

Living with Sea Level Rise & Adapting to Climate Change in the Florida Keys



MONROE COUNTY
FLORIDA



June 24, 2021

Rhonda Haag Chief Resilience Officer

Judy Clarke Director Engineering Svsc & Roads

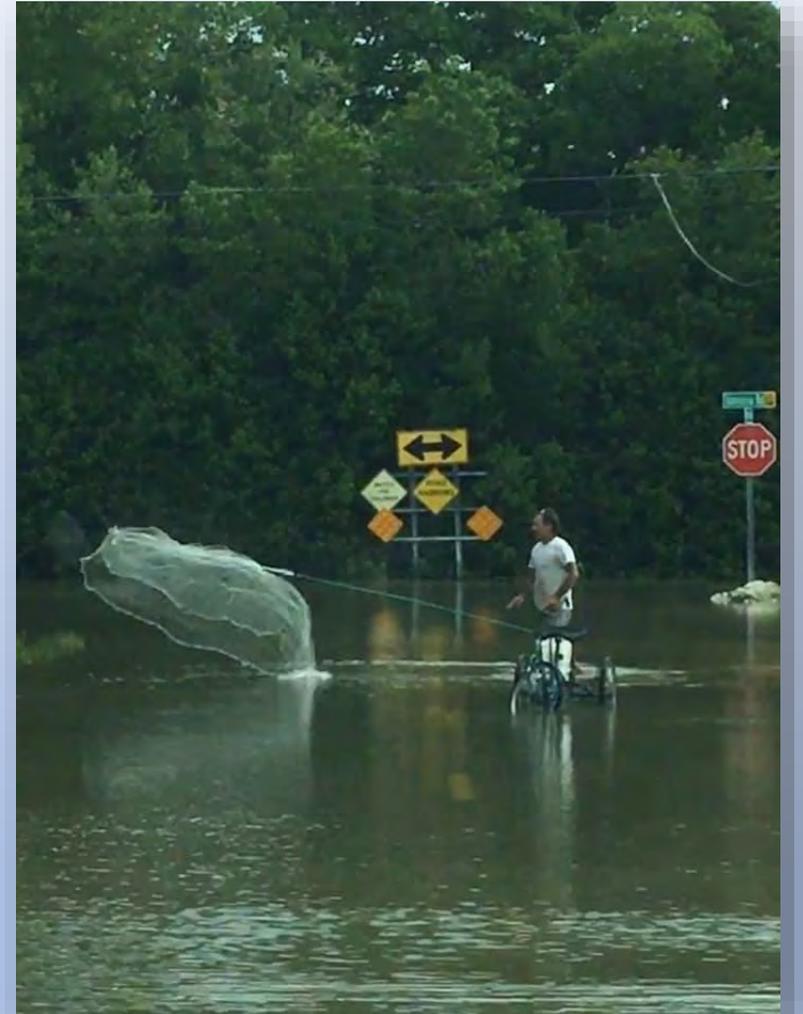


ERIN L. DEADY, P.A. 

Monroe County Roadway Vulnerability Study

Agenda for Today

1. Background on County's Resiliency and Climate Program
2. Introduction to Sea Level Rise (SLR) Roads Vulnerability Project
 - a. Project approach and status
 - b. Vulnerability and Criticality approach used to identify the initial 25% of roadway segments
 - c. Engineering concept design evaluation
3. Roads Program and Resiliency Policy Relationships



Kristen Key Szpak, 10/19/20

Monroe County Roadway Vulnerability Study

GOAL: Help make the Keys more able to withstand sea level rise impacts (become more resilient), help maintain access to homes and businesses, and help protect property values.



Kennedy Drive



King Ave



King Ave



Sexton Way

©Rhonda Haag

Background Efforts on SLR-Related Planning to Date

1. County's sea level rise planning launched in 2016: GreenKeys

- 5-year work plan, 165 recommendations
- Recommendations included:
 - Pilot Roads Projects
 - Improve elevation data
 - Engineering level analysis of transportation impacts countywide (**this Roads Adaptation Project**)
 - Numerous other vulnerability recommendations, including updates when significant new data available

2. Energy and Climate Element of Comprehensive Plan (2016)

3. Pilot Road Elevation Projects (Big Pine and Twin Lakes) initiated in 2016 and design/permits completed 2020

4. New Roads Mobile LiDAR elevation data (2019 completed)

5. Grants for SLR planning and projects (3 awarded and completed)

- Harry Harris Park, Bayshore Manor, National Oceanic and Atmospheric Administration



SLR-Related Planning Efforts *In Process or Coming Up*

1. Roads Adaptation Plan (this project launched 2019)

- Identify sea level rise impacts to roads and drainage comprehensively
- Identify policy and funding options
- Develop engineering alternatives and Implementation Plan

2. Vulnerability Assessment for other County non-road assets updated for habitat, buildings, and infrastructure (funded by Resilience Planning Grant 2020)

3. Comprehensive Plan (2021 initiate update)

- Peril of Flood amendments to address State requirements (drafted, RPG 2019)
- Adaptation Action Areas (in process RPG 2020)
- Other amendments as necessary

4. Pending Grants and Projects in application review

- Twin Lakes x 2 (State & Fed)
- Sands Subdivision x 2 (State & Fed) (Grant in Process)
- Natural Areas Adaptation Plan (State)- awarded
- Stillwright Point (State)



