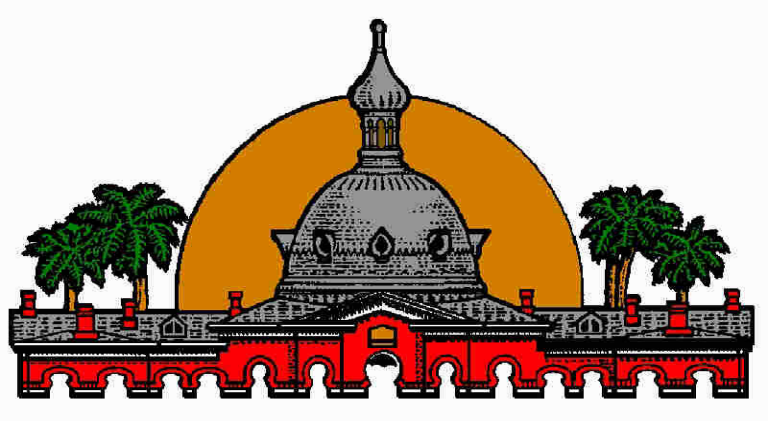
DOUBLE BRANCH CREEK AREA

STORMWATER MANAGEMENT MASTER PLAN (UPDATE NO. 2)



Hillsborough County
Florida

Updated By

PBS&J

Tampa, Florida
Original: September 1998
Update 1: September 2002
Update 2: June 2007

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Executive Summary

Introduction

The Double Branch Creek (DBA) watershed lies in the northwest portion of Hillsborough County. It drains approximately 23 square miles and is composed primarily of undeveloped and residential land uses. The study area includes approximately 2.7 square miles of the Brooker Creek watershed that had not been previously been included as part of the DBA to account for the flow that enters the watershed at the northwest corner of the Nine Eagles Subdivision.

Purpose of the Study

The purpose of the Watershed Management Plan (WMP) update was to: a) upgrade the 1998 hydrologic and hydraulic (H&H) model and b) re-evaluate previously recommended stormwater improvement projects. The project was jointly funded by Hillsborough County and the Southwest Florida Water Management District's (District) Northwest Hillsborough Basin.

Specific project objectives were to:

- Make computer model upgrades as needed to meet the requirements of the District's Watershed Management Program Guidelines and Specifications (G&S), per the comments provided in the District's model review as well as further analysis conducted as part of this project. In this manner, the model can be considered as "best available information" for County stormwater permitting as well as for the District's Environmental Resource Permit (ERP) process.
- Identify recommended improvement projects based on a re-evaluation of the flood protection levels of service (FPLOS) and an identification of needs to correct any identified deficiencies.
- Make use of the recent digital topographic data obtained by the County, including the datum conversion from the 1929 National Geodesic Vertical Datum (NGVD) to the 1988 North American Vertical Datum (NAVD).
- Be able to use the model for any potential modification of the FEMA regulatory floodplain.
- Reflect recent land use changes in the watershed. The model update considered both changes in land uses as well as modifications of drainage patterns due to new development.
- Make adjustments to the study area boundaries to conform to those of adjacent watersheds.

Major Conveyance Systems

The DBA watershed is drained by two major drainage conveyance systems that outfall to Double Branch Bay: the Double Branch Creek system and the Memorial Channel system. The Double

Branch Creek system drains the western portion of the watershed and includes two distinct branches referred to as the West Branch and the East Branch. Upon the convergence of the East and West Branches the channel meanders downstream, crosses Memorial Highway, and splits into two well defined outfall channels that discharge into Double Branch Bay.

The Memorial Channel is an existing channel located on the eastern part of the basin that is not part of Double Branch Creek. The system originates in a large wetland just north of South Mobley Road and is comprised of a series of channels that connect various additional wetland systems. It outfalls into Double Branch Bay as a loosely defined tidal plain.

Computer Model Update and Model Calibration

The computer model update included both the hydrologic and hydraulic model components. The subbasin delineation was updated using the 2004 aerial imagery and the 2004 one-foot contours. For areas where recent construction has taken place, the subbasin delineation was updated using data from recent Environmental Resource Permits (ERPs), which are listed below. The number of delineated subbasins in the new model increased from 178 to 256 subbasins, which shows a significant increase in the model's level of detail.

Environmental Resource Permits (ERPs) Used for Computer Model Update

ERP Number	ERP Name	ERP Issue Date
274	Northern Groves Subdivision	9/9/2003
2996	WestChase Subdivision	11/7/2000
3855	Arbor Lakes Phase 4	4/7/2000
5997	Meadow Brook Subdivision	11/7/2002
17406	Fawn Lake Phase 5	10/18/2000
18211	Tuscany Bay Apartments	3/17/2000
20581	Noell Purcell Site	4/10/2001
20815	Ashton Gardens	12/1/2000
23028	Tree Tops	4/1/2000
23549	River Chase	12/13/2002
25239	Bayport Colony	1/27/2004

The hydraulic portion of the computer model was updated with information available from previous studies, ERPs, construction drawings, and the digital topography. In addition, field reconnaissance was conducted to better assess the hydraulic connectivity and accuracy of the input data. Lakes, ponds and wetland areas were represented by stage/area relationships assigned to model junctions. These stage/area relationships were developed utilizing one of two methods: a) when available, they were obtained from ERPs and/or construction plans, or b) they were developed using a GIS tool based on the triangulated irregular network (TIN) created from available digital topographic data. Roughness coefficients for the right, left, and center portion of channel sections were determined from field observations and general knowledge of the area.

The model boundaries represented the system at Double Branch Bay, south of Hillsborough Avenue.

The storm event used for model calibration was Hurricane Frances. This event was the second of a series of three hurricane events that hit the Tampa Bay area in August and September 2004. Hurricane Frances reached Hillsborough County on September 3rd and lasted for approximately 48-hours. Data indicated that the rainfall volume during the calibration event amounted to about 6.2 inches. Data were obtained from the District's OneRain data, which contains Doppler rainfall measurements at 15-minute intervals.

During calibration, the model was adjusted so that computed values would closely match the measured real time water stage values at the USGS gage located at the Country Way Crossing of Double Branch Creek. Calibration parameters included the establishment of initial water surface elevations, roughness coefficients and overland flow roughness values. The values of these parameters were adjusted based on interpretation of photographs, field observations, gage data and a general knowledge of the area. Results of the calibration process indicated that the predicted model peak stages provide a good match to the recorded gage stages.

Existing Conditions Level of Service Analysis

The Hillsborough County Comprehensive Plan Stormwater Management Element contains definitions for flood protection levels of service (FPLOS) designations. FPLOS are defined in terms of road access conditions based on the 25-year/24-hour storm event. The acceptable FPLOS applied in this study was Level B, which considers that problems should be limited to minor street flooding and roads should have at least one traffic lane drivable.

The computer model was used to predict water surface elevations under the design storm event conditions listed below. FPLOS conditions were then assessed by comparing predicted peak model stages to road overtopping elevations. While the level-of-service criteria are defined for the 25-year/24-hour storm event, other permitting requirements require the 100-year/24-hour and 2.33-year/24-hour storm event results as well. The remaining storm events were run to meet Hillsborough County criteria as well as the District's G&S.

Design Storm Event	Rainfall Depth (inches)
Mean Annual	4.50
5-year/24-hour	5.75
10-year/24-hour	7.25
25-year/24-hour	8.50
50-year/24-hour	9.75
100-year/24-hour	12.00
100-year/5-day	17.80

The level of service analysis revealed that violations of the FPLOS occur at the Nine Eagles Subdivision, located in the northwest corner of the DBA watershed. This result is consistent with

flooding complaint records, per the County files, which indicated that flooding occurs at the Patterson Road / Brooker Creek crossing and the portion of the Nine Eagles Subdivision adjacent to, and downstream from, Patterson Road. The problem is caused by the lack of maintenance of the channel downstream of Patterson Road, as well as an undersized, single barrel, 30-inch RCP culvert located on a ditch that runs along the west side of the Nine Eagles subdivision.

The existing conditions computer modeling results indicated an expected 7.5 inches of road flooding depth (LOS C) in this area during the 25-year/24-hour design storm event. The flooding would extend along a 2,100-ft length of road extending from the bend in Patterson Road south to the entrance of the Nine Eagles Subdivision. Flooding in this area is predicted even for smaller rainfall events, with about 0.5 inches of road flooding depth expected during the 5-year/24-hour storm event.

The computer model was also used to identify the recommended improvements to solve the FPLOS problems. It is recommended that the 400-feet of channel downstream from Patterson Road be cleaned out and maintained. In addition, the undersized culvert should be replaced with a double 42-inch RCP culvert structure. Modeling results showed that these improvements would reduce flood stages during the 25-year/24-hour storm event by 6 inches and the road would then meet the County's FPLOS access criteria. Modeling results also predict the elimination of road flooding during the 10-year/24-hour and smaller storm events.

Floodplain Delineation and Mapping

The extent of the floodplain in the Double Branch Watershed was revised using the modeled peak stages from the 100-year/24-hour design storm event. The 100-year/5-day storm event was also run for comparison because critical conditions could result from any of the two storm events depending on the time of concentration and whether a subbasin is peak or volume sensitive. Results showed that the larger peak stage differences occur in volume-sensitive subbasins located primarily in the northeast portion of the watershed that comprise relatively large drainage areas compared to the storage volume available. For mapping purposes, it is considered that the results of the 100-year/24-hour storm are more realistic and adequate for defining the regulatory floodplain because the 100-year/24-hour event better matches historical peak stages in the area. In addition, a critical factor associated with the 100-year/5-day design storm simulations is that the computer model does not have the capability to account for the water volume losses due to leakage to the Floridan aquifer, which results in an overestimation of predicted water elevations.

Data Management

To facilitate future computer model updates, the data collected and developed as part of this project were stored in geo-database/GIS format, per Hillsborough County and the District G&S.

1.0 Introduction

1.1 Project Location and Description

The Double Branch Creek (DBA) watershed lies in the northwest portion of Hillsborough County. It drains approximately 23 square miles and is composed primarily of undeveloped and residential land uses. **Figures 1-1** and **1-2** show the DBA location map and watershed boundary. The update of the Watershed Management Plan (WMP) was necessary due to the tremendous amount of development that has occurred in the study area recent years. This is illustrated in **Figure 1-3** that shows the location of developments that received an Environmental Resource Permit (ERP) between 2001 and 2006. Significant residential areas located in the DBA watershed include: Countryway, Westchase, Nine Eagles, Twin Branch Acres, and Arbor Lakes.

The DBA watershed is drained by two major drainage conveyance systems that outfall to Double Branch Bay:

a) The Double Branch Creek system, which drains the western portion of the watershed and discharges through two main outfalls. It includes two distinct branches referred to as the West Branch and the East Branch. The East Branch can be further broken down into the Nine Eagles Fork and the Right Fork.

b) An existing channel system, hereafter referred to as the Memorial Channel, that drains the eastern portion of the watershed, and discharges into what is known as the minor outfall.

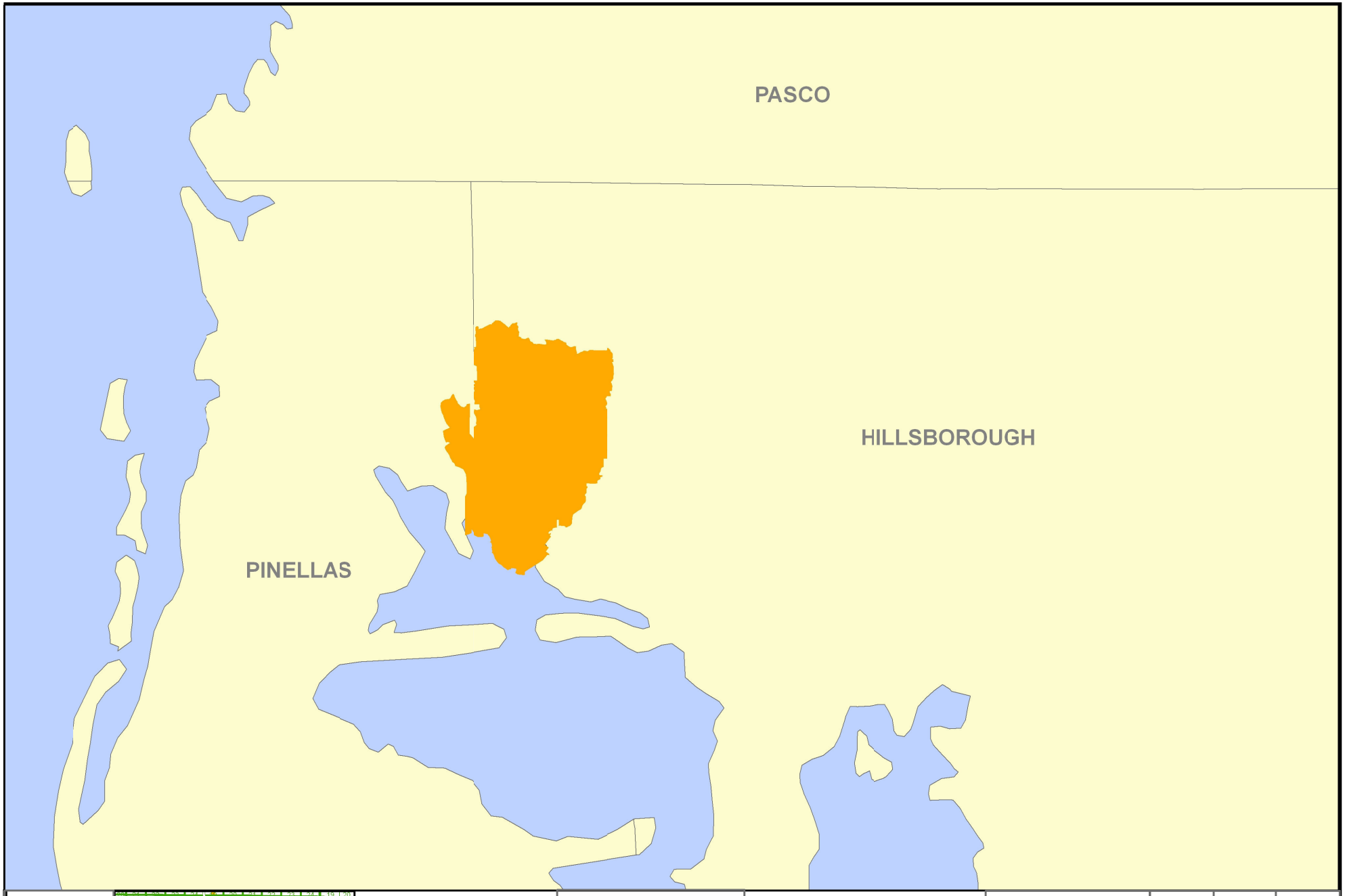
A more detailed description of the configuration of the drainage network is provided in Chapter 3 of this report.

1.2 Purpose and Scope

The objective of this study was to update the existing conditions hydrologic and hydraulic (H&H) model for the DBA watershed and re-evaluate improvement projects recommended in the previous WMP. The WMP proposed improvements are based on an evaluation of the flood protection levels of service (FPLOS) and an identification of improvements necessary to correct any deficiencies.

The objectives of the H&H model update were to:

- Make model updates necessary to meet the requirements of the Southwest Florida Water Management District (District) Watershed Management Program Guidelines and Specifications (G&S), per the comments provided in the District's model review as well as further model evaluations conducted as part of this project. In this manner, the model will be considered as "best available information" for County Stormwater permitting as well as for the District's Environmental Resource Permit (ERP) process.
- Make use of the recent digital topographic data obtained by the County, including the



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Legend

- Watershed Boundary
- State Counties

Notes:

This area is used for general map note information such as map accuracy/standards, source information, elevation information, etc.

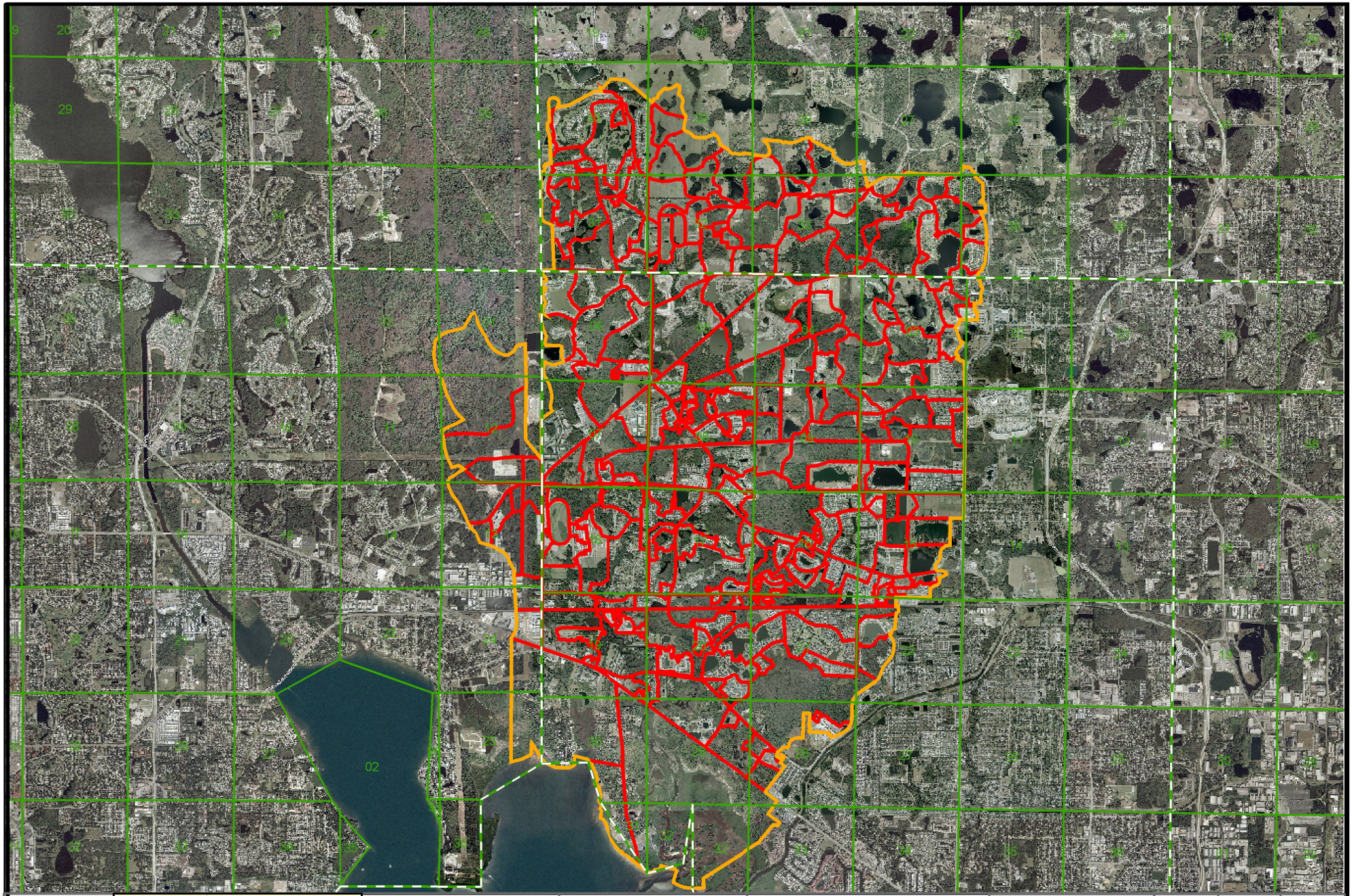
Hillsborough County Florida

1:427,035

0 10,000 20,000 40,000 Feet

0 3 6 Miles

Figure 1-1: Location Map	Filename:	Map Date:	Map Prepared By:
Project: 100716.06	Map1.mxd	Dec. 2006	PBS&J
Watershed: Double Branch	Date of Photography: 2004		
Watershed Masterplan Update			



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Legend

- Township/Range
- Section, Township, Range
- Watershed Boundary
- Subbasin Boundaries

Notes:

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Southwest Florida Water Management District

Hillsborough County Florida

1:78,952

N W E S

0 1,950 3,900 7,800 Feet

0 0.5 1 Miles

Figure 1-2: Watershed Boundary Map

Project: 100716.06

Watershed: Double Branch

Watershed Masterplan Update

Filename:	Map Date:	Map Prepared By:
Map2.mxd	Dec. 2006	PBS&J

Date of Photography: 2004

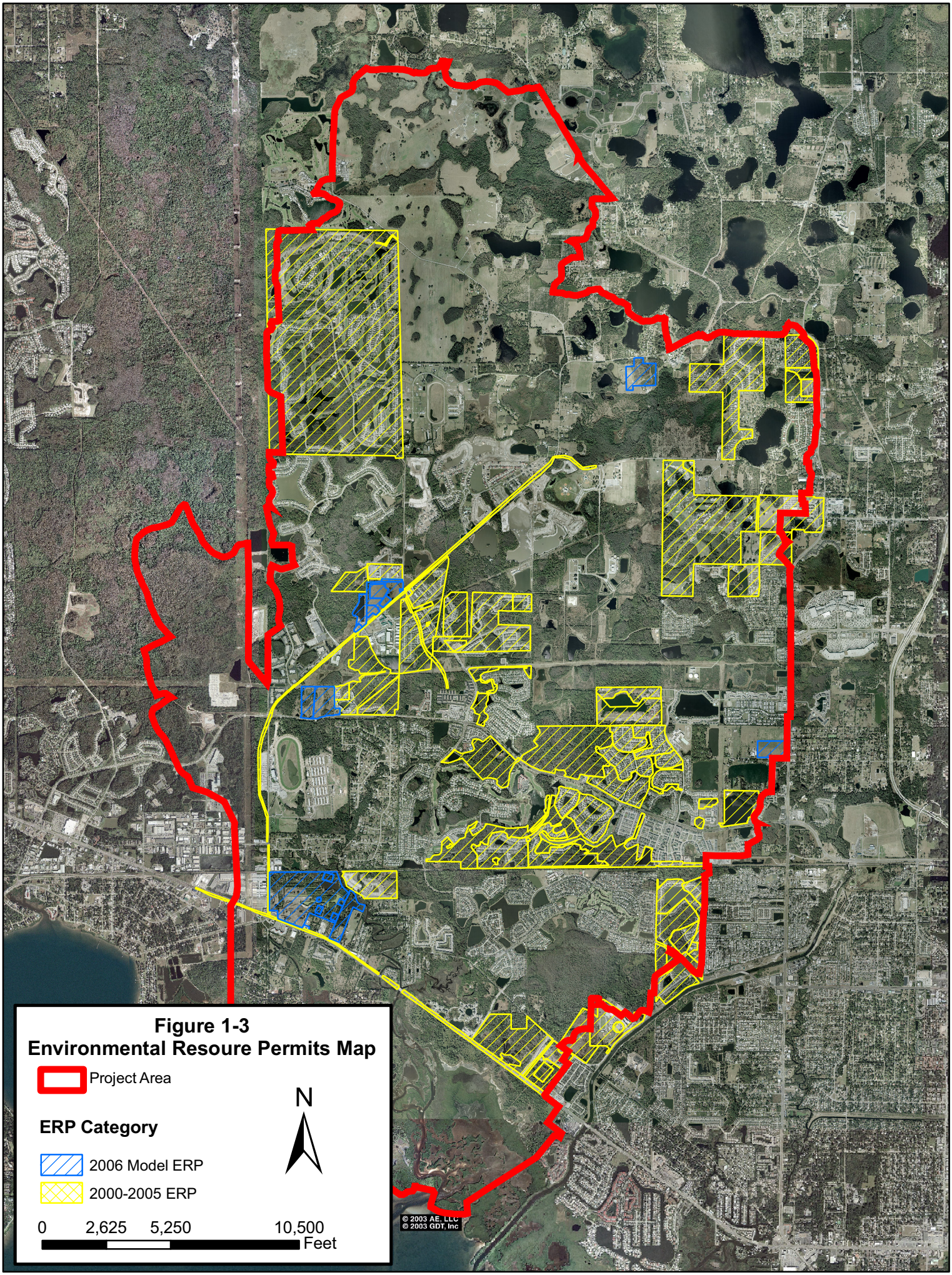
Figure 1-3
Environmental Resoure Permits Map
Project Area
ERP Category
2006 Model ERP
2000-2005 ERP
N
0
2,625
5,250
10,500
Feet
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datum conversion from the 1929 National Geodesic Vertical Datum (NGVD) to the 1988 North American Vertical Datum (NAVD).

- Be able to use the model for any potential modification of the FEMA regulatory floodplain.
- Reflect recent land use changes in the watershed.
- Make adjustments to account for changes in watershed boundaries to conform to those of adjacent watersheds.

The scope of this project included an evaluation of the watershed existing and proposed H&H conditions. This evaluation was based on six design storm events of 24-hour duration and return periods of 2.33, 5, 10, 25, 50, and 100 year, and one design storm event of 5-day duration and 100-year return period. The project was jointly funded by Hillsborough County and the Southwest Florida Water Management District.

1.3 Background

In 1994 Hillsborough County developed an H&H model for the Double Branch Creek watershed using the Hillsborough County Stormwater Management Modeling System (HILLSMMS), a predecessor of the current Hillsborough County Stormwater Management Model (HC-SWMM), which is the County's current standard modeling software. The model was developed using the available aerial contour maps (1989) and survey information. This model was stabilized, but required further calibration. The calibration process was undertaken in 1998. Work at that time also included generation of a Watershed Management Plan (WMP) report.

Subsequently, in November of 2001, Advantage Engineering completed an update of the SMMP that included:

- Updating the HILLSMMS model to the new HC-SWMM version.
- Renumbering all nodes and junctions to include the DBA descriptor number 48 for easy identification of the watershed.
- The addition of new land use features or significant physical changes that have occurred in the watershed during the period from 1995 – 2000 (e.g. new roads, developments, stormwater projects, etc.).

The update also included additional verification of the previous model calibration using the June 2001 storm. This made the process consistent with watershed management planning efforts that were being conducted for other watersheds at that time.

2.0 Watershed Description

2.1 Introduction

This chapter describes the climate, physiography and hydrology, geology and hydrogeology, and soils and land use characteristics of the Double Branch Creek Area (DBA) watershed.

2.2 Climate

The climate of the DBA, and for Hillsborough County as a whole, can be classified as humid subtropical. Annual average precipitation is around 52 inches and almost 60 percent 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 localized, are highly variable in both intensity and volume. The larger, normal summer storm events and those associated with tropical systems can cause flooding problems in areas where there are deficiencies in the drainage systems.

Winter rainfall 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 mean annual temperature in Hillsborough County is approximately 72^{o} F (Fahrenheit). The mean monthly temperature ranges from a low of approximately 60^{o} F in January to a high of approximately 82^{o} 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^{o} 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.

2.3 Soils

Soil properties that influence hydrologic conditions, particularly infiltration rates are: a) depth to the water table, b) soil permeability, and c) depth to a layer or layers that slow or impede water movement. For hydrologic analysis purposes, soils are grouped into four categories A, B, C, and D depending on infiltration capacity. The major hydrologic soil 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.

- 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.

- 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.

Soils are also assigned dual hydrologic classifications (e.g. A/D or B/D) if they 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 characteristics. During the dry season when the water levels recede, infiltration rates increase to those corresponding to Group A or Group B levels.

