EAST LAKE AREA

STORMWATER MANAGEMENT MASTER PLAN

Prepared for the Hillsborough County Board of County Commissioners

By

Public Works Department Engineering Division Stormwater Management Section

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EAST LAKE AREA WATERSHED MANAGEMENT PLAN

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INTRODUCTION

This plan was prepared by the Hillsborough County Public Works Department's Stormwater Management Section to characterize the existing flooding and water quality conditions within the East Lake Area watershed. In addition to recommending solutions, the plan will also foster 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 East Lake Area watershed lies in the central portion of Hillsborough County. The watershed area can be classified as urban and encompasses approximately 7.9 square miles or about 5070 acres. The watershed includes six conveyance outfalls that ultimately discharge into the Tampa By-Pass Canal as well as six stormwater conveyance systems that directly drain into East Lake located at the center of the watershed. The East Lake Area watershed is generally bordered by the Tampa By-Pass Canal to the east, the CSX railroad to the west, the Harney Canal on the north and by Broadway Avenue on the south. The location of the East Lake Area watershed is shown in Figure 1-1.

The climate in the watershed and for Hillsborough County in general, can be characterized as subtropical. The average annual rainfall is approximately 52 inches. The wet season is approximately four months long during the summer, usually beginning in June and ending in September. The summer is generally hot and humid with daily high temperatures in the 90's. Afternoon thunderstorms of high intensity and short duration are common during the wet season. The majority of the basin's soils are designated as well drained by the classification system developed by the United States Soil Conservation Service (SCS) for Hillsborough County. The East Lake Area watershed is contained within the Polk Upland portion of the Midpeninsular Zone, which is one of the three geomorphic divisions of Florida (White 1970).

Land uses within the watershed are diverse and include several office parks / light industries, major and minor roadways, residential subdivisions, the Hillsborough County State Fairgrounds, a golf course and agricultural areas. Significant commercial areas located within the East Lake Area watershed include: NetPark (the old East Lake Mall), the Florida State Fairgrounds, Mary Help of Christians School and Camp, Breckenridge Industrial Park, Eastwood Commerce Center and the Interstate Business Park. Given the urban nature of the area, not many land use changes are anticipated for the future. Most changes will center primarily around the conversion of the remaining amount of agricultural area in the northeast portion of the watershed

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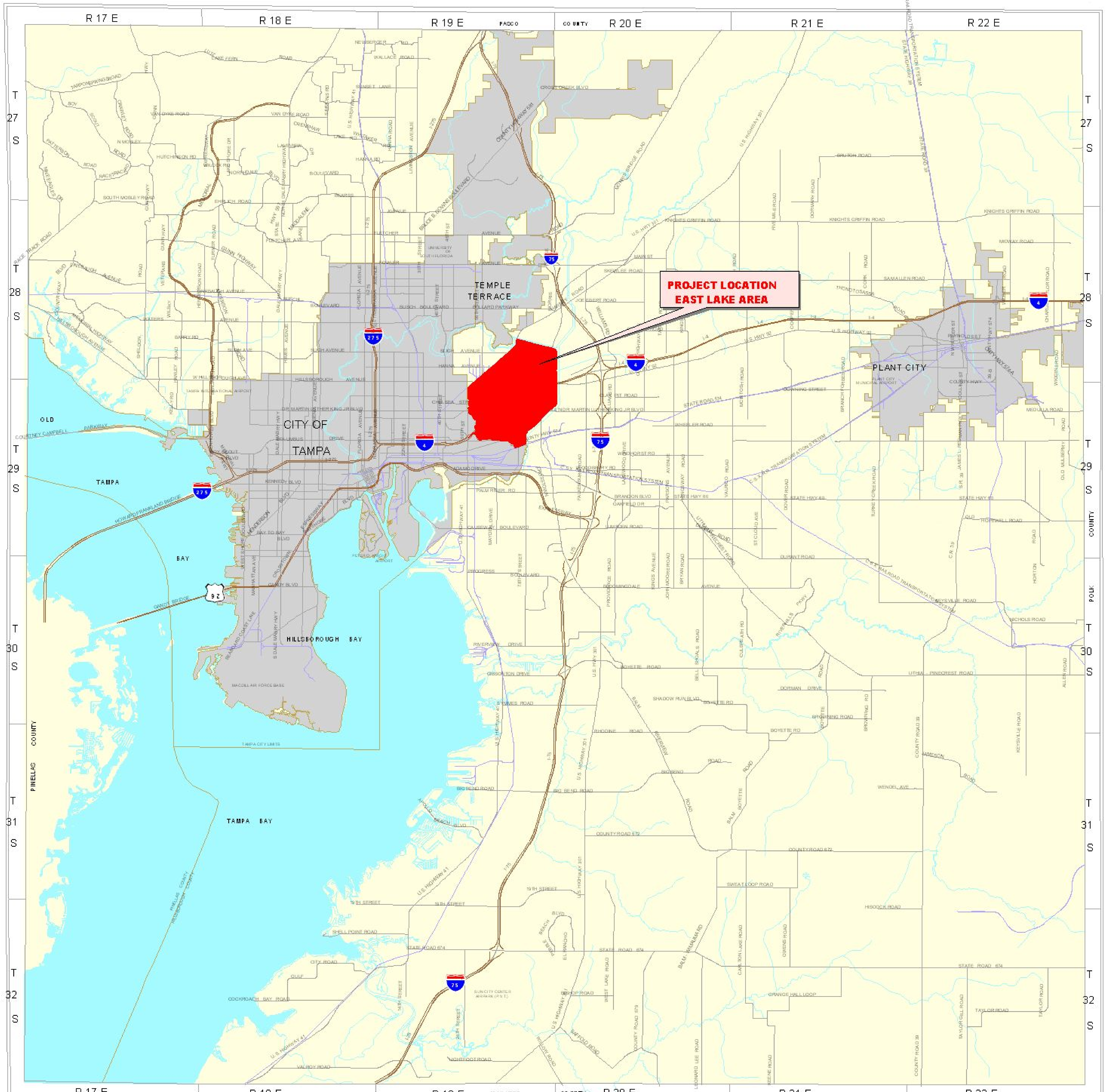

LEGEND

EAST LAKE AREA
MINOR ROAD
WATER FEATURES

FIGURE 1-1
PROJECT LOCATION MAP

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into mixed urban residential and commercial uses. Very little acreage of natural systems exists within the watershed, the majority of which exist in the historic area of Harney Prairie, which has been altered through agricultural use. Due to the lack of natural systems, few listed species can expected to be found in the basin. Expected species will be primarily wading birds, which will still be able to use the few remaining 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 one of three factors. The first two are a direct result of development. First, habitat can be degraded by development, especially when pollution control methods are not used. Second, the habitat is fragmented into smaller and smaller units as development increases. Finally, the introduction of exotic and invasive plant or animal species replaces all or portions of the original, natural communities. In order to better assess the impacts of stormwater run-off to these systems, a pollutant loading and reduction 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 East Lake or any other water body in the watershed, information for this report was gathered from a number of environmental studies or samplings by governmental agencies on or around East Lake. The earliest information was gathered as a result of an agreement in May 1974 between the East Lake Square Associates and the East Lake Civic Association as a result of the proposal to build East Lake Square Mall. The lake was monitored on a monthly basis between June 1974 and June 1975 and quarterly thereafter. Stations were located in the mall's retention pond, the inflow canal to the lake and near the lake's center. Greiner Environmental did the next round of sampling between 1974 and 1977, twice in 1974 and almost quarterly from 1975 to 1977. The Environmental Protection Commission of Hillsborough County sampled twice in 1978, once each in 1979 and 1980, and once in 1983, all in response to citizen's complaints about the lake's water quality. Thornton Labs sampled quarterly during 1984 and 1985. Enviropak sampled the lake quarterly from 1986 to 1987 and twice in 1989. Finally in 1995, Hillsborough County and the SWFWMD commissioned Environmental Research and Design (ERD) to perform a study on the lake as part of a restoration / evaluation plan. This study indicated that a major loading source for nitrogen and other nutrients being introduced into the lake had its origins in the bird rookery that exists on a small island in the northeast portion of the lake. Volunteers with the East Lake Park Civic Association have recently done sampling in the lake for the Hillsborough County LAKEWATCH program and will participate in the water quality sampling in the lake prior to and after the whole lake alum treatment of the lake that was recommended by the ERD study.

An Initial Report of Stormwater Management Master Plan (SMMP) for the East Lake watershed was originally developed in 1993. The report and model were developed using the latest available SWFWMD aerial contours, survey information from Hillsborough County and construction and as-built plans. The original spirit of task was to use "public domain" software to develop the watershed model, which will be a benefit to all parties.

The 1993 SMMP prepared by the Planning and Growth Management Department paved the way for the current study. Since the completion of the 1993 East Lake Area Stormwater Management Master Plan, most of the recommended projects from that study have been implemented by the County in addition to the current widening of Interstate 4 by the Florida Department of Transportation (FDOT). All completed drainage construction projects have been included in this report.

In addition to drainage systems updates and report revisions to include drainage improvements done by the County between 1993 and the present, the current watershed model has been significantly revised to integrate hydrograph computation internally, as well as taking into consideration system entrance and headloss.

The environmental conditions portion of the report will summarize the existing environmental information for the watershed, identify potential environmental issues associated with the proposed flood control projects and develop general recommendations to address areas of concern within the watershed.

1.2 PROJECT OBJECTIVES

The objectives of this study include the development of an existing condition model for the East Lake Area watershed, as well as to develop a Stormwater Management Plan that will be an update to the 1993 report. This plan shows Level Of Service (LOS) analysis for existing flood conditions and water quality and evaluates potential improvements for improving both of these Levels Of Service.

The scope of the plan includes the establishment of the existing conditions for the East Lake Area watershed stormwater management infrastructure in terms of computed water surface elevations and discharge rates. A computer model of the major physical characteristics of the stormwater conveyance / storage system has been developed to determine the existing conditions for the 2.33-year, 5-year, 10-year, 25-year, 50-year and 100-year design storm events.

As of the preparation of this document, several roadway crossing structures are under construction along Interstate 4. These future I-4 cross drains, as well as the proposed detention ponds, have been modeled as permitted conditions which is prior to the alternatives analysis. The effects of these results are reported herein.

Water surface profiles showing computed water surface elevations at major conveyance systems for the East Lake Area watershed have been included. Computed water surface elevations on channels and / or waterways are frequently slightly higher than the expected flood elevations at adjacent or offline sites due to the inclusion of conservative entrance and exit headloss with the drainage system. There is frequently a significant gradient between the computed data point and the remote site. Water surface elevations at points outside the immediate floodplain of a channel where computed water surface elevations are reported should be evaluated by a registered professional engineer before being used for design or construction purposes which may require more detailed hydraulic analysis.

Base on the results of the existing conditions 25-year design storm event, there are three (3) areas of focus for recommended improvements in the proposed condition. These improvements include structural upgrades and non-structural improvements. All of these efforts will lead to achievement of Level Of Service B in the East Lake Area watershed, for a 25-year / 24 hour storm event.

1.3 REPORT ORGANIZATION

This plan is organized into two general portions. Existing conditions are described in the first ten (10) chapters, with alternatives analysis and recommendations in the last eight (8) chapters.

- Chapter 1 provides an introduction and an overview of the report along with a description 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 the watershed's natural systems
- Chapter 9 discusses existing conditions affecting water supply, including ground and surface water use

- Chapter 10 discusses the pollutant loading model and its uses and results
- Chapter 11 provides a summary of the existing conditions water quality treatment level of service
- Chapter 12 provides for a public meeting to allow for citizen's input on the existing conditions found within the watershed
- Chapter 13 discusses flood control and water quality alternatives
- Chapter 14 summarizes the second public meeting to address issues and concerns raised in the first public 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 summarizes the final public meeting

  Chapter 18 contains the watershed maintenance plan

- Chapter 19 lists the recommended projects

Also included in this plan is an executive summary and lists of figures, tables references, exhibits and appendices.

WATERSHED DESCRIPTION

2.1 OVERVIEW

The ELW drains an area of approximately 7.9 square miles or 5070.5 acres in central Hillsborough County. The watershed is primarily urban, and drains into Tampa Bay proper through the Tampa By-Pass Canal, which has McKay Bay as its receiving water body. The basin is roughly bounded on its north side by the Harney Canal, to its east side by the Tampa By-Pass Canal, along its south side by Columbus Drive and on its west side by the C.S.X Railroad and 50th/56th Street. Additionally, several major roads, including U.S. Interstate 4, U.S. Highway 301, Harney and Orient Roads, Hillsborough Avenue and Martin Luther King, Jr. Boulevard, bisect the watershed. The basin, shown in **Figure 2.1**, is composed of 287 smaller units or sub-basins ranging in size from 0.68 to 258.34 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 18-20 feet NGVD at its outfall at the By-Pass Canal and is depicted in **Figure 2.2**.

The major natural feature of the watershed is East Lake, itself. Much of the watershed's drainage passes through the lake on its way to the By-Pass Canal. The lake comprises 98 acres of its drainage basin, which totals 1127 acres, and varies in depth from 0 to 8 feet. Its mean depth is 5.45 feet and the water surface elevation is at about 23 feet NGVD. The lake's depth has varied from a low of 22.29 to a high of 24.51 feet NGVD since the level has been controlled. This is accomplished by two non-adjustable control structures located in the southeast corner of the lake. Water passes to the southeast out of these structures on its way to the Tampa By-Pass Canal. During construction on the north side of the lake for the East Lake Park Subdivision in the 1950's and 60's, a loop canal was dredged to provide fill material to level off the low spots and to provide additional lake access for the subdivision. At or around this time, a small island, approximately 0.79 acres in size, was created in the northeast corner of the lake. It is not clear whether the island was created by the piling of spoil in the lake during the dredging or if it is a remnant area of upland that was not removed during the dredging process. A wading and water bird roost / rookery has become established on the island, which is presently under the ownership of the Tampa Audubon Society. These birds use the island as a refuge; coming back to it each night just before dusk and leaving just after sun-up. Some species of herons and egrets as well as blackbirds and grackles use the island to nest and raise their young in the relatively predator-free environment. Unfortunately, the ERD report identified the rookery as one of the major sources of nutrient loading in the lake, especially in the case of nitrogen. The island is also a source of nuisance plant species, with its shore being ringed by a dense area of Southern cattails (*Typha latifolia*) and the island itself being overgrown with Coastal Plains willow

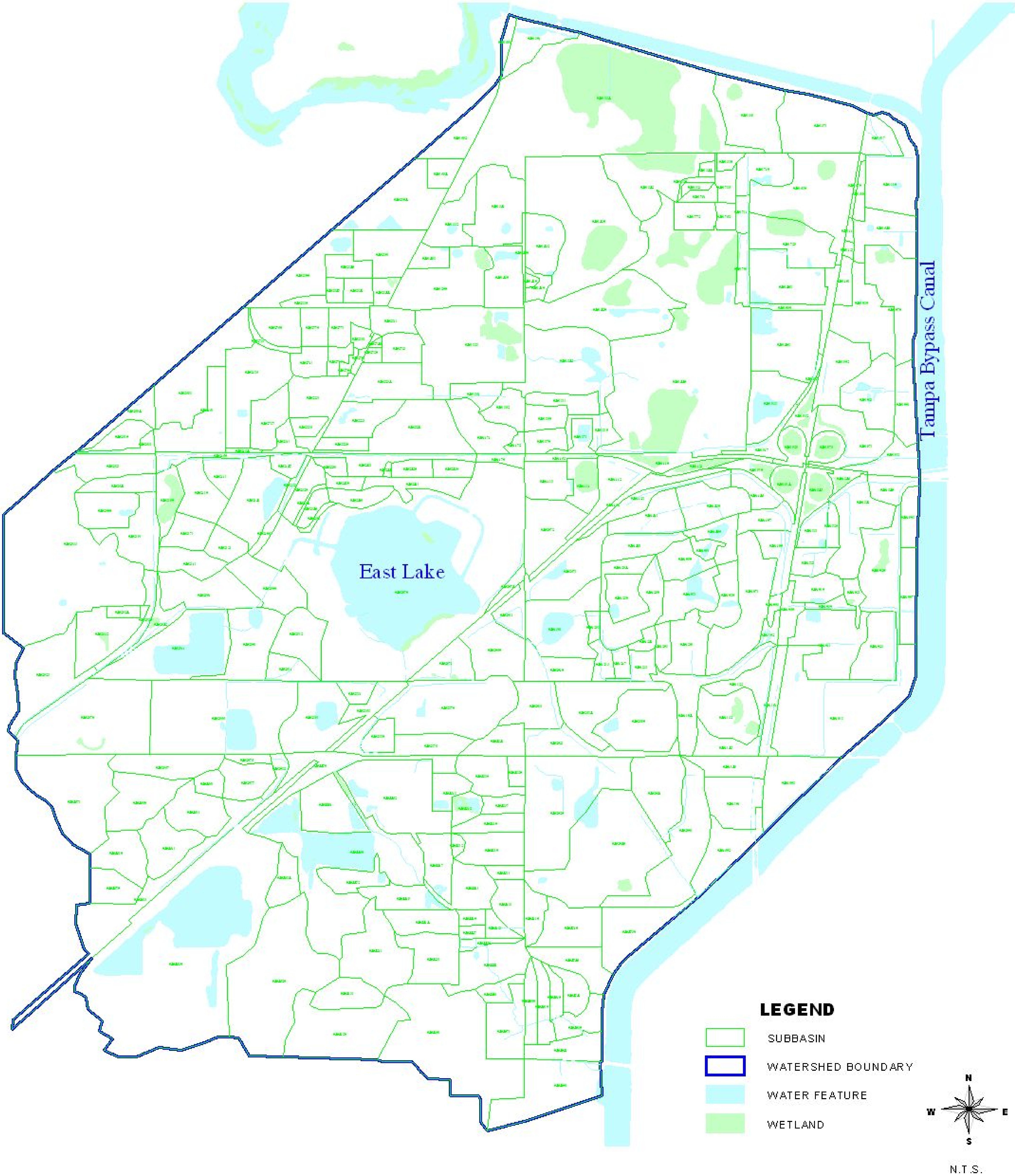

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Figure 2-1
Basin Delineation
map

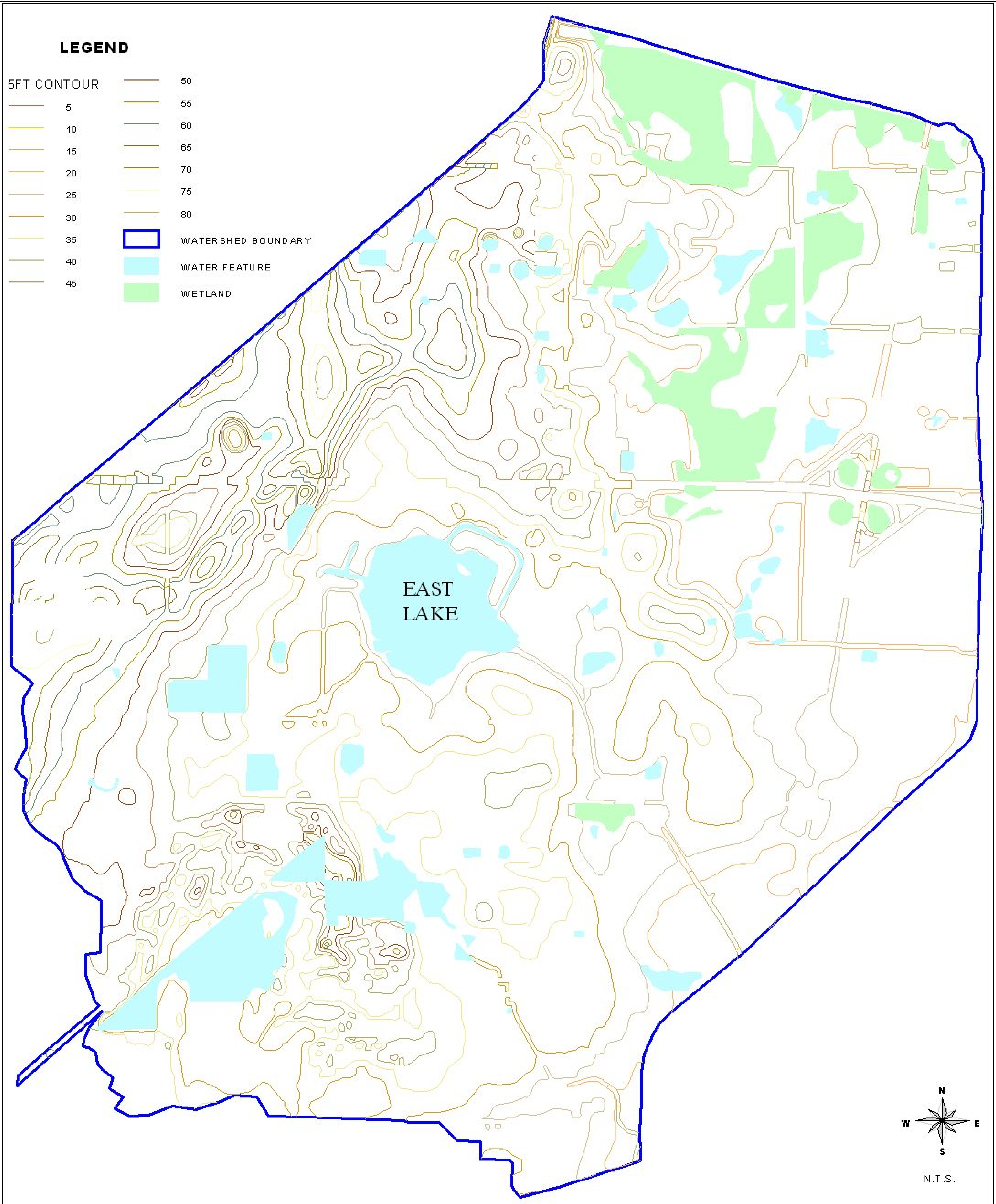

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Figure 2-2
TOPOGRAHY
MAP

(*Salix caroliniana*), lead tree (*Leucaena leucocephala*) and other exotics. Land uses within the watershed boundaries are diverse and include a large commercial mall, several offices parks and areas of light industry, major and minor roadways, residential subdivisions, a golf course, the Hillsborough County Fairgrounds, a small landfill which is closed, a few areas of wetlands and some agricultural acreage.

2.2 CLIMATE

The climate of the ELW, and for Hillsborough County as a whole can be classified as humid subtropical. Annual average precipitation is around 52 inches and almost 60% of this total falls during the four month rainy season that extends from June through September. This time frame coincides with the occurrence of most tropical storms and hurricanes. In addition, 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 lights 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 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 routinely 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% with the 1 P.M. time period recording 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 often quoted for use in Hillsborough County are those reported from Lake Alfred in Polk County, 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 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 ELW that fall into this group include 7, 8 & 9 - the Candler fine sands, 36 - Orsino fine sand, 53 & 54 - the Tavares-Millhopper fine sands and 55 - Tavares-Urban land complex.

! Group B (moderately 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 ELW that fall into this group includes 26 - Lochloosa-Micanopy fine sand, 41 - Pomello fine sand and 61 - Zolfo fine sand.

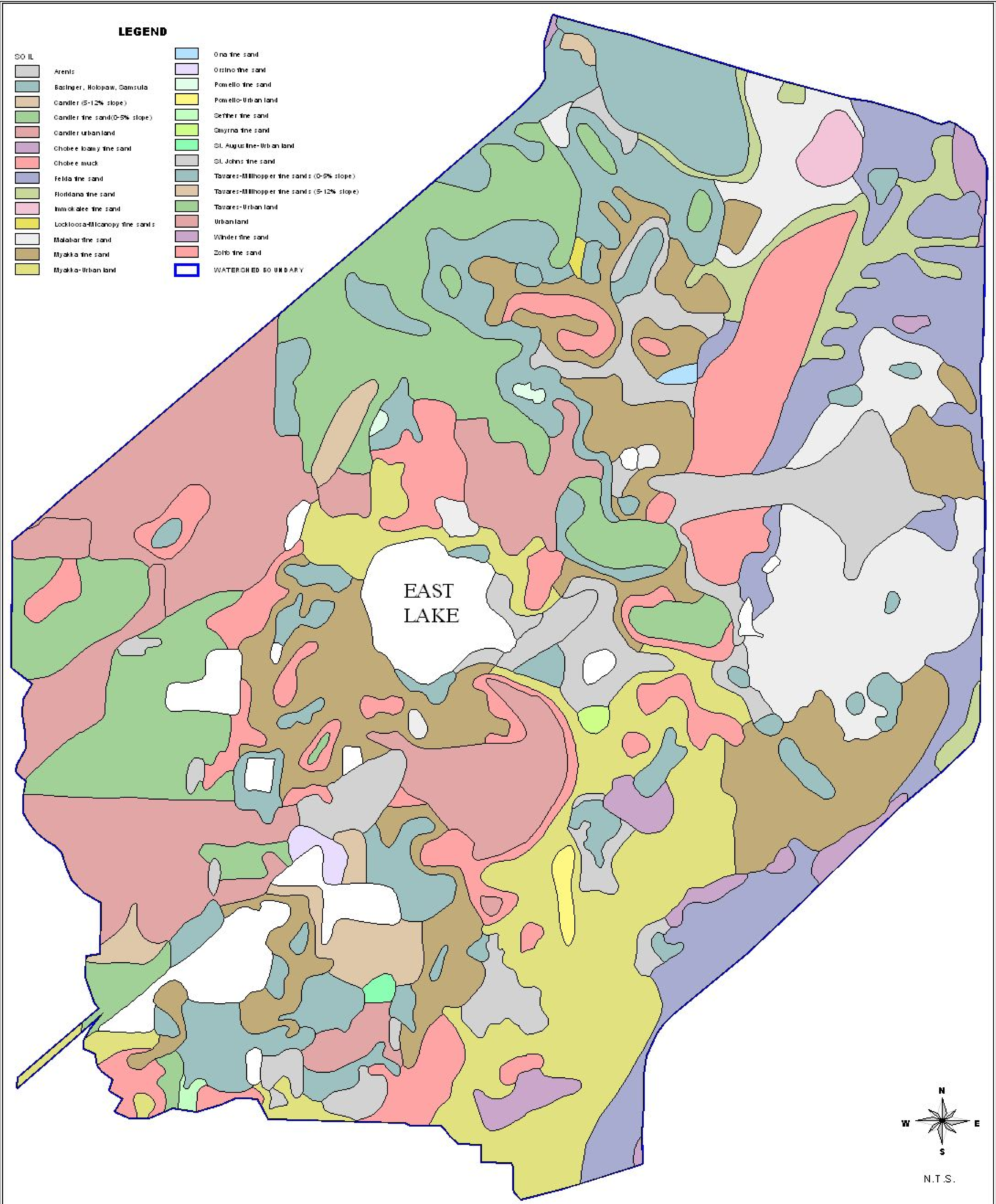

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Figure 2-3
Soil Classification
Map

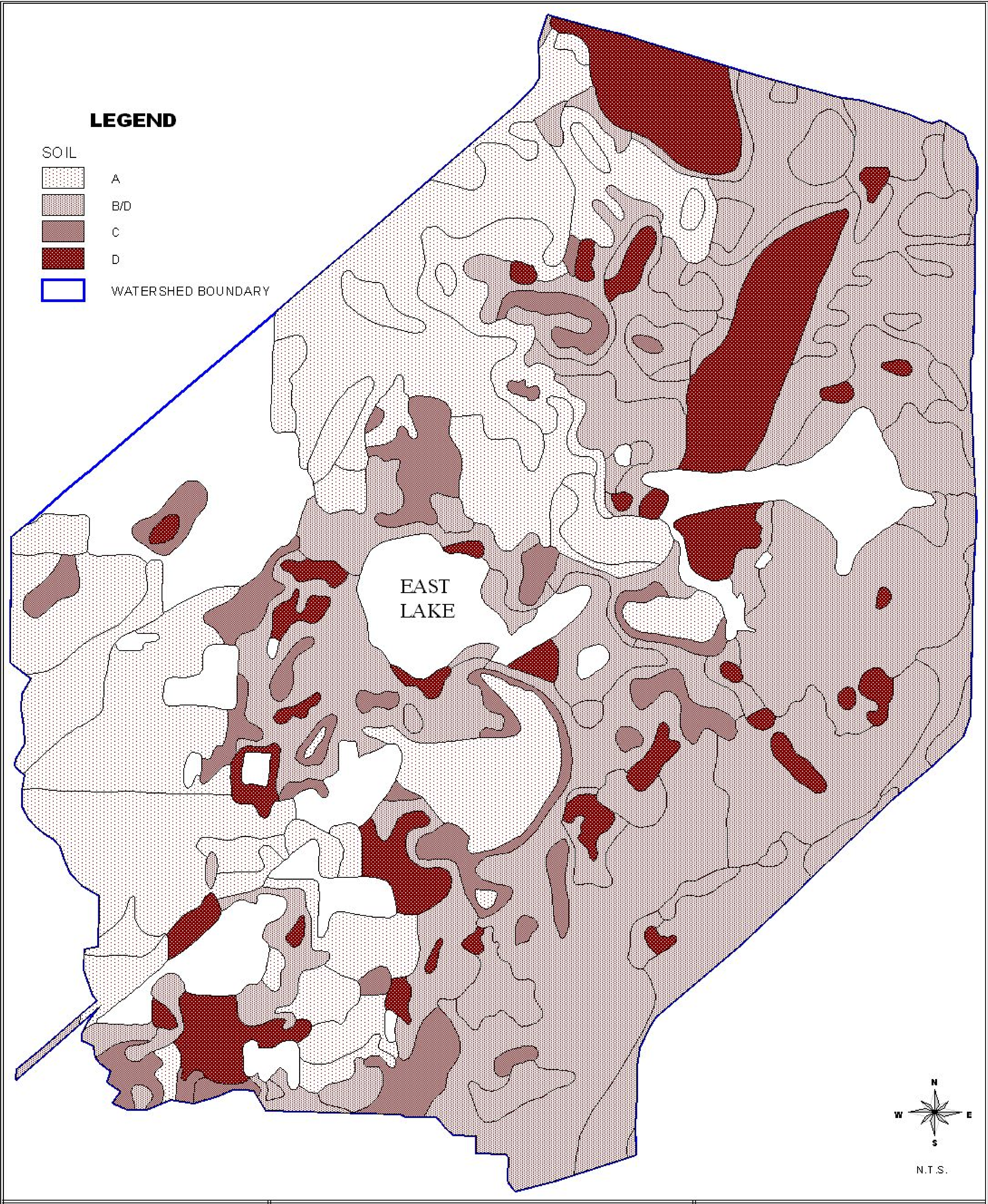

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Figure 2-4
Soil Hydrologic Group
map

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. Soil types found in the ELW that fall within this group include 5 - Basinger, Holopaw and Samsula, 11 - Chobee muck and 14 - Eaton mucky sand.

! 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 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 ELW are 10 - Chobee loamy fine sand, 15 - Felda fine sand, 17- Floridana fine sand, 21 - Immokalee fine sand, 27 - Malabar fine sand, 29 - Myakka fine sand, 32 - Myakka-Urban land complex, 33 - Ona fine sand, 46 - St. Johns fine sand, 52 - Smyrna fine sand, 58 - Wabasso-Urban land complex and 60 - Winder fine sand.

Two soil types found within the ELW, 4 - Arents and 56 - Urban land, are not assigned to any group due to the developed nature of the land, which leaves it virtually 100% impervious.

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, are poorly to very poorly drained or depressional in nature, and are associated with a high seasonal water table. Those soils, which are non-hydric, lack these characteristics and are associated with upland or transitional areas. Soil types with the hydric classification found within the ELW are 5 - Basinger, Holopaw and Samsula, 10 - Chobee loamy fine sand, 11 - Chobee muck, 14 - Eaton mucky sand, 15 - Felda fine sand, 17- Floridana fine sand, 27 - Malabar fine sand, 46 - St. Johns fine sand and 60 - Winder fine sand. All of the other types would be considered non-hydric.

2.4 PHYSIOGRAPHY AND HYDROLOGY

The ELW lies within the Polk Upland physiographic unit as defined by White. This unit is part of the Central or Mid-Peninsular physiographic zone, one of three in Florida. This zone is characterized by discontinuous highlands formed by sub-parallel ridges that are separated by broad valleys. Land elevations in the ELW vary between a high of about 80 feet NGVD in the northern portions of the watershed to a low of around 20 feet NGVD at the East Lake outfall on the Tampa By-Pass Canal. These elevations are shown on **Figure 2.2.** The watershed has six major outfalls, one each for Harney Prairie, Interstate 4, the Fairgrounds, East Lake, Orient Park and Judson Creek/Grant Park. The first five of these outfall to the Tampa By-Pass Canal; while the final one flows out of the County□s jurisdiction and into the City of Tampa. In addition to these outfalls, there are also six major stormwater conveyance systems within the basin. These are the Fairgrounds System - South, the Hillsborough Avenue/Harney Road System, and the East Lake Mall - North System, the East Lake Mall - South System, the 50th/56th Street System and the Mary Help of Christian School System. These six systems in conjunction with the outfall systems listed above handle the majority of the stormwater conveyance within the watershed.

East Lake is the watershed's major surface water feature and is approximately 98 acres in size. Its volume is estimated to be 661,901 m^2 or 536 acre-feet of water. Much of the basin's water is ultimately routed through the lake, whose drainage basin is approximately 1216 acres or close to 2 square miles. This basin can be further divided into 14 smaller sub-basins that range in size from the largest at 467 acres, down to the smallest which encompasses only 2.9 acres. The percent impervious area for these sub-basins ranges from 0 to 27.7%. The lake is the receiving water body for the East Lake outfall and both of the East Lake Mall conveyance systems.

Surface flows are generally from the west to the east or southeast toward the Tampa By-Pass Canal 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. However, the ERD study did demonstrate that East Lake does receive a minor groundwater component. Two averages were obtained; one for the "wet" season and one for the "dry" season. The wet season average was 2.22 liters/m^2/day; while, the dry season average was 1.58 liters/m^2/day. ERD estimated that 2,434,295 m^3 or 1972 acre-feet of water enters the lake on a net annual basis. Of this amount, stormwater runoff, 50% from baseflow, 11% by groundwater seepage and 20% by rainfall contributes 19%.

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 slower zone of consolidated carbonate rock.

At land surface, undifferentiated sediments including silt, sand, and clay form surficial deposits vary in thickness from less than 10 feet in coastal areas to over 100 feet in paleokarst depression 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, which 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 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 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 a tan-colored crystalline, limestone containing prominent gastropod and pelecypod molds and the lower portion is a 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 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**.

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 is highly variable. The depth of the water table ranges from near land surface to several tens of feet below land surfaces. Water table elevation is primarily influenced by rainfall, with annual highs in most years occurring during the end of the wet season (in Sept.- Oct.) and annual lows

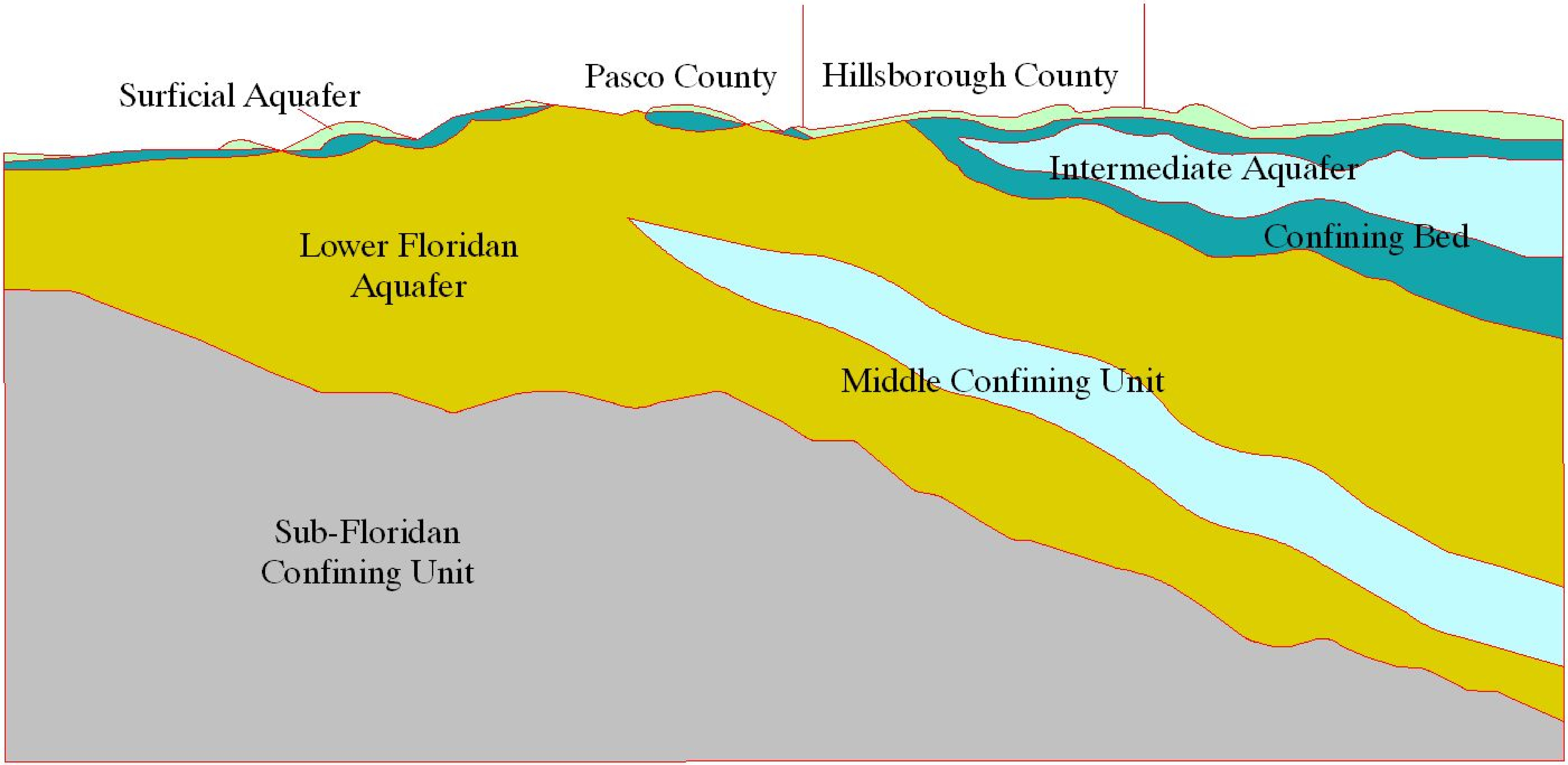

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FIGURE 2-5

HYDROGEOLOGIC CROSS SECTION MAP

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 somewhat retards 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 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 Tamar Member 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.

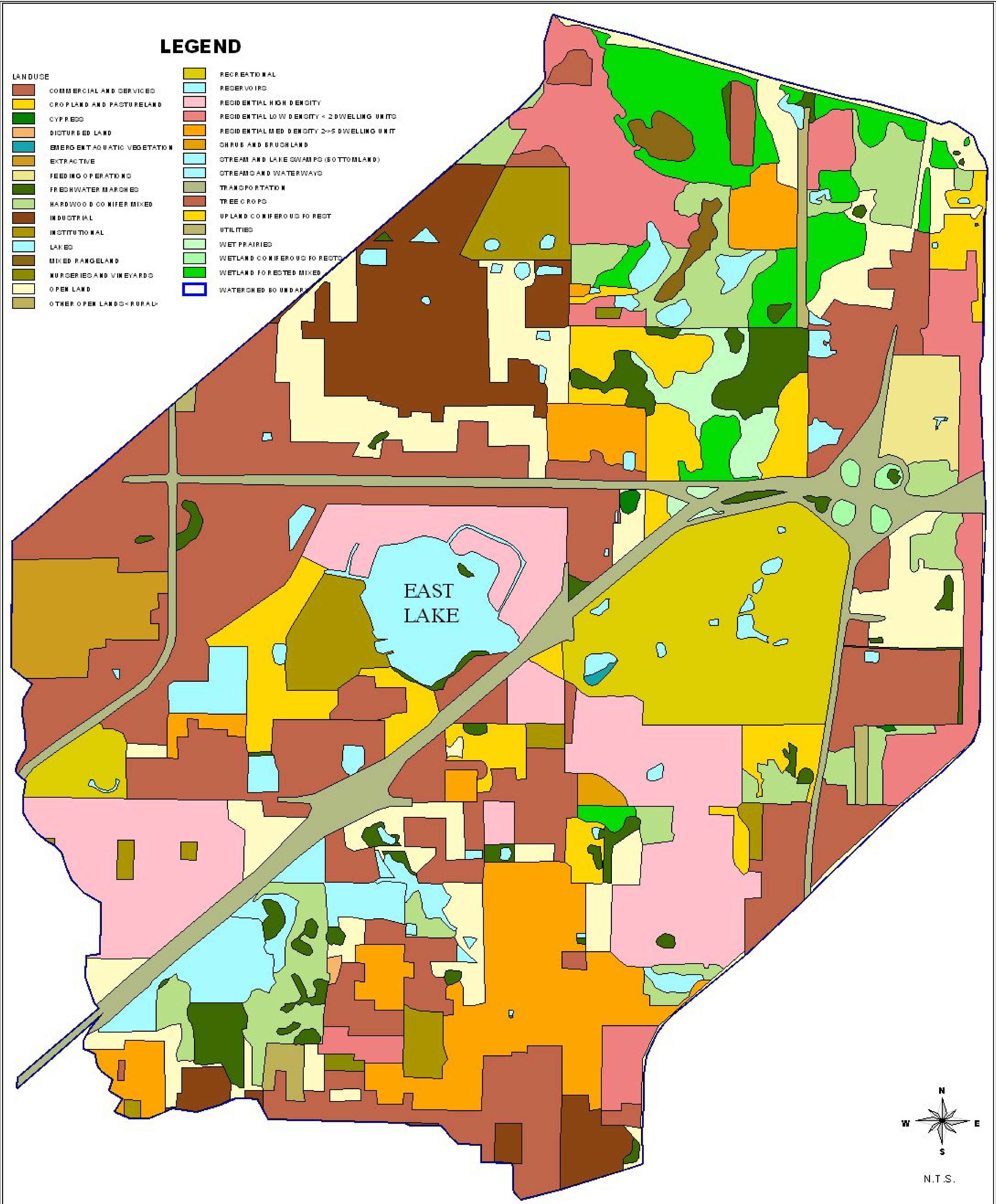
Near the base of the Avon Park Formation lies the middle confining unit of the Floridan aquifer, an evaporite sequence of very low permeability that is composed of gypsiferous dolomite and dolomitic limestone. The middle confining unit generally delineates the boundary between the freshwater Upper Floridan 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 that 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. Recharge can be highly variable throughout the area; however, due to karst ecology 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

2.6.1 EXISTING LAND USES

As stated previously, the ELW encompasses a wide variety of 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. Industrial uses are primarily found along the area's main roads - U.S. Highway 301, Hillsborough Avenue, 50th and 56th Streets and Harney Road. As shown in **Figure 2-9**, there are only two vested projects and no Development of Regional Impact (DRI) projects within the watershed. Most of the natural and recreation lands are contained in the County Fairgrounds and other public parks and the golf course. No areas of Significant or Essential Upland Wildlife Habitat exist within the watershed area. Residential areas are concentrated around the north rim and to the south of East Lake with other subdivisions scattered throughout the watershed. The majority of these residential areas tend to be older subdivisions with little or no stormwater treatment being provided. This lack of stormwater treatment and the impact of pollutant loading will be discussed further in Chapter 7 - Existing Conditions Water Quality and Chapter 10 - the Pollutant Loading and Removal Model. The lots are typically less than a quarter acre in size. Most of the agricultural areas are encompassed within the Harney Prairie area on the north side



Hillsborough County
Florida

EAST LAKE AREA
STORMWATER MANAGEMENT
MASTER PLAN
(APRIL 2001)

Public Works Department
Engineering Division
Stormwater Management Section

Figure 2-6
Landuse Landcover
Map

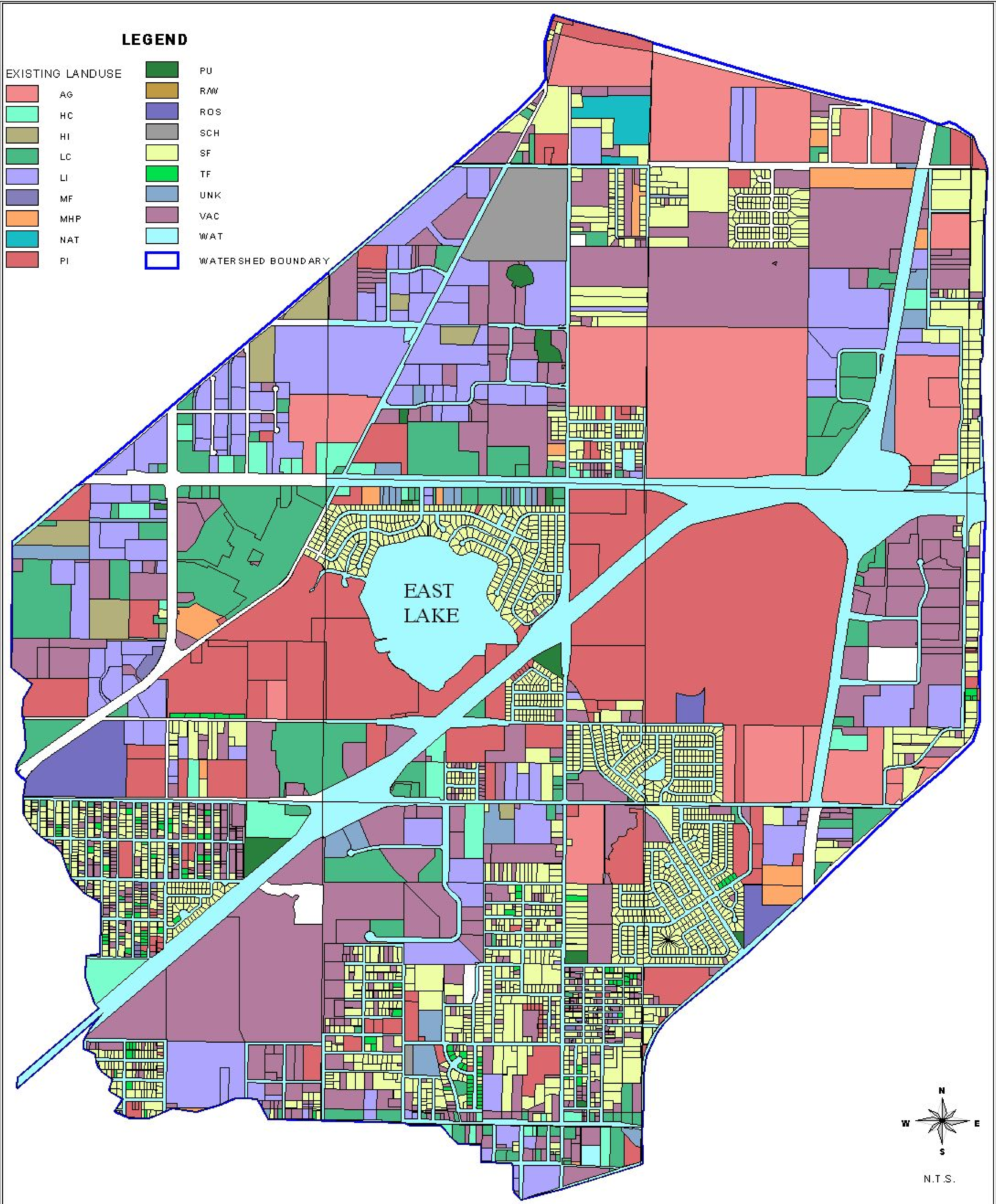


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Figure 2-7
Existing Landuse
Map

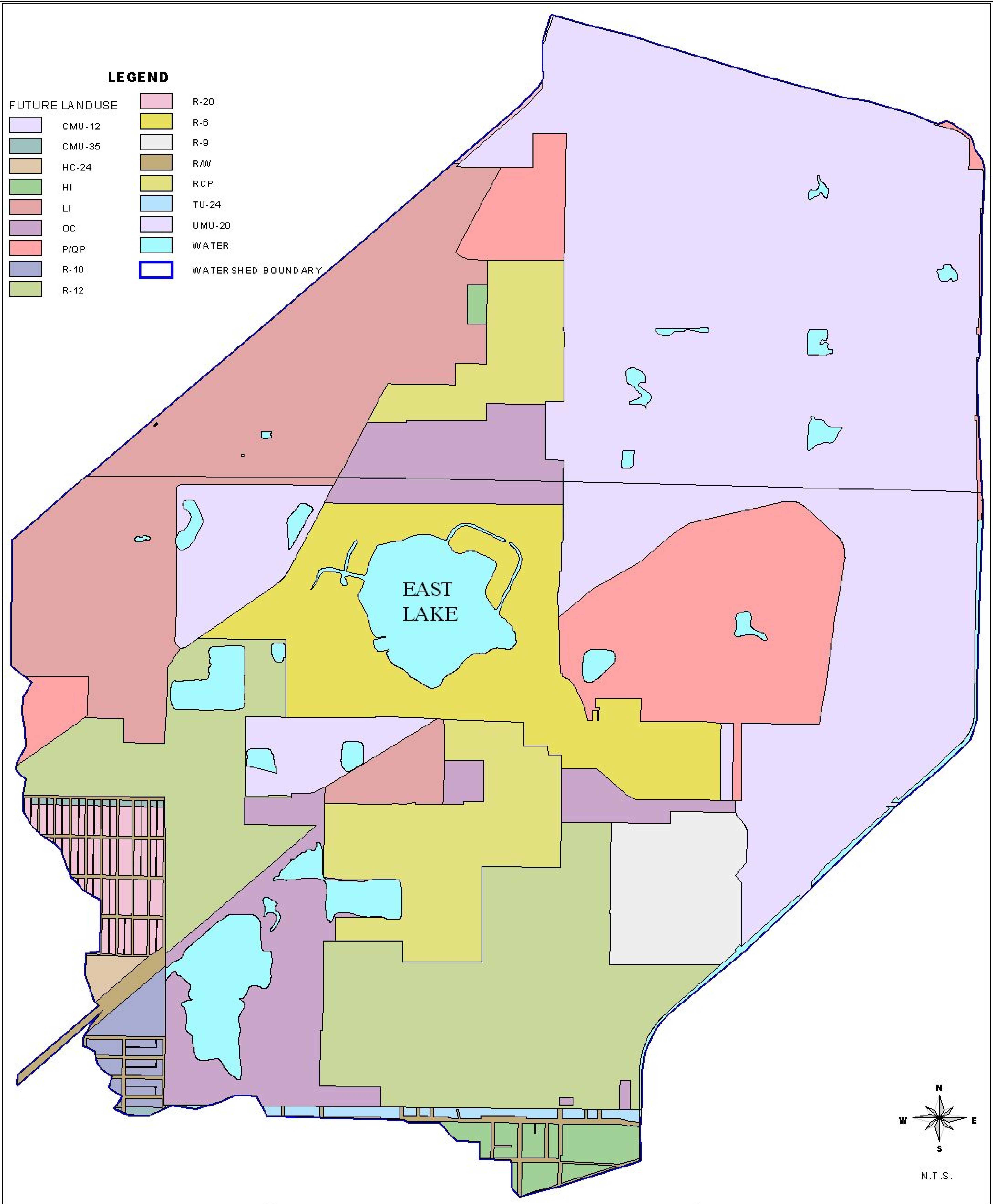

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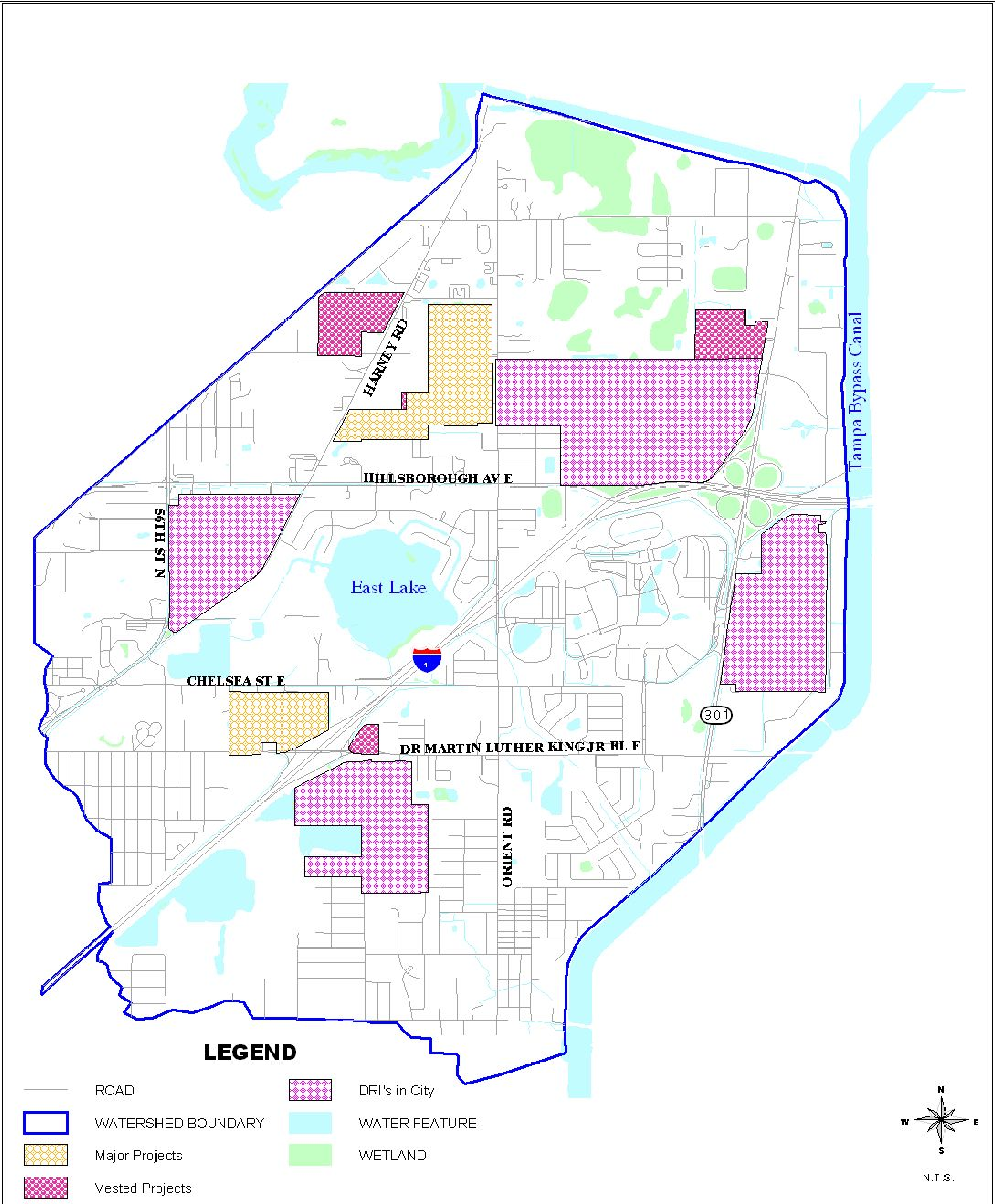
Figure 2-8
Future Landuse
Map



Hillsborough County
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EAST LAKE AREA
STORMWATER MANAGEMENT
MASTER PLAN
(APRIL 2001)

Public Works Department
Engineering Division
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Figure 2-9
Major Projects,DRI's,&
Vested Projects
Map

of Interstate 4, between Orient Road and U.S. Highway 301. Two of the larger remaining areas exist to the south of the Fairgrounds and north of Martin Luther King Boulevard. Major transportation corridors contain almost as much acreage as the agricultural uses do. Roads and highways are a major contributor of a variety of pollutants, especially metals such as lead, cadmium and copper. In addition, much of the nitrogen compounds spread by atmospheric deposition have their origins in the vehicles that use these roadways.

Table 2.1
Existing Land Uses (1995) - East Lake Watershed

Land Use Category	Total Acreage	Percent of Total
Low / Medium Density Residential	616.46	12.16
High Density Residential	477.82	9.42
Light Industrial	272.77	5.38
Agricultural	353.32	6.32
Commercial	1069.42	21.09
Institutional	140.61	2.77
Highway / Utility	285.64	5.63
Recreational	327.56	6.46
Open Land	440.59	8.69
Extractive (Mining) / Disturbed	105.60	2.08
Upland Forested	271.82	5.36
Wetland Forested	242.07	4.77
Wetland Non-Forested	192.65	3.80
Water	274.20	5.41
TOTAL	**5070.53**	**99.98**

This indicates that 73.68% of the watershed has been developed with the remainder being composed of agricultural, natural areas and open water.

2.6.2 FUTURE LAND USES

Due to the highly developed nature of the ELW, not many changes in land use are predicted by the Hillsborough County Comprehensive Plan. The majority of predicted changes will be in the Harney Prairie area as this largely agricultural area is changed over to a mixed urban use of residential and light commercial / industrial.

Table 2.2
Future Land Uses Changes - East Lake Watershed

Land Use Category	Total Acreage	Percent of Total
Low / Medium Density Residential	0.0	0.0
High Density Residential	2823.699	55.70
Light Industrial	975.964	19.25
Agricultural	0.0	0.0
Commercial	508.961	10.04
Institutional	397.002	7.83
Highway / Utility	90.736	1.79
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	272.962	5.38
TOTAL	**5069.324**	**99.99**

As shown by the table, many land uses are predicted to be lost within the coming years. Some of this loss will be actual, as in the case of open land, extractive and agriculture. Some of the losses are an artifact of the way the land uses are compiled. For instance, without a radical change in environmental regulation, it is not very likely that all of the wetland areas will be developed.

MAJOR CONVEYANCE SYSTEMS

3.1 OVERVIEW

This chapter contains a general description of the twelve (12) conveyance systems within the ELA watershed, including the six major outfall systems that discharge to the project boundary and the six major conveyance systems that discharge into East Lake affected by its stage.

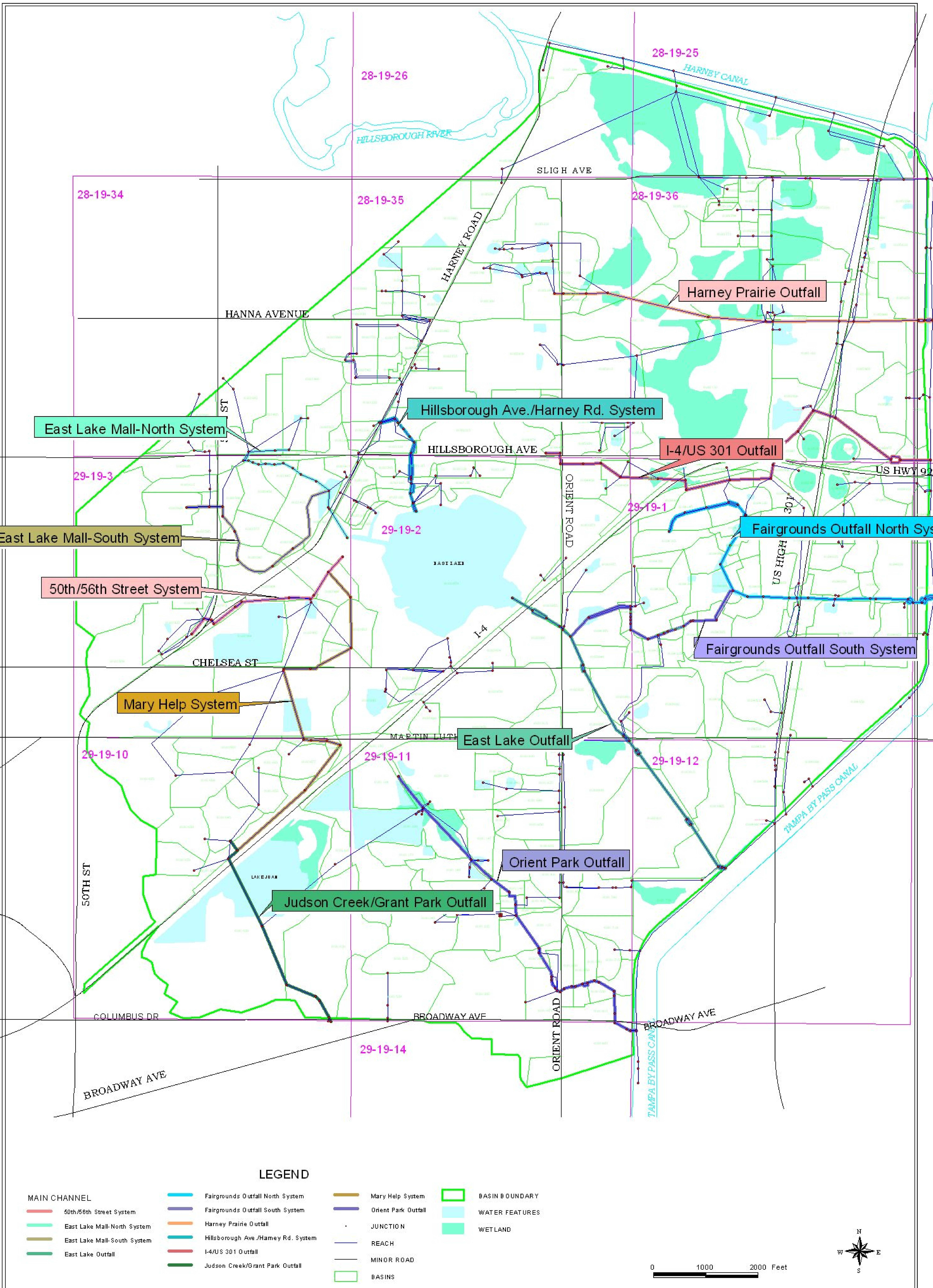
The description of major conveyance systems in the ELA watershed has been segmented into the following discussion areas:

3.2 The Harney Prairie Outfall
3.3 The I-4 Outfall
3.4 The Fairgrounds Outfall – North System
3.5 The East Lake Outfall
3.6 The Orient Park Outfall
3.7 The Judson Creek / Grant Park Outfall
3.8 The Fairgrounds System – South System
3.9 The Hillsborough Avenue / Harney Road System
3.10 The East Lake Mall – North System
3.11 The East Lake Mall – South System
3.12 The 50th / 56th Street System
3.13 The Mary Help of System

Each discussion area represents a distinct outfall, system, or lateral. **Figure 3-1** identifies the locations of a major outfall, as well as other existing conditions features within the ELA project area.

3.2 THE HARNEY PRAIRIE OUTFALL

The Harney Prairie Outfall flows in an easterly direction from its beginnings at Orient Road near Tampa Bay Vo-Tech. It maintains this easterly flow pattern across the grassy Harney Prairie toward U.S. Highway 301. In the vicinity of Breckenridge Business Park, the Outfall becomes more channelized as it prepares to cross under U.S. Highway 301. Once under the highway, the outfall passes under several secondary roads to its terminal point at the Tampa By-Pass Canal. For



Hillsborough County
Florida

EAST LAKE AREA
STORMWATER MANAGEMENT
MASTER PLAN
(APRIL 2001)

Public Works Department
Engineering Division
Stormwater Management Section

FIGURE 3-1
MAJOR CONVEYANCE SYSTEM
MAP

the most part, the outfall has a very slight bottom slope, the exception being an area near its headwaters at Orient Road.

3.3 THE INTERSTATE 4 (I-4) OUTFALL

The headwaters of the I-4 outfall are approximately at the intersection of Orient Road and Hillsborough Avenue. A culvert and ditch system, which begins at the southwest corner of this intersection, directs flow under Orient Road and then to the east, in the south right-of-way ditch of Hillsborough Avenue. The direction of flow is generally to the east, through the I-4 culverts to a large ditch at the north property line of the Fairgrounds. In the vicinity of U.S. Highway 301 and I-4 interchange, the large ditch directs flow north via culverts located to the north. The flow is generally north through an open ditch along the west side of the exit ramp of U.S. Highway 301 to a culverted system which directs the flow east again, under U.S. Highway 301. The culvert system then discharges into a ditch which takes the flow to the Tampa By-Pass Canal. The ditches through the outfall are relatively flat with gentle side slopes, and are in maintained in a relatively good condition.

3.4 THE FAIRGROUNDS OUTFALL - North System

The Fairgrounds Outfall-North System originates within the Fairgrounds property at the oval, dirt racetrack, which is located near the northern property line. Several culverts direct stormwater under the racetrack and into the central pond system located adjacent to Expo Hall. The central pond system is comprised of five interconnected ponds that provide attenuation before discharging to a ditch/culvert system at the southernmost pond. At this point, the South System joins with the North System. The ditch / culvert system then transfers flow east toward U.S. Highway 301. Once under the highway, a large ditch directs the flow due east toward the Tampa By-Pass Canal, through the Interstate Commerce Park. The ditch systems have insignificant bottom slopes throughout, and vary a great deal in maintenance characteristics.

3.5 THE EAST LAKE OUTFALL

The East Lake Outfall is another stormwater conveyance system which, like the Fairgrounds Outfall, contains other major contributing systems. The East Lake Outfall conveyance system begins at the outflow point of East Lake. The other identified stormwater conveyance systems are located upstream of East Lake and directs flow into East Lake or the downstream main channel (Fairgrounds-South System). These other systems are the Fairgrounds-South System, the Hillsborough Avenue/ Harney Road System, the East Lake Mall-North System, the East Lake Mall-South System, the 50th/

56th Street System and the Mary Help System. These six contributing systems will be described in the last half of this chapter (from 3.8 to 3.13) following the description of the outfall systems.

East Lake, which receives stormwater runoff not only from the previously described five conveyance systems, but also from its own immediate drainage basin, is the point of beginning of the East Lake Outfall. The lake's outflow or discharge point is at its southeast corner. Flow from the lake passes under I-4 and toward the lake’s control structures which are located in a channel approximately 200 feet south of I-4. Two large, non-adjustable concrete weirs regulate the lake's water levels, and direct all flow toward Orient Road. Once passed Orient Road, the flow is joined by flow coming from the Fairgrounds-South System. From this point, the conveyance system can be characterized as having deep channels with steep side slopes. The channel passes mostly through areas with developed residential subdivisions on both sides. The flow direction is southeasterly until the outfall's termination at the Tampa By-Pass Canal.