Monroe County Roadway Vulnerability Study

Engineering Analysis – SLR Projections and King Tide Predictions

Southeast Florida Regional Climate Change Compact

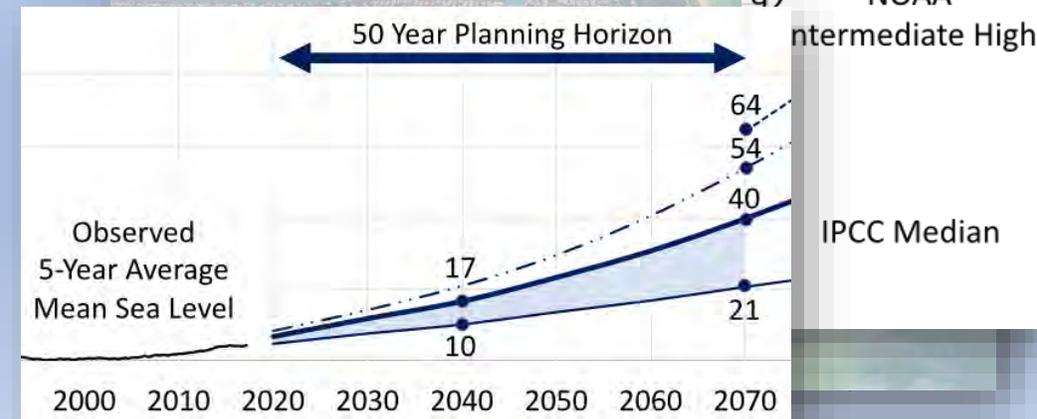
- Broward, Miami-Dade, Monroe, and Palm Beach counties recognized the need to unify local sea level rise projections to create a single, regionally unified projection, ensuring consistency in adaptation planning and policy, and infrastructure siting and design.
- 2011 - First Regionally Unified Sea Level Rise Projection for Southeast Florida (Updates in 2015 and 2019)
- The 2019 Projection is based on projections of sea level rise developed by the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (IPCC, 2014), as well as projections from the National Oceanic and Atmospheric Administration (NOAA) (Sweet et al., 2017), and accounts for regional effects, such as gravitational effects of ice melt, changes in ocean dynamics, vertical land movement, and thermal expansion from warming of the Florida Current that produce regional differences in Southeast Florida's rate of sea level rise compared to global projections.
- Estimates of sea level rise are provided from a baseline year of 2000, and the planning horizon has been extended to 2120, in response to the release of climate scenarios extending beyond the year 2100 by federal agencies (NOAA and the U.S. Army Corps of Engineers) and the need for planning for infrastructure with design lives greater than 50 years.

Monroe County Roadway Vulnerability Study

Engineering Analysis – SLR Projections and King Tide Predictions (Cont.)

Unified SLR Projection SE Florida (Guidance Report)

- Blue shaded zone between the IPCC median curve and the NOAA Intermediate-High curve is recommended by Compact counties generally to be applied to most projects within a short term planning horizon (Up to 2070)
- IPCC median curve represents the most likely **average** sea level before 2070, but is not representative of realistic interannual and interdecadal **variations** that will occur with SLR.
- Use of IPCC Median curve, must consider the consequences of **under-designing** for the potential likely sea level condition. Such consequences may include premature infrastructure failure.
- Use IPCC Median curve for small risk projects (**projects whose failure would result in limited consequences to others**) such as a small culvert in an isolated area.

