

City of Haines City

# Integrated “1Water” Approach to Restore Beautiful Lake Eva

Bryan T. Veith, P.E., F.ASCE

January 17, 2019

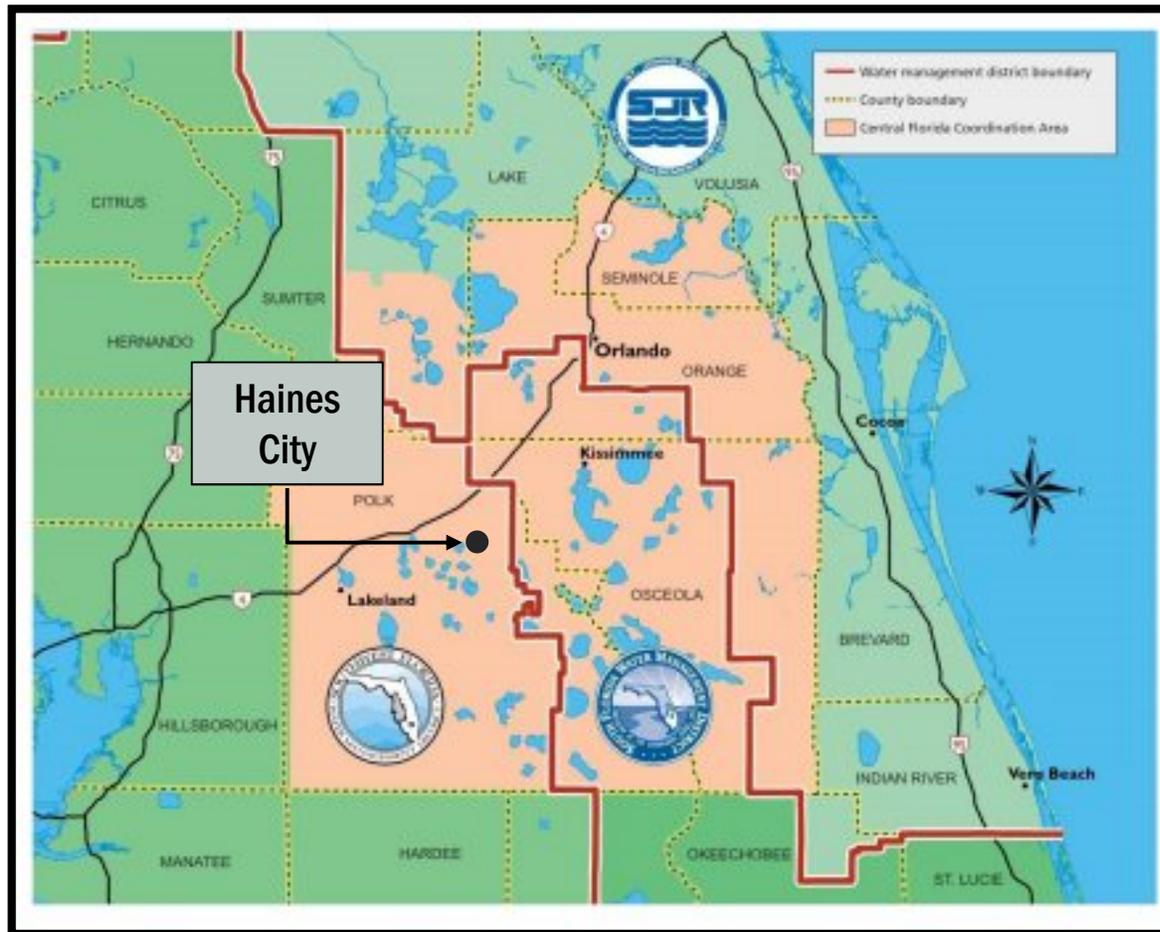


# Agenda

1. Project Need
2. The City's Vision
3. Project Benefits
4. City's Partners and Stakeholders
5. Project Objectives
6. 1Water Approach
7. H&H Modeling
8. Lake Existing Conditions Assessment
9. Conclusions and Next Steps



# Central Florida Water Initiative



- Five County Area
- Traditional Groundwater Sources Will Not Meet Estimated Demand w/o Adverse Impacts
- Most of Capacity Will Need to Come From Alternative Sources
- Promoting Multi-jurisdictional Partnerships for Regional Benefits

# The City's Vision

- **Environmental:** Protect our natural amenities by encouraging proactive environmental initiatives intended to safeguard our natural resources.
- **Infrastructure:** Maintain, protect and design infrastructure that ensures a desired level of service and provides for future needs.
- **Quality of Life:** Create an environment that enhances the quality of life and benefits the community culturally, recreationally and economically.

# Lake Eva and Lake Henry Restoration Benefits

- This project can provide a variety of benefits, including water quality improvements, ecological restoration, aquifer recharge, and stormwater harvesting.
- By helping to address water quality, water supply, natural systems, and flood protection needs.



Lake Eva 2011

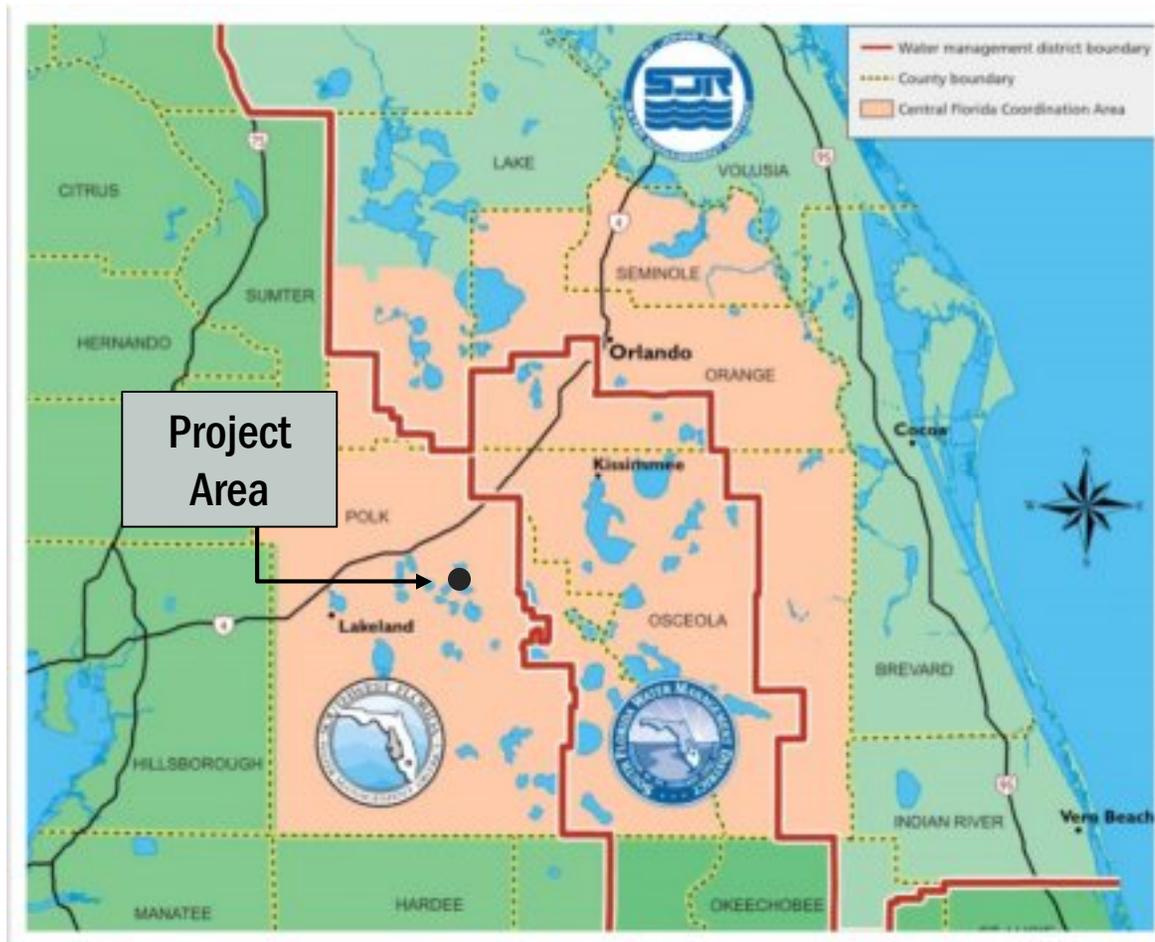


# City's Partners and Stakeholders

- SWFWMD
- Haines City Water Control District
- City of Winter Haven
- Polk County
- FDEP
- FDOT

