SFWMD Saltwater Intrusion Mapping, Modeling, and Water Supply Vulnerability Assessment

Florida Water and Climate Alliance Drought Webinar

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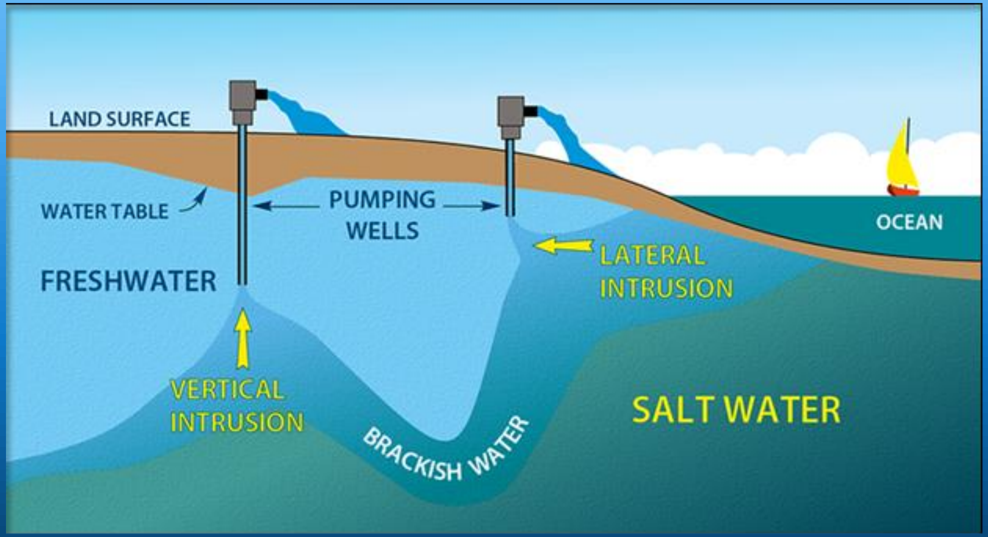
Pete Kwiatkowski, PG
Section Administrator, Resource Evaluation
Water Supply Bureau, Water Resources Division
South Florida Water Management District

Presentation Overview

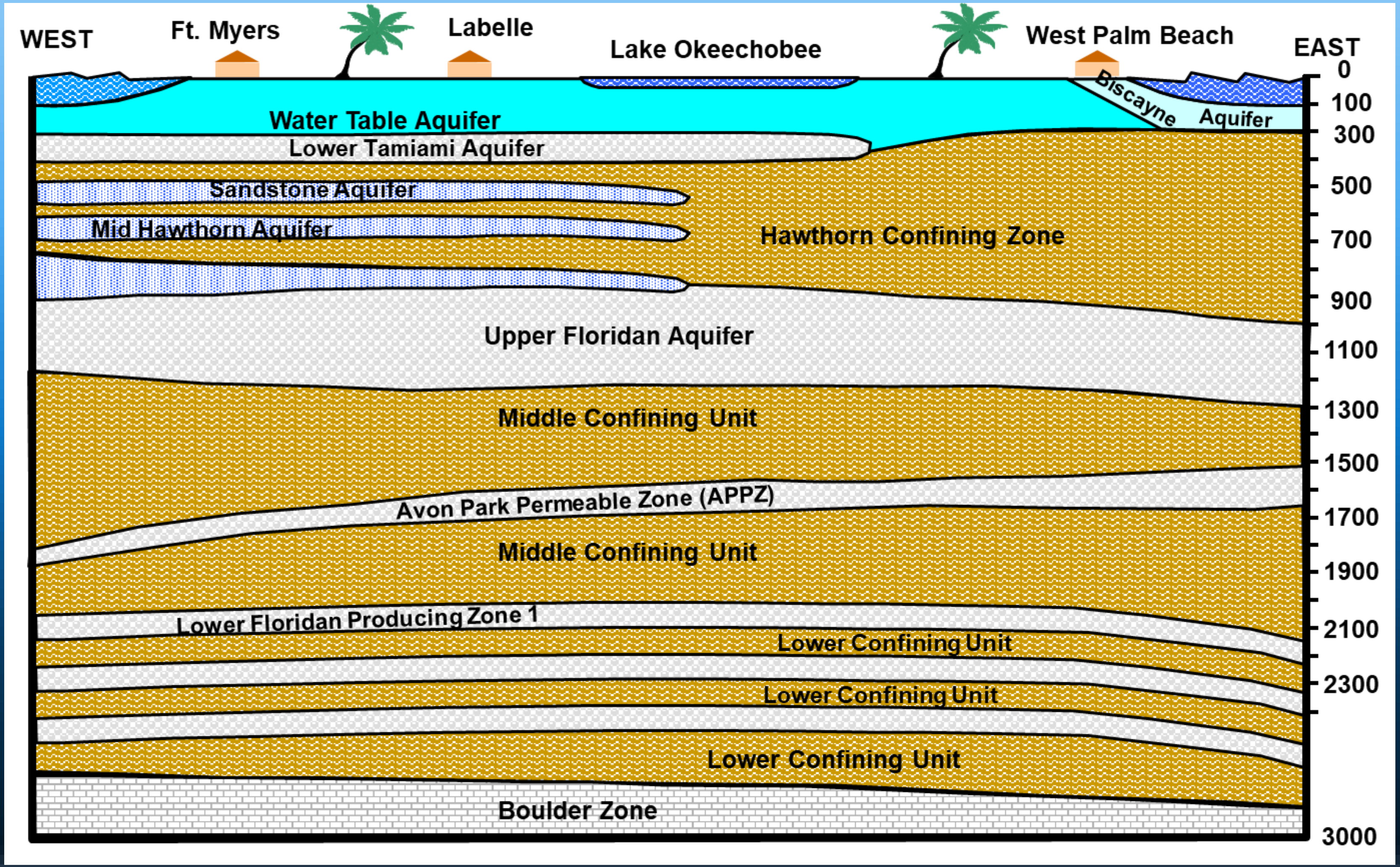
- Overview of Saltwater Intrusion, Aquifers, Wellfields
- Saltwater Intrusion Mapping Program
- Groundwater Modeling
- Water Supply Vulnerability Assessment
- Discussion

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



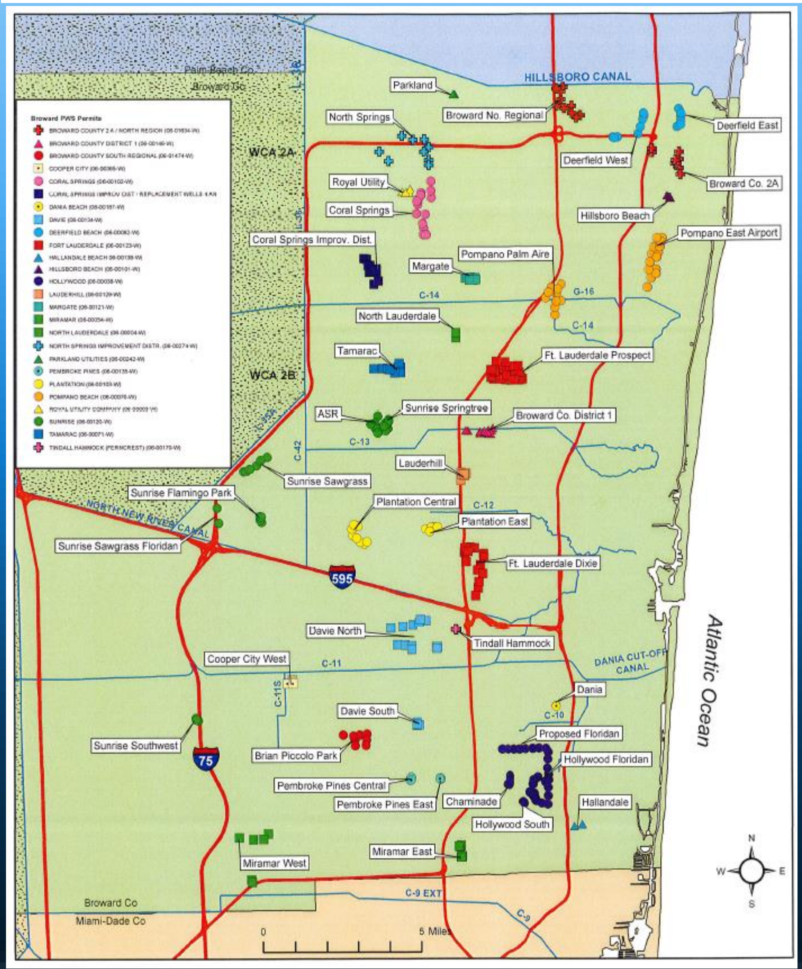
Generalized Hydrogeology of South Florida



Why is this Important?

