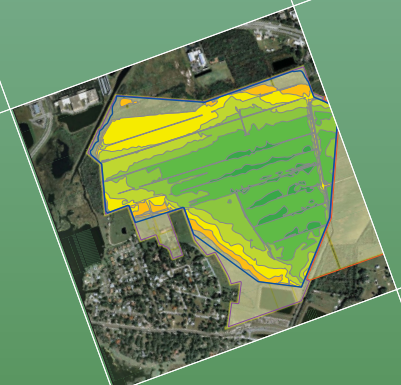


Judge Farms Water Storage Facility Preliminary Feasibility Analysis

FINAL REPORT



February 2012

**CDM
Smith**

Judge Farms Water Storage Facility

Preliminary Feasibility Analysis

Executive Summary

On behalf of the City of Kissimmee, City of St. Cloud, Osceola County, and the Toho Water Authority (Stakeholders), CDM completed a preliminary evaluation of the feasibility of integrating the Judge Farms Property into an overall water resources plan to provide storage for reuse augmentation purposes and treatment of surface waters. Surface water flows from East Lake Tohopekaliga as well as surface water from three local tributaries (East City Ditch, Mill Slough, and the Judge Farms Ditch) were evaluated for the purpose of providing an alternative water supply for reuse augmentation purposes. The intent for this alternative water supply is to maximize reuse to the extent practicable in order to offset using potable water for irrigation. This will help extend the supply of groundwater for potable purposes for both Toho Water Authority and the City of St. Cloud (recipients of the supplied water), which is very important since both utilities are located in the Central Florida Coordination Area and have established limits on groundwater withdrawals.

This preliminary feasibility analysis included data collection and analysis; field reconnaissance for hydrologic and environmental conditions; continuous modeling of flows in East City Ditch, Mill Slough, and Judge Farms Ditch; surface water storage facility site screening analysis; preparation of site configuration layouts; conceptual feasibility analysis; and preparation of estimates of probable conceptual capital costs.

From a review of existing site permits and field reconnaissance, the Judge Farms Property does not contain preferred habitat for wetland-dependent endangered or threatened wildlife species or species of special concern. No other wetland-dependent endangered or threatened wildlife species or species of special concern were observed on-site in recent field investigations, and it has been determined that the potential use of the site by such species is minimal. Additionally, past impacts to wetlands have been mitigated for. If the proposed water storage facility does not encroach on additional wetlands, then no wetland mitigation will be required.

Based on feedback from the Stakeholders, the site environmental assessment, existing surrounding land use, and a proposed Osceola County softball complex in the eastern part of the site, two potential water storage facility configurations were identified in the western part of the site. A minimal and a complete perimeter berm were evaluated for this study.

The minimal berm option consists of a 228 acre storage facility footprint with minimal perimeter berms west of Judge Farms Ditch and selected low areas around the remaining perimeter of the site; thereby, using the existing topography to contain the stored surface water. For this alternative, fill would have to be placed along 6,730 feet of existing berm along the west side of Judge Farms Ditch to raise the top of berm elevation along the ditch to 52 feet NAVD to prevent co-mingling of the stored water with water in the ditch and fill in low areas around the perimeter of the storage facility footprint to elevation 52 feet NAVD to prevent stored water from flowing off-site. This alternative will provide for up to 754 acre-feet (246 million gallons) of live storage between the bottom of the storage facility (48 feet NAVD) and

an elevation of 52 feet NAVD. The effective storage (from the bottom of the storage facility to the maximum operating water depth) is 335 acre-feet (109 million gallons).

The perimeter berm option consists of a 259 acre storage facility footprint with more extensive, higher berms around the majority of the perimeter of the proposed storage facility. The eastern limit of the proposed storage facility crosses Judge Farms Ditch. The top of berm elevation would be 54 feet NAVD and provide for up to 1,305 acre-feet (425 million gallons) of live storage between the bottom of the storage facility (48 ft NAVD) and the top of berm. The effective storage is 805 acre-feet (262 million gallons).

In order to determine the flows and stages that would occur in the three urban tributaries (Mill Slough, East City Ditch, and Judge Farms Ditch) that will contribute to the proposed water storage facility, a SWMM model of the channels and their contributing subcatchments was developed from 1990 to 2010 at a daily time step. This daily input of simulated flows from the tributaries was used as an inflow into the systems model.

A dynamic systems model was developed from 1990 to 2010 using STELLA® software to assist in the water budget analysis as well as to conceptually size and evaluate the performance of the proposed water storage facility configurations. The conceptual water storage facility was represented in the systems model as a storage basin that receives inflows pumped from three tributaries (East City Ditch, Mill Slough, and Judge Farms Ditch), inflow pumped from East Lake Toho, and direct rainfall. The system loses water to free-surface evaporation and groundwater seepage. Two additional outflows from the water storage facility consisted of water supply releases and a discharge for emergency overflows to Lake Toho. The annual average demand for the reuse supply ranged from 10 to 30 mgd and was discretized into monthly values using seasonally varying demand fractions specific to the net irrigation requirement for pasture grass in Osceola County (USDA, 1982).

For the minimal berm option, the reliability of the supply ranges from 87 percent (30 mgd) to 92 percent (10 mgd) since there are some limited occurrences when supply is not sufficient to meet highest peak demands such as in April and May. The amount of inflow that the tributaries can contribute is limited since they are low flow, “flashy” systems. Inflows from East Lake Toho are needed to meet the vast majority of the demand. Without augmentation from East Lake Toho, this option would be able to reliably supply an annual average flow of 1 mgd approximately 90 percent of the time, while a higher flow of 3 mgd can be supplied approximately 69 percent of the time.

For the perimeter berm option, the reliability of the supply ranges from 90 percent (30 mgd) to 95 percent (10 mgd) since there are some limited occurrences when supply is not sufficient to meet highest peak demands such as in May. Again, the amount of inflow that the tributaries can contribute is limited since they are low flow, “flashy” systems and inflows from East Lake Toho are needed to meet the vast majority of the demand. However, because the available storage is greater in this option due to the higher berms, the residence times are larger and hence inflows from East Lake Toho are initiated less often. These greater residence times will result in higher pollutant reduction benefits than for the minimal berm option. Without augmentation from East Lake Toho, this option would be able to reliably supply an annual average flow of 1 mgd approximately 100 percent of the time, while a higher flow of 5 mgd can be supplied approximately 77 percent of the time.

The total nitrogen (TN) and total phosphorus (TP) load removals associated with a water storage facility at the Judge Farms Property were quantified for the two proposed configurations. To calculate the load reduction, two scenarios based on the potential future use of the site and possible phasing of

implementation were considered. The first scenario considered the proposed storage facility for wet detention purposes only (i.e., storage and treatment of surface water from the three tributaries), while the second scenario considered the facility at its optimal desired use (storage and treatment of surface waters for water supply purposes with augmentation from East Lake Toho).

As raw water demand increases within each berm option, the amount of nutrient removal is also increased, as there is a lesser probability of the water being released to Lake Toho. Similar to the wet detention scenario, the perimeter berm option provides more volume and, therefore, greater storage for alternative uses. The perimeter berm option results in a greater nutrient load removal compared to the minimal berm option.

A comparison of the two scenarios (wet detention vs. water storage) also demonstrates the added nutrient load removal benefit of using the treated surface water for alternative uses. Under the wet detention scenario, the TN load removal ranges from 29,454 to 30,632 lbs/yr whereas TP removal ranges from 5,633 to 6,183 lbs/yr. Under the water storage facility option, TN load removal ranges from 58,720 to 71,294 lbs/yr whereas TP removal ranges from 6,329 to 7,684 lbs/yr. In the case of TN removal, the water storage facility scenario at a minimum doubles the load removal. TP removal is increased from 8 to 24 percent over the wet detention scenario.

Conceptual estimates of capital cost were prepared for a combined end-use of the facility (stormwater treatment and reuse augmentation) as summarized in **Table ES-1**. The water supply options varied by raw water demand (10 mgd to 30 mgd) and berm configuration (minimal and perimeter). All options were based on utilizing the available footprint west of the proposed sports complex and relied on inflows from the three tributaries and East Lake Toho for the raw water source. As directed by the Stakeholders, the available supply from the water storage facility was evaluated as divided equally between the City of St. Cloud and Toho Water Authority for reuse augmentation. Two alternative transmission routes—an East route and a West route—were considered for distributing raw water to the City of St. Cloud Lakeshore Stormwater Augmentation Facility site and to the Toho Water Authority's South Bermuda Water Reclamation Facility (WRF), respectively. For the minimal berm option, estimates of total capital cost range from \$45.9 million (10 mgd) to \$102.2 million (30 mgd). For the perimeter berm option, estimates of total capital cost range from \$46.6 million (10 mgd) to \$103.0 million (30 mgd). For both the minimal and perimeter berm configurations, the total capital costs for the combined end-use of the facility ranges from approximately \$3M/mgd (30 mgd) to \$5M/mgd (10 mgd), which are on the low to typical end of the range when measured against the volume of alternative water supply provided.

Conceptual estimates of capital cost were prepared (**Table ES-2**) for construction of a water storage facility on the available footprint west of the proposed sports complex to provide stormwater treatment only (i.e., inflow from the three tributaries to the water storage facility). Estimates of total capital cost range from \$11.5 million (minimal berm option) to \$14.0 million (perimeter berm option) for this end-use of the facility.

Conceptual estimates of capital cost were prepared (**Table ES-3**) for construction of a water storage facility on the available footprint west of the proposed sports complex to provide reuse augmentation only (i.e., inflow from East Lake Toho to the water storage facility). For the minimal berm option, estimates of total capital cost range from \$34.9 million (10 mgd) to \$89.6 million (30 mgd). For the perimeter berm option, estimates of total capital cost range from \$35.6 million (10 mgd) to \$90.4 million (30 mgd). Depending on the end-use of the storage facility, the cost per pound per year of total nitrogen removal ranges from around \$400 to \$800 for the minimal berm option to \$500 to \$1,400 for the perimeter

berm option. The cost per pound per year of total phosphorus removal ranges from around \$2,000 to \$7,000 for the minimal berm option to \$2,200 to \$13,000 for the perimeter berm option.

From a permitting perspective, the two major permits will be the Water Use Permit and the Environmental Resource Permit from the South Florida Water Management District (SFWMD) to use the surface water sources and connect to them. A SFWMD right-of-way utilization permit will be required for a portion the City of St. Cloud transmission lines and an Osceola County building department permit will be required for certain structures and electrical connections. Also, Florida Department of Transportation and Osceola County Right-of-Way permits for construction of the transmission pipelines will be needed. Both the City of St. Cloud and Toho Water Authority would have to modify their Florida Department of Environmental Protection facility permits (Southside WWTP and Bermuda WRF) to accommodate the supplemental (surface water) sources and to permit their transmission pipelines and the water storage facility.

Table ES-1. Summary of Conceptual Capital Costs (Combined Stormwater Treatment and Reuse Augmentation)

Raw Water Demand	10 mgd			20 mgd			30 mgd		
Minimal Berm									
Subtotal of Construction Cost (\$ Millions) ¹	\$34.0M			\$52.5M			\$65.9M		
Adjustments to Capital Cost from Construction Cost (\$ Millions) ^{2,3}	35%	45%	55%	35%	45%	55%	35%	45%	55%
	\$11.9M	\$15.3M	\$18.7M	\$18.4M	\$23.7M	\$28.9M	\$23.1M	\$29.7M	\$36.2M
Total Capital Cost (\$ Millions) ⁴	\$45.9M	\$49.3M	\$52.7M	\$70.9M	\$76.2M	\$81.5M	\$89.0M	\$95.6M	\$102.2M
Perimeter Berm									
Subtotal of Construction Cost (\$ Millions) ¹	\$34.5M			\$53.1M			\$66.4M		
Adjustments to Capital Cost from Construction Cost (\$ Millions) ^{2,3}	35%	45%	55%	35%	45%	55%	35%	45%	55%
	\$12.1M	\$15.5M	\$19.0M	\$18.5M	\$23.9M	\$29.2M	\$23.2M	\$29.9M	\$36.5M
Total Capital Cost (\$ Millions) ⁴	\$46.6M	\$50.0M	\$53.5M	\$71.6M	\$76.9M	\$82.3M	\$89.7M	\$96.3M	\$103.0M
Notes:									
¹ Conceptual construction costs include pumps for East City Ditch, Mill Slough, Judge Farms Ditch, East Lake Toho, and high service pump station; water storage facility; conveyance from East City Ditch, Judge Farms Ditch, and East Lake Toho to water storage facility; conveyance to City of St. Cloud and TWA connection points.									
² Adjustments from construction cost to capital cost consist of: mobilization/demobilization and contingency (20%); non-construction capital cost consisting of planning, engineering, design, and construction services (15%).									
³ Adjustments from construction cost to capital cost consist of: mobilization/demobilization (5%); contingency (20 or 30%); non-construction capital cost consisting of planning, engineering, design, and construction services (20%).									
⁴ Costs do not include estimates for water treatment, operations and maintenance (O&M), proposed Judge Farms Property acquisition, potential wetlands mitigation, or hazardous material/soil remediation.									

Table ES-2. Summary of Conceptual Capital Costs (Stormwater Treatment)

	Minimal Berm			Perimeter Berm		
Subtotal of Construction Cost (\$ Millions) ¹	\$8.5M			\$9.0M		
Adjustments to Capital Cost from Construction Cost (\$ Millions) ^{2,3}	35% \$3.0M	45% \$3.8M	55% \$4.7M	35% \$3.2M	45% \$4.1M	55% \$5.0M
Total Capital Cost (\$ Millions) ⁴	\$11.5M	\$12.3M	\$13.2M	\$12.2M	\$13.1M	\$14.0M
Notes: ¹ Conceptual construction costs include pumps for East City Ditch, Mill Slough, and Judge Farms Ditch; water storage facility; and conveyance from East City Ditch and Judge Farms Ditch to water storage facility. Individual cost components are summarized in Table 17. ² Adjustments from construction cost to capital cost consist of: mobilization/demobilization and contingency (20%); non-construction capital cost consisting of planning, engineering, design, and construction services (15%). ³ Adjustments from construction cost to capital cost consist of: mobilization/demobilization (5%); contingency (20 or 30%); non-construction capital cost consisting of planning, engineering, design, and construction services (20%). ⁴ Costs do not include estimates for water treatment, O&M, proposed Judge Farms Property acquisition, potential wetlands mitigation, or hazardous material/soil remediation.						

Table ES-3. Summary of Conceptual Capital Costs (Reuse Augmentation)

Raw Water Demand	10 mgd			20 mgd			30 mgd		
Minimal Berm									
Subtotal of Construction Cost (\$ Millions) ¹	\$25.9M			\$44.4M			\$57.8M		
Adjustments to Capital Cost from Construction Cost (\$ Millions) ^{2,3}	35% \$9.0M	45% \$11.6M	55% \$14.2M	35% \$15.6M	45% \$20.0M	55% \$24.4M	35% \$20.2M	45% \$26.0M	55% \$31.8M
Total Capital Cost (\$ Millions) ⁴	\$34.9M	\$37.5M	\$40.1M	\$60.0M	\$64.4M	\$68.9M	\$78.0M	\$83.8M	\$89.6M
Perimeter Berm									
Subtotal of Construction Cost (\$ Millions) ¹	\$26.4M			\$44.9M			\$58.3M		
Adjustments to Capital Cost from Construction Cost (\$ Millions) ^{2,3}	35% \$9.2M	45% \$11.9M	55% \$14.5M	35% \$15.7M	45% \$20.2M	55% \$24.7M	35% \$20.4M	45% \$26.2M	55% \$32.1M
Total Capital Cost (\$ Millions) ⁴	\$35.6M	\$38.2M	\$40.9M	\$60.6M	\$65.1M	\$69.6M	\$78.7M	\$84.5M	\$90.4M
Notes: ¹ Conceptual construction costs include pumps for East Lake Toho and high service pump station; water storage facility; conveyance from East Lake Toho to water storage facility; and conveyance from water storage facility to City of St. Cloud and TWA connection points. Individual cost components summarized in Table 18. ² Adjustments from construction cost to capital cost consist of: mobilization/demobilization and contingency (20%); non-construction capital cost consisting of planning, engineering, design, and construction services (15%). ³ Adjustments from construction cost to capital cost consist of: mobilization/demobilization (5%); contingency (20 or 30%); non-construction capital cost consisting of planning, engineering, design, and construction services (20%). ⁴ Costs do not include estimates for water treatment, O&M, proposed Judge Farms Property acquisition, potential wetlands mitigation, or hazardous material/soil remediation.									

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Appendices

Appendix A – Field Reconnaissance Photographs

Appendix B – Systems Model Sensitivity Analysis Results

Appendix C – Cost Estimate Tables

Judge Farms Water Storage Facility Preliminary Feasibility Analysis

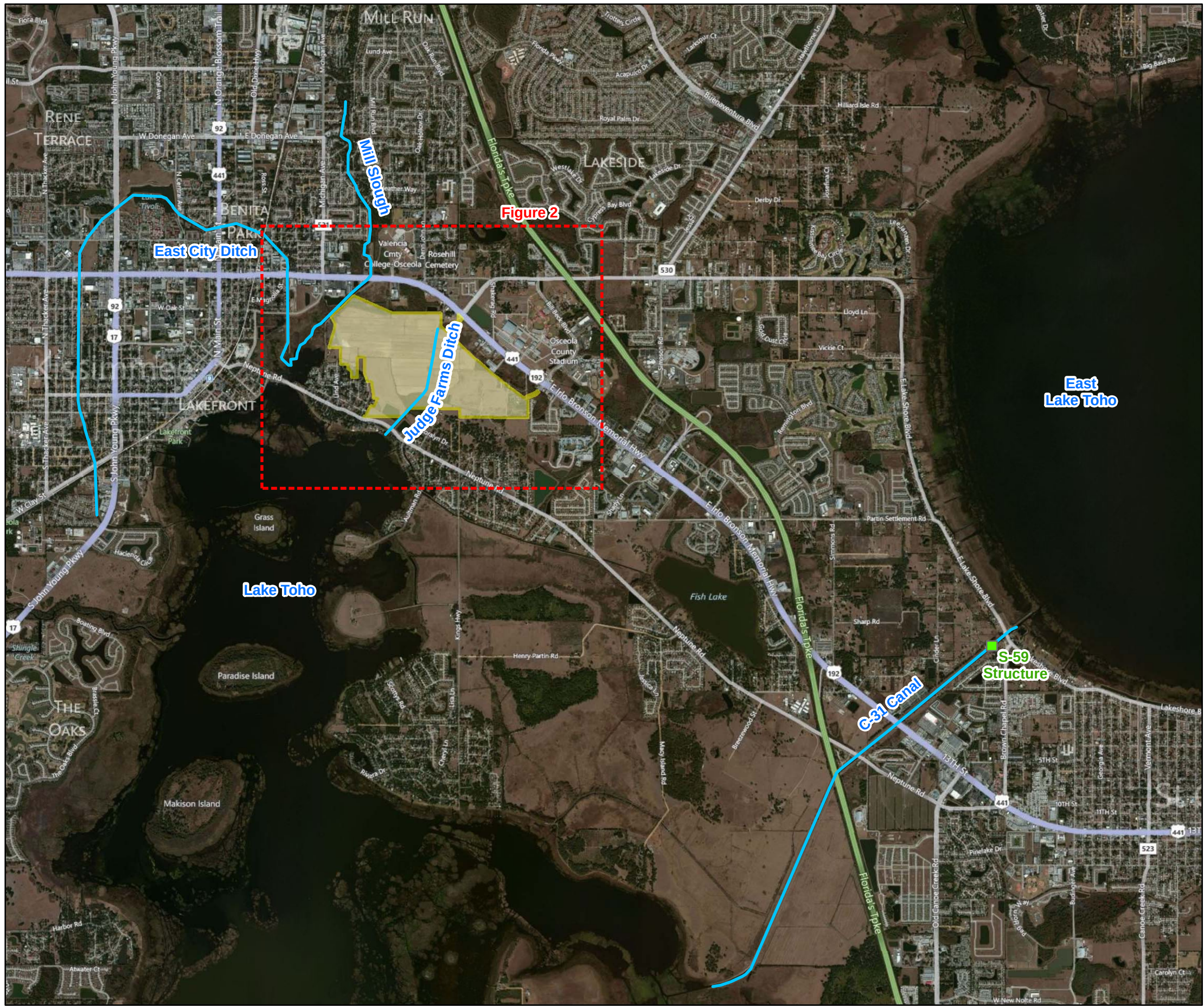
1.0 Background and Purpose

In 2011, the City of Kissimmee, City of St. Cloud, Osceola County, and the Toho Water Authority (TWA) initiated a study to perform a preliminary evaluation of the feasibility of integrating the “Judge Farms Property” (property), located northeast of Lake Tohopekaliga (Toho) in Osceola County, into an overall water resources plan to harvest stormwater for reuse augmentation and provide treatment of surface waters (**Figure 1**). As shown on **Figure 2**, the Judge Farms Property is privately owned by Avatar Properties, Inc. and two other parcel owners. The study area consists of approximately 452 acres of land situated just southeast of the City of Kissimmee between Neptune Road and US 192. The western half of the Judge Farms Property (west of Judge Farms Ditch) consists of a large depressional area that was once historic wetland floodplain along Lake Toho that has been used for sod farming purposes. This part of the site was extensively ditched and drained to support the historic sod farming. The eastern half of the site (east of Judge Farms Ditch) gradually rises in elevation by as much as 20 feet and has been used for dairy farming purposes.

The property has been considered on a number of occasions for treatment and storage of surface waters. Its natural low topography, size and proximity to surface waters make it desirable as a surface water management facility. In 1991, CDM developed the Upper Lake Toho Restoration Area (ULTRA) Preliminary Design for the City of Kissimmee, Osceola County, and the South Florida Water Management District (SFWMD). This study evaluated the feasibility of utilizing the site to provide stormwater treatment (quantity and quality) of runoff from Mill Slough and East City Ditch as part of ecosystem restoration in a community park setting. This work would have been performed in coordination with clearing of nuisance vegetation and debris by the State as a part of the 7 year drawdown cycle for the lake. In 2003, Berryman and Henigar evaluated a treatment scheme for the City of Kissimmee that included a regional stormwater treatment system with passive park facilities on the Judge Farms Property, wetland creation and restoration, and diversion of the Mill Slough and East City Ditch through the Judge Farms Property.

The emphasis of this evaluation is to determine the feasibility and potential configuration of a water storage facility constructed on the Judge Farms Property to provide storage for harvesting stormwater and treatment of surface water. Surface water flows from East Lake Toho as well as surface water from three local tributaries (East City Ditch, Mill Slough, and the Judge Farms Ditch) were evaluated for the purpose of providing an alternative water supply for reuse augmentation purposes. This supplemental source of water for reuse will allow the utilities to increase the quantity and reliability of delivery of reclaimed water to its customers using the lowest acceptable quality water source for irrigation (a SFWMD mandate for all utilities) and thereby reducing irrigation with potable water. This is specifically addressed in both TWA’s and the City of St. Cloud’s Water Use Permits. This will help extend the supply of groundwater for potable purposes for both TWA and the City of St. Cloud, which is very

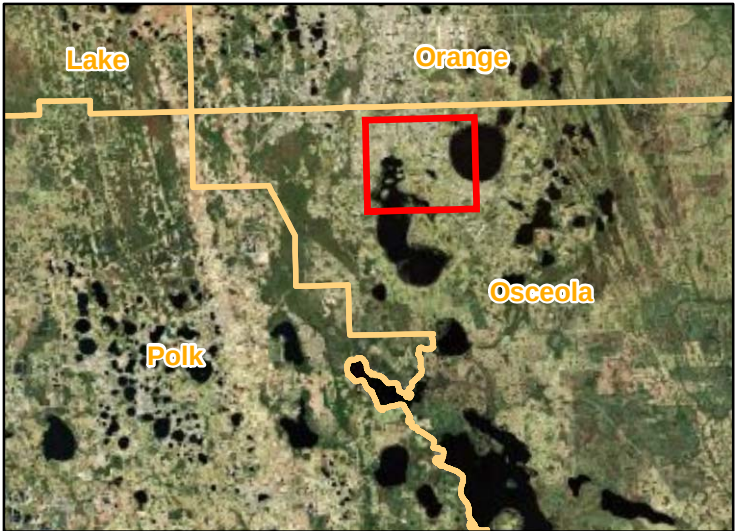
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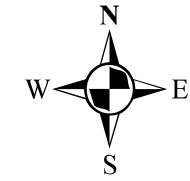
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- Major Channels
- Judge Farms Property



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0 600 1,200 2,400 Feet

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- Major Channels
- Judge Farms Property
- Roads

important since both utilities are located in the Central Florida Coordination Area and there are established limits on groundwater withdrawals.

The Florida Department of Environmental Protection (FDEP) recently listed Lake Toho as an impaired water body based on the narrative nutrient criteria for an imbalance of flora and fauna due to excessive hydrilla growth in the lake. Therefore, in addition to reducing the demand of potable water for non-potable irrigation purposes, the water storage facility has the potential to reduce a significant nutrient load to the lake, which is aligned with the goals of the Lake Tohopekaliga Nutrient Reduction Plan (CDM, 2011). This plan, accepted by FDEP, was prepared in response to the impairment listing.

Tasks performed in support of this preliminary water supply feasibility analysis included:

1. Data collection and analysis;
2. Field reconnaissance for hydrologic and environmental conditions;
3. Continuous hydrologic modeling of flows in East City Ditch, Mill Slough, and Judge Farms Ditch;
4. Surface water storage facility site screening analysis;
5. Preparation of site configuration layouts;
6. Conceptual feasibility analysis; and
7. Preparation of estimates of probable conceptual capital costs.

2.0 Data Collection and Analysis

2.1 Local Hydrology and Site Drainage

The project site is located within the vicinity of the outfalls of three major tributaries into Lake Toho. These include East City Ditch, Mill Slough, and the Judge Farms Ditch. The tributaries and their proximity to the study area are shown on Figure 2. The drainage basins of these tributaries, as delineated in the *Osceola County Stormwater Master Plan Update* (Boyle, 2006), are shown on **Figure 3**. The delineations of the Mill Slough and East City Ditch basins and catchments as presented in the Boyle master plan are generally similar to those originally developed by CDM in the 1988 *City of Kissimmee Stormwater Drainage Study* (CDM, 1988). The CDM study provided more resolution than the Boyle master plan, which condensed multiple smaller catchments into larger sub-basins. The general basin delineations, however, are largely compatible. The Judge Farms Ditch basins were not included in CDM's 1988 drainage study.

The East City Ditch consists of approximately 12,000 feet of man-made channels and culverts and conveys urban runoff from a contributing area of approximately 3,020 acres, mostly in the City of Kissimmee, and discharges into Lake Toho approximately 1,500 feet west of the Judge Farms Property. There is very limited available water level data for East City Ditch.

Mill Slough is approximately 18,000 feet long, with headwaters consisting of a series of wetlands in Orange County. From the Osceola County line, it flows south along a sinuous, natural path; south of the Vine Street crossing, it becomes a man-made channel flowing along the western property line of Judge Farms. It serves an area of approximately 6,740 acres, including approximately 3,000 acres in Orange County. There is limited historic water level data available for Mill Slough. **Figure 4** summarizes water

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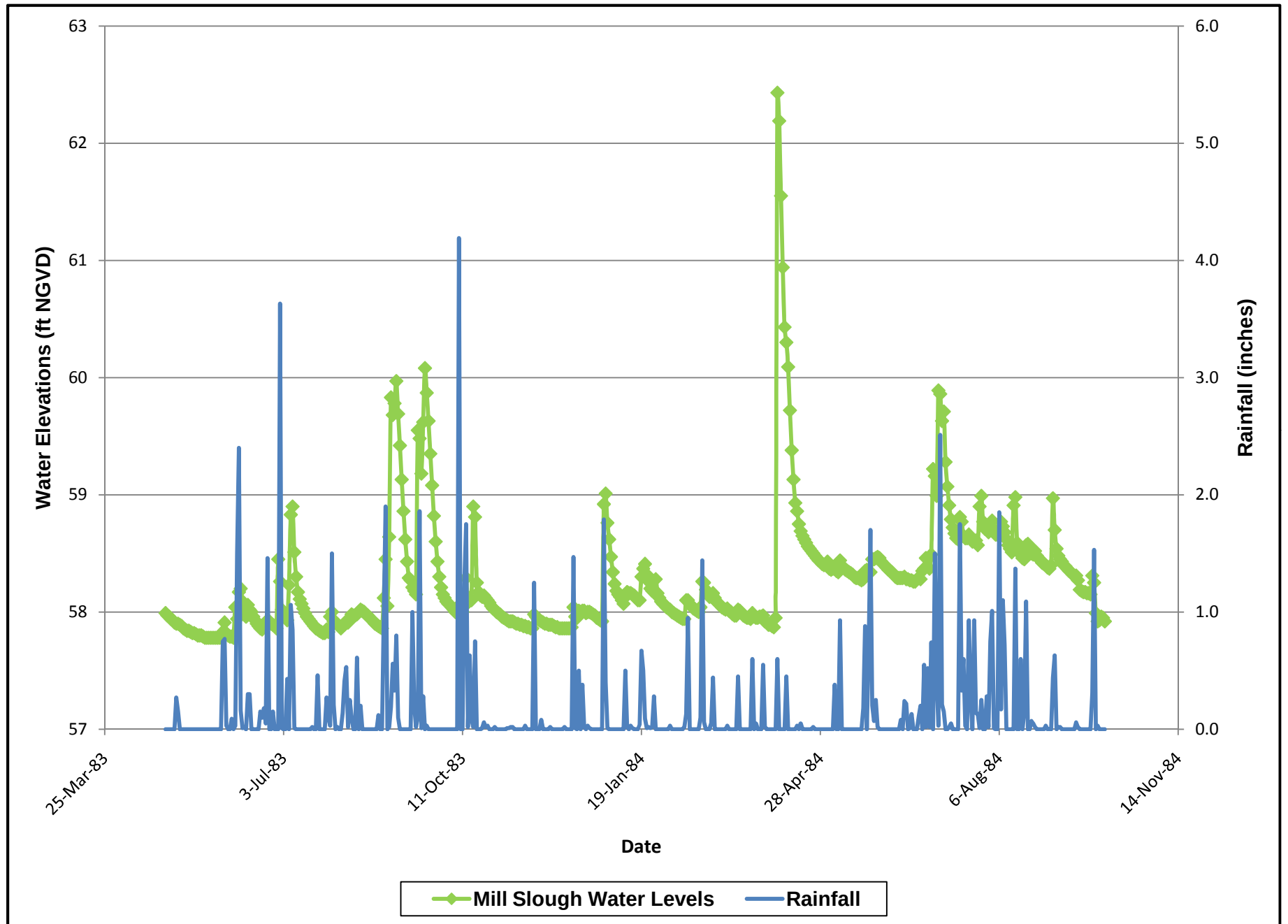
Subcatchments

- East City Ditch
- Judge Dairy
- Mill Slough

- Judge Farms Property
- County Boundary

- Rainfall Station
- Water Level Monitoring Locations

Figure 3
Subcatchments and Locations of Monitoring Stations (Rainfall and Stage)
Judge Farms Water Storage Facility Project



levels in Mill Slough from April 1983 to October 1984 at a station located as shown on Figure 3. Over this time period, the minimum, average, and maximum water elevations in Mill Slough are 57.8, 58.3, and 62.4 feet NGVD, respectively. Rainfall during this time period was very close to normal.

The Judge Farms Ditch has a contributing area of approximately 1,140 acres, including the entirety of the Judge Farms Property. The 5,700-foot man-made channel runs through the geographic center of the Judge Farms Property and receives drainage from many small agricultural ditches throughout the property. The ditch discharges into Lake Toho by means of a pump station (due to the difference in water elevation between the ditch and Lake Toho) on the southern border of the property and newly-constructed culverts under Neptune Road. The pump station is manually operated by Avatar Properties to minimize flooding on-site. There is also a permitted gravity inflow structure in Mill Slough to the Judge Farms Property along its western border for sod irrigation purposes. There is very limited available water level data for Judge Farms Ditch. Water levels in Lake Toho from June 2000 through mid October 2011 at a station located in the northern portion of the lake (Figure 3) are presented on **Figure 5**. Over this time period, the minimum, average, and maximum water elevations in Lake Toho are 48.5, 53.6, and 56.7 feet NGVD, respectively.

