Lake Prevatt MFLs

HSPF Model Peer Review
Kick-off Meeting

12/11/2023

St. Johns River
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Agenda

- Overview of Lake Prevatt and MFLs process
- Overview of HSPF model development
- Comments / Questions
- Site visit

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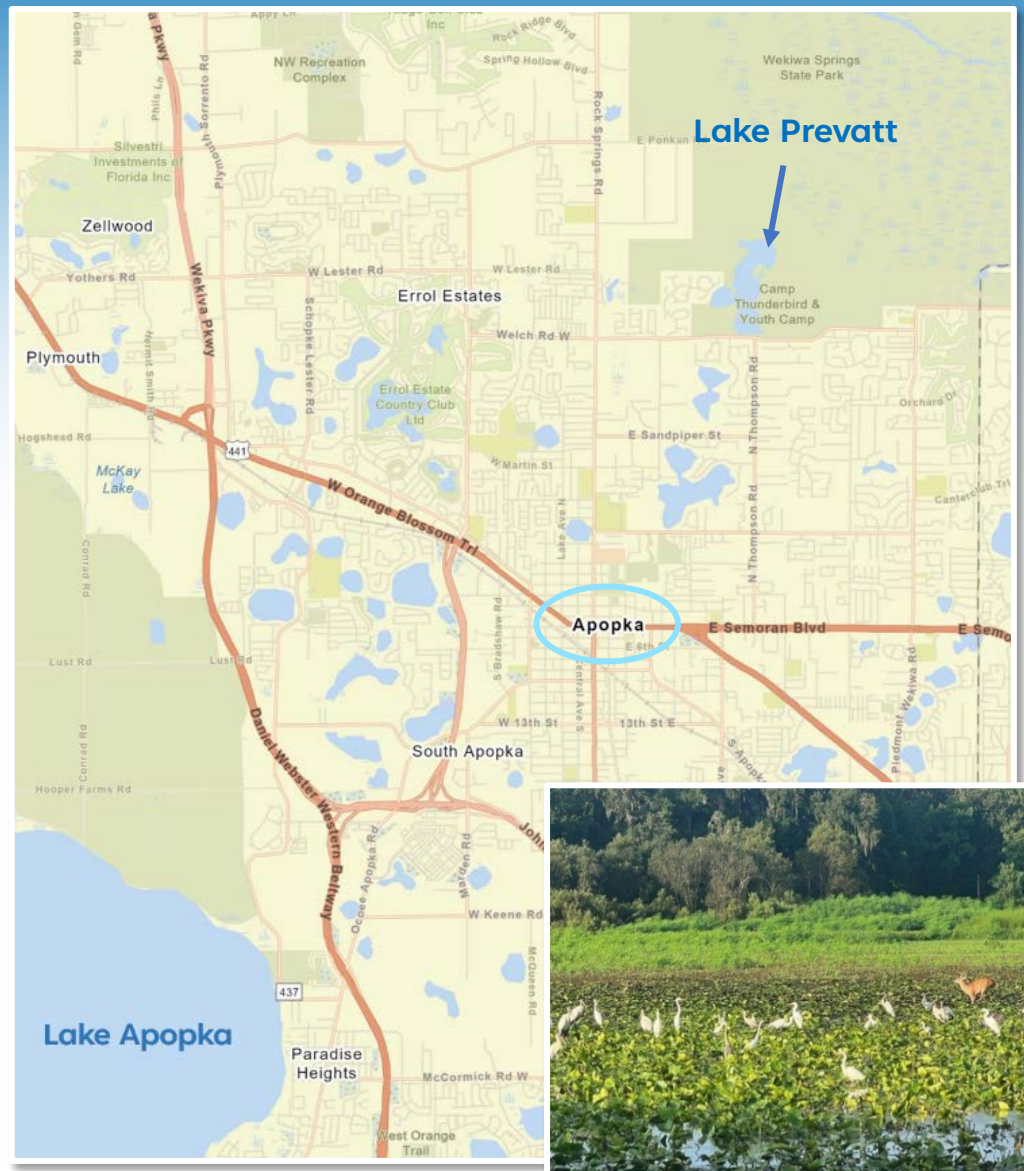
Lake Prevatt

- Located in Orange County, north of Apopka
- Within Wekiva Springs State Park (OFW)
- Watershed area = ~27 mi²
- ~99-acre lake; flows to Rock Springs Run
- important habitat for wading birds, fish, and wildlife.
- regionally important recreation resource
  - hiking trails
  - youth camping cabins
  - access for canoeing and kayaking from an additional youth camp



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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.)

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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

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MFLs 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)
- Compare the MFLs and current-pumping conditions to determine if water is available (freeboard)

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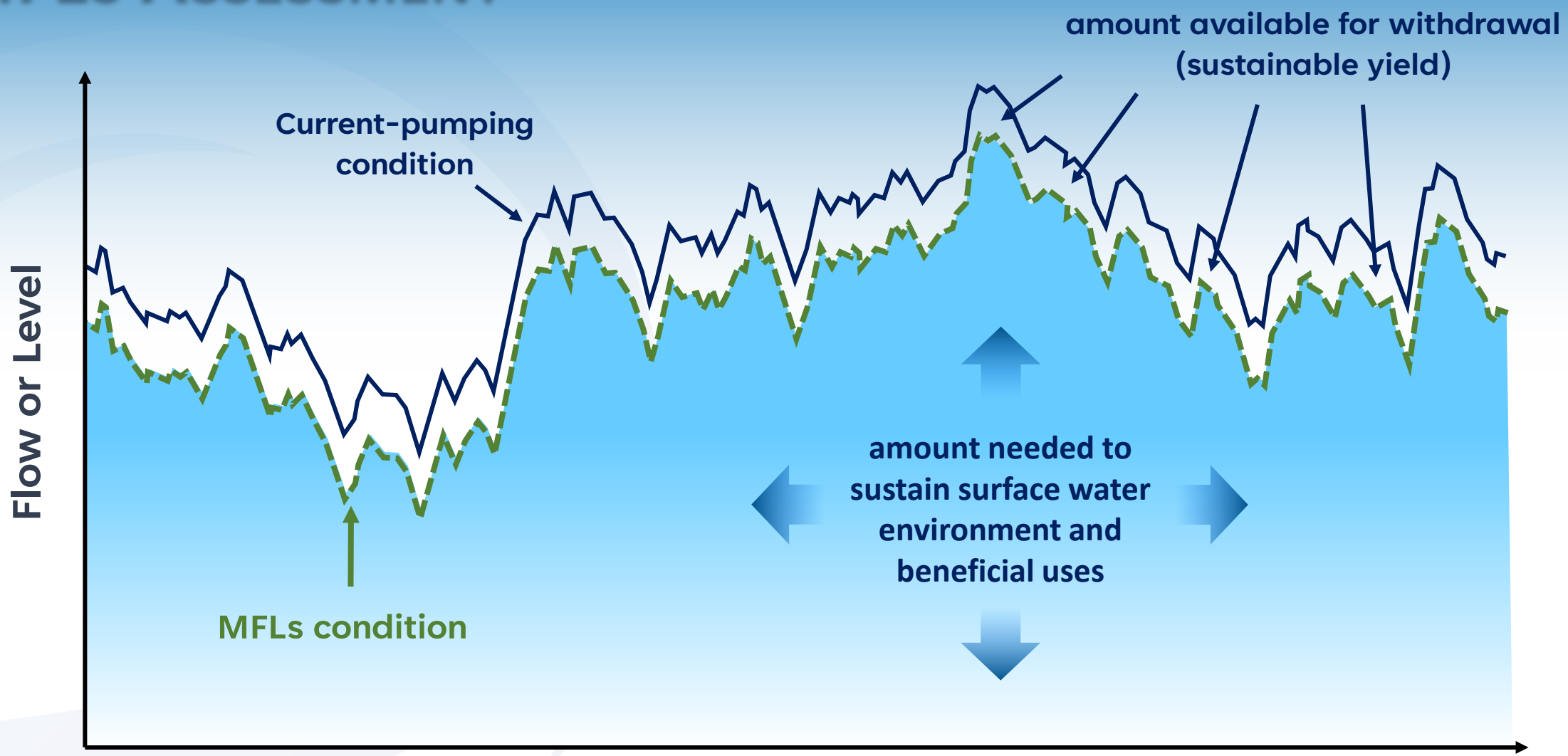
MFLs Assessment



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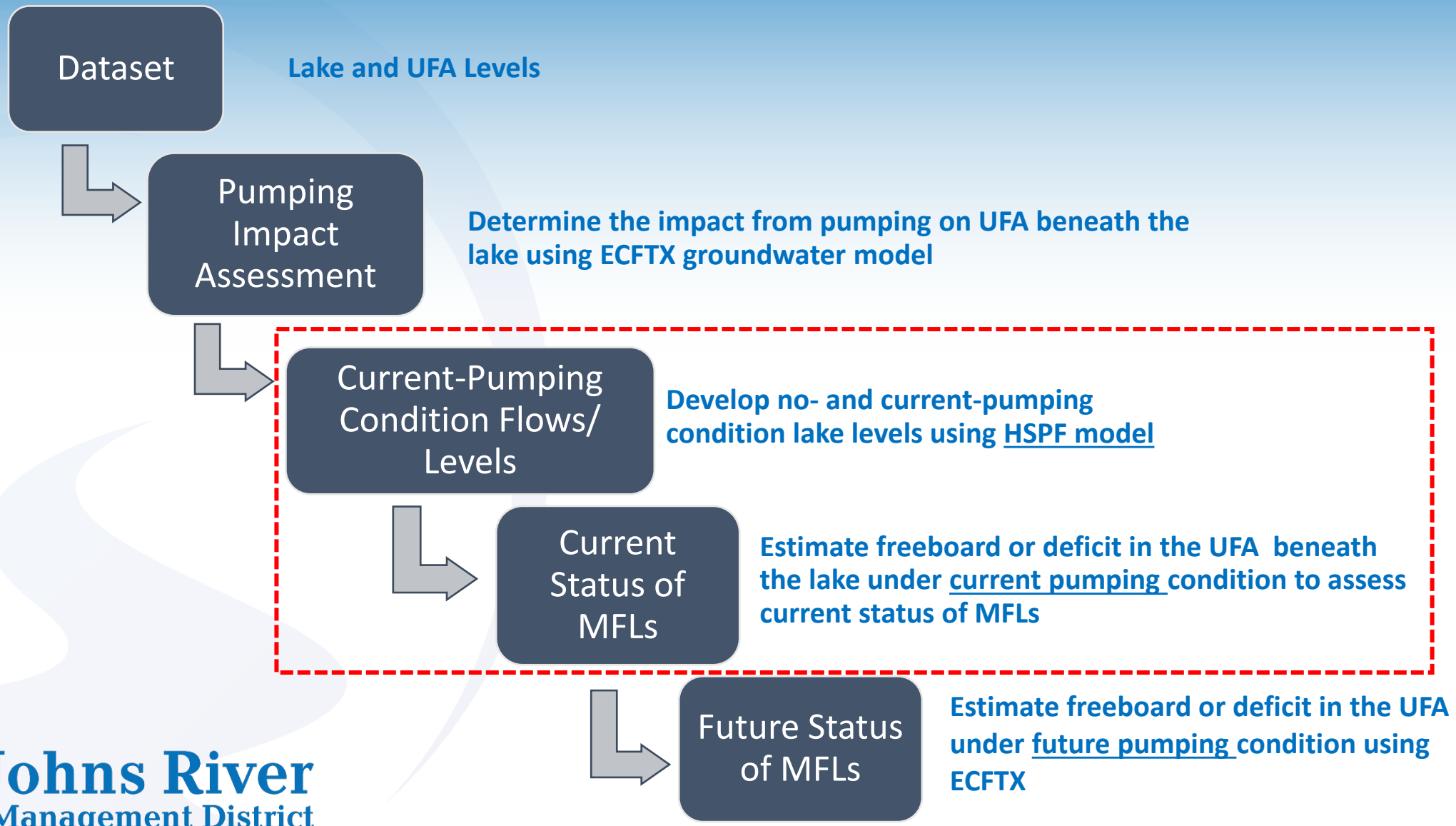
Hydrological Analyses



