ROCKY / BRUSHY CREEK WATERSHED MANAGEMENT PLAN

(Chapters 1-15)

Submitted to:

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December 2007

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EXECUTIVE SUMMARY

Introduction

In September 2003, Hillsborough County retained Ayres Associates Inc to update the Watershed Management Plan (WMP) for the Rocky/Brushy Creek watershed, which was originally prepared in 2001. The main objective of this project is to perform water resources, natural systems assessment, Total Maximum Daily Load, and water quality modeling for the watershed and prepare its supporting documents.

This study does not include the task of updating hydrological and hydraulic models for the watershed. As a result, Chapters 1 through 6 of this report remain for the most part, similar to the original version prepared in 2001. Throughout the report, where water quantity is discussed, this was generally left unchanged. Chapters 7 through 15 have been added to the report to reflect recent watershed conditions and studies performed during this study.

Based on the information collected and the analysis performed, a series of alternatives were developed to address water quality issues within the watershed. Chapter 15 presents the recommended projects for water quality improvement. In addition, a cost estimate for each recommended project was prepared. Since no hydraulic analysis could be performed, the accurate project sizing was not known. Therefore, project costs presented in this report may be subject to adjustments, depending on their actual size and detailed designs.

Existing Condition

The Rocky Creek/Brushy Creek watershed lies in the northwest portion of Hillsborough County and in the southern portion of Pasco County. The Brushy Creek drainage area is in the eastern portion of the watershed and the Rocky Creek drainage area is in the western portion of the watershed. Rocky Creek and Brushy Creek join at a confluence point south of Gunn Highway. There is a portion of the watershed that lies mostly within the political boundaries of Pasco County. It has outfall connections to the Anclote River and to Rocky Creek. Significant residential areas located in the RBA watershed include: Cheval, Calusa Trace, Van Dyke Farms, Belle Meade, Hammock Woods, Cumberland Meadows, Mandaron Lakes, Eagle Brook, Turtle Creek, Woodbriar West, Indian Lakes, Heather Lakes, Northdale, Carrollwood Village, Logan Gate, and Plantation.

Water Quality, Natural Systems, and TMDL Requirements

The assessment of existing water quality and natural systems for the watershed is presented in Chapters 7 and 8, respectively, while water supply issues are discussed in Chapter 9. The existing information was used to perform pollutant loading and removal modeling (Chapter 10). The modeling results were used to develop water quality level of service (LOS) that is discussed in Chapter 11. Public involvement process and survey of potential contaminant sources are described in Chapters 12 and 13, respectively. Subsequently, best management practices (BMPs) were developed to address existing water quality issues that are presented in Chapter 14. In selecting the location for final structural BMPs, attempts were made to identify and use available publicly owned properties. Additional exploratory site visits were also performed to examine the suitability of the sites for specific projects. Final recommendations along with individual preliminary cost estimates are presented in Chapter 15.

To meet water quality standards both the Federal (Clean Water Act [CWA]) and state (Chapter 62-302, Florida Administrative Code [F.A.C.]) rules apply, and certain actions must be taken to protect, restore, and maintain water quality. In addition, for the area of this project, discharges to surface waters are also regulated by the Florida Department of Environmental Protection (FDEP), Southwest Florida Water Management District (SWFWMD), Hillsborough County Environmental Protection Commission (HCEPC), and/or the US EPA, depending on types and magnitude of the discharge. Water quality assessment of the watershed and TMDL evaluations were conducted taken into considerations all the applicable regulations by collecting water quality data and using a water quality model described in Chapter 7. A brief summary is described below.

Overall Water Quality Level of Service (LOS)

Using an average score for all water quality parameters combined, the overall LOS score for the entire watershed is an F. The scores of D and F for total nitrogen, total phosphorus, and TSS dominated the watershed, with greatest concentrations located towards the center and south of the watershed, where major residential neighborhoods are located. This area is predominantly comprised of various density residential land uses. These land uses contribute large quantities of various pollutants into surface water bodies. The overall low LOS score for the entire watershed (F) indicates that most subbasins have been developed and extensive contiguous natural systems do not exists in the watershed.

Unless effective treatment measures are implemented, continued loading to surface waters in the watershed, and eventually into Old Tampa Bay, may result in significant water quality degradation. Efforts to reduce loading of pollutants to the Rocky/Brushy Creek, channels, lakes, sinkholes, and groundwater should be incorporated into future management activities for the watershed. Reduction of pollutant loading should include implementation of local and regional stormwater best management practices (BMPs) to reduce or eliminate pollutant loading to receiving waters. To achieve this goal, a variety of BMPs, such as wet detention ponds, baffle boxes, alum treatment, improved wastewater treatment systems, and restoration of natural ecosystems may be used.

Natural System Conditions

The Rocky/Brushy Creek watershed area encompasses 38,201 acres in Hillsborough County. The watershed contains plant communities, both terrestrial and aquatic, that provide a variety of important environmental functions, including habitat for listed species and other wildlife, stability for stream banks and lake shores, improvement of water and air quality, protection of coastal shorelines from storm surges, and moderation of water and air temperatures. However, plant communities have undergone several periods of significant alteration since the 1830's as land use in the watershed changed from original conditions to agriculture to the current suburban/urban uses. Land use shifts have left the watershed with substantially less acreage in native plant communities, impaired water quality in streams, degradation of all plant communities by non-native invasive plants, highly disturbed stream banks and lake shores, and a reduction of length of coastal shoreline protected by marshes. Most populations of native wildlife have been reduced and/or eliminated. The changes to the natural system impact ecosystem behavior in ways that may alter water quality and viability of habitats. In order to remedy the adverse impacts to water quality, maintain healthy habitats, and meet the regulatory requirements, appropriate BMPs are recommended. Such recommendations are made based on the survey of existing natural conditions and water quality improvement goals.

Regulatory Background/TMDL

The Total Maximum Daily Load (TMDL) was originally promulgated as a part of the Federal Water Pollution Control Act and was later expanded by the Clean Water Act (CWA). The law requires states to define state-specific water quality standards for various designated uses and to identify water bodies that do not meet established water quality standards. Water bodies that do not meet such water quality standards as a result of human-induced conditions, are to be considered impaired.

In Florida, the TMDL process is multi-phased and includes identification, verification, and listing of impaired waterbodies, followed by the development and implementation of constituent-specific TMDL for different water quality parameters. Waters within marine segments of Rocky Creek were identified as impaired for dissolved oxygen and nutrients. Fresh water segments of Rocky Creek are not on the FDEP list, but US EPA proposed a TMDL for coliforms, dissolved oxygen, nutrients, and total suspended solids. Brushy Creek is not on the FDEP list, but US EPA proposed a TMDL for coliforms and dissolved oxygen. Two lakes in the watershed, Reinheimer and Brant, are scheduled by FDEP for TMDL development for nutrients in 2008. Public water supply requirements have impacted water levels/quality in both the surface water system and aquifers in the Tampa Bay region and TMDL development for receiving waters will be required in the near future.

Pollutant Loading and Water Quality Level of Service (LOS)

The gross pollutant loading within the watershed was estimated based on the 2004 land use and soils characteristics. The 2004 land use map indicated 10 different land use categories that were evaluated for the pollutant loading model. Water quality evaluations were performed by assessing 12 water quality constituents in receiving waters. Gross pollutant loading was estimated by assuming no treatment of stormwater runoff. This parameter indicates the potential of each land use in yielding contaminants into the environment. To approximate the net pollutant loading within the watershed, the loading reduction due to the existing BMPs, was subtracted from the gross loading value for that watershed. Analyses were conducted at both watershed and subbasin levels. The details of these analyses are discussed in Chapter 10 of this report.

Based on these results, a water quality treatment level of service was determined at the subbasin and watershed levels within the Rocky/Brushy Creek watershed. This type of analysis facilitates prioritization of water quality improvement alternatives for the watershed. Water quality treatment levels-of-service criteria were used as part of this study to allow comparisons of existing and proposed stormwater treatment conditions to pollutant loading goals and to help prioritize alternative BMPs throughout the watershed.

Three water quality constituents were identified and analyzed in greater detail due to their importance in local water quality management programs. These parameters included total suspended solids, total phosphorus, and total nitrogen. In addition, based on specific concerns, some subbasins required assessment of other parameters, including heavy metals and bacteria. Excess nitrogen can stimulate algal growth resulting in reduced light penetration through the water column, resulting in loss of seagrass. Other factors that affect light availability in the Bay are also of concern, including excess total suspended solids. Excess phosphorous can promote eutrophication and algal blooms, leading to degradation of water quality. Results from the pollutant loading model were used to develop LOS for each water quality constituents that are fully described in Chapter 11 of this report.

Structural BMP Alternatives

Analyses were performed using GIS to strategically locate structural BMP sites for water quality and natural systems improvements. Various methods were used to identify feasible alternative projects for implementation that are described extensively in Chapter 14. Water quality conditions were evaluated using the County's Water Quality Treatment Level of Service criteria and pollutant loading model. The proposed alternatives are developed to improve water quality and natural systems consistent with the overall goals of the County.

Recent aerial photos were used to identify the most suitable and cost-effective sites for implementation of structural BMPs. The main criteria for site selection included proximity to streams/rivers (500-meter buffer zone), open areas, and publicly owned properties that are readily available for stormwater treatment in the form of retention or detention facilities. Initially a total of 104 locations for potential sitting of structural BMPs are identified. Of the 104 potential sites, 77 fall within the 500-meter buffer of major streams. GIS analyses were performed to verify that the identified sites had no existing construction and were open areas suitable for construction of a stormwater treatment facility. The analysis showed that only 37 of the 104 identified sites met this criterion. Further GIS analyses were performed to identify the parcels that were publicly owned. This resulted in 6 sites that met all the criteria. A field survey was conducted to examine the feasibility of placing BMPs at these 6 facilities. The survey eliminated three sites due to a variety of reasons discussed in Chapter 15. The three remaining sites are recommended as potential structural BMPs locations based on the established criteria in this study. Site location, photos, maps and detailed preliminary cost estimates are described in Chapter 15. A brief summary of each site and total costs are presented below:

1. Landings

This site is located in the northwestern portion of the Rocky/Brushy Creek watershed within the Lake Park, located along Dale Mabry Highway. It is represented by a small open land parcel located along Landings Point Lane. It is located within about 1,000 feet of a major stream network and is governmentally owned. The closest major intersection to the area is Dale Mabry Highway and Veterans Expressway. The parcel is located in the middle of what appears to be an upland hardwood area. It is suitable for construction of a stormwater treatment facility. The estimated cost of implementing such facility is $907,658.

2. Webb Road

This site is located within Town'N'Country Greenway in the southeastern portion of the Rocky/Brushy Creek watershed. According to the aerial photography of the area, this parcel is represented by a narrow strip of open land located at the junction of two streams: Rocky Creek and Channel "G". The parcel can be accessed via Webb Road, with nearest major intersection of Sheldon Road and Memorial Highway. It is under governmental ownership, eliminating the need for land acquisition. It is deemed suitable for construction of a stormwater treatment facility and/or a retention pond. The estimated cost of implementing this facility is $250,946.

3. Hamilton Avenue

This site is located in the south central portion of the Rocky/Brushy Creek watershed within Hamilton Park. According to the aerial photography of the area, this parcel is a relatively large open land area located along Hamilton Avenue. The nearest major intersection is Sheldon Road and Hamilton Avenue. It is under governmental ownership, eliminating the need for land acquisition. It is suitable for construction of a stormwater treatment facility and/or constructed wetland. The estimated cost of implementing this facility is $1,591,000.

In addition to the structural BMPs enumerated above, there are various state and local agencies that provide educational and outreach materials for the public at large and academic institutions. The specifics of these educational programs are presented in Chapter 15.

CHAPTER 1: INTRODUCTION

1.1 Project Location and Description

The Rocky Creek/Brushy Creek (RBA) watershed lies in the northwest portion of Hillsborough County and in the southern portion of Pasco County. The Brushy Creek drainage area is in the eastern portion of the watershed and the Rocky Creek drainage area is in the western portion of the watershed. Rocky Creek and Brushy Creek join at a confluence point south of Gunn Highway. There is a portion of the watershed that lies mostly within the political boundaries of Pasco County. It has outfall connections to the Anclote River and to Rocky Creek. The portion within Pasco County is not included in the study area for RBA; however, the Pasco County portion has been evaluated by private developers and their results have been incorporated for the purpose of accounting the runoff from these areas and the effect that such runoff may have on streamflow in the Hillsborough County portion of the watershed. The location of the RBA watershed is indicated on Figure 1-1.

The RBA project area contains mostly urban land use/cover. Significant residential areas located in the RBA watershed include: Cheval, Calusa Trace, Van Dyke Farms, Belle Meade, Hammock Woods, Cumberland Meadows, Mandaron Lakes, Eagle Brook, Turtle Creek, Woodbriar West, Indian Lakes, Heather Lakes, Northdale, Carrollwood Village, Logan Gate, and Plantation.

1.2 Current Management of the Watershed

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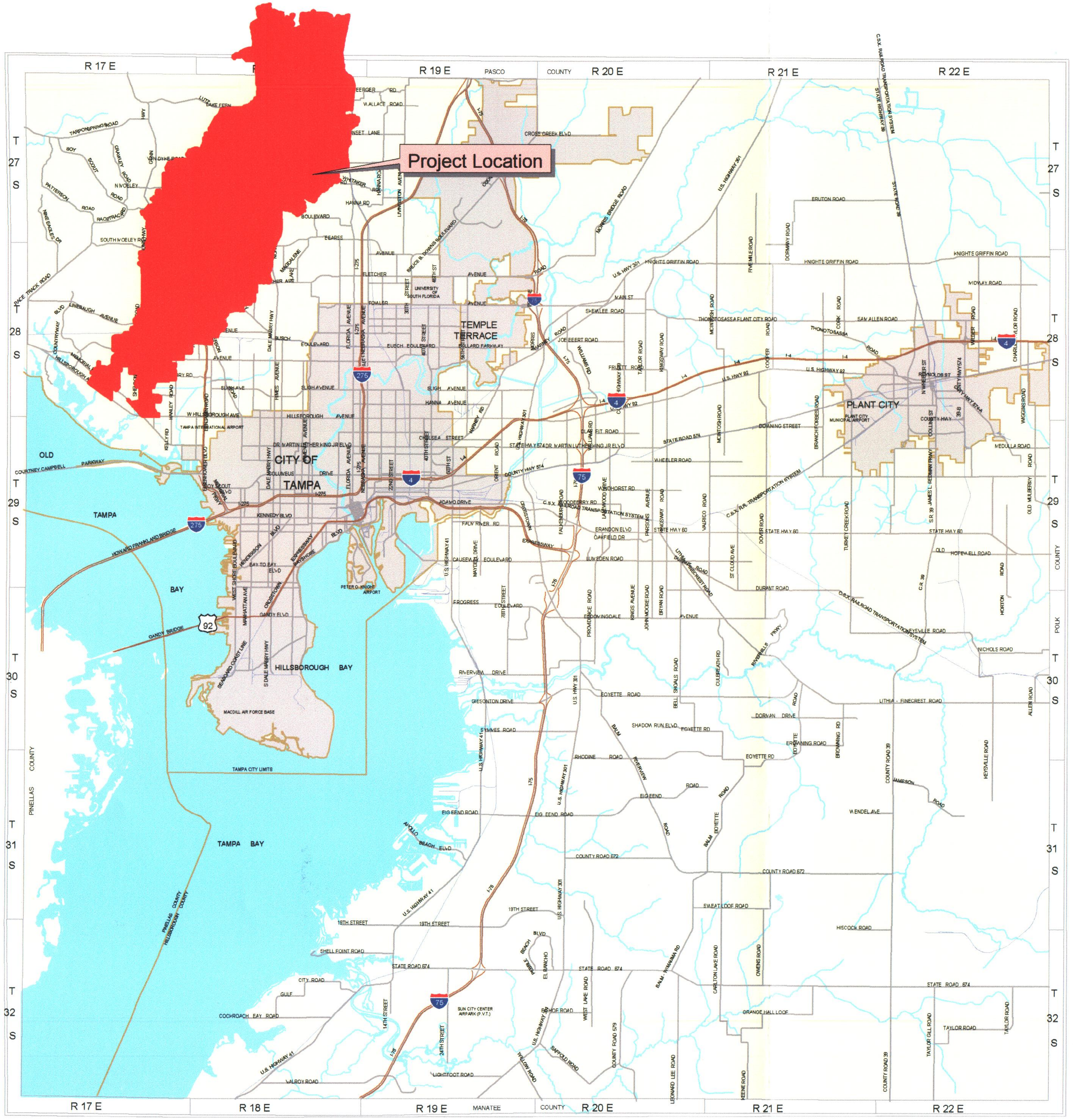
1.3 Climate of the Rocky/Brushy Creek Watershed

The climate in Hillsborough County can be characterized as subtropical. The average annual rainfall is approximately 50 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.



ROCKY BRUSHY AREA STORMWATER MANAGEMENT MASTER PLAN (SEPT 2002)

LEGEND

- ROCKY BRUSHY AREA
- MINOR ROAD
- WATER FEATURES

FIGURE 1-1
PROJECT LOCATION MAP

Hillsborough County
Florida

Department of Public Works
Engineering Division
Stormwater Management Section

N

4000 0 4000 Feet

1.4 Historical Flooding

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1.5 Scope of the Project

The scope of the project includes the establishment of the existing conditions for the RBA 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.

Water surface profiles showing computed water surface elevations at major conveyance systems along the Rocky Creek main channel, along the Brushy Creek main channel and also Lake Ruth system, Channel A and Carrollwood are included. Computed water surface elevations on channels and /or waterways are frequently lower than the expected flood elevations at adjacent or offline sites. Stage at points outside the immediate flood plain 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.

Based on the 1998 RBA Masterplan report, there are four areas of focus for recommended improvements in the proposed condition. The majority of these improvements have been implemented. These improvements include structural upgrades and non-structural improvements. All of these efforts will lead to achievement of the Level of Service (LOS), Level B in the Rocky/Brushy Creek Area.

1.6 Background and Data Collection

Camp Dresser and Mckee, Inc. (CDM) developed a Stormwater Management Master Plan (SMMP) for the Rocky Creek/ Brushy Creek watershed in 1986. The CDM study was prepared for the Southwest Florida Water Management District (SWFWMD) and Hillsborough County. CDM used the RUNOFF block of the EPA Stormwater Management Model (SWMM) to compute peak discharge values. They used the U.S. Army Corps of Engineers HEC-2 model to compute flood elevations within the Rocky Creek channel system. Hillsborough County staff continues the effort of updating the CDM model in 1998 using a modified version of SWMM software. The enclosed report is a 2002 update by the Hillsborough County Stormwater Section using a Federal Emergency Management Agency approved version SWMM modified by the County staff, HCSWMM4.31B respectively.

The Federal Emergency Management Agency (FEMA) has published three versions of the Flood Insurance Rate Maps (FIRM) for the RBA watershed. The first was in 1984, and there were subsequent revisions in 1989 and 1992. Many of the existing conditions peak discharge values reported in the CDM 1986 report are also shown in the FEMA Flood Insurance Study (1992). The 1992 FIRM maps show calculated water surface elevations upstream from Gunn Highway that were not included in the previous versions. The inundation areas appear to have been updated on the basis of these computed water surface elevations, and in many areas show larger areas of inundation (Zone A).

In 1989, Gee and Jensen conducted a Flood Insurance Study under a contract with the Federal Emergency Management Agency (FEMA). Existing Conditions peak discharge values were apparently taken from the CDM (1986) report and used to compute water surface profiles with the U.S. Army Corps of Engineers HEC-2 computer program.

Since the completion of the 1986 CDM, and 1998 Hillsborough County Rocky/Brushy Creek Stormwater Management Master Plan, most of the recommended improvements listed in both studies have been implemented. All those completed drainage construction projects have been included in the current existing conditions portion of this report.

The modeling effort reported herein is based partially on the data used by County staff in 1998 and partially on additional data that was not available at the time of the previous studies. It is also based on a hydrodynamic modeling technology that computes discharge and water surface elevation as a function of simulated time.

1.7 Project Objectives

The objective of this study is to develop an existing conditions model for the RBA watershed, as well as to develop a Stormwater Management Plan. The plan shows level-of-service analysis for existing flood conditions and evaluates potential improvements for improving the level-of-service.

CHAPTER 2: GENERAL DESCRIPTION

The Rocky/Brushy Creek Area (RBA) watershed drains approximately 55 square miles of land located in northwest area of Hillsborough County, Florida. The creek has a West and an East Branch, which converge just South of Gunn Highway (State Road 587). The East branch is named Brushy Creek and west branch is named Rocky Creek respectively. The outfall of the RBA drainage system is in the Old Tampa Bay at near Old Memorial Highway through culverts under Hillsborough Avenue. The project area contains a mix of undeveloped and urban land use. Significant residential areas located in the RBA watershed include: Odessa Area, Cheval Subdivision, Cosme Area, Citrus Park, the majority of Carrollwood Area, and the west part of Town N' Country Area.

The RBA drains an area of approximately 55.33 square miles or 35,413 acres in northwest of Hillsborough County. The Watershed is primarily suburban, and drains into Old Tampa Bay. The basin is roughly bounded on its north side by the Pasco County, to its east side by Sheldon Road and Suncoast Expressway, Dale Mabry Highway and US 41 on the east. The Basin, shown in Figure 2-1, is composed of 455 smaller units or sub-basins ranging in size from approximately 1.1 to 791 acres.

2.1 Climate

The climate of the RBA, 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 and 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 existing stormwater systems.

Winter rainfalls is, historically, relatively light and is generally associated with the weak cold fronts that descend from the northern part of the country and travel south through the region. However, in late 1997 and early 1998, some of the largest rain events 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 in the study area.

2.2 Topography

Topography varies from a high of 75 feet National Geodetic Vertical Datum (NGVD) in the north portion of the watershed to a low of below 0 feet NGVD at its outfall at the old Tampa Bay.

2.3 Soils

Soil distribution by type is shown in Figure 2-4. 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 obtained 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 2-5. 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: a) depth to seasonally high water table, b) intake rate and permeability, and c) 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 in./hr when dry and 0.50 in./hr when saturated. Soil types found in the RBA that fall into this group include the Candler fine sands, Orsino fine sand, and the Tavares-Millhopper fine sands.

- 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 in./hr 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 in./hr when dry and 0.25 in./hr when saturated. Soil types found in the RBA that fall into this group includes Seffner fine sand, and Zolfo fine sand.

- Group D (high runoff potential) soils have very slow infiltration rates when thoroughly wetted and a very low rate of water transmission. They have typical infiltration rates of 3 in./hr when dry and 0.10 in./hr when saturated. Soil types found in the RBA that fall within this group include Basinger, Holopaw and Samsula, Chobee muck.

- 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 RBA are Chobee loamy fine sand, Felda fine sand, Floridana fine sand, Immokalee fine sand, Malabar fine sand, Myakka fine sand, Myakka-Urban land complex, Ona fine sand, St. Johns fine sand, Wabasso-Urban land complex and Winder fine sand.

Soils can also be classified as either hydric or non-hydric, which relates to whether the soils had wetland or upland origins, respectively. Those soils designated as hydric develop under anaerobic conditions in wetland areas and generally contain a large amount of organics, 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 RBA are Basinger, Holopaw and Samsula, Chobee loamy fine sand, Chobee muck, Eaton mucky sand, Felda fine sand, Floridana fine sand, Malabar fine sand, St. Johns fine sand and Winder fine sand. All of the other types would be considered non-hydric.

2.4 Land Use / Coverage

Existing Land Uses

As stated previously, the RBA encompasses a wide variety of land uses. The Southwest Florida Water Management District's 1999 Land Use/Land Cover Map is shown in Figure 2-7. Additional existing land use information provided by the County's Property Appraiser's Office is illustrated in Figure 2-8. Figure 2-10 shows the Planning Commission's projected land use for the year 2015. There are several areas of Significant or Essential Upland Wildlife Habitat which exist within the watershed area which are associated with the Rocky-Brushy Creek floodplain and other large lake and wetland areas. Residential areas are concentrated around many of the lakes with other subdivisions scattered throughout the western portion of the watershed. The majority of these residential areas tend to be older subdivisions with little or no stormwater treatment being provided.

Table 2-1 Existing Land Uses (1999)

LAND USE CATEGORY	TOTAL ACREAGE	PERCENT OF TOTAL
Low / Medium Density Residential	3,369.0	16.1
High Density Residential	788.9	3.8
Light Industrial	6.7	-0
Agricultural	3,026.1	14.5
Commercial	303.5	1.5
Institutional	98.4	0.5
Highway / Utility	644.1	3.2
Recreational	47.0	0.2
Open Land	2,431.7	11.6
Extractive (Mining) / Disturbed	5.3	-0
Upland Forested	2,179.2	10.4
Wetland Forested	3,602.5	17.2
Wetland Non-Forested	3,375.3	16.1
Water	1,023.4	4.9
TOTAL	20,901.1	100.0

Future Land Uses

Due to the large lake and wetland areas in the RBA, not many changes in land use are predicted by the Hillsborough County Comprehensive Plan. The majority of predicted changes will be in the north western portion of the watershed as this largely agricultural area is changed over to a mixed urban use of residential and light commercial.

2.5 Physiography and Hydrology

The RBA 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 RBA vary between a high of about 75 feet NGVD in the north portions of the watershed to a low of around 0 feet NGVD at the Rocky-Brushy Creek outfall to the Old Tampa Bay. These elevations are shown on Figure 2-3. The watershed has twelve major outfalls. These include the Channel A System, Carrollwood System, Brushy Creek System, Rocky Creek System and Lake Ruth System. The Lake Ruth Drainage System has a secondary outfall in the northwest to Anclote River Watershed in Pasco County. The remainder of the sub basin discharge south to the Rocky Creek System considered to start at Lutz Lake Fern Road in Hillsborough County. Brushy Creek and Carrollwood Systems have their own secondary outfalls to Sweetwater Creek Watershed.

There are many lakes, wetland areas, and depressions located within the watershed. The numerous lakes and other depressional features in the area have been formed by sinkhole formation and other processes associated with the dissolution of the underlying limestone formations. Small lakes tend to be round, the most common expression of a sinkhole or solution feature. Larger lakes usually are formed by the coalescence of several or many solution features and do not express a characteristic shape.

Surface flows are generally from the north to the south or east toward the Rocky/Brushy Creek Main channels. The Rocky/Brushy Creek Main channel flows north to south from Pasco County to the Old Tampa Bay at Hillsborough Avenue (State Road 580) in the northwest Hillsborough County. Hydrologically, surface flows originate for the most part through stormwater runoff with some influence from groundwater flows from lake seepage.

2.6 Hydrogeology

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

At land surface, undifferentiated sediments including silt, sand, and clay form surficial deposits which vary in thickness from less than 10 feet in coastal areas to over 100 feet in paleokarst 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 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 foraminifers 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 2-6.

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 surface. Water table elevation is primarily influenced by rainfall; annual highs n most years occur during the end of the wet season (in Sept.- Oct.), and annual lows occur 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.

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 Floridan Aquifer. The confining materials are comprised of blue-green to gray, 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 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).

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 evaporate 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.

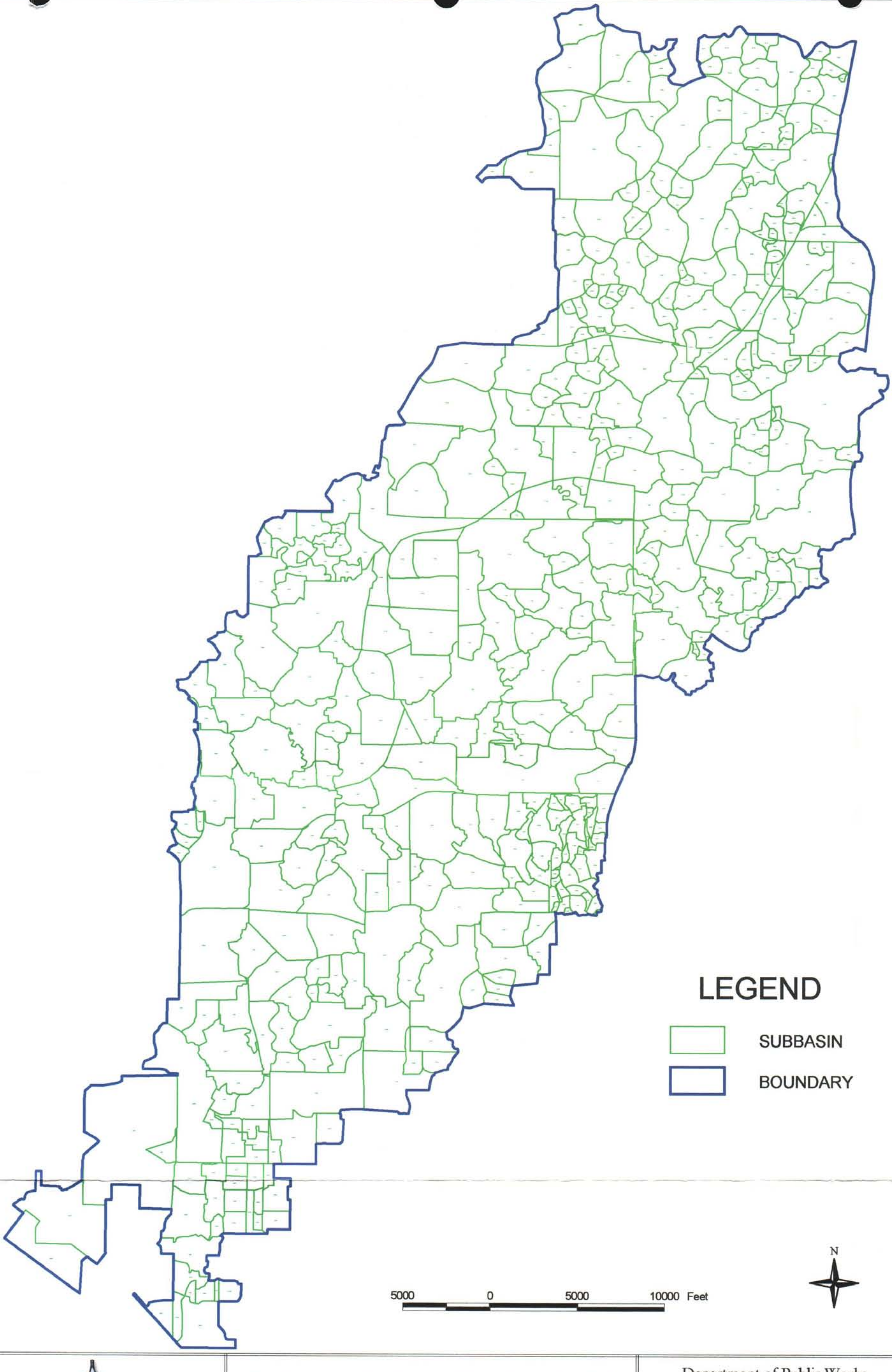

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FIGURE 2-1
WATERSHED DELINENATION MAP

