




Low-lying Roads: Orleans

An Economic Development
Administration Disaster Grant
Project

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Woods Hole Group: Joe Famely, Brittany Hoffnagle

Purpose and Objectives of Workshop

- 
- **Gain understanding of coastal climate hazards**
 - **Review flood projections and impacts on roadways for the town under future scenarios**
 - **Discuss priority vulnerable low-lying roads or other transportation infrastructure**
 - **Prepare the town to address priority road segments for design and permitting**

Agenda

- Project Overview
- Local Coastal Climate Hazards
- Vulnerability and Risk Assessment
- Results of Low-Lying Roads Screening
- Breakout Groups
- Next Steps

Low Lying Roads Project

10

TOWNS

EDA and MVP
funding thru 2023



Vulnerability assessment of low-lying roads and transportation infrastructure



Municipal prioritization



Potential design solutions

NEXT STEPS: PUBLIC MEETINGS

Prioritize most critical road segments for development of alternative solutions for sea level rise and storm surge adaptation

FALL - DECEMBER

6 public workshops

LATE WINTER - SPRING

4 public workshops

FALL

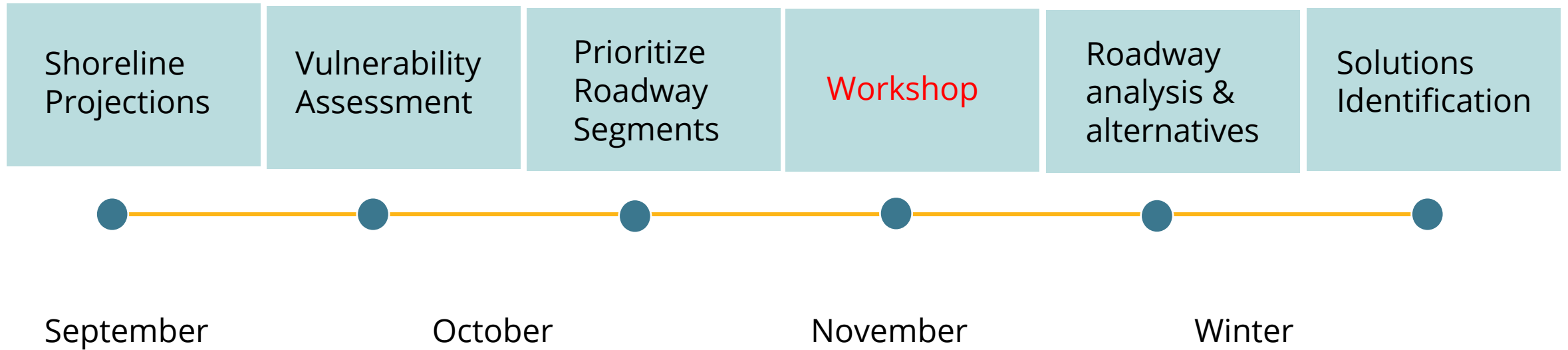
Yarmouth, Orleans,
Eastham, Wellfleet,
Sandwich, Dennis

WINTER

Barnstable, Bourne,
Brewster, Truro

SPRING

PROJECT TIMELINE



Questions?

- Workshop Purpose or Objectives
- Low Lying Roads project
 - Key components
 - Vulnerability Assessment - Identify Potential Sites
 - Public Outreach and Engagement
 - Roadway Feasibility and Alternative Solutions
 - Solutions Identification
 - Timeline

Types of Hazards



CHANGES IN PRECIPITATION



Inland Flooding



Drought



Landslide



RISING TEMPERATURES



Fire (Urban & Wild)



