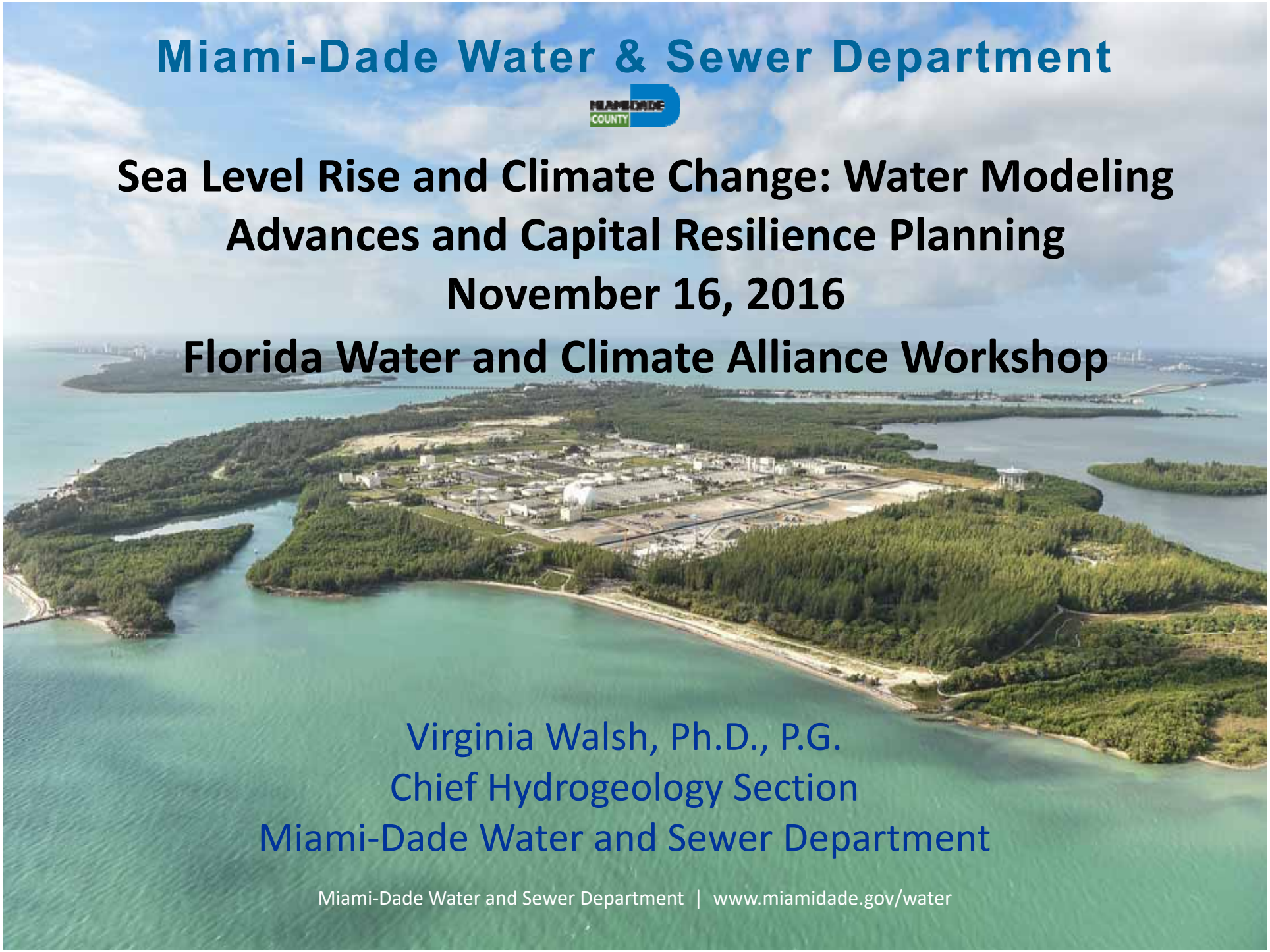


Miami-Dade Water & Sewer Department

Sea Level Rise and Climate Change: Water Modeling Advances and Capital Resilience Planning

November 16, 2016

Florida Water and Climate Alliance Workshop

Virginia Walsh, Ph.D., P.G.
Chief Hydrogeology Section
Miami-Dade Water and Sewer Department

Miami-Dade Water and Sewer Department (WASD)

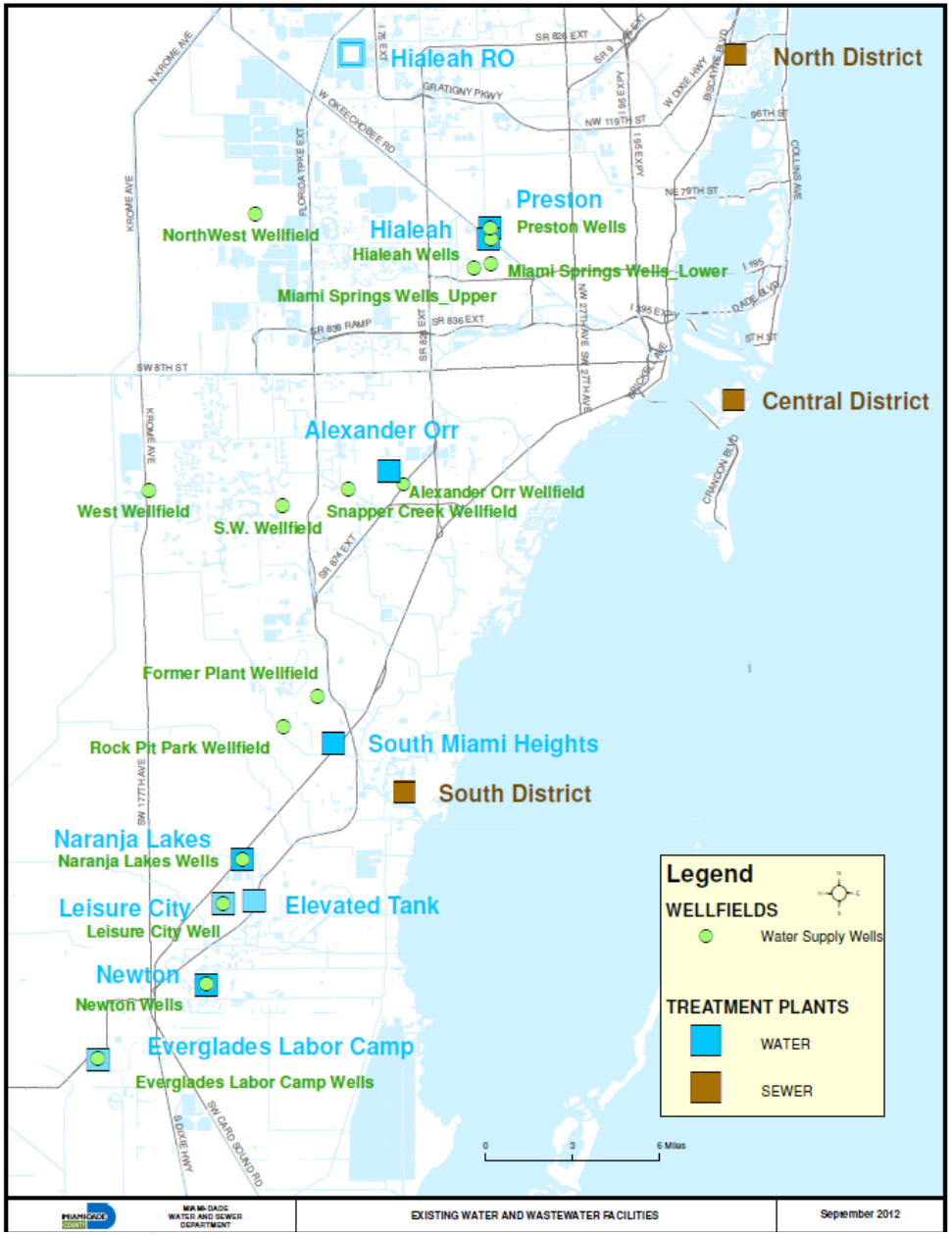
- Largest Water & Sewer Utility in the Southeastern United States
- Serving more than 2.3 million residents
- FY2015-2016 Budget:
  - Projected Revenues $732 Million
  - $13.5 Billion Multi-Year Capital Plan (FY16-21)
  - 2626 Total Budgeted Positions

Miami-Dade Water and Sewer Department (WASD) Overview

- Largest water and sewer utility in Florida, serving more than 2.2 million residents
- Water System:
  - 3 large regional and 5 small water treatment plants
  - Supplying an average of 304 million gallons per day
  - 90% of the County's public water supply
  - Per capita water use 137 gpcd
  - 100 water supply wells
    - Biscayne Aquifer
    - Floridan Aquifer
    - Aquifer Storage and Recovery
  - 7,918 miles of pipes
  - 38,381 fire hydrants
  - 126,913 valves

WASD Overview

- **<u>Wastewater System</u>**:
  - 3 wastewater treatment plants
  - 2 ocean outfalls (3 and 7 miles from coast) and 21 deep injection wells (~2,500 ft depth)
  - Collecting, treating, and disposing 316 MGD
  - 6,292 miles of mains and laterals
  - 1,042 sewer pumps stations (operated)
  - Reusing 10.2 MGD



Miami-Dade Water and Sewer Department Water & Wastewater Treatment Facilities

Miami-Dade County entered into a Joint Funding Agreement (JFA) with the USGS in February 2008 in response to the South Florida Water Management District 20-Year Water Use Permit (WUP)

U.S. Geological Survey
United States
Department of the Interior

USGS Point of Contact

Name: Jean Happel
Address: 3110 S. W. 9th Avenue
Ft. Lauderdale, FL 33315
DUNS #: 137784026
Telephone: 954.377.5932
Email: jhappel@usgs.gov

Signatures

By _____ Date 12/04/07
Name: Dr. Barry Rosen
Title: FISC Director

By _____ Date _____
Name:
Title:

MIAMI-DADE COUNTY

Customer Point of Contact

Name: Virginia Walsh, P.G.
Address: 3071 S. W. 38th Avenue
Room 554-10
Miami, FL 33146
Telephone: 786.552.8266
Email: WALSHV@miamidade.gov

Signatures

By _____ Date _____

By _____ Date 2/26/2008
Deputy Clerk

One of the objectives of the model is to evaluation of sea level rise (SLR):

An Integrated Model of Surface and Groundwater Flow for Evaluating the Effects of Competing Water Demands in Miami-Dade County
A Proposal Prepared by the U.S. Geological Survey
November 29, 2007
Problem Statement

1.How much impact do well-fields have on surface and groundwater flows to Biscayne Bay?
2.What areas recharge the municipal well fields?
3.Do canal management practices or well-field withdrawals increase water losses from Everglades National Park?
4.Could the Biscayne aquifer be better managed by changing well-field operation or canal management practices?
5.Where are the most effective locations to apply reuse water?

6.Will sea-level rise cause saltwater intrusion into coastal well fields?

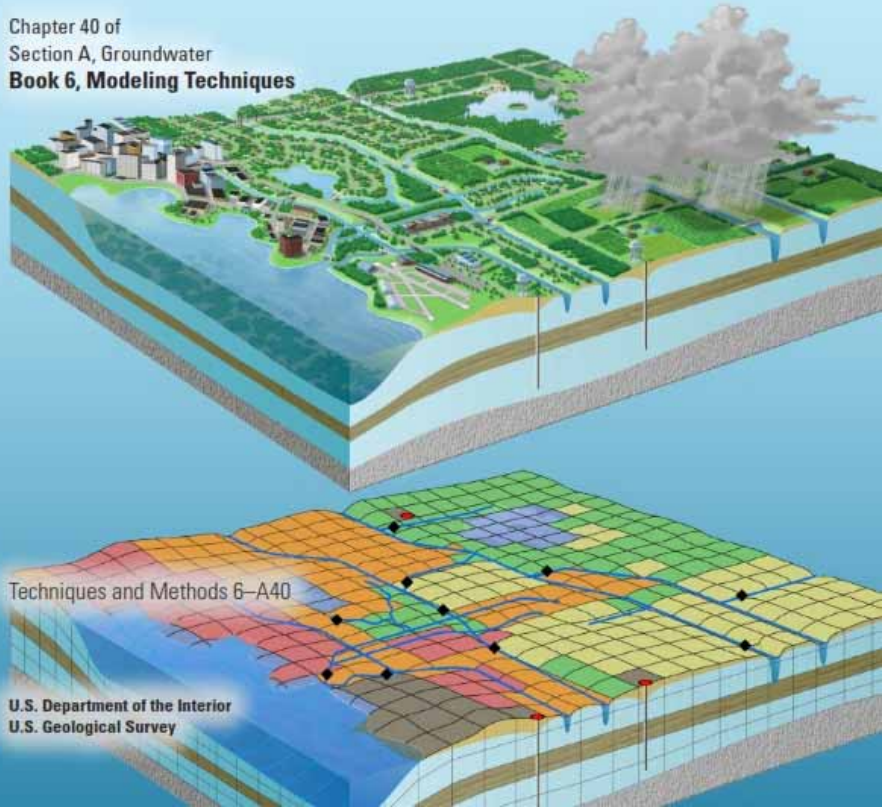
7.Can well-field operation be optimized to meet hydrologic constraints, such as those mandated for the Northwest Wellfield?
8.What are the impacts of lake excavations on area wide groundwater flows and saltwater intrusion?
9.What are the impacts to the groundwater flow regime if lakes are filled?