3.6 THE ORIENT PARK OUTFALL

The Orient Park Outfall begins at the intersection of I-4 and Martin Luther King Boulevard Stormwater runoff is collected from the adjacent areas and conveyed to the southeast, into the Corporex Business Park site. This business park contains a large stormwater storage area (borrow pit), in addition to several smaller attenuation ponds which discharge into this large reservoir. The flow from Corporex is directed toward the southeast corner of the property where a ditch system conveys flow into an older residential area. The conveyance network through the residential area is comprised primarily of open ditches and culverts. The system is old and contains many sharp changes in direction which have contributed to soil erosion on adjacent properties. The outfall flows in a zigzag pattern in a southeastern direction toward Orient Road. At Orient Road, the flow moves in an easterly direction under the road, with the downstream system showing the same basic characteristics as described for its upper reaches. The channels in this region tend to traverse private property and display steep side slopes with depths on the order of 3 to 5 feet. After passing under 76th Street, the outfall turns south into a pipe system which conveys the flow through a few private lots, a commercial business and then under Broadway Avenue. Once under Broadway, the flow turns again to the east and ultimately discharges into the Tampa By-Pass Canal. This outfall has channels with moderate bottom slopes in the area between 21st and 76th Streets. The channels closer to the By-Pass Canal and at the discharge point of Corporex, show less bottom slope than the rest of the Outfall. In addition, a high point exists between the Corporex outflow point and Vermont Avenue (see Exhibit 6-1(e) - Orient Park Outfall). This high point partially controls water surface elevations upstream of the Corporex Business Park near Vermont Avenue.

3.7 THE JUDSON CREEK / GRANT PARK OUTFALL

The headwaters of the Judson Creek / Grant Park Outfall area are located in the Grant Park Subdivision, which is at the southeast corner of I-4 and Martin Luther King Boulevard intersection. Portions of Grant Park are contained in both the County and the City of Tampa. During higher frequency storm events, stormwater runoff from the portion in the City may build-up and spill over into the County portion. The outfall receives this runoff and other stormwater from the subdivision's stormwater collection system and conveys the flow toward I-4. Flow is then transported under I-4 into the large Alderman’s borrow pit to the southwest. Stormwater is conveyed out of the pit through several culverts and under Columbus Drive. Once under Columbus Drive, the flow re-enters the City of Tampa and into a channel system that ultimately discharges into McKay Bay. The outfall is predominately comprised of the large Alderman’s borrow pit adjacent to I-4. This man-made surface water feature attenuates the flows from Grant Park and, at times, from Corporex, and accounts for nearly half of the conveyance features of the outfall.

3.8 THE FAIRGROUNDS OUTFALL - SOUTH SYSTEM

The Fairgrounds-South System lies, for the most part, within the property of the Fairgrounds. It encompasses the area north of the Fairgrounds' south property boundary, south and west of the interconnected lake system within the Fairgrounds, and east of Orient Road. This system interconnects with the East Lake Outfall and the Fairgrounds Outfall-North System. The system contains a high point near Kings Forest Park, where an offsite connection conveys flow under the south wall of the Fairgrounds and into the system. This offsite flow is conveyed through twin pipes, and is the stormwater runoff from the area north of Chelsea Avenue, including the Park. From the high point, the portion of the system to the east is composed of ditches and culverts that convey flow to the southernmost Fairgrounds pond at the center of the complex. This pond is part of the Fairgrounds Outfall-North System. From the high point to the west, the system again consists of ditches and culverts. However, this portion of the system discharges into a pond at the southwestern portion of the Fairgrounds property. A pipe that discharges into the East Lake Outfall controls the flow from this pond. The Fairgrounds-South System is, in general, a poorly maintained collection of pipes and ditches which were intended to convey the internal stormwater runoff of the Fairgrounds property into the property's ponds.

3.9 THE HILLSBOROUGH AVENUE / HARNEY ROAD OUTFALL SYSTEM

The northernmost major system contributing flow to East Lake is the Hillsborough Avenue / Harney Road System. This system begins in the vicinity of the intersection of Hanna Avenue and Harney Road. At this location is the Kash-n-Karry warehouse complex. The complex contains a high percentage of impervious area, some of which discharges down a rip-rap flume onto Harney Road. Stormwater runoff from the warehouse complex and adjacent areas discharges to the right-of-way of Harney Road and collects at the road's low point, which is approximately 300 feet north of Hillsborough Avenue. The flow is then conveyed through an inlet / pipe system to the Good Shepherd Church property, which is located adjacent to the east side of Harney Road. During higher frequency storms, the stormwater can flow overland through the church property and to the ditch system along Hillsborough Avenue, located to the south. Flow is then conveyed under Hillsborough Avenue and through a County-modified detention pond situated at the northern boundary of the East Lake subdivision. A pipe system then transfers stormwater from the pond's control structure into East Lake.

3.10 **THE EAST LAKE MALL OUTFALL** - NORTH SYSTEM

This system begins north of Hillsborough Avenue in an area of commercial / light industrial land use located east of the CSX Railroad. Stormwater runoff is collected in small roadside ditches, and is discharged toward Hillsborough Avenue. Flow is then conveyed under Hillsborough Avenue into the North storm sewer collection network within the East Lake Mall property. The North System discharges into the mall's stormwater pond, at which point it joins with the South System. After being attenuated in the pond, flow is discharged to a pipe system which carries it to East Lake.

3.11 **THE EAST LAKE MALL OUTFALL** - SOUTH SYSTEM

The South System begins at the northwest intersection of Hillsborough Avenue and 56th Street. From this location, stormwater is conveyed through a series of roadside ditches and culverts to a low point in the west right-of-way of 56th Street, approximately 500 feet south of Hillsborough Avenue. This low point has known to flood and overtop 56th Street. Under non-flooding conditions, the flow is generally conveyed under 56th Street and into a depressed, wet area on the west side of the East Lake

Mall property. Stormwater collected in this depressional area is discharged into the mall's South storm sewer collection system, and ultimately through the mall's stormwater pond and into East Lake.

3.12 THE 50TH / 56TH STREET OUTFALL SYSTEM

The fourth major stormwater conveyance system discharging to East Lake is the 50th / 56th Street System. This system originates at the 56th Street Commerce Park at the intersection of Harney Road and 56th Street. The stormwater runoff from the Commerce Park is attenuated in an onsite stormwater collection facility, and is discharged to the roadside ditch in the west right-of-way of 56th Street. The stormwater is then conveyed under 56th Street to the east, and into the east roadside ditch of Harney Road. Flow from the Harney Road ditch discharges onto private property, into a steep concrete channel. This well maintained concrete channel moves the flow in an easterly direction and delivers it through a series of pipes to a large unlined channel. At this point, flow from the Mary Help System (to be described below) joins with the flow from the 50th / 56th Street System. From this confluence, the large channel flows in a north, then east, direction and discharges to East Lake. The 50th / 56th Street System is unique in that it contains one of the few concrete-lined channels in the project area. Overall, the system is well maintained, with mowed roadside ditches and culverts free of debris.

3.13 THE MARY HELP OUTFALL SYSTEM

The final stormwater conveyance system that has East Lake as its depository is the Mary Help System. The Mary Help System provides an interconnection between the Judson Creek / Grant Park outfall and East Lake. From the ditches in the west right-of-way of I-4, the Mary Help System flows west in the south right-of-way of Martin Luther King Boulevard. The flow is then conveyed under the road to the north, and into the stormwater pond of the Fairgrounds Outlet Mall site. The mall's pond attenuates the flow and discharges north, under Chelsea Avenue, into an extensive pipe system within the grounds of the Mary Help School. The pipe system, which also collects stormwater runoff from the school site, eventually joins the 50th / 56th System.

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 East Lake Area watershed (ELA). This chapter provides a general description of these methods and approaches.

4.1 GENERAL METHODOLOGY AND DATABASE DEVELOPMENT

The United States Department of Agriculture's Natural Resources Conservation Service (NRCS), formerly known as the Soil Conservation Service (SCS), Runoff Curve Number (CN) method has been used to generate runoff hydrographs from rainfall data and watershed parameters. This method estimates expected storm water runoff based on soil and land cover characteristics as well as watershed flow path and slope characteristics. Runoff hydrographs have been developed using the NRCS Dimensionless Unit Hydrograph method.

Inflow hydrographs have been generated at junctions. Discharges have been 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's version of SWMM. The EXTRAN block of SWMM provides a hydrodynamic channel routing model.

4.2 HYDROLOGY

In the Hillsborough County version of SWMM, 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, inch;

I_a = initial abstraction, inch;

F = cumulative infiltration excluding $I_{a,}$ inch;

λ = non-dimensional parameter;

P_E = direct runoff, inch; and

S = potential maximum retention or infiltration, inch

The current version of the SCS-CN method assumes λ equal to 0.2 for usual practical applications. 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 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 texture. 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 impervious area percentage**	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

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

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

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
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%)
(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, ranges 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 below shows the definition of U_{p}, T_{p}, for a triangular unit hydrograph used in Hillsborough County version of SWMM.

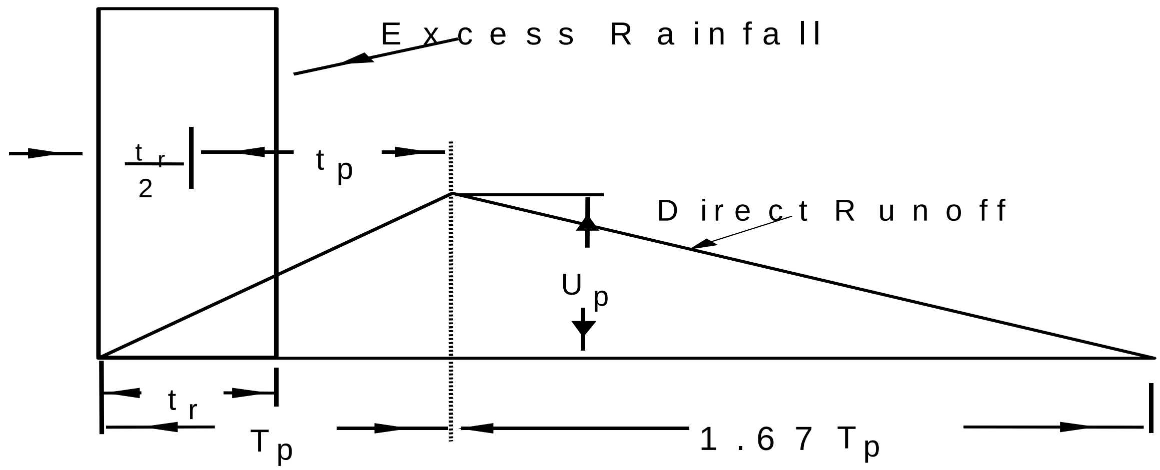


Figure 4-1 Definition of Unit Hydrograph

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 Eq. (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, inch;

$U_{n\text{-}m+1}$ = 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 (inches)**
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 ELA 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 ELA 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 the existing conditions land use. Each land use polygon in the GIS coverage is associated with an attribute that designates a classification from the Florida Land Use Classification Code System (FLUCCS) - also known as the Florida Land Use, Cover and Forms Classification System (FLUCFCS). There has been some development in the ELA watershed since 1995 that would is not represented in the SWFWMD coverage. As impervious area increases, runoff usually increases. However, SWFWMD has been regulating quantity of stormwater runoff since 1984. The objective of regulation has been to prevent peak runoff rates under the developed conditions from exceeding peak runoff rates associated with the predevelopment conditions. The Land Use/Land Cover data used in the analysis were shown in Figure 2-6. It is based on the SWFWMD GIS coverage for land use/land cover. The SWFWMD land use coverage is based on 1995 aerial infrared photography. SWFWMD uses the ARC/INFO GIS in Unix System, which is compatible to Hillsborough County's 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 the County's 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 FLUCCS code. Each soil type was then associated with a hydrologic soil group (A, B, C, or D) as discussed in previous sections, and each FLUCCS 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 times for each segment of the appropriate flow path. The methods used for calculating travel times are based on those 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	0.010	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)	0.30	0.19 - 0.47
Chisel Plow (>3 tons/acre residue)	0.40	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)	0.30	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)	0.30	0.16 - 0.47
Plow (fall)	0.06	0.02 - 0.10
Coulter	0.10	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

A modification of the U.S. EPA SWMM 4.31, Hillsborough County version of SWMM, was used 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 both computed peak discharge values and 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 invert elevations input on the conduit records to determine the channel 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
Straight headwall	

Table 4.4 - cont'd.
Culvert Entrance Loss Coefficients

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
Type of Structure and Design of Entrance	**Coefficient k_e**
Beveled edges, 33.7° or 45° 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
Pipe or Pipe-Arch, Corrugated Metal	
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
Box, Reinforced Concrete	
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
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^o to 25^o 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 portion of 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 Section 4.3.1.

4.3.5 NUMERICAL INSTABILITY

The EXTRAN model solves the St. Vennant equations that describes unsteady flow in channels based on three different numerical methods: the explicit finite difference method, the implicit finite difference method, and the 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 debugging. 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 are 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, decreased time step, adjusting 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

CALIBRATION AND VERIFICATION

5.1 OVERVIEW

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

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.

5.2 BOUNDARY CONDITIONS

The major outfalls within the ELA all have outflow points at the Tampa By-Pass Canal, the Harney Canal, or at the City of Tampa jurisdictional limits (along Judson Creek). The Southwest Florida Water Management District governs the operations of the Harney Canal and the Tampa By-Pass Canal. There are several major flood-control structures which regulate the water surface levels in the Harney and Tampa By-Pass Canals. According to District staff, the relevant operational water surface levels between Structures S-160 and S-162 are controlled at a peak elevation of 11.0 feet N.G.V.D. The normal water surface elevation (initial) for this segment of canal is assumed to be at 9.7 feet N.G.V.D. These "boundary conditions" elevations apply to the Orient Park Outfall and East Lake Outfall, as well. The relevant operational water surface levels between Structures S-162 and S-161 are controlled at a peak elevation of 15.0 feet N.G.V.D., while the normal level is assumed to be at elevation 13.7 feet N.G.V.D. These "boundary conditions" apply to the Fairgrounds, Harney Prairie and I-4 Outfalls, and also to the smaller project area outfalls at the By-Pass and Harney Canals. The assumed initial water surface elevations along Tampa By-pass Canal with the design storm events effects will reflect the peak stage at Structures S-160, S-161 and S-162 controlled by SWFWMD. The Judson Creek / Grant Park

Outfall "boundary condition" was assumed to be at a constant elevation of 28.0 feet. This value was arrived at through conversations with City of Tampa staff, and through infrastructure data obtained during the project.

5.3 DATA COLLECTION

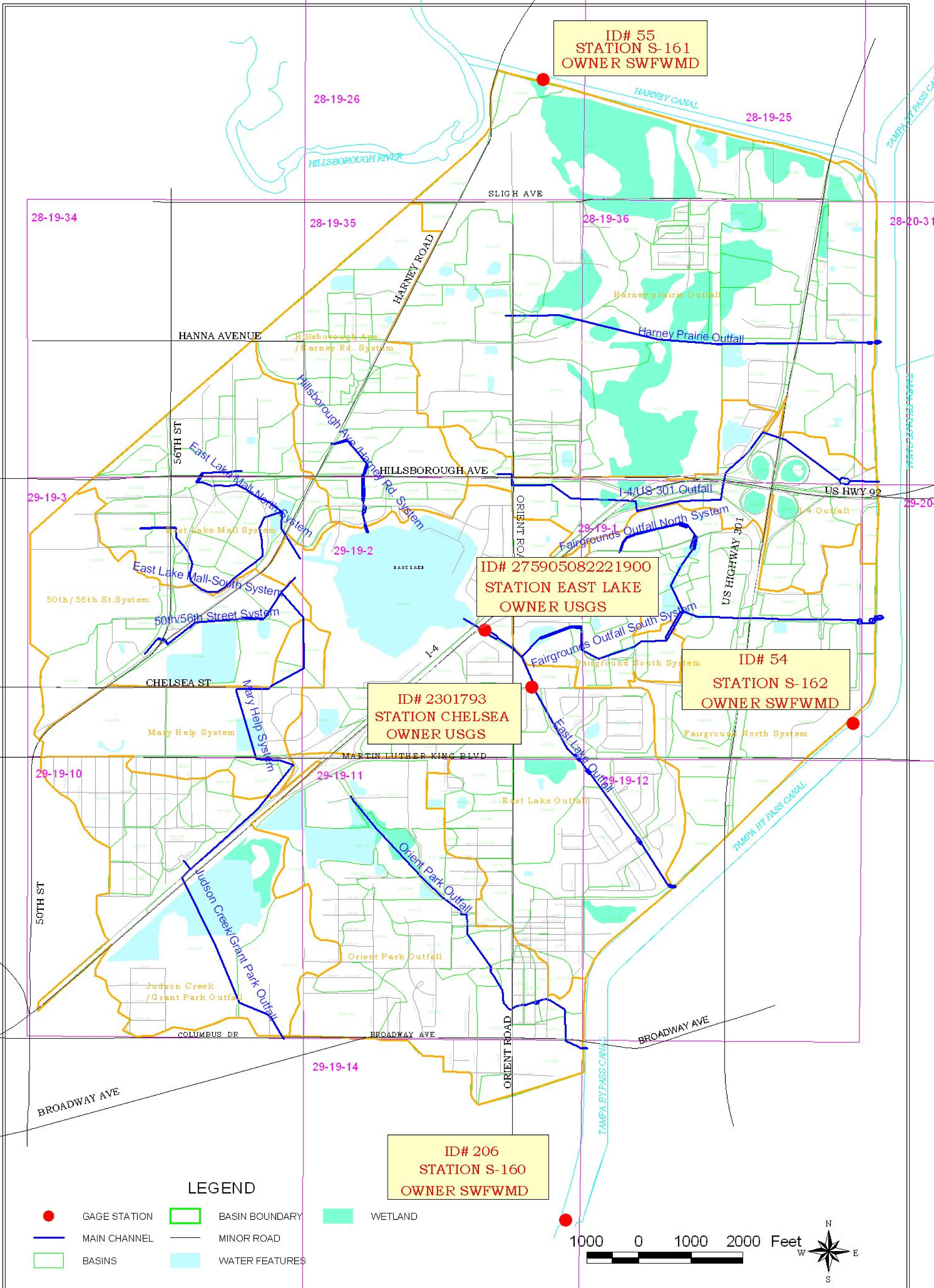
The East Lake Area watershed is a highly developed urban area without significant changes in the last decade. Therefore, data of the historical events and the most recent storm events are all considered suitable for watershed model calibration and verification.

Several storm events had a dramatic impact on the East Lake Watershed occurred between July 1990 to June 1999. These selected storm events are used in this study for model calibration and verification and are as follows:

1. July 13-19, 1990 with a 140 hours duration
2. July 9-14, 1991 with a 140 hours duration
3. June 23-30, 1992 with a 190 hours duration
4. May 18-23, 1999 with a 120 hours duration
5. June 11-18, 1999 with a 160 hours duration

There were no available stage / discharge gages within the East Lake Area drainage system except for the stage of East Lake. The NOAA rainfall data, collected at Tampa International Airport (TIA) and the SWFWMD East Lake Level and rain gages of the Harney Canal (S-161), were used to calibrate the model for those storm events recorded prior to new gages which were installed in the East Lake Outfall near Chelsea Street. In conjunction with the information of the SWFWMD and TIA rain gages, the newly installed rain / stage gage near the East Lake Outfall just south of Chelsea Street was also used for calibration with the latest available lake level elevation in 1999 of East Lake. The USGS stage gage located at East Chelsea Street is identified as **Station Number 02301793,** while the rainfall gage located at Orient Road is identified as **Station Number (USGS No. 275917082222500)**. **Figure 5-1** shows the gage station locations.

The 1999 rainfall records were collected from the S-161 gage; while, the rainfall records prior to 1999 were collected from the TIA gage. The TIA rainfall records were used to compare with the SWFWMD East Lake gage before 1999. However, the S-161 rainfall records were compared with the USGS Chelsea gage after 1999. A summarized table of the recorded data for these rainfall gage stations is provided in Table 5–1. This table lists the appropriate total rainfall



Hillsborough County
Florida

EAST LAKE AREA
STORMWATER MANAGEMENT
MASTER PLAN
(APRIL 2001)

Public Works Department
Engineering Division
Stormwater Management Section

FIGURE 5-1
GAGE STATION LOCATION
MAP

intensities occurring during the storm events that were used for calibration and verification. A graphical representation of rainfall recorded data for hourly operating gage stations can be observed as **Figure 5.2a to 5.2e**. Figure 5.1 shows the locations where this rainfall data was collected.

Streamflow parameter data includes recorded values of stage and rainfall intensity during the storm events used for calibration, and verification procedures. **Tables 5-1 and 5-3** contain data collected from this USGS gage for storm events considered for the purpose of model calibration and verification.

In addition, Lake Water Surface Elevation provided by SWFWMD was used for the time period subjected to study for model calibration and verification. A complete table with this information is provided for each selected storm event in Table 5-3.

5.4 EXISTING CONDITIONS MODEL CALIBRATION

In the modified EPA SWMM model, most of the required input data simply describes the geometry and size of the hydraulic and hydrologic units of the subdivided study area. These data, such as the subbasin areas, channel widths, lengths and cross drain dimensions, are known quantities and are subject to very little interpretation. A few of the input requirements; however, are not derived from measurable qualities of the subcatchements. These data are referred to as calibration parameters and include:

- The maximum and minimum infiltration rates for pervious areas
- The pervious and impervious depression storage volumes
- The channel and overland flow roughness coefficients

These parameters are first approximated with values derived from local data (e.g., aerial topographic photographs and soil surveys), but their final values are ultimately determined through model calibration.

After a fundamental hydrologic and hydraulic check, a calibration process is conducted to evaluate the general reliability of the model for producing reasonable results.

The July 13-19, 1990 event was selected for calibrating the existing conditions model due to the availability of recorded data, the magnitude and flooding which occurred during this storm event.

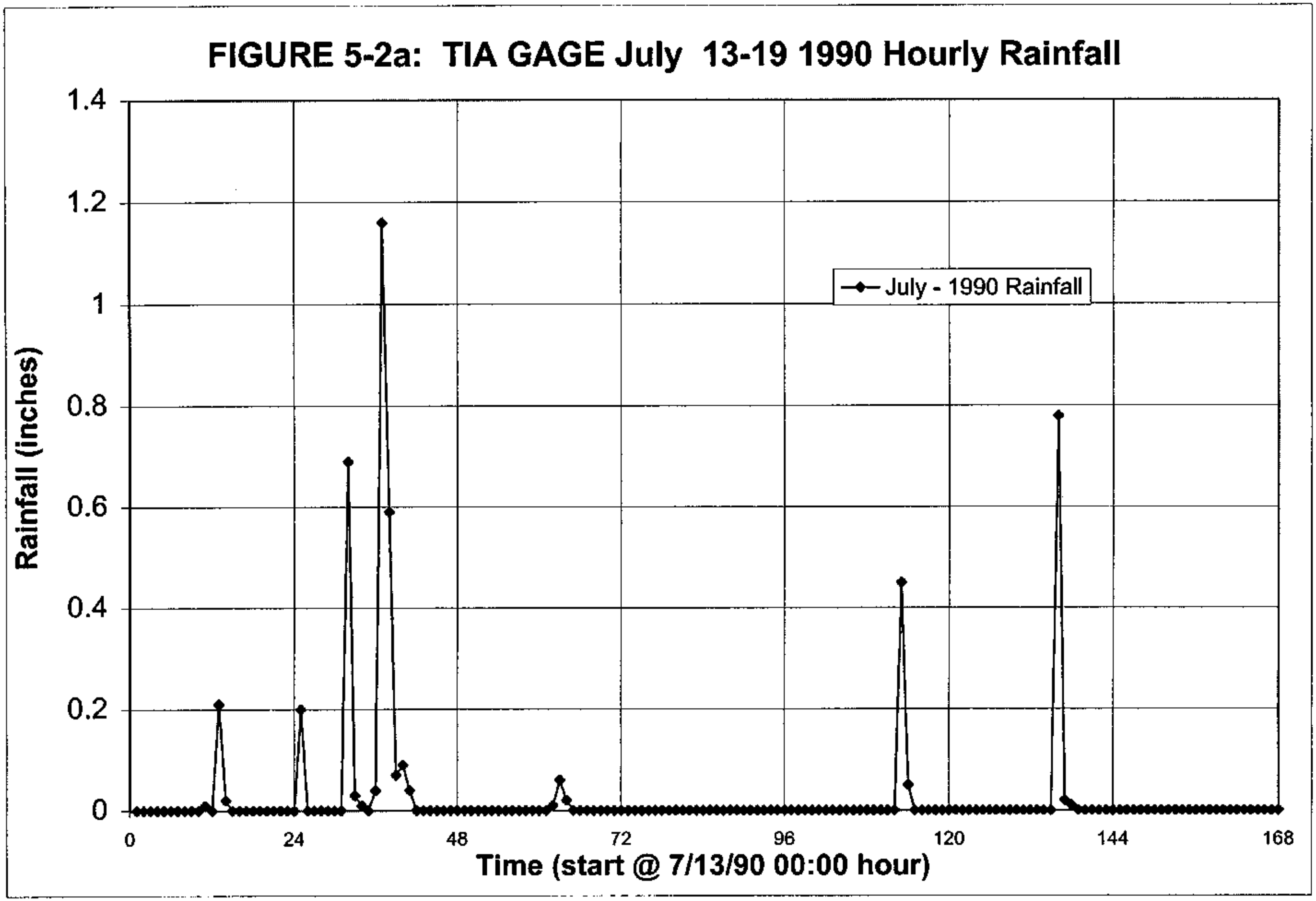


FIGURE 5-2a: TIA GAGE July 13-19 1990 Hourly Rainfall
July - 1990 Rainfall
Rainfall (inches)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
24
48
72
96
120
144
168
Time (start @ 7/13/90 00:00 hour)

FIGURE 5-2b: TIA GAGE July 7-14 1991 Hourly Rainfall

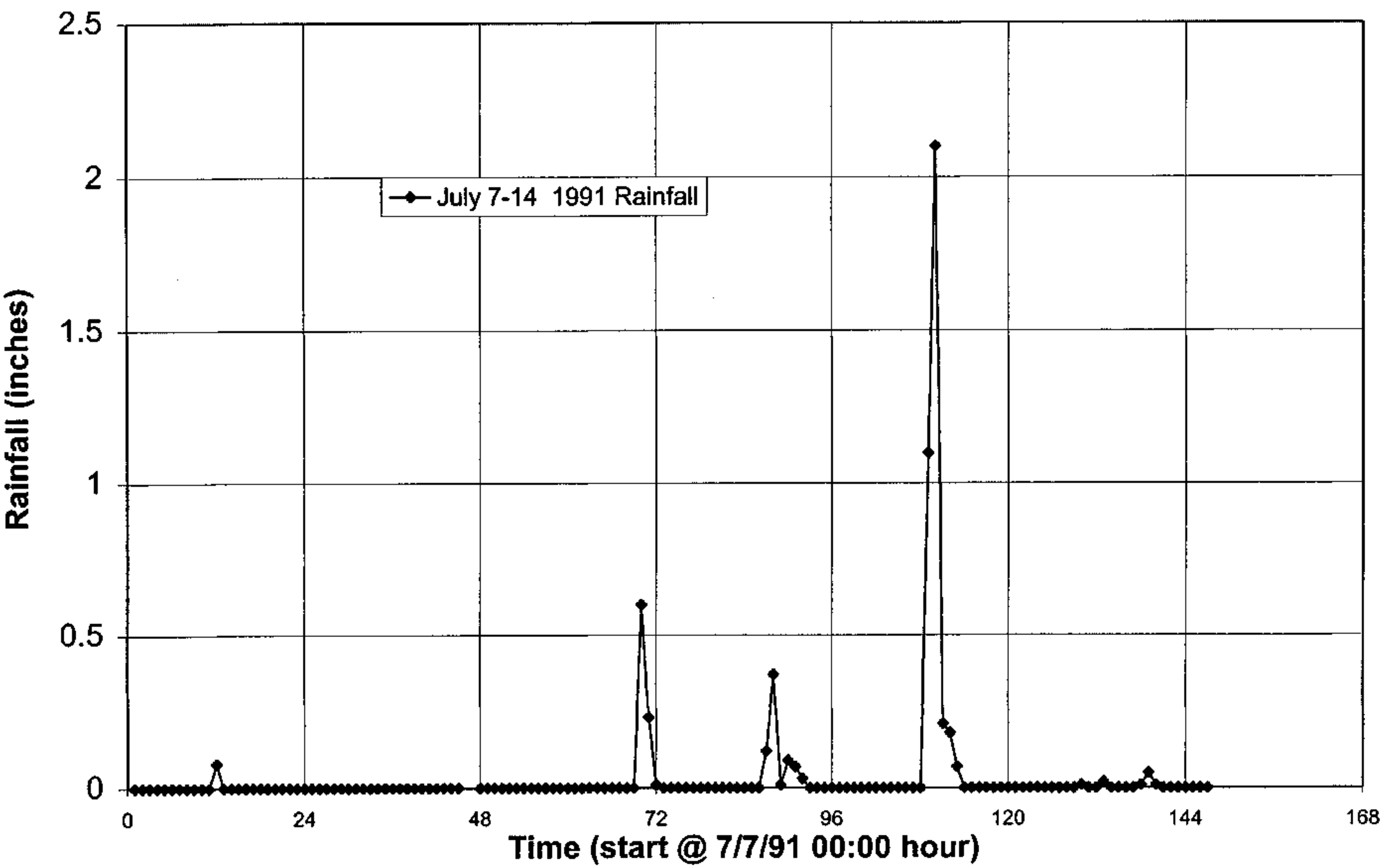


Figure 5-2c: S-161 gage June 23-30, 1992 Hourly Rainfall

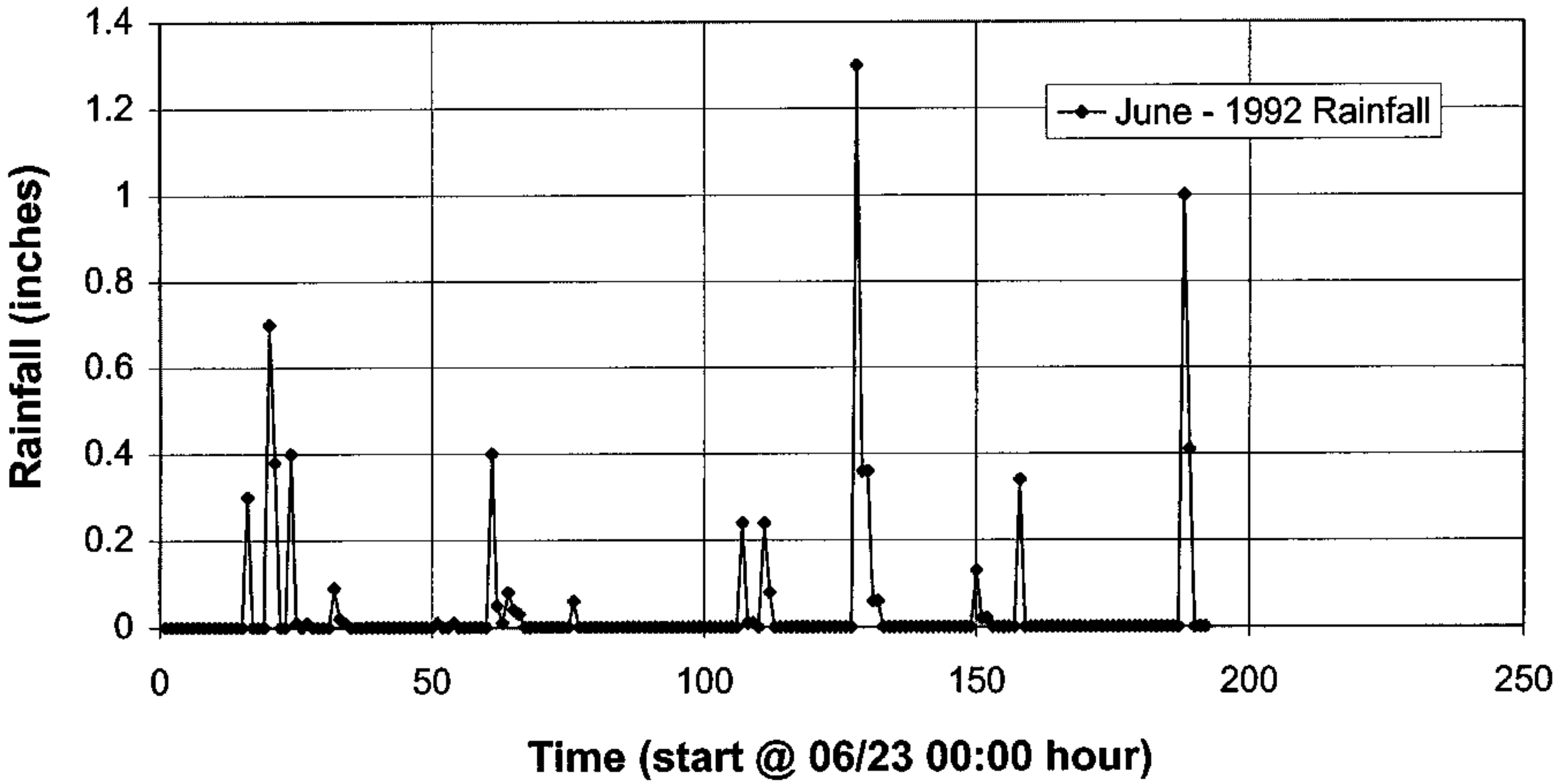


Figure 5-2d: S-161 Gage May 18-23, 1999 Hourly Rainfall

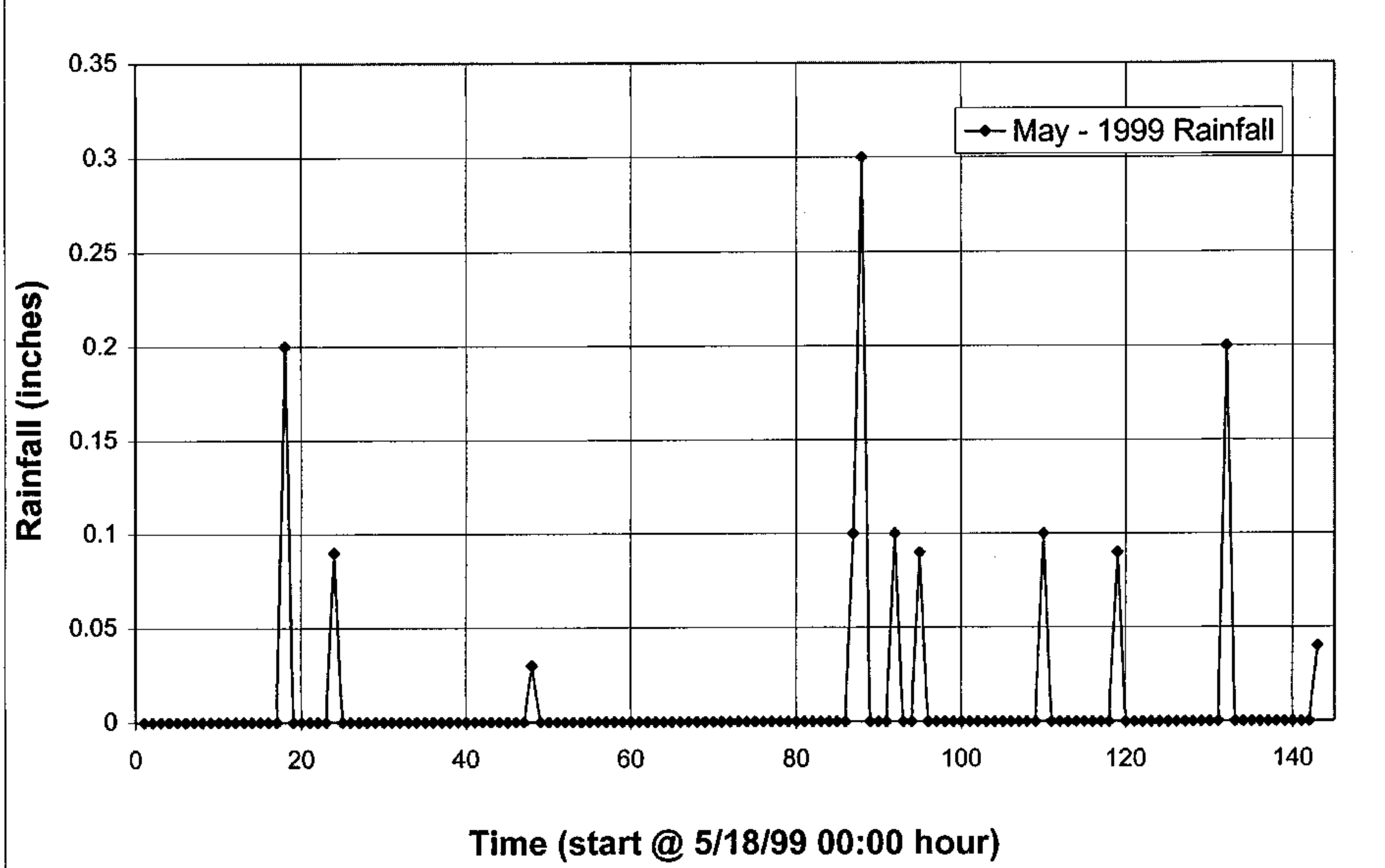


Figure 5-2e: 6/01 thru 6/20 1999 Hourly Rainfall

(use 11-18 6/99 for Calibration)

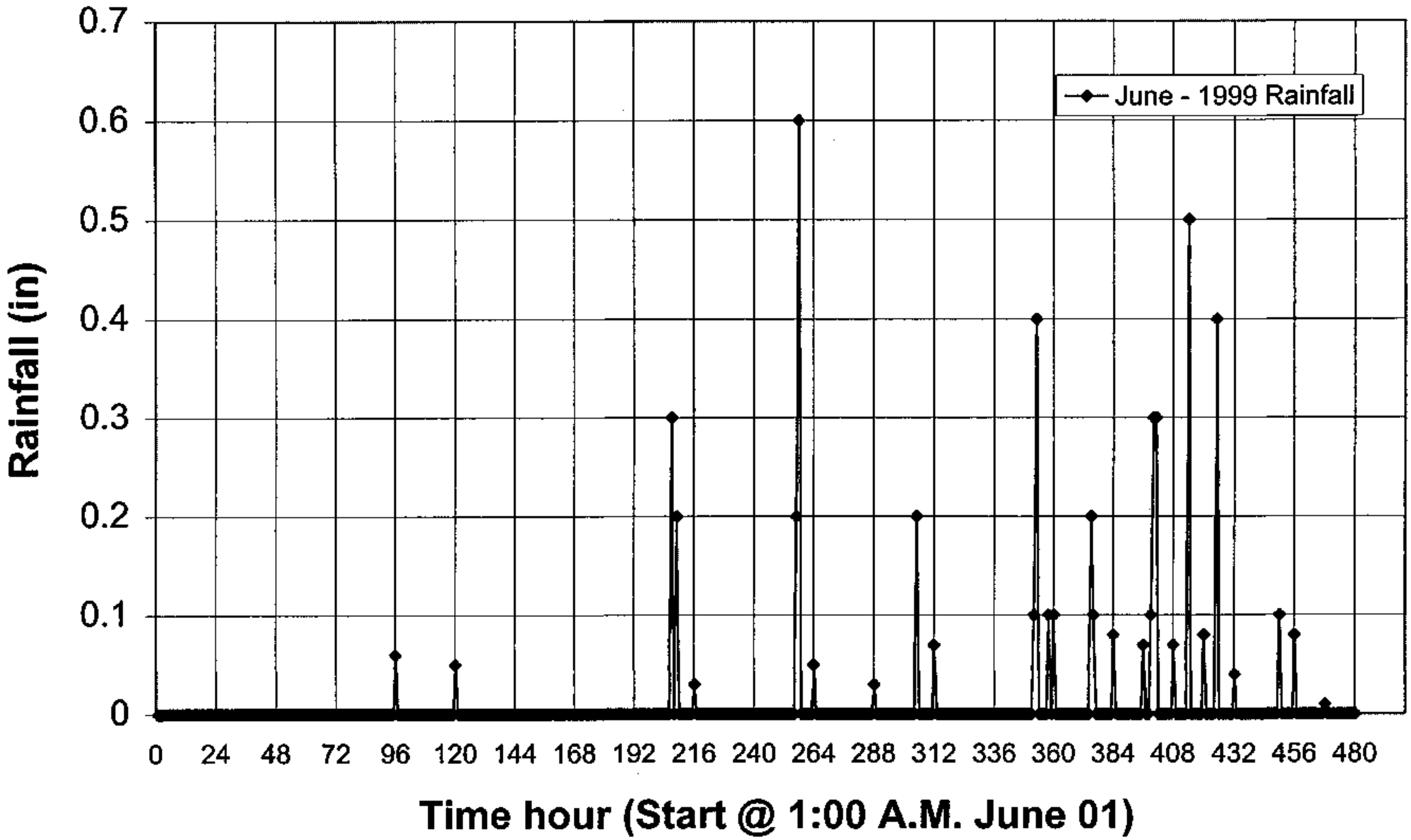


TABLE 5 - 1 RAINFALL GAUGE DATA SUMMARY

	RECORDED STORM EVENT	RAINFALL STATION NAME	
		TIA NOAA	S-161
TOTAL RAINFALL INTESITY	JULY 13-19 1990	4.56"	
	JULY 9-14 1991	5.37"	
	JUNE 23-30 1992	4.13"	7.25"
	MAY 18-23 1999		1.34"
	JUNE 11-18 1999		4.09"
Hourly recording data		x	
Daily recording data			x

** includes recorded data on December 29th due to 0" rainfall recorded on December 28th.
*** No recorded data available.

TABLE 5 - 2

RECORDED STORM EVENT	S-161 SWFWMD STA# 6614 STAGE [FT-NGVD]	CHELSEA ST USGS STA# 02301793 STAGE [FT-NGVD]
JULY 13-19 1990	23.66	
JULY 9-14 1991	24.51	
JUNE 23-30 1992	23.88	
MAY 18-23 1999		22.36
JUNE 11-18 1999		22.65

* No two decimal accuracy data available
NOTE: Above data represents peak values during the appropriate storm event.

TABLE 5-3

GAGE INITIAL STAGE DATA SUMMARY

RECORDED STORM EVENT	USGS STATION NAME	
	S-161 SWFWMD STA# 6614	CHELSEA ST. USGS STA# 02301793
	STAGE [FT-NGVD]	STAGE [FT-NGVD]
JULY 13-19 1990	23.18	
JULY 9-14 1991	23.12	
JUNE 23-30 1992	22.9	
MAY 18-23 1999		21.5
JUNE 11-18 1999		21.69

* No two decimal accuracy data available

The East Lake Area watershed covers an area of 7.9 square miles. The total rainfall for the above storms, subject to study for calibration, was not uniformly distributed. Distribution ranges between 4.5 inches at the TIA gage station in the southern part of the watershed and 1.34 inches at the S-161 gage located north of the watershed (see Table 5-1). For the daily record gages, the rainfall distribution of the closest hourly record gage is used, while keeping the total intensity of the gage in mind. Hourly record distributions are used for the daily records as follows:

> Lake Water Surface Elevation and USGS streamflow gage data is used as initial water elevation input for the model calibration. It is important for the model to produce reliable stages in this portion of the watershed since observed flooding has occurred in the past. Therefore, the initial junction elevation is calculated with linear interpolation between the elevation values where (lakes and streamflow gages) recorded data was available.

The objectives of calibration are to better match the stages and discharges of the calculated hydrographs based on the recorded data. Adjustments to the infiltration rates increase or decrease flow rates during the time period of runoff. Similarly, adjustments to the total infiltration capacity affect the runoff volume, shift the time of the runoff, and alter the recession limb of the hydrograph. Based on a given set of calibration parameters, the model is adequately calibrated when the observed and calculated hydrograph agree with the 1990 storm. The model is then ready for further verification using different storm events.

The maximum collected water surface elevations at the SWFWMD and the two USGS gages with in the East Lake Watershed are found to be generally higher than the computed gage data for the July 1990 event. **Figure 5.3a** contains the graphical representation of this comparison.

5.5 EXISTING CONDITIONS MODEL VERIFICATION

Model verification is an important step which ensures that adjustments made to the model during calibration are appropriate and to ensure that the model will produce reliable results.

The July 9-14, 1991, June 23-30, 1992, May 18-23, 1999 and June 11-18, 1999 rainfall events are selected as the verification events due to the availability of gage data and the magnitude of each storm. Total rainfall recorded data at SWFWMD stations during the two June storm events are summarized in Table 5-1. Lake Water Surface Elevation and USGS streamflow

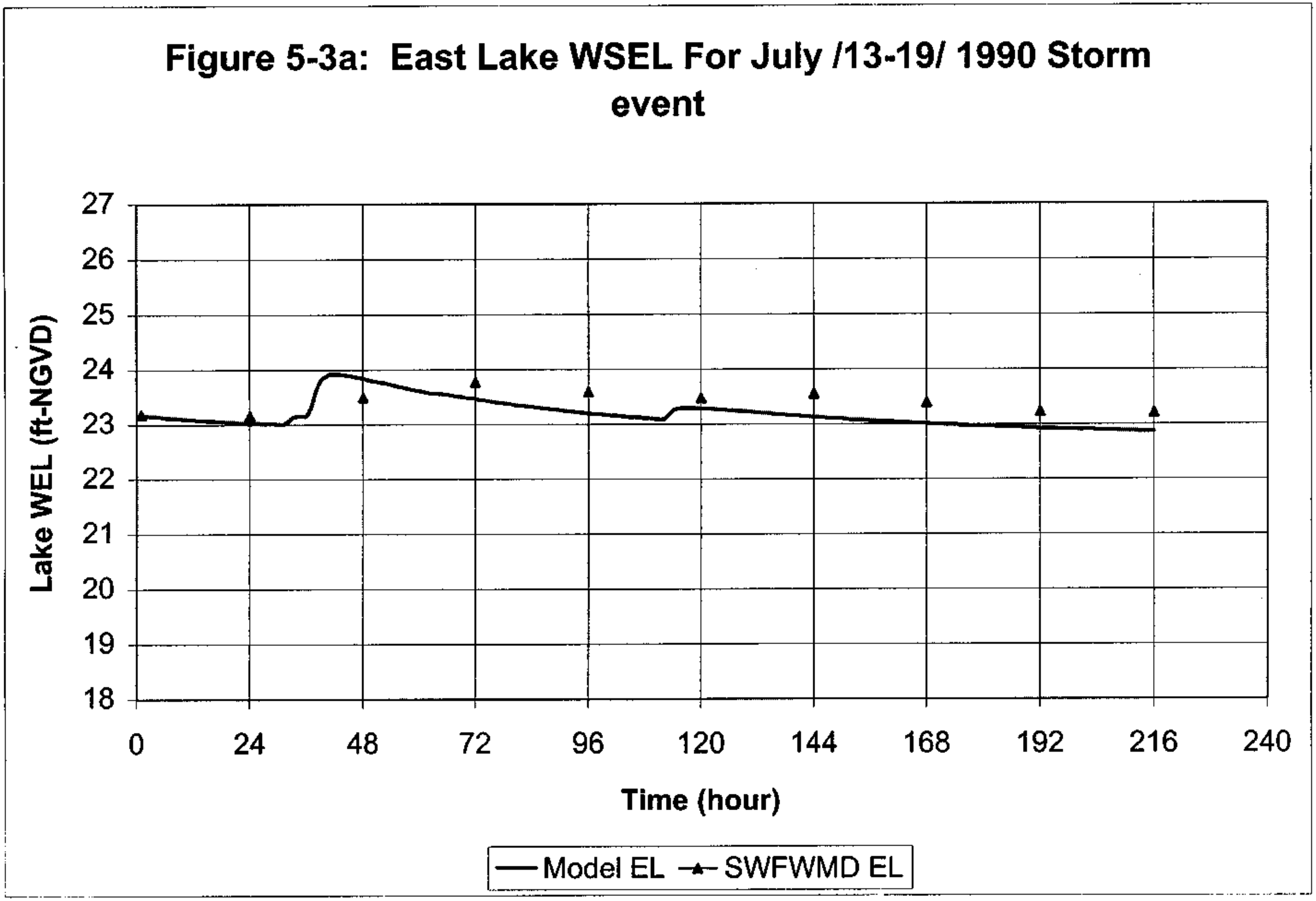


Figure 5-3a: East Lake WSEL For July /13-19/ 1990 Storm event
Lake WEL (ft-NGVD)
27
26
25
24
23
22
21
20
19
18
0
24
48
72
96
120
144
168
192
216
240
Time (hour)
Model EL
SWFWMD EL

gage recorded data collected prior to and following the June events are also considered in the verification process. USGS streamflow gage data recorded at the beginning of each verification storm event is summarized in Table 5-3.

The verification event's hydrologic input file was developed using the same SWFWMD and USGS source data for the appropriate storm events.

An important aspect of the hydrologic model that evolved during the calibration process was the establishment of antecedent soil moisture conditions. The numerous lakes and retention ponds are not the only storage elements that retain precipitation and runoff during storm events. The unsaturated portion of the soil profile acts as a storage reservoir for the water, which infiltrates the ground. In Florida, where the water table is usually very shallow, the available soil moisture holding capacity can vary over a wide range depending on the seasonal elevation of the water table. It is apparent in model calibration that the antecedent water table elevation (elevation at the beginning of the storm event) is an important factor, which determines the resultant magnitude of runoff.

Rainfall in antecedent periods of 5 to 30 or more days prior to a storm is commonly used as indices of watershed wetness. An increase in an index means an increase in the runoff potential. Such indices are only rough approximations because they do no include the effects of evapotranspiration and infiltration on watershed wetness. Therefore, it is not worthwhile to attempt great accuracy in computing the index described below. The index of watershed wetness used with the runoff estimation method is Antecedent Moisture Condition (AMC). Two levels of AMC are used:

AMC-I - Lowest runoff potential. The watershed soils are dry enough for satisfactory plowing or cultivation to take place.

AMC-II - The average condition.

Using the traditional method the AMC can be estimated from 5-day antecedent rainfall by the using the information below, which gives the rainfall limits by season categories.

Total 5-day Antecedent Rainfall

AMC Group	Dormant Season	Growing Season
AMC-I	Less than 0.50"	Less than 1.40"
AMC-II	0.50" to 1.10"	1.40" to 2.10"
AMC-III	Over 1.10"	Over 2.10"

A comparison analysis between the rainfall daily average value uniformly distributed to the rainfall gage value recorded at USGS streamflow gage East Lake Watershed for each particular storm event is necessary. As shown in Table 5-1 and Table 5-2, the June 1992 has a high rainfall precipitation volume but generates the lowest stage at the S-161 gage. Also, the June 1999 storm that generates a high stage at the USGS gauge has a low rainfall daily average. The above mentioned analysis requires adopting a different Antecedent Moisture Condition for each storm event studied for calibration verification purposes. AMC-I and AMC-II based on the lake water surface elevation is used for the June 11-18, 1999 storm. A table of the curve number adjustments is provided below.

CN Adjustment lookup table F.3 in Stormwater Management (Wanielista, Yousef, 1993)

AMC 2	AMC 1	AMC 3
100	100	100
95	87	98
90	78	96
85	70	94
80	63	91
75	57	88
70	51	85
65	45	82
60	40	78
55	35	74
50	31	70
45	26	65
40	22	60
35	18	55
30	15	50

Figure 5-4a shows the verification results of the July 1991 event for East Lake water levels. Similar to calibration results, the computed maximum water level in East Lake is relatively high compared to the observed water level. As for the June 1992 event, the verification results for the

East Lake water levels are shown on **Figure 5-4b**. The figure reveals computed maximum water level in East Lake is lower than the observed water level due to the non-uniform rainfall distribution. Although the peak rainfall of the July 1990 event is smaller than the June 1992 event (see Figures 5-2a and 5-2d), the maximum water levels in East Lake are reversed. Figures 5-3a and 5-4b show water levels for the July 1990 event are higher than the June 1992 event. This effect is due to a big rainfall event that had occurred about 3 hours prior to the peak rainfall of the July 1990 event.

USGS installed a gage station (USGS No. - 02301793) at East Chelsea Street in January 1999. Recorded water levels at this station are available after January. Two events, May 1999 and June 1999, were verified at this station. **Figure 5-4c** shows the verification results for the May 1999 event, and **Figure 5-4d** shows the verification results for the June 1999 event. For both events, the simulated water levels at that station are lower than the observed due to several reasons. The USGS gage was just installed at the beginning of 1999. In addition, after its installation in January, the gage needed to be calibrated and verified. The spring of 1999 was a relatively dry, so records were not conservative enough for verification due to the evaporation effect. In other words, water levels in East Lake may be lower than the ground water table. Seepage inflow to the lake, which was not included in the numerical model, contributed to the total inflow. Lastly, the peak rainfalls and the total rainfalls for the May and June 1999 events were relatively small.

5.6 CONCLUSION

Based on the availability of field observation data, the July 1990 event was selected for model calibration. The model was further verified with events of July 1991, June 1992, May 1999, and June 1999, respectively.

In the July 1990 and July 1991 events, in which the East Lake water levels were compared, the simulated results agree well with the data observed. The computed maximum water levels are a slightly higher than the observed results. In the June 1992 event, the simulated results are also matched well with the observed results. In the May 1999 and June 1999 events, in which the water levels at Chelsea Street gage station were compared, the simulated water levels are generally lower than the data observed. This may have been affected by runoff reduction due to the dry season evaporation, less base flow, and a high initial infiltration around the area surrounding East Lake. Another factor may occur because the lack of calibration and verification for the newly installed USGS gage at East Chelsea Street.

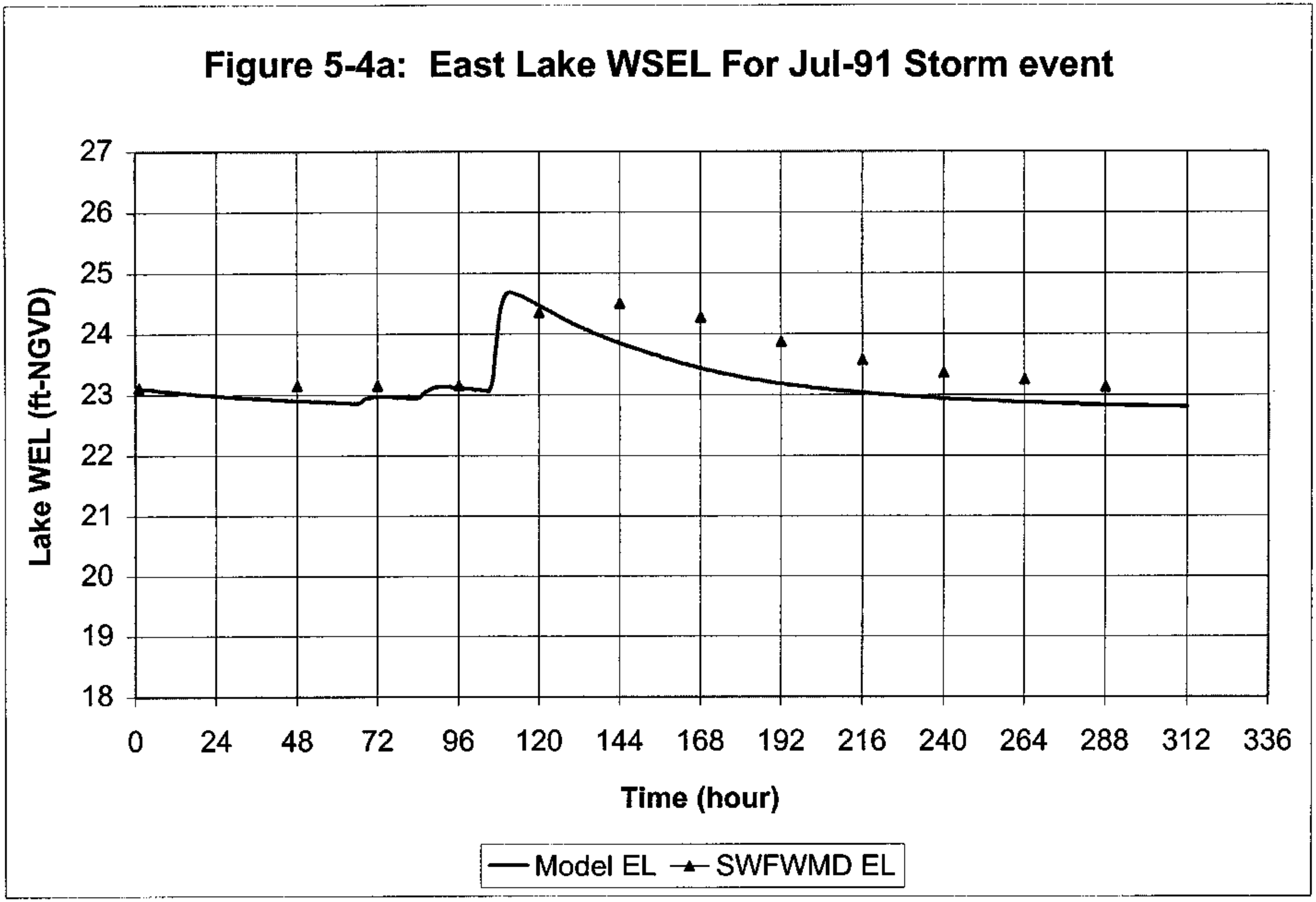


Figure 5-4a: East Lake WSEL For Jul-91 Storm event
27
26
25
24
23
22
21
20
19
18
Lake WEL (ft-NGVD)
0
24
48
72
96
120
144
168
192
216
240
264
288
312
336
Time (hour)
Model EL
SWFWMD EL

Figure 5-4b: East Lake WSEL For June -1992 Storm event

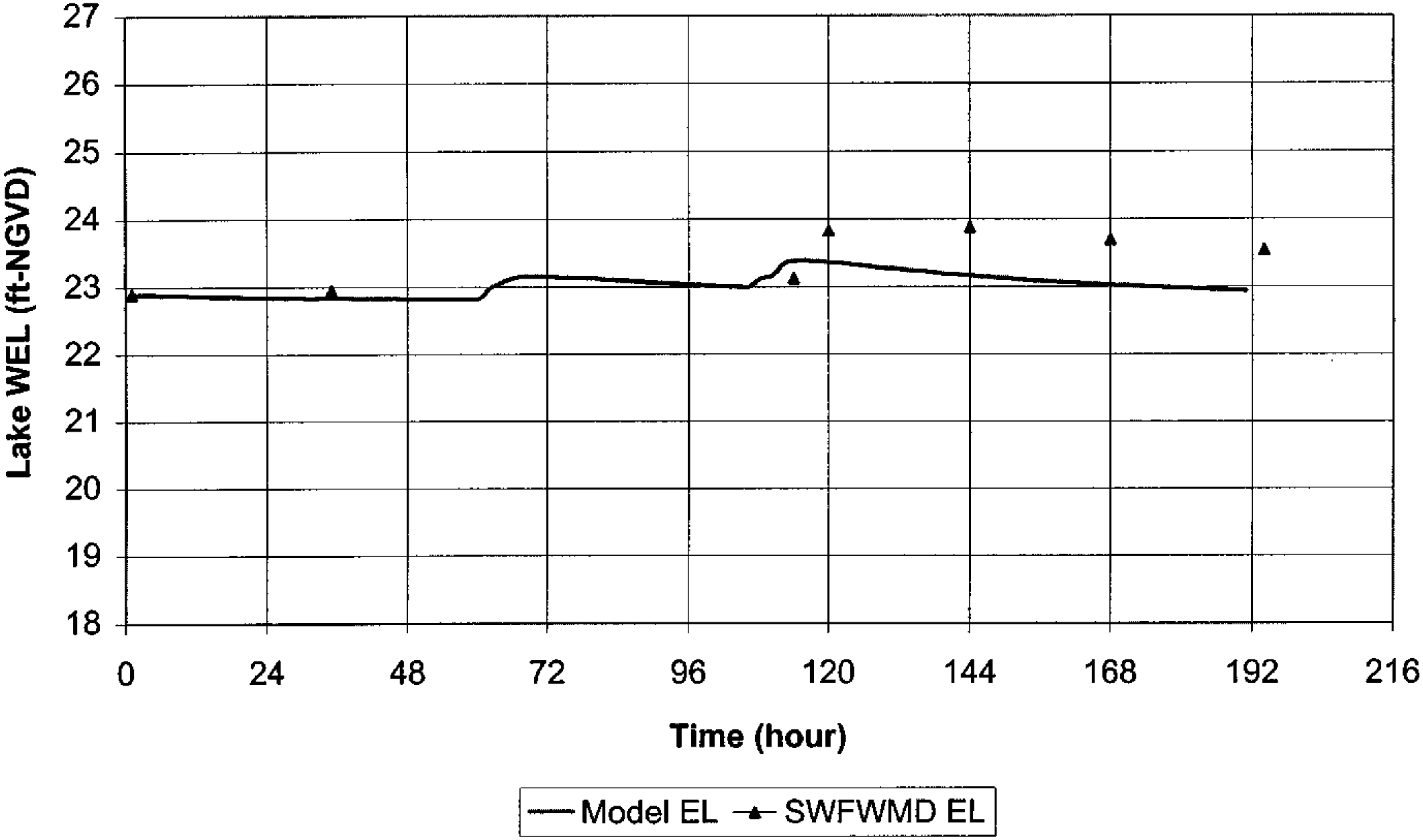
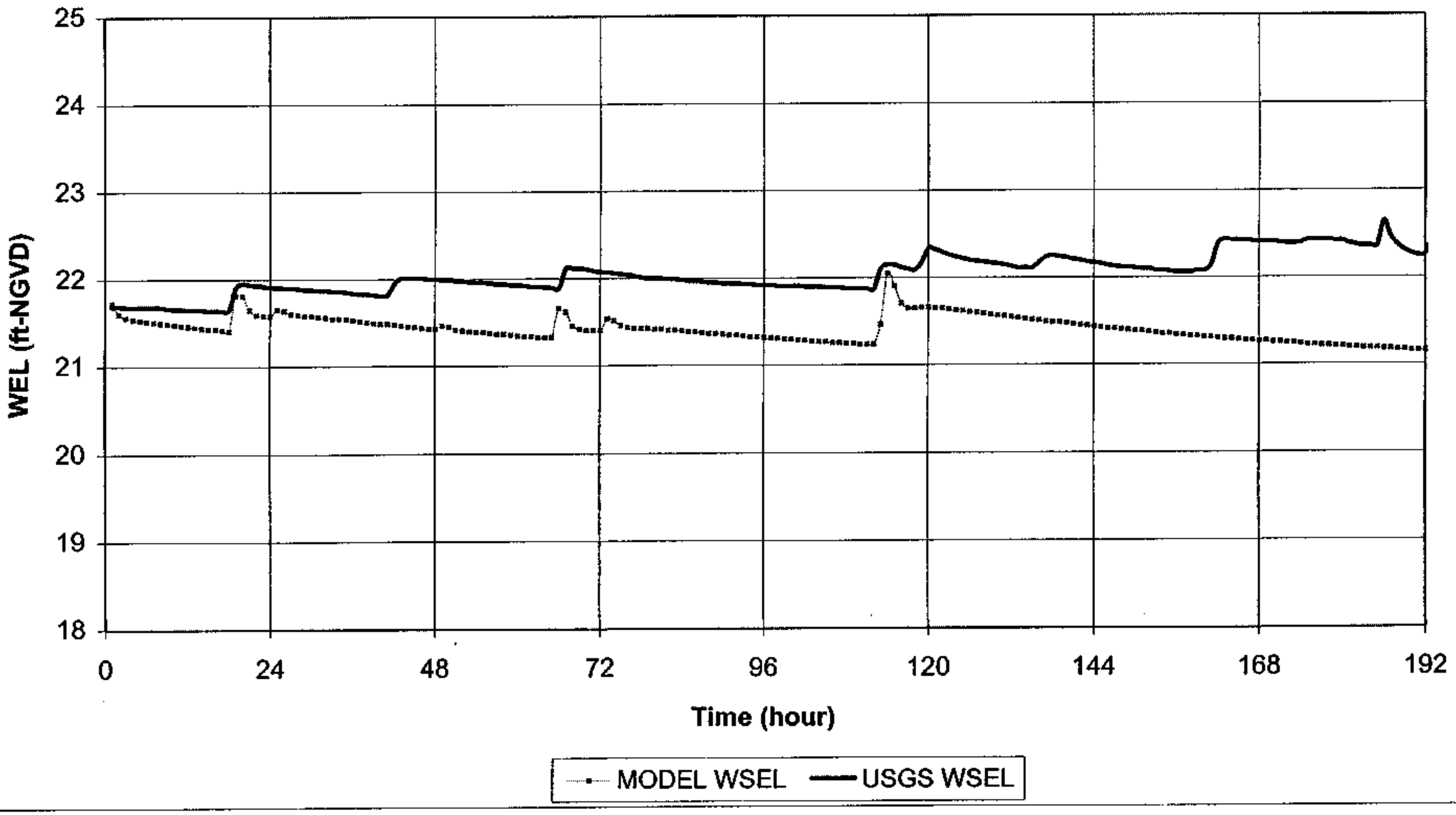


FIGURE 5-4c Not available At Time of Posting.

Figure 5 - 4d: Chelsea St. WSEL For June 11-18, 1999 Storm Event



In all five calibration and verification events, after peak time, the simulated water levels in East Lake drop faster than the data recorded. The explanation for this phenomenon is that, in reality, the seepage inflow and/or non-point surface sheet flow to the lake, which were not included in the model, delays the water level drop.

In general, this model is well calibrated and verified. The model is capable of simulating major storm events in the East Lake watershed.

EXISTING CONDITIONS FLOOD LEVEL OF SERVICE

6.1 EXISTING CONDITIONS AND STANDARD DESIGN STORM EVENTS

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

There are six standard design storms used to analyze the flooding impact in the East Lake Area watershed. The standard design storms used in this study are the100yr, 50yr, 25yr, 10yr, 5yr and 2.33yr (mean annual). 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.

The total amount of rainfall for a particular frequency was determined by using the SWFWMD rainfall map, which may vary with physical location inside the watershed.

The total rainfall used for each design storm event is as follows in **Table 6.1**:

Table 6.1
Standard Design Storm Rainfall Intensities

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

East Lake's initial lake elevation used in the stormwater management model at the start of the design storm event was determined from the recorded data provided by SWFWMD.

6.2 EXISTING CONDITIONS MODEL SIMULATION RESULTS

The East Lake Area's stormwater management model results for the 2.33-yr, 5-yr, 10-yr, 25-yr, 50-yr and 100-yr design storm events are listed in **Table 6.2**. This table presents peak flood elevations in the main channel network.

Each subbasin's hydrograph is generated by the hydrologic model and routes (for Connectivity Map see Exhibit 5-1) through the hydrodynamic model, to calculate stages and discharges. These main channel profiles are presented in Exhibit 6-1 (a) through 6-1 (l). The following sections discuss the individual problem areas predicted by the EXTRAN model.

The East Lake Watershed is divided into 12-main Channel systems, which are listed below:

1. The Harney Prairie Outfall
2. The I-4 Outfall
3. The Fairgrounds Outfall – North System
4. The East Lake Outfall
5. The Orient Park Outfall
6. The Judson Creek / Grant Park Outfall
7. The Fairgrounds Outfall – South System
8. The Hillsborough Avenue / Harney Road Outfall System
9. The East Lake Mall Outfall – North System
10. The East Lake Mall Outfall – South System
11. The 50th / 56th Street Outfall System
12. The Mary Help Outfall System

The objective of this section is to present both the areas and major structures where the computer modeling indicates that insufficient channel capacity exists and flooding occurs along the East Lake Area watershed main channel alignments.