Extreme Temperature



Invasive Species



SEA LEVEL RISE



Coastal Flooding



Coastal Erosion



Dam/Culvert Failure



Tsunami



EXTREME WEATHER



High Winds



Tornados

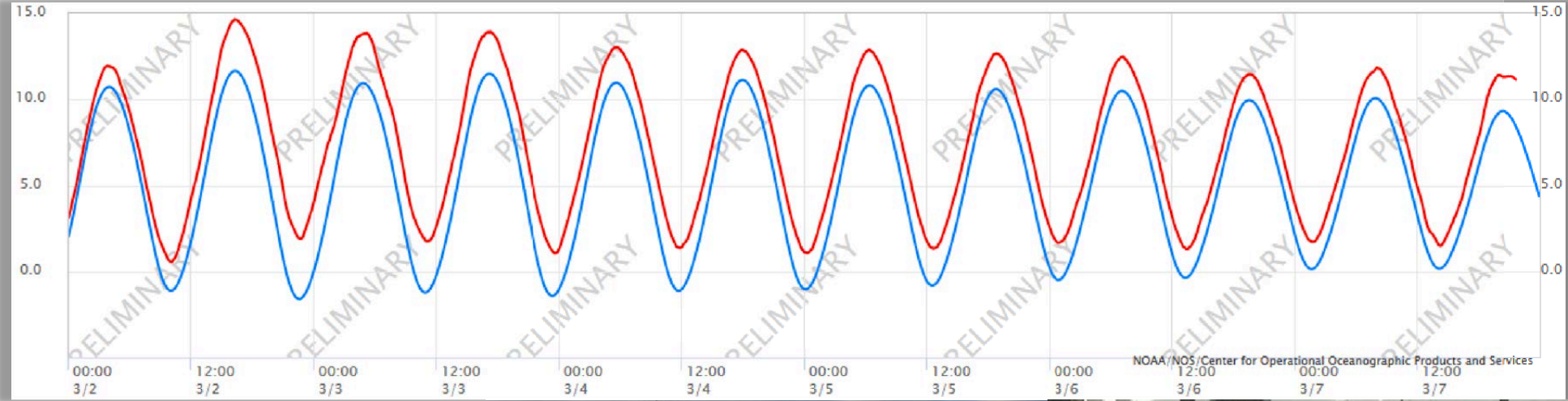


Severe Winter Storm/
Nor'easter



Hurricanes/Tropical Storms

HAZARD Storms



HAZARD
Erosion &
Flooding



HAZARD
Sea Level
Rise



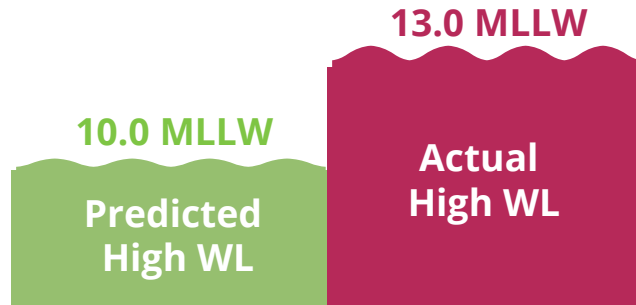
HURRICANE SANDY (10/29-30/2012)



Max Surge: 4.5'
High Tide Surge: 2.5'



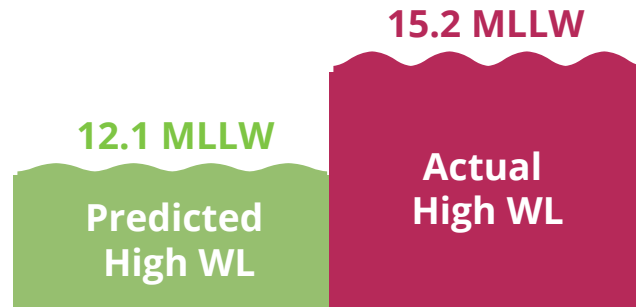
NOR'EASTER NEMO (2/8-9/2013)



Max Surge: 3.9'
High Tide Surge: 3.0'



NOR'EASTER GRAYSON (1/4-5/2018)



Max Surge: 3.1'
High Tide Surge: 3.1'