***We're in this together***

# Project Vicinity Map

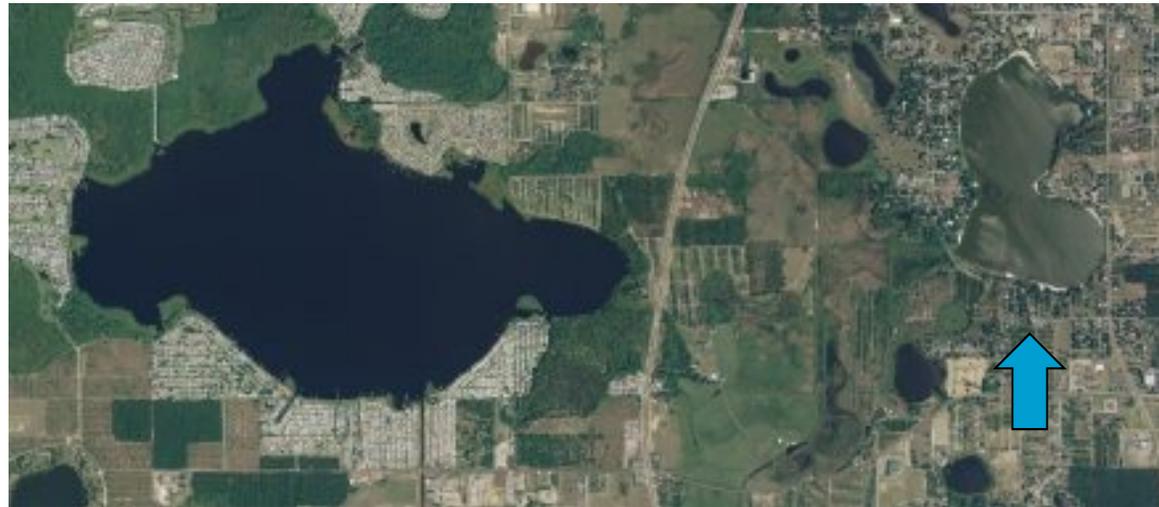


# Project Study Area



# Lake Eva– Historical Observations from the Sky

2004

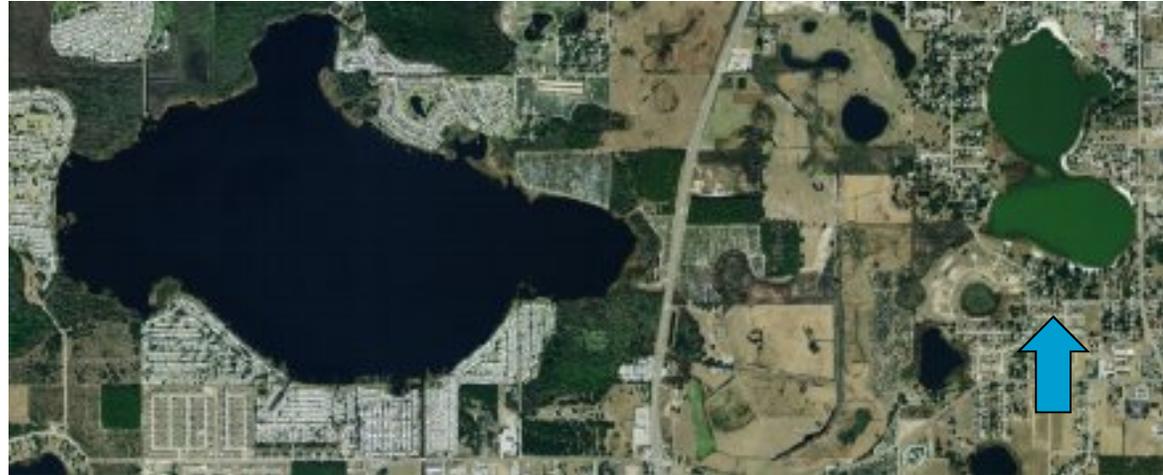


2008



# Lake Eva– Historical Observations from the Sky

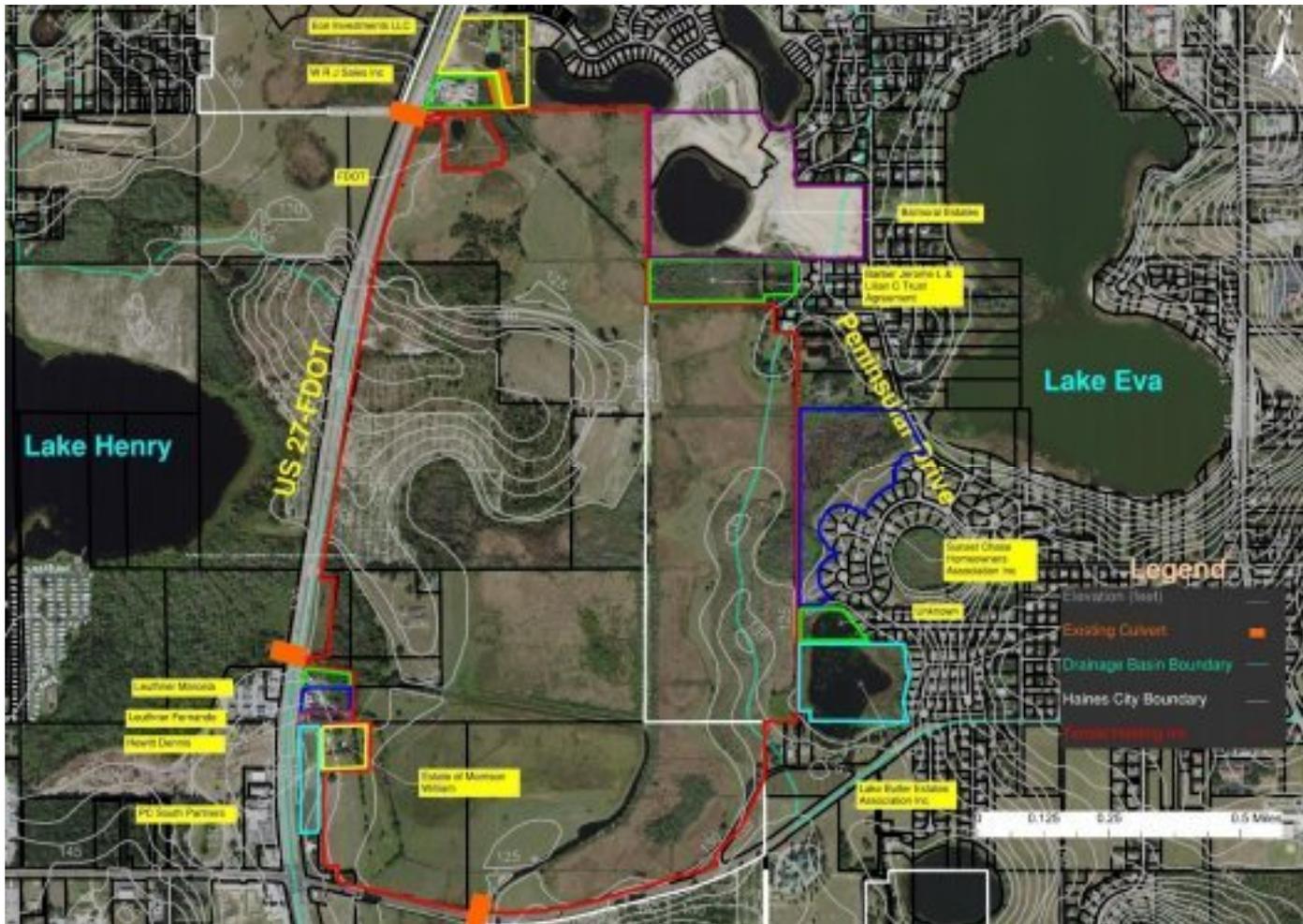
2011



2014



# Project Area



# Project Objectives



Address Lake Eva Minimum Flow and **Level** (MFL) and SWFWMD guidance levels



Improve **water quality** in Lake Eva



Improve **flood protection** in the vicinity of Lake Henry, while protecting **water recreation** opportunities



Improve **groundwater recharge** and potentially obtain water supply credits from SWFWMD



**Natural systems** enhancement/improvement



**ONE** WATER

**What is One Water and  
is it the Answer???**

# Challenges Drive New Thinking about Water



# To Meet Current Challenges - One Water Shifts How We Manage Our Water Resources



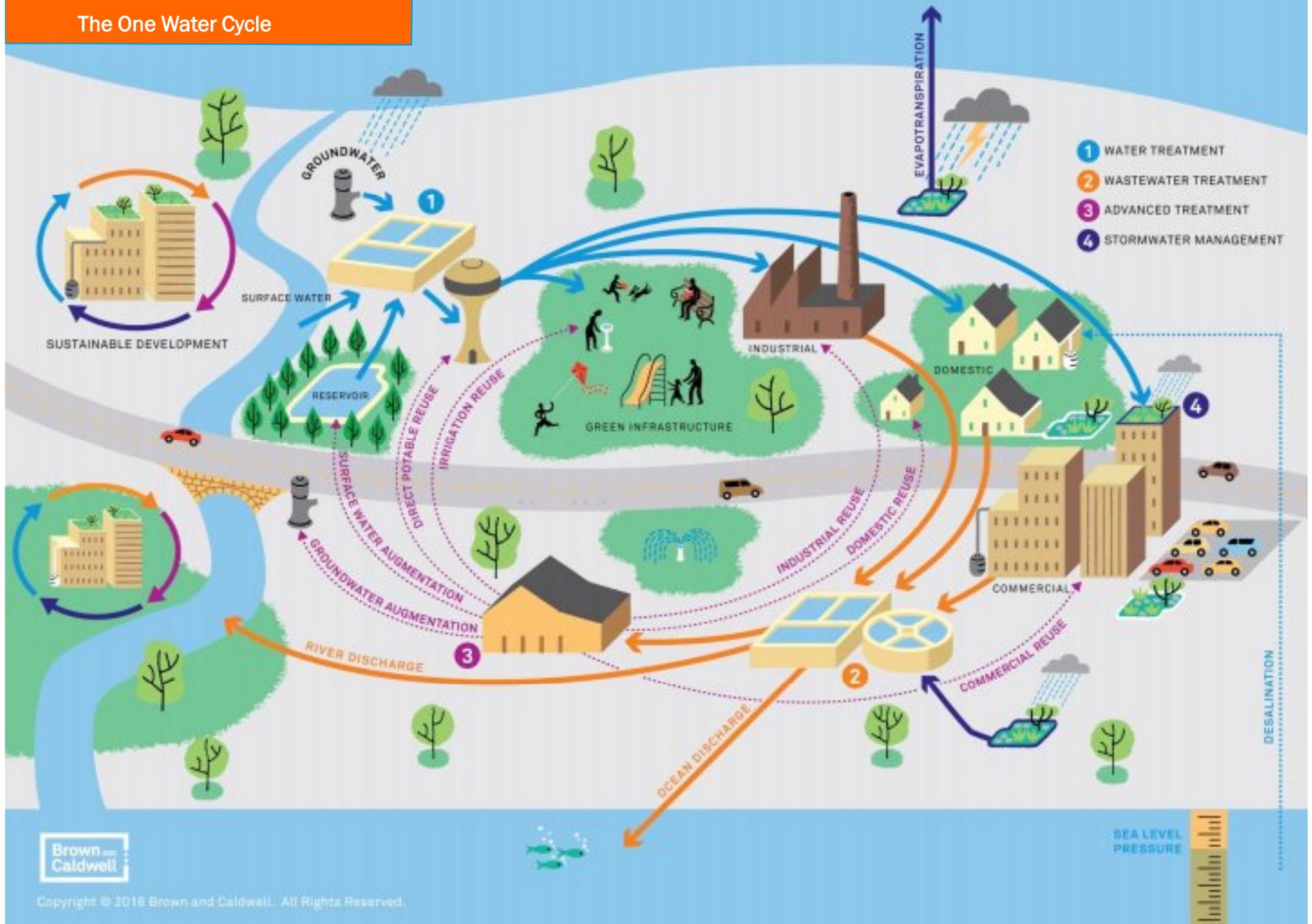


**ONE** WATER

## One Water defined

One Water is an integrated planning and implementation approach to managing finite water resources for long-term resilience and reliability, meeting both community and ecosystem needs.

# The One Water Cycle



# Florida Faces a Variety of Challenges



Nobody ever said that saving the Everglades would be easy. Or quick.

By [author name]  
[social media icons]  
If you see these shares of the Everglades, here's a reason to be a little more optimistic.

There's a solution to the Southeast's water crisis. But will Georgia and Florida agree to it?

The plan could bring water equality to the Southeast.

By [author name]  
[social media icons]



Drainage upgraded in Jacksonville neighborhood flooded by Irma

By [author name]  
[social media icons]



MCCORMICK, Fla. One of the Jacksonville neighborhoods hardest hit during Hurricane Irma.

Mayors Talk Aging Infrastructure Using Flint As Example

By [author name] February 18, 2016 4:31 PM

Filed Under: Miami Beach



Water

It's no shoulder with mayors from afar sounded the alarm.

