



Designing for High Tidal Tailwater

Presented By:

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Understanding Tidal Fluctuation



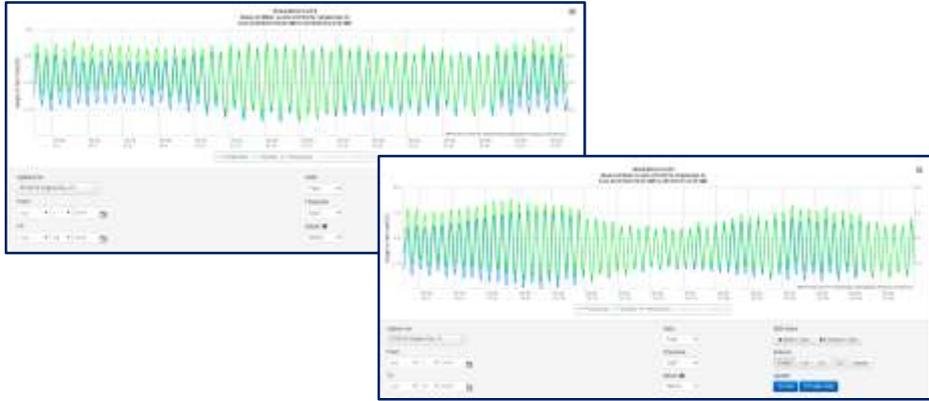
Daily Tide Fluctuation:

High Tide Elevation = +0.2' NAVD – Low Tide Elevation = -2.0' NAVD

Tidal Station: Virginia Key, Miami (Date: 4/4/15 – Source: NOAA – Vertical Datum: NAVD-88)



Understanding Tidal Fluctuation



June & October 2014 Tide Fluctuation:

June: High Tide Fluctuated from 0.0' to 0.5' NAVD

October: High Tide Fluctuated from 0.7' to 1.5' NAVD

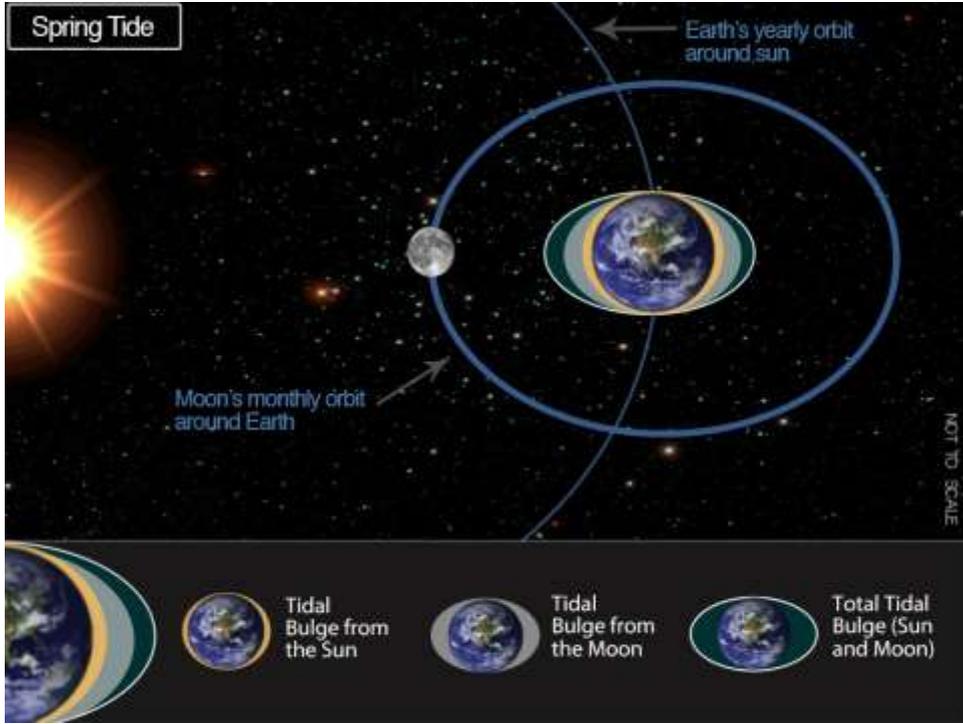


Understanding Tidal Fluctuation

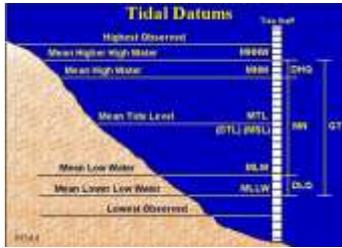


October, November & December 2014 experienced extreme High-High Tide conditions (High Tide Elevations Ranged from 1.0' to 1.5' NAVD)





