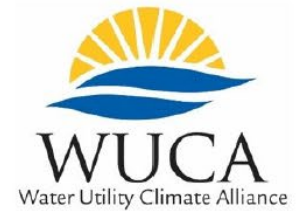


**Building Resilience to a Changing Climate:**

A Technical Training in Water Sector  
Utility Decision Support



# **WATER RESOURCES RESILIENCE IN BROWARD COUNTY**

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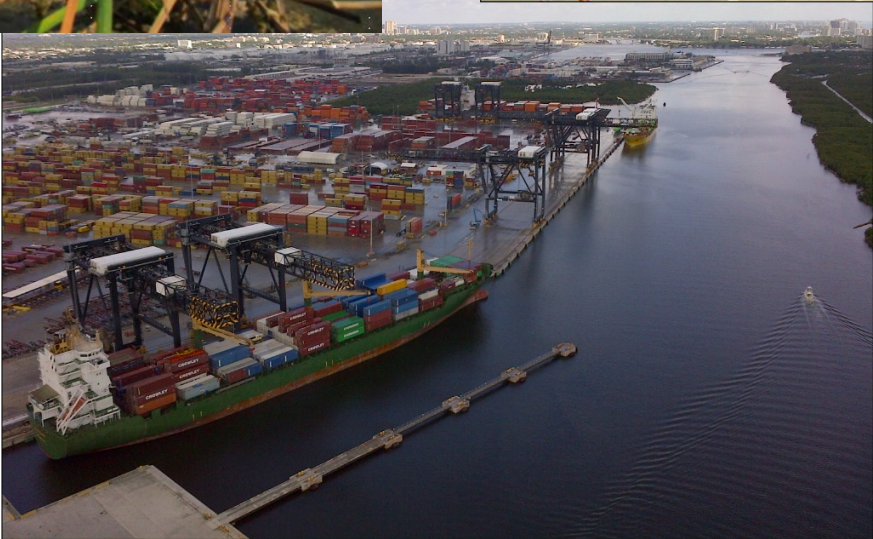
**Carolina Maran, Ph.D, P.E.**

Water Resource Manager, Environmental Planning  
and Community Resilience Division