Changes in Land-use

Population has increased 4.75x since the 1950s

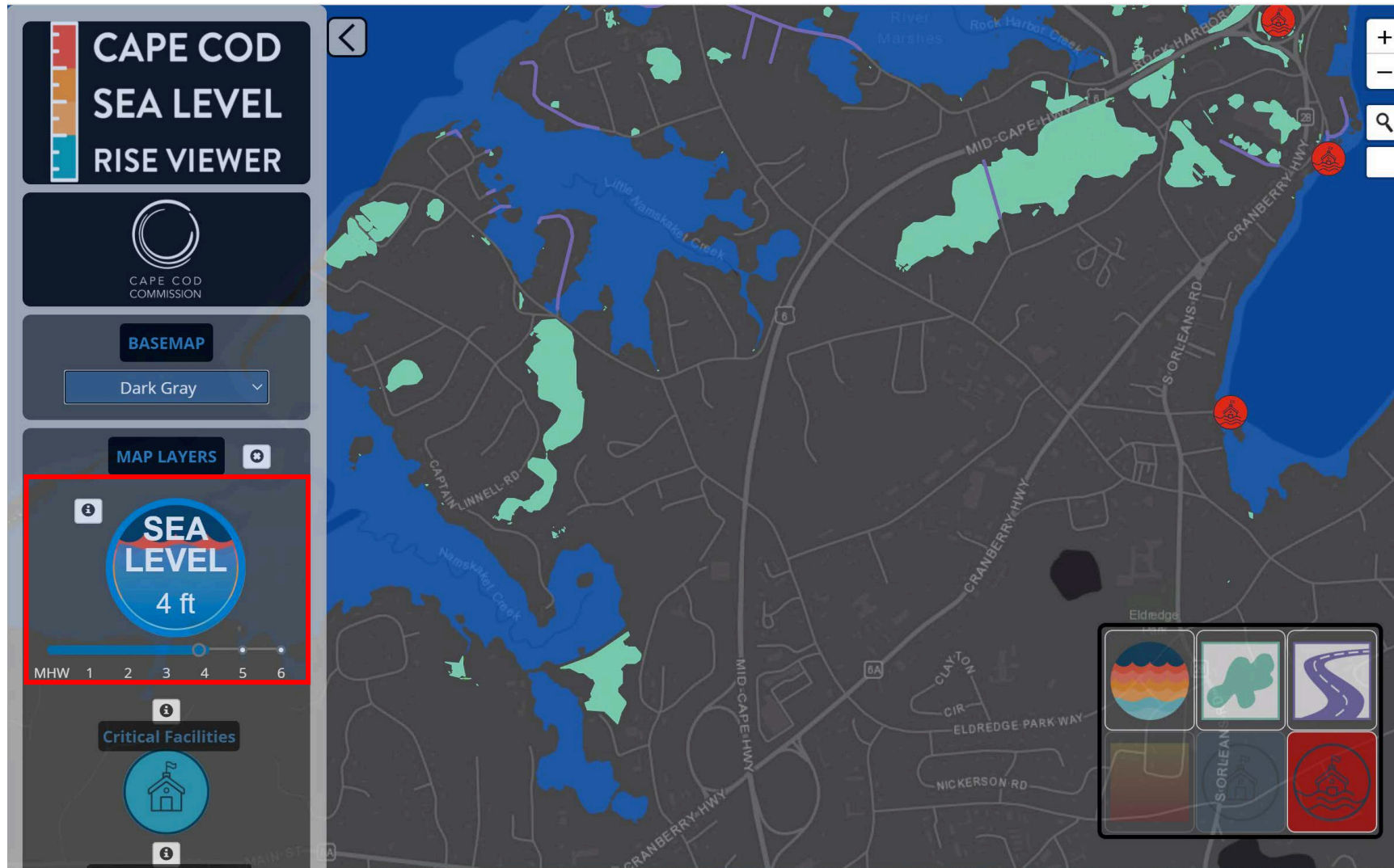


In 1954, Hurricane Carol caused 65 deaths, \$15 million in crop damage (\$461 million total), 10,000 houses damaged



With such a high increase in population since Hurricane Carol, future hurricanes could have a much greater impact on the area, causing more damage to life, infrastructure, and livelihood

