

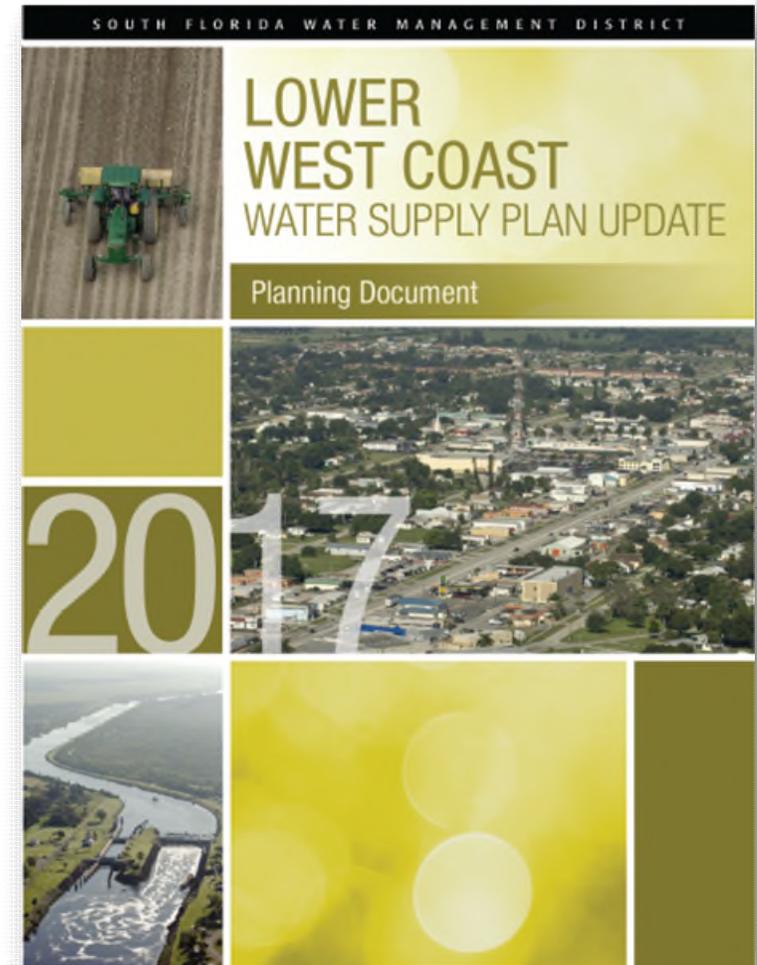
West Coast Floridan Model

Stakeholder Meeting

July 1, 2020

2017 Lower West Coast Water Supply Plan Update Future Direction

- Continue diversification of water supply sources through alternative water supplies
- Implement long-term management of the Floridan aquifer system in coordination with public water supply utilities
- Complete West Coast Floridan Model (WCFM) updates and conduct simulations



Lower West Coast Planning Area (2014 – 2040)

➤ Population

- 2014 1,031,924 residents
- 2040 1,632,168 residents
58% increase

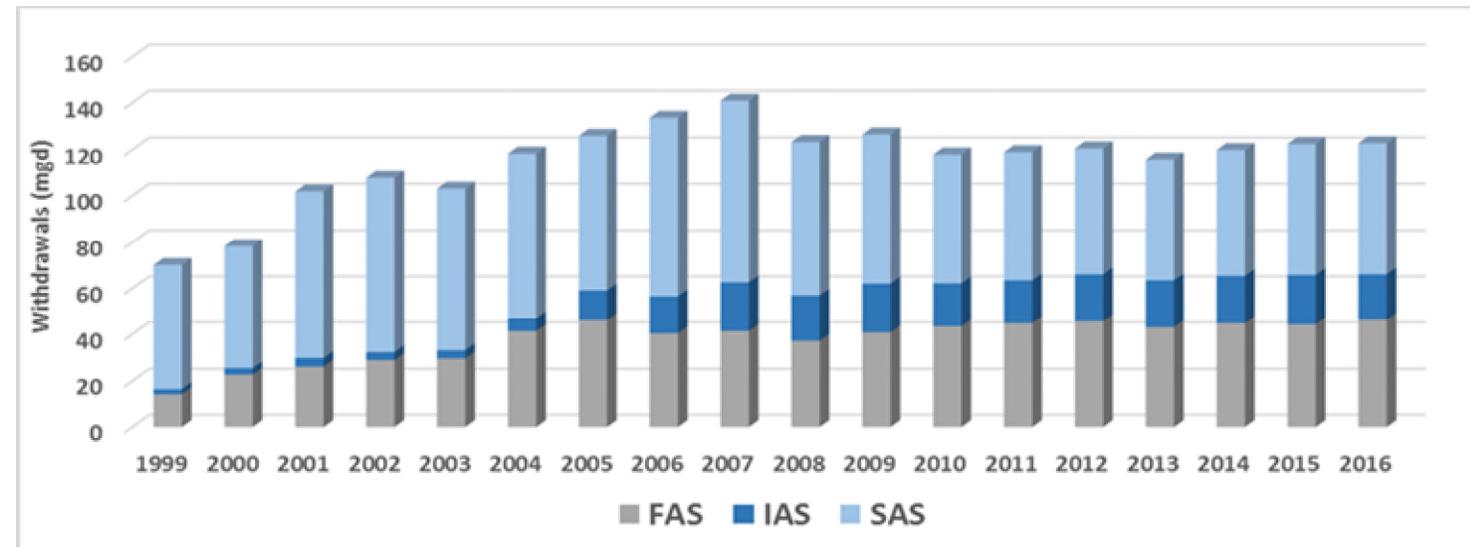
➤ Public water supply demand

- 2014 129 mgd
- 2040 200 mgd
55% increase

➤ Gross water demand

- 2014 971 mgd
- 2040 1,210 mgd
25% increase

PWS Withdrawals (1999-2016)

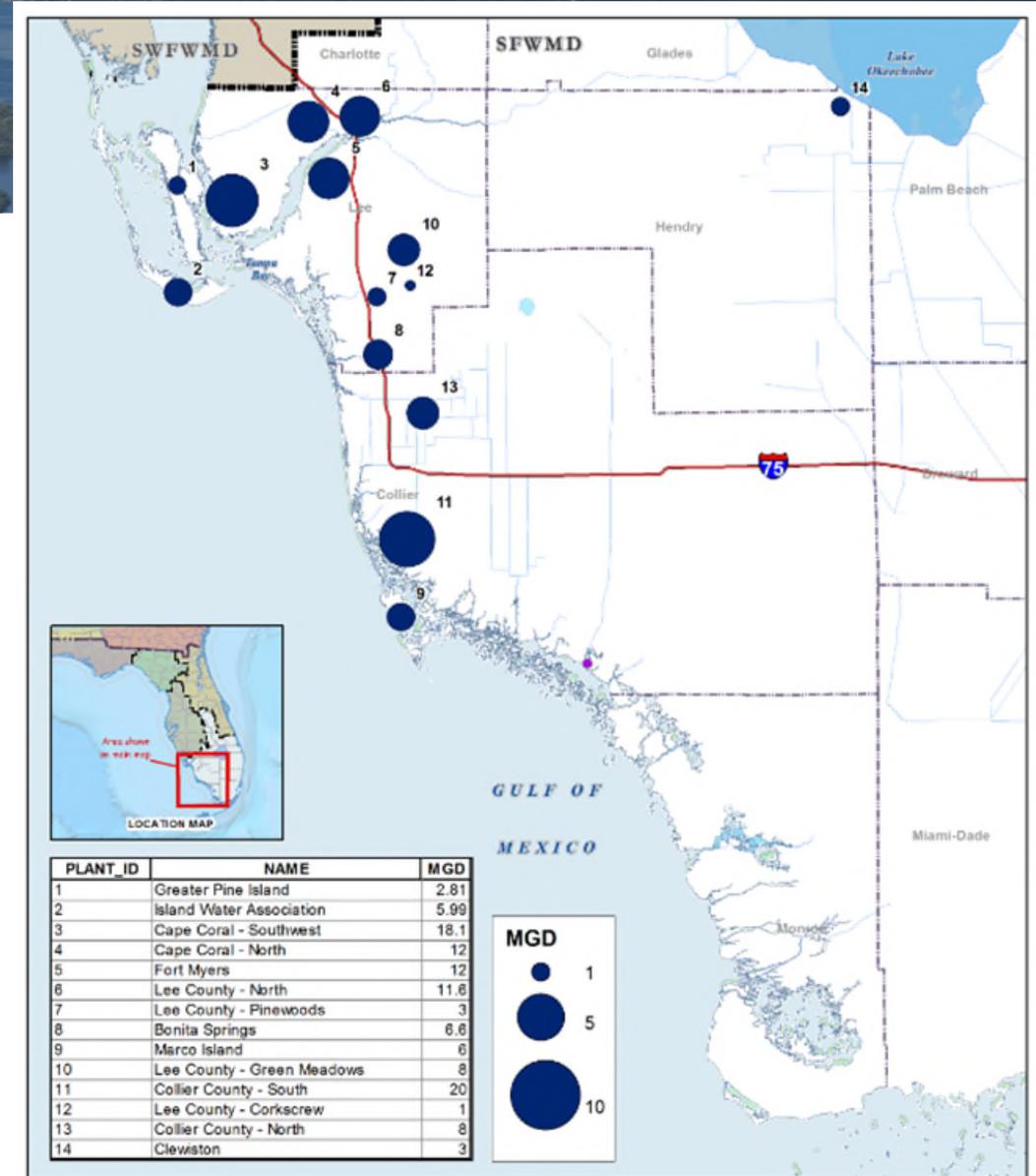
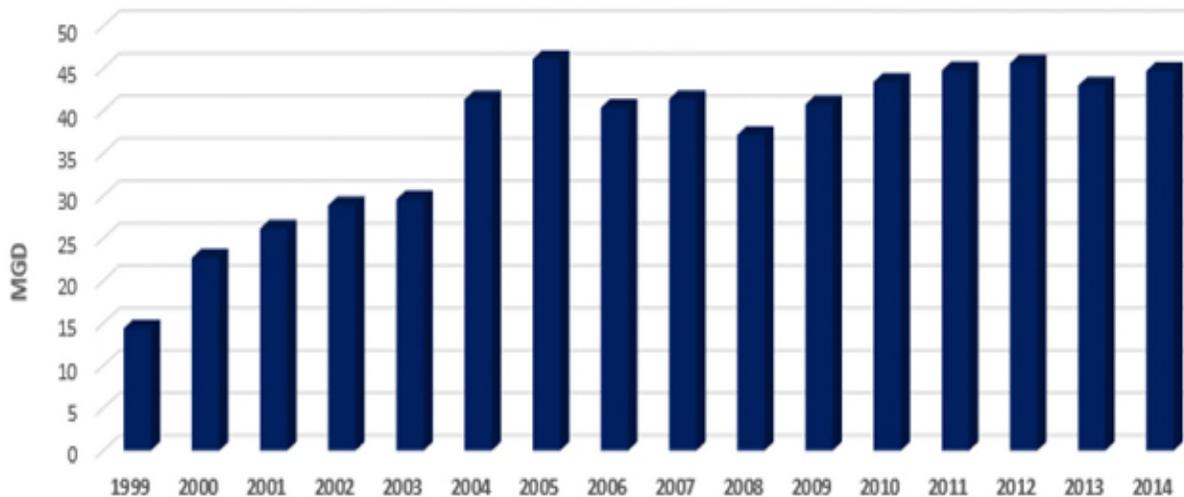


mgd = million gallons per day

Brackish Water from the Floridan Aquifer System

- Currently 14 facilities, 120 mgd capacity, reverse osmosis treatment
- Increase in development through 2040

LWC Planning Area
Public Water Supply FAS Water Withdrawals
(1999-2014)



West Coast Floridan Model Calibration and Application

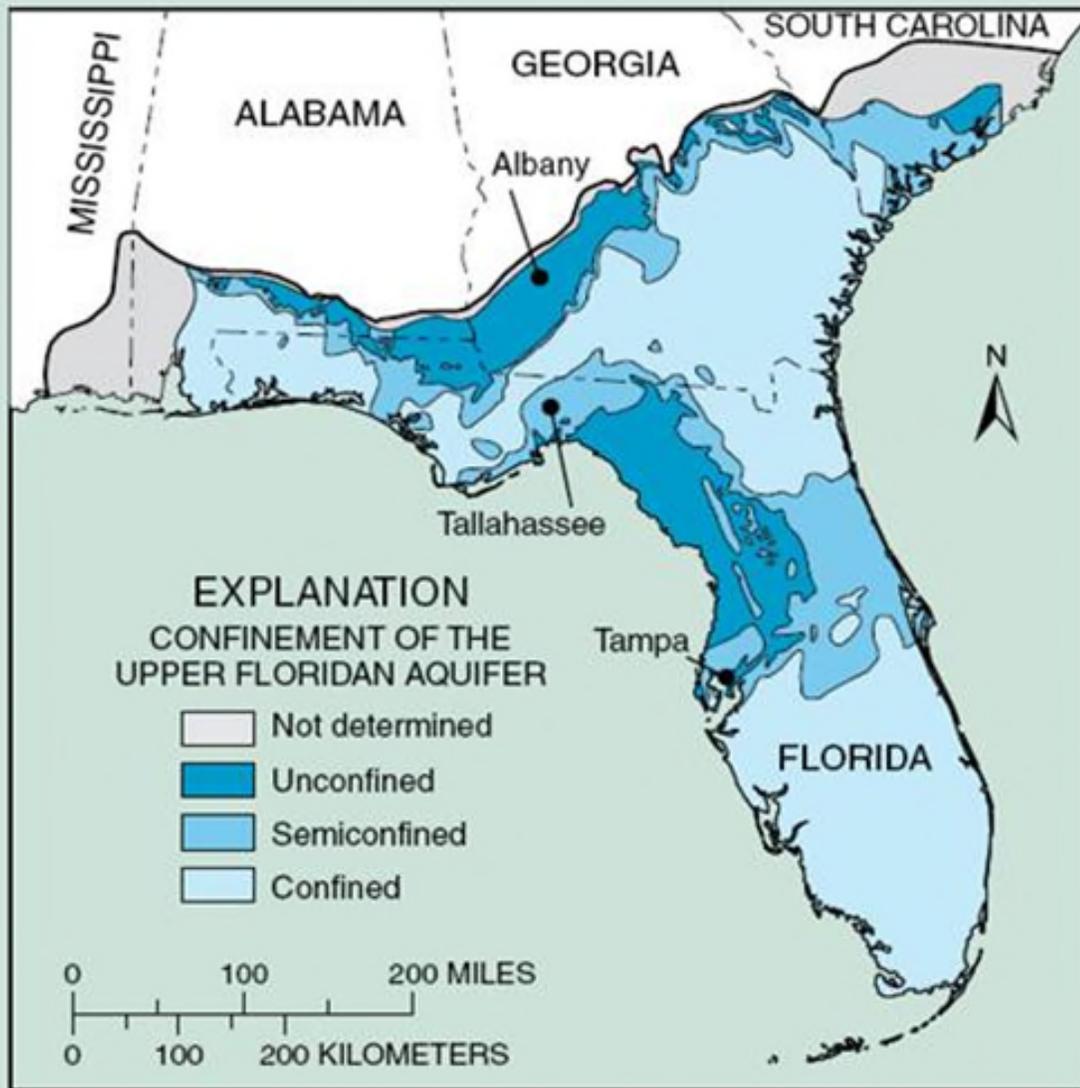
Anushi Obeysekera, E.I.T.