USGS
science for a changing world

Prepared in cooperation with the Miami-Dade Water and Sewer Department

Documentation of the Surface-Water Routing (SWR1) Process for Modeling Surface-Water Flow with the U.S. Geological Survey Modular Groundwater Model (MODFLOW–2005)

Chapter 40 of
Section A, Groundwater
Book 6, Modeling Techniques



Techniques and Methods 6–A40

U.S. Department of the Interior
U.S. Geological Survey

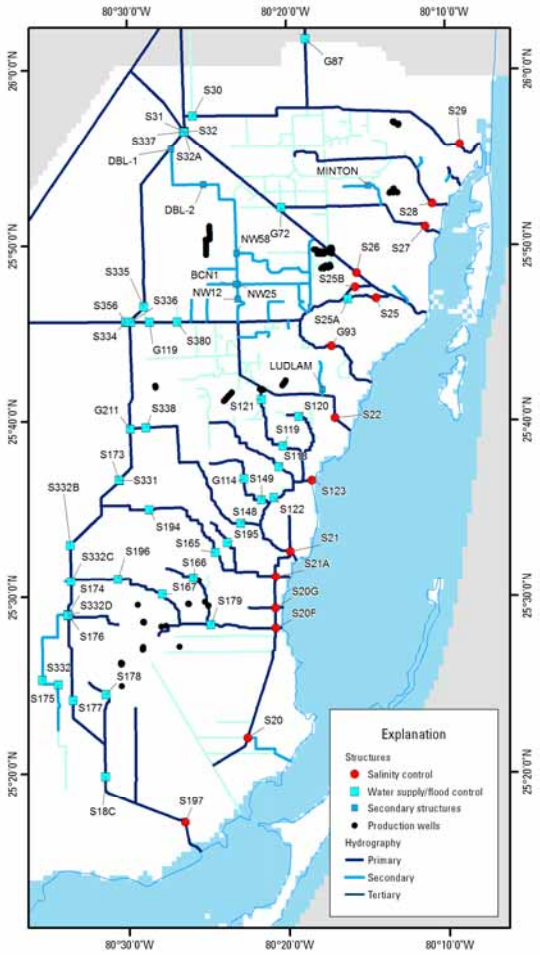
USGS
science for a changing world

Prepared in cooperation with the Miami-Dade Water and Sewer Department

Hydrologic Conditions in Urban Miami-Dade County, Florida, and the Effect of Groundwater Pumpage and Increased Sea Level on Canal Leakage and Regional Groundwater Flow

Scientific Investigations Report 2014–5162

U.S. Department of the Interior
U.S. Geological Survey

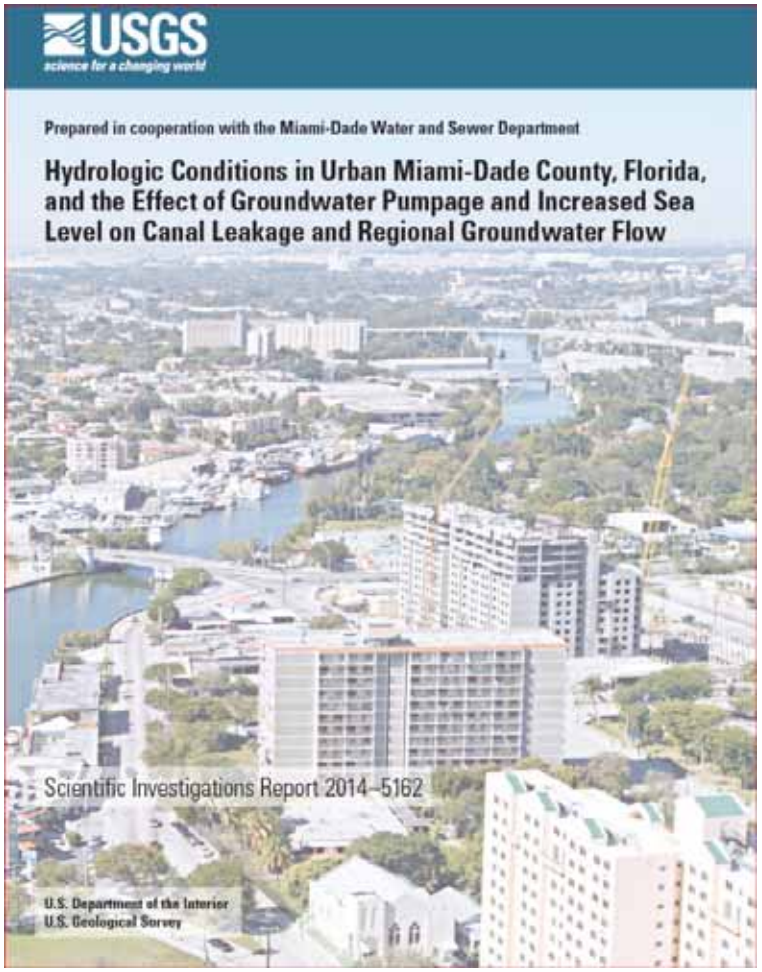


Surface-water system Managed system used to control urban flooding

supply recharge to municipal well fields
control saltwater intrusion

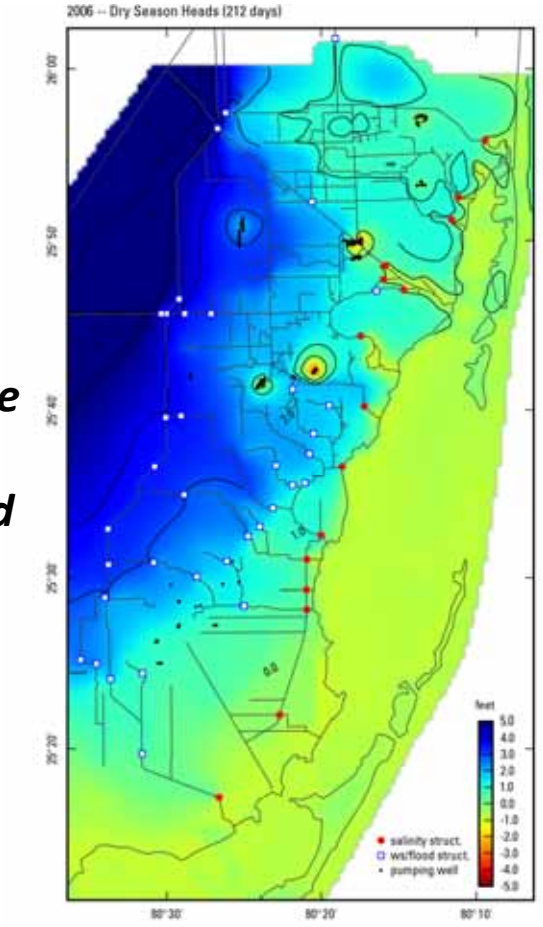
66 operable primary and secondary Canal surface water control structures

•Time-varying surface water component (SWR1 Process)
•2,352 discretized reaches and 637 reach groups
•1,009 unique trapezoidal cross sections
•61 primary and 12 secondary canal surface-water structures using specified gate opening data
•Everglades Depth Estimation Network (EDEN) data used to define upstream stage in C-304 and L-29 canal in WCA3B
•Virginia Key tidal data used to define downstream stage for all canals connected to Biscayne Bay



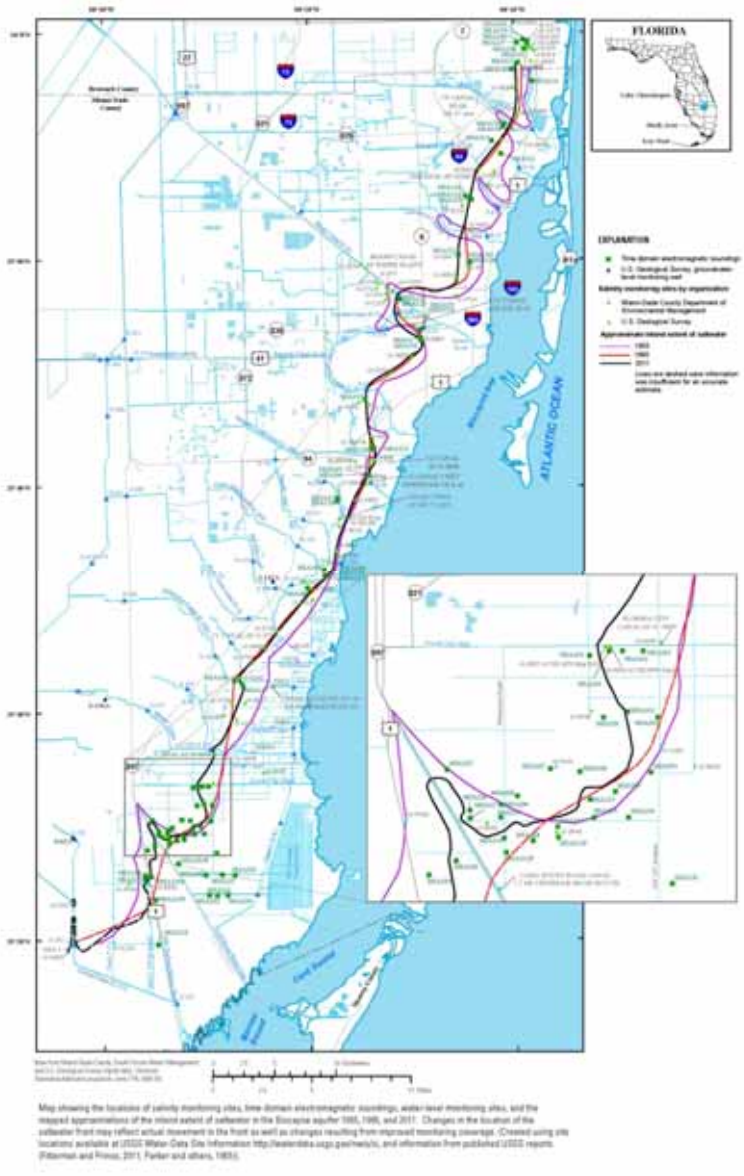
http://pubs.er.usgs.gov/publication/sir20145162

Scientifically defensible at this point in time with available SLR and climate change data available

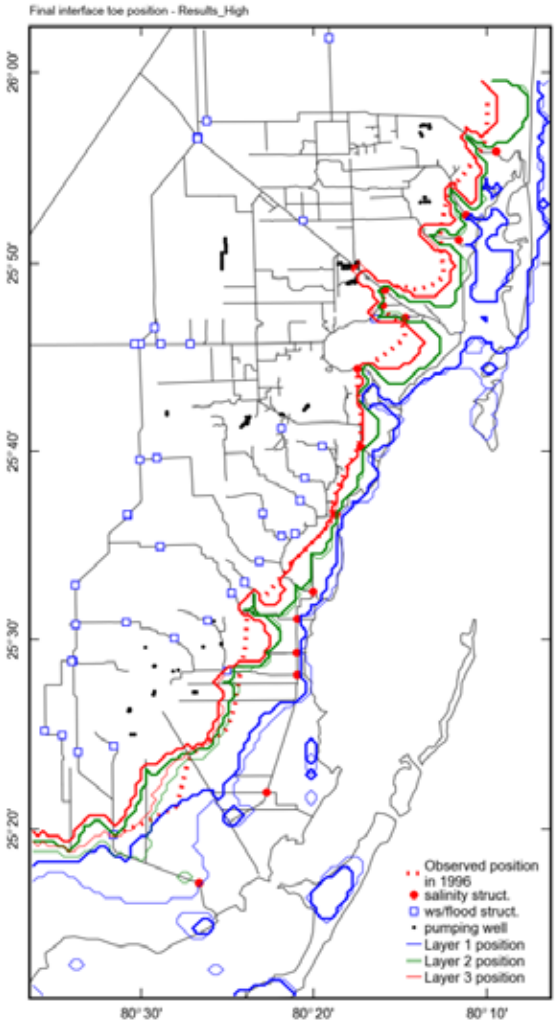


•Simulation period from 1/1/1996 to 12/31/2010

- **30-year scenario simulation period representing conditions from 2011 through 2040**
  - **NRC III rate of 1.23 ft increase over 30 years**
  - **Assumed current climatic conditions**



Miami-Dade County in Cooperation with the US Geological Survey has one of the most technically advanced monitoring network for Salt Water Intrusion in the World



Model result 2040 end of Dry Season – Scenario 2

Hazen and Sawyer

Miami Springs Wellfield:

integrating science into operations

EDP SPECIAL REQUEST SCOPE
EDP-WS-SR-211
Hazen and Sawyer, P.C.

Background

The Miami Dade Water and Sewer Department (MDWASD) operates the Preston and Hialeah Water Treatment Plants (WTP) which process raw water from the Biscayne Aquifer. These facilities utilize lime softening processes to remove hardness present in the raw water prior to recarbonation, filtration, disinfection, air stripping, and finished water storage. The Preston and Hialeah WTPs were constructed in 1968 and 1924, respectively, with several upgrades and expansions since initial commissioning. Given their age, condition and level of treatment, both plants have been considered candidates for process upgrades and redesign in recent years. Several other facilities also currently supply the MDWASD system including the Orr WTP, Hialeah LLP WTP, and several smaller "Pump and Treat" systems in the southern portion of the service area. A new plant, the South Miami Heights WTP, is also in the final stages of design. This interconnected treatment system provides approximately 300 mgd to the system on an average daily basis.

Purpose

The purpose of this Task Authorization is for Hazen and Sawyer, P.C. (ENGINEER) to evaluate the specific repair, replacement and process upgrades needs of the Preston and Hialeah WTPs to achieve compliance with potential future regulatory requirements. These requirements include the possibility of the wellfields being declared groundwaters under the direct influence of surface water (GWUDI). This task authorization also includes a review of the specific need for the new Northwest Wellfield Water Treatment (NWWWTP).

Scope

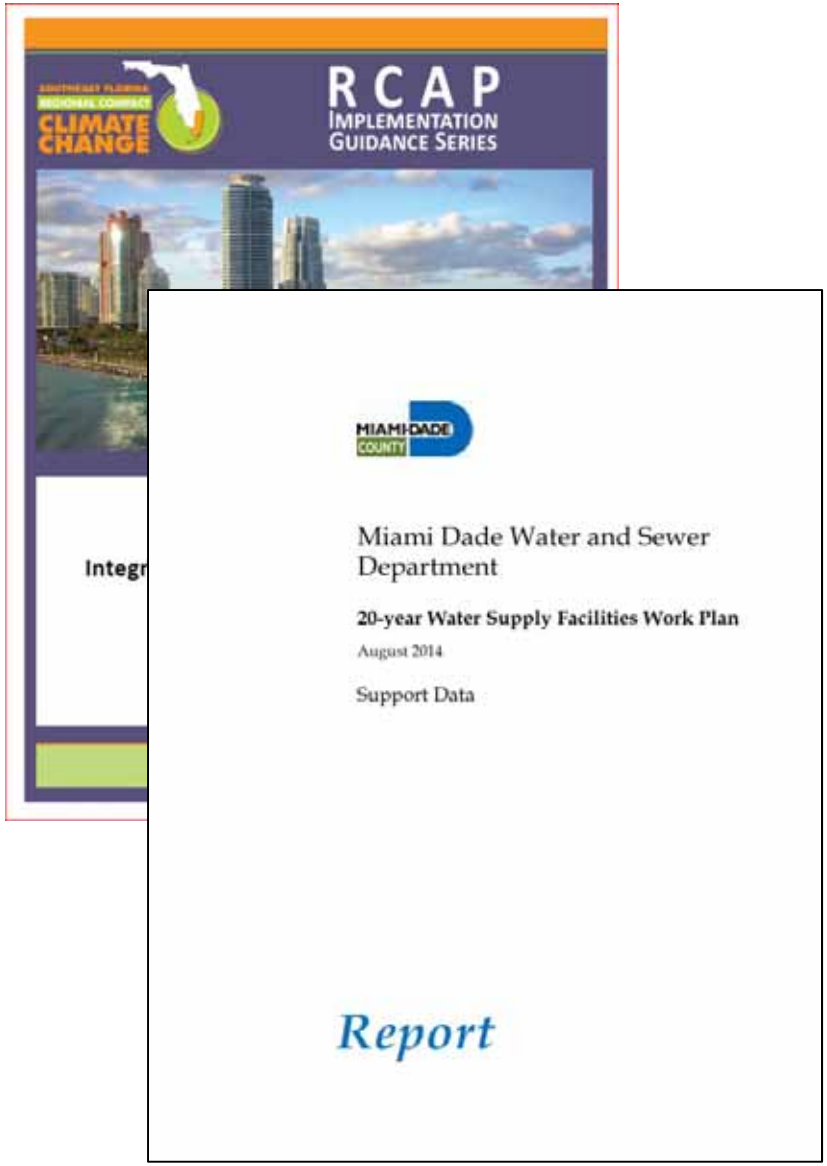
Task 1 – Data collection and Document Review

Task 6 – Analysis of Potential Hydrogeochemical Impacts on Preston and Hialeah WTP Wellfields

ENGINEER will perform an analysis of USGS Urban Miami-Dade County Surface/Groundwater Model future scenario results for salt water intrusion and groundwater elevation changes (up to 30 years in future and NRC III SLR). This analysis will consider existing and future water treatment requirements along with wellfield operations for Hialeah/Preston with respect to USGS model results.

