Spring Lake Watershed

Hydrologic and Hydraulic Analysis

Seminole County

January 9, 2013

ATKINS

SEMINOLE COUNTY
FLORIDA'S NATURAL CHOICE

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1. Introduction

1.1. Background and Purpose

Seminole County is in the third cycle of its National Pollutant Discharge Elimination System (NPDES), Municipal Separate Storm Sewer System (MS4) permit. One of the conditions of the permit requires the County to address 303(d) listed impaired waterbodies, by first prioritizing each waterbody for which a Total Daily Maximum Load (TMDL) has been established, yet without an adopted Basin Management Action Plan (BMAP). Then based upon the prioritization, the County is to formulate a plan and initiate water quality improvements.

In 2012, Seminole County performed the impaired waters prioritization, considering factors such as access, pollutant of concern, stakeholder involvement, jurisdictional contributing area among other ranking factors and selected Spring Lake (WBID 2987A) as its highest priority waterbody. Ranking criteria of note elevating Spring Lake to the top of the list included having an active Municipal Service Benefiting Unit (MSBU), containing direct discharges from Seminole County's MS4, and any capital improvement project (CIP) implemented in the watershed would serve a dual benefit of also improving water quality conditions in the Little Wekiva River, another impaired waterbody, immediately downstream of Spring Lake.

The implementation plan for improving water quality conditions in Spring Lake included monitoring of water quality, sampling lake inflows, and performing a groundwater seepage study. The results of these efforts were then used to develop an in-lake model calibrated against existing conditions with the ability to predict benefits of CIP implementation. The in-lake modeling included both developing hydrologic and nutrient budget using all of the components in the watershed, both inside and outside of the lake. Seminole County is currently under contract with Environmental Research and Design (ERD) to perform the monitoring and in-lake modeling under a separate work product, while the development of watershed inflows for water quantity and quality are the focus and main purpose of the study presented herein.

To develop the inflow model, a digital watershed management plan was developed for Spring Lake. As part of the digital approach, watershed data such as EPR permits, locations of storm sewers and inlets were spatially located with supporting data hyperlinked through ESRI's ArcMap software. This platform enables spatial access to model input parameters and results, as well as, serving as a storehouse for future watershed data collection. Given the recent changes in the watershed, particularly from the Gateway development and roadway extension, the digital approach enabled spatially laying out the current construction plans into the existing digital terrain and integrating it into the existing conditions model.

1.2. Project Location

The Spring Lake watershed is a subbasin of the Little Wekiva River watershed, encompassing 1.6 square miles of southern Seminole County and northern Orange County including portions of the City of Maitland and the City of Altamonte Springs. The Spring Lake watershed is generally bound by Maitland Boulevard on the South, Interstate 4 on the East, State Road 434 on the West and Spring Valley Road just south of State Road 436 on the North. Spring Lake is controlled by a spillway on its western edge just east of Spring Valley Road, prior to discharging into the Little Wekiva River **Figure 1-1** and **Figure 1-2** show the general location of the Spring Lake watershed and the extents of the Spring Lake watershed boundary.

Lake Destiny and a no named lake West of I-4, both located south of Spring Lake and west of I-4 have been included in this study due to hydraulic connections between these and Spring Lake, however the detail hydraulic modeling of these subbasins was limited to the Seminole County portion. Details from the Orange County portion focused on integrating the data necessary to accurately represent model inflows to Lake Destiny rather than site flooding in the Orange County subbasins.

Figure 1-1: Spring Lake Project Location

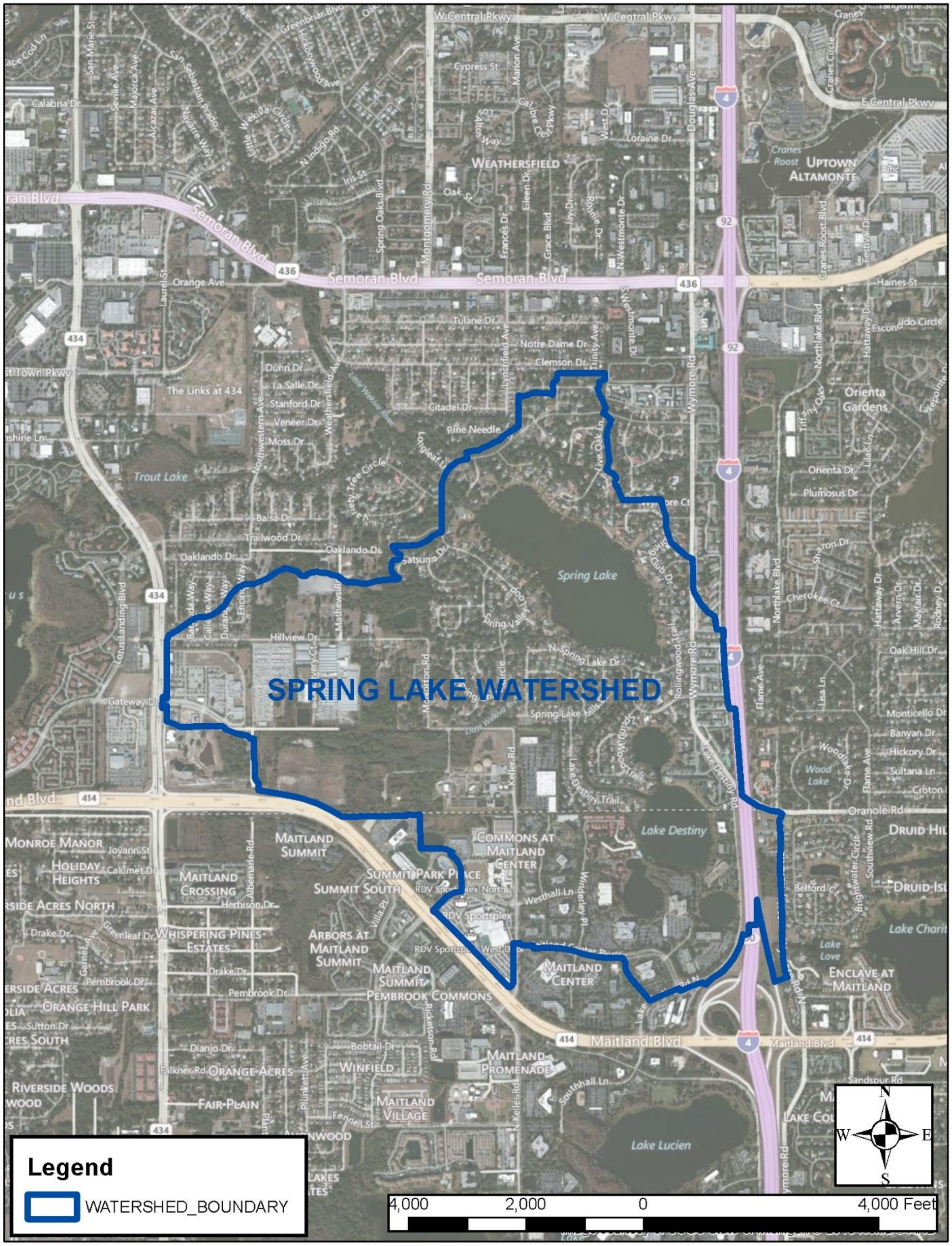

Figure 1-2: Spring Lake Watershed Boundary

2. Watershed Inventory and Data Collection

2.1. Previous / On-going Studies

Spring Lake and Lake Destiny are major features in the Little Wekiva River watershed and as such, have been incorporated in recent hydrologic and hydraulic studies within the Little Wekiva River Watershed. The focus of these studies specifically looked at the lakes and hydraulic conditions within the lakes rather than detailed conditions of subbasins contributing to the lakes. A list of recent studies includes:

- Little Wekiva River Watershed Management Plan in 2005 that became the basis for FEMA's Flood Insurance Study (FIS).
- Seminole County, Florida and Incorporated Areas FIS in 2007.
- City of Maitland, Stormwater Lake Management Plan update in 2007.

As noted in the introduction, this work product supports the on-going water quality sampling work performed by ERD in Spring Lake and Lake Destiny and will serve as inflow conditions to the in-lake water quality modeling performed subsequent to ERD's sampling efforts. On-going ERD studies in the watershed include:

- Spring Lake Hydrologic/Nutrient Budget and Water Quality Management Plan Evaluation
- Lake Destiny Outfalls Investigation and Sampling – as a supplemental to the Spring Lake Management Plan Evaluation

2.2. Digital Project Folder

The project deliverable, including this Hydrologic and Hydraulic Modeling report are included as a digital deliverable, standardized to promote consistency across watershed management plan developments and future updates within this watershed. All data and documentation utilized as part of the Spring Lake watershed study was digitally catalogued and organized under this single organized digital data structure. Each folder within the digital project deliverable is discussed below along with a brief description of its contents.

***Aerials* –** Contains 2006, 2012, and historic imagery. The 2006 imagery was included as it most closely represents the conditions related to the effective FIS and the 2012 aerials represent the most recent imagery available. Historic images include reference imagery dating back to 1890's as well as imagery prior to and during the construction of Maitland Blvd. The aerial images are spatially georeferenced and can be used with ESRI ArcMap GIS or AutoCAD or MicroStation.

***DTM* –** Contains digital topographic data including the LAS files and breaklines from the FEMA update as well as contours from Orange County used to generate the project Digital Elevation Model (DEM) included in the Spring Lake DEMs file geodatabase.

Geodatabase – Contains multiple geodatabases which combine to hold all the geospatial data and tables collected or generated to characterize the watershed inventory and ICPR model development and results.

GWIS_SPRINGLAKE.gdb – Geographic Watershed Information System (GWIS). This Geodatabase contains all watershed data necessary to create the ICPR model, including basins, links, nodes, hydronetwork, soils, land use and all basin, node, and link parameterization tables.

MISC_DATA.mdb – Contains miscellaneous watershed data including the complete stormwater inventory for the watershed, time of concentration paths and other supplemental and supporting watershed model features and tables.

FLOODPLAIN.mdb – Contains the inundation extents associated with peak conditions resulting from design storm events.

PL_ESTIMATE_PRE_GATEWAY.mdb and PL_ESTIMATE_POST_GATEWAY.mdb – Contains data specific to the generation of the pollutant load model, consistent with the model development generated for the Seminole County NPDES permit and Lake Jesup pollutant load model generation along with model output data grouped by Spring Lake inflow location for conditions prior to and including the Gateway roadway extension.

HTML – Contains all digital documents including photos, permit documents, and ERP permitted construction plans.

Misc_Ref_Materials – Contains additional supporting data and data collected as part of the watershed management plan collected from outside data sources.

Model – Contains ICPR model input data and model result files.

MXD – Contains a “BASE_MAP” mxd which is relatively referenced to the full project deliverable folder and opens with ESRI’s ArcMap 10.1 software. The base map displays all of the geospatial data collected and generated during the development of this watershed management plan including base maps, model network, structures inventory, and permit data. Data within the map is also hyperlinked to data within the digital deliverable such as pdfs “as-built” permit plans, field surveys, photographs, model input data, and watershed reports. Note: as each of the hyperlinks are relatively reference to the mxd folder, and additional base maps created should also be saved to this mxd folder to retain the links to underlying data and open properly.

Reports – Contains reports generated under the Spring Lake Watershed Management Plan.

Tables – Contains various tables generated for use in the watershed model development, including time of concentration and curve number calculations, as well as, historic lake stage and water quality data presentation.

2.3. Data Sources

The generation of the watershed management plan integrated data from a number of different sources, primarily St Johns River Water Management District (SJRWMD), Seminole County, Orange County, and the Cities of Altamonte Springs and Maitland. All data collected for use in the hydraulic model was converted to NGVD29 for consistency using a 1.0 foot data conversion from NAVD88 datum whereby NAVD88 elevations plus 1.0 feet equal NGVD29 elevations. Specific data references to spatial locations were additionally hyperlinked to related model features within the GWIS geodatabase with hyperlinks accessible in the base map mxd. Descriptions of key individual data collected are described in the following subsections.

2.3.1. SJRWMD

The Spring Lake Watershed is entirely within the SJRWMD. Data from the SJRWMD was available as an online resource of the District and included: soils, land use, Environmental Resource Permit (ERPs), and digital terrain LiDAR data. Each data source is further discussed below.

ERPs – Using the SJRWMD ERP shapefile available from the SJRWMD website, ERPs within the watershed boundary were identified and collected from SJRWMD website. Then, as necessary to accurately identify the spatial location of the storm sewer system, drainage sheets were georeferenced. The documentation for 66 ERPs with an additional 26 permit revisions collected and digitally catalogued are located in the (..\HTML\PLANS) project folder. **Figure 2-1** shows the ERPs collected. For each permit a GIS polygon was created in the "SPRING_LAKE_DATA_SOURCES" GIS feature class and hyperlinked to the folder containing all digital documents. The most significant geo-referencing effort was related to the Gateway Drive Permit, which is currently under construction. **Figure 2-2** shows an example of a geo-referenced plan sheet.

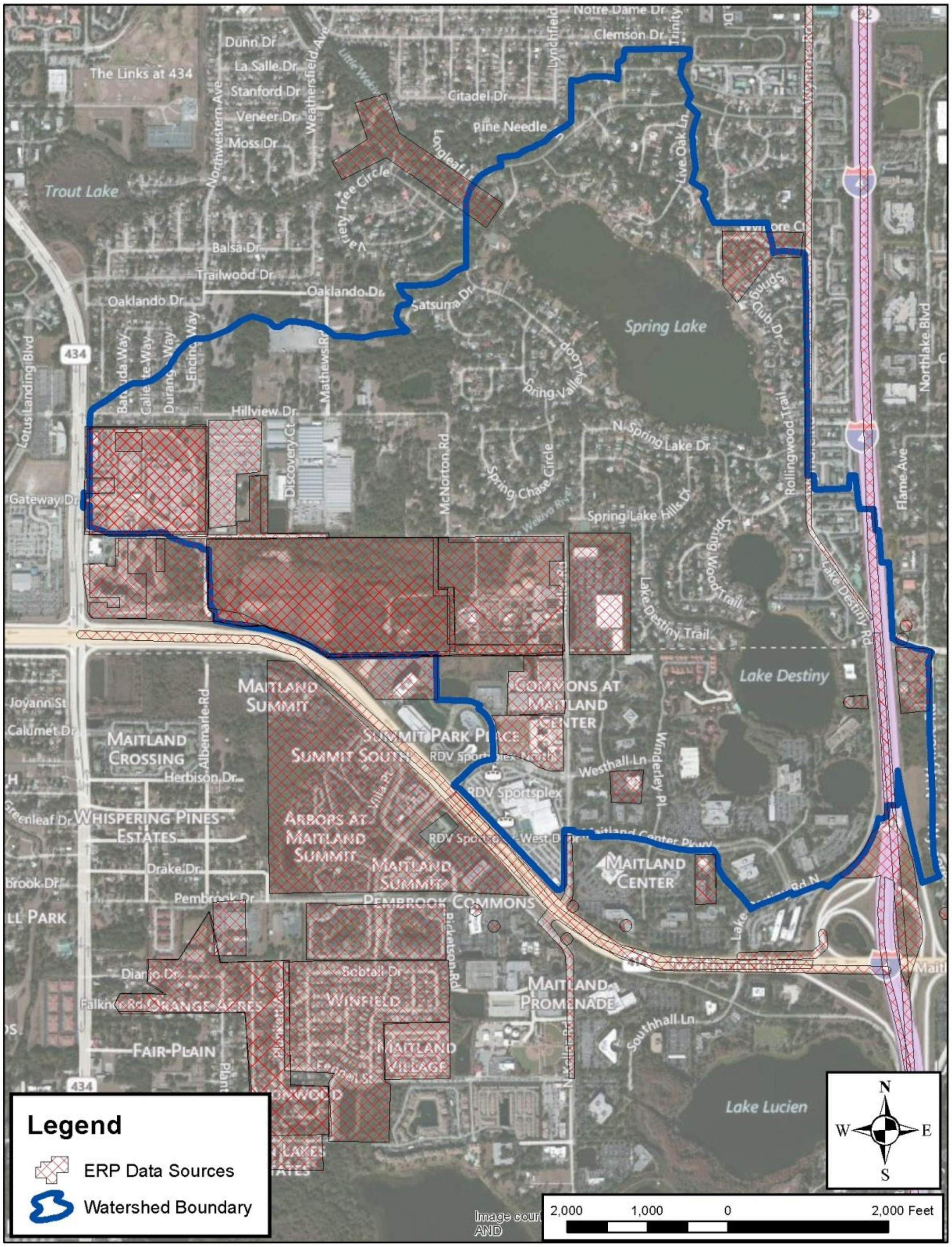

Figure 2-1: Spring Lake ERPs Collected

Figure 2-2: Gateway Georeferenced ERP Plan Set

LiDAR – As a portion of the FEMA flood plain update SJRWMD commissioned LiDAR to be flown over the Seminole County portion of the Spring Lake Watershed. The dataset included raw LiDAR data points and breaklines, however each data set was generated from a different data provider and reviews of the two data sets produced elevation inconsistencies, concluding that the two datasets were not compatible with one another. To generate the DEM to use for hydraulic model parameterization, only the LiDAR points were used.

Land Use Coverage – SJRWMD provides updates to the land uses throughout the District approximately every three years. The latest land use update occurred in 2012. This land use served as the basis for the watershed land use which was subsequently updated based upon model condition aerials and “as-builts”.

Soils Coverage – developed and maintained by the Natural Resource Conservation Services (NRCS) was also obtained from the SJRWMD web site. This dataset included both Orange County and Seminole County soil surveys. It is of note that the many portions of the residential land immediately around Spring Lake in Seminole County were characterized as Urban Land, These areas were characterized as soil Type A/D consistent with adjacent land uses.

2.3.2. Seminole County Data

The Spring Lake Watershed and a majority of direct inflows into the lake fall under Seminole County's MS4. As such, Seminole County has inventoried a significant portion of these designated MS4 outfalls and obtained, at a minimum, the horizontal location of each outfall. Other available County data included, historic subdivision plats and plan sets and water quality data through the Seminole county watershed atlas. Specific descriptions of each data set obtained from Seminole County are described below.

Stormwater Inventory – a county wide initiative from the Public Works Department, sought to locate the storm sewer system throughout the Seminole County, beginning with major outfalls and proceeding to the secondary system. While every effort was made to accurately depict the system, occasional errors, omissions or misrepresentations occurred within the data set. Also, feasibility dictated that only the spatial location and not the vertical location of data were captured, through the inventory. As applicable and available in the Spring Lake Watershed, the Seminole County inventory was verified and incorporated into the Spring Lake GWIS inventory, while maintaining links to the original County data throughout the process.

Design Plan Sets – Various design/construction plan sets were provided by Seminole County. Each plan set was scanned, digitally catalogued and hyperlinked to the "SPRING_LAKE_DATA_SOURCES" GIS polygon feature class shown in **Figure 2-3.**

Little Wekiva Watershed Management Plan – The Wekiva River WMP included Spring Lake and Lake Destiny, at coarse level of detail necessary to characterize flows into the Little Wekiva River, this study was the basis for the FEMA FIS update in 2007, which was used to set the 100 year levels in these two lakes as a basis of comparison this study.

Figure 2-3: Seminole County Historic Plan Set and Plats in the Spring Lake Watershed

2.3.3. Orange County Data

Contours at one foot increments were collected, basin by basin in the 1970's and 1980's by Orange County. This data has since been spatially rectified and digitized. In the Wekiva Basin the contours were collected prior to the extension of Maitland Blvd (SR 414) to Forrest City Road (SR 434), and subsequently before much of the development along Maitland Blvd. Where conditions had not significantly changed between the 1980's and present, these contours represented a more accurate representation of the topography than the USGS 5 foot interval contours. Where conditions had changed, watershed delineations from as-built construction plans were deemed more accurate.

2.3.4. City of Maitland Data

Stormwater Lake Management Plan (SLMP) – The City of Maitland completed a city-wide Stormwater Lake Management Plan in July 1996. This study included Lake Destiny which is the southern portion of the Spring Lake Watershed. The City of Maitland SLMP was subsequently updated in 2007 and focused on in-lake conditions rather than the secondary drainage network. The lake delineation for Lake Destiny served as a starting point and outer boundary, which was then refined based upon storage in the watershed and as-built permit conditions.

2.3.5. City of Altamonte Springs

Gateway Drive Extension – Although permitted design plans for the Gateway Drive extension were available through SJRWMD. This project is currently underdevelopment and represents a significant watershed development. As the construction was not underway at the time of the SJRWMD LiDAR, the updated topography was not captured in the DEM. In a meeting with Altamonte Springs, details of the project were reviewed and the future plan for the area clarified. The city showed the conceptual master plan, highlighting the future development along Gateway Drive that will receive treatment and compensatory floodplain storage from the ponds west of the WWTP, currently under construction. Altamonte Springs also clarified the connectivity between the existing ponds and the bypass pipe set up to convey the current extent of the offsite drainage area.

Altamonte Springs WWTP – The City of Altamonte Springs provide a tour of the WWTP on Keller Rd. A few of the key points and observations from the tour included how the stormwater onsite is treated and conveyed; clarification that the open water feature at the corner of Keller Rd and McNorton Rd was used to supplement reuse water supply and not part of the storm sewer system. Further, the plant is permitted to have a wet weather discharge through a 48" outfall pipe in to the Little Wekiva River taking any discharges from the plant itself out of the Spring Lake Watershed. This pipe also receives flow from the wetland west of the WWTP entrance road off of McNorton Rd through a control structure as pictured in **Figure 2-4**. This connection effectively removes a portion of the water from the Gateway Drive area out of the Spring Lake Watershed.

Figure 2-4: Outfall Structure near McNorton Road

2.4. Structure Inventory Development

As part of the Spring Lake Watershed Study, Atkins gathered and digitally catalogued available information related to the Spring Lake Watershed stormwater collection system. Starting with Seminole County's stormwater inventory, additional data was collected through ERPs or in the field to complete the GWIS stormwater inventory coverage. **Figure 2-5** shows the final inventory with data fields hyperlinked to the GIS feature spatially available through the ArcMap BaseMap.mxd, specifying the metadata related to each feature. The metadata includes ERP plans, Seminole County inventory documents, and field reconnaissance. Inventory parameters such as size, shape and material were also populated when readily available. The inventory represents a complete coverage for the Seminole County/Spring Lake portion of the watershed and substantially complete dataset in the Orange County/Lake Destiny portion. Storm water inventory in the Orange County portion was digitized only to the extent it was readily available and needed to provide accurate boundary delineation. Many stormwater elements outside of the watershed boundary have also been included clarifying the watershed boundary delineation decisions and to assist in completing Seminole County's Countywide inventory.

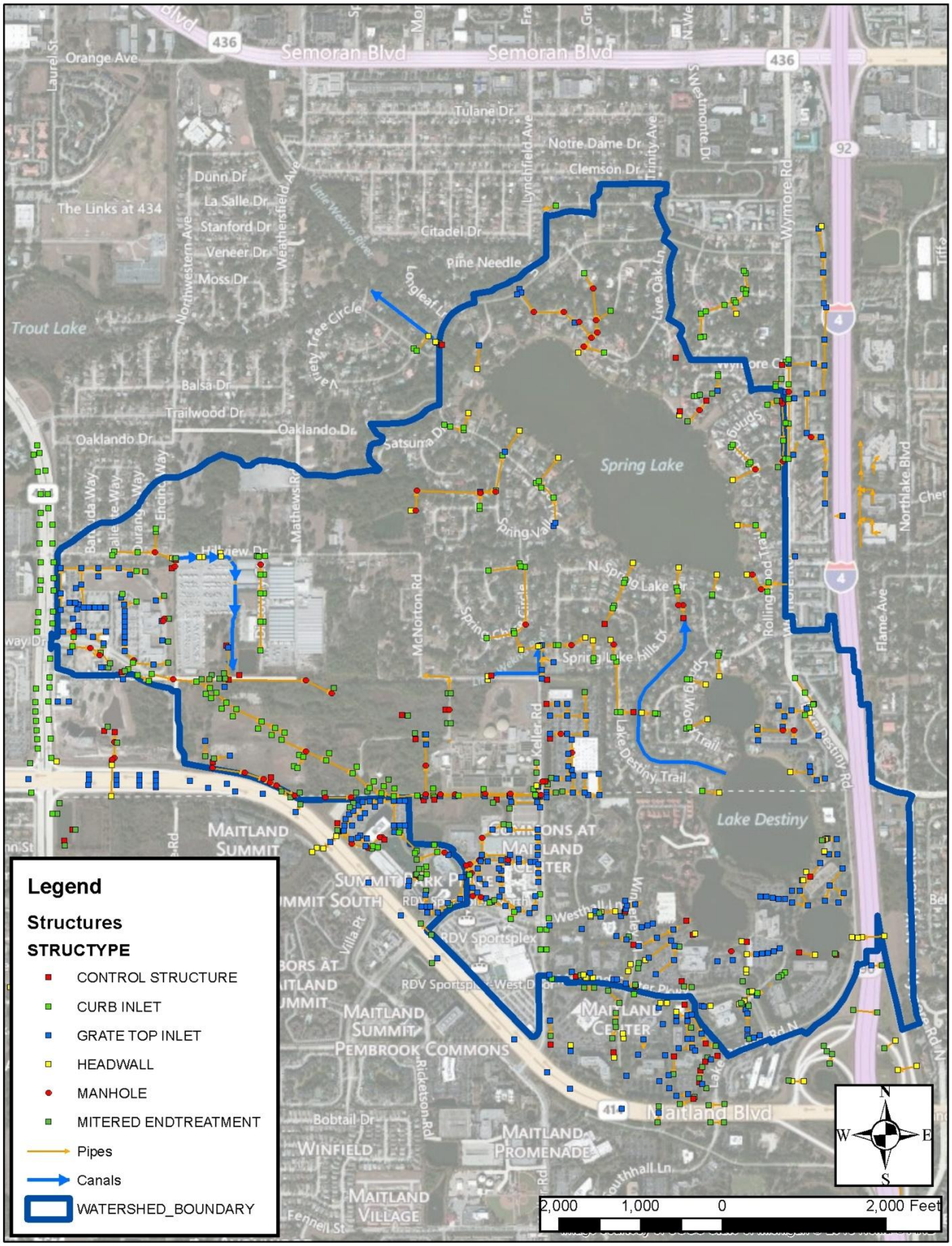

Figure 2-5: Spring Lake Detailed Stormwater Inventory

2.4.1. Field Data Collection

To supplement and verify existing stormwater inventory data from Seminole County and collected plans, Atkins staff performed a field reconnaissance effort to ensure all stormwater elements have been identified and connectivity correctly depicted. Photographs were taken at all sites visited as part of this project and hyperlinked to the stormwater inventory feature class. **Figure 2-6** shows an example of the fields available at each inventory point and how digital documents and photos have been hyperlinked to the stormwater inventory elements. Notice in the identify window the pipe feature class is related to the INV_HYPERLINK table which lists the available photos and documents linked to each hydraulic element point. Each of these documents when selected will open in a separate window.