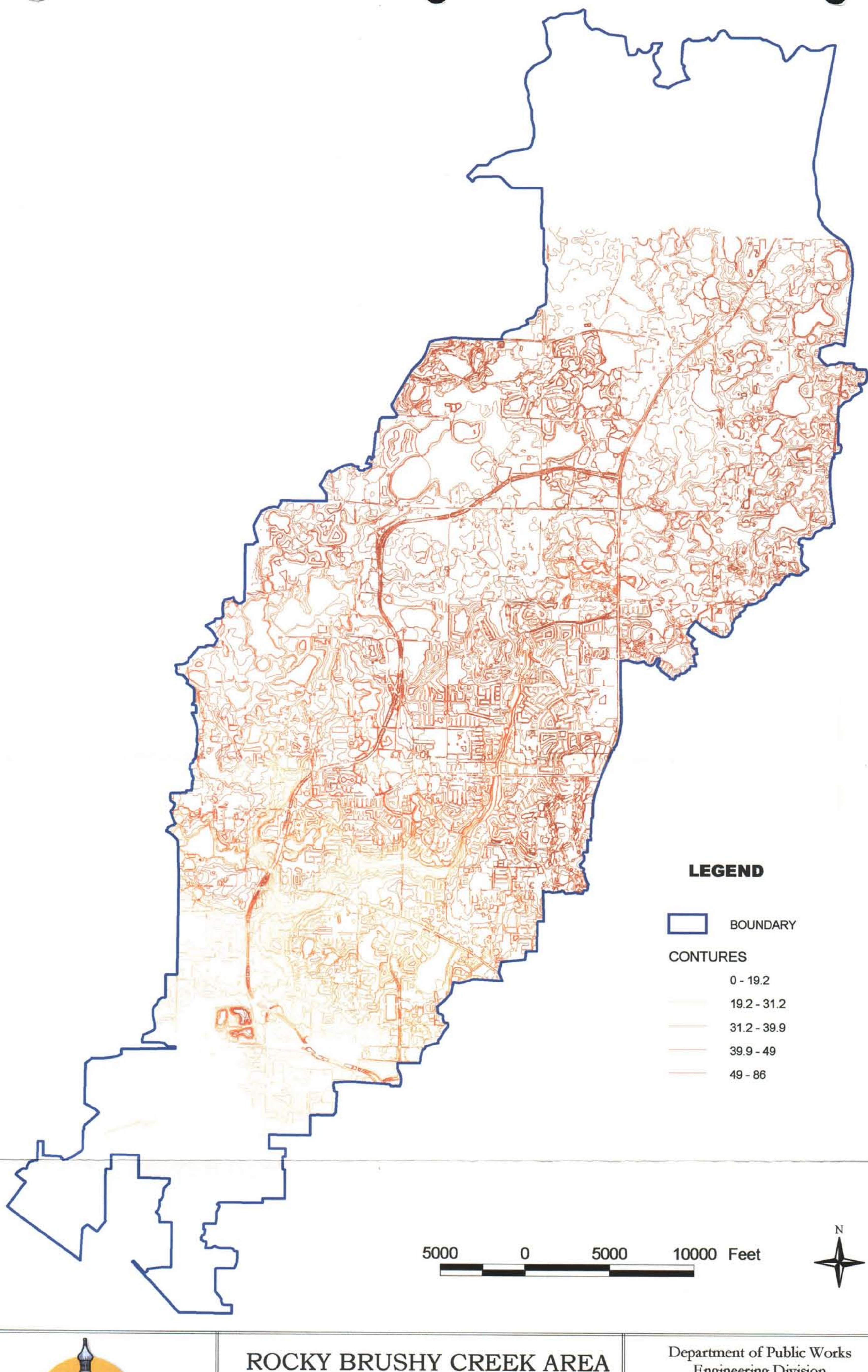

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FIGURE 2-3
TOPOGRAPHIC MAP

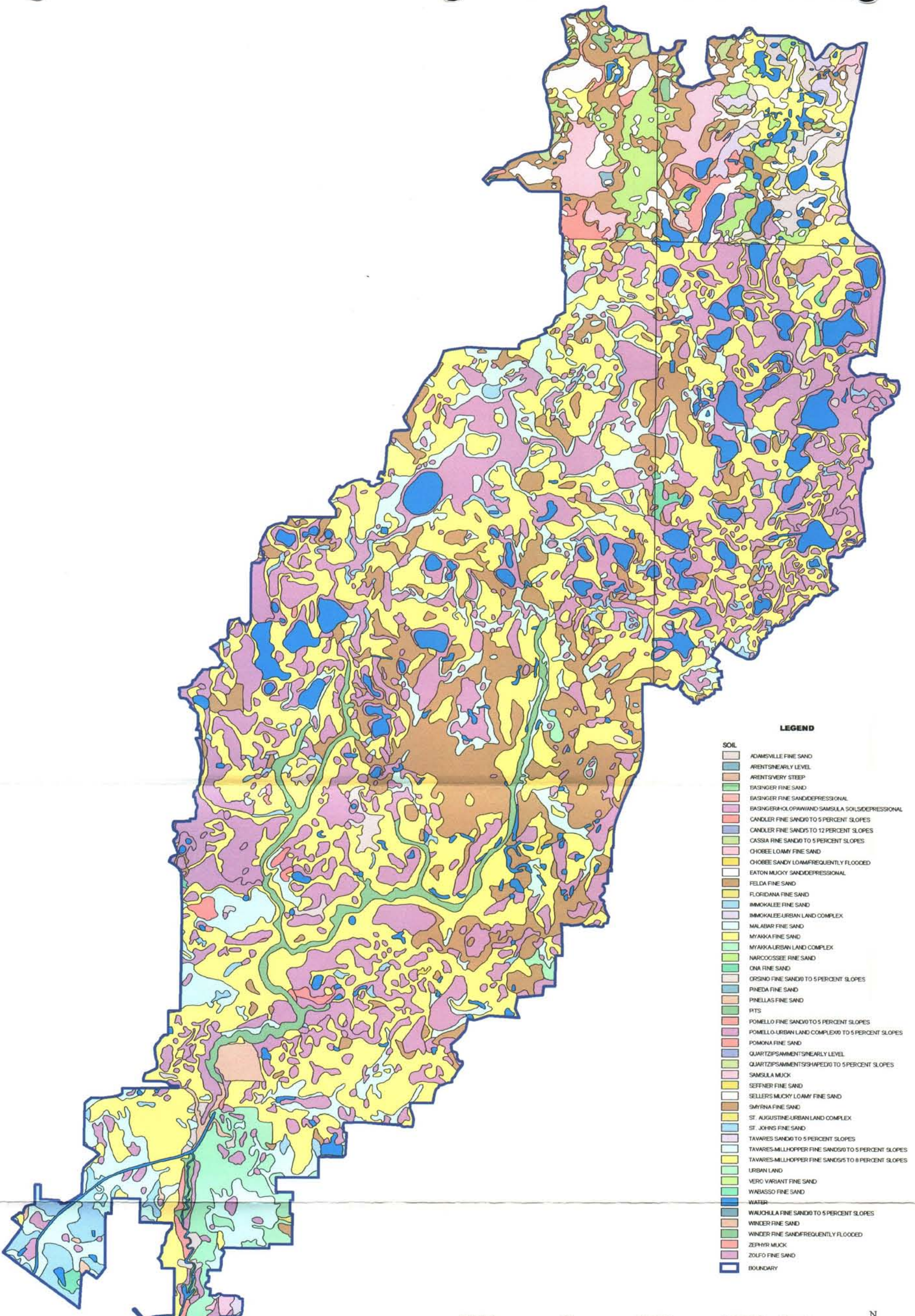

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FIGURE 2-4
SOIL CLASSIFICATION BY TYPE MAP

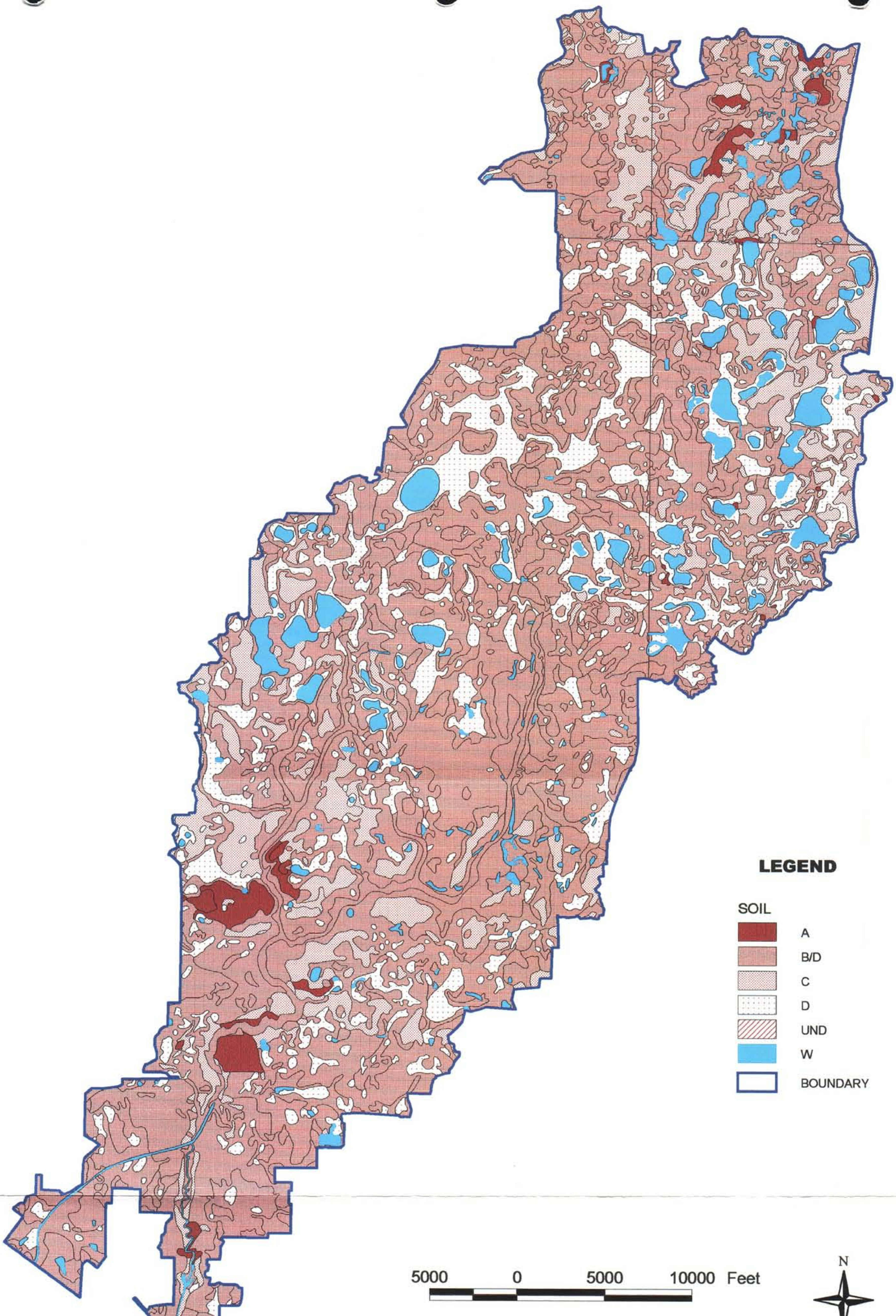

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FIGURE 2-5
Soil Classification By Hydrologic Group
MAP

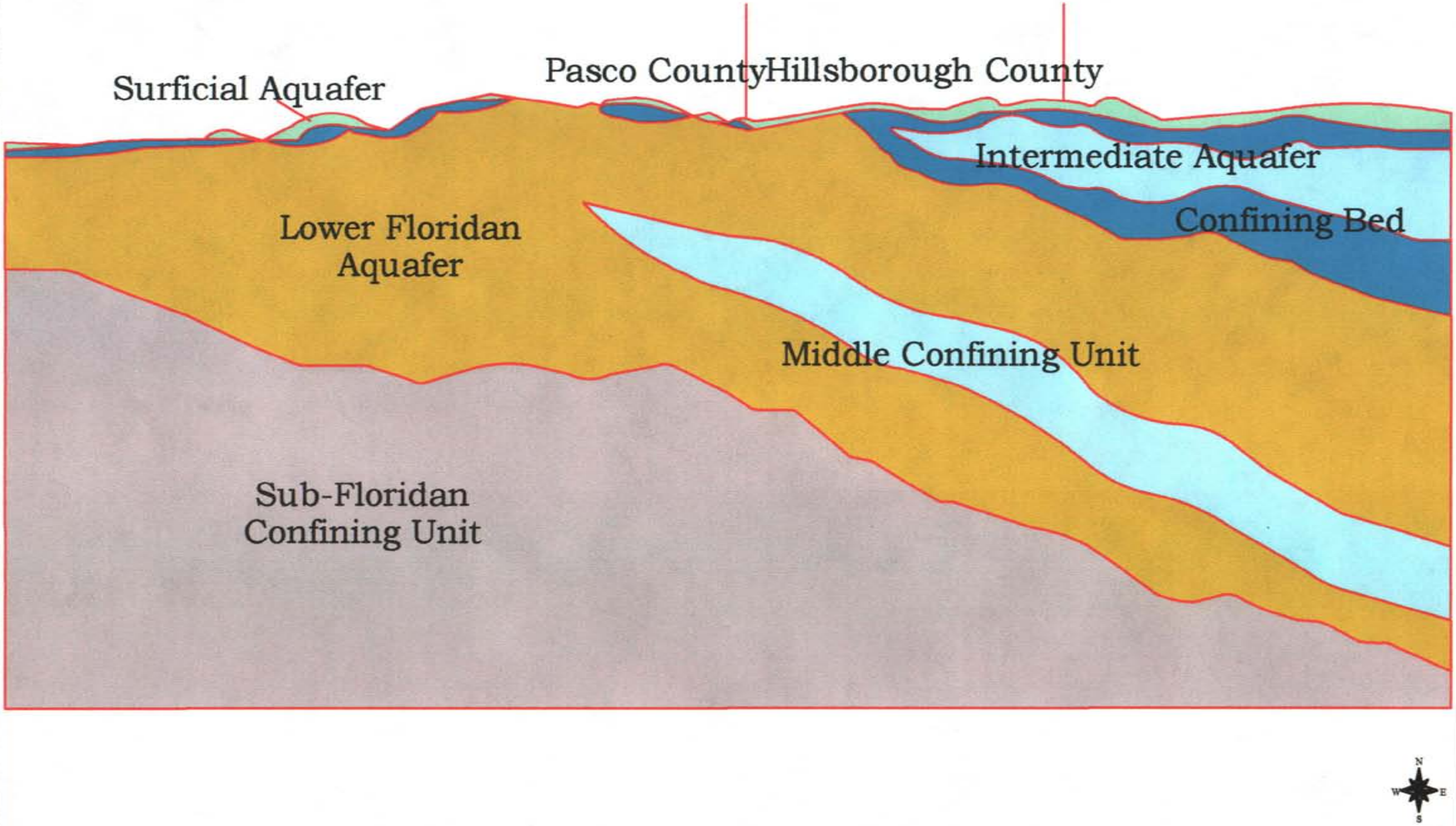

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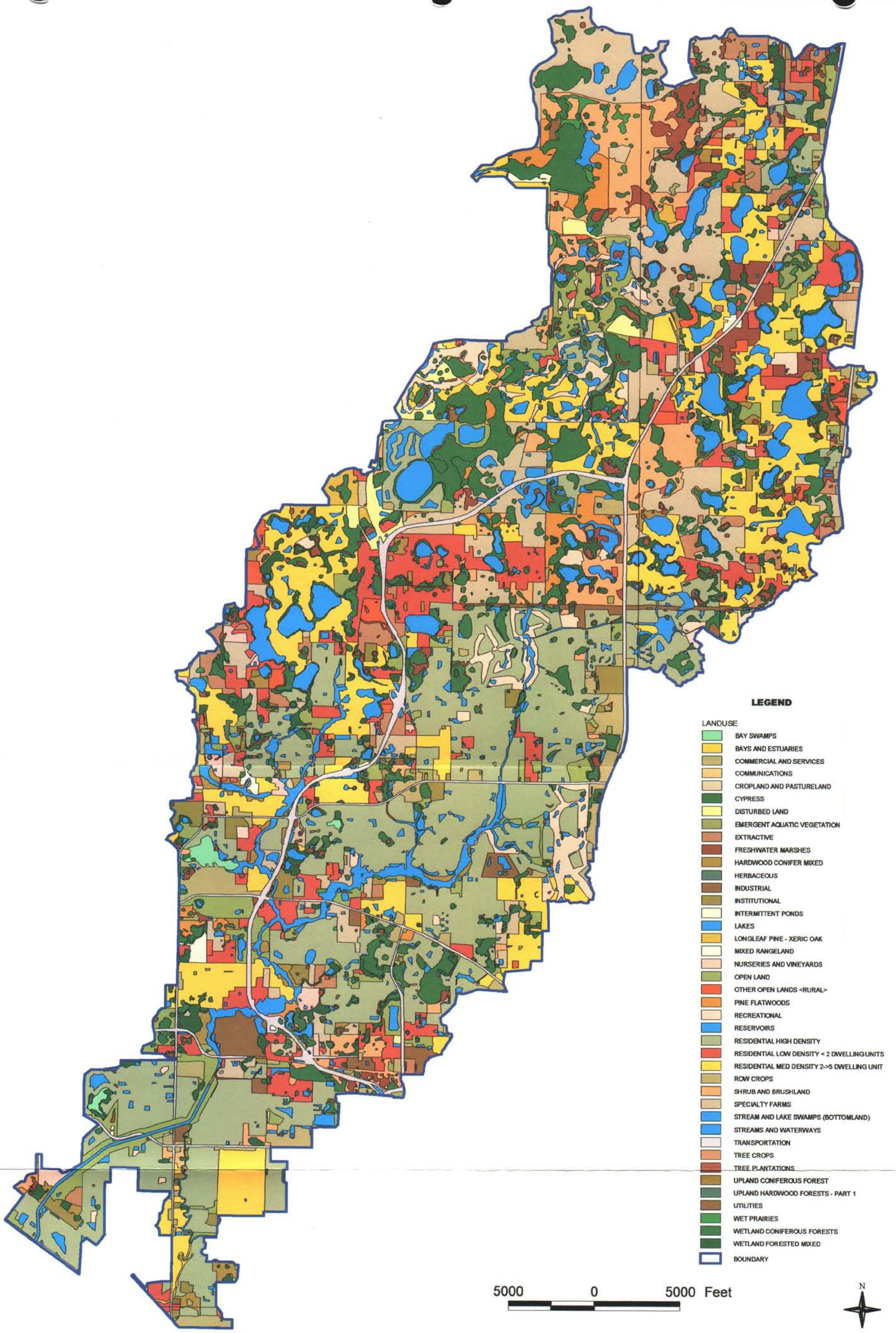
FIGURE 2-6

HYDROGEOLOGIC CROSS SECTION MAP



Hillsborough County Florida	ROCKY BRUSHY CREEK AREA STORMWATER MANAGEMENT MASTER PLAN SEPTEMBER 2002	Department of Public Works Engineering Division Stormwater Management Section FIGURE 2-7 1999 SWFWMD Land Use/Land Cover MAP

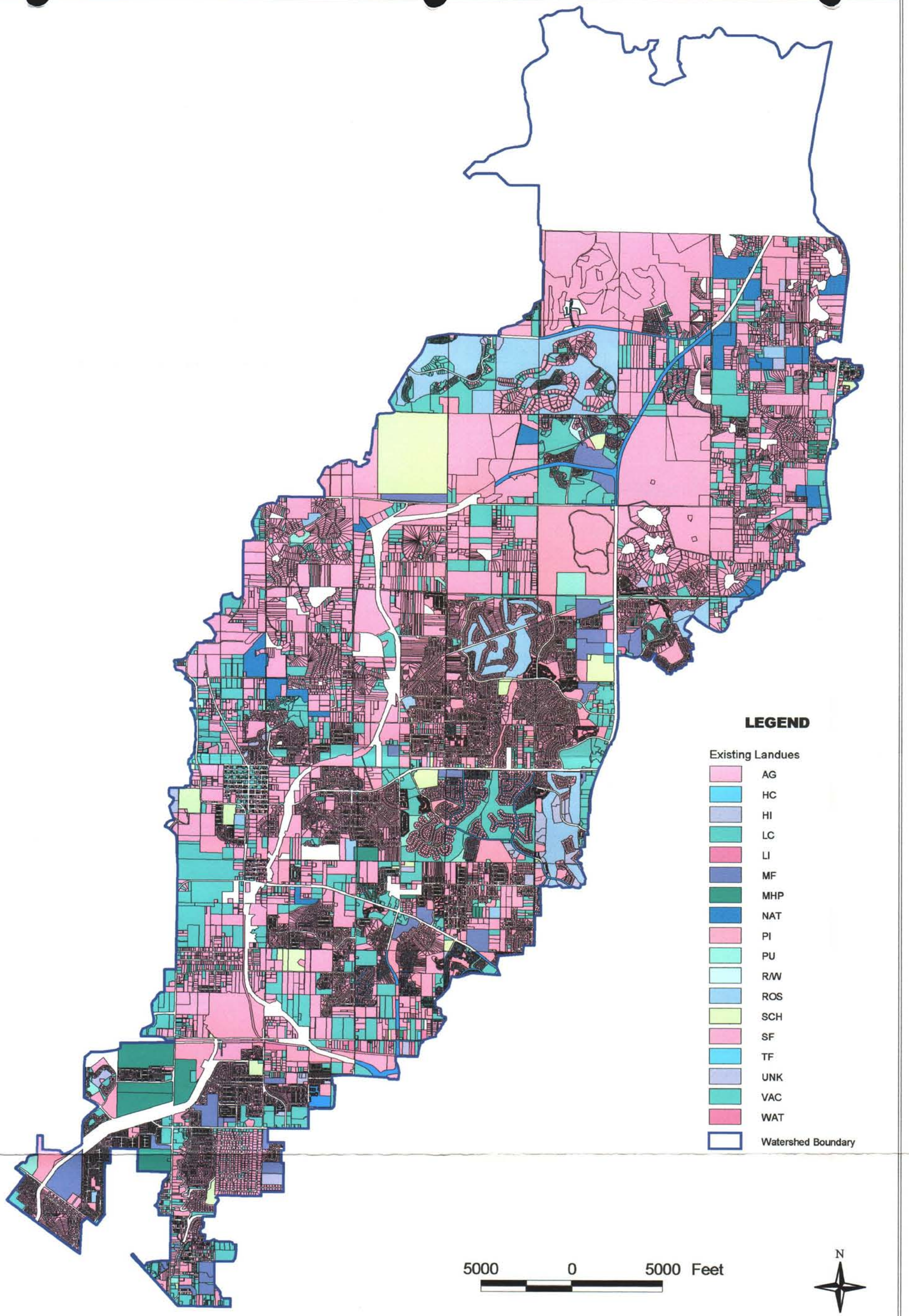


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FIGURE 2-8
EXISTING LAND USE
MAP

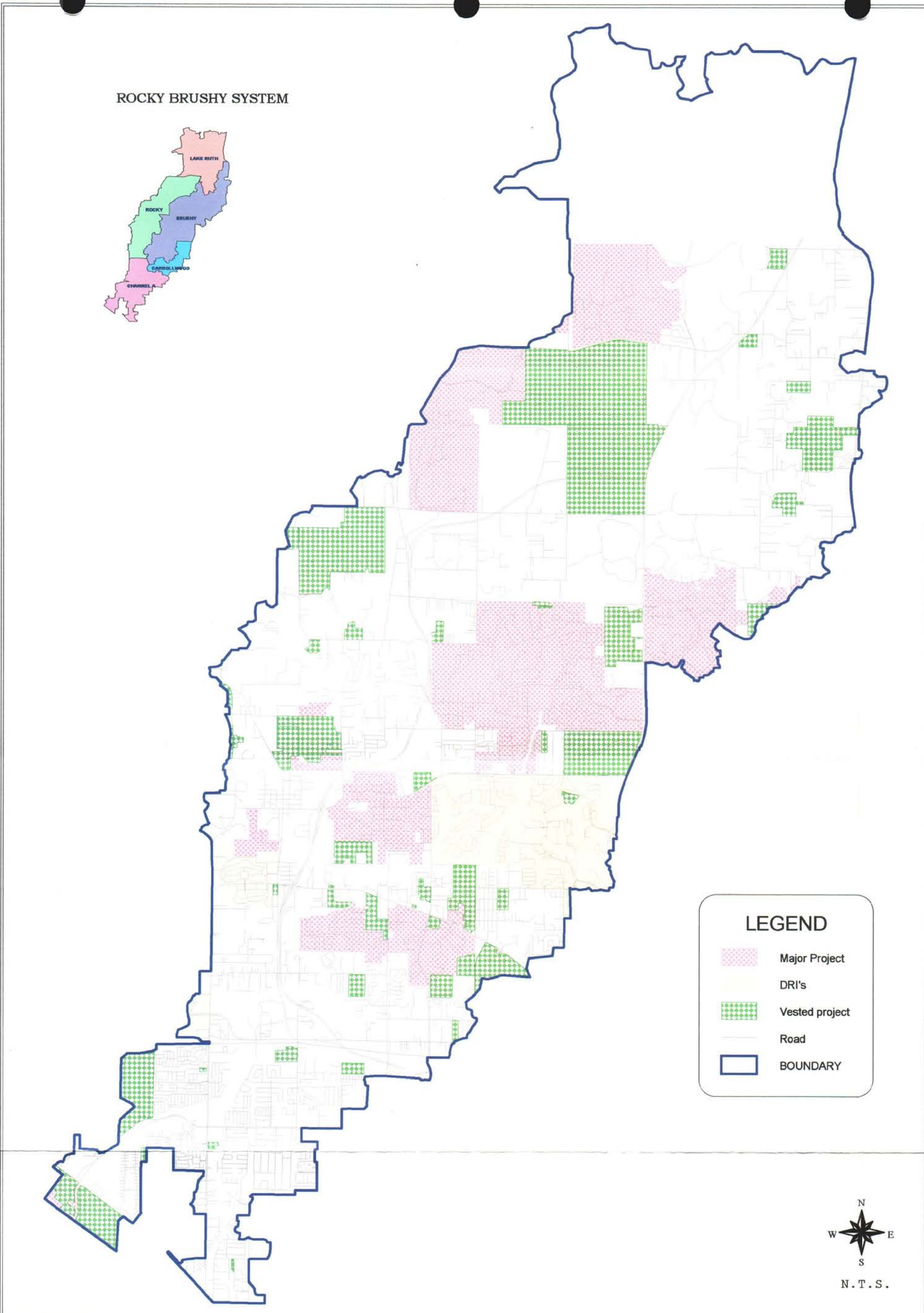

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FIGURE 2-9
Major Project, DRI's and Vested Projects
MAP

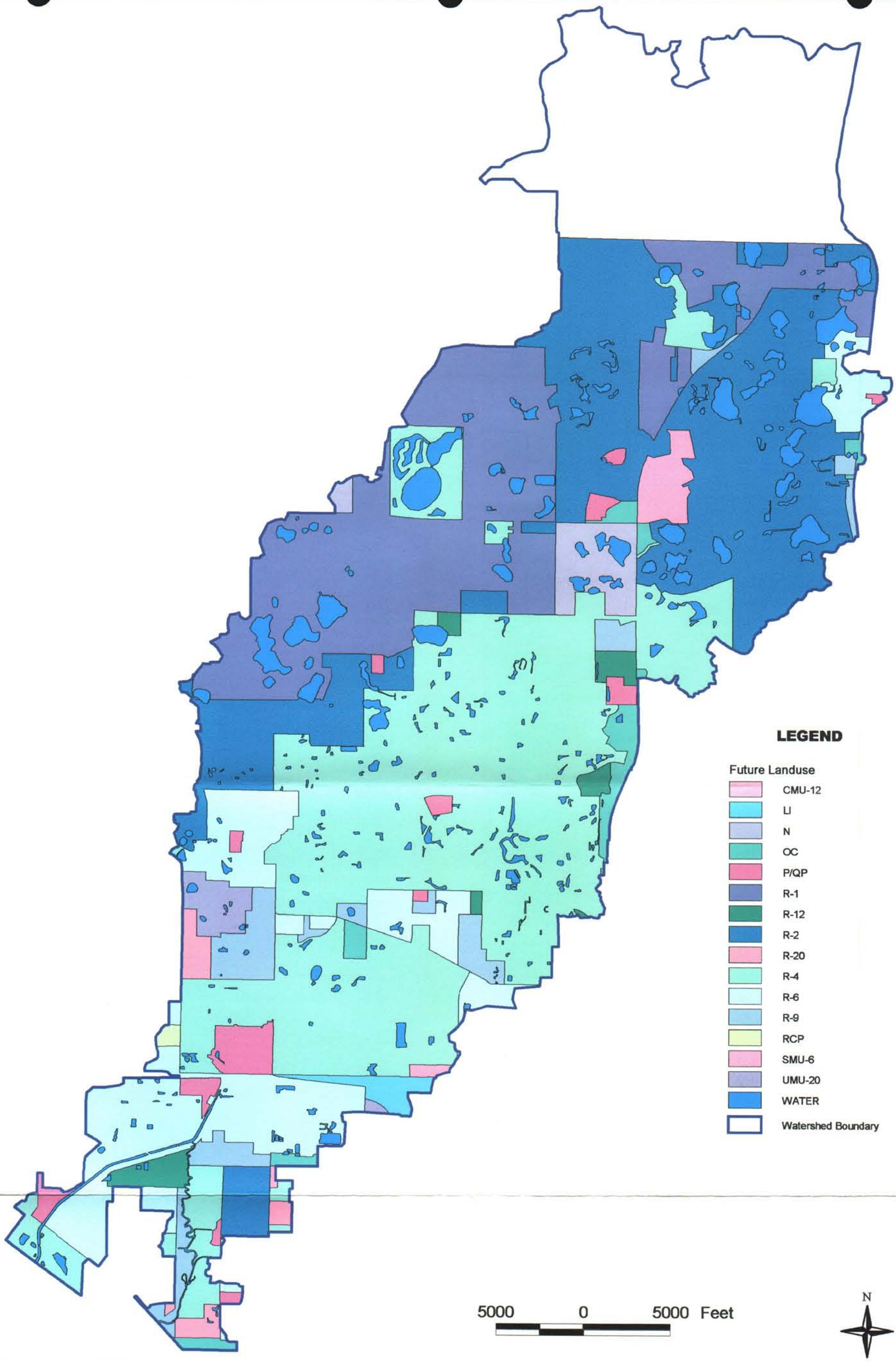

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FIGURE 2-10
FUTURE LAND USE MAP

CHAPTER 3: WATERSHED DESCRIPTION

3.1 Introduction

This chapter contains a general description of the major conveyance systems in the RBA watershed. The existing condition system performance for the major conveyance systems is contained in Chapter 3.

The description of major conveyance systems in the RBA watershed has been segmented into discussion as distinctive five (5) sub-watershed areas. The five sub-watersheds are as follows:

- Channel A System
- Channel D System, with Carrollwood Village
- Brushy Creek System
- Rocky Creek System
- Lake Ruth Area (Hillsborough/Pasco County)

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

3.1 Channel A System (Junction ID 42xxxx series)

The Channel A sub-watershed is a 9.6 square mile highly developed area. The Channel A system is addressed in this report as drainage along Rocky Creek together with all its tributary systems except the Carrollwood system, downstream of the confluence Rocky with Brushy Creek. The Channel A system is southern sub-watershed before the Rocky/Brushy Creek discharges into the Old Tampa Bay. The general system boundaries are the Gunn Highway to the north and Old Tampa Bay to the south. Double Branch Creek borders the system to the west and the Lower Sweetwater Creek system to the east.

The confluence of the Carrollwood System with the Rocky Creek main channel is in the Channel A sub-watershed approximately 1.3 miles downstream from Gunn Highway and approximately 1.0 mile downstream from the confluence of Rocky Creek with Brushy Creek. The Channel A main channel crosses Linebaugh approximately 2.8 miles downstream from Gunn Highway.

There is a fixed concrete control structure located on the Rocky Creek within Channel A sub watershed approximately 3.0 miles downstream from Gunn highway, south of Linebaugh Avenue.

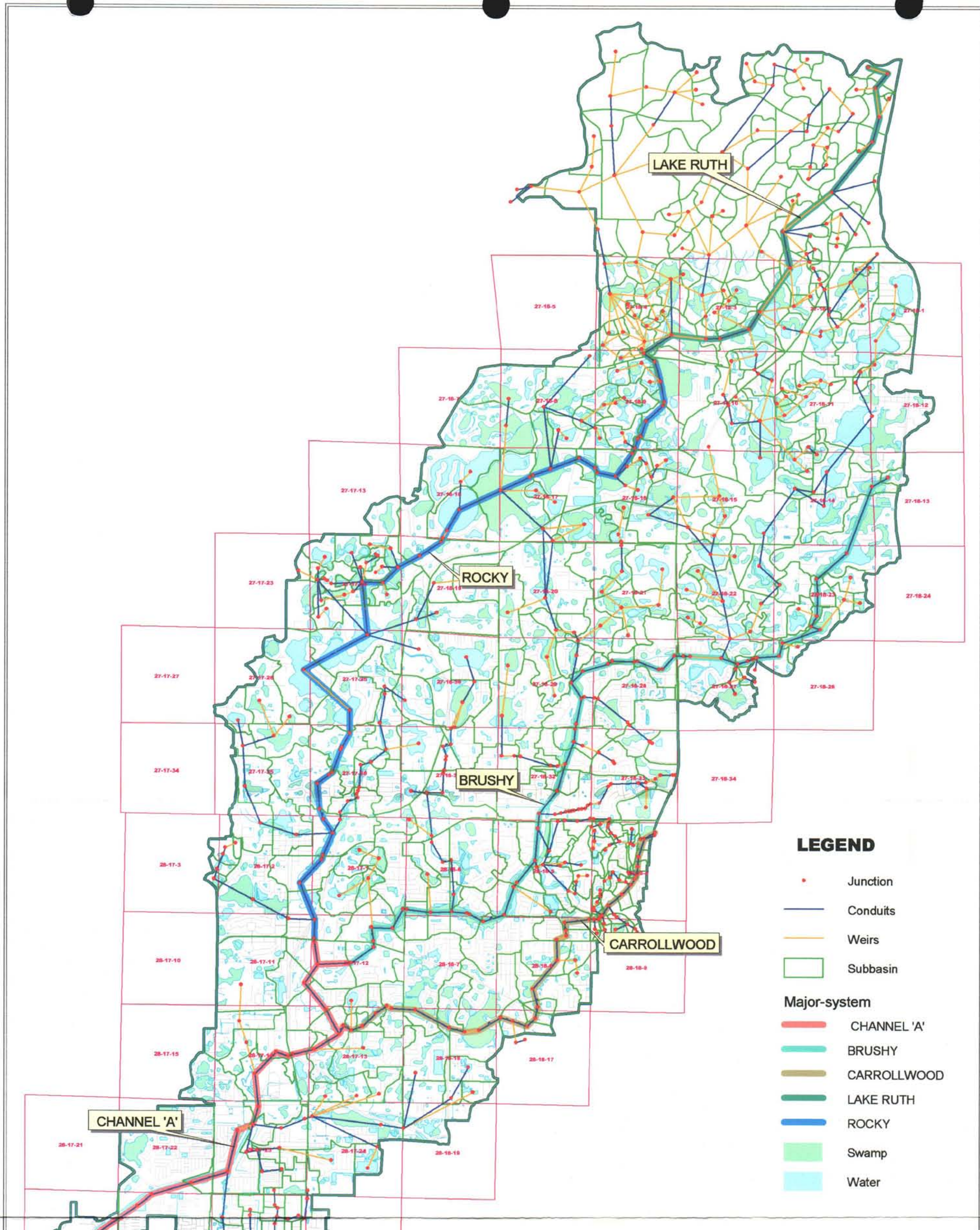

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FIGURE 3-1
MAJOR CONVEYANCE SYSTEM MAP

3.2 Carrollwood System (Junction ID 43xxxx series)

The Carrollwood sub-watershed is a 3.7 square mile highly developed area. The system has its headwaters in the Carrollwood Village area. The Carrollwood sub-watershed contains two major outfalls. The south outfall is located near Dale Mabry Highway and discharges to the Sweetwater Creek watershed. The Carrollwood Village west outfall enters the system at Casey Road. From that point, the flow is generally to the west along the TECO power easement. At a point approximately 1,300 feet west of Casey Road the flow turns to the south and passes through a wetland area and then under Lowell Road.

There are two crossings downstream from Lowell Road that are on private property and are not under County maintenance. Downstream from the two private crossings, the flow passes through an apartment complex, crosses Gunn Highway, and then passes through the Plantation development. There is a point in the Plantation development where the Carrollwood system is hydraulically connected (at flood stage) to Sweetwater Creek. The interconnections between Sweetwater Creek and Rocky Creek are evaluated in the Sweetwater Creek Stormwater Plan. From the Plantation development, the Carrollwood system flows generally to the west. From there it crosses Anderson Road and Henderson Road. The Carrollwood sub-watershed has a confluence with the Rocky Creek main channel within the Channel A sub-watershed approximately 0.6 miles upstream from the Veterans Expressway.

