Johns Lake MFLs

Modeling Peer Review Kick-off

March 3, 2022

Division of Water Supply Planning and Assessment
St. Johns River Water Management District

Agenda

- Introductions and meeting objectives
- Overview of SJRWMD MFLs process
- Overview of ICPR4 2D model
- Stakeholder comments
- Site visit

Johns Lake

Orange and Lake Counties

- Lake area = ~2,500 acres
- Watershed area = ~40.1 mi^2
- Regionally important parks, fishing pier, kayak and canoe launches.
- Large wetlands to east (Conservation Area) and south (Scrub Point Preserve) with important habitat for fish, wading birds and other wildlife

Statutory Directive

"...consideration shall be given to... non-consumptive uses, and environmental values..." *62-40.473, F.A.C.*

- **Recreation in and on the water**
- **Fish & wildlife habitats and the passage of fish**
- **Estuarine resources**
- **Transfer of detrital material**
- **Maintenance of freshwater storage & supply**
- **Aesthetic and scenic attributes**
- **Filtration / absorption of nutrients & pollutants**
- **Sediment loads**
- **Water quality**
- **Navigation**

Statutory Directive

Water management districts must establish MFLs that set…

"…the limit at which further withdrawals would be significantly harmful to the water resources or the ecology of the area."

Section 373.042(1), Florida Statutes (F.S.)

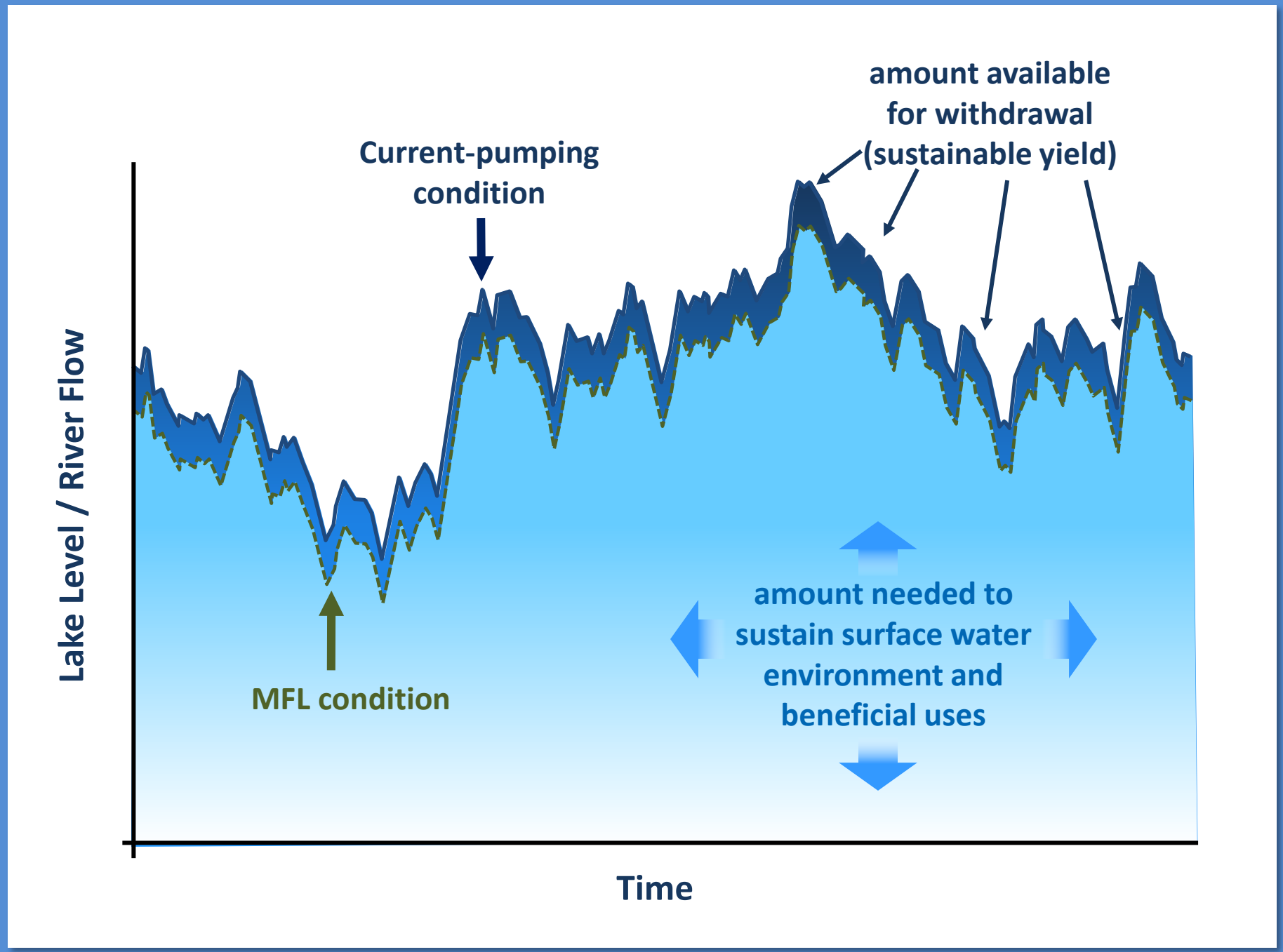
MFL Process Overview

MFLs Determination:

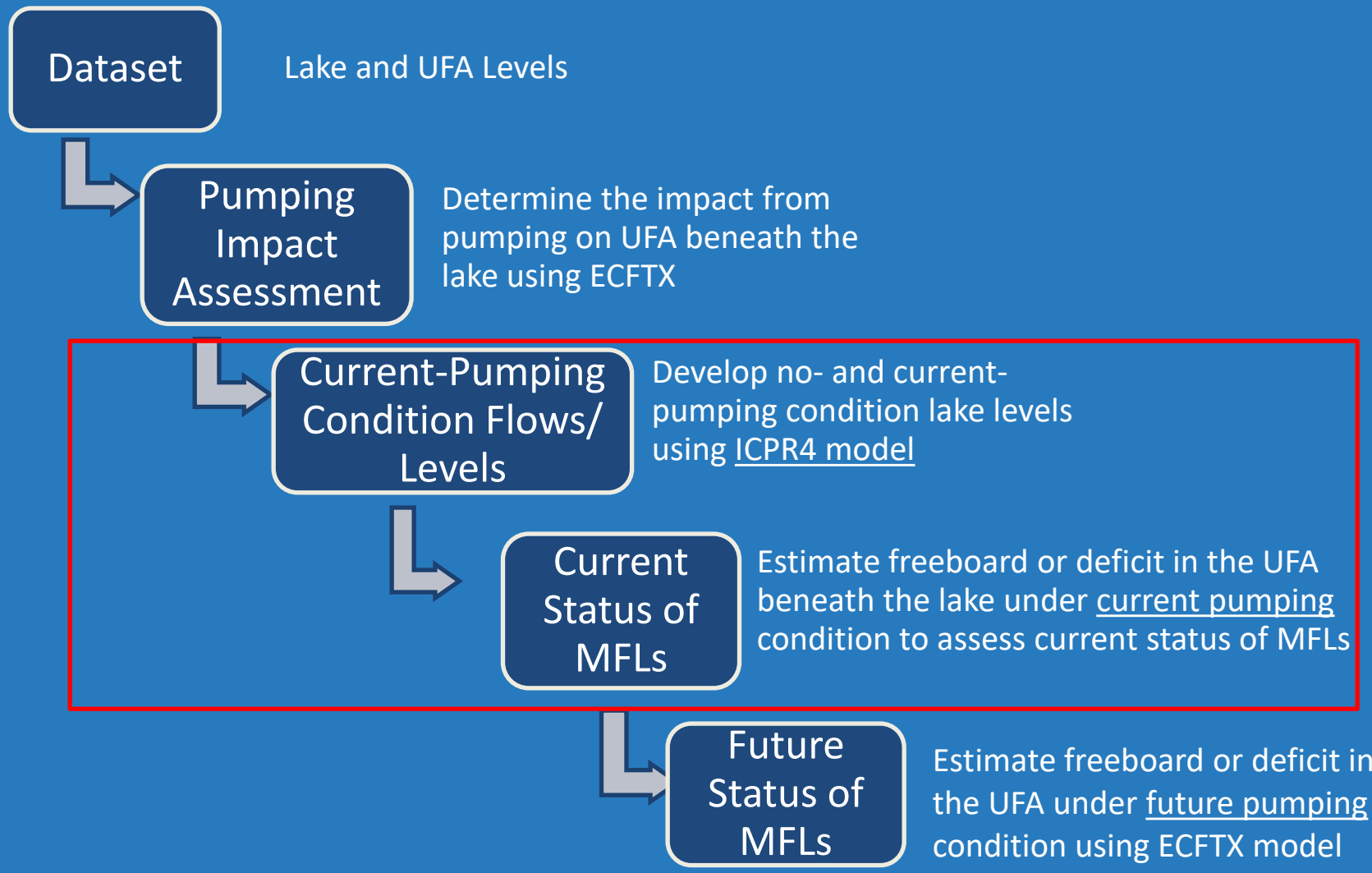
- Determine the most critical environmental features to protect and the minimum hydrologic regime required for their protection (MFLs condition)

