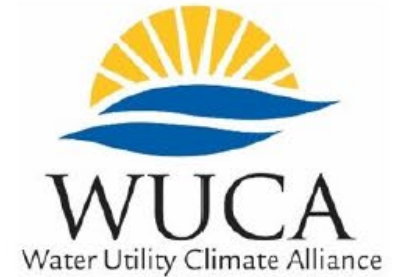


## Building Resilience to a Changing Climate:

A Technical Training in Water Sector  
Utility Decision Support



# WATER RESOURCES RESILIENCE IN BROWARD COUNTY

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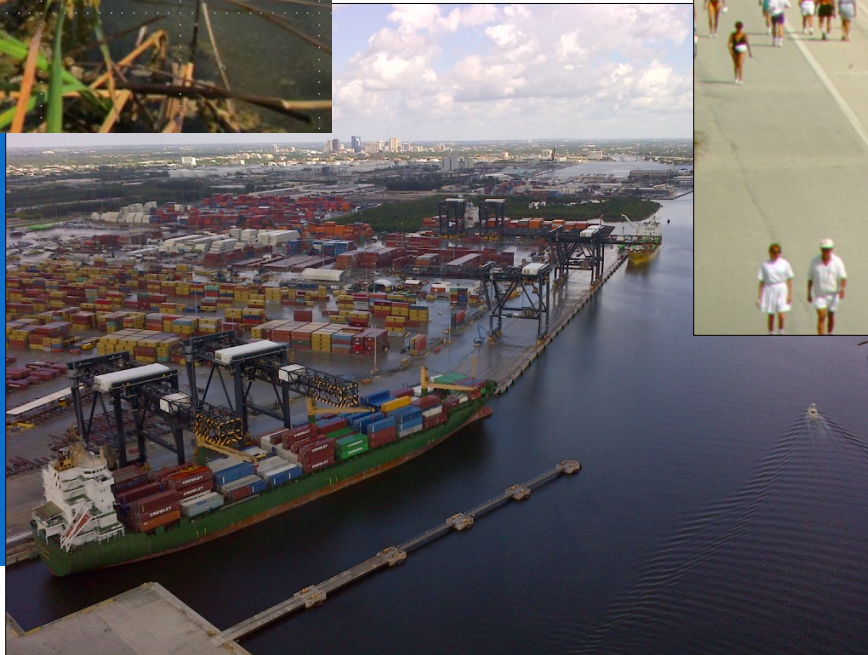
**Carolina Maran, Ph.D, P.E.**

Water Resource Manager, Environmental Planning  
and Community Resilience Division

May 29, 2019

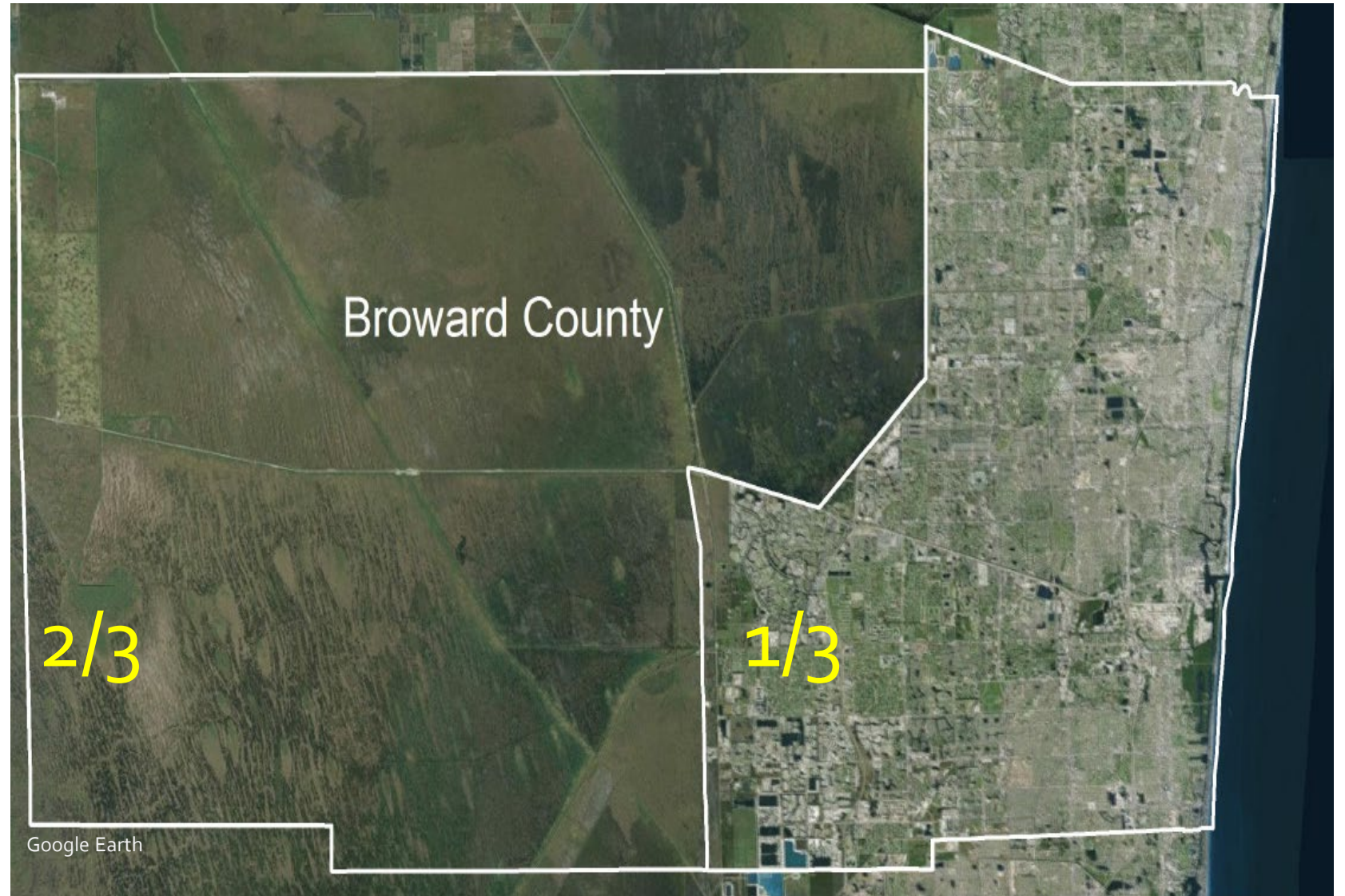


# Broward Water Resources Abundance





# Broward and the Everglades



# Land Use and Water Management



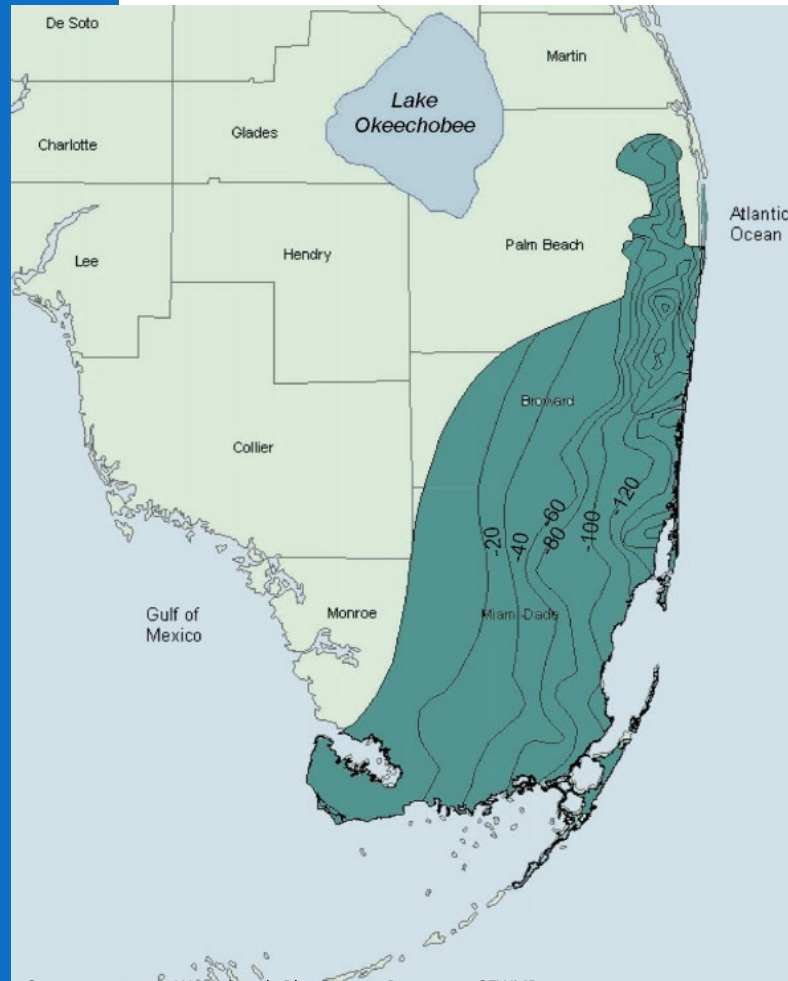
Source: Broward County Historical Commission