CAPE COD COMMISSION SLR VIEWER



CAPE COD COMMISSION SLR VIEWER



Spectrum of Adaptation Strategies



**DO
NOTHING**

**DUNE
CREATION**

**LIVING
SHORELINE**

**COASTAL
ARMORING**

Adaptation Strategies



- | Green Infrastructure, or Nature-based Solutions
- | Gray Infrastructure, or Traditional Engineering Structures
- | Other approaches – Managed Retreat, Abandonment

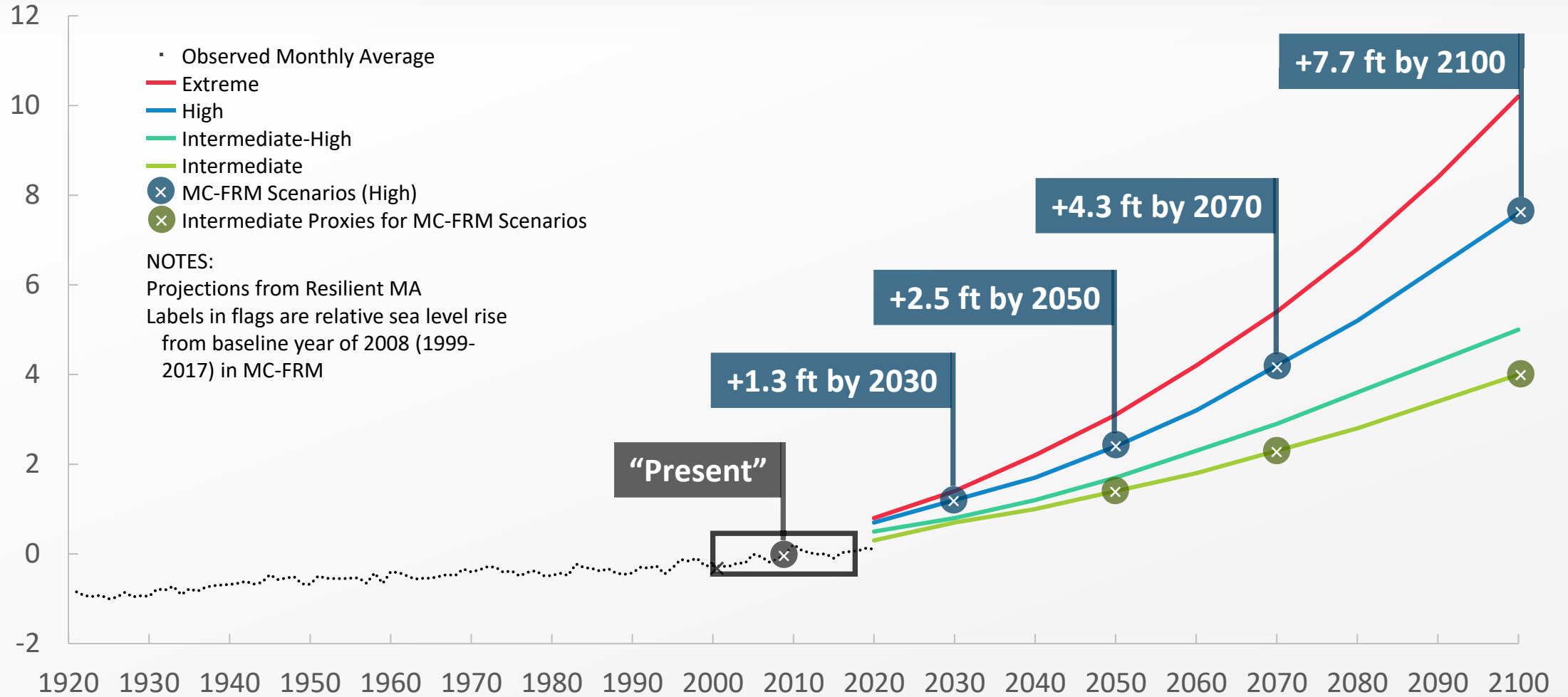
Questions?