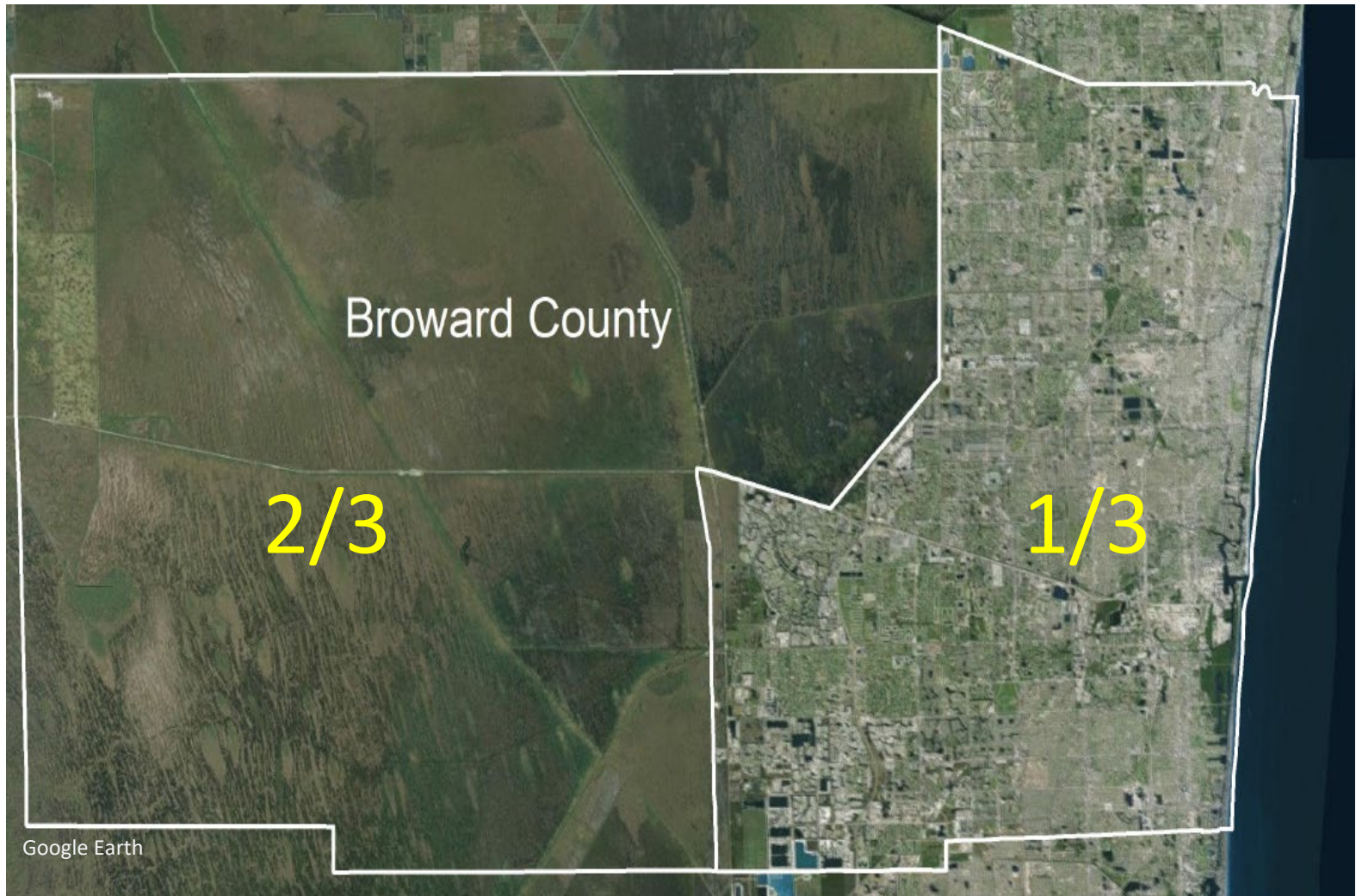
May 29, 2019



# Broward Water Resources Abundance



# Broward and the Everglades



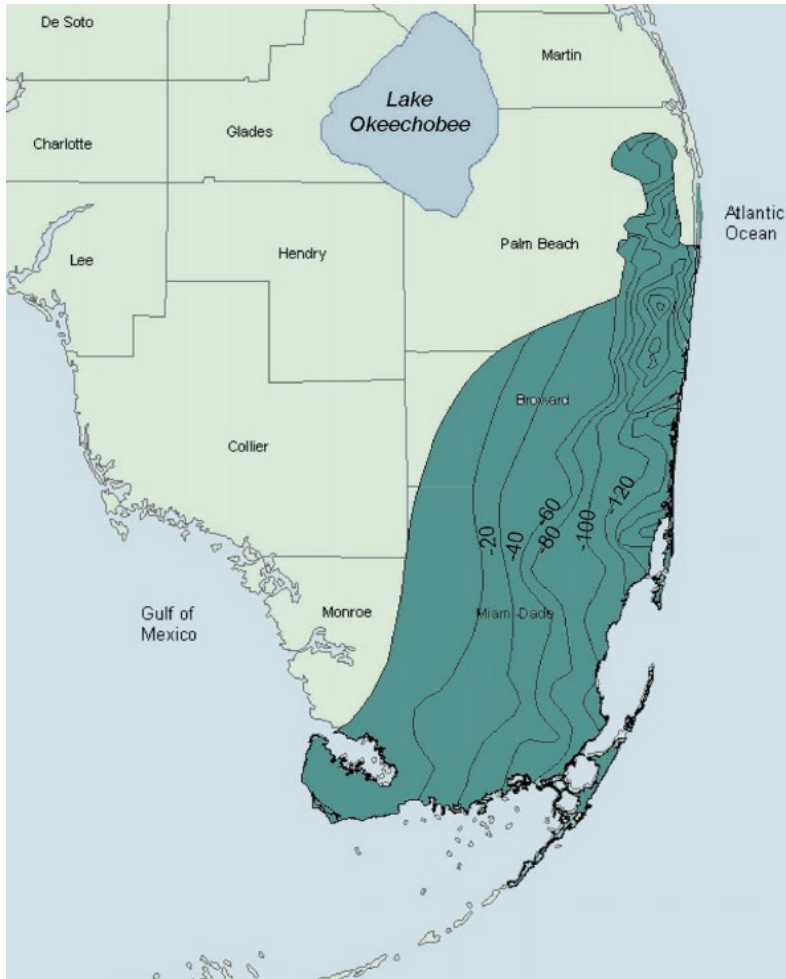
# Land Use and Water Management



Source: Broward County Historical Commission

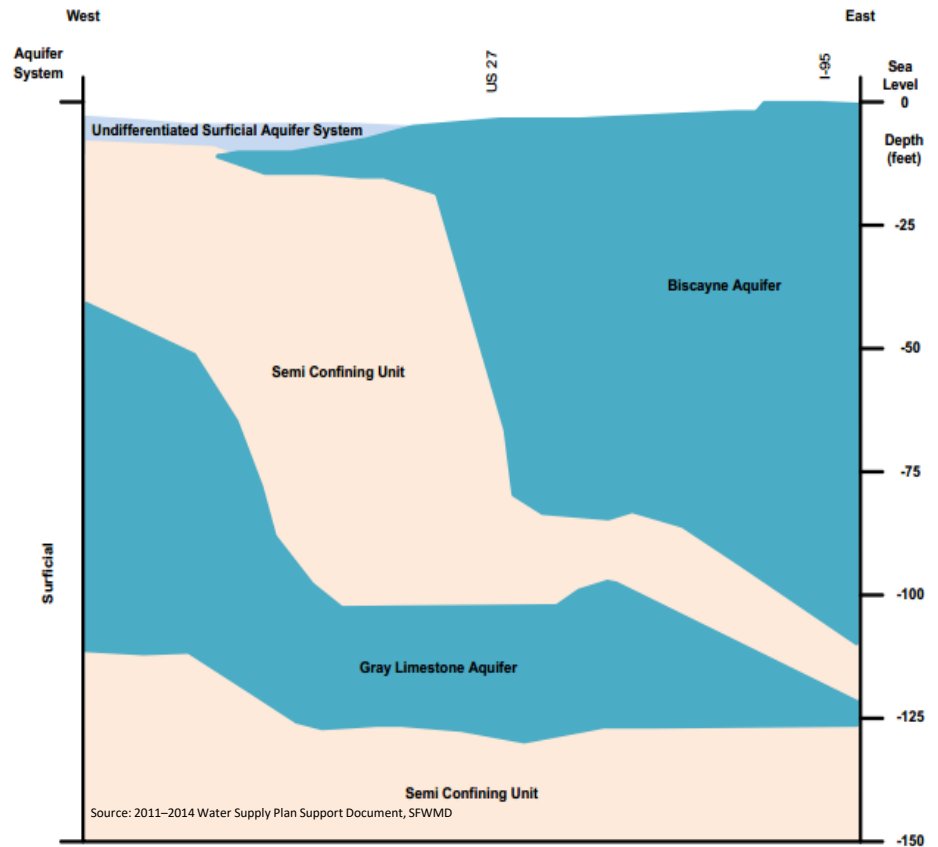
Source: SFWMD

# Biscayne Aquifer as Water Source



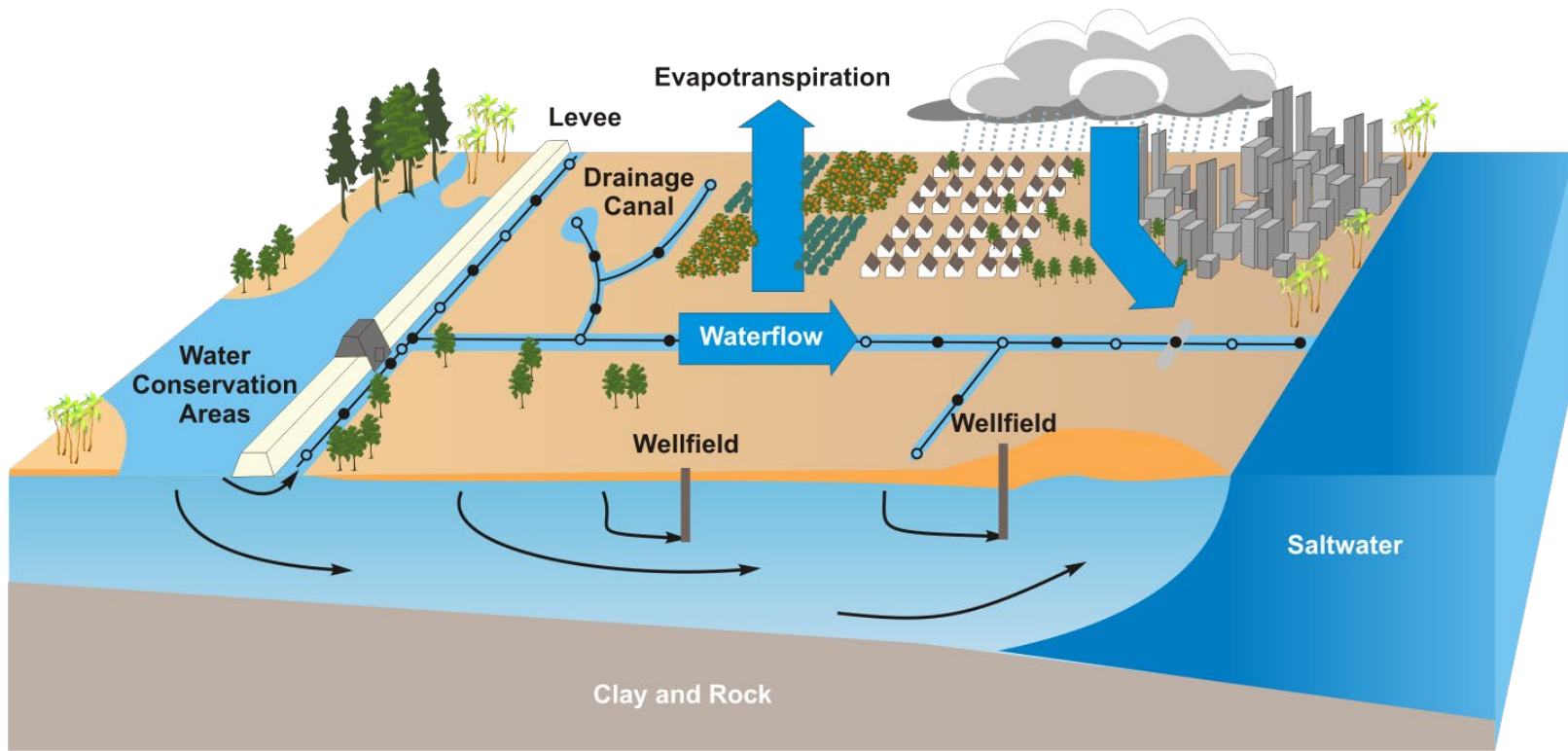
Source: 2011–2014 Water Supply Plan Support Document, SFWMD

## Coastal Aquifer



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

# Water System Integration

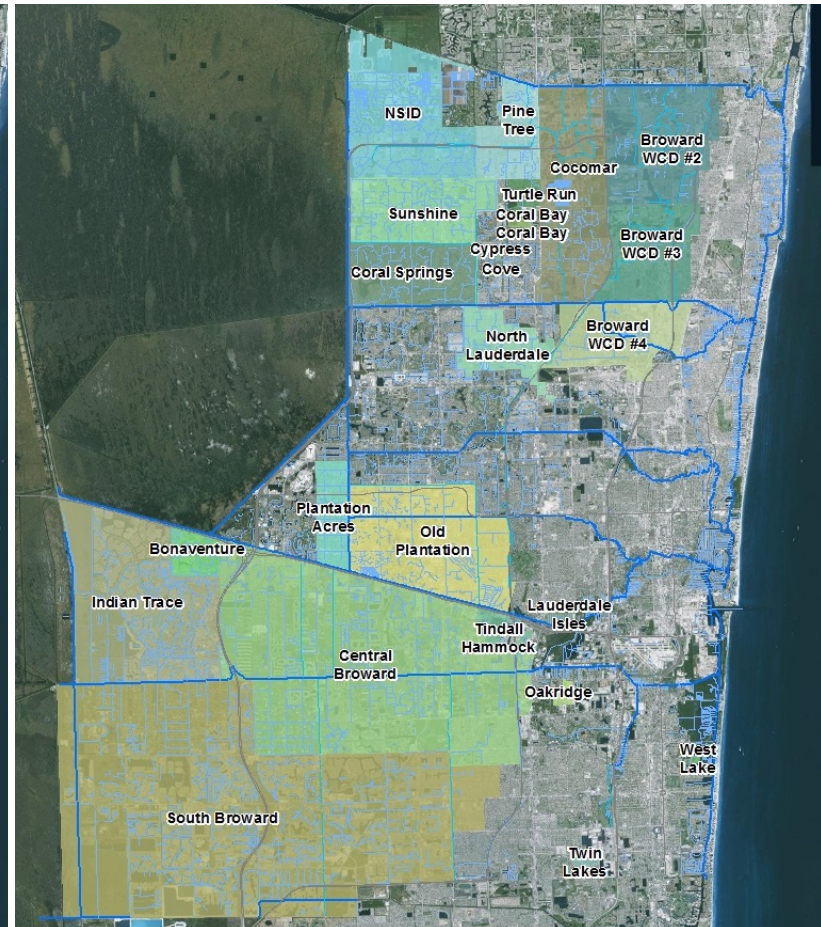
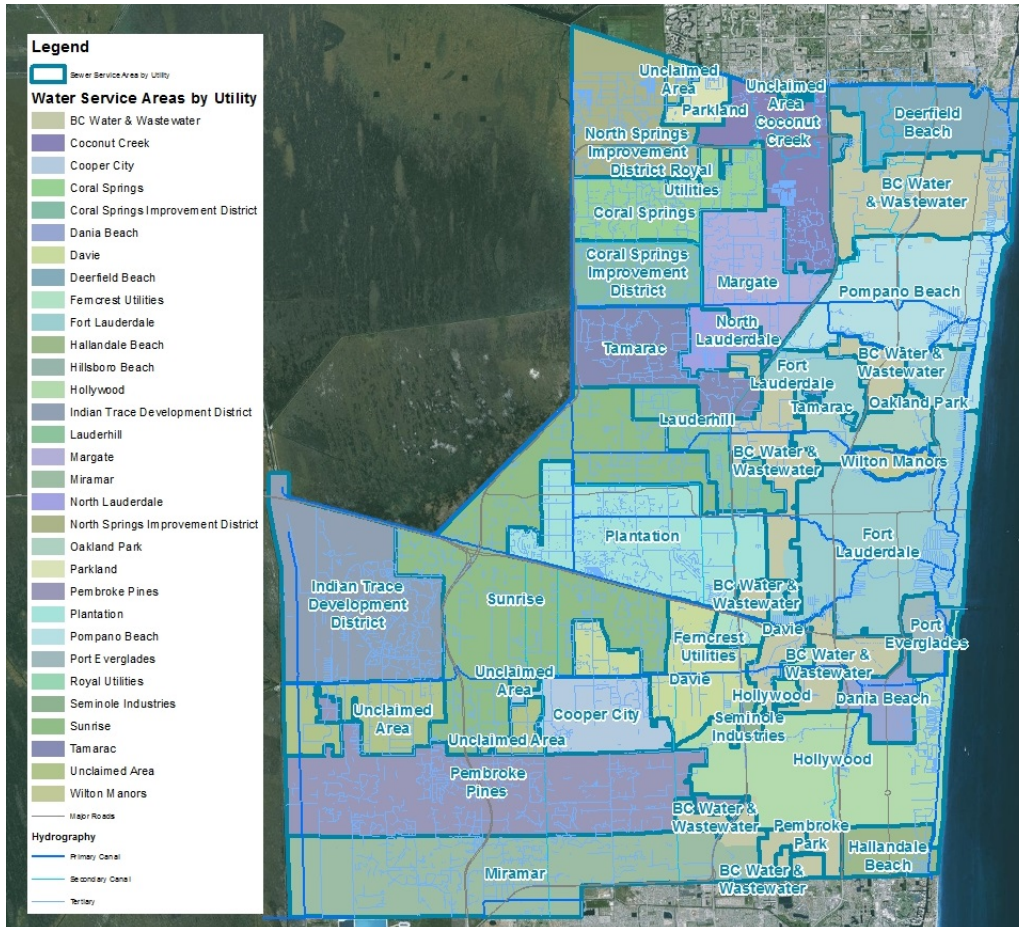


# Water System Stressors

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



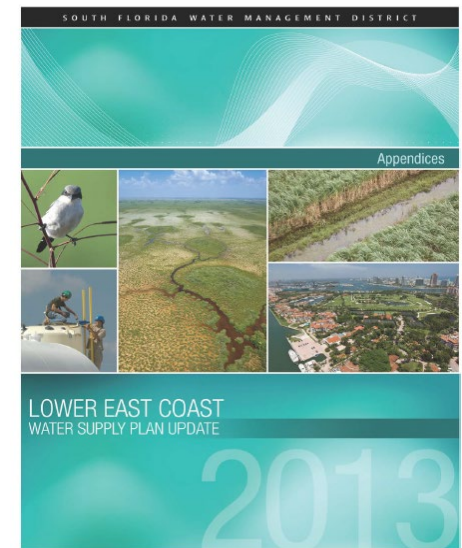
# Diverse Water Managers: Utilities and Drainage/Water Control Districts





# 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 TASK FORCE

SHANNON A. ES  
Governing Board  
South Florida Water Mana  
*Chair*

KRISTIN D. JA  
Commission  
Broward County Board of Cou  
*Vice Chair*

Lisa Aronson  
Douglas Bell  
Peter Bober  
Joy Cooper  
Beth Flansbaum-Talabisco  
Lamar Fisher  
Glen Hanks  
Richard Kaplan  
Jack McCluskey  
Charlotte Rodstrom  
Donald Rosen  
Susan Starkey  
Allegra Webb Murphy

Mayor, City of  
Chair, Central  
Mayor, City of  
Mayor, City of  
Mayor, City of  
Secretary, Co  
Mayor, City of  
Vice Mayor, C  
Commissioner  
Commissioner  
Vice Mayor, T  
Mayor, City of

August 2010

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

LOWER EAST COAST WATER SUPPLY  
Planning Document

2018

SOUTHEAST FLORIDA REGIONAL COMPACT CLIMATE CHANGE

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 »](#)