TABLE 6.2

DESIGN STORM MODEL OUTPUT SUMMARY

Major Road Name	Model Junction ID	Channel Alignment [Station]	DESIGN STORM EVENT ELEVATIONS 100-YR	50-YR	25-YR	10-YR	5-YR	2.33-YR	Overtop AT 25-YR
(1.) THE HARNEY PRAIRIE OUTFALL MAIN CHANNEL ALIGNMENT									
	100008	0	15.80	15.70	15.48	15.35	15.22	15.07	
TBC Bank	105040	64	15.56	15.44	15.19	15.05	14.90	14.75	
	105060	269	15.73	15.60	15.33	15.18	15.01	14.85	
Maple Lane	105070	369	16.63	16.48	16.17	16.01	15.84	15.65	NO
	105080	1409	17.06	16.91	16.60	16.42	16.23	16.02	
US 301	105090	1548	17.09	16.94	16.62	16.45	16.26	16.05	NO
	105100	3118	17.75	17.59	17.23	17.03	16.82	16.60	
	105110	3148	18.31	18.07	17.57	17.33	17.08	16.80	
	105120	4348	18.61	18.39	17.87	17.58	17.27	16.93	
	105130	6348	19.65	19.54	19.29	19.15	19.00	18.84	
	105140	6848	22.67	22.62	22.37	22.24	22.12	21.95	
	105150	7336	31.09	31.02	30.64	29.10	28.71	28.37	
Orient Rd	105160	7386	31.93	31.78	31.13	30.79	30.52	30.21	NO
(2.)THE I-4 OUTFALL MAIN CHANNEL ALIGNMENT									
	100010	0	15.49	15.40	15.18	15.07	14.93	14.79	
	105985	500	17.13	17.08	16.87	16.73	16.60	16.45	
I-4	105975	585	19.46	19.18	18.49	18.15	17.85	17.48	NO
	105932	1960	19.76	19.54	19.17	19.07	18.97	18.86	
US 301	105927	2420	21.60	21.40	20.97	20.76	20.54	20.26	NO
	105928	2970	21.64	21.45	21.03	20.83	20.61	20.36	
	105947	3630	21.67	21.48	21.07	20.88	20.67	20.44	
I-4	105950	3800	22.64	22.29	21.71	21.48	21.22	20.91	NO
I-4	104416	4000	23.18	22.71	21.93	21.69	21.44	21.11	NO
	104420	4960	23.18	22.72	21.95	21.72	21.48	21.14	
	104428	5760	23.19	22.72	21.96	21.73	21.49	21.16	
I-4	104432	5969	24.15	23.80	23.09	22.76	22.38	21.88	NO
I-4	104442	6459	25.95	25.51	24.49	23.62	23.03	22.25	NO
	104454	7159	29.18	29.15	29.07	28.96	28.66	28.40	
	104462	7559	30.03	29.82	29.50	29.35	29.19	29.02	
	104466	7859	30.89	30.72	30.4	30.3	30.18	30.06	
Orient Rd.	104470	8359	34.03	33.89	33.63	33.54	33.46	33.36	NO
(3.) FAIRGROUNDS OUTFALL - NORTH SYSTEM MAIN CHANNEL ALIGNMENT									
	100013	0	15.39	15.30	15.09	14.97	14.84	14.70	
TBC Bank	104002	64	16.68	16.35	15.72	15.41	15.08	14.77	NO
	104007	64	17.52	17.21	16.57	16.21	15.80	15.35	
	104013	284	18.73	18.51	18.06	17.78	17.44	17.04	
Garden Lane	104020	331	20.56	20.11	19.26	18.69	18.09	17.47	NO
	104025	1011	21.07	20.67	19.92	19.43	18.88	18.27	
Oak Fair Blvd	104030	1091	21.59	21.14	20.20	19.68	19.10	18.44	NO
	104040	1801	21.90	21.48	20.61	20.13	19.56	18.92	
	104060	2301	22.12	21.72	20.91	20.46	19.91	19.28	
US 301	104063	2431	22.72	22.29	21.37	20.88	20.26	19.55	NO
	104070	2505	23.47	23.08	21.86	21.26	20.54	19.70	
	104075	3005	23.52	23.12	21.92	21.31	20.60	19.76	
	104080	3195	23.84	23.44	22.22	21.61	20.88	20.01	
	104085	3720	24.45	24.15	23.51	23.17	22.84	22.47	
	104090	4270	24.56	24.27	23.65	23.31	22.98	22.63	

Major Road Name	Model Junction ID	Channel Alignment [Station]	DESIGN STORM EVENT ELEVATIONS						Overtop AT 25-YR
			100-YR	50-YR	25-YR	10-YR	5-YR	2.33-YR	
	104095	4632	24.79	24.54	23.90	23.48	23.10	22.71	
	104100	5054	24.98	24.78	24.14	23.64	23.21	22.77	
	104130	5302	25.04	24.88	24.27	23.64	23.21	22.79	
	104135	5552	25.06	24.89	24.27	23.65	23.22	22.81	
	104140	5682	25.31	25.08	24.34	23.69	23.27	22.87	
	104145	5762	26.74	26.50	25.89	25.44	24.86	24.16	
	104150	5842	26.98	26.79	26.34	25.95	25.23	24.42	
	104165	6242	27.20	26.96	26.42	25.99	25.25	24.49	
(4.) EAST LAKE OUTFALL MAIN CHANNEL ALIGNMENT									
	100020	0	12.05	11.9	11.61	11.44	11.26	11.04	
TBC Bank	102001	82	13.43	13.02	12.2	11.84	11.51	11.21	
	102005	87	15.1	14.78	14.15	13.83	13.49	13.14	
	102010	1087	15.62	15.32	14.71	14.4	14.06	13.7	
Danny Bryan Blvd	102015	1144	16.34	15.97	15.21	14.86	14.47	14	NO
	102016	2544	17.7	17.45	17.29	17.18	17.04	16.85	
	102018	2595	24.63	24.29	23.49	23.01	22.54	21.95	
	102020	2995	24.75	24.4	23.65	23.2	22.77	22.25	
MLK	102025	3082	25.16	24.95	24.11	23.59	23.03	22.45	NO
	102035	4632	25.22	25	24.18	23.68	23.15	22.7	
Chelsea St	102040	4709	26.41	25.72	24.37	23.85	23.33	22.96	NO
	102045	5309	26.7	26.13	24.95	24.47	24.03	23.63	
	102050	5509	26.76	26.22	25.08	24.59	24.14	23.74	
Orient Rd	102055	5559	26.88	26.33	25.14	24.64	24.19	23.78	NO
	102060	5889	27.04	26.52	25.52	25	24.49	24.03	
	102065	6219	27.18	26.68	25.78	25.34	24.91	24.46	
I-4	102070	6344	27.35	26.83	25.84	25.38	24.93	24.47	NO
(5.) ORIENT PARK OUTFALL MAIN CHANNEL ALIGNMENT									
	100022	0	12.03	11.89	11.6	11.44	11.26	11.04	
	101005	80	13.2	12.9	12.35	12.02	11.71	11.4	
	101007	80	13.66	13.36	12.81	12.47	12.19	11.94	
	101010	480	14.68	14.38	13.87	13.56	13.29	13	
E Broadway Ave	101015	630	18.65	17.56	16.46	16.02	15.43	14.96	NO
	101025	1080	19.91	19.26	17.83	17.11	16.43	15.87	
	101030	1130	20.44	19.95	18.77	17.89	17.12	16.43	
	101035	1530	20.48	19.98	19.09	18.95	18.82	18.74	
76th St	101040	1560	22.21	21.55	20.17	19.89	19.69	19.51	NO
	101045	1760	22.26	21.61	20.3	20.03	19.84	19.67	
75th St	101050	1800	23.82	23.49	22.75	22.16	21.51	21.19	YES
	101055	1990	23.9	23.57	22.84	22.27	21.68	21.4	
Missouri Ave	101060	2105	24.4	24.15	23.62	23.27	22.84	22.63	YES
	101065	2265	24.45	24.2	23.67	23.32	22.9	22.7	
Orient Rd	101070	2315	25.66	25.46	25	24.7	24.32	23.75	YES
	101075	2465	25.74	25.54	25.07	24.78	24.4	23.86	
	101080	2502	26.22	25.92	25.54	25.32	25.04	24.61	
	101090	2564	26.92	26.62	26.12	25.94	25.71	25.4	
	101095	2676	27.36	27.09	26.61	26.45	26.27	26.03	
	101105	2961	30.54	30.28	29.79	29.63	29.45	29.24	
21st Ave	101115	3026	32.04	31.85	31.27	30.87	30.45	30.02	NO
	101120	4026	32.22	32	31.4	31	30.59	30.17	
Rhode Island	101127	4066	32.43	32.2	31.58	31.22	30.93	30.63	YES
Vermont Dr	101140	4210	33.1	32.86	32.32	32.03	31.75	31.46	YES
	101145	4710	33.21	32.96	32.43	32.13	31.85	31.62	

Major Road Name	Model Junction ID	Channel Alignment [Station]	DESIGN STORM EVENT ELEVATIONS						Overtop AT 25-YR
			100-YR	50-YR	25-YR	10-YR	5-YR	2.33-YR	
	101150	5260	33.44	33.22	32.68	32.4	32.3	32.3	
Corporex Dr	101160	5360	33.47	33.24	32.7	32.42	32.3	32.3	NO
Citicorp Dr	101170	5480	33.48	33.25	32.84	32.65	32.44	32.3	NO
(6.) JUDSON CREEK / GRANT PARK OUTFALL MAIN CHANNEL ALIGNEMENT									
	100026	0	27	27	27	27	27	27	
Columbus Dr	101605	50	28.1	28.03	28	28	28	28	NO
	101610	228	28.63	28.41	28.28	28.23	28.15	28	NO
60th Strt	101615	257	30.24	29.94	29.36	29.12	28.82	28.42	NO
	101620	907	30.71	30.42	30.04	29.87	29.65	29.28	
	101630	2532	30.77	30.49	30.06	29.88	29.61	29.22	
Interstate 4	101635	4069	34.29	33.7	31.92	30.62	30	29.3	NO
	101640	4369	35.25	34.98	34.3	33.58	31.34	30.29	NO
Teraceia	101645	4427	36.04	35.75	35.02	34.4	33.63	33.24	YES
(7.) FAIRGROUNDS - SOUTH SYSTEM MAIN CHANNEL ALIGNMENT									
	104085	0	24.45	24.15	23.51	23.17	22.84	22.47	
	104205	650	26.24	26.02	25.31	24.26	23.38	22.85	
	104207	1200	26.47	26.31	25.9	25.14	24.03	23.76	
	104208	1250	27.45	27.35	27.09	26.73	26.42	25.79	
	104215	1302	28.18	28.09	27.92	27.84	27.69	26.93	
	104220	1802	28.17	28.09	27.91	27.81	27.64	27.12	
	104230	1842	28.38	28.29	28.09	27.97	27.78	27.55	
	104247	1882	28.79	28.69	28.42	28.2	27.89	27.62	
	104253	2082	29.09	29.03	28.9	28.56	28.11	27.74	
	104257	2130	29.03	28.9	28.65	28.25	27.89	27.59	
	104261	2300	29.02	28.89	28.64	28.25	27.88	27.59	
	104262	2330	28.98	28.83	28.06	27.74	27.55	27.36	
	104265	2445	28.98	28.83	28.05	27.74	27.55	27.36	
	104270	2465	26.85	26.26	26.03	25.99	25.95	25.91	
	104298	2690	26.89	26.34	25.29	24.83	24.38	23.95	
	104305	3468	26.71	26.14	25.21	24.8	24.37	23.94	
	102045	3990	26.7	26.13	24.95	24.47	24.03	23.63	
(8.) HILLSBOROUGH AVENUE / HARNEY ROAD MAIN CHANNEL ALIGNMENT									
	102070	0	27.35	26.83	25.84	25.38	24.93	24.47	
	102105	160	29.11	28.72	27.03	25.83	25.18	24.52	
Walton Way	102110	192	29.17	28.79	27.28	26.56	25.84	25.11	NO
	102179	335	30.24	29.92	28.69	27.84	26.97	26.1	
Travis Boulevard	102180	532	31.71	31.44	30.36	29.83	29.58	29.32	YES
	102181	665	33.32	33.27	33.09	32.48	31.88	31.27	
	102185	915	33.32	33.27	33.09	32.48	31.9	31.29	
Hillsborough Ave	102215	1025	34.6	34.52	34.22	34.04	33.74	33.33	NO
	102220	1190	35.08	34.95	34.37	34.08	33.83	33.48	
	102229	1440	35.08	34.95	34.37	34.09	33.84	33.49	
	102228	1470	35.09	34.97	34.78	34.64	34.27	33.74	
	102227	1670	35.09	34.97	34.78	34.64	34.28	33.74	
	102225	1970	35.09	34.98	34.87	34.81	34.42	33.81	
	102230	2150	36.28	36.2	35.93	35.13	34.55	33.88	
Harney Road	102235	2203	39.31	38.33	36.46	35.24	34.56	33.91	NO
(9.) EAST LAKE MALL - NORTH SYSTEM MAIN CHANNEL ALIGNMENT									
	102070	0	27.35	26.83	25.84	25.38	24.93	24.47	
Harney Rd	102406	642	35.51	34.97	32.55	30.75	28.87	27.2	NO
	102410	642	36.58	36.02	33.96	33.12	32.43	31.82	
	102415	1042	37.59	37.14	36.22	35.76	35.29	34.77	
	102420	1457	40.5	40.43	40.17	40.03	39.87	39.63	

Major Road Name	Model Junction ID	Channel Alignment [Station]	DESIGN STORM EVENT ELEVATIONS						Overtop AT 25-YR
			100-YR	50-YR	25-YR	10-YR	5-YR	2.33-YR	
	102425	1722	42.79	42.56	42	41.74	41.46	41.07	
	102430	1982	45.15	44.79	43.99	43.59	43.14	42.46	
	102435	2127	46.86	46.42	45.44	44.93	44.36	43.5	
	102440	2307	48.77	48.23	47.06	46.43	45.73	44.54	
	102445	2407	50.24	49.63	48.3	47.58	46.78	45.44	
	102450	2502	51.73	51.11	49.74	48.98	48.13	46.7	
	102455	2637	52.01	51.44	50.21	49.54	48.79	47.53	
	102460	2807	53.98	53.3	51.8	51.21	50.56	49.5	
Hillsborough Ave	102465	2938	54.02	53.33	51.83	51.25	50.6	49.91	YES
	102479	3471	54.04	53.35	51.86	51.28	51.12	49.91	
	102481	3738	54.06	53.78	53.43	53.32	52.05	50.55	
(10.) EAST LAKE MALL - SOUTH SYSTEM MAIN CHANNEL ALIGNMENT									
	102415	0	37.59	37.14	36.22	35.76	35.29	34.77	
	102525	1145	39.68	38.82	37.54	37.13	36.75	36.37	
	102545	1990	41.55	40.1	38.49	38.04	37.69	37.42	
	102560	2410	41.93	40.38	38.82	38.5	38.31	38.15	
	102575	2939	43.6	41.81	41.27	41.05	40.84	40.61	
	102585	3349	42.69	42.47	42.08	41.86	41.64	41.35	
	102590	3439	44.56	44.19	43.34	42.84	42.29	41.73	
56th ST	102595	3569	44.56	44.2	43.75	43.37	42.75	41.98	YES
	102600	3830	44.57	44.41	44.18	43.88	43.23	42.47	
(11.) 50TH / 56TH ST MAIN CHANNEL ALIGNMENT									
	102070	0	27.35	26.83	25.84	25.38	24.93	24.47	
	102900	550	27.35	26.83	25.85	25.42	25.26	25.07	
	102902	1300	27.37	27.13	26.46	26.14	25.87	25.6	
Dirt Road	102904	1324	31.11	30.82	30.23	29.96	29.78	29.61	YES
	102908	1504	35.66	35.38	34.67	34.14	33.16	31.96	
	102910	3354	42.79	42.73	42.53	42.37	42.12	42	
	102912	3414	44.34	44.24	43.97	43.78	43.53	43.39	
	102916	3864	44.82	44.69	44.34	44.1	43.76	43.56	
Harney Rd	102918	3911	47	46.9	46.6	46.38	45.69	44.47	YES
56th Street	102920	4111	49.27	49.12	48.71	48.43	48.02	46.97	YES
	102923	4211	49.5	49.36	48.98	48.72	48.35	47.45	
(12.) MARY HELP SYSTEM MAIN CHANNEL ALIGNMENT									
	102900	0	27.35	26.83	25.85	25.42	25.26	25.07	
	102952	580	32.07	31.81	31.17	30.79	30.33	29.4	
	102954	1605	32.34	32.28	32.2	32.13	32.1	32.02	
Chelsea Ave	102960	2605	34.15	34.1	33.98	33.92	33.86	33.31	YES
	102964	3205	34.35	34.3	34.19	34.12	34.05	33.45	
	102966	3225	35.4	35.18	34.71	34.43	34.19	33.56	
Martin Luther King Jr. Blvd	102076	4625	35.39	35.18	34.71	34.43	34.19	33.56	NO
	102078	4816	35.23	34.97	34.49	34.34	34.18	34	
	102080	4969	35.26	34.98	34.52	34.37	34.23	34.06	
	102082	5369	35.26	34.98	34.52	34.38	34.25	34.1	
	102084	5969	35.25	34.98	34.41	34.29	34.18	34.1	
	101640	8369	35.25	34.98	34.3	33.58	31.34	30.29	

6.2.1 THE HARNEY PRAIRIE OUTFALL

The majority of the Harney Prairie Outfall area lies generally south of Sligh Avenue, north of Hillsborough Avenue and east of Orient Road. The outfall receives stormwater flows from SMS's located west of Orient Road. These SMS's include those for Parke East Phase I, Parke East Phase II and Tampa Bay Vo-Tech. All of these systems discharge under Orient Road and contribute flow to the Harney Prairie; however, they discharge under Orient Road at different locations. The Parke East Phase I system discharges under Orient Road approximately 1700 feet north of Hillsborough Avenue, while the Tampa Bay Vo-Tech outflow combines with the discharge from Parke East Phase II and passes under Orient Road approximately 1100 feet south of Sligh Avenue. The Harney Prairie itself can be clearly seen on an aerial photograph, as the large wetland system located north of Hillsborough Avenue and east of Orient Road. There is a small neighborhood located near the southwest corner of the Prairie. This neighborhood is denoted as the Commanche / Staley area, which also discharges stormwater directly to the Prairie. The neighborhood has a pond located in its center. Stormwater flows from the described areas pass through the Harney Prairie as the Outfall moves east. Near the center of the Prairie, a ditch has been constructed to help with the conveyance of flow and to lower the groundwater levels in the adjoining areas. This ditch becomes more pronounced as the flow moves to the eastern edge of the Prairie. At the eastern Prairie boundary, the ditch conveyance system connects with a north-south tributary ditch system. This tributary ditch delivers stormwater flows from a neighborhood to the north. The north / south ditch also interconnects to the Harney Canal through a culvert under Sligh Avenue. East of the Harney Prairie, the ditch is much larger and more pronounced. At this point the Breckenridge Business Park and Sherwood Forest Business Park SMS's discharge to the Harney Prairie Outfall. The Outfall then conveys the flows east under U.S. Highway 301. The upstream side of U.S. Highway 301 has an interconnection to the south to the I-4 Outfall and receives stormwater runoff from the north from the U.S. Highway 301 roadside ditches. The Outfall then continues east through a series of culverts to a control structure at the Tampa By-Pass Canal. A graphical representation of the water surface profile for all six standard storm events is provided in Exhibit 6-1 (a).

The EXTRAN model predicts overtopping along the main channel alignment as follows:

Orient Road during the 50 and 100 year design storm events.

6.2.2 THE INTERSTATE 4 (I-4) OUTFALL

The I-4 Outfall area is generally the area associated with Hillsborough Avenue east of Orient Road, the I-4 / U.S. Highway 301 interchange and I-4 east of the interchange. It is a narrow strip of land with a rather complex hydraulic character. There is a collection system at the intersection of Hillsborough Avenue and Orient Road. This system accepts the stormwater runoff from the area west of

Orient Road and north of Hillsborough Avenue. Most of this area is commercially developed with little or no SMS's. The collection system directs flow south under Hillsborough Avenue. At this point, the flow is directed through Orient Road and east, within the south right-of-way of Hillsborough Avenue, and continues as a series of side drain culverts and ditches. The outfall then discharges into a wetland area where the SMS for the Seminole Indian property contributes flow. The wetland area's water level is controlled by a structure that discharges east, under Lenox Road. The I-4 Outfall continues to convey flow east, through a series of stormwater storage areas, culverts and ditches through the I-4 / Hillsborough Avenue interchange. The stormwater continues to flow east, in the south right-of-way of I-4, to the U.S. Highway 301 interchange. At this location, there is an interconnection between the I-4 Outfall and the Fairgrounds Outfall-North System via the roadside ditches of I-4 and the western right-of-way ditch for U.S. Highway 301. From the south right-of-way of the I-4/U.S. Highway 301 interchange, the stormwater is conveyed to the north under I-4 through a pipe system. Once the flow has been passed to the north of I-4, the southern portion of the Breckenridge Business Park SMS discharges to the outfall. The outfall continues to convey flow north in the ditch until it reaches a pipe system that directs the flow east under U.S. Highway 301. The conveyance system continues to flow east, through ditches and culverts, until it discharges into the Tampa By-Pass Canal. It should be noted that there is no control structure at the discharge point of the I-4 Outfall into the Canal.

Exhibit 6-1(b) shows the peak water level comparisons along the I-4 Outfall for all six standard storm events. The 100-year storm model simulation for the I-4 Outfall does not anticipate any structural flooding within the profiled sections. However, the depth of flooding in the Outfall facilities should be more significant.

6.2.3 THE FAIRGROUNDS OUTFALL - NORTH SYSTEM

The majority of the Fairgrounds Outfall-North System lies to the southwest of the I-4, U.S. Highway 301 interchange and due east from the Fairgrounds property toward the Tampa By-Pass Canal. A large percentage of this system is internal to the Fairgrounds property. A series of small ditches and culverts convey stormwater runoff from the northern area of the Fairgrounds property to its central lake system. This lake system is made up of five interconnected ponds. Only the last two downstream ponds have weir controls that are of significance. The downstream most pond also receives flow from the Fairgrounds Outfall-South System. The lake system receives stormwater runoff from the adjacent buildings, parking lots and other surfaces of the complex. From the lake system, flow is conveyed to U.S. Highway 301 through an open ditch. The box culvert under U.S. Highway 301 also accepts flow from its north and south roadside ditches. The north ditch is connected to the I-4 Outfall. The flow is then directed east under U.S. Highway 301 and into a large channel. This channel continues to move the stormwater east and receives flow from the adjacent Interstate Business Park SMS. The flow passes under Elm Fair Boulevard and Garden Lane and is discharged to the Tampa By-Pass Canal through a control structure.

Exhibit 6-1(c) shows the peak water level comparisons along the Fairgrounds Outfall - North System for the six storm events. The 25-year profile of the Fairgrounds Outfall-North System indicates that there are no expected flooding problems at any of the major roadway crossings shown; however, the results show some road overtopping within the fairgrounds in the upper reach. The profile shows a substantial headloss at the control structure at the Tampa By-Pass Canal, and additional large headlosses at the lake controls within the Fairgrounds. Many of the culverts do not experience full flow conditions during this event. The large channel east of U.S. Highway 301 is anticipated to be flowing within a few feet of the top-of-bank, but no out-of-bank conditions are expected. The channel itself controls the flow of stormwater within the Interstate Business Park. The lake system within the Fairgrounds is expected to remain in-bank with freeboard. There may be some minor flooding of parking areas within the Fairgrounds between U.S. Highway 301 and the onsite lake system. During this event the I-4 Outfall is delivering minor flows to the U.S. Highway 301 box culvert via the roadside ditch that connects the Fairgrounds and I-4 Outfalls.

The 100-year storm simulations project that some overtopping will occur within the fairgrounds northern reach area. The large ditch through the Interstate Business Park is expected to flow in-bank. The box culvert at U.S. Highway 301 is not estimated to experience a full flow condition. The interconnection to the I-4 Outfall is delivering more flow to the Fairgrounds Outfall, but this connection is still not anticipated to be highly significant. The flooding of the parking areas of

the Fairgrounds is more pronounced, but still not projected to be severe. The lake system within the Fairgrounds is expected to remain in-bank, but with little or no freeboard. The 10-year storm simulation, and the profiles associated with the Fairgrounds Outfall-North System, projected no problems with floodwaters or conveyance.

6.2.4 THE EAST LAKE OUTFALL

The East Lake Outfall lies generally south of East Lake, west of U.S. Highway 301 and east of Orient Road. East Lake discharges to the East Lake Outfall at the southeast corner of the Lake. From this point, the flow is directed under I-4 through box culverts to the southeast. Downstream of the I-4 crossing are two weir structures. These weirs control the water levels in East Lake and discharge into a large ditch that conveys flow to Orient Road. Once the stormwater has been conveyed under Orient Road, the flow is joined by the flow discharging from the Fairgrounds Outfall-South System. Downstream from this point the channel becomes quite large with steep banks. The Outfall passes under Chelsea Avenue and continues to flow generally in a southeasterly direction toward Martin Luther King Boulevard. After the stormwater is conveyed under the Boulevard, the flow passes through a dirt road culvert crossing and continues to flow southeasterly toward Danny Bryan Boulevard. The channel in this region of the Outfall is deep with steep side slopes. There are residential subdivisions to the east and west of the channel. These subdivisions discharge directly to the Outfall, and for the most part, do not contain any SMS's. After passing under Danny Bryan Boulevard Road the channel bottom begins to flatten. The stormwater continues to flow to the southeast until it is discharged to the Tampa By-Pass via a control structure.

The profiles for the East Lake Outfall (Exhibit 6-1(d)) indicate there are no anticipated flooding problems at any of the roadway crossings shown for all six storm events simulated, except at Martin Luther King Boulevard for the 100-year event. The profiles show a substantial headloss at the control structure to the Tampa By-Pass Canal and another at the culvert under the dirt road, downstream of Martin Luther King Boulevard. The crossing at Martin Luther King Boulevard is estimated to be flowing full, but this appears to be due to the flow constriction at the downstream dirt road culvert crossing. The only other noteworthy headlosses occur at the East Lake control structures. The channel from East Lake is flowing within a few feet of the top-of-bank, but out-of-bank conditions are not expected anywhere within the channel portion of the outfall. The outfall receives a substantial amount of flow from the conveyance system in the right-of-way of Orient Road. This system is designed to flow south and discharge to the East Lake Outfall at its connection point with the Tampa By-Pass Canal. However, the system is expected to surcharge and send flow overland to the Outfall at a point just downstream from Martin Luther King Boulevard.

6.2.5 THE ORIENT PARK OUTFALL

The majority of the Orient Park Outfall lies in a southeasterly direction from the intersection of Martin Luther King Boulevard and I-4, to the Tampa By-Pass Canal. The outfall begins in the Corporex Business Park. This office complex was constructed around a large borrow pit. The complex itself has a SMS that discharges into the now water-filled pit. The complex's SMS is comprised mostly of several small ponds with individual control structures. The pit discharges, without a control structure, to a ditch at the southeast corner of the Corporex property. The ditch appears to have been constructed some time ago and discharges through an older residential area. The outfall conveys stormwater through a residential area in a zigzag pattern, but conveys the flow in generally a southeasterly direction. The outfall in this area is characterized by steep ditches with sharp changes in direction. The ditches traverse private property and are sometimes located very close to homes and other structures. Many of the conveyance features within the outfall appear to have been constructed by property owners in an effort to manage the flow in the outfall. The stormwater is conveyed in this manner until it reaches 21st Street where the stormwater enters a pipe system that crosses a church property. The system emerges on the south side of that property where it flows through an open ditch for a distance and then makes a ninety-degree turn east toward Orient Road. Once under Orient Road, the ditches become deeper and the side slopes become steeper. There is strong evidence of erosion in this portion of the Outfall. The stormwater infrastructure through this section is generally in very poor condition and failing. Many culvert headwalls are falling over and in need of replacement. Many portions of the conveyance system are non-engineered, and were installed by residents. Next, the outfall flows east passing under Missouri Avenue, 75th Street, and 76th Street. On the downstream side of 76th Street, the channel makes a turn to the south and discharges flow into a pipe system. This rather long, privately maintained system was designed to unknown specifications and is in an unknown condition. The flow does not emerge from the pipe system again until it is south of Broadway Avenue, where it discharges to an open channel and flows to a control structure to the Tampa By-Pass Canal.

The 25-year profile for the Orient Park Outfall (Exhibit 6-1(e)) indicates that several roads are projected to overtop. All of the pipes in the profiled system are flowing full, with 75th Street, Missouri Avenue, Orient Road, 21st Street, Rhode Island Drive, and Vermont Drive overtopping. Large headlosses are not characteristic of the outfall, however the channel bottom does show a considerable grade change from 21st Street downstream to approximately Broadway Avenue. The profile also indicates the high point in the channel bottom downstream from Corporex Business Park, and the impact this high point has on controlling the water levels within Corporex. The simulation results agree with the investigation results. One resident confirmed flooding in Orient Park Outfall, specifically the overtopping of 75th Street during 1997. Evidence shows that Missouri Avenue, which is upstream from 75th Street, with a lower overtopping elevation has also experienced overtopping in the past.

There are several other problem areas associated with the 25-year storm event, in the profiled portions of the Outfall area. There is a significant amount of out-of-bank flooding projected for the area north of 21st Street. The depth of this flooding ranges between 1-2 feet for the 25-year storm. At the outflow point of Corporex, there is also out-of-bank flooding. The problem in this area is limited mostly to street and yard flooding, with projected depths of about 1 foot to a few inches. The area upstream from Orient Road is expected to experience flooding in yards and around structures. Downstream from Orient Road, in the vicinity of 75th and 76th Streets near the outfall, the channel again flows out-of-bank, flooding yards to depths of about 1 foot.

The 100-year model simulation projected rather severe overbank flooding in the area north of 21st Street, with flood depths of over 2 feet expected. There is a possibility of structural flooding in this area. Flooding at the outflow point of Corporex was also more severe than projected for the 25-year event. Flooding east and west of Orient Road, in the vicinity of the outfall, is more severe than for the 25-year storm, with the possibility of structural flooding in this area also. For the 10-year storm event, all flooded points mentioned above, except 75th Street, were also projected to overtop. The model simulation also indicates that the flows should be in-bank for the 10-year storm event in the area north of 21st Street. At the outflow point of Corporex, there is expected to be yard flooding of a relatively minor nature. The areas west of Orient Road are also anticipated to experience minor yard flooding.

6.2.6 THE JUDSON CREEK / GRANT PARK OUTFALL

The majority of the Judson Creek / Grant Park Outfall lies south of Martin Luther King Boulevard and north of Columbus Drive, near the large Alderman borrow pit adjacent to I-4. This area includes the Grant Park subdivision, which lies partially in the City of Tampa. Grant Park can be characterized as having depression areas that collect stormwater runoff and, at least for smaller storms, discharge the stormwater through percolation. The modeling effort does not consider percolation, due to its unreliability during larger storms. Therefore, the depression areas were modeled as storage areas that can fill and overflow, transferring the stormwater overland according to other physical storage and conveyance features. The storage areas of Grant Park eventually "pop-off" to a collection system located on the East Side of the subdivision, adjacent to the west right-of-way of I-4. The system discharges to and then under, I-4. The flow under I-4 is made up of the Grant Park stormwater and the flow from the west right-of-way of I-4. The ditch in the west I-4 right-of-way is also an interconnection between the I-4 Outfall and the Mary Help System. The flow emerges on the East Side of I-4, and is conveyed through the Alderman borrow pit. This borrow pit interconnects with the borrow pit on the Corporex Business Park property via an overland flow connection. The Alderman borrow pit discharges flow to the south into a ditch. The flow is then conveyed through a series of ditches and culverts, which comprise the beginnings of Judson Creek, and into the City of Tampa at Columbus Drive. Although Judson Creek continues south of Columbus Drive, the outfall considered in this project ends at the Columbus Drive project boundary. A second small tributary of Judson Creek lies within the project area further to the east, and collects stormwater runoff from the area north of Columbus Drive. This stormwater is conveyed under Columbus Drive and joins Judson Creek at 14th Avenue.

The 25-year profile for the Judson Creek / Grant Park Outfall (Exhibit 6-1(f)) indicates that Terra Ceia Drive in Grant Park, and Mary Help Outfall Confluence are projected to be substantially overtopped. The remaining structures in the profile are projected to be adequate for conveyance of the 25-year event estimated flows. I-4 is not projected to be in danger of being overtopped during the event. The floodwaters in the Alderman borrow pit are expected to be in-bank. The simulations indicate that a minor amount of flow is contributed to this outfall from the borrow pit on the Corporex Business Park property.

There are several problem areas in the non-profiled portion of the outfall area, which have been projected by the model simulations. All of these problems are in the Grant Park Subdivision. The profile identified the expected overtopping of Terra Ceia Drive, but there are several other problems associated with this area. As mentioned above, Grant Park contains several depression areas which are "landlocked", with no means to discharge stormwater other than through percolation. For higher frequency storms, these areas are anticipated to fill with stormwater runoff and eventually pop-off to the inlet at Terrace Drive. This unmanaged, overland flow is expected to discharge through streets and yards. Grant Park contains rather loose sandy soils that are highly vulnerable to erosion, making overland flow in this area even more of a problem. The streets that are expected to be flooded in this manner are near 56th Street and 29th Avenue. High velocity flow may occur in this area due to the street and yard grades. Also, there is the possibility for structural flooding in areas not associated with the profiles, especially in the west portion of Grant Park near the intersection of 52nd and 32nd street intersection during the 25-year storm event.

The 50-year and 100-year model simulations project the same basic trends that are expected during the 25-year event with exception of upstream of Columbus Dr., where overtopping is expected for these two events. The Alderman borrow pit is expected to detain more floodwaters. For the most part, the water will be contained within the pit, but the edge of the water should be at the low edge of pavement on the east side of I-4. However, I-4 is not expected to overtop in this area during the 50-year or 100-year storm events. The flow entering the outfall from the Corporex property's borrow pit is expected to be increased over the 25-year flows, but since this overland flow connection does not occur in a developed area, it is not considered a problem. Again, the major concerns are in the Grant Park Subdivision. Higher flow rates were projected for the pop-off locations of the landlocked areas. Structural flooding in the subdivision is a possibility even more so in the areas discussed near 52nd and 32nd Street.

6.2.7 THE FAIRGROUNDS OUTFALL - SOUTH SYSTEM

The Fairgrounds-South System lies mostly within the property of the Fairgrounds. It encompasses the area north of the Fairgrounds' south property boundary, south and west of the interconnected lake system within the Fairgrounds, and east of Orient Road. It interconnects the East Lake Outfall and the Fairgrounds Outfall-North System. The system contains a high point near Kings Forest Park where an offsite connection conveys flow under the south wall of the Fairgrounds, and into the system. This offsite flow is conveyed through twin pipes, and is the stormwater runoff from the area north of Chelsea Avenue, including the Park. From the high point, the portion of the system to the east is composed of ditches and culverts that convey flow to the southernmost Fairgrounds pond at the center of the complex. This pond is part of the Fairgrounds Outfall-North System. From the high point to the west, the system again consists of ditches and culverts. However, this portion of the System discharges into a pond at the southwestern portion of the Fairgrounds property. The flow from this pond is controlled by a pipe that discharges into the East Lake Outfall. In general, the Fairgrounds-South System is a poorly maintained collection of pipes and ditches which were intended to convey the internal stormwater runoff of the Fairgrounds property into the property's ponds.

The 25-year profile for the Fairgrounds-South System (Exhibit 6-1 (g)) shows that several pipes are flowing full and four pipes are expected to overtop within the system. The high point in the channel-bed profile is also very apparent. The remainder of the system is anticipated to be adequate for the 25-year storm.

The 100-year storm simulation does not project any structural flooding within the profiled section of the Fairgrounds-South System. However, the culvert system within the Fairgrounds-South System is not projected to have adequate conveyance capacity for the estimated 100-year storm flows. Most of the pipes within the property are expected to overtop.

6.2.8 THE HILLSBOROUGH AVENUE / HARNEY ROAD OUTFALL SYSTEM

The Hillsborough Avenue / Harney Road System lies generally north of East Lake, east of the CSX Railroad and west of Orient Road. Stormwater runoff from the northern extent of the system's watershed collects at the Good Shepherd Church, which is a landlocked area. If sufficient stormwater volume is accumulated at this location, floodwaters will pop-off to the south. They will be conveyed under Hillsborough Avenue and into the East Lake Subdivision. The stormwater runoff from the East Lake Subdivision, in addition to the flow from north of Hillsborough Avenue, is then conveyed to the Lake. Individual storm sewer collection systems within the subdivision were not modeled hydraulically unless the system was actually part of the major stormwater conveyance network. The stormwater runoff from the commercial area between the south right-of-way of Hillsborough Avenue and the north boundary of the subdivision has been established as a source of flooding problems in the past, and therefore was taken into account in the modeling effort.

Stormwater runoff contributing to the Good Shepherd Church pond comes from the area that lies to the north. This area consists mostly of commercial properties, which for the most part, have SMS's. The properties adjacent to Harney Road, on the east, discharge to a roadside ditch that begins at the intersection of Hanna Avenue and Harney Road. This ditch flows south and accepts discharge from the adjacent properties. Once the flow has passed through the culvert at the entrance of Parke East, however, the ditch dissipates and the flow is transferred to the paved right-of-way of Harney Road. At this point, during certain storm events, the Kash-n-Karry warehouse also discharges flow down a rip-rap flume and onto the pavement of Harney Road. The road in this vicinity has a substantial grade and conveys the water toward the inlets at the low point in the road, located north of the intersection with Hillsborough Avenue.

The 25-year profile for the Hillsborough Avenue / Harney Road System (Exhibit 6-1(h)) indicates that Harney Road, and Travis Boulevard will overtop. The 25-year storm simulation further indicates additional street flooding caused by the stormwater runoff from the commercial area south of

Hillsborough Avenue. This stormwater is discharged directly to the pavement of Travis Boulevard (entrance road for the East Lake Subdivision), which then acts as a channel. Street flooding is also projected for the northwestern portion of the subdivision through which a small system conveys stormwater collected from sections of Hillsborough Avenue and Harney Road.

The 100-year storm simulations indicate that overtopping will take place all the way from the beginning of the system to the end. Generally, the overtopping in the downstream part is higher than that of upstream part.

6.2.9 THE EAST LAKE MALL OUTFALL - NORTH SYSTEM

The majority of the East Lake Mall-North System lies slightly to the north of Hillsborough Avenue, east of 56th Street, and includes about the northern half of the East Lake Mall site. The system receives stormwater runoff from several commercial areas that are located north of Hillsborough Avenue. Much of this stormwater is collected in a percolation pond located north of the Cummins Diesel facility. During higher frequency storm events this pond may (and has) surcharged to the south, into the ditch conveyance system of Hillsborough Avenue. The stormwater is then conveyed through a culvert under Hillsborough Avenue, and discharges into the storm sewer collection system of East Lake Mall. The mall's collection system is a rather deep system that was designed to convey flows through what used to be a natural ridge line (physical drainage boundary) for East Lake. The entirely piped collection system terminates at the mall's stormwater pond. This pond is controlled by a structure that discharges to a pipe. The pipe then conveys the flow to East Lake.

The 25-year profile of the East Lake Mall-North System (Exhibit 6-1(i)) indicates that overtopping is anticipated. Overtopping will occur upstream including Hillsborough Avenue and continue downstream to the Mall Collection System. The system shows a significant amount of slope through the mall. The pond at the mall is projected to be within bank for the 25-year storm event. The 100-year profile of the East Lake Mall-North System also indicates overtopping in the same locations however, more severe.

6.2.10 THE EAST LAKE MALL OUTFALL - SOUTH SYSTEM

The majority of the East Lake Mall-South system lies east of 56th Street, north of Harney Road and includes about the southern half of the East Lake Mall property. Stormwater runoff is collected from the area west of 56th Street and is discharged to the west right-of-way of 56th Street. The stormwater collects at the low point on 56th Street, which is located about 700 feet south of the intersection of Hillsborough Avenue and 56th Street. From the low point, the stormwater is conveyed through a culvert under 56th Street and into a depressed, wet area on the west side of the mall property.

This stormwater storage area then discharges into the southern leg of the mall's storm sewer collection system. The flow is transported by the collection system to the mall's detention pond located on the east side of the mall property. At the detention pond, the stormwater from the East Lake Mall-South System joins the flow from the East Lake Mall-North System. The detention pond, as was stated previously, ultimately discharges to East Lake through a pipeline and channel.

The 25-year profile for the East Lake Mall-South System (Exhibit 6-1(j)) indicates that the System is anticipated to be adequate for the conveyance of the estimated 25-year storm event flows, except 56th Street and its upstream.

The 100-year simulation shows the same trend as that of 25-year event, except 56th Street and its upstream. The profile itself was very characteristic of the 25-year profile, projecting the same types of headlosses in the conveyance network.

6.2.11 THE 50TH / 56TH STREET OUTFALL SYSTEM

The 50th / 56th Street System receives stormwater runoff from several commercial areas that are located west of 56th Street. The majority of this area is composed of the 56th Street Commerce Park which has a SMS. Flow leaves the 56th Street Commerce Park SMS and is discharged to the roadside ditch of 56th Street. The ditch conveys flow north to a culvert under 56th Street at Harney Road. This culvert discharges to a roadside ditch along the south side of Harney Road. The system continues to the east where the flow is conveyed in a concrete lined ditch that bypasses a large borrow pit adjacent to the ditch. The concrete ditch is quite steep, but in very good condition. When the ditch's slope does eventually lessen, the flow is conveyed through several driveway culverts. At this point, the ditch is no longer concrete lined. Overland flow from the south joins the system in this vicinity. The overland flow is from an adjacent borrow pit and wetland / pond. The ditch then turns to the northeast where it accepts flow from the Mary Help System and eventually discharges into East Lake.

The 2.33-year, 5-year, 10-year, 25-year, 50-year, and 100-year profiles for the 50th / 56th Street System (Exhibit 6-1(k)) clearly show the slope associated with the concrete lined channel that conveys water from the south right-of-way of Harney Road. The system is expected to overtop during the 25-year, 50-year, and 100-year storm events. The overland flow entering the system from the south is significant, but the connection is not located in an area where overland flow should be a problem.

6.2.12 THE MARY HELP OUTFALL SYSTEM

The Mary Help System lies generally to the southwest of East Lake, north of I-4, and east of Harney Road. The system includes a portion of the roadside ditch in the north right-of-way of I-4. A high point exists in the ditch at the overpass of I-4 and Martin Luther King Boulevard. This high point directs flow to the west alongside Martin Luther King Boulevard, and to the southwest into the roadside ditch of I-4. This I-4 ditch interconnects the Mary Help System with the Judson Creek / Grant Park Outfall, with normal flows directed toward the outfall. From the overpass at Martin Luther King Boulevard and I-4, stormwater runoff is also directed west through a series of driveway culverts. At approximately the toe of the overpass ramp on Martin Luther King Boulevard, the flow is conveyed north through a culvert connection to the stormwater attenuation pond of the Fairgrounds Outlet Mall. During higher frequency storm events (10-year and above), the mall pond also receives overland flow from a small area south of Martin Luther King Boulevard to the west, and from the adjacent golf course. A control structure on the mall pond regulates flow that is delivered north to the roadside ditch of Chelsea Avenue. A culvert conveys the flow under the road and into a field which contains a small pond. This pond discharges to an iron pipe that conveys the stormwater north through the Mary Help School property. The pipeline eventually makes its way to the outfall channel of the 50th / 56th Street System which conveys the flow into East Lake. The pipeline appears to be old, and in some locations, appears to be eroding its earth overburden causing depressions to appear. It should be noted that this pipeline passes under some of the school facility buildings.

The 25-year profile for the Mary Help System (Exhibit 6-1(l)) indicates that most of the road crossings are adequate with the exception of Chelsea, which is projected to overtop. In general the profile shows that little headloss occurs within the System. The pipe system through Mary Help does not have capacity for the conveyance of the estimated 25-year storm flows. During this event, the flow will develop a separate overland connection to the 50th / 56th Street System to the northwest, across the school grounds.

The 100-year storm event simulation indicates the same problem areas, as did the 25-year simulation. Chelsea Avenue is projected to be severely overtopped. The overland flow from the City of Tampa, as well as the overland connection across the Mary Help School grounds, becomes much more pronounced. The 2.33-yr, 5-yr, and 10-year simulations also project that Chelsea Avenue will overtop.

6.3 LEVEL OF SERVICE

This chapter briefly describes the level of service (LOS) methodology used to analyze the East Lake Area watershed and then discusses existing conditions LOS deficiencies within the study area. Exhibit 6-3 contains a graphical representation of the ELA level of service analysis for the 25-yr / 24-hr storm event.

Discussion areas include the following topics below:

- Level of Service Methodology
- Level of Service Designations

The LOS designations are discussed for the ELA systems listed below:

1. Harney Prairie Outfall System
2. I-4 Outfall System
3. Fairgrounds Outfall – North System
4. East Lake Outfall System
5. Orient Park Outfall System
6. Judson Creek / Grant Park Outfall System
7. Fairgrounds – South System
8. Hillsborough Avenue / Harney Road System
9. East Lake Mall System
10. 50th / 56th Street System
11. Mary Help System

6.3.1 LEVEL OF SERVICE METHODOLOGY

The Hillsborough County Comprehensive Plan's, 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, with A being the highest level and D being 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 6.3** below. This table contains the interpretation of the

Comprehensive Plan definitions used in the LOS analysis herein.

Table 6.3
Level of Service Definition Interpretations

Level	**HC Comprehensive Plan Definitions**	**Master Plan Interpretations**
A	No significant street flooding	No flooding
B	No major residential yard flooding	Street flooding is 3" or more above the crown
C	No significant structure flooding	Site flooding is 6" or more
D	No limitation on flooding	Structure flooding

The LOS designations contained in the Comprehensive Plan contain the assumption that sites are higher than roads and structures are higher than sites as is illustrated in **Figure 6-1**. 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 10-year / 24-hour level B is the target LOS for the East Lake Area. However, this is very conservative. In many areas of ELA, the 25-year / 24-hour level B LOS can be achieved.

One goal of this report is to update the LOS designation for ELA with the results of a formal LOS analysis for this watershed. The LOS analysis for Adopted (or existing conditions) is contained in this chapter. Chapter 7 contains the LOS analysis for proposed conditions.

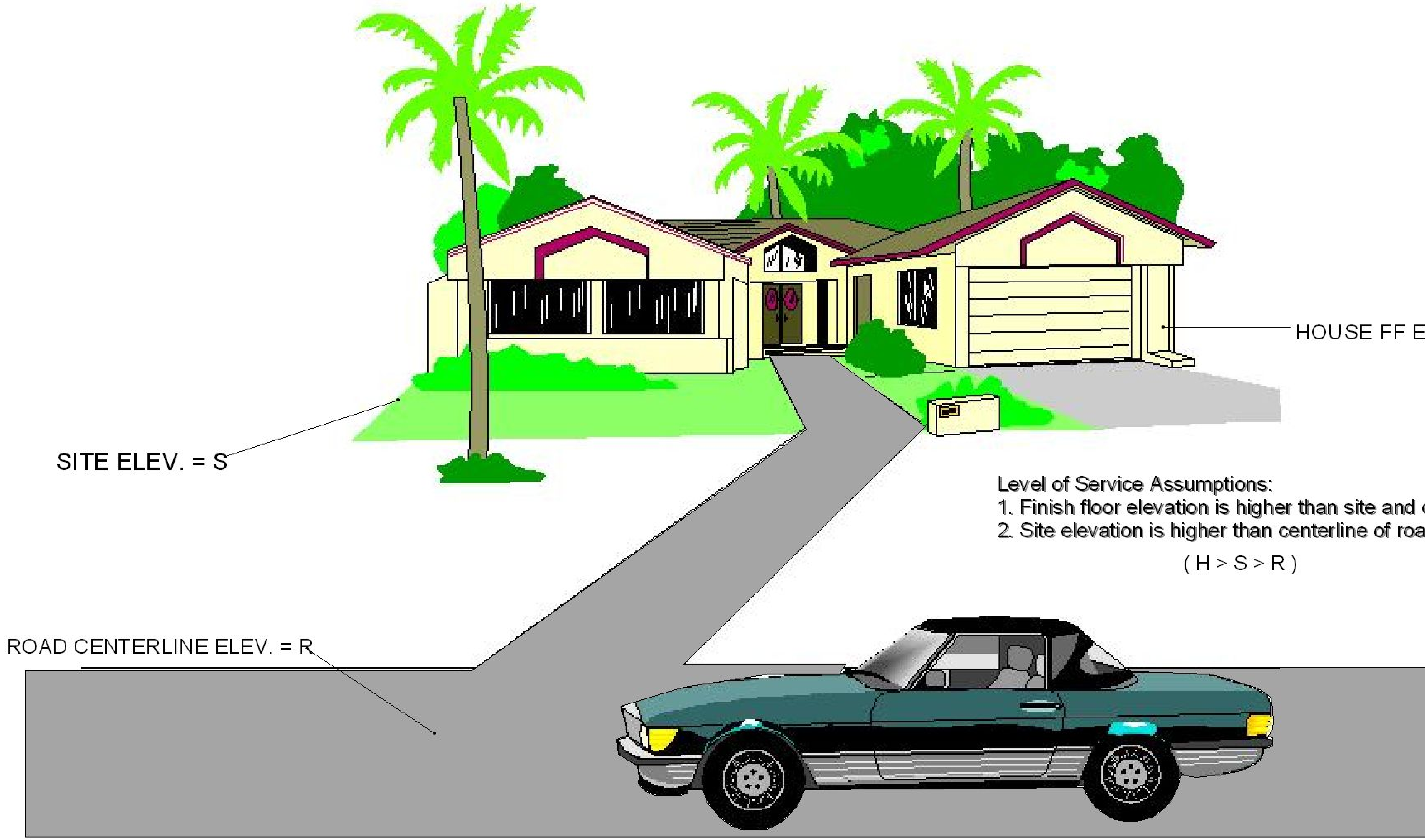
6.3.2 ESTABLISHMENT OF LANDMARK ELEVATIONS

In order to evaluate the 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 subbasin in the watershed is examined for the critical structure, site and road elevation. **Table 6.4** contains landmark elevations determined for each ELA subbasin in the unincorporated portion of Hillsborough County. These landmark elevations reflect the flood depth tolerance contained in **Table 6.3**.

6.3.3 COMPARISON OF COMPUTED RESULTS AND LANDMARK ELEVATIONS

Using flood protection LOS designation criteria contained in **Table 6.3**, 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 6.4** contains the difference between established landmark elevations

Level of Service Model



Level of Service Assumptions:
1. Finish floor elevation is higher than site and centerline of road
2. Site elevation is higher than centerline of road

(H > S > R)

Hillsborough County
Florida

Public Works Department
Engineering Division
Stormwater MANAGEMENT Section

EAST LAKE AREA
STORMWATER MANAGEMENT
MASTER PLAN
(AORIL 2001)

FIGURE 6-1
LEVEL OF SERVICE
DIAGRAM MAP

Updated 9/20/99 by JG
Requested Survey on 6/23/99

Bolded elevations are where road is higher than site or structu
Expected survey request Completion 7/16/99

TABLE 6.4

EXISTING CONDITIONS LEVEL OF SERVICE

East Lake Area (Existing Conditions) 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	50-yr	100-yr	25-Year Predicted Flooding Locations
Harney Prairie Outfall																	***LOS 25-YR/24-HR D***
3	105005	21.3	19.5	20.5	17.43	17.76	18.10	18.38	18.93	19.23	A	A	A	A	A	A	
3	105025	21.3	22.5	23.5	19.59	19.74	19.80	19.86	19.97	20.03	A	A	A	A	A	A	
3	105070	17.3	18.5	19.5	15.65	15.84	16.01	16.17	16.48	16.63	A	A	A	A	A	A	
3	105080	23.3	19.5	20.5	16.02	16.23	16.42	16.60	16.91	17.06	A	A	A	A	A	A	
3	105090	22.3	20.5	21.5	16.05	16.26	16.45	16.62	16.94	17.09	A	A	A	A	A	A	
3	105103	20.3	20.5	21.5	16.70	17.02	17.32	17.62	18.21	18.51	A	A	A	A	A	A	
3	105108	19.6	19.5	20.5	16.79	17.07	17.33	17.57	18.06	18.30	A	A	A	A	A	A	
3	105110	21.3	19.5	20.5	16.80	17.08	17.33	17.57	18.07	18.31	A	A	A	A	A	A	
4	105120	32.3	32.8	33.8	16.93	17.27	17.58	17.87	18.39	18.61	A	A	A	A	A	A	
3	105130	21.4	23.0	24.0	18.84	19.00	19.15	19.29	19.54	19.65	A	A	A	A	A	A	
4	105132	37.3	35.5	36.5	21.67	21.98	22.28	22.58	23.15	23.26	A	A	A	A	A	A	
4	105140	34.3	25.5	26.5	21.95	22.12	22.24	22.37	22.62	22.67	A	A	A	A	A	A	
4	105150	35.0	30.9	31.5	28.37	28.71	29.10	30.64	31.02	31.09	A	A	A	A	C	C	
4	105160	34.3	999.0	999.0	30.21	30.52	30.79	31.13	31.78	31.93	A	A	A	A	A	A	
4	105180	45.3	42.0	43.4	36.30	36.62	36.92	37.18	37.63	37.95	A	A	A	A	A	A	
4	105198	48.3	47.5	48.5	45.18	45.65	46.11	46.55	47.15	47.23	A	A	A	A	A	A	
4	105200	45.3	55.5	56.5	38.70	39.06	39.40	39.73	40.31	40.55	A	A	A	A	A	A	
2	105304	32.8	999.0	999.0	14.80	14.83	14.97	15.09	15.30	15.40	A	A	A	A	A	A	
3	105311	18.3	18.5	19.5	16.23	16.49	16.74	16.97	17.40	17.61	A	A	A	A	A	A	
3	105312	20.3	18.5	20.0	16.22	16.49	16.74	16.97	17.40	17.61	A	A	A	A	A	A	
4	105315	42.3	42.5	43.5	38.20	39.45	40.51	41.09	41.91	42.40	A	A	A	A	A	B	
3	105320	19.3	19.5	20.5	16.23	16.49	16.74	16.97	17.60	18.12	A	A	A	A	A	A	
3	105324	19.3	20.2	21.2	16.23	16.49	16.74	16.97	17.73	18.27	A	A	A	A	A	A	
3	105330	20.3	999.0	999.0	16.50	16.97	17.35	17.69	18.40	18.71	A	A	A	A	A	A	
1	105331	21.1	19.0	20.0	16.22	16.48	16.72	16.94	17.35	17.56	A	A	A	A	A	A	
4	105332	45.3	43.5	44.5	37.95	39.05	40.34	41.61	43.06	43.14	A	A	A	A	A	A	
1	105365	21.3	20.5	21.5	18.32	18.49	18.61	18.71	18.86	18.92	A	A	A	A	A	A	
1	105375	22.3	999.0	999.0	17.28	17.52	17.60	17.75	18.03	18.15	A	A	A	A	A	A	
3	105405	22.3	22.5	23.5	20.27	20.57	20.86	21.15	21.52	21.57	A	A	A	A	A	A	
3	105425	22.3	999.0	999.0	20.11	20.38	20.64	20.88	21.12	21.14	A	A	A	A	A	A	

East Lake Area (Existing Conditions) 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	50-yr	100-yr	25-Year Predicted Flooding Locations
3	105445	22.3	19.5	20.5	18.75	18.75	18.75	18.75	18.79	18.84	A	A	A	A	A	A	
3	105550	17.9	17.6	18.6	16.47	16.81	17.04	17.18	17.39	17.47	A	A	A	A	A	A	
3	105610	19.3	18.8	19.8	16.70	16.80	16.91	17.05	17.25	17.33	A	A	A	A	A	A	
1	105657	19.3	999.0	999.0	16.48	16.82	17.05	17.20	17.40	17.48	A	A	A	A	A	A	
3	105660	17.9	18.8	19.8	16.49	16.83	17.06	17.20	17.40	17.49	A	A	A	A	A	A	
3	105670	22.3	999.0	999.0	16.75	17.20	17.44	17.58	17.79	17.88	A	A	A	A	A	A	
3	105680	22.3	999.0	999.0	17.16	17.85	18.07	18.18	18.40	18.50	A	A	A	A	A	A	
4	105691	46.3	48.0	49.0	45.66	45.70	45.73	45.76	45.82	45.84	A	A	A	A	A	A	
2	105692	35.2	36.0	37.0	34.91	34.92	34.96	35.00	35.05	35.08	A	A	A	A	A	A	
2	105693	27.8	29.7	30.7	22.16	22.47	22.76	23.05	23.58	23.82	A	A	A	A	A	A	
3	105705	999.0	999.0	999.0	16.73	17.00	17.25	17.49	17.97	18.20	A	E	E	E	A	E	
3	105729	999.0	22.5	23.5	17.07	17.45	17.83	18.19	18.92	19.28	A	A	A	A	A	A	
3	105740	22.8	22.0	23.0	17.07	17.45	17.83	18.20	18.93	19.29	A	A	A	A	A	A	
3	105754	999.0	19.4	20.0	17.07	17.46	17.83	18.20	18.93	19.29	A	A	A	A	A	A	
3	105762	18.8	19.4	20.0	17.32	17.78	18.21	18.61	19.36	19.71	A	A	A	A	B	C	
3	105772	20.3	20.7	21.7	17.45	17.97	18.47	18.95	19.90	20.39	A	A	A	A	A	B	
3	105786	19.3	20.5	21.5	17.21	17.68	18.15	18.64	19.64	20.17	A	A	A	A	B	B	
3	105794	20.3	21.5	22.5	17.23	17.72	18.21	18.72	19.78	20.33	A	A	A	A	A	B	
4	105812	21.8	22.5	23.5	20.81	20.91	21.00	21.06	21.11	21.13	A	A	A	A	A	A	
4	105828	34.4	40.5	41.0	33.26	33.71	34.18	34.78	35.77	36.07	A	A	A	B	B	B	Orient & Hanna AVE
3	105850	24.3	25.5	26.5	22.61	22.83	23.04	23.20	23.40	23.50	A	A	A	A	A	A	
4	105855	23.9	24.4	24.8	23.03	23.58	24.22	24.92	26.48	27.38	A	A	B	D	D	D	Deleuil AVE W of Lenox
4	105860	27.3	27.5	28.5	23.45	24.44	25.60	26.94	30.09	31.92	A	A	A	A	D	D	
4	105862	39.3	39.5	40.5	37.18	37.79	38.40	39.21	39.28	39.33	A	A	A	A	B	B	
4	105864	999.0	999.0	999.0	41.90	42.17	42.41	42.43	42.47	42.51	A	E	E	E	A	E	
4	105870	28.3	29.0	31.0	24.73	26.59	28.69	31.11	35.89	38.61	A	A	B	D	D	D	SW corner of Mohawk & Staley
4	105875	27.3	25.5	26.5	24.74	24.79	24.83	24.89	25.16	25.30	A	A	A	A	A	A	
3	105902	23.0	999.0	999.0	20.08	20.28	20.41	20.53	20.72	20.81	A	A	A	A	A	A	
3	105927	22.3	999.0	999.0	20.26	20.54	20.76	20.97	21.40	21.60	A	A	A	A	A	A	
3	105938	21.3	21.5	22.5	20.27	20.55	20.79	21.03	21.51	21.73	A	A	A	A	C	C	
3	105985	23.3	999.0	999.0	16.45	16.60	16.73	16.87	17.08	17.13	A	A	A	A	A	A	
Interstate 4 Outfall																	***LOS 25-YR/24-HR A***
7	104416	25.3	23.5	24.5	21.11	21.44	21.69	21.93	22.71	23.18	A	A	A	A	A	A	
7	104424	25.3	999.0	999.0	21.16	21.50	21.75	21.98	22.67	23.02	A	A	A	A	A	A	
7	104428	25.3	23.5	24.5	21.16	21.49	21.73	21.96	22.72	23.19	A	A	A	A	A	A	
7	104432	25.3	999.0	999.0	21.88	22.38	22.76	23.09	23.80	24.15	A	A	A	A	A	A	
3	104440	26.3	999.0	999.0	22.12	22.61	22.98	23.30	23.91	24.23	A	A	A	A	A	A	
7	104442	27.3	35.0	36.0	22.25	23.03	23.62	24.49	25.51	25.95	A	A	A	A	A	A	

Story Board	Subbasin	Landmark Elevations: Road	Site	Struct	Water Surface Elevations: 2.33-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Flood Level Designations: 2.33-yr	5-yr	10-yr	25-yr	50-yr	100-yr	25-Year Predicted Flooding Locations
East Lake Area (Existing Conditions) Level of Service Analysis																	
8	104454	32.1	999.0	999.0	28.40	28.66	28.96	29.07	29.15	29.18	A	A	A	A	A	A	
8	104458	32.3	37.1	38.1	29.63	29.77	29.91	30.04	30.28	30.39	A	A	A	A	A	A	
8	104462	32.3	999.0	999.0	29.02	29.19	29.35	29.50	29.82	30.03	A	A	A	A	A	A	
8	104470	38.3	40.5	41.5	33.36	33.46	33.54	33.63	33.89	34.03	A	A	A	A	A	A	
4	104472	37.3	39.5	40.5	34.48	34.56	34.78	35.08	35.37	35.42	A	A	A	A	A	A	
4	104474	40.3	39.8	40.8	37.22	37.40	37.66	37.93	38.52	38.86	A	A	A	A	A	A	
7	104810	24.3	24.5	25.5	20.96	21.41	21.84	22.24	22.96	23.28	A	A	A	A	A	A	
7	104815	25.3	999.0	999.0	21.00	21.43	21.85	22.24	22.96	23.28	A	A	A	A	A	A	
7	104816	25.3	999.0	999.0	21.32	21.79	22.17	22.48	23.04	23.31	A	A	A	A	A	A	
7	104818	25.3	999.0	999.0	21.46	21.94	22.30	22.57	23.08	23.35	A	A	A	A	A	A	
7	104820	25.3	999.0	999.0	21.02	21.44	21.85	22.25	22.96	23.28	A	A	A	A	A	A	
7	104825	24.3	24.7	25.7	21.02	21.44	21.85	22.25	22.96	23.28	A	A	A	A	A	A	
7	104835	23.3	24.5	25.5	21.25	21.71	22.16	22.58	23.40	23.78	A	A	A	A	B	B	
6	104908	24.3	24.5	25.5	17.15	17.32	17.47	17.61	17.88	18.01	A	A	A	A	A	A	
3	105929	24.3	999.0	999.0	20.42	20.69	21.00	21.21	21.54	21.70	A	A	A	A	A	A	
3	105932	25.3	999.0	999.0	18.86	18.97	19.07	19.17	19.54	19.76	A	A	A	A	A	A	
3	105947	23.3	999.0	999.0	20.44	20.67	20.88	21.07	21.48	21.67	A	A	A	A	A	A	
7	105950	25.3	999.0	999.0	20.91	21.22	21.48	21.71	22.29	22.64	A	A	A	A	A	A	
7	105951	25.3	999.0	999.0	21.42	21.65	21.88	22.11	22.51	22.71	A	A	A	A	A	A	
3	105975	23.3	24.0	25.0	17.48	17.85	18.15	18.49	19.18	19.46	A	A	A	A	A	A	
3	105976	23.3	999.0	999.0	17.56	17.93	18.22	18.49	19.00	19.22	A	A	A	A	A	A	
Fairgrounds Outfall North System																	***LOS 25-YR/24-HR A***
10	104602	21.3	20.8	21.8	15.11	15.23	15.33	15.44	15.63	15.72	A	A	A	A	A	A	
6	104007	20.3	21.5	22.5	15.35	15.80	16.21	16.57	17.21	17.52	A	A	A	A	A	A	
7	104020	21.0	999.0	999.0	17.47	18.09	18.69	19.26	20.11	20.56	A	A	A	A	A	A	
7	104023	27.3	27.5	28.5	19.93	20.18	20.41	20.64	21.08	21.31	A	A	A	A	A	A	
7	104025	24.4	999.0	999.0	18.27	18.88	19.43	19.92	20.67	21.07	A	A	A	A	A	A	
7	104030	25.3	999.0	999.0	18.44	19.10	19.68	20.20	21.14	21.59	A	A	A	A	A	A	
7	104045	23.8	25.5	26.5	21.01	21.44	21.85	22.24	22.98	23.33	A	A	A	A	A	A	
7	104050	25.3	27.5	28.5	19.19	19.76	20.29	20.79	21.67	22.10	A	A	A	A	A	A	
7	104060	26.3	999.0	999.0	19.28	19.91	20.46	20.91	21.72	22.12	A	A	A	A	A	A	
7	104063	25.3	999.0	999.0	19.55	20.26	20.88	21.37	22.29	22.72	A	A	A	A	A	A	
7	104075	999.0	25.2	26.2	19.76	20.60	21.31	21.92	23.12	23.52	A	A	A	A	A	A	
7	104080	999.0	25.5	26.5	20.01	20.88	21.61	22.22	23.44	23.84	A	A	A	A	A	A	
7	104085	999.0	26.5	27.5	22.47	22.84	23.17	23.51	24.15	24.45	A	A	A	A	A	A	
7	104090	999.0	27.0	28.0	22.63	22.98	23.31	23.65	24.27	24.56	A	A	A	A	A	A	
7	104095	999.0	26.5	27.5	22.71	23.10	23.48	23.90	24.54	24.79	A	A	A	A	A	A	
7	104100	999.0	26.8	27.8	22.77	23.21	23.64	24.14	24.78	24.98	A	A	A	A	A	A	