MFLs Assessment:

- Determine the current impacted hydrologic regime (current-pumping condition)
  - Requires determination of no-pumping hydrologic regime, which represents historical no-pumping condition
- Compare the MFLs and current-pumping conditions to determine if water is available (freeboard)


amount available
for withdrawal
(sustainable yield)
Current-pumping
condition
Lake Level / River Flow
MFL condition
amount needed to
sustain surface water
environment and
beneficial uses
Time

Hydrological Analysis



Use of ICPR4 Model for MFLs

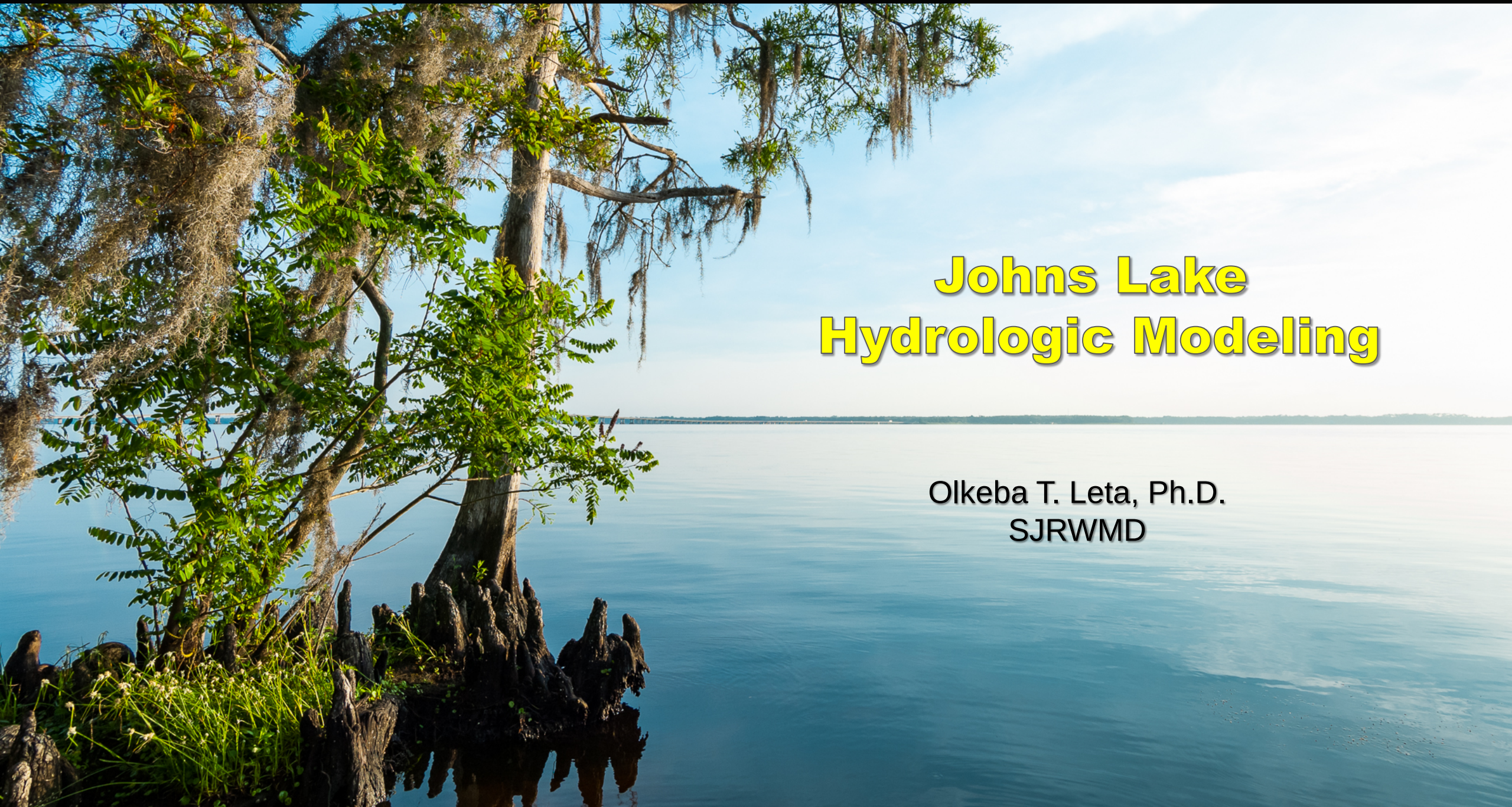
- **Simulation of interaction between the lake and the UFA**
- **Evaluation of the effect of pumping on critical lake levels needed for WRVs (fish and wildlife habitat, recreation, water quality, etc)**
- **Assessment of the current status of MFLs to estimate water availability or deficit**

Model Simulations

- **Long-term simulations (1948-2018)**
- **Scenarios (by adjusting UFA boundary condition)**
  - **No-pumping condition simulations**
  - **Current-pumping condition simulations**

Peer Reviewer

- **Jeffrey King, PhD, PE (ATM, Inc)**



Johns Lake Hydrologic Modeling

Olkeba T. Leta, Ph.D.
SJRWMD

Outline

- Background on Johns Lake modeling
- Interconnected Channel and Pond Routing (ICPR4) Model:
  - Set-up
  - Calibration and validation
- Sensitivity analysis
- Long-term simulation

Model Development

- Collect, review and process GIS and hydro-meteorological data
- Set-up ICPR4 model
- Calibrate and validate the model
- Run long-term simulations
- Receive technical support and recommendations from Streamline Technologies (SLT) for model refinement