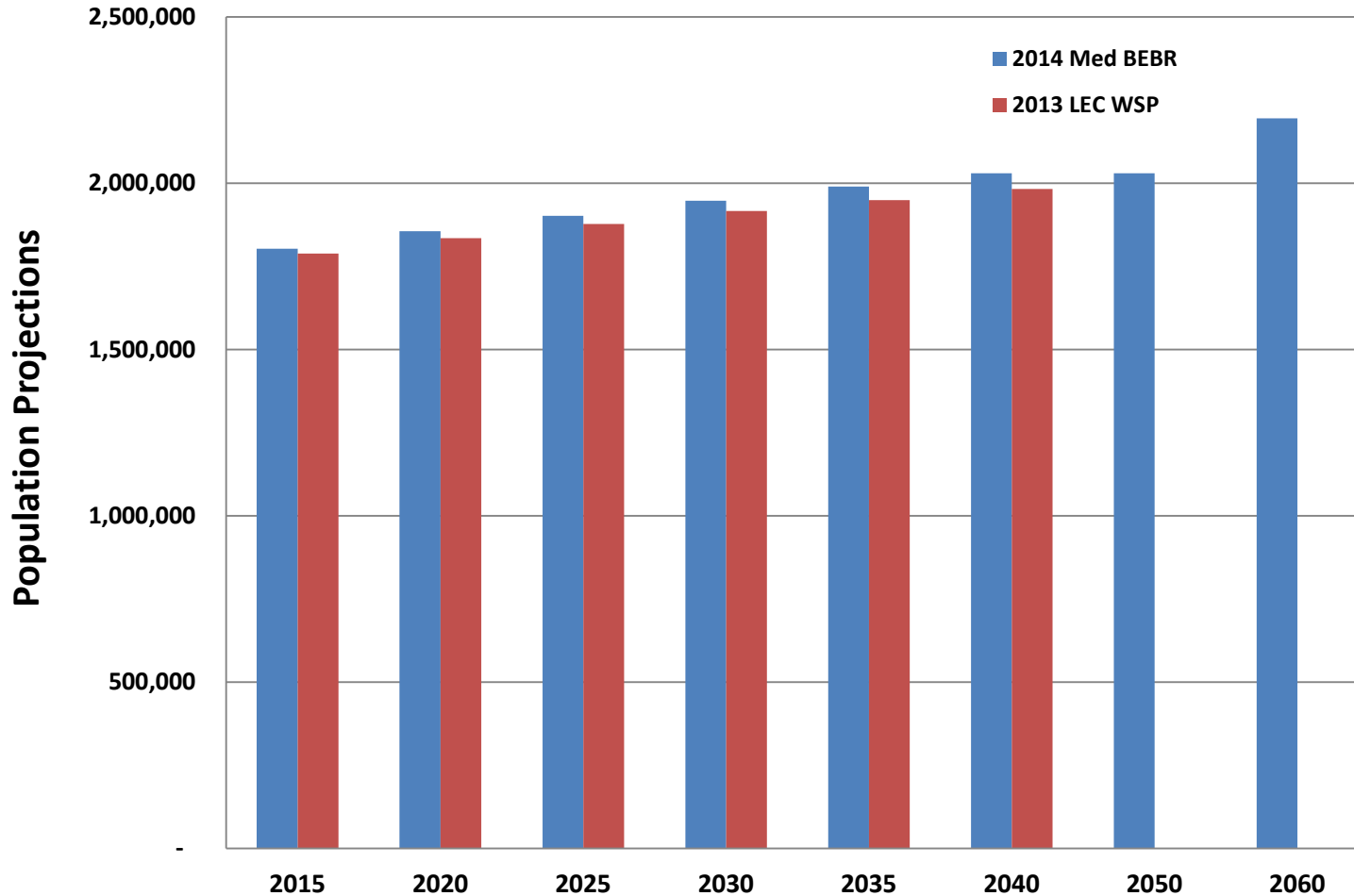
WS-1 Foster innovative water management [+](#)

WS-2 Ensure consistency in water resource scenario planning [+](#)

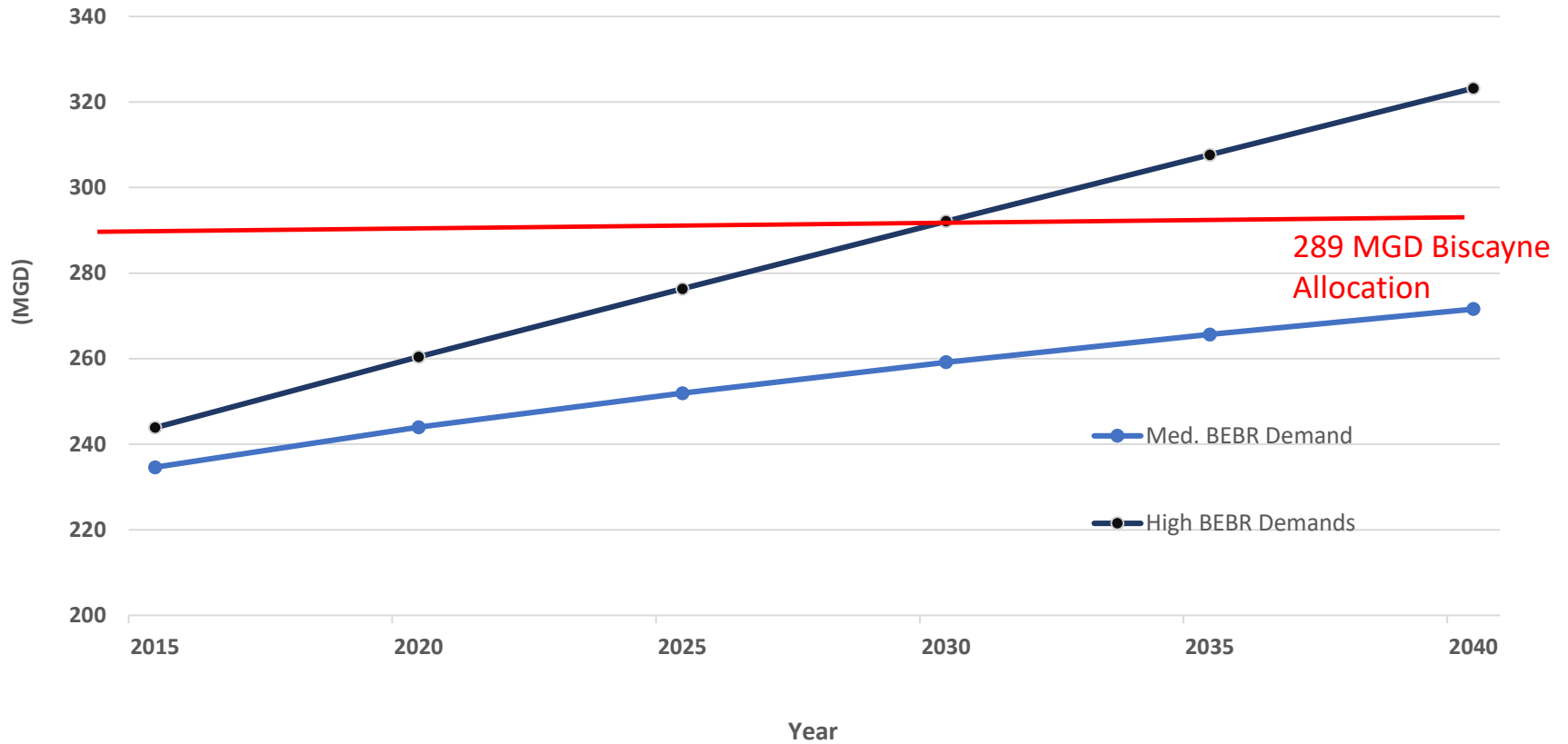
Water figures prominently in building the future resilience and sustainability of Southeast Florida. Efforts to protect drinking water supplies, prevent water pollution, and manage stormwater must continue within the context of rising sea levels. The recommendations for regional action around water derive 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.

# Long-term Growth Trends

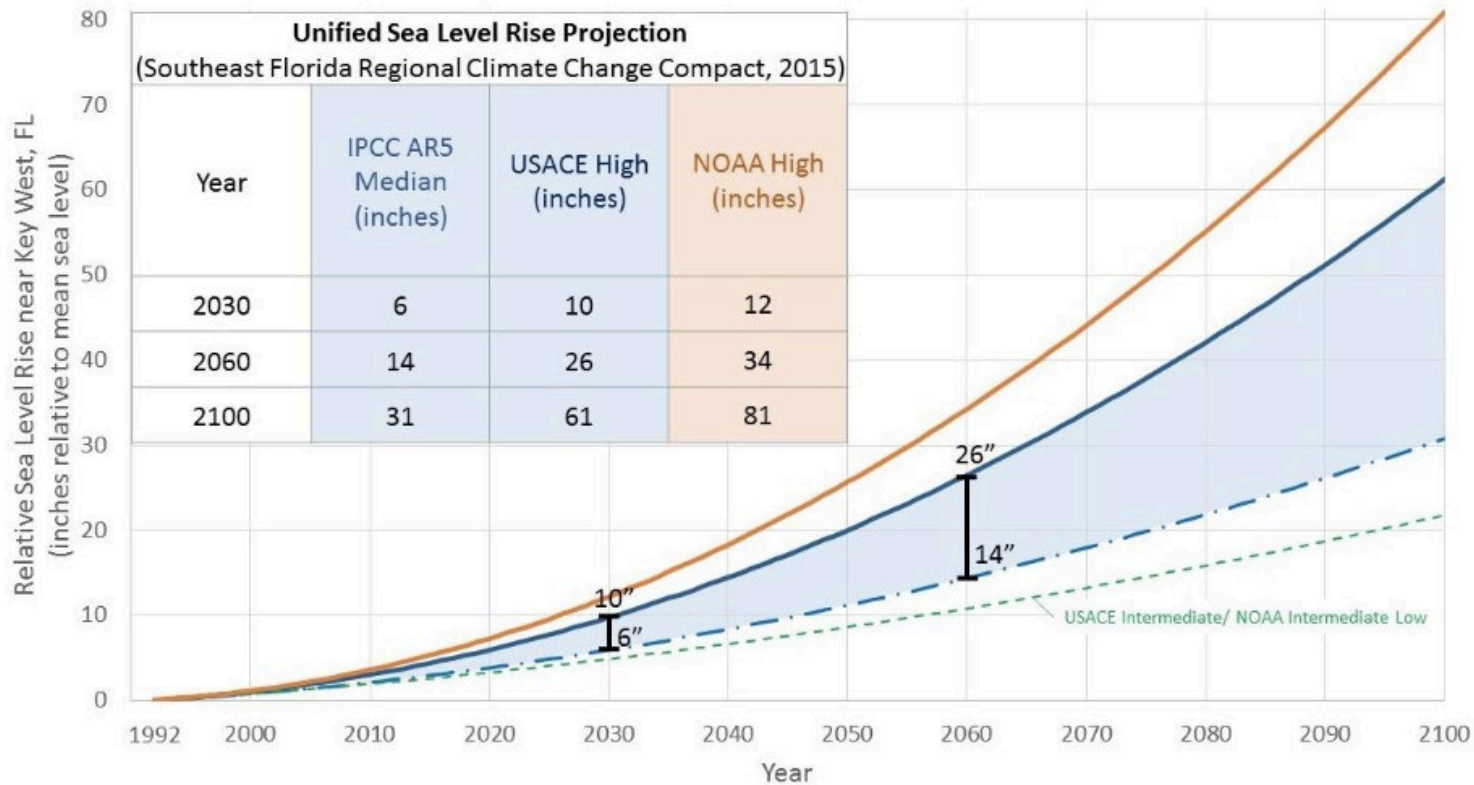
## Broward County Population Projections