Tidal Datum



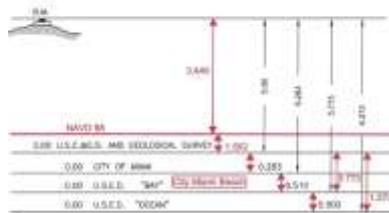
- MHHW : Mean Higher-High Water
- MHW: Mean High Water
- DTL: Mean Diurnal Tide Level
- MTL: Mean Tide Level
- MSL: Mean Sea Level
- MLW: Mean Low Water
- MLLW: Mean Lower-Low Water
- MN: Mean Range of Tide
- DHQ: Mean Diurnal High Water Inequality
- DLQ: Mean Diurnal Low Water Inequality
- GT: Great Diurnal Range

Vertical Datum Conversion Software:
VERTCON by National Geodetic Survey

RELATIVE DATUM PLANES

BM	U.S.C.S. "02544"	SLR	6.213	M.S.L.
BM	U.S.C.S. "561"	SLR	5.772	M.L.W.
BM	CITY OF MIAMI	SLR	5.240	M.L.W.
BM	U.S.C. & G.S.	SLR	5.000	M.S.L.
BM	U.S. GEOLOGICAL SURVEY	SLR	6.273	M.S.L.

THE ABOVE INDICATES THE COMPARATIVE ELEVATION OF A BENCH MARK FOR THE FOUR PLANES.



DATUM PLANE RELATIONSHIPS



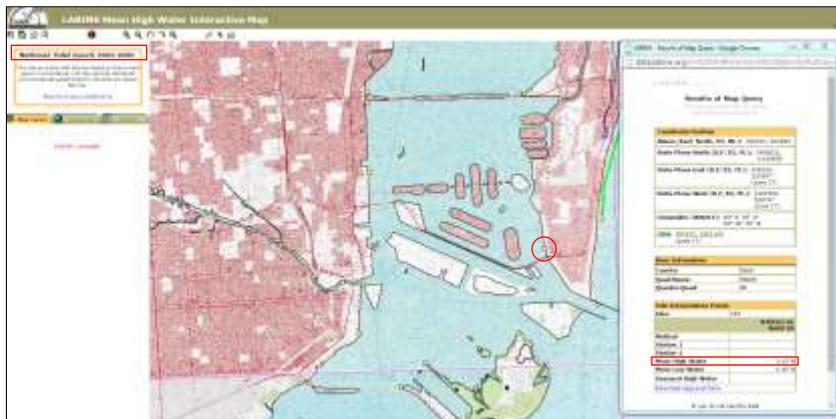
Mean High Water Establishment



Mean High Tide Data Source: Labins.org (FDEP/USGS)



Mean High Water Establishment



Mean High Water in Miami Beach = 0.15' NAVD
Based on recorded average high tide data from 1983 to 2001



Tidal Tailwater Criteria

Mean High Water (MHW) is based on 1983 to 2001 historical average high tide records

Recent high tide patterns are consistently higher each year

Current FDOT tidal tailwater criteria does not address present high tide patterns conditions

Need for FDOT tidal tailwater criteria to be re-evaluated and upgraded to account for current high tide conditions & anticipated sea level rise



2016 Drainage Manual – Sea Level Rise

- Sea Level Rise: based on historical tidal records
- Climate Change Prediction Model: not included at this time
- Jan 1, 2015: New requirement for the following coastal projects:
 - New construction
 - Reconstruction
 - Projects rebuilding drainage systems
- Straight line regression equation extrapolation based on design service life
- Existing system criticality/vulnerability and project costs will be factors to consider