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Use of HSPF Model for MFLs

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

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Model Simulations

- Long-term simulations (1953-2020)
- Scenarios (by adjusting UFA boundary condition)
  - No-pumping condition simulations
  - Current-pumping condition simulations

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Peer Reviewer

- Jeffrey King, PhD, PE (Geosyntec Consultants, Inc)

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Lake Prevatt

Hydrologic Modeling

Tom Jobes, Awes Karama, PhD, and Shiblu Sarker, PhD

Bureau of Watershed Management & Modeling

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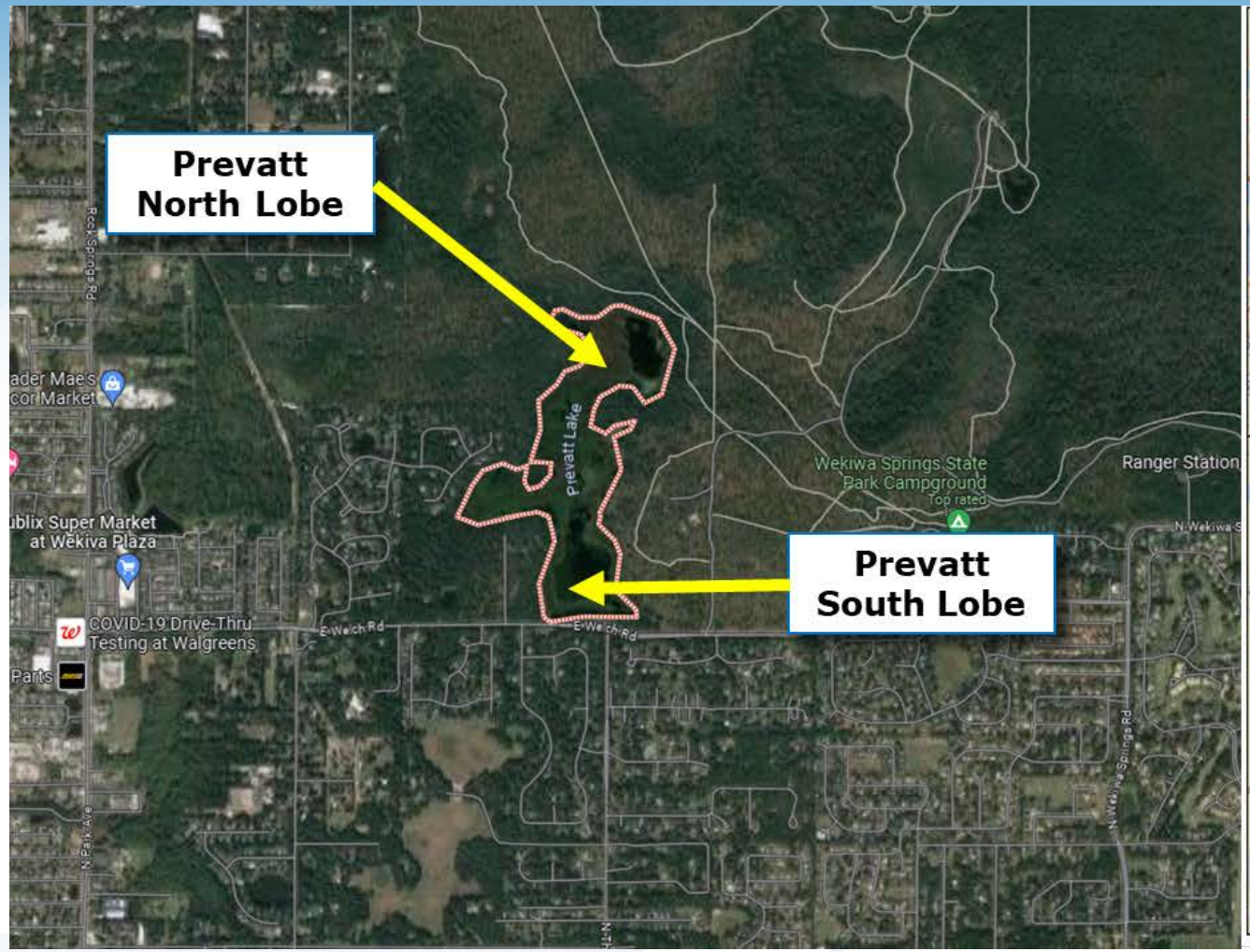
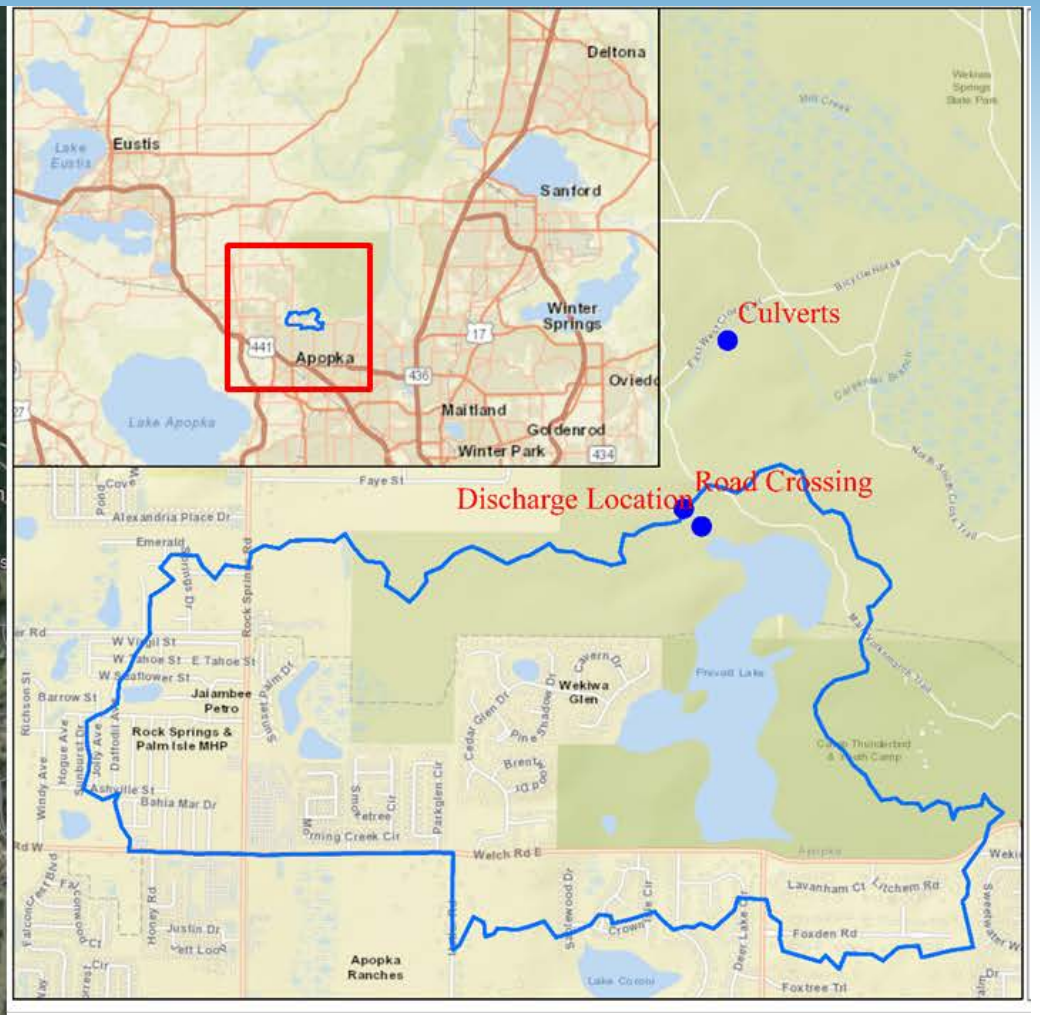
Prevatt Lake Watershed Location





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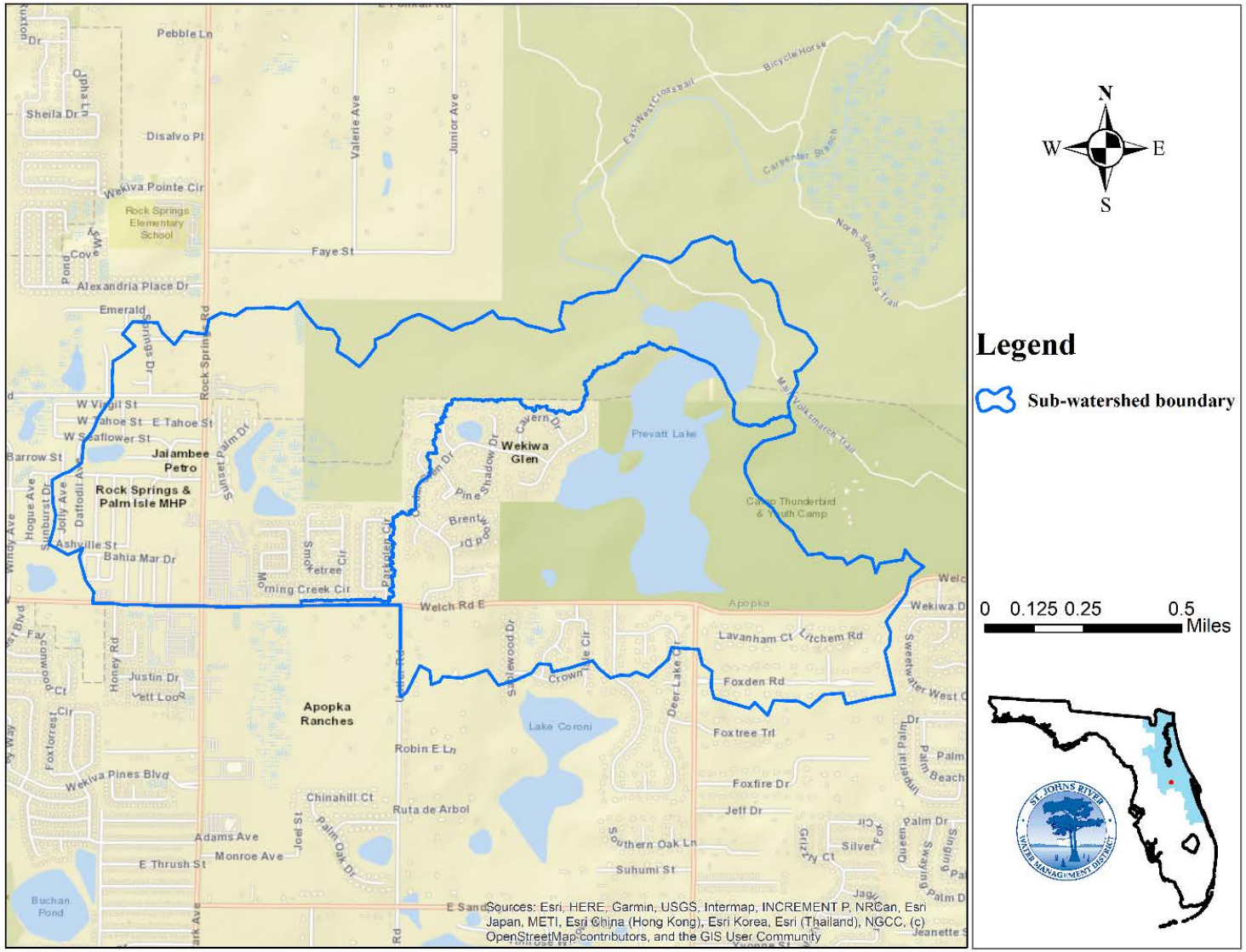
Prevatt Lake Watershed



Prevatt Lake Area: 100 acres

Prevatt Lake Watershed

- Total Area: 1039 acres
- North Lobe: 531 acres
- South Lobe: 508 acres

Hydrologic Modeling

- SJRWMD developed an HSPF model to simulate the hydrologic and hydraulic processes, surface water – groundwater interaction, and water budget components of Prevatt Lake and its watershed.
- The model was calibrated and validated for the periods 2008 to 2020 and 1995 to 2007, respectively.
- A long-term simulation model was developed from 1953 to 2020.
- The model uses an hourly time step