Sea Level Rise Will Rapidly Worsen Coastal Flooding in Coming Decades, NOAA Warns

A new report shows how vulnerable U.S. coastal areas are to rising seas, with some flooding daily by 2100. San Francisco faces a double whammy if it's also sinking.

By [author name] [social media icons]



Our stories. Your inbox. Every weekday.



Polk Regional Water Cooperative proposes new water supply projects

By [author name] For [author name]  
[social media icons]

ALBUQUERQUE — Polk Regional Water Cooperative board members voted unanimously Wednesday to only state funding for their supply needs for the future.

will study for development in the. They would produce it.



MO: Sea-level rise is a regional threat. It will need a regional game plan to fight it

# Integrated Approach = Technical + Business Case Evaluation + Stakeholder/Community Input

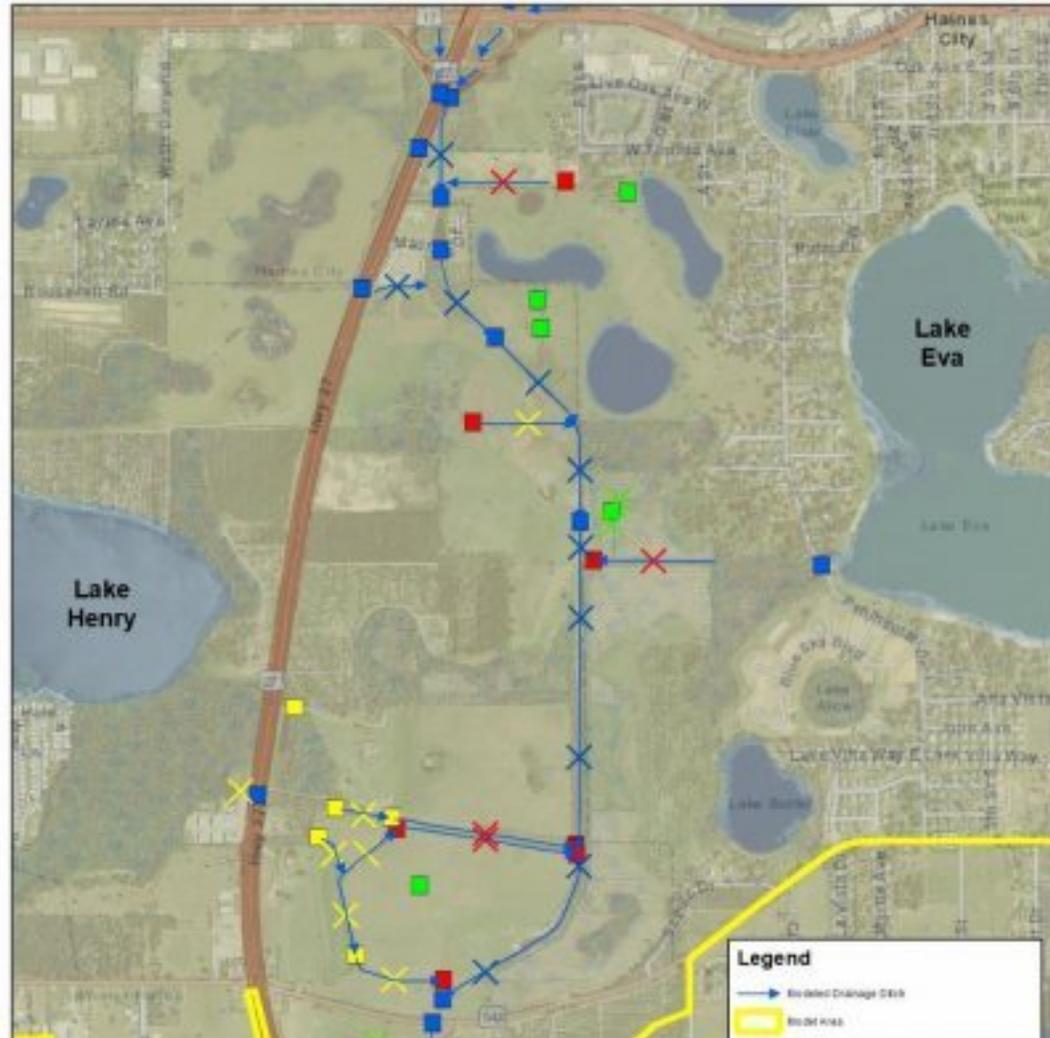
1. Series of Technical Memorandums
  - a. Summary of Collected/Evaluated Existing Data (#1)
  - b. Data Collection Plan (#2)
  - c. Data Acquisition, Analysis, and Modeling (#3)
    - i. H&H 2-D Modeling
    - ii. Water Quality Analysis
    - iii. Statistical Analysis
  - d. Alternative Analysis and BCE Evaluation (#4)
2. Stakeholder/Community Involvement
3. Conceptual Design and Final Report



***The series of key project TM's summarizing the science-based approach/input/findings and rolling up to Final Report keeps project stakeholders and the community well informed and involved throughout process to reach the most effective and publicly acceptable 1Water solution***

# Data Collection Techniques

- Best Available Historic Info
- Field
  - GPS units
  - Drone Video and Photography w/coordinates
  - Ground Photos w/coordinates
  - Google Earth
  - Field Measurements
  - Water Quality Sampling



# Data Collection Techniques



# Data Collection Techniques



Looking South

Looking North



# Water Availability for Hydrologic Restoration

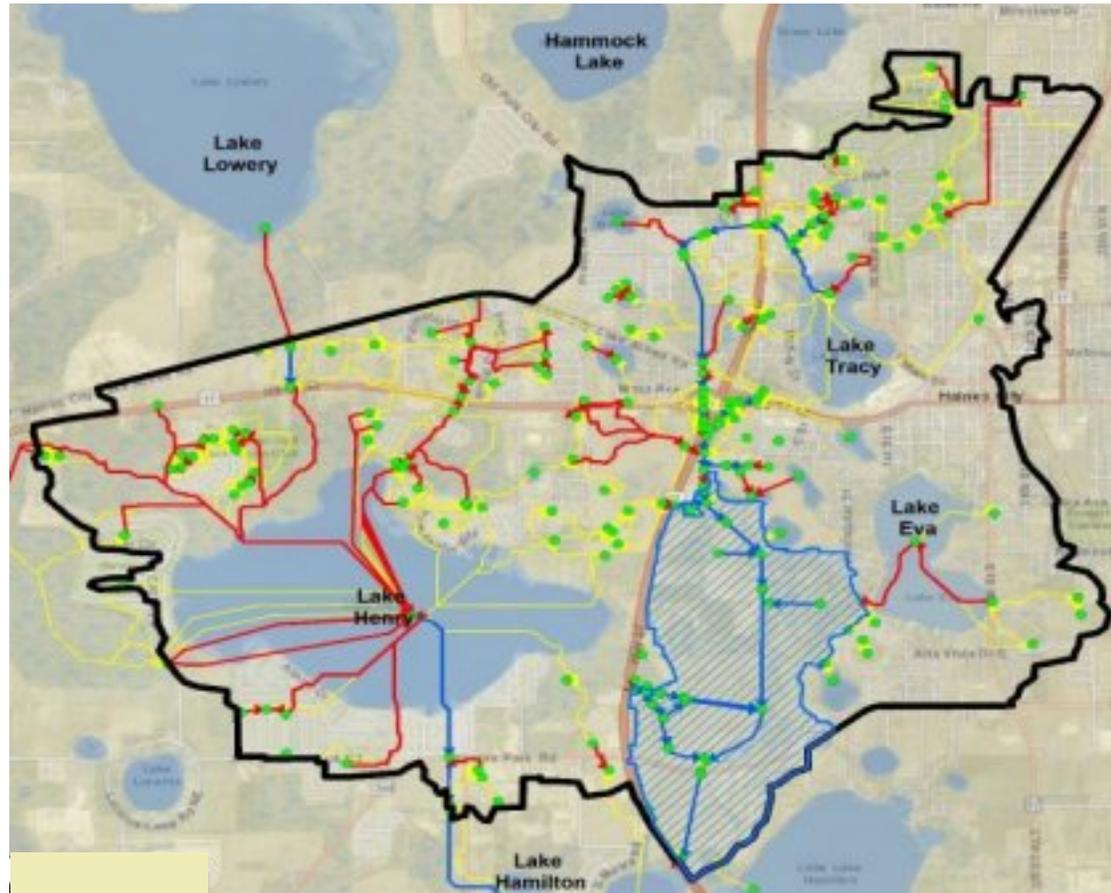
- 1. Is there enough “Excess” water to meaningfully restore Lake Eva water levels?*
- 2. Is the “Excess” water available when Lake Eva needs it?*
- 3. Where is the “Excess” water coming from?*
- 4. Can the “Excess” water be re-routed the Lake Eva?*
- 5. Will intercepting/re-directing “excess” water negatively impact downstream waterbodies?*

***Answering these questions requires a detailed hydrologic analysis!***

# H&H Modeling Approach Overview

**Project Hydrologic Analysis Included Development of a Surface Water/Groundwater routing model (~11 sq. mile Drainage Area)**

- ***Utilized ICPR v4 Modeling Software***
- ***Simulated ~20-year period ( 2002 – 2016) and Range of Design 24 hr. Storms (1, 2, 10, 25, and 100-year events)***
- ***Included Both 1-D and 2-D Surface Water Routing***
- ***Included 2-D Groundwater Model***
- ***Calibrated/Verified using Lake Monitoring Data***