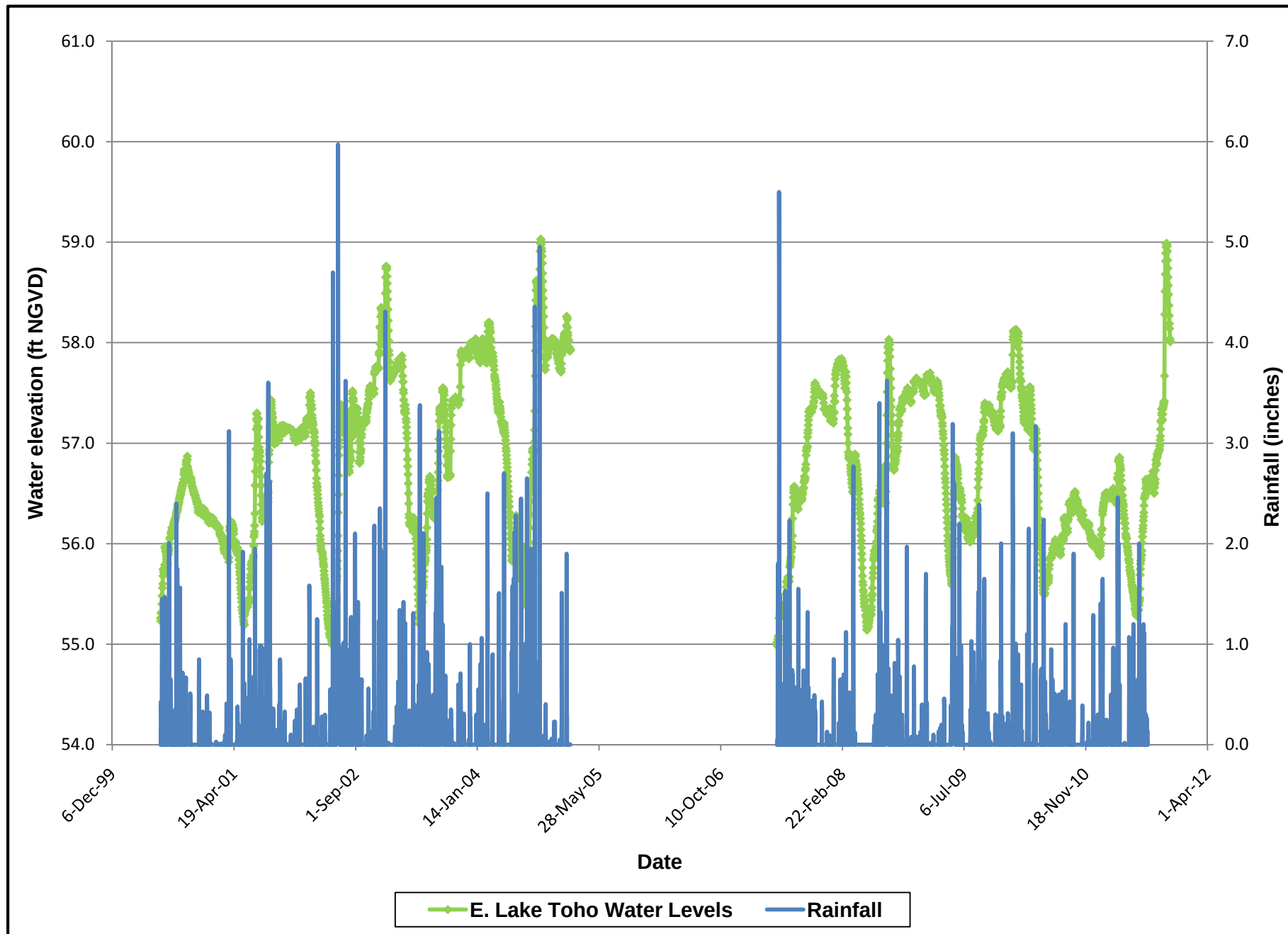
In addition to these urban ditches, the St. Cloud Canal (C-31 Canal) connects East Lake Toho with Lake Toho. The S-59 control structure is an adjustable gate structure in the C-31 canal that regulates flow from East Lake Toho into Lake Toho. Water level data for East Lake Toho and the C-31 Canal (just upstream of the S-59 structure) are shown on **Figures 6 and 7**, respectively. For the period of record for East Lake Toho (late June 2000 through Mid October 2011), the minimum, average, and maximum water levels are 55.0, 56.8, 59.0 feet NGVD, respectively. For the period of record for C-31 Canal (November 2005 through October 2011), the minimum, average, and maximum water levels are 52.0, 54.0, 56.9 feet NGVD, respectively.

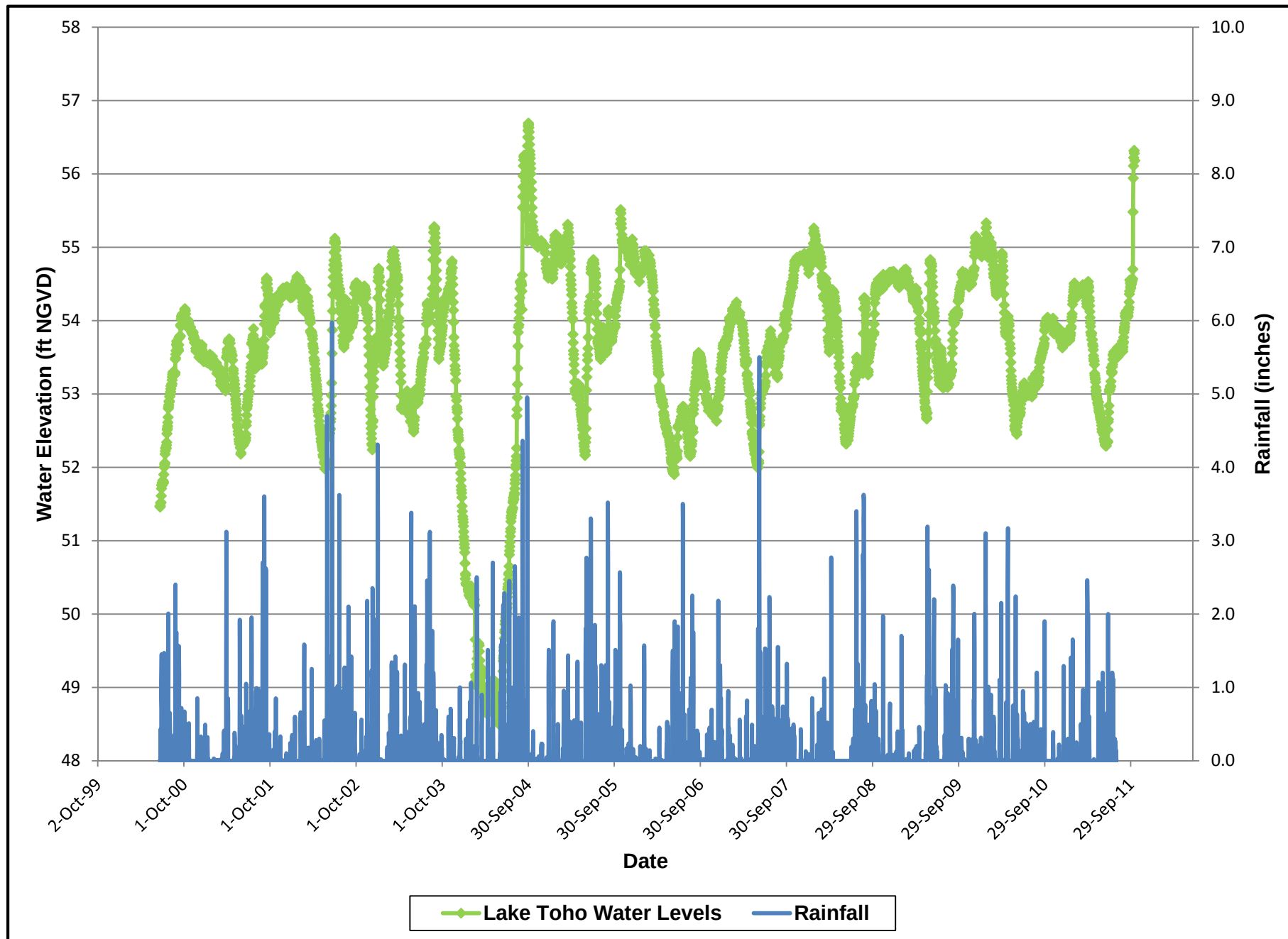
2.2 Topography

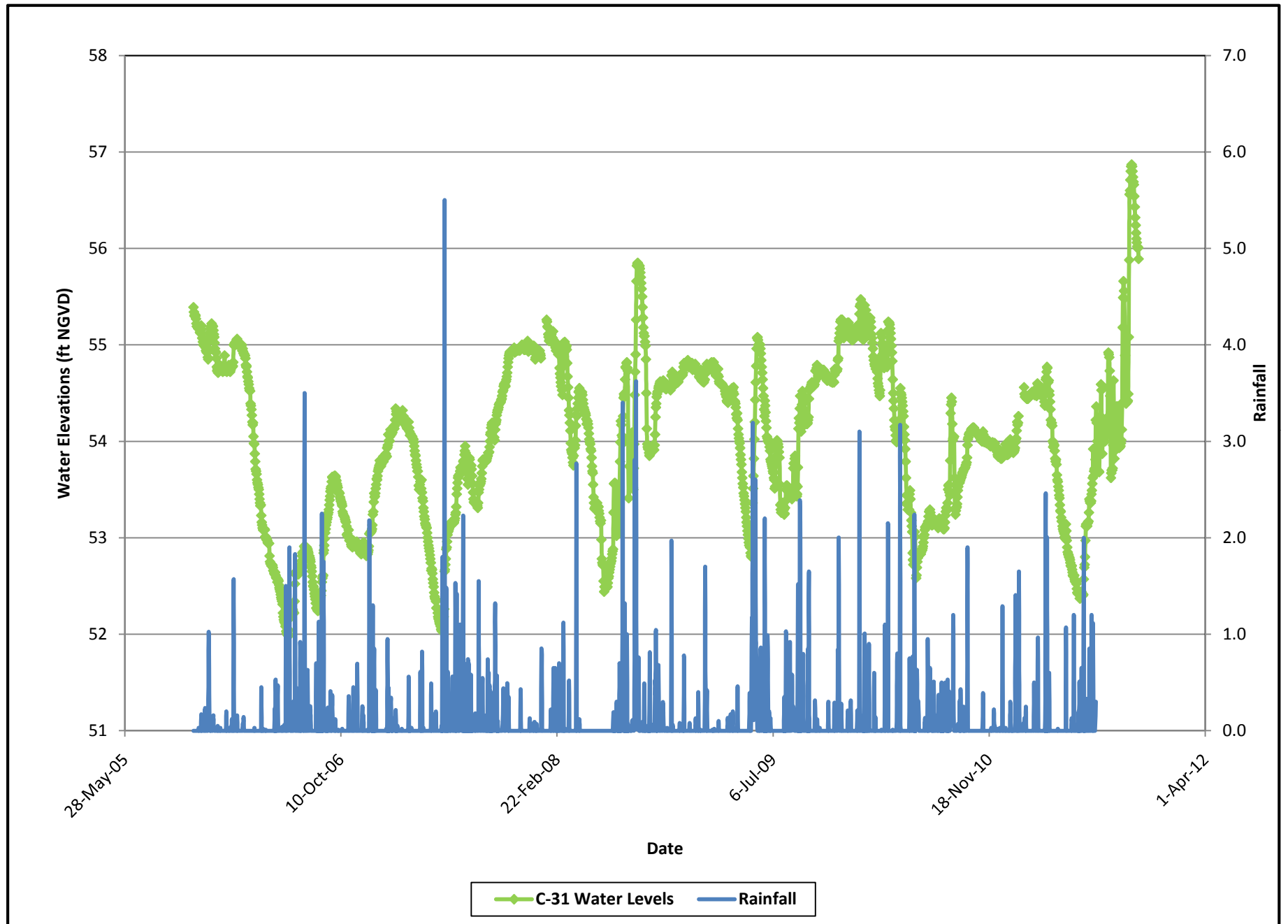
Topographic data were available from the City of Kissimmee in the form of one-foot contours developed from a LiDAR study of the City and its surroundings conducted by Imagery Prime in 2009. Site topography is illustrated on **Figure 8**. Topographic elevations at the 452 acre site range from 47 to 72 feet NAVD. Elevations in the majority of the project site lies within elevations 47 to 55 feet NAVD, which roughly coincide with the depressional portion of the site and the sod farming operations. The lateral ditch network within this part of the property drains to Judge Farms Ditch. The perimeter of the property is elevated, surrounding a large, well-defined depression, as the site was once historic lake bottom of Lake Toho. Topographic data were used to site and size the proposed water storage facility, as well as develop slope and flow width parameters for the hydrologic portion of the tributary yield model (Section 4.2).

2.3 Historical Rainfall and Evaporation

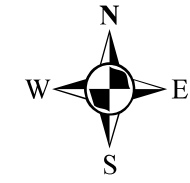
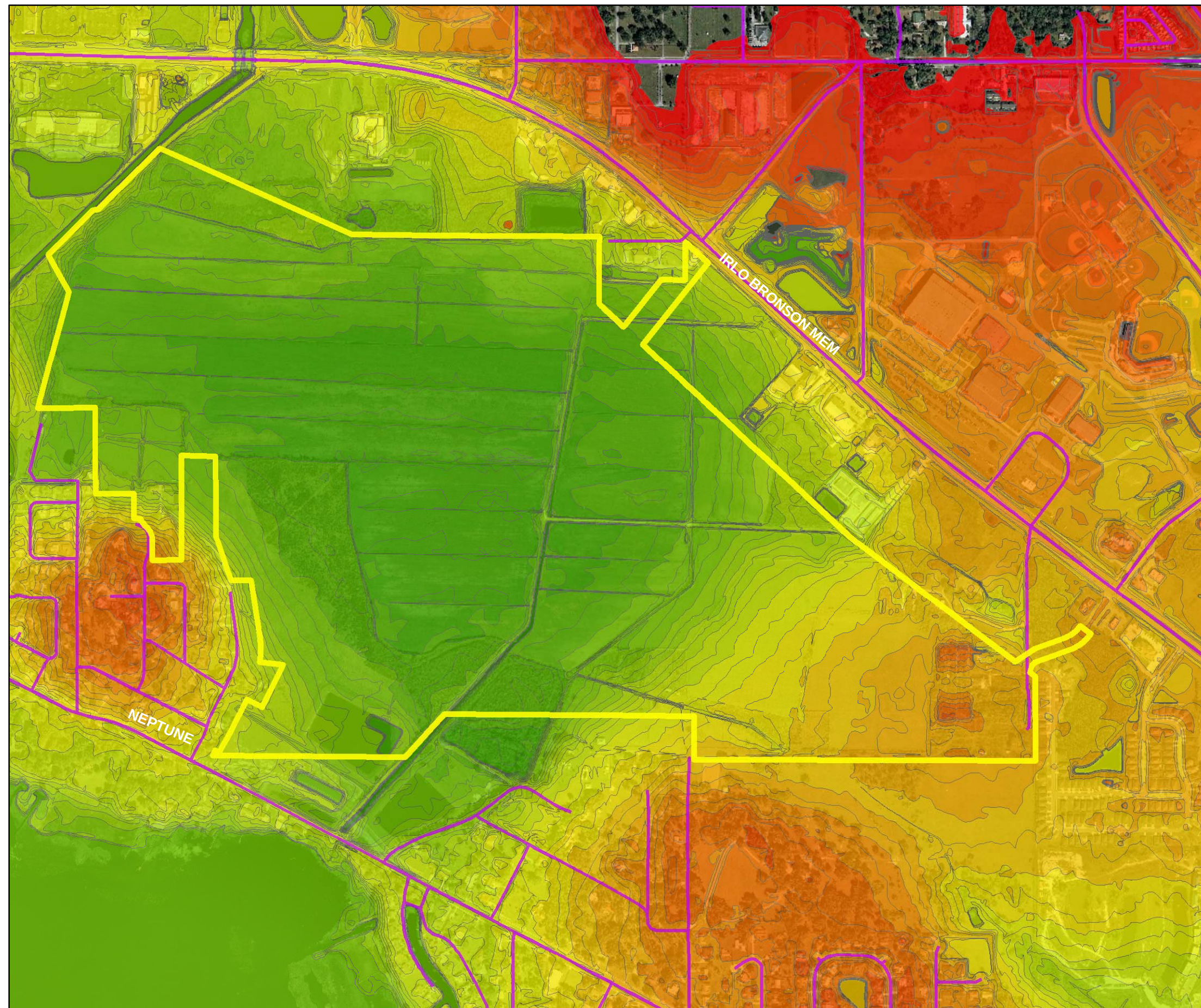
The National Oceanic and Atmospheric Administration (NOAA) rainfall station with the most complete period of record and located closest to the study area is the Kissimmee station. NOAA weather station 08-4620 referred to herein as Kissimmee has daily, monthly, and annual rainfall totals for the period between January 1931 and December 1958. The minimum, average, and maximum annual rainfall totals for the period of record for this station are 33.0, 50.9, and 76.3 inches per year, respectively. The historical annual and monthly rainfall data for the NOAA Kissimmee station are shown on **Figure 9**. The station location was moved starting in January 1959 to a new location (the Kissimmee municipal airport) approximately 1.25 miles south of the existing gauge and is herein referred to as Kissimmee 2 (NOAA station 08-4625). At the time of this study, daily rainfall totals for NOAA Kissimmee 2 were available







J:\6111-Kissimmee\04951 (Judge Farms)\GIS\mxd\Figure8 Topography 9-3.mxd 12-15-2011 pernezybj



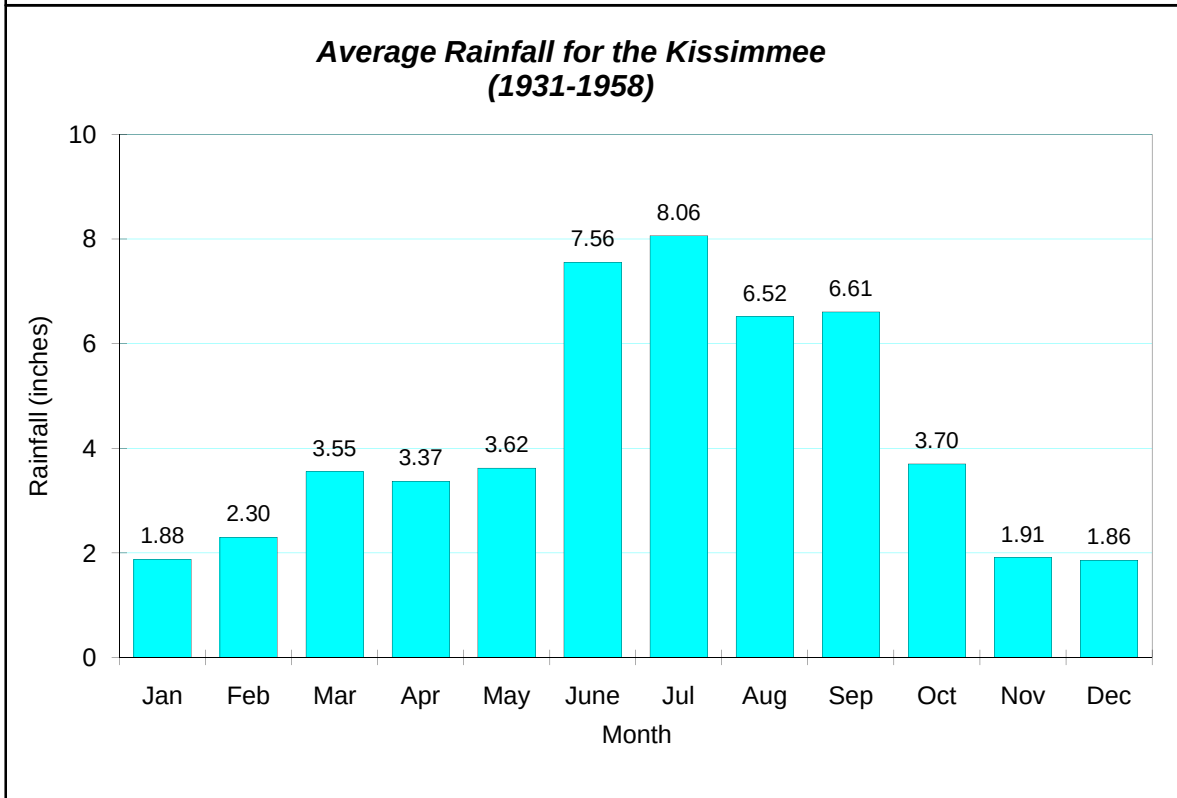
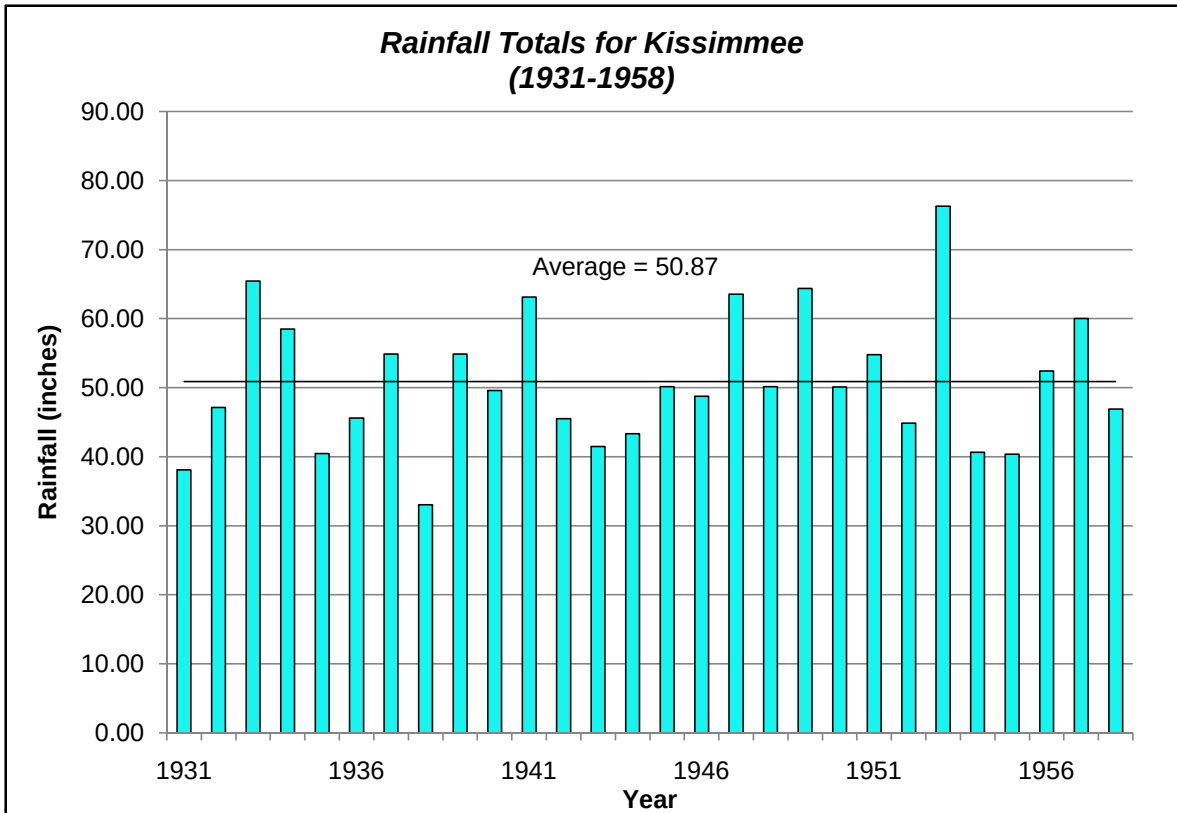
0 400 800 1,600 Feet

Legend

- Judge Farms Property
- Roads

Surface Elevation (ft NAVD)

- 44 - 45
- 46 - 47
- 48 - 49
- 50 - 51
- 52 - 53
- 54 - 55
- 56 - 57
- 58 - 59
- 60 - 61
- 62 - 63
- 64 - 65
- 66 - 67
- 68 - 69
- 70 - 71
- 72 - 73
- 74 - 75
- 76 - 77
- 78 - 79



CDM

Figure 9

NOAA Rainfall Data for Kissimmee, Florida (Station 08-4620)

from January 1959 through July 2011. The minimum, average, and maximum annual rainfall totals for the period of record for this station are 28.1, 48.2, and 80.4 inches per year, respectively. The historical annual and monthly rainfall data for the Kissimmee 2 station are shown on **Figure 10**. The Kissimmee 2 rainfall data, supplemented by data from the next closest station (Orlando International Airport Station No. 08-6628, located about 12 miles northeast of the Kissimmee 2 station) when data from Kissimmee 2 were missing, were used in the modeling evaluations for this project.

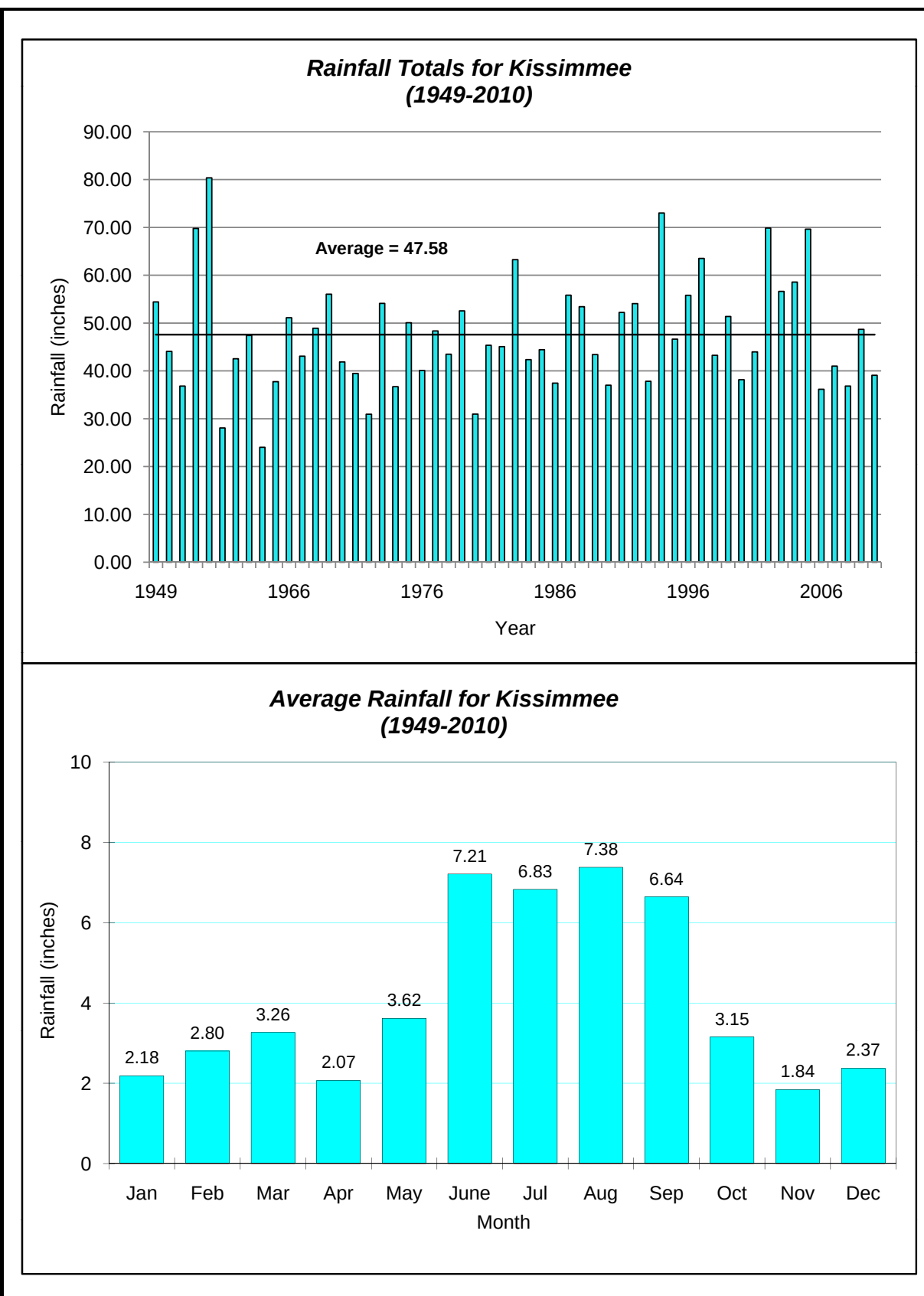
Daily pan evaporation data were obtained from NOAA's National Climatic Data Center (NCDC); however, of the available stations, none are located within the upper Kissimmee River Basin. The Lisbon station is the closest station that measures pan evaporation data and is located approximately 47 miles northwest of the project site in Lake County. The monthly and annual summaries for evaporation totals at the Lisbon station for the period from January 1960 through April 2008 are provided on **Figure 11**.

CDM also obtained pan evaporation data from the NOAA Moore Haven Lock station for the area for the period January 1949 through May 2011 to supplement the Lisbon pan evaporation data, when missing. The Moore Haven Lock station is located approximately 102 miles south of the project site in Glades County. The locations of these two NOAA pan evaporation stations are shown on **Figure 12**. The pan evaporation data was adjusted to estimate a free water surface evaporation using a pan evaporation coefficient ($0.77 \times \text{pan evaporation}$) developed by the National Weather Service (Kohler *et al.*, 1959).

2.4 Surficial Soils and Site Hydrogeology

Surficial soils data were obtained from the Soil Survey Geographic Database (SSURGO) maintained by the Natural Resources Conservation Service (NRCS). Site soils are illustrated on **Figure 13**. The entirety of the project site lies within dual-hydrologic soil group "A/D" soils; these soils can be expected to have high infiltration rates and soil storage capacity when the area is well drained, but have very low infiltration rates and soil storage capacity in an undrained condition. For the purposes of the tributary yield model (Section 4.2), these dual-class soils were treated as class "C" soils, conservatively simulating a partially-drained condition. Dual-class "A/D" soils dominate the areas draining to the major tributaries, with small areas of class "A" and dual-class "C/D" soils also present.

As indicated in the NRCS Soil Survey for Osceola County (Readle, 1979; Leach *et al.*, 2011), three primary soil series occur within the overall site: Samsula Muck, Placid Fine Sand, and Immokalee Fine Sand. The Samsula Muck is the predominant soil series occurring in the lower lying depressional portion of the site west of the Judge Farms Ditch. This soil series is characterized by a 2 feet thick layer of dark colored muck underlain by 3.5 feet of dark colored sand. This soil type typically has a high water table and is poorly drained ("D" soils) unless improved with ditches. Placid Fine Sand is a transitional soil between the Samsula Muck and the soils that occur in the upland portions of the site and in the surrounding area. Placid Fine Sand is characterized by 2 feet of dark colored sand underlain by 4.5 feet of light colored sand. Immokalee Fine Sand occurs in the upland portions of the site east of Judge Farms Ditch. These surface and near surface soil types are consistent with the geotechnical data previously collected at the site (Geotechnical and Environmental Consultants, 2006).



CDM

Figure 10

NOAA Rainfall Data for Kissimmee, Florida (Station 08-4625)

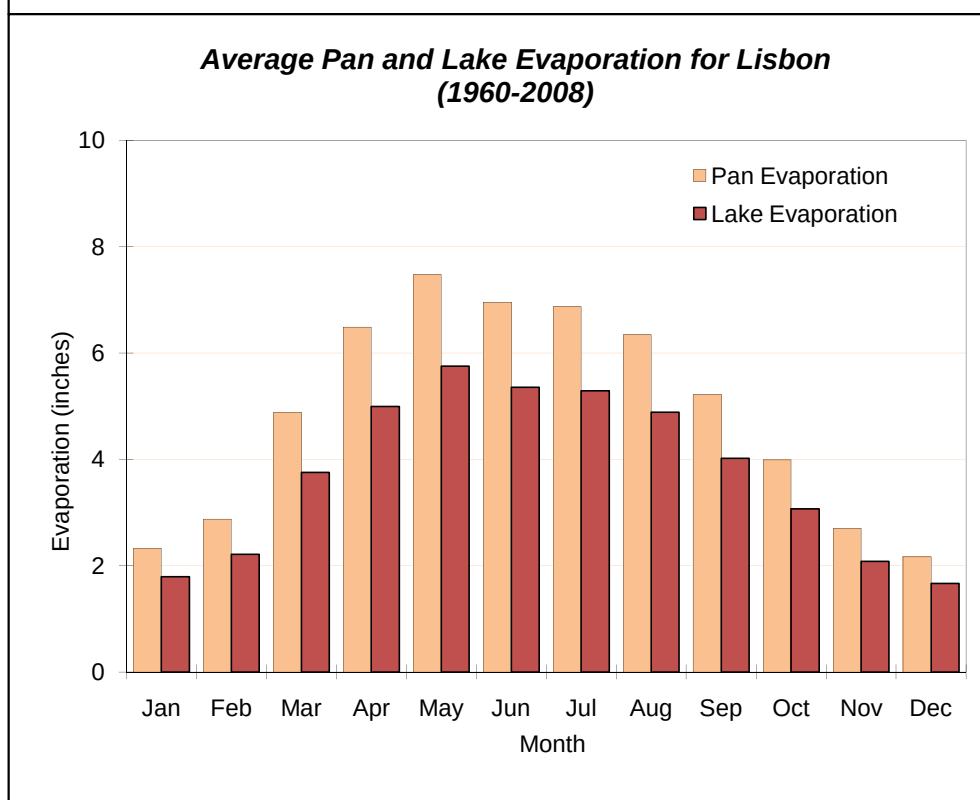
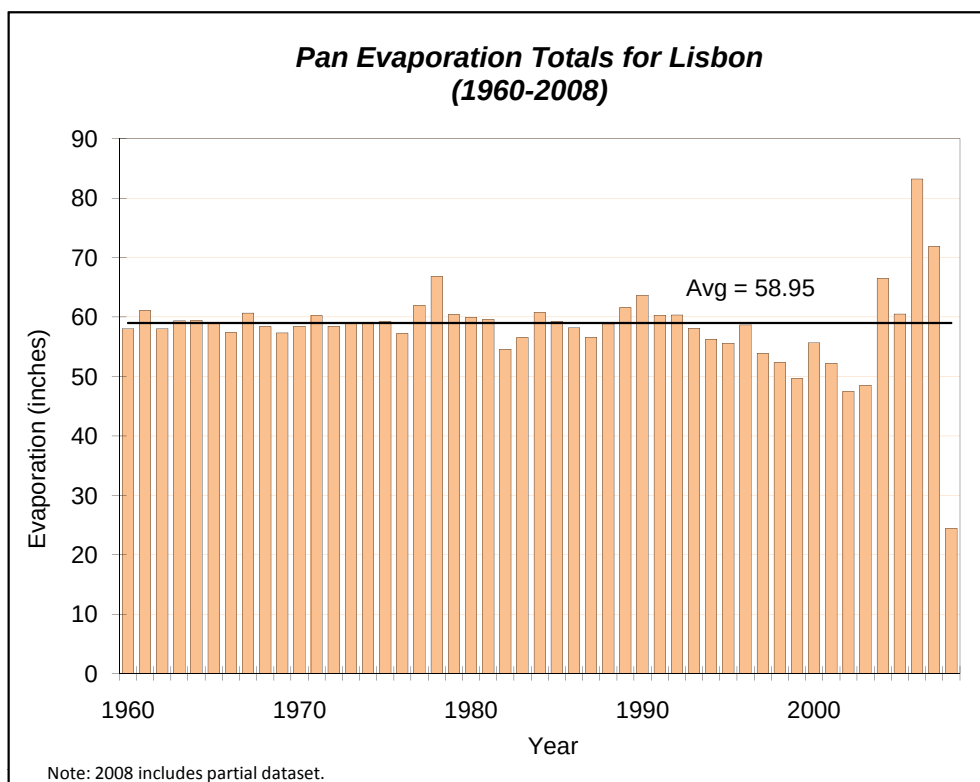