MDWASD will provide the USGS model files and associated software (to be published in Sept). The intent is to take the model results and apply them to the operational conditions in wellfield and at th water treatment plants in this study. The objective is to determine the need to modify the model to best establish operational planning. Results of the model analysis will be used to determine effectiveness of existing water treatment plants process and when system will require upgrades for degrading water quality. Results will also be used to estimate how long Miami Springs and Plant-site wellfields will pump fresh water (i.e., less than 500 mg/L TDS). Potential flooding impacts on water quality and operations will be considered as well.

Deliverable: Technical Memorandum presenting findings, conclusions and recommendations.



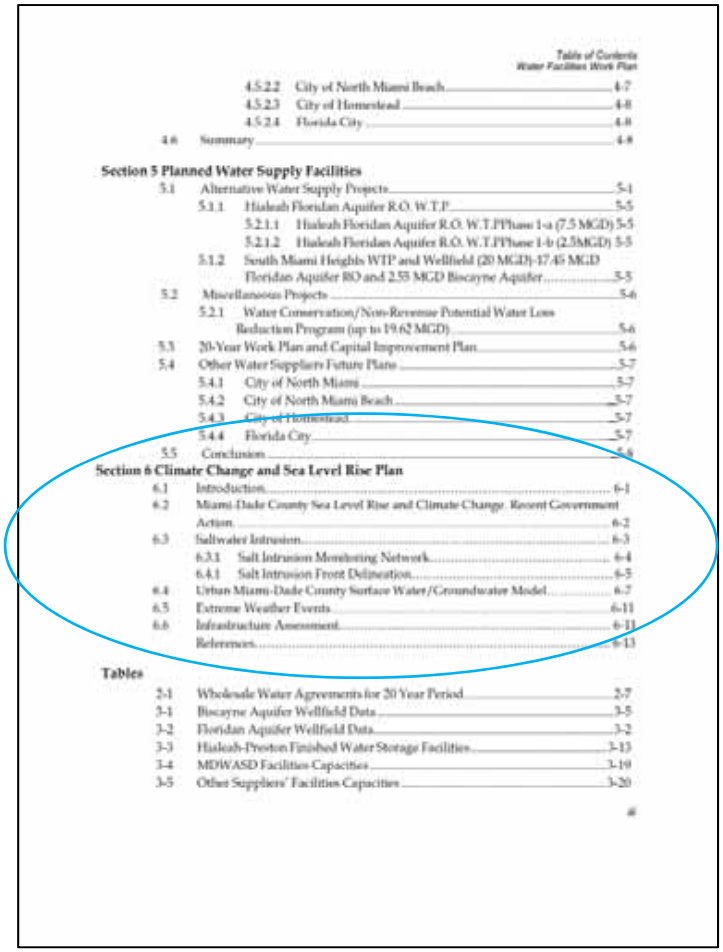


Table of Contents
Water Facilities Work Plan

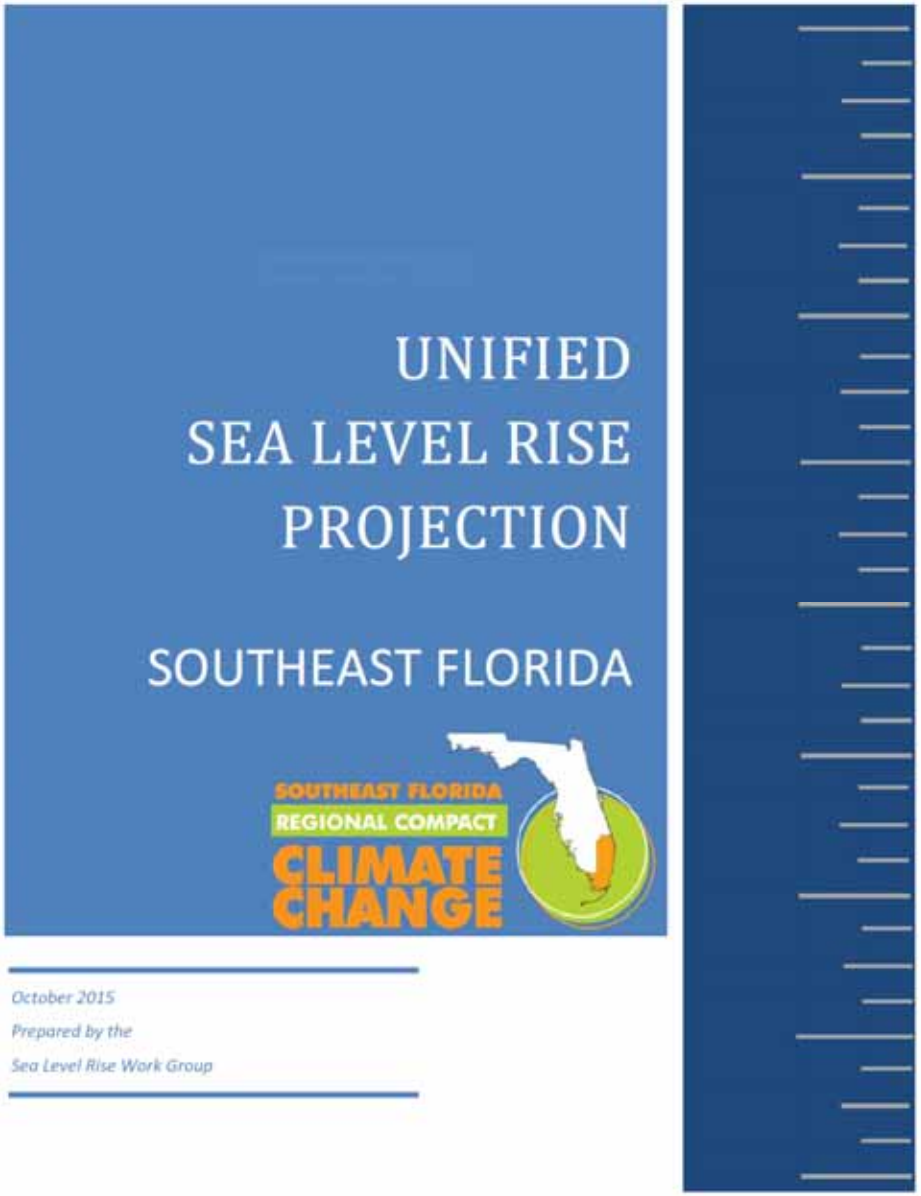
Climate change and SLR assessment is now a critical component of Water and Sewer Department (WASD) planning

Executed by the Counties in 2010

The Compact calls for the Counties to work cooperatively to:

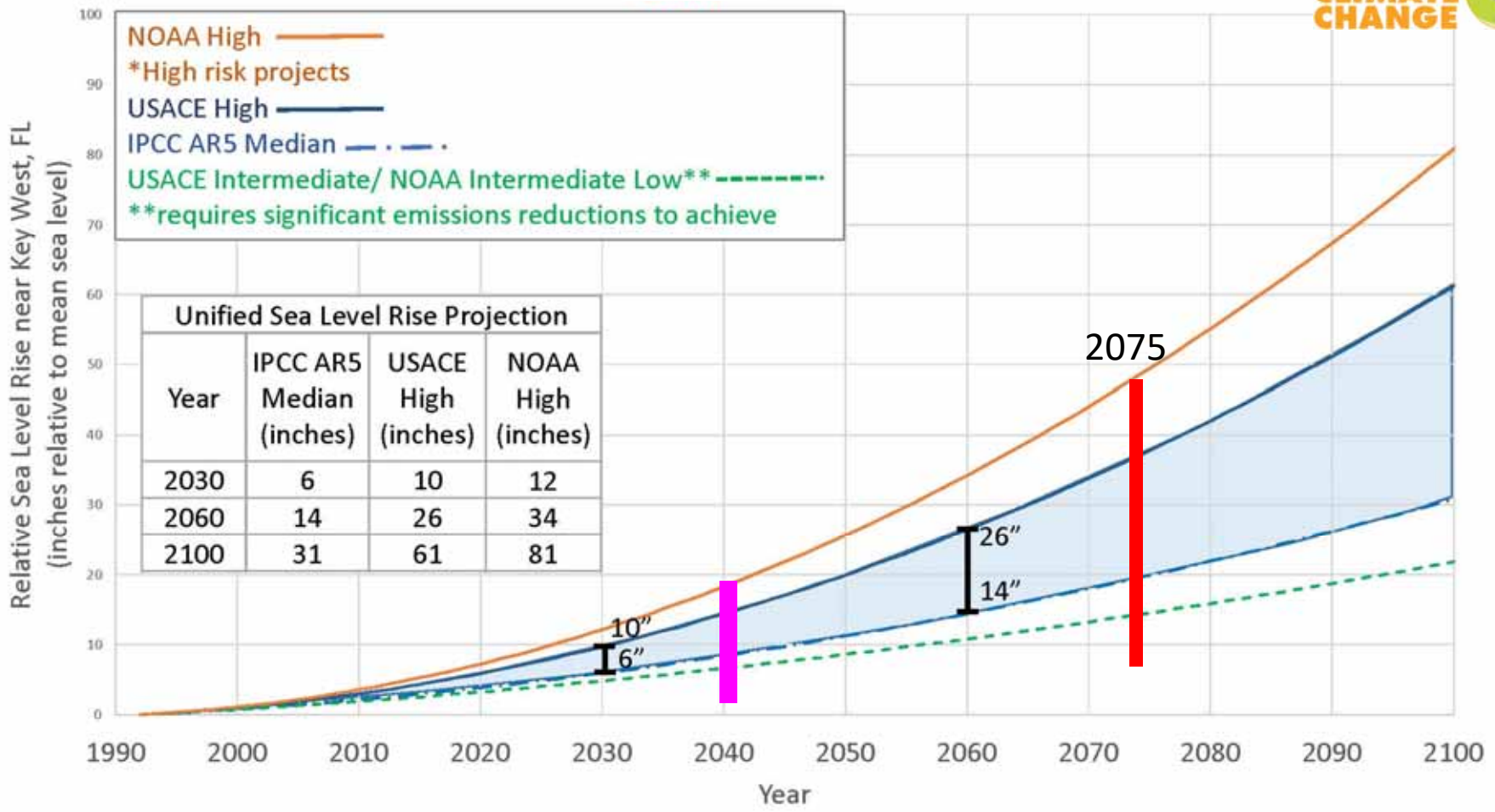
- Develop annual Legislative Programs and jointly advocate for state and federal policies and funding
- Dedicate staff time and resources to create a Southeast Florida Regional Climate Action Plan to include mitigation and adaptation strategies
- Meet annually in Regional Climate Summits to mark progress and identify emerging issues.

http://www.southeastfloridaclimatecompact.org/wp-content/uploads/2015/10/2015-Compact-Unified-Sea-Level-Rise-Projection.pdf



WASD's Capital Improvement Program $13.5 billion

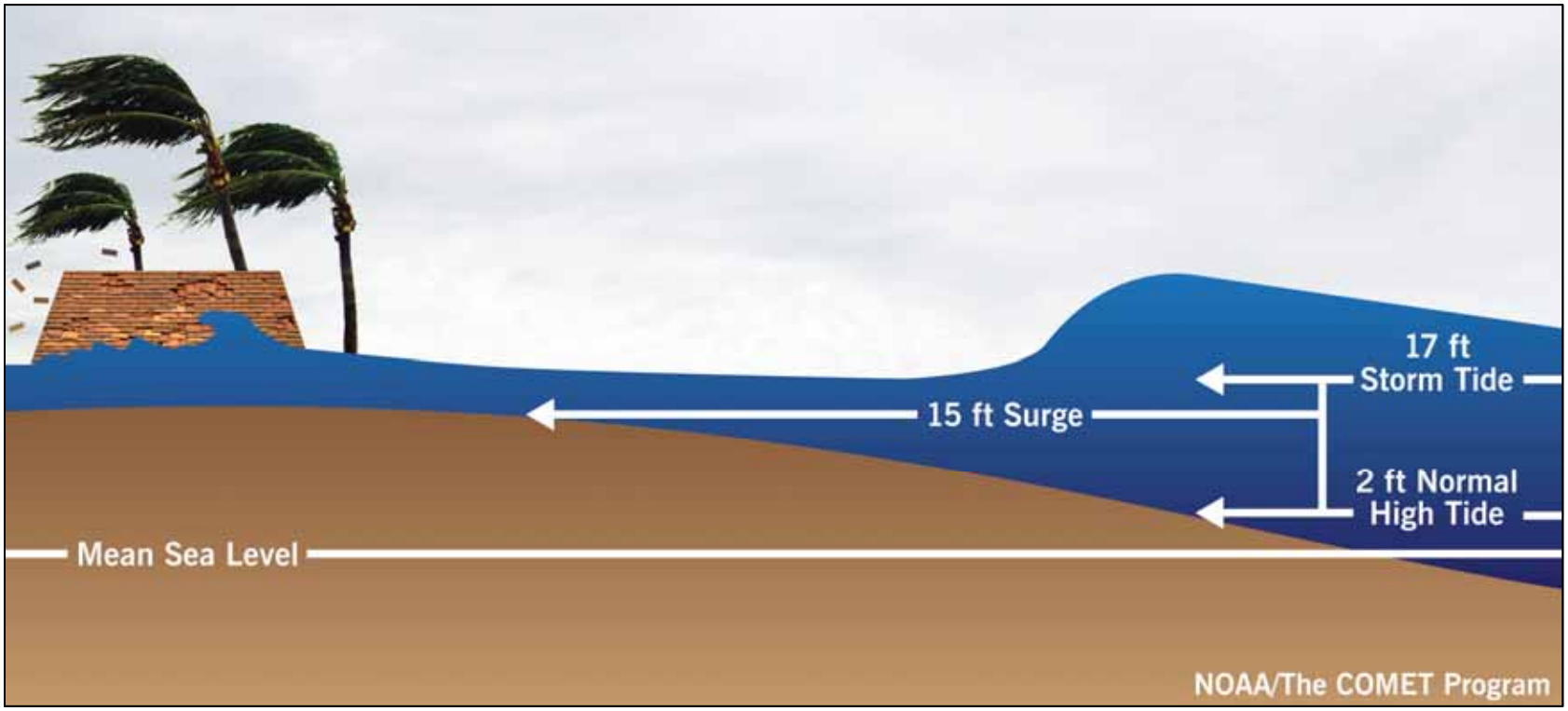
50 year life cycle for critical infrastructure