# Model Inputs/Data Collection

## *Hydrologic Data:*

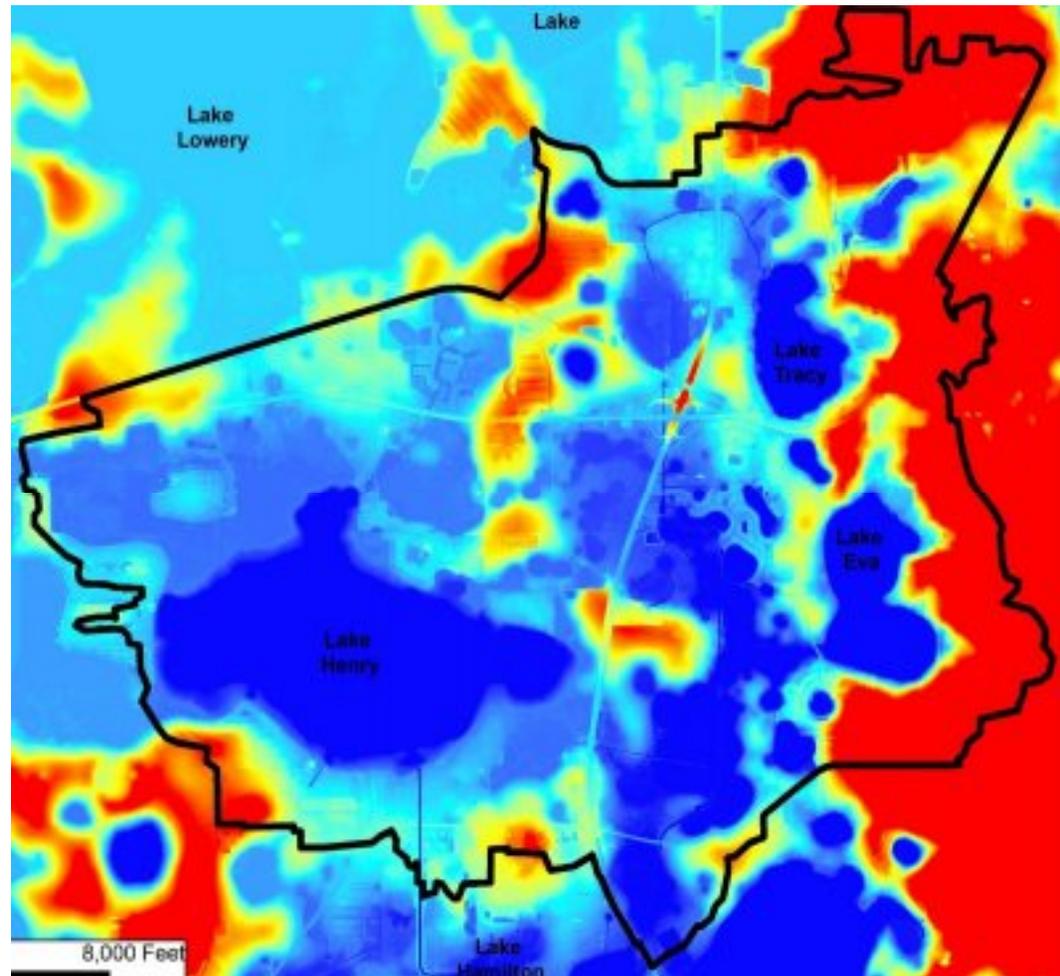
- *Rainfall*
- *Evapotranspiration (ET)*
- *Soils*
- *Land Cover*

## *Hydraulic Data:*

- *Topographic*
- *Conveyance Features*
- *Water Levels*

## *Groundwater Data:*

- *Surficial Aquifer (SA) Conductivity*
- *Intermediate Aquifer (IA) Leakance*
- *Upper Floridan Aquifer (UFA) Potentiometric Surface*
- *Lake Bathymetry*



***LiDAR Based Digital Elevation Model***

# Model Inputs/Data Collection

## Hydrologic Data:

- Rainfall
- Evapotranspiration (ET)
- Soils
- Land Cover

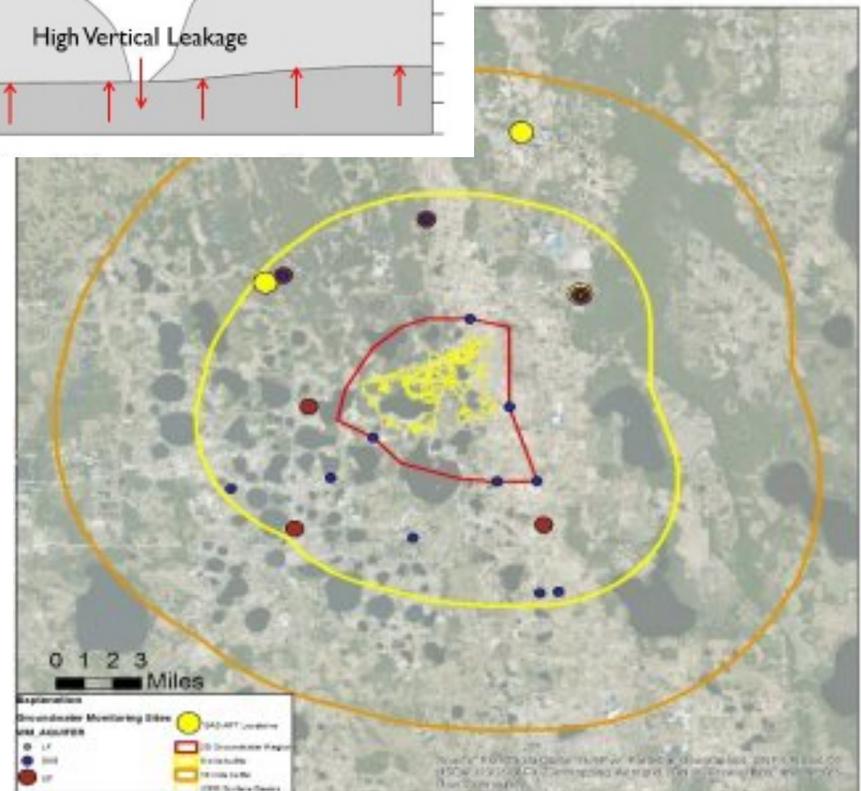
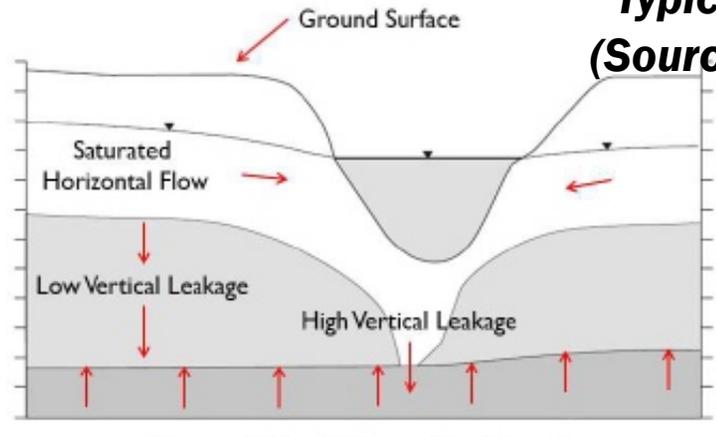
## Hydraulic Data:

- Topographic
- Conveyance Features
- Water Levels

## Groundwater Data:

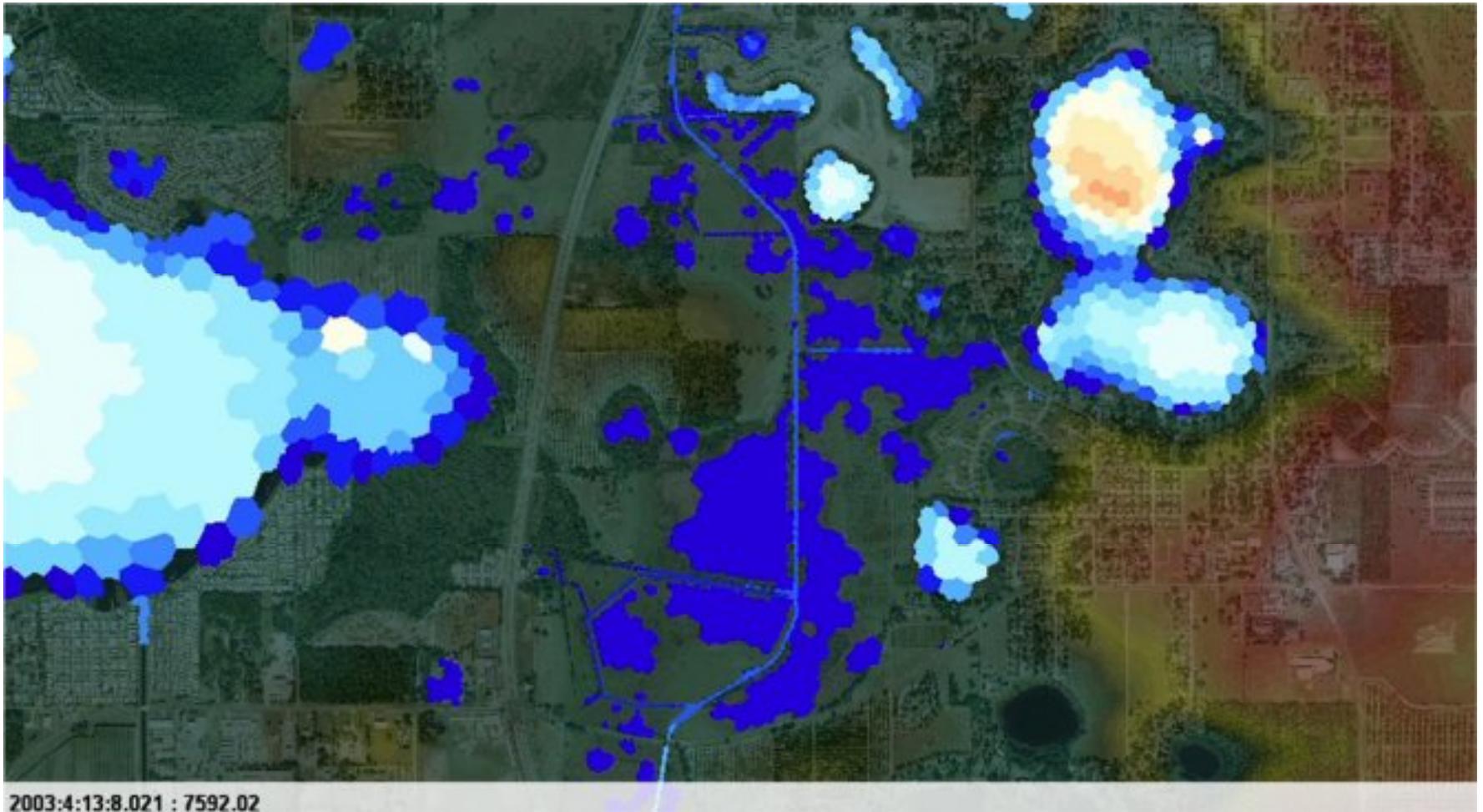
- Surficial Aquifer (SA)  
Conductivity
- Intermediate Aquifer (IA)  
Leakance
- Upper Floridan Aquifer (UFA) Potentiometric Surface
- Lake Bathymetry

Typical GW Flow Diagram  
(Source: ICPR User Manual)