Atkins staff visited the majority of the stormwater elements in the watershed, excluding minor inlets and those with ERP “as-builts”. At each location, at a minimum, an accurate spatial locations was captured and connectivity between the storm sewer system verified. Each site visited also had a maintenance evaluation performed noting system deficiencies. For stormwater elements considered significant in scale to include in the hydraulic model, the size, shape, material and inverts distance below edge of pavement were documented and converted to a GWIS hydraulic element points. Hydraulic Element Points are the building blocks of the hydraulic model and described in more detail in Section 4.

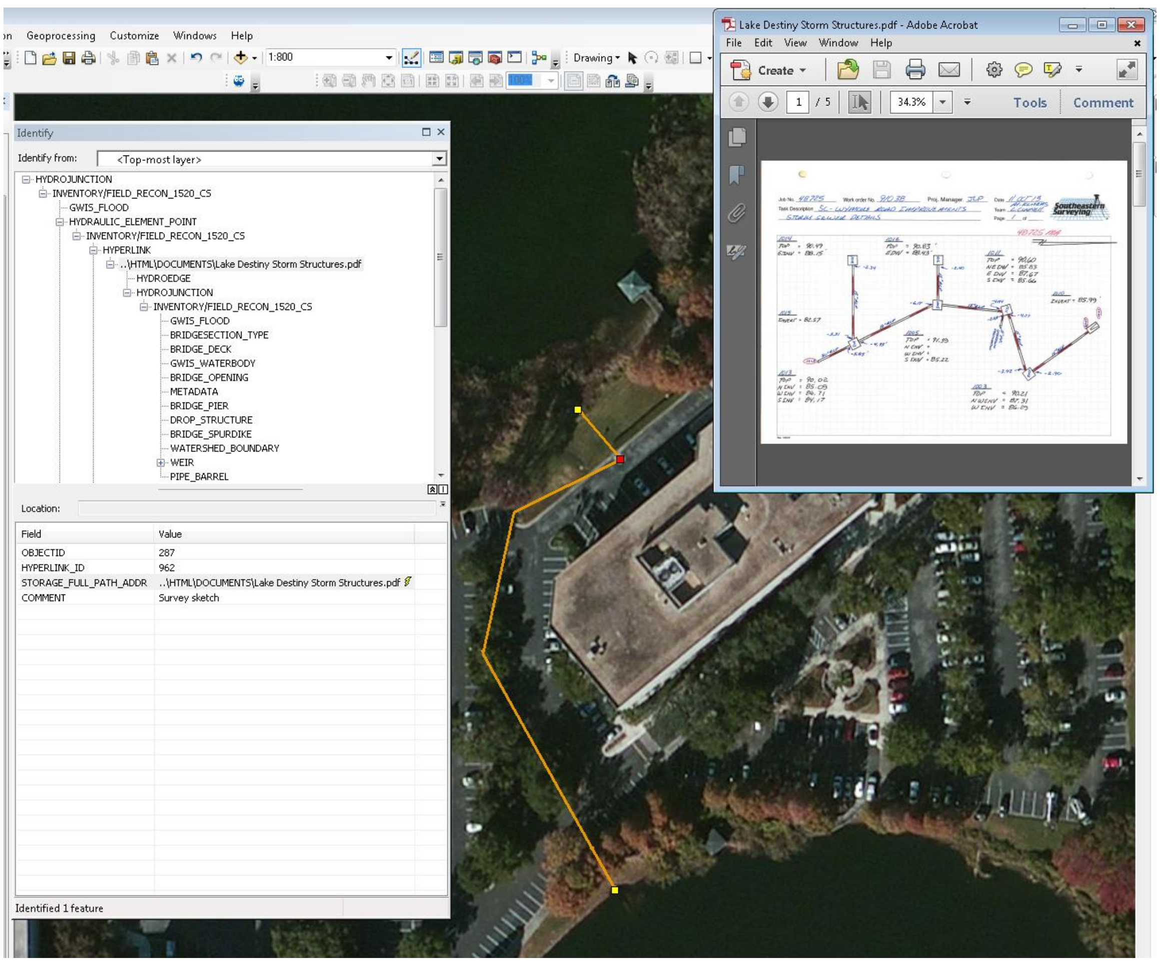

Figure 2-6: Example of Digital Data Collected and Field Hyperlinking

2.4.2. Maintenance Evaluation

Each structure visited in the field had a maintenance evaluation performed by a professional engineer. Evaluations were performed to identify system deficiencies and identify areas where the stormwater system would not perform as simulated due to a maintenance concern. In general maintenance conditions throughout the system were in fair to good condition with few obvious structural defects. The age of the system, particularly in the commercial areas adjacent to Lake Destiny and Spring Lake Estates area was evident in looking at pipe material and configurations. However, only in isolated cases, did these appear deficient. **Figure 2-7** shows the location of maintenance issues identified as immediate and material to proper storm sewer operations. Descriptions of each of the identified maintenance concerns are detailed below.

Maintenance Issue #1 – The inlet located at Hamlin T Lane has two trash can lids partially blocking the outfall pipe. The lids should be removed and discarded.

Maintenance Issue #2 – The steel grate is missing from the top of the control structure causing a potential safety hazard and increased probability of debris entering the inlet, blocking flow. The structure should be considered for full replacement, at a minimum the grate should be replaced.

Maintenance Issue #3 – Significant sediment has built up downstream of the culvert outfalls, in the roadside swale may causes excess roadway flooding on Hillview Drive. The swale should be cleaned and regraded to the culvert outfalls.

Maintenance Issue #4 – The gap under the wall north of McNorton Road appears to be designed to convey water from the culvert under McNorton and including the significant drainage area from the Publix Shopping complex and Gateway Drive area. This critical feature seems prone to overgrowth and blockage, as well as, the potential of structural failure of the wall itself. While, it is not anticipated that peak conditions will change as a result of the Gateway improvements, however it is anticipated that with the system upgrades and associated routine maintenance, will cause more low flows through the area and an increasing the opportunities for a structural failure.

Maintenance Issue #4a – Existing culvert crossing the access road to Altamonte Springs WWTP off McNorton Rd contains both sediment in the pipe and sediment in the upstream and downstream topography leading away from the culvert. This impacts the controlling elevation for water flowing to Spring Lake compared to the controlling elevation of the structure into the WWTP 48” wet weather discharge pipe. During design storm events, the roadway will overtop rendering the culvert flow minimal, however, the conditions of this culvert will impact normal flow conditions. It is also of note that as part of the Gateway road extension an additional culvert in parallel with the existing crossing of the WWTP access road, which as well, may limit the necessity of flows through the existing access road culvert.

Maintenance Issue #5 –Much of the stormwater collection system south of Lake Destiny is filled with sediment and leaves. Permits were not available for the majority of these systems as they predate the SJRWMD, however, visual observations indicate that the conveyance capacity appears greatly reduced through these systems. Coordination should occur between the City of Maitland and private system owners to improve maintenance of the stormwater system to prevent adverse impacts to roadways.

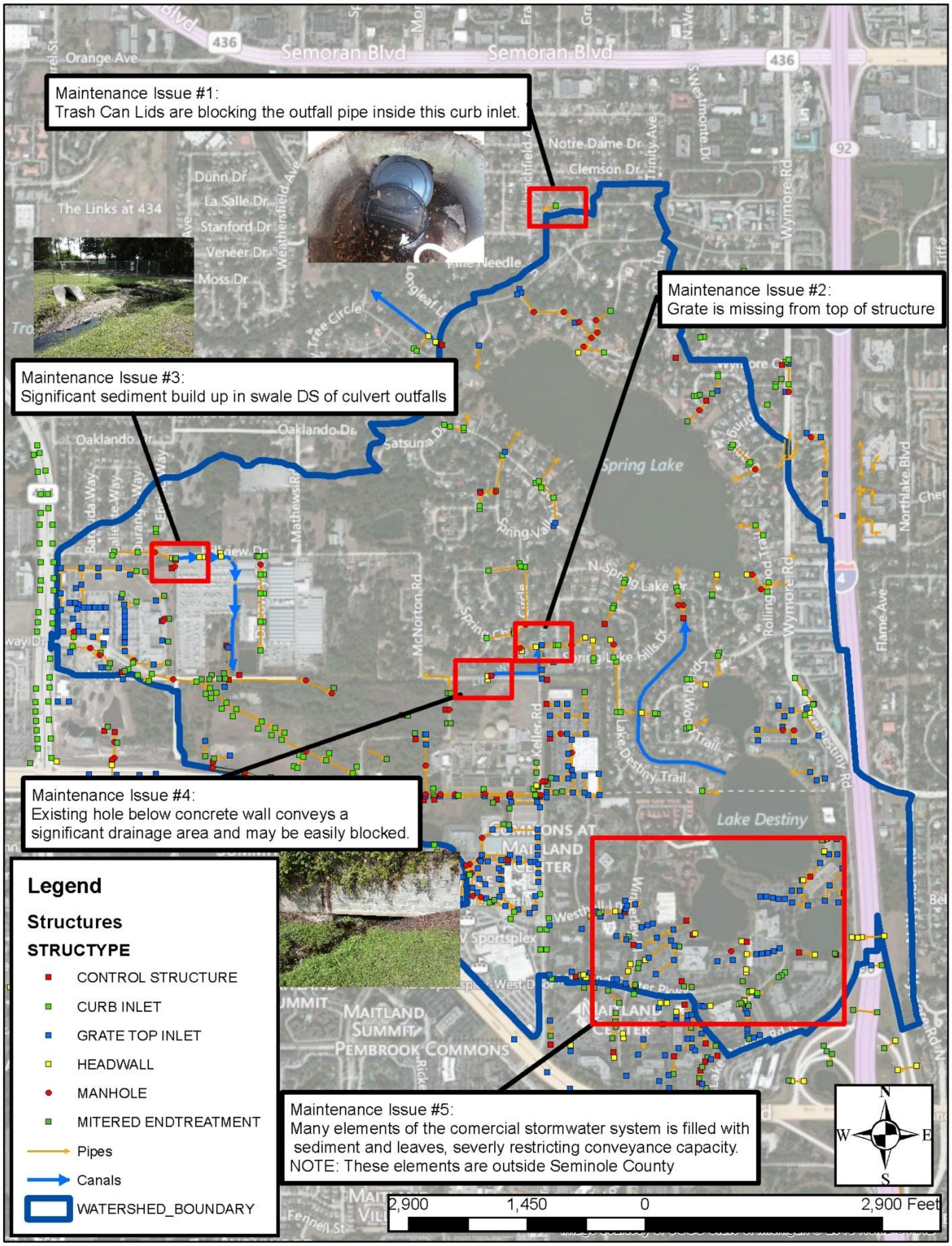

Figure 2-7: Maintenance Evaluation Summary

2.5. Watershed Topography

Watershed parameterization and subbasin delineation is based upon accurate topographic information. Topographic data is used for determining the watershed storage capacity, irregular cross sections, and floodplain delineation. The main source of topographic information for this project was Seminole County LiDAR and Orange County 1-foot Contours supplemented by data obtained from the ERPs to fill-in topographic voids. Topographic voids include areas where recent improvements in the watershed are not reflected in the digital topography or the area within the watershed neither covered by the Seminole County nor the Orange County datasets. As noted in Section 2.2.1 the use of the SJRWMD LiDAR data included only the Raw LiDAR points not the breaklines which were deemed inconsistent with the raw LiDAR data.

The topographic data sources were merged into a single DEM and the resulting Spring Lake DEM is shown in **Figure 2-8** and included in the digital deliverable, projected to NGVD29 vertical datum and NAD 1983 Florida State Plain East horizontal datum. The DEM shows that the project area generally slopes from south to north towards the Little Wekiva River with elevations ranging from about 110 ft NGVD29 at the east boundary, to about 60 ft NGVD29 at the Spring Lake outfall.

Note: Vertical Datum NGVD29 is used through out this analysis for consistency with existing data collected and ERPs collected within the watershed. Elevation difference between NGVD29 and NAVD88 is 1.0 foot, where elevation expressed in NGVD29 is 1.0’ higher than elevations in NAVD88’. This conversion value was used whenever it was necessary to convert data provided in NAVD88’ into NGVD29’.

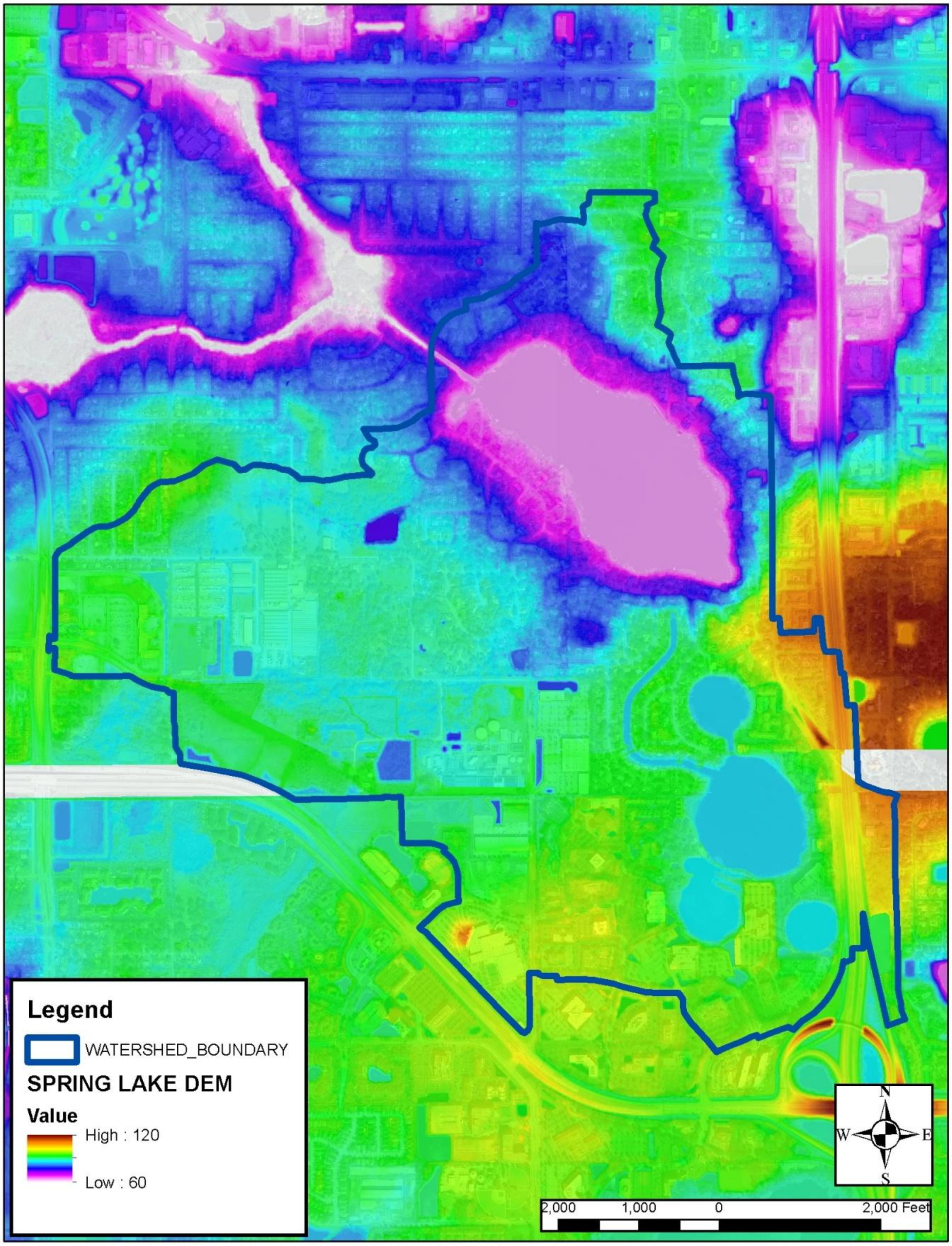

Figure 2-8: Spring Lake Watershed Topography

2.6. Water Quality Data

The main objective of this Spring Lake project is to provide inflows which will feed into ERD's work product and ultimately improve water quality conditions in Spring Lake. The ERD work effort will focus on in-lake conditions and includes the collection of water quality samples taken within the lake, including a specific emphasis on inflow culverts from the Seminole County MS4. The inflow sampled data will be incorporated into an in-lake model including nutrient budget leading to BMP recommendations necessary to improve lake water quality conditions. The data collected by ERD, expands upon the existing data collected by Seminole County, the Florida Department of Environmental Protection (FDEP), and Lake Watch volunteers accumulated into the Seminole County Watershed Atlas.

An independent analysis of the existing water quality data was performed for this report which confirmed the nutrient impairment condition under either the TSI or FDEP's newer numeric nutrient criteria (NNC) impairment criteria. Numeric nutrient flow chart for high colored lakes is presented in **Figure 2-9**. As shown in the Figure, for a high colored lake with geometric mean chlorophyll-a level greater than 20 ug/L, yields an impairment threshold of 1.23 mg/L for Total Nitrogen (TN) and 0.05 mg/L threshold for Total Phosphorus (TP). Exceeding these levels also results in a base chlorophyll-a target of 20 ug/L.

Relevant water quality data presented by the Watershed Atlas is provided in the digital deliverable in the Misc_Ref_Materials\WaterAtlas folder with graphs of the water quality metrics reproduced in **Figures 2-10** through **2-15** and including TSI, total nitrogen, total phosphorus, uncorrected chlorophyll-a, color, and alkalinity. As seen in the graphs, data between 2003 and 2013 shows that while many individual data points are below the impairment threshold, there are a sufficient number to exceed the NNC annual geometric mean threshold to satisfy the impairment listing designation.

The latest water quality values collected by Seminole County in September 2013 are below the target values for TN and TP, of having values of 1.125 mg/L total nitrogen, 0.028 mg/L total phosphorus, the corrected chlorophyll-a value of 27 ug/L chlorophyll-a exceeds the threshold. Again, using NNC requires an annual geometric mean and these are only discrete indications, the full nutrient budgeting is required to solidify the site specific lake conditions necessary to assimilate nutrients and restore Spring Lake.

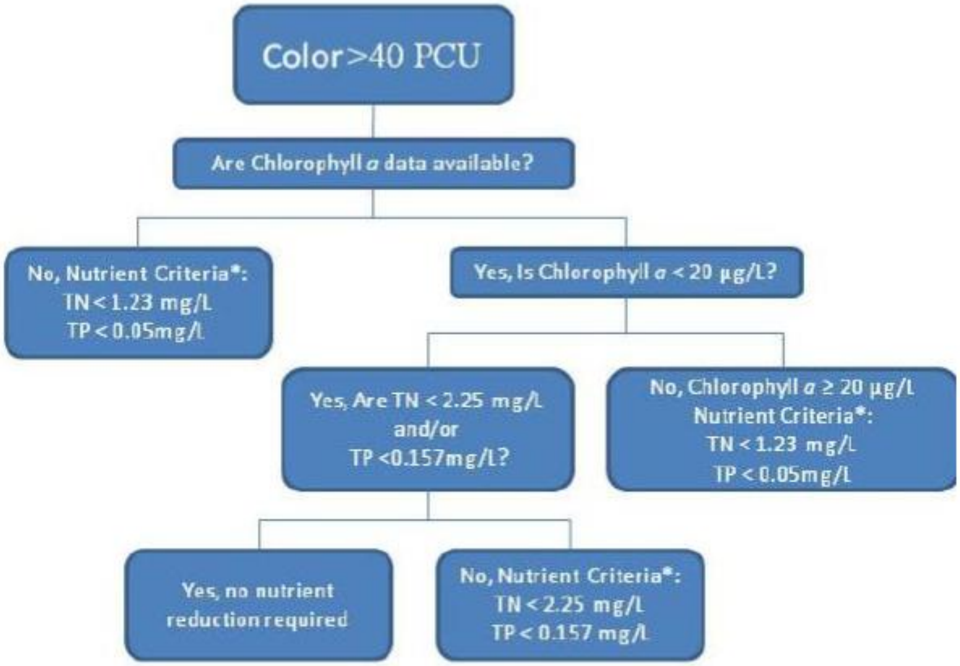

Figure 2-9: Numeric Nutrient Criteria for High Colored Lakes

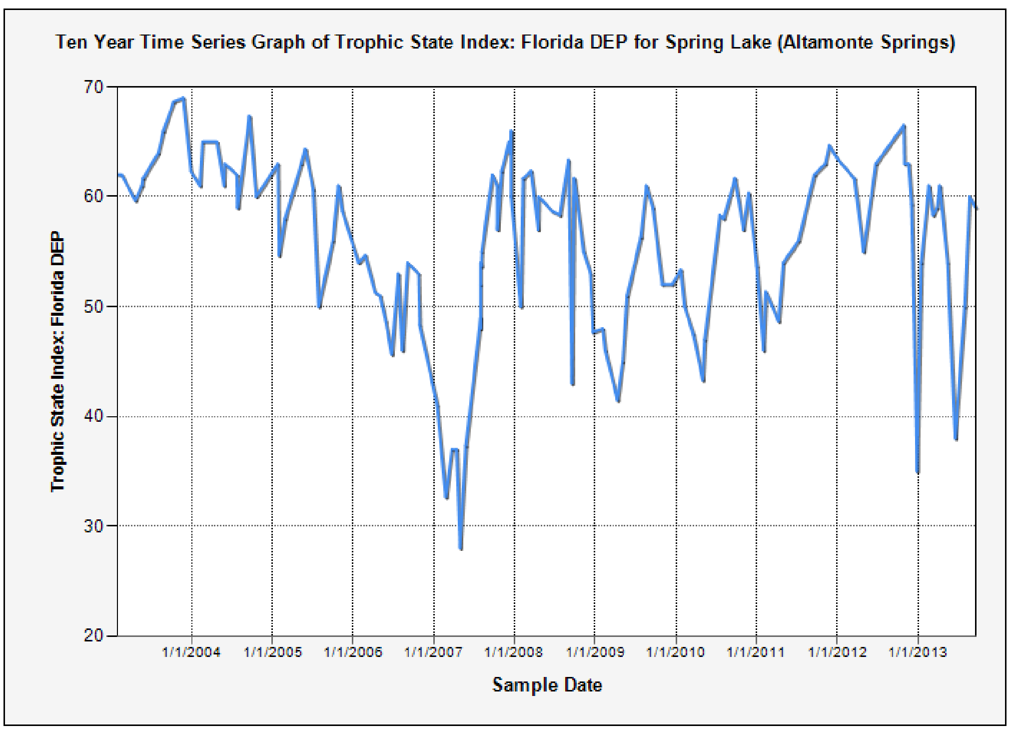

Figure 2-10: Spring Lake Water Quality Data (TSI)

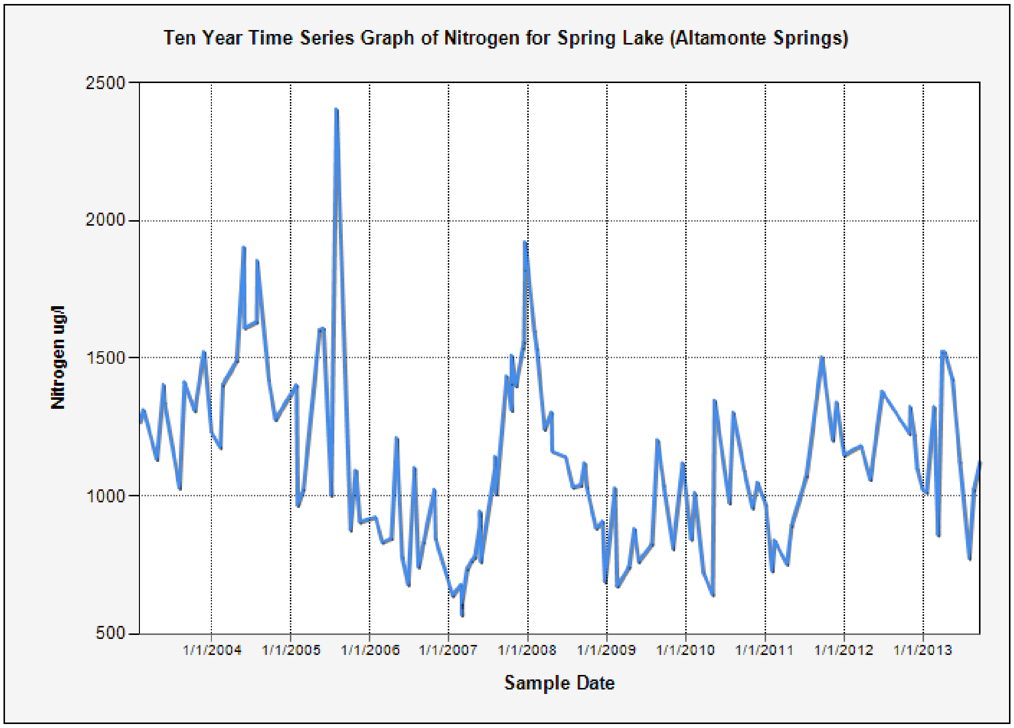

Figure 2-11: Spring Lake Water Quality Data (Total Nitrogen)