# Water Demands for Med/High BEBR



# Unified Sea Level Rise Projections

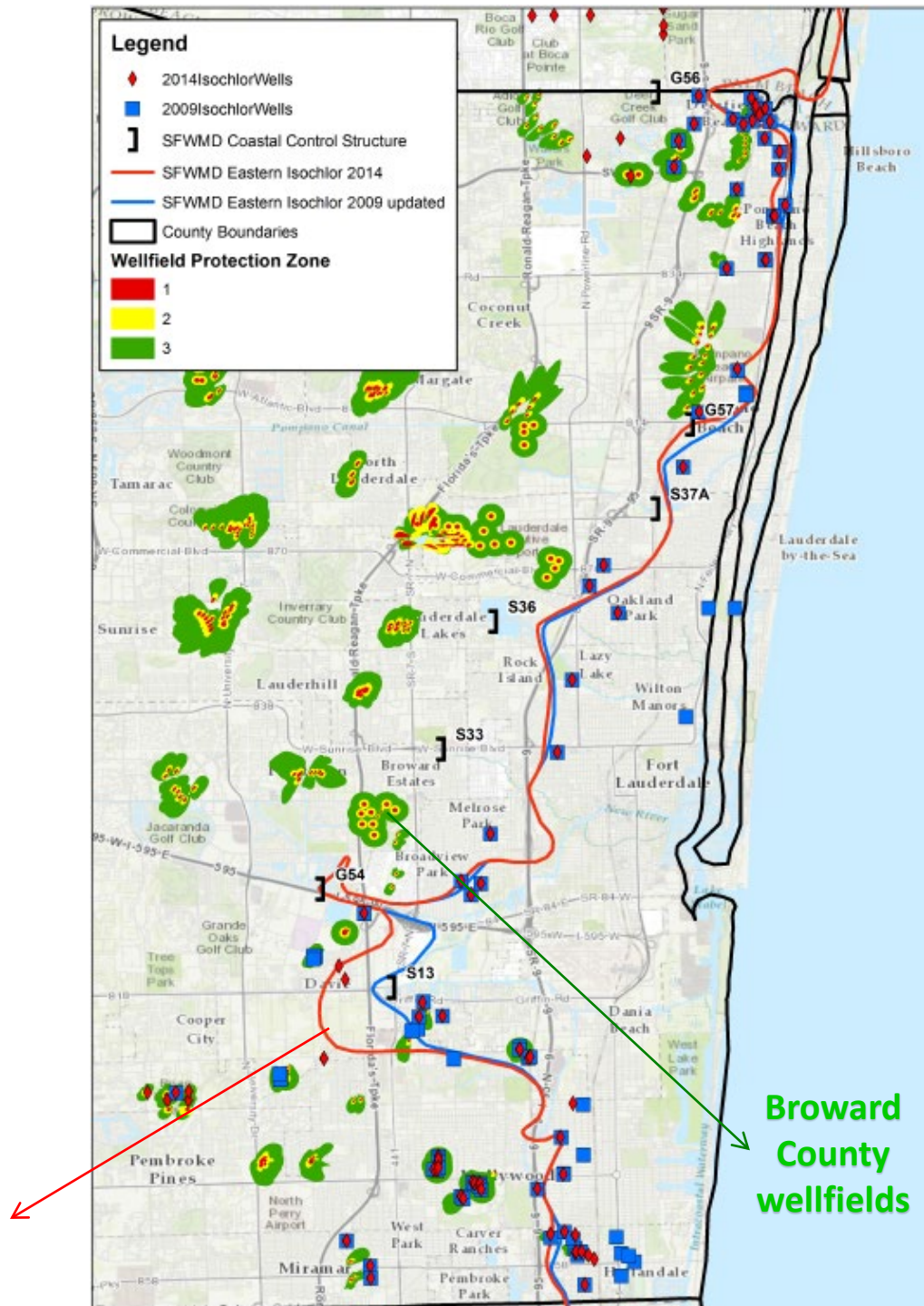


# Biscayne Wellfields Impacted by SWI

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)**



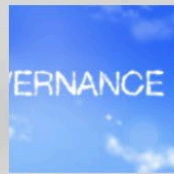
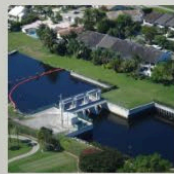
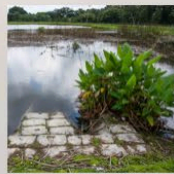
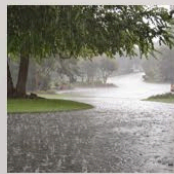
**Broward County wellfields**

# Broward's County-wide Integrated 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's County-wide Integrated Water Resource Plan (2019)

## URBAN WATER RESOURCE MANAGEMENT STRATEGIES



Conservation



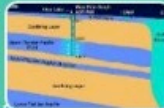
Flood Control System Enhancements and Secondary Canal Integration