- Types of Hazards
- Local Hazards
 - Storms
 - Erosion and flooding
 - Sea level rise
- Changes in Land Use
- Cape Cod Commission Sea Level Rise Viewer
- Adaptation Strategies

MA EOEEA Probabilistic Sea Level Rise Projections

MC-FRM NORTH (DeConto & Kopp, 2017)

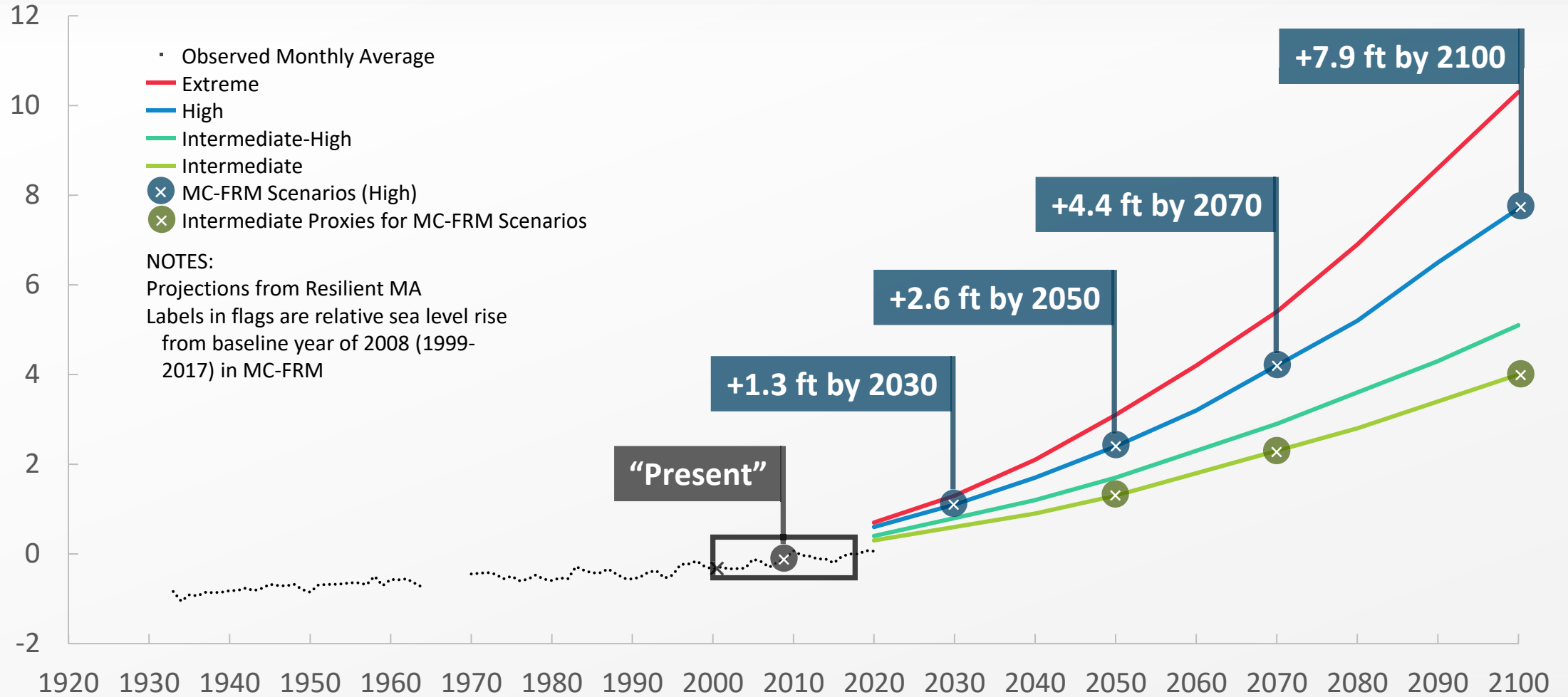
Relative Mean Sea Level (feet NAVD88)