Source: SFWMD

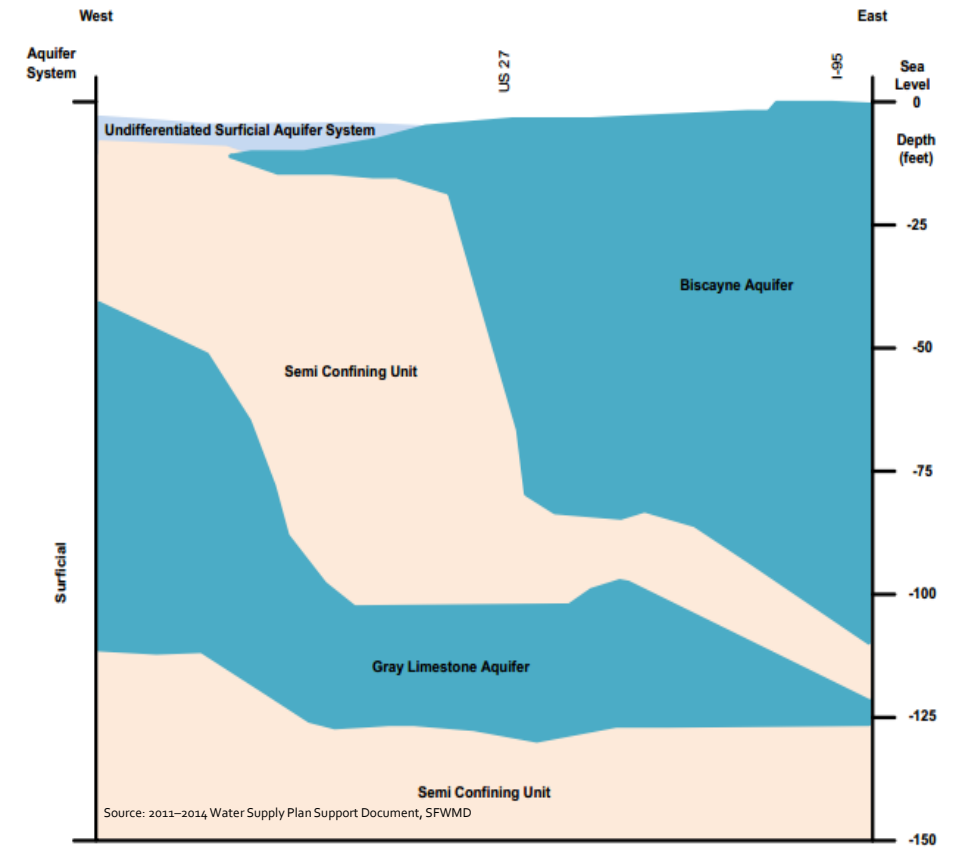


# Biscayne Aquifer as Water Source

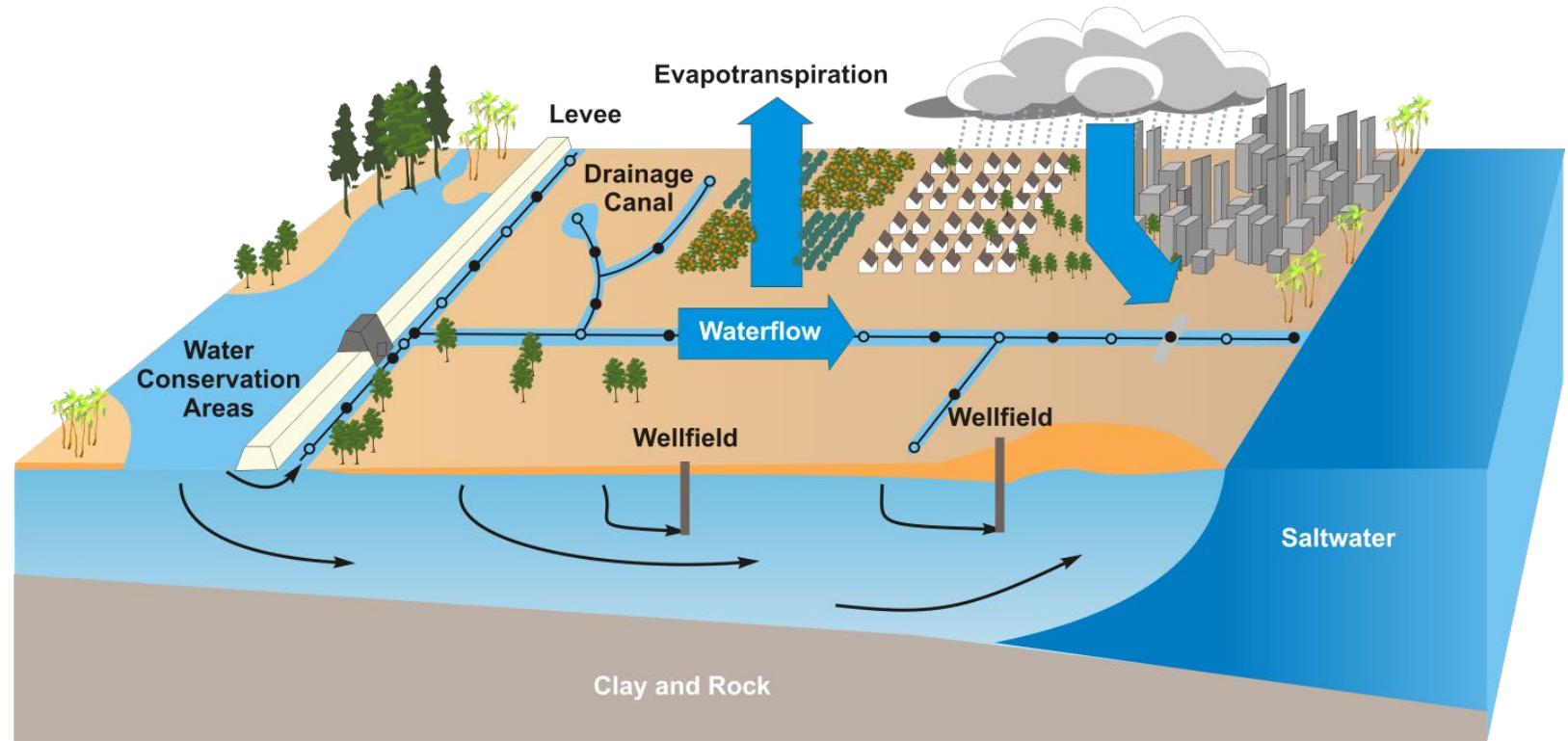


Source: 2011–2014 Water Supply Plan Support Document, SFWMD

## Coastal Aquifer



# Water System Integration





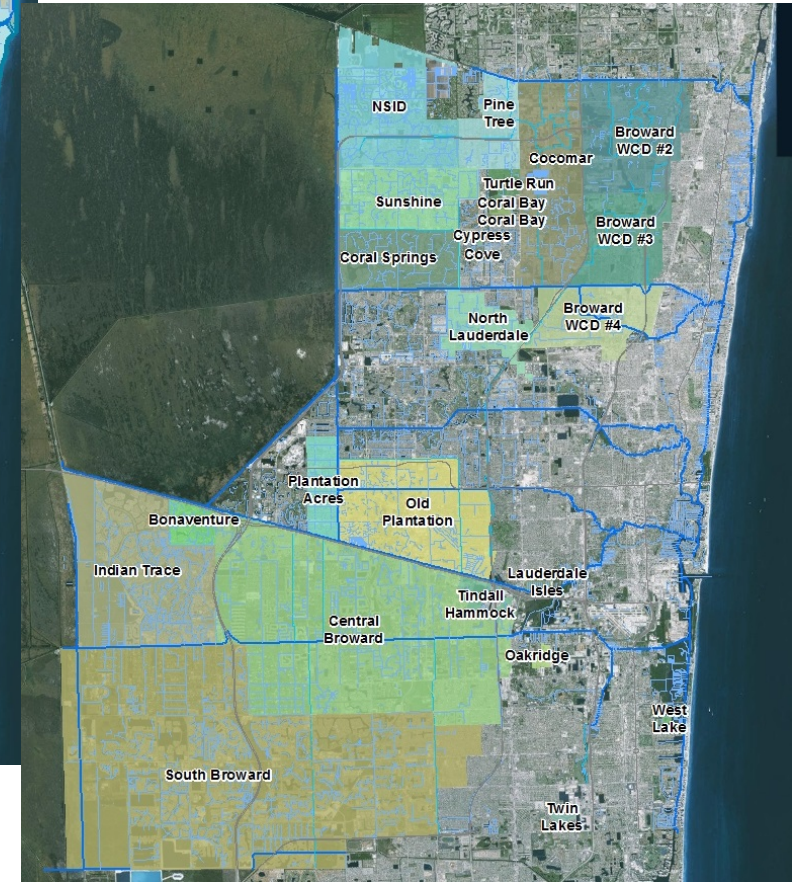
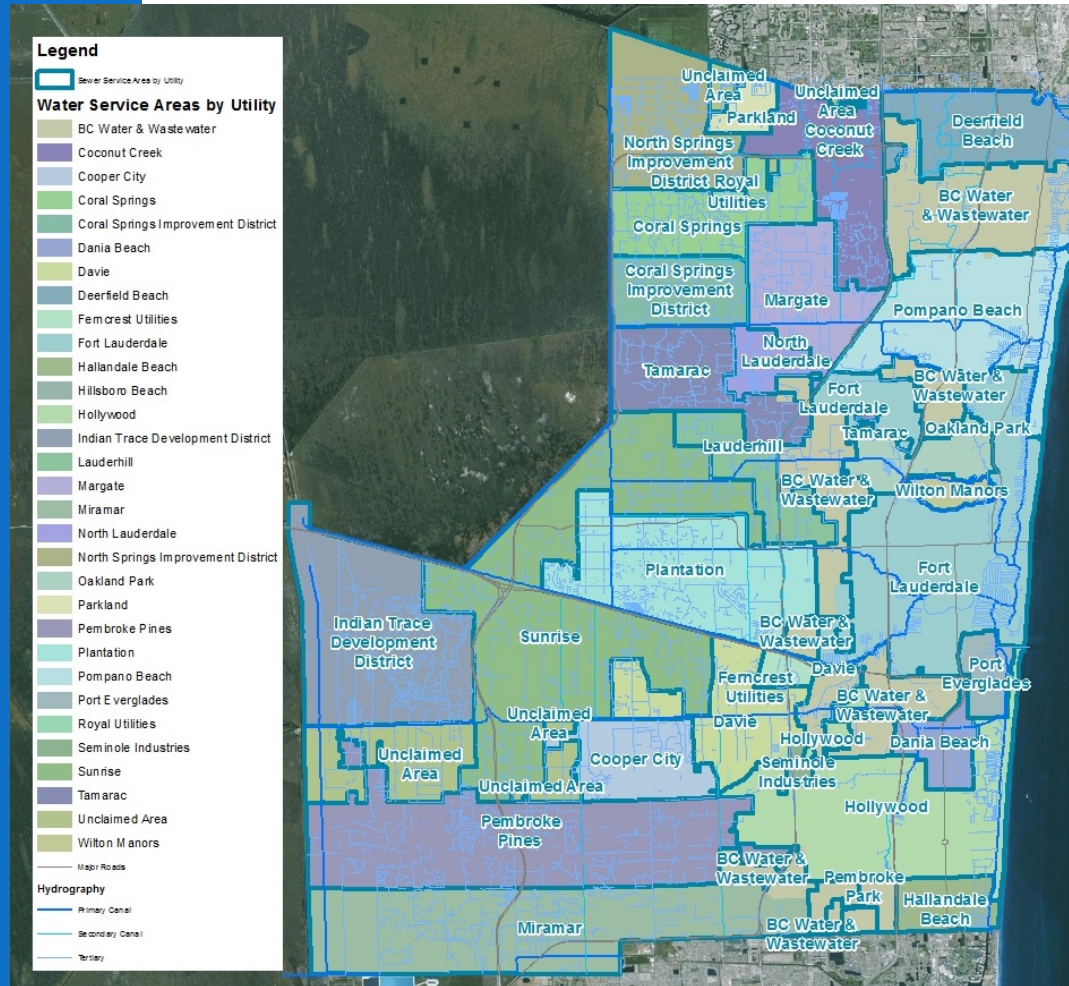
# Water System Stressors

- Human-induced Stresses:
  - Urban Development
  - Wellfield pumping
  - Canal water level management
  - Everglades Drainage
  - Agricultural Needs
  - Lake Okeechobee Levels Regulation Schedules
- Natural Stresses (and Climate Change):
  - Sea level rise
  - Extreme events



# Diverse Water Managers:

## Utilities and Drainage/Water Control Districts





# A History of Evolving Water Policy

1972 – Land and Water Management Act (Areas of Critical State Concern)  
and Florida Water Resources Act

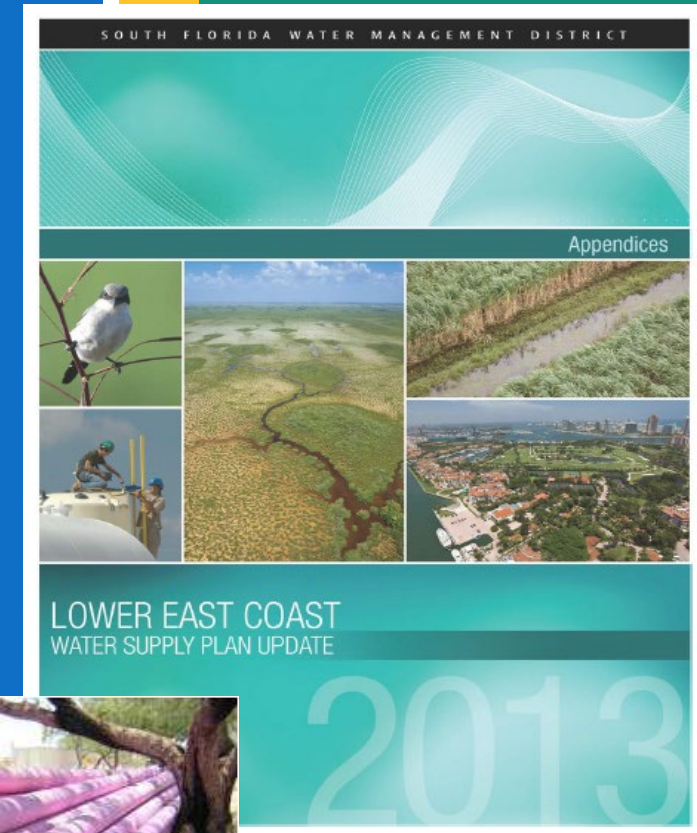
1985 – Growth Management Act (+ later amendments)  
Water Supply Facility Work Plans

2002 – Florida Water Conservation Initiative

2007 – Regional Water Availability Rule  
•Alternative Water Supply

2008 – Ocean Outfall Legislation  
•Mandated Beneficial Reuse

2011 – Numeric Nutrient Criteria  
•Stricter water quality protections



# Planning for Tomorrow



## BROWARD WATER RESOURCES TASK FORCE REPORT

SHANNON A. ESTENOZ  
Governing Board Member  
South Florida Water Management District  
*Chair*

KRISTIN D. JACOBS  
Commissioner  
Broward County Board of County Commissioners  
*Vice Chair*

Lisa Aronson	Mayor, City of Coconut Creek
Douglas Bell	Chair, Central Broward Water Control District
Peter Bober	Mayor, City of Hollywood
Joy Cooper	Mayor, City of Hallandale Beach
Beth Flansbaum-Talabisco	Mayor, City of Tamarac
Lamar Fisher	Mayor, City of Pompano Beach
Glen Hanks	Secretary, Coral Springs Improvement District
Richard Kaplan	Mayor, City of Lauderdale
Jack McCluskey	Vice Mayor, City of Pembroke Pines
Charlotte Rodstrom	Commissioner, City of Fort Lauderdale
Donald Rosen	Commissioner, City of Sunrise
Susan Starkey	Vice Mayor, Town of Davie
Allegra Webb Murphy	Mayor, City of Oakland Park

August 2010

SOUTH FLORIDA WATER MANAGEMENT DISTRICT



## LOWER EAST COAST WATER SUPPLY PLAN U

Planning Document



CLIMATE ACTION PLAN

RESOURCES

NEWS

SUMMIT

ABOUT

CONTACT



RECOMMENDATIONS

MUNICIPALITIES

CASE STUDIES

## Welcome to RCAP 2.0

BUILD YOUR OWN PLAN

GET STARTED



### WATER

WS-3

Plan for future water supply [READ MORE »](#)

WS-10

Integrate surface and groundwater impacts in planning [READ MORE »](#)

Water figures prominently in building the future resilience and sustainability of Southeast Florida. Efforts to protect drinking water supplies, prevent water pollution, and manage stormwater must continue within the context of rising sea levels. The recommendations for regional action around water derive from four overarching principles. First, as the regional agency responsible for the operation and maintenance of the Central and South Florida flood control system and the infrastructure changes that affect system performance, the South Florida Water Management District, jointly with local governments, should play a prominent role in a) developing regional and sub-regional models and b) creating a framework to inform local models and ensure coordinated water management planning, system improvements, and resilience investments across the region. Second, resilience requires consistency in the use of current science and technology to support planning, management, and investment decisions across all agencies and the region. Third, resilience planning must address spatial and temporal dimensions, ranging from local to regional perspectives, inland to coastal to barrier island settings, chronic to acute stressors, and short-to long-term impacts. Fourth, regional resilience strategies should be developed with consideration of upstream and downstream consequences, including regional water quality and quantity implications, to avoid unintended effects on neighboring communities.