East Lake Area (Existing Conditions) 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	50-yr	100-yr	25-Year Predicted Flooding Locations
7	104130	999.0	25.5	26.5	22.79	23.21	23.64	24.27	24.88	25.04	A	A	A	A	A	A	
7	104145	999.0	999.0	999.0	24.16	24.86	25.44	25.89	26.50	26.74	A	E	E	E	A	E	
7	104165	999.0	29.5	30.5	24.49	25.25	25.99	26.42	26.96	27.20	A	A	A	A	A	A	
7	104400	24.3	24.5	25.5	19.56	20.32	21.01	21.56	22.54	23.06	A	A	A	A	A	A	
7	104407	25.0	24.5	25.5	21.18	21.44	21.64	21.85	22.66	23.16	A	A	A	A	A	A	
7	104501	26.3	999.0	999.0	23.35	23.89	24.31	24.74	25.50	25.85	A	A	A	A	A	A	
7	104502	26.3	999.0	999.0	22.81	23.22	23.54	23.93	24.52	24.94	A	A	A	A	A	A	
10	104504	23.3	25.5	26.5	20.60	21.01	21.34	21.69	22.37	22.71	A	A	A	A	A	A	
7	104518	25.3	999.0	999.0	23.84	24.12	24.49	24.88	25.61	25.96	A	A	A	A	B	B	
10	104519	25.3	25.8	26.8	23.67	24.02	24.46	25.06	26.49	27.28	A	A	A	A	C	D	
7	104522	26.3	999.0	999.0	23.84	24.13	24.49	24.88	25.61	25.96	A	A	A	A	A	A	
7	104532	999.0	999.0	999.0	23.87	24.16	24.53	24.92	25.65	25.99	A	E	E	E	A	E	
7	104564	25.3	25.5	26.5	20.82	21.01	21.18	21.35	21.67	21.83	A	A	A	A	A	A	
10	104608	21.3	19.5	20.5	16.11	16.36	16.60	16.82	17.22	17.39	A	A	A	A	A	A	
7	104658	21.3	21.7	22.7	18.60	19.05	19.57	20.23	23.06	24.94	A	A	A	A	D	D	
East Lake Outfall																	***25-YR/24-HR LOS C***
11	101425	31.0	32.0	32.5	31.18	31.25	31.33	31.59	32.20	32.44	B	B	B	B	C	C	Rhode Island DR W of Orient RD
11	101710	21.2	21.5	22.5	19.80	20.40	20.95	21.46	22.15	22.45	A	A	A	B	C	C	Kingswood S of NY DR
11	101715	999.0	30.5	31.5	20.09	20.63	21.08	21.47	22.16	22.46	A	A	A	A	A	A	
10	101730	19.3	20.5	21.5	17.02	17.12	17.23	17.34	17.57	17.66	A	A	A	A	A	A	
8	101815	28.3	30.5	31.5	26.69	27.24	27.48	27.70	28.00	28.13	A	A	A	A	A	A	
11	101820	28.2	29.5	30.5	27.71	28.21	28.30	28.37	28.43	28.46	A	B	B	B	B	B	Orient RD S of MLK
11	101830	30.3	32.5	33.5	29.40	30.82	31.22	31.56	31.85	31.29	A	B	B	B	B	B	Orient RD
11	101837	31.3	31.5	32.0	29.45	30.16	30.37	30.51	30.73	30.82	A	A	A	A	A	A	
11	101840	32.3	32.0	33.0	32.19	32.26	32.43	32.58	32.99	33.15	C	C	C	C	C	D	Orient RD
11	101842	999.0	41.5	42.5	35.44	35.48	35.51	35.55	35.67	35.71	A	A	A	A	A	A	
11	101843	39.3	39.7	40.7	38.33	38.42	38.44	38.49	38.56	38.58	A	A	A	A	A	A	
11	101850	34.9	34.1	36.2	33.81	34.36	34.91	35.34	36.00	36.24	A	C	C	C	C	D	Orient RD
11	101852	38.3	999.0	999.0	35.65	35.72	35.79	35.85	36.06	36.29	A	A	A	A	A	A	
11	101855	36.1	35.5	36.5	33.78	34.23	34.67	35.02	35.56	35.76	A	A	A	A	C	C	
10	102005	16.3	17.5	18.5	13.14	13.49	13.83	14.15	14.78	15.10	A	A	A	A	A	A	
10	102010	16.5	18.5	19.5	13.70	14.06	14.40	14.71	15.32	15.62	A	A	A	A	A	A	
10	102015	17.3	20.5	21.5	14.00	14.47	14.86	15.21	15.97	16.34	A	A	A	A	A	A	
11	102020	25.3	27.5	28.5	22.25	22.77	23.20	23.65	24.40	24.75	A	A	A	A	A	A	
8	102025	24.7	24.5	25.5	22.45	23.03	23.59	24.11	24.95	25.16	A	A	A	A	C	C	
8	102035	28.3	29.5	30.5	22.70	23.15	23.68	24.18	25.00	25.22	A	A	A	A	A	A	
8	102040	28.3	28.8	29.8	22.96	23.33	23.85	24.37	25.72	26.41	A	A	A	A	A	A	
8	102055	29.3	27.5	28.5	23.78	24.19	24.64	25.14	26.33	26.88	A	A	A	A	A	A	

East Lake Area (Existing Conditions)
Level of Service Analysis

Story Board	Subbasin	Landmark Elevations: Road	Site	Struct	Water Surface Elevations: 2.33-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Flood Level Designations: 2.33-yr	5-yr	10-yr	25-yr	50-yr	100-yr	25-Year Predicted Flooding Locations
8	102060	27.3	27.5	28.5	24.03	24.49	25.00	25.52	26.52	27.04	A	A	A	A	A	A	
8	102070	26.8	27.5	28.5	24.47	24.93	25.38	25.84	26.83	27.35	A	A	A	A	B	B	
8	102071	28.3	999.0	999.0	24.47	24.93	25.38	25.85	26.83	27.35	A	A	A	A	A	A	
8	102072	29.3	31.5	32.5	25.05	25.43	25.76	26.09	26.85	27.37	A	A	A	A	A	A	
8	102681	24.2	25.5	26.5	24.16	24.29	24.48	24.69	25.05	25.29	A	B	B	B	B	B	Berkely
7	102690	25.6	27.0	27.5	25.40	26.12	26.35	26.42	26.53	26.57	A	B	B	B	B	B	Fawn & Cromwell
8	102868	32.3	37.5	38.5	28.93	29.69	30.37	30.96	31.68	31.90	A	A	A	A	A	A	
8	102870	30.3	33.5	34.5	28.57	28.81	29.05	29.31	29.77	29.98	A	A	A	A	A	A	
8	102876	32.3	37.5	38.5	28.81	28.91	29.06	29.34	29.80	30.01	A	A	A	A	A	A	
8	102880	999.0	37.5	38.5	33.01	33.20	33.39	33.56	33.88	34.03	A	A	A	A	A	A	
8	102884	32.3	35.5	36.5	28.96	29.72	30.41	31.00	31.67	31.76	A	A	A	A	A	A	
8	102895	35.3	36.5	37.5	32.28	32.64	32.99	33.32	33.70	33.84	A	A	A	A	A	A	
8	102974	30.3	29.5	30.5	28.76	29.02	29.24	29.39	29.78	29.99	A	A	A	A	C	C	
Orient Park Outfall																	***25-YR/24-HR D***
14	101005	19.6	22.5	23.5	11.40	11.71	12.02	12.35	12.90	13.20	A	A	A	A	A	A	
11	101015	19.1	19.5	20.5	14.96	15.43	16.02	16.46	17.56	18.65	A	A	A	A	A	A	
11	101030	21.3	21.5	22.5	16.43	17.12	17.89	18.77	19.95	20.44	A	A	A	A	A	A	
11	101040	22.4	23.5	24.5	19.51	19.69	19.89	20.17	21.55	22.21	A	A	A	A	A	A	
11	101050	22.7	23.5	24.5	21.19	21.51	22.16	22.75	23.49	23.82	A	A	A	B	B	C	75th Street Crossing (Main Channel)
11	101060	22.6	23.5	24.5	22.63	22.84	23.27	23.62	24.15	24.40	B	B	B	C	C	C	Missouri Avenue Crossing (Main Channel)
11	101075	24.5	25.5	26.5	23.86	24.40	24.78	25.07	25.54	25.74	A	A	B	B	C	C	Orient Road Crossing (Main Channel)
11	101105	31.3	30.5	31.5	29.24	29.45	29.63	29.79	30.28	30.54	A	A	A	A	A	C	
11	101115	31.7	31.4	32.4	30.02	30.45	30.87	31.27	31.85	32.04	A	A	A	A	C	C	
11	101120	30.3	30.5	32.0	30.17	30.59	31.00	31.40	32.00	32.22	A	C	C	C	D	D	Rhode Islanc
11	101127	30.3	31.5	32.7	30.63	30.93	31.22	31.58	32.20	32.43	B	B	B	C	C	C	Rhode Islanc
11	101140	31.3	32.7	33.1	31.46	31.75	32.03	32.32	32.86	33.10	B	B	B	B	C	D	Vermont Dr
11	101145	33.0	32.5	33.5	31.62	31.85	32.13	32.43	32.96	33.21	A	A	A	A	C	C	
11	101147	36.3	39.5	40.5	33.54	33.91	34.29	34.67	35.46	35.85	A	A	A	A	A	A	
11	101149	35.8	35.5	36.5	33.33	33.68	34.02	34.29	34.40	34.43	A	A	A	A	A	A	
11	101151	33.3	33.5	34.5	32.55	32.62	32.72	32.78	32.97	33.21	A	A	A	A	A	A	
11	101160	36.3	37.6	38.6	32.30	32.30	32.42	32.70	33.24	33.47	A	A	A	A	A	A	
11	101162	36.8	37.5	38.5	34.66	35.15	35.39	35.58	35.88	36.00	A	A	A	A	A	A	
11	101164	35.3	36.5	37.5	33.70	34.12	34.54	34.96	35.14	35.18	A	A	A	A	A	A	
11	101170	34.3	999.0	999.0	32.30	32.44	32.65	32.84	33.25	33.48	A	A	A	A	A	A	
11	101172	37.3	37.5	38.5	33.88	34.14	34.39	34.65	35.18	35.45	A	A	A	A	A	A	
11	101235	33.0	33.0	33.8	34.36	34.43	34.49	34.54	34.63	34.68	D	D	D	D	D	D	Spillers Ave
11	101245	36.3	38.5	39.5	35.14	35.40	35.50	35.57	35.67	35.71	A	A	A	A	A	A	

East Lake Area (Existing Conditions) 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	50-yr	100-yr	25-Year Predicted Flooding Locations
11	101305	26.3	27.5	28.5	25.06	25.22	25.37	25.50	25.77	25.90	A	A	A	A	A	A	
11	101435	34.2	33.6	34.6	32.04	32.45	32.85	33.21	33.77	33.96	A	A	A	A	C	C	
11	101450	32.3	33.0	34.0	31.20	31.45	31.54	31.60	31.69	31.74	A	A	A	A	A	A	
11	101520	29.3	28.5	29.5	27.18	27.32	27.48	27.68	28.18	28.38	A	A	A	A	A	A	
11	101535	37.5	35.5	36.5	29.46	29.54	29.60	29.70	29.84	29.89	A	A	A	A	A	A	
12	101631	999.0	999.0	999.0	31.18	31.43	31.66	31.89	32.64	32.81	A	E	E	E	A	E	
11	101740	25.5	26.0	27.0	23.79	23.88	23.94	23.98	24.18	24.25	A	A	A	A	A	A	
Judson Creek / Grant Park Outfall																	**25-YR/24 Hour D**
12	101620	30.2	30.5	31.5	29.28	29.65	29.87	30.04	30.42	30.71	A	A	A	A	B	C	
12	101630	34.3	35.5	36.5	29.22	29.61	29.88	30.06	30.49	30.77	A	A	A	A	A	A	
12	101635	35.3	33.5	34.5	29.30	30.00	30.62	31.92	33.70	34.29	A	A	A	A	C	C	
12	101645	32.8	34.5	35.5	33.24	33.63	34.40	35.02	35.75	36.04	B	B	B	C	D	D	Terra Ceia (Main Channel
12	101650	34.8	35.5	36.5	35.08	35.16	35.23	35.29	35.76	36.04	B	B	B	B	C	C	Intersection of the N55th St. & E 28th Av
12	101655	36.5	37.0	37.5	34.90	35.06	35.27	35.44	35.84	36.11	A	A	A	A	A	A	
12	101660	44.1	44.2	45.9	42.01	42.19	42.37	42.52	42.76	42.85	A	A	A	A	A	A	
12	101665	39.3	42.5	43.5	37.57	37.59	37.65	37.70	37.77	37.80	A	A	A	A	A	A	
12	101670	38.3	40.5	41.5	37.84	37.86	37.88	37.90	37.93	37.94	A	A	A	A	A	A	
12	101675	46.5	46.9	47.0	48.60	48.71	48.81	48.91	49.06	49.13	D	D	D	D	D	D	Northeast of intersection of 52nd St. & E 32nd Ave.
Fairgrounds Outfall South System																	***25-YR/24-HR A***
8	102675	29.3	999.0	999.0	24.15	24.59	25.14	25.75	27.00	27.60	A	A	A	A	A	A	
7	104205	999.0	26.5	27.5	22.85	23.38	24.26	25.31	26.02	26.24	A	A	A	A	A	A	
7	104208	999.0	28.5	29.5	25.79	26.42	26.73	27.09	27.35	27.45	A	A	A	A	A	A	
7	104215	999.0	29.5	30.5	26.93	27.69	27.84	27.92	28.09	28.18	A	A	A	A	A	A	
7	104235	32.0	32.7	33.7	29.34	29.58	29.79	29.97	30.25	30.30	A	A	A	A	A	A	
7	104247	999.0	999.0	999.0	27.62	27.89	28.20	28.42	28.69	28.79	A	E	E	E	A	E	
7	104253	29.3	999.0	999.0	27.74	28.11	28.56	28.90	29.03	29.09	A	A	A	A	A	A	
7	104280	999.0	29.5	30.5	25.12	25.49	25.80	26.10	26.65	26.93	A	A	A	A	A	A	
7	104290	999.0	29.5	30.5	24.66	24.80	24.96	25.22	26.16	26.73	A	A	A	A	A	A	
7	104291	999.0	30.0	30.5	29.50	29.59	29.67	29.74	29.87	29.93	A	A	A	A	A	A	
8	104298	999.0	999.0	999.0	23.95	24.38	24.83	25.29	26.34	26.89	A	E	E	E	A	E	
8	104305	28.9	32.5	33.5	23.94	24.37	24.80	25.21	26.14	26.71	A	A	A	A	A	A	
Hillsborough Ave. / Harney Rd System																	***25-YR / 24-HR LOS B***
8	102105	26.7	29.5	30.5	24.52	25.18	25.83	27.03	28.72	29.11	A	A	A	B	B	B	Walton Way E of Vinson Dr.
8	102115	30.8	31.1	32.1	29.73	29.86	30.00	30.09	30.23	30.29	A	A	A	A	A	A	
8	102120	999.0	33.0	33.5	32.21	32.40	32.54	32.63	32.76	32.81	A	A	A	A	A	A	
8	102130	999.0	34.5	35.5	33.64	33.88	34.04	34.27	34.88	35.19	A	A	A	A	C	C	

East Lake Area (Existing Conditions) 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	50-yr	100-yr	25-Year Predicted Flooding Locations
8	102155	28.2	30.7	31.7	28.81	28.97	29.11	29.24	29.44	29.53	B	B	B	B	B	B	Travis BLVD and Walton Way.
8	102180	30.3	31.5	32.5	29.32	29.58	29.83	30.36	31.44	31.71	A	A	A	B	B	C	Travis BLVD
8	102185	34.3	33.4	33.3	31.29	31.90	32.48	33.09	33.27	33.32	A	A	A	A	D	D	
8	102205	35.3	39.5	40.5	31.22	31.79	32.32	32.87	33.21	33.36	A	A	A	A	A	A	
4	102215	34.3	34.5	35.5	33.33	33.74	34.04	34.22	34.52	34.60	A	A	A	A	C	C	
4	102220	35.3	36.5	37.5	33.48	33.83	34.08	34.37	34.95	35.08	A	A	A	A	A	A	
4	102225	36.3	36.3	36.5	33.81	34.42	34.81	34.87	34.98	35.09	A	A	A	A	A	A	
4	102231	48.3	48.5	50.0	37.78	38.69	39.55	40.37	40.53	40.56	A	A	A	A	A	A	
4	102235	37.3	58.5	59.5	33.91	34.56	35.24	36.46	38.33	39.31	A	A	A	A	B	B	
4	102236	999.0	45.5	46.5	36.72	37.62	37.73	37.76	38.34	39.32	A	A	A	A	A	A	
4	102705	48.8	62.5	63.5	43.41	44.92	46.70	46.78	46.92	46.99	A	A	A	A	A	A	
4	102706	999.0	59.7	60.7	48.27	48.31	48.34	48.43	48.53	48.55	A	A	A	A	A	A	
4	102716	59.3	61.5	62.5	51.76	52.76	53.81	54.84	55.90	56.41	A	A	A	A	A	A	
4	102720	55.3	55.5	56.0	54.79	54.90	54.99	55.05	55.93	56.44	A	A	A	A	C	D	
4	102725	999.0	64.5	65.5	54.97	55.56	56.20	56.84	58.19	58.84	A	A	A	A	A	A	
5	102735	999.0	999.0	999.0	59.34	60.19	61.02	61.29	61.60	61.79	A	E	E	E	A	E	
4	102745	999.0	63.0	64.0	60.17	60.51	61.02	61.28	61.56	61.72	A	A	A	A	A	A	
4	102750	999.0	62.5	63.5	60.29	61.06	61.06	61.26	61.49	61.62	A	A	A	A	A	A	
5	102760	64.3	73.5	74.5	59.34	60.19	61.02	61.29	61.61	61.81	A	A	A	A	A	A	
4	102770	63.0	63.1	64.5	59.49	60.19	61.02	61.29	61.62	61.83	A	A	A	A	A	A	
4	102775	999.0	65.5	66.0	60.35	61.71	63.33	65.26	69.65	72.09	A	A	A	A	D	D	
4	102800	55.3	72.5	73.5	41.35	42.99	44.65	46.12	48.14	49.18	A	A	A	A	A	A	
4	102801	50.3	46.5	47.0	43.60	44.28	44.96	45.91	48.14	49.18	A	A	A	A	D	D	
4	102805	46.3	47.0	48.0	41.36	43.01	44.66	46.12	48.14	49.19	A	A	A	A	D	D	
4	102810	49.3	48.5	49.5	42.25	43.01	44.68	46.12	48.15	49.20	A	A	A	A	A	C	
4	102811	55.3	999.0	999.0	52.24	52.77	53.28	53.79	54.77	55.25	A	A	A	A	A	B	
4	102815	50.8	51.5	52.5	43.54	44.04	45.18	46.52	49.82	51.01	A	A	A	A	A	B	
4	102817	999.0	51.5	52.5	49.84	49.96	50.07	50.17	50.36	51.15	A	A	A	A	A	A	
4	102830	54.3	999.0	999.0	49.25	49.79	50.29	50.75	51.65	52.16	A	A	A	A	A	A	
4	102845	59.3	61.9	62.9	56.05	56.50	56.93	57.28	57.99	58.32	A	A	A	A	A	A	
4	102865	60.0	60.5	61.5	57.56	57.80	58.23	59.17	61.14	62.17	A	A	A	A	C	D	
East Lake Mall System																	***25-YR / 24-HR LOS D***
8	102305	28.3	28.5	29.5	24.88	25.22	25.88	26.60	27.93	28.31	A	A	A	A	A	B	
8	102310	28.2	29.5	30.5	27.87	28.50	28.76	28.95	29.27	29.45	A	B	B	B	B	B	Walton Way SW of Harney Rd
8	102315	29.3	30.3	30.7	30.69	30.84	30.97	31.10	31.34	31.45	D	D	D	D	D	D	Between Travis Blvd.& Walton Way
8	102320	30.4	31.5	32.0	30.76	30.93	31.08	31.22	31.49	31.61	B	B	B	B	B	C	Travis Blvd SW of Vinson Rd
9	102325	34.3	38.5	39.5	32.23	32.59	33.01	33.63	35.18	35.40	A	A	A	A	B	B	
5	102345	45.3	58.5	59.5	43.10	43.56	43.99	44.22	44.45	44.54	A	A	A	A	A	A	

East Lake Area (Existing Conditions) 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	50-yr	100-yr	25-Year Predicted Flooding Locations
9	102406	33.3	999.0	999.0	27.20	28.87	30.75	32.55	34.97	35.51	A	A	A	A	B	B	
9	102415	43.3	46.5	47.5	34.77	35.29	35.76	36.22	37.14	37.59	A	A	A	A	A	A	
9	102417	45.3	50.5	51.5	38.17	38.25	38.32	38.39	38.52	38.58	A	A	A	A	A	A	
9	102445	54.3	65.5	66.5	45.44	46.78	47.58	48.30	49.63	50.24	A	A	A	A	A	A	
9	102450	999.0	50.0	50.5	46.70	48.13	48.98	49.74	51.11	51.73	A	A	A	A	D	D	
9	102460	52.0	52.5	53.5	49.50	50.56	51.21	51.80	53.30	53.98	A	A	A	A	C	D	
5	102465	50.3	49.8	50.5	49.91	50.60	51.25	51.83	53.33	54.02	C	D	D	D	D	D	NE of Hillsborough Ave.& 59th St
5	102481	55.3	999.0	999.0	50.55	52.05	53.32	53.43	53.78	54.06	A	A	A	A	A	A	
5	102486	54.3	53.5	54.5	51.39	52.19	53.33	53.44	53.78	54.07	A	A	A	A	C	C	
9	102525	55.3	65.5	66.5	36.37	36.75	37.13	37.54	38.82	39.68	A	A	A	A	A	A	
9	102545	45.3	48.5	49.5	37.42	37.69	38.04	38.49	40.10	41.55	A	A	A	A	A	A	
9	102575	46.3	48.5	49.5	40.61	40.84	41.05	41.27	41.81	43.60	A	A	A	A	A	A	
9	102590	45.3	999.0	999.0	41.73	42.29	42.84	43.34	44.19	44.56	A	A	A	A	A	A	
9	102595	44.3	44.8	45.8	41.98	42.75	43.37	43.75	44.20	44.56	A	A	A	A	A	B	
9	102600	45.3	44.8	45.8	42.47	43.23	43.88	44.18	44.41	44.57	A	A	A	A	A	A	
9	102615	46.1	49.5	50.5	46.56	46.70	46.83	46.94	47.16	47.25	B	B	B	B	B	B	56th St N of Shadowlawr
9	102625	50.5	50.5	51.5	47.85	48.67	49.50	50.40	52.22	53.24	A	A	A	A	D	D	
5	102635	56.3	58.5	59.5	51.55	51.65	51.76	51.86	52.33	53.42	A	A	A	A	A	A	
5	102650	61.3	58.5	59.5	55.34	55.43	55.50	55.56	55.66	55.71	A	A	A	A	A	A	
5	102691	56.3	59.5	60.5	55.32	55.41	55.47	55.53	55.62	55.66	A	A	A	A	A	A	
5	102693	55.3	55.5	56.5	54.36	54.42	54.47	54.52	54.61	54.65	A	A	A	A	A	A	
5	102787	999.0	59.0	60.0	57.13	57.33	57.60	57.81	58.13	58.27	A	A	A	A	A	A	
50th / 56th Street System																	***25-YR/24-HR LOS D***
9	102525	55.3	65.5	66.5	36.37	36.75	37.13	37.54	38.82	39.68	A	A	A	A	A	A	
9	102545	45.3	48.5	49.5	37.42	37.69	38.04	38.49	40.10	41.55	A	A	A	A	A	A	
9	102575	46.3	48.5	49.5	40.61	40.84	41.05	41.27	41.81	43.60	A	A	A	A	A	A	
9	102900	37.0	999.0	999.0	25.07	25.26	25.42	25.85	26.83	27.35	A	A	A	A	A	A	
9	102904	30.3	32.7	33.7	29.61	29.78	29.96	30.23	30.82	31.11	A	A	A	A	B	B	
9	102905	33.3	32.0	33.0	30.02	30.08	30.25	30.58	31.17	31.46	A	A	A	A	A	A	
9	102912	45.0	43.6	43.8	43.39	43.53	43.78	43.97	44.24	44.34	A	A	D	D	D	D	Southwest corner of intersection of Harney Rd. & E osborne Ave
9	102920	48.3	59.5	60.5	46.97	48.02	48.43	48.71	49.12	49.27	A	A	B	B	B	B	56th St Crossing / Harney Rd (main channel
9	102921	999.0	49.5	50.5	47.87	48.43	48.94	49.03	49.11	49.30	A	A	A	A	A	A	
9	102928	53.3	69.5	70.5	51.55	51.72	51.87	52.01	52.26	52.38	A	A	A	A	A	A	
9	102932	51.3	51.5	52.0	50.74	50.91	51.04	51.15	51.31	51.39	A	A	A	A	B	B	
9	102933	48.0	48.3	48.5	44.57	45.65	46.68	47.67	49.54	50.21	A	A	A	A	D	D	
9	102944	40.3	36.5	37.5	30.10	30.23	30.38	30.53	30.82	30.96	A	A	A	A	A	A	
8	102952	35.3	34.6	33.7	29.40	30.33	30.79	31.17	31.81	32.07	A	A	A	A	A	A	

East Lake Area (Existing Conditions) 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	50-yr	100-yr	25-Year Predicted Flooding Locations
Mary Help System																	***25-YR/24-HR LOS B***
12	102076	37.5	38.5	39.5	33.56	34.19	34.43	34.71	35.18	35.39	A	A	A	A	A	A	
12	102077	999.0	37.5	38.5	35.83	36.08	36.33	36.57	37.05	37.22	A	A	A	A	A	A	
12	102082	36.3	38.5	39.5	34.10	34.25	34.38	34.52	34.98	35.26	A	A	A	A	A	A	
9	102954	32.3	999.0	999.0	32.02	32.10	32.13	32.20	32.28	32.34	A	A	A	A	B	B	
9	102966	32.7	35.6	36.5	33.56	34.19	34.43	34.71	35.18	35.40	B	B	B	B	B	B	Chelsea Ave. / Interstate Corporate Center N of MLK BLVD
12	102967	40.0	40.0	40.5	39.73	39.79	39.85	39.90	39.99	40.04	A	A	A	A	A	C	
9	102970	41.3	43.5	44.5	40.67	40.79	40.91	41.02	41.23	41.33	A	A	A	A	A	B	

LEGEND

A - No flooding
B - Road Flooding
C - Site Flooding
D - Structure Flooding
E - No Facility

and computed water surface elevations for the 2.33-yr/24-hr, 5-yr/24-hr, 10-yr/24-hr, 25-yr/24-hr, 50-yr/24-hr, and 100-yr/24-hr storm events, respectively.

6.4 LEVEL OF SERVICE DESIGNATIONS

LOS designations are assigned in three levels of detail: subbasin, system and watershed.

Subbasins were aggregated into eleven systems (Harney Prairie Outfall, I-4 Outfall, Fairgrounds Outfall – North System, East Lake Outfall, Orient Park Outfall and Judson Creek/Grant Park Outfall, Fairgrounds South System, Hillsborough/Harney Road System, East Lake Mall System, 50^{th} / 56^{th} Street System and Mary Help System) according to general drainage patterns. For each return period storm event, the LOS designation is first determined for the subbasin. Then the LOS is determined for the individual systems based on the aggregated subbasins comprising the system. Finally, the LOS designation is determined for the overall watershed. The LOS of the ELA watershed is reflective of the worst case system and the LOS of the system is reflective of the worst case subbasin. Exhibit 6-3 contains a graphical representation of the ELA level of service analysis for the 2.33-yr/24-hr, 5-yr/24-hr, 10-yr/24-hr, and 25-yr/24-hr storm event, the Ultimate LOS.

It is important to be aware of the limits of the methodology used in the LOS analysis. Most landmark elevation information was taken from topographic maps, some of which are approximately 20 years old. In addition, the LOS analysis does not identify flood protection deficiencies for secondary systems contained in a subbasin since only the major systems are contained in the hydraulic model. Conversely, since only the critical landmark elevations were identified in each subbasin, areas within a subbasin may contain a higher LOS than that assigned.

6.4.1 THE HARNEY PRAIRIE OUTFALL SYSTEM

The Harney Prairie Outfall system has a LOS B for the 25-yr/24-hr (Exhibit 6-3) design storm simulation with the exception of the Commanche Staley Neighborhood. Although the model does predict finish floor flooding in this neighborhood, the severity of the flooding should be taken into consideration. Table 6.4 shows the degree of severity of structural flooding to generally be minimal for this neighborhood. Furthermore, detailed calibration of the model for the Harney Prairie Outfall may be necessary for a more detailed analysis. Based on historical evidence this neighborhood has experienced localized street and site flooding thus agreeing with model simulations. Detailed locations where flooding is predicted to occur for the 25-year / 24 hour storm event can be seen in Exhibit 6-3. Summarized below are general locations where the EXTRAN model has predicted flooding to occur during the 25-year/24 hour storm event.

Structural flooding during the 25-year / 24 hour storm event:

Commanche / Staley neighborhood
- Deleuil Avenue west of Lenox
- Southwest corner of Mohawk and Staley Avenue

Site flooding during the 25-year / 24 hour storm event:

- Near Deleuil Avenue west of Lenox Avenue
- Near Southwest Corner of Mohawk and Staley Avenue

Street flooding during the 25-year / 24 hour storm event:

- Orient Road and Hanna Avenue intersection
- Delevil Avenue
- Mohawk and Staley Intersection

6.4.2 THE INTERSTATE 4 (I-4) OUTFALL SYSTEM

The I-4 Outfall system has a LOS A for the 25-year / 24-hour design storm simulation. The EXTRAN model predicts no major street, site, or structural flooding is expected to occur during the 25-year / 24 hour storm event.

6.4.3 THE FAIRGROUNDS OUTFALL - NORTH SYSTEM

The Fairgrounds Outfall –North System has a LOS A for the 25-year / 24 hour storm event. The EXTRAN model predicts that during the 25-year / 24 hour storm event no major structural, site, or street flooding will occur.

6.4.4 THE EAST LAKE OUTFALL SYSTEM

The East Lake Outfall System has a LOS C for the 25-year / 24 hour storm event. It should be noted that the East Lake Outfall LOS System includes the East Lake subbasin in addition to the East Lake Outfall contributing drainage area. The Hillsborough County Modified EXTRAN model predicts that during the 25-year / 24 hour storm event, localized site and street flooding will occur in the main channel area of the system. Detailed locations where flooding is predicted to occur for the 25-year/24 hour storm event is shown in Exhibit 6-3.

<u>Site flooding during the 25-year / 24 hour storm event:</u>

- Along Orient Road South of Martin Luther King Boulevard

<u>Street flooding during the 25-year / 24 hour storm event:</u>

- Rhode Island Drive west of Orient Road
- Kingswood Drive south of New York Drive
- Orient Road south of Martin Luther King Boulevard
- Berkley Drive
- Near the intersection of Fawn and Cromwell Drive

6.4.5 THE ORIENT PARK OUTFALL SYSTEM

The Orient Outfall System has a LOS C for the 25-year / 24 hour storm event with the exception of an area near Spillers Avenue, where structural flooding is predicted. Table 6.4 shows the predicted severity of the finish floor flooding in more detail. Based on historical evidence this system has experienced site and street flooding which agrees with the model simulations for the 25-year / 24 hour storm event. Detailed calibration of the Orient Park Outfall may be necessary for further determination of the extent of any finish floor flooding within this system. Specific locations where flooding is predicted to occur for the 25-year / 24 hour storm event can be seen in Exhibit 6-3. General locations where the EXTRAN model predicts LOS deficiencies are summarized below.

<u>Structural flooding during the 25-year/24-hour storm event:</u>

- Near Spillers Avenue

<u>Site flooding during the 25-year / 24-hour storm event:</u>

- Near Spillers Avenue
- Near Missouri Avenue
- Near Rhode Island

Street flooding during the 25-year / 24 hour storm event:

- 75th Street
- Missouri Avenue
- Orient Road
- Rhode Island
- Vermont Drive
- Spillers Avenue

6.4.6 THE JUDSON CREEK / GRANT PARK OUTFALL SYSTEM

The Judson Creek / Grant Park Outfall system has a LOS C for the 25-year / 24-hour storm event with the exception of the area in the western portion of Grant Park. The Hillsborough County Modified EXTRAN model predicts that during the 25-year/24 hour storm event, structural, localized site, and street flooding will occur in the Judson Creek / Grant Park Outfall system. Further calibration analysis of this outfall may be necessary for detailed finish floor flooding information within this system. Detailed locations where flooding is predicted to occur for the 25-year / 24 hour storm event can be seen in Exhibit 6-3. General locations of predicted street and site flooding are summarized below.

Structural flooding during the 25-year / 24 hour storm event:

- Northeast of 52nd Street and East 32nd Avenue intersection

Site flooding during the 25-year / 24 hour storm event:

- Grant Park Subdivision near Terra Ceia Drive
- Area northeast of 52nd Street and 32nd Avenue intersection

Street flooding during the 25-year / 24 hour storm event:

- Terra Ceia Drive
- North 55th Street and East 28th Avenue intersection
- 52nd Street and East 32nd Avenue intersection

6.4.7 THE FAIRGROUNDS OUTFALL - SOUTH SYSTEM

The I-4 Outfall system has a LOS A for the 25-year / 24-hour design storm simulation. No major street, site, or structural flooding is expected to occur during this storm event.

6.4.8 THE HILLSBOROUGH AVENUE / HARNEY ROAD OUTFALL SYSTEM

The Hillsborough Avenue / Harney Road System has a LOS B during the 25-year / 24 hour storm event. Detailed locations where flooding is predicted to occur for the 25-year / 24 hour storm event can be seen in Exhibit 6-3. General locations of predicted street and site flooding are listed below.

Street flooding during the 25-year / 24 hour storm event:

- Walton Way
- Travis Boulevard

6.4.9 THE EAST LAKE MALL OUTFALLS - NORTH AND SOUTH SYSTEMS

The East Lake Mall System has a LOS C during the 25-year / 24 hour storm event with the exception of two areas that have the possibility for finish floor flooding. Although historical flooding data does not indicate finish floor flooding in these two areas, the EXTRAN model does support that the potential exists for structural flooding in this system. Detailed locations where flooding is predicted to occur for the 25-year / 24 hour storm event can be seen in Exhibit 6-3. General locations of predicted street and site flooding are summarized below.

Structural flooding during the 25-year / 24 hour storm event:

- Between Travis Boulevard and Walton Way
- Northeast of Hillsborough Avenue and 59th Street

<u>Site flooding during the 25-year / 24 hour storm event:</u>

- Northeast of Travis Boulevard and Walton Way intersection
- Northeast of Hillsborough Avenue and 59th Street

<u>Street flooding during the 25-year / 24 hour storm event:</u>

- Walton Way southwest of Harney Road
- Travis Boulevard
- Hillsborough Avenue
- 56th Street

6.4.10 THE 50TH / 56TH STREET OUTFALL SYSTEM

The 50th / 56th Street System has a LOS D during the 25-year / 24 hour storm event. Detailed locations where flooding is predicted to occur for the 25-year / 24 hour storm event can be seen in Exhibit 6-3. General locations where the EXTRAN model predicts flooding are listed below.

<u>Structural flooding during the 25-year / 24 hour storm event:</u>

- Southwest of Harney Road and East Osborne Avenue intersection

<u>Site flooding during the 25-year / 24 hour storm event:</u>

- Southwest of Harney Road and East Osborne Avenue intersection

<u>Street flooding during the 25-year / 24 hour storm event:</u>

- 56th Street
- Harney Road

6.4.11 THE MARY HELP OUTFALL SYSTEM

The Mary Help System has a LOS B during the 25-year / 24 hour storm event. Detailed locations where flooding is predicted to occur for the 25-year / 24 hour storm event can be seen in Exhibit 6-3. The EXTRAN model predicts street flooding during the 25-year / 24 hour storm event to occur at Chelsea Avenue and the Interstate Corporate Center intersection north of ML King Boulevard.

EXISTING WATER QUALITY CONDITIONS

7.1 OVERVIEW

As previously shown in Table 2.1 of Chapter 2, there are very few wetland communities in the East Lake Area watershed. Lakes and stream contribute less than 7% of the total wetland acreage and constitute less than 1% of the watershed's total acreage. The largest natural surface water feature in the watershed is East Lake, which covers almost 100 acres, and according to SWFWMD information is the twelfth largest lake / reservoir in the County. The East Lake Area watershed contains six different outfalls and an equal number of stormwater conveyance systems for the transport of surface waters. The drainage basin for the lake is 1127 acres and the lake receives overland flow from the East Lake outfall and both of the East Lake Mall conveyance systems.

Very little has been done in the way of studies in the watershed area, possibly due to the highly developed nature of the area. A sampling / monitoring program was established in 1974 as a result of the negotiations held during the permitting of East Lake Square Mall. The EPC has done periodic sampling as a result of citizen complaints through the years but has no permanent sampling stations within the lake or the ELW. Dawes, et.al. included East Lake in their study of several lakes in Hillsborough County which is entitled, "Limnological Characteristics of Two Eutrophic and Four Mesotrophic Lakes in West-central Florida" (1987). In June 1997, ERD completed its report to Hillsborough County and SWFWMD. This report summarized the existing data and made recommendations that included one suggesting the lake be treated with alum. More recently, the East Lake Park Civic Association has begun routine sampling with the LAKEWATCH program in conjunction with the University of Florida and Hillsborough County.

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. Chapter 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. Chapter 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 and streams within the ELW are considered to be Class III Florida waters. This designation allows uses 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.). East Lake discharges into the Tampa By-Pass Canal, which in turn discharges into Tampa Bay via McKay Bay. The By-Pass Canal will be a focal point of the Minimum Flows and Levels (MFLs) being developed by a joint water use group consisting of Hillsborough, Pinellas and Pasco Counties in conjunction with SWFWMD and Tampa Bay Water.

7.2 LAKES

7.2.1 DATA AND ASSESSMENT METHODS

There is only one large, natural lake within the watershed, East Lake. Almost all other waterbodies are man-made with the largest ones, designated as reservoirs, occurring along the U.S. Interstate 4 / U.S. Highway 301 corridors. These are, in most cases, the result of borrow needed to build these roadways - especially the overpasses. Other smaller features are scattered throughout the watershed with a small group, used mainly for stormwater purposes, located on the Fairgrounds property. The condition of these waterbodies, especially East Lake, is a watershed area of concern. The lake has undergone numerous man-induced changes through the years due to the progressively urban nature of the land uses which surround it. This has resulted in the accelerated eutrophication of the lake.

There have been no long-term studies or water quality monitoring on any of the lakes or reservoirs within the ELW. The earliest monitoring within the basin was done on East Lake in conjunction with the development of the East Lake Square Mall. On May 23, 1974, an agreement was reached between the East Lake Square Associates, who was the mall developer, and the East Lake Park Civic Association. This agreement addressed the concerns of the Civic Association in regards to potential water quality impacts to the lake associated with the development of the mall. As part of the agreement, a 4.3 acre retention pond with a skimmer was constructed on the site and a regular program of parking lot cleaning by sweeping and vacuuming was initiated. Water quality was monitored from June 1974 to June 1975 on a monthly basis and periodically thereafter until mid 1978. Samples were collected from four locations - in the retention pond, at the outfall of the canal leading into East Lake from the mall, near the lake's center and at the lake's southeast corner at its outfall that passes under I-4. These locations are depicted in **Figure 7-1**. **Table 7.1** contains this data for the sampling site at the center of East Lake only.

Review of this data, for the most part, does not reveal any significant changes or trends in the water chemistry, at least in the years between 1974 and 1992 (no samples were taken between May 1978 and August 1983). The lake's pH remains around the average of 8.5. It has approached a value of 10 on three occasions and has dipped below 8 on 9 separate occasions. On only one of these 9 times did it fall below 7. Total suspended solids probably had the largest range of variation over the sampling period, revolving around an average of 22.2 mg/l and generally ranging between 10 and 30 mg/l. TSS was generally at its highest at the end of the rainy season in August and September and lowest toward the end of the dry season in February and March, fluctuating from a high of 55 mg/l to a low of 1.0 mg/l. Calcium, a measure of the water's hardness, probably varied the least. The average value was 26.7 mg/l with a high of 56.2 and a low of 19.0. All but 6 of the 37 samples ranged between 20 and 30 mg/l. With the exception of one spike up to 9.5 mg/l in January 1978, the Total Kjeldahl Nitrogen in the lake appeared to be on a slow decline between 1974 and 1986. Since 1986, there seems to be a trend of a slow increase, but levels are still below the levels of the mid-70's. While not as pronounced as the TSS values, the fluctuation seem to follow the amount of rainfall; the more rain, the higher the deposition. The lowest Total Kjeldahl Nitrogen value was 0.25 mg/l with the maximum spiking out at 9.5 mg/l. This maximum value was double the second highest value and almost three times more than the third highest sampling result. Total Phosphorus has remained relatively stable throughout the period of sampling; averaging 0.19 mg/l and only rising above 0.5 mg/l on three occasions. The maximum value was 2.14 mg/l with a minimum of 0.01 mg/l. Biological Oxygen Demand (BOD) ranged from a low of 1.0 to a high of 16.0 mg/l with an average of 6.76 mg/l. The range of values for Chemical Oxygen Demand (COD) varied almost as much as TSS, with a high of 132.0 mg/l and a low of 13.0 mg/l around an average of 61.12 mg/l. The only clear trend (while sampling was ongoing) was in dissolved oxygen. There was a sharp decline in surface D.O. from a high of 18.0 mg/l in Sept. 1974 to 1.74 mg/l in the next to last sampling event in January 1978. D.O. at mid-depth seemed to follow the same downward trend as surface D.O. prior to 1979, but the trend seems to be slightly upward with the resumption of sampling in 1984. The highest value was found in the initial sampling in September 1974 at 16.0 mg/l with the lowest at 4.06 mg/l and an average of 9.83 mg/l. Dissolved oxygen concentration can be variable; increasing during the day as a result of the release of large amounts of oxygen from photosynthesizing algae and plants, and decreasing during the night when photosynthesis stops and oxygen is consumed through respiration and decomposition. The D.O. values can also be expected to vary with depth; being higher closer to the surface where there is sufficient sunlight to drive photosynthesis and dropping with depth as the amount of light decreases. D.O. levels below 5 mg/l can be harmful to most aquatic organisms and levels below 2 mg/l can be fatal to all but the most pollutant-tolerant species. Annual D.O. averages, as well as yearly maximums and minimums, can be seen in **Figure 7-2**. Total coliform bacterial counts have been low and stable since May 1984. Prior to that, there were small peaks during the rainy season as would be expected. The average value was 1348.51 MPN /100 ml, with a low of < 1 and a maximum of 24,000 detected during the initial sampling. If this first sample is disregarded, the average falls to 682.29 MPN/100 ml. The state water quality standard of 2,400 per 100 ml. was exceeded on only three occasions. Total coliform annual average, minimum and maximum values are shown in **Figure 7-3**. Fecal coliform counts mirrored the total counts for the most part being low and stable since May 1984 with a few spikes prior to May 78 that coincide with the rainy season. Values ranged from a high of 4500 to a minimum of < 1 and averaged 260.72 per 100 ml. The state water quality standard of 800 per 100 ml. was also exceeded on three occasions, although not at the same times as the total coliform count. **Figure 7-4** depicts the annual averages as well as the minimum and maximum values for this parameter.

Table 7.1
East Lake Square Mall Water Quality Sampling Data for East Lake Station ('74-'78)

Date	Water Temp.		pH	Turbidity	Total Suspended Solids	Calcium	Total Kjeldahl Nitrogen	Total Phosphorus	BOD	COD	Dissolved Oxygen Surface	mid-depth	Total Coliform	Fecal Coliform	Lead	Oil & Grease
	E F	EC		JTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100 ml	MPN/100 ml	mg/l	mg/l
9/27/74	---	---	---	65	32.0	21.1	2.82	0.01	11.0	79.0	18.00	16.00	24,000	91.0	0	-
10/30/74	---	---	---	95	---	---	2.68	0.09	4.0	70.0	13.00	10.00	---	---	--	--
11/29/74	---	---	---	65	---	---	3.20	0.09	4.0	36.0	10.50	10.50	---	---	--	--
12/31/74	---	---	8.5	80	47.0	22.4	4.31	0.01	8.0	79.0	10.10	10.80	---	91.0	0	--
1/30/75	---	---	---	72	---	---	2.85	0.13	4.0	68.0	10.00	8.00	---	---	--	--
2/27/75	---	---	---	53	---	---	2.85	0.06	4.0	66.0	12.00	11.00	---	---	--	--
4/30/75	---	---	---	104	---	---	3.65	0.14	11.0	70.0	10.40	9.90	---	---	--	--
5/29/75	---	---	---	65	---	---	3.46	0.17	8.0	32.0	9.70	9.50	---	---	--	--
6/27/75	---	---	7.8	54	39.0	27.3	1.10	0.08	7.0	73.0	9.10	8.70	< 2100	< 30.0	<	--
7/25/75	---	---	---	44	20.0	---	1.73	0.11	7.0	29.0	11.10	11.80	---	---	--	--
8/25/75	---	---	---	36	6.0	---	0.25	0.07	---	29.0	11.40	10.00	---	---	--	--
10/1/75	---	---	8.5	47	10.0	56.2	3.48	0.11	6.5	64.0	11.70	12.00	2100	< 30.0	<	--
1/29/76	---	---	8.6	67 (FTU)	22.0	25.3	3.03	0.08	7.5	104.9	11.90	12.30	1500	230.0	0	--
5/25/76	---	---	9.2	65	16.0	28.1	3.38	0.14	5.5	92.2	9.70	9.50	210	< 30.0	<	--
9/76	---	---	8.9	49	27.0	31.5	3.00	0.14	6.4	62.0	8.70	4.10	750	90.0	<	--
2/8/77	---	---	---	---	---	---	---	---	---	---	---	---	---	---	--	--
2/14/77	62	17.0	7.9	24	21.0	27.5	2.60	0.09	5.9	69.0	9.60	9.50	1500	930.0	<	--
5/27/77	81	27.0	9.6	9	16.0	32.0	2.00	0.10	4.6	23.0	9.03	6.35	360	NF	<	--
9/19/77	84	27.0	9.2	24	26.0	23.0	2.80	< 0.10	16.0	71.0	6.92	5.22	4600	150.0	<	--
1/18/78	56	13.5	8.2	69	37.0	26.2	9.50	0.14	14.0	95.0	1.74	5.81	790	790.0	<	--
5/8/78	82	28.0	8.9	65	22.0	26.0	2.10	0.27	3.5	57.0	3.98	4.06	230	230.0	<	--

Table 7.1 (cont'd.)
East Lake Square Mall Water Quality Sampling Data for East Lake Station ('83-'87)

Date	Water Temp.		pH	Turbidity	Total Suspended Solids	Calcium	Total Kjeldahl Nitrogen	Total Phosphorus	BOD	COD	Dissolved Oxygen		Total Coliform	Fecal Coliform	Lead		Oil & Grease
											Surface	mid-depth					
	E F	EC		NTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100 ml	MPN/100 ml	mg/l	mg/l	
8/25/83	86.0	30.0	7.3	11.0	16.0	25.0	1.30	0.11	4.0	41.0	---	---	240	160	< 0.01	1.60	
11/22/83	68.0	20.0	7.1	14.0	22.0	23.0	1.80	0.25	6.5	44.0	---	14.0	1500	1000	< 0.01	1.20	
2/23/84	70.0	21.0	7.2	17.0	18.0	24.0	2.10	0.63	7.1	62.0	---	5.6	5000	4500	< 0.01	1.30	
5/24/84	84.0	29.0	9.7	23.0	55.0	30.0	1.70	0.12	8.3	63.0	---	10.6	< 1	< 1	0.02	4.40	
8/23/84	82.0	28.0	8.9	6.6	13.0	21.0	1.50	0.09	5.0	34.0	---	11.0	> 200	38	< 0.01	1.10	
11/15/84	65.0	18.5	8.9	12.0	15.0	20.0	1.80	0.14	6.7	54.0	---	11.2	---	270	< 0.01	0.96	
2/21/85	64.0	18.0	9.4	11.0	20.0	27.0	1.30	0.12	7.7	59.0	---	10.8	75	75	< 0.01	0.24	
5/23/85	85.0	29.5	9.9	19.0	28.0	31.0	1.60	0.20	7.8	128.0	---	9.7	< 3	< 3	< 0.01	0.99	
8/21/85	88.0	31.1	9.0	8.6	11.0	26.0	1.84	0.14	7.0	59.0	---	9.8	200	20	< 0.02	< 1.00	
11/25/85	76.0	24.6	7.7	9.3	18.0	27.0	2.07	0.10	6.0	56.0	---	7.7	240	93	< 0.01	4.00	
2/28/86	66.0	19.0	9.1	13.0	22.0	29.0	2.12	0.12	1.0	49.0	---	9.3	120	23	< 0.02	3.00	
5/28/86	83.0	28.6	9.5	17.0	26.0	31.0	1.45	0.14	10.0	61.0	---	9.9	7	7	< 0.01	< 1.00	
8/28/86	82.0	28.0	8.5	9.2	13.0	25.0	1.27	0.13	5.0	13.0	---	11.2	93	93	< 0.01	< 1.00	
11/25/86	77.0	24.9	8.5	13.0	5.0	26.0	2.23	0.11	7.0	132.0	---	6.0	130	80	< 0.01	< 1.00	
2/25/87	68.0	20.0	8.3	40.0	27.0	25.0	2.06	0.16	8.0	66.0	---	10.6	130	79	< 0.01	< 1.00	
5/29/87	82.0	28.0	9.3	16.0	48.0	27.0	1.85	0.53	9.0	56.0	---	8.0	4	3	< 0.01	< 1.00	
8/25/87	89.0	31.5	8.8	13.0	23.0	26.0	2.91	< 0.02	7.0	68.0	---	13.6	100	100	< 0.02	5.00	
11/24/87	63.0	17.0	7.9	3.9	1.0	24.0	1.03	0.06	4.0	37.0	---	9.6	< 1	< 1	< 0.02	< 1.00	

Table 7.1 (cont'd.)
East Lake Square Mall Water Quality Sampling Data for East Lake Station ('88-'89)

Date	Water Temp.		pH	Turbidity	Total Suspended Solids	Calcium	Total Kjeldahl Nitrogen	Total Phosphorus	BOD	COD	Dissolved Oxygen		Total Coliform	Fecal Coliform	Lead	Oil & Grease
												Surface	mid-depth			
	E F	EC		NTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100 ml	MPN/100 ml	mg/l	mg/l
2/25/88	59.0	15.0	8.5	14.0	2.0	19.0	2.66	0.13	7.0	59.0	---	13.8	500	4	< 0.02	3.00
5/27/88	74.0	23.5	7.6	17.0	26.0	20.0	2.18	0.26	5.0	55.0	---	10.4	14	< 1	< 0.02	< 1.00
8/26/88	81.0	27.0	5.8	11.0	10.0	30.0	1.13	2.14	4.0	38.0	---	10.6	200	2	< 0.005	2.00
11/30/88	61.0	16.0	8.5	17.0	23.0	22.0	2.79	0.12	7.1	58.0	---	13.4	170	76	< 0.02	3.00
2/24/89	51.8	11.0	8.8	18.0	39.0	27.8	2.14	0.19	8.0	15.5	---	14.0	120	60	< 0.02	< 1.00
5/23/89	76.0	24.5	9.2	23.0	33.0	33.1	3.70	0.11	6.3	130.0	---	7.8	< 1	< 1	< 5.0	10.00
8/24/89	79.7	26.5	8.6	7.6	11.0	21.3	1.00	0.08	5.0	44.0	---	8.8	9	4	< 0.02	< 1.00
Average	**74.2**	**23.4**	**8.5**	[redacted]	**22.2**	**26.7**	**2.41**	**0.19**	**6.76**	**61.12**	**9.92**	**9.83**	**1348.51**	**260.72**	**< 0.15**	**< 2.07**

Figure 7.1 Not Available At Time of Posting

Figure 7-2 Not Available At Time of Posting

Figure 7-3 Not Available At Time of Posting

Figure 7-4 Not Available At Time of Posting

FDEP recommends the use of the Florida Trophic Site Index (TSI) to characterize water quality conditions in lakes and estuaries 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 also includes total nitrogen (TN) concentration as an additional trophic state indicator. Secchi depth has been dropped as an indicator in recent FDEP guidance for calculation of TSI values (Hand et. al. 1996) because interpretation of Secchi depth data in many "blackwater" (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 Florida 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≅

As seen in **Table 7.2** below, the two main regulatory agencies that work within Hillsborough County, SWFWMD and EPC, have not done extensive sampling on East Lake. Those samples taken were largely the result of citizen complaints and focused primarily on coliform counts. Notes on EPC's sampling results from as far back as May 19, 1980 and September 19, 1986, state that the ratio of the fecal coliform to strep coliform counts indicate this loading may be from a non-human source. This would tend to indicate the pastureland surrounding the lake and the bird roost / rookery have been influencing the lake's water quality for many years. The EPC has four sampling sites on East Lake, which are almost identical to those used for the mall samplings. Both sample the lake's center and at the canal's outfall into the lake. EPC samples at the retention pond's outfall rather than in the pond and has added a fourth site near the civic association clubhouse in the southeast corner of the lake. The only other difference in sampling is that the agencies do not sample for oil and grease.

Table 7.2
Governmental Agency Water Quality Sampling Data for East Lake Station ('78-'92)

Date	Agency[1] and Site #	Water Temp.		pH	Turbidity	Total Suspended Solids	Calcium	Total Kjeldahl Nitrogen	Total Phosphorus	BOD	COD	Dissolved Oxygen		Total Coliform	Fecal Coliform	Lead
												Surface	mid-depth			
		EF	EC		NTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100 ml	mg/l
January 18 1978	EPC #1	---	---	7.6	12.0	30.0	28.0	0.51	0.17	6.7	---	9.8	---	5700	100	0.03
	EPC #2	---	---	7.5	7.0	1.0	24.0	0.19	0.03	2.1	---	10.9	---	5900	100	0.03
	EPC #3	---	---	7.9	7.0	1.0	22.0	0.16	0.03	2.0	---	8.7	---	28,000	200	0.03
2/8/79	SWFWMD	---	---	8.7	7.7	20.8	30.8	---	---	11.3	---	---	11.9	---	---	---
2/7/80	SWFWMD	---	13.0	7.3	6.4	18.4	25.9	---	---	6.8	---	---	13.0	---	---	---
5/14/80	EPC	---	---	---	---	---	---	---	---	---	---	---	---	200	100	---
10/6/81	EPC #4	---	---	---	---	---	---	---	---	---	---	---	---	2500	1400	---
9/17/86	EPC #2	---	---	---	---	---	---	---	---	---	---	---	---	600	460	---
6/1/87	EPC #4	---	---	---	---	---	---	---	---	---	---	---	---	40	10	---
July 30 1987	EPC #1	---	---	8.6	8.0	---	---	3.56	0.06	7.4	---	---	---	50	60	---
	EPC #2	---	---	7.9	7.0	---	---	2.95	0.05	5.7	---	---	---	900	900	---
	EPC #3	---	---	8.2	9.0	---	---	3.40	0.07	6.9	---	---	---	310	310	---
	EPC #4	---	---	9.0	10.0	---	---	3.61	0.07	7.1	---	---	---	50	60	---
August 25 1987	EPC #1	30.6	17.0	8.8	13.0	23.0	26.0	2.91	< 0.02	7.0	68.0	13.6	---	100	100	---
	EPC #2	30.6	17.0	6.7	3.6	1.0	25.0	1.54	0.10	< 3.0	38.0	8.4	---	< 1	< 1	---
	EPC #3	30.6	17.0	7.9	3.9	1.0	24.0	1.03	0.06	4.0	37.0	9.6	---	< 1	< 1	---
7/8/92	EPC #4	---	---	---	---	---	---	---	---	---	---	---	---	400	100	---
Average		**63.0**	**16.0**	**8.0**	**7.88**	**12.025**	**25.71**	**1.99**	**0.066**	**5.83**	**47.67**	**10.167**	**12.45**	**2983.467**	**260.133**	**0.03**

Agency[1] - EPC site #1 - located at approximate center of the lake
EPC site #3 - located at outfall for Mall's retention pond
EPC site #2 - located at Mall canal's outfall into the lake
EPC site #4 - located near Civic Center boat ramp in southeast corner of lake

The data collected by the East Lake LAKEWATCH group is reflected in **Table 7.3** below. While this group has not been collecting information for an extended period of time, once enough data has been collected, it can be used to calculate TSI values for the lake. These values can then be used as a baseline for comparison of future values.

Table 7.3
LAKEWATCH Water Quality Sampling Data for East Lake Stations

TOTAL PHOSPHORUS (Φg/l)					TOTAL NITROGEN (Φg/l)				CHLOROPHYLL (Φg/l)				AVERAGE SECCHI DEPTH (ft)			
DATE	**Station 1**	**Station 2**	**Station 3**	**Lake Average**	**Station 1**	**Station 2**	**Station 3**	**Lake Average**	**Station 1**	**Station 2**	**Station 3**	**Lake Average**	**Station 1**	**Station 2**	**Station 3**	**Lake Average**
8/16/98	80	82	83	**82**	1800	1820	1810	**1810**	86	80	73	**80**	1.5	1.5	1.5	**1.5**
9/20/98	130	135	132	**132**	1980	1980	2090	**2017**	13	12	13	**13**	1.3	1.3	1.3	**1.3**
10/18/98	129	121	125	**125**	1960	1940	1930	**1943**	17	16	16	**16**	1.0	1.0	1.0	**1.0**
11/15/98	127	115	118	**120**	2120	1960	2020	**2033**	12	11	12	**12**	1.0	1.0	1.0	**1.0**
12/27/98	122	135	128	**128**	1870	1980	1980	**1943**	12	17	12	**14**	1.3	1.0	1.0	**1.1**
Average	**117.6**	**117.6**	**117.2**	**117.4**	**1946**	**1936**	**1966**	**1949.2**	**28**	**27.2**	**25.2**	**27.0**	**1.22**	**1.16**	**1.16**	**1.18**

Hillsborough County also sampled the lake as part of a one-time alum treatment that was performed on the lake March 16th through March 18th, 1999. As with the LAKEWATCH data, this data collected by Hillsborough County could be used to generate TSI values, but due to the limited amount of sampling done, these values may not be an accurate representation of the existing conditions. These values are given in **Table 7.4** below.

Table 7.4
Hillsborough County Water Quality Sampling Data for East Lake Stations (1999)

Parameter	Station #1			Station #2			Station #3			Maximum Secchi Depth (ft)	Date
	Bottom	Mid-Depth	Surface	Bottom	Mid-Depth	Surface	Bottom	Mid-Depth	Surface		
Temperature (C)	20.94	21.17	21.5	21.08	21.24	21.41	20.42	20.46	21.18	1.0	1/29/99+
	21.57	22.01	22.35	21.03	21.28	22.57	22.37	22.78	23.11	6.4	3/19/99++
	21.55	21.55	21.55	21.84	21.80	21.93	21.69	21.70	21.87	5.5	3/22/99++
pH	7.17	7.82	8.81	8.81	9.0	9.12	8.91	7.16	8.32	1.0	1/29/99+
	4.76	4.85	4.87	5.26	5.12	5.06	5.54	5.55	5.57	6.4	3/19/99++
	5.39	5.50	5.48	5.50	5.52	5.52	5.39	5.5	5.48	5.5	3/22/99++
Total Dissolved Solids (mg/l)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0	1/29/99+
	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	6.4	3/19/99++
	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.5	3/22/99++
Dissolved Oxygen (%)	23.6	47.9	108.1	85.71	112.5	116.6	78.0	83.9	111.9	1.0	1/29/99+
	121.3	113.1	107.3	122.0	120.4	113.8	122	116.6	115.7	6.4	3/19/99++
	72.5	75.4	78.0	84.2	82.4	83.1	87.0	85.1	81.4	5.5	3/22/99++
Dissolved Oxygen (mg/l)	2.37	4.27	9.54	7.78	9.97	10.26	0.93	7.20	9.94	1.0	1/29/99+
	10.60	9.80	9.28	10.92	10.56	9.81	10.59	9.96	9.86	6.4	3/19/99++
	6.42	6.64	6.86	7.34	7.19	7.23	7.64	7.46	7.15	5.5	3/22/99++
Oxidation / Reduction Potential	358	337	328	229	232	239	212	153	167	1.0	1/29/99+
	530	522	518	499	511	514	508	507	505	6.4	3/19/99++
	351	389	399	417	421	427	432	436	438	5.5	3/22/99++
Specific Conductivity	169	167	167	168	166	166	270	168	167	1.0	1/29/99+
	238	234	235	221	227	229	225	226	226	6.4	3/19/99++
	227	227	228	227	226	226	226	226	226	5.5	3/22/99++
Salinity	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0	1/29/99+
	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	6.4	3/19/99++
	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.5	3/22/99++

\+ - prior to whole lake treatment with alum
++ - after whole lake treatment with alum
Treatment dates March 16 through 18, 1999

In 1987, Dawes, et. al., did a comparison of six lakes in Hillsborough County which included East Lake along with Lakes Thonotosassa, Ellen, Pretty, Fairy and Padgett. These six lakes were sampled on a bi-weekly basis for 16 weeks. Twenty-two physical, chemical and biological parameters such as turbidity, temperature, color, light penetration, nutrients, metals, dissolved oxygen, conductivity, pH, chlorophyll *a*, and microorganisms were investigated to see if a relationship could be determined between these parameters and standing algal crops. Multiple regression analysis were performed and trophic state indices were determined using the data. Employing the parameters of Secchi depth, chlorophyll *a* concentration and total nitrogen, East Lake and Lake Thonotosassa, were classified as hypereutrophic. In terms of the physical parameters of the six lakes, East Lake had the highest mean D.O. value at 9.8 mg/l, possibly because it was the shallowest lake in the group. East Lake also had the highest mean values for alkalinity (67 mg/l), turbidity (5.8 NTUs), total nitrogen (2.13 mg/l), calcium (28.83 mg/l), ammonia and silicate concentrations (419 *u*g/l and 2.6 mg/l respectively) and pH (9.1). Given all these high values, it is not surprising that the lowest mean Secchi depth at 0.4 meters was recorded in East Lake. In terms of biological parameters, East Lake was highest in mean cell volumes of total phytoplankton at all depths (30.7 *u*g/l), number of taxa (63) and mean density of zooplankton (70.6/l).

7.3 WATER QUALITY ISSUES / AREAS OF CONCERN

7.3.1 LAKES

As the data compiled above shows, trophic state conditions in East Lake would be characterized as "poor" under FDEP's classification method. This is due to the high nutrient levels that in turn result in large population explosions or "blooms" of algae in the lake. East Lake is the chief source of habitat for wildlife in the ELW as well as being a resource for human recreation. If the Tampa By-Pass Canal, which is the receiving water body for a large part of the ELW, figures as largely into the Minimum Flows and Levels plan for drinking water as it appears it will, the quality of water flowing into it from East Lake could become an issue.

This water quality appears to be affected by various factors according to the most recent study by ERD. ERD investigated the various inputs, both hydrologic and pollutant loads, for East Lake. This information can be found in Table 7.5. Surface water run-off contributes 474,762 m^3 or 384.6 acre-feet of water to the lake on an annual basis. This is approximately 19% of the total hydrologic input to the lake and adds 1044 kg/yr of total nitrogen, 115 kg/yr of total phosphorus, 3604 kg/yr of BOD and 20,145 kg/yr of total suspended solids to the lake. Wet and dry season baseflow accounts for 50% of the hydrologic input and adds 2277 kg/yr of total nitrogen, 164 of total phosphorus, 4244 kg/yr of BOD and 24,287 kg/yr of TSS to the lake.Bulk precipitation input averages 485,131 m^3 or 393 acre-feet of water or 20% of the total input on a yearly basis. Rainfall deposits 393 kg of total nitrogen, 41 kg of total phosphorus, 484 kg of BOD and 3017 kg of TSS per year. Groundwater seepage accounts for approximately 11% of the lake's input of water and introduces 980 kg of total nitrogen, 31.3 kg of total phosphorus, 278 kg of BOD and 0.0 kg of TSS per year. The bird island is a major contributor to the pollutant load, especially nutrients, of the lake. Roughly one third of the total nitrogen, three quarters of the total phosphorus, two thirds of the BOD and one tenth of the TSS are introduced into the lake as a result of the run-off from the island.

Table 7.5
Summary of Hydrologic and Pollutant Loading Inputs for East Lake

Input Type	Input (m^3)	Input (acre-feet)	% of Total Input	Total Nitrogen (kg/yr)	Total Phosphorus (kg/yr)	BOD (kg/yr)	TSS (kg/yr)
Stormwater run-off	474,762	384.6	19.0	1,044.0	115.0	3,604.0	20,145.0
Wet/Dry Season Baseflow	1,206,038	977.0	50.0	2,277.0	164.0	4,244.0	24,287.0
Bulk Precipitation	485,131	393.0	20.0	393.0	41.0	484.0	3,017.0
Groundwater Seepage	267,871	217.0	11.0	980.0	31.3	278.0	0.0
Bird Island	---	---	---	2,619.0	1,065.0	18,489.0	5,133.0
TOTAL	**2,433,802**	**1971.6**	**100.0**	**7313.0**	**1416.3**	**27099.0**	**52582.0**

As poor as the water quality seems to be as a result of these inputs, it does appear that the water quality of East Lake is improving since the initial water samples were taken with the advent of East Lake Square Mall. There may be many factors that would account for this. In the case of lead in particular, the phasing out of the use of lead in gasoline in the late 70's and early 80's seems to be reflected in the data on lead. Increased standards for stormwater treatment is another likely reason for the slight increase of water quality in through the 70's and 80's. Unfortunately, not enough sampling has been done in the 1990's to see if this trend is still proceeding on an upward curve. The main exceptions to to this is the totals for phosphorus fecal coliforms and TSI. The increases in all three of these parameters can be accounted for by the establishment of the roost / rookery on the island. As shown by the estimates done by ERD, the birds are far and away the largest single contributor of total phosphorus in the lake, which in turn directly affects the lake's TSI values. While no direct measurements were done in relation to fecal coliforms and the island, it can be assumed that a large amount of this load originates from the birds.