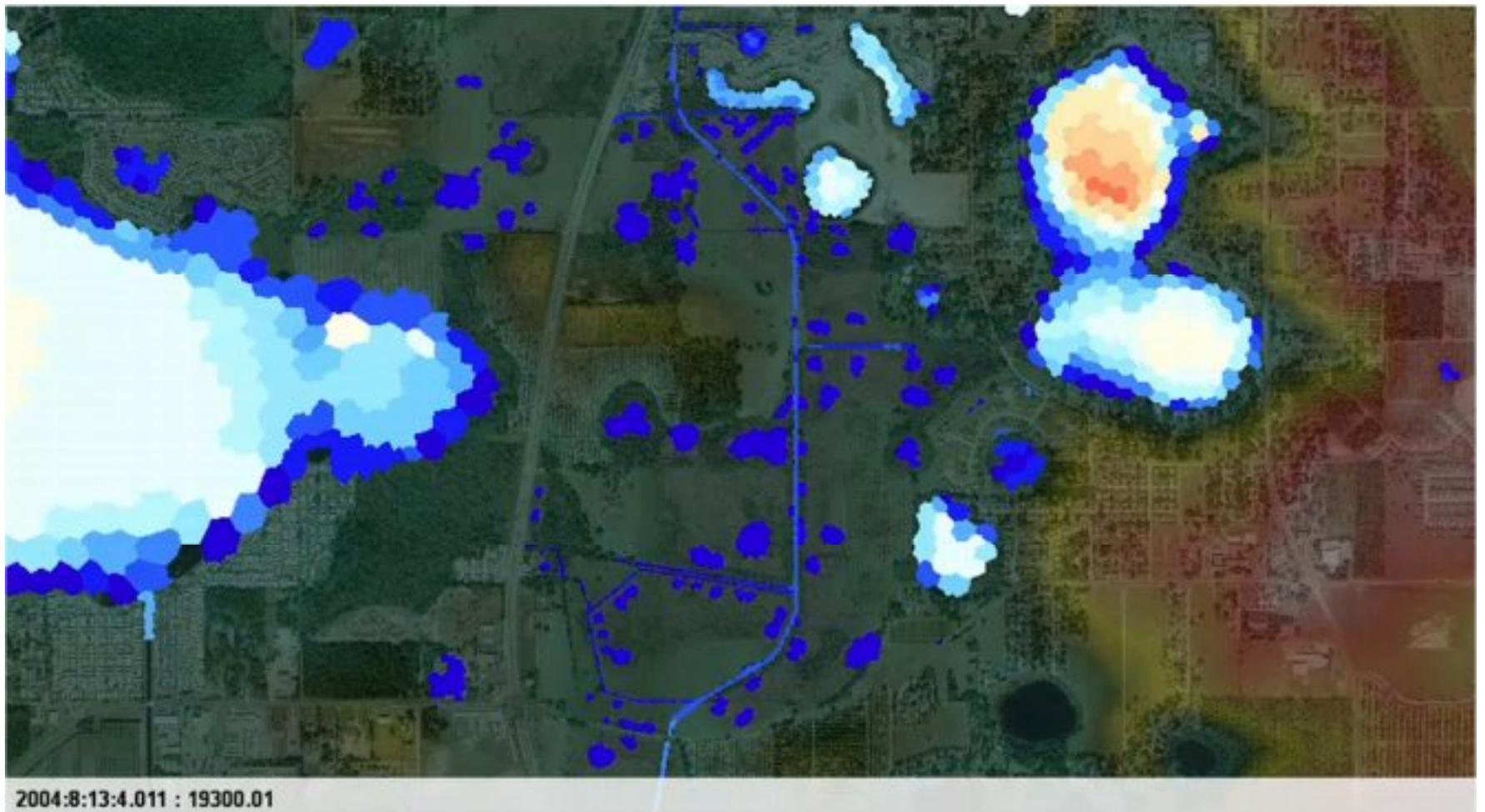


GW Monitoring Well Locations

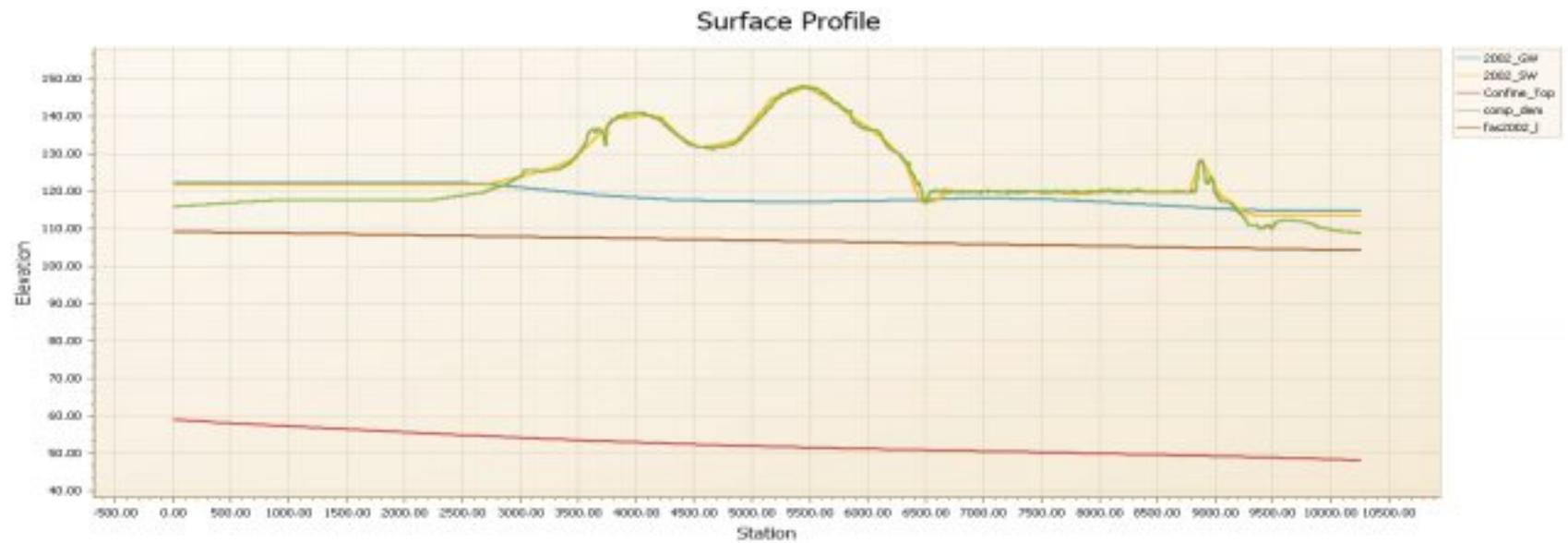
# Model Outputs (Animation – Normal Wet Season)



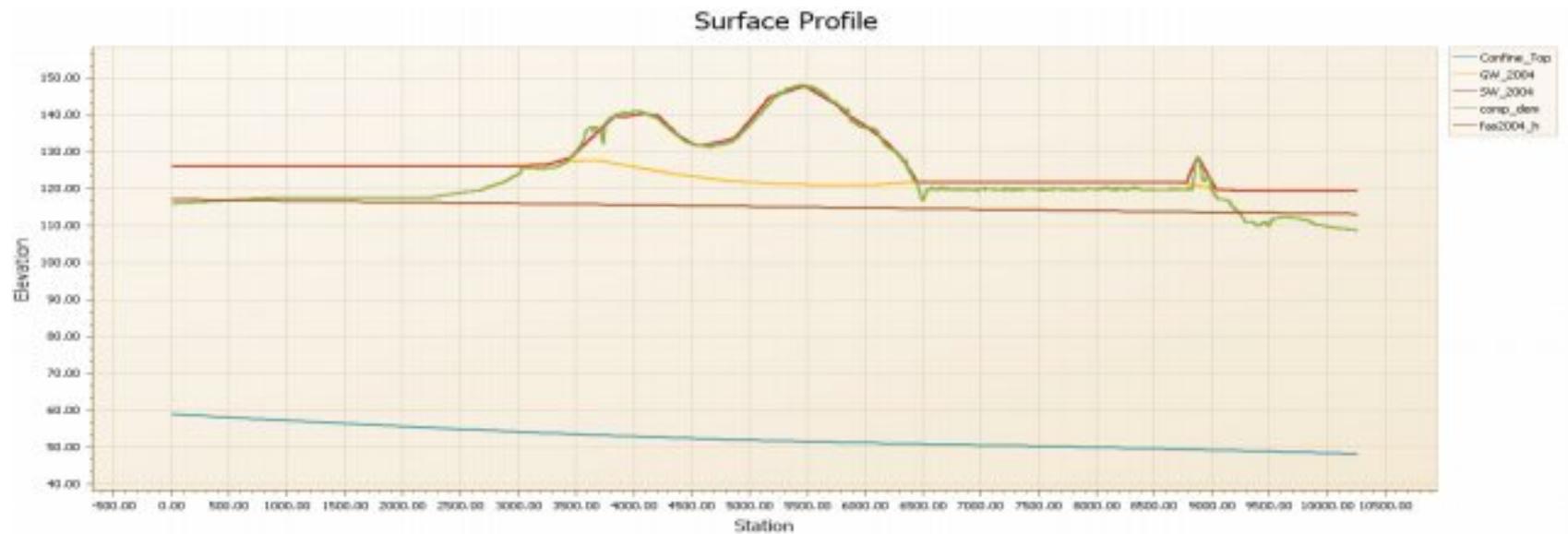
# Model Outputs (Animation – 2004 Hurricanes)



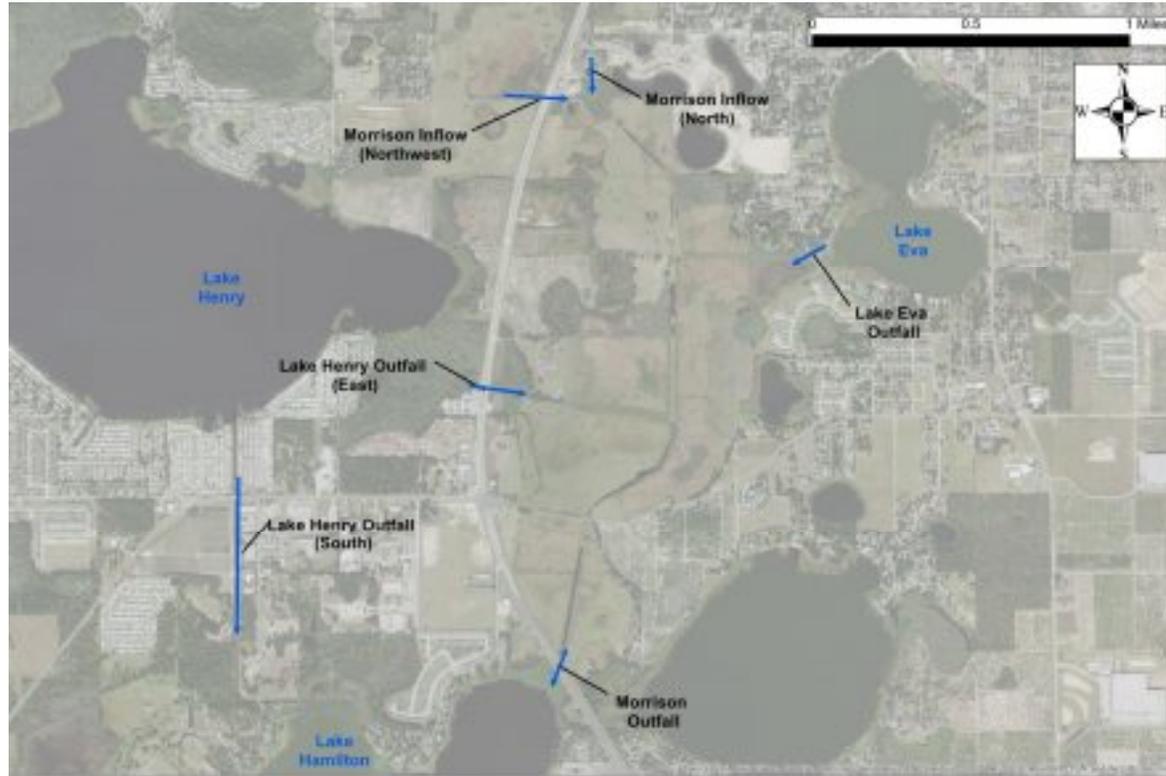
# Model Outputs (Surface Profile - 2002 (Dry))