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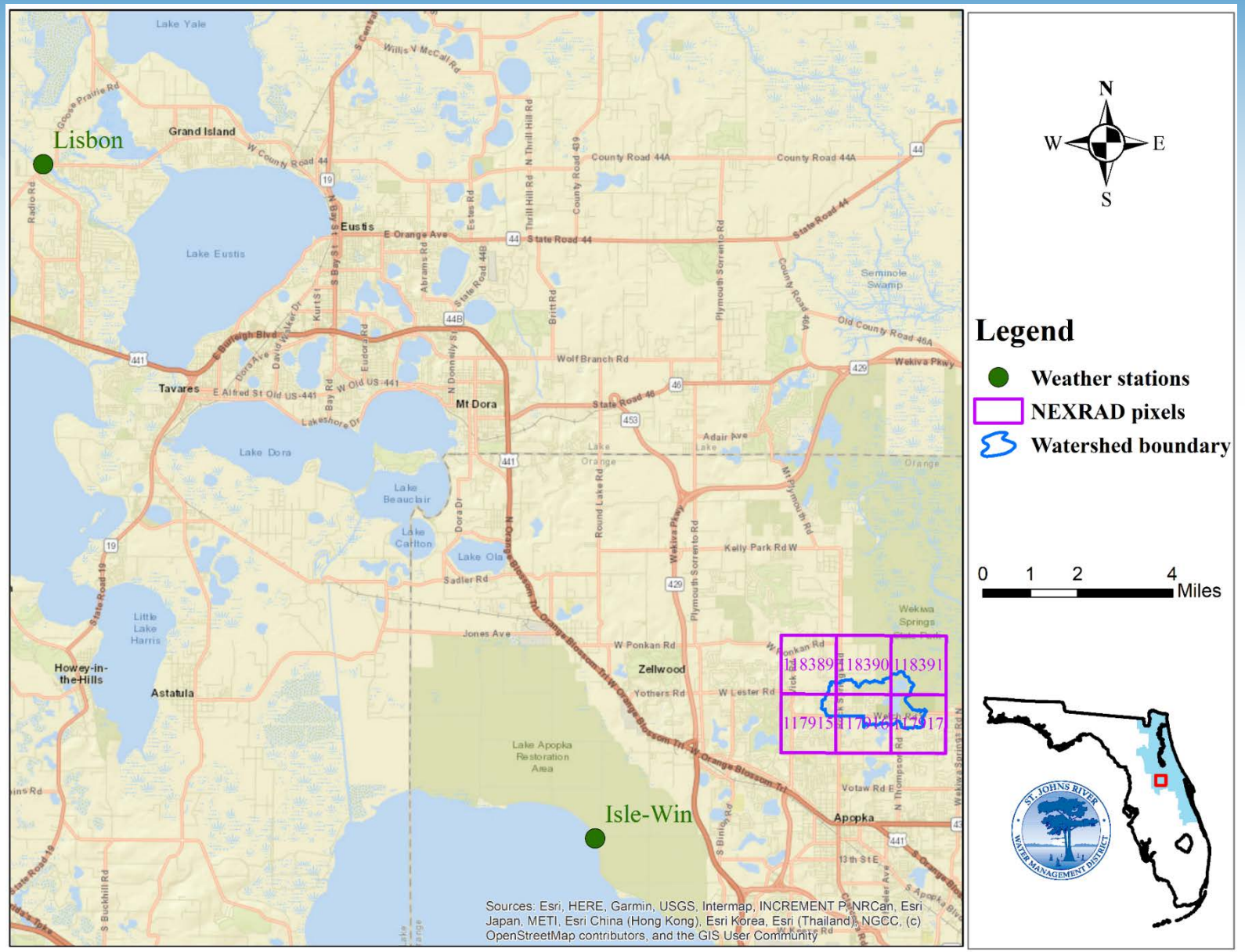
Meteorological Data



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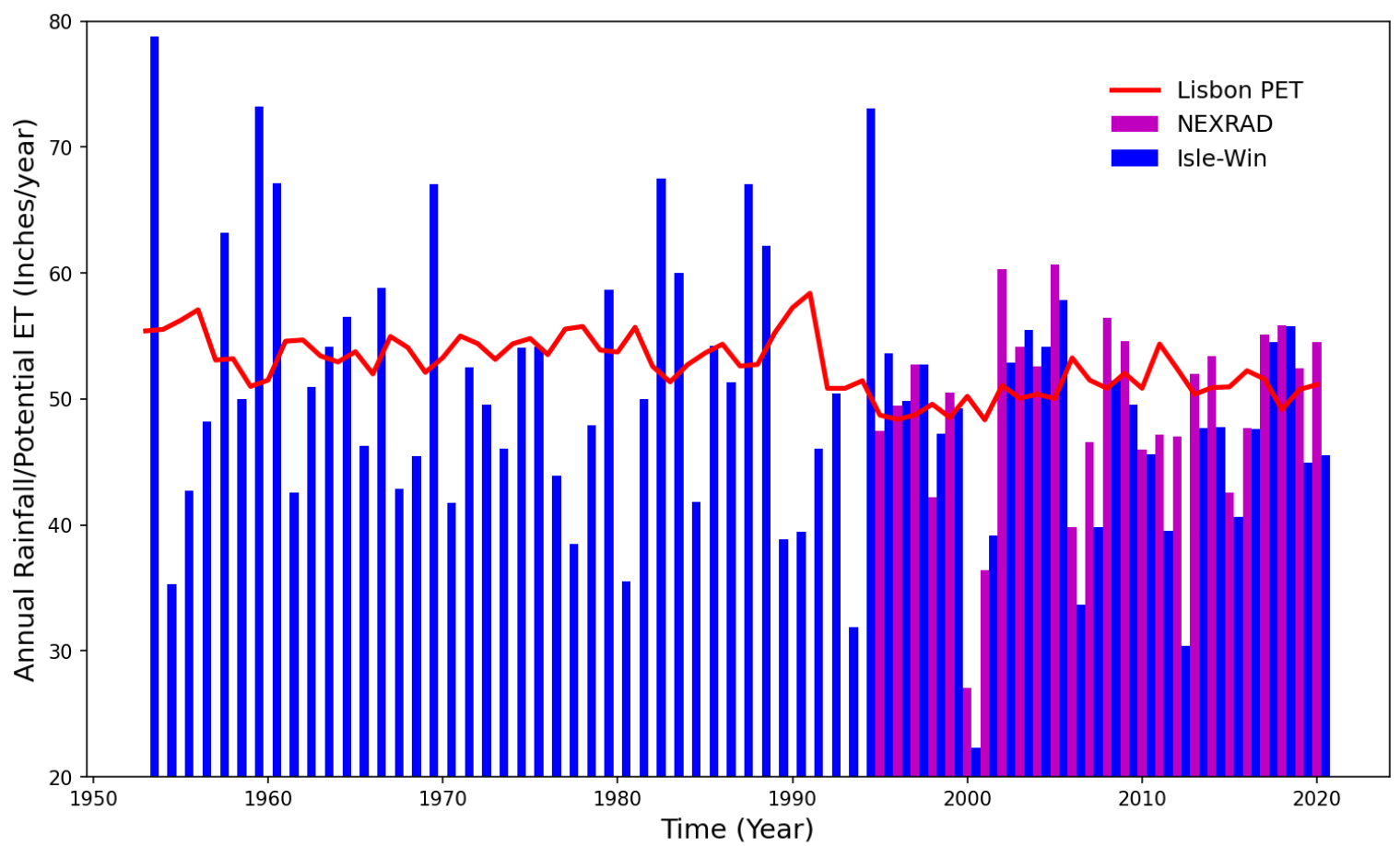
Meteorological Data



Inches/year	NEXRAD	Isle-Win	Lisbon PET
Min	27.0	22.3	48.3
Max	60.6	78.8	58.4
Mean	49.4	49.8	52.6
Start	1995	1953	1953
End	2020	2020	2020

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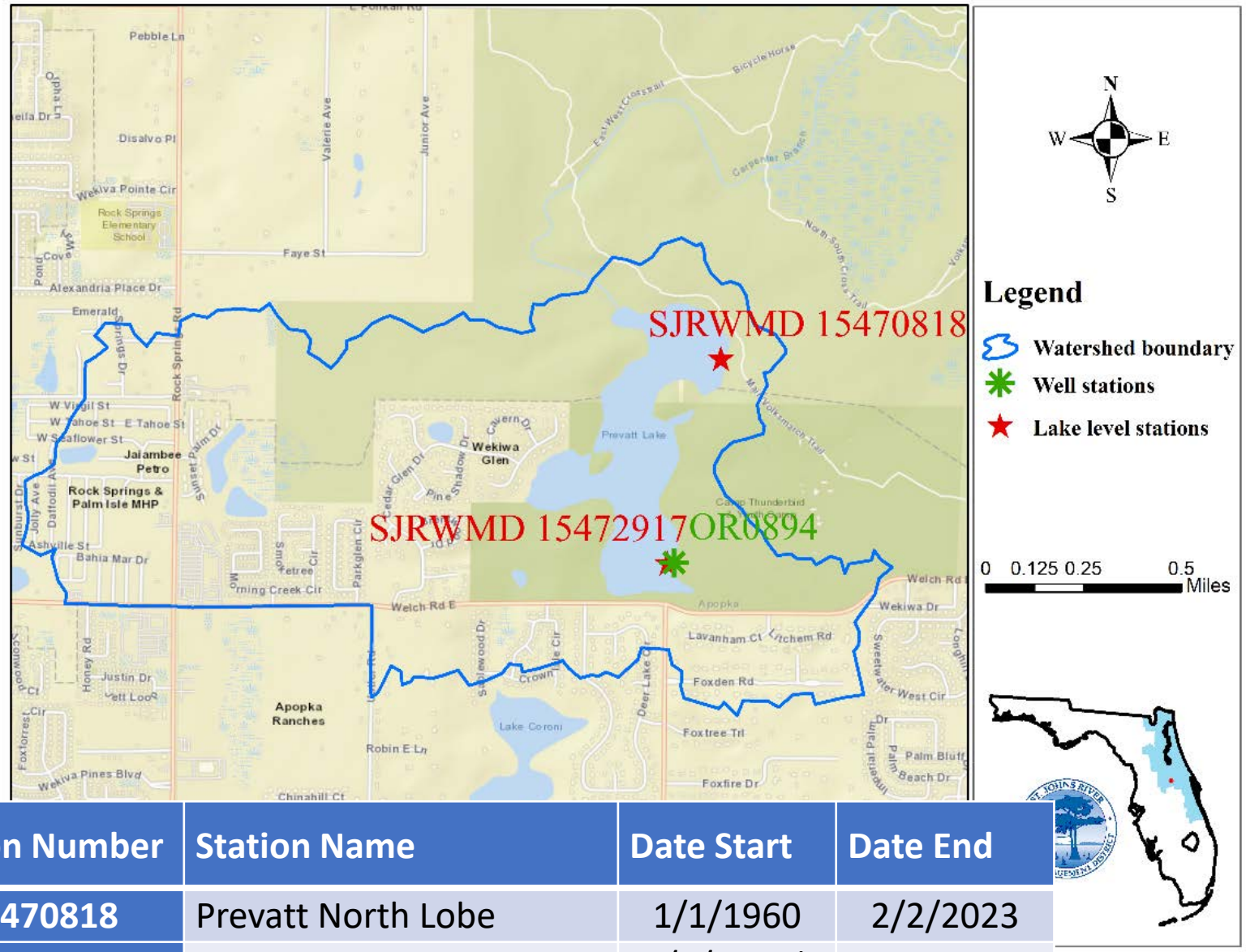
Lake Level Data

Used for calibration and validation



Station Number	Station Name	Date Start	Date End
15470818	Prevatt North Lobe	1/1/1960	2/2/2023
15472917	Prevatt South Lobe	3/1/2010* 5/19/2022	present
OR0894	Prevatt Lake Surficial Aquifer	1/11/2008	present

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South Lobe Data Extension and Adjustment

- North Lobe existing stage recorder has good record (SJRWMD 15470818). However, at low stage the lake divides into north and south lobes.
- An additional station (SJRWMD 15472917) was added to continuously collect South Lobe stage data in 2022. This location had only occasionally sampled stages starting in 2010.
- This South Lobe stage data was extended by using the Line of Organic Correlation method (LOC) to develop a correlation (R^2=0.99) between it and the data from a nearby surficial aquifer well (OR0894).

