SFWMD Saltwater Intrusion Mapping And Modeling – An Update

Palm Beach County Water Resources Task Force Meeting

August 17, 2023

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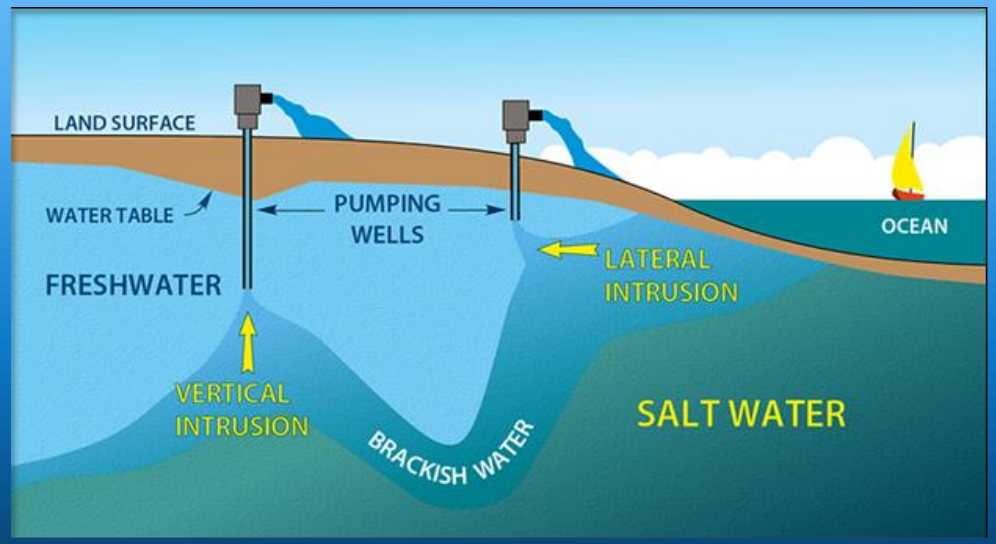
Presentation Overview

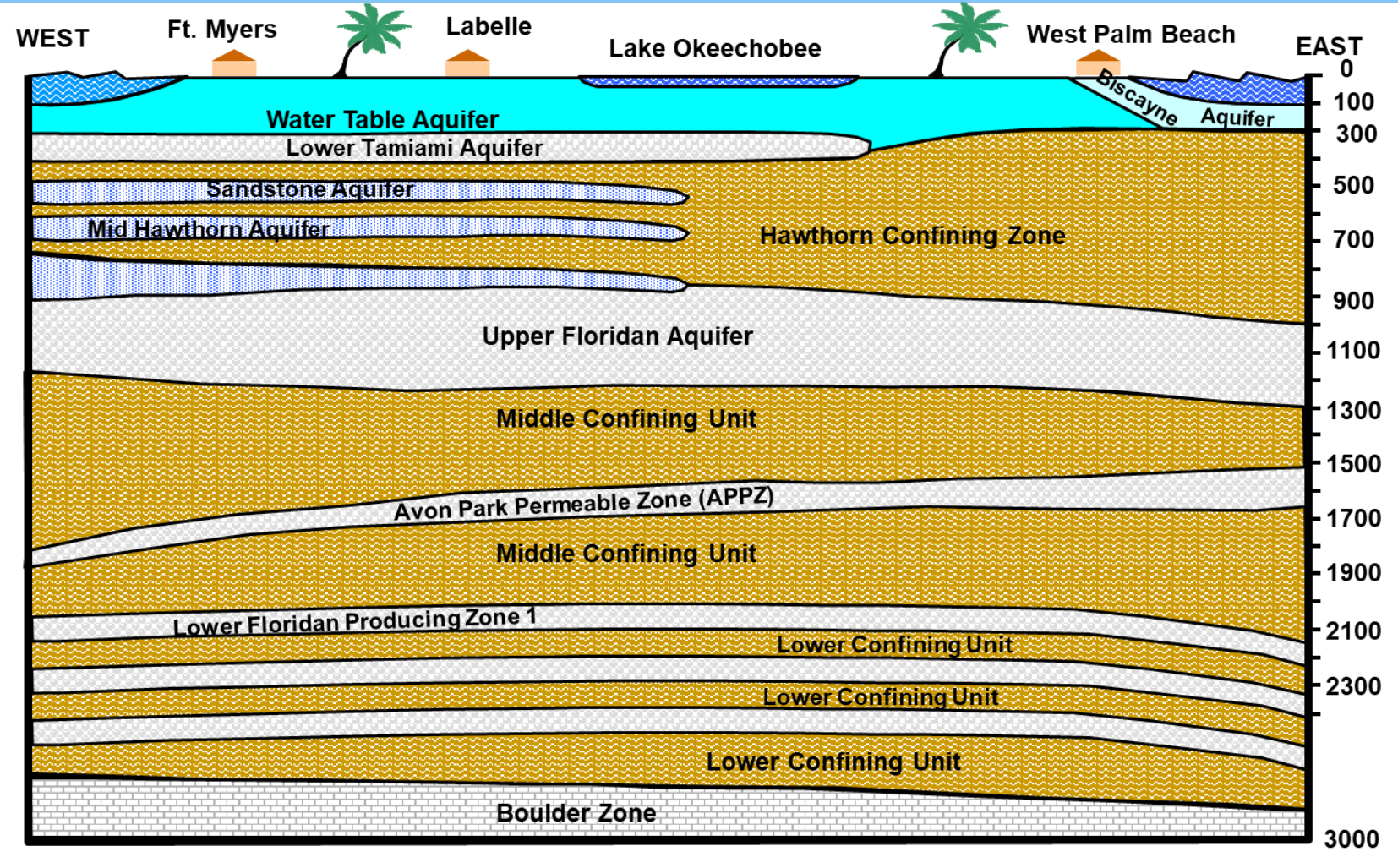
- Overview of Saltwater Intrusion, Aquifers, Wellfields
- Saltwater Intrusion Monitoring and Mapping Program
- Groundwater Modeling
- Schedule
- Questions and Discussion

Common Sources of Saltwater Intrusion

- Lateral intrusion from the coast
- Vertical Intrusion (upconing from saltwater below)
- Surface Infiltration – estuaries, boat basins, saltwater marshes, saltwater canals, etc.
- Ancient (relict) seawater trapped in low permeability aquifers



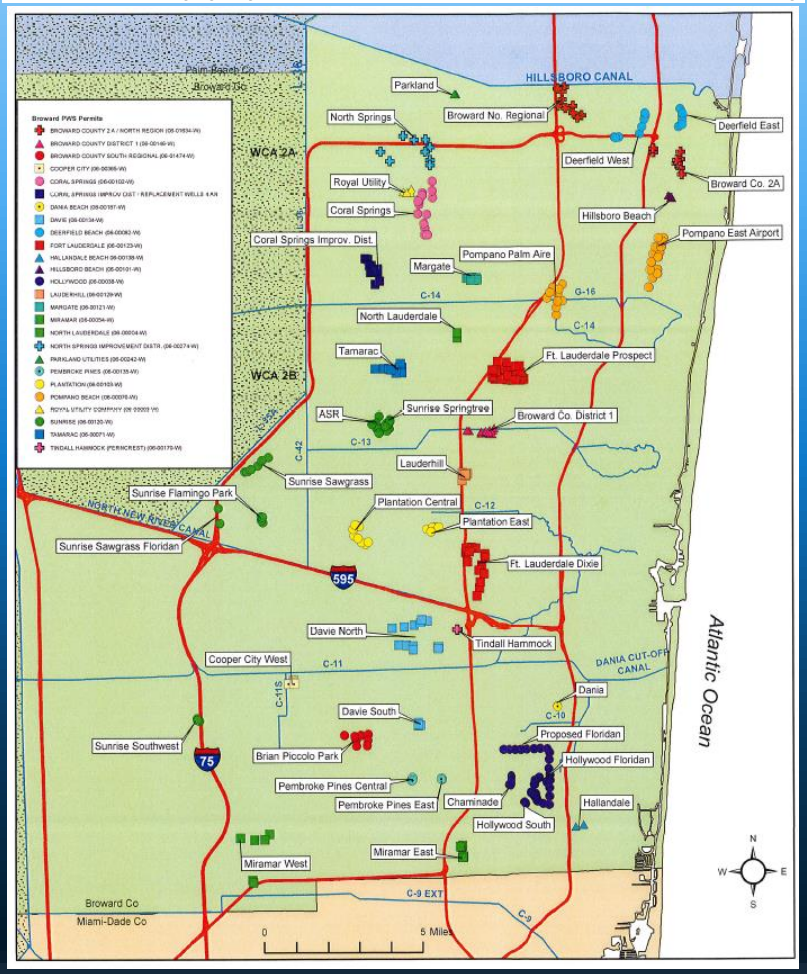
Generalized Hydrogeology of South Florida



Why is this Important?