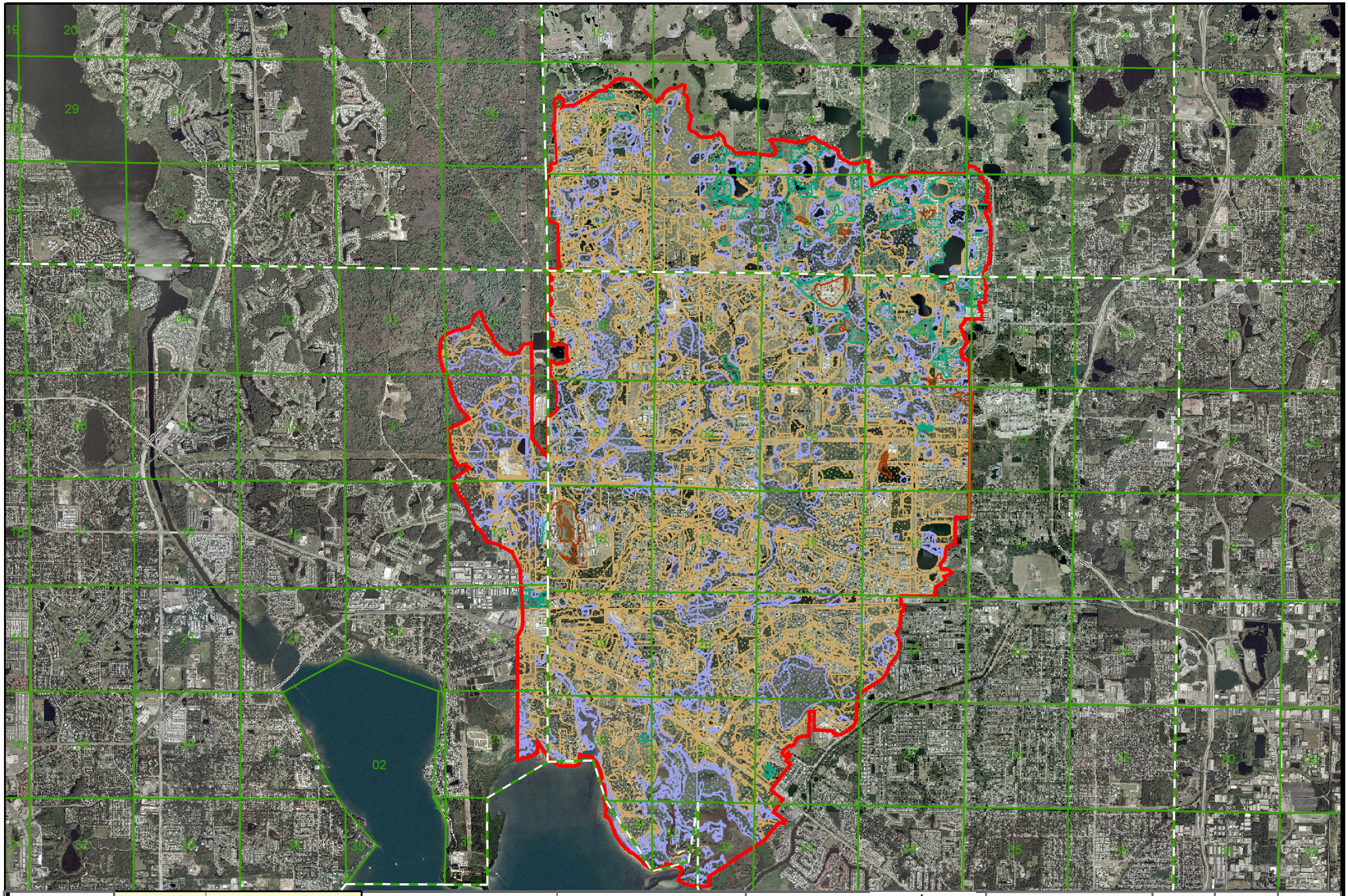
Table 2-1 and **Figure 2-1** show the area soils distribution by hydrologic soils group. As show, the predominant soil type is B/D. Soils types that fall within the B/D classification found within the DBA are Malabar, Myakka, Immokalee, Wabasso, and Oldsmar. This information was obtained from the Geographical Information Systems (GIS) layers developed by the Southwest Florida Water management District. Additional soil information, such as drainage classification, percent slope, water table depth, permeability, natural vegetation and potential uses for development and agriculture, is available from the Natural Resources Conservations Service (NRCS) Soil Survey for Hillsborough County.

Table 2-1
Soil Distribution by Hydrologic Soil Group

Hydrologic Soil Group	Area (acres)	Percent of Project Area
A	17	1.10
B/D	1049	67.23
C	91	5.83
D	337	21.61
W	66	4.24
Total	**1560**	**100.00**

2.4 Physiography and Hydrology

The DBA lies within the Polk Upland physiographic unit. 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



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Legend

- Township/Range
- Section, Township, Range
- Watershed Boundary
- A
- A/D
- B
- B/D
- C
- C/D
- D

Notes:

This area is used for general map note information such as map accuracy/standards, source informaton, elevation information, ect.

Southwest Florida Water Management District

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0 1,850 3,700 7,400 Feet

0 0.5 1 Miles

Figure 2-1: Soil Map	Filename:	Map Date:	Map Prepared By:
Project: 100716.06	Map4.mxd	Dec. 2006	PBS&J
Watershed: Double Branch	Date of Photography:		
Watershed Masterplan Update	2004		

elevations in the DBA vary between a high of approximately 69 feet NAVD in the north portions of the watershed to a low of around -6 feet NAVD near the Double Branch Bay. **Figure 2-2** shows the basin topography.

There are many wetland areas, lakes and depressions located within the watershed. These wetlands and depressions are areas of watershed storage that have a significant effect on the hydraulic system performance. The lakes and depressions 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 toward Double Branch Bay.

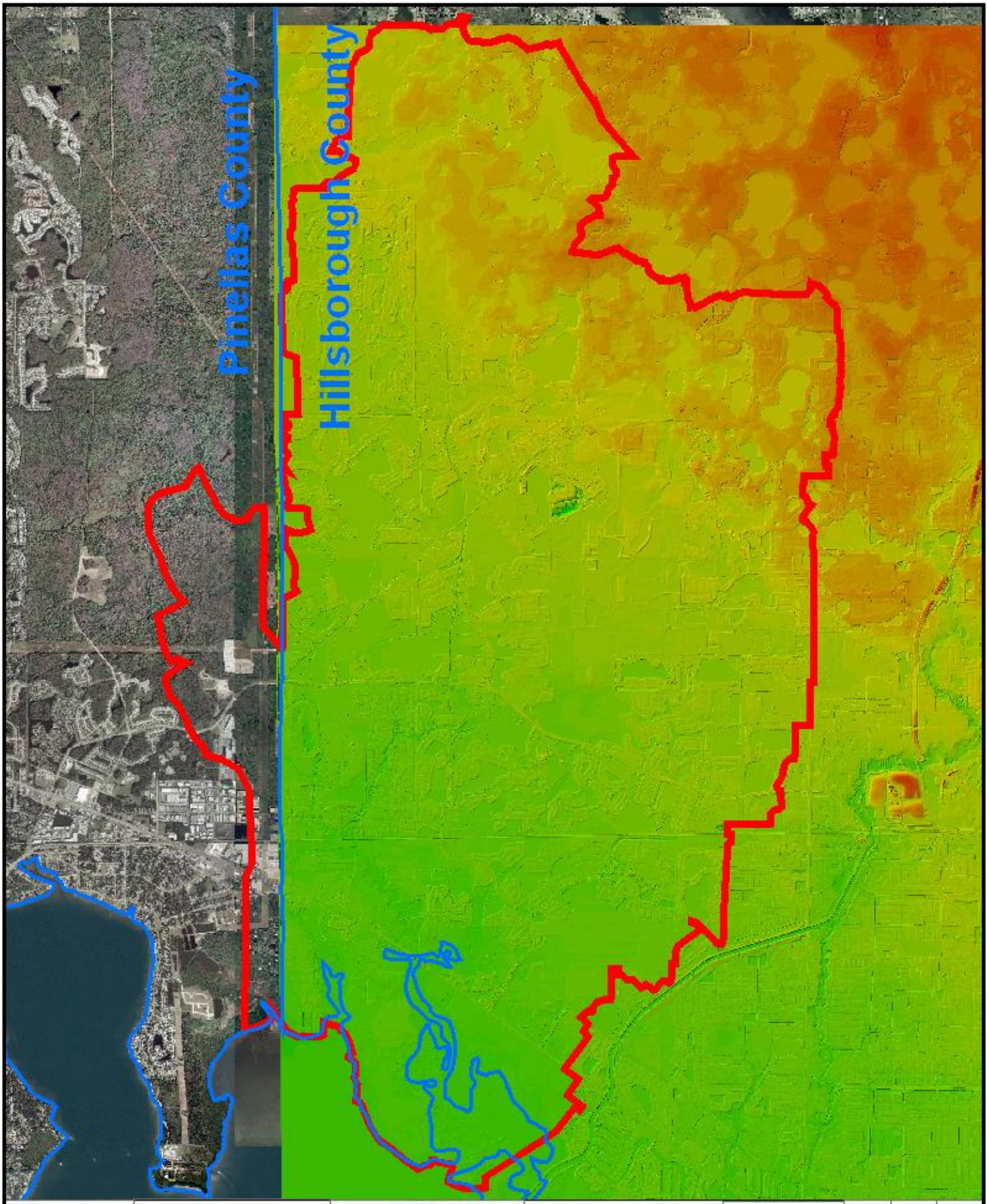
2.5 Geology and Hydrogeology

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

At land surface, undifferentiated sediments including silt, sand, and clay form surficial deposits which vary in thickness from less than 10 feet in coastal areas to over 100 feet in paleokarst 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 and minor amounts of phosphate. 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.



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Watershed Boundary
County Boundary

Notes:

This area is used for general map note information such as map accuracy/ standards, source information, elevation information, etc.

0 2,400 4,800 Feet

Figure 2-2:
Topographic Map

Project: 1007 16.06

Watershed: Double Branch

Watershed Master plan Update

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

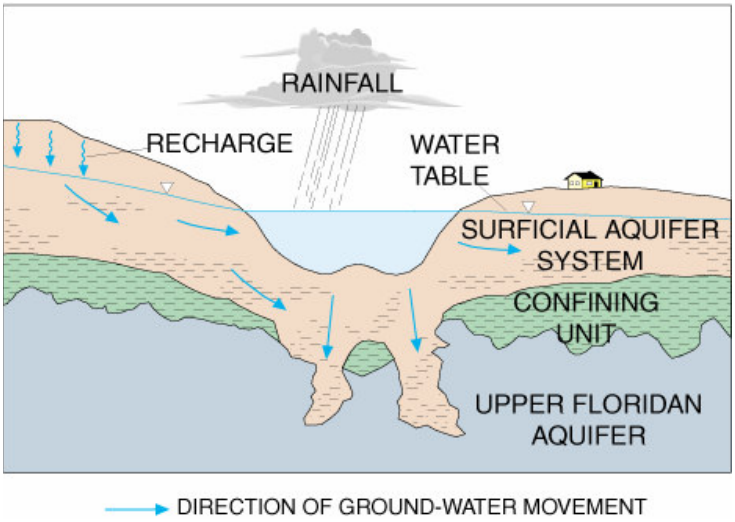


Figure 2-3: Groundwater Flow

2.5.1 Surficial Aquifer

The surficial aquifer is comprised primarily of unconsolidated deposits of fine-grained sand with an average thickness of 30 feet. Due to the karst geology of the region, thickness of the sand is highly variable. The depth of the water table ranges from near land surface to several tens of feet below land surface. Water table elevation is primarily influenced by rainfall; annual highs in most years occur during the end of the wet season (September and October), 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.

2.5.2 Semi-Confining Zone

Below the surficial aquifer is a semi-confining unit comprised of clay, silt and sandy clay that somewhat retards the movement of water between the overlying surficial aquifer and the underlying 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).

2.5.3 Upper Floridan Aquifer

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

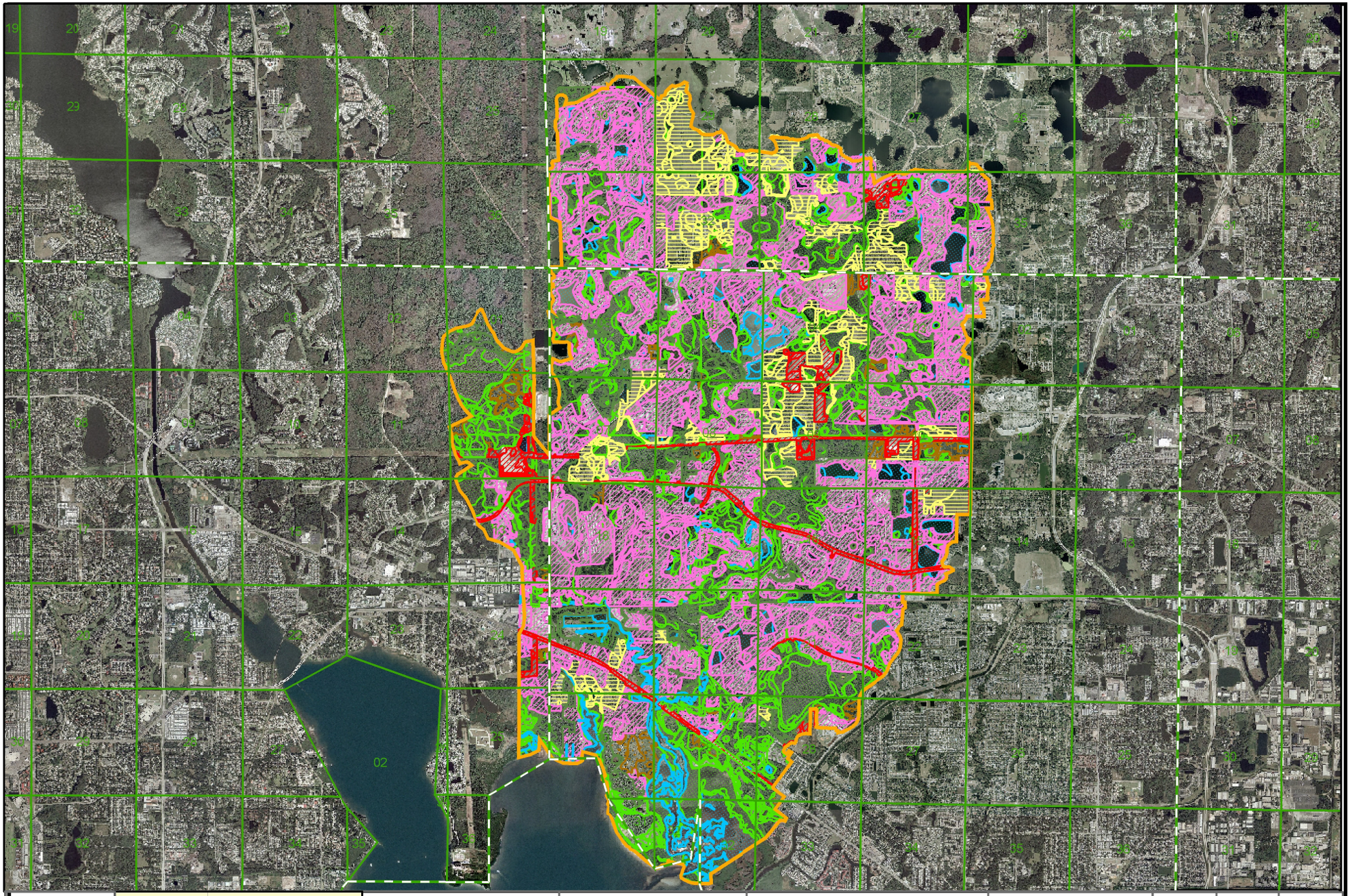
Near the base of the Avon Park Formation lies the middle confining unit of the Floridan aquifer, an evaporate sequence of very low permeability that is composed of gypsiferous dolomite and dolomitic limestone. The middle confining unit generally delineates the boundary between the freshwater Upper Floridan 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. **Figure 2-3** shows the relationship between surface water and groundwater.

2.6 Land Uses

Preliminary land use distribution data for the Double Branch Watershed was obtained from the District's GIS land use layer. The layer is based on the Florida Land Use and Cover Classification System (FLUCCS) and represents conditions as observed in 2004. Residential land uses account for 26 percent of the watershed area; lakes, streams, and reservoirs represent 11 of

the area; and wetland forests encompass 8 percent of the watershed. **Figure 2-4 and Table 2-2** show the DBA land use distribution.



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Legend

- Township/Range
- Section, Township, Range
- Watershed Boundary
- Urban and Built-Up
- Agriculture
- Rangeland
- Upland Forests
- Water
- Wetlands
- Barren Land
- Transportation
- Special Classifications

Notes:

This area is used for general map note information such as map accuracy/standards, source information, elevation information, etc.

Hillsborough County Florida

N
W
E
S
0 2,100 4,200 8,400 Feet
0 .5 1 Miles

Figure 2-4: Land Use Map

Project: 100716.06

Watershed: Double Branch

Watershed Masterplan Update

Filename:	Map Date:	Map Prepared By:
Map5.mxd	Dec. 2006	PBS&J

Date of Photography: 2004

Table 2-2
Land Use Distribution

FLUCCS Code	Description	Area (acres)	Percent of Project Area (%)
1100	RESIDENTIAL LOW DENSITY < 2 DWELLING UNITS	99	6.32
1200	RESIDENTIAL MED DENSITY 2->5 DWELLING UNIT	105	6.71
1300	RESIDENTIAL HIGH DENSITY	203	13.04
1400	COMMERCIAL AND SERVICES	15	0.99
1500	INDUSTRIAL	20	1.27
1700	INSTITUTIONAL	15	0.98
1800	RECREATIONAL	37	2.40
1820	GOLF COURSES	54	3.49
1900	OPEN LAND	59	3.80
2100	CROPLAND AND PASTURELAND	55	3.53
2200	TREE CROPS	6	0.42
2400	NURSERIES AND VINEYARDS	3	0.19
2500	SPECIALTY FARMS	24	1.55
2600	OTHER OPEN LANDS <RURAL>	60	3.86
3200	SHRUB AND BRUSHLAND	31	2.01
3300	MIXED RANGELAND	5	0.32
4100	UPLAND CONIFEROUS FOREST	2	0.15
4110	PINE FLATWOODS	72	4.59
4120	LONGLEAF PINE - XERIC OAK	5	0.31
4340	HARDWOOD CONIFER MIXED	65	4.14
4400	TREE PLANTATIONS	5	0.33
5200	LAKES	17	1.10
5300	RESERVOIRS	88	5.62
5400	BAYS AND ESTUARIES	35	2.24
6100	WETLAND HARDWOOD FORESTS	1	0.05
6110	BAY SWAMPS	16	1.03
6120	MANGROVE SWAMPS	24	1.56
6150	STREAM AND LAKE SWAMPS (BOTTOMLAND)	89	5.68
6200	WETLAND CONIFEROUS FORESTS	6	0.37
6210	CYPRESS	69	4.40
6300	WETLAND FORESTED MIXED	117	7.47
6400	VEGETATED NON-FORESTED WETLANDS	1	0.09
6410	FRESHWATER MARSHES	40	2.54
6420	SALTWATER MARSHES	35	2.22
6430	WET PRAIRIES	16	1.05
6440	EMERGENT AQUATIC VEGETATION	6	0.39
6530	INTERMITTENT PONDS	0	0.01
6600	SALT FLATS	4	0.24
7400	DISTURBED LAND	0	0.00
8100	TRANSPORTATION	17	1.10
8200	COMMUNICATIONS	2	0.10
8300	UTILITIES	37	2.34
	Total:	**1560**	**100.00**

3.0 Major Conveyance Systems

3.1 Introduction

This chapter contains a general description of the conveyance systems and subsystems in the DBA watershed. As indicated in Chapter 1, the DBA watershed is drained by two major conveyance systems that outfall to Double Branch Bay: a) Double Branch Creek that drains the western half of the watershed and discharges through a major outfall, and b) an existing channel system, hereafter referred to as the Memorial Channel, that drains the eastern half of the watershed and discharges into a minor outfall. Double Branch Creek includes two distinct branches referred to as the West Branch and the East Branch. In turn, the East Branch is further broken down into the Nine Eagles Fork and the Right Fork.

Based on the number of main creeks, branches, and sub-branches, the watershed conveyance system was divided into the six systems described below. The five Double Branch systems are described first by location from downstream to upstream, followed by the description of the Memorial Channel system. The location of each tributary system is shown in **Figure 3-1**. **Figure 3-2** shows the location and name of the streams that make up the DBA conveyance systems.

3.2 Double Branch Creek System

The Double Branch Creek conveyance system is defined herein as the portion of the creek that originates at the convergence of the East and West Branches downstream (south) of Twin Branch Acres Road. From this point, the channel flows in a southerly direction and passes under the Seaboard Coast Railroad Line approximately 300 feet downstream of where the East and West Branch converge. The channel meanders downstream, crosses Memorial Highway, and between Memorial Highway and Hillsborough Avenue it splits into two well defined outfall channels that discharge into Double Branch Bay under Hillsborough Avenue.

3.3 West Branch System

The West Branch System has its headwaters in the wetlands that stretch from south of the Nine Eagles Development to Race Track Road. The channel becomes well defined in the area of the commercial park located to the northwest of Race Track Road. It crosses the road and runs south for approximately 1800 feet to the crossing under Linebaugh Avenue. The West Branch then curves around the east side of the Tampa Bay Downs Racetrack, passes under the access road to the racetrack stables and continues flowing south. The channel segment along the east side of the racetrack consists of a series of storage areas with connecting culvert conveyances. In this area, the West Branch also receives inflow from roadside ditches and wetlands located to the west of the racetrack in Pinellas County. These wetlands surround Florida Power's Lake Tarpon Substation. Just south of Twin Branch Acres road the West Branch turns towards the east and joins with the East Branch to form the Double Branch System.

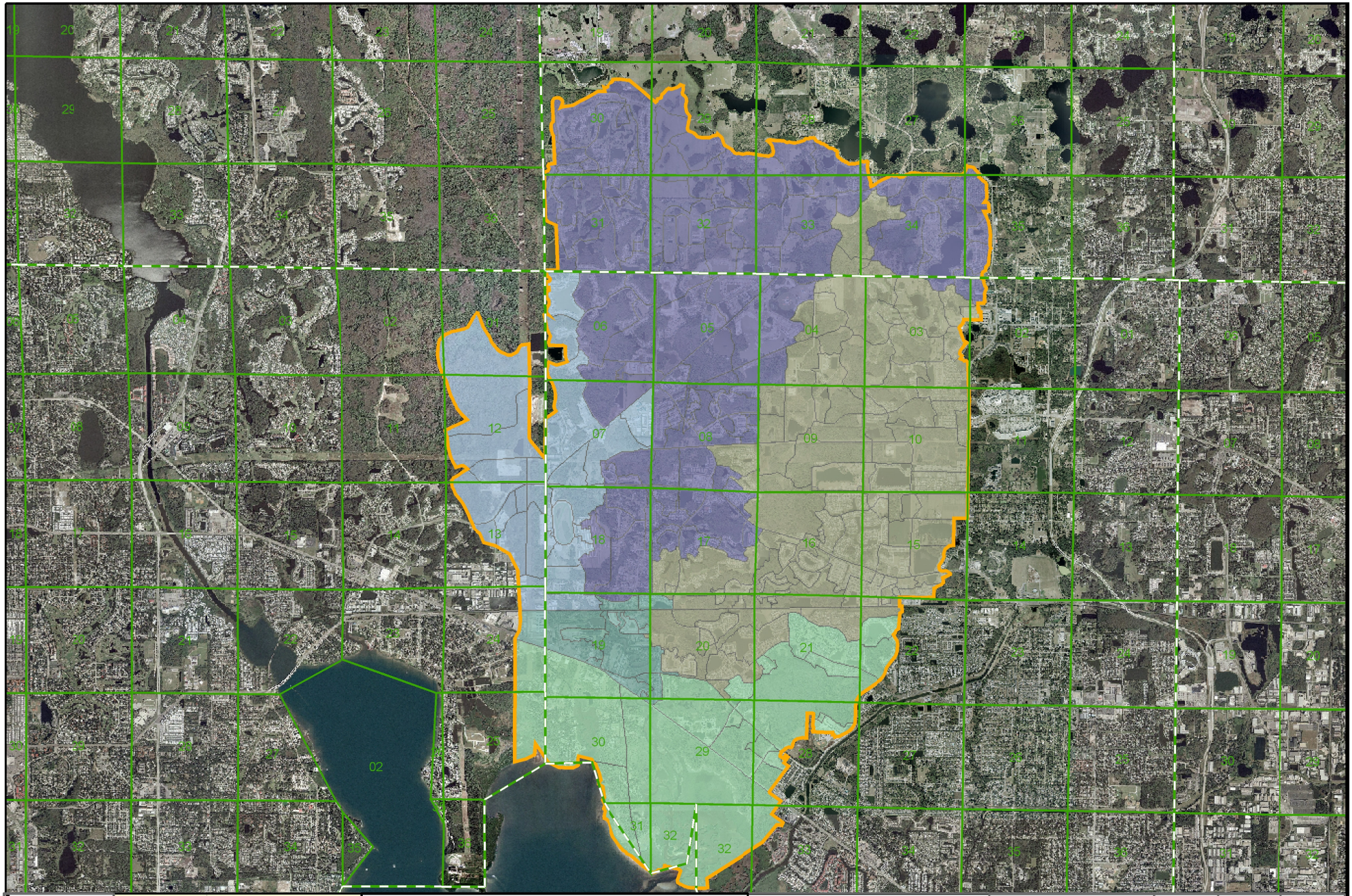

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Figure 3-1: Major Tributary Map

Project: 100716.06

Watershed: Double Branch

Watershed Masterplan Update

Filename:	Map Date:	Map Prepared By:
Map7.mxd	Dec. 2006	PBS&J

Date of Photography: 2004

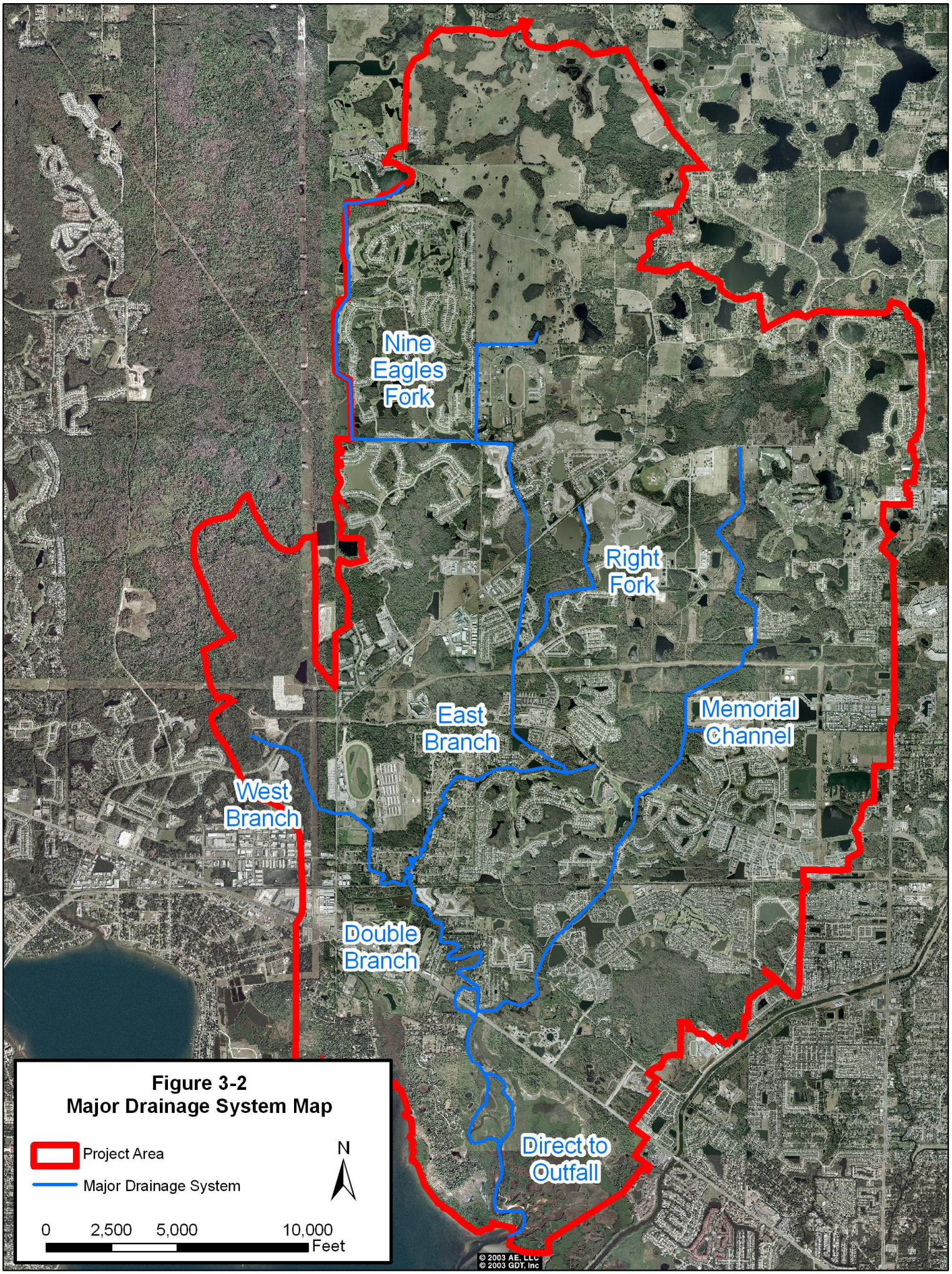

Figure 3-2
Major Drainage System Map

3.4 East Branch System

The East Branch System begins at the convergence of the Nine Eagles and Right Forks. This occurs upstream of a utility easement, north of the Westchase Subdivision. The first stretch of this system is Channel B which flows due south under Linebaugh Avenue. Downstream from this crossing the channel joins a secondary tributary that flows under Countryway Boulevard and turns west. From this point, the East Branch runs through the Westchase Subdivision and then crosses under Twin Branch Acres Road in two locations. Downstream from the second crossing, the East Branch joins the West Branch to form the Double Branch System.