WS-1 Foster innovative water management



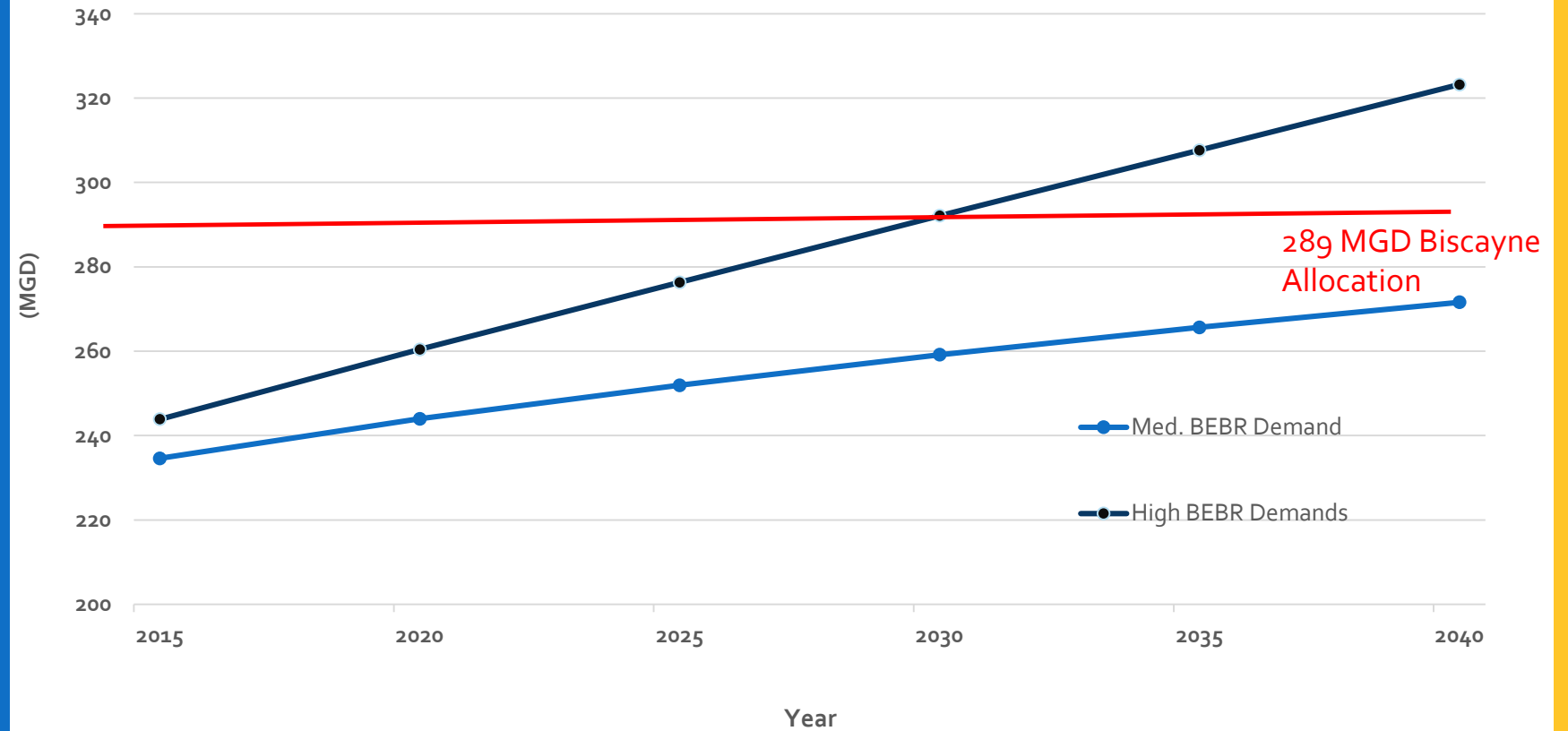
WS-2 Ensure consistency in water resource scenario planning



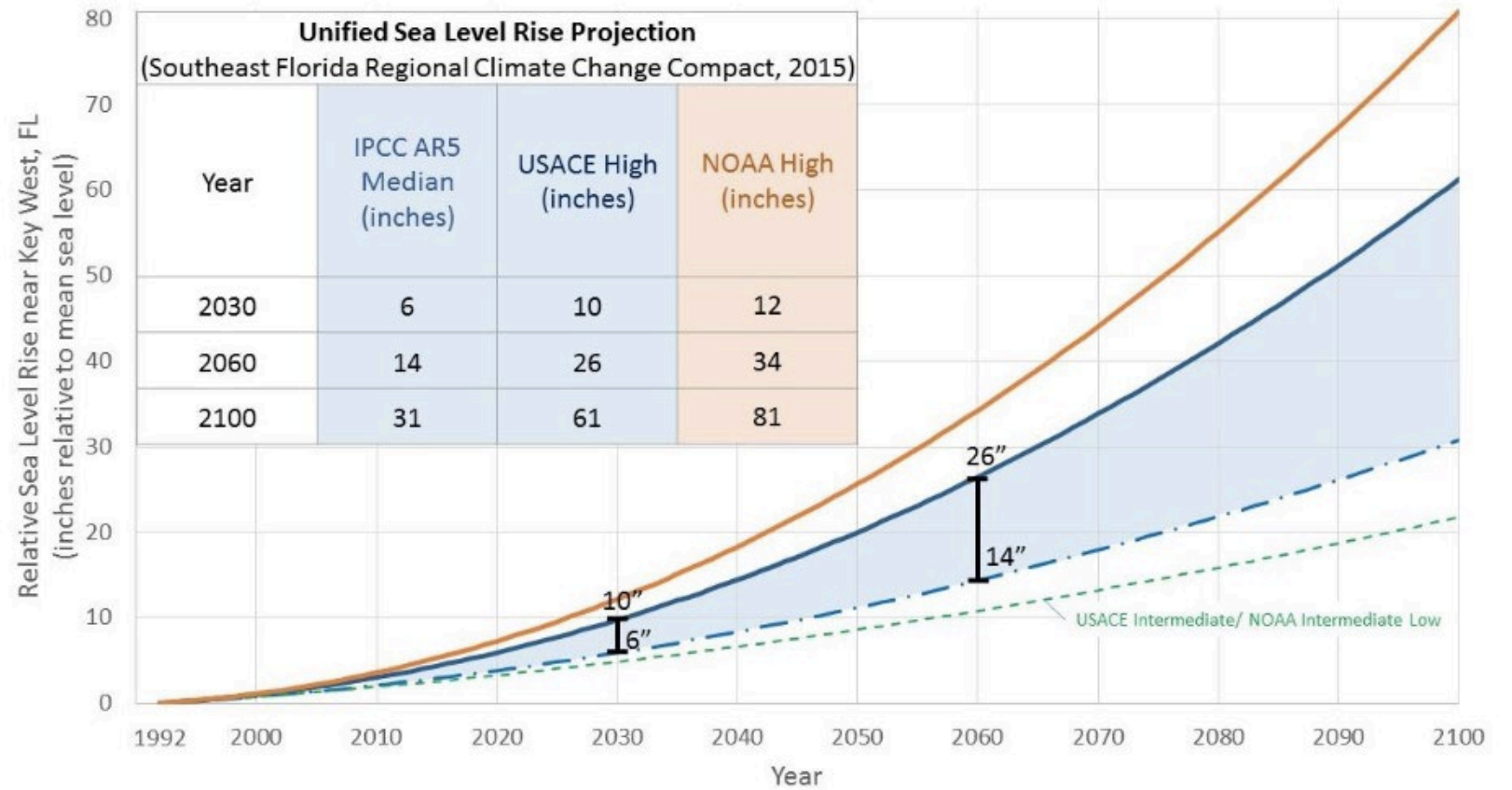


# Long-term Growth Trends

## Water Demands for Med/High BEBR



# Unified Sea Level Rise Projections



SOUTHEAST FLORIDA  
REGIONAL COMPACT

CLIMATE  
CHANGE



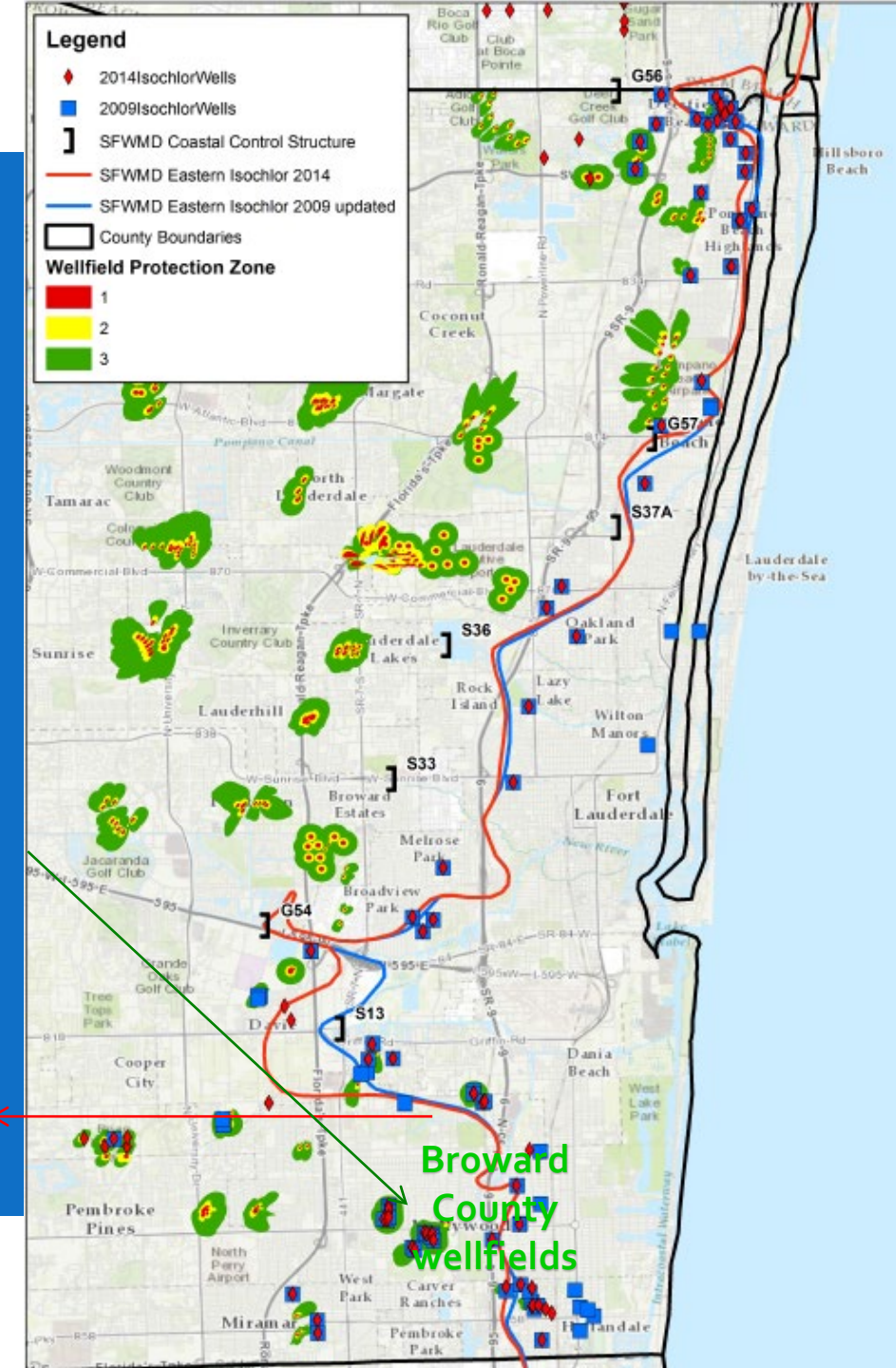


# Biscayne Wellfields Impacted by Saltwater Intrusion

220 MGD withdrawals in Broward County (2013)

- 86 MGD are within the coastal area (39% of total)
- 35 MGD of those coastal withdrawal would be threatened by SWI in a 2060 - 3 ft. SLR scenario (16% of total)

SFWMD 2014  
Isochlor Line  
(250 mg/L)





# Water Resource Plan Update: Building Resiliency in Water Management



01

02

03

04

05

06

07

08

Introduction and ...