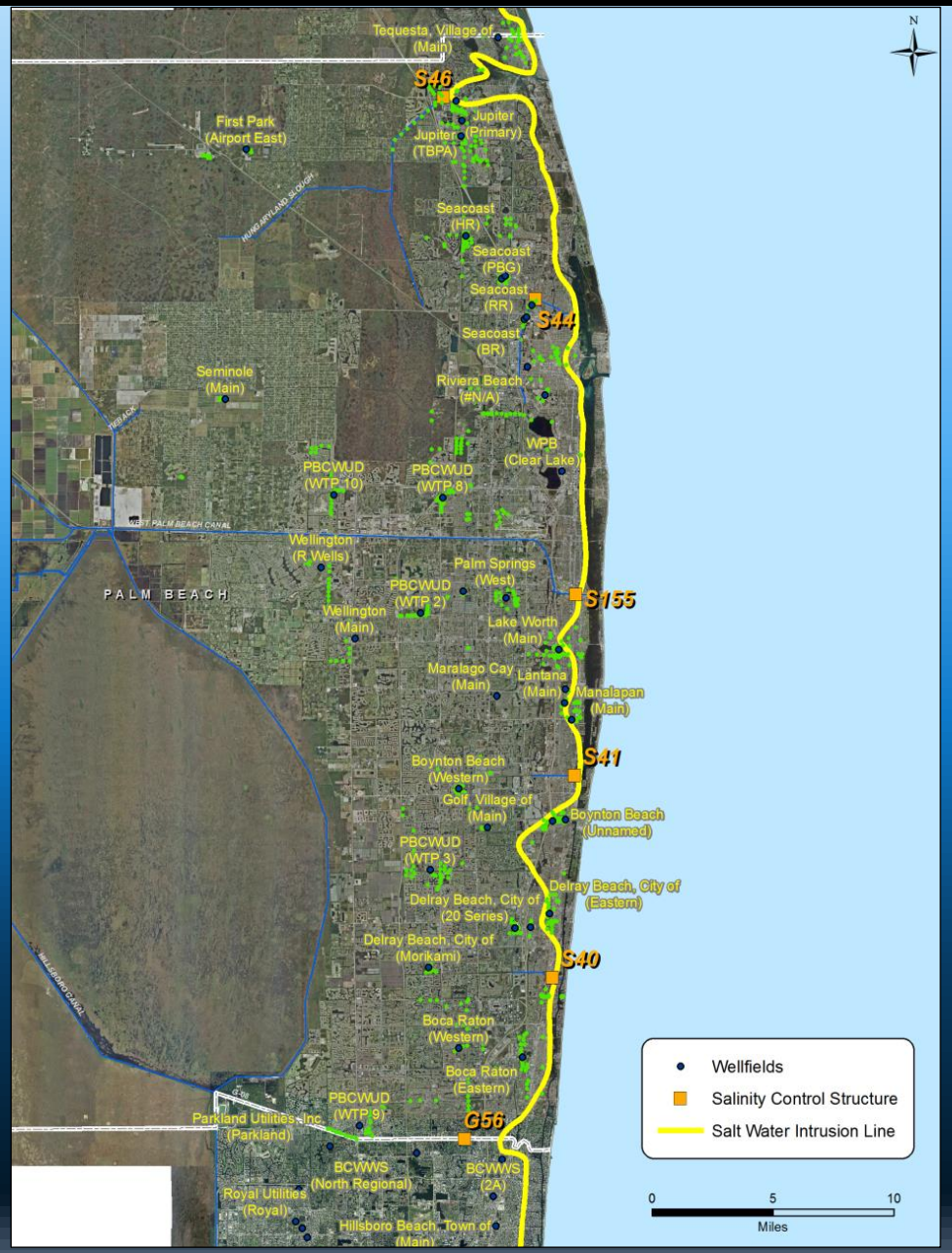
- Wellfields are a major water supply source – protect investment
- Once saltwater enters wells, very difficult – if not impossible – to reverse
- Very expensive to relocate wellfields and associated infrastructure (pipelines, treatment plants and processes, etc.)
- Other sources of water more expensive to treat (e.g., Floridan aquifer – reverse osmosis)

Public Supply Wellfields, Broward County



What factors affect the position of the saltwater interface?

- Surface Water Control Structures
  - Maintain canal stages to prevent inland saltwater movement
  - Help maintain groundwater levels to minimize inland movement of saltwater into aquifer
- Public Supply Wellfields
  - Well Locations
  - Well Depths
  - Pumping Rates
  - Proximity to Saltwater
  - Proximity to Canals (Recharge)
- Sea-Level Rise and Climate Change

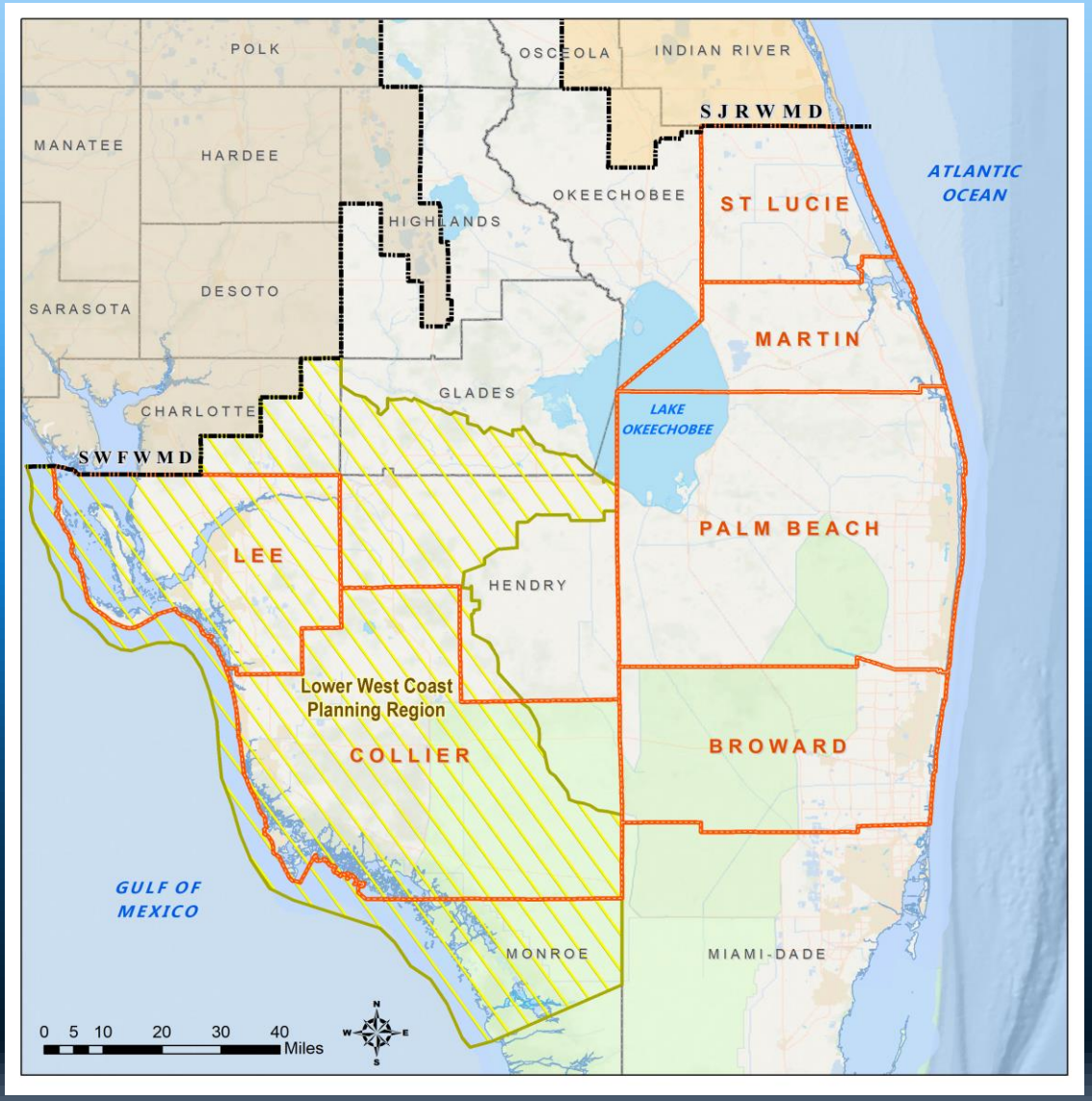


SFWMD Saltwater Interface Mapping Project

- Strategy -- Compare interface positions (i.e., 2009, 2014, 2019), note areas of concern, and adjust monitoring as necessary
- Update Maps Every 5 Years
- Use all available data (USGS, SFWMD, Counties, Water Use Permittees)
- Furthest Inland Extent – Dry Season
- Maximum chloride value March/April/May (with some exceptions)
- 250 milligrams per liter (mg/L) chlorides – Primary drinking water standard
- Coastal aquifers: Water Table (Biscayne aquifer), Lower Tamiami, Sandstone, Mid-Hawthorn