Groundwater Modeling Unit, Water Supply Bureau

July 1, 2020

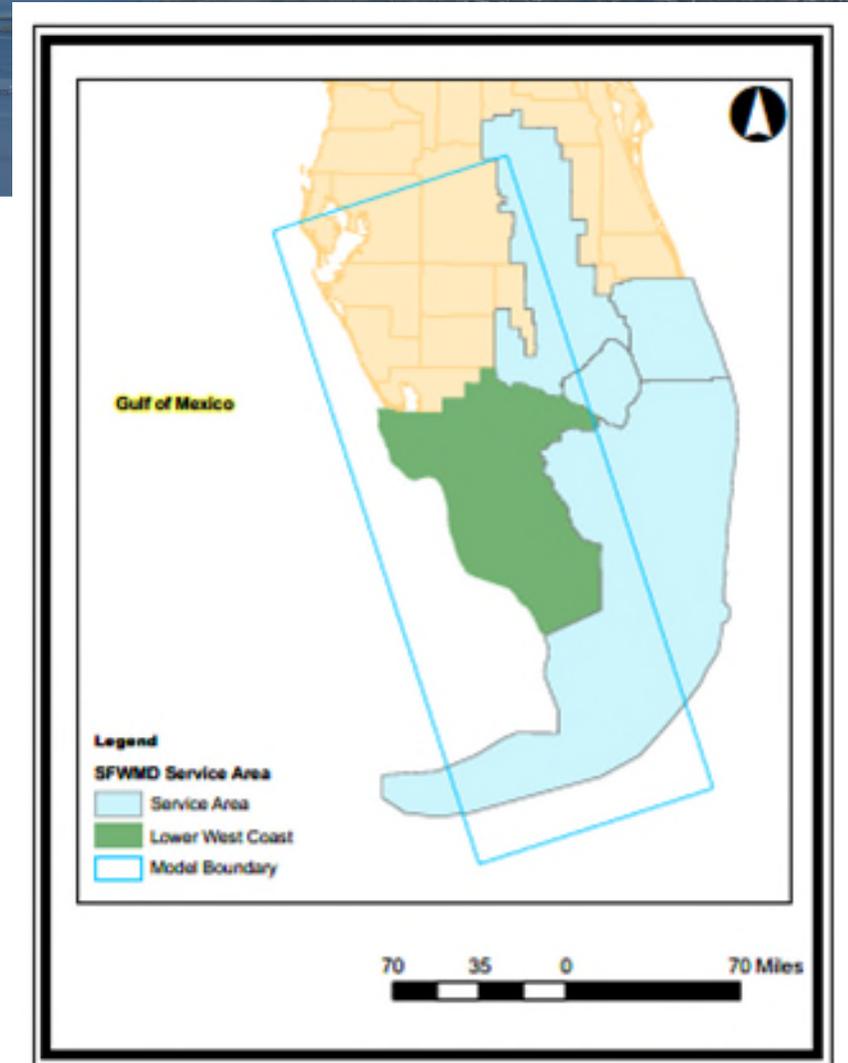
Agenda

- Model overview
- Model calibration
- Model application
- Model results



Previous Work

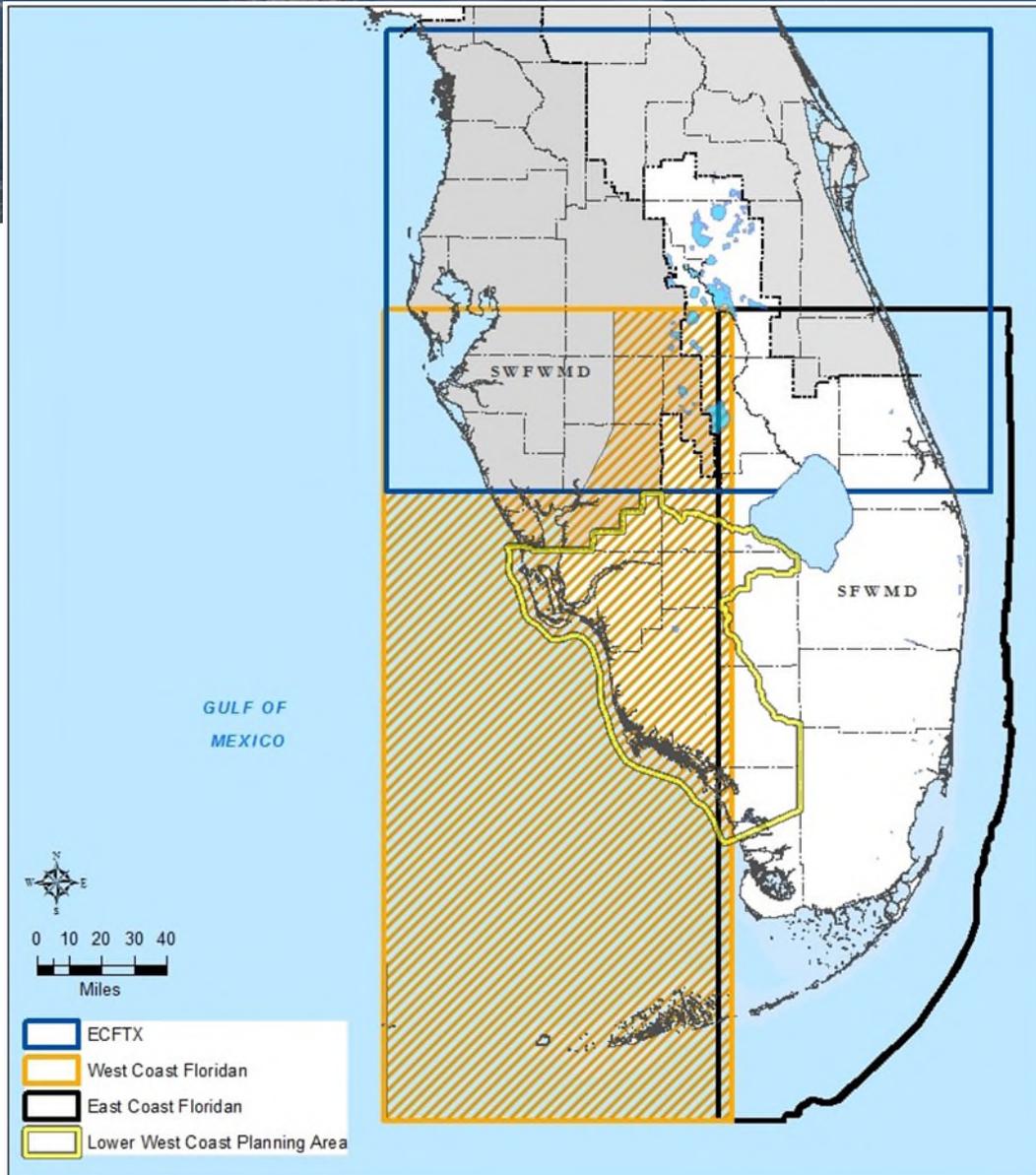
- Lower West Coast Floridan Aquifer System (LWCFAS) Phase I – 2008
- Peer-review report of LWCFAS Phase I – 2008
- Phase II of LWCFAS – 2011



West Coast Floridan Model Updates

- Reoriented the grid
- Incorporated temperature-dependent heads in the Boulder Zone
- Added new monitor wells for water level and water quality
- Used historical data from the Southwest Florida Water Management District
- Modified the hydrostratigraphy to be consistent with the East Central Florida Transient Expanded (ECFTX) Model and East Coast Floridan Model (ECFM)
- Extended the calibration period through 2012
- Incorporated ECFM peer-review recommendations on calibration criteria and water budget analysis

