CITY OF TAMPA, FLORIDA - RFQ
c/o Contract Administration Department
306 East Jackson Street #280A4N
Tampa, Florida 33602

21-D-00043; Sulphur Springs Flow Augmentation Feasibility Study

PUBLIC ANNOUNCEMENT IN COMPLIANCE WITH REQUIREMENTS OF SECTION 287.055, FLORIDA STATUTES (CONSULTANTS' COMPETITIVE NEGOTIATION ACT) APPLICABLE LAW, EXECUTIVE ORDERS, RULES, REGULATIONS, AND THE CITY'S STANDARD PROCEDURES. A NOTICE OF INTENT TO AWARD SHALL BE POSTED, IF AT ALL, ON THE CITY'S WEBSITE ACCESSIBLE BY UTILIZING THIS WEBSITE LINK: www.tampagov.net/contract-administration/programs/architectural-engineering-construction-and-related-rfqs .

The City of Tampa Water Department desires to obtain Professional Engineering Services to develop a feasibility study to investigate routing surface water from Curiosity Creek high flow events, options to store and treat excess storm water, and mechanisms to reduce salinity and improve flow to Sulphur Springs and ultimately the Lower Hillsborough River to be considered as augmentation freshwater sources to assist in meeting the Sulphur Springs Run Minimum Flows established by Southwest Florida Water Management District.

The selected firm is expected to perform engineering investigations, groundwater and stormwater modeling, evaluation of alternatives and all related work as part of the feasibility study. Key tasks to be performed are:

- refine the SEAWAT model previously developed for another project to understand the benefit of freshwater augmentation to Sulphur Springs.
- expand the Hillsborough County's Curiosity Creek stormwater model to include additional City of Tampa areas.
- evaluate storage and pumping including existing and new facilities.
- evaluate natural system connectivity (ponds, lakes, Curiosity Creek, sinks, caverns and springs) and perform hydrogeologic field investigation including review of prior studies and investigations
- investigate alternatives to accomplish project goals. and provide an Alternatives Analysis Report for this task. Cost information shall be included.
- investigate sources causing clogging of sinks and caverns and removal solution development.

The project is expected to be performed over multiple years with an overall $640,000 for the feasibility study. If SEAWAT modeling results do not demonstrate feasibility, then the subsequent tasks will not be performed and the project will not move forward.

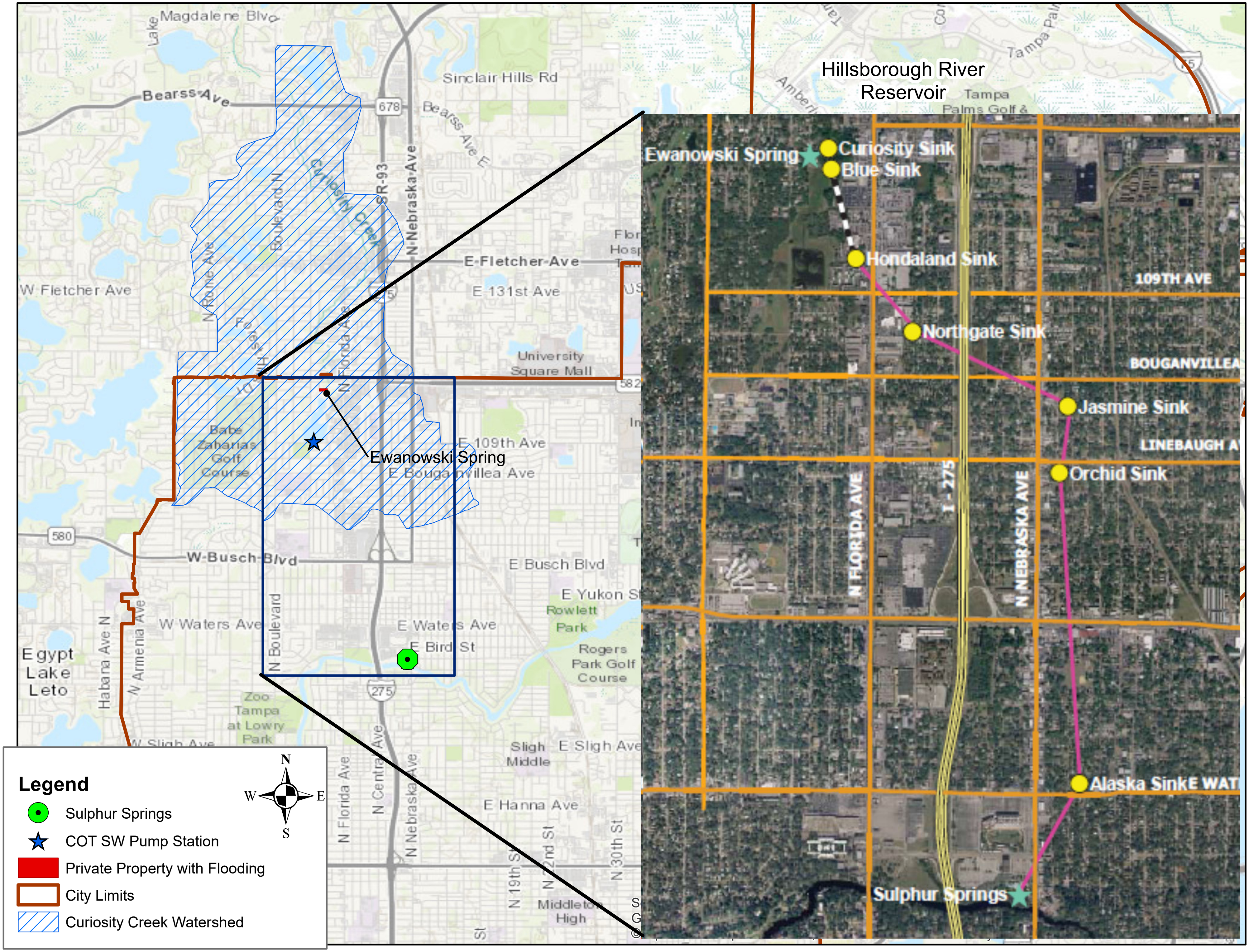
Additional material may be found at demandstar.com and at: www.tampagov.net/contract-administration/programs/architectural-engineering-construction-and-related-rfqs
Questions may be directed to Jim Greiner, P.E., Contract Administration, City of Tampa, (813) 274-8598, or E-Mail jim.greiner@tampagov.net.

An individual or entity ("Firm") responding to this RFQ must provide evidence of any required licenses, certificates, or registrations with its submission or within 10 days thereof in order to be considered. The City shall own all ideas, documents, plans, and materials developed as a result of this solicitation and Firm is informed same shall be subject to reuse in accordance with Section 287.055(10), Florida Statutes. Firm (i) confirms it has read and is familiar with Section 119.071(3), Florida Statutes regarding certain building plans, blueprints, schematic drawings, which depict the internal layout and structural elements of a building, facility, or other structure owned or operated by the City or other agency that are per said section exempt from Section 119.07(1), Florida Statutes and Section 24(a), Art. I of the Florida Constitution ("Exempt Plans") and (ii) agrees Firm shall remain in compliance with same, including maintaining the exempt status of such Exempt Plans for so long as they are held by Firm or otherwise in its possession. Pursuant to Section 2-282, City of Tampa Code, during the solicitation period, including any protest or appeal, NO CONTACT with City officers or employees is permitted from any proposer, other than as specifically stated in this solicitation. The City may cancel, withdraw, or modify this RFQ at any time and reserves the right to reject any or all responses and to waive irregularities, formalities, and informalities as it determines in the City's best interest.

Firms desiring to provide these services to the City must submit a single electronic file in searchable PDF format, Smaller than 5MB, that includes the attached RFQ Transmittal Memorandum completed as appropriate, a Letter of Interest addressed to Brad L, Baird, P.E., Chairman, and referring to this RFQ by number, together with a Statement of Qualifications and any supplemental material allowing evaluation for further consideration (short-listing) based upon the following criteria/point system: Successful Comparable Project Experience, (65 pts); Workload and Availability (5 pts); Past performance/Low amount of City work (5 pts); Standard Form #330 or similar data (5 pts); Planned WMBE/SLBE Solicitation & Utilization, Form MBD 10 & 20 (20 pts).

The PDF file must be **E-Mailed to ContractAdministration@tampagov.net BEFORE 2 P.M., July 29, 2021.** As a courtesy, the City will endeavor provide an email acknowledgement usually sent within a few days after submission receipt (submissions received on the day of the deadline may not be acknowledged before the deadline or at all). It is Firm's responsibility to confirm its submission (PDF file) has been received.

Figure 1 - Project Location Map



The fate of an urban spring: pumping-induced seawater intrusion in Sulphur Springs Cave

A report prepared for the City of Tampa by:

Robert J. Scharping, K. Michael Garman, Ryan P. Henry, Prahathees J. Eswara, and James R. Garey

University of South Florida, Department of Cell Biology, Microbiology, and Molecular Biology

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Abstract

Sulphur Springs Cave is an extensive phreatic cavity that produces a large, historic spring in the middle of metropolitan Tampa, Florida, USA. The city of Tampa extracts groundwater from the spring to supplement municipal water supply and to support low-salinity habitat in the estuarine Hillsborough River. Extraction at this site has occurred for many decades, but has intensified since the early 2000s, rapidly increasing the salinity of the spring and cave water. The purpose of this study was to address the potential mechanisms of seawater intrusion at this site using historical and current high-resolution data published in the literature and in online databases. We also deployed probes within the cave to measure specific conductance, temperature, dissolved oxygen, pH, and discharge. We examined the Sulphur Springs hydrogeologic system on a regional scale, and explored the cave to identify point-sources of saltwater intrusion. We collected water and biological samples from inside the cave to identify potential ecosystem impacts of increasing cave salinity. We found numerous vents in the cave which issue warm, saline, sulfidic water and host distinct microbial mat communities. These vents are likely connected to bedrock fractures that provide preferential flow-paths along which deep-sourced saline water enters the freshwater portion of the aquifer. Cave-water salinity not only increased during dry-season pumping activity but also throughout wet seasons, likely because artesian recharge from regional topographic highs disproportionately pressurizes saline water which lies beneath aquitards. Sulphur Springs salinity increased both during wet and dry seasons due to artesian recharge and pumping activity, respectively, which may disrupt the cave microbe and stygobite communities and eventually make the spring unsuitable to maintain low-salinity habitat in the Hillsborough River.

Introduction

Coastal aquifers, vertical seawater intrusion, and urban caves

A mixing zone interface between fresh groundwater and the underlying seawater wedge is characteristically present in many coastal aquifers, though identifying the coastal mixing zone is not as simple as was once believed (Weyer 2018). A complicated relationship between land surface topography, groundwater hydrodynamics, and human aquifer development defines mixing zone shape and behavior. Artesian recharge to topographic highs can pressurize the seawater wedge in low-lying coastal areas, causing saline groundwater to seep upward into freshwater portions of the aquifer (Van Rees Vellinga et al. 1981). In a regional flow system with sufficient topographic relief, artesian recharge can pressurize discharge zones hundreds of kilometers away. For example, coastal discharge zones throughout south Florida are primarily recharged in the central Florida uplands, producing flow systems stretching more than 300 km (Weyer 2018). Anthropogenic development of coastal groundwater resources can deform the mixing zone. Groundwater extraction generates low-pressure zones directly below wells, causing the saltwater-freshwater interface to cone upward (reviewed by Bower et al. 1999). Based on extraction rate, freshwater head position and sea level, the saltwater cone can reach a stable state some distance below the bottom of the well. If the cone rises past a critical point, it becomes unstable and the well begins to draw saline water. On coasts with more diffuse mixing zones, a well can upcone and draw shallow saline water long before the deeper main interface is deformed (Bear et al. 2001). Groundwater extraction can therefore expand the coastal mixing zone toward the surface. Modeling saltwater upconing both nearby and distal to an active well, Jakovivic et al. (2016) found that the mixing zone disproportionately widens in the immediate vicinity of a well.

Preferential groundwater flow-paths can further complicate interpretations of aquifer dynamics, as has been shown in coastal systems (e.g., deLouw et al. 2010), as well as in lacustrine (e.g., Kishel and Gerla 2002) and hyporheic (e.g., LaSage et al. 2008, Kalbus et al. 2009) environments. Preferential flow-paths such as fractures, karstic voids, or conduits of high-conductivity sediment types offer paths of least resistance along which deep-sourced saline groundwater can infiltrate into shallower, freshwater aquifer units. In the coastal Netherlands, sand boils vent deep-sourced saline water through fresh groundwater layers into overlying surface water (deLouw et al. 2010). The boils are fed by sand-filled fractures that penetrate underlying confining units. Groundwater venting from the boils originates from the saltwater wedge, which is under high artesian pressure from recharge to topographic highs tens of km away. The discharge rate and low head of the boils cause the underlying mixing zone to upcone, similar to the mechanism that Tellam et al. (1986) presented in the context of saltwater upconing below springs in Mersey Valley, UK. Both studies likened these examples of natural saltwater upconing to that which is induced by groundwater extraction.

Caves are physical manifestations of aquifer hydrodynamic processes. This is especially true concerning phreatic caves, which are preferential groundwater flow-paths large enough to transmit water rapidly and turbulently. Freshwater phreatic caves beneath coastal human population centers could be subject to problems associated with mixing zone deformation if groundwater extraction occurs nearby or from the cave directly. Sulphur Springs Cave is an extensive underwater cavity developed beneath Tampa, Florida, USA. The cave discharges groundwater to a surface pool, from which the city of Tampa extracts water.

Sulphur Springs Cave

Sulphur Springs Cave is a phreatic void developed in the eogenetic limestone beneath Tampa, Florida (Fig. 1). Eogenetic karst develops in young limestones which have maintained their initial primary porosity, such that diffuse matrix flow and storage occur simultaneously with fracture/karst hydrodynamics (Vacher and Mylroie 2002). About 1 km of the cave conduit has been mapped by divers. The cave consists of a Main Tunnel which splits into two smaller passages: the Orchid Tunnel and Alaska Tunnel. The tunnels lie at a water depth of ~30 m. About 25% of Sulphur Springs Cave passageway is higher than it is wide, compared to the 10% exhibited by most Floridan caves (Garman 2010), suggesting the importance of vertical bedrock fracturing in the speleogenesis of Sulphur Springs Cave.

Groundwater from the confined Upper Floridan Aquifer flows through the Sulphur Springs tunnels toward the cave mouth, producing an artesian spring. The cave mouth is less than 1 m high and 2 m wide, and is submerged in a ~10 m deep pool. The pool was impounded by the city of Tampa in the early twentieth century to create a public swimming area. The pool was used as such until the 1980s, when fecal coliforms were detected and the pool was closed to swimming. Pumps were installed at Sulphur Springs pool in 1964, when the city started using spring water to replenish the Hillsborough River Reservoir during droughts. In 2002, the pumping system was modified to allow extracted spring water to be diverted to below the reservoir dam to support the downstream Lower Hillsborough River (SWFWMD 2004, SWFWMD 2006). Diverted spring water maintains low-salinity habitat and manatee thermal refuge in this estuary. When spring water is not pumped, it overflows from the impounded pool into the Hillsborough River ~4 km downstream of the dam. When pumps are active, the pool level can drop ~1 m and water no longer flows over the spillway flumes.

The dynamics of the spring pool have been monitored and studied since the 1940s (see Menke et al. 1961, Rosenau et al. 1977, Stewart and Mills 1984). Specific conductance of the spring water increases when the pool is lowered, regardless of local aquifer head position. Water quality of the spring and cave can thus be maintained by controlling pool depth, yet the specific conductance of the spring water has increased gradually over the past century and rapidly over the past two decades (Fig. 2). The purpose of this current study was to explain the increase in spring water salinity observed at Sulphur Springs and to identify potential impacts of salinity increase on the underlying cave ecosystem.

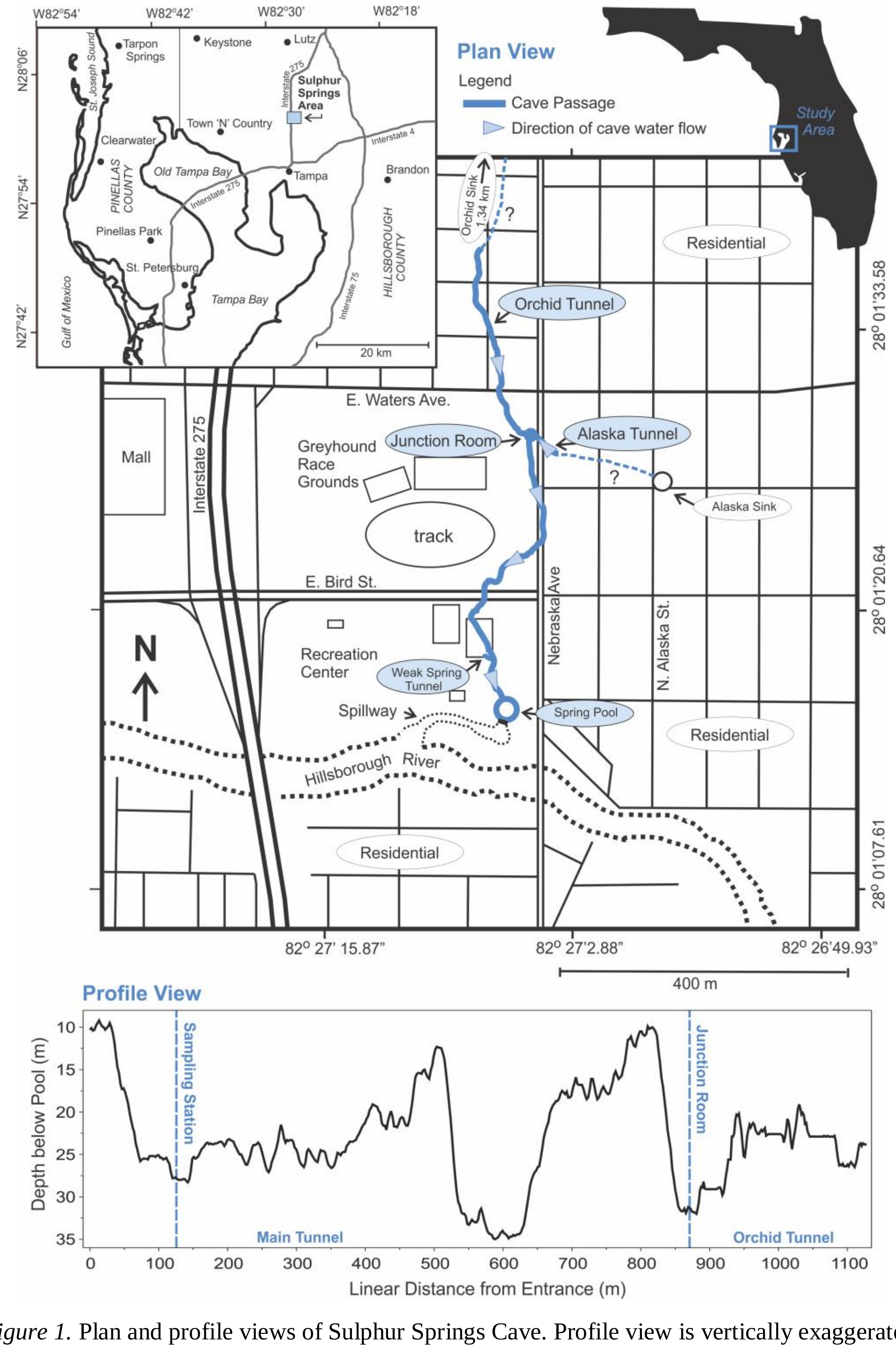

Figure 1. Plan and profile views of Sulphur Springs Cave. Profile view is vertically exaggerated.

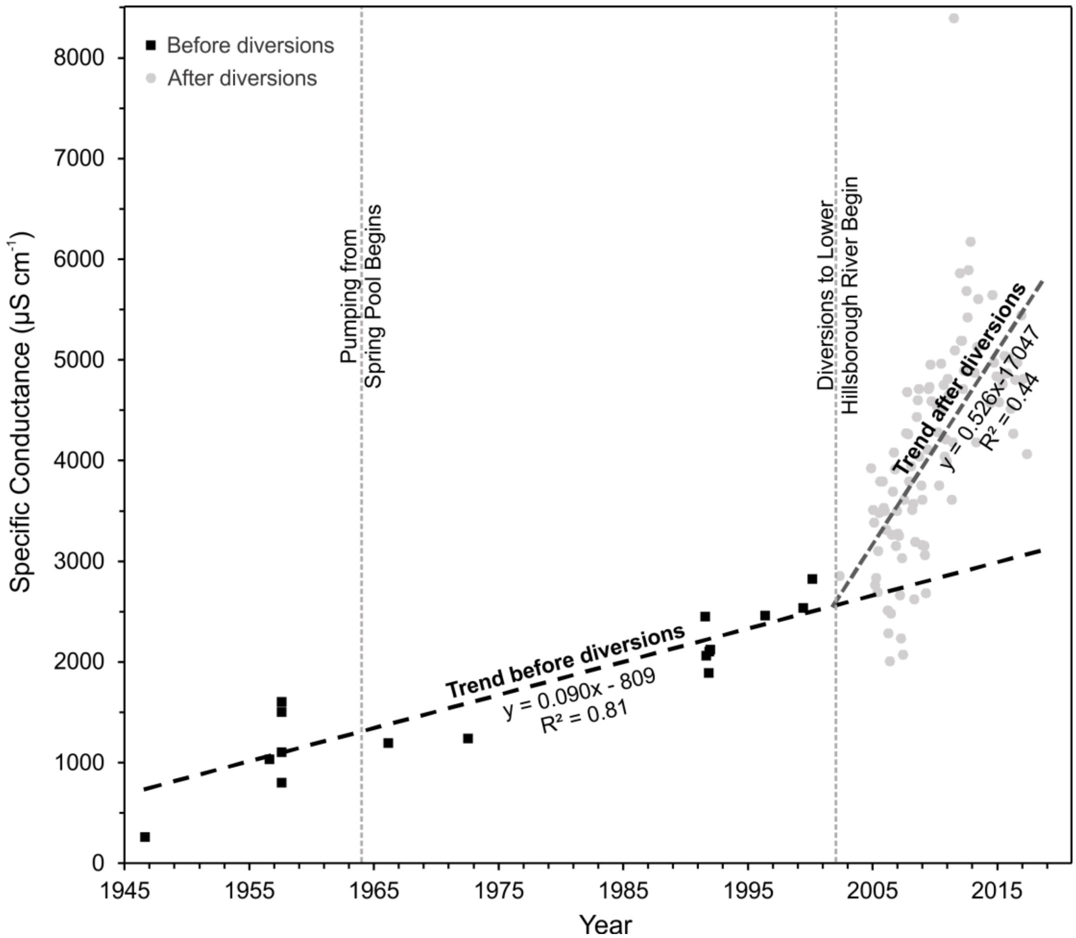

Figure 2. Specific conductance values measured at the Sulphur Springs pool from 1946 to 2017. Two linear regressions were generated from datasets 1) years 1946-2000 and 2) years 2002-2017.

Deterioration of Sulphur Springs Water Quality

North of Sulphur Springs Cave, swallets and sinkholes are present which have historically contributed to Sulphur Springs recharge (Menke et al. 1961). However, direct connections between important swallets (i.e., Curiosity Sink, Blue Sink) and Sulphur Springs have been blocked since the 1980s (EEC 1990; Schreuder 1997, 2001). Although these discrete connections have been thoroughly investigated, the contribution of diffuse recharge to Sulphur Springs has largely been ignored.

Stewart and Mills (1984) found a strong correlation ($R^2 = 0.90$) between the discharge of Sulphur Springs and the water level at a nearby well. This relationship indicates a connection between cave water and surrounding matrix-stored groundwater. Florida limestone has maintained much of its primary (matrix) porositiy, which communicates easily with any secondary (fracture/cave) porositiy that has developed (e.g., Martin and Dean 2001). Thus the response of Florida springs to recharge is less punctuated than that of springs primarily fed by swallet/sinkhole-focused recharge (Florea and Vacher 2006). The contribution of matrix-stored groundwater to spring discharge is especially important in Florida, where evapotranspiration prevents most of wet season precipitation from reaching the aquifer (Martin and Gordon 2000, Florea and Vacher 2007).

Because discrete recharge is relatively unimportant to Florida springs and because the deterioration of Sulphur Springs water quality was noticed before the 1980s (Rosenau et al. 1977), the loss of communication with local freshwater swallets is probably not the primary cause of the increasing spring water salinity. Additionally, municipal spring water extraction occurs only during the dry season when water is needed, so the pumping-induced reduction of spring pool head cannot totally explain the salinity increase. Hydraulic head levels of distant, diffuse recharge areas probably drive the hydrological regime of Sulphur Springs Cave. Examination of Sulphur Springs Cave regional hydrogeology should explain the deterioration of water quality at this site.

Materials and Methods

Data collection and analysis

Major ion (Na^+, K^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, Cl^-, alkalinity), specific conductance, water level, and discharge measurements from Sulphur Springs pool and nearby wells were collected and published by the Southwest Florida Water Management District (SWFWMD; watermatters.org) and by USGS (usgs.gov). Precipitation in the recharge area was measured at the Green Swamp Tower (SWFWMD station 19053), and local precipitation was measured on the Hillsborough River near Sulphur Springs (SWFWMD station 19436). Precipitation data were also published online by SWFWMD. We used GW Chart v.1.29 (Winston 2000) to generate Piper diagrams of major ion concentrations from Sulphur Springs and associated wells.

Although a USGS monitoring station was set up in Sulphur Springs pool, there were no stations deployed within the underlying cave. We deployed a long term monitoring station and collected samples for laboratory analysis ~100 m linearly into the cave (Fig. 1). We deployed multiprobes (Hydrolab Datasonde, Hach, USA) at this station to record continuous depth, temperature, pH, dissolved oxygen, and specific conductance profiles. We used a spectrophotometer (DR 3900, Hach, USA) to measure total organic carbon, sulfate, sulfide, ammonia, nitrite, nitrate, phosphate, and alkalinity concentrations of discrete water samples collected in replicates of 3 at the station. We collected cave water samples in glass jars with Teflon-lined lids. These jars were acid-washed and filled with sterile, organic-free water until the moment of collection, when they were each purged 3 times with helium.

Scuba diving through cave passages allows direct observation of aquifer dynamics and the sampling of water while it remains underground, relatively unaffected by surface conditions (e.g., Beddows et al. 2007). Such field work allows researchers to isolate features or organisms that may have a disproportionate impact on the groundwater ecosystem (e.g., Brigmon et al. 1994), rather than relying on well bore samples. Sampling was conducted by trained scientific cave divers under the auspices of the University of South Florida Scientific Diving Program.

Microbial mat was sampled from the cave walls 5 m upstream from the monitoring station and from a vent located 30 m downstream using10 mL syringes that were filled with sterile, organic-free water until collection. Mat samples were gently homogenized and four 100-µL subsamples individually mixed with 1x phosphate buffered saline solution. Ten µL of each subsample was mixed with 2 µL of 2 µg mL^{-1} (final concentration) DAPI stain and 2 µL of 1 µg mL^{-1} (final concentration) FM4-64 membrane dye. Samples (5 µL) were placed on glass bottom culture dishes (MatTek Corp., USA) and covered using 1% agarose pads made with distilled water and multiple fields imaged using fluorescence microscopy (DeltaVision Elite, GE, USA).

The *pcor.test* function of Program R v.3.4.3 was used to run partial correlation analyses (*ppcor* package; Kim 2015) and the *ccf* function was used for cross-correlations (from *stats* package; R Development Core Team 2008). We ran partial correlation analyses (PCA) to calculate correlation coefficients between two variables while controlling for a third variable. Cross-correlation analyses calculated correlation coefficients between two time-series datasets as one of the datasets was incrementally shifted, providing lag time information between the datasets (e.g., aquifer level and spring discharge). Only lag times with the highest correlation coefficient from each analysis were reported in this study. Alpha values of 0.05 were used for partial correlations.

Results and Discussion

Hydrogeology/site description of the Sulphur Springs System

Three principal lithologic sequences underlie the Tampa Bay region. The uppermost sequence is a collection of unconsolidated sands, clays, and other sediments (Holocene and Pleistocene), which confine an underlying limestone/dolomite sequence. In descending order, this limestone sequence includes the Tampa Limestone (Miocene/Oligocene; a member of the Arcadia Formation, Hawthorn Group), Suwannee Limestone (Oligocene), Ocala Limestone (Eocene), and the Avon Park Formation (Eocene). The Tampa Limestone contains layers of sand and clay, and acts as an additional confining unit. These limestones dip from the northeast, where the Suwannee and Ocala Limestones are exposed at land surface, to the southwest where they are confined (Fig. 3). The Tampa Limestone is exposed throughout the Hillsborough River basin (Fig. 3). Below this limestone sequence lies a gypsiferous limestone/dolomite sequence which is confined by the lower part of the Avon Park Formation.

These sequences host two distinct aquifers (Parker et al. 1955). The Surficial Aquifer resides in the shallow clastic sediments, while the Floridan Aquifer lays within the limestones. The Floridan Aquifer is separated into Upper and Lower zones by the Avon Park confining bed (Miller 1986). The Upper Floridan Aquifer is hosted by the younger, non-gypsiferous limestone sequence, while the Lower Floridan Aquifer is resides in the older, gypsiferous limestones. The Upper Floridan Aquifer near Sulphur Springs is further divided into two distinct hydrological units (SWFWMD 1988). The shallower hydrological unit consists of the Suwannee and Ocala Limestones, and the upper and lower boundaries of the Suwannee Limestone are the most permeable parts of this unit (Fig. 3). In the Sulphur Springs area, the mid-Suwannee Limestone is comprised of thick, wackestone-rich layers, which could confine the underlying Suwannee/Ocala interface (O'Sullivan and Werner 1991). Beneath the Suwannee/Ocala interface is the wackestone-rich Ocala Limestone which semiconfines the fractured, dolomitic Avon Park Formation. The Avon Park Formation hosts the second major hydrological unit of the Upper Floridan Aquifer. Horizontal hydraulic conductivity in the Upper Floridan Aquifer can range from as low as 0.16 m d^{-1} in Suwannee Limestone with an effective porosity of 21% (Robinson 1995), to as high as 6.1×10^3 m d^{-1}, measured by dye tracing in the highly cavernous Tampa/Suwannee interface beneath the city of Tampa (Stewart and Mills 1984).

Based on its depth and horizontally-persistent morphology, Sulphur Springs Cave is likely developed along the cavernous Tampa/Suwannee interface (Figs. 1 & 3). Precipitation entering exposures of the Suwannee Limestone is probably important to the artesian recharge of Sulphur Springs. We therefore used the water level recorded at the monitoring well ROMP 87 as a measure of regional recharge to the Sulphur Springs system (Fig. 3, Table 1). This well is bored near a large, high-elevation exposure of Suwannee Limestone, and is screened at a shallow interval of this limestone. The Upper Floridan Aquifer measured at ROMP 87 is not artesian, i.e., water level in the well never exceeds land surface elevation.

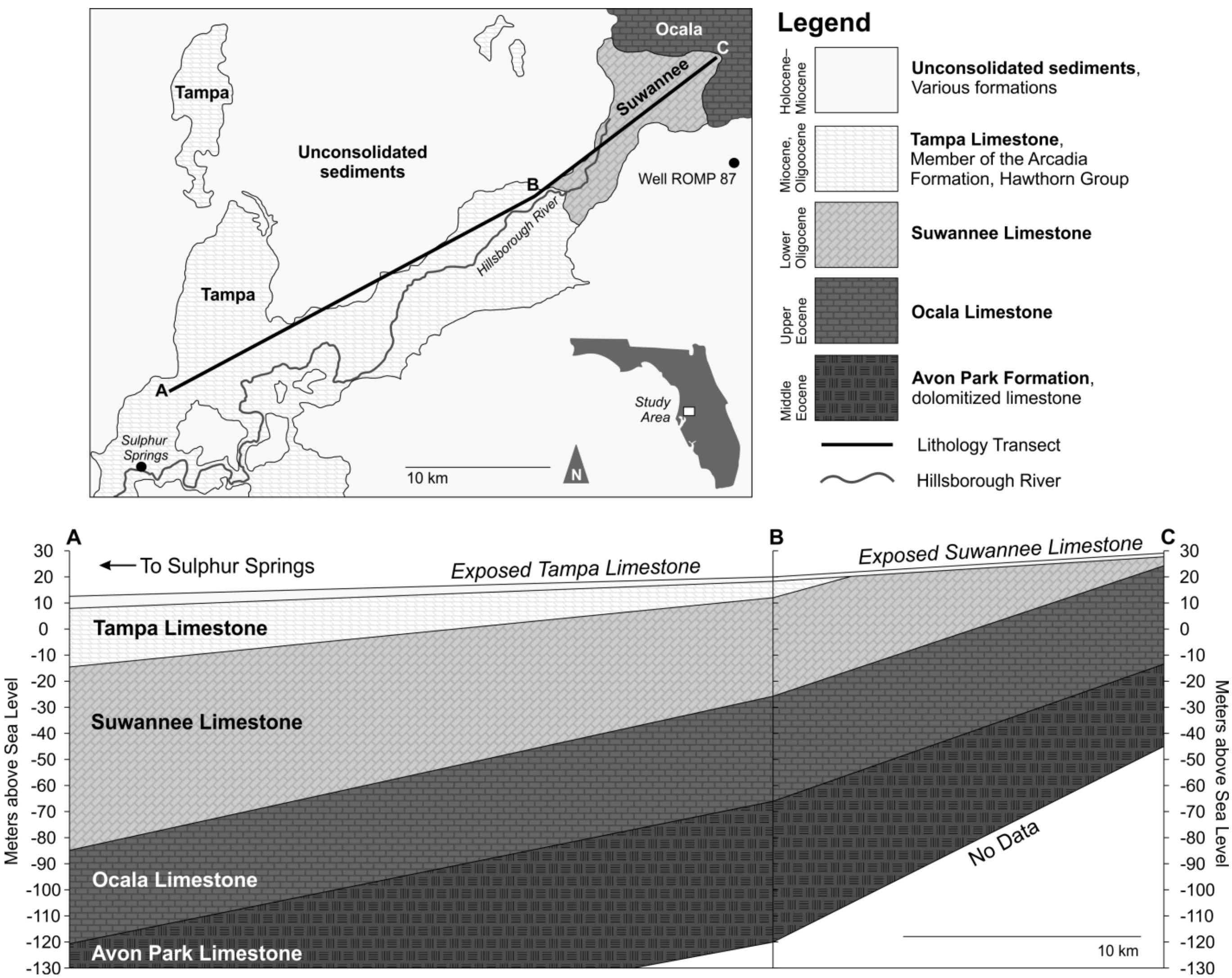

Figure 3. Surface geology and lithology transects of the Sulphur Springs area. Surface geology map was redrawn from maps published online by the Florida Geological Survey (Green et al. 2012). Lithology transects A, B, and C shown in this figure correspond to Florida Geological Survey wells W-5069, W-17991, and W-19364, respectively.

Table 1. Details of the wells examined in this study, including recent specific conductance and chloride concentration measurements

Well Information					*Most Recent Measurement*		
Well Name	**Identifier**	**Open Interval (m)**	**Land Surface Elevation (m above NAVD88)**	**Geology of Open Interval**	**SpCond (μS cm^{-1})**	**Chloride (mg/L)**	**Date measured**
ROMP 87	18827	9-12	33	Suwannee Limestone	481	15	5/5/1999
ROMP 66	18670	13-76	11	Tampa Limestone, Sand, Clay	333	15	6/30/1999
Sligh Park: Shallow	19230	88-119	8	Suwannee Limestone, Ocala Limestone	434	34	5/19/2017
Sligh Park: Deep	18657	219-235	8	Avon Park Formation	5586	1520	5/19/2017
Hillsborough Dam: Suwannee	18627	46-55	11	Suwannee Limestone	890	130	3/15/2017
Hillsborough Dam: Ocala	18626	139-155	12	Ocala Limestone	4442	1170	6/16/2017
Hillsborough Dam: Avon Park	18628	190-221	11	Avon Park Formation	7675	2120	6/29/2010
Tourist Club	18624	24-97	2	Tampa Limestone, Suwannee Limestone	9917	2960	2/14/2017
Kinder Morgan	670322	43-302	2	Suwannee, Ocala, Avon Park Limestones	53420	18300	7/12/2006

Table 2. Partial correlation analysis results (A) and summary statistics (B) of Sulphur Springs specific conductance trends as explained by the hydraulic head of the aquifer and discharge pool

A. Partial Correlation Analyses

Partial Correlation Analysis: Whole dataset (n=2940)					
Variable 1	*Variable 2*	*Control*	***Correlation***	*Statistic*	*p value (a=0.05)*
Aquif Level	Pool Level	Time	0.54	34.9	<0.001
Aquif Level	SpCond	Pool Level	**0.60**	40.9	<0.001
Pool Level	SpCond	Aquif Level	**-0.74**	-59.5	0
Pool Level Explained Trends, Pool Level < 1.8 m asl (n=811)					
Variable 1	*Variable 2*	*Control*	***Correlation***	*Statistic*	*p value (a=0.05)*
Aquif Level	Pool Level	Time	-0.11	-3.25	0.001
Aquif Level	SpCond	Pool Level	**0.68**	26.2	<0.001
Pool Level	SpCond	Aquif Level	**-0.76**	-33.0	<0.001
Aquifer Level Explained Trends, Pool Level > 1.8 m asl (n=2129)					
Variable 1	*Variable 2*	*Control*	***Correlation***	*Statistic*	*p value (a=0.05)*
Aquif Level	Pool Level	Time	0.61	35.8	<0.001
Aquif Level	SpCond	Pool Level	**0.33**	16.2	<0.001
Pool Level	SpCond	Aquif Level	**0.11**	5.26	<0.001

B. Summary Statistics

Summary Statistics							
SpCond	*Min*	*1st Q.*	*Median*	***Mean***	*3rd Q.*	*Max*	*n*
Whole Dataset	3070	4550	4880	**4910**	5230	8230	2940
Pumping	3070	4890	5260	**5342**	5680	8230	811
No Pumping	3270	4460	4790	**4745**	5040	6140	2129
Aquifer Level	*Min*	*1st Q.*	*Median*	***Mean***	*3rd Q.*	*Max*	*n*
Whole Dataset	29.79	31.07	31.44	**31.63**	31.76	32.24	2940
Pumping	29.79	30.46	30.93	**30.84**	31.15	31.91	811
No Pumping	30.24	31.32	31.59	**31.55**	31.83	32.24	2129
Pool Level	*Min*	*1st Q.*	*Median*	***Mean***	*3rd Q.*	*Max*	*n*
Whole Dataset	-0.1219	1.7221	1.908	**1.7158**	1.9446	2.0452	2940
Pumping	-0.1219	0.858	1.278	**1.1682**	1.5987	1.7983	811
No Pumping	1.801	1.902	1.923	**1.924**	1.957	2.045	2129

Specific conductance relationship to hydraulic head

Compared to the trend observed from 1946-2002, specific conductance at Sulphur Springs began increasing rapidly after 2002, the year that spring water diversions to the Lower Hillsborough River began (Fig. 2). Continuous monitoring of Sulphur Springs pool began in October 2009, when the USGS installed a gauge in the pool that recorded specific conductance, pool level, and discharge once every 15 min. These data allowed for a high-resolution examination of Sulphur Springs specific conductance trends. Concurrent to these data were those collected at the ROMP 87 monitor well, which was located near the high-elevation Suwannee Limestone exposure northeast of Sulphur Springs (Fig. 3, Table 1). Water level in the Suwannee Limestone was recorded in this well once daily. The continuous specific conductance profile of Sulphur Springs pool closely corresponded to the water level in the Suwannee Limestone exposure, except during instances of intense spring water extraction (Fig. 4). All specific conductance values recorded during this study period were higher than those predicted by the pre-diversion specific conductance trend generated from data collected from 1946-2002 (Figs. 2 & 4).

Rapid specific conductance spikes in the Sulphur Springs chemograph corresponded strikingly to intense pumping activity, indicated in this analysis by pool levels lower than 1.8 m asl (above sea level). At levels below 1.8 m asl, Sulphur Springs pool water was too low to flow over its spillway flumes, indicating that the rate of extraction was higher than the rate of spring discharge. During these periods of pumping, specific conductance was strongly negatively correlated to pool level (PCA controlling for aquifer level: $r = -0.76$, $p < 0.001$, $n = 811$; Table 2; Fig. 4). When pool level remained above 1.8 m asl, specific conductance spikes still occasionally occurred, but correlated more strongly to recharge level in the Suwannee Limestone than to pool level (PCA controlling for pool level: $r = 0.33$, $p < 0.001$, $n = 2129$; Table 2; Fig. 4). Throughout the entire study period, the specific conductance of Sulphur Springs pool best correlated to pool level, while aquifer level had a lesser affect (PCA controlling for aquifer level: $r = -0.74$, $p < 0.001$, $n = 2940$; PCA controlling for pool level: $r = 0.60$, $p < 0.001$, $n = 2940$; Table 2). Recharge level and pool level best corresponded to each other when pool level remained above 1.8 m asl, exhibiting a strong positive correlation (PCA controlling for time: $r = 0.61$, $p < 0.001$, $n = 2129$; Table 2; Fig. 4).

Wet season 2017 hydrograph analysis

Discharge from Sulphur Springs was measured by a USGS gauge as pool water flowed over spillway flumes into the Hillsborough River. Seasonal groundwater extraction at this site lowered the pool level to a point at which spring water would no longer overflow its impoundment, making it impossible to analyze yearly discharge trends from the spring. Pumps were inactive between 17 June and 30 November 2017, allowing at least for an analysis of wet season discharge during this year.

Aquifer level and spring discharge increased throughout this period, peaking with Hurricane Irma (10 September 2017, Fig. 5). Cross-correlation analysis showed that the level of the Upper Floridan Aquifer hosted by the Suwannee Limestone exposure responded to rainfall within 1 d (measured at ROMP 87). Discharge from Sulphur Springs responded immediately to recharge to the Suwannee Limestone exposure, the two hydrographs correlating with an $R^2 = 0.67$. The ratio of the maximum to mean discharge observed over this period was 1.4.

Sulphur Springs specific conductance dropped 2 d after local rainfall events. This lag matched the time it took for tracer dye to reach Sulphur Springs when injected into nearby sinkholes (Stewart and Mills 1984). Specific conductance correlated weakly to spring discharge during this period ($R^2 = 0.40$), but specific conductance remained high while discharge rate dropped during the latter half of the wet season (Fig. 5). The specific conductance chemograph lagged 25 days behind the recharge hydrograph. Specific conductance eventually dropped in the beginning of November 2017, but shouldered on about the tenth day of that month. This trend corresponded to a flattening-out of aquifer level in the Suwannee Limestone (Fig. 5). This head trend was not observed at any other well in the area (e.g., ROMP 66; Fig. 5), and did not correspond to any rainfall events. Groundwater extraction resumed immediately after 30 November 2017.

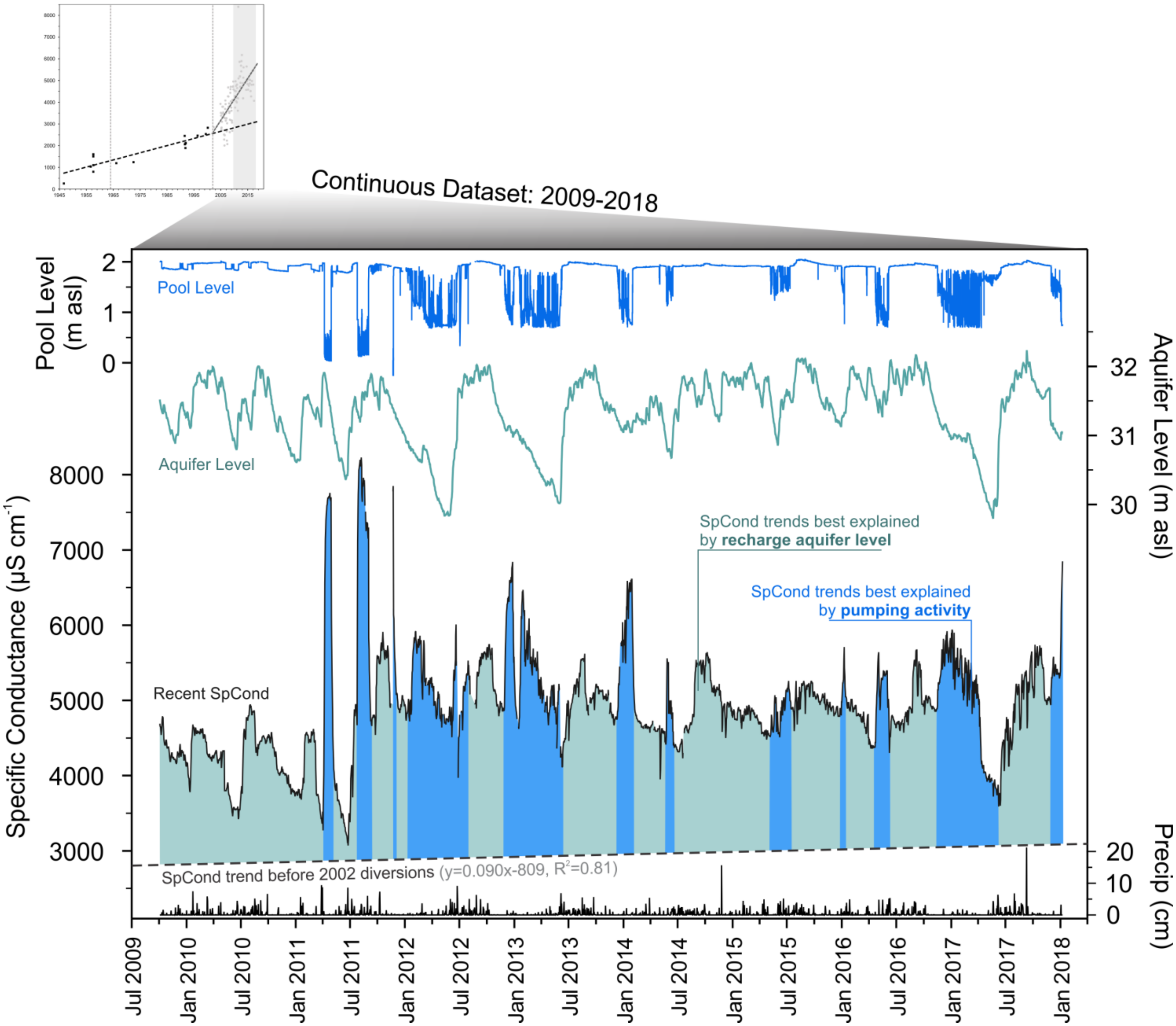

Figure 4. Continuous specific conductance, pool level, recharge aquifer level, and precipitation profiles recorded from October 2009 to January 2018. Blue and green shaded regions show when deviations from the pre-diversion specific conductance trend (black dashed line) are best explained by pumping activity or recharge level, respectively.

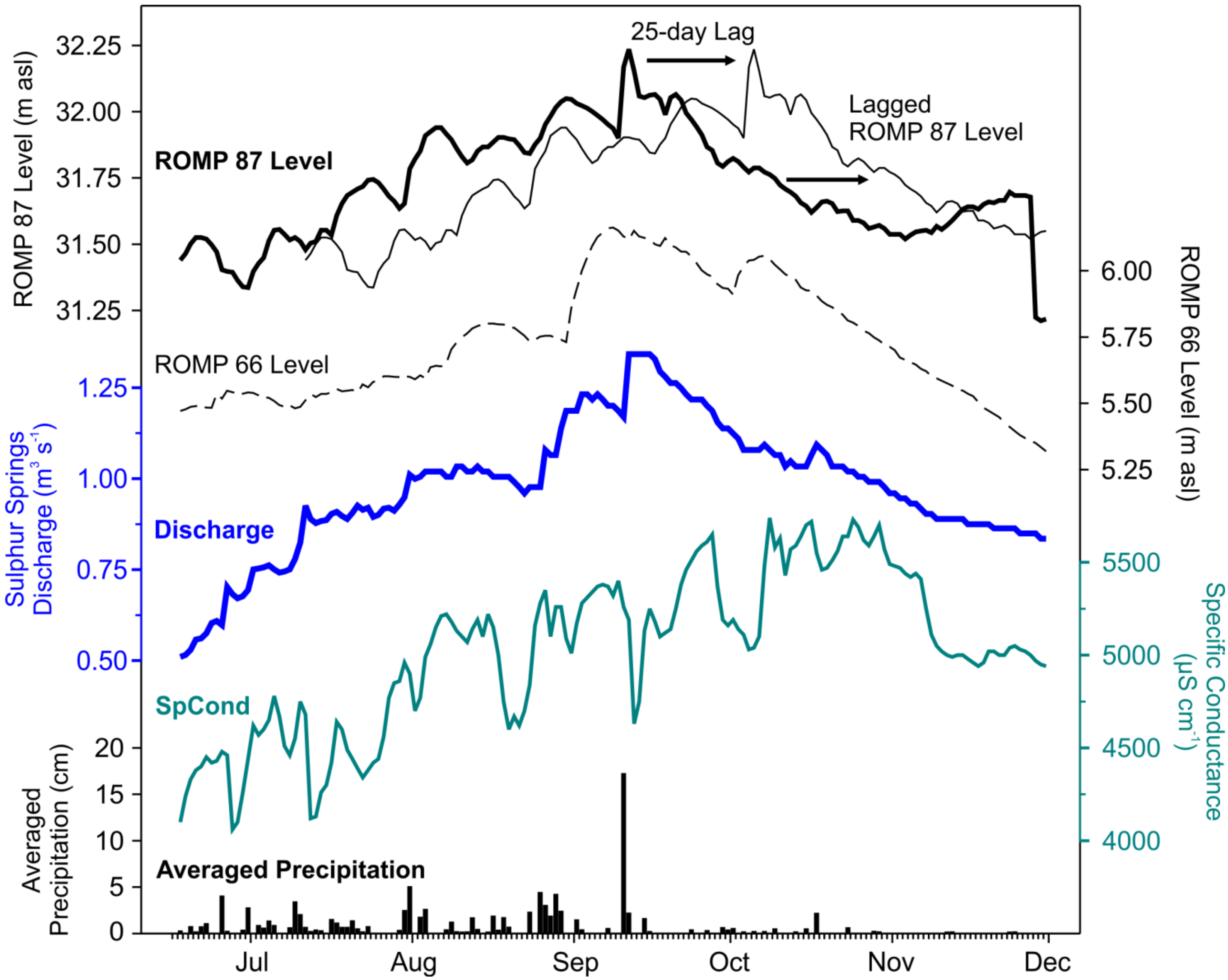

Figure 5. Cross-correlation analysis of the 2017 wet season, designated by a period when municipal spring water pumps were inactive.

Observations made in Sulphur Springs Cave

Vents of hydrochemically distinct water contribute to the bulk water of Sulphur Springs Cave (Fig. 6). These vents were visually apparent because of changes in microbial mat communities on the cave walls. Mats are normally of a dense consistency (~3-5 cm long) with a dark brown color (Fig. 7a), but become white and feathery surrounding vents (Fig. 7b). The feathery mats consisted of segmented filaments measuring 1.0-2.5 µm in diameter made up of individual cells that contain intracellular granules (Fig. 7b i'-iii'). Samples of feathery mat contained water that smelled strongly of reduced sulfur compounds when processed in the lab. Datasonde profiles recorded by divers revealed a particularly large vent located in the Alaska Tunnel (Fig. 6). On 14 October 2001, vent water salinity, temperature, dissolved oxygen concentration, and pH were 17.7, 26.1 °C, 0.00 mg/L, and 6.39 respectively, while that of the Orchid Tunnel was 1.3, 24.9 °C, 0.07 mg/L, and 6.84 respectively (Fig. 6). These vents are most likely the sources of seawater intrusion to Sulphur Springs Cave.

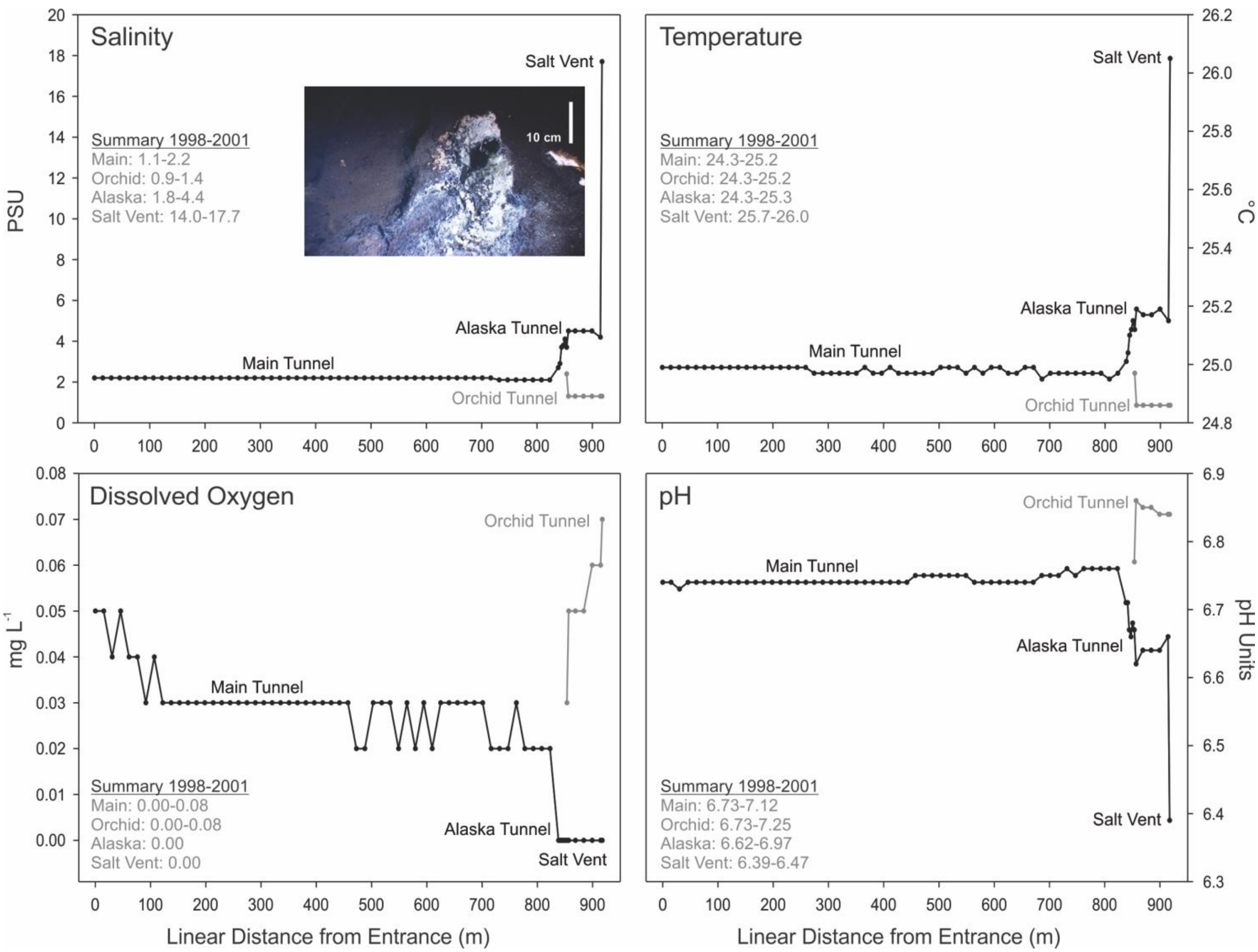

Figure 6. Datasonde profiles collected by divers swimming through Sulphur Springs Cave. The detailed profile was measured on 14 Oct 2001. Summary tables summarize data collected on similar dives from 1998-2001.

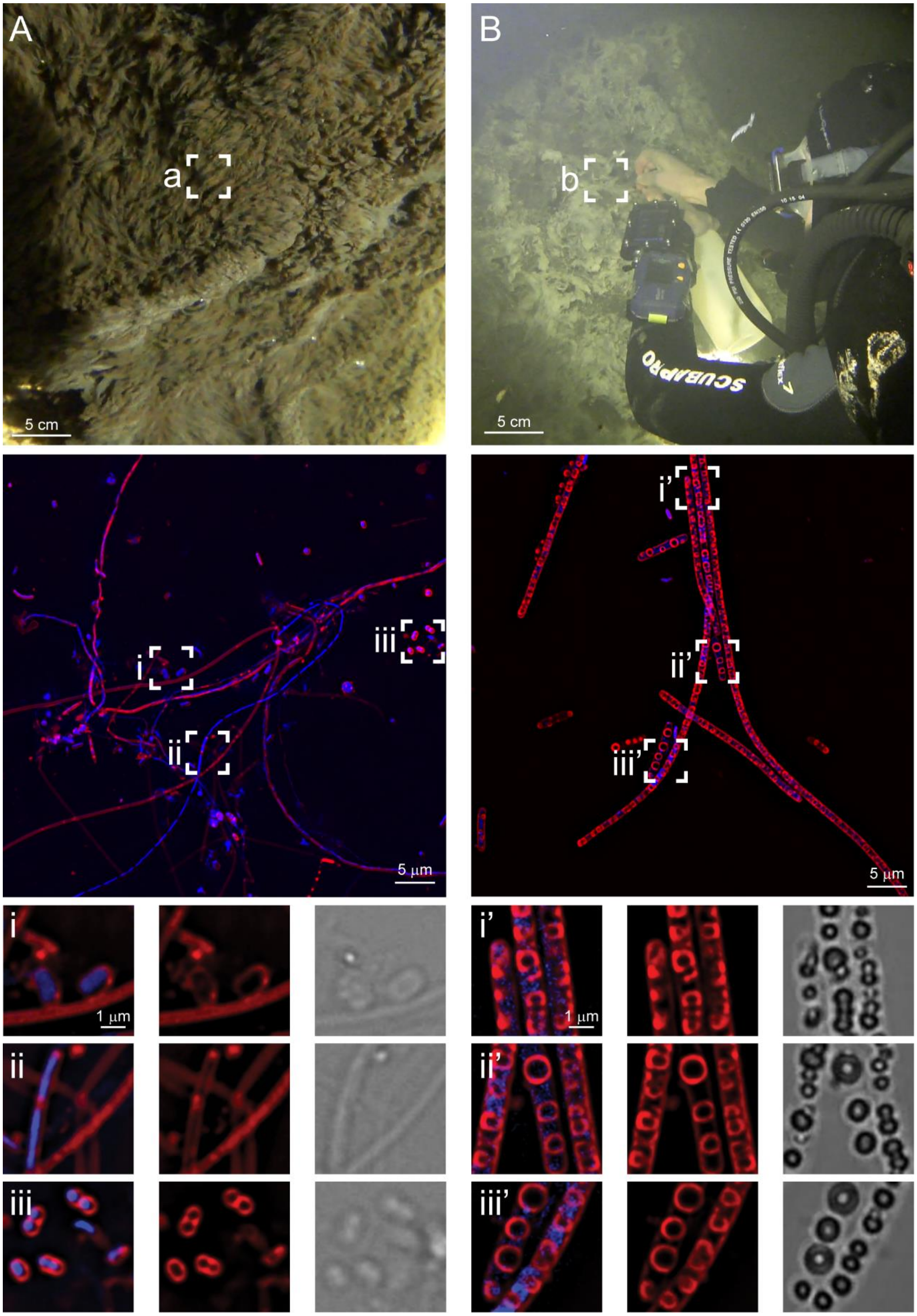

Figure 7. Images of microbial mats collected from Sulphur Springs Cave. (A) Brown biofilm – the sample from site "a" in the top panel was collected for microscopy. The cells were stained with DAPI (blue) to visualize DNA and FM4-64 dye (red) to visualize the membrane. The magnified versions of boxed area i, ii, and iii are shown in the bottom panel together with their corresponding differential interference contrast (DIC) information. (B) White biofilm - the sample from site "b" in the top panel was prepared for imaging as described above. The magnified versions of boxed area i', ii', and iii' together with corresponding DIC are shown in the bottom panel.

Well survey and major ion analysis

A survey of wells in the Sulphur Springs area showed that only the Tourist Club Well (an inactive, artesian well screened in the Suwannee Limestone) contained water with a specific conductance comparable to that of the Sulphur Springs salt vent (10000-20000 µS cm-1; Fig. 6, Table 1). Tourist Club Well was also the closest well to Sulphur Springs (Fig. 8). All other wells in the area contained water less saline than the Sulphur Springs salt vent and Tourist Club Well, although those screened at great depths still contained water with specific conductances and chloride concentrations indicative of saltwater contamination (i.e., >250 mg L-1 Cl-; Table 1). These wells were the Deep Sligh Park Well (screened in the Avon Park Formation) and two of the Hillsborough Dam Wells (screened respectively in the Ocala Limestone and Avon Park Formation). Recent specific conductance values measured at these wells were 5586, 4442, and 7675 µS cm-1, respectively. Recent chloride concentrations at these wells were 1520, 1170, and 2120 mg L-1, respectively.

The specific conductances of the Tourist Club and Deep Sligh Park Wells have increased over the past two decades with a similar slope, though the specific conductance at Deep Sligh Park exhibited an oscillating pattern (Fig. 9a). Specific conductance increased with depth at the Hillsborough Dam Well, but did not increase over time at any screened interval (Fig. 9b). Water levels in wells containing freshwater (i.e., ROMP 87, ROMP 66, Shallow Sligh Park; Table 1) showed seasonal oscillations, but had no net head reduction over the past two decades (Fig. 10).

Between 1946 and 1972, Sulphur Springs water exhibited a calcium-sulfate hydrochemical type. Since then, its hydrochemical character has changed to sodium-chloride type (Fig. 11), corresponding with the long-term specific conductance increase observed at this site (Fig. 4). The nearest freshwater well to Sulphur Springs (ROMP 66, screened in the Tampa and Suwannee Limestones at a depth encompassing that of Sulphur Springs Cave; Fig. 8, Table 1) most recently contained calcium-sulfate type water (Fig. 11, Table 3). The Tourist Club Well contained sodium-chloride type water (Fig. 11, Table 3). A well near Tampa Bay widely screened in the Suwannee, Ocala, and Avon Park Limestones contained water of a specific conductance resembling that of seawater (Kinder Morgan Well, Fig. 8, Table 1). Kinder Morgan Well water plotted near seawater on a Piper diagram, falling in the sodium-chloride type, but was slightly more mineralized with respect to calcium ions (Fig. 11). The deep wells surrounding Sulphur Springs contained sodium-chloride type water (Fig. 12). The hydrochemical character of the Deep Sligh Park Well water shifted from being borderline calcium-sulfate type to strongly sodium-chloride type (Fig. 12). This trend corresponded with the major specific conductance oscillation observed at this well during the late 2000s (Fig. 9a).

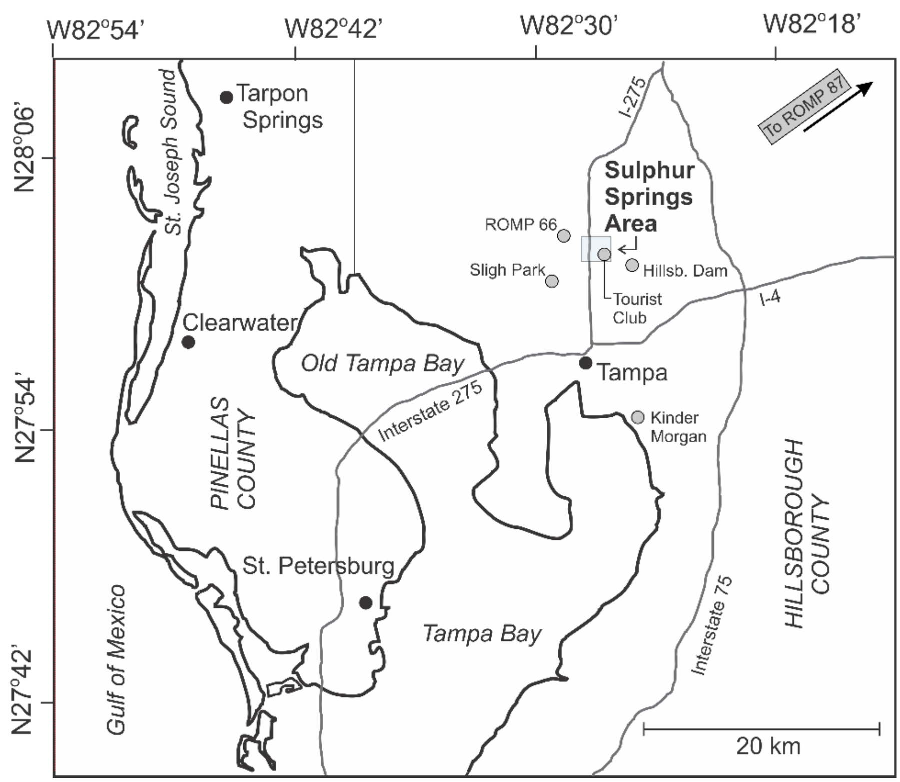

Figure 8. Locations of groundwater monitoring wells used in this study.

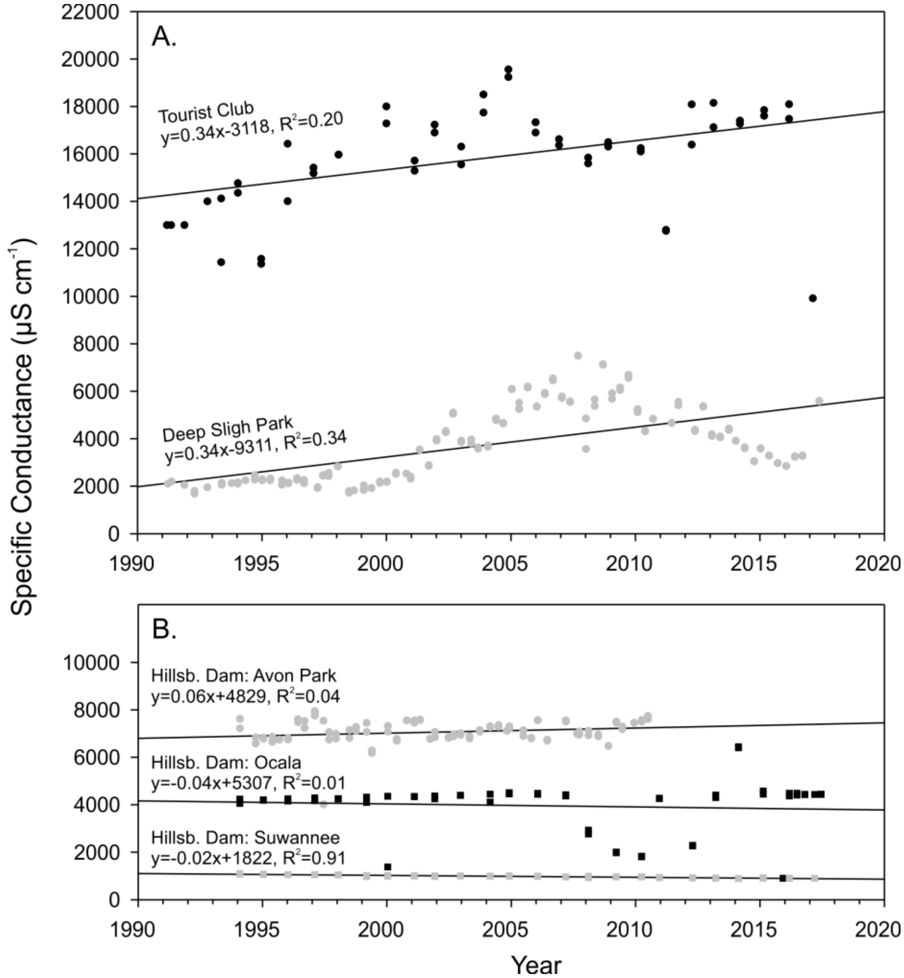

Figure 9. Specific conductance time-series profiles of wells at varying depths in the Sulphur Springs area. Refer to Table 1 for depths of screened intervals. Low R^2 values indicate nearly horizontal trends.

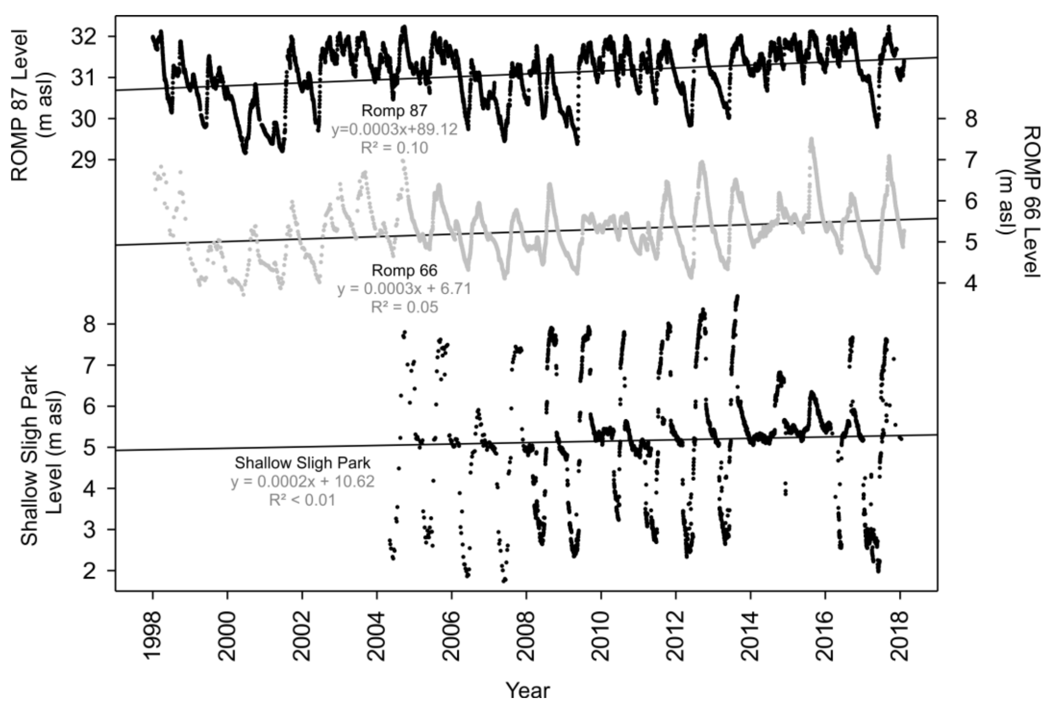

Figure 10. Water level in the recharge area (ROMP 87), just north of Sulphur Springs (ROMP 66), and just southwest of Sulphur Springs (Shallow Sligh Park). All wells were screened in the Suwannee Limestone. Low R^2 values indicate nearly horizontal trends.