Broward's Water R...

Goals and Objecti...

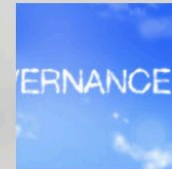
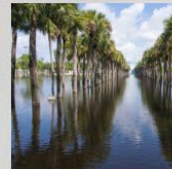
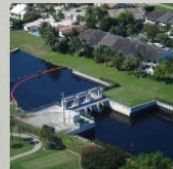
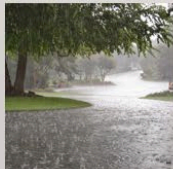
Status of Recomm...

Water Resources ...

Coordination with...

Governance

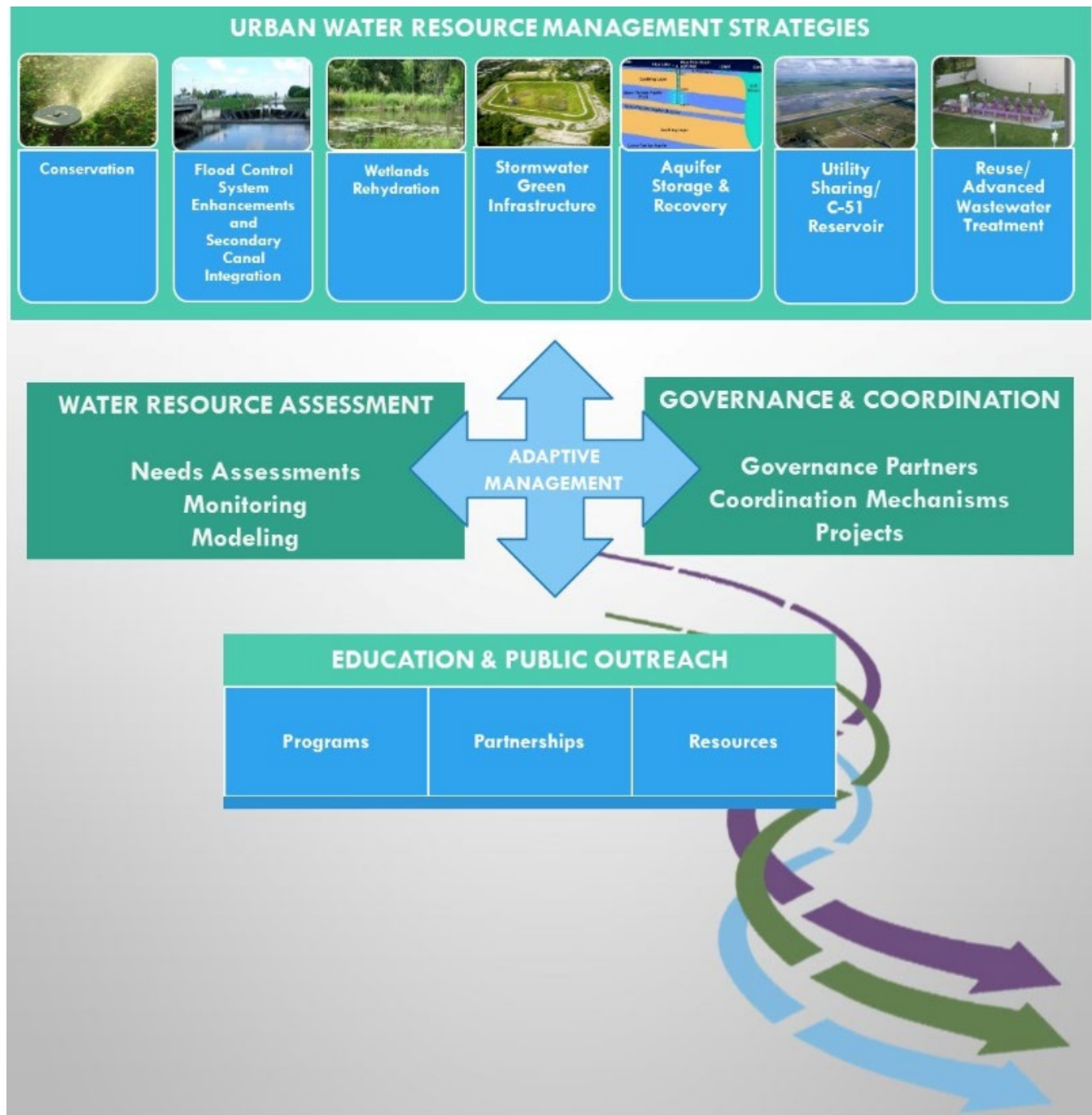
2019 Recommend...





# Broward County-wide Integrated Water Resource Plan

## 2019 Report

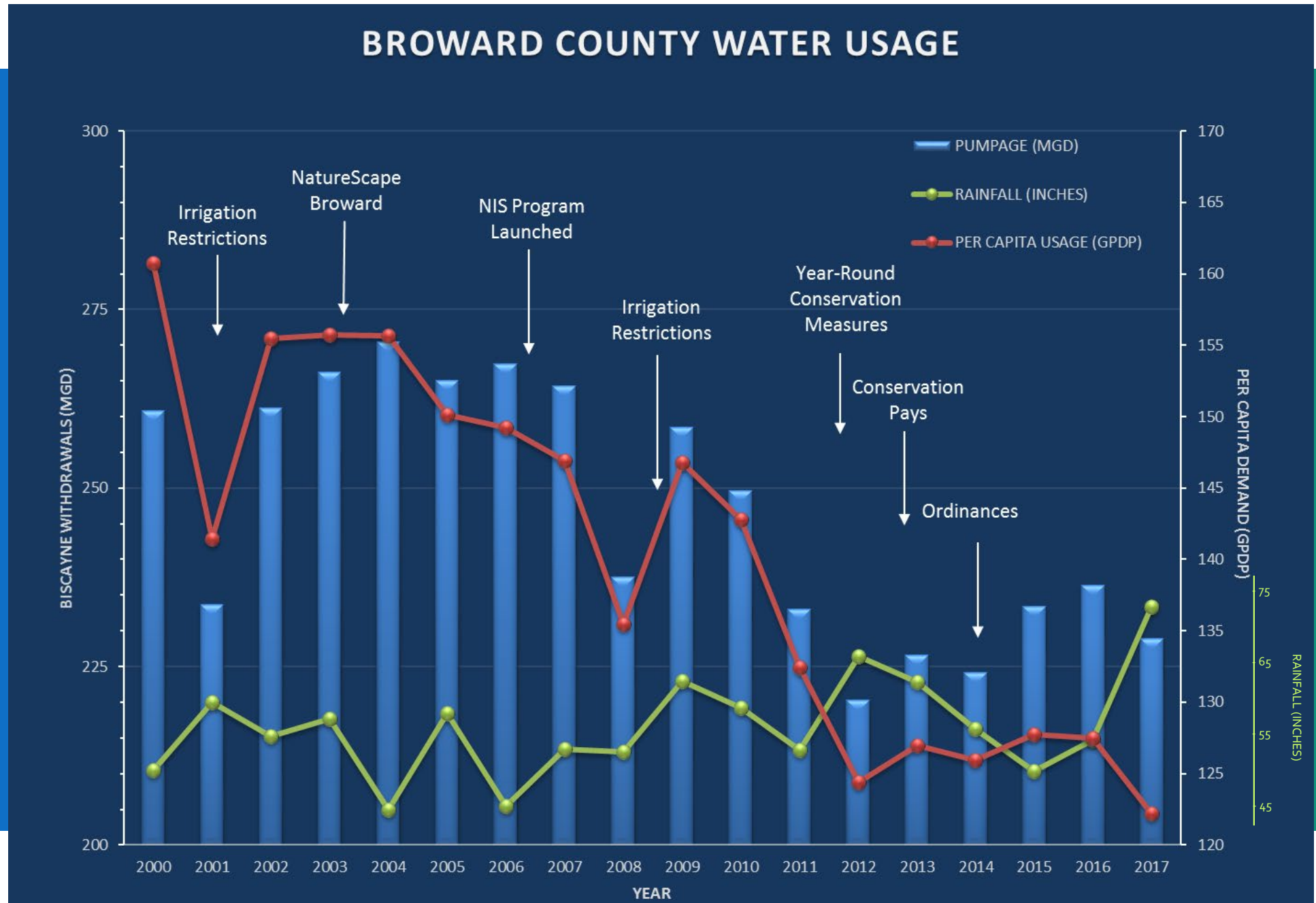


# Goals of the 2019 IWRP Report

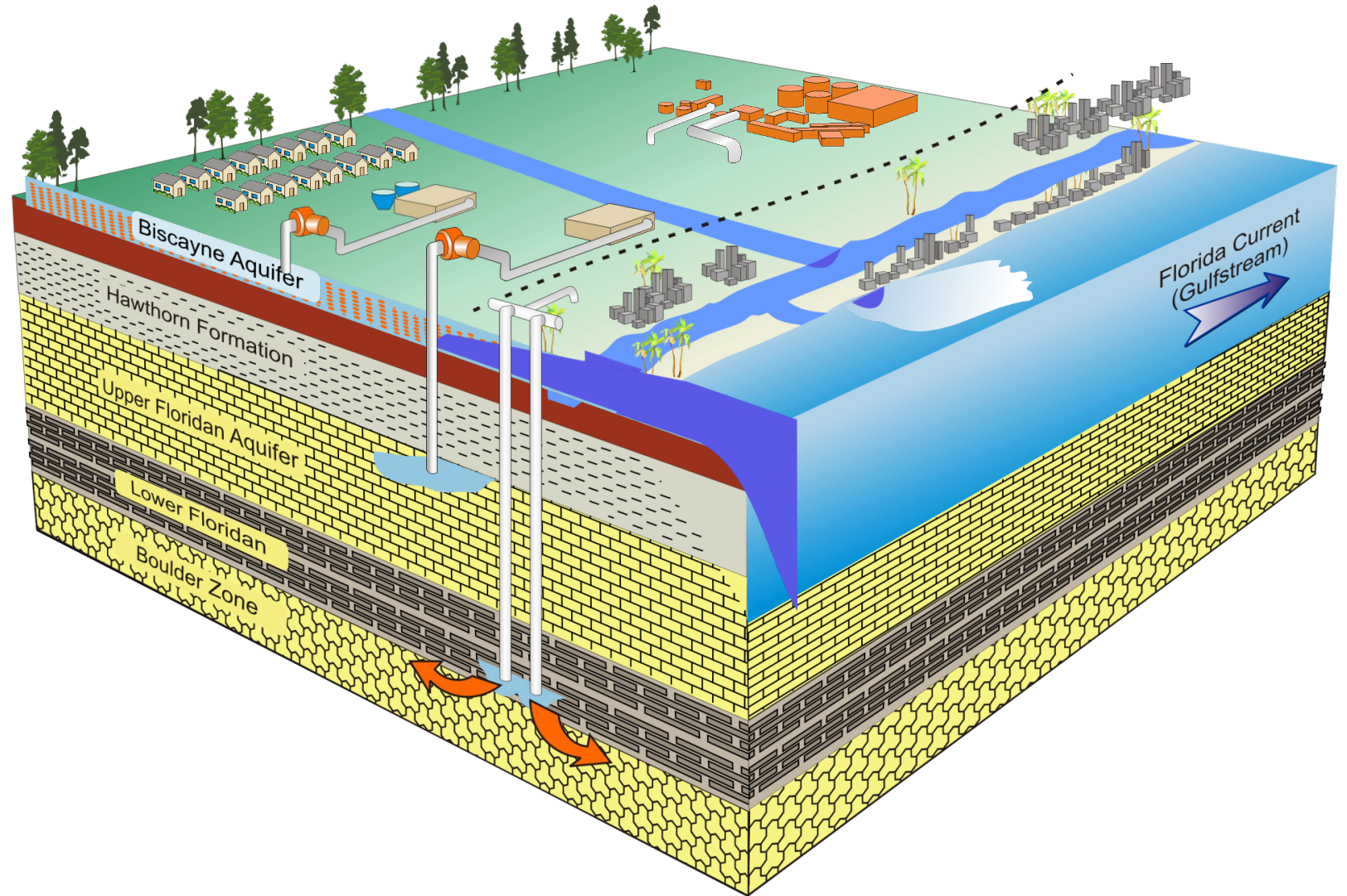
- To make the most of our local water resources to meet long-term water supply needs
- To coordinate a diverse water management community to ensure efficient and effective management of resources
- To match local water sources and users to ensure supplies are available when and where needed
- To diversify water supplies to create flexibility to create flexibility and options to meet urban and natural system needs under wet and dry conditions
- To promote water resources resiliency by evaluating future conditions, including potential climate impacts and adopt strategies to mitigate, adapt, and prevent disruptions to our overall goal of more efficient and effective water management