3.5 Nine Eagles Fork System

The headwaters of the Nine Eagles Fork are located in the Nine Eagles subdivision. The golf course ponds of this development are interconnected, drain to the west, and outfall into the ditch, which subsequently flows due south along the subdivision for approximately 6600 feet. At this location the channel turns due east and flows for another 4600 feet to the Nine Eagles Drive crossing. The channel continues flowing eastward for an additional 1500 feet before turning to the south for approximately 4100 feet to Race Track Road. After passing under the road, the channel continues to flow southward and joins the Right Fork approximately 4300 feet downstream.

3.6 Right Fork System

The Right Fork System has its headwaters in the wetlands north of Race Track Road and to the east of Nine Eagles Road. The system flows under Race Track Road and heads south for an approximate distance of 3000 feet before turning west/southwest. The Right Fork then joins the Nine Eagles Fork, forming the East Branch. As indicated above, the Right Fork joins the Nine Eagles Fork approximately 4300 feet downstream from Race Track Road.

3.7 Memorial Channel System

The Memorial Channel is the name that has been assigned to the existing channel located on the eastern part of the basin that is not part of Double Branch Creek. The system originates in a large wetland just north of South Mobley Road and is comprised of a series of channels that connect additional downstream wetlands. Downstream from the South Mobley Road crossing, the channel passes through a series of wetlands on its way to Linebaugh Avenue in the Westchase Subdivision area. It flows through one of the golf course ponds and continues southwest until it reaches the first of two railroad crossings approximately 600 feet apart. About 2600 feet further downstream, the channel crosses Countryway Boulevard and continues to flow southwest for an additional 2300 feet before passing under Memorial Highway. The channel section from Memorial Highway to Hillsborough Avenue is a not well defined tidal plain that outfall into Double Branch Bay.

4.0 Computer Modeling Methodology

4.1 Introduction

This chapter provides a general description of the computer software and engineering analysis techniques that were used to develop the existing conditions hydrologic and hydraulic model for the DBA watershed. Engineering approaches and assumptions used are also explained. As indicated in Chapter 1, the update of the hydrologic and hydraulic (H&H) model was based on the results of the computer model review conducted by the District, as well as further analysis performed as part of this project.

4.2 General Methodology and Database Development

The Hillsborough County modified version of the EPA Storm Water Management Model (HC-SWMM) was used for analysis of the H&H conditions of the DBA watershed.

The hydrologic model contained in the HC-SWMM makes use of the U.S. Soil Conservation Service (SCS) Runoff Curve Number (CN) method. Stormwater runoff hydrographs are developed on the basis of soil and land cover characteristics. Subbasin inflow hydrographs are input at subbasin nodes within the hydraulic model. Discharges are routed through the system using a modified version of the SWMM EXTRAN block to compute water surface elevations at nodes and discharges at links throughout the hydraulic network.

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 (US Army Corps of Engineers) cross section data. EXTAN uses the cross section data only to obtain channel geometry. The program uses invert elevations input on the conduit records to determine elevations. A natural channel is, thus, treated as a prismatic conduit with an irregular shape.

4.3 Hydrology

As indicated previously, the SCS method, as included in the HC-SWMM was used for this application. The Hillsborough County Storm Water Management Technical Manual indicates that a value of 256 with a corresponding dimensionless unit hydrograph is appropriate for the County. An initial abstraction coefficient of 0.2 was used throughout this study. Initial abstraction is computed as the initial abstraction coefficient multiplied by the soil storage depth. The soil storage depth(s) is computed from the runoff curve number (CN) on the basis of the SCS methodology.

Rainfall depths associated with the design storm events used in this study to evaluate H&H conditions were determined from the isohyetal maps included in the Southwest Florida Water Management District's Environmental Resource Permitting Information Manual. The rainfall depths by storm event used in the model simulations are as follows:

Design Storm Event	Rainfall Depth (inches)
Mean Annual	4.50
5-year	5.50
10-year	7.00
25-year	8.00
50-year	10.5
100-year	11.5

The design storms' rainfall distribution was the SCS 24-Hour Type II Florida Modified as required by SWFWMD and Hillsborough County.

4.3.1 Subbasin Delineation

The original subbasin delineation for the DBA watershed included 178 subbasins ranging in size from 6.5 acres to 476.2 acres. The original delineation was updated using the 2004 aerial imagery and the 2004 one-foot contours to include 256 subbasins, ranging in size from 0.2 acres to 1061.4 acres. That represents an increase of 44 percent in the level of study detail. The delineation was made consistent with the District's G&S by tracing ridgelines around depressions measuring one acre or greater in size and having an associated depth of two-feet or more. **Table 4-1** lists the subbasins and corresponding drainage area.

For areas where recent construction has taken place, the subbasin delineations were updated using data from Environmental Resource Permits (ERPs). The ERPs used in the model update are listed in **Table 4-2** and shown on **Figure 4-1**. In addition, a portion of the Brooker Creek watershed, located to the north of the DBA, was included as part of this study to account for the flows which enter into the DBA from the north.

Figure 1 in Appendix A is the Subbasin Delineation Map. To emphasize the model updating effort, the map shows the original as well as the updated subbasin delineations.

4.3.2 Soils Data

As described in Section 2, an updated version of the SWFWMD GIS soil layer was used to obtain soil information for the DBA watershed. Each soil polygon in the GIS layer was 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). **Figure 2-1** shows the soil distribution by hydrologic soil group in the watershed.

Table 4-1
Hydrologic Parameters

Subbasin	Area (acres)	Time of Concentration (minutes)	Curve Number
480010	197.70	62	92.8
480020	12.39	35	96.2
480030	99.34	69	94.4
480036	17.66	85	85.4
480038	1.93	14	84.9
480040	21.37	31	93.0
480050	31.86	38	90.3
480060	435.95	174	93.7
480061	2.68	6	89.7
480062	7.37	57	93.2
480065	87.99	31	92.4
480066	51.43	35	93.7
480080	34.79	33	91.8
480090	13.48	26	92.6
480100	137.03	72	88.9
480110	38.62	109	92.3
481020	32.57	83	87.7
481030	31.29	30	92.8
481050	149.63	38	86.6
481056	5.94	63	77.0
481058	7.45	28	78.5
481062	19.46	58	79.4
481064	4.59	30	81.2
481065	51.43	90	93.7
481067	13.94	46	78.6
481070	121.48	135	81.8
481080	32.53	40	84.4
481090	25.49	52	83.4
481100	27.32	36	93.0
481110	50.75	53	88.4
481112	52.61	110	89.7
481130	59.96	44	79.9
481140	51.88	56	63.4
481145	9.67	19	56.6
481150	79.85	103	87.9
481170	13.62	40	64.8
481180	76.78	50	81.5
481190	14.94	59	65.3
481200	26.95	64	87.4
481205	27.47	33	89.7
481210	46.95	21	65.8
481220	175.88	170	93.5

Subbasin	Area (acres)	Time of Concentration (minutes)	Curve Number
481230	74.68	127	89.8
481235	116.24	116	91.4
481240	22.30	45	95.8
481250	29.02	63	95.7
481260	57.52	58	82.8
481270	229.47	115	92.0
481275	16.49	36	93.9
481278	69.34	102	93.5
481280	61.15	12	90.6
481281	80.78	94	93.6
481290	110.55	117	91.5
481295	66.80	60	89.4
481300	177.62	110	88.5
481306	24.37	51	89.2
481310	152.76	85	93.4
481320	121.79	63	90.2
481330	86.49	103	93.2
481348	95.02	74	78.7
481350	169.20	57	83.7
481370	56.40	36	85.4
481390	68.30	49	83.6
481400	12.10	46	92.2
481402	19.07	41	91.8
481410	63.24	68	89.2
481415	20.52	50	91.8
481420	21.26	21	92.3
481430	62.04	88	96.4
481440	32.13	42	93.3
481450	59.16	70	92.7
481480	33.13	14	93.6
481484	45.56	73	87.0
481492	135.52	33	92.5
481497	22.77	13	88.2
481499	38.12	68	91.3
481500	37.46	29	84.2
481501	56.20	106	89.6
481505	6.25	58	90.4
481510	37.54	78	89.2
481520	83.31	54	90.0
481530	10.06	34	95.6
481540	20.89	59	91.8
481541	15.55	17	90.3

Table 4-1
Hydrologic Parameters

Subbasin	Area (acres)	Time of Concentration (minutes)	Curve Number
481225	423.98	156	92.3
481545	2.51	14	84.5
481550	32.41	56	96.8
481560	8.06	11	92.8
481565	4.70	25	93.5
481570	46.72	68	87.0
481580	31.67	20	91.0
481582	18.43	66	90.3
481586	10.28	12	87.9
481587	9.02	22	91.9
481588	8.91	30	91.9
481589	14.59	47	91.8
481590	104.67	57	88.7
481592	44.44	44	92.0
481610	220.48	105	87.8
481620	80.07	57	81.9
481630	271.91	81	85.0
481640	113.48	74	88.6
481650	127.32	58	82.3
481660	73.79	54	90.7
481675	21.46	24	91.4
481676	74.99	26	88.3
481677	95.66	96	91.0
481680	35.86	15	87.5
481695	31.61	24	86.4
481700	102.02	71	89.0
481710	46.86	85	87.8
481712	5.12	21	85.4
481720	25.73	62	85.2
481725	10.97	42	81.3
481730	5.98	11	82.1
481740	118.88	102	84.1
481750	10.04	14	85.3
481760	155.40	79	86.6
481766	10.64	31	83.4
481770	10.68	20	84.0
481780	41.39	26	83.7
481790	92.66	78	87.0
481800	52.38	24	86.8
481810	74.72	39	81.9
481820	57.72	33	84.8
481830	57.14	26	83.1

Subbasin	Area (acres)	Time of Concentration (minutes)	Curve Number
481542	7.33	29	93.2
481860	48.86	27	83.2
481865	36.35	22	84.0
481870	34.58	69	83.7
481880	52.12	52	85.1
481890	23.04	53	84.7
481900	70.42	50	85.9
481910	15.89	21	85.7
481915	7.90	12	92.6
481920	31.57	33	89.0
481925	16.68	37	79.1
481930	143.10	57	88.2
481935	68.73	40	87.9
481940	96.00	17	85.7
481950	94.65	29	87.7
481960	21.71	12	84.4
481970	84.98	34	81.7
481980	140.47	33	86.9
481990	81.35	25	83.5
481995	25.37	42	93.4
482005	40.74	46	91.7
482010	133.31	72	88.3
482020	39.25	107	89.9
482030	47.19	79	93.2
482032	7.98	19	86.8
482040	180.35	111	91.5
482042	7.97	15	92.2
482044	8.31	31	86.1
482046	19.33	24	85.0
482050	57.76	59	92.4
482060	73.08	44	93.2
482070	16.72	38	92.5
482100	34.51	37	92.3
482120	106.10	39	93.3
482130	104.97	118	90.1
482140	61.66	77	91.3
482155	90.13	71	90.7
482160	16.31	46	82.0
482165	1.48	7	82.5
482170	7.82	57	84.8
482173	17.24	33	79.8
482175	12.55	64	83.4

Table 4-1
Hydrologic Parameters

Subbasin	Area (acres)	Time of Concentration (minutes)	Curve Number
481840	75.99	53	84.4
481850	119.59	75	83.2
482192	52.22	25	91.7
482194	19.03	16	90.0
482195	11.49	8	93.3
482196	0.44	6	91.0
482197	4.43	9	91.9
482198	23.93	17	90.7
482199	12.55	12	85.9
482200	26.07	28	91.9
482205	12.35	35	84.9
482215	19.27	43	84.9
482220	14.19	19	87.8
482225	31.78	48	85.5
482230	26.50	44	87.6
482235	22.21	28	84.3
482250	234.66	102	93.4
482260	7.83	25	92.7
482265	4.22	17	92.1
482270	44.25	48	92.0
482271	140.79	35	91.6
482273	56.07	26	89.7
482275	52.96	81	91.9
482280	132.44	40	90.5
482290	41.92	27	81.9
482300	40.13	10	96.9
482310	55.38	13	94.7
482315	16.08	21	94.7
482317	0.20	6	91.0
482320	60.74	27	91.1
482330	42.25	32	87.1
482340	22.74	21	92.6
482360	70.26	70	82.8
482380	15.61	28	89.6
482392	1.16	6	77.0
482400	14.86	21	80.9
482402	1.68	6	91.8
482405	12.34	25	89.9
482410	79.66	47	86.2
482420	23.84	37	82.7
482425	67.35	14	94.7
482440	73.29	84	90.6

Subbasin	Area (acres)	Time of Concentration (minutes)	Curve Number
482180	6.06	14	91.5
482190	60.60	56	91.3
482510	138.00	115	81.6
482520	69.61	73	88.9
482540	43.86	42	90.7
482560	24.63	28	86.5
482580	57.73	66	95.3
482600	42.14	36	90.7
482620	103.84	55	90.5
482630	152.83	53	87.1
482660	106.79	62	94.0
482680	109.58	46	90.4
482686	31.77	17	85.9
482700	97.66	26	87.6
482720	136.99	22	86.4
482740	43.65	34	84.1
482751	15.11	20	87.4
482760	165.91	124	84.5
482780	34.13	22	86.7
482790	29.89	12	94.1
482800	36.04	38	86.7
482820	63.99	22	78.0
482840	222.23	31	80.7
482841	23.13	24	82.1
482848	43.46	14	84.5
482850	133.16	61	86.0
482860	37.81	31	89.0
482870	16.09	11	79.6
482890	162.84	42	85.7
482895	4.15	9	88.3
482900	138.82	52	88.1
482920	51.35	26	84.5
482930	39.85	50	84.0
482940	68.20	19	91.6
482950	21.10	14	84.0
482960	77.90	35	81.9
482970	48.61	9	92.1
482980	36.81	13	89.4
482990	27.45	35	91.6
482995	116.87	34	87.3
485000	1061.41	109	95.4
486000	652.98	68	85.6

Table 4-1
Hydrologic Parameters

Subbasin	Area (acres)	Time of Concentration (minutes)	Curve Number
482460	51.23	95	82.9
482480	133.77	44	86.5
482500	26.27	47	93.6
491000	30.82	20	82.6
491010	20.56	37	88.5
491020	13.38	77	82.6
491021	2.53	7	82.8
491040	44.39	53	82.5
491041	14.02	10	89.3
491042	3.19	9	89.0
491060	46.58	67	84.4
491080	54.18	75	86.4
491100	122.03	47	87.6
491102	25.25	30	82.2
491120	105.92	48	86.9
491123	20.09	149	82.2

Subbasin	Area (acres)	Time of Concentration (minutes)	Curve Number
491240	110.44	64	84.2
491260	34.51	42	86.9
491280	225.30	56	89.4
491300	164.99	66	88.8
491302	24.06	45	84.2
491340	138.68	45	87.6
491342	39.05	74	84.5
491344	48.91	62	79.5
491360	19.61	79	83.8
491380	100.80	80	84.6
491382	21.84	73	83.9
491384	57.26	87	83.7
491480	29.92	58	79.3
487000	137.90	54	91.7
490030	86.32	60	88.6
490050	153.00	57	87.2

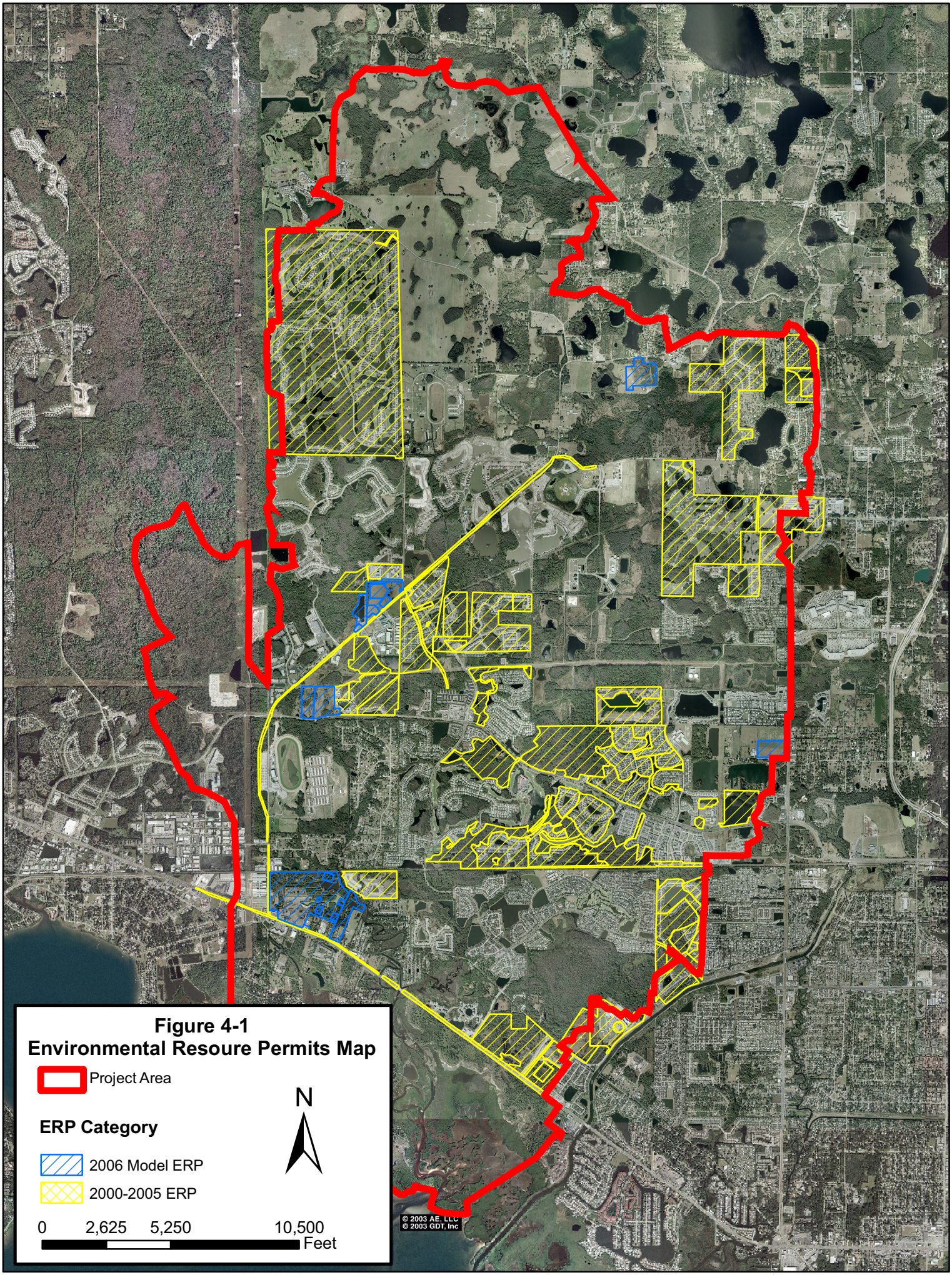
Figure 4-1
Environmental Resoure Permits Map
Project Area
ERP Category
2006 Model ERP
2000-2005 ERP
N
0
2,625
5,250
10,500
Feet
© 2003 AE, LLC
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Table 4-2
Environmental Resource Permits (ERPs)
Included in the H&H Model Update

ERP Number	ERP Name	ERP Issue Date
274	Northern Groves Subdivision	9/9/2003
2996	WestChase Subdivision	11/7/2000
3855	Arbor Lakes Phase 4	4/7/2000
5997	Meadow Brook Subdivision	11/7/2002
17406	Fawn Lake Phase 5	10/18/2000
18211	Tuscany Bay Apartments	3/17/2000
20581	Noell Purcell Site	4/10/2001
20815	Ashton Gardens	12/1/2000
23028	Tree Tops	4/1/2000
23549	River Chase	12/13/2002
25239	Bayport Colony	1/27/2004

4.3.3 Land Use

As described in Section 2, the District GIS Land Use layer (2004) was used to represent existing conditions land use. Each land use polygon in the GIS layer is associated with an attribute that designates a classification from the FLUCCS. **Figure 2-3 and Table 2-2,** which are included in Chapter 2, show the watershed landuse distribution used in this analysis.

4.3.4 Runoff Curve Numbers

The curve number (CN) is an index that represents the combined hydrologic effect of soil, land use, hydrologic condition, and antecedent soil moisture. The CN method requires land use and soil information (specifically HSG) for each subbasin. A runoff CN is assigned to each land use and soils combination. A single CN is computed for each subbasin by taking an area-weighted average of CNs for all land use and soil combinations comprising the subbasin.

SCS runoff curve number calculations were based on the GIS intersection of the SWFWMD soil layer, the updated land use/land cover layer and subbasin layer for the watershed. The resulting polygons have attributes of HSG, FLUCCS code and subbasin number. A runoff curve number lookup table provided by Hillsborough County containing the land use FLUCCS code and soils information (HSG) was used to assign a runoff curve number to each GIS land use/soil polygon in the watershed. **Table 4-3** is the database lookup table. **Table 4-1** also shows the CN associated with each subbasin.

4.3.5 Time-of-Concentration

The extensive subbasin delineation updates required a recalculation of all time-of-concentration estimates. The method used for calculating travel times is based on that described in the

Table 4-3
Curve Number Look-Up Table

FLUCCS Code	Land Use Description	Hydrologic Soil Group (HSG)					
		A	B	C	D	B/D	W
1100	RESIDENTIAL LOW DENSITY <2 DWELLING UNITS	50	68	79	84	81.5	100
1200	RESIDENTIAL MED DENSITY 2->5 DWELLING UNIT	57	72	81	86	83.5	100
1300	RESIDENTIAL HIGH DENSITY	77	85	90	92	91	100
1400	COMMERCIAL AND SERVICES	89	92	94	95	94.5	100
1700	INSTITUTIONAL	69	81	87	90	88.5	100
1800	RECREATIONAL	49	69	79	84	81.5	100
1820	GOLF COURSE	49	69	79	84	81.5	100
1900	OPEN LAND	39	61	74	80	77	100
2100	CROPLAND AND PASTURELAND	49	69	79	84	81.5	100
2140	ROW CROPS	49	69	79	84	81.5	100
2200	TREE CROPS	44	65	77	82	79.5	100
2400	NURSERIES AND VINEYARDS	57	73	82	86	84	100
2500	SPECIALTY FARMS	59	74	82	86	84	100
2550	TROPICAL FISH FARMS	59	74	82	86	84	100
2600	OTHER OPEN LANDS (RURAL)	30	58	71	78	74.5	100
3100	HERBACEOUS	63	71	81	89	85	100
3200	SHRUB AND BRUSHLAND	35	56	70	77	73.5	100
3300	MIXED RANGELAND	49	69	79	84	81.5	100
4100	UPLAND CONIFEROUS FOREST	45	66	77	83	80	100
4110	PINE FLATWOODS	57	73	82	86	84	100
4120	LONGLEAF PINE - XERIC OAK	43	65	76	82	79	100
4340	HARDWOOD CONIFER MIXED	36	60	73	79	76	100
4400	TREE PLANTATIONS	36	60	73	79	76	100
5200	LAKES	100	100	100	100	100	100
5300	RESERVOIRS	100	100	100	100	100	100
5400	BAYS AND ESTUARIES	100	100	100	100	100	100
6110	BAY SWAMPS	98	98	98	98	98	98
6120	MANGROVE SWAMPS	98	98	98	98	98	98
6150	STREAM AND LAKE SWAMPS (BOTTOMLAND)	98	98	98	98	98	98
6200	WETLAND CONIFEROUS FORESTS	98	98	98	98	98	98
6210	CYPRESS	98	98	98	98	98	98
6300	WETLAND FORESTS MIXED	98	98	98	98	98	98
6400	VEGETATED NON-FORESTED WETLANDS	98	98	98	98	98	98
6410	FRESHWATER MARSHES	98	98	98	98	98	98
6420	SALTWATER MARSHES	98	98	98	98	98	98
6430	WET PRAIRIES	98	98	98	98	98	98
6440	EMERGENT AQUATIC VEGETATION	98	98	98	98	98	98
6500	NON - VEGETATED	98	98	98	98	98	98
6510	TIDAL FLATS / SUBMERGED SHALLOW PLATFORM	98	98	98	98	98	98
6520	SHORELINES	98	98	98	98	98	98
6530	INTERMITTENT PONDS	98	98	98	98	98	98
7100	BEACHES OTHER THAN SWIMMING BEACHES	77	86	91	94	92.5	100
7400	DISTURBED LAND	77	86	91	94	92.5	100
8100	TRANSPORTATION	81	88	91	93	92	100
8200	COMMUNICATIONS	81	88	91	93	92	100
8300	UTILITIES	81	88	91	93	92	100

Hillsborough County Stormwater Technical Manual, and are summarized below. Calculations were made by adding the travel time for segments of appropriate flow paths. **Table 4-1** shows the time of concentration calculated for each subbasin.

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

4.4 Hydraulics

The HC-SWMM EXTRAN block was used to simulate the hydraulic conditions within the watershed. A large portion of the original model input data were updated as part of this project due to the extensive changes and land uses. These updates, as described in more detail below, include connectivity updates, datum conversion, storage representation, boundary condition, overflow weirs, roughness coefficients, and model numerical instabilities.