Figure 11
NOAA Evaporation Data for Lisbon, Florida

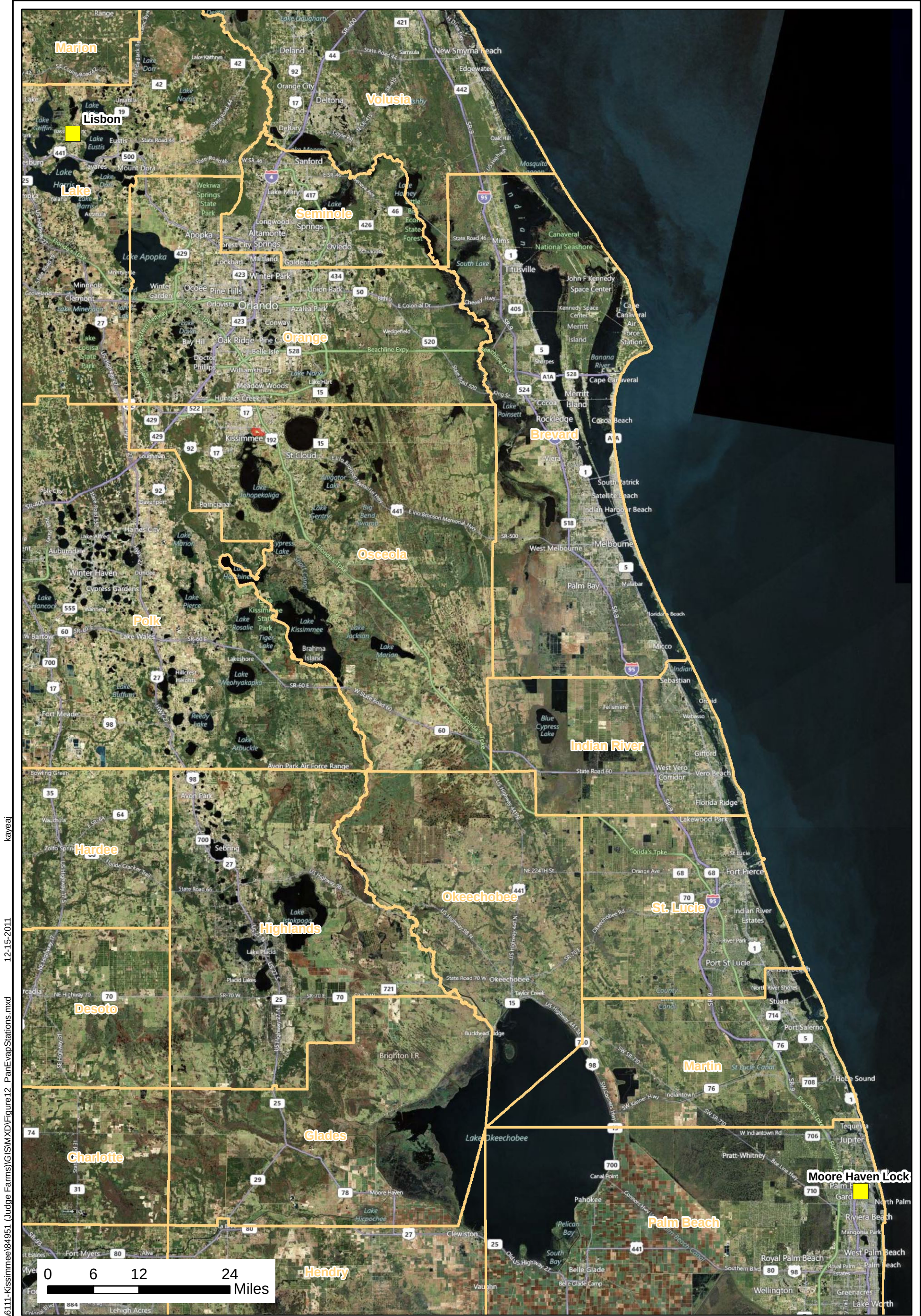
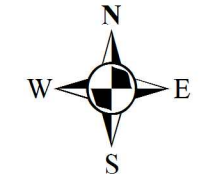
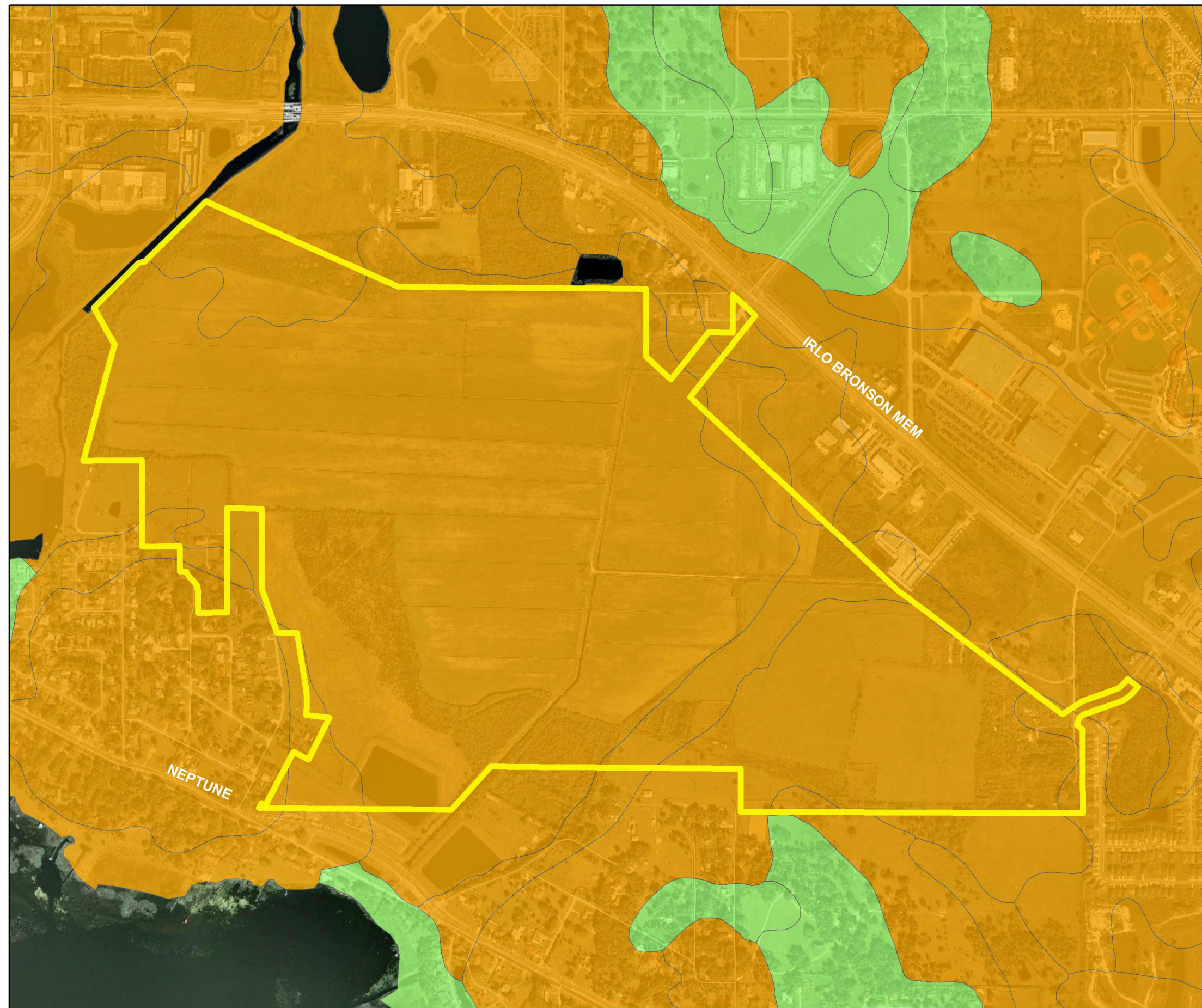


Figure 12
Pan Evaporation Station Locations
Judge Farms Water Storage Facility Project

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0 400 800 1,600 Feet

Legend

 Judge Farms Property

 Roads

Hydrologic Soil Group

 A

 A/D

2.5 Land Use

Land use coverage was developed from the draft 2008/2009 SFWMD Land Use/Land Cover database. Generalized land uses in the project area are illustrated on **Figure 14**. Agriculture dominates the project area, with medium density residential, low density residential, and commercial land uses surrounding the Judge Farms Property. Medium density residential and commercial are the dominant land uses, accounting for approximately 44 percent of the tributary area to East City Ditch, Mill Slough, and Judge Farms Ditch. Land use data were used in the development of the hydrologic portion of the tributary yield model (Section 4.2) and in the pollutant load analysis (Section 5).

3.0 Environmental Assessment

The purpose of this evaluation is to determine the environmental factors that could influence feasibility and the potential configuration of a water storage facility constructed on the Judge Farms Property. The total property area is approximately 452 acres of which the western 271 acres is potentially available for a water storage facility. The eastern two thirds of the property is planned to be used as a sports complex by Osceola County. To take into account the ecological conditions and determine the regulatory feasibility, data were collected from property permit applications, development plans, and previous environmental assessments, including information on wetlands, other land uses, canals and ditches, listed species, and state sovereign land boundaries. A one day field reconnaissance was performed on October 6, 2011 to identify potential water storage facility options and ecological considerations affecting the feasibility of constructing a water storage facility on the property.

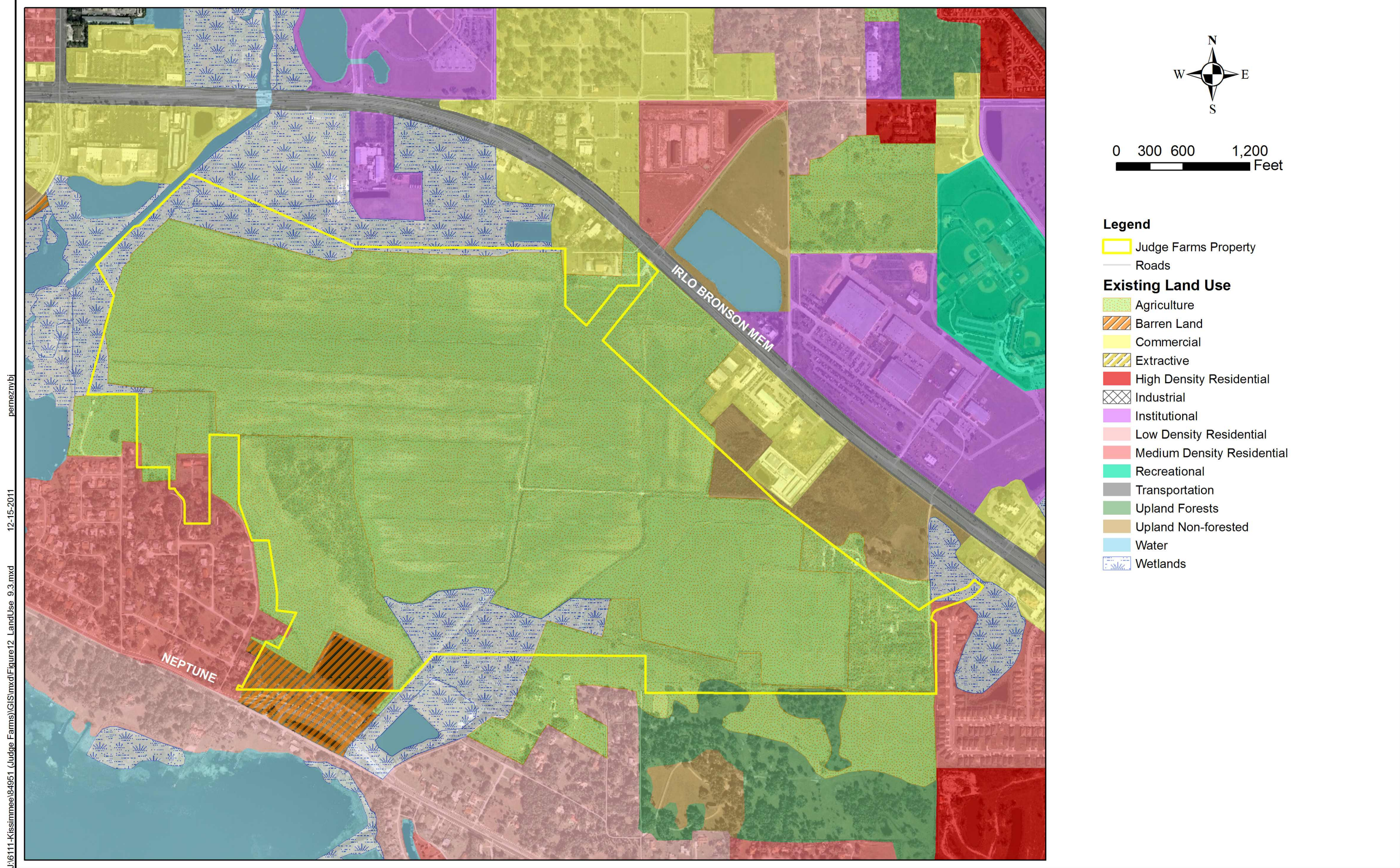
3.1 Ecological Conditions

3.1.1 Upland and Wetland Verification

The base map and field reconnaissance of the property indicate that the property is used primarily for agricultural purposes. There are no upland forests on the property and limited non-forested uplands on the property. There is an upland forested area adjacent to the northeastern property boundary. As shown on **Figure 15**, there are limited wetlands on the property, which consist of emergent and scrub-shrub wetlands that contain nuisance and exotic species. There are small forested wetlands adjacent to the eastern, northern, and western property boundaries. There is a large emergent wetland system west of the property between Mill Slough and East City Ditch that surrounds a large open water area connected to Lake Toho. There is an approximately 9.7 acre mitigation site located along the western boundary of the property (both on-site and off-site), which was constructed by Avatar Properties, Inc. as a requirement of the Environmental Resource Permits (ERPs) (Section 3.2) associated with the site. Surface water flows through the property in a primary canal (Judge Farms Ditch) that flows across US 192 northeast of the property and through the property to Lake Toho. The discharge from Judge Farms Ditch to Lake Toho is delivered using two large pumps located south of Neptune Road. Lateral agricultural ditches throughout the property drain to this primary canal.

3.1.2 Potential Listed Species Concerns

Regarding listed species, two bald eagle nests are located south of the property, but only one primary bald eagle protection zone overlaps the property boundary. Although sandhill cranes have been observed foraging on the property, no nesting activities were observed in recent field investigations. The property does not contain preferred habitat for wetland-dependent endangered or threatened wildlife species or species of special concern. No other wetland-dependent endangered or threatened wildlife species or species of special concern were observed on-site in recent field investigations, and it has been determined that the potential use of the site by such species is minimal.



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J:\6111-Kissimmee\84951 (Judge Farms)\GIS\mxd\Figure12 LandUse 9.3.mxd

3.2 Regulatory Feasibility

On January 13, 2009, an Environmental Resource Permit 49-01771-P was issued by the SFWMD to Avatar Properties, Inc. (Judge Farms) to construct and operate a surface water management system to serve an approximately 473.34 acre residential and commercial project. Historically, a large portion of this property was jurisdictional wetland (approximately 321 acres). The project impacts approximately 320 acres of low functioning wetlands that have a long history of agricultural usage, but continue to reflect soils, hydrology, and vegetation sufficient to identify it as jurisdictional wetlands. The required mitigation plan for the wetland impacts within the property includes restoration of 4.54 acres of on-site wetlands and 5.15 acres of adjacent off-site Sovereign Submerged Lands, and preservation of 431.65 acres of forested wetlands and 8.34 acres of uplands in Reedy Creek Swamp. Therefore, mitigation has been provided for all on-site wetlands.

On October 21, 2009 an Individual Permit (IP) SAJ-2-6-5462 was issued by the United States Army Corps of Engineers (USACE) (Jacksonville District) to Avatar Properties, Inc. (Judge Farms) for a 473.34 acre project. The IP authorizes impact to 11.86 acres of wetlands and 303 acres of sod farm (Section 10) waters of the United States. The IP requires the same compensatory mitigation extents, as previously described in the ERP.

The proposed water storage facility configurations are within the property boundary and should avoid direct impacts to 4.54 acres of on-site wetland mitigation and 5.15 acres of adjacent off-site Sovereign Submerged Lands. Indirect impacts to these areas should also be avoided as well as indirect impacts to the large emergent wetland system west of the property between Mill Slough and East City Ditch that surrounds a large open water area connected to Lake Toho.

The SFWMD ERP (49-01771-P) also requires compliance with the Florida Fish and Wildlife Conservation Commission (FFWCC) Bald Eagle Management Plan Guidance Document. In accordance with the plan, all construction activities must be coordinated with the FFWCC and potential nuisance activities must be avoided during critical bald eagle nesting periods. No permit is required as long as the activities are no closer than 330 feet from the one active nest in the primary bald eagle protection zone. These same requirements should be adhered to for construction of any water storage facility on the property. Additional surveys for listed species should be performed in support of permits for constructing a water storage facility on the property.

4.0 Surface Water Availability and Water Storage Facility Site Screening Analysis

4.1 Preliminary Water Storage Facility Configuration and Siting

Based on feedback from the Stakeholders, the site environmental assessment, existing surrounding land use, and the proposed Osceola County softball complex in the eastern part of the site, two potential water storage facility configurations were identified in the western part of the site. Given the low existing topography of the site west of the Judge Farms Ditch and surrounding land use, it was desired to minimize the extent and heights of any berms for both aesthetic reasons and flood control purposes. A no berm alternative was also considered for the property; however, this option is not practicable because it would severely limit the volume of live storage and does not provide complete control of water within the property (particularly under wet conditions).

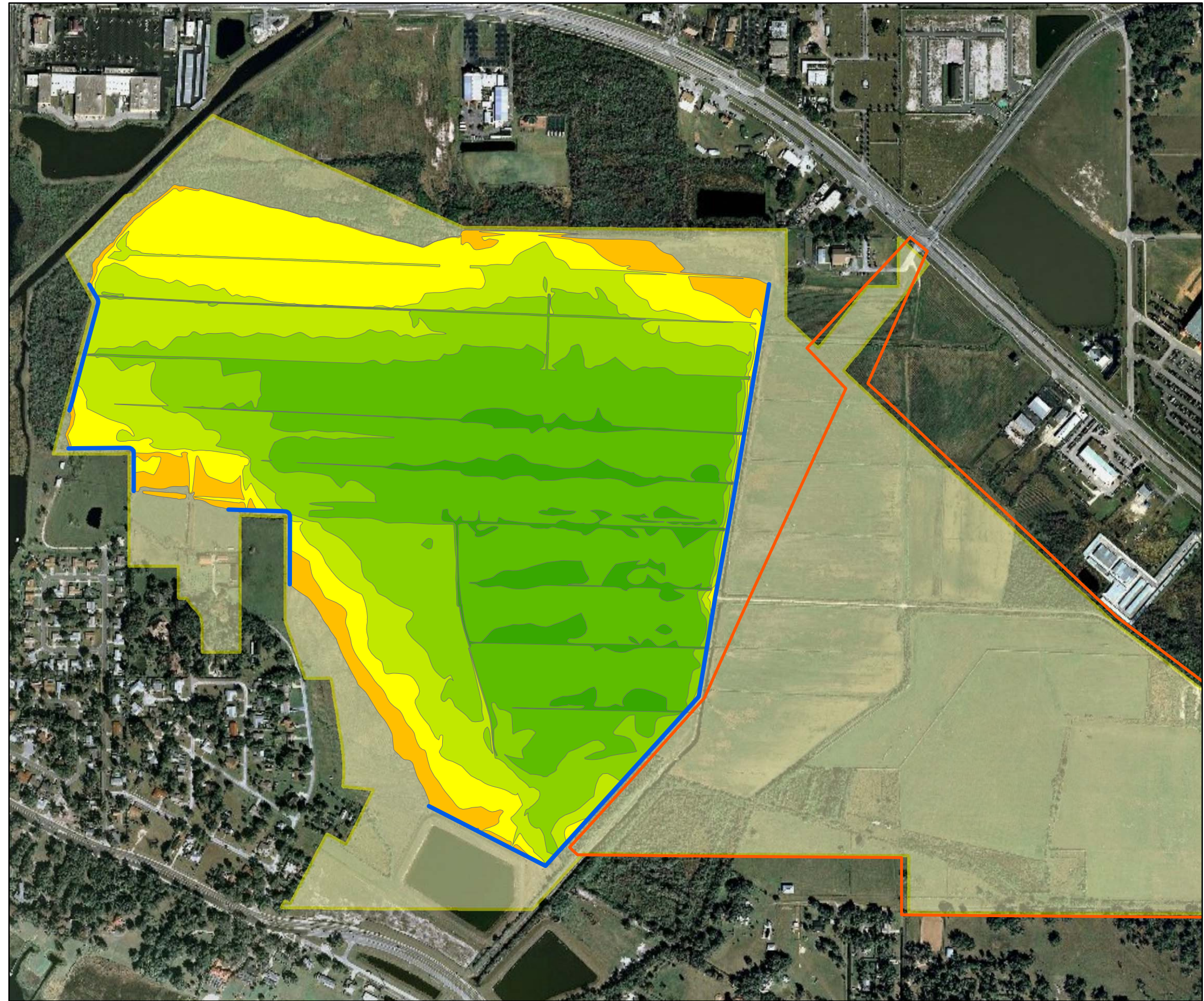
Given these project considerations, the first configuration consists of 228 acre storage facility footprint with minimal perimeter berms west of Judge Farms Ditch and selected low areas around the remaining perimeter of the site; thereby using the existing topography to contain the stored surface water (**Figure 16**). For this alternative, fill would have to be placed along 6,730 feet of existing berm along the west side of Judge Farms Ditch to raise the top of berm elevation along the ditch to 52 feet NAVD to prevent comingling of the stored water with water in the ditch and fill in low areas around the perimeter of the storage facility footprint to elevation 52 feet NAVD to prevent stored water from flowing off-site. This alternative will provide for up to 754 acre-feet (246 million gallons) of live storage between the bottom of the storage facility (48 feet NAVD) and an elevation of 52 feet NAVD. Excavating the bottom of the storage facility any lower than 48 feet NAVD will not provide any additional live storage since the water table in this area is around 48 feet NAVD. The effective storage (from the bottom of the storage facility to the maximum operating water depth) is 335 acre-feet (109 million gallons). The berm height for this alternative ranges from 0 to 3 feet above surrounding grades depending on the location around the perimeter of the facility. No berm would be required around the majority of the perimeter of the facility. The highest berms (3 feet) occur along the eastern perimeter of the facility (just east of Judge Farms Ditch).

The second alternative consists of 259 acre storage facility footprint with more extensive, higher berms around the majority of the perimeter of the proposed storage facility (**Figure 17**). The eastern limit of the proposed storage facility crosses Judge Farms Ditch. The top of berm elevation would be 54 feet NAVD and provide for up to 1,305 acre-feet (425 million gallons) of live storage between the bottom of the storage facility (48 feet NAVD) and the top of berm. The effective storage (from the bottom of the storage facility to the maximum operating water depth) is 805 acre-feet (262 million gallons). The berm height for this alternative ranges from 0 to 6 feet above surrounding grades depending on the location around the perimeter of the facility. No berm would be required in the northeastern corner of the facility or the northwestern corner of the facility adjacent to Mill Slough. The highest berms (6 feet) occur along short lengths of the eastern perimeter of the facility (just east of Judge Farms Ditch). Both water facility configurations are evaluated with the project systems model (Section 4.3) to determine their effectiveness in storing and managing the proposed supplemental sources of water.

From a flood hazard perspective, both alternatives would be classified as low hazard potential impoundments [Federal Emergency Management Agency (FEMA), 2004]. The FEMA hazard classification system categorizes dams based on the probable loss of human life and the impacts on economic, environmental, and lifeline interests. Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property. This designation is appropriate since the maximum operating water levels for the minimal berm alternative is 50 feet NAVD and the maximum operating water level for the perimeter berm alternative is 52 feet NAVD. In addition, for both options surface waters would be nearly wholly contained on-site and there would be no anticipated loss of human life or impacts to economic, environmental, and lifeline interests.

4.2 Tributary Yield Analysis

In order to determine the flows and stages that would occur in the three urban tributaries (Mill Slough, East City Ditch, and Judge Farms Ditch) that will contribute to the proposed water storage facility, a hydrologic and hydraulic (H/H) model of the channels and their contributing subcatchments was developed. The output of the H/H model constitutes a major component of the water budget and systems model discussed in Section 4.3.



0 300 600 1,200 Feet

Legend

- Judge Farms Property
- Ballfield Project Area (181 acres)
- Berm (Total length = 6,734 ft)

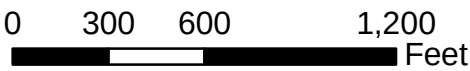
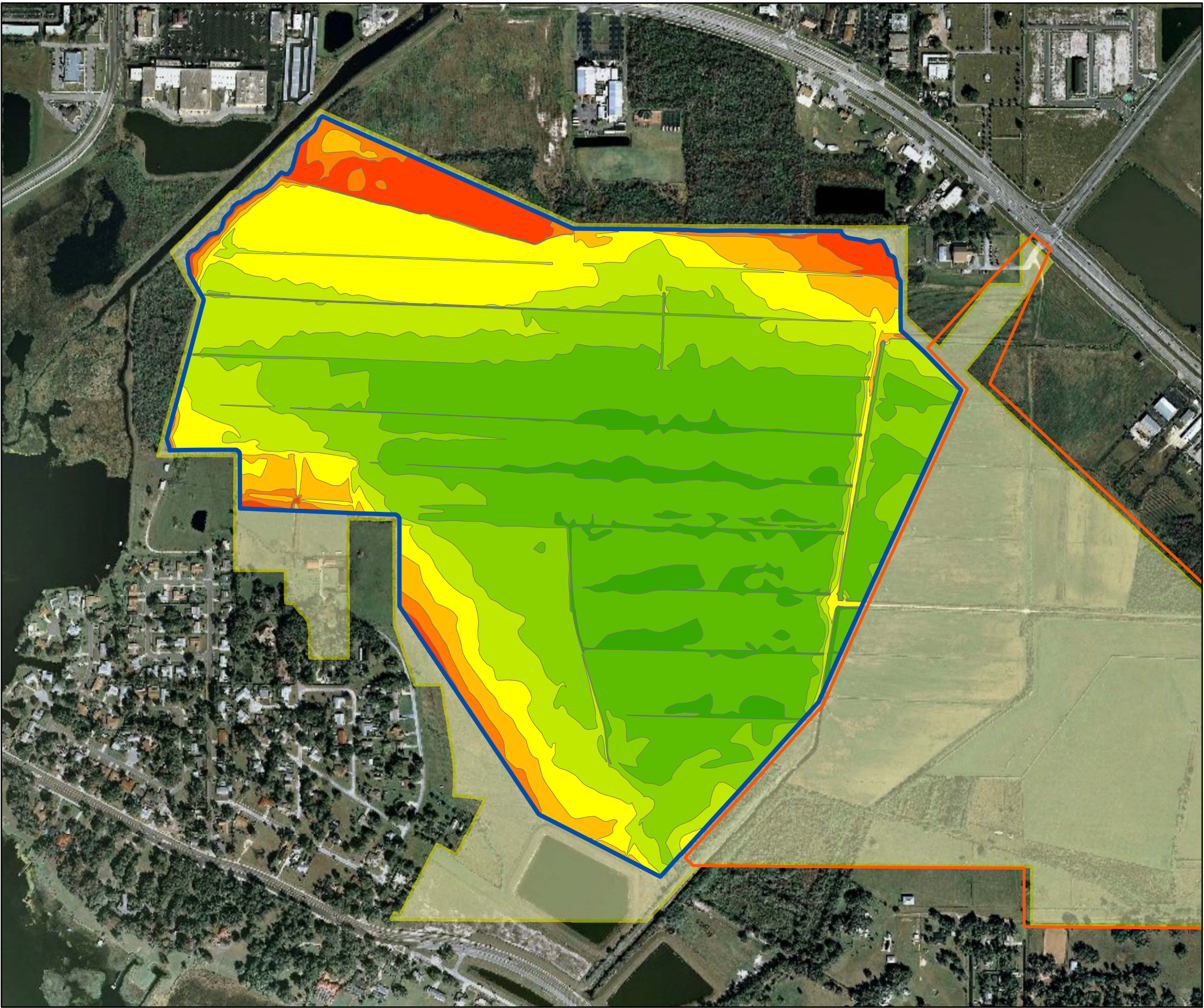
Topography

Elevation (feet NAVD)

- 47
- 48
- 49
- 50
- 51
- 52

Elevation	Area	Incremental	Total	Total
ft	acres	Volume	Volume	Volume
		acre-ft	acre-ft	MG
47	13	0	0	0
48	97	55	55	18
49	142	120	175	57
50	178	160	335	109
51	216	197	532	173
52	228	222	754	246

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Legend

- Judge Farms Property
- Ballfield Project Area (181 acres)
- Berm (Area = 259 acres; Total Length = 14,467 ft)

Topography

Elevation (feet NAVD)

- 47
- 48
- 49
- 50
- 51
- 52
- 53
- 54

Elevation	Area	Incremental	Total	Total
ft	acres	Volume	Volume	Volume
		acre-ft	acre-ft	MG
47	14	0	0	0
48	104	59	59	19
49	153	128	187	61
50	191	172	359	117
51	229	210	569	186
52	242	236	805	262
53	249	246	1,051	342
54	259	254	1,305	425

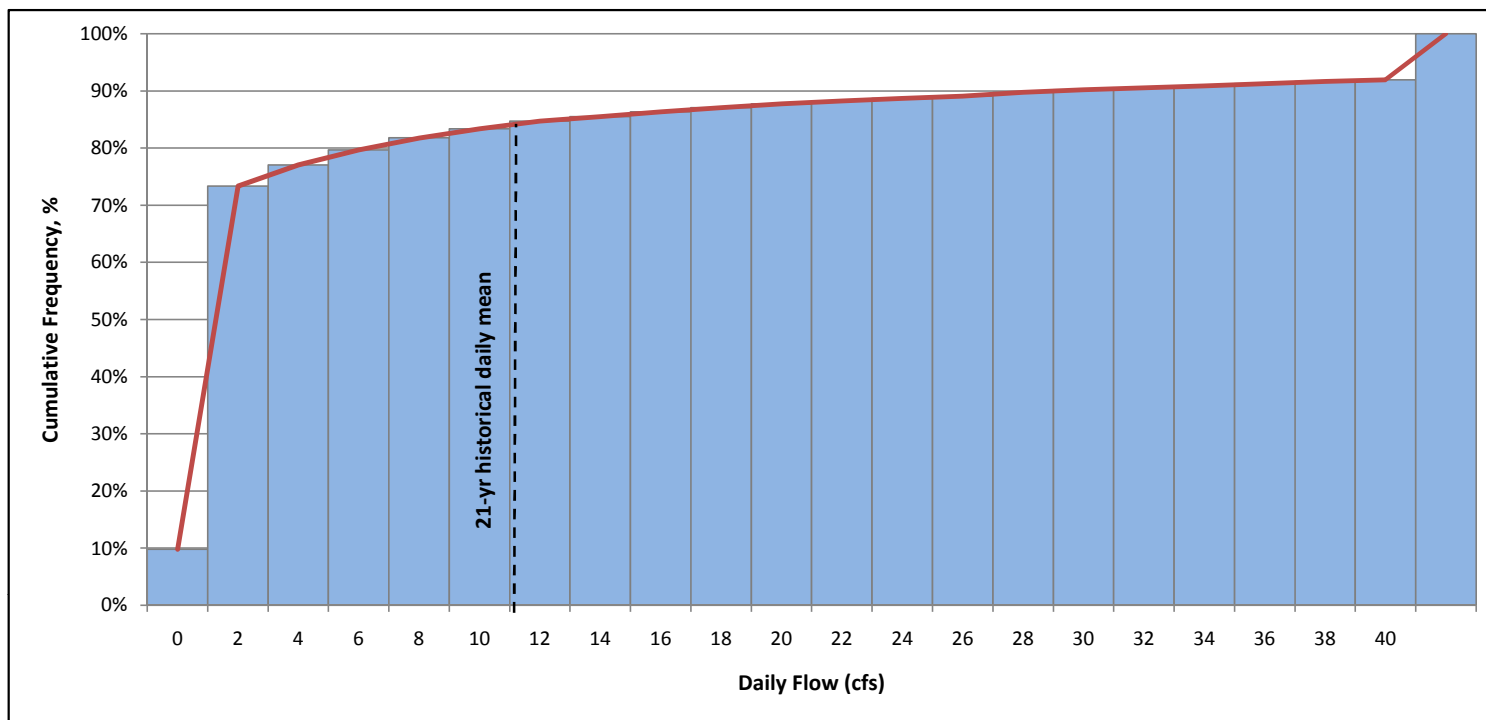
A planning-level H/H model for the Mill Slough, East City Ditch, and Judge Farms Ditch basins was previously developed by Boyle (now AECOM) and most recently updated in the 2006 *Osceola County Stormwater Master Plan Update*. This model was developed using the Interconnected Channel and Pond Routing Model (ICPR), Version 3. ICPR's hydrology module uses the methodology outlined in Technical Release 55 (NRCS, 1986), commonly known as the "SCS method" or "curve number method". Whereas this method of runoff estimation is acceptable for standard design storm analyses, it is less applicable for the long-term continuous simulation modeling necessary for the development of the water budget and systems model. Therefore, the 2006 H/H model was adapted to the EPA Stormwater Management Model (SWMM), Version 5 (USEPA, 2008).

The hydrologic model component of SWMM simulates the rates of runoff developed from basins using a non-linear reservoir approximation (Manning's equation). Topographic data (Section 2.2), soils (Section 2.4), and land use data (Section 2.5) are used to develop a series of parameters including overland flow width and slope, overland roughness coefficients, initial abstraction, and soil infiltration and storage. The SWMM method uses these parameters to calculate a runoff hydrograph for each hydrologic unit; these hydrographs are routed to the specified node in the hydraulic model component. The SWMM method of runoff estimation uses a more complex method of infiltration estimation (Horton Method) than is provided by the SCS method; the Horton Method allows for the gradual refresh of soil storage during dry periods, which is critical in performing accurate long-term continuous simulation analyses.

The hydrologic component of the tributary yield was developed using the best available soils, land use, and topographic data as described in Section 2; the subcatchment boundaries were maintained from the 2006 study. The hydraulic component of the 2006 study was imported into SWMM without modification, except for the addition of a drainage upgrade under Neptune Road that was constructed since the development of the original model.