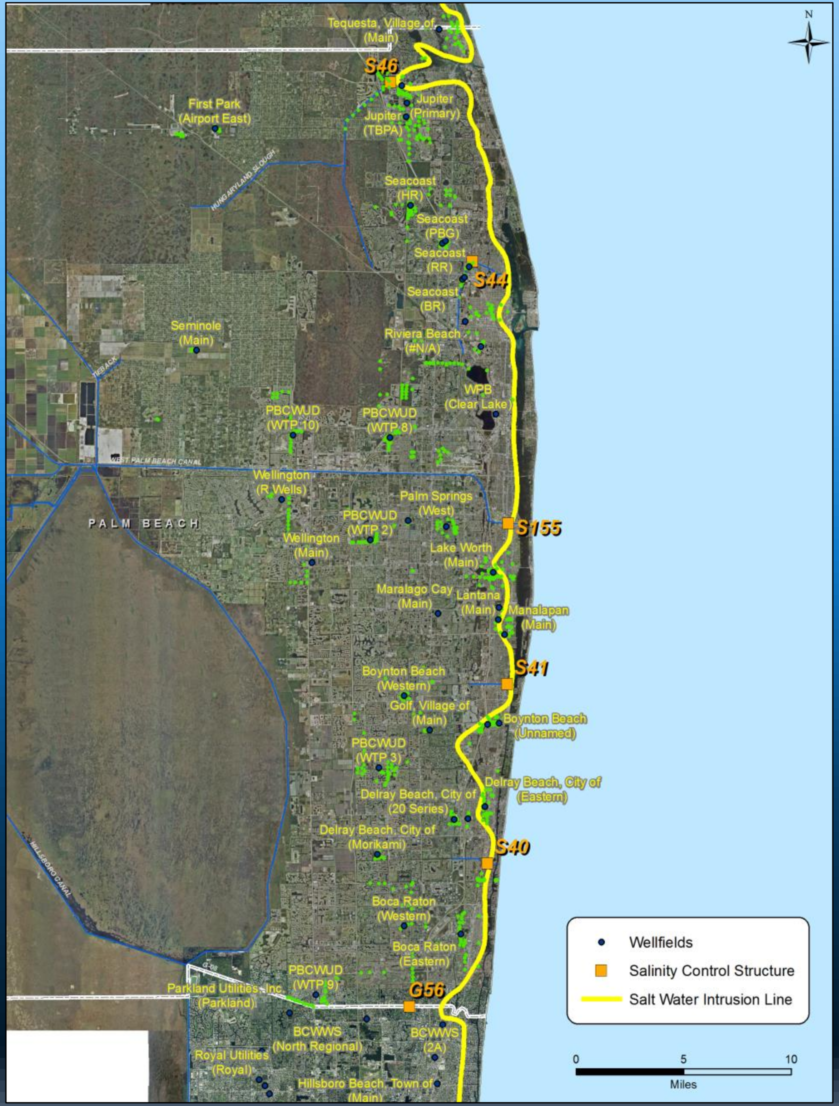
- Wellfields are a major water supply source – protect investment
- Once saltwater enters wells, very difficult – if not impossible -- to reverse
- Very expensive to relocate wellfields and associated infrastructure (pipelines, treatment plants and processes, etc.)
- Other sources of water more expensive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



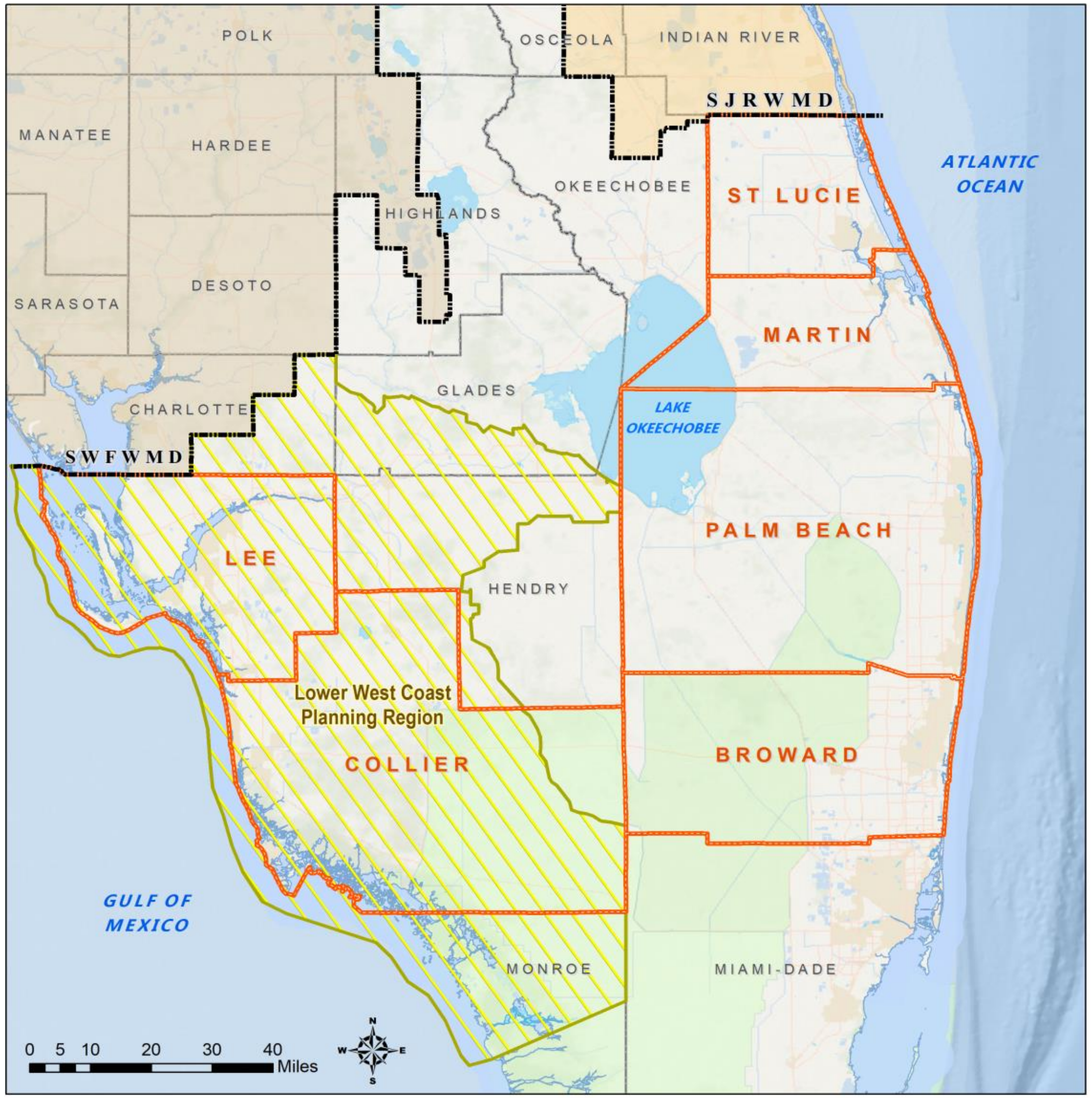
Presenter: Pete Kwiatkowski, P.G.