EXISTING NATURAL SYSTEMS CONDITIONS

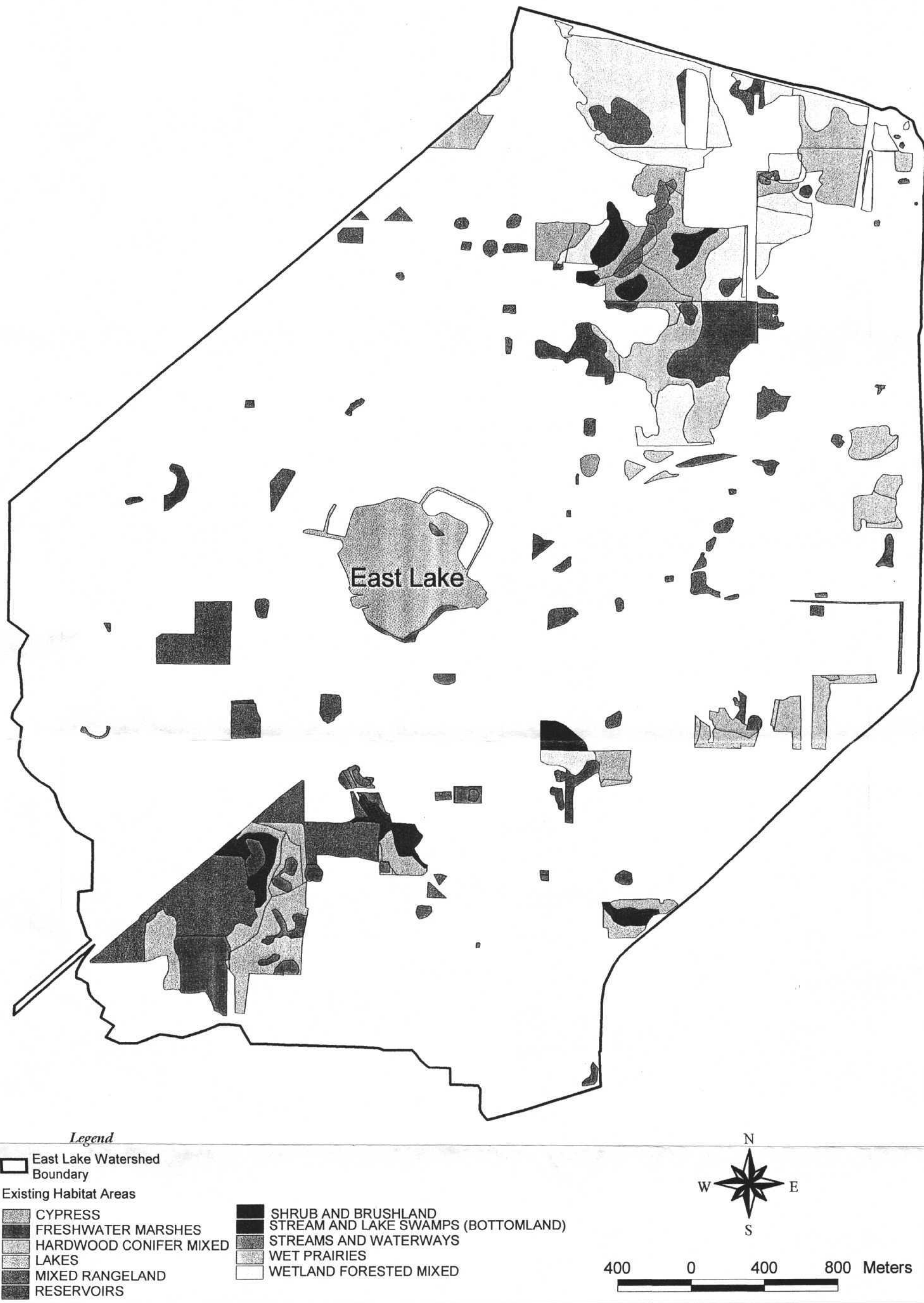
8.1 OVERVIEW

Due to the highly developed nature of the watershed, few if any, of the remaining natural systems remain undisturbed. This loss of both upland and wetland habitat 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 terrestrial wildlife (Schueler 1994). Included in the goals of watershed management is the protection of these remaining natural areas (**Figure 8-1**) and the restoration or creation of natural areas back to levels that will be able to properly treat run-off. This in turn will increase water quality and biodiversity by providing more suitable wildlife habitat. In addition, a decrease in volume will increase stream channel stability and decrease stream bank erosion (Schueler 1994).

8.2 EXISTING HABITAT TYPES

The degradation caused by the impacts to these natural systems affects the quality of life of all the citizens in, and in some cases, outside the watershed. These impacts 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 identification and quantification of each system. Next, issues and areas of concern must be identified for each of the systems involved, and from there possible solutions for improvements can then be explored. This section identifies the remaining wetland and upland natural systems in the ELW and describes the flora and fauna that can be expected to occur in each of the habitat types.

Of the total 5070.5 acres within the watershed, only 1013.65 acres or 19.98 % remains undeveloped. Of this total, 274.20 acres or 5.4 % is contained by lakes, reservoirs, streams and waterways. This represents 27.05 % of the undeveloped lands. The remaining 739.45 acres or 72.95 % of this undeveloped area is made up of various uplands and wetlands. Wetlands comprise 434.72 acres or 4.8 % of the watershed or 42.89 % of the undeveloped area. Uplands constitute 304.73 acres or 6.0 % of the watershed and 30.06 % of the undeveloped area.



HILLSBOROUGH COUNTY FLORIDA

EAST LAKE AREA
Existing Habitat
Areas Map
(September 1999)

Public Works Department
Engineering Division
Stormwater Management Section

Figure 8-1
Existing Habitat
Areas Map

Table 8.1 below lists the habitat or land use types and provides relative percentages for both the total watershed area and the natural systems area. The natural systems are described in the following paragraphs. As stated earlier, no Significant or Essential Wildlife habitat exists within the ELW as defined in the Hillsborough County Land Development Code (LDC). **Figure 8-2** shows the public lands that can be found within the watershed.

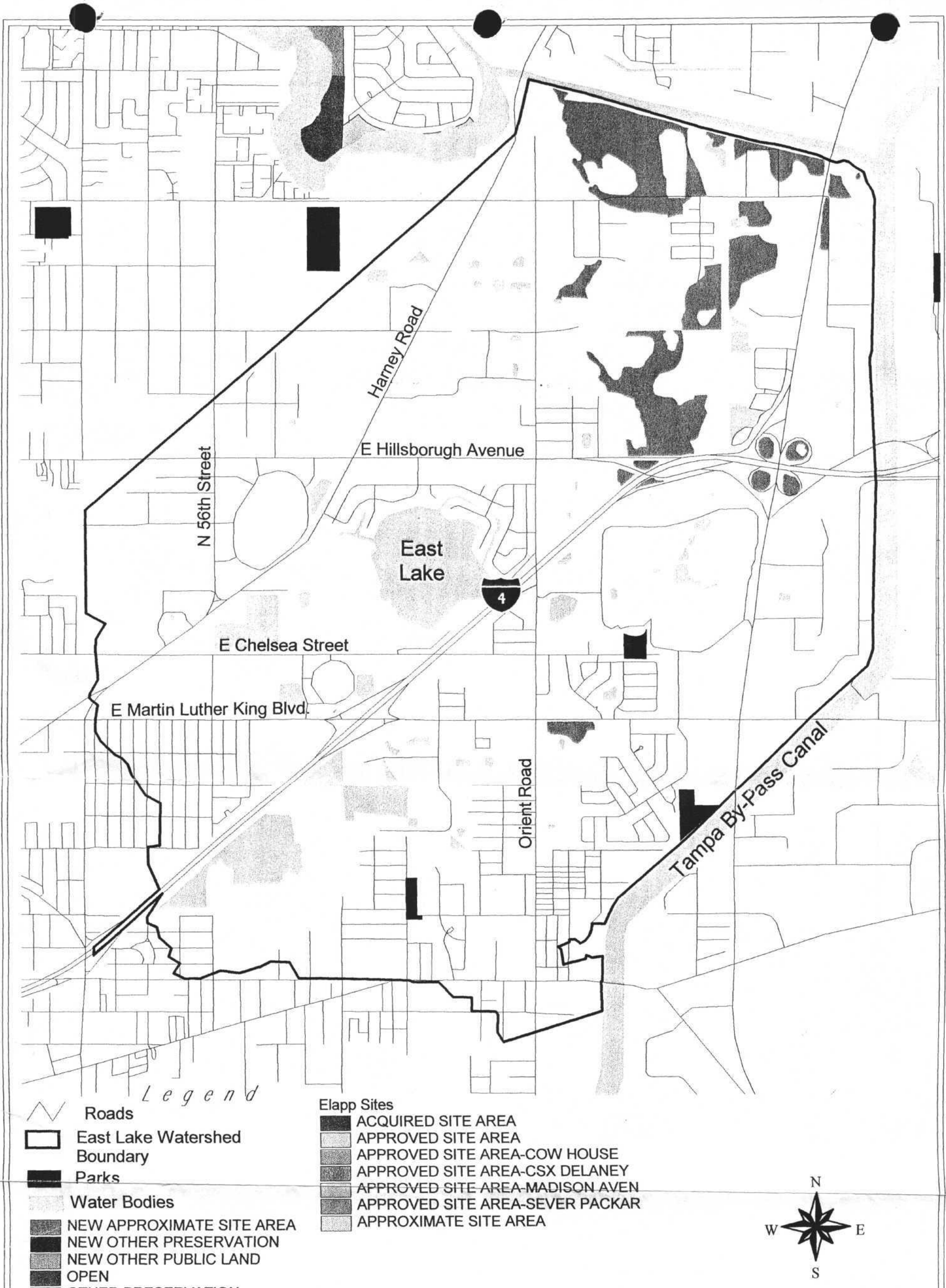
Table 8.1
Natural Systems Land Use Distribution for the East Lake Watershed

FLUCCS Code	Land Use Type	Acres	% Of Natural Systems	% of Watershed
320	Shrub & Brushland	7.94	0.78	0.16
330	Mixed Rangeland	24.97	2.46	0.49
410	Upland Coniferous Forest	20.24	2.00	0.40
434	Hardwood - Conifer Mixed	251.58	24.82	4.96
510	Streams and Waterways	0.069	0.006	0.001
523	Lakes - 10 to 100 acres	103.59	10.22	2.04
533	Reservoir - 10 to 100 acres	170.54	16.82	3.36
615	Stream and Lake Swamps	48.21	4.76	0.95
620	Wetland Coniferous Forest	11.64	1.15	0.23
621	Cypress	2.88	0.28	0.06
630	Wetland Forested Mixed	179.34	17.69	3.53
641	Freshwater Marsh	142.61	14.07	2.81
643	Wet Prairie	48.15	4.75	0.95
644	Emergent Aquatic Vegetation	1.89	0.19	0.04
Total		**1013.65**	**99.996**	**19.981**

8.2.1 UPLAND NATURAL SYSTEMS

8.2.1.1 Rangelands

Rangeland is defined as land on which the natural vegetation is dominated by grasses,



HILLSBOROUGH COUNTY
FLORIDA

EAST LAKE AREA
ELAPP, Parks &
Other Public
Lands Map
(September 1999)

Public Works Department
Engineering Division
Stormwater Management Section

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

sedges, forbs and some shrubs. The land is commonly used for the grazing of livestock and management practices are generally limited to brush control and prescribed burning. As a general rule, rangelands are not fertilized, cultivated or irrigated. Less than 33 acres of this general land type exists within the watershed. The Florida Land Use, Cover and Forms Classification Code System (FLUCCS) further subdivides rangelands into grasslands, shrub and brushlands and mixed rangelands. There are no grasslands found within the ELW.

8.2.1.1.1 Shrub and Brushlands

As shown in **Table 8.1**, there are less than 8 acres of this habitat type found in the ELW area and it comprises less than 1% of both the watershed and the natural systems. This plant community, as the name implies, is made up of a combination of shrubs and brushes and is many times the result of the removal of the canopy from a pine flatwoods system. Because of this, generally the dominant plant species is saw palmetto (*Serenoa repens*). The species composition of the vegetation is largely fire-dependent. When fire is suppressed, the system will, through natural succession, become forested again. If the burns occur on a regular cycle of four to five years, the saw palmetto can become the dominant species and form a dense monoculture. If the system burns on a more frequent basis than this, the grasses and other herbaceous vegetation will become the dominant species.

Other vegetation that can be expected are ruderal or pioneering species such as wax myrtle (*Myrica cerifera*), saltbush or groundsel tree (*Baccharis* species), gallberry (*Ilex cassine*), Brazilian pepper (*Schinus terebinthifolius*), air potato (*Dioscorea bulbifera*), sweet white clover (*Melilotus indica*), Caesar=s weed (*Urena lobata*), ragweed (*Ambrosia artemisiifolia*), bluestem grasses (*Andropogon* species), smutgrass (*Sporobolus indicus*), bahia grass (*Paspalum notatum*), grape vine (*Vitis* species), morning glories (*Ipomea* species), sandspurs (*Cenchrus* species), dog fennel (*Eupatorium* species), blackberries (*Rubus* species) and Spanish needles (*Bidens alba*).

Mammals expected to be found in this habitat include opossum (*Didelphis virginiana*), nine-banded armadillo *(Dasypus novemcinctus*), raccoon (*Carpiodes cyprinus*), and hispid cotton rat (*Sigmodon hispidus*).

Birds that could be anticipated to be found are year round or resident species such as northern cardinal (*Cardinalis cardinalis*), northern mockingbird (*Mimus polyglottos*), mourning dove (*Zenaida macroura*), eastern towhee (*Pipilo erythrophthalmus*), common yellowthroat (*Geothlypis trichas*), white-eyed vireo (*Vireo griseus*), turkey vulture (*Cathartes aura*), Carolina wren (*Thryothorus ludovicianus*), loggerhead shrike (*Lanius ludovicianus*), and red-tailed hawk (*Buteo jamaicensis*). Other species such as palm warbler (*Dendroica palmarum*), yellow-rumped or “Myrtle” warbler (*Dendroica coronata*) and gray catbird (*Dumetella carolinensis*) could be expected in spring and fall during their migration or as overwintering species.

8.2.1.1.2 Mixed Rangeland

This plant community occupies just less than 25 acres within the watershed area, comprising approximately 2.5% of the natural areas and less than 1% of the total watershed. This community is found where there is a mixture of grassland and shrub and brushland plant species, but neither dominates. If more than α of the area is composed of either of the two community types, the area is classified as Mixed Rangeland. Plants and animals will be similar to those found in the either of the two community types and will vary with habitat quality.

8.2.1.2 Upland Forest

This plant community is characterized by being upland in nature and supporting forested systems with greater than 10% canopy closure. Upland forests can be further subdivided into xeric or dry and mesic or moderately moist habitats. If 66 percent or more of the total canopy can be attributed to one particular species or group of species, it can be given its own category type, i.e. sand pine or xeric oak. The upland forest category can include tree plantations for commercial use as well as many recreational areas. Within the ELW, upland forests cover just over 270 acres. This acreage is divided between the upland coniferous forest and hardwood mixed conifer classification.

8.2.1.2.1 Upland Coniferous Forest

If the natural forest stand has a canopy that is composed of a minimum of 66 percent coniferous trees, it will qualify for this land use designation. Pine tree farms, which are not natural communities, have their own category of tree plantation. As with the shrub and brushland community, this natural system type, especially its groundcover and shrub layers, is fire dependent. While the slash (*Pinus elliottii*) and longleaf pine (*P. palustris*) trees that dominate these systems are fairly fire resistant, if they do not burn on a regular basis of every 1 to 8 years, hardwoods such as the various oaks, can take hold and begin to dominate and change the system's species composition. The slash pines, which are the less fire resistant of the two pines, inhabit the moister upland areas. It has been found that the cones of slash pine open better when subjected to heat such as that given off by a fire. Because of this, slash pine is sometimes considered fire dependent rather than resistant. The drier areas are occupied by longleaf pine due to its higher resistance to fire. With the advent of modern agricultural methods that favor the creation of monocultures that are easily managed when compared to mixed natural systems, slash pine has become the dominate species in coniferous systems due to its ease of cultivation. A little over 20 acres of forest fall into this land use designation within the ELW. This constitutes 2% of the natural systems area and less than 1% of the watershed's total acreage.

Vegetation that can be expected to make up the canopy of upland coniferous forests include longleaf and slash pines, with to a minor extent, various oaks (*Quercus* species), loblolly bay (*Gordonia lasianthus*), sweet gum (*Liquidambar styraciflua*) and hickories (*Carya* species). While subcanopies generally are absent in this system type, if present, they would mainly be made up of saplings of the canopy species. The shrub layer could contain saw palmetto, saltbush, wax myrtle, gallberry and various shrubs in the blueberry family (*Lyonia* and *Vaccinium* species). Groundcover species could include bluestem grasses, sandspurs, dog fennel, blackberries, pineland goldenrod (*Solidago fistulosus*), blueberries (*Vaccinium darrowii* and *V. myrsinites*), pennyroyal (*Piloblephis rigida*), deertongue (*Carphephorus corymbosus*), narrow-leaf sabatia (*Sabatia brevifolia*), wiregrass (*Aristida stricta*) and candyweed (*Polygala lutea*).

Expected mammals would include opossum, nine-banded armadillo, raccoon, gray squirrel (*Sciurus carolinensis*), hispid cotton rat, and evening bat (*Nycticeius humeralis*).

Resident birds would include northern cardinal, northern mockingbird, mourning dove, eastern towhee, common yellowthroat, white-eyed vireo, red-tailed hawk, turkey vulture, downy woodpecker (*Picoides pubescens*), red-bellied woodpecker (*Melanerpes carolinus*), great horned owl (*Bubo virginianus*), pine warbler (*Dendroica pinus*), great crested flycatcher (*Myiarchus crinitus*) and northern bobwhite (*Colinus virginianus*). Other species such as palm and "Myrtle" warblers, thrushes (*Catharus* species), Carolina chickadee (*Parus carolinensis*), tufted titmouse (*Parus bicolor*) and gray catbird could be expected in spring and fall during their migration or as overwintering species.

Expected reptiles and amphibians would include black racer (*Coluber constrictor*), eastern garter snake (*Thamnophis sirtalis*), yellow rat snake (*Elaphe obsoleta*), Cuban or brown anole (*Anolis sagrei*), oak toad (*Bufo quercicus*) and squirrel tree frog (*Hyla squirella*).

8.2.1.2.2 Hardwood - Conifer Mixed

To qualify for this land use category, the system must be naturally occurring with neither the hardwoods nor the conifers achieving the minimum of 66% canopy dominance. As with pines, any hardwood plantations will fall under a separate tree plantation category. This community type may be a result of the natural succession process from a coniferous system to a hardwood community where the fire regime has been altered. This allows the hardwoods to become established and reproduce and, in time, out compete the conifers. Hardwood-conifer mixed uplands encompass over 250 acres in the watershed. The land use covers almost 5% of the total watershed and close to 25%

of the natural systems total.

Vegetation that can be expected to make up the canopy of hardwood-conifer mixed forest include longleaf and slash pines, various oaks, loblolly bay, sweet gum and hickories. The shrub and groundcover layers could be expected to show a mix of those species present in a hardwood system and those found in pine flatwoods.

As with the vegetation, the faunal species would be a mix of those species found in a hardwood system and those found in pine flatwoods.

8.2.2 WATER

8.2.2.1 Open Water

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 routinely classify waterbodies that are ten acres or less. Within the East Lake Watershed, approximately 275 acres fall in this category in three types - streams and waterways, lakes and reservoirs.

8.2.2.2 Streams and Waterways

This category includes the natural systems of rivers, creeks, canals and other linear waterbodies that do not have their course interrupted by control structures. If control structures exist, the waterbody is included in the reservoir land use category. In the watershed, this system type occupies only 0.069 acres, which is less than 1% of both the watershed and natural systems totals.

Vegetation that would be expected in this habitat would include red maple (*Acer rubrum*), Coastal Plains willow, wax myrtle, Brazilian pepper, primrose willow (*Ludwigia peruviana*), cattails, umbrella pennywort (*Hydrocotyle umbellata*), paragrass (*Brachiaria mutica*), spreading dayflower (*Commelina diffusa*), various sedges (*Cyperus* species) and softrush (*Juncus effusus*).

Due to the extremely small size of this habitat in the watershed, faunal usage would be limited. However, it would be expected that species common to other wetland habitats might use this area on a transitional basis.

8.2.2.3 Lakes

This habitat type is characterized as large, non-flowing, natural areas of permanent water. The FLUCCS system separates the vegetated portion of a lake into a separate wetland category depending on the species. East Lake is the dominant land form within the watershed and is approximately 98 acres in size. It serves as an important area for the wildlife of the ELW. Within the watershed lakes occupy 103.59 acres which translates into a little over 10% of the natural systems area and 2% of the total watershed area.

Trees found include pond cypress (*Taxodium ascendens*), Coastal Plains willow, laurel oak (*Quercus laurifolia*), lead tree, red maple, live oak (*Quercus virginiana*), sweet gum and slash pine. Shrubs include primrose willow, Mexican seedbox (*Ludwigia octovalvis*), wax myrtle and groundsel bush. Herbaceous vegetation includes cattails, umbrella pennywort, sacred lotus (*Nelumbo nucifera*), spatterdock (*Nuphar lutea*), fragrant waterlily (*Nymphaea odorata*), pickerelweed (*Pontederia cordata*) and duck potato (*Sagittaria lancifolia*).

During various field visits to East Lake, numerous types of wildlife were observed. Observed birds include pied-billed grebe (*Podilymbus podiceps*), brown pelican *(Pelecanus occidentalis)*, double-crested cormorant (*Phalacrocorax auritus*), anhinga (*Anhinga anhinga*), great blue heron (*Ardea herodius*), great egret (*Ardea alba*), snowy egret (*Egretta thula*), little blue heron (*Egretta caerulea*), tricolored heron (*Egretta tricolor*), cattle egret (*Bubulcus ibis*), green heron (*Butorides virescens*), black-crowned night-heron (*Nycticorax nycticorax*), white ibis (*Eudocimus albus*), glossy ibis (*Pledadis falcinellus*), black vulture (*Coragyps atratus*), turkey vulture, Muscovy duck (*Cairina moschata*), mottled duck (*Anas fulvigula*), mallard duck (*Anas platyrhynchos*), lesser scaup (*Aythya affinis*), osprey (*Pandion haliaetus*), bald eagle (*Haliaeetus leucocephalus*), red-shouldered hawk (*Buteo lineatus*), red-tailed hawk (*Buteo jamaicensis*), common moorhen (*Gallinula chloropus*), American coot (*Fulica americana*), laughing gull (*Larus atricilla*), ring-billed gull (*Larus delawarensis*), Caspian tern (*Sterna caspia*), Forster's tern (*Sterna forsteri*), mourning dove, red-bellied woodpecker, downy woodpecker, blue jay (*Cyanocitta cristata*), fish crow (*Corvus ossifragus*), purple martin (*Progne subis*), tree swallow (*Tachycineta bicolor*), northern mockingbird, northern parula, yellow-rumped or "Myrtle" warbler, palm warbler, red-winged blackbird (*Agelaius phoeniceus*) and boat-tailed grackle (*Quiscalus major*).

Fish observed were large-mouthed bass (*Micropterus salmoides*), grass carp (*Tilapia mossambica*), red-ear sunfish or bream (*Lepomis microlophus*) and yellow bullhead (*Ameiurus natalis*). Insects seen were whirligig beetle (*Dineutus* sp.), monarch butterfly (*Danaus plexippus*), various dragonflies and love bug (*Plecia nearctica*). The only other observed invertebrate was grass shrimp (*Palaemonetes paludosus*). The only mammal seen was the gray squirrel. The Cuban or brown anole was the only observed reptile that could be identified. Several turtles, mostly likely red-eared turtles, were seen but could not be positively identified. American alligator (*Alligator mississippiensis*) has also been reported by the residents of East Lake, but this species was not observed during any of the field visits.

8.2.2.4 Reservoirs

These are areas of permanent water which are artificial or man-made. They have been created for various reasons including irrigation, flood control or fill material. As a general rule they can be identified by their dams, levees, control structures or regular geometric shape. In many cases, this land use will closely mimic natural lake systems in function and wildlife use. A total of 170.54 acres of this land use category can be found in the basin. Reservoirs occupy almost 17% of the natural systems acreage and over 3% of the watershed's total acreage.

Although they are man-made, over time these bodies of water can be expected to hold the same floral and faunal components as natural lakes of the same size and habitat quality.

8.2.3 WETLAND NATURAL SYSTEMS

Wetlands are generally considered to be those areas that support wetland or hydrophytic vegetation and are regularly or periodically inundated by water. The exception to this rule is the alluvial or tidal flats areas that do not support vegetation. Wetlands are usually found in the topographic lows. The state's methodology for wetland delineation, F.A.C. 62-340, has been incorporated into the County's Wetland Rule, Chapter 1-11. This methodology introduces the concept of hydric soils in determining the extent of wetlands. Within the ELW, wetlands occupy 434.72 acres or 4.8 % of the watershed or 42.89 % of the undeveloped area. They are found in seven land use categories, stream and lake swamps, wetland coniferous forest, cypress, wetland mixed forest, freshwater marsh, wet prairie and emergent aquatic vegetation.

8.2.3.1 Stream and Lake Swamps

This community type is also referred to as bottomland and is generally restricted to flowing wetland systems. Because this type of system is associated with flowing water, it is commonly impacted as a result of flood control projects. These projects typically result in the channelization of the stream portions which are then routinely maintained. The side slopes are usually well maintained as well to allow easy access for equipment and this leads to the depauperization of these areas. Canopy species are primarily hardwoods with a minor coniferous component. This land use category occupies just over 48 acres in the basin which means that it covers almost 5% of the natural systems area and almost 1% of the total watershed area.

Hardwoods that would be expected in the canopy would be red maple, sweet gum, laurel and water oaks (*Quercus niger*), sweetbay (*Magnolia virginiana*), Coastal Plains willow, tupelo or black gum (*Nyssa biflora*) and green ash (*Fraxinus caroliniana*). Conifers in the canopy would include bald cypress (*Taxodium distichum*) and slash pine. The subcanopy's expected species would include primrose willow, buttonbush (*Cephalanthus occidentalis*), wax myrtle, St. Johnsworts (*Hypericum* species), fetterbush (*Lyonia lucida*) and elderberry (*Sambucus canadensis*). Groundcover species would include cinnamon fern (*Osmunda cinnamonea*), climbing aster (*Aster carolinianus*), Virginia chain fern (*Woodwardia virginica*), bog hemp (*Boehmeria cylindrica*), wild taro (*Colocassia esculentum*), swamp lily (*Crinum americanum*), water hoarhound (*Lycopus rubellus*) and horned beakrush (*Rhynchospora inundata*).

Birds species that could be expected include Carolina wren, northern parula, red-shouldered hawk, pileated woodpecker (*Dryocopus pileatus*), turkey vulture, red-bellied woodpecker, Carolina chickadee, blue jay, fish crow, common yellowthroat, red-eyed vireo (*Vireo olivaceus*), blue-gray gnatcatcher (*Polioptila caerulea*) and great crested flycatcher. Normally, this habitat type is an important stopover point for migratory birds; however, in this case due to the small size and the developed nature of the area, it is not expected that this will be frequently used by migratory species.

Other expected animals could include opossum, nine-banded armadillo, raccoon, gray squirrel, hispid cotton rat, marsh rabbit, cotton mouse (*Peromyscus gossypinus*), evening bat, squirrel treefrog, green treefrog (*Hyla cinerea*), Cuban treefrog (*Osteopilus septentrionalis*), Florida box turtle (*Terrapene carolina*), Mediterranean gecko (*Hemidactylus turcicus*), brown anole, green anole, southeastern five-lined skink (*Eumeces inexpectatus*), black racer, yellow rat snake, southern ringneck snake (*Diadophis punctatus*) and eastern garter snake.

8.2.3.2 Wetland Coniferous Forest / Cypress

This wetland type is generally dominated by cypress and other conifers with a mixture of subdominant species, usually hardwoods, with slash pine along the outer edge. They can commonly be found on the edges of lake or river systems or as stand alone systems in the case of cypress "domes". As with most other wetland systems, this habitat type is important in treatment and storage of stormwater run-off and water quality. Within the watershed, this land use category can be found on a little over 14 acres which means it occupies over 1% of the natural systems area but less than 1% of the watershed's total area.

The dominate canopy species is one of the two species of cypress, pond cypress is more prevalent in dome or lake/pond situations while bald cypress is the expected species on flowing systems. Mixed in with the cypress, especially in riverine systems, are various hardwoods such as red maple, black gum, sweet bay, American elm (*Ulmus americana*), Carolina ash and slash pine. The subcanopy frequently has saplings of the canopy species as well as dahoon holly (*Ilex cassine*), hornbeam (*Carpinus caroliniana*) and red bay (*Persea palustris*). The shrub layer could be expected to include buttonbush, fetterbush, wax myrtle, highbush blueberry (*Vaccinium corymbosum*) and various St. Johnsworts. Understory vegetation typically includes water hoarhound, cinnamon fern, royal fern (*Osmunda regalis*), Virginia chain fern, netted chain fern (*Woodwardia aerolata*), swamp fern (*Blechnum serrulatum*), swamp milkweed (*Asclepias perrenis*), bog hemp, warty sedge (*Carex verrucosa*), shiny chasmanthium (*Chasmanthium nitidum*), swamp lily, stiff marsh bedstraw (*Galium tinctorium*) and grape and potato vines.

Faunal species would be similar to those listed under the stream and lake swamp category above.

8.2.3.3 Wetland Mixed Forest

As with the upland mixed forest, in this habitat type neither the hardwoods nor the conifers reach 66% canopy dominance. Also mirroring the upland systems, this land use category could be the result of fire suppression or the reduction of the system's hydroperiod. The result of both is essentially the same; the replacement of the conifers with hardwoods. Another way this type of system may have been created is by the removal of the mature cypress trees through logging. These areas can provide the same water treatment functions as those listed for the coniferous / cypress systems. This habitat is relatively extensive within the basin, second to only the upland mixed forest and covering close to 180 acres. This equates to almost 18% of the natural systems and over 3% of the total watershed coverage.

The canopy vegetation will be expected to be a mixture of cypress, red maple, red bay, American elm, sweet gum, water, laurel and live oaks, sweetbay and other hardwoods. The subcanopy would be comprised of saplings of the canopy species in addition to dahoon, hornbeam, buttonbush, elderberry and other shrubs. Groundcover would vary with the dominant canopy species. Wildlife as well would vary with the canopy dominants. Because there are still relatively large tracts of this habitat remaining, it would be expected to attract more migrant bird species such as black-throated blue warbler (*Dendroica caerulescens*), palm and "myrtle" warblers, summer tanager (*Piranga rubra*), hooded warbler (*Wilsonia citrina*), blue grosbeak (*Guiraca caerulea*), yellow-bellied sapsucker (*Sphyrapicus varius*), American robin (*Turdus migratorius*), hermit thrush (*Catharus guttatus*) and ruby-crowned kinglet (*Regulus calendula*).

8.2.3.4 Freshwater Marsh

A freshwater marsh is a non-forested wetland plant community that is seasonally flooded or at least the soil is saturated for most of the year. However, in the shallower marshes it is not unusual to find one or more black gums in their center. Because they are wet almost year-round and in some cases year-round, these marshes are generally underlain with a thick layer of peat and other organic material. They usually occur in depressions in the landscape, frequently in pine flatwoods or rangelands. As with many of the Florida's plant communities, the freshwater marsh depends on fire to maintain its species composition; it must burn often enough to remain treeless. The hydrology of the system also aids in determining this composition and usually results in the zonation of plants within the system.

This zonation starts in the center of the marsh, where there is frequently an open water component. Within this zone are various floating and submerged plants. Included in this band would be floating plants such as fragrant waterlily, spatterdock and floating hearts (*Nymphoides aquatica*). Submerged plants in this open water area could include mermaidweed (*Myriophyllum* species), lemon bacopa (*Bacopa caroliniana*), and Baldwin's spikerush (*Eleocharis baldwinii*). At the outside edge of the water, cattails, pickerelweed, duck potato, Canna lily (*Canna flaccida*) alligatorweed (*Alternanthera philoxeriodes*) and sawgrass (*Cladium jamaicense*) are typically found. Landward of this edge, in the water's zone of fluctuation, can be found maidencane (*Panicum hemitomom*), star rush (*Rhynchospora latifolia*), redroot (*Lachnanthes caroliniana*), bog buttons (*Eriocaulon decangelare*), blue flag (*Iris hexagona*), yellow-eyed grasses (*Xyris* species), various flat sedges and beakrushes (*Cyperus* and *Rhynchospora*), softrush, pennywort, Asian coinwort (*Centella asiatica*), meadow beauties (*Rhexia* species), smartweeds (*Polygonum* species), Virginia buttonweed (*Diodia virginiana*) and false-pimpernel (*Lindernia grandiflora*).

Animals that could be expected to be found would include wading birds, such as heron, egrets, ibis and roseate spoonbill (*Ajaia ajaja*), red-winged blackbird, red-shouldered hawk, common moorhen, common yellowthroat, anhinga, Carolina wren, sandhill crane (*Grus canadensis*), various treefrogs, oak toad, black racer, Florida watersnake, Florida box turtle, raccoon, opossum, hispid cotton rat and cotton mouse.

8.2.3.5 Wet Prairie

This plant community differs from freshwater marsh in that it is dominated by more grasses and sedges, generally has standing water only during the rainy season and the soils are slightly acidic and typically much sandier with less organic material. The reason for the sandier soils is related to the water regime. With a short hydroperiod of 50 to 100 days, the soils are able to dry out which allows organic matter to oxidize. Within the ELW, this habitat contains almost 50 acres translating to close to 5% of the natural systems area and almost 1% of the total area of the watershed.

The shortened hydroperiod also enables to a wide variety of vegetation to utilize this type of wetland. As with the freshwater marsh, fire plays an important role in limiting the amount of shrubs such as wax myrtle and buttonbush. Typically, wet prairies will burn on a cycle of every 2 to 4 years. Many of the plants found in the freshwater marsh's zone of fluctuation can be found in the wet prairie. These include maidencane, carpetgrass (*Axonopus* species), bahia grass, vasey grass (*Paspalum urvillei*), redroot, wiregrass, flat sedges, Piedmont seedbox (*Ludwigia arcuata*), blue maidencane (*Amphicarpum muhlenbergianum*), beakrushes, yellow-eyed grasses, spike rushes (*Eleocharis* species), star rushes, meadow beauties and clubmosses (*Lycopodium* species).

The faunal component of this plant community will be very similar to that of the freshwater marsh. This habitat is an important link in the life cycles of many amphibians, especially tree frogs and salamanders. Since standing water is limited to the summer rainy season, fish and many other aquatic predators are not able to establish themselves. Many of these breeding species have an accelerated life cycle that allows them to mature before the water completely dries up.

8.2.3.6 Emergent Aquatic Vegetation

This category of wetlands occurs in standing water and includes plant species that are floating, emergent or submerged. It generally occurs on the littoral shelves of lakes and ponds as well as the edges of streams and creeks. The ELW contains less than 2 acres of this habitat type. Vegetation and faunal composition will be similar to that found associated with lakes and the open water component of freshwater marshes.

8.3 LISTED SPECIES WITHIN THE WATERSHED

Listed species are those animals and plants that are protected by federal and state regulations which prohibit certain activities that might harm these species or their habitats. In order to protect these plants and animals, the federal government passed the Endangered Species Act of 1973. 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 "any 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 "which 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 the Florida Game and Fish Commission (GFC) for animals and by the Florida Department of Agriculture and Consumer Services (ACS) for plants. Animals are divided 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 "fish 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 "fish 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 "faunal 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 "native 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 Stat. 884)".

State listed threatened plants refer to "species 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 "species 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."

On a local level, the Hillsborough County LDC provides protection for endangered and threatened species as well as species of special concern. This portion of the LDC is under the authority of the Planning and Growth Management Department.

Table 8.2 summarizes listed flora and fauna that could potentially be found or was observed in the ELW and 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

Table 8.2
Listed Flora and Fauna Potentially Found and/or Observed in the East Lake Watershed

		STATUS [1]		**HABITAT PREFERENCE [2]**							
Common Name	**Scientific Name**	**GFC**	**FWS**	**MR**	**UC**	**UM**	**LR**	**WC**	**WM**	**FM**	**WP**
Reptiles and Amphibians											
American Alligator	*Alligator mississippiensis*	SSC	T(SA)				X				
Eastern Indigo Snake	*Drymarchon corias couperi*	T	T	X	X						
Alligator Snapping Turtle	*Macroclemys temmincki*	SSC	---				X				
Birds											
Roseate Spoonbill	*Ajaia ajaja*	SSC	---				X			X	X
Little Blue Heron	*Egretta caerulea*	SSC	---				**X**	X	X	**X**	X
Snowy Egret	*Egretta thula*	SSC	---				**X**	X	X	X	X
Tricolored Heron	*Egretta tricolor*	SSC	---				**X**	X	X	X	X

White Ibis	*Eudocimus albus*	SSC	---	**X**			**X**	X	**X**	**X**	**X**
Peregrine Falcon	*Falco peregrinus*	E	---	X	X	X	X	X	X	X	X
Southeastern Kestrel	*Falco sparverius*	T	---	X	X	X	X	X	X	X	X
Sandhill Crane	*Grus canadensis*	T	---	**X**			X			X	X
Bald Eagle	*Haliaeetus leucocephalus*	T	T	X	X	X	**X**	X	X	X	X
Wood Stork	*Mycteria americana*	E	E	X			X			X	X
Brown Pelican	*Pelecanus occidentalis*	SSC	---				**X**				
Mammals											
Sherman's Fox Squirrel	*Sciurus niger shermani*	SSC	---	X		X					
Plants											
Butterfly Orchid	*Encyclia tampensis*	CE	---			X			X		
Cinnamon Fern	*Osmunda cinnamomea*	CE	---				X	**X**	**X**	X	
Royal Fern	*Osmunda regalis*	CE	---				X	**X**	X		

Status [1] - GFC - Florida Game and Freshwater Fish Commission
FWS - United States Fish and Wildlife Service
E - Endangered
T - Threatened
T(SA) - Threatened / Similarity of Appearance
SSC - Species of Special Concern
CE - Commercially Exploited

Habitat Preference [2] - MR - Mixed Rangeland
UC - Upland Coniferous Forest
UM - Upland Mixed Forest
LR - Lakes and Reservoirs
WC - Wetland Coniferous Forest
WM - Wetland Mixed Forest
FM - Freshwater Marsh
WP - Wet Prairie

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. The key to the abbreviations is listed below.

8.4 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 reduction of flow into estuarine systems. Stressed habitats are depicted in **Figure 8-3**. These issues are described in more detailed in the following paragraphs.

8.4.1 LOSS OF HABITAT AS A RESULT OF FRAGMENTATION AND DEGRADATION

Two of the main reasons for habitat loss within the ELW are fragmentation and degradation of the existing habitats. Fragmentation is the slicing up of large pieces of habitat or entire ecosystems into smaller "islands" which themselves are frequently subjected 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 "islands" are filled with development, the lack of greenways or corridors prevents most wildlife from recolonizing one area from another until the habitat's value is near zero. Another aspect of this process is what has come to be termed the "edge 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 "edge 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.

Figure 8-3 Not Available At Time Of Posting

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 is 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 “mud-boggers”. Illegal dumping or discharges can also lead to degradation, both direct and indirect.

8.4.2. 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 ELW and the state of Florida. Given Florida’s mild climate and abundant rain, close to one-third of the state=s flora is 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 cylindrical*) 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.

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 hurricane floodings 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 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 and the Cuban treefrog predates directly on our native treefrogs. The cane toad is also very toxic and can easily kill any small animal that tries to eat it. 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 "edge 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 East Lake Area watershed.

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 and therefore, the East Lake Watershed. Within Hillsborough County, groundwater supplies at least three-quarters of the water used, only the City of Tampa relies on surface water for its 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 the recently formed 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 has increased by over 400 percent, from 60 million gallons per day (mgd) to over 251 mgd. Since 1993, because of the recognition of the water supply problem, water use has stabilized due to the practices of water conservation and reuse.

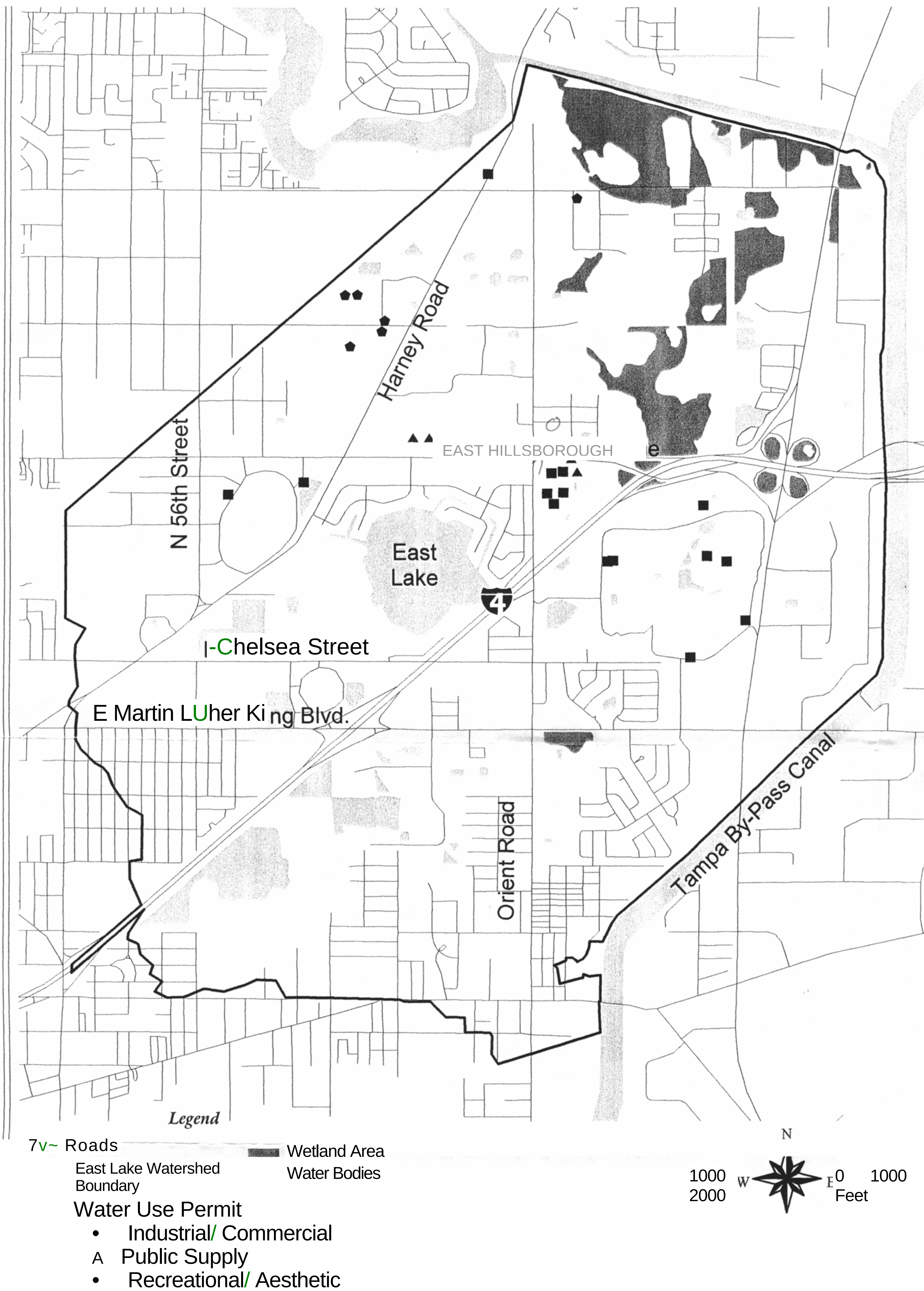
Watershed management issues in the ELW that are directly related to public water supply include: a) ground and surface water use, b) aquifer recharge, c) impacts due to water withdrawal and d) minimum flows and levels. Following is a discussion of these issues.

9.2 GROUNDWATER USE

Within the area of the watershed, two aquifers exist, the shallow surficial and deeper Floridan. There is no cap of the surficial aquifer which is essentially the seasonal high water table. Between the surficial and Floridan aquifers is a semi-confining unit composed of clay, silt and sandy clay soils. The Floridan is also bounded on the bottom by a lower confining unit consisting of less permeable limestone and dolomite. In areas to the north, in north Hillsborough into Pasco County, the surficial aquifer is absent and the Floridan aquifer can approach the land's surface.

As can be seen from **Figure 9-1**, there are no water supply wellfields within or closely adjacent to the East Lake Watershed. All groundwater withdrawals are from a variety of sources - residential, industrial and agricultural. These locations can be found on **Figure 9-2**. No adverse impacts to either lakes or wetlands have been attributed to these withdrawals according to Hancock and Smith (1996). They assessed wetland health in the northern Tampa Bay

FIGURE 9-1 Not Available At Time Of Posting



HILLSBOROUGH COUNTY
FLORIDA

EAST LAKE AREA
Water Use Permit
Locations Map
(September 1999)

Public Works Department
Engineering Division
Stormivater Management Section

Figure *9-2*
Water Use
<u>Permit Map</u>

watershed using the following criteria - water levels, soil condition, canopy condition, fire effects, plant and animal life and human effects. Wetlands were then ranked by the following scale, which is ranked from most to least impacted:

1.0 to 1.5 - Surface water almost never observed. Fire effects, when present, often include severe peat burns. Tree canopy thinned and leaning, with fallen trees usually apparent.

2.0 to 2.5 - Surface water absent except when rainfall is considerable above normal. Fire effects may include some peat burning. Tree canopy thinned, with weedy and upland plants dominating the understory. Wetland wildlife usage virtually nonexistent.

3.0 to 3.5 - Water levels much lower than expected and sites may be dry in below normal rainfall years. Fire effects may be greater than expected. Weedy and upland plants beginning to dominate the understory. Wetland wildlife usage poor.

4.0 to 4.5 - Water levels lower than expected. Weedy and upland plants found in greater abundance than under natural conditions. Wetland wildlife usage is likely not as high as under natural conditions.

5.0 - Water levels, soil conditions, and canopy appearance generally are all normal. No excessive fire effects observed. Plants and animals are all, or nearly all, associated with a wetland environment.

9.3 SURFACE WATER USE

While no wellfields are located within the East Lake Watershed, the Tampa By-Pass Canal plays a substantial role in the water supply, primarily for the City of Tampa. Tampa Bay Water is proposing to withdraw water from the Canal, which would be used to augment their public drinking water supply. If water levels in the City's reservoir fall below acceptable levels, water can also be pumped out of the canal and into the Hillsborough River, again augmenting the city's water supply. The only other use of surface water would be withdrawals from stormwater ponds and East Lake for irrigation, primarily for yard watering purposes.

9.4 WATER SUPPLY AREAS OF CONCERN

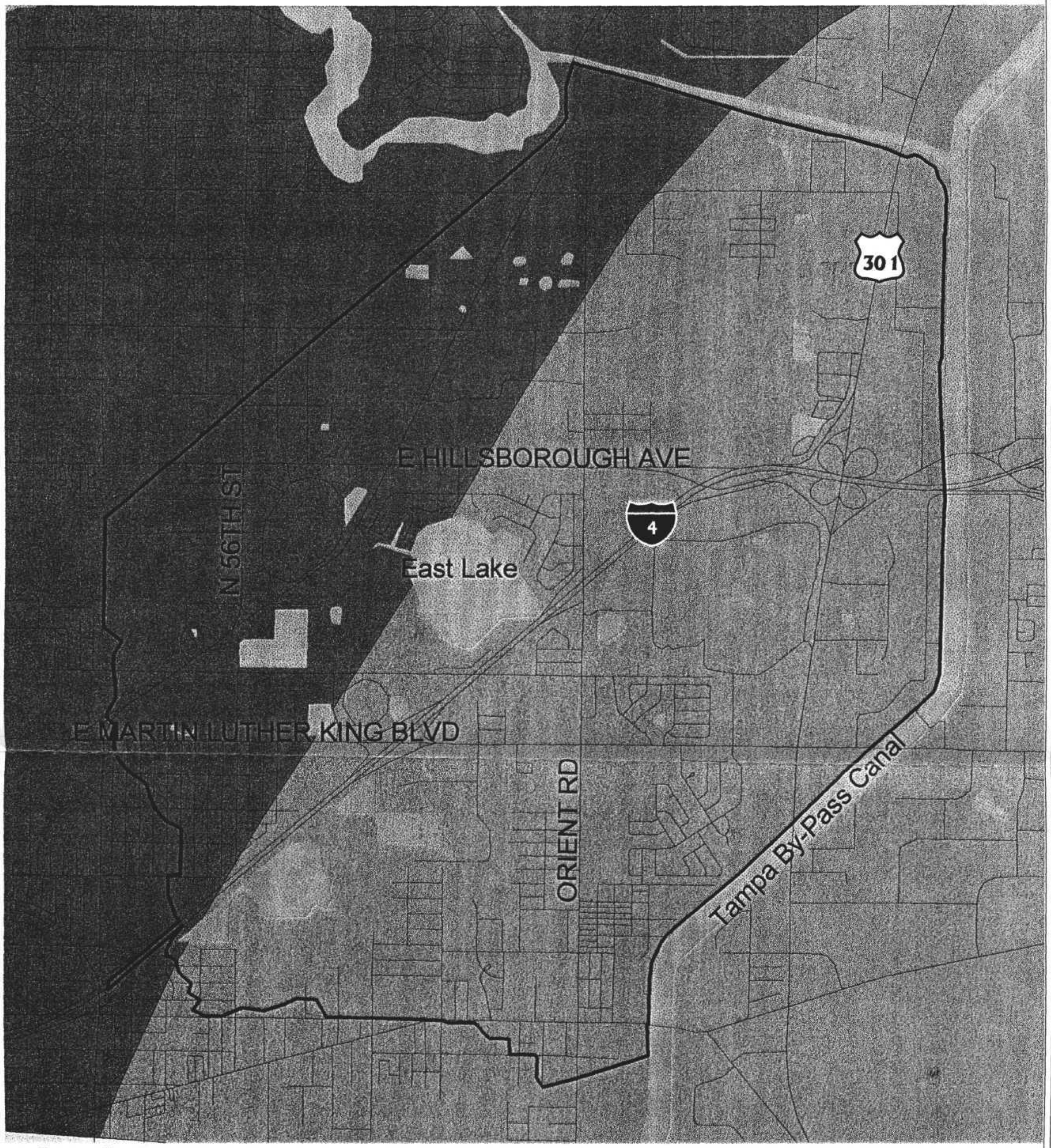
As stated above, public water supply for the ELW is administered by Tampa Bay Water. This organization was originally established by the Florida Legislature in 1974 as the West Coast

Regional Water Supply Authority (WCRWSA), but as the importance and needs of supplying water to the Tampa Bay area increased, it was recognized that a single authority might be able to do a better job of supplying the water than a mixture of counties, municipalities and the existing authority. The WCRWSA was originally made up of the cities of Tampa and St. Petersburg and Hillsborough, Pinellas and Pasco Counties. Later, the city of New Port Richey was added as a non-voting member. With the re-organization into TBW, the County members were given two votes a piece and the City members were given one vote each. In addition, 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, those wellfield(s) can be taken off-line. Those wellfield(s) 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. The reorganization also gave TBW the responsibility and authority to develop new water supplies to meet the Tampa Bay area's water needs. These include a proposed reservoir in eastern Hillsborough County, possible new wellfields in areas of Brandon and Cone Ranch and a desalination plant in southern Tampa Bay.

9.4.1 AQUIFER RECHARGE

Recharge for the surficial aquifer is directly related to rainfall. This means annual highs 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 is greater in the areas where the aquifer approaches the land's surface, such as wetlands or streams.

The ELW is in an area of recharge for the Upper Floridan aquifer. Some of this recharge occurs through the semi-confining unit between the surficial and Floridan aquifers. In his study, Aucott (1988) designates the eastern two-thirds of the watershed as an area of low recharge, less than 1 inch of recharge per year, with the remaining western third as an area of high discharge of around 1 to 5 inches per year. This is reflected in **Figure 9-3**. Aucott based his findings primarily on the thickness of the Floridan's upper confining unit. In a more detailed study centering on potential aquifer contamination, Swancar and Hutchinson (1992) determined that the ELW was in an area of high contamination potential and therefore in an area of high recharge. They found that in addition to thickness of the confining layer, the integrity of the confinement and the head difference between the surficial and Floridan aquifers played a role in determining recharge potential.



Legend

Roads

East Lake Watershed Boundary

Water Bodies

Recharge to/Discharge Legend

- DISCHARGE/1 TO 5
- DISCHARGE/GREATER THAN 5
- DISCHARGE/LESS THAN 1
- RECHARGE/1 TO 10
- RECHARGE/GREATER THAN 10
- RECHARGE/LESS THAN 1

N W E S

This data was digitized from the map in the USGS document "Areal Variation in Recharge to and Discharge from the Florida Aquifer System in Florida." Investigations Report 88-4057 by W.R. Aucott. The scale of the source map was approximately 1:100,000.

HILLSBOROUGH COUNTY FLORIDA

EAST LAKE AREA
Recharge to /Discharge from The Floridan Aquifer Map (September 1999)

Public Works Department
Engineering Division
Stormwater Management Section

Figure 9-3
Recharge to/Discharge from The Floridan Aquifer Map

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 such as the East Lake Watershed, the run-off from these 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. 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. Another, more subtle effect of surface water withdrawal from areas such as the By-Pass canal, is that this water, which has the potential to be used in aquifer recharge, can be moved outside its original recharge area and lost. An example of this is that almost 50% of the water, which is withdrawn from inland areas like the ELW, may be transported by TBW's loop system to a coastal area where it is used and then discharged directly into the Gulf of Mexico or injected into deep, non-potable aquifers in Pinellas County. Soils can also influence the recharge of the surficial aquifer in particular; the sandier the soil, the greater the recharge potential.

9.4.2 IMPACTS DUE TO WATER WITHDRAWALS

The most common type of impact due to water withdrawal is the dewatering of wetlands by the lowering of the water table. Groundwater withdrawals from a permanent source such as a well, will typically create a cone shaped area, known as a cone of influence, in which the water table is depressed to some extent. The farther from the cone's center, the lesser the influence will be on the water's level. In the ELW, the Tampa By-Pass Canal exhibits a similar effect. In a study done by Rushton and Dye in 1993, it was found that the area of influence was limited to a radius of approximately 300 feet. A larger area of influence would be expected because of the canal's large width, in some places more than 300 feet, and its depth of up to 20 feet, but it was found that the drawdown was mitigated by the high clay content of the soil. Another effect attributed to the canal was changing the relationship between the surficial and Floridan aquifer (Knutilla and Corral 1984). They found the confining layer between the aquifers had been removed during the creation of the canal. In areas where the surficial water level was previously below the Upper Floridan aquifer water level, the lowering of the Upper Floridan aquifer water levels has caused a greater induced recharge, and subsequent lowering of the water table. Again, it seems the high clay content of the soils reduced the impact from what might have been expected.

9.4.3 MINIMUM FLOWS AND LEVELS

In recent years, it has become clear that the availability of potable water is one of the major problems to be addressed in the near future. 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 watercourses, 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 group or 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 has not yet gone into effect. Also in 1996, the Northern Tampa Bay Water Resources Assessment Project determined that groundwater withdrawals from various wellfields around Hillsborough County must be reduced because of low water levels in creeks and lakes around the County. This has spurred the search for alternative freshwater supplies. One of those alternatives is capturing water from the Tampa By-Pass Canal which is the receiving waterbody for the majority of the water falling into the ELW. The minimum flow for the Tampa By-Pass Canal is currently proposed to be set at zero, which translates to no flow over control structure S-160.

POLLUTANT LOADING AND REMOVAL MODEL

10.1 OVERVIEW

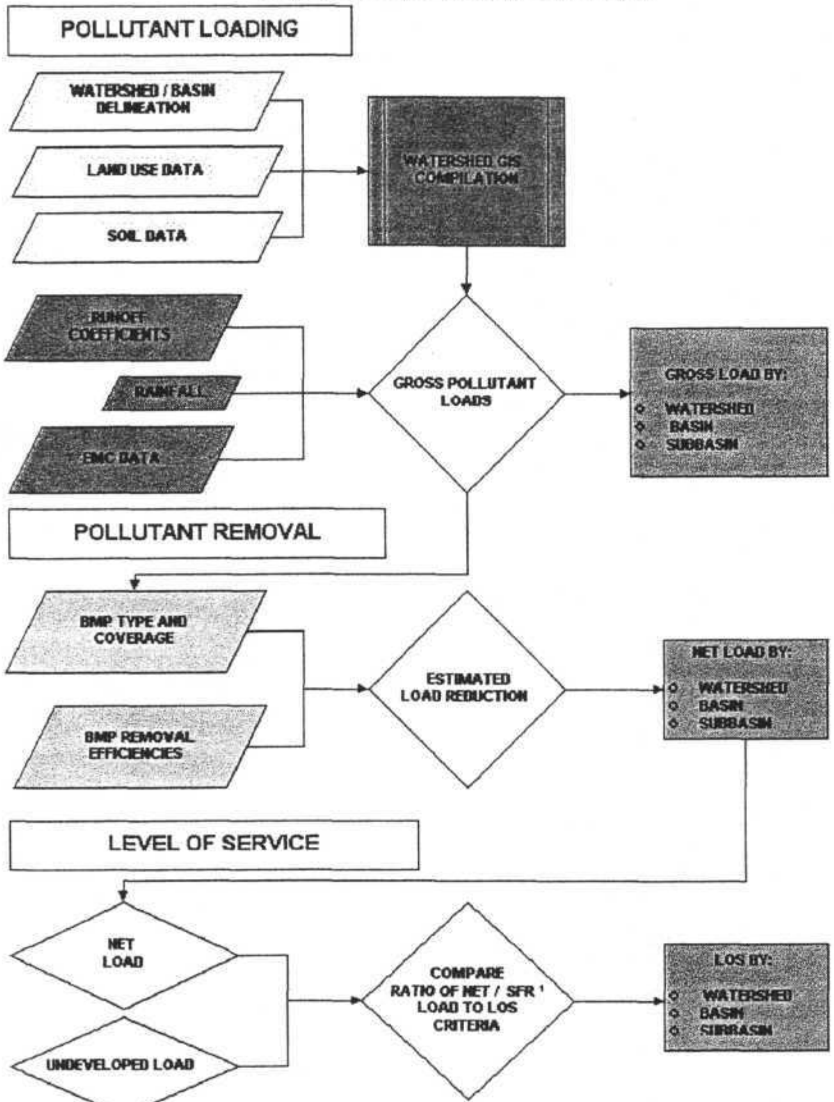
Development in Hillsborough County has been proceeding steadily throughout the last decade. This is especially true in the northwest and northcentral portions of the County. In order to better evaluate the water quality impacts that may result from this development and to establish a water quality treatment level of service, 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. The model's purpose is to qualitatively assess the amount of pollutant loading and water quality treatment level of service for a given area; these areas can be an entire watershed or a basin, subbasin or catchment area.

The model is based on spreadsheets which can be worked from the Excel[8] spreadsheet program. However, during initial development, a GIS based version was also considered. The spreadsheet concept was chosen due to its ease of use and because it does not need special equipment or software. Sensitivity analysis is also easier to perform with spreadsheets. To allow use in the Excel[8] program, the model was written in VisualBasic[8] code and includes various input or editing screens to facilitate its use. Because land uses will almost certainly change in the future, the model was made so 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. These are schematically illustrated in **Figure 10-1**. In the first component, gross pollutant loads can be determined using soil and land use data with the subbasin delineations in combination with run-off coefficients, rainfall amounts and event mean concentration (EMC) information. 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. The WQTLOS can be determined on a watershed, basin or subbasin level.

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

Source of Pollutant Load Data:
Parsons Engineering Sciences Inc.

HILLSBOROUGH COUNTY FLORIDA

EAST LAKE AREA
Pollutant Loading
Model Schematic
(September 1999)

Public Works Department
Engineering Division
Stormwater Management Section

Figure 10-1
Pollutant Loading
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.

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
- wetland non-forested
- highway / utility
- recreational
- open land
- extractive (mining) / disturbed
- upland forest
- wetland forest

See **Table 2.1** for a summary of the existing land uses in the East Lake Area watershed.

10.2.2 SOIL CHARACTERISTICS

Here, soils are divided into their hydrologic soils group. 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, some soils can change their classification 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. Having a dual designation means that during the dry season, a soil may act like an A or B class soil with higher infiltration rates, but under wet season conditions the soil will have a slower infiltration rate and, therefore, act more like a D class soil.

10.2.3 RUN-OFF COEFFICIENT

Run-off volume calculations were based on the application of run-off coefficients by 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 Pollutant Loading and Removal model 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
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

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

Land Use	Hydrologic Soil Group	Run-off Coefficient
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 East Lake Area watershed can be broken down into 287 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 less than one acre to over 258 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. Watershed areas outside the County or within the City of Tampa are not included in this evaluation.

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 amount of loading can be determined. The 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

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		1.363	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		2.047	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		2.275	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		2.970	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		2.378	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		1.686	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		2.032	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	2.032	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	4.130	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	2.598	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	2.598	g	0.19	c	0.13	f	0.9	f	0.0003	c	0.001	c	0.001	c	0.006	
Extractive (Mining) /	28.94	c	13.2	c	3.50	c	0.03	c	3.530	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

Note

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 NH_3 + organic N (TKN) + oxidized N (NO_2+NO_3)

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)

10.2.6 Best Management Practices (BMP) Information

residential land uses and nitrogen and phosphorus for agricultural land uses, the EMCs used are similar to or lower than EMCs 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. The type of BMP and its percent coverage for each land use within each subbasin is determined using aerial photography, 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. This file must be in a specific format which can be generated by the model.