4.4.1 Connectivity Updates

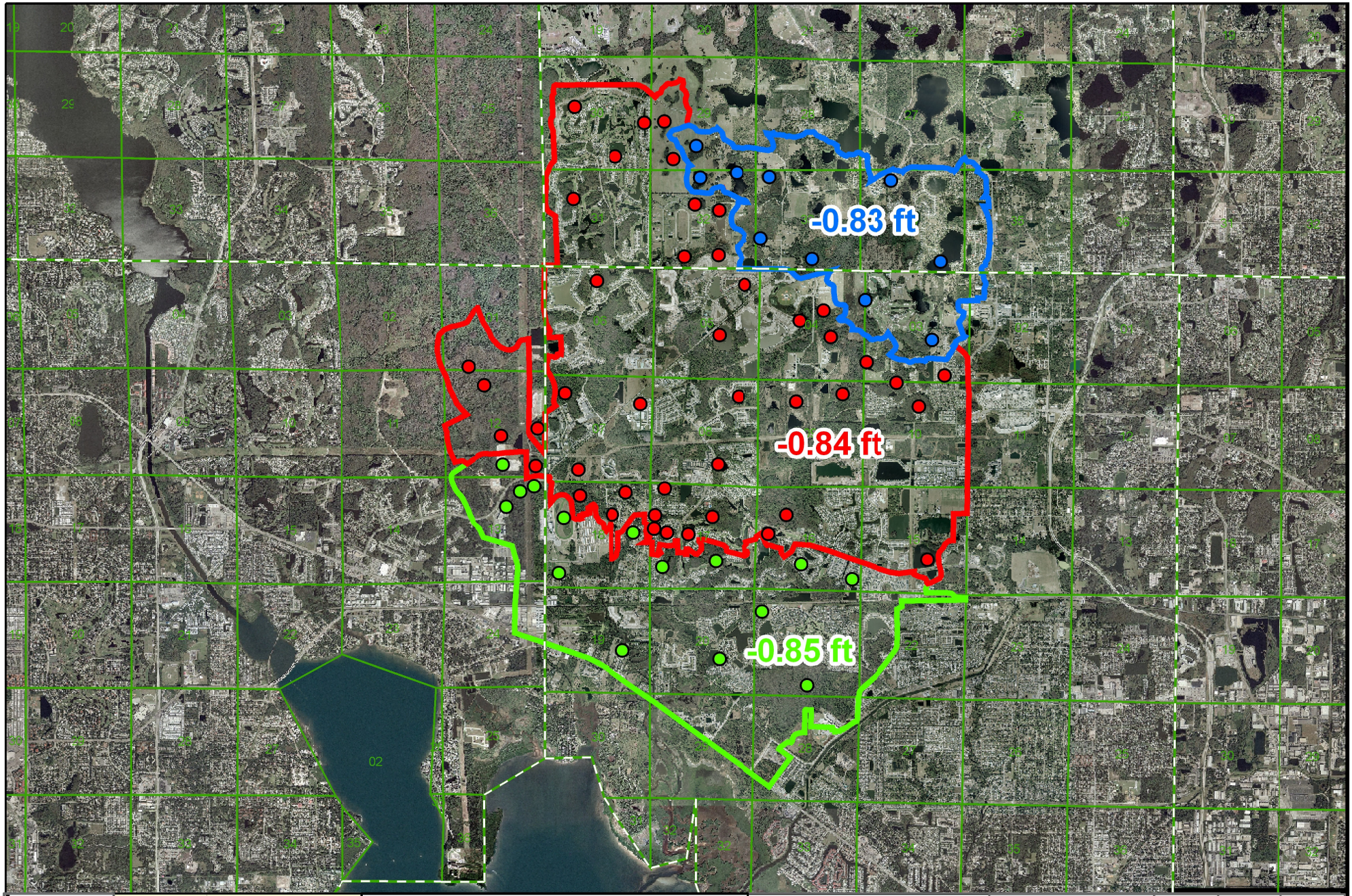
The original model connectivity was obtained and then updated with information available from previous studies, new ERPs, construction drawings, and digital topography. In addition, field reconnaissance was conducted to better assess the hydraulic connectivity and accuracy of the existing model input data. The ERPs used in the model update are listed above in **Table 4-2**. The updated existing conditions link-node diagram is included as **Figure 2** in **Appendix A**.

4.4.2 Datum Conversion

As part of the DBA watershed update, the model hydraulics were converted from NGVD29 to NAVD88 in order to meet new Hillsborough County criteria. The conversion factors were determined using the Army Corps of Engineer's Corpscon program. As seen in **Figure 4-2**, a conversion factor of -0.83 feet was used for the northern portion of the watershed, -0.84 feet was used for the central portion of the watershed, and -0.85 feet was utilized for the southern portion of the watershed.

4.4.3 Storage Representation

Lake, pond and wetland storage are represented in the hydraulic model by stage/area relationships assigned to model junctions. This relationship was developed utilizing one of two methods. When available, the stage/area relationships were obtained from ERPs and/or construction plans. Otherwise, the relationship was developed using GIS methods based on the triangulated irregular network (TIN) created from the digital topographic data provided by Hillsborough County. A GIS tool developed for this application uses the TIN to compute area-volume ratios at one-foot intervals for each node and subbasin in the model.



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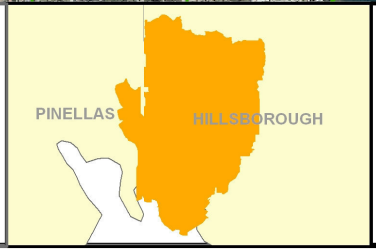
5300 W. Cypress St.
Ste. 200
Tampa, FL 33607



Legend

Township/Range

Section, Township, Range
-0.85
-0.84
-0.83

-0.85
-0.84
-0.83

Hillsborough County Florida

0 1,900 3,800 7,600 Feet

0 0.5 1 Miles

Figure 4-2: Datum Conversion Map

Project: 100716.06

Watershed: Double Branch

Watershed Masterplan Update

Filename:	Map Date:	Map Prepared By:
Map7.mxd	Dec. 2006	PBS&J

Date of Photography: 2004

4.4.4 Boundary Conditions

As described in Chapter 1, the DBA watershed contains three outfalls that drain the watershed south under Hillsborough Avenue and into the Double Branch Bay portion of the Tampa Bay. These outfalls represent downstream boundary conditions and were set at 1.65 ft NAVD (2.5 ft NGVD), which represents NOAA's minimum overflow elevation in Tampa Bay. That assumption is consistent with Hillsborough County recommendations for management planning of riverine conditions. It is also consistent with the District's regulatory requirements per ERP training memorandum TM/ERP – 961017.b1. The boundary elevation is considered to be the best way to set peak tailwater elevations coincident with peak watershed discharges.

The DBA computer model also considered an upstream hydraulic boundary. Field reconnaissance performed by Hillsborough County staff showed that a portion of the flows from the Brooker Creek watershed are conveyed south into the DBA watershed via a channel located west of Patterson Road. To account for this flow into the DBA watershed, an approximately 2.8 square mile portion of the Brooker Creek watershed was added to the Double Branch hydraulic/hydrologic computer model.

Figure 4-3 shows the location of the watershed model boundaries as well as the portion of the Brooker Creek watershed included in the DBA model update.

4.4.5 Overflow Weirs

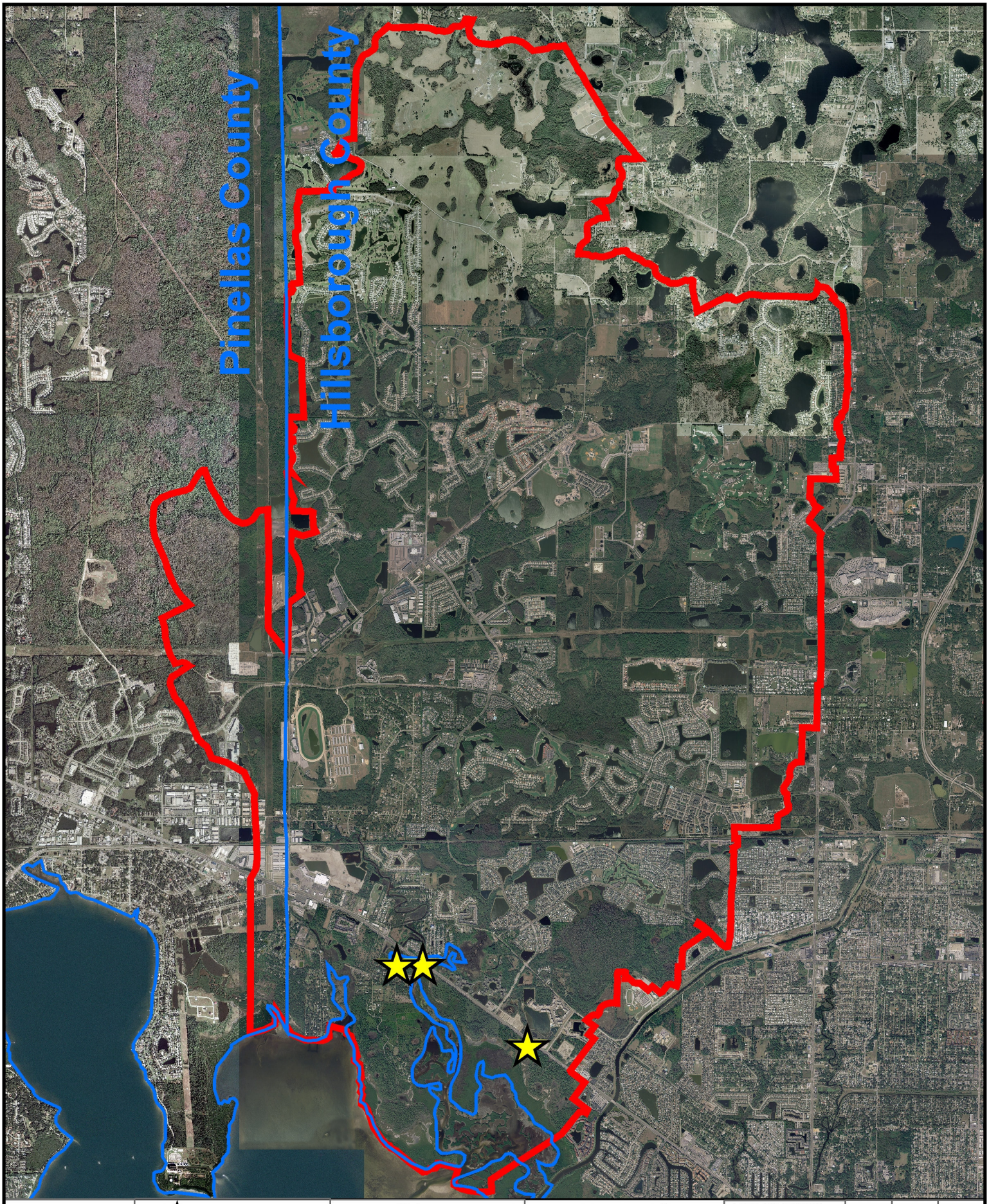
Broad crested weirs were used to represent road overtopping and overland flow connections. Weir elevations and geometry were obtained from ERPs, construction plans, and digital topographic data. The value of the weir flow coefficients to be used for modeling purposes was provided by Hillsborough County. **Table 4-4** lists the value of the flow coefficient by weir type.

Table 4-4
Weir Flow Coefficients

Weir Type	Weir Flow Coefficient
Overland Flow Weir	1.0
Road Overtopping Weir	2.0
Structural Weir	2.6 – 3.2

4.4.6 Roughness Coefficients

The Manning's roughness coefficients for the right, left, and center portion of channel sections were evaluated separately. The value of the coefficients represent common field conditions and were derived from field visits, aerial photographs, documentation provided by Hillsborough County, and general knowledge of the area.



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Boundary Node

Watershed Boundary

County Boundary

Notes:

This area is used for general map note information such as map accuracy/ standards, source information, elevation information, etc.

Hillsborough County Florida

0 2,200 4,400 Feet

Figure 4-3: Boundary Node Location Map

Project: 100716.06

Watershed: Double Branch

Watershed Masterplan Update

Filename:	Map Date:	Map Prepared By:
Outfall.mxd	Mar. 5, 2007	PBS&J

Date of Photography: 2004

4.4.7 Numerical Instability

The EXTRAN model is based on an explicit solution algorithm used to solve the St. Vennant equations that describe unsteady flow in channels. Explicit solution algorithms are subject to numerical instability caused by accumulated round-off error. It is difficult to predict the conditions that cause numerical instability; however, short conduit lengths (less than 100 feet), steep bottom slopes for conduits, and low storage at nodes are frequently associated with numerical instability. Achieving numerical stability requires numerous adjustments to the model input data. Such adjustments include the use of the stretch factor to calculate equivalent pipes with longer lengths and lower roughness than the actual pipe dimensions, and the addition of storage at the junctions. An important part of the model update process consisted of manipulating the model to eliminate numerical instabilities. The continuity error achieved for the simulations is approximately 0.5 percent, which is excellent.

5.0 Computer Model Calibration

5.1 Boundary Conditions

This chapter describes the calibration procedure and data used for the DBA existing conditions model. The goal of the calibration effort was to develop a hydraulic model that reflects observed conditions in the watershed and that can be used to predict system performance under design storm events and future watershed scenarios. Once calibrated, the model can be used to determine the benefits and impacts of proposed watershed improvements.

5.2 Boundary Conditions

As described in Chapter 4 (Methodology) of this report, the Double Branch watershed includes three downstream boundaries. Each of these boundaries represents the system conditions at the Double Branch Bay discharge, south of Hillsborough Avenue. The modeled tailwater condition at each of these locations was set at 1.65 ft NAVD (2.5 ft NGVD), which represents National Oceanic and Atmospheric Administration (NOAA) minimum overflow elevation in Tampa Bay.

5.3 Existing Conditions Hydraulic Model Calibration Process

After the hydrologic and hydraulic model input checks were completed, the calibration process was conducted to compare model predicted results with known hydrologic observations and/or measurements within the watershed. The storm event used for calibration was Hurricane Frances. This event was the second of a series of three hurricane events that hit the Tampa Bay area in August and September 2004. Hurricane Frances reached Hillsborough County on September 4th and lasted for approximately 48-hours. As described later in more detail, calibration data available for comparison of predicted and simulated conditions consisted of only stage versus time measurements at an existing USGS station.

5.3.1 Rainfall Data

Rainfall data for model calibration was obtained from the District's OneRain dataset. The OneRain dataset contains 15-minute Doppler rainfall measured between 1995 and 2005. From this data, rainfall volumes as well as distributions can be determined for various rainfall events, including the 2004 hurricane season events.

The Double Branch watershed was subdivided into seven rainfall zones, as shown on **Figure 5-1**. These rainfall zones were delineated based on OneRain rainfall data cells that had similar rainfall volumes and distributions during the calibration event. The cells within each rainfall area were averaged to determine the volume and distribution to be used during the calibration process. The rainfall volume used for each rainfall area is shown in **Table 5-1**. As shown, the difference in total rainfall between the areas receiving the largest and smallest rainfall volumes is approximately 0.48-inches.

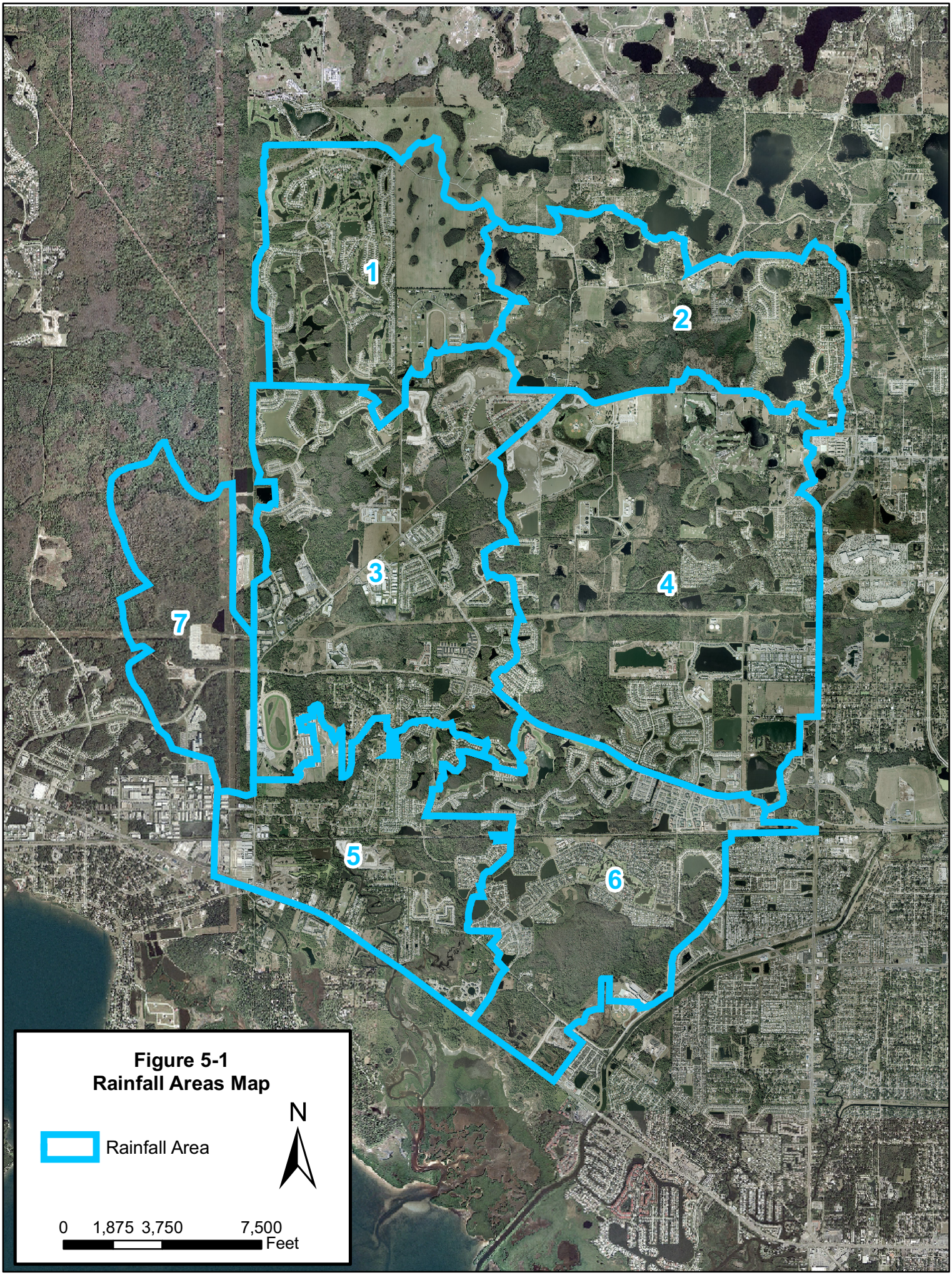

1
2
3
4
5
6
7
Figure 5-1
Rainfall Areas Map
Rainfall Area
N
0 1,875 3,750 7,500
Feet

Table 5-1
Hurricane Frances Recorded Rainfall Volumes

Rainfall Area	Rainfall Volume (inches)*
1	6.10
2	6.46
3	6.13
4	6.20
5	6.12
6	6.18
7	5.98

*Rainfall volumes based on OneRain data, September 4-8, 2004

5.3.2 Adjustment of Model Input Parameters

The objective of this task was to simulate the recorded event and to compare computed water surface elevations to measured values. The hydrologic and hydraulic model was then adjusted so that computed and measured values would more closely match. Calibration parameters included roughness coefficients and overland flow roughness values. The values of these parameters were adjusted based on interpretation of photographs, field observations, and a general knowledge of the area. Documentation was included in the project's geodatabase.

A model parameter that is of main importance for H&H model simulations, particularly for model calibration purposes, is the establishment of initial water surface elevations at the model junctions. Minimal measured data is available throughout the project area. However, a factor that was considered during the model verification process was that storage capacity in the watershed prior to Hurricane Frances was limited because of the antecedent wet conditions created by Hurricane Charley, which passed through the area three week prior. Starting water elevations in the model were determined using three methods, as described below:

- At the location where measured gage data was available, the water surface elevation prior to Hurricane Frances was selected as the initial surface elevation.

- For subbasins hydraulically linked to the rest of the system, the control elevation (pipe invert, orifice elevation, weir elevations, etc.) was used as the initial starting water elevation.

- For storage areas with an undefined hydraulic control structure, the seasonal high water elevation as estimated from the 2004 aerials and one-foot contour data was used as the starting water elevation.

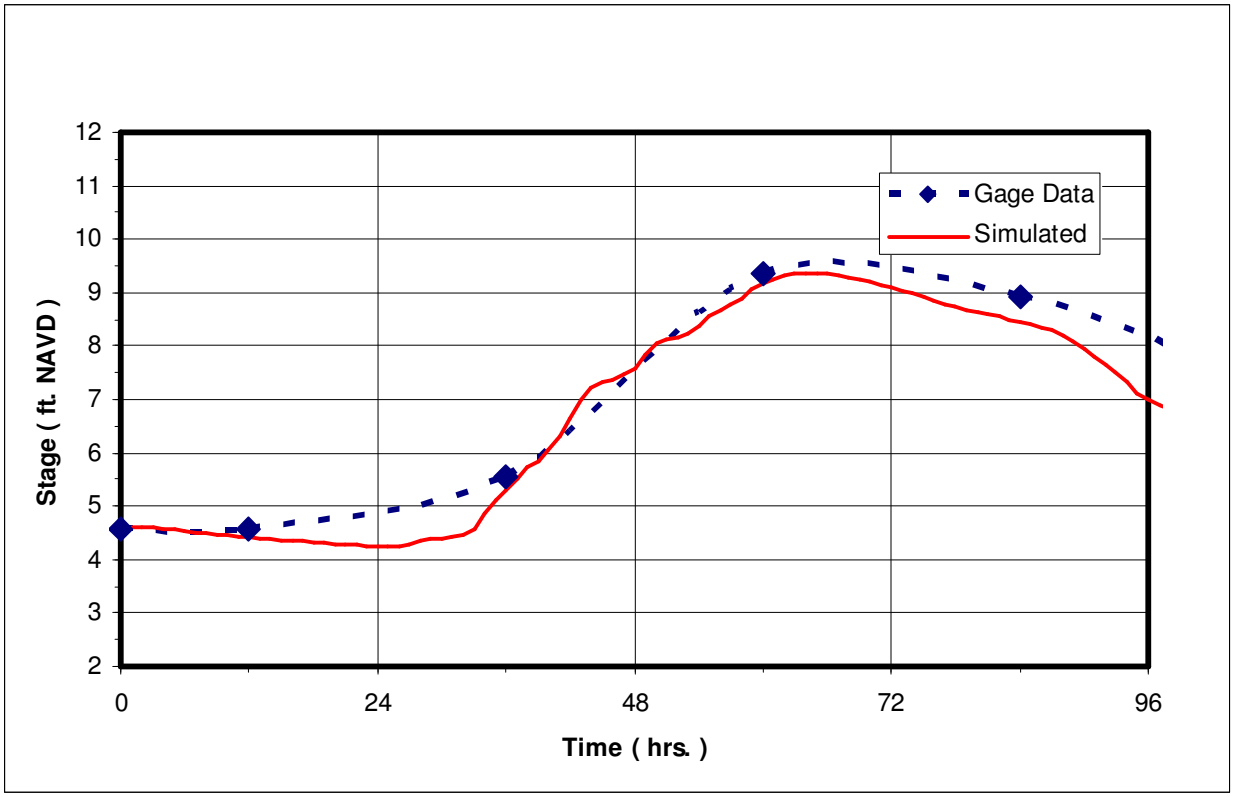
5.3.3 Gage Data

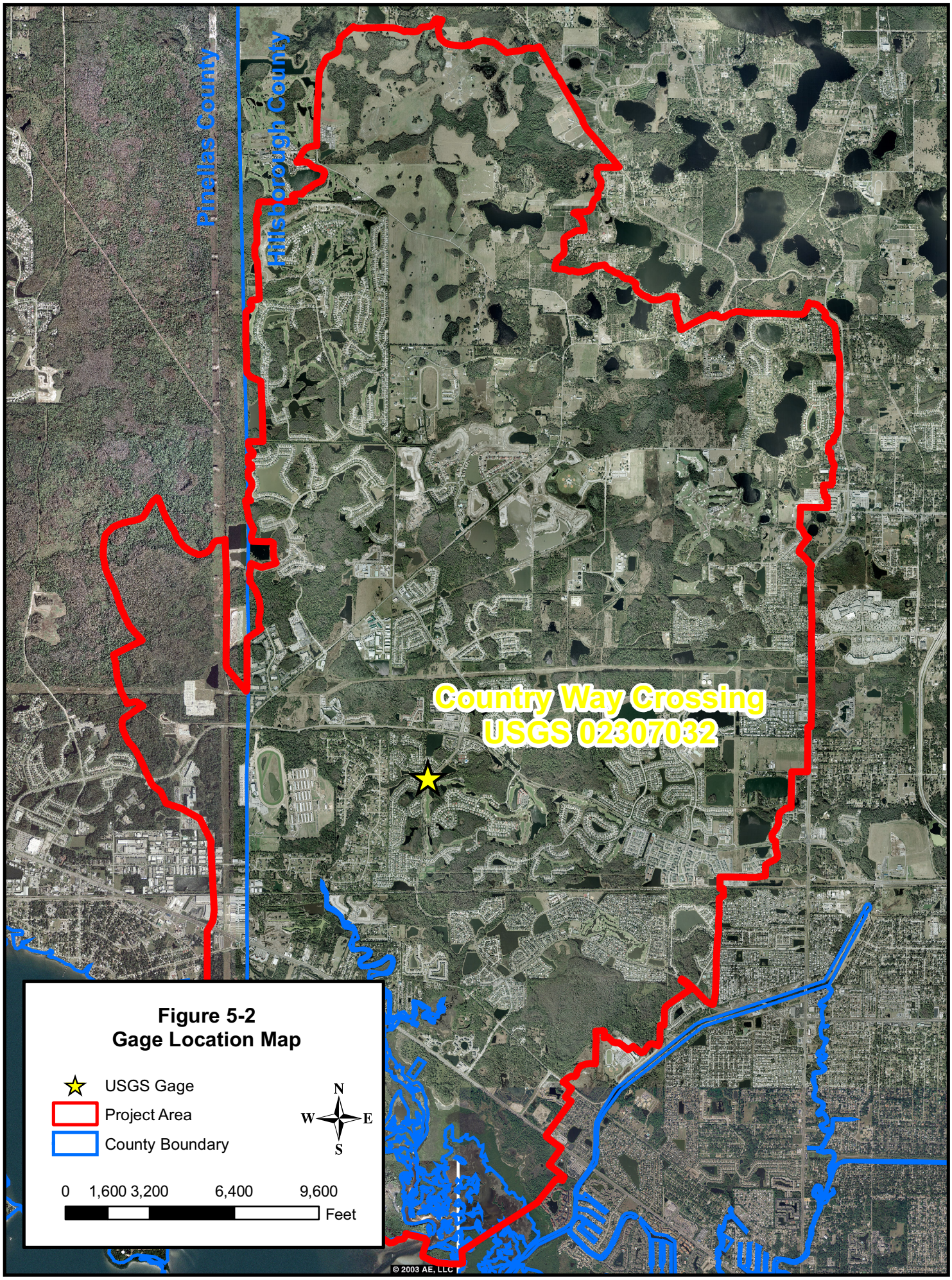
To be useful for calibration purposes, rainfall data and stream stage records must be available for the same time period. As previously described, a limited amount of H&H model calibration data was available for this project. In addition to rainfall data that was obtained from the District's OneRain data, available water stage data was obtained from the United States Geological Society (USGS) for Gage No. 02307032. The gage is a real time water stage recorder that is located at the Country Way Crossing of Double Branch Creek and was installed in May of 2001. **Figure 5-2** shows the location of the USGS gage. Data was available for the calibration event.