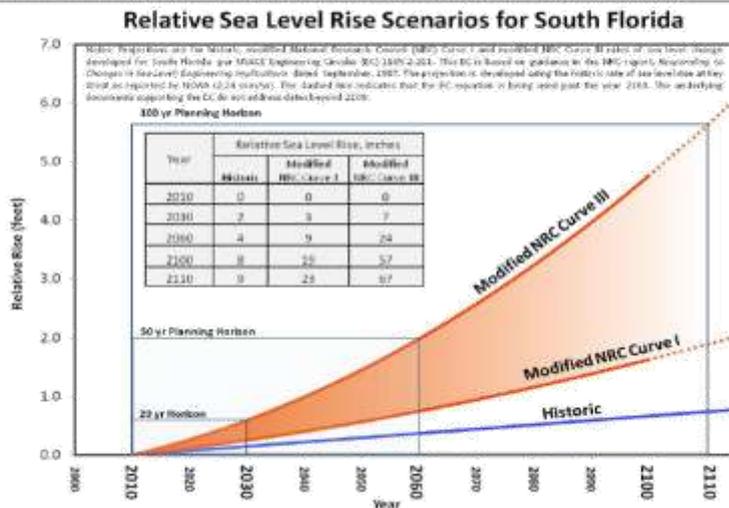


Sea Level Data

- National Water Level Observation Network (NWLON), managed by NOAA
<http://tidesandcurrents.noaa.gov/sltrends/sltrends.html>
- Minimum of 30 years of observation data
- 14 Tidal Gauge Stations in Florida
- Use station most adjacent to site for analysis



Figure 3. USACE Sea Level Rise Projection for the South Florida Region through 2110. Unlike the SE FL unified sea level rise projection developed by the Work Group shown in Figure 2, this graphic is developed directly according to the USACE Guidance document and illustrates the projection beyond 2100. With time, the projection increasingly diverges from the historic rate of rise.



April 2011- Transmittal Draft to the Steering Committee



Sea Level Rise Prediction



Coastal Communities Addressing Sea Level Rise



City of Miami Beach Island
Low Lying Barrier Island – Vulnerable to Flooding
Most of Existing Roadway Gutter Elevation Range = 1.0' to 2.0' NAVD



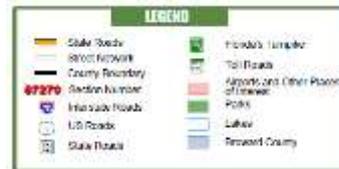
Coastal Communities Addressing Sea Level Rise



SR A1A / 5th Street, Collins Avenue, Indian Creek Drive, Harding Avenue

SR 907 / Alton Road

SR 112/I-195/41st Street, Arthur Godfrey Road



City of Miami Beach State Road Map



Coastal Communities Addressing Sea Level Rise



Miami Beach Flooding October 2012



Coastal Communities Addressing Sea Level Rise

- Tailwater Elevation = 2.7' NAVD (4.2' NGVD)
- Minimum Seawall Top Elevation = 5.7' NAVD (7.2' NGVD)
- Minimum Crown Elevation = 3.7' NAVD (5.2' NGVD)
- Minimum Building Finished Floor Elevation = 8.5' NAVD (10.0' NGVD)
- Pump Station Wet Well Top Elevation = 5.0' NAVD (6.5' NGVD)
- Design Storm : SFWMD 5-year, 24-hour storm (7.5-inches rainfall)

City of Miami Beach Upgraded Flood Protection Criteria



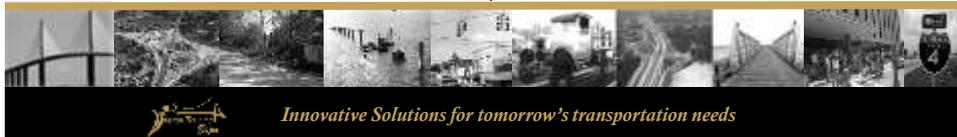
Coastal Communities Addressing Sea Level Rise



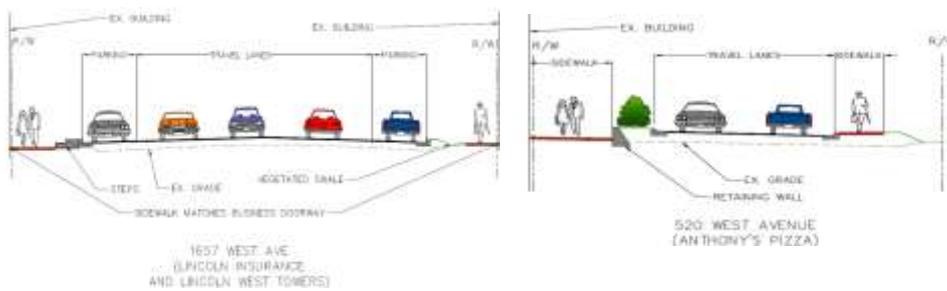
City of Miami Beach

Upgraded Flood Protection Criteria –

Tailwater, Minimum Seawall Top Elevation, Minimum Building Finished Floor & Minimum Roadway Crown Elevation