3.3 Brushy Creek System (Junction ID 44xxxx series)

The Brushy Creek System is a 17.8 square mile area flowing from north to south. The Brushy Creek sub-watershed lies generally upstream (north) of Gunn Highway. Brushy Creek has a confluence with Rocky Creek approximately 0.7 miles downstream from Gunn Highway. The main channel has headwaters originating near the Hillsborough/Pasco County line at a chain of lakes referred to as the Deer/Charles Lake System (Piercefield, et al. 1983). Named lakes in the chain include Deer Lake, Little Deer Lake, Lake Hobbs, Cooper Lake, Strawberry Lake, South Crystal Lake, Brandt Lake, and Lake Charles. This chain of lakes, encompassing approximately 5 square miles, originally flowed south from Lake Charles into Bird Lake. However, following heavy rains in 1979, the County Interceptor canal was extended to include this drainage area in the Brushy Creek watershed.

Flows from Deer Lake, Little Deer Lake, Lake Hobbs, Cooper Lake, Strawberry Lake and South Crystal Lake drain to Reinheimer Lake and Lake Merry Water and then finally discharge south to Lake Heather. Flows from Brant Lake are now generally to the west along the Interceptor Canal toward Lake Heather. The creek continues in a general westerly direction and passes under Dale Mabry Highway.

The confluence of the Interceptor Canal with the Brushy Creek natural channel alignment is located upstream from Northdale Boulevard. From that point, the flow is generally to the south. There are several crossings within the Northdale development upstream from Northdale Boulevard. Downstream from this point there are crossings at Ehrlich Road, West Village Drive, the TECO easement, Lynn Turner Road, the Henderson Road Embankment, and Gunn Highway.

The Henderson Road Embankment is on private property approximately 3,200 feet upstream from Gunn Highway. This crossing was privately constructed and shows up on the 1979 aerial photographs. It consists of an earthen road with several pipes that are in various states of repair. The CDM (1986) study states that the embankment is overtopped during a mean annual flood event and that there is evidence of previous wash-outs. There is no known geotechnical data on the embankment.

3.4 Rocky Creek System (Junction ID 45xxxx series)

The Rocky Creek sub-watershed encompasses 12.4 square miles. The Rocky Creek System is considered to start at the Lutz Lake Fern Road end of Lake Ruth System. The downstream end is at the confluence with Brushy Creek south of Gunn Highway.

Two drainage tributaries are the upstream end of Rocky Creek Sub-watershed. Both cross Lutz-Lake Fern Road from north to south and, from Lake Ruth sub-watershed to Rocky Creek Sub-watershed respectively. From there, it flows in a southwesterly direction through a chain of lakes including: Lake Carlton (Turkey Ford), Rock Lake, Lake Josephine, Pretty Lake, and Lake Armistead. Downstream from the chain of lakes, the main channel crosses Hammock Woods Drive, Heathridge Drive, Turtle Creek Boulevard, Ehrlich Road, the Veterans Expressway, and Gunn Highway. The confluence of Rocky Creek with Brushy Creek is located approximately 0.2 miles downstream from Gunn Highway.

The system downstream of Rocky Creek confluence with Brushy Creek is addressed in this report as Channel A system, and the main channel is known as Rocky Creek.

3.5 Lake Ruth System (Junction ID 46xxxx series)

Lake Ruth sub-watershed is an 11.8 square mile rural area, located mostly in the Pasco County and contains the headwater of Rocky Creek at the upstream end. The southern boundary of Lake Ruth sub-watershed is considered to be at Lutz Lake Fern Road.

The Lake Ruth System lies mostly in Pasco County and is included only for the purpose of estimating the contributing discharge that enters Hillsborough County. The Lake Ruth System has at least two hydraulic connections to the Anclote River in Pasco County; therefore, all of its runoff could be discharged to Pasco County or Hillsborough County. The portion that drains to Hillsborough County is automatically determined by the water surface level in both counties. The outfall from the Lake Ruth System to Rocky Creek is located just upstream from Lutz-Lake Fern Road. There is an area of the Lake Ruth system located in Hillsborough County north of Lutz-Lake Fern Road. That area drains generally to the north into Pasco County; it then has a confluence with the flow path that enters Hillsborough County and Rocky Creek.

CHAPTER 4: HYDROLOGIC/HYDRAULIC MODEL METHODOLOGY

General Hydrology / Hydrologic Model Development

Several computer software products and analysis techniques have been used to develop the current model for all the County watershed studies, including the Rocky-Brushy Creek Area watershed (RBA). This chapter provides a general description of these methods and approaches.

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.

4.1 Hydrology

SWFWMD Geographic Information System (GIS) soil coverage was used to obtain soil information for the RBA 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 PBA 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 2-3. It is based on the SWFWMD GIS soil coverage.

The SWFWMD GIS Land Use Coverage (1999) 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 RBA watershed since 1999 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 2-5. 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.

4.1.1 Hydrologic Model

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

4.1.2 Rainfall Depths and Distribution

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.

4.1.3 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

4.1.4 Basin Delineations

Left Blank for Inclusion in Future Updates.

4.1.5 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.

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:

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

If λ =0.2, then

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

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:

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

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
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
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 > 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.

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:

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

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

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 $U_{p,\ Tp,}$ for a triangular unit hydrograph used in Hillsborough County version of SWMM.

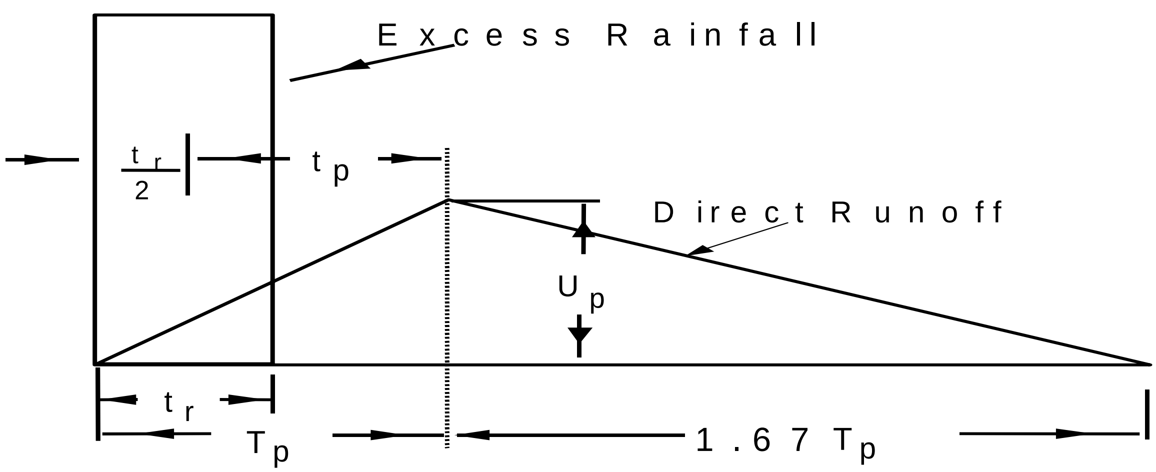

Figure 4-1 Definition of Unit Hydrograph

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).

Model Implementation

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

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

where:

P_{Em} = excess rainfall of *mth* pulse, inch;

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

. t = time step, minutes;

Q_n = total runoff at time $n \quad t$, cfs;

M = total pulses of excess rainfall.

4.1.6 Initial Abstraction

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4.1.7 Shape Factor

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4.2 Hydraulics

4.2.1 Hydraulic Model

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.

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	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D) (Indexes 250, 251, 252, 253, 255)	0.2
Mitered to conform to fill slope (Indexes 272, 273, 274)	0.7
End section conforming to fill slope'	0.5
Beveled edges, 33.7^o or 45^o bevels	0.2
Side- or slope-tapered inlet	0.2
Straight sand-cement (Index 258)	0.3
U-type with grate (Index 260)	0.7
U-type (Index 261)	0.5
Winged concrete (Index 266)	0.3
U-type sand-cement (Index 268)	0.5
Flared end concrete (Index 270)	0.5
Side drain, mitered with grate (Index 273)	1.0
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^o or 45^o 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	0.2

Type of Structure and Design of Entrance	Coefficient k_e
three sides (Index 290)	
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwalls at 10° to 25° to barrel, square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square edged at crown	0.7
Side- or slope-tapered inlet	0.2

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

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

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

4.2.2 Natural Channels

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.

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.

4.2.3 Conduits

Elliptical and arch pipes are included in the current County version SWMM model.

4.2.4 Storage Facilities

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4.2.5 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.

4.2.6 Orifices

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4.2.7 Initial Water Surface Elevations

The Rocky Creek / Brushy Creek project area has two outfalls to Old Tampa Bay. For model calibration, both outfalls were set at a constant water surface elevation of 2.5 feet above msl (NGVD). This elevation represents the mean high tide for this region of Old Tampa Bay. An initial water surface elevation of 2.5 is used for tidally influenced junctions.

4.2.8 Dummy Junctions and Conduits

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4.2.9 Boundary 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. There is some flow across the watershed boundaries between Rocky Creek and Sweetwater Creek, including locations in the Plantation development and within Carrollwood sub-watershed near Dale Mabry Highway and County North Lakes Park. For purposes of this analysis, these locations were assumed to be no-flow boundaries. Known potential hydraulic connection points between Rocky Creek and the Anclote River in Pasco County have not been evaluated. Boundary conditions in the model at Anclote River in Pasco County have been provided by an outside source. The details of boundary and initial conditions are discussed in Chapter 5.

4.2.10 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

4.2.11 Link-Node Diagram

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CHAPTER 5: HYDROLOGIC/HYDRAULIC MODEL CALIBRATION & VERIFICATION

This chapter contains the data, calibration and verification procedure used for the RBA existing conditions model. The goal of the calibration effort is to develop a 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 in 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. 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 agreement with the recorded data at the established gauge stations. The model is then adjusted with specific parameters and verified with another storm event's data.

The Rocky Creek / Brushy Creek project area has two outfalls to Old Tampa Bay. For model calibration, both outfalls were set at a constant water surface elevation of 2.5 feet above msl (NGVD). This elevation represents the mean high tide for this region of Old Tampa Bay. An initial water surface elevation of 2.5 is used for tidally influenced junctions.

5.1 Existing Conditions Data Collection

5.1.1 Selection

Rocky Creek/Brushy Creek watershed is highly developed except the north area, with significant urban area increase in the last decade. Therefore, data of the most recent storm events are considered for calibration and verification purposes.

There are three storm events with a dramatic impact on Rocky Creek/Brushy Creek watershed which occurred within a 3-month period prior to January 1998. The selected storm event used in this study for model calibration and verification is as follows:

- December 10-13 with a 96 hours duration

5.1.2 Antecedent Moisture Condition (AMC)

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 which 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.

Rainfalls in antecedent periods of 5 to 30 or more days prior to a storm are 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). Three 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

- AMC-III Highest runoff potential. The watershed is practically saturated from antecedent rains

Using the traditional method the AMC can be estimated from 5-day antecedent rainfall by the use of the table 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"

However, in the Lake data provided by SWFWMD (see Tables 5-4 to 5-6) it is observed that lake water surface elevations within Rocky Creek/Brushy Creek watershed increase significantly from September 1997 to December 1997.

A comparison analysis between the rainfall daily average value uniformly distributed to the eight rainfall gauges and the peak discharge value recorded at USGS streamflow gauges over Rocky Creek/Brushy Creek watershed for each particular storm event is necessary. As it is observed in Table 5-7, the September 26-27 has the highest rainfall precipitation volume generating the least discharge at the Linebaugh USGS gauge. Also, the December 25-28 storm which generates the highest discharge at the same USGS gauge has the lowest rainfall daily average value uniformly distributed throughout the eight rainfall gauges volume. The above mentioned analysis requires adopting a different Antecedent Moisture Condition for each storm event studied for calibration and verification purposes. AMC-II based on the lake water surface elevation is used for the December

10-13 storm. For the September 26-27 storm, AMC-I is selected. Finally, AMC-III is used for the December 25-28 storm event, respectively. 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

5.1.3 Precipitation Data

Rainfall records were collected from eight gauges in or near the Rocky Creek/Brushy Creek watershed. Seven rainfall precipitation gauge stations are owned and operated by SWFWMD. The SWFWMD maintains an extensive network throughout the region and these gauges that provide an excellent resource for this type of data. The “Lake Allen” gauge is owned and operated by Hillsborough County. A summarized table of these rainfall gauge stations recorded data, with the appropriate total rainfall intensities which occurred during the storm events used for calibration and verification, is provided in Table 5 -1.

A graphical representation of rainfall recorded data for hourly operating gauge stations can be observed as Figures 5-1 to 5-2. Figure 5-1 shows locations where all rainfall data was collected.

There are three operating streamflow gauge stations owned by USGS located on the main channels of Rocky Creek/Brushy Creek watershed. These gauge stations are:

- USGS gauge station number 02307000 is located down stream of Rocky/Brushy Creek confluence, approximately 1500’ south of Linebaugh Avenue, near Sulphur Springs

- USGS gauge station number 02306950 is located on Brushy Creek up stream of confluence with Rocky Creek, North of Gunn Highway (S.R. 587) crossing, near Citrus Park

- USGS gauge station number 02306774 is located on Rocky Creek up stream of confluence with Brush Creek North of Gunn Highway (S.R. 587) crossing, near Citrus Park

Streamflow parameters data includes recorded values of stage and discharge during the storm events used for calibration and verification procedures. Tables 5-2 and 5-3 contain data collected from these USGS gauges for storm events considered for the purpose of model calibration and verification. Figure 5-1 shows the location where calibration information was collected.

5.1.4 Surface Water Data

In addition, Lake Water Surface Elevation provided by SWFWMD was used for the time period subjected to study for model calibration and verification. SWFWMD has developed a wide range of lake stage recording gauges within Rocky Creek/Brushy Creek watershed. A complete table with this information is provided for each selected storm event in Table 5-5.

5.2 Calibration Parameters and Methodology

5.2.1 Hydrologic Parameters

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 sub-basin 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.

5.2.2 Hydraulic Parameters

In general, the recorded and estimated stage information used as initial elevation input data for the Extran model for December 10-13 storm event is the closest to SWFWMD Minimum Lake Level.

5.2.3 Calibration Method

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

5.3 Existing Conditions Model Calibration

The December 10-13, 1997 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.

December 10-13 recorded data also contained above average rainfall and stage/discharge values. An average of 6.18 inches of total rainfall was recorded in Rocky Creek/Brushy Creek during the December 10-13, 1997 storm event.

Rocky Creek/Brushy Creek watershed covers a wide area of 55.3 square miles. The total rainfall during the December 10-13 storm, subject to study for calibration, was not uniformly distributed. Distribution ranges between 3.85 inches at the South Pasco gauge station in the Northern part of the watershed and 8.11 inches at the Bay Lake gauge station located east of the Brushy watershed (see Table 5-1). For a better model calibration, graphical Thiessen method has been selected to determine the radius of influence for each rainfall gauge over the Rocky Creek/Brushy Creek watershed. Based on the Thiessen method, a defined number of sub-basins are assigned for each rainfall gauge intensity and distribution by dividing the watershed area in 8 unequal polygons. The practical use of the Thiessen graphical method is provided in Exhibit 5-2. As summarized in Table 5-1, four out of the eight rainfall stations record data hourly and the remaining four record data daily.

For the daily record gauges the rainfall distribution of the closest hourly record gauge is used, while keeping the total intensity of the gauge in mind. Hourly record distributions are used for the daily records as follows:

- E-101 was used with rainfall distribution from Channel “A”
- Whalen was used with rainfall distribution from Bay Lake
- South Pasco was used with distribution from Lake Allen
- Crenshaw was used with distribution from Bay Lake

Lake Water Surface Elevation and USGS streamflow gauge 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 gauges) recorded data was available.

A summary of initial stage with SWFWMD and USGS recorded data is shown in Table 5-3 and Table 5-5, respectively, for the December 10-13 calibration storm event.

The objectives of calibration are to better match stage and discharge, of the calculated hydrographs with 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 runoff volume, shift the time of the runoff, and alter the recession limb of the hydrograph. When, for a given set of calibration parameters, the observed and calculated hydrograph agree for December 10-13 storm, the model is considered calibrated. The model is ready for further verification using different storm events.

The maximum computed water surface elevations at the three USGS gauges along the Rocky Creek/Brushy Creek main channel are found to be generally higher than the collected gauge data for the December 10-13, 1997 events. Figures 5-19 to 5-24 contain the graphical representation of this comparison.

Model Verification
When the impervious portion of the study area has been calibrated, the next step was to execute the model on several observed storms that were large enough to produce runoff from the pervious portions of the study area.

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 September 26-27, 1997 rainfall event is selected as one of the verification events. This storm event occurred near the beginning of a weather pattern known as El Nino which brought heavier than normal rainfall for the 1997-1998 winter.

This event is selected due to the availability of gage data and the magnitude of the storm. The December 25-28 rainfall event was also selected for calibration verification due to the high discharge/stage recorded data at USGS gauges despite the lowest precipitation data compared with the other two storm events. Total rainfall recorded data at SWFWMD stations during the September 26-27 and December 25-28 are summarized in Table 5-1.

Lake Water Surface Elevation and USGS streamflow gauge recorded data collected prior to and following the December 10, 1997 event is also considered in the verification process. The procedure of calculating initial elevations for the other two verification storm events, September 26-27 and December 25-28 is similar to the one described for the December 10-13 storm.

A summary of the data, with the above-mentioned SWFWMD information, is included in this chapter as Table 5-4 for the September event and as Table 5-5 for the December 10-13 event, respectively. USGS streamflow gauge data recorded at the beginning of the each verification storm event is summarized in Table 5-3.

The Bay Lake rainfall station measured 10.10 inches of rainfall during the 48-hour period of September 26-27 storm event. Rainfall records at the Southwest Florida Water Management District (SWFWMD) Channel A rainfall gauge located within of the RBA watershed show only 4.22 inches of rainfall over the same two day period. Due to non-uniformity of rainfall distribution and for consistency purposes, the same gauge influence distribution based on the Thiessen has been method used for September 26-27 and December 25-29 events.

The same sub-basins assigned for a particular rainfall gauge, used on December 10-13 calibration storm, were used for the two verification storm events. The practical use of the graphical Thiessen method is provided in Exhibit 5-2.

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

Conclusions

Based on selected calibration and verification storm events, the model represents the existing conditions for the period from September 1997 to January 1998.

Generally, for all three storm events, the recorded peak discharge is somewhat smaller than the computed peak discharge. Comparison of computed stages with the Lake Water Surface Elevation data provided by SWFWMD along Rocky Creek/Brushy Creek and by the USGS gauges reveals that the computed stages are generally higher than the estimated peak stages. Therefore, it is observed that the model produces reliable results.

In general, the recorded and estimated stage information used as initial elevation input data for the Extran model for December 10-13 storm event is the closest to SWFWMD Minimum Lake Level.

The computed and measured values more closely match the December 10-13 storm event when compared with September 26-27 and December 25-28. Therefore, the December 10-13 storm event input data will be used on standard design storm event (2.33yr; 5yr; 10yr; 25yr; 50yr; 100yr) runs to predict potential flood areas and to evaluate possible alternatives in resolving flood problems.

Table 5-1 Rainfall Gauge Stations Recorded Data

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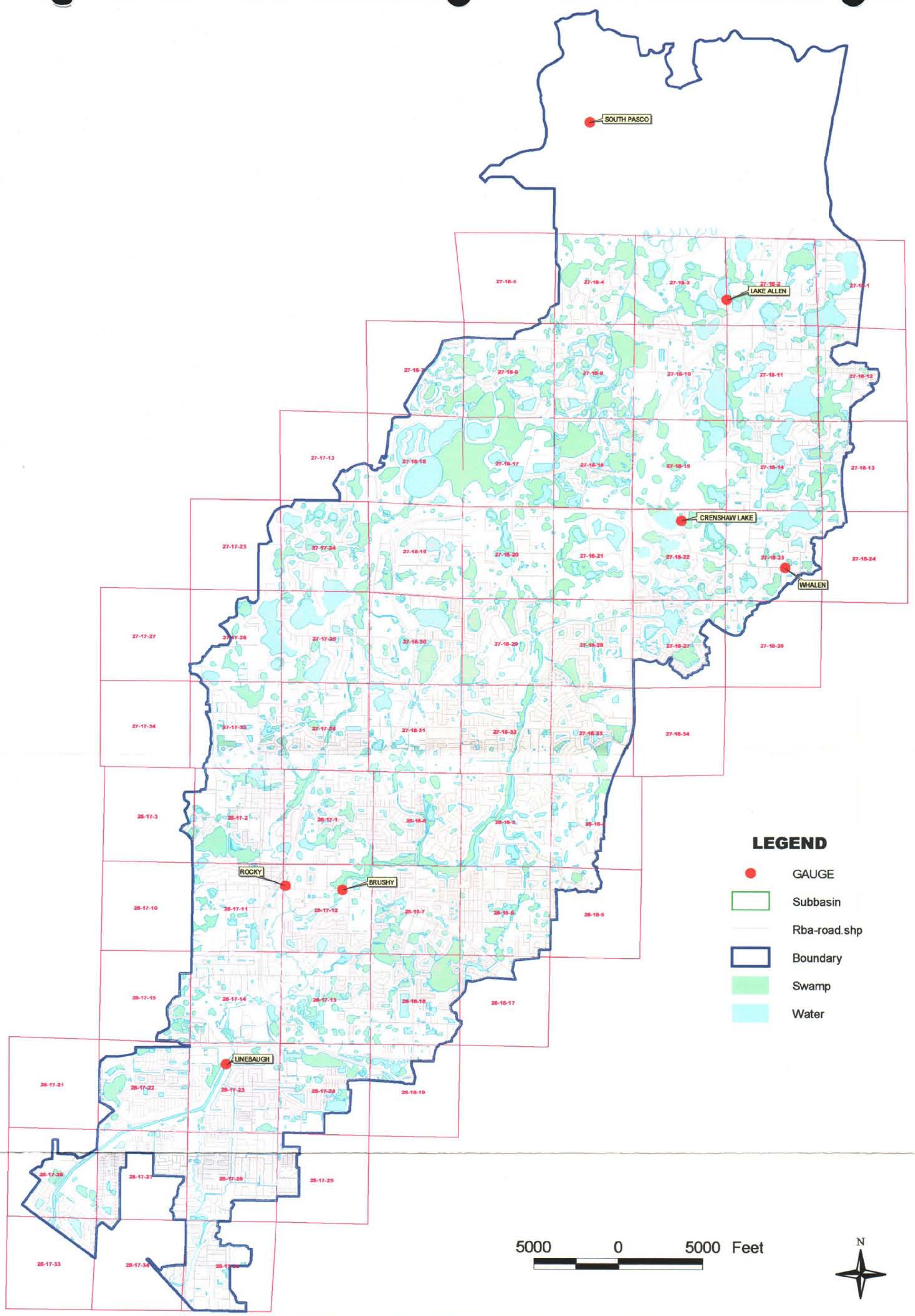


Hillsborough County
Florida

ROCKY BRUSHY CREEK AREA
STORMWATER MANAGEMENT
MASTER PLAN
SEPTEMBER 2002

Department of Public Works
Engineering Division
Stormwater Management Section

FIGURE 5-1
GAUGE STATION LOCATION
MAP

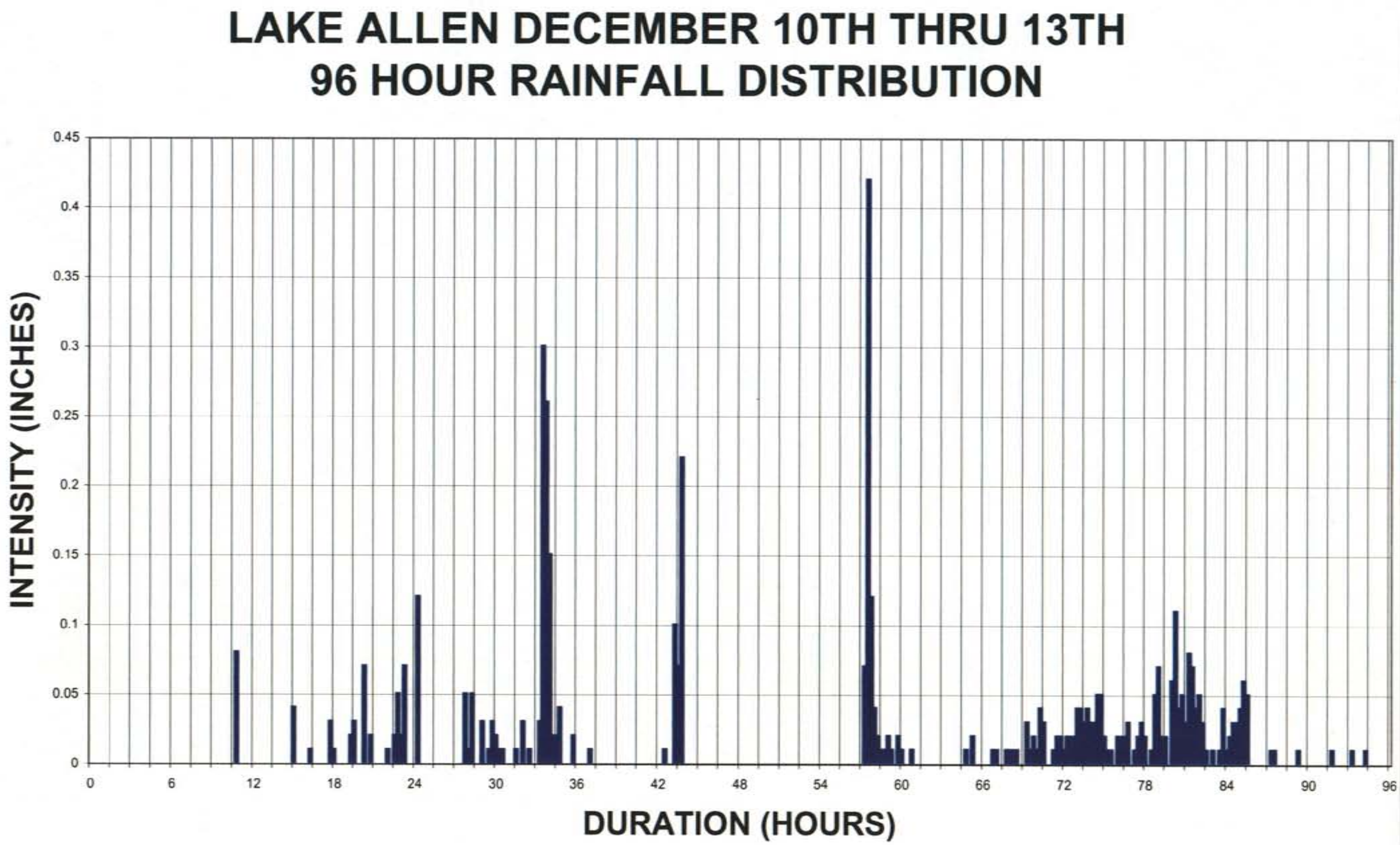
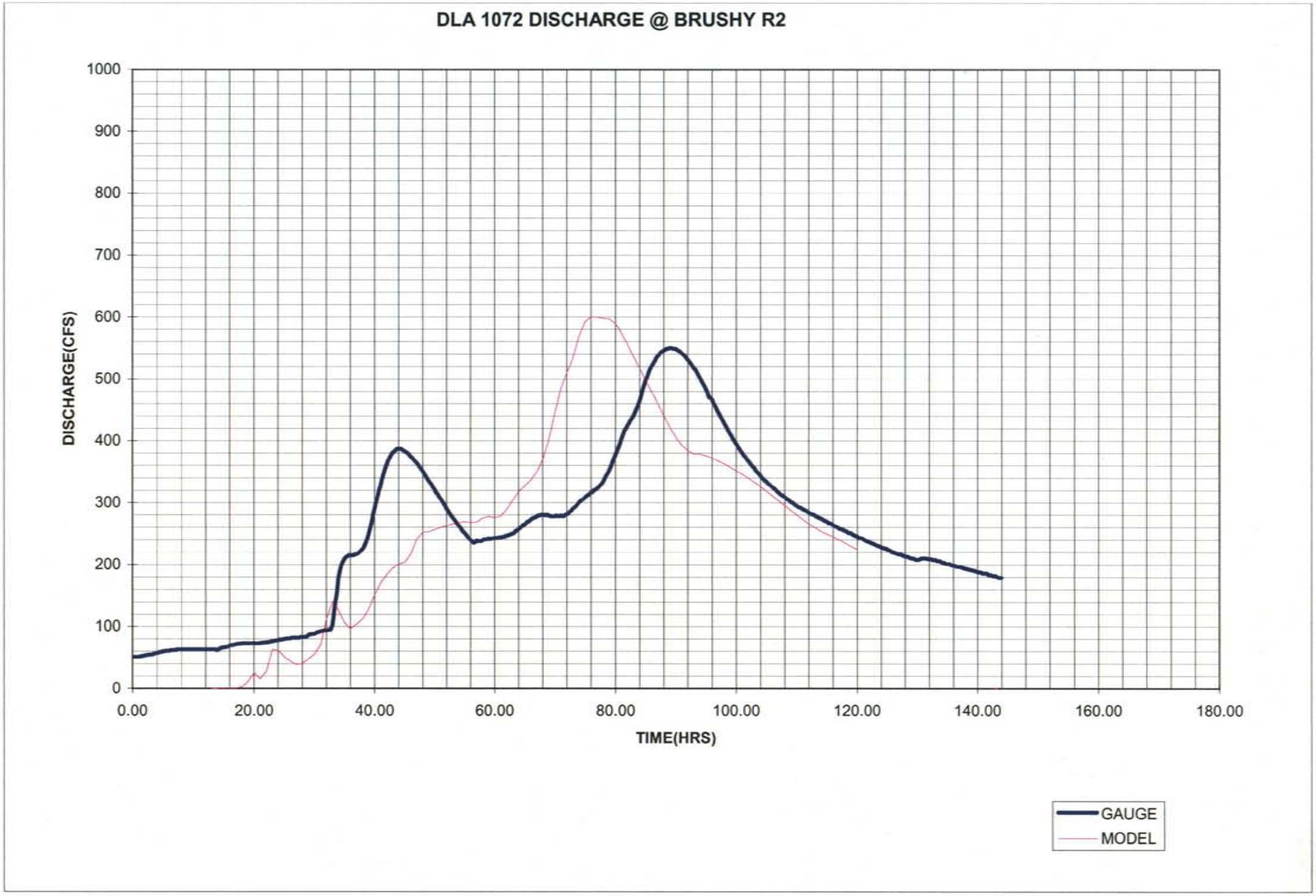
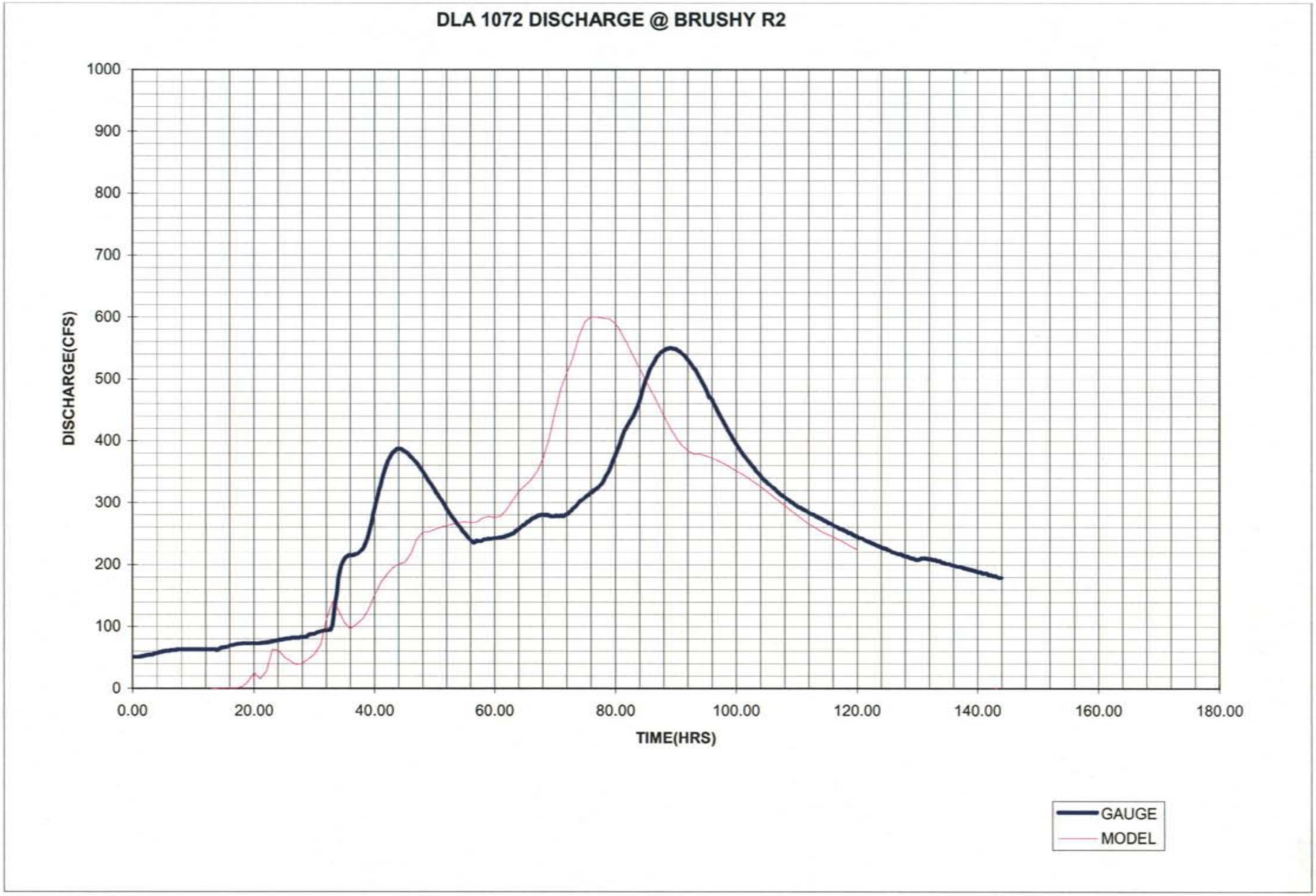

LAKE ALLEN DECEMBER 10TH THRU 13TH
96 HOUR RAINFALL DISTRIBUTION
INTENSITY (INCHES)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
6
12
18
24
30
36
42
48
54
60
66
72
78
84
90
96
DURATION (HOURS)