Wetlands Rehydration



Stormwater Green Infrastructure



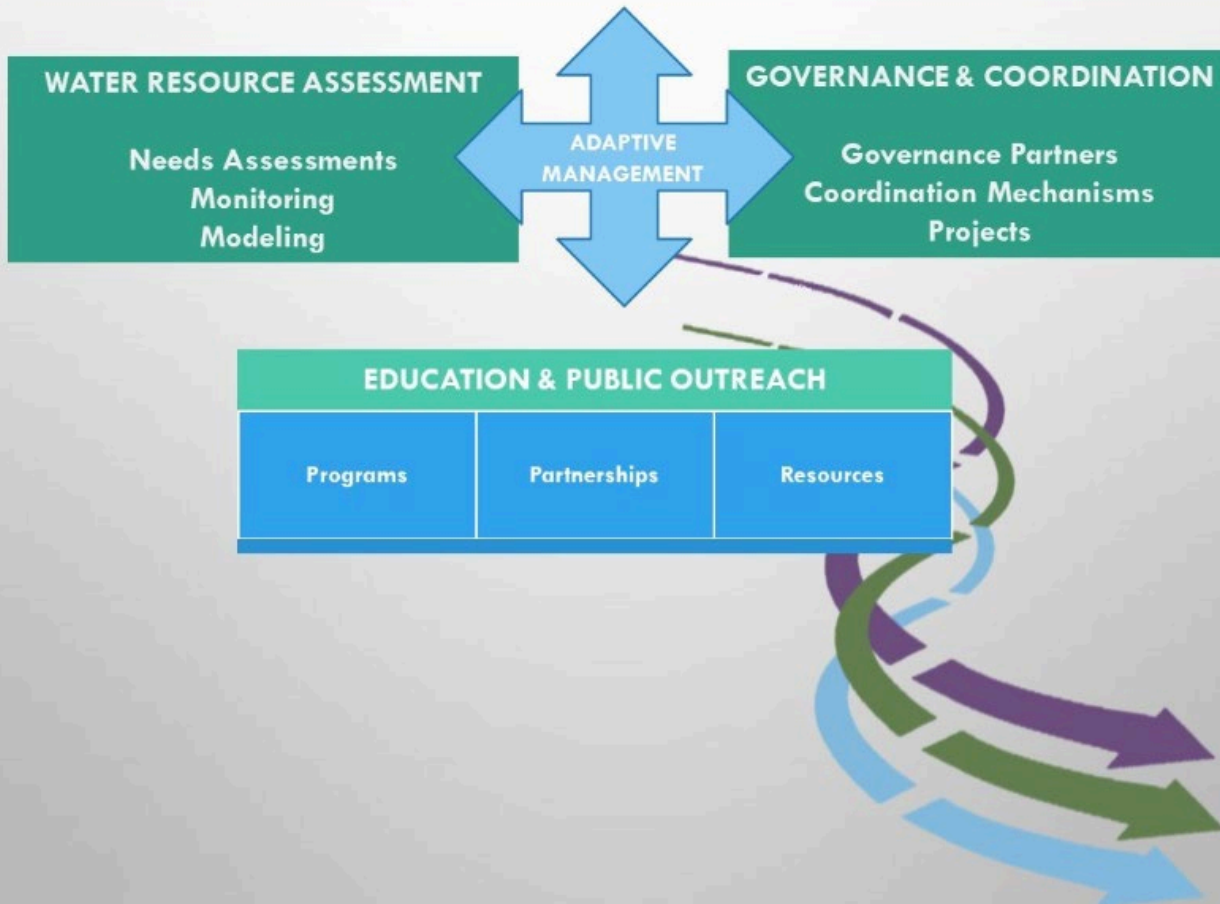
Aquifer Storage & Recovery



Utility Sharing/ C-51 Reservoir



Reuse/ Advanced Wastewater Treatment

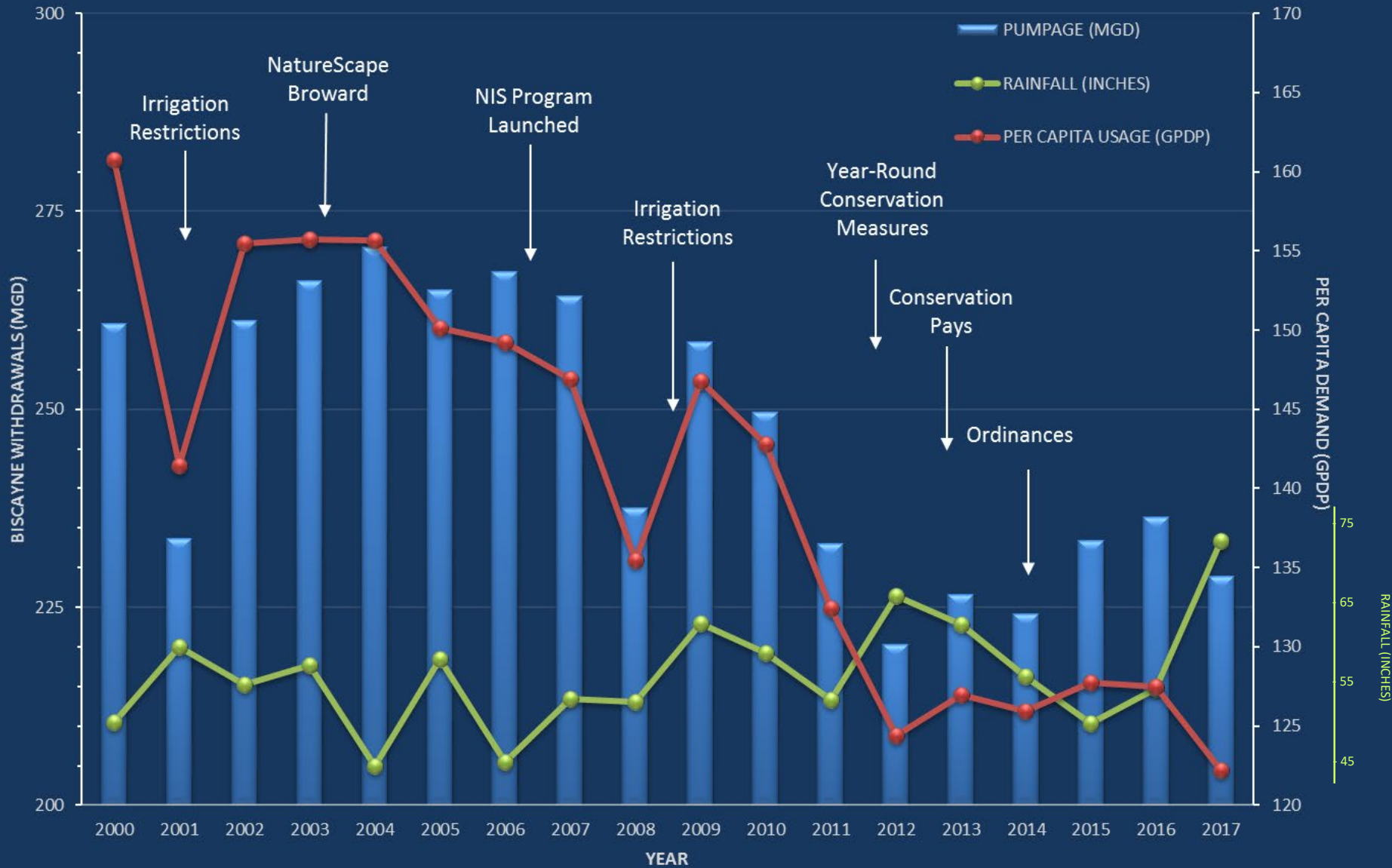




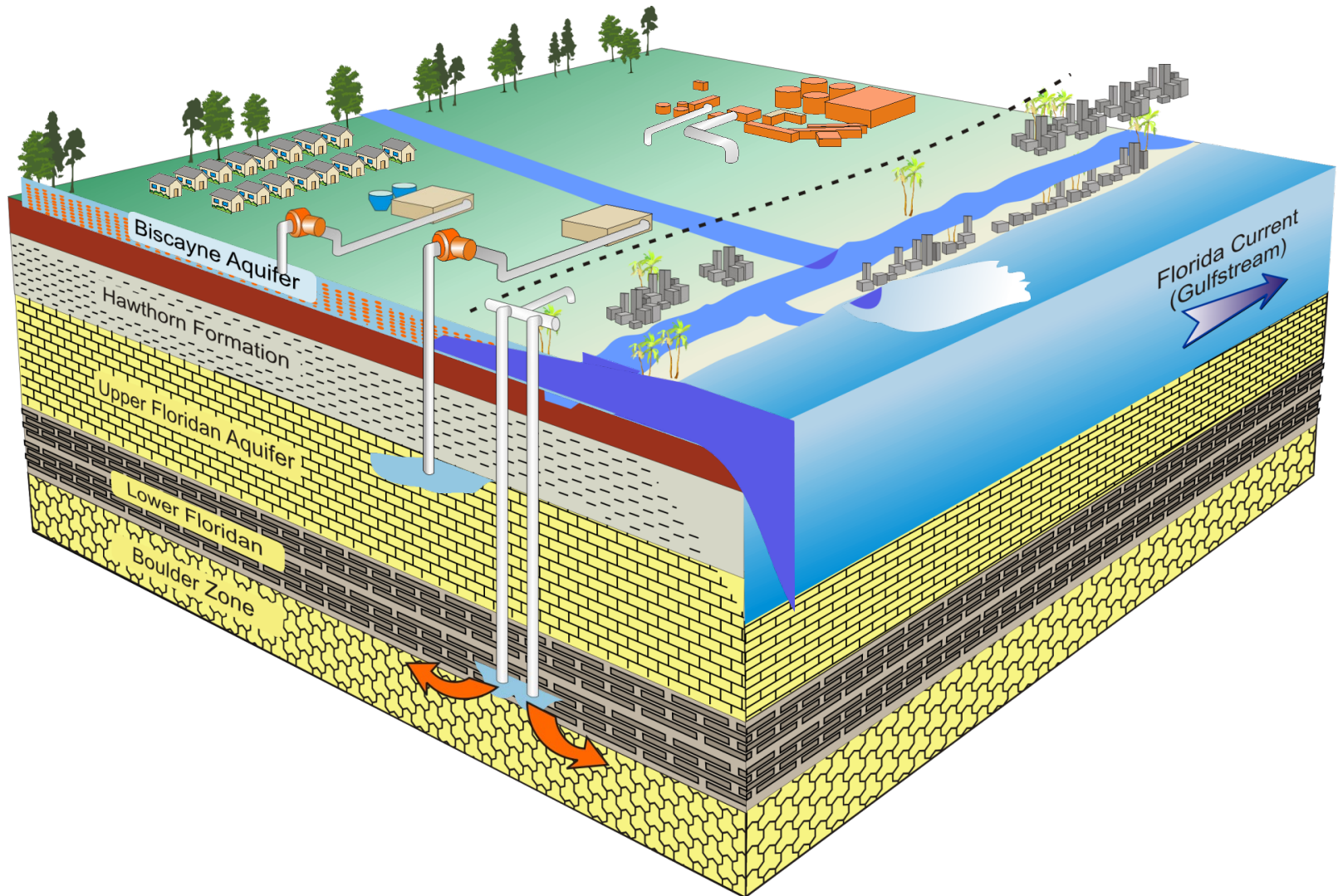
# Goals of the 2019 IWRP Report

- To make the most of our local water resources to meet longterm 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

# BROWARD COUNTY WATER USAGE



# Water Management Strategies: Beyond the Biscayne

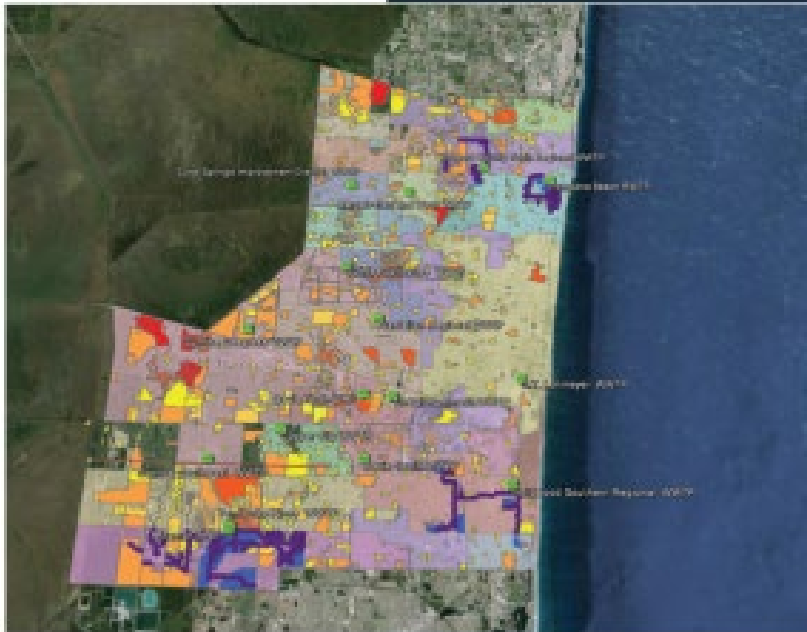


# Regional Reuse Master Plan



Regional Reuse Master Plan

January 2014



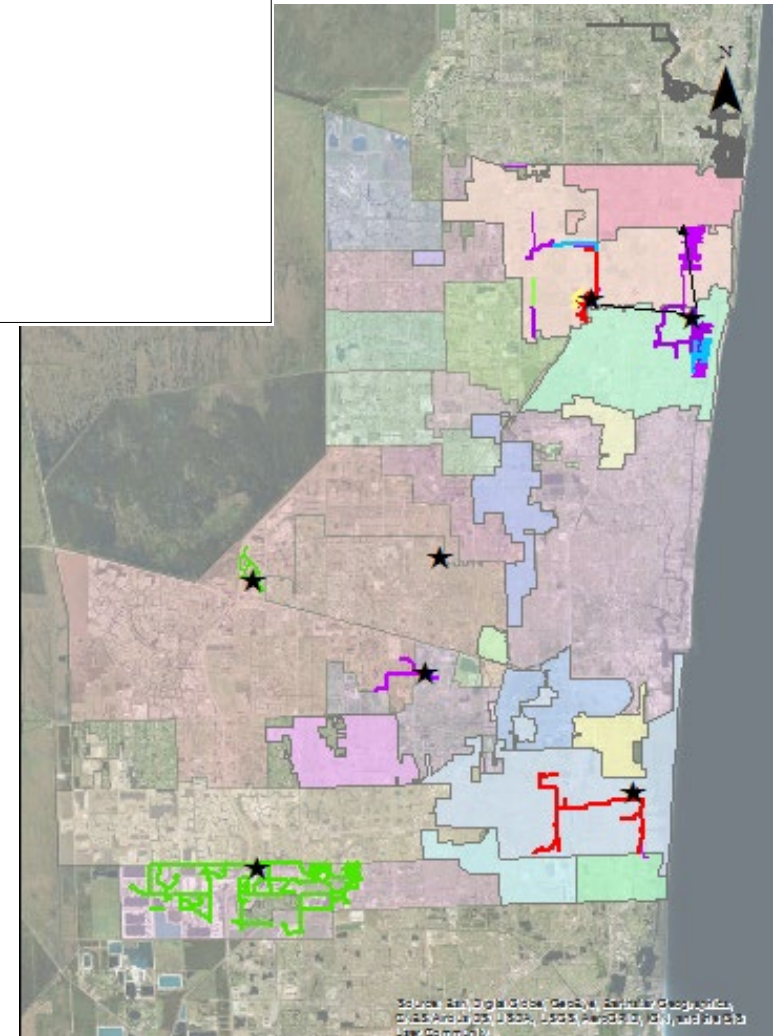
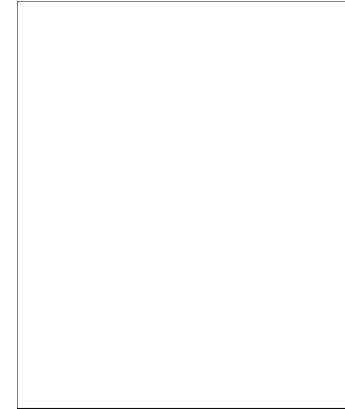
**HAZEN AND SAWYER**  
Environmental Engineers & Scientists



**CRIMEN THOMPSON & ASSOCIATES INC.**

*Federico Lamb & Associates, Inc.*

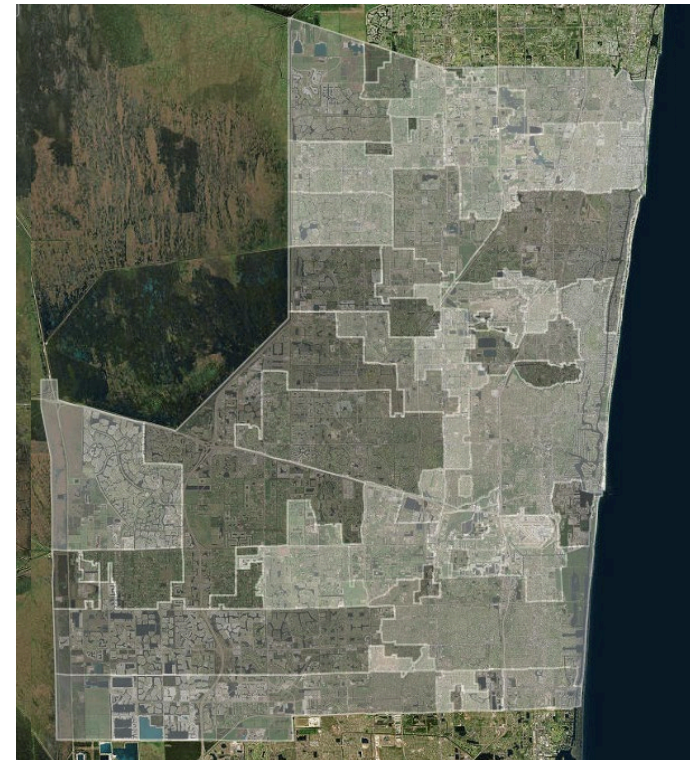
## REUSE EVOLUTION IN BROWARD



Source: San Diego Global Geospatial Geomatics, Digital Aerials of USA, USGS Floods of 1917, and Florida Law Community