5.3.4 Calibration Results

Results of the calibration process are shown on **Figure 5-3**. As shown, the predicted model peak stages at Country Way Crossing provide a good match to the recorded gage stages throughout the Hurricane Frances storm event in both magnitude and timing.

Figure 5-3
Hurricane Frances Calibration Results
County Way Crossing Gage (USGS 02307032)




Pinellas County
Hillsborough County
Country Way Crossing
USGS 02307032
Figure 5-2
Gage Location Map
USGS Gage
Project Area
County Boundary
N
W
E
S
0 1,600 3,200 6,400 9,600
Feet
© 2003 AE, LLC

5.4 Recommendations for Additional Calibration

Although the predicted model results are considered valid for further analysis, additional model calibration data would be desirable to further validate model predictions, particularly in the areas subject to flooding in the mid-section of the Memorial Channel system. A stream gage could be installed at the railroad crossing located north of Linebaugh Avenue and east of Race Track Road to check model prediction along the eastern portion of the watershed.

6.0 Existing Conditions Level of Service Analysis

6.1 Introduction

The existing conditions model was used to predict water surface elevations under the design storm events listed below. While the level-of-service criteria are defined for the 25-year/24-hour storm event, other permitting requirements require the 100-year/24-hour and 2.33-year/24-hour storm event results as well. The remaining storm events were run to meet Hillsborough County criteria as well as the District's G&S. The characteristics of the design storm events, both in terms of rainfall volume and rainfall distribution were as specified by the District regulatory requirements.

Design Storm Event	Accumulated Rainfall Volume (inches)
100-year/5-day	17.00
100-year/24-hour	11.50
50-year/24-hour	10.50
25-year/24-hour	8.00
10-year/24-hour	7.00
5-year/24-hour	5.50
2.33-year/24-hour	4.50

Minor model stability adjustments were conducted once the preliminary simulation results were completed. Peak simulated water surface elevations for existing conditions throughout the watershed are shown in **Table 1 in Appendix B**. Model results are also included in the geo-databases attribute tables developed for this project.

6.2 Level of Service Criteria

The Hillsborough County Comprehensive Plan Stormwater Management Element contains definitions for flood protection levels of service (FPLOS) designations. According to the Comprehensive Plan, a storm return period and storm duration are used to define the FPLOS using a letter designation (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.

The level of service ratings A through D were assigned to the basins based on flood depth criteria and road access conditions. Those criteria are listed in **Table 6-1**.

Table 6-1
Level of Service Criteria

Level of Service Category	Level of Service Definition*
A	No significant street flooding. All lanes are drivable.
B	Minor street flooding. At least one lane is drivable.
C	Street Flooding. Flooding depth above the crown of the road is less than one foot.
D	No limitation on flooding.

*The term drivable was defined as less than or equal to three (3) inches of water above the crown of the road.

6.3 Model Predicted Problem Areas

Using the existing conditions predicted model results for the 25-year/24-hour storm event, FPLOS were developed throughout the Double Branch Watershed by comparing predicted peak model stages to road overtopping elevations. The results of the level of service analysis by computer model node are found in **Table 2 in Appendix B**. The analysis revealed that violations of the FPLOS occur at the Nine Eagles Subdivision that is located in the northwest corner of the DBA watershed. The FPLOS issues at that location are described below.

A reality check of the FPLOS analysis results was also conducted by comparing the project findings to flooding complaint records, per the County files. The FPLOS analysis matched the complaint records. In addition to the Nine Eagles subdivision, those records indicated only few localized problems in the secondary drainage system (e.g. undersized driveway culverts, small depressional areas, etc.) that are not of watershed management planning concern.

6.4 Nine Eagles Subdivision

Drainage from the Brooker Creek watershed flows south from Patterson Road through a channel that runs along the west side of the Nine Eagles Subdivision. A review of County complaint records indicated that flooding occurs at the Patterson Road Brooker Creek crossing and the portion of the Nine Eagles Subdivision adjacent to, and downstream from, Patterson Road.

Extensive field reconnaissance throughout this area conducted by County personnel and PBS&J staff indicated that the causes of the flooding problems were the lack of maintenance along the channel downstream from Patterson Road and the presence of an undersized culvert located in the Double Branch watershed, approximately 5700-feet downstream from Patterson Road, on a private property along the west side of the Nine Eagles Subdivision.

The channel that flows west and then south downstream from Patterson Road is overgrown with tall grass and other vegetation. This overgrowth impedes flow and causes a back-up of water at Patterson Road. The picture below shows the location of the flooding problem area.

Looking east at the downstream side of the culverts under Patterson Road from the west side of the street.

The undersized culvert is a single 30-inch RCP located under an access road to a borrow pit that is located along the County line. Investigations conducted by the County indicated that this structure was probably constructed as a temporary facility, as necessary construction permits were not obtained. The inverts of this culvert are at approximately 17.5-ft NAVD, whereas the channel inverts at this location are approximately 13.5-ft NAVD. Both the small pipe and high pipe inverts are restricting flow and creating water back-up in the Nine Eagles Subdivision.

The existing conditions computer modeling results supports the field findings. Those results indicate a peak water stage of 22.62-ft NAVD, which represents 7.5 inches of road flooding depth (LOS C) in this area during the 25-year/24-hour design storm event. The flooding would extend along a 2,100-ft length of road extending from the bend in Patterson Road south to the entrance of the Nine Eagles Subdivision. Flooding in this area is predicted even for smaller rainfall events, with about 0.5 inches of road flooding depth expected during the 5-year/24-hour storm event.

6.5 Floodplain Delineation

The floodplain for the Double Branch Watershed was updated using the modeled peak stages from the 100-year/24-hour design storm event. **Figure 3 in Exhibit A** contains the Floodplain Delineation Map. This map shows the original as well as the updated floodplain delineations.

The 100-year/5-day storm event was also run for comparison against the 100-year/24-hour modeled peak stages. Predicted peak stages are included in **Table 1 in Appendix B**. **Figure 6-1** shows the hyetographs for the two storm events.

Figure 6-1
100-Year Design Storm Event Rainfall Hyetographs

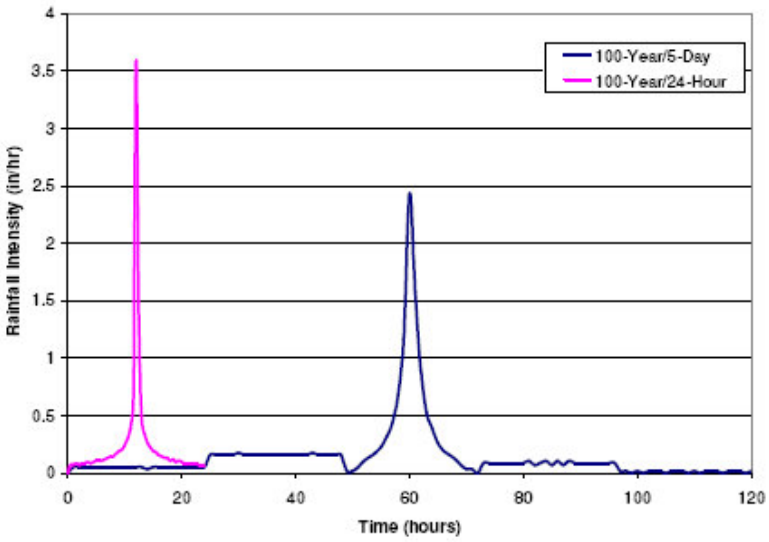
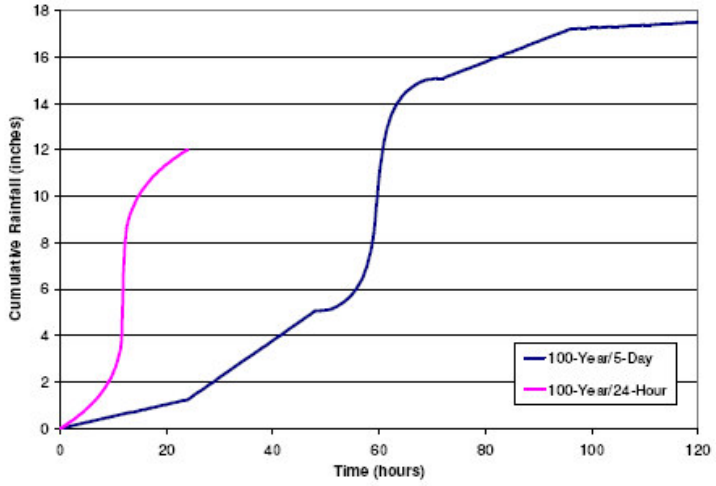


Figure 6-2 indicates the storms' cumulative volume over the duration period. As shown, the 100-year/24-hour storm accumulates less volume than the 100-year/5-day storm, but the intensity (measured in inches/hour) is larger. Therefore, critical conditions could result from any of the two storm events depending on the time of concentration and whether a subbasin is peak or volume sensitive.

Figure 6-2
100-Year Design Storm Event Cumulative Rainfall Totals



The average peak stage difference between the two storm events (100-year/5-day - 100-year/24-hour) was approximately 0.21-feet and ranged between -0.92 and 1.69 feet. Results showed that the larger peak stage differences occur in volume-sensitive subbasins located primarily in the northeast portion of the watershed that comprise relatively large drainage areas compared to the storage volume available. It is considered that the results of the 100-year/24-hour storm are more realistic and adequate for defining the regulatory floodplain because, as discussed previously, the 100-year/24-hour event matches historical peak stages in the Brooker Creek watershed, which is located immediately to the north of Double Branch, whereas the 100-year/5-day simulations far exceeds those historical stages.

In addition, the 100-year/5-day storm simulations are affected by the lack of the computer model capabilities to take into account the water volume losses due to leakage to the Floridan aquifer. According to the US Geological Survey (Simulated Effects of Ground-Water Augmentation on the Hydrology of Round and Halfmoon Lakes in Northwestern Hillsborough County, Florida, 2004), lakes in this area experience up to 1.1-inches of volume losses per day to the aquifer. This number translates to approximately 6-inches over the 5-day storm event, which is larger than the average difference between the 100-year/24-hour and 100-year/5-day storm events.

A key factor to assess if the use of the 100-year/5-day storm event as the basis for establishing the extent of the regulatory floodplain would be advantageous is to determine if the higher peak flow stages would provide additional protection to local residents during flood events. For that purpose, those locations with differences between the two storm events of greater than one-foot were investigated in more detail. It was found that at the higher water stages would not impact the floodplain delineation to include roads and/or homes in the area. The regulatory floodplain limits would be kept within the lakes and surrounding wetlands.

13.0 Analysis of Alternatives

13.1 Introduction

This chapter describes the alternatives that were identified as part of this study to help meet the flood protection levels of service (FPLOS) criteria in the problem area at the Nine Eagles subdivision. As described in Chapter 6, the Patterson Road crossing at this location would experience 7.5 inches of road flooding depth during the 25-year/24-hour design storm event. The flooding would extend along a 2,100-ft length of road extending from the bend in Patterson Road south to the entrance of the Nine Eagles Subdivision. Flooding in this area is predicted even for smaller rainfall events, with about 0.5 inches of road flooding depth expected during the 5-year/24-hour storm event.

The causes of the flooding problems were the lack of maintenance along the channel downstream from Patterson Road and the presence of an undersized culvert located in the Double Branch watershed, approximately 5,700-feet downstream from Patterson Road, along the west side of the Nine Eagles Subdivision. Per the County standards, the FPLOS for Patterson Road is defined as "minor street flooding, with one lane drivable during the 25-year/24-hour storm event."

13.2 Alternatives

Hillsborough County has already addressed the maintenance issues in the area downstream of Patterson Road. Three alternatives were identified as part of this project to address the problem of the undersized structure. They are described in **Table 13-1**, along with issues that characterize the alternatives in terms of improved flood stages, regulatory permitting, economical feasibility, and public acceptance. These issues were used as evaluation criteria for selecting the recommended alternative, which is discussed in the updated Chapter 15 of this report.

Table 13-1
Proposed Alternatives to Address the Flooding Problem
Nine Eagles Subdivision / Patterson Road

Alternative	Description	Characteristics / Issues
1	Replace the existing 30-inch RCP culvert with a larger structure that would allow meeting FPLOS along Patterson Road.	• Flood stages downstream would increase from existing conditions, but they would be below historical conditions. It is assumed that historical conditions would be accepted by regulators to represent the baseline for project impact analysis because the culvert structure was not permitted as a permanent facility. • Increases in flood conditions downstream would not negatively impact existing development. • Feasible and economical. • Access to the borrow pit would be maintained, thus avoiding issues with the property owner.
2	Remove the existing 30-inch RCP culvert and restore the natural channel to eliminate the flow constriction and reduce flood water elevations.	• Best option to restore the system to historical conditions. However, regulators may consider that baseline is represented by existing conditions. In that case, increases in flood stages downstream would be a regulatory issue. • The increases in flood conditions downstream would not negatively impact existing development. • The most economical alternative in terms of implementation costs for the County. • Access to the borrow pit would be eliminated. This may not be acceptable to the property owner and could result in creating controversy that would cause project implementation delays.
3	Create additional storage upstream of the undersized structure to reduce flood levels and meet the FPLOS along Patterson Road.	• The storage facility could be designed to maintain existing flood stages upstream and downstream. Therefore, permitting issues due to project impacts would be eliminated. • Project permitting would require mitigation due to potential impact to wetland systems. It is likely that mitigation would be provided on-site. • Extremely costly. It would require land acquisition, large volumes of excavation, and construction of various water control structures. The benefit versus cost ratio would be much lower than 1. • Access to the borrow pit would be maintained, thus avoiding issues with the property owner.

15.0 Final Recommendations

15.1 Introduction

This chapter describes the recommended improvements that were identified as part of this study to help meet the flood protection levels of service (FPLOS) criteria in the problem area at the Nine Eagles subdivision. As described in Chapter 6, the Patterson Road crossing at this location would experience 7.5 inches of road flooding depth during the 25-year/24-hour design storm event. The flooding would extend along a 2,100-ft length of road extending from the bend in Patterson Road south to the entrance of the Nine Eagles Subdivision. Flooding in this area is predicted even for smaller rainfall events, with about 0.5 inches of road flooding depth expected during the 5-year/24-hour storm event.

15.2 Recommendations

Based on the issues described in **Table 13-1**, it is recommended that Alternative 1 be implemented. Alternative 3 better addresses permitting issues, but the benefit versus cost ratio would be very low and Alternative 2 may be desirable if the elimination of maintenance access to the channel and borrow pit is not an issue. However, the County has indicated that the structure is necessary to allow maintenance activities in the area.

An important factor to consider in the implementation of Alternative 1 is that additional flows would be conveyed downstream, thus increasing slightly water stages. These slight increases will not affect any existing development. For permitting purposes, the County must make the case that flood impacts downstream are compared to historical conditions (no culvert structure in the channel), as opposed to current conditions.

Figure 15-1 shows the location of the proposed structure. It would consist of a double 42-inch RCP culvert structure with an invert elevation set at 13.16 ft NAVD, which is just above the invert of the existing channel. Permitting should be feasible if the regulatory agencies consider that the existing conditions (undersize structure in place) represent the baseline for assessing flooding impacts downstream.

Modeling results showed that this project, along with maintenance of the channel downstream from Patterson Road would reduce peak flooding stages during the 25-year/24-hour storm event from 22.62-ft NAVD to 22.12-ft NAVD, thus reducing the expected flood depth from 7.5 inches to about 2 inches, which meets the County's FPLOS criteria for road access. Modeling results also predict the elimination of road flooding during the 10-year/24-hour and smaller storm events.

15.3 Cost Estimates

Table 15-1 shows a detailed construction cost estimate of the recommended project. The estimate is based on estimated quantities for culvert replacement taken from site and aerial photographs of the proposed improvements location. Construction cost unit prices were based on recent similar work


EAGLES ENTRY DR
Replace Culvert
BIRKDALE DR
COLWOOD DR
STARLING DR
NINE EAGLES DR
Figure 15-1
Recommended Project Map
Recommended Project
Project Area
N
0
100
200
400
Feet

in the Tampa area from Hillsborough County public works projects and FDOT projects from District Seven historical costs.

Based on the site photographs, the construction appears to be in "Other Surface Waters" that are wetland areas that do not require wetland impact mitigation. No costs have been included for engineering design, permitting, or wetland mitigation.

Table 15-1
Recommended Project Cost Estimate

Description	Unit	Quantity	Unit Price	Total Amount
Mobilization/Demobilization	LS	1	$12,000	$12,000
Site Layout Surveys	LS	1	$2,000	$2,000
Clearing and Grubbing/Demolition	LS	1	$8,000	$8,000
Silt Fence Staked	LF	300	$3	$900
Hay or Straw, Baled	TN	.5	$500	$250
Floating Turbidity Barrier	LF	200	$15	$3,000
Dewatering	LS	1	$25,000	$25,000
Excavation Regular, Grading	CY	350	$15	$5,250
Bedding Material (Select)	CY	40	$100	$4,000
Access Road Stabilization	SY	100	$10	$1,000
RCP (Class III) (42" CD)	LF	96	$140	$13,440
Concrete Headwall (2) 42" RCP	CY	17	$1,500	$25,500
Sodding (Bahia)	SY	550	$6	$3,300
Miscellaneous Work/Cleanup	LS	1	$4,000	$4,000
Subtotal				$107,640
Contingency (15%)				$16,100
Estimate Total				**$123,700**

17.0 Summary and Conclusions

17.1 Summary

The purpose of the Double Branch Watershed Management Plan (WMP) update was to: a) upgrade the 1998 hydrologic and hydraulic (H&H) model and b) re-evaluate previously recommended stormwater improvement projects. The project was jointly funded by Hillsborough County and the Southwest Florida Water Management District's (District) Northwest Hillsborough Basin.

Specific project objectives were to:

- Make computer model upgrades as needed to meet the requirements of the District's Watershed Management Program Guidelines and Specifications (G&S), per the comments provided in the District's model review as well as further analysis conducted as part of this project. In this manner, the model can be considered as "best available information" for County stormwater permitting as well as for the District's Environmental Resource Permit (ERP) process.
- Identify recommended improvement projects based on a re-evaluation of the flood protection levels of service (FPLOS) and an identification of needs to correct any identified deficiencies.
- Make use of the recent digital topographic data obtained by the County, including the datum conversion from the 1929 National Geodesic Vertical Datum (NGVD) to the 1988 North American Vertical Datum (NAVD).
- Be able to use the model for any potential modification of the FEMA regulatory floodplain.
- Reflect recent land use changes in the watershed. The model update considered both changes in land uses as well as modifications of drainage patterns due to new development.
- Make adjustments to the study area boundaries to conform to those of adjacent watersheds.

17.2 Conclusions

The Hillsborough County Comprehensive Plan Stormwater Management Element contains definitions for flood protection levels of service (FPLOS) designations. FPLOS are defined in terms of road access conditions based on the 25-year/24-hour storm event. The acceptable FPLOS applied in this study was Level B, which considers that problems should be limited to minor street flooding and roads should have at least one traffic lane drivable.

The computer model was used to predict water surface elevations under the design storm event conditions listed below. FPLOS conditions were then assessed by comparing predicted peak model stages to road overtopping elevations. Level-of-service criteria are defined for the 25-year/24-hour storm event.

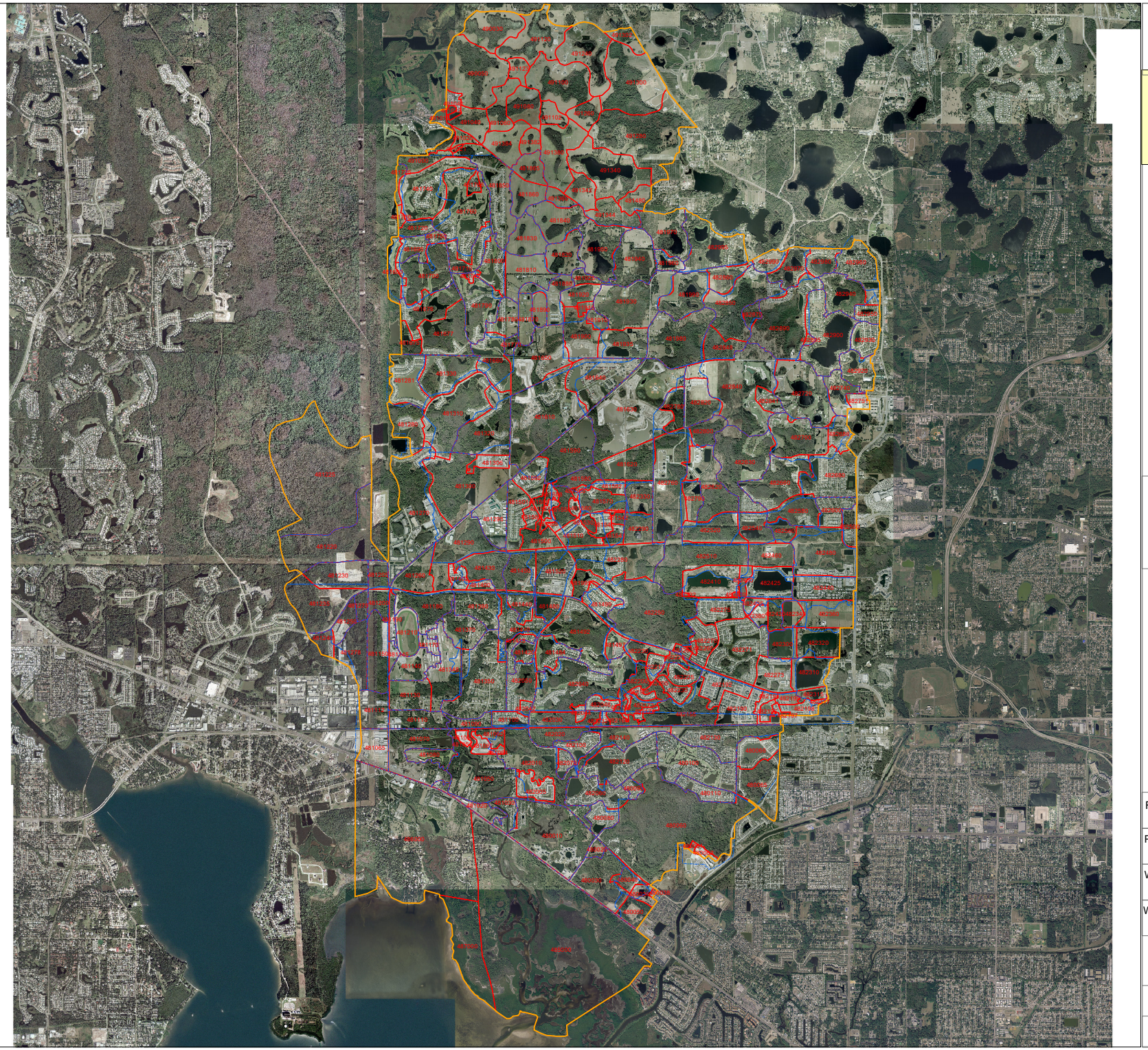
The level of service analysis revealed that violations of the FPLOS occur at the Nine Eagles Subdivision, located in the northwest corner of the DBA watershed. This result is consistent with

flooding complaint records, per the County files, which indicated that flooding occurs at the Patterson Road / Brooker Creek crossing and the portion of the Nine Eagles Subdivision adjacent to, and downstream from, Patterson Road. The problem is caused by the lack of maintenance of the channel downstream of Patterson Road, as well as an undersized, single barrel, 30-inch RCP culvert located on a ditch that runs along the west side of the Nine Eagles subdivision.

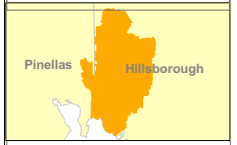
The existing conditions computer modeling results indicated an expected 7.5 inches of road flooding depth (LOS C) in this area during the 25-year/24-hour design storm event. The flooding would extend along a 2,100-ft length of road extending from the bend in Patterson Road south to the entrance of the Nine Eagles Subdivision. Flooding in this area is predicted even for smaller rainfall events, with about 0.5 inches of road flooding depth expected during the 5-year/24-hour storm event.

The computer model was also used to identify the recommended improvements to solve the FPLOS problems. It is recommended that the 400-feet of channel downstream from Patterson Road be cleaned out and maintained. In addition, the undersized culvert should be replaced with a double 42-inch RCP culvert structure with an invert elevation set at 13.16 ft NAVD. Modeling results showed that these improvements would reduce flood stages during the 25-year/24-hour storm event by 6 inches and the road would then meet the County's FPLOS access criteria. Modeling results also predict the elimination of road flooding during the 10-year/24-hour and smaller storm events. The estimated construction cost of the recommended structure is approximately $124,000.00, not including engineering design, permitting, or costs associated with wetland mitigation. Wetland mitigation costs are considered unlikely because construction appears to be in an area that can be categorized as "Other Surface Waters", which are wetland areas that do not require wetland impact mitigation.

Exhibit A



PBSJ
5300 W. Cypress Street, Ste. 200
Tampa, Florida 33607



Legend

- Watershed Boundary
- Subbasin Boundary
- Original Subbasin Boundary

Notes:

This area is used for general map note information such as map accuracy/standards, source information, elevation information, etc.