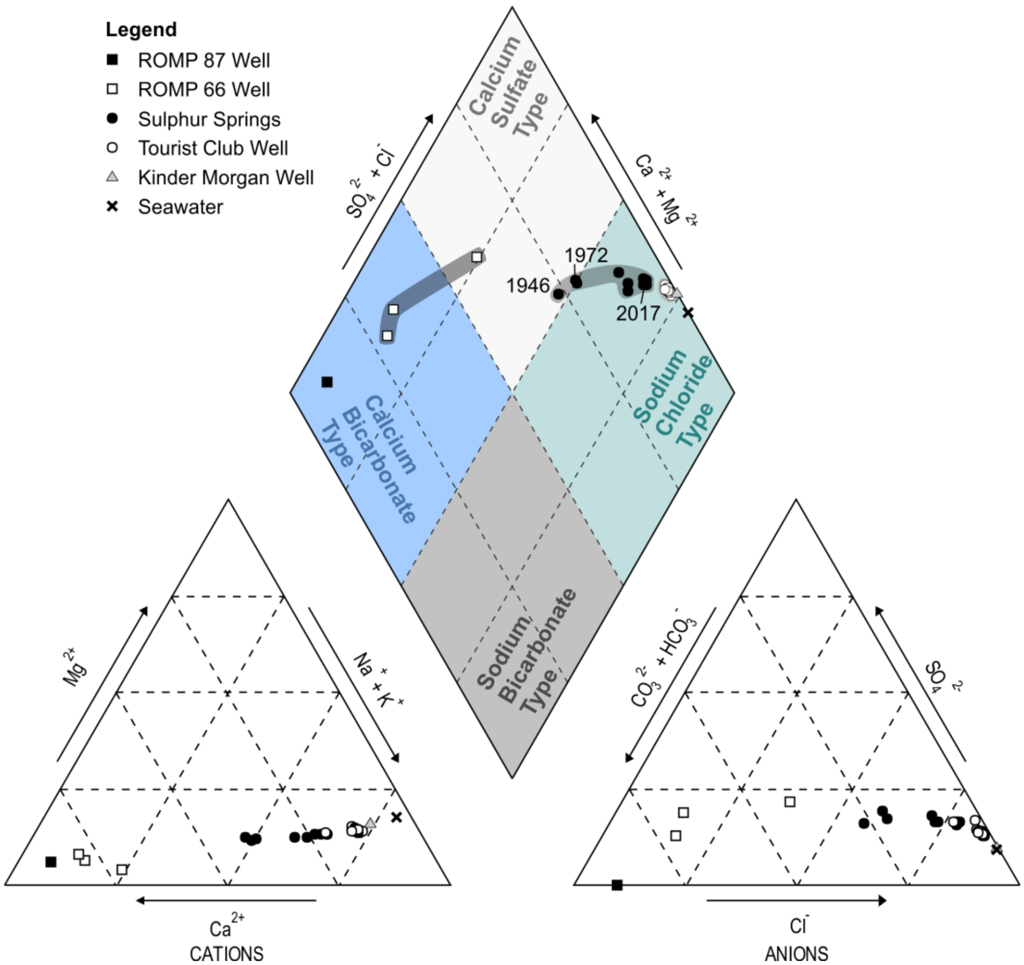

Figure 11. Piper diagram showing the hydrochemical facies of Sulphur Springs, Tourist Club Well, a nearby freshwater well (ROMP 66), and saline endmembers (Kinder Morgan Well and seawater). Refer to Fig. 8 and Table 1 for well details. Note the gradual shift of Sulphur Springs hydrochemistry from the calcium-sulfate type to sodium-chloride type from 1946 to 2017.

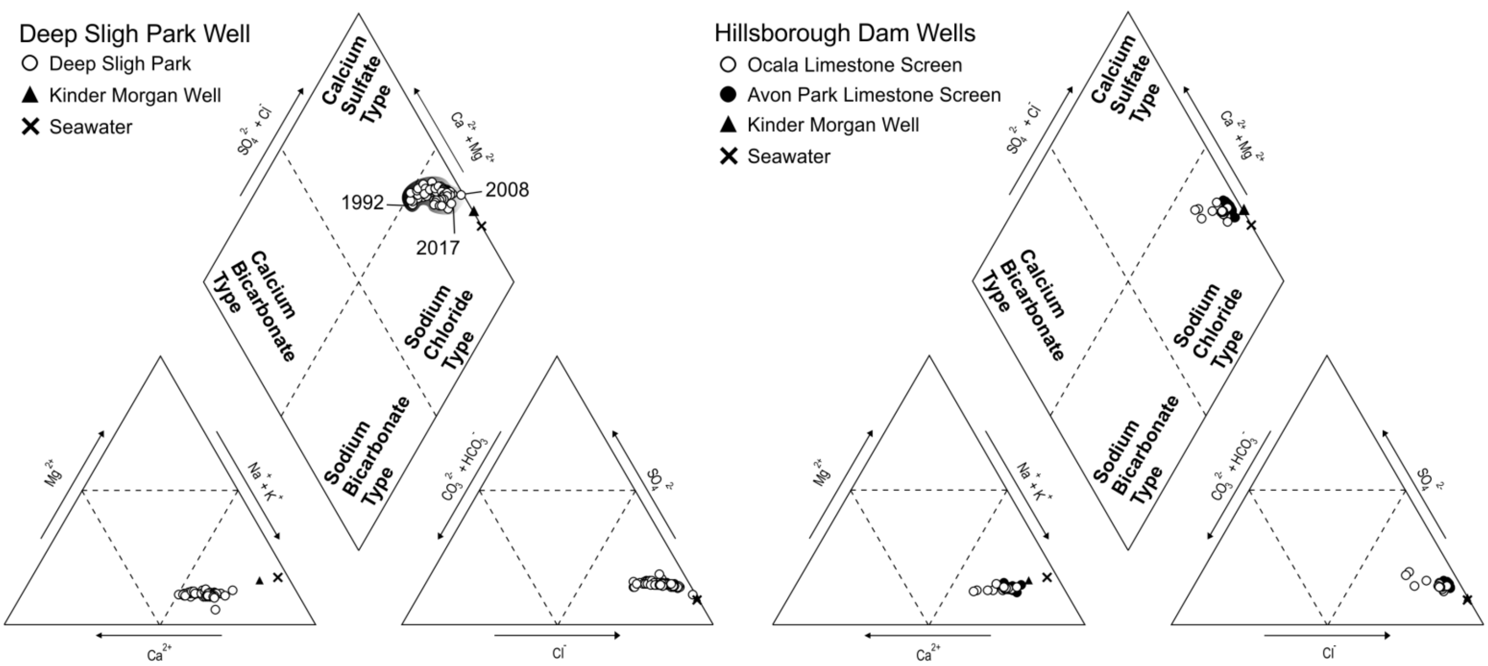

Figure 12. Piper diagram showing the hydrochemical facies of Deep Sligh Park and Hillsborough Dam Wells. Refer to Figure 8 and Table 1 for well details. Note the correspondence between the Deep Sligh Park specific conductance trend (Fig. 9a) and the hydrochemical shift toward the sodium-chloride type between 1992 and 2017.

Table 3. Major ion concentrations used to determine the hydrochemical facies of Sulphur Springs and associated wells

		Concentration (mg L^{-1})						
Site	Date	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Alkalinity/HCO_3^-	Cl^-	SO_4^{2-}
ROMP 87	5/5/1999	91.3	3.94	8.6	0.348	235	15	0.2
Romp 66	2/27/1990	21.2	0.7	7.9	0.7	26	14	10.9
Romp 66	2/18/1991	41.9	2.1	8.5	0.7	120	16	17
Romp 66	6/13/1996	63.3	3.97	10.7	1.43	134	18	30
Sulphur Springs Pool	11/8/1946	64	12	86	3.4	130	160	60
Sulphur Springs Pool	5/11/1966	84	15	120	4.4	130	220	84
Sulphur Springs Pool	10/10/1972	93	18	140	4.4	140	230	100
Sulphur Springs Pool	7/24/1996	141	36.6	320	9.71	149	580	200
Sulphur Springs Pool	8/17/1999	130	38.3	349	10.9	153	660	200
Sulphur Springs Pool	7/17/2002	130	43.2	384	14.4	176	691	212
Sulphur Springs Pool	5/16/2013	196	74.5	688	22.9	178.8	1280	348
Sulphur Springs Pool	10/12/2016	198	76.6	703	24.3	174.2	1290	367
Sulphur Springs Pool	2/6/2017	220	83.1	767	26	172.9	1460	414
Sulphur Springs Pool	4/3/2017	203	74.1	664	22.5	172.4	1270	368
Sulphur Springs Pool	7/13/2017	163	62.7	565	19.6	155.6	1060	307
Tourist Club Well	1/11/1994	426	258	2339	69	160	4819	985
Tourist Club Well	12/20/1994	350	205	1930	55	171	3490	808
Tourist Club Well	1/11/1996	421	270	2539	84	152	4350	909
Tourist Club Well	1/24/1997	434	276	2672	76	167	5031	1068
Tourist Club Well	1/28/1998	459	276	2708	83.6	169	5325	1090
Tourist Club Well	12/29/1999	506	309	3080	98.6	171	5750	1200
Tourist Club Well	2/15/2001	485	277	2640	98	174	4845	971
Tourist Club Well	12/6/2001	445	305	2930	96.9	171	5445.31	1195.76
Tourist Club Well	12/31/2002	514	325	2790	92.7	188	4910	1360
Tourist Club Well	11/24/2003	492	306	2840	91.0999	176	5620	1160
Tourist Club Well	11/23/2004	554	339	3170	100	182.0399	5637.77	1172.78
Tourist Club Well	12/27/2005	476	305	2760	89.7	166.2	5300	1070
Tourist Club Well	12/5/2006	458	290	2600	85	170	5110	1050
Tourist Club Well	2/7/2008	452	264	2640	84.2	170.7	4740	1030
Tourist Club Well	11/26/2008	464	286	2610	85.4	167.8	4890	1080
Tourist Club Well	3/19/2010	454	271	2680	80.4	166.2	4950	1070
Tourist Club Well	3/25/2011	363	216	2010	63.4	165.7	3820	852
Tourist Club Well	4/5/2012	468	288	2770	85.2	176.6	5100	1090
Tourist Club Well	2/19/2013	504	320	2970	95.1	180.1	5640	1180
Tourist Club Well	3/12/2014	485	307	2890	87.9	178.9	5520	1240
Tourist Club Well	3/2/2015	504	311	2850	92.6	180.2	5490	1180
Tourist Club Well	3/2/2016	485	314	2890	88	175.7	5590	1190
Tourist Club Well	2/14/2017	298	167	1560	47.5	159.9	2960	662
Deep Sligh Park	4/15/1992	120	24	200	6.6	200	420	120
Deep Sligh Park	1/11/1994	142	28	236	5.6	165	509	161
Deep Sligh Park	9/16/1994	157	32	293	8.2	100	566	177
Deep Sligh Park	1/4/1995	155	32	277	8	172	524	161
Deep Sligh Park	5/4/1995	158	31	264	7.5	175	533	162
Deep Sligh Park	10/20/1995	152	31	258	8.7	174	524	159
Deep Sligh Park	1/25/1996	140	25	246	7.4	174	496	156
Deep Sligh Park	5/29/1996	144	30	270	7.9	174	529	165
Deep Sligh Park	9/9/1996	147	30	257	7.9	174	563	172
Deep Sligh Park	3/26/1997	131	26	224	6.7	174	436	135
Deep Sligh Park	6/13/1997	155	32.4	290	8.19	171	640	176
Deep Sligh Park	9/2/1997	156	33.2	296	8.36	173	578	179
Deep Sligh Park	1/16/1998	179	38.6	345	9.27	172	715	201
Deep Sligh Park	6/30/1998	128	22.5	206	6.13	173	375	122
Deep Sligh Park	9/11/1998	124	22.5	194	5.12	171	370	104
Deep Sligh Park	2/1/1999	134	27.7	229	8.97	167	466	137
Deep Sligh Park	5/24/1999	132	23.5	194	5.81	172	401	121
Deep Sligh Park	9/27/1999	154	29.8	245	7.45	167	476	141
Deep Sligh Park	1/7/2000	162	30.1	255	7.78	174	526	150
Deep Sligh Park	5/18/2000	198	36.2	323	8.67	170	624	192
Deep Sligh Park	10/19/2000	166	36.9	300	10.8	164	621	177
Deep Sligh Park	12/19/2000	149	34	280	9.42	165	548	152
Deep Sligh Park	5/1/2001	216	48.4	437	12.6	175	919	254
Deep Sligh Park	9/12/2001	184	39.2	350	10.2	168	726	195
Deep Sligh Park	1/3/2002	237	48.2	512.69	13.7	163	1046.8	285.93
Deep Sligh Park	5/21/2002	255	60.2	555	15	179	1130	306
Deep Sligh Park	9/4/2002	279	68.9	667	17.9	181	1380	366
Deep Sligh Park	12/31/2002	239	54.6	523	12.6	184	981	338
Deep Sligh Park	5/27/2003	220	56.7	476	12.5	181	1000	266
Deep Sligh Park	9/5/2003	219	49.5	474	11	174	915	241
Deep Sligh Park	1/27/2004	218	49.7999	453	12.1999	172	928	240
Deep Sligh Park	5/25/2004	264	68	597	16.5	177.15	1377.05	346.22
Deep Sligh Park	9/8/2004	239	65.6999	544	13.8999	179.94	1225.9399	324.7999
Deep Sligh Park	1/13/2005	315	82.1999	805	20.8999	182.3399	1631.3599	400.4299
Deep Sligh Park	4/29/2005	295	73.1	705	17.8	169.3	1490	357
Deep Sligh Park	9/2/2005	321	88.6	837	20	168.8	1710	418
Deep Sligh Park	1/13/2006	278	73.2	679	16.2	166.3	1400	344
Deep Sligh Park	5/11/2006	304	79.8	774	17.9	169.4	1630	386
Deep Sligh Park	9/8/2006	317	85.9	860	19.7	169.4	1820	430
Deep Sligh Park	1/16/2007	290	78.2	751	18.3	167	1660	380
Deep Sligh Park	5/17/2007	291	75.1	736	17.8	164.6	1540	393
Deep Sligh Park	9/11/2007	363	106	1070	25.9	172	2230	517
Deep Sligh Park	1/4/2008	131	50	487	12.1	23.2	1220	208
Deep Sligh Park	5/12/2008	309	74.1	754	18.5	171.2	1550	364
Deep Sligh Park	9/11/2008	355	94.7	954	28.4	168.1	1920	464
Deep Sligh Park	1/21/2009	292	75	752	18.9	168.4	1490	369
Deep Sligh Park	5/20/2009	302	79.4	818	21.6	177	1680	402
Deep Sligh Park	9/21/2009	333	94.5	967	21.8	168.2	1900	435
Deep Sligh Park	2/1/2010	256	65.1	652	16.7	162	1370	349
Deep Sligh Park	5/21/2010	224	53.9	524	14.3	164.8	1130	271
Deep Sligh Park	9/15/2010	251	62.6	640	15.2	169.9	1310	311
Deep Sligh Park	6/15/2011	268	64.3	670	15.5	174.1	1190	300
Deep Sligh Park	9/21/2011	272	70.1	710	17.8	172.4	1470	363
Deep Sligh Park	5/23/2012	229	54.2	564	15.3	176.2	1100	287
Deep Sligh Park	9/19/2012	263	70.8	710	19.2	173.8	1450	353
Deep Sligh Park	1/25/2013	221	52.6	566	14.3	180	1080	287
Deep Sligh Park	5/28/2013	211	24.3	535	6.82	185.2	1060	275
Deep Sligh Park	10/2/2013	235	55.9	605	15.2	180.4	1090	286
Deep Sligh Park	1/10/2014	200	47.4	501	12.7	181.3	995	267
Deep Sligh Park	5/22/2014	200	44.5	478	12.3	183	910	244
Deep Sligh Park	10/8/2014	182	37.7	404	10.5	180.8	734	199
Deep Sligh Park	1/9/2015	207	44.7	497	12.6	184.2	911	232
Deep Sligh Park	5/14/2015	185	39.4	424	11.1	181.7	822	219
Deep Sligh Park	9/18/2015	160	34.9	362	9.87	183.8	728	196
Deep Sligh Park	1/22/2016	151	33.5	350	9.91	182.9	685	185
Deep Sligh Park	5/27/2016	166	38.2	420	11.7	178.5	801	216
Deep Sligh Park	9/16/2016	174	38.6	444	11.7	175.1	811	217
Deep Sligh Park	5/19/2017	257	71.9	801	23.1	185.4	1520	401

Continued

		Concentration (mg L^{-1})						
Site	Date	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Alkalinity/HCO_3^-	Cl^-	SO_4^{2-}
Hillsborough Dam: Ocala	2/2/1994	159	68	633	22	159	1095	295
Hillsborough Dam: Ocala	1/12/1995	147	65	585	19	158	1080	283
Hillsborough Dam: Ocala	1/10/1996	151	68	633	23	160	1157	275
Hillsborough Dam: Ocala	2/7/1997	141	63	603	21	159	1191	250
Hillsborough Dam: Ocala	1/16/1998	145	65.4	610	20.5	160	1141	253
Hillsborough Dam: Ocala	3/10/1999	142	63.6	624	21	162	1200	282
Hillsborough Dam: Ocala	1/14/2000	160	68.9	631	20	161	1160	298
Hillsborough Dam: Ocala	2/8/2001	144	65.6	644	22.5	168	1200	284
Hillsborough Dam: Ocala	12/5/2001	140	65.9	640	22.7	160	1156.8	285.59
Hillsborough Dam: Ocala	12/17/2002	120	66.6	635	20.9	178	1150	288
Hillsborough Dam: Ocala	2/25/2004	157	69.4	649	22.7	170	1170	273
Hillsborough Dam: Ocala	12/3/2004	150	67.4	622	22	174.16	1171.4599	273.8599
Hillsborough Dam: Ocala	1/25/2006	155	70.7	628	22.2	161.5	1190	267
Hillsborough Dam: Ocala	3/12/2007	154	68.9	632	21.9	162.6	1210	291
Hillsborough Dam: Ocala	2/8/2008	123	40.7	380	13.9	160.5	683	208
Hillsborough Dam: Ocala	3/23/2009	103	27.8	241	9.2	156.6	426	170
Hillsborough Dam: Ocala	3/30/2010	97.5	25	217	8.31	152.6	376	143
Hillsborough Dam: Ocala	12/15/2010	162	62.6	611	19.3	160.7	1110	293
Hillsborough Dam: Ocala	4/18/2012	105	33	295	10.7	181.9	507	140
Hillsborough Dam: Ocala	3/22/2013	154	66.1	631	21.5	181.6	1140	282
Hillsborough Dam: Ocala	2/18/2014	212	97.3	911	29.4	172	1760	426
Hillsborough Dam: Ocala	2/18/2015	162	68.6	631	21.6	184.9	1160	282
Hillsborough Dam: Ocala	3/8/2016	160	71.9	556	19.9	180.1	1170	278
Hillsborough Dam: Ocala	6/28/2016	151	66.7	612	21.5	174.9	1160	280
Hillsborough Dam: Ocala	10/20/2016	159	70.6	652	23.2	173.2	1160	279
Hillsborough Dam: Ocala	3/15/2017	159	70.6	636	22.8	173	1180	287
Hillsborough Dam: Ocala	6/16/2017	156	69.3	626	22.6	178.6	1170	281
Hillsborough Dam: Avon Park	2/2/1994	261	124	1165	36	161	2095	540
Hillsborough Dam: Avon Park	9/23/1994	218	110	1060	32	172	1825	477
Hillsborough Dam: Avon Park	1/12/1995	235	110	992	32	171	1935	470
Hillsborough Dam: Avon Park	5/23/1995	207	97	1077	31	168	1958	483
Hillsborough Dam: Avon Park	9/6/1995	228	110	1053	35	170	2018	450
Hillsborough Dam: Avon Park	1/10/1996	235	116	1074	37	174	1869	469
Hillsborough Dam: Avon Park	6/3/1996	254	124	1206	36	172	2140	555
Hillsborough Dam: Avon Park	9/9/1996	245	120	1168	37	172	2287	560
Hillsborough Dam: Avon Park	2/7/1997	251	124	1214	37	168	2188	532
Hillsborough Dam: Avon Park	6/13/1997	269	131	1246	36.1	177	2375	597
Hillsborough Dam: Avon Park	9/2/1997	236	109	1065	33	179	1970	477
Hillsborough Dam: Avon Park	12/12/1997	232	110	1064	32.9	173	2004	482
Hillsborough Dam: Avon Park	6/30/1998	251	115	1130	35.8	171	1990	476
Hillsborough Dam: Avon Park	10/5/1998	244	120	1080	26.7	170	1950	483
Hillsborough Dam: Avon Park	3/10/1999	243	116	1030	37.5	175	1990	498
Hillsborough Dam: Avon Park	5/25/1999	213	96	919	27.5	173	1760	411
Hillsborough Dam: Avon Park	1/14/2000	250	118	1160	36.1	174	2080	511
Hillsborough Dam: Avon Park	5/24/2000	233	107	1050	31.2	174	1820	463
Hillsborough Dam: Avon Park	10/19/2000	270	126	1120	44.8	168	2110	537
Hillsborough Dam: Avon Park	2/8/2001	250	124	1170	42.4	174	2135	508
Hillsborough Dam: Avon Park	5/1/2001	255	123	1170	37.6	179	2230	561
Hillsborough Dam: Avon Park	9/25/2001	202	109	983	32.2	168	1940	467
Hillsborough Dam: Avon Park	12/5/2001	219	113	1070	35	170	2010.83	529.79
Hillsborough Dam: Avon Park	6/24/2002	224	109	1060	35.4	183	1930	463
Hillsborough Dam: Avon Park	9/6/2002	224	115	1080	36.9	182	1940	483
Hillsborough Dam: Avon Park	12/18/2002	162	111	1010	30.7	190	1910	523
Hillsborough Dam: Avon Park	4/29/2003	238	119	975	32.8	185	1900	439
Hillsborough Dam: Avon Park	9/24/2003	243	121	1090	37.4	174	1940	484
Hillsborough Dam: Avon Park	2/25/2004	252	121	1100	36.9	180	2030	488
Hillsborough Dam: Avon Park	6/28/2004	268	123	1100	34.7	182.68	2003.1	515.91
Hillsborough Dam: Avon Park	10/28/2004	237	117	1060	32.0999	180.83	1892.6899	475.01
Hillsborough Dam: Avon Park	12/3/2004	239	117	1060	31.8999	183.63	1888.25	462.72
Hillsborough Dam: Avon Park	6/27/2005	251	120	1080	33.9	175.6	2000	542
Hillsborough Dam: Avon Park	10/19/2005	234	111	1060	33.4	170.8	1880	460
Hillsborough Dam: Avon Park	1/25/2006	252	124	1130	34.6	170.3	2120	493
Hillsborough Dam: Avon Park	6/12/2006	225	109	970	30.7	169.9	1880	479
Hillsborough Dam: Avon Park	3/13/2007	261	126	1130	36	170.5	2210	545
Hillsborough Dam: Avon Park	8/27/2007	241	115	1030	32.9	172	1970	541
Hillsborough Dam: Avon Park	9/25/2007	241	114	1150	36.1	172.8	2090	474
Hillsborough Dam: Avon Park	2/8/2008	251	115	1040	33.2	168.5	1950	522
Hillsborough Dam: Avon Park	7/1/2008	248	108	912	34.4	172.1	1870	458
Hillsborough Dam: Avon Park	11/26/2008	221	104	918	32	167.7	1760	437
Hillsborough Dam: Avon Park	3/23/2009	252	120	1090	37.8	174	2130	537
Hillsborough Dam: Avon Park	6/18/2009	241	125	998	37.1	173.1	1870	531
Hillsborough Dam: Avon Park	12/10/2009	254	115	1110	36.2	167.8	2100	517
Hillsborough Dam: Avon Park	3/30/2010	238	116	1050	38.6	166.2	2060	548
Hillsborough Dam: Avon Park	6/29/2010	263	125	1110	40	167.6	2120	559
Kinder Morgan Well	7/12/2006	1120	1080	9240	297	203	18300	2710
Seawater Endmember		419	1295	10752	390	145	19345	2701

Data collected from probes deployed in the cave

Profiles generated by hydrolabs deployed in Sulphur Springs Cave during the dry season show the impacts of municipal pumping activity (Fig. 13). Pumping rate was apparently higher than the rate of dry-season cave water discharge, thus Sulphur Springs pool level dropped ~1 m when pumps were active. The lowered pool level reduced the pressure head over the entire cave system, allowing saltwater vents to issue more water. This was indicated by increased specific conductance, increased temperature, and decreased pH during periods of pumping (Fig. 13). Each of these parameters are characteristic of Sulphur Springs Cave saltwater vents (Fig. 6). When pumping stopped and the spring pool began refilling, rapid spikes of specific conductance and temperature occurred. This was probably due to the entrainment and turbulent mixing of vent water as bulk cave water rushed out to refill the pool, which was previously at a low head level. When high pool levels were maintained, specific conductance dropped, temperature dropped, and pH rose (Fig. 13). The cave was anoxic during this study period (Fig. 13).

Over the course of a year, the specific conductance profile recorded in the cave deviated from that of the spring pool (Fig. 14). Specific conductance measurements recorded in the cave and spring pool were closely aligned during the two dry seasons studied so far, but split during the wet season. This indicates that there must be at least one saltwater vent between our cave sampling station and the spring mouth. It is interesting that this (or these) vent(s) are more active during the wet season. Based on the salinity profiles collected by divers exploring Sulphur Springs Cave in the late 1990s, this salt water is probably sourced from the Weak Spring Tunnel, a side passage containing a unique salinity-stratified room. We will begin monitoring the specific conductance of this tunnel.

The temperature profile measured in the cave was not influenced by diurnal cycles (Fig. 15) so it is more useful than the spring pool profile when interpreting cave hydrodynamics. Cave water temperature was consistently above a two-year average of surface air temperature, indicating that the cave is geothermally heated. Cave water temperature increased throughout the summer as surface air temperature increased. This cave temperature trend also corresponded with an increase in specific conductance, complicating the interpretation of this trend. The warming cave temperature could be due to heat diffusion from the surface, but could also be due to an increase in saltwater vent influence as recharge head increased throughout the wet season. During winter months, surface air temperature dropped far below the 2-yr average. Cave water temperature only dropped below the 2-yr average once, during early February 2018. During the cold snap of January 2018, cave temperature stayed near at it was during summer months. This was due to pumps being active during that month. When pumps were shut off, cave temperature dropped to or below the 2-yr average. Pumping activity makes it difficult to interpret the Sulphur Springs Cave temperature profile, but a probe deployed in a part of the cave with relatively little saltwater vent influence (i.e., the Orchid Tunnel) would produce a profile mostly independent of pumping activity.

Companion to these profiles are the cave discharge profiles collected by deployed ADVs. The measured discharge of cave water did not align with discharge of the spring pool as it overflowed from its impoundment (data not shown). We are currently experimenting with different ADV sampling set-ups to confirm that this observation was not a sampling artifact. So far, cave discharge profiles have been consistently different from those of spring pool discharge. Sulphur Springs Cave features abundant side-passages that are not shown on its map (Fig. 1). Some of these passages have been observed to siphon water, while others issue water. The disparity between cave and spring pool discharge profiles is probably due to the complex hydrodynamics of the Sulphur Springs Cave passages.

Finally, we collected monthly water chemistry samples at the cave monitoring station. The cave water was consistently low in all nutrients, and our measurements have matched those conducted by government agencies at the spring pool. One geochemical constituent that is not currently monitored by SWFWMD or the City of Tampa is sulfide. We found that sulfide is the only nutrient to correlate with changes in specific conductance (PCA controlling for date; $r = 0.98$, $p = 0.022$, $n = 7$), though it exists in bulk cave water in rather low concentrations (highest measurement ~5 $\mu g\ L^{-1}$). Because sulfide correlates strongly to specific conductance, it is likely issuing from saltwater vents. Sulfide measurements will probably be higher from water collected inside the vents. We are currently developing methods in order to cleanly sample vent water.

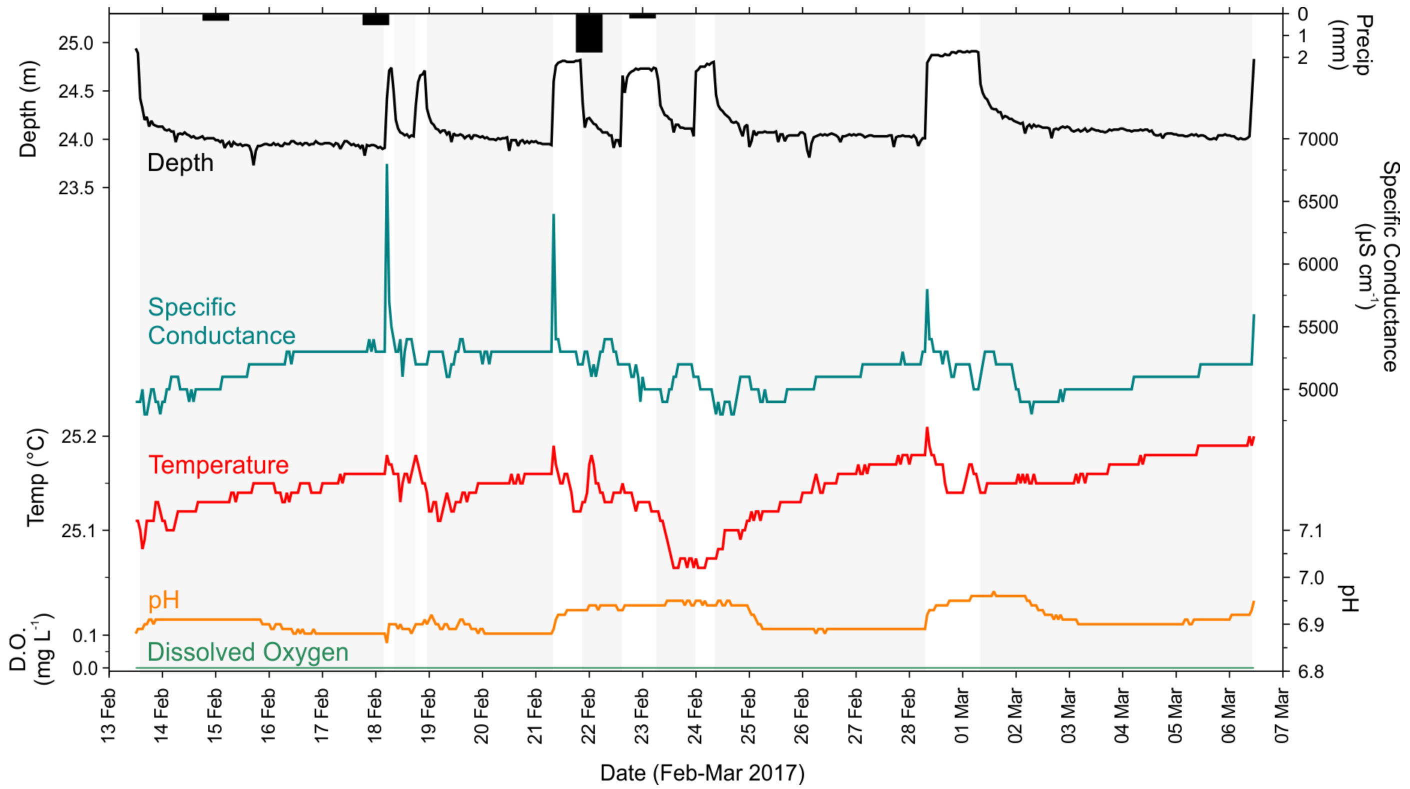

Figure 13. Time series profile collected by a hydrolab multiprobe deployed ~100 linear m into Sulphur Springs Cave. Shaded areas indicate periods of groundwater extraction from the spring pool.

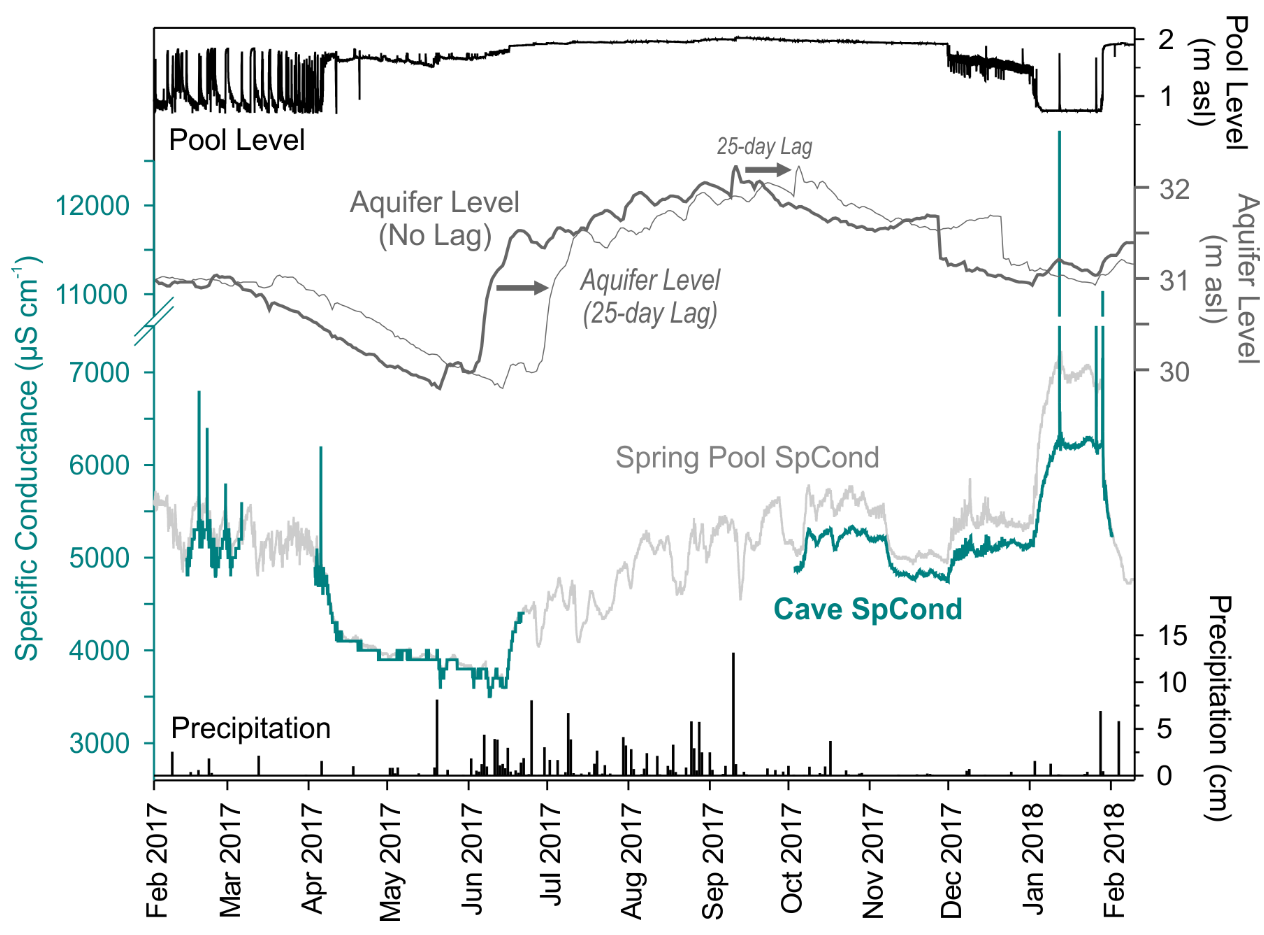

Figure 14. Specific conductance profiles measured in Sulphur Springs Cave (green line) and in Sulphur Springs pool (light gray line). Lowered pool levels (top black line) indicate periods of pumping.

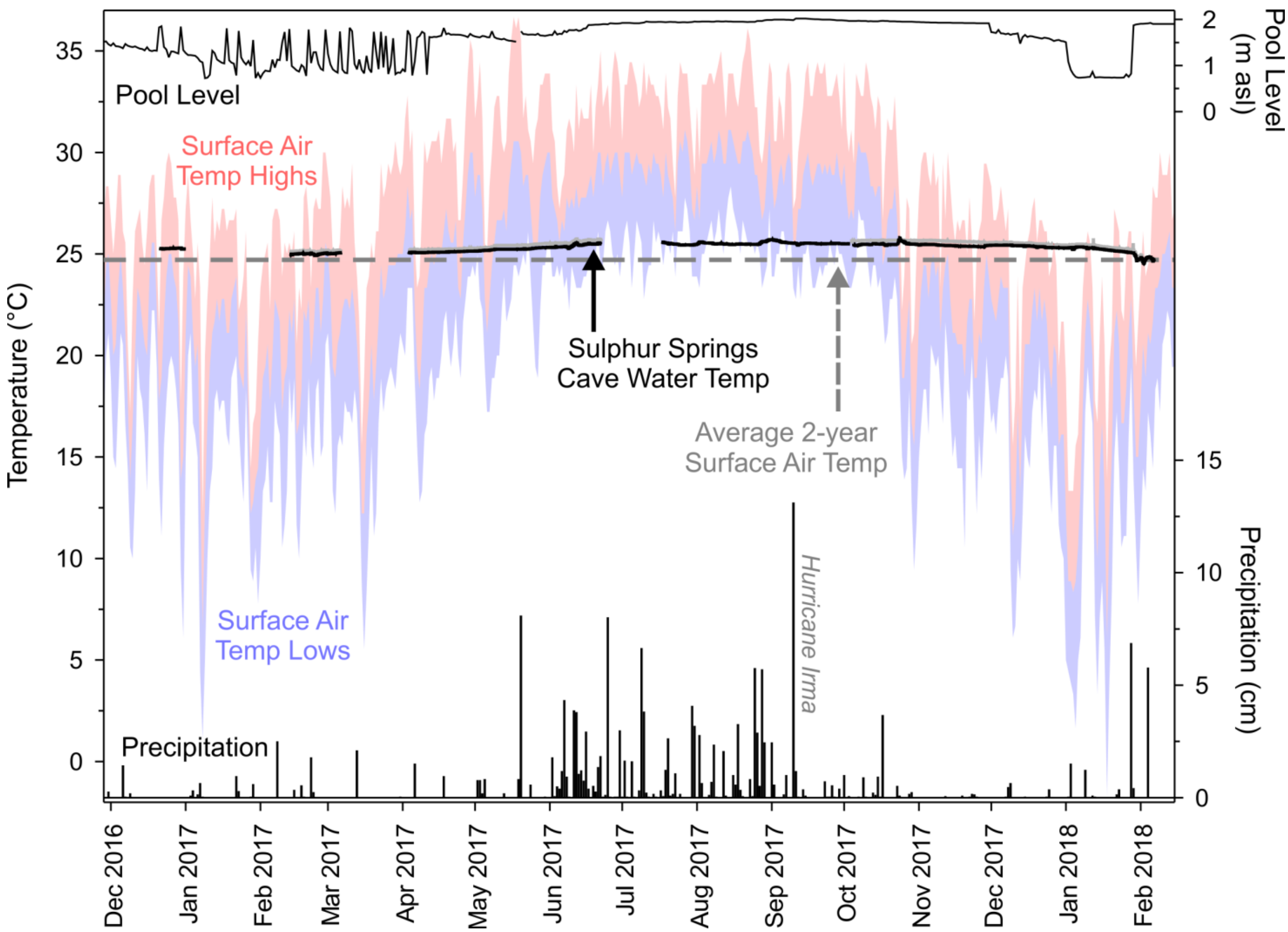

Figure 15. Temperature profile recorded in Sulphur Springs Cave by our ADV (thick black line) and hydrolab (solid gray line). The hydrolab temperature profile measured slightly warmer values than did the ADV, but both showed similar patterns. Tops of red-shaded areas show daily surface air temperature highs, and bottoms of blue-shaded areas show daily lows. Daily averages are shown at the interface between red and blue areas. Averaged daily temperature for 2 yr is shown by the dashed gray line. Temperature data were published by NOAA/NWS. Low pool levels indicate periods of pumping (top black line).

Hypotheses for seawater intrusion in Sulphur Springs Cave

In general, recharge level rose and stayed high during wet seasons and declined during dry seasons (Fig. 4). Pool level tended to stay high during wet seasons and wet years, while it was lower throughout dry seasons when pumping occurred. Specific conductance mostly mirrored aquifer level with a 25 day lag, except during periods of lowered pool level when rapid, immediate specific conductance spikes would occur. Specific conductance trends explained by pumping activity and recharge head position are summarized in Table 4.

It makes intuitive sense that pumping-induced pool head reduction could increase the specific conductance of Sulphur Springs by facilitating the vertical intrusion of salt vent water. Specific conductance also climbed throughout wet seasons when pumps were inactive and pool level remained high (Figs. 4 & 5), which was unexpected. This trend was especially apparent during 2017, when an unusually dry winter was followed by the largest precipitation event recorded in this area during the study period (Hurricane Irma, which struck the area on 10 September 2017; Figs. 4 & 5). When recharge lows accompanied periods when pool level was kept high, Sulphur Springs specific conductance dropped, but the water still did not return to being as fresh as it was before the 1960s (Figs. 2 & 4). Spring water extraction and subsequent pool lowering usually occurred during dry seasons, which prevented Sulphur Springs from recovering to a low-salinity state during many years (Fig. 4). Indeed, present Sulphur Springs specific conductance was often 6-fold, and sometimes 8-fold, higher than it was in 1957 (Menke et al. 1961), and never dropped below ~3,000 µS cm^{-1} (Fig. 4, Table 2b). In the following sections, we propose a model explaining why Sulphur Springs specific conductance has increased gradually over the past century, rapidly over the past decades, and anomalously during the recharge season (Fig. 16).

Table 4. Generalized Sulphur Springs specific conductance trends explained by recharge and pool level

	Pool Level	Recharge Level	Specific Conductance
No Pumping	High	High	High
	High	Low	Low
Pumping	Low	High	Very High
	Low	Low	High

<u>Seawater Intrusion Model: Initial state</u>

Vertical fractures, flexures, and subsidence features are common in the limestone underlying west-central Florida, based on seismic-reflection surveys conducted on the Lower Hillsborough River (Wolansky and Thompson 1987) and rivers of neighboring watersheds (Lewelling et al. 1998, Trommer et al. 2009). The morphology of Sulphur Springs Cave (Fig. 1) indicates the presence of vertical fractures in the immediate area, which have contributed to the speleogenesis of the cave. Vertical bedrock fractures act as preferential groundwater flow-paths and can be conduits for saline water intrusion into freshwater layers (e.g., Spechler 1994, their Fig. 37).

The salt vents found in Sulphur Springs Cave are probably termini of fractures which must either intercept the coastal mixing zone or draw up mixing zone water by providing an avenue of reduced head, similar to how saline groundwater upcones toward depressed potentiometric surfaces produced by extraction wells (e.g., Bower et al. 1999). Vertical intrusion of saline groundwater into overlying freshwater has also been observed in the absence of wells. This natural phenomenon has been attributed to the reduced potentiometric head generated by a discharging spring (Tellman et al. 1986) and to fracturing of aquitards in an artesian system (deLouw et al. 2010).

In the pre-extraction state of the Sulphur Springs system (Fig. 16a), variations in spring pool head controlled the influence of vertically-migrating saline water (Menke et al. 1961, p. 42). This indicates that the Sulphur Springs salt vents were active before pumping began. In the 1950s, Menke et al. (1961, p. 41) found no evidence of saline water in the Suwannee Limestone around Sulphur Springs, and suggested that saline water must be moving up through fractures from below the Ocala Limestone confining unit, i.e., the Avon Park Formation. The wet-season salinity increases observed during the present study period were not mentioned in previous studies of Sulphur Springs (Menke et al. 1961, Rosenau et al. 1977, Stewart and Mills 1984).

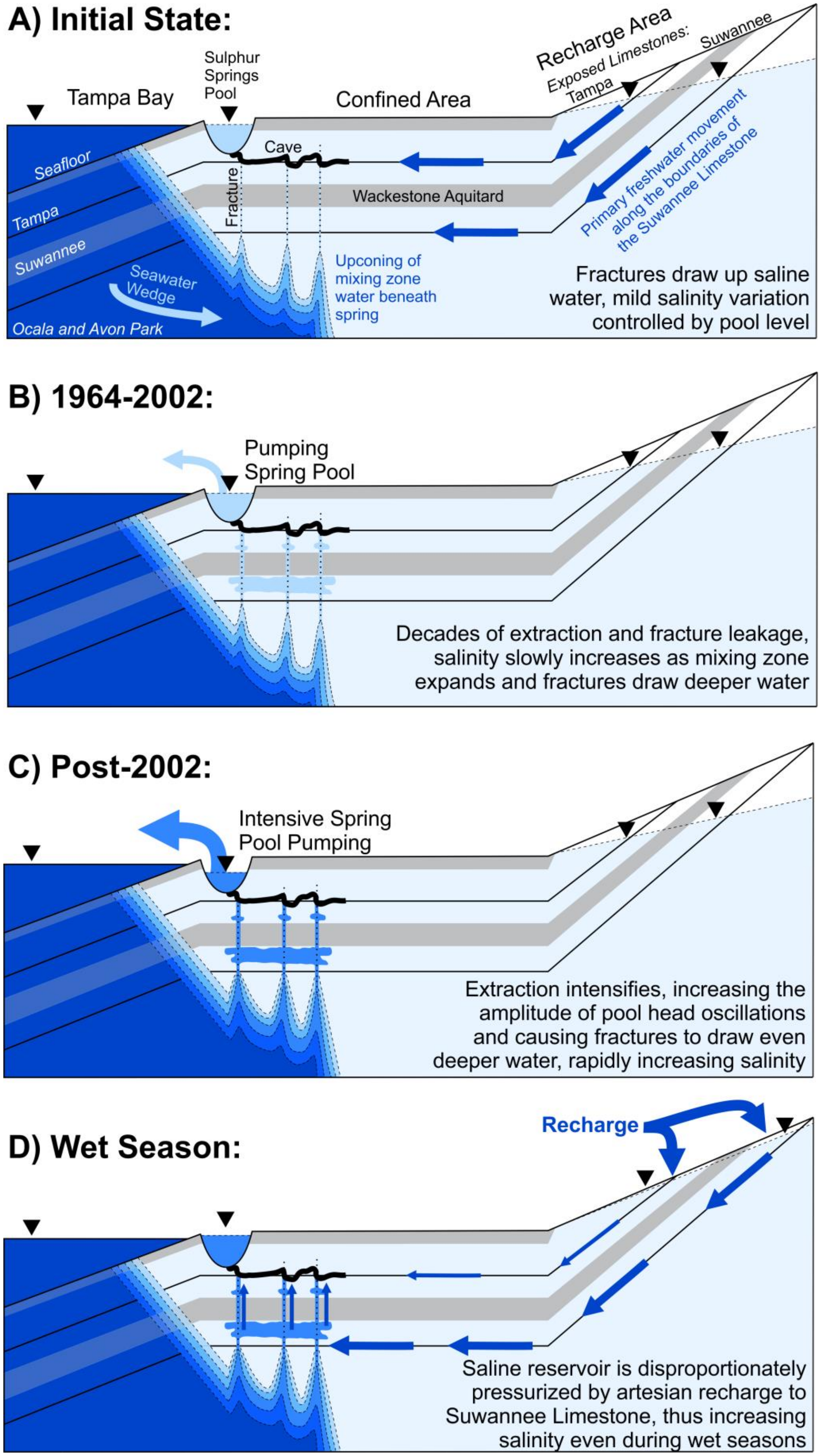

Figure 16. Model of Sulphur Springs Cave seawater intrusion. The upper and lower bedding planes of the Suwannee Limestone are the most permeable units of this portion of the aquifer. Confining units/aquitards are indicated by gray bars.

Seawater Intrusion Model: Dry season pumping

Upper Floridan Aquifer levels surrounding Tampa Bay can seasonally drop to lower than 6 m below sea level, especially in areas of major groundwater extraction activity (Hickey 1981, Hutchinson 1983, Trommer 1993). This would allow for landward groundwater movement and for seawater to recharge the coastal aquifer. In Tampa, the extent of the coastal groundwater mixing zone is at least 16 km inland from Tampa Bay (Hickey 1981, Trommer 1993). In highly permeable zones such as the Avon Park Formation, this boundary can extend even farther. Sulphur Springs Cave lies well within this transition zone, being situated only ~10 km north of the bay (Fig. 1).

Pumps were installed in Sulphur Springs pool in 1964, and were modified in 2002 to allow for spring water to be diverted to below the Hillsborough River Reservoir dam. The intense pumping activity observed since 2011 lowered Sulphur Springs pool level to near—and occasionally equal to or below—sea level (Fig. 4, Table 2b). Such activity could have led to rapid, local seawater intrusion as head pressure above each one of the fractures intersecting Sulphur Springs Cave dropped whenever municipal pumps drew down the spring pool.

Seasonal rainfall patterns and groundwater extraction in the Tampa Bay region and at Sulphur Springs causes the potentiometric head of the Upper Floridan Aquifer to oscillate dramatically. Although there is no net annual loss in freshwater head around Sulphur Springs Cave (Fig. 10), natural oscillation of the freshwater/saltwater interface would be enhanced by extraction activity, causing the mixing zone to expand over time based on the "rinsing" principle developed by Wentworth (1948). Unstable saltwater upconing can additionally expand an already-wide mixing zone and cause a well or spring to draw increasingly-saline groundwater (Bear et al. 2001). These mechanisms have probably contributed to the salinity increase of Sulphur Springs water occurring slowly since 1964 (Fig. 16b) and rapidly since 2002 (Fig. 16c). Over time the fractures intersecting Sulphur Springs Cave would have drawn water from deeper and deeper into the coastal mixing zone, while the mixing zone itself was expanding and introducing increasingly-saline water to shallower depths.

Seawater Intrusion Model: Wet season recharge

Decades of reduced pool head due to pumping would have increased the frequency and time that deep-sourced, saline groundwater would have resided in the fractures intersecting Sulphur Springs Cave. Because matrix porosity communicates freely with fractures and voids in eogenetic karst, vertically-infiltrating water could have slowly leaked from fractures into the shallow Suwannee Limestone underlying Sulphur Springs Cave (Fig. 16b & c). Stewart and Mills (1984) reported that the specific conductance and chloride concentrations of the Tourist Club Well (screened in the Suwannee Limestone nearby Sulphur Springs) had steadily increased during the 1970s and 1980s. In 1963, specific conductance and chloride concentrations in this well were as low as 1,000 µS cm^{-1} and 200 mg L^{-1}, respectively (Stewart and Mills 1984). From 1991 to 2017, specific conductance at this well never dropped below 9,900 µS cm^{-1} and reached values higher than 19,000 µS cm^{-1} (Fig. 9a). In summary, the specific conductance of Suwannee Limestone groundwater increased concurrently with that of Sulphur Springs water. This saline groundwater lies at a depth at least as shallow as 97 m below land surface (the maximum screened interval of the Tourist Club Well; Table 1). We only observed this phenomenon in the immediate Sulphur Springs area, as other wells screened at similar intervals did not experience specific conductance increases (Table 1).

If the increasingly-saline, matrix-stored water beneath Sulphur Springs Cave resided below an aquitard such as the wackestone layer present in the mid-Suwannee Limestone, it would have received more artesian pressure than would freshwater in overlying aquifer units for any given recharge event (Fig. 16d). This is similar to what occurs in salt vents beneath coastal Dutch polders (Van Rees Vellinga et al. 1981, deLouw et al. 2010). This could explain the increase in Sulphur Springs specific conductance observed during wet seasons (Fig. 4). The presence of multiple confining units in the Sulphur Springs hydrogeological system would make this a multi-story artesian spring, with hydrochemically distinct water residing in each story.

The low maximum to mean discharge ratio of Sulphur Springs (1.4) supports the idea that diffuse recharge to exposures of the cave's parent limestone drove spring discharge more than did recharge to discrete locations (i.e., sinkholes; Florea and Vacher 2006). The immediate response of Sulphur Springs discharge to recharge events was simply due to the propagation of a pressure wave through the system. Discrete recharge still seemed to impact Sulphur Springs Cave, however, by introducing rainwater directly to the system, thereby lowering specific conductance and probably introducing surface-derived nutrients and oxygen to the cave.

Despite the short-lived influence that discrete recharge had on Sulphur Springs, specific conductance at this site increased throughout the wet season. Spring discharge responded immediately to Suwannee Limestone recharge. The turbulent movement of groundwater through the cave and could have entrained salt vent water and mixed it with bulk cave water, but specific conductance at the spring continued to increase long after seasonal discharge peaked (Fig. 5). Diffuse Suwannee Limestone recharge best correlated to specific conductance when recharge was lagged 25 d. This 25-d delay might be the time it took for salt water to move up through fractures after the hypothetical Suwannee Limestone matrix-stored, saline reservoir was pressurized by recharge.

Well-survey and hydrochemical evidence

The Tourist Club Well was screened at an interval encompassing the Suwannee Limestone above and below a wackestone layer, and has experienced an increase in specific conductance since at least 1971 (Stewart and Mills 1984; Fig. 9a). No other Suwannee Limestone wells in the area showed evidence of seawater intrusion (Table 1). A deeper well located southwest of Sulphur Springs (i.e., Deep Sligh Park, screened in the Avon Park Formation) showed an increasing specific conductance trend similar to that of the Tourist Club Well (Fig. 9a, Table 1), suggesting an upward migration or expansion of the coastal mixing zone in this area. Another well screened at a similar depth as the Deep Sligh Park Well located southeast of Sulphur Springs (i.e., Hillsborough Dam: Avon Park) contained more saline water, but did not experience an increase in specific conductance (Fig. 9b). Potentiometric head above the Hillsborough Dam Well was less likely to oscillate since it is located near a large reservoir, perhaps explaining why specific conductance did not increase here.

Most recently, the saline water found in Sulphur Springs and Tourist Club Well was hydrochemically similar to modern seawater (Fig. 11). Based on the relatively high sulfate concentrations they measured at Sulphur Springs, Menke et al. (1961) hypothesized that the source of the vertically-infiltrating saline water was not seawater, but instead gypsum-influenced water from below the Ocala Limestone confinement. Indeed, based on our analysis of historical data, Sulphur Springs water in the 1950s and 1960s fell into the calcium-sulfate type (Fig. 11). The same analysis of more recent measurements suggested that the increasing specific conductance of Sulphur Springs was due to the influence of sodium-chloride type water (Fig. 11). The sulfate-enriched water influencing Sulphur Springs hydrochemistry must have been sourced from freshwater portions of the Tampa and Suwannee Limestones, since this type of water is found in well ROMP 66 (Fig. 11). Future stable oxygen and hydrogen isotope analysis of Sulphur Springs salt vent water will clarify if this water is indeed intruding modern seawater and not residual Pleistocene seawater leftover from a past high sea level stand. Hydrochemical analysis reported by Trommer (1993, p. 13) suggested that the aquifer in our study area has been flushed of residual seawater, and therefore that groundwater mineralization in the area is a result of freshwater mixing with intruding modern seawater. Our analysis of major ion data provided by SWFWMD at least makes it clear that the vertically-infiltrating water was not sourced from the Lower Floridan Aquifer, which contains calcium-sulfate type water (e.g., Spechler 1994, Moore et al. 2009).

Ecosystem impacts of saltwater intrusion and conservation of Sulphur Springs Cave

Throughout 2017, nutrient concentrations were measured from bulk water from the sampling station in the cave (data not shown). The cave was oligotrophic, and the only nutrient concentration to correlate with specific conductance was that of sulfide, which varied between ~0.5-5 µg L^{-1} (PCA controlling for date; $r = 0.98$, $p = 0.022$, $n = 7$). The long-residing, anoxic, saline groundwater migrating vertically into Sulphur Springs Cave was therefore probably rich in sulfide. This was corroborated by the observation that Sulphur Springs Cave salt vent water had a strong sulfidic odor, while bulk cave water did not. Sulfide is usually present in anoxic groundwaters where sulfate or sulfur concentrations are also high, and is produced by sulfur-reducing bacteria. While sulfide seems to be another tracer of salt vent influence, its presence might also have an impact on the cave ecosystem.

Based on their morphology and ecological niche, the feathery, white microbial mats growing near Sulphur Springs Cave salt vents are likely sulfide-oxidizing Gammaproteobacteria, similar to those found in Frasassi Cave, Italy (Macalady et al. 2006). Any sulfide-oxidizing bacteria living in Sulphur Springs Cave could produce sulfuric acid as a metabolic byproduct, enhancing limestone dissolution (Engel et al. 2004). Enhanced speleogenesis would primarily enlarge salt vents around which the acid-producing bacteria live, leading to an increased rate of vertical infiltration as fracture diameter grows. Additionally, sulfide is toxic to aquatic macro-organisms (see Tobler et al. 2011), so increased sulfide concentrations in the Sulphur Springs system would be detrimental to the cave, spring, and downstream ecosystems.

Over the past century, the hydrochemistry of water in Sulphur Springs Cave has increasingly resembled that of its salt vents (Figs. 2, 4, 6, 11). The brown microbial mats observed on the cave walls contained varying amounts of white filaments, and microscope images of brown mat samples showed that the segmented filaments characteristic of the feathery mats are sometimes present (Fig. 7a i-iii). As municipal groundwater extraction alters the Sulphur Springs Cave ecosystem, conditions will probably favor the growth of sulfur-oxidizing bacteria at the cost of brown iron-cycling/sulfur-reducing bacteria (metabolic capability of brown Sulphur Springs Cave mats was determined by Garman (2010), p. 82). A community overhaul by sulfur-oxidizers would possibly lead to enhanced dissolution of the cave, which underlies a busy highway in metropolitan Tampa.

Additionally, while Garman (2010) usually recorded the presence of dissolved oxygen in Sulphur Springs Cave on dives conducted in the early 2000s (Fig. 6), the Main Tunnel was anoxic for all of 2017 except for during a few days in November (data not shown). Some tunnels of Sulphur Springs Cave are home to stygobitic crustaceans (Garman 2010). If dissolved oxygen levels throughout the entire cave currently drop to zero for many months at a time, Sulphur Springs Cave may no longer be able to support these rare, cave-adapted animals.

The specific conductance of Sulphur Springs has increased rapidly since diversions to the Lower Hillsborough River began in 2002 (Fig. 2). As specific conductance continues to increase, it is likely that associated factors such as sulfide concentration, anoxia, temperature, and acidity will increase as well. To effectively conserve the ecosystem of this urban cave, alternative methods of supporting the minimum flows of the Lower Hillsborough River are needed. This is especially apparent in the observation that eventually Sulphur Springs water will no longer be able to support low-salinity habitat in the river below the dam.

Conclusions

1. Dry season specific conductance spikes in Sulphur Springs Cave are explained by municipal pumping activity and subsequent pool level lowering

2. Wet season specific conductance highs in Sulphur Springs Cave are probably due to artesian recharge disproportionately pressurizing deep-sourced saline groundwater

3. If current specific conductance trends continue, Sulphur Springs water may one day be unsuitable for the maintenance of low-salinity habitat in the Lower Hillsborough River

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CURIOSITY CREEK

WATERSHED MANAGEMENT PLAN UPDATE

(Known Conditions through December 2015)

Prepared for:

Stormwater Management Section
Public Works Department, Hillsborough County
601 E. Kennedy Blvd
Tampa, FL 33602

Prepared by:

7650 West Courtney Campbell Causeway
Tampa, Florida 33607-1462

September 2017

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APPENDIX A CIP Evaluation and Cost Analysis

EXECUTIVE SUMMARY

Hillsborough County has undertaken a program to develop or update watershed management plans for all of unincorporated Hillsborough County areas. Flood protection issues have been addressed for each of the seventeen watersheds in separate watershed management master plans (WMP), which were completed between 2000 and 2002. Since then, changes have occurred within each of the watersheds and affected the hydrologic and hydraulic features. Furthermore, change in standards, reference elevation datum and newer LiDAR-based topographic datasets have been considered. The combined changes warrant periodic updating of the existing models used for the WMP development, associated GIS mapping, and reassessment of previously proposed flood control projects and costs.

The Curiosity Creek Watershed Management Master Plan update is a part of the County's overall watershed management program. Although this update has increased the level of detail for hydrology and hydraulics south of Blue Sink (within the City of Tampa) and updated surface conditions throughout the watershed through 2015, the area of evaluation for stormwater management is concentrated on the watershed area within the Hillsborough County limits.

The objectives of this WMP update are to:

- Update surface conditions defined in the previous stormwater simulation model to reflect existing development and stormwater management system conditions through the year 2015 with added hydrologic and hydraulic detail;
- Update geographic information system (GIS) input/output features and data tables to a personal geodatabase (HCSWMM_GWIS.mdb) template that allows direct export to an EPA SWMM version 5.1.010 software for model simulations;
- Calibrate and verify the existing conditions model response to recorded rainfall events;
- Update watershed 100-year floodplain information and mapping;
- Identify flood areas of concern (FAC) under the existing condition and to perform an updated Level of Service (LOS) evaluation; and
- Evaluate proposed capital improvements and provide final recommendations for flood protection, water quality enhancements, and natural systems protection.

Watershed Characteristics

Location: Northwestern region of Hillsborough County. (**Figure 1-1**)

Extent: Approximately 5.5 square miles, of which the northern 3.6 square miles are within the limits of unincorporated Hillsborough County. The southern portion lies within the City of Tampa. The watershed is generally bounded by Lake Blue Gill, north of Bearss Avenue, to the north; by Interstate-275 to the east; by Armenia Avenue to the west and by the Hillsborough River to the south. (**Figure 1-2**)

Hydrologic Setting: The system contains many small lakes, ponds and depression areas. The larger lakes in the watershed include Gass, Golden Trout, Butler, Cedar East, Cedar West, Pine, Eckles and Noreast. The entire watershed drains to the Blue Sink, which is a sinkhole located in the City of Tampa just south of Country Club Drive. Flows in excess of the Blue Sink's capacity are pumped via the City of Tampa's Curiosity Creek pump station to the gravity systems south of Patbur Avenue which drain to the Hillsborough River.

Character: Highly urbanized and predominantly comprised of single-family homes that predate the 1960's. Major roadway corridors (Florida Avenue, Bearss Avenue, Fletcher Avenue, Fowler Avenue and Busch Boulevard) are highly developed with commercial businesses, apartment complexes and mobile home parks. The drainage basin is characterized by a mostly flat topography, with high water tables, natural and man-made lakes, many ditched outfalls and few remaining isolated wetlands. As with most highly urbanized watersheds, much of the main channel system has been artificially constrained by manmade developments. Culverts and ditches connect most of the lakes. The free-flowing Curiosity Creek channel discharges to a closed basin as it enters City of Tampa's Blue Sink and Curiosity Creek Detention Area and Pump Station.

Major Basins and Conveyance Systems: The unincorporated Hillsborough County portion of the watershed has been divided into major basins and conveyance systems which include the Northwest Lake System, the Curiosity Creek Main Channel and the Forest Hills Basin. (**Figure 3-1**)

Details of this watershed's major environmental features, as related to stormwater management, and its major conveyance systems are presented in **Chapter 2** and **Chapter 3** of this WMP document.

- Hillsborough County – previous WMP modeling and report files, capital improvement projects, flood records, stormwater asset/feature inventory and development plans, 2014 aerial imagery, 1999 channel survey;

- Southwest Florida Water Management District (SWFWMD) – GIS mapping of soil, land use/land cover features, LiDAR based 2011 digital elevation models (DEM), new and historic Environmental Resource Permit (ERP) construction plans, NEXRAD Doppler rainfall time series for calibration and verification storm events;

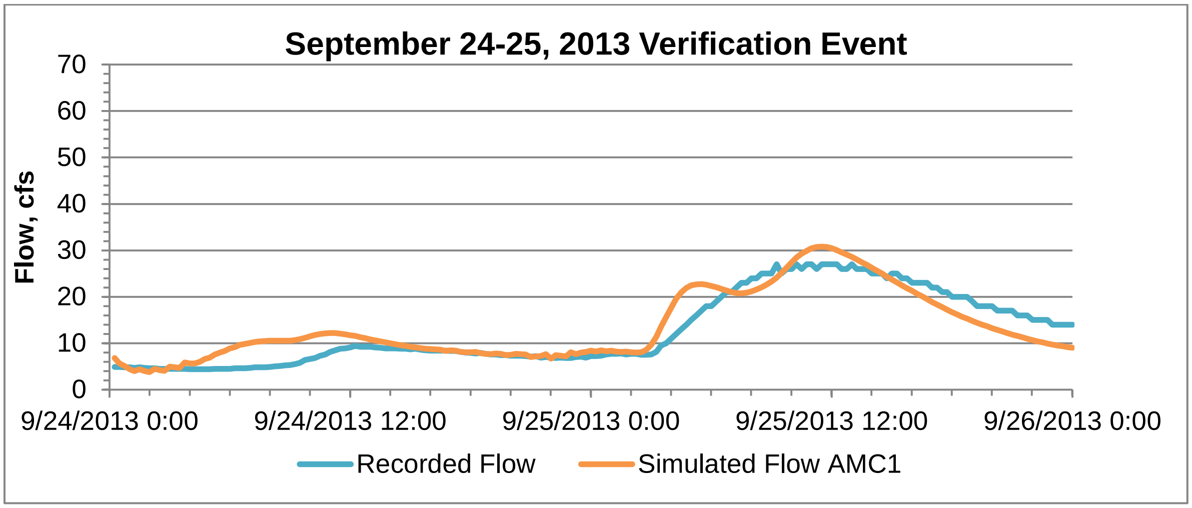
- City of Tampa (COT) – pump system capacities and operation, stormwater asset/feature inventory;

- Federal Emergency Management Agency (FEMA) – currently effective floodplain mapping and flood profiles for Curiosity Creek;

- United States Geological Survey (USGS) – streamflow, gage height and datum, and precipitation records for Curiosity Creek at 122nd Avenue;

In addition, limited supplemental professional survey of portions of the Curiosity Creek channel and several pipes and stormwater pond control structures was performed in June-July 2015. Site visits with photo documentation and field measurements were also conducted throughout the area to confirm the existing conditions within Curiosity Creek watershed.

The WMP model update included a calibration and verification analysis, using two historic events, Tropical Storm Andrea focusing on June 8-9, 2013 and the unnamed storm of September 24-25, 2013, to ensure that the simulated stormwater network and hydrologic basin input would produce a realistic system response to design rainfall events used in determining the existing flood control level of service (LOS) and proposed flood protection project designs. **Chapters 4 and 5** of this WMP document present the details of hydrologic and hydraulic model updates and the results of the calibration and verification analysis. Simulated and measured flow-through volumes, streamflow rates and channel stages correlate well for the Tropical Storm Andrea event, which occurred prior to the onset of regular summer rainfall. The best correlation is seen in the wet season event (September 24-25) presented below, which reflects the watershed condition assumed for design event modeling.


September 24-25, 2013 Verification Event
Flow, cfs
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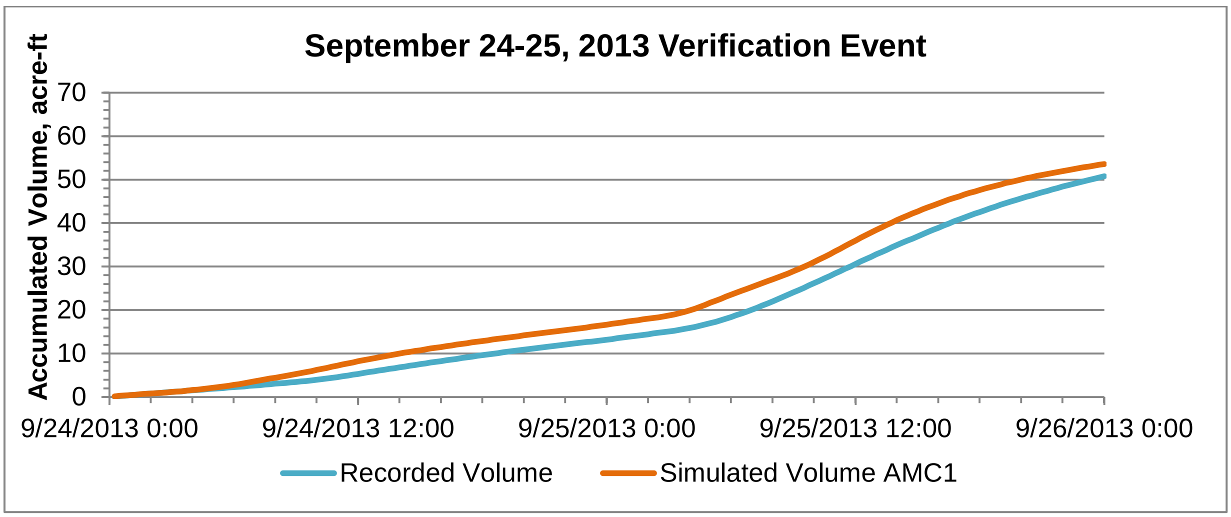
60
50
40
30
20
10
0
9/24/2013 0:00
9/24/2013 12:00
9/25/2013 0:00
9/25/2013 12:00
9/26/2013 0:00
Recorded Flow
Simulated Flow AMC1


September 24-25, 2013 Verification Event
Accumulated Volume, acre-ft
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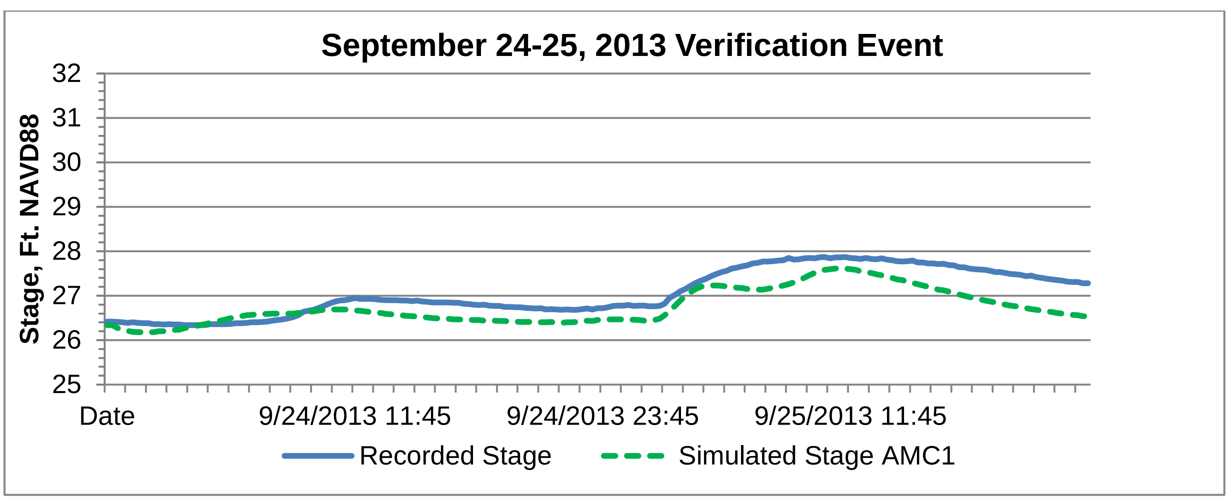
60
50
40
30
20
10
0
9/24/2013 0:00
9/24/2013 12:00
9/25/2013 0:00
9/25/2013 12:00
9/26/2013 0:00
Recorded Volume
Simulated Volume AMC1


September 24-25, 2013 Verification Event
Stage, Ft. NAVD88
32
31
30
29
28
27
26
25
Date
9/24/2013 11:45
9/24/2013 23:45
9/25/2013 11:45
Recorded Stage
Simulated Stage AMC1

Current Flood Levels and Floodplain Mapping

Watershed responses to seven separate 24-hour (1-Day) design storm events were simulated within the Curiosity Creek watershed as follows:

- 500-year, 24-hour duration, total rainfall depth 14.0 inches
- 100-year, 24-hour duration, total rainfall depth 11.0 inches
- 50-year, 24-hour duration, total rainfall depth 10.0 inches
- 25-year, 24-hour duration, total rainfall depth 8.0 inches
- 10-year, 24-hour duration, total rainfall depth 6.8 inches
- 5-year, 24-hour duration, total rainfall depth 5.6 inches
- 2.33-year (mean annual), 24-hour duration, total rainfall depth 4.5 inches

Chapter 6, **Table 6.1** shows the peak elevations for ponds, lakes, selected stormwater inlets and channel locations throughout the watershed. The 100-yr flood stages are generally used to regulate development with respect to placement and compensation for fill within the floodplain; protection of buildings through sufficient elevation of the first floor; and federal flood insurance. In addition to the 100-year 1-day design storm listed above, three additional 100-year flood events have been modeled for assessment of flood stages:

- 100-year, 3-day duration, total rainfall depth 15.0 inches
- 100-year, 5-day duration, total rainfall depth 17.8 inches
- 100-year, 7-day duration, total rainfall depth 20.0 inches

The rainfall distributions vary substantially with regard to both timing and intensity of rainfall, as well as the total volume of precipitation. The 24-hour design event is generally the more severe for rate-sensitive watersheds, while the 5-day design event will simulate higher flood stages for volume-sensitive watersheds. Discussion and comparison of the 100-yr simulations is presented in **Section 6.2** of this WMP document. Mapping of inundated roadways and ground surfaces for the 100-year, 24-hour event is presented in **Figure 6-1**. The floodplain map is generated by the 2015 model stages overlaid on the DEM. Flood zones labeled “AE” represent areas where base flood elevations can be directly discerned from model output. Flood zones labeled as “A” represent flow transition paths between flooded subbasins where exact flow depth and width cannot be quantified; or smaller, isolated depressions within larger subbasins that have not been individually modeled but lie below the anticipated flood stage.