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

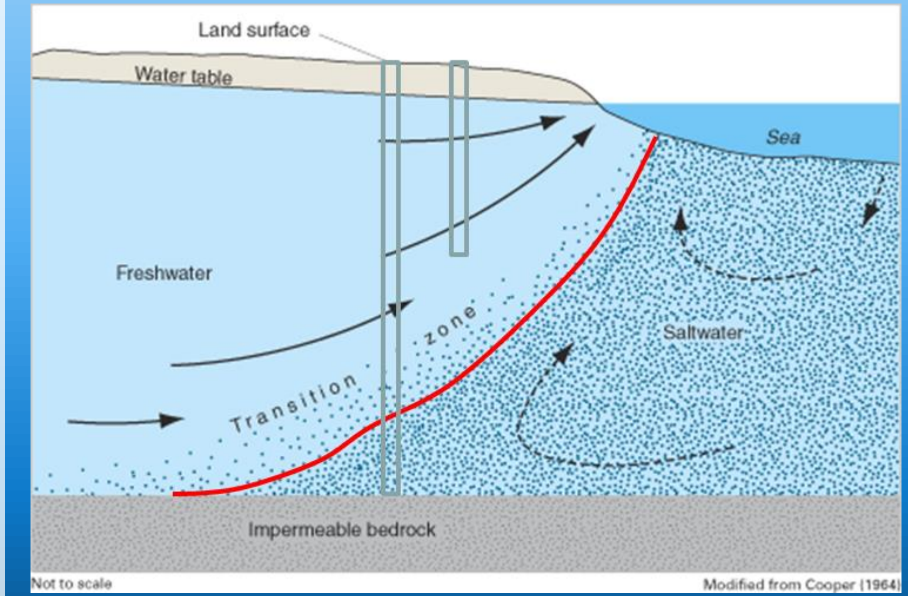
Location of SFWMD Coastal Counties

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			



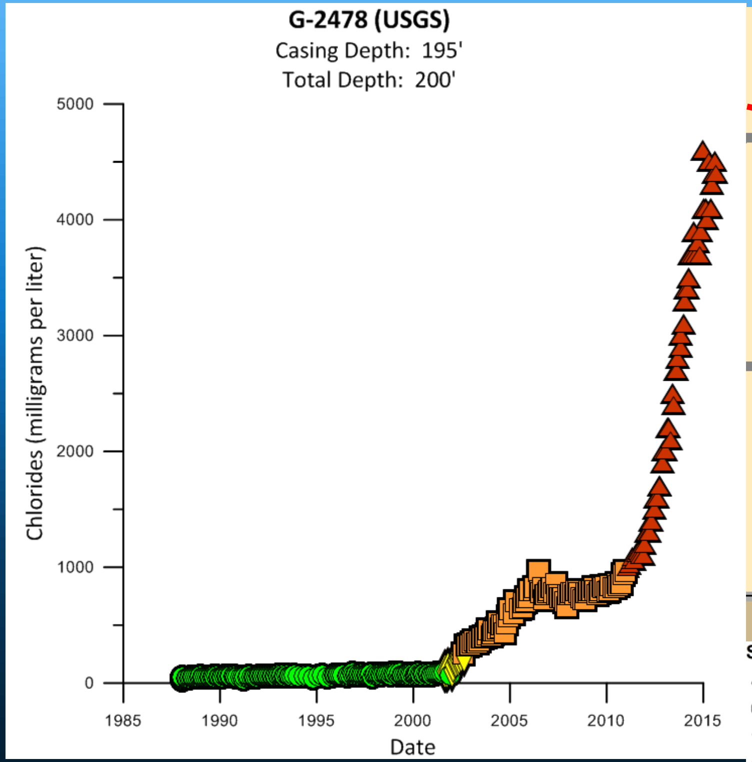
Mapping Challenges

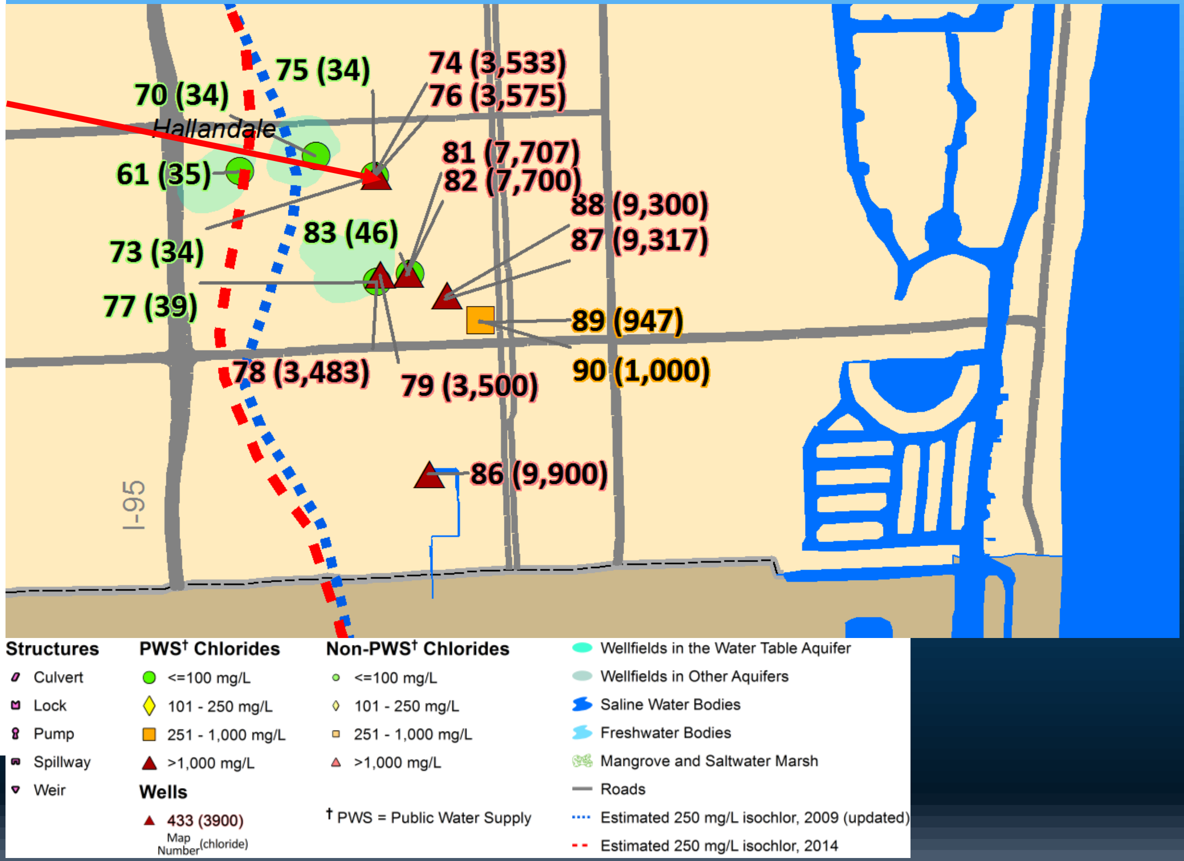
- Representing a 3-D feature on a 2-D map
- Representing a dynamic interface with fixed-time snapshots
- Representing a diffuse front with a single line
- Mapping from data that may represent one of several saltwater intrusion pathways
- Some wells used in 2009 and 2014 were not available in 2019 (abandoned, 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



Hallandale Beach Area, 2009 vs. 2014

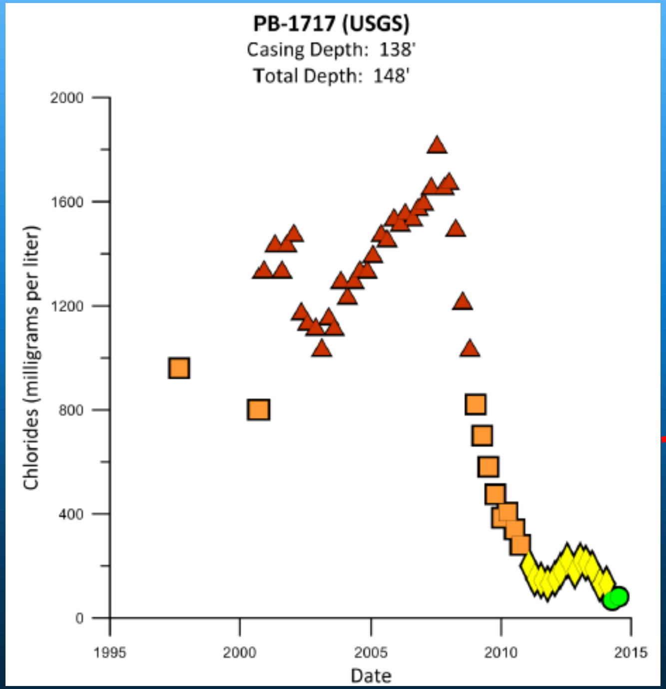
- G-2478 (Map # 76, Cl = 3,575 mg/L) -- Saltwater toe (195 to 200 feet depth) continued to advance inland
- G-2477 (Map # 75, Cl = 34 mg/L) -- Freshwater (75 to 80 feet depth) -- Upconing potential