Coastal Communities Addressing Sea Level Rise



City of Miami Beach

Upgraded Flood Protection Criteria – Raising Roadways



Coastal Communities Addressing Sea Level Rise

CITY OF MIAMI BEACH STORMWATER MANAGEMENT MASTER PLAN

GOING FORWARD

Implement Stormwater System Improvements

- Install backflow preventers at outfalls
- Construct new stormwater pump stations
- Add pumps to gravity systems
- Create storage for stormwater
- Raise seawalls to mandated heights

Monitor change in sea level rise;

Modify programmed stormwater improvements







City of Miami Beach Stormwater Master Plan



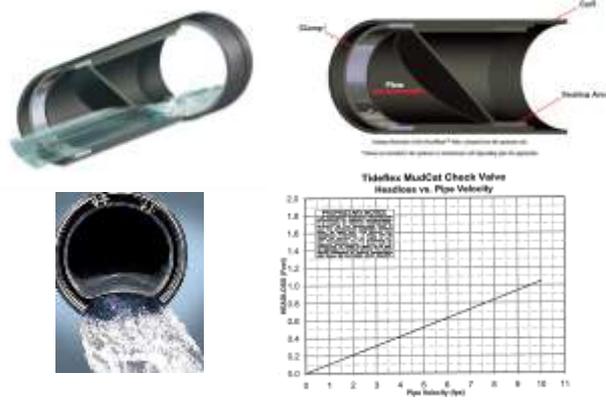
FDOT Addressing Sea Level Rise

- SR 907/Alton Rd. at 5th St., 6th St. & 10th St. – Outfall Check Valves
- SR 826/Sunny Isle Blvd. Business Loop – Outfall Check Valves
- SR A1A/Indian Creek Dr. at 43rd St. – Pump Station (1) – under construction
- SR 907 /Alton Rd. – 5th St. To Michigan Ave.(2.0 mi.) – Pump Station (3) – under construction
- SR 907/Alton Rd - Michigan Ave. to 43rd St. (1.5 mi.) – Pump Station (2) – under design
- SR 907/Alton Rd. – 43rd St. to Allison Rd. (2.6-mi.) – Pump Station (4) – under design

FDOT District 6 –Ongoing High Tide Flood Protection Projects



FDOT Addressing Sea Level Rise



FDOT District 6 – Preferred Tidal Backflow Preventer Option:
In-Line Check Valve – “Check-Mate”