Current Flood Levels of Service

The Hillsborough County Comprehensive Plan contains Adopted (existing) and Ultimate (proposed) LOS designations for several watersheds in Hillsborough County. The Hillsborough County Comprehensive Plan, Stormwater Element contains general definitions for flood protection LOS designations A, B, C, and D. A is the highest service level and D is the lowest.

Hillsborough County has requested the LOS definitions interpreted in the chart below, be used for project analysis. These definitions are to be applied to the 25-year, 24-hour storm event. The desired LOS for Hillsborough County is Level B.

Level	Hillsborough County Comprehensive Plan Definition	Master Plan Definition
A	No significant street flooding. All lanes are drivable.	No flooding.
B	Minor street flooding. At least one lane is drivable.	Street Flooding is more than 3” and 6” or less above crown of road.
C	Street flooding. Flooding depth above the crown of the road is less than one foot.	Street Flooding is more than 6” and 12” or less above crown of road. Site flooding.
D	No limitation on flooding.	Street Flooding is more than 12” above crown of road. Structure flooding.

The following quantitative interpretations have been applied for the roadway LOS analyses, regardless of whether the road is publically owned and maintained or privately owned and maintained:

- “Drivable” roads have less than, or equal to, three (3) inches of water above the crown of the road.
- One (1) passable lane means one (1) lane in each direction for a four (4) lane road or larger, or one (1) lane along the center of the road for a two (2) lane road.

The following additional quantitative interpretations have been applied for the site and structure LOS analyses:

- Site flooding of less than, or equal to, three (3) inches of water above the land surface and outside of the right of way is considered minor and is designated LOS Level A.
- Site flooding greater than three (3) inches, but less than or equal to six (6) inches of depth above the land surface and outside of the right of way is designated LOS Level B.
- Site flooding above six (6) inches in depth and outside of the right of way is designated LOS Level C.
- Permanent structures are assumed to be flooded (LOS Level D) when the adjacent grade indicated by the DEM is below the peak flood stage.
- Mobile home structures are assumed to be elevated a minimum of one foot above the adjacent grade; therefore are assumed to be flooded when the peak water level is greater than one foot above the adjacent grade.

The existing condition LOS associated with the 25-year, 24-hour storm for each subbasin of the Curiosity Creek watershed within the County’s jurisdiction is presented in **Table 6.3a**. **Figure 6-3** illustrates the LOS for roadways based on depth of flooding. Roadway segments not meeting the desired LOS are represented in blue (LOS C) and red (LOS D). The Northwest Lake System and the Forest Hills Basin each contain one area of significant road flooding. The most severe roadway flooding (and in some cases potential structure flooding) occurs within the Curiosity Creek Main Channel Basin.

Flood Areas of Concern and Alternative Analysis

Chapter 13 of this WMP document describes the series of Best Management Practices (BMP) that were developed as alternatives for flood control within the County portion of the Curiosity Creek watershed. Areas not meeting the desired LOS were evaluated as part of the alternatives analysis utilizing the following approach:

- Review the flood areas of concern and flood control alternatives described in the 2000 update of the Curiosity Creek WMP;
- Identify flood control projects that have been fully or partially implemented since that time;
- Identify added or deleted flood areas now apparent due to increased model detail or changes in the conveyance system (i.e. pump station capacity or operational changes);
- Review flood complaint locations and specific issues compiled by Hillsborough County staff;
- Develop and test alternative pipe sizes, channel cross-sections, flow attenuation/storage facilities or control mechanisms sufficient to provide an LOS level of B or better using the SWMM5 model;
- Estimate costs associated with proposed improvements; and
- Prioritize proposed BMPs using the Hillsborough County prioritization matrix.

The alternatives analysis identified regions of flooding, or flooding areas of concern (FAC). **Figure 13-1** presents the FAC and identifies the major conveyance system affected; the Northwest Lake System, the Curiosity Creek Main Channel, or the Forest Hills Basin

Alternatives to address LOS deficiencies were then developed for each problem area. These alternatives include structural and non-structural improvements, as well as maintenance needs that were identified during field observations. Alternatives are conceptual in nature and have not been optimized, although assumed configurations have been modeled.

A summary of the more significant flood areas of concern (FAC) is presented below.

- FAC 1 represents Samy Drive road flooding in the Northwest Lakes System associated with pond stages north of the roadway. A low segment approximately 250 feet in length is inundated by the 25-year, 24-hour pond stage by almost eleven inches. Yards and structures are not at risk. According to simulations, lower level street inundation begins at the 5-year return frequency.

- FAC 12 represents LOS C roadway flooding of N. Rome Avenue adjacent to Lake Eckles which is caused by overtopping of a stormwater wetland on the west side of Rome Avenue, resulting in sheetflow across the roadway. Flood flows are collected in the eastern roadside inlets and conveyed to Lake Eckles. Wetland overtopping sheetflow across Rome Avenue appears to occur even for the mean-annual design event.

- FAC 2 represents LOS C and D roadway flooding along Floral Drive, Carnation Drive, Lakewood Avenue, Leisure Avenue and North Boulevard

- FAC 3 represents LOS D roadway flooding of Ambassador Loop and possible structure flooding adjacent to Curiosity Creek in the same vicinity. FAC 3 also encompasses significant flooding of private roads and mobile home structures within Rose Lake Estates.

- FAC 4 represents the LOS D roadway flooding of Arkwright Drive with potential flooding of several residential structures; as well as the Tyrone Mobile Home Park flood prone area (private) and LOS D road flooding on W. 138th Avenue, N. Ola Avenue, and North Point subdivision roads (Constitution Drive, Proclamation Drive, Magna Carta Way and Candidate Place)

- FAC 5 represents LOS D roadway flooding of Wildwood Street east of Arkwright Drive at the N. Florida Avenue intersection, with potential flooding of residential and commercial structures. Flooding on Wildwood Street obstructs ingress and egress for the residential areas in that vicinity.

- FAC 6 represents LOS D roadway flooding between Garland Court and E. 145th Avenue, east of Florida Avenue and west of Interstate 275. Several residential structures are also at risk of flooding. County projects have been and continue to be constructed in this area.

- FAC 7 represents LOS C and D road flooding between E. 138th Avenue and E. 137th Avenue west of Central Avenue, with potential structure flooding.

- FAC 9 represents LOS D road flooding along E. 121st Avenue with potential structure flooding for low properties north of E. 121st Avenue.

- FAC 16 represents severe and widespread flooding of private roads and mobile home structures within Halliday Park and one single family residential structure south of

Halliday Park, adjacent to the creek. Because public roadways are not impacted by the flooding in this region, BMP analysis has not been conducted.

All of the BMP alternatives were developed within the following constraints: 1) the Curiosity Creek watershed is a closed system that does not have a free surface discharge but is controlled by the capacity of the COT pump station network, and 2) the Hillsborough County stormwater program is confined to projects which are for the protection of public roadways. The Statewide ERP regulatory program for projects within this watershed will be subject to the criteria for closed system, volume-sensitive basins. Alternatives must not cause an increase in the rate or volume of runoff that could adversely impact adjacent properties.

Modeling was used to quantity the level of flood relief afforded by various BMP solutions for each FAC and to identify the most practical solution. Detailed descriptions of each BMP are presented in **Chapter 13**. The preferred BMP solutions for FACs are summarized in a set of graphic representations and Fact Sheets at the end of this chapter.

Flood Control Project Ranking and Recommendations

Chapter 15 of this WMP document is dedicated to the priority ranking and recommendations for flood control projects to address the more severe LOS deficiencies within the Curiosity Creek Watershed.

The ranking methodology utilizes an evaluation matrix developed by Hillsborough County to facilitate the logical implementation order (phasing) of proposed capital improvement projects. The Capital Improvements Program (CIP) Evaluation Matrix utilizes a point system to quantify project benefits with respect to, a) consequences of continued flooding, and b) frequency of flooding. Flooding consequences are differentiated by type under the following categories:

- Arterial Road
- Local Street
- Home
- Yard
- Increased Hazard (special characteristics that may impact public safety)

Flooding frequency point values are weighted such that roads, yards and structures which flood more frequently will have a point value than those which flood rarely. An additive point value is also assigned to flood areas with a long history of chronic flooding.

Other problems associated with a project site such as erosion/siltation, high groundwater table, maintenance issues, or system structural failures are also accounted for by an assigned point value in the matrix. The total point value assigned to the consequences of <u>not</u> correcting the problem is considered the project benefit, B. Project benefits can then be compared with estimated project costs, C, to determine a Benefit to Cost (B/C) ratio by dividing the Evaluation Matrix point total by the estimated construction cost for each project. The resulting ratio is then used to rank the projects in order to aid the County's CIP decision making process. CIP Evaluation sheets and preferred BMP Cost Analysis tables are found in Appendix A. The final set of ten recommended CIP projects and their priority rank is presented below (taken from WMP report **Table 15.2**).

Rank	FAC #: Project Name	Major Basin	Benefit Score	Construction Cost ($1,000)	Benefit/Cost Ratio
1	FAC 5: Wildwood Street at N. Florida Avenue - Raise Road	Curiosity Creek Main Channel	213	31	6.87
2	FAC 9: E. 121st Avenue Gravity Outfall	Curiosity Creek Main Channel	266	268	0.99
3	FAC 12: Joshua Bend Wetland Control Structure Modification	Forest Hills Basins	76	95	0.80
4	FAC 8: E. 132nd Avenue at Central Avenue Drainage Improvement	Curiosity Creek Main Channel	246	555	0.44
5	FAC 10: E. 122nd Avenue and Country Club Drive Culvert Replacements	Curiosity Creek Main Channel	72	254	0.28
6	FAC 6: Garland Court / E. 145th Avenue - New Pond	Curiosity Creek Main Channel	236	1,240	0.19
7	FAC 7: E. 137th Avenue / E. 138th Avenue Drainage Improvements	Curiosity Creek Main Channel	110	893	0.12
8	FAC 2: Floral Drive/Carnation Drive/ Ambassador Loop and Rose Lake Estates MHP Improvements	Curiosity Creek Main Channel	472	6,819	0.07
9	FAC 1: Samy Drive and Leisure Avenue– New Pond	Northwest Lake System	36	651	0.06
10	FAC 4: Arkwright Drive/Tyrone Village MHP/North Pointe Lakes Regional Detention	Curiosity Creek Main Channel	286	5,370	0.05

CHAPTER 1 INTRODUCTION

1.1 Project Location and General Description

The Curiosity Creek Watershed is approximately 5.5 square miles and is located in the northwest part of Hillsborough County and in the City of Tampa (**Figure 1-1**). The northern two-thirds (approximately 3.6 square miles) of the watershed lies within the limits of Hillsborough County and is bounded by Country Club Drive to the south (Hillsborough County boundary), Interstate I-275 and Nebraska Avenue on the east, Lake Magdalene Boulevard on the north and the lakes of Magdalene, Carroll and Platt on the west. The remaining one-third of the watershed lies within the City of Tampa. The system contains many small lakes, ponds and depression areas. The larger lakes in the watershed include Gass, Golden Trout, Butler, Cedar East, Cedar West, Pine, Eckles and Noreast. Lake Gass is the largest lake in the watershed and is approximately 40 acres in surface area. The entire watershed drains to the Blue Sink, which is a sinkhole located in the City of Tampa. Flows in excess of the Blue Sink's capacity are pumped via the City of Tampa's Curiosity Creek pump station to the gravity systems south of Patbur Avenue. **Figure 1-2** illustrates the watershed and surrounding features.

The watershed is highly developed with only a few areas that have not undergone some type of land alteration. Much of the area has been developed with single-family homes that predate the 1960's. The areas near major roadways are highly developed with commercial businesses, apartment complexes and mobile home parks. The land use for these areas has been commercially oriented for decades. The drainage basin is characterized by a mostly flat topography, with high water tables, natural and man-made lakes, many ditched outfalls and few remaining isolated wetlands. As with most highly urbanized watersheds, much of the main channel system has been artificially constrained by manmade developments. Culverts and ditches connect most of the lakes.

The drainage system of Curiosity Creek can be divided into three segments, the Northwest Lake System, the Curiosity Creek Main Channel and the Forest Hills Basin. The Northwest Lake System comprises an area of approximately 530 acres. This area has been developed mostly into residential land use and contains many interconnected lakes. Runoff from the Northwest Lake System originates in the area north of Fletcher Avenue, south of Bearss Avenue and west of Rome Avenue. Most of the lakes in this system transfer flow through pipes and ditches discharging into Curiosity Creek, located approximately one-half mile north of the crossing at Fowler Avenue (Country Club Drive). It should be noted that not all of the lakes in this system (and throughout the watershed) have positive outfalls. These areas are known as "blinds" and may discharge in an "out of bank" condition during intense storm events. The main channel of Curiosity Creek originates at a borrow pit in the headwaters of the basin, within Country Lakes Estates, and moves through the system in generally a southerly direction until ultimately discharging directly to the Blue Sink area which is located in the City of Tampa. The Blue Sink is a sinkhole located south of Fowler Avenue (Country Club Drive) and west of Florida Avenue. The storage capacity of the sink is limited, although the flood attenuation volume has been expanded by the construction the sizeable City of Tampa Curiosity Creek Detention Area to the south. The sink itself currently has very limited seepage characteristics. Water surface elevations within the sinkhole were historically controlled by a portable pump station operated by the City of Tampa that was taken off line after the Curiosity Creek Pump Station at 109th Avenue was constructed. The lower catchments, south of Busch Boulevard, slope significantly southward toward the Hillsborough River outfall, located 2¾ miles downstream of the City of Tampa Dam.

Although most of the Forest Hills Basin is in the City of Tampa, there is an area within unincorporated Hillsborough County that contributes runoff to this basin. This area includes those lakes within Hillsborough County that discharge to the Forest Hills Basin either by conveyance, or direct runoff. Round Lake, Mid Lake, and Lake Eckles are part of the Forest Hills Basin. Curiosity Creek was studied in 1982 for the Southwest Florida Water Management District, Hillsborough County and the City of Tampa in response to the severe and prolonged flooding that occurred in September 1979. This master plan was used in the development of the expanded flood storage detention area to the south of the Blue Sink (Curiosity Creek Detention Pond, FLD&E, 1987 for the City of Tampa, Project 10683.00), as well as other improvements in the watershed. The watershed within the County limit and City limit was restudied in 2001 and in 2002, respectively, to address flood protection issues since 1982 study. The most recent watershed management model update prior to this effort was completed by Ayres Associates in January 2007 and updated the existing conditions model to reflect 2005 watershed conditions.

1.2 Background and Scope of the Project

Hillsborough County has undertaken a program to develop or update watershed management plans for all of unincorporated Hillsborough County areas. Flood protection issues have been addressed for each of the seventeen watersheds in separate watershed management master plans (WMP), which were completed between 2000 and 2002. Since then, changes have occurred within each of the watersheds and affected the hydrologic and hydraulic features. Furthermore, change in standards, reference elevation datum and newer LiDAR-based topographic datasets have been considered. The combined changes warrant periodic updating of the existing models used for the WMP development, associated GIS mapping, and reassessment of previously proposed flood control projects and costs.

The Curiosity Creek Watershed Management Master Plan update is a part of the County's overall watershed management program. Although this update has increased the level of detail for hydrology and hydraulics south of Blue Sink (within the City of Tampa) and updated surface conditions through 2015, the area of evaluation for stormwater management is concentrated on the watershed area within the Hillsborough County limits.

The objectives of this WMP update are to:

- Update surface conditions for the previous HCSWMM version 4.3 surface water model to reflect existing development and stormwater management system conditions through the year 2015;
- Load the updated GIS input and output features and data tables to the HCSWMM_GWIS.mdb template for export to EPA SWMM version 5.1.010 software for updated model simulations;
- Calibrate and verify the existing conditions model response to recorded rainfall events;
- Update floodplain information and mapping;
- Identify flood areas of concern (FAC) under the existing condition and to perform an updated Level of Service (LOS) evaluation; and
- Re-evaluate proposed capital improvements and provide final recommendations for flood protection, water quality enhancements, and natural systems protection.

Existing conditions modeling is based on hydrology derived from available land use, soils and topographic data. Input data for the hydraulic model was then developed based on the physical characteristics of the watershed and was subsequently calibrated to known storms from the past and available stream gage and flood complaint data to ensure the accuracy of the model. Updated model input includes development reflected in collected ERPs and "As Built" drawings through December 2015. **Figure 1-3** illustrates the locations of ERP projects areas and County stormwater project areas that were reviewed for this update. All elevations for this study and associated modeling files have been referenced to North American Vertical Datum (NAVD) 1988.

The results from the calibrated existing conditions model were used to evaluate the location and degree of expected flooding within the study area under the existing conditions for the 2.33-year, 5-year, 10-year, 25-year, 50-year, 100-year and 500-year 24-hours design storms. Multiday events for the 100-year return frequency (3-day, 5-day and 7-day) were also simulated. The model results were evaluated to determine the existing conditions LOS for the watershed. Where possible, the output from the model was compared with historical high water marks and flooding complaints registered with Hillsborough County. Historical, documented flooding problems were given priority. Hillsborough County has a targeted LOS for the primary conveyance features that will protect homes as well as limit street and yard flooding during the 25-year, 24-hour duration storm event.

Based on the LOS analysis, flooding areas of concern (FAC) were identified and have formed the basis for locations evaluated for best management practices (BMPs) to alleviate flooding. Proposed BMPs have been modeled using EPA SWMM 5.1 (with HCSWMM hydrology), with recommended projects subsequently evaluated for estimated cost and then ranked using the County's prioritization matrix.

1.3 Data Collection

The update of the previous existing conditions model was performed by review and use of data from many sources. The following agencies were involved during data collection:

- Hillsborough County
- Southwest Florida Water Management District (SWFWMD)
- City of Tampa (COT)
- Federal Emergency Management Agency (FEMA)
- United States Geological Survey (USGS)

In addition, site visits were conducted throughout the area to confirm the existing conditions within Curiosity Creek watershed.

Existing conditions (2015) modeling is derived from the available digital land use, soils, topographic and hydraulic feature data listed below:

- Existing infrastructure elements reflected in COT and Hillsborough County stormwater asset/inventory databases
- 2011 Florida Land Use Cover Classification System (FLUCCS) dataset
- Natural Resource Conservation Service (NRCS) Soil Mapping
- 2014 aerial photographs
- 2011 LiDAR datasets for creating a digital elevation model (DEM)
- Environmental Resource Permit (ERP) data and "As-Built" drawings in pdf format
- Capital Improvement plan sets in pdf format
- Significant older development plan sets (or excerpts) in pdf format
- Professional survey (historic and recent)
- Field investigation and on-site measurements

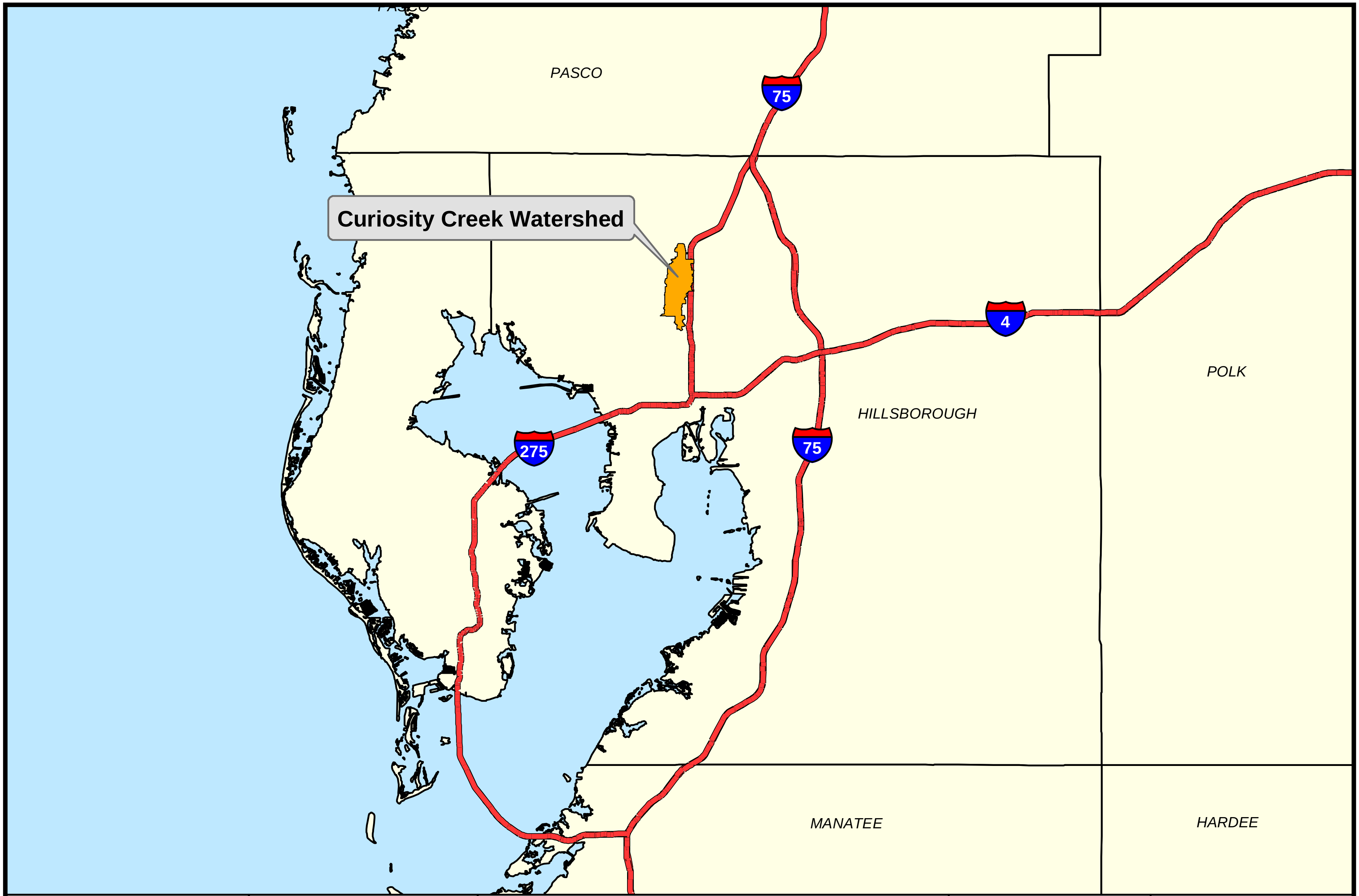
Additional data collected to support model calibration and verification included :

- Historic flood complaint locations (September 1997, December 1997, January 1998, and September 2004-Hurricane Frances)
- NEXRAD 15-minute Doppler rainfall datasets for June 5-14, 2013 (Tropical Storm Andrea) and for September 20-25, 2013 (unnamed storm)
- USGS 15-minute discharge and gage height data for Site 02305851 Curiosity Creek at 122nd Avenue near Sulphur Springs Florida for June 7-13, 2013 (Tropical Storm Andrea) and for September 22-October 1, 2013 (unnamed storm)

1.4 Report Organization

The Curiosity Creek Watershed Management Update report is organized into eight "replacement" chapters, with referenced figures located at the end of each chapter, and following the original plan organization as follows:

- Chapter 1 provides an introduction and an overview of the report with a description of objectives;
- Chapter 2 provides an overview of the watershed including major environmental features related to stormwater management;
- Chapter 3 describes the basin's major conveyance systems;
- Chapter 4 explains the hydrologic and hydraulic modeling methods and assumptions;
- Chapter 5 presents updated model calibration and verification process;
- Chapter 6 describes the existing conditions flood levels, level of service analysis and simulated floodplain;
- Chapter 13 describes the alternatives analysis modeling results;
- Chapter 15 presents the proposed project cost estimates, prioritization and recommendations.



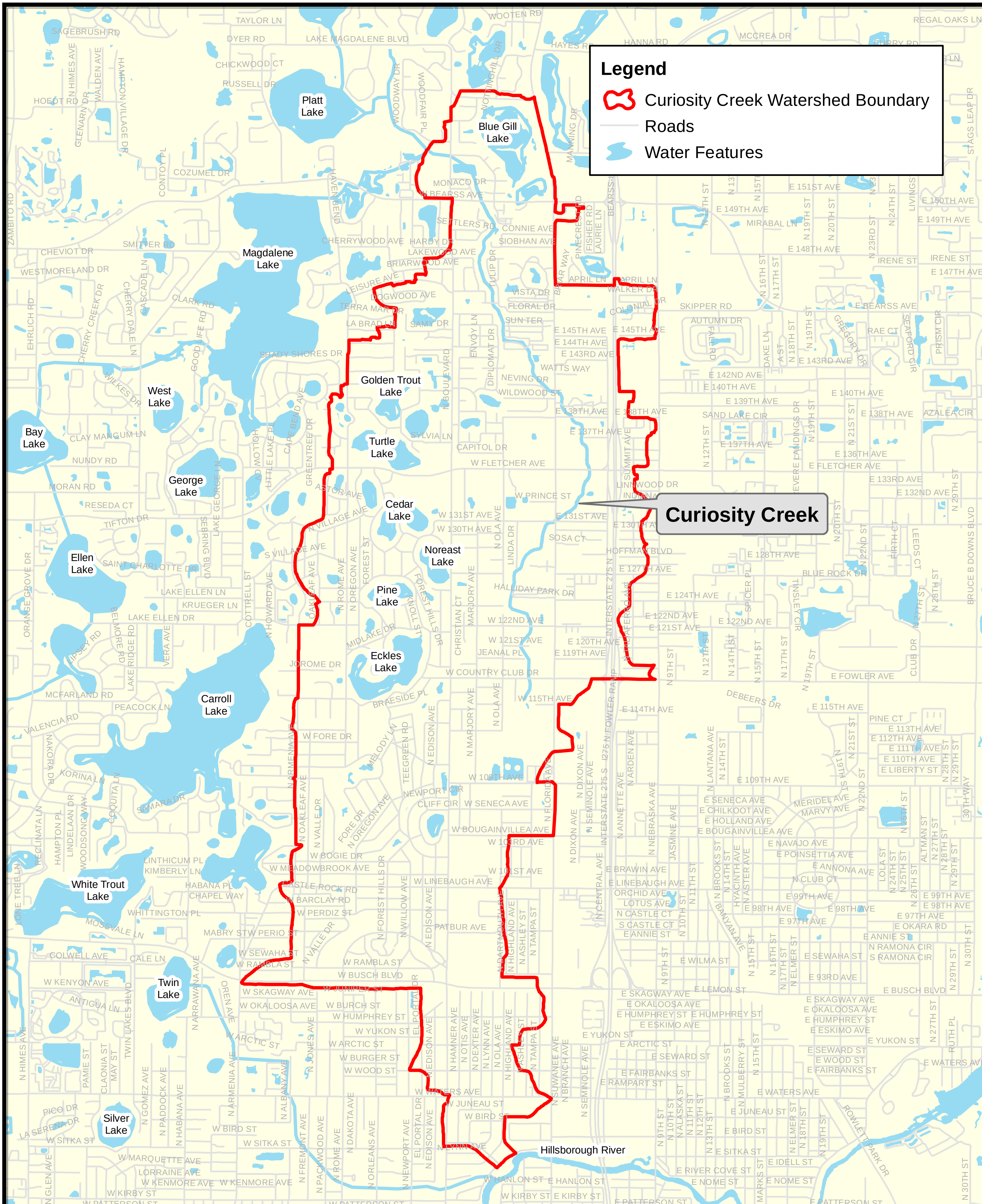
Curiosity Creek Watershed
County Boundary
Interstate Roads

N
0 4 8 Miles

Figure 1-1
Curiosity Creek Watershed Location Map

Hillsborough County Florida

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607



N

0 0.3 0.6

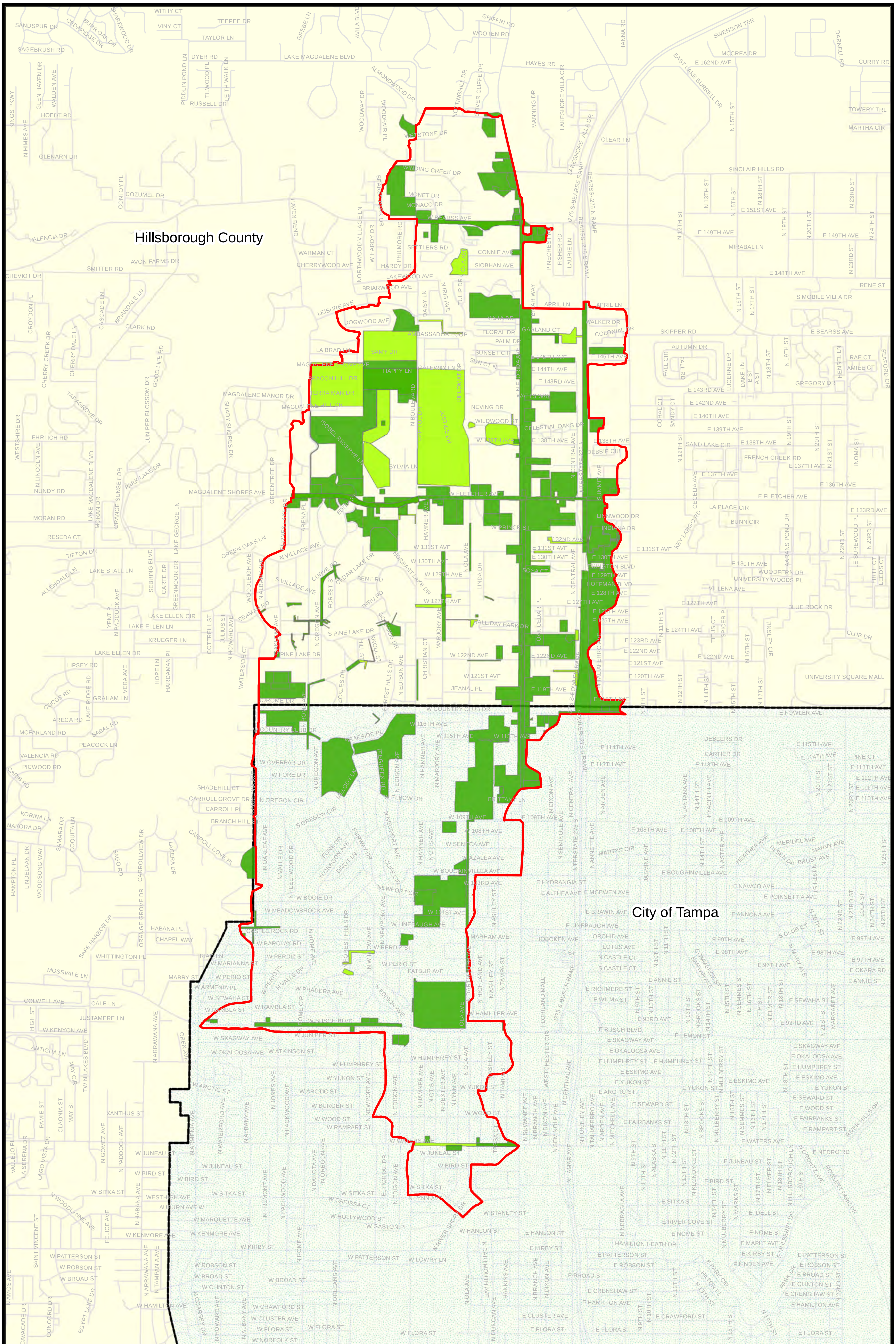
Miles

Figure 1-2
Curiosity Creek Watershed and Surrounding Features

Hillsborough County Florida

URS

7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607



Legend

- Curiosity Creek Watershed Boundary
- SWFWMD ERP's Reviewed
- County Plans Reviewed
- Hillsborough County
- City of Tampa
- Roads

N

0 0.2 0.4
Miles

Figure 1-3
Curiosity Creek Watershed Locations of ERP's and County Plans Reviewed for WMP Update

Hillsborough County Florida

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607

CHAPTER 2 WATERSHED DESCRIPTION

2.1 General Description

2.1.1 Climate

The climate in Hillsborough County can be classified as subtropical. The average rainfall for the county is approximately 50 inches per year. The rainy season generally begins in late June and lasts until September. The summer months are hot and humid with high temperatures in the 90's. During the summer months, late afternoon thunderstorms are common. These storms are generally of high intensity but short duration.

2.1.2 Topography

The topography of Curiosity Creek Watershed can be characterized as relatively flat. Land surface elevations vary from about 20 feet around the Blue Sink to near 70 feet above the North American Vertical Datum (NAVD) of 1988 in the northern portion of the watershed (**Figure 2-1**). This gives the basin area an average slope of approximately 0.0015 feet/feet.

2.1.3 Soils

According to the NRCS classification system, there are 15 different types of soils that occur within the area. Hydrologic Soil Group (HSG) is commonly used for hydrologic analysis to estimate infiltration rates and soil moisture capacities. The HSG classifications identify soil infiltration potential as A (high), B (moderately high), C (moderately low) or D (low). These groups are used in watershed planning to estimate runoff from rainfall, where runoff potential is inversely proportional to infiltration potential. Soil properties that determine the HSG classification are: depth to seasonal high water table, infiltration rate and permeability after prolonged wetting, and depth to confining layer.

A description of these groups is as follows:

Hydrologic Soil Group A (low runoff potential): Soils that have high infiltration rates even when thoroughly wetted and a high rate of water transmission.

Hydrologic Soil Group B (moderately low runoff potential): Soils that have moderate infiltration rates when thoroughly wetted and a moderate rate of water transmission.

Hydrologic Soil Group C (moderately high runoff potential): Soils that have a slow infiltration rate when thoroughly wetted and a slow rate of water transmission.

Hydrologic Soil Group D (high runoff potential): Soils having very slow infiltration rates when thoroughly wetted and a very slow rate of water transmission.

Some soils are classified as belonging to dual hydrologic groups (for example B/D, the first letter in the designation applies to the drained condition). These soils are rated as D when in their natural condition, but can improve to a hydrologic characteristic of B if the water table is lowered sufficiently. Artificial lowering of the water table to this degree is not generally permitted in urban settings and is more commonly practiced in agricultural or mining operations.

The soil coverage has been intersected with the Hillsborough County portion of the watershed boundary using GIS, resulting in the distribution of hydrologic soil groups illustrated in **Figure 2-2** and summarized **Table 2.1**.

2.1.4 Land Use/Land Cover

The existing (2011) land use coverage is published by SWFWMD as a Geographical Information System database based on the Florida Land Use and Cover Classification System (FLUCCS). The GIS feature was obtained through Hillsborough County.

Major ERP plans (since 2005) have been incorporated to update the land use. Aerial imagery (2014) obtained from Hillsborough County has also been used to adjust FLUCCS designations where justified. The modified existing land use coverage within the Hillsborough County portion of the watershed is presented in **Figure 2-3**.

The Curiosity Creek Watershed is generally highly developed with a predominance of residential and commercial/institutional land use. Only a small percentage (1%) of the watershed remains as open land. Approximately 9% of the watershed is made up of water bodies and wetlands which serve to store stormwater runoff during extreme flooding events. **Table 2.2** presents a composite breakdown of acreage and percentage for each type of land use within the Hillsborough County portion of the watershed.

2.2 Features

The most notable natural features in the watershed area are the various lakes of the Northwest Lakes and Forest Hills major basins and the lakes and creek channel of the Curiosity Creek main channel basin. The largest lakes that are totally contained within the limits of Hillsborough County are Lake Gass (a.k.a. Lake Blue Gill) and Lake Butler (a.k.a. Turtle Lake). Lake Gass has a surface area of approximately 33 acres. Lake Butler is a smaller lake that lies to the south of Lake Gass and has a surface area of approximately 16 acres. Lake Eckles is another sizeable water feature that straddles the COT municipal boundary at the southern end of the study area and has a surface area of approximately 23 acres. The most notable roadway features in the study area are Florida Avenue and Interstate 275. Florida Avenue is a four-lane state highway that gives access to many commercial and residential centers in the study area.

2.3 Historical Synopsis of Flooding in the Watershed

March 1960 – Heavy rains caused flooding in the Forest Hills area. Many families were forced to evacuate. References indicate that flooding also occurred during the previous fall of 1959 in the Forest Hills area.

May 1979 – Rainfall totals from May 7, 1979 were reported as 11.45 inches in 24 hours, and may have been as high as 15 inches. However, only minor and localized flooding was reported. This was attributed to the relatively dry conditions of the basin during the time the storm occurred.

September 1979 – Approximately 36 to 38 inches of rain fell in the months of August and September. Heavy rainfall (similar to that of May 1979) caused severe flooding in areas of the Curiosity Creek basin, which was already saturated from previous rainfall events. Widespread flooding of Forest Hills and the Tyrone Trailer Park forced residents from their homes.

September 1997 to January 1999 – The El Niño winter of 1997 was arguably the strongest El Niño on record. The normal total average rainfall for the month of December is 2.14 inches. December of 1997 produced 15.01 inches of rainfall, which is 701% higher than normal for that month (ref. SWFWMD Daily Rainfall Report 29-Dec-97; Regional Summary, Northwest Hillsborough). This event produced records of reported flooding problems that are mostly related to areas with no outfall or maintenance issues within the creek. These flood reports were concentrated around the lakes in the Northwest Lake System. Although there did not appear to have been any house flooding, there were reports of prolonged street and yard flooding. Ground saturation led to problems with septic systems, and concerns about well contamination.

September 2004 – Hurricane Frances brought heavy rainfall and widespread flooding to southwest-central Florida September 4-14, 2004. The hurricane moved across the Florida Peninsula generating 5 to 11 inches of rain over already saturated ground. Record flooding occurred in the parts of Hardee, Hillsborough, Pasco, and Polk Counties. Based on the USGS gage data, a peak discharge of 205 cubic feet per second (cfs) and a peak stage of 35.15 feet occurred at Curiosity Creek at 122nd Avenue near Sulphur Springs. Many places within the watershed are recorded flooding, including but not limited to: W 131st Avenue, Cedar Lake, North Ola Avenue between 131st Avenue and Fletcher Avenue, Forest Hill Drive, North Rome Avenue, crossing of North Boulevard and Leisure Avenue.

Flood complaint records and locations supplied by Hillsborough County do not include any complaints beyond Hurricane Frances (2004). The SWFWMD High Water database includes only one additional flood complaint (dated September 11, 2012) which is located at the northeast boundary of the watershed on April Lane. The study area does not appear to have experienced flood conditions as severe as those listed above in the years since, which may be partially attributable to the absence of high volume events and to the construction, in late 2003, of a permanent pump station operated by the COT and located at 109th Avenue at the Curiosity Creek Detention Area. The following storm events, notable either for intensity or total rainfall, have been recorded in the watershed, without specific reports of significant flooding.

June 2012 - Tropical Storm Debby brought rainfall and high winds to southwest-central Florida June 23-25, 2012. The storm coursed across the Tampa Bay area generating 7.5 to 7.9 inches of rainfall within the Curiosity Creek watershed, according to Doppler rainfall data supplied by the SWFWMD. The USGS gaging station on Curiosity Creek at 122nd Avenue was not operational at the time, however. No specific flood complaints have been supplied associated with this event.

June 2013 - Tropical Storm Andrea, in the following year, occurred between June 6 and June 8, 2013. The rainfall amounts recorded in the Curiosity Creek basin were fairly low, with just under 3 inches falling on June 6th followed by a relatively dry day on June 7th and another 0.7 to 1.7 inches falling on the June 8th. The USGS continuous stream data records for Curiosity Creek at 122nd Avenue include stage and flow data only from June 7th onward and record a peak discharge and stage of 25 cfs and 27.8 feet for June 8th, 2013. An estimated peak discharge and stage of 53 cfs and 28.56 feet for June 6, 2013 is cited in the NWIS online records for annual peak streamflow at this station. No specific flood complaints are recorded for this event.

September 2013 - Approximately 2.7 inches of rainfall was seen in this basin, resulting from a late summer storm event on September 24-25, 2013. The event was distributed similarly to Tropical Storm Andrea, with respect to comprising two fairly intense rainfall periods separated by approximately 18 hours without significant rainfall. The event produced a peak discharge of 27 cfs and a peak stage of 27.84 feet at the gaging station on Curiosity Creek at 122nd Avenue near Sulphur Springs.

September 2015 – An unnamed storm front brought approximately 7.8 inches of rainfall over the Curiosity Creek basin between August 1-3, 2015, with an average of 3.5 inches falling on August 1st, followed by light rain on August 2nd and over 4 inches falling on August 3rd. The USGS gaging station on Curiosity Creek at 122nd Avenue was down for maintenance during this period. No specific flood complaints have been supplied associated with this event.

2.4 Hydrogeology

Undifferentiated surficial deposits of silt, sand, and clay that vary in thickness from 40 to 70 feet underlie the Curiosity Creek Watershed area. The lower part of these deposits consists of clay, sandy clay, and clayey sand and act as a confining layer over the Floridan aquifer throughout most of the area (Stewart and Mills, 1984). The Floridan aquifer system consists of several hundred feet of limestone and dolomite formations and is separated into the Upper Floridan Aquifer, the Middle Confining Unit, and the Lower Floridan Aquifer. The formations that make up this system include in descending order, the Tampa Limestone, the Suwannee Limestone, Ocala Limestone, Avon Park Limestone, and the Oldsmar Limestone.

Groundwater flow within the surficial aquifer is generally south, but will vary locally in relation to Curiosity Creek and the many lakes and ponds in the area. Flow within the Floridan is generally to the south also, but can vary due to extensive cavity systems that occur within the upper part of the Floridan aquifer. Due to the cavernous nature of the upper limestone units, many sinkholes occur in the watershed, especially in the southern part. These include Blue Sink into which the creek discharges, and numerous other sinkholes, most of which occur to the south and east of Blue Sink. Several dye tracer studies have been performed in Blue Sink dating back at least to the 1950's. These tests have shown that many of the sinkholes are connected via underground cavities, and that the groundwater eventually discharges to Sulphur Springs in the COT. The velocity of the groundwater within these cavity systems is very high, and based on the past dye tests have shown ranged from approximately 5,000 feet/day to over 7,000 feet/day (Cardinale, 1993). However, the connection from Blue Sink to Sulphur Springs has been severely impacted over the years due to increasing clogging of the sink from erosion and sedimentation, trash, and other debris.

Table 2.1 Summary Statistics of Soils Information

Hydrologic Soil Group	Area (acres)	Percentage
A	383.22	17%
B/D	254.11	11%
C	1446.22	63%
D	108.53	5%
W	99.06	4%
Total	**2291.13**	**100%**

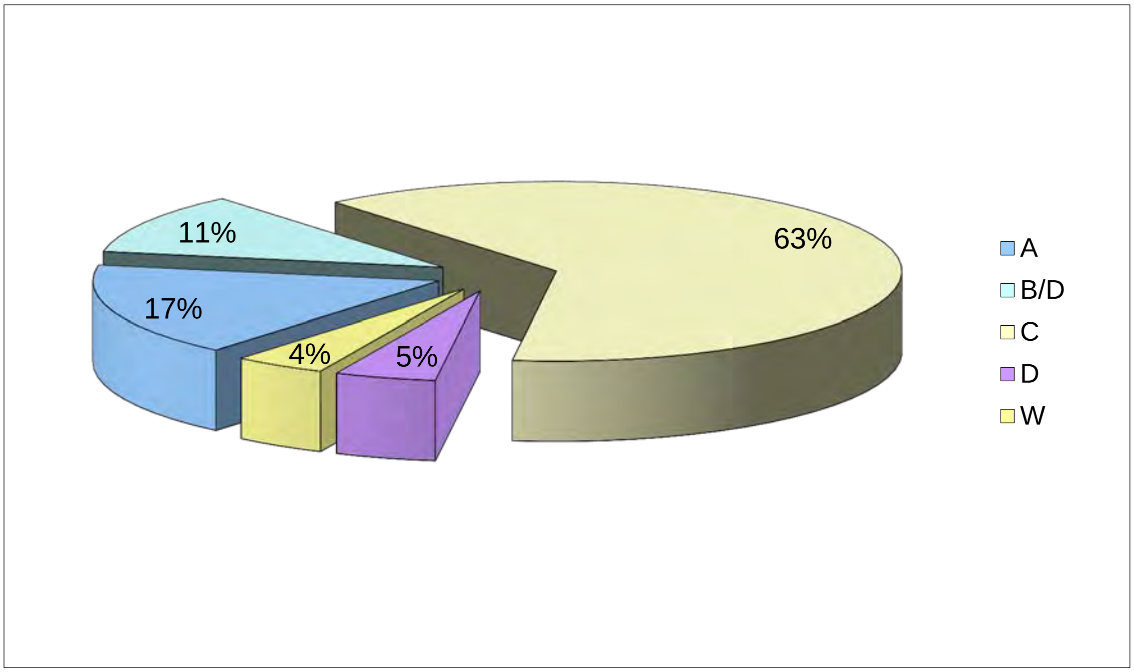
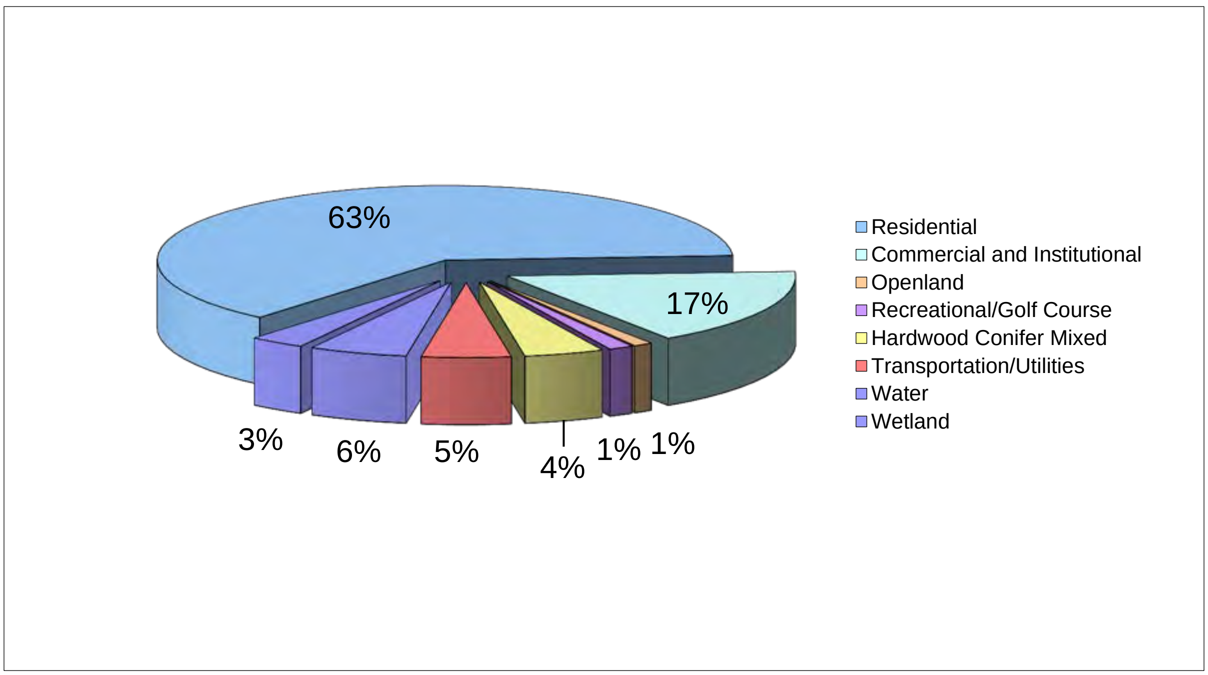


Table 2.2 Summary Statistics of Land Use/Land Cover

Land Use/Land Cover	Area (acres)	Percentage
Residential	1441.37	63%
Commercial and Institutional	379.86	17%
Openland	24.36	1%
Recreational/Golf Course	31.14	1%
Hardwood Conifer Mixed	102.35	4%
Transportation/Utilities	114.54	5%
Water	126.31	6%
Wetland	71.20	3%
Total	**2291.13**	**100%**



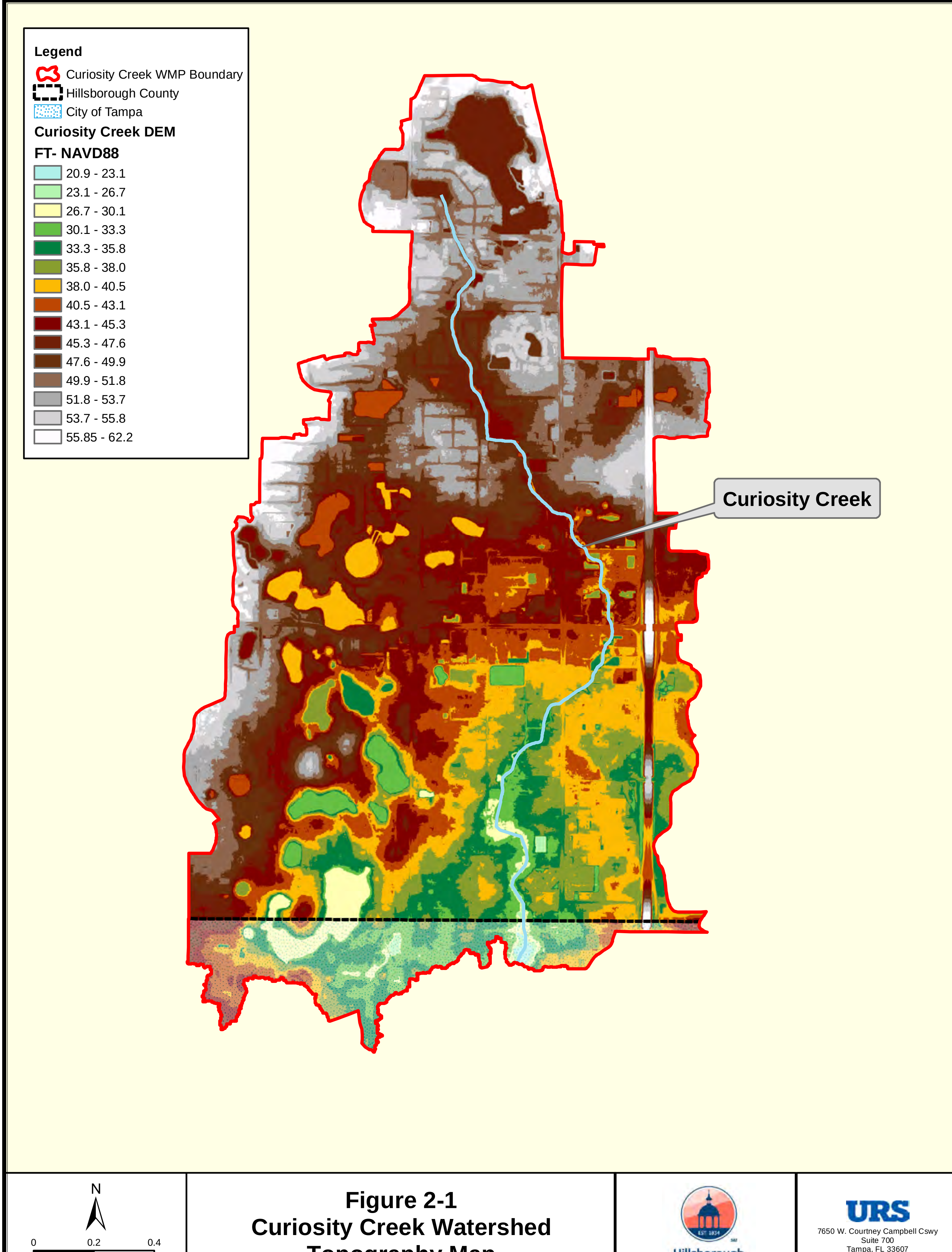


Figure 2-1
Curiosity Creek Watershed
Topography Map

Hillsborough County Florida

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607

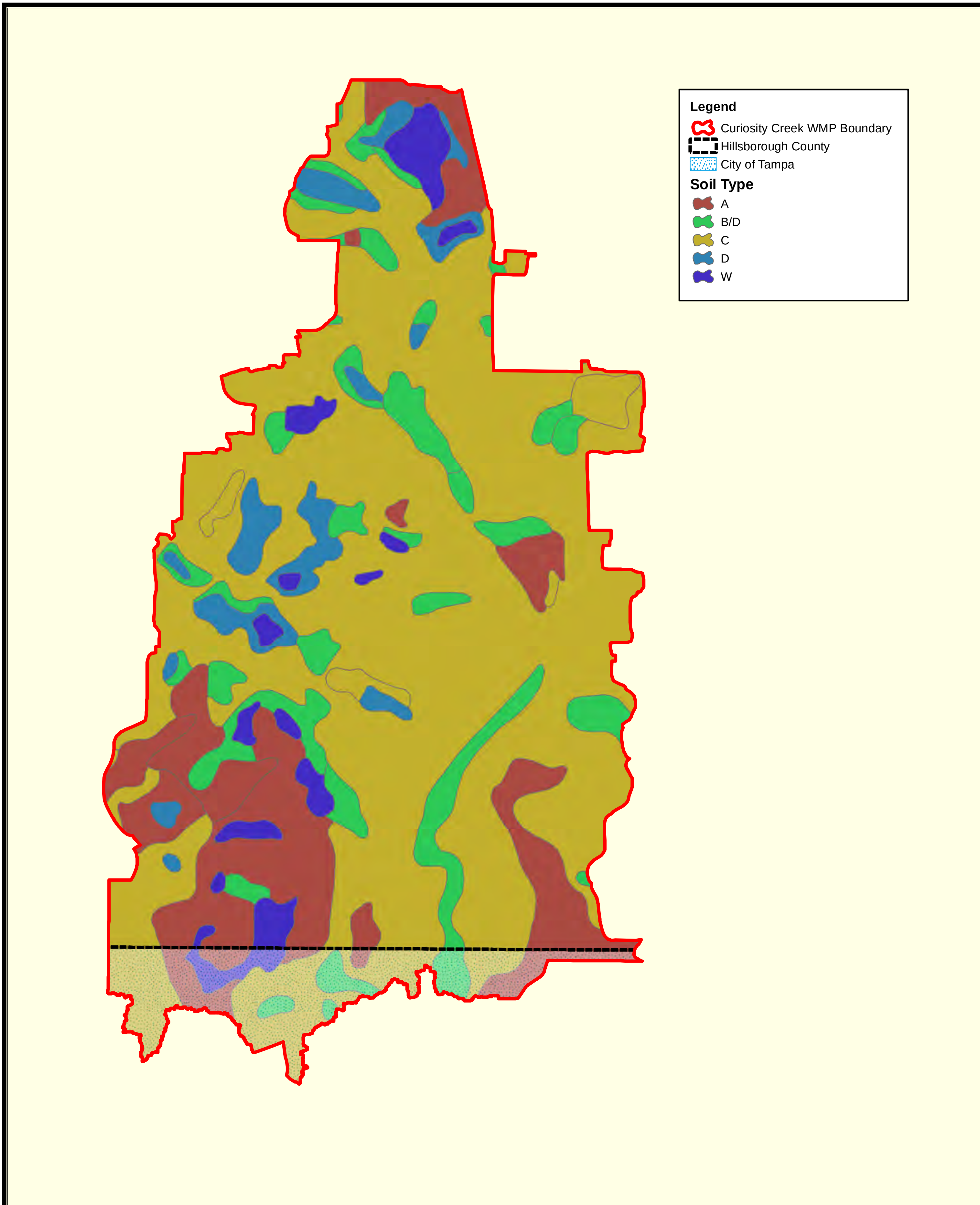
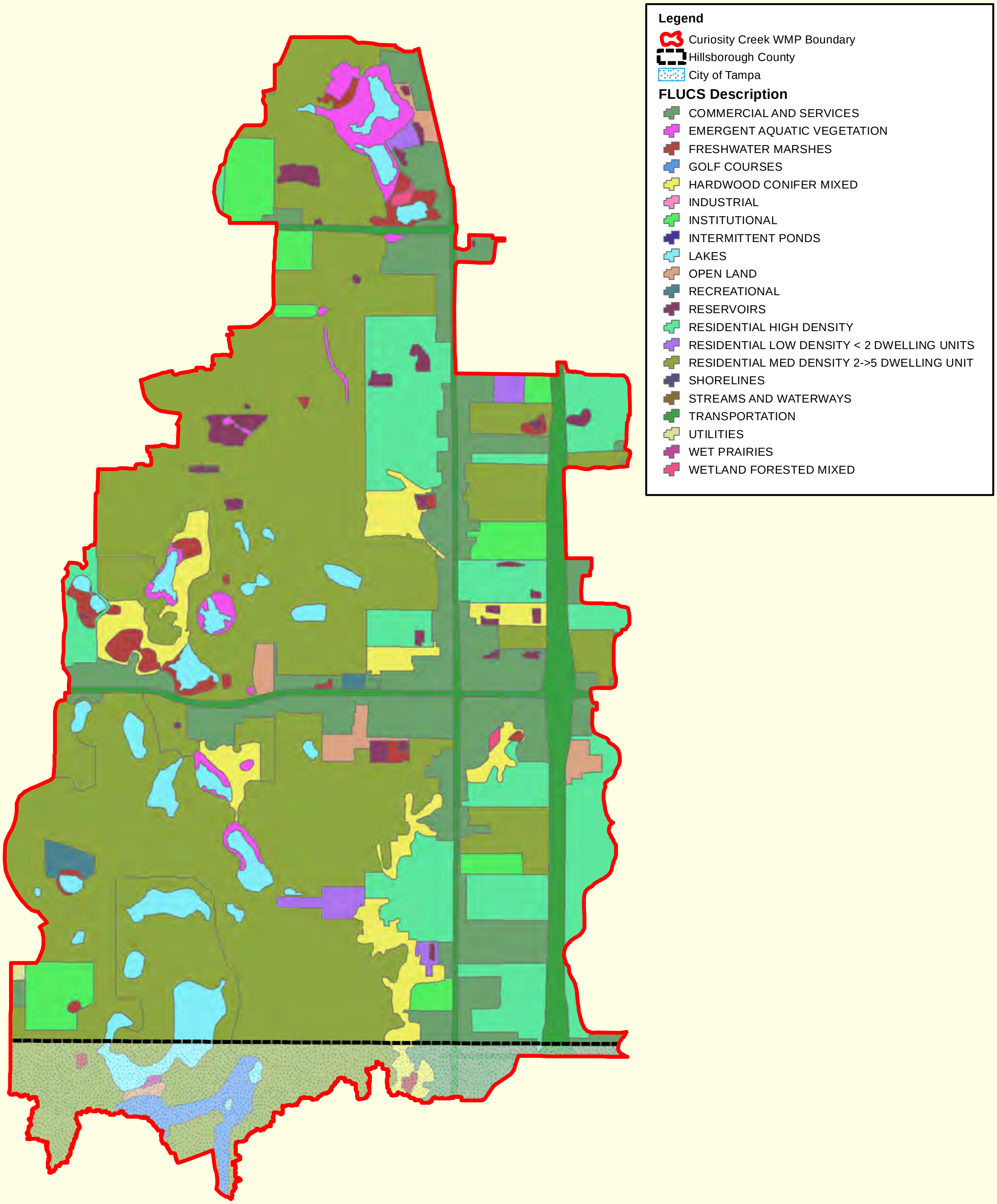


Figure 2-2
Curiosity Creek Watershed
Hydrologic Soil Groups

Hillsborough County Florida

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607



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0 0.2 0.4
Miles

Figure 2-3
Curiosity Creek Watershed
Updated SWFWMD 2011 Land Use

Hillsborough County Florida

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607

CHAPTER 3 MAJOR CONVEYANCE SYSTEM

3.1 Introduction

The purpose of this chapter is to describe and define the area of analysis presented in this report. The major conveyance areas, or major basins, of the Curiosity Creek Watershed area are as follows:

- The Northwest Lake System
- The Curiosity Creek Main Channel
- The Forest Hills Basin

Figure 3-1 illustrates the major basins of the watershed.

3.2 The Northwest Lake System

This system of lakes lies in the northwest section of the watershed. It is bounded by Leisure Avenue to the north, Rome Avenue to the west, North Boulevard to the east, and to the south by Pine Lake Drive. The total drainage area for this portion of the watershed is approximately 574 acres. The major lakes in the system are Golden Trout, Butler, Dorset, Cedar West, Cedar East, Noreast and Pine.

The upper most lake in the Northwest Lake System is Lake Golden Trout. This lake is approximately 6 acres and discharges to an unnamed lake that is located to the southeast of Golden Trout. Lake Golden Trout does not have a stormwater control structure to regulate water levels. At stages above elevation 44.97 feet, this lake will discharge in an overland manner to the unnamed lake. Water from the unnamed lake discharges through a 24-inch corrugated metal pipe (CMP) to Lake Butler. This lake has a control structure and delivers excess runoff through a pipe system under Fletcher Avenue to a small lake immediately to the south. There is a series of small lakes with interconnected pipes that ultimately, deliver water to Lake Cedar East. From Cedar East, water is discharged through a pipe to Lake Noreast that is located to the southeast. Lake Noreast has a set of discharge pipes that are connected to Curiosity Creek.

Lakes Dorset, Cedar West, Pine, Sophia, Burnes, Round Pond and Pine Pond, as well as several other unnamed lakes, have historically been land locked water bodies with no outfall. These lakes accumulate rainfall during the wet months and have historically been slow to recover. Toward the end of the rainy season many of these lakes have lost considerable storage volume due to the compounding of storm events. It is at this time that the system has the greatest potential for flooding. A set of Hillsborough County drainage improvement projects, constructed between 2003 and 2004 created new high stage outfalls and connectivity between Lake Sophia, Round Pond, Pine Lake, Pine Pond and Noreast Lake to provide a positive outfall to Curiosity Creek for this part of the system.

3.3 The Curiosity Creek Main Channel

3.3.1 The Main Channel

The headwater of Curiosity Creek begins at a small pond north of Bearss Avenue and east of North Boulevard. Historically, the headwaters were connected to the Sweetwater Creek watershed at a point somewhere between Lake Platt and Lake Magdalene. This connection appears to have been severed sometime in the late 1950's. From the small pond, located within the Country Lakes subdivision, the channel flows southeast and passes under Bearss Avenue. This section of channel is straight and has steep side slopes, with a flat sand bottom, and is typical of urban ditch conveyance systems. After Bearss Avenue the channel receives discharge from Lake Gass/Lake Blue Gill. This discharge is limited by an 18-inch reinforced concrete pipe (RCP) and enters the creek from the east at a point about 500 feet south of the Bearss Avenue crossing.

The channel continues to flow to the south and enters an area bounded by residential land use. This portion of the creek widens and has been excavated. The system is mostly straight, and is wet, with very little apparent flow during the normal condition. The survey of this portion of the creek indicated that the depth of the water in some areas under normal conditions was approximately 6 feet. The channel vegetation is made up of wetland type species and is sometimes very heavily saturated with algae. The side slopes are steep and there is evidence of erosion. This section of the channel has a silty bottom. The creek continues to flow to the southeast until after it crosses under the roadway of Floral Drive.

At a point approximately 500 feet downstream of the Floral Drive crossing, the creek turns due south. This appears to be an unnatural change in direction. There is a mobile home community at this location, which altered the creek as a result of development (Hydrologic Investigation and Stormwater Management Plan for the Curiosity Creek Watershed; Reynolds, Smith and Hills 1982). The creek cross section is considerably narrower than the cross section above Floral Drive. The creek follows the western edge of the development and turns sharply to the east passing through the mobile home community. This portion of the channel is well maintained. The difference in elevation from the top of bank on the right to that on the left is approximately 5 feet. Historic contour maps, which predate the portion of the development to the south, indicate that this large difference in elevation is a natural condition and not totally the result of fill. It also appears that the mobile homes that are to the north of the channel may be located within the floodplain limits.

After passing under a private roadway within the mobile home community, the creek turns again to the south. It is bordered to the east by the berm of a FDOT stormwater detention pond. This pond serves the roadway of Florida Avenue and discharges through a pipe system to a point immediately upstream of the crossing at Curiosity Creek and Florida Avenue (north crossing). The property to the west is owned by Hillsborough County and an unpaved crossing of the creek at this location conveys flows through two 48-inch RCP. The channel in this portion is fairly straight with a silty bottom and has side slopes that are vegetated with small brush and trees.

The channel continues to flow to the southeast and eventually passes under Florida Avenue through twin box culverts (7-foot span by 3.5-foot rise). Downstream of the Florida Avenue crossing, the channel takes on a more natural appearance. The channel begins to meander and is very incised and is narrower than the upstream sections. This configuration continues as it flows through the Oak Groves apartment complex development and toward the crossing at 138th Avenue. The creek begins to turn due south after passing under 138th Avenue where another FDOT roadway detention pond for Florida Avenue discharges to the system. This was the location of a formerly active USGS gaging station from 1981 to 1988.

The system continues and passes under Fletcher Avenue via twin 7-foot x 6-foot box culverts. These box culverts are set very deep. The culvert inverts at Fletcher Avenue are approximately 4.2 feet deeper than the next downstream structure (driveway crossing for an automobile dealership) and approximately 5.0 feet deeper than the upstream structure at 138th Avenue. The channel bottom, in the vicinity of the Fletcher Avenue crossing, is approximately 4 feet higher than the inverts of the box culverts.

After passing under Fletcher Avenue, the channel straightens again and passes under two driveway crossings. The first is a driveway crossing for an automobile dealership and the second is a driveway crossing for a mobile home community. The structure under the upstream driveway (the dealership) utilizes a 4-foot x 9-foot box culvert. The downstream driveway structure (within the mobile home community) was previously a single 3-foot diameter corrugated metal pipe (CMP) crossing, severely constricting flow compared to the upstream crossings. It would generally be expected that the smaller pipes in a conveyance system would be found upstream as flow generally increases in a system from upstream to downstream. The crossing has been replaced with twin 30-inch CMPs since the 2007 WMP update, which while improving the flow capacity, is still very restrictive. It should be noted that for floods above the mean annual design event, the majority of the flow is carried over the crossing rather than through it.

The creek at this point begins to turn to the southwest. The side slopes are rather steep with little vegetation in the actual bottom, but the channel is vegetated with brush and trees along the top of bank. The system then passes under Florida Avenue at 131st Avenue via twin 72-inch RCP's. Between 131st Avenue and 122nd Avenue the stream receives discharge from two additional systems. The first is a FDOT detention pond at Ola Avenue and W. 131st Avenue, receiving runoff from both Fletcher Avenue and Florida Avenue as well as runoff areas contributory to Ola

Avenue north of 131st Ave as far as Wildwood Street. The second system is the Northwest Lake System that discharges to Curiosity Creek through a series of pipes ranging in diameter from a 30-inch to a 42-inch (equivalent), originating at Noreast Lake and entering the creek at a point approximately 2,300 feet north of Country Club Drive. This section of the creek system has two privately-owned minor crossings, including an interior roadway within a mobile home park and a small one-lane private drive aligned with 124th Avenue. Both of these crossings appear to be privately owned and constructed and carry only a small portion of the total creek flow during significant events. The vast majority of the flow is carried over the drives. There are some older mobile home communities existing in very close proximity to the top of bank of the creek. Much of the creek system appears to have been constrained by development.

Downstream of the 122nd Avenue crossing, the channel is well vegetated with a rather narrow bottom width (approximately 7 feet). The creek passes behind many private residences as it flows in a southerly direction to Country Club Drive. At Country Club Drive the creek receives direct runoff from Florida Avenue and the adjacent residential areas. The creek delivers runoff to the Blue Sink south of this location. When the Blue Sink exceeds its retention capacity it discharges over an earthen berm of over 80 feet in width to a large detention facility owned by the COT. The Curiosity Creek Detention Area also receives runoff from the subbasins in the Forest Hills residential area. The Curiosity Creek Detention Area is equipped with a permanent pump station utilizing three separate pumps with 22,400-22,450 gallons per minute (50 cfs) output per pump and utilizing tiered activation elevations, the lowest of which is 22.0 feet. Pump station output is directed through a 48-inch forcemain to gravity stormwater systems south of Patbur Avenue that ultimately discharge to the Hillsborough River.

A summary of the main channel conveyance features is shown in **Figure 3-2** and **Table 3.1**.

3.3.2 Tyrone Mobile Home Park Area

The Tyrone Mobile Home Park area lies north of Fletcher Avenue between Ola Avenue and Florida Avenue. This area includes the North Point residential development west of Ola Avenue and its water management features (Lake Morris, Lake Russel and an unnamed retention area); the mobile home park and its stormwater pond; and residential areas along Arkwright Drive and Wildwood Street to the north that drain to a small pond at its southeast boundary. The pond associated with the low-lying mobile home park does not have an outfall. Runoff from the surrounding area drains into the small retention area within the park. The capacity of this small pond is quickly diminished and subsequent flooding occurs resulting in overland flow to the Ola Avenue and Fletcher Avenue inlets. The residential area served by the Arkwright Drive retention pond also lacks a formal outfall. When this pond capacity is exceed it overtops and discharges floodwater southward into the mobile home park, where the natural depressional storage for this area is located. The North Point lakes and ponds tie into the Ola Avenue storm sewer system which drains south, crosses Fletcher Avenue, and is received into the Ola Avenue FDOT and County retention pond. Flood stages must reach an approximate elevation of 43.67 feet before the overtopping of Fletcher Avenue is possible.

3.4 The Forest Hills Basin

The Hillsborough County portion of the Forest Hills Basin contains Lake Eckles, Mid Lake, and (historically) Round Lake. In 2003, Hillsborough County drainage improvements connected Round Lake to the Northwest Lakes System through a new control structure and storm sewer pipe network. There is also a small area to the north of Country Club Drive and west of the main channel of Curiosity Creek that discharges through a collection system to the south side of the crossing of Country Club Drive and Curiosity Creek. Mid Lake is located southeast of Round Lake and has a pipe connection to Lake Eckles. Lake Eckles is also a land locked water body that has experienced flooding due to a lack of an adequate outfall. This lake is split by the political boundaries of Hillsborough County and the COT. At the present time, a pump station operated by the COT maintains water elevations on the lake. Lake Eckles has a high out of bank overflow to the south at approximate elevation of 34.67 feet . Should the lake overflow, it will discharge to Penalty Lake to the south which is located within the City limits and also served by a pump station operated by the COT.

Table 3.1 Summary of Major Conveyance Features of Curiosity Creek Main Channel

Model Reach ID	Description	Length (ft)	Manning's n	Inv. Upstream	Inv. Downstream
P550100	78" RCP at Country Club Drive	40	0.013	18.45	17.89
P550300	60" RCP at 122nd Avenue	33	0.013	25.76	25.16
P550500	43" X 68" ERCP at Private Dirt Drive	15	0.013	27.06	26.16
P550700	48" CMP at Private Road within Michigan MHP	20	0.024	27.85	27.56
P550900B	(2) 72" RCP at North Florida Avenue and W 131st Avenue Crossing	152	0.013	30.90	30.60
P550900C		152	0.013	31.13	30.70
P551100A	(2) 30" CMP at Dirt Road within McDowell MHP	20	0.024	33.25	33.25
P551100B		20	0.024	33.25	33.25
P551300	4' x 9' Box Culvert at an auto dealership	54	0.013	34.58	34.87
P551400A	(2) 7' x 6' Box Culvert at E. Fletcher Avenue	86	0.013	30.68	30.68
P551400B		86	0.013	30.67	30.67
P551410	Private bridge equivalent box culvert 8.12' x 29.7'	24	0.013	34.16	34.16
P551415	Private bridge equivalent box culvert 8.12' x 28.6'	24	0.013	34.16	34.16
P551800	54" CMP at E. 138th Avenue	51	0.024	36.66	35.65
P551900	4' x 8' Box Culvert at Oak Grove apartments	55	0.013	37.95	37.61
P552150A	(2) 3.5' x 7' Box Culvert at North Florida Avenue	83	0.013	39.66	39.86
P552150B		83	0.013	39.56	39.76
P552300A	(2) 48" RCP easement Hillsborough County parcel	23	0.013	38.03	38.85
P552300B		20	0.013	38.16	38.81
P552400A	60" CMP at Sun Valley Lane within a MHP	24	0.024	39.17	39.14
P552400B	(2) 24" CMP at Sun Valley Lane within a MHP	24	0.024	41.88	41.67
P552400C		24	0.024	42.01	41.70
P552600A	(2) 54" RCP at Floral Drive	38	0.013	38.67	38.67
P552600B		38	0.013	38.67	38.67
P553000A	(2) 60" CMP at Bearss Avenue	100	0.024	44.90	43.68
P553000B		100	0.024	44.90	43.65

Notes:

1. Elevations shown are in NAVD 88 (North American Vertical Datum); to convert to NGVD 29 add 0.83.
2. Conduits listed in this table are from downstream to upstream along the Curiosity Creek main channel.
3. MHP stands for Mobile Home Park.