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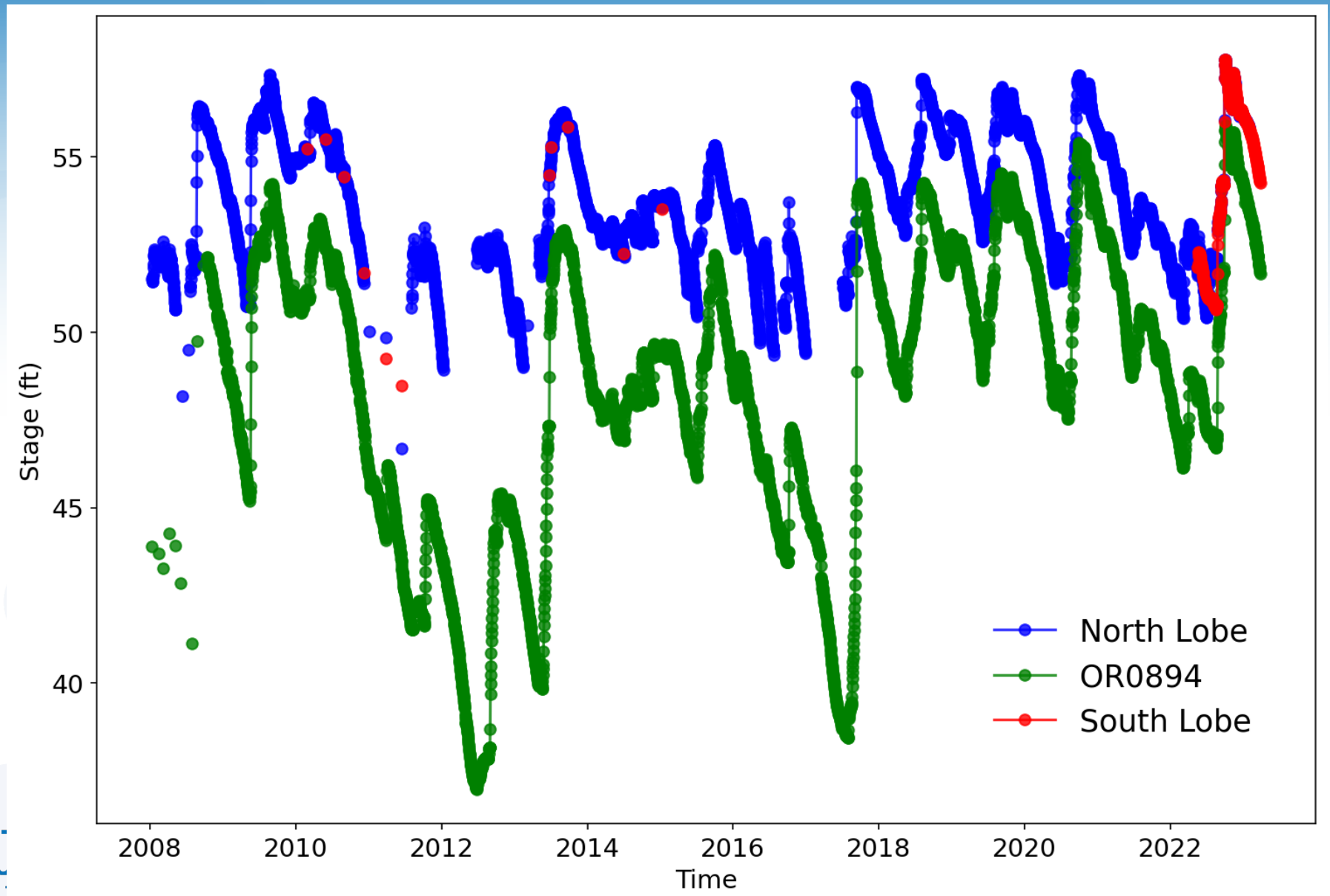

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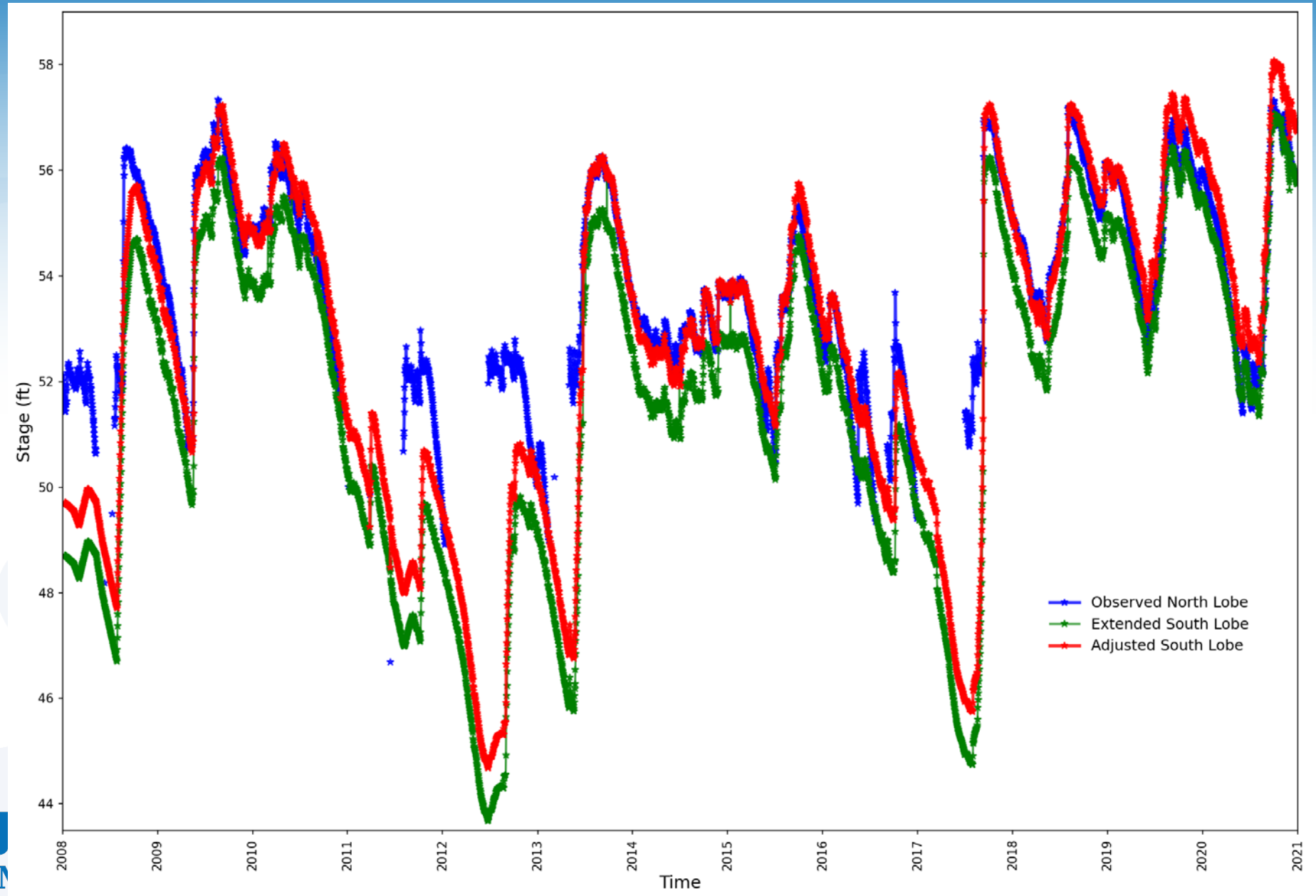
Stage (ft)
58
56
54
52
50
48
46
44
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Time
Observed North Lobe
Extended South Lobe
Adjusted South Lobe

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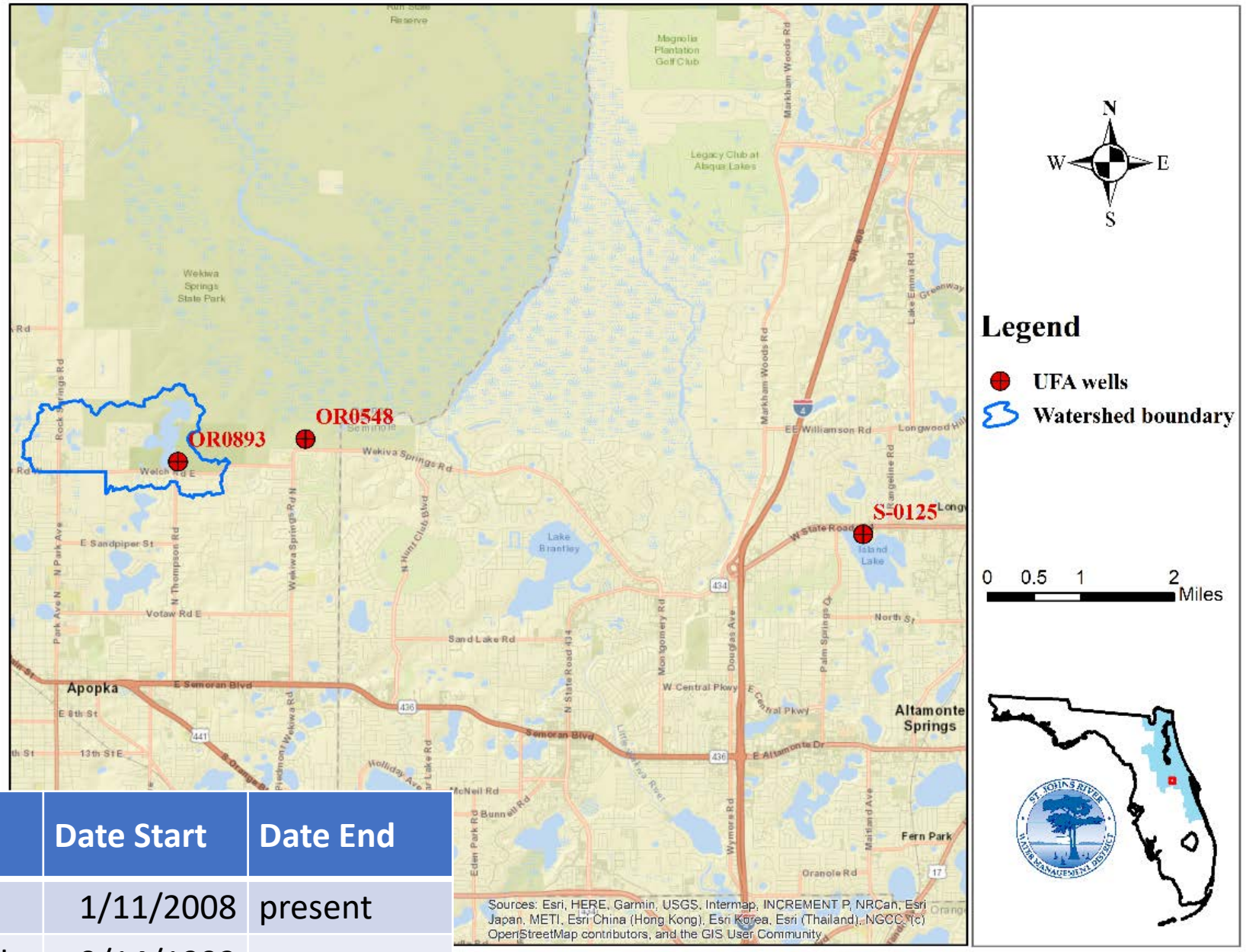
UFA Level Data

Used as a boundary condition for lake-GW interaction



Station Number	Station Name	Date Start	Date End
OR0893	Prevatt Lake UFA	1/11/2008	present
OR0548	Wekiva Springs State Park	9/14/1992	present
S-0125	Seminole Observation Well	10/25/1951	present

OR0893 Extension and Gap Filling Data

- OR0893 is located inside the watershed and therefore was used as the primary station. For extending the OR0893 records, the Line of Organic Correlation method (LOC) was used.

- First, linear interpolation was used to fill in the missing data at OR0893.