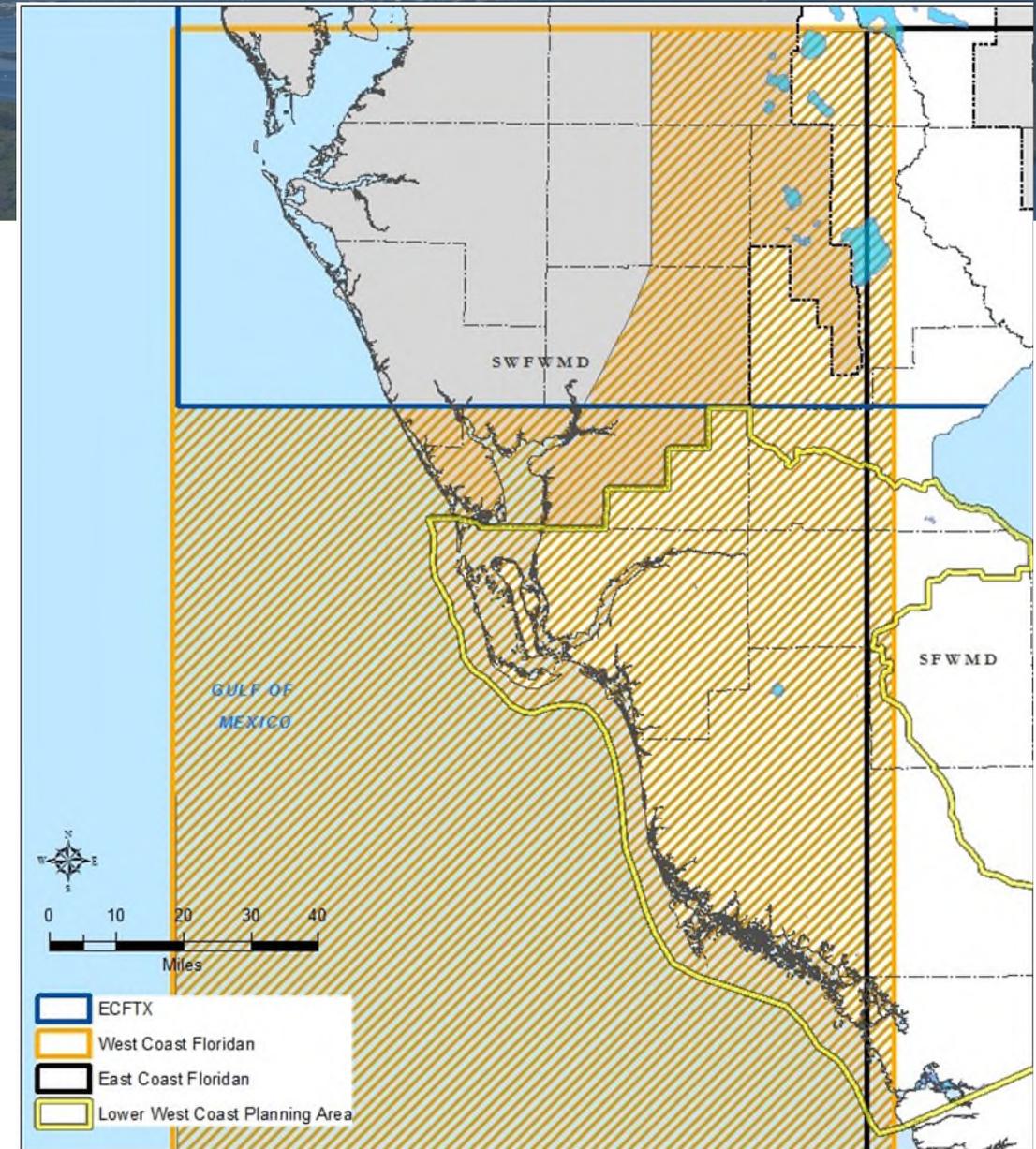
West Coast Floridan Model



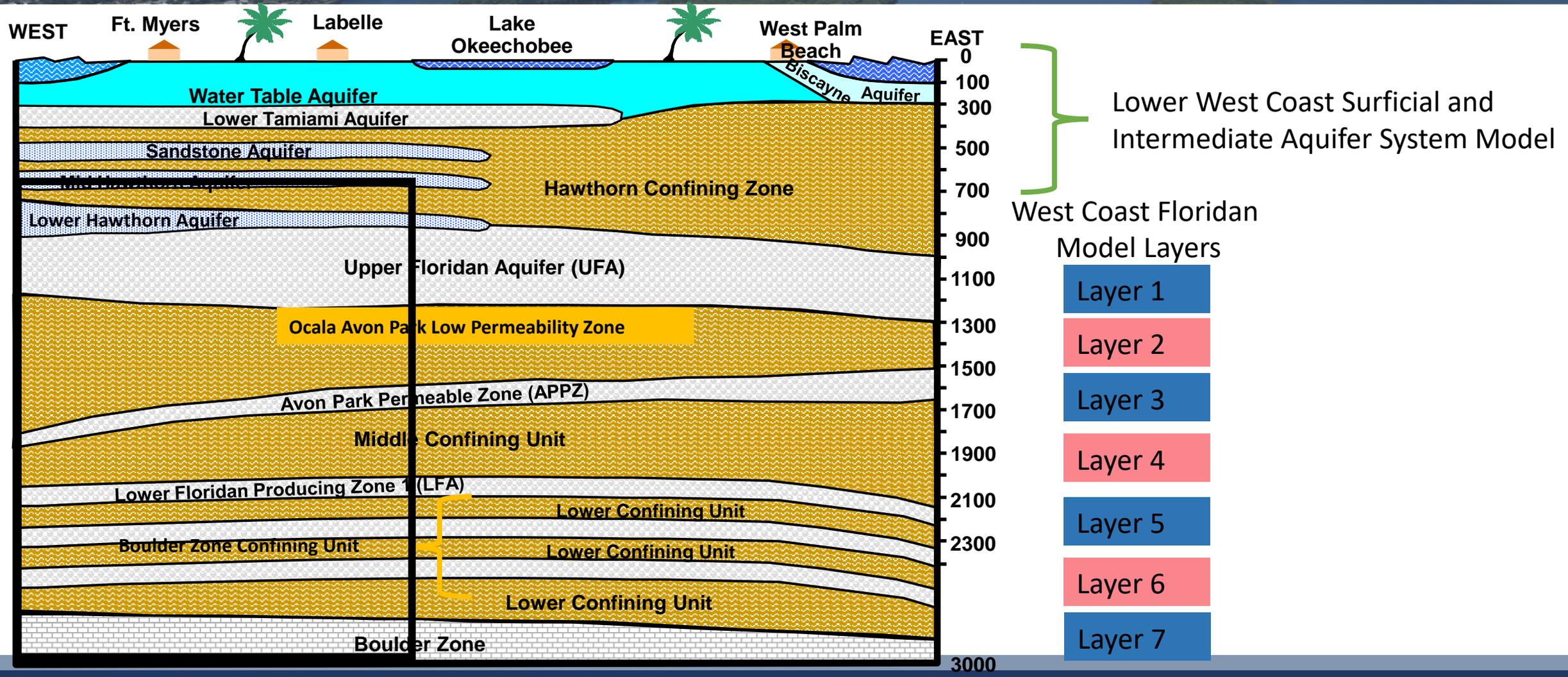
- Northern boundary: Lake Wales
 - Northern portion of model domain overlaps the ECFTX Model
- Southern boundary: Key West/Florida Straits
- Western boundary: Dry Tortugas
- Eastern boundary: ECFM
 - Eastern portion of model domain overlaps the ECFM
- Active model domain follows SR17

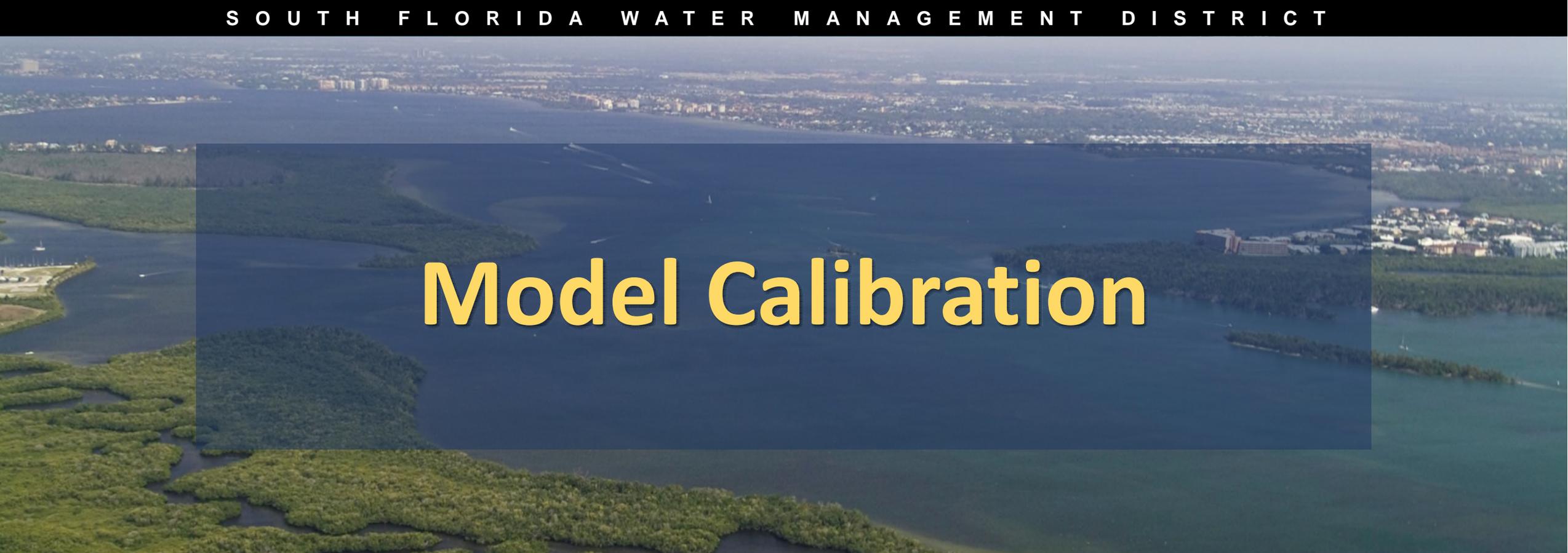
West Coast Floridan Model

- SEAWAT model (USGS 2012)
- Period of record: 1989-2012
- Monthly simulation periods
- Cell size: 2,400 ft × 2,400 ft
- 7 model layers
 - Layer 1: Upper Floridan aquifer
 - Layer 7: Boulder Zone
- Calibrated to water levels and water quality



Model Layers





Model Calibration

Calibration Comparison

LWCFAS Phase II

- Calibration period: 2001-2010
- Only provided mean error for steady-state calibration of water levels
- 25 water level monitoring locations
 - 17 in Upper Floridan aquifer (UFA)
 - 6 in Avon Park permeable zone (APPZ)
 - 2 in Lower Floridan aquifer (LFA)
- 17 water quality monitoring locations

WCFM

- Calibration period: 1989-2012
- Provides global statistics and more stringent calibration criteria on par with other regional groundwater models
- 112 water level monitoring locations
 - 91 in UFA
 - 18 in APPZ
 - 3 in LFA
- 120 water quality monitoring locations
 - 79 in UFA
 - 18 in APPZ
 - 10 in LFA
 - 13 in confining units

Calibration Criteria

Water level calibration criteria, by aquifer (UFA, APPZ, LFA):

- Mean error: ± 1 ft
- Mean absolute error (MAE): < 2.5 ft
 - 50% of wells in an aquifer with MAE < 2.5 ft
 - 80% of wells in an aquifer with MAE < 5.0 ft

Calibration Criteria

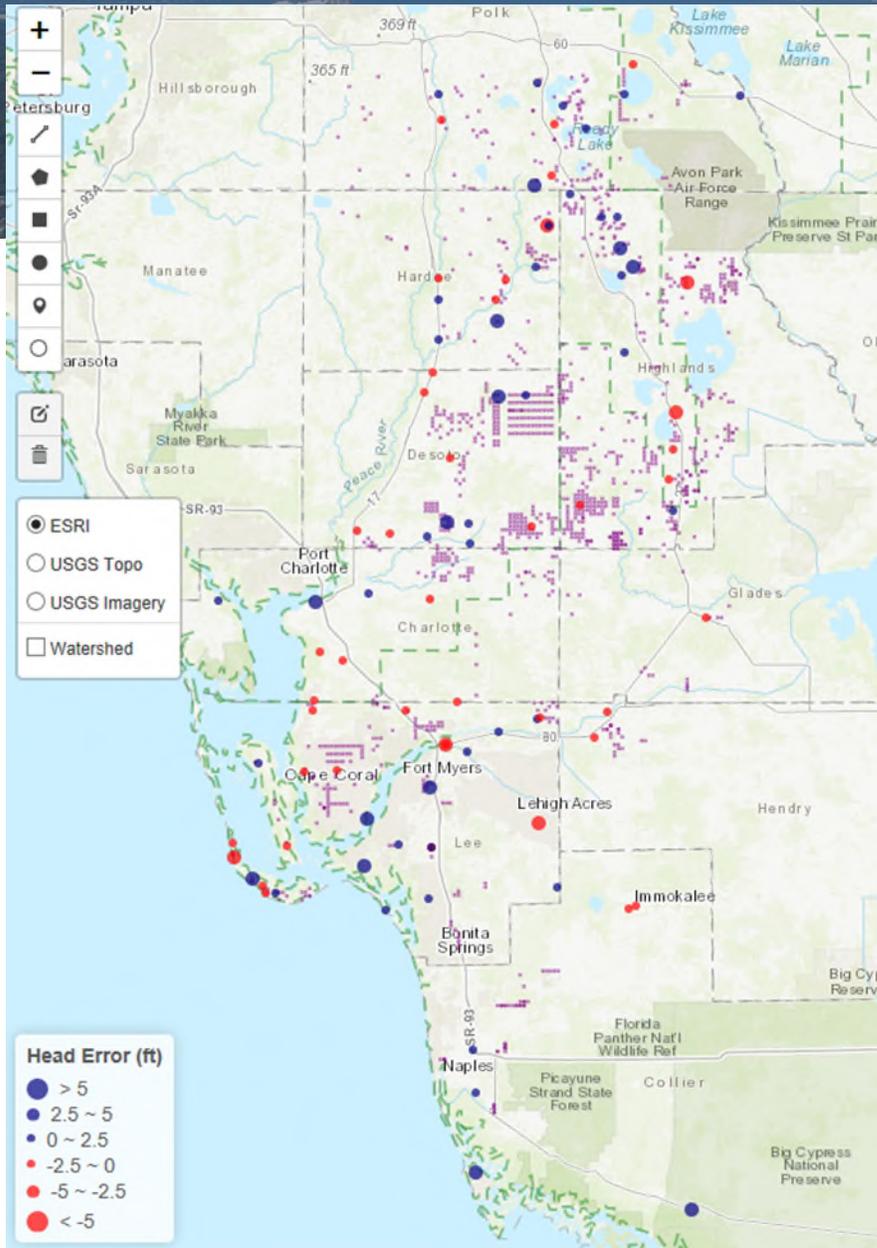
- Water quality calibration criteria determined by salinity, as set forth in Jacobs et al. (2011)

	Fresh to Brackish Water		Moderately Saline	Saline Water
Total Dissolved Solids (mg/L)	0 – 4,000	4,000 – 10,000	10,000 – 18,000	>18,000
Calibration Error Band (mg/L)	±500	±750	±3,000	±4,000

Calibration Target: 80% of all water quality monitor wells will simulate total dissolved solids concentration within its individual calibration error band.

Jacobs, B., M. Stewart, R. Therrien, and C. Zheng, 2011. Peer Review Report – East Coast Floridan Aquifer System Model Phase II Project, South Florida Water Management District, West Palm Beach, FL.