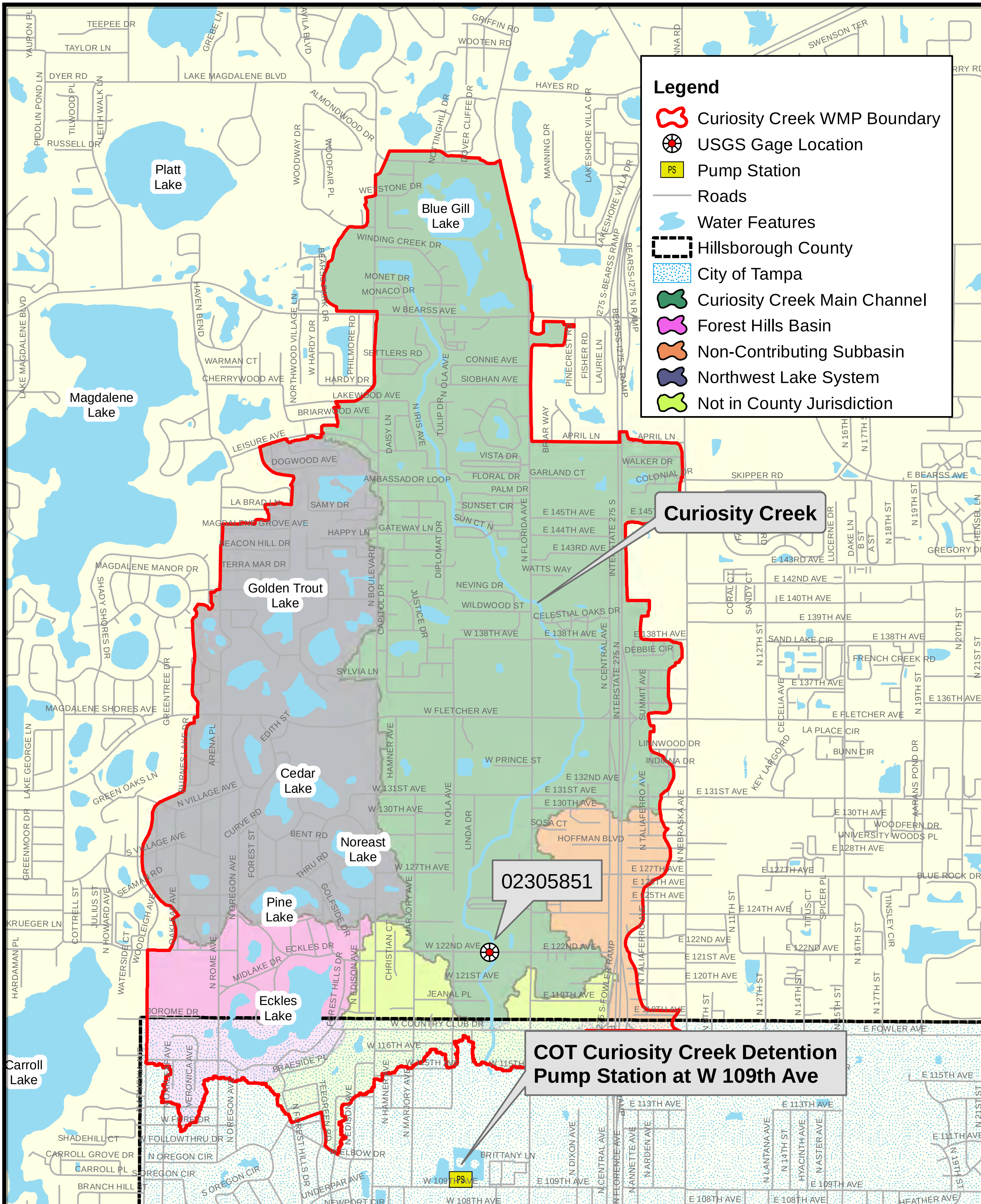
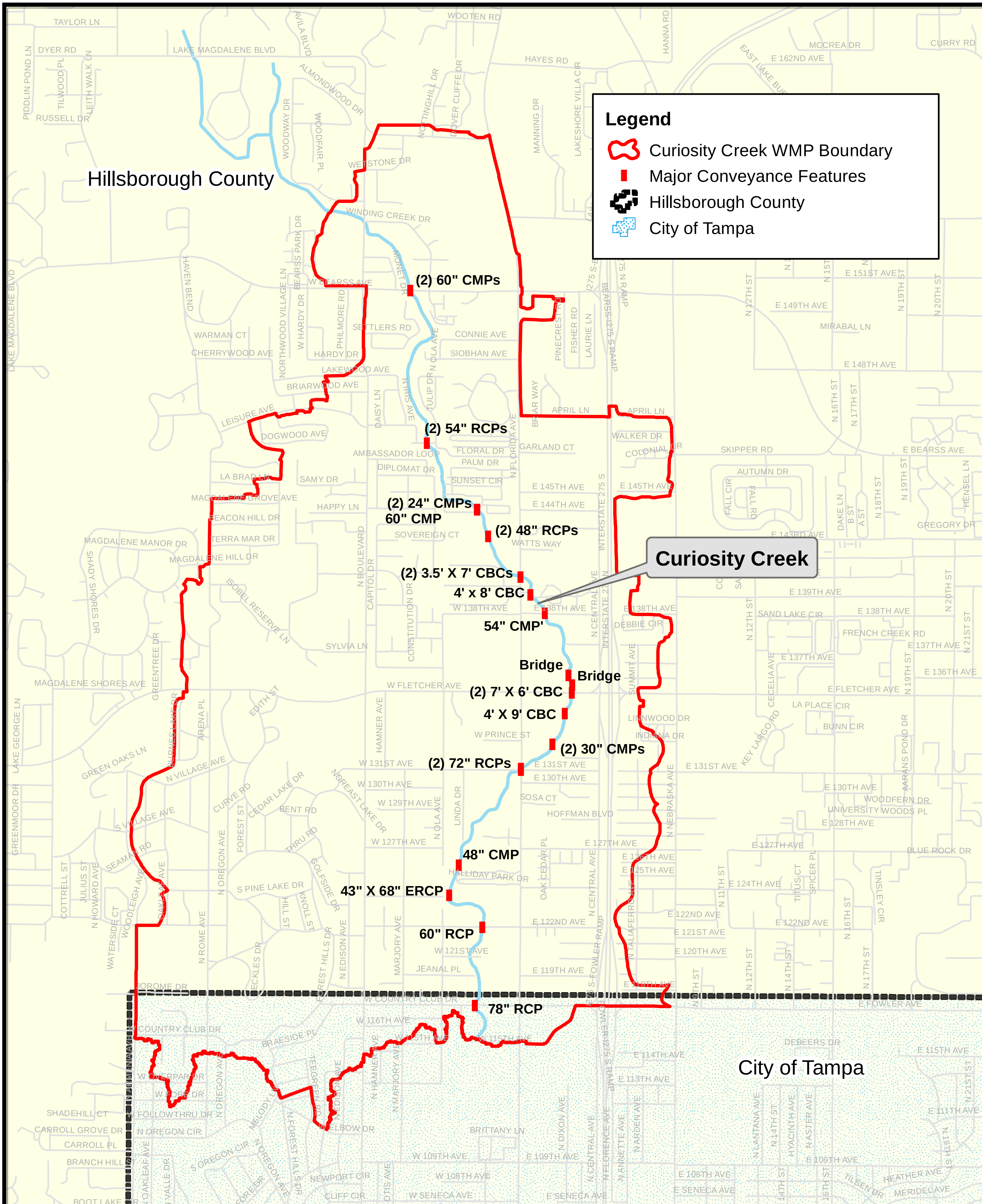


Figure 3-1
Curiosity Creek Watershed Major Basins

Hillsborough County Florida

URS

7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607



N
0 0.2 0.4
Miles

Figure 3-2
Curiosity Creek Watershed
Major Conveyance Systems
of Main Channel

Hillsborough County Florida

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607

CHAPTER 4 HYDROLOGIC/HYDRAULIC MODEL METHODOLOGY

4.1 General Hydrologic/Hydraulic Model – Database Development

The U.S. Soil Conservation Service (SCS) Runoff Curve Number (CN) method was used to convert rainfall into runoff. This method uses soil and land cover characteristics to estimate runoff. The runoff hydrographs were developed using the U.S. Soil Conservation Dimensionless Unit Hydrograph Method. A modified version of the HEC-1 (U.S. Army Corps of Engineers) computer program, developed by Hillsborough County, was utilized to generate runoff hydrographs.

Routing of runoff hydrographs through the Curiosity Creek storage and conveyance systems was performed in version 5.1.010 of the public domain software EPA Storm Water Management Model (SWMM5). SWMM5 is a dynamic rainfall-runoff-routing simulation model that can be used for single event or long-term (continuous) simulation of runoff quantity and quality from primarily urban areas. The routing portion of SWMM5 transports this runoff through a system of pipes, channels, storage/treatment devices, pumps, and regulators. SWMM5 tracks the quantity of runoff generated within each subcatchment, and the flow rate, flow depth of water in each pipe and channel during a simulation period comprised of multiple time steps. The geospatial attributes of the node-link schematic can be imported to SWMM5 to enhance the interpretation and evaluation of input and results.

Because the runoff component of SWMM5 does not include the unit hydrograph curve number method as an option, the customized tool “NRCS UH-CN Hydrology” was provided by Hillsborough County to be imported to the SWMM application as a third party add-in tool. This executable generates each of the basin hydrograph time series and assigns them to the appropriate SWMM5 routing node using an interface file.

All model input parameters have been defined by populating a spatially-referenced personal geodatabase template HCSWMM5_GWIS.mdb using ESRI ArcMap® tools and then exporting the data to a SWMM5-compatible input file using another Microsoft Access-based tool called SWMM_WRITER.mdb, developed by Hillsborough County. This approach results in a hydrologic/hydraulic simulation file that is fully consistent with the spatially-referenced technical support data and can therefore be more readily reproduced and verified by others.

4.2 Hydrology

4.2.1 Hydrologic Model

The HEC-1 hydrologic computer model unit hydrograph method was modified by Hillsborough County for use with earlier versions of the EPA SWMM routing program. The Hillsborough County Stormwater Technical Manual specifies that a shape factor of 256 be utilized for hydrologic analysis relating to areas within the County because of the flat terrain, rather than the default shape factor of 484 used in many other regions with higher topographic relief. The previously mentioned "NRCS UH-CN Hydrology" executable code derives the runoff response for each time increment in each basin using the specific parameters described in the following sections and writes the data into SWMM5-compatible interface files.

4.2.2 Rainfall Depth, Rainfall Distribution and Initial Abstraction

The rainfall depths used for the one-day design events were taken from the SWFWMD isohyetal maps published in Volume II of the 2013 Environmental Resource Permit Applicant's Handbook (ERPAH). The rainfall depths shown for each return frequency reflect a storm event of 24-hour duration (see the chart below):

Storm Event – 24 hour Duration	2.33-year	5-year	10-year	25-year	50-year	100-year	500-year
Rainfall Depth (inch)	4.5	5.6	6.8	8.0	10.0	11.0	14.0

The 24-hour design storm events utilized the SCS Type II Florida Modified accumulated rainfall distribution, which is specified by Hillsborough County and published in the ERPAH using 30 minute time increments. Multi-day events were also simulated for the 100-year return frequency. The chart below summarizes the selected event rainfall depth, distribution interval and source for each:

Storm Event Duration	Rainfall Depth (inch)	Time Interval (hours)	Source
72-hour (3-day)	15.0	4.0	FDOT
120-hour (5-day)	17.8	1.0	SWFWMD G&S
168-hour (7-day)	20.0	8.0	FDOT

An initial abstraction of 0.2 was utilized throughout the study area as the initial soil abstraction. This value was not altered during calibration. The soil storage was computed as a function of the curve number according to SCS guidelines and literature.

4.2.3 Subbasin Delineations

The determination of the subbasin boundaries within the watershed was made on the basis of the existing physical features such as the drainage areas (topography), storage areas and conveyance elements (pipes, control structures etc.), which make up the system network. One major objective for this update was to increase the level of subbasin discretization south of Country Club Drive (within the COT) to a level consistent with the Hillsborough County portion of the watershed.

The main source utilized for subbasin delineation was a digital elevation model (DEM) based on 2011 SWFWMD LiDAR data sets supplied to URS through Hillsborough County. The contents of the LiDAR geodatabase provided to URS included the following:

- Tiled LiDAR data
- Masspoint files
- Breakline and associated data: ACCURACYCHECKPTS, ACTUALFLIGHTLINES, CONNECTOR, FLIGHTPLAN, FOOTPRINT, GROUNDCONTROL, HYDROGRAPHICFEATURE, LOWCONFIDENCE, MARSH, OVERPASS, WATERBODY

The supplied ground points covered the entire study area with an average return density of approximately 2 feet. The supplied LiDAR points were projected in the NAD 1983HARN State Plane Florida West FIPS 0902 horizontal datum and NAVD 88 vertical datum with units of feet.

In order to provide a deliverable in the County's preferred projection of NAD 1983 State Plane Florida West FIPS 0902 (feet), the source data was converted from its original projection. LiDAR ground points, along with the GROUNDCONTROL, HYDROGRAPHICFEATURE, OVERPASS, MARSH and WATERBODY layers were utilized to create the project DEMs with 4-foot cell grid size and points were interpolated using the "nearest neighbor" method. Breaklines were employed along hydrographic features, and are widespread throughout the study area.

The generated DEM was carefully reviewed for apparent errors in land surface and waterbody representation. Additionally, aerial imagery from 2006, 2011 and 2014 were utilized to identify areas where land use or cover had been altered which might not be represented in the created DEM. The highly developed nature of this watershed limited the number of topographic voids related to new development or substantial re-development. In areas where aerial imagery indicated development newer than the DEM, ERP As-built grading plans were used to edit the

DEM. The final DEM was used in conjunction with automated ArcHydro tools to draw preliminary subbasin delineations and to identify the overland connections between subbasins.

Once the surface-based delineations were made, additional subbasin refinement was executed using knowledge of the underlying pipe systems represented in:

- ERP plans ("As-Built") of recent developments and roadway projects (predominantly post-2005)
- Historic County-recorded plans (pdf) for larger subdivision and roadway projects
- County Capital Improvement Project (CIP) plans
- Stormwater asset inventory features (attributed points and polylines) for both Hillsborough County and COT maintained systems

Figure 4-1 shows the subbasin delineations in GIS environment. Each subbasin feature was given a unique alpha-numeric ID consistent with the current Hillsborough County Stormwater Management Master Plan Hydrologic and Hydraulic Model Set-Up guidelines. The attribute tables include the necessary data fields to inform the EPA SWMM5 model and to comply with SWFWMD Watershed Data Management System guidelines. **Table 4.1** summarizes the updated hydrologic parameters for each subbasin within the watershed. **Figure 4-2** compares the subbasin delineations for this update to the previous watershed management plan model.

4.2.4 Runoff Curve Numbers

The SCS Runoff Curve Number (CN) method was used to generate runoff from rainfall. The method estimates runoff on the basis of soil and land cover characteristics. Runoff curve numbers are related to land use and hydrologic soil group. Land use polygon, hydrologic soil group polygon, and subbasin delineation polygon coverages were overlaid utilizing GIS intersection techniques. This procedure generated unique polygons within subbasin polygons that were assigned a land-use, subbasin number and soil type. These polygons were aggregated into a weighted CN for each subbasin using a database script and a lookup table. The procedure calls for a polygon element within a subbasin to be assigned a CN value based on soil type and land use (**Table 4.2**). Based on this, a composite (area weighted) CN for each subbasin was calculated and assigned. All curve numbers reflect an average antecedent moisture condition (AMC2), which is recommended for use with design event simulations.

4.2.5 Time of Concentration

The time of concentration (Tc) is defined as the time for the runoff to travel from the hydraulically most distant point in the drainage basin to the point of interest, usually the basin outlet. The hydraulically most distant point refers to the point from which the computed surface travel time is longest. Due to variations in surface slope and cover, the hydraulically most distant point may not always coincide with the physically most distant point. TR-55 provides the methodology for calculating Tc in three types of flow regimes: sheet flow (overland flow), shallow concentrated flow, and open channel flow. The various components that may make up the travel time for each subbasin are described in the chart below:

Flow Regime	Method/Assumptions
Overland Flow	Kinetic Wave Equation
Shallow Concentrated Flow - Paved	SCS Equations Relating Velocity to Watercourse Slope
Shallow Concentrated Flow - Unpaved	SCS Equations Relating Velocity to Watercourse Slope
Channel Flow	Mannings open channel flow equation
Pipe Flow	Neglected due to small basin sizes (very short travel time)

Grassed/unpaved n values of 0.2 were utilized for yards and grassed rights-of-way in velocity and travel time computations under the sheetflow regime. The TR-55 Second Edition Figure 3-1 cover/slope/velocity relationships were utilized for shallow concentrated flow.

Overland roughness values applied for sheetflow over the wooded floodplain adjacent to natural portions of Curiosity Creek ranged from 0.4 to 0.6. For shallow concentrated flow over these surfaces, the more detailed "Watercourse Slope-Velocity" curves from the first edition of TR-55 were utilized.

4.3 Hydraulics

4.3.1 Hydraulic Model

The SWMM5 modeling software was used to route the hydrographs generated by the Hillsborough County hydrologic program through the hydraulic system. SWMM5 calculates water surfaces and flow rates as time dependent values using a dynamic wave solution technique with variable computational time steps and a user-defined minimum time step, as well as user-defined head convergence tolerance and maximum number of iterations per time step. Execution of the hydraulic model requires definition of all conveyance features (pipes, channels, control structures, pumps, etc) as well as transition features such as flow junctions (manholes or inlets) and storage units (lakes, surface depressions, natural or manmade ponds). Model boundary conditions and initial system stages and/or flows are also defined prior to simulation.

Input data for the various hydraulic features in the model domain have been derived from a variety of sources, the primary sources being construction plans and survey data. Missing or questionable data points were investigated in the field when possible. A field survey program, approved by Hillsborough County, was developed to identify: (1) critical areas where professionally surveyed data points were desired; and (2) less critical areas where existing data sources should be verified or supplemented with on-site dimensional measurements and control elevation checks (height above or below pavement or ground surface) that could be tied to the DEM. The professional survey was executed by NWI, Inc. in August 2015. Collection of field measurements, GPS points, maintenance condition evaluation and photographic documentation were performed by URS between May and December 2015. Survey data and field notes and photographs are provided in the digital Technical Support Data Notebook (TSDN) on the path "TSDN_Report\5_Misc_Ref_Material\" under "Survey2015" and "Field_Recon" folders.

Sources for hydraulic elements have been identified using a numeric code in the "Tag" attribute field of the GWIS geodatabase and have been subsequently exported to the model input files as a comment line. The following key explains the various source codes:

Tag Value	Source
1	ERP – plans and reports as available in pdf format
2	Survey (1999 or 2015)
3	Previous update model input
4	Estimated using best engineering judgment
5	COT stormwater assets database
6	Hillsborough County stormwater assets database
7	Field measurement (paired with DEM data for inverts and control elevations)
8	Arc Hydro tools
9	DEM
10	County-supplied plans in pdf or tiff format
11	CIP plan sets in pdf format

4.3.2 Channels

The data for the natural channel geometry were derived mostly from the 1999 channel cross-section survey data provided by the County. Supplemental channel cross-sections were surveyed for this update by NWI in August 2015. Natural channel reaches were evaluated for out of bank conveyance capability based on aerial photographs, field photographs of the actual channel, and field evaluations. Lower lying areas of channel basins outside of the conveyance area were treated as floodplain storage with no conveyance capability. Thus, each channel was evaluated for a friction loss that related to the roughness conditions at the bottom, and the right and left out of bank. Channel roughness (Manning's coefficients) values utilized in this update are based on observed stream bed and bank conditions from December 2015. Roughness values for main channel and floodplain areas were computed using the Cowan method presented in USGS Water Supply Paper 2339, "*Guide for Selecting Manning's Roughness Coefficients for Natural channels and Flood Plains*." This method assigns a base roughness value, $\mathbf{n_b}$, according to bed composition and then adds adjustment values to account for other factors such as surface irregularities, change in channel cross-section, vegetation, obstructions and degree of channel meander. For floodplain n values a similar method is applied, with the $\mathbf{n_b}$ value being selected according to the floodplain's natural bare soil surface and adjustments made based on surface irregularity, changes in size of floodplain cross-section, obstructions, vegetation and sinuosity. Photos and composite roughness value computations have been included in the project's digital TSDN. Initial Manning's roughness values, estimated during winter months when vegetation is unusually sparse, were adjusted during the calibration phase of the study (described in Chapter 5) to reflect values more representative of wet season growth.

Man-made open channels (ditches) have been defined using plans, where available, and field review measurements. Manning's roughness coefficients are based on observed field conditions.

4.3.3 Conduits

Closed conduit shape, material, length and invert elevations have been defined based on available data sources, previously described. The City and County stormwater assets databases identify feature location, approximate length, material and dimension (rise and span) of underground storm sewers. Upstream and downstream invert data fields in the asset geodatabases were not populated in the study area; so engineering judgment was often required to estimate invert elevations. Where conduit inverts have been estimated, governing assumptions include:

- A minimum of one foot is maintained between ground surface and crown of conduit to account for cover and pipe thickness;
- When extending from a system with known conduit invert and slope, maintain the same slope unless other data further down the system conflicts with this assumption;
- In the absence of any conduit slope data, assume a slope of 0.20% ; and
- For conduit diameter changes within systems of unknown invert and slope, maintain conduit crown elevations and lower the invert of the larger diameter pipe (more stable in simulations).

Friction loss for conduits is based on the defined pipe material roughness value as well as minor losses of the conduit such as entrance, exit, and transitions. Minor loss computations performed in SWMM5 were not available in the EPA SWMM version 4 software.

4.3.4 Storage Facilities

The SWMM5 model allows the user to input variable relationships between stage and area. These areas can represent the flood storage created by depressions, lakes, wetlands, retention/detention ponds or out of bank storage. This relationship is assigned to a specific junction within the model schematic. This storage is especially important in the Curiosity Creek Area because many areas which contain lakes experience out of bank conditions during high flow. During the model update, stage-area curves in one-foot increments were generated for each subbasin using the DEM generated through GIS Spatial Analyst rendering. Storage curves cover the full range of elevations within each basin and cannot exceed the total subbasin area. These data were then input into the computer model to represent the basin storage available during storm simulations. In basins where open channels have been modeled, there is potential for double-counting of storage volume. For this reason, storage exclusion polygons were delineated to represent the conveyance area defined for the channels (included in the GWIS database). This area was excluded from the subbasin polygon area before the Spatial Analyst tools were applied for storage curve generation. A minimal nodal surface area of 200 square feet was defined for junctions without assigned variable storage, to stabilize the model.

4.3.5 Weirs and Orifices

Surface water control structures have been described in the model using weirs and orifices. Control structure weir information was verified with construction plans, where available. In the absence of construction plans, field measurements were taken or survey requested. Typical control structure configurations often have multiple components in combination, such as vertical orifices for bleed-down, vertical weirs cut-outs for design overflow, and top grate overtopping (modeled as a horizontal orifice) for high water overflow. A weir coefficient of 3.2 has been selected for control structure weirs and a discharge coefficient of 0.65 for orifice discharge.

The overtopping of roadways at channel crossings was simulated using transverse, rectangular broad crested weirs as the conveyance mechanism. The weir invert elevations were obtained from the DEM. The width of the weir was reviewed against the upstream and downstream channel widths to assess appropriate effective lengths in accordance with the County's preferred methods. Although some overtopping roadways are relatively flat for extended lengths, weir lengths were limited to values adequate to carry the flow without destabilizing the hydraulic model. After preliminary simulations were made, the weir widths were evaluated to verify or modify these initial values based on model stability and profile obstruction. Generally, the weir coefficients for roadway overtopping are set at 2.6.

In many areas of the watershed transverse, rectangular broad crested weirs were used to simulate flow that may occur in an overland fashion from basin to basin. The weir invert elevations were obtained from the DEM using the Arc Hydro generated flow paths and basin overspill elevations. Weir coefficients for overland basin interchange were generally set to 2.5 and weir widths limited to between 100 and 200 feet to enhance model stability, unless wider widths were justified by modeling results.

4.3.6 Lift Stations/Pumps

The lower end of the Curiosity Creek watershed, primarily within the COT, is served by several pump stations, modeled with Type 2 pump curves. Type 2 indicates an in-line pump where flow increases incrementally with inlet node depth. Individual pump discharge capacity and associated activation stages were updated through coordination with the COT. Several changes in pump station operation and connectivity had occurred since the last update. Two pumping locations, Blue Sink at 115th Avenue and the Seneca Avenue pond have been taken out of service since the last update. Water features currently equipped with permanent or portable pumps include: the COT Curiosity Creek Detention Area, Penalty Lake, Lake Eckles, pond at 109th Avenue and North Boulevard, and the COT ditch near the recreation center soccer fields. **Table 4.3** summarizes the pump operational data that has been input to the SWMM5 model.

4.3.7 Initial Water Surface Elevations

The initial water surface elevations for the ponds and lakes in the watershed were obtained through several methods. Assuming that the high intensity storm events represented by the design distributions are most likely to occur in the wet season, seasonal high water table (SHWT) elevations were determined to be the most appropriate starting points for simulating available system storage at the start of the event.

Daily, monthly or quarterly lake level readings (for varying periods of record) were obtained for any of the lakes with data retrievable from the University of South Florida's Tampa Bay Water Atlas website http://www.tampabay.wateratlas.usf.edu/. Downloaded lake stage records have been provided in the digital TSDN folder under TSDN_Report\2_Engineering_Analyses\ Hydrologic Analyses. Preferred water elevation data sources consisted of SHWT or normal high water citations on design plans and ERP documents. For stormwater management facilities where a control structure exists, and with no specific SHWT elevation cited, the starting elevation was assumed to be equal to the lowest discharge invert (bleeder orifice or low weir crest). Documented SHWT levels for some lakes were assigned to adjacent water features when in close proximity to known levels and, in some cases, the difference between DEM static water surface elevation and known seasonal high water estimates were applied to isolated waterbodies as a best estimate for starting elevation. Wetland and depressional area starting elevations were also guided by NRCS database "depth to SHWT" values.

Mean monthly discharge records for Curiosity Creek at 122nd Avenue indicate a fairly low wet season baseflow value (less than 6 cfs). In order to simulate the starting elevations and flows within the Curiosity Creek main channel, a zero-precipitation hot start simulation file was created to identify the peak system flow and channel stage generated by having the contributory waterbodies discharging at the seasonal high water stage. The generated channel flow was verified to be consistent with typical wet season baseflow at the gage. Channel nodes were then assigned initial water surface elevations consistent with the peak stages of the hot start simulation.

4.3.8 Boundary Conditions

Downstream model boundary conditions at the Hillsborough River are simulated as variable stage-time conditions varying from an initial elevation of 3.17 feet to a peak elevation of 5.17 feet. Several out-of-watershed boundaries were necessary for the higher precipitation events. Fixed outfall stages were generally estimated using the DEM data to inform the selection.

4.3.9 Model Schematic

The hydraulic model of the watershed consists of all of the features that make up the primary conveyance network. These features include lakes, wetlands, pipes, natural channels and control structures, as well as natural overland and street-flow paths. The geodatabase features were created to estimate the actual flow alignment for channels and pipe networks. Weir structures and overland/over-road weir paths will cross the basin or edge-of-pond boundaries at the estimated control point. Large storage areas will generally have node placement at the lowest DEM elevation or near the mid-point of the waterbody. Co-located line features such as multiple pipes with roadway overtopping weirs or multiple-opening control structure links will be adjusted slightly from their true alignment in order to allow visual differentiation

The SWMM5 model uses a conduit- junction concept to idealize the hydraulics of the system. The junctions within the model are the discrete locations within the watershed where the conservation of mass is maintained. These represent the storage and stage-related elements of the model. The conduits are the connections between the junctions. These represent the flow and conveyance related elements of the model. Although the model does not require connectivity schematics to be spatially referenced, it has the capability of importing coordinate-based spatial data for junction points, link polylines, and subbasin polygons using GUI files generated from the GIS geodatabase. The 2015 Curiosity Creek watershed model schematic has been developed in this manner, to facilitate interpretation of model input and results.

Table 4.1 Summary of Subbasin Hydrologic Parameters

Subbasin	Junction	Location	Area (Acres)	Time of Concentration (min)	Curve Number	Shape Factor	Initial Abstraction
SUB550100	550100	Hillsborough County	12.71	78	82.5	256	0.2
SUB550150	550150	Hillsborough County	10.07	22	91.0	256	0.2
SUB550175	550175	Hillsborough County	6.94	17	79.1	256	0.2
SUB550200	550200	Hillsborough County	16.60	73	80.3	256	0.2
SUB550300	550300	Hillsborough County	7.74	58	83.2	256	0.2
SUB550350	550350	Hillsborough County	19.45	105	79.9	256	0.2
SUB550400	550400	Hillsborough County	26.76	21	88.7	256	0.2
SUB550600	550600	Hillsborough County	31.97	71	83.8	256	0.2
SUB550692	550692	Hillsborough County	24.90	44	81.0	256	0.2
SUB550720	550720	Hillsborough County	26.92	63	84.4	256	0.2
SUB550740	550740	Hillsborough County	3.81	26	81.0	256	0.2
SUB550747	550747	Hillsborough County	8.56	41	81.0	256	0.2
SUB550800	550800	Hillsborough County	18.87	78	85.5	256	0.2
SUB550900	550900	Hillsborough County	25.06	98	88.7	256	0.2
SUB551000	551000	Hillsborough County	18.76	29	86.9	256	0.2
SUB551050	551050	Hillsborough County	116.90	55	85.1	256	0.2
SUB551100	551100	Hillsborough County	15.15	80	92.0	256	0.2
SUB551300	551300	Hillsborough County	10.29	7	93.0	256	0.2
SUB551400	551400	Hillsborough County	3.29	43	93.8	256	0.2
SUB551418	551418	Hillsborough County	5.47	9	94.0	256	0.2
SUB551420	551420	Hillsborough County	7.80	7	94.2	256	0.2
SUB551430	551430	Hillsborough County	7.58	13	91.6	256	0.2
SUB551440	551440	Hillsborough County	6.60	36	82.8	256	0.2
SUB551442	551442	Hillsborough County	4.77	43	74.5	256	0.2
SUB551445	551445	Hillsborough County	4.56	110	49.2	256	0.2
SUB551475	551475	Hillsborough County	1.07	7	83.9	256	0.2
SUB551500	551500	Hillsborough County	43.86	33	89.2	256	0.2
SUB551700	551700	Hillsborough County	2.71	13	87.5	256	0.2
SUB551800	551800	Hillsborough County	3.19	45	79.6	256	0.2
SUB551900	551900	Hillsborough County	6.57	131	91.1	256	0.2
SUB551940	551940	Hillsborough County	9.10	52	85.5	256	0.2
SUB551950	551950	Hillsborough County	7.02	35	83.5	256	0.2
SUB551954	551954	Hillsborough County	3.11	10	77.0	256	0.2
SUB551960	551960	Hillsborough County	3.29	7	81.2	256	0.2
SUB551962	551962	Hillsborough County	10.92	40	88.0	256	0.2

Subbasin	Junction	Location	Area (Acres)	Time of Concentration (min)	Curve Number	Shape Factor	Initial Abstraction
SUB552000	552000	Hillsborough County	6.15	38	87.2	256	0.2
SUB552050	552050	Hillsborough County	64.86	36	87.0	256	0.2
SUB552060	552060	Hillsborough County	35.18	40	89.3	256	0.2
SUB552100	552100	Hillsborough County	11.45	25	84.2	256	0.2
SUB552160	552160	Hillsborough County	22.33	132	82.8	256	0.2
SUB552200	552200	Hillsborough County	10.54	11	92.7	256	0.2
SUB552230	552230	Hillsborough County	0.84	12	79.0	256	0.2
SUB552300	552300	Hillsborough County	3.55	15	82.0	256	0.2
SUB552400	552400	Hillsborough County	13.20	21	87.0	256	0.2
SUB552500	552500	Hillsborough County	54.97	60	86.3	256	0.2
SUB552560	552560	Hillsborough County	3.41	26	84.4	256	0.2
SUB552580	552580	Hillsborough County	6.18	41	83.9	256	0.2
SUB552590	552590	Hillsborough County	20.41	38	81.6	256	0.2
SUB552600	552600	Hillsborough County	13.30	18	84.1	256	0.2
SUB552650	552650	Hillsborough County	13.38	18	81.7	256	0.2
SUB552700	552700	Hillsborough County	6.36	58	82.5	256	0.2
SUB552710	552710	Hillsborough County	3.71	7	84.5	256	0.2
SUB552800	552800	Hillsborough County	9.23	19	91.6	256	0.2
SUB552860	552860	Hillsborough County	13.51	7	91.3	256	0.2
SUB552910	552910	Hillsborough County	25.03	75	90.2	256	0.2
SUB552920	552920	Hillsborough County	16.47	28	82.6	256	0.2
SUB552940	552940	Hillsborough County	18.43	34	81.8	256	0.2
SUB552945	552945	Hillsborough County	4.29	7	94.2	256	0.2
SUB553000	553000	Hillsborough County	11.30	27	82.4	256	0.2
SUB553040	553040	Hillsborough County	13.68	34	88.1	256	0.2
SUB553100	553100	Hillsborough County	48.07	70	85.9	256	0.2
SUB554100	554100	Hillsborough County	5.51	20	87.1	256	0.2
SUB554150	554150	Hillsborough County	6.42	7	93.0	256	0.2
SUB554200	554200	Hillsborough County	92.43	35	87.7	256	0.2
SUB554210	554210	Hillsborough County	5.38	7	88.7	256	0.2
SUB554220	554220	Hillsborough County	4.82	8	62.9	256	0.2
SUB554240	554240	Hillsborough County	8.95	41	83.4	256	0.2
SUB560000	560000	Hillsborough County	36.93	29	78.2	256	0.2
SUB560100	560100	Hillsborough County	7.32	18	83.0	256	0.2
SUB560150	560150	Hillsborough County	8.08	12	62.2	256	0.2

Subbasin	Junction	Location	Area (Acres)	Time of Concentration (min)	Curve Number	Shape Factor	Initial Abstraction
SUB560200	560200	Hillsborough County	32.08	34	72.2	256	0.2
SUB560205	560205	Hillsborough County	6.26	9	57.0	256	0.2
SUB560300	560300	Hillsborough County	26.15	41	68.0	256	0.2
SUB560400	560400	Hillsborough County	118.76	32	71.3	256	0.2
SUB560500	560500	Hillsborough County	3.36	11	63.7	256	0.2
SUB560600	560600	Hillsborough County	17.84	29	70.8	256	0.2
SUB560700	560700	Hillsborough County	10.35	24	78.3	256	0.2
SUB560800	560800	Hillsborough County	25.46	15	83.0	256	0.2
SUB560900	560900	Hillsborough County	42.10	68	80.2	256	0.2
SUB561000	561000	Hillsborough County	23.44	32	78.3	256	0.2
SUB561100	561100	Hillsborough County	75.05	65	67.7	256	0.2
SUB561200	561200	Hillsborough County	1.44	15	81.3	256	0.2
SUB561300	561300	Hillsborough County	8.84	68	79.6	256	0.2
SUB561330	561330	Hillsborough County	10.17	21	83.1	256	0.2
SUB561350	561350	Hillsborough County	3.23	35	91.2	256	0.2
SUB561400	561400	Hillsborough County	3.84	17	83.0	256	0.2
SUB561500	561500	Hillsborough County	3.19	7	82.3	256	0.2
SUB561600	561600	Hillsborough County	15.03	18	77.3	256	0.2
SUB561700	561700	Hillsborough County	13.70	22	83.0	256	0.2
SUB561800	561800	Hillsborough County	63.04	47	87.8	256	0.2
SUB561900	561900	Hillsborough County	16.87	26	83.9	256	0.2
SUB562000	562000	Hillsborough County	23.13	44	88.7	256	0.2
SUB562100	562100	Hillsborough County	72.48	18	82.5	256	0.2
SUB562150	562150	Hillsborough County	0.84	8	86.4	256	0.2
SUB562170	562170	Hillsborough County	5.57	30	80.6	256	0.2
SUB562200	562200	Hillsborough County	8.73	13	93.1	256	0.2
SUB562220	562220	Hillsborough County	9.22	18	91.6	256	0.2
SUB562230	562230	Hillsborough County	4.53	8	81.0	256	0.2
SUB562300	562300	Hillsborough County	15.58	17	85.1	256	0.2
SUB562400	562400	Hillsborough County	12.82	26	82.4	256	0.2
SUB562500	562500	Hillsborough County	42.39	30	85.0	256	0.2
SUB562520	562520	Hillsborough County	4.27	15	86.0	256	0.2
SUB562550	562550	Hillsborough County	6.41	7	83.8	256	0.2
SUB570000	570000	Hillsborough County	10.91	41	85.3	256	0.2
SUB570100	570100	Hillsborough County	16.22	41	88.2	256	0.2

Subbasin	Junction	Location	Area (Acres)	Time of Concentration (min)	Curve Number	Shape Factor	Initial Abstraction
SUB570120	570120	Hillsborough County	15.01	14	91.7	256	0.2
SUB570200	570200	Hillsborough County	14.91	15	93.8	256	0.2
SUB570300	570300	Hillsborough County	13.30	22	81.1	256	0.2
SUB570350	570350	Hillsborough County	6.40	8	92.5	256	0.2
SUB570400	570400	Hillsborough County	11.66	7	84.7	256	0.2
SUB570500	570500	Hillsborough County	37.38	110	87.2	256	0.2
SUB570600	570600	Hillsborough County	19.12	22	81.8	256	0.2
SUB570700	570700	Hillsborough County	33.26	66	82.5	256	0.2
SUB570800	570800	Hillsborough County	21.86	33	82.0	256	0.2
SUB570810	570810	Hillsborough County	11.80	31	79.2	256	0.2
SUB570820	570820	Hillsborough County	17.61	23	81.5	256	0.2
SUB559100	559100	City of Tampa	84.23	25	79.9	256	0.2
SUB559120	559120	City of Tampa	25.05	36	78.1	256	0.2
SUB559150	559150	City of Tampa	58.41	36	78.5	256	0.2
SUB559152	559152	City of Tampa	31.13	50	77.6	256	0.2
SUB559182	559182	City of Tampa	26.84	32	80.0	256	0.2
SUB559200	559200	City of Tampa	53.79	54	84.9	256	0.2
SUB559205	559205	City of Tampa	24.86	41	73.3	256	0.2
SUB559207	559207	City of Tampa	10.61	26	73.5	256	0.2
SUB559210	559210	City of Tampa	13.83	23	57.0	256	0.2
SUB559230	559230	City of Tampa	37.08	57	61.2	256	0.2
SUB559235	559235	City of Tampa	26.93	66	58.4	256	0.2
SUB559240	559240	City of Tampa	12.37	14	72.2	256	0.2
SUB559255	559255	City of Tampa	32.65	31	74.3	256	0.2
SUB559257	559257	City of Tampa	10.77	20	89.0	256	0.2
SUB559260	559260	City of Tampa	45.44	54	66.9	256	0.2
SUB559265	559265	City of Tampa	62.08	27	63.6	256	0.2
SUB559270	559270	City of Tampa	38.90	45	60.9	256	0.2
SUB559320	559320	City of Tampa	16.89	26	60.0	256	0.2
SUB559360	559360	City of Tampa	23.03	35	71.0	256	0.2
SUB559362	559362	City of Tampa	42.35	45	60.7	256	0.2
SUB559385	559385	City of Tampa	26.84	42	85.2	256	0.2
SUB559395	559395	City of Tampa	21.79	31	81.8	256	0.2
SUB559400	559400	City of Tampa	71.22	29	85.4	256	0.2
SUB559420	559420	City of Tampa	10.04	35	82.4	256	0.2

Subbasin	Junction	Location	Area (Acres)	Time of Concentration (min)	Curve Number	Shape Factor	Initial Abstraction
SUB559430	559430	City of Tampa	11.73	15	81.7	256	0.2
SUB559500	559500	City of Tampa	20.15	56	83.5	256	0.2
SUB559650	559650	City of Tampa	36.33	38	78.4	256	0.2
SUB559655	559655	City of Tampa	16.79	41	79.8	256	0.2
SUB559660	559660	City of Tampa	14.75	27	79.5	256	0.2
SUB559665	559665	City of Tampa	3.52	9	71.6	256	0.2
SUB559675	559675	City of Tampa	19.06	16	75.8	256	0.2
SUB559680	559680	City of Tampa	34.77	27	67.5	256	0.2
SUB559685	559685	City of Tampa	43.52	66	78.8	256	0.2
SUB559700	559700	City of Tampa	8.44	7	62.4	256	0.2
SUB559710	559710	City of Tampa	53.27	48	64.8	256	0.2
SUB559720	559720	City of Tampa	16.93	15	81.0	256	0.2
SUB559725	559725	City of Tampa	28.84	57	81.7	256	0.2
SUB559730	559730	City of Tampa	29.56	32	75.1	256	0.2
SUB559738	559738	City of Tampa	8.92	14	60.8	256	0.2
SUB559740	559740	City of Tampa	37.94	46	66.1	256	0.2
SUB559750	559750	City of Tampa	22.26	11	81.0	256	0.2
SUB559760	559760	City of Tampa	16.89	32	75.5	256	0.2
SUB559810	559810	City of Tampa	31.16	25	76.5	256	0.2
SUB559815	559815	City of Tampa	2.08	25	81.9	256	0.2
SUB559820	559820	City of Tampa	44.64	47	81.0	256	0.2
SUB559828	559828	City of Tampa	9.83	19	66.4	256	0.2
SUB559830	559830	City of Tampa	4.11	13	66.6	256	0.2
SUB559840	559840	City of Tampa	23.94	36	78.5	256	0.2
SUB559900	559900	City of Tampa	41.52	51	87.9	256	0.2

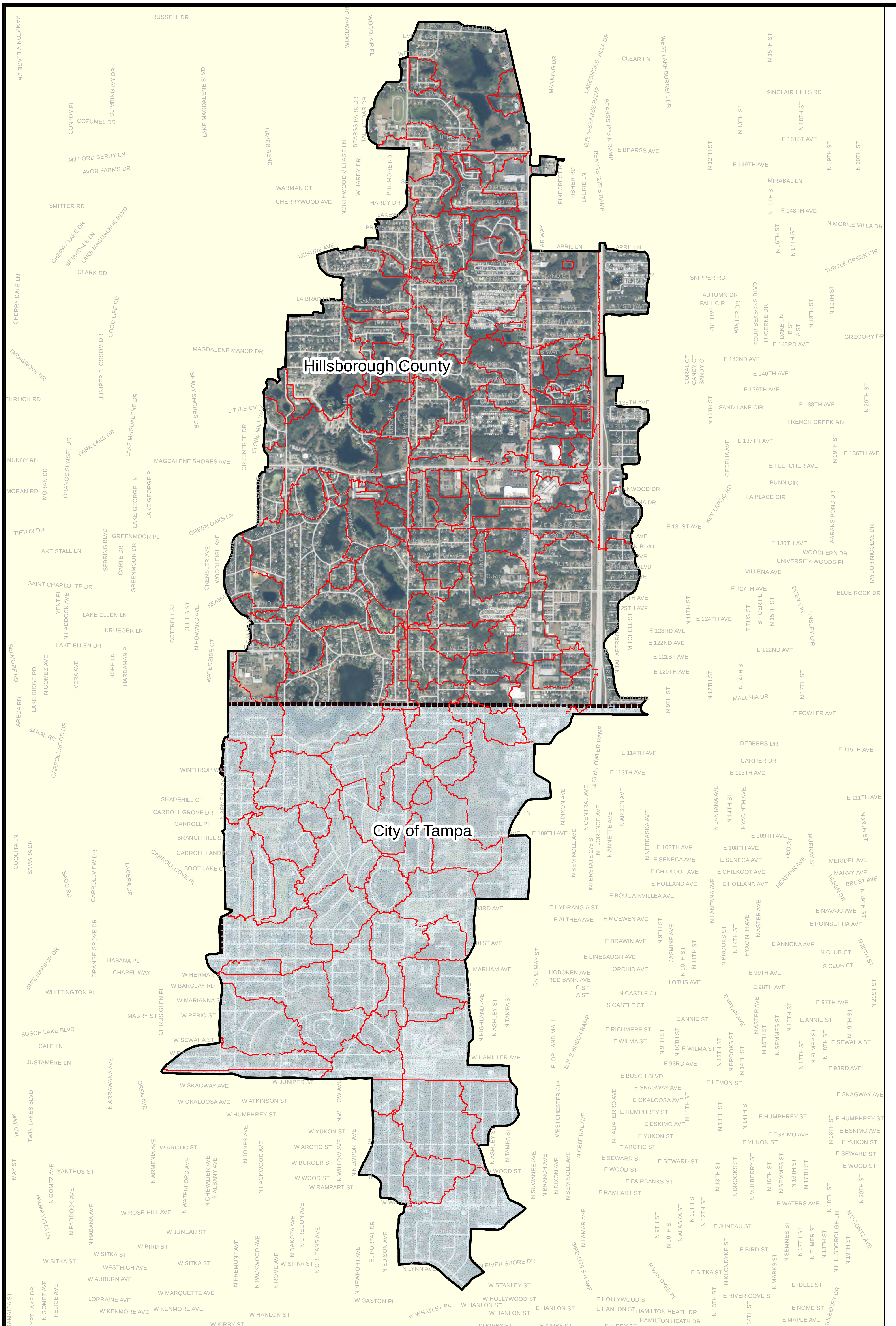
Table 4.2 Curve Number Lookup Table for Land Use Code and Soil Hydrologic Group

FLUCCS ID	A	B	C	D	B/D	W	Description
1100	50	68	79	84	82	100	Residential, low density
1200	57	72	81	86	84	100	Residential, medium density
1300	77	85	90	92	91	100	Residential, high density
1400	89	92	94	95	95	100	Commercial and services
1500	81	88	91	93	92	100	Industrial
1600	77	86	91	94	93	100	Extractive
1700	69	81	87	90	89	100	Institutional
1800	49	69	79	84	82	100	Recreational
1820	49	69	79	84	82	100	Golf Courses
1900	39	61	74	80	77	100	Open land (Urban)
2100	49	69	79	84	82	100	Cropland and pastureland
2140	49	69	79	84	82	100	Cropland (row crops)
2200	44	65	77	82	80	100	Tree crops
2300	73	83	89	92	91	100	Feeding operations
2400	57	73	82	86	84	100	Nurseries and vineyards
2500	59	74	82	86	84	100	Specialty farms
2550	59	74	82	86	84	100	Aquaculture
2600	30	58	71	78	75	100	Other open land (Rural)
3100	63	71	81	89	85	100	Rangeland
3200	35	56	70	77	74	100	Shrub and brushland
3300	49	69	79	84	82	100	Mixed rangeland
4100	45	66	77	83	80	100	Upland coniferous forests
4110	57	73	82	86	84	100	Pine flatwoods
4120	43	65	76	82	79	100	Longleaf pine - xeric oak
4200	36	60	73	79	76	100	Upland hardwood forests
4340	36	60	73	79	76	100	Mixed coniferous/hardwood
4400	36	60	73	79	76	100	Tree plantations
5100	100	100	100	100	100	100	Streams and waterways
5200	100	100	100	100	100	100	Lakes
5300	100	100	100	100	100	100	Reservoirs
5400	100	100	100	100	100	100	Bays and estuaries
5720	100	100	100	100	100	100	Gulf of Mexico
6100	98	98	98	98	98	98	Wetland hardwood forests
6110	98	98	98	98	98	98	Bay swamps
6120	98	98	98	98	98	98	Mangrove swamps
6150	98	98	98	98	98	98	Stream and lake swamps
6200	98	98	98	98	98	98	Wetland coniferous forests

FLUCCS ID	A	B	C	D	B/D	W	Description
6210	98	98	98	98	98	98	Cypress
6300	98	98	98	98	98	98	Wetland forested mixed
6400	98	98	98	98	98	98	Vegetated non-forested wetlands
6410	98	98	98	98	98	98	Freshwater marshes
6420	98	98	98	98	98	98	Saltwater marshes
6430	98	98	98	98	98	98	Wet prairies
6440	98	98	98	98	98	98	Emergent aquatic vegetation
6500	98	98	98	98	98	98	Non-vegetated
6510	98	98	98	98	98	98	Tidal flats
6520	98	98	98	98	98	98	Shorelines
6530	98	98	98	98	98	98	Intermittent ponds
6600	98	98	98	98	98	98	Salt flats
7100	77	86	91	94	93	100	Beaches
7200	77	86	91	94	93	100	Sand other than beaches
7400	77	86	91	94	93	100	Disturbed land
8100	81	88	91	93	92	100	Transportation
8200	81	88	91	93	92	100	Communications
8300	81	88	91	93	92	100	Utilities

Table 4.3 Curiosity Creek Pump Operation Data

SWMM Link	Description	Activation Elevation, ft.	Shut-off Elevation, ft.	Pumping Rate, cfs
L559362	COT Soccer Field Pump	24.00	22.00	13.0
L559400a	Curiosity Creek Pump Station Pump 1	22.00	21.00	50.0
L559400b	Curiosity Creek Pump Station Pump 2	22.50	21.00	50.0
L559400c	Curiosity Creek Pump Station Pump3	23.00	21.00	50.0
L559655	East Ridge Pump Station	21.26	20.66	26.5
L559820a	Penalty Lake Pump 1	28.00	27.00	3.0
L559820b	Penalty Lake Pump 2	29.00	27.00	3.0
L560400a	Eckles Lake Pump 1	30.20	29.00	3.0
L560400b	Eckles Lake Pump 2	30.20	29.00	3.0



Legend

- Curiosity Creek Watershed Boundary
- 2015 Subbasin Delineations
- City of Tampa
- Roads

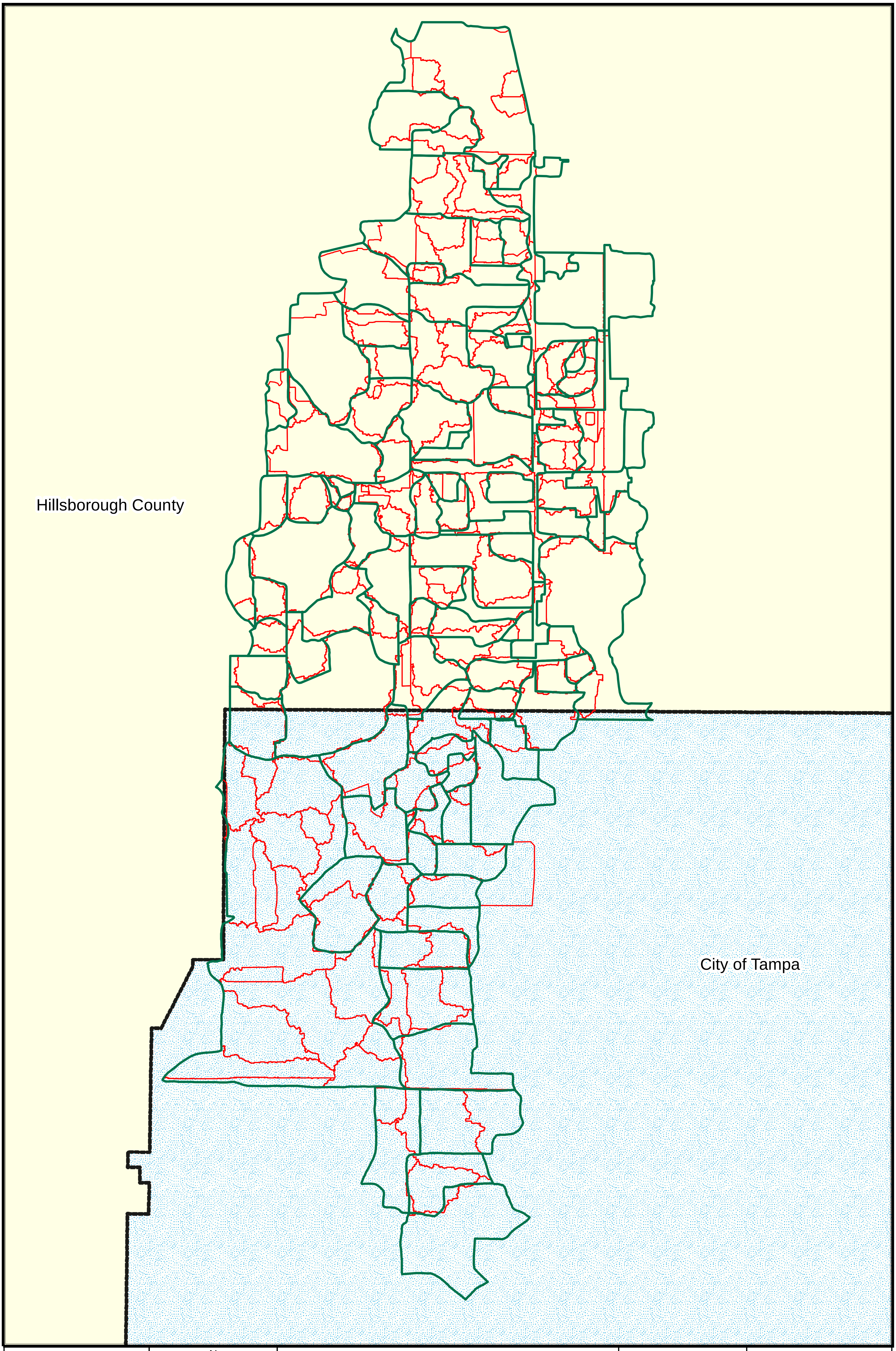
N

0 0.2 0.4
Miles

Figure 4-1
Curiosity Creek Watershed
Subbasin Delineations

Hillsborough County Florida

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607



Legend
2005 Subbasin Delineation
2015 Subbasin Delineation
Hillsborough County
City of Tampa

N
0 0.2 0.4
Miles

Figure 4-2
Curiosity Creek Watershed
Comparison of Subbasin Delineations

Hillsborough County Florida

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607

CHAPTER 5 HYDROLOGIC/HYDRAULIC MODEL CALIBRATION AND VERIFICATION

Model calibration is the process of comparing simulated computer model results with a set of measured data. Streamflow and water surface elevations are obtained from gage data for a rain event from the past. The input hydrologic parameters are adjusted (rainfall and distribution) to the measured rainfall values and then the water surface elevations and flows from the model are compared to the measured values. The hydrologic and hydraulic modeling parameters can then be adjusted so that the simulated volumes, flows and stages correlate well with the measured values. Computer models are considered well calibrated when the results from the simulation are in reasonable agreement with the recorded data from the gage station. Model verification is the process of testing the calibrated model against measured data from other storms of varying intensity without making model adjustments.

5.1 Preliminary Model

A preliminary SWMM5 model was developed and reviewed by the County that defined hydrologic parameters (Tc, weighted CN, unit hydrograph shape, initial soil moisture and contributing basin area) based on standard engineering values or automated GIS tool output. GIS tools were used to:

- Overlay spatially-referenced SWFWMD land use and NRCS soils coverages and compute CN based on Hillsborough County-approved lookup tables;
- Delineate ridge lines around identified “sinks” or ponding areas throughout the watershed;
- Identify subbasin overspill locations and elevations; and
- Delineate preferential flow paths and surface slopes based on the DEM and compute Tc paths and travel times for each subbasin.

Hydraulic elements had been defined in the manner described in Chapter 4. Preliminary model performance, stability and the provision of sufficient overland links for inter-basin flow was tested using a NRCS Type II Florida Modified 100-year, 1-day design event of 11 inches. This preliminary model provided the starting point for the calibration and verification process.

5.2 Selection of Calibration and Verification Events

The selection of storm events for calibration and verification took several factors into consideration. The ideal candidates would:

- Reflect the current buildout of the basin to the extent practicable
- Occur after the construction and operation of the COT's Curiosity Creek pump station and new force main
- Represent varied hydrologic conditions (wet versus dry or high versus low volume precipitation)
- Have continuous stream gage records for flow and stage and 15-minute Doppler rainfall datasets available
- Have flood complaint records, lake stages and/or high water marks available

The rainfall events originally considered included the no-name storm in July (7/8-7/9) 2011, Tropical Storm Debby in June (6/23-6/25) 2012, Tropical Storm Andrea in June (6/6-6/8) 2013, the no-name storm in September (9/22-9/24) 2013, and the no-name storm in August (8/1-8/3) 2015.

One stream gaging station, USGS station 02305851, is located in the watershed on Curiosity Creek at the north/upstream side of 122nd Ave (refer to **Figure 3-2**). The gage is maintained by the USGS Florida Water Science Center in Tampa, Florida. This gage was discovered to be either malfunctioning or taken off-line for maintenance during the highest volume events - Tropical Storm Debby and the August 2015 no-name storm.

With County approval, the 2013 Tropical Storm Andrea event, occurring at the end of the dry season, was selected for calibration. The September 2013 no-name event, occurring during the wet season, was selected for model verification. No flood complaints or high water marks are on record with the County for the selected events, both of which produce a relatively low volume of total precipitation, however streamflow and gage height records are available.

Both events occur after the construction and start-up of the Curiosity Creek pump station and reflect current basin buildout with the exception of two newer subdivisions. Review of 2013 aerial imagery revealed that the two new subdivisions being completed in 2015 had undergone sufficient grading, road construction, model home building and pond construction to be reasonably characterized as residential land use and would exhibit surface slope and basin storage similar to that defined in the preliminary model. No adjustments were required for those areas. The COT Seneca Avenue pond pump station, taken out of operation in 2015, was added to the pump links for the calibration and verification scenarios.

5.3 NEXRAD Doppler Precipitation Data

NEXRAD Doppler rainfall datasets in 15-minute intervals were acquired from SWFWMD for the project area. Data is supplied by grid location using a Pixel ID. The "RainGrid" feature is included in the project deliverable. Each grid/pixel covers approximately 1.43 square miles. The Curiosity Creek watershed lies wholly or partly within ten individual pixels (**Figure 5-1**). Incremental precipitation data was supplied as time series in units of inches for the requested events in Excel® spreadsheet format and included several days before and after the event of interest, to facilitate assessment of appropriate antecedent soil moisture conditions for curve number selection. Time series data for each pixel were transferred to the HCSWMM5_GWIS_CURIOSITY_CREEK database for the selected simulation period. The Pixel ID has been used as the "Station No.". A summary of the precipitation totals for each station is presented in **Table 5.1**.

The TS Andrea calibration event rainfall data was divided into a "Pre-calibration" and a "Calibration" series. The pre-calibration 060613 series recorded rainfall from hour 0:00 to hour 17:00 for most stations. No significant rainfall was recorded for 06072013. The calibration series 060813 indicates rainfall from about hour 16:00 to hour 21:15 and is followed by 16 hours of no precipitation. The verification rainfall time series for the no-name event recorded rainfall from hour 2:00 to hour 10:00 on September 24th with another period of rainfall on the 25th between hours 1:45 to 3:45 and hours 6:45 to 11:00 for most stations. These datasets were processed as one continuous rainfall series.

Time series datasets for each event and each station were transformed into dimensionless mass distributions of cumulative rainfall (retaining the 15 minute time increment) for use in calibration and verification SWMM5 modeling. These data were coded into HCSWMM wpx formatted files to be processed by the SWMM5_WRITER tool from external wpx files to hydrologic interface files (*.rof) to be used by the SWMM5 routing programs. The wpx files developed for these simulations are included in the deliverable "Model" folder. Subcatchments not wholly located within a single grid were assigned rainfall from the pixel/station containing the largest percentage of that basin's area.

Monthly climatological summary statistics for southwest Florida in the year 2013 were downloaded from http://www.capeweather.com/noaa-reports.html to assess general hydrologic conditions leading up to the selected events. These statistics were compared to average precipitation values cited for the Tampa area and posted on the website http://www.usclimatedata.com/climate/tampa/florida/united-states/usfl0481, for the purpose of estimating how far above or below "normal" the surficial water table and baseflow for the watershed and creek channel might be for simulation initial conditions. Findings are summarized in **Table 5.2** Rainfall for the month of the calibration event (June) is consistent with the average rainfall. Rainfall for the month of the verification event (September) is significantly below average.

5.4 Streamflow Flow and Stage Data

Streamflow records for USGS gage 02305851 were downloaded from the USGS Water Data for the Nation website https://waterdata.usgs.gov/nwis for the calibration and verification storm dates. Data were provided as ASCI text files that were imported to Excel for comparison to simulated flows and stages. Stream flow (cfs) and gage height (feet) are reported in 15-minute increments. The gage height datum is documented as 3.86 feet below the NGVD 1929 vertical datum. Since the NAVD 1988 datum is approximately 0.84 feet above the NGVD 1929 datum, 4.7 feet must be subtracted from the recorded gage height to compare with simulated (NAVD 1988) stages.

Recorded lake level data described in Section 4.3.7 included the calibration and verification period for a few of the lakes within the watershed, specifically Lake Gass (Lake Blue Gill), Cedar Lake, Noreast Lake and Lake Eckles. These records have been used to define starting water levels for those specific lakes for each event and were also used to better inform estimates of dry season fluctuation below SHWT for other waterbodies during the dry season calibration event. The lake level records were also used to confirm documented SHWT levels gleaned from plans and permits for the wet season verification simulation and subsequent design event modeling.

5.5 Model Calibration

5.5.1 Initial Simulation

Available streamflow records for the calibration event TS Andrea begin on June 7, 2013; on the falling end of the hydrograph for the highest rainfall day, but cover the second part of the multi-day event on June 8, 2013. Additionally, a break in the rainfall of 23 hours duration between June 6th and June 8th occurred which might have justified a different AMC condition for CN subbasin computation between the two portions of the event. For this reason the June 6, 2013 portion of TS Andrea was simulated independently to create a “Pre-calibration” hotstart file to assign appropriate system stage and flow conditions at each model node for the onset of rainfall in the June 8, 2013 TS Andrea simulation. Simulated flow and stage responses are then compared with gage data only for the June 8th -9th portion of the event.

The approved preliminary model subcatchment data was used to create the hydrologic (wpx) file for the initial “Pre-calibration” simulation for the 06062013 portion of the TS Andrea event. An AMC2 soil condition was used for CN values. Initial water elevations for lakes, ponds and stormwater management areas were adjusted to reflect levels consistent with a “less than average” rainfall year and low surficial water table elevations. Monthly lake stage records downloaded from the Tampa Bay Water Atlas website for Lake Gass/BlueGill, Lake Butler, Cedar Lake, Noreast Lake, Pine Lake and Lake Eckles indicated water levels for this month and year that were generally 0.8 to 1.0 foot below seasonal high water elevations cited for these waterbodies and range from 0.5 to 0.8 feet above the DEM water surface. This pattern was extrapolated to other storage nodes to select reasonable starting elevations for the calibration simulation.

Although an AMC3 soil moisture condition was considered for the June 8th -9th simulation (and was later tested) the calibration event hydrologic file initially assumed an AMC2 soil condition and was executed with the SWMM5 input for the 06082013 portion of the TS Andrea event.

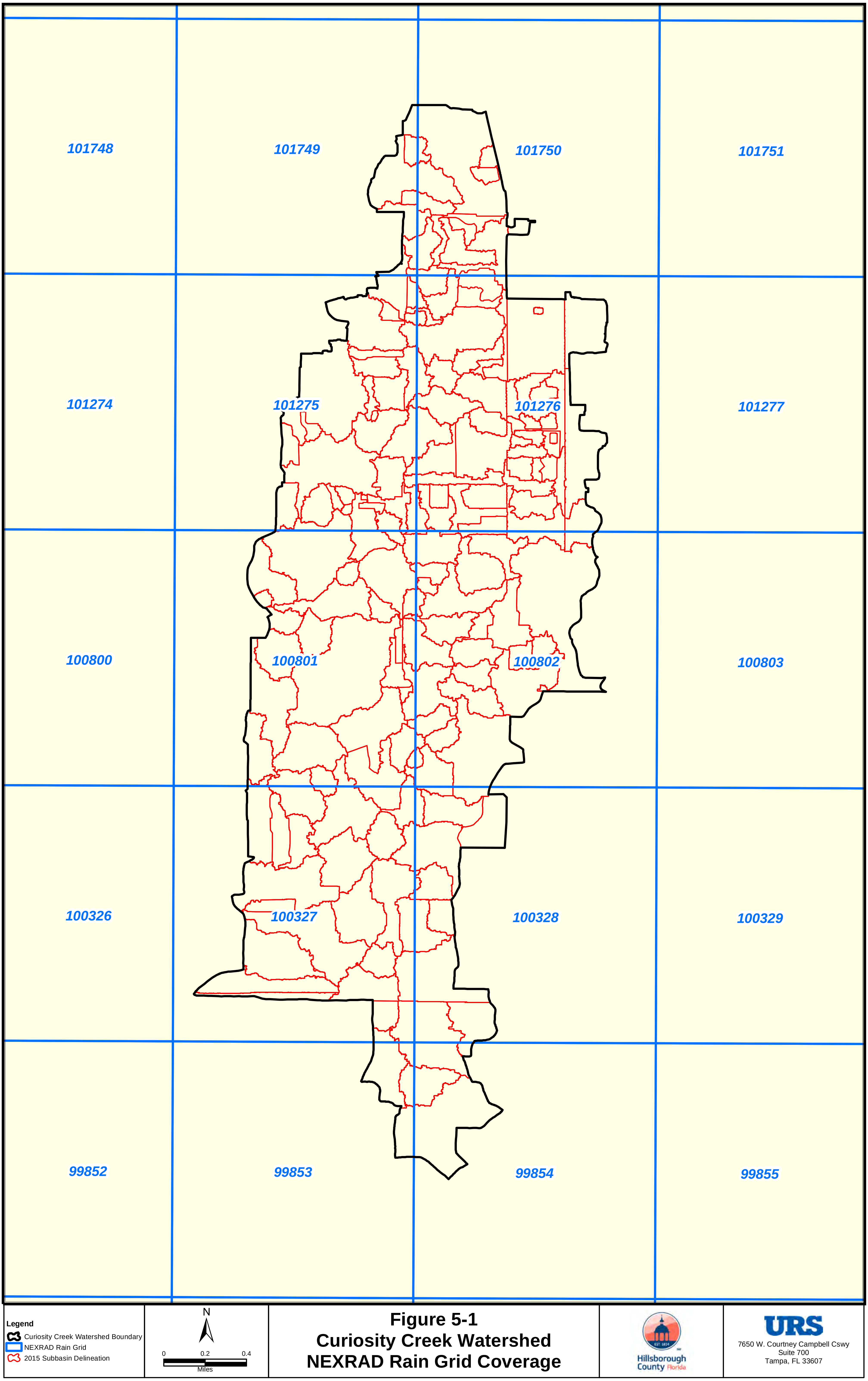


Figure 5-1
Curiosity Creek Watershed
NEXRAD Rain Grid Coverage

Figure 5-2a illustrates the comparison of recorded and simulated flow, using channel C550350 as the comparison link. **Figure 5-2b** plots the cumulative volume of the recorded and simulated flow hydrographs for the initial run. **Figure 5-2c** presents the stage comparison utilizing model node 550300.

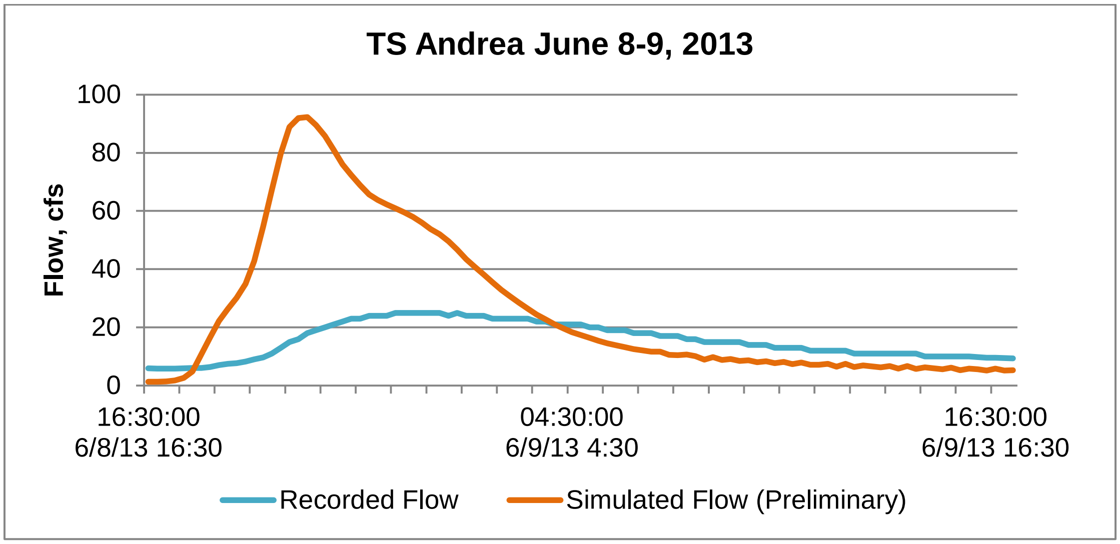


Figure 5-2a Station 02305851 Preliminary Calibration Run - Flow Comparison

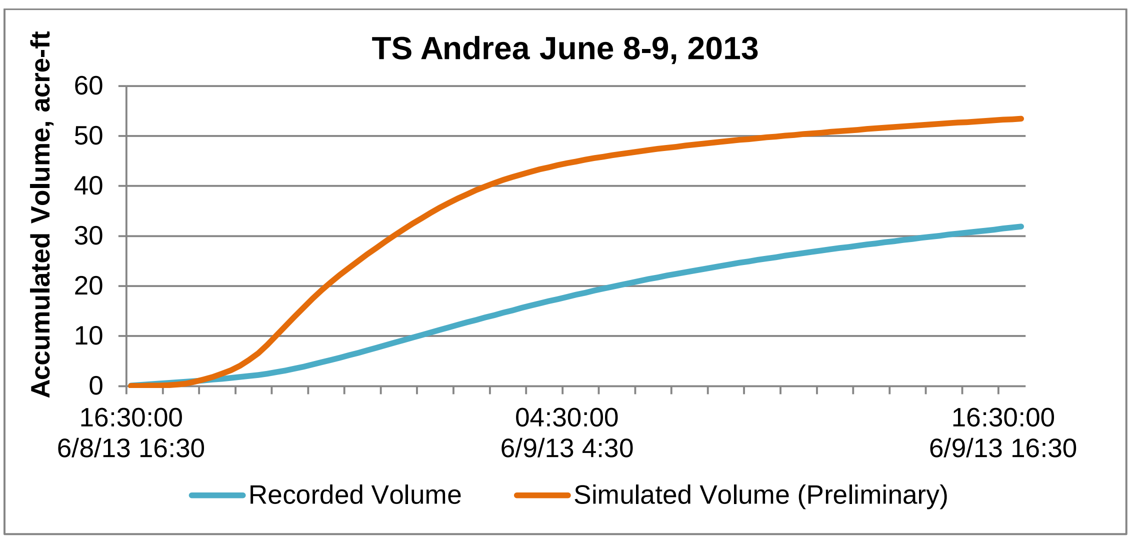


Figure 5-2b Station 02305851 Preliminary Calibration Run - Volume Comparison

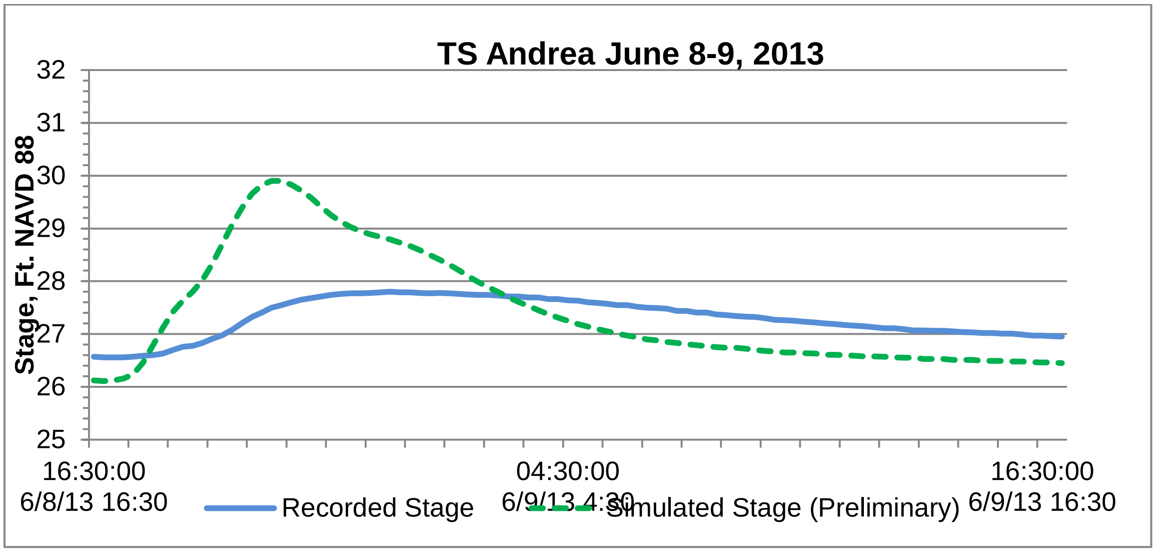


Figure 5-2c Station 02305851 Preliminary Calibration Run - Stage Comparison

As seen in the previous figures, the simulated flows were peaking and falling much too abruptly and, despite the hotstart file, were underestimating the flow leading into the 060813 event. Overall runoff volume contribution to the creek was being significantly over-predicted.