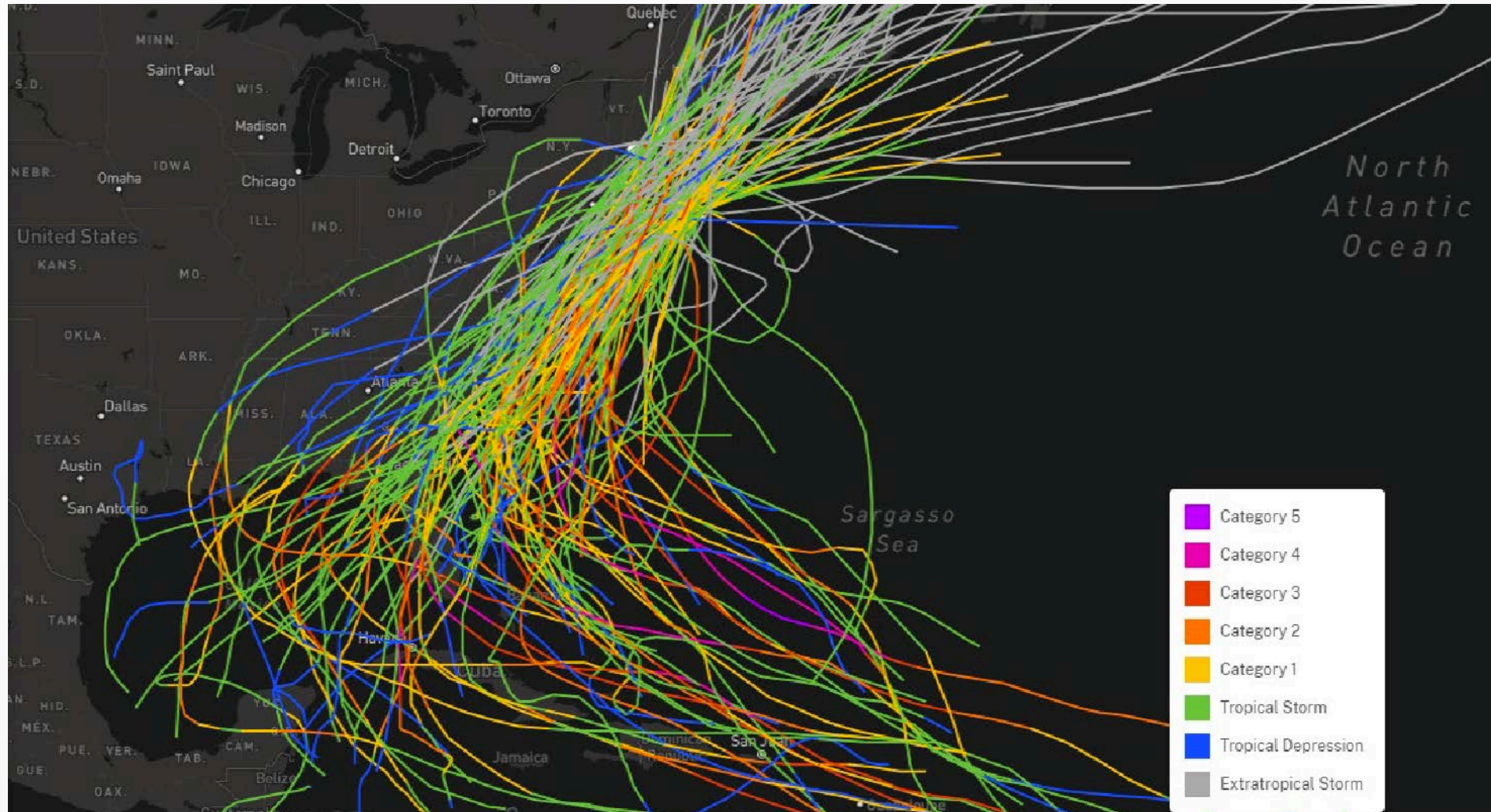
MA EOEEA Probabilistic Sea Level Rise Projections

MC-FRM SOUTH (DeConto & Kopp, 2017)

Relative Mean Sea Level (feet NAVD88)



Tropical / Extra-tropical Storms



NOAA National Ocean Service