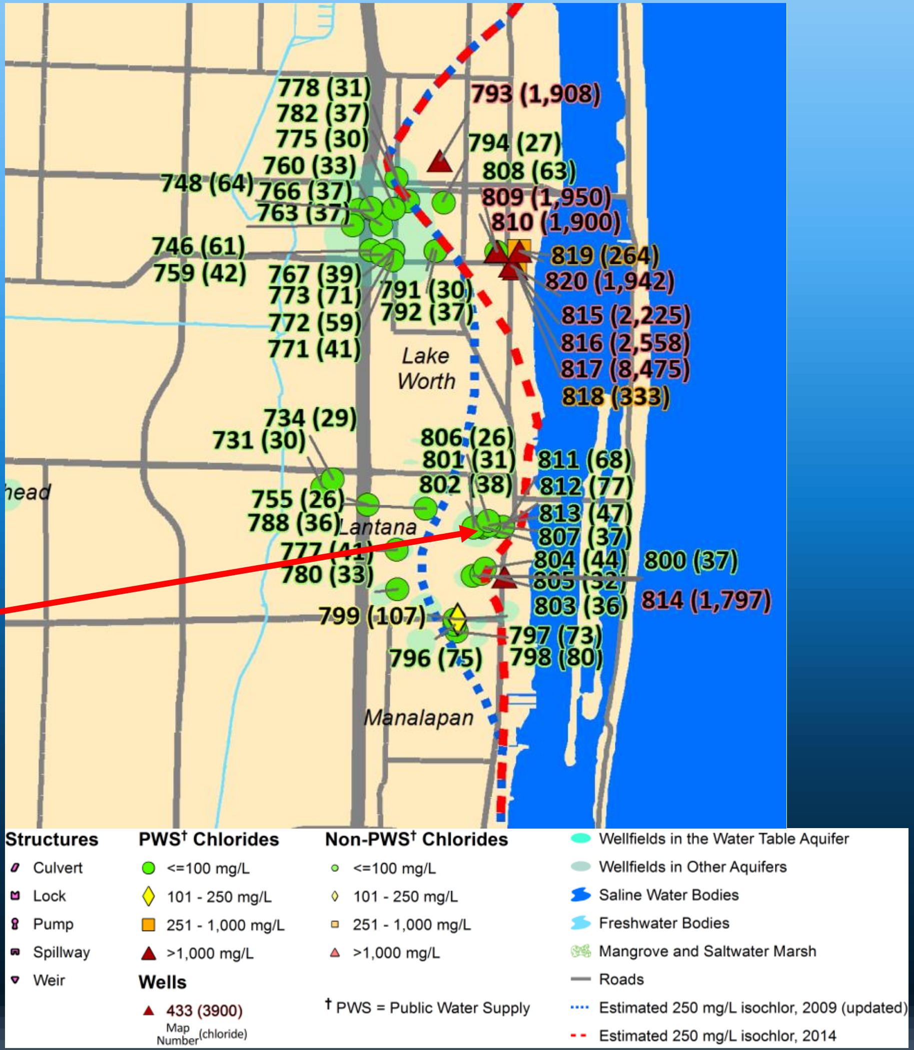




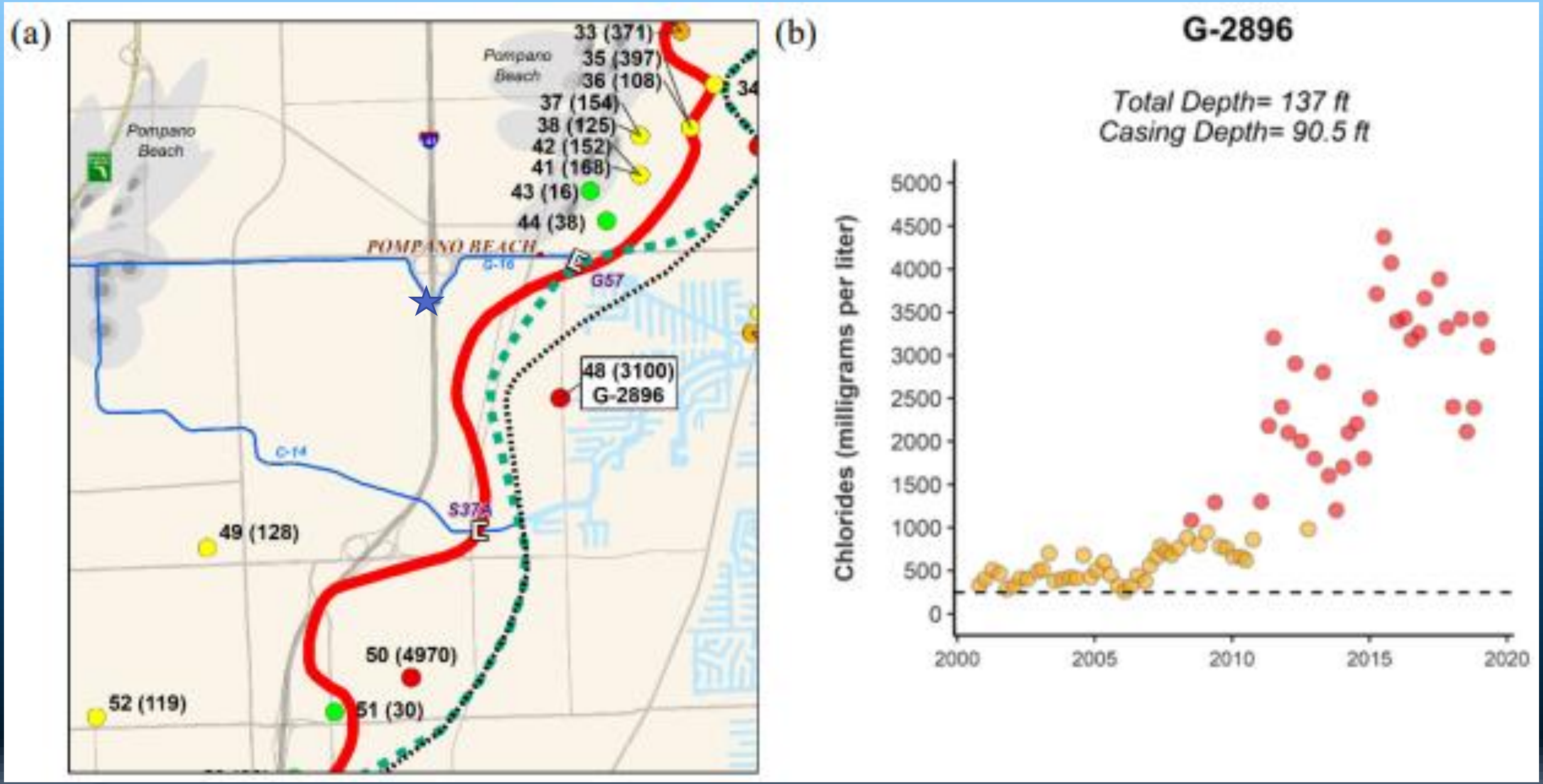
Lantana/Lake Worth Beach Area 2009 vs. 2014

- Saltwater interface retreated towards the coast
- Reduced withdrawals from coastal wells