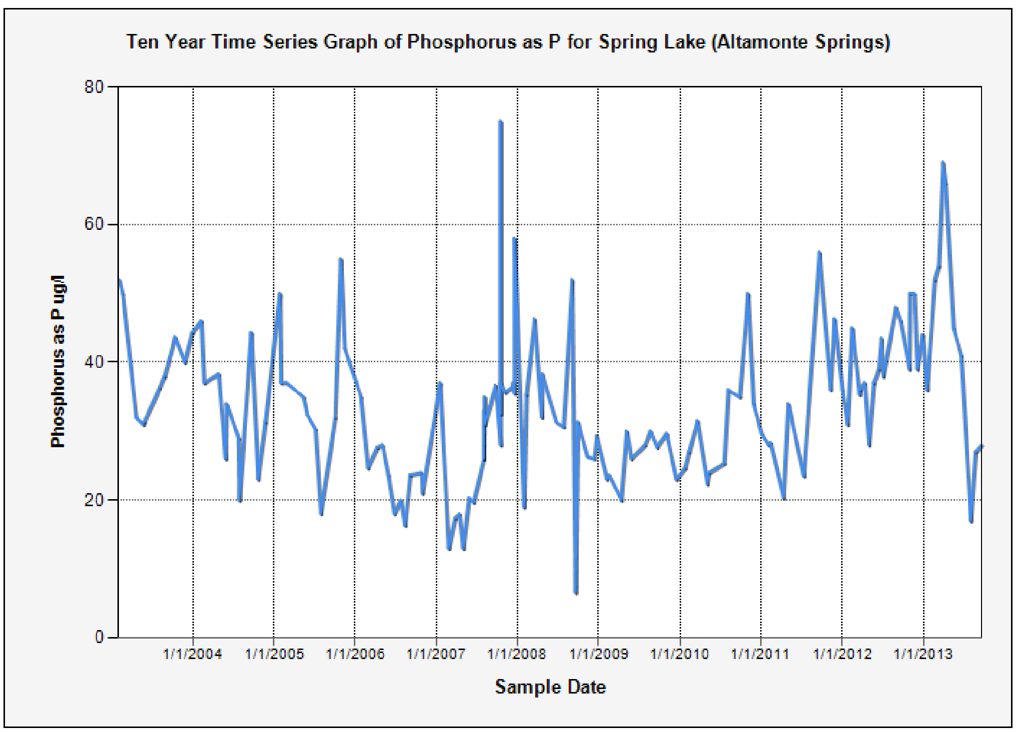

Figure 2-12: Spring Lake Water Quality Data (Total Phosphorus)

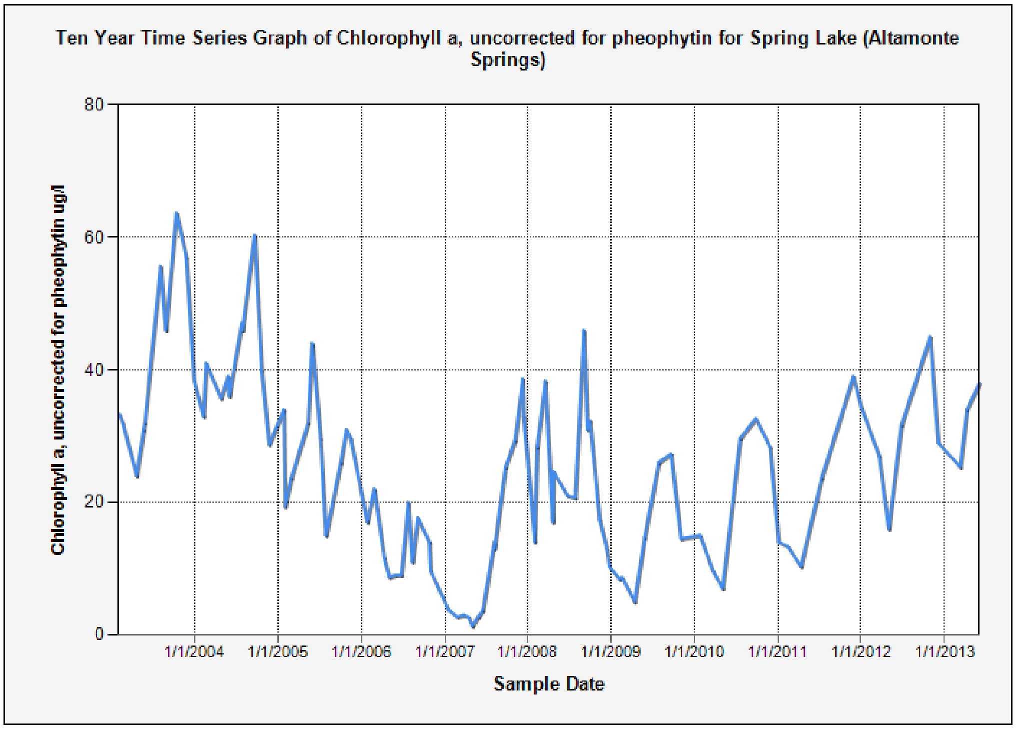

Figure 2-13: Spring Lake Water Quality Data (Uncorrected Chlorophyll a)

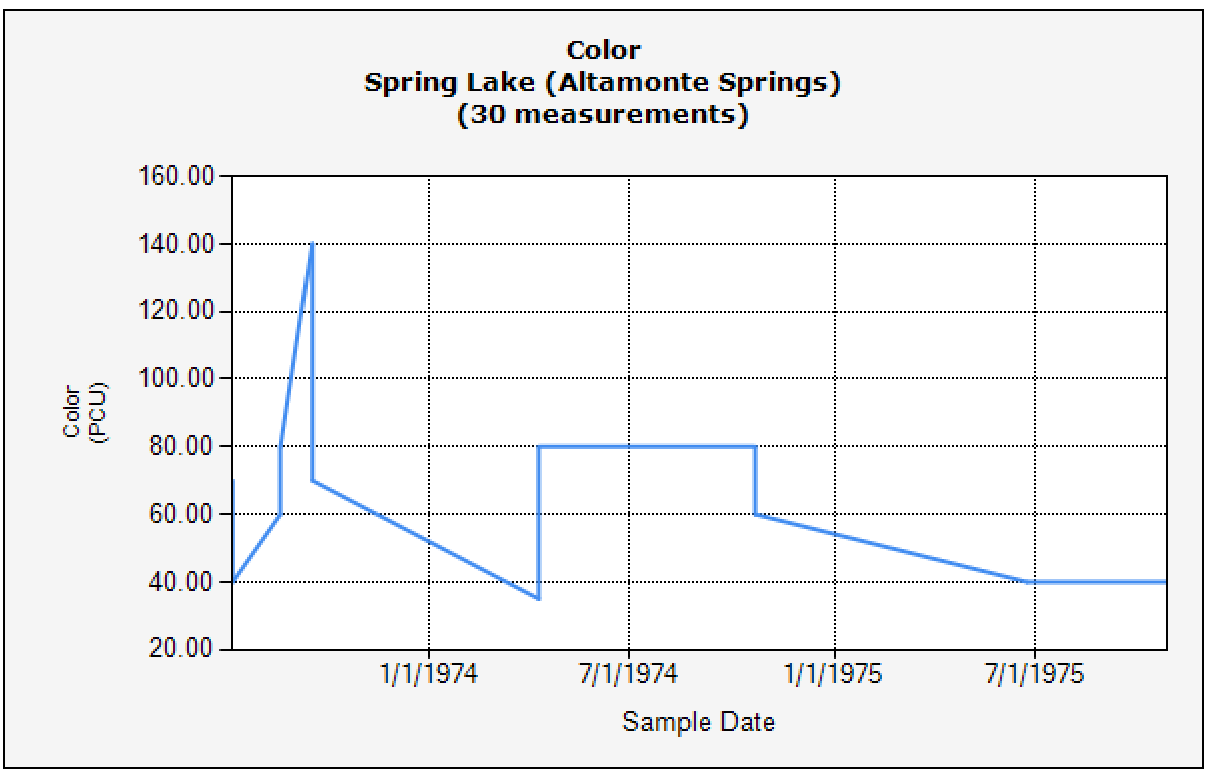

Figure 2-14: Spring Lake Water Quality Data (Color)

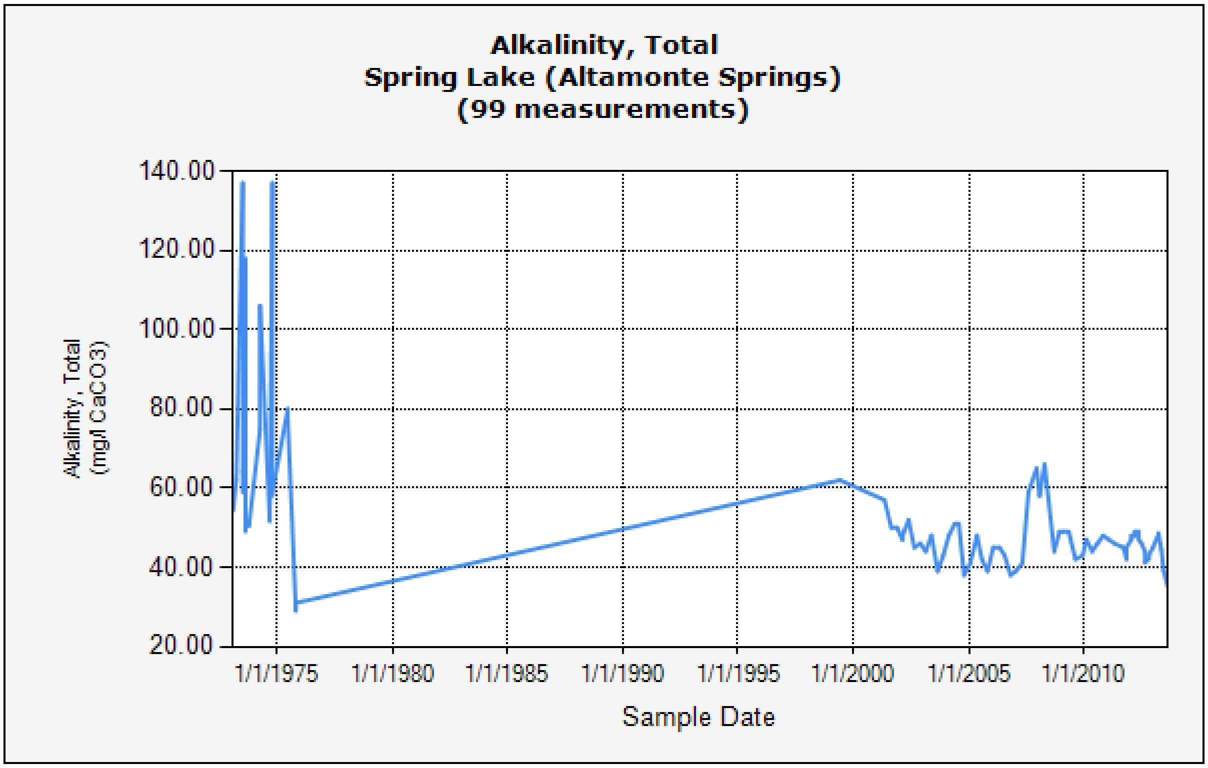

Figure 2-15: Spring Lake Water Quality Data (Alkalinity)

3. Hydrologic Model Development

The hydrologic analysis consists of generating information that characterizes and defines the runoff component of the watershed. This includes watershed characterization, subbasin delineations, soils and land use characterizations, as well as, hydrologic runoff parameterization. The results of the hydrologic analysis consist of ICPRv3 model input parameters sufficient to generate simulated runoff from design storms on the Spring Lake watershed.

3.1. Sub-basin Delineation and Characterization

The Spring Lake watershed is mostly built-out with a combination of transportation, residential, and commercial land uses. Each of these features altered the natural drainage patterns in the watershed and to comply with permit regulations a series of sub-surface drainage pipes were added to route water to retention ponds or around houses. Using the available ERP plans for the developments including Gateway Drive, I-4 and the various other developments within the watershed, a preliminary delineation was formed. This delineation was then further refined through the structures inventory combine with the DEM automated flow paths and field investigations.

In total, the 1.6 square mile Spring Lake Watershed was delineated into 77 unique subbasins with largest basins being direct rainfall on Lake Destiny and Spring Lake of basin sizes 102 and 138 acres respectively. Excluding the two lakes, the median and mean subbasin sizes are 6.7 and 10.7 acres respectively, which indicates the extensive level of detail for the watershed analysis. **Figure 3-1** depicts the resulting Spring Lake watershed delineation. For ease of identification and characterization, the subbasins were aggregated into five groups, as shown in **Figure 3-2,** with the basin summary statistics of each watershed group presented in **Table 3-1**.

Table 3-1: Spring Lake Watershed Group Summary

Watershed Group	Area (acres)	# of Subbasins	Minimum SubBasin Size (acres)	Maximum SubBasin Size (acres)
Gateway	300	29	1.2	43.8
Downstream of Gateway	85	13	0.7	26.1
Spring Lake	360	18	2.0	148.5
Lake Destiny	258	14	2.5	102.1
I-4	41	3	7.4	21.1
Total	1044	77		

Gateway – In the western portion of the watershed, the Gateway group covers 300 acres and extends from SR 434 at the Gateway shopping Center to the Altamonte Springs Waste Water Treatment Facility (WWTP) on the East. The terrain in the gateway group is in the process of alteration due to the current construction of the Gateway Drive extension from SR 434 to Keller Road and the associated development adjacent to Gateway Drive. As part of the construction, a bypass pipe has been installed to convey water from commercial areas south of the roadway to the north in addition to stormwater treatment pond and flood plain compensatory ponds associated with the roadway construction. Discharge from the Gateway group will either cross the WWTP access off of McNorton Rd or enter the wet weather discharge pipe from the WWTP. Note: Water entering the WWTP's wet weather discharge pipe takes water out of the Spring Lake watershed and discharges it to the Little Wekiva River downstream of Trout Lake, between SR 434 and the Spring Lake outfall.

Downstream of Gateway – This Group consists of basins between the Gateway group and Spring Lake. The Downstream of Gateway group covers 85 acres and receives flow from both the Gateway Group, as well as, 50% of the flow out of Lake Destiny, through one of its two lake control structures. Flow from the Gateway group crosses the WWTP access road then McNorton Rd prior to going under the wall that serves as the boundary of the Spring Valley Chase Subdivision. From under the wall, flow is combine with discharge from the Spring Valley Chase stormwater pond before it enters the main feature in the Downstream of Gateway group, the central wetland within the Spring Lake Hills Subdivision. This wetland serves as a blending point between water from Lake Destiny and Gateway prior to discharging into Spring Lake.

Spring Lake – The 84 acre Spring Lake is the central feature in this group and the ultimate receiving waterbody for each of the other groups. The Spring Lake group covers 360 acres of residential and open water land uses and includes 13 direct stormwater discharges. These discharges included treated and untreated stormwater and are part of the focus of the on-going in-lake nutrient budget work performed by ERD. The lake has a single outfall over a free discharge weir structure on the west end of the lake, sending water to the Little Wekiva River.

Lake Destiny – The Lake Destiny group includes drainage from both Orange and Seminole County and includes a combination of commercial, high density residential (apartments), and single family residential land uses. The central features in the 258 acre Lake Destiny group are four interconnected water features. Lake Destiny, Spring Wood Lake and Lake Lomond representing 31, 8, and 9 acres of open water respectively are essentially a single open water feature separated by a canal on the north and dense vegetation on the south. The fourth water feature, termed "No Name" Lake is a 6 acre lake that discharges into Lake Destiny through a pipe and smart box in the commercial property between the two lakes, effectively maintaining no name lake slightly higher than Lake Destiny. The Lake Destiny group receives water from the I-4 group to the east and discharges into Spring Lake through two outfall structures, both located in the access channel at the northwest portion of the lake. The northern most discharge structure at the end of the access canal discharges directly into Spring Lake, while the other located mid-way down the canal discharges into Spring Lake via the wetland in the Downstream of Gateway group in the Spring Lake Hills Subdivision.

Interstate 4 (I-4) – The I-4 group is the smallest of the Spring Lake Watershed groups, including just 3 basins and made up entirely of transportation and transportation drainage land uses associated with Interstate 4 discharging across Lake Destiny Drive into the No-Name Lake in the Lake Destiny Group. Prior to discharge into No-Name Lake, the drainage from I-4 is routed into a stormwater pond on the east side of the road. While there is a permitted plan set that alters the I-4 drainage along this outfall, which included decreasing the size of the pipes under I-4 from dual 42" to dual 36" pipes, these were not incorporated into this model update, as those construction efforts are not currently underway and there are possibilities that the stormwater drainage in this area maybe altered again to supersede the permitted plans.

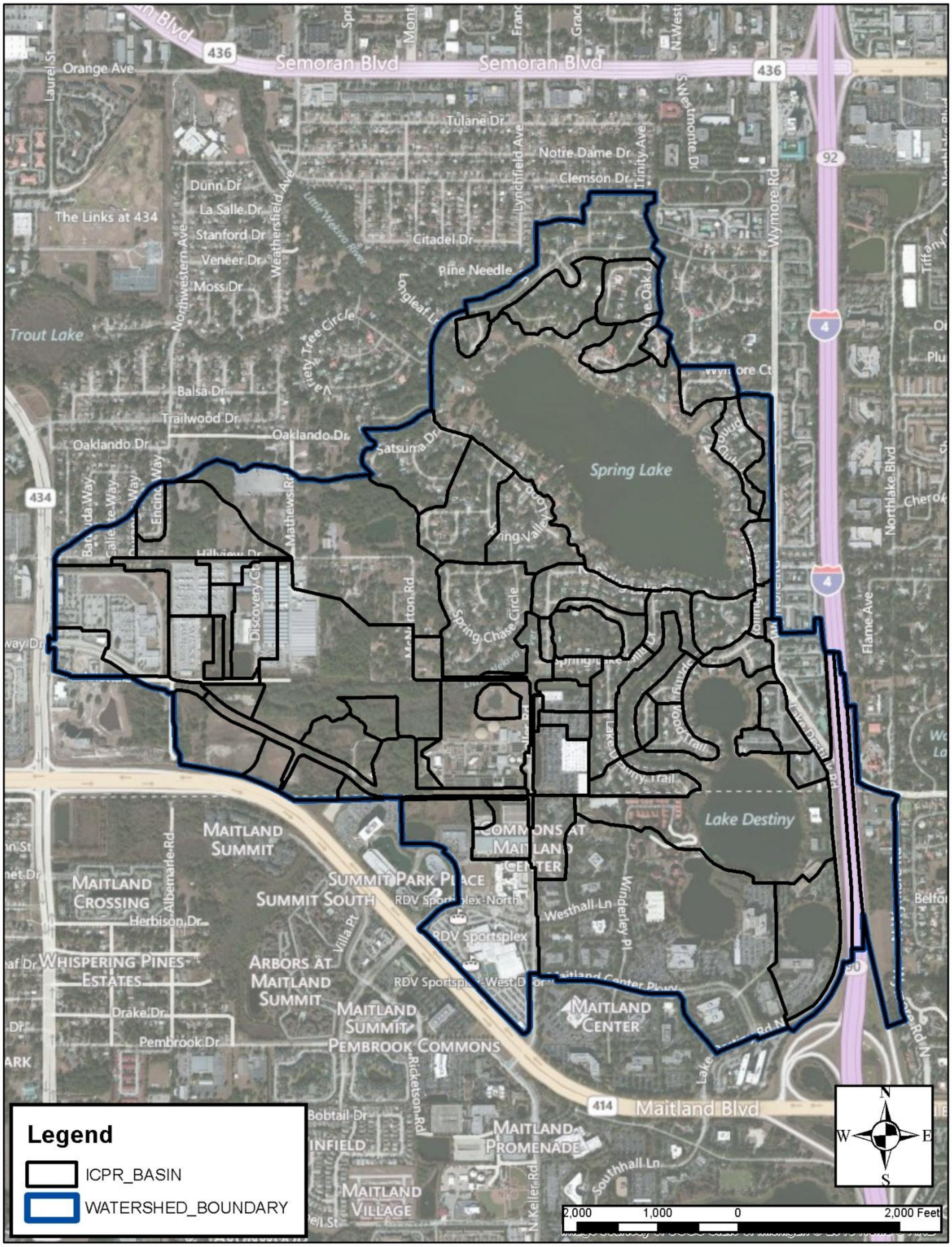

Figure 3-1: Spring Lake Basin Delineation

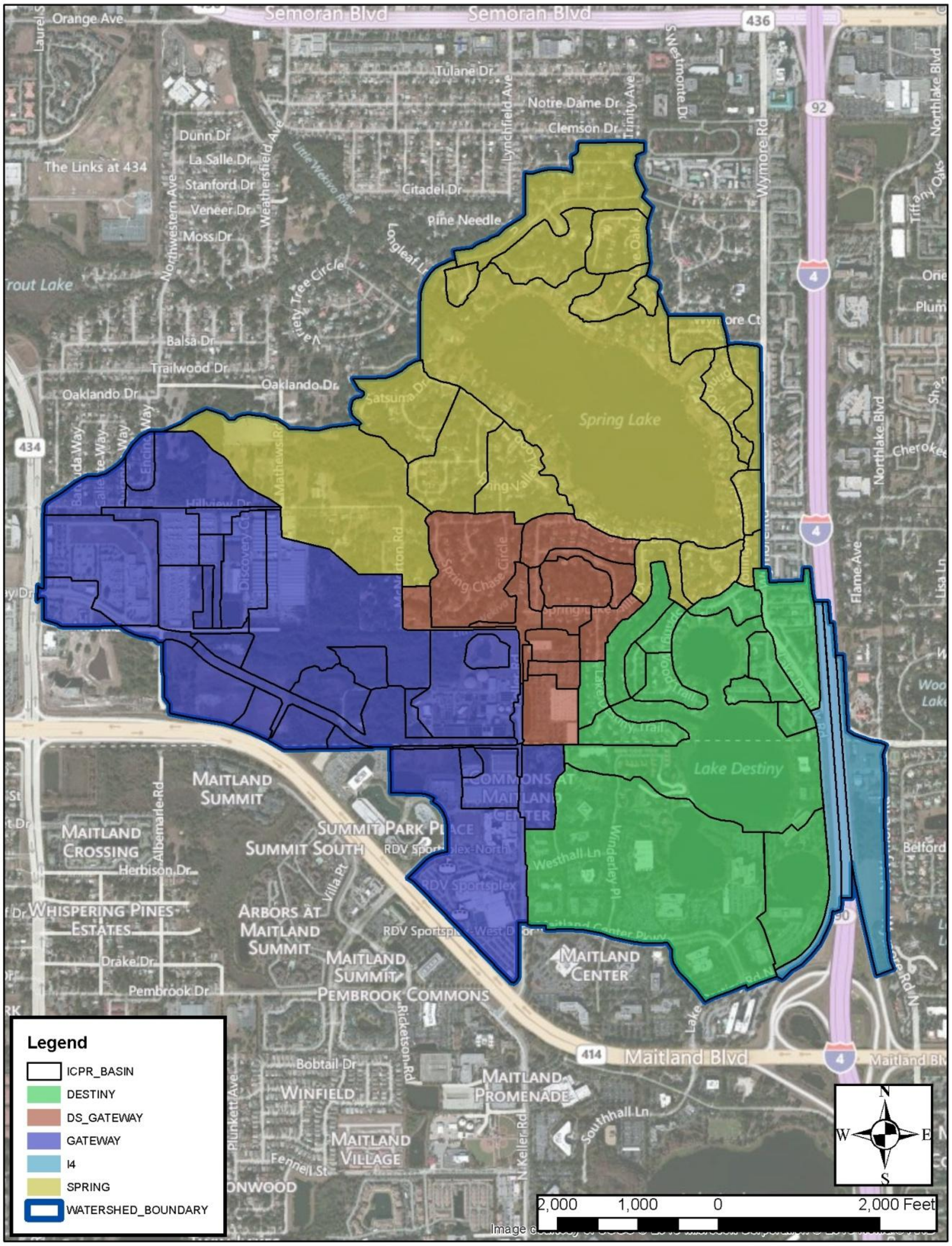

Figure 3-2: Spring Lake Subwatershed Groups

3.2. Land Use Characterization

The primary sources of land uses in the Spring Lake watershed were obtained from the SJRWMD's GIS land use coverage representing 2011 conditions. The coverage is based on the Florida Land Use and Cover Classification System (FLUCCS). The land use map was subsequently updated to incorporate areas of recent development, particularly along the Gateway Drive extension and improve level of detail to provide appropriate runoff volumes. **Figure 3-3** shows the updated area's land use map.

The primary land use in the Spring Lake Watershed is residential surrounding Spring Lake followed by commercial around Lake Destiny and along Gateway drive. Medium Density residential covers 334 acres and 32% of the watershed while commercial covers 285 acres or 27% over the watershed. **Table 3-2** shows the percentage land use distribution by category and watershed group.