- OR0548 had a good correlation with OR0893, with a coefficient of determination (R^2) of 0.70. S-0125 had a reasonable correlation with OR0893, with an R^2 of 0.48.

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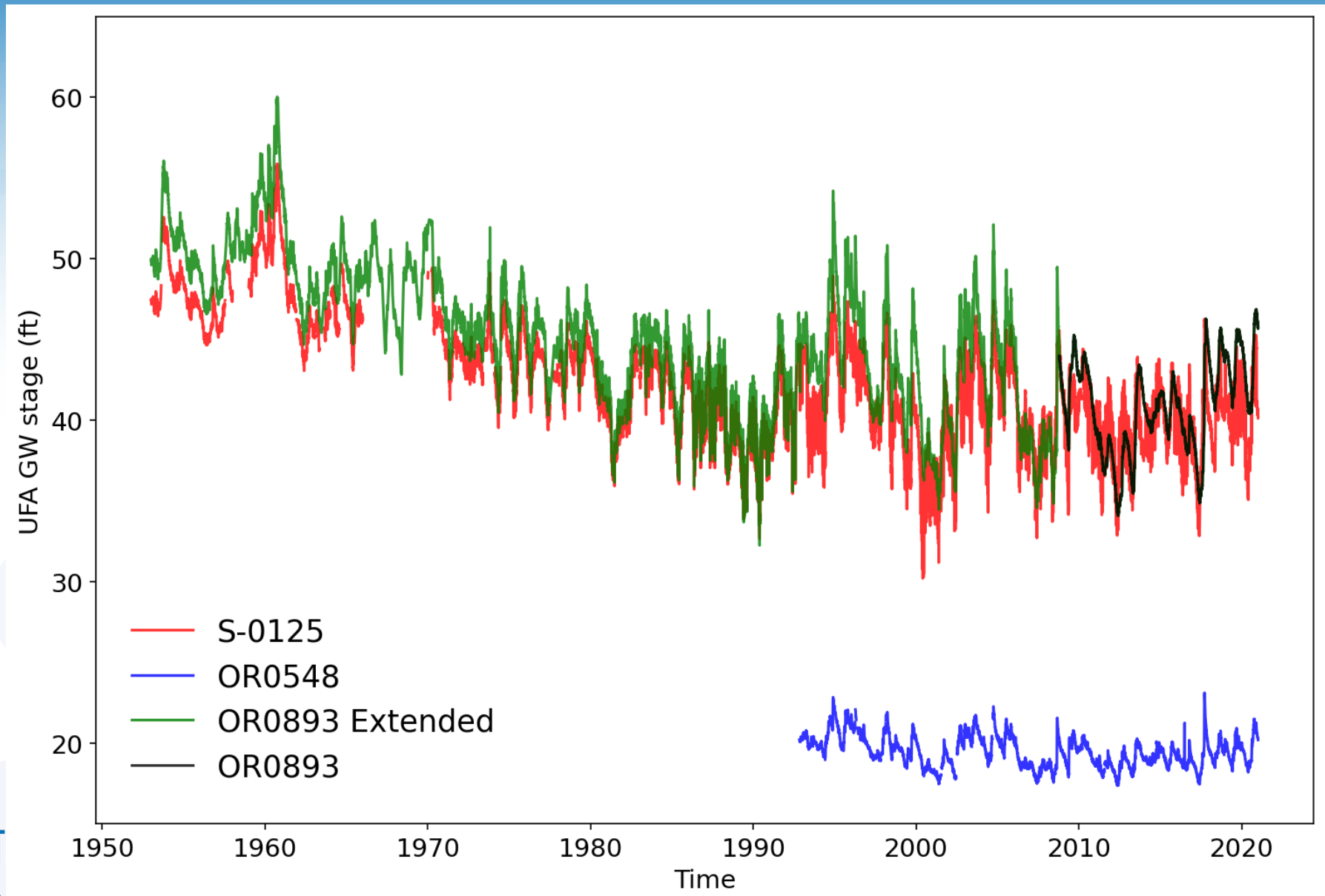
UFA GW stage (ft)
60
50
40
30
20
1950
1960
1970
1980
1990
2000
2010
2020
Time
S-0125
OR0548
OR0893 Extended
OR0893

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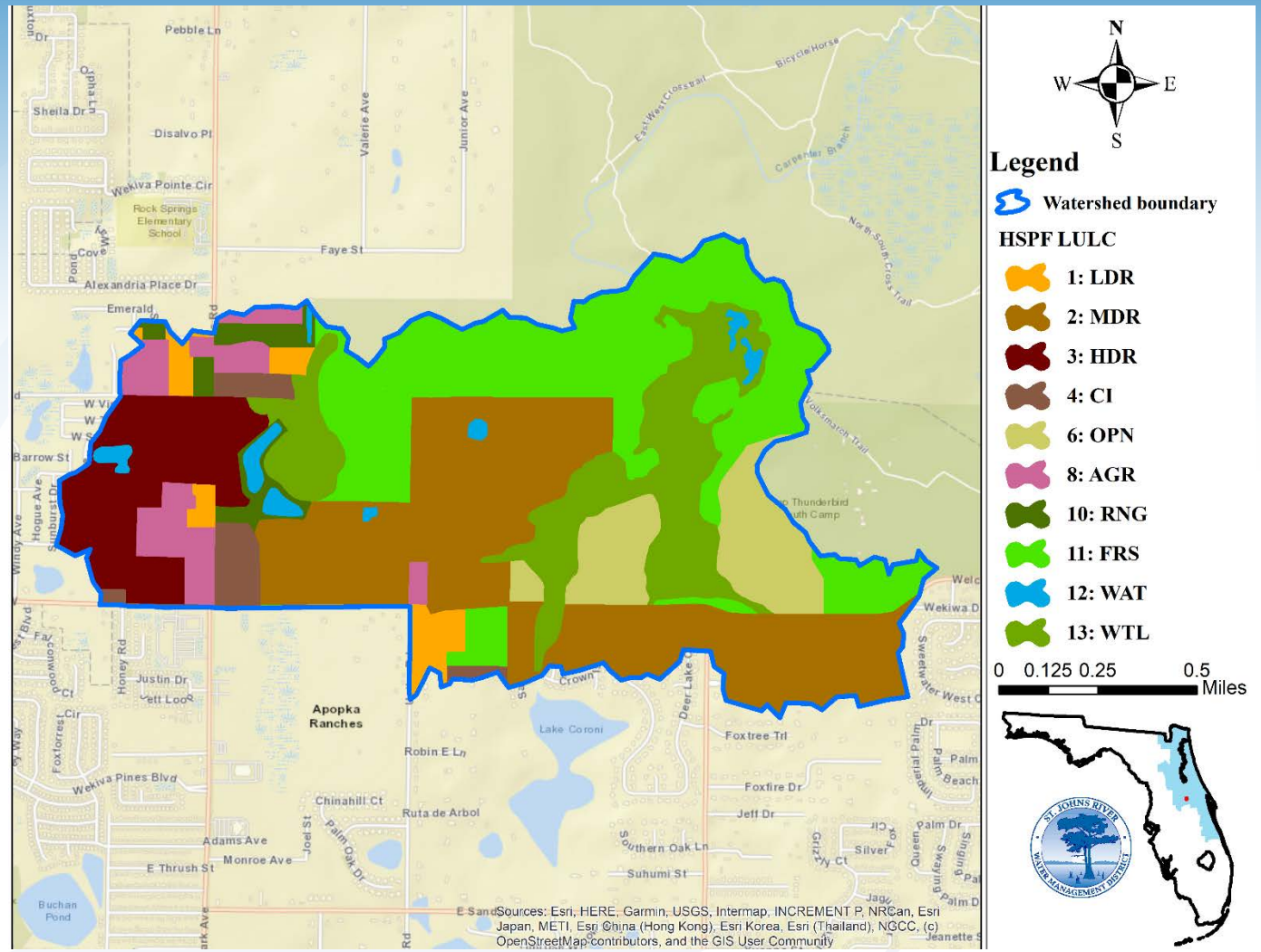
Prevatt Basin Land Use



Land cover	Pervious Acres	Impervious Acres	Imp Pct
1: Low density residential	29.5	1.6	5%
2: Medium density residential	254.1	45.0	15%
3: High density residential	62.2	33.5	35%
4: Commercial/Industrial	14.2	14.2	50%
6: Open	81.7	0.0	-
8: General agriculture	49.1	0.0	-
10: Range	23.3	0.0	-
11: Forest	263.4	0.0	-
12: Water	17.2	0.0	-
13: Wetland	149.6	0.0	-

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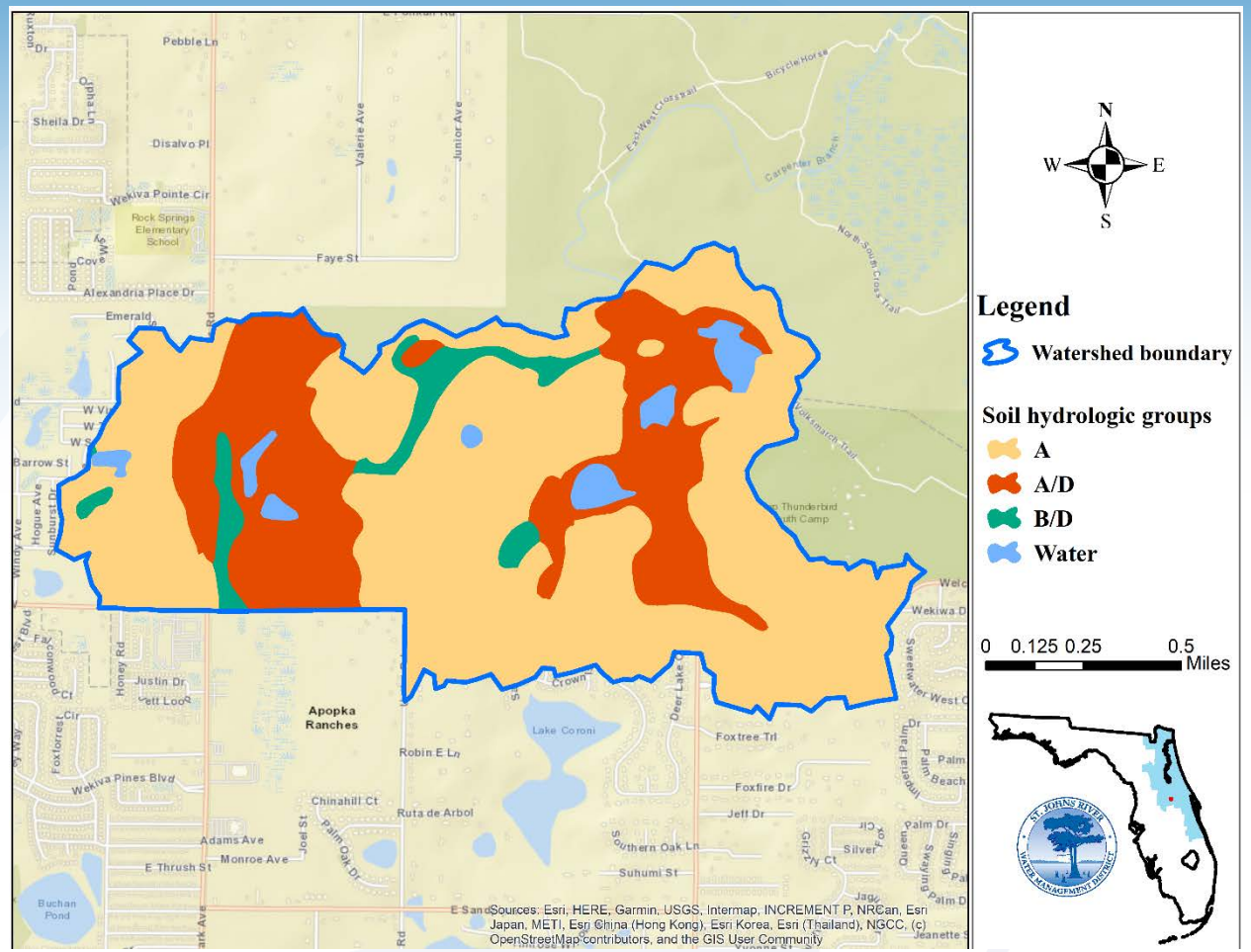
Hydrologic Soil Groups