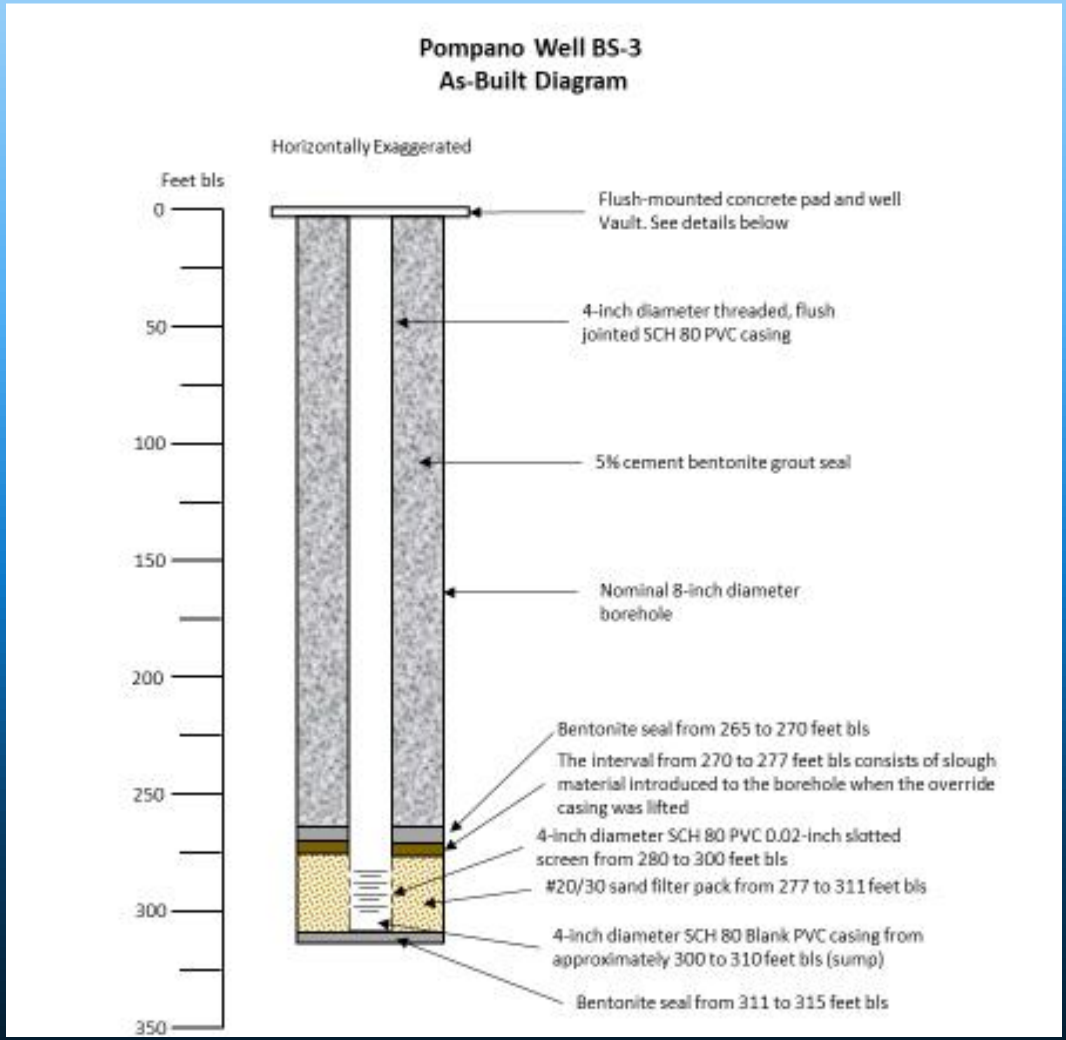


Saltwater Intrusion, Pompano Beach Area



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

BS-3 Wellhead



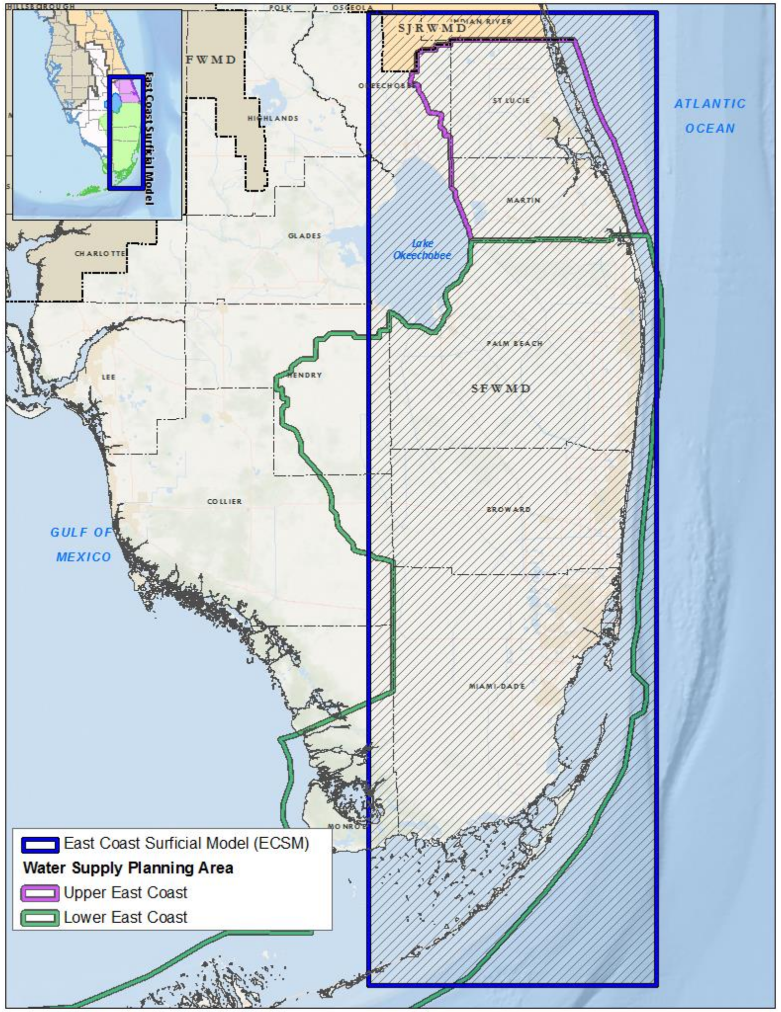
BS-3 Well Construction Diagram

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

East Coast Surficial Model (ECSM)

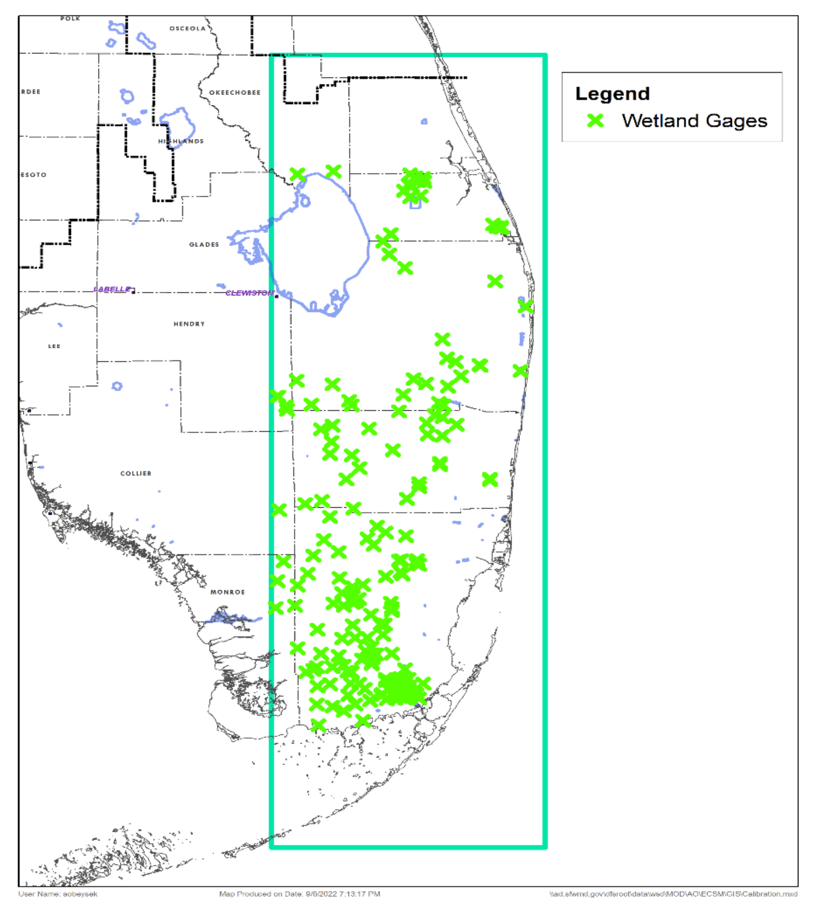
- SEAWAT model with code changes to accommodate SFWMD specialized packages
- Calibration Period of Record: 1985 – 2012
- Verification period of record: 2013 – 2016
- Daily stress period
- Cell size: 1,000 ft x 1,000 ft
- 5 model layers
- Calibrated to water levels and water quality (TDS) mg/L
- Boundaries