ICPR4 2D Model

GIS Data

Inputs

Hydro-meteorological Data

DEM, Land use/land cover, etc

Soil properties, imperviousness, crop coefficient

Aquifer properties, GW levels, WT

1D Overland Region

Vadose Zone

2D GW Region

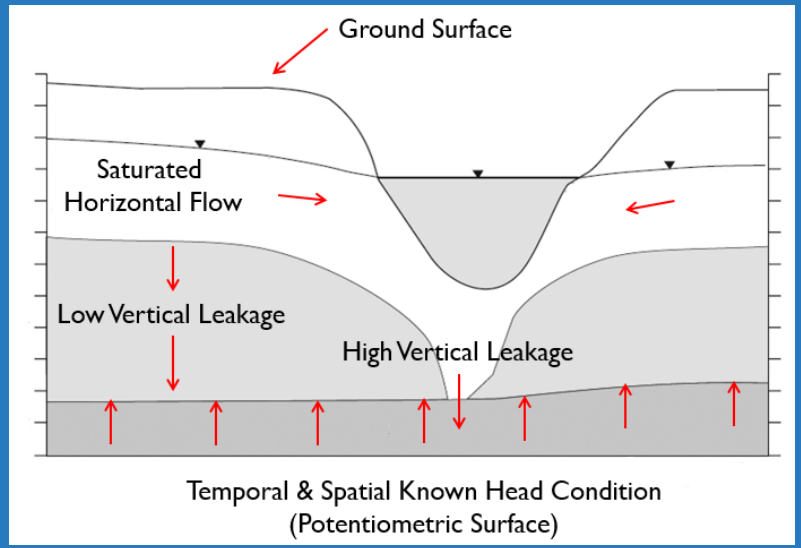
2D SW Model

2D GW Model

Integrated Model

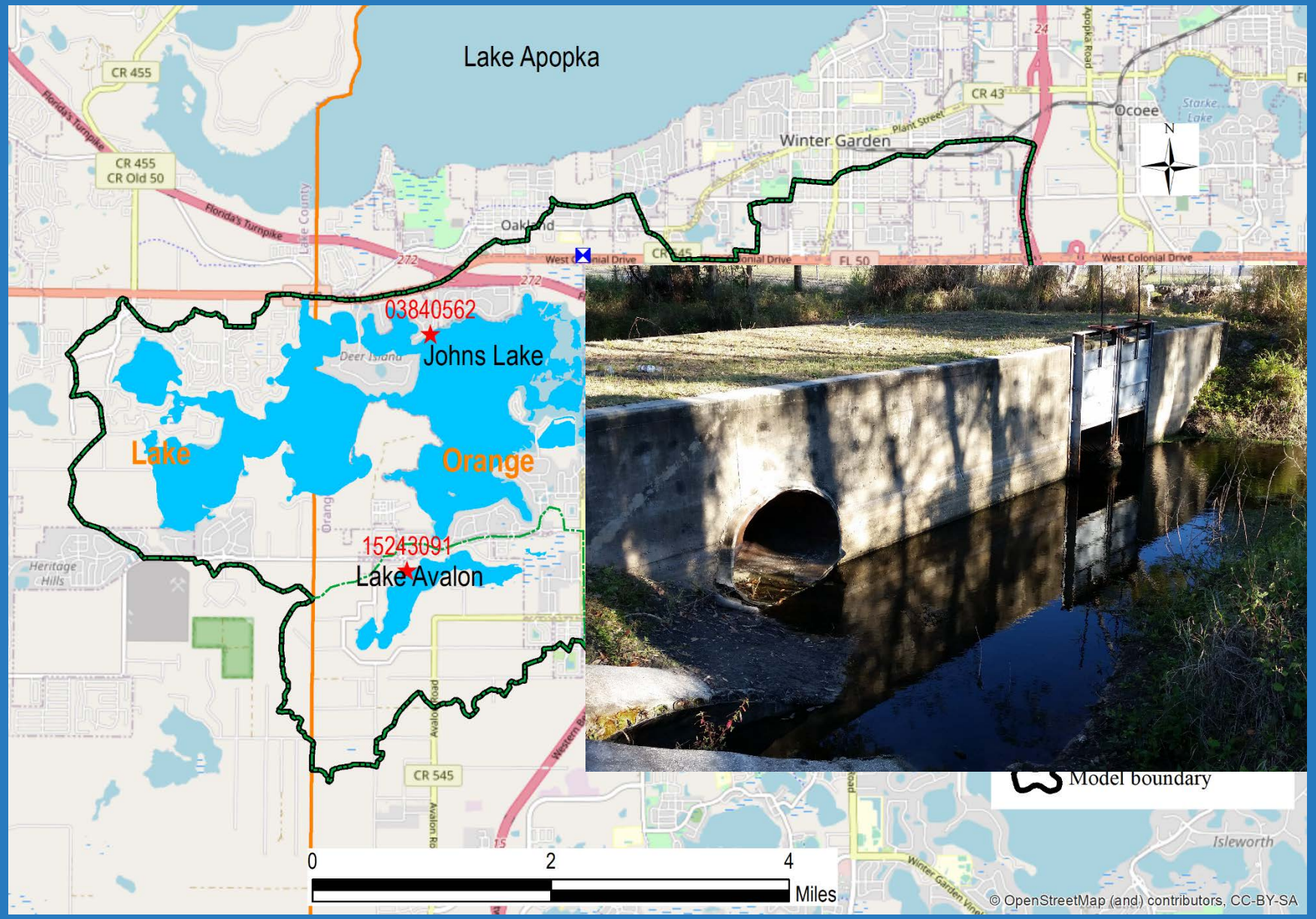
Run

Outputs

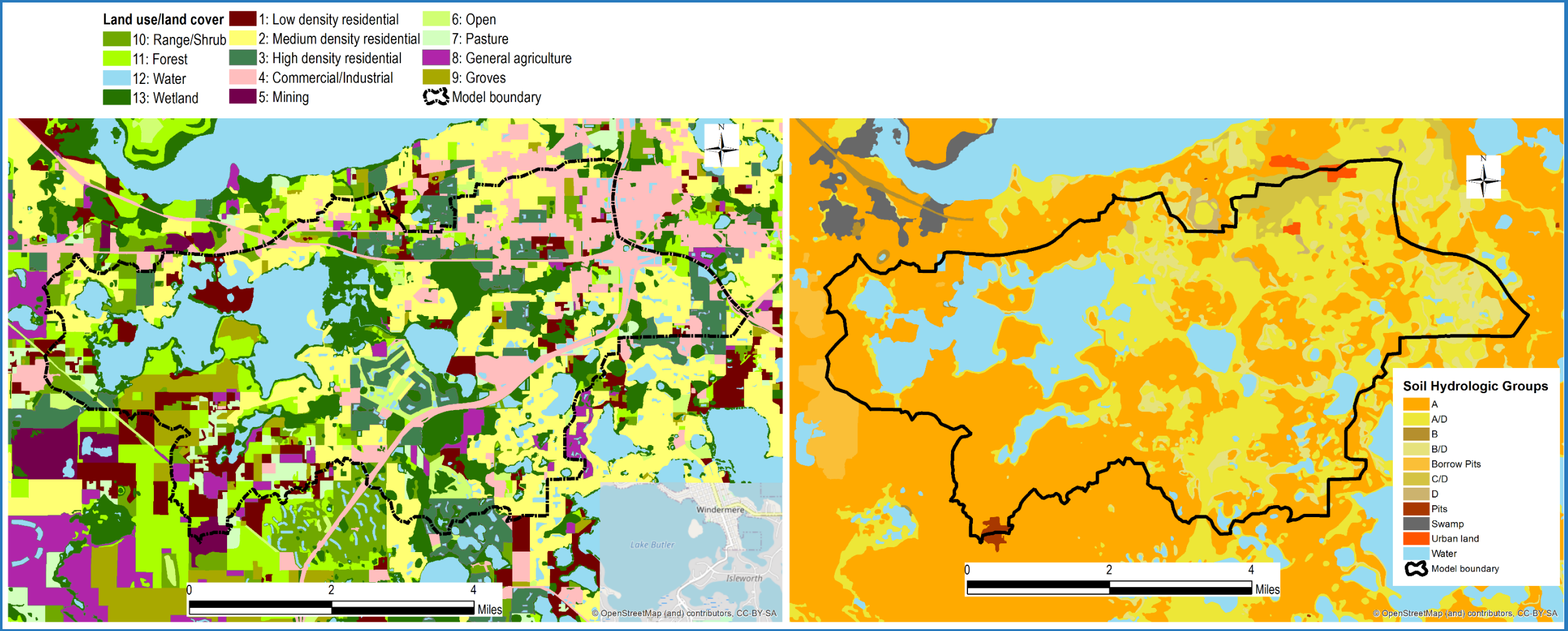


Johns Lake Watershed

- Located in Orange & Lake counties
- Outfall Culverts
- Major inflows from Black Lake
- Wetland systems in SE



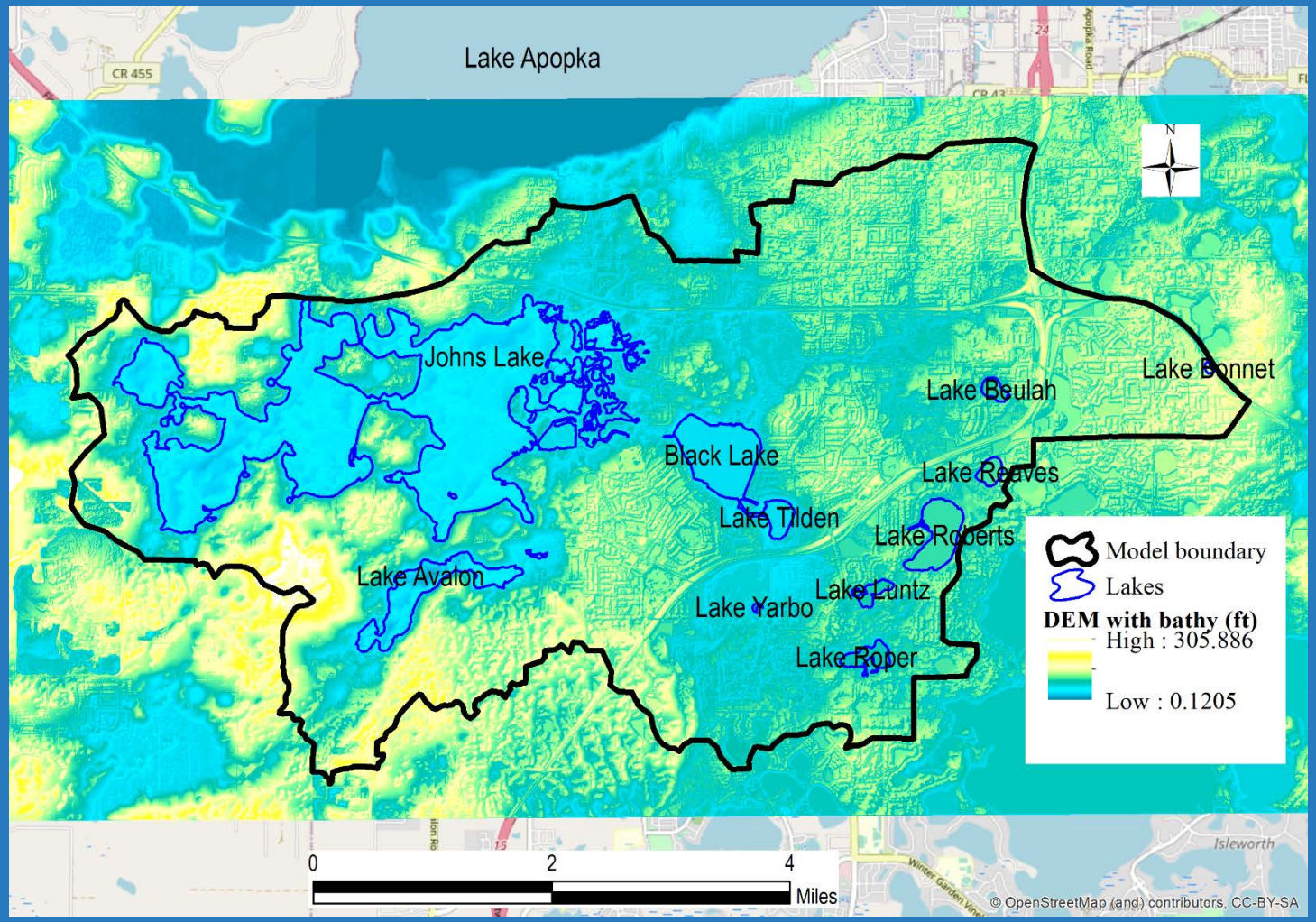
Land Use and Soil



- Modified LULC2014 (CWR, 2019) with SJRWMD LULC2014
- Vertical layers' properties based on SSURGO dominant component keys