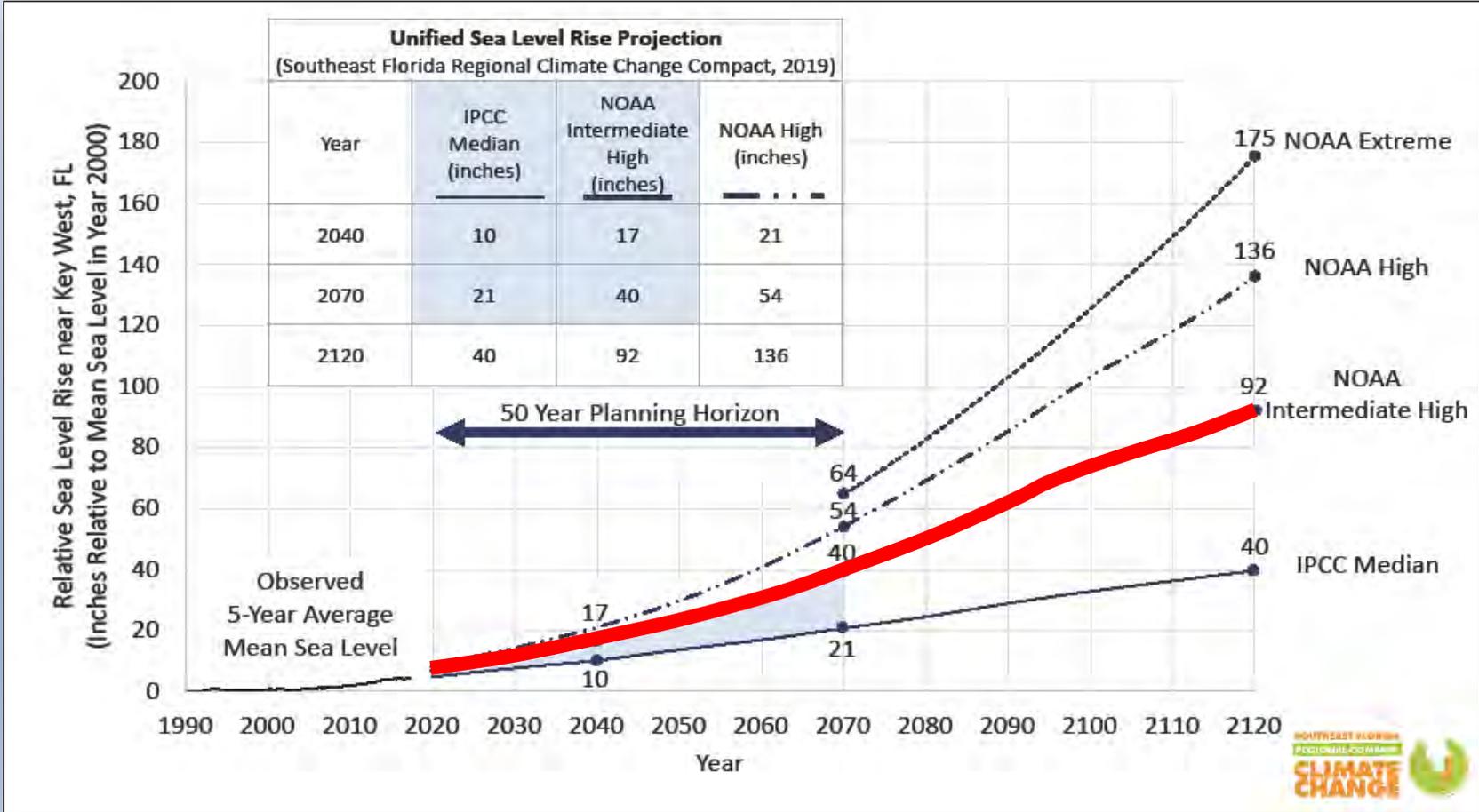


Monroe County Roadway Vulnerability Study

Increasing Projected Water Levels Throughout County...

SLR Condition: NOAA 2017 Intermediate-High

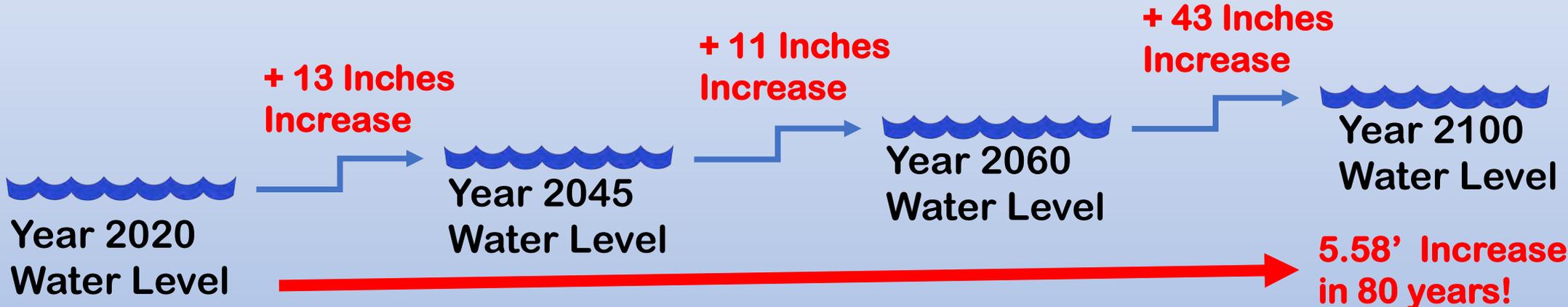
SE FL Regional Climate Compact Updated Projections 2019



Monroe County Roadway Vulnerability Study

Increasing Projected Water Levels Throughout County...

SLR Condition: NOAA 2017 Intermediate-High from 2000 Baseline year



Monroe County Roadway Vulnerability Study

Increasing Projected Water Levels Throughout County...

SLR Condition: NOAA 2017 Intermediate-High + King Tides



Monroe County Roadway Vulnerability Study

Increasing Projected Water Levels Throughout County...

SLR Condition: NOAA 2017 Intermediate-High + King Tides

\$1.8 Billion*

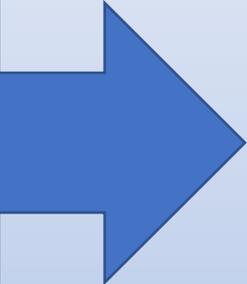
Projected SLR + King Tides will affect the following:	2045	Unincorporated Countywide %	2060	Unincorporated Countywide %	2100	Unincorporated Countywide %
Miles of Vulnerable and Critical County Maintained Roadways	152 MI	49%	206 MI	66%	252 MI	81%
# of Residential Units along County Maintained Roadways	12,585 Res. Units	71%	14,501 Res. Units	82%	16,370 Res. Units	92%

311 Total Road Miles County Wide

* Cost estimate is conceptual and assumes reconstruction of the roadway and use of an injection well system. Cost estimates do not include design, right-of-way acquisition, harmonization/cost to cure, and legal fees. Cost estimates are preliminary and subject to change.

Monroe County Roadway Vulnerability Study

Vulnerability and Criticality Evaluation to determine **Initial 25%** of road segments to be further evaluated (remaining 75% addressed later)



Task 1:
Data Collection



Task 2:
Engineering Analysis



Task 3:
Concept Development

....IN PROGRESS



Task 4:
Policy Review & Regulations

....IN PROGRESS



Task 5:
Stakeholder & Public Outreach



Task 6:
Implementation Plan

Monroe County Roadway Vulnerability Study



2-Step Modeling Process to Rank the Roads according to Vulnerability and Criticality



Good quality data is available for all roadway segments



Initial modeling is for SLR (NOAA 2017 Intermediate-High) Projections + King Tide Predictions to identify roadway segments impacted by future water levels.