N
W E
S

1:17,285

0 1,500 3,000 6,000 Feet

0 0.45 0.9 Miles

Hillsborough County Florida

Figure 11: Watershed Subbasin Delineation Map

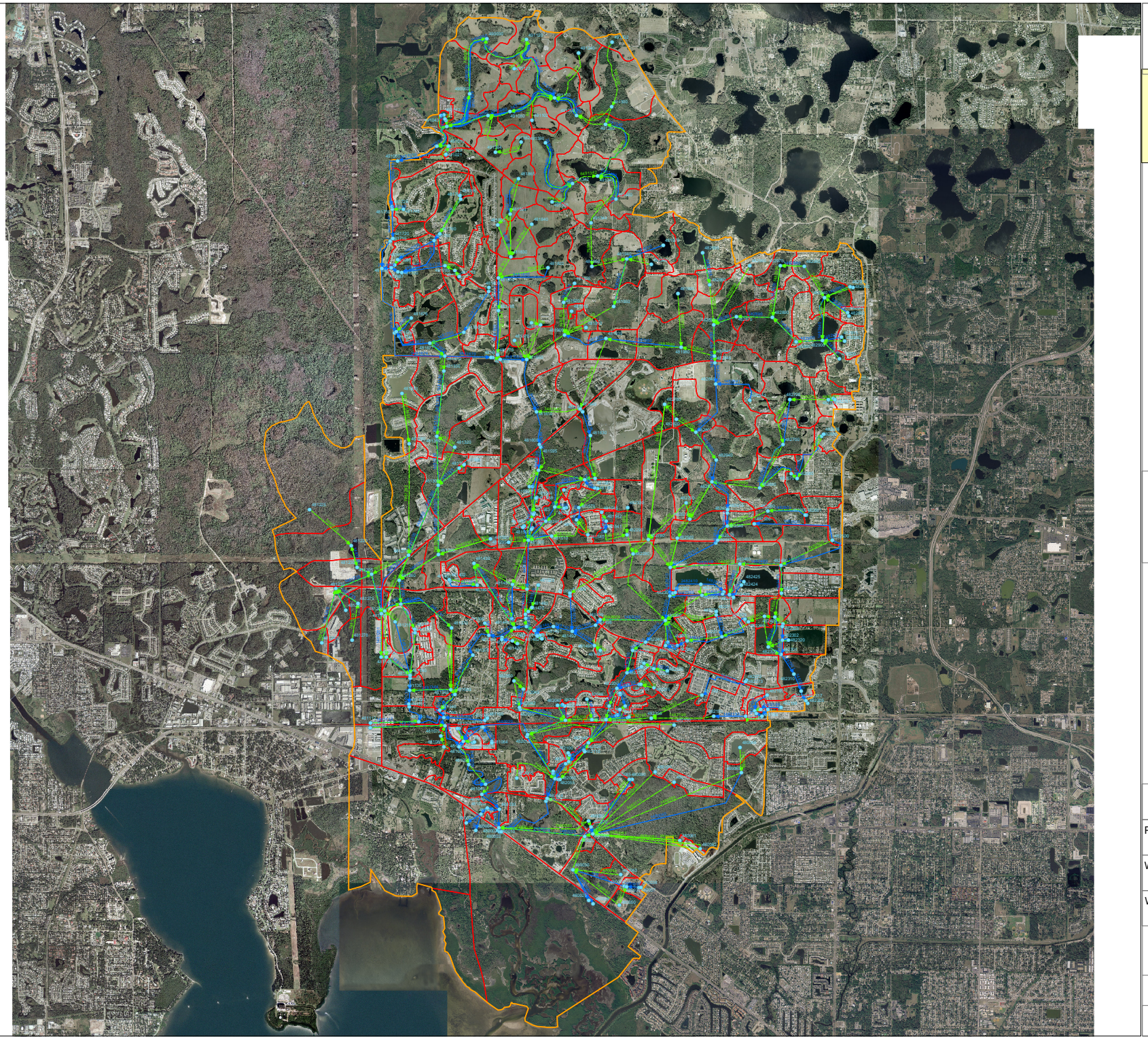
Project: 100716.06

Watershed: Double Branch

Watershed Masterplan Update

Filename:	Map Date:	Map Prepared By:
Map11.mxd	March 5, 2007	PBS&J

Date of Photography:
2004



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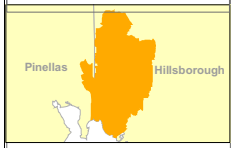
5300 W. Cypress St., Ste. 200
Tampa, FL 33607



Legend

- Junction
- Reach
- Weir
- Watershed Boundary
- Subbasin Boundary

Notes:

This area is used for general map note information such as map accuracy/standards, source information, elevation information, etc.

N
W E
S

1:17,365

0 1,500 3,000 6,000 Feet

0 0.375 0.75 Miles

Hillsborough County Florida

Figure 2: Junction/ Reach Map

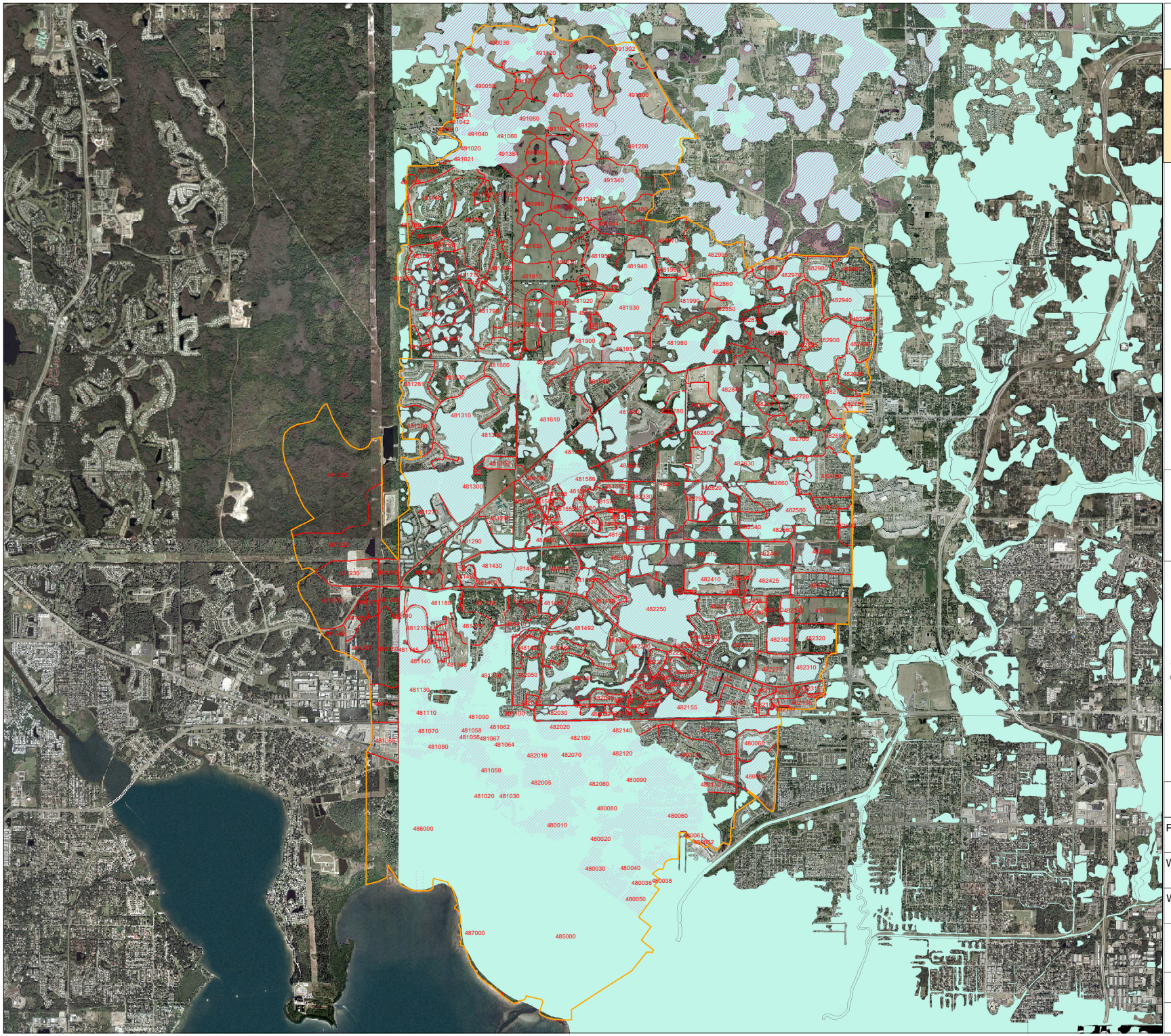
Project: 100716.06

Watershed: Double Branch

Watershed Masterplan Update

Filename:	Map Date:	Map Prepared By:
Map13.mxd	March 5, 2007	PBS&J

Date of Photography:
2004



PBSJ
5300 W. Cypress St., Ste. 200
Tampa, FL 33607

Legend

- Watershed Boundary
- Subbasin Boundaries
- Updated Floodplain
- Original Floodplain

Notes:

This area is used for general map note information such as map accuracy/standards, source information, elevation information, etc.

N
W E
S

1:17,581

0 1,500 3,000 6,000 Feet
0 0.45 0.9 Miles

Hillsborough County Florida

Figure 3: Floodplain Map

Project: 100716.06

Watershed: Double Branch

Watershed Masterplan Update

Filename:	Map Date:	Map Prepared By:
Map11.mxd	March 5, 2007	PBSJ

Date of Photography:
2004

Exhibit B

Table 1
Existing Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
480001	1.65	1.65	1.65	1.65	1.65	1.65	1.65
480002	1.65	1.65	1.65	1.65	1.65	1.65	1.65
480003	1.65	1.65	1.65	1.65	1.65	1.65	1.65
480004	1.65	1.65	1.65	1.65	1.65	1.65	1.65
480005	1.65	1.65	1.65	1.65	1.65	1.65	1.65
480010	1.85	1.97	2.16	2.29	2.66	2.83	3.13
480012	2.32	2.54	2.77	2.92	3.24	3.36	3.59
480014	2.83	3.26	3.75	4.09	4.85	5.13	5.53
480020	6.12	6.18	6.25	6.37	6.76	6.90	6.92
480025	1.65	1.65	1.65	1.65	1.65	1.65	1.65
480026	1.65	1.65	1.65	1.65	1.65	1.65	1.65
480030	4.23	4.45	4.71	4.87	5.78	6.26	6.23
480035	5.37	5.38	5.38	5.40	5.78	6.26	6.23
480036	7.14	7.18	7.22	7.25	7.31	7.33	7.28
480037	7.19	7.27	7.40	7.49	7.75	7.87	7.48
480038	8.21	8.27	8.35	8.39	8.49	8.52	8.35
480040	4.45	4.60	4.79	4.91	5.79	6.26	6.23
480050	4.66	4.92	5.28	5.51	6.05	6.25	7.18
480060	7.38	7.66	7.99	8.16	8.46	8.56	8.57
480061	9.93	9.97	10.02	10.06	10.14	10.17	9.94
480062	10.35	10.37	10.41	10.43	10.47	10.49	10.44
480065	11.62	11.84	12.13	12.33	12.80	12.98	13.37
480066	14.07	14.29	14.60	14.79	15.23	15.39	15.94
480070	6.81	6.91	7.01	7.06	7.15	7.18	7.18
480080	6.56	6.62	6.67	6.76	7.02	7.08	7.00
480085	7.38	7.66	7.99	8.16	8.46	8.56	8.57
480090	7.47	7.67	7.99	8.16	8.46	8.56	8.58
480100	8.55	8.70	8.90	9.03	9.30	9.39	9.28
480110	7.39	7.67	8.00	8.17	8.47	8.57	8.59
481010	1.92	2.06	2.30	2.45	2.86	3.05	3.38
481020	1.92	2.06	2.30	2.45	2.86	3.05	3.38
481030	1.92	2.06	2.30	2.45	2.86	3.05	3.39
481040	2.07	2.27	2.61	2.79	3.26	3.48	3.87
481045	2.16	2.37	2.73	2.93	3.41	3.64	4.03
481050	2.38	2.65	3.09	3.31	3.84	4.09	4.52
481055	2.45	2.74	3.20	3.44	3.98	4.24	4.69
481056	2.47	2.76	3.23	3.48	4.04	4.32	4.77
481057	2.47	2.76	3.23	3.48	4.04	4.32	4.77
481058	3.98	4.09	4.25	4.35	4.55	4.60	4.83
481060	2.53	2.84	3.33	3.59	4.16	4.43	4.91
481061	2.83	2.87	3.24	3.48	4.04	4.32	4.78
481062	5.54	5.64	5.79	5.89	6.11	6.20	6.45
481063	5.54	5.64	5.79	5.89	6.11	6.20	6.45
481064	5.47	5.59	5.75	5.84	6.05	6.06	6.45
481065	5.23	5.51	5.89	6.14	6.72	6.94	6.94

Table 1
Existing Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
481066	3.49	3.78	4.28	4.63	5.09	5.18	5.07
481067	4.68	4.77	4.89	4.96	5.19	5.27	5.15
481070	3.21	3.35	3.56	3.70	4.19	4.47	4.93
481080	4.56	4.70	4.91	5.04	5.29	5.35	5.60
481090	2.63	2.98	3.53	3.81	4.42	4.72	5.24
481095	5.56	5.76	6.05	6.22	6.60	6.75	6.56
481100	6.62	6.79	7.02	7.17	7.51	7.65	7.47
481110	2.69	3.05	3.61	3.89	4.50	4.80	5.34
481112	5.52	5.91	6.52	6.91	7.78	8.09	8.24
481115	2.76	3.13	3.69	3.98	4.59	4.88	5.44
481120	2.98	3.53	4.28	4.66	5.48	5.88	6.40
481130	3.10	3.65	4.40	4.78	5.59	5.98	6.53
481135	3.31	3.87	4.60	4.98	5.77	6.17	6.77
481140	3.81	4.66	5.85	6.56	7.85	8.02	8.24
481145	3.88	4.73	5.97	6.58	7.87	8.05	8.30
481150	4.24	4.77	5.99	6.63	7.88	8.07	8.32
481170	7.11	8.19	8.41	8.61	8.90	8.99	9.07
481175	8.00	8.70	8.90	9.02	9.21	9.27	9.36
481180	8.64	8.98	9.16	9.26	9.43	9.49	9.57
481190	8.75	9.03	9.20	9.27	9.43	9.49	9.76
481200	8.76	9.04	9.22	9.29	9.47	9.55	9.79
481205	8.79	9.07	9.12	9.14	9.85	9.97	10.41
481210	3.88	4.58	6.23	7.11	9.20	9.42	9.76
481220	11.26	11.43	11.68	11.83	12.12	12.22	12.55
481225	11.27	11.44	11.68	11.83	12.13	12.24	12.58
481230	11.25	11.43	11.67	11.82	12.11	12.21	12.53
481235	9.90	10.29	10.75	10.87	11.57	11.82	12.08
481240	12.12	12.20	12.30	12.37	12.51	12.56	12.43
481250	9.90	10.29	10.75	10.87	11.57	11.82	12.08
481260	9.39	10.21	10.89	11.25	11.91	12.12	12.31
481270	11.16	11.59	11.93	12.08	12.42	12.53	12.59
481275	9.83	10.17	10.60	10.88	11.60	11.84	12.18
481278	9.85	10.17	10.60	10.89	11.60	11.85	12.19
481280	16.30	16.38	16.49	16.55	16.70	16.75	16.58
481281	18.39	18.57	18.83	18.99	19.38	19.53	19.76
481290	12.57	12.81	13.10	13.25	13.58	13.68	13.73
481295	14.65	14.82	14.97	15.05	15.23	15.29	15.16
481300	14.43	14.54	14.70	14.80	15.01	15.07	15.07
481305	14.46	14.58	14.78	14.90	15.17	15.31	15.23
481306	17.06	17.28	17.58	17.82	18.45	18.63	18.34
481310	15.65	15.80	15.95	16.05	16.28	16.38	16.47
481320	15.96	15.96	15.96	16.04	16.26	16.35	16.41
481330	17.19	18.30	19.66	20.41	21.15	21.27	21.55
481340	2.68	3.04	3.62	3.92	4.58	4.89	5.42
481348	3.78	4.39	4.63	4.84	5.60	5.99	6.52

Table 1
Existing Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
481350	3.20	3.60	4.33	4.71	5.52	5.89	6.43
481370	7.68	7.89	8.02	8.12	8.46	8.58	8.61
481375	4.38	4.93	5.96	6.42	7.28	7.64	8.17
481380	4.86	5.45	6.55	7.06	8.07	8.49	9.12
481390	6.28	7.41	8.51	8.70	8.91	8.97	9.13
481400	12.74	12.93	13.18	13.33	13.68	13.80	13.70
481401	12.92	13.22	13.63	13.88	14.36	14.51	14.63
481402	12.95	13.26	13.67	13.92	14.41	14.56	14.68
481410	6.88	7.49	8.35	8.76	9.65	10.03	10.64
481414	6.98	7.58	8.46	8.87	9.65	10.03	10.64
481415	7.33	7.77	8.62	8.96	9.66	10.03	10.64
481417	7.39	7.89	8.81	9.12	9.70	10.06	10.55
481420	8.69	8.84	9.07	9.24	9.75	10.07	10.55
481430	11.30	11.74	12.17	12.43	13.07	13.25	13.55
481440	10.03	10.09	10.16	10.19	10.27	10.38	10.73
481450	11.38	11.77	12.21	12.46	13.10	13.28	13.58
481455	7.17	7.78	8.69	9.13	10.08	10.45	11.03
481460	7.24	7.91	8.97	9.65	11.16	11.46	11.85
481465	7.42	8.05	9.47	10.56	11.79	12.01	12.30
481470	7.50	8.15	9.59	10.69	11.81	12.04	12.32
481480	10.67	10.91	11.22	11.39	11.86	12.07	12.35
481481	7.17	7.78	8.70	9.14	10.10	10.47	11.05
481482	7.16	7.79	8.71	9.14	10.10	10.47	11.05
481483	7.29	7.87	8.81	9.16	10.11	10.48	11.05
481484	8.79	8.95	9.17	9.32	10.12	10.49	11.06
481490	7.88	8.28	9.22	9.76	11.10	11.51	12.28
481491	9.36	9.56	9.83	10.06	10.51	10.79	11.24
481492	9.51	9.70	9.95	10.19	10.61	10.86	11.29
481496	9.74	9.93	10.20	10.34	10.69	10.87	11.29
481497	12.23	12.39	12.61	12.75	13.08	13.19	13.02
481498	11.06	11.12	11.53	11.71	11.83	11.88	11.96
481499	11.87	12.04	13.60	14.77	15.90	16.41	17.22
481500	13.43	13.53	13.65	13.72	13.91	13.99	14.14
481501	15.88	16.07	16.32	16.48	16.85	16.99	16.90
481505	13.57	13.70	13.90	14.03	14.32	14.43	14.40
481510	16.76	17.08	17.55	17.87	18.60	18.84	19.05
481520	10.73	11.04	11.48	11.73	12.26	12.47	12.35
481530	18.38	18.47	18.60	18.69	18.88	18.95	19.11
481540	19.78	20.00	20.29	20.47	20.89	21.04	20.83
481541	19.09	19.13	19.25	19.33	19.53	19.61	19.59
481542	19.42	19.53	19.67	19.76	19.97	20.07	20.17
481545	21.88	22.18	22.57	22.63	22.82	22.93	23.20
481548	16.06	16.60	17.40	17.82	18.40	18.51	18.71
481550	17.42	17.51	17.66	17.91	18.49	18.63	18.87
481559	17.55	17.69	17.89	18.01	18.50	18.64	18.87

Table 1
Existing Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
481560	18.95	19.13	19.37	19.52	19.87	20.01	19.63
481565	19.23	19.28	19.34	19.38	19.47	19.50	19.33
481570	19.01	19.14	19.33	19.45	19.79	19.92	20.16
481580	18.87	18.98	19.12	19.19	19.41	19.53	19.78
481581	19.94	20.35	20.76	21.01	21.37	21.47	21.44
481582	20.27	20.50	20.88	21.12	21.46	21.56	21.52
481585	14.40	14.58	14.81	14.95	15.25	15.36	15.57
481586	14.49	14.78	15.26	15.58	16.37	16.69	17.40
481587	15.65	15.86	16.16	16.36	16.64	16.69	17.40
481588	15.99	16.20	16.48	16.66	17.10	17.28	17.42
481589	15.46	15.71	16.05	16.26	16.79	17.00	16.56
481590	18.03	18.43	18.80	19.00	19.40	19.54	19.83
481592	18.09	18.52	18.72	18.82	19.04	19.12	19.28
481595	18.58	19.10	19.66	19.96	20.35	20.48	20.72
481600	18.68	19.28	20.08	20.52	21.42	21.64	22.07
481610	18.75	19.37	20.17	20.63	21.55	21.80	22.28
481620	20.52	20.92	21.36	21.55	21.92	22.04	22.23
481630	21.37	21.49	21.66	21.76	22.00	22.10	22.28
481635	21.88	21.88	21.91	21.94	22.09	22.17	22.33
481640	23.79	23.97	24.16	24.27	24.49	24.57	24.59
481650	18.91	19.53	20.34	20.81	21.75	22.00	22.55
481655	19.01	19.60	20.41	20.86	21.80	22.04	22.58
481660	19.07	19.63	20.26	20.59	21.21	21.78	22.58
481665	20.04	20.25	20.48	20.64	21.27	21.42	21.80
481670	20.04	20.25	20.48	20.64	21.27	21.42	21.80
481674	20.05	20.26	20.51	20.68	21.30	21.47	21.90
481675	20.05	20.26	20.51	20.68	21.29	21.46	21.89
481676	20.05	20.26	20.51	20.68	21.28	21.43	21.87
481677	20.04	20.25	20.51	20.68	21.28	21.45	21.88
481680	20.06	20.30	20.58	20.78	21.39	21.58	22.10
481685	20.13	20.46	20.82	21.05	21.63	21.84	22.30
481687	20.15	20.53	20.96	21.19	21.75	21.97	22.41
481690	20.25	20.55	20.92	21.15	21.71	21.93	22.38
481695	20.39	20.66	21.02	21.25	21.80	22.01	22.45
481700	20.59	20.79	21.08	21.28	21.82	22.02	22.46
481705	20.72	21.00	21.29	21.47	21.93	22.11	22.46
481710	21.02	21.15	21.38	21.55	21.99	22.16	22.47
481712	21.02	21.15	21.38	21.55	22.00	22.17	22.47
481715	20.09	20.36	20.68	20.83	21.44	21.65	22.23
481720	20.13	20.42	20.77	20.93	21.56	21.80	22.45
481725	22.03	22.27	22.47	22.62	22.97	23.11	23.41
481730	20.16	20.48	20.86	20.94	21.57	21.81	22.50
481740	20.15	20.45	20.82	20.94	21.57	21.81	22.48
481750	20.59	20.81	21.12	21.34	21.87	22.08	22.54
481760	20.69	21.04	21.50	21.78	22.44	22.68	23.05

Table 1
Existing Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
481765	20.69	21.04	21.50	21.83	22.81	23.29	23.90
481766	24.47	25.00	25.43	25.55	26.02	26.21	26.33
481770	21.59	21.94	22.40	22.69	23.40	23.67	23.64
481780	21.86	22.32	22.89	23.21	23.82	24.04	23.99
481790	20.05	20.26	20.55	20.75	21.33	21.51	22.04
481795	21.41	21.85	22.25	22.48	23.04	23.26	23.76
481800	21.80	21.98	22.30	22.53	23.08	23.30	23.80
481810	24.45	24.65	24.94	25.11	25.50	25.64	25.43
481820	28.99	29.13	29.29	29.38	29.57	29.63	29.37
481830	28.05	28.17	28.33	28.44	28.68	28.77	28.65
481840	32.38	32.42	32.49	32.52	32.61	32.64	32.54
481850	28.07	28.19	28.37	28.48	28.73	28.83	28.70
481860	30.42	30.57	30.71	30.77	30.89	30.93	30.79
481865	32.77	33.06	33.41	33.61	34.03	34.18	34.21
481870	22.89	22.94	23.03	23.08	23.20	23.24	23.22
481880	24.63	24.69	24.76	24.81	24.91	24.95	24.83
481890	23.26	23.74	24.33	24.64	25.25	25.44	25.91
481900	24.31	24.43	24.61	24.74	25.04	25.16	25.49
481910	28.02	28.07	28.16	28.21	28.33	28.37	28.21
481915	24.98	25.02	25.05	25.09	25.16	25.18	25.49
481920	29.30	29.36	29.43	29.47	29.57	29.61	29.45
481925	31.90	32.17	32.49	32.68	33.10	33.24	32.72
481930	27.86	27.98	28.11	28.19	28.37	28.46	28.93
481935	27.77	28.09	28.47	28.79	29.44	29.56	29.74
481940	27.90	28.15	28.62	28.96	29.83	30.10	30.48
481950	33.26	33.40	33.60	33.73	34.06	34.18	34.48
481960	36.36	36.60	36.95	37.18	37.52	37.54	37.71
481970	33.99	34.20	34.51	34.72	35.29	35.52	35.73
481980	29.12	29.36	29.67	29.86	30.51	30.76	31.29
481990	35.37	35.57	35.77	35.82	35.99	36.07	36.32
481993	11.18	11.91	14.65	15.48	17.11	17.40	17.59
481995	14.47	14.74	15.17	15.65	17.19	17.47	17.65
482005	9.33	9.40	9.50	9.56	9.70	9.76	9.75
482010	3.14	3.55	4.01	4.34	5.05	5.32	5.70
482015	6.18	6.41	6.72	6.90	7.31	7.44	7.61
482020	8.08	8.28	8.56	8.74	9.14	9.28	9.45
482030	8.13	8.34	8.58	8.72	9.02	9.13	9.30
482032	8.86	9.01	9.20	9.31	9.55	10.01	10.65
482035	8.18	8.40	8.65	8.80	9.14	9.30	9.59
482040	9.03	9.14	9.30	9.39	9.61	9.69	9.69
482042	8.23	8.45	8.70	8.85	9.20	9.36	9.64
482043	9.03	9.14	9.30	9.40	9.61	9.70	9.72
482044	9.78	9.88	10.01	10.08	10.26	10.33	10.07
482045	8.46	8.70	8.97	9.16	9.68	10.23	10.85
482046	8.95	9.17	9.51	9.74	10.31	10.54	10.65

Table 1
Existing Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
482050	9.34	9.53	9.82	10.01	10.43	10.55	10.89
482055	3.45	4.04	6.87	7.30	7.78	7.91	8.18
482060	4.69	4.98	6.98	7.37	7.85	7.97	8.23
482065	3.16	3.59	4.06	4.39	5.17	5.46	5.81
482070	5.23	5.51	5.91	6.18	6.58	6.64	6.58
482080	3.75	4.20	4.57	4.78	5.33	5.55	5.90
482085	5.28	6.20	6.90	7.21	7.79	7.97	8.24
482090	7.86	8.37	8.75	8.96	9.38	9.52	9.59
482100	8.37	8.63	8.95	9.13	9.51	9.64	9.69
482110	7.34	7.72	7.93	8.04	8.25	8.32	8.48
482120	7.34	7.72	7.91	8.01	8.20	8.27	8.42
482130	11.92	12.09	12.30	12.42	12.69	12.79	12.77
482140	7.45	7.73	7.95	8.08	8.36	8.45	8.66
482155	12.16	12.37	12.64	12.81	13.17	13.30	13.26
482160	8.29	8.76	9.33	9.63	10.07	10.17	10.69
482164	8.29	8.76	9.33	9.63	10.07	10.17	10.69
482165	9.97	10.02	10.09	10.14	10.24	10.27	10.69
482169	8.29	8.76	9.34	9.63	10.08	10.18	10.69
482170	8.29	8.77	9.34	9.63	10.08	10.18	10.69
482172	8.29	8.76	9.34	9.63	10.08	10.18	10.69
482173	8.84	9.06	9.36	9.64	10.09	10.21	10.69
482174	9.15	9.51	10.08	10.52	11.57	11.99	11.21
482175	10.21	10.31	10.48	10.67	11.66	12.04	11.29
482180	9.30	9.55	9.80	9.96	10.28	10.37	10.89
482190	13.75	13.96	14.24	14.41	14.78	14.90	14.70
482191	14.04	14.23	14.70	15.03	15.88	16.21	16.18
482192	13.79	14.02	14.33	14.52	14.94	15.09	14.51
482193	13.80	14.04	14.40	14.62	15.18	15.38	15.30
482194	13.99	14.15	14.45	14.68	15.25	15.45	15.38
482195	16.44	16.61	16.83	16.97	17.27	17.38	17.39
482196	16.56	16.70	16.92	17.06	17.36	17.47	17.47
482197	14.04	14.22	14.50	14.72	15.26	15.47	15.43
482198	16.71	16.89	17.14	17.30	17.67	17.81	17.62
482199	16.45	16.61	16.84	16.98	17.32	17.45	17.44
482200	8.76	9.52	11.07	11.47	11.92	12.04	12.55
482204	10.15	10.63	11.12	11.50	11.95	12.13	12.60
482205	11.88	12.06	12.20	12.29	12.57	12.68	13.01
482210	10.34	10.47	11.24	11.61	12.06	12.17	12.68
482214	11.00	11.91	12.98	13.26	13.76	14.02	14.26
482215	12.84	13.02	13.27	13.46	13.92	14.14	14.31
482220	12.89	13.09	13.39	13.59	14.07	14.25	14.33
482225	12.92	13.15	13.48	13.69	14.18	14.31	14.34
482230	11.73	12.04	12.37	12.53	12.89	13.02	13.47
482235	12.21	12.38	12.61	12.75	13.07	13.18	13.11
482240	12.58	13.34	14.19	14.62	15.82	16.35	17.16