A 21-year continuous simulation analysis was performed using recorded rainfall and evaporation data (Section 2.3) for the period 1990-2010. Critical output from the model included time-series of predicted stages and flows in the channel reaches within the Judge Farms Property; these values were incorporated into the water budget and systems model (Section 4.3). **Figures 18-20** display the flow frequency analysis for East City Ditch, Mill Slough, and Judge Farms Ditch, respectively, based on the output of the continuous simulation model. As shown on Figure 18, the mean daily flow through East City Ditch is approximately 11 cubic feet per second (cfs). The flow distribution is heavily skewed on both extremes, with the flow frequency analysis demonstrating that more than 70 percent of modeled daily observations are less than 2 cfs; the mean daily flow is similarly influenced on the upper end by rare extreme rainfall events producing modeled flows as high as 575 cfs. Figure 19 illustrates a similar distribution of modeled flows for Mill Slough. The mean daily flow for the model period of 1990-2010 is approximately 24 cfs, with approximately 75 percent of modeled observations less than 5 cfs. A heavy rainfall event in November 1994 produced the maximum modeled flow of over 1,200 cfs.

Figure 20 presents the model results for the Judge Farms Ditch. Having a very small upstream contributing area as compared to East City Ditch and Mill Slough, the flows through this ditch are predicted to be much smaller than those of the other tributaries. The modeled daily average flow is 0.7 cfs, with more than 70 percent of modeled observations less than 0.1 cfs. The maximum modeled observation is approximately 35 cfs.



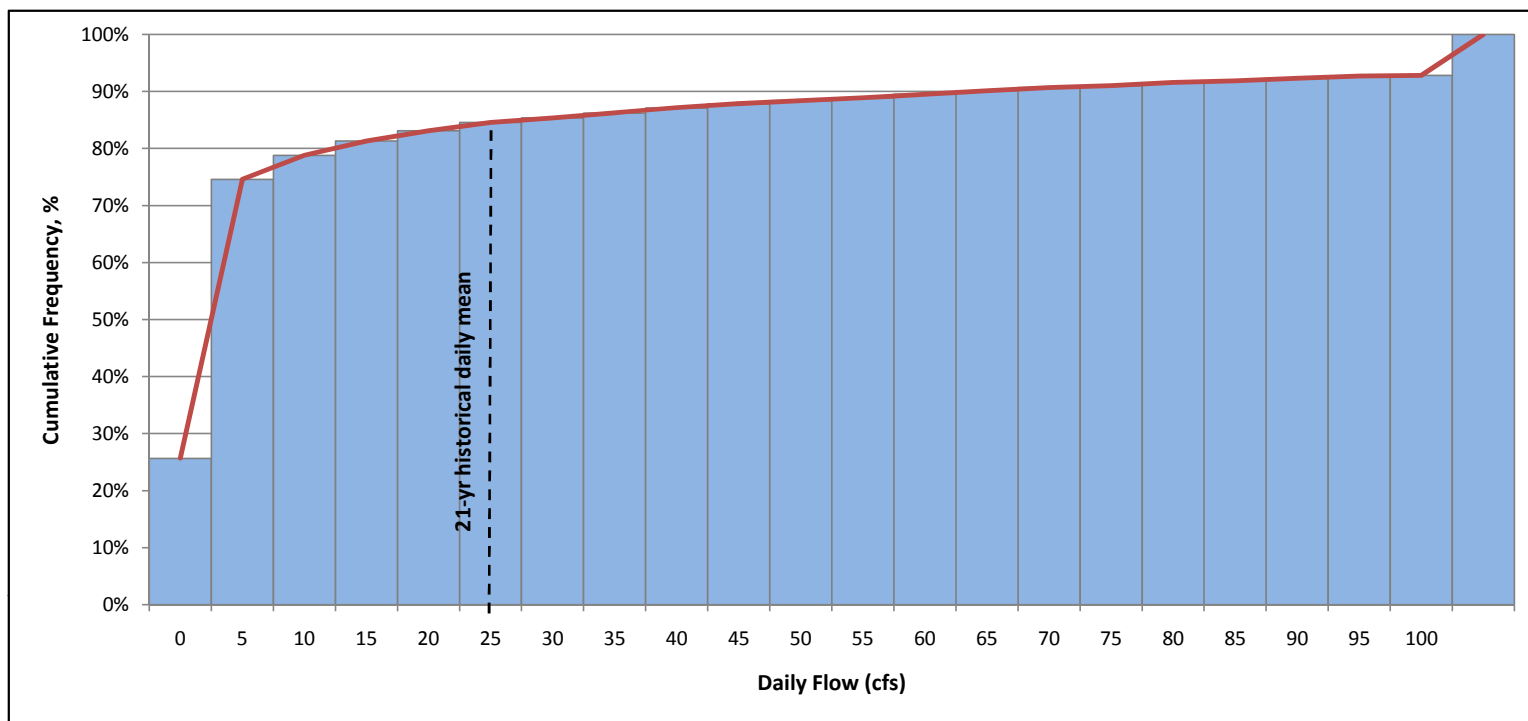
21-Yr Statistics for Flow (cfs)

Mean	11.27
Standard Error	0.43
Median	0.17
Standard Deviation	37.52
Minimum	0.00
Maximum	574.6
Count	7,671

Monthly Statistics for Flow (cfs)

% of daily flow above 21-yr mean

January	8.90%
February	12.82%
March	11.37%
April	8.57%
May	9.37%
June	31.11%
July	24.27%
August	29.80%
September	25.87%
October	12.44%
November	6.03%
December	9.06%
TOTAL	15.80%



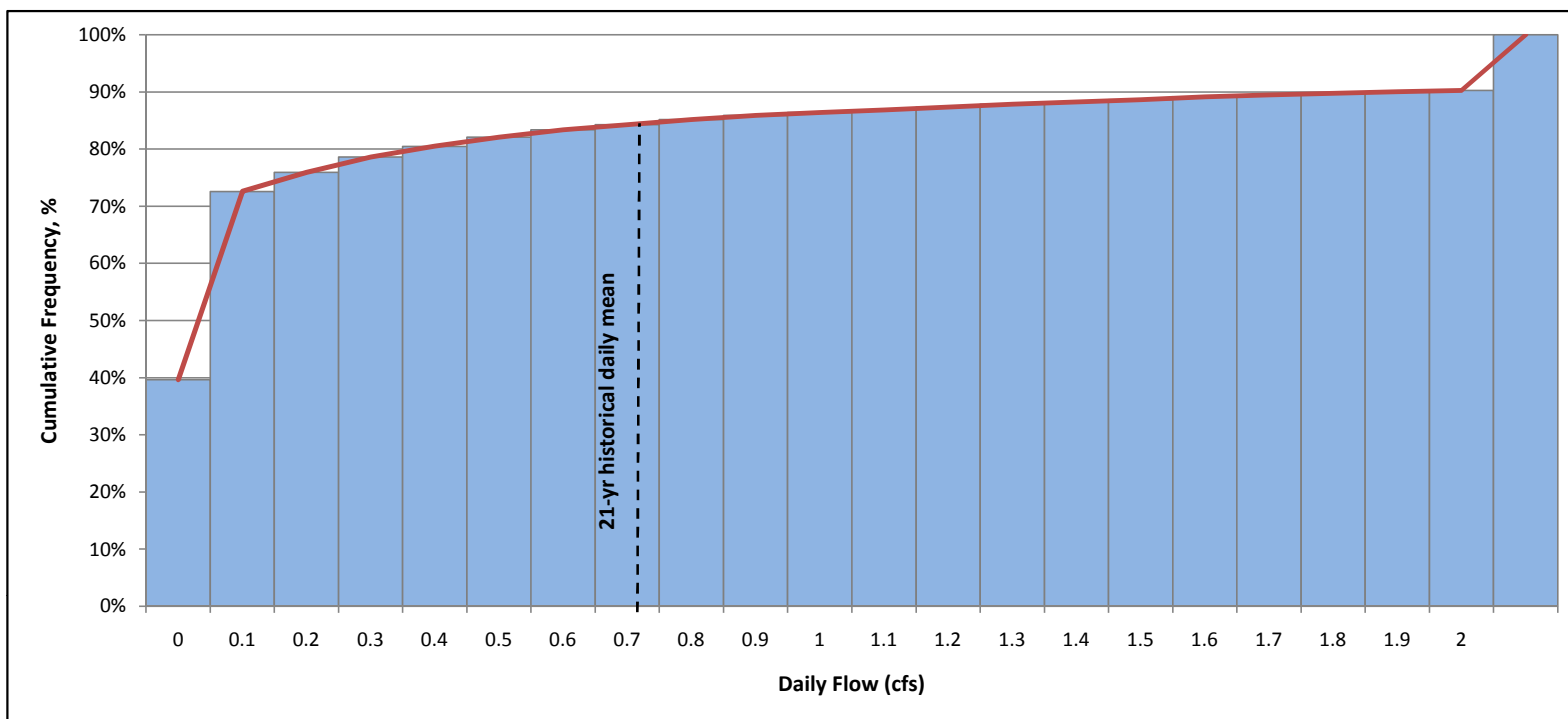
21-Yr Statistics for Flow (cfs)

Mean	24.09
Standard Error	0.92
Median	0.05
Standard Deviation	80.55
Minimum	0.00
Maximum	1,233.7
Count	7,671

Monthly Statistics for Flow (cfs)

% of daily flow above 21-yr mean

January	8.74%
February	12.48%
March	11.21%
April	8.57%
May	9.22%
June	30.79%
July	24.58%
August	28.88%
September	26.35%
October	12.75%
November	6.19%
December	8.76%
TOTAL	15.71%



21-Yr Statistics for Flow (cfs)

Mean	0.70
Standard Error	0.03
Median	0.01
Standard Deviation	2.32
Minimum	0.00
Maximum	35.4
Count	7,671

Monthly Statistics for Flow (cfs)

% of daily flow above 21-yr mean

January	8.59%
February	12.82%
March	11.06%
April	8.73%
May	9.37%
June	30.48%
July	24.73%
August	29.49%
September	25.71%
October	12.90%
November	5.87%
December	9.06%
TOTAL	15.73%

4.3 Systems Model and Evaluation

4.3.1 Water Budget

The water resources data collected and evaluated as well as modeling data were used to develop a conceptual estimate of an annual water mass balance (also called a water budget) for a proposed water storage facility located on the Judge Farms Property. The analysis conceptually quantifies flows for this area, using historical data, published information and model-estimated flows. The governing equation for this analysis is as follows:

$$\Sigma \text{Inflows} = \Sigma \text{Outflows} + \Delta \text{Storage} / \Delta \text{Time} \quad \text{Equation 1}$$

As shown on **Figure 21**, the inflow terms for the water storage facility control volume consisted of the following:

- Rainfall;
- Pumping from the three tributaries (East City Ditch, Mill Slough, and Judge Farms Ditch); and
- Pumping from East Lake Toho (the C-31 Canal upstream of the S-59 structure).

Also shown on Figure 21 are the outflow terms for the water storage facility control volume, which consisted of the following:

- Evaporation;
- Release from the water storage facility for reuse augmentation (water supply) to the City of St. Cloud and Toho Water Authority;
- Overflow from the water storage facility to Lake Toho (emergency conditions); and
- Groundwater seepage.

The change in storage over time reflects changing water levels in the water storage facility and a corresponding increase or decrease in storage. The water budget analysis was performed using a daily time interval for the 21-year period between 1990 and 2010. This time period includes 8 high rainfall years, 3 low rainfall years, and 10 near average rainfall years, as defined using the period of record (1949-2010) for the Kissimmee rainfall station (Station No. 08-4625). A dynamic systems model was developed using STELLA® (Systems Thinking Experimental Learning Laboratory with Animation) software to assist in the water budget analysis as well as to conceptually size and evaluate the performance of the proposed water storage facility configurations.

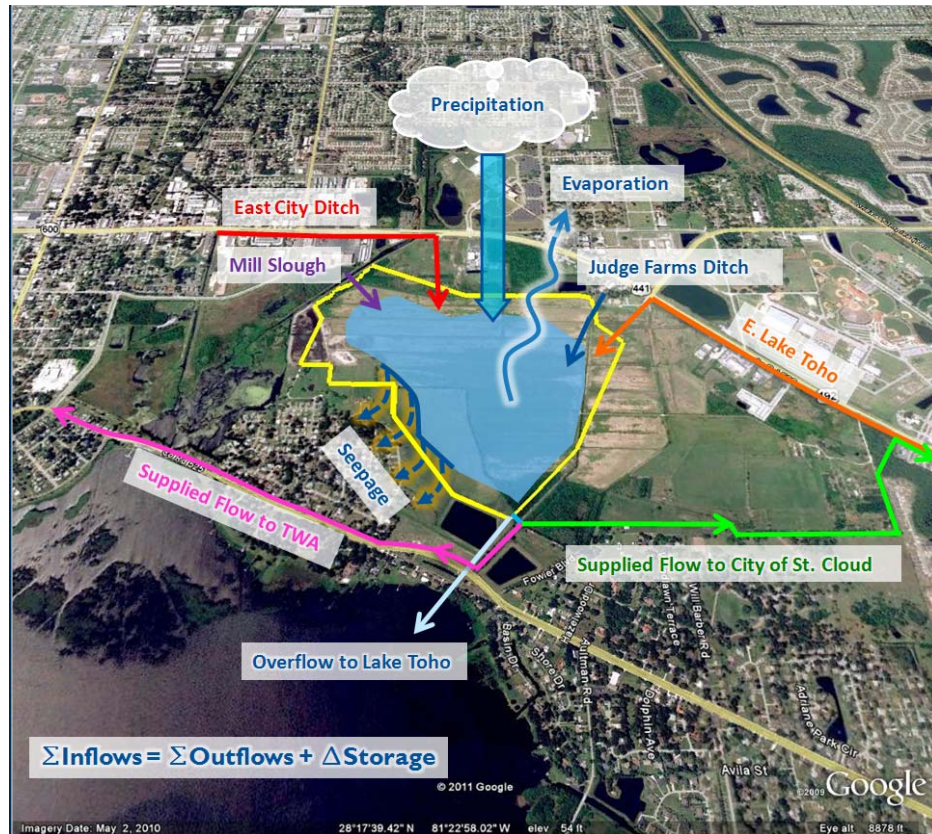


Figure 21 – Water Budget Inflows and Outflows

4.3.2 Systems Model

During this initial evaluation phase, the systems model was used to:

- Integrate climatologic data with results from SWMM for a 21-year period of record (1990 to 2010) using daily inputs of simulated flows from the tributaries (and East Lake Toho as needed for augmentation), rainfall, and evaporation. An analytical groundwater mounding model (Hantush, 1967) was utilized for the project site to determine seepage from the facility to the surficial aquifer as a function head differential between operating water level in the water storage facility and the water table elevation. This seepage relationship was entered into the systems model in order to represent daily seepage from the water storage facility;
- Develop a site-wide average annual water budget as well as evaluate the full range of hydrologic conditions in estimating inflows, outflows, and changes in storage;
- Help guide sizing component elements of the water storage facility, including water levels (minimum and maximum) and pump capacities; and
- Predict system-wide performance using metrics of water capture, continuity of system hydration, and reliability of supply.

4.3.2.1 STELLA® Overview

The commercial software package STELLA® (iSee, 2006) is a graphical simulation tool designed to evaluate conceptual design and operations of complex flow systems and the factors that influence their performance. While it has been used to address numerous water resources planning issues in Florida and throughout the United States, it was used specifically during this property evaluation to integrate data from NOAA, SJRWMD, and USGS databases to quantify rainfall, and evaporation along with output from other models, such as runoff and groundwater seepage to evaluate the dynamic interactions of the system.

The internal mechanisms in the STELLA® model focus on the mass balance calculation within storage elements and flow sequencing for multiple outflows from single storage elements. STELLA® allows the user to sketch a system or a combination of systems on a blank worksheet and study its response to dynamic input. The tool includes a modeling worksheet in which the interconnected system and all influencing factors are “drawn” schematically and mathematical equations are entered to compute mass balance across all system elements. The model can simulate time periods of any practical duration with any specified time step, and flows and storage levels are computed and recorded for each time step during the simulation. For this analysis, the model was configured to function with a one-day time interval for a 21-year period.

Once a model of a flow system has been built in the STELLA® environment, planners, designers, and decision-makers can utilize the model to:

- Screen alternative system configurations for feasibility and effectiveness;
- Compare and contrast feasible alternatives with respect to design and operating parameters;
- Understand sensitivities in the system, that is, understanding the ranges of variables over which performance changes significantly, and over which it changes very little; and
- Fine-tune system performance by adjusting its variables and operating rules to improve performance toward specific operational goals.

4.3.2.2 Model Structure

The conceptual water storage facility is represented in the systems model as a storage basin that receives inflows pumped from three tributaries (East City Ditch, Mill Slough, and Judge Farms Ditch), inflow pumped from East Lake Toho, and direct rainfall (**Figure 22**). The system loses water to free-surface evaporation and groundwater seepage. Two additional outflows from the water storage facility consist of water supply releases and a discharge for emergency overflows to Lake Toho.

Input Parameters

The model was programmed with five types of daily input time series as described below:

- Measured rainfall;
- Measured evaporation;
- Simulated seepage;
- Simulated flows in tributaries (East City Ditch, Mill Slough, and Judge Farms Ditch); and
- Inflow from East Lake Toho.

Control Logic

The systems model currently represents flow into and from the water storage facility, as follows:

- Inflow from each of the three tributaries, as available, is pumped if the water depth in the water storage facility is less than a specified operating depth for each source, which ranges from the minimum depth to the maximum depth in the water storage facility. This acts as a “trigger” to initiate flows from each of the surface water supply sources;
- The inflow is limited by the minimum of either the specified pump capacity or the flow available for withdrawal from the individual tributaries, which is estimated by calculating the gross flow at a given day by a specified withdrawal limit. Since there is no minimum flow or level (MFL) established for any of the tributaries by SFWMD, a withdrawal estimate of 50 percent, 50 percent, and 100 percent was used in the evaluation to constrain the available supply from East City Ditch, Mill Slough, and Judge Farms Ditch, respectively. A lower withdrawal limit was estimated for Mill Slough and East City Ditch (50 percent) to minimize potential environmental impacts to these off-site water bodies. In addition, the pumping logic is further restricted by preventing withdrawals from the tributaries when the flow is less than the baseflow;
- Baseflow for each tributary was estimated by multiplying the upstream contributing areas to each water body by a surficial aquifer net recharge rate of 3 in/yr, which is considered to be representative for this area, as mapped by the SFWMD (Fairbank and Hohner, 1995). Approximately 85 percent of this recharge rate is estimated to contribute to baseflow, while the remainder is considered to be “lost” to the system via deep recharge;
- Water from East Lake Toho, as available, is pumped into the water storage facility (10-30 mgd depending on the scenario) if the water depth in the storage facility is less than the specified trigger depth. It should be noted that any proposed withdrawals from East Lake Toho would need to be further evaluated for compliance with the Kissimmee Basin Water Reservation rule once this effort is finalized and the rule is adopted by the SFWMD;
- Water is released from the water storage facility for water supply purposes at an annual average rate (10 mgd-30 mgd) multiplied by monthly demand distributions specific to the net irrigation requirement for pasture grass for this area (USDA, 1982). Water can also be released as an emergency overflow if the maximum storage capacity is exceeded in the facility; and
- No outflows are allowed if water is below the minimum specified level.

The intent for this alternative water supply is to maximize reuse to the extent practicable in order to offset using potable water for irrigation by the Stakeholders. Therefore, the annual average demand (ranging from 10 mgd-30 mgd for this analysis) was discretized into monthly values using seasonally varying demand fractions specific to the net irrigation requirement (in an average rainfall year) for pasture grass in Osceola County (Climatic Zone 4) as referenced in the Florida Irrigation Guide (USDA, 1982). **Table 1** summarizes the monthly distribution that was used as peaking factors in the systems model to represent the growing season for pasture grass, which extends from February 1st-December 15th per the Florida Irrigation Guide. It should be noted that normal practice by the customers of the Stakeholder utilities is to irrigate throughout January, despite the dormant state of most Florida grasses and plants.

Table 1. Monthly Peaking Factors for Pasture Grass (Zone 4)

Month	Net Irrigation Requirement (inches)	Monthly Contribution (%)	Normalized Monthly Peaking Factors
February	0.60	2.6	0.31
March	1.38	6.0	0.71
April	3.04	13.1	1.57
May	4.04	17.4	2.09
June	2.80	12.1	1.45
July	2.78	12.0	1.44
August	2.65	11.4	1.37
September	1.87	8.1	0.97
October	2.19	9.4	1.13
November	1.64	7.1	0.85
December	0.20	0.9	0.10
Total	23.19	100	12

Source: Florida Irrigation Guide (USDA, 1982).

Configuration of Water Storage Facility

The systems model was used to evaluate and compare a variety of alternatives for the conceptual water storage facility. During the evaluation, several combinations of operating water depths, pump capacities, and storage footprints were evaluated in an effort to converge on the combinations that appeared most likely to effectively and reliably supply the available water (**Table 2**). As part of this evaluation, a sensitivity analysis was performed to determine the optimized water level in the water storage facility that would serve as a “trigger” for initiating flows from each of the water supply sources.

Water Storage Facility Area

As previously described, two configurations (minimal berm and perimeter berm) for a potential water storage facility on the Judge Farms Property were identified. Both configurations were sited on the remaining property (approximately 291 ac) west of the proposed ballfield complex (estimated at 181 ac). For the minimal berm option, an average area between the elevations of 49 feet NAVD (141.5 ac) and 50 feet NAVD (177 ac) was calculated (159 ac) and used as a constant in the model to represent the water storage facility area. For the perimeter berm option, a regression analysis was completed to determine the relationship between area (acres) as a function of volume (MGal). A coefficient of variance (R^2) of 0.9895 resulted from this analysis, which indicates a very good fit.

$$\text{Area} = 63,541 \ln(\text{Volume}) - 108.56 \quad \text{Equation 2}$$

Pump Capacity

The flow duration curves for simulated flows in each tributary (Figures 16-18) were used as guidance in sizing the inflow pump capacities used. For each alternative, an inflow pump capacity of 15 cfs, 30 cfs, and 5 cfs was used in the systems analysis for East City Ditch, Mill Slough, and Judge Farms Ditch, respectively, in order to balance cost and flow capture constraints. The inflow capacity for East Lake Toho was set equal to the raw water demands (up to 30 mgd as prescribed by the Stakeholders).

Operating Water Levels

For the perimeter and minimal berm options, a minimum water level was set at 1 foot (49 feet NAVD) in order to minimize sediment build-up and re-suspension of solids (*i.e.*, nutrients). For the perimeter berm option, a maximum water level was set at 4 feet (52 feet NAVD) in order to provide maximum storage while minimizing berm height. For the minimal berm option, the maximum water level was set at 2 feet (50 feet NAVD).

Table 2. Systems Model Variables for the Water Storage Facility

Variable Category	Variable	Input Value
Geometry (Minimal Berm Option)	Average Water Storage Facility Area (ac)	159
	Maximum Sidewater Depth (feet)	2
	Minimum Sidewater Depth (feet)	1
Geometry (Perimeter Berm Option)	Water Storage Facility Area (ac)	See Equation 2
	Maximum Sidewater Depth (feet)	4
	Minimum Sidewater Depth (feet)	1
Hydraulic Capacity	East City Ditch Inflow Pump Capacity (cfs)	15
	Mill Slough Inflow Pump Capacity (cfs)	30
	Judge Farms Ditch Inflow Pump Capacity (cfs)	5

4.3.3 Alternatives Evaluation

A series of system configuration alternatives were evaluated with the combination of variables described above. Two alternatives that will be further described herein include system configurations reflecting the minimal and perimeter berm options, which were evaluated using a monthly distribution of raw water demands ranging from 10 mgd-30 mgd.

4.3.4 Systems Model Results Summary

For the optimized system configurations, **Table 3** summarizes the inflow and outflow water budget terms and performance metrics such as reliability of the supplied water, percent of flow withdrawn from each source (tributaries and East Lake Toho), residence time of the water storage facility, frequency that the available storage is depleted (percent of time below minimum depth), and frequency of overflow to Lake Toho when the maximum storage capacity is exceeded.

4.3.4.1 Minimal Berm Option

For the minimal berm option, the difference between the minimum and maximum operating water levels is small (1 foot) and, therefore, there are limited storage opportunities with this option. To maximize the available flow from each tributary and East Lake Toho, the trigger depth for each of these sources was set equal to 2 feet. The reliability of the supply ranges from 87 percent (30 mgd) to 92 percent (10 mgd) since there are some limited occurrences when supply is not sufficient to meet highest peak demands such as in April and May (**Table 4**). The residence times, which range from 22 days (30 mgd) to 26 days (10 mgd) will be used for calculating pollutant reduction based on this configuration. The residence time was calculated by dividing the volume in the water storage facility by the sum of the outflows. The amount of inflow that the tributaries can contribute is limited since they are low flow, “flashy” systems. Inflows from East Lake Toho are needed to meet the vast majority of the demand. **Table 3** and **Figure 23** summarize the results from the 2 feet trigger depth evaluation; results from the 1 foot trigger depth evaluation are presented in **Appendix B**. To determine the reliability of the water supply without

augmentation from East Lake Toho (**Table 5**), inflows from the three tributaries were simulated for a range of annual average raw water demands from 1 mgd to 3 mgd (using a monthly irrigation distribution). The trigger depth for each of these sources was set equal to 2 feet, since this is the maximum depth of the water storage facility in the minimal berm configuration. For this option, an annual average flow of 1 mgd can be supplied approximately 90 percent of the time, while a higher flow of 3 mgd can be supplied approximately 69 percent of the time. The residence times ranged from 65 days (3 mgd) to 77 days (1 mgd) under this option due to the limited storage capacity.

Table 3. Systems Model Results Summary (Tributary and East Lake Toho Inflows)

Systems Model Components		Water Storage Facility Scenarios					
		Minimal Berm ¹			Perimeter Berm ²		
Raw Water Demand		10 mgd	20 mgd	30 mgd	10 mgd	20 mgd	30 mgd
Average Inflows (mgd)	Rainfall	0.6	0.6	0.6	0.9	0.9	0.9
	Pump from East City Ditch	1.0	1.1	1.1	1.4	1.5	1.5
	Pump from Mill Slough	1.9	2.1	2.2	2.7	2.9	3.0
	Pump from Judge Farms Ditch	0.2	0.2	0.2	0.2	0.3	0.3
	Pump from East Lake Toho	7.8	15.9	24.1	5.4	13.0	20.8
	<i>Total Inflows</i>	11.5	20.0	28.3	10.6	18.6	26.4
Average Outflows (mgd)	Evaporation	0.6	0.6	0.6	0.8	0.8	0.8
	Seepage	0.1	0.1	0.1	0.3	0.2	0.2
	Water Supply Releases	8.7	16.5	24.1	9.2	17.4	25.3
	Emergency Overflow	2.1	2.7	3.5	0.4	0.2	0.2
	<i>Total Outflows</i>	11.5	20.0	28.3	10.6	18.6	26.4
Average Residence Time (days)		26.4	23.2	22.1	69.4	57.0	52.7
% of Time Water Demand Supplied		92.0	88.7	86.7	95.0	92.0	90.0
% of Time Below Minimum Depth		7.3	10.2	12.0	4.5	7.3	9.1
% of Time Overflow		21.3	20.0	19.5	3.7	1.8	1.5
% Flows Withdrawn from East City Ditch		21.4	23.2	24.1	28.2	30.0	30.4
% Flows Withdrawn from Mill Slough		19.5	21.3	22.1	26.2	28.0	28.4
% Flows Withdrawn from Judge Farms Ditch		12.6	14.2	14.8	17.8	19.3	19.7
% Flows Withdrawn from East Lake Toho		78.4	79.7	80.3	53.9	65.2	69.3
Notes:							
¹ Water storage facility trigger depths were set at 2 feet for the tributaries and East Lake Toho withdrawals.							
² Water storage facility trigger depths were set at 4 feet for the tributaries and 3 feet for East Lake Toho withdrawals.							

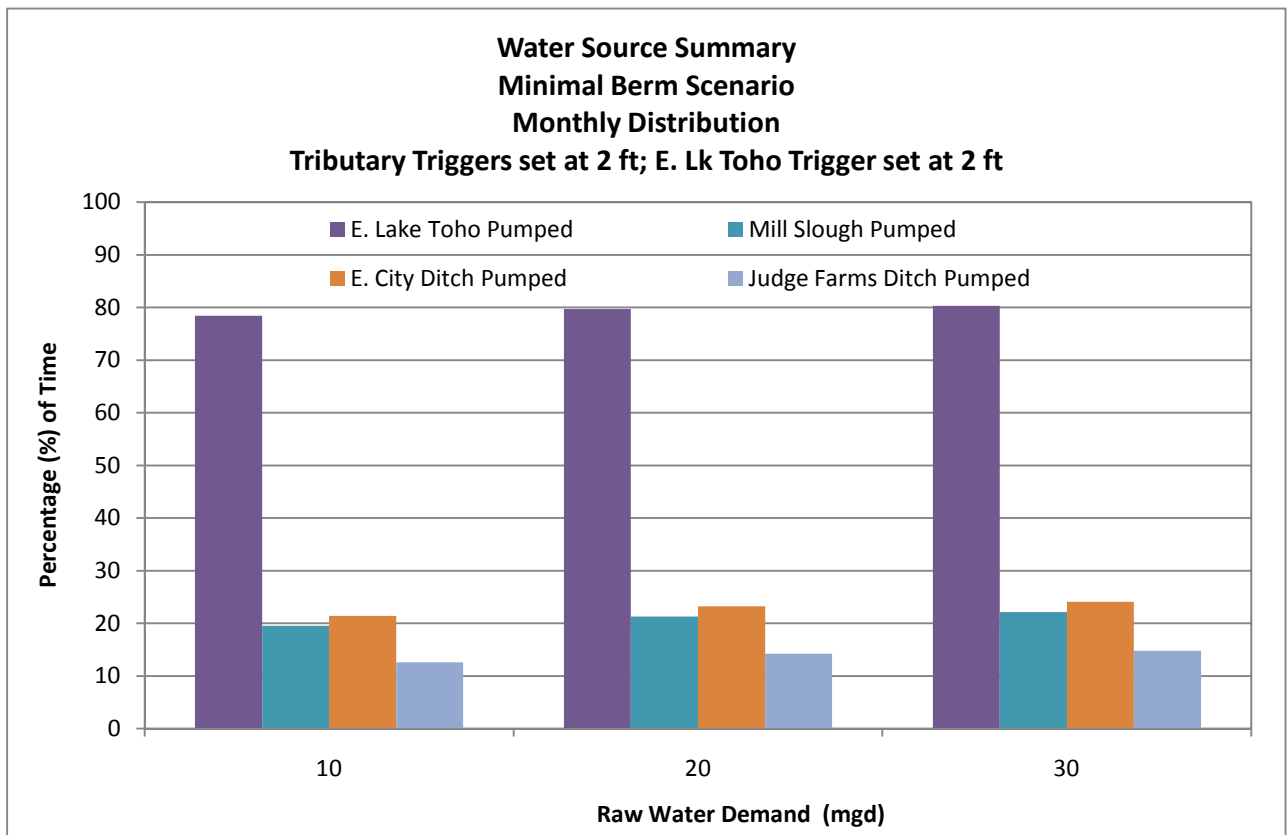
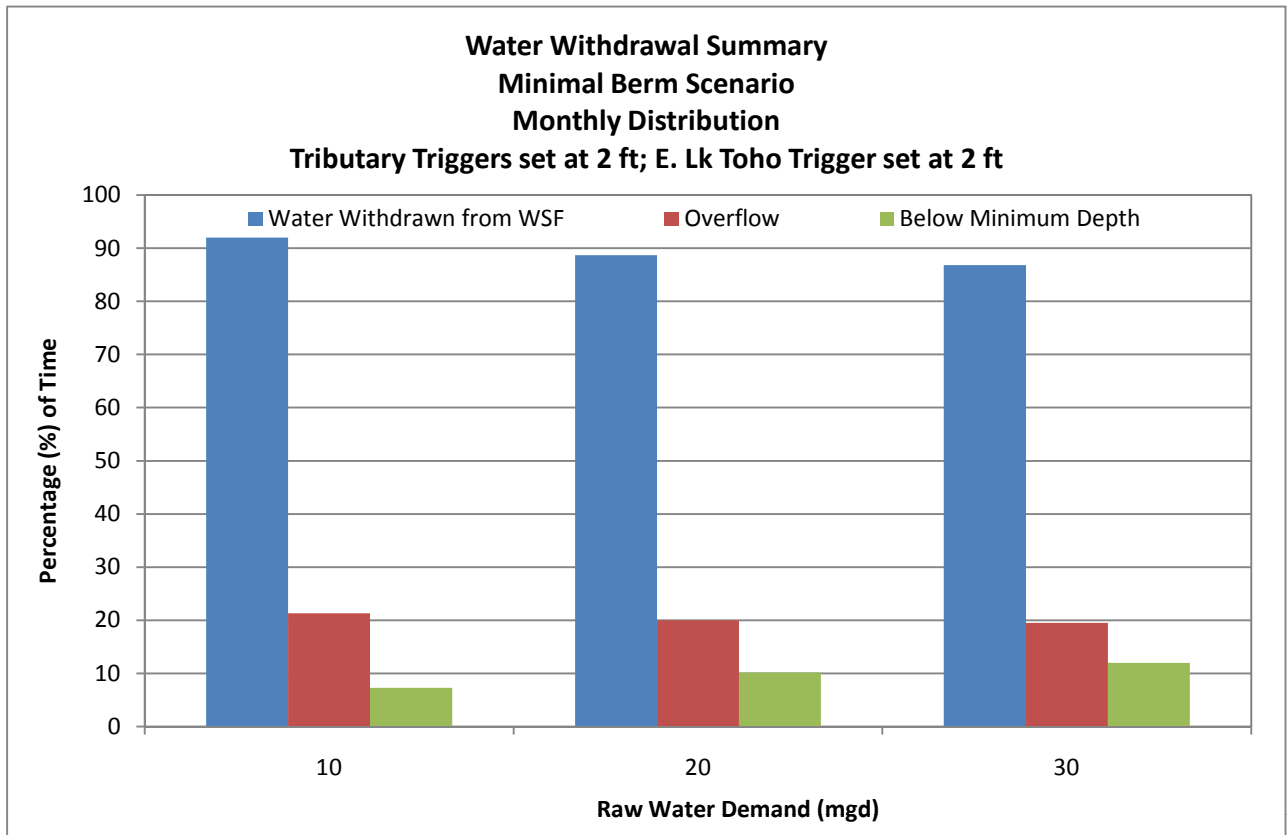


Table 4. Summary of Water Supply Reliability

Month ¹	Percent of Days with Water Supply Available (%)					
	Minimal Berm ²			Perimeter Berm ³		
	10 mgd	20 mgd	30 mgd	10 mgd	20 mgd	30 mgd
February	100	100	100	100	100	100
March	100	100	100	100	100	100
April	77.9	71.4	68.4	94.3	81.1	75.7
May	55.8	52.2	51.3	59.9	53.6	51.3
June	92.2	85.4	80.3	95.1	90.3	86.8
July	93.1	84.6	80.3	98.9	93.7	88.2
August	95.4	88.9	84.5	98.9	94.9	90.9
September	100	99.7	99.7	99.8	100	100
October	98.9	96.0	93.2	100	99.7	99.1
November	100	99.7	99.5	100	100	100.0
December	99.2	99.2	99.2	99.2	99.2	99.2
Overall	92.0	88.7	86.7	95.0	92.0	90.0
Notes:						
¹ Per the Florida Irrigation Guide, the growing season for pasture grass extends from February 1 st -December 15 th .						
² Water storage facility trigger depths were set at 2 feet for the tributary withdrawals.						
³ Water storage facility trigger depths were set at 4 feet for the tributary withdrawals.						