2045 Design Year (standard “useful life” of a road project)

Monroe County Roadway Vulnerability Study

What is vulnerability?



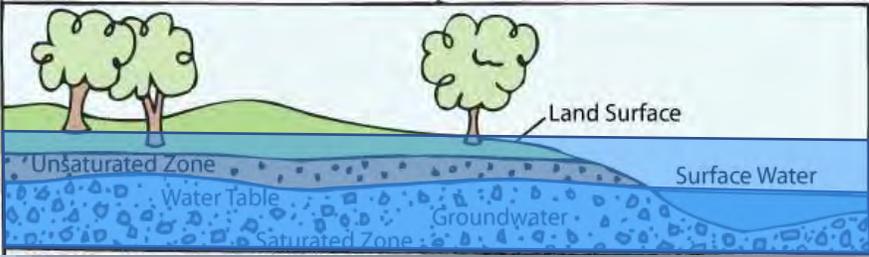
What is criticality?



Monroe County Roadway Vulnerability Study

Step 1: Vulnerability Assessment

- Very High Vulnerability
- High Vulnerability
- Moderate Vulnerability
- Low Vulnerability
- Very Low Vulnerability



1. Groundwater Clearance



2. Surface Inundation Depth (SLR)



3. Storm Surge



4. Surface Wave Impact Potential



5. Roadway Existing Pavement Condition

Monroe County Roadway Vulnerability Study

Step 1: Vulnerability Assessment – What did it reveal?

Old State Rd 4A (SLR Projection + King Tide measured from Roadway Surface Elevation)



Monroe County Roadway Vulnerability Study

Step 2: Criticality Assessment

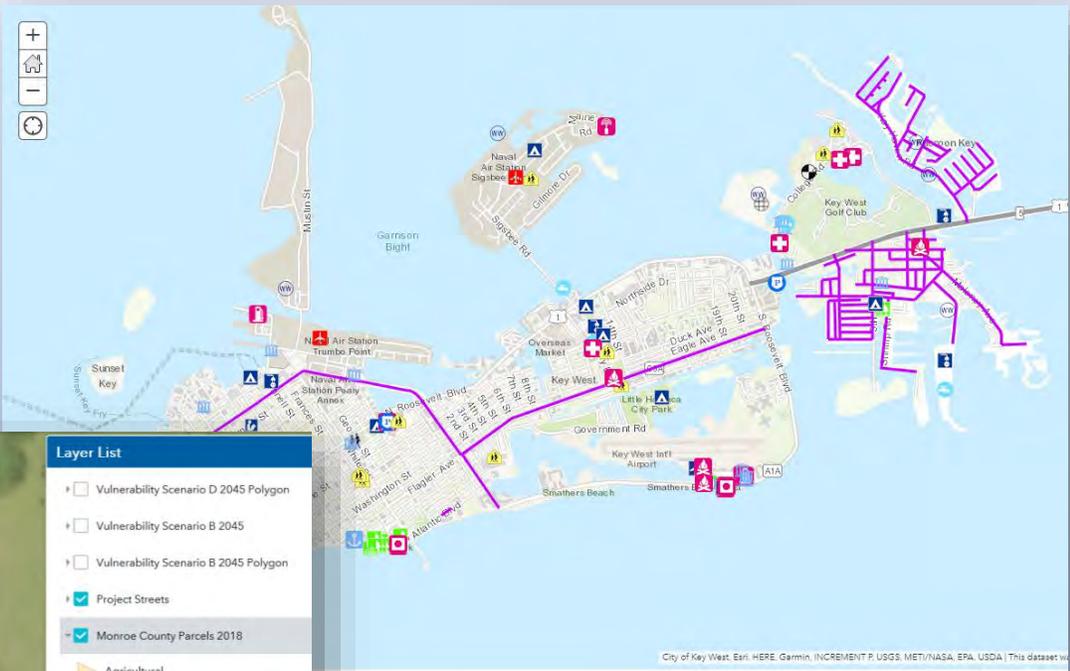
- Very High Criticality
- High Criticality
- Moderate Criticality
- Low Criticality
- Very Low Criticality



1. Vulnerability Score



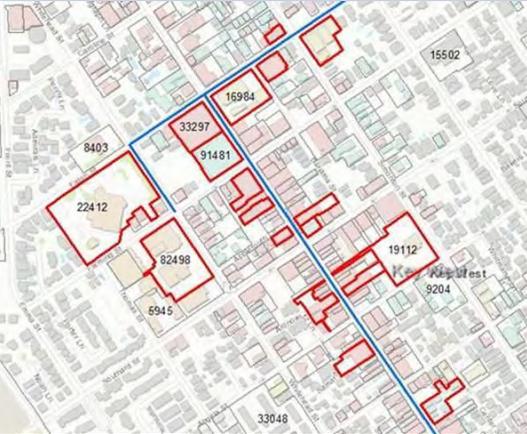
2. Number of Residential Units



3. Roadways Associated with Critical Facilities

Monroe County Roadway Vulnerability Study

Step 2: Criticality Assessment (Cont.)