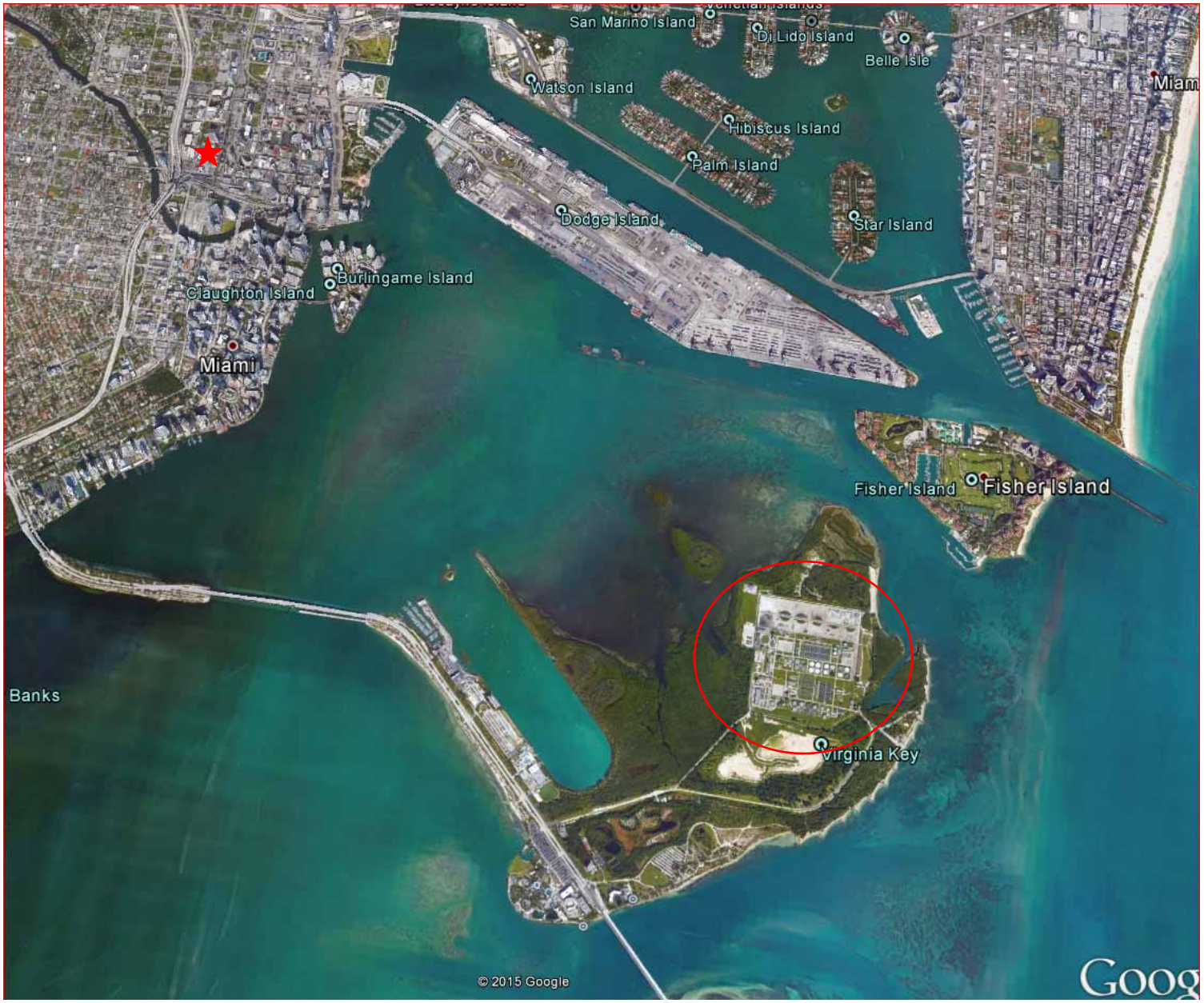
IN PROGRESS:

Updated data sets
Updated SLR projection curves (2015 USLRP)
Running Model Scenarios out to year 2075

Initial Sea Level Rise Assessments
WASD Facilities



Storm Surge and Tide = Storm Tide



Central District Wastewater Treatment Plant

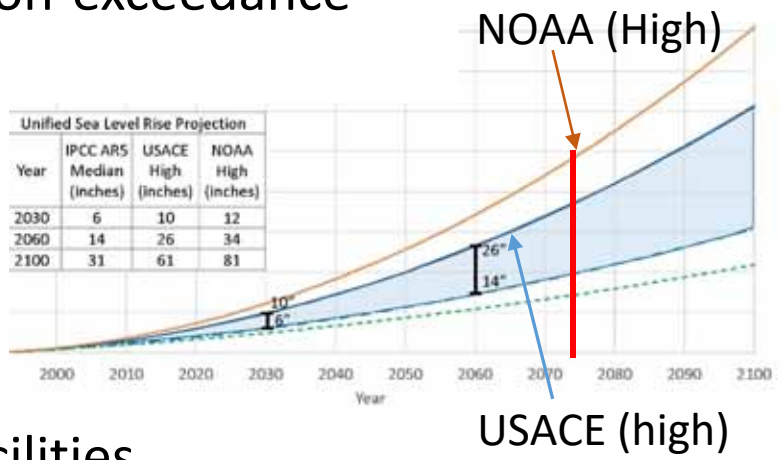
WASD
Design Guidance on Facility Hardening with Climate Change

- Climate Change Stressors and Impacts:
  - Heat
  - Rainfall
  - Sea Level Rise
  - Storm Surge (Wind and Pressure)
- WASD Guidance for Facility Hardening
  - Planning horizon
  - Safety Factors

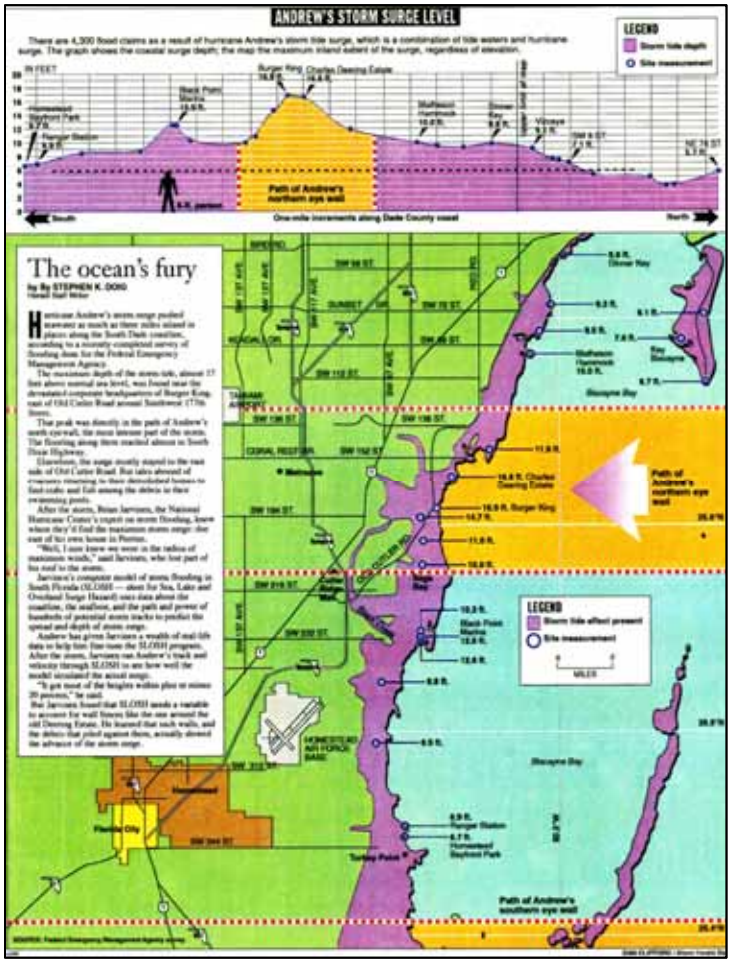
WASD Guidance on Key Climate Variables for Scenario Analysis

- **Planning Horizon:**
  - 2075 for Critical Long-Term Facilities (e.g. WWTPs)
  - 2040 selected for pump station flows
- **Climate scenarios:**
  - Greenhouse Gas Scenario: RCP – 8.5
  - GCM ensemble upper bound - 90% non-exceedance
- **Design storms:**
  - 2-year 24-hr
  - 10-year 24-hr
  - 100-year 24-hr
- Sea Level Rise:
  - NOAA (High) projection for critical facilities
  - USACE (high) projection for others

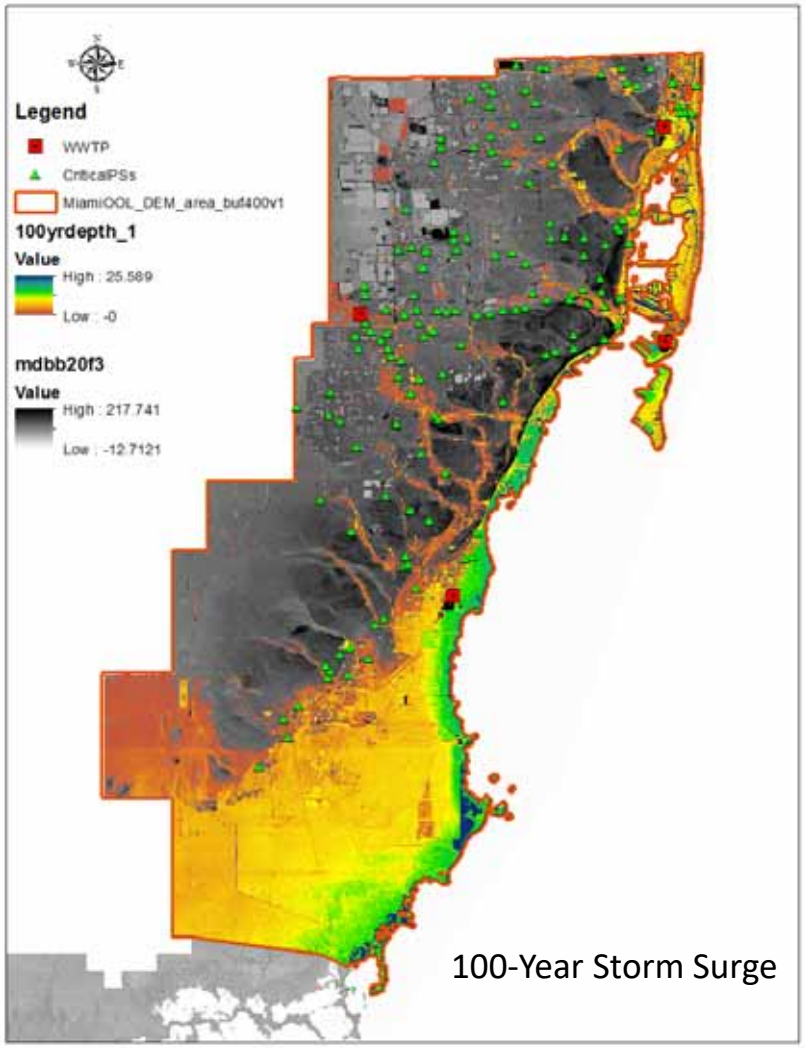
- Surge and inundation modeling run with 1.23 m (48”) SLR (2075 NOAA High).