Figure 5-2



DLA 1072 DISCHARGE @ BRUSHY R2
1000
900
800
700
600
500
400
300
200
100
0
DISCHARGE(CFS)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
TIME(HRS)
GAUGE
MODEL

Figure 5.19



DLA 1072 DISCHARGE @ BRUSHY R2
DISCHARGE(CFS)
1000
900
800
700
600
500
400
300
200
100
0
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
TIME(HRS)
GAUGE
MODEL

Figure 5.19

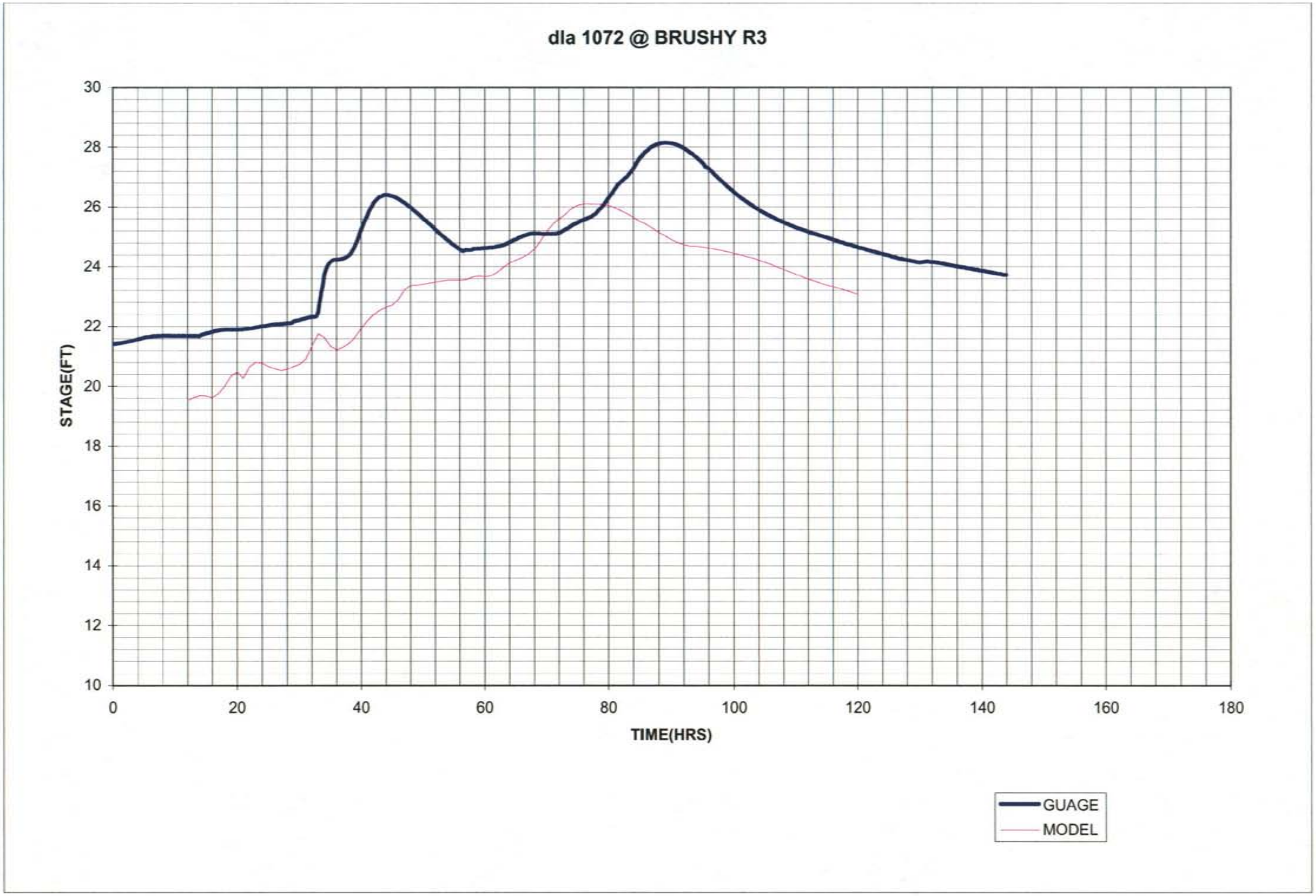

dla 1072 @ BRUSHY R3
30
28
26
24
22
20
18
16
14
12
10
STAGE(FT)
0
20
40
60
80
100
120
140
160
180
TIME(HRS)
GUAGE
MODEL

Figure 5.20

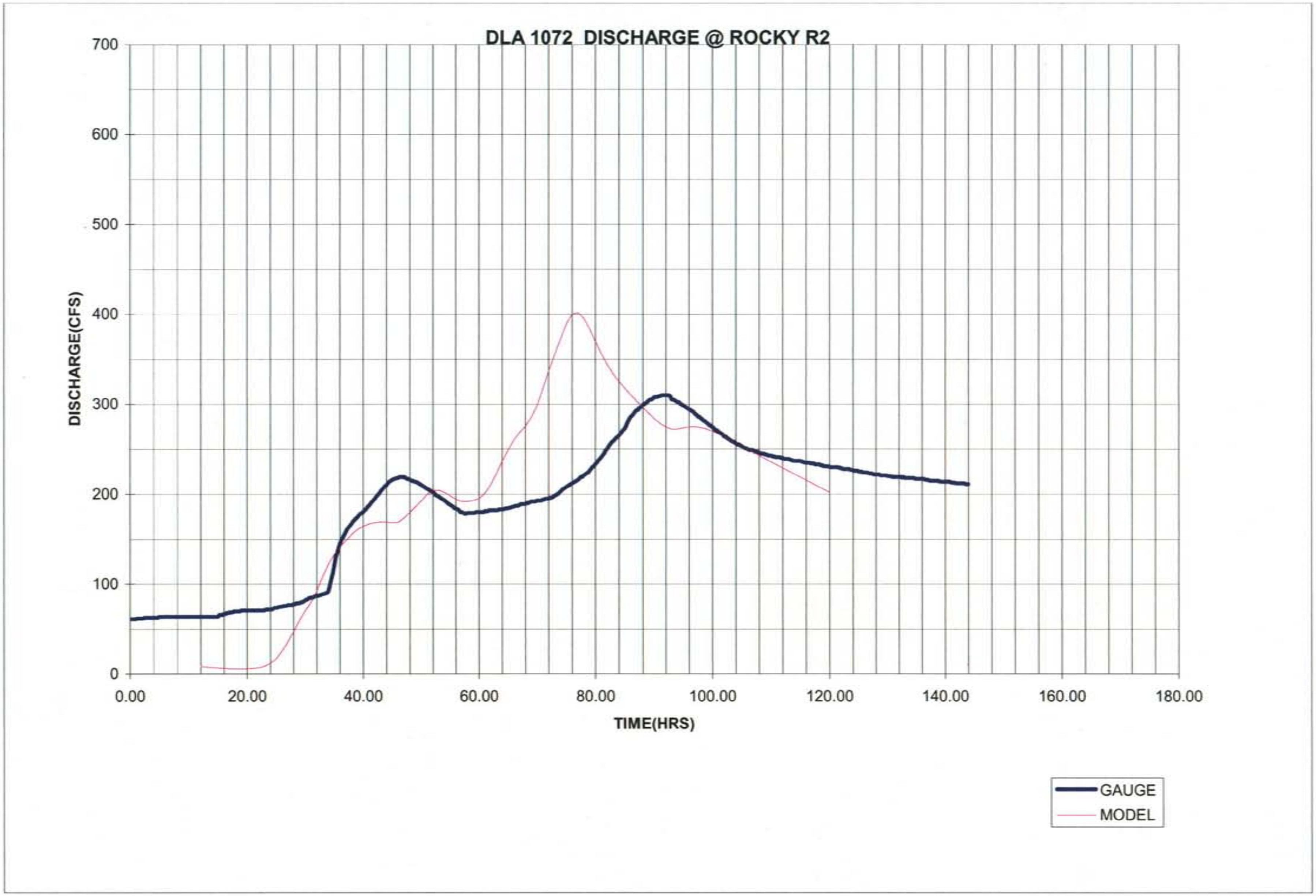

DLA 1072 DISCHARGE @ ROCKY R2
DISCHARGE(CFS)
700
600
500
400
300
200
100
0
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
TIME(HRS)
GAUGE
MODEL

Figure 5.21

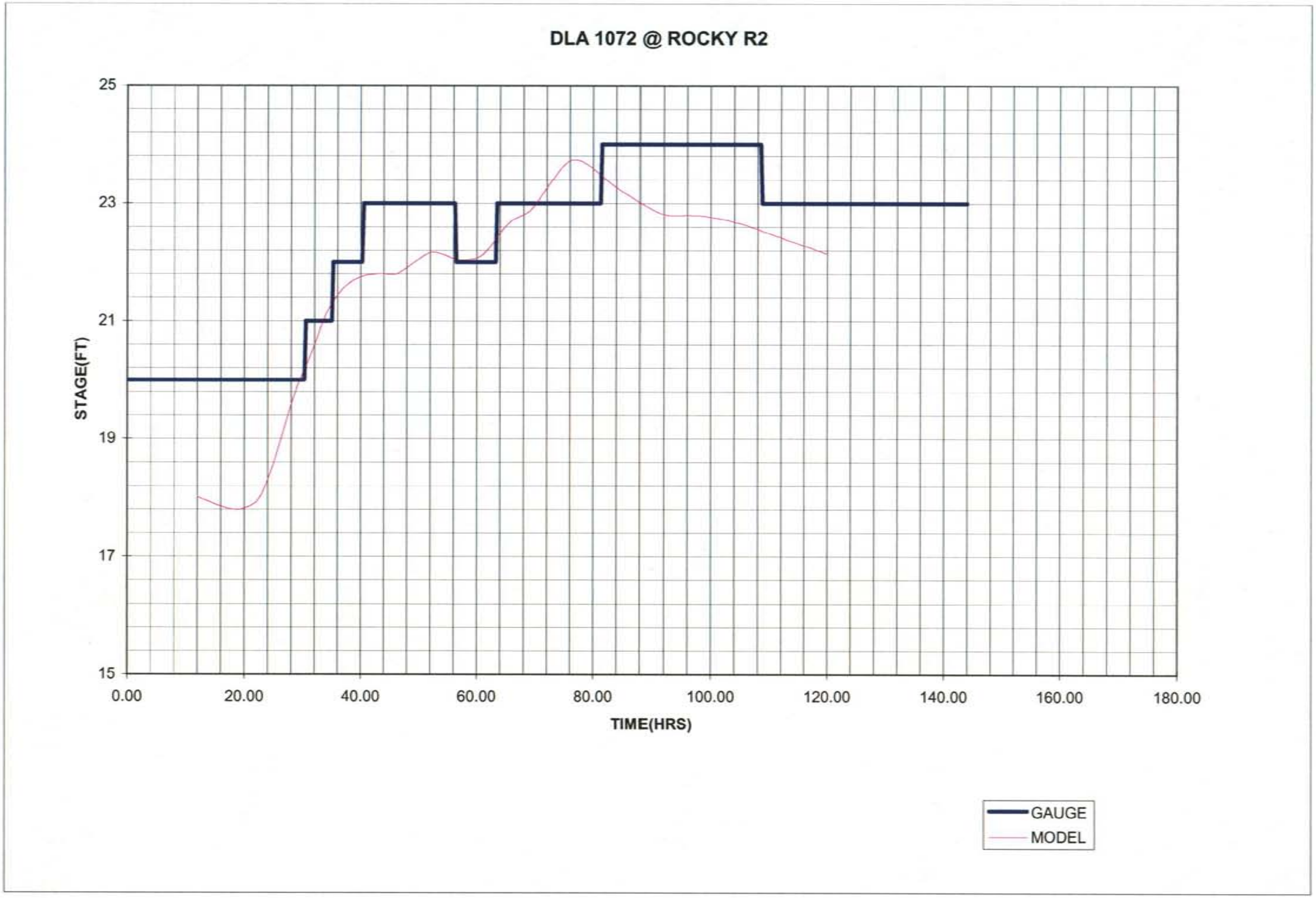

DLA 1072 @ ROCKY R2
STAGE(FT)
25
23
21
19
17
15
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
TIME(HRS)
GAUGE
MODEL

Figure 5.22

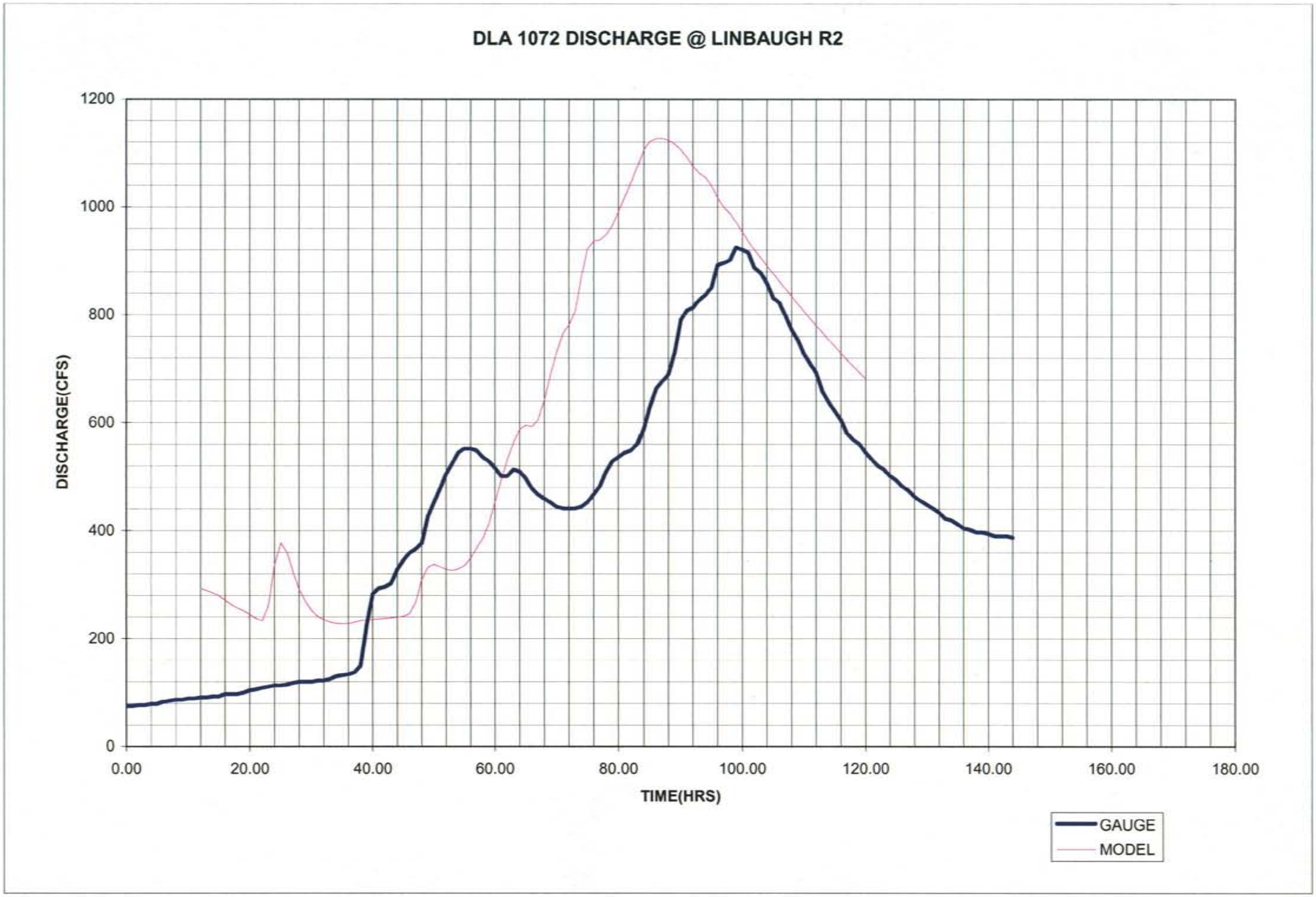

DLA 1072 DISCHARGE @ LINBAUGH R2
DISCHARGE(CFS)
1200
1000
800
600
400
200
0
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
TIME(HRS)
GAUGE
MODEL

Figure 5.23

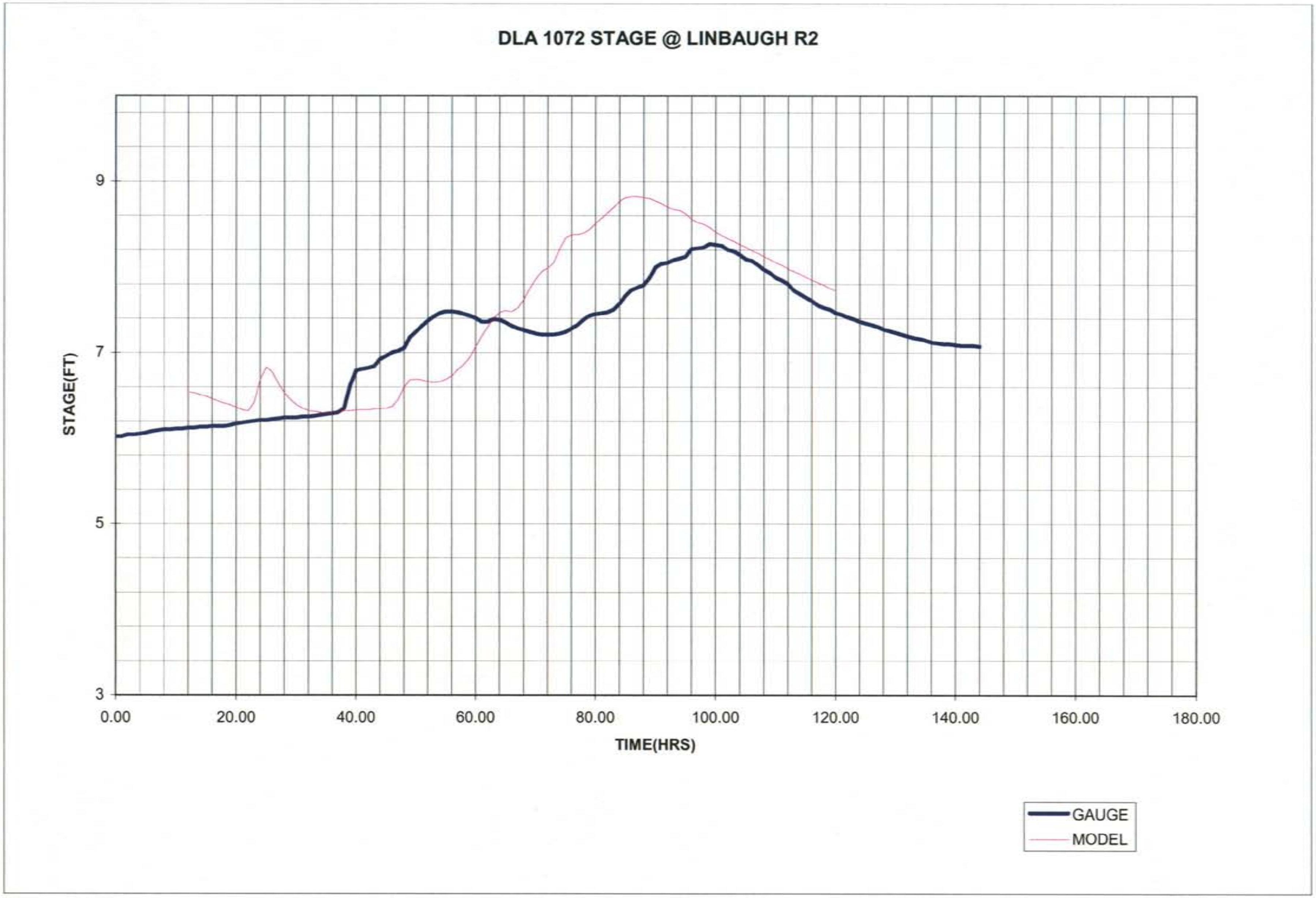

DLA 1072 STAGE @ LINBAUGH R2
STAGE(FT)
9
7
5
3
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
TIME(HRS)
GAUGE
MODEL

Figure 5.24

CHAPTER 6: EXISTING CONDITIONS LEVEL OF SERVICE

6.1 Standard Design Storm Events

Based on the Hillsborough County Stormwater Drainage Manual and Southwest Florida Water Management District (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 Rocky/Brushy Creek watershed. The standard design storms used in this study are: 100 yr, 50 yr, 25 yr, 10 yr, 5 yr and 2.33 yr (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 based on SWFWMD rainfall map, which may vary with physical location of watershed. The total rainfall used for each design storm event is as follows:

100 yr/24 hr	=	11.50 inches
50 yr/24 hr	=	10.50 inches
25 yr/24 hr	=	8.00 inches
10 yr/24 hr	=	7.00 inches
5 yr/24 hr	=	5.50 inches
2.33 yr/24 hr	=	4.50 inches

In a watershed such as Rocky/Brushy Creek, with a large amount of storage available in numerous lakes, wetlands, depressions, and ponds, development of a design storm event must be closely coordinated with the determination of initial conditions of lake levels and antecedent soil moisture infiltration capacity.

Initial lake elevations used in the stormwater management model at the start of the design storm event were determined by the recorded lake data provided by SWFWMD, the Hillsborough County Lake Atlas or from SWFWMD aerial topographic maps. For those lakes with no available gage data, initial elevations were selected based on nearby lake relationships, Minimum Low Water Elevation set by SWFWMD or from the SWFWMD aerial maps.

The rest of junction initial elevations were calculated with linear interpolation between the elevation values where (lakes and streamflow gages) recorded data was available.

6.2 Existing Conditions Model Simulation Results

The Rocky/Brushy Creek stormwater management model results for the 2.33-, 5-, 10-, 25-, 50-year, and 100-year design storm events are listed in Table 6-1. This table presents peak flood elevations in the main channel network.

Each sub-basin 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 Exhibits 6-1(a) through 6-1(d). The following sections discuss the individual problem areas predicted by EXTRAN model.

The Rocky/Brushy Creek watershed is divided into five main channel systems or tributaries, which are listed below:

- Channel “A” System (42XXXX junction ID series)
- Channel D System, with Carrollwood Village (43XXXX junction ID series)
- Brushy Creek System (44XXXX junction ID series)
- Rocky Creek System (45XXXX junction ID series)
- Lake Ruth Area (Hillsborough/Pasco County) (46XXXX junction ID series)

The objective of this section is to present both the areas and major structures where the computer model indicated that insufficient channel capacity exists and flooding occurs along the Rocky-Brushy Creek watershed main channel alignments.

Channel A System (Junction ID 42xxxx series)
The Channel A sub-watershed is an 9.6 square mile highly developed area. The Channel A system is addressed in this report as drainage along Rocky Creek together with all its tributary systems except the Carrollwood system, downstream of the confluence Rocky with Brushy Creek. The Channel A system is southern sub-watershed before the Rocky-Brushy Creek discharges into the Old Tampa Bay. The general system boundaries are the Gunn Highway to the north and Old Tampa Bay to the south. Double Branch Creek borders the system to the west and the Lower Sweetwater Creek system to the east.

The confluence of the Carrollwood System with the Rocky Creek main channel is in the Channel A sub-watershed approximately 1.3 miles downstream from Gunn Highway and approximately 1.0 mile downstream from the confluence of Rocky Creek with Brushy Creek. The Channel A main channel crosses Linebaugh approximately 2.8 miles downstream from Gunn Highway. There is a fixed concrete control structure located on the Rocky Creek within Channel A sub watershed approximately 3.0 miles downstream from Gunn highway, south of Linebaugh Avenue. A graphical representation of the water surface profile for all six standard storm events is provided in Exhibit 6-1 (a).

Table 6-1 Peak Flood Elevations in the Main Channel Network

Table is missing

Carrollwood System (Junction ID 43xxxx series)

The Carrollwood sub-watershed is a 3.7 square mile highly developed area. The system has its headwaters in the Carrollwood Village area. The Carrollwood sub-watershed contains two major outfalls. The south outfall is located near Dale Mabry Highway and discharges to the Sweetwater Creek watershed. The Carrollwood Village west outfall enters the system at Casey Road. From that point the flow is generally to the west along the TECO power easement. At a point approximately 1,300 feet west of Casey Road, the flow turns to the south and passes through a wetland area and then under Lowell Road.

There are two crossings downstream from Lowell Road that are on private property and are not under County maintenance. Downstream from the two private crossings, the flow passes through an apartment complex, crosses Gunn Highway, and then passes through the Plantation development. There is a point in the Plantation development where the Carrollwood system is hydraulically connected (at flood stage) to Sweetwater Creek. The interconnections between Sweetwater Creek and Rocky Creek are evaluated in the Sweetwater Creek Stormwater Plan. From the Plantation development, the Carrollwood system flows generally to the west, and from there it crosses Anderson Road and Henderson Road. The Carrollwood sub-watershed has a confluence with the Rocky Creek main channel within the Channel A sub-watershed approximately 0.6 miles upstream from the Veterans Expressway.

A graphical representation of the water surface profile for all six standard storm events is provided in Exhibit 6-1(b).

Brushy Creek System (Junction ID 44xxxx series)

The Brushy Creek System is a 17.8 square mile area flowing from north to south. The Brushy Creek sub-watershed lies generally upstream (north) of Gunn Highway. Brushy Creek has a confluence with Rocky Creek approximately 0.7 miles downstream from Gunn Highway. The main channel has headwaters originating near the Hillsborough/Pasco County line at a chain of lakes referred to as the Deer/Charles Lake System (Piercefield, et al. 1983). Named lakes in the chain include Deer Lake, Little Deer Lake, Lake Hobbs, Cooper Lake, Strawberry Lake, South Crystal Lake, Brandt Lake, and Lake Charles. This chain of lakes, encompassing approximately 5 square miles, originally flowed south from Lake Charles into Bird Lake. However, following heavy rains in 1979, the County Interceptor canal was extended to include this drainage area in the Brushy Creek watershed.

Flows from Deer Lake, Little Deer Lake, Lake Hobbs, Cooper Lake, Strawberry Lake and South Crystal Lake drain to Reinheimer Lake and Lake Merry Water and then finally discharge south to Lake Heather. Flows from Brant Lake are now generally to the west along the Interceptor Canal toward Lake Heather. The creek continues in a general westerly direction and passes under Dale Mabry Highway. The confluence of the Interceptor Canal with the Brushy Creek natural channel alignment is located upstream from Northdale Boulevard. From that point, the flow is generally to the south.

There are several crossings within the Northdale development upstream from Northdale Boulevard. Downstream from this point there are crossings at Ehrlich Road, West Village Drive, the TECO easement, Lynn Turner Road, the Henderson Road Embankment, and Gunn Highway.

The Henderson Road Embankment is on private property approximately 3,200 feet upstream from Gunn Highway. This crossing was privately constructed and shows up on the 1979 aerial photographs. It consists of an earthen road with several pipes that are in various states of repair. The CDM (1986) study states that the embankment is overtopped during a mean annual flood event and that there is evidence of previous wash-outs. There is no known geotechnical data on the embankment.

A graphical representation of the water surface profile for all six standard storm events is provided in Exhibit 6-1 (c).

Rocky Creek System (Junction ID 45xxxx series)

The Rocky Creek sub-watershed encompasses 12.4 square miles of the RBA watershed. The Rocky Creek System is considered to start at the Lutz-Lake Fern Road end of Lake Ruth System. The downstream end is at the confluence with Brushy Creek south of Gunn Highway.

Two drainage tributaries are the upstream end of Rocky Creek Sub-watershed. Both cross Lutz-Lake Fern Road from north to south and, from Lake Ruth sub-watershed to Rocky Creek Sub-watershed respectively. From there, it flows in a southwesterly direction through a chain of lakes including: Lake Carlton (Turkey Ford), Rock Lake, Lake Josephine, Pretty Lake, and Lake Armistead. Downstream from the chain of lakes, the main channel crosses Hammock Woods Drive, Heathridge Drive, Turtle Creek Boulevard, Ehrlich Road, the Veterans Expressway, and Gunn Highway. The confluence of Rocky Creek with Brushy Creek is located approximately 0.2 miles downstream from Gunn Highway.

The system downstream of Rocky Creek confluence with Brushy Creek is addressed in this report as Channel A system, and the main channel is known as Rocky Creek.

A graphical representation of the water surface profile for all six standard storm events is provided in Exhibit 6-1 (d).

Lake Ruth System (Junction ID 46xxxx series)

Lake Ruth sub-watershed is an 11.8 square mile rural area, located mostly in the Pasco County and contains the headwater of Rocky Creek at the upstream end. The southern boundary of Lake Ruth sub-watershed is considered to be at Lutz Lake Fern Road.

The Lake Ruth System lies mostly in Pasco County and is included only for the purpose of estimating the contributing discharge that enters Hillsborough County. The Lake Ruth System has at least two hydraulic connections to the Anclote River in Pasco County; therefore, all of its runoff could be discharged to Pasco County or Hillsborough County. The portion draining to Hillsborough

County is automatically determined by the water surface level for both counties. The outfall from the Lake Ruth System to Rocky Creek is located just upstream from Lutz-Lake Fern Road. There is an area of the Lake Ruth system located in Hillsborough County north of Lutz-Lake Fern Road. That area drains generally to the north into Pasco County; it then has a confluence with the flow path that enters Hillsborough County and Rocky Creek.

6.3 Level of Service (LOS) Analysis

This section briefly describes the level of service (LOS) methodology used to analyze the Rocky-Brushy Creek Watershed (RBA) and then discusses existing conditions LOS deficiencies within the study area.

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

- Channel “A” System (42XXXX junction ID series)
- Channel D System, with Carrollwood Village (43XXXX junction ID series)
- Brushy Creek System (44XXXX junction ID series)
- Rocky Creek System (45XXXX junction ID series)
- Lake Ruth Area (Hillsborough/Pasco County) (46XXXX junction ID series)

The Hillsborough County Comprehensive Plan, Stormwater Management Element contains definitions for level of service flood protection designations. According to these definitions, a storm return period and duration (i.e. 25-year/24-hour) and letter designation (i.e. B) are needed to define the level of flood protection (i.e. 25-year/24-hour level B). The flood level designations contained in the Comprehensive Plan are A, B, C and D, A 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 6-2 below. This table contains the interpretation of the Comprehensive Plan definitions used in the LOS analysis herein.

Table 6-2 Level of Service Definition Interpretations

LEVEL	HC COMPREHENSIVE PLAN DEFINITIONS	WATERSHED 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 shown 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 25-year/24-hour level B is the target LOS for all areas of Hillsborough County for the Rocky-Brushy Creek Area. However, this is very conservative. In many areas of RBA, the 25-year/24-hour level B LOS can be achieved.

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

During the flooding conditions of 1997 to 1998, flood complaint locations in the watershed were documented by Hillsborough County. These flood complaint locations are shown on Figure 6-6.

Existing flood locations within watershed identified by FEMA in the FEMA Flood Insurance Rate maps (FIRM) are shown in Figure 6-7.

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 6-3 contains landmark elevations determined for each RBA subbasin in the unincorporated portion of Hillsborough County. These landmark elevations reflect the flood depth tolerance contained in Table 6-2.

Comparison of Computed Results and Landmark Elevations

Using flood protection LOS designation criteria contained in Table 6-1, the landmark elevations for each subbasin are compared to the computed results of the hydraulic model. In general, the computed result for the most downstream junction was used for comparison with landmark elevations. Table 6-3 contains the difference between established landmark elevations and computed water surface elevations for the 2.33-yr/24-hr, 5-yr/24-hr, 10-yr/24-hr, and 25-yr/24-hr storm events.

Table 6-3 Differences between Landmark Elevations & Water Surface Elevations

Table is missing

6.4 Level of Service (LOS) Determinations

LOS designations are assigned in three levels of detail: subbasin, system, and watershed. Subbasins were aggregated into five areas 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 RBA watershed is reflective of the worst case system and the LOS of the system is reflective of the worst case subbasin. Figures 6-2, 6-3, 6-4 and 6-5 contains a graphical representation of the RBA level of service analysis for the 2.33-yr, 5-yr/24-hr, 10-yr/24-hr, and 25-yr/24-hr storm events.

It is important to be aware of the limits of the methodology used in the LOS analysis. Most landmark elevation information was taken from SWFWMD 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 Channel A System (42XXXX junction ID Series)

The Rocky-Brushy Creek main channel has a LOS A for the 25-year / 24-hour design storm simulation. This area includes the Rocky-Brushy Creek main channel and its associated floodplain. The EXTRAN model predicts no major street, site, or structural flooding is expected to occur during the 25-year / 24 hour storm event. Since this area has previously been identified as flood prone area, no development has occurred in the area. Therefore, no flooding problems have been identified.

6.4.2 Carrollwood System (43XXXX junction ID Series)

The County Line Drainage System and Willow Bend area has an LOS C for the 25-year/24-hour storm event. 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 area. Detailed locations where flooding is predicted to occur for the 25-year/24-hour storm event is shown in Exhibit 6-3. General locations where the EXTRAN model predicts LOS deficiencies are summarized below.