Hydrologic Soil Group	Acres	Description
A	684.2	High infiltration rate
A/D	275.6	High or very low infiltration rate
B/D	45.7	Moderate or very low infiltration rate
Water	33.2	Water

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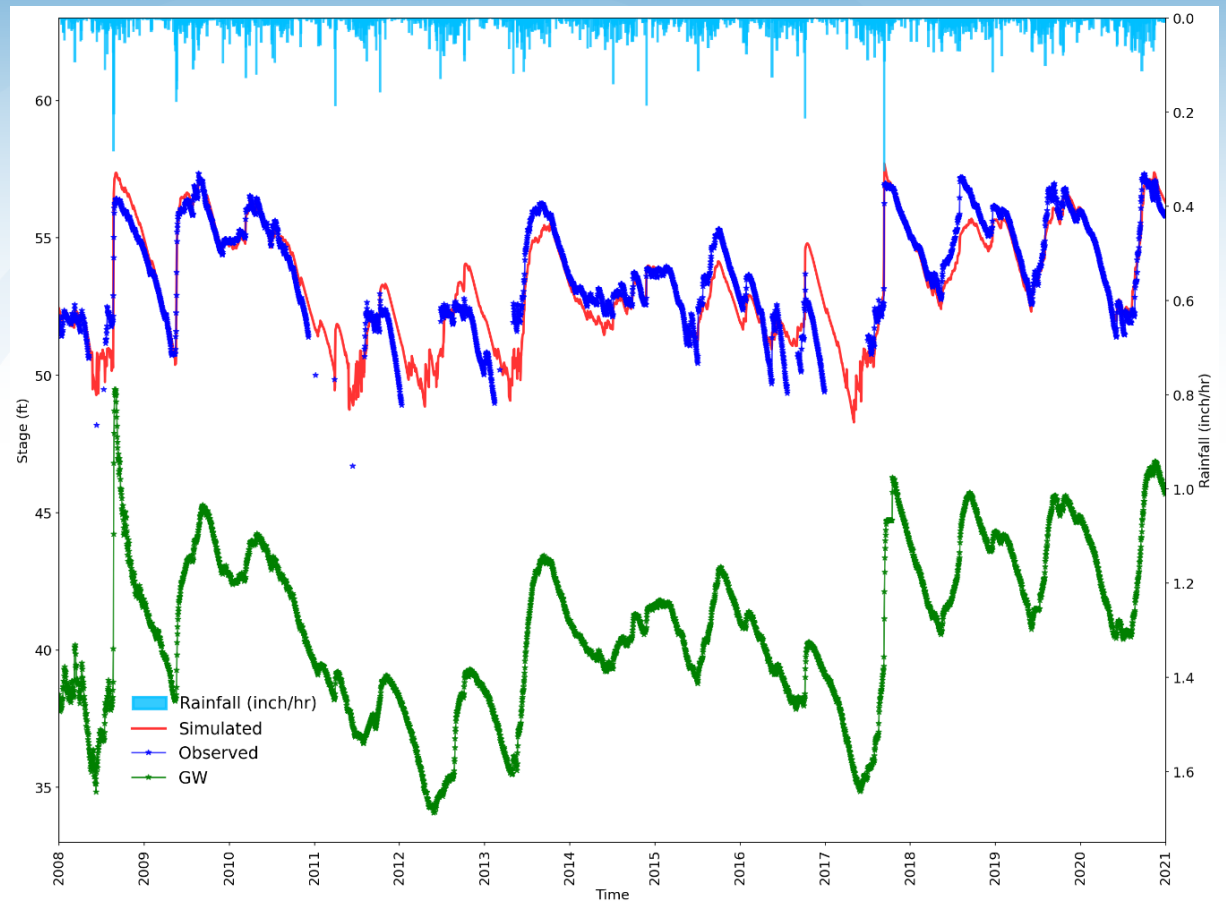
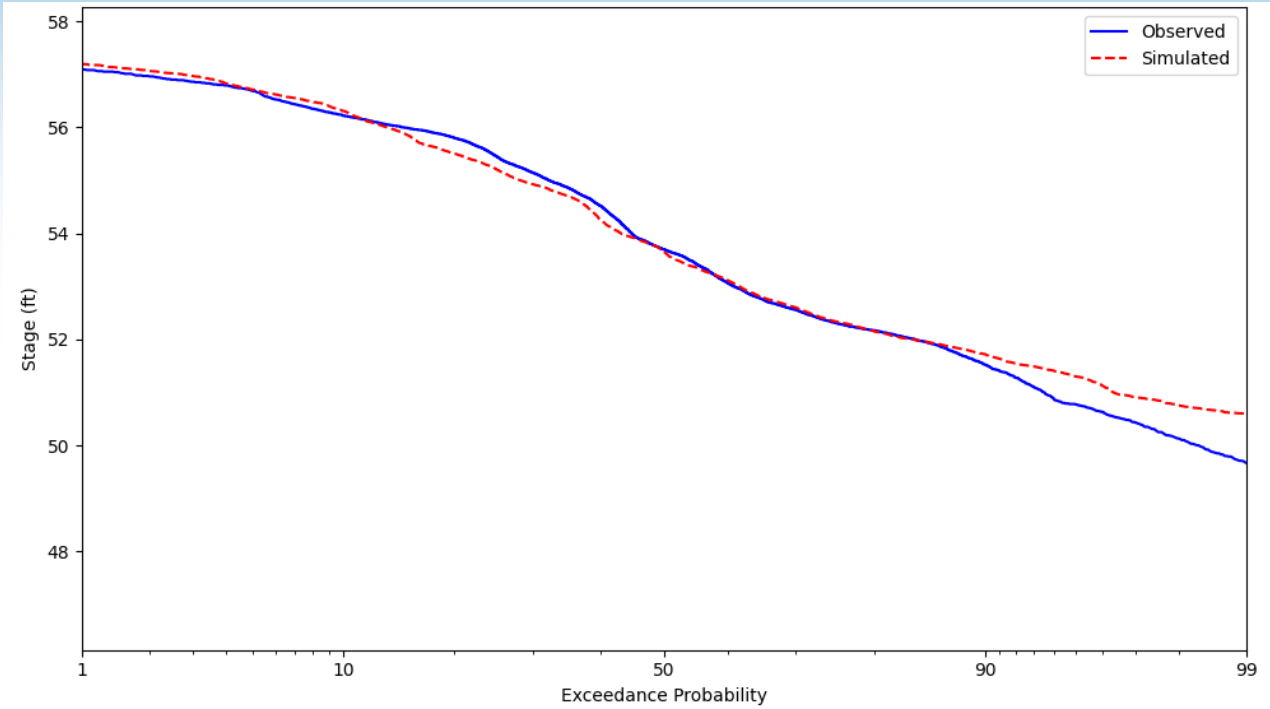
Model Calibration Results – North Lobe Water Level





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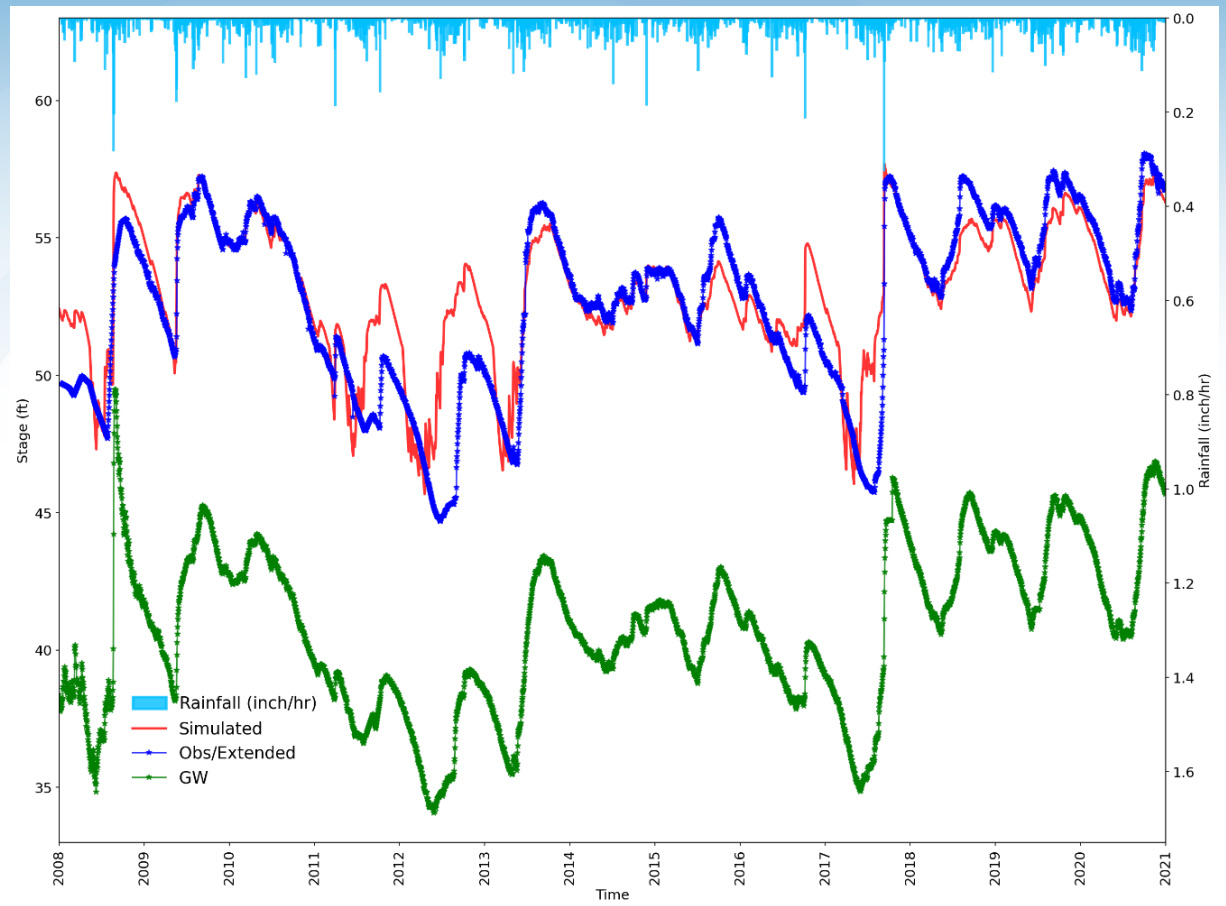
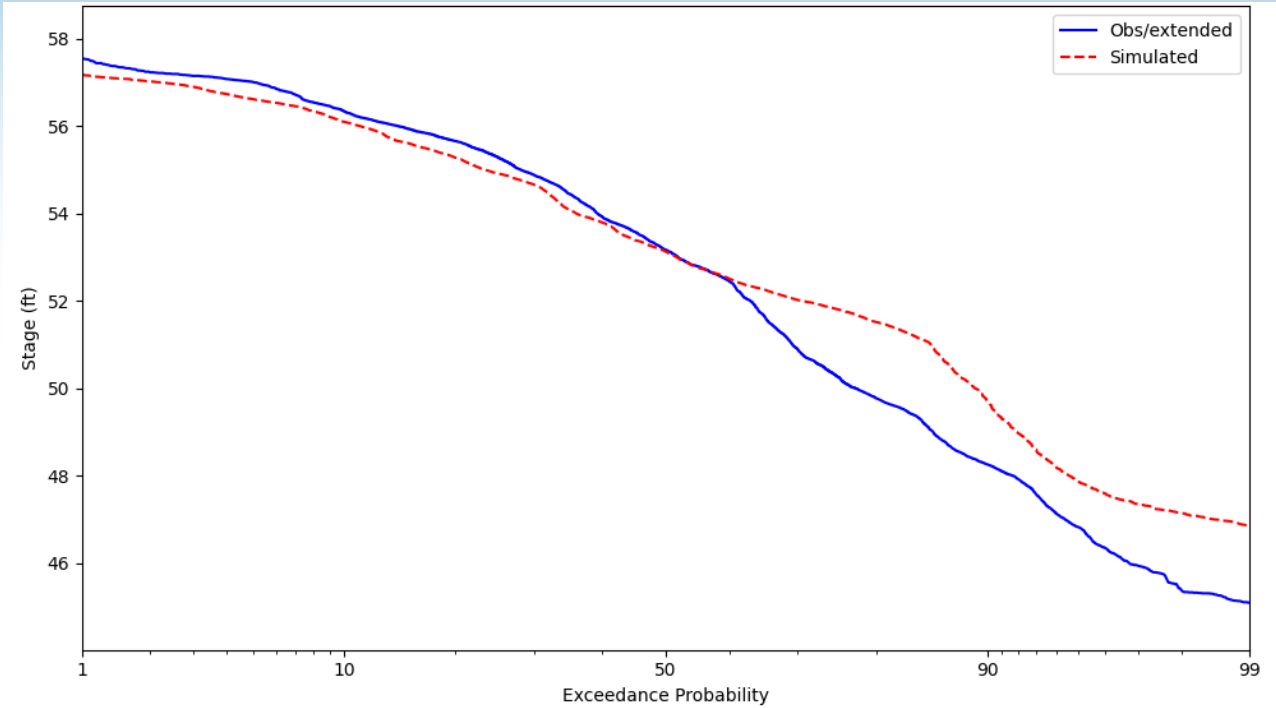
Model Calibration Results – South Lobe Water Level