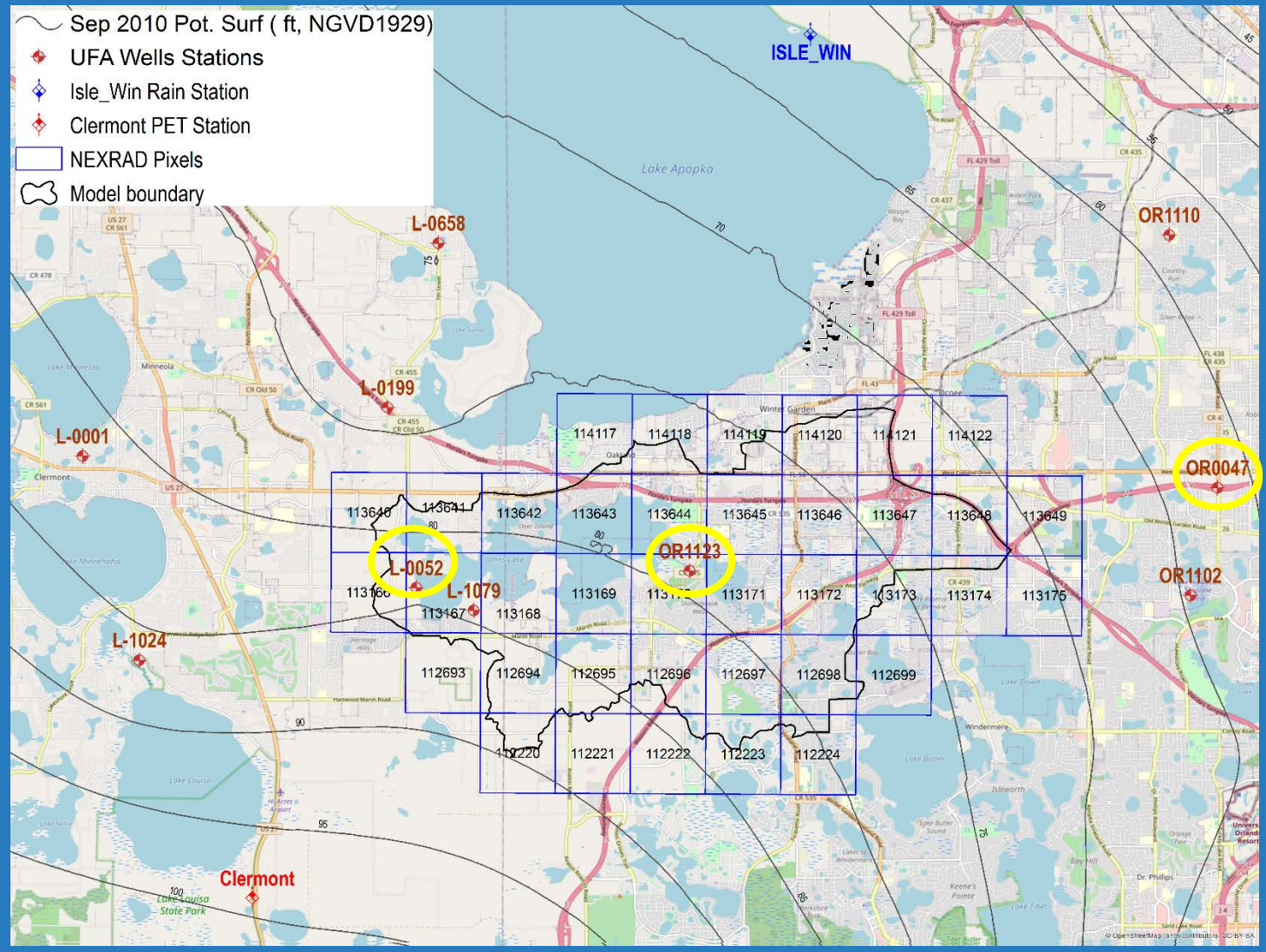
DEM with Bathymetry

- LiDAR-derived contours
- Field survey
- Digitized aerial photographs

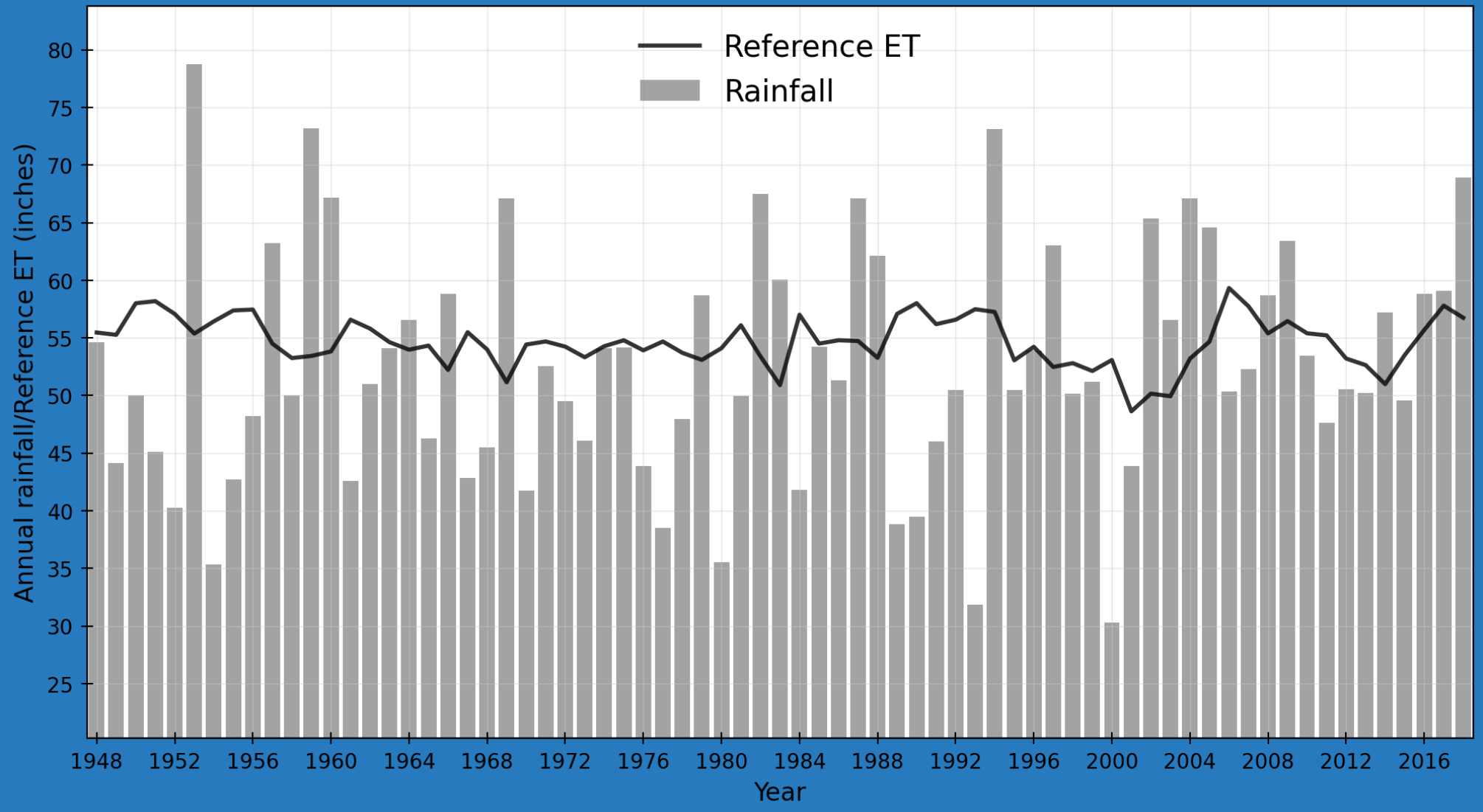


Hydro-meteorological stations

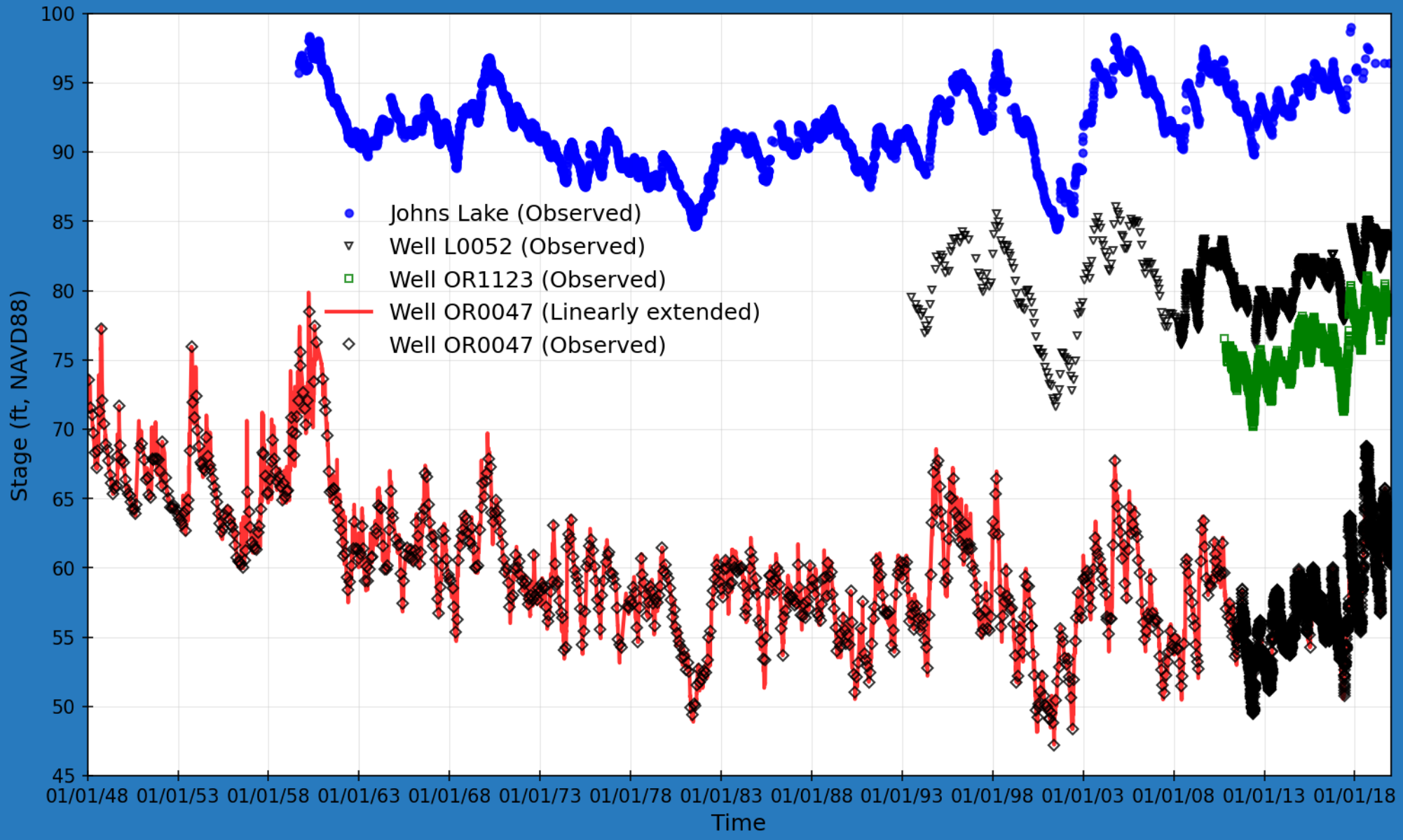
- **Rainfall (NEXRAD + ISLE_WIN)**
- **Reference ET (USGS + Clermont)**
- **UFA levels (OR1123, L-0052, and OR0047)**