4.3.4.2 Perimeter Berm Option

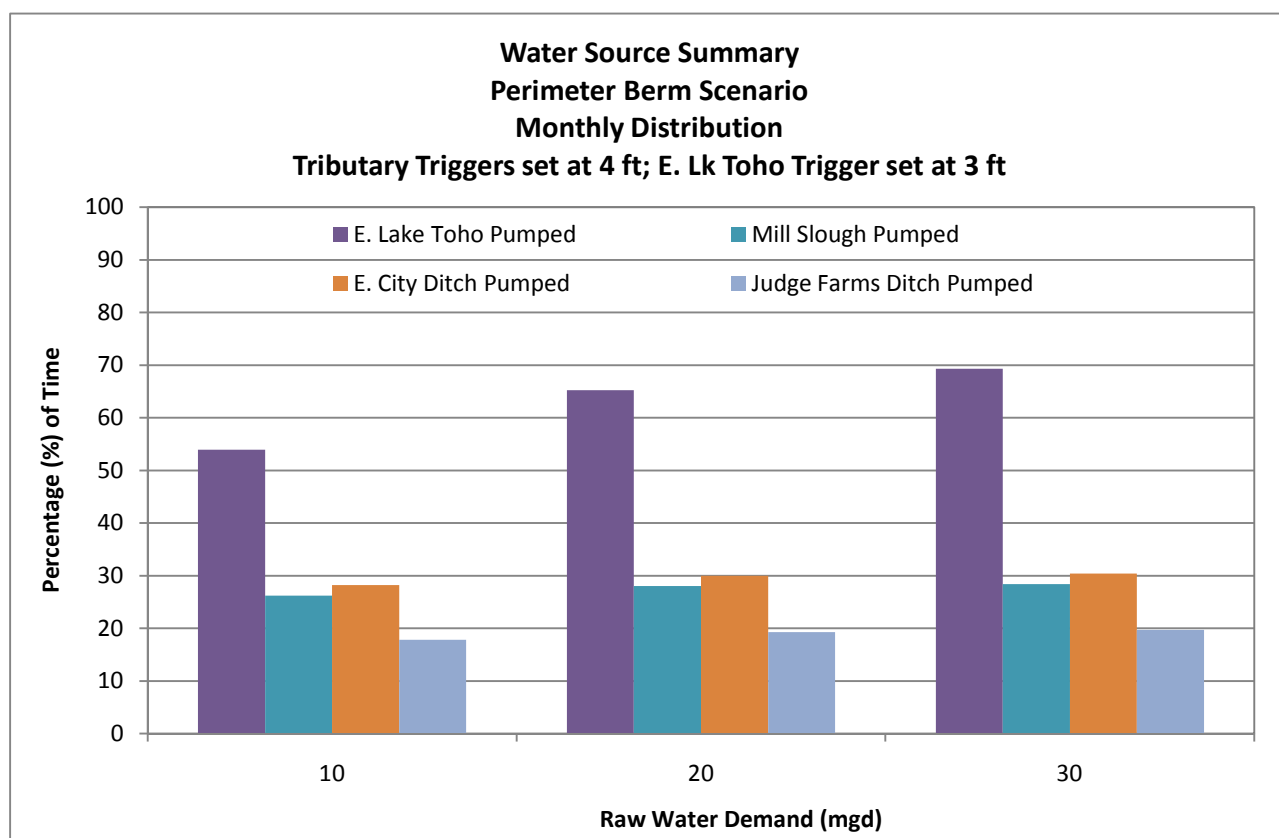
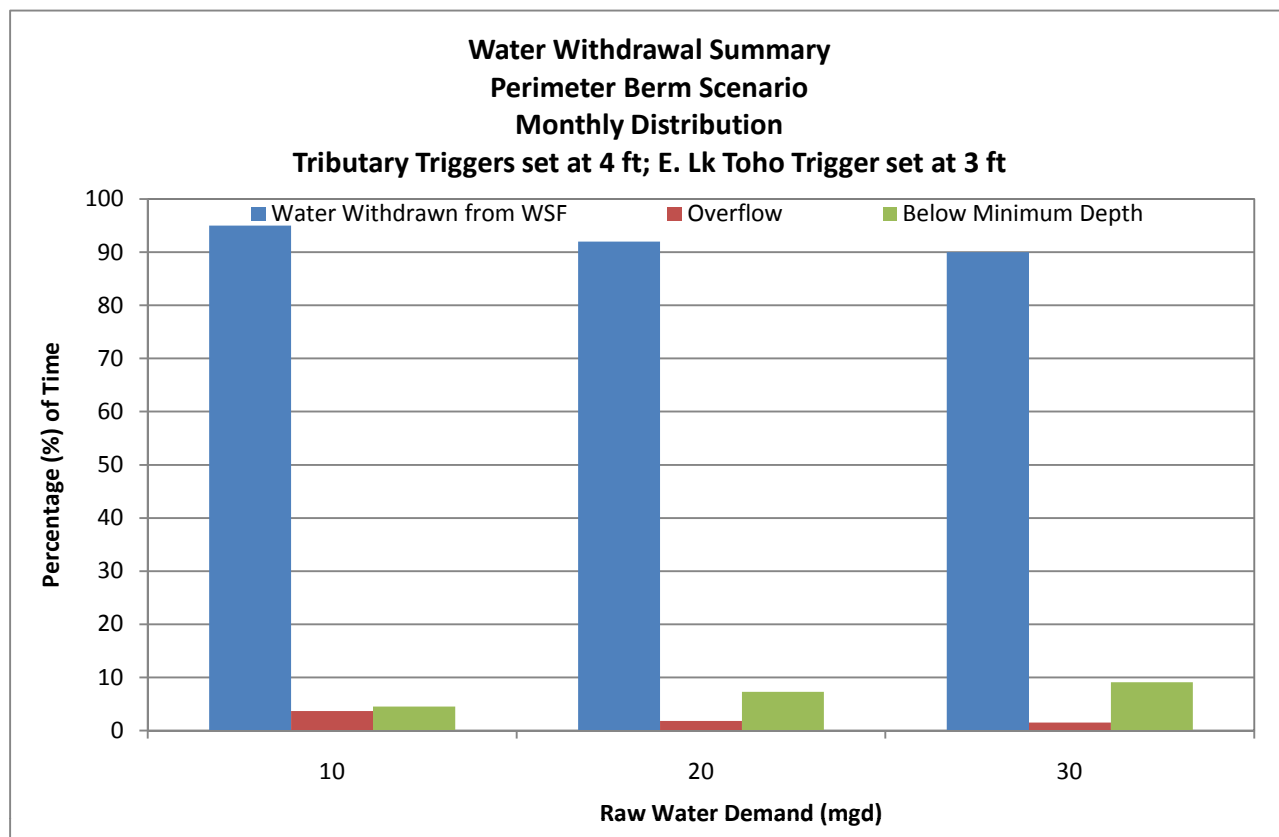
For the perimeter berm option, the difference between the minimum and maximum operating water levels is 3 feet and there are greater storage opportunities with this option. To maximize the available flow from each tributary, the trigger depth for each of these sources was set equal to 4 feet. A sensitivity analysis was performed ranging the East Lake Toho trigger depths from 1 foot to 4 feet. The optimized trigger depth resulted in 3 feet for East Lake Toho since this configuration maximized reliability of the water supply while minimizing overflow (thereby increasing residence time and loading reduction benefits). As summarized in Table 3 and **Figure 24**, the reliability of the supply in this scenario ranges from 90 percent (30 mgd) to 95 percent (10 mgd) since there are some limited occurrences when supply is not sufficient to meet highest peak demands such as in May (Table 4). The residence times are larger than the minimal berm option, ranging from 53 days (30 mgd) to 69 days (10 mgd), which will result in greater pollutant reduction. The amount of inflow that the tributaries can contribute is limited since they are low flow, “flashy” systems. Inflows from East Lake Toho are needed to meet the vast majority of the demand. However, because the available storage is greater in this option due to the higher berms, the residence times are larger and hence inflows from East Lake Toho are initiated less often. Results from the 1 foot, 2 feet, and 4 feet trigger depth evaluations are presented in Appendix B.

To determine the reliability of the water supply without augmentation from East Lake Toho (Table 4), inflows from the three tributaries were simulated for a range of annual average raw water demands from 1 mgd to 5 mgd (using a monthly irrigation distribution). The trigger depth for each of these sources was set equal to 4 feet, since this is the maximum depth of the water storage facility in the perimeter berm configuration. For this option, an annual average flow of 1 mgd can be supplied approximately 100 percent of the time, while a higher flow of 5 mgd can be supplied approximately 77 percent of the time. The residence times ranged from 84 days (5 mgd) to 168 days (1 mgd) under this option due to the increase in storage capacity. These higher residence times allow for greater pollutant removal efficiencies and reductions in pollutant loading than the minimal berm option.

Table 5. Systems Model Results Summary (Tributary Inflows)

Systems Model Components		Water Storage Facility Scenarios							
		Minimal Berm ¹			Perimeter Berm ²				
Raw Water Demand		1 mgd	2 mgd	3 mgd	1 mgd	2 mgd	3 mgd	4 mgd	5 mgd
Average Inflows (mgd)	Rainfall	0.6	0.6	0.6	1.0	1.0	0.9	0.9	0.9
	Pump from East City Ditch	0.9	1.0	1.1	0.9	1.1	1.2	1.3	1.4
	Pump from Mill Slough	1.7	1.9	2.1	1.8	2.1	2.3	2.5	2.6
	Pump from Judge Farms Ditch	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.2
	<i>Total Inflows</i>	3.4	3.7	3.9	3.8	4.3	4.6	4.9	5.1
Average Outflows (mgd)	Evaporation	0.6	0.6	0.6	0.9	0.9	0.8	0.8	0.8
	Seepage	0.1	0.1	0.1	0.3	0.3	0.3	0.2	0.2
	Water Supply Releases	0.9	1.5	1.9	1.0	1.9	2.6	3.1	3.6
	Emergency Overflow	1.8	1.5	1.3	1.6	1.3	1.0	0.7	0.6
	<i>Total Outflows</i>	3.4	3.7	3.9	3.8	4.3	4.6	4.9	5.1
Average Residence Time (days)		77.4	67.4	65.3	168.4	126.7	102.7	88.8	84.3
% of Time Water Demand Supplied		89.5	77.8	69.0	99.6	96.2	90.2	84.0	76.6
% of Time Below Minimum Depth		9.7	20.9	29.0	0.3	3.4	8.9	14.8	21.7
% of Time Overflow		13.0	11.0	9.5	12.0	9.1	7.0	5.5	4.2
% Flows Withdrawn from East City Ditch		19.3	21.1	22.6	20.0	22.8	24.8	26.5	27.7
% Flows Withdrawn from Mill Slough		17.4	19.1	20.5	18.1	20.7	22.8	24.4	25.6
% Flows Withdrawn from Judge Farms Ditch		11.4	12.5	13.5	11.9	13.7	15.2	16.5	17.3
Notes:									
¹ Water storage facility trigger depths were set at 2 feet for the tributary withdrawals.									
² Water storage facility trigger depths were set at 4 feet for the tributary withdrawals.									

It should be noted that the modeling evaluations described above did not consider in-stream flow requirements for minimizing impacts to the endangered snail kite. No snail kite nests were observed during the environmental site assessment conducted at the Judge Farms Property, therefore, the evaluation performed did not consider local potential environmental impacts to snail kite habitat as a result of the water storage facility being constructed. However, slight lowering of surface water levels in these canals promotes the growth of hydrilla, which provides habitat for apple snails that are a major food source for snail kites. Therefore, some lowering of water levels in the tributary canals and ditches will enhance snail kite habitat. Additionally, the open water of the water storage facility will also provide direct habitat for the snail kite. This issue may need to be evaluated in future phases of the project and the SFWMD may be concerned that alternative uses of surface water may affect the hydrology of Lake Toho, which also supports the snail kite population.



5.0 Pollutant Load Analysis

5.1 Background

In 2011, Osceola County and the cities of Kissimmee and St. Cloud participated as Stakeholders in the development of the *Lake Tohopekaliga Nutrient Reduction Plan* (CDM, 2011). In the 2010 adopted verified listing of impaired waters, the FDEP determined that Lake Toho was impaired for nutrients based on an increasing trend in trophic state index (TSI). Local Stakeholders including Osceola County and the City of Kissimmee disagreed with the listing and entered into discussions with FDEP over the justification for the impairment listing. An independent analysis performed by the City and the County convinced FDEP to re-consider the impairment listing for TSI. FDEP decided to modify the cause of impairment to an imbalance of flora and fauna, which is included under the narrative nutrient criteria in Chapter 62-303, Florida Administrative Code (FAC). FDEP's decision to rely on the narrative nutrient criteria is due to the growth of hydrilla that is present in the lake based on hydrilla biocover data collected by the FFWCC since 2001. Due to the complex interactions between ambient water quality, hydrilla, and management activities within Lake Toho which still have yet to be completely understood, FDEP agreed that more research and a better understanding of lake dynamics is needed before appropriate water quality targets [i.e., total maximum daily load (TMDL)] can be set for the lake. Therefore, in addition to modifying the cause for impairment, FDEP would also consider modifying the lake's assessment status from Category 5 (i.e., water quality standards are not attained and a TMDL is required) to Category 4e (i.e., impaired, but recently completed or on-going restoration activities are underway to restore the designated uses of the waterbody) if FDEP is provided assurance that measures are being put in place to reduce external nutrient loads to the lake. As a result of this decision, local Stakeholders decided to develop a Nutrient Reduction Plan (NRP) for Lake Toho to address FDEP's requirements to facilitate the change in assessment category.

As part of the NRP, pollutant loads for total nitrogen (TN) and total phosphorus (TP) were calculated for the entire Lake Toho watershed and were broken out by jurisdiction so that each stakeholder could discern their individual loads. In order to satisfy FDEP that nutrient reductions are occurring within the watershed, the Stakeholders also had to document implemented and/or planned projects that achieve this goal. Quantified nutrient load reductions associated with implemented and planned projects were also presented in the Lake Toho NRP. The Judge Farms Water Storage Facility Preliminary Feasibility Analysis was included as an on-going study in the list of planned projects and activities, yet the TN and TP loads were not quantified at the time.

As part of this study, the nutrient load removals associated with a water storage facility at the Judge Farms Property were estimated. As the cities and the County continue with implementation of the Lake Toho NRP, it was deemed appropriate to employ the same methodology used in the Lake Toho NRP to quantify load reductions associated with the proposed water storage facility on the Judge Farms site.

5.2 Methodology

Pollutant loading and the reductions associated with planned projects were quantified using output from the Hydrologic Simulation Program - FORTRAN (HSPF) model developed by FDEP (2011) for the purposes of establishing draft TMDLs for the Upper Kissimmee River Basin. The output was used in combination with various geographic information systems (GIS) layers for the watershed in order to quantify the TN and TP loads. Specifics of the modeling and pollutant load calculations are detailed in the Lake Toho NRP.

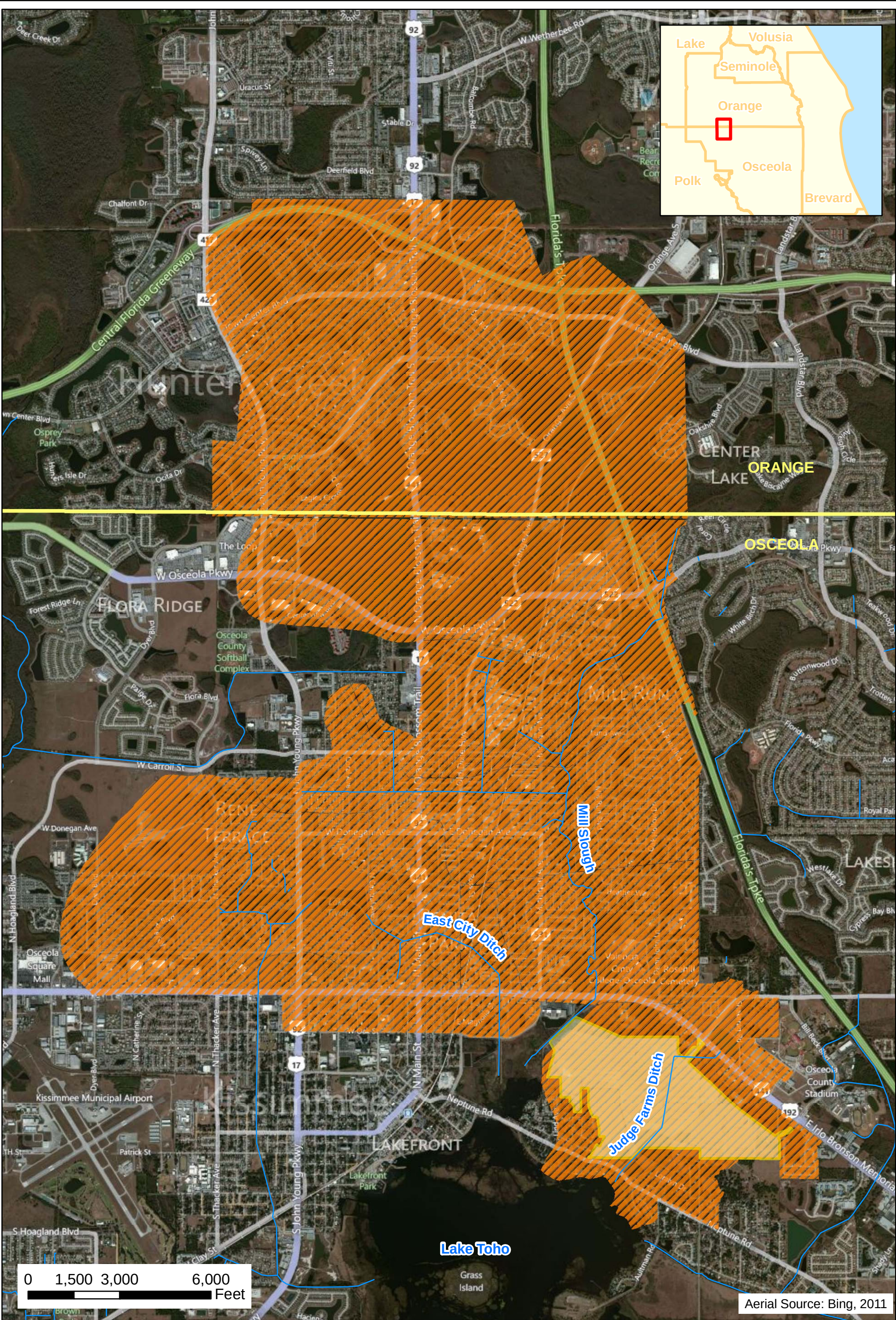
CDM used this same methodology to quantify the load reduction associated with each proposed water storage facility at the Judge Farms site. For the purposes of this exercise, it was necessary to quantify the load treated by the proposed water storage facility. As discussed in Section 4.2, flow from the tributaries (i.e., East City Ditch, Mill Slough, and Judge Farms Ditch) were simulated to quantify how much flow could be diverted into the proposed facility on an annual basis. This tributary area is shown on **Figure 25**. The upstream tributary area is approximately 10,200 acres. As can be seen from the figure, the tributary area is comprised of portions of the City of Kissimmee (3,403 acres or 33 percent), Osceola County (2,606 acres or 26 percent), and Orange County (3,707 acres or 30 percent).

For the tributary area, CDM estimated the existing treated load. This is the load that accounts for treatment associated with existing stormwater best management practices (BMPs) that were constructed through 2008 (the baseline condition for the Lake Toho NRP analysis). The existing load within the tributary area, broken out by jurisdiction, is shown in **Table 6**. In the NRP, natural loads were distinguished separately from the anthropogenic loads. This was due in part to the fact that natural loads from undeveloped lands and conservation areas are deemed as uncontrollable loads. In the case of the proposed facility on the Judge Farms site, the entire load (both natural and anthropogenic loads) will be captured and treated.

Table 6. Existing Nutrient Loads

Jurisdiction/ Area	Area (Acres) ²	TN Load (lbs/yr) ³	TP Load (lbs/yr) ³
Osceola County	2,606	19,111	2,121
City of Kissimmee	3,403	25,577	2,636
Orange County	3,070	15,017	1,484
FDOT District 5	204	1,879	194
Agriculture	707	7,296	918
Other ¹	208	2,958	390
Total	10,198	71,839	7,742
Notes: ¹ Other is defined as areas including Expressway and toll roads (i.e., Orlando-Orange County Expressway Authority, Osceola County Expressway Authority). ² With the exception of the Agriculture category, the areas reported do not include agricultural area. ³ Represents both the anthropogenic and natural loads.			

It should also be noted that existing BMP treatment was not originally defined for Orange County in the NRP as the County was not a financial partner in the development of the plan. However, in order to accurately quantify the load from the tributary area for the Judge Farms Property, existing treatment within Orange County was accounted for as part of this study. This was accomplished by using the County's parcel database and selecting those parcels constructed after 1983 (i.e., when stormwater management regulations went into effect) using GIS tools. Comparing the selected parcels to the 2008 aerials (baseline year) indicated that this is an accurate representation of BMP treatment within Orange County. Existing BMPs all appear to be wet detention; therefore, this is what was assigned in the model.



5.3 Potential Load Reduction Credits

Once the existing load for the tributary area was determined, it was then necessary to calculate the load reduction associated with routing flow from the tributaries into the proposed facility. For the purpose of the water balance analysis (Section 4.3), it was assumed that at a minimum, baseflow from the tributaries would be maintained as an input into Lake Toho. Any flow in excess of baseflow would be diverted to the proposed facility for storage and treatment. The original loading analysis performed as part of the Lake Toho NRP only accounted for land-based loads generated from each jurisdictional area (*i.e.*, the anthropogenic loads the Stakeholders could control). Baseflow was not considered in the original loading analysis as it was deemed an uncontrollable load. Therefore, as baseflow is still maintained to the lake in this scenario (not diverted to the proposed storage facility), the same methodology applied in the original analysis is still valid.

To calculate the load reduction, two scenarios based on the potential future use of the site and possible phasing of implementation were considered. The first scenario considers the proposed storage facility for wet detention purposes only (*i.e.*, storage and treatment of surface water from the three tributaries). The second scenario considers the facility at its optimal desired use [(storage and treatment of surface waters for water supply purposes (with augmentation from East Lake Toho)]. Both scenarios account for nutrient reduction for the harvested water.

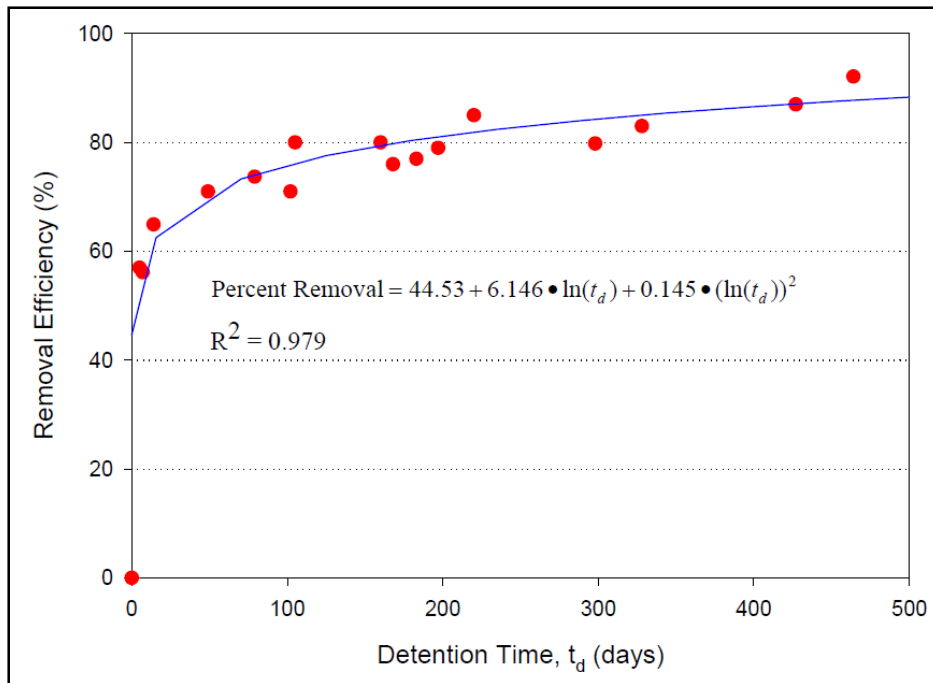
5.3.1 Wet Detention Scenario

Under this scenario, the proposed facility acts like a wet detention BMP that accepts and treats routed flows from the three local tributaries (East City Ditch, Mill Slough and Judge Farms Ditch); however the stored water is not discharged back into Lake Toho. To estimate the nutrient load removal associated with wet detention, it is necessary to determine the residence time. Residence time is one of the parameters that is calculated by the STELLA® model used in the water balance. Therefore, these same residence times previously shown in Table 5 for tributary inflows were used in order to determine load reduction. The *Draft Environmental Resource Permit (ERP) Stormwater Quality Applicant's Handbook* (FDEP, 2010) includes regression analyses for wet detention ponds, allowing the user to estimate TN and TP removal as a function of residence time. The relationships for TN and TP are provided below (t_d is the residence time in days):

$$\% \text{ TN removal} = (43.75 * t_d) / (4.38 + t_d) \quad \text{Equation 3}$$

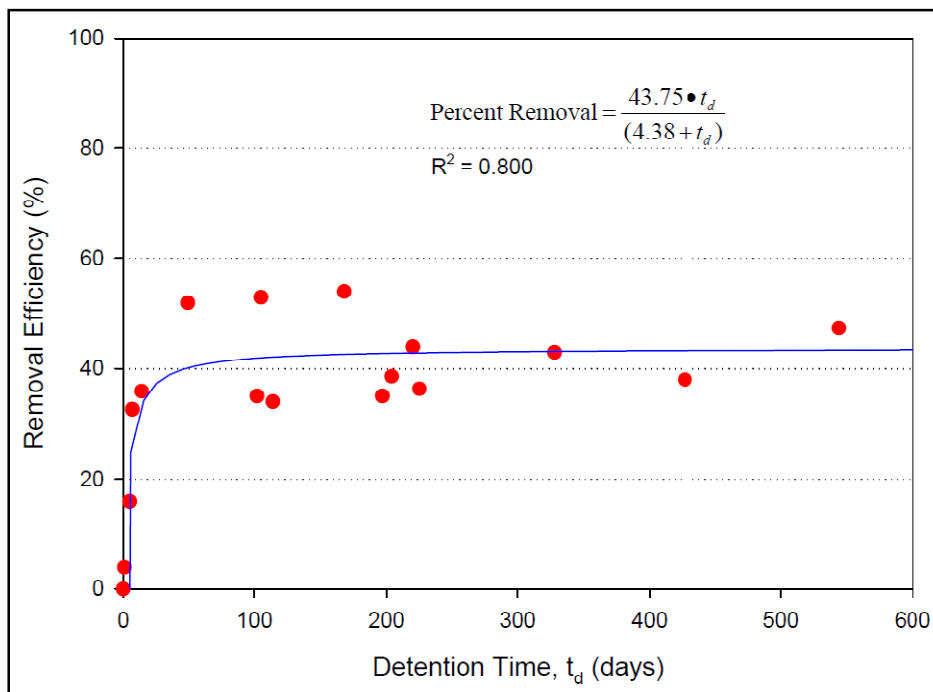
$$\% \text{ TP removal} = 44.53 + 6.146 * \ln(t_d) + 0.145 * (\ln(t_d))^2 \quad \text{Equation 4}$$

These relationships are also shown graphically in **Figures 26** and **27**. The residence times and the calculated removal efficiencies using the equations for wet detention are summarized in **Table 7**.



Source: Draft Environmental Resource Permit Stormwater Quality Applicant's Handbook (FDEP, 2010)

Figure 26 - Removal Efficiency of Total Phosphorus in Wet Detention Ponds as a Function of Residence Time



Source: Draft Environmental Resource Permit Stormwater Quality Applicant's Handbook (FDEP, 2010)

Figure 27 - Removal Efficiency of Total Nitrogen in Wet Detention Ponds as a Function of Residence Time

Table 7. Residence Times and Estimated Nutrient Removal Efficiencies (Tributary Inflows)

Raw Water Demand	Water Storage Facility Scenarios					
	Minimal Berm ¹			Perimeter Berm ²		
	1 mgd	2 mgd	3 mgd	1 mgd	3 mgd	5 mgd
Average Residence Time (days)	77.4	67.4	65.3	168.4	102.7	84.3
% TN Removal	41.4	41.1	41.0	42.6	42.0	41.6
% TP Removal	74.0	73.0	72.7	79.8	76.1	74.6
Notes: ¹ Water storage facility trigger depths were set at 2 feet for the tributary withdrawals. ² Water storage facility trigger depths were set at 4 feet for the tributary withdrawals.						

The calculated removal efficiencies for TN and TP were then applied to the existing loads previously summarized in Table 6 to estimate nutrient removal provided through wet detention treatment. It should be noted that there is no apportionment of loading by individual Stakeholders; therefore, the total load delivered at the downstream end of the system from all the Stakeholders receives the same level of treatment (i.e., residence time). The estimated load removals for TN and TP are summarized in **Tables 8** and **9**, respectively.

Table 8. TN Load Removal for Wet Detention

Jurisdiction/Area	Area (Acres)	TN Load (lbs/yr)	Water Storage Facility Scenarios					
			Minimal Berm			Perimeter Berm		
			1 mgd	2 mgd	3 mgd	1 mgd	3 mgd	5 mgd
			TN Load Removal (lbs/yr)					
Osceola County	2,606	19,111	7,913	7,851	7,835	8,149	8,019	7,948
City of Kissimmee	3,403	25,577	10,591	10,507	10,487	10,906	10,732	10,637
Orange County	3,070	15,017	6,218	6,169	6,157	6,403	6,301	6,245
FDOT District 5	204	1,879	778	772	770	801	788	781
Agriculture	707	7,296	3,021	2,997	2,991	3,111	3,061	3,034
Other	208	2,958	1,225	1,215	1,213	1,261	1,241	1,230
Total	10,198	71,839	29,746	29,511	29,454	30,632	30,144	29,877
% TN Removed	-	-	41.4	41.1	41.0	42.6	42.0	41.6

Table 9. TP Load Removal for Wet Detention

Jurisdiction/Area	Area (Acres)	TP Load (lbs/yr)	Water Storage Facility Scenarios					
			Minimal Berm			Perimeter Berm		
			1 mgd	2 mgd	3 mgd	1 mgd	3 mgd	5 mgd
			TP Load Removal (lbs/yr)					
Osceola County	2,606	2,121	1,570	1,548	1,543	1,694	1,614	1,583
City of Kissimmee	3,403	2,636	1,951	1,924	1,918	2,105	2,006	1,967
Orange County	3,070	1,484	1,098	1,083	1,080	1,185	1,129	1,108
FDOT District 5	204	194	144	142	141	155	148	145
Agriculture	707	918	679	670	668	733	699	685
Other	208	390	289	285	284	311	297	291
Total	10,198	7,742	5,730	5,651	5,633	6,183	5,893	5,779
% TP Removed	-	-	74.0	73.0	72.8	79.9	76.1	74.6

As shown by the results, the nutrient load removal does not vary significantly within each berm option. There is, however, more variance when comparing the optimized scenarios (*i.e.*, minimal berm vs. perimeter berm). The perimeter berm option provides more volume and, therefore, longer residence times, which in turn maximizes nutrient removal.

5.3.2 Water Storage Facility for Alternative Uses

Under this scenario, the proposed facility acts as a water storage facility with inflows from the local tributaries as well as augmentation from East Lake Toho in order to offset potable water demands for non-potable purposes (irrigation). This is the facility's ultimate intended use by the Stakeholders. For the purposes of estimating nutrient load removal, the BMP this most closely resembles is a stormwater harvesting facility. These types of facilities not only treat stormwater runoff, but use the treated water for alternative purposes such as irrigation source water. To calculate the removal efficiency associated with this type of facility, it is necessary to estimate the amount of water that is not discharged annually because it is being used for other purposes. Therefore, the average outflows previously provided in Table 3 were used in calculating removal efficiency. The volume of water that is released for emergency overflow purposes will be the load realized by the lake. The remaining loads entering the facility will be removed via other pathways (*i.e.*, water supply, seepage, *etc.*). Therefore, the removal efficiency is represented by the following equation:

$$\text{Removal Efficiency} = 1.0 - \text{Emergency Overflow} / \text{Total Outflows} \quad \text{Equation 5}$$

In this case, the same removal efficiency will be applied for both TN and TP removal. These removal efficiencies are summarized in **Table 10**.

Table 10. Estimated Nutrient Removal Efficiencies for Water Storage/Supply Facility

	Water Storage Facility Scenarios					
	Minimal Berm ¹			Perimeter Berm ²		
Raw Water Demand	10 mgd	20 mgd	30 mgd	10 mgd	20 mgd	30 mgd
% Nutrient Removal	82	87	88	96	99	99
Emergency Overflow (mgd)	2.1	2.7	3.5	0.4	0.2	0.2
Total Outflows (mgd)	11.5	20.0	28.3	10.6	18.6	26.4
Notes: ¹ Water storage facility trigger depths were set at 2 feet for the tributaries and East Lake Toho withdrawals. ² Water storage facility trigger depths were set at 4 feet for the tributaries and East Lake Toho withdrawals.						