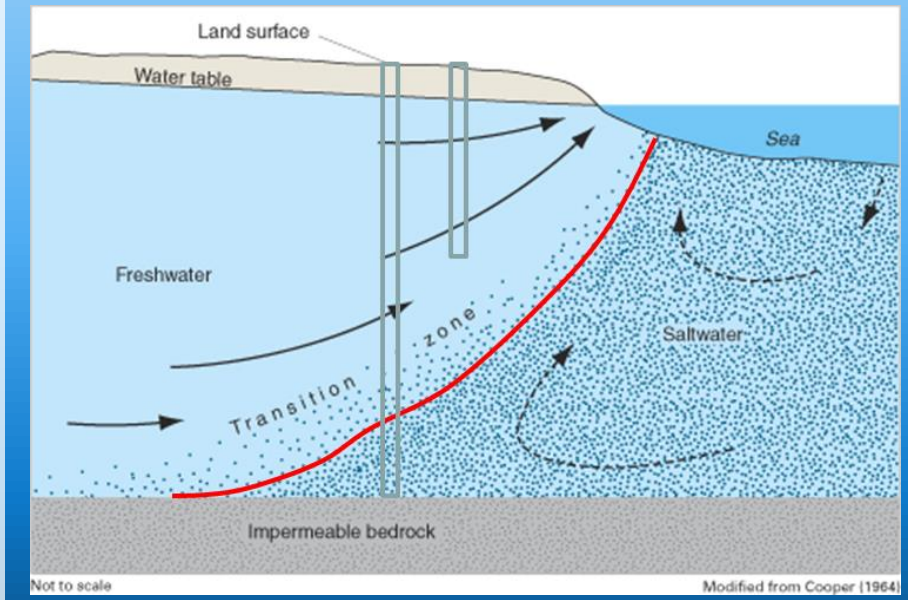
Location of SFWMD Coastal Counties

COUNTY	Aquifer	2009	2014	2019
Martin & St. Lucie	SAS	X	X	X
Palm Beach	SAS	X	X	X
Broward	SAS	X	X	X
Lee	WTA	X	X	X
Lee	MHA	X	X	-
Lee & Collier	SSA	X	X	X
Lee & Collier	LTA	X	X	X
Collier	WTA	X	X	X
Collier	MHA	X	X	-
Lee & Collier	MHA			X
Notes:				
Miami-Dade County mapping performed by USGS				
SAS	Surficial Aquifer System			
WTA	Water Table Aquifer			
MHA	Mid-Hawthorn Aquifer			
SSA	Sandstone Aquifer			
LTA	Lower Tamiami Aquifer			



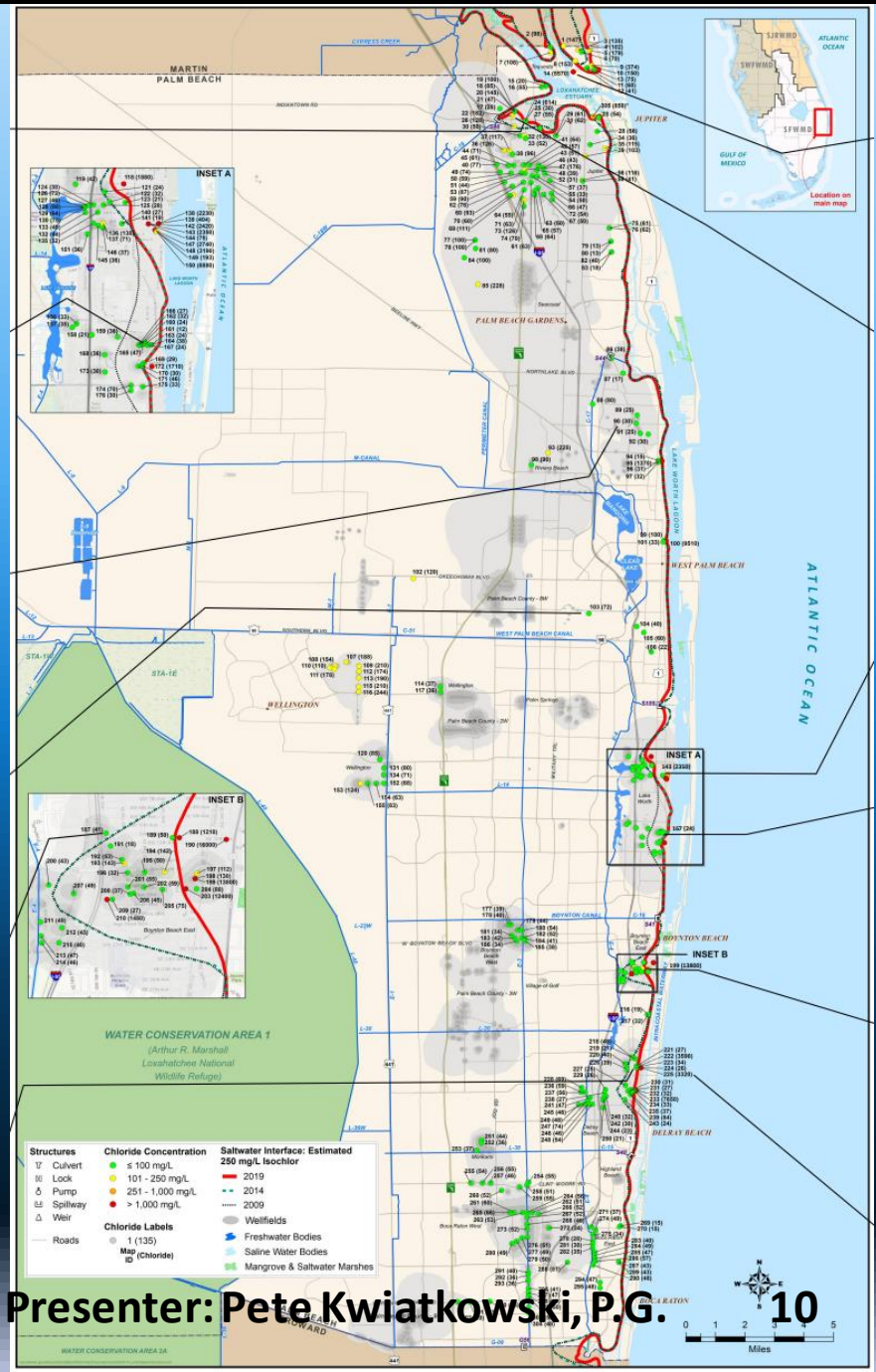
Mapping Challenges

- Representing a 3-D feature on a 2-D map
- Representing a dynamic interface with fixed-time snapshots
- Representing a diffuse front with a single line
- Mapping from data that may represent one of several saltwater intrusion pathways
- Some wells used in 2009 and 2014 were not available in 2019 (abandoned, destroyed, no longer monitored, etc.)
- New wells added to 2019 may alter interpretation of isochlor line.
- Use existing monitor wells with varying well depths, construction, and spacing