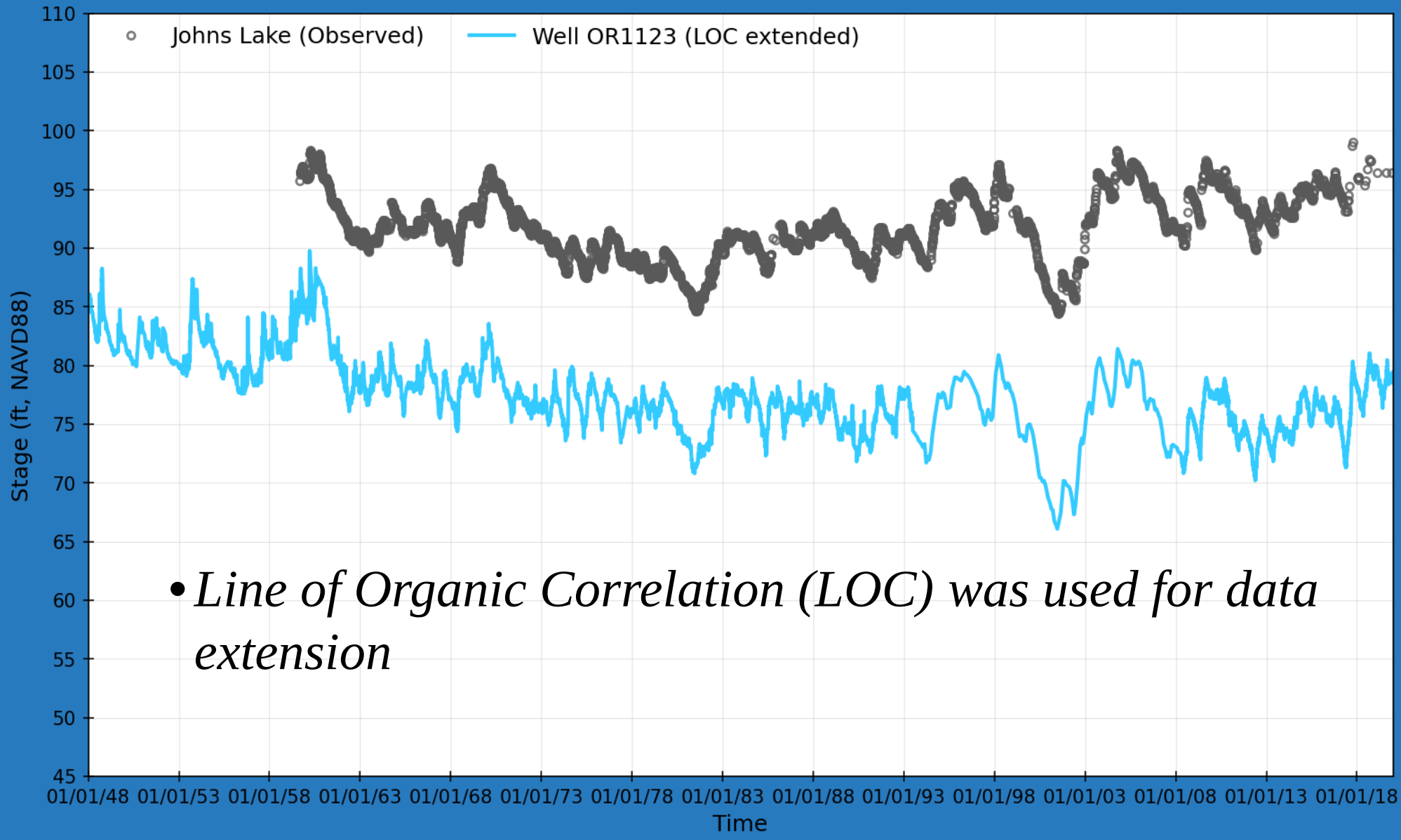
Rainfall and RET



Available Groundwater Levels

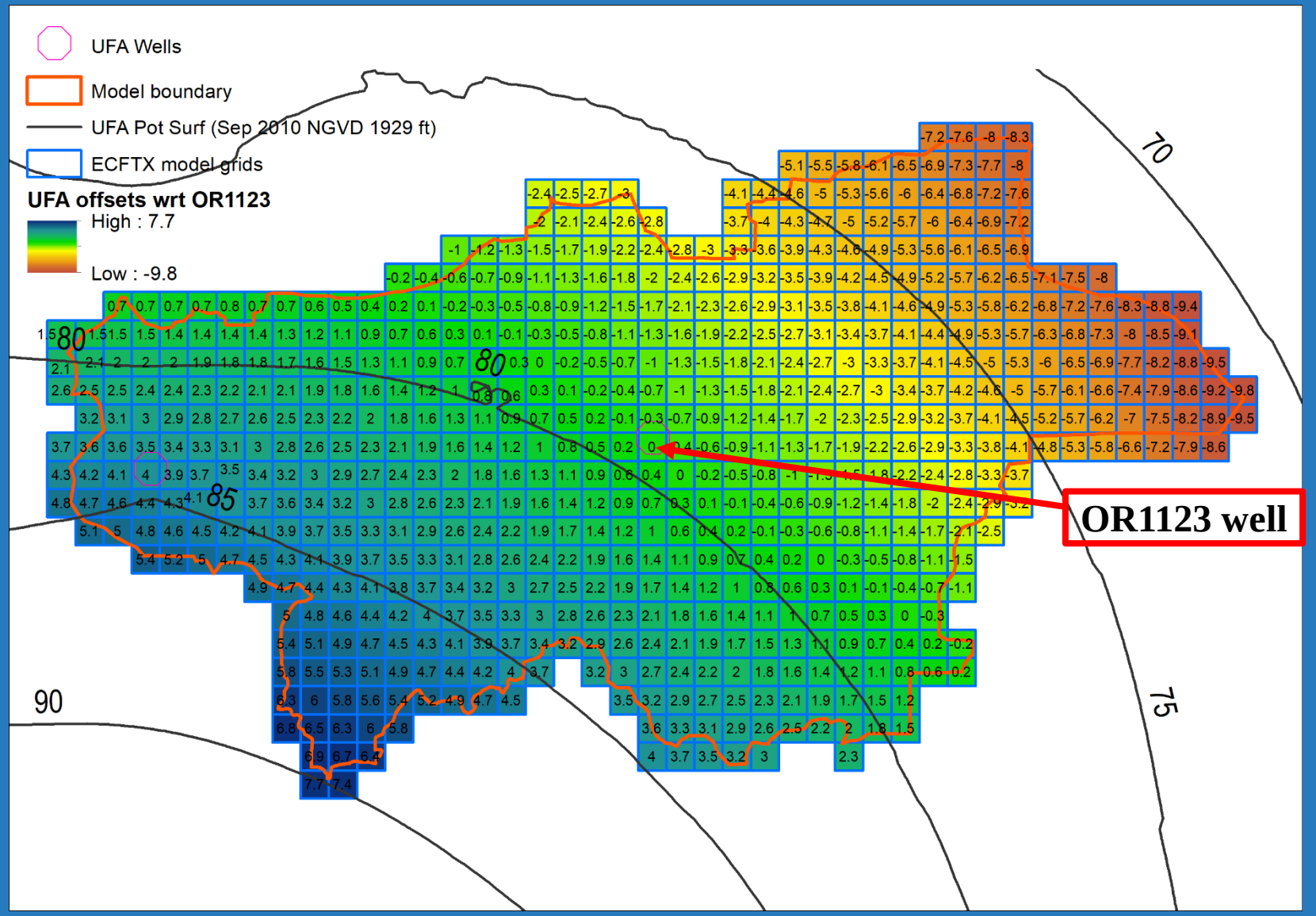


Extended UFA Levels



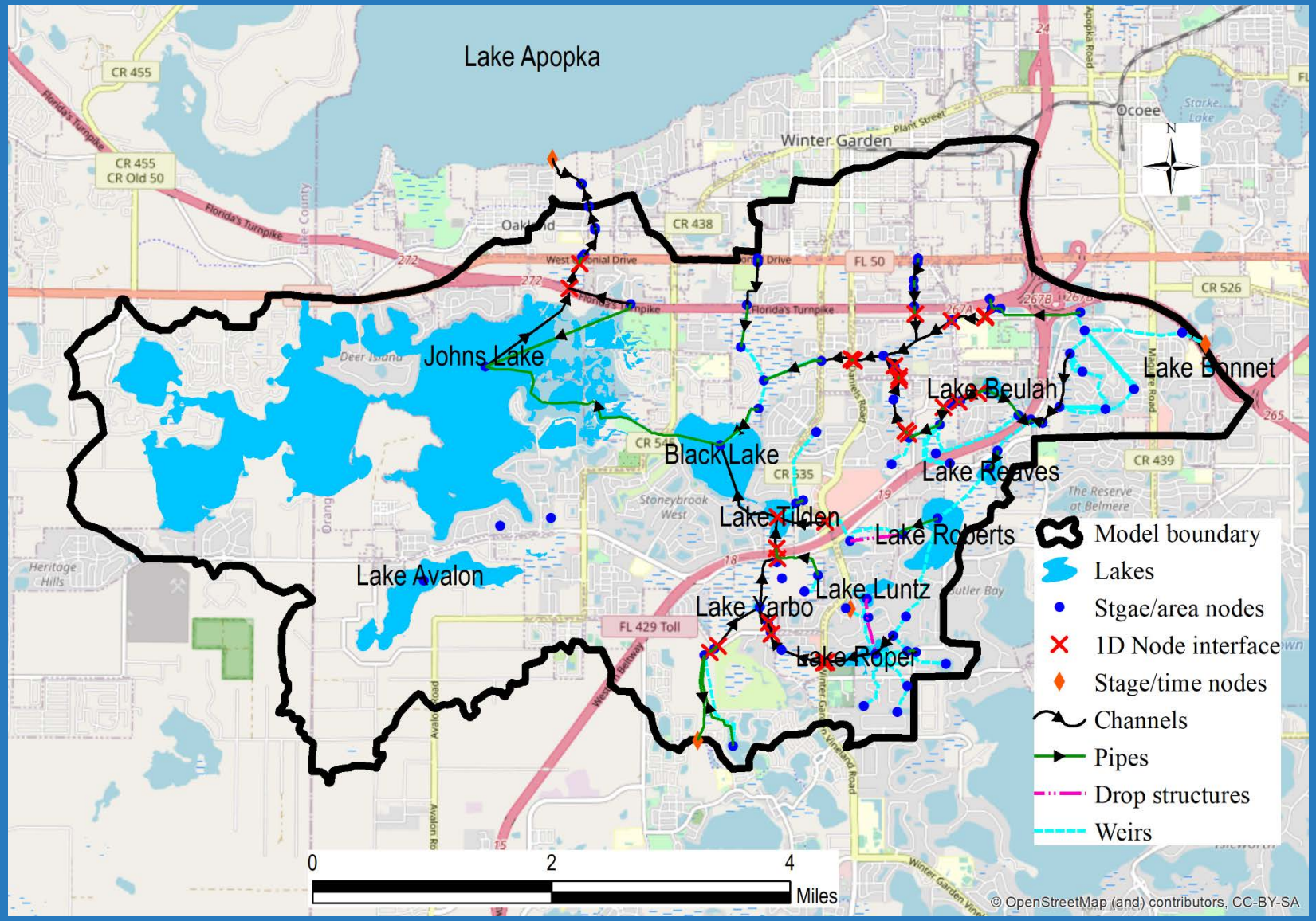
- *Line of Organic Correlation (LOC) was used for data extension*