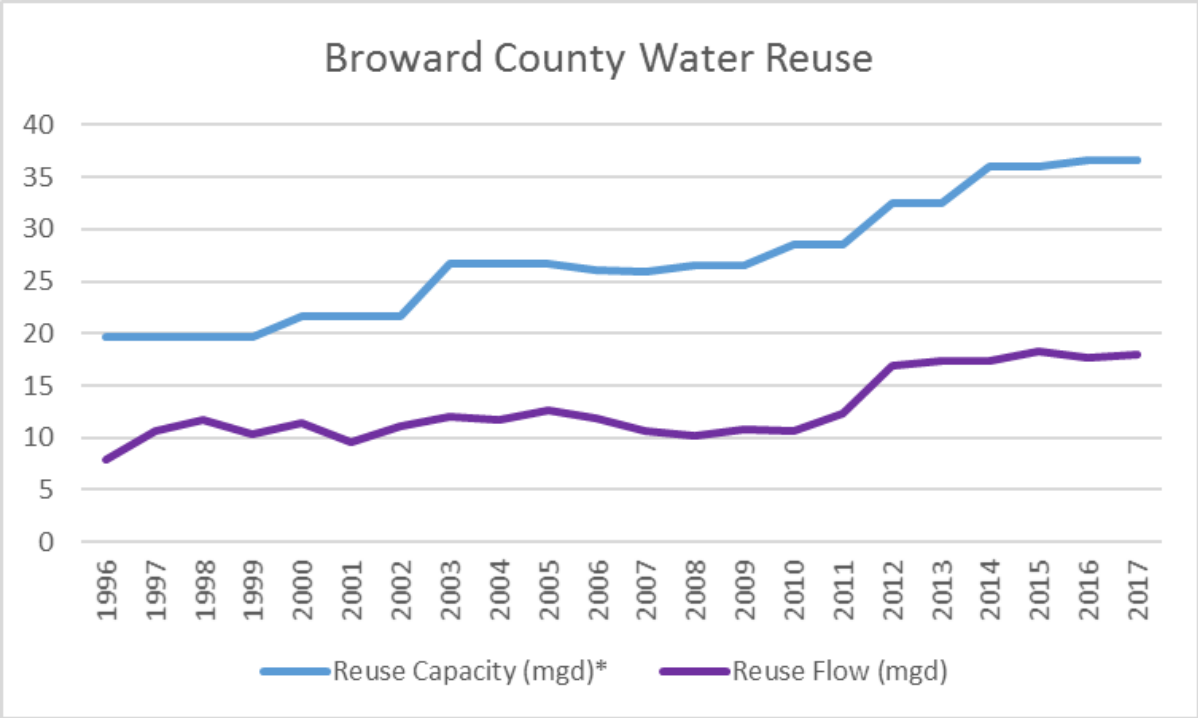
# Broward Challenges to Traditional Reclaimed Water Implementation

- 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

# Total Reuse In Broward



**Current Reuse Capacity in Broward: 36 MGD**

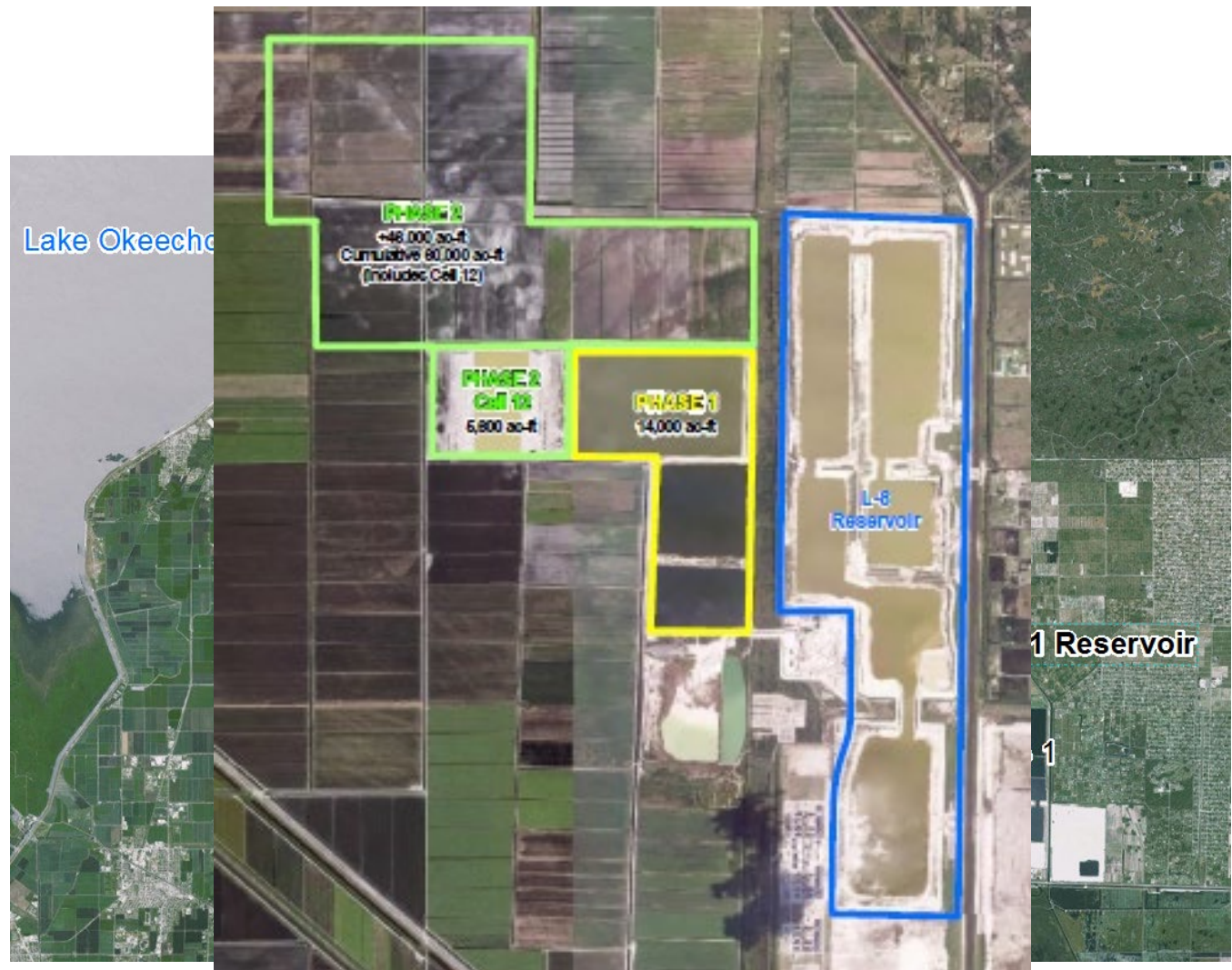
**Current Total Reuse Flows in Broward: 18 MGD**

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

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

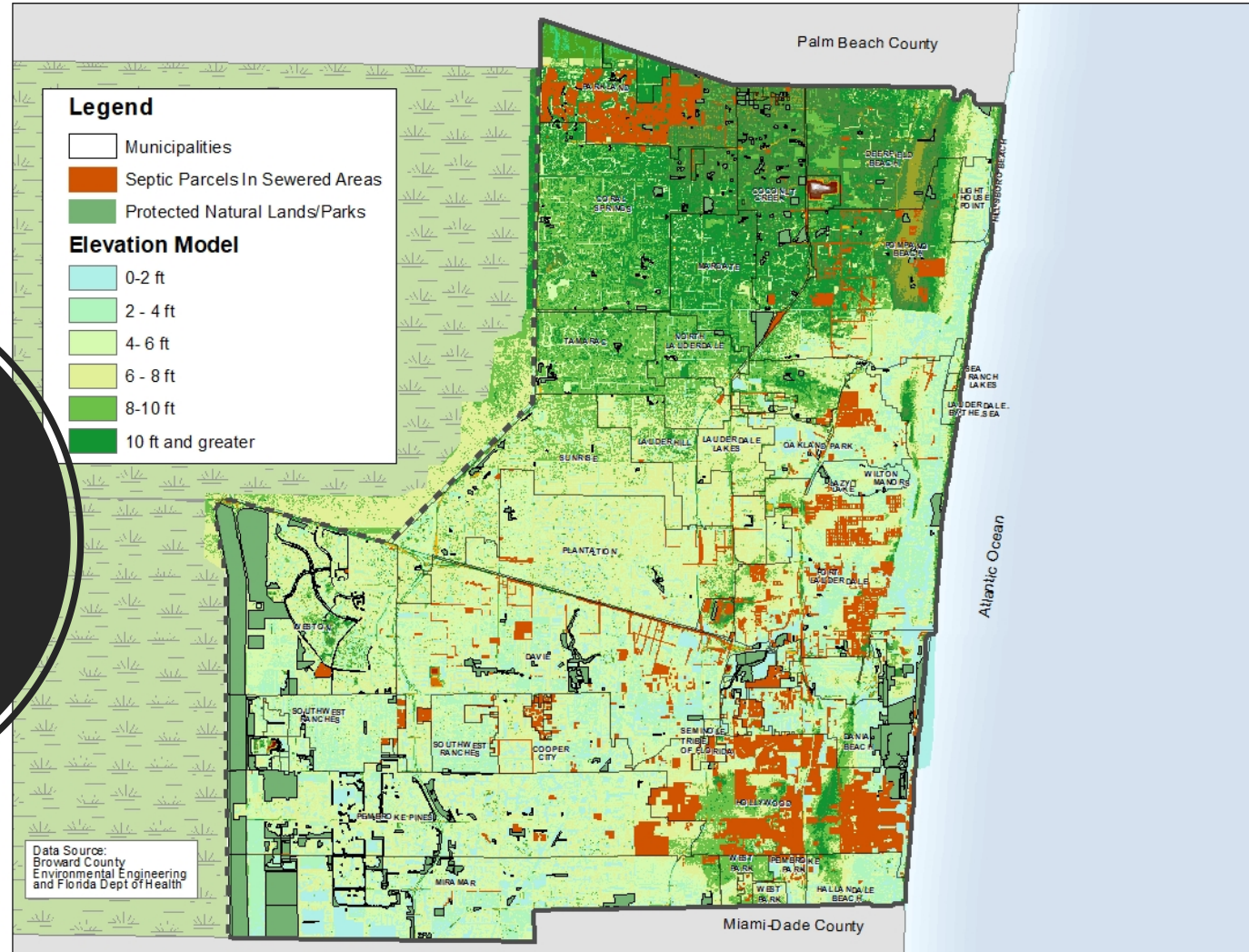
Consumptive Water Use Permit issued for WWS and Hallandale

