## The Impact of Sea Level Rise on Urban Infrastructure

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## **Risks of Climate Change**

- Changes in the amount of rainfall
- Change in rainfall timing
- Sea Level rise

## Sea Level Rise Atlantic Coast





The Problem is Time and Creep

1 ft – 20 to 40 years



The Problem is Time and Creep

2 ft – 30 to 70 years



### The Problem is Time and Creep

3 ft – 50 to 150 years, but – too late?





## Consequences...

- Saltwater Intrusion may be offset with GW rise
- Flooding during storms, mostly because GW rise = Loss of soil storage capacity
- Hurricane frequency uncertain, but 3 ft SLR is a problem





# What it Really Looks like



## **Reality – roads underwater**





## Broward County at 0, 1, 2, 3 ft SLR

Miami-Dade 3ft SLR Transportation Vulnerabilty



## Miami-Dade County at 0, 1, 2, 3 ft SLR

## **Compare with Bathtub Model**

Percent increase from bathtub model				
Model	Current	1ft	2ft	3ft
April 50 <sup>th</sup> %	36	38	41	40
Oct. 50 <sup>th</sup> %	78	83	92	85
Oct. 100 <sup>th</sup> %	154	233	182	138

## **Difference in Inundation**



## Message

- Timeline for change
  - No regret policy
  - Costs at appropriate time
- At Risk Infrastructure
  - Water
  - Sewer
  - Stormwater
  - Transportation

## What to do?

- Protect infrastructure from the impacts of Climate changes
- Adapt to the changes
- Retreat from the change (worst case?)

## **Options to Adapt**

- Install more coastal salinity structures
- Raise road beds
- Abandon certain roads
- Increase stormwater pumping
- Added stormwater retention
- Wellpoints/dewatering (permanent pumping systems)

## **Roadways at Risk**



### **Base saturation = Failure**

### Sealing the Sewers!!! (G7 Program)



## Flood control system can backup



(Obeysekera, SFWMD, 2009)

## Coastal structures will lose capacity as sea level rises



#### **S-13 Pumping Station**

• Capacity = 540 cfs =14.5 million gal/hr



and Heimlich et al., FAU, 2009

### Install Pumping Stations In Low Lying Areas To Reduce Storm Water Flooding (for illustration only – study required)



### Add Salinity/lock structures



## **Tides vs Water Levels**





#### Figure 1 – Normal dra

## Moving Wellfields/ horizontal wells



## Too Much Water...



## **Reclaim Some of It?**

### Multi-Barrier System

- Conventional treatment
- Media filtration with chlorine disinfection
- Advanced treatment
  Microfiltration (MF)
  - Reverse osmosis (RO)
  - Ultraviolet advanced oxidation (UVAOP)



## Pilot

### **Post Treatment Stabilization**

- pH
- Hardness
- Mineral Content
- DO
- ORP





### **Stabilization Techniques**

- Sodium hydroxide
- Hydrated lime
- Limestone filter
- Kiln dust
- Sodium metabisulfate

## **Alternative Water Supply Evaluation**

### **Present Worth Value of AWS Options**



## **Or Recover More Water**



## **Innovative Four-Stage NF/RO Process**

Site spatial constraints combined nanofiltration third stage and reverse osmosis fourth stage on one skid



## Requires a Dedicated Design and Construction Team



## Awards



8/3/12 NCEES: Florida Atlantic University wins 2012 NCEES Engineering Award

In the news

#### Florida Atlantic University wins 2012 NCEES Engineering Award

Congratulations to the Fiorida Atlantic University Department of Civil, Environmental, and Geomatics Engineering on winning the 2012 NCEES Engineering Award grand prize.

The department received the \$25,000 award for its submission, Dania Beach Nanofiltration Plant Expansion. Read more about all of the 2012 award

ACEC

American Council of Engineering Companies

#### **100 Years of Excellence**

#### 2010 DRINKING WATER STATE R<u>evolving</u> fund Award

For Sustainable Public Health Protection Awarded to

CITY OF DANIA BEACH, FLORIDA

For Showing Exceptional Creativity and Dedication to Public Health Protection







### FLORIDA REGION

DESIGN-BUILD



## **Conclusions About Climate and Water**

- We are unlikely to stop climate change anytime soon
- We need to adapt to the changes
- We will have more water
- We will need to manage it better
- The adaptation will critically alter the current built and natural environments
- Those "crazy" ideas may be the norm

## Questions?