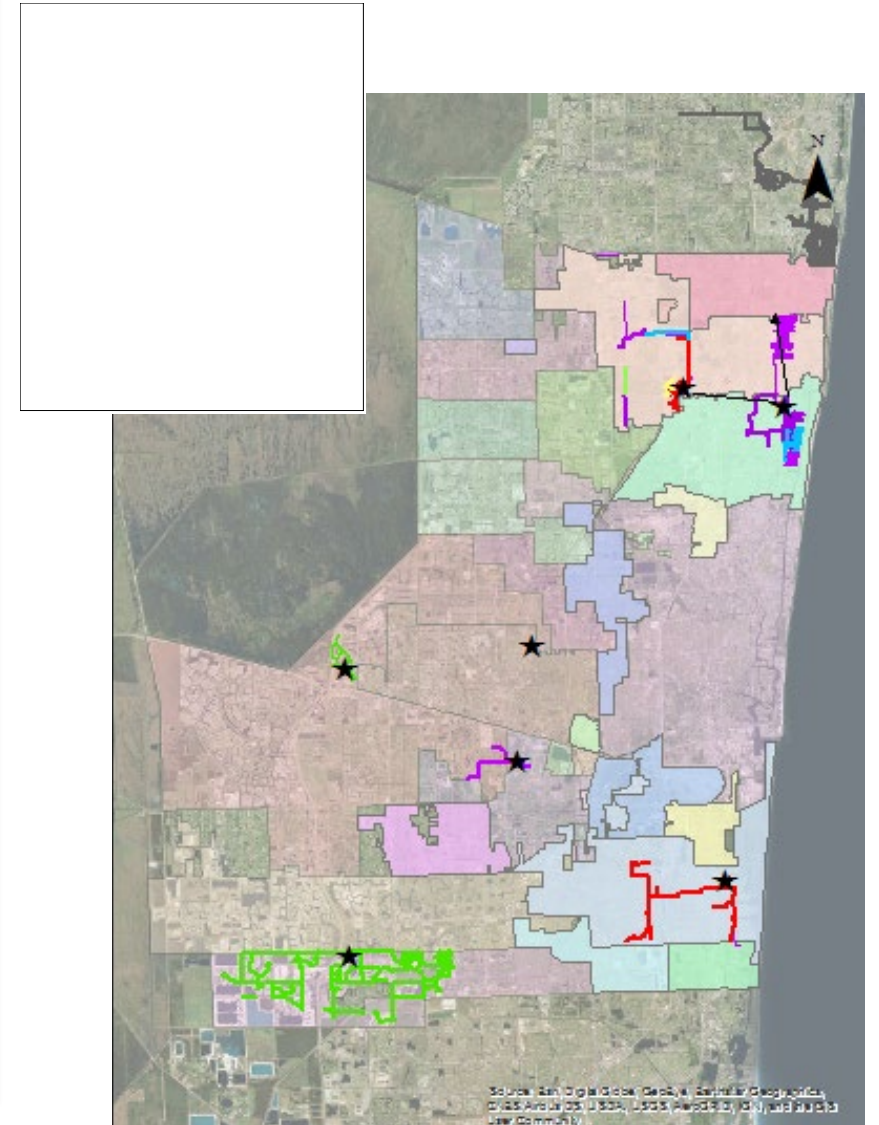
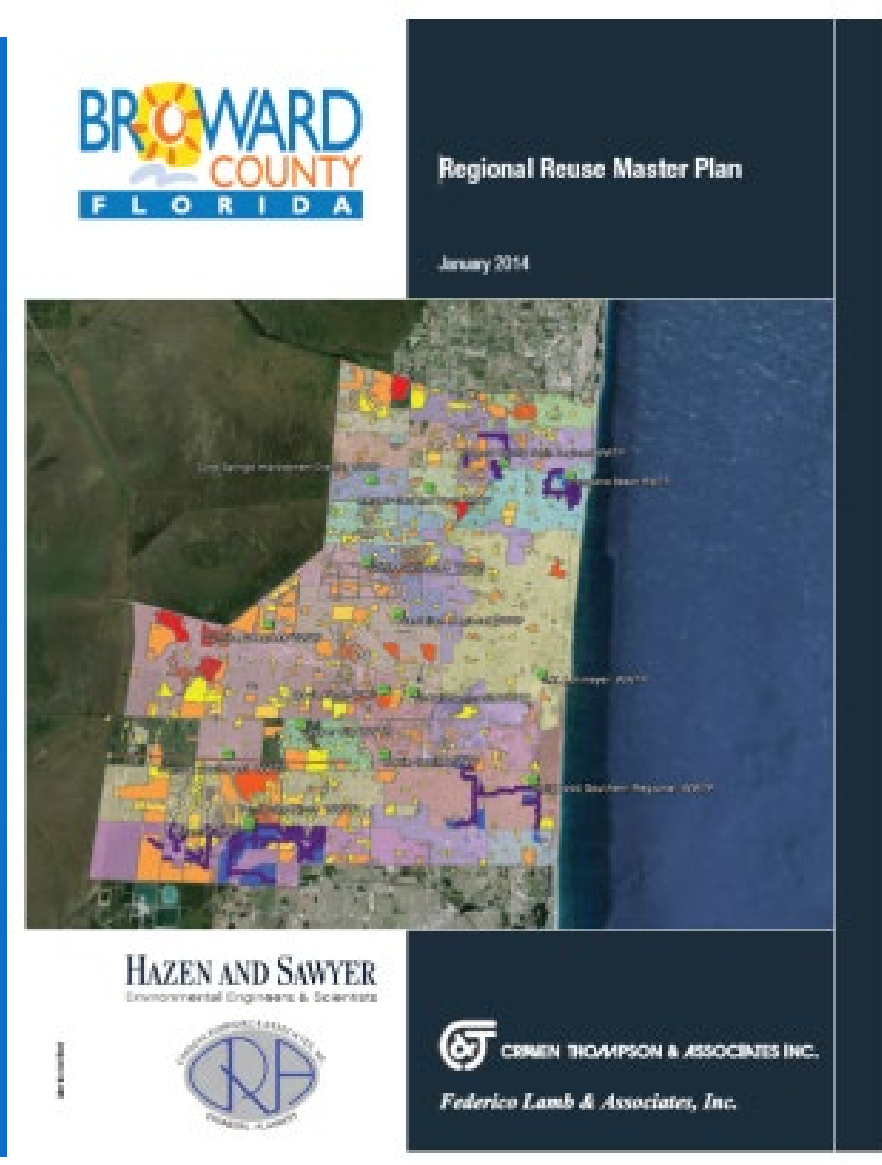
# Investments in Conservation



Water  
Management  
Strategies:  
Beyond the  
Biscayne



# Regional Reuse Master Plan





# Broward Challenges to Traditional Reclaimed Water Implementation

Developed urban areas - densely populated urban core with developed infrastructure

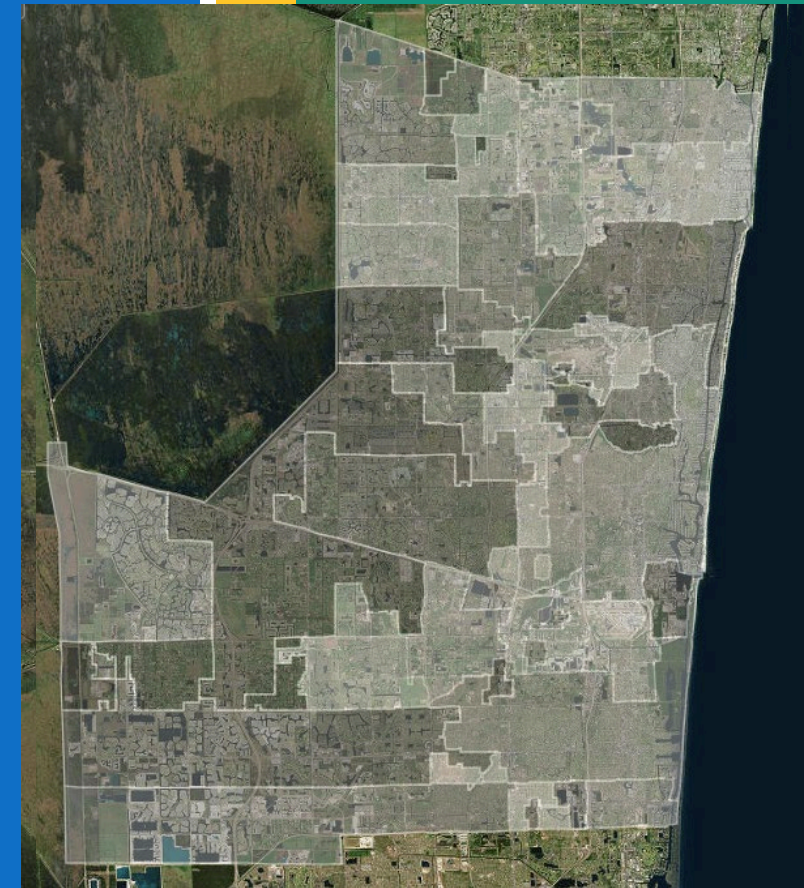
Current parcel occupation/size limits the reclaimed water demand (and cost efficiency)

25 distinct water providers (and additional wholesale agreements)

15 distinct wastewater providers (and additional wholesale agreements)