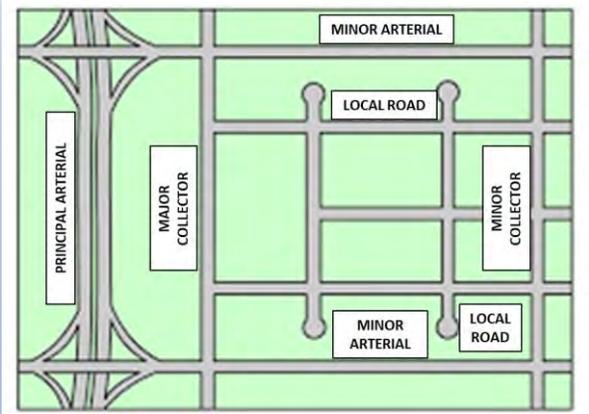
4. Commercial Buildings



5. Threatened, Endangered and Focus Species



6. Wetlands/Natural Habitats



7. Roadway Functional Classification and Evacuation Route

Monroe County Roadway Vulnerability Study

Recommended Weight Factors to obtain Weighted Averages

STEP 1

Vulnerability Evaluation Factors	Weighting Percentages
Roadway Surface Inundation Depth	60%
Roadway Groundwater Clearance	25%
Roadway Inundation Due to Storm Surge	5%
Roadway Surface Wave Impact Potential	5%
Roadway Existing Pavement Condition	5%



STEP 2

Criticality Evaluation Factors	Weighting Percentages
Vulnerability Score	50%
Number of Residential Units	25%
Roadways Associated with Critical Facilities (Police, Fire, Hospital)	10%
Wetlands/Natural Habitats associated with Road Segment	5%
Roadway Functional Classification and Evacuation Routes	5%
Non-Residential Parcel Building Size (Commercial Buildings)	3%
T&E and Focus Species associated with Road Segment	2%

Monroe County Roadway Vulnerability Study

Initial 25% of Road Segments Based on Preliminary Scoring to proceed to Engineering Concept Design Evaluation

	No. of Keys	Rdwy Segments	Sub-Divisions	Length (Miles)	Residential Units
Initial 25%	17	709	240	78.01	8303
All Unincorporated County (100%)	24	2383	260	311.00	17703
Percentage of Total	71%	30%	92%	25%	47%



Upper Keys

- Roadway Segments: 221
- Length (Miles): 20.98
- Residential Units: 2360

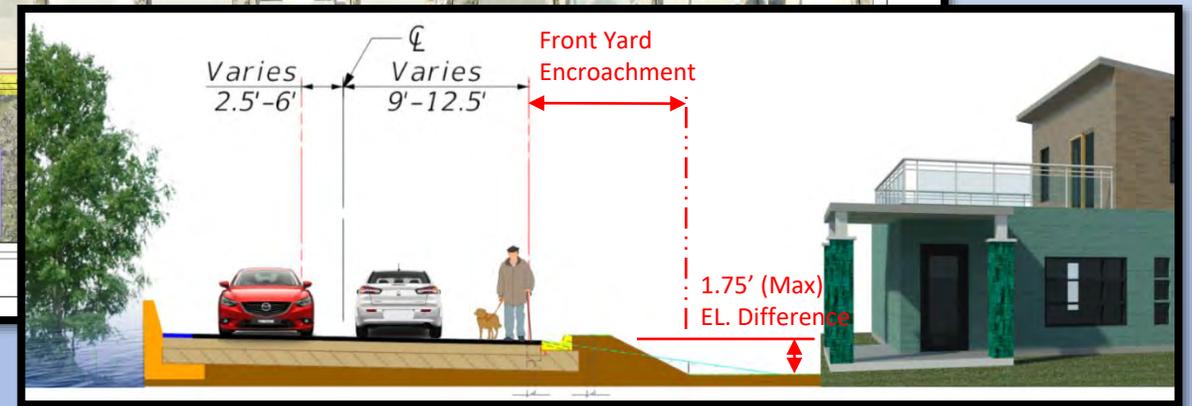
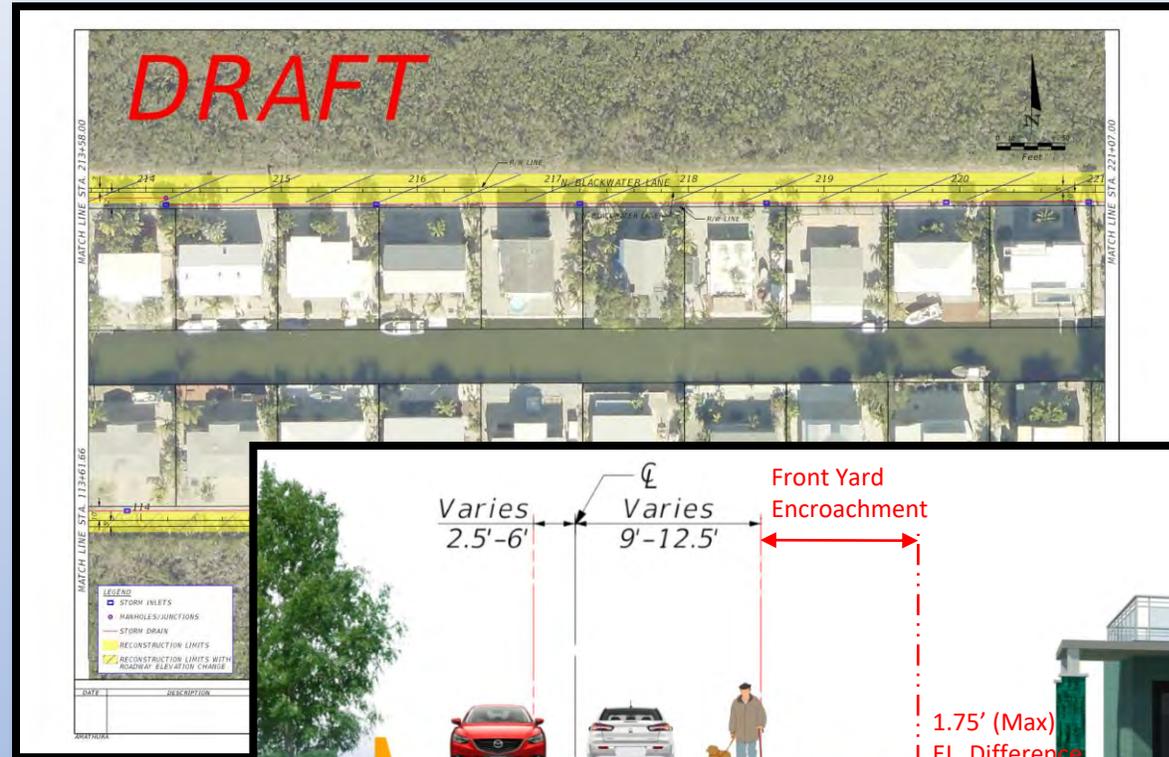
NOAA 2017 Intermediate-High SLR Projection + King Tide Prediction for 2045