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



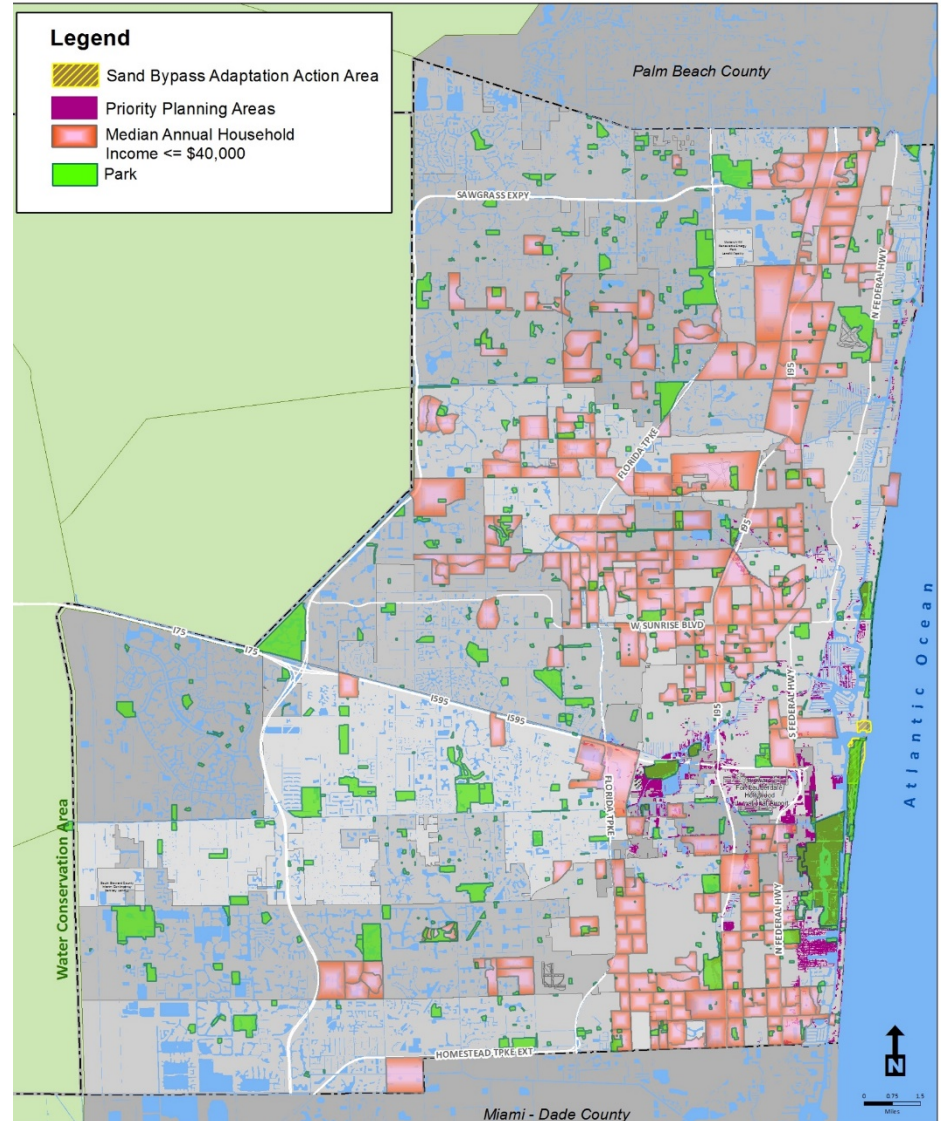
# Septic Tank Ordinance (under discussion)

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





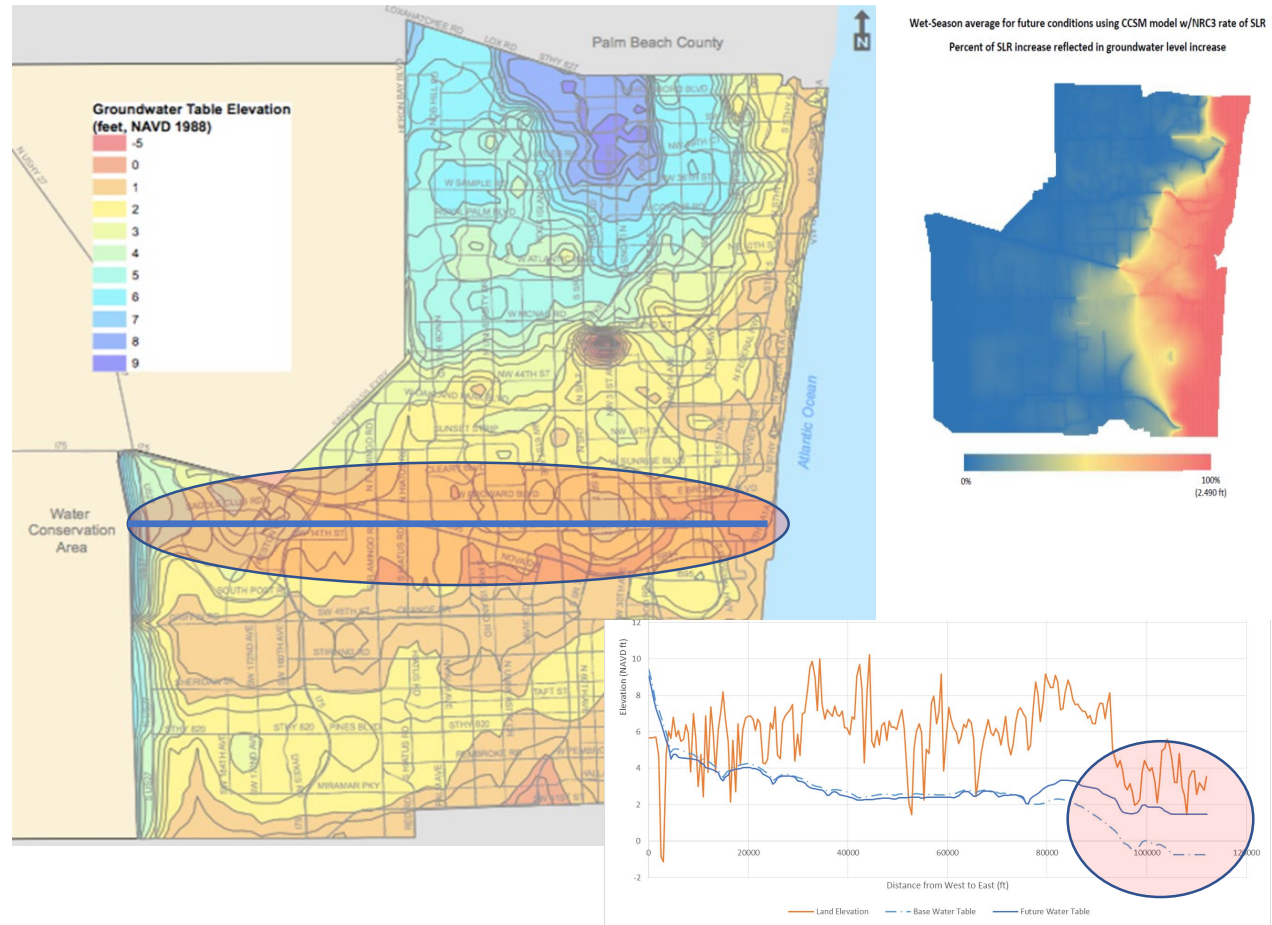
# Stormwater Green Infrastructure

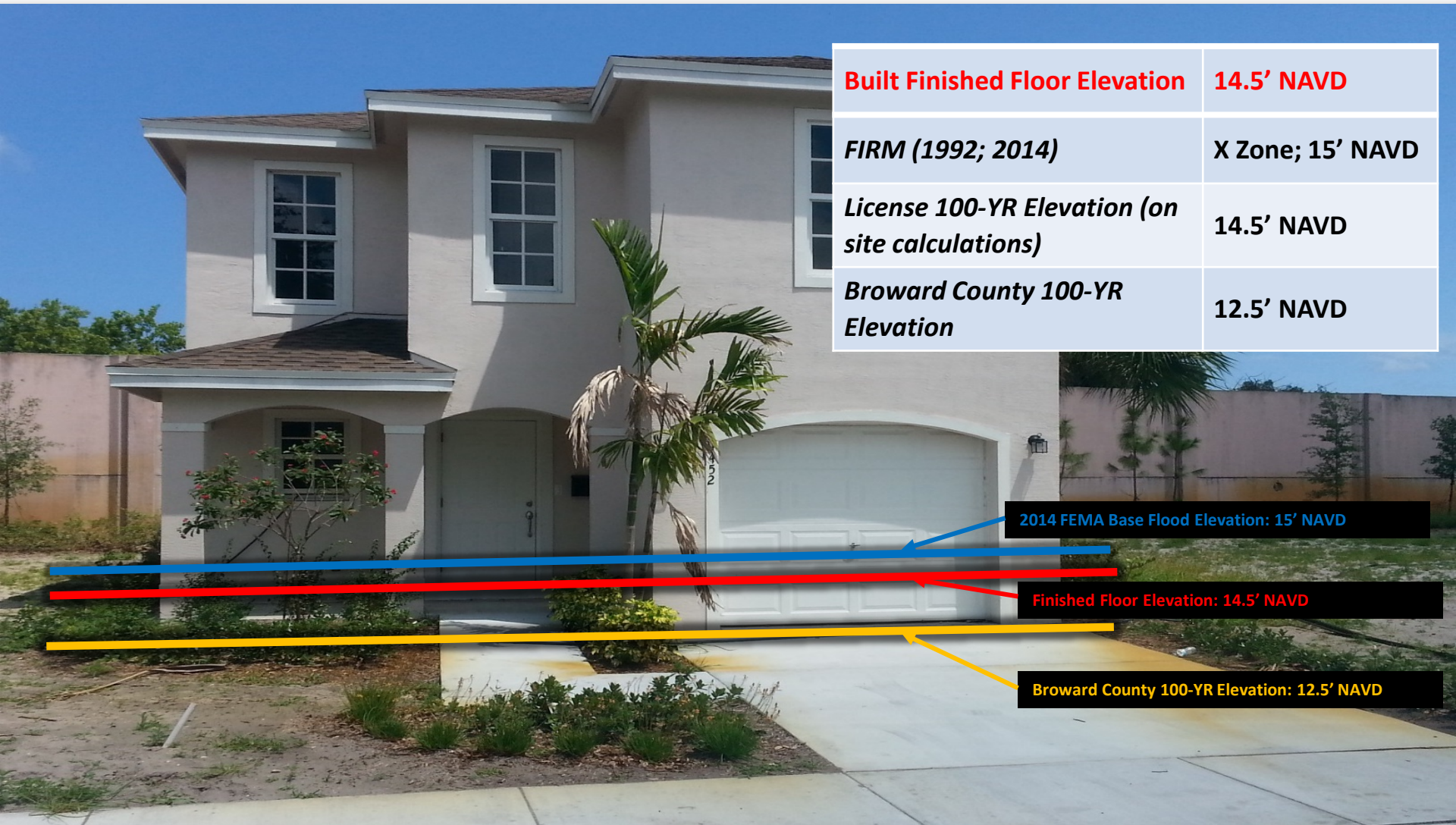


# Future Conditions Map Series

Future Average  
Wet Season  
Groundwater  
Elevation Map

Modern Design  
Standards





<b>Built Finished Floor Elevation</b>	<b>14.5' NAVD</b>
<b>FIRM (1992; 2014)</b>	<b>X Zone; 15' NAVD</b>
<b>License 100-YR Elevation (on site calculations)</b>	<b>14.5' NAVD</b>
<b>Broward County 100-YR Elevation</b>	<b>12.5' NAVD</b>