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

BMP Type	BOD_5	TSS	TKN	NO_3 + 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 non-point 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, in acres, for every combination of land use and hydrologic soils group within 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 TREATMENT 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.
Table 10.4
Summary of Net Pollutant Loads by Subbasin for the East Lake Area Watershed

Subbasin ID	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
100999	176.3	1675	75.45	19.58	95.03	13.6	7.964	28.574	0.152	1.054	2.833	2.24
101005	231.8	1553	162.5	19.14	181.7	25.72	14.64	242.75	0.081	1.81	0.416	6.481
101015	65.84	528.5	45.62	7.601	53.22	8.21	4.863	50.644	0.026	0.503	0.134	1.395
101030	14.54	254.5	15.01	3.886	18.9	5.305	3.764	14.56	0.014	0.172	0.106	0.292
101040	6.638	126.1	7.182	1.865	9.047	2.662	1.872	7.1686	0.007	0.086	0.053	0.146
101050	18.96	247.3	17.36	3.402	20.76	5.058	3.412	22.234	0.013	0.205	0.097	0.519
101060	18.19	225.8	16.23	3.091	19.32	4.558	3.051	20.949	0.012	0.191	0.087	0.496
101075	113	972.2	69.75	16.41	86.16	11.88	6.696	27.782	0.042	0.742	0.171	1.084
101105	26.59	262.6	17.92	4.303	22.23	3.754	2.298	9.2252	0.012	0.196	0.061	0.295
101115	28.2	535.9	30.52	7.926	38.44	11.31	7.954	30.461	0.028	0.367	0.226	0.621
101120	4.683	88.97	5.067	1.316	6.383	1.878	1.321	5.0574	0.005	0.061	0.037	0.103
101127	3.598	68.36	3.893	1.011	4.904	1.443	1.015	3.8857	0.004	0.047	0.029	0.079
101140	4.429	84.15	4.792	1.245	6.037	1.776	1.249	4.7831	0.004	0.058	0.035	0.097
101145	24.61	393	24.16	6.232	30.39	8.07	5.791	22.668	0.021	0.261	0.161	0.447
101147	39.09	142.8	22.45	5.488	27.93	1.205	1.779	10.759	0.012	0.033	0.024	0.098
101149	26.23	99.93	26.42	2.337	32.68	2.446	1.053	10.534	0.007	0.139	0.03	0.106
101151	42.58	297.4	26.38	6.352	32.73	3.7	2.692	12.532	0.016	0.189	0.06	0.305
101160	52.11	182.1	41.2	2.96	51.57	3.884	1.553	19.923	0.028	0.245	0.495	0.234
101162	88.26	240.7	86.69	6.019	107.5	5.565	2.225	32.547	0.024	0.354	0.22	0.264
101164	37.19	115	37.35	2.543	46.25	2.894	0.989	13.666	0.011	0.189	0.099	0.131
101170	1001	10821	135.4	50.34	185.7	9.001	14.28	22.905	1.638	4.379	39.14	16.95
101172	16.73	58.26	15.57	1.577	19.26	1.277	0.607	6.1279	0.004	0.073	0.015	0.057
101235	44.97	560	36.59	9.159	45.75	10.06	6.938	27.542	0.029	0.386	0.189	0.63
101245	154.2	1457	101	24.1	125.1	19.93	11.94	48.293	0.066	1.094	0.315	1.633
101305	409.6	3735	274.3	59.37	333.7	53.29	31.86	186.32	0.173	3.003	0.853	5.688
101425	6.319	120.1	6.838	1.776	8.613	2.534	1.782	6.825	0.006	0.082	0.051	0.139
101435	15.23	289.5	16.48	4.281	20.76	6.109	4.296	16.453	0.015	0.198	0.122	0.335
101450	24.49	287.4	18.55	4.56	23.11	4.757	3.096	12.17	0.014	0.208	0.085	0.326
101520	205.4	1739	124.4	30.1	154.5	26.41	16.02	60.689	0.094	1.316	0.386	1.938
101535	45.91	291	19.51	5.365	24.87	9.012	5.586	14.91	0.034	0.253	0.107	0.339
101620	364.9	1115	102.9	27.35	130.3	44.03	24.12	48.064	0.22	1.267	0.226	1.488
101630	676.1	2712	248.8	20.95	317.3	14.68	8.558	157.53	0.627	2.795	14.5	4.571
101631	0	0	0	0	0	0	0	0	0	0	0	0
101635	907.6	9698	140.8	54.63	195.5	27.41	20.75	37.885	1.423	4.415	33.7	15.38
101645	99.66	1111	52.45	26.02	78.46	51.22	21.15	41.117	0.038	1.801	0.23	2.222
101650	89.78	999.5	47.3	23.36	70.67	45.87	18.95	36.93	0.035	1.615	0.207	1.994
101655	95.53	1041	50.94	24.01	74.94	45.77	19.03	38.064	0.037	1.63	0.213	2.023
101660	128.3	1379	69.37	31.16	100.5	57.67	24.13	49.529	0.049	2.086	0.28	2.604

Table 10.4 (cont'd.)
Summary of Net Pollutant Loads by Subbasin for the East Lake Area Watershed

Subbasin ID	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
101665	24.42	259.9	12.89	6.184	19.07	11.8	4.914	9.8108	0.009	0.414	0.053	0.513
101670	62.35	695.4	32.8	16.28	49.09	32.06	13.24	25.73	0.024	1.127	0.144	1.391
101675	261.4	2895	138	67.56	205.6	131.9	54.55	106.86	0.102	4.66	0.598	5.747
101710	21.82	405.2	23.3	6.045	29.34	8.524	6.009	23.075	0.021	0.276	0.17	0.468
101715	11.31	215	12.24	3.179	15.42	4.537	3.191	12.219	0.011	0.147	0.091	0.249
101730	20.4	246.6	15.1	4.832	19.93	7.097	3.96	12.607	0.012	0.241	0.08	0.349
101740	28.78	520.9	29.44	7.972	37.41	11.7	7.827	28.921	0.027	0.384	0.212	0.628
101815	57.97	497.8	35.74	8.407	44.14	6.061	3.411	14.12	0.022	0.38	0.087	0.554
101820	26.05	223.7	16.06	3.778	19.84	2.724	1.533	6.3455	0.01	0.171	0.039	0.249
101830	81.94	766.2	48.19	14.82	63.02	18.92	8.704	24.247	0.031	0.827	0.143	1.103
101837	20.73	116.5	12.25	2.947	15.2	1.245	1.05	5.4306	0.007	0.065	0.02	0.11
101840	12.62	239.7	13.65	3.546	17.2	5.06	3.558	13.627	0.013	0.164	0.101	0.278
101842	7.008	84.73	5.166	1.665	6.832	2.464	1.366	4.3167	0.004	0.084	0.027	0.121
101843	25.43	208.4	18.6	4.854	25.16	9.063	3.664	10.327	0.008	0.342	0.046	0.39
101850	21.97	417.4	23.77	6.173	29.94	8.808	6.194	23.724	0.022	0.286	0.176	0.483
101852	2.587	49.15	2.799	0.727	3.526	1.037	0.729	2.7938	0.003	0.034	0.021	0.057
101855	5.461	103.8	5.909	1.534	7.443	2.19	1.54	5.8976	0.005	0.071	0.044	0.12
102005	324.3	2467	131.5	58.9	190.4	114.8	49.31	89.201	0.158	3.891	0.501	4.657
102010	389.9	4179	208.7	98.65	307.4	187	78.57	159.95	0.15	6.563	0.878	8.163
102015	173.2	1686	81.54	40.12	121.7	79.99	33.35	62.406	0.074	2.758	0.349	3.36
102020	360.7	747.6	79.52	25.28	104.8	49.12	26.84	36.026	0.236	1.083	0.183	0.933
102025	85.21	740.2	46.9	17.65	64.55	26.56	11.82	28.663	0.03	0.98	0.141	1.261
102035	99.58	1036	55.02	22.63	77.65	39.28	16.68	36.177	0.038	1.465	0.206	1.85
102040	86.85	920.7	47.26	20.63	67.89	37.39	15.72	32.855	0.034	1.369	0.186	1.708
102055	322.9	2291	40.39	15.09	55.48	16.22	10.51	7.1011	0.425	1.157	8.122	3.572
102060	420.1	4419	102.9	46.5	149.4	67.4	30.99	56.607	0.522	3.475	11.36	7.522
102070	1958	13292	560.8	216.7	777.4	365.8	170.5	287.19	1.608	13.95	20.84	21.93
102071	189.9	2065	23.66	9.021	32.68	0.95	2.374	3.1653	0.317	0.815	7.597	3.244
102072	298.7	3045	76.18	21.98	98.16	9.269	7.406	23.144	0.394	1.444	8.871	4.477
102076	48.04	466	14.73	4.021	18.75	1.806	1.376	4.8989	0.056	0.231	1.22	0.663
102077	38.16	202.6	20.81	5.133	25.94	1.927	1.676	8.7483	0.015	0.107	0.116	0.205
102082	144.9	1552	22.18	7.702	29.89	1.515	2.189	4.3369	0.23	0.637	5.467	2.406
102105	51.46	573.9	27.07	13.44	40.51	26.46	10.92	21.236	0.02	0.93	0.119	1.148
102115	5.406	46.42	3.333	0.784	4.117	0.565	0.318	1.3168	0.002	0.035	0.008	0.052
102120	47.98	438.1	23.97	5.847	29.82	3.882	2.295	9.1014	0.033	0.289	0.511	0.544
102130	34.11	308.4	17.76	4.317	22.08	2.963	1.721	6.8304	0.021	0.21	0.306	0.378
102155	69.19	768.8	36.5	17.94	54.44	35.12	14.52	28.364	0.027	1.238	0.159	1.529
102180	22.66	247.1	12.12	5.66	17.78	10.74	4.47	8.9766	0.009	0.384	0.05	0.477

Table 10.4 (cont'd.)
Summary of Net Pollutant Loads by Subbasin for the East Lake Area Watershed

Subbasin ID	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
102185	486.4	5213	77.06	26.37	103.4	5.765	7.631	15.703	0.767	2.163	18.17	8.057
102205	55.93	570	15.19	4.286	19.47	1.943	1.473	4.7241	0.072	0.278	1.594	0.83
102215	371.6	3549	124.2	33.13	157.3	15.92	11.58	42.647	0.409	1.823	8.628	4.96
102220	40.39	374.3	18.99	4.686	23.67	3.027	1.82	7.1122	0.031	0.238	0.523	0.476
102225	54.9	323.5	32.11	7.665	39.77	3.354	2.587	13.196	0.018	0.196	0.05	0.316
102231	112.5	645.2	78.12	8.813	86.94	10.9	6.69	121.33	0.037	0.773	0.181	3.087
102235	49.16	266.3	26.67	6.038	32.71	2.199	2.025	15.028	0.021	0.145	0.217	0.382
102236	15.18	103.4	11.19	1.895	13.82	1.453	0.751	4.3125	0.005	0.091	0.019	0.114
102305	9.882	110.2	5.2	2.581	7.78	5.082	2.098	4.0783	0.004	0.179	0.023	0.22
102310	28.41	316.8	14.95	7.418	22.36	14.61	6.031	11.723	0.011	0.513	0.066	0.634
102315	8.645	96.43	4.549	2.258	6.806	4.446	1.835	3.5678	0.003	0.156	0.02	0.193
102320	50.04	529.6	26.06	11.16	37.22	19.75	8.356	17.609	0.023	0.738	0.223	0.963
102325	23.01	220.4	10.16	2.789	12.95	2.388	1.276	4.141	0.019	0.155	0.338	0.303
102345	84.8	875.6	20.56	6.011	26.57	2.447	2.002	6.0269	0.115	0.41	2.609	1.295
102406	22.46	193.1	13.84	3.268	17.11	2.385	1.335	5.4862	0.008	0.148	0.034	0.216
102415	130.1	966.3	82	14.02	101.9	10.64	5.538	30.458	0.073	0.766	1.061	1.181
102417	107	1119	22.87	6.972	29.84	2.465	2.236	6.1834	0.153	0.503	3.532	1.681
102445	49.31	376.3	27.83	4.859	34.72	3.513	1.883	10.092	0.034	0.279	0.588	0.481
102450	76.96	554.5	53.91	9.05	66.73	7.165	3.635	20.439	0.033	0.473	0.316	0.642
102460	333.2	3597	47.38	16.99	64.37	2.852	4.718	8.2578	0.54	1.457	12.87	5.603
102465	233.7	2224	97.46	24.65	122.1	15	9.359	35.424	0.21	1.318	3.999	2.947
102481	48.29	518.8	7.371	2.562	9.933	0.516	0.731	1.4299	0.077	0.213	1.825	0.804
102486	130.4	951	85.38	17.75	105.5	11.89	6.856	33.666	0.045	0.736	0.167	1.03
102525	35.49	250.3	26.56	4.411	32.81	3.578	1.79	10.187	0.012	0.224	0.047	0.279
102545	51	370.7	36.38	6.119	44.99	4.866	2.463	13.863	0.021	0.317	0.179	0.427
102575	45.53	321.2	34.08	5.66	42.1	4.591	2.296	13.072	0.015	0.288	0.061	0.357
102590	72.93	701.1	28.87	7.386	36.25	4.368	2.775	10.341	0.07	0.404	1.369	0.943
102595	377.9	3603	78.77	22.66	101.4	8.389	7.45	21.475	0.49	1.622	11.25	5.387
102600	93.21	800.4	57.46	13.52	70.98	9.745	5.484	22.704	0.035	0.611	0.14	0.891
102615	109.2	1071	38.74	10.17	48.91	5.633	3.733	13.415	0.116	0.584	2.401	1.481
102625	226.1	2274	68	18.63	86.63	9.191	6.578	22.237	0.272	1.154	5.928	3.256
102635	105.3	1112	20.22	6.405	26.63	1.963	1.985	5.0873	0.157	0.485	3.657	1.692
102650	55.6	483.8	32.89	7.789	40.68	5.534	3.141	12.906	0.024	0.358	0.191	0.552
102675	85.33	283.2	34.76	2.962	45.13	0.528	0.769	10.075	0.091	0.444	1.612	0.416
102681	168.3	1864	88.62	43.75	132.4	85.72	35.44	69.177	0.067	3.031	0.387	3.719
102690	167.6	1732	95.99	41.21	143.6	84.94	33.5	74.275	0.062	2.986	0.37	3.465
102691	140.6	1423	40.45	11.23	51.67	5.344	3.918	12.921	0.174	0.709	3.831	2.052
102693	387.4	3733	150.5	38.68	189.2	22.58	14.46	53.651	0.377	2.129	7.485	5.046

Table 10.4 (cont'd.)
Summary of Net Pollutant Loads by Subbasin for the East Lake Area Watershed

Subbasin ID	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
102705	11.73	74.37	8.532	0.764	9.296	1.357	0.764	14.967	0.004	0.098	0.022	0.392
102706	11.09	70.3	8.065	0.722	8.787	1.282	0.722	14.148	0.004	0.093	0.021	0.371
102716	4.381	27.78	3.187	0.285	3.472	0.507	0.285	5.591	0.002	0.037	0.008	0.147
102720	11.69	74.13	8.505	0.762	9.266	1.352	0.762	14.92	0.004	0.098	0.022	0.391
102725	55.03	349	40.04	3.586	43.62	6.366	3.586	70.239	0.019	0.46	0.105	1.841
102735	7.468	38.73	4.532	0.908	5.44	0.449	0.355	3.4911	0.002	0.028	0.007	0.08
102745	41.54	256.5	29.86	2.844	32.71	4.599	2.644	50.927	0.014	0.331	0.076	1.325
102750	25.14	159	18.27	1.647	19.92	2.896	1.634	31.96	0.009	0.209	0.048	0.837
102760	38.24	191.6	25.09	3.559	28.65	2.867	2.021	32.689	0.012	0.196	0.048	0.788
102770	49.3	312.6	35.87	3.212	39.08	5.703	3.212	62.923	0.017	0.412	0.094	1.649
102775	57.82	366.7	42.06	3.767	45.83	6.688	3.767	73.794	0.02	0.483	0.111	1.934
102787	58.48	453.4	35.48	8.384	43.86	5.328	3.229	14.188	0.021	0.329	0.077	0.49
102800	26.05	49.55	30.1	1.19	34.26	1.758	0.697	37.25	0.005	0.121	0.021	0.209
102801	74.54	177.3	94.91	2.428	103.4	7.545	2.428	154.6	0.016	0.545	0.089	0.935
102805	102.9	604.4	81.45	6.309	88.74	11.73	6.309	140.95	0.034	0.848	0.188	3.188
102810	24.48	102.3	25.08	1.162	27.33	2.636	1.16	41.859	0.007	0.191	0.037	0.539
102811	10.18	24.2	12.96	0.332	14.12	1.03	0.332	21.108	0.002	0.074	0.012	0.128
102815	24.26	126.4	21.43	1.355	23.35	2.706	1.355	36.491	0.008	0.196	0.042	0.667
102817	8.288	19.71	10.55	0.27	11.5	0.839	0.27	17.19	0.002	0.061	0.01	0.104
102830	22.38	130.6	15.7	1.684	17.38	2.251	1.356	25.138	0.008	0.16	0.037	0.644
102845	55.4	351.3	40.3	3.609	43.91	6.408	3.609	70.702	0.019	0.463	0.106	1.853
102865	18.78	119.1	13.66	1.223	14.88	2.172	1.223	23.963	0.007	0.157	0.036	0.628
102868	416.1	3990	55.55	20.38	75.93	9.154	8.337	9.335	0.634	1.7	14.31	6.227
102870	247.1	2432	90.2	24.68	114.9	16.82	10.27	34.527	0.257	1.418	5.244	3.41
102876	320.6	3456	61.65	19.78	81.43	7.119	7.048	18.81	0.488	1.5	11.36	5.254
102880	37.7	323.8	23.24	5.468	28.71	3.942	2.218	9.1834	0.014	0.247	0.057	0.36
102884	56.26	138.4	12.93	3.741	16.67	6.922	3.659	4.2582	0.036	0.18	0.025	0.161
102895	207.6	803.7	88.32	7.369	114.1	5.265	2.456	24.067	0.176	0.879	3.986	1.189
102900	291.7	869.2	76.61	21.34	97.95	35.43	18.82	26.237	0.179	1.018	0.155	1
102904	333	813.2	75.78	22	97.78	40.94	21.64	24.874	0.213	1.062	0.169	0.949
102905	154.3	85.3	45.09	4.158	59.64	17.17	5.159	12.699	0.066	0.36	0.028	0.103
102912	111.7	1148	28.21	8.14	36.35	3.453	2.743	8.4593	0.149	0.545	3.347	1.689
102920	274.6	2952	41.67	14.52	56.2	2.883	4.136	8.0189	0.438	1.213	10.4	4.577
102921	17.91	148.1	10.7	2.497	13.19	1.805	1.016	4.2149	0.006	0.113	0.026	0.165
102928	342.9	3230	110.9	29.02	140	15.57	10.58	37.471	0.364	1.712	7.674	4.518
102932	87.06	655.2	58.83	11.26	72.62	8.67	4.577	22.777	0.03	0.544	0.13	0.73
102933	698.5	1589	161.9	23.21	185.1	19.97	11.7	54.912	0.077	1.043	0.253	1.605
102944	64.12	169.5	43.02	3.164	54.1	5.256	1.73	15.336	0.03	0.28	0.372	0.215

Table 10.4 (cont'd.)
Summary of Net Pollutant Loads by Subbasin for the East Lake Area Watershed

Subbasin ID	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
102952	156	772.6	60.4	15.36	75.76	18.03	9.756	22.466	0.083	0.713	0.136	0.871
102954	179	138.9	22.13	8.044	30.17	22.94	11.95	5.2945	0.127	0.409	0.027	0.182
102966	396.7	2253	211.9	39.71	264.3	44.29	23.54	85.375	0.214	2.049	1.313	2.645
102967	91.45	970.2	48.92	22.5	71.43	41.97	17.56	35.764	0.035	1.498	0.197	1.864
102970	310.7	2629	117.6	30.53	148.1	12.54	10.17	43.261	0.385	1.927	5.922	3.493
102974	335.3	3538	66.55	21.25	87.8	8.007	7.023	17.666	0.493	1.59	11.45	5.384
104007	17.17	314.4	18.19	4.716	22.9	6.601	4.66	17.925	0.017	0.214	0.132	0.363
104020	57.19	222	32.8	7.991	40.79	1.902	2.559	15.297	0.017	0.066	0.036	0.163
104023	114.3	982.7	70.52	16.59	87.12	11.98	6.743	27.912	0.043	0.75	0.172	1.094
104025	13.51	62.74	7.703	1.853	9.555	0.553	0.563	3.2272	0.004	0.029	0.009	0.054
104030	8.171	37.06	4.649	1.119	5.768	0.32	0.337	1.951	0.002	0.017	0.005	0.031
104045	141.2	995.9	105.7	17.55	130.6	14.23	7.12	40.533	0.047	0.893	0.189	1.108
104050	130.9	1268	30.61	9.081	39.69	2.381	2.708	9.1349	0.176	0.538	4.022	1.883
104060	190.9	2013	37.16	11.72	48.88	3.653	3.644	9.3556	0.283	0.881	6.587	3.055
104063	5.819	17	3.201	0.778	3.979	0.077	0.199	1.3783	0.011	0.063	0.009	0.006
104075	96.54	282	53.1	12.91	66	1.27	3.303	22.865	0.178	1.042	0.152	0.102
104080	12.95	14.18	12.46	0.865	15.49	0.149	0.221	4.9831	0.015	0.122	0.013	0.005
104085	14.65	16.05	14.1	0.979	17.53	0.169	0.251	5.6395	0.017	0.138	0.014	0.006
104090	11.08	12.13	10.66	0.74	13.25	0.128	0.189	4.2635	0.013	0.105	0.011	0.004
104095	3.174	3.477	3.055	0.212	3.798	0.037	0.054	1.2216	0.004	0.03	0.003	0.001
104100	9.103	9.972	8.762	0.608	10.89	0.105	0.156	3.5036	0.01	0.086	0.009	0.004
104130	70.02	204.5	38.51	9.361	47.87	0.921	2.395	16.584	0.129	0.756	0.111	0.074
104145	63.45	185.3	34.9	8.483	43.38	0.835	2.171	15.028	0.117	0.685	0.1	0.067
104165	41.91	122.4	23.05	5.602	28.65	0.551	1.434	9.9251	0.077	0.452	0.066	0.044
104205	49.13	143.5	27.02	6.568	33.59	0.646	1.681	11.636	0.091	0.53	0.078	0.052
104208	13.9	40.6	7.645	1.858	9.504	0.183	0.476	3.2922	0.026	0.15	0.022	0.015
104215	9.851	28.78	5.418	1.317	6.735	0.13	0.337	2.3332	0.018	0.106	0.016	0.01
104235	20.33	59.37	11.18	2.717	13.9	0.267	0.695	4.8141	0.037	0.219	0.032	0.021
104247	11.85	34.61	6.517	1.584	8.101	0.156	0.405	2.8065	0.022	0.128	0.019	0.012
104253	20.26	102	11.02	3.372	14.39	2.873	1.62	5.7139	0.03	0.257	0.036	0.132
104280	9.625	10.54	9.264	0.643	11.52	0.111	0.165	3.7044	0.011	0.091	0.009	0.004
104290	46.01	134.4	25.3	6.151	31.45	0.605	1.574	10.897	0.085	0.496	0.073	0.048
104291	18.42	53.81	10.13	2.463	12.59	0.242	0.63	4.3629	0.034	0.199	0.029	0.019
104298	7.799	22.78	4.289	1.043	5.332	0.103	0.267	1.8472	0.014	0.084	0.012	0.008
104305	33.88	57.89	28.59	2.137	36.07	1.051	0.664	11.595	0.037	0.3	0.162	0.058
104400	290.3	2959	46.76	15.93	62.69	1.655	4.169	10.319	0.488	1.408	10.66	4.56
104407	59.06	451.6	17.56	4.871	22.43	0.491	1.259	6.2628	0.103	0.409	1.441	0.625
104416	113.7	1088	22.12	7.014	29.14	0.721	1.828	6.0129	0.193	0.61	3.831	1.643

Table 10.4 (cont'd.)
Summary of Net Pollutant Loads by Subbasin for the East Lake Area Watershed

Subbasin ID	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
104424	108.8	1183	13.55	5.167	18.72	0.544	1.36	1.813	0.181	0.467	4.351	1.858
104428	293.1	2969	48.18	16.28	64.47	1.689	4.259	10.924	0.493	1.436	10.67	4.567
104432	578.4	6290	72.06	27.47	99.53	2.892	7.23	9.6399	0.964	2.482	23.14	9.881
104440	520.5	5661	64.85	24.72	89.57	2.603	6.507	8.6754	0.868	2.234	20.82	8.892
104442	521.8	4169	64.58	24.35	88.93	20.75	14.53	10.51	0.728	1.933	14.97	6.522
104454	50.18	413.7	16.69	4.479	21.17	1.279	1.356	5.985	0.052	0.18	1.1	0.572
104458	65.78	565.4	40.49	9.607	50.09	7.104	3.957	16.122	0.025	0.437	0.099	0.635
104462	175.4	1904	22.68	8.495	31.17	1.043	2.27	3.3029	0.29	0.757	6.952	2.984
104470	125.4	1345	19.71	6.767	26.48	1.454	1.952	3.9751	0.198	0.557	4.696	2.08
104472	24.61	246.7	7.973	2.149	10.12	1.147	0.799	2.779	0.028	0.129	0.607	0.348
104474	61.49	460.6	27.12	4.542	34.19	1.832	1.438	9.8046	0.063	0.235	1.37	0.659
104501	130.1	753.7	51.77	20.77	72.55	34.97	15.91	31.817	0.109	1.452	0.196	1.339
104502	16.22	106.5	5.761	1.528	7.289	0.153	0.394	2.206	0.029	0.127	0.311	0.136
104504	225.2	2192	83.26	21.64	104.9	12.3	8.015	29.222	0.23	1.221	4.686	3.002
104518	36.63	42.87	5.436	1.832	7.268	4.653	2.432	1.4798	0.025	0.092	0.008	0.053
104519	126.9	1234	47.18	12.41	59.59	7.534	4.751	16.846	0.129	0.703	2.603	1.698
104522	196.1	320.4	28.64	9.768	38.41	21.85	11.87	7.7792	0.168	0.576	0.659	0.432
104532	265.7	184.4	31.47	11.66	43.13	34.11	17.76	7.2604	0.189	0.595	0.036	0.247
104564	348.2	3730	54.72	18.79	73.5	4.085	5.442	11.041	0.55	1.546	13.02	5.768
104608	135.4	1124	82.66	19.49	102.1	13.44	7.76	32.777	0.051	0.842	0.22	1.242
104658	550.3	6126	158.6	46.02	204.7	30.05	23.58	79.515	0.765	2.955	16.92	8.896
104810	109	1194	16.98	5.976	22.96	1.659	2.149	5.1525	0.177	0.485	4.202	1.849
104815	131.5	1058	36.86	10.41	47.27	1.2	2.776	13.013	0.153	0.378	3.371	1.517
104816	255	2773	31.77	12.11	43.88	1.275	3.188	4.2501	0.425	1.094	10.2	4.356
104818	154.7	630.4	34.11	3.696	47.05	0.716	0.977	4.3549	0.161	0.582	3.856	0.99
104820	13.62	70.19	7.601	1.833	9.434	0.605	0.571	3.1526	0.005	0.035	0.028	0.066
104825	49.07	381.9	18.06	4.729	22.79	1.409	1.443	6.7134	0.046	0.169	0.924	0.511
104835	68.62	646.1	30.09	7.531	37.62	4.703	2.887	11.082	0.058	0.394	1.059	0.843
104908	12.1	187.3	11.68	3.01	14.69	3.824	2.756	10.834	0.01	0.124	0.076	0.212
105005	25.82	417	19.27	5.142	24.41	6.77	4.842	18.262	0.032	0.257	0.496	0.524
105025	385.1	276.7	46.1	17.02	63.12	49.57	25.85	11.067	0.274	0.868	0.057	0.369
105070	100.1	680.5	44.27	12.35	56.62	21.79	13.79	37.824	0.08	0.581	0.275	0.795
105080	216	1135	66.84	18.48	85.32	26.42	15.26	31.833	0.166	0.931	1.362	1.437
105090	94.41	896.5	36.83	9.46	46.29	5.369	3.5	13.195	0.091	0.507	1.799	1.209
105103	78.58	249.9	83.86	5.645	103.6	7.21	2.316	30.735	0.019	0.447	0.073	0.278
105108	85.51	428.5	49.02	8.265	61.13	2.609	2.353	18.849	0.052	0.226	0.898	0.514
105110	1016	2350	127	46.43	173.4	111.4	59.91	30.493	0.868	2.615	6.324	3.511
105120	462.2	468.6	64.27	22.47	86.74	60.73	32.29	22.069	0.328	1.108	0.122	0.605

Table 10.4 (cont'd.)
Summary of Net Pollutant Loads by Subbasin for the East Lake Area Watershed

Subbasin ID	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
105130	157.9	1254	81.74	22.28	104	35.93	23.42	70.678	0.126	0.998	0.505	1.447
105132	10.31	138.8	9.02	2.03	11.05	2.85	1.93	9.7554	0.008	0.107	0.054	0.223
105140	17.82	97.68	6.701	1.87	8.572	3.527	2.172	5.6892	0.014	0.091	0.039	0.123
105150	14.44	25.12	2.6	0.814	3.414	2.05	1.122	1.5444	0.01	0.042	0.008	0.039
105160	13.37	95.93	9.172	1.268	10.44	1.491	0.839	11.924	0.005	0.103	0.024	0.328
105180	46.73	110.2	59.26	1.548	64.68	4.662	1.511	95.635	0.01	0.337	0.055	0.577
105198	16.24	39.25	19.84	0.646	21.71	1.542	0.531	31.552	0.004	0.111	0.018	0.191
105200	143	755.2	96.15	12.35	108.5	12	7.945	136.46	0.046	0.837	0.201	3.372
105304	57.65	258.6	22.13	6.098	28.23	8.861	5.711	15.128	0.039	0.218	0.092	0.282
105311	2.315	43.99	2.505	0.651	3.156	0.928	0.653	2.5005	0.002	0.03	0.019	0.051
105312	16.67	220.2	14.65	3.736	18.39	4.286	3.115	12.486	0.012	0.143	0.085	0.245
105315	98.04	689.6	73.3	12.15	90.48	9.863	4.948	28.758	0.033	0.619	0.131	0.784
105320	2.447	46.5	2.648	0.688	3.336	0.981	0.69	2.643	0.002	0.032	0.02	0.054
105324	2.634	50.05	2.85	0.74	3.59	1.056	0.743	2.8449	0.003	0.034	0.021	0.058
105330	17.61	151.9	5.347	1.505	6.852	0.428	0.545	2.3458	0.021	0.059	0.453	0.216
105331	439.6	3458	252.8	63.09	315.9	54.27	37.15	143.35	0.248	2.315	1.926	3.87
105332	31.2	99.09	33.83	2.22	41.6	2.845	0.918	14.089	0.007	0.179	0.029	0.12
105365	198.1	2093	47.04	14.48	61.52	6.586	6.636	22.643	0.291	0.882	6.622	3.114
105375	18.44	164.3	13.8	3.477	17.27	2.906	2.333	10.158	0.01	0.092	0.058	0.169
105405	33.72	289.9	20.71	4.875	25.58	3.51	1.977	8.1781	0.013	0.221	0.057	0.323
105425	7.897	67.82	4.868	1.145	6.014	0.826	0.465	1.9237	0.003	0.052	0.012	0.075
105445	6.626	54	4.05	0.955	5.006	0.646	0.377	1.6105	0.002	0.04	0.009	0.059
105550	218.5	232.5	41.54	12.85	54.38	23.86	13.42	13.576	0.139	0.418	0.034	0.227
105610	243	395.6	43.52	13.77	57.29	30.99	16.5	14.702	0.165	0.661	0.083	0.471
105657	13.49	39.39	7.417	1.803	9.22	0.177	0.461	3.194	0.004	0.004	0.004	0.021
105660	2.947	22.75	1.786	0.422	2.209	0.267	0.162	0.7147	0.001	0.016	0.004	0.025
105670	3.376	13.52	1.9	0.459	2.358	0.103	0.131	0.8039	0.001	0.005	0.002	0.01
105680	50.5	235.8	28.83	6.935	35.77	2.098	2.123	12.121	0.015	0.111	0.033	0.204
105691	41.03	260.2	29.85	2.674	32.53	4.747	2.674	52.371	0.014	0.343	0.079	1.373
105692	9.583	104.6	8.141	1.384	9.526	2.075	1.36	11.227	0.006	0.095	0.039	0.274
105693	4.492	78.51	4.634	1.2	5.834	1.636	1.161	4.4929	0.004	0.053	0.033	0.09
105705	401	4360	49.95	19.05	69	2.005	5.012	6.6826	0.668	1.721	16.04	6.85
105729	33.37	109.9	22.94	3.767	28.45	1.185	1.069	9.1697	0.01	0.066	0.063	0.091
105740	171.8	1902	26.96	9.495	36.45	2.968	3.601	8.7491	0.281	0.779	6.657	2.943
105754	185.9	2036	24.75	9.22	33.97	1.587	2.772	4.8636	0.309	0.812	7.385	3.185
105762	5.703	108.4	6.17	1.602	7.773	2.287	1.608	6.1589	0.006	0.074	0.046	0.125
105772	11.4	216.6	12.34	3.204	15.54	4.572	3.215	12.313	0.011	0.148	0.091	0.251
105786	7.919	130.7	7.916	2.044	9.96	2.7	1.929	7.5182	0.007	0.087	0.054	0.149

Table 10.4 (cont'd.)
Summary of Net Pollutant Loads by Subbasin for the East Lake Area Watershed

Subbasin ID	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
105794	4.852	92.19	5.25	1.363	6.614	1.946	1.368	5.2404	0.005	0.063	0.039	0.107
105812	360.2	447.3	53.83	18.41	72.24	48.84	26.23	22.209	0.258	0.92	0.132	0.584
105828	218.4	1093	163.2	17.4	182.8	19.16	11.68	239.76	0.068	1.34	0.307	4.92
105850	76.51	171.5	15.75	4.884	20.63	10.8	5.949	7.586	0.054	0.239	0.05	0.205
105855	11.78	223.8	12.75	3.31	16.06	4.723	3.322	12.722	0.012	0.153	0.094	0.259
105860	10.95	190.3	11.06	2.846	13.9	3.887	2.709	10.405	0.01	0.131	0.077	0.22
105862	13.18	144.1	10.79	2.632	13.42	2.735	2.052	9.4386	0.008	0.092	0.054	0.181
105864	15.79	61.85	9.497	1.797	11.29	0.678	0.682	8.4993	0.005	0.041	0.012	0.171
105870	44.71	431.6	21.17	5.278	26.44	3.668	2.283	8.8244	0.036	0.27	0.629	0.553
105875	14.6	58.38	9.803	0.747	12.42	0.938	0.373	4.3972	0.01	0.074	0.211	0.08
105902	542.7	2576	65.66	24.61	90.27	43.01	24.53	12.556	0.592	1.659	8.683	3.994
105927	14.89	142.5	6.048	1.539	7.587	0.923	0.581	2.1824	0.014	0.083	0.268	0.19
105929	109.1	445.1	23.8	2.592	32.87	0.477	0.682	2.9559	0.114	0.41	2.729	0.699
105932	433.9	4716	54.44	20.69	75.13	2.248	5.46	7.4112	0.722	1.864	17.32	7.406
105938	126.9	831.4	61.93	15.09	77.03	14.05	7.729	23.834	0.059	0.691	0.146	0.93
105947	313.5	3362	43.6	15.78	59.38	2.801	4.485	7.3542	0.508	1.361	12.08	5.245
105950	232.8	2531	29	11.06	40.06	1.164	2.91	3.8796	0.388	0.999	9.311	3.977
105951	113.5	463	24.75	2.696	34.19	0.497	0.71	3.0746	0.118	0.426	2.838	0.727
105975	389.3	2631	47.54	17.93	65.47	21.37	13.42	8.1798	0.498	1.348	9.297	4.108
105976	83.2	339.3	18.14	1.976	25.05	0.364	0.52	2.2532	0.087	0.312	2.08	0.533
105985	588.6	6410	74.59	28.27	102.9	3.486	7.722	11.212	0.98	2.537	23.5	10.06
Minimum	2.3152	3.4768	1.7864	0.2122	2.2086	0.0365	0.0543	0.71468	0.0010	0.0035	0.0017	0.0013
Maximum	1958.4	13292	560.78	216.67	777.45	365.75	170.50	287.192	1.6378	13.946	39.141	21.927
Average	131.29	1012.1	43.238	11.582	55.783	13.004	7.1343	24.4172	0.1313	0.7472	2.3015	1.6117

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.

10.5 ADDITIONAL FEATURES AND UTILITIES

10.5.1 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 treatment level of service.

10.5.2 UTILITIES

The model has the capability to create a template for inputting BMP coverage information. Land uses can be reaggregated according to FLUCCS codes to have the required land use categories. After reaggregation, all identically numbered basins must be regrouped together, if they were separated from each other during the reaggregation process.

10.5.3 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

One of the latest tools to be applied to watershed management is the determination of a water quality treatment level of service (WQTLOS). Designating levels of service has been done routinely for years in such different areas as traffic volume or flood control, which water quality has rarely been a component of. 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 WQTLOS is that numerous parameters are measured. In this case, twelve different water quality elements are used. 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.

Total nitrogen will be used as the WQLOS standard for several reasons. This is one of the most difficult constituents 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 TBEP'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, these compounds should be removed on the subbasin level prior to reaching the Bay, rather than letting it impact the Bay and then trying to remove it. 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 primary reason that TSS has been chosen as the second parameter. Pathogens are not normally considered in LOS determinations and this would be one way to increase their removal.

11.2 WATER QUALITY TREATMENT LEVEL OF SERVICE DEFINITIONS

The WQLOS is determined by using the Pollutant Loading and Removal Model to compare a particular subbasin's existing net pollutant load against the non-treated pollutant load of the same subbasin, assuming that it has attained 100% coverage of single family low to medium density land use. 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 those subbasins with no treatment 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 East Lake Watershed subbasins is summarized in Exhibit 11-A. As can be seen from this information, the majority of the subbasins, for the majority of the parameters used, are at level of service D and F. The only exceptions to this pattern are those subbasins that are undeveloped or have low to medium single family residential land uses with adequate stormwater treatment.

For example, for the parameter of total Kjeldahl nitrogen, only one subbasin rated a LOS A, eight subbasins rated a LOS B, fourteen subbasins rated a LOS C, forty-four subbasins rated a LOS D and the remaining two hundred and twenty subbasins rated a LOS F. Total nitrogen is almost identical, with one less LOS B and two more LOS C ratings. This means that around 97% of the subbasins did not meet or exceed the benchmark LOS for the pollutants total Kjeldahl nitrogen and total nitrogen. On the other end of the scale, total dissolved phosphorus probably had the best overall LOS rating with around 73% of the subbasins not achieving LOS A or B. This translates to twenty-five subbasins meeting LOS A, fifty-one subbasins having LOS B, thirty-four achieving LOS C, sixty-three at LOS D and the remaining 114 subbasins at LOS F.

Only one subbasin achieved LOS A across the board. This subbasin is composed of 100% natural systems, being made up of hardwood conifer mixed wetlands and freshwater marsh. Only six subbasins had LOSs that did not include a LOS D or F. These subbasins turn out to be a combination of open lands, wetlands, low and medium density residential and if commercial land use was present, it was only a small percentage of the subbasins and received 100% stormwater treatment.

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 "benchmark". Because of this, it will be extremely difficult for any basin with non-residential land uses to achieve a high LOS without the incorporation of extra or extraordinary stormwater treatment system(s). Additionally, the low to medium density residential land use generally had the lowest EMCs values, and with the exception of agriculture, all other land uses tend to have greater amounts of impervious area. The model consistently showed, as would be expected, that the land uses with a larger percentage of impervious area yielded greater pollutant loads. Again, 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.

Due to time constraints and staffing problems, public meetings were not able to be held in the manner which had initially been planned. However, at least one and most likely two meetings will be held in the future for this watershed.

ALTERNATIVES ANALYSIS

13.1 OVERVIEW

This chapter will review the proposed flood control and water quality projects and one or more alternatives for each of those projects. These projects are meant to provide the citizens of Hillsborough County with a reasonable level of service for both flood control and water quality. The alternatives are explored to see which, if any, of them can provide this expected level of service, generally at a reasonable cost. Therefore, each project should be designed to serve multiple functions in terms of flood control and increasing water quality and, if possible, wildlife habitat. Components used for the environmental portion of this review are broken down into three broad categories. The first component looked at is water quality, which can be further subdivided into the categories of pollutant loading, pathogen loading and erosion and sedimentation. The second factor is natural systems. Aspects of this component include habitat loss, minimum flows and levels (water regime), aquatic ecosystems, and exotic vegetation. Finally, water supply is looked at in terms of stressed lakes or wetlands, potable water quality, surface water yield and groundwater discharge.

13.2 FLOOD CONTROL ALTERNATIVES

Major flooding problem areas during the past are shown in Figure 13-1. Since 1992, many projects have been carried out to solve these problems. Table 13.1 lists all the completed projects since 1992. The under construction projects are also listed in this table. These projects are also shown in Figure 13-1. All these improvements have been included in the model. Some problem areas, therefore, disappear in the model results. Problem areas will be presented and discussed in the order of major conveyance systems within the study area as presented in previous chapters 3 and 6. These alternatives analysis and discussion include:

13.2.1 Harney Prairie Outfall
13.2.2 I-4 Outfall
13.2.3 Fairgrounds Outfall - North System
13.2.4 East Lake Outfall
13.2.5 Orient Park Outfall
13.2.6 Judson Creek/Grant Park Outfall
13.2.7 Fairgrounds Outfall - South System
13.2.8 Hillsborough/Harney System
13.2.9 East Lake Mall - North System
13.2.10 East Lake Mall - South System
13.2.11 50th/56th Street System
13.2.12 Mary Help System

Figure 13-1 Not Available at Time of Posting.

Table 13.1

Completed and Under Construction Projects

Project ID.	Project Name	System	Design Date	Completed Date	Comments
CIP45402	Comanche & Staley Phase II	Harney Prairie Outfall	7-92	7-93	
CIP40931	Harney Road Outfall	I-4 Outfall	7-93	8-97	
CIP41029	Boran Pond Phase II	East Lake Outfall	8-94	5-95	
CIP40933	King Forest Phase I, II	East Lake Outfall	12-96	8-98	
CIP40962	King Forest Phase III	East Lake Outfall	8-98	10-99	

Existing Conditions profiles for each discussion area is contained in Chapter 6. Potential problem area locations identified in the alternative analysis for the 25-year design event are contained in the Existing Condition Level of Service Analysis, Chapter 6.

The following criteria were used to evaluate the feasibility of each of the proposed projects:

Only model predicts potential flooding area with known (observed or documented) problem areas will be considered for proposed improvement. Improvements for potential road overtopping and structural flooding along minor secondary conveyance systems are not included and recommended in this study.

Projects are only proposed for problem areas within the County right-of-way. However, a second benefit may be utilized by private or commercial developments adjacent to County right-of-way for the recommended improvements to benefit the drainage system within County right-of-way.

Potential problem area elevations were identified by the most current Southwest Florida Water Management District (SWFWMD) aerial photography with one foot contours and available construction plan or as-built plan. Road elevations were estimated by comparing the corresponding contours or spot elevations. Structure elevations were estimated by adding one (1) foot to adjacent contour lines or spot elevations. Survey data were also available at limited locations in the watershed. Target 25-year computed peak water surface elevation for proposed condition is intended to prevent the road from overtopping along major conveyance system.

Computed water surface elevations for the proposed conditions shall not have adverse impacts to the existing conditions for the 25-year and 100-year events on both upstream and downstream of the proposed project. Both environmental and water quality impacts were considered in developing alternative solution scenarios.

13.2.1 HARNEY PRAIRIE OUTFALL

The computed 25-year water surface elevations for the Harney Prairie Outfall from Harney Road to the confluence of Tampa By-Pass Canal indicate no restricted flow along the system and has minimal head loss through conveyance system which will not cause flooding. The existing condition model projects that a series of structures will not overflow or overtop. Since historical flooding were not reported for this system, improvements will not be necessary.

13.2.2 I-4 OUTFALL

Major storm water management problems are not expected within the I-4 Outfall system for the storms analyzed both in existing condition and FDOT permitted condition. The FDOT proposed improvements will eliminate the reported flooding in Maple Lane located at Northeast corner of I-4 & US 301 intersection. Therefore, no alternatives were evaluated for this system.

13.2.3 FAIRGROUNDS OUTFALL - NORTH SYSTEM

Major storm water management problems are not expected within the Fairgrounds Outfall-North System for the storms analyzed, except for some projected internal flooding within the Fairgrounds property. However, this internal flooding of the private property does not appear to cause any offsite adverse impacts. Therefore, no alternatives were evaluated for this situation. However, there are problems at the Fairgrounds- South System at the interconnection of the System to the Kings Forest. Overtopping of Chelsea Avenue and the discharge of flows into the Kings Forest neighborhood dictated that an evaluation be done to address the observed problem. However, it should be noted that using Forest Phase I & II have been completed and Phase III channel improvements and stabilization is under construction for major improvements. The major problem for this system is high tail water elevation at downstream of East Lake Outfall Channel, which will be addressed in this Chapter later. These improvements will alleviate the flooding problems.

13.2.4 EAST LAKE OUTFALL

The 25-year design event computed water surface elevations for the East Lake Outfall System indicate high stages at King Forest Subdivision with potential flooding and overtopping of M.L. King Boulevard. The Kings Forest Subdivision will experience flooding of internal roadways and possible structures during the 100-year/24-hour and 25-year/24-hour design storm events. It should be noted that Kings Forest Phase III and several areas within the East Lake Outfall system are under construction for major improvements. In addition, the watershed master plan is mainly concentrated on the major conveyance system with large sub-basin delineation and will not address the localized flooding situation. The improvements will alleviate the flooding problems as reported on Figure 13-1.

The alternative evaluation for private road bottleneck crossing at 300 feet downstream of M.L. King Boulevard is as follows:

13.2.4.1 Alternative 1 (Figure 13-2a)

Upgrade existing 2-42” CMPs located approximately 300 feet downstream of M.L. King Boulevard to 2-48” HDPE round pipes.

13.2.4.2 Alternative 2 (Figure 13-2b)

Upgrade existing 2-42” CMPs located approximately 300 feet downstream of M.L. King Boulevard to 2-54” RCP.

13.2.4.3 Alternative 3 (Figure 13-2c)

Add an extra 42” CMP to the existing 2-42” CMPs located approximately 300 feet downstream of M.L. King Boulevard.

All the computed results of the three alternatives are compared to existing conditions and presented in Table 13.2. Figures 13-3a and 13-3b show the maximum water level profiles of all three alternatives compared with existing conditions for 25-year and 100-year events, respectively. As shown in Fig. 13-2, all three alternatives can gain significant water level drop from the “Bottleneck” up to Chelsea Avenue. Among them, alternative 2 gains most and alternative 3 gains least. There is no overtopping downstream of “Bottleneck” to the end of the system for all three alternatives. However, for 100-year event, as shown in Fig. 13-3, Danny Bryan Blvd will be flooded for all three alternatives, compared with existing condition, in which there is no flooding problem.

13.2.5 ORIENT PARK OUTFALL

The 25-year design event computed water surface elevations for the Orient Park Outfall System indicate high stages with potential flooding at several areas. The road crossings to be overtopped are 75th Street, Missouri Avenue and Orient Road. The profile identifies the potential for significant overtopping depths at these road crossings for the 25- and 100-year design storm events. Top of road elevations is based on Hillsborough County survey data for these crossings. Some street flooding may also occur in the vicinity of these crossings within the sub-watershed. The watershed master plan is concentrated on the major conveyance system with large sub-basin delineation and will not address the localized flooding situation.

Insert Figure 13-2a, East Lake Outfall Improvement 1

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FIGURE 13-2B

EAST LAKE OUTFALL
IMPROVEMENT 2

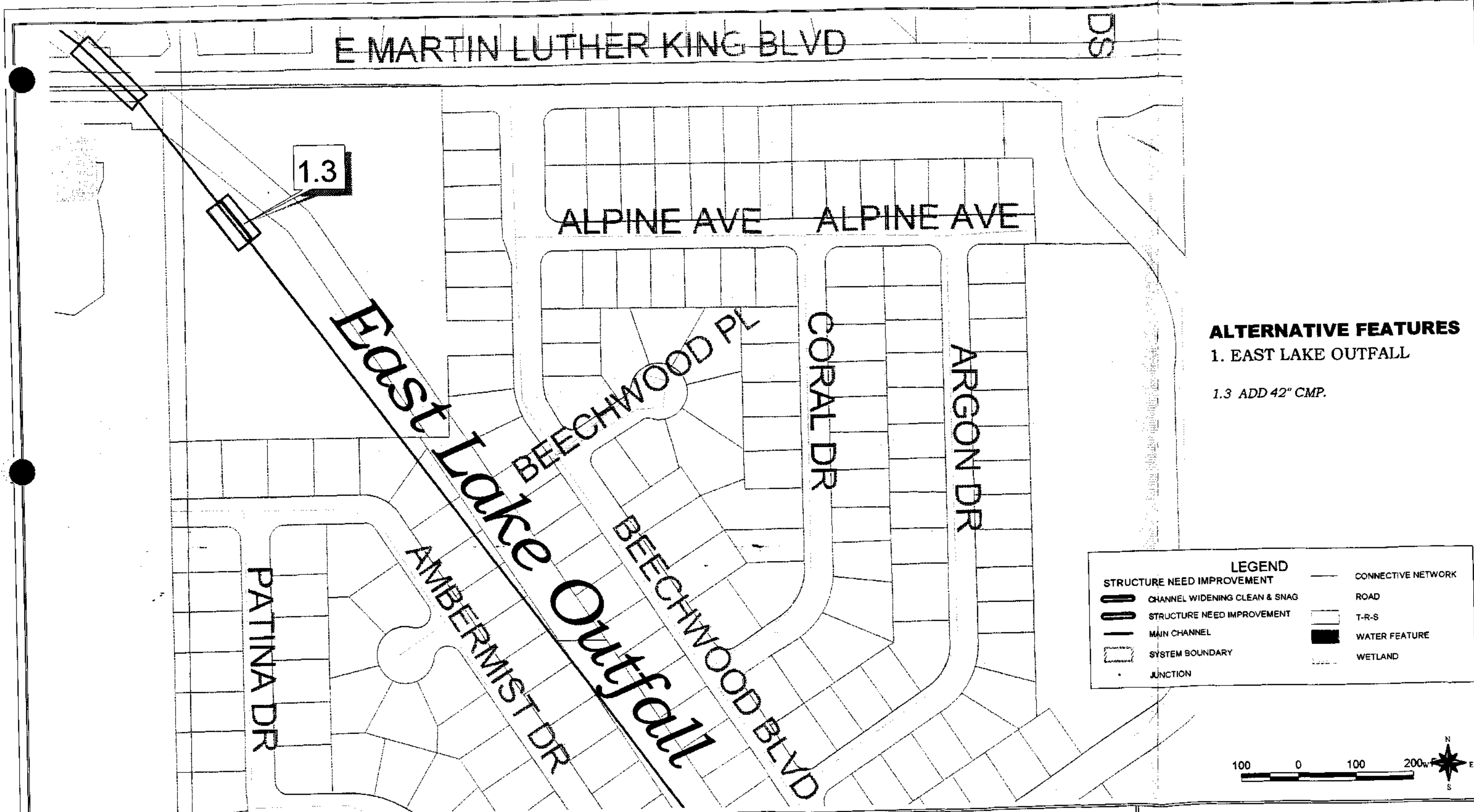

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FIGURE 13-2C

EAST LAKE OUTFALL
IMPROVEMENT 3

Table 13.2

EAST LAKE OUTFALL("BOTTLENECK") IMPROVEMENTS
ALTERNATIVE ANALYSIS

25-YEAR 24-HOUR STORM EVENT(STAGES)

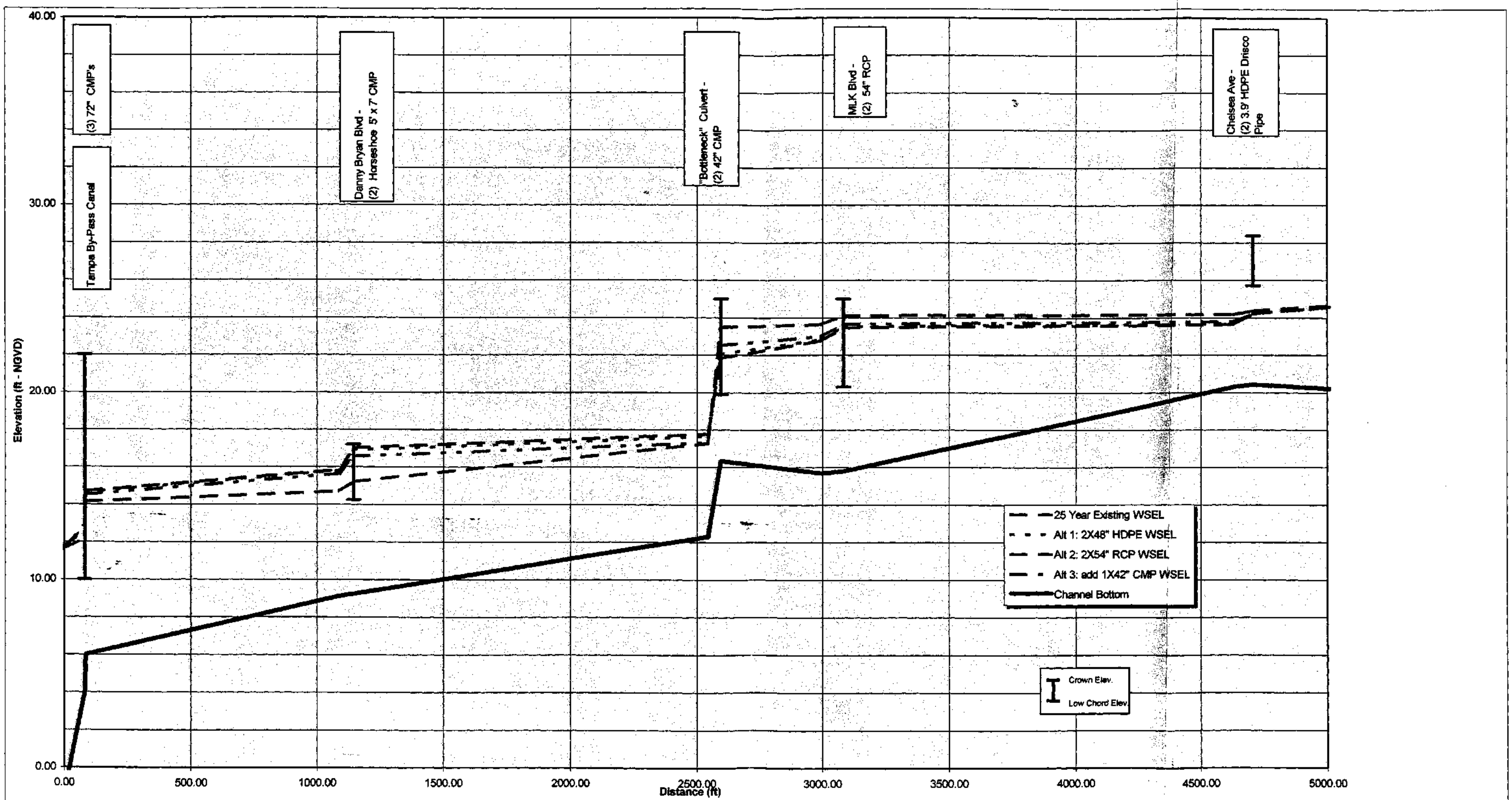
		SCENARIO				COMPARISON		
LOCATION	JUNCTION	A	B	C	D	B-A	C-A	D-A
"BOTTLENECK"	102025	23.66	22.06	21.82	22.52	-1.6	-1.84	-1.14
CHELSEA	102035	24.18	23.69	23.65	23.80	-0.49	-0.53	-0.38
DANNY BRYAN BLVD	102010	14.71	15.81	15.85	15.64	1.10	1.14	0.93

100-YEAR 24-HOUR STORM EVENT(STAGES)

		SCENARIO				COMPARISON		
LOCATION	JUNCTION	A	B	C	D	B-A	C-A	D-A
"BOTTLENECK"	102025	24.80	23.34	22.86	23.73	-1.46	-1.94	-1.07
CHELSEA	102035	25.29	25.00	24.93	25.08	-0.29	-0.36	-0.21
DANNY BRYAN BLVD	102010	16.34	16.73	16.93	16.53	0.39	0.59	0.19

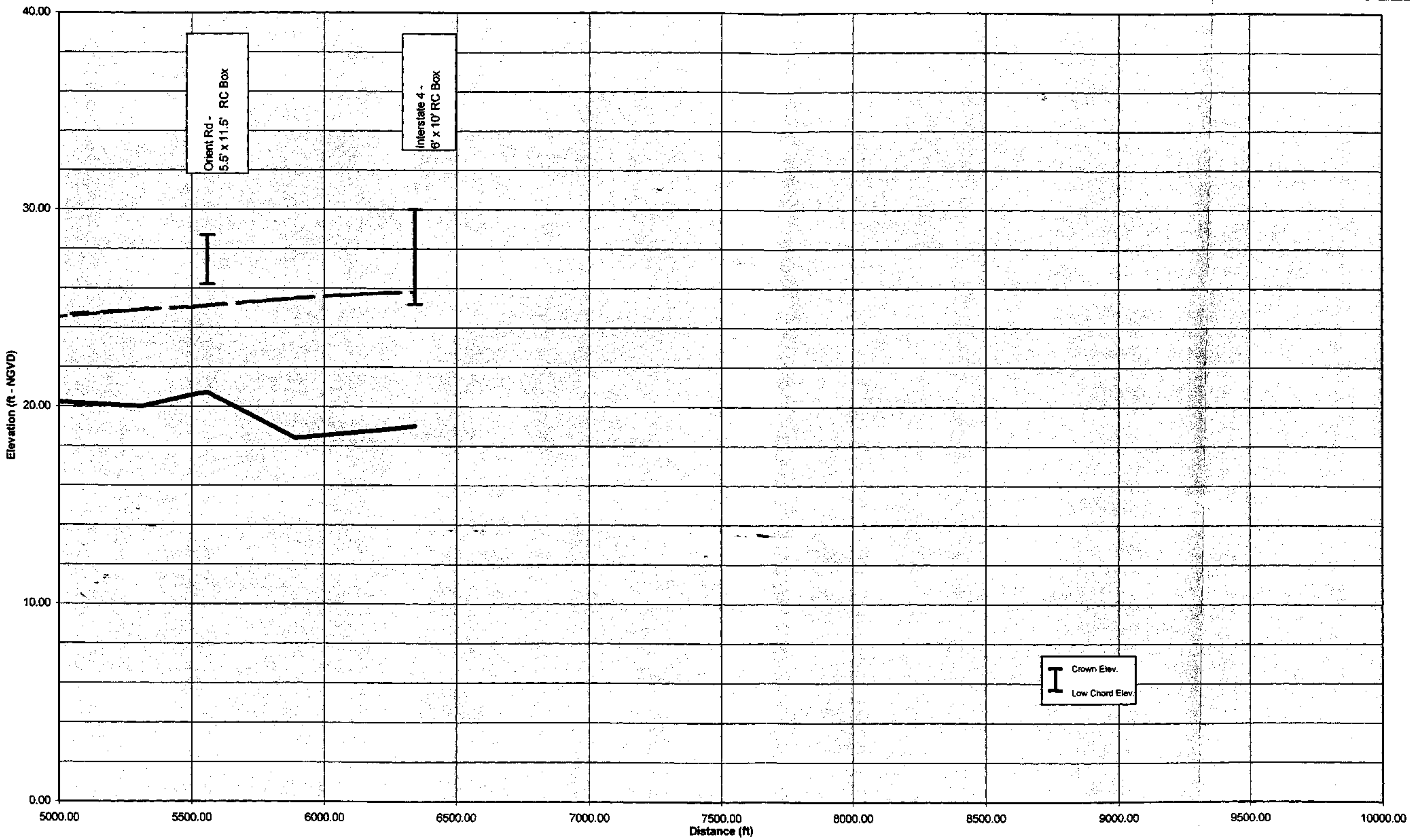
SCENARIO

A = EXISTING CONDITION (2-42" RCP)
B = ALTERNATIVE 1 – PROPOSED 2-48" HDPE
C = ALTERNATIVE 2 – PROPOSED 2-54" RCP
D = ALTERNATIVE 3 – PROPOSED 1 ADDITIONAL 42" CMP

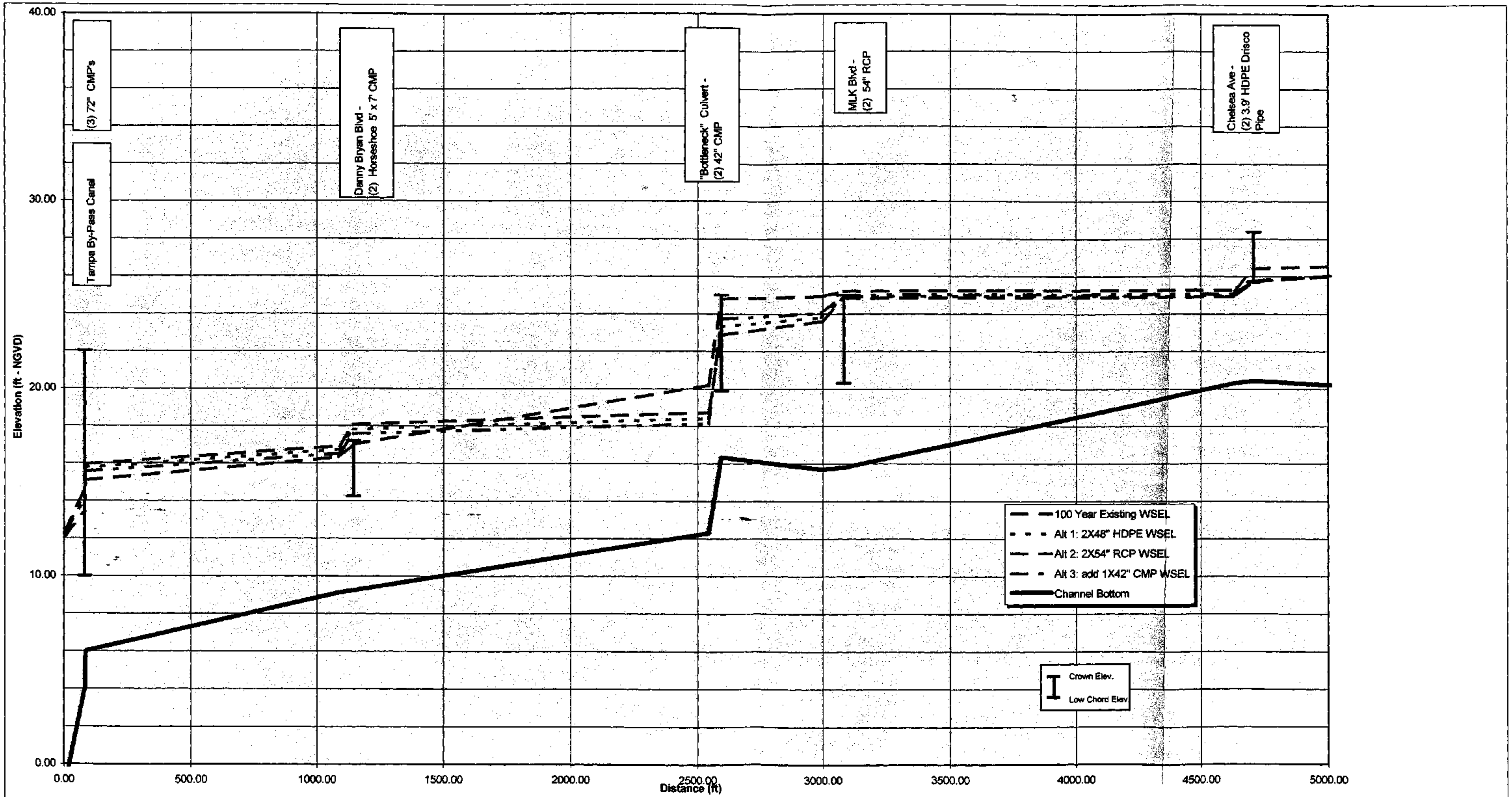


East Lake Area
Computed Water Surface Profiles
(September 1999)

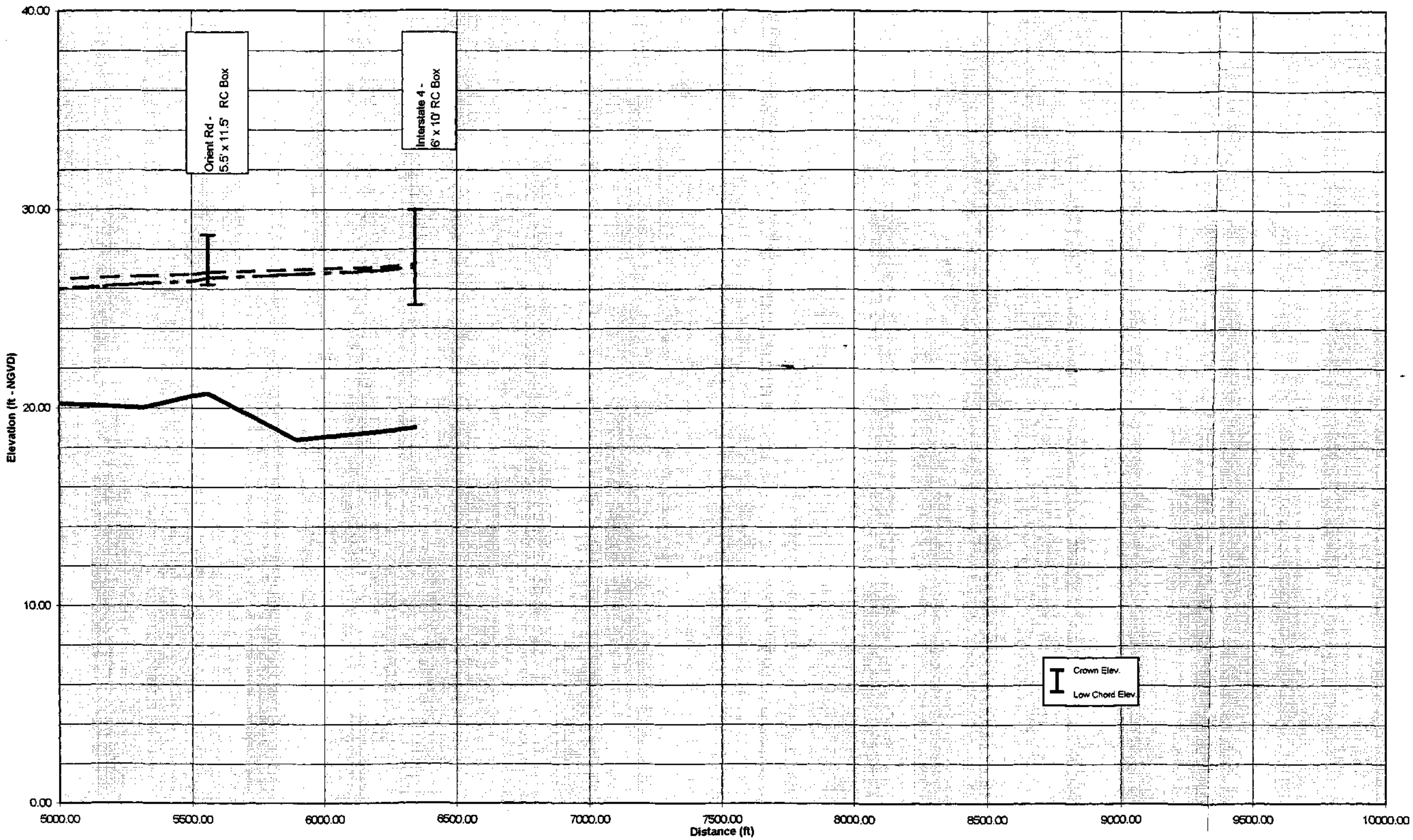
Figure 13-3a East Lake Outfall
Comparison of Water Levels Among Different Alternatives
Sheet 1 of 2



East Lake Area	Figure 13-3a East Lake Outfall
Computed Water Surface Profiles (September 1999)	Comparison of Water Levels Among Different Alternatives Sheet 1 of 2



East Lake Area Computed Water Surface Profiles (September 1999)	**Figure 13-3b East Lake Outfall** Comparison of Water Levels Among Different Alternatives Sheet 1 of 2



East Lake Area
Computed Water Surface Profiles
(September 1999)

Figure 13-3b East Lake Outfall
Comparison of Water Levels Among Different Alternatives
Sheet 1 of 2

Originally, County's Community Development Block Grant Program (CDBG) finalized construction plans for a combined water system and roadway pavement for the downstream of Orient Outfall from Orient Road. CDBG had proposed culvert sizes for roadway crossings east of Orient Road at Missouri Avenue, 75th Street and 76th Street to be 4'x 8' concrete box culvert (CBC) at each of the roadway crossings mentioned and including Orient Road. The analysis included the following:

Only CDBG box culverts added
Only storm water improvements culvert added
Contributing area to Orient Road reduced
CDBG box culverts and storm water improvements culvert added
CDBG box culverts added and contributing area reduced

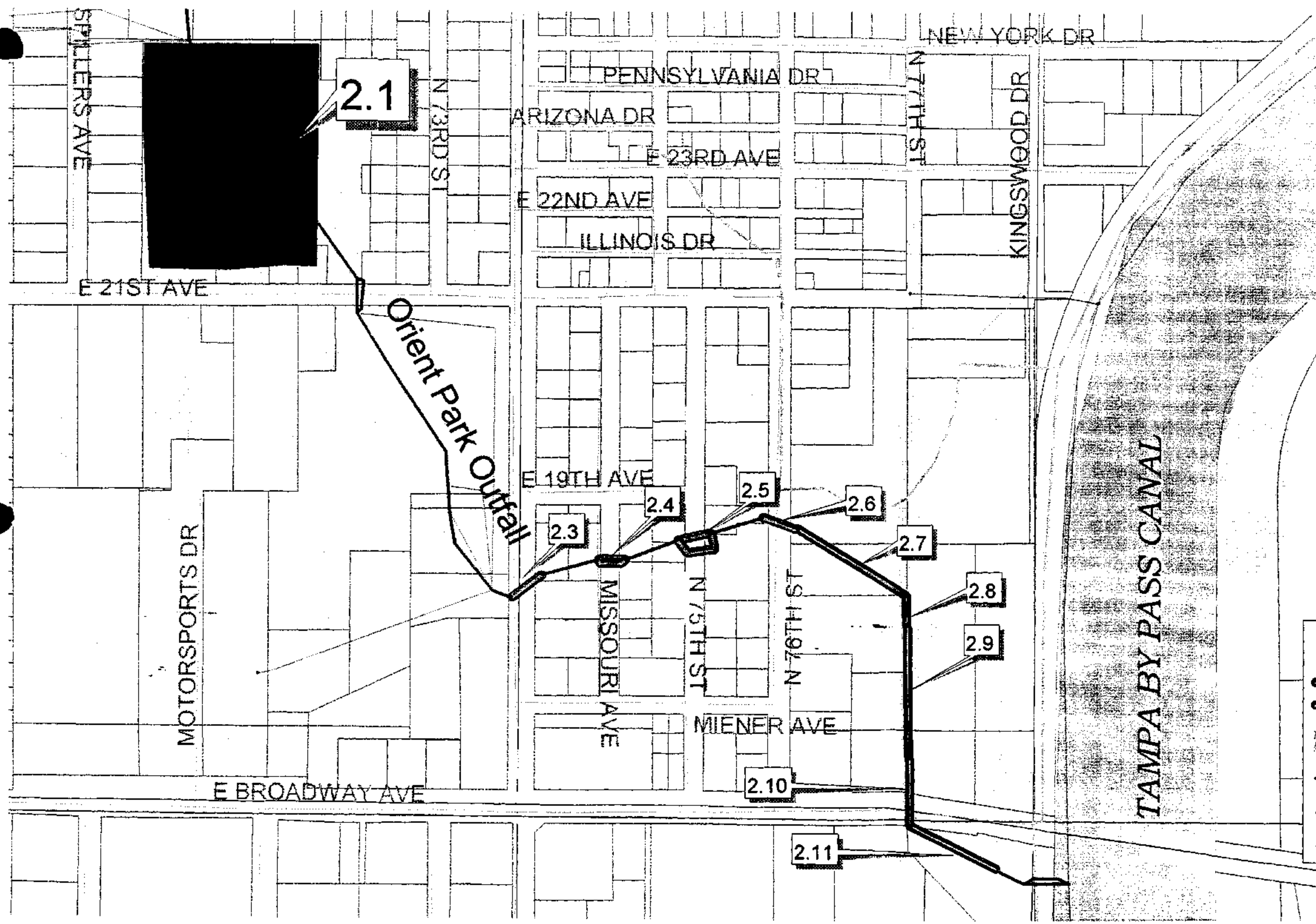
In current study, the alternatives are evaluated and summarized as follows:

13.2.5.1 Alternative 1 (Figure 13-4a)

A. Channel improvements are recommended at two segments located east of 76th Street and south of E. Broadway Avenue along the Orient Park Outfall channel. The improvements to both segments of the Orient Park Outfall channel will consist of widening, clearing and snagging. The first channel improvement will extend from 76th Street to a point located 650 feet north of E. Broadway Avenue. The second channel improvement will extend from south of E. Broadway Avenue to a point located 80 feet west of the Tampa Bypass Canal south of Broadway Avenue outfall pipes to reduce the channel roughness coefficient. Please notice ha the roughness is justified based on engineering experience and can be found in U.S. Geological Survey publication: Determination of Roughness Coefficients for Streams in West-Central Florida. The outfall pipes of the second channel improvement are located on the right channel bank of the Tampa Bypass Canal.