Monroe County Roadway Vulnerability Study

What Road Design will work and where?

- Develop preliminary **conceptual** design of roadway and flood mitigation improvements
 - Future water levels
 - Existing ground elevations
 - Safety
 - Accessibility
 - Utility Impacts
 - R/W Impacts
 - Collection, conveyance, treatment, and disposal of water on the roadways
- Deliverable: Roadway Plan Sheets and Typical Sections for each neighborhood.



Monroe County Roadway Vulnerability Study

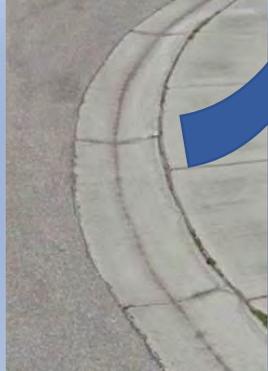
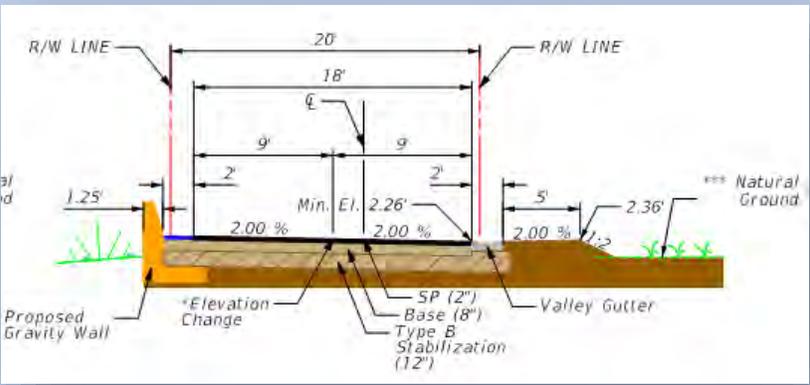
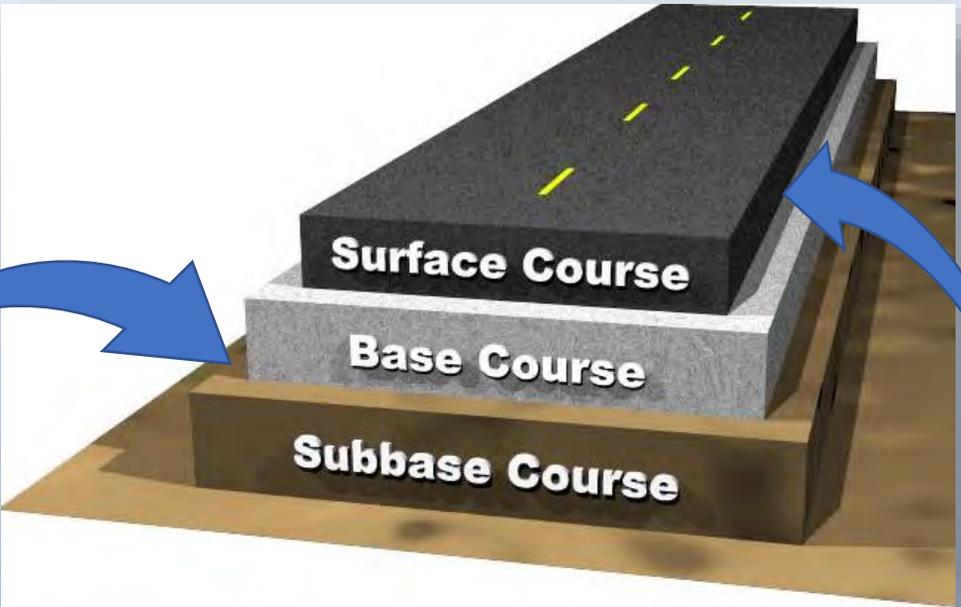
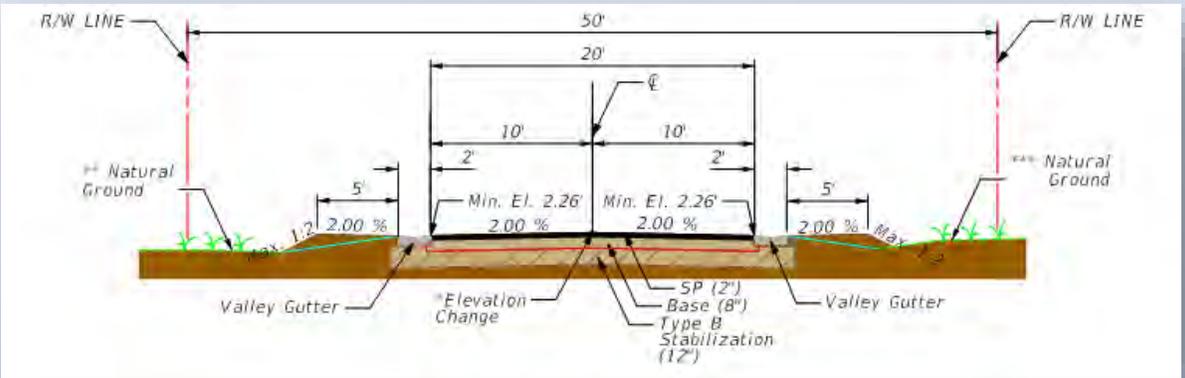
What other impacts / factors to consider?