5.5.2 Calibration Model Adjustments

The response of the initial simulation precipitated several adjustments to subcatchment hydrology as described below. Priority was given to achieving reasonable volume correlation through hydrologic parameter adjustment, followed by hydraulic parameter adjustment to improve the stage-discharge match at the gage.

Curve Number Re-assessment

In order to reduce the volume of runoff, FLUCCS code adjustments recommended earlier in the project were revisited. Large areas of medium density residential development that are coded in the 2011 land use feature as "high density residential" were identified by URS during the watershed evaluation tasks using aerial imagery, but FLUCCS codes were not immediately altered; awaiting calibration results. These areas were now justified for recoding by model results and were revised to a 1200 FLUCCS code. A wooded FDOT-owned parcel, located south of 138th Ave and used for wet stormwater management ponds, was also broken out of a larger "medium density residential" (1200) polygon and recoded as "reservoirs" (5300) and "hardwood conifer mixed" (4340). Area-weighted curve numbers were recalculated for these subcatchments.

Time of Concentration

The abrupt rise and fall of the simulated hydrograph, as compared to the recorded flow hydrograph indicates that runoff lag time was being underestimated. Subcatchment times of concentration for the preliminary model had been generated by a combination of ArcHydro tools (based on NRCS TR-55 methodology) and spreadsheet computations using the same methods. Paths and computed times had been reviewed and were consistent with the approved methods.

Preliminary model overland roughness values were defined simplistically using either a “grassed”/”unpaved” or “paved” designation; where “unpaved” overland n-values were generally representative of the yards and manicured landscaping dominating this developed residential and commercial watershed. However, the basins immediately adjacent to the Curiosity Creek channel often include flow through wooded areas with significant underbrush prior to entering the creek. These basins were identified and alternate flow paths and more representative n-values were applied to recalculate total travel time. Flow through grassed areas and flows through wooded areas were computed separately. For sheetflow, values of 0.4 to 0.6 were applied to wooded and/or brushy areas. For shallow concentrated flow, the more detailed “Watercourse Slope-Velocity” curves from the first edition of TR-55 were utilized. Travel time flow paths in several cases were moved to a shorter but rougher and more mildly sloped route which generated a longer total travel time. Time of concentration was refined in the manner described above for 27 subcatchments during calibration.

Baseflow

A small baseflow (1.0 cfs per mile) was added to the SWMM5 dry season calibration model at two node locations: 553100 (the headwaters at County Lakes subdivision) and 551100 (roughly half the distance to the gage). This minimal baseflow was added to reflect the small baseflow recorded in the gage records and observed as very shallow flow in the outfall channel of the County Lakes pond during dry-season field investigations. For calibration comparisons, it is necessary to either add baseflow to the simulation or subtract estimated baseflow from the recorded data. Because subtracting the baseflow from recorded data would alter the true stage-discharge relationship, URS has opted to add it to the simulation as a steady nodal flow input.

Channel n-values

The assessment of channel and floodplain roughness values was computed using winter season field observations and photos. Once the hydrologic adjustments had been made to the model, and simulated volume and timing was correlating well at the gage; it was noted that the simulated stages were being under predicted while discharges were fairly closely matched. The stage-discharge curve being exhibited by the channel justified higher n-values than those originally calculated during the dormant season. Main channel n-values computed for the preliminary model were therefore increased by 0.01 during the calibration exercise to account for natural increases in vegetation density and height during the growing season. The revised n-values would also be appropriate for the late summer verification simulations as well as design storm event simulations, which typically reflect warmer, growing season conditions.

5.5.3 Calibration Model Results

The response of the revised calibration simulation is presented in **Figures 5-3a**, **5-3b** and **5-3c**.

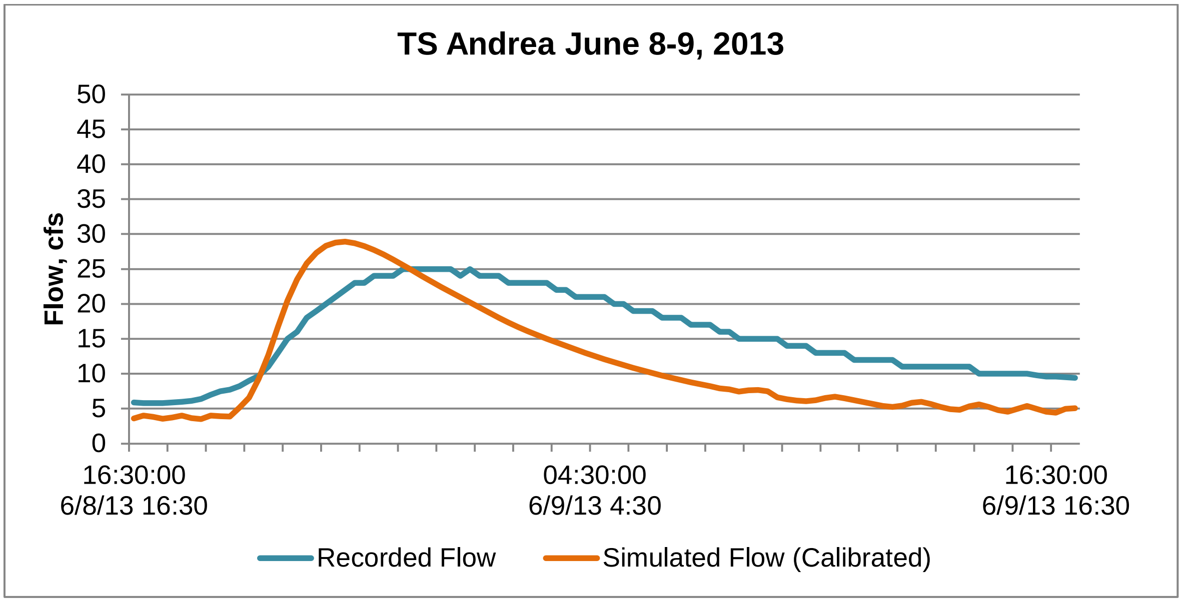


Figure 5-3a Station 02305851 Final Calibration Run - Flow Comparison

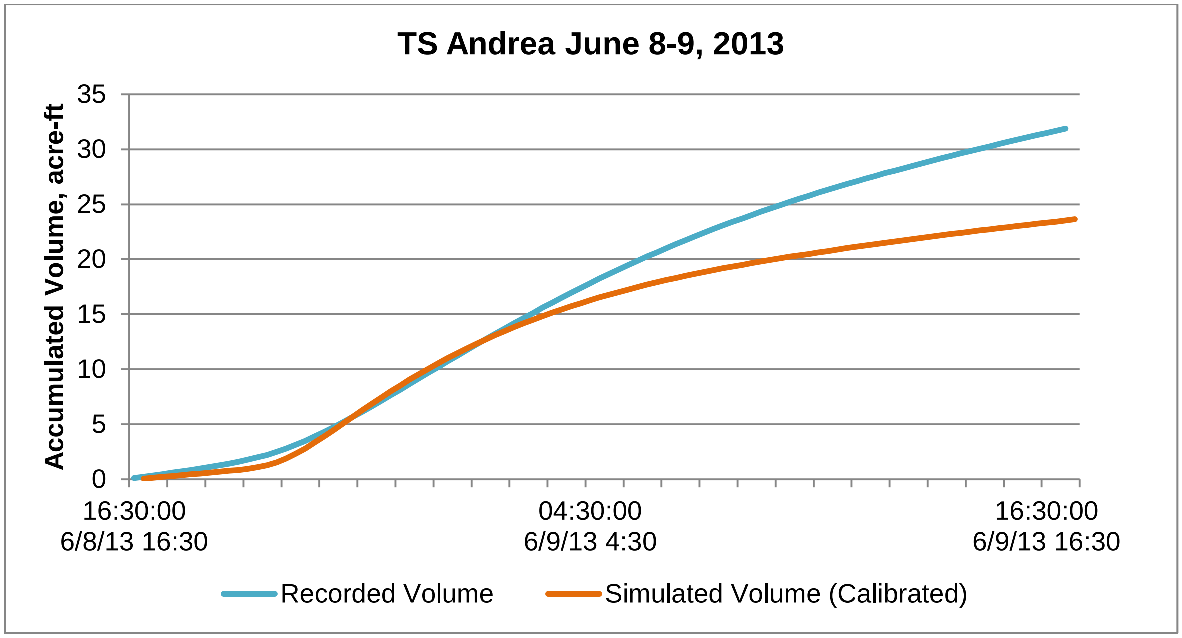


Figure 5-3b Station 02305851 Final Calibration Run - Volume Comparison

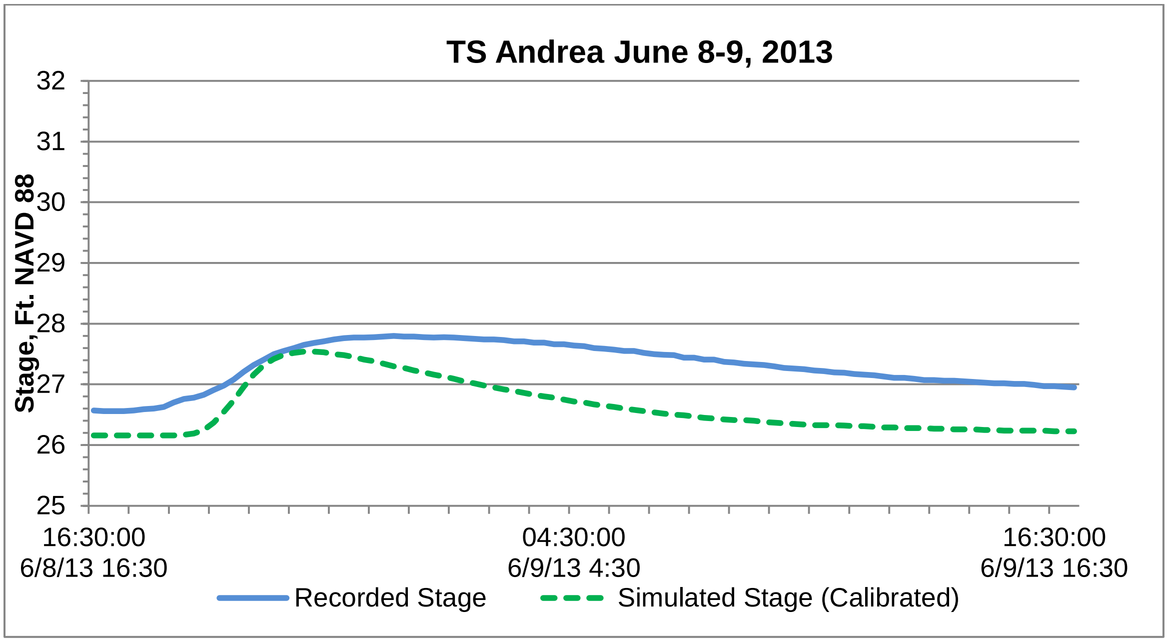


Figure 5-3c Station 02305851 Final Calibration Run - Stage Comparison

Correlation for the active portion of the storm event is greatly improved, however the receding stage and flow conditions within the creek fall off more rapidly in the simulation than in recorded data. It is possible that contributions from saturated soil zones and surficial groundwater may be generating additional flow to the system after the storm which the SWMM5 model is not able to simulate.

5.6 Model Verification

Following calibration, the system was tested under wet season conditions using the September 24-25, 2013 storm event. The hydraulic network was only modified for the initial verification run with respect to initial stages for open waterbodies and their hydraulically connected junctions.

5.6.1 Initial Simulation

The calibration model subcatchment data was used to create the hydrologic (wpx) file for the verification simulation, changing only the precipitation distribution and total rainfall values. The AMC2 soil condition was initially maintained for CN values. Starting water elevations for lakes, ponds and stormwater management areas were adjusted to seasonal high water levels and reflect recorded levels for those lakes with historic data available (Lake Gass/BlueGill, Cedar Lake, Noreast Lake, Pine Lake and Lake Eckles). The initial stages in the creek channel and hydraulically connected nodes were established in the manner described in Section 4.3.7.

Figures 5-4a, **5-4b** and **5-4c** present the results of the initial verification run compared to recorded flows and stages.

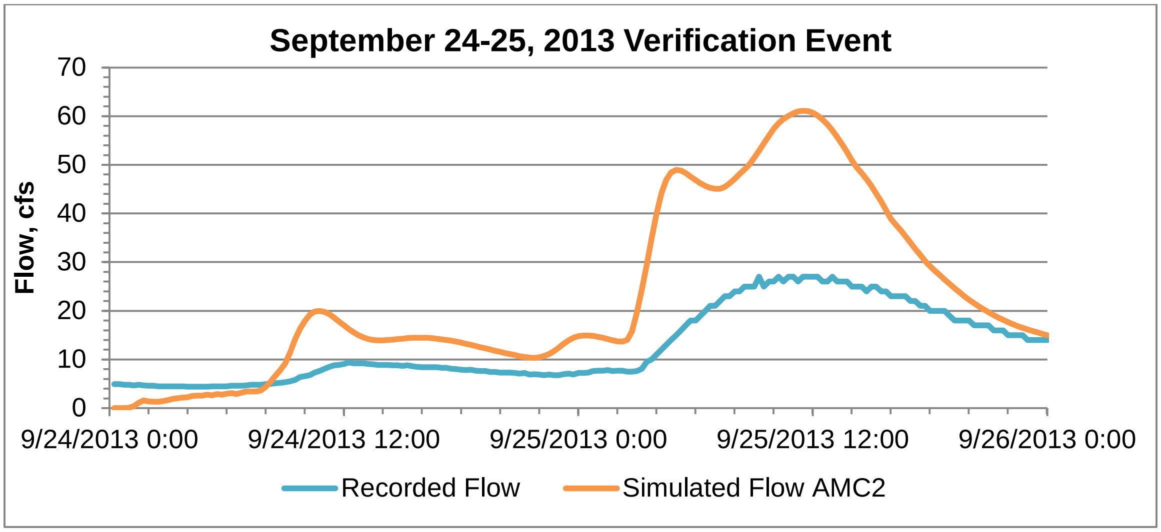


Figure 5-4a Station 02305851 Initial Verification Run - Flow Comparison

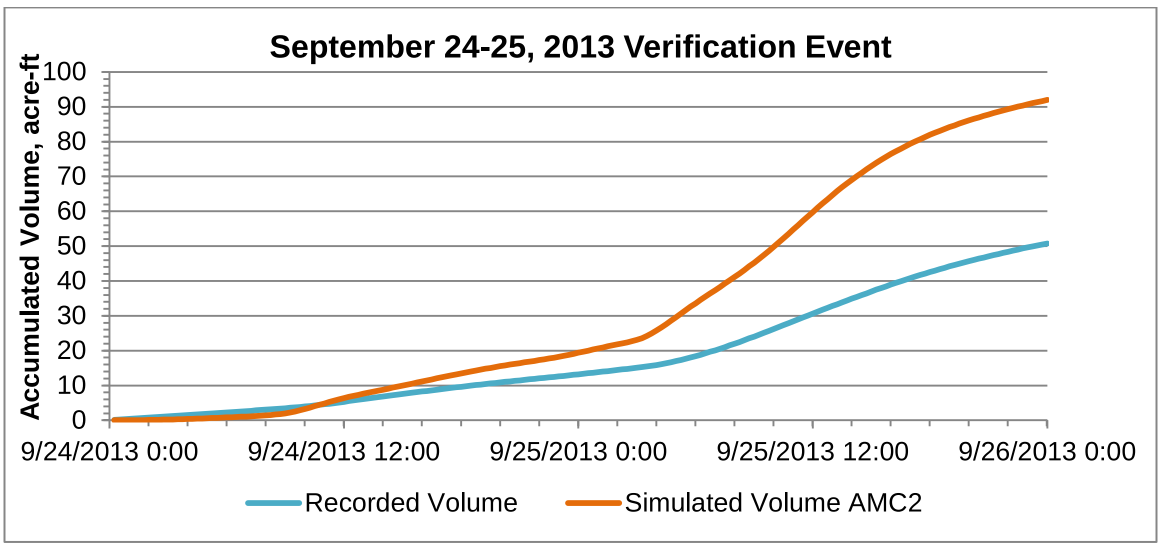


Figure 5-4b Station 02305851 Initial Verification Run - Volume Comparison

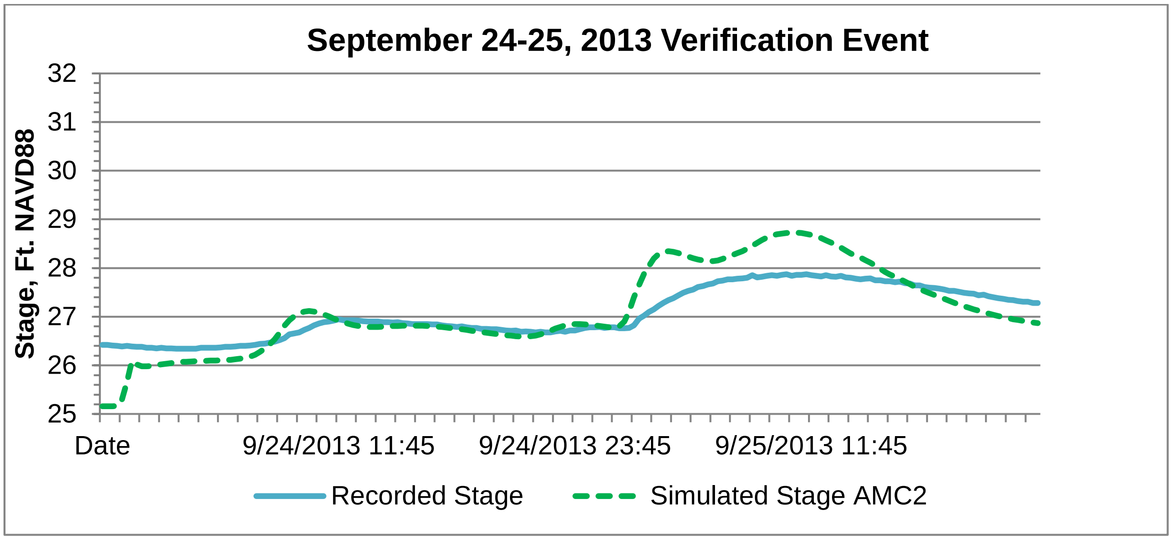


Figure 5-4c Station 02305851 Initial Verification Run - Stage Comparison

5.6.2 Verification Model Adjustments

The response of the initial simulation over-predicted the flow, volume and stage response of the Curiosity Creek system. However, the timing of the runoff response correlates well. Antecedant soil moisture is an indicator of available soil storage and can significantly impact runoff volume and rate. NRCS (formerly known as SCS, Soil Conservation Service) developed guidelines for adjusting the AMC for dry (AMC1), normal (AMC2) or wet (AMC3) conditions using the five-day period preceding a storm. Review of the antecedent rainfall records justified the reduction of the AMC2 soil moisture condition to an AMCI condition (see insert below). Although the 5-day antecedent rainfall totals were below 1.4 inches, the assumed seasonal high water table levels for ponds and lakes are still appropriate.

Table 3.--Classification of Antecedent Moisture Conditions (SCS, 1972).

AMC	Total 5-day Antecedent Rainfall (inches) Dormant Season	Growing Season
I	Less than 0.5	Less than 1.4
II	0.5 to 1.1	1.4 to 2.1
III	over 1.1	over 2.1

Curve numbers were adjusted according to the 1985 NRCS (SCS) Technical Publication 85-5 guidelines using the values presented in **Table 5.3.** Linear interpolation was used to compute adjusted values between the published 5-unit CN increments.

5.6.3 Verification Model Results

As illustrated by **Figures 5-5a**, **5-5b** and **5-5c**, the adjustment to the AMC condition produced very good timing and flow correlation with the historic September 24-25 creek response. A slight over prediction of flow early in the simulation is notable in the small offset between recorded and simulated volume in Figure 5-5b.

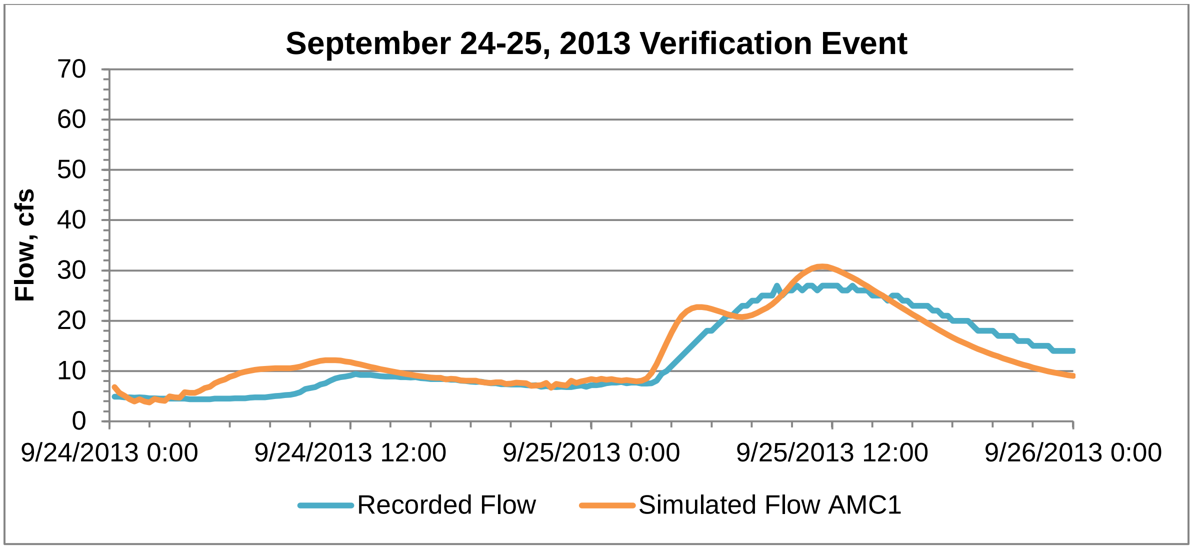


Figure 5-5a Station 02305851 Final Verification Run - Flow Comparison

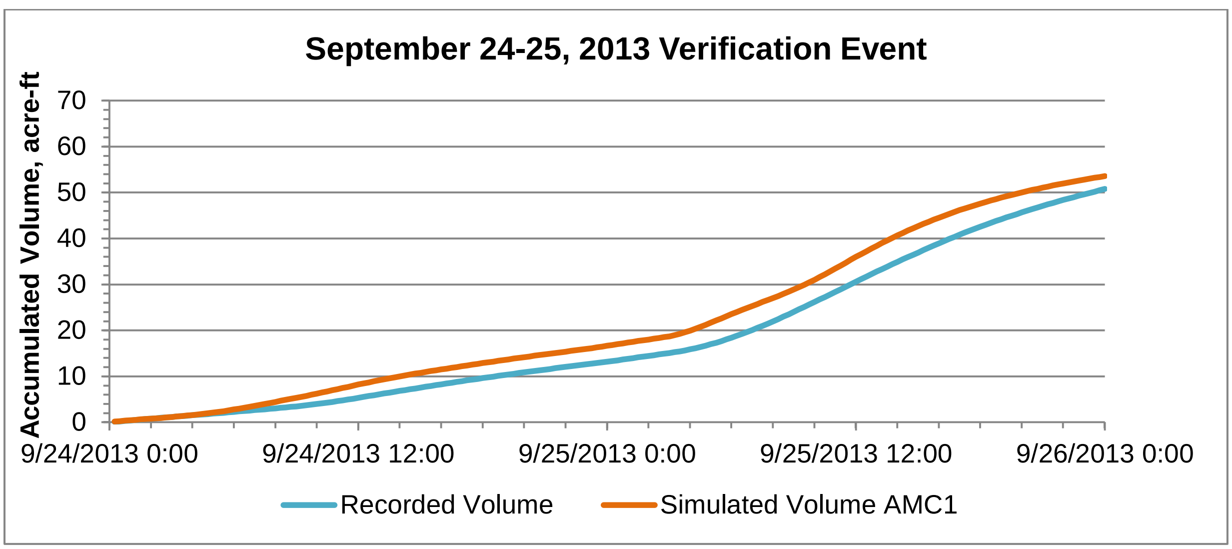


Figure 5-5b Station 02305851 Final Verification Run - Volume Comparison

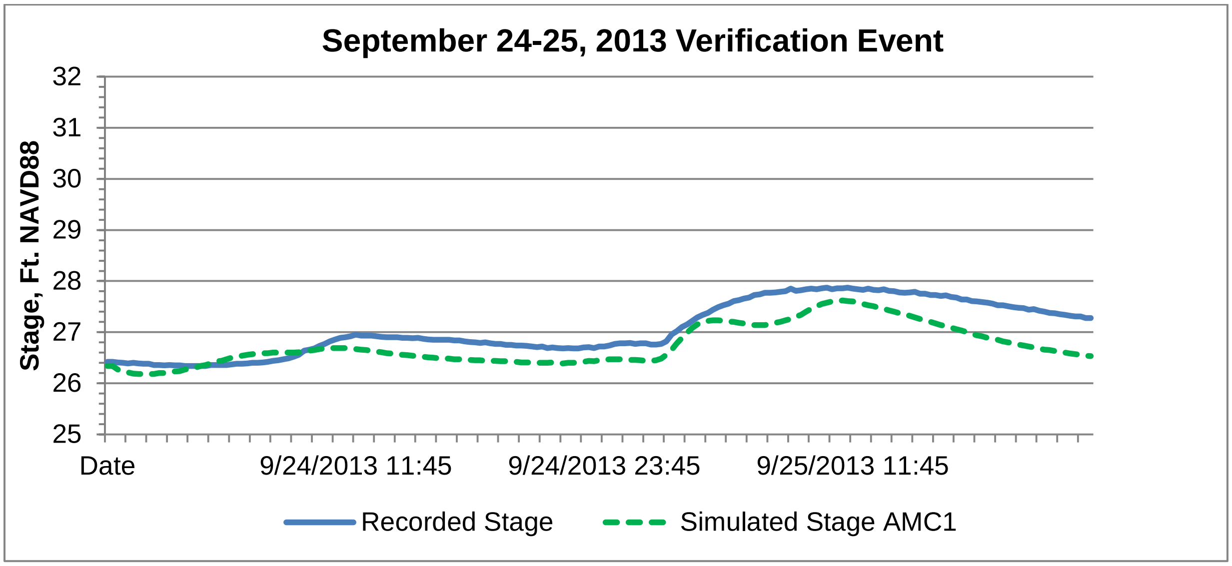


Figure 5-5c Station 02305851 Final Verification Run - Stage Comparison

Table 5.1 Precipitation Totals (Inch) for Curiosity Creek NEXRAD Stations

Pixel/ Station No.	Date: 06062013	Date: 06082013	Date: 09242013
99853	2.90	1.35	2.85
99854	2.80	1.09	2.59
100327	2.79	1.73	2.82
100328	2.77	1.52	2.69
100801	2.63	1.46	2.81
100802	2.64	1.50	2.79
101275	2.50	1.07	2.68
101276	2.54	1.16	2.63
101749	2.39	0.68	2.62
101750	2.42	0.88	2.49

Table 5.2 Monthly Rainfall Comparisons for Southwest Florida

Month	Southwest Florida 2013 Monthly Totals (inch)	Southwest Florida "Average" Monthly Totals (inch)
January	0.31	2.24
February	1.98	2.80
March	1.00	3.03
April	2.30	2.05
May	1.34	2.09
June	6.65	6.69
July	4.04	7.09
August	7.94	7.76
September	2.16	6.30
October	0.92	2.24
November	0.77	1.54
December	0.64	2.48
Totals	**30.05**	**46.31**

Table 5.3 TP 85-5 Curve Number Adjustments for AMC1 and AMC3

AMC2	AMC1	AMC3
100	100	100
95	99	87
90	98	78
85	97	70
80	94	63
75	91	57
70	87	51
65	83	45
60	79	40
55	75	35
50	70	31
45	65	27

CHAPTER 6
EXISTING CONDITIONS LEVEL OF SERVICE

Hillsborough County has requested that seven 24-hour (1-Day) design storm events be applied to the Curiosity Creek watershed to evaluate system response. The design storms are as follows:

- 500-year, 24-hour duration, total rainfall depth 14.0 inches
- 100-year, 24-hour duration, total rainfall depth 11.0 inches
- 50-year, 24-hour duration, total rainfall depth 10.0 inches
- 25-year, 24-hour duration, total rainfall depth 8.0 inches
- 10-year, 24-hour duration, total rainfall depth 6.8 inches
- 5-year, 24-hour duration, total rainfall depth 5.6 inches
- 2.33-year (mean annual), 24-hour duration, total rainfall depth 4.5 inches

The rainfall distribution that was used for the various storm events was the SCS Florida Type II Modified cumulative rainfall distribution.

It should be noted that design elevations may be exceeded for longer duration or higher volume storms of the same frequency and under very wet conditions.

6.1 Existing Conditions Model Simulation Results

The summary in **Table 6.1** shows the peak elevations for junctions throughout the watershed, including the lower portion within the COT, indicated by the ID prefix “559”. Peak stages do not occur simultaneously throughout the watershed. Time varying output from the model is found in the complete output file for each of the storms modeled.

6.2 Simulated 100-year Floodplain

The 100-yr flood stages are generally used to regulate development with respect to placement of and compensation for fill within the floodplain; protection of buildings through sufficient elevation of the first floor; and federal flood insurance. In addition to the 100-year 1-day design storm, three additional 100-year flood events have been modeled for assessment of flood stages:

- 100-year, 3-day duration, total rainfall depth 15.0 inches
- 100-year, 5-day duration, total rainfall depth 17.8 inches

- 100-year, 7-day duration, total rainfall depth 20.0 inches

The rainfall distributions vary substantially with regard to both timing and intensity of rainfall, as well as the total volume of precipitation. The 24-hour design event is generally the more severe for rate-sensitive watersheds, while the 5-day design event will simulate higher flood stages for volume-sensitive watersheds. It must be noted, however, that the use of the 5-day event, coupled with typical stormwater modeling tools, may be overly conservative for watersheds with a high proportion of closed subbasins or with severely limited discharge (as is the case for Curiosity Creek) that results in substantial surface flooding. Most stormwater models, including ICPR and various SWMM-based models, will not simulate infiltration over pervious surfaces beyond that which occurs during computation of runoff excess. Additionally, large lakes and wetlands will typically percolate significant volumes of water on a daily basis, with higher driving heads increasing the percolation rate even further. For these reasons, the 100-year, 24-hour design event is considered the more realistic gage of 100-year flooding for regulatory purposes. The simulation accuracy of the 5-day design event would be improved by coupling with a 2-D groundwater-surface water model.

Figure 6-1 illustrates the simulated 100-year, 1-day floodplain generated by the 2015 model stages overlaid on the DEM. Flood zones labeled “AE” represent areas where base flood elevations can be directly discerned from model output. Flood zones labeled as “A” represent flow transition paths between flooded subbasins where exact flow depth and width cannot be quantified; or smaller, isolated depressions within larger subbasins that have not been individually modeled but lie below the anticipated flood stage. **Table 6.2** compares the 1-day simulation results with peak stages generated from the additional multi-day simulations for the County portion of the watershed.

6.3 Level of Service Analysis

This section describes the methodology utilized in defining the Level of Service (LOS) for the various subbasins within the Curiosity Creek Watershed study area. **Figure 6-2** contains a graphical representation of the subbasin LOS for this watershed based on the 25-year, 24-hour storm event and **Figure 6-3** indicates roadway LOS based on depth of flooding.

6.3.1 Level of Service Methodology

The Comprehensive Plan contains estimated Adopted (existing) and Ultimate (proposed) LOS designations for several watersheds in Hillsborough County. The Hillsborough County Comprehensive Plan, Stormwater Element contains definitions for the level of service flood protection designations. These definitions specify that a storm return period, storm duration and a letter designation are required to define a level of flood protection. The flood level of service designations contained in the Comprehensive Plan are A, B, C, and D. A is the highest service level and D is the lowest. However, these criteria are somewhat subjective in what is termed as "significant" flooding. Therefore, for the purposes of this study, an interpretation of this definition is assigned to the LOS categories. The following contains the interpretation of the Comprehensive Plan definitions used in the LOS analysis.

Hillsborough County has recently updated the LOS definitions to be used throughout the project area as interpreted in the chart below. These definitions are for the 25-year, 24-hour storm event. The desired LOS for Hillsborough County is Level B.

Level	Hillsborough County Comprehensive Plan Definition	Master Plan Definition
A	No significant street flooding. All lanes are drivable.	No flooding.
B	Minor street flooding. At least one lane is drivable.	Street Flooding is more than 3" and 6" or less above crown of road.
C	Street flooding. Flooding depth above the crown of the road is less than one foot.	Street Flooding is more than 6" and 12" or less above crown of road. Site flooding.
D	No limitation on flooding.	Street Flooding is more than 12" above crown of road. Structure flooding.

The following quantitative interpretations have been applied for the roadway LOS analyses, regardless of whether the road is publically owned and maintained or privately owned and maintained:

- "Drivable" roads have less than, or equal to, three (3) inches of water above the crown of the road.
- One (1) passable lane means one (1) lane in each direction for a four (4) lane road or larger, or one (1) lane along the center of the road for a two (2) lane road.

The following additional quantitative interpretations have been applied for the site and structure LOS analyses:

- Site flooding of less than, or equal to, three (3) inches of water above the land surface and outside of the right of way is considered minor and is designated LOS Level A.
- Site flooding greater than three (3) inches, but less than or equal to six (6) inches of depth above the land surface and outside of the right of way is designated LOS Level B.
- Site flooding above six (6) inches in depth and outside of the right of way is designated LOS Level C.
- Permanent structures are assumed to be flooded (LOS Level D) when the adjacent grade indicated by the DEM is below the peak flood stage.
- Mobile home structures are assumed to be elevated a minimum of one foot above the adjacent grade; therefore are assumed to be flooded when the peak water level is greater than one foot above the adjacent grade.

The LOS designations in the Comprehensive Plan assumed that the sites (ground level surrounding adjacent property) are higher than the roads and that the houses are higher than the roads and the sites, although this is not always the case. It is possible to have a subbasin where the road does not flood (LOS A) or has only minor flooding (LOS B) yet the site, or even the structure, may flood. These situations can be discerned from the referenced landmark elevations.

6.3.2 Establishment of Landmark Elevations

To establish the LOS for each subbasin and thus the LOS for the major sub areas, landmark elevations were determined. These elevations were established using the 2011 LiDAR-based DEM. Elevations relating to road crowns, site elevations and structure elevations were established for each subbasin. The structures in each subbasin were assumed to be constructed at grade unless they are mobile homes. Mobile homes were assumed to have floor elevations one foot above grade. The basin LOS designations were assigned to the subbasins, the major subbasins and the overall watershed. The LOS of the Curiosity Creek watershed is reflective of the worst case for each major subbasin and the LOS for each major subbasin is reflective of the worst case for each subbasin. The subbasin LOS reflects the worst case for each interior node.

6.4 Existing Conditions Level of Service

Using flood protection LOS designation criteria contained in the previous section, the landmark elevations for each subbasin are compared to the computed results of the hydraulic model. In general, the computed result for the nearest junction was used for comparison with landmark elevations. **Table 6.3a** presents the existing condition LOS associated with the 25-year, 24-hour storm for each subbasin of Curiosity Creek watershed within the County’s jurisdiction. **Table 6.3b** presents the existing condition LOS associated with the 100-year, 24-hour storm for each subbasin within Curiosity Creek watershed within the County's jurisdiction. Road flooding LOS is differentiated in these tables from site and structure flooding LOS. Road flooding LOS criteria have been applied in the same manner to both public and private roadways. However, engineering alternatives will only be developed for protection of public roadways.

To follow the same pattern as Chapter 3, three regions of the watershed described in Chapter 3 will be used as follows:

- The Northwest Lake System
- The Curiosity Creek Main Channel
- The Forest Hills Basin

The following sections present both the areas and major structures where the computer modeling indicates that insufficient drainage conduit capacity exists and flooding is predicted during the 25-year, 24-hour design storm event.

6.4.1 The Northwest Lake System

All but five subbasins within the Northwest Lake System have an LOS of A during the 25-year, 24-hour design storm event. Subbasin 562170 has an LOS of B. Of the subbasins with an LOS below B, the model predicts street flooding at the following location:

- Subbasin 562500 (LOS C) – Samy Drive street flooding for up to 18 hours, associated with high stages in the pond located to the north. Site and structure flooding is not indicated.

The model indicated that site and structure flooding might occur at the following locations:

- Subbasin 560300 (LOS C) – backyard flooding for more than 24 hours associated with elevated stage in Lake Sophia.
- Subbasin 560700 (LOS C) – backyard flooding for up to 10 hours, associated with elevated stage in Round Pond.
- Subbasin 560205 (LOS C) – site flooding of extended duration for two parcels adjacent to a depressional feature with no identified outlet and located west of Summit Street. The roadway LOS is level A.

6.4.2 The Curiosity Creek Main Channel

Several subbasins within the Curiosity Creek Main Channel system have a LOS of C or D due to anticipated street flooding during the 25-year, 24-hour design storm event. The model predicts significant street flooding at the following locations:

- Subbasin 550100 (LOS C) – Country Club Drive.
- Subbasin 550175 (LOS D) – E. 121st Avenue, served by an exfiltration trench without a known positive outfall. Also site and potential structure flooding for up to five parcels between E. 121st Avenue and E. 122nd Avenue.
- Subbasin 550300 (LOS C) – W. 122nd Avenue floods one inch above the LOS B level for approximately 4 hours over a 30-foot segment immediately above the culvert crossing. Also site flooding north of W. 122nd Avenue associated with creek stages.
- Subbasin 550720 (LOS C) – Linda Drive. Also site flooding in Glen Oaks mobile home park and on three residential parcels east of the creek. One permanent residential structure at risk (LOS D).
- Subbasin 550900 (LOS C) – N. Central Avenue flooding for up to 4 hours. Also some site flooding impacting four parcels. One permanent residential structure on E. 132nd Avenue at risk (LOS D).
- Subbasin 551000 (LOS D) – N. Taliaferro Avenue flooding for up to 12 hours. Also site flooding for four parcels and structure flooding risk for three parcels east of N. Taliaferro Avenue along Mitchell Street and private mobile home park roadways, Arizona Avenue and Indiana Drive (LOS D).
- Subbasin 551100 (LOS C) – McDowell MHP private road floods at the creek crossing. Also site flooding east of the creek.
- Subbasin 551440 (LOS D) – E. 137th Avenue flooding for up to 4 hours. Also site flooding for four parcels with structures at risk for flooding on two parcels (LOS D).
- Subbasin 551442 (LOS C) – E. 137th Avenue flooding for up to 5 hours. Also site flooding for two parcels with one structure at risk for flooding (LOS D).
- Subbasin 551500 (LOS D) – E. Orange Avenue and Summit Avenue flooding. Twelve parcels experience significant site flooding and ten structures at risk for flooding (LOS D).
- Subbasin 551962 (LOS C) – E. 138th Avenue flooding for a length of approximately 400 feet west of N. Central Avenue and a duration of roughly 10 hours.
- Subbasin 552050 (LOS D) – Flooding of Garland Court and E. 145th Avenue with site flooding and potential structure flooding for thirteen parcels. This subbasin is internally drained and remains flooded for an extended duration.
- Subbasin 552060 (LOS D) – Flooding of private mobile home and multi-family residential roadways (Colonial Drive, Oaks Drive and Walker Drive) with potential flood risk to three multi-family structures due to pond stages (LOS D).
- Subbasin 552100 (LOS D) – Arkwright Drive and W. 138th Avenue flooding for extended durations due to being an internally drained subbasin. Sixteen parcels experience site flooding and nine structures along Arkwright Drive and Wildwood Street are at risk of flooding (LOS D).

- Subbasin 552160 (LOS D) – Wildwood Street near Florida Avenue flooding for up to 6 hours. Also one commercial parcel flooded with risk to the structures and one residential structure at risk of flooding (LOS D).
- Subbasin 552400 (LOS D) – Private roadway Sun Valley Lane flooding and thirteen associated mobile home park sites and nine structures at flood risk (LOS D).
- Subbasin 552500 (LOS D) – Floral Drive and Ambassador Drive Loop flooding and private mobile home park roadways flooding (Palm Drive, Sun Terrace, Sunset Circle and Sun Valley). Up to twenty-nine mobile home structures and sites may flood and two permanent residential structures are at risk of flooding (LOS D).
- Subbasin 552580 (LOS C) – Leisure Avenue flooding and associated yard flooding (LOS B).
- Subbasin 552580 (LOS C) – North Boulevard flooding north of Leisure Avenue.
- Subbasin 552600 (LOS C) – Leisure Avenue, Floral Drive and Carnation Drive roadway flooding. Also site flooding less than six inches in depth for three parcels (LOS B).
- Subbasin 552650 (LOS D) – Carnation Drive and Lakewood Avenue flooding for up to 6 hours. No significant site flooding.
- Subbasin 570500 (LOS C) – W. 138th Avenue flooding near Ola Avenue and flooding of private interior access roads of the Tyrone Mobile Home Park. Also widespread site flooding is indicated with potential flooding for approximately fifty mobile homes within the park for durations exceeding 30 hours (LOS D).
- Subbasin 570600 (LOS D) – Ola Avenue, Proclamation drive and Candidate Place flooding for durations exceeding 30 hours. Also yard flooding for six parcels and potential flooding of three structures along Candidate Place (LOS D).
- Subbasin 570700 (LOS D) – Constitution drive and Magna Carta Way flooding for up to 30 hours, associated with Lake Morris stages. Also yard flooding and one structure at risk for flooding (LOS D).

The model indicated that site and structure flooding might occur at the following locations where the desired roadway LOS is being met:

- Subbasin 550350 (LOS D) – site flooding for two parcels and potential structure flooding for one parcel along a privately owned segment of W. 124th Avenue near Curiosity Creek.
- Subbasin 550600 (LOS D) – site flooding and private drive flooding in the Halliday Village mobile home park with potential for flooding of approximately 13 mobile homes.
- Subbasin 551445 (LOS C) – significant yard flooding for one parcels on E. 137th Avenue adjacent to Curiosity Creek.

6.4.3 The Forest Hills Basin

All but one subbasin within the Forest Hills Basin system have a roadway LOS of A for the 25-year, 24-hour design storm event. The model predicts significant street flooding at the following location:

- Subbasin 560900 (LOS C) – Overbank flow from an adjacent wetland (to the west) may flood a 150-foot segment of N. Rome Avenue for up to 4 hours.

No significant site flooding is simulated within the Forest Hills Basin and no structures appear to be at risk.

Table 6.1 Design Storm Event - Existing Conditions

Model Junction ID	2.33-Year (ft NAVD)	5-Year (ft NAVD)	10-Year (ft NAVD)	25-Year (ft NAVD)	50-Year (ft NAVD)	100-Year (ft NAVD)	500-Year (ft NAVD)
550100	25.72	27.52	29.02	29.50	30.74	31.38	33.04
550150	34.86	35.69	35.73	35.84	36.00	36.05	36.17
550175	36.89	36.91	36.97	37.02	37.08	37.11	37.17
550200	27.51	27.89	29.17	29.68	30.81	31.45	33.08
550250	29.09	29.93	30.37	30.69	31.24	31.68	33.14
550300	31.51	31.74	31.94	32.09	32.36	32.51	33.34
550350	31.61	31.87	32.11	32.29	32.63	32.82	33.56
550390	31.51	31.76	32.04	32.25	32.69	32.90	33.36
550400	32.14	32.67	33.15	33.56	34.00	34.13	34.36
550405	31.51	31.76	32.04	32.25	33.06	33.60	34.12
550500	31.68	31.96	32.23	32.45	32.86	33.10	33.85
550600	31.71	32.00	32.28	32.50	32.92	33.16	33.91
550675	32.09	32.47	32.76	33.03	33.47	33.74	34.42
550680	31.75	32.17	32.70	33.02	33.42	33.66	34.31
550685	32.32	32.67	33.13	33.47	33.91	34.15	34.84
550690	33.14	33.44	33.88	34.38	34.82	35.03	35.60
550692	36.02	37.17	37.69	37.85	38.07	38.17	38.44
550700	32.54	32.82	33.09	33.35	33.80	34.13	34.87
550720	33.25	33.35	33.46	33.60	33.96	34.27	34.99
550740	34.24	34.63	35.10	35.46	35.95	36.19	36.99
550745	34.56	35.05	35.87	36.43	37.10	37.38	37.90
550747	36.40	36.60	36.81	37.06	37.47	37.66	38.10
550750	36.40	36.60	36.81	37.06	37.47	37.66	37.83
550800	35.00	35.22	35.39	35.51	35.80	35.99	36.39
550825	35.00	35.23	35.40	35.52	35.97	36.14	36.50
550875	35.61	35.96	36.30	36.51	36.80	36.94	37.27
550900	35.79	36.23	36.71	37.06	37.59	37.87	38.59
550925	37.11	37.63	38.06	38.17	38.32	38.40	38.78
550950	37.62	38.35	38.79	39.03	39.37	39.51	39.85
550980	37.80	38.62	39.03	39.24	39.51	39.62	39.90
551000	37.80	38.60	39.02	39.25	39.56	39.69	40.05
551050	35.20	35.30	35.40	35.50	35.68	35.76	35.96
551100	37.64	37.90	38.23	38.34	38.50	38.59	38.95
551250	38.73	39.22	39.44	39.51	39.61	39.66	39.83

Table 6.1 Design Storm Event - Existing Conditions

Model Junction ID	2.33-Year (ft NAVD)	5-Year (ft NAVD)	10-Year (ft NAVD)	25-Year (ft NAVD)	50-Year (ft NAVD)	100-Year (ft NAVD)	500-Year (ft NAVD)
551300	38.98	39.65	39.94	40.04	40.17	40.24	40.43
551350	39.34	39.97	40.34	40.50	40.72	40.83	41.16
551400	39.38	40.05	40.46	40.66	40.94	41.10	41.44
551408	39.40	40.07	40.48	40.69	40.97	41.13	41.48
551410	39.41	40.08	40.51	40.71	41.00	41.17	41.53
551412	39.51	40.19	40.63	40.85	41.16	41.33	41.72
551415	39.52	40.20	40.66	40.88	41.20	41.37	41.78
551417	39.52	40.21	40.66	40.88	41.20	41.37	41.78
551418	39.58	40.27	40.85	41.37	41.86	41.98	42.24
551420	40.79	41.03	41.40	41.67	42.03	42.24	42.75
551430	40.17	40.31	40.44	40.53	40.64	40.67	40.76
551440	40.25	40.89	41.40	41.67	42.03	42.24	42.75
551442	41.98	42.06	42.15	42.24	42.31	42.38	42.80
551445	40.53	41.13	41.64	41.91	42.27	42.47	42.99
551450	40.89	41.50	42.01	42.29	42.64	42.83	43.35
551470	40.52	41.08	41.57	41.85	42.26	42.45	42.91
551475	40.52	41.06	41.54	41.83	42.25	42.38	42.80
551500	41.22	41.36	41.50	41.61	41.77	41.85	42.04
551700	40.54	41.13	41.64	41.94	42.31	42.52	43.02
551800	42.38	42.61	42.74	42.80	42.93	43.05	43.46
551875	42.81	43.18	43.46	43.61	43.85	43.98	44.44
551900	43.14	43.76	44.35	44.70	45.09	45.20	45.48
551925	43.64	44.21	44.75	45.04	45.40	45.51	45.84
551940	43.14	43.76	44.35	44.70	45.09	45.20	45.48
551950	42.81	43.86	44.31	44.71	45.10	45.20	45.48
551954	42.38	42.61	42.74	42.80	42.93	43.05	43.46
551956	42.37	42.61	42.74	42.80	42.93	43.05	43.46
551958	42.06	42.16	42.28	42.39	42.51	42.56	42.83
551960	40.71	41.47	42.00	42.21	42.42	42.54	42.82
551962	42.06	42.16	42.27	42.38	42.51	42.56	42.82
552000	44.01	44.10	44.31	44.71	45.10	45.20	45.48
552050	47.54	48.08	48.55	48.94	49.46	49.58	49.78
552060	47.54	48.10	48.60	49.03	49.64	49.90	50.52
552100	43.11	43.48	43.68	44.33	45.11	45.34	45.82

Table 6.1 Design Storm Event - Existing Conditions

Model Junction ID	2.33-Year (ft NAVD)	5-Year (ft NAVD)	10-Year (ft NAVD)	25-Year (ft NAVD)	50-Year (ft NAVD)	100-Year (ft NAVD)	500-Year (ft NAVD)
552150	43.79	44.46	45.04	45.26	45.55	45.66	45.99
552160	43.82	44.50	45.08	45.30	45.59	45.70	46.04
552175	43.87	44.56	45.15	45.39	45.72	45.84	46.21
552200	46.68	46.87	47.07	47.26	47.56	47.70	48.10
552229	47.54	48.08	48.55	48.94	49.46	49.58	49.78
552230	49.12	49.15	49.19	49.23	49.46	49.58	49.78
552300	44.03	44.74	45.37	45.73	46.26	46.47	47.03
552350	44.10	44.80	45.42	45.80	46.34	46.56	47.14
552400	44.56	45.33	45.85	46.26	46.86	47.10	47.71
552500	44.83	45.55	46.07	46.52	47.17	47.43	48.06
552550	44.91	45.63	46.16	46.62	47.29	47.56	48.20
552560	45.04	45.78	46.33	46.63	47.29	47.56	48.20
552570	45.92	46.76	47.29	47.48	47.66	47.74	48.32
552580	45.95	46.80	47.31	47.50	47.66	47.74	48.32
552590	46.08	46.92	47.48	47.68	47.82	47.87	48.32
552600	45.01	45.81	46.46	46.96	47.49	47.72	48.32
552650	45.01	45.81	46.47	46.96	47.49	47.73	48.32
552700	45.01	45.81	46.47	46.96	47.49	47.73	48.33
552710	45.82	46.20	46.33	46.63	47.29	47.56	48.20
552799	46.86	46.91	47.10	47.52	48.23	48.50	49.06
552800	50.16	50.62	51.12	51.35	51.46	51.52	51.64
552859	49.73	50.15	50.47	50.73	51.03	51.15	53.12
552860	51.09	51.50	51.95	52.37	52.86	53.05	53.41
552908	45.83	46.31	46.78	47.20	47.70	47.92	48.49
552909	45.83	46.31	46.59	46.96	47.49	47.73	48.33
552910	49.37	49.67	49.94	50.14	50.38	50.49	50.81
552918	47.05	47.91	48.24	48.49	48.73	48.82	49.04
552920	48.82	49.12	49.19	49.24	49.31	49.34	49.43
552925	45.22	45.95	46.60	47.12	47.67	47.91	48.49
552930	45.22	45.95	46.60	47.12	47.67	47.92	48.49
552940	48.13	48.18	48.22	48.26	48.32	48.35	48.50
552945	53.07	53.10	53.15	53.21	53.27	53.29	53.33
552950	45.81	46.33	46.91	47.41	48.00	48.25	48.84
552975	48.16	48.42	48.77	49.14	49.74	49.84	49.92

Table 6.1 Design Storm Event - Existing Conditions

Model Junction ID	2.33-Year (ft NAVD)	5-Year (ft NAVD)	10-Year (ft NAVD)	25-Year (ft NAVD)	50-Year (ft NAVD)	100-Year (ft NAVD)	500-Year (ft NAVD)
553000	46.01	46.50	47.08	47.61	48.30	48.61	49.43
553010	47.69	47.87	48.06	48.24	48.56	48.73	49.75
553030	46.06	46.51	47.09	47.61	48.30	48.61	49.44
553040	51.17	51.20	51.22	51.25	51.28	51.29	51.34
553100	46.51	46.92	47.39	47.85	48.50	48.79	49.58
554100	48.25	48.61	49.03	49.45	50.11	50.21	50.30
554148	47.82	47.97	48.10	48.26	48.63	48.79	49.28
554150	47.69	47.90	48.12	48.36	48.75	48.95	49.56
554200	47.69	47.90	48.12	48.36	48.75	48.95	49.56
554210	48.00	48.63	49.30	49.95	51.00	51.50	51.68
554220	47.77	48.19	48.60	48.61	48.75	48.95	49.56
554240	47.69	47.90	48.12	48.36	48.75	48.95	49.56
559012	10.47	10.94	11.29	11.61	12.06	12.25	12.71
559100	16.71	18.02	19.19	20.29	21.89	22.61	24.24
559120	21.41	22.81	23.74	24.49	25.49	25.90	27.06
559150	23.34	24.76	25.57	26.18	26.91	27.22	27.96
559152	23.43	24.91	25.77	26.40	27.13	27.35	27.77
559180	24.14	25.60	26.43	27.11	27.95	28.34	29.24
559182	24.57	26.25	26.90	27.25	27.95	28.34	29.24
559200	24.77	26.22	27.10	27.93	29.28	29.75	31.06
559205	25.24	26.59	27.46	28.34	29.56	30.02	31.27
559207	25.68	26.20	26.66	27.03	27.08	27.12	27.32
559210	29.78	30.39	30.79	30.82	30.95	31.03	31.59
559230	28.94	29.15	29.66	29.92	30.49	30.83	31.59
559235	31.24	31.28	31.39	31.43	31.49	31.53	31.85
559237	31.25	31.28	31.41	31.44	31.51	31.54	31.88
559240	31.24	31.28	31.40	31.43	31.49	31.53	31.86
559250	25.58	26.38	27.80	29.24	30.43	30.81	31.59
559255	25.78	26.81	28.16	29.33	30.44	30.81	31.59
559257	25.78	26.81	28.16	29.33	30.44	30.81	31.59
559260	25.80	26.84	28.18	29.34	30.44	30.82	31.59
559265	25.81	26.84	28.18	29.34	30.44	30.82	31.59
559268	25.81	26.91	28.19	29.39	30.53	30.91	31.69
559270	26.52	27.39	28.53	29.37	30.44	30.82	31.59

Table 6.1 Design Storm Event - Existing Conditions

Model Junction ID	2.33-Year (ft NAVD)	5-Year (ft NAVD)	10-Year (ft NAVD)	25-Year (ft NAVD)	50-Year (ft NAVD)	100-Year (ft NAVD)	500-Year (ft NAVD)
559320	31.25	31.29	31.41	31.45	31.51	31.54	31.89
559360	22.97	23.72	25.75	28.45	30.33	31.10	32.85
559362	22.97	23.72	25.73	28.44	30.33	31.10	32.85
559385	24.16	25.89	27.63	28.51	30.33	31.10	32.85
559390	24.16	25.88	27.63	28.51	30.33	31.10	32.85
559393	24.15	25.88	27.63	28.51	30.35	31.13	32.88
559395	24.27	26.16	27.85	28.75	30.38	31.12	32.88
559400	24.27	26.16	27.85	28.77	30.40	31.12	32.89
559420	26.16	27.32	27.94	28.79	30.40	31.12	32.89
559430	28.56	28.92	29.35	29.94	30.45	31.12	32.89
559500	24.91	26.34	27.97	28.90	30.55	31.23	32.97
559650	23.90	25.26	26.89	28.23	30.33	31.10	32.85
559655	21.37	24.29	26.89	28.23	30.33	31.10	32.85
559660	24.09	25.64	26.98	28.23	30.51	31.17	32.91
559665	26.81	27.27	27.71	28.23	30.51	31.17	32.91
559670	24.86	26.51	27.91	28.23	30.33	31.10	32.85
559675	25.87	27.18	28.13	28.53	30.33	31.10	32.85
559678	31.79	32.64	33.39	33.93	34.67	34.88	35.44
559680	31.81	32.65	33.42	34.00	34.82	35.15	35.77
559683	34.62	34.81	34.94	35.05	35.30	35.41	35.77
559685	34.62	34.81	34.94	35.04	35.29	35.42	35.76
559700	27.62	28.58	29.66	30.72	31.36	31.97	32.38
559710	28.67	28.98	29.30	29.57	31.39	31.97	32.38
559715	35.15	35.60	36.02	36.11	35.91	36.08	36.93
559720	40.65	41.57	42.28	42.87	43.52	43.77	44.22
559723	39.34	39.97	40.87	41.36	41.91	42.12	42.49
559725	40.11	40.69	41.75	42.35	43.03	43.29	43.88
559728	40.75	40.84	41.80	42.35	42.89	43.05	43.41
559730	38.89	38.89	39.00	39.09	39.38	39.53	40.00
559735	41.94	41.98	42.03	42.34	42.79	42.91	43.19
559738	38.89	38.89	39.00	39.09	39.38	39.52	39.98
559740	36.25	36.66	37.08	37.48	37.67	37.73	38.00
559750	42.72	42.83	42.93	43.02	43.15	43.21	43.38
559760	39.50	40.46	40.52	40.62	40.82	40.90	41.10

Table 6.1 Design Storm Event - Existing Conditions

Model Junction ID	2.33-Year (ft NAVD)	5-Year (ft NAVD)	10-Year (ft NAVD)	25-Year (ft NAVD)	50-Year (ft NAVD)	100-Year (ft NAVD)	500-Year (ft NAVD)
559810	31.42	31.99	32.49	32.90	33.23	33.33	33.57
559815	31.46	31.89	32.08	32.26	33.09	33.29	33.80
559820	29.90	30.89	31.70	32.26	33.09	33.29	33.80
559826	32.44	32.70	32.92	33.05	33.27	33.40	33.89
559828	32.76	32.98	33.12	33.24	33.42	33.51	33.80
559830	32.79	33.13	33.63	34.42	35.92	36.30	36.46
559840	34.32	34.62	34.76	34.85	34.95	34.99	35.09
559900	24.92	26.35	27.97	28.92	31.11	31.83	32.97
560000	35.11	35.33	35.56	35.80	36.41	36.76	39.48
560025	35.12	35.34	35.57	35.82	36.64	36.99	39.58
560050	35.12	35.34	35.57	35.83	36.73	37.08	39.57
560100	31.95	32.97	34.06	35.07	36.53	37.14	39.48
560150	35.12	35.34	35.58	35.84	36.77	37.10	39.48
560165	35.12	35.34	35.64	35.91	36.94	37.27	39.55
560175	35.13	35.35	35.59	35.86	37.39	37.65	39.50
560180	35.13	35.36	35.60	35.86	37.42	37.68	39.45
560200	35.72	36.02	36.39	36.96	37.71	37.99	39.46
560205	39.95	41.25	42.04	42.65	43.46	43.80	44.70
560210	36.79	37.06	37.41	37.77	38.17	38.37	39.78
560220	38.67	38.92	39.25	39.60	39.97	40.02	40.11
560230	40.03	40.24	40.50	40.75	41.07	41.12	41.20
560240	42.55	42.57	42.60	43.29	44.16	44.25	44.33
560250	43.01	43.03	43.07	43.78	45.38	45.53	45.61
560260	43.20	43.24	43.28	44.13	46.27	46.49	46.62
560265	43.49	43.51	43.54	44.37	46.86	47.13	47.35
560270	40.86	41.29	42.18	42.38	42.72	42.85	43.24
560280	40.99	41.45	42.69	42.95	43.33	43.52	44.12
560285	41.47	41.82	43.19	43.53	44.06	44.34	45.25
560290	41.81	42.22	43.85	44.28	45.04	45.44	46.49
560295	41.98	42.40	44.05	44.56	45.48	45.93	47.07
560300	45.44	45.96	46.55	46.73	47.18	47.48	47.72
560400	30.98	31.47	32.02	32.56	33.09	33.29	33.80
560450	31.09	31.63	32.20	32.82	33.43	33.64	34.13
560500	44.40	45.10	45.84	46.54	47.56	48.01	49.20

Table 6.1 Design Storm Event - Existing Conditions

Model Junction ID	2.33-Year (ft NAVD)	5-Year (ft NAVD)	10-Year (ft NAVD)	25-Year (ft NAVD)	50-Year (ft NAVD)	100-Year (ft NAVD)	500-Year (ft NAVD)
560600	33.77	34.03	34.35	34.70	35.34	35.67	36.06
560700	43.73	44.02	44.29	44.85	45.84	46.32	47.52
560800	37.78	38.90	40.07	41.12	41.91	42.15	42.68
560850	31.36	31.86	32.47	33.05	33.67	33.90	34.53
560900	35.19	35.36	35.52	35.67	35.90	36.00	36.28
561000	37.93	38.57	39.29	39.90	41.02	41.53	42.37
561030	38.01	38.67	39.41	40.11	41.16	41.66	42.46
561050	38.03	38.69	39.44	40.18	41.15	41.65	42.47
561100	38.22	38.90	39.71	40.45	41.02	41.53	42.37
561200	38.22	38.94	39.77	40.45	41.44	41.79	42.38
561275	38.37	39.15	40.05	40.97	41.73	42.52	42.75
561300	39.09	39.15	39.29	39.90	41.02	41.53	42.37
561330	42.16	42.19	42.23	42.26	42.31	42.33	42.39
561350	43.14	43.46	43.56	43.74	44.02	44.05	44.11
561400	41.02	41.14	41.24	41.36	41.93	42.85	42.99
561480	41.02	41.14	41.24	41.36	41.93	42.91	43.04
561500	41.10	41.26	41.48	41.71	42.14	43.05	43.16
561600	40.77	41.08	41.42	41.77	42.34	42.62	43.43
561700	45.00	45.61	46.29	46.95	48.02	48.54	49.97
561750	41.08	41.21	41.40	41.59	42.21	43.15	43.74
561775	41.08	41.22	41.36	41.52	42.14	43.17	43.94
561800	41.59	41.97	42.48	42.93	43.61	43.86	44.22
561900	42.43	42.71	42.81	42.97	43.61	43.86	44.22
562000	40.72	41.52	42.44	43.15	43.86	44.32	45.27
562100	43.64	44.05	44.54	45.03	45.81	46.09	46.57
562148	40.79	41.63	42.59	43.41	44.37	44.51	45.55
562150	43.42	43.63	43.89	44.10	44.53	44.57	45.27
562170	43.45	43.70	44.04	44.36	45.00	45.18	46.26
562175	43.45	43.70	44.04	44.45	45.13	45.23	46.26
562177	43.45	43.70	46.11	46.22	46.24	46.24	46.26
562200	47.54	47.69	47.80	48.05	48.52	48.76	49.45
562210	47.54	47.69	47.80	48.05	48.52	48.76	49.45
562220	49.79	49.85	49.94	49.99	50.05	50.07	50.13
562230	47.54	47.68	47.72	47.76	47.82	47.84	47.92

Table 6.1 Design Storm Event - Existing Conditions

Model Junction ID	2.33-Year (ft NAVD)	5-Year (ft NAVD)	10-Year (ft NAVD)	25-Year (ft NAVD)	50-Year (ft NAVD)	100-Year (ft NAVD)	500-Year (ft NAVD)
562250	41.99	42.03	42.45	43.16	43.86	44.32	45.27
562300	42.87	43.37	43.91	44.19	44.58	44.82	45.29
562350	43.45	43.70	46.29	47.28	47.69	47.76	47.88
562400	46.12	47.10	47.40	47.51	47.98	48.06	48.20
562500	45.99	46.51	47.00	47.41	47.95	48.19	48.88
562520	46.23	46.75	47.00	47.41	47.95	48.19	48.88
562549	45.99	46.51	47.00	47.33	47.95	48.20	48.88
562550	45.73	46.21	46.72	47.32	47.99	48.26	48.88
570000	35.02	35.25	35.44	35.57	37.12	37.42	37.92
570080	35.03	35.26	35.45	35.58	37.14	37.43	37.94
570085	35.11	35.36	35.57	35.73	37.27	37.58	38.14
570100	36.89	37.38	37.93	38.47	39.28	39.37	39.54
570110	37.39	37.61	37.95	38.48	40.95	41.47	41.80
570120	39.23	39.56	39.91	40.24	43.14	43.32	43.54
570180	36.93	37.45	38.01	38.55	39.30	39.37	39.54
570200	39.40	39.53	39.61	39.67	39.74	39.77	39.86
570300	38.99	39.41	39.65	39.73	39.92	40.04	40.36
570350	40.75	40.78	40.81	40.83	40.87	40.89	40.95
570400	35.90	36.78	37.70	38.56	39.86	40.39	40.45
570500	41.62	42.00	42.75	43.45	43.77	43.85	44.03
570580	41.50	42.48	42.83	43.45	43.77	43.85	44.04
570590	41.94	43.50	43.78	43.94	44.05	44.09	44.18
570595	43.00	44.11	44.50	45.00	45.16	45.22	45.34
570600	41.61	42.61	43.02	43.59	43.86	43.96	44.21
570700	41.67	42.70	43.33	43.72	44.02	44.14	44.45
570800	44.01	44.67	44.86	45.02	45.16	45.22	45.35
570810	44.53	44.71	45.12	45.74	47.30	48.09	49.55
570815	44.01	44.67	45.08	45.67	46.02	46.15	46.48
570820	45.66	46.06	46.46	46.89	47.60	47.88	48.59

Table 6.2 Comparison of Peak 100-year WSEL for the 1-day and Multi-day Events (County Portion Only)

NODE	100-YR/1 DAY PEAK WSEL (ft-NAVD)	100-YR/3 DAY PEAK WSEL (ft-NAVD)	100-YR/5 DAY PEAK WSEL (ft-NAVD)	100-YR/7 DAY PEAK WSEL (ft-NAVD)	NOTES
559500	31.23	31.30	32.74	31.44	Blue Sink (closed)
550100	31.38	31.33	32.78	31.45	assoc. w/Blue Sink
550150	36.05	35.8	35.95	35.78	
550175	37.11	36.95	37.04	36.94	
550200	31.45	31.34	32.83	31.46	assoc. w/Blue Sink
550250	31.68	31.46	32.9	31.48	assoc. w/Blue Sink
550300	32.51	32.18	33.17	32.25	
550350	32.82	32.41	33.41	32.48	
550390	32.90	32.21	33.21	32.29	
550400	34.13	32.65	33.93	32.66	
550405	33.6	32.21	33.21	32.29	
550500	33.10	32.6	33.72	32.69	
550600	33.16	32.66	33.78	32.75	
550675	33.74	33.31	34.32	33.40	
550680	33.66	32.89	34.17	33.06	
550685	34.15	33.40	34.74	33.82	
550690	35.03	33.33	35.21	33.37	
550692	38.17	35.82	37.94	35.52	
550700	34.13	33.65	34.76	33.74	
550720	34.27	33.83	34.88	33.90	
550740	36.19	35.75	37.03	36.98	
550745	37.38	35.92	37.59	37.09	
550747	37.66	36.45	37.68	37.07	
550750	37.66	36.45	37.68	37.07	
550800	35.99	35.7	36.31	35.74	
550825	36.14	35.87	36.43	35.91	
550875	36.94	36.44	37.13	36.48	
550900	37.87	36.94	38.24	37.00	
550925	38.40	38.15	38.56	38.16	
550950	39.51	38.97	39.6	39.01	
550980	39.62	39.15	39.63	39.17	
551000	39.69	39.16	39.69	39.17	
551050	35.76	35.35	35.71	35.34	
551100	38.59	38.32	38.75	38.34	

Table 6.2 Comparison of Peak 100-year WSEL for the 1-day and Multi-day Events (County Portion Only)

NODE	100-YR/1 DAY PEAK WSEL (ft-NAVD)	100-YR/3 DAY PEAK WSEL (ft-NAVD)	100-YR/5 DAY PEAK WSEL (ft-NAVD)	100-YR/7 DAY PEAK WSEL (ft-NAVD)	NOTES
551250	39.66	39.50	39.74	39.51	
551300	40.24	40.03	40.33	40.04	
551350	40.83	40.48	41.00	40.49	
551400	41.10	40.64	41.27	40.66	
551408	41.13	40.66	41.31	40.68	
551410	41.17	40.69	41.35	40.71	
551412	41.33	40.82	41.53	40.84	
551415	41.37	40.85	41.58	40.87	
551417	41.37	40.85	41.58	40.87	
551418	41.98	41.81	42.00	41.78	
551420	42.24	41.62	42.49	41.65	
551430	40.67	40.28	40.52	40.25	
551440	42.24	41.62	42.49	41.65	
551442	42.38	42.22	42.61	42.22	
551445	42.47	41.84	42.71	41.88	
551450	42.83	42.19	43.05	42.23	
551470	42.45	41.84	42.67	41.88	
551475	42.38	41.85	42.61	41.88	
551500	41.85	41.29	41.65	41.24	
551700	42.52	41.98	42.85	41.98	
551800	43.05	42.76	43.20	42.77	
551875	43.98	43.49	44.12	43.51	
551900	45.20	44.40	45.27	44.44	
551925	45.51	44.76	45.59	44.80	
551940	45.20	44.40	45.27	44.44	
551950	45.20	44.54	45.28	44.53	
551954	43.05	42.76	43.20	42.77	
551956	43.05	42.76	43.20	42.77	
551958	42.56	42.34	42.67	42.35	
551960	42.54	42.48	42.68	42.47	
551962	42.56	42.34	42.67	42.34	
552000	45.20	44.55	45.28	44.54	
552050	49.58	49.70	49.90	49.74	pond/closed basin
552060	49.90	50.20	50.71	50.23	