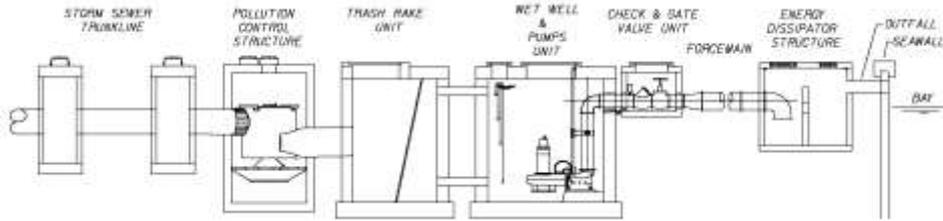
FDOT Addressing Sea Level Rise



SR 907/Alton Rd. at 5th Street – 72” RCP Outfall Check Valve Installation



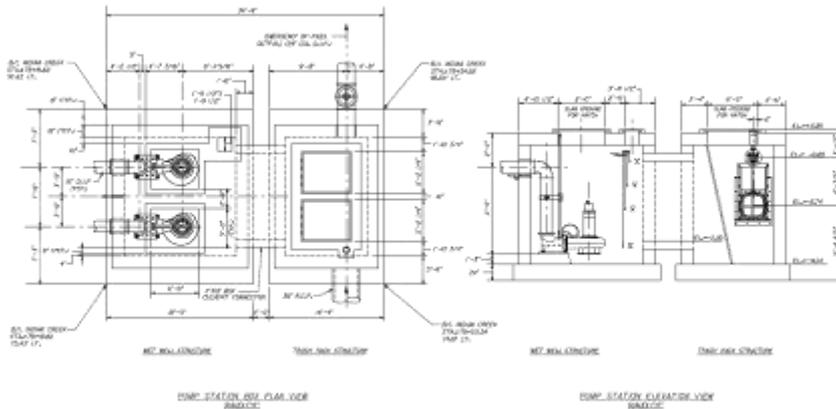
FDOT Addressing Sea Level Rise



Stormwater Pump Station Typical Layout Scheme
City of Miami Beach Direct Discharge Policy



FDOT Addressing Sea Level Rise



SR A1A/Indian Creek Drive at 43rd Street Project
Pump Station Plans



FDOT Addressing Sea Level Rise



SR A1A/Indian Creek Drive at 43rd Street Project
Pumps, Wet-Pit, Check-Valve Box Under Construction



FDOT Addressing Sea Level Rise



SR A1A/Indian Creek Drive at 43rd Street Project
Pre-Cast Pump Station Wet-Pit, Check & Gate Valve Box Units



FDOT Addressing Sea Level Rise



SR A1A/Indian Creek Drive at 43rd Street Project Roadway & Storm Sewer Construction



FDOT Addressing Sea Level Rise



SR A1A/Indian Creek Drive at 29th Street Flooding King Tide (October 10th, 2014) Seawall Canal Overtopping



FDOT Addressing Sea Level Rise



SR 907/Alton Road at 5th Street FDOT 48" Outfall
Temporary mobile pump unit operating during King Tide Week (October 2014)



FDOT Addressing Sea Level Rise



FDOT Ongoing Projects
SR A1A/Indian Creek Dr. at 43rd St. Pump Station



FDOT Addressing Sea Level Rise



FDOT Ongoing Projects
SR 907/Alton Rd. at 6th Street Pump Station



FDOT Addressing Sea Level Rise



FDOT Ongoing Projects
SR 907/Alton Rd. from 43rd St. to Allison Rd.