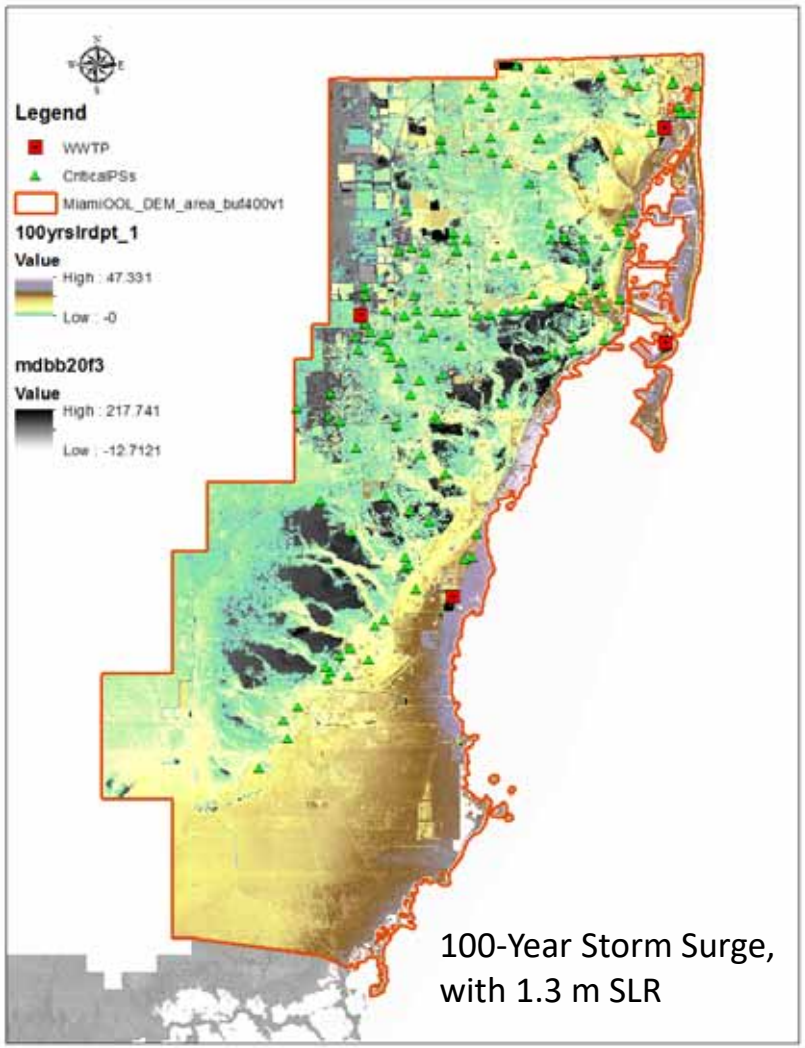
Andrew is the storm of record
August 1992



Stressor: Storm Surge with Sea Level Rise
Impacts: Coastal Flooding



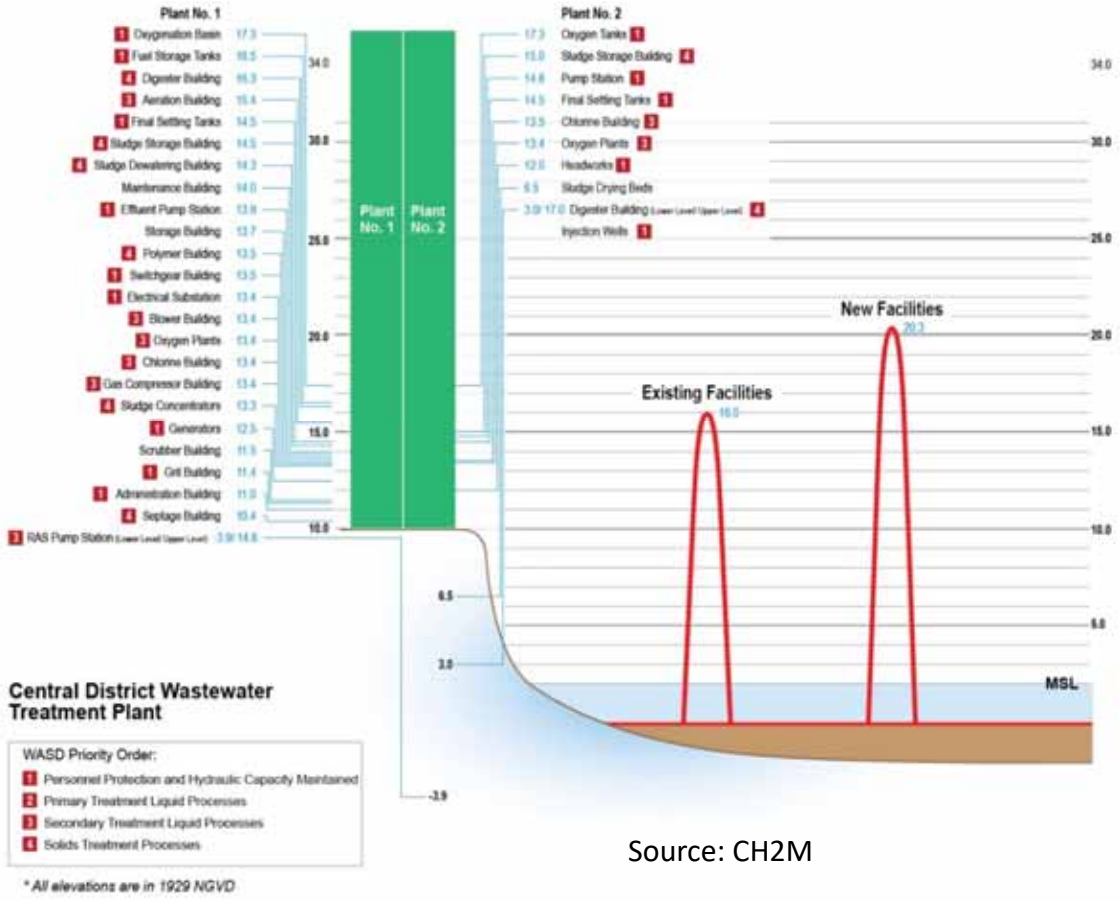
100-Year Storm Surge



100-Year Storm Surge, with 1.3 m SLR

Source: CH2M, 2015

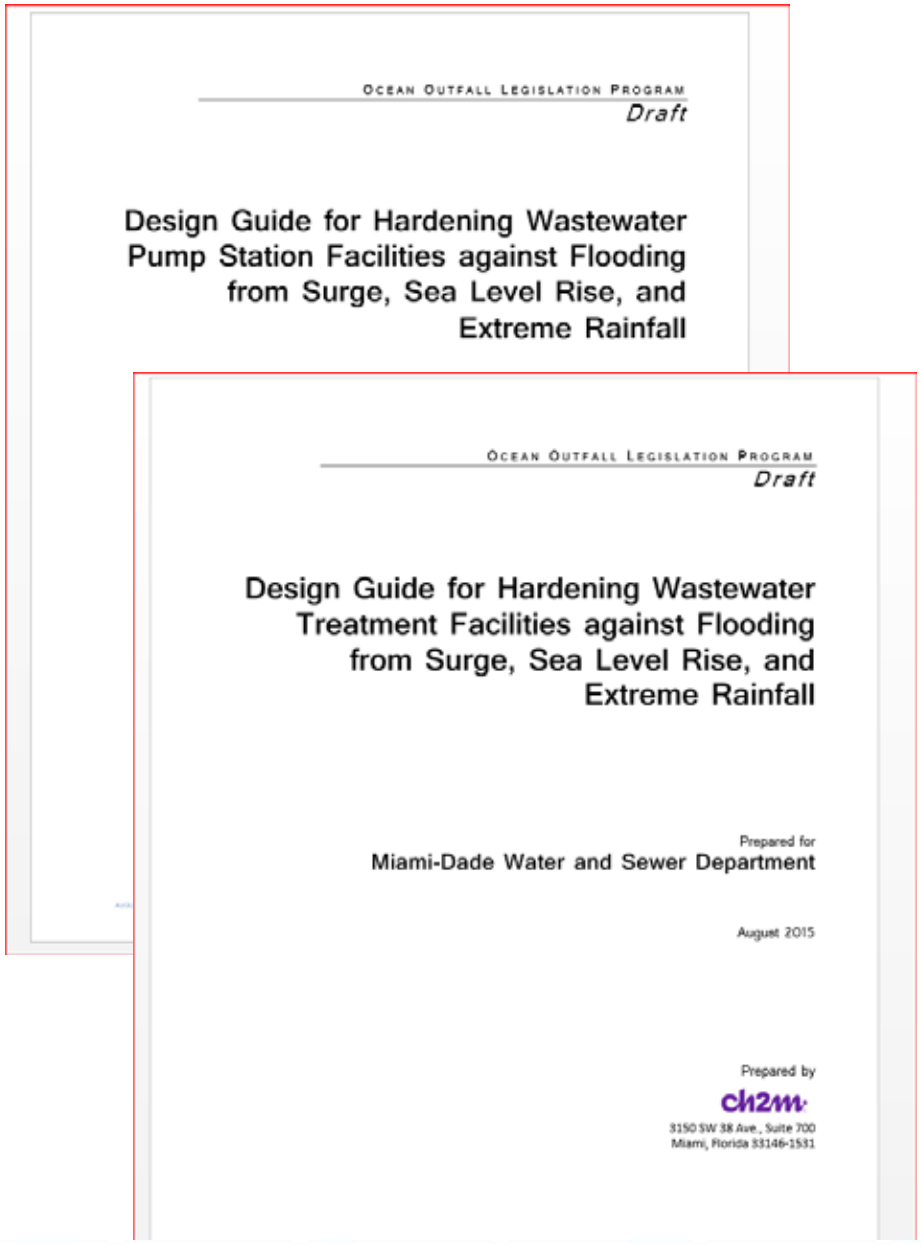
Facility Hardening Design Elevations and Prioritization of Critical Facilities for Central District Wastewater Treatment Plant.



Source: CH2M

Level of Service Priorities for Facility Resilience during Extreme Events

1. Personnel protection and hydraulic capacity maintained.
2. Primary treatment liquid processes
3. Secondary treatment liquid processes
4. Solids treatment processes



- summarizes elevations below which wastewater treatment facility assets should be protected or hardened to withstand or recover from:
  - flooding from projected future combinations of storm surge from tropical storms and hurricanes
  - extreme rainfall
  - sea level rise (SLR)

- Risk-based framework to guide the design of wastewater facilities for extreme events
- Recognizes that these extreme events are low probability, but potentially high consequence if systems fail.

Department of Regulatory and Economic Resources / **Office of Resilience**

The Office of Resilience

Department of Regulatory and Economic Resources / Office of Resilience

Sea Level Rise

Progress on the Recommendations

County staff produced several final reports summarizing their research in coordination with multiple departments, external organizations, and universities. Each report focuses on a different facet of sea level rise including:

Adaptation Action Areas

Environmentally Endangered Lands Program

Enhanced Capital Plan

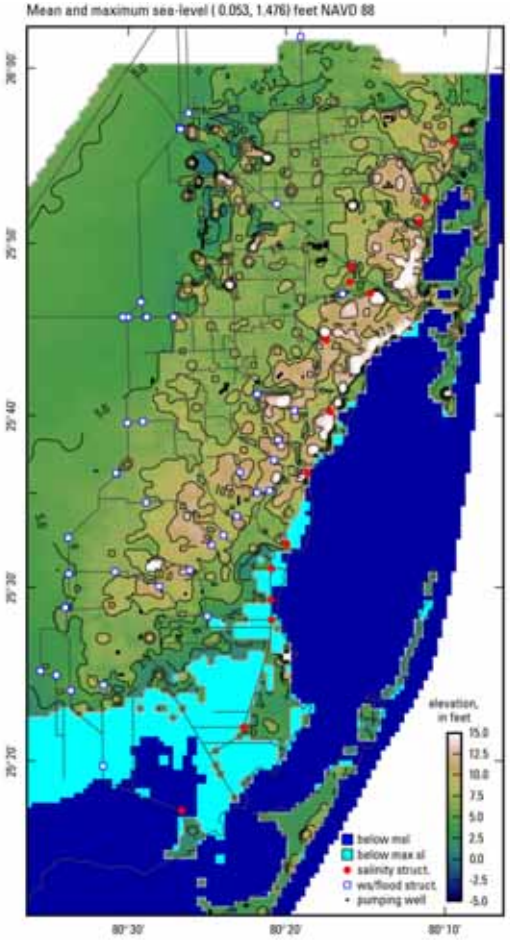
Insurance and Risk Management

Flooding and Saltwater Intrusion

Climate Change Advisory Task Force

Inundated areas

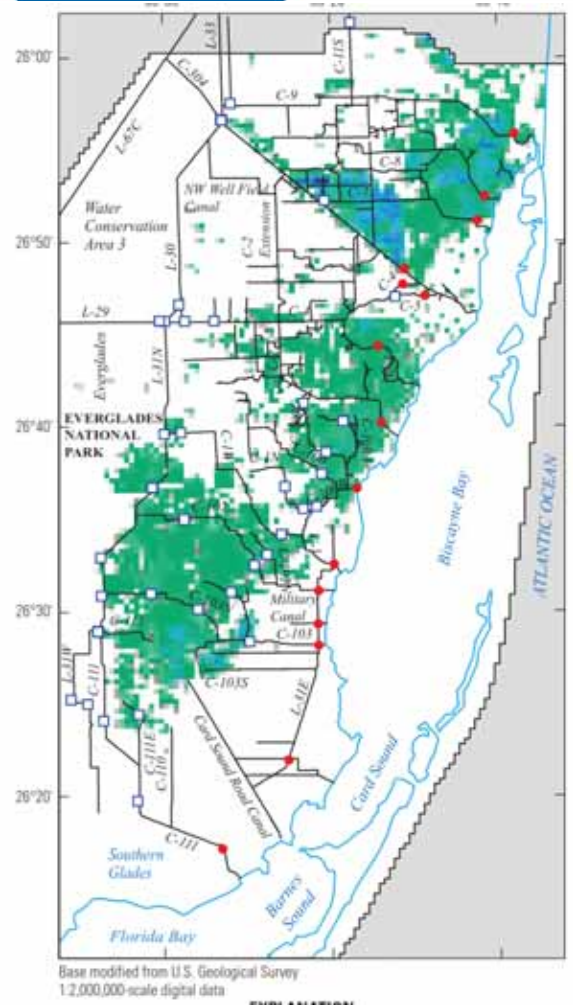
Historical



High Rate 2040

Going forward…WASD

- Full time groundwater modeler now on staff
- Working with USGS on updating UMD model
- Running scenarios to include SLR year 2100 and climate change variability
- Using future scenario groundwater levels for import into storm water modeling (XP-SWMM with DERM)

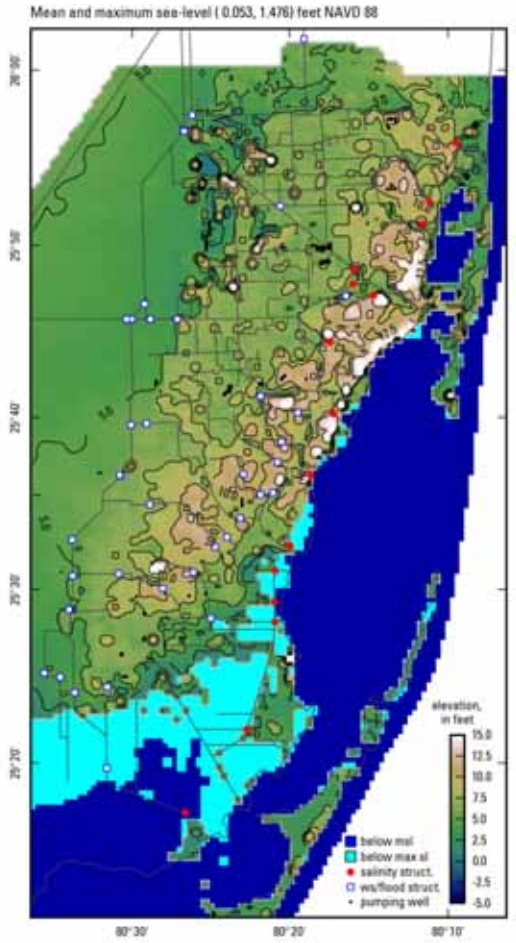


Base modified from U.S. Geological Survey
1:2,000,000-scale digital data

Going forward…

- Using future scenario groundwater levels for import into storm water modeling (XP-SWMM with DERM)