- Environmental and permitting assessment
- Roadway cost estimates for preliminary design concepts
- Financial analysis for road segments
- Impact to residents



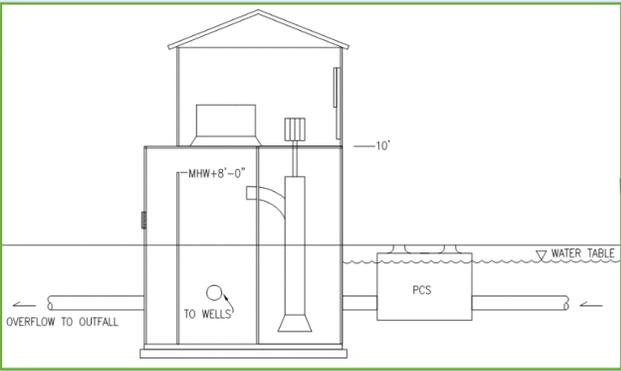
Monroe County Roadway Vulnerability Study

Roadway Typical Sections



Monroe County Roadway Vulnerability Study

Storm Drain Layout



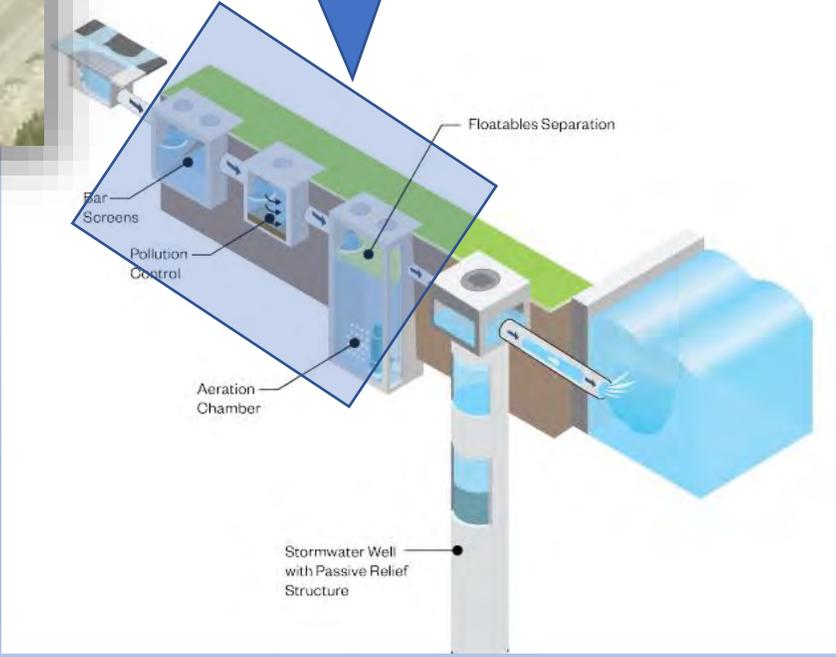
Pump Station



Pump Station Area



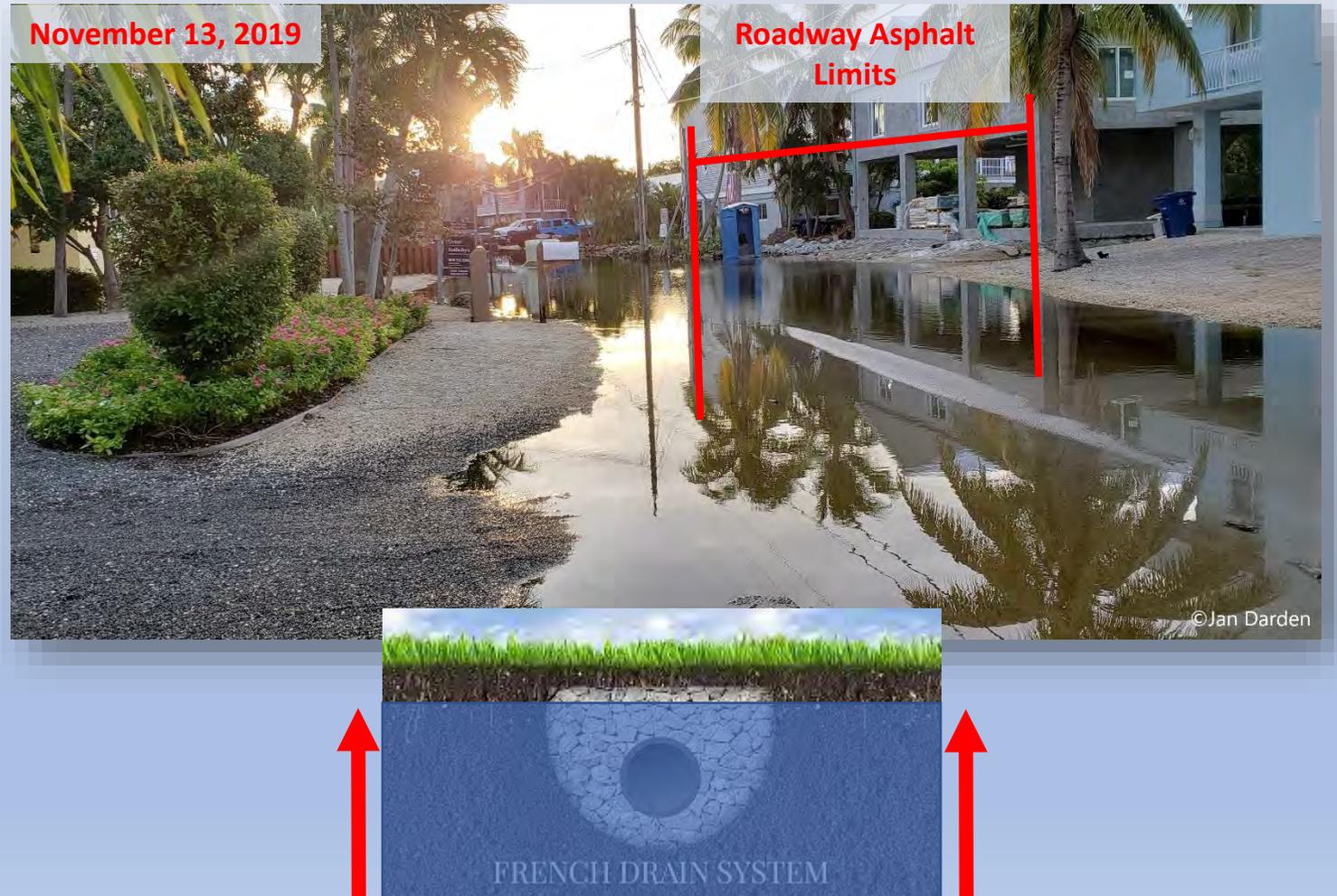
Injection Well on Patricia Street, Key West



Typical Water Quality Treatment Systems (Graphic from City of Miami Beach)

Would adding a couple of asphalt inches and installing an exfiltration drainage system work?

- Inability to get a permit
- Minimum short-term benefits
- Private property flooding potential
- With or without drainage features, salt water flooding will still occur along the roadsides
- With or without drainage features condition will be exacerbated by rain events
- Flooding will accelerate roadway deterioration
- Is it legal?



Work to Develop Roads and Flood Mitigation Implementation Strategy

- **Decision Framework of Adaptation Approaches**
 - **Analysis of Future Growth**
 - Where is the remaining growth (and demand for services) going to go?
 - **Level of Service issues**
 - Differing levels of service across neighborhoods
 - Case studies related to “natural hazards” and government providing services (ie; flooding, snow plowing, fire management, etc.)
 - **“Road Maintenance”**
 - County obligations to maintain ITs roads and authority to upgrade
- **Regulatory requirements**
 - Feds, State & County related to sea level rise
- **Funding**
 - Case studies in resiliency funding
- **Implementation strategies:**
 - Comprehensive Plan, Ordinances, Code, Special Districts/MSBU, etc.



Twin Lakes

County Adaptation + Parcel Adaptation

Projected SLR impacts to private properties (due to low elevation) will continue to increase along vacant lots, shorelines and property lines