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

Cool Kell Lake
South of Newberger Road on Livingston Avenue

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

Panther Path Road just south of County Line Road

6.4.3 Brushy Creek System (44XXXX junction ID Series)

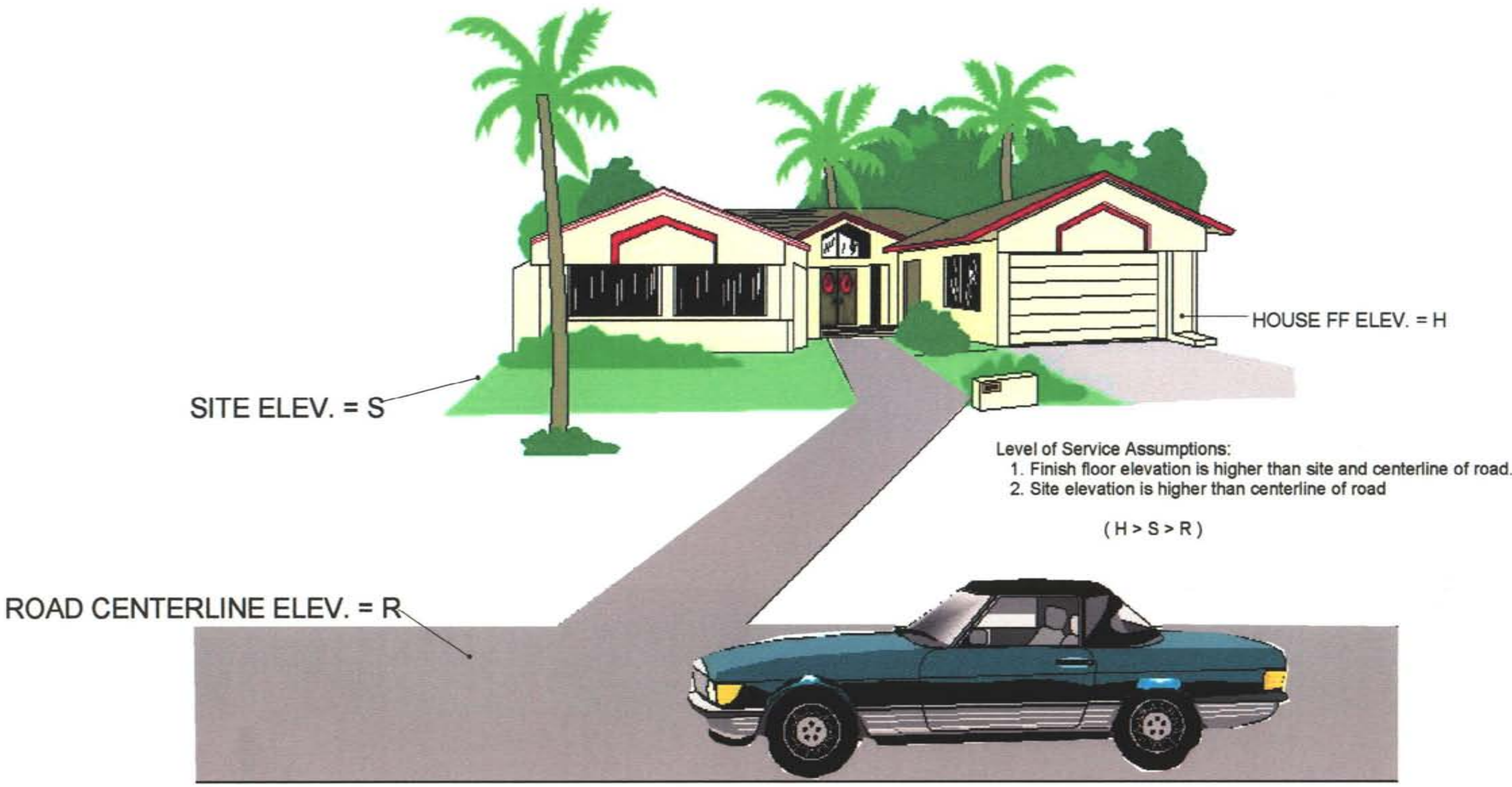
The Country Oaks system has a LOS A for the 25-year/24-hour design storm simulation. The EXTRAN model predicts no major street, site, or structural flooding is expected to occur during the 25-year/24 hour storm event.

6.4.4 Rocky Creek System (45XXXX junction ID Series)

The Ridge Lake 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.

6.4.5 Lake Ruth System (46XXXX junction ID Series)

The Sherry Brook 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.

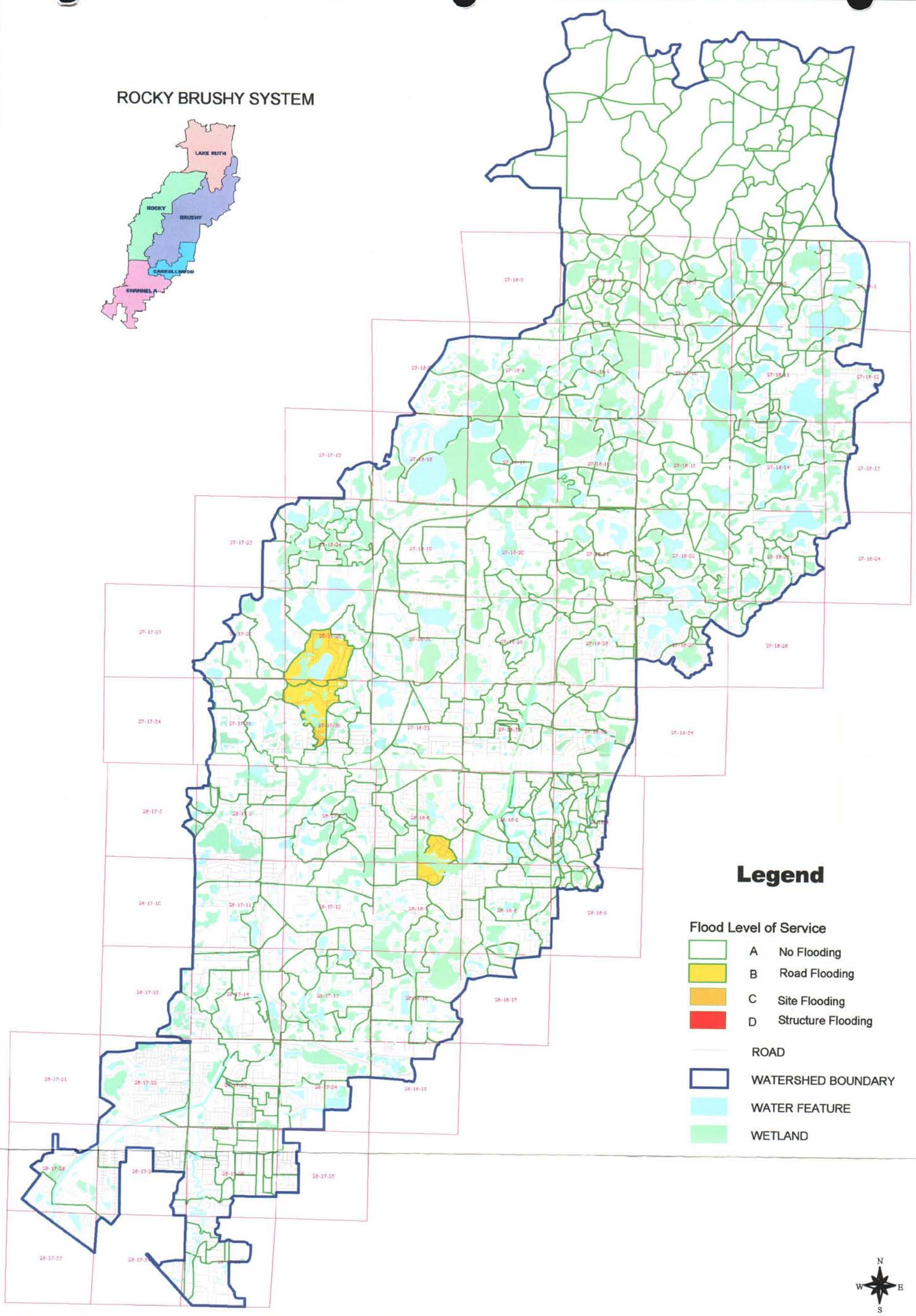


Hillsborough County
Florida

ROCKY BRUSHY CREEK AREA
STORMWATER MANAGEMENT
MASTER PLAN
SEPTEMBER 2002

Department of Public Works
Engineering Division
Stormwater management Section

FIGURE 6-1
LEVEL OF SERVICE DIAGRAM
MAP

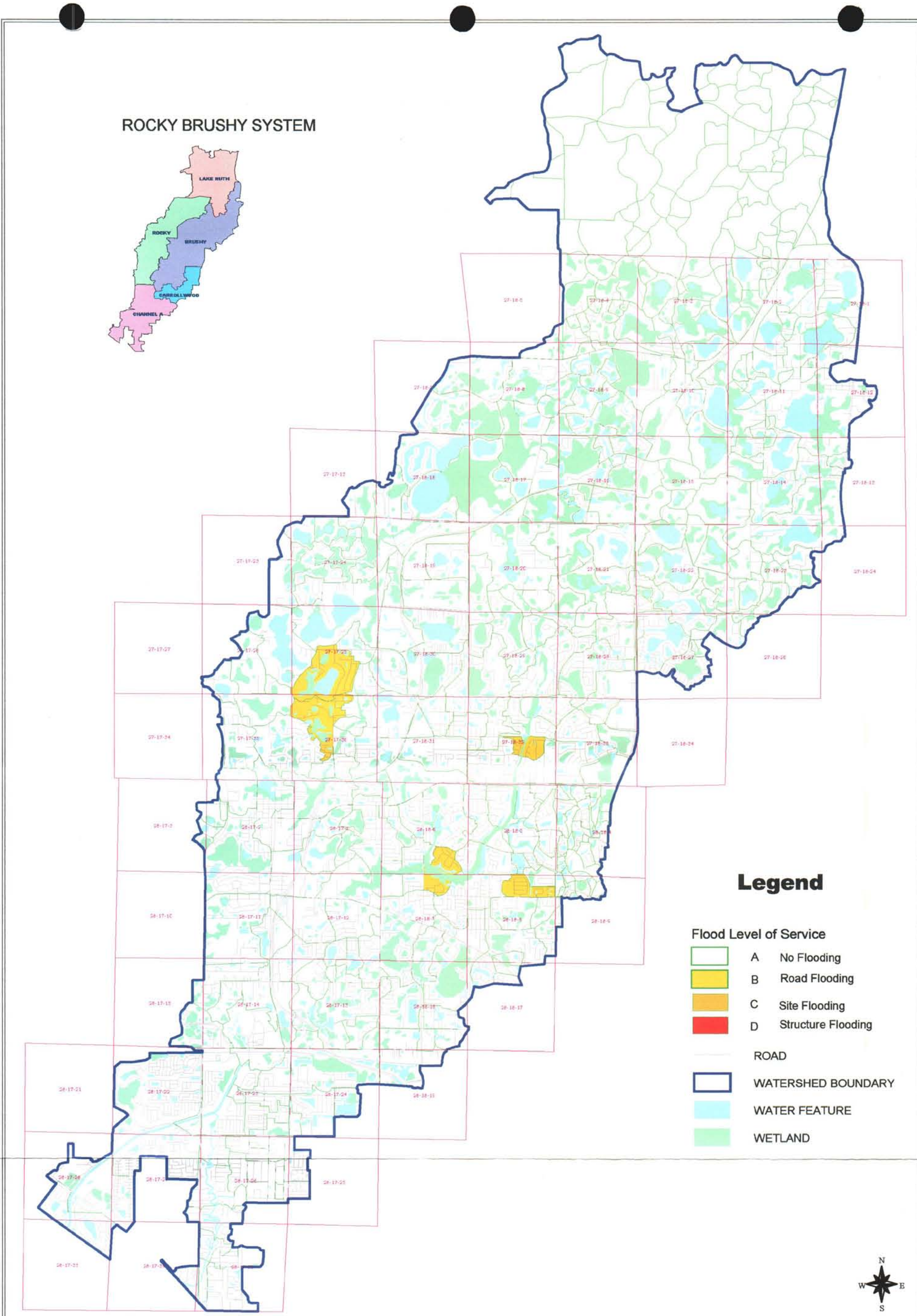


Hillsborough County
Florida

ROCKY BURSHY CREEK AREA
STORMWATER MANAGEMENT
MASTER PLAN
JUNE 2002

Public Works Department
Engineering Division
Stormwater Management ection

Figure 6-2
Existing Conditions 2.33Yr./24Hr.
Level of Service Analysis
Map

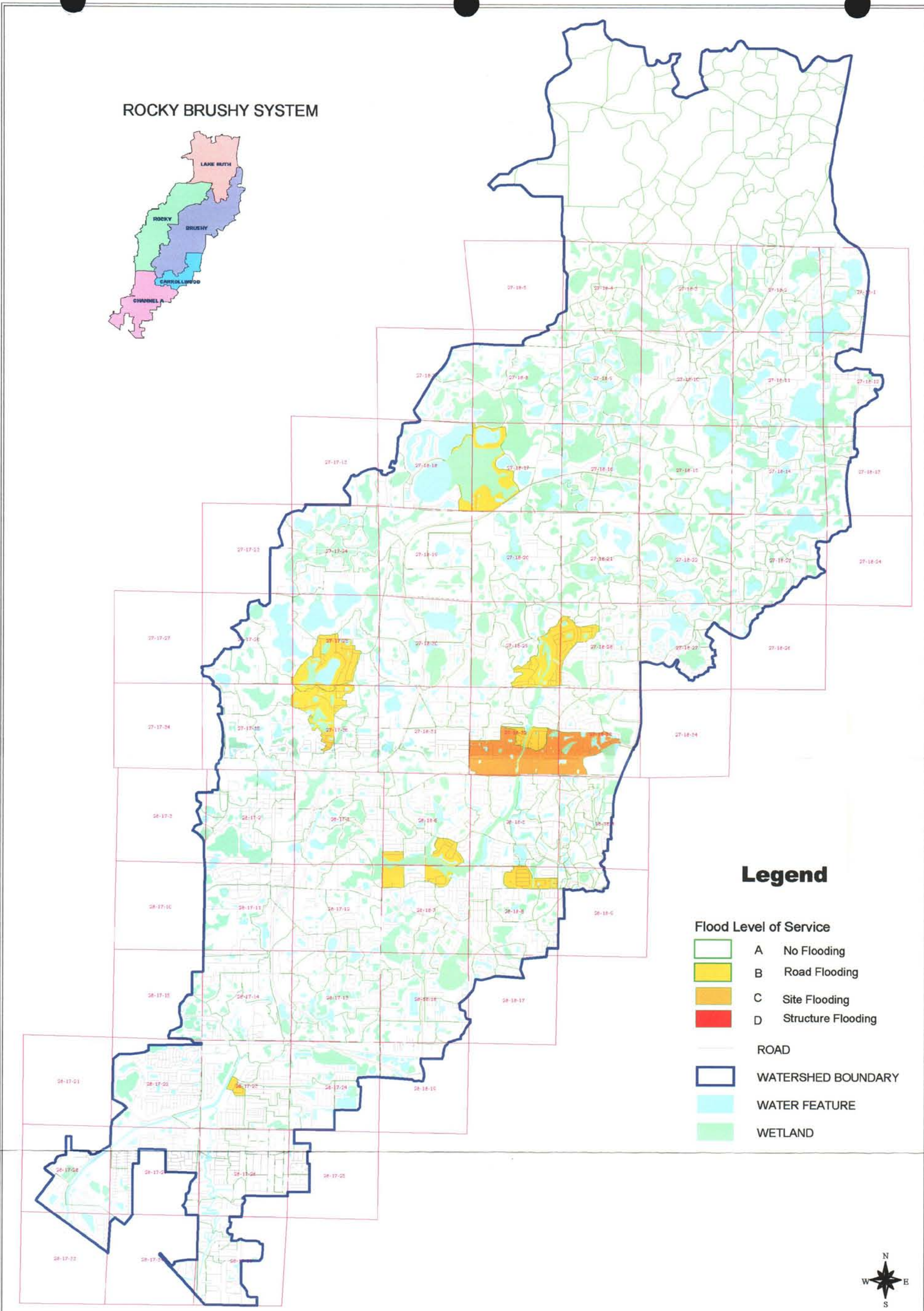


Hillsborough County
Florida

ROCKY BURSHY CREEK AREA
STORMWATER MANAGEMENT
MASTER PLAN
JUNE 2002

Public Works Department
Engineering Division
Stormwater Management ection

Figure 6-3
Existing Conditions 5Yr./24Hr.
Level of Service Analysis
Map



Hillsborough County
Florida

ROCKY BURSHY CREEK AREA
STORMWATER MANAGEMENT
MASTER PLAN
JUNE 2002

Public Works Department
Engineering Division
Stormwater Management ection

Figure 6-4
Existing Conditions 10Yr./24Hr.
Level of Service Analysis
Map

Figure 6-5 25 yr/24 hr Level Of Service Map

Figure is missing

Figure 6-6 Flood Complaint Map

Figure is missing

Figure 6-7 FEMA Flood Insurance Rate maps (FIRM)

Figure is missing

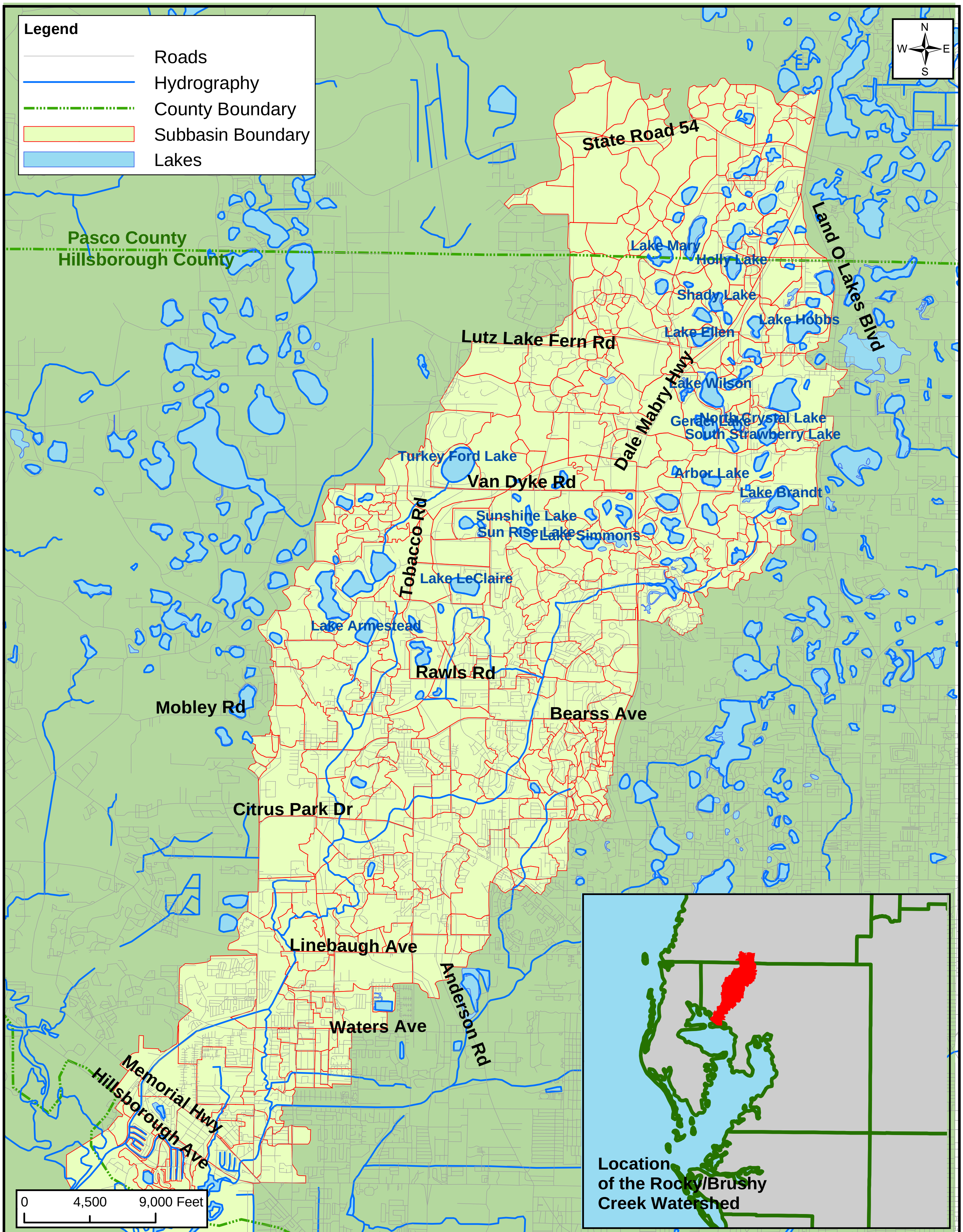
CHAPTER 7: EXISTING WATER QUALITY CONDITIONS

7.1 Overview

Prior to the permanent settlement of Hillsborough County in the first half of the 19th century, approximately 70% of the land in the Rocky/Brushy Creek watershed was occupied by native upland and wetland habitat types (pine flatwoods, longleaf pine-xeric oak, cypress swamps, stream and lake swamp, bay swamps, wetland forested mixed, lakes, freshwater marshes and wet prairies, saltwater marshes, tidal flats/submerged shallow platform, and mangrove swamps). The swamps bordering the channels, the large areas of cypress swamp, and the saltwater marshes adjacent to the channel in the lower reaches of Rocky Creek were significant contiguous wetlands in the watershed. By 1910, Hillsborough was the most populous county in the state, and considerable development of roads and railroads had occurred. By 1916, major roadways (Old Memorial Highway, Van Dyke Road, Lutz Lake Fern Road, U.S. 41) were hard surface facilities, and numerous secondary roads were in place. Over 200 homes and buildings had been constructed, and the Tampa and Gulf Coast Railroad had several lines through the watershed. Several small communities and villages (Stemper, Citrus Park, Tarpon Junction, Blockton, Lutz, Cosme) had grown up around roadway intersections and rail lines. By 1938, agriculture had become well established on the uplands (longleaf pine-xeric oak, pine flatwoods) in the central and northern regions of the watershed. Cattle, row crops, and citrus were the dominant commodities. By 1950, agriculture accounted for 19.5% of the lands in the watershed, while uplands were reduced to 51% of the watershed. By 2004, the percent coverage of the watershed by native uplands was further reduced to 5.4%.

The rapid development of agriculture followed by urbanization over the previous 150 years has resulted in both major physical alterations and a documented decline in the water quality of surface water features in the watershed. Surface and ground water quality, together with water quantity, is the single most important environmental support factor in sustaining the well-being of human populations, promoting economic growth, and maintaining viable aquatic ecosystems in Florida, including the Rocky/Brushy Creek watershed. This chapter describes historical and existing trends in water quality for the streams, lakes, and groundwater within the Rocky/Brushy Creek watershed (Figure 7-1) for the purposes of identifying significant problem areas/issues and potential sources of contamination. Detailed analyses of water quality conditions are addressed later in this chapter.

The 60-square mile Rocky/Brushy Creek watershed is comprised of streams, canals, ponds, lakes, and open water estuarine systems.



Location of the Rocky/Brushy Creek Watershed

Figure 7-1

AYRES ASSOCIATES

Surface water features include: the channels of Brushy Creek, Rocky Creek, Channel A, Woods Creek, and Pepper Mound Creek; 57 natural lakes; and 33 man-made lakes/ponds. Because of the critical importance of maintaining satisfactory water quality conditions in the watershed, the conservation and restoration of these resources are important components of a number of ongoing planning activities and action projects for this area including:

- Florida Department of Environmental Protection (FDEP) Impaired Waters and Total Maximum Daily Load (TMDL) Program
- Hillsborough County's Comprehensive Plan (Stormwater Management, Conservation and Aquifer Recharge, and Coastal Management Elements)
- Southwest Florida Water Management District's (SWFWMD) Tampa Bay/Anclote River Comprehensive Watershed Management Plans (CWM)
- Southwest Florida Water Management District's Minimum Flows and Levels (MFL) Program
- Southwest Florida Water Management District's Surface Water Improvement and Management (SWIM) Program for Tampa Bay
- Southwest Florida Water Management District's Northern Tampa Bay Phase II Program
- Southwest Florida Water Management District's Tampa Bay/Anclote River Comprehensive Watershed Management Plans (CWM)
- Tampa Bay Estuary Program's Comprehensive Conservation Management Plan

Both federal (Clean Water Act [CWA]) and state (Chapter 62-302, Chapter 62-303, and Chapter 62-304 Florida Administrative Code [F.A.C.]) initiatives have been developed to protect, restore, and maintain surface waters. During the 1997 session, the Florida Legislature amended the Water Resources Act (Chapter 373.036, Florida Statute) and clarified responsible agencies' roles relating to water supply planning. The primary goals of these initiatives have been to provide water supply assessment and water quality conditions that protect human health and are capable of supporting viable fish and wildlife populations. A classification system has been developed by the FDEP that designates a waterbody based on one of five classes related to a particular waterbody's designated use (Table 7-1).

Each classification has specific water quality criteria necessary for the protection and preservation of surface waters, which are also consistent with minimum federal standards set by the U.S. Environmental Protection Agency (US EPA) (Appendix 7-1)[1].

Discharges to surface waters are regulated by the FDEP, SWFWMD, Hillsborough County Environmental Protection Commission (HCEPC), and/or the US EPA, depending on the type and magnitude of a particular discharge. Comprehensive stormwater regulation is also required under Section 402(p) of the CWA, and cities/municipalities with populations greater than 100,000 are required to develop and implement stormwater plans under Phase I of the National Pollutant Discharge Elimination System (NPDES) stormwater regulations. Phase II of the NPDES program, which was implemented in 2004, required smaller communities to obtain a permit and develop a program for water quality improvement.

[1] Appendix 7-1 – FDEP Surface water classification chart

Table 7-1 Surface Water Classifications Developed under Chapter 62-302, F.A.C.

SURFACE WATER CLASSIFICATION	DESIGNATED USE	WATER QUALITY CRITERIA
CLASS 1	Potable Water Supplies	Very stringent
CLASS 2	Shellfish Propagation or Harvesting	Stringent
CLASS 3	Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife	Moderately stringent
CLASS 4	Agricultural Water Supplies	Less stringent
CLASS 5	Navigation, Utility and Industrial Use	Less stringent

There are no Class I waterbodies in the watershed. Class II waterbodies include the lower reaches of Rocky Creek and Channel A. Class III waterbodies include the reach of Rocky Creek upstream of SR 580, all of Brushy Creek, Channel A upstream of the line of mean high water, other minor streams, and the natural lakes and man-made ponds located within the watershed. In addition, waters located within the Bower Tract and the Rocky Creek Coastal Preserve are designated Outstanding Florida Waters (*62-302 F.A.C. amended 09JAN06*).

The following section provides a brief discussion of the Federal and Florida rules and regulations in regard to water quality protection.

7.1.1 Regulatory Background

The Total Maximum Daily Load (TMDL) requirements were originally promulgated as a part of the Federal Water Pollution Control Act of 1972 and were later expanded by the Clean Water Act (CWA) of 1977 and the Water Quality Act (WQA) of 1987. The law requires states to define state-specific water quality standards for various designated uses and to identify water bodies that do not meet established water quality standards (Subsection 303(d)). Water bodies that do not meet such water quality standards as a result of human-induced conditions are to be considered impaired. An updated list of impaired water bodies must be presented by the state to the Environmental Protection Agency (EPA) every two years and must designate which of the listed impaired water bodies will require implementation of the TMDL process.

State of Florida issued a full 303(d) planning list in 2002 and has been producing basin-specific 303(d) impaired waters lists recently in accordance with the Florida Watershed Restoration Act (FWRA, Chapter 403.067, Florida Statute).

In Florida, the TMDL process is multi-phased and includes identification, verification, and listing of impaired waters, followed by the development and implementation of constituent specific TMDL (e.g., DO, TN, etc.). As a first step, FDEP develops a planning list of impaired waters based on existing data. FDEP then prepares a verified list following the collection of additional corroborating water quality, biological, or other data. The verified list is then adopted by the FDEP Secretary as the basin specific 303(d) list to be sent to EPA in compliance with the CWA. Once a water body is placed on the verified list of impaired waters, the next phase of the TMDL process is to develop a TMDL, including the initial allocation of allowable loads. The next step in the TMDL process is the development of the Basin Management Action Plan (BMAP), or the TMDL implementation plan, in which detailed allocations of allowable loadings for point and non-point sources (NPS) for a specific water quality constituent is done and load reduction strategies are evaluated.

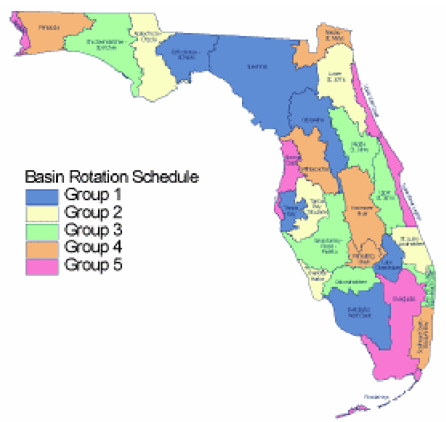
Florida's TMDL development and implementation process includes the following phases:

Phase 1: Data Compilation and Assessment
Phase 2: Collection and Assessment of Additional Data
Phase 3: Determination of Total Maximum Daily Load
Phase 4: Development of Allocation and Basin Management Action Plan (BMAP)
Phase 5: Implementation of the TMDL and BMAP

The process for the determination of impaired waters is described in the Impaired Water Rule, 62-303 FAC. In Phase 3, the TMDL is estimated, generally with the use of mathematical models associated with water quantity and quality data and watershed information. Details of the applicable models and input requirements are discussed in the FDEP, TMDL Protocol version 6.0 (2006). This section is adopted from the FDEP, TMDL protocol for completeness.

Once the TMDL is established in Phase 3, the allowable loads are allocated in Phase 4 to both the point and non-point sources for each specific water quality constituent. Point sources would include domestic and industrial wastewater and National Pollutant Discharge Elimination System (NPDES), industrial and municipal separate storm sewer systems (MS4s), and stormwater discharges. Non-point sources would include septic tanks, agricultural, silvicultural, atmospheric, and natural flora and fauna discharges, as well as legacy sediment effects. One or more implementation plans are then developed to define how each source will be controlled to achieve the allocated load. For contributing pollutant sources under NPDES permits, the allocation will be achieved through permit-specified effluent limitations and load reductions. For other sources, such as agricultural areas that are not regulated by NPDES permits, load allocations will be achieved through non-regulatory programs based on the implementation of Best Management Practices (BMPs) associated with each crop type. Lastly, in Phase 5 of the TMDL process, the implementation of the BMAPs are initiated. FDEP uses the concept of watershed approach to implement the TMDL program that is briefly described here.

To implement the watershed approach for all water bodies in Florida, FDEP has divided each of the six FDEP Districts into five geographically based groups of watersheds. A map of the groups is shown in the inset and a table that lists the groups by basin and district is provided below (Table 7.1a). As illustrated in Table 7.1b, the five phases of the State's TMDL program for each group are completed in annual cycles, starting with Group 1.



For each TMDL completed under the phased watershed management approach outlined above, a technical analysis of the assimilative capacity of the subject water segment in question may be conducted. The assimilative capacity is the total amount of a pollutant that can be discharged into a water segment without causing use impairment.

FDEP Basin Rotation Schedule (Source: FDEP, 2007)

Thus, the assimilative capacity, as a result, is numerically equivalent to that segment's TMDL with a Margin of Safety (MOS). To determine the assimilative capacity, the fate of the total loading to a water segment may be compared to water quality criteria and other environmental targets to test for use impairment. Such comparisons are usually done using water quality data and hydraulic-hydrologic-water quality modeling tools.

Table 7-1a Watersheds Listed by Group and FDEP District

YEAR*	00 01	01 02	02 03	03 04	04 05	05 06	06 07	07 08	08 09	09 10
Group 1	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Group 2		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 1	Phase 2	Phase 3	Phase 4
Group 3			Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 1	Phase 2	Phase 3
Group 4				Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 1	Phase 2
Group 5					Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 1
	1st Five-Year Cycle – High Priority Waters					**2nd Five-Year Cycle – Medium Priority Waters**				

Table 7-1b Schedule of Phases for Each Group

DEP District	*Group 1 Basins*	*Group 2 Basins*	*Group 3 Basins*	*Group 4 Basins*	*Group 5 Basins*
NW	Ochlockonee-St. Marks	Apalachicola-Chipola	Choctawhatchee-St. Andrews Bay	Pensacola Bay	Perdido Bay
NE	Suwannee	Lower St. Johns		Nassau-St. Marys	Upper East Coast
Central	Ocklawaha	Middle St. Johns	Upper St. Johns	Kissimmee	Indian River Lagoon
SW	**Tampa Bay**	**Tampa Bay Tributaries**	Sarasota Bay-Peace-Myakka	Withlacoochee	Springs Coast
S	Everglades West Coast	Charlotte Harbor	Caloosahatchee	Fisheating Creek	Florida Keys
SE	Lake Okeechobee	St. Lucie-Loxahatchee	Lake Worth Lagoon-Palm Beach Coast	Southeast Coast - Biscayne Bay	Everglades

7.1.2 Existing Literature

The following reports and data sources were reviewed to determine existing water quality conditions, historical trends, water quality models, areas of concern, relevant issues, and ongoing management activities in the Rocky/Brushy Creek watershed:

- FDEP 2002 Update to Florida's List of Impaired Waters, as amended on March 11, 2003
- FDEP 2004 305(b) Report
- Hillsborough County Environmental Protection Commission (HCEPC) Annual Water Quality Reports
- Hillsborough County Comprehensive Plan
- Hillsborough River Greenways Task Force Ecosystem Protection Plan
- Hillsborough County Watershed Atlas
- Southwest Florida Water Management District (SWFWMD) Tampa Bay/Anclote Comprehensive Watershed Management (CWM) Plan
- SWFWMD's Save Our Rivers Five Year Work Plan
- SWFWMD's Tampa Bay Surface Water Improvement and Management (SWIM) Plan for Tampa Bay
- SWFWMD's Groundwater Quality of the Southwest Florida Water Management District, Central Region
- Tampa Bay Estuary Program (TBEP) Comprehensive Conservation Management Plan (CCMP) and related technical reports

- United States Environmental Protection Agency Total Maximum Daily Load Reports for Rocky Creek
- University of Florida LAKEWATCH Annual Data Summary for 2004

Water quality data were obtained from Florida LAKEWATCH and Hillsborough County Watershed Atlas for all parameters and all stations lying within the Rocky/Brushy Creek watershed boundary. The majority of data obtained from the Hillsborough County Watershed Atlas originated from USGS, SWFWMD, or HCEPC.

7.1.3 Water Quality Contaminants

Despite relatively stringent regulatory criteria (e.g., Chapter 62-302, F.A.C.), contaminants are found in streams and lakes which sometimes exceed allowable regulatory limits. Surface waters in the watershed are the receiving water bodies for untreated and partially treated stormwater runoff from lands that are developed (70%) for commercial, residential, and agricultural purposes. Runoff contains complex mixtures of nutrients (i.e., nitrogen and phosphorus compounds), toxic organic substances (pesticides, herbicides, industrial chemicals, oils and greases), metals, solids (trash, litter), particulates from eroded soils. Virtually all of the agricultural development and much of the urban/suburban development within the watershed preceded regulations implemented in the 1970s and 1980s to protect water quality. While regulations have been implemented for 20-30 years and there are stormwater treatment projects underway within the watershed, contaminants occur in the surface waters of the Rocky/Brushy Creek. These are described below:

- **Nutrients**, compounds of nitrogen and phosphorus, are derived from several sources, including:

    - fertilizers applied to landscapes around homes, golf courses, parks, residential complexes, and commercial facilities;
    - animal excrement from pets, feral animal, and wildlife;
    - wastewater treatment facilities, including septic tanks; and
    - atmospheric deposition in rainfall that contains combustion products from incinerators and electric generating plants.