# Model Outputs (Surface Profile - 2004 (Wet))



# Existing Condition Model Results

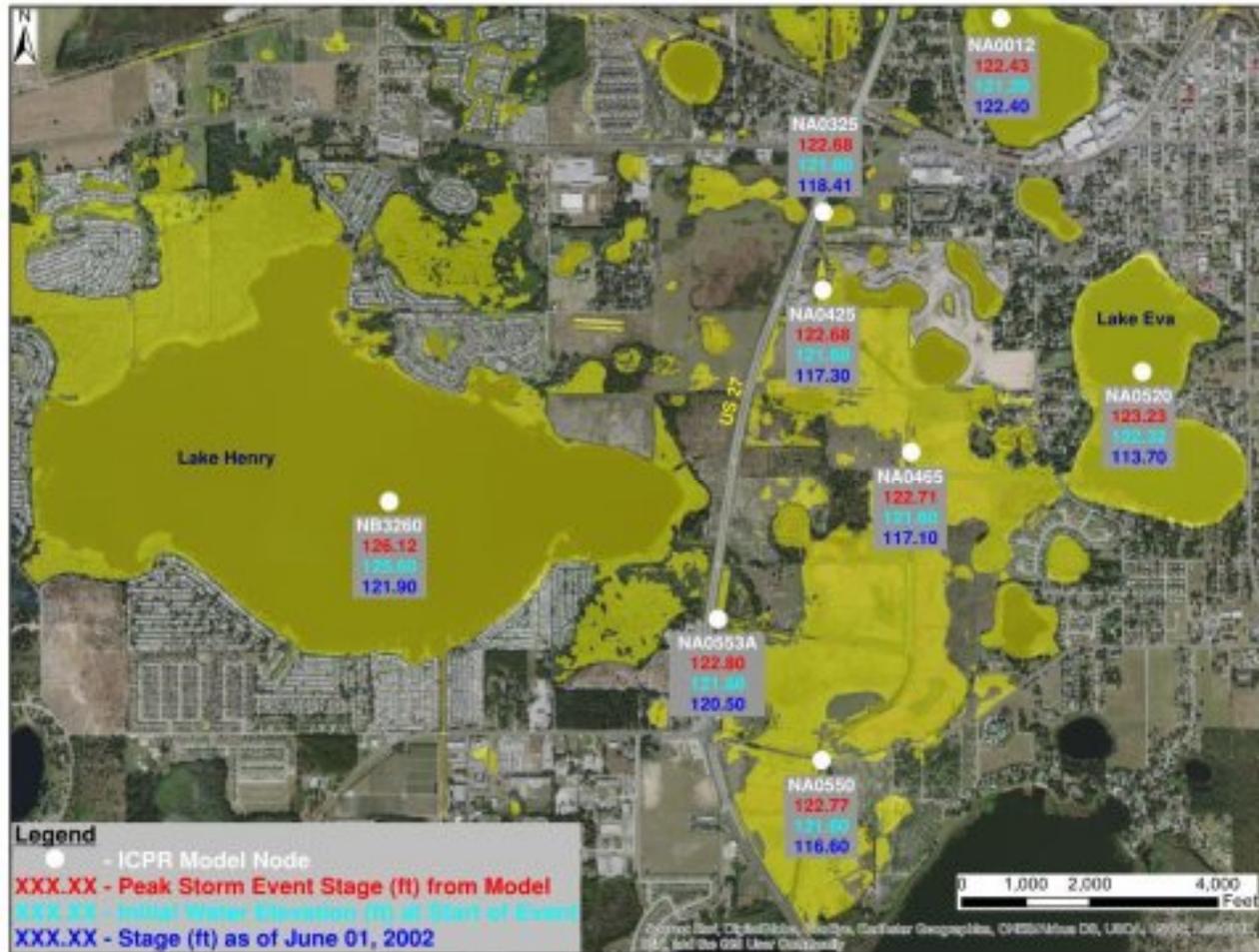


**Project Area Water Availability – Average Annual**

**Water Availability in the Lake Eva - Lake Henry Study Area Based on ICPR Modeling Results (average annual water volume from 6/1/2002 to 5/31/2016)**

Lake Eva Outfall (West to Morrison) Ac-ft/yr	Lake Henry Outfall (South to Hamilton) Ac-ft/yr	Lake Henry Outfall (East to Morrison) Ac-ft/yr	Morrison Outfall (South to Hamilton) Ac-ft/yr	Morrison Inflow (from North) Ac-ft/yr	Morrison Inflow (from Northwest) Ac-ft/yr
0	213	413	2,752	1,661	91

# Existing Condition Model Results



**Lake Eva and Lake Henry 100-year, 24-hour Storm Event Flood Inundation and Peak Stages**

# Lake Assessment Purpose

Trends

Understand

Baseline Conditions

Document

Develop Tools

Quality

Inform Alt.  
Selection

Evaluate

Relationships

Comparison



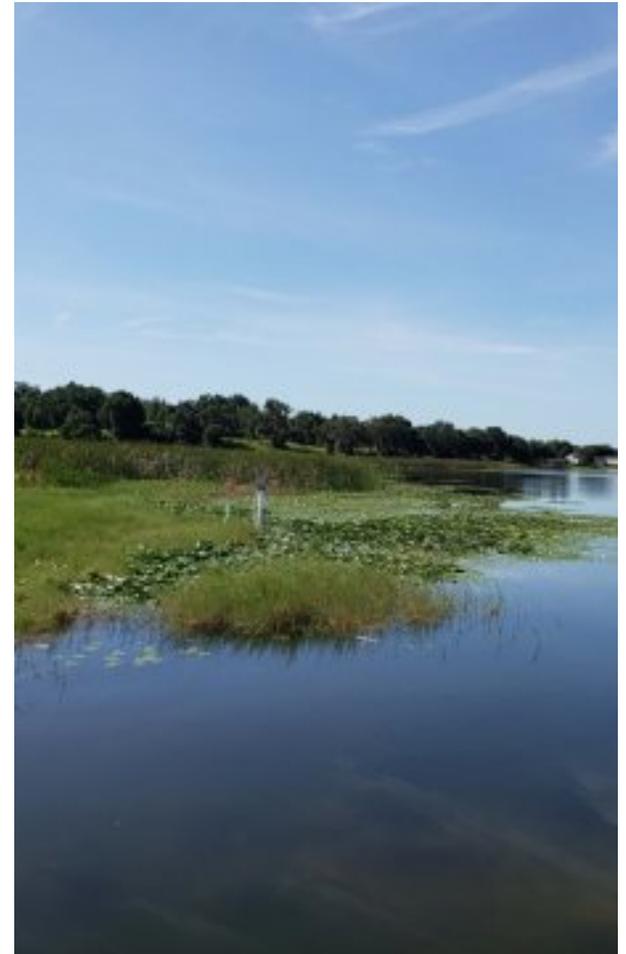
Improve **water quality** in Lake Eva



# Lake Conditions Assessment Approach

## Characteristics Evaluated

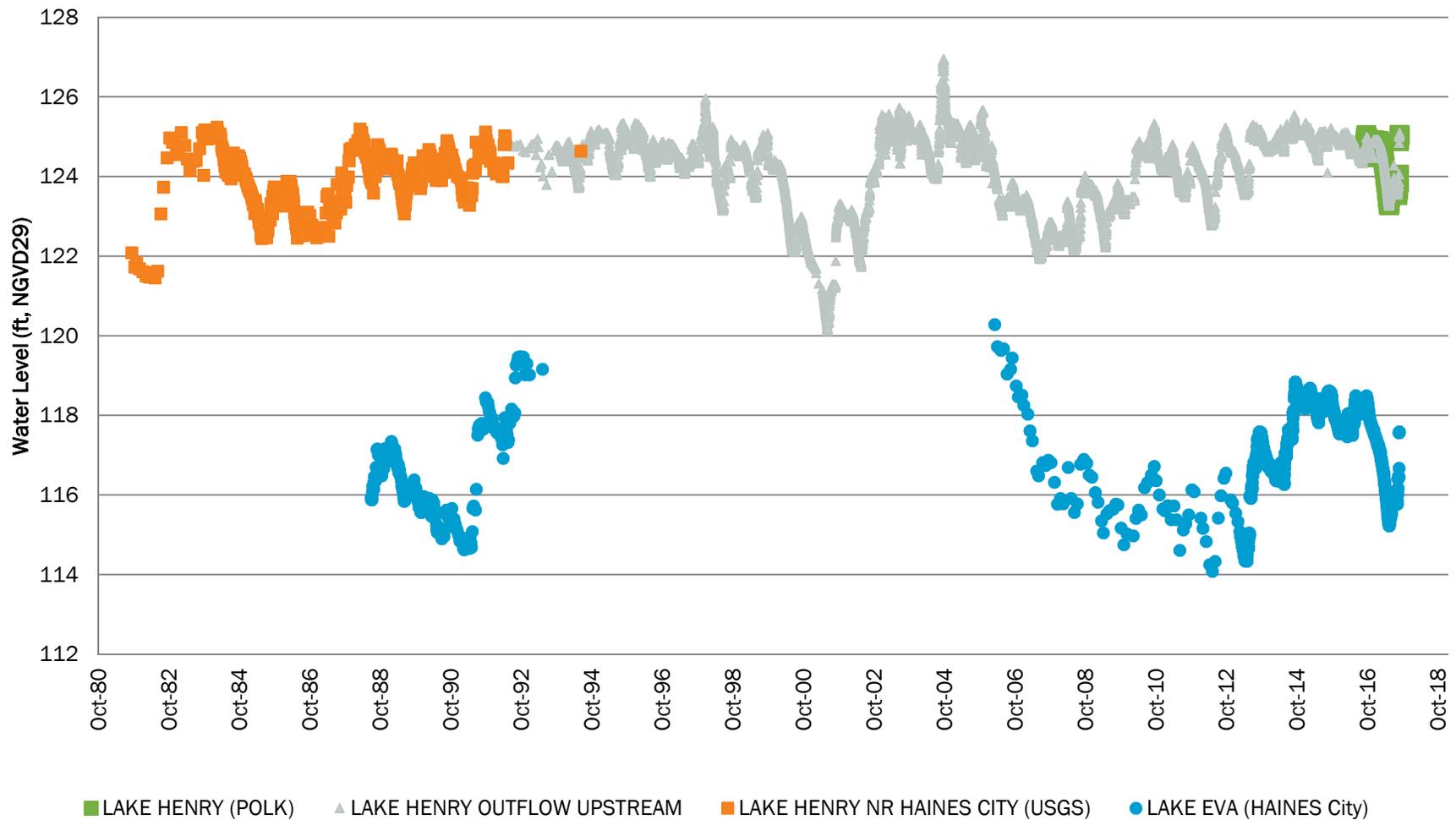
- Water Surface Level
- Lake Level Response to Rainfall
- Lake Stage/Volume Relationship
- Surface Water/Lake Bottom Sediment Quality
- Aquatic Vegetation
- Lake WQ Parameters Correlation
- Hydrologic and Nutrient Budgets
- Nutrient Assessment