The calculated removal efficiencies were then applied to the existing nutrient loads previously summarized in Table 6 to estimate nutrient removal provided through the water storage facility. The estimated load removals for TN and TP are summarized in **Tables 11** and **12**, respectively.

Table 11. TN Load Removal for Water Storage Facility

Jurisdiction/Area	Area (Acres)	TN Load (lbs/yr)	Water Storage Facility Scenarios					
			Minimal Berm			Perimeter Berm		
			10 mgd	20 mgd	30 mgd	10 mgd	20 mgd	30 mgd
			TN Load Removal (lbs/yr)					
Osceola County	2,606	19,111	15,621	16,531	16,747	18,390	18,906	18,966
City of Kissimmee	3,403	25,577	20,906	22,124	22,414	24,612	25,302	25,383
Orange County	3,070	15,017	12,275	12,990	13,160	14,450	14,856	14,903
FDOT District 5	204	1,879	1,536	1,625	1,647	1,808	1,859	1,865
Agriculture	707	7,296	5,964	6,311	6,394	7,021	7,218	7,241
Other	208	2,958	2,418	2,559	2,592	2,846	2,926	2,936
Total	10,198	71,839	58,720	62,140	62,953	69,127	71,066	71,294
% TN Removed	-	-	81.7	86.5	87.6	96.2	98.8	99.2

Table 12. TP Load Removal for Water Storage Facility

Jurisdiction/Area	Area (Acres)	TN Load (lbs/yr)	Water Storage Facility Scenarios					
			Minimal Berm			Perimeter Berm		
			10 mgd	20 mgd	30 mgd	10 mgd	20 mgd	30 mgd
			TP Load Removal (lbs/yr)					
Osceola County	2,606	2,121	1,734	1,835	1,859	2,041	2,098	2,105
City of Kissimmee	3,403	2,636	2,155	2,280	2,310	2,537	2,608	2,616
Orange County	3,070	1,484	1,213	1,284	1,300	1,428	1,468	1,473
FDOT District 5	204	194	159	168	170	187	192	193
Agriculture	707	918	750	794	804	883	908	911
Other	208	390	319	337	342	375	386	387
Total	10,198	7,742	6,329	6,698	6,785	7,451	7,660	7,684
% TP Removed	-	-	81.7	86.5	87.6	96.2	98.9	99.3

From Tables 11 and 12, as raw water demand increases within each berm option, the amount of nutrient removal is also increased, as there is a lesser probability of the water being released to Lake Toho. Similar to the wet detention scenario, the perimeter berm option provides more volume and, therefore, greater storage for alternative uses. This results in a greater nutrient load removal compared to the minimal berm option. The nutrients in the harvested water will also be beneficial for the irrigated vegetation supplied by the reclaimed water system.

The comparison of the two scenarios (wet detention vs. water storage) also demonstrates the added nutrient load removal benefit of using the treated surface water for alternative uses. Under the wet detention scenario, the TN load removal ranges from 29,454 to 30,632 lbs/yr whereas TP removal ranges from 5,633 to 6,183 lbs/yr. Under the water storage facility option, TN load removal ranges from 58,720 to 71,294 lbs/yr whereas TP removal ranges from 6,329 to 7,684 lbs/yr. In the case of TN removal, the water storage facility scenario at a minimum doubles the load removal. TP removal is increased from 8 to 24 percent over the wet detention scenario.

The City of St. Cloud's jurisdiction is not within the tributary area that was evaluated for capturing and treating pollutant loads. However, as the City is a Stakeholder in this process and a potential financial partner if the project is implemented, load reduction credits may be based on cost-sharing. This is especially true if other jurisdictions/entities outside of Osceola County do not participate, but receive a benefit (*i.e.*, Orange County, FDOT, *etc.*). The ultimate pollutant load credit assignments would need to be agreed to by the Stakeholders.

Under the water storage facility scenario, flows from East Lake Toho would be used to augment the stored volume of water at the proposed facility on the Judge Farms Property. Flow from East Lake Toho to Lake Toho is regulated by the S-59 control structure. Next to Shingle Creek, East Lake Toho is also a

major contributor of surface water flows into Lake Toho. Routing flow from East Lake Toho that otherwise would be discharged via the control structure may constitute a significant nutrient load removal to Lake Toho.

As per the scope of services, the loads from East Lake Toho were not specifically quantified; however, CDM did examine discharge records and water quality data from East Lake Toho to generally determine the potential for nutrient load removal. Discharge records for the S-59 canal were available from SFWMD. The average annual flow (in mgd) for the available period of record is summarized in **Table 13**. Based on measured flows, there is significant variability in the volume of water released from East Lake Toho on an annual basis. Compared to the water withdrawal scenarios previously discussed, up to 30 mgd is proposed to be withdrawn from East Lake Toho for alternative uses. It should be noted that any withdrawals from East Lake Toho would need to be further evaluated for compliance with the Kissimmee Basin Water Reservation rule once this effort is finalized and the rule is adopted by the SFWMD. For most years within the period of record, this exceeds the annual volume that is discharged to Lake Toho. If withdrawals are occurring for alternative uses, this does not necessarily mean that discharge from East Lake Toho to Lake Toho will be completely eliminated. The frequency and volume of discharge may be reduced though. Therefore, the Stakeholders may be able to take credit for at least the amount of load transferred from East Lake Toho to Lake Toho that does not exceed withdrawal volumes (*i.e.*, 10 mgd, 20 mgd, *etc.*) on an annual basis. CDM also obtained the measured water quality data for TN and TP from FDEP's Florida Storage and Retrieval (STORET) database to calculate the average annual load discharged from East Lake Toho into Lake Toho based on the measured flow rates.

Table 13. Annual Average East Lake Toho Discharges and Associated Pollutant Loads

Year	Average Annual Discharge at S-59 Structure (MGD)	Average TN Concentration at S-59 Structure (mg/l)	TN Load Discharged from East Lake Toho (lbs/yr)	Average TP Concentration at S-59 Structure (mg/l)	TP Load Discharged from East Lake Toho (lbs/yr)
1993	5.81	0.799	14,136	0.018	313
1994	25.34	0.804	62,069	0.022	1,659
1995	0.75	0.915	2,082	0.027	62
1996	0.03	0.789	77	0.022	2
1997	28.53	0.770	66,948	0.020	1,728
1998	40.72	0.800	99,188	0.029	3,577
1999	0.03	0.552	55	0.024	2
2000	0	0.730	9	0.027	0
2001	23.01	0.766	53,719	0.018	1,285
2002	37.07	0.671	75,708	0.016	1,849
2003	17.55	0.905	48,366	0.030	1,617
2004	22.14	0.693	46,715	0.026	1,724
2005	64.34	0.623	122,146	0.021	4,099
2006	0.02	0.675	47	0.020	1
2007	0	0.719	0	0.019	0
2008	7.62	0.840	19,516	0.024	557

6.0 Water Supply Options and Conceptual Estimates of Capital Costs

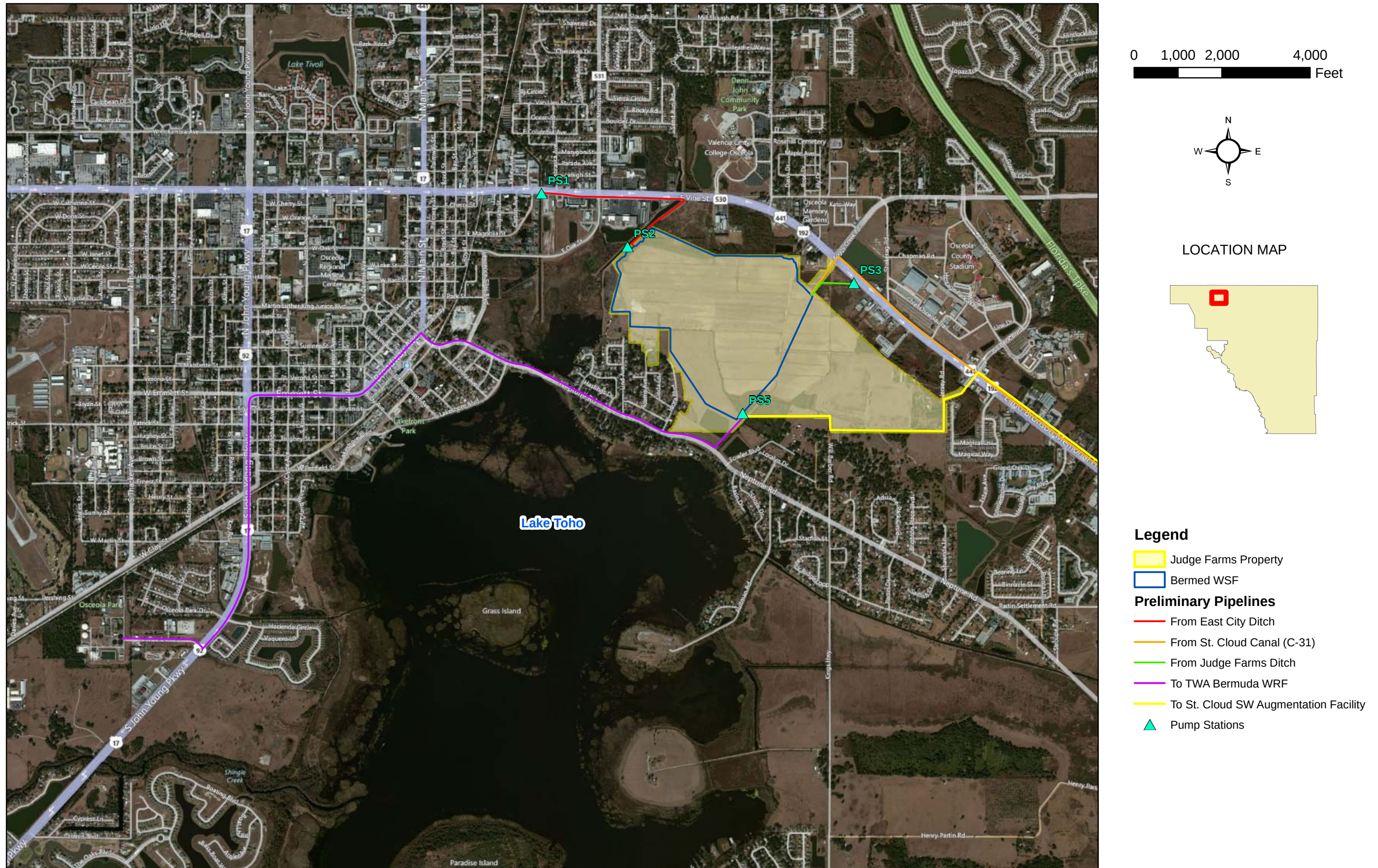
6.1 Development of Water Supply Options

An evaluation of possible water supply options have been developed and are presented in this section. The water supply options vary by raw water demand (10 mgd to 30 mgd), berm configuration (minimal and perimeter), and end use of the water (stormwater treatment, reuse augmentation, or combined). All options are based on utilizing the available footprint west of the proposed sports complex and rely on inflows from the three tributaries and/or East Lake Toho for the raw water source. For the purposes of this conceptual evaluation, the available supply from the water storage facility was evaluated as being divided equally for reuse augmentation between the City of St. Cloud and Toho Water Authority. Two alternative transmission routes—an East route and a West route—were considered for distributing raw water to the City of St. Cloud Lakeshore Stormwater Augmentation Facility site (**Figure 28**) and to the Toho Water Authority's South Bermuda Water Reclamation Facility (**Figure 29**), respectively. It is recommended that the existing pump station currently discharging flows from the Judge Farms Property to Lake Toho continue to remain in operation; however, the pump would only be used to convey emergency overflows from the water storage facility into Lake Toho.

There are several major assumptions, which are the primary drivers in developing the various options and the cost estimates summarized in **Table 14**, which accounts for a combined end-use of the facility to provide both stormwater treatment and reuse augmentation. The basis of the costs presented consisted of the following:

- A pump station (PS₁ on Figure 28) and pipeline would convey the water from East City Ditch to the water storage facility. The pump station would be sized for the peak design flow to be taken from East City Ditch, which was modeled at 15 cfs. This is equivalent to approximately 6,700 gallons per minute (gpm) of peak design flow into the water storage facility. The pipeline distance is about 0.9 miles and would be sized to convey the peak flow;
- A pump station (PS₂ on Figure 28) would pump water from Mill Slough into the water storage facility. The pump station would be sized for the peak design flow to be taken from Mill Slough, which was modeled at 30 cfs. This is equivalent to approximately 13,500 gpm of peak design flow into the water storage facility. This site can be designed to accommodate both pumped flows and gravity flows; however, a pump station would allow for more control of inflows (timing and rate) from Mill Slough, especially under dry conditions ;
- A pump station (PS₃ on Figure 28) would be located at the entrance of Judge Farms Ditch into the property. The pump station would be sized for the peak design flow to be taken from the ditch, which was modeled at approximately 5 cfs. This is equivalent to approximately 2,200 gpm of peak design flow into the water storage facility. The pipeline distance is about 0.2 miles and would be sized to convey the peak flow;
- A pump station (PS₄ on Figure 29) would be located at the intake of East Lake Toho. The pump station would be sized to withdraw from 10 mgd to 30 mgd of water from the Lake depending on the raw water demand option evaluated. The pipeline length to route the water from the Lake into the water storage facility along US-192 (Figure 28) is approximately 5.6 miles and sized to meet the range of flows withdrawn;

J:\6111-Kissimmee\84951 (Judge Farms)\GIS\MXD\Figure28 Pipeline Routing(11x17)-West.mxd 12-16-2011 kaveal



Aerial Imagery Source: Bing (2011)
CDM

Figure 28
Preliminary Pipeline Routing (West)
Judge Farms Water Storage Facility Project



Aerial Imagery Source: Bing (2011)

CDM

Figure 29
Preliminary Pipeline Routing (East)
Judge Farms Water Storage Facility Project

- A pump station (PS5 on Figure 28) would be located at the southern end of the property to pump the raw water from the storage facility to the two Stakeholders (City of St. Cloud and Toho Water Authority). The pump station would be sized to meet the maximum monthly flow, which is approximately twice the annual average flow rate (Table 1). This flow would then be distributed equally between the two Stakeholders referenced above;
- As previously discussed, the raw water will be delivered to the two Stakeholders via two alternative transmission routes. The eastern route distributing water to the City of St. Cloud Lakeshore Stormwater Augmentation Facility site (Figure 28) was sized to meet half of the available flow and is 6.7 miles long. Since Osceola County would be the ultimate owner of the ballfield complex, it is proposed to route the eastern pipeline segment along the south edge of the ballfield property boundary and connect to US-192. The western route distributing water to the Toho Water Authority's South Bermuda Water Reclamation Facility (Figure 29) was sized to meet half of the available flow and is 3.9 miles long; and
- The water storage facility would be used to store raw water. Two configurations were sized with varying areas and side water depths. The perimeter berm option consists of a 260 acre water storage facility with a 4 feet side water depth (SWD). Another surface water storage facility option with a minimal footprint consists of a 180 acre water storage facility with a 2 feet SWD. Both of these configurations were evaluated with an allowance for an additional 2 feet to account for berm height (freeboard), where applicable. Per cost estimating guidelines of the SJRWMD (SJ2010-SP4) and the USACE (1994), which are consistent with industry cost estimation guidelines, the water storage facility can be assumed to have an economic service life of 35 years for planning purposes.

6.2 Conceptual Estimates of Capital Costs

The estimate of probable total capital cost is summarized in Table 14 for a combined end-use of the facility (stormwater treatment and reuse augmentation). To calculate total capital costs, an additional 35 percent to 55 percent was applied to the construction costs to account for contingencies, non-construction capital costs, and mobilization/ demobilization. Per the scope of services, total capital costs do not include estimates for water treatment, operations and maintenance (O&M), proposed Judge Farms Property acquisition, potential wetlands mitigation, or hazardous material/soil remediation. For the minimal berm option, estimates of total capital cost range from \$45.9 million (10 mgd) to \$102.2 million (30 mgd). For the perimeter berm option, estimates of total capital cost range from \$46.6 million (10 mgd) to \$103.0 million (30 mgd). For both the minimal and perimeter configurations, the total capital cost ranges from approximately \$3M/mgd (30 mgd) to \$5M/mgd (10 mgd), which are on the low to typical end of the range when measured against the volume of alternative water supply provided. As summarized in the cost breakdown tables for the 55 percent total adjustment scenarios (Appendix C), the largest cost components for all options are the transmission and pumping costs. The cost for the water storage facility is relatively small when compared to transmission and pumping costs.

The total capital costs for construction of a water storage facility to provide stormwater treatment only (*i.e.*, inflow from the three tributaries to the water storage facility) are provided in **Table 15**. Conceptual construction costs include pumps for East City Ditch, Mill Slough, and Judge Farms Ditch; water storage facility; and conveyance from East City Ditch and Judge Farms Ditch to the water storage facility. To calculate total capital costs, an additional 35 percent to 55 percent was applied to the construction costs to account for contingencies, non-construction capital costs, and mobilization/demobilization. Individual

Table 14. Summary of Conceptual Capital Costs (Combined Stormwater Treatment and Reuse Augmentation)

Raw Water Demand	10 mgd			20 mgd			30 mgd		
Minimal Berm									
Subtotal of Construction Cost (\$ Millions) ¹	\$34.0M			\$52.5M			\$65.9M		
Adjustments to Capital Cost from Construction Cost (\$ Millions) ^{2,3}	35%	45%	55%	35%	45%	55%	35%	45%	55%
	\$11.9M	\$15.3M	\$18.7M	\$18.4M	\$23.7M	\$28.9M	\$23.1M	\$29.7M	\$36.2M
Total Capital Cost (\$ Millions) ⁴	\$45.9M	\$49.3M	\$52.7M	\$70.9M	\$76.2M	\$81.5M	\$89.0M	\$95.6M	\$102.2M
Perimeter Berm									
Subtotal of Construction Cost (\$ Millions) ¹	\$34.5M			\$53.1M			\$66.4M		
Adjustments to Capital Cost from Construction Cost (\$ Millions) ^{2,3}	35%	45%	55%	35%	45%	55%	35%	45%	55%
	\$12.1M	\$15.5M	\$19.0M	\$18.5M	\$23.9M	\$29.2M	\$23.2M	\$29.9M	\$36.5M
Total Capital Cost (\$ Millions) ⁴	\$46.6M	\$50.0M	\$53.5M	\$71.6M	\$76.9M	\$82.3M	\$89.7M	\$96.3M	\$103.0M
Notes:									
¹ Conceptual construction costs include pumps for East City Ditch, Mill Slough, Judge Farms Ditch, East Lake Toho, and high service pump station; water storage facility; conveyance from East City Ditch, Judge Farms Ditch, and East Lake Toho to water storage facility; conveyance to City of St. Cloud and TWA connection points.									
² Adjustments from construction cost to capital cost consist of: mobilization/demobilization and contingency (20%); non-construction capital cost consisting of planning, engineering, design, and construction services (15%).									
³ Adjustments from construction cost to capital cost consist of: mobilization/demobilization (5%); contingency (20 or 30%); non-construction capital cost consisting of planning, engineering, design, and construction services (20%).									
⁴ Costs do not include estimates for water treatment, operations and maintenance (O&M), proposed Judge Farms Property acquisition, potential wetlands mitigation, or hazardous material/soil remediation.									

Table 15. Summary of Conceptual Capital Costs (Stormwater Treatment)

	Minimal Berm			Perimeter Berm		
Subtotal of Construction Cost (\$ Millions) ¹	\$8.5M			\$9.0M		
Adjustments to Capital Cost from Construction Cost (\$ Millions) ^{2,3}	35% \$3.0M	45% \$3.8M	55% \$4.7M	35% \$3.2M	45% \$4.1M	55% \$5.0M
Total Capital Cost (\$ Millions) ⁴	\$11.5M	\$12.3M	\$13.2M	\$12.2M	\$13.1M	\$14.0M
Notes: ¹ Conceptual construction costs include pumps for East City Ditch, Mill Slough, and Judge Farms Ditch; water storage facility; and conveyance from East City Ditch and Judge Farms Ditch to water storage facility. Individual cost components are summarized in Table 17. ² Adjustments from construction cost to capital cost consist of: mobilization/demobilization and contingency (20%); non-construction capital cost consisting of planning, engineering, design, and construction services (15%). ³ Adjustments from construction cost to capital cost consist of: mobilization/demobilization (5%); contingency (20 or 30%); non-construction capital cost consisting of planning, engineering, design, and construction services (20%). ⁴ Costs do not include estimates for water treatment, O&M, proposed Judge Farms Property acquisition, potential wetlands mitigation, or hazardous material/soil remediation.						

Table 16. Summary of Conceptual Capital Costs (Reuse Augmentation)

Raw Water Demand	10 mgd			20 mgd			30 mgd		
Minimal Berm									
Subtotal of Construction Cost (\$ Millions) ¹	\$25.9M			\$44.4M			\$57.8M		
Adjustments to Capital Cost from Construction Cost (\$ Millions) ^{2,3}	35% \$9.0M	45% \$11.6M	55% \$14.2M	35% \$15.6M	45% \$20.0M	55% \$24.4M	35% \$20.2M	45% \$26.0M	55% \$31.8M
Total Capital Cost (\$ Millions) ⁴	\$34.9M	\$37.5M	\$40.1M	\$60.0M	\$64.4M	\$68.9M	\$78.0M	\$83.8M	\$89.6M
Perimeter Berm									
Subtotal of Construction Cost (\$ Millions) ¹	\$26.4M			\$44.9M			\$58.3M		
Adjustments to Capital Cost from Construction Cost (\$ Millions) ^{2,3}	35% \$9.2M	45% \$11.9M	55% \$14.5M	35% \$15.7M	45% \$20.2M	55% \$24.7M	35% \$20.4M	45% \$26.2M	55% \$32.1M
Total Capital Cost (\$ Millions) ⁴	\$35.6M	\$38.2M	\$40.9M	\$60.6M	\$65.1M	\$69.6M	\$78.7M	\$84.5M	\$90.4M
Notes:									
¹ Conceptual construction costs include pumps for East Lake Toho and high service pump station; water storage facility; conveyance from East Lake Toho to water storage facility; and conveyance from water storage facility to City of St. Cloud and TWA connection points. Individual cost components summarized in Table 18.									
² Adjustments from construction cost to capital cost consist of: mobilization/demobilization and contingency (20%); non-construction capital cost consisting of planning, engineering, design, and construction services (15%).									
³ Adjustments from construction cost to capital cost consist of: mobilization/demobilization (5%); contingency (20 or 30%); non-construction capital cost consisting of planning, engineering, design, and construction services (20%).									
³ Costs do not include estimates for water treatment, O&M, proposed Judge Farms Property acquisition, potential wetlands mitigation, or hazardous material/soil remediation.									

cost components are summarized in **Table 17**. Estimates of total capital cost range from \$11.5 million (minimal berm option) to \$14.0 million (perimeter berm option) for this end-use of the facility.

The total capital costs for construction of a water storage facility to provide reuse augmentation only (i.e., inflow from East Lake Toho to the water storage facility) are provided in **Table 16**. Conceptual construction costs include pumps for East Lake Toho and high service pump station; water storage facility; conveyance from East Lake Toho to the water storage facility; and conveyance from the water storage facility to the City of St. Cloud and TWA connection points. To calculate total capital costs, an additional 35 percent to 55 percent was applied to the construction costs to account for contingencies, non-construction capital costs, and mobilization/demobilization. Individual cost components are summarized in **Table 18**. For the minimal berm option, estimates of total capital cost range from \$34.9 million (10 mgd) to \$89.6 million (30 mgd). For the perimeter berm option, estimates of total capital cost range from \$35.6 million (10 mgd) to \$90.4 million (30 mgd).

The cost estimate for each water supply option is a conceptual cost and has been generated based primarily on unit prices presented in the *Water Supply Cost Estimation Study* developed by CDM for the South Florida Water Management District (2007) and other sources of construction data. In addition, the SJRWMD's conceptual planning level costing methodologies (Black & Veatch, 2008; Wycoff, 2010; and Water Supply Solutions, 2008 and 2009) were evaluated and utilized as appropriate for consistency. This desktop feasibility analysis uses conceptual cost data; therefore, the cost estimates provided should be refined prior to final selection and design.

As discussed above, the primary driver for this project is development of an alternative water supply for reuse augmentation; however, there is also a treatment and attenuation benefit associated with the project. Based on the conceptual capital costs and nutrient loading estimates previously provided, a summary of the cost of pollutant removal for the stormwater treatment and combined end-use scenarios is presented in **Table 19**.

Table 19. Cost per Pound of Pollutant Removed

Water Storage Facility Scenarios	Minimal Berm	Perimeter Berm
Stormwater Treatment		
TN Load Removal (lb/yr)	29,454	30,632
Cost per lb of TN Removed (\$/lb/yr)	\$390	\$457
TP Load Removal (lb/yr)	5,633	6,183
Cost per lb of TP Removed (\$/lb/yr)	\$2,042	\$2,264
Stormwater Treatment and Reuse Augmentation		
TN Load Removal (lb/yr)	58,720	71,294
Cost per lb of TN Removed (\$/lb/yr)	\$782	\$1,445
TP Load Removal (lb/yr)	6,329	7,684
Cost per lb of TP Removed (\$/lb/yr)	\$7,252	\$13,404

Table 17. Summary of Conceptual Capital Costs for Individual Components (Stormwater Treatment)

Component Description	Minimal Berm			Perimeter Berm		
Intake Pump Station East City Ditch (ECD)	\$2.1M			\$2.1M		
Intake Pump Station Mill Slough	\$4.2M			\$4.2M		
Intake Pump Station Judge Farms Ditch (JFD)	\$0.70M			\$0.70M		
Force Main from ECD Pump Station to Storage Facility (0.9 miles)	\$1.0M			\$1.0M		
Force Main from JFD Pump Station to Storage Facility (0.2 miles)	\$0.053M			\$0.053M		
Water Storage Facility (WSF)	\$0.39M			\$0.89M		
Subtotal of Construction Cost (\$ Millions) ¹	\$8.5M			\$9.0M		
Adjustments to Capital Cost from Construction Cost (\$ Millions) ^{2,3}	35% \$3.0M	45% \$3.8M	55% \$4.7M	35% \$3.2M	45% \$4.1M	55% \$5.0M
Total Capital Cost (\$ Millions) ⁴	\$11.5M	\$12.3M	\$13.2M	\$12.2M	\$13.1M	\$14.0M

Notes:

¹ Conceptual construction costs include pumps for East City Ditch, Mill Slough, and Judge Farms Ditch; water storage facility; and conveyance from East City Ditch and Judge Farms Ditch to water storage facility.

² Adjustments from construction cost to capital cost consist of: mobilization/demobilization and contingency (20%); non-construction capital cost consisting of planning, engineering, design, and construction services (15%).

³ Adjustments from construction cost to capital cost consist of: mobilization/demobilization (5%); contingency (20 or 30%); non-construction capital cost consisting of planning, engineering, design, and construction services (20%).

⁴ Costs do not include estimates for water treatment, operations and maintenance (O&M), proposed Judge Farms Property acquisition, potential wetlands mitigation, or hazardous material/soil remediation.

Table 18. Summary of Conceptual Capital Costs for Individual Components (Reuse Augmentation)

Raw Water Demand	10 mgd			20 mgd			30 mgd		
Minimal Berm									
Intake Pump Station E. Lake Toho	\$2.2M			\$4.4M			\$6.5M		
Force Main from E. Lk Toho Pump Station to Storage Facility (5.6 miles)	\$6.5M			\$10.6M			\$12.9M		
Raw Water Distribution--High Service Pump Station	\$4.6M			\$9.1M			\$13.7M		
Water Storage Facility	\$0.39M			\$0.39M			\$0.39M		
Pipeline from WSF to City of St. Cloud Delivery Point (6.7 miles)	\$7.7M			\$12.6M			\$15.4M		
Pipeline from WSF to TWA Delivery Point (3.9 miles)	\$4.5M			\$7.4M			\$8.9M		
Subtotal of Construction Cost (\$ Millions) ¹	\$25.9M			\$44.4M			\$57.8M		
Adjustments to Capital Cost from Construction Cost (\$ Millions) ^{2,3}	35% \$9.0M	45% \$11.6M	55% \$14.2M	35% \$15.6M	45% \$20.0M	55% \$24.4M	35% \$20.2M	45% \$26.0M	55% \$31.8M
Total Capital Cost (\$ Millions) ⁴	\$34.9M	\$37.5M	\$40.1M	\$60.0M	\$64.4M	\$68.9M	\$78.0M	\$83.8M	\$89.6M
Perimeter Berm									
Intake Pump Station E. Lake Toho	\$2.2M			\$4.4M			\$6.5M		
Force Main from E. Lk Toho Pump Station to Storage Facility (5.6 miles)	\$6.5M			\$10.6M			\$12.9M		
Raw Water Distribution--High Service Pump Station	\$4.6M			\$9.1M			\$13.7M		
Water Storage Facility	\$0.89M			\$0.89M			\$0.89M		
Pipeline from WSF to City of St. Cloud Delivery Point (6.7 miles)	\$7.7M			\$12.6M			\$15.4M		
Pipeline from WSF to TWA Delivery Point (3.9 miles)	\$4.5M			\$7.4M			\$8.9M		
Subtotal of Construction Cost (\$ Millions) ¹	\$26.4M			\$44.9M			\$58.3M		
Adjustments to Capital Cost from Construction Cost (\$ Millions) ^{2,3}	35% \$9.2M	45% \$11.9M	55% \$14.5M	35% \$15.7M	45% \$20.2M	55% \$24.7M	35% \$20.4M	45% \$26.2M	55% \$32.1M
Total Capital Cost (\$ Millions) ⁴	\$35.6M	\$38.2M	\$40.9M	\$60.6M	\$65.1M	\$69.6M	\$78.7M	\$84.5M	\$90.4M

Notes:

¹ Conceptual construction costs include pumps for East Lake Toho and high service pump station; water storage facility; conveyance from East Lake Toho to water storage facility; and conveyance from water storage facility to City of St. Cloud and TWA connection points.

² Adjustments from construction cost to capital cost consist of: mobilization/demobilization and contingency (20%); non-construction capital cost consisting of planning, engineering, design, and construction services (15%).

³ Adjustments from construction cost to capital cost consist of: mobilization/demobilization (5%); contingency (20 or 30%); non-construction capital cost consisting of planning, engineering, design, and construction services (20%).

⁴ Costs do not include estimates for water treatment, O&M, proposed Judge Farms Property acquisition, potential wetlands mitigation, or hazardous material/soil remediation.

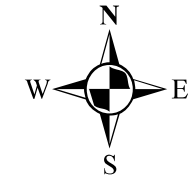
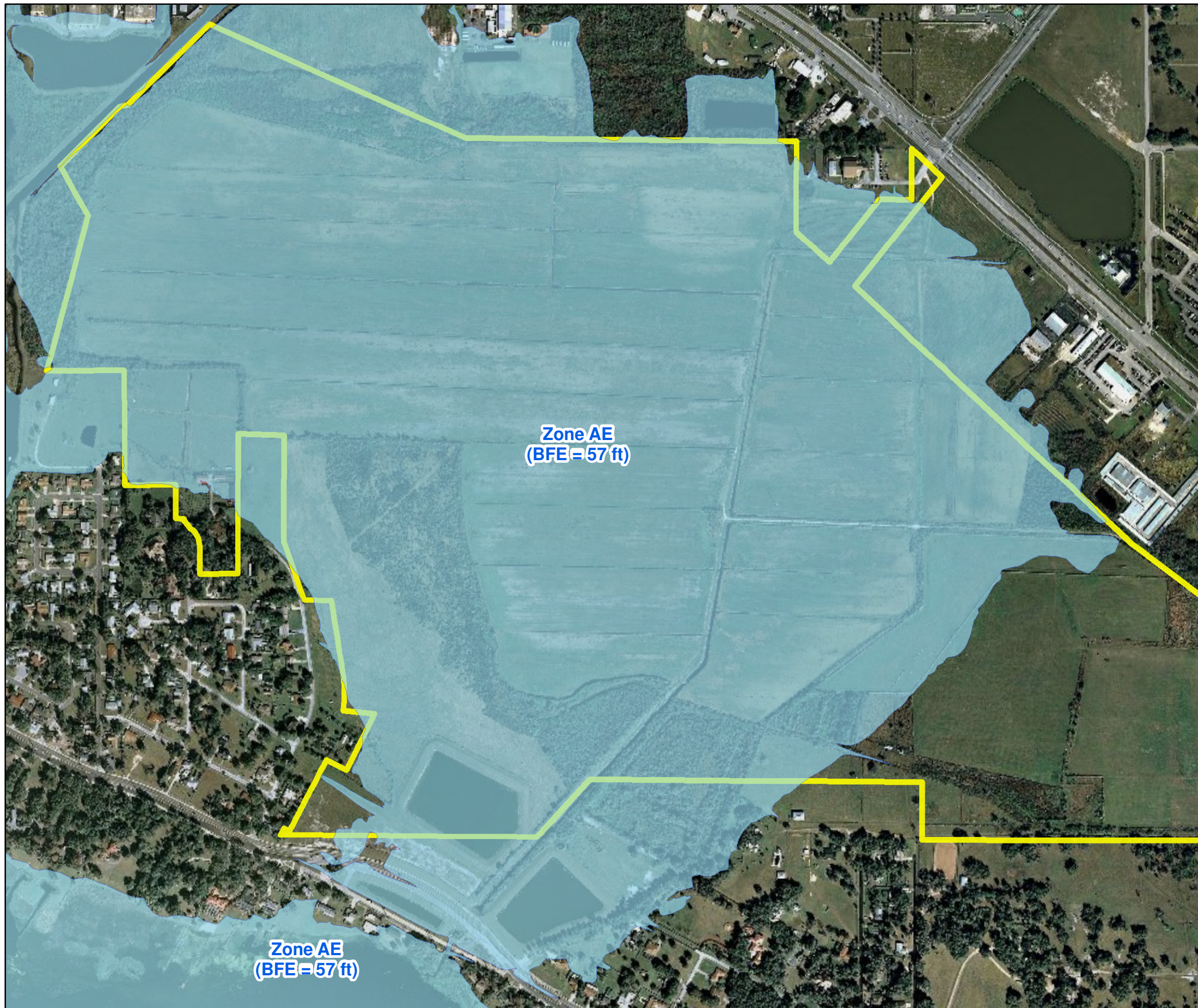
Depending on the end-use of the storage facility, the cost per pound per year of total nitrogen removal ranges from around \$400 to \$800 for the minimal berm option to \$500 to \$1,400 for the perimeter berm option. The cost per pound per year of total phosphorus removal ranges from around \$2,000 to \$7,000 for the minimal berm option to \$2,200 to \$13,000 for the perimeter berm option. There is a large variability in BMP performance to assign an average cost per lb per year of nutrient removal. Many factors including the incoming load, actual residence time, land acquisition and construction costs, O&M and overall design all play a role in determining the cost benefit of nutrient removal. Preliminary data compiled by FDEP for the purpose of evaluating wet detention ponds funded under the 319(h) grant program showed that nutrient removal ranged from \$72 to \$18,000/lb for TN and \$1,500 to \$34,000/lb for TP. Based on the estimated loads reductions and capital costs presented in Table 19, the costs per lb of nutrient removed appear to fall within the lower end of the ranges compiled by FDEP.