Table 3-2: Spring Lake Land Use Distribution

Land Use Description	Lake Destiny (%)	DS of Gateway (%)	Gateway (%)	I-4 (%)	Spring Lake (%)	**Watershed %**	**Watershed (acres)**
Commercial and services	41%	20%	49%	20%	2%	**27%**	**285**
Disturbed land			1%			**<1%**	**2**
Waste Water Treatment Plant		<1%	7%			**2%**	**21**
Institutional				4%	1%	**<1%**	**4**
Residential, high density	17%		2%	<1%		**5%**	**50**
Residential, low density		4%	4%		8%	**4%**	**43**
Residential, medium density	17%	70%	6%		59%	**32%**	**334**
Residential, rural			<1%			**<1%**	**1**
Roads and highways	1%		5%	56%		**4%**	**41**
Lakes	19%				24%	**13%**	**134**
Pits, retention ponds	1%	2%	7%		1%	**3%**	**28**
Surface water collection basins			<1%	9%		**1%**	**6**
Emergent aquatic vegetation	<1%	1%				**<1%**	**2**
Freshwater marshes	2%		3%			**1%**	**14**
Herbaceous upland nonforested			2%	11%		**1%**	**11**
Hydric pine flatwoods			<1%			**<1%**	**1**
Improved pastures			3%		3%	**2%**	**20**
Mixed scrub-shrub wetland			2%			**1%**	**7**
Mixed upland nonforested			<1%			**<1%**	**1**
Upland hardwood forests			1%		3%	**1%**	**15**
Upland mixed			4%		<1%	**1%**	**11**
Wet prairies			1%			**<1%**	**2**
Wetland forested mixed		3%	2%			**1%**	**9**
Total (acres)	**258**	**85**	**300**	**40**	**360**		**1044**

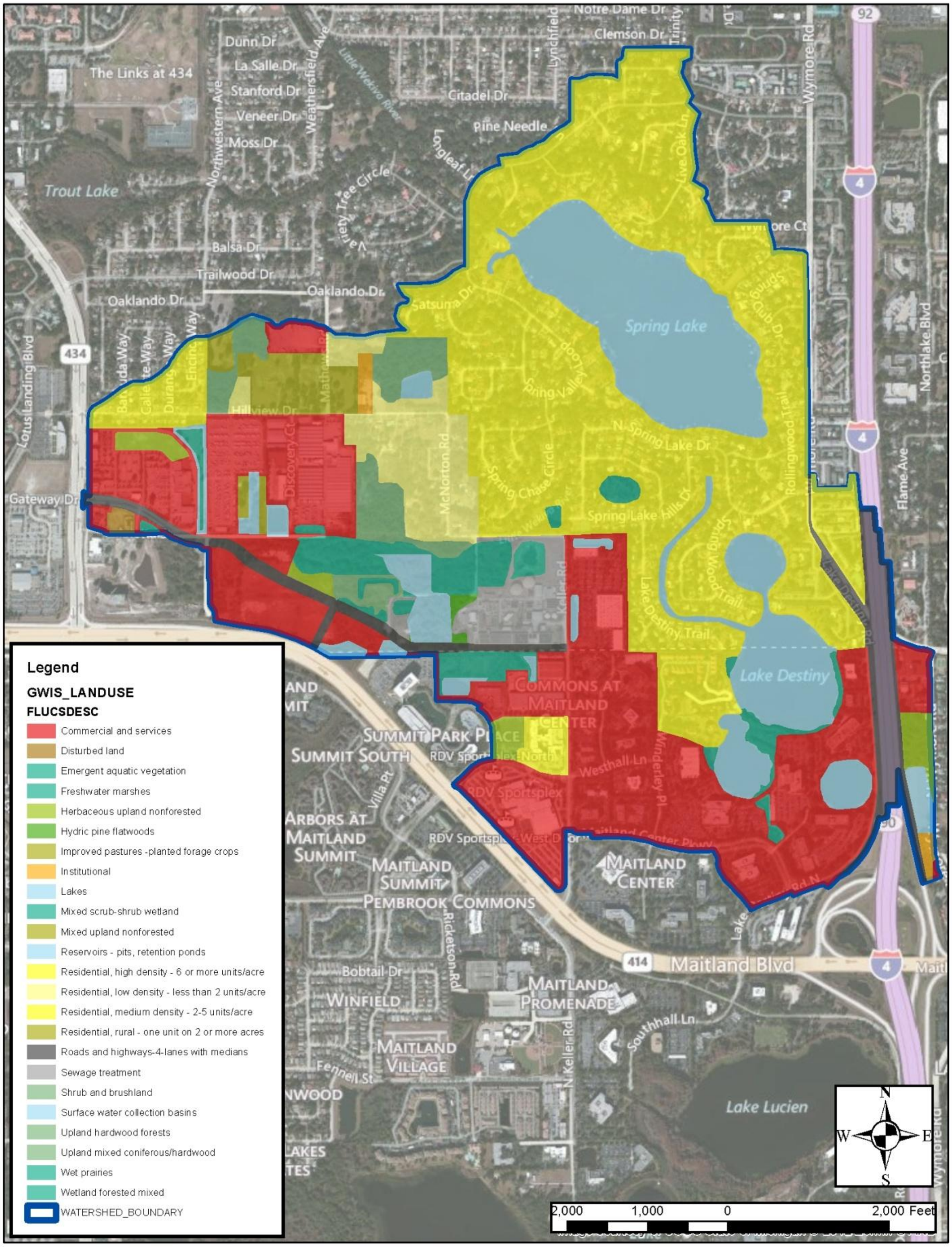

Figure 3-3: Spring Lake Landuse Coverage

3.3. Soil Characterization

Hydrologic Soil Data for the Spring Lake Watershed was obtained from the SJRWMD GIS soils coverage, which combines the United States Department of Agriculture – Natural Resource Conservation Service (formerly USDA/SCS) soil data from Orange and Seminole Counties. Soils are classified by their hydrologic characteristics. The hydrologic soil groups (HSG) designation for soils is used to estimate runoff from precipitation. There are four major HSG groups A through D. In addition to these major groups, “water”, is classified independently representing a land surface that is mostly impervious. Also, combination types A/D and B/D represent soils that act more permeable during drought conditions than in storm conditions. For these soil types, under design simulations, the soil characteristics were assumed to act more similar to type D hydric soils than their well drained drought characteristic. The areal coverage of each soil type is seen in **Figure 3-4** and tabulated over the watershed group in **Table 3-3**. As seen in the table the majority of the watershed falls in the A/D category, which is a combination of A/D soils and soils characterized as Urban Land, which denotes areas where development has disturbed the soils and it is no longer representative of its original characteristics. This is followed by soil type A on the ridges between wetland strands.

- HSG A: Soils having high infiltration rates when the groundwater elevation exceeds 3 feet of depth. Soil types comprising this group generally include deep well drained to excessively drained sands that produce significant rainfall losses as infiltration.
- HSG B: Soils having a moderate infiltration rate when saturated. This group is chiefly comprised of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture.
- HSG C: Soils having a slow infiltration rate when saturated. This group consists chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture.
- HSG D: Soils having a very slow infiltration rate and high runoff potential. These consist primarily of soils that have a permanent high water table; soils that have a clay pan, clay layer, or other relatively impermeable material at or near the surface; or mucky wetland soils.

Table 3-3: Spring Lake Watershed Soil Type Summary

Hydric Soil Type	Area	Watershed Percentage
A	310	30%
A/D	572	55%
B	0	0%
B/D	22	2%
C	0	0%
D	0	0%
Water	140	13%

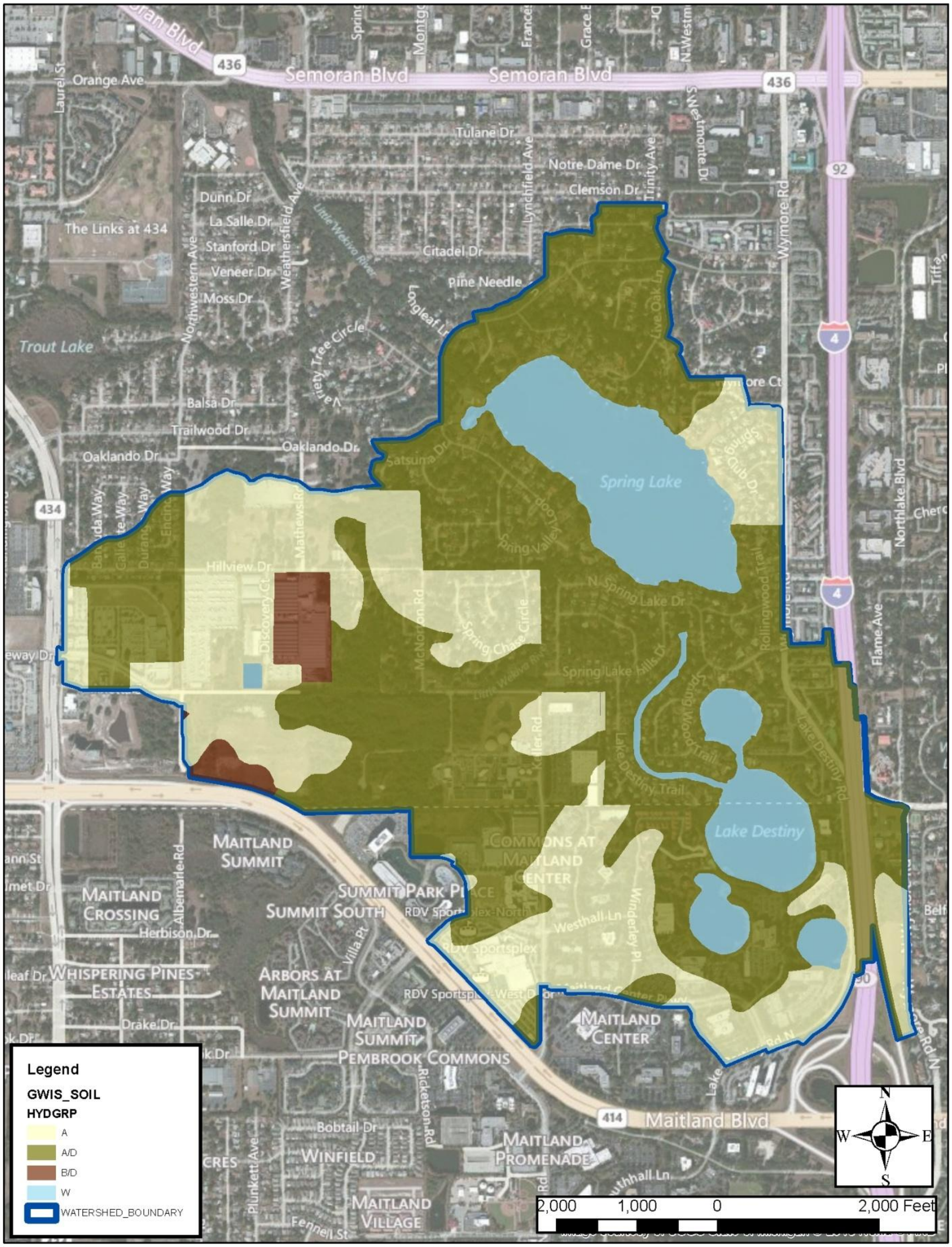

Figure 3-4: Spring Lake Soil Coverage

3.4. Hydrologic Parameterization

Hydrologic parameterization consists of calculating basin runoff characteristics from underlying soils and land use coverages generate runoff characteristics by subbasin. Hydraulic parameterization including curve number calculations, unit hydrograph methods, directly connected impervious area (DCIA), and time of concentration detailed as follows.

3.4.1. Curve Number Calculations

Hydrologic rainfall abstraction in the Spring Lake watershed is calculated with the SCS Curve Number method, as incorporated in the ICPR software. In general, the Curve Number (CN) values were established using typical literature values associated with the various land use/soil categories intersected with watershed subbasins. The values represent the non-DCIA portion of a specific land use area, as the DCIA had already been broken out as a model parameter. Internal model runoff calculations will treat the DCIA portion of a subbasin as 100% runoff while utilizing the assigned CN for the remaining non-DCIA portion. CN calculations based upon an area weighted contributions from each individual land use / soil combination have been included as part of the digital deliverable. **Table 3-4** displays the CN lookup table used for hydrologic calculations including DCIA for each Land Use.

Table 3-4: Soil / Land Use Curve Number Lookup Table

Land Use Description	FLUCC	A	B	C	A/D	B/D	D	Water	DCIA (%)
Low Density Residential	1100	47	66	77	81	81	83	100	0
Rural Development	1180	42	64	73	78	78	80	100	0
Medium Density Residential	1200	49	67	78	81	81	83	100	75
Apartments / HDR	1300	56	72	81	84	84	85	100	62
Commercial	1400	41	61	72	75	75	77	100	78
Institutional	1700	53	70	80	83	83	84	100	31
Pasture	2110	49	69	79	82	82	84	100	0
Herbaceous	3100	63	71	81	85	85	89	100	0
Shrubs	3200	35	56	70	74	74	77	100	0
Rangeland	3300	49	69	79	82	82	84	100	0
Upland Hardwood	4200	36	60	73	76	76	79	100	0
Hardwood Conifer	4340	36	60	73	76	76	79	100	0
Lakes	5200	98	98	98	98	98	98	100	100
Ponds	5300	98	98	98	98	98	98	100	100
Flatwoods	6250	98	98	98	98	98	98	100	96
Wetlands	6300	98	98	98	98	98	98	100	98
Marshes	6410	98	98	98	98	98	98	100	100
Wet Prairies	6430	98	98	98	98	98	98	100	98
Emergent Vegetation	6440	98	98	98	98	98	98	100	100
Shrub Wetland	6460	98	98	98	98	98	98	100	95
Disturbed Land	7400	77	86	91	93	93	94	100	0
Transportation	8140	64	77	84	87	87	88	100	30
WWTP	8340	81	88	91	92	92	93	100	50
Retention Ponds	8370	81	88	91	92	92	93	100	100

3.4.2. Unit Hydrograph Method

The SCS unit hydrograph method was used to convert precipitation excess into a runoff hydrograph. A synthetic unit hydrograph with a shape factor of 323 was used for this watershed. This value of the shape factor is considered adequate for areas with mild slopes and relatively flat terrain, such as those in the Spring Lake Watershed.

3.4.3. Directly Connected Impervious Area

DCIA is a critical hydrologic parameter when using the SCS-CN method. In general, the values of DCIA were established using typical literature values associated with the various land use categories. However, the values were adjusted based on actual site conditions in the watershed.

3.4.4. Time of Concentration Calculations

The time of concentration (Tc) for hydrologic modeling was calculated as the sum of the overland, shallow concentrated and channel flows for the path identified for each subbasin. Tc paths were developed using Arc Hydro's longest flow path tool then clipped to terminate at the initial storage area or stormwater collection inlet. Each line was split into three flow types; overland, shallow concentrated, and channel. The aerial photographs and DEM were the main data source used for Tc path determination.

In some cases Tc values were determined to be minimal due to limited drainage area, extensive stormwater collection system, or significant directly connected impervious area, in each case a point was created to identify these areas and a Tc value was assigned based on engineering judgment

The Tc overland flow component was calculated based on the SCS TR-55 method, using the following formula:

$$T_c = \frac{.07\,(\mathrm{n} \times L)^{0.8}}{\mathrm{P}^{0.5}\ \mathrm{S}^{0.4}}$$

Where:
L= Length (feet)
n= Surface roughness coefficient
S= Slope of hydraulic grade line (feet/feet)
P= 2-year, 24-hour rainfall (inches)

The shallow concentrated flow component of the Tc was calculated using the velocity method. Tc calculations of less than ten (10) minutes were increased to a 10 minute minimum.

3.4.5. Hydrologic Parameterization Summary

Using the hydrologic parameterization presented herein, basin characteristics were calculated for each subbasin. The resulting parameters for each of the 77 subbasins in the Spring Lake watershed are presented in **Table 3-5** including area, CN, time of concentration (TC) and DCIA for each basin.

Table 3-5: Spring Lake Subbasin Summary Statistics

Basin	Area (acres)	CN	DCIA (%)	TC (min)
Gateway Group				
GATEWAY_0010	3.8	81.3	75	11
GATEWAY_0020	7.1	80.5	75	14
GATEWAY_0040	26.7	74.6	68	13
GATEWAY_0050	8	54	78.5	20
GATEWAY_0060	18	48.5	12.5	18
GATEWAY_0070	3.2	42	76.2	10
GATEWAY_0080	3.5	46.6	53.2	10
GATEWAY_0090	3.5	43.9	76.3	12
GATEWAY_0100	2.1	62.5	40.4	10
GATEWAY_0120	7.3	77.8	50.2	12
GATEWAY_0130	2.1	44.2	96.5	10
GATEWAY_0140	8.3	42.3	68.6	20
GATEWAY_0160	12.5	51.8	80.8	15
GATEWAY_0170	13.5	56.7	76.8	15
GATEWAY_0180	3.8	56	75.3	15
GATEWAY_0200	5.3	74.6	81.3	15
GATEWAY_0210	1.4	77.9	89.5	10
GATEWAY_0220	32.5	81	75	20
GATEWAY_0230	8.6	45.5	77.9	24
GATEWAY_0240	1.2	87.5	57.2	12
GATEWAY_0260	7.7	74.1	80	10
GATEWAY_0265	1.6	80	87	10
GATEWAY_0290	1.4	80.4	86.1	10
GATEWAY_0310	43.8	67	72.2	39
GATEWAY_0330	2	91.8	73.7	10
GATEWAY_0340	4.6	76.2	99.1	10
GATEWAY_0350	40	73.7	48.9	63
GATEWAY_0375	23.4	90.5	59	35
GATEWAY_0380	3.6	84.6	88	10
I-4 Group				
I4_0010	21.1	72	50.6	26
I4_0020	7.4	86.5	30	45
I4_0030	12.1	81.2	38.4	38
Spring Lake Group				
SPRING_0010	6.2	81.3	75	10
SPRING_0020	8.1	81.3	75	10
SPRING_0030	2.6	81.3	75	10
SPRING_0040	3.8	81.3	75	10
SPRING_0050	6.2	50	75	14
SPRING_0060	7.4	48.8	75	13
SPRING_0070	5.7	63.2	75	10
SPRING_0080	9.5	81.3	75	14
SPRING_0090	23.5	81.3	75	35
SPRING_0100	12.5	81.3	75	10
SPRING_0130	6.5	81.3	75	11
SPRING_0150	2	81.3	75	10
SPRING_0160	2.9	81.3	75	14
SPRING_0170	18.2	72.3	70.3	10
SPRING_0180	62.9	52.6	15.9	36
SPRING_0190	18.4	80.3	75	14
SPRING_0200	15.4	79.7	75	11
SPRING_0210	148.5	77.2	89.4	20
Lake Destiny Group				
DESTINY_0010	21.6	49.8	83.9	18
DESTINY_0020	102.1	56	79.4	28
DESTINY_0030	2.9	83.7	62	10
DESTINY_0040	14.8	84.7	54.7	14
DESTINY_0050	5.6	83.8	61.3	10
DESTINY_0060	2.6	83.7	62	12
DESTINY_0070	4.7	81.3	75	13
DESTINY_0080	3.4	81.3	75	11
DESTINY_0090	5.7	81.3	75	17
DESTINY_0095	7.3	79.6	75.1	14
DESTINY_0100	71.6	78	86.6	25
DESTINY_0110	4.3	76.6	75.4	19
DESTINY_0120	2.5	81.3	75	10
DESTINY_0130	9	81.9	82.2	10
Downstream of Gateway Group				
DS_GATEWAY_0010	9.7	66.1	80.3	14
DS_GATEWAY_0040	0.7	41.3	78	12
DS_GATEWAY_0050	2.8	52.2	78	12
DS_GATEWAY_0060	4.2	41.8	83.2	12
DS_GATEWAY_0075	4.1	73.7	11.6	22
DS_GATEWAY_0090	26.1	56.5	75.2	19
DS_GATEWAY_0100	4.7	74.1	75.4	16
DS_GATEWAY_0120	1.5	81.3	75	10
DS_GATEWAY_0130	3.1	78.7	75.4	11
DS_GATEWAY_0140	5.3	78.4	75.1	14
DS_GATEWAY_0150	8.3	81.8	81.8	10
DS_GATEWAY_0160	4.2	81.3	75	10
DS_GATEWAY_0170	10.3	81.3	75	20

4. Hydraulic Model Development

Hydrologic and hydraulic parameters for each subbasin were developed consistent with the ICPRv3 model requirements. Hydraulic parameters included geometry of conveyance structures and overland weirs, stage-area relationships, roughness coefficients, starting water elevations, base-flow and boundary conditions. Following is a description of the application of these parameters to the Spring Lake model.

4.1. Hydraulic Feature Development Process

Hydraulic features in the watershed including natural channels, pipes, storage areas, overland flow elements, and road overflows were developed using data from existing stormwater inventories, ERPs, and field reconnaissance. The Seminole County Stormwater Inventory combine with the City of Maitland and Altamonte Springs inventories provided, at a minimum, the connectivity and location of many of the stormwater features in the watershed. District ERPs which often contained as-built drawings, engineering plans, and reports containing drainage feature data, used to build the geometric data for hydraulic features in the watershed. In total 66 permits with an additional 26 permit revisions were collected and evaluated for inclusion. ERPs are located in the digital deliverable in the (..\HTML\PLANS) project folder.

Once the review of existing data was completed, the extent of the field data collection effort was determined, and a field visits made to verify and retrieve additional hydraulic information. As much of the data from the stormwater inventories contained only horizontal information, data was needed to complete the hydraulic inventory sufficient for modeling, including pipe size, invert and material. A survey benchmark was identified at each location using the LiDAR data. Spot elevations at road centerlines or edge of pavement, or a nearby easily-identified field features were used. All collected data (survey, permits, plans, etc.) were assembled into the GWIS Hydronetwork. **Figure 4-1** shows the hydraulic inventory map. The inventoried hydraulic features summarized by type are as shown in **Table 4-1**.

Table 4-1: Spring Lake Watershed Summary of Hydraulic Features

Feature Type	Count
Control Structures	28
Inlets/Outlets	63
Structural Weirs	4
Channel	2
Pipe Segments	107

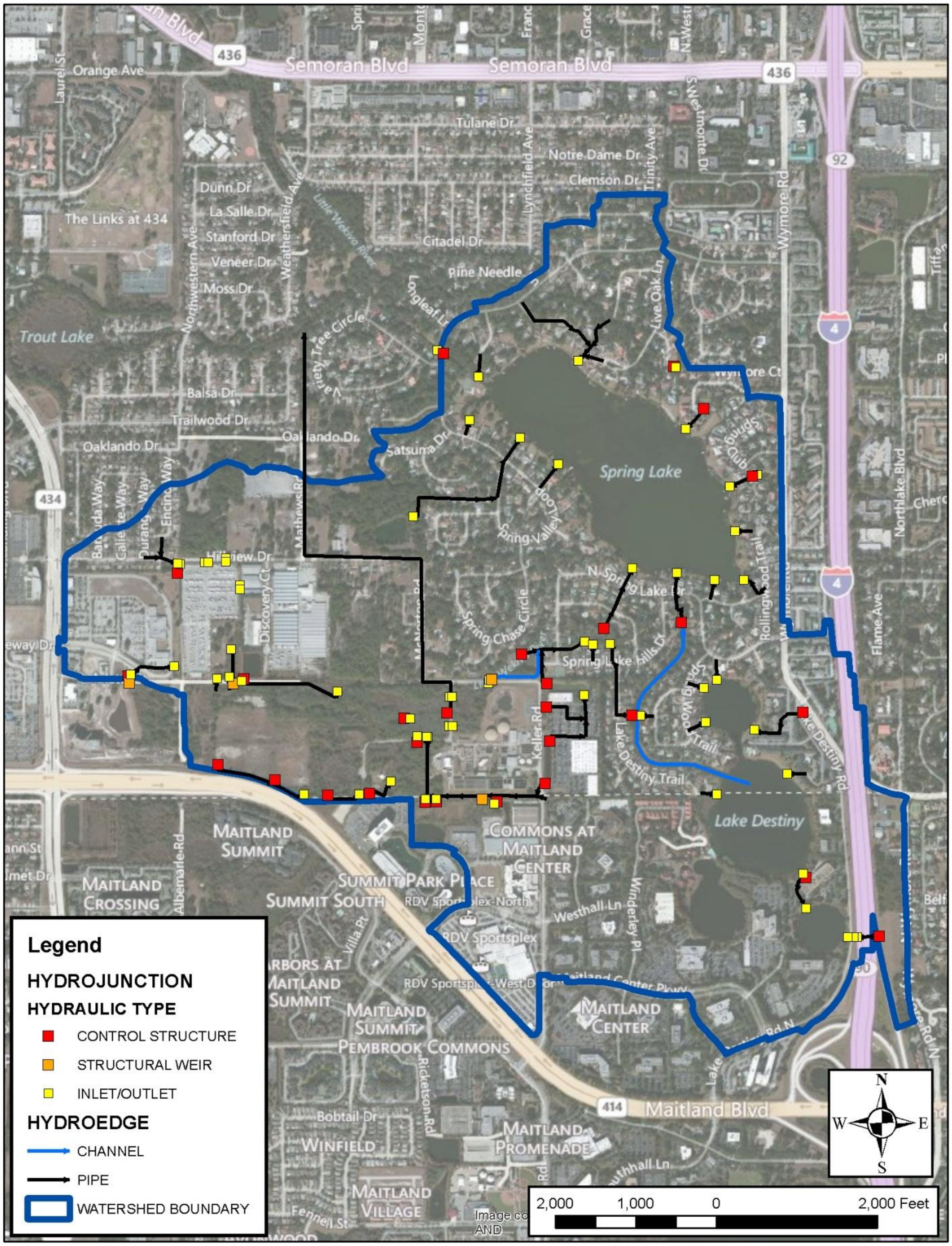

Figure 4-1 Modeled Hydraulic Network

4.2. Hydraulic Connectivity

Once the hydraulic inventory was complete, the model condition junction/reach coverage was developed. Reaches represent the hydraulic conveyance structures such as culverts, weirs, open channels, etc., while junctions represent modeled nodes where subbasin runoff enters the conveyance system and subbasin storage is accounted for. These modeled nodes represent features such as manholes, lakes, wetlands, or other depressions throughout the watershed. Hydraulic reaches (links) were represented by lines in the junction/reach coverage while the junctions (nodes) were the terminal ends of the lines. A junction-reach connectivity diagram for the project area has been provided as **Figure 4-2** and in digital format as part of the GWIS Geodatabase and basemap.mxd. Model link features are also summarized in **Table 4-2** which lists the count of each link types used in the model.