2019 Map, Palm Beach County

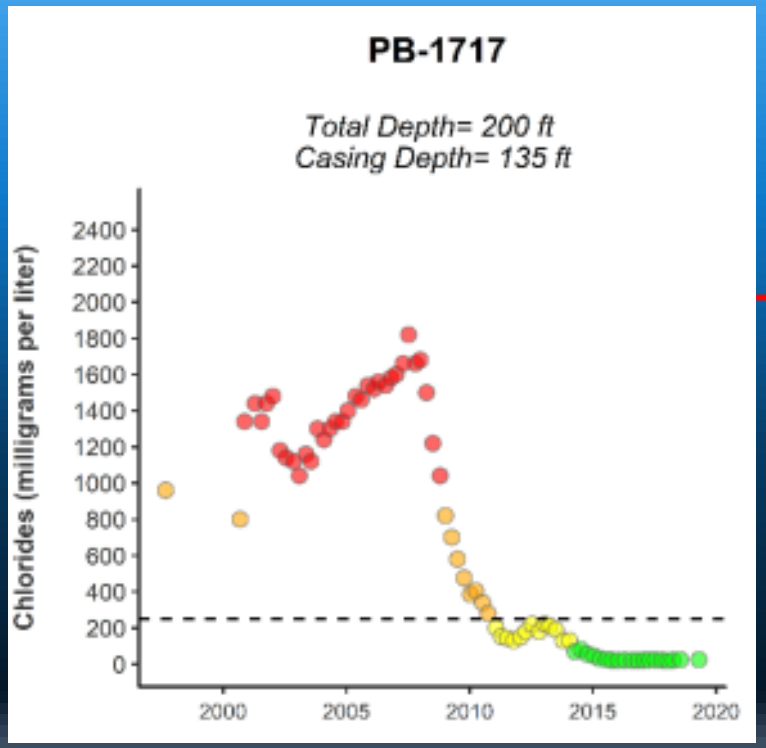
- In general, interface close to the coast
- Older wellfields close to the coast are more vulnerable to saltwater intrusion and are areas of concern
- Lake Worth Drainage District maintains surface water control elevations in southern half of County that help maintain groundwater elevations to fend off saltwater intrusion
- Western wellfields (e.g., PBCWUD) at much less risk of saltwater intrusion
- Floridan aquifer wellfields (e.g., Jupiter, LWB, etc.) reduce water demands on coastal wellfields

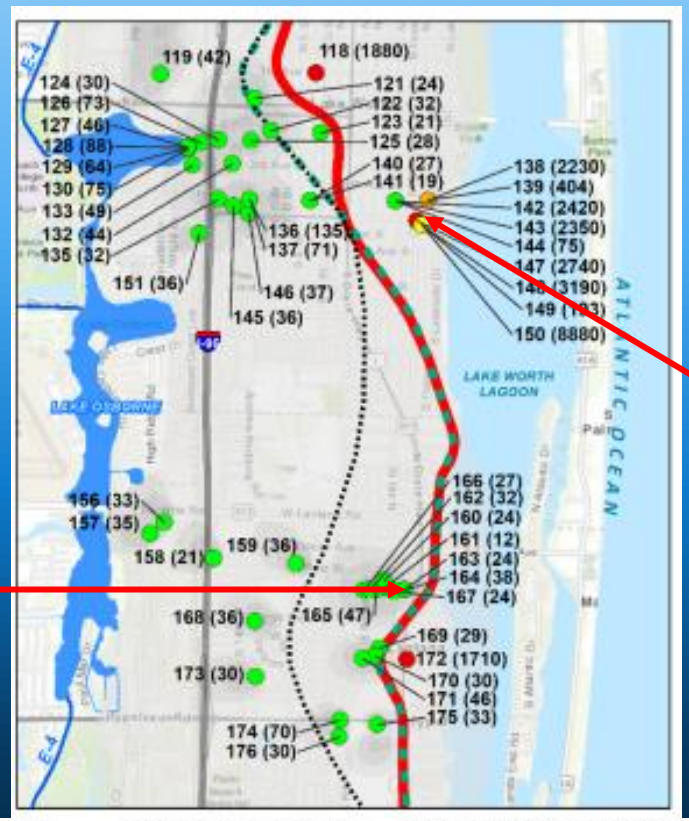


Presenter: Pete Kwiatkowski, P.G.