Lake Eva Vegetation

# Lake Existing Conditions Assessment

## Lake Eva and Henry Historic Water Surface Levels



# Lake Existing Conditions Assessment

## Lakes' Stage, Area, and Storage

Lake	Bottom EI	High EI	TOB Area (acres)	Volume (acre-ft)
Henry	113.63	134	1,385	18,062
Eva	102	121	176	1,881

***Lake Henry Storage Volume is Approximately 10 times greater than Lake Eva's***



Lake Eva

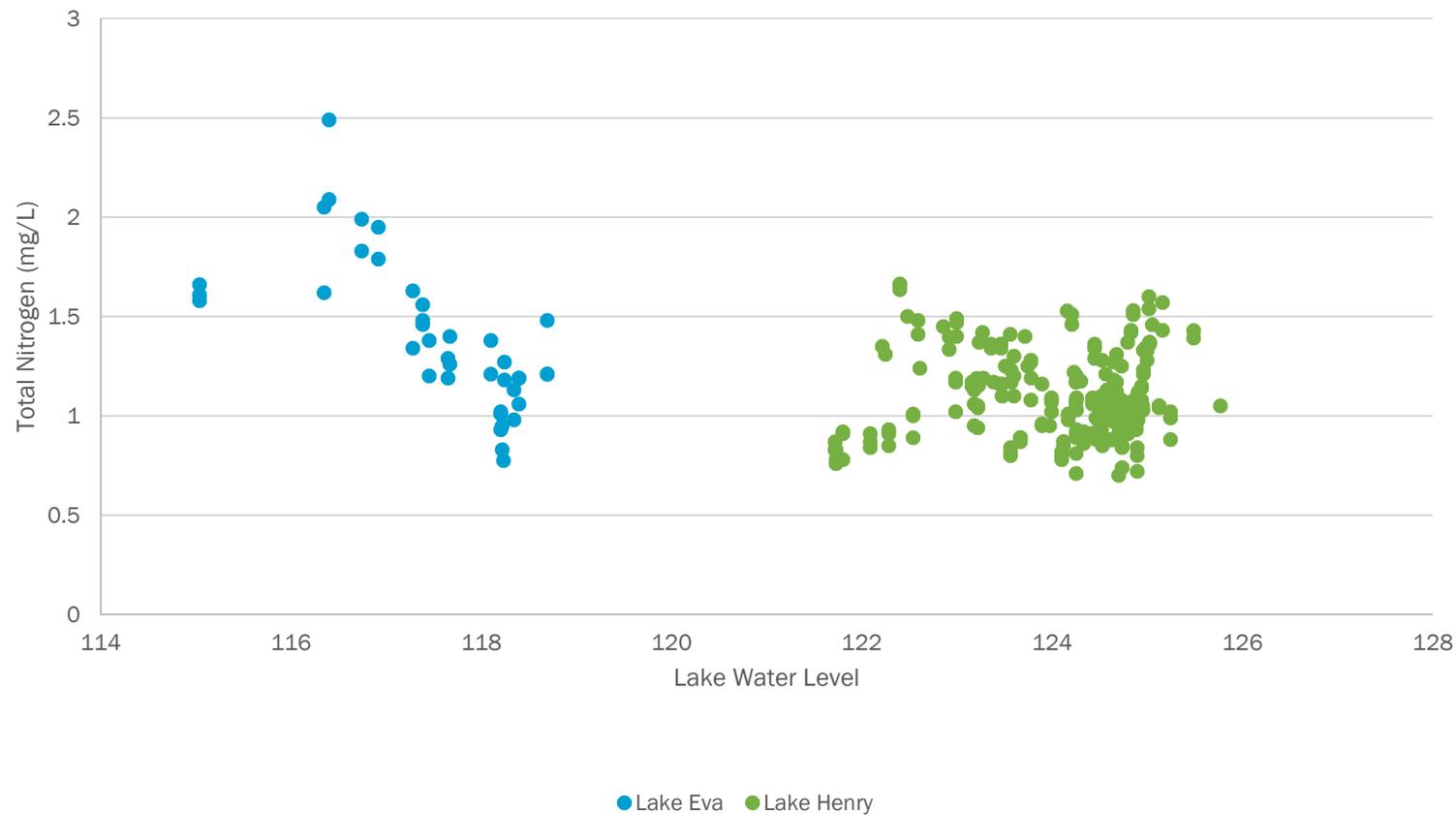
# Lake Existing Conditions Assessment

## *Water Quality Analysis - Statistical Methods and Results*

- Lake Eva time series of TN, TP, and chlorophyll-a
- Lake Henry time series of TN, TP, and chlorophyll-a
- Annual geometric mean TN and TP and avg. annual TN-TP ratio in Lake Eva and Lake Henry
- Annual geometric mean chlorophyll-a, DO, and PH in Lake Eva and Lake Henry
- Annual geometric mean Secchi disk depth, TSS, and turbidity in Lake Eva and Lake Henry
- Annual geometric mean alkalinity, color, and temperature in Lake Eva and Lake Henry
- Water quality and WQ/depth correlations