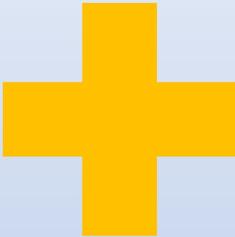


2025
2035
2045

County Adaptation + Parcel Adaptation

Countywide Adaptation

- Roads
- Habitat/Resources
- Elevate or mitigate County buildings
- Infrastructure



Private Property Response

- Elevate or mitigate private structures
- Lot fill and driveways
 - Shorelines



Achieving Resilience

- County
- People
- Habitat
- Economy



Coordinating the Response

Examples of what we mean by “Implementation”

1. Comprehensive Plan

- Peril of flood
- Policies for maintaining v. upgrading levels of service
- New policies in various elements
- **Examples of Adaptation Action Areas**

2. Code

- Road design criteria and flooding levels of service
- Driveway elevations
- Fill and onsite retention
- Seawall elevations

3. Funding

- County funding for adaptation projects
- Federal/State Grants
- 35% Cost share for Corps study
- Assessments, utility or user fees

4. Partnerships

- SFWMD/USGS- Rainfall data
- Florida DEP- Planning, projects and **grants**



Aligning Efforts to Achieve Results

New Laws and Rules

- Linkages to Comprehensive Plans (Peril of Flood)
- Sea Level Impact Projection (SLIP) studies for projects
- Vulnerability assessment and analytical standards (HB 7019)
- Uniform State Stormwater Rules

New Funding Sources

- Resilient Florida program
- Federal programs
- Other sources/partnerships

The Planning Work

The resiliency planning work we do now, means that we are ready when these initiatives come online or funding sources open up. We are tracking 1) various regulatory efforts to ensure that when we are ready to design or permit a project, we don't run into surprises and 2) funding sources to fund our projects.



Keys Countywide Project...What's next?

Completion of the Monroe County Roadways Vulnerability Study will enable a complete understanding of the areas of concern, overall improvements needed and the costs for road and drainage infrastructure adaptation



Discussion & Questions

THANK YOU!