  Such compounds can cause an overabundance of nuisance aquatic weeds and blooms of algae and blue-green bacteria (aka, blue-green algae) in surface waters. In addition to unsightly appearance and taste/odor problems, the most injurious result of excessive algal and bacterial growth is the depression of dissolved oxygen in affected waters. Low dissolved oxygen (<5.0 mg/liter of water) contributes directly to fish kills, stress to all aquatic organisms, and a decline in fishery quality. In addition, some blue-green bacteria produce toxins that are harmful to humans and other animals. The Class III water bodies criterion for DO, as established by Subsection 62-302.530(31), F.A.C., states that DO shall not on average be less than 5.0 mg/L in a 24-hour period, and shall not be less than 4 mg/L at any time, and that normal daily and seasonal fluctuations above these levels shall be maintained. In Florida waters due to warm temperatures (subtropical climate), nitrogen and phosphorus are most often the limiting nutrients, and nitrogen is typically the limiting nutrient in most Florida estuaries. There is a general understanding in the scientific community that nitrogen is the principal cause of nutrient over-enrichment in urban water courses and coastal systems. Determining the limiting nutrient in a water body can be accomplished by calculating the ratio of nitrogen to phosphorus. When the ratios of total nitrogen (TN) to total phosphorus (TP) in a water body is less than 10 then it is classified as nitrogen limited. If nitrogen is the limiting nutrient, reductions in TN loadings would be expected to result in decreases in algal growth, and are measured as decreases in chlorophyll *a* levels. Reductions in TN loading are also expected to result in additional benefits for other water quality parameters of concern, including DO and biochemical oxygen demand (BOD). Reductions in nitrogen will result in lower algal biomass levels in the water column; lower algal biomass levels will result in smaller diurnal fluctuations in DO, fewer algal-based total suspended solids, and reduced BOD. The expectation that reductions in nitrogen loading will provide improvements in other water quality parameters is supported by a statistical evaluation of water quality data through a simple linear regression of chlorophyll *a* versus BOD**.**

Processes that consume oxygen from the water column, such as the microbial breakdown of organic material and sediment oxygen demand (SOD), are fairly constant over the short term. Algal populations, however, can increase rapidly, and the production of oxygen as a result of photosynthesis during daylight hours and the respiration or consumption of water from the water column at night can result in large diurnal fluctuations of DO in the water column. Portions of increased algal biomass will also become part of the organic material that will be broken down by microbes or settle to the bottom. Therefore, management of nutrients in the watershed to maintain the assimilative capacity of receiving waters will improve the water quality by preventing algal growth and maintaining required DO levels for the aquatic life.

- **Total suspended solids (TSS)** may cause high biological or chemical oxygen demand that also can reduce the availability of oxygen in the water for aquatic life. Metals and injurious organic compounds that are toxic in high concentrations are often bound to TSS and can be found in the sediments of receiving waters as a result of having been washed into a lake or stream in stormwater runoff. Excessive TSS concentrations also reduce water clarity which affect aquatic plant communities and may interfere with the feeding efficiency of filter-feeding aquatic insects and shellfish. High TSS in a lake or stream also increase the tendency of the water to heat during the day, further reducing the water's ability to hold oxygen.

- **Metals**, including mercury, lead, and copper, can reach levels that are toxic to many fish, amphibians, and aquatic insects. In some cases, metals such as mercury may accumulate in fish, posing a threat to human health if contaminated fish are consumed regularly. Currently, there have been advisories concerning fish consumption from the Rocky/Brushy Creek watershed.

- **Toxicants**, organic contaminants, and pesticides (which include insecticides, herbicides, and fungicides) can be found in residential, commercial, industrial, and agricultural areas, which can potentially be transported to surface waters via stormwater runoff. Though often undetectable in the water column, some compounds (e.g., pesticides) and their derivatives may accumulate in sediments in concentrations that are harmful to aquatic life.

- **Pathogens**, which may include bacteria, viruses, and protozoa, can cause a number of human diseases including respiratory and gastrointestinal ailments, skin rashes, and eye and ear infections. Transport of pathogens can occur via stormwater runoff or groundwater (from inadequately constructed septic tank systems) to surface waters. Illnesses may occur if pathogens are ingested either through accidental contact by recreational users of lakes and streams or through ingestion of inadequately treated drinking water. Pathogenic organisms are not routinely monitored by most water sampling agencies, except for potable water supplies. Indicators of pathogen contamination include total and fecal coliform bacteria that are tested by some agencies (e.g., health departments) at public bathing beaches and in ambient water quality monitoring programs. Efforts are currently underway by the US EPA to adopt standards for two new indicators, *E. coli* and the enterococcal group.

- **Litter, trash**, and other discarded solid objects originate from humans around shopping and commercial areas, industrial sites, landfills, automobiles, and overflowing trash cans. Litter poses a health and safety risk to humans and aquatic animals and impairs the aesthetic and economic values of neighborhoods, streams, and lakes.

7.1.4 Pollution Sources and Transport

Excess nutrients, pathogens, and toxic contaminants can follow several different pathways to the streams, lakes, and groundwater in the Rocky/Brushy Creek watershed including:

- stormwater runoff from urban, residential, commercial, and agricultural land uses;
- on-site wastewater treatment and disposal systems (i.e., septic tanks), which may contribute significantly to nitrogen and pathogen loading;
- animal waste from pets, feral dogs and cats, and wildlife;
- untreated domestic wastewater which may occur as accidental discharges during heavy rainfall events from wastewater treatment and transport facilities;
- long-term discharge of treated wastewater to area streams from permitted wastewater treatment facilities;
- leachate from several historical dump sites may migrate to groundwater and/or surface water;
- contaminated sediments which may be re-suspended during high flow or wind events in streams and lakes/bays, respectively; and,
- atmospheric deposition (primarily nitrogen oxides and certain heavy metals like mercury which can be transported to the creeks and lakes in rainfall and dryfall).

7.1.5 Superfund/Landfills/Point Sources

Superfund sites - A survey of US EPA's National Priority List indicated that there are no active Superfund sites located in the Rocky/Brushy Creek watershed.

Landfills and other waste facilities – There are two active waste facilities in the watershed:

1. NW Hillsborough Transfer Station located north of Linebaugh Avenue; and
2. University Community Hospital Biohazardous Waste Storage Facility.

There are two closed landfills in the watershed:

1. NW Hillsborough Class III facility closed as of October 1990, located north of Linebaugh Avenue; and
2. NW Hillsborough Sanitary Landfill closed as of June 1984, also located north of Linebaugh Avenue.

There is one inactive sludge composting facility in the watershed, the NW Regional Sludge Management Facility located south of Ehrlich Road (Figure 7-2).

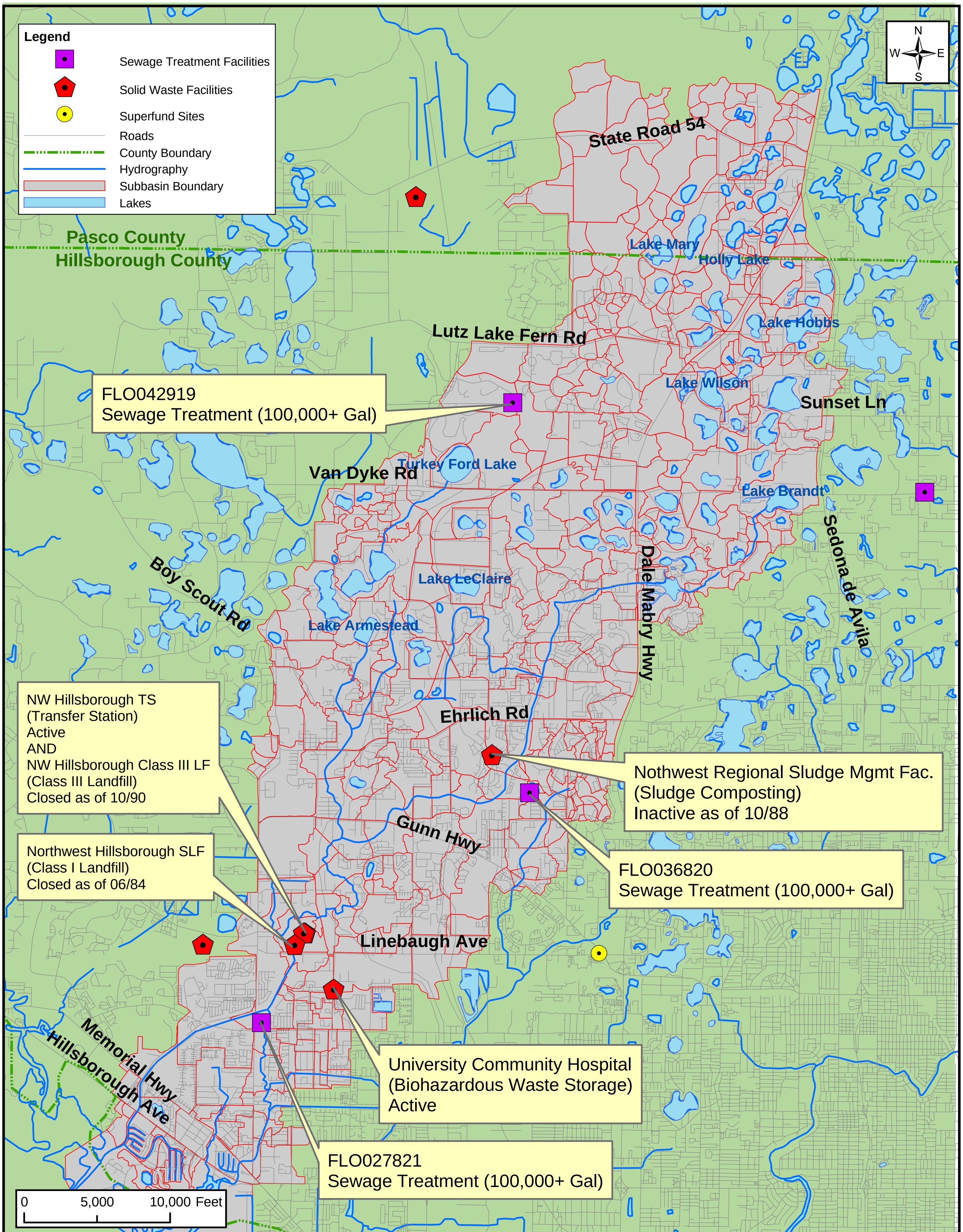
Point sources – There are three active sewage treatment facilities in the watershed:

1. FLO027821 (River Oaks WWTP) located at the juncture of Rocky Creek and Channel A;
2. FLO042919 (NW Regional WWTP) located south of Lutz Lake Fern Road; and
3. FLO036820 (Dale Mabry WWTP) located southeast of Gunn Highway.

7.1.6 Other Issues

A number of other issues related to existing water quality conditions in the Rocky/Brushy Creek include:

- **Atmospheric deposition**, which has recently been identified as a major contributor of pollutants in the Tampa Bay area. Recent reports by the TBEP and other investigators estimate that more than 25% of the bay's total nitrogen burden can be attributed to atmospheric sources. The pollution originates from power plant emissions, industrial smokestacks and vehicle exhaust. All of these sources carry nitrogen oxides (NOx), which can fall on both land and water surfaces dissolved in rain or as particulate matter. Research performed for the TBEP indicates that as much as 7,000 tons of nitrogen per year may fall on the land surface area within the Tampa Bay watershed. A portion of this load can be transported to the bay through stormwater. Stationary sources such as coal-fired power plants or garbage incinerators are believed to contribute about 66 percent of the nitrogen oxides released to the air in the Tampa Bay watershed, while vehicles and boats account for about 34 percent. Ongoing efforts by TECO are underway to reduce NOx emissions. Mercury contamination resulting in fish consumption advisories is also believed to occur through atmospheric deposition. Control of mercury emissions is relatively complex since sources of mercury may be originating in other countries which have less strict air quality regulations than the U.S.



Location of the Superfund Sites, Solid Waste Facilities, and Sewage Treatment Facilities in the Rocky/Brushy Creek Watershed

Figure 7-2

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- **Contaminated sediments** –Although we have no specific data on sediments in the Rocky/Brushy Creek watershed to indicate specific issues, it is helpful to indicate that recent studies in the Tampa Bay area have identified the presence of contaminated sediments in several areas of the Bay (Long et al., 1991 and 1994; Long and Greening, 1999, Grabbe and Barron, 2002). Of the areas sampled, Old Tampa Bay, the receiving water body for Rocky/Brushy Creek and Channel A, had consistently lower levels of polychlorinated biphenyls (PCBs), organochlorine pesticides, and polycyclic aromatic hydrocarbons (PAHs) than other segments of the Tampa Bay system. While PCBs and PAHs were detected in sediment in the estuaries of Rocky Creek and Channel A, concentrations exceeded national standards for sediment quality in less than 30% of the samples tested. Few, if any, samples have been taken within the Rocky/Brushy Creek watershed to evaluate sediment quality, but since contaminated sediments have been detected within the Bay, it is recommended that all contributing areas be sampled for potential contaminated sediment flux to the Bay. A number of management activities have been proposed to reduce contaminant loading to Hillsborough Bay, including source reductions and stormwater treatment. Such activities may be needed for all sources of inflow to the Bay. A sediment sampling plan may be needed to determine whether a sediment TMDL is warranted for this watershed.

7.1.7 Total Maximum Daily Loads (TMDLs)

Section 303(d) of the Clean Water Act includes a requirement for states to identify, list, and prioritize waters for which water quality standards are not being protected by technology-based effluent limitations. Based on the priorities reported, each state must develop Total Maximum Daily Loads (TMDLs) for those waters that do not meet applicable water quality standards. The TMDL process quantifies and allocates the amount of a pollutant that can be assimilated by a waterbody. The process also identifies the source(s) of the pollutant and recommends appropriate regulatory actions to achieve compliance with water quality standards. A TMDL can be expressed as the sum of all point sources (waste load allocations or WLAs), non-point sources (load allocations or LAs), and an appropriate margin of safety (MOS), as shown below:

$$\text{TMDL} = \Sigma \text{ WLAs} + \Sigma \text{ LAs} + \text{MOS}$$

The calculation must also account for seasonal variation in water quality. Nationally, the issues that are implicated in the most impaired waterbodies/segments include: sediments, nutrients, pathogens, low dissolved oxygen, and metals.

In the TMDL process, watersheds are evaluated using the following phased approach:

- Phase 1 - Initial Basin Assessment
- Phase 2 - Coordinated Monitoring
- Phase 3 - Data Analysis and TMDL Development
- Phase 4 - Basin Management Plan Development
- Phase 5 - Begin Implementation of Basin Management Plan
- Linkage to TMDL Implementation

Figure 7-3 displays the location of watersheds scheduled for TMDL development as of 2002 in the US EPA 303(d) report for Florida and their WBIDs. The Rocky/Brushy Creek watershed was broken down into the Rocky Creek marine segment (WBID 1507A) and the freshwater segment (WBID 1507).

Waters within segment 1507A were identified as impaired for dissolved oxygen (DO) and nutrients. Waters within WBID 1507 are not on the FDEP list, but US EPA proposed a TMDL for Coliforms, DO, Nutrients, and TSS. Brushy Creek (WBID 1498) is not on the FDEP list, but US EPA proposed a TMDL for Coliforms and DO. Two lakes in the watershed, Reinheimer and Brant, are scheduled by FDEP for TMDL development for nutrients in 2008 (Table 7-2). Refer to Appendix 7-2 for a complete list of waterbodies and their corresponding TMDL schedule.

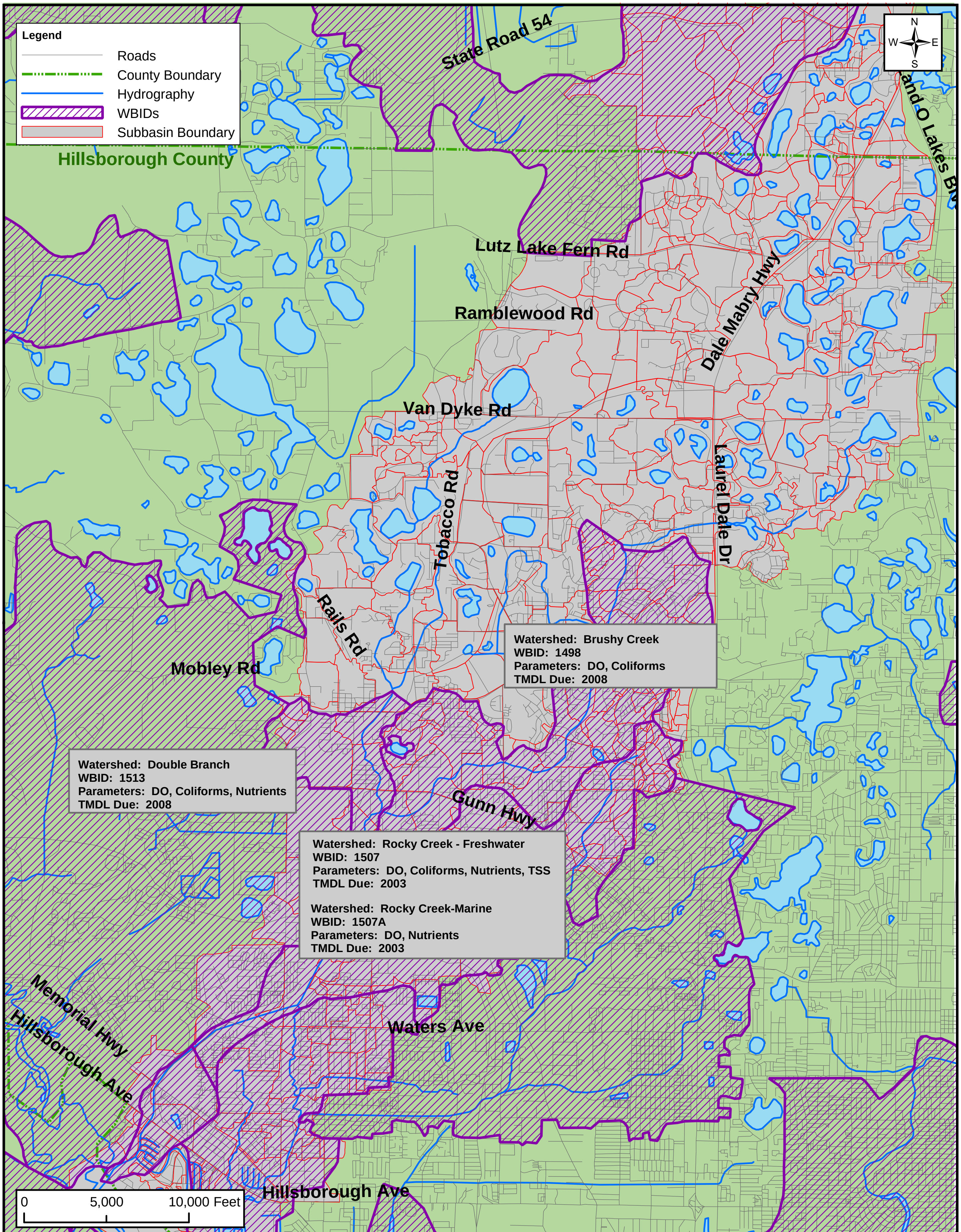
Table 7-2 List of 303(d) Waterbodies and their Schedules in the Rocky/Brushy Creek Watershed

		FDEP		US EPA	
Name	**WBID**	**Parameters**	**Schedule**	**Proposed TMDL**	**Approved TMDL**
Rocky Creek - marine	1507A	Nutrients (chl a), DO	2003	DO, Nutrients, 2003	None
Rocky Creek - marine	1507A	Nutrients (Historic Chlorophyll)	2008		
Rocky Creek - freshwater	1507	None	N/A	Coliforms, DO, Nutrients, TSS, 2003	None
Brushy Creek	1498	None	N/A	Coliforms, DO, 2008	None
Lake Reinheimer	1478H	Nutrients (TSI)	2008	Nutrients	None
Brant Lake	1494B	Nutrients (TSI)	2008	Nutrients	None

1-FDEP parameters and schedule based on FDEP Verified List of Impaired Waters for the Group 1 Basins (including amended order – March 2003) G1CompositeVerifiedList_2-7-05.xls

2-US EPA TMDLs based on information downloaded on Nov 2007 APPROVED/DISAPPROVED by EPA on JUN-11-2003, Section 303(d) List Fact Sheet for Watershed TAMPA BAY.

US EPA issued its draft report for Rocky Creek TMDLs for DO and nutrients in September 2004. The FDEP will be evaluating various areas of the state based on a “rotating watershed” approach (Livingston, 2000). FDEP’s assessment study for the Tampa Bay area, which includes Rocky/Brushy Creek, was issued in February 2004.



Location of WBIDs as they pertain to the Rocky/Brushy Creek Watershed

Figure 7-3

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7.2 Water Quality Conditions in the Rocky/Brushy Creek Watershed

7.2.1 Overall Data Assessment Methodology

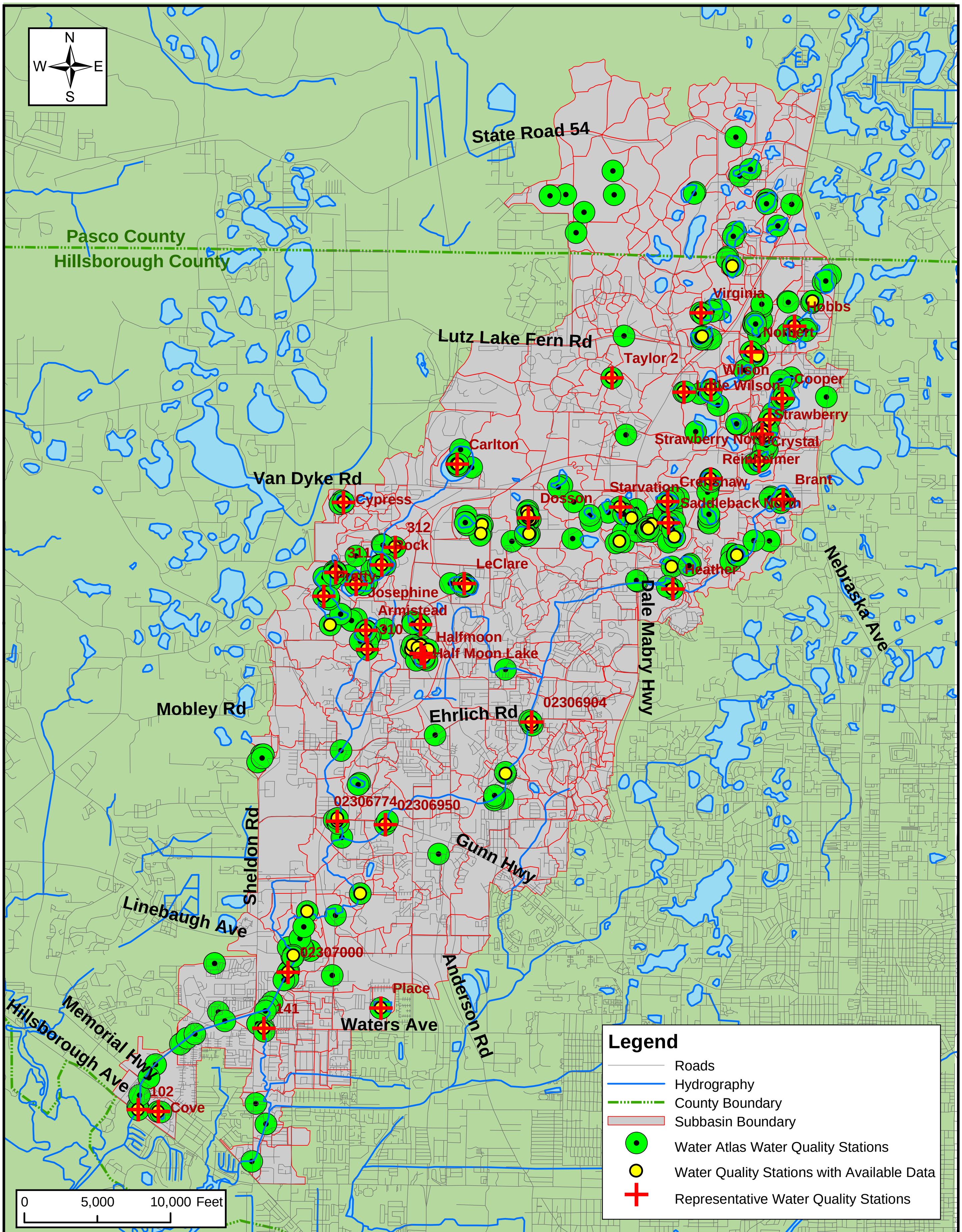
Station Selection

Locations of all surface water quality sampling stations evaluated in this chapter are shown in Figure 7-4. Data were available over the period 1990 through mid-2005 for the database as a whole; however, data for most lakes and streams was sporadic during that period. The most extensive database existed for the following streams and lakes:

- Rocky Creek
- Brushy Creek
- Channel A
- Brant Lake
- Crenshaw Lake
- Lake Hobbs
- Lake LeClare
- Little Halfmoon Lake
- Place Lake
- Pretty Lake
- Lake Strawberry
- Sunrise Lake
- Lake Taylor

Because many stations contained insufficient water quality data, only stations with at least 20 data points per parameter were used in the analyses; these stations are the “representative” stations discussed in next section of this report and are listed in Table 7-3.

It is important to note that the data sets used for this evaluation were the most current available at the time at the start of the project. More recent sample data is available, but not included in this analysis.



Location of all Surface Water Quality Sampling Stations in the Rocky/Brushy Creek Watershed

Figure 7-4

Table 7-3 Number of Samples for Selected Parameters for Representative Stations in the Rocky/Brushy Creek Watershed

	Parameters										
STATIONID	**DO**	**BOD5**	**ChlA**	**TN**	**NH3**	**NOx**	**TKN**	**TP**	**Fecal Coli**	**Total Coli**	**pH**
Streams											
Brushy Cr near Sulphur Spr 02306904	22	22			22	22	23	24	20	20	43
Brushy Cr near Citrus Park											31
Channel A at Hillsborough Av	179	183		170	181	181	184	184	182	144	182
Rocky Cr near Sulphur Spr	39	32			37	37	40	39	32	32	72
Rocky Cr at State Hwy 587	44				42	42	42	42			64
Rocky Cr at Hillsborough Av	95	183		170	182	182	184	184	181	144	95
Rocky Cr at Waters Av	149	183		170	181	183	184	184	181	144	149
Rocky Cr at L. Armistead				34				34			
Rocky Cr at Hutchinson Rd	34			27				27			34
Rocky Cr at Fitzgerald Rd	88			164				165			87
Lakes											
Armistead			215	266				240			
Brant			411	478				429			
Carlton			25	23				25			
Cooper			71	100				86			
Cove			216	246				242			
Crenshaw			261	376				335			
Crystal			139	207				178			
Cypress			116	164				144			
Deer			151	268				242			
Dosson			51	41				50			
Half Moon Lake			30	25				24			
Halfmoon			37	61				53			
Heather			117	123				123			
Hobbs			94	173				137			
Josephine			224	245				218			
LeClare			26	30				26			
Little Halfmoon			136	160				137			
Little Wilson			128	139				136			
Norbert			49	69				67			
Place			18	32				29			
Pretty			71	89				72			
Reinheimer			176	206				184			
Rock			224	238				220			
Saddleback North			88	156				132			
Starvation			12	20				18			
Strawberry North			42	57				52			
Strawberry			20	28				22			
Taylor 2			56	56				56			
Virginia			152	169				144			
Wilson			151	212				187			

Surface Waters

Lakes

Fifty-seven named, natural lakes exist in the Rocky/Brushy Creek watershed study area. Thirty-three man-made ponds and lakes are also present in the watershed. Because 52% of the watershed is in urban land uses, and 16% is in agricultural land uses, the vast majority of all ponds and lakes in the watershed occupy lands which have the potential to contribute significant quantities of nutrients, sediment, petroleum-based substances, and metals to all surface water bodies via stormwater runoff, with undesirable ecological and water quality consequences.

Due to the highly developed nature of the basin, maintaining and enhancing water quality in the both natural and man-made lakes and ponds is an important issue because this watershed discharges to Old Tampa Bay. The SWFWMD, HCEPC, United States Geological Survey (USGS), and FDEP collect data in a number of lakes and streams in Hillsborough County. These agencies monitor such parameters as lake levels, water quality, and habitat value for a select number of lakes in the county.

In order to evaluate and compare lake water quality throughout Florida, the FDEP makes use of a Trophic State Index (TSI). Initially developed by Carlson (1977), the TSI is a number generated by inserting values for three water quality indicators (total phosphorus concentration, chlorophyll a concentration, and Secchi depth) into an equation modified from the original to include total nitrogen concentrations and exclude the Secchi depth measurement. Today, the TSI is interpreted as follows: a TSI between 0 and 59 is *good*, while a value between 60 and 69 is *fair,* and 70 to 100 is *poor.* In Table 7-3a, lakes having sufficient data for TSI calculations are listed in order of increasing (good→ bad) TSI. Lakes with the lowest TSI are Snake, Helen, LeClare, and Cypress, while lakes with the highest TSI are Merrywater and Taylor.

Streams

The watershed contains five named streams: Brushy Creek, Rocky Creek, Channel A, Woods Creek, and Pepper Mound Creek. Stream water quality was assessed the data obtained from the Hillsborough County Watershed Atlas. The Atlas contains water quality data provided by HCEPC, USGS, STORET, and other organizations. Summary statistics of all data extracted from the Hillsborough County Watershed Atlas for the watershed can be found at the end of this chapter (Appendix 7-3). Locations of all surface water quality sampling stations evaluated in this chapter are shown in Figure 7-4. Since many stations contained insufficient water quality data, only stations with at least 20 data points per parameter were used in the analyses; these stations are the “representative” stations discussed in the next section of this report.

Usually, to assess and compare water quality within watersheds, the Florida Water Quality Index (WQI) developed by Hand et al. (1992) is used. Table 7-3b provides the WQIs for Rocky, Brushy, and Channel A. Data for other named streams were not available. The WQI is interpreted as follows: between 0 and 45 is *good*, while a value between 45 and 60 is *fair,* and *>60* is *poor.*

Table 7-3a Trophic State Indices (TSIs) for Lakes with Available Data

LAKE	TSI
CATEGORY - GOOD	
Snake	27.20
Helen	27.40
LeClare	27.60
Cypress	28.70
Round	31.10
Norbert	33.30
Hobbs	35.80
Politz	36.80
Sunrise	36.80
Little Halfmoon	39.70
Little Deer	40.20
Deer	40.80
Starvation	41.40
Brown	41.90
Halfmoon	41.90
Strawberry	43.20
Crum	44.80
Cooper	46.10
Place	46.30
Crystal	48.80
Thomas	49.80
Charles	50.30
Saddleback	50.60
Dosson	50.90
Crenshaw	51.00
Allen	51.20
Reinheimer	51.20
Armistead	51.50
Harvey	57.10
Cove	58.30
CATEGORY - FAIR	
Brant	59.30
Pretty	61.60
Josephine	62.00
Rock	62.40
Virginia	62.50
Carlton	63.30
Little Lake Wilson	66.20
CATEGORY - POOR	
Merrywater	69.90
Taylor	73.90

Table 7-3b Water Quality Indices (WQIs) for Streams in the Rocky/Brushy Creek Watershed

ROCKY CREEK REACH 106

TIME PERIOD	YEAR 2002	2003	2004	2005
Jan - Mar	N/A	70	80	90
Apr - Jun	N/A	N/A	N/A	N/A
Jul - Sep	N/A	N/A	N/A	N/A
Oct - Dec	90	N/A	N/A	N/A

ROCKY CREEK REACH 274

TIME PERIOD	YEAR 2002	2003	2004	2005
Jan - Mar	N/A	N/A	30	N/A
Apr - Jun	N/A	N/A	N/A	N/A
Jul - Sep	N/A	N/A	N/A	N/A
Oct - Dec	N/A	N/A	N/A	N/A

ROCKY CREEK REACH 068

TIME PERIOD	YEAR 2002	2003	2004	2005
Jan - Mar	38	34	20	46
Apr - Jun	55	73	N/A	44
Jul - Sep	69	45	N/A	N/A
Oct - Dec	51	39	N/A	N/A

ROCKY CREEK REACH 439

TIME PERIOD	YEAR 2002	2003	2004	2005
Jan - Mar	N/A	N/A	10	N/A
Apr - Jun	N/A	N/A	N/A	N/A
Jul - Sep	N/A	40	N/A	N/A
Oct - Dec	N/A	50	N/A	N/A

ROCKY CREEK REACH 440

TIME PERIOD	YEAR 2002	2003	2004	2005
Jan - Mar	N/A	N/A	35	N/A
Apr - Jun	N/A	N/A	N/A	N/A
Jul - Sep	N/A	42	N/A	N/A
Oct - Dec	N/A	49	N/A	N/A

ROCKY CREEK REACH 293 south of Waters Ave

TIME PERIOD	YEAR 2002	2003	2004	2005
Jan - Mar	44	61	63	44
Apr - Jun	54	71	70	71
Jul - Sep	72	63	65	66
Oct - Dec	52	61	72	60

ROCKY CREEK REACH 473 at Memorial Hwy

TIME PERIOD	YEAR 2002	2003	2004	2005
Jan - Mar	50	77	62	67
Apr - Jun	69	54	57	60
Jul - Sep	77	73	73	74
Oct - Dec	39	72	76	63

BRUSHY CREEK

TIME PERIOD	YEAR 2002	2003	2004	2005
Jan - Mar	N/A	N/A	30	40
Apr - Jun	N/A	N/A	N/A	44
Jul - Sep		N/A	N/A	54
Oct - Dec	N/A	90	N/A	36

CHANNEL A

TIME PERIOD	YEAR 2002	2003	2004	2005
Jan - Mar	51	70	34	64
Apr - Jun	66	67	47	43
Jul - Sep	77	77	62	56
Oct - Dec	30	38	68	N/A

Of the Rocky Creek stations, only the two lower reaches had data sufficient to calculate a WQI during the period 2002 – 2005. The WQIs calculated from available data indicate that these two reaches were in poor condition for 69% of the time and in fair condition 22% of the time. A good condition prevailed only 9% of the time.