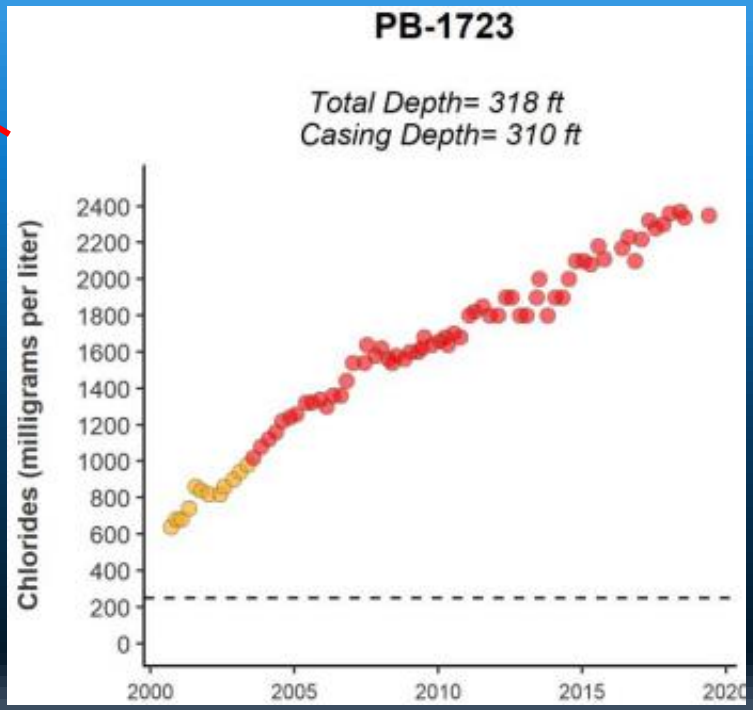
Lantana/Lake Worth Beach Area

- Interface retreated
- Reduced coastal pumping



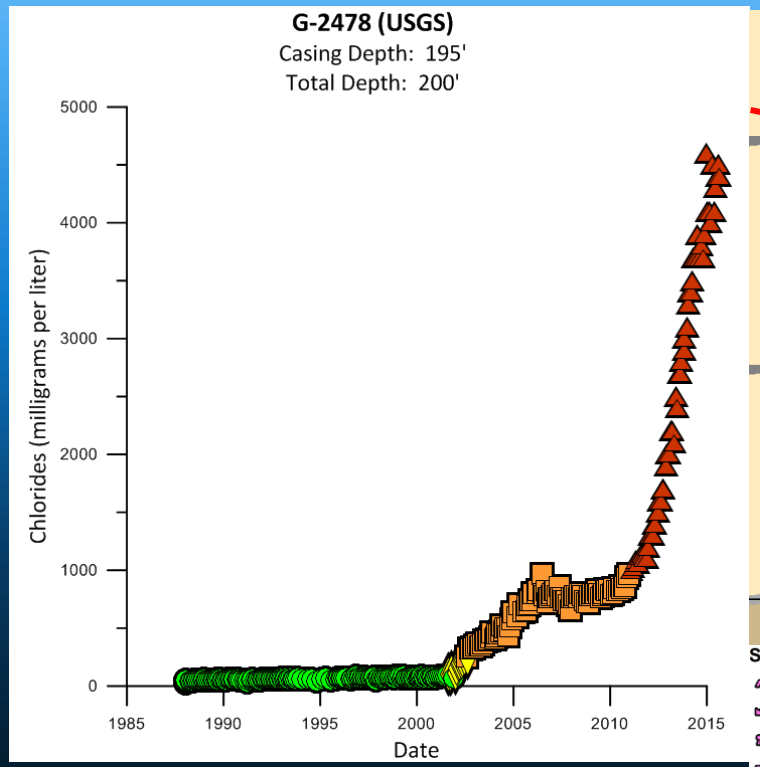


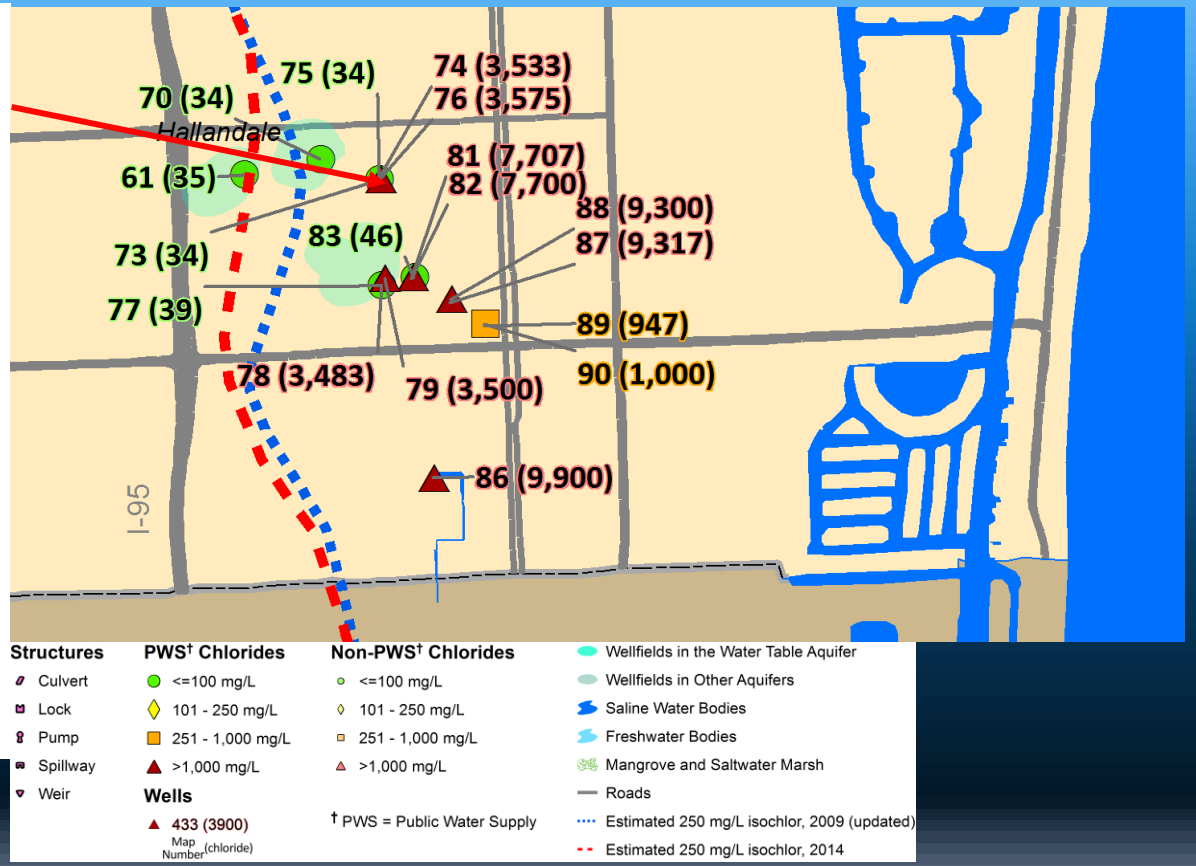
- Chlorides increased and leveling off?



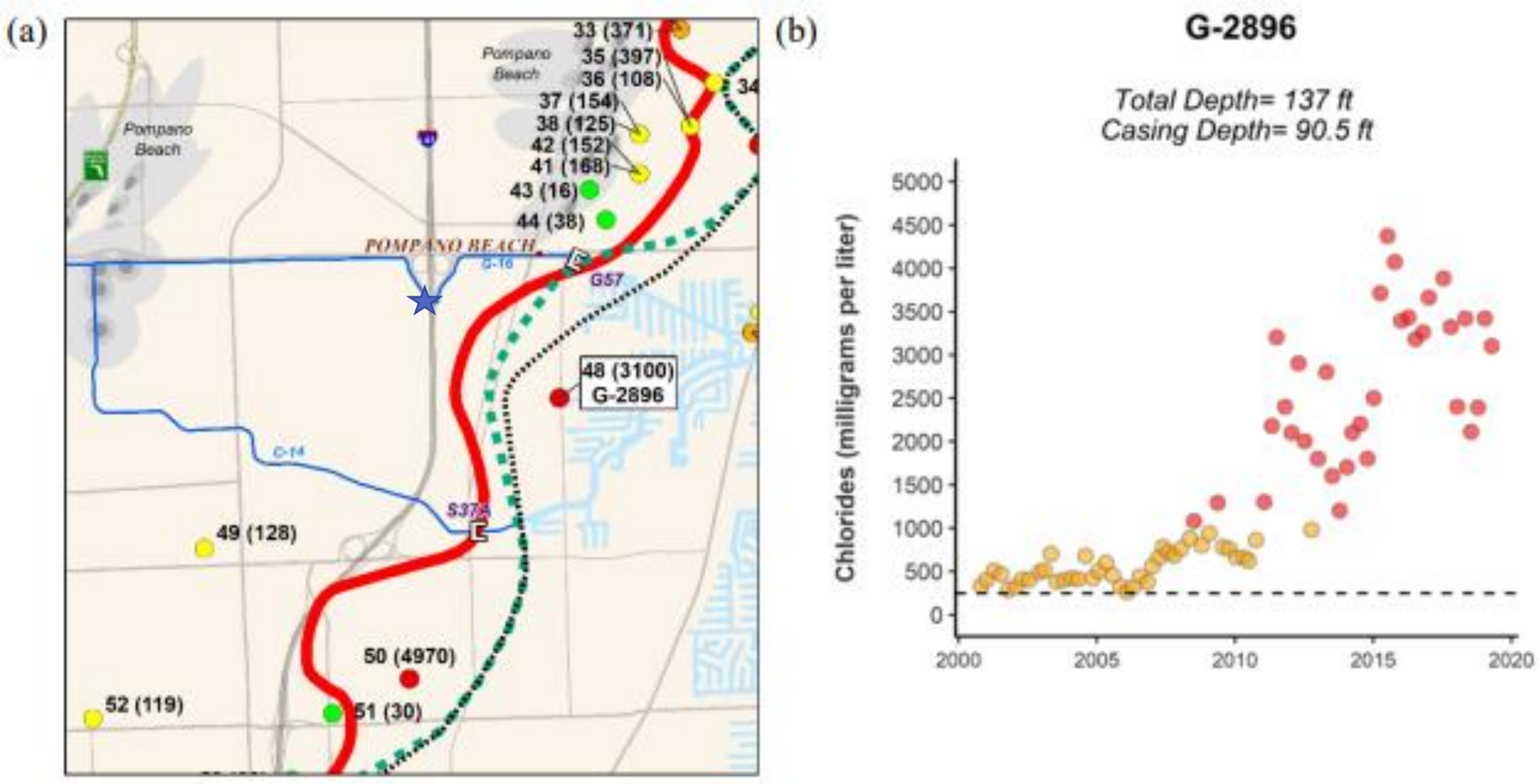
Hallandale Beach Area

- G-2478 (Map # 76, Cl = 3,575 mg/L) -- Saltwater toe (195 to 200 feet depth) continued to advance inland
- G-2477 (Map # 75, Cl = 34 mg/L) -- Freshwater (75 to 80 feet depth) -- Upconing potential