Table 4-2: Summary of Model Link Types

Link Type	Count
Pipes	82
Channels	2
Overflow Weirs	109
Structural Weirs	6
Drop Structures	25

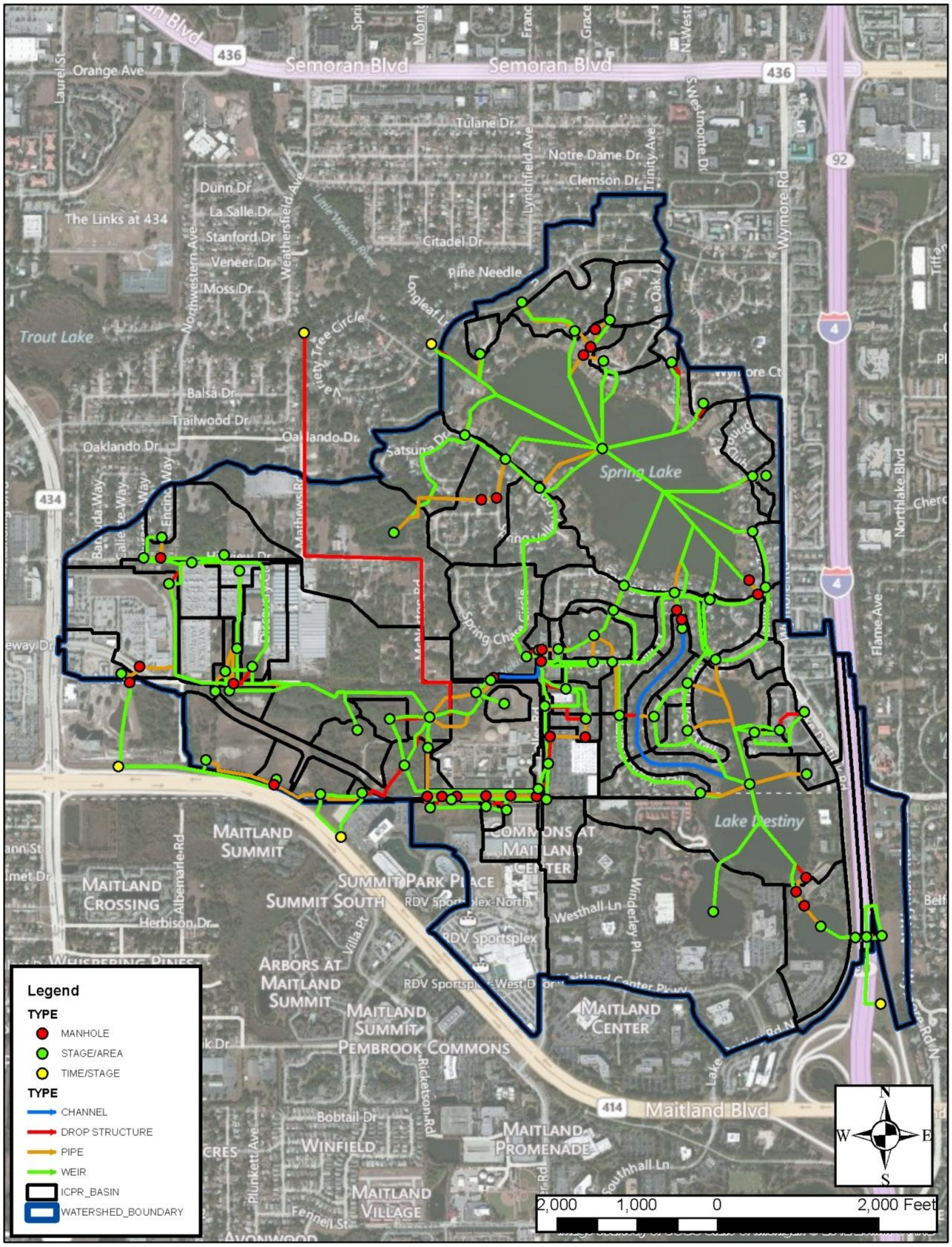

Figure 4-2 Spring Lake Model Link-Node Diagram

4.3. Geometry of Conveyance Structures

Conveyance structures include roadway culverts, bridge crossings, open channels, and control structures. As indicated previously, data were identified from field reconnaissance/survey, ERPs, and available as-built/construction plans. The location of each structure was entered into a database as a hydraulic element point. Each hydraulic element point was linked to an attribute table that contains geometry details for each structure.

4.4. Geometry of Overflow Weirs

In order to represent overland flow or road overtopping conditions between subbasins, hydraulic features were connected as needed with pop-off conveyance features. These features are more typically referred to as overflow weirs. Including structural weirs, three types of overflow weirs were used in the hydrologic/hydraulic model. Weir coefficients for each type, determined from the literature based on flow type and ground cover are shown in **Table 4-3** below.

Table 4-3 Spring Lake Weir Coefficients

Weir Type	Flow Type/Ground Cover	Weir Coefficient
Structural Weir	Sharp Crested Concrete Weir	3.2
Structural Weir	Broad Crested Concrete Weir	3.0
Road Overtopping Weir	Gravel Road	2.8
Road Overtopping Weir	Paved Road	3.0
Subbasin Overland Weir	Brush/Shrub Overbank Flow	2.0
Subbasin Overland Weir	Grass Overbank Flow	2.4

4.5. Manning's Roughness Coefficients

The values of Manning's coefficients for all conveyance features were selected from literature values. The values of the coefficients, listed in **Table 4-4**, for the channel cross-sections (left bank, right bank and main channel) were selected based on field reconnaissance and aerial photography. For other structures, the values of the coefficients were set assuming maintained conditions based on pipe material as shown in **Table 4-5**.

Table 4-4 Spring Lake Channel Manning's Lookup

Description	Manning's
CHANNEL-Lined	0.015
CHANNEL-Mowed Ditch	0.035
CHANNEL-Clean (Natural)	0.04
CHANNEL-Light Vegetation	0.05
CHANNEL-Medium Vegetation	0.06
CHANNEL-Heavy Vegetation	0.08
CHANNEL-Heavy Vegetation/Medium Underbrush	0.1
CHANNEL-Heavy Vegetation/Extra Thick Underbrush	0.12
OVERBANK-Asphalt/Concrete	0.02
OVERBANK-Bare Dirt	0.05
OVERBANK-Pasture Grass	0.09
OVERBANK-Lawn grass	0.1
OVERBANK-Light Woods	0.12
OVERBANK-Woods/Medium Underbrush	0.16
OVERBANK-Heavy Woods/Heavy Underbrush	0.2

Table 4-5 Spring Lake Pipe Manning's Lookup

Material	Manning's
RCP	0.012
CMP	0.024
PVC	0.01
ADS	0.011
ABS	0.011
HDPE	0.01
STL	0.01

4.6. Initial Stage Determination

Starting water surface elevations or initial conditions at the beginning of the computer model simulation were selected using, one of two methods. If a subbasin was hydraulically connected to the rest of the system, then the control elevation (pipe invert, orifice elevation, weir elevation) was used as the starting elevation. For storage areas with no hydraulic control, the starting elevation was set at the seasonal high water elevation (SHWE), which was estimated from the aerials and LiDAR data or was taken from permit data. Initial conditions were set to ensure no initial flows occurred at the start of the model simulation.

4.7. Stage-Area Calculations

Stage-area relationships were obtained from the DEM for each subbasin, taking into consideration channel exclusion areas, controls below DEM and ponds in “New Development” areas. ArcHydro Drainage Area Characterization tool was used to develop the storage table at 0.25 ft intervals.

Channel exclusion areas were defined to eliminate double-accounting of the basin storage capacity. The stage-area relationship for areas developed after the SJRWMD LiDAR was based on “Pond” polygons digitized from permit data and aerial imagery.

4.8. Boundary Conditions

Discharging the Spring Lake watershed requires the use of boundary conditions. Four time stage boundary nodes have been provided to allow for these possible discharges from the watershed. **Figure 4-3** shows the location of these boundary nodes including:

- Gateway_0005 at Maitland Blvd south of Gateway Center.
- Gateway_0360 at the outfall to the Little Wekiva River through the 48” WWTP wet weather discharge pipe.
- LIL_WEKIVA which is downstream of the weir controlling the water level in Spring Lake.
- I4_0005 which accounts for possible surface overflows from the I-4 pond which discharges to “No Name” Lake and to the ponds within the intersection of I-4 and Maitland Blvd, which flow south.

Figure 4-3 Spring Lake Boundary Nodes

5. Hydrologic and Hydraulic Model Analysis

The previous sections provided a description of the hydrologic and hydraulic development. Using that formatted data, this section describes the model selection, simulation description and results

5.1. Computer Model Selection

The Interconnected Pond Routing model version 3, (ICPRv3), was used for analysis of the hydrologic and hydraulic conditions of the study area. As the name indicates, the model simulates storage areas connected by hydraulic elements dynamically routing design storm events through the watershed. Also, the ICPR model has become the industry standard for hydraulic model simulations for new developments and was the model used for each of the ERPs incorporated as part of this project and a logical choice for the Spring Lake Watershed.

5.2. Storms Simulated

Design storms simulated include the mean annual, 5 year, 10 year, 25 year, 50 year and 100 year storms of 24 hour duration and 100 year storm of 96 hour duration. **Table 5-1** lists each of the design storm events and its associated flood depth.

Table 5-1: Design Storm Rainfall Depths

Storm	Duration	Distribution	Rainfall Depth
Mean Annual	24 hour	SCS Fl Modified	4.3
5-year	24 hour	SCS Fl Modified	5.7
10-year	24 hour	SCS Fl Modified	6.8
25-year	24 hour	SCS Fl Modified	8.4
50-year	24 hour	SCS Fl Modified	10.1
100-year	24 hour	SCS Fl Modified	11.4
100-year	96 hour	SJRWMD 96	15

5.3. Hydrologic and Hydraulic Model Results

The ICPRv3 model was used to simulate the seven design storms listed in **Table 5-1**; converting rainfall into runoff on 77 subbasins, then routing stormwater runoff through storm sewer system, Spring Lake and to the Little Wekiva River. The ICPRv3 model and simulation results are included in the digital deliverable in the MODEL subfolder. The results are also incorporated into the GWIS geodatabase results table which is digitally hyperlinked to ICPR_Nodes and related features. Peak stage results for each node for each of the design storms simulated is presented in **Table 5-2**.

Table 5-2: Peak Node Stages for Design Storm Simulations

Node Name	Mean Annual / 24 hr	5 year / 24 hr	10 year / 24 hr	25 year / 24 hr	50 year / 24 hr	100 year / 24 hr	100 year / 96 hr	
DESTINY_0008	89.8	90.5	91.0	91.4	91.6	91.7	91.9	
DESTINY_0009	90.0	90.8	91.3	91.9	92.1	92.2	92.3	
DESTINY_0010	90.0	90.8	91.4	91.9	92.1	92.2	92.3	No Name Lake
DESTINY_0015	89.5	89.8	90.0	90.3	90.5	90.6	90.8	
DESTINY_0020	89.3	89.6	89.7	89.9	90.1	90.2	90.3	
DESTINY_0030	91.0	91.2	91.4	91.7	92.0	92.3	92.4	
DESTINY_0040	98.7	99.4	99.5	99.6	99.7	99.7	99.7	
DESTINY_0050	94.8	94.8	94.9	95.0	95.0	95.0	95.1	
DESTINY_0060	92.8	92.9	92.9	93.0	93.0	93.1	93.1	
DESTINY_0070	92.5	93.1	93.2	93.3	93.3	93.4	93.4	
DESTINY_0080	91.7	92.2	92.6	92.8	92.9	93.0	93.0	
DESTINY_0090	92.3	92.5	92.6	92.8	92.9	93.0	93.0	
DESTINY_0095	93.1	93.1	93.1	93.1	93.1	93.1	93.1	
DESTINY_0100	89.3	89.6	89.7	89.9	90.1	90.2	90.3	Lake Destiny
DESTINY_0110	89.0	89.2	89.3	89.4	89.5	89.6	89.6	
DESTINY_0120	92.0	92.5	92.7	92.9	93.0	93.1	93.1	
DESTINY_0130	89.3	89.6	89.7	89.9	90.1	90.2	90.3	
DESTINY_0132	88.7	89.1	89.3	89.5	89.6	89.7	89.8	
DS_GATEWAY_0010	88.8	89.3	89.5	90.7	90.8	90.9	91.0	
DS_GATEWAY_0020	86.4	87.4	88.1	89.6	90.0	90.8	91.0	
DS_GATEWAY_0030	86.4	87.4	88.0	88.5	89.3	90.7	90.9	
DS_GATEWAY_0040	88.2	88.2	88.2	88.4	89.1	89.1	89.1	
DS_GATEWAY_0050	86.4	87.4	87.9	88.4	89.2	90.7	90.9	
DS_GATEWAY_0060	86.4	87.4	87.9	88.2	88.8	89.1	89.1	
DS_GATEWAY_0070	81.4	81.5	82.0	82.8	83.7	85.9	89.1	
DS_GATEWAY_0075	85.2	85.9	86.6	87.0	87.3	87.9	87.4	
DS_GATEWAY_0080	84.4	84.7	84.8	84.8	84.9	84.9	84.9	
DS_GATEWAY_0090	83.0	83.0	83.0	83.0	83.0	83.0	83.0	
DS_GATEWAY_0100	82.8	82.9	83.0	83.0	83.0	83.1	83.2	
DS_GATEWAY_0110	80.7	80.9	81.2	81.5	82.0	83.1	83.4	
DS_GATEWAY_0120	79.4	79.7	79.9	80.4	81.6	82.8	83.2	
DS_GATEWAY_0130	80.5	80.8	80.9	82.6	83.6	83.9	84.0	
DS_GATEWAY_0140	82.9	84.7	86.1	86.3	86.3	86.4	86.4	
DS_GATEWAY_0150	79.3	79.5	79.7	79.9	80.3	80.7	80.9	
DS_GATEWAY_0160	75.2	75.9	76.0	77.0	77.5	78.0	79.7	

Node Name	Mean Annual / 24 hr	5 year / 24 hr	10 year / 24 hr	25 year / 24 hr	50 year / 24 hr	100 year / 24 hr	100 year / 96 hr
DS_GATEWAY_0170	69.4	70.7	72.3	73.9	74.1	74.2	74.3
GATEWAY_0005	87.0	87.0	87.0	87.0	87.0	87.0	87.0
GATEWAY_0010	91.0	92.2	92.6	92.9	93.1	93.1	93.2
GATEWAY_0020	89.3	89.3	89.4	89.4	89.4	89.4	89.4
GATEWAY_0030	88.9	89.1	89.2	89.2	89.3	89.3	89.4
GATEWAY_0040	91.7	92.0	92.2	92.5	92.7	92.8	92.8
GATEWAY_0050	87.6	87.6	87.7	87.8	88.0	88.1	88.1
GATEWAY_0060	87.3	87.5	87.6	87.8	88.0	88.1	88.1
GATEWAY_0070	87.3	87.5	87.6	87.8	88.0	88.1	88.1
GATEWAY_0080	87.3	87.6	87.8	87.9	88.1	88.1	88.1
GATEWAY_0090	89.8	90.3	90.6	90.9	91.1	91.3	91.7
GATEWAY_0100	89.8	90.3	90.6	90.9	91.1	91.3	91.7
GATEWAY_0110	91.7	92.0	92.2	92.4	92.6	92.8	92.8
GATEWAY_0120	91.6	92.0	92.2	92.3	92.5	92.7	92.7
GATEWAY_0130	89.8	90.3	90.6	90.9	91.1	91.3	91.7
GATEWAY_0140	87.5	87.6	87.8	87.9	88.1	88.1	88.1
GATEWAY_0150	89.8	90.3	90.6	90.9	91.1	91.2	91.4
GATEWAY_0160	87.5	87.6	87.8	87.9	88.1	88.1	88.1
GATEWAY_0170	90.4	91.0	91.6	92.3	93.0	93.1	93.1
GATEWAY_0180	89.9	90.4	90.7	91.3	91.8	92.2	92.4
GATEWAY_0190	89.9	90.3	90.7	91.2	91.7	92.1	92.3
GATEWAY_0200	89.7	90.1	90.3	90.7	91.2	91.6	91.8
GATEWAY_0210	89.6	89.9	90.1	90.5	91.0	91.3	91.6
GATEWAY_0220	89.1	89.5	89.8	90.2	90.6	90.8	91.1
GATEWAY_0230	90.5	91.0	91.2	91.6	92.0	92.1	92.1
GATEWAY_0240	88.7	88.9	90.0	91.0	91.4	91.5	91.5
GATEWAY_0250	86.3	87.9	89.9	91.0	91.5	91.7	91.8
GATEWAY_0260	91.5	91.7	91.9	92.1	92.2	92.4	92.5
GATEWAY_0265	89.2	89.2	90.1	91.4	91.8	92.1	92.2
GATEWAY_0270	86.3	87.9	89.8	90.9	91.4	91.6	91.6
GATEWAY_0280	86.4	87.8	89.6	90.7	91.1	91.4	91.4
GATEWAY_0285	88.3	88.5	88.6	88.7	88.8	88.8	88.8
GATEWAY_0290	86.3	88.0	90.1	91.4	91.8	92.1	92.2
GATEWAY_0295	87.3	87.3	87.3	87.3	87.3	87.3	87.3
GATEWAY_0300	86.2	87.6	89.3	90.3	90.7	91.0	90.9
GATEWAY_0310	91.0	91.2	91.3	91.5	91.8	92.1	92.2
GATEWAY_0320	86.3	87.4	88.9	89.7	90.1	90.2	90.2
GATEWAY_0330	86.2	87.0	87.4	87.9	88.1	88.1	87.9

Node Name	Mean Annual / 24 hr	5 year / 24 hr	10 year / 24 hr	25 year / 24 hr	50 year / 24 hr	100 year / 24 hr	100 year / 96 hr	
GATEWAY_0340	89.1	89.5	89.8	90.2	90.6	90.8	91.1	
GATEWAY_0350	86.2	87.0	87.4	87.9	88.1	88.1	87.9	
GATEWAY_0360	56.0	56.0	56.0	56.0	56.0	56.0	56.0	
GATEWAY_0370	86.3	88.0	90.0	91.1	91.6	91.7	91.8	
GATEWAY_0375	86.2	86.5	86.6	87.0	87.3	87.9	87.4	
GATEWAY_0380	88.8	89.0	89.2	89.4	89.6	89.8	90.3	
I4_0005	86.4	86.4	86.4	86.4	86.4	86.4	86.4	
I4_0010	94.5	94.7	94.9	95.2	95.5	95.8	96.0	
I4_0020	90.0	90.8	91.4	91.9	92.1	92.3	92.7	
I4_0030	90.0	90.8	91.4	91.9	92.1	92.2	92.5	
LIL_WEKIVA	59.0	59.0	59.0	59.0	59.0	59.0	59.0	
SPRING_0005	81.2	81.9	81.7	81.6	81.9	82.1	82.3	
SPRING_0010	72.1	75.1	75.2	75.4	75.5	75.7	75.7	
SPRING_0020	76.4	76.6	76.7	76.8	76.8	76.9	76.9	
SPRING_0030	86.0	86.9	88.1	89.9	91.0	91.1	91.1	
SPRING_0036	80.3	82.2	83.3	84.0	82.6	82.7	82.7	
SPRING_0037	66.5	67.6	68.0	70.6	66.8	67.4	67.8	
SPRING_0040	71.0	73.2	77.0	77.9	78.0	78.1	78.1	
SPRING_0050	75.8	76.0	76.1	76.2	76.4	76.5	76.6	
SPRING_0060	75.8	75.9	75.9	76.0	76.1	76.1	76.1	
SPRING_0070	72.1	72.2	72.3	72.3	72.3	72.3	72.3	
SPRING_0080	81.7	81.8	81.9	81.9	82.0	82.0	82.1	
SPRING_0090	76.7	76.8	76.9	77.0	77.1	77.2	77.2	
SPRING_0100	70.6	70.8	71.0	71.2	71.3	71.4	71.5	
SPRING_0110	75.1	75.2	75.2	75.2	75.2	75.2	75.2	
SPRING_0120	66.7	67.5	67.9	68.6	69.2	69.6	69.9	
SPRING_0130	67.1	68.8	69.5	69.9	69.9	70.0	70.0	
SPRING_0140	65.7	66.3	66.6	67.1	67.5	67.8	68.1	
SPRING_0150	84.0	84.1	84.1	84.1	84.1	84.1	84.1	
SPRING_0160	70.3	71.4	72.3	73.9	75.9	76.2	76.3	
SPRING_0170	67.5	68.4	68.5	68.7	68.8	69.0	69.1	
SPRING_0180	80.1	81.7	83.5	84.9	85.4	85.6	85.9	
SPRING_0182	78.2	78.3	78.7	79.4	79.7	79.8	79.9	
SPRING_0185	73.5	73.5	73.5	73.5	73.5	73.5	73.5	
SPRING_0190	67.8	68.0	68.1	68.3	68.4	68.5	68.5	
SPRING_0200	67.8	67.9	68.0	68.1	68.2	68.2	68.3	
SPRING_0210	65.1	65.4	65.7	66.2	66.8	67.4	67.8	Spring Lake

5.4. Results Comparisons

Simulating the design conditions provided both a basis of comparison to the effective Flood Insurance Study (FIS) for Seminole County and the recently permitted Gateway Drive Extension. The results indicated that the peak elevations generated in and around the Gateway Drive design condition model were consistent with those of this study, confirming that the proposed design condition will be contained within the proposed storm sewer system and associated ponds.

Comparing the 10 year, 50 year and 100 year storm events presented in the FIS to those simulated by this detailed study show that the peak elevation in Spring Lake are roughly 0.3 feet higher than FIS while Lake Destiny is roughly 0.3' lower than the FIS. This difference is explained in both the level of detail and connectivity between Lake Destiny and Spring Lake. The level of detail of the FIS was designed to be a more regional river model simulating the Spring Lake Watershed with just two basins, compared to 77 simulated in this study. Additionally, the connectivity between Lake Destiny and Spring Lake was simulated in the FIS as only a single overflow structure located at the end of the access canal on the northwest side of Lake Destiny. This neglects the second parallel overflow structure located in the middle of the access canal. The combination of these two structures appears to have the capacity to effectively move water from Lake Destiny into Spring Lake which both reduces the peak stage in Destiny while increasing the stage in Spring Lake. Comparison of the results are shown in **Table 5-3** and stage hydrographs for Spring Lake and Lake Destiny outputted from ICPRv3 are presented in **Figures 5-1** and **5-2** respectively.