Water Level Calibration – Upper Floridan Aquifer

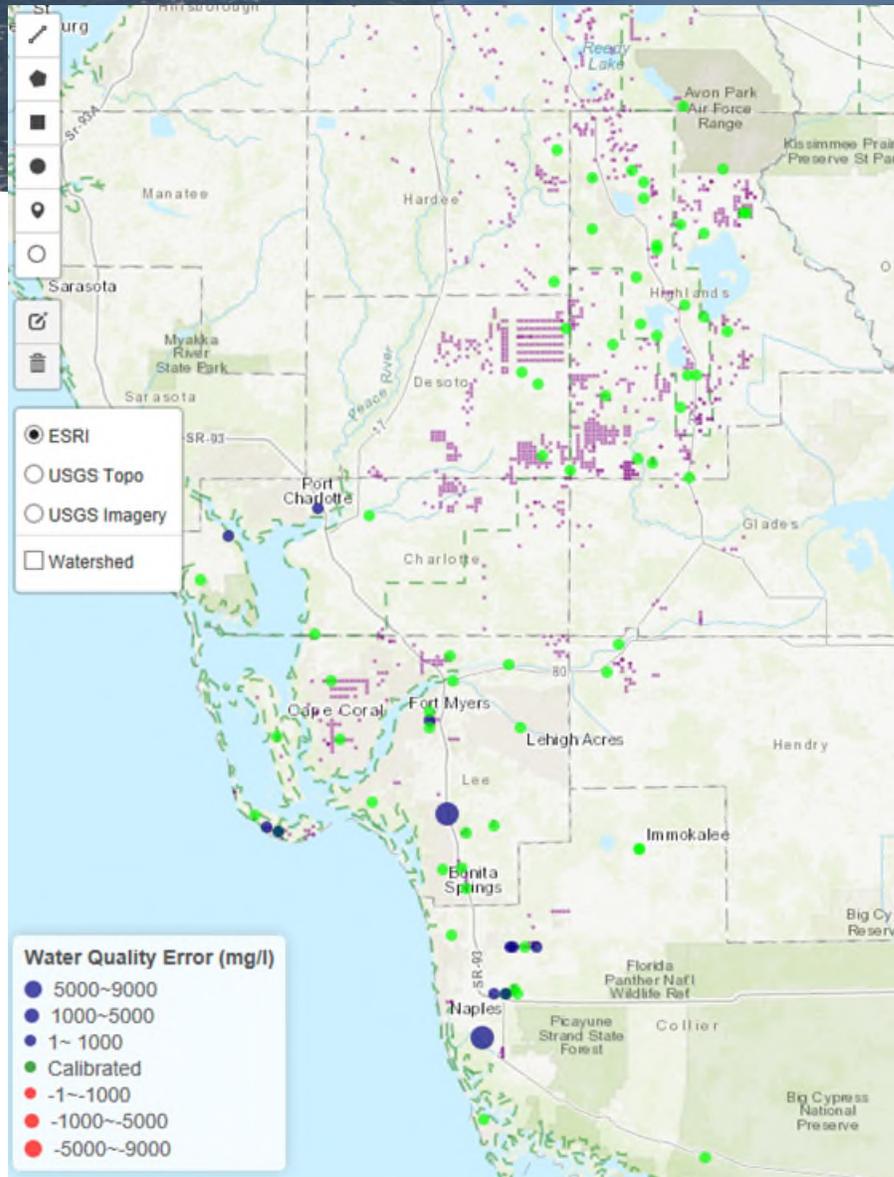


	Criteria	All Layers	UFA in WCFM	UFA in LWC
Mean error	±1 ft	0.03	-0.15	-0.13
Mean absolute error (MAE)	<2.5 ft	2.24	2.26	2.20
Number of wells		112	91	36
% of wells with MAE < 2.5 ft	>50%	63%	64%	61%
% of wells with MAE < 5.0 ft	>80%	100%	100%	100%

All water level calibration criteria for the UFA are met

Note: Wells depicted in **blue** are overpredicting
 Wells depicted in **red** are underpredicting

Water Quality Calibration – Upper Floridan Aquifer

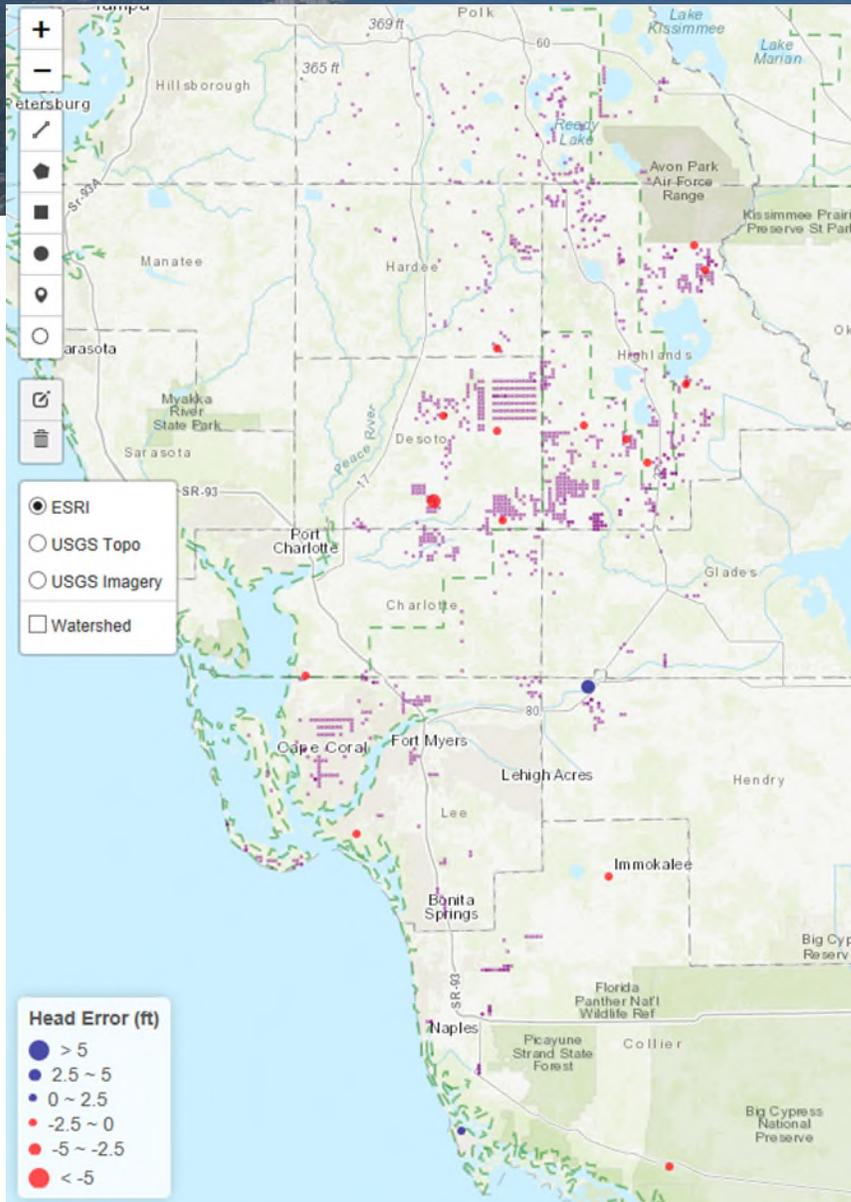


	Criteria	All Layers	UFA in WCFM	UFA in LWC
Number of wells		120	79	38
Number of wells meeting calibration		106	69	29
Percentage of calibrated wells	80%	88%		

All water quality calibration criteria for the UFA are met

Note: Wells depicted in **green** are meeting calibration criteria
 Wells depicted in **blue** are not meeting calibration criteria

Water Level Calibration – Avon Park Permeable Zone

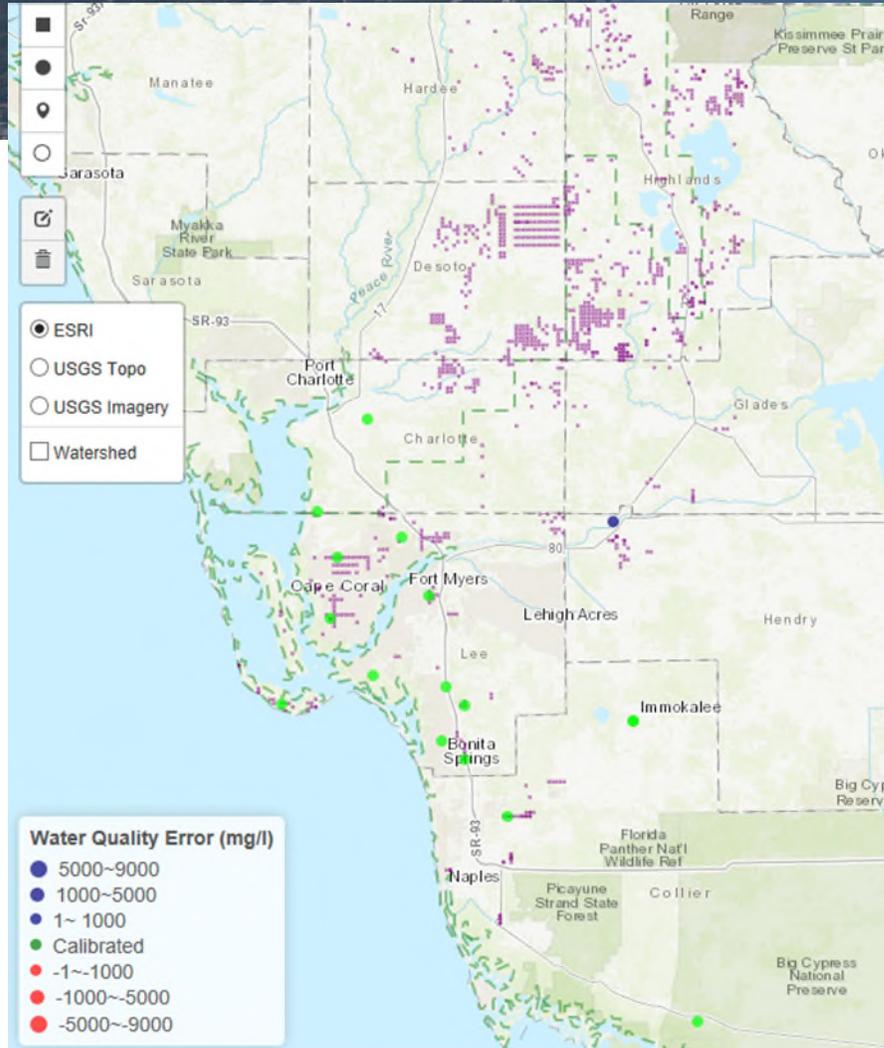


	Criteria	All Layers	APPZ in WCFM	APPZ in LWC
Mean error	±1 ft	0.03	0.88	-0.16
Mean absolute error (MAE)	<2.5 ft	2.24	2.22	1.64
Number of wells		112	18	5
% of wells with MAE < 2.5 ft	>50%	63%	56%	60%
% of wells with MAE < 5.0 ft	>80%	100%	100%	100%

All water level calibration criteria for the APPZ are met

Note: Wells depicted in blue are overpredicting
 Wells depicted in red are underpredicting

Water Quality Calibration – Avon Park Permeable Zone

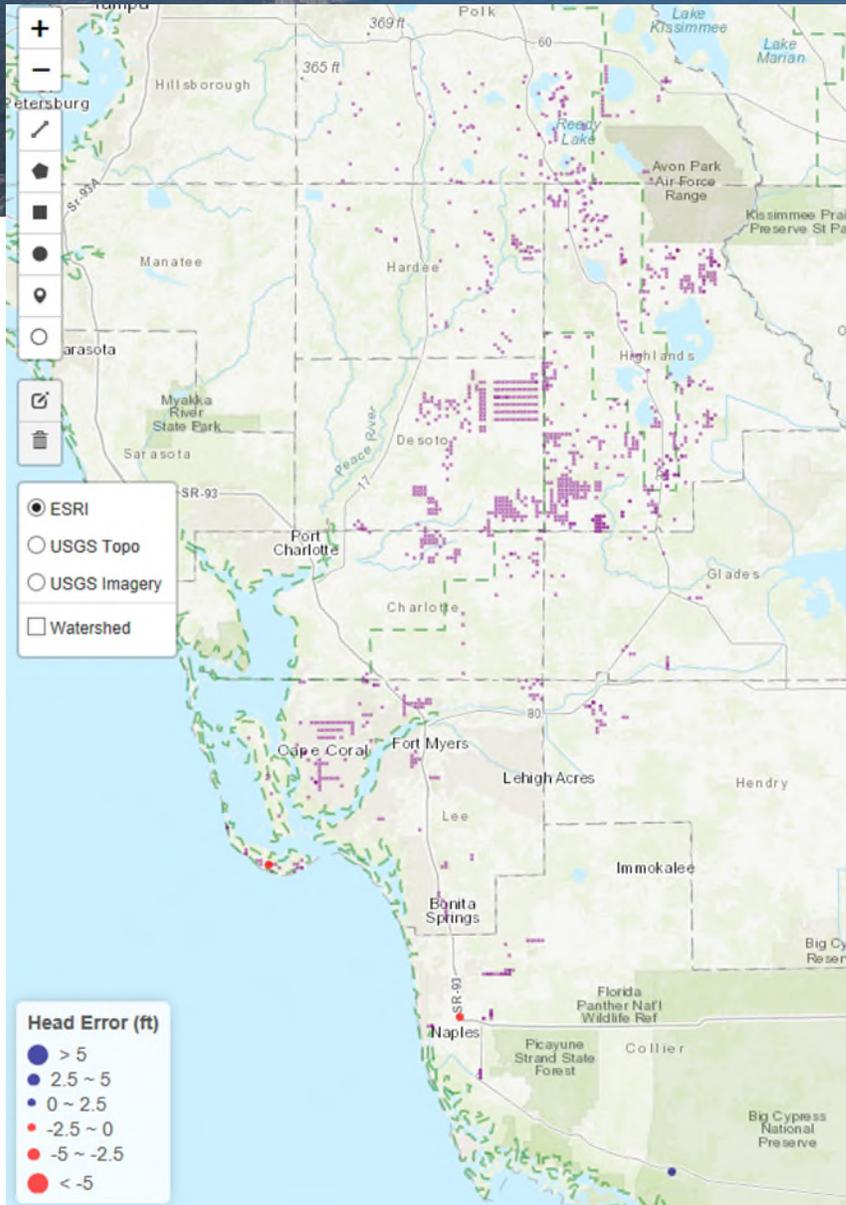


	Criteria	All Layers	APPZ in WCFM	APPZ in LWC
Number of wells		120	18	16
Number of wells meeting calibration		106	17	15
Percentage of calibrated wells	80%	88%		

All water quality calibration criteria for the APPZ are met

Note: Wells depicted in **green** are meeting calibration criteria
 Wells depicted in **blue** are not meeting calibration criteria