Table 6.2 Comparison of Peak 100-year WSEL for the 1-day and Multi-day Events (County Portion Only)

NODE	100-YR/1 DAY PEAK WSEL (ft-NAVD)	100-YR/3 DAY PEAK WSEL (ft-NAVD)	100-YR/5 DAY PEAK WSEL (ft-NAVD)	100-YR/7 DAY PEAK WSEL (ft-NAVD)	NOTES
552100	45.34	43.88	45.49	43.91	
552150	45.66	45.03	45.73	45.06	
552160	45.70	45.07	45.78	45.09	
552175	45.84	45.13	45.92	45.16	
552200	47.70	46.54	47.20	46.45	
552229	49.58	49.70	49.90	49.74	
552230	49.58	49.70	49.90	49.74	isolated pond
552300	46.47	45.34	46.55	45.38	
552350	46.56	45.39	46.65	45.43	
552400	47.10	45.79	47.18	45.84	
552500	47.43	46.00	47.50	46.05	
552550	47.56	46.09	47.64	46.14	
552560	47.56	46.35	47.64	46.37	
552570	47.74	47.31	47.82	47.36	
552580	47.74	47.32	47.82	47.36	
552590	47.87	47.53	47.87	47.58	
552600	47.72	46.34	47.79	46.41	
552650	47.73	46.35	47.80	46.41	
552700	47.73	46.35	47.80	46.41	
552710	47.56	46.35	47.64	46.37	
552799	48.50	47.20	48.59	47.20	
552800	51.52	51.40	51.51	51.39	
552859	51.15	50.27	51.25	50.27	
552860	53.05	52.11	53.19	52.12	
552908	47.92	46.60	47.95	46.62	
552909	47.73	46.56	47.79	46.57	
552910	50.49	49.70	50.37	49.62	
552918	48.82	48.16	48.79	48.19	
552920	49.34	49.06	49.23	49.03	
552925	47.91	46.46	47.95	46.52	
552930	47.92	46.46	47.95	46.52	
552940	48.35	48.12	48.26	48.11	
552945	53.29	53.11	53.18	53.11	
552950	48.25	46.68	48.21	46.71	

Table 6.2 Comparison of Peak 100-year WSEL for the 1-day and Multi-day Events (County Portion Only)

NODE	100-YR/1 DAY PEAK WSEL (ft-NAVD)	100-YR/3 DAY PEAK WSEL (ft-NAVD)	100-YR/5 DAY PEAK WSEL (ft-NAVD)	100-YR/7 DAY PEAK WSEL (ft-NAVD)	NOTES
552975	49.84	49.01	49.69	50.07	
553000	48.61	46.80	48.49	46.81	
553010	48.73	47.50	48.52	47.42	
553030	48.61	46.81	48.49	46.82	
553040	51.29	51.14	51.23	51.12	
553100	48.79	47.03	48.64	47.00	Country Lakes Borrow
554100	50.21	49.31	50.06	50.49	
554148	48.79	49.43	49.83	50.49	
554150	48.95	49.73	50.15	50.49	
554200	48.95	49.73	50.15	50.49	Lk Gass/Lk Blue Gill
554210	51.50	51.69	51.74	51.68	
554220	48.95	49.73	50.15	50.49	
554240	48.95	49.73	50.15	50.49	
560000	36.76	38.75	40.36	40.51	Noreast Lake
560025	36.99	38.79	40.47	40.55	
560050	37.08	38.78	40.46	40.55	
560100	37.14	38.75	40.36	40.50	closed basin - pond
560150	37.10	38.75	40.36	40.51	Pine Pond
560165	37.27	38.79	40.47	40.54	
560175	37.65	38.88	40.47	40.54	
560180	37.68	38.88	40.36	40.51	
560200	37.99	39.12	40.36	40.51	Pine Lake
560205	43.80	44.98	45.24	45.35	
560210	38.37	39.46	40.43	40.84	
560220	40.02	39.96	40.61	41.41	
560230	41.12	41.06	41.18	41.64	
560240	44.25	44.28	44.33	44.28	
560250	45.53	45.53	45.63	45.53	
560260	46.49	46.50	46.61	46.51	
560265	47.13	47.20	47.35	47.20	
560270	42.85	42.43	43.17	42.51	
560280	43.52	43.02	44.03	43.07	
560285	44.34	43.67	45.02	43.73	
560290	45.44	44.54	46.32	44.62	

Table 6.2 Comparison of Peak 100-year WSEL for the 1-day and Multi-day Events (County Portion Only)

NODE	100-YR/1 DAY PEAK WSEL (ft-NAVD)	100-YR/3 DAY PEAK WSEL (ft-NAVD)	100-YR/5 DAY PEAK WSEL (ft-NAVD)	100-YR/7 DAY PEAK WSEL (ft-NAVD)	NOTES
560295	45.93	44.89	46.90	44.99	
560300	47.48	47.55	47.72	47.56	Lake Sophia
560400	33.29	33.67	33.95	33.89	Lake Eckles
560450	33.64	33.95	34.27	34.16	
560500	48.01	49.53	50.10	50.18	
560600	35.67	35.11	35.98	35.29	Mid Lake
560700	46.32	45.21	47.33	45.32	Round Pond
560800	42.15	40.08	41.99	40.34	
560850	33.9	34.31	34.57	34.49	
560900	36.00	35.32	35.87	35.28	
561000	41.53	42.33	42.48	42.60	East Cedar Lake
561030	41.66	42.37	42.58	42.65	
561050	41.65	42.35	42.56	42.64	
561100	41.53	42.33	42.48	42.61	West Cedar Lake
561200	41.79	42.33	42.49	42.61	
561275	42.52	42.73	42.79	42.84	
561300	41.53	42.33	42.48	42.60	
561330	42.33	42.33	42.49	42.62	
561350	44.05	43.84	44.05	43.78	
561400	42.85	42.98	43.01	43.03	
561480	42.91	43.03	43.05	43.07	
561500	43.05	43.16	43.17	43.18	
561600	42.62	43.68	44.36	44.82	Dorset Lake
561700	48.54	50.03	50.09	50.21	Burnes Lake
561750	43.15	43.64	43.82	43.88	
561775	43.17	43.89	44.06	44.24	
561800	43.86	44.15	44.37	44.57	Lk Butler/Turtle Lk
561900	43.86	44.15	44.35	44.53	
562000	44.32	45.44	46.08	46.28	No Name Lake
562100	46.09	46.37	46.73	46.64	Golden Trout Lake
562148	44.51	45.62	46.41	46.53	
562150	44.57	45.44	46.08	46.28	
562170	45.18	45.86	46.5	46.56	
562175	45.23	45.86	46.51	46.56	

Table 6.2 Comparison of Peak 100-year WSEL for the 1-day and Multi-day Events (County Portion Only)

NODE	100-YR/1 DAY PEAK WSEL (ft-NAVD)	100-YR/3 DAY PEAK WSEL (ft-NAVD)	100-YR/5 DAY PEAK WSEL (ft-NAVD)	100-YR/7 DAY PEAK WSEL (ft-NAVD)	NOTES
562177	46.24	46.24	46.50	46.56	
562200	48.76	48.16	49.09	48.10	
562210	48.76	48.16	49.09	48.10	
562220	50.07	49.85	49.96	49.84	
562230	47.84	47.78	47.85	47.77	
562250	44.32	45.44	46.08	46.29	
562300	44.82	45.44	46.08	46.28	
562350	47.76	47.66	47.78	47.66	
562400	48.06	47.95	48.09	47.94	
562500	48.19	48.10	48.86	48.01	
562520	48.19	48.10	48.86	48.01	
562549	48.20	48.24	48.86	48.17	
562550	48.26	48.32	48.86	48.28	Samy Drive Pond
570000	37.42	36.92	37.87	37.02	
570080	37.43	36.93	37.88	37.03	
570085	37.58	37.05	38.08	37.16	
570100	39.37	39.24	39.51	39.25	
570110	41.47	39.99	41.72	40.05	
570120	43.32	42.78	43.48	42.82	
570180	39.37	39.27	39.52	39.28	
570200	39.77	39.45	39.60	39.43	
570300	40.04	40.08	40.42	40.05	
570350	40.89	40.67	40.80	40.66	
570400	40.39	40.48	40.55	40.46	
570500	43.85	43.64	43.95	43.63	
570580	43.85	43.67	43.97	43.65	
570590	44.09	43.79	44.02	43.76	
570595	45.22	44.53	45.11	44.35	
570600	43.96	43.93	44.21	43.95	
570700	44.14	44.06	44.40	44.06	Lake Morris
570800	45.22	44.86	45.12	44.82	Lake Russell
570810	48.09	45.02	46.28	44.93	
570815	46.15	44.99	45.84	44.90	
570820	47.88	45.23	47.18	45.07	

Table 6.3a Existing Conditions 25-Year Level of Service

Model Subbasin ID	Model Junction ID	Landmark Elevations			25-Year Design Storm Water Surface (ft NAVD)	Existing Condition LOS for Road	Existing Condition LOS for Site or Structure	Low Road
		Road Elevation (ft NAVD)	Site Elevation (ft NAVD)	Structure Elevation (ft NAVD)				
SUB550100	550100	28.60	29.60	31.30	29.50	C	A	W. COUNTRY CLUB DR.
SUB550150	550150	37.30	37.00	37.60	35.84	A	A	E. 120TH AVE
SUB550175	550175	35.70	34.90	35.80	37.02	D	D	E. 121ST AVE
SUB550200	550200	34.00	33.30	34.40	29.68	A	A	W 121ST AVE
SUB550200	550250	31.50	32.60	34.50	30.69	A	A	W 122ND AVE
SUB550300	550300	31.50	31.50	32.80	32.09	C	C	W 122ND AVE
SUB550350	550350	32.60	30.00	31.92	32.29	A	D	N. OLA AVE
SUB550400	550390	33.20	34.00	34.20	32.25	A	A	W 122ND AVE
SUB550400	550400	NA	33.50	NA	33.56	A	A	NO ROAD-STRUCTURE
SUB550400	550405	32.80	32.80	32.80	32.25	A	A	W 122ND AVE
SUB550600	550500	31.00	31.30	32.40	32.45	D	D	HALLIDAY PARK DR
SUB550600	550600	31.00	31.40	31.40	32.50	D	D	HALLIDAY PARK DR
SUB550600	550675	29.70	31.30	32.00	33.03	D	D	PRIVATE ROAD MICHIGAN MHP
SUB550600	550680	31.00	35.60	38.10	33.02	D	A	HALLIDAY PARK DR
SUB550600	550685	31.00	37.70	38.00	33.47	D	A	HALLIDAY PARK DR
SUB550600	550690	35.30	35.70	36.50	34.38	A	A	N OLA AVE
SUB550600	550700	29.70	31.30	32.00	33.35	D	D	PRIVATE ROAD MICHIGAN MHP
SUB550692	550692	37.60	37.90	38.30	37.85	A	A	W 130TH AVE
SUB550720	550720	33.00	32.90	33.00	33.60	C	D	LINDA DR
SUB550740	550740	37.70	37.20	39.70	35.46	A	A	W 127TH AVE
SUB550747	550745	38.40	36.70	37.50	36.43	A	A	MARJORY AVE
SUB550747	550750	38.40	36.70	37.50	37.06	A	B	MARJORY AVE

Table 6.3a Existing Conditions 25-Year Level of Service

Model Subbasin ID	Model Junction ID	Landmark Elevations			25-Year Design Storm Water Surface (ft NAVD)	Existing Condition LOS for Road	Existing Condition LOS for Site or Structure	Low Road
		Road Elevation (ft NAVD)	Site Elevation (ft NAVD)	Structure Elevation (ft NAVD)				
SUB550800	550800	37.20	36.00	36.70	35.51	A	A	LINDA DR
SUB550800	550825	36.90	35.70	36.00	35.52	A	A	W 131ST AVE
SUB550800	550875	36.90	36.30	36.80	36.51	A	A	W 131ST AVE
SUB550900	550900	37.60	37.00	37.70	37.06	A	A	E 131ST AVE
SUB550900	550925	37.80	37.90	38.60	38.17	B	B	PRIVATE ROAD MCDOWELL MHP
SUB550900	550950	38.30	38.00	38.70	39.03	C	D	N CENTRAL AVE
SUB551000	551000	38.10	38.30	37.50	37.50	D	D	N TALIAFERRO AVE
SUB551050	551050	34.10	35.40	36.70	35.50	D	A	N CENTRAL AVE
SUB551100	551100	37.80	39.00	40.80	38.34	C	A	PRIVATE ROAD MCDOWELL MHP
SUB551100	551250	39.70	40.10	40.40	39.51	A	A	FLETCHER-I275 S RAMP
SUB551300	551300	39.70	40.00	41.30	40.04	B	A	FLETCHER-I275 S RAMP
SUB551300	551350	40.80	41.50	41.70	40.50	A	A	E FLETCHER AVE
SUB551400	551400	40.80	43.40	45.00	40.66	A	A	E FLETCHER AVE
SUB551400	551408	NA	43.40	45.00	40.69	A	A	NO ROAD
SUB551400	551410	NA	43.40	45.00	40.71	A	A	NO ROAD
SUB551400	551412	NA	43.40	45.00	40.85	A	A	NO ROAD
SUB551400	551415	NA	43.40	45.00	40.88	A	A	NO ROAD
SUB551418	551417	NA	43.20	43.50	40.88	A	A	NO ROAD
SUB551418	551418	NA	43.20	43.50	41.37	A	A	NO ROAD
SUB551420	551420	43.90	41.20	44.70	41.67	A	B	N FLORIDA AVE NB
SUB551430	551430	40.70	41.70	42.70	40.53	A	A	I275 S-FLETCHER RAMP
SUB551440	551440	40.60	40.40	41.00	41.67	D	D	E 137TH AVE

Table 6.3a Existing Conditions 25-Year Level of Service

Model Subbasin ID	Model Junction ID	Landmark Elevations			25-Year Design Storm Water Surface (ft NAVD)	Existing Condition LOS for Road	Existing Condition LOS for Site or Structure	Low Road
		Road Elevation (ft NAVD)	Site Elevation (ft NAVD)	Structure Elevation (ft NAVD)				
SUB551442	551442	41.70	41.30	41.60	42.24	C	D	E 137TH AVE
SUB551445	551445	42.10	40.50	41.95	41.91	A	C	E 138TH AVE
SUB551445	551450	42.10	42.70	45.00	42.29	A	A	E 138TH AVE
SUB551475	551475	NA	NA	NA	41.83	A	A	NO ROAD-STRUCTURE
SUB551500	551500	39.40	40.20	40.60	41.61	D	D	E ORANGE AVE
SUB551700	551700	NA	44.20	44.30	41.94	A	A	NO ROAD
SUB551800	551800	42.40	43.50	46.00	42.80	B	A	E 138TH AVE
SUB551800	551875	45.00	45.70	46.00	43.61	A	A	N FLORIDA AVE NB
SUB551800	551956	42.30	43.50	46.00	42.80	B	A	E 138TH AVE
SUB551900	551900	45.00	45.30	45.60	44.70	A	A	N FLORIDA AVE NB
SUB551900	551925	44.80	45.30	45.56	45.04	A	A	N FLORIDA AVE NB
SUB551940	551940	49.90	48.50	50.00	44.70	A	A	WATTS WAY
SUB551950	551950	51.00	45.00	46.70	44.71	A	A	N CENTRAL AVE
SUB551954	551954	NA	44.90	46.30	42.80	A	A	NO ROAD
SUB551960	551960	NA	44.20	46.00	42.21	A	A	NO ROAD
SUB551962	551958	42.20	53.00	55.00	42.39	A	A	E 138TH AVE
SUB551962	551962	41.70	53.00	55.00	42.38	C	A	E 138TH AVE
SUB552000	552000	51.80	50.50	54.00	44.71	A	A	N CENTRAL AVE
SUB552050	552050	47.20	46.00	47.80	48.94	D	D	GARLAND CT
SUB552060	552060	46.70	46.10	47.30	49.03	D	D	COLONIAL DR
SUB552100	552100	41.00	41.20	43.00	44.33	D	D	ARKWRIGHT DR
SUB552160	552150	44.20	43.70	44.30	45.26	D	D	WILDWOOD ST

Table 6.3a Existing Conditions 25-Year Level of Service

Model Subbasin ID	Model Junction ID	Landmark Elevations: Road Elevation (ft NAVD)	Landmark Elevations: Site Elevation (ft NAVD)	Landmark Elevations: Structure Elevation (ft NAVD)	25-Year Design Storm Water Surface (ft NAVD)	Existing Condition LOS for Road	Existing Condition LOS for Site or Structure	Low Road
SUB552160	552160	45.10	46.10	47.80	45.30	A	A	NEVING DR
SUB552160	552175	51.00	46.00	47.00	45.39	A	A	N FLORIDA AVE SB
SUB552200	552200	50.30	50.00	50.70	47.26	A	A	N FLORIDA AVE SB
SUB552230	552230	NA	52.00	NA	49.23	A	A	NO ROAD-STRUCTURE
SUB552300	552300	NA	48.70	49.00	45.73	A	A	NO ROAD
SUB552300	552350	48.50	48.30	49.40	45.80	A	A	SOUTH PINE DR
SUB552400	552400	43.70	43.90	45.00	46.26	D	D	SUN VALLEY LN
SUB552500	552500	43.80	43.90	45.10	46.52	D	D	SUNSET CIR
SUB552500	552550	45.30	45.50	45.70	46.62	D	D	FLORAL DR
SUB552560	552560	NA	46.50	47.20	46.63	A	A	NO ROAD
SUB552560	552570	NA	47.50	47.50	47.48	A	A	NO ROAD
SUB552580	552580	46.50	47.00	47.70	47.50	C	B	LEISURE AVE
SUB552590	552590	46.90	47.90	48.50	47.68	C	A	N BOULEVARD
SUB552600	552600	46.00	46.50	47.20	46.96	C	B	FLORAL DR
SUB552650	552650	45.33	47.50	47.80	46.96	D	A	CARNATION DR
SUB552700	552700	NA	48.00	51.90	46.96	A	A	NO ROAD
SUB552700	552925	NA	50.00	51.00	47.12	A	A	NO ROAD
SUB552700	552950	51.50	51.00	51.80	47.41	A	A	W BEARSS AVE EB
SUB552710	552710	50.30	49.00	50.30	46.63	A	A	N BOULEVARD
SUB552800	552800	53.00	53.50	54.00	51.35	A	A	SHADY KNOLL CT
SUB552860	552860	52.50	53.00	53.70	52.37	A	A	WINDWOOD OAKS DR
SUB552910	552908	NA	48.00	50.80	47.20	A	A	NO ROAD

Table 6.3a Existing Conditions 25-Year Level of Service

Model Subbasin ID	Model Junction ID	Landmark Elevations: Road Elevation (ft NAVD)	Landmark Elevations: Site Elevation (ft NAVD)	Landmark Elevations: Structure Elevation (ft NAVD)	25-Year Design Storm Water Surface (ft NAVD)	Existing Condition LOS for Road	Existing Condition LOS for Site or Structure	Low Road
SUB552910	552909	NA	47.30	48.80	46.96	A	A	NO ROAD
SUB552910	552910	NA	50.60	51.30	50.14	A	A	NO ROAD
SUB552920	552920	49.50	49.00	50.00	49.24	A	A	SETTLERS RD
SUB552940	552940	49.30	52.30	52.40	48.26	A	A	WINDING CREEK CT
SUB552945	552945	NA	52.80	53.60	53.21	A	B	NO ROAD
SUB553000	553000	50.00	51.00	52.00	47.61	A	A	MONET DR
SUB553040	553040	51.00	51.90	52.80	51.25	A	A	MONET DR
SUB553100	553100	50.00	49.30	50.70	47.85	A	A	SHELLCRACKER CT
SUB554100	554100	NA	50.20	51.30	49.45	A	A	NO ROAD
SUB554150	554150	50.75	50.80	52.70	48.36	A	A	CRISIS CENTER PLZ
SUB554200	554200	50.90	50.00	52.00	48.36	A	A	WETSTONE DR
SUB554210	554210	54.30	54.80	56.70	49.95	A	A	FORD DR
SUB554220	554220	55.60	52.00	55.00	48.61	A	A	N FLORIDA AVE SB
SUB554240	554240	50.80	50.40	52.80	48.36	A	A	STONE CREEK LN
SUB560000	560000	38.00	35.30	39.10	35.80	A	B	N BOULEVARD & NOREAST LK DR
SUB560100	560100	42.00	37.00	38.20	35.07	A	A	N BOULEVARD
SUB560150	560150	39.50	36.00	38.50	35.84	A	A	N EDISON AVE
SUB560200	560200	39.50	38.00	42.10	36.96	A	A	FOREST HILLS DR
SUB560205	560205	43.30	41.50	43.71	42.65	A	C	SUMMIT ST
SUB560300	560300	47.80	46.00	47.70	46.73	A	C	POND LAKE DR
SUB560400	560400	32.90	33.00	33.60	32.56	A	A	N FOREST HILLS DR
SUB560500	560500	50.10	50.10	50.80	46.54	A	A	OAKLEAF AVE

Table 6.3a Existing Conditions 25-Year Level of Service

Model Subbasin ID	Model Junction ID	Landmark Elevations			25-Year Design Storm Water Surface (ft NAVD)	Existing Condition LOS for Road	Existing Condition LOS for Site or Structure	Low Road
		Road Elevation (ft NAVD)	Site Elevation (ft NAVD)	Structure Elevation (ft NAVD)				
SUB560600	560600	41.80	35.70	36.00	34.70	A	A	N OREGON AVE
SUB560700	560700	47.40	44.00	46.50	44.85	A	C	VERONICA AVE
SUB560800	560800	42.50	42.30	42.50	41.12	A	A	N ROME AVE
SUB560900	560900	34.80	35.80	36.80	35.67	C	A	N ROME AVE
SUB561000	561000	41.80	41.80	40.30	39.90	A	A	W 131ST AVE
SUB561100	561100	43.20	41.00	41.80	40.45	A	A	FOREST HILLS DR
SUB561200	561200	43.20	44.10	45.70	40.45	A	A	DORSET CIR
SUB561300	561300	42.50	39.40	40.40	39.90	A	B	W 131ST AVE
SUB561330	561330	42.80	43.00	44.00	42.26	A	A	N BOULEVARD
SUB561350	561350	NA	44.50	45.20	43.74	A	A	NO ROAD
SUB561400	561400	46.50	45.80	47.00	41.36	A	A	EDITH ST
SUB561500	561500	45.50	45.20	45.90	41.71	A	A	FOREST HILLS DR
SUB561600	561600	48.80	44.00	44.40	41.77	A	A	N OREGON AVE
SUB561700	561700	50.70	50.00	50.70	46.95	A	A	ASTOR AVE
SUB561800	561800	44.70	42.60	44.50	42.93	A	B	HERITAGE WAY
SUB561900	561900	45.40	45.60	45.50	42.97	A	A	W FLETCHER AVE WB
SUB562000	562000	45.10	43.00	43.30	43.15	A	A	SYLVIA LN
SUB562100	562100	46.30	46.40	46.90	45.03	A	A	TERRA MAR DR
SUB562150	562150	44.70	45.20	46.00	44.10	A	A	SYLVIA LN
SUB562170	562170	44.30	45.50	46.30	44.36	A	A	SYLVIA LN
SUB562170	562175	44.50	45.30	46.00	44.45	A	A	SYLVIA LN
SUB562170	562177	45.72	46.60	46.80	46.22	B	A	SYLVIA LN

Table 6.3a Existing Conditions 25-Year Level of Service

Model Subbasin ID	Model Junction ID	Landmark Elevations			25-Year Design Storm Water Surface (ft NAVD)	Existing Condition LOS for Road	Existing Condition LOS for Site or Structure	Low Road
		Road Elevation (ft NAVD)	Site Elevation (ft NAVD)	Structure Elevation (ft NAVD)				
SUB562200	562200	49.80	51.00	55.00	48.05	A	A	N ROME AVE
SUB562220	562220	51.80	54.70	55.20	49.99	A	A	FLETCHERS MILL DR
SUB562230	562230	49.80	50.30	51.00	47.76	A	A	N ROME AVE
SUB562300	562300	44.50	44.50	45.70	44.19	A	A	JUSTICE DR
SUB562400	562400	47.50	48.80	48.80	47.51	A	A	HAPPY LN
SUB562500	562500	46.50	47.60	48.20	47.41	C	A	SAMY DR
SUB562520	562520	51.20	51.00	52.60	47.41	A	A	N. BOULEVARD
SUB562550	562550	49.67	48.70	48.80	47.32	A	A	OAK STONE DR
SUB570000	570000	36.90	36.00	37.80	35.57	A	A	W 131ST AVE
SUB570100	570100	39.00	38.50	39.30	38.47	A	A	W PRINCE ST
SUB570100	570110	40.50	40.60	41.50	38.48	A	A	N OLA AVE
SUB570120	570120	42.20	43.00	42.50	40.24	A	A	N OLA AVE
SUB570200	570200	40.00	40.00	40.70	39.67	A	A	N FLORIDA AVE
SUB570300	570300	39.90	39.80	41.00	39.73	A	A	N OLA AVE
SUB570350	570350	NA	42.80	44.10	40.83	A	A	NO ROAD
SUB570400	570400	40.10	40.30	40.70	38.56	A	A	HAMNER AVE
SUB570500	570500	42.80	41.30	40.40	43.45	C	D	W 138TH AVE
SUB570600	570580	41.50	42.00	42.30	43.45	D	D	N OLA AVE
SUB570600	570590	42.80	43.00	43.50	43.94	D	D	N OLA AVE
SUB570600	570600	42.10	43.00	43.00	43.59	D	D	CANDIDATE PL
SUB570700	570700	42.70	43.00	43.70	43.72	D	D	CONSTITUTION DR
SUB570800	570800	45.30	44.70	45.40	45.02	A	B	TISH PLACE

Table 6.3a Existing Conditions 25-Year Level of Service

Model Subbasin ID	Model Junction ID	Landmark Elevations			25-Year Design Storm Water Surface (ft NAVD)	Existing Condition LOS for Road	Existing Condition LOS for Site or Structure	Low Road
		Road Elevation (ft NAVD)	Site Elevation (ft NAVD)	Structure Elevation (ft NAVD)				
SUB570800	570815	46.40	46.60	46.80	45.67	A	A	JUSTICE DR
SUB570810	570810	48.80	51.00	51.30	45.74	A	A	DIPLOMAT DR
SUB570820	570820	48.40	49.00	49.50	46.89	A	A	CAPITOL DR

Table 6.3b Existing Conditions 100-Year Level of Service

Model Subbasin ID	Model Junction ID	Landmark Elevations: Road Elevation (ft NAVD)	Landmark Elevations: Site Elevation (ft NAVD)	Landmark Elevations: Structure Elevation (ft NAVD)	100-Year Design Storm Water Surface (ft NAVD)	Existing Condition LOS for Road	Existing Condition LOS for Site or Structure	Low Road
SUB550100	550100	28.60	29.60	31.30	31.38	D	D	W. COUNTRY CLUB DR.
SUB550150	550150	37.30	37.00	37.60	36.05	A	A	E. 120TH AVE
SUB550175	550175	35.70	34.90	35.80	37.11	D	D	E. 121ST AVE
SUB550200	550200	34.00	33.30	34.40	31.45	A	A	W 121ST AVE
SUB550200	550250	31.50	32.60	34.50	31.68	A	A	W 122ND AVE
SUB550300	550300	31.50	31.50	32.80	32.51	D	C	W 122ND AVE
SUB550350	550350	32.60	30.00	31.92	32.82	A	D	N. OLA AVE
SUB550400	550390	33.20	34.00	34.20	32.90	A	A	W 122ND AVE
SUB550400	550400	NA	33.50	NA	34.13	A	C	NO ROAD-STRUCTURE
SUB550400	550405	32.80	32.80	32.80	33.60	C	D	W 122ND AVE
SUB550600	550500	31.00	31.30	32.40	33.10	D	D	HALLIDAY PARK DR
SUB550600	550600	31.00	31.40	31.40	33.16	D	D	HALLIDAY PARK DR
SUB550600	550675	29.70	31.30	32.00	33.74	D	D	PRIVATE ROAD MICHIGAN MHP
SUB550600	550680	31.00	35.60	38.10	33.66	D	A	HALLIDAY PARK DR
SUB550600	550685	31.00	37.70	38.00	34.15	D	A	HALLIDAY PARK DR
SUB550600	550690	35.30	35.70	36.50	35.03	A	A	N OLA AVE
SUB550600	550700	29.70	31.30	32.00	34.13	D	D	PRIVATE ROAD MICHIGAN MHP
SUB550692	550692	37.60	37.90	38.30	38.17	C	B	W 130TH AVE
SUB550720	550720	33.00	32.90	33.00	34.27	D	D	LINDA DR
SUB550740	550740	37.70	37.20	39.70	36.19	A	A	W 127TH AVE
SUB550747	550745	38.40	36.70	37.50	37.38	A	C	MARJORY AVE
SUB550747	550750	38.40	36.70	37.50	37.66	A	D	MARJORY AVE

Table 6.3b Existing Conditions 100-Year Level of Service

Model Subbasin ID	Model Junction ID	Landmark Elevations: Road Elevation (ft NAVD)	Landmark Elevations: Site Elevation (ft NAVD)	Landmark Elevations: Structure Elevation (ft NAVD)	100-Year Design Storm Water Surface (ft NAVD)	Existing Condition LOS for Road	Existing Condition LOS for Site or Structure	Low Road
SUB550800	550800	37.20	36.00	36.70	35.99	A	A	LINDA DR
SUB550800	550825	36.90	35.70	36.00	36.14	A	D	W 131ST AVE
SUB550800	550875	36.90	36.30	36.80	36.94	A	D	W 131ST AVE
SUB550900	550900	37.60	37.00	37.70	37.87	B	D	E 131ST AVE
SUB550900	550925	37.80	37.90	38.60	38.40	C	B	PRIVATE ROAD MCDOWELL MHP
SUB550900	550950	38.30	38.00	38.70	39.51	D	D	N CENTRAL AVE
SUB551000	551000	38.10	37.50	37.50	39.69	D	D	N TALIAFERRO AVE
SUB551050	551050	34.10	35.40	36.70	35.76	D	B	N CENTRAL AVE
SUB551100	551100	37.80	39.00	40.80	38.59	C	A	PRIVATE ROAD MCDOWELL MHP
SUB551100	551250	39.70	40.10	40.40	39.66	A	A	FLETCHER-I275 S RAMP
SUB551300	551300	39.70	40.00	41.30	40.24	C	A	FLETCHER-I275 S RAMP
SUB551300	551350	40.80	41.50	41.70	40.83	A	A	E FLETCHER AVE
SUB551400	551400	40.80	43.40	45.00	41.10	B	A	E FLETCHER AVE
SUB551400	551408	NA	43.40	45.00	41.13	A	A	NO ROAD
SUB551400	551410	NA	43.40	45.00	41.17	A	A	NO ROAD
SUB551400	551412	NA	43.40	45.00	41.33	A	A	NO ROAD
SUB551400	551415	NA	43.40	45.00	41.37	A	A	NO ROAD
SUB551418	551417	NA	43.20	43.50	41.37	A	A	NO ROAD
SUB551418	551418	NA	43.20	43.50	41.98	A	A	NO ROAD
SUB551420	551420	43.90	41.20	44.70	42.24	A	C	N FLORIDA AVE NB
SUB551430	551430	40.70	41.70	42.70	40.67	A	A	I275 S-FLETCHER RAMP
SUB551440	551440	40.60	40.40	41.00	42.24	D	D	E 137TH AVE

Table 6.3b Existing Conditions 100-Year Level of Service

Model Subbasin ID	Model Junction ID	Landmark Elevations: Road Elevation (ft NAVD)	Landmark Elevations: Site Elevation (ft NAVD)	Landmark Elevations: Structure Elevation (ft NAVD)	100-Year Design Storm Water Surface (ft NAVD)	Existing Condition LOS for Road	Existing Condition LOS for Site or Structure	Low Road
SUB551442	551442	41.70	41.30	41.60	42.38	C	D	E 137TH AVE
SUB551445	551445	42.10	40.50	41.95	42.47	B	D	E 138TH AVE
SUB551445	551450	42.10	42.70	45.00	42.83	C	A	E 138TH AVE
SUB551475	551475	NA	NA	NA	42.38	A	A	NO ROAD-STRUCTURE
SUB551500	551500	39.40	40.20	40.60	41.85	D	D	E ORANGE AVE
SUB551700	551700	NA	44.20	44.30	42.52	A	A	NO ROAD
SUB551800	551800	42.40	43.50	46.00	43.05	C	A	E 138TH AVE
SUB551800	551875	45.00	45.70	46.00	43.98	A	A	N FLORIDA AVE NB
SUB551800	551956	42.30	43.50	46.00	43.05	C	A	E 138TH AVE
SUB551900	551900	45.00	45.30	45.60	45.20	A	A	N FLORIDA AVE NB
SUB551900	551925	44.80	45.30	45.56	45.51	C	A	N FLORIDA AVE NB
SUB551940	551940	49.90	48.50	50.00	45.20	A	A	WATTS WAY
SUB551950	551950	51.00	45.00	46.70	45.20	A	A	N CENTRAL AVE
SUB551954	551954	NA	44.90	46.30	43.05	A	A	NO ROAD
SUB551960	551960	NA	44.20	46.00	42.54	A	A	NO ROAD
SUB551962	551958	42.20	53.00	55.00	42.56	B	A	E 138TH AVE
SUB551962	551962	41.70	53.00	55.00	42.56	C	A	E 138TH AVE
SUB552000	552000	51.80	50.50	54.00	45.20	A	A	N CENTRAL AVE
SUB552050	552050	47.20	46.00	47.80	49.58	D	D	GARLAND CT
SUB552060	552060	46.70	46.10	47.30	49.89	D	D	COLONIAL DR
SUB552100	552100	41.00	41.20	43.00	45.34	D	D	ARKWRIGHT DR
SUB552160	552150	44.20	43.70	44.30	45.66	D	D	WILDWOOD ST

Table 6.3b Existing Conditions 100-Year Level of Service

Model Subbasin ID	Model Junction ID	Landmark Elevations: Road Elevation (ft NAVD)	Landmark Elevations: Site Elevation (ft NAVD)	Landmark Elevations: Structure Elevation (ft NAVD)	100-Year Design Storm Water Surface (ft NAVD)	Existing Condition LOS for Road	Existing Condition LOS for Site or Structure	Low Road
SUB552160	552160	45.10	46.10	47.80	45.70	C	A	NEVING DR
SUB552160	552175	51.00	46.00	47.00	45.84	A	A	N FLORIDA AVE SB
SUB552200	552200	50.30	50.00	50.70	47.70	A	A	N FLORIDA AVE SB
SUB552230	552230	NA	52.00	NA	49.58	A	A	NO ROAD-STRUCTURE
SUB552300	552300	NA	48.70	49.00	46.47	A	A	NO ROAD
SUB552300	552350	48.50	48.30	49.40	46.56	A	A	SOUTH PINE DR
SUB552400	552400	43.70	43.90	45.00	47.10	D	D	SUN VALLEY LN
SUB552500	552500	43.80	43.90	45.10	47.43	D	D	SUNSET CIR
SUB552500	552550	45.30	45.50	45.70	47.56	D	D	FLORAL DR
SUB552560	552560	NA	46.50	47.20	47.56	A	D	NO ROAD
SUB552560	552570	NA	47.50	47.50	47.74	A	D	NO ROAD
SUB552580	552580	46.50	47.00	47.70	47.74	D	D	LEISURE AVE
SUB552590	552590	46.90	47.90	48.50	47.87	C	A	N BOULEVARD
SUB552600	552600	46.00	46.50	47.20	47.72	D	D	FLORAL DR
SUB552650	552650	45.33	47.50	47.80	47.73	D	A	CARNATION DR
SUB552700	552700	NA	48.00	51.90	47.73	A	A	NO ROAD
SUB552700	552925	NA	50.00	51.00	47.91	A	A	NO ROAD
SUB552700	552950	51.50	51.00	51.80	48.25	A	A	W BEARSS AVE EB
SUB552710	552710	50.30	49.00	50.30	47.56	A	A	N BOULEVARD
SUB552800	552800	53.00	53.50	54.00	51.52	A	A	SHADY KNOLL CT
SUB552860	552860	52.50	53.00	53.70	53.05	C	A	WINDWOOD OAKS DR
SUB552910	552908	NA	48.00	50.80	47.92	A	A	NO ROAD

Table 6.3b Existing Conditions 100-Year Level of Service

Model Subbasin ID	Model Junction ID	Landmark Elevations: Road Elevation (ft NAVD)	Landmark Elevations: Site Elevation (ft NAVD)	Landmark Elevations: Structure Elevation (ft NAVD)	100-Year Design Storm Water Surface (ft NAVD)	Existing Condition LOS for Road	Existing Condition LOS for Site or Structure	Low Road
SUB552910	552909	NA	47.30	48.80	47.73	A	B	NO ROAD
SUB552910	552910	NA	50.60	51.30	50.49	A	A	NO ROAD
SUB552920	552920	49.50	49.00	50.00	49.34	A	B	SETTLERS RD
SUB552940	552940	49.30	52.30	52.40	48.35	A	A	WINDING CREEK CT
SUB552945	552945	NA	52.80	53.60	53.29	A	B	NO ROAD
SUB553000	553000	50.00	51.00	52.00	48.61	A	A	MONET DR
SUB553040	553040	51.00	51.90	52.80	51.29	B	A	MONET DR
SUB553100	553100	50.00	49.30	50.70	48.79	A	A	SHELLCRACKER CT
SUB554100	554100	NA	50.20	51.30	50.21	A	A	NO ROAD
SUB554150	554150	50.75	50.80	52.70	48.95	A	A	CRISIS CENTER PLZ
SUB554200	554200	50.90	50.00	52.00	48.95	A	A	WETSTONE DR
SUB554210	554210	54.30	54.80	56.70	51.50	A	A	FORD DR
SUB554220	554220	55.60	52.00	55.00	48.95	A	A	N FLORIDA AVE SB
SUB554240	554240	50.80	50.40	52.80	48.95	A	A	STONE CREEK LN
SUB560000	560000	38.00	35.30	39.10	36.76	A	C	N BOULEVARD & NOREAST LK DR
SUB560100	560100	42.00	37.00	38.20	37.14	A	A	N BOULEVARD
SUB560150	560150	39.50	36.00	38.50	37.10	A	C	N EDISON AVE
SUB560200	560200	39.50	38.00	42.10	37.99	A	A	FOREST HILLS DR
SUB560205	560205	43.30	41.50	43.71	43.80	B	D	SUMMIT ST
SUB560300	560300	47.80	46.00	47.70	47.48	A	C	POND LAKE DR
SUB560400	560400	32.90	33.00	33.60	33.29	B	B	N FOREST HILLS DR
SUB560500	560500	50.10	50.10	50.80	48.01	A	A	OAKLEAF AVE

Table 6.3b Existing Conditions 100-Year Level of Service

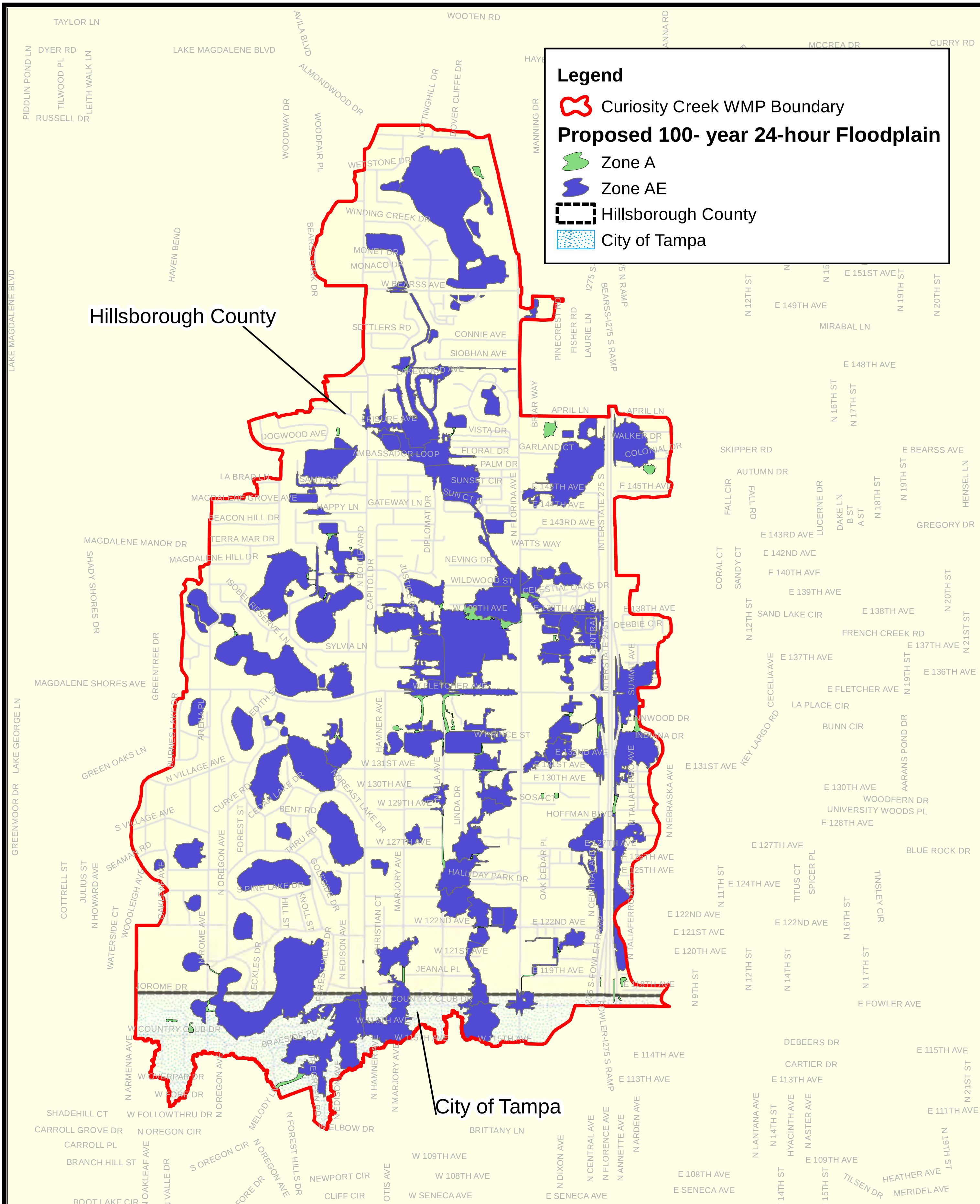
Model Subbasin ID	Model Junction ID	Landmark Elevations Road Elevation (ft NAVD)	Site Elevation (ft NAVD)	Structure Elevation (ft NAVD)	100-Year Design Storm Water Surface (ft NAVD)	Existing Condition LOS for Road	Existing Condition LOS for Site or Structure	Low Road
SUB560600	560600	41.80	35.70	36.00	35.67	A	A	N OREGON AVE
SUB560700	560700	47.40	44.00	46.50	46.32	A	C	VERONICA AVE
SUB560800	560800	42.50	42.30	42.50	42.15	A	A	N ROME AVE
SUB560900	560900	34.80	35.80	36.80	36.00	D	A	N ROME AVE
SUB561000	561000	41.80	41.80	40.30	41.53	A	D	W 131ST AVE
SUB561100	561100	43.20	41.00	41.80	41.53	A	C	FOREST HILLS DR
SUB561200	561200	43.20	44.10	45.70	41.79	A	A	DORSET CIR
SUB561300	561300	42.50	39.40	40.40	41.53	A	D	W 131ST AVE
SUB561330	561330	42.80	43.00	44.00	42.33	A	A	N BOULEVARD
SUB561350	561350	NA	44.50	45.20	44.05	A	A	NO ROAD
SUB561400	561400	46.50	45.80	47.00	42.85	A	A	EDITH ST
SUB561500	561500	45.50	45.20	45.90	43.05	A	A	FOREST HILLS DR
SUB561600	561600	48.80	44.00	44.40	42.62	A	A	N OREGON AVE
SUB561700	561700	50.70	50.00	50.70	48.54	A	A	ASTOR AVE
SUB561800	561800	44.70	42.60	44.50	43.86	A	C	HERITAGE WAY
SUB561900	561900	45.40	45.60	45.50	43.86	A	A	W FLETCHER AVE WB
SUB562000	562000	45.10	43.00	43.30	44.32	A	D	SYLVIA LN
SUB562100	562100	46.30	46.40	46.90	46.09	A	A	TERRA MAR DR
SUB562150	562150	44.70	45.20	46.00	44.57	A	A	SYLVIA LN
SUB562170	562170	44.30	45.50	46.30	45.18	C	A	SYLVIA LN
SUB562170	562175	44.50	45.30	46.00	45.23	C	A	SYLVIA LN
SUB562170	562177	45.72	46.60	46.80	46.24	C	A	SYLVIA LN

Table 6.3b Existing Conditions 100-Year Level of Service

Model Subbasin ID	Model Junction ID	Landmark Elevations			100-Year Design Storm Water Surface (ft NAVD)	Existing Condition LOS for Road	Existing Condition LOS for Site or Structure	Low Road
		Road Elevation (ft NAVD)	Site Elevation (ft NAVD)	Structure Elevation (ft NAVD)				
SUB562200	562200	49.80	51.00	55.00	48.76	A	A	N ROME AVE
SUB562220	562220	51.80	54.70	55.20	50.07	A	A	FLETCHERS MILL DR
SUB562230	562230	49.80	50.30	51.00	47.84	A	A	N ROME AVE
SUB562300	562300	44.50	44.50	45.70	44.82	B	B	JUSTICE DR
SUB562400	562400	47.50	48.80	48.80	48.06	C	A	HAPPY LN
SUB562500	562500	46.50	47.60	48.20	48.19	D	C	SAMY DR
SUB562520	562520	51.20	51.00	52.60	48.19	A	A	N. BOULEVARD
SUB562550	562550	49.67	48.70	48.80	48.26	A	A	OAK STONE DR
SUB570000	570000	36.90	36.00	37.80	37.42	C	C	W 131ST AVE
SUB570100	570100	39.00	38.50	39.30	39.37	B	D	W PRINCE ST
SUB570100	570110	40.50	40.60	41.50	41.47	C	C	N OLA AVE
SUB570120	570120	42.20	43.00	42.50	43.32	D	D	N OLA AVE
SUB570200	570200	40.00	40.00	40.70	39.77	A	A	N FLORIDA AVE
SUB570300	570300	39.90	39.80	41.00	40.04	A	A	N OLA AVE
SUB570350	570350	NA	42.80	44.10	40.89	A	A	NO ROAD
SUB570400	570400	40.10	40.30	40.70	40.39	B	A	HAMNER AVE
SUB570500	570500	42.80	41.30	40.40	43.85	D	D	W 138TH AVE
SUB570600	570580	41.50	42.00	42.30	43.85	D	D	N OLA AVE
SUB570600	570590	42.80	43.00	43.50	44.09	D	D	N OLA AVE
SUB570600	570600	42.10	43.00	43.00	43.96	D	D	CANDIDATE PL
SUB570700	570700	42.70	43.00	43.70	44.14	D	D	CONSTITUTION DR
SUB570800	570800	45.30	44.70	45.40	45.22	A	C	TISH PLACE

Table 6.3b Existing Conditions 100-Year Level of Service

Model Subbasin ID	Model Junction ID	Landmark Elevations			100-Year Design Storm Water Surface (ft NAVD)	Existing Condition LOS for Road	Existing Condition LOS for Site or Structure	Low Road
		Road Elevation (ft NAVD)	Site Elevation (ft NAVD)	Structure Elevation (ft NAVD)				
SUB570800	570815	46.40	46.60	46.80	46.15	A	A	JUSTICE DR
SUB570810	570810	48.80	51.00	51.30	48.09	A	A	DIPLOMAT DR
SUB570820	570820	48.40	49.00	49.50	47.88	A	A	CAPITOL DR



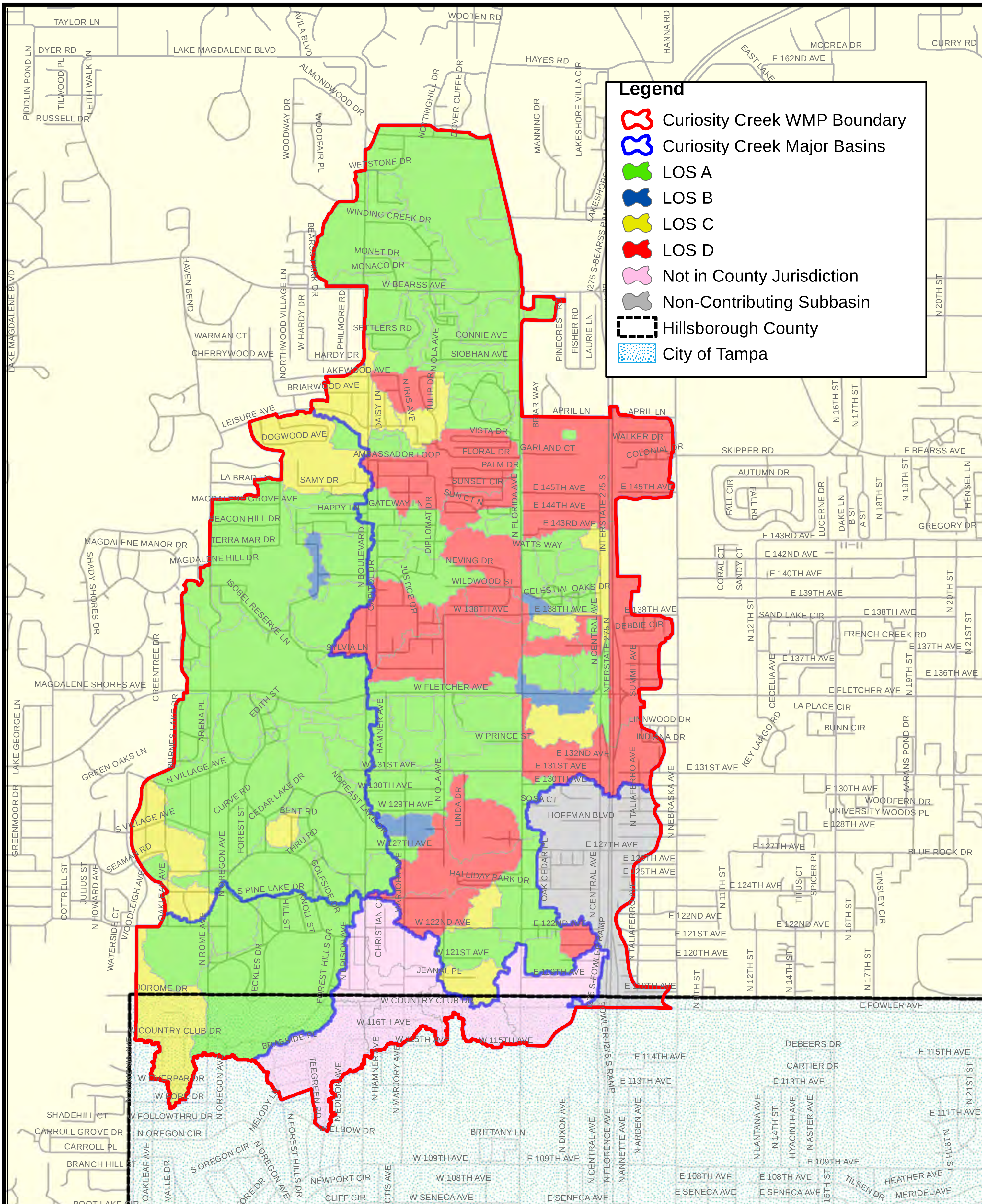
N

0 0.2 0.4
Miles

Figure 6-1
Curiosity Creek Watershed
Simulated 100-Year Floodplain

Hillsborough County Florida

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607



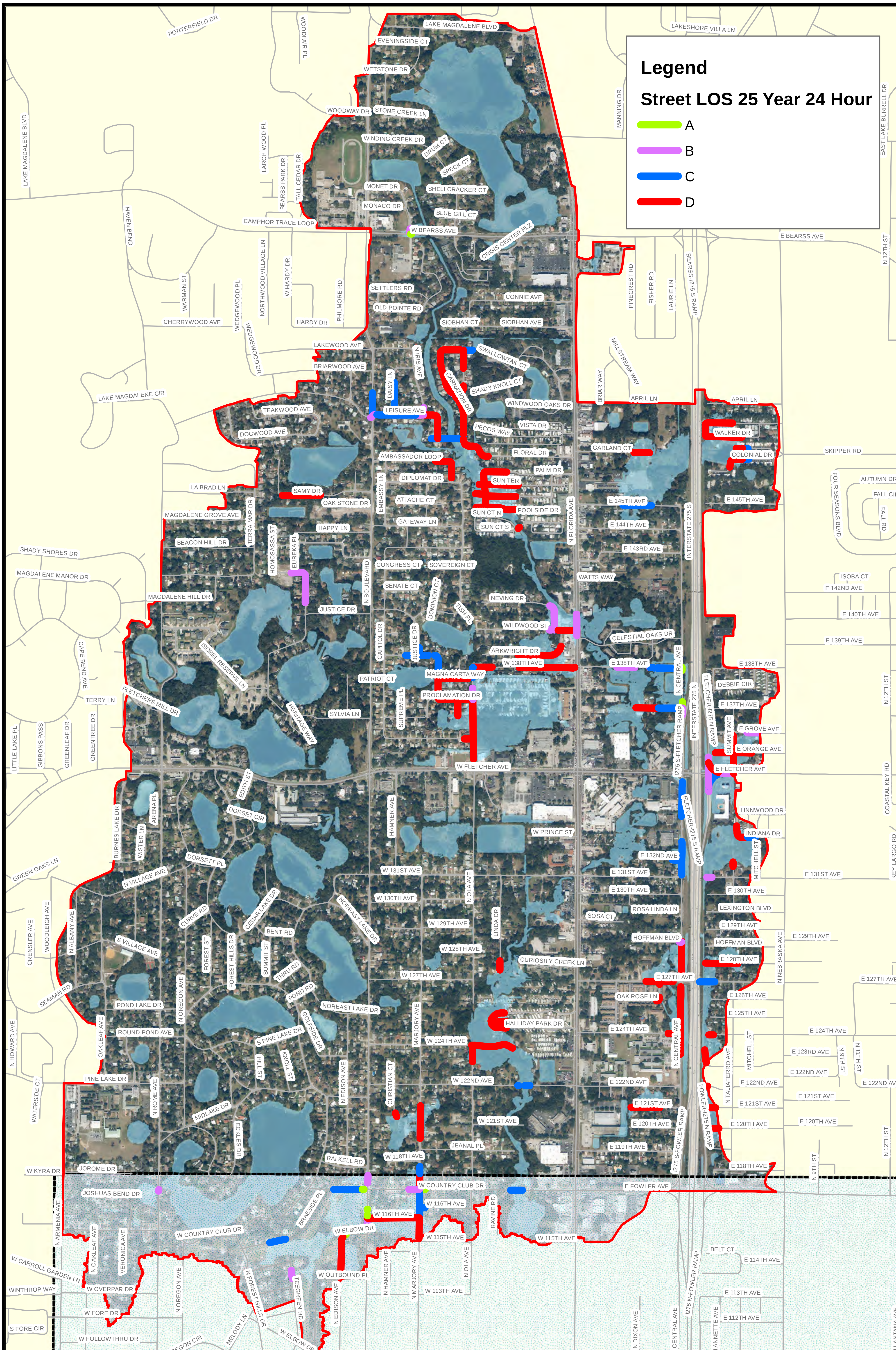
N

0 0.2 0.4
Miles

Figure 6-2
Curiosity Creek Watershed
Existing Conditions Level of Service

Hillsborough County Florida

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607



Legend

- Curiosity Creek WMP Boundary
- Roads
- Hillsborough County
- 25 Year 24 Hr Inundation

N

0 550 1,100
Feet

Figure 6-3
Curiosity Creek Watershed
Road Level of Service Map

Hillsborough County Florida

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607

CHAPTER 13 ALTERNATIVE ANALYSIS

This Chapter describes the series of Best Management Practices (BMP) that were developed as alternatives for flood control within the County portion of the Curiosity Creek watershed. Areas not meeting the desired LOS were described in Chapter 6 and the alternatives analysis has utilized the following approach:

- Review the flood areas of concern and flood control alternatives described in the 2000 update of the Curiosity Creek WMP;
- Identify flood control projects that have been fully or partially implemented since that time;
- Identify added or deleted flood areas now apparent due to increased model detail or changes in the conveyance system (i.e. pump station capacity or operational changes);
- Review flood complaint locations and specific issues compiled by Hillsborough County staff;
- Develop and test alternative pipe sizes, channel cross-sections, flow attenuation/storage facilities or control mechanisms sufficient to provide an LOS level of B or better using the SWMM5 model;
- Estimate costs associated with proposed improvements; and
- Prioritize proposed BMPs using the Hillsborough County prioritization matrix.

While the LOS Analysis evaluated flooding on a subbasin basis, the alternatives analysis has identified regions of flooding, or flooding areas of concern (FAC). **Figure 13-1** presents the FAC and identifies the major conveyance system affected:

- The Northwest Lake System
- The Curiosity Creek Main Channel
- The Forest Hills Basin

Alternatives to address LOS deficiencies were then developed for each problem area. These alternatives include structural and non-structural improvements, as well as maintenance needs that were identified during field observations. Alternatives described in this section are conceptual in nature and have not been optimized, although assumed configurations have been modeled. Proposed ponds may be relocated based on factors such as land availability, subsurface conditions or utility conflicts. Should any of these alternatives move forward for future implementation, additional site specific survey, utility and geotechnical investigation, permitting, and final design modeling will be required. Cost estimates were developed for each alternative and included in a matrix which ranked all of the alternatives.

All of the alternatives were developed within the following constraints: 1) the Curiosity Creek watershed is a closed system that does not have a free surface discharge but is controlled by the capacity of the COT pump station network, and 2) the Hillsborough County stormwater program is confined to projects which are for the protection of public roadways. The Statewide ERP regulatory program for projects within this watershed will be subject to the criteria for closed system, volume-sensitive basins. Alternatives must not cause an increase in the rate or volume of runoff that could adversely impact adjacent properties.

13.1 The Northwest Lake System BMP Evaluations

Three FACs were identified within the Northwest Lake System, listed below:

- FAC 1 represents Samy Drive road flooding associated with pond stages north of the roadway
- FAC 13 represents potential yard flooding adjacent to Round Pond with a roadway LOS designation of A (no BMPs will be evaluated)
- FAC 14 represents potential yard flooding adjacent to Lake Sophia with a roadway LOS designation of A (no BMPs will be evaluated)
- FAC 15 represents potential yard flooding adjacent to an unnamed pond near Summit Street with a roadway LOS designation of A (no BMPs will be evaluated)

13.1.1 Samy Pond (Subbasin 562500) – FAC 1

Stormwater from Samy Drive is collected via inlets and directed to Samy Pond, a 7.2-acre water feature to the north with an estimated SHWT elevation of 45.0 feet. The existing pond outlet is a single 18-inch RCP with a control invert of 44.76 feet. The low road crown elevation for Samy Drive is approximately 46.5 feet which is inundated by the 25-year, 24-hour pond stage by almost eleven inches. Yards and structures are not at risk. According to simulations, lower level street inundation begins at the 5-year return frequency.

Potential BMP approaches included increasing the outfall pipe diameter, lowering the control elevation to create additional storage capacity in the existing pond, creating new storage connected to the basin, and raising the road elevation.

Increasing the outfall pipe diameter would be effective only if taken all the way to Curiosity Creek and would involve replacing a system that has already been upgraded as part of the Floral Drive Structure Rehabilitation Project (2005). Additionally, the increased flow to the creek will elevate downstream profiles unless conducted in coordination with proposed BMPs for FAC 2.

CUC-1A: Creating 2.35 acres of new storage east of North Boulevard and connecting the two ponds via a 19” x 30” ERCP will achieve LOS B at Samy Drive. The new pond is conceptualized to have a connection to the Floral Drive Rehabilitation Project’s storm sewer system. Property would need to be acquired for this alternative. In addition to achieving the desired LOS for Samy Drive, this alternative also provides benefits for two road flooding areas within FAC 2, Leisure Avenue and North Boulevard, upgrading their status from LOS C to LOS B.

CUC-1B: Lowering the initial stage of Samy Pond by one foot (to 44.0 feet) results in a peak design stage of 46.84, lowered by 7 inches, which also meets the LOS B for Samy Drive. It would require pumping during the wet season to maintain the lowered pond stage. The continuous pumping of groundwater resources for stormwater management is not a concept consistent with State policies for water resource protection and is therefore not the preferred alternative.

CUC-1C: Raising the low road elevation by five inches, to a minimum elevation of 46.92 feet would achieve the desired LOS B without modifying the existing stormwater management system. The length of roadway below the target LOS elevation is approximately 250 linear feet, with up to six driveways impacted.

Recommendation – Due to its flood control benefit for two FACs and potential added water quality benefits, consider CUC-1A. Project components are detailed below and conceptual costs and benefits are summarized in the CUC-1A Fact Sheet, **Figure 13.1-1**.

1. Purchase property to construct a 2.35 acre detention area (conceptually TOB= 47 feet; Bottom=44 feet; pond side slopes 3H:1V)
2. Install 458 LF of new 19” x 30” ERCP (24-inch equiv.) from Samy Pond to the new detention area
3. Install 25 LF of new 19” x 30” ERCP between the new detention area and existing manhole (Node 552570) for the Floral Drive Rehabilitation Project outfall to Curiosity Creek

13.2 The Curiosity Creek Main Channel

Eleven FACs were identified within the Curiosity Creek Main Channel System, listed below:

- FAC 2 represents LOS C and D roadway flooding along Floral Drive, Carnation Drive, Lakewood Avenue, Leisure Avenue and North Boulevard
- FAC 3 represents LOS D roadway flooding of Ambassador Loop and possible structure flooding adjacent to Curiosity Creek in the same vicinity. FAC 3 also encompasses significant flooding of private roads and mobile home structures within Rose Lake Estates.

- FAC 4 represents the LOS D roadway flooding of Arkwright Drive with potential flooding of several residential structures; as well as the Tyrone Mobile Home Park flood prone area (private) and LOS D road flooding on W. 138th Avenue, N. Ola Avenue, and North Point subdivision roads (Constitution Drive, Proclamation Drive, Magna Carta Way and Candidate Place)
- FAC 5 represents LOS D roadway flooding of Wildwood Street east of Arkwright Drive at the N. Florida Avenue intersection, with potential flooding of residential and commercial structures.
- FAC 6 represents LOS D roadway flooding between Garland Court and E. 145th Avenue, east of Florida Avenue and west of Interstate 275. Several residential structures are also at risk of flooding.
- FAC 7 represents LOS C and D road flooding between E. 138th Avenue and E. 137th Avenue west of Central Avenue, with potential structure flooding.
- FAC 8 represents LOS C roadway flooding at E. 132nd Avenue and Central Avenue with one at risk structure west of Interstate 275. East of the interstate there is private road flooding with structures potentially at risk along Mitchell Street and Arizona Avenue.
- FAC 9 represents LOS D road flooding along E. 121st Avenue with potential structure flooding for low properties north of E. 121st Avenue.
- FAC 10 represents LOS C flooding of a 35-foot stretch W. 122nd Avenue. As the inundation depth is only one inch above the LOS B criteria, it is considered a lower priority.
- FAC 11 represents LOS C road flooding of Country Club Drive at the City of Tampa municipal boundary. The City of Tampa has indicated that this FAC is considered a low priority.
- FAC 16 represents flooding of private roads and mobile home structures within Halliday Park and one single family residential structure south of Halliday Park, adjacent to the creek. Because public roadways are not impacted by the flooding in this region, BMP analysis has not been conducted.

13.2.1 Floral Drive/Carnation Drive/Leisure Avenue (Subbasins 552580, 552590, 552600, 552650, 552500) – FAC 2 and Ambassador Loop/ Rose Lake Estates MHP (Subbasins 552400, 552500) – FAC 3

Stormwater runoff from residential areas on either side of Curiosity Creek north of Floral Drive is primarily conveyed through 18-inch and 24-inch pipes to the main channel. Significant street flooding is simulated along Floral Drive near the undersized creek crossing, and on Carnation Drive, Leisure Avenue and North Boulevard, despite the implementation of the 2005 Floral Drive Structure Rehabilitation Project consisting of a 36-inch HDPE stormwater outfall just south of the Floral Drive constriction. Lower level street flooding is simulated for the mean annual design event and low-lying homes and yards appear to be at risk for the 5-year return frequency.

Further downstream, 18-inch flood depths are simulated over Ambassador Loop and widespread private road, site and potential mobile home flooding are anticipated within Rose Lake Estates MHP for a 25-year, 24-hour event. Potential street, yard and mobile home flooding is simulated for even a mean annual, 24-hour event.

Potential BMP approaches to address flooding in these two areas included lowering the creek profile by increased pipe capacity for the Floral Drive crossing and Rose Lake Estates' Sun Valley Lane crossing, adding new storage to attenuate increased flows and mitigate flood damages, improving channel conveyance and increasing the 2005 Floral Drive Structure Rehabilitation system's conveyance capacity.

CUC-2A: This alternative relies on several components to meet the desired LOS B for FAC 2 and FAC 3 without creating downstream flooding impacts. Twin box culverts are proposed to replace existing pipes under Floral Drive and Sun Valley Lane to relieve flooding for Floral Drive, Ambassador Loop and Carnation Drive. Increased flows are attenuated by the proposed 4.5-acre detention facility on County lands located west of the main channel (immediately north of the Neving Drive residential area). Double 48-inch RCPs within Curiosity Creek just east of the County site are proposed for removal. Areas within Rose Lake Estates lying below elevation 46.15 feet, approximately 5.13 acres, cannot be protected and are therefore recommended to be purchased as flood damage mitigation and incorporated as a water quality BMP, creek enhancement or nature park area. Channel cross-section expansion is also recommended adjacent to this mobile home park to widen the channel bottom and cross-sectional area. This solution achieves LOS B for all roadways adjacent to the main channel and also provides a small benefit to FAC 4 Wildwood Avenue at Florida Ave (southbound). The low portion of Wildwood Avenue benefits by a designation upgrade from LOS D to LOS C. **Note:** This alternative relies on the implementation of CUC-1A to relieve flooding on Leisure Avenue and North Boulevard.

CUC-2B: This alternative incorporates all of the elements of Alternative 2A but addresses the Leisure Avenue and North Boulevard road flooding by upgrading the 2005 Floral Drive Structure Rehabilitation system's conveyance capacity, rather than relying on construction of the CUC-1A detention pond. Due to the increased flow to the main channel from the Floral Drive outfall upgrade, this alternative minimally exceeds the target LOS B level (by 0.4 inches) at Ambassador Loop.

Recommendation – Due to its flood control benefit for two FACs and potential added water quality benefits, consider CUC-2A. Project components are detailed below and conceptual costs and benefits are summarized in the CUC-2A Fact Sheet, **Figure 13.2-1.**

1. Implement the Alternative 1A 2.35-acre detention pond component
2. Purchase properties below 46.16 feet for creation of 5.13 acre creek/water quality enhancement area
    - Equip the enhancement area with an inflow diversion weir at the northern end (concept weir inv.=44.0 feet; L=10 feet)

- Provide an outfall weir at the southern end (concept weir inv.=44.0 feet; L=10 feet)

3. Construct 4.5 acre detention area on County-owned parcel U-01-28-18-OTD-000012-00002.0 (conceptually TOB=47 feet; Bottom=43.5 feet; bank slopes 4H:1V)
   - Equip the detention pond with an inflow diversion weir (concept weir inv.=42.0 feet; L=30 feet)
   - Provide an outfall weir to the main channel (concept weir inv.=42.75 feet; L=20 feet)
4. Remove 23 LF of twin 48-inch RCP within the channel east of the County property and restore the local creek cross-section
5. Replace twin 54-inch RCPs at Floral Drive with 38 LF twin 8-foot x 5-foot box culverts
6. Replace 23 LF multiple CMP crossing at Sun Valley Lane with twin 10-foot x 5-foot box culverts
7. Improve conveyance for 1,143 LF of Curiosity Creek channel between Floral Drive and Sun Valley Lane by expanding the left bank (east side) and bottom width by 8 feet.

13.2.2 Arkwright Drive (Subbasin 552100) and Tyrone Village MHP Flood Prone Area/ North Pointe (Subbasins 570500, 570600, 570700) – FAC 4

The FAC 4 area includes widespread flooding of Arkwright Drive and W. 138th Avenue associated with insufficient storage within a closed subbasin (552100). The subbasin's flood area includes severe site and possible structure flooding. FAC 4 comprises another closed subbasin (570500) east of N. Ola Avenue that is dominated by the Tyrone Village MHP, which eventually spills over into the N. Ola Avenue drainage system north of Fletcher Avenue. North Pointe subdivision areas west of N. Ola Avenue and between Lake Russel and Fletcher Avenue are served by stormwater ponds and Lakes Russell and Morris, with limited discharge capacity to the Ola Avenue storm sewer system which drains southward to a large detention facility at Ola Avenue and W. Prince Street. Simulated street, yard and potential structure flooding occur for the mean annual design event. Flood depths of 18 inches or more are simulated for the 25-year, 24-hour event over the N. Ola Avenue and North Pointe subdivision roadways and flood depths in excess of 3 feet are simulated over the low crown of Arkwright Drive.

Potential BMP approaches to address flooding in these two areas include creation of a regional detention/flood damage mitigation facility connecting the closed basins, provision of control structures for Lake Morris and Lake Russel to improve storage, and increasing the discharge capacity to and through the N. Ola Avenue storm sewer system.

CUC-4A: Purchase of the Tyrone Village MHP for flood damage mitigation as well as regional stormwater management, in addition to maximizing the storage capacity of existing North Pointe subdivision water features through provision of a protective berm (south of Lake Russel) and several new control structures will provide the desired LOS for all areas within FAC 4. Upgrading of the connecting storm sewer systems within North Pointe and N. Ola Avenue, as well as a new connection to the Arkwright Drive subbasin is also proposed. This alternative increases the peak 25-year stormwater level in the County's Ola Avenue-Prince Street pond by 0.5 feet (within TOB) without causing a rise in profile elsewhere in the system.

Recommendation – Due to its widespread flood control benefit and potential for added water quality benefits, consider CUC-4A. Project components are detailed below and conceptual costs and benefits are summarized in the CUC-4A Fact Sheet, **Figure 13.2-2**.

1. Purchase low-lying property for creation of 13 acres of floodplain mitigation and regional wet detention (conceptually TOB=43 feet; Bottom=36.0 feet; bank slopes 3H:1V) with potential for water quality benefits.
2. Construct a new inflow to the new detention facility from N. Ola Avenue using 40 LF of 34" x 53" ERCP (42-inch equiv.).
3. Construct an outfall structure from the new detention area (weir inv.= 37.5 feet; L=2.0 feet) with 675 LF new 24-inch RCP connection to Ola Avenue system at W. Fletcher Avenue.
4. Provide a new control structure (weir inv.=40.16 feet; L=15 feet) and 160 LF of new 24-inch RCP inflow from the Arkwright pond to the new detention facility.
5. Construct a protective berm at the southeast corner of Lake Russel with a minimum elevation of 45.0 feet.
6. Install a new control structure for Lake Russell (weir inv.=43.56 feet; L=15 feet) and 695 LF of 34" x 53" ERCP (90 feet new and 605 feet replacement) from Lake Russel, south along N. Ola Avenue to a new inflow to the proposed detention area.
7. Install a new control structure for Lake Morris (weir inv.=42.6 feet; L=19 feet) and 615 LF of new 36-inch RCP from Lake Morris to N. Ola Avenue.
8. Install a new control structure for the SMA west of Candidate Place (weir inv.=41.9 feet; L=19 feet) and 360 LF of 36-inch replacement RCP from the SMA to N. Ola Avenue.
9. Replace 1,120 LF of 18-inch RCP along N. Ola Avenue between Magna Carta Way and W. Fletcher Avenue with:
    - 390 LF of 29" x 45" ERCP (36-inch equiv.) flowing from the existing SMA outfall at N. Ola Avenue to the new detention area inflow from N. Ola Avenue
    - 730 LF of 24-inch RCP flowing south to the W. Fletcher Avenue junction

13.2.3 Wildwood Street at N. Florida Avenue (Subbasin 552160) – FAC 5

The FAC 5 area includes significant flood depths (>12 inches) for a short segment of low-lying Wildwood Street at the intersection with southbound N. Florida Avenue that is associated with main channel flood stages. The flood area includes site and possible commercial and residential structure flooding. Though the road segment experiencing severe flooding is a relatively short length, it is the only exit for residences along Neving Drive, Wildwood Street and Arkwright Drive. Lower level street flooding, as well as site and potential structure flooding is simulated from the 5-year return frequency upward.