6.3 Limitations of the Analysis

This feasibility analysis is a preliminary desktop evaluation of water supply availability, conceptual design, and conceptual capital costs of this site for use as a water storage facility for raw water supply. There are several issues, which would need to be studied further in order to determine if the use of this site is truly feasible for this application. Some of the major siting issues include:

- 1) Location within the 100-year floodplain: Per **Figure 30**, the areal extents for the two proposed water storage facility configurations lie entirely within the 100-year floodplain for Lake Toho. This is a significant issue, which may require providing for compensating storage for the water storage facility outside the Lake Toho Basin;
- 2) Soils suitable for fill: The soils would need to be evaluated both for structural stability as well as suitability for fill. If the on-site soils are not suitable, then fill will have to be brought in from off-site, which will add even more cost to the storage facility. As an alternative, soils from the adjacent ballpark complex may be available for fill if found to meet suitability requirements; and
- 3) Seepage management: Groundwater seepage control should be further considered during the design of the storage facility. Modeling would have to be performed to evaluate the impact of seepage and mounded groundwater on the area around the property.

J:\6111-Kissimmee\84951 (Judge Farms)\GIS\mxd\FigureX Floodplain.mxd 01-25-2012 perneznbyj



0 300 600 1,200 Feet

Legend

-  100-Year Floodplain (Osceola County, 2012)
-  Judge Farms Property

Note: Map displays provisional floodplain boundaries supplied by Osceola County and are subject to FEMA review and revision.

7.0 Permitting and Environmental Considerations

The following permits will need to be obtained in support of construction and operation of the water storage facility:

- A Joint Application for an Environmental Resource Permit will be required for construction of the preferred storage facility and connection to waters of the state and the U.S. This application will be to FDEP, who will forward to the Army Corps of Engineers for review. If needed, this facility could provide stormwater treatment attenuation for the proposed Osceola County softball complex adjacent to the water storage facility;
- Both the City of St. Cloud and Toho Water Authority would have to modify their FDEP facility permits (Southside WWTP and Bermuda WRF) to accommodate the supplemental (surface water) sources and to permit their transmission pipelines and the water storage facility;
- A SFWMD Water Use Permit for the use of surface water from Mill Slough, East City Ditch, Judge Farms Ditch, and East Lake Toho via the C-31 Canal;
- Osceola County Building Department permits for facility structures and electrical service connections;
- Florida Department of Transportation (FDOT) and Osceola County Right-of-Way permits for construction of the transmission pipelines; and
- A SFWMD Right-of-Way Acquisition Permit for construction of the City of St. Cloud transmission pipeline along the C-31 Canal.

In siting the water storage facility options, the proposed layouts were recommended in order to minimize wetland impacts and T&E. Wetland mitigation may need to be provided for construction of the pump stations and transmission pipelines and determined during more detailed design of the facilities.

8.0 Summary

On behalf of the City of Kissimmee, City of St. Cloud, Osceola County, and the Toho Water Authority, CDM completed a preliminary evaluation of the feasibility of integrating the Judge Farms Property into an overall water resources plan to provide storage and treatment of surface waters. Surface water flows from East Lake Toho as well as surface water from three local tributaries (East City Ditch, Mill Slough, and the Judge Farms Ditch) were evaluated for the purpose of providing an alternative water supply for reuse augmentation purposes. The intent for this alternative water supply is to maximize reuse to the extent practicable in order to offset using potable water for irrigation by the Stakeholders. This will help extend the supply of groundwater for potable purposes for both TWA and the City of St. Cloud (recipients of the supplied water), which is very important since both utilities are located in the Central Florida Coordination Area and there are established limits on groundwater withdrawals.

Tasks performed in support of this preliminary feasibility analysis included data collection and analysis; field reconnaissance for hydrologic and environmental conditions; continuous modeling of flows in East City Ditch, Mill Slough, and Judge Farms Ditch; surface water storage facility site screening analysis; preparation of site configuration layouts; conceptual feasibility analysis; and preparation of estimates of probable conceptual capital costs.

The following summary and observations are provided in support of the evaluation performed.

- The property does not contain preferred habitat for wetland-dependent endangered or threatened wildlife species or species of special concern. No other wetland-dependent endangered or threatened wildlife species or species of special concern were observed on-site in recent field investigations and it has been determined that the potential use of the site by such species is minimal.
- Based on feedback from the Stakeholders, the site environmental assessment, existing surrounding land use, and the proposed Osceola County softball complex in the eastern part of the site, two potential water storage facility configurations were identified in the western part of the site.
 - The minimal berm option consists of 228 acre storage facility footprint with minimal perimeter berms west of Judge Farms Ditch and selected low areas around the remaining perimeter of the site; thereby using the existing topography to contain the stored surface water. For this alternative, fill would have to be placed along 6,730 feet of existing berm along the west side of Judge Farms Ditch to raise the top of berm elevation along the ditch to 52 feet NAVD to prevent co-mingling of the stored water with water in the ditch and fill in low areas around the perimeter of the storage facility footprint to elevation 52 feet NAVD to prevent stored water from flowing off-site. This alternative will provide for up to 754 acre-feet (246 million gallons) of live storage between the bottom of the storage facility (48 feet NAVD) and an elevation of 52 feet NAVD. The effective storage (from the bottom of the storage facility to the maximum operating water depth) is 335 acre-feet (109 million gallons).
 - The perimeter berm option consists of 259 acre storage facility footprint with more extensive, higher berms around the majority of the perimeter of the proposed storage facility. The eastern limit of the proposed storage facility crosses Judge Farms Ditch. The top of berm elevation would be 54 feet NAVD and provide for up to 1,305 acre-feet (425 million gallons) of live storage between the bottom of the storage facility (48 feet NAVD) and the top of berm. The effective storage (from the bottom of the storage facility to the maximum operating water depth) is 805 acre-feet (262 million gallons).
- In order to determine the flows and stages that would occur in the three urban tributaries (Mill Slough, East City Ditch, and Judge Farms Ditch) that will contribute to the proposed water storage facility, a SWMM of the channels and their contributing subcatchments was developed from 1990 to 2010 at a daily time step. This daily input of simulated flows from the tributaries was used as an inflow into the systems model.
- A dynamic systems model was developed from 1990 to 2010 using STELLA® software to assist in the water budget analysis as well as to conceptually size and evaluate the performance of the proposed water storage facility configurations. The conceptual water storage facility was represented in the systems model as a storage basin that receives inflows pumped from three tributaries (East City Ditch, Mill Slough, and Judge Farms Ditch), inflow pumped from East Lake Toho, and direct rainfall. The system loses water to free-surface evaporation and groundwater seepage. Two additional outflows from the water storage facility consisted of water supply releases and a discharge for emergency overflows to Lake Toho. The annual average demand for the reuse supply ranged from 10 to 30 mgd and was discretized into monthly values using

seasonally varying demand fractions specific to the net irrigation requirement for pasture grass in Osceola County (USDA, 1982).

- For the minimal berm option, the reliability of the supply ranges from 87 percent (30 mgd) to 92 percent (10 mgd) since there are some limited occurrences when supply is not sufficient to meet highest peak demands such as in April and May. The amount of inflow that the tributaries can contribute is limited since they are low flow, “flashy” systems. Inflows from East Lake Toho are needed to meet the vast majority of the demand. Without augmentation from East Lake Toho, this option would be able to reliably supply an annual average flow of 1 mgd approximately 90 percent of the time, while a higher flow of 3 mgd can be supplied approximately 69 percent of the time.
- For the perimeter berm option, the reliability of the supply ranges from 90 percent (30 mgd) to 95 percent (10 mgd) since there are some limited occurrences when supply is not sufficient to meet highest peak demands such as in May. Again, the amount of inflow that the tributaries can contribute is limited since they are low flow, “flashy” systems and inflows from East Lake Toho are needed to meet the vast majority of the demand. However, because the available storage is greater in this option due to the higher berms, the residence times are larger and hence inflows from East Lake Toho are initiated less often. These greater residence times will result in higher pollutant reduction benefits than for the minimal berm option. Without augmentation from East Lake Toho, this option would be able to reliably supply an annual average flow of 1 mgd approximately 100 percent of the time, while a higher flow of 5 mgd can be supplied approximately 77 percent of the time.
- The TN and TP load removals associated with a water storage facility at the Judge Farms Property were quantified for the two proposed configurations. To calculate the load reduction, two scenarios based on the potential future use of the site and possible phasing of implementation was considered. The first scenario considered the proposed storage facility for wet detention purposes only (*i.e.*, storage and treatment of surface water from the three tributaries), while the second scenario considered the facility at its optimal desired use (storage and treatment of surface waters for water supply purposes with augmentation from East Lake Toho).
 - As raw water demand increases within each berm option, the amount of nutrient removal is also increased, as there is a lesser probability of the water being released to Lake Toho. Similar to the wet detention scenario, the perimeter berm option provides more volume and, therefore, greater storage for alternative uses. This results in a greater nutrient load removal compared to the minimal berm option.
 - The comparison of the two scenarios (wet detention vs. water storage) also demonstrates the added nutrient load removal benefit of using the treated surface water for alternative uses. Under the wet detention scenario, the TN load removal ranges from 29,454 to 30,632 lbs/yr whereas TP removal ranges from 5,633 to 6,183 lbs/yr. Under the water storage facility option, TN load removal ranges from 58,720 to 71,294 lbs/yr whereas TP removal ranges from 6,329 to 7,684 lbs/yr. In the case of TN removal, the water storage facility scenario at a minimum doubles the load removal. TP removal is increased from 8 to 24 percent over the wet detention scenario.

- Conceptual estimates of capital cost were prepared for a combined end-use of the facility (stormwater treatment and reuse augmentation). The water supply options varied by raw water demand (10 mgd to 30 mgd) and berm configuration (minimal and perimeter). All options were based on utilizing the available footprint west of the proposed sports complex and relied on inflows from the three tributaries and East Lake Toho for the raw water source. As directed by the Stakeholders, the available supply from the water storage facility was evaluated as divided equally between the City of St. Cloud and Toho Water Authority. Two alternative transmission routes—an East route and a West route—were considered for distributing raw water to the City of St. Cloud Lakeshore Stormwater Augmentation Facility site and to the Toho Water Authority's South Bermuda Water Reclamation Facility, respectively. For the minimal berm option, estimates of total capital cost range from \$45.9 million (10 mgd) to \$102.2 million (30 mgd). For the perimeter berm option, estimates of total capital cost range from \$46.6 million (10 mgd) to \$103.0 million (30 mgd).
- Conceptual estimates of capital cost were prepared for construction of a water storage facility on the available footprint west of the proposed sports complex to provide stormwater treatment only (*i.e.*, inflow from the three tributaries to the water storage facility). Costs include pumps for East City Ditch, Mill Slough, and Judge Farms Ditch; water storage facility; and conveyance from East City Ditch and Judge Farms Ditch to the water storage facility. Estimates of total capital cost range from \$11.5 million (minimal berm option) to \$14.0 million (perimeter berm option) for this end-use of the facility.
- Conceptual estimates of capital cost were prepared for construction of a water storage facility on the available footprint west of the proposed sports complex to provide reuse augmentation only (*i.e.*, inflow from East Lake Toho to the water storage facility). Costs include pumps for East Lake Toho and high service pump station; water storage facility; conveyance from East Lake Toho to the water storage facility; and conveyance from the water storage facility to the City of St. Cloud and TWA connection points. For the minimal berm option, estimates of total capital cost range from \$34.9 million (10 mgd) to \$89.6 million (30 mgd). For the perimeter berm option, estimates of total capital cost range from \$35.6 million (10 mgd) to \$90.4 million (30 mgd).

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Appendix A

Field Reconnaissance Photographs



A-1. Judge Farms property (facing south)



A-2. Sod farm near southern end of Judge Farms property



A-3. East City Ditch south of US 192 (facing south)



A-4. Judge Farms Ditch near center of Judge Farms property



A-5. Lateral Ditch connecting to Judge Farms Ditch



A-6. Mill Slough (facing north toward US-192 bridge)



A-7. Twin pumps at southern end of Judge Farms Ditch



A-8. Lake Toho at Neptune Road (facing south)



A-9. Judge Farms Inlet Structure at Mill Slough



A-10. Wetland Mitigation Area (W. Side of Property)



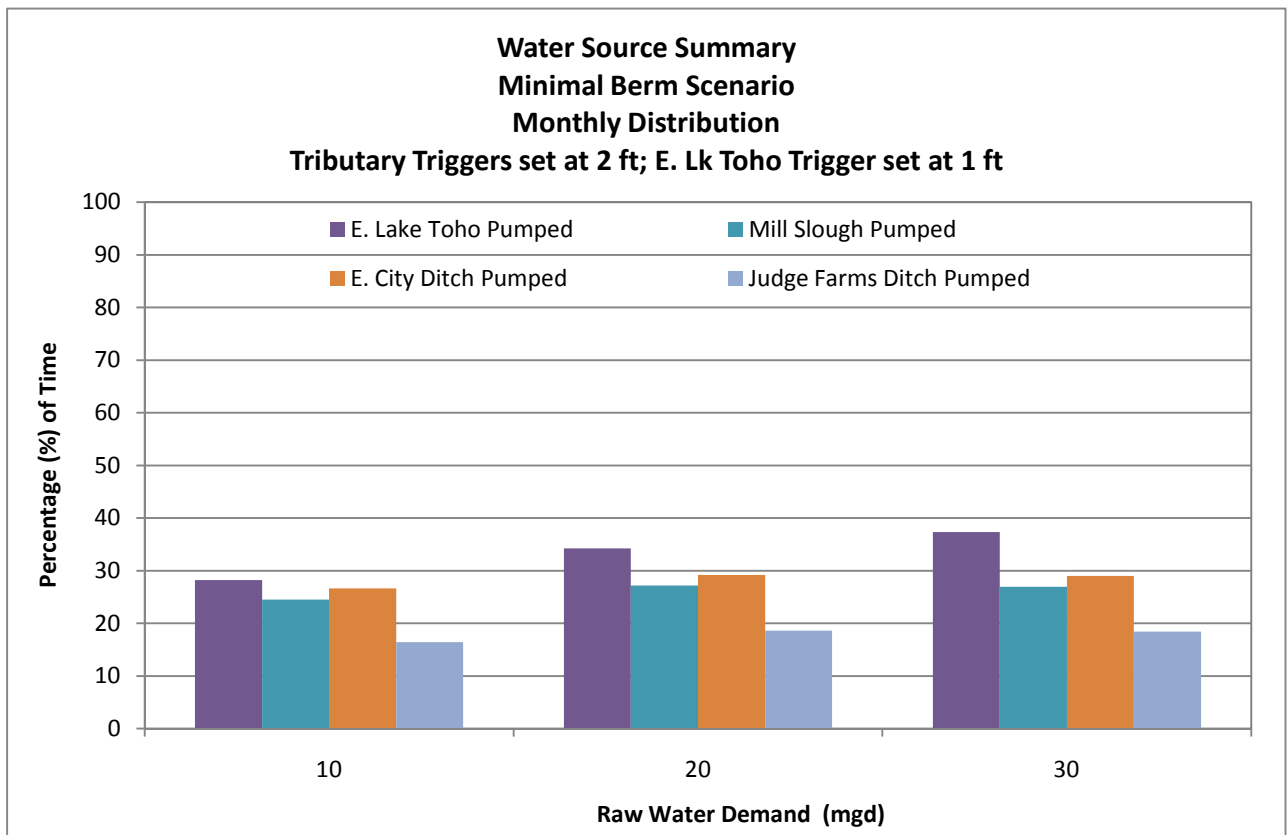
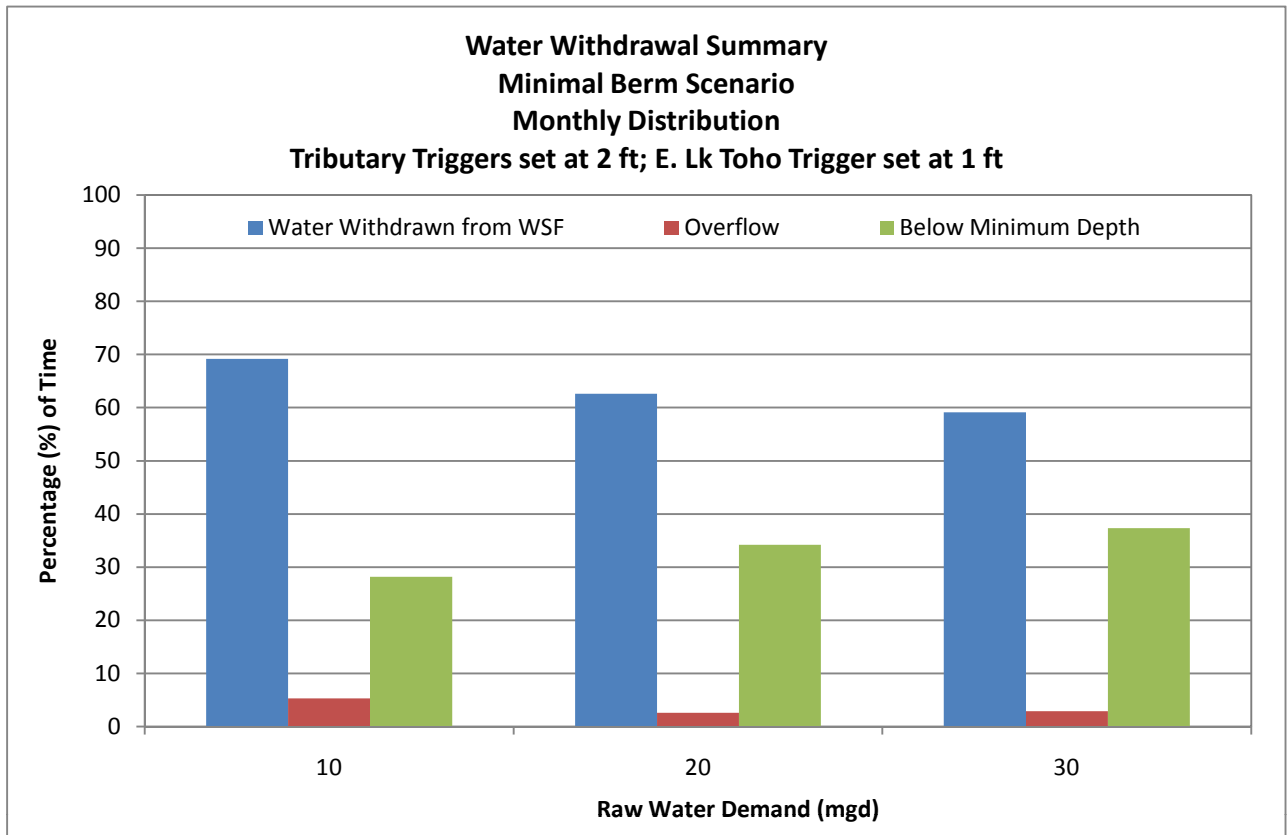
A-11. Wetland Mitigation Outlet Structure

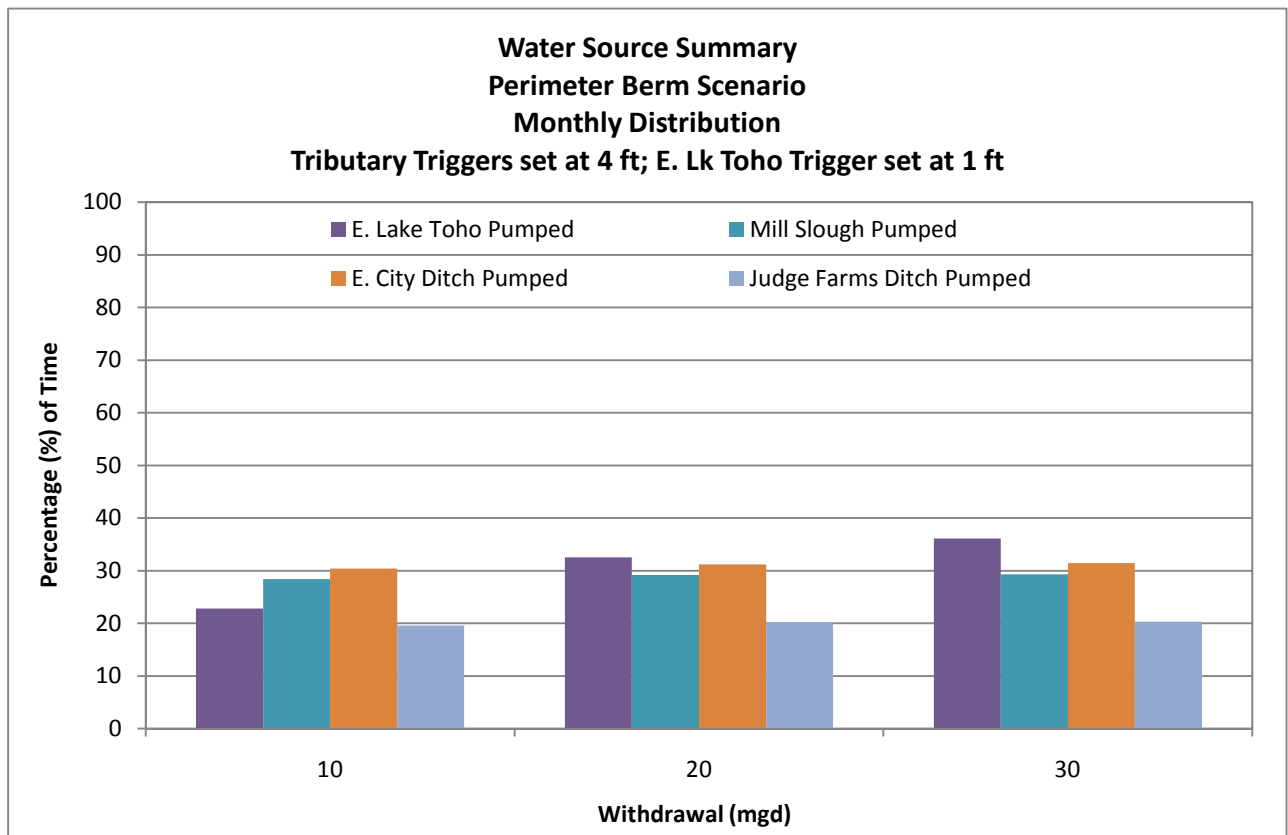
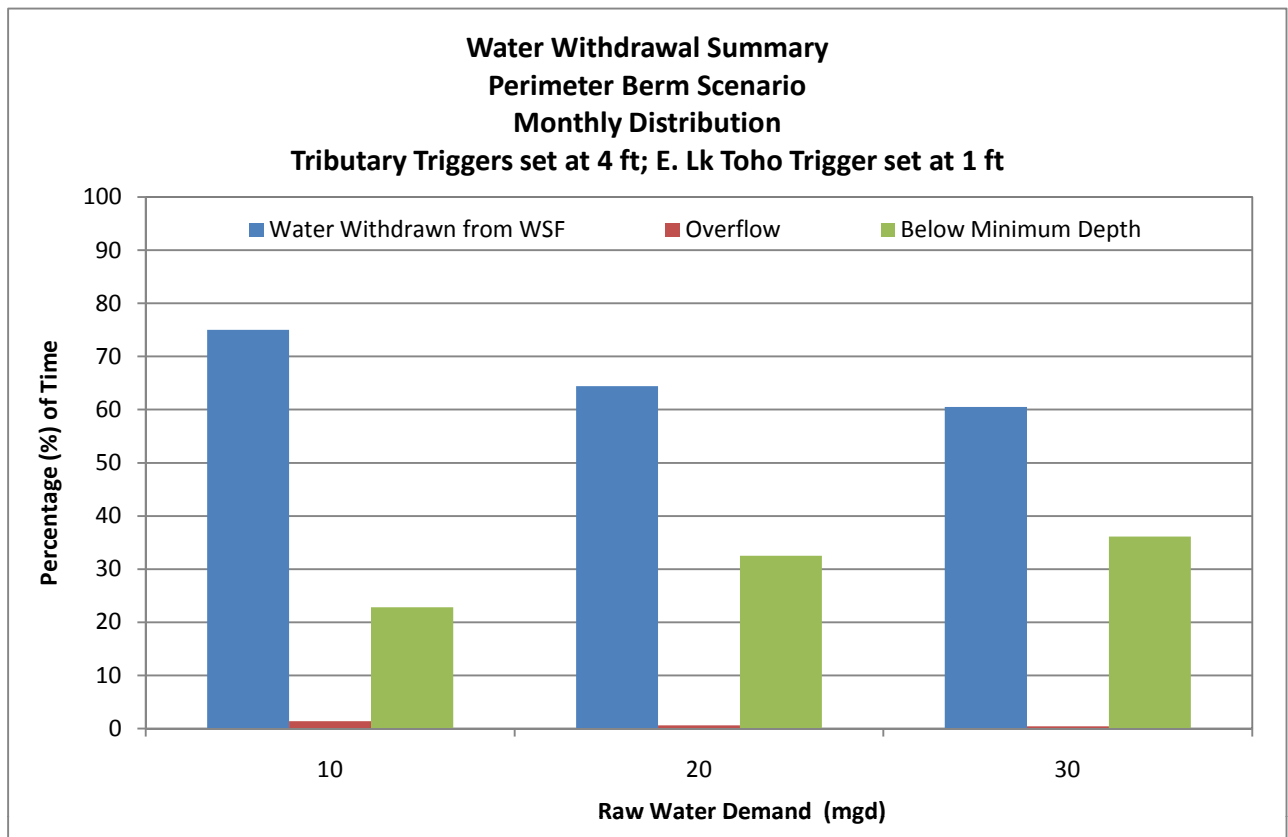


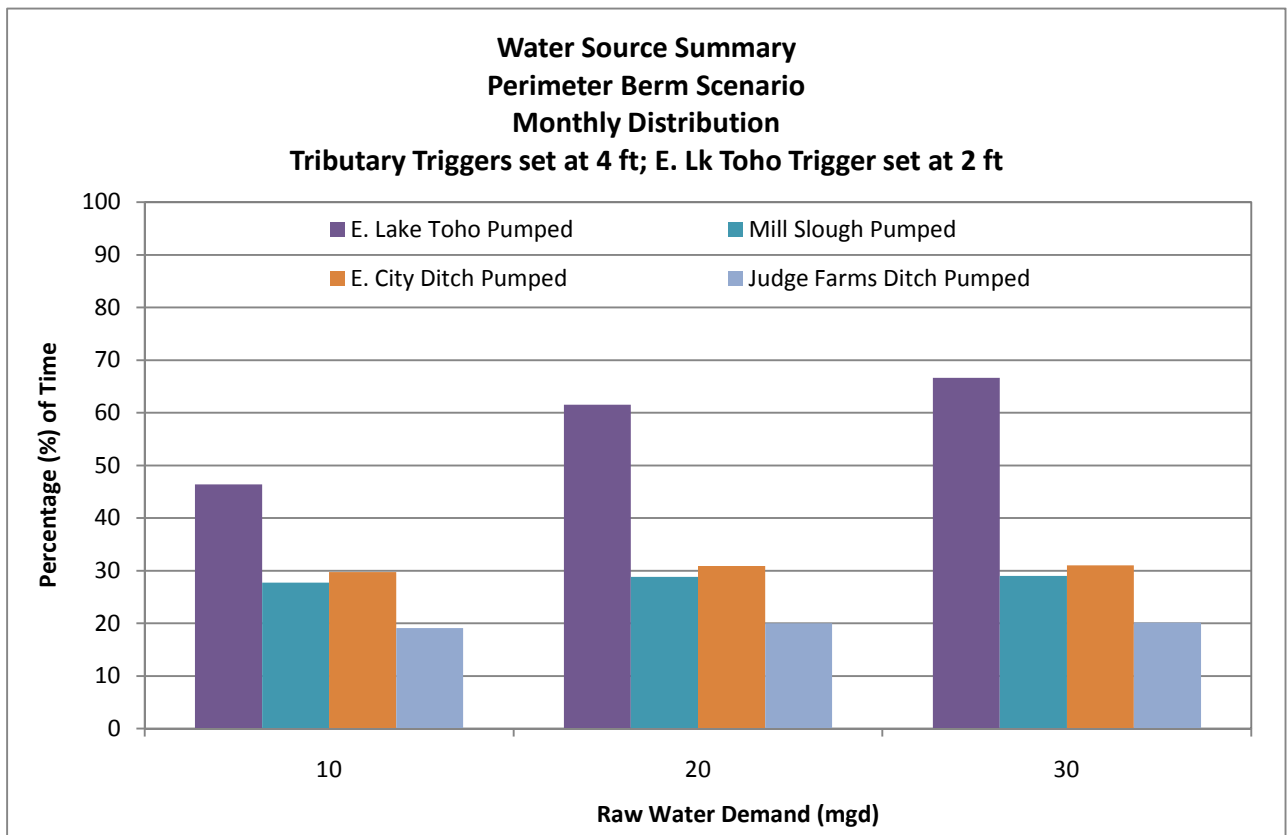
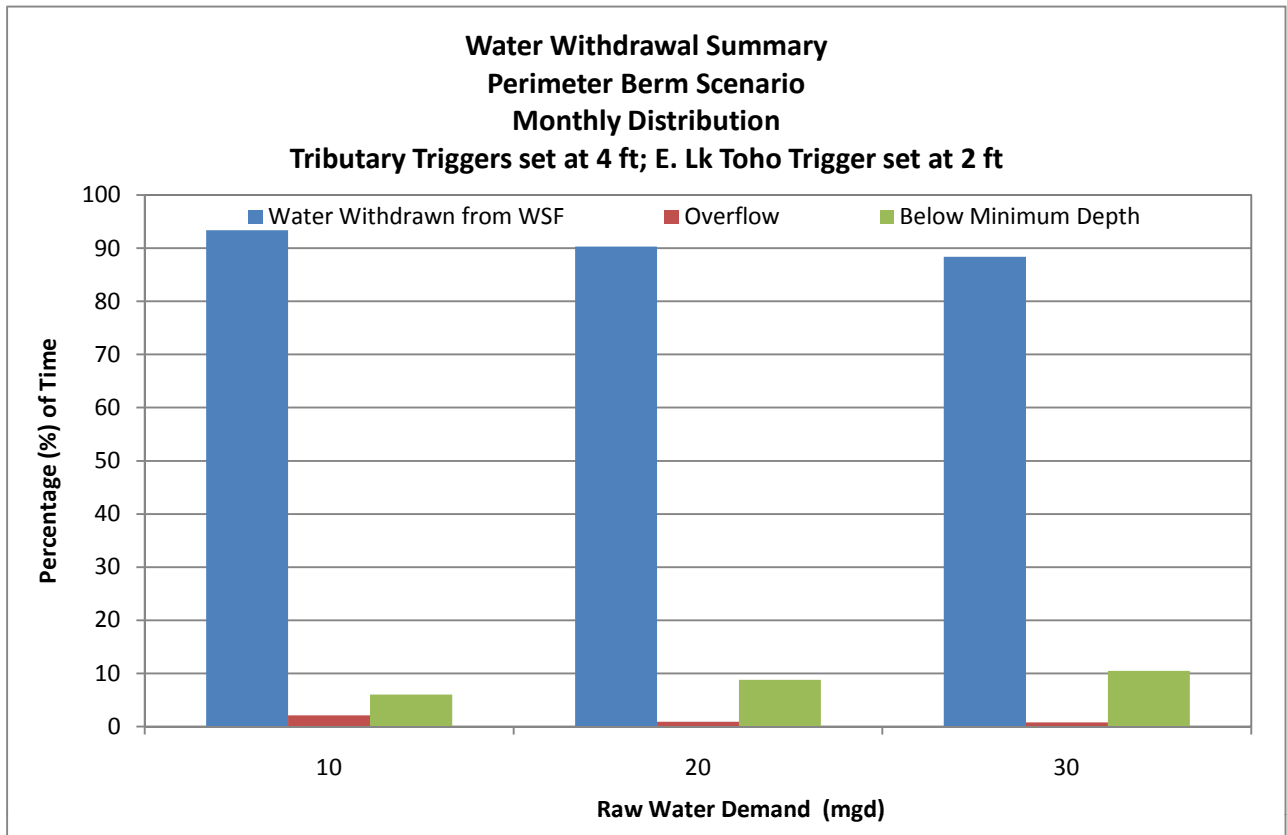
A-12. Wetland Mitigation Area Vegetation