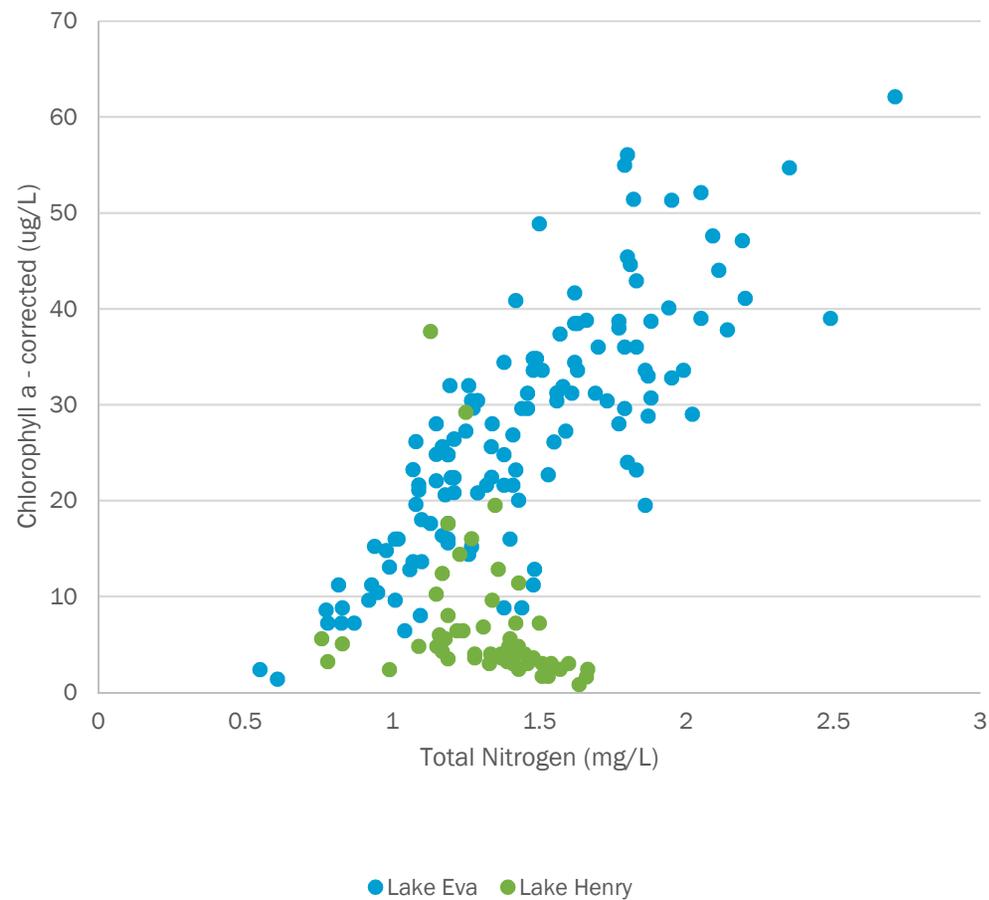
# Lake Existing Conditions Assessment

## Water Quality Samples (TN) by Level for Lake Eva



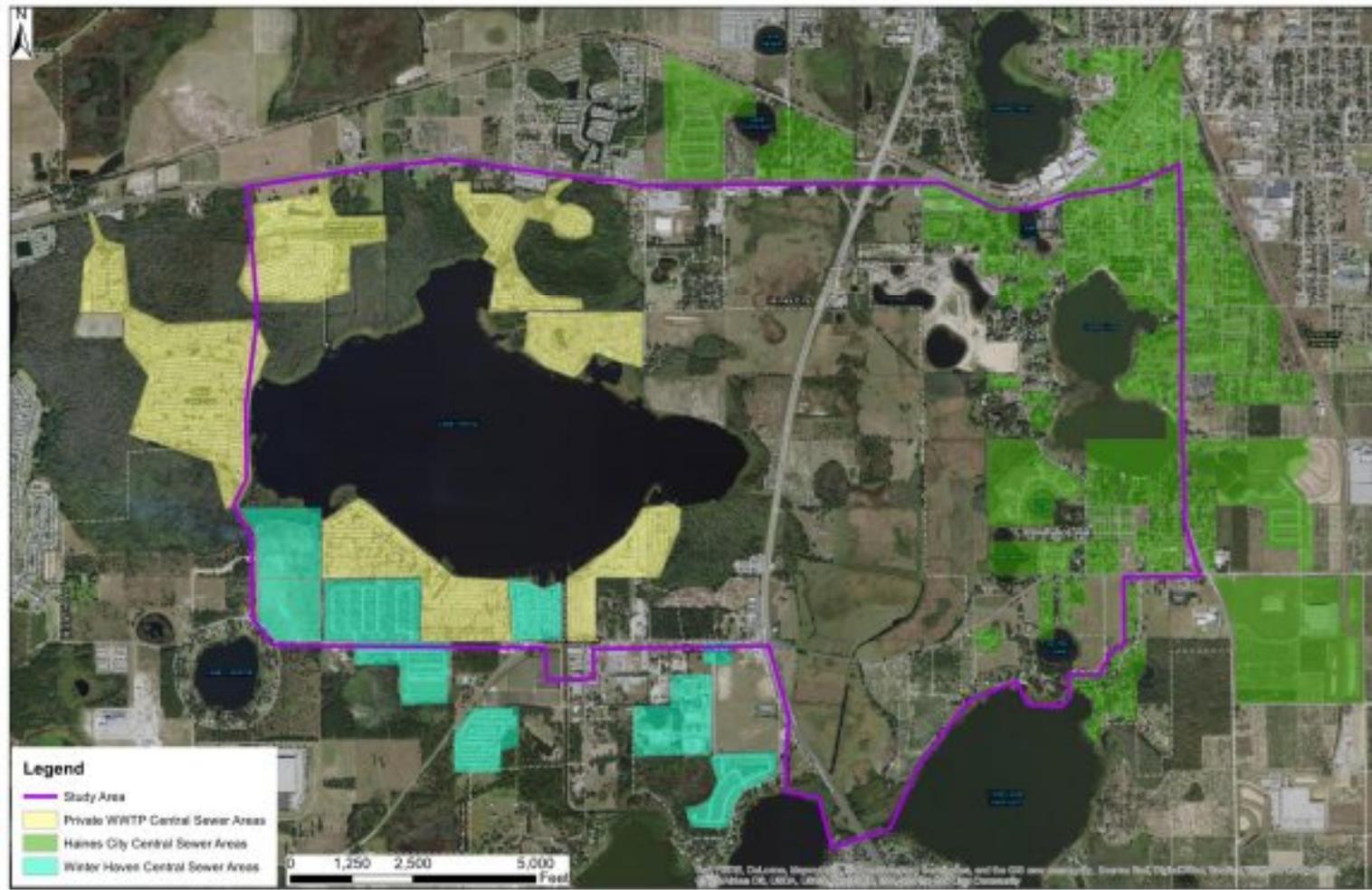
# Lake Existing Conditions Assessment

## Chlorophyll-a versus Total Nitrogen for Lake Eva



# Lake Existing Conditions Assessment

## *Central Sewer Areas in Lake Eva and Lake Henry Study Area*



# Lake Existing Conditions Assessment

## *Lake Eva Sediment and Aquatic Vegetation Analysis*



***Saloid-bound and iron-bound phosphorus concentrations were a small portion of total P in the sediment samples. This indicates a low propensity for sediments in Lake Eva to contribute significant internal P loading to the Lake***

# Lake Existing Conditions Assessment

## *Lake Eva Hydrologic and Nutrient (TN, TP) Budgets*

- Estimating Stormwater Runoff Loadings
  - Land Use GIS
  - H&H Model Results
  - Literature-based bulk deposition areal loading rates
  - Literature-based TP and TN concentrations (FDEP)
- Nutrient Budget
  - Stormwater
  - Direct Precipitation
  - Groundwater Seepage

***Lake Eva Estimated External Annual Average Nutrient Loadings  
1,708 kg TN and 218 kg TP***

# Lake Existing Conditions Assessment

## Lake Eva Water Quality

Lake Trophic Condition	Carlson TSI	Secchi Disk Depth (ft)	Chlorophyll-a ( $\mu\text{g/l}$ )	TP ( $\mu\text{g/l}$ )
Oligotrophic	< 38	> 15	< 2.2	< 10
Mesotrophic	38 - 48	7.5 - 15	2.2 - 6	10 - 20
Eutrophic	49 - 61	3 - 7.4	6.1 - 22	20.1 - 50
Hypereutrophic	> 61	< 3	> 22	> 50

***Based on historic total phosphorus and chlorophyll-a concentrations, and Secchi disk depth, Lake Eva water quality varies from eutrophic to hypereutrophic***



Hypereutrophic Lake w/Elevated Algal Concentration

# Lake Existing Conditions Assessment

## Lake Eva Water Quality Existing Conditions Summary

- Lower Chlorophyll-a concentrations associated with higher lake water levels and lower TN
- Chlorophyll-a was strongly positively correlated with TN, TSS, and turbidity
- Regression Analysis showed TN is more important than TP in predicting Chlorophyll-a
- Lake Eva from 2002-2016 only met state applicable NNC during one 3-year period

***Statistical Analysis indicates Lake Eva water quality improves at higher levels.***

# Alternative Analysis Evaluation Criteria and Priority

Selection Evaluation Criteria	Priority*	Description
Meet Regional Integrated Water Resources Needs		Follow Central Florida Water Initiative (CFWI) guidelines, use regional approach to solve multi-jurisdictional "One Water" needs
Address Lake Eva Low Water Level Concerns		Address Regulatory Requirements for Maintaining Minimum Level and Flow (MFL) in Lake Eva
Improve Lake Eva Water Quality		Achieve Lake Water Quality Improvement for Key Parameters including Total Phosphorus and Chlorophyll-a
Life-Cycle Cost		Lowest combined Capital and O&M Costs for 20-year life
Likelihood or Ease of Permitting		Regulatory Acceptability and Less Time/Lower Cost for Project Permitting
Minimize Need for Land Acquisition and Easements		Maximize the use of existing public lands and easements for project improvements and minimize the need to acquire additional private land or easements
Minimize Impacts (temporary/permanent) to residences and businesses		Construction and Operation of Proposed Improvements has minimal impact on residences and businesses
Proven Treatment/Recharge Approach		Use project elements which are effective and meet regulatory requirements
Provide Groundwater Recharge and Water Supply Credits		Infiltrate "Excess" Water into project area groundwater system with the goal of generating water supply credits
Provide Natural Systems Enhancement		Improve ecosystem form and function within the project area
Public / Stakeholder Acceptance		Consensus of acceptance by Stakeholders, Residences, and Businesses
Recreational Benefits		Maintain or improve Lake Recreational Benefits (Swimming, boating, fishing, etc.)
Reduce Lake Henry Flooding During Wet Weather Periods		Reduce extent/depth of flooding for residents adjacent to Lake Henry based on existing flood maps
Social Benefits		Provide public benefits such as increased property value, economic development, educational opportunities, aesthetics, etc.
Utilize Existing Infrastructure and Natural Conveyances		Maximize natural conveyance and maintain existing drainage system infrastructure in such a way that it's compatible with maximizing natural conveyance.

\*Rank from 1 to 15, "1" is most preferred

# Collaborative Process for Criteria Prioritization

Evaluation Criteria and Priority		
<i>City / District / BC Team Final Prioritization Meeting - January 14, 2019</i>		
Selection Criteria	Priority	Description
Improve Lake Eva Water Quality	1	Achieve Lake Water Quality Improvement for Key Parameters including Total Phosphorus and Chlorophyll-a
Address Lake Eva Low Water Level Concerns	2	Address Regulatory Requirements for Maintaining Minimum Level and Flow (MFL) in Lake Eva
Meet Regional Integrated Water Resources Needs including Groundwater Recharge and Water Supply Credits	3	Follow Central Florida Water Initiative (CFWI) guidelines, use regional approach to solving multi-jurisdictional "One Water" needs. Infiltrate "Excess" Water into project area groundwater system with the goal of generating water supply credits
Minimize Need for Land Acquisition and Easements / Utilize Existing Infrastructure & Natural Conveyances	4	Maximize the use of existing public lands and easements for project improvements and minimize the need to acquire additional private land or easements. Maximize natural conveyance and maintain existing drainage system infrastructure in such a way that it's compatible with maximizing natural conveyance.
Public / Stakeholder Acceptance	5	Consensus of acceptance by Stakeholders, Residences, and Businesses
Life-Cycle Cost	6	Lowest combined Capital and O&M Costs for 20-year life
Provide Natural Systems Enhancement, Recreational Benefits, Social Benefits	7	Improve ecosystem form and function within the project area. Maintain or improve Lake Recreational Benefits (Swimming, boating, fishing, etc.). Provide public benefits such as increased property value, economic development, educational opportunities, aesthetics, etc.
Reduce Lake Henry Flooding During Wet Weather Periods	8	Reduce extent/depth of flooding for residents adjacent to Lake Henry for the 100-year, 24-hour event based on existing flood maps
Minimize Impacts (temporary/permanent) to residences and businesses	9	Construction and Operation of Proposed Improvements has minimal impact on residences and businesses
Likelihood or Ease of Permitting	10	Regulatory Acceptability and Less Time/Lower Cost for Project Permitting
Proven Treatment/Recharge Approach	11	Use project elements which are effective and meet regulatory requirements

# Finding a “Win-Win” Via Key Stakeholder Collaboration



# Sustainable and Cost-Effective Alternatives



# Pre-Restoration, Baseline & Year 4



# Enhanced Wetland Treatment System



# Recreational and Educational Elements



**Include recreational elements to allow a stormwater treatment system to be useful to the public and a benefit to community**



# Conclusions

1. Model Results indicate there is sufficient water (avg. basis) reaching Morrison Ranch property (project area) to evaluate alternatives to meet project objectives
2. No need to alter Lake Henry water inflow, elevation or water quality
3. Additional long-term simulations are required to evaluate seasonal variability
4. Flooding in the vicinity Lake Henry appears to be limited
5. Statistical Analysis indicates Lake Eva WQ improves at higher lake levels
6. Options to improve Lake Eva water quality include wetland treatment (west), LIDs (north and east), and Pretreatment (Alum)
7. Areas exist for wetland rehydration and enhancement
8. Options to improve Lake Eva water level include improving conveyance systems and storing/rerouting inflows from North

# Next Steps

1. BCE Approach to Alternative Analysis and Ranking (in Progress)
  - a. Brainstorm Alternatives
  - b. Conduct Fatal Flaw Analysis
  - c. H&H Modeling and Water Quality Analysis of Alternatives Short-list
  - d. Quantify Benefits and Identify Potential Risks
  - e. Develop Estimated Life-Cycle Costs
  - f. Apply Weighted Evaluation Criteria to Rank Alternatives
  - g. Summarize Analysis and Results in TM#4
2. Feasibility Report
3. Final Design and Permitting



***Stakeholder/ Community  
Involvement and City  
Commission Workshops***



Questions?

[bc1Water.com](http://bc1Water.com)