- Septic Tank Task Force with OOR – identifying priority areas to convert to sewer

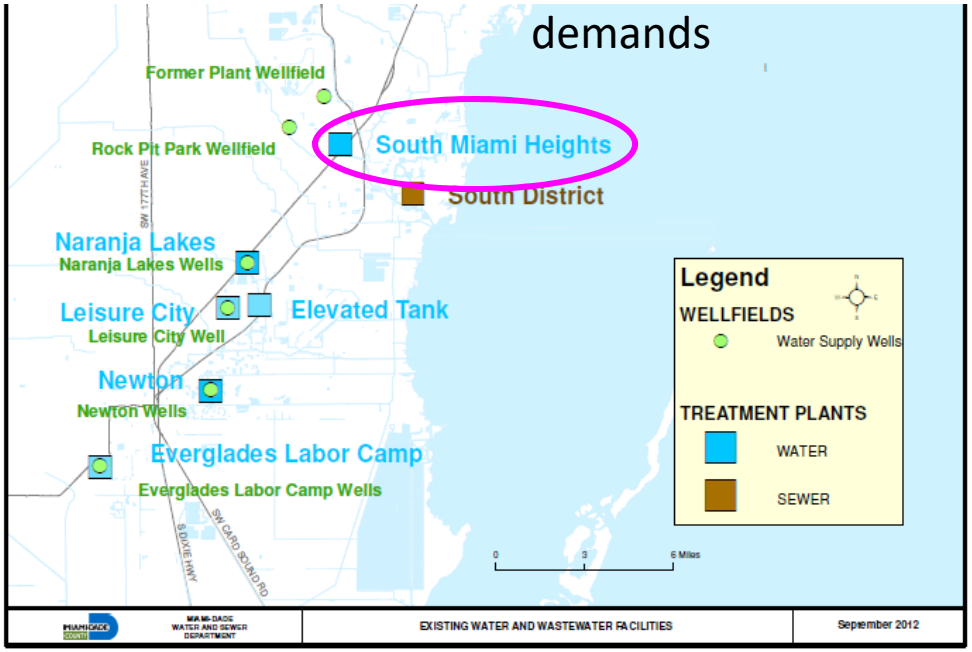


High Rate
2040

Going forward…

- *Stranded Assets*

$230 million Floridan Aquifer Wellfield and RO WTP to meet projected future demands



Collaborative Effort

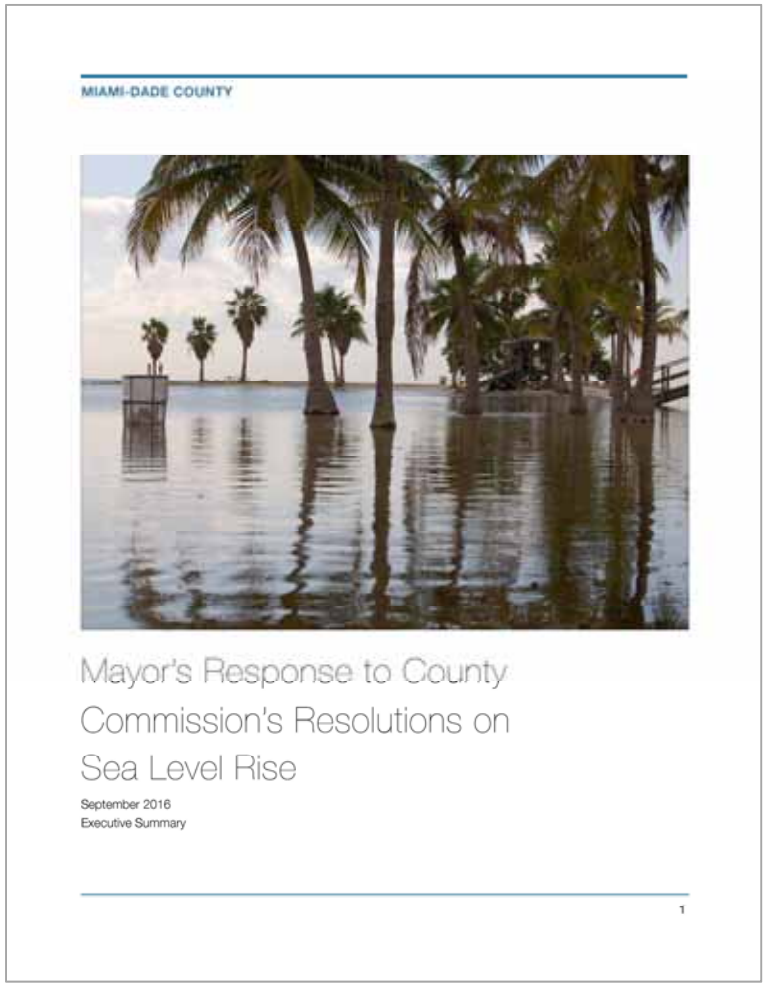
For further information contact:

Dr. Virginia Walsh

walshv@miamidade.gov

Department of Regulatory and Economic Resources / Office of Resilience

Sea Level Rise



- Full report covering six recommendations
- Executive summary available
- Both available on miamidade.gov/green

Sea Level Rise - Task Force

- Explored sea level rise implications on our environment, economy, communities and government policies
- Made recommendations for Miami-Dade County to better prepare for rising sea levels
- Seven resolutions, which support implementation of the Task Force recommendations, were adopted by the Board of County Commissioners on January 21, 2015

Department of Regulatory and Economic Resources / Office of Resilience

Adaptation Action Areas

Adaptation Action Areas – Pilot Arch Creek

Visiting Experts - Urban Land Institute Resilience Panel

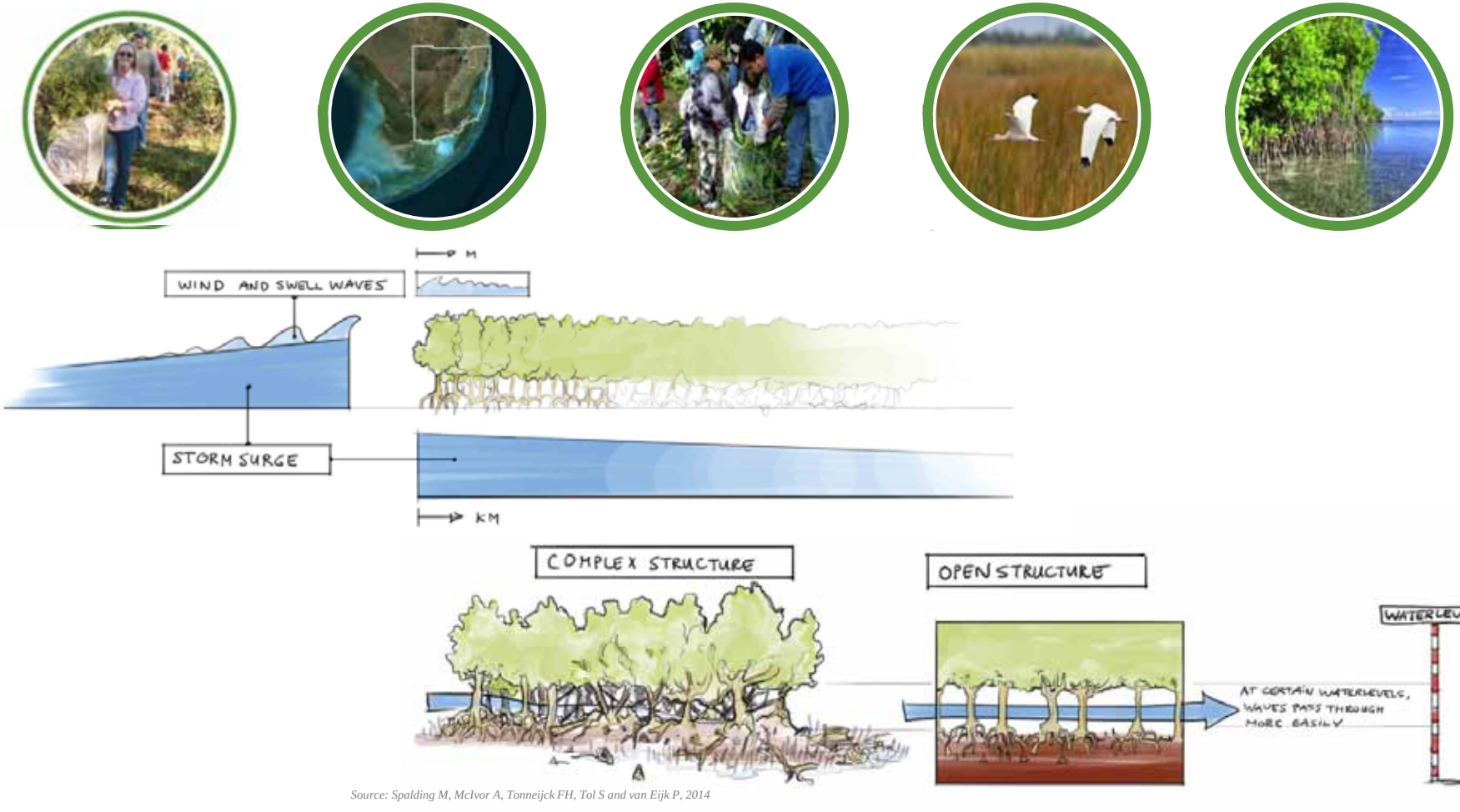
Renowned land use and urban planning experts, convened by the Urban Land Institute (UBI), visited Miami-Dade County in 2016 to make recommendations on improving the resilience of the Arch Creek Basin.

Next Step - Resilient Redesign

The Arch Creek Basin was chosen as the focus area for one of the design teams for Resilient Redesign, hosted by the Southeast Florida Regional Climate Change Compact. Participants from multiple disciplines, areas and backgrounds, including students from the University of Miami's School of Architecture, will help the County and municipal partners advance adaptation measures within the basin.

Department of Regulatory and Economic Resources / Office of Resilience

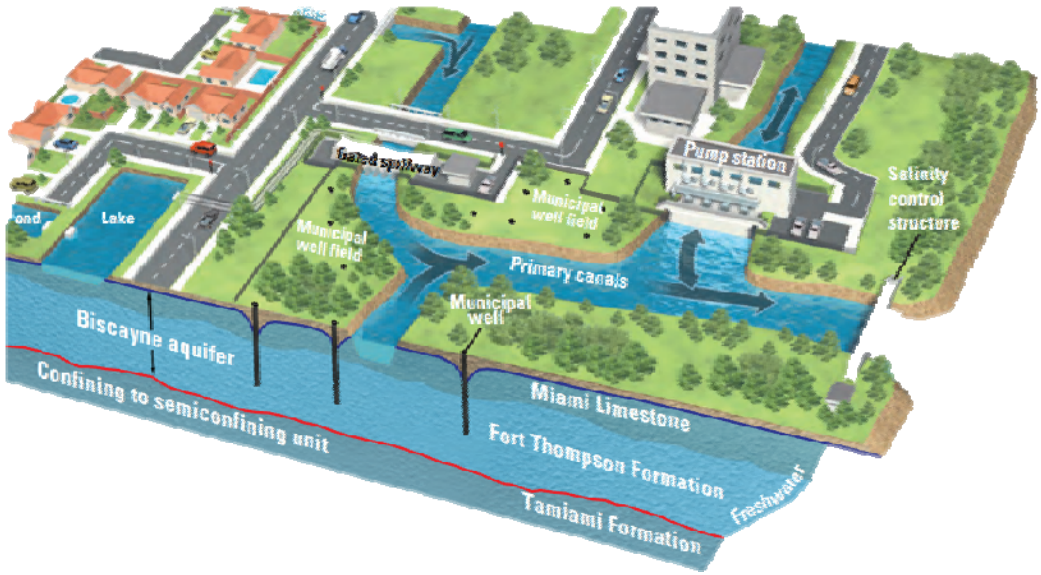
Environmentally Endangered Lands Program



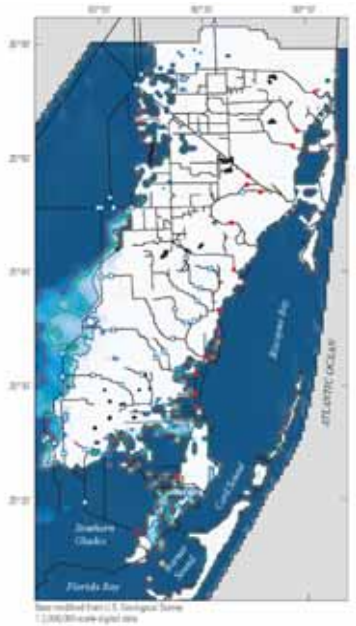
Source: Spalding M, McIvor A, Tonneijck FH, Tol S and van Eijk P, 2014

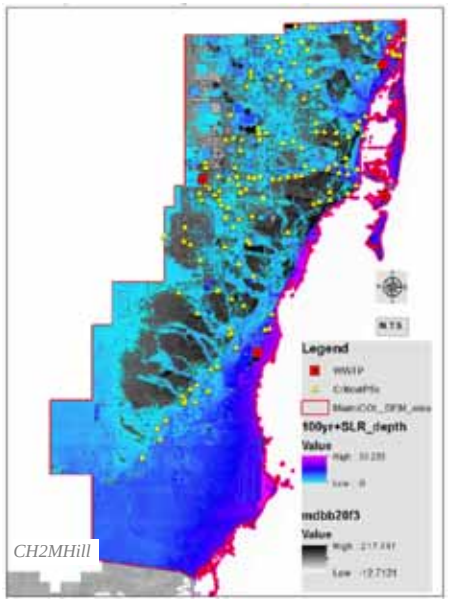
Department of Regulatory and Economic Resources / Office of Resilience

Flooding & Saltwater Intrusion

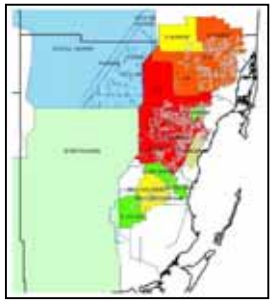


Source: Image modified from South Florida Water Management District, 2010





CH2MHill



Department of Regulatory and Economic Resources / Office of Resilience

Enhanced Capital Plan

Enhanced Capital Plan

Typical planning process

Next Steps

- Funding allocated for vulnerability analysis ($200,000)
- Beginning procurement for strategy development & prioritization ($600,000)