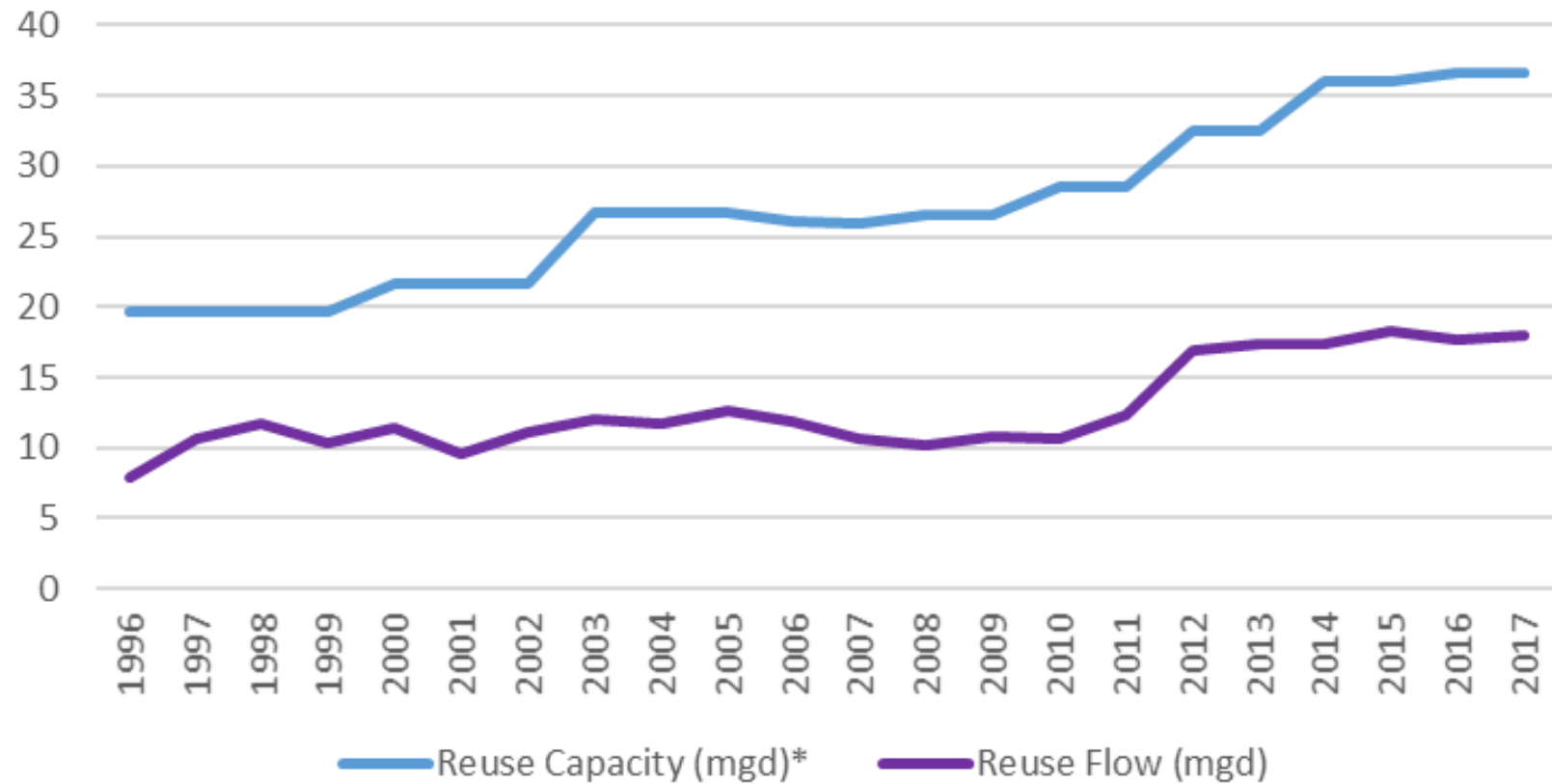
Seasonal demand fluctuations

Treatment costs/disposal options



Water Service Providers

## Broward County Water Reuse



Current Reuse Capacity  
in Broward:  
36 MGD

Current Total Reuse  
Flows in Broward:  
18 MGD

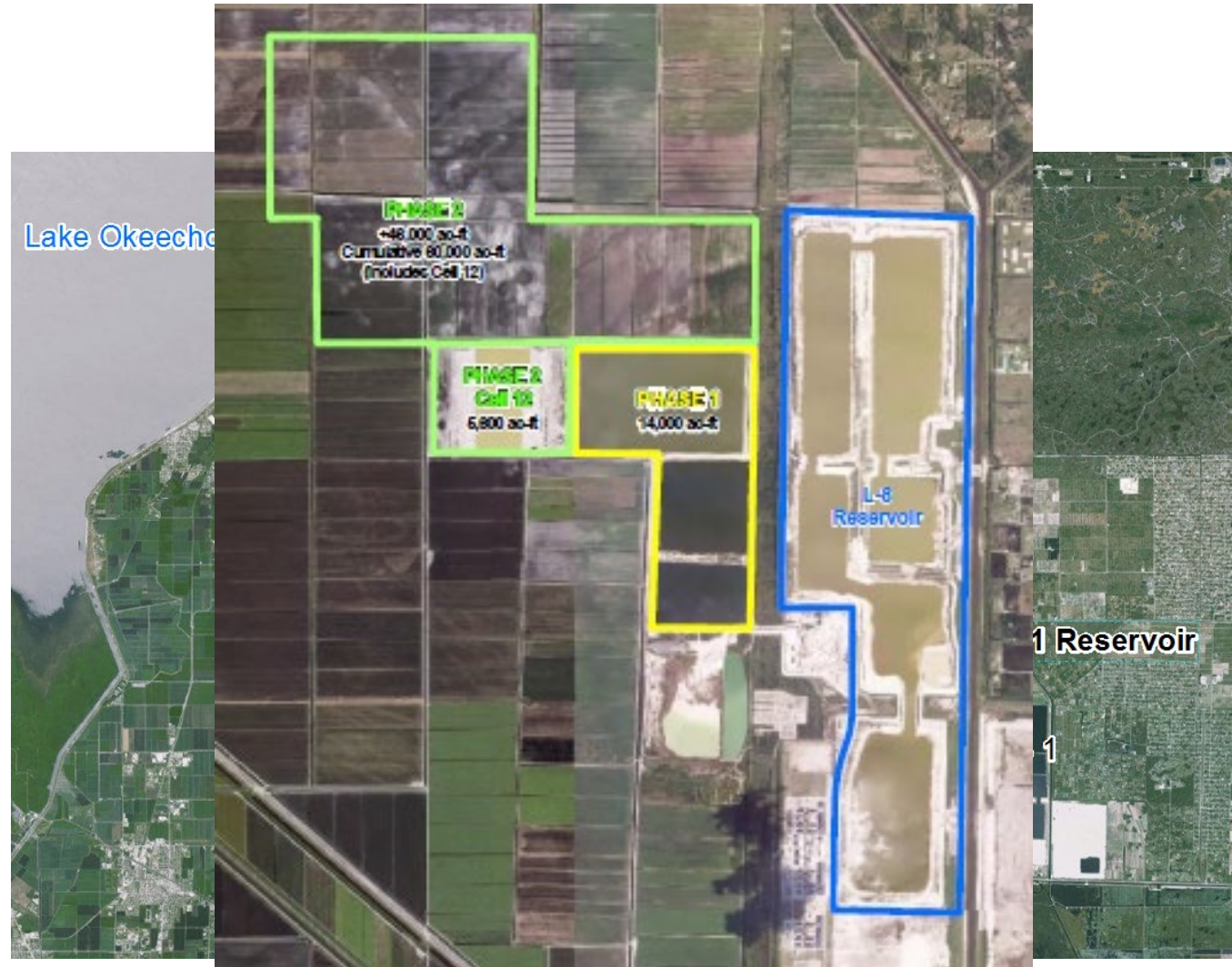
# Total Reuse

# C-51 Reservoir: Regional Alternative Water Supply and Stormwater Management Project

Capacity Allocation Agreement signed with WWS, Sunrise, Dania Beach and Hallandale

Consumptive Water Use Permit issued for WWS and Hallandale

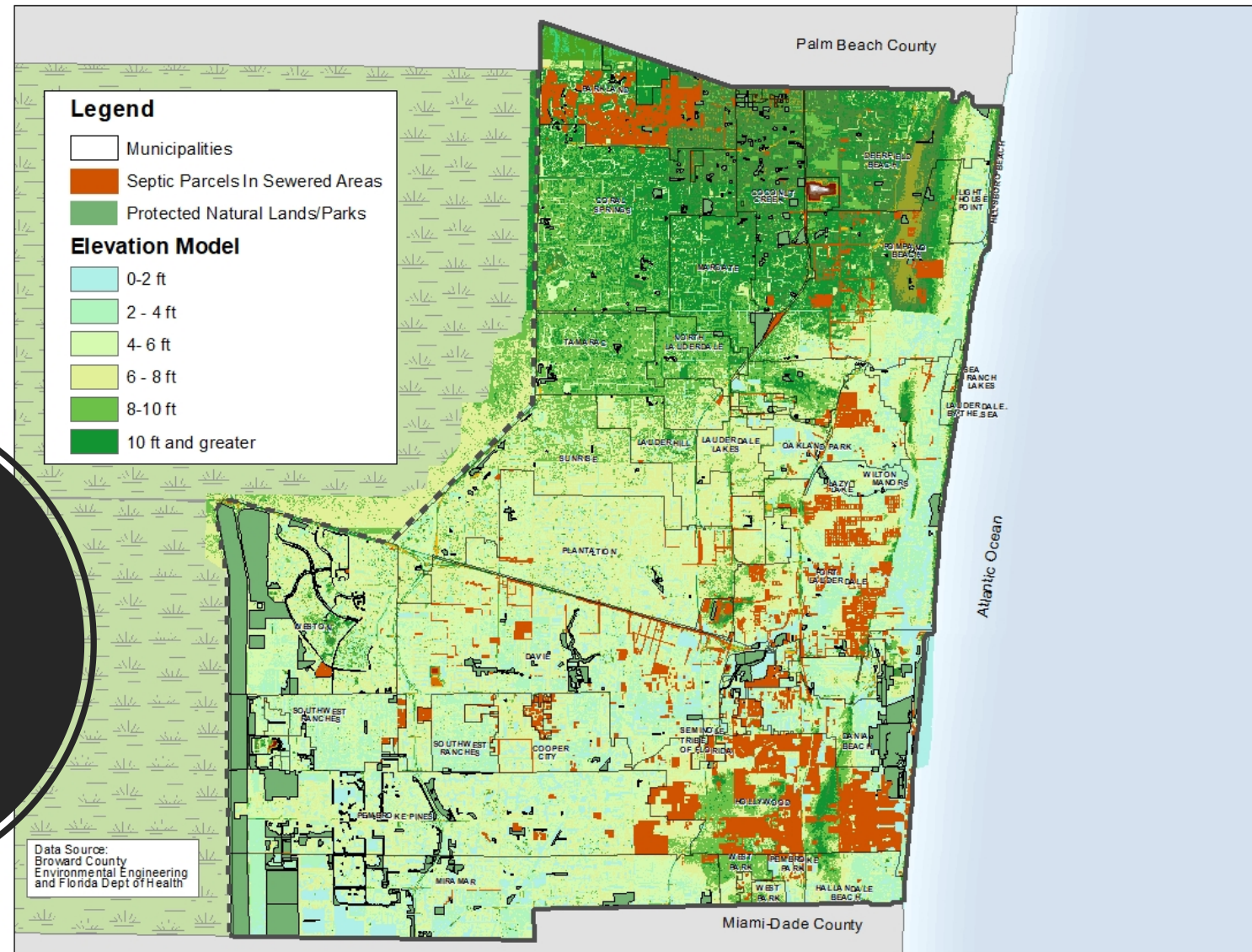
SB10 (2017): \$30 million in funding for Phase 1 implementation – Draft loan document