OR1123 Data Used with POT offsets



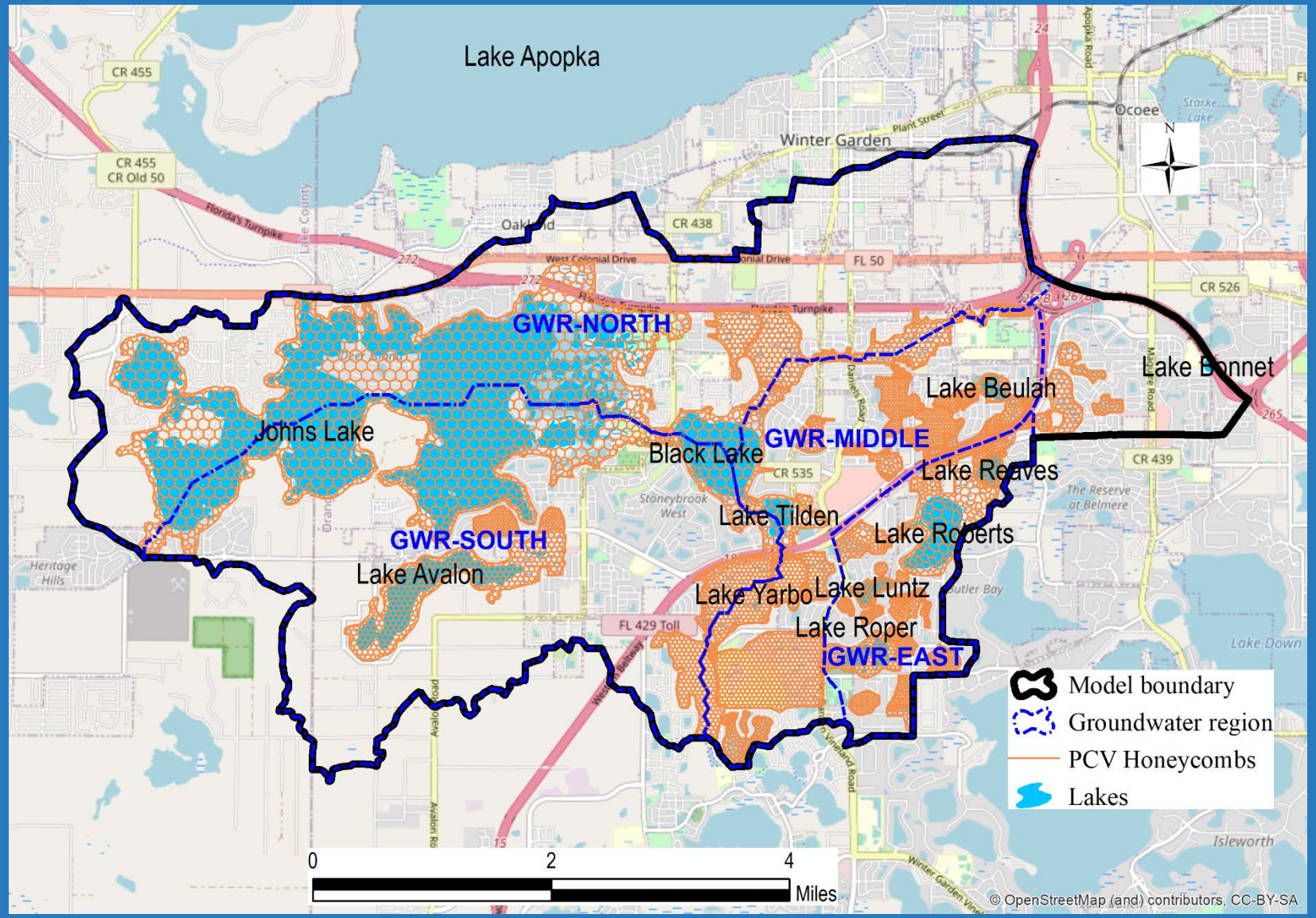
Hydrological Model Set-up

- 58 sub-watersheds (mapped-basins)
- Stage nodes
- Links (channel, pipe, drop structure, & weir)