Channel A had data for the 2002-2005 time period except for the last quarter of 2005. The WQIs calculated for Channel A indicate that the canal was in a poor condition 53% of the time, while a fair or good condition prevailed for 47% and 20% of the time, respectively. Data sufficient to calculate a WQI for Brushy Creek was scant in general, but data were available in 2005. That data indicated that the Creek was in a fair to good condition during that year.

Groundwater

The RULES of the ENVIRONMENTAL PROTECTION COMMISSION of HILLSBOROUGH COUNTY (CHAPTER 1-5 – WATER QUALITY STANDARDS, Amended 11/10/04) have adopted the groundwater quality standards, groundwater classifications, and criteria established or adopted in Sections 62-520.400, 62-520.410, 62-520.420, 62-520.430, and 62-520.440, F.A.C. as amended on 12/9/1996.

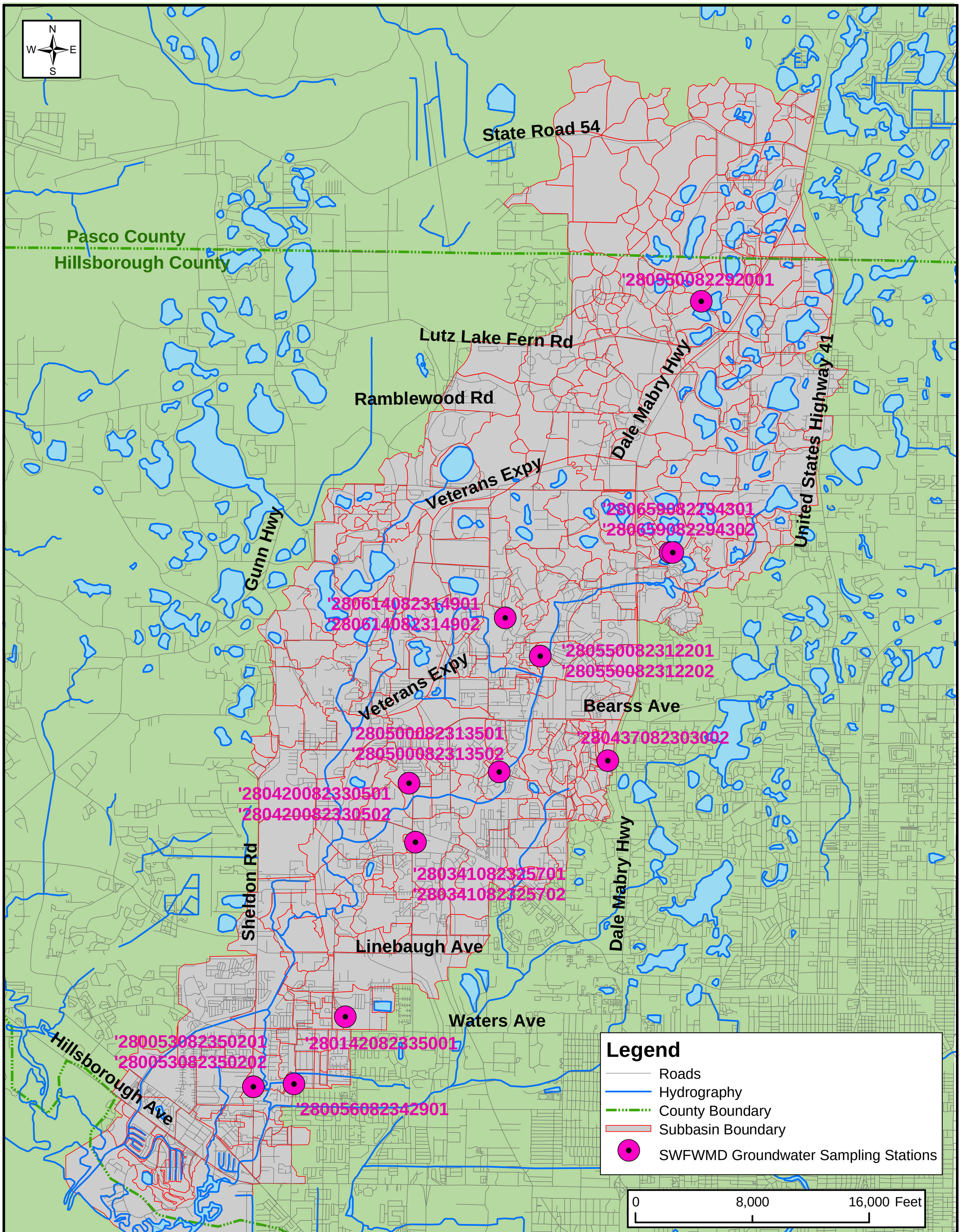
Groundwater water quality data was obtained from the STORET database. Although groundwater sampling stations exist within the Rocky/Brushy Creek watershed (Figure 7-5), the water quality data are insufficient to make definite conclusions regarding the current quality status of the aquifers. Data are available for 18 well sites from various times during the period 1984 through 1996. However, the data indicate that in 1996, several wells sampled failed to meet FDEP quality criteria for arsenic, chromium, lead, nickel, and strontium. In 1990, toxic organic compounds, including pesticides, were detected at concentrations that failed to meet FDEP criteria. Appendix 7-6 contains a summary of groundwater sampling events and groundwater water quality data.

7.2.2 Historical Trends (1990 – 2005)

Data for an historical comparison analysis among sampling stations are available for chlorophyll *a* (chl a), total nitrogen (TN), and total phosphorus (TP) (Table 7-3). For TP, all of the stations reported average concentrations exceeding the EPA standard of 0.01 milligram per liter (mg/L) (Table 7-3). All of the stream stations had consistently higher average concentrations than the lake stations, and all stations reported TP concentrations exceeding 0.1 mg/L. The lowest concentrations, those less than 0.02 mg/L, were reported from Lakes Cypress, Deer, Halfmoon, Hobbs, Little Halfmoon, Place, and Saddleback (north pool).

For TN, all but three of the stations (Lakes Cypress, Hobbs, Saddleback – north pool) reported concentrations exceeding the EPA standard of 0.52 mg/L. Further, all of the stream stations and some of the lake stations (Cove, Dosson, Heather, Reinheimer, Rock, Virginia) reported average concentrations exceeding 1.0 mg/L. Lowest concentrations for TN were reported from Lakes Cypress, Hobbs, and Saddleback (north pool).

For chl a, all stations reported average concentrations exceeding the EPA standard of 2.6 ug/L. Concentrations ranged from a low of 3.23 ug/L (Halfmoon Lake) to a high of 53.85 ug/L (Lake Virginia). No data for chl a were reported for stream stations.



Location of Groundwater Quality Sampling Stations in the Rocky/Brushy Creek Watershed

Figure 7-5

AYRES ASSOCIATES

For dissolved oxygen (DO), data were available for stream stations. Data indicated that DO averaged above the EPA standard of 5.0 mg/L only in Rocky Creek at Waters Avenue; all other stations reported concentrations below the standard, with Rocky Creek at Fitzgerald Road reporting the lowest average concentration of 2.08 mg/L.

Table 7-3 Mean Historical Concentrations for Various Constituents in the Rocky/Brushy Creek Watershed

STATION ID	DO (mg/L)	BOD5 (mg/L)	Chl a (ug/L)	TN (mg/L)	TKN (mg/L)	TP (mg/L)	Fecal Coli (col/100 ml)	Total Coli col/100 ml)
Rocky Cr at Hwy 587	4.27				0.769	0.047		
Brushy Cr near Sulphur Springs	4.19	1.16			0.6448	0.0567	761	1743.7
Rocky Cr near Sulphur Springs	4.84	1.46			0.88175	0.17505	691.8	2561
Channel A at Hillsborough Av	4.36	3.96		1.29982	1.2424	0.2551	230.5	516.5
Rocky Cr at Hillsborough Av	4.02	1.88		1.2508	1.065	0.1833	510.1	2187.1
Rocky Cr at Waters Av	5.55	1.46		1.2083	0.9049	0.18495	643.2	2255
Rocky Cr at L Armistead	4.06			1.205		0.057		
Rocky Cr at Fitzgerald Rd	2.08			0.8944		0.0276		
				1.0176		0.0542		
Armistead			12.7	0.8099		0.0251		
Brant			24.6	0.9758		0.03499		
Carlton			16.14	0.93696		0.05308		
Cooper			12.6	0.7105		0.01834		
Cove			27.7	1.083		0.06404		
Crenshaw			10.5	0.6836		0.0177		
Crystal			7.17	0.8147		0.01699		
Cypress			5.52	0.4518		0.01105		
Deer			6.39	0.5624		0.01378		
Dosson			44.1	1.2961		0.03836		
Half Moon Lake			3.23	0.8544		0.01204		
Halfmoon			7.01	0.5726		0.0149		
Heather			36.2	1.1474		0.0708		
Hobbs			5.19	0.4812		0.0112		
Josephine			16.02	0.9885		0.0392		
LeClare			11.46	0.7233		0.0244		
Little Halfmoon			4.92	0.53575		0.0117		
Little Wilson			18.25	0.9369		0.0512		
Norbert			12.5	0.84304		0.0212		
Place			5.76	0.9928		0.01255		
Pretty			8.86	0.88876		0.0282		
Reinheimer			16.78	1.109		0.0219		
Rock			16.87	1.0075		0.0415		
Saddleback North			3.84	0.4432		0.01155		
Starvation			6.5	0.732		0.0165		
Strawberry North			7.7	0.6867		0.016		
Strawberry			6.9	0.7964		0.0195		
Taylor 2			36.37	0.71804		0.0385		
Virginia			53.85	1.7729		0.04925		
Wilson			10.77	0.7983		0.01722		

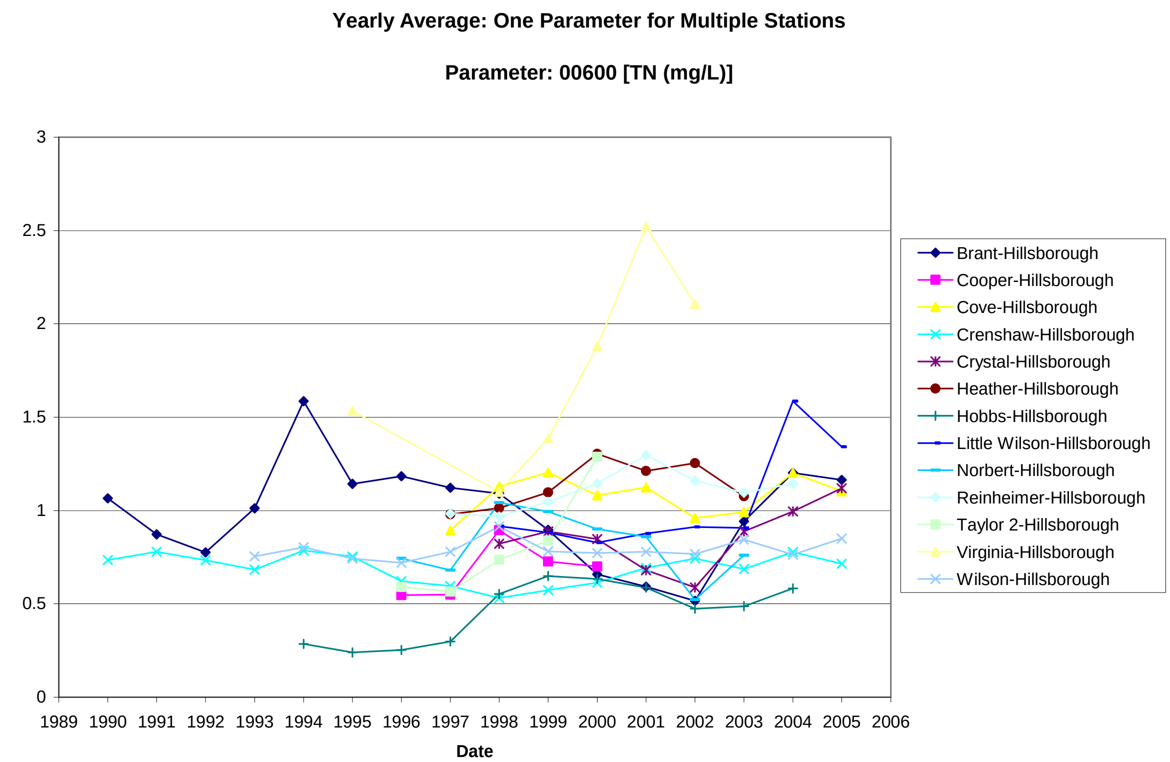
Water Quality Criteria

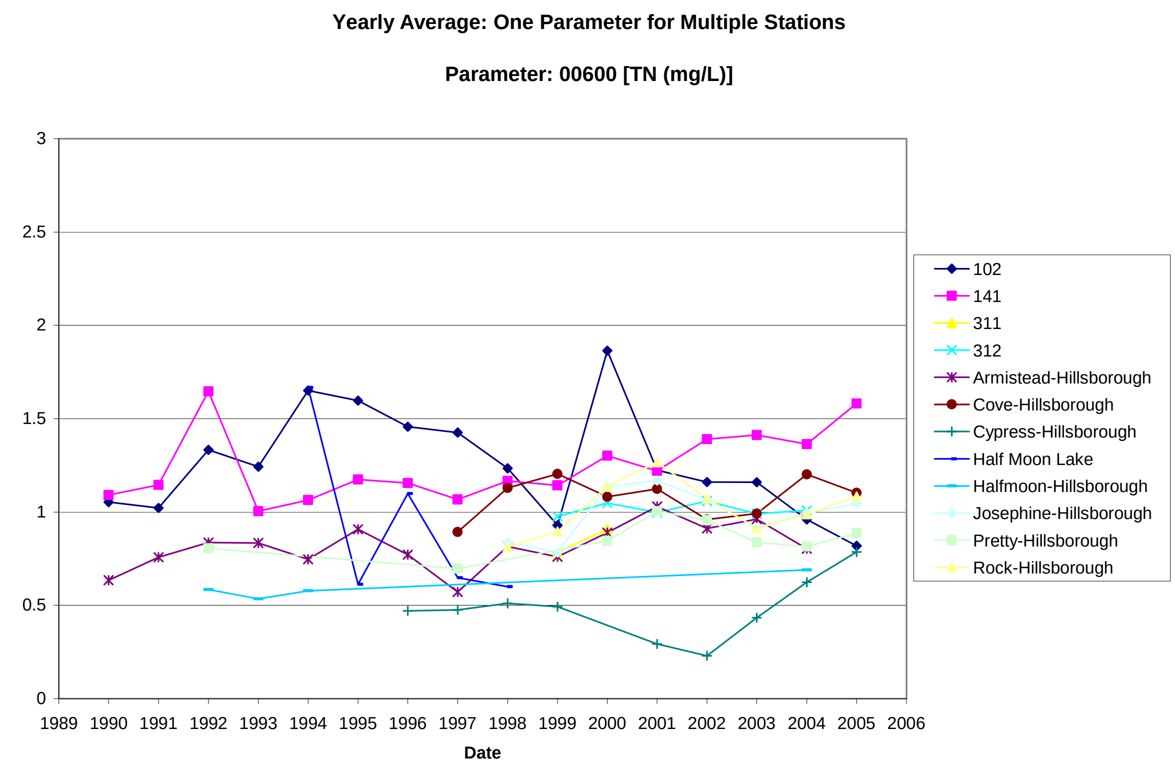
The following water quality criteria has been specified by EPA:

Parameter	Comment	Concentration
TP	Agg. Ecoregion XII	0.01 mg/L
TN	Agg. Ecoregion XII	0.52 mg/L
Chlorophyll A	Agg. Ecoregion XII	2.6 ug/L
DO	Class III Waterbodies	No less than 5.0 mg/L
pH	Class III Waterbodies	Normal between 6.0 and 8.5

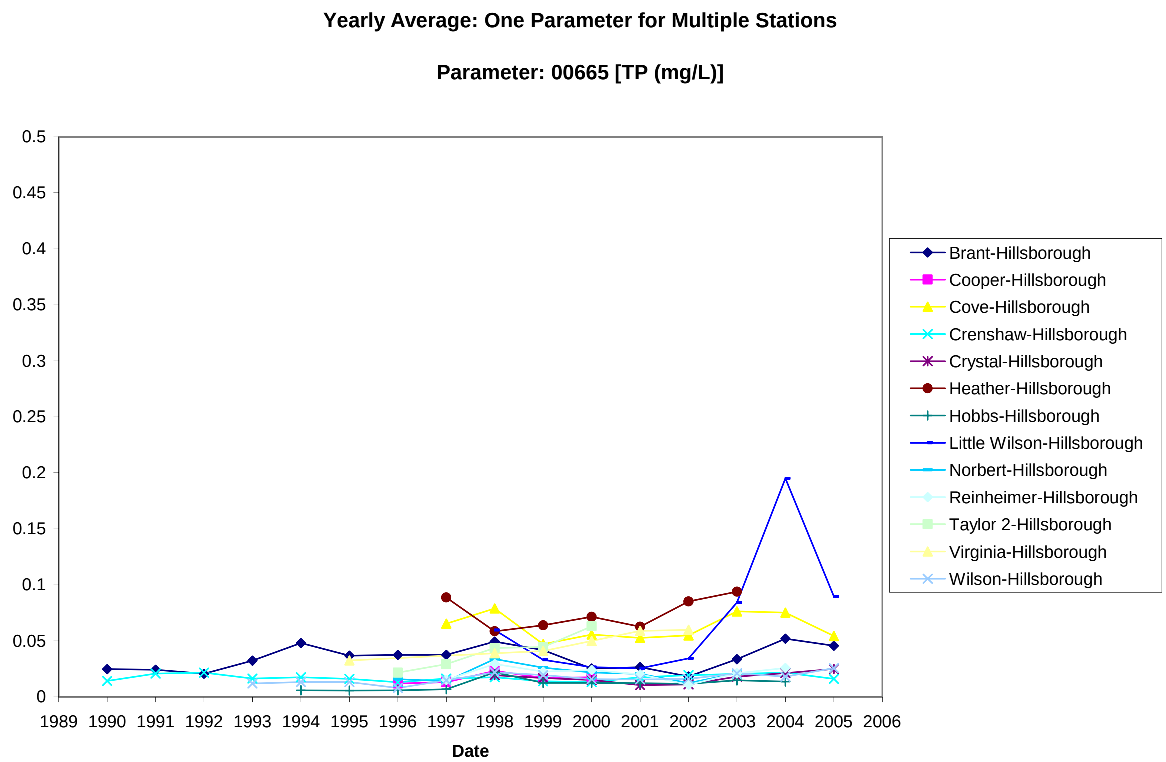
mg/L = milligrams per liter *ug/L = microgram per liter*

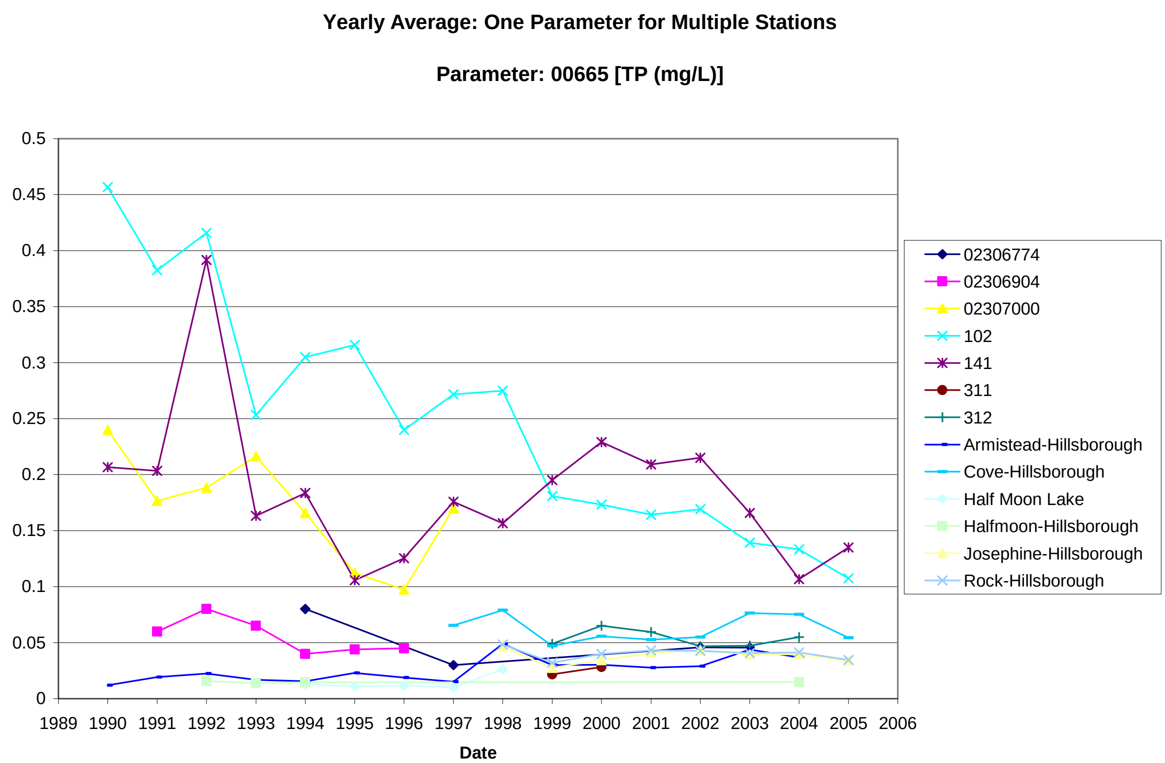
See Appendix 7-5 for surface water quality criteria information.



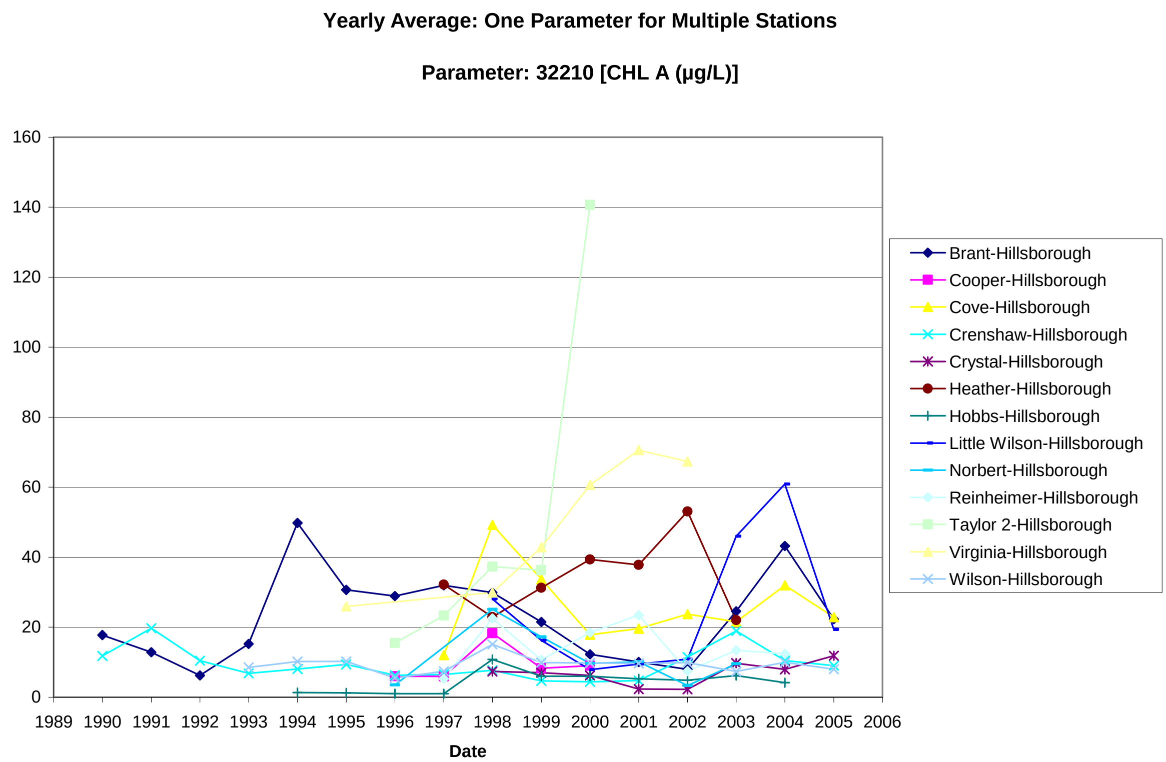


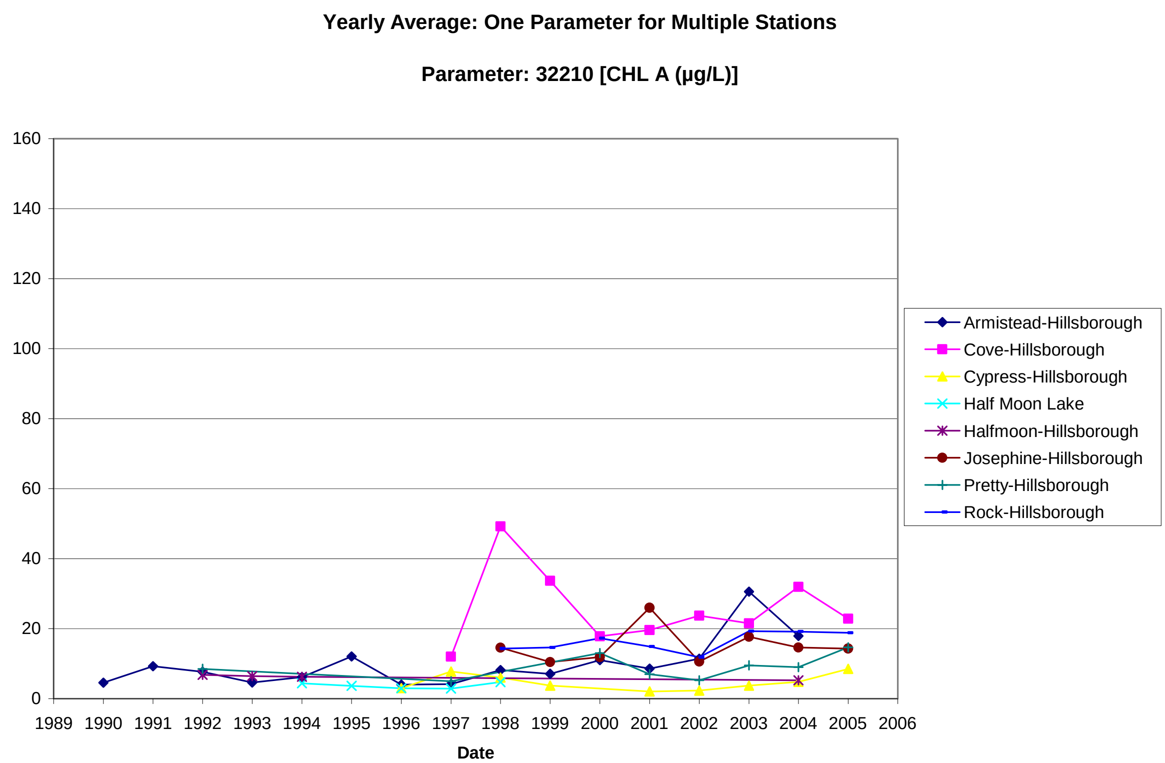
Mean Total Nitrogen (mg/L) Concentrations (1990-2005)



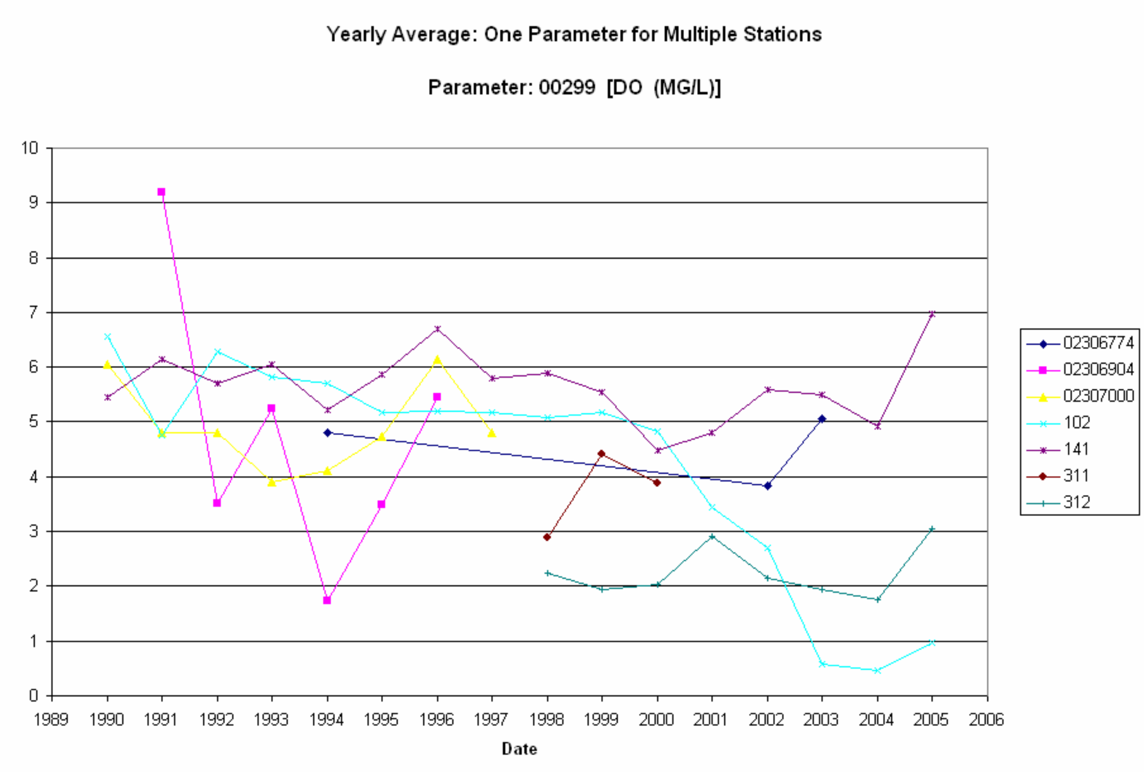


Mean Total Phosphorus (mg/L) Concentrations (1990-2005)

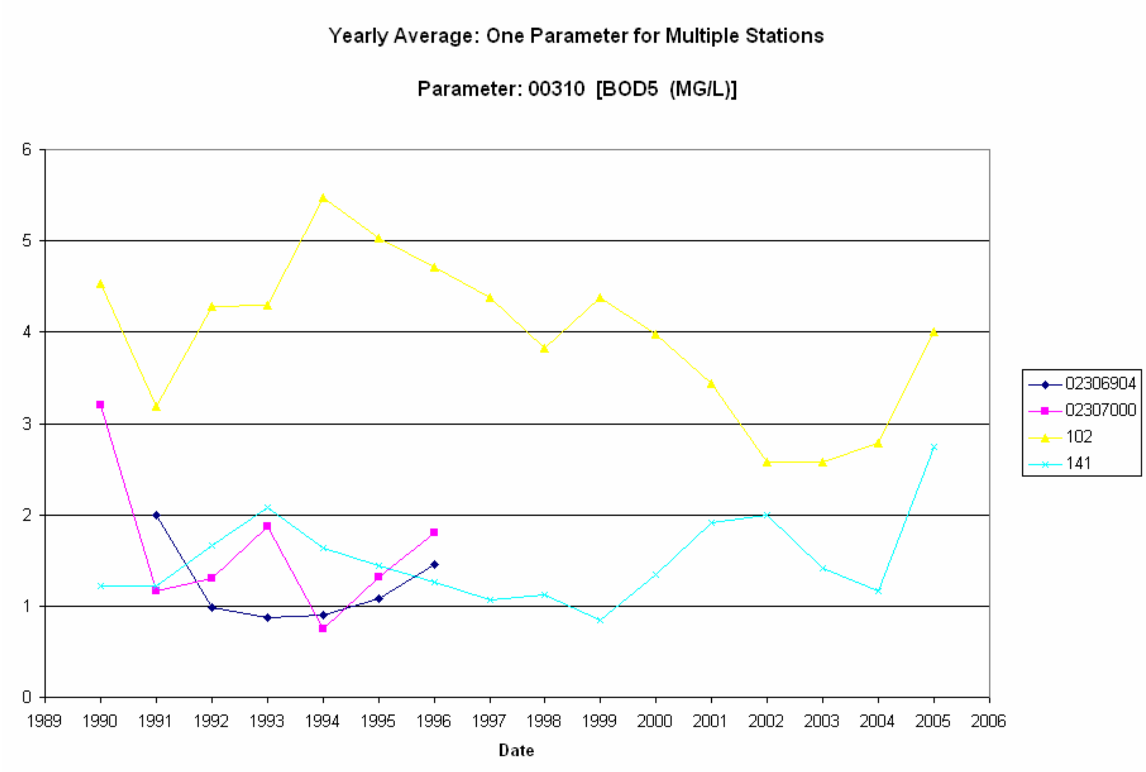




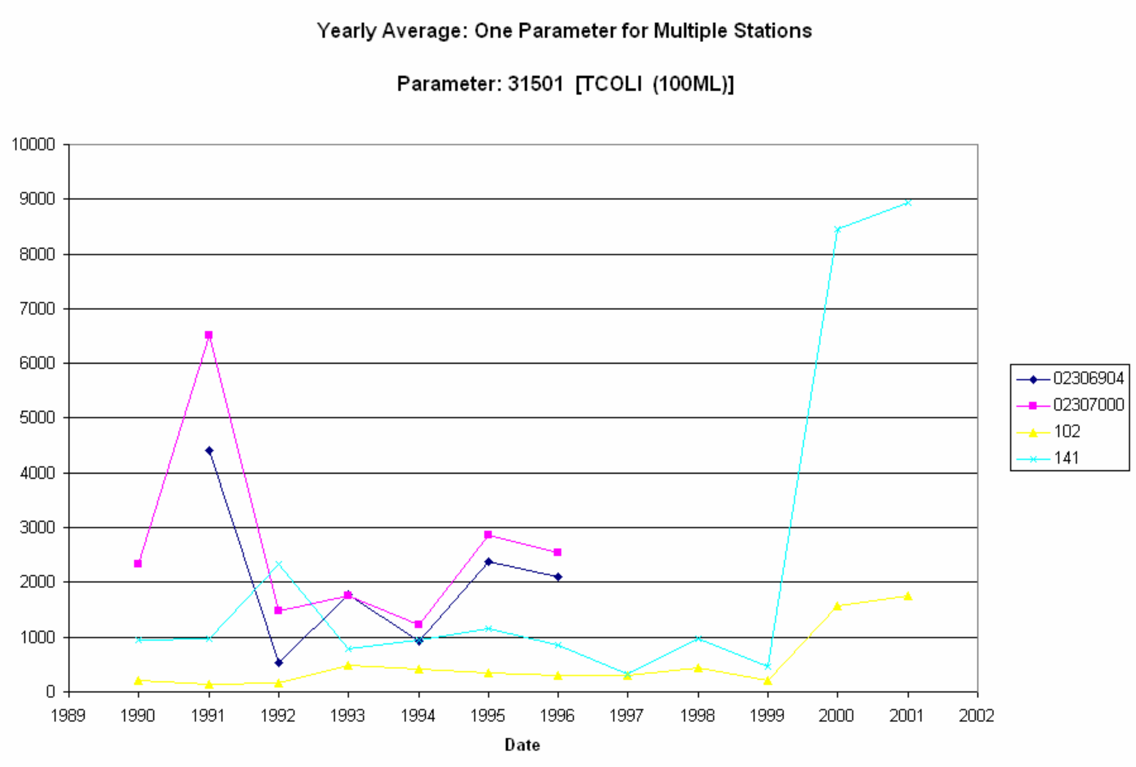
Mean Chlorophyll A (micro-g/L) Concentrations (1990-2005)