B. Upgrade existing pipes located 400 feet east of 76th Street and perpendicular to Broadway Avenue. There are three existing RCP diameter pipes with sizes of 54, 66 and 72 inches. These pipes will be upgraded to 90", 84" and 78" reinforced concrete pipes. The proposed pipes will alleviate the flooding problems for the Orient Park Outfall system.

C. A six (6) acres detention pond is proposed which is located north of E. Broadway Avenue with a control structure. This pond will detain the runoff from the tributary located west of Orient Road and Motor-sports Drive.



ALTERNATIVE FEATURES

2. ORIENT PARK OUTFALL

2.1 PROPOSED 6.0 ACRES POND NORTH OF 21ST STREET.
2.3 UPGRADE THE EILLPTICAL PIPE TO 4' X 8' BOX CULVERT @ ORIENT ROAD.
2.4 UPGRADE 2 X 36" RCP TO A 4' X 8' BOX CULVERT @ MISSOURI STREET.
2.5 UPGRADE 2 X 36" RCP TO A 4' X 8' BOX CULVERT @ 75TH STREET.
2.6 UPGRADE THE EILLPTICAL PIPE TO A 4' X 8' BOX CULVERT @ 76TH STREET.
2.7 WIDEN, CLEAN AND SNAG 400' CHANNEL D/S FROM 76TH STREET.
2.8 UPGRADE THE 66" RCP TO 78" RCP.
2.9 UPGRADE THE 72" RCP TO 84" RCP.
2.10 UPGRADE THE 54" RCP TO 90" RCP.
2.11 WIDEN, CLEAN AND SNAG 400' CHANNEL D/S FROM E.BROADWAY AVE.

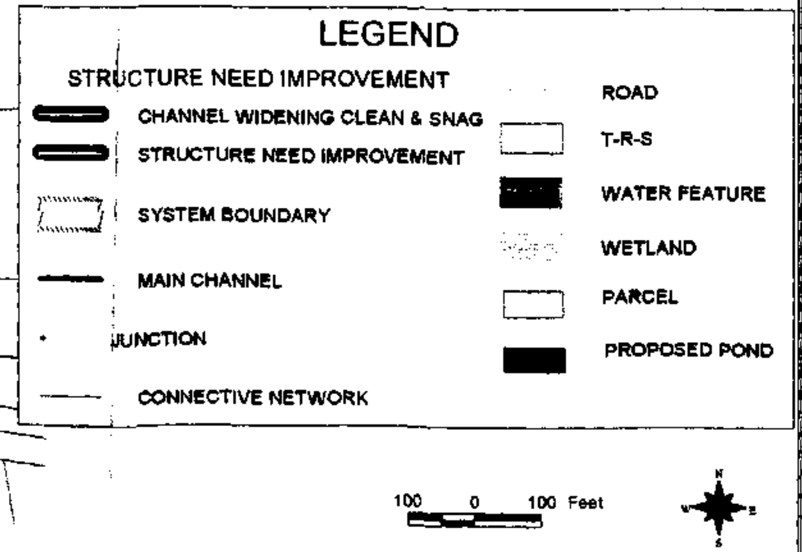


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FIGURE 13-4A

ORIENT PARK OUTFALL
IMPROVEMENT 1

13.2.5.2 **Alternative 2** (Figure 13-4b)

A & B. is the same as Alternative 1 A. & B.

C. A six (6) acre detention pond is proposed which is located at north of 21st Street with a control structure. This pond will detain the runoff from upstream of Rhode Island Drive and Vermont Drive to the further upstream Business Park.

13.2.5.3 **Alternative 3** (Figure 13-4c)

A. Two (2) - six (6) acre detention ponds located north of 21st Street and north of E. Broadway Avenue both with control structures are proposed. The first pond located at 21st Street pond will collect runoff upstream of Rhode Island Drive and Vermont Drive of the Orient Park Outfall channel while the second pond will collect runoff upstream of Motorsports Drive and N. 71st Street for the tributary of Orient Park Outfall. These ponds will function similar to the Alternatives 1 & 2 to alleviate the flooding problems experienced in the downstream of Orient Park Outfall.

The results of these three scenarios with 25-year/24-hour and 100-year/24-hour design storm events are presented in Table 13.3. Figures 13-5a and 13-5b show the maximum water level profiles of all three alternatives compared with existing conditions for 25-year and 100-year events, respectively. Based on model simulation, as shown in Fig. 13-5a, the existing cross-drains at 76th Street, 75th Street, Missouri Street and Orient Road cause head losses ranging from 0.35 to 1.22 in 25-year storm events. As shown Fig. 13-5b, the structure upgrades will completely eliminate the minor head loss within the cross-drains. All three alternatives will effectively eliminate the flooding problems in 75th Street, Missouri Avenue, and Orient Road areas. Channel widening, clearing and snagging will more effectively reduce the water surface elevation along the Orient Park Outfall channel around the upstream/downstream of Orient Road. The addition of the 6.0-acre detention pond shall be sufficient to prevent existing Rhode Island Drive and Vermont Drive from overtopping during the 25-year storm event.

13.2.6 JUDSON CREEK/GRANT PARK OUTFALL

In the Grant Park area, the natural depression storm water storage areas are projected to collect storm water runoff to the depths where overflow occurs and causes street and apparent structural flooding.

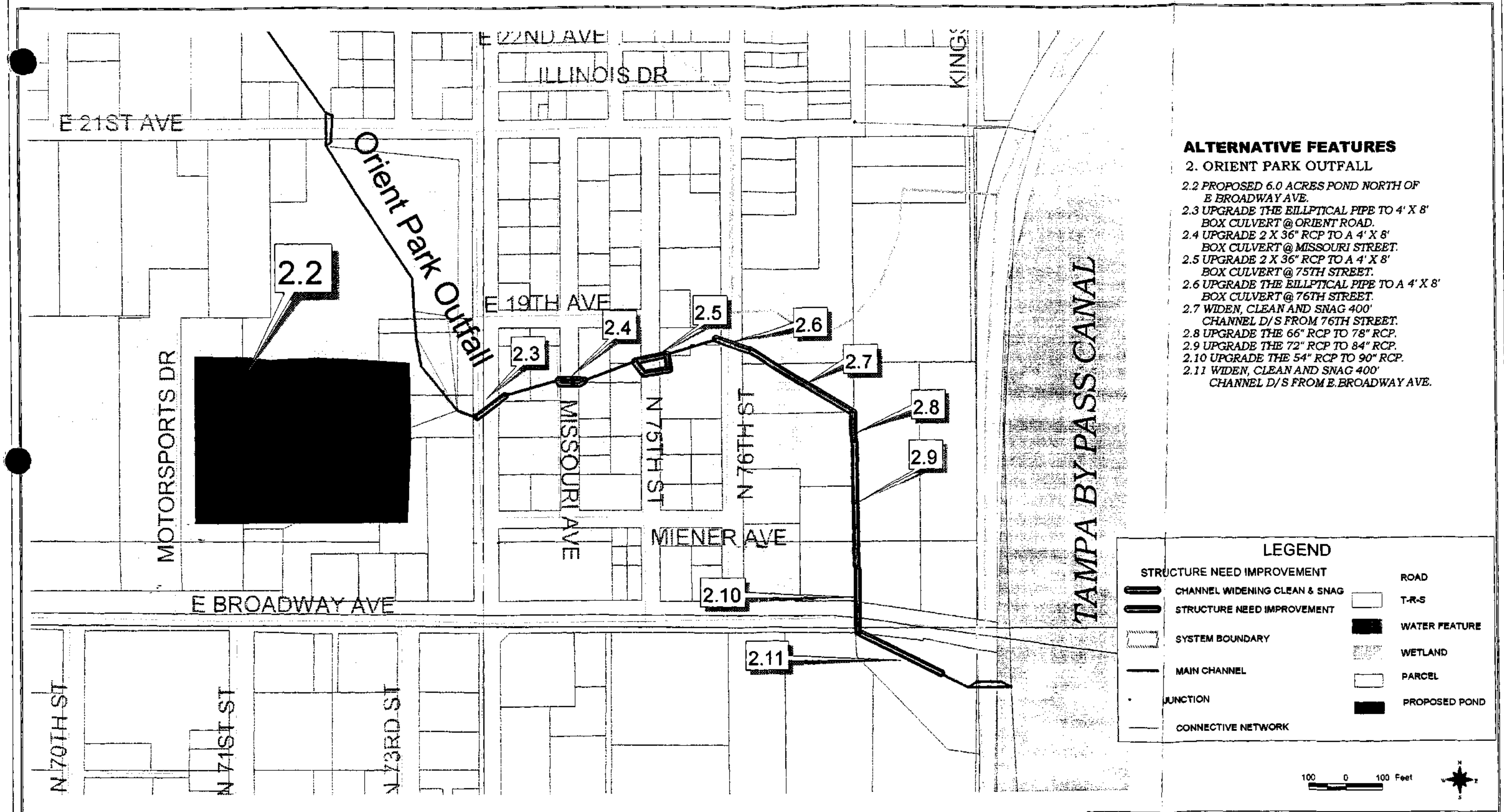

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FIGURE 13-4B

ORIENT PARK OUTFALL
IMPROVEMENT 2

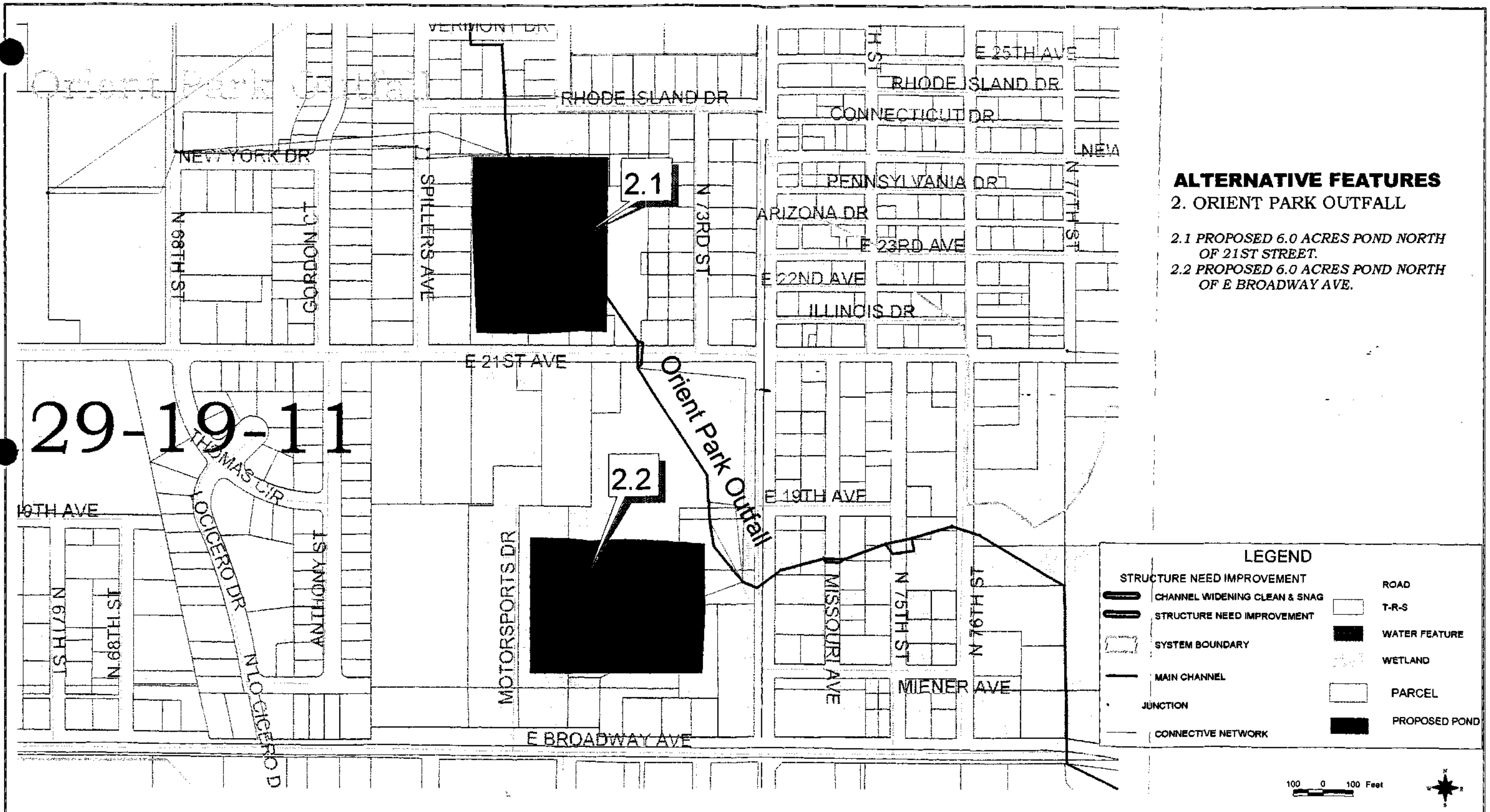

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FIGURE 13-4C

ORIENT PARK OUTFALL
IMPROVEMENT 3

Table 13.3

ORIENT PARK OUTFALL IMPROVEMENTS
ALTERNATIVE ANALYSIS

25-YEAR 24-HOUR STORM EVENT(STAGES)

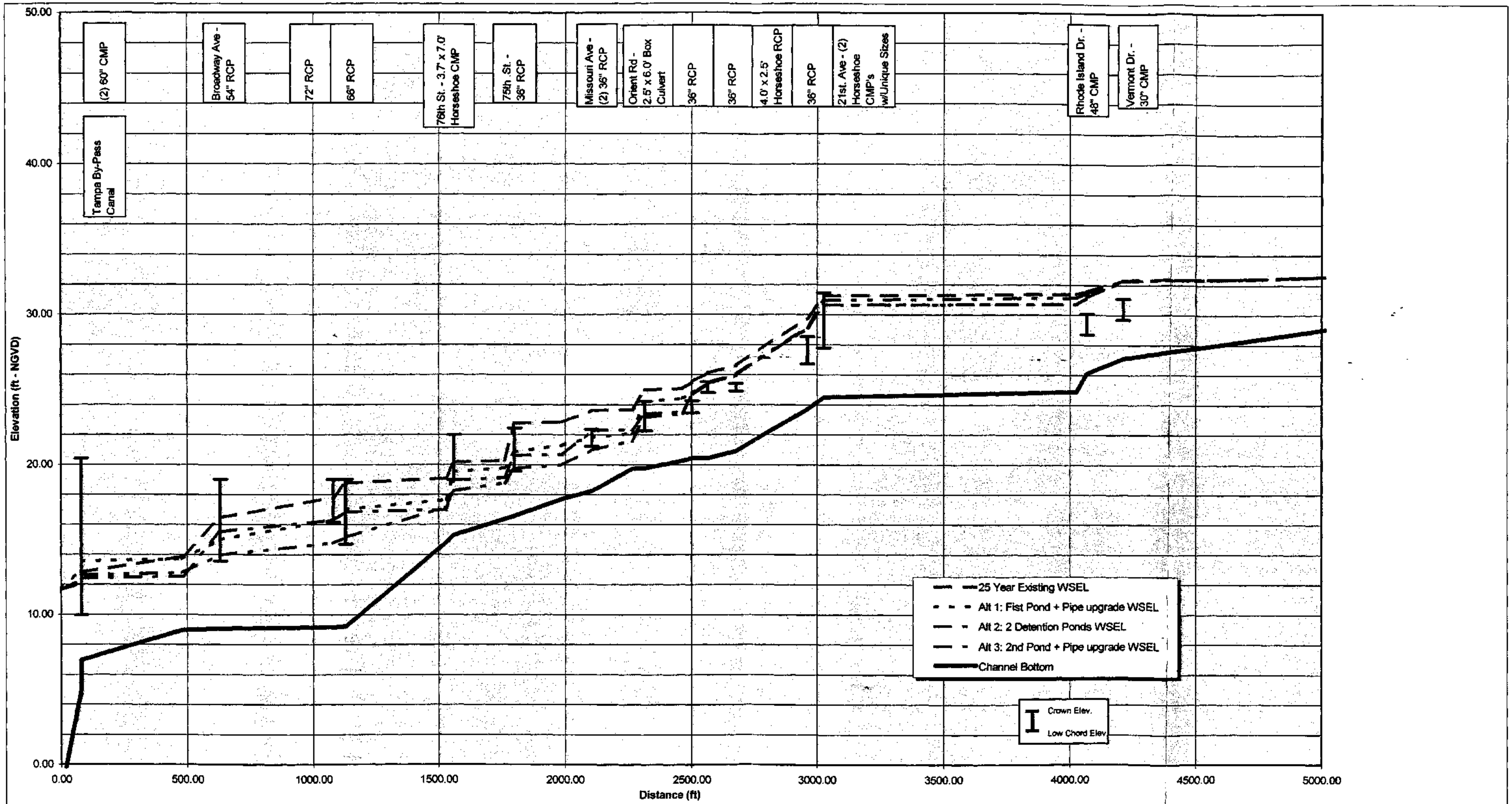
		SCENARIO				COMPARISON		
LOCATION	JUNCTION	A	B	C	D	B-A	C-A	D-A
75 St.	101050	22.8	20.85	20.61	19.74	-1.95	-2.19	-3.06
Missouri Ave.	101055	23.8	21.31	20.69	20.02	-2.49	-3.11	-3.78
Orient Rd.	101065	25.0	22.08	22.34	21.60	-2.92	-2.66	-3.4

100-YEAR 24-HOUR STORM EVENT(STAGES)

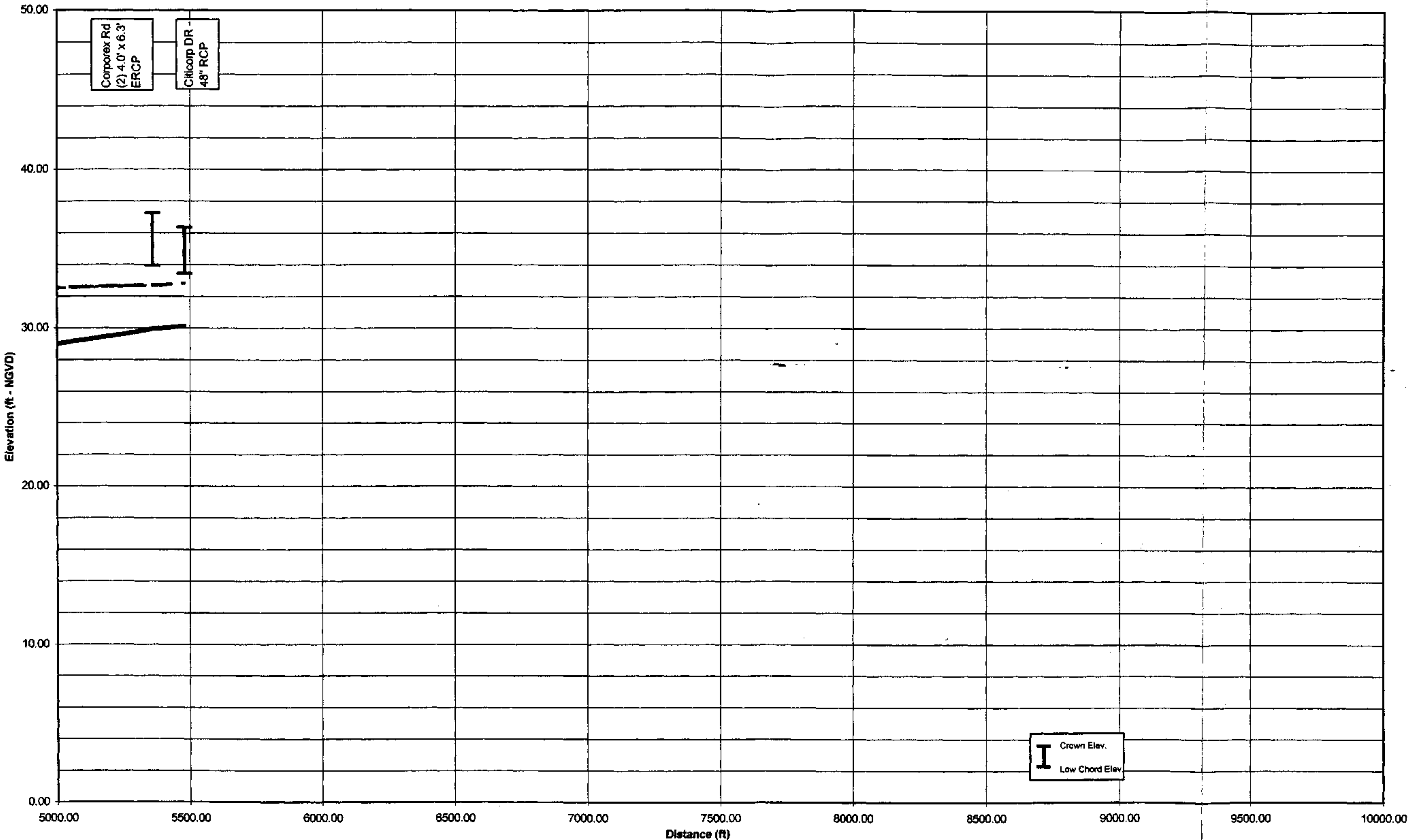
		SCENARIO				COMPARISON		
LOCATION	JUNCTION	A	B	C	D	B-A	C-A	D-A
75 St.	101050	24.4	22.1	22.26	20.68	-2.3	-2.14	-3.72
Missouri Ave.	101055	24.8	23.4	22.29	20.86	-1.4	-2.51	-3.94
Orient Rd.	101065	25.8	24.8	23.42	22.03	-1.0	-2.38	-3.77

SCENARIO

A = EXISTING CONDITION
B = ALTERNATIVE 1 – ADD ONE DETENTION POND BETWEEN 21st AVE and NEW YORK DR.; UPGRADE STRUCTURES & IMPROVE CHANNELS STARTING FROM 75TH STREET TO END OF THE SYSTEM
C = ALTERNATIVE 2 – PROPOSED DETENTION PONDS NEAR MOTORSPORTS DR. AND 21ST AVE.
D = ALTERNATIVE 3 – ADD ONE DETENTION POND NEAR MOTORSPORTS DR, IMPROVE CHANNELS, AND UPGRADE PIPES LIKE ALTERNATIVE 1

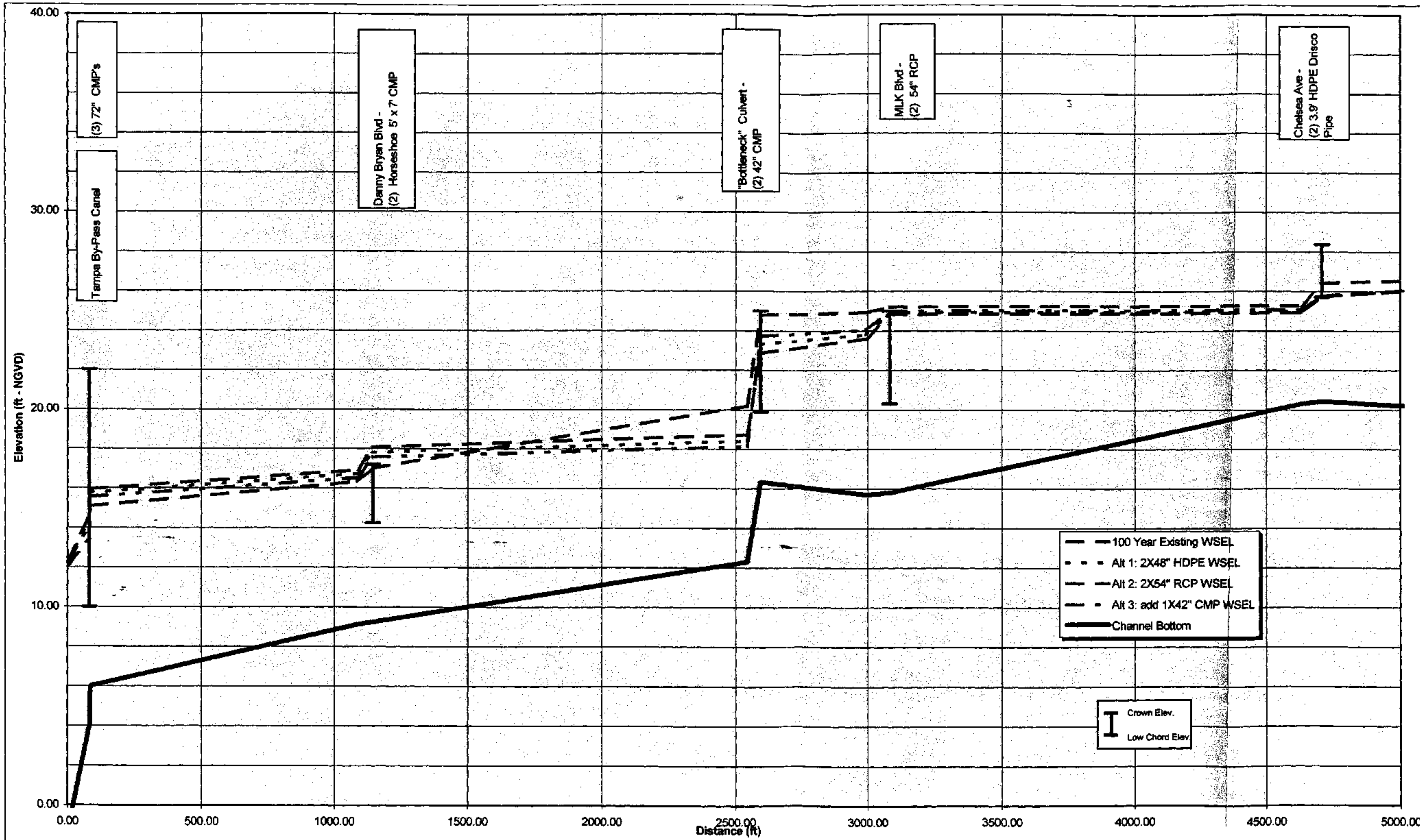


East Lake Area Computed Water Surface Profiles (September 1999)	**Figure 13-5a Orient Park Outfall** Comparison of Water Levels among Different Alternatives Sheet 1 of 2



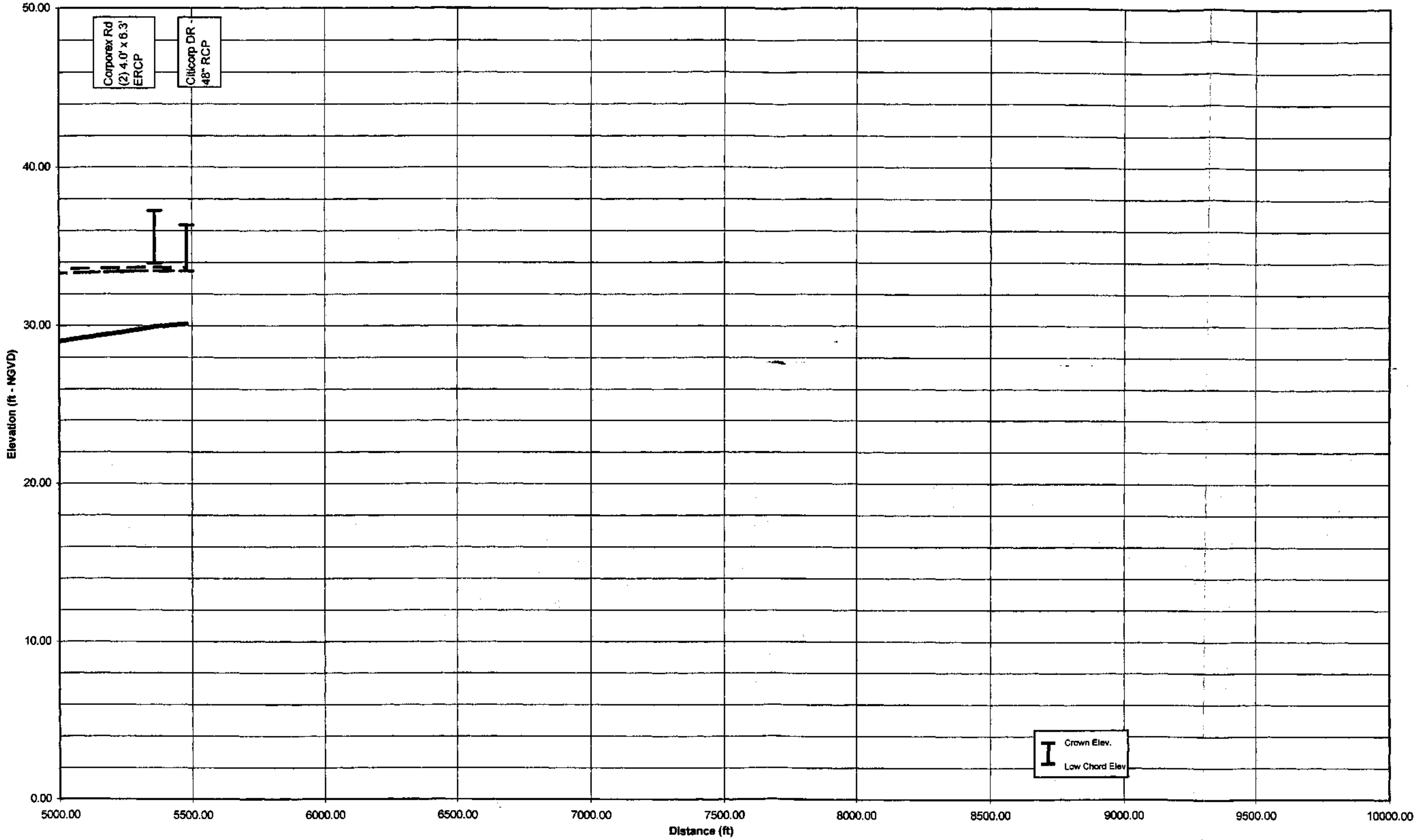
East Lake Area
Computed Water Surface Profiles
(September 1999)

Figure 13-5a Orient Park Outfall
Proposed Conditions Model
Sheet 2 of 2



East Lake Area
Computed Water Surface Profiles
(September 1999)

Figure 13-3b East Lake Outfall
Comparison of Water Levels Among Different Alternatives
Sheet 1 of 2



East Lake Area	Figure 13-5b Orient Park Outfall
Computed Water Surface Profiles	Proposed Conditions Model
(September 1999)	Sheet 2 of 2

In the master plan, a detailed inner storm sewer system design will not be taken into consideration. However, the alternatives will be evaluated and provided for future construction design.

13.2.6.1 Alternative 1 (Figure 13-6a)

Alternative 1 was developed to address the level of service problems in Grant Park by upgrading the existing culverts of Terra Ceia Drive to connect with the FDOT new system parallel to I-4. Both the existing 24 inch culverts of Terra Ceia Drive and the existing 18 inch RCP connected to Terra Ceia Drive (west of I-4) will be replaced with 36 inch culverts. The results of the above evaluation indicated sufficient reduction of flooding should be achievable without causing adverse impacts to other areas.

13.2.6.2 Alternative 2 (Figure 13-6b)

Addition of a 24-inch culvert parallel to the existing 24” RCP of Terra Ceia Drive to connect with the FDOT I-4 system. The results of the above evaluation indicated sufficient reduction of flooding should be achievable without causing adverse impacts to other areas.

13.2.6.3 Alternative 3 (Figure 13-6c)

Upgrading the existing Terra Ceia Drive to connect with the FDOT new system parallel to I-4. Both the existing 24-inch culvert of Terra Ceia Drive and the existing 18-inch RCP connected to Terra Ceia Drive (west of I-4) will be replaced with 30-inch culverts. The results of the above evaluation indicated sufficient reduction of flooding should be achievable without causing adverse impacts to other areas.

Please notice, all three alternatives will require a proposed 2.5 acres detention in the subbasin 101655 to handle the subbasin overtopping flow from subbasins 101665, 101660, and 101655 located south of ML King Boulevard and flow to subbasin 101645 where Terra Ceia Drive is located.

All the computed results of the three alternatives are compared to existing conditions and presented in Table 13.4. Figures 13-7a and 13-7b show the maximum water level profiles of all

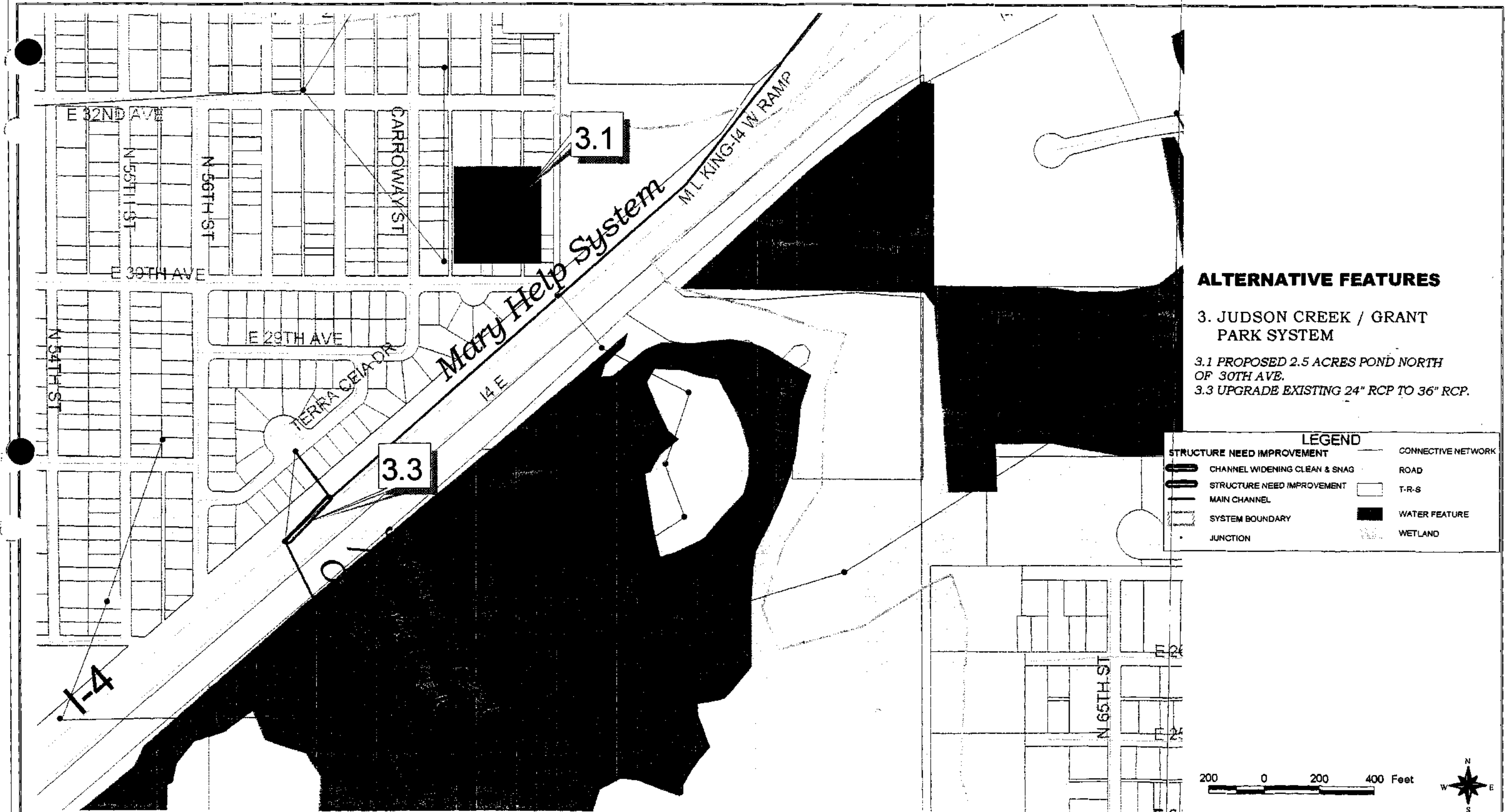


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FIGURE 13-6A

JUDSON CREEK/GRANT PARK SYSTEM
IMPROVEMENT 1

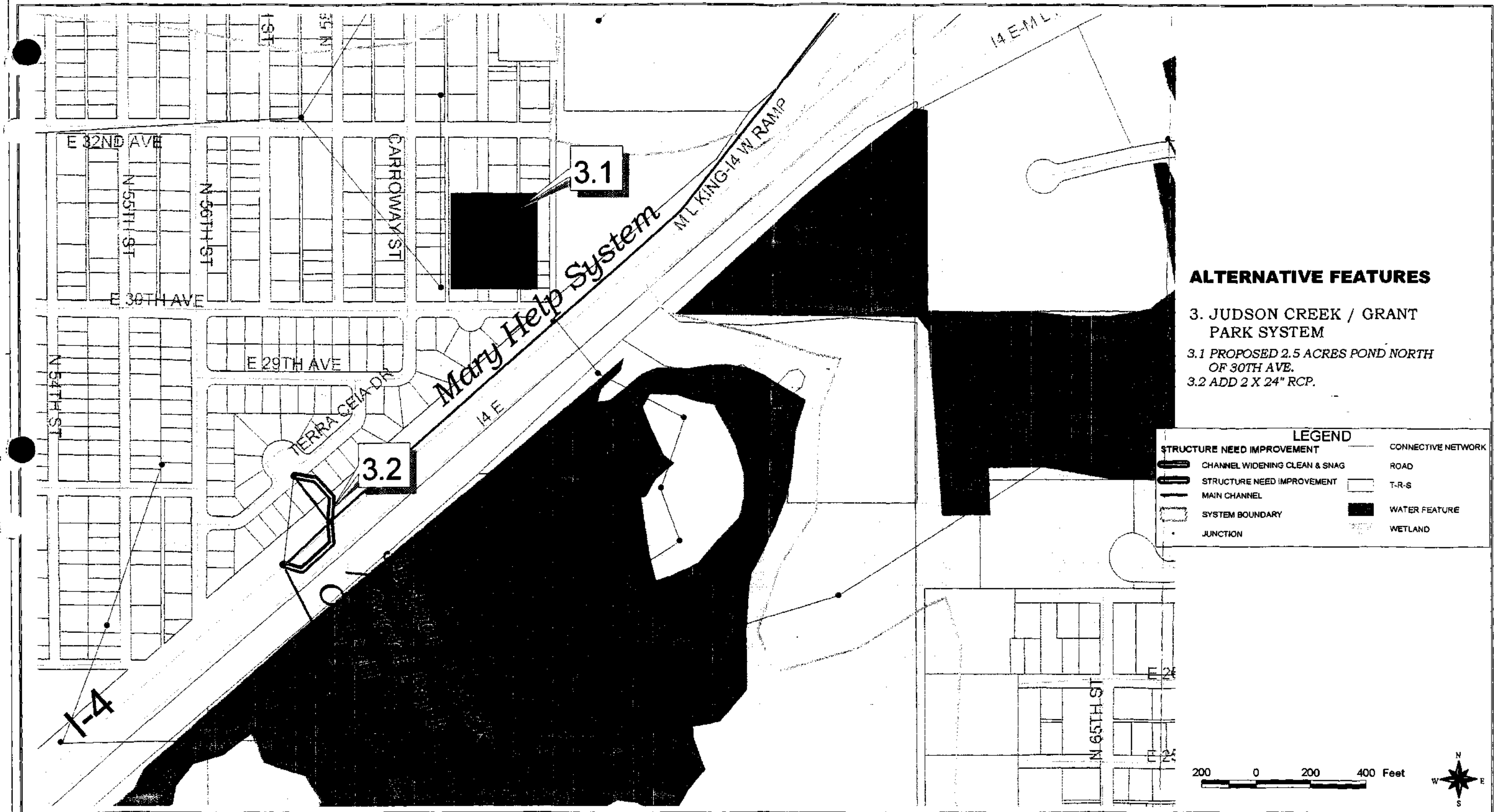

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FIGURE 13-6B

JUDSON CREEK/GRANT PARK SYSTEM
IMPROVEMENT 2

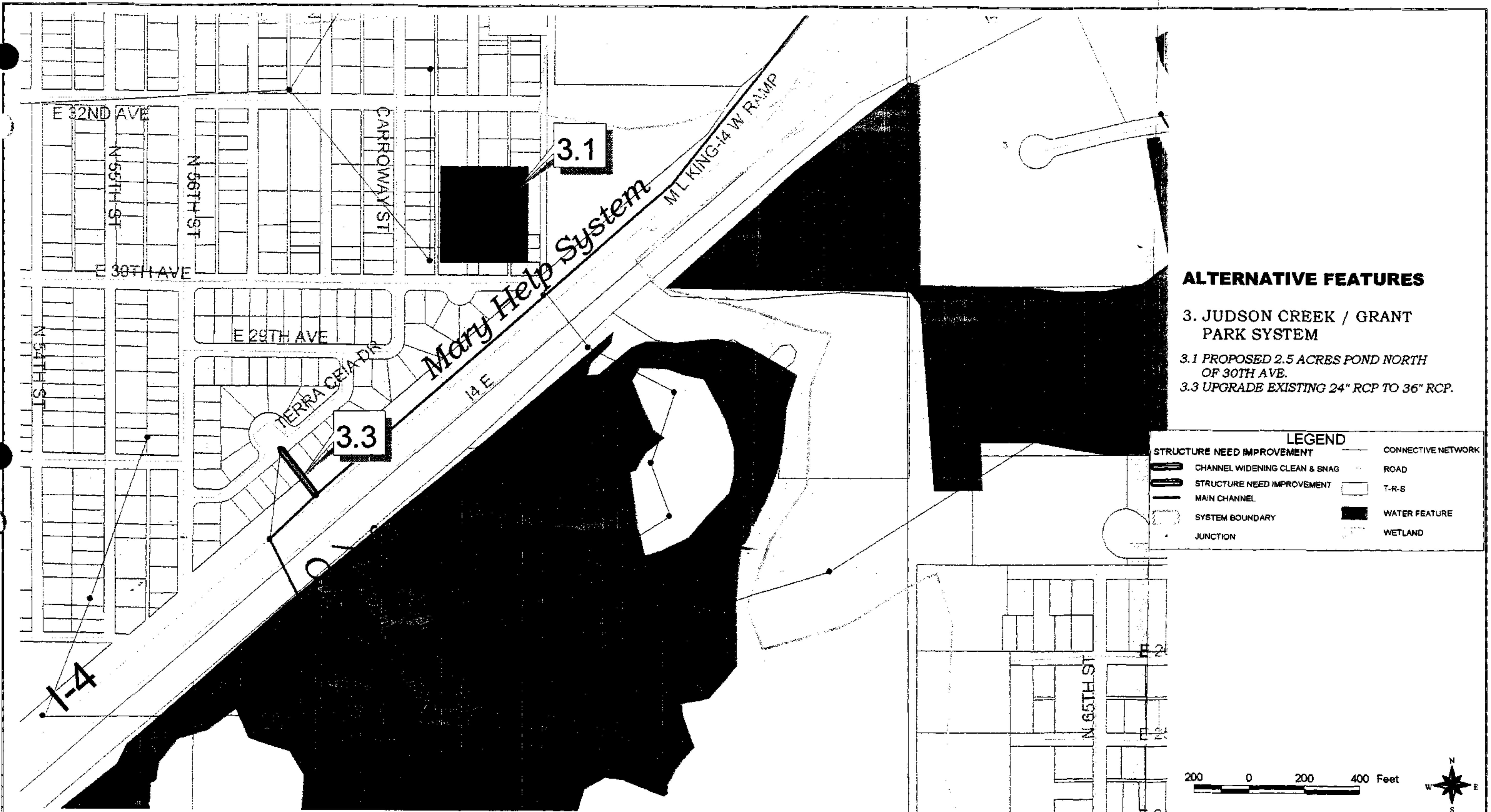

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FIGURE 13-6C

JUDSON CREEK/GRANT PARK SYSTEM
IMPROVEMENT 3

Table 13.4

JUDSON GREEK/GRANT PARK OUTFALL IMPROVEMENTS
ALTERNATIVE ANALYSIS

25-YEAR 24-HOUR STORM EVENT(STAGES)

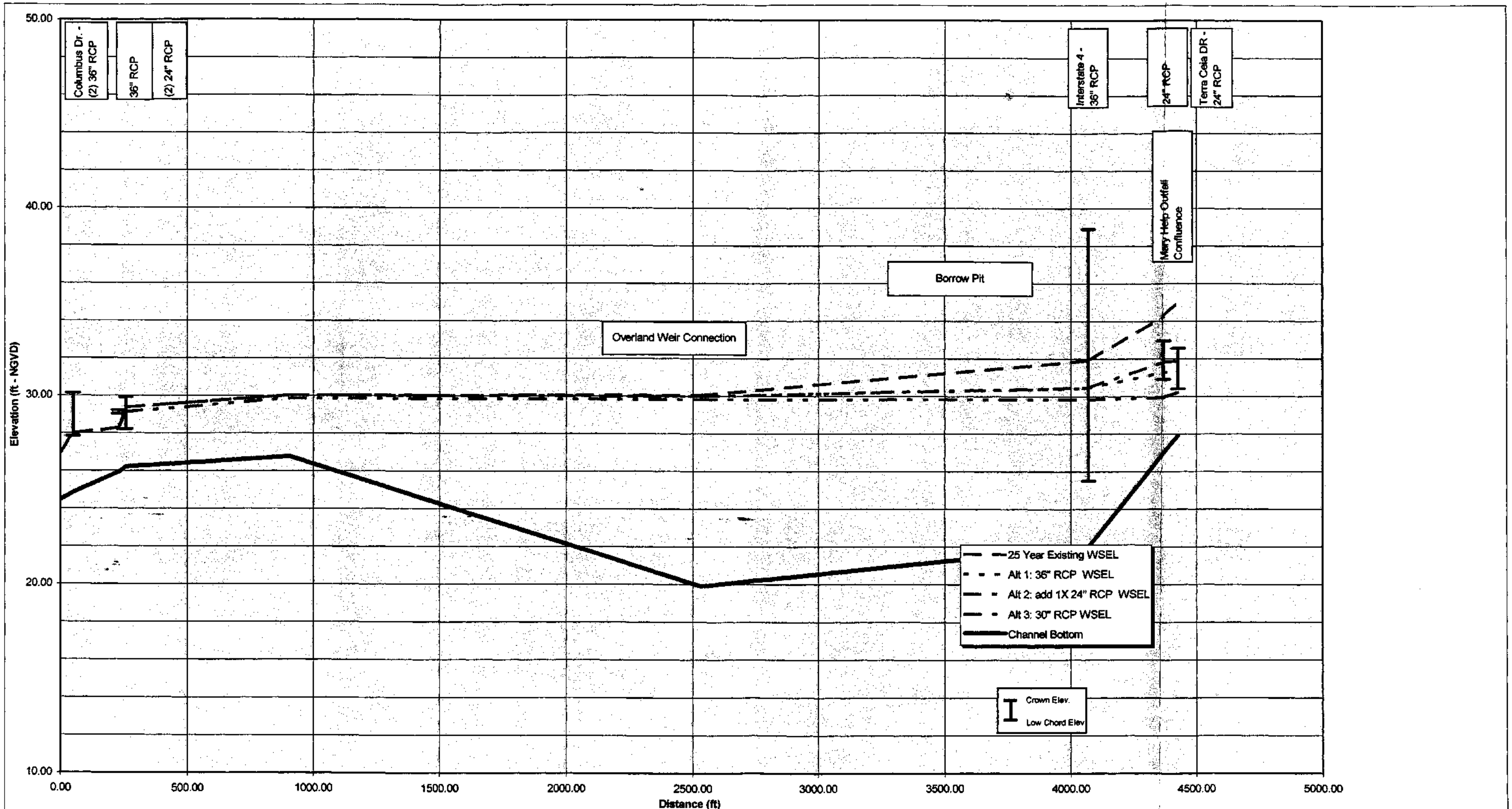
		SCENARIO				COMPARISON		
LOCATION	JUNCTION	A	B	C	D	B-A	C-A	D-A
Marry Help Outfall	101640	34.00	31.30	31.84	32.44	-2.7	-2.16	-1.56
Terra Ceia Dr.	101645	35.00	31.31	31.86	32.47	-3.69	-3.14	-2.53

100-YEAR 24-HOUR STORM EVENT(STAGES)

		SCENARIO				COMPARISON		
LOCATION	JUNCTION	A	B	C	D	B-A	C-A	D-A
Marry Help Outfall	101640	35.1	34.31	34.51	34.66	-0.79	-0.59	-0.44
Terra Ceia Dr.	101645	35.1	34.32	34.52	34.67	-0.78	-0.58	-0.43

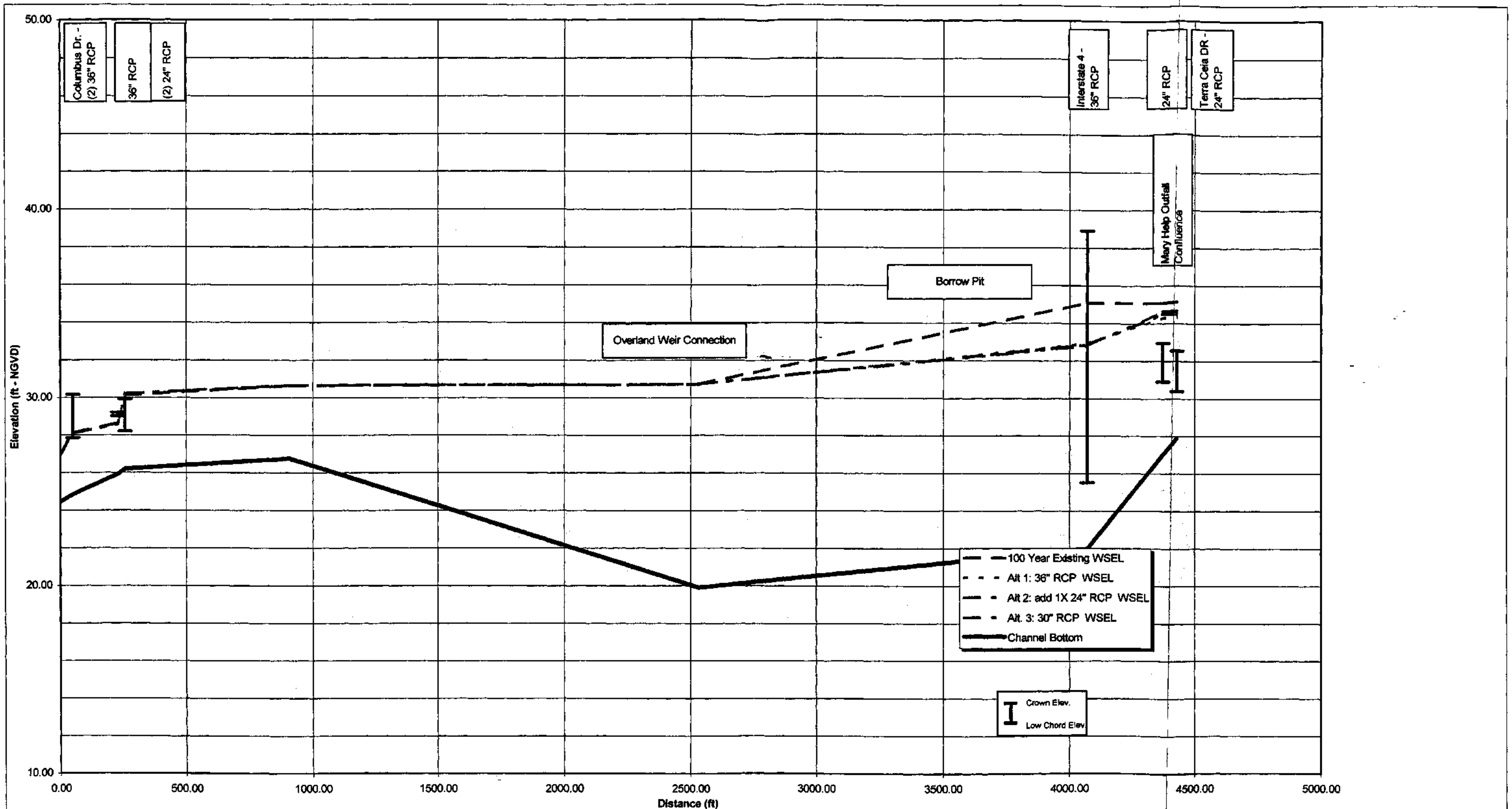
SCENARIO

A = EXISTING CONDITION (1x24" RCP)
B = ALTERNATIVE 1 – PROPOSED 36" RCP
C = ALTERNATIVE 2 – PROPOSED 1 ADDITIONAL 24" RCP
D = ALTERNATIVE 3 – PROPOSED 30" RCP



East Lake Area
Computed Water Surface Profiles
(September 1999)

Figure 13-7a Judson Creek/Grant Park Outfall
Comparison of Water Levels Among Different Alternatives!
Sheet 1 of 1



East Lake Area
Computed Water Surface Profiles
(September 1999)

Figure 13-7b Judson Creek/Grant Park Outfall
Comparison of Water Levels among Different Alternatives
Sheet 1 of 1

three alternatives compared with existing conditions for the 25-year and 100-year events, respectively. As shown in Fig. 13-7a, all three alternatives will eliminate the Terra Ceia Drive culvert overtopping as well as improve the conveyance system along Grant Park area without impacting the structures downstream of the Terra Ceia Drive culvert. Among them, Alternative 1, the 36" RCP pipes, gains the most water level drop, and Alternative 3, the 30" pipes, gains the least water level drop. Fig. 13-7b shows that all three alternatives can not eliminate the Terra Ceia Drive culvert overtopping during the 100-year event.

13.2.7 THE FAIRGROUNDS - SOUTH SYSTEM

The 25-year profile for the Fairgrounds-South System (Exhibit 6-1 (g)) shows that several pipes are flowing full and four pipes are expected to overtop within the System. The high point in the channel-bed profile is also very apparent. However, the overtoppings of this system occur inside of Fairground Property. No improvements are proposed at this time. The remainder of the System is anticipated to be adequate for the 25-year storm.

13.2.8 HILLSBOROUGH AVENUE/HARNEY ROAD SYSTEM

The evaluation results for the 25-year storm projected the attainment of the level of service target throughout the group of problem areas, i.e., Hillsborough Avenue, Harney Road, Good Shepherd Church, and East Lake neighborhood, without adversely impacting the water surface elevations in the Lake or in downstream reaches. It should be noted that the Harney Road Outfall SMI project has been completed for major improvements. The improvement consists of a piped conveyance system to connect the drainage system located between Hillsborough Avenue and the East Lake neighborhood, to an upgraded outflow system to the Lake. Also included, along Harney Road south of Hillsborough Avenue, is a piped conveyance system which has been connected to the western Hillsborough Avenue storm sewer collection system to carry collected flows along the road south, into a new storm water storage area that ultimately outflow to the East Lake. No further alternative analysis are provided in current study.

13.2.9 EAST LAKE MALL - NORTH SYSTEM

The East Lake Mall - North System has problem areas mostly north of Hillsborough Avenue. The 25-year design event computed water surface elevations for the East Lake Mall-North System indicate high stages north of the CSX with potential flooding and overtopping.

The East Lake Mall - North System will experience flooding of internal roadways and possible structures during the 100-year/24-hour and 25-year/24-hour design storm events. However, it should be noted that alternatives were not evaluated since historical flooding was not reported for this system.

13.2.10 EAST LAKE MALL - SOUTH SYSTEM

The problem areas associated with the East Lake Mall-South System are located at a low point in 56th Street and at an adjacent depression, wet area on the mall property. Both of these areas are located south of the 56th Street and Hillsborough Avenue intersection. The possible overtopping of 56th Street is a potential level of service problem based on reported observations of this occurrence in the past. The 100-year storm simulation resulted in the projection of the significant overtopping of 56th Street. However, alternatives were not evaluated since historical flooding was not reported for this system.

13.2.11 50TH/56TH STREET SYSTEM

The 50th/56th Street System has a low point as mentioned in the East Lake Mall - South System. The 25-year and the 100-year storm simulation showed significant overtopping of several structures in this system. However, alternatives were not evaluated since a historical flooding site was based on a neighbor's land alteration for this system. This system is also independent of the main conveyance systems.

13.2.12 MARY HELP SYSTEM

The Mary Help System has problems in areas where there are no storm sewer collection systems, and where depression areas overflow to transfer storm water runoff to lower areas, aggregating the flooding in these areas. These areas occur in the western portion of the contributing area of this System.

Several historical flooding areas are based on the El Nino event in this system. These historical flooding areas, which are located on private property, will be alleviated with the Judson Creek/Grant Park Outfall proposed alternatives.

13.3 WATER QUALITY ALTERNATIVES

13.3.1 STRUCTURAL ALTERNATIVES

Structural stormwater best management practices are those systems that can be constructed. The best example of a structural stormwater BMP is a stormwater pond. Since much 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

Stormwater treatment usually occurs on the parcel of land that generates the runoff. Regional stormwater facilities, in contrast, treat stormwater that has been gathered from usually more than one subbasin and transported it 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. It is recommended that regional facilities be designed to allow for multiple uses such as open / green space / corridors, recreation, groundwater recharge, reuse, etc. These facilities should incorporate into their design enough land to have sufficient slope to have planted littoral shelves if wet detention is used. This slope should be a minimum of 4 to 1 with 6:1 to 10:1 preferred.

13.3.1.2 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 survive constantly changing conditions from periods of inundation to 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. Also as with regional facilities, this type should be designed to maximize slopes that can be planted with native vegetation for treatment.

13.3.1.3 Pervious Concrete and Turf 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. These BMPs have the disadvantage in that neither is good to use in areas used by heavy equipment.

13.3.1.4 Chemical Treatment

The most common of these types of treatments is with the use of alum; however types of iron (ferric) compounds as well as polyacrylics can also be used. In these types of systems, flocculation is the method to remove the pollutants. When the coagulant is introduced into the system, it forms a precipitate that binds with it many different chemicals, suspended 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. Drawbacks of this type of treatment are toxicity and its effects on flora and fauna and that it does not readily remove dissolved constituents contained in stormwater.

13.3.1.5 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. However, as with alum treatment, removal efficiencies for pollutants other than gross pollutants typically run 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. All of these structures can 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.

13.3.1.6 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 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. Different examples of this technique are discussed below.

13.3.2.1 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 much more 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 harbor more habitat for wildlife.

13.3.2.2 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 uses. Soils must likewise be 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.

13.3.2.3 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.

13.3.3 NON-STRUCTURAL ALTERNATIVES

As the alternative to structural BMPs, non-structural alternatives do not require construction. They generally center on source reduction by various means.

13.3.3.1 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.

13.3.3.2 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, clean up programs, festivals and Earth Day events, xeriscaping and gardening programs and school programs.

13.3.3.3 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 pollutants prior to their introduction into the system. Maintenance is reduced by the prevention of clogging of the system. 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. Other measures can be used to reduce the amount of run-off generated by impervious surfaces. While they are "constructed" BMPs, again the idea is to reduce the run-off and therefore the pollutant load. Included in this category are cisterns, rooftop holding areas and rain barrels. In agricultural areas, the reuse of water through a system of tailwater recovery ponds will help in reducing loads by recycling nutrients and other chemicals. 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. In those areas where cattle are a contributing factor, simply fencing the area to prevent their direct entry into the affected waterbody(s) can greatly reduce the loading. Providing separate "watering holes" can work in the same way. Treatment ponds can be used here as well. 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.

13.3.3.4 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.

13.3.3.5 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 many will be recommended in the following chapters.

Due to time constraints and staffing problems, public meetings were not able to be held in the manner which had initially been planned. However, at least one and most likely two meetings will be held in the future for this watershed.

PROPOSED CONDITIONS LEVEL OF SERVICE AND THE PREFERRED ALTERNATIVES

15.1 INTRODUCTION

This chapter discusses the improved level of service (LOS) for the East Lake Area watershed with the recommendations as described in Chapter 13. Exhibit 15-1 contains a graphical representation of the ELA proposed LOS analysis for the 25-year / 24 hour storm event. Tables in Exhibit 15-2a-d depict the proposed level of service for the three proposed alternatives ponds and the alum treatment facility.

Discussion areas include the following topics below:

- The ELA LOS goals
- Level of Service Designation for the individual system

The proposed conditions LOS designations are discussed for the ELA systems listed below:

- East Lake Outfall
- Orient Park Outfall
- Judson Creek/Grant Park Outfall

15.2 LEVEL OF SERVICE GOALS FOR THE ELA WATERSHED

As defined in the Hillsborough County Comprehensive, Stormwater Management Element one of the goals of this report is to achieve an ultimate flood protection LOS for the East Lake Area Watershed (i.e., 25-yr / 24 hour / level B). Although this is the ultimate goal of our ELA Watershed Master Plan, certain limitations have to be taken into consideration. For instance, not all subdivisions and facilities discharging into the major conveyance systems have adequate stormwater management systems. Also, as mentioned in the Stormwater Management Element, both physical and environmental constraints affect proposed channel alterations. This limits the recommendations and thus limits the flood protection LOS achieved with the implementation of the proposed conditions.

The water quality level of service is not defined in any county or state law or rule nor is it defined in the Comprehensive Plan. It was thought, for the purposes of comparison standard, the best benchmark for water quality level of service was low / medium density residential land use. This was a compromise between using one of the natural systems, which would have skewed the results downward because these systems generally treat stormwater rather than input loads. Any higher land use category would skew the level of service upward due to the large amounts of pollutant load generated by more intensive land uses such as commercial and light industrial. Level of service C will be the target water quality LOS for the East Lake Area Watershed.

15.3 EAST LAKE OUTFALL SYSTEM

With the proposed recommendations for the East Lake Outfall System, the ultimate flood protection LOS (i.e., 25-year / 24 hour B) is achieved for the main channel system. Increasing the capacity downstream of Martin Luther King Jr. Boulevard, (Improvement 3.1 Exhibit 13-1) improves the tail-water conditions for the Kings Forest Subdivision. Lowering the tail-water conditions for the Kings Forest Subdivision is critical to the improvement of the flood protection LOS for the subdivision. The model predicts secondary site and street flooding along Orient Road, just south of Martin Luther King Jr. Boulevard for the 25-year / 24 hour storm event. Table 15.1 shows the landmark elevations, water surface elevations, and flood level designations for the Proposed LOS. Detailed locations where flooding is predicted to occur for the 25-year / 24 hour storm event is shown in Exhibit 15-1.

As discussed in Chapter 13, the alternative chosen for the alum treatment facility was the off-line system on the outfall canal. Exhibit 15.2a, depicts the level of service that the PLR model predicts for the parameters of TSS and TN. As the summary table in the exhibit shows, LOS C or better is attained in 61 of the 75 subbasins for the parameter of TSS. This translates to 81% of those subbasins. LOS for total nitrogen fairs much more poorly, with only five out of the 75 subbasins reaching LOS C. There are no levels higher than LOS C. This amounts to only 6% of the subbasin total. Total nitrogen LOS remains the same as existing LOS due to the intensity of land uses in the treated subbasins. However, many of the non-reported parameters have large increases in LOS, generally jumping two levels.