Groundwater Region (GWR) Representation

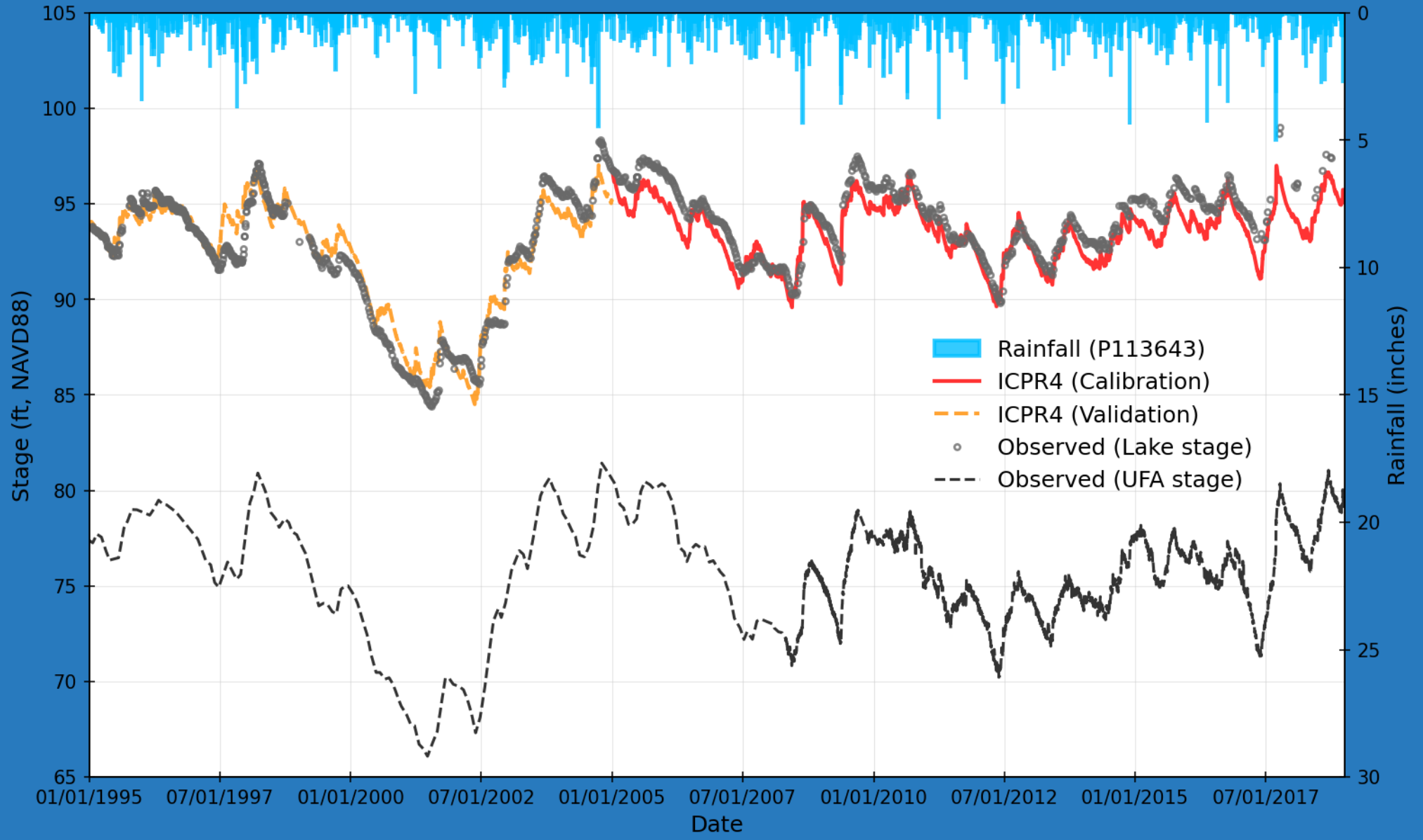
- **Four GW regions**
  - **North**
  - **South**
  - **Middle**
  - **East**



Hydrologic Model Calibration/Validation

- **Calibration Period**
  - **1/1/2005- 12/31/2018**
- **Validation Period**
  - **1/1/1995-12/31/2004**

Calibration/Validation Results



Hydrologic Model Performance

Statistics			Period	
Description	**Symbol**	**Target value**	**Calibration (cal)**	**Validation (val)**
Nash-Sutcliffe Efficiency	NSE	≥0.8 (cal) & 0.7 (val)	**0.73**	0.92
Root Mean Squared Error	RMSE	≤ |±1| ft	0.93	0.92
Mean Error	ME	≤ |±1| ft	-0.73	0.15
Absolute Mean Error	AME	≤ |±1| ft	0.81	0.71
Percent Bias	PBIAS	≤ |±10%| (cal) & |±15%| (val)	-0.78	0.17
Pearson Correlation Coefficient	R	≥0.8 (cal) & 0.7 (val)	0.95	0.96
Percent of observations bracketed within ± 1ft	±1ft (%)	≥0.85 (cal) & 0.75 (val)	**65.20**	**71.69**