Potential BMP approaches to address flooding in this area included increasing the capacity of a constricting downstream creek crossing and raising the road elevation. It is noted that Wildwood Street flooding is reduced from LOS D to LOS C levels by implementation of CUC-2A, described in section 13.2.1, but it is not relieved to a level considered safe for traffic flow.

CUC-5A: Lowering the Curiosity Creek profile to achieve LOS B at Wildwood Street was initially attempted through replacement of a constricting 8-foot x 4-foot box culvert crossing at the Oak Grove apartment complex entrance just downstream of the Florida Avenue crossing. The downstream impacts of increasing that driveway culvert's capacity were unacceptable due to a 0.24-foot rise for areas already experiencing LOS C and D site and structure flooding; and while lowering the flood depth at Wildwood Street, LOS B was still not achieved.

CUC-5B: Raising a 100-foot segment of the roadway to a minimum elevation of 44.8 feet would allow safe ingress and egress along Wildwood Street for the residential areas without adverse impacts to other areas. This alternative but will not address site and potential structure flooding risks.

Recommendation – Consider CUC-5B. Project components, conceptual costs and benefits are summarized in the CUC-5B Fact Sheet, **Figure 13.2-3**.

13.2.4 Garland Court and E. 145th Avenue (Subbasin 552050) – FAC 6

The FAC 6 is a closed subbasin that collects runoff within a 5-acre borrow pit located between the eastern terminus of Garland Court and Interstate 275. The borrow pit site is privately owned. A small county stormwater pond was constructed in 2001 to eliminate continued damages for a repetitive flood loss property and to add storage within the basin. As of May 2017, this pond was about to be expanded to the east onto an adjacent repetitive flood loss property.

Subbasin 552060 on the east side of Interstate 275 flows into this FAC via a 24-inch RCP pipe connected to a private residential stormwater management pond. Private roads and properties on the east side of the interstate also experience flooding but have not been evaluated for flood control solutions beyond residual benefits from the FAC 6 BMPs. Inadequate storage capacity within the borrow pit results in extensive site flooding and potential residential structure flooding for the design event. The roadway LOS designation is D for Garland Court and C for E. 145th Avenue. The absence of a gravity outfall results in very long street flooding durations. Lower level street and yard flooding is simulated for the mean annual design event, with potential flood risk to low-lying structures occurring for the 5-year return frequency.

Potential BMP approaches to address flooding included creation of a regional detention/flood damage mitigation facility and provision of a gravity outfall.

CUC-6A: Mitigate flood damages and increase basin storage capacity by expanding the borrow pit's retention area by an additional 5.6 acres. This alternative requires purchase of and/or easement acquisition on privately owned properties. The alternative performs well, bringing the LOS C and D designations to an LOS A for both Garland Court and E. 145th Avenue. The LOS designation of the connected subbasin 552060 is not altered.

CUC-6B: Modify the existing high connection (18-inch RCP) under April Lane to provide a formal outfall to the Cypress Creek watershed. Review of the latest Cypress Creek WMP update indicates that design flood stage in the receiving Cypress Creek watershed pond (Cypress Creek Node ID 505540) are higher than the peak stages within subbasin 552050. Alternative 6B is therefore not considered a viable alternative.

Recommendation – Consider CUC-6A. Project components are detailed below and conceptual costs and benefits are summarized in the CUC-6A Fact Sheet, **Figure 13.2-4**.

This alternative has potential water quality benefits in additional to its flood relief benefit.

1. Purchase five (5) flooding residential parcels at the east end of Garland Court for floodplain mitigation and a new 2.8-acre stormwater retention pond (conceptually TOB=48 feet; Bottom=41.0 feet; bank slopes 4H:1V).
2. Purchase or obtain easement for additional lands for a new 2.8-acre stormwater retention pond (conceptually TOB=48 feet; Bottom=41.0 feet; bank slopes 4H:1V).
3. Connect the new storage areas (totaling 5.6 acres) to the existing borrow pit via a weir (control inv.=43.0 feet; L=10 feet).

13.2.5 E. 137th Avenue and E. 138th Avenue near Central Avenue (Subbasins 551440, 551442, 551445 and 551962) – FAC 7

The FAC 7 is characterized by LOS C and LOS D level roadway flooding, as well as some site and potential structure flooding for the 25-year design event associated with the Curiosity Creek profile. Lower level roadway and yard flooding are simulated for the mean annual, 24-hour event.

Potential BMP approaches to address flooding included provision of additional floodplain storage, removal or upgrade of constricting channel crossings and channel cross-section improvements.

CUC-7A: Replace the existing 54-inch CMP creek crossing at E. 138th Avenue with a single 8-foot x 5-foot box culvert and create 1.75 acres of new storage downstream along Curiosity Creek (subbasin 51100) to attenuate the increased flow and reduce main channel flood stages. This alternative provides the desired LOS for E. 138th Avenue and Central Avenue as well as the eastern portion of E. 137th Avenue. It fails to improve the LOS D designation of the west end of E. 137th Avenue adjacent to Curiosity Creek.

The benefit of improving the creek cross-section through this area was tested but failed to solve the local problem without creating new flooding downstream. The final alternative tested, CUC-7B, mitigates flood damages through property acquisition.

CUC-7B: In addition to the CUC-7A improvements, purchase flooding properties east of Curiosity Creek on E. 137th Avenue and create a floodplain/creek enhancement area. The performance of this alternative, in terms of peak flood stages along the main channel is essentially the same as for CUC-7A. Its primary benefit is to reduce potential property damages associated with creek flooding.

Recommendation – Consider CUC-7A. Project components are detailed below and conceptual costs and benefits are summarized in the CUC-7A Fact Sheet, **Figure 13.2-5**.

This alternative has potential water quality benefits in additional to its flood relief benefit.

1. Replace 51 LF of 54-inch CMP under E. 138th Avenue at Curiosity Creek with an 8-foot x 5-foot box culvert.
2. Purchase property for a new 1.85-acre stormwater detention area (conceptually TOB=38.25 feet; Bottom=33.25 feet; bank slopes 3H:1V).
3. Remove the 20 LF of twin 30-inch CMP and wooden bridge crossing and restore the channel cross-section.
4. Connect the new storage area to the main channel using and inflow diversion weir (control inv.= 35.25 feet; L=10 feet) and outfall weir (control inv.=36.0 feet; L=10 feet).

13.2.6 E. 132nd Avenue and Central Avenue and N. Taliaferro Avenue (Subbasins 550900 and 551000) – FAC 8

The FAC 8 is characterized by LOS C roadway flooding on the west side of Interstate 275 (basin 550900) at the corner of Central Avenue and E. 132nd Avenue, with potential structure flooding for one residence during the 25-year design event. On the east side of Interstate 275 (basin 551000), N. Taliaferro Avenue is inundated by more than 12 inches at its northern terminus by the 25-year design event, and some low site and potential structure flooding is anticipated west of Mitchell Street for even the mean annual design event.

Because the issues east of Interstate 275 are associated with sites lying below public road grades and the existing stormwater pipe connection is located beneath the interstate right-of-way, potential BMPs focus on the west basin. The preferred approach was to increase the capacity of the existing gravity connection discharging to Curiosity Creek.

CUC-8A: Replace 810 LF of existing 30-inch equivalent ERCP with 34” x 53” ERCP (42-inch equiv.) from the intersection of Central and E. 132nd Avenues to Curiosity Creek.

Recommendation: Consider CUC-8A. Project components, conceptual costs and benefits are summarized in the CUC-8A Fact Sheet, **Figure 13.2-6**.

This BMP will achieve LOS A for the west basin of FAC 8 and does not alter the LOS D designation for the east basin, although peak flood stage is reduced by 1.3 inches. This alternative creates a 0.07-foot (0.8 inch) rise in creek profile at the upstream face of the N. Florida Avenue crossing without impacting its LOS A status.

13.2.7 E. 121st Avenue (Closed Subbasin 550175) – FAC 9

The FAC 9 is an internally drained subbasin underlain by well drained (HSG A) soils, but served only by a french drain (exfiltration) system beneath E. 121st Avenue west of N. Central Avenue. The capacity of the french drain system, while adequate for day to day rainfall, is insufficient to accommodate runoff from the 25-year design event. The design event inundates the roadway to a depth greater than 12 inches and also floods several residential sites with potential flood damages for structures. Lower levels of site, roadway and potential structure flooding are simulated for even the mean annual, 24-hour event.

Potential BMP approaches to address flooding included creation of local stormwater retention and provision of a new gravity outfall.

CUC-9A: Acquire property for siting a 1.24-acre stormwater management pond and connect the French drain system to the new pond as an overflow. Underlying soils are Candler fine sands (HSG A) and are expected to be able to infiltrate a significant volume of runoff. This alternative improves the LOS for E. 121st Avenue from level D to LOS A and also has potential water quality benefits for Curiosity Creek.

CUC-9B – Provide a new gravity storm sewer outfall from the west end of the existing trench drain system, north to 122nd Avenue and west to the manhole west of Florida Avenue (Junction 550405). This will connect to an existing 36-inch to 48-inch outfall to Curiosity Creek. This alternative improves the LOS for E. 121st Avenue from level D to the desired LOS B without negatively impacting downstream system performance. This alternative leaves two of the original five low-lying structures at potential risk of flood damages, although finished floor elevations are not known.

Recommendation – Consider Alternative 9B. Project components are described below and are summarized with conceptual costs and benefits in the CUC-9B Fact Sheet, **Figure 13.2-7**.

1. Connect the existing french drain system on E. 121st Avenue to the existing storm sewer system on 122nd Avenue west of Florida with a new gravity storm sewer using 1,185 LF of 19" x30" ERCP (24-inch equiv).

13.2.8 E. 122nd Avenue (Subbasin 550300) – FAC 10

The FAC 10 is concerned with an undesirable level of street flooding (LOS C) on W. 122nd Avenue for the 25-year design event associated with a constricting culvert crossing at this location. Low levels of simulated roadway inundation begin at the 5-year return frequency. The preferred BMP approach was to increase the capacity of the 122nd Avenue culvert crossing at Curiosity Creek in combination with increasing the culvert crossing capacity at W. Country Club Drive downstream, dependent on concurrence with the City of Tampa.

CUC-10A: Initial BMP simulations indicated that increasing the W. 122nd Avenue crossing to a twin 7-foot x 5-foot box culvert could achieve an LOS A designation at FAC10. The increased flow, however, created a 0.4-foot rise at W. Country Club Drive downstream, thus causing the FAC 11 LOS designation to drop from C to D. Therefore, upgrades at both locations were optimized to minimize downstream impacts.

Recommendation: Consider CUC-10A. Project components are detailed below and conceptual costs and benefits are summarized in the CUC-10A Fact Sheet, **Figure 13.2-8**.

This BMP will achieve LOS B for W. 122nd Avenue and decrease peak flood stage at the downstream crossing, Country Club Drive, by 3 inches. The Country Club Drive LOS will still be a C designation. The simulation indicates a very slight rise in peak stage at Blue Sink and the COT Curiosity Creek Detention Area, by 0.07 feet and 0.06 feet (0.84 and 0.72 inches), respectively.

1. Replace 33 LF of 60-inch RCP at W. 122nd Avenue with a single 7-foot x 5-foot box culvert.
2. Replace 40 LF of 78-inch RCP at Country Club Drive Connect with a single 8-foot x 6-foot box culvert.

13.2.9 Country Club Drive (Subbasin 550100) – FAC 11

The FAC 11 is located at the municipal boundary between City of Tampa and unincorporated Hillsborough County and just upstream of the creek terminus at Blue Sink. Simulated road inundation for the 25-year event indicates almost eleven inches of flooding over the low road crown. Low levels of simulated roadway inundation begin at the 10-year return frequency. The City of Tampa has indicated to the County that BMPs for this location would be a low priority.

Simulations were run to determine the magnitude of culvert upgrade required to meet an LOS B designation, with the following findings:

CUC-11A: Increasing the capacity of the Country Club Drive crossing of Curiosity Creek to a twin 7-foot x 5-foot box culvert will achieve the desired LOS B without causing downstream impacts. This culvert upgrade (alone) has no positive benefit for the W. 122nd Avenue flooding (FAC 10) upstream.

Recommendation: Do not consider Alternative 11A, as it provides no benefit to the County roadways and is not a priority for the City.

13.3 The Forest Hills Basin

One FAC was identified within the Forest Hills Basin, listed below:

- FAC 12 represents LOS C roadway flooding of N. Rome Avenue adjacent to Lake Eckles

13.3.1 Rome Avenue west of Lake Eckles (Subbasin 560900) – FAC 12

The FAC 12 represents overflow from a wetland depression on the west side of Rome Avenue, opposite from Lake Eckles. The wetland is equipped with an overflow control structure which has inadequate capacity for the 25-year design event, resulting in sheet flow over Rome Avenue at LOS C depths. Lower levels of sheet flow over Rome Avenue are simulated for even the mean annual, 24-hour event.

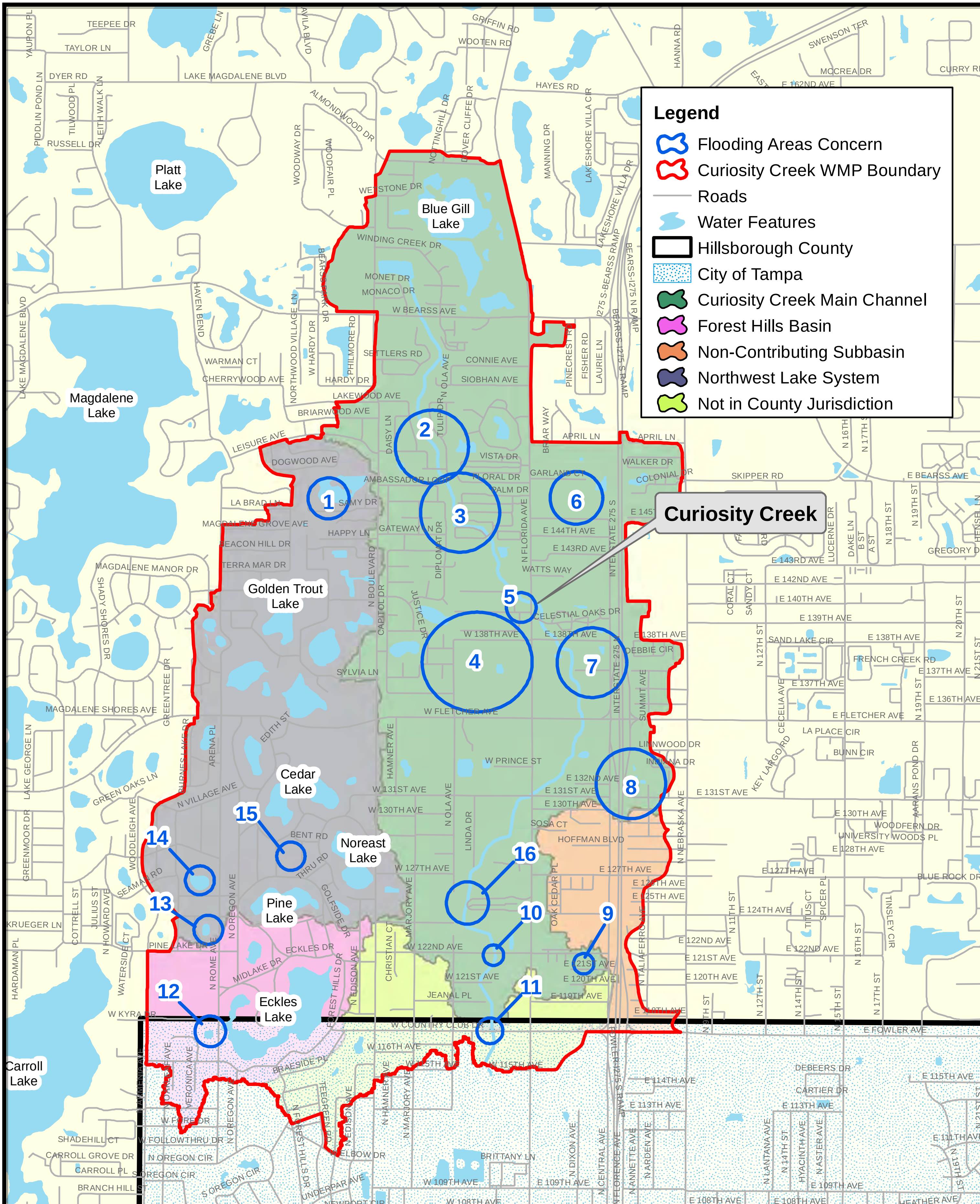
The preferred BMP approach was to address the street flooding by equipping the wetland with a replacement outfall structure and discharge pipe as follows:

CUC-12A: Eliminate the road flooding by increasing the control structure weir length and outfall pipe diameter.

Recommendation: Consider CUC-12A. Project components, conceptual costs and benefits are summarized in **Figure 13.3-1**.

The alternative performs well, bringing the LOS C designations to an LOS A for Rome Avenue without adversely impacting Lake Eckles peak design stage.

1. Replace the existing outfall structure with a control weir length of 4.0 feet and crest elevation of 33.77 feet with a new drop inlet structure (conceptually weir inv.= 33.77 feet; L=19 feet).
2. Replace the 24-inch RCP outfall to Lake Eckles with 68 LF of 38” x 60” ERCP (48-inch equiv.)



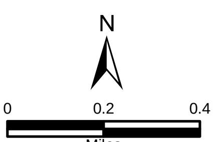
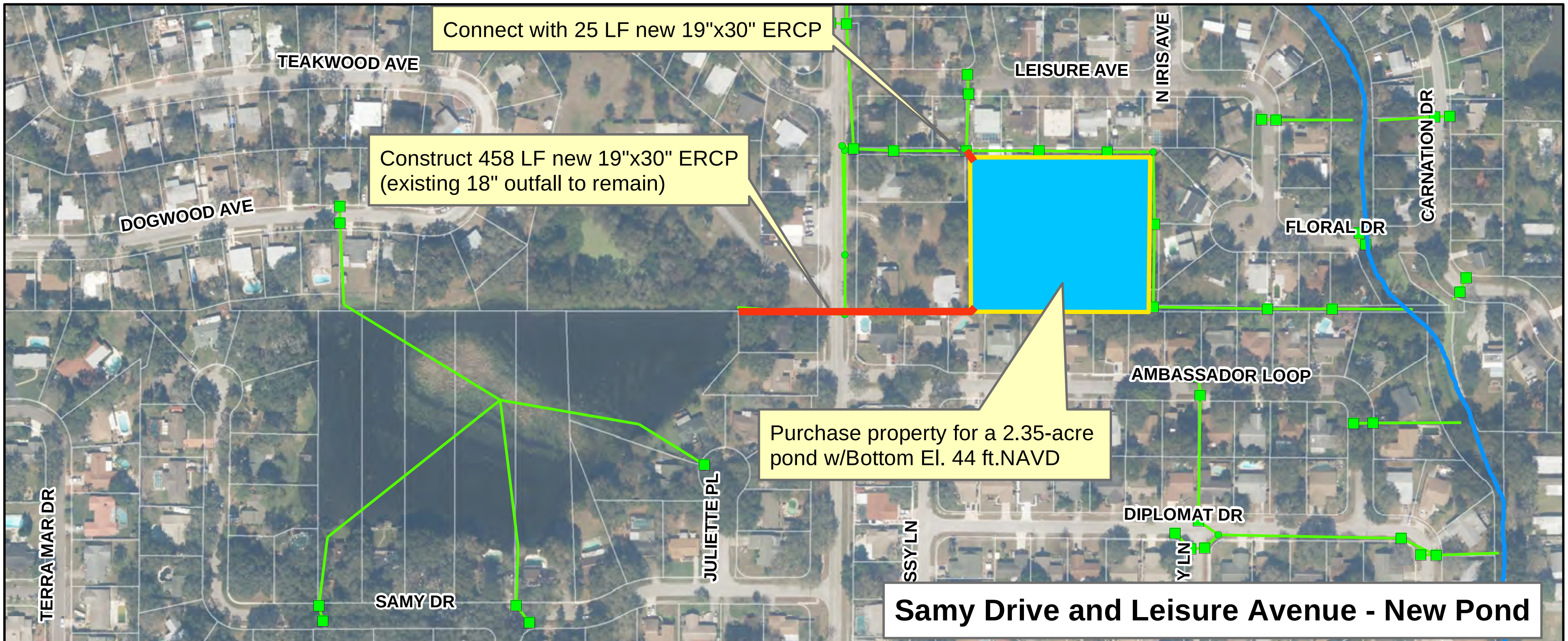


Figure 13-1
Curiosity Creek Watershed
Flooding Areas of Concern

Hillsborough County Florida

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607



Samy Drive and Leisure Avenue - New Pond

PROBLEM
Stormwater from Samy Drive is collected via inlets and directed to Samy Pond, a 7.2-acre water feature controlledby a single 18-inch RCP. Road inundation occurs for the 5-year frequency and above. The low crown elevation for Samy Drive is inundated by the 25-year, 24-hour pond stage by almost eleven inches.

PROJECT BENEFITS
This project achieves LOS B at Samy Drive for the 25-year, 24-hour event and may improve water quality. Connection of the new pond to the existing outfall system also improves the LOS for North Blvd and Leisure Ave from C to B.

SOLUTION
Provide an additional outlet from Samy Pond to a proposed 2.35-acre detention pond on open property to the east. Connect the new pond to the existing County outfall to Curiosity Creek.

COST

Construction & Contingency:	**$369,000**
Land Acquisition:	**$171,000**
Engineering:	**$111,000**
Total:	**$651,000**

Legend
- Curiosity Creek Channel
- Proposed Control Structure
- Proposed Pipe
- Proposed Pond
- Exist. Inlets
- Exist. Manholes
- Exist Pipes

N
0 75 150 300 Feet

Curiosity Creek Watershed Preferred Alternative CUC-1A Fact Sheet

Figure 13.1-1

Hillsborough County Florida

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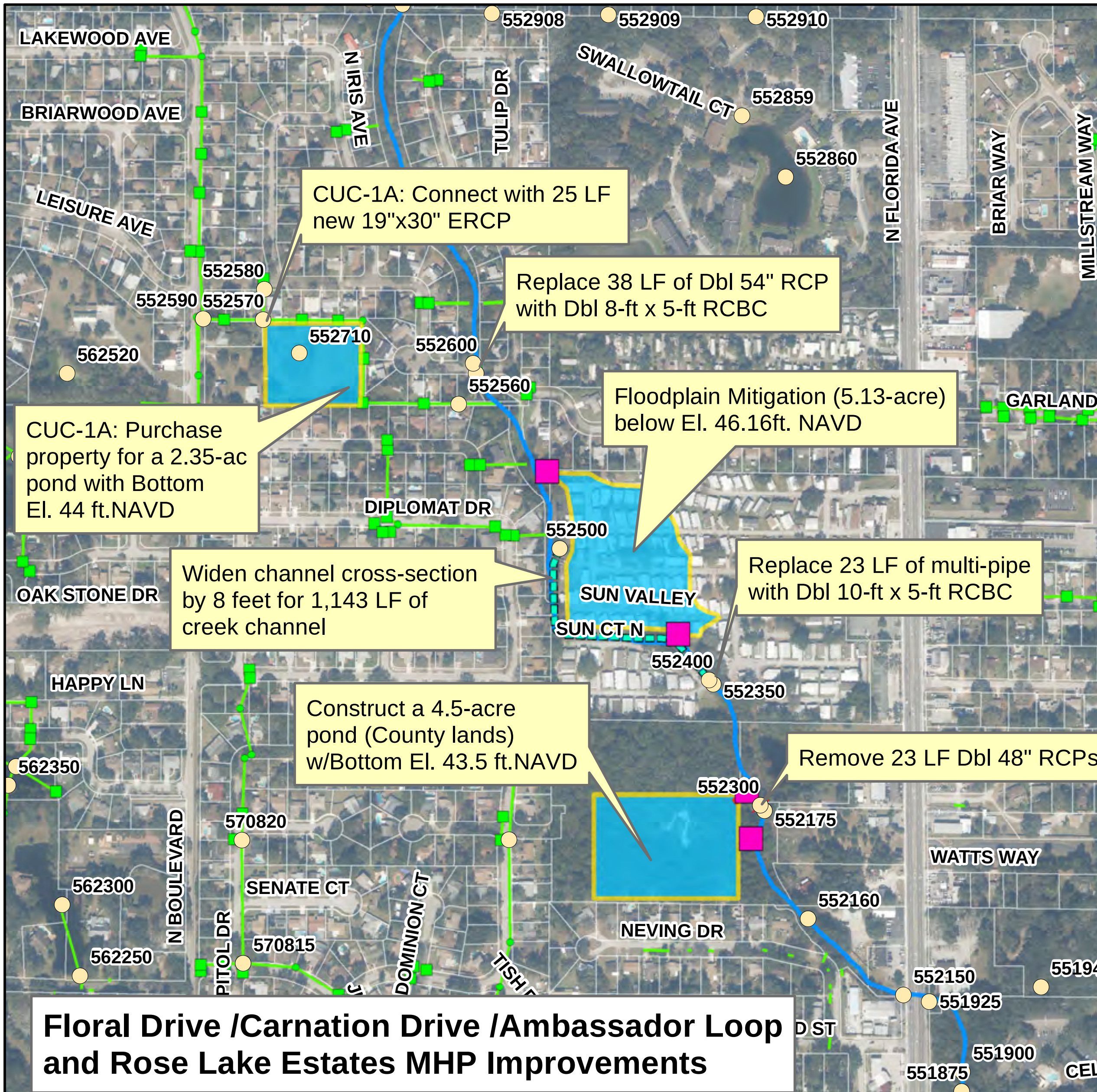
Suite 700
Tampa, FL 33607

Floral Drive /Carnation Drive /Ambassador Loop and Rose Lake Estates MHP Improvements



PROBLEM

Stormwater from residential areas from Floral Drive north to Lakewood Avenue adjacent to Curiosity Creek experience significant street flooding associated with creek stages, beginning with the mean annual event (FAC 2). Ambassador Loop to the south and Rose Lake Estates MHP sites and roadways (FAC 3) are also subject to street site and structure flooding for a mean annual event and flood depths of 18+ inch for a 25-yr, 24-hr event.

SOLUTION

Lower the creek profile by (1) replacing constricting channel crossings at Floral Drive and Sun Valley Lane; (2) Remove a dbl 48" pipe crossing and restore the channel (3) provide 6.85 acres of new detention to attentuate increased flows; (4) widen the creek channel adjacent to Rose Lake Estates; and (4) create a 5.13-acre floodplain mitigation area by purchasing lowlying properties at high flood risk.

PROJECT BENEFITS

This project improves LOS C and D roadways to LOS B throughout both FAC 2 and FAC 3 and also removes many "at risk" structures from the floodplain. The new detention ponds may improve water quality in the creek and/or function as park areas.

COST

Construction & Contingency:	$1,240,000
Land Acquisition:	$5,207,000
Engineering:	$372,000
Total:	$6,819,000

Legend

- SWMM Node
- Proposed Weir Structures
- Channel Improvement
- Proposed Pipe
- Pipe Removal
- Proposed Pond
- Curiosity Creek Channel
- Exist. Inlets
- Exist. Manholes
- Exist Pipes

N

0 155 310 620 Feet

Curiosity Creek Watershed
Preferred Alternative
CUC-2A Fact Sheet

Figure 13.2-1

Hillsborough County Florida

URS
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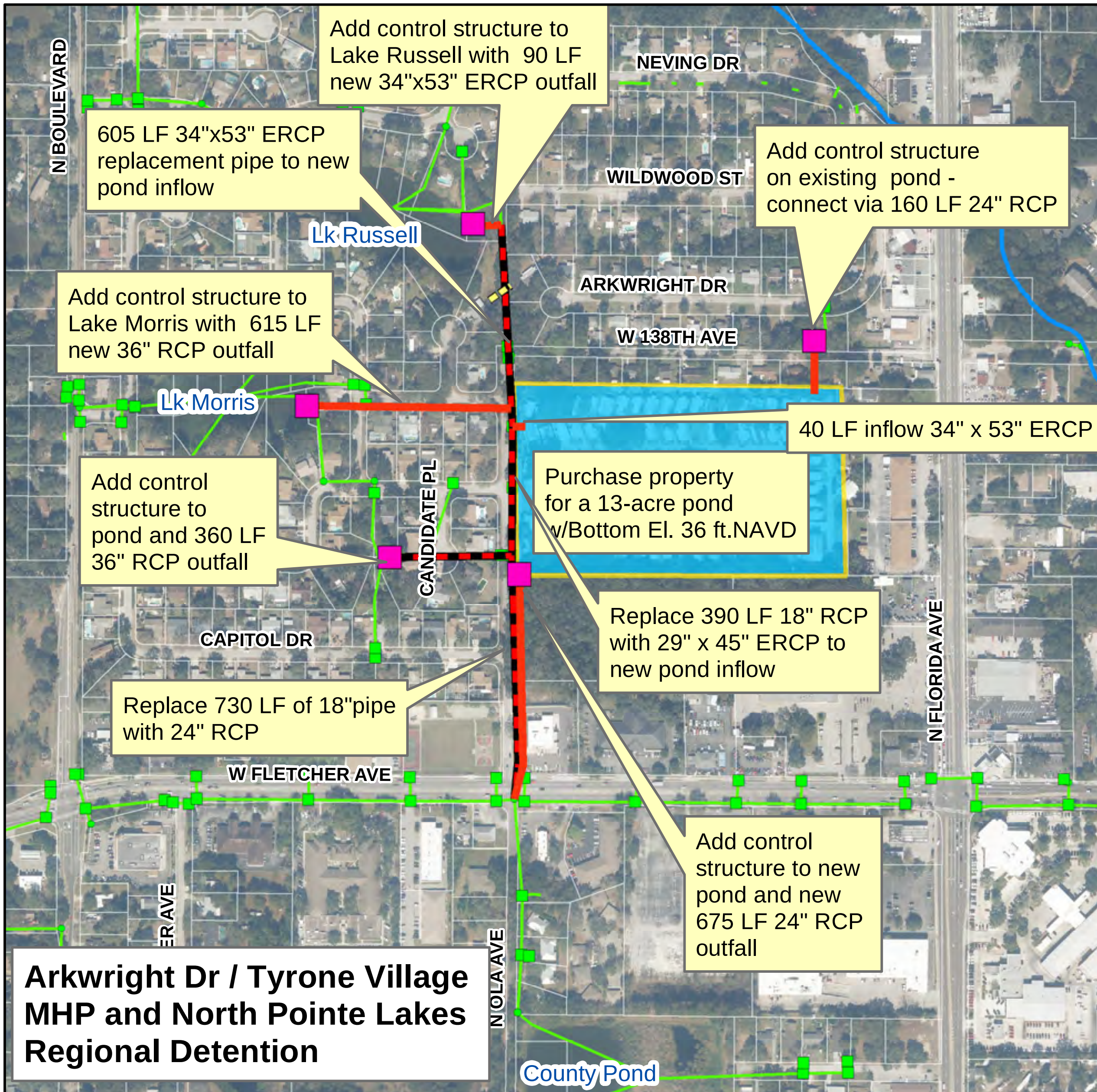
Suite 700
Tampa, FL 33607

Arkwright Dr / Tyrone Village MHP and North Pointe Lakes Regional Detention



PROBLEM

Limited storage capacity and either no positive outlet (Arkwright) or limited outflow capacity (Ola Ave) contribute to flooded streets, yards and structures south of Arkwright Drive, along N. Ola Avenue, within Tyrone MHP and for several North Pointe subdivision streets. Flooding occurs for the mean annual event and exceeds 12 inch depths (LOS D) for the 25-yr, 24-hr event.

SOLUTION

Provide a poitive outfall for the Arkwright pond Construct a regional flood detention facility over low-lying property and maximize storage within existing North Pointe subdivision waterbodies by installing control structures with upgraded outlet pipes.

Note: This solution increases 25-year flood stage in the County's Ola Ave-Prince St. pond without exceeding TOB.

PROJECT BENEFITS

This project improves LOS C and D roadways to LOS B throughout FAC 4, eliminates site flooding and also removes "at risk" structures from the floodplain. The new detention pond may offer water quality benefits.

COST

Construction & Contingency:	**$2,438,000**
Land Acquisition:	**$2,201,000**
Engineering:	**$731,000**
Total:	**$5,370,000**

Legend

- Proposed Control Structure
- BERM
- NEW PIPE
- REPLACE PIPE
- Proposed Pond
- Curiosity Creek Channel
- Exist. Inlets
- Exist. Manholes
- Exist Pipes

N

0 125 250 500 Feet

Curiosity Creek Watershed
Preferred Alternative
CUC-4A Fact Sheet

Figure 13.2-2

Hillsborough County Florida

URS

7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607

Wildwood Street at N. Florida Avenue - Raise Road

PROBLEM
Stormwater from Wildwood Street drains to Curiosity Creek via Neving Drive. 25-year flood depths >12 inches occur for a short segment of Wildwood Street at the intersection with southbound N. Florida Avenue associated with main channel flood stages. Commercial site flooding occurs for a mean annual event and the road floods for the 5-year event. Though the road segment experiencing severe flooding is relatively short, it is the only exit for residences along Neving Dr., Wildwood St. and Arkwright Dr.

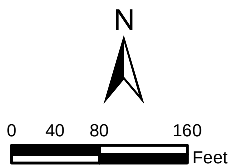
SOLUTION
Raise a 100-foot segment of Wildwood Street to a minimum elevation of 44.8 ft. NAVD

PROJECT BENEFITS
Raising the road grade will allow safe ingress and egress along Wildwood Street for the residential areas without adverse impacts to other areas and provide LOS B for the street. This alternative will not address site and potential structure flooding risks.

COST

Construction & Contingency:	**$24,000**
Land Acquisition:	**$0**
Engineering:	**$7,000**
Total:	**$31,000**

Legend
- Curiosity Creek Channel
- Raise Road
- Exist. Inlets
- Exist. Manholes
- Exist Pipes



Curiosity Creek Watershed
Preferred Alternative
CUC-5B Fact Sheet

Figure 13.2-3

Hillsborough County Florida

URS
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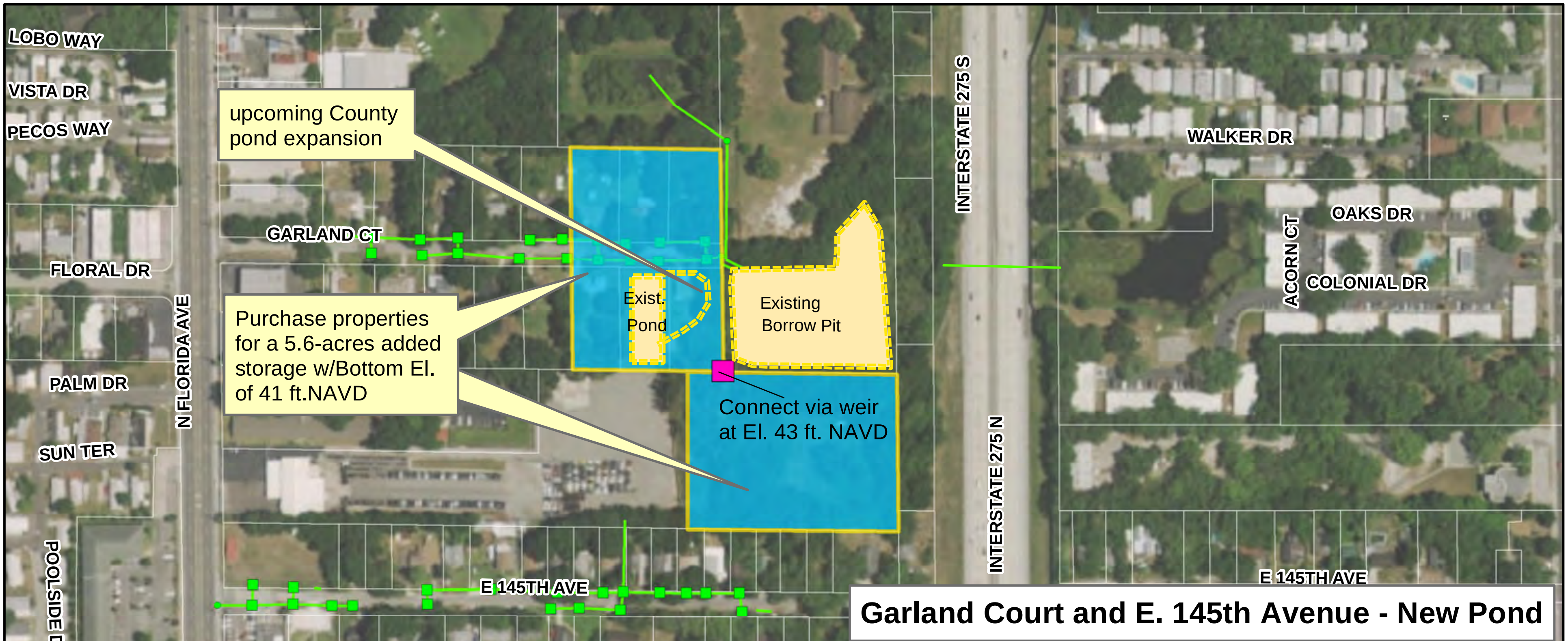
Suite 700
Tampa, FL 33607



Garland Court and E. 145th Avenue - New Pond

PROBLEM
This area is a closed subbasin that collects runoff within a 5-acre borrow pit located between the eastern terminus of Garland Court and Interstate 275. Inadequate storage capacity within the borrow pit results in street flooding for a mean annual event and extensive site flooding and potential structure flooding for the design event. The roadway LOS designation is D for Garland Court and C for E. 145th Avenue. The absence of a gravity outfall results in very long street flooding durations.

SOLUTION
A small county stormwater pond constructed in 2001 is about to be expanded eastward on the adjacent repetitive flood property. To achieve the desired LOS, purchase 5.6 total acres for flood damage mitigation and regional storage. Connect the new pond(s) to the existing borrow pit by control structure(s).

PROJECT BENEFITS
This project achieves LOS A for Garland Court and 145th Avenue for the 25-year, 24-hour event and may be used for water quality enhancement or park area. Private properties flooding on the east side of I-275 do not benefit from this project due to a constricting pipe connection under the I-275 ROW.

COST

Construction & Contingency:	**$560,000**
Land Acquisition:	**$512,000**
Engineering:	**$168,000**
Total:	**$1,240,000**

Legend
- Curiosity Creek Channel
- Proposed Control Structure
- Proposed Pond
- Exist. Inlets
- Exist. Manholes
- Exist Pipes

N

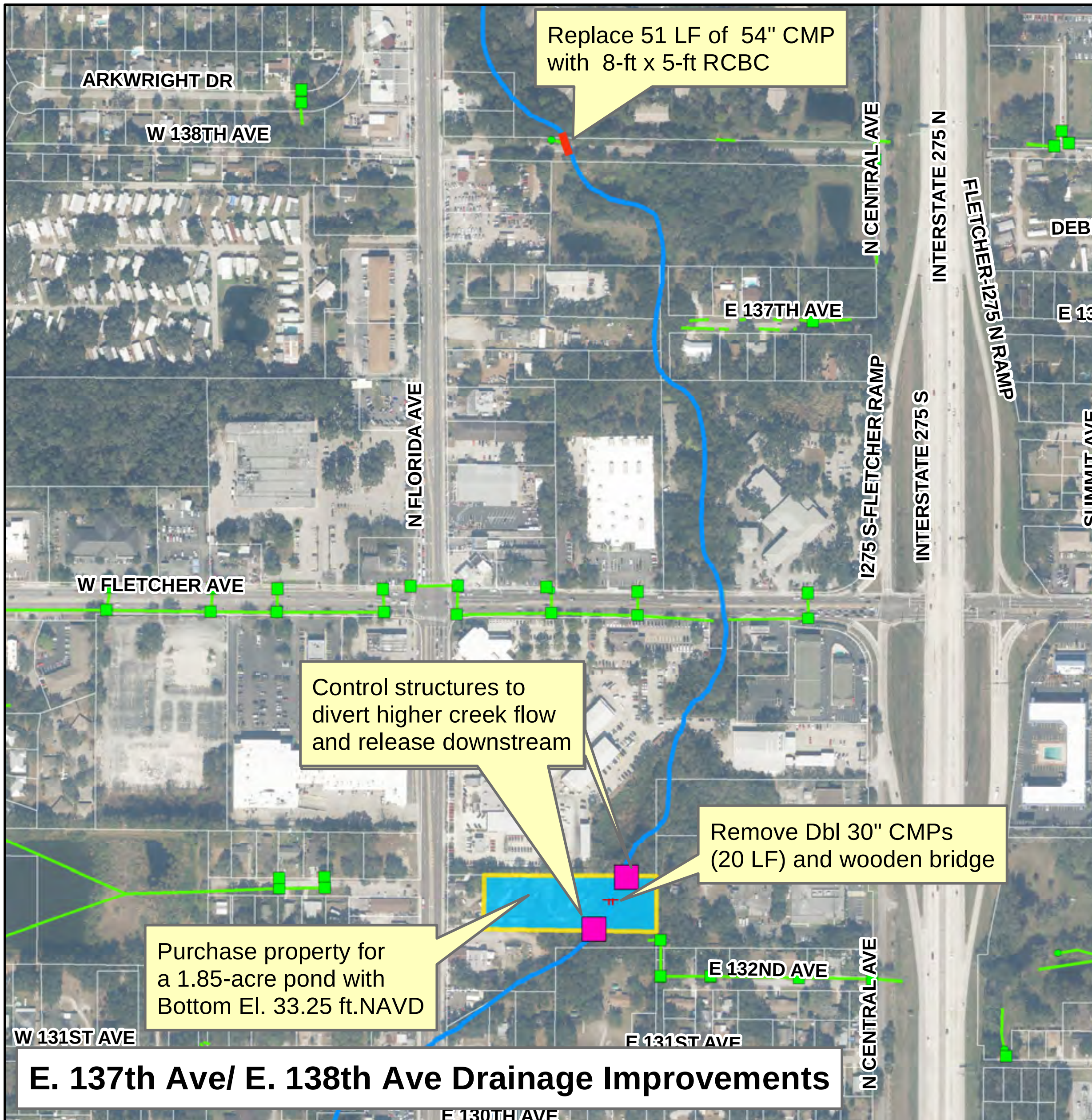
0 75 150 300 Feet

Curiosity Creek Watershed
Preferred Alternative
CUC-6A Fact Sheet

Figure 13.2-4

Hillsborough County Florida

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607



E. 137th Ave/ E. 138th Ave Drainage Improvements

PROBLEM

Stormwater from residential areas along E. 137th Avenue and E. 138th Avenue west of Central Avenue experience significant street flooding associated with creek stages, beginning with the 5-year event. Structures are potentially at risk for the 10-year event. The west end of E. 137th Avenue near the creek has an LOS D with >12 inch depth over the crown. The east portion of E. 137th Avenue and E. 138th Avenue have an LOS C for the 25-yr event.

SOLUTION

Lower the creek profile by replacing the 54" CMP at E. 138th Avenue with a single 8-ft x 5-ft RCBC. Attenuate increased flows by adding a new 1.85-acre detention facility and remove a constricting wooden bridge with twin 30" CMPs.

PROJECT BENEFITS

This project improves LOS C roadway flooding to LOS B throughout the FAC with the exception of the west end of E. 137th Avenue. This low-lying segment remains at LOS D and adjacent homes are at risk of flood damage. The new detention pond has potential for adding a water quality benefit and may function as a small park area.

COST

Construction & Contingency:	**$301,000**
Land Acquisition:	**$502,000**
Engineering:	**$90,000**
Total:	**$893,000**

Legend

- Proposed Control Structure
- Proposed Pipe
- Pipe Removal
- Proposed Pond
- Curiosity Creek Channel
- Exist. Inlets
- Exist. Manholes
- Exist Pipes

N

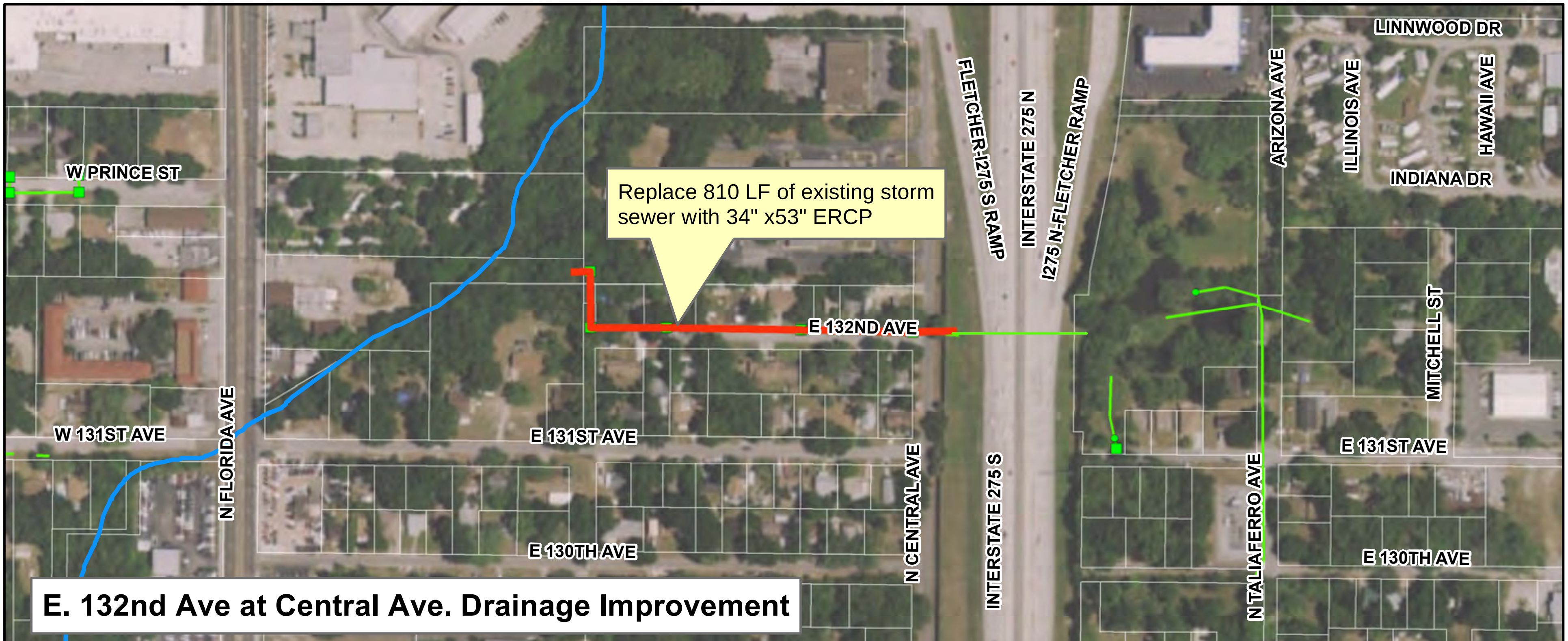
0 125 250 500 Feet

Curiosity Creek Watershed
Preferred Alternative
CUC-7A Fact Sheet

Figure 13.2-5

Hillsborough County Florida

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607



E. 132nd Ave at Central Ave. Drainage Improvement

PROBLEM
Private roadway, site and potential structure flooding may occur east of I-275 near Mitchell Street for a mean annual event. Simulated road flooding west of I-275 at the corner of Central Avenue and E. 132nd Avenue begins at the 5-year event and increases to an LOS C level for the design event, due to inadequate capacity in the existing storm sewer system. One structure west of I-275 may be at flood risk for the 25-year, 24-hour event.

PROJECT BENEFITS
This project achieves LOS A for E. 132nd Avenue and Central Avenue and removes the flood risk to the adjacent home. Flood levels east of I-275 are reduced by only 1.3 inches and remain LOS D for the low-lying private roads, yards and homes.

SOLUTION
Replace 810 LF of existing 30-inch equivalent ERCP with 34" x 53" ERCP (42-inch equiv) from the intersection of Central and E. 132nd Avenues to Curiosity Creek.

COST

Construction & Contingency:	**$427,000**
Land Acquisition:	**$0**
Engineering:	**$128,000**
Total:	**$555,000**

Legend
- Curiosity Creek Channel
- Proposed Control Structure
- Proposed Pipe
- Proposed Pond
- Exist. Inlets
- Exist. Manholes
- Exist Pipes

N

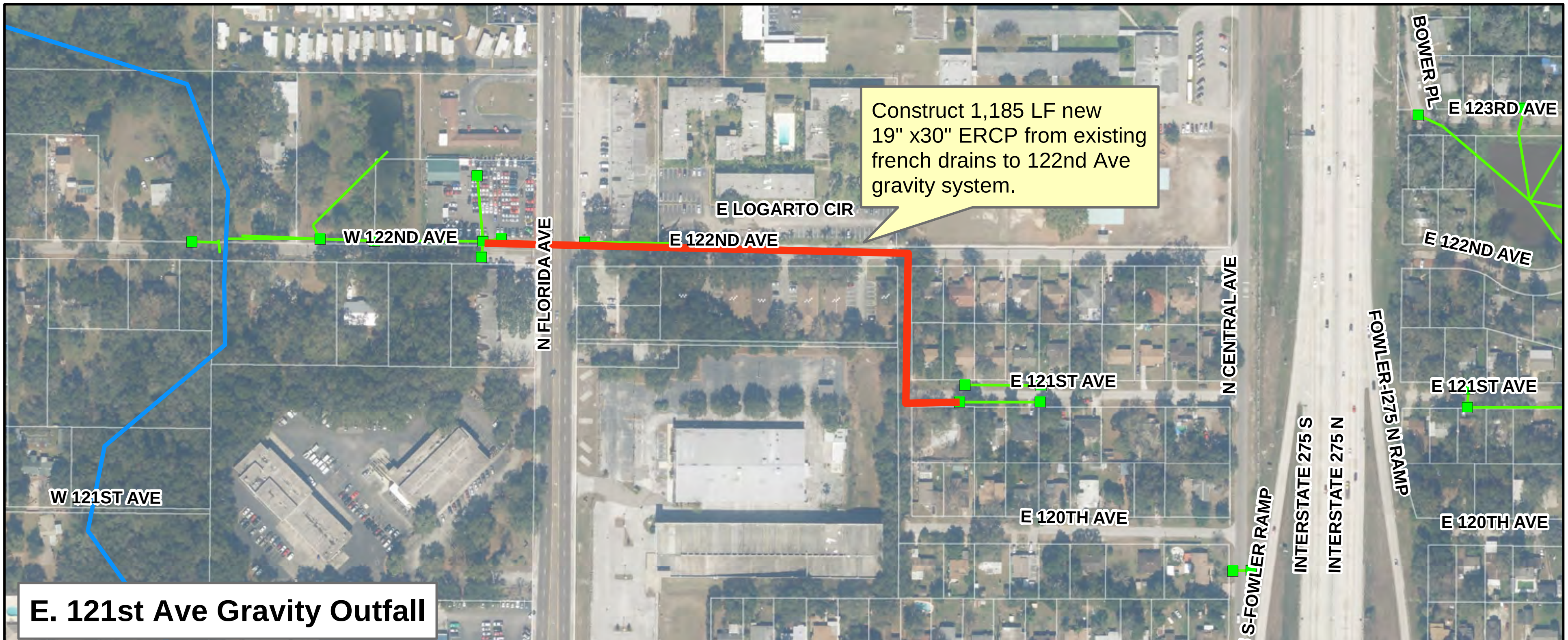
0 75 150 300 Feet

Curiosity Creek Watershed
Preferred Alternative
CUC-8A Fact Sheet

Figure 13.2-6

Hillsborough County Florida
EST 1834

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607



E. 121st Ave Gravity Outfall

PROBLEM
The area of E. 120th Avenue and E. 121st Ave west of Central Avenue is internally drained and served only by a french drain (exfiltration) system beneath E. 121st Avenue. The capacity of the french drain system, while adequate for small rainfall events, is insufficient to keep roads dry for even a mean annual 24-hour event, and cannot meet LOS B for the 25-year design event. The design event inundates the roadway to a depth >12 inches and also floods residential sites with potential flood damages for several structures.

SOLUTION
Provide a positive gravity outfall to Curiosity Creek by connecting the existing french drain in E. 121st Avenue to the W. 122nd Avenue storm sewer with 19" x 30" ERCP.

PROJECT BENEFITS
This project improves the flood level for E. 121st Avenue from LOS D to the desired LOS B without negatively impacting downstream system performance. The peak stage is lowered by 1 foot, however there are still two low-lying structures potentially at risk. Note: finished floor elevations are not known.

COST

Construction & Contingency:	**$206,000**
Land Acquisition:	**$0**
Engineering:	**$62,000**
Total:	**$268,000**

Legend
- Curiosity Creek Channel
- Proposed Pipe
- Exist. Inlets
- Exist. Manholes
- Exist Pipes

N

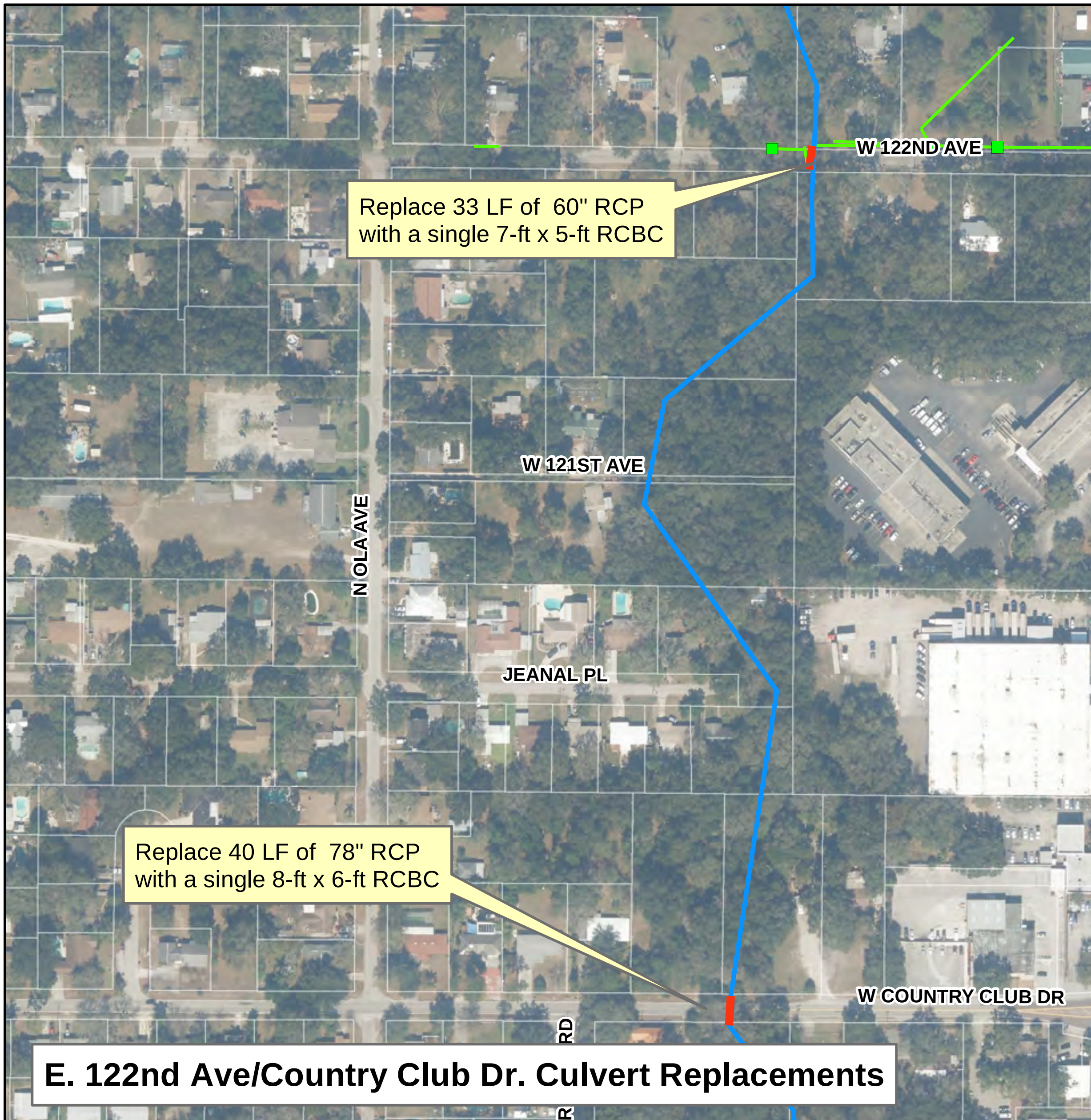
0 75 150 300 Feet

Curiosity Creek Watershed
Preferred Alternative
CUC-9B Fact Sheet

Figure 13.2-7

Hillsborough County Florida

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607



PROBLEM
An undesirable level of street flooding (LOS C) occurs on W. 122nd Avenue for the 25-year design event, associated with a constricting culvert crossing at this location. Minor road flooding and yard flooding is simulated from the 5-year design event upwards.

SOLUTION
Lower the creek profile by replacing the 60" RCP at W. 122nd Avenue with a single 7-ft x 5-ft RCBC, and replacing the 78" RCP at W. Country Club Drive with a single 8-ft x 6-ft RCBC. COT concurrence will be required.

PROJECT BENEFITS
This BMP will achieve LOS B for W. 122nd Avenue and decrease peak flood stage at Country Club Drive by 3 inches. The Country Club Drive road flooding will still be an LOS C. The simulation indicates a very slight rise in peak stage at Blue Sink and the COT Curiosity Creek Detention Area (0.84 and 0.72 inches, respectively).

COST

Construction & Contingency:	$195,000
Land Acquisition:	$0
Engineering:	$59,000
Total:	$254,000

Legend
- Proposed Pipe
- Curiosity Creek Channel
- Exist. Inlets
- Exist. Manholes
- Exist Pipes

N
0 90 180 360 Feet

Curiosity Creek Watershed
Preferred Alternative
CUC-10A Fact Sheet

Figure 13.2-8

Hillsborough County Florida

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607

PROBLEM
Overflow from a wetland depression on the west side of Rome Avenue opposite from Lake Eckles, is simulated for the mean annual design event. The wetland is equipped with an overflow control structure which has inadequate capacity and results in sheet flow over Rome Avenue at LOS C depths for the design event.

SOLUTION
Eliminate the road flooding by increasing the control structure weir length and increasing the outfall pipe diameter.

PROJECT BENEFITS
This BMP will achieve LOS A for N. Rome Avenue and retain the 25-year event on site.

COST

Construction & Contingency:	**$73,000**
Land Acquisition:	**$0**
Engineering:	**$22,000**
Total:	**$95,000**

Joshua Bend Wetland Control Structure Modification

Legend
- Proposed Control Structure
- Proposed Pipe
- Curiosity Creek Channel
- Exist. Inlets
- Exist. Manholes
- Exist Pipes

N

0 35 70 140 Feet

Curiosity Creek Watershed
Preferred Alternative
CUC-12A Fact Sheet

Figure 13.3-1

Hillsborough County Florida

URS
7650 W. Courtney Campbell Cswy
Suite 700
Tampa, FL 33607

CHAPTER 15 RECOMMENDATIONS

This Chapter describes the ranking methodology and results for the recommended alternatives for flood control described in Chapter 13.

15.1 Flood Control Project Ranking Methodology

The ranking methodology utilizes an evaluation matrix developed by Hillsborough County to facilitate the logical implementation order (phasing) of proposed capital improvement projects to address LOS deficiencies. The Capital Improvements Program (CIP) Evaluation Matrix utilizes a point system to quantify project benefits with respect to, a) consequences of continued flooding, and b) frequency of flooding. Flooding consequences are differentiated by type under the following categories:

- Arterial Road
- Local Street
- Home
- Yard
- Increased Hazard (special characteristics that may impact public safety)

Flooding frequency point values are multiplied by the flooding type value such that roads, yards and structures which flood more frequently will have a higher frequency multiplier than those which flood rarely. An additive point value (10 points per year) is also assigned to flood areas with a long history of chronic flooding.

Other problems associated with a project site such as erosion/siltation, high groundwater table, maintenance issues, or system structural failures are also accounted for by an assigned point value in the matrix. The total point value assigned to the consequences of not correcting the problem is considered the project benefit. Project benefits can then be compared with estimated project costs to determine a Benefit to Cost (B/C) ratio by dividing the Evaluation Matrix point total by the estimated construction cost for each project. The resulting ratio is then used to rank the projects in order to aid the County's CIP decision making process.

15.2 Ranking Results

Table 15.1 summarizes the CIP Evaluation Matrix scores for each recommended project. Projects are ranked in this table by flood problem severity. A CIP Evaluation score, or benefit score, was tabulated for each FAC. The table includes the corresponding CIP Project ID and associated FAC number. The raw CIP evaluation sheets are included in **Appendix A**. In computing Benefit to Cost ratio, the total score for all FACs corrected by a CIP are divided by the estimated cost.

Table 15.1 CIP Evaluation Score (Benefit Score) Ranking

Rank	ID Number	FAC #: Project Name	Major Basin	Benefit Score
1	CUC-2A	FAC 3: Ambassador Loop and Rose Lake Estates MHP Improvements	Curiosity Creek Main Channel	286
	CUC-2A	FAC 2: Floral Drive/Carnation Drive/Leisure Avenue Improvements	Curiosity Creek Main Channel	186
			Total	472
2	CUC-4A	FAC 4: Arkwright Drive/Tyrone Village MHP/North Pointe Lakes Regional Detention	Curiosity Creek Main Channel	286
3	CUC-9B	FAC 9: E. 121st Avenue Gravity Outfall	Curiosity Creek Main Channel	266
4	CUC-8A	FAC 8: E. 132nd Avenue at Central Avenue Drainage Improvement	Curiosity Creek Main Channel	246
5	CUC-6A	FAC 6: Garland Court / E. 145th Avenue - New Pond	Curiosity Creek Main Channel	236
6	CUC-5B	FAC 5: Wildwood Street at N. Florida Avenue - Raise Road	Curiosity Creek Main Channel	213
7	CUC-7A	FAC 7: E. 137th Avenue / E. 138th Avenue Drainage Improvements	Curiosity Creek Main Channel	110
8	CUC-12A	FAC 12: Joshua Bend Wetland Control Structure Modification	Forest Hills Basins	76
9	CUC-10A	FAC 10: E. 122nd Avenue and Country Club Drive Culvert Replacements	Curiosity Creek Main Channel	72
10	CUC-1A	FAC 1: Samy Drive and Leisure Avenue– New Pond	Northwest Lake System	36
----	No Project	FAC 11: W. Country Club Drive	Curiosity Creek Main Channel	12

A total of ten (10) projects are recommended for implementation within the Curiosity Creek Watershed, to meet the County's desired LOS B target.

Recommended prioritization of CIP Projects, presented in **Table 15.2** has taken into account the probable cost for construction and the ratio of Benefit to Cost. The Engineer's Opinion of Probable Construction Cost analysis sheets are also provided in **Appendix A**.