Updated 9/24/99 by JG
Requested Survey on 6/23/99

Bolded elevations are where road is higher than site or structu
Expected survey request Completion 7/16/99

c d e f g h I j k l

<u>TABLE 15.1</u>
PROPOSED CONDITIONS LEVEL OF SERVICE

East Lake Area (Proposed Conditions) 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	50-yr	100-yr	25-Year Predicted FloodingLocation
Harney Prairie Outfall																	***LOS 25-YR/24-HR D***
3	105005	21.3	19.5	20.5	17.44	17.77	18.10	18.39	18.93	19.23	A	A	A	A	A	A	
3	105025	21.3	22.5	23.5	19.61	19.74	19.80	19.86	19.97	20.03	A	A	A	A	A	A	
3	105070	17.3	18.5	19.5	15.66	15.84	16.01	16.17	16.48	16.63	A	A	A	A	A	A	
3	105080	23.3	19.5	20.5	16.03	16.24	16.42	16.60	16.91	17.06	A	A	A	A	A	A	
3	105090	22.3	20.5	21.5	16.06	16.26	16.45	16.62	16.94	17.09	A	A	A	A	A	A	
3	105103	20.3	20.5	21.5	16.71	17.02	17.33	17.63	18.21	18.51	A	A	A	A	A	A	
3	105108	19.6	19.5	20.5	16.78	17.06	17.32	17.56	18.05	18.29	A	A	A	A	A	A	
3	105110	21.3	19.5	20.5	16.80	17.08	17.34	17.58	18.08	18.31	A	A	A	A	A	A	
4	105120	32.3	32.8	33.8	16.93	17.27	17.58	17.87	18.39	18.61	A	A	A	A	A	A	
3	105130	21.4	23.0	24.0	18.84	19.00	19.15	19.29	19.54	19.65	A	A	A	A	A	A	
4	105132	37.3	35.5	36.5	21.67	21.98	22.28	22.58	23.15	23.26	A	A	A	A	A	A	
4	105140	34.3	25.5	26.5	21.95	22.12	22.24	22.37	22.62	22.67	A	A	A	A	A	A	
4	105150	35.0	30.9	31.5	28.37	28.71	29.10	30.64	31.02	31.09	A	A	A	A	C	C	
4	105160	34.3	999.0	999.0	30.21	30.52	30.79	31.13	31.78	31.93	A	A	A	A	A	A	
4	105180	45.3	42.0	43.4	36.30	36.62	36.92	37.18	37.63	37.95	A	A	A	A	A	A	
4	105198	48.3	47.5	48.5	45.18	45.65	46.11	46.55	47.15	47.23	A	A	A	A	A	A	
4	105200	45.3	55.5	56.5	38.70	39.06	39.40	39.73	40.31	40.55	A	A	A	A	A	A	
2	105304	32.8	999.0	999.0	14.80	14.84	14.98	15.12	15.37	15.49	A	A	A	A	A	A	
3	105311	18.3	18.5	19.5	16.23	16.49	16.74	16.97	17.40	17.61	A	A	A	A	A	A	
3	105312	20.3	18.5	20.0	16.22	16.49	16.74	16.97	17.40	17.61	A	A	A	A	A	A	
4	105315	42.3	42.5	43.5	38.20	39.49	40.55	41.12	41.94	42.43	A	A	A	A	A	B	
3	105320	19.3	19.5	20.5	16.23	16.49	16.74	16.97	17.60	18.12	A	A	A	A	A	A	
3	105324	19.3	20.2	21.2	16.23	16.49	16.74	16.97	17.73	18.27	A	A	A	A	A	A	
3	105330	20.3	999.0	999.0	16.55	17.02	17.39	17.72	18.43	18.73	A	A	A	A	A	A	
1	105331	21.1	19.0	20.0	16.22	16.48	16.72	16.94	17.36	17.56	A	A	A	A	A	A	
4	105332	45.3	43.5	44.5	37.95	39.05	40.34	41.61	43.06	43.14	A	A	A	A	A	A	
1	105365	21.3	20.5	21.5	18.32	18.49	18.61	18.71	18.86	18.92	A	A	A	A	A	A	
1	105375	22.3	999.0	999.0	17.27	17.52	17.59	17.76	18.03	18.15	A	A	A	A	A	A	

		East Lake Area (Proposed Conditions) 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	50-yr	100-yr	25-Year Predicted FloodingLocation
3	105405	22.3	22.5	23.5	20.27	20.57	20.86	21.15	21.52	21.57	A	A	A	A	A	A	
3	105425	22.3	999.0	999.0	20.11	20.38	20.64	20.88	21.12	21.14	A	A	A	A	A	A	
3	105445	22.3	19.5	20.5	18.75	18.75	18.75	18.75	18.79	18.84	A	A	A	A	A	A	
3	105550	17.9	17.6	18.6	16.50	16.84	17.05	17.19	17.39	17.48	A	A	A	A	A	A	
3	105610	19.3	18.8	19.8	16.70	16.80	16.92	17.06	17.25	17.33	A	A	A	A	A	A	
1	105657	19.3	999.0	999.0	16.51	16.85	17.06	17.20	17.41	17.49	A	A	A	A	A	A	
3	105660	17.9	18.8	19.8	16.52	16.86	17.07	17.21	17.41	17.49	A	A	A	A	A	A	
3	105670	22.3	999.0	999.0	16.80	17.27	17.45	17.59	17.81	17.89	A	A	A	A	A	A	
3	105680	22.3	999.0	999.0	17.24	17.99	18.09	18.20	18.41	18.51	A	A	A	A	A	A	
4	105691	46.3	48.0	49.0	45.66	45.70	45.73	45.76	45.82	45.84	A	A	A	A	A	A	
2	105692	35.2	36.0	37.0	34.93	34.96	35.03	35.12	35.28	35.34	A	A	A	A	B	B	
2	105693	27.8	29.7	30.7	22.16	22.47	22.76	23.05	23.58	23.82	A	A	A	A	A	A	
3	105705	999.0	999.0	999.0	16.72	16.99	17.25	17.48	17.97	18.20	A	E	E	E	A	E	
3	105729	999.0	22.5	23.5	17.11	17.50	17.87	18.24	18.96	19.32	A	A	A	A	A	A	
3	105740	22.8	22.0	23.0	17.11	17.50	17.87	18.24	18.96	19.32	A	A	A	A	A	A	
3	105754	999.0	19.4	20.0	17.11	17.50	17.87	18.24	18.96	19.32	A	A	A	A	A	A	
3	105762	18.8	19.4	20.0	17.39	17.87	18.29	18.68	19.40	19.74	A	A	A	A	C	C	
3	105772	20.3	20.7	21.7	17.54	18.08	18.57	19.05	19.98	20.46	A	A	A	A	A	B	
3	105786	19.3	20.5	21.5	17.25	17.72	18.20	18.68	19.68	20.20	A	A	A	A	B	B	
3	105794	20.3	21.5	22.5	17.28	17.77	18.26	18.77	19.82	20.37	A	A	A	A	A	B	
4	105812	21.8	22.5	23.5	20.81	20.91	20.99	21.05	21.10	21.12	A	A	A	A	A	A	
4	105828	34.4	40.5	41.0	33.26	33.71	34.18	34.78	35.77	36.15	A	A	A	B	B	B	Orient & Hanna AVE
3	105850	24.3	25.5	26.5	22.60	22.82	23.01	23.18	23.39	23.49	A	A	A	A	A	A	
4	105855	23.9	24.4	24.8	23.02	23.57	24.20	24.90	26.47	27.37	A	A	B	D	D	D	Deleuil AVE W of Lenox
4	105860	27.3	27.5	28.5	23.44	24.41	25.57	26.91	30.07	31.89	A	A	A	A	D	D	
4	105862	39.3	39.5	40.5	37.74	38.34	38.90	39.24	39.30	39.36	A	A	A	A	B	B	
4	105864	999.0	999.0	999.0	41.90	42.17	42.41	42.43	42.47	42.51	A	E	E	E	A	E	
4	105870	28.3	29.0	31.0	24.43	25.90	27.46	29.14	32.40	34.11	A	A	A	C	D	D	SW corner of Mohawk & Staley
4	105875	27.3	25.5	26.5	24.74	24.79	24.83	24.87	25.10	25.23	A	A	A	A	A	A	
3	105902	23.0	999.0	999.0	20.12	20.30	20.43	20.54	20.72	20.81	A	A	A	A	A	A	
3	105927	22.3	999.0	999.0	18.64	18.97	19.23	19.44	19.79	19.97	A	A	A	A	A	A	
3	105938	21.3	21.5	22.5	19.94	20.10	20.29	20.50	20.90	21.10	A	A	A	A	A	A	
3	105985	23.3	999.0	999.0	16.66	16.93	17.12	17.29	17.53	17.63	A	A	A	A	A	A	
Interstate 4 Outfall																	***LOS 25-YR/24-HR A***
7	104416	25.3	23.5	24.5	19.64	20.10	20.48	20.85	22.01	22.60	A	A	A	A	A	A	
7	104424	25.3	999.0	999.0	20.67	21.15	21.50	21.85	22.49	22.85	A	A	A	A	A	A	
7	104428	25.3	23.5	24.5	20.53	20.74	21.00	21.28	22.17	22.69	A	A	A	A	A	A	
7	104432	25.3	999.0	999.0	20.72	21.18	21.52	21.87	22.49	22.85	A	A	A	A	A	A	

		East Lake Area (Proposed Conditions) 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	50-yr	100-yr	25-Year Predicted FloodingLocation
3	104440	26.3	999.0	999.0	20.85	21.34	21.75	22.13	22.71	22.96	A	A	A	A	A	A	
7	104442	27.3	35.0	36.0	22.05	22.22	22.38	22.54	23.28	24.11	A	A	A	A	A	A	
8	104454	32.1	999.0	999.0	28.40	28.66	28.96	29.16	29.43	29.55	A	A	A	A	A	A	
8	104458	32.3	37.1	38.1	29.63	29.77	29.91	30.04	30.28	30.39	A	A	A	A	A	A	
8	104462	32.3	999.0	999.0	29.02	29.19	29.35	29.50	29.82	30.03	A	A	A	A	A	A	
8	104470	38.3	40.5	41.5	33.36	33.46	33.54	33.63	33.89	34.03	A	A	A	A	A	A	
4	104472	37.3	39.5	40.5	34.48	34.56	34.78	35.08	35.37	35.42	A	A	A	A	A	A	
4	104474	40.3	39.8	40.8	37.22	37.40	37.66	37.93	38.52	38.86	A	A	A	A	A	A	
7	104810	24.3	24.5	25.5	20.53	20.99	21.42	21.82	22.60	22.99	A	A	A	A	A	A	
7	104815	25.3	999.0	999.0	20.59	21.03	21.43	21.83	22.61	22.99	A	A	A	A	A	A	
7	104816	25.3	999.0	999.0	18.47	18.73	18.96	19.18	19.54	19.68	A	A	A	A	A	A	
7	104818	25.3	999.0	999.0	19.66	20.00	20.38	20.83	21.49	21.84	A	A	A	A	A	A	
7	104820	25.3	999.0	999.0	20.65	21.06	21.45	21.84	22.61	22.99	A	A	A	A	A	A	
7	104825	24.3	24.7	25.7	20.65	21.06	21.45	21.84	22.61	22.99	A	A	A	A	A	A	
7	104835	23.3	24.5	25.5	20.99	21.44	21.87	22.30	23.12	23.52	A	A	A	A	A	B	
6	104908	24.3	24.5	25.5	17.15	17.32	17.47	17.61	17.88	18.01	A	A	A	A	A	A	
3	105929	24.3	999.0	999.0	19.08	19.49	19.82	20.11	20.69	21.05	A	A	A	A	A	A	
3	105932	25.3	999.0	999.0	18.60	18.91	19.16	19.38	19.73	19.90	A	A	A	A	A	A	
3	105947	23.3	999.0	999.0	19.25	19.67	20.02	20.33	21.02	21.42	A	A	A	A	A	A	
7	105950	25.3	999.0	999.0	19.51	19.96	20.33	20.68	21.63	22.10	A	A	A	A	A	A	
7	105951	25.3	999.0	999.0	19.53	20.00	20.38	20.73	21.64	22.11	A	A	A	A	A	A	
3	105975	23.3	24.0	25.0	18.46	18.71	18.90	19.06	19.31	19.42	A	A	A	A	A	A	
3	105976	23.3	999.0	999.0	18.58	18.88	19.14	19.36	19.74	19.92	A	A	A	A	A	A	
Fairgrounds Outfall North System																	***LOS 25-YR/24-HR A***
10	104602	21.3	20.8	21.8	15.11	15.23	15.33	15.44	15.63	15.72	A	A	A	A	A	A	
6	104007	20.3	21.5	22.5	15.36	15.82	16.23	16.59	17.24	17.57	A	A	A	A	A	A	
7	104020	21.0	999.0	999.0	17.51	18.14	18.74	19.30	20.16	20.63	A	A	A	A	A	A	
7	104023	27.3	27.5	28.5	19.93	20.18	20.41	20.64	21.08	21.33	A	A	A	A	A	A	
7	104025	24.4	999.0	999.0	18.31	18.93	19.47	19.94	20.71	21.13	A	A	A	A	A	A	
7	104030	25.3	999.0	999.0	18.48	19.14	19.73	20.22	21.18	21.65	A	A	A	A	A	A	
7	104045	23.8	25.5	26.5	21.01	21.44	21.85	22.25	22.99	23.34	A	A	A	A	A	A	
7	104050	25.3	27.5	28.5	19.21	19.80	20.34	20.82	21.72	22.17	A	A	A	A	A	A	
7	104060	26.3	999.0	999.0	19.33	19.95	20.49	20.93	21.76	22.17	A	A	A	A	A	A	
7	104063	25.3	999.0	999.0	19.61	20.30	20.91	21.38	22.33	22.77	A	A	A	A	A	A	
7	104075	999.0	25.2	26.2	19.82	20.64	21.34	21.93	23.15	23.55	A	A	A	A	A	A	
7	104080	999.0	25.5	26.5	20.06	20.91	21.63	22.24	23.47	23.88	A	A	A	A	A	A	
7	104085	999.0	26.5	27.5	22.47	22.84	23.17	23.51	24.16	24.47	A	A	A	A	A	A	
7	104090	999.0	27.0	28.0	22.63	22.98	23.31	23.66	24.28	24.57	A	A	A	A	A	A	

East Lake Area (Proposed Conditions) 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	50-yr	100-yr	25-Year Predicted FloodingLocation
7	104095	999.0	26.5	27.5	22.71	23.10	23.48	23.90	24.55	24.80	A	A	A	A	A	A	
7	104100	999.0	26.8	27.8	22.77	23.21	23.64	24.14	24.78	24.98	A	A	A	A	A	A	
7	104130	999.0	25.5	26.5	22.79	23.21	23.64	24.27	24.88	25.04	A	A	A	A	A	A	
7	104145	999.0	999.0	999.0	24.16	24.86	25.44	25.89	26.51	26.75	A	E	E	E	A	E	
7	104165	999.0	29.5	30.5	24.49	25.25	25.99	26.42	26.96	27.20	A	A	A	A	A	A	
7	104400	24.3	24.5	25.5	19.63	20.37	21.04	21.53	22.53	23.02	A	A	A	A	A	A	
7	104407	25.0	24.5	25.5	21.58	21.71	21.81	21.83	22.57	23.05	A	A	A	A	A	A	
7	104501	26.3	999.0	999.0	23.35	23.89	24.31	24.74	25.50	25.86	A	A	A	A	A	A	
7	104502	26.3	999.0	999.0	22.81	23.22	23.54	23.93	24.53	24.97	A	A	A	A	A	A	
10	104504	23.3	25.5	26.5	20.60	21.01	21.34	21.69	22.37	22.71	A	A	A	A	A	A	
7	104518	25.3	999.0	999.0	23.84	24.12	24.49	24.88	25.61	25.97	A	A	A	A	B	B	
10	104519	25.3	25.8	26.8	23.67	24.02	24.46	25.06	26.49	27.28	A	A	A	A	C	D	
7	104522	26.3	999.0	999.0	23.84	24.13	24.49	24.88	25.61	25.97	A	A	A	A	A	A	
7	104532	999.0	999.0	999.0	23.87	24.16	24.53	24.92	25.65	26.00	A	E	E	E	A	E	
7	104564	25.3	25.5	26.5	20.82	21.01	21.18	21.35	21.67	21.83	A	A	A	A	A	A	
10	104608	21.3	19.5	20.5	16.11	16.36	16.60	16.82	17.22	17.39	A	A	A	A	A	A	
7	104658	21.3	21.7	22.7	18.60	19.05	19.57	20.22	23.07	24.95	A	A	A	A	D	D	
East Lake Outfall																	***25-YR/24-HR LOS C***
11	101425	31.0	32.0	32.5	31.18	31.25	31.32	31.39	31.79	32.05	B	B	B	B	B	C	Rhode Island DR W of Orient RD
11	101710	21.2	21.5	22.5	19.80	20.40	20.95	21.46	22.15	22.45	A	A	A	B	C	C	Kingswood S of NY DR
11	101715	999.0	30.5	31.5	20.09	20.63	21.08	21.47	22.16	22.46	A	A	A	A	A	A	
10	101730	19.3	20.5	21.5	17.02	17.12	17.23	17.34	17.57	17.66	A	A	A	A	A	A	
8	101815	28.3	30.5	31.5	26.66	27.12	27.43	27.60	27.91	28.05	A	A	A	A	A	A	
11	101820	28.2	29.5	30.5	27.70	28.15	28.26	28.33	28.44	28.45	A	A	B	B	B	B	Orient RD S of MLK
11	101830	30.3	32.5	33.5	29.38	30.70	31.12	31.43	31.99	32.03	A	B	B	B	B	B	Orient RD
11	101837	31.3	31.5	32.0	29.45	30.15	30.36	30.50	30.72	30.82	A	A	A	A	A	A	
11	101840	32.3	32.0	33.0	32.19	32.27	32.38	32.52	32.85	33.02	C	C	C	C	C	D	Orient RD
11	101842	999.0	41.5	42.5	35.45	35.50	35.54	35.60	35.76	35.82	A	A	A	A	A	A	
11	101843	39.3	39.7	40.7	38.33	38.44	38.47	38.55	38.69	38.74	A	A	A	A	A	A	
11	101850	34.9	34.1	36.2	33.81	34.36	34.90	35.33	35.99	36.23	A	C	C	C	C	D	Orient RD
11	101852	38.3	999.0	999.0	35.65	35.72	35.79	35.85	36.06	36.28	A	A	A	A	A	A	
11	101855	36.1	35.5	36.5	33.78	34.24	34.67	35.02	35.55	35.75	A	A	A	A	C	C	
10	102005	16.3	17.5	18.5	13.35	13.81	14.26	14.66	15.42	15.76	A	A	A	A	A	A	
10	102010	16.5	18.5	19.5	14.52	15.00	15.45	15.81	16.45	16.73	A	A	A	A	B	B	
10	102015	17.3	20.5	21.5	14.99	15.64	16.39	16.91	17.62	17.83	A	A	A	A	B	B	
11	102020	25.3	27.5	28.5	21.64	22.14	22.51	22.84	23.52	23.81	A	A	A	A	A	A	
8	102025	24.7	24.5	25.5	21.87	22.50	23.00	23.53	24.52	24.92	A	A	A	A	C	C	
8	102035	28.3	29.5	30.5	22.71	22.91	23.20	23.69	24.61	25.00	A	A	A	A	A	A	

Story Board	Subbasin	Landmark Elevations: Road	Site	Struct	Water Surface Elevations: 2.33-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Flood Level Designations: 2.33-yr	5-yr	10-yr	25-yr	50-yr	100-yr	25-Year Predicted FloodingLocation
East Lake Area (Proposed Conditions) Level of Service Analysis																	
8	102040	28.3	28.8	29.8	22.95	23.30	23.73	24.21	25.24	25.76	A	A	A	A	A	A	
8	102055	29.3	27.5	28.5	23.77	24.18	24.63	25.11	26.13	26.56	A	A	A	A	A	A	
8	102060	27.3	27.5	28.5	24.03	24.49	24.98	25.49	26.36	26.77	A	A	A	A	A	A	
8	102070	26.8	27.5	28.5	24.46	24.92	25.37	25.82	26.69	27.14	A	A	A	A	A	B	
8	102071	28.3	999.0	999.0	24.46	24.92	25.37	25.82	26.69	27.14	A	A	A	A	A	A	
8	102072	29.3	31.5	32.5	25.05	25.43	25.76	26.09	26.73	27.16	A	A	A	A	A	A	
8	102681	24.2	25.5	26.5	24.12	24.26	24.39	24.60	24.92	25.10	A	B	B	B	B	B	Berkely
7	102690	25.6	27.0	27.5	25.35	26.10	26.44	26.59	26.81	26.89	A	B	B	B	B	B	Fawn & Cromwell
8	102868	32.3	37.5	38.5	27.30	27.43	27.53	27.60	27.78	28.15	A	A	A	A	A	A	
8	102870	30.3	33.5	34.5	28.08	28.33	28.55	28.75	29.11	29.29	A	A	A	A	A	A	
8	102876	32.3	37.5	38.5	28.81	28.91	29.00	29.08	29.23	29.30	A	A	A	A	A	A	
8	102880	999.0	37.5	38.5	33.01	33.20	33.39	33.56	33.88	34.03	A	A	A	A	A	A	
8	102884	32.3	35.5	36.5	28.71	28.86	29.00	29.13	29.37	29.49	A	A	A	A	A	A	
8	102895	35.3	36.5	37.5	32.28	32.64	32.99	33.32	33.70	33.84	A	A	A	A	A	A	
8	102974	30.3	29.5	30.5	28.23	28.48	28.70	28.89	29.23	29.37	A	A	A	A	A	A	
Orient Park Outfall																	***25-YR/24-HR D***
14	101005	19.6	22.5	23.5	11.42	11.93	12.46	13.02	14.25	14.71	A	A	A	A	A	A	
11	101015	19.1	19.5	20.5	14.00	14.39	14.67	15.02	16.02	16.45	A	A	A	A	A	A	
11	101030	21.3	21.5	22.5	15.19	15.82	16.36	17.03	19.19	19.67	A	A	A	A	A	A	
11	101040	22.4	23.5	24.5	18.31	18.64	18.95	19.51	20.38	21.12	A	A	A	A	A	A	
11	101050	22.7	23.5	24.5	19.83	20.12	20.53	20.85	21.66	22.17	A	A	A	A	A	A	75th Street Crossing (Main Channel)
11	101060	22.6	23.5	24.5	21.04	21.30	21.55	21.83	22.91	23.19	A	A	A	A	B	B	Missouri Avenue Crossing (Main Channel)
11	101075	24.5	25.5	26.5	23.39	23.74	24.09	24.40	24.85	25.03	A	A	A	A	B	B	Orient Road Crossing (Main Channel)
11	101105	31.3	30.5	31.5	28.73	28.91	29.04	29.14	29.30	29.43	A	A	A	A	A	A	
11	101115	31.7	31.4	32.4	29.27	29.76	30.22	30.66	31.48	31.72	A	A	A	A	C	C	
11	101120	30.3	30.5	32.0	29.33	29.83	30.29	30.73	31.55	31.80	A	A	A	C	C	C	Rhode Islanc
11	101127	30.3	31.5	32.7	30.19	30.56	30.87	31.18	31.78	32.05	A	B	B	B	C	C	Rhode Islanc
11	101140	31.3	32.7	33.1	31.48	31.66	31.98	32.28	32.82	33.05	B	B	B	B	C	C	Vermont Dr
11	101145	33.0	32.5	33.5	31.65	31.79	32.11	32.41	32.96	33.18	A	A	A	A	C	C	
11	101147	36.3	39.5	40.5	33.54	33.91	34.29	34.67	35.46	35.85	A	A	A	A	A	A	
11	101149	35.8	35.5	36.5	33.36	33.72	34.09	34.35	34.55	34.61	A	A	A	A	A	A	
11	101151	33.3	33.5	34.5	32.61	32.70	32.84	32.96	33.17	33.27	A	A	A	A	A	B	
11	101160	36.3	37.6	38.6	32.30	32.30	32.38	32.67	33.21	33.44	A	A	A	A	A	A	
11	101162	36.8	37.5	38.5	34.66	35.15	35.39	35.58	35.88	36.00	A	A	A	A	A	A	
11	101164	35.3	36.5	37.5	33.70	34.12	34.54	34.96	35.34	35.46	A	A	A	A	B	B	
11	101170	34.3	999.0	999.0	32.30	32.44	32.65	32.84	33.22	33.45	A	A	A	A	A	A	
11	101172	37.3	37.5	38.5	33.88	34.14	34.39	34.65	35.18	35.45	A	A	A	A	A	A	

East Lake Area (Proposed Conditions) 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	50-yr	100-yr	25-Year Predicted FloodingLocation
11	101235	33.0	33.0	33.8	34.36	34.43	34.49	34.55	34.64	34.69	D	D	D	D	D	D	Spillers Ave
11	101245	36.3	38.5	39.5	35.14	35.44	35.59	35.71	35.90	35.98	A	A	A	A	A	A	
11	101305	26.3	27.5	28.5	25.06	25.22	25.36	25.50	25.75	25.86	A	A	A	A	A	A	
11	101435	34.2	33.6	34.6	32.04	32.45	32.85	33.21	33.79	34.00	A	A	A	A	C	C	
11	101450	32.3	33.0	34.0	31.20	31.45	31.54	31.60	31.70	31.74	A	A	A	A	A	A	
11	101520	29.3	28.5	29.5	27.18	27.32	27.48	27.68	28.18	28.38	A	A	A	A	A	A	
11	101535	37.5	35.5	36.5	29.46	29.54	29.60	29.70	29.84	29.89	A	A	A	A	A	A	
12	101631	999.0	999.0	999.0	31.18	31.43	31.66	31.89	32.61	32.79	A	E	E	E	A	E	
11	101740	25.5	26.0	27.0	23.79	23.88	23.94	23.98	24.18	24.25	A	A	A	A	A	A	
Judson Creek / Grant Park Outfall																	**25-YR/24 Hour D**
12	101620	30.2	30.5	31.5	29.28	29.65	29.87	30.04	30.35	30.66	A	A	A	A	B	C	
12	101630	34.3	35.5	36.5	29.16	29.54	29.82	30.00	30.42	30.71	A	A	A	A	A	A	
12	101635	35.3	33.5	34.5	29.16	29.54	29.84	30.45	32.20	32.92	A	A	A	A	A	A	
12	101645	32.8	34.5	35.5	29.60	29.92	30.23	31.31	33.81	34.32	A	A	A	A	B	B	Terra Ceia (Main Channel
12	101650	34.8	35.5	36.5	35.08	35.16	35.23	35.29	35.39	35.43	B	B	B	B	B	B	Intersection of the N55th St. & E 28th Av
12	101655	36.5	37.0	37.5	35.02	35.29	35.66	36.10	36.90	37.23	A	A	A	A	B	C	
12	101660	44.1	44.2	45.9	42.00	42.17	42.33	42.47	42.71	42.79	A	A	A	A	A	A	
12	101665	39.3	42.5	43.5	37.57	37.59	37.65	37.70	37.77	37.80	A	A	A	A	A	A	
12	101670	38.3	40.5	41.5	37.91	37.97	38.01	38.05	38.12	38.15	A	A	A	A	A	A	
12	101675	46.5	46.9	47.0	48.62	48.73	48.85	48.96	49.14	49.23	D	D	D	D	D	D	Northeast of intersection of 52nd St. & E 32nd Ave.
Fairgrounds Outfall South System																	***25-YR/24-HR A***
8	102675	29.3	999.0	999.0	24.16	24.58	25.11	25.69	26.94	27.55	A	A	A	A	A	A	
7	104205	999.0	26.5	27.5	22.85	23.38	24.26	25.30	26.02	26.24	A	A	A	A	A	A	
7	104208	999.0	28.5	29.5	25.79	26.42	26.73	27.09	27.34	27.46	A	A	A	A	A	A	
7	104215	999.0	29.5	30.5	26.93	27.69	27.84	27.92	28.09	28.18	A	A	A	A	A	A	
7	104235	32.0	32.7	33.7	29.34	29.58	29.79	29.97	30.25	30.30	A	A	A	A	A	A	
7	104247	999.0	999.0	999.0	27.62	27.89	28.20	28.42	28.69	28.79	A	E	E	E	A	E	
7	104253	29.3	999.0	999.0	27.74	28.11	28.56	28.90	29.03	29.09	A	A	A	A	A	A	
7	104280	999.0	29.5	30.5	25.12	25.49	25.80	26.10	26.65	26.92	A	A	A	A	A	A	
7	104290	999.0	29.5	30.5	24.66	24.80	24.96	25.22	25.91	26.42	A	A	A	A	A	A	
7	104291	999.0	30.0	30.5	29.50	29.59	29.67	29.74	29.87	29.93	A	A	A	A	A	A	
8	104298	999.0	999.0	999.0	23.95	24.38	24.83	25.29	26.01	26.52	A	E	E	E	A	E	
8	104305	28.9	32.5	33.5	23.94	24.37	24.80	25.22	25.96	26.31	A	A	A	A	A	A	
Hillsborough Ave. / Harney Rd System																	***25-YR / 24-HR LOS B***
8	102105	26.7	29.5	30.5	24.50	25.13	25.78	26.58	28.15	28.56	A	A	A	A	B	B	Walton Way E of Vinson Dr.
8	102115	30.8	31.1	32.1	29.69	29.82	29.96	30.07	30.22	30.28	A	A	A	A	A	A	

East Lake Area (Proposed Conditions) 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	50-yr	100-yr	25-Year Predicted FloodingLocation
8	102120	999.0	33.0	33.5	32.16	32.34	32.51	32.61	32.75	32.80	A	A	A	A	A	A	
8	102130	999.0	34.5	35.5	33.53	33.81	33.98	34.20	34.78	35.09	A	A	A	A	C	C	
8	102155	28.2	30.7	31.7	28.81	28.96	29.10	29.23	29.44	29.53	B	B	B	B	B	B	Travis BLVD and Walton Way.
8	102180	30.3	31.5	32.5	29.32	29.58	29.82	29.99	30.86	31.13	A	A	A	A	B	B	Travis BLVD
8	102185	34.3	33.4	33.3	31.29	31.89	32.47	33.10	33.62	33.78	A	A	A	A	D	D	
8	102205	35.3	39.5	40.5	31.22	31.79	32.32	32.89	33.47	33.70	A	A	A	A	A	A	
4	102215	34.3	34.5	35.5	33.33	33.74	34.04	34.22	34.57	34.71	A	A	A	A	C	C	
4	102220	35.3	36.5	37.5	33.48	33.83	34.08	34.29	34.76	34.95	A	A	A	A	A	A	
4	102225	36.3	36.3	36.5	33.81	34.42	34.83	35.01	35.30	35.41	A	A	A	A	A	A	
4	102231	48.3	48.5	50.0	37.78	38.69	39.55	40.37	40.62	40.68	A	A	A	A	A	A	
4	102235	37.3	58.5	59.5	33.91	34.56	35.24	36.46	38.33	39.32	A	A	A	A	B	B	
4	102236	999.0	45.5	46.5	36.72	37.62	37.73	37.76	38.34	39.33	A	A	A	A	A	A	
4	102705	48.8	62.5	63.5	43.41	44.92	46.70	46.78	46.92	46.99	A	A	A	A	A	A	
4	102706	999.0	59.7	60.7	48.27	48.31	48.34	48.43	48.53	48.55	A	A	A	A	A	A	
4	102716	59.3	61.5	62.5	51.76	52.76	53.81	54.84	55.90	56.41	A	A	A	A	A	A	
4	102720	55.3	55.5	56.0	54.79	54.90	54.99	55.05	55.93	56.44	A	A	A	A	C	D	
4	102725	999.0	64.5	65.5	54.97	55.56	56.20	56.84	58.19	58.84	A	A	A	A	A	A	
5	102735	999.0	999.0	999.0	59.37	60.23	61.05	61.30	61.61	61.81	A	E	E	E	A	E	
4	102745	999.0	63.0	64.0	60.17	60.51	61.05	61.29	61.57	61.74	A	A	A	A	A	A	
4	102750	999.0	62.5	63.5	60.29	61.06	61.05	61.26	61.49	61.62	A	A	A	A	A	A	
5	102760	64.3	73.5	74.5	59.37	60.23	61.05	61.30	61.62	61.82	A	A	A	A	A	A	
4	102770	63.0	63.1	64.5	59.49	60.23	61.05	61.30	61.63	61.84	A	A	A	A	A	A	
4	102775	999.0	65.5	66.0	60.35	61.71	63.33	65.26	69.64	72.09	A	A	A	A	D	D	
4	102800	55.3	72.5	73.5	41.40	43.07	44.77	46.13	48.24	49.30	A	A	A	A	A	A	
4	102801	50.3	46.5	47.0	43.60	44.28	44.96	46.02	48.24	49.30	A	A	A	A	D	D	
4	102805	46.3	47.0	48.0	41.42	43.08	44.78	46.13	48.24	49.31	A	A	A	A	D	D	
4	102810	49.3	48.5	49.5	42.25	43.09	44.81	46.14	48.25	49.32	A	A	A	A	A	C	
4	102811	55.3	999.0	999.0	52.24	52.77	53.28	53.79	54.77	55.25	A	A	A	A	A	B	
4	102815	50.8	51.5	52.5	43.54	44.04	45.18	46.52	49.85	51.03	A	A	A	A	A	B	
4	102817	999.0	51.5	52.5	49.84	49.96	50.07	50.17	50.36	51.17	A	A	A	A	A	A	
4	102830	54.3	999.0	999.0	49.25	49.79	50.29	50.75	51.65	52.16	A	A	A	A	A	A	
4	102845	59.3	61.9	62.9	56.05	56.50	56.93	57.28	57.99	58.32	A	A	A	A	A	A	
4	102865	60.0	60.5	61.5	57.56	57.80	58.23	59.17	61.14	62.17	A	A	A	A	C	D	
East Lake Mall System																	***25-YR / 24-HR LOS D***
8	102305	28.3	28.5	29.5	24.88	25.22	25.88	26.61	27.93	28.31	A	A	A	A	A	B	
8	102310	28.2	29.5	30.5	27.87	28.50	28.76	28.95	29.27	29.45	A	B	B	B	B	B	Walton Way SW of Harney Rd
8	102315	29.3	30.3	30.7	30.69	30.84	30.97	31.10	31.34	31.45	D	D	D	D	D	D	Between Travis Blvd.& Walton Way
8	102320	30.4	31.5	32.0	30.76	30.93	31.08	31.22	31.49	31.61	B	B	B	B	B	C	Travis Blvd SW of Vinson Rd

East Lake Area (Proposed Conditions)
Level of Service Analysis

		Landmark Elevations			Water Surface Elevations						Flood Level Designations						
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	50-yr	100-yr	25-Year Predicted FloodingLocation
9	102325	34.3	38.5	39.5	32.23	32.59	33.01	33.63	35.19	35.40	A	A	A	A	B	B	
5	102345	45.3	58.5	59.5	43.10	43.56	43.99	44.22	44.45	44.54	A	A	A	A	A	A	
9	102406	33.3	999.0	999.0	27.20	28.89	30.79	32.57	34.97	35.51	A	A	A	A	B	B	
9	102415	43.3	46.5	47.5	34.77	35.29	35.76	36.22	37.14	37.59	A	A	A	A	A	A	
9	102417	45.3	50.5	51.5	38.17	38.25	38.32	38.39	38.52	38.58	A	A	A	A	A	A	
9	102445	54.3	65.5	66.5	45.43	46.77	47.58	48.30	49.63	50.24	A	A	A	A	A	A	
9	102450	999.0	50.0	50.5	46.69	48.13	48.98	49.73	51.10	51.73	A	A	A	A	D	D	
9	102460	52.0	52.5	53.5	49.49	50.55	51.21	51.80	53.30	53.98	A	A	A	A	C	D	
5	102465	50.3	49.8	50.5	49.90	50.60	51.25	51.84	53.33	54.02	C	D	D	D	D	D	NE of Hillsborough Ave.& 59th St
5	102481	55.3	999.0	999.0	50.55	52.04	53.32	53.35	53.77	54.06	A	A	A	A	A	A	
5	102486	54.3	53.5	54.5	51.39	52.19	53.33	53.40	53.77	54.06	A	A	A	A	C	C	
9	102525	55.3	65.5	66.5	36.37	36.75	37.13	37.54	38.82	39.68	A	A	A	A	A	A	
9	102545	45.3	48.5	49.5	37.42	37.69	38.04	38.49	40.10	41.54	A	A	A	A	A	A	
9	102575	46.3	48.5	49.5	40.61	40.84	41.05	41.27	41.82	43.59	A	A	A	A	A	A	
9	102590	45.3	999.0	999.0	41.73	42.30	42.85	43.34	44.20	44.56	A	A	A	A	A	A	
9	102595	44.3	44.8	45.8	42.01	42.78	43.38	43.76	44.21	44.57	A	A	A	A	A	B	
9	102600	45.3	44.8	45.8	42.49	43.25	43.90	44.18	44.42	44.57	A	A	A	A	A	A	
9	102615	46.1	49.5	50.5	46.56	46.70	46.83	46.94	47.16	47.25	B	B	B	B	B	B	56th St N of Shadowlawr
9	102625	50.5	50.5	51.5	47.85	48.67	49.50	50.40	52.22	53.24	A	A	A	A	D	D	
5	102635	56.3	58.5	59.5	51.55	51.65	51.76	51.86	52.33	53.42	A	A	A	A	A	A	
5	102650	61.3	58.5	59.5	55.34	55.43	55.50	55.56	55.66	55.71	A	A	A	A	A	A	
5	102691	56.3	59.5	60.5	55.32	55.41	55.47	55.53	55.62	55.66	A	A	A	A	A	A	
5	102693	55.3	55.5	56.5	54.36	54.42	54.47	54.52	54.61	54.65	A	A	A	A	A	A	
5	102787	999.0	59.0	60.0	57.13	57.33	57.60	57.81	58.13	58.27	A	A	A	A	A	A	
50th / 56th Street System																	***25-YR/24-HR LOS D***
9	102525	55.3	65.5	66.5	36.37	36.75	37.13	37.54	38.82	39.68	A	A	A	A	A	A	
9	102545	45.3	48.5	49.5	37.42	37.69	38.04	38.49	40.10	41.54	A	A	A	A	A	A	
9	102575	46.3	48.5	49.5	40.61	40.84	41.05	41.27	41.82	43.59	A	A	A	A	A	A	
9	102900	37.0	999.0	999.0	25.06	25.25	25.41	25.82	26.69	27.14	A	A	A	A	A	A	
9	102904	30.3	32.7	33.7	29.61	29.78	29.96	30.21	30.76	31.03	A	A	A	A	B	B	
9	102905	33.3	32.0	33.0	30.02	30.08	30.23	30.52	31.08	31.35	A	A	A	A	A	A	
9	102912	45.0	43.6	43.8	43.39	43.53	43.78	43.97	44.24	44.34	A	A	D	D	D	D	Southwest corner of intersection of Harney Rd. & E osborne Ave
9	102920	48.3	59.5	60.5	46.94	48.01	48.42	48.71	49.12	49.27	A	A	B	B	B	B	56th St Crossing / Harney Rd (main channel
9	102921	999.0	49.5	50.5	47.87	48.43	48.94	49.03	49.11	49.30	A	A	A	A	A	A	
9	102928	53.3	69.5	70.5	51.55	51.72	51.87	52.01	52.26	52.38	A	A	A	A	A	A	
9	102932	51.3	51.5	52.0	50.74	50.91	51.04	51.15	51.31	51.39	A	A	A	A	B	B	
9	102933	48.0	48.3	48.5	44.57	45.65	46.68	47.67	49.54	50.21	A	A	A	A	D	D	

East Lake Area (Proposed Conditions) 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	50-yr	100-yr	25-Year Predicted FloodingLocation
9	102944	40.3	36.5	37.5	30.10	30.23	30.37	30.53	30.82	30.97	A	A	A	A	A	A	
8	102952	35.3	34.6	33.7	29.40	30.33	30.79	31.17	31.81	32.07	A	A	A	A	A	A	
Mary Help System																	***25-YR/24-HR LOS B***
12	102076	37.5	38.5	39.5	33.57	34.23	34.52	34.86	35.45	35.72	A	A	A	A	A	A	
12	102077	999.0	37.5	38.5	35.83	36.08	36.33	36.57	37.05	37.24	A	A	A	A	A	A	
12	102082	36.3	38.5	39.5	34.29	34.74	35.23	35.76	36.77	37.24	A	A	A	A	B	B	
9	102954	32.3	999.0	999.0	32.02	32.10	32.15	32.22	32.31	32.36	A	A	A	A	B	B	
9	102966	32.7	35.6	36.5	33.57	34.23	34.50	34.80	35.32	35.55	B	B	B	B	B	B	Chelsea Ave. / Interstate Corporate Center N of MLK BLVD
12	102967	40.0	40.0	40.5	39.73	39.79	39.85	39.90	39.99	40.04	A	A	A	A	A	C	
9	102970	41.3	43.5	44.5	40.67	40.79	40.91	41.02	41.23	41.33	A	A	A	A	A	B	

LEGEND

A - NO FLOODING
B - ROAD FLOODING
C - SITE FLOODING
D - STRUCTURE FLOODING
E - NO FACILITY

15.4 ORIENT PARK OUTFALL SYSTEM

In the Orient Park Outfall System, flood protection LOS B for the 25-year / 24-hour storm event is achieved along the main channel with the exception of the area near Rhode Island Drive. The proposed conditions eliminate road overtopping at 75th Street, Missouri Avenue, and Orient Road. Table 15.1 shows the landmark elevations, water surface elevations, and flood level designations. Specific locations where flooding is predicted to occur for the 25-year / 24 hour storm event can be seen in Exhibit 15-1.

No specific projects were proposed for this outfall regarding water quality LOS. However, retrofitting options such as solid / liquid separators and / or curb inlets protectors, and / or street sweeping, where appropriate, should be employed to mitigate some of the impacts due to decreased residence times in the system. Of the ponds to be built, Alternative 3A in the Judson Creek / Grant Park Outfall would have the least environmental impact. However, this alternative was given a lower priority than the other two alternatives; and therefore, Alternative 1C is the preferred alternative for this system. It appears that with some careful planning, a pond could be placed in this parcel without significant, or any, impact to the adjacent wetlands. Exhibit 15-2b shows the proposed level of service predicted by computer modeling for the parameters .of TSS and TN for the three alternatives ponds. The exhibit's summary table for this outfall shows all twelve of the subbasins have C or better LOS for TSS. In this case, LOS rises to the A or B category. Again, the TN figures lag behind with only four of the twelve subbasins reaching only LOS C for a 33% total. As discussed in Chapter 13, the dramatic improvements to the water quality LOS in the treated subbasins is due primarily to the low intensity of the land uses. Similar results can be seen in Exhibit 15-2c for Alternative 2C, where again, 100% of the nine subbasins reached LOS of C or better for the category of TSS. For TN, only four subbasins or 44% reached only LOS C.

15.5 JUDSON CREEK / GRANT PARK OUTFALL SYSTEM

In the Judson Creek / Grant Park Outfall system along the main channel, a flood protection LOS B is achieved for the 25-year / 24-hour storm event with the exception of the area in the western portion of Grant Park. The model does not predict road overtopping at Terra Ceia Drive with the implementation of the proposed conditions. Detailed locations where flooding is predicted to occur for the 25-year / 24 hour storm event can be seen in Exhibit 15-1.

The results of the PLRM can be found in Exhibit 15-2d. As its associated summary table shows, again there are some large rises in the water quality parameter of TSS with all subbasins reaching LOS B or C. However, in this instance, the water quality LOS for TN remains at level F. This seems to be due to higher intensity land uses compared to those in the previous outfalls.

RECOMMENDATIONS

16.1 INTRODUCTION

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:

1. East Lake Outfall
2. Upgrade stormwater conveyance/collection network
3. Construction of an off-line alum treatment system for the outfall canal from East Lake
4. Retrofitting of the affected basins with measures such as baffle boxes and / or curb inlet protectors.
5. Streets sweeping where appropriate on streets with curb and gutters.

Orient Park Outfall

1. Upgrade stormwater conveyance / collection network downstream of Orient Road
2. Channel Improvements
3. Provide local, controlled stormwater treatment and attenuation upstream of Orient Road

Figure 16-1 Not Available at Time of Posting.

Judson Creek / Grant Park Outfall

1. Upgrade Stormwater conveyance / collection network at Terra Ceia Drive conveyance system to provide additional storage and manage remaining flow from I-4

2. Proposed 2.5 acres detention pond located at subbasin 101655.

16.2 EAST LAKE OUTFALL

The structure north of the "bottleneck" culverts was predicted to flood in the East Lake Outfall system during the 100-year storm event. However, the 25-year event is not expected to overtop the road crossings upstream of the "bottleneck" culvert. Three alternatives were examined to alleviate the existing flooding conditions. Preliminary cost estimate calculations were based on the County's guide and comparative pricing. It was determined that Alternative 1 is the most effective option to improve the East Lake Outfall conveyance system. The County's recommended solution is to replace the "bottleneck" culverts along the East Lake Outfall channel. The planning-level cost estimate for this recommendation is included in Appendix F. To offset some of the minor impacts to water quality due to the reduction of residence time for stormwater treatment within the outfall system, some measures of pollutant source reduction are recommended as part of the improvements. These BMPs should be something that can be retrofitted such as solid / liquid separators or curb inlet protectors or both. They will primarily reduce gross pollutants, but also reduce other pollutants as well. These options will have to be regularly maintained, as they are known to clog easily. Street sweeping is another option to be explored. One of its drawbacks is that it requires a curb and gutter system be present on the roads to be maintained.

16.2.1 STRUCTURE UPGRADE

The twin CMPs located 300 feet downstream of Martin Luther King Boulevard will be upgraded to two HDPE pipes. The proposed pipes will maintain the same head loss while conveying more discharge.

16.2.2 WATER QUALITY IMPROVEMENTS

One of the preferred alternatives for this outfall was the construction of an off-line treatment plant set along the outfall canal. The pond would be built south of I-4 and just to the west of Orient Road.

This project has the potential to raise the water quality treatment level of service for TSS by two to three letters grades. On the other hand, TN LOS is not expected to change significantly. Due to this inability to "hold the line" on nitrogen loading, addition measures are needed. These measures should revolve around source reduction, due to the developed nature of the outfall area, which further limits options. Retrofitting projects such as baffle boxes or curb inlet protectors are probably the best options in this regard. Along these same lines and to augment these two options would be to develop a regular program of street sweeping.

16.3 ORIENT PARK OUTFALL

The Orient Park Outfall represents a major problem area. Orient Road and Missouri Avenue are expected to overtop during the 10-year storm event. In addition, the 25-year event is projected to overtop these roads, as well as Rhode Island and Vermont Drives. Significant to severe out-of-bank flooding is also projected in this area. There is a possibility of structural flooding during the 100-year storm event. Three alternatives were examined to alleviate the existing flooding conditions. Preliminary cost estimate calculations were based on the County's guide and comparative pricing (see Appendix F). It was determined that Alternative 1 is the most effective option to improve the East Lake Outfall conveyance system.

16.3.1 STRUCTURE UPGRADE

A series of stormwater elliptical pipes located north of E. Broadway Avenue will be upgraded to larger round pipes. Road crossing culverts at 76th Street, 75th Street, Missouri Avenue and Orient Road will be upgraded to box culverts. The proposed structures will prevent road overtopping while conveying more discharge. As with the improvements in the East Lake Outfall, while this part of the proposed project will not greatly affect water quality, some mitigating options should be explored. These could include additional stabilization of the banks of the outfall to decrease erosion and sedimentation as well as the same types of source reduction measures proposed for the East Lake Outfall.

16.3.2 CHANNEL CROSS SECTION IMPROVEMENTS

The expected water surface elevation reductions throughout the area for the channel improvement, for the 25-year storm, should range between about 0.7 foot and 2.0 feet, relative to the existing conditions projections. The proposed conditions profiles (Appendix B) for the outfall indicate that all of the roads have achieved the Ultimate level of service for the 25-year storm event. Orient Park Outfall channel, from Vermont Drive to Columbus Drive, should be cleared and snagged regularly. It is anticipated that these improvements will have mild impacts to water quality in terms of pollutant loading and natural systems degradation. Several things can be done to offset these impacts. Again, retrofitting existing areas to treat stormwater prior to its entry into the system can reduce pollutant loadings. All excavated materials should be removed from the system rather than creating or adding to spoil berms. Side slopes should be 3:1 or gentler (4:1 is preferred) to allow for stabilization and lessen erosion. To prevent dewatering of upstream systems, invert and channel bottom elevations must not be lowered. Once excavation is complete, the area(s) need to be immediately sodded or seeded. If possible, activities should occur during the dry season between November and April. If enough land can be acquired, littoral shelves should be constructed and planted with desirable wetland vegetation. Project costs should reflect maintenance costs for these shelves, if constructed.

16.3.3 STORMWATER TREATMENT AND ATTENUATION

The proposed detention pond located north of Broadway Avenue will provide storage attenuation by collecting the water upstream of Rhode Island Drive and Vermont Drive, which will help to alleviate the downstream area of Orient Road. This area will have to be field delineated for wetlands by either EPC or SWFWMD to determine the appropriate upland location of the pond, since aerial photography and the USGS soils maps indicate wetlands exist on the parcel(s) proposed for the pond construction. Once this has been determined, the amount of room needed for the pond construction will be addressed. This area should be as large as possible to allow for uses other than just stormwater treatment. Adjustments should be made to allow minimum 4:1 slopes for the creation of littoral shelves, which should be planted with desirable wetland vegetation. Slopes of 6:1 to 10:1 are preferred for littoral shelf creation. The pond should be designed to have a 14 day residence time to maximize treatment. As with the channel improvements, project cost should include maintenance costs for the removal of nuisance and exotic plant species and sediment removal. To decrease the need for sediment removal, the option of a sediment sump should be explored.

16.4 JUDSON CREEK / GRANT PARK OUTFALL

The Grant Park portion of the Judson Creek / Grant Park Outfall contains several landlocked areas which are projected to fill and overflow stormwater to the inlets at Terra Ceia Drive. The landlocked areas are anticipated to discharge overland during the 10-, 25- and 100-year storm events. The exposed soils in the subdivision could experience erosion because of the overland sheetflow. There is a possibility of structural flooding during the 100-year event.

16.4.1 HISTORIC CONDITIONS AND PROJECT OBJECTIVES

Within the Judson Creek / Grant Park Outfall area the neighborhood west of 62nd Street was projected to experience flooding. This incident, although expected to occur according to the model simulations, has never actually been field verified. Columbus Drive and 62nd Street is also expected to overtop at another location during the 25-year storm, at the outflow point of Judson Creek / Grant Park system. Three alternatives were examined to alleviate the existing flooding conditions. Preliminary cost estimate calculations were based on the County's guide and comparative pricing. It was determined that Alternative 1 is the most effective recommendation to improve the East Lake Outfall conveyance system. The planning-level cost estimate for this recommendation is included in Appendix F.

16.4.2 STRUCTURE UPGRADE

A series of stormwater pipes located south of Terra Ceia Drive will be upgraded and connected to the I-4 system. The proposed pipes will reduce the head loss while conveying more discharge. Measure similar to those for the East Lake and Orient Park Outfalls should be used here.

16.4.3 STORMWATER TREATMENT AND ATTENUATION

The proposed detention pond located north of Terra Ceia Drive and south of Martin Luther King Boulevard within subbasin 101655 will provide storage and attenuation by collecting the runoff from the surrounding subbasins (101665, 101660,a and 101655) which are experiencing flooding. However, a detailed inner storm sewer shall be provided during the design stage. Water quality concerns expressed with the pond in the Orient Park Outfall should all be applied to this pond as well.

16.5 WATER QUALITY RECOMMENDATIONS

16.5.1 REVISIT / REVISE PRESENT DAY RULES AND 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. **Housing densities should be reduced around wetlands and waterbodies for the same reason setback variances should be limited**. One of the projected land use changes in the watershed is the conversion of all or most of the agricultural areas to high-density residential housing (greater than 5 units per acre). Limiting densities 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. **Clustering of homes and ancillary buildings should be encouraged around wetlands and waterbodies.** This will provide more buffering and the appearance of open space in these areas. Traditional zoning regulations require evenly spaced development which is fine for most developments, but can be counter productive around aquatic systems.

4. **Stricter enforcement of Chapter 1-11, the Wetland Rule, must be allowed.** Wetland encroachments in present day development are the rule rather than the exception. 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. The agency should also take into account the "watershed importance" of the wetland requesting to be impacted. This is more important in a highly developed watershed such as this one, where there are very few wetlands left and those that exist are the only refugia of the area's wildlife and native flora.

5. **The SWFWMD should be encouraged to raise their standards, and failing this, the County should implement stricter standards.** As demonstrated by the pollutant loading and reduction model, one of the most efficient BMP types, alum treatment, does not seem to be able to treat stormwater to the agreed upon standard of "holding the line" for nitrogen loading in Tampa Bay. Literature values for load reduction can be as low as 50% for this parameter. Present day standards assume 80% treatment, but this is based on removal of particulates, not dissolved pollutants. 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.

6. **Animal wastes from both livestock and pet animals serve as a pollution source.** The County's Animal Ordinance should be amended to require owners remove the feces deposited by their animals. Livestock should be maintained outside the appropriate setback or buffer area to allow this area to provide some water treatment. At the same time, this buffer will prevent direct impacts by the animals when entering or leaving wetlands and waterbodies.

16.5.2 GENERAL RECOMMENDATIONS

1. **The plan should be updated on no less than a five-year cycle with public input as an integral part**. This constant updating will allow 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 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. These should be incorporated into all new County drainage or flood control projects.

4. **The shortcomings of the alum treatment facility demonstrate the need for additional treatment options in the watershed as listed in the Alternatives Chapter 13.**

5. **Incentives for xeriscaping or enrollment into the Florida Yards and Neighborhood program should be explored**. Credits toward residential water bills or some type of limited green belt credits would be desirable.

6. **County maintenance practices should be standardized for dealing with the materials removed through dredging and vegetation maintenance.** Presently, when the County performs one of these two activities, the results are left on site. All dredged soils and removed vegetation should be taken from the site and properly disposed of in an upland area or reuse in other county projects. When dredged materials are removed, especially in the case of ditches, they are typically cast up onto the bank in piles and left. If this material is not quickly stabilized by vegetation, which is extremely difficult due to the steepness of the slopes involved, they will erode right back into where they have been removed with the next storm event. The same can be true for vegetation. With all the borrow pits being dug in the County, there must be some way of using the dredge material in place of borrow. Within two years of the approval of this plan, this coordination effort should be explored and recommendations made to the Planning and Growth Management Department toward this end. Removed wetland vegetation should be move to an upland area or disposed of by other method, such as landfilling or preferably burning as fuel at a County facility.

16.5.3 POLLUTANT LOADING AND REDUCTION MODEL

The model gave some unexpected results, especially with the runs associated with the alum treatment facility. Alum treatment did not noticeably increase the LOS as expected. This can be due to several factors.

1. **The first area to explore is the 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. **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. **Additional investigation needs to be performed to determine the best EMCs to use for the model.** This issue is directly related to the benchmark issue above. Ideally, these values should be derived from research done within Hillsborough County and correspond closely to the watershed being studied.

4. **Pollutant reduction numbers similar to the EMC issue above.** These numbers need to reflect the best literature numbers and be applicable to Hillsborough County.

5. **Toxicity Effects –** similar projects in other parts of the state have reported toxicity problems related to aluminum as well as zinc which has been found as a contaminant in alum solutions. Aluminum has been demonstrated to be toxic to some types of fishes as well as macroinvertebrates. Studies have found no significant impact to benthic organisms. As part of the watershed's monitoring plan, aluminum and zinc concentrations should be monitored downstream of the facility's outfall and additional treatment may be required if toxicity problems arise.

6. **Future land use –** in terms of proposed land use, the PLR model was only applied to the specific projects outlined in the watershed plan. To be better able to plan for impacts associated with the change in land use, the model should be run with the future land uses to be able to plan ahead and identify potential hot spots or areas that might need preservation. This will involve working with the Planning Commission in order to get the proper land use information from their 2015 projections. Unfortunately, the mixed land uses proposed by the Commission do not translate well for use in the model.

7. **Source reduction -** One of the biggest lessons learned from the model is the impact of impervious area when determining pollutant loads. The sheer amount of run-off in the developed subbasins seems to make the task of raising the WQTLOS almost impossible. Therefore, the best way to help alleviate this problem is by reducing the source of the run-off. **Toward this end, a Low Impact Development manual should be developed Hillsborough County.** It should incorporate some of the issues already discussed such as increased setbacks, clustering of development, and devices that hold water on-site, preferably for some type of reuse such as irrigation.

16.5.4 SPECIFIC RECOMMENDATIONS

16.5.4.1 State Fairgrounds Property

The State has been recently approached by a major mall development company about the possibility of placing one of the State's largest malls on this property in the ELW. In return, the developer will redevelop the fairgrounds at another site within the County. Due to the existing ponds on the site, existing LOS is relatively high for those subbasins, with TSS LOS of either A or B. For treated subbasins, the TN LOS is at C and at LOS D in the untreated subbasins. This LOS should not be allowed to degrade. Development of the fairground parcels would provide an excellent opportunity to explore some of the Low Impact Development measures now being tried throughout the country. Other source reduction measures such as parking lot sweeping, the decrease of impervious areas and retrofitting may also be appropriate for the site. In the case of sweeping, if a curb and gutter system is required, designing it as part of the overall site plans will be the best time to tackle that issue.

16.5.4.2 Harney Prairie

This is the largest block of undeveloped property in the watershed. As the future land use map, Figure 2-6 shows, this area will evolve from an agricultural area to an area of mixed urban use including both residential and commercial land uses. Measure should be taken now to acquire this property as an offset against future development. Its restoration would go a long way toward mitigating some of the impacts that are sure to come with the change of land uses in other portions of the watershed. Within two years of approval of this plan, this property should be nominated for inclusion in the ELAP program.

16.5.4.3 East Lake Management Plan

A lake management plan should be developed for East Lake. This plan should be created by a group consisting of representatives of the area landowners, the regulatory agencies and other involved parties such as the Audubon Society and the Florida Department of Transportation. Included as part of this plan would be the future whole lake alum treatments and associated vegetation plantings.

Due to time constraints and staffing problems, public meetings were not able to be held in the manner which had initially been planned. However, at least one and most likely two meetings will be held in the future for this watershed.

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:

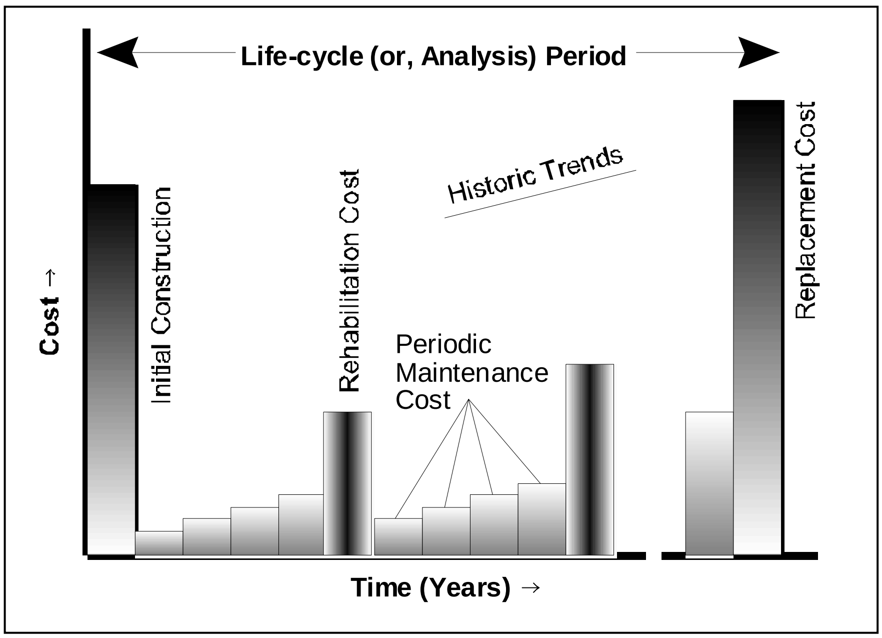
- Inflation – for example, in cost of money, materials, and labor
- System aging – requiring more effort to achieve the same performance (i.e., level of service)
- Technological enhancements – consider increases in performance made possible by new materials, methods, or systems
- Changing regulatory 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 are 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. Error! Bookmark not defined. 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 excess 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 DELANEY CREEK AREA WATERSHED ASSETS

The Delaney Creek Area watershed includes a primary channel drainage system that receives and conveys discharge from numerous secondary and local stormwater systems to Tampa Bay. 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 treatment 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 Delaney Creek Area watershed falls within portions of the Central and South Service Areas.

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. Stream Dumping Regulations (SDR)

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. Coastal Erosion Protection Maintenance (EPM)

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

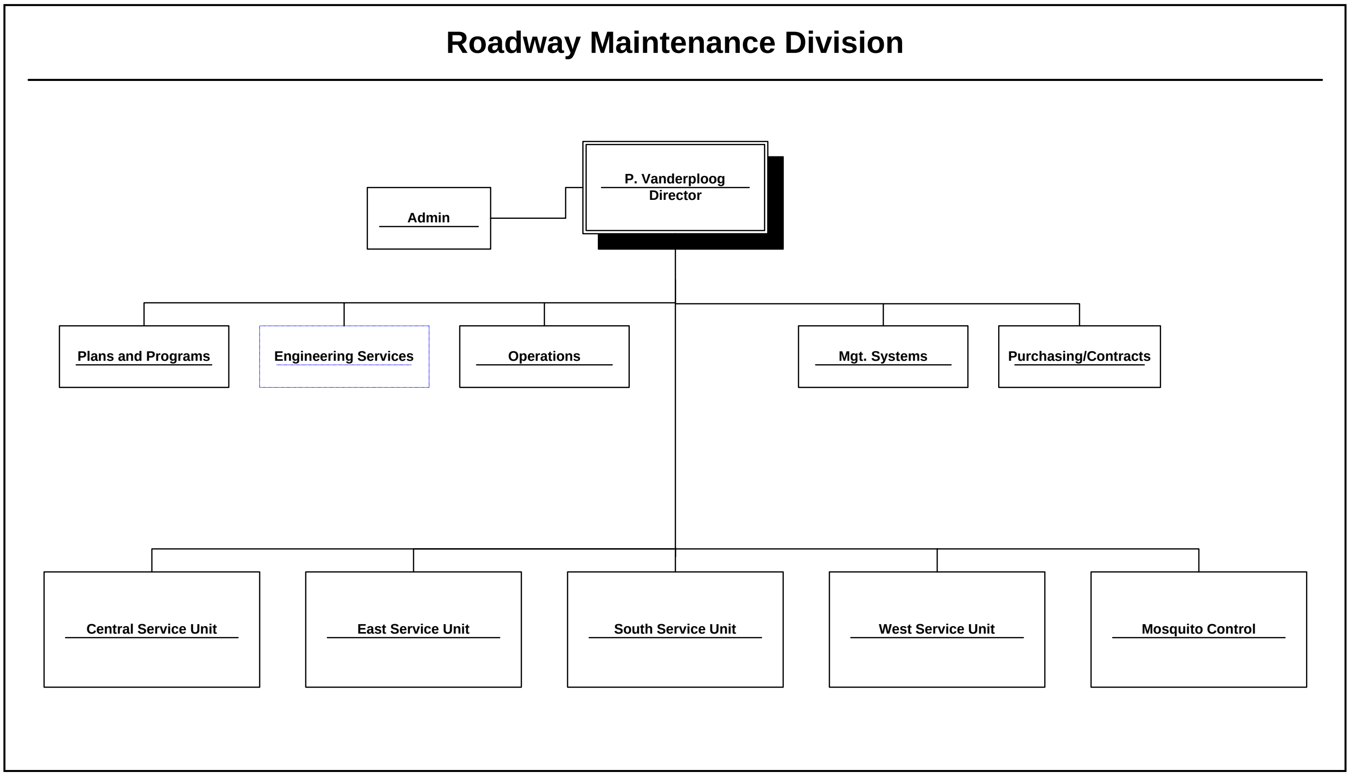
The County maintenance's authority and responsibility extends to the entire jurisdictional area of the County. Undeveloped areas deliberately receive less frequent maintenance than the developed and populated areas. Maintenance is not improvement. Where the basin CIP program is not yet complete, the 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.

2. **Description of Community's Drainage System**. The County is presently in the process of identifying all the Stormwater Assets that it owns. This inventory is scheduled to be completed by December 2001.

Figure 18-2
Organization Chart



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 the responsible entities

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 InnovationError! Bookmark not defined.

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 is 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 attempts 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 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 RECOMMENDED PROJECTS

19.1 INTRODUCTION

Flooding problem areas and their recommended solutions have been identified and described in this chapter. Figure 18-1 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:

1. East Lake Outfall
2. Upgrade stormwater conveyance/collection network
3. Construction of an off-line alum treatment system for the outfall canal from East Lake
4. Retrofitting of the affected basins with measures such as baffle boxes and / or curb inlet protectors.
5. Streets sweeping where appropriate on streets with curb and gutters.

Orient Park Outfall

1. Upgrade stormwater conveyance / collection network downstream of Orient Road
2. Channel Improvements
3. Provide local, controlled stormwater treatment and attenuation upstream of Orient Road

Judson Creek / Grant Park Outfall

1. Upgrade Stormwater conveyance / collection network at Terra Ceia Drive conveyance system to provide additional storage and manage remaining

Figure 19-1 Not Available At Time of Posting

flow from I-4

2. Proposed 2.5 acres detention pond located at subbasin 101655.

MONITORING PLAN

D.1 CURRENT MONITORING

Presently, there is only one area inside the watershed where water quality monitoring is being done. This is the LaMP / LAKEWATCH site for East Lake. On this location, four parameters are being measured. These are the standard parameters to determine a Trophic State Index (TSI). The first is water clarity as measured in Secchi depth. The second and third are nutrients in the form of total phosphorus and total nitrogen. Finally, algal content is determined as a function of chlorophyll *a* concentration.

While the Environmental Protection Commission has sampled waterbodies in the County since the early 1970's, they have no permanent sampling stations inside the watershed. They have; however, taken samples on East Lake as a result of citizen's complaints. While not in the watershed, EPC does have a site at M. L. King Boulevard and the Tampa By-Pass Canal. This is in the vicinity of the East Lake Outfall. Similarly, the Southwest Florida Water Management District maintains no staff gauges or other sampling stations in the basin. There are no USGS flow gauges present.

D.2 RECOMMENDED MONITORING

D.2.1 LaMP / LAKEWATCH MONITORING

The present LaMP / LAKEWATCH monitoring on East Lake should continue. Since the coverage of these two lakes has not been continuous over the years, the program may want to consider trying to form monitoring teams for the lakes rather than having just individuals. This way if an individual can no longer do the monitoring, there will be no loss in sampling continuity; the other member(s) of the team can carry on. Another member can then be recruited and training by the team can begin.

D.2.2 OTHER MONITORING

Other types of monitoring should be expanded within the watershed. These should include the monitoring of rainfall, sediments, stream flow and water quality.

D.2.2.1 Rainfall Monitoring

The first type of additional monitoring should be for rainfall. A rainfall gauge should be installed in the basin, preferably on East Lake, to record the amount of rainfall occurring in the watershed. At this point in time the nearest station is at Tampa International Airport. This information could be used to predict flooding in the watershed. It would also be useful in determining atmospheric deposition of pollutants in the watershed. More watershed specific information would allow more accurate prediction of pollutant loading through the use of the Pollutant Loading and Removal model.

D.2.2.2 Sediment Monitoring

Sediments also need to be monitored in the watershed. This needs to be done primarily in the basin's stormwater treatment and conveyance systems, but it should include natural systems such as the East Lake and its outfall creek. Two aspects should be monitored.

The first is the rate of sedimentation in the system. This information will be used primarily in determining when the system(s) needs maintenance. Toward this end, the "ideal" configuration should be agreed on for each part of the system that takes into account aspects of the system such as conveyance, water quantity, water quality, wildlife habitat and maintenance. Once this configuration is agreed upon and approved by all involved departments and agencies, including regulatory, all future maintenance should be done in accordance with this model. After the first maintenance event, a professional land surveyor should be employed to generate "as-built" cross-sections of each area that can be used as a permitting baseline for all future maintenance events.

The second aspect of sediment monitoring that needs to be addressed is the possible chemical contamination of sediments. A problem that has recently arisen throughout the County is the inability to dispose of sediments found in stormwater systems because they have been designated as possible hazardous waste by the Florida Department of Environmental Regulation. A sampling program needs to be enacted that will investigate this possibility. For those areas that are found not be meet the hazardous materials criteria, monitoring should continue to verify that there is no change in this status. These soils, when removed, should be sent to a County facility for storage and reuse in future County projects. For those areas found to be contaminated, additional monitoring may need to be instituted to find the source of contamination, if it is not obvious.

D.2.2.3 Flow Monitoring

In order to get a more accurate representation of pollutant loading in the watershed, a flow monitoring station should be set up in the watershed. The best area for this in the basin would be at the outfall of East Lake into its outfall creek in the area of Interstate 4. An automatic sampler should also be installed to take corresponding water quality information.

D.2.2.4 Alum Treatment Facility

Studies have shown that alum treatment may be toxic to some aquatic animals. This is due to aluminum and zinc. Water quality should be monitored above the inflow structure to the treatment facility and just downstream of the facilities outfall. Zinc and aluminum should be tested for in both sets of samples to determine the how much of these toxic metals are being introduced into the aquatic system.