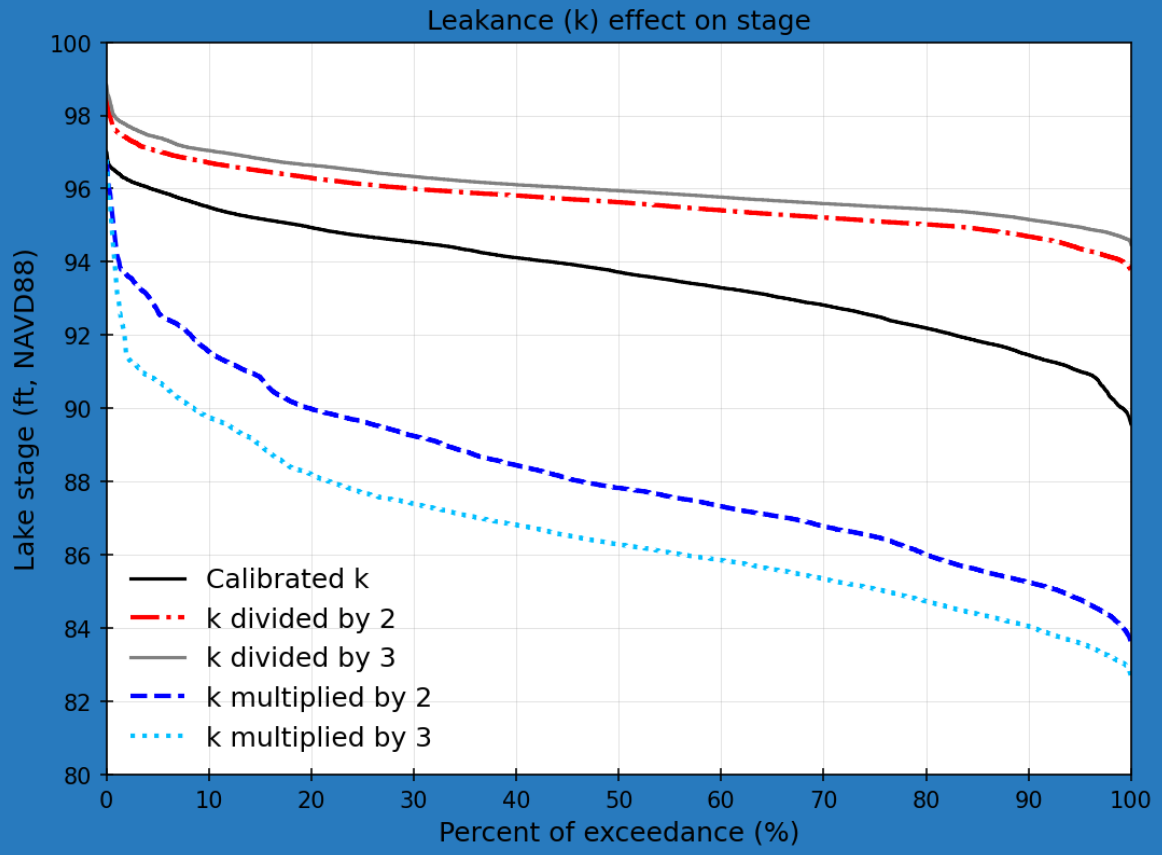
Johns Lake Water Balance

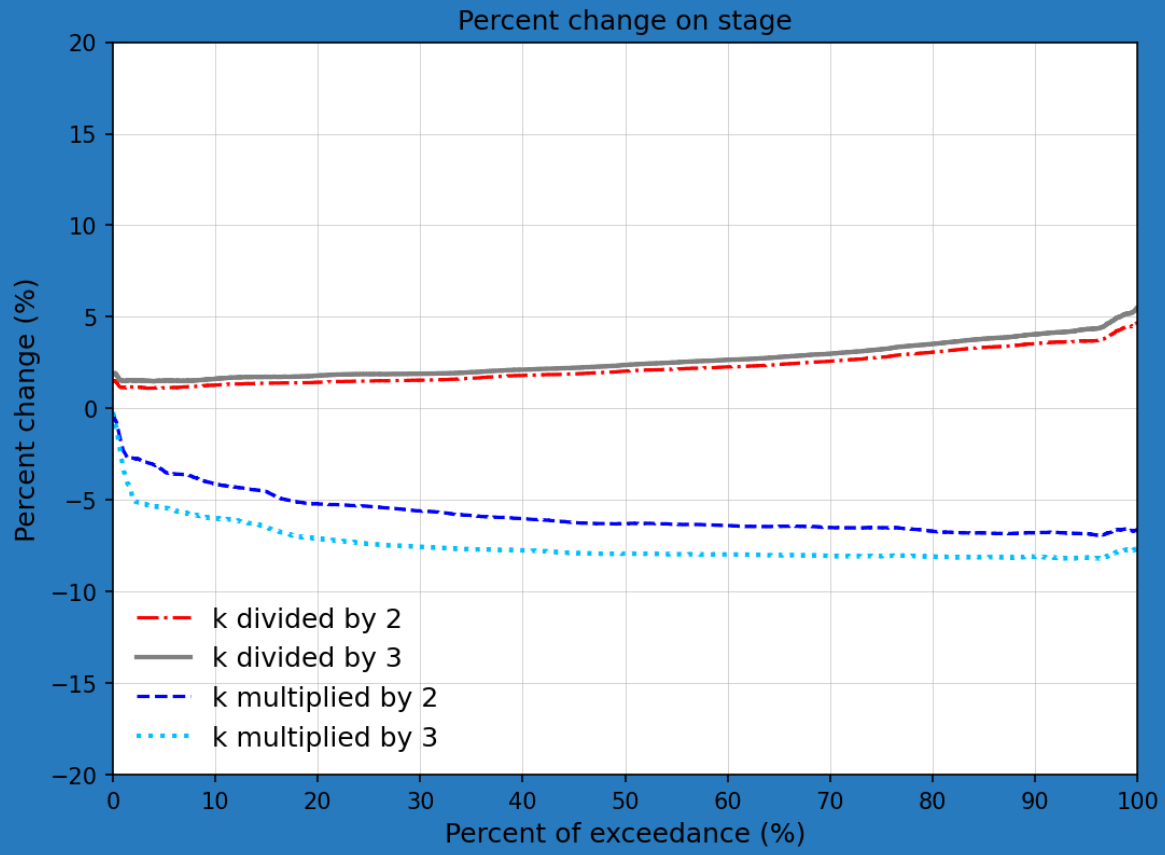
Components	Calibration (2005-2018)		Validation (1995-2004)	
	Flux (in/yr)	Percent	Flux (in/yr)	Percent
Total inflows	**219.2**		**196.3**	
Direct rainfall	49.9	22.8	44.1	22.5
Black Lake inflow	125.4	57.2	117.1	59.6
Watershed baseflow	32.9	15.0	26.4	13.5
Watershed runoff	11.1	5.1	8.7	4.4
Total outflows	**221.1**		**196.0**	
Evapotranspiration	45.0	20.3	39.9	20.4
Initial abstraction	1.6	0.7	1.7	0.9
Infiltration	52.9	23.9	46.0	23.5
Johns outflow	10.2	4.6	7.3	3.7
Vertical seepage	111.3	50.4	101.1	51.6
Surface Storage Change	**-2.0**		**0.3**	

Sensitivity Analysis

Parameter	Description	Calibrated value	Change
Ia	Initial abstraction	Varied with LULC type	Decreased by 10% or 20% Increased by 10% or 20%
kc	Crop coefficient	Varied with LULC type	Decreased by 10% or 20% Decreased by 10% or 20%
kv	Vertical Saturated Hydraulic Conductivity	Varied with soil type	Divided by 2 or 3 Multiplied by 2 or 3
kh	Horizontal saturated hydraulic conductivity	40 feet per day	Divided by 2 or 3 Multiplied by 2 or 3
k	Leakance	Varied with zones	Divided by 2 or 3 Multiplied by 2 or 3

Leakance (k) value





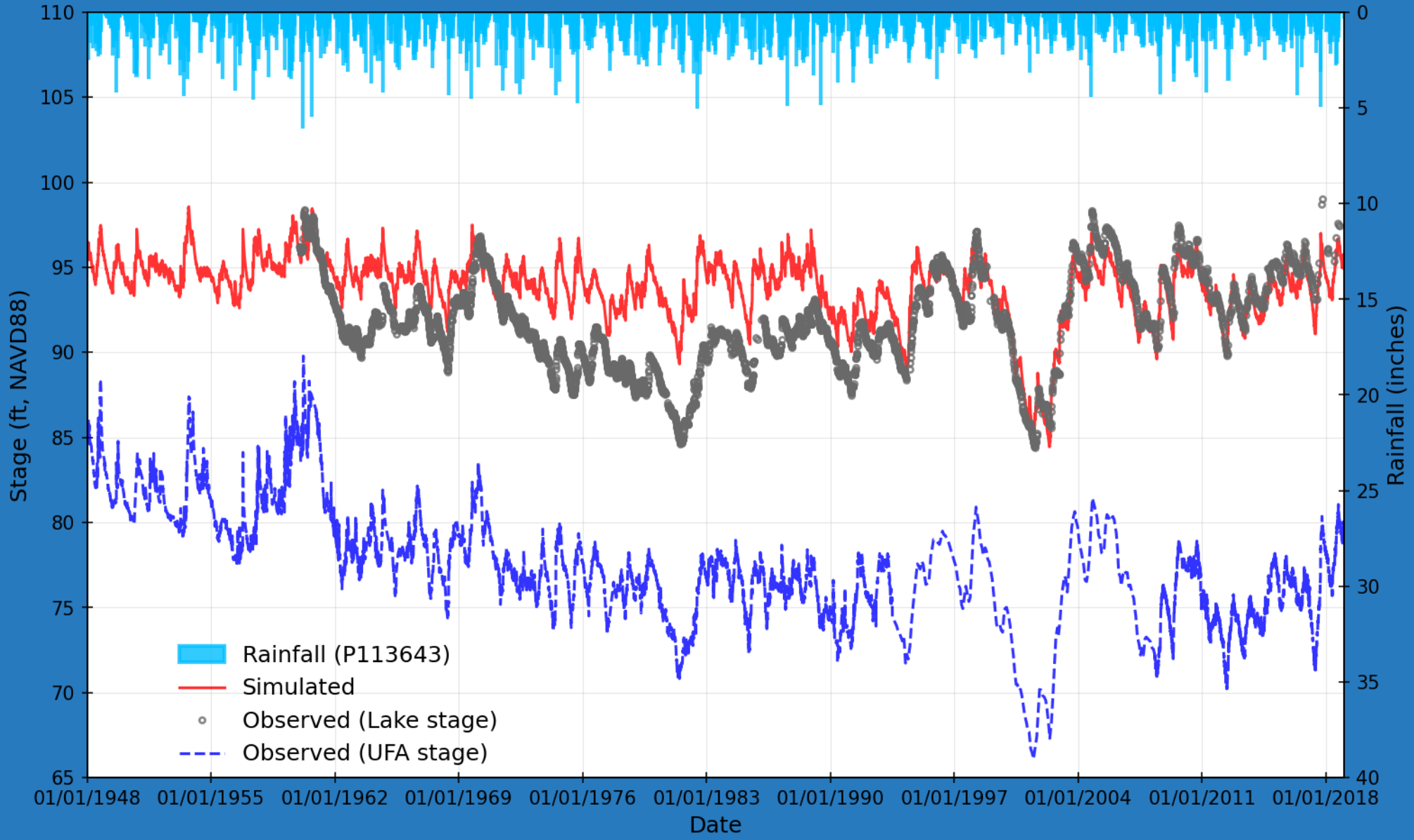
Sensitivity Analysis Takeaways

- **Parameter of leakance k is the most sensitive parameter**
- **kh and kv are the parameters with medium sensitivity**
- **Parameters of la and kc have the lowest sensitivity**

Long-term Simulation

- **Calibrated model was run from January 1, 1948 to December 31, 2018**
  - **Extensions of:**
    - **Hourly rainfall (composite dataset ISLE_WIN and NEXRAD)**
    - **Daily RET (composite dataset Clermont and USGS)**
    - **Daily UFA groundwater levels**
  - **All the hydrologic parameters were kept the same.**

Long-term Results



Questions?

Next Steps

• Teleconference (Reviewer to discuss initial findings)	April 6, 2022
• Draft model review TM	April 27, 2022
• Teleconference (Discuss draft TM)	May 5, 2022
• Final TM	May 24, 2022
• Draft MFLs Report	Mid 2023
• Rulemaking	End of 2023

For more information on the Johns Lake ICPR model and MFLs development go to:

https://www.sjrwmd.com/minimumflowsandlevels/johns-lake/

…or email Andrew Sutherland at:

asutherl@sjrwmd.com