Table 5-3: FIS Stage Comparison Spring Lake and Lake Destiny

Spring Lake			
	10 year	50 year	100 year
FIS	65.36	66.56	67.16
Model Result	65.67	66.82	67.36
Difference	(0.31)	(0.26)	(0.20)
Lake Destiny			
	10 year	50 year	100 year
FIS	89.36	90.36	90.96
Model Result	89.73	90.08	90.21
Difference	(0.37)	0.28	0.75

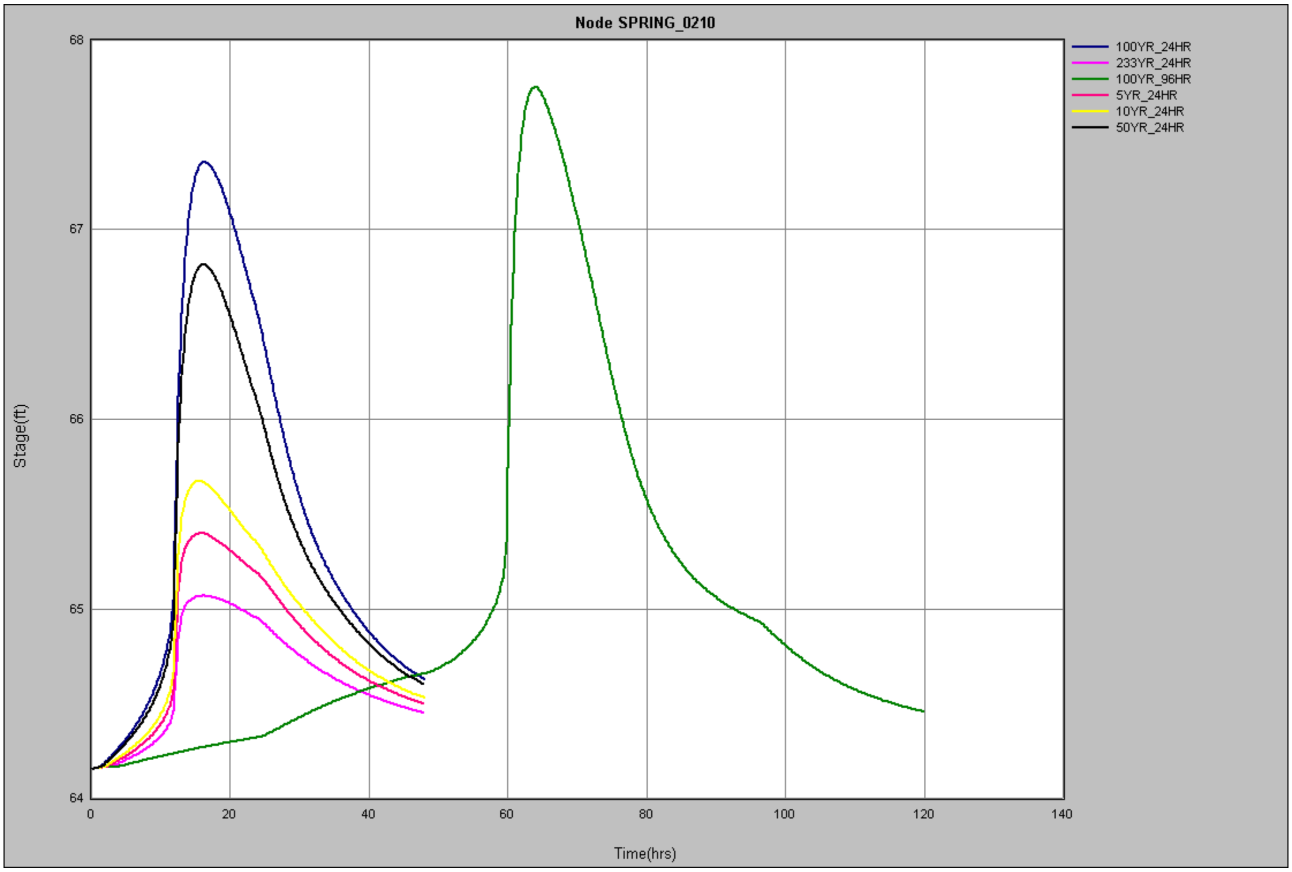

Figure 5-1: Spring Lake Design Storm Stage Hydrographs

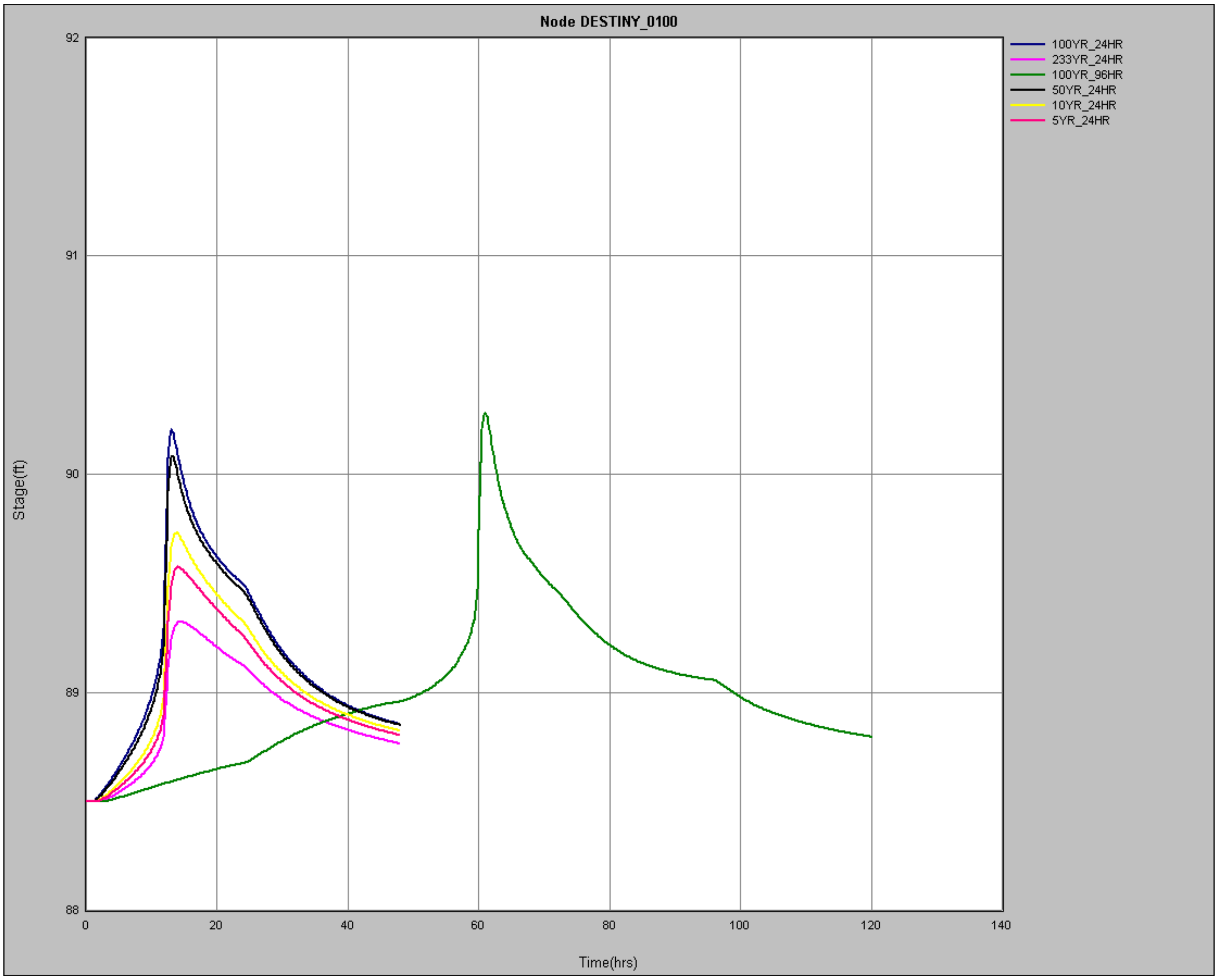

Figure 5-2: Lake Destiny Design Storm Stage Hydrographs

5.5. Flood Inundation Extents

Plotting the flood extent associated with each of the 77 basins for the seven design storm events showed the aerial extent of where water rose in the watershed and highlighted overland connectivity between subbasins. It also showed which storm events were contained within the storm sewer system and which potentially produced simulated flooding conditions. **Figure 5-3** shows the mean annual design storm inundation extent overlaid with the 100 year 24 hour design storm event flood extent to provide a contrast between where water would rise to during under normal and extreme conditions. Inundation shapes for each of the seven events simulated is provided digitally in the Floodplain.mdb geodatabase and shown on the basemap.mxd ArcMap.

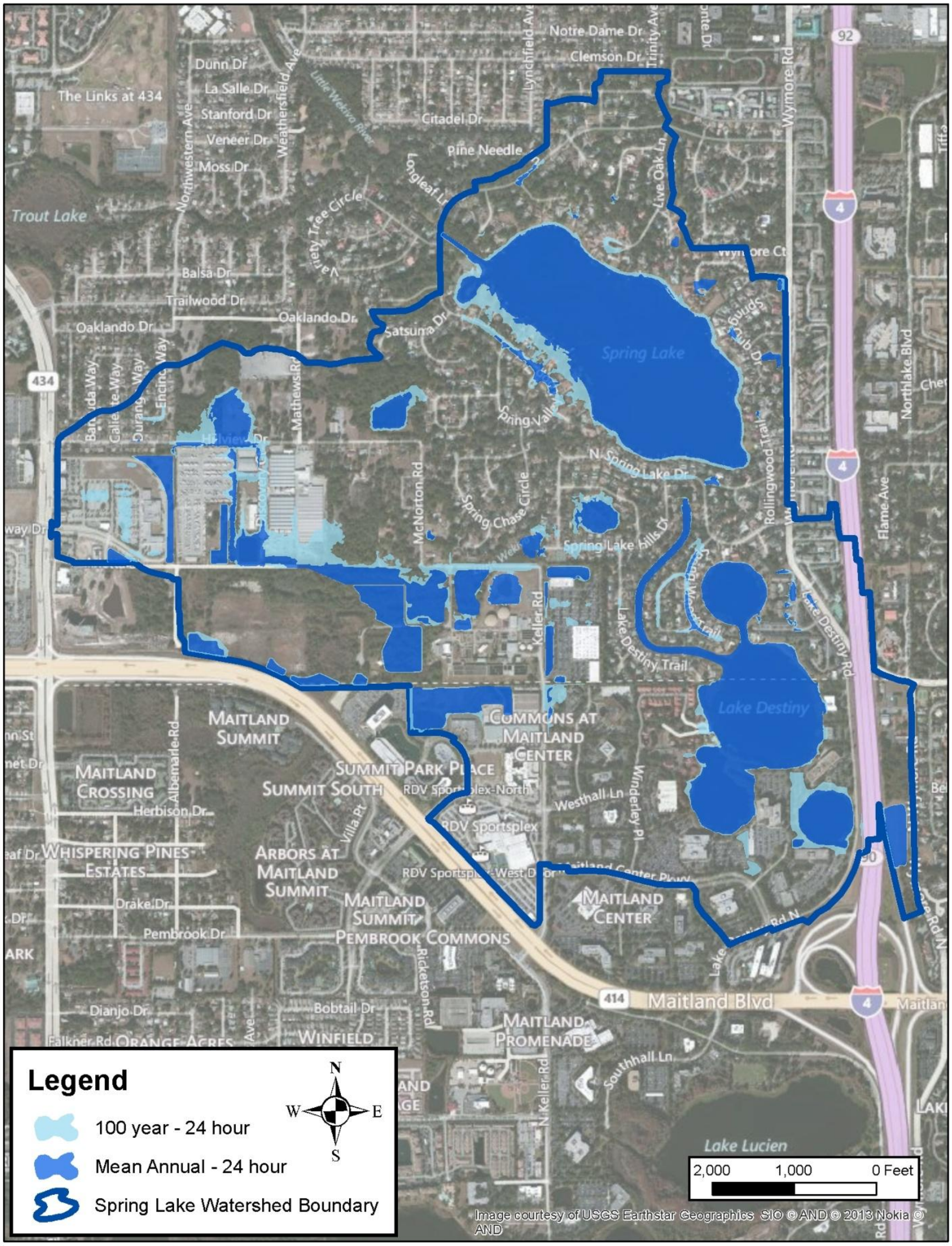

Figure 5-3: Spring Lake Inundation Extent: Mean Annual and 100yr/24hr Design Storm

5.6. Level of Service Determination

Building upon the ICPRv3 model results, each basin was given a flooding level of service determination. This process involved identifying elevations within each basin that correspond to a designated flooding concern, such as, roadway flooding, structural flooding or a storm sewer capacity exceedance. For each basin, elevations were associated with each of the applicable level of service categories and comparisons made between the elevation and the categories critical design storm. Then the basin's level of service would be determined by the most severe deficiency over the various level of service categories often present in a single subbasin. **Table 5-4** list the level of service criteria for each category with an examples and **Figure 5-4** highlights hich basin level of service grades A through D. As a reference the level of service determination, critical category and applicable notes have been added as fields to the ICPR_Basin feature class in the Spring Lake GWIS geodatabase and seen in the Basemap.mxd.

Table 5-4: Spring Lake Watershed Level of Service Categories

Category / Storm	A	B	C	D	Examples
Local Roads and Swales 10yr- 24hr	Water at curbline, contained within Stormwater management system	Water on, but not over roadway. Minor Parking lot flooding	Water just over roadway. Significant extent of parking lot flooding	Water depth over road 6"	Spring Lake Hills Subdivision Roadways, Commercial Parking Lots
Primary Canals and Stormwater Ponds 25yr- 24hr	Water contained within the stormwater management system (top of bank)	Water outside of storm sewer system (2 inches)	Water outside of storm sewer system (6 inches)	Water outside of storm sewer system > 6"	Stormwater Ponds
Arterial Roads 50yr- 24hr	Water at curbline, contained within Stormwater management system	Water on, but not over roadway (1/2 of one travel lane)	Water just over roadway	Water depth over road 6"	Wymore, Lake Destiny, Gateway and Keller
Structures 100yr- 24hr	Water contained within the storm sewer system.	Minor yard flooding	Major yard flooding up to house pad	Structure Flooding	House Pad
Evacuation Routes 100yr- 24hr	Water at curbline, contained within Stormwater management system	Water on, but not over roadway (1/2 of one travel lane)	Water just over roadway	Water depth over road 6"	I-4

As seen in **Figure 5-4** and summarized in **Table 5-5**, structural flooding was not a wide spread concern in the Spring Lake Watershed. Only one structure in one basin received a Level of Service "D" for structural flooding during the 100 year event. This single LOS deficiency within the Springs Lake Hills Subdivision was not surveyed, so it is not confirmed that the structure's house pad definitely is lower than the 100 year flood elevation, it is possible that the it is a mere reflection of the resolution of the DEM.

Over the 77 basins in the Spring Lake Watershed 13 basins fell within LOS category B, 15 fell into category C and 13 were in category D. Specific watershed examples of LOS criteria D include:

- Roadway flooding greater than 6” for the 50 year – 24 hour design storm event along McNorton Rd, just north of the Altamonte Springs WWTP and along Hillview Drive just East of SR 434.
- Roadway flooding greater than 6” for the 50 year – 24 hour design storm event in Spring Lake Hills Subdivision along Springwood trail and Spring Valley Loop. According to the DEM, at this flood depth, water will stand in yards yet not up to the house pad.

Table 5-5: Level of Service Summary

LOS Category	A	B	C	D
ARTERIAL ROAD	2	1	3	6
EVACUATION ROUTE	3	0	0	0
LOCAL ROAD/PARKING LOT	14	9	8	6
PONDS	13	1	0	0
STRUCTURE	1	2	4	1

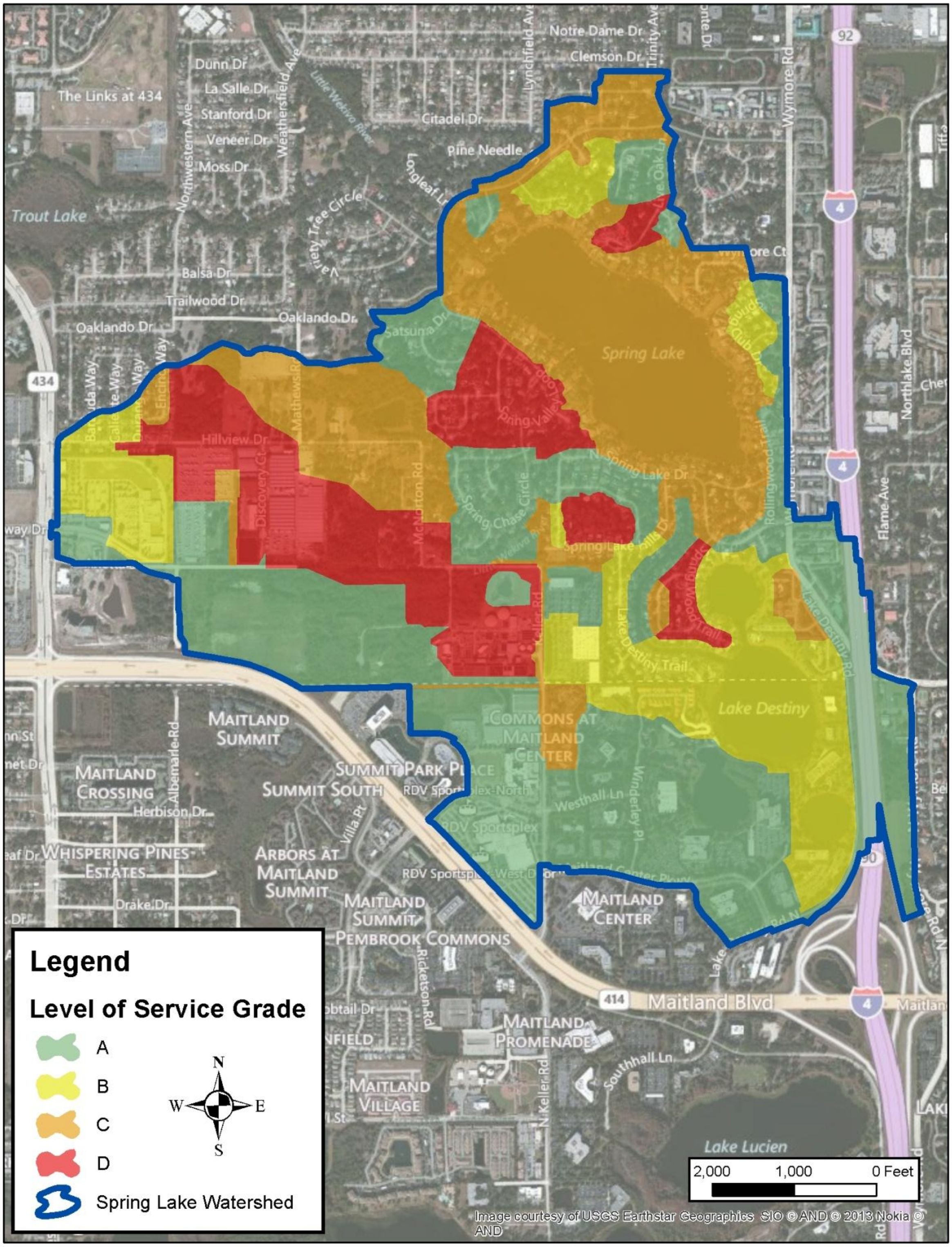

Figure 5-4: Spring Lake Flood Level of Service

6. Water Quality Analysis

6.1. Atkins' Pollutant Loading Model

An approach that has been used by regulatory agencies in Florida to quantify the amount of nonpoint source pollutants from surface water discharges into a waterbody is to estimate average annual pollutant loads. The Atkins Pollutant Loading Model, formerly the PBS&J Loading Model was used for this purpose in the Spring Lake Watershed. This tool previously served as the basis for calculating inflow loads as part of the Lake Jesup TMDL; it was used to calculate the NPDES loadings by major watershed in Seminole County; and used to quantify the load reduction of Seminole County's CIP projects associated with the Wekiva BMAP.

For the Spring Lake Watershed, average annual pollutant loads were calculated using the Atkins Pollutant Loading Model for each of the 13 direct discharges into Spring Lake. The model is an event mean concentration (EMC) based model that utilizes GIS to perform intersections of hydrologic characteristics, drainage characteristics and best management practices (BMP) to estimate annual stormwater runoff volumes and corresponding pollutant loads. The approach follows the flow chart seen in **Figure 6-1** and described below, incorporating basins, soils, land use, and BMP GIS coverages with Rainfall, Runoff, EMC, and BMP efficiency lookup tables to calculate runoff volumes, gross loads, and net loads on an annual basis.

- *Calculation of stormwater runoff volume.* The runoff volume from a subbasin is calculated as the product of the average, daily, monthly, annual or seasonal, rainfall amount and the sub-basin's weighted land use and soils rainfall / runoff coefficient. GIS coverages of land use and hydrologic soil characteristics were intersected with sub-basin delineations to determine the area's hydrologic characteristics.

- *Calculation of gross pollutant loads.* Gross pollutant loads are defined as the amount of pollutant that is generated within a sub-basin. This load is calculated as the sum of the non-point source loads. The non-point source load is defined as the product of the estimated runoff volume times the stormwater EMC for each selected pollutant and land use category.

- *Calculation of net pollutant loads.* Net pollutant loads are defined as the amount of a pollutant from a subbasin that is discharged into a receiving waterbody. This load is calculated as the product of the gross pollutant load times a factor that represents the estimated pollutant removal due to the occurrence of stormwater treatment within each sub-basin.

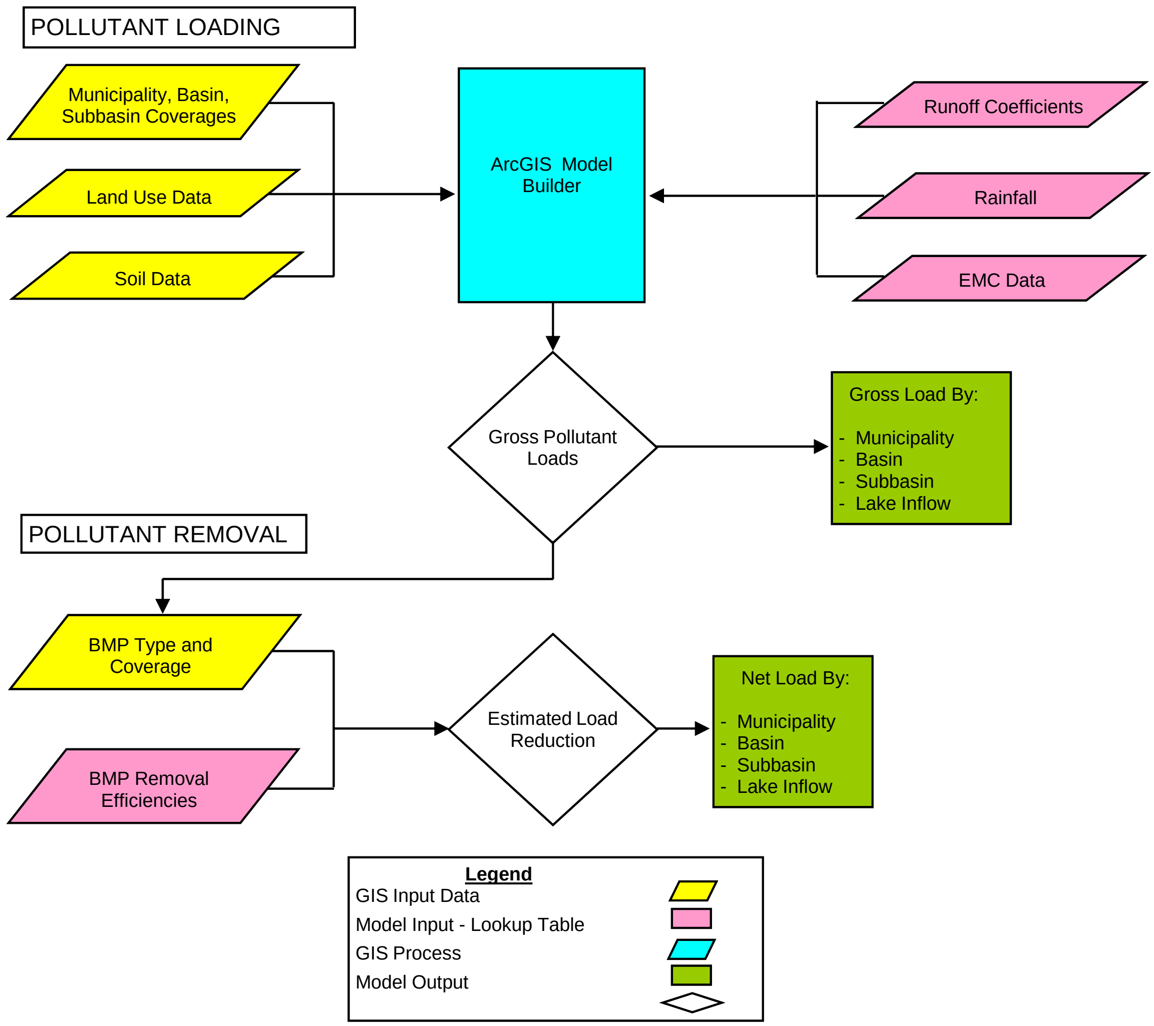

Figure 6-1: Atkins' Pollutant Loading Model Flow Chart

6.2. Model Development

Following the flow chart presented in **Figure 6-1,** GIS input features and loading lookup tables were compiled or developed to generate the estimate of annual watershed loadings in the Spring Lake Watershed. Also to perform a comparison of the potential loadings associated with the Gateway development, a separate pollutant loading model was created. The first, called the Existing Conditions Gateway model includes the Gateway Roadway extension, commercial development, and associated storm sewer / retention pond system. The second model termed, PreGateway reflects land use conditions prior to the Gateway roadway extension, reverting land uses from commercial, water, and roadway back to undeveloped open space and wetlands. This section highlights some of the data assembly specifics as applied to the Spring Lake Watershed.

6.2.1. Pollutant Load Sub-basins

When the pollutant loading model is run, it generates contributions of runoff and loads for each unique intersected polygon of soils, land use, and BMP feature. For the 1.6 square mile Spring Lake watershed this amounts to approximately 600 individual contributions of runoff and pollutant load. To provide additional context into these individual contributions the data is grouped by intersecting the GIS components of the pollutant loading model by an aggregation layer. An aggregation layer can include jurisdictional boundaries, political boundaries or other logical groupings of the data. For Spring Lake data was aggregated by the 13 direct outfalls flowing into the lake. **Figure 6-2** shows the hydrologic delineation of each lake inflow, used to aggregate pollutant loads.