Department of Regulatory and Economic Resources / Office of Resilience

Insurance & Risk Management

Long-term Risk Management Practices:

- Mitigate the County's own exposure – connecting departments
- Promote the Community Rating System – saving $19 million for residents & business owners
- Work to address gaps for sub-groups which are more vulnerable
- Working with the insurance & reinsurance sector to identify risk
- Promote more resilient development

Next Steps

- Roundtable discussion on flood insurance (Beacon Council)
- Discussion on economic resilience (British Consulate)

Full Plant Replacement: Cost with Electrical and I&C Losses

Treatment Plant	Permitted Capacity (MGD)	Estimated Replacement Cost	Electrical Cost (15% of Replacement)	I&C Cost (10% of Replacment)	Electrical LOSS (90% Elect. Cost)	I&C LOSS (100% I&C Cost)	Total LOSS
NDWWTP	120	$ 2,400,000,000	$ 360,000,000.00	$ 240,000,000.00	$ 324,000,000.00	$ 240,000,000.00	$ 564,000,000.00
CDWWTP	143	$ 2,860,000,000	$ 429,000,000.00	$ 286,000,000.00	$ 386,100,000.00	$ 286,000,000.00	$ 672,100,000.00
SDWWTP	112.5	$ 2,250,000,000	$ 337,500,000.00	$ 225,000,000.00	$ 303,750,000.00	$ 225,000,000.00	$ 528,750,000.00
TOTAL	**375.5**	**$ 7,510,000,000**	**$ 1,126,500,000**	**$ 751,000,000**	**$ 1,013,850,000**	**$ 751,000,000**	**$ 1,764,850,000**

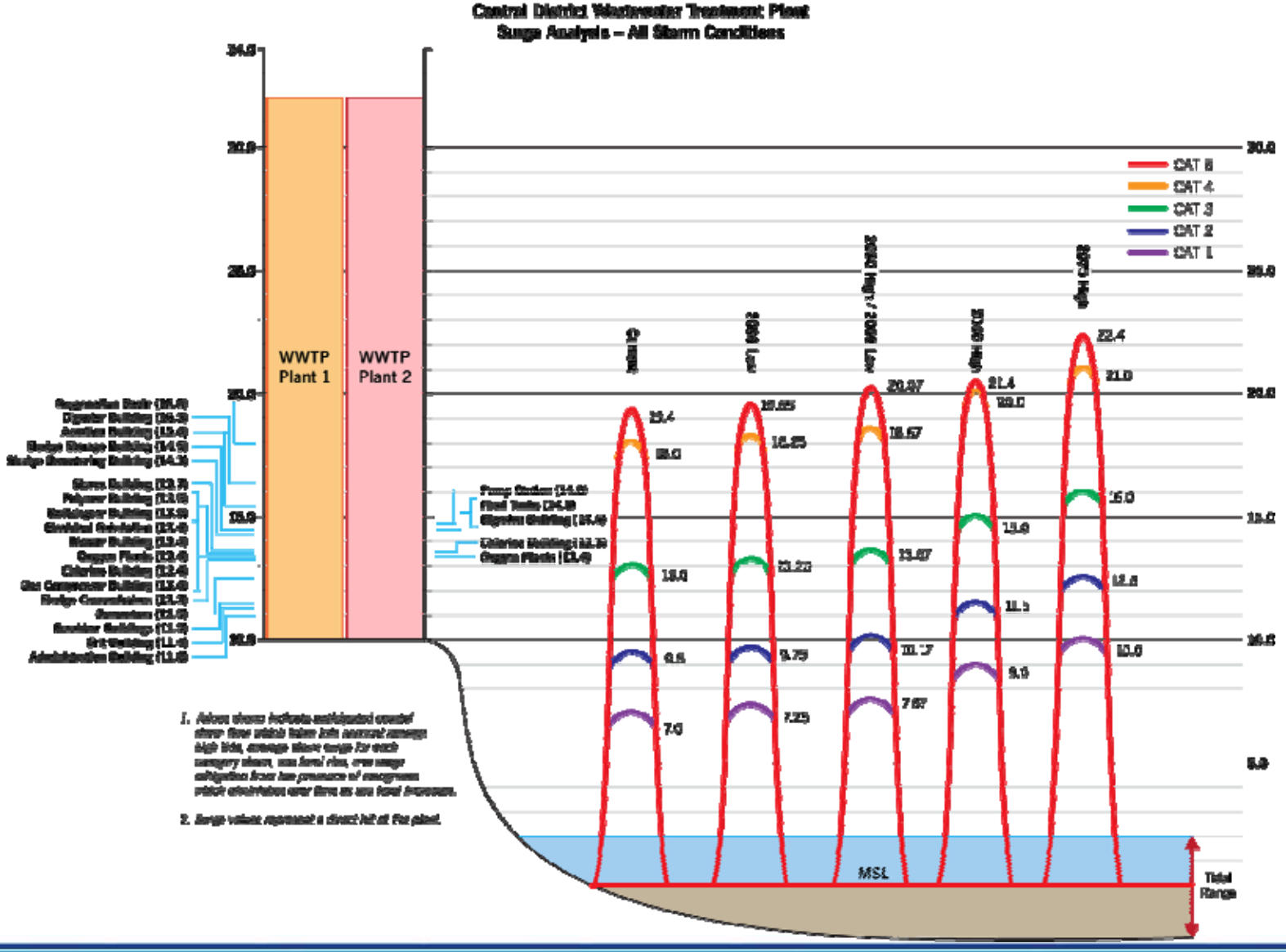
Assumptions:

% Loss = 23.5%

1. *Electrical costs are 15% total capital cost, with 90% of electrical costs being a total LOSS*
2. *Instrumentation and control costs are 10% total capital cost, with 100% of I&C costs being a total LOSS*
3. *Replacement cost $ 20.00 per gallon/day*

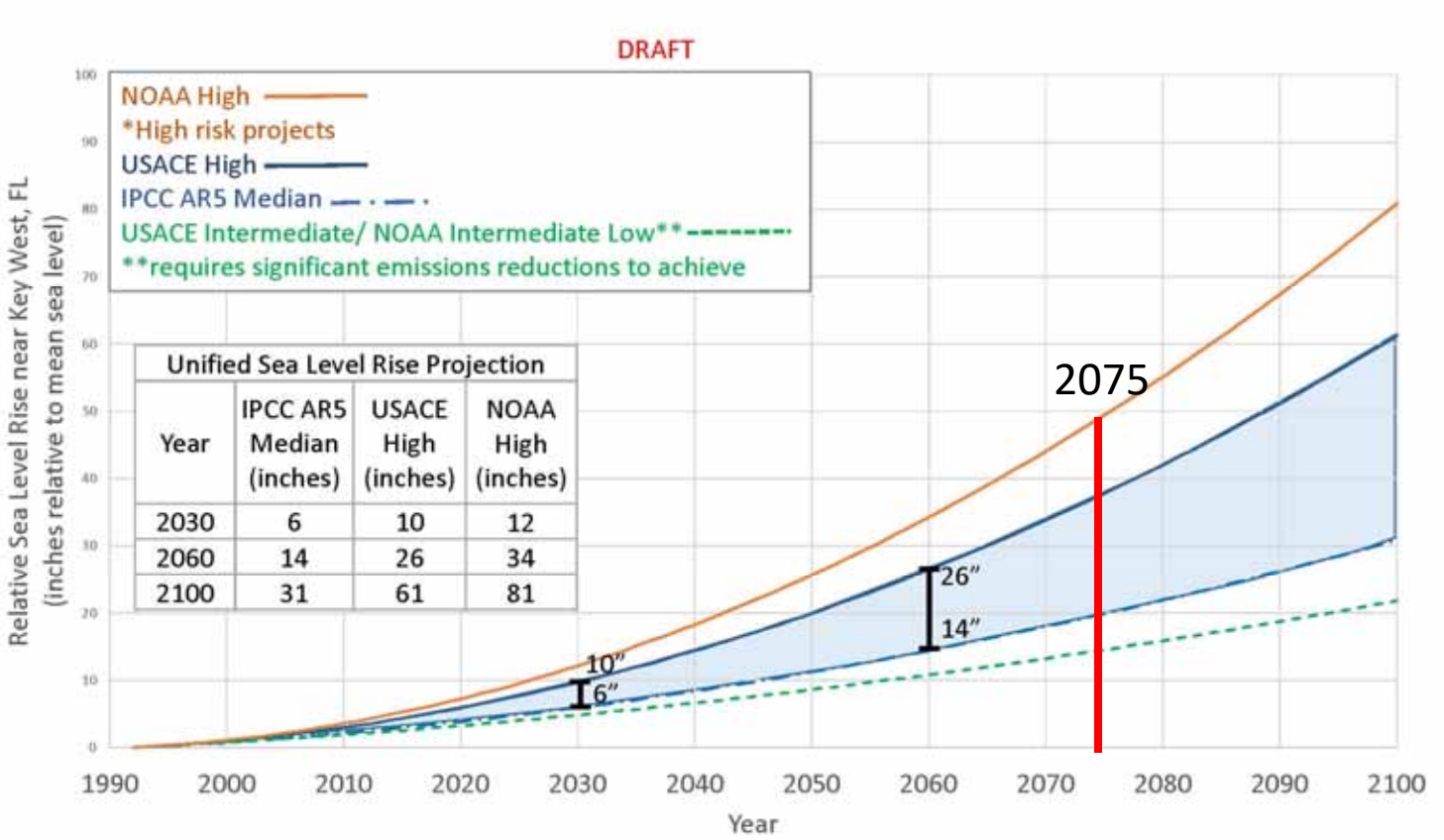
HAZEN AND SAWYER
Environmental Engineers & Scientists

CDWWTP Storm Tide Analysis

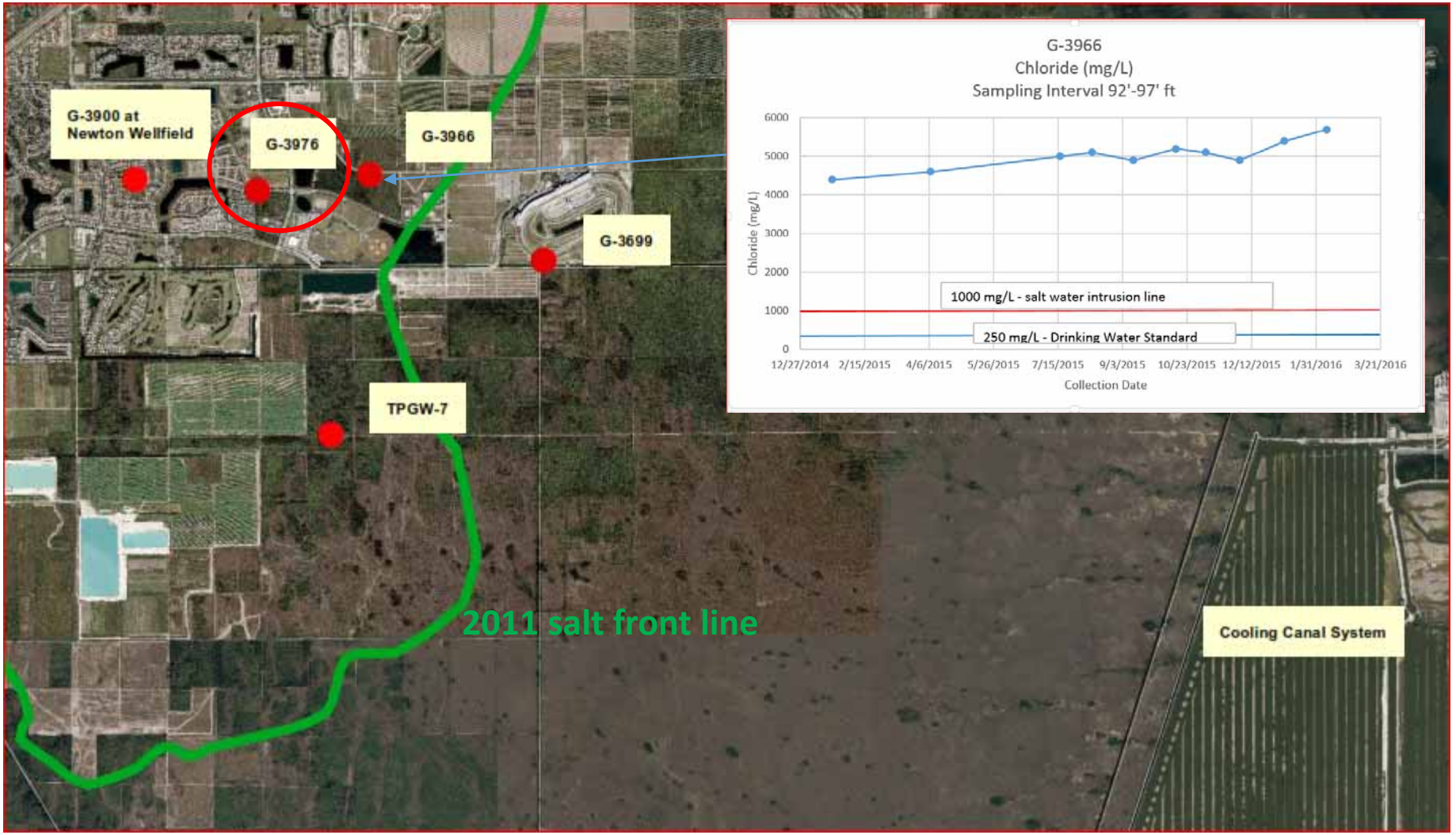


Stressor: Sea Level Rise
Impacts: Coastal Flooding and Increased I/I (due higher GW)