Water Level Calibration – Lower Floridan Aquifer

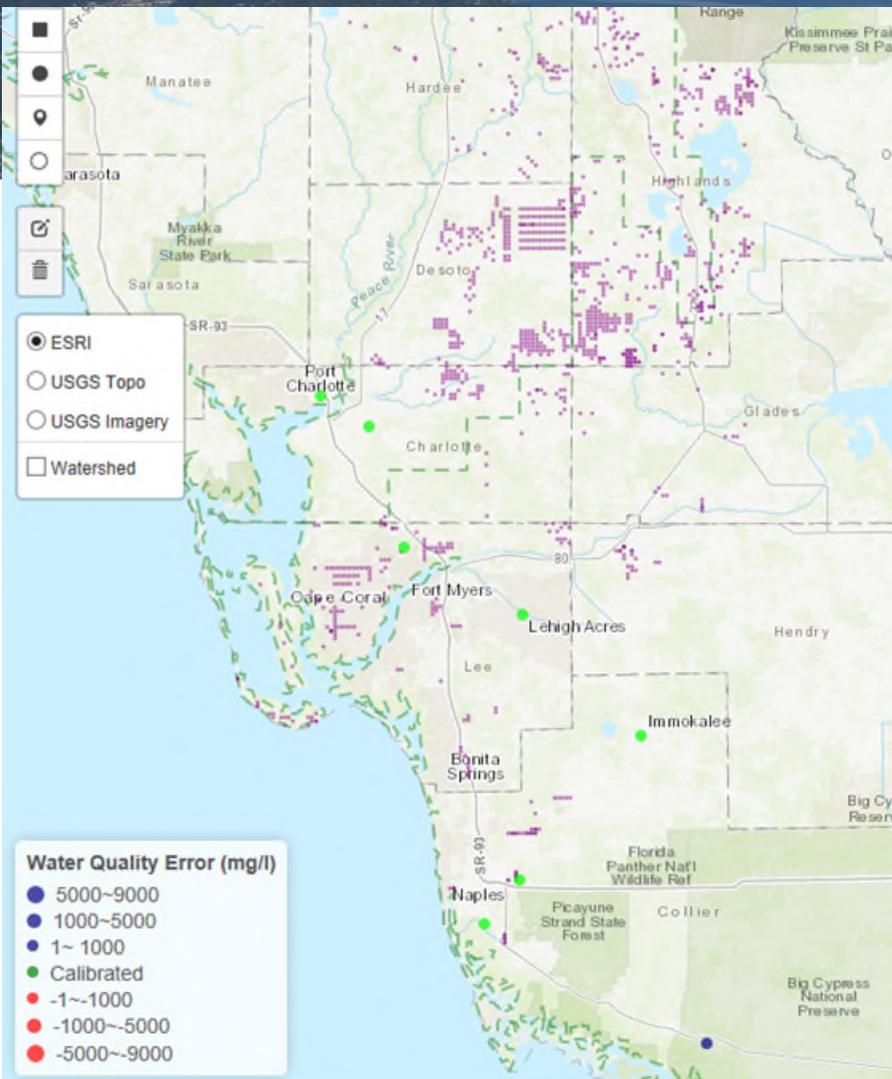


	Criteria	All Layers	LFA in WCFM	LFA in LWC
Mean error	±1 ft	0.03	0.45	0.45
Mean absolute error (MAE)	<2.5 ft	2.24	1.58	1.58
Number of wells		112	3	3
% of wells with MAE < 2.5 ft	>50%	63%	100%	100%
% of wells with MAE < 5.0 ft	>80%	100%	100%	100%

All water level calibration criteria for the LFA are met

Note: Wells depicted in blue are overpredicting
 Wells depicted in red are underpredicting

Water Quality Calibration – Lower Floridan Aquifer



	Criteria	All Layers	LFA in WCFM	LFA in LWC
Number of wells		120	10	8
Number of wells meeting calibration		106	9	7
Percentage of calibrated wells	80%	88%		

All water quality calibration criteria for the LFA are met

Note: Wells depicted in **green** are meeting calibration criteria
 Wells depicted in **blue** are not meeting calibration criteria



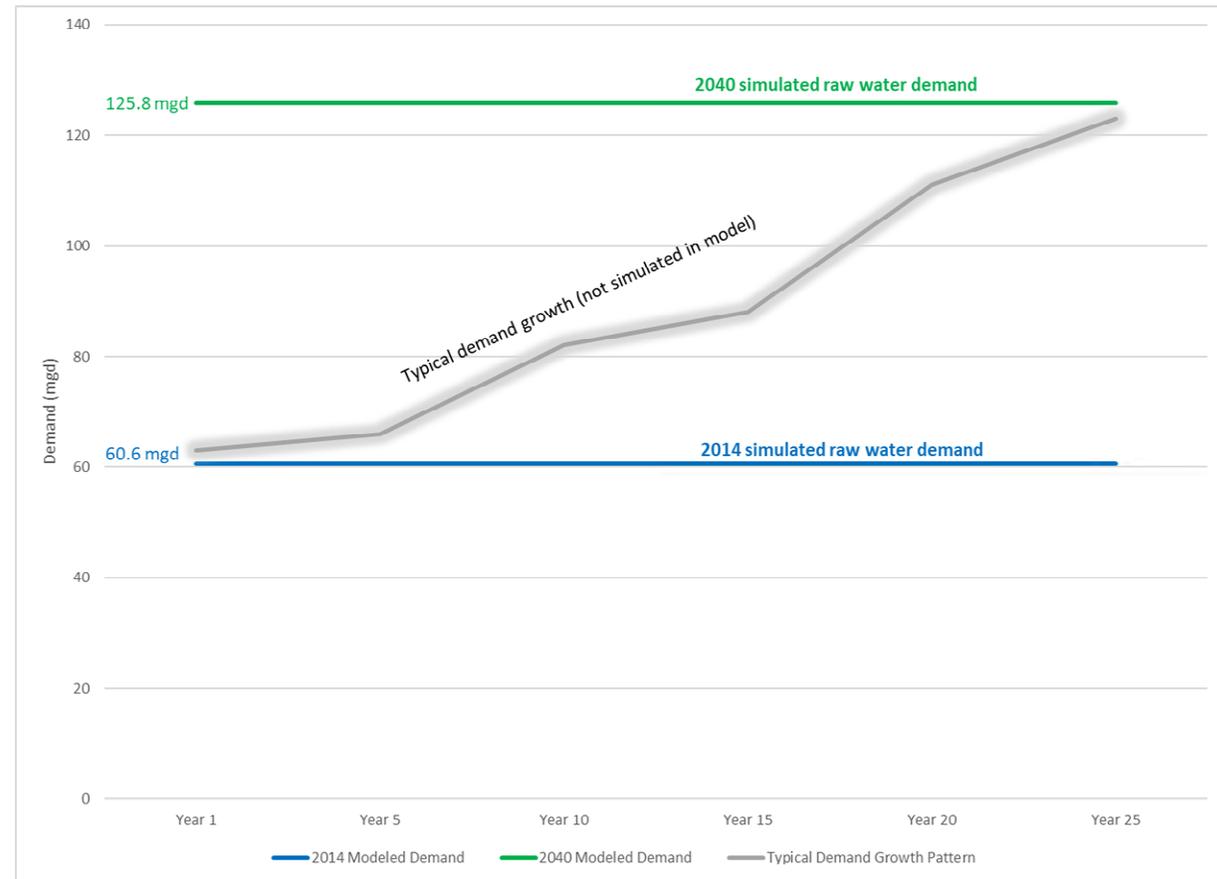
Model Application

Model Application

- 2014 base condition
 - Public water supply demands from historical pumpage data
 - Agricultural and recreational/landscape demands estimated based on AFSIRS (simulates irrigation demands)
 - Industrial demands from permitted allocations
 - Areas overlapping the ECFTX Model domain have demands consistent with the Central Florida Water Initiative regional water supply plan
- 2040 future condition
 - Public water supply, agricultural, and recreational/landscape demands from planning projections
 - Industrial demands from permitted allocations
 - Areas overlapping the ECFTX Model domain have demands consistent with the 2040 projections in the Central Florida Water Initiative regional water supply plan
 - 2040 projected demands are simulated starting at the initial condition

Limitations in Simulating Demands

- Each simulation is 23 years
 - Same as calibration period
- Model does not simulate annual demand growth
- Raw water demand shown for all use types
- Simulated demands are “instant on”
- Results from the 2040 simulation are considered conservative



Regional Model Limitations

- Multiple wells in a single model cell
 - Model aggregates all withdrawals at the center of the model cell
 - Tends to exaggerate water level drawdowns and water quality degradation
 - Results are conservative
- Regional model may not capture local heterogeneity in the Floridan aquifer system and the response at individual wells
- Regional model results should be used as an overall planning tool; results should not be considered absolute

Public Water Supply FAS Demands

County	Permit Number	Utility	FAS Allocation (mgd)	2014 (mgd)	2040 (mgd)	Difference (mgd)
Lee	36-00046-W	Cape Coral Utilities	39.25	11.32	27.60	16.28
	36-00035-W	City of Fort Myers	15.25	8.93	17.49*	8.56
	36-00003-W	Lee County – Corkscrew/Green Meadows/Olga	14.21	0.27	13.57	13.29
	36-00152-W	Lee County Utilities – North	16.13	5.00	10.98	5.98
	36-04062-W	Bonita Springs Utilities	13.07	5.61	10.69	5.09
	36-00122-W	Lee County Utilities – Pinewoods	4.90	2.24	6.15*	3.91
	36-00034-W	Island Water Association	4.96	4.43	4.70	0.27
	36-00045-W	Greater Pine Island	2.49	1.54	2.24	0.70
Total Lee County Demand			110.26	39.34	93.42	54.08
Collier	11-00249-W	Collier County North & South Regional	19.52	3.42	14.12	10.70
	11-00013-W	Immokalee Water & Sewer District	0.70	0.00	0.002	0.002
	Total Collier County Demand			20.22	3.42	14.122
Hendry	26-00105-W	Labelle Public Water Supply	1.06	0.33	0.74	0.41
	Total Hendry County Demand			1.06	0.33	0.74

* Indicates a modeled demand over the current permitted allocation; however, it is not guaranteed to be permitted by SFWMD Water Use Bureau