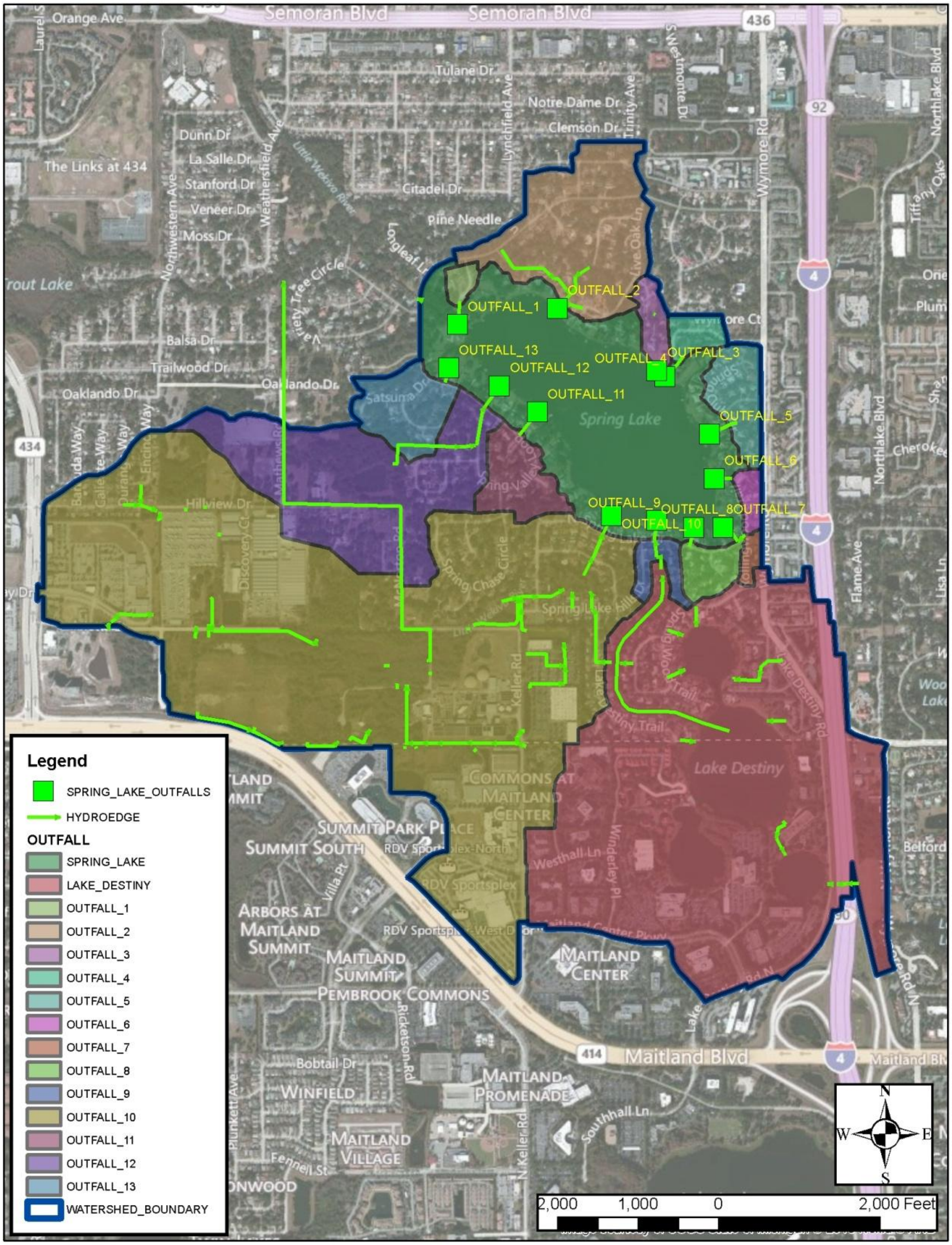

Figure 6-2: Spring Lake Inflow Delineations

6.2.2. Land Uses

The Spring Lake watershed drains about 1.6 square miles of urbanized residential and commercial area. The watershed includes areas of unincorporated Seminole County, the City of Altamonte Springs and the City of Maitland in Orange County. The 2011 SJRWMD land use coverage within the Spring Lake Watershed was updated as part of the hydrologic and hydraulic modeling effort of Spring Lake WMP, to reflect the 2013 aerial groundcover. The primary updates to the coverage surrounding the Gateway roadway extension and associated commercial development in Altamonte Springs. To then generate pollutant loads from the land use coverage the run-off land use categories were aggregated into 10 EMC Land Uses based on **Table 6-1**.

The watershed EMC land uses shown in **Figure 6-3** show that the watershed is significantly build-out with anthropogenic land uses representing 75% of the watershed; 19% is covered by water or wetlands; and 6% is categorized as undeveloped open space. This is in contrast to the PreGateway conditions in which only 69% of the watershed was build-out. The Gateway roadway extension and associated development replaced portions of undeveloped open space and some wetlands with roadway and commercial land uses. **Table 6-2** shows a comparison of the areas and watershed percentages of the Existing and PreGateway EMC land uses in the Spring Lake Watershed.

Table 6-1: Spring Lake Runoff to EMC Land Use Conversion

FLUCC	RUNOFF LANDUSE TYPE	EMC LANDUSE TYPE
1100	Residential, low density - less than 2 units/acre	LOW DENSITY RESIDENTIAL
1200	Residential, medium density - 2-5 units/acre	SINGLE FAMILY
1300	Residential, high density - 6 or more units/acre	MULTI FAMILY
1400	Commercial and services	HIGH INTENSITY COMMERCIAL
1700	Institutional	LOW INTENSITY COMMERCIAL
2110	Improved pastures -planted forage crops	UNDEVELOPED/RANGELAND/FOREST
3100	Herbaceous upland nonforested	UNDEVELOPED/RANGELAND/FOREST
3300	Freshwater marshes	WETLANDS
3300	Herbaceous upland nonforested	UNDEVELOPED/RANGELAND/FOREST
3300	Mixed upland nonforested	UNDEVELOPED/RANGELAND/FOREST
3300	Shrub and brushland	UNDEVELOPED/RANGELAND/FOREST
4200	Upland hardwood forests	UNDEVELOPED/RANGELAND/FOREST
4340	Upland mixed coniferous/hardwood	UNDEVELOPED/RANGELAND/FOREST
5200	Lakes	WATER
5300	Reservoirs - pits, retention ponds	WATER
6250	Hydric pine flatwoods	UNDEVELOPED/RANGELAND/FOREST
6300	Wetland forested mixed	WETLANDS
6410	Freshwater marshes	WETLANDS
6430	Wet prairies	WETLANDS
6440	Emergent aquatic vegetation	WETLANDS
6460	Mixed scrub-shrub wetland	WETLANDS
7400	Disturbed land	UNDEVELOPED/RANGELAND/FOREST
8140	Roads and highways-4-lanes with medians	HIGHWAY
8340	WWTP	LIGHT INDUSTRIAL
8370	Surface water collection basins	WATER

Table 6-2: Spring Lake EMC Land Use Summary

EMC Land Use	Pre Gateway Area (acres)	%		Existing / Gateway Area (acres)	%	Difference (acres)
HIGH INTENSITY COMMERCIAL	247	24%		285	27%	38
LIGHT INDUSTRIAL[1]	21	2%		21	2%	0
LOW INTENSITY COMMERCIAL	4	0%		4	0%	0
LOW DENSITY RESIDENTIAL	43	4%		43	4%	0
SINGLE FAMILY	334	32%		336	32%	1
MULTI FAMILY	50	5%		50	5%	0
HIGHWAY	26	3%		41	4%	15
UNDEVELOPED/RANGELAND/FOREST	115	11%		62	6%	-53
WATER	152	15%		168	16%	16
WETLANDS	51	5%		34	3%	-17
TOTAL	1044			1044		

[1] Altamonte Springs WWTP was classified as light industrial land use using its runoff characteristics only, the point source loading associated with wet weather discharges from the plant were not considered as the discharge pipe for this flow terminates outside of the Spring Lake Watershed.

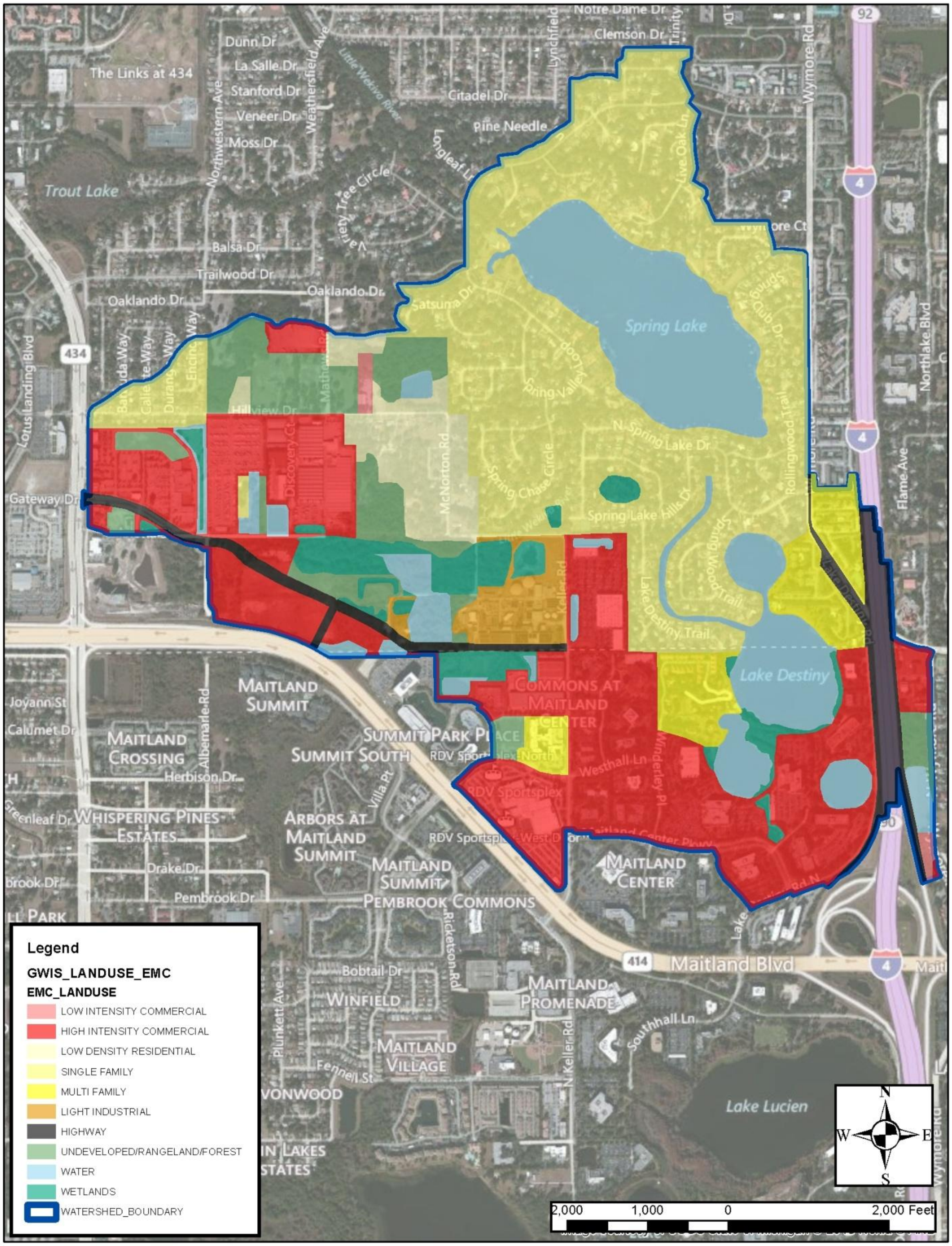

Figure 6-3: Spring Lake EMC Land Use Coverage

6.2.3. Best Management Practices (BMPs)

The areas covered by different BMPs are seen graphically in **Figure 6-4**. This GIS coverage of BMPs was developed by classifying each sub-basin based upon aerials maps, hydraulic inventory, DEN and SWFWMD ERP coverage to identify BMP treatment facility type. This data is summarized in **Table 6-3**, 64% of the watershed is covered by some type of BMP treatment before discharging into Spring Lake. This includes traditional water quality BMPs such as wet ponds and swales, as well as, elements acting as BMP treatment such as significant depressional areas, and upstream disconnected waterbodies. Although the non-traditional BMPs do not provide water quality treatment to the immediate area draining to them, by virtue of the residence time within these features water quality is provided prior to water reaching Spring Lake.

Table 6-4 shows the pollutant removal efficiencies of the various traditional BMPs used in the pollutant load model, as well as, the non-traditional BMPs associated with the area upstream of the Altamonte Springs WWTP and Lake Destiny. Traditional BMP removal percentages were applied from Harper 2007 and non-traditional BMP removal efficiencies are discussed below.

Lake Destiny "BMP" – Lake Destiny has a storage volume of over 300 acre-feet which is considerable compared to the capacity of the two outfall structures located in the Lake Destiny access canal. The structures are both overflow type devices that operate typically under very low head conditions. Applying the annual runoff volume generated to the lake, as calculated by the Atkins Pollutant Loading Model, the mean residence time was calculated in the range of 6 months. Using this residence time and the charts provided in the Evaluation of Current Stormwater Design Criteria within the State of Florida Final Report June 2007 by ERD provided removal efficiencies for total phosphorus and total nitrogen of 80% and 44% respectively. Total suspended solid removal of 90%, was used as typical of wet ponds, and 45% removal of BOD. The extent of the area receiving the additional treatment associated with residence in Lake Destiny is shown in red hatching in **Figure 6-4.**

Altamonte Springs Wet Weather Discharge Pipe – Drainage from the Gateway Road extension in Altamonte Springs, including 300 acres of commercial, residential and open space, flows past the Altamonte Springs WWTP, crossing the access road just south of McNorton Rd. Under this access road is the plant's wet weather discharge pipe which serves as an outfall for the Gateway area, discharging storm water directly into the Little Wekiva River, bypassing Spring Lake. Water from the wetland just west of the access road will either, flow through a culvert under the access road, flow into a control structure which is connected to the 48" wet weather discharge pipe, or overtop the access road. Using the hydraulic model of the Spring Lake Watershed and analyzing the various design storm events simulated revealed that approximately 50% of the flow discharges Gateway through the wet weather discharge pipe and 50% continues to flow downstream into Spring Lake. As such, to depict the flow and loading to Spring Lake a 50% reduction in water quantity and pollutant loads were applied upstream of the WWTP. This area is shown hatched in black in **Figure 6-4.**

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Table 6-3: Spring Lake BMP Treatment Summary

BMP	AREA (ACRES)	PERCENT OF WATERSHED (%)
No Stormwater Treatment	477	46%
Dry Retention 0.25"	86	8%
Dry Retention 1.00"	28	3%
Dry Detention	22	2%
Wet Detention	172	17%
Wet Retention	197	19%
Wet Retention / Treatment Train	61	6%
Lake Destiny	102	10%

Table 6-4: BMP Categories and Removal Efficiencies

		REMOVAL EFFICENCY (%)			
BMP CODE	**BMP DESCRIPTION**	**TN**	**TP**	**TSS**	**BOD**
DRY_DET	Dry Detention	15	25	70	40
DRY_025	*0.25" Dry Retention*	60	60	60	60
DRY_050	*0.50" Dry Retention*	80	80	80	80
DRY_075	*0.75" Dry Retention*	90	90	90	90
DRY_100	*1.00" Dry Retention*	95	95	95	95
DRY_125	*1.25" Dry Retention*	98	98	98	98
OFFLINE	Off-line Retention/Detention	60	85	90	80
WET_RET	Wet Retention	40	50	85	40
WET_DET	Wet Detention	25	65	85	55
WET_DET_FILTER	Wet Detention with Filtration	0	60	98	99
WET_RET_TRAIN	Cascading Wet Retention	64	75	95	64
-	Dry Detention with Filtration	-	-	-	-
DRY_DET_FILTER_AB	*Type A or B soils*	0	0	75	0
DRY_DET_FILTER_CD	*Type C or D soils*	0	0	60	0
ALUM	Alum Treatment	50	90	90	75
LAKE DESTINY	Wet Retention associated with 6 months residence time in Lake Destiny	44	80	90	45
GATEWAY US of WWTP	Wet Weather discharge pipe diverting water out of the watershed	50	50	50	50

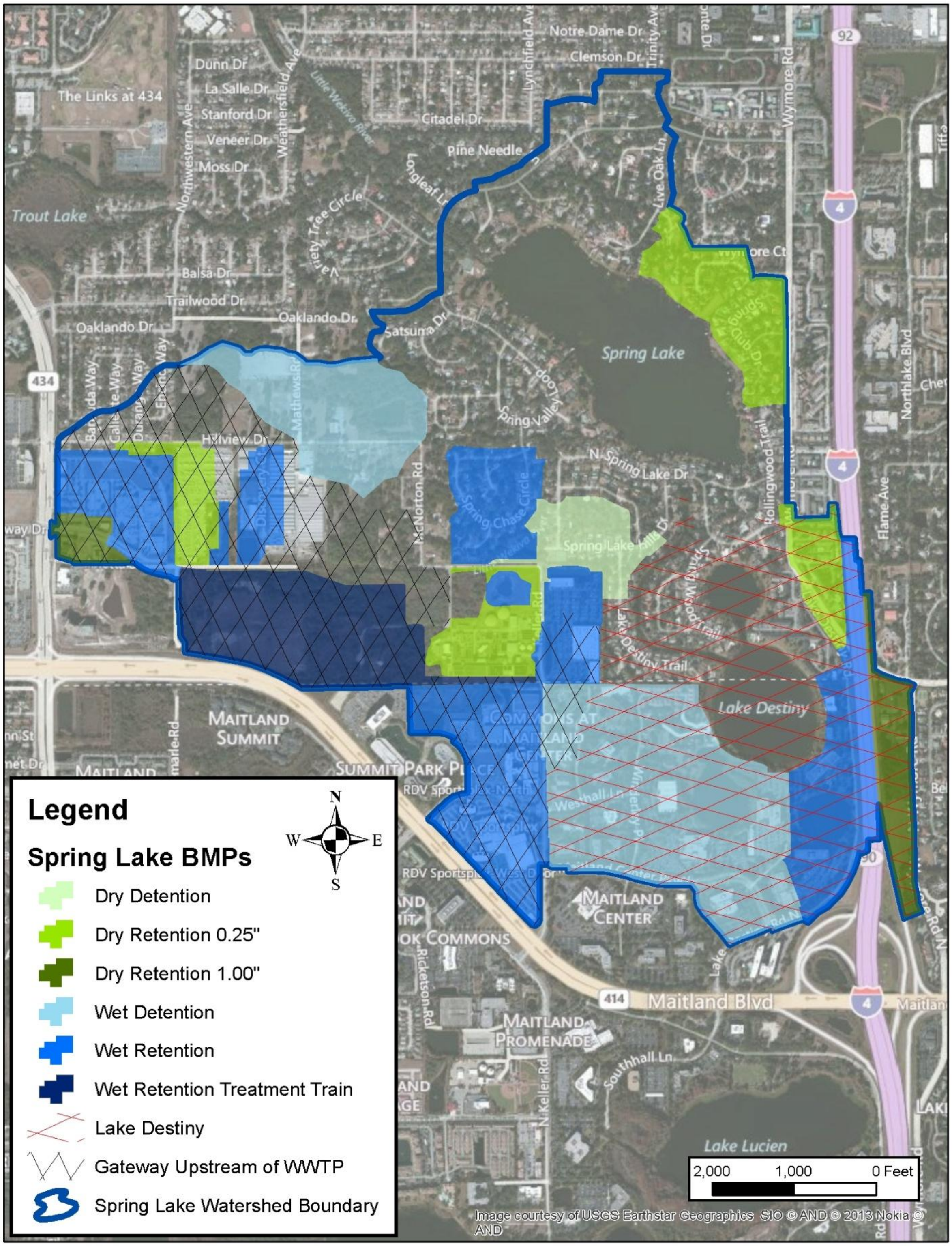

Figure 6-4: Spring Lake BMP Treatment Coverage

6.2.4. Rainfall

The average annual rainfall for the Seminole County and the Spring Lake Watershed was determined to be 51" based on FDEP rainfall isopleths map shown as **Figure 6-5**.

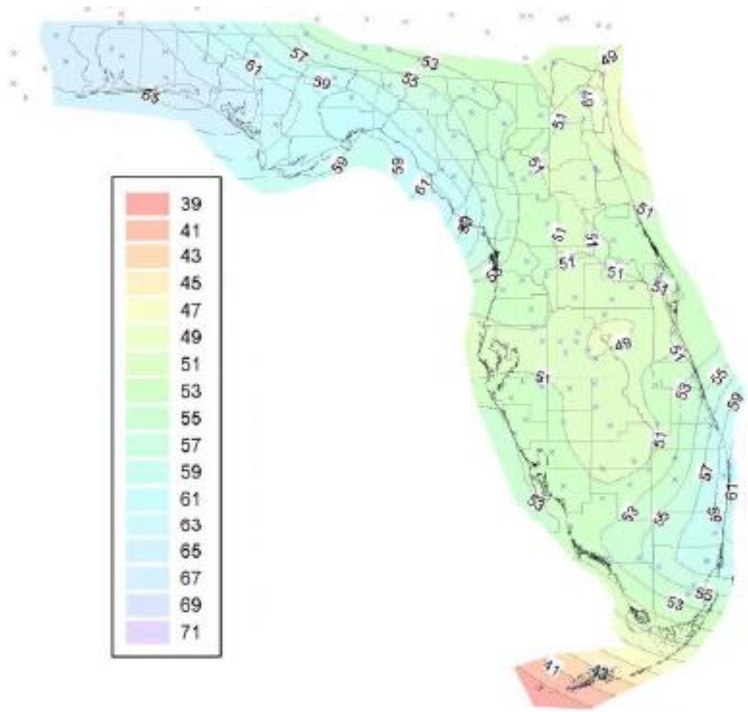

Figure 6-5: Rainfall Isopleth Map for Florida (Figure 3.2 of FDEP Storm Handbook – Draft)

6.3. Pollutant Loading Model Results

6.3.1. Existing Conditions

The results of the pollutant loading model are presented in **Table 6-5** through **Table 6-8** which summarize the pollutant loading results by Spring Lake Outfall for total phosphorus, total nitrogen, total suspended solids, and biological oxygen demand respectively. Result tables include annual runoff volume, contributing area, gross pollutant load, BMP removal rate & efficiency, net pollutant load and the outfall's effective EMC. The EMC value is a reflection of the land use and BMP treatment characteristics of the watershed and can be directly compared to outfall samples collected by Dr. Harvey Harper within Spring Lake and at the outfalls of Lake Destiny.

The results indicate that the largest net loading into the Spring Lake Watershed is through Outfall #10 at 179 lbs of total phosphorus and 1,714 lb of total nitrogen per year which represents 60% of the watershed inflows through direct discharges into Spring Lake. The contribution from the area upstream of the WWTP represents nearly half of this contribution as well.

Comparing the result tables against BMP coverage, **Figure 6-4** shows that the largest contributing basins with untreated stormwater are upstream of outfalls #2 and 12, which make up a combine 18% of the loading from direct discharges into Spring Lake. Targeting these outfalls for BMPs will likely yield greatest percentage reduction associated with BMP projects and have relatively higher cost benefit ratio.