Table 1
Existing Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
482250	13.42	13.82	14.47	14.85	15.94	16.45	17.26
482259	13.42	13.82	14.47	14.85	15.94	16.45	17.26
482260	15.69	15.78	15.92	15.99	16.07	16.45	17.26
482265	15.50	15.52	15.56	15.57	15.95	16.45	17.26
482270	15.80	15.88	15.98	16.04	16.33	16.50	17.30
482271	16.22	16.45	16.79	17.00	17.35	17.46	17.57
482272	14.23	14.66	15.35	15.93	17.55	17.93	17.01
482273	17.26	17.42	17.65	17.80	18.15	18.29	18.03
482274	16.24	16.45	16.78	16.96	17.12	17.16	17.29
482275	16.27	16.35	16.44	16.50	16.64	16.69	17.26
482280	17.09	17.18	17.32	17.42	17.66	17.75	17.75
482290	18.99	19.10	19.24	19.32	19.52	19.60	19.58
482300	18.07	18.26	18.57	18.81	19.10	19.17	19.39
482301	18.85	19.20	19.50	19.67	20.03	20.16	20.02
482302	18.89	19.26	19.60	19.80	20.22	20.37	20.19
482303	18.93	19.33	19.71	19.93	20.41	20.57	20.36
482305	15.03	15.04	15.05	15.06	15.07	15.08	15.21
482310	17.98	18.14	18.36	18.52	18.86	18.97	19.32
482315	17.92	18.04	18.21	18.32	18.58	18.67	18.92
482317	17.82	17.89	17.97	18.02	18.11	18.13	18.21
482320	18.93	19.09	19.31	19.45	19.80	19.93	20.27
482330	20.47	20.51	20.57	20.60	20.68	20.71	20.60
482340	18.07	18.26	18.56	18.76	19.03	19.15	19.40
482360	20.48	20.59	20.71	20.77	20.91	20.96	20.88
482379	16.24	16.49	16.86	17.10	17.58	17.68	17.94
482380	16.48	16.78	17.20	17.46	18.12	18.19	18.36
482390	16.16	16.41	16.66	16.76	16.96	17.09	17.45
482391	16.16	16.42	16.69	16.80	17.07	17.22	17.72
482392	17.05	17.24	17.51	17.68	18.06	18.19	18.59
482395	16.30	16.60	16.90	16.96	17.05	17.10	17.29
482400	16.67	17.05	17.52	17.78	18.33	18.53	18.74
482401	16.30	16.60	16.90	16.96	17.05	17.11	17.42
482402	17.07	17.27	17.58	17.79	18.29	18.44	18.70
482405	16.75	17.37	18.23	18.60	19.28	19.48	19.19
482410	17.07	17.28	17.59	17.79	18.30	18.48	19.04
482420	18.07	18.26	18.56	18.76	19.00	19.10	19.34
482424	16.67	17.07	17.55	17.82	18.43	18.66	18.96
482425	19.30	19.42	19.59	19.71	19.99	20.10	20.39
482440	22.16	22.52	22.94	23.10	23.35	23.43	23.49
482460	18.97	19.19	19.46	19.62	20.02	20.20	20.43
482480	21.90	22.26	22.68	22.91	23.35	23.47	23.63
482500	27.59	27.64	27.70	27.72	27.79	27.81	27.72
482510	17.59	17.90	18.30	18.47	18.85	18.99	19.07
482517	19.05	19.48	19.97	20.21	20.59	20.80	20.93
482520	20.66	20.66	20.70	20.77	20.92	20.98	21.00

Table 1
Existing Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
482530	19.25	19.74	20.36	20.73	21.62	21.82	21.94
482540	20.10	20.58	21.20	21.57	22.15	22.29	22.38
482560	22.92	22.97	23.06	23.11	23.24	23.28	23.22
482580	23.15	23.25	23.39	23.48	23.69	23.78	23.71
482600	24.79	25.20	25.77	26.13	26.78	26.88	26.37
482601	24.70	25.09	25.64	25.99	26.62	26.72	26.21
482610	20.63	21.07	21.65	21.98	22.61	22.79	22.90
482615	20.79	21.27	22.02	22.51	23.64	24.13	24.43
482620	23.17	23.33	23.55	23.67	23.94	24.03	24.11
482630	23.59	23.88	24.29	24.50	24.93	25.08	25.19
482640	24.44	24.71	24.98	25.13	25.48	25.60	25.73
482660	24.19	24.36	24.61	24.76	25.15	25.30	25.41
482670	25.70	25.72	25.74	25.75	25.77	25.78	25.76
482680	28.48	28.60	28.77	28.87	29.08	29.16	28.97
482685	31.97	33.15	34.99	35.77	36.53	36.80	36.94
482686	35.05	35.30	35.66	35.89	36.57	36.84	36.98
482700	27.76	28.05	28.46	28.75	29.48	29.67	29.86
482720	27.99	28.33	28.81	29.12	30.06	30.44	31.61
482740	38.78	39.07	39.42	39.47	39.63	39.71	39.88
482750	38.78	39.07	39.43	39.47	40.17	40.41	40.50
482751	38.78	39.07	39.43	39.58	40.34	40.57	40.63
482760	20.66	20.66	20.85	20.98	21.24	21.33	21.38
482780	24.84	24.90	24.97	25.02	25.12	25.15	24.96
482790	23.07	23.20	23.38	23.48	23.68	23.75	23.81
482800	25.55	25.89	26.14	26.25	26.51	26.60	26.71
482820	26.05	26.10	26.23	26.30	26.52	26.61	26.73
482840	26.65	26.93	27.34	27.58	28.06	28.23	28.39
482841	31.35	31.65	32.07	32.33	32.95	33.18	33.05
482845	27.77	28.26	28.62	28.75	28.93	29.03	29.17
482848	28.64	29.24	29.90	30.18	30.57	30.81	31.33
482850	29.92	30.26	30.67	30.89	31.42	31.61	31.83
482860	35.10	35.13	35.21	35.26	35.37	35.41	35.36
482870	31.27	31.27	31.42	31.76	32.18	32.31	32.74
482890	30.66	31.08	31.64	32.02	32.68	32.81	33.23
482895	31.47	31.59	31.90	32.21	32.84	32.96	34.66
482900	33.43	33.70	34.08	34.34	34.96	35.25	36.09
482915	33.43	33.70	35.17	35.92	36.77	37.09	37.23
482920	33.43	33.70	34.22	34.58	35.44	35.77	36.82
482930	35.36	35.64	35.93	36.11	36.82	37.14	37.26
482940	34.69	34.97	35.43	35.74	36.50	36.76	36.93
482945	37.49	37.84	38.11	38.29	38.72	38.89	38.26
482950	37.76	37.90	38.16	38.33	38.76	38.93	38.29
482955	38.43	39.33	40.63	41.07	41.46	41.57	41.39
482960	39.29	39.91	40.82	41.23	41.64	41.75	41.56
482970	35.95	36.09	36.24	36.30	36.47	36.55	36.66

Table 1
Existing Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
482980	38.07	38.24	38.48	38.63	39.01	39.17	39.63
482990	39.84	39.91	40.00	40.05	40.15	40.19	40.06
482995	35.28	35.48	35.78	35.98	36.44	36.62	37.05
490030	28.04	28.30	28.67	28.87	29.29	29.45	29.83
490050	27.69	28.04	28.39	28.57	28.91	29.01	29.12
491000	22.04	22.28	22.48	22.64	23.03	23.18	23.52
491010	23.87	24.16	24.52	24.73	25.28	25.50	25.99
491019	26.92	27.19	27.66	28.05	29.11	29.43	29.54
491020	29.27	29.35	29.46	29.50	29.60	29.64	29.66
491021	29.27	29.36	29.46	29.51	29.63	29.69	29.77
491022	29.27	29.35	29.45	29.50	29.61	29.66	29.70
491040	24.52	24.74	25.02	25.26	26.17	26.63	28.14
491041	28.97	29.19	29.50	29.70	30.13	30.28	30.21
491042	28.59	28.69	28.86	28.98	29.29	29.38	29.43
491043	28.34	28.54	28.77	28.89	29.20	29.31	29.36
491044	28.90	29.11	29.41	29.61	30.09	30.24	30.18
491060	28.95	29.37	29.81	29.89	30.08	30.15	30.38
491080	28.97	29.41	29.92	30.08	30.53	30.76	31.53
491100	30.24	30.43	30.73	30.93	31.56	31.82	32.66
491102	30.92	31.07	31.28	31.41	31.70	31.82	32.67
491120	29.61	29.91	30.34	30.63	31.29	31.54	32.50
491123	33.45	33.55	33.70	33.78	33.99	34.07	34.07
491240	32.70	32.96	33.34	33.59	33.87	33.93	34.32
491260	31.14	31.32	31.55	31.71	32.07	32.22	32.92
491280	31.32	31.46	31.67	31.81	32.14	32.29	32.99
491300	31.42	31.56	31.76	31.86	32.11	32.25	32.94
491302	34.95	35.27	35.73	36.03	36.71	36.95	38.18
491340	32.35	32.77	33.36	33.74	34.39	34.58	35.11
491342	33.95	34.01	34.09	34.14	34.41	34.60	35.16
491344	37.85	37.92	38.02	38.08	38.21	38.26	38.22
491360	36.37	36.59	36.86	37.01	37.20	37.24	37.23
491380	35.00	35.21	35.49	35.62	35.85	35.93	35.95
491382	33.34	33.41	33.51	33.58	33.72	33.77	33.68
491384	32.25	32.36	32.51	32.60	32.81	32.89	32.96
491480	35.74	36.31	36.67	36.76	36.94	37.00	36.84
481504	13.45	13.54	13.71	13.82	14.09	14.20	14.23
481579	13.70	13.97	14.46	14.85	15.95	16.36	15.58
481583	14.50	14.79	15.26	15.59	16.38	16.69	17.40
481584	14.51	14.80	15.27	15.59	16.58	16.92	17.40
481591	18.06	18.48	18.73	18.85	19.12	19.21	19.38

Table 2
Existing Conditions Level of Service (LOS)

Node	Lowest Road Overtopping Elevation	Peak Stage (ft NAVD)	Depth (ft)	25-Year/24-Hour LOS
480010	9.59	2.29	-7.30	A
480020	7.55	6.37	-1.18	A
480030	9.00	4.87	-4.13	A
480050	8.00	5.51	-2.49	A
480060	8.00	8.16	0.16	B
480065	14.29	12.33	-1.96	A
480066	17.00	14.79	-2.21	A
480080	7.00	6.76	-0.24	A
481060	9.15	3.59	-5.56	A
481065	9.15	6.14	-3.01	A
481110	9.15	3.89	-5.26	A
481112	9.15	6.91	-2.24	A
481115	5.75	3.98	-1.77	A
481120	5.75	4.66	-1.09	A
481135	7.76	4.98	-2.78	A
481150	7.15	6.63	-0.52	A
481190	10.00	9.27	-0.73	A
481200	10.00	9.29	-0.71	A
481205	9.74	9.14	-0.60	A
481210	8.95	7.11	-1.84	A
481235	14.15	10.87	-3.28	A
481240	15.15	12.37	-2.78	A
481250	14.15	10.87	-3.28	A
481260	13.16	11.25	-1.91	A
481270	13.16	12.08	-1.08	A
481275	14.15	10.88	-3.27	A
481290	17.00	13.25	-3.75	A
481300	17.00	14.80	-2.20	A
481310	17.16	16.05	-1.11	A
481330	21.00	20.41	-0.59	A
481370	11.00	8.12	-2.88	A
481380	9.06	7.06	-2.00	A
481390	8.50	8.70	0.20	B
481400	15.96	13.33	-2.63	A
481402	14.66	13.92	-0.74	A
481430	14.76	12.43	-2.33	A
481440	10.00	10.19	0.19	B
481450	13.00	12.46	-0.54	A
481455	11.00	9.13	-1.87	A
481460	11.00	9.65	-1.35	A
481480	15.16	11.39	-3.77	A
481481	11.96	9.14	-2.82	A
481500	18.10	13.72	-4.38	A
481520	15.16	11.73	-3.43	A
481548	18.16	17.82	-0.34	A
481585	16.50	14.95	-1.55	A

Table 2
Existing Conditions Level of Service (LOS)

Node	Lowest Road Overtopping Elevation	Peak Stage (ft NAVD)	Depth (ft)	25-Year/24-Hour LOS
481586	16.50	15.58	-0.92	A
481587	16.50	16.36	-0.14	B
481588	18.00	16.66	-1.34	A
481595	21.26	19.96	-1.30	A
481600	21.26	20.52	-0.74	A
481635	25.16	21.94	-3.22	A
481640	25.16	24.27	-0.89	A
481655	21.66	20.86	-0.80	A
481660	21.66	20.59	-1.07	A
481670	22.00	20.64	-1.36	A
481675	22.00	20.68	-1.32	A
481676	22.00	20.68	-1.32	A
481677	22.00	20.68	-1.32	A
481715	22.00	20.83	-1.17	A
481720	22.00	20.93	-1.07	A
481725	22.00	22.62	0.62	C
481730	22.00	20.94	-1.06	A
481740	22.00	20.94	-1.06	A
481790	22.00	20.75	-1.25	A
481865	34.30	33.61	-0.69	A
481880	25.86	24.81	-1.05	A
481890	25.86	24.64	-1.22	A
481900	25.00	24.74	-0.26	A
481920	34.16	29.47	-4.69	A
481925	34.16	32.68	-1.48	A
481930	29.97	28.19	-1.78	A
481935	31.77	28.79	-2.98	A
481940	29.97	28.96	-1.01	A
481960	37.47	37.18	-0.29	A
481980	31.77	29.86	-1.91	A
482010	11.57	4.34	-7.23	A
482020	11.57	8.74	-2.83	A
482030	9.67	8.72	-0.95	A
482032	9.85	9.31	-0.54	A
482042	9.67	8.85	-0.82	A
482046	11.15	9.74	-1.41	A
482050	11.05	10.01	-1.04	A
482060	7.65	7.37	-0.28	A
482080	10.15	4.78	-5.37	A
482085	10.15	7.21	-2.94	A
482160	12.00	9.63	-2.37	A
482173	12.15	9.64	-2.51	A
482200	11.52	11.47	-0.05	A
482215	14.15	13.46	-0.69	A
482220	14.15	13.59	-0.56	A
482225	14.15	13.69	-0.46	A

Table 2
Existing Conditions Level of Service (LOS)

Node	Lowest Road Overtopping Elevation	Peak Stage (ft NAVD)	Depth (ft)	25-Year/24-Hour LOS
482230	17.20	12.53	-4.67	A
482240	17.20	14.62	-2.58	A
482271	17.00	17.00	0.00	A
482275	18.00	16.50	-1.50	A
482310	20.16	18.52	-1.64	A
482320	20.16	19.45	-0.71	A
482340	20.66	18.76	-1.90	A
482360	21.36	20.77	-0.59	A
482380	18.00	17.46	-0.54	A
482395	16.86	16.96	0.10	B
482400	23.16	17.78	-5.38	A
482405	23.16	18.60	-4.56	A
482410	20.00	17.79	-2.21	A
482440	24.02	23.10	-0.92	A
482460	21.66	19.62	-2.04	A
482480	23.29	22.91	-0.38	A
482500	29.00	27.72	-1.28	A
482510	20.66	18.47	-2.19	A
482610	25.46	21.98	-3.48	A
482615	25.46	22.51	-2.95	A
482660	29.57	24.76	-4.81	A
482700	29.57	28.75	-0.82	A
482720	37.87	29.12	-8.75	A
482780	27.00	25.02	-1.98	A
482820	27.00	26.30	-0.70	A
482845	32.37	28.75	-3.62	A
482848	32.37	30.18	-2.19	A
482850	35.00	30.89	-4.11	A
482890	34.47	32.02	-2.45	A
482895	34.47	32.21	-2.26	A
482900	35.77	34.34	-1.43	A
482920	37.67	34.58	-3.09	A
482930	37.87	36.11	-1.76	A
482940	36.67	35.74	-0.93	A
482950	40.00	38.33	-1.67	A
482970	38.47	36.30	-2.17	A
482980	42.00	38.63	-3.37	A
482995	38.67	35.98	-2.69	A
490030	29.96	28.87	-1.09	A
490050	28.66	28.57	-0.09	A
491010	28.46	24.73	-3.73	A
491040	28.46	25.26	-3.20	A
491080	31.26	30.08	-1.18	A
491100	32.66	30.93	-1.73	A
491120	32.50	30.63	-1.87	A
491240	33.66	33.59	-0.07	A

Table 2
Existing Conditions Level of Service (LOS)

Node	Lowest Road Overtopping Elevation	Peak Stage (ft NAVD)	Depth (ft)	25-Year/24-Hour LOS
491260	33.66	31.71	-1.95	A
491280	34.17	31.81	-2.36	A
491300	39.00	31.86	-7.14	A
491302	39.00	36.03	-2.97	A
491340	34.17	33.74	-0.43	A
491342	35.46	34.14	-1.32	A
491360	37.07	37.01	-0.06	A

Exhibit C

Table 1
Proposed Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
480001	1.65	1.65	1.65	1.65	1.65	1.65	1.65
480002	1.65	1.65	1.65	1.65	1.65	1.65	1.65
480003	1.65	1.65	1.65	1.65	1.65	1.65	1.65
480004	1.65	1.65	1.65	1.65	1.65	1.65	1.65
480005	1.65	1.65	1.65	1.65	1.65	1.65	1.65
480010	1.85	1.97	2.16	2.29	2.66	2.83	3.13
480012	2.32	2.54	2.77	2.92	3.24	3.36	3.59
480014	2.83	3.26	3.75	4.09	4.85	5.13	5.53
480020	6.12	6.18	6.25	6.37	6.76	6.90	6.92
480025	1.65	1.65	1.65	1.65	1.65	1.65	1.65
480026	1.65	1.65	1.65	1.65	1.65	1.65	1.65
480030	4.23	4.45	4.71	4.87	5.78	6.26	6.23
480035	5.37	5.38	5.38	5.40	5.78	6.26	6.23
480036	7.14	7.18	7.22	7.25	7.31	7.33	7.28
480037	7.19	7.27	7.40	7.49	7.75	7.87	7.48
480038	8.21	8.27	8.35	8.39	8.49	8.52	8.35
480040	4.45	4.60	4.79	4.91	5.79	6.26	6.23
480050	4.66	4.92	5.28	5.51	6.05	6.25	7.18
480060	7.38	7.66	7.99	8.16	8.46	8.56	8.57
480061	9.93	9.97	10.02	10.06	10.14	10.17	9.94
480062	10.35	10.37	10.41	10.43	10.47	10.49	10.44
480065	11.62	11.84	12.13	12.33	12.80	12.98	13.37
480066	14.07	14.29	14.60	14.79	15.23	15.39	15.94
480070	6.81	6.91	7.01	7.06	7.15	7.18	7.18
480080	6.56	6.62	6.67	6.76	7.02	7.08	7.00
480085	7.38	7.66	7.99	8.16	8.46	8.56	8.57
480090	7.47	7.67	7.99	8.16	8.46	8.56	8.58
480100	8.55	8.70	8.90	9.03	9.30	9.39	9.28
480110	7.39	7.67	8.00	8.17	8.47	8.57	8.59
481010	1.92	2.06	2.30	2.45	2.86	3.05	3.39
481020	1.92	2.06	2.30	2.45	2.86	3.05	3.39
481030	1.92	2.06	2.30	2.45	2.86	3.05	3.39
481040	2.07	2.27	2.61	2.79	3.26	3.48	3.87
481045	2.16	2.37	2.73	2.93	3.41	3.64	4.04
481050	2.38	2.65	3.09	3.31	3.84	4.09	4.52
481055	2.45	2.74	3.20	3.44	3.98	4.24	4.69
481056	2.47	2.76	3.23	3.48	4.04	4.32	4.77
481057	2.47	2.76	3.23	3.48	4.04	4.32	4.77
481058	3.98	4.09	4.25	4.35	4.55	4.60	4.83
481060	2.53	2.84	3.33	3.59	4.16	4.43	4.91
481061	2.83	2.87	3.24	3.48	4.04	4.32	4.78
481062	5.54	5.64	5.79	5.89	6.11	6.20	6.45
481063	5.54	5.64	5.79	5.89	6.11	6.20	6.45
481064	5.47	5.59	5.75	5.84	6.05	6.06	6.45
481065	5.23	5.51	5.89	6.14	6.72	6.94	6.94

Table 1
Proposed Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
481066	3.49	3.78	4.28	4.63	5.09	5.18	5.07
481067	4.68	4.77	4.89	4.96	5.19	5.27	5.15
481070	3.21	3.35	3.56	3.70	4.19	4.47	4.93
481080	4.56	4.70	4.91	5.04	5.29	5.35	5.60
481090	2.63	2.98	3.53	3.81	4.42	4.72	5.24
481095	5.56	5.76	6.05	6.22	6.60	6.75	6.56
481100	6.62	6.79	7.02	7.17	7.51	7.65	7.47
481110	2.69	3.05	3.61	3.89	4.50	4.80	5.34
481112	5.52	5.91	6.52	6.91	7.78	8.09	8.24
481115	2.76	3.13	3.69	3.98	4.59	4.89	5.44
481120	2.98	3.53	4.28	4.66	5.48	5.88	6.40
481130	3.10	3.66	4.40	4.78	5.59	5.99	6.54
481135	3.31	3.87	4.60	4.98	5.77	6.17	6.78
481140	3.81	4.66	5.86	6.56	7.85	8.02	8.25
481145	3.88	4.74	5.97	6.58	7.87	8.05	8.31
481150	4.24	4.78	5.99	6.63	7.88	8.07	8.33
481170	7.12	8.20	8.42	8.61	8.90	8.99	9.08
481175	8.01	8.70	8.90	9.02	9.21	9.27	9.36
481180	8.64	8.98	9.16	9.26	9.43	9.49	9.57
481190	8.75	9.03	9.20	9.27	9.43	9.49	9.77
481200	8.76	9.04	9.22	9.29	9.47	9.55	9.79
481205	8.80	9.08	9.12	9.14	9.85	9.97	10.41
481210	3.88	4.60	6.24	7.12	9.21	9.43	9.76
481220	11.26	11.43	11.68	11.83	12.12	12.22	12.55
481225	11.27	11.44	11.68	11.83	12.13	12.24	12.58
481230	11.25	11.43	11.67	11.82	12.11	12.21	12.53
481235	9.90	10.29	10.75	10.87	11.58	11.82	12.08
481240	12.12	12.20	12.30	12.37	12.51	12.56	12.43
481250	9.90	10.29	10.75	10.87	11.58	11.82	12.08
481260	9.39	10.21	10.89	11.25	11.91	12.13	12.32
481270	11.16	11.59	11.93	12.09	12.42	12.53	12.60
481275	9.83	10.17	10.60	10.88	11.60	11.84	12.18
481278	9.85	10.17	10.60	10.89	11.60	11.85	12.19
481280	16.30	16.38	16.49	16.55	16.70	16.75	16.58
481281	18.39	18.57	18.83	18.99	19.38	19.53	19.76
481290	12.57	12.81	13.10	13.25	13.58	13.68	13.74
481295	14.65	14.82	14.97	15.05	15.23	15.29	15.16
481300	14.43	14.54	14.70	14.80	15.01	15.07	15.07
481305	14.46	14.58	14.78	14.90	15.17	15.32	15.23
481306	17.06	17.28	17.58	17.82	18.45	18.63	18.34
481310	15.65	15.80	15.95	16.05	16.28	16.38	16.46
481320	15.96	15.96	15.96	16.04	16.26	16.35	16.41
481330	17.37	18.47	19.80	20.46	21.15	21.28	21.55
481340	2.68	3.05	3.62	3.92	4.58	4.89	5.42
481348	3.79	4.39	4.63	4.84	5.60	5.99	6.53

Table 1
Proposed Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
481350	3.20	3.60	4.33	4.71	5.52	5.89	6.44
481370	7.69	7.90	8.02	8.12	8.46	8.58	8.62
481375	4.38	4.93	5.97	6.42	7.28	7.64	8.17
481380	4.86	5.45	6.55	7.06	8.07	8.49	9.13
481390	6.28	7.41	8.51	8.70	8.91	8.97	9.13
481400	12.74	12.93	13.18	13.33	13.68	13.80	13.70
481401	12.92	13.22	13.63	13.88	14.36	14.51	14.63
481402	12.95	13.26	13.67	13.92	14.41	14.56	14.68
481410	6.88	7.49	8.35	8.76	9.65	10.03	10.64
481414	6.98	7.58	8.46	8.87	9.65	10.03	10.64
481415	7.33	7.77	8.62	8.96	9.66	10.03	10.64
481417	7.39	7.89	8.81	9.12	9.70	10.06	10.55
481420	8.69	8.84	9.07	9.24	9.75	10.07	10.55
481430	11.30	11.74	12.17	12.43	13.07	13.25	13.55
481440	10.03	10.09	10.16	10.19	10.27	10.38	10.73
481450	11.38	11.77	12.21	12.46	13.10	13.28	13.58
481455	7.17	7.78	8.69	9.13	10.08	10.45	11.03
481460	7.24	7.91	8.97	9.65	11.16	11.46	11.85
481465	7.42	8.06	9.47	10.56	11.79	12.01	12.30
481470	7.50	8.15	9.59	10.70	11.81	12.04	12.32
481480	10.67	10.91	11.22	11.39	11.86	12.07	12.35
481481	7.17	7.78	8.70	9.14	10.10	10.47	11.05
481482	7.16	7.79	8.71	9.14	10.10	10.47	11.05
481483	7.29	7.87	8.81	9.16	10.11	10.48	11.05
481484	8.79	8.95	9.17	9.32	10.12	10.49	11.06
481490	7.88	8.28	9.22	9.76	11.10	11.51	12.28
481491	9.36	9.56	9.83	10.06	10.51	10.79	11.25
481492	9.51	9.70	9.95	10.19	10.61	10.86	11.29
481496	9.74	9.93	10.20	10.34	10.69	10.87	11.29
481497	12.23	12.39	12.61	12.75	13.08	13.19	13.02
481498	11.06	11.12	11.53	11.71	11.83	11.88	11.96
481499	11.87	12.04	13.60	14.77	15.90	16.41	17.22
481500	13.43	13.53	13.65	13.72	13.91	13.99	14.14
481501	15.88	16.07	16.32	16.48	16.85	16.99	16.90
481505	13.57	13.70	13.90	14.03	14.32	14.43	14.40
481510	16.76	17.08	17.55	17.87	18.60	18.84	19.05
481520	10.73	11.04	11.48	11.73	12.26	12.47	12.35
481530	18.38	18.47	18.60	18.69	18.88	18.95	19.11
481540	19.78	20.00	20.29	20.47	20.89	21.04	20.83
481541	19.09	19.13	19.25	19.33	19.53	19.61	19.59
481542	19.42	19.53	19.67	19.76	19.97	20.07	20.17
481545	21.88	22.18	22.57	22.63	22.82	22.93	23.20
481548	16.06	16.60	17.40	17.82	18.40	18.51	18.71
481550	17.42	17.51	17.66	17.91	18.49	18.63	18.87
481559	17.55	17.69	17.89	18.01	18.50	18.64	18.87