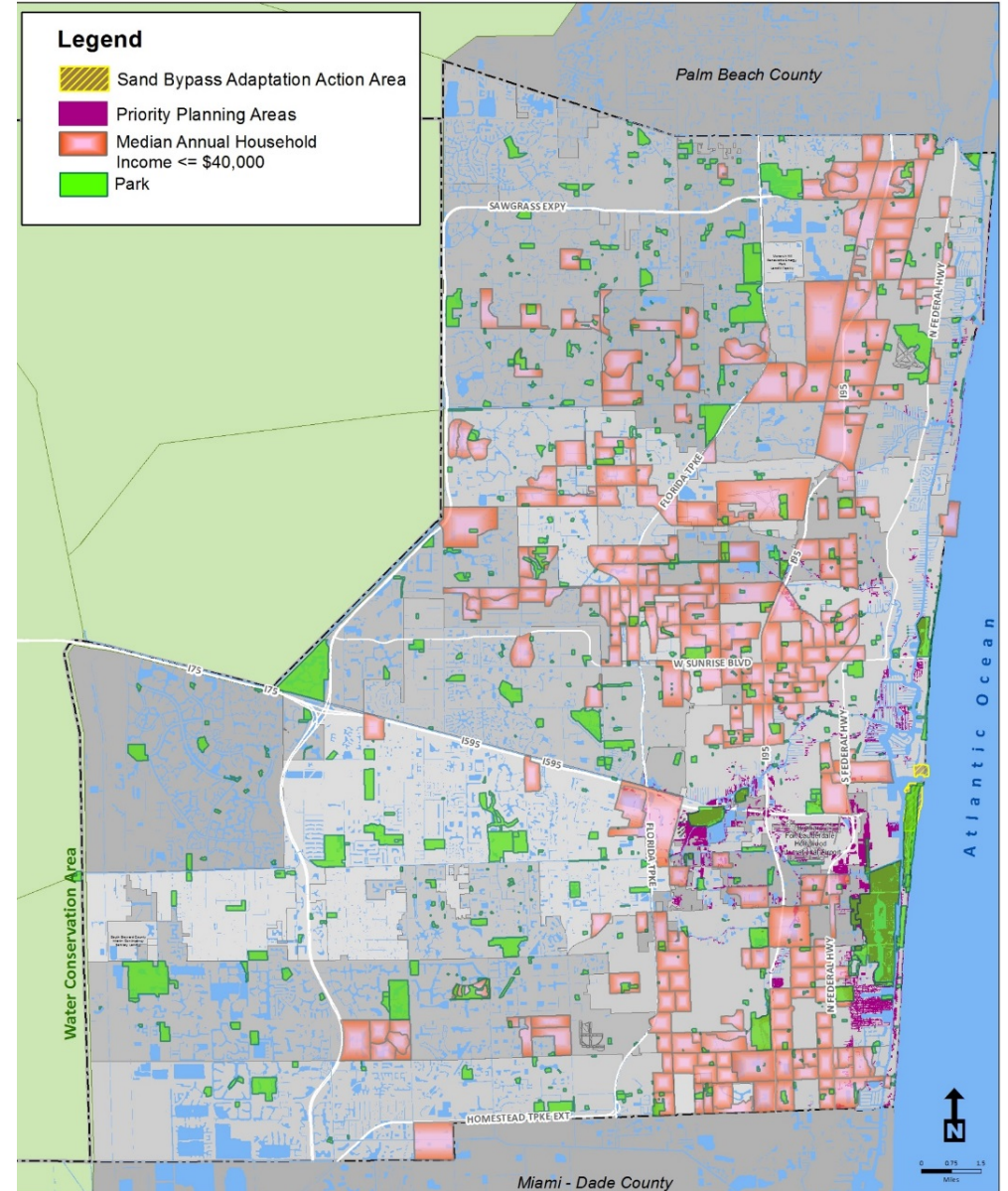


# Septic Tank Ordinance (under discussion)

Many areas in Broward County have low land elevation and high groundwater tables



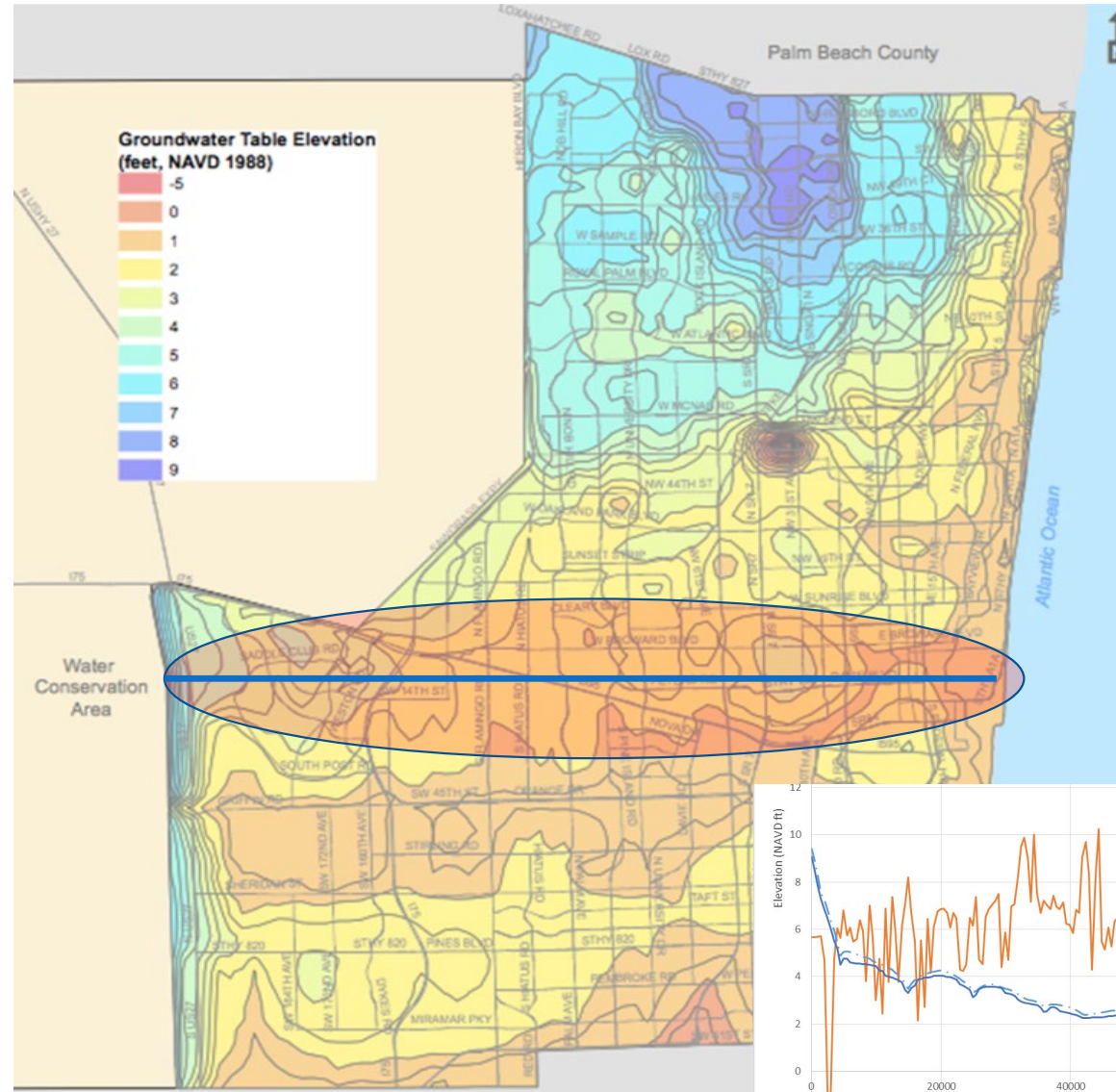




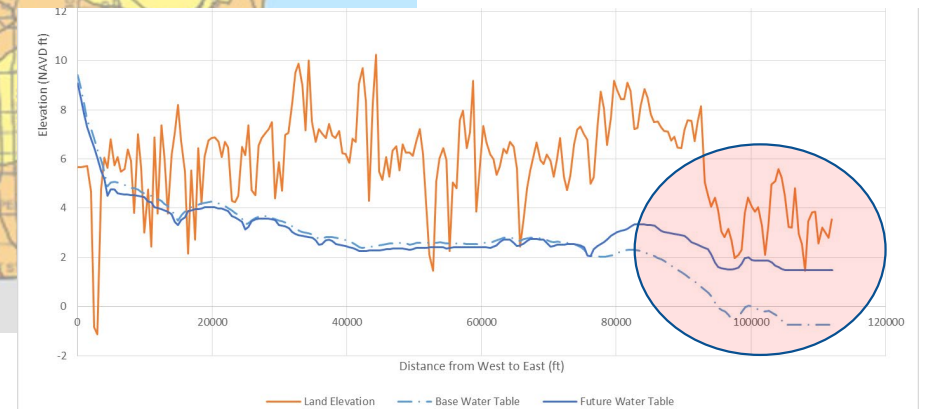
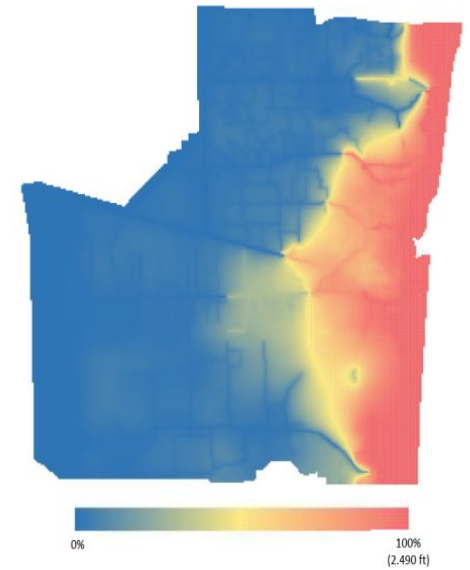


# Future Conditions Map Series

## Future Average Wet Season Groundwater Elevation Map



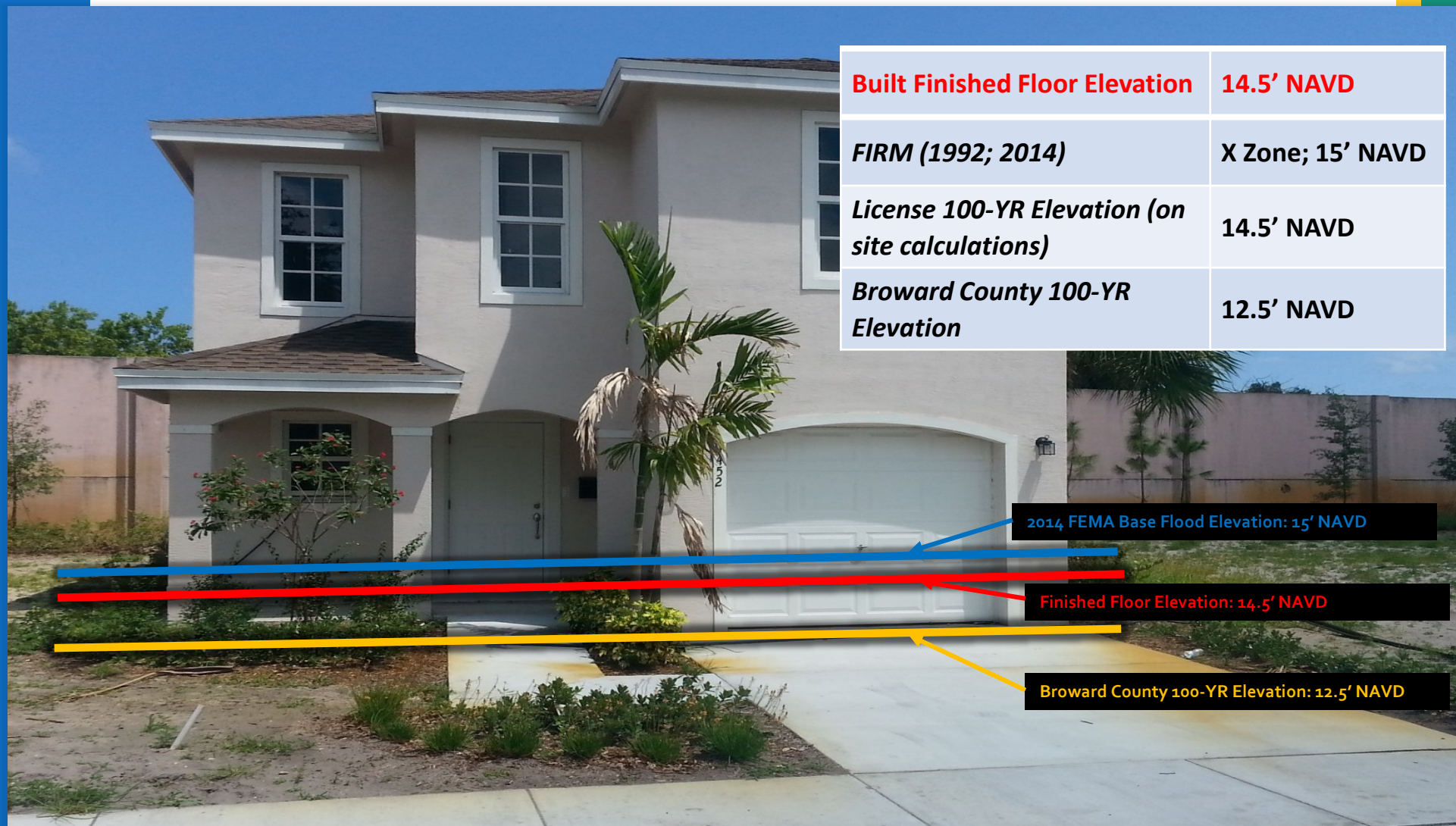
Wet-Season average for future conditions using CCSM model w/NRC3 rate of SLR  
Percent of SLR increase reflected in groundwater level increase





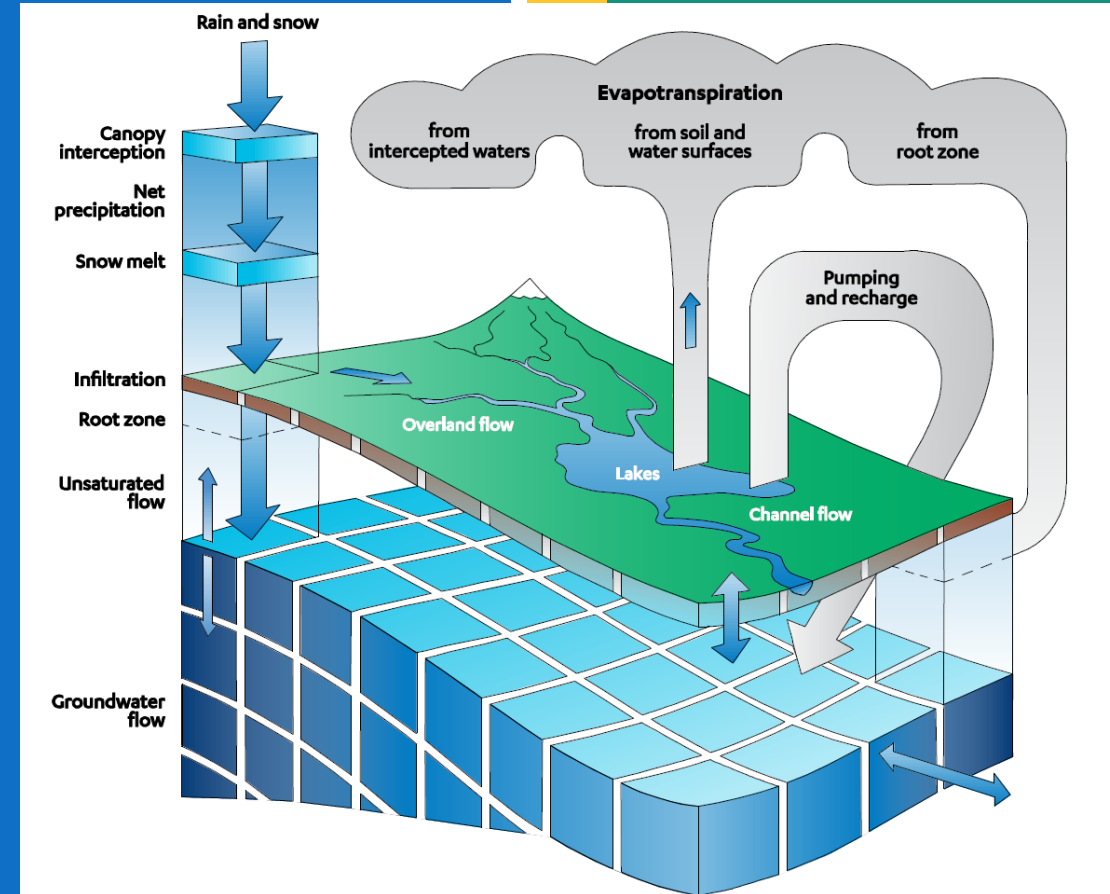
# Future Conditions Map Series

## Future Conditions Flood Elevation Map



# Future Conditions Flood Elevation Map

- Mapping Future Floodplains:
  - Increased rainfall due to warming climate
  - Year 2060-2069 sea level rise
  - Increased runoff due to higher water tables
  - Land use changes
    - Accomplished through integrated GW/SW modeling
- Enhance infrastructure resilience:
  - Regulatory purpose
  - Finished floor elevations, streets, sanitary manholes, etc.