2040 Public Water Supply FAS Wellfields

Cape Coral Utilities

- 18 additional wells
- 16.28 mgd increase

Greater Pine Island

- 0.70 mgd increase

Island Water Association

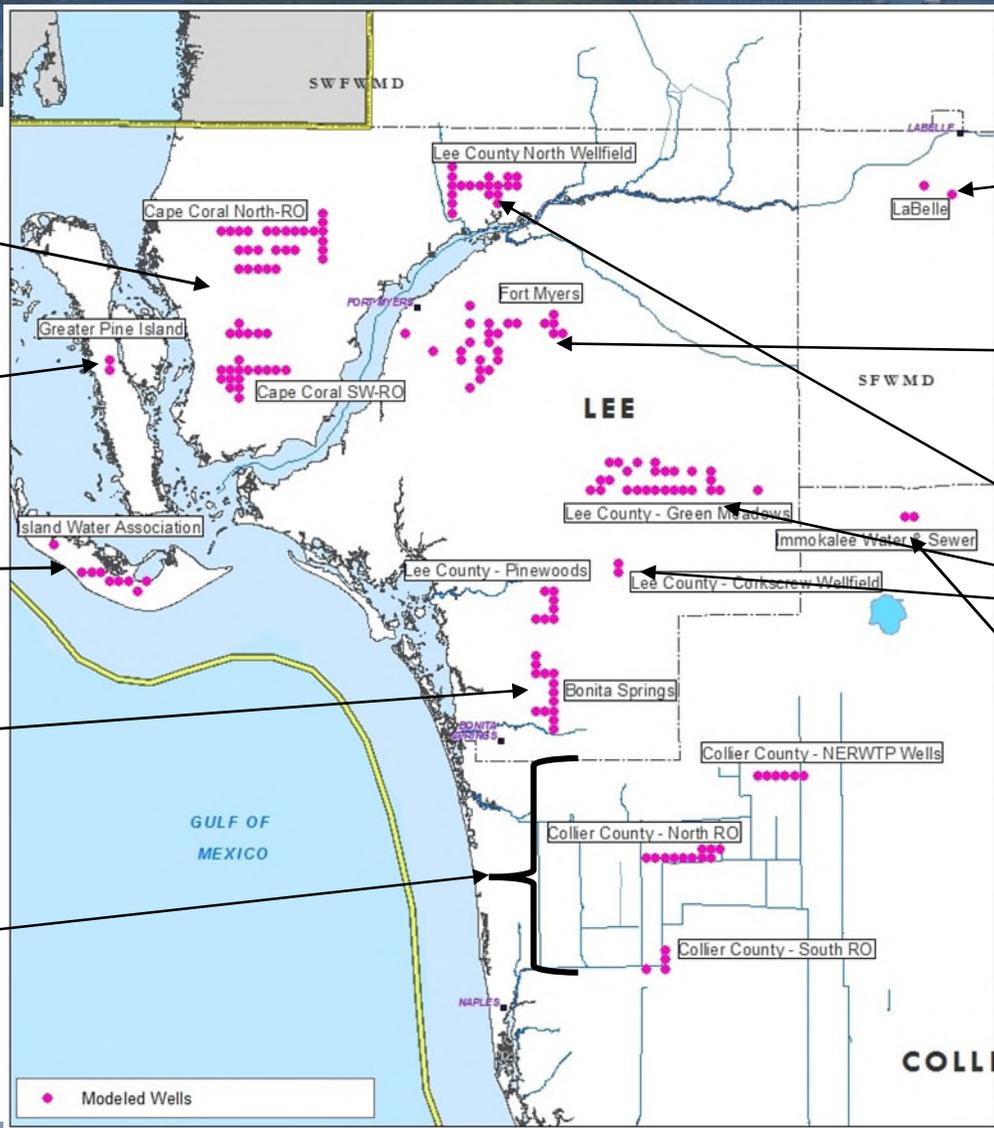
- 0.27 mgd increase

Bonita Springs

- 8 additional wells
- 5.09 mgd increase

Collier County

- 16 additional wells
- 10.70 mgd increase



LaBelle

- 0.41 mgd increase

Fort Myers

- 25 additional wells
- 8.56 mgd increase

Lee County Utilities

- 29 additional wells
- 13.29 mgd increase

Immokalee Water & Sewer

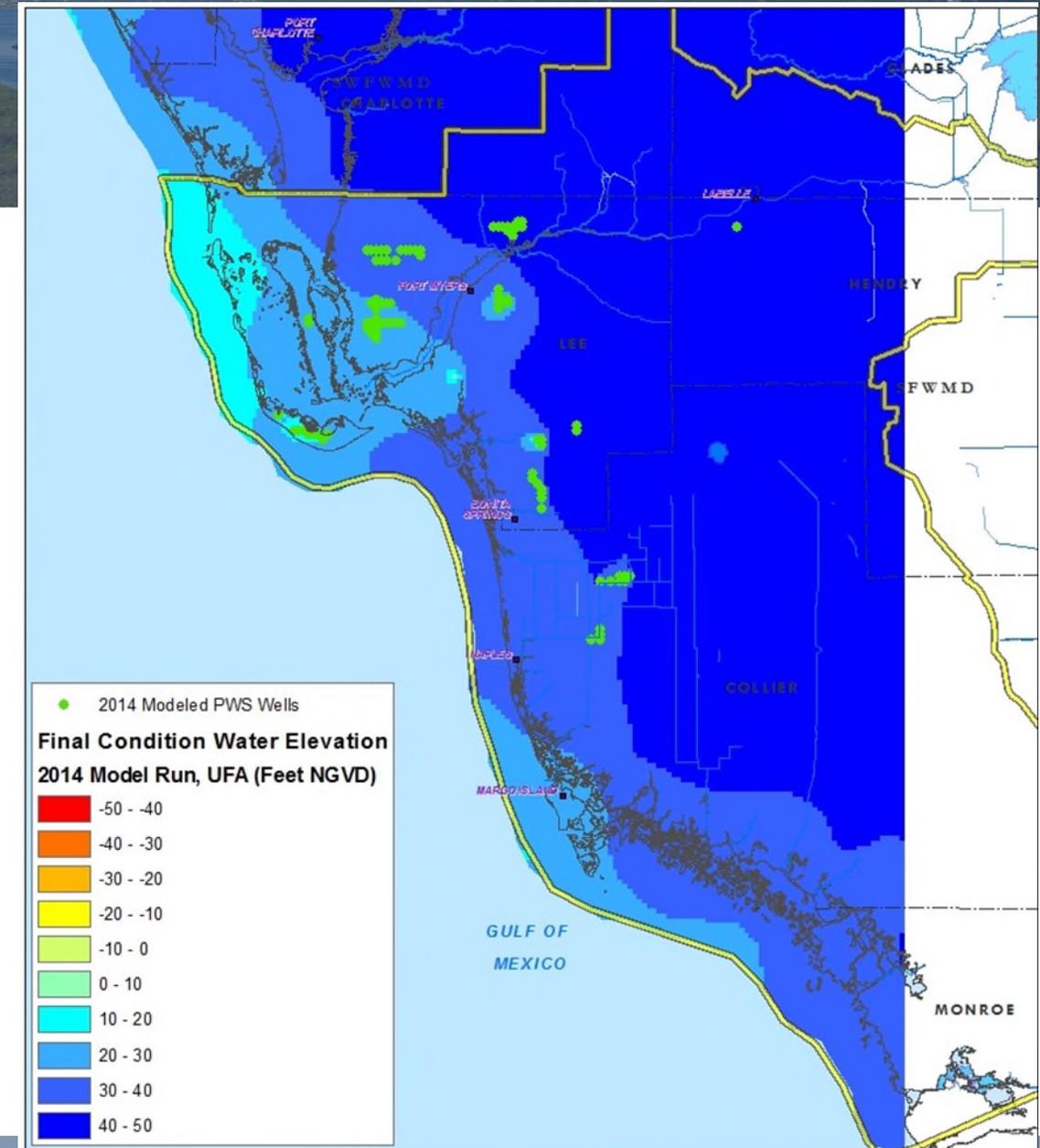
- 0.002 mgd increase



Model Results

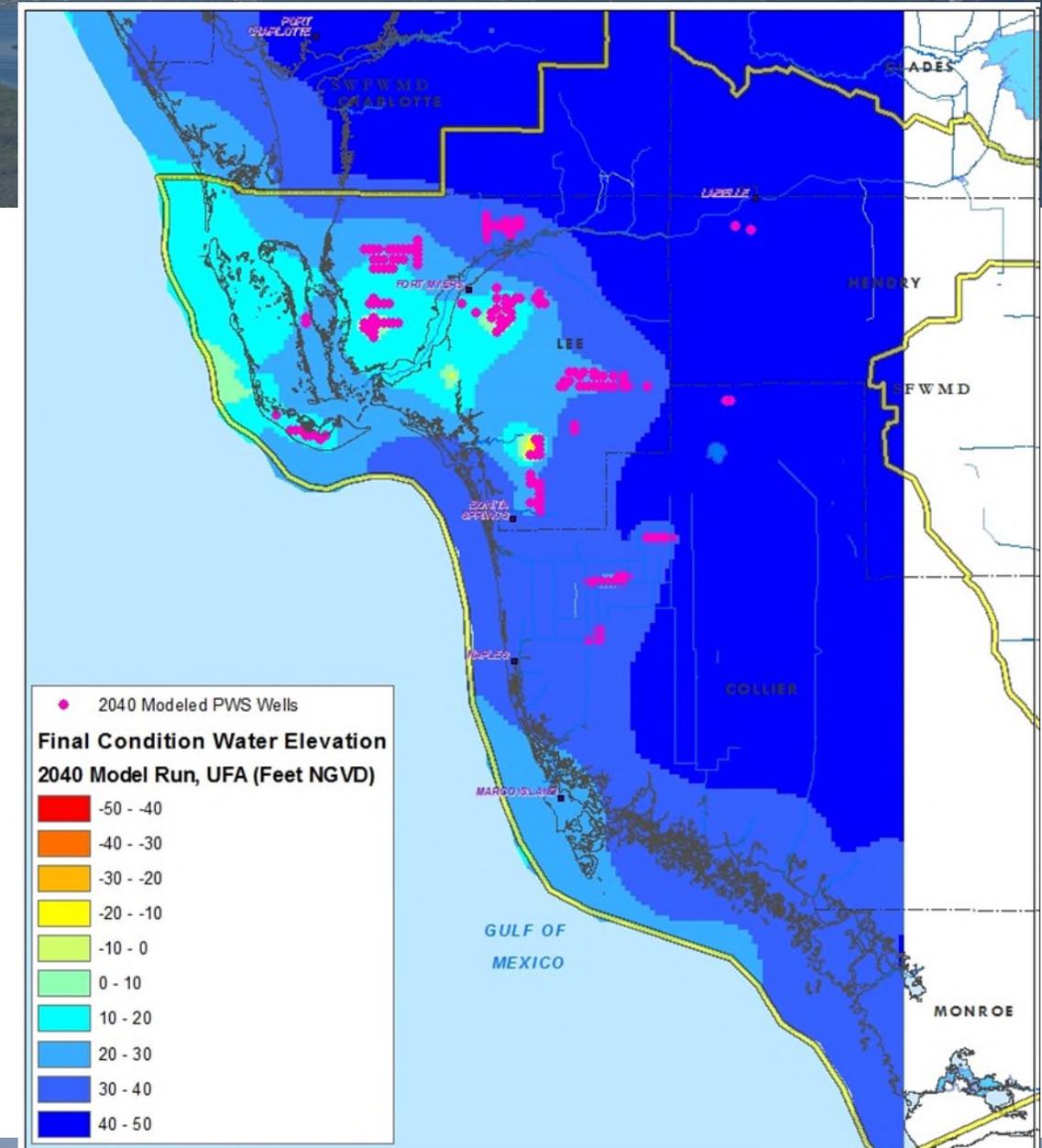
Interpreting the Results

- Model run
 - 2014 final condition
 - 2040 final condition
 - (2040 – 2014) final condition difference map
- Layer
 - UFA
 - APPZ
- Well symbol
- Units and scale
 - ft, mg/L, ft³/d