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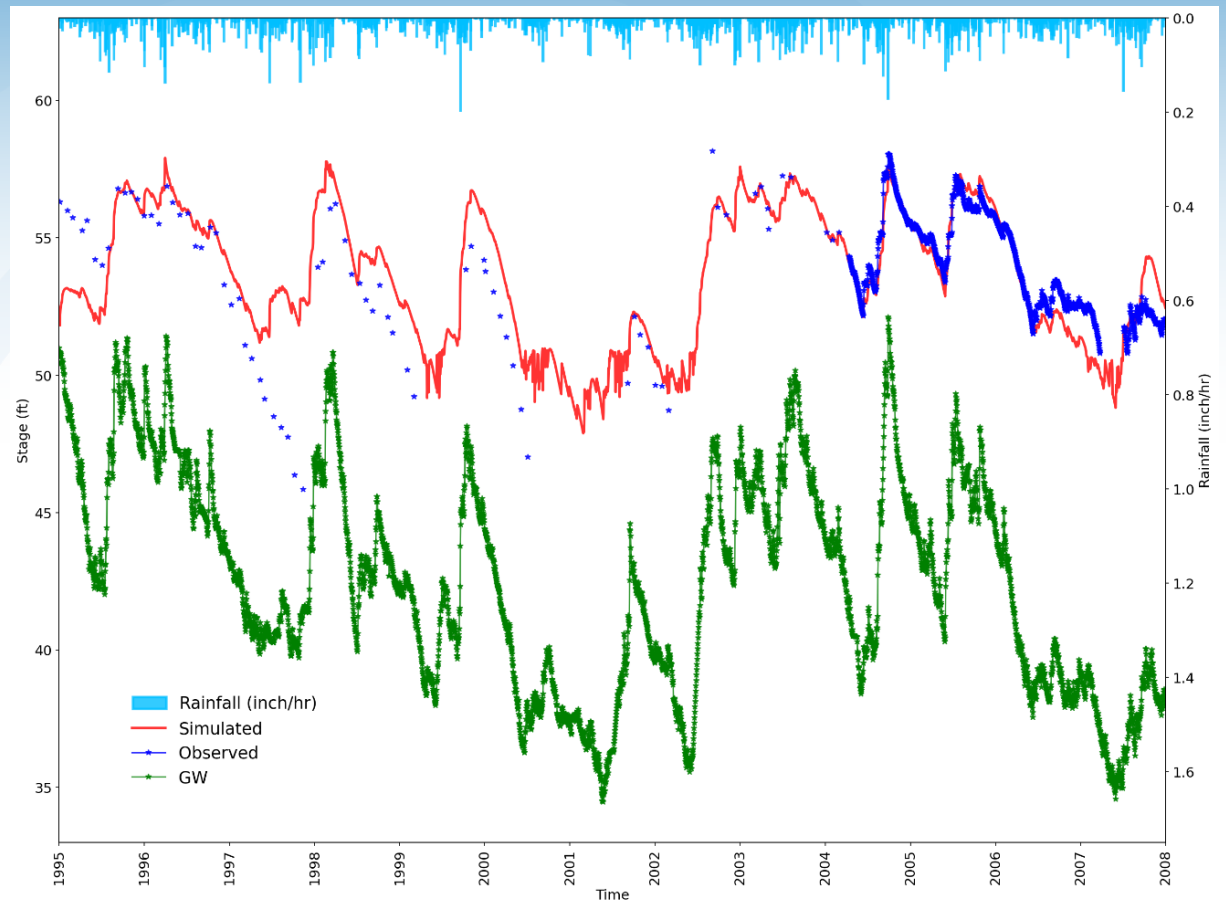
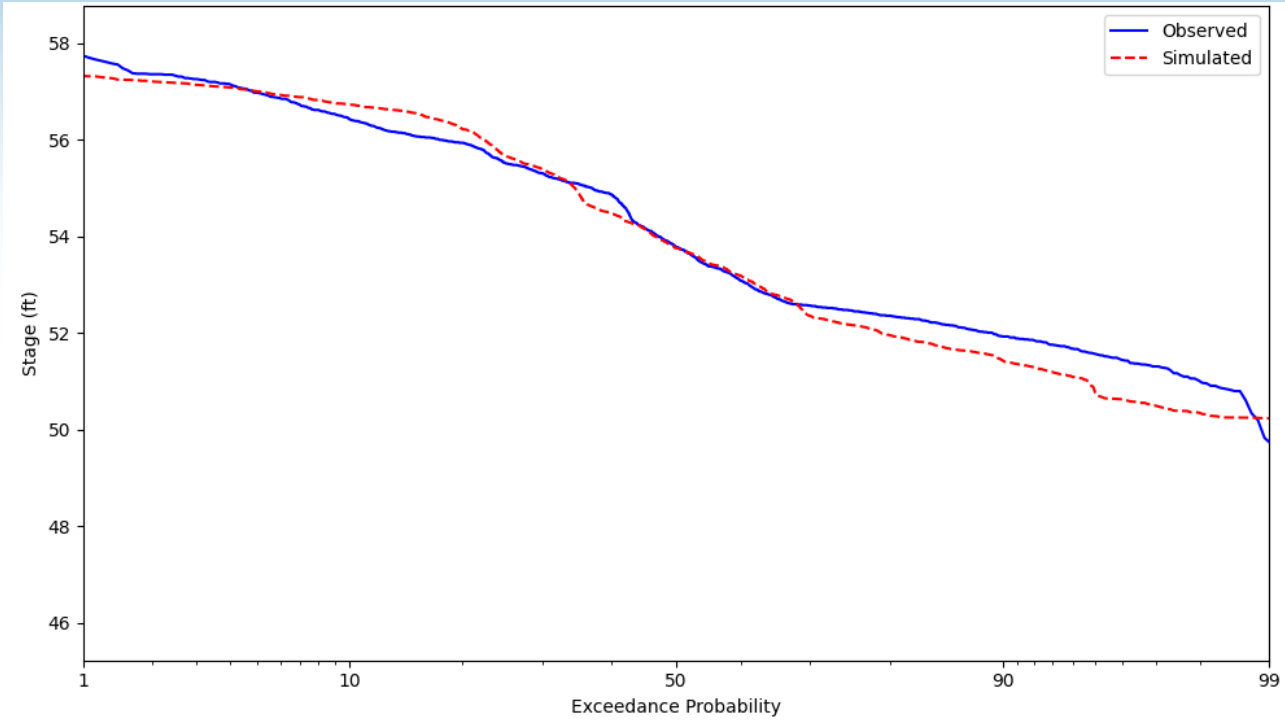
Model Verification Results – North Lobe Water Level





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Calibration Statistics – North Lobe Water Level

Statistic	Target	Calibration	Validation
Nash-Sutcliffe Efficiency	≥0.8 (cal) ≥0.7 (val)	0.83	0.77
Root Mean Squared Error	≤|±1| ft	0.77	0.90
Mean Error	≤|±1| ft	-0.01	-0.07
Percent Bias	≤|±10%|(cal) &|±15%|(val)	-0.01	-0.14
Pearson Correlation Coefficient	≥0.8 (cal) & 0.7 (val)	0.91	0.89
Pct of observations within ± 1ft	≥0.85 (cal) & 0.7 (val)	82.72	78.25

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Calibration Statistics – South Lobe Water Level

Statistic	Target	Calibration	Validation
Nash-Sutcliffe Efficiency	≥0.8 (cal) ≥0.7 (val)	0.73	-
Root Mean Squared Error	≤|±1| ft	1.63	-
Mean Error	≤|±1| ft	0.37	-
Percent Bias	≤|±10%|(cal) &|±15%|(val)	0.72	-
Pearson Correlation Coefficient	≥0.8 (cal) & 0.7 (val)	0.86	-
Pct of observations within ± 1ft	≥0.85 (cal) & 0.7 (val)	65.30	-

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Annual average watershed water budget (in/yr)
1995-2022

North Lobe Watershed

Description	LDR	MDR	HDR	CI	OPN	AGR	RNG	FRS	WTL	Watershed
Rainfall	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1
Evapotranspiration	35.4	33.1	28.3	24.7	27.8	39.8	38.3	42.3	48.3	37.1
Total runoff	11.5	14.3	20	24.2	16.1	7.5	8.7	5.7	0.7	10.5
Recharge to UFA	4.3	4.3	4.3	4.3	7.2	3.6	4.0	2.9	1.1	3.2

South Lobe Watershed

Description	LDR	MDR	HDR	CI	OPN	AGR	RNG	FRS	WTL	Watershed
Rainfall	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7	47.7
Evapotranspiration	33.4	31.2	26.7	23.3	26.5	37.5	36.1	39.6	46.0	35.0
Total runoff	10.6	13.2	18.5	22.5	14.8	6.9	7.9	5.4	0.9	9.8
Recharge to UFA	4.2	4.2	4.2	4.2	6.8	3.6	4.0	2.9	1.0	3.2

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Annual Average Lake Water Budget (acre-ft)

North Lobe	Direct Rain	Water-shed Inflow	Flow from South	Total Inflow		ET	GW Loss	Outfall	Flow to South	Total Outflow
Calibration	61.1	451.7	44.4	557.3		59.4	155.0	57.3	280.1	551.8
Percent	11.0	81.1	8.0	-		10.8	28.1	10.4	50.8	-
Validation	65.7	420.9	76.6	563.2		63.1	144.1	125.3	235.8	568.2
Percent	11.7	74.7	13.6	-		11.1	25.4	22.0	41.5	-

South Lobe	Direct Rain	Water-shed Inflow	Flow from North	Total Inflow		ET	GW Loss	Flow to North	Total Outflow
Calibration	236.5	440.2	280.1	956.8		231.3	660.4	44.4	936.1
Percent	24.7	46.0	29.3	-		24.7	70.5	4.7	-
Validation	239.3	408.0	235.8	883.1		231.7	566.7	76.6	875.1
Percent	27.1	46.2	26.7	-		26.5	64.8	8.8	-

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Long Term Simulation

The calibrated model was extended back to 1953

- NEXRAD Rainfall was replaced by IsleWin station
- Lisbon PET was available for the full period
- UFA head boundary condition data

