6. Assimilative capacity studies should be conducted on lakes in this watershed in order to determine proper regulatory needs for protection of the lakes. Once the assimilative capacity studies are completed, the information should be used to develop a lake management plan for each lake.

19.2.3 Natural Systems

1. Programs such as the Pepper Busters and County's Adopt-A-Pond should be expanded in the watershed to aid in controlling nuisance vegetation. Plants from the EPPC's category one list should be targeted. A program should be instituted for single family homeowners, that has as an incentive, free access to dumpsters or special garbage pick-up for large amounts of nuisance vegetation that they have removed.

2. Upland natural systems have been eliminated from the watershed. The agricultural parcel in the watershed should be purchased by the County and a restoration project should be undertaken within five years of the approval of this plan. This area should be restored to the habitat that was originally on the site.
3. Existing areas of natural buffers such as wetland conservation area setbacks should be identified and preserved. Projects similar to the Delaney Creek Restoration project should be explored for Kirby Creek that will take into account the proposed maintenance

schedule.

19.2.4 Water Supply

1. Consideration should be given to the aquifer recharge potential when siting stormwater treatment systems. Care should be taken to avoid moving water from an area of high recharge potential to an area of low potential.

2. Water conservation and the use of reclaimed water should be encouraged through educational programs including LAKEWATCH and StreamwaterWatch.

19.2.5 Pollutant Loading and Reduction Model

1. **Benchmark –** The appropriateness of low / medium density land use is justified; however, the value used to model the loading may have been somewhat low. Some studies have found loadings almost twice as high as those used in the model, but values used were from direct measurements done in Hillsborough County. Using higher numbers would raise the benchmark and could have the effect of raising some LOSs.

2. **BMPs –** One of the model's shortcomings is that it does not allow the use of multiple BMPs. In addition, literature values for multiple BMPs are extremely difficult to find or extrapolate.

3. One of the lessons learned in using the PLR model is that impervious surfaces are the main component in the creation of pollutant loads. A method should be developed to track the amount of impervious surface in the watershed. The County has minimal parking requirements for specific land uses that are governed by zoning. The Planning and Growth Management Division should revisit these requirements and do whatever possible to reduce these requirements or amend them to encourage the use of other alternatives where appropriate.

4. Another problem in using the model is in the determination of pollutant loads for future proposed land uses. This drawback is due to the incompatibility in translating the existing land use based on SWFWMD's application of FLUCCS codes into the future land use designations of the Planning Commission, which does not use FLUCCS codes. The Planning Commission should be urged to adopt the FLUCCS code in predicting future land use or develop a system that is directly comparable to FLUCCS. Presently the Planning Commission's system groups diverse land uses such as residential and commercial into mixed urban uses. This should be done prior to the next updating of this portion of the watershed plan.

5. The County should immediately embark on a program to develop as many specific EMC values as possible for land uses to be used in future applications of the model.

19.2.6 Level Of Service

1. To increase the water quality treatment level of service, stormwater ponds built in this watershed should be the Conservation Wet Detention design to maximize pollution load reductions.

2. A project / program should be started within two years of approval of this plan that would create a series of bioretention ponds along the shores of both Silver and Twin Lakes. These lakes are on the verge of passing from the "good" to "fair" range in terms of trophic state index and it will be easier to stop this drop in water quality at this point in time than it will several more years from now.

19.2.7 Revisit Regulations

1. Land Alteration and Landscaping rules should be revised to include larger buffers around wetlands and waterbodies. Studies have demonstrated that larger setbacks provide better protection by allowing some treatment of stormwater run-off prior to its introduction into the receiving waterbody. Variances should be either eliminated or allowed uses should be curtailed. Activities such as grading should not be allowed. Construction and other related activities should also be limited; no impervious areas should be allowed. It has been shown that as little as 10% impervious area within a watershed can have serious detrimental impacts on aquatic ecosystems.

2. One of the projected land use changes in the watershed is the conversion of the agricultural areas to high-density residential housing (greater than 5 units per acre). These housing densities should be reduced around wetlands and waterbodies for the same reason setback variances should be limited. This will have the effect of reducing impervious areas around these sensitive habitats. Studies have shown a wide range of pollutant loading for this land use category. Some of these loadings can approach those expected for more intensive land uses such as institutional and commercial.

3. The flooding caused by the recent El Nino events, primarily in 1998, demonstrated the damage that can be caused by unchecked building in the 25 and 100-year floodplains. Regulations should seek to avoid encroachment into these natural areas and allow them to function as the flood storage areas. By preserving these naturally occurring areas, "free" stormwater functions are provided that saves the County money.

4. Clearly, wet detention times must be increased. Recent studies show that a residence time of 14 days in conjunction with planted littoral areas may be necessary to provide adequate treatment. The SWFWMD should be encouraged to raise their standards, and failing this, the County should implement stricter standards.

5. Sedimentation and erosion has been identified as a significant source of pollutant load in the watershed. PGMD should reassess the need for mass grading of projects over 2 acres. Developers should be encouraged to grade small areas at a time rather than clearing entire project areas at one time. Erosion control techniques should required in all construction plans and then be inspected during construction in addition to the requirement of inspection prior to construction to ensure their continued maximum efficiency.

6. Low Impact Development techniques should be required in this watershed to minimize the volume of runoff and therefore the total pollutant load. As part of this recommendation, a team of representatives from the various County and State regulatory agencies as well as the regulated community should be immediately formed to develop a Hillsborough County Low Impact Development Technical Manual and incentives to carry out its recommendations once it has been developed.

7. All CIP’s should include life-cycle costing, a maintenance plan, and mitigation plan if appropriate for the facility. In addition, sediment transport has been a problem in the watershed and sediment control devices, such as sumps, should be incorporated into as many projects as possible.

8. Upon adoption of this plan, all CIP projects should incorporate water quality BMP’s into their design. The type of treatment used shall be based on the LOS parameter contributing the greatest load in the subbasin that the project(s) is being constructed. This aspect should be tracked so that a number of parameters can be addressed with subsequent projects and that a single parameter is not addressed by multiple projects. A matrix or flowchart should be developed that will aid the designers in choosing the appropriate parameter to be addressed and using the best BMP(s) to achieve that goal.