Table 1
Proposed Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
481560	18.95	19.13	19.37	19.52	19.87	20.01	19.63
481565	19.23	19.28	19.34	19.38	19.47	19.50	19.33
481570	19.01	19.14	19.33	19.45	19.79	19.92	20.16
481580	18.87	18.98	19.12	19.19	19.41	19.53	19.78
481581	19.94	20.35	20.76	21.01	21.37	21.47	21.44
481582	20.27	20.50	20.88	21.12	21.46	21.56	21.52
481585	14.40	14.58	14.81	14.95	15.25	15.36	15.57
481586	14.49	14.79	15.26	15.58	16.37	16.69	17.40
481587	15.65	15.86	16.16	16.36	16.64	16.69	17.40
481588	15.99	16.20	16.48	16.66	17.10	17.28	17.42
481589	15.46	15.71	16.05	16.26	16.79	17.00	16.56
481590	18.03	18.44	18.80	19.00	19.40	19.54	19.83
481592	18.09	18.52	18.72	18.82	19.04	19.12	19.28
481595	18.58	19.10	19.66	19.96	20.35	20.48	20.72
481600	18.68	19.28	20.08	20.52	21.42	21.64	22.07
481610	18.75	19.37	20.17	20.63	21.55	21.80	22.28
481620	20.52	20.92	21.36	21.55	21.92	22.04	22.23
481630	21.37	21.49	21.66	21.76	22.00	22.10	22.28
481635	21.88	21.88	21.91	21.94	22.09	22.17	22.33
481640	23.79	23.97	24.16	24.27	24.49	24.57	24.59
481650	18.91	19.53	20.34	20.81	21.75	22.00	22.55
481655	19.01	19.60	20.41	20.87	21.80	22.04	22.58
481660	19.08	19.63	20.26	20.60	21.23	21.79	22.58
481665	20.08	20.28	20.50	20.65	21.27	21.43	21.79
481670	20.08	20.28	20.50	20.65	21.27	21.43	21.79
481674	20.09	20.29	20.53	20.69	21.31	21.48	21.89
481675	20.09	20.29	20.53	20.69	21.30	21.47	21.88
481676	20.09	20.29	20.53	20.69	21.29	21.44	21.87
481677	20.09	20.29	20.53	20.69	21.29	21.46	21.87
481680	20.11	20.33	20.60	20.79	21.40	21.59	22.09
481685	20.19	20.50	20.85	21.07	21.64	21.85	22.30
481687	20.22	20.59	20.98	21.20	21.76	21.97	22.40
481690	20.30	20.59	20.94	21.16	21.73	21.94	22.37
481695	20.42	20.70	21.04	21.26	21.81	22.02	22.44
481700	20.59	20.80	21.09	21.29	21.83	22.03	22.45
481705	20.72	21.00	21.29	21.48	21.94	22.11	22.46
481710	21.02	21.15	21.38	21.55	21.99	22.17	22.46
481712	21.02	21.15	21.38	21.56	22.00	22.17	22.46
481715	20.14	20.39	20.69	20.91	21.45	21.66	22.21
481720	20.19	20.45	20.79	21.02	21.57	21.81	22.42
481725	20.39	20.80	21.52	22.12	22.62	22.80	23.18
481730	20.23	20.51	20.87	21.12	21.58	21.82	22.45
481740	20.21	20.49	20.84	21.09	21.58	21.82	22.45
481750	20.59	20.82	21.13	21.35	21.88	22.09	22.54
481760	20.69	21.04	21.50	21.79	22.44	22.68	23.05

Table 1
Proposed Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
481765	20.69	21.04	21.50	21.83	22.81	23.29	23.90
481766	24.47	25.00	25.43	25.55	26.02	26.21	26.33
481770	21.59	21.94	22.40	22.69	23.40	23.67	23.64
481780	21.86	22.32	22.89	23.21	23.82	24.04	23.99
481790	20.09	20.30	20.58	20.76	21.34	21.52	22.04
481795	21.39	21.85	22.25	22.48	23.04	23.26	23.76
481800	21.80	21.98	22.30	22.53	23.08	23.30	23.80
481810	24.45	24.65	24.94	25.11	25.50	25.64	25.43
481820	28.99	29.13	29.29	29.38	29.57	29.63	29.37
481830	28.05	28.17	28.33	28.44	28.68	28.77	28.65
481840	32.38	32.42	32.49	32.52	32.61	32.64	32.54
481850	28.07	28.19	28.37	28.48	28.73	28.83	28.70
481860	30.42	30.57	30.71	30.77	30.89	30.93	30.79
481865	32.77	33.06	33.41	33.61	34.03	34.18	34.21
481870	22.89	22.94	23.03	23.08	23.20	23.24	23.22
481880	24.63	24.69	24.76	24.81	24.91	24.95	24.83
481890	23.26	23.74	24.33	24.64	25.25	25.44	25.91
481900	24.31	24.43	24.61	24.74	25.04	25.16	25.49
481910	28.02	28.07	28.16	28.21	28.33	28.37	28.21
481915	24.98	25.02	25.05	25.09	25.16	25.18	25.49
481920	29.30	29.36	29.43	29.47	29.57	29.61	29.45
481925	31.90	32.17	32.49	32.68	33.10	33.24	32.72
481930	27.86	27.98	28.11	28.19	28.37	28.46	28.93
481935	27.77	28.09	28.47	28.79	29.44	29.56	29.74
481940	27.90	28.15	28.62	28.96	29.83	30.10	30.48
481950	33.26	33.40	33.60	33.73	34.06	34.18	34.48
481960	36.36	36.60	36.95	37.18	37.52	37.54	37.71
481970	33.99	34.20	34.51	34.72	35.29	35.52	35.73
481980	29.12	29.36	29.67	29.86	30.51	30.76	31.29
481990	35.37	35.57	35.77	35.82	35.99	36.07	36.32
481993	11.18	11.91	14.65	15.48	17.11	17.40	17.59
481995	14.47	14.74	15.17	15.65	17.19	17.47	17.65
482005	9.33	9.40	9.50	9.56	9.70	9.76	9.75
482010	3.14	3.55	4.01	4.34	5.05	5.32	5.70
482015	6.18	6.41	6.72	6.90	7.31	7.44	7.61
482020	8.08	8.28	8.56	8.74	9.14	9.28	9.45
482030	8.13	8.34	8.58	8.72	9.02	9.13	9.30
482032	8.86	9.01	9.20	9.31	9.55	10.01	10.65
482035	8.18	8.40	8.65	8.80	9.14	9.30	9.59
482040	9.03	9.14	9.30	9.39	9.61	9.69	9.69
482042	8.23	8.45	8.70	8.85	9.20	9.36	9.64
482043	9.03	9.14	9.30	9.40	9.61	9.70	9.72
482044	9.78	9.88	10.01	10.08	10.26	10.33	10.07
482045	8.46	8.70	8.97	9.16	9.68	10.23	10.85
482046	8.95	9.17	9.51	9.74	10.31	10.54	10.65

Table 1
Proposed Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
482050	9.34	9.53	9.82	10.01	10.43	10.55	10.89
482055	3.45	4.04	6.87	7.30	7.78	7.91	8.18
482060	4.69	4.98	6.98	7.37	7.85	7.97	8.23
482065	3.16	3.59	4.06	4.39	5.17	5.46	5.81
482070	5.23	5.51	5.91	6.18	6.58	6.64	6.58
482080	3.75	4.20	4.57	4.78	5.33	5.55	5.90
482085	5.28	6.20	6.90	7.21	7.79	7.97	8.24
482090	7.86	8.37	8.75	8.96	9.38	9.52	9.59
482100	8.37	8.63	8.95	9.13	9.51	9.64	9.69
482110	7.34	7.72	7.93	8.04	8.25	8.32	8.48
482120	7.34	7.72	7.91	8.01	8.20	8.27	8.42
482130	11.92	12.09	12.30	12.42	12.69	12.79	12.77
482140	7.45	7.73	7.95	8.08	8.36	8.45	8.66
482155	12.16	12.37	12.64	12.81	13.17	13.30	13.26
482160	8.29	8.76	9.33	9.63	10.07	10.17	10.69
482164	8.29	8.76	9.33	9.63	10.07	10.17	10.69
482165	9.97	10.02	10.09	10.14	10.24	10.27	10.69
482169	8.29	8.76	9.34	9.63	10.08	10.18	10.69
482170	8.29	8.77	9.34	9.63	10.08	10.18	10.69
482172	8.29	8.76	9.34	9.63	10.08	10.18	10.69
482173	8.84	9.06	9.36	9.64	10.09	10.21	10.69
482174	9.15	9.51	10.08	10.52	11.57	11.99	11.21
482175	10.21	10.31	10.48	10.67	11.66	12.04	11.29
482180	9.30	9.55	9.80	9.96	10.28	10.37	10.89
482190	13.75	13.96	14.24	14.41	14.78	14.90	14.70
482191	14.04	14.23	14.70	15.03	15.88	16.21	16.18
482192	13.79	14.02	14.33	14.52	14.94	15.09	14.51
482193	13.80	14.04	14.40	14.62	15.18	15.38	15.30
482194	13.99	14.15	14.45	14.68	15.25	15.45	15.38
482195	16.44	16.61	16.83	16.97	17.27	17.38	17.39
482196	16.56	16.70	16.92	17.06	17.36	17.47	17.47
482197	14.04	14.22	14.50	14.72	15.26	15.47	15.43
482198	16.71	16.89	17.14	17.30	17.67	17.81	17.62
482199	16.45	16.61	16.84	16.98	17.32	17.45	17.44
482200	8.76	9.52	11.07	11.47	11.92	12.04	12.55
482204	10.15	10.63	11.12	11.50	11.95	12.13	12.60
482205	11.88	12.06	12.20	12.29	12.57	12.68	13.01
482210	10.34	10.47	11.24	11.61	12.06	12.17	12.68
482214	11.00	11.91	12.98	13.26	13.76	14.02	14.26
482215	12.84	13.02	13.27	13.46	13.92	14.14	14.31
482220	12.89	13.09	13.39	13.59	14.07	14.25	14.33
482225	12.92	13.15	13.48	13.69	14.18	14.31	14.34
482230	11.73	12.04	12.37	12.53	12.89	13.02	13.47
482235	12.21	12.38	12.61	12.75	13.07	13.18	13.11
482240	12.58	13.34	14.19	14.62	15.82	16.35	17.16

Table 1
Proposed Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
482250	13.42	13.82	14.47	14.85	15.94	16.45	17.26
482259	13.42	13.82	14.47	14.85	15.94	16.45	17.26
482260	15.69	15.78	15.92	15.99	16.07	16.45	17.26
482265	15.50	15.52	15.56	15.57	15.95	16.45	17.26
482270	15.80	15.88	15.98	16.04	16.33	16.50	17.30
482271	16.22	16.45	16.79	17.00	17.35	17.46	17.57
482272	14.23	14.66	15.35	15.93	17.55	17.93	17.01
482273	17.26	17.42	17.65	17.80	18.15	18.29	18.03
482274	16.24	16.45	16.78	16.96	17.12	17.16	17.29
482275	16.27	16.35	16.44	16.50	16.64	16.69	17.26
482280	17.09	17.18	17.32	17.42	17.66	17.75	17.75
482290	18.99	19.10	19.24	19.32	19.52	19.60	19.58
482300	18.07	18.26	18.57	18.81	19.10	19.17	19.39
482301	18.85	19.20	19.50	19.67	20.03	20.16	20.02
482302	18.89	19.26	19.60	19.80	20.22	20.37	20.19
482303	18.93	19.33	19.71	19.93	20.41	20.57	20.36
482305	15.03	15.04	15.05	15.06	15.07	15.08	15.21
482310	17.98	18.14	18.36	18.52	18.86	18.97	19.32
482315	17.92	18.04	18.21	18.32	18.58	18.67	18.92
482317	17.82	17.89	17.97	18.02	18.11	18.13	18.21
482320	18.93	19.09	19.31	19.45	19.80	19.93	20.27
482330	20.47	20.51	20.57	20.60	20.68	20.71	20.60
482340	18.07	18.26	18.56	18.76	19.03	19.15	19.40
482360	20.48	20.59	20.71	20.77	20.91	20.96	20.88
482379	16.24	16.49	16.86	17.10	17.58	17.68	17.94
482380	16.48	16.78	17.20	17.46	18.12	18.19	18.36
482390	16.16	16.41	16.66	16.76	16.96	17.09	17.45
482391	16.16	16.42	16.69	16.80	17.07	17.22	17.72
482392	17.05	17.24	17.51	17.68	18.06	18.19	18.59
482395	16.30	16.60	16.90	16.96	17.05	17.10	17.29
482400	16.67	17.05	17.52	17.78	18.33	18.53	18.74
482401	16.30	16.60	16.90	16.96	17.05	17.11	17.42
482402	17.07	17.27	17.58	17.79	18.29	18.44	18.70
482405	16.75	17.37	18.23	18.60	19.28	19.48	19.19
482410	17.07	17.28	17.59	17.79	18.30	18.48	19.04
482420	18.07	18.26	18.56	18.76	19.00	19.10	19.34
482424	16.67	17.07	17.55	17.82	18.43	18.66	18.96
482425	19.30	19.42	19.59	19.71	19.99	20.10	20.39
482440	22.16	22.52	22.94	23.10	23.35	23.43	23.49
482460	18.97	19.19	19.46	19.62	20.02	20.20	20.43
482480	21.90	22.26	22.68	22.91	23.35	23.47	23.63
482500	27.59	27.64	27.70	27.72	27.79	27.81	27.72
482510	17.59	17.90	18.30	18.47	18.85	18.99	19.07
482517	19.05	19.48	19.97	20.21	20.59	20.80	20.93
482520	20.66	20.66	20.70	20.77	20.92	20.98	21.00

Table 1
Proposed Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
482530	19.25	19.74	20.36	20.73	21.62	21.82	21.94
482540	20.10	20.58	21.20	21.57	22.15	22.29	22.38
482560	22.92	22.97	23.06	23.11	23.24	23.28	23.22
482580	23.15	23.25	23.39	23.48	23.69	23.78	23.71
482600	24.79	25.20	25.77	26.13	26.78	26.88	26.37
482601	24.70	25.09	25.64	25.99	26.62	26.72	26.21
482610	20.63	21.07	21.65	21.98	22.61	22.79	22.90
482615	20.79	21.27	22.02	22.51	23.64	24.13	24.43
482620	23.17	23.33	23.55	23.67	23.94	24.03	24.11
482630	23.59	23.88	24.29	24.50	24.93	25.08	25.19
482640	24.44	24.71	24.98	25.13	25.48	25.60	25.73
482660	24.19	24.36	24.61	24.76	25.15	25.30	25.41
482670	25.70	25.72	25.74	25.75	25.77	25.78	25.76
482680	28.48	28.60	28.77	28.87	29.08	29.16	28.97
482685	31.97	33.15	34.99	35.77	36.53	36.80	36.94
482686	35.05	35.30	35.66	35.89	36.57	36.84	36.98
482700	27.76	28.05	28.46	28.75	29.48	29.67	29.86
482720	27.99	28.33	28.81	29.12	30.06	30.44	31.61
482740	38.78	39.07	39.42	39.47	39.63	39.71	39.88
482750	38.78	39.07	39.43	39.47	40.17	40.41	40.50
482751	38.78	39.07	39.43	39.58	40.34	40.57	40.63
482760	20.66	20.66	20.85	20.98	21.24	21.33	21.38
482780	24.84	24.90	24.97	25.02	25.12	25.15	24.96
482790	23.07	23.20	23.38	23.48	23.68	23.75	23.81
482800	25.55	25.89	26.14	26.25	26.51	26.60	26.71
482820	26.05	26.10	26.23	26.30	26.52	26.61	26.73
482840	26.65	26.93	27.34	27.58	28.06	28.23	28.39
482841	31.35	31.65	32.07	32.33	32.95	33.18	33.05
482845	27.77	28.26	28.62	28.75	28.93	29.03	29.17
482848	28.64	29.24	29.90	30.18	30.57	30.81	31.33
482850	29.92	30.26	30.67	30.89	31.42	31.61	31.83
482860	35.10	35.13	35.21	35.26	35.37	35.41	35.36
482870	31.27	31.27	31.42	31.76	32.18	32.31	32.74
482890	30.66	31.08	31.64	32.02	32.68	32.81	33.23
482895	31.47	31.59	31.90	32.21	32.84	32.96	34.66
482900	33.43	33.70	34.08	34.34	34.96	35.25	36.09
482915	33.43	33.70	35.17	35.92	36.77	37.09	37.23
482920	33.43	33.70	34.22	34.58	35.44	35.77	36.82
482930	35.36	35.64	35.93	36.11	36.82	37.14	37.26
482940	34.69	34.97	35.43	35.74	36.50	36.76	36.93
482945	37.49	37.84	38.11	38.29	38.72	38.89	38.26
482950	37.76	37.90	38.16	38.33	38.76	38.93	38.29
482955	38.43	39.33	40.63	41.07	41.46	41.57	41.39
482960	39.29	39.91	40.82	41.23	41.64	41.75	41.56
482970	35.95	36.09	36.24	36.30	36.47	36.55	36.66

Table 1
Proposed Conditions Peak Stage (ft NAVD)

Node Name	Peak Stage (ft NAVD)						
	Mean Annual	5-Year/ 24-Hour	10-Year/ 24-Hour	25-Year/ 24-Hour	50-Year/ 24-Hour	100-Year/ 24-Hour	100-Year/ 120-Hour
482980	38.07	38.24	38.48	38.63	39.01	39.17	39.63
482990	39.84	39.91	40.00	40.05	40.15	40.19	40.06
482995	35.28	35.48	35.78	35.98	36.44	36.62	37.05
490030	28.04	28.30	28.67	28.87	29.29	29.45	29.83
490050	27.69	28.04	28.39	28.57	28.91	29.01	29.12
491000	20.87	21.09	21.54	22.15	22.69	22.88	23.31
491010	23.87	24.16	24.54	24.77	25.33	25.57	26.03
491019	26.92	27.19	27.66	28.05	29.11	29.43	29.54
491020	29.27	29.35	29.46	29.50	29.60	29.64	29.66
491021	29.27	29.36	29.46	29.51	29.63	29.69	29.77
491022	29.27	29.35	29.45	29.50	29.61	29.66	29.70
491040	24.52	24.74	25.02	25.26	26.18	26.66	28.20
491041	28.97	29.19	29.50	29.70	30.13	30.28	30.21
491042	28.59	28.69	28.86	28.98	29.29	29.38	29.43
491043	28.34	28.54	28.77	28.89	29.20	29.31	29.36
491044	28.90	29.11	29.41	29.61	30.09	30.24	30.18
491060	28.95	29.37	29.81	29.89	30.08	30.15	30.38
491080	28.97	29.41	29.92	30.08	30.53	30.76	31.53
491100	30.24	30.43	30.73	30.93	31.56	31.82	32.66
491102	30.92	31.07	31.28	31.41	31.70	31.82	32.67
491120	29.61	29.91	30.34	30.63	31.29	31.54	32.50
491123	33.45	33.55	33.70	33.78	33.99	34.07	34.07
491240	32.70	32.96	33.34	33.59	33.87	33.93	34.32
491260	31.14	31.32	31.55	31.71	32.07	32.22	32.92
491280	31.32	31.46	31.67	31.81	32.14	32.29	32.99
491300	31.42	31.56	31.76	31.86	32.11	32.25	32.94
491302	34.95	35.27	35.73	36.03	36.71	36.95	38.18
491340	32.35	32.77	33.36	33.74	34.39	34.58	35.11
491342	33.95	34.01	34.09	34.14	34.41	34.60	35.16
491344	37.85	37.92	38.02	38.08	38.21	38.26	38.22
491360	36.37	36.59	36.86	37.01	37.20	37.24	37.23
491380	35.00	35.21	35.49	35.62	35.85	35.93	35.95
491382	33.34	33.41	33.51	33.58	33.72	33.77	33.68
491384	32.25	32.36	32.51	32.60	32.81	32.89	32.96
491480	35.74	36.31	36.67	36.76	36.94	37.00	36.84
481504	13.45	13.54	13.71	13.82	14.09	14.20	14.23
481579	13.70	13.97	14.46	14.85	15.95	16.36	15.58
481583	14.50	14.80	15.26	15.59	16.38	16.69	17.40
481584	14.51	14.80	15.27	15.59	16.58	16.92	17.40
481591	18.06	18.48	18.73	18.85	19.12	19.21	19.38

Table 2
Proposed Conditions Level of Service (LOS)

Node	Lowest Road Overtopping Elevation	Peak Stage (ft NAVD)	Depth (ft)	25-Year/24-Hour LOS
480010	9.59	2.29	-7.30	A
480020	7.55	6.37	-1.18	A
480030	9.00	4.87	-4.13	A
480050	8.00	5.51	-2.49	A
480060	8.00	8.16	0.16	B
480065	14.29	12.33	-1.96	A
480066	17.00	14.79	-2.21	A
480080	7.00	6.76	-0.24	A
481060	9.15	3.59	-5.56	A
481065	9.15	6.14	-3.01	A
481110	9.15	3.89	-5.26	A
481112	9.15	6.91	-2.24	A
481115	5.75	3.98	-1.77	A
481120	5.75	4.66	-1.09	A
481135	7.76	4.98	-2.78	A
481150	7.15	6.63	-0.52	A
481190	10.00	9.27	-0.73	A
481200	10.00	9.29	-0.71	A
481205	9.74	9.14	-0.60	A
481210	8.95	7.12	-1.83	A
481235	14.15	10.87	-3.28	A
481240	15.15	12.37	-2.78	A
481250	14.15	10.87	-3.28	A
481260	13.16	11.25	-1.91	A
481270	13.16	12.09	-1.07	A
481275	14.15	10.88	-3.27	A
481290	17.00	13.25	-3.75	A
481300	17.00	14.80	-2.20	A
481310	17.16	16.05	-1.11	A
481330	21.00	20.46	-0.54	A
481370	11.00	8.12	-2.88	A
481380	9.06	7.06	-2.00	A
481390	8.50	8.70	0.20	B
481400	15.96	13.33	-2.63	A
481402	14.66	13.92	-0.74	A
481430	14.76	12.43	-2.33	A
481440	10.00	10.19	0.19	B
481450	13.00	12.46	-0.54	A
481455	11.00	9.13	-1.87	A
481460	11.00	9.65	-1.35	A
481480	15.16	11.39	-3.77	A
481481	11.96	9.14	-2.82	A
481500	18.10	13.72	-4.38	A
481520	15.16	11.73	-3.43	A
481548	18.16	17.82	-0.34	A
481585	16.50	14.95	-1.55	A

Table 2
Proposed Conditions Level of Service (LOS)

Node	Lowest Road Overtopping Elevation	Peak Stage (ft NAVD)	Depth (ft)	25-Year/24-Hour LOS
481586	16.50	15.58	-0.92	A
481587	16.50	16.36	-0.14	B
481588	18.00	16.66	-1.34	A
481595	21.26	19.96	-1.30	A
481600	21.26	20.52	-0.74	A
481635	25.16	21.94	-3.22	A
481640	25.16	24.27	-0.89	A
481655	21.66	20.87	-0.79	A
481660	21.66	20.60	-1.06	A
481670	22.00	20.65	-1.35	A
481675	22.00	20.69	-1.31	A
481676	22.00	20.69	-1.31	A
481677	22.00	20.69	-1.31	A
481715	22.00	20.91	-1.09	A
481720	22.00	21.02	-0.98	A
481725	22.00	22.12	0.12	B
481730	22.00	21.12	-0.88	A
481740	22.00	21.09	-0.91	A
481790	22.00	20.76	-1.24	A
481865	34.30	33.61	-0.69	A
481880	25.86	24.81	-1.05	A
481890	25.86	24.64	-1.22	A
481900	25.00	24.74	-0.26	A
481920	34.16	29.47	-4.69	A
481925	34.16	32.68	-1.48	A
481930	29.97	28.19	-1.78	A
481935	31.77	28.79	-2.98	A
481940	29.97	28.96	-1.01	A
481960	37.47	37.18	-0.29	A
481980	31.77	29.86	-1.91	A
482010	11.57	4.34	-7.23	A
482020	11.57	8.74	-2.83	A
482030	9.67	8.72	-0.95	A
482032	9.85	9.31	-0.54	A
482042	9.67	8.85	-0.82	A
482046	11.15	9.74	-1.41	A
482050	11.05	10.01	-1.04	A
482060	7.65	7.37	-0.28	A
482080	10.15	4.78	-5.37	A
482085	10.15	7.21	-2.94	A
482160	12.00	9.63	-2.37	A
482173	12.15	9.64	-2.51	A
482200	11.52	11.47	-0.05	A
482215	14.15	13.46	-0.69	A
482220	14.15	13.59	-0.56	A
482225	14.15	13.69	-0.46	A

Table 2
Proposed Conditions Level of Service (LOS)

Node	Lowest Road Overtopping Elevation	Peak Stage (ft NAVD)	Depth (ft)	25-Year/24-Hour LOS
482230	17.20	12.53	-4.67	A
482240	17.20	14.62	-2.58	A
482271	17.00	17.00	0.00	A
482275	18.00	16.50	-1.50	A
482310	20.16	18.52	-1.64	A
482320	20.16	19.45	-0.71	A
482340	20.66	18.76	-1.90	A
482360	21.36	20.77	-0.59	A
482380	18.00	17.46	-0.54	A
482395	16.86	16.96	0.10	B
482400	23.16	17.78	-5.38	A
482405	23.16	18.60	-4.56	A
482410	20.00	17.79	-2.21	A
482440	24.02	23.10	-0.92	A
482460	21.66	19.62	-2.04	A
482480	23.29	22.91	-0.38	A
482500	29.00	27.72	-1.28	A
482510	20.66	18.47	-2.19	A
482610	25.46	21.98	-3.48	A
482615	25.46	22.51	-2.95	A
482660	29.57	24.76	-4.81	A
482700	29.57	28.75	-0.82	A
482720	37.87	29.12	-8.75	A
482780	27.00	25.02	-1.98	A
482820	27.00	26.30	-0.70	A
482845	32.37	28.75	-3.62	A
482848	32.37	30.18	-2.19	A
482850	35.00	30.89	-4.11	A
482890	34.47	32.02	-2.45	A
482895	34.47	32.21	-2.26	A
482900	35.77	34.34	-1.43	A
482920	37.67	34.58	-3.09	A
482930	37.87	36.11	-1.76	A
482940	36.67	35.74	-0.93	A
482950	40.00	38.33	-1.67	A
482970	38.47	36.30	-2.17	A
482980	42.00	38.63	-3.37	A
482995	38.67	35.98	-2.69	A
490030	29.96	28.87	-1.09	A
490050	28.66	28.57	-0.09	A
491010	28.46	24.77	-3.69	A
491040	28.46	25.26	-3.20	A
491080	31.26	30.08	-1.18	A
491100	32.66	30.93	-1.73	A
491120	32.50	30.63	-1.87	A
491240	33.66	33.59	-0.07	A

Table 2
Proposed Conditions Level of Service (LOS)

Node	Lowest Road Overtopping Elevation	Peak Stage (ft NAVD)	Depth (ft)	25-Year/24-Hour LOS
491260	33.66	31.71	-1.95	A
491280	34.17	31.81	-2.36	A
491300	39.00	31.86	-7.14	A
491302	39.00	36.03	-2.97	A
491340	34.17	33.74	-0.43	A
491342	35.46	34.14	-1.32	A
491360	37.07	37.01	-0.06	A