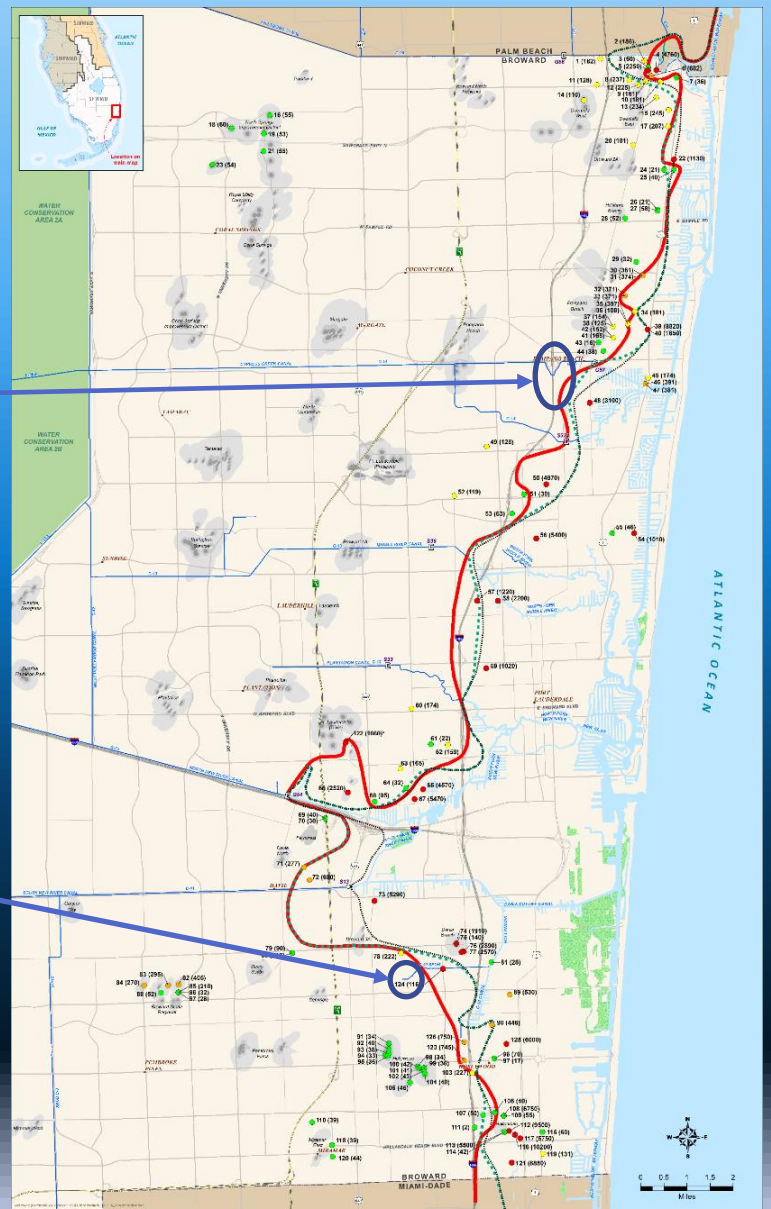
Pompano Beach Area



Two New Monitor Wells to Fill Data Gaps

Pompano Beach

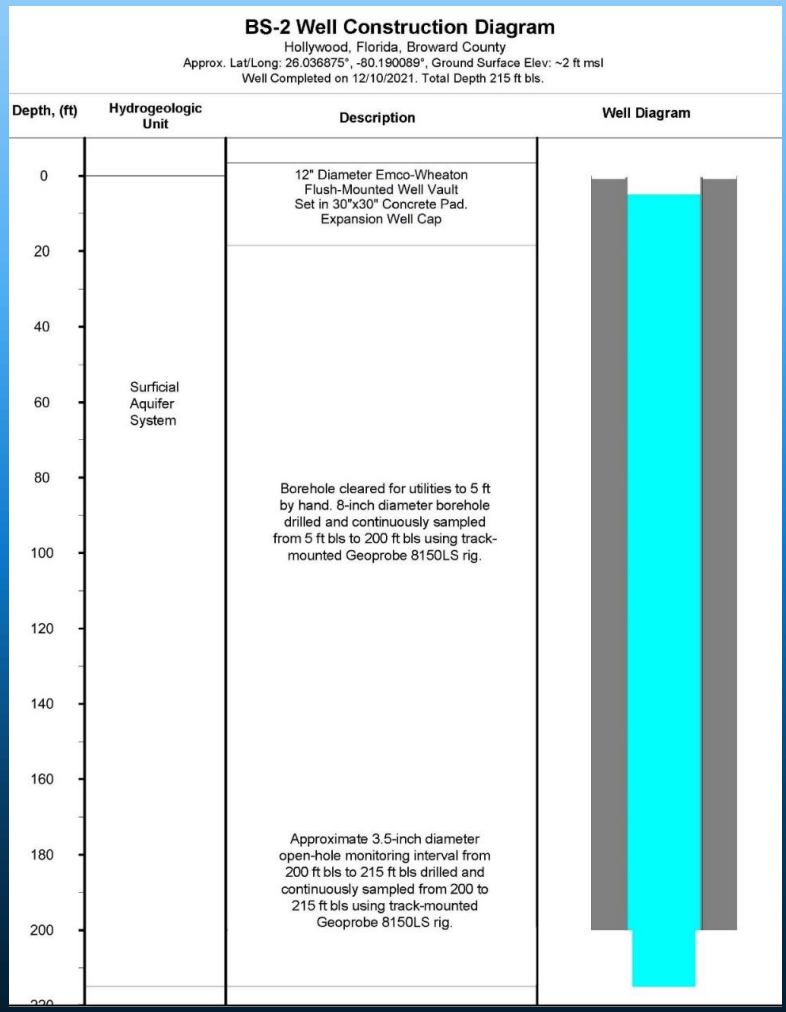
C-10 Canal Spur



New SFWMD Saltwater Intrusion Monitor Well BS-2, Hollywood

BS-2 Monitor Well

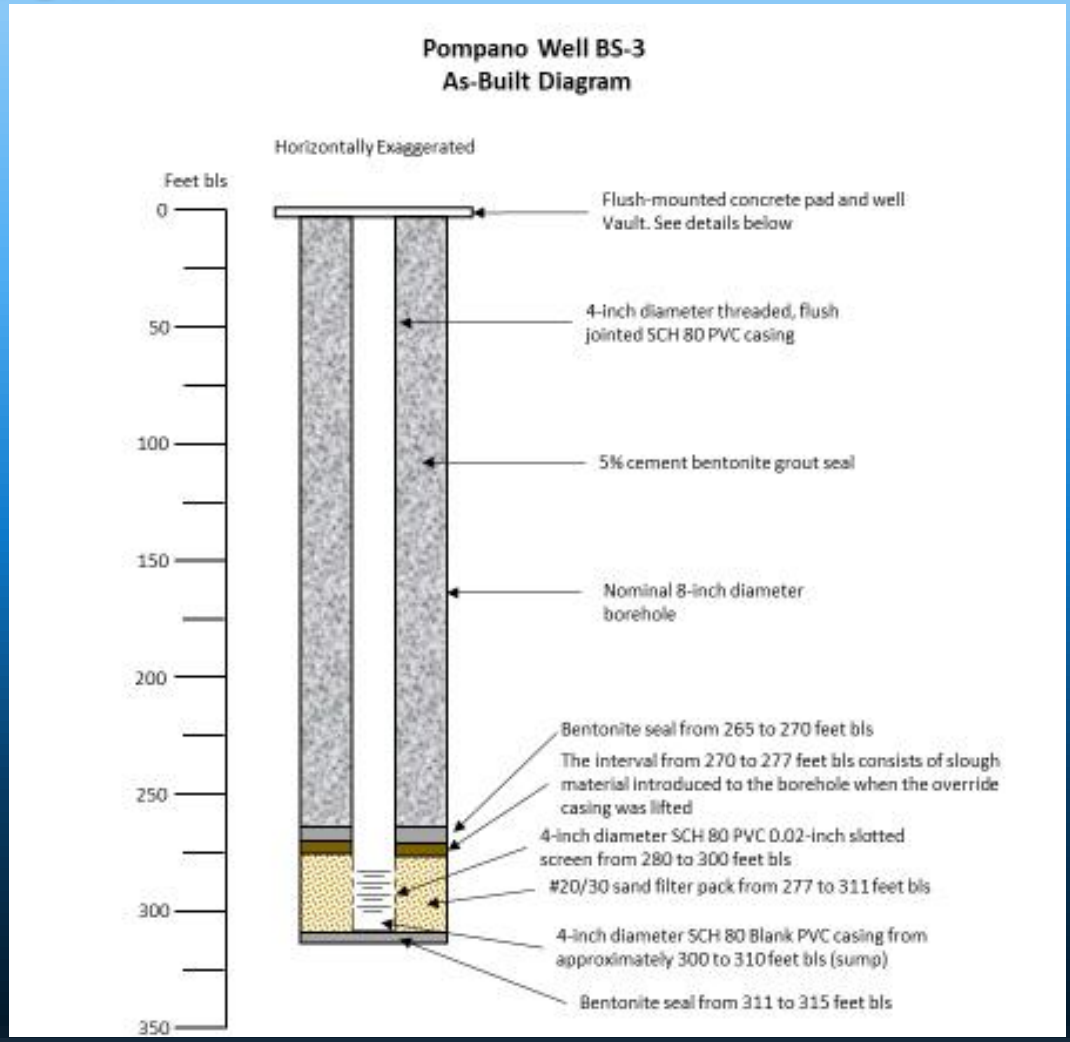
- Open-hole interval: 200 to 215 feet below land surface
- Sample Date: December 20, 2021
- Chlorides = 203 mg/L
- Specific Conductance = 1,179 umhos/cm



New SFWMD Saltwater Intrusion Monitor Well BS-3, Pompano Beach

BS-3 Wellhead

- Open-hole interval: 280 to 300 feet below land surface
- Sample Date: April 12, 2023
- Chlorides = 24 mg/L
- TDS = 311 mg/L
- Specific Conductance = 526 umhos/cm



BS-3 Well Construction Diagram

Presenter: Pete Kwiatkowski, P.G.