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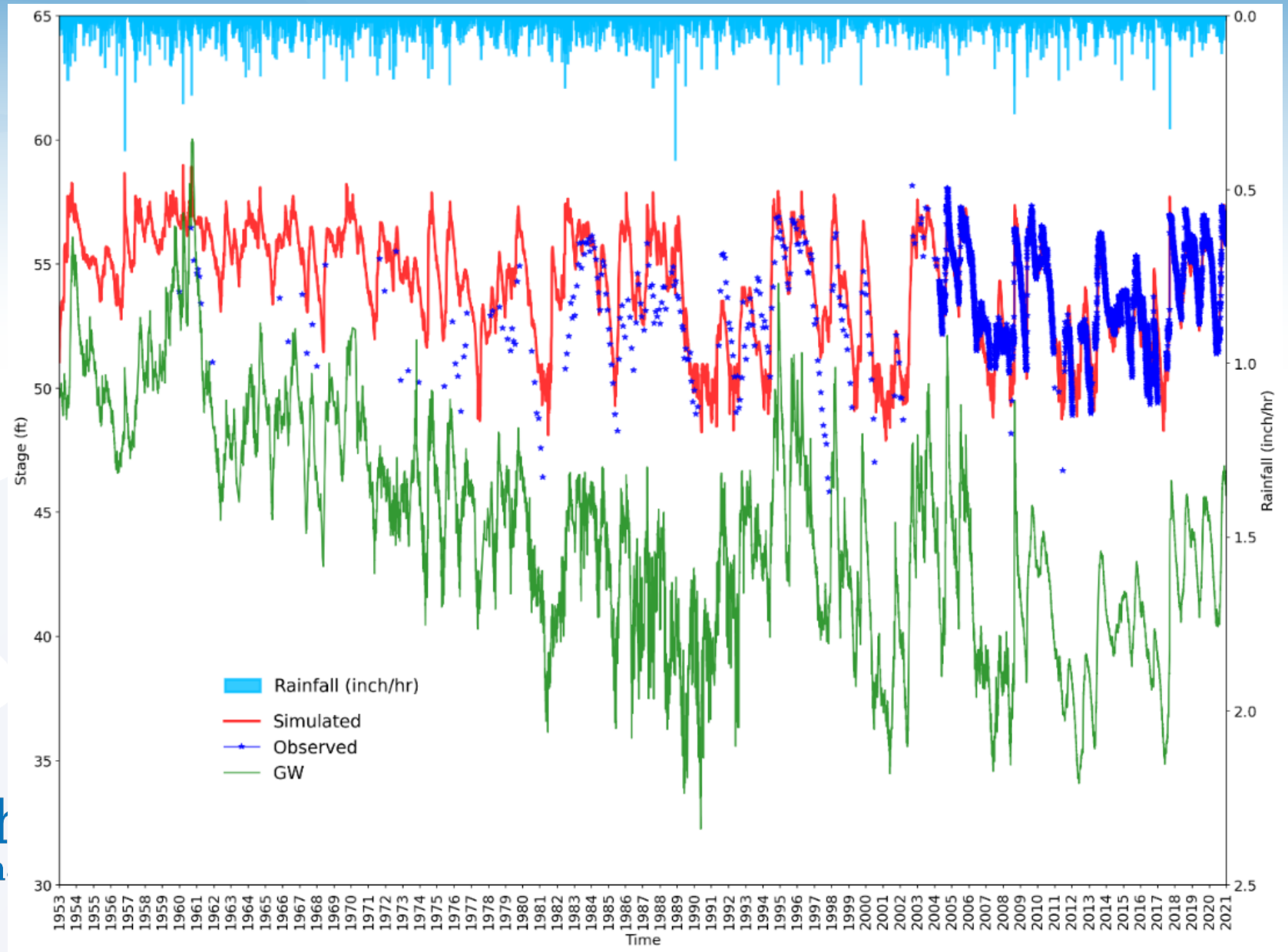
Long Term Simulation – North Lobe



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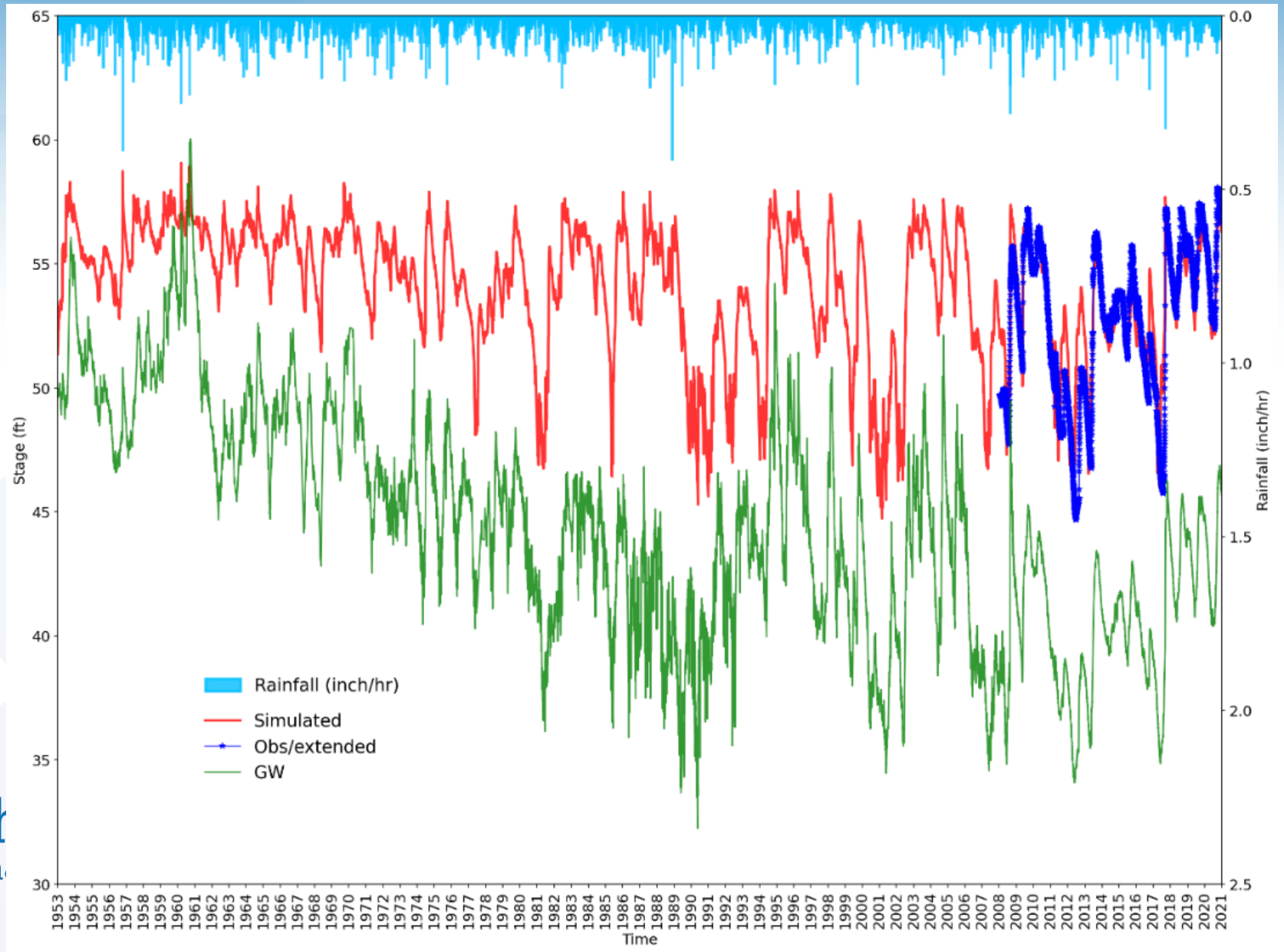
Long Term Simulation – South Lobe



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Sensitivity Analysis

Five important parameters were varied, to examine the model's response.

Leakance (L)	+/- factor of 2 and 3
Lower zone nominal storage (LZSN)	+/- 10%, 20%
Groundwater loss fraction (DEEPFR)	+/- 10%, 20%
Lower zone ET parameter (LZETP)	+/- 10%, 20%
Infiltration index (INFILT)	+/- 10%, 20%

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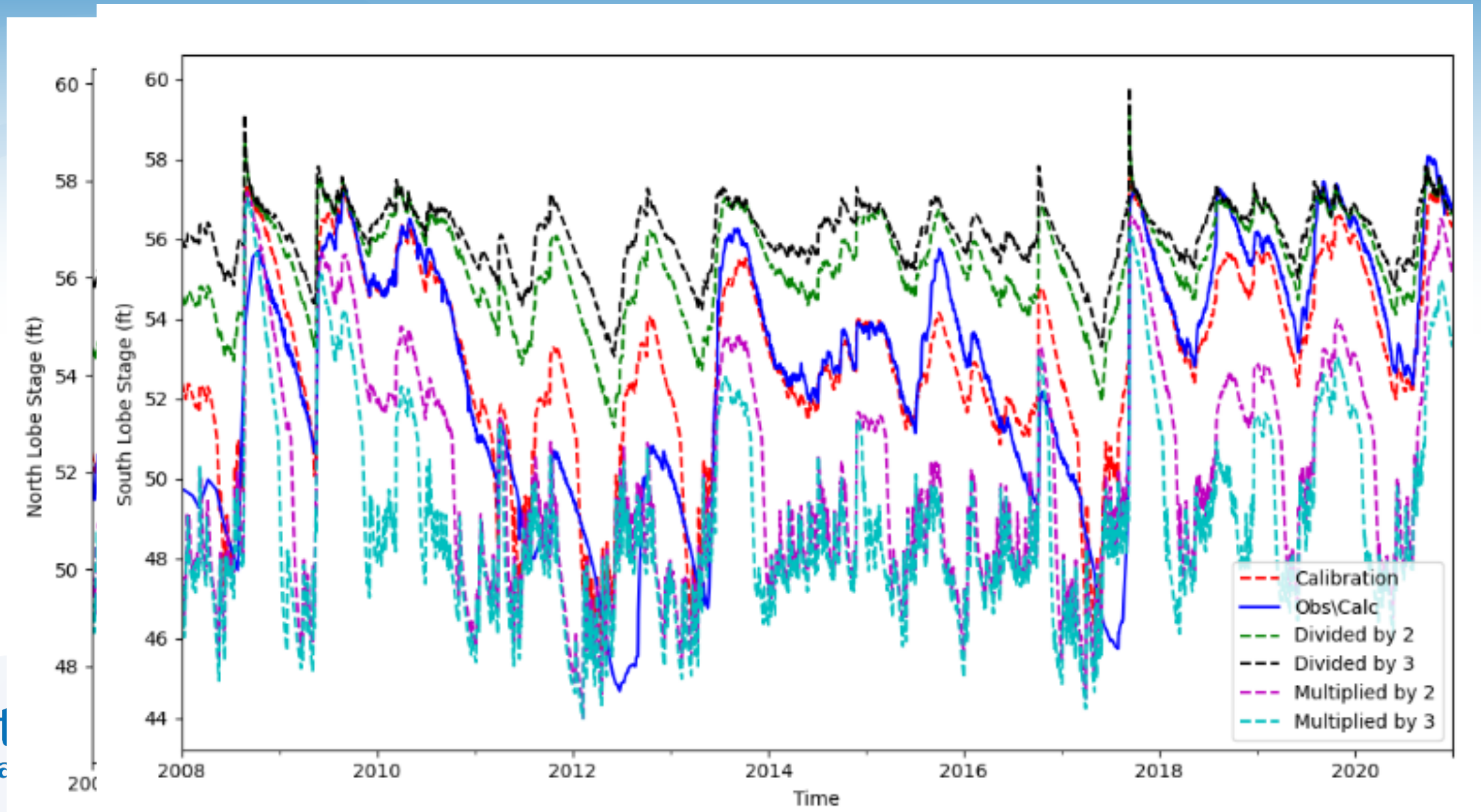
Sensitivity Analysis – Leakance (the most sensitive)



Conclusions

- The model reasonably reproduced the observed daily water levels.
- Most of the daily statistical measures met the targets.
- The model adequately replicated the long-term daily observed stages.
- We identified the leakance and lower zone ET parameters as the most sensitive parameters.
- Overall, the model showed reasonable simulations of surface water-groundwater interaction processes and the water budget of Prevatt Lake, indicating the model can be used for MFL analysis.

Next Steps

• Reviewer to discuss initial findings (teleconference)	January 8, 2024
• Draft model review TM	January 29, 2024
• Reviewer to discuss final comments (teleconference)	February 5, 2024
• Final TM	February 14, 2024
• Draft MFLs Report	Early Fall 2024
• Rulemaking	End of 2024

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For more information on the Lake Prevatt HSFP model and MFLs development go to:

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

...or email Andrew Sutherland at:

asutherl@sjrwmd.com

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