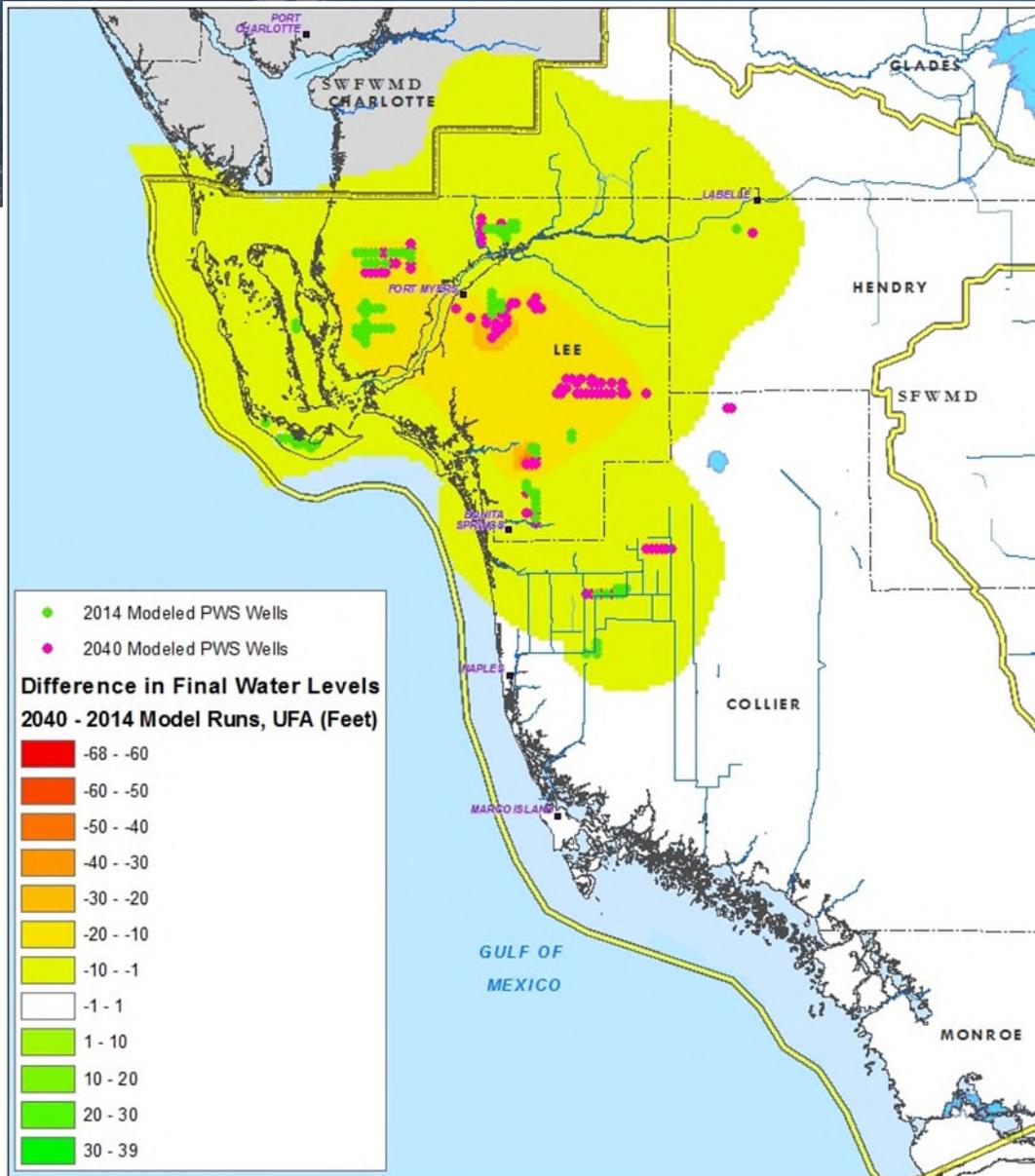


Interpreting the Results

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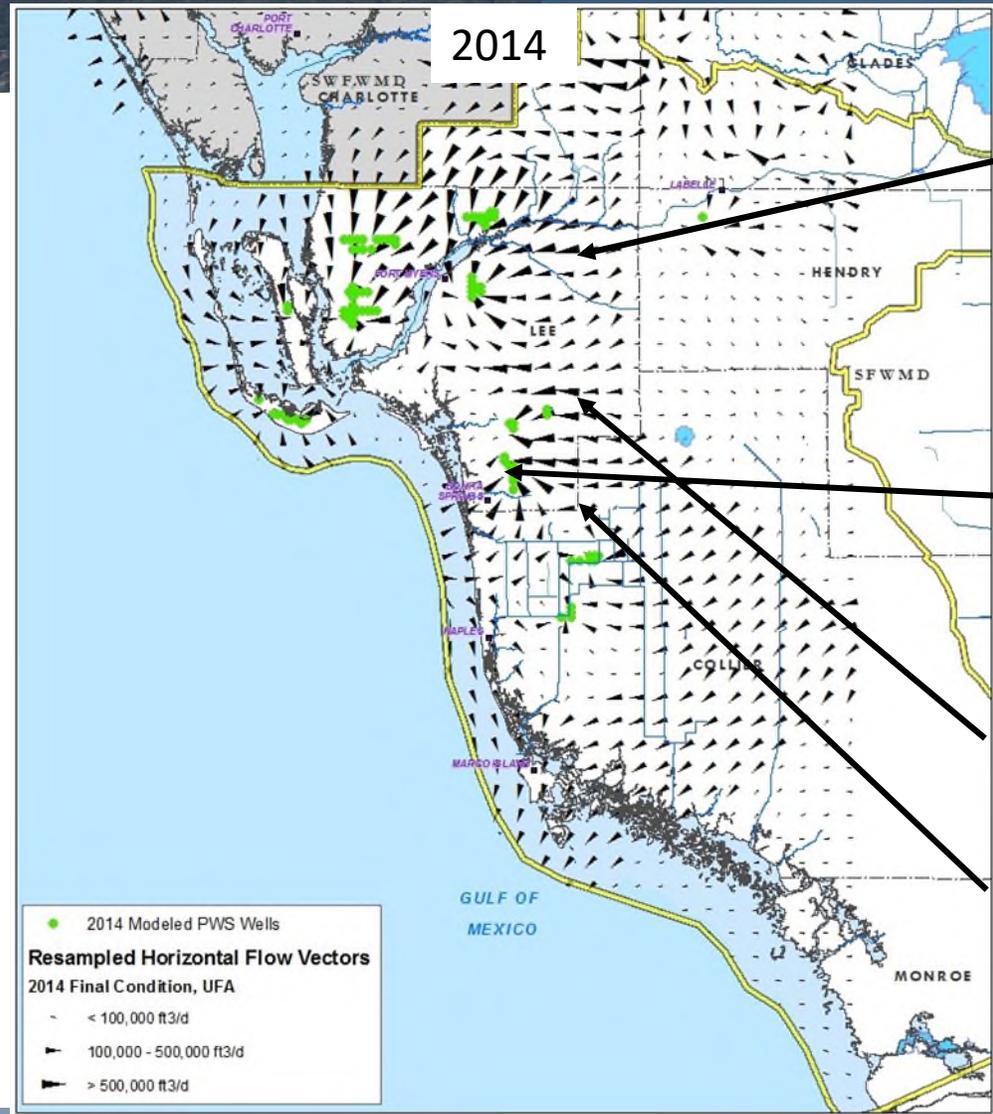


UFA Water Level Difference



- (2040 – 2014) final condition water level difference
- 20-35 ft of additional drawdown at Cape Coral
- 20-30 ft of additional drawdown at Fort Myers
- Average drawdown at Lee County – Pinewoods approximately 40 ft, with maximum drawdown of 68 ft

UFA Horizontal Flow Vectors

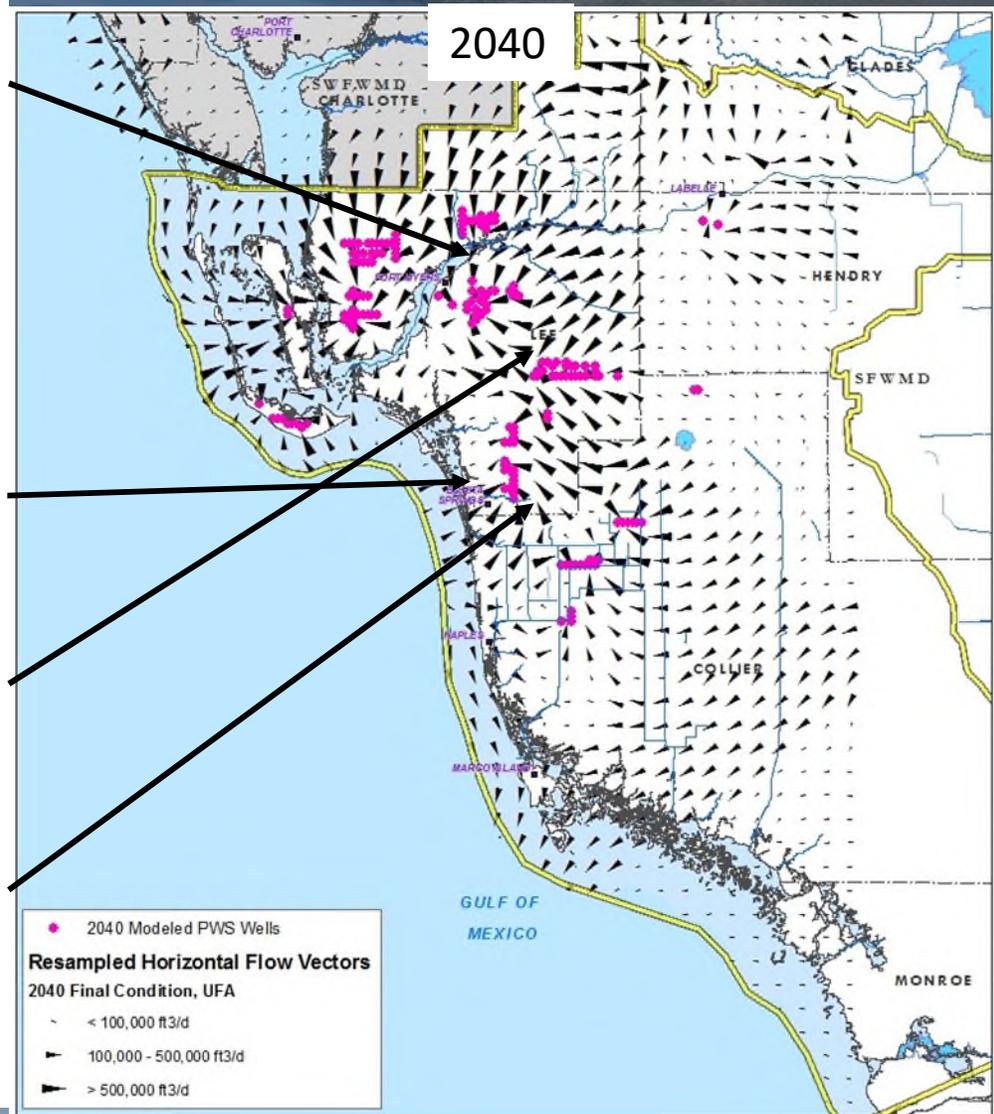


Increase in horizontal flow from the northern area of the model domain towards Lee County – North wellfield and Fort Myers wellfield

Increase in lateral saltwater intrusion near Bonita Spring wellfield

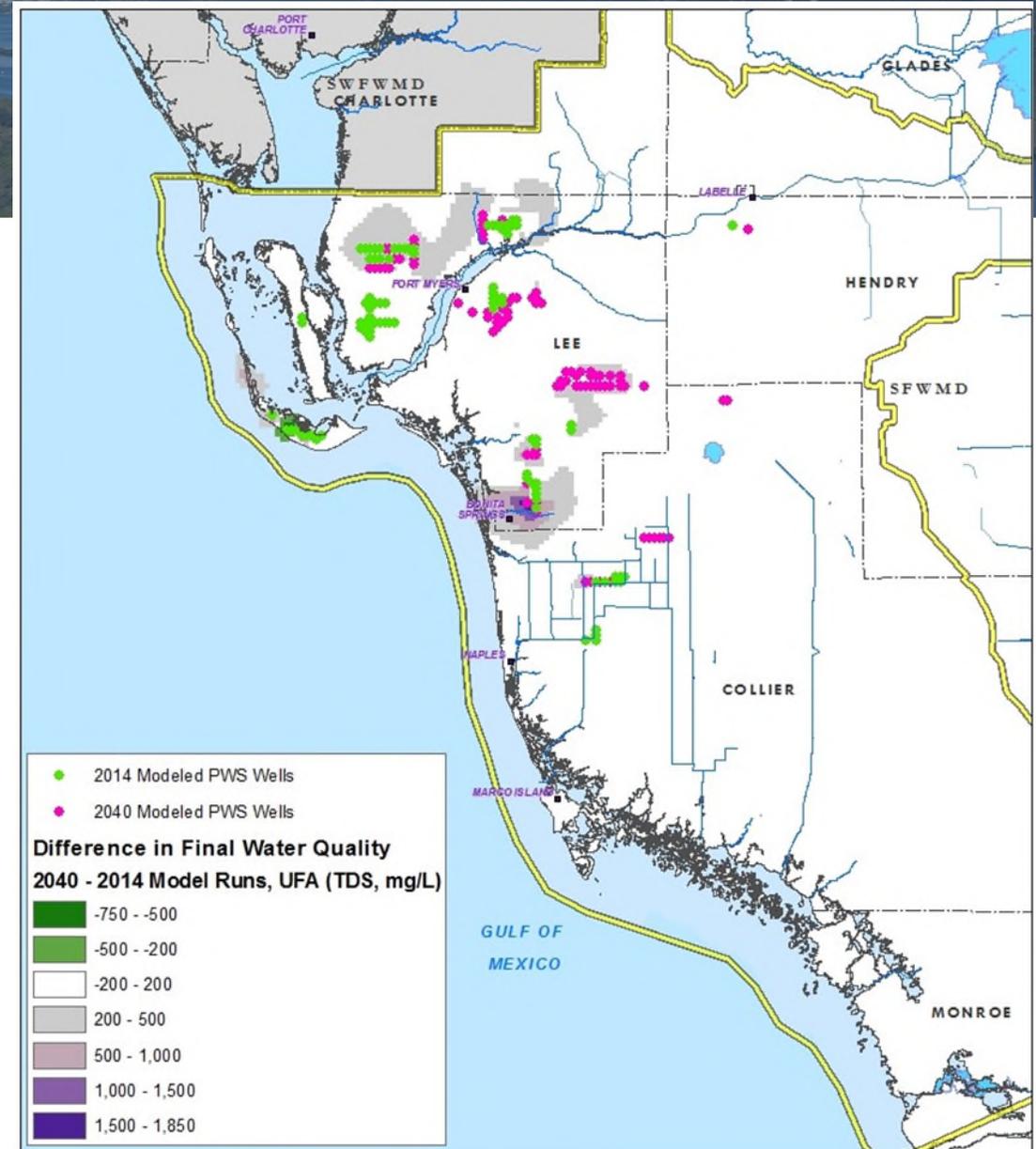
Increase in horizontal flow towards the Green Meadows wellfield

Increase in horizontal flow from southeast towards several wellfields

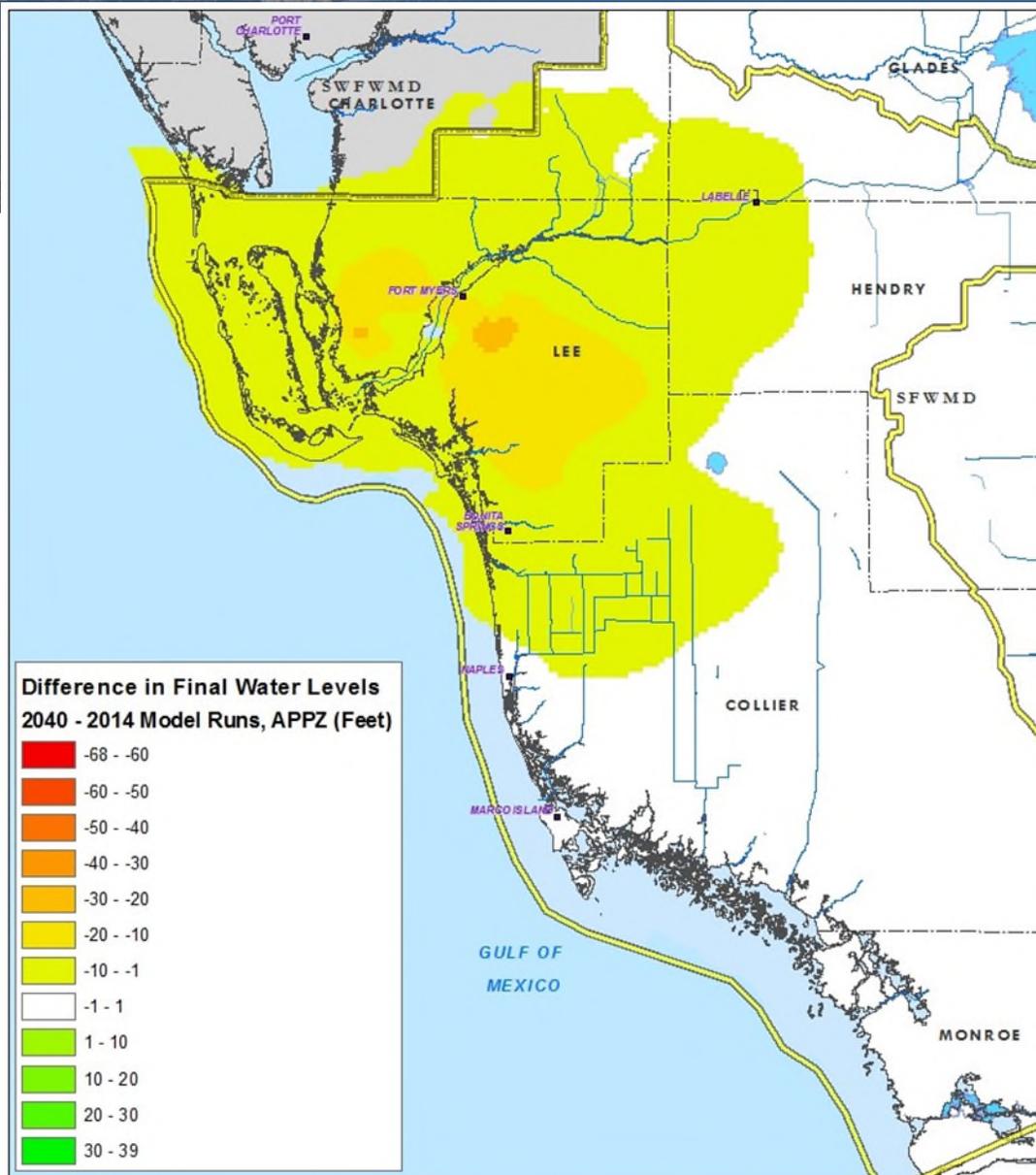


UFA Water Quality Difference

- (2040 – 2014) final condition water quality difference
- Total dissolved solids (TDS) degradation at Cape Coral and Fort Myers is <500 mg/L
- TDS degradation at Green Meadows wellfield is <700 mg/L
- TDS degradation at Pinewoods wellfield is <1,000 mg/L
- TDS degradation at Bonita Springs wellfield is <2,000 mg/L