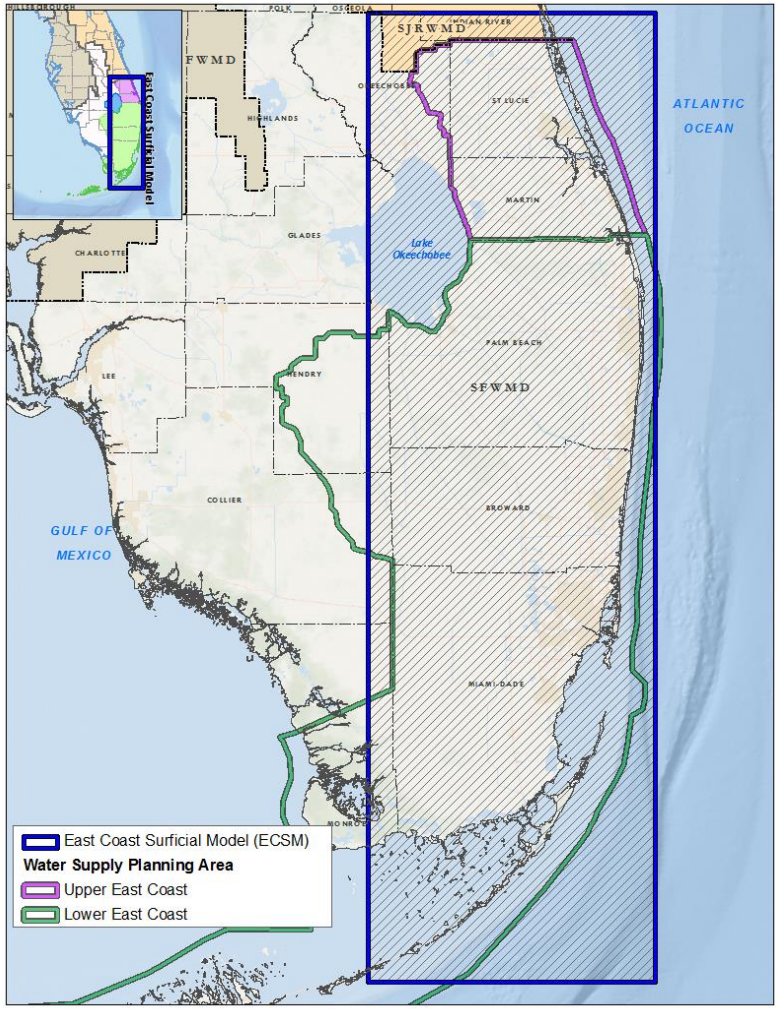
What Can We Do?

- Water conservation
- Reduce pumpage in coastal wellfields
- Prioritize withdrawals from western wellfields, provided they do not cause adverse effects on natural systems
- Increase groundwater recharge (canals, reclaimed water, etc.) to maintain and improve freshwater heads to counteract saltwater
- Use alternative water supplies (e.g., Floridan aquifer, reuse for irrigation, surface water storage, etc.) to reduce reliance on coastal wellfields
- Maintain, enhance and conduct monitoring of the saltwater intrusion monitoring network
- Conduct density-dependent groundwater modeling to simulate future saltwater intrusion as a result of future pumping, sea-level rise, and climate change

SEAWAT-2022

- SEAWAT-2000 is a coupled version of MODFLOW-2000 and MT3DMS [as published by the USGS] designed to simulate three-dimensional, variable-density groundwater flow and multi-species transport.
- SEAWAT-2022 is SFWMD's modified version of this code to accommodate the unique hydrologic features of South Florida
- Selected the SEAWAT-2022 computer code as the basis for development of SFWMD's East Coast Surficial Model (ECSM), a regional, density-dependent groundwater model -- currently being developed and peer-reviewed -- covering the Lower and Upper East Coast Planning Regions.

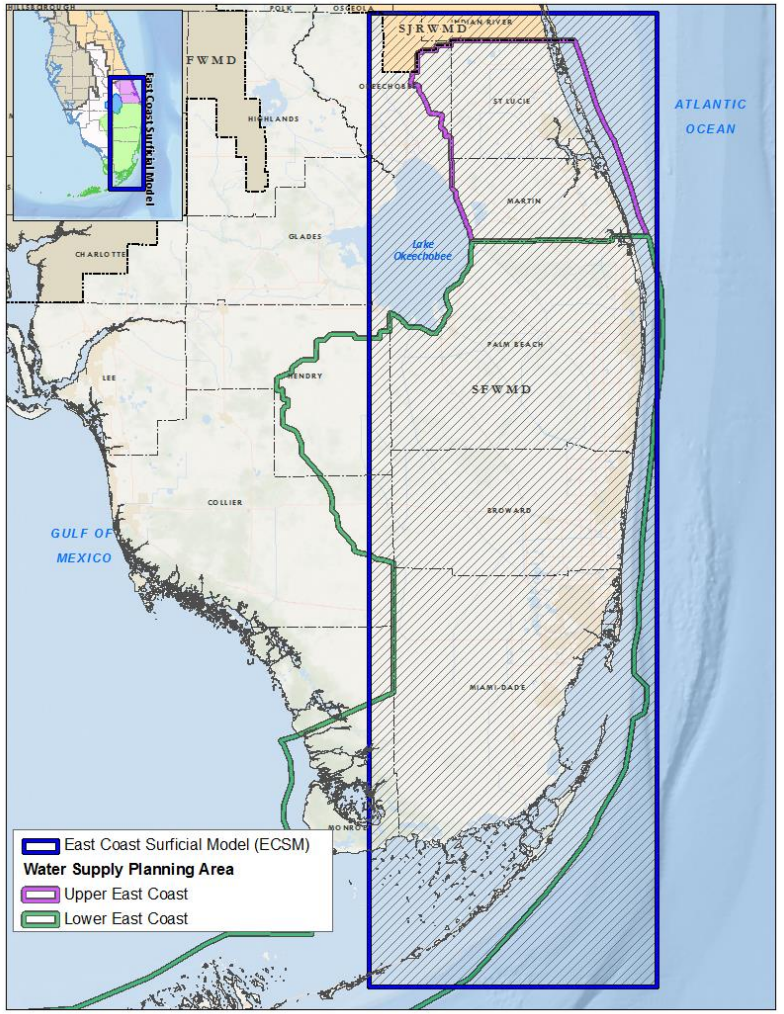
Objectives of Groundwater Modeling East Coast Surficial Model (ECSM)



- Evaluate if the water supply demands within the East Coast water supply planning regions can be met within a 20-year planning horizon without undue effects on existing legal users of water and natural systems
- Simulate and evaluate the effects of sea-level rise and climate change on the aquifer system as part of SFWMD's Water Supply Vulnerability Assessment

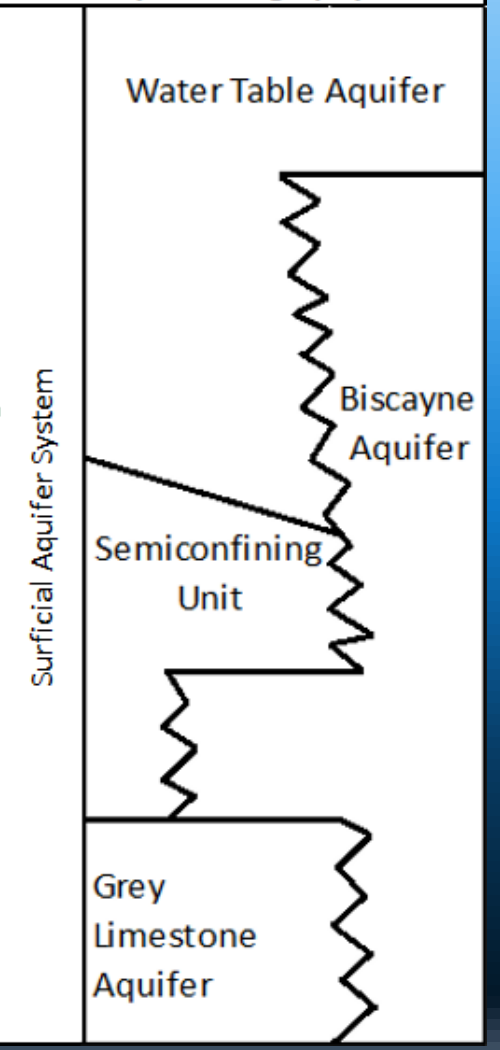
East Coast Surficial Model (cont'd)

- SEAWAT model with code changes to accommodate SFWMD specialized packages
- Calibration Period of Record: 1985 – 2012
- Verification period of record: 2013 – 2016
- Daily stress period
- Cell size: 1,000 ft x 1,000 ft
- 5 model layers
- Calibrated to water levels and water quality (TDS) mg/L
- Boundaries