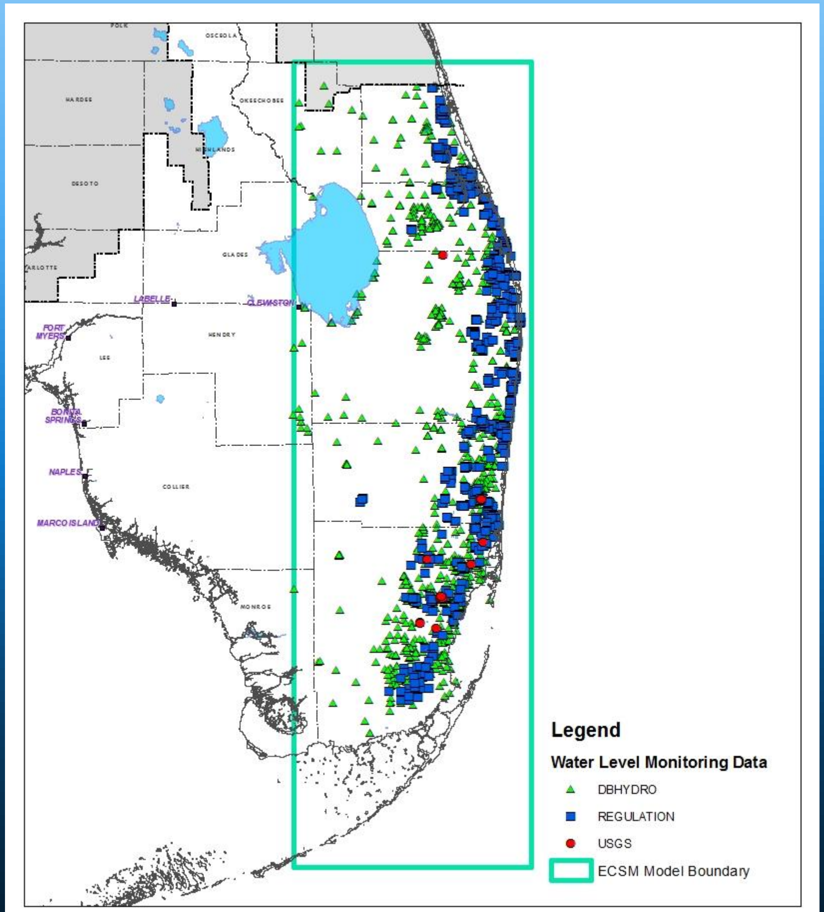
ECSM Layers

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: Water Table Aquifer
Pleistocene	Layer 1	Q4, Q5	Pamlico Sand	Quartz sand	Biscayne Aquifer
Pleistocene	Layer 1	Q4, Q5	Miami Limestone	Oolitic limestone and fossiliferous limestone	Biscayne Aquifer
Pleistocene	Layer 1 / Layer 2	Q4, Q5 / Q2, Q3	Fort Thompson Formation	Marine limestone, gastropod-rich freshwater limestone, sandy limestone, and fossiliferous quartz sandstone	Biscayne Aquifer
Pleistocene	Layer 2	Q2, Q3	Key Largo Limestone	Coralline limestone and minor amounts of sandy limestone	Biscayne Aquifer / Semiconfining Unit
Pleistocene	Layer 3	Q1	Anastasia Formation	Coquina, shell, quartz sand, and sandy limestone	Biscayne Aquifer / Semiconfining Unit
Pleistocene	Layer 3	Q1	Caloosahatchee Formation	Sandy to shelly marl, clay, silt, and quartz sand	Semiconfining Unit
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	Semiconfining Unit
Pliocene	Layer 5		Tamiami Formation: Ochopee Limestone Member	Bivalve-rich limestone, bivalve-rich quartz sand and sandstone, and moldic quartz sandstone	Grey Limestone Aquifer

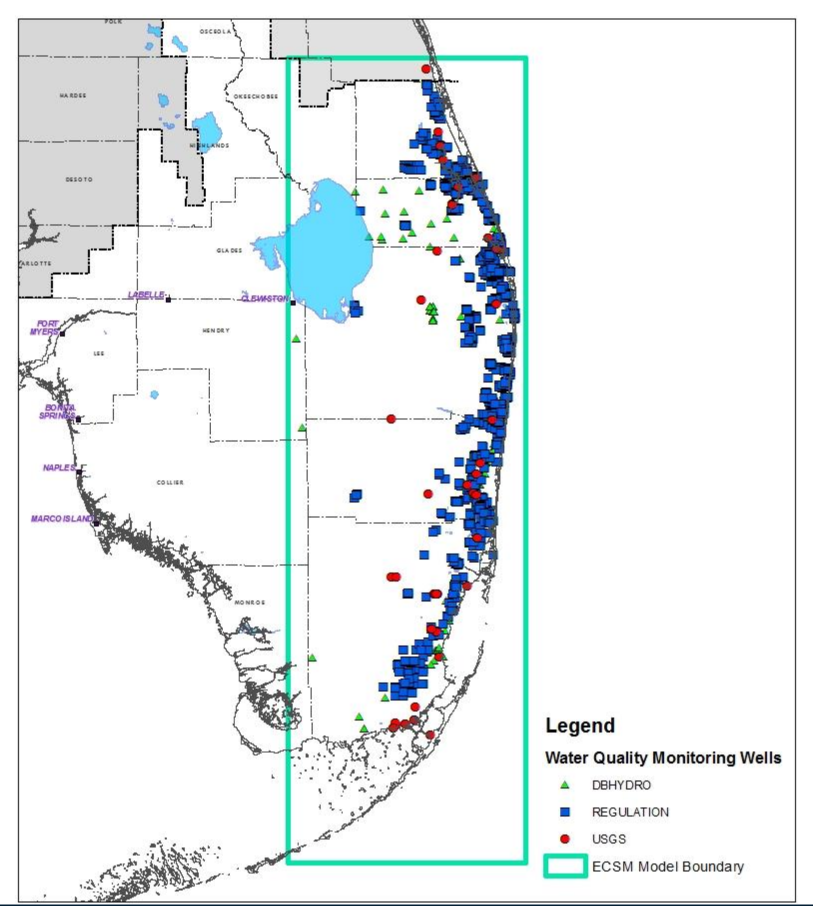
Monitoring Locations for Model Calibration



Wetland Gages
(Water Levels)

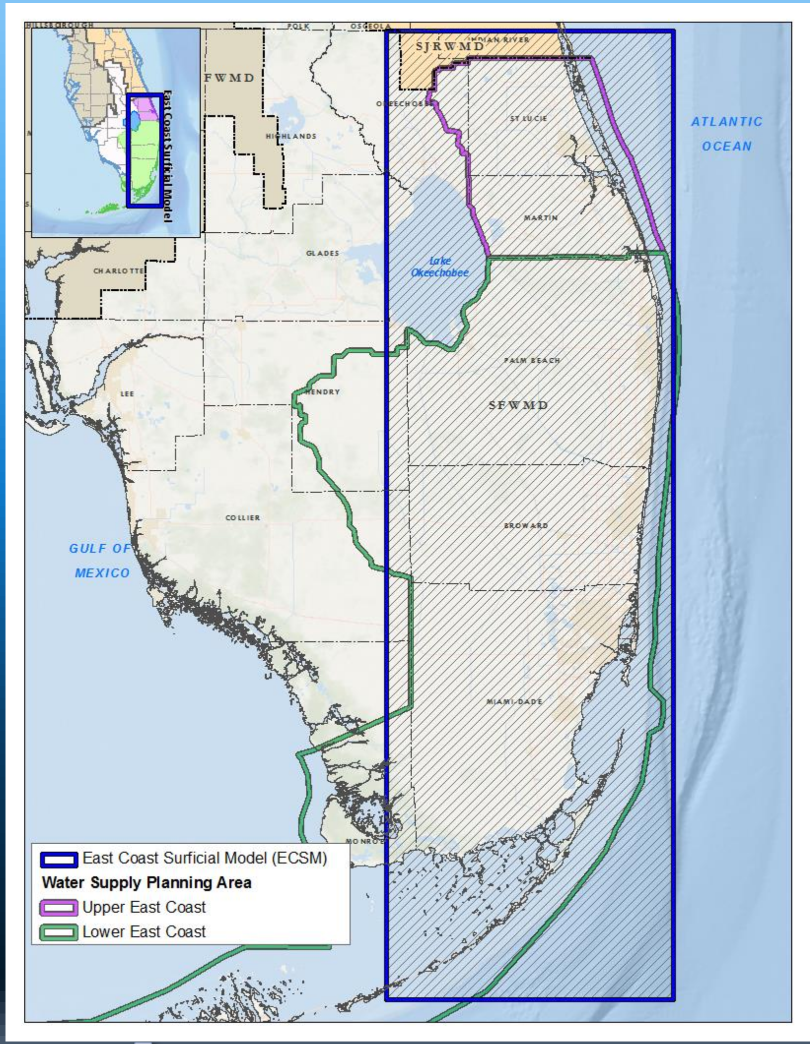


Groundwater Wells and
Surface Water Stations
(Water Levels)



Groundwater Monitoring Wells
(Water Quality)

Objectives of Groundwater Modeling East Coast Surficial Model (ECSM)