Appendix B

Systems Model Sensitivity Analysis Results







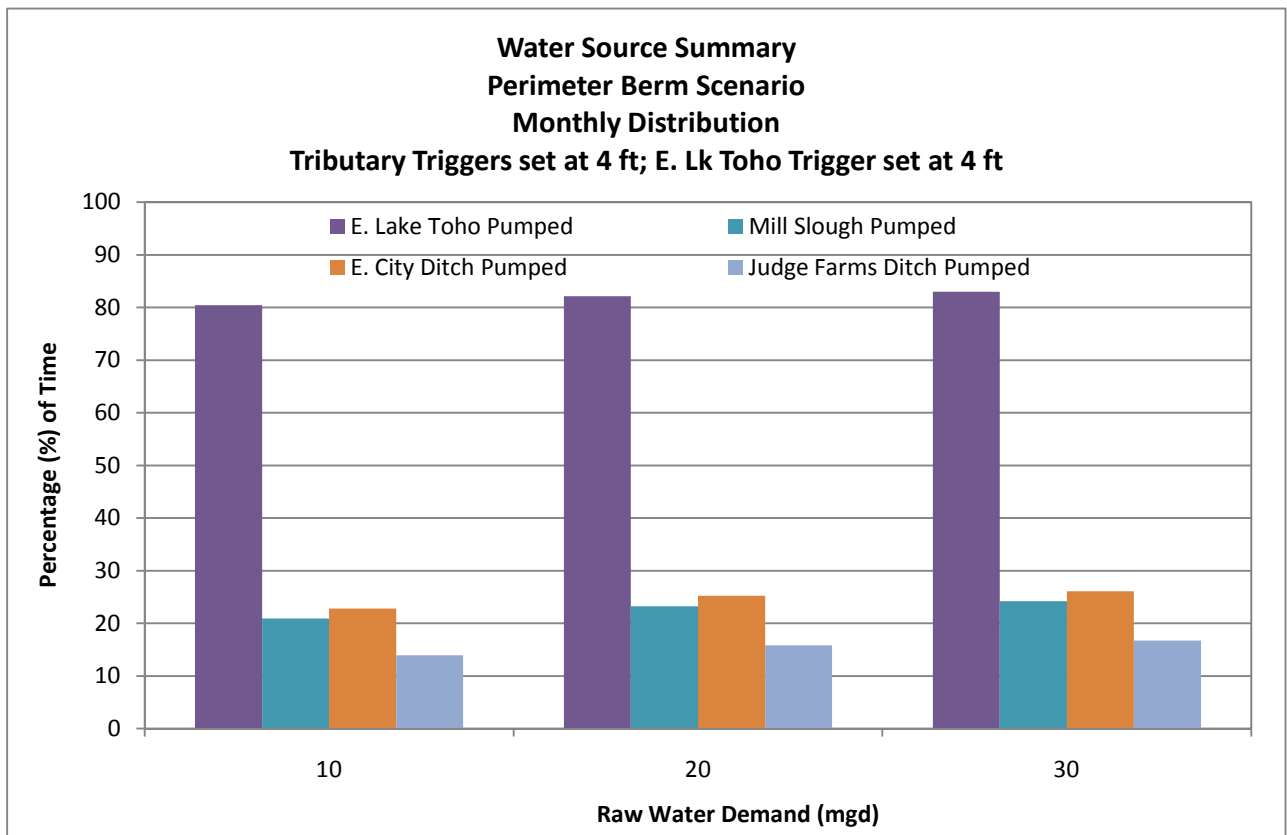
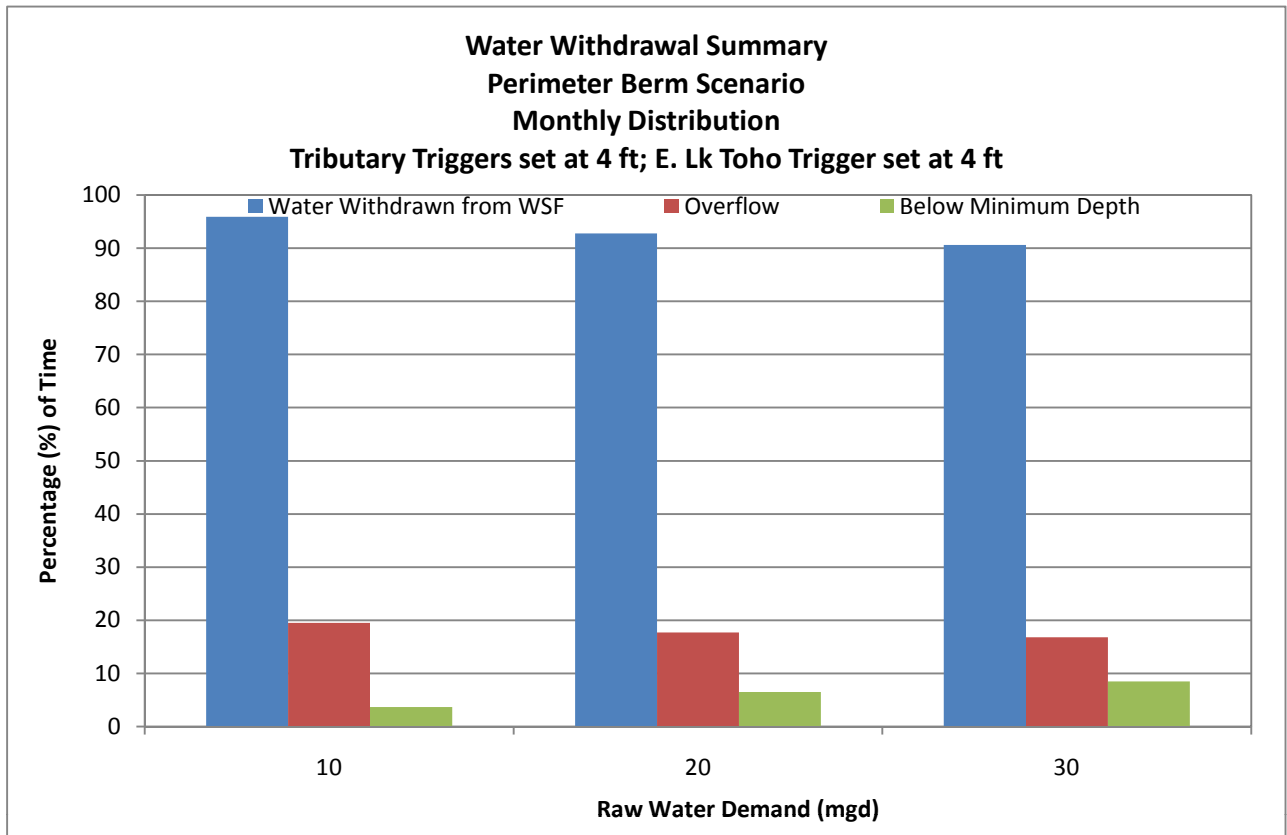


Table B-1. Systems Model Supplementary Results Summary

Systems Model Components		Minimal Berm Option ¹			Perimeter Berm Option ²			Perimeter Berm Option ³			Perimeter Berm Option ⁴		
Raw Water Demand		10 mgd	20 mgd	30 mgd	10 mgd	20 mgd	30 mgd	10 mgd	20 mgd	30 mgd	10 mgd	20 mgd	30 mgd
Average Inflows (mgd)	Rainfall	0.6	0.6	0.6	0.8	0.8	0.8	0.9	0.8	0.8	0.9	0.9	0.9
	Pump from E. City Ditch	1.3	1.5	1.4	1.5	1.6	1.6	0.3	1.6	1.6	1.1	1.2	1.3
	Pump from Mill Slough	2.5	2.8	2.8	3.0	3.1	3.1	1.5	3.0	3.1	2.1	2.4	2.5
	Pump from Judge Farms Ditch	0.2	0.2	0.2	0.3	0.3	0.3	4.6	0.3	0.3	0.2	0.2	0.2
	Pump from E. Lake Toho	2.8	6.8	11.2	2.3	6.5	10.8	8.9	12.3	20.0	8.0	16.4	24.9
	<i>Total Inflows</i>	<i>7.4</i>	<i>12.0</i>	<i>16.3</i>	<i>7.9</i>	<i>12.2</i>	<i>16.5</i>	<i>10.1</i>	<i>18.0</i>	<i>25.7</i>	<i>12.3</i>	<i>21.2</i>	<i>29.8</i>
Average Outflows (mgd)	Evaporation	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.8	0.8
	Seepage	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3
	Water Supply Releases	6.2	11.1	15.4	6.8	11.3	15.7	2.9	17.0	24.7	9.3	17.6	25.5
	Emergency Overflow	0.5	0.2	0.3	0.2	0.1	0.1	0.2	0.1	0.1	1.9	2.4	3.2
	<i>Total Outflows</i>	<i>7.4</i>	<i>12.0</i>	<i>16.3</i>	<i>7.9</i>	<i>12.2</i>	<i>16.6</i>	<i>10.1</i>	<i>18.0</i>	<i>25.7</i>	<i>12.3</i>	<i>21.2</i>	<i>29.8</i>
Average Residence Time (days)		52.3	49.8	47.1	67.7	64.7	62.0	62.2	52.0	48.8	53.2	40.4	36.3
% of Time Water Demand Supplied		69.2	62.6	59.1	75.0	64.4	60.5	93.4	90.3	88.4	95.9	92.8	90.6
% of Time Below Minimum Depth		28.2	34.2	37.3	22.8	32.5	36.1	6.0	8.8	10.5	3.7	6.5	8.5
% of Time Overflow		5.3	2.6	2.9	1.4	0.6	0.4	2.1	0.9	0.8	19.5	17.7	16.8
% Flows Withdrawn from E. City Ditch		26.6	29.2	29.0	30.4	31.2	31.4	29.7	30.9	31.0	22.8	25.2	26.1
% Flows Withdrawn from Mill Slough		24.5	27.2	26.9	28.4	29.2	29.3	27.7	28.8	29.0	20.9	23.2	24.2
% Flows Withdrawn from Judge Farms Ditch		16.4	18.6	18.4	19.6	20.2	20.3	19.1	20.0	20.1	13.9	15.8	16.7
% Flows Withdrawn from E. Lake Toho		28.2	34.2	37.3	22.8	32.5	36.1	46.4	61.5	66.6	80.4	82.1	83.0
Notes:													
¹ Trigger depths were set at 2 ft for the tributaries and 1 ft for E. Lake Toho withdrawals.													
² Trigger depths were set at 4 ft for the tributaries and 1 ft for E. Lake Toho withdrawals.													
³ Trigger depths were set at 4 ft for the tributaries and 2 ft for E. Lake Toho withdrawals.													
⁴ Trigger depths were set at 4 ft for the tributaries and 4 ft for E. Lake Toho withdrawals.													

Appendix C

Cost Estimate Tables

**Combined End-Use (Stormwater Treatment and Reuse Augmentation) of
the Water Storage Facility and 55 Percent Construction Cost Adjustment**

CONCEPTUAL COST ESTIMATE FOR JUDGE FARMS WATER SUPPLY COMPONENTS

MINIMAL BERM OPTION (10 MGD RAW WATER DEMAND)

	COMPONENT DESCRIPTION	CAPACITY			Pipe Size Inches	UNIT	QUANTITY	Unit Cost from Source	ENR Construction Cost Factor	PRICE/UNIT Adj. to December 2011	COMPONENT COST	COMMENTS/Source of Data
		CFS	MGD	GPM								
				Design								
	CAPITAL COSTS								9171.73			Costs are December 2011 ENR Index
	Intake Pump Station East City Ditch (ECD)	15	9.7	6,732		MGD	9.7	\$183,600	1.19	\$218,069	\$2,113,090	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Intake Pump Station Mill Slough	30	19.4	13,464		MGD	19.4	\$183,600	1.19	\$218,069	\$4,226,179	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Intake Pump Station Judge Farms Ditch (JFD)	5	3.2	2,244		MGD	3.2	\$183,600	1.19	\$218,069	\$704,363	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Intake Pump Station E. Lake Toho	15.5	10	6,947		MGD	10.0	\$183,600	1.19	\$218,069	\$2,180,691	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Force Main from ECD Pump Station to Storage Facility (0.9 miles)	15	9.7	6,732	24	LF	4752	\$184	1.19	\$219	\$1,041,489	SFWMD Table 10-3 \$184/LF for 24" pipe (urban setting) June 2006 ENR 7700
	Force Main from JFD Pump Station to Storage Facility (0.2 miles)	5	3.2	2,244	12	LF	1056	\$42	1.19	\$50	\$52,829	SFWMD Table 10-3 \$42/LF for 12" pipe (urban setting) June 2006 ENR 7700
	Force Main from E. Lk Toho Pump Station to Storage Facility (5.6 miles)	15.5	10	6,947	24	LF	29568	\$184	1.19	\$219	\$6,480,378	SFWMD Table 10-3 \$184/LF for 24" pipe (urban setting) June 2006 ENR 7700
	Raw Water Distribution--High Service Pump Station											
	Yield--Max Month											
	20.9	32.3	20.9	14,513		MGD	20.9	\$183,600	1.19	\$218,069	\$4,557,644	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Water Storage Facility										\$393,402	See Estimated Component Cost Breakdown for Water Storage Facility
	Pipeline for Water Supply From WSF to Delivery Point											
	East Route--6.7 miles--35,376 LF											
	Yield--Max Month											
	10.5	16.2	10.5	7256	24	LF	35376	\$184	1.19	\$219	\$7,753,309	SFWMD Table 10-3 \$184/LF for 24" pipe (urban setting) June 2006 ENR 7700
	West Route--3.9 miles--20,592 LF											
	Yield--Max Month											
	10.5	16.2	10.5	7256	24	LF	20592	\$184	1.19	\$219	\$4,513,120	SFWMD Table 10-3 \$184/LF for 24" pipe (urban setting) June 2006 ENR 7700

CONCEPTUAL COST ESTIMATE FOR JUDGE FARMS WATER SUPPLY COMPONENTS													
MINIMAL BERM OPTION (10 MGD RAW WATER DEMAND)													
COMPONENT DESCRIPTION		CAPACITY			Pipe Size	UNIT	QUANTITY	Unit Cost from Source	ENR Construction Cost Factor	PRICE/UNIT Adj. to December 2011	COMPONENT COST		COMMENTS/Source of Data
		CFS	MGD	GPM	Inches								
				Design									
ADJUSTMENTS TO CONSTRUCTION COST													
Mobilization/Demob--5%						EA	1		0.05				SJRWMD Eng Assistance in Updating Info on Water Supply--Publication SJ2008-SP10 Section 1.1.22
Contingencies						EA	1		0.30				SJRWMD Eng Assistance in Updating Info on Water Supply--Publication SJ2008-SP10 Section 1.1.22
Non-Construction Capital Costs						EA	1		0.20				SJRWMD Cost Estimating & Engineering Economy Training Presentation--March 2010
Total Adjustments to Construction Cost for Capital Cost									0.55				
Subtotal of Construction Costs											\$34,016,494		
Total Adjustments to Construction Cost for Capital Cost											\$18,709,072		
Sub Total Capital Cost											\$52,725,566		
Rounded Subtotal Capital Cost											\$52,700,000		

CONCEPTUAL COST ESTIMATE FOR JUDGE FARMS WATER SUPPLY COMPONENTS												
MINIMAL BERM OPTION (20 MGD RAW WATER DEMAND)												
	COMPONENT DESCRIPTION	CAPACITY			Pipe	UNIT	QUANTITY	Unit Cost from Source	ENR Construction Cost Factor	PRICE/UNIT Adj. to December 2011	COMPONENT COST	COMMENTS/Source of Data
		CFS	MGD	GPM Design	Size Inches							
CAPITAL COSTS									9171.73			Costs are December 2011 ENR Index
	Intake Pump Station E. City Ditch	15	9.7	6,732		MGD	9.7	\$183,600	1.19	\$218,069	\$2,113,090	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Intake Pump Station Mill Slough	30	19.4	13,464		MGD	19.4	\$183,600	1.19	\$218,069	\$4,226,179	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Intake Pump Station Judge Farms Ditch	5	3.2	2,244		MGD	3.2	\$183,600	1.19	\$218,069	\$704,363	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Intake Pump Station E. Lake Toho	31	20	13,895		MGD	20.0	\$183,600	1.19	\$218,069	\$4,361,382	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Force Main from ECD Pump Station to Storage Facility (0.9 miles)	15	9.7	6,732	24	LF	4752	\$184	1.19	\$219	\$1,041,489	SFWMD Table 10-3 \$184/LF for 24" pipe (urban setting) June 2006 ENR 7700
	Force Main from JFD Pump Station to Storage Facility (0.2 miles)	5	3.2	2,244	12	LF	1056	\$42	1.19	\$50	\$52,829	SFWMD Table 10-3 \$42/LF for 12" pipe (urban setting) June 2006 ENR 7700
	Force Main from E. Lk Toho Pump Station to Storage Facility (5.6 miles)	31	20	13,895	36	LF	29568	\$300	1.19	\$357	\$10,565,833	SFWMD Table 10-3 \$300/LF for 36" pipe (extrapolation based on urban setting) June 2006 ENR 7700
	Raw Water Distibution--High Service Pump Station											
	Yield--Max Month											
	41.8	64.7	41.8	29,026		MGD	41.8	\$183,600	1.19	\$218,069	\$9,115,289	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Water Storage Facility										\$393,402	See Estimated Component Cost Breakdown for Water Storage Facility
	Pipeline for Water Supply From WSF to Delivery Point											
	East Route--6.7 miles--35,376 LF											
	Yield--Max Month											
	20.9	32.3	20.9	14513	36	LF	35376	\$300	1.19	\$357	\$12,641,264	SFWMD Table 10-3 \$300/LF for 36" pipe (extrapolation based on urban setting) June 2006 ENR 7700
	West Route--3.9 miles--20,592 LF											
	Yield--Max Month											
	20.9	32.3	20.9	14513	36	LF	20592	\$300	1.19	\$357	\$7,358,348	SFWMD Table 10-3 \$300/LF for 36" pipe (extrapolation based on urban setting) June 2006 ENR 7700

[illegible]

CONCEPTUAL COST ESTIMATE FOR JUDGE FARMS WATER SUPPLY COMPONENTS												
MINIMAL BERM OPTION (30 MGD RAW WATER DEMAND)												
	COMPONENT DESCRIPTION	CAPACITY			Pipe Size	UNIT	QUANTITY	Unit Cost from Source	ENR Construction Cost Factor	PRICE/UNIT Adj. to December 2011	COMPONENT COST	COMMENTS/Source of Data
		CFS	MGD	GPM	Design Inches							
CAPITAL COSTS												
									9171.73			Costs are December 2011 ENR Index
	Intake Pump Station E. City Ditch	15	9.7	6,732		MGD	9.7	\$183,600	1.19	\$218,069	\$2,113,090	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Intake Pump Station Mill Slough	30	19.4	13,464		MGD	19.4	\$183,600	1.19	\$218,069	\$4,226,179	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Intake Pump Station Judge Farms Ditch	5	3.2	2,244		MGD	3.2	\$183,600	1.19	\$218,069	\$704,363	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Intake Pump Station E. Lake Toho	46	30	20,842		MGD	30.0	\$183,600	1.19	\$218,069	\$6,542,073	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Force Main from ECD Pump Station to Storage Facility (0.9 miles)	15	9.7	6,732	24	LF	4752	\$184	1.19	\$219	\$1,041,489	SFWMD Table 10-3 \$184/LF for 24" pipe (urban setting) June 2006 ENR 7700
	Force Main from JFD Pump Station to Storage Facility (0.2 miles)	5	3.2	2,244	12	LF	1056	\$42	1.19	\$50	\$52,829	SFWMD Table 10-3 \$42/LF for 12" pipe (urban setting) June 2006 ENR 7700
	Force Main from E. Lk Toho Pump Station to Storage Facility (5.6 miles)	46.4	30	20,842	42	LF	29568	\$365	1.19	\$435	\$12,855,097	SFWMD Table 10-3 \$365/LF for 42" pipe (extrapolation based on urban setting) June 2006 ENR 7700
	Raw Water Distribution--High Service Pump Station											
	Yield--Max Month											
	62.7	97.0	62.7	43,539		MGD	62.7	\$183,600	1.19	\$218,069	\$13,672,933	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Water Storage Facility										\$393,402	See Estimated Component Cost Breakdown for Water Storage Facility
	Pipeline for Water Supply From WSF to Delivery Point											
	East Route--6.7 miles--35,376 LF											
	Yield--Max Month											
	31.4	48.5	31.4	21769	42	LF	35376	\$365	1.19	\$435	\$15,380,205	SFWMD Table 10-3 \$365/LF for 42" pipe (extrapolation based on urban setting) June 2006 ENR 7700
	West Route--3.9 miles--20,592 LF											
	Yield--Max Month											
	31.4	48.5	31.4	21769	42	LF	20592	\$365	1.19	\$435	\$8,952,657	SFWMD Table 10-3 \$365/LF for 42" pipe (extrapolation based on urban setting) June 2006 ENR 7700

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CONCEPTUAL COST ESTIMATE FOR JUDGE FARMS WATER SUPPLY COMPONENTS												
PERIMETER BERM OPTION (10 MGD RAW WATER DEMAND)												
	COMPONENT DESCRIPTION	CAPACITY			Pipe	UNIT	QUANTITY	Unit Cost from Source	ENR Construction Cost Factor	PRICE/UNIT Adj. to December 2011	COMPONENT COST	COMMENTS/Source of Data
		CFS	MGD	GPM	Size							
				Design	Inches							
CAPITAL COSTS									9171.73			Costs are December 2011 ENR Index
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	Intake Pump Station Judge Farms Ditch	5	3.2	2,244		MGD	3.2	\$183,600	1.19	\$218,069	\$704,363	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Intake Pump Station E. Lake Toho	15.5	10	6,947		MGD	10.0	\$183,600	1.19	\$218,069	\$2,180,691	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Force Main from ECD Pump Station to Storage Facility (0.9 miles)	15	9.7	6,732	24	LF	4752	\$184	1.19	\$219	\$1,041,489	SFWMD Table 10-3 \$184/LF for 24" pipe (urban setting) June 2006 ENR 7700
	Force Main from JFD Pump Station to Storage Facility (0.2 miles)	5	3.2	2,244	12	LF	1056	\$42	1.19	\$50	\$52,829	SFWMD Table 10-3 \$42/LF for 12" pipe (urban setting) June 2006 ENR 7700
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	Yield--Max Month											
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	Water Storage Facility										\$885,166	See Estimated Component Cost Breakdown for Water Storage Facility
	Pipeline for Water Supply From WSF to Delivery Point											
	East Route--6.7 miles--35,376 LF											
	Yield--Max Month											
	10.5	16.2	10.5	7256	24	LF	35376	\$184	1.19	\$219	\$7,753,309	SFWMD Table 10-3 \$184/LF for 24" pipe (urban setting) June 2006 ENR 7700
	West Route--3.9 miles--20,592 LF											
	Yield--Max Month											
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[illegible]

CONCEPTUAL COST ESTIMATE FOR JUDGE FARMS WATER SUPPLY COMPONENTS												
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	Force Main from E. Lk Toho Pump Station to Storage Facility (5.6 miles)	31	20	13,895	36	LF	29568	\$300	1.19	\$357	\$10,565,833	SFWMD Table 10-3 \$300/LF for 36" pipe (extrapolation based on urban setting) June 2006 ENR 7700
	Raw Water Distribution--High Service Pump Station											
	Yield--Max Month											
	41.8	64.7	41.8	29,026		MGD	41.8	\$183,600	1.19	\$218,069	\$9,115,289	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Water Storage Facility										\$885,166	See Estimated Component Cost Breakdown for Water Storage Facility
	Pipeline for Water Supply From WSF to Delivery Point											
	East Route--6.7 miles--35,376 LF											
	Yield--Max Month											
	20.9	32.3	20.9	14513	36	LF	35376	\$300	1.19	\$357	\$12,641,264	SFWMD Table 10-3 \$300/LF for 36" pipe (extrapolation based on urban setting) June 2006 ENR 7700
	West Route--3.9 miles--20,592 LF											
	Yield--Max Month											
	20.9	32.3	20.9	14513	36	LF	20592	\$300	1.19	\$357	\$7,358,348	SFWMD Table 10-3 \$300/LF for 36" pipe (extrapolation based on urban setting) June 2006 ENR 7700

CONCEPTUAL COST ESTIMATE FOR JUDGE FARMS WATER SUPPLY COMPONENTS												
PERIMETER BERM OPTION (30 MGD RAW WATER DEMAND)												
	COMPONENT DESCRIPTION	CAPACITY			Pipe Size	UNIT	QUANTITY	Unit Cost from Source	ENR Construction Cost Factor	PRICE/UNIT Adj. to December 2011	COMPONENT COST	COMMENTS/Source of Data
		CFS	MGD	GPM	Inches							
				Design								
CAPITAL COSTS									9171.73			Costs are December 2011 ENR Index
	Intake Pump Station E. City Ditch	15	9.7	6,732		MGD	9.7	\$183,600	1.19	\$218,069	\$2,113,090	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Intake Pump Station Mill Slough	30	19.4	13,464		MGD	19.4	\$183,600	1.19	\$218,069	\$4,226,179	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Intake Pump Station Judge Farms Ditch	5	3.2	2,244		MGD	3.2	\$183,600	1.19	\$218,069	\$704,363	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Intake Pump Station E. Lake Toho	46	30	20,842		MGD	30.0	\$183,600	1.19	\$218,069	\$6,542,073	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Force Main from ECD Pump Station to Storage Facility (0.9 miles)	15	9.7	6,732	24	LF	4752	\$184	1.19	\$219	\$1,041,489	SFWMD Table 10-3 \$184/LF for 24" pipe (urban setting) June 2006 ENR 7700
	Force Main from JFD Pump Station to Storage Facility (0.2 miles)	5	3.2	2,244	12	LF	1056	\$42	1.19	\$50	\$52,829	SFWMD Table 10-3 \$42/LF for 12" pipe (urban setting) June 2006 ENR 7700
	Force Main from E. Lk Toho Pump Station to Storage Facility (5.6 miles)	46.4	30	20,842	42	LF	29568	\$365	1.19	\$435	\$12,855,097	SFWMD Table 10-3 \$365/LF for 42" pipe (extrapolation based on urban setting) June 2006 ENR 7700
	Raw Water Distribution--High Service Pump Station											
	Yield--Max Month											
	62.7	97.0	62.7	43,539		MGD	62.7	\$183,600	1.19	\$218,069	\$13,672,933	SFWMD Table 5-12A \$918,000/5 MGD August 2006 ENR 7722
	Water Storage Facility										\$885,166	See Estimated Component Cost Breakdown for Water Storage Facility
	Pipeline for Water Supply From WSF to Delivery Point											
	East Route--6.7 miles--35,376 LF											
	Yield--Max Month											
	31.4	48.5	31.4	21769	42	LF	35376	\$365	1.19	\$435	\$15,380,205	SFWMD Table 10-3 \$365/LF for 42" pipe (extrapolation based on urban setting) June 2006 ENR 7700
	West Route--3.9 miles--20,592 LF											
	Yield--Max Month											
	31.4	48.5	31.4	21769	42	LF	20592	\$365	1.19	\$435	\$8,952,657	SFWMD Table 10-3 \$365/LF for 42" pipe (extrapolation based on urban setting) June 2006 ENR 7700

[illegible]

Osceola County, FL
Judge Farms Water Storage Facility
Opinion of Probable Construction Cost, December 2011
Concept Design for Water Storage Facility (Minimal Berm Option)

Project name Judge Farms Water Storage

Estimator Rowe

Labor rate table FL 11 Labor Template

Equipment rate table 00 11 Equip Rate

Project

Estimate Type OPCC

Design Level Concept

ENR 20 City CCI: Dec. 2011:9171.73

Notes This is an Opinion of Probable Construction Cost only, as defined by the documents provided at the level of design indicated above. CDM has no control over the cost of labor, materials, equipment, or services furnished, over schedules, over contractor's methods of determining prices, competitive bidding (at least 3 each - both prime bidders and major subcontractors), market conditions or negotiating terms. CDM does not guarantee that this opinion will not vary from actual cost, or contractor's bids. There are not any costs provided for: Change Orders, Design Engineering, Construction Oversight, Client Costs, Finance or Funding Costs, Legal Fees, Land Acquisition or temporary/permanent Easements, Operations, or any other costs associated with this project that are not specifically part of the bidding contractor's proposed scope. Assumptions: No rock excavation is required. Only nominal dewatering is needed. No consideration for contaminated soils or hazardous materials is included (i.e. asbestos, lead, etc). Based on a normal 40 hour work week with no overtime.

Report format Sorted by 'Area/95CSI Sctn/Element'

'Detail' summary

Allocate addons

Combine items



Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
05 Site Work								
02300 Earthwork								
05.02300.3100 Dewater Berm Area	3.50 wk	6,309	560		548		2,118.99 /wk	\$ 7,416
05.02300.3105 Demuck Berm Area (2' Deep X 28' Wide)	10,644.00 cy	14,837			26,616		3.89 /cy	\$ 41,453
05.02300.3110 Strip Borrow Area 6" Thick (15 Acres)	12,100.00 cy	14,920			41,621		4.67 /cy	\$ 56,540
05.02300.3115 Back Haul Fill from Borrow Area	27,427.00 cy	25,872			52,727		2.87 /cy	\$ 78,599
05.02300.3120 Construct 2' High Berm	5,132.00 lf	22,180			30,732		10.31 /lf	\$ 52,912
05.02300.3125 Dewatering Borrow Area	3.50 wk	6,309	559		548		2,118.99 /wk	\$ 7,416
05.02300.3130 Seed & Mulch Berm and Pond Slopes	35,000.00 sf			2,450			0.07 /sf	\$ 2,450
		90,426	1,119	2,450	152,792			\$ 246,787
02600 Drainage & Containment								
05.02600.3110 Stilling Well	1.00 ea	820	1,365	2	4	108	2,298.56 /ea	\$ 2,299
05.02600.3115 Hardened Influent Area	208.00 tn	482	13,291	2,080	192		77.14 /tn	\$ 16,045
		1,302	14,656	2,082	195	108		\$ 18,343
02700 Base/Ballast/Pavements & Appurtenances								
05.02700.3105 6" Limerock Base (10' Wide on Top of Berm)	5,702.00 sy	2,591	43,377	29,621	3,508		13.87 /sy	\$ 79,096
		2,591	43,377	29,621	3,508			\$ 79,096
03000 Concrete								
05.03000.3105 Emergency Spillway (6' Reinforced Concrete 30' Long)	870.00 sf	3,692	5,611	168	40	35	10.97 /sf	\$ 9,546
05.03000.3110 Skimmer at Emergency Spillway	1.00 ea	226	1,174		133		1,533.41 /ea	\$ 1,533
05.03000.3115 Collection Sump (50' X 50' X 2')	2,500.00 sf	15,227	18,070	533	1,657	1,191	14.67 /sf	\$ 36,677
05.03000.3120 Dewater Collection Sump & Spillway	2.00 wk	918	480		21		709.58 /wk	\$ 1,419
		20,063	25,335	702	1,851	1,225		\$ 49,175
	1.00 LS	114,382	84,487	34,855	158,345	1,333	393,401.84 /LS	\$ 393,402

Osceola County, FL
Judge Farms Water Storage Facility
Opinion of Probable Construction Cost, December 2011
Concept Design for Water Storage Facility (Perimeter Berm Option)

Project name	Judge Farms Water Storage
Estimator	Rowe
Labor rate table	FL 11 Labor Orlando
Equipment rate table	00 11 Equip Rate
Project	Pump Station Rehab
Estimate Type	OPCC
Design Level	Concept
ENR 20 City CCI:	Dec. 2011:9171.73
Notes	This is an Opinion of Probable Construction Cost only, as defined by the documents provided at the level of design indicated above. CDM has no control over the cost of labor, materials, equipment, or services furnished, over schedules, over contractor's methods of determining prices, competitive bidding (at least 3 each - both prime bidders and major subcontractors), market conditions or negotiating terms. CDM does not guarantee that this opinion will not vary from actual cost, or contractor's bids. There are not any costs provided for: Change Orders, Design Engineering, Construction Oversight, Client Costs, Finance or Funding Costs, Legal Fees, Land Acquisition or temporary/permanent Easements, Operations, or any other costs associated with this project that are not specifically part of the bidding contractor's proposed scope. Assumptions: No rock excavation is required. Only nominal dewatering is needed. No consideration for contaminated soils or hazardous materials is included (i.e. asbestos, lead, etc). Based on a normal 40 hour work week with no overtime.
Report format	Sorted by 'Area/95CSI Sctn/Element' 'Detail' summary Allocate addons

		Spreadsheet Level	Takeoff Quantity	Labor Amount	Material Amount	Sub Amount	Equip Amount	Other Amount	Total Cost/Unit	Total Amount
05 Site Work										
	02300 Earthwork									
		05.02300.3100 Dewatering Muck Excavation	10.00 wk	20,467	906		1,551		2,292.41 /wtk	\$ 22,924
		05.02300.3105 Demuck Berm Area (2' Deep X 28' Wide)	30,126.00 cy	40,744			70,861		3.71 /cy	\$ 111,605
		05.02300.3110 Strip Borrow Area 6" Thick (50 Acres)	40,333.00 cy	49,755			135,853		4.60 /cy	\$ 185,608
		05.02300.3115 Back Haul Fill from Borrow Area	79,027.00 cy	73,406			147,078		2.79 /cy	\$ 220,484
		05.02300.3120 Construct 2' High Berm	14,525.00 lf	63,083			86,180		10.28 /lf	\$ 149,264
		05.02300.3125 Dewatering Borrow Area	10.00 wk	20,467	906		1,551		2,292.41 /wtk	\$ 22,924
		05.02300.3130 Seed & Mulch Berm and Pond Slopes	99,225.00 sf			6,946			0.07 /sf	\$ 6,946
		02300 Earthwork		267,924	1,811	6,946	443,074			\$ 719,755
	02600 Drainage & Containment									
		05.02600.3110 Stilling Well	1.00 ea	925	1,365	2	4	108	2,403.47 /ea	\$ 2,403
		05.02600.3115 Hardened Influent Area	208.00 tn	482	13,291	2,080	192		77.14 /tn	\$ 16,045
		02600 Drainage & Containment		1,407	14,656	2,082	195	108		\$ 18,448
	02700 Base/Ballast/Pavements & Appurtenances									
		05.02700.3105 6" Limerock Base (10' Wide on Top of Berm)	16,139.00 sy	2,544	54,547	37,249	3,444		6.06 /sy	\$ 97,784
		02700 Base/Ballast/Pavements & Appurtenances		2,544	54,547	37,249	3,444			\$ 97,784
	03000 Concrete									
		05.03000.3105 Emergency Spillway (6' Reinforced Concrete 30' Long)	870.00 sf	3,658	5,616	168	43	41	10.95 /sf	\$ 9,527
		05.03000.3110 Skimmer at Emergency Spillway	1.00 ea	233	1,174		133		1,540.23 /ea	\$ 1,540
		05.03000.3115 Collection Sump (50' X 50' X 2')	2,500.00 sf	15,140	18,085	533	1,665	1,214	14.66 /sf	\$ 36,638
		05.03000.3120 Dewater Collection Sump & Spillway	1.00 ls	974	480		21		1,474.92 /ls	\$ 1,475
		03000 Concrete		20,006	25,355	702	1,862	1,255		\$ 49,180
	05 Site Work		1.00 LS	291,880	96,369	46,979	448,575	1,363	885,166.34 /LS	\$ 885,166



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