FDOT Improving Resiliency



FDOT District 4 – Common Tidal Backflow Preventer Option:
Aluminum Flap Gate



FDOT Improving Resiliency



FDOT District 4 – SR-A1A Shoreline Revetment Projects Improving Resiliency



FDOT Improving Resiliency



FDOT District 4 – Sandy’s Waves Visit SR A1A in Fort Lauderdale



FDOT Improving Resiliency

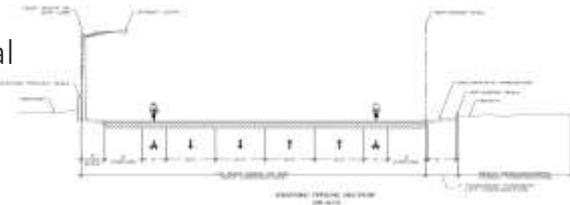


FDOT District 4 – The Aftermath of Sandy’s Waves

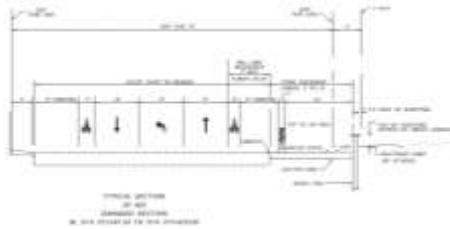


FDOT Improving Resiliency

Old Typical



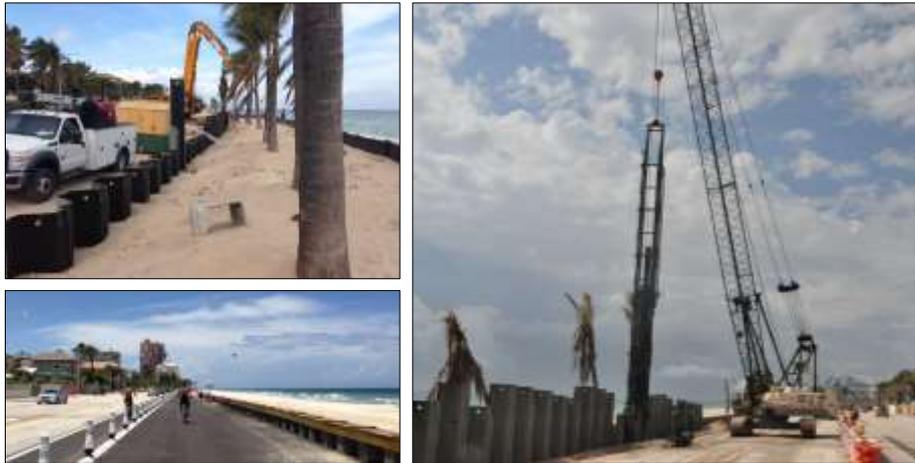
“Interim” Typical



FDOT District 4 – Emergency Repairs



FDOT Improving Resiliency

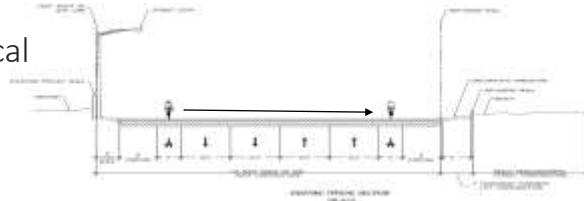


FDOT District 4 – Emergency Repair for SR A1A in Fort Lauderdale

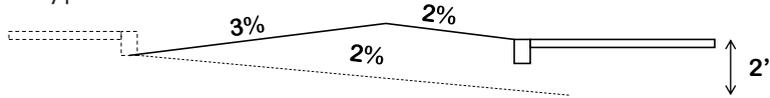


FDOT Improving Resiliency

Old Typical



New Typical



Raising the EOP of SR A1A in Fort Lauderdale

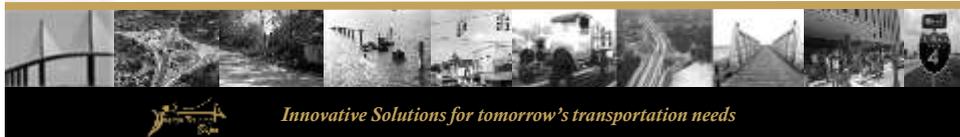


FDOT Improving Resiliency

Sandy's Visit – October 26th, 2012
 Follow-up Storms through Thanksgiving 2012
 "Emergency Repair" – Completed April 2013
 New Design – Completed December 2013
 Ongoing Construction – Started August 2014



FDOT District 4 – Building Resiliency for SR A1A in Fort Lauderdale



FDOT Addressing Sea Level Rise

- Tidal Tailwater
- Roadway Base Clearance/Design High Water
- FDOT Rainfall Distribution
- FDOT IDF Curves
- Pump Station Design
- Bridge Hydraulics & Scour
- Bridge Vertical Clearance Requirements

FDOT Drainage Design Criteria Re-Evaluation/Upgrade



Sea Level Rise Future Implications

- Widespread Flooding
- Saltwater Intrusion
- Fresh Water Aquifer & Water Supply Impacts
- Environmental Impacts – Everglades
- Economic Impacts (Tourism, Cruise Ships, etc.)



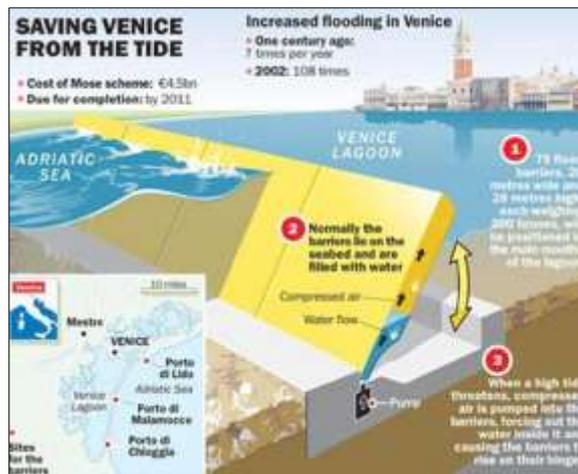
Sea Level Rise – High Tide Control

Possible Future Scenarios: Floating Lock and Sand Engine



Sea Level Rise – High Tide Control

Possible Future Scenario: Floating Lock Details



Sea Level Rise in South Florida

Overview



Questions?