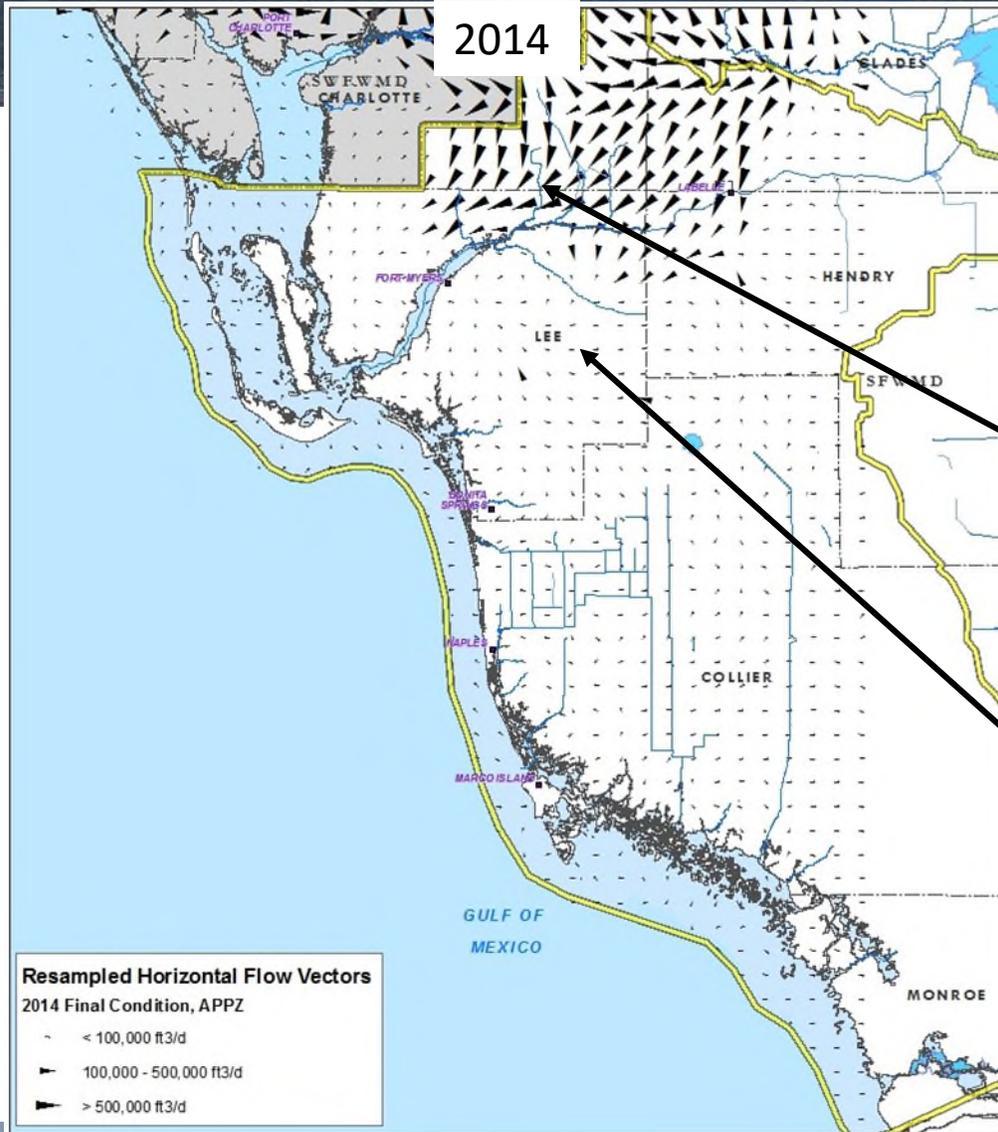


APPZ Water Level Difference



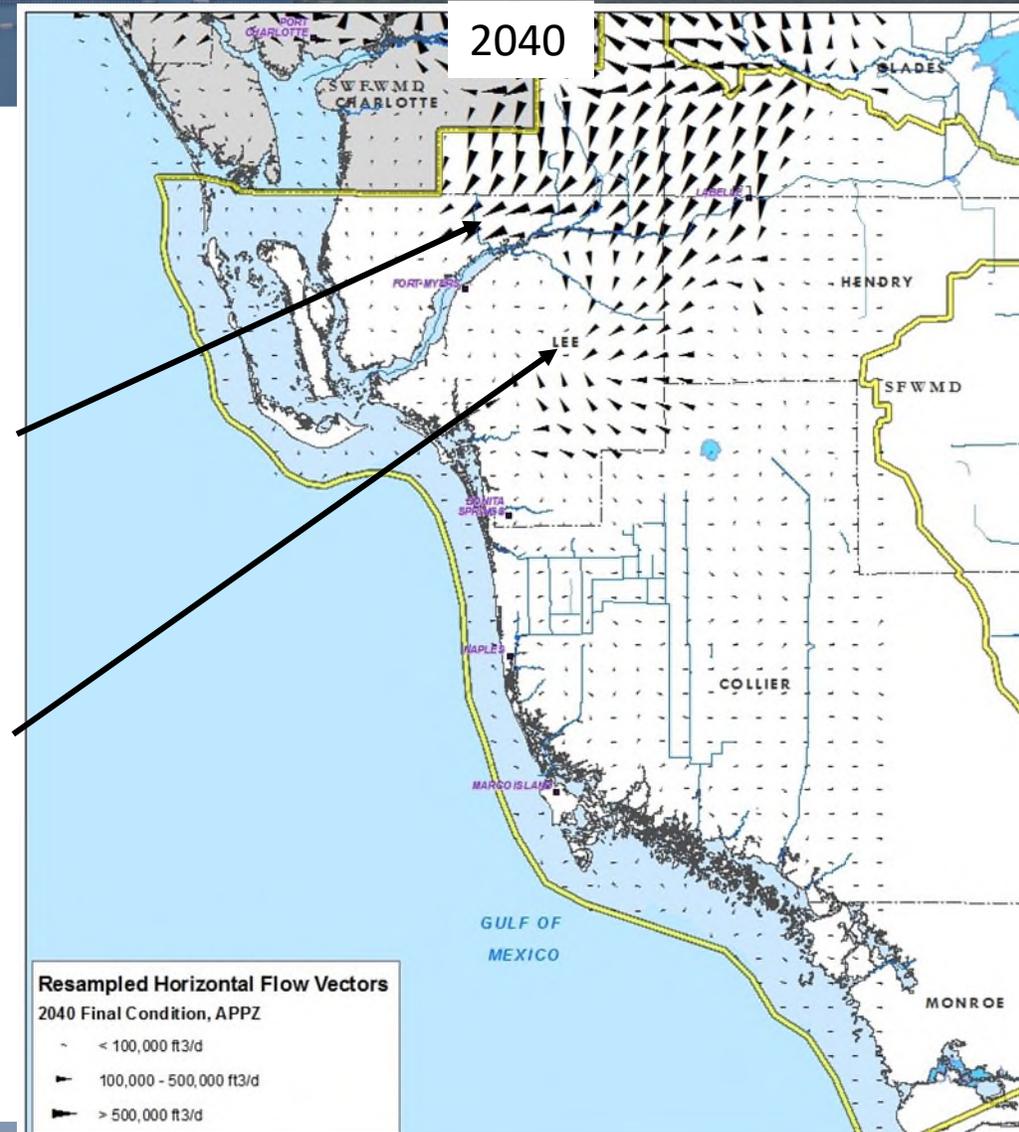
- (2040 – 2014) final condition water level difference
- 25 ft of additional drawdown at Cape Coral due to increased withdrawals from the UFA
- 22 ft of additional drawdown at Fort Myers due to increased withdrawals from the UFA

APPZ Horizontal Flow Vectors



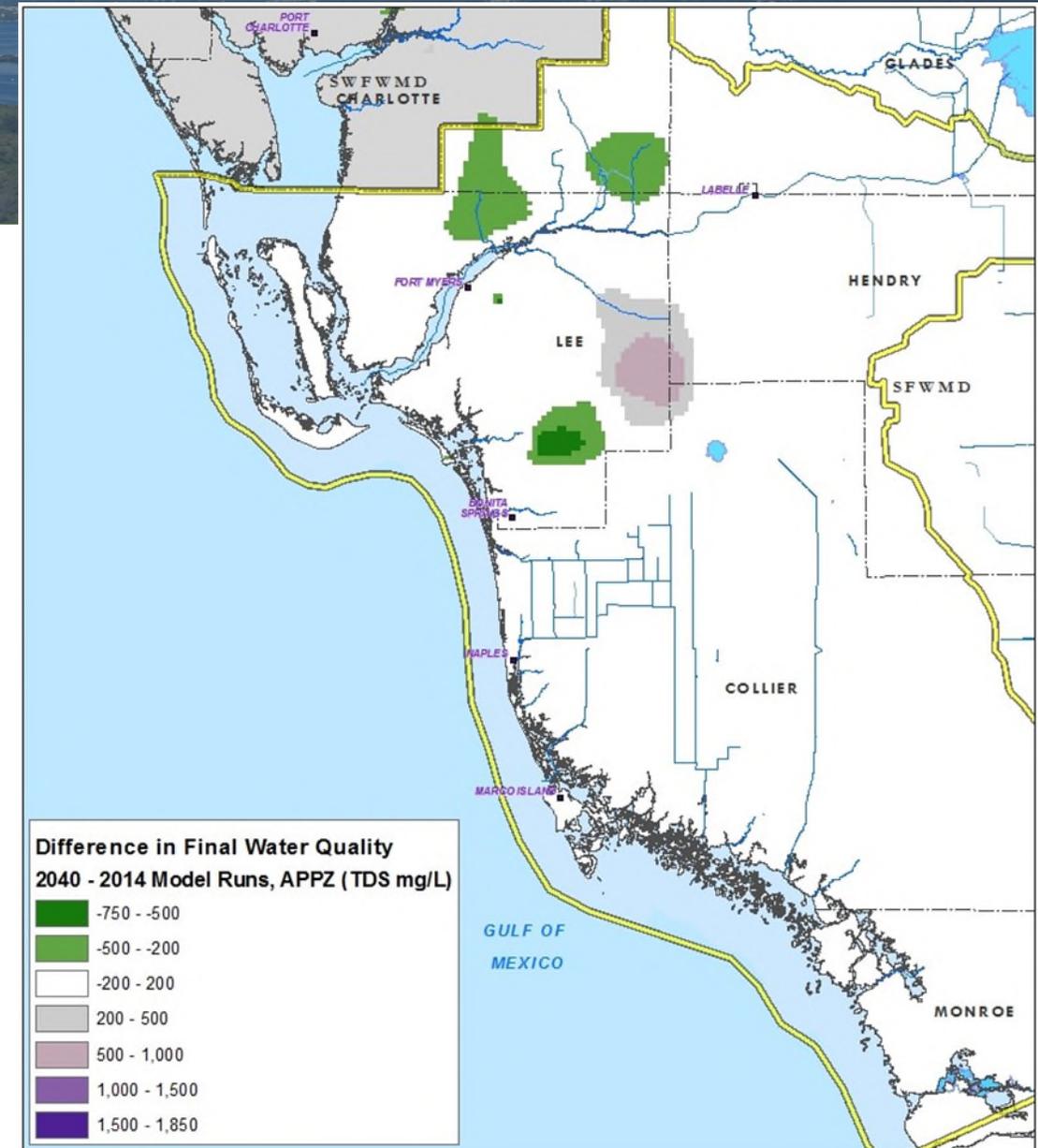
Increase in horizontal flow from the north due to additional withdrawal in UFA near Lee County North wellfield

Increase in horizontal flow due to the Green Meadows wellfield in the UFA



APPZ Water Quality Difference

- (2040 – 2014) final condition water quality difference
- TDS degradation between 200 and 1,000 mg/L near Lee County's Green Meadows wellfield



Conclusions

- Spatial expansion of wellfields in Fort Myers and Cape Coral, combined with lateral recharge from the northeast, minimized drawdown impacts despite significant increase in demands. Wellfield expansion also minimized potential water quality degradation.
- Although Lee County – Pinewoods increases the number of production wells, the wells are clustered, which accounts for 20 to 68 ft of additional drawdown in the area. The utility has a demand increase of 3.91 mgd.
- Water quality degradation in Bonita Springs is a result of lateral saltwater intrusion and lateral movement of water from northern Collier County, which has higher salinity.
- Based on planning projections, with wellfield management, the 2040 model results do not indicate a significant adverse impact to groundwater levels and quality, indicating prolonged use of the FAS is sustainable.

Modeling Team

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Thank You

Questions?