Source: DHI, Inc.

# Future Rainfall Conditions

Develop Rainfall Data Set (options under evaluation)

- Use NOAA Atlas 14 data

- Statistically downscaled localized constructed analogs (LOCA)

- Dynamically downscaled data from COAPS

- Dynamically downscaled data from CORDEX

- Hyperion Group Data

- Probabilistic approach

Other considerations

- Future average GW levels from BC MODFLOW models

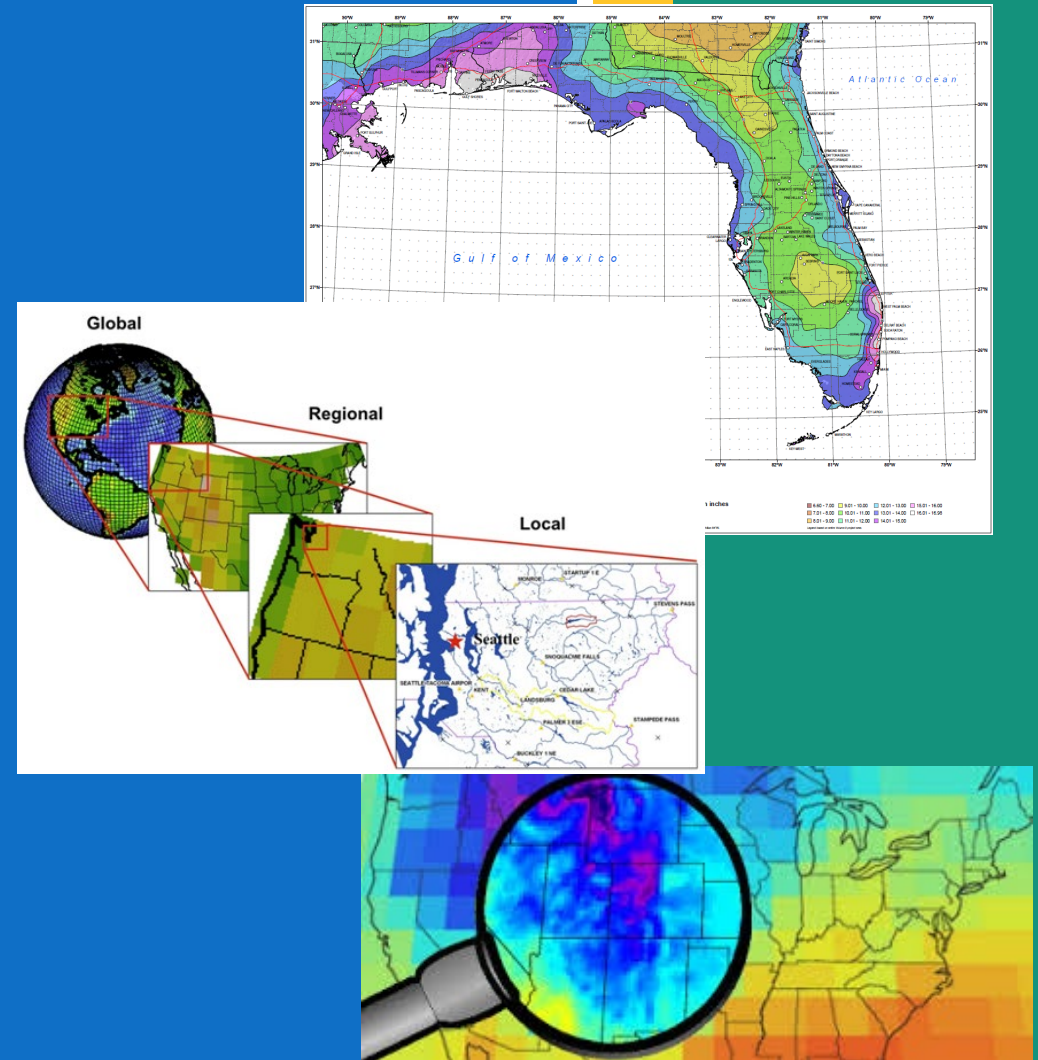
- Future Land Use

- Future Structure Operations

- Planned Infrastructure Improvements

- No storm surge (FEMA Coastal Zone A)

- No joint probabilistic distribution analysis





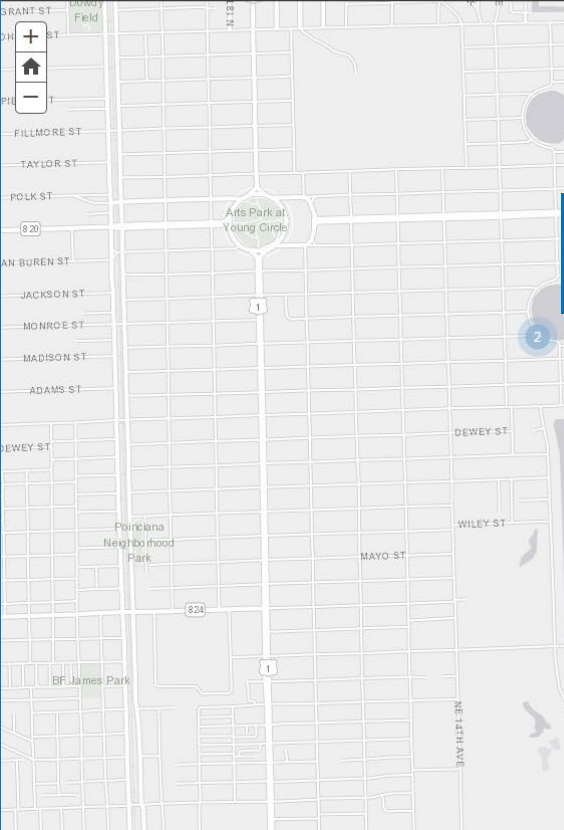


# King Tide and Flood Crowdsourcing Tools



Documenting the Floods

+ Add My Photo



## Moving Forward to 2040: Draft Utilities Dashboard

### Water Demands



Last update: a few seconds ago

### Source



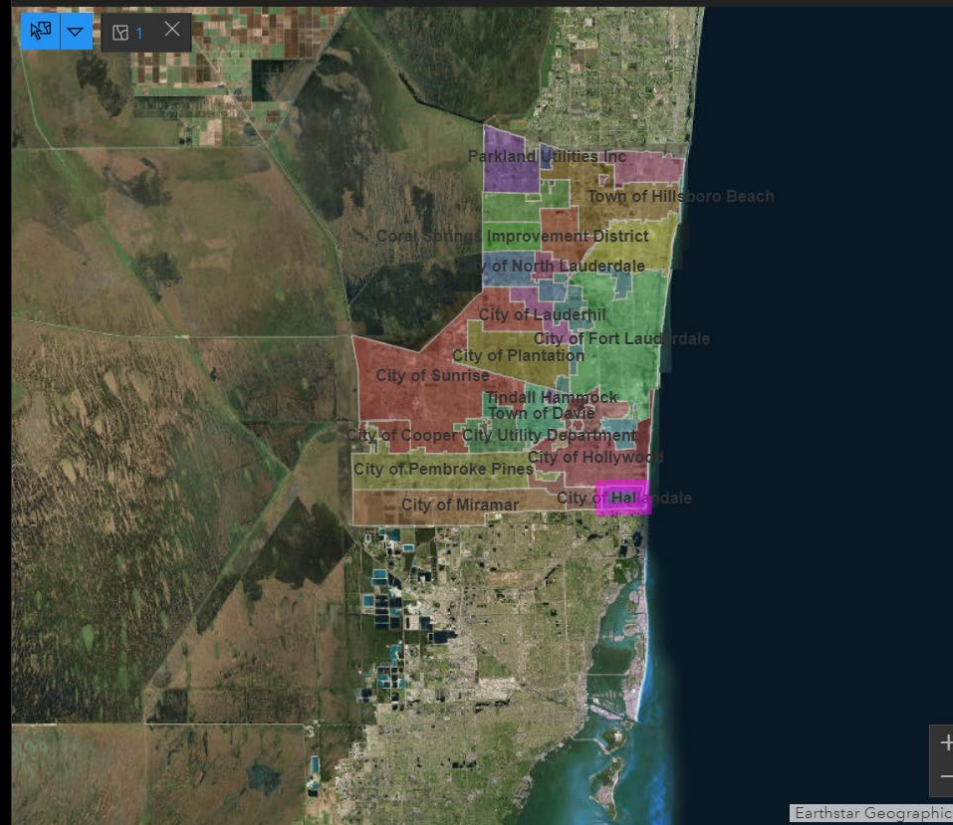
Last update: a few seconds ago

### City of Hallandale



Last update: a few seconds ago

### Water Demand Projections



-3.37

Unmet Demands, 2040 (mgd)

Last update: a few seconds ago

0

Reuse Capacity, 2040 (mgd)

Last update: a few seconds ago

C51 Allocation

1

C51 Allocation, 2040 (mgd)

Last update: a few seconds ago

Earthstar Geographics

# Water Utilities Resilience Aspects

- Complex Water Management System – Integration GW and SW
- Reliance on Biscayne Aquifer as main source of water supply (more affordable alternative)
- Alternative Water Supply Options (Reuse, C-51 Reservoir, Floridan) & Conservation Goals
- Future Conditions - Flood and Droughts (extremes events impacts)
- Future Water Supply Demands and Integration with Flood Protection System
- Stormwater Green Infrastructure
- SSOs, Septic Tanks and Water Quality Issues
- Hardening Infrastructure and Redundancy



# Resilient Utility Coalition: Operationalizing Resilience

**Benchmarking:** develop regional guidelines and best practices manuals for utilities'  
**information sharing:** implement a sharing platform for with databases, contacts, guidelines and other information

**Data Management:** data analytics and coordinated software platforms for utilities

**Foster Innovation:** partnerships with universities for research and development, technology committees, internships

**Emergency Preparedness:** formulate tools for regional integration

**Partnerships and Community Outreach:** develop key partnerships with stakeholders and encourage community involvement





# Florida's Water Utilities:

## Adapting to Long and Short Term Resilience Stressors

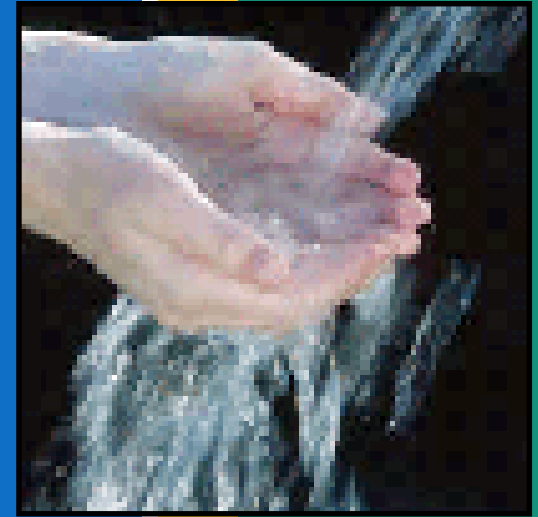


Miami-Dade County Increased Building Elevation

# The Future

Sustainable water resources management solutions will require:

- Addressing of future conditions and the potential impacts of climate change
- Community-wide conservation ethic
- Continued partnerships
- Participation of both public and private sectors
- Integration of new technologies and advanced solutions
- Continued leadership



# Thanks!

# Questions?

**Carolina Maran, Ph.D, P.E.**

Water Resources Manager

[cmaran@broward.org](mailto:cmaran@broward.org)