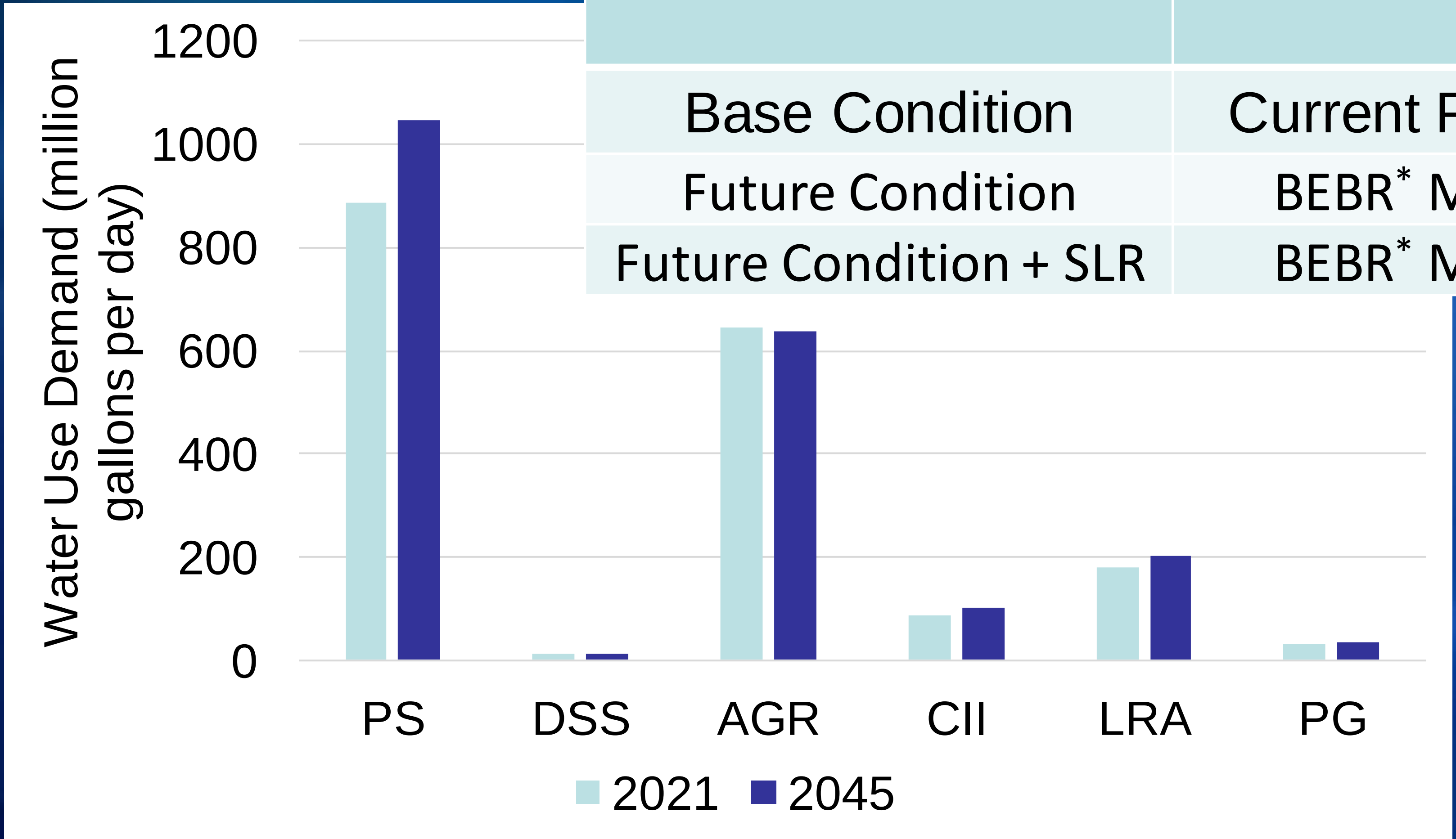


- Evaluate if the water supply demands within the East Coast water supply planning regions can be met within a 20-year planning horizon without undue effects on existing legal users of water and natural systems
- Simulate and evaluate the effects of sea-level rise and climate change on the aquifer system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

Lower East Coast Water Supply Plan

Scenario	Growth Variable	Climate Variable
Base Condition	Current Population	Current Climate
Future Condition	BEBR* Med 2045	Current Climate
Future Condition + SLR	BEBR* Med 2045	SLR1

* BEBR – University of Florida's Bureau of Economic and Business Research



PS – Public Supply
DSS – Domestic Self-Supply
AGR – Agricultural
CII – Commercial/Industrial/Institutional
LRA – Landscape/Recreational
PG – Power Generation

Water Supply Vulnerability Assessment Scenarios

	Growth Variable	Climate Variable
Scenario Runs	Current Population	Current Climate
	BEBR Med 2075	Current Climate
	BEBR Med 2075	SLR1
	BEBR Med 2075	Warmer and Drier
	BEBR Med 2075	Warmer, Drier, & SLR1
	BEBR Med 2075	Hot, Driest, & SLR2

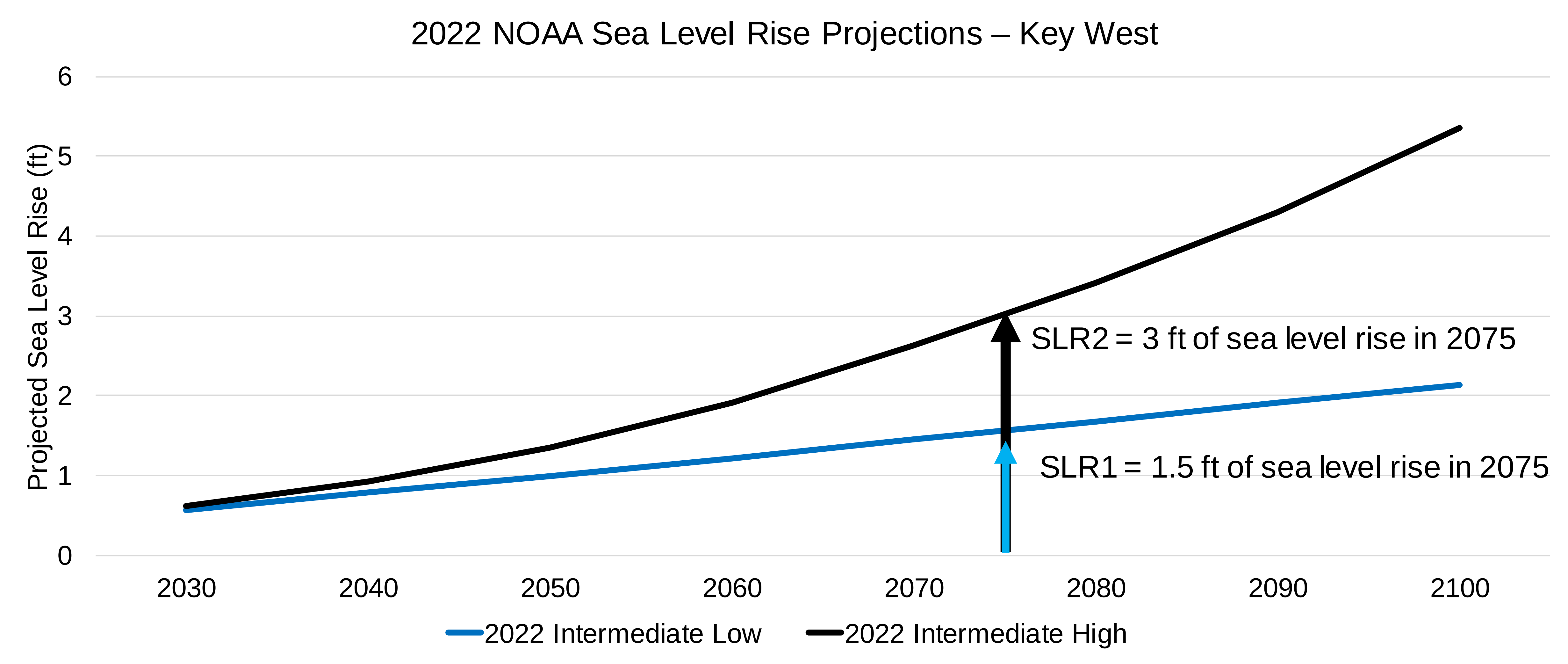
BEBR – University of Florida's Bureau of Economic and Business Research