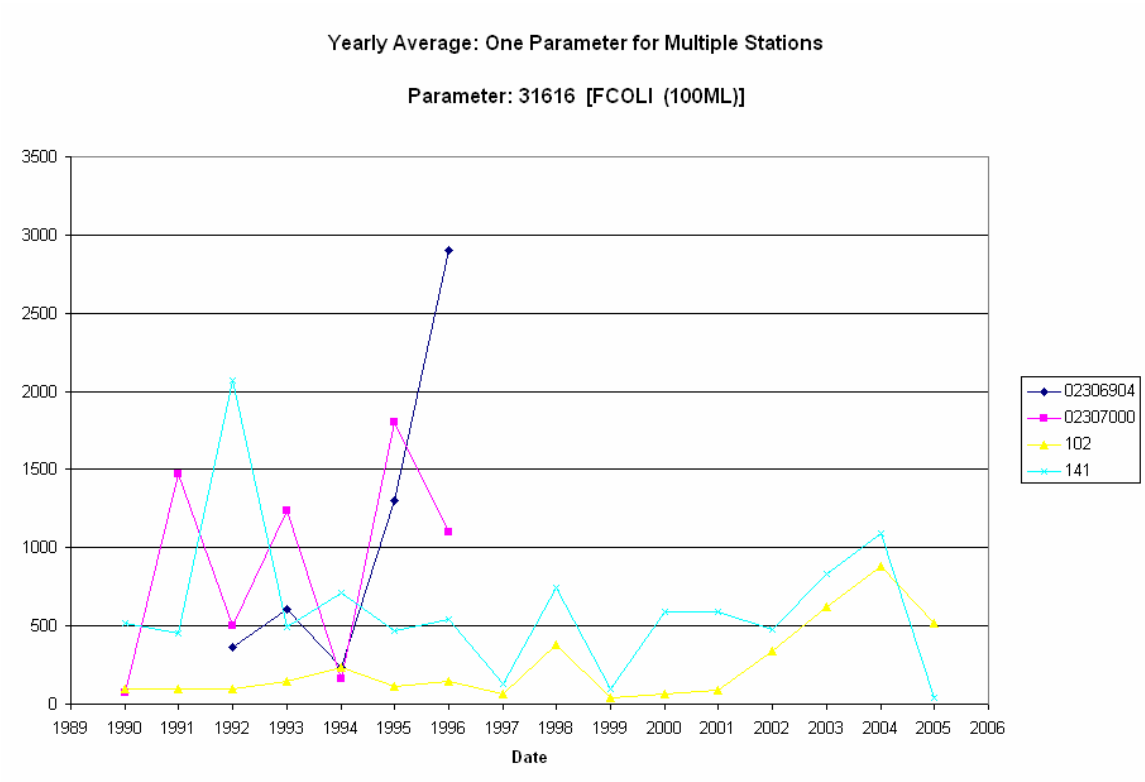
Mean Dissolved Oxygen (mg/L) Concentrations (1990-2005)



Mean BOD5 (mg/L) Concentrations (1990-2005)



Mean Total Coliform (#/100ml) Concentrations (1990-2005)



Mean Fecal Coliform (#/100ml) Concentrations (1990-2005)

7.2.3 Recent Trends (2004 – 2005)

Data for a recent (2004-2005) comparison analysis among sampling stations are available for chlorophyll a (chl a), total nitrogen (TN), and total phosphorus (TP) (Table 7-4). For TP, all of the stations reported average concentrations exceeding the EPA standard of 0.01 milligram per liter (mg/L) (Table 7-4). Of the stream stations, Channel A reported the highest concentration, and Rocky Creek at Lake Armistead reported the lowest concentration. Among lake stations, Little Wilson had the highest and Cypress, the lowest, concentration at 0.15 mg/L and 0.012 mg/L, respectively.

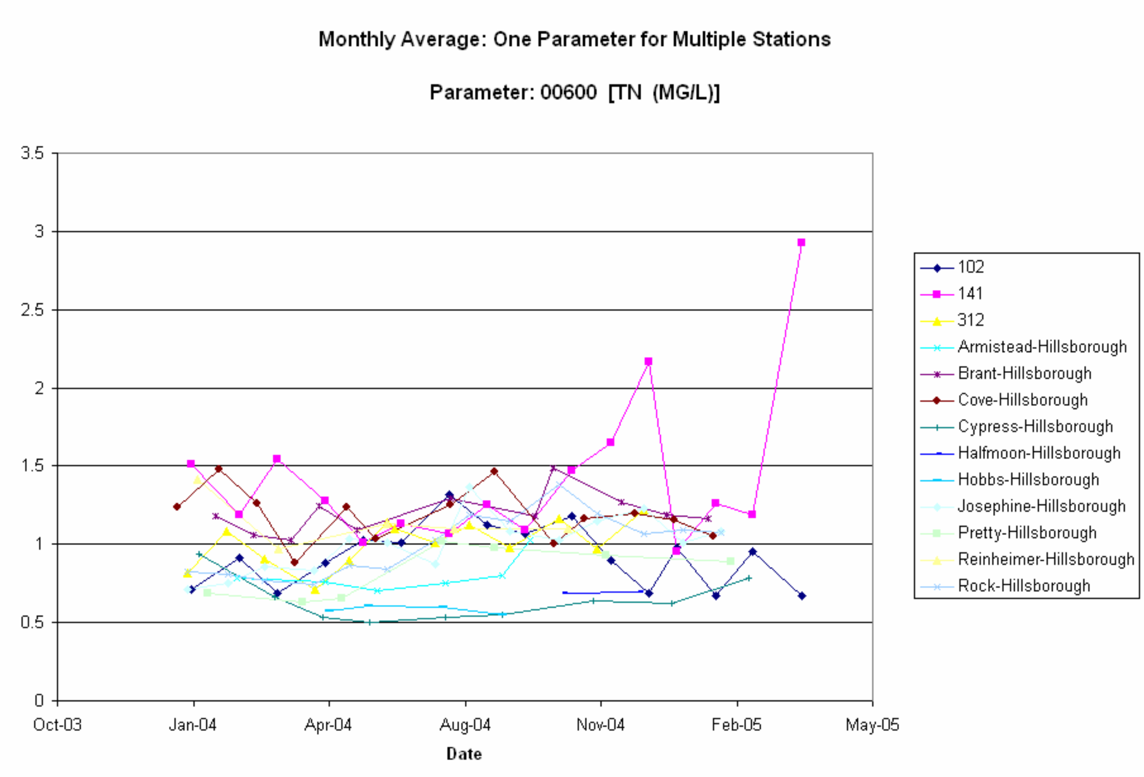
For TN, all but three of the stations reported concentrations exceeding the EPA standard of 0.52 mg/L. Further, several stations reported average concentrations exceeding 1.0 mg/L, including Rocky Creek at Hillsborough Ave, Waters Ave, and Fitzgerald Rd; and Lakes Brant, Cove, Crystal, Little Wilson, Reinheimer, and Rock. Lowest concentrations for TN were reported from Lakes Cypress, Hobbs, and Saddleback (north pool).

For chl a, all stations reported average concentrations exceeding the EPA standard of 2.6 ug/L. Concentrations ranged from a low of 4.4 ug/L (Hobbs Lake) to a high of 40.5 ug/L (Lake Brant). No data for chl a were reported for stream stations.

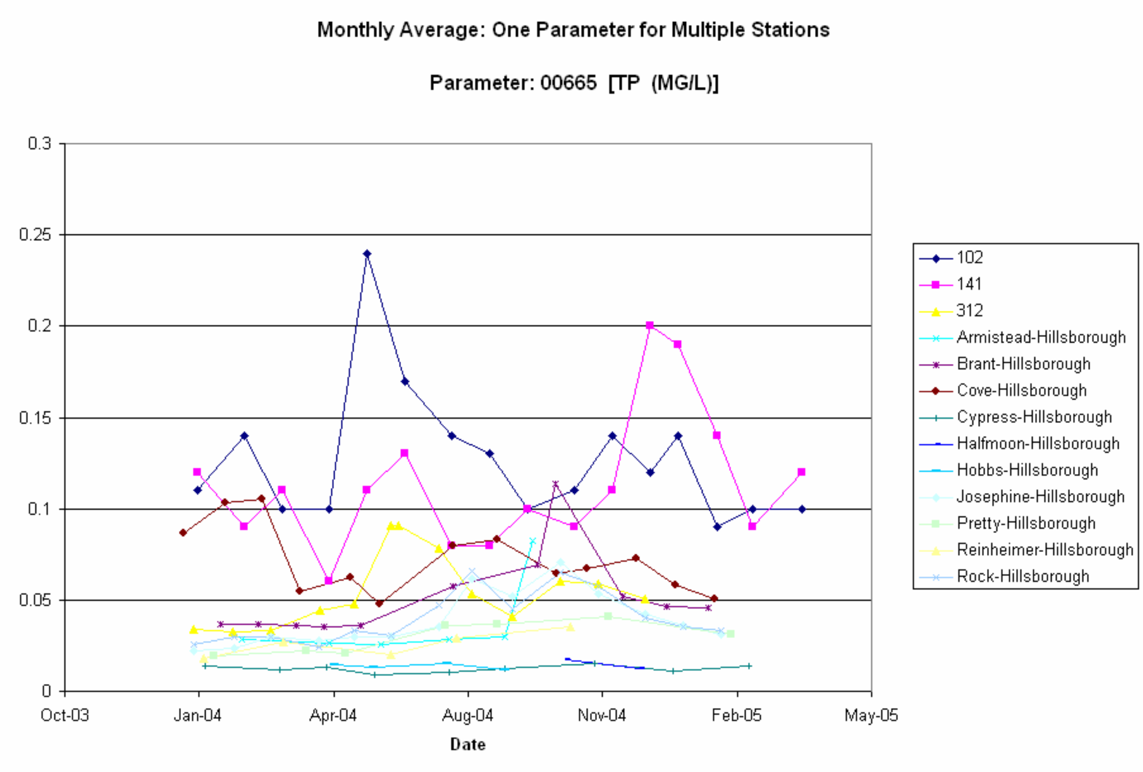
For dissolved oxygen (DO), data were available for stream stations. Data indicated that DO averaged above the EPA standard of 5.0 mg/L only in Rocky Creek at Waters Ave; all other stations reported concentrations below the standard, with Channel A reporting the lowest average concentration of 0.59 mg/L.

Table 7-4 Mean Recent Concentrations for Various Constituents in the Rocky/Brushy Creek Watershed

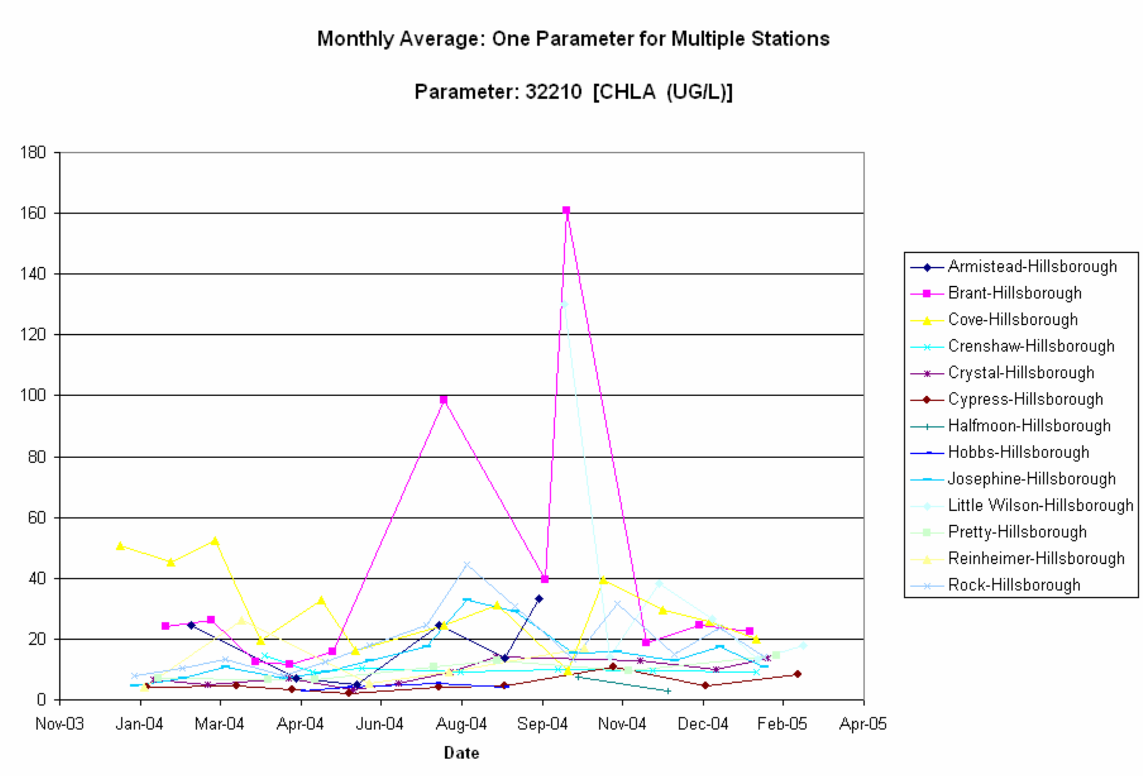
STATIONID	DO (mg/L)	BOD5 (mg/L)	Chl a (ug/L)	TN (mg/L)	TKN (mg/L)	TP (mg/L)	Fecal Coli (col/100ml)
Channel A at Hillsborough Av	0.59	3.09		0.94	0.85375	0.1269	828.6
Rocky Cr at Hillsborough Av	3.07	1.19		1.092	0.85875	0.1075	417
Rocky Cr at Waters Av	5.44	1.56		1.326	1.02	0.11375	1009
Rocky Cr at L Armistead				0.65		0.023	
Rocky Cr at Fitzgerald Rd	1.92			1.008		0.0549	
Armistead			20.4	0.803		0.0373	
Brant			40.5	1.19875		0.05174	
Cove			30.7	1.189		0.0729	
Crenshaw			10.47	0.769		0.0207	
Crystal			9.36	1.007		0.0223	
Cypress			5.72	0.6408		0.01205	
Deer			7.83	0.6756		0.02325	
Halfmoon			6	0.69		0.01483	
Hobbs			4.4	0.578		0.0137	
Josephine			14.85	0.997		0.0398	
Little Wilson			41.4	1.492		0.1458	
Pretty			9.89	0.8185		0.03006	
Reinheimer			14.3	1.005		0.0271	
Rock			21.2	1.123		0.0407	
Starvation			6.5	0.732		0.0165	
Strawberry			5.08	0.7259		0.0186	
Wilson			10.9	0.7665		0.0199	



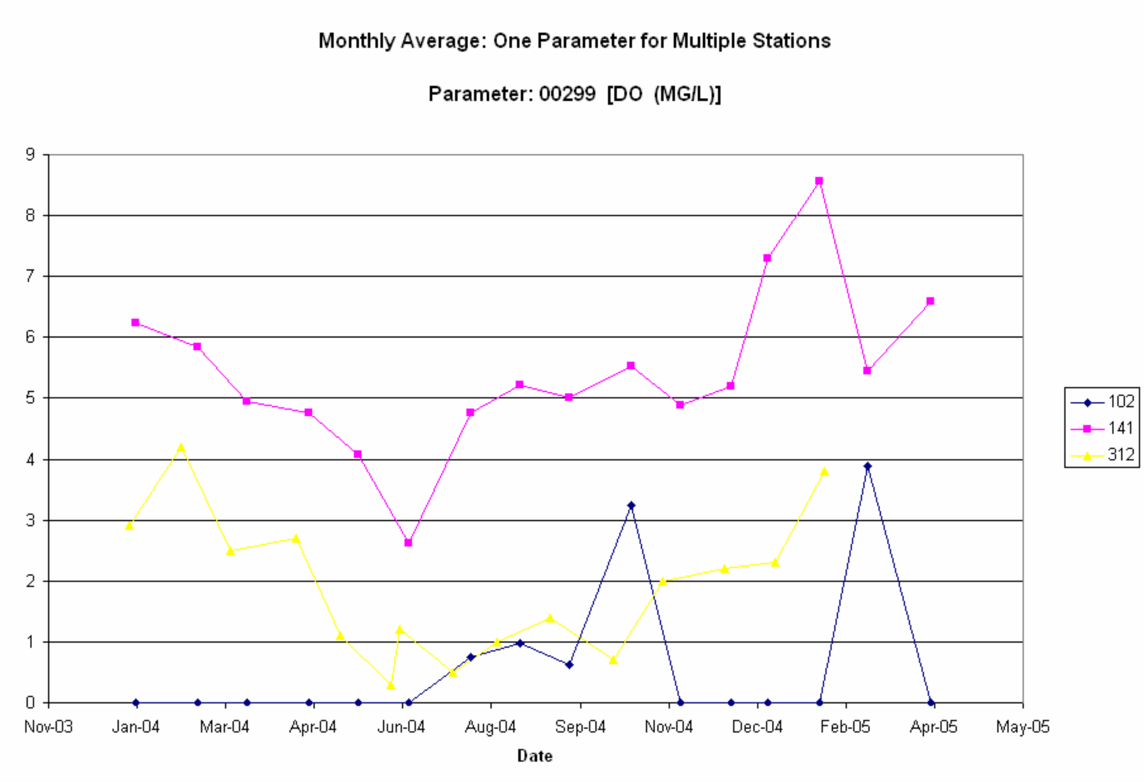
Mean Total Nitrogen (mg/L) Concentrations (2004-2005)



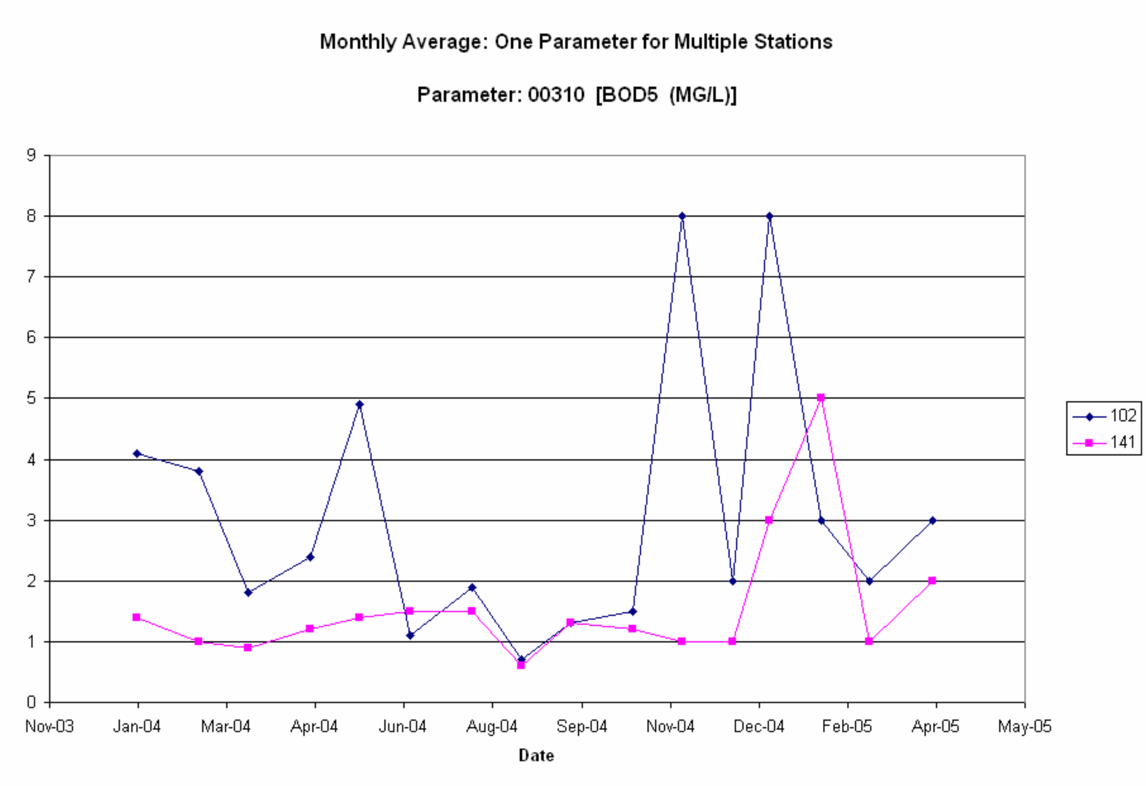
Mean Total Phosphorus (mg/L) Concentrations (2004-2005)



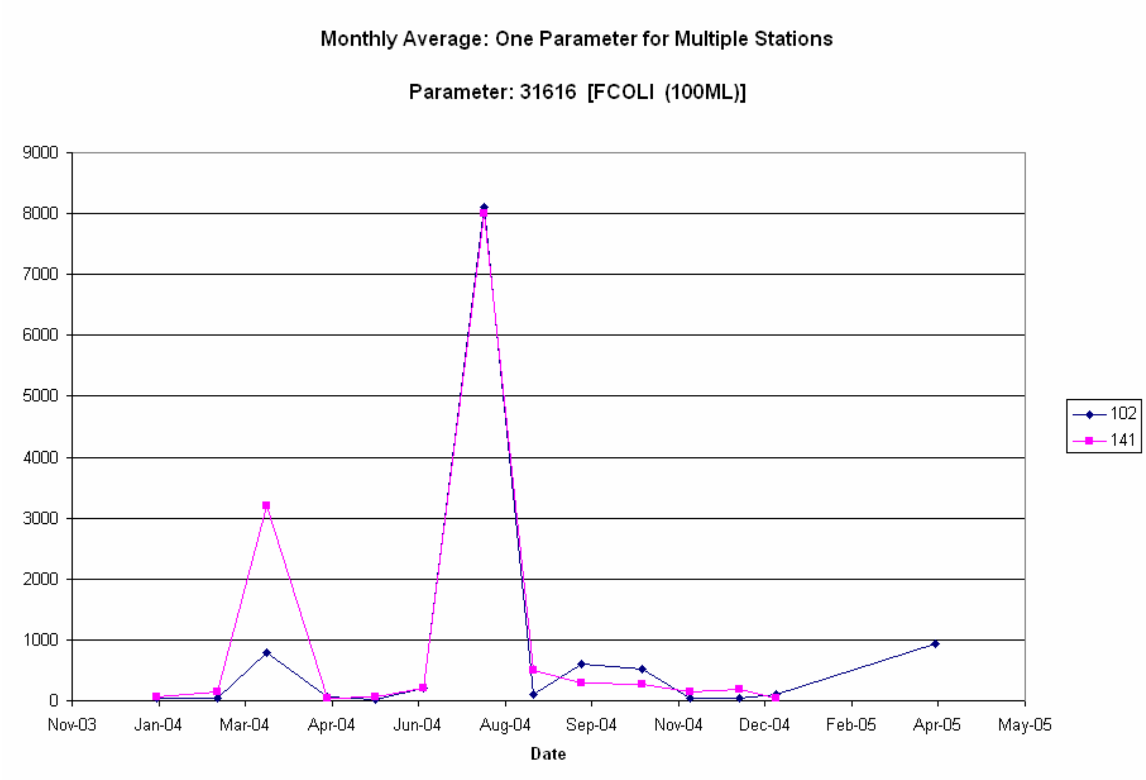
Mean Chlorophyll A (micro-g/L) Concentrations (2004-2005)



Mean Dissolved Oxygen (mg/L) Concentrations (2004-2005)



Mean BOD5 (mg/L) Concentrations (2004-2005)



Mean Fecal Coliform (#/100ml) Concentrations (2004-2005)

Groundwater

The Rocky/Brushy Creek watershed is located within the Tampa Bay/Anclote River (TB/A) watershed. The useable aquifer system within this area consists of the Surficial Aquifer System (SAS), Intermediate Aquifer System (IAS), and Upper Floridan Aquifer (UFA). Groundwater within this area (from the UFA) provides a dependable potable water supply and is available through much of the TB/A watershed. In addition to agricultural, residential, mining, and industrial users, Tampa Bay Water and municipalities within the area withdraw groundwater (mostly from the Floridan Aquifer) for consumptive use. The Water Management District has recognized groundwater as a limited resource, therefore, intending to reduce stress on groundwater by assisting large water users in developing alternative resources (e.g., sea water desalination). Groundwater in the Rocky/Brushy Creek watershed interacts with surface water in wetlands, streams and lakes. The direct and indirect hydraulic connections between the surface water and groundwater around wellfields caused negative impact on wetland and other surface water bodies.

In the upper Rocky/Brushy Creek watershed, groundwater provides contributes to surface waters, including Rocky and Brushy Creeks, and it is also an important source of high quality potable drinking water for both public and private wells. Ongoing management activities for the region's water supplies are discussed in more detail in Chapter 9.

To protect this important resource, in 1983, the Florida Legislature passed the Water Quality Assurance Act, which required FDEP to "establish a ground-water quality monitoring network designed to detect or predict contamination of the state's water resources" (403.063 F.S.). In agreement and cooperation with the SWFWMD, the Ambient Ground-Water Quality Monitoring Program (AGWQMP) was implemented to satisfy the statutory requirements. The FDEP has also implemented a sophisticated ground water protection program based on groundwater classifications, water quality standards, and monitoring regulations. The state also administers the federally-delegated Underground Injection Control (UIC) Program, which protects the quality of underground sources of drinking water, and prevents degradation of other aquifers adjacent to injection zones. The FDEP exercises regulatory authority over groundwater quality under Chapter 62-520, F.A.C., which is augmented by monitoring and permitting activities (for withdrawals) through each of the state's water management districts. In Florida, groundwater standards are equivalent to drinking water standards.

The FDEP classification system for groundwater is as follows (Chapter 62-520.410, F.A.C.):

- Class F-I Potable water use, ground water in a single source aquifer described in Rule 62-520.460, F.A.C. which has a total dissolved solids content of less than 3,000 mg/l and was specifically reclassified as Class F-I by the Environmental Regulation Commission.
- Class G-I Potable water use, ground water in single source aquifers which has a total dissolved solids content of less than 3,000 mg/l.
- Class G-II Potable water use, ground water in aquifers which has a total dissolved solids content of less than 10,000 mg/l, unless otherwise classified by the Commission.

- Class G-III Non-potable water use, ground water in unconfined aquifers which has a total dissolved solids content of 10,000 mg/l or greater; or which has total dissolved solids of 3,000-10,000 mg/l and either has been reclassified by the Commission as having no reasonable potential as a future source of drinking water, or has been designated by the Department as an exempted aquifer pursuant to Rule 62-28.130(3), F.A.C.
- Class G-IV Non-potable water use, ground water in confined aquifers which has a total dissolved solids content of 10,000 mg/l or greater.

In addition to the regulatory activities described above, the FDEP has developed specific rules under 62-521.200, F.A.C. for wellhead protection to protect potable water wells from contamination, and subsequent replacement or restoration due to contamination. This statewide wellhead protection program includes criteria for delineating wellhead protection areas, and FDEP imposed permitting and monitoring requirements within these wellhead protection areas. Hillsborough County has also developed a Wellhead Protection Program similar to the FDEP program.

Groundwater Quality

The quality of groundwater has direct relationship with the quality of the recharge water, porous media, and the resident time for groundwater in the media. Surface and underground chemical spills and the process of saltwater intrusion can also impact the quality of groundwater, locally or regionally. Water quality within the Northern Tampa Bay area is generally good in the aquifers above the middle confining unit of the Floridan Aquifer system (SWFWMD, 1996). The Upper Floridan aquifer is poorly confined over the most of the area, resulting in relatively high recharge. The groundwater quality is typically a calcium bicarbonate water of relatively low total dissolved solids (TDS). Groundwater near the coastal areas is generally higher in TDS. There are limited groundwater quality data for the area, and most information dates from the 1990 – 1999 time period (Appendix 7-6).

As part of the Northern Tampa Bay WRAP completed in the 1996 – 1997 time frame, SWFWMD monitored a number of wells within this area. Some wells in the Rocky/Brushy Creek watershed were noted as failing to meet FDEP quality criteria for arsenic, chromium, lead, and strontium. Also, aluminum concentrations also failed to meet criteria in one well. Nitrate and nitrite concentrations were typically greater in surficial samples than in Floridan samples for all stations evaluated, but none exceeded FDEP criteria.

Issues/Areas of Concern

The available groundwater quality information from the Rocky/Brushy Creek is not sufficient to draw statistically significant conclusions. Based on available information, it can be concluded that problems exist in localized areas with some metals and some toxic organic substances, including pesticides. Further monitoring on a regular basis is a clear need.

Some potential issues can be anticipated in the area is subject to continued large-scale groundwater withdrawal that affects groundwater quality. Also, saltwater intrusion and direct recharge through agricultural and urbanized areas will reduce water quality by increase TDS and organic and metals contaminants in the groundwater. Sinkholes are always a possibility and could become a source of local water quality deterioration if they provide a direct hydraulic connection between the surface runoff and groundwater within Floridan Aquifer. The area has been of concern to the SWFWMD as a source of nitrate loading, and to mitigate the impact of groundwater pumping within this area, it has been designated as the Northern Tampa Bay Water Use Cautionary Area (WUCA).

7.3 Overall Trends and Summary

7.3.1 Overall Water Quality Issues/Areas of Concern

The primary water quality issues/areas of concern for water resources in the Rocky/Brushy Creek watershed are related to both the highly urbanized nature of the landscape in the areas, high concentration of wellfields, as well as the potential for future growth in the area. The overriding area of concern is untreated stormwater runoff from areas developed prior to the implementation of effective surface water management regulation. This condition is widespread throughout the watershed and has resulted in negative impacts to lakes, streams, and estuaries where both water quality and habitat have been impaired. Several chemical/physical parameters are of concern in water bodies that receive untreated stormwater, including: total suspended solids, dissolved oxygen, turbidity, nutrients, toxic metals (e.g., arsenic, chromium, lead, aluminum) and toxic organic substances (e.g., insecticides, herbicides, fungicides). The situation is of particular concern in the Rocky/Brushy Creek watershed for four reasons:

1. Substantial quantities of drinking water are developed from wellfield located in the watershed.
2. The streams draining the watershed are relatively short and highly altered along some reaches. Therefore, the natural water cleansing function usually provided by streams is not fully available to improve the quality of stream flow by the time it reaches its final outfall in Old Tampa Bay.
3. The estuaries of Rocky Creek and Channel A are utilized for both recreational and commercial fishing. The bioaccumulation of toxic metals in fish and invertebrates harvested for human food is a potential problem when inflow water (both surface and ground) contain unacceptable concentrations of such metals.
4. Lakes are an economic asset to the watershed and to the County, and there are over 50 lakes in the watershed that have attracted economic development. The preservation of lake water quality and habitat is critical to sustain continued development, and untreated stormwater already can be seen as a factor in the degradation of both the chemical quality and the appearance of some lakes and ponds in the watershed.

As urbanization and commercial development in the watershed continue, other adverse impacts to both water quality and habitat may occur or increase in areas already experiencing problems, including:

- Increased impervious surface area (construction of roads, buildings, etc.);
- Continued diversion of surface runoff and natural flow from their historic path and away from receiving water bodies;
- Increased potential for sinkhole development due to the excess drawdown at wellfields;
- Excessive impact on groundwater quality through introduction of pollutants via sinkholes;
- Decreased stormwater infiltration to replenish and maintain groundwater levels in the aquifer;
- Increases in peak flows which can cause stream bank erosion, sedimentation, and increased pollutant loading;
- Continued losses of riparian and upland buffer areas which can protect streams and lakes from water quality degradation;
- Increases in surface water pollution from stormwater runoff, residual applications (septage and sludge spreading), and atmospheric deposition; and
- Potential contamination of groundwater from stormwater runoff.

Based on the County's future land use plan for the area, these activities are anticipated to occur at various locations in the watershed and are anticipated to cause similar negative trends in water quality. Existing agricultural and waste management activities in these areas already contribute occasional high levels of nutrients (primarily nitrogen). A study by Ayres Associates (1995) indicated that land application of residuals (septage and sludge) in the Tampa Bypass Canal, New River, and Holloman's Branch areas could contribute significant nitrogen loading. Development of both non-structural and structural best management practices (BMPs) will be necessary to reduce pollutant loading to the tributaries in these subwatersheds in order to comply with TMDL requirements. Waters within the marine segment of Rocky Creek were identified as impaired for dissolved oxygen and nutrients. Currently, Brushy Creek is not on the FDEP list for TMDLs.

Estimates of pollutant loading are developed in Chapter 10 of this report, followed by an evaluation of water quality treatment level of service for this watershed (Chapter 11). A list of recommended management activities along with specific, strategically-located alternatives to alleviate water quality problems and pollutant loading will be developed in subsequent chapters of this report.

7.4 Bibliography

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