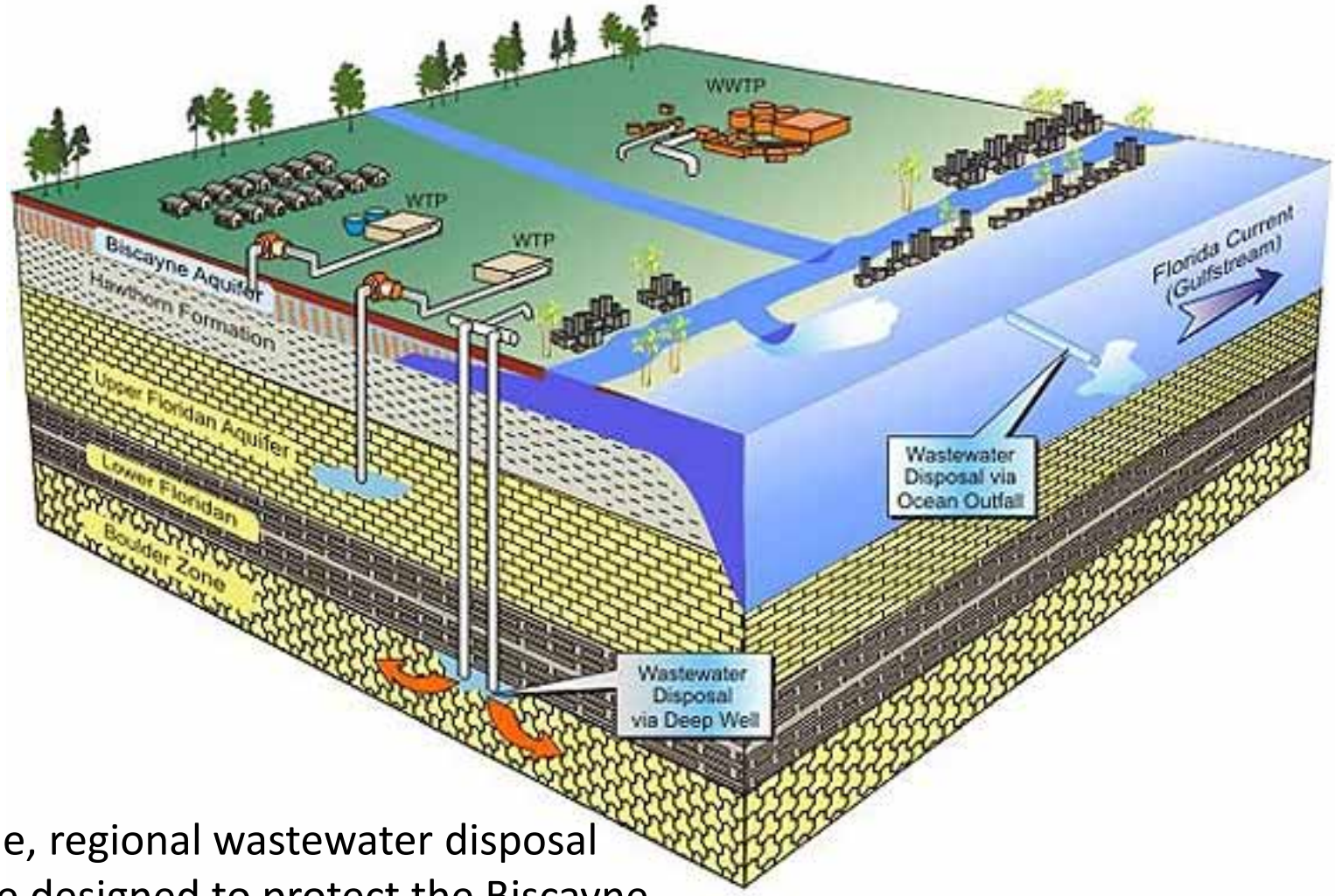
Source: SE FL Climate Compact, DRAFT April 2015



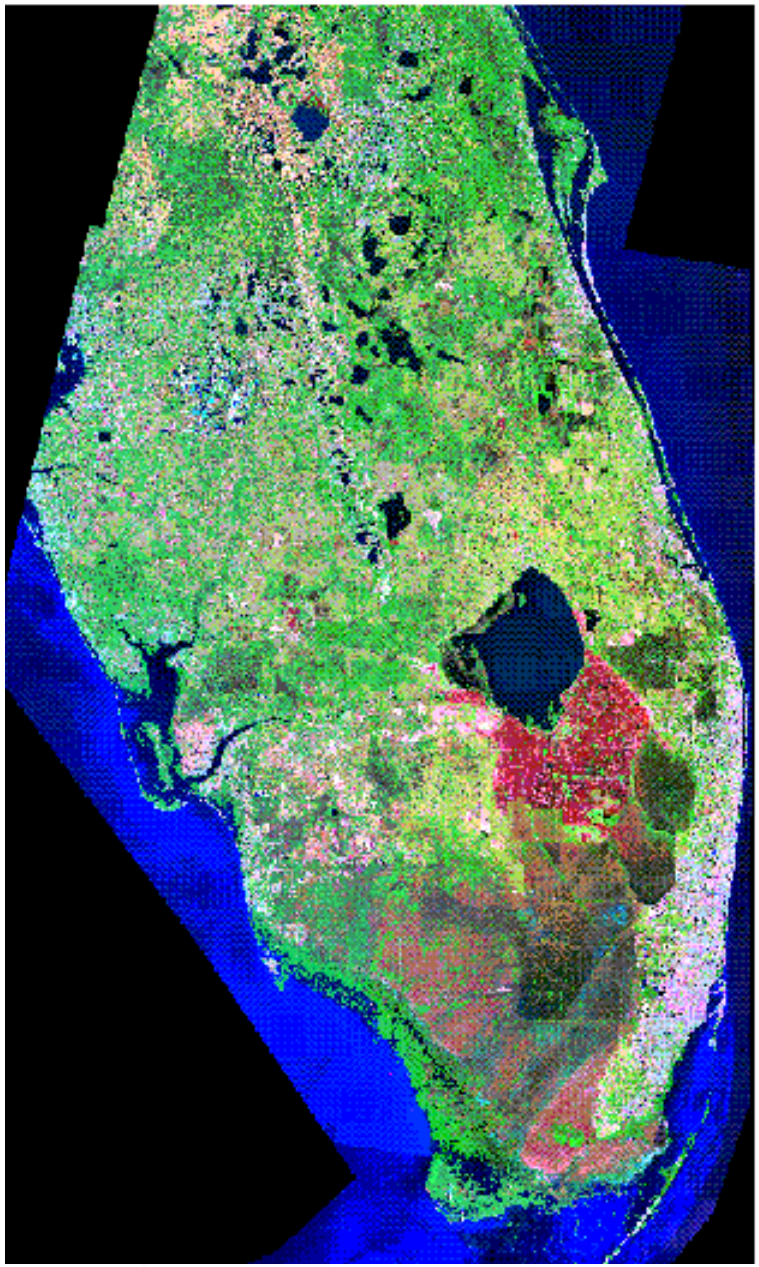
- Surge and inundation modeling run with 1.23 m (48”) SLR (2075 NOAA High).
- Surge modeling also run with 0.93 m (37”) SLR (2075 USACE High), to test linearity assumption if smaller SLR design criteria are selected based on risk.

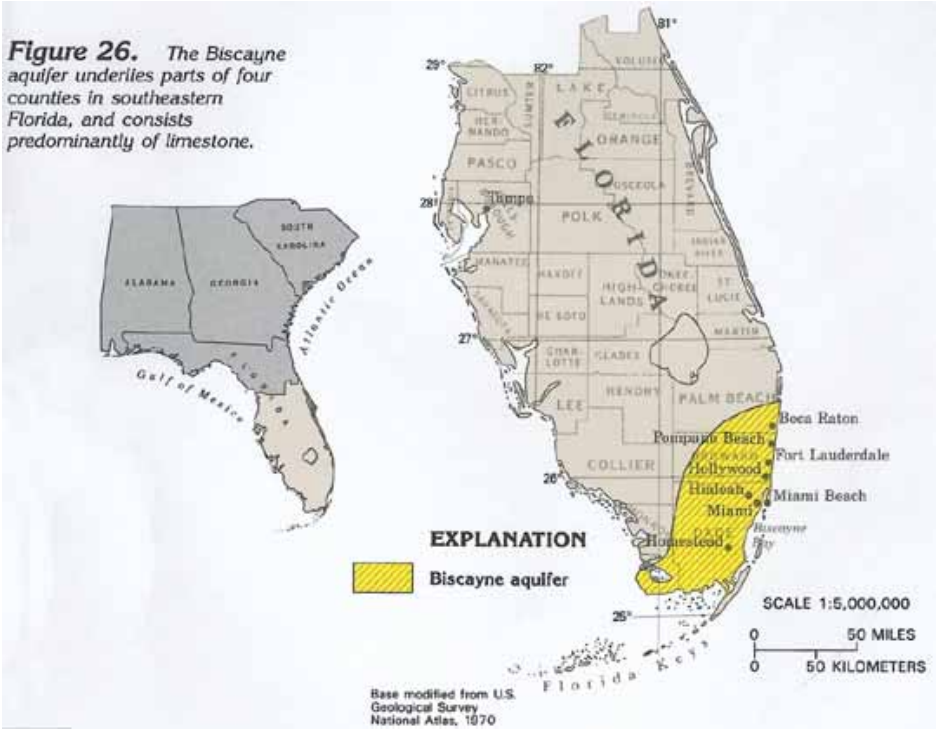


2016 Conditions



In Miami-Dade, regional wastewater disposal methods were designed to protect the Biscayne Aquifer, the major source of drinking water in Miami-Dade County, via deep injection wells and ocean outfalls.





Biscayne Aquifer
Surficial Aquifer

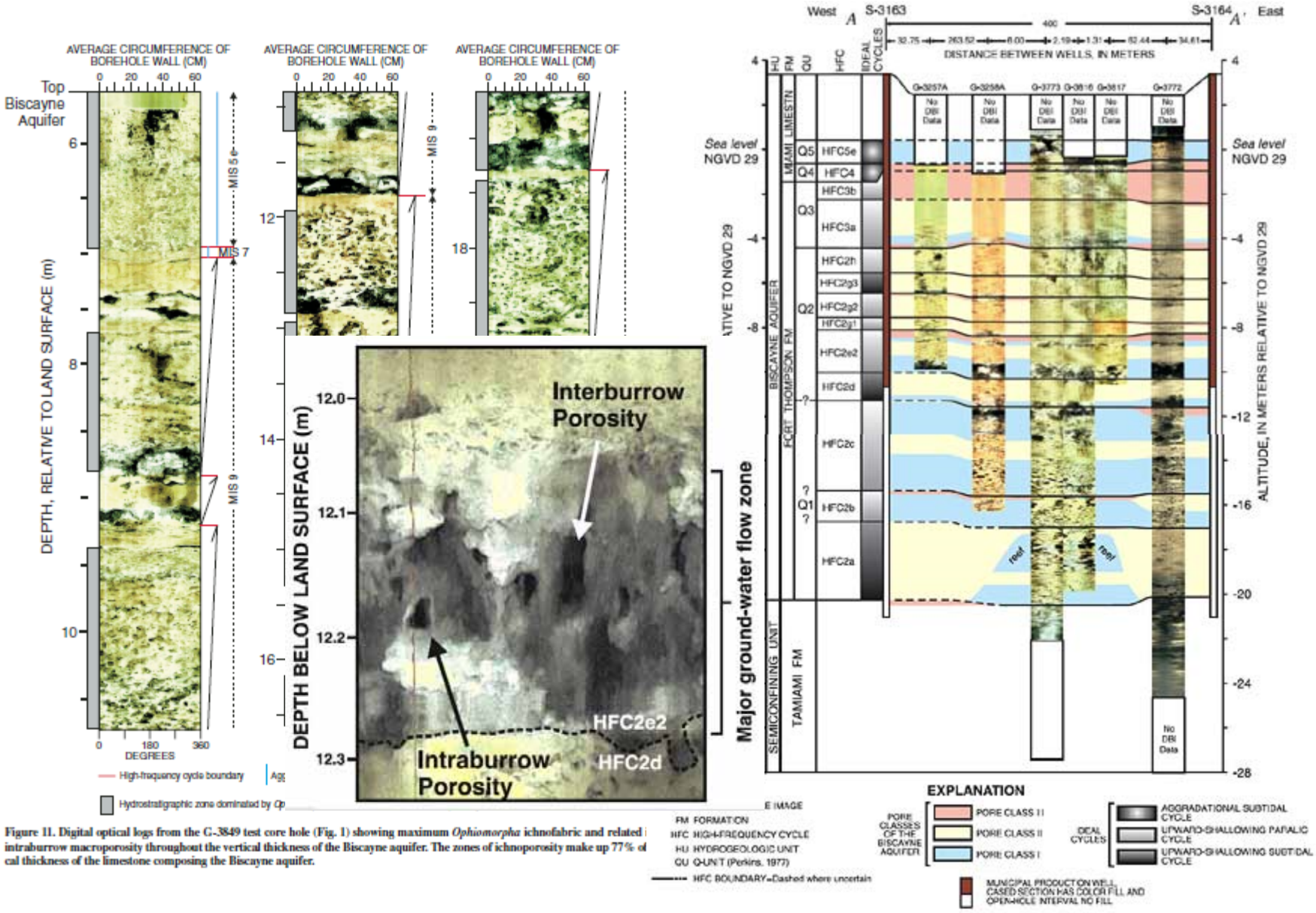


Figure 11. Digital optical logs from the G-3849 test core hole (Fig. 1) showing maximum *Ophiomorpha* ichnofabric and related i intraburrow macroporosity throughout the vertical thickness of the Biscayne aquifer. The zones of ichnoporosity make up 77% of cal thickness of the limestone composing the Biscayne aquifer.

Design Elevations for Existing and New Facilities

Facility Resilience during Extreme Events

Table 1
WWTP Summary of Design Criteria for Hardening against Flooding from Surge, Sea Level Rise and Extreme Storm Events.

	Existing WWTP Facility Assets		New WWTP Facility Assets	
	ft NGVD29	Basis	ft NGVD29	Basis
CDWWTP	16.0	FEMA BFE + 3ft SLR from SEFLCC(2011) +FB +SF	20.3	2075 Surge+1.23m(48")SLR + FB +SF+21”(100-yr, 72-hr rainfall)
SDWWTP	16.0	FEMA BFE + 3ft SLR from SEFLCC(2011) +FB +SF	19.0	2075 Surge+1.23m(48")SLR + FB +SF+21”(100-yr, 72-hr rainfall)
NDWWTP	16.0	Same as CDWWTP and SDWWTP	17.1	2075 Surge+1.23m(48")SLR + FB +SF+21”(100-yr, 72-hr rainfall)

FB= Freeboard = 2.0 ft per ASCE Standard 24-05/2010 FBC Category IV

SF= Safety Factor = 1.0 ft per 2014 MWH study at CDWWTP

SLR = 1.23m = 48" per NOAA High projection for 2075 (USACE High projection is 0.93m)

Source: CH2M