50-year Water Supply Demand Projections

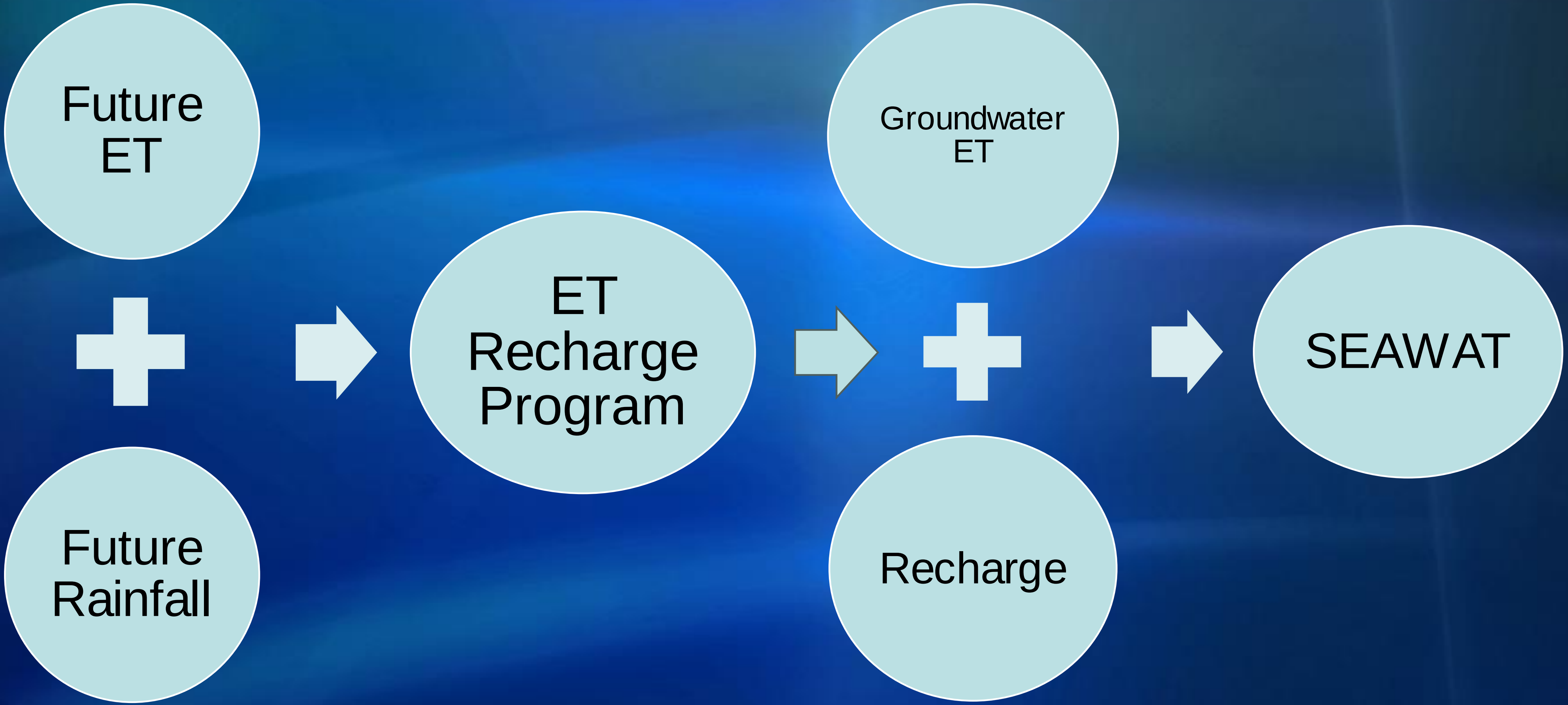
Public Supply	• Population = BEBR Med 2075 • Demand = Per Capita Use Rate for 50 years
Domestic Self-Supply	• Population = BEBR Med 2075 • Demand = Per Capita Use Rate for 50 years
Agricultural	• Projected agricultural acreages will remain consistent with the 2045 projections. AFSIRS will be utilized to determine irrigation demands.
Landscape/Recreational	• Water use demands will increase proportional to population
Commercial/Industrial/Institutional	• Scenario runs will utilize 2045 Water Supply Plan demands
Power Generation	• Scenario runs will utilize 2045 Water Supply Plan demands

AFSIRS – Agricultural Field-Scale Irrigation Requirement Simulation

Sea Levels in 2075



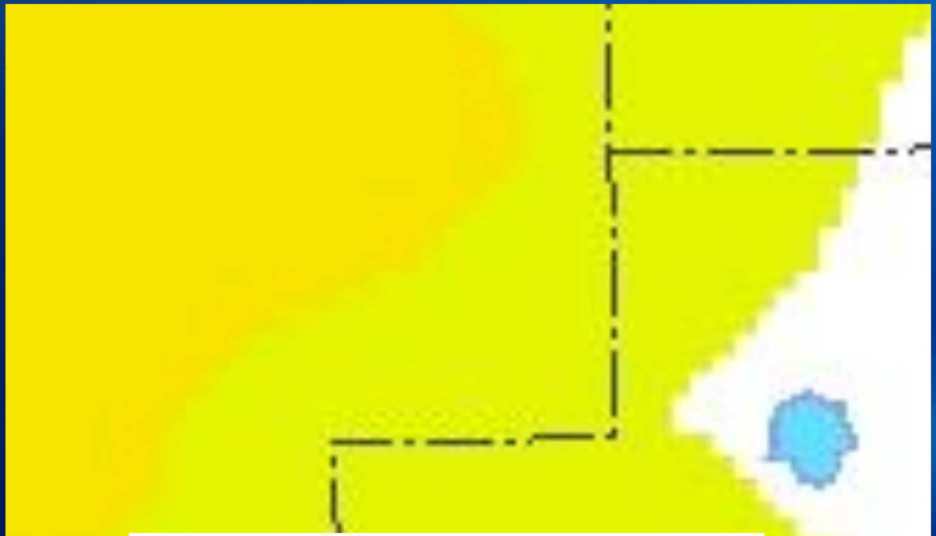
Climate Conditions



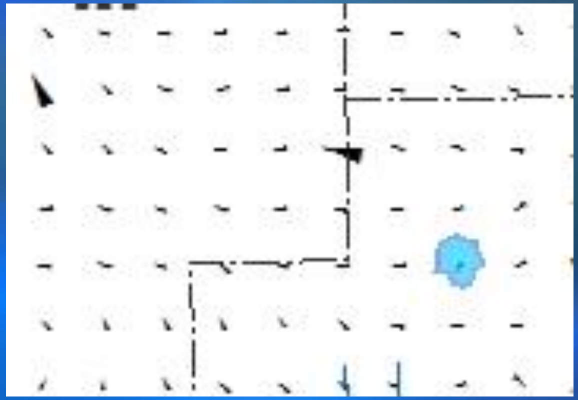
Sample Model Analysis

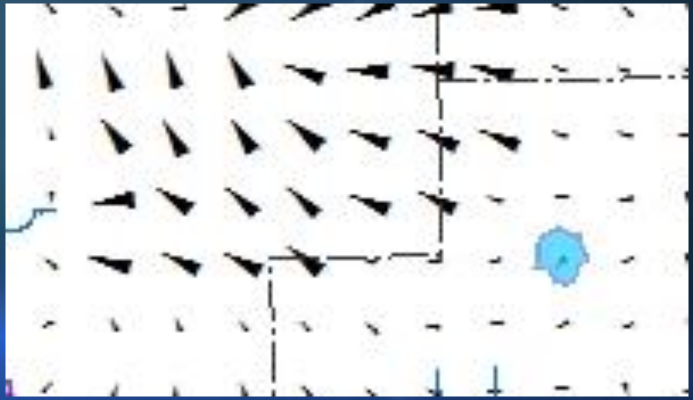
Differences between model scenarios are compared to each other to look for impacts

Future water levels – Current water levels = Water Level Difference Map



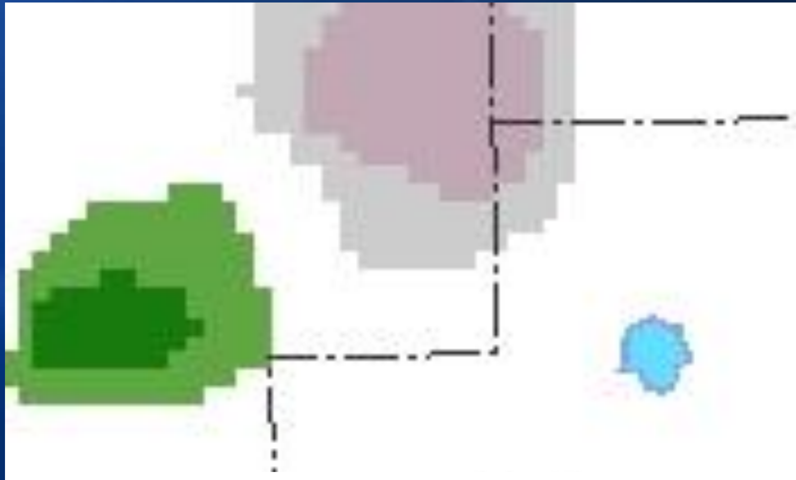
Water Level Difference Map





Flow vectors from different scenarios are compared to each other

Future water quality – Current water quality = Water Quality Difference Map



Water Quality Difference Map

Schedule

- 2024 – Complete ECSM Calibration and Peer Review
- Fall 2024 – Publish 2024 Saltwater Interface Maps, SFWMD Coastal Aquifers
- 2025 -- Conduct Model Application and Water Supply Vulnerability Assessment

Discussion