Table 15.2 Capital Improvement Project Priority Ranking

Rank	ID Number	FAC #: Project Name	Major Basin	Benefit Score	Construction Cost ($1,000)	Benefit/Cost Ratio
1	CUC-5B	FAC 5: Wildwood Street at N. Florida Avenue - Raise Road	Curiosity Creek Main Channel	213	31	6.87
2	CUC-9B	FAC 9: E. 121st Avenue Gravity Outfall	Curiosity Creek Main Channel	266	268	0.99
3	CUC-12A	FAC 12: Joshua Bend Wetland Control Structure Modification	Forest Hills Basins	76	95	0.80
4	CUC-8A	FAC 8: E. 132nd Avenue at Central Avenue Drainage Improvement	Curiosity Creek Main Channel	246	555	0.44
5	CUC-10A	FAC 10: E. 122nd Avenue and Country Club Drive Culvert Replacements	Curiosity Creek Main Channel	72	254	0.28
6	CUC-6A	FAC 6: Garland Court / E. 145th Avenue - New Pond	Curiosity Creek Main Channel	236	1240	0.19
7	CUC-7A	FAC 7: E. 137th Avenue / E. 138th Avenue Drainage Improvements	Curiosity Creek Main Channel	110	893	0.12
8	CUC-2A	FAC 2: Floral Drive/Carnation Drive/ Ambassador Loop and Rose Lake Estates MHP Improvements	Curiosity Creek Main Channel	472	6819	0.07
9	CUC-1A	FAC 1: Samy Drive and Leisure Avenue– New Pond	Northwest Lake System	36	651	0.06
10	CUC-4A	FAC 4: Arkwright Drive/Tyrone Village MHP/North Pointe Lakes Regional Detention	Curiosity Creek Main Channel	286	5370	0.05

APPENDIX A
CIP Evaluation and Cost Analysis

STORMWATER MANAGEMENT C.I.P EVALUATION

PROJECT NAME: CUC-1A -Samy Drive and Leisure Avenue – New Pond		DESIGN COST:
DATE OF SITE VISIT:	ENGINEER:	R/W COST:
DATE OF EVALUATION:	CHECKED BY:	CONST. COST:
	DESIGN HOURS:	TOTAL COST EST.:

LOCATION: FAC 1 - At Samy Drive south of Samy Pond	PROJECT: CUC-1A- Samy Drive and Leisure Avenue – New Pond (see description in WMP report section 13.1.1 and Figure 13.1-1)
APPARENT SOLUTION: See description in WMP report section 13.1.1 and Figure 13.1-1	
COMMENTS:	

PROBLEM		CONSEQUENCES						
		INCREASED HAZARD	ARTERIAL ROAD FLOODING	LOCAL STREET FLOODING	HOME FLOODING	YARD FLOODING	INCREASE PTS/YEAR	TOTAL
	PTS	9	6	4	6	4	10	
FREQUENCY OF FLOOD HIGH (3-YR/24-HR) FLOODS DURING 3 OR LESS	10							
FREQUENCY OF FLOOD MEDIUM: (5-YR/24-HR)	6			24				24
FREQUENCY OF FLOOD LOW: (1O-YR/24-HR) OVER	3			12				12
INCREASE (YEARLY)								
EROSION/SILTATION	20							
HIGH GROUNDWATER TABLE	20							
MAINTENANCE PROBLEM	20							
STRUCTURAL FAILURE	80							
							GRAND TOTAL	36

STORMWATER MANAGEMENT C.I.P EVALUATION

PROJECT NAME: CUC- 2A - Floral Drive/Carnation Drive/Leisure Avenue Improvements		DESIGN COST:
DATE OF SITE VISIT:	ENGINEER:	R/W COST:
DATE OF EVALUATION:	CHECKED BY:	CONST. COST:
	DESIGN HOURS:	TOTAL COST EST.:

LOCATION: FAC 2 - Along Curiosity Creek between Lakewood Avenue and Floral Drive

APPARENT SOLUTION: see description in WMP report section 13.2.1 and Figure 13.2-1

COMMENTS:

PROJECT: CUC- 2A - Floral Drive/Carnation Drive/Leisure Avenue Improvements (see description in WMP report section 13.2.1 and Figure 13.2-1)

PROBLEM		CONSEQUENCES						
		INCREASED HAZARD	ARTERIAL ROAD FLOODING	LOCAL STREET FLOODING	HOME FLOODING	YARD FLOODING	INCREASE PTS/YEAR	TOTAL
	PTS	9	6	4	6	4	10	
FREQUENCY OF FLOOD HIGH (3-YR/24-HR) FLOODS DURING 3 OR LESS	10			40				40
FREQUENCY OF FLOOD MEDIUM: (5-YR/24-HR)	6			24	36	24		84
FREQUENCY OF FLOOD LOW: (1O-YR/24-HR) OVER	3			12	18	12		42
INCREASE (YEARLY)		January 1998 Flood Complaint and 2004 Frances Flood Complaint					20	20
EROSION/SILTATION	20							
HIGH GROUNDWATER TABLE	20							
MAINTENANCE PROBLEM	20							
STRUCTURAL FAILURE	80							
							GRAND TOTAL	186

STORMWATER MANAGEMENT C.I.P EVALUATION

PROJECT NAME: CUC-2A - Ambassador Loop and Rose Lake Estates MHP Improvements		DESIGN COST:
DATE OF SITE VISIT:	ENGINEER:	R/W COST:
DATE OF EVALUATION:	CHECKED BY:	CONST. COST:
	DESIGN HOURS:	TOTAL COST EST.:

LOCATION: FAC 3 - West of N. Florida Avenue and south of Floral Drive

APPARENT SOLUTION: see description in WMP report section 13.2.1 and Figure 13.2-1

COMMENTS:

PROJECT: CUC-2A - Ambassador Loop and Rose Lake Estates MHP Improvements
(see description in WMP report section 13.2.1 and Figure 13.2-1)

PROBLEM		CONSEQUENCES						
		INCREASED HAZARD	ARTERIAL ROAD FLOODING	LOCAL STREET FLOODING	HOME FLOODING	YARD FLOODING	INCREASE PTS/YEAR	TOTAL
	PTS	9	6	4	6	4	10	
FREQUENCY OF FLOOD HIGH (3-YR/24-HR) FLOODS DURING 3 OR LESS	10			40	60	40		140
FREQUENCY OF FLOOD MEDIUM: (5-YR/24-HR)	6			24	36	24		84
FREQUENCY OF FLOOD LOW: (1O-YR/24-HR) OVER	3			12	18	12		42
INCREASE (YEARLY)		December 1997 MHP flood complaint; Recent Ambassador Loop Flood Complaint					20	10
EROSION/SILTATION	20							
HIGH GROUNDWATER TABLE	20							
MAINTENANCE PROBLEM	20							
STRUCTURAL FAILURE	80							
							GRAND TOTAL	286

STORMWATER MANAGEMENT C.I.P EVALUATION

PROJECT NAME: CUC-4A – Arkwright Drive/Tyrone Village MHP/North Pointe Lakes Regional Detention		DESIGN COST:
DATE OF SITE VISIT:	ENGINEER:	R/W COST:
DATE OF EVALUATION:	CHECKED BY:	CONST. COST:
	DESIGN HOURS:	TOTAL COST EST.:

LOCATION: FAC 4 – Along N. Ola Avenue, between 138th Avenue and Fletcher Avenue and Arkwright Drive

APPARENT SOLUTION: see description in WMP report section 13.2.2 and Figure 13.2-2

COMMENTS:

PROJECT: CUC-4A - Arkwright Drive/Tyrone Village MHP/North Pointe Lakes Regional Detention (see description in WMP report section 13.2.2 and Figure 13.2-2)

PROBLEM		CONSEQUENCES						
		INCREASED HAZARD	ARTERIAL ROAD FLOODING	LOCAL STREET FLOODING	HOME FLOODING	YARD FLOODING	INCREASE PTS/YEAR	TOTAL
	PTS	9	6	4	6	4	10	
FREQUENCY OF FLOOD HIGH (3-YR/24-HR) FLOODS DURING 3 OR LESS	10			40	60	40		140
FREQUENCY OF FLOOD MEDIUM: (5-YR/24-HR)	6			24	36	24		84
FREQUENCY OF FLOOD LOW: (1O-YR/24-HR) OVER	3			12	18	12		42
INCREASE (YEARLY)		December 1997 and January 1998 Flood Complaint					20	20
EROSION/SILTATION	20							
HIGH GROUNDWATER TABLE	20							
MAINTENANCE PROBLEM	20							
STRUCTURAL FAILURE	80							
							GRAND TOTAL	286

STORMWATER MANAGEMENT C.I.P EVALUATION

PROJECT NAME: CUC-5B - Wildwood Street at N. Florida Avenue - Raise Road		DESIGN COST:
DATE OF SITE VISIT:	ENGINEER:	R/W COST:
DATE OF EVALUATION:	CHECKED BY:	CONST. COST:
	DESIGN HOURS:	TOTAL COST EST.:

LOCATION: FAC 5 West of N. Florida Avenue between Neving Drive and W. 138th Avenue

APPARENT SOLUTION: see description in WMP report section 13.2.3 and Figure 13.2-3

COMMENTS: Wildwood Street is the only exit for this residential area – considered increased hazard when flood depth exceeds 6 inches over crown

PROJECT: CUC-5B - Wildwood Street at N. Florida Avenue - Raise Road (see description in WMP report section 13.2.3 and Figure 13.2-3)

PROBLEM		CONSEQUENCES						
		INCREASED HAZARD	ARTERIAL ROAD FLOODING	LOCAL STREET FLOODING	HOME FLOODING	YARD FLOODING	INCREASE PTS/YEAR	TOTAL
	PTS	9	6	4	6	4	10	
FREQUENCY OF FLOOD HIGH (3-YR/24-HR) FLOODS DURING 3 OR LESS	10					40		40
FREQUENCY OF FLOOD MEDIUM: (5-YR/24-HR)	6			24	36	24		84
FREQUENCY OF FLOOD LOW: (1O-YR/24-HR) OVER	3	27		12	18	12		69
INCREASE (YEARLY)		Recorded flood complaints in September 1997 and January 1998					20	20
EROSION/SILTATION	20							
HIGH GROUNDWATER TABLE	20							
MAINTENANCE PROBLEM	20							
STRUCTURAL FAILURE	80							
							GRAND TOTAL	213

STORMWATER MANAGEMENT C.I.P EVALUATION

PROJECT NAME: CUC-6A - Garland Court / E. 145th Avenue - New Pond		DESIGN COST:
DATE OF SITE VISIT:	ENGINEER:	R/W COST:
DATE OF EVALUATION:	CHECKED BY:	CONST. COST:
	DESIGN HOURS:	TOTAL COST EST.:

LOCATION: FAC 6 - East of Florida Ave, between Garland Court and E 145th Avenue

APPARENT SOLUTION: see description in WMP report section 13.2.4 and Figure 13.2-4

COMMENTS:

PROJECT: CUC-6A - Garland Court / E. 145th Avenue - New Pond (see description in WMP report section 13.2.4 and Figure 13.2-4)

PROBLEM		CONSEQUENCES						
		INCREASED HAZARD	ARTERIAL ROAD FLOODING	LOCAL STREET FLOODING	HOME FLOODING	YARD FLOODING	INCREASE PTS/YEAR	TOTAL
	PTS	9	6	4	6	4	10	
FREQUENCY OF FLOOD HIGH (3-YR/24-HR) FLOODS DURING 3 OR LESS	10			40		40		80
FREQUENCY OF FLOOD MEDIUM: (5-YR/24-HR)	6			24	36	24		84
FREQUENCY OF FLOOD LOW: (1O-YR/24-HR) OVER	3			12	18	12		42
INCREASE (YEARLY)		7 Recorded Flood Complaints (December 1997, January 1998,and 2004 Frances Flooding)					30	30
EROSION/SILTATION	20							
HIGH GROUNDWATER TABLE	20							
MAINTENANCE PROBLEM	20							
STRUCTURAL FAILURE	80							
							GRAND TOTAL	236

STORMWATER MANAGEMENT C.I.P EVALUATION

PROJECT NAME: CUC-7A – E. 137th Avenue / E. 138th Avenue Drainage Improvements		DESIGN COST:
DATE OF SITE VISIT:	ENGINEER:	R/W COST:
DATE OF EVALUATION:	CHECKED BY:	CONST. COST:
	DESIGN HOURS:	TOTAL COST EST.:

LOCATION: FAC 7 - Between E 138th Avenue and E. 137th Avenue, immediately west of Interstate 275	PROJECT: CUC-7A – E. 137th Avenue / E. 138th Avenue Drainage Improvements (see description in WMP report section 13.2.5 and Figure 13.2-5)
APPARENT SOLUTION: see description in WMP report section 13.2.5 and Figure 13.2-5	
COMMENTS:	

PROBLEM		CONSEQUENCES						
		INCREASED HAZARD	ARTERIAL ROAD FLOODING	LOCAL STREET FLOODING	HOME FLOODING	YARD FLOODING	INCREASE PTS/YEAR	TOTAL
	PTS	9	6	4	6	4	10	
FREQUENCY OF FLOOD HIGH (3-YR/24-HR) FLOODS DURING 3 OR LESS	10							
FREQUENCY OF FLOOD MEDIUM: (5-YR/24-HR)	6			24		24		48
FREQUENCY OF FLOOD LOW: (1O-YR/24-HR) OVER	3			12	18	12		42
INCREASE (YEARLY)		December 1997 and January 1998 Flood Complaint					20	20
EROSION/SILTATION	20							
HIGH GROUNDWATER TABLE	20							
MAINTENANCE PROBLEM	20							
STRUCTURAL FAILURE	80							
							GRAND TOTAL	110

STORMWATER MANAGEMENT C.I.P EVALUATION

PROJECT NAME: CUC-8A - E. 132nd Avenue at Central Avenue Drainage Improvement		DESIGN COST:
DATE OF SITE VISIT:	ENGINEER:	R/W COST:
DATE OF EVALUATION:	CHECKED BY:	CONST. COST:
	DESIGN HOURS:	TOTAL COST EST.:

LOCATION: FAC 8 – Either side of Interstate 275 north of 131st Avenue	PROJECT: CUC-8A - E. 132nd Avenue at Central Avenue Drainage Improvement (see description in WMP report section 13.2.6 and Figure 13.2-6)
APPARENT SOLUTION: see description in WMP report section 13.2.6 and Figure 13.2-6	
COMMENTS:	

PROBLEM		CONSEQUENCES						
		INCREASED HAZARD	ARTERIAL ROAD FLOODING	LOCAL STREET FLOODING	HOME FLOODING	YARD FLOODING	INCREASE PTS/YEAR	TOTAL
	PTS	9	6	4	6	4	10	
FREQUENCY OF FLOOD HIGH (3-YR/24-HR) FLOODS DURING 3 OR LESS	10				60	40		100
FREQUENCY OF FLOOD MEDIUM: (5-YR/24-HR)	6			24	36	24		84
FREQUENCY OF FLOOD LOW: (1O-YR/24-HR) OVER	3			12	18	12		42
INCREASE (YEARLY)		September 1997 and January 1998 Flood Complaint					20	20
EROSION/SILTATION	20							
HIGH GROUNDWATER TABLE	20							
MAINTENANCE PROBLEM	20							
STRUCTURAL FAILURE	80							
							GRAND TOTAL	246

STORMWATER MANAGEMENT C.I.P EVALUATION

PROJECT NAME: CUC- 9B – E. 121st Avenue Gravity Outfall		DESIGN COST:
DATE OF SITE VISIT:	ENGINEER:	R/W COST:
DATE OF EVALUATION:	CHECKED BY:	CONST. COST:
	DESIGN HOURS:	TOTAL COST EST.:

LOCATION: FAC 9 - Between E. 122nd Avenue and E. 121st Avenue, west of Interstate 275

APPARENT SOLUTION: see description in WMP report section 13.2.7 and Figure 13.2-7

COMMENTS: Internally drained with underlying soils HSG A

PROJECT: CUC- 9B – E. 121st Avenue Gravity Outfall (see description in WMP report section 13.2.7 and Figure 13.2-7)

PROBLEM		CONSEQUENCES						
		INCREASED HAZARD	ARTERIAL ROAD FLOODING	LOCAL STREET FLOODING	HOME FLOODING	YARD FLOODING	INCREASE PTS/YEAR	TOTAL
	PTS	9	6	4	6	4	10	
FREQUENCY OF FLOOD HIGH (3-YR/24-HR) FLOODS DURING 3 OR LESS	10			40	60	40		140
FREQUENCY OF FLOOD MEDIUM: (5-YR/24-HR)	6			24	36	24		84
FREQUENCY OF FLOOD LOW: (1O-YR/24-HR) OVER	3			12	18	12		42
INCREASE (YEARLY)								
EROSION/SILTATION	20							
HIGH GROUNDWATER TABLE	20							
MAINTENANCE PROBLEM	20							
STRUCTURAL FAILURE	80							
							GRAND TOTAL	266

STORMWATER MANAGEMENT C.I.P EVALUATION

PROJECT NAME: CUC-10A – E. 122nd Avenue and Country Club Drive Culvert Replacements		DESIGN COST:
DATE OF SITE VISIT:	ENGINEER:	R/W COST:
DATE OF EVALUATION:	CHECKED BY:	CONST. COST:
	DESIGN HOURS:	TOTAL COST EST.:

LOCATION: FAC 10 - Curiosity Creek at 122nd Avenue	PROJECT: CUC-10A – E. 122nd Avenue and Country Club Drive Culvert Replacements (see description in WMP report section 13.2.8 and Figure 13.2-8)
APPARENT SOLUTION: see description in WMP report section 13.2.8 and Figure 13.2-8	
COMMENTS:	

PROBLEM		CONSEQUENCES						
		INCREASED HAZARD	ARTERIAL ROAD FLOODING	LOCAL STREET FLOODING	HOME FLOODING	YARD FLOODING	INCREASE PTS/YEAR	TOTAL
	PTS	9	6	4	6	4	10	
FREQUENCY OF FLOOD HIGH (3-YR/24-HR) FLOODS DURING 3 OR LESS	10							
FREQUENCY OF FLOOD MEDIUM: (5-YR/24-HR)	6			24		24		48
FREQUENCY OF FLOOD LOW: (1O-YR/24-HR) OVER	3			12		12		24
INCREASE (YEARLY)								
EROSION/SILTATION	20							
HIGH GROUNDWATER TABLE	20							
MAINTENANCE PROBLEM	20							
STRUCTURAL FAILURE	80							
							GRAND TOTAL	72

STORMWATER MANAGEMENT C.I.P EVALUATION

PROJECT NAME: CUC-11A – W. Country Club Drive		DESIGN COST:
DATE OF SITE VISIT:	ENGINEER:	R/W COST:
DATE OF EVALUATION:	CHECKED BY:	CONST. COST:
	DESIGN HOURS:	TOTAL COST EST.:

LOCATION: FAC 11 – Curiosity Creek at W. Country Club Drive, east of Ravine Road	PROJECT: CUC-11A – W. Country Club Drive
APPARENT SOLUTION: Replace culverts with (2) 5' x7' RCBC	
COMMENTS: No project recommended	

PROBLEM		CONSEQUENCES						
		INCREASED HAZARD	ARTERIAL ROAD FLOODING	LOCAL STREET FLOODING	HOME FLOODING	YARD FLOODING	INCREASE PTS/YEAR	TOTAL
	PTS	9	6	4	6	4	10	
FREQUENCY OF FLOOD HIGH (3-YR/24-HR) FLOODS DURING 3 OR LESS	10							
FREQUENCY OF FLOOD MEDIUM: (5-YR/24-HR)	6							
FREQUENCY OF FLOOD LOW: (1O-YR/24-HR) OVER	3			12				12
INCREASE (YEARLY)								
EROSION/SILTATION	20							
HIGH GROUNDWATER TABLE	20							
MAINTENANCE PROBLEM	20							
STRUCTURAL FAILURE	80							
							GRAND TOTAL	12

STORMWATER MANAGEMENT C.I.P EVALUATION

PROJECT NAME: CUC-12A -Joshua Bend Wetland Control Structure Modification (at Rome Avenue)		DESIGN COST:
DATE OF SITE VISIT:	ENGINEER:	R/W COST:
DATE OF EVALUATION:	CHECKED BY:	CONST. COST:
	DESIGN HOURS:	TOTAL COST EST.:

LOCATION: FAC 12- West of N Rome Avenue and north of W. Country Club Drive

APPARENT SOLUTION: see description in WMP report section 13.3.1 and Figure 13.3-1

COMMENTS:

PROJECT : CUC-12A -Joshua Bend Wetland Control Structure Modification (at Rome Avenue) (see description in WMP report section 13.3.1 and Figure 13.3-1)

PROBLEM		CONSEQUENCES						
		INCREASE D HAZARD	ARTERIAL ROAD FLOODING	LOCAL STREET FLOODING	HOME FLOODING	YARD FLOODING	INCREASE PTS/YEAR	TOTAL
	PTS	9	6	4	6	4	10	
FREQUENCY OF FLOOD HIGH (3-YR/24-HR) FLOODS DURING 3 OR LESS	10			40				40
FREQUENCY OF FLOOD MEDIUM: (5-YR/24-HR)	6			24				24
FREQUENCY OF FLOOD LOW: (1O-YR/24-HR) OVER	3			12				12
INCREASE (YEARLY)								
EROSION/SILTATION	20							
HIGH GROUNDWATER TABLE	20							
MAINTENANCE PROBLEM	20							
STRUCTURAL FAILURE	80							
							GRAND TOTAL	76

PROJECT NAME: Curiosity Creek WMP Update
DATE: 6/20/2017
PREPARED BY: ERG **CHECKED BY:** RJD

OPINION OF PROBABLE COST

SAMY DRIVE AND LEISURE AVENUE - NEW POND
CUC-1A

ITEM NUMBER	ITEM DESCRIPTION	UNIT OF MEASURE	QUANTITY	UNIT PRICE	COST
1	MOBILIZATION (10%)	LS	1	$24,028.10	$24,028.10
2	MAINTENANCE OF TRAFFIC (3%)	LS	1	$7,208.43	$7,208.43
3	EROSION, SEDIMENT, AND TURBITY CONTROL (5%)	LS	1	$12,014.05	$12,014.05
4	CLEARING & GRUBBING (MOST OF SITE IS OPEN, GRASSY)	AC	1	$12,850.00	$12,850.00
5	EXCAVATION - REGULAR	CY	10706	$5.00	$53,530.00
6	EXCAVATION - CHANNEL	CY	0	$8.00	$0.00
7	PIPE REMOVAL (NOT REPLACEMENT)	LF	0	$35.00	$0.00
8	SODDING	SY	35052	$3.00	$105,156.00
9	JUNCTION/MANHOLE NEW/REPLACE	EA	2	$4,600.00	$9,200.00
10	TYPE "C" DBI, MODIFIED (OUTFALL CS)	EA	0	$5,000.00	$0.00
11	TYPE "H" DBI, MODIFIED (OUTFALL CS)	EA	0	$10,500.00	$0.00
12	REINFORCED CONCRETE PIPE SECTION (24" CD)	LF	0	$85.00	$0.00
13	REINFORCED CONCRETE PIPE SECTION (36" CD)	LF	0	$168.00	$0.00
14	ELLIPTICAL REINFORCED CONCRETE PIPE (48" S/CD)	LF	0	$350.00	$0.00
15	ELLIPTICAL REINFORCED CONCRETE PIPE (42" S/CD)	LF	0	$300.00	$0.00
16	ELLIPTICAL REINFORCED CONCRETE PIPE (36" S/CD)	LF	0	$250.00	$0.00
17	ELLIPTICAL REINFORCED CONCRETE PIPE (24" S/CD)	LF	483	$115.00	$55,545.00
18	MITERED END SECTION (24" - 30")	EA	2	$2,000.00	$4,000.00
19	MITERED END SECTION (36"-48")	EA	0	$4,000.00	$0.00
20	CONTINGENCY AMOUNT (30%)	LS	1	$85,059.47	$85,059.47
	CONSTRUCTION SUBTOTAL				**$369,000.00**
	One Parcel (2016 Assessed Value)	LS	1	$171,211.00	$171,211.00
	PROPERTY ACQUISITION SUBTOTAL				**$171,000.00**
	SURVEYING AND TESTING (5%)	LS	1	$18,450.00	$18,450.00
	DESIGN (15%)	LS	1	$55,350.00	$55,350.00
	PERMITTING (5%)	LS	1	$18,450.00	$18,450.00
	CONSTRUCTION ADMINISTRATION & OVERSIGHT (5%)	LS	1	$18,450.00	$18,450.00
	PROFESSIONAL SERVICES SUBTOTAL				**$111,000.00**
	TOTAL COST ESTIMATE				**$651,000.00**

Note: Unit prices are based on FDOT Area 08 - 12-month moving average costs (04/01/2016 - 03/31/2017), as available.
A contingency of 30% was used to account for uncertainties in conceptual level design

PROJECT NAME: Curiosity Creek WMP Update
DATE: 6/20/2017
PREPARED BY: ERG **CHECKED BY:** RJD

OPINION OF PROBABLE COST

FLORAL DRIVE/CARNATION DRIVE/AMBASSADOR LOOP AND ROSE LAKE ESTATES MHP IMPROVEMENTS
CUC-2A

ITEM NUMBER	ITEM DESCRIPTION	UNIT OF MEASURE	QUANTITY	UNIT PRICE	COST
1	MOBILIZATION (10%)	LS	1	$80,803.30	$80,803.30
2	MAINTENANCE OF TRAFFIC (3%)	LS	1	$24,240.99	$24,240.99
3	EROSION, SEDIMENT, AND TURBITY CONTROL (5%)	LS	1	$40,401.65	$40,401.65
4	CLEARING & GRUBBING	AC	9.6	$12,850.00	$123,360.00
5	EXCAVATION - REGULAR	CY	62406	$5.00	$312,030.00
6	EXCAVATION - CHANNEL	CY	1355	$8.00	$10,840.00
7	PIPE REMOVAL (NOT REPLACEMENT)	LF	23	$35.00	$805.00
8	CONCRETE WEIR (10 FEET LONG)*	LS	2	$1,485.00	$2,970.00
9	CONCRETE WEIR (20 FEET LONG)*	LS	1	$2,965.00	$2,965.00
10	CONCRETE WEIR (30 FEET LONG)*	LS	1	$4,445.00	$4,445.00
11	CONCRETE BOX CULVERT (7' X 5')*	LF	0	$1,610.00	$0.00
12	CONCRETE BOX CULVERT (8' X 5')*	LF	76	$1,725.00	$131,100.00
13	CONCRETE BOX CULVERT (8' X 6')*	LF	0	$1,840.00	$0.00
14	CONCRETE BOX CULVERT (10' X 5')*	LF	46	$1,955.00	$89,930.00
15	CONCRETE BOX CULVERT (10' X 8')*	LF	0	$2,300.00	$0.00
16	SODDING	SY	43196	$3.00	$129,588.00
17	CONTINGENCY AMOUNT (30%)	LS	1	$286,043.68	$286,043.68
	CONSTRUCTION SUBTOTAL				**$1,240,000.00**
	MHP Parcel - (2016 Assessed Value)	LS	1	$5,207,026.00	$5,207,026.00
	PROPERTY ACQUISITION SUBTOTAL				**$5,207,000.00**
	SURVEYING AND TESTING (5%)	LS	1	$62,000.00	$62,000.00
	DESIGN (15%)	LS	1	$186,000.00	$186,000.00
	PERMITTING (5%)	LS	1	$62,000.00	$62,000.00
	CONSTRUCTION ADMINISTRATION & OVERSIGHT (5%)	LS	1	$62,000.00	$62,000.00
	PROFESSIONAL SERVICES SUBTOTAL				**$372,000.00**
	TOTAL COST ESTIMATE				**$6,819,000.00**

Note: Unit prices are based on FDOT Area 08 - 12-month moving average costs (04/01/2016 - 03/31/2017), as available.
A contingency of 30% was used to account for uncertainties in conceptual level design

* Costs determined by computed concrete quantities at $800/CY weir, $1550/CY culvert; includes footing, coffer dam, de-watering, and water transfer costs

PROJECT NAME: Curiosity Creek WMP Update
DATE: 6/22/2017
PREPARED BY: ERG   CHECKED BY: RJD

OPINION OF PROBABLE COST

URS

ARKWRIGHT DRIVE/TYRONE VILLAGE MHP AND NORTH POINTE LAKES REGIONAL DETENTION CUC-4A

ITEM NUMBER	ITEM DESCRIPTION	UNIT OF MEASURE	QUANTITY	UNIT PRICE	COST
1	MOBILIZATION (10%)	LS	1	$158,899.70	$158,899.70
2	MAINTENANCE OF TRAFFIC (3%)	LS	1	$47,669.91	$47,669.91
3	EROSION, SEDIMENT, AND TURBITY CONTROL (5%)	LS	1	$79,449.85	$79,449.85
4	CLEARING & GRUBBING	AC	13	$12,850.00	$167,050.00
5	EXCAVATION - REGULAR	CY	131565	$5.00	$657,825.00
6	EXCAVATION - CHANNEL	CY	0	$8.00	$0.00
7	PIPE REMOVAL (NOT REPLACEMENT)	LF	0	$35.00	$0.00
8	SODDING	SY	20499	$3.00	$61,497.00
9	JUNCTION/MANHOLE NEW/REPLACE	EA	8	$4,600.00	$36,800.00
10	TYPE "C" DBI, MODIFIED (OUTFALL CS)	EA	1	$5,000.00	$5,000.00
11	TYPE "H" DBI, MODIFIED (OUTFALL CS)	EA	4	$10,500.00	$42,000.00
12	REINFORCED CONCRETE PIPE SECTION (24" CD)	LF	1565	$85.00	$133,025.00
13	REINFORCED CONCRETE PIPE SECTION (36" CD)	LF	975	$168.00	$163,800.00
14	ELLIPTICAL REINFORCED CONCRETE PIPE (48" S/CD)	LF	0	$350.00	$0.00
15	ELLIPTICAL REINFORCED CONCRETE PIPE (42" S/CD)	LF	735	$300.00	$220,500.00
16	ELLIPTICAL REINFORCED CONCRETE PIPE (36" S/CD)	LF	390	$250.00	$97,500.00
17	ELLIPTICAL REINFORCED CONCRETE PIPE (24" S/CD)	LF	0	$115.00	$0.00
18	MITERED END SECTION (24" - 30")	EA	2	$2,000.00	$4,000.00
19	MITERED END SECTION (36"-48")	EA	0	$4,000.00	$0.00
20	CONTINGENCY AMOUNT (30%)	LS	1	$562,504.94	$562,504.94
	CONSTRUCTION SUBTOTAL				**$2,438,000.00**
	Parcel - MHP (2016 Assessed Value)	LS	1	$2,200,575.00	$2,200,575.00
	PROPERTY ACQUISITION SUBTOTAL				**$2,201,000.00**
	SURVEYING AND TESTING (5%)	LS	1	$121,900.00	$121,900.00
	DESIGN (15%)	LS	1	$365,700.00	$365,700.00
	PERMITTING (5%)	LS	1	$121,900.00	$121,900.00
	CONSTRUCTION ADMINISTRATION & OVERSIGHT (5%)	LS	1	$121,900.00	$121,900.00
	PROFESSIONAL SERVICES SUBTOTAL				**$731,000.00**
	TOTAL COST ESTIMATE				**$5,370,000.00**

Note: Unit prices are based on FDOT Area 08 - 12-month moving average costs (04/01/2016 - 03/31/2017), as available.
A contingency of 30% was used to account for uncertainties in conceptual level design

PROJECT NAME: Curiosity Creek WMP Update
DATE: 6/22/2017
PREPARED BY: ERG **CHECKED BY:** RJD

OPINION OF PROBABLE COST

WILDWOOD STREET AT N. FLORIDA AVENUE - RAISE ROAD
CUC-5B

ITEM NUMBER	ITEM DESCRIPTION	UNIT OF MEASURE	QUANTITY	UNIT PRICE	COST
1	MOBILIZATION (10%)	LS	1	$1,568.70	$1,568.70
2	MAINTENANCE OF TRAFFIC (3%)	LS	1	$470.61	$470.61
3	EROSION, SEDIMENT, AND TURBITY CONTROL (5%)	LS	1	$784.35	$784.35
4	ASPHALT REMOVAL	SY	278	$7.00	$1,946.00
5	ROADWAY SUBGRADE (FILL)	SY	278	$16.00	$4,448.00
6	ROADWAY BASE	SY	278	$15.00	$4,170.00
7	ASPHALT	SY	278	$16.00	$4,448.00
8	SODDING	SY	225	$3.00	$675.00
9	CONTINGENCY AMOUNT (30%)	LS	1	$5,553.20	$5,553.20
	CONSTRUCTION SUBTOTAL				**$24,000.00**
	NONE REQUIRED	LS	0	$0.00	$0.00
	PROPERTY ACQUISITION SUBTOTAL				**$0.00**
	SURVEYING AND TESTING (5%)	LS	1	$1,200.00	$1,200.00
	DESIGN (15%)	LS	1	$3,600.00	$3,600.00
	PERMITTING (5%)	LS	1	$1,200.00	$1,200.00
	CONSTRUCTION ADMINISTRATION & OVERSIGHT (5%)	LS	1	$1,200.00	$1,200.00
	PROFESSIONAL SERVICES SUBTOTAL				**$7,000.00**
	TOTAL COST ESTIMATE				**$31,000.00**

Note: Unit prices are based on FDOT Area 08 - 12-month moving average costs (04/01/2016 - 03/31/2017), as available.
A contingency of 30% was used to account for uncertainties in conceptual level design

PROJECT NAME: Curiosity Creek WMP Update
DATE: 6/22/2017
PREPARED BY: ERG **CHECKED BY:** RJD

OPINION OF PROBABLE COST

GARLAND COURT AND E. 145TH AVENUE - NEW POND
CUC-6A

ITEM NUMBER	ITEM DESCRIPTION	UNIT OF MEASURE	QUANTITY	UNIT PRICE	COST
1	MOBILIZATION (10%)	LS	1	$36,530.60	$36,530.60
2	MAINTENANCE OF TRAFFIC (3%)	LS	1	$10,959.18	$10,959.18
3	EROSION, SEDIMENT, AND TURBITY CONTROL (5%)	LS	1	$18,265.30	$18,265.30
4	CLEARING & GRUBBING	AC	5.6	$12,850.00	$71,960.00
5	EXCAVATION - REGULAR	CY	47333	$5.00	$236,665.00
6	EXCAVATION - CHANNEL	CY	0	$8.00	$0.00
7	PIPE REMOVAL (NOT REPLACEMENT)	LF	0	$35.00	$0.00
9	CONCRETE WEIR (10 FEET LONG)*	LS	1	$1,485.00	$1,485.00
10	RIPRAP - RUBBLE	TN	0	$165.00	$0.00
11	SODDING	SY	12582	$3.00	$37,746.00
12	JUNCTION/MANHOLE NEW/REPLACE	EA	2	$4,600.00	$9,200.00
13	TYPE "C" DBI, MODIFIED (OUTFALL CS)	EA	0	$5,000.00	$0.00
14	TYPE "H" DBI, MODIFIED (OUTFALL CS)	EA	0	$10,500.00	$0.00
15	REINFORCED CONCRETE PIPE SECTION (24" CD)	LF	50	$85.00	$4,250.00
16	REINFORCED CONCRETE PIPE SECTION (36" CD)	LF	0	$168.00	$0.00
17	ELLIPTICAL REINFORCED CONCRETE PIPE (48" S/CD)	LF	0	$350.00	$0.00
18	ELLIPTICAL REINFORCED CONCRETE PIPE (42" S/CD)	LF	0	$300.00	$0.00
19	ELLIPTICAL REINFORCED CONCRETE PIPE (36" S/CD)	LF	0	$250.00	$0.00
20	ELLIPTICAL REINFORCED CONCRETE PIPE (24" S/CD)	LF	0	$115.00	$0.00
21	MITERED END SECTION (24" - 30")	EA	2	$2,000.00	$4,000.00
22	MITERED END SECTION (36"-48")	EA	0	$4,000.00	$0.00
23	CONTINGENCY AMOUNT (30%)	LS	1	$129,318.32	$129,318.32
	CONSTRUCTION SUBTOTAL				**$560,000.00**
	Multiple Parcels (2016 Assessed Value)	LS	1	$512,070.00	$512,070.00
	PROPERTY ACQUISITION SUBTOTAL				**$512,000.00**
	SURVEYING AND TESTING (5%)	LS	1	$28,000.00	$28,000.00
	DESIGN (15%)	LS	1	$84,000.00	$84,000.00
	PERMITTING (5%)	LS	1	$28,000.00	$28,000.00
	CONSTRUCTION ADMINISTRATION & OVERSIGHT (5%)	LS	1	$28,000.00	$28,000.00
	PROFESSIONAL SERVICES SUBTOTAL				**$168,000.00**
	TOTAL COST ESTIMATE				**$1,240,000.00**

Note: Unit prices are based on FDOT Area 08 - 12-month moving average costs (04/01/2016 - 03/31/2017), as available.
A contingency of 30% was used to account for uncertainties in conceptual level design

* Costs determined by computed concrete quantities at $800/CY weir; includes footing, coffer dam, de-watering, and water transfer costs

PROJECT NAME: Curiosity Creek WMP Update
DATE: 6/22/2017
PREPARED BY: ERG **CHECKED BY:** RJD

OPINION OF PROBABLE COST

E. 137TH AVENUE / E. 138TH AVENUE DRAINAGE IMPROVEMENTS
CUC-7A

ITEM NUMBER	ITEM DESCRIPTION	UNIT OF MEASURE	QUANTITY	UNIT PRICE	COST
1	MOBILIZATION (10%)	LS	1	$19,628.50	$19,628.50
2	MAINTENANCE OF TRAFFIC (3%)	LS	1	$5,888.55	$5,888.55
3	EROSION, SEDIMENT, AND TURBITY CONTROL (5%)	LS	1	$9,814.25	$9,814.25
4	CLEARING & GRUBBING	AC	1.9	$12,850.00	$24,415.00
5	EXCAVATION - REGULAR	CY	13097	$5.00	$65,485.00
6	EXCAVATION - CHANNEL	CY	0	$8.00	$0.00
7	PIPE REMOVAL (NOT REPLACEMENT)	LF	40	$35.00	$1,400.00
8	CONCRETE WEIR (10 FEET LONG)*	LS	2	$1,485.00	$2,970.00
9	CONCRETE BOX CULVERT (7' X 5')*	LF	0	$1,610.00	$0.00
10	CONCRETE BOX CULVERT (8' X 5')*	LF	51	$1,725.00	$87,975.00
11	CONCRETE BOX CULVERT (8' X 6')*	LF	0	$1,840.00	$0.00
12	CONCRETE BOX CULVERT (10' X 5')*	LF	0	$1,955.00	$0.00
13	CONCRETE BOX CULVERT (10' X 8')*	LF	0	$2,300.00	$0.00
14	SODDING	SY	4680	$3.00	$14,040.00
15	CONTINGENCY AMOUNT (30%)	LS	1	$69,484.89	$69,484.89
	CONSTRUCTION SUBTOTAL				**$301,000.00**
	MHP Parcel - (2016 Assessed Value)	LS	1	$502,047.00	$502,047.00
	PROPERTY ACQUISITION SUBTOTAL				**$502,000.00**
	SURVEYING AND TESTING (5%)	LS	1	$15,050.00	$15,050.00
	DESIGN (15%)	LS	1	$45,150.00	$45,150.00
	PERMITTING (5%)	LS	1	$15,050.00	$15,050.00
	CONSTRUCTION ADMINISTRATION & OVERSIGHT (5%)	LS	1	$15,050.00	$15,050.00
	PROFESSIONAL SERVICES SUBTOTAL				**$90,000.00**
	TOTAL COST ESTIMATE				**$893,000.00**

Note: Unit prices are based on FDOT Area 08 - 12-month moving average costs (04/01/2016 - 03/31/2017), as available.
A contingency of 30% was used to account for uncertainties in conceptual level design

* Costs determined by computed concrete quantities at $800/CY weir, $1550/CY culvert; includes footing, coffer dam, de-watering, and water transfer costs

PROJECT NAME: Curiosity Creek WMP Update
DATE: 6/22/2017
PREPARED BY: ERG **CHECKED BY:** RJD

OPINION OF PROBABLE COST

E. 132ND AVENUE AT CENTRAL AVENUE DRAINAGE IMPROVEMENT
CUC-8A

ITEM NUMBER	ITEM DESCRIPTION	UNIT OF MEASURE	QUANTITY	UNIT PRICE	COST
1	MOBILIZATION (10%)	LS	1	$27,809.70	$27,809.70
2	MAINTENANCE OF TRAFFIC (3%)	LS	1	$8,342.91	$8,342.91
3	EROSION, SEDIMENT, AND TURBITY CONTROL (5%)	LS	1	$13,904.85	$13,904.85
4	CLEARING & GRUBBING	AC	0	$12,850.00	$0.00
5	EXCAVATION - REGULAR	CY	0	$5.00	$0.00
6	SODDING	SY	2699	$3.00	$8,097.00
7	JUNCTION/MANHOLE NEW/REPLACE	EA	5	$4,600.00	$23,000.00
8	REINFORCED CONCRETE PIPE SECTION (24" CD)	LF	0	$85.00	$0.00
9	REINFORCED CONCRETE PIPE SECTION (36" CD)	LF	0	$168.00	$0.00
10	ELLIPTICAL REINFORCED CONCRETE PIPE (48" S/CD)	LF	0	$350.00	$0.00
11	ELLIPTICAL REINFORCED CONCRETE PIPE (42" S/CD)	LF	810	$300.00	$243,000.00
12	ELLIPTICAL REINFORCED CONCRETE PIPE (36" S/CD)	LF	0	$250.00	$0.00
13	ELLIPTICAL REINFORCED CONCRETE PIPE (24" S/CD)	LF	0	$115.00	$0.00
14	MITERED END SECTION (24" - 30")	EA	0	$2,000.00	$0.00
15	MITERED END SECTION (36"-48")	EA	1	$4,000.00	$4,000.00
16	CONTINGENCY AMOUNT (30%)	LS	1	$98,446.34	$98,446.34
	CONSTRUCTION SUBTOTAL				**$427,000.00**
	NONE REQUIRED	LS	0	$0.00	$0.00
	PROPERTY ACQUISITION SUBTOTAL				**$0.00**
	SURVEYING AND TESTING (5%)	LS	1	$21,350.00	$21,350.00
	DESIGN (15%)	LS	1	$64,050.00	$64,050.00
	PERMITTING (5%)	LS	1	$21,350.00	$21,350.00
	CONSTRUCTION ADMINISTRATION & OVERSIGHT (5%)	LS	1	$21,350.00	$21,350.00
	PROFESSIONAL SERVICES SUBTOTAL				**$128,000.00**
	TOTAL COST ESTIMATE				**$555,000.00**

Note: Unit prices are based on FDOT Area 08 - 12-month moving average costs (04/01/2016 - 03/31/2017), as available.
A contingency of 30% was used to account for uncertainties in conceptual level design

PROJECT NAME: Curiosity Creek WMP Update
DATE: 6/22/2017
PREPARED BY: ERG **CHECKED BY:** RJD

OPINION OF PROBABLE COST

E. 121ST AVENUE GRAVITY OUTFALL
CUC-9B

ITEM NUMBER	ITEM DESCRIPTION	UNIT OF MEASURE	QUANTITY	UNIT PRICE	COST
1	MOBILIZATION (10%)	LS	1	$13,454.00	$13,454.00
2	MAINTENANCE OF TRAFFIC (3%)	LS	1	$4,036.20	$4,036.20
3	EROSION, SEDIMENT, AND TURBITY CONTROL (5%)	LS	1	$6,727.00	$6,727.00
4	CLEARING & GRUBBING	AC	0	$12,850.00	$0.00
5	EXCAVATION - REGULAR	CY	0	$5.00	$0.00
6	SODDING	SY	3605	$3.00	$10,815.00
7	JUNCTION/MANHOLE NEW/REPLACE	EA	5	$4,600.00	$23,000.00
8	TYPE "C" DBI, MODIFIED (OUTFALL CS)	EA	0	$5,000.00	$0.00
9	TYPE "H" DBI, MODIFIED (OUTFALL CS)	EA	0	$10,500.00	$0.00
10	REINFORCED CONCRETE PIPE SECTION (24" CD)	LF	1185	$85.00	$100,725.00
11	REINFORCED CONCRETE PIPE SECTION (36" CD)	LF	0	$168.00	$0.00
12	MITERED END SECTION (24" - 30")	EA	0	$2,000.00	$0.00
13	MITERED END SECTION (36"-48")	EA	0	$4,000.00	$0.00
14	CONTINGENCY AMOUNT (30%)	LS	1	$47,627.16	$47,627.16
	CONSTRUCTION SUBTOTAL				**$206,000.00**
	NONE REQUIRED	LS	0	$0.00	$0.00
	PROPERTY ACQUISITION SUBTOTAL				**$0.00**
	SURVEYING AND TESTING (5%)	LS	1	$10,300.00	$10,300.00
	DESIGN (15%)	LS	1	$30,900.00	$30,900.00
	PERMITTING (5%)	LS	1	$10,300.00	$10,300.00
	CONSTRUCTION ADMINISTRATION & OVERSIGHT (5%)	LS	1	$10,300.00	$10,300.00
	PROFESSIONAL SERVICES SUBTOTAL				**$62,000.00**
	TOTAL COST ESTIMATE				**$268,000.00**

Note: Unit prices are based on FDOT Area 08 - 12-month moving average costs (04/01/2016 - 03/31/2017), as available.
A contingency of 30% was used to account for uncertainties in conceptual level design

PROJECT NAME: Curiosity Creek WMP Update
DATE: 6/22/2017
PREPARED BY: ERG **CHECKED BY:** RJD

OPINION OF PROBABLE COST

E. 122ND AVENUE AND COUNTRY CLUB DRIVE CULVERT REPLACEMENTS
CUC-10A

ITEM NUMBER	ITEM DESCRIPTION	UNIT OF MEASURE	QUANTITY	UNIT PRICE	COST
1	MOBILIZATION (10%)	LS	1	$12,723.10	$12,723.10
2	MAINTENANCE OF TRAFFIC (3%)	LS	1	$3,816.93	$3,816.93
3	EROSION, SEDIMENT, AND TURBITY CONTROL (5%)	LS	1	$6,361.55	$6,361.55
4	CLEARING & GRUBBING	AC	0	$12,850.00	$0.00
5	EXCAVATION - REGULAR	CY	0	$5.00	$0.00
6	CONCRETE BOX CULVERT (7' X 5')*	LF	33	$1,610.00	$53,130.00
7	CONCRETE BOX CULVERT (8' X 5')*	LF	0	$1,725.00	$0.00
8	CONCRETE BOX CULVERT (8' X 6')*	LF	40	$1,840.00	$73,600.00
9	CONCRETE BOX CULVERT (10' X 5')*	LF	0	$1,955.00	$0.00
10	CONCRETE BOX CULVERT (10' X 8')*	LF	0	$2,300.00	$0.00
11	SODDING	SY	167	$3.00	$501.00
12	CONTINGENCY AMOUNT (30%)	LS	1	$45,039.77	$45,039.77
	CONSTRUCTION SUBTOTAL				**$195,000.00**
	NONE REQUIRED	LS	0	$0.00	$0.00
	PROPERTY ACQUISITION SUBTOTAL				**$0.00**
	SURVEYING AND TESTING (5%)	LS	1	$9,750.00	$9,750.00
	DESIGN (15%)	LS	1	$29,250.00	$29,250.00
	PERMITTING (5%)	LS	1	$9,750.00	$9,750.00
	CONSTRUCTION ADMINISTRATION & OVERSIGHT (5%)	LS	1	$9,750.00	$9,750.00
	PROFESSIONAL SERVICES SUBTOTAL				**$59,000.00**
	TOTAL COST ESTIMATE				**$254,000.00**

Note: Unit prices are based on FDOT Area 08 - 12-month moving average costs (04/01/2016 - 03/31/2017), as available.
A contingency of 30% was used to account for uncertainties in conceptual level design

* Costs determined by computed concrete quantities at $1550/CY culvert; includes footing, coffer dam, de-watering, and water transfer costs

PROJECT NAME: Curiosity Creek WMP Update
DATE: 6/22/2017
PREPARED BY: ERG CHECKED BY: RJD

OPINION OF PROBABLE COST

URS

JOSHUA BEND WETLAND CONTROL STRUCTURE MODIFICATION
CUC-12A

ITEM NUMBER	ITEM DESCRIPTION	UNIT OF MEASURE	QUANTITY	UNIT PRICE	COST
1	MOBILIZATION (10%)	LS	1	$4,773.40	$4,773.40
2	MAINTENANCE OF TRAFFIC (3%)	LS	1	$1,432.02	$1,432.02
3	EROSION, SEDIMENT, AND TURBITY CONTROL (5%)	LS	1	$2,386.70	$2,386.70
4	CLEARING & GRUBBING	AC	0	$12,850.00	$0.00
5	EXCAVATION - REGULAR	CY	0	$5.00	$0.00
6	PIPE REMOVAL (NOT REPLACEMENT)	LF	0	$35.00	$0.00
7	SODDING	SY	78	$3.00	$234.00
8	JUNCTION/MANHOLE NEW/REPLACE	EA	2	$4,600.00	$9,200.00
9	TYPE "C" DBI, MODIFIED (OUTFALL CS)	EA	0	$5,000.00	$0.00
10	TYPE "H" DBI, MODIFIED (OUTFALL CS)	EA	1	$10,500.00	$10,500.00
11	REINFORCED CONCRETE PIPE SECTION (24" CD)	LF	0	$85.00	$0.00
12	REINFORCED CONCRETE PIPE SECTION (36" CD)	LF	0	$168.00	$0.00
13	ELLIPTICAL REINFORCED CONCRETE PIPE (48" S/CD)	LF	68	$350.00	$23,800.00
14	ELLIPTICAL REINFORCED CONCRETE PIPE (42" S/CD)	LF	0	$300.00	$0.00
15	ELLIPTICAL REINFORCED CONCRETE PIPE (36" S/CD)	LF	0	$250.00	$0.00
16	ELLIPTICAL REINFORCED CONCRETE PIPE (24" S/CD)	LF	0	$115.00	$0.00
17	MITERED END SECTION (24" - 30")	EA	0	$2,000.00	$0.00
18	MITERED END SECTION (36"-48")	EA	1	$4,000.00	$4,000.00
19	CONTINGENCY AMOUNT (30%)	LS	1	$16,897.84	$16,897.84
	CONSTRUCTION SUBTOTAL				**$73,000.00**
	NONE REQUIRED	LS	0	$0.00	$0.00
	PROPERTY ACQUISITION SUBTOTAL				**$0.00**
	SURVEYING AND TESTING (5%)	LS	1	$3,650.00	$3,650.00
	DESIGN (15%)	LS	1	$10,950.00	$10,950.00
	PERMITTING (5%)	LS	1	$3,650.00	$3,650.00
	CONSTRUCTION ADMINISTRATION & OVERSIGHT (5%)	LS	1	$3,650.00	$3,650.00
	PROFESSIONAL SERVICES SUBTOTAL				**$22,000.00**
	TOTAL COST ESTIMATE				**$95,000.00**

Note: Unit prices are based on FDOT Area 08 - 12-month moving average costs (04/01/2016 - 03/31/2017), as available.
A contingency of 30% was used to account for uncertainties in conceptual level design

RFQ TRANSMITTAL MEMORANDUM
FOR A SUBMITTAL TO THE CITY OF TAMPA, FLORIDA

TRANSMITTAL DATE:

RFQ NO. & TITLE: 20-D-00043; Sulphur Springs Flow Augmentation Feasibility Study

TO: **Brad L. Baird, P. E., Chairman Selection & Certification Committee (CCNA)**
c/o Contract Administration Department via ContractAdministration@tampagov.net
306 East Jackson Street, 4th Floor North, Tampa, Florida 33602

SUBMITTER ("Firm") NAME:

FEDERAL TAX ID#:

FIRM TYPE: ☐ **Individual/Sole Proprietor** ☐ **Joint Venture (JV)*** ☐ **Partnership (PN)*** ☐ **Corporation**
☐ **Limited Liability Company** ☐ **Other:** ______________________________

FIRM **CONTACT NAME:** **EMAIL:** **PHONE:**

CERTIFICATIONS: **Firm is licensed, permitted, and certified as required to do business in Florida:** ☐ **Yes |** ☐ **No**
License/registration/certification no(s): ______________________________

Per §287.133, Fla. Stat., individuals or entities (including those meeting the §287.133, Fla. Stat. definition of "affiliate") placed on the convicted vendor list ("List") following a conviction for public entity crimes may not submit a bid, proposal, or reply ("Response") on a contract to provide any goods or services to a public entity, may not submit a Response on a contract with a public entity for the repair or construction of a public building or public work, may not submit a Response for leases of real property to a public entity, and may not be awarded or perform work as a contractor, supplier, subcontractor, or consultant under a contract with any public entity; and may not transact business with any public entity in excess of the threshold amount provided in §287.017, Fla. Stat. for CATEGORY TWO for a period of 36 months from the date of placement on the List. Neither Firm nor its affiliates have been placed on the List: ☐ **Yes |** ☐ **No**

Firm's own initial application for employment has criminal history screening practices similar to those contained in Chapter 12, Article VI, Tampa Code (responses, whether "Yes" or "No", are for informational purposes only and will not be used as a basis for award or denial, or for any protest): ☐ **Yes |** ☐ **No**

Firm shall comply with all applicable governmental rules & regulations, including the City's Ethics Code (Sec. 2-522, Tampa Code). The City's Charter & Ethics Code prohibit any City employee from receiving any substantial benefit or profit out of any award or obligation entered into with the City, or from having any direct or indirect financial interest in effecting any such award or obligation. If Firm is successful, it shall ensure no City employee receives any such benefit or interest as a result of such award (See Sec.2-514(d),Tampa Code): ☐ **Yes |** ☐ **No**

Firm is not in arrears and is not in default upon any obligation to the City of Tampa: ☐ **Yes |** ☐ **No**

Firm agrees that if the City of Tampa determines Firm has participated in any collusive, deceptive, or fraudulent practices with regard to this submittal, in addition to any other remedy it may exercise, the City will have the right to debar Firm and deem invalid any contract let under such circumstances: ☐ **Yes |** ☐ **No**

Data or material Firm asserts to be exempted from public disclosure under Chapter 119, Fla. Stat., is submitted in a separate, single electronic searchable PDF file labeled with the above RFQ number and the phrase "Confidential Material", which identifies the data/material to be protected, states the reasons the date/material is exempt from public disclosure, and the specific Florida statute allowing such exemption (if "No" or otherwise, then Firm waives any possible or claimed exemption upon submission, effective at opening): ☐ **Yes |** ☐ **No**

FAILURE TO COMPLETE THE ABOVE MAY RESULT IN FIRM'S SUBMITTAL BEING DECLARED NON-RESPONSIVE

Authorized Signature (wet): ______________________________
[SEAL] **Printed Name:** ______________________________
Title: ☐ **Sole Prop** ☐ **Pres** ☐ **Sr VP** ☐ **Gen Ptnr** ☐ **LLC Auth.Mbr/Mgr**
☐ **Other** ______________________ **(attach proof of authority)**

STATE OF
COUNTY OF
The forgoing instrument was sworn (or affirmed) before me before me by means of ☐ physical presence or ☐ online notarization, this ____ **day of** ______________________, **20**____ **by** ______________________________
either in his/her individual capacity or where Firm is an entity as the ______________________ **of** ______________ ☐ ______________ ☐ **, on behalf of such entity. He/She is personally known to me** OR **produced identification.** Type of identification produced:

[NOTARY SEAL]

____
Printed Name: ______________ **Notary Public, State of** __________
My Commission Expires: ______________ **Commission No:**________

* **With submittal or within 10 days thereafter, Firm must provide a signed copy of the complete agreement between all JV/PN members indicating respective roles, responsibilities, and levels of participation.**

Points Pursuant to Designated Industry Category:_______________

FORM MBD-71

(Refer to MBD Form 70 and Form 50-GFE Outreach)

	Evaluation Criteria	Point Values
A.	Underutilized WMBE Firms participating as the Prime Contractor (City of Tampa Certified Only)	20
B.	City of Tampa Certified SLBE firms participating as the Prime Contractor, which include City of Tampa Certified WMBE/SLBE sub-(contractor, consultant) participation	5 - 15
C.	Non-City of Tampa Certified WMBE/SLBE Prime Contractor with meaningful sub-(contractor, consultant) participation by City Certified Underutilized WMBE and/or SLBE firms	1 - 15
D.	* External agency WMBE/SLBE/DBE certifications recognized by City of Tampa for designated RFP, RFQ, RFI solicitations	0 – 7
NOTE: The maximum points available for WMBE and/or SLBE participation will not exceed twenty (20)		

Points are determined as follows (Requires Form 50-GFE):

A. A maximum of twenty (20) rating points may be awarded when the Proposer is a City of Tampa Certified WMBE firm deemed underutilized within the Industry category established by the RFQ.

B. A maximum of fifteen (15) rating points may be awarded when the Proposer is a City of Tampa certified SLBE with meaningful participation by City certified WMBE/SLBE sub-contractors/consultants.

C. One to Fifteen (1-15) rating points may be awarded when the Proposer is not a City of Tampa certified WMBE/SLBE prime contractor but utilizes either Underutilized WMBE and/or SLBE certified firm(s) as sub-contractors/consultants and assigned to perform meaningful segments of the contractual services detailed herein and documented on the enclosed MBD Form 10-20.

D. A maximum of seven (7) “discretionary” rating points may be awarded when the Proposer provides WMBE/SLBE participation from an external agency recognized by the City. Discretionary points may be awarded for ancillary participation (see definition). The point values for ancillary participation may be subordinate to weighted values outlined in categories A, B and C above.

NOTE: ***WMBE** participation is narrowly tailored (per policy) to target underutilization of affected groups in specific trade/industry categories. Any WMBE/SLBE achievement that was not designated on MBD Form 70 is considered ancillary. Ancillary participation may be counted with overall participation and credited to your rating points when underutilization criteria are met.

The maximum number of points available for WMBE and/or SLBE participation will not exceed a total of twenty (20) points.

Equal Business Opportunity Evaluation Weighted Points: CCNA Proposal Guidelines

Under CCNA solicitations, proposers must submit to preconstruction Good Faith Efforts (GFE) requirements covering the inclusion of City of Tampa certified WMBE & SLBE firms. Such inclusion shall be clearly addressed and documented utilizing Forms MBD 10, 20 & 50. Proof of certification shall include copies of current certification certificates. This applies to ALL Phase 1 preconstruction design services.

Points awarded during the shortlist selection process will be more heavily weighted predominantly on the design side (this does not preclude identification of phase 2 projections of construction participation which follow in the future, i.e., GMPs). In order to ensure the maximum points, a proposer must **clearly identify and quantify** its planned participation without ambiguity. Simply marking "To Be Determined" (TBD) will not satisfy this requirement and may receive significantly lower ratings. Finally, additional favorable consideration will be granted to the firm(s) that beyond all others, provide(s) the highest *relevant* and most binding participation.

The evaluation includes but is not limited to the following criteria:

- Diversity of WMBE/SLBE subcontractors listed to be utilized (MBD Form 20)
- Percentage of proposal/scope committed to WMBE/SLBE subcontracting
- The collective factors in determining the total points awarded will be based on the overall weight of evidence in the proposal that specified the participation.

In all cases, the Proposer and/or subcontractor(s) must be WMBE and/or SLBE certified prior to the opening date and time of the RFP to be eligible to earn WMBE/SLBE rating points. The evaluation process of WMBE and SLBE participation will be evaluated by the City of Tampa's Equal Business Opportunity Department. The Successful Proposer will be required to execute MBD Form 40 (Letter of Intent-LOI) with their subcontractors/sub-consultants prior to award.

Good Faith Effort Compliance Plan Guidelines

for Women/Minority Business Enterprise\Small Local Business Enterprise Participation
City of Tampa - Equal Business Opportunity Program
(MBD Form 50 – detailed instructions on page 2 of 2)

Contract Name____ **Bid Date** ___________
Bidder/Proposer____
Signature ____ **Date** ____________
Name _________________________________ **Title** _____________________________

The Compliance Plan with attachments is a true account of Good Faith Efforts (GFE) made to achieve the participation goals as specified for Women/Minority Business Enterprises/Small Local Business Enterprises (WMBE/SLBE) on the referenced contract:

□ The WMBE/SLBE participation Goal is Met or Exceeded. See DMI Forms 10 and 20 which accurately report all subcontractors solicited and all subcontractors to-be-utilized.

□ The WMBE/SLBE participation Goal is Not Achieved. The following list is an overview of the baseline GFE action steps already performed. Furthermore, it is understood that these GFE requirements are weighted in the compliance evaluation based on the veracity and demonstrable degree of documentation provided with the bid/proposal:

(Check applicable boxes below. Must enclose supporting documents accordingly with remarks)

(1) Solicited through reasonable and available means the interest of WMBE/SLBEs that have the capability to perform the work of the contract. The Bidder or Proposer must solicit this interest within sufficient time to allow the WMBE/SLBEs to respond. The Bidder or Proposer must take appropriate steps to follow up initial solicitations with interested WMBE/SLBEs. □ **See DMI report forms for subcontractors solicited**. □ **See enclosed supplemental data on solicitation efforts**. □ **Qualifying Remarks**:

(2) Provided interested WMBE/SLBEs with adequate, specific scope information about the plans, specifications, and requirements of the contract, including addenda, in a timely manner to assist them in responding to the requested-scope identified by bidder/proposer for the solicitation. □ **See enclosed actual solicitations used**. □ **Qualifying Remarks**:

(3) Negotiated in good faith with interested WMBE/SLBEs that have submitted bids (e.g. adjusted quantities or scale). Documentation of negotiation must include the names, addresses, and telephone numbers of WMBE/SLBEs that were solicited; the date of each such solicitation; a description of the information provided regarding the plans and specifications for the work selected for subcontracting; and evidence as to why agreements could not be reached with WMBE/SLBEs to perform the work. Additional costs involved in soliciting and using subcontractors is not a sufficient reason for a bidder/proposer's failure to meet goals or achieve participation, as long as such costs are reasonable. Bidders are not required to accept excessive quotes in order to meet the goal.
□ **DMI Utilized Forms for sub-(contractor/consultant) reflect genuine negotiations** □ **This project is an RFQ/RFP in nature and negotiations are limited to clarifications of scope/specifications and qualifications.** □ **See enclosed documentation.**
□ **Qualifying Remarks**:

(4) Not rejecting WMBE/SLBEs as being unqualified without justification based on a thorough investigation of their capabilities. The WMBE/SLBEs standing within its industry, membership in specific groups, organizations / associations and political or social affiliations are not legitimate causes for rejecting or not soliciting bids to meet the goals.
□ **Not applicable.** □ **See attached justification for rejection of a subcontractor's bid or proposal.** □ **Qualifying Remarks**:

(5) Made scope(s) of work available to WMBE/SLBE subcontractors and suppliers; and, segmented portions of the work or material consistent with the available WMBE/SLBE subcontractors and suppliers, so as to facilitate meeting the goal. □ **Sub-Contractors were allowed to bid on their own choice of work** or **trade without restriction to a pre-determined portion**. □ **See enclosed comments**. □ **Qualifying Remarks**:

(6) Made good faith efforts, despite the ability or desire of Bidder/Proposer to perform the work of a contract with its own forces/organization. A Bidder/Proposer who desires to self-perform the work of a contract must demonstrate good faith efforts if the goal has not been met. □ Sub-Contractors were not prohibited from submitting bids/proposals and were solicited on work typically self-performed by the prime. □ Qualifying Remarks:

(7) Segmented portions of the work to be performed by WMBE/SLBEs in order to increase the likelihood that the goals will be met. This includes, where appropriate, breaking out contract work items into economically feasible units (quantities/scale) to facilitate WMBE/SLBE participation, even when the Bidder/Proposer might otherwise prefer to perform these work items with its own forces. □ **Sub-Contractors were allowed to bid on their own choice of work or trade without restriction to a pre-determined portion.** □ **Sub-Contractors were not prohibited from submitting bids/proposals and were solicited on work typically self-performed by the prime.** □ **See enclosed comments.** □ **Qualifying Remarks:**

(8) Made efforts to assist interested WMBE/SLBEs in obtaining bonding, lines of credit, or insurance as required by the city or contractor.
□ **See enclosed documentation on initiatives undertaken and methods to accomplish**. □ **Qualifying Remarks**:

(9) Made efforts to assist interested WMBE/SLBEs in obtaining necessary equipment, supplies, materials, or related assistance or services, including participation in an acceptable mentor-protégé program. □ **See enclosed documentation of initiatives and/or agreements.** □ **Qualifying Remarks**:

(10) Effectively used the services of the City and other organizations that provide assistance in the recruitment and placement of WMBE/SLBEs.
□ **See enclosed documentation.** □ **The following services were used**:

Note: Provide any unsolicited information that will support the Bid/RFP Compliance Evaluation. □ **Named Documents Are:**

Participation Plan: Guidance for Complying with Good Faith Efforts Outreach

1. All firms on the WMBE/SLBE Goal Setting List must be solicited and documentation provided for email, fax, letters, phone calls, and other methods of outreach/communication with the listed firms. The DMI Solicited and DMI-Utilized forms must be completed for all firms solicited or utilized. Other opportunities for subcontracting may be explored by consulting the City of Tampa MBD Office and/or researching the on-line Diversity Management Business System Directory for Tampa certified WMBE/SLBE firms.

2. Solicitation of WMBE/SLBEs, via written or electronic notification, should provide specific information on the services needed, where plans can be reviewed and assistance offered in obtaining these, if required. Solicitations should be sent a minimum of a week (i.e. 5 business days or more) before the bid/proposal date. Actual copies of the bidder's solicitation containing their scope specific instructions should be provided.

3. With any quotes received, a follow-up should be made when needed to confirm detail scope of work. For any WMBE/SLBE low quotes rejected, an explanation Shall be provided detailing negotiation efforts.

4. If a low bid WMBE/SLBE is rejected or deemed unqualified the contractor must provide an explanation and supporting documentation for this decision.

5. Prime Shall break down portions of work into economical feasible opportunities for subcontracting. The WMBE/SLBE directory may be useful in identifying additional subcontracting opportunities and firms not listed in the "WMBE/SLBE Goal Setting Firms List."

6. Contractor Shall not preclude WMBE/SLBEs from bidding on any part of work, even if the Contractor may desire to self-perform the work.

7. Contractor Shall avoid relying solely on subcontracting out work-scope where WMBE/SLBE availability is not sufficient to attain the pre-determined subcontract goal set for the Bid or when targeted sub-consultant participation is stated within the RFP/RFQ.

8. In its solicitations, the Bidder should offer assistance to WMBE/SLBEs in obtaining bonding, insurance, et cetera, if required of subcontractors by the City or Prime Contractor.

9. In its solicitation, the Bidder should offer assistance in obtaining equipment for a specific job to WMBE/SLBEs, if needed.

10. Contractor should use the services offered by such agencies as the City of Tampa Minority and Small Business Development Office, Hillsborough County Entrepreneur Collaborative Center, Hillsborough County Economic Development Department's MBE/SBE Program and the NAACP Empowerment Center to name a few for the recruitment and placement of WMBEs/SLBEs.

City of Tampa Florida

Failure to Complete, Sign and Submit Both Forms 10 & 20 SHALL render the Bid or Proposal Non-Responsive

City of Tampa – Schedule of All Solicited Sub-(Contractors/Consultants/Suppliers)

(FORM MBD-10)

Contract No.:_______________ **Contract Name:**____

Company Name:______________________________ **Address:**____________________________________

Federal ID:________________ **Phone:**_____________ **Fax:**______________ **Email:**_________________________

Check applicable box(es). Detailed Instructions for completing this form are on page 2 of 4.

[ ] No Firms were contacted or solicited for this contract.

[ ] No Firms were contacted because:____

[ ] See attached list of additional Firms solicited and all supplemental information (List must comply to this form)

Note: Form MBD-10 must list ALL subcontractors solicited including Non-minority/small businesses

NIGP Code Categories: Buildings = 909, General = 912, Heavy = 913, Trades = 914, Architects = 906, Engineers & Surveyors = 925, Supplier = 912-77

S = SLBE W=WMBE O = Neither Federal ID	Company Name Address Phone, Fax, Email	Type of Ownership (F=Female M=Male) BF BM = African Am. HF HM = Hispanic AF AM = Asian Am. NF NM = Native Am. CF CM = Caucasian	Trade or Services NIGP Code (listed above)	Contact Method L=Letter F=Fax E=Email P=Phone	Quote or Response Received Y/N

It is hereby certified that the information provided is an accurate and true account of contacts and solicitations for sub–contracting opportunities on this contract.

Signed:________________________________ **Name/Title:**____________________________ **Date:**______________

Failure to Complete, Sign and Submit Both Forms 10 & 20 SHALL render the Bid or Proposal Non-Responsive

Forms must be included with Bid / Proposal

Instructions for completing The Sub-(Contractors/Consultants/ Suppliers) Solicited Form (Form MBD-10)

This form must be submitted with all bids or proposals. **All** subcontractors (regardless of ownership or size) solicited and subcontractors from whom unsolicited quotations were received must be included on this form. The instructions that follow correspond to the headings on the form required to be completed. Note: Ability or desire to self-perform all work shall not exempt the prime from Good Faith Efforts to achieve participation.

- **Contract No.** This is the number assigned by the City of Tampa for the bid or proposal.
- **Contract Name.** This is the name of the contract assigned by the City of Tampa for the bid or proposal.
- **Contractor Name.** The name of your business and/or doing business as (dba) if applicable.
- **Address.** The physical address of your business.
- **Federal ID.** FIN. A number assigned to your business for tax reporting purposes.
- **Phone.** Telephone number to contact business.
- **Fax.** Fax number for business.
- **Email.** Provide email address for electronic correspondence.
- **No Firms were contacted or solicited for this contract.** Checking the box indicates that a pre-determined Subcontract Goal or Participation Plan Requirement was not set by the City resulting in your business not using subcontractors and will self-perform all work. If during the performance of the contract you employ subcontractors, the City must pre-approve subcontractors. Use of the "Sub-(Contractors/Consultants/Suppliers) Payments" form (MBD Form-30) must be submitted with every pay application and invoice. Note: Certified SLBE or WMBE firms bidding as Primes are not exempt from outreach and solicitation of subcontractors.
- **No Firms were contacted because.** Provide brief explanation why no firms were contacted or solicited.
- **See attached documents.** Check box, if after you have completed the DMI Form in its entirety, you need more space to list additional firms and/or if you have supplemental information/documentation relating to the form. All DMI data not submitted on the MBD Form-10 must be in the same format and have all requested data from MBD Form-10 included.

The following instructions are for information of any and all subcontractors solicited.

- **"S" = SLBE, "W" = WMBE.** Enter "**S**" for firms Certified by the City as Small Local Business Enterprises and/or "**W**" for firms Certified by the City as either Women/Minority Business Enterprise; **"O" = Non-certified others**.
- **Federal ID.** FIN. A number assigned to a business for tax reporting purposes. This information is critical in proper identification and payment of the contractor/subcontractor.
- **Company Name, Address, Phone & Fax**. Provide company information for verification of payments.
- **Type of Ownership.** Indicate the Ethnicity and Gender of the owner of the subcontracting business.
- **Trade, Services, or Materials** indicate the trade, service, or materials provided by the subcontractor. NIGP codes aka "National Institute of Governmental Purchasing" are listed at top section of document.
- **Contact Method L=letter, F=fax, E=Email, P=Phone.** Indicate with letter the method(s) of soliciting for bid.
- Q**uote or Resp. (response) Rec'd (received) Y/N**. Indicate "Y" Yes if you received a quotation or if you received a response to your solicitation. Indicate "N" No if you received no response to your solicitation from the subcontractor. Must keep records: log, ledger, documentation, etc. that can validate/verify.

If additional information is required or you have questions, please contact the Equal Business Opportunity Program - Minority and Small Business Development Office at (813) 274-5522.

Failure to Complete, Sign and Submit Both Forms 10 & 20 SHALL render the Bid or Proposal Non-Responsive

Page 3 of 4 – DMI Solicited/Utilized Schedules
City of Tampa – Schedule of All To-Be-Utilized Sub-(Contractors/Consultants/Suppliers)

(FORM MBD-20)

Contract No.:_______________ **Contract Name:**_______________________________________
Company Name:______________________________ **Address:**______________________________
Federal ID:________________ **Phone:**______________ **Fax:**______________ **Email:**_______________

Check applicable box(es). Detailed Instructions for completing this form are on page 4 of 4.

[ ] See attached list of additional Firms Utilized and all supplemental information (List must comply to this form)

Note: Form MBD-20 must list ALL subcontractors To-Be-Utilized including Non-minority/small businesses

[ ] No Subcontracting/consulting (of any kind) will be performed on this contract.

[ ] No Firms are listed to be utilized because:_______________________________________

NIGP Code General Categories: Buildings = 909, General = 912, Heavy = 913, Trades = 914, Architects = 906, Engineers & Surveyors = 925, Supplier = 912-77

Enter "S" for firms Certified as Small Local Business Enterprises, "W" for firms Certified as Women/Minority Business Enterprise, "O" for Other Non-Certified

S = SLBE W=WMBE O =Neither / Federal ID	Company Name Address Phone, Fax, Email	Type of Ownership (F=Female M=Male) BF BM = African Am. HF HM = Hispanic Am. AF AM = Asian Am. NF NM = Native Am. CF CM = Caucasian	Trade, Services, or Materials NIGP Code Listed above	$ Amount of Quote. Letter of Intent (LOI) if available	Percent of Scope or Contract %

Total ALL Subcontract / Supplier Utilization $__________________
Total SLBE Utilization $ __________________________________
Total WMBE Utilization $ _________________________________
Percent SLBE Utilization of Total Bid/Proposal Amt. _____% Percent WMBE Utilization of Total Bid/Proposal Amt. _____%

It is hereby certified that the following information is a true and accurate account of utilization for sub-contracting opportunities on this Contract.

Signed:_________________________________ **Name/Title:**______________________________ **Date:**_______________

Failure to Complete, Sign and Submit Both Forms 10 & 20 SHALL render the Bid or Proposal Non-Responsive

Forms must be included with Bid / Proposal

Instructions for completing The Sub-(Contractors/Consultants/ Suppliers) to be Utilized Form
(Form MBD-20)

This form must be submitted with all bids or proposals. All subcontractors (regardless of ownership or size) projected to be utilized must be included on this form. Note: Ability or desire to self-perform all work shall not exempt the prime from Good Faith Efforts to achieve participation.

Contract No. This is the number assigned by the City of Tampa for the bid or proposal.

- **Contract Name.** This is the name of the contract assigned by the City of Tampa for the bid or proposal.
- **Contractor Name.** The name of your business and/or doing business as (dba) if applicable.
- **Address.** The physical address of your business.
- **Federal ID.** FIN. A number assigned to your business for tax reporting purposes.
- **Phone.** Telephone number to contact business.
- **Fax.** Fax number for business.
- **Email.** Provide email address for electronic correspondence.
- **No Subcontracting/consulting (of any kind) will be performed on this contract.** Checking box indicates your business will not use subcontractors when no Subcontract Goal or Participation Plan Requirement was set by the City, but will self-perform all work. When subcontractors are utilized during the performance of the contract, the "Sub-(Contractors/Consultants/Suppliers) Payments" form (MBD Form-30) must be submitted with every pay application and invoice. Note: certified SLBE or WMBE firms bidding as Primes are not exempt from outreach and solicitation of subcontractors, including completion and submitting Form-10 and Form-20.
- **No Firms listed To-Be-Utilized.** Check box; provide brief explanation why no firms were retained when a goal or participation plan requirement was set on the contract. Note: mandatory compliance with Good Faith Effort outreach (GFECP) requirements applies (MBD Form-50) and supporting documentation must accompany the bid.
- **See attached documents.** Check box, if after completing the DMI Form in its entirety, you need more space to list additional firms and/or if you have supplemental information/documentation relating to the scope/value/percent utilization of subcontractors. Reproduce copies of MBD-20 and attach. All data not submitted on duplicate forms must be in the same format and content as specified in these instructions.

The following instructions are for information of Any and All subcontractors To Be Utilized.

- **Federal ID.** FIN. A number assigned to a business for tax reporting purposes. This information is critical in proper identification of the subcontractor.
- **"S" = SLBE, "W" = WMBE.** Enter "**S**" for firms Certified by the City as Small Local Business Enterprises and/or "**W**" for firms Certified by the City as Women/Minority Business Enterprise; **"O" = Non-certified others**.
- **Company Name, Address, Phone & Fax**. Provide company information for verification of payments.
- **Type of Ownership.** Indicate the Ethnicity and Gender of the owner of the subcontracting business.
- **Trade, Services, or Materials (NIGP code if Known)** Indicate the trade, service, or material provided by the subcontractor. Abbreviated list of NIGP is available at http:/www.tampagov.net/mbd "Information Resources".
- **Amount of Quote, Letters of Intent** (required for both SLBEs and WMBEs).
- **Percent of Work/Contract.** Indicate the percent of the total contract price the subcontract(s) represent. For CCNA only (i.e. Consultant A/E Services) you must indicate subcontracts as percent of total scope/contract.
- **Total Subcontract/Supplier Utilization.** – Provide total dollar amount of all subcontractors/suppliers projected to be used for the contract. (Dollar amounts may be optional in CCNA depending on solicitation format).
- **Total SLBE Utilization.** Provide total dollar amount for all projected SLBE subcontractors/Suppliers used for this contract. (Dollar amounts may be optional in CCNA proposals depending on the solicitation format).
- **Total WMBE Utilization.** Provide total dollar amount for all projected WMBE subcontractors/Suppliers used for this contract. (Dollar amounts may be optional in CCNA proposals depending on the solicitation format).
- **Percent SLBE Utilization.** Total amount allocated to SLBEs divided by the total bid/proposal amount.
- **Percent WMBE Utilization.** Total amount allocated to WMBEs divided by the total bid/proposal amount.

If additional information is required or you have questions, please contact the Equal Business Opportunity Program - Minority and Small Business Development Office at (813) 274-5522.

Procurement Guidelines To Implement Minority & Small Business Participation

Underutilized WMBE Primes by Industry Category

FORMAL PROCUREMENT

Construction	Construction-Related	Professional	Non-Professional	Goods
Black	Asian	Black	Black	Black
Hispanic	Native Am.	Hispanic	Asian	Hispanic
Native Am.	Woman	Asian	Native Am.	Asian
Woman		Native Am.		Native Am.
		Woman		Woman

Underutilized WMBE Sub-Contractors / Sub-Consultants

SUB WORK

Construction	Construction-Related	Professional	Non-Professional	Goods
Black	Black	Black	Black	Black
	Asian	Hispanic	Asian	Asian
	Native Am.	Asian	Native Am.	Native Am.
	Woman	Native Am.		Woman
		Woman		

Policy

The Guidelines apply to formal procurements and solicitations. WMBE participation will be narrowly-tailored.

Index

- Black = Black/African-American Business Enterprise
- Hispanic = Hispanic Business Enterprise
- Asian = Asian Business Enterprise
- Native Am. = Native American Business Enterprise
- Woman = Woman Business Enterprise (Caucasian)

Industry Categories

Construction is defined as: new construction, renovation, restoration, maintenance of public improvements and underground utilities.
Construction-Related Services are defined as: architecture, professional engineering, landscape architecture, design build, construction management services, or registered surveying and mapping.
Professional Services are defined as: attorney, accountant, medical doctor, veterinarian, miscellaneous consultant, etc.
Non-Professional Services are defined as: lawn maintenance, painting, janitorial, printing, hauling, security guard, etc.
Goods are defined as: all supplies, materials, pipes, equipment, machinery, appliances, and other commodities.

MBD Form-70