Table 6-5: Spring Lake Pollutant Loading Model Results by Outfall: Total Phosphorus

Outfall	Runoff (ac-ft / Yr)	Area (acres)	Gross TP (lb/yr)	Outfall BMP Load Reduction	BMP load Removal (lb/yr)	Net TP (lb/yr)	Effective Outfall EMC	Notes
OUTFALL_1	**2**	**3**	**2**	**0%**	**0**	**2**	**0.33**	
OUTFALL_2	**38**	**55**	**34**	**0%**	**0**	**34**	**0.33**	
OUTFALL_3	**4**	**6**	**4**	**60%**	**2**	**2**	**0.13**	
OUTFALL_4	**4**	**6**	**4**	**60%**	**2**	**1**	**0.13**	
OUTFALL_5	**9**	**14**	**8**	**60%**	**5**	**3**	**0.13**	
OUTFALL_6	**3**	**4**	**2**	**0%**	**0**	**2**	**0.33**	
OUTFALL_7	**2**	**3**	**2**	**0%**	**0**	**2**	**0.33**	
OUTFALL_8	**6**	**8**	**5**	**0%**	**0**	**5**	**0.33**	
	4	6	4	0%	0	4	0.33	DS of Lk Destiny
	300	147	236	90%	211	25	0.03	50% of Lk Destiny
OUTFALL_9	**304**	**153**	**239**	**88%**	**211**	**28**	**0.03**	
	576	310	456	51%	233	223	0.14	Load US of WWTP
						50%		Discharge Pipe
	288	310	456	76%	344	112	0.14	Contributing Load
	78	80	64	32%	21	43	0.21	Load DS of WWTP
	300	147	236	90%	211	25	0.03	50% of Lk Destiny
OUTFALL_10	**665**	**537**	**756**	**76%**	**576**	**179**	**0.10**	
OUTFALL_11	**11**	**15**	**10**	**0%**	**0**	**10**	**0.33**	
OUTFALL_12	**43**	**81**	**33**	**40%**	**13**	**20**	**0.17**	
OUTFALL_13	**12**	**18**	**11**	**0%**	**0**	**11**	**0.33**	
	600	294	471	48%	226	245	0.15	Lk Destiny
						80%		BMP effect
LAKE_DESTINY (outfall)	**600**	**294**	**471**	**90%**	**422**	**49**	**0.03**	
SPRING_LAKE	**309**	**141**	**159**	**2%**	**4**	**155**	**0.19**	

Table 6-6: Spring Lake Pollutant Loading Model Results by Outfall: Total Nitrogen

Outfall	Runoff (ac-ft / Yr)	Area (acres)	Gross TN (lb/yr)	Outfall BMP Load Reduction	BMP load Removal (lb/yr)	Net TN (lb/yr)	Effective Outfall EMC	Notes
OUTFALL_1	**2**	**3**	**11**	**0%**	**0**	**11**	**2.07**	
OUTFALL_2	**38**	**55**	**215**	**0%**	**0**	**215**	**2.07**	
OUTFALL_3	**4**	**6**	**25**	**60%**	**15**	**10**	**0.83**	
OUTFALL_4	**4**	**6**	**22**	**60%**	**13**	**9**	**0.83**	
OUTFALL_5	**9**	**14**	**53**	**60%**	**32**	**21**	**0.83**	
OUTFALL_6	**3**	**4**	**14**	**0%**	**0**	**14**	**2.07**	
OUTFALL_7	**2**	**3**	**10**	**0%**	**0**	**10**	**2.07**	
OUTFALL_8	**6**	**8**	**31**	**0%**	**0**	**31**	**2.07**	
	4	6	24	0%	0	24	2.07	DS of Lk Destiny
	300	147	1445	60%	865	580	0.71	50% of Lk Destiny
OUTFALL_9	**304**	**153**	**1469**	**59%**	**865**	**604**	**0.73**	
	576	310	2978	42%	1264	1714	1.10	Load US of WWTP
						50%		Discharge Pipe
	288	310	1489	42%	632	857	1.10	Contributing Load
	78	80	408	25%	101	307	1.45	Load DS of WWTP
	300	147	1445	60%	865	580	0.71	50% of Lk Destiny
OUTFALL_10	**665**	**537**	**3341**	**48%**	**1598**	**1743**	**0.96**	
OUTFALL_11	**11**	**15**	**60**	**0%**	**0**	**60**	**2.07**	
OUTFALL_12	**43**	**81**	**221**	**16%**	**34**	**186**	**1.59**	
OUTFALL_13	**12**	**18**	**67**	**0%**	**0**	**67**	**2.07**	
	600	294	2889	28%	819	2070	1.27	Lk Destiny
						44%		BMP effect
LAKE_DESTINY (outfall)	**600**	**294**	**2889**	**60%**	**1730**	**1159**	**0.71**	
SPRING_LAKE	**309**	**141**	**799**	**3%**	**25**	**774**	**0.92**	

Table 6-7: Spring Lake Pollutant Loading Model Results by Outfall: Total Suspended Solids

Outfall	Runoff (ac-ft / Yr)	Area (acres)	Gross TSS (lb/yr)	Outfall BMP Load Reduction	BMP load Removal (lb/yr)	Net TSS (lb/yr)	Effective Outfall EMC	Notes
OUTFALL_1	**2**	**3**	**203**	**0%**	**0**	**203**	**37**	
OUTFALL_2	**38**	**55**	**3836**	**0%**	**0**	**3836**	**37**	
OUTFALL_3	**4**	**6**	**441**	**60%**	**265**	**176**	**15**	
OUTFALL_4	**4**	**6**	**399**	**60%**	**239**	**160**	**15**	
OUTFALL_5	**9**	**14**	**945**	**60%**	**567**	**378**	**15**	
OUTFALL_6	**3**	**4**	**257**	**0%**	**0**	**257**	**37**	
OUTFALL_7	**2**	**3**	**177**	**0%**	**0**	**177**	**37**	
OUTFALL_8	**6**	**8**	**562**	**0%**	**0**	**562**	**37**	
	4	6	431	0%	0	431	37	DS of Lk Destiny
	300	147	37568	97%	36511	1057	1	50% of Lk Destiny
OUTFALL_9	**304**	**153**	**37999**	**96%**	**36511**	**1487**	**2**	
	576	310	80416	74%	59872	20544	13	Load US of WWTP
						50%		Discharge Pipe
	288	310	40208	74%	29936	10272	13	Contributing Load
	78	80	8602	65%	5598	3004	14	Load DS of WWTP
	300	147	37568	97%	36511	1057	1	50% of Lk Destiny
OUTFALL_10	**665**	**537**	**86378**	**83%**	**72046**	**14332**	**8**	
OUTFALL_11	**11**	**15**	**1077**	**0%**	**0**	**1077**	**37**	
OUTFALL_12	**43**	**81**	**5136**	**61%**	**3108**	**2029**	**17**	
OUTFALL_13	**12**	**18**	**1190**	**0%**	**0**	**1190**	**37**	
	600	294	75136	72%	54003	21133	13	Lk Destiny
						90%		BMP effect
LAKE_DESTINY (outfall)	**600**	**294**	**75136**	**97%**	**73022**	**2113**	**1**	
SPRING_LAKE	**309**	**141**	**11405**	**4%**	**441**	**10964**	**13**	

Table 6-8: Spring Lake Pollutant Loading Model Results by Outfall: Biological Oxygen Demand

Outfall	Runoff (ac-ft / Yr)	Area (acres)	Gross BOD (lb/yr)	Outfall BMP Load Reduction	BMP load Removal (lb/yr)	Net BOD (lb/yr)	Effective Outfall EMC	Notes
OUTFALL_1	**2**	**3**	**43**	**0%**	**0**	**43**	**7.9**	
OUTFALL_2	**38**	**55**	**819**	**0%**	**0**	**819**	**7.9**	
OUTFALL_3	**4**	**6**	**94**	**60%**	**57**	**38**	**3.2**	
OUTFALL_4	**4**	**6**	**85**	**60%**	**51**	**34**	**3.2**	
OUTFALL_5	**9**	**14**	**202**	**60%**	**121**	**81**	**3.2**	
OUTFALL_6	**3**	**4**	**55**	**0%**	**0**	**55**	**7.9**	
OUTFALL_7	**2**	**3**	**38**	**0%**	**0**	**38**	**7.9**	
OUTFALL_8	**6**	**8**	**120**	**0%**	**0**	**120**	**7.9**	
	4	6	92	0%	0	92	7.9	DS of Lk Destiny
	300	147	6091	70%	4277	1813	2.2	50% of Lk Destiny
OUTFALL_9	**304**	**153**	**6183**	**69%**	**4277**	**1905**	**2.3**	
	576	310	13547	43%	5851	7696	4.9	Load US of WWTP
						50%		Discharge Pipe
	288	310	6774	43%	2926	3848	4.9	Contributing Load
	78	80	1704	32%	547	1158	5.5	Load DS of WWTP
	300	147	6091	70%	4277	1813	2.2	50% of Lk Destiny
OUTFALL_10	**665**	**537**	**14569**	**53%**	**7750**	**6819**	**3.8**	
OUTFALL_11	**11**	**15**	**230**	**0%**	**0**	**230**	**7.9**	
OUTFALL_12	**43**	**81**	**905**	**36%**	**324**	**581**	**4.9**	
OUTFALL_13	**12**	**18**	**254**	**0%**	**0**	**254**	**7.9**	
	600	294	12181	46%	5587	6594	4.0	Lk Destiny
						45%		BMP effect
LAKE_DESTINY (outfall)	**600**	**294**	**12181**	**70%**	**8554**	**3627**	**2.2**	
SPRING_LAKE	**309**	**141**	**2012**	**5%**	**94**	**1918**	**2.3**	

6.3.2. Gateway Development Comparison

The Gateway roadway extension and associated development in Altamonte Springs represents approximately 60 acres of development that discharges into Spring Lake through Outfall #10 on the south side of the lake. The 60 acres are part of the 310 acres that discharges either to the WWTP wet weather discharge pipe or continues on to contribute to Outfall # 10. **Table 6-9** shows the results of the loading upstream of the WWTP as compared to PreGateway conditions. The table also shows the impact the development had on the loads at Spring Lake.

Results indicate that flow, total phosphorus, total nitrogen, and BOD increased between 3 and 8 percent while total suspended solids decreased by 2 percent. It is of note that each of these changes is within 10% error associated the modeling and is the cumulative result of the various assumptions made in this report and not a definitive calibrated amount.

Table 6-9: Loading Comparison of Recent Watershed Developments

	Runoff (ac-ft / Yr)	Area (acres)	Gross TP (lb/yr)	Net TP (lb/yr)	Gross TN (lb/yr)	Net TN (lb/yr)	Gross TSS (lb/yr)	Net TSS (lb/yr)	Gross BOD (lb/yr)	Net BOD (lb/yr)
Gateway (Existing)	576	310	456	223	2978	1714	80416	20544	13547	7696
PreGateway	468	310	358	216	2299	1541	60977	20998	10904	7152
Delta	**108**	**0**	**98**	**8**	**679**	**173**	**19439**	**-454**	**2644**	**544**
Impact on Outfall #10	**54**	**0**	**49**	**4**	**339**	**86**	**9719**	**-227**	**1322**	**272**
Percentage Impact on Outfall #10	**8%**			**3%**		**7%**		**-2%**		**5%**

7. Recommendations

Based upon the analysis of field observations, development of digital stormwater infrastructure, and assessing the results of the hydraulic and pollutant loading model results, the following are the key observations and recommendations for the Spring Lake Watershed. These recommendations are intended to either stand alone or be incorporated into the ongoing work by ERD to understand the in-lake dynamics and specific conditions necessary to improve the health of Spring Lake.

Recommendation 1: Digital Data Maintenance

This watershed management plan was developed as a digital watershed management plan, which included providing a consistent format for data collected as part of the project, including ERPs, data collected in the field, and those data collected from the cities and Seminole County. As relevant data was georeferenced and specific structure data catalogued in a geometric and model networks. These geospatially accurate geometric networks of the stormwater infrastructure include: vertical data, structure sizes, material, and maintenance condition, as well as, providing links to model input data and data source documents and pictures. The data is presented digitally in the folder structure seen in **Figure 7-1**. Maintaining this data structure for the digital collection of data and storing model input data in a single geodatabase will facilitate future model updates to the Spring Lake Watershed. Through the automated GIS tools to regenerate ICPRv3 model input files rather than maintaining separate data sets. Further, this is an approach that can be applied to any other watersheds in the county regardless of size and source datasets.

Building upon the automated watershed approach techniques also make it easy to incorporate existing watershed models that were created within or even without the use of GIS into this model schema, whereby obtaining the benefits of the digital approach and making future updates to those models both consistent with watersheds in Seminole County and within the specific watershed.

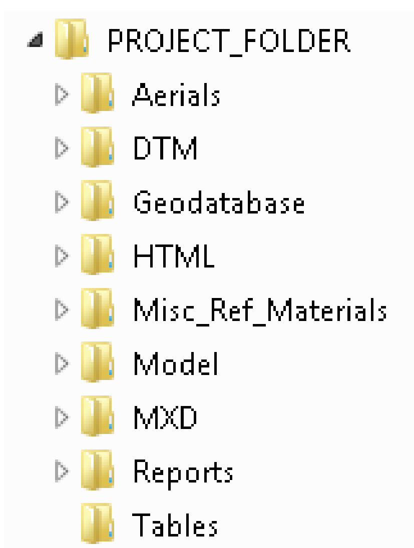

Figure 7-1: Digital Watershed Deliverable Project Folder Setup

Recommendation 2: Structure Rehabilitation: Spring Valley Oaks

Identified as immediate maintenance concern #2, the control structure between the Spring Valley Oaks and Spring Lake Hills Subdivisions is in a significant state of disrepair. The structure top is missing, presenting a hazardous liability and increased chance to have debris block flow. The structure is identified in the 1981 Spring Valley Oaks plans as an existing structure and appears that limited maintenance has been performed recently. It is recommended that the structure be replaced with an in kind maintenance improvement to maintain the life of the system. This junction has an upstream watershed in excess of 300 acres and includes all flow that is not diverted into the WWTP wet weather discharge pipe.

Recommendation 3: Roadway Flooding Hillview Drive

Hillview Drive east of SR 434 has been identified as immediate maintenance condition #3, the area of Hillview Drive near the Adult Toy storage property also received a flooding level of service grade of “D” indicating that it had greater than 6” of standing water occurring during a 50 year design storm event and making the roadway in accessible to normal traffic and limiting the ability for emergency vehicles to provide service to the area during design level storm events. Compounding the periodic roadway flooding is the sediment buildup in the roadside swale, pictured in **Figure 7-2**. This area, in the upper reach of the watershed is drained with by only a slight gradient, magnifying the impact of swale sedimentation and debris accumulation.

In the near term, it is recommended that the swale be regarded to provide a positive flow line downstream. A more permanent solution is to elevate the road or drain stormwater to one of the adjacent parcels. As roadway improvements area likely inevitable due to the resources and investment Altamonte Springs is devoting to the “downtown” Altamonte Springs area, also known as, the area along Gateway Drive. It may be more practical to incorporate any improvements to the roadway in this area into, or at least, in conjunction with future developments in the area.

Figure 7-2: Hillview Drive Swale Sedimentation

Recommendation 4: McNorton Cross Culvert Extension

Identified as immediate maintenance concern #4 and receiving Level of Service Grade of "D" for roadway flooding, McNorton Road just west of Keller Road overtops during minor flooding events and simulated to be inaccessible to emergency vehicles during extreme flooding events. Drainage in this area flows from the Gateway area, under McNorton Road, under the wall in the Spring Valley Chase subdivision (pictured in **Figure 7-3**) and to Spring Lake. Although, the annual peak conditions are not anticipated to increase, according to SJRWMD permit and validated through this analysis, this conveyance way is likely to receive more routine flows from daily local rainfall events. This conveyance way has relied upon the stability of the wall and the maintenance of conditions under the wall, to be free of silt and debris, a condition that, if blocked, would have a dramatic impact on the flooding at McNorton and possibly extend up into the Gateway Roadway extension development impacting that storm sewers ability to function as designed.

Improvement alternatives to the McNorton Road crossing include both upsizing the pipe size under McNorton Road and extending the existing piping past the wall. This would provide added stability to the wall and alleviate a significant maintenance concern as well as mitigate the roadway flooding and facilitating future roadway improvements to McNorton Road.

Figure 7-3: Conveyance between McNorton Road and Spring Valley Chase Subdivision

Recommendation 5: Monitor Aging Infrastructure - Spring Lake Hills

During field investigations within the Spring Lake Hills Subdivision, the general condition of the infrastructure was noted to consistently show signs of its age. While no single structure was identified as failing at the time of the investigations, it is recommended that this area receive routine inspections to look for increased signs of degradation. As area of particular interest are the outfalls and outfall paths between Lake Destiny and Spring Lake. This includes both the outfall along Lake Destiny Trail, into the depression across Spring Lake Hills Drive and crossing North Springs Trail and North Spring Lake Drive, as well as, the outfall at the end of the Lake Destiny access canal, which also crosses Spring Lake Drive. These flow paths are critical infrastructure to the proper functioning of the Spring Lake / Lake Destiny connection and if they fall into disrepair, there is an increased chance of structural flooding even under typical summer rainfall events.

The outfall midway down the Lake Destiny access canal, has recently been replaced, located between the canal and Lake Destiny Trail as part of a Spring Lake Hills Subdivision Homeowners Association project. The project also replaced the outfall structure in the canal, as pictured below in **Figure 7-4**. The replacement used sand bags to set the elevation of the overflow control structure; however field observations showed that the elevation of the overflow was higher than the outfall at the end of the access canal by a few inches, when they should have been set at the same elevation. Additionally, this structure appears to be leaking and will effectively bleeding down the Lake Destiny during extreme dry conditions. This outfall should be reviewed per design plans and at a minimum be set to match existing conditions. Alternatively, as will be discussed in recommendation number 9, performing a coordinated effort between rehabilitation of these structures and other water quality improvements can both enhance the aging infrastructure while providing a water quality benefit to Spring Lake and likely qualify for grant funding.

Figure 7-4: Lake Destiny Outfall Structure, Midway Down Access Canal

Recommendation 6: Structural Flooding Review

Structural flooding identified along North Spring Trail in the Spring Lake Hills Subdivision. During the level of service determination, Basin DS_Gateway_0150 received a "D" grade for structural flooding. This basin was the only one of the 77 modeled basins to indicate structural flooding. As noted in the Level of Service section, this determination was based the elevation of the home as extracted from the DEM and compared to the 100 year – 24 hr flood stage in the basin. Although this home does currently fall within the effective FEMA flood zone, it is possible that the DEM may have been obscured by a topographic void in the area and may not have identified the precise house pad elevation.

It is recommended that the flooding concern is first verified though a survey tied to a known benchmark. Once the proposed flooding is verified, flood proofing options can be evaluated, including flood proofing, outfall modifications or flood attenuation in upstream basins. This area receives water from both the Gateway area and Lake Destiny prior to outfalling into Spring Lake. Although the upstream contributing areas are significant, if this is a verifiable flooding issue, there are also alternatives and opportunities in those basins to alter drainage patterns to help manage the flood risk.

Recommendation 7: BMP treatment – Outfall #2

On the north side of Spring Lake untreated stormwater drains from Camphor Tree Lane, Water Oak Land and Live Oak Lane to combine and discharge into Spring Lake. This area, 55 acres, represents the largest untreated loading from an inflow adjacent to Spring Lake accounting for 11% of the total phosphorus load. Providing water quality treatment in this area will enable the efficiency of treating a large quantity of stormwater in a single place. Although the open space along the discharge pipe is very limited as depicted in **Figure 7-5**, there appears to be sufficient vertical distance, even in close proximity to the lake to provide inline exfiltration trench type treatment along the trunk line of the discharge pipe. According to the DEM, the topography in this area is approximately 7 feet higher than the lake. As seen in **Figure 7-5** the biggest challenge to implementing this BMP will likely be access during construction and will require close coordination with homeowners and the homeowners association.

Figure 7-5: Spring Lake Outfall #2 BMP

Recommendation 8: BMP treatment – Outfall #12

On the south side of Spring Lake, the second largest untreated direct inflow represents 7% of the total phosphorus load originating from 81 acres of residential, open space, and open water feature. The area platted as Spring Valley Farms Section 8 and 9, was developed prior to water quality permitting regulations and includes significant street drainage before entering the inlet on Spring Valley Loop near Valencia Loop. This first inlet has a connection that follows the open space between two houses and received drainage from portions of Hillview Drive and McNorton as well as untreated residential. The existing inlet seen in **Figure 7-6** can be retrofitted as a smart box in combination with a baffle box / exfiltration trench located along the existing inflow pipe to provide treatment for the majority of the untreated stormwater leading to Spring Lake.

Other alternatives for treatment of this basin include installing an exfiltration trench and smart box along the outfall pipe on Spring Valley Loop near the intersection with Spring Valley Road as conceptually seen in **Figure 7-7**. Both of these proposed BMPs would fit within the existing ROW and provide treatment for currently untreated residential areas contributing to Spring Lake.

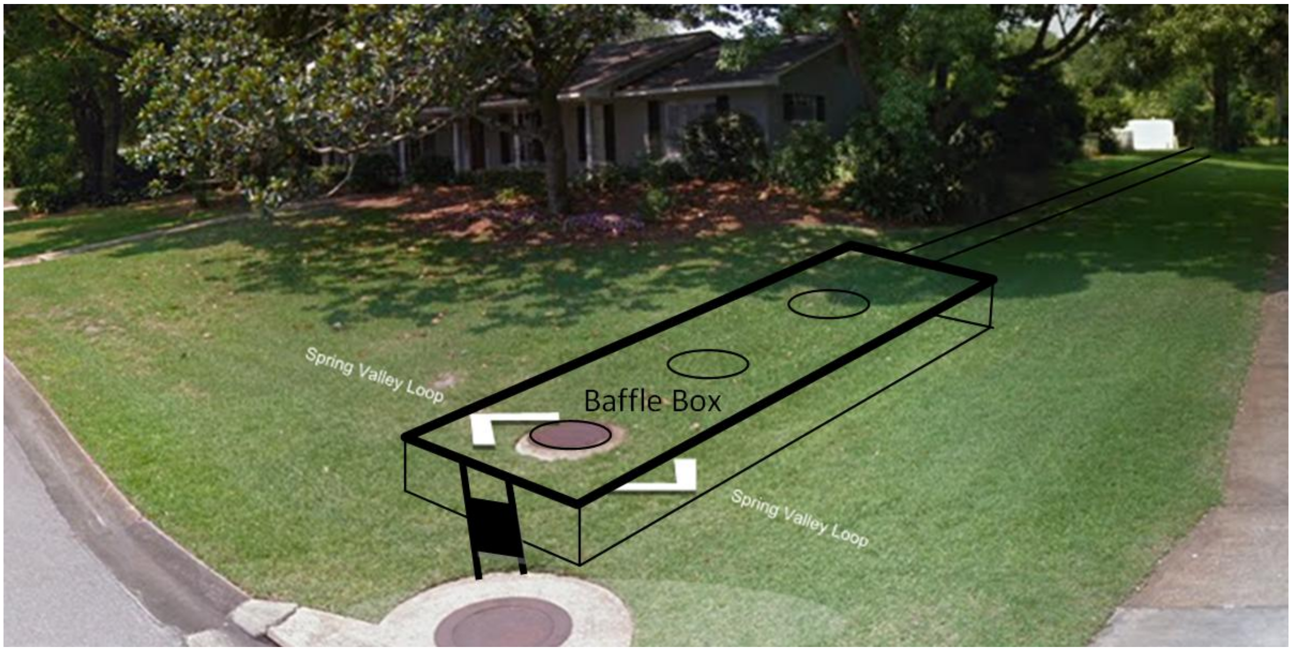

Figure 7-6: Outfall #12: Baffle Box BMP

Figure 7-7: Outfall #12: Exfiltration Trench BMP

Recommendation 9: Spring Lake Hills Wetland BMP

The infow with the largest load contribution to Spring lake is Outfall #10, which contributes 60% of the total phosphorus and 58% of the total nitrogen load. This outfall receives drainage from Lake Destiny as well as the Gateway area, the Spring Valley Chase subdivision and portions of the Spring Lake Hills subdivision. The total drainage area upstream of Outfall #10 is 537 acres which includes only 50% of the area and inflow from Lake Destiny and only 50% of the inflow from the Gateway area. With the exception of the Spring Lake Hills subdivision, the vast majority of the contributing watershed receives some level of water quality treatment. Even with the existing treatments in place, the loading calculated by the loading model shows this as the most significant contributing inflow in the entire watershed.

While the majority of the infrastructure is built out and opportunities for BMPs with larger footprints are limited, the flow through wetland located in Spring Lake Hills is the exception. This wetland, seen in **Figure 7-8** is the blending point for water discharging Lake Destiny and water from the Gateway area. Out of Lake Destiny there is an almost constant stream of water which has historically served the wetland well, based upon its apparent health as observed in field visits to the area. At current however, the area does not retain any significant amount of water and appears mostly as a flow through feature rather than a treatment feature. Through modifications to the existing wetland to create cells and overflows, storm water will have a longer contact time within the wetland providing both the opportunity for nutrient uptake and settling of particles. The additional water will also promote a more viable and asthetic feature for the homeowners, who could optionally install a boardwalk feature as depicted in **Figure 7-9**. As this project would serve to provide water quality treatment to areas previous untreated or undertreated within the jurisdictions of the DOT, the City of Maitland, the City of Altamonte, and Seminole County there are opportunities to combine resources serve a mutual benefit.

At a minimum, this alternative would require coordination with the HOA and permitting through SJRWMD for work performed in and around surface waters / wetlands. Additional considerations to maximize the effectiveness of the project would be to analyze alterations to the Lake Destiny outfall structures and provide replacements or rehabilitation to the existing structures while also diverting more of the low flows through the treatment wetland without altering the peak flow divisions associated with design storm events.

Figure 7-8: Spring Lake Outfall #10: Spring Lake Hills Wetland Enhancement

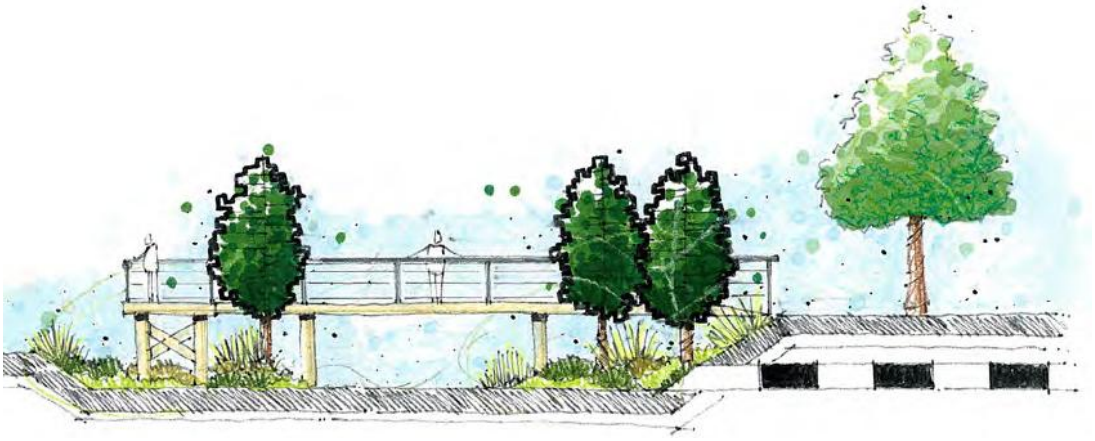

Figure 7-9: Spring Lake Hills Wetland Cross-seciton

Recommendation 10: WWTP Flood Attenuation / Water Quality Pond

On the City of Altamonte Spring's WWTP there is a holding pond used to supplement the City's reuse water supply. Treated water and stormwater from the plant are stored in this pond for supplemental use. Currently the pond is not directly connected to the conveyance from the Gateway Drive area that flows under McNorton Road. However, if this pond were available for a use by the surface water system, it could provide both flood attenuation to alleviate flooding along McNorton Road and provide water quality treatment from all areas upstream and including the WWTP. Additionally, the pond could be configured with a flap gate to retain the water that flows in, and thereby increasing the water available as supplemental reuse water.

In either scenario, coordination with the City of Altamonte would need to occur to both design and implement water quality and flood attenuation alternatives. A conceptual sketch of the current flow path and connection to the pond are shown in **Figure 7-10**.

Figure 7-10: Water Quality Pond Connection

8. References

Florida Department of Environmental Protection and Water Management Districts, (2010-Draft) "Environmental Resource Permit Stormwater Quality Handbook – Design Requirements for Stormwater Treatment Systems in Florida"

Harper, H. H. (1995) "Pollutant Removal Efficiencies for Typical Stormwater Management Systems in Florida", Proceedings of the 4th Biennial Stormwater Research Conference, South West Florida Water Management District, Clearwater, FL, October 18-20, 1995

Harper, H. H. "Evaluation of Current Stormwater Design Criteria within the State of Florida - Final Report". June 2007.

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