2014 FEMA Base Flood Elevation: 15' NAVD

Finished Floor Elevation: 14.5' NAVD

Broward County 100-YR Elevation: 12.5' NAVD

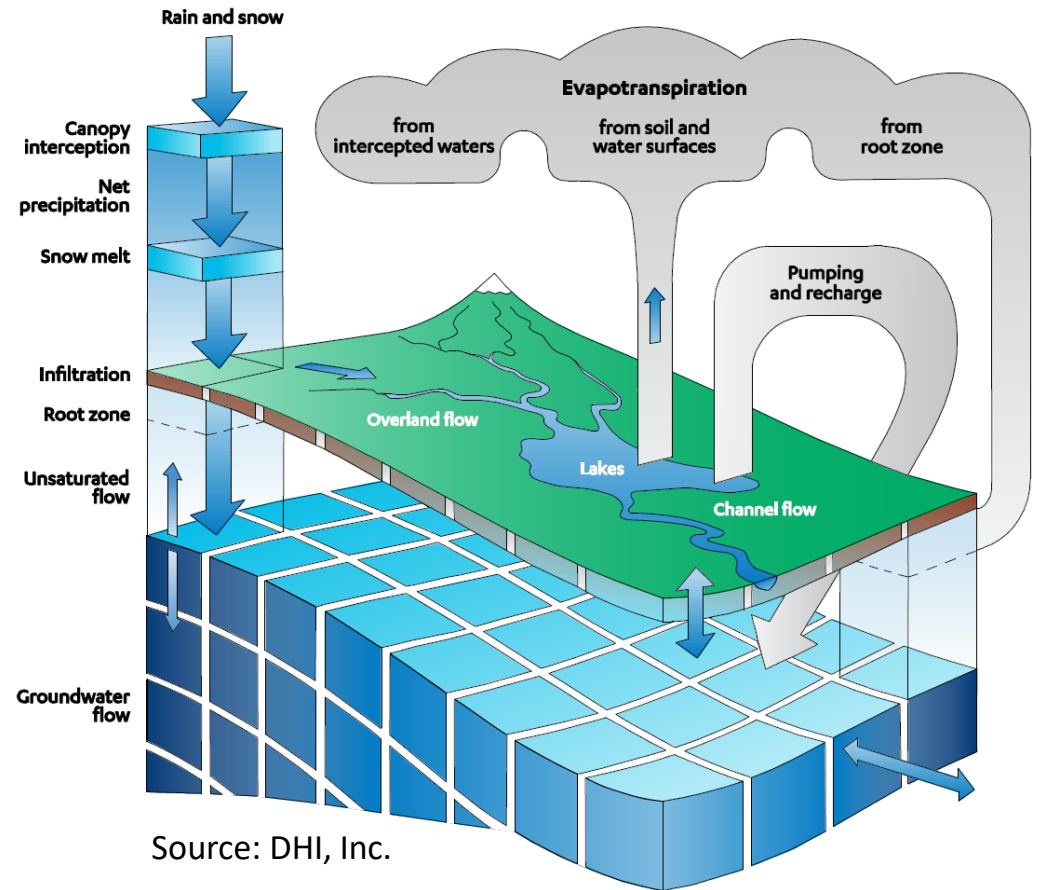
# Future Conditions Flood Elevation Map

- 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

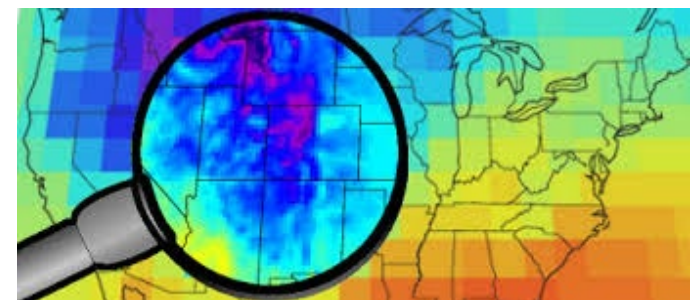
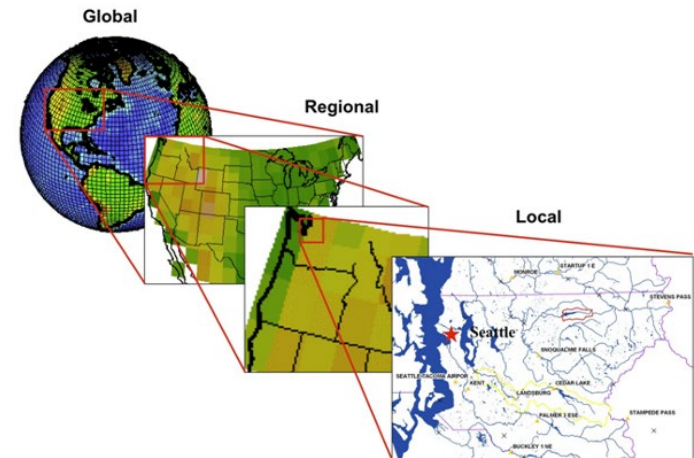
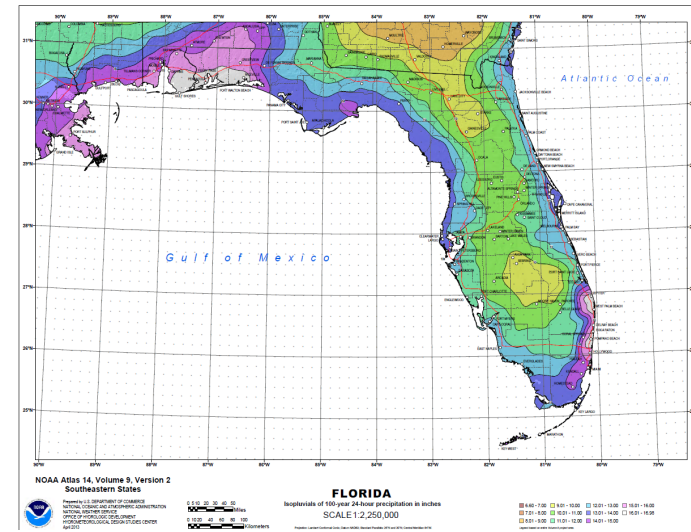
- Will enhance infrastructure resilience:

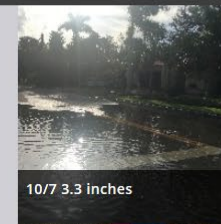
- Regulatory purpose
- Finished floor elevations, streets, sanitary manholes, etc.



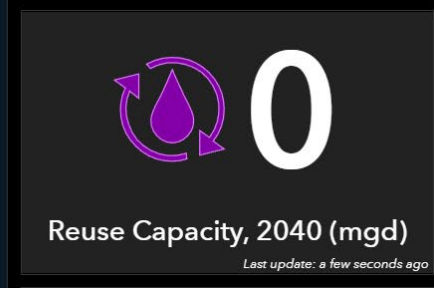
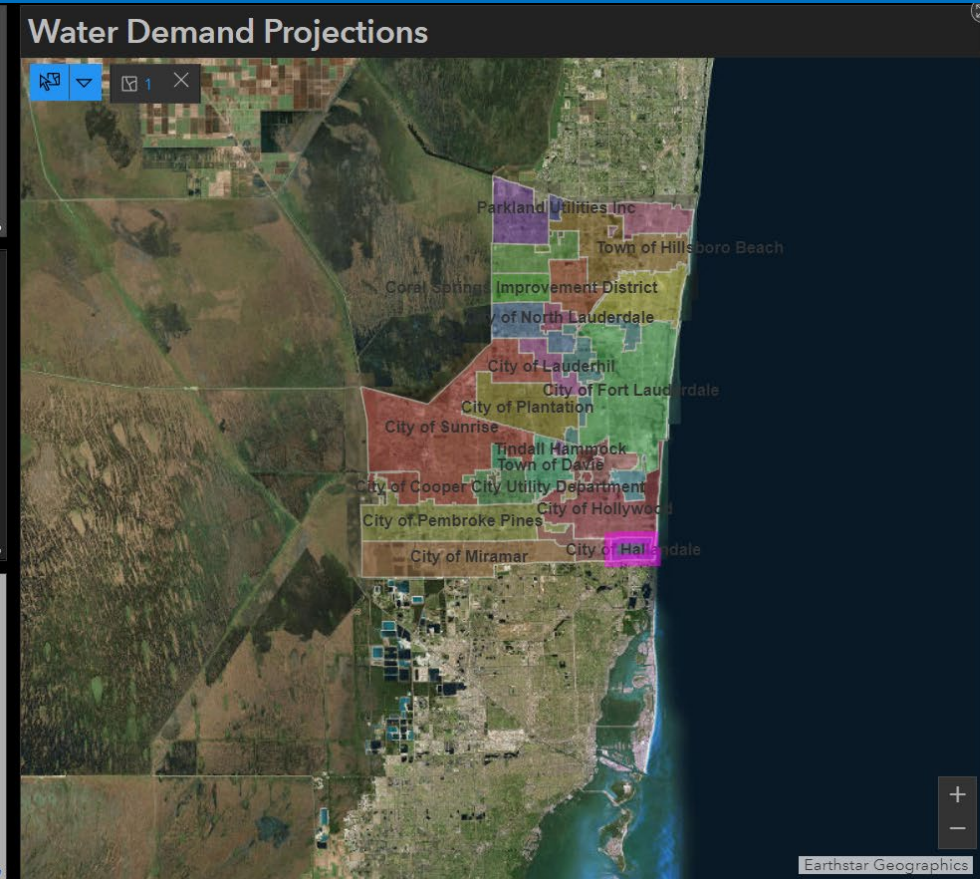
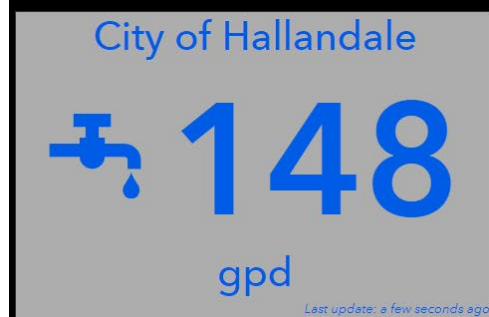
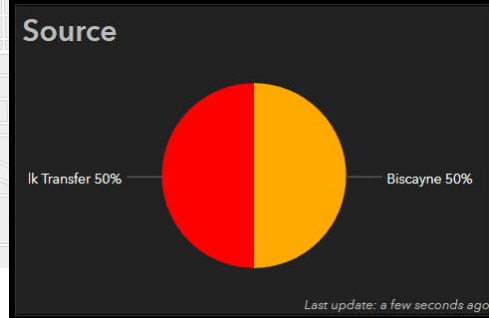
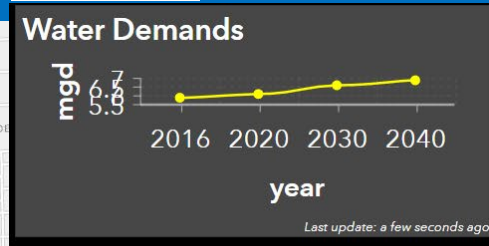
# Future Rainfall Conditions

- 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



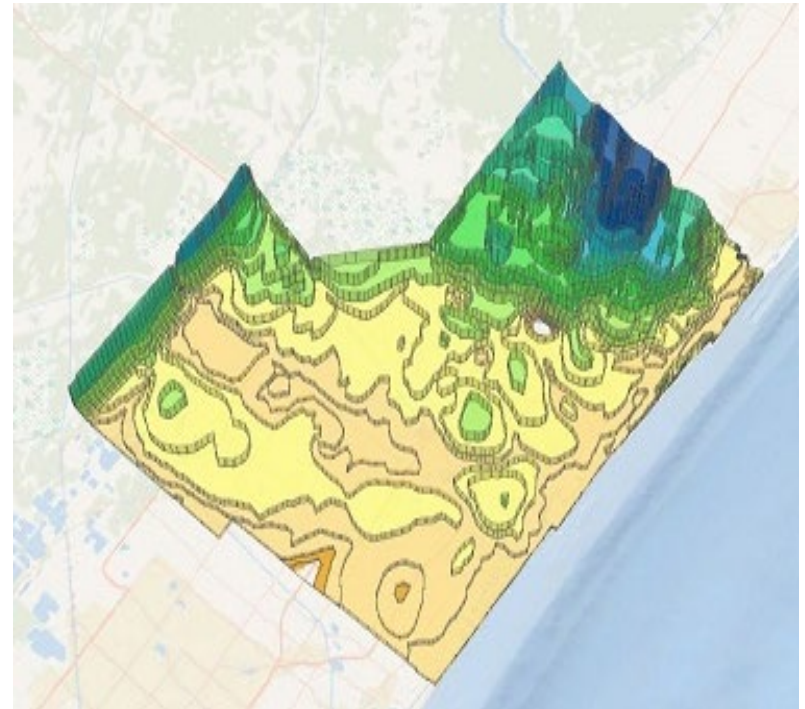


## Moving Forward to 2040 – Utilities Dashboard



# Water Resources Resilience Aspects

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



# 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



# 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
- Continued leadership