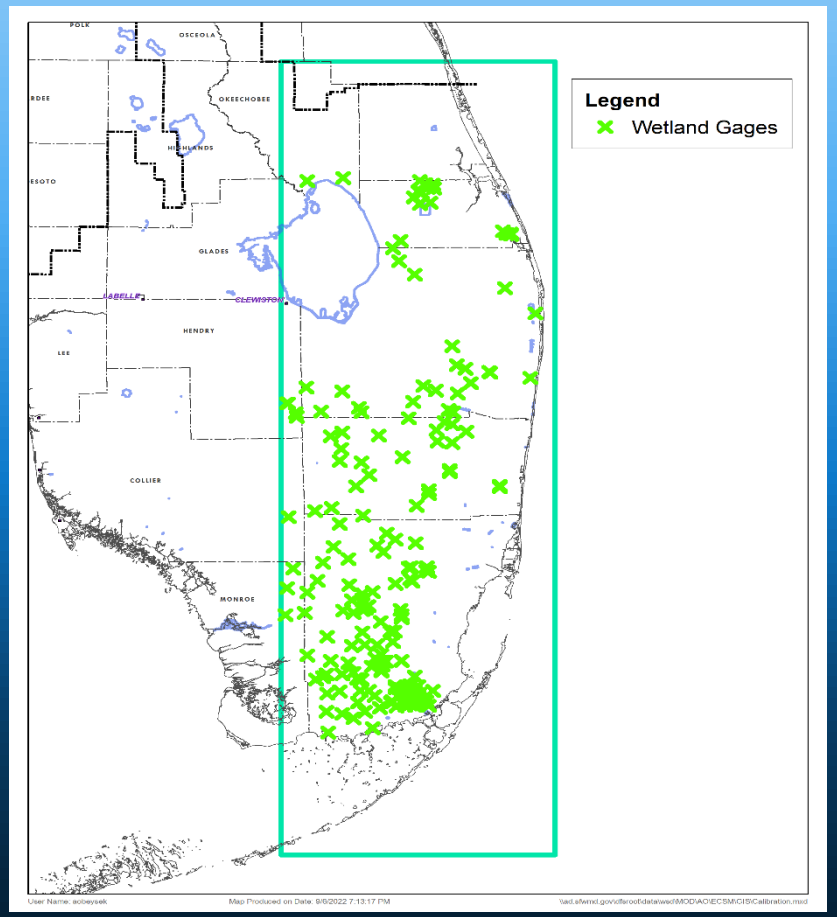


ECSM Layers

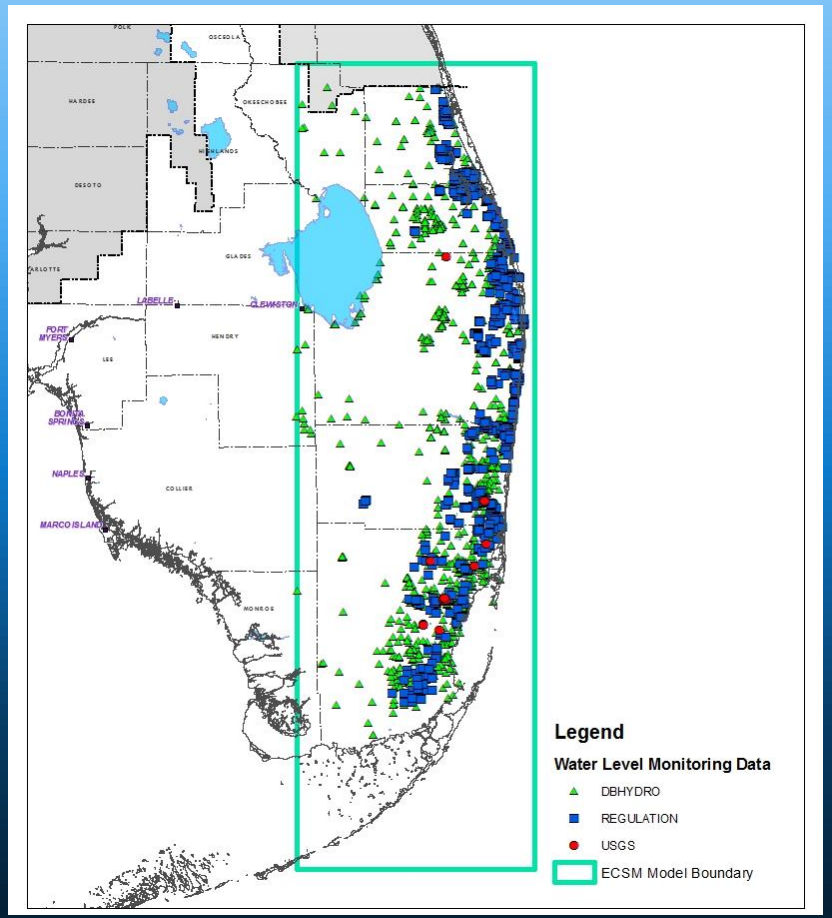
Age	Model Layer	Q Layer	Stratigraphy		Lithology	Hydrostratigraphy
Holocene	Layer 1		Lake Flirt Marl, Undifferentiated Soil and Sand		Marl, peat, organic soil, and quartz sand	Surficial Aquifer System
Pleistocene	Layer 1	Q4, Q5	Pamlico Sand		Quartz sand	
			Miami Limestone		Oolitic limestone and fossiliferous limestone	
			Fort Thompson Formation		Marine limestone, gastropod-rich freshwater limestone, sandy limestone, and fossiliferous quartz sandstone	
	Layer 2	Q2, Q3	Key Largo Limestone		Coralline limestone and minor amounts of sandy limestone	
	Layer 3	Q1	Anastasia Formation		Coquina, shell, quartz sand, and sandy limestone	
			Caloosahatchee Formation		Sandy to shelly marl, clay, silt, and quartz sand	
Pliocene	Layer 4		Tamiami Formation	Pinecrest Sand Member	Quartz sand, bivalve-rich quartz sandstone and sandy limestone, shell, mudstone, and minor amounts of phosphate grains	
	Layer 5			Ochopee Limestone Member	Bivalve-rich limestone, bivalve-rich quartz sand and sandstone, and moldic quartz sandstone	



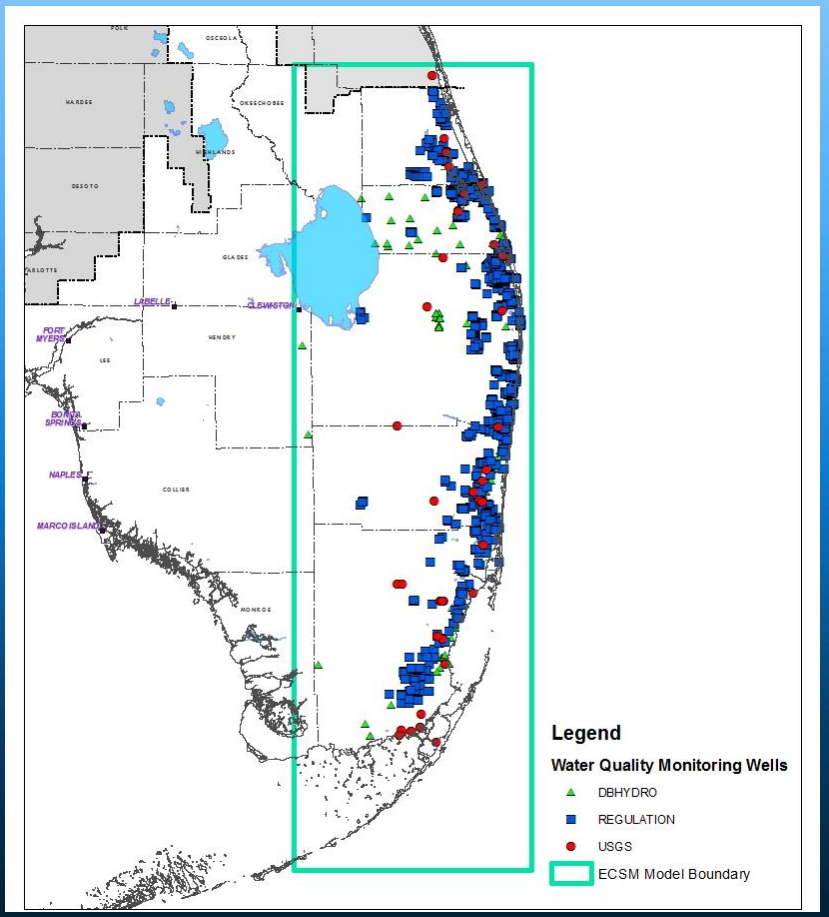
Monitoring Locations for Model Calibration



Wetland Gages
(Water Levels)



Groundwater Wells and
Surface Water Stations
(Water Levels)



Groundwater Monitoring Wells
(Water Quality)

Schedule

- 2023 – ECSM Calibration (Draft) and Peer Review
- 2024 – Complete ECSM Calibration, Peer Review, and Conduct Model Application for LEC Plan
- 2024 Dry Season – Conduct chloride sampling and compile water quality data from monitor wells in network
- Fall 2024 – Publish 2024 Saltwater Interface Maps, SFWMD Coastal Aquifers
- 2024/2025 – Model Application for Water Supply Vulnerability Assessment

Questions and Discussion

2009, 2014 & 2019 maps available:
https://www.sfwmd.gov/documents-by-tag/saltwaterinterface

Merged Isochlor 2019: https://geo-sfwmd.hub.arcgis.com/datasets/merged-isochlor-2019

Chloride Data, 2019: https://geo-sfwmd.hub.arcgis.com/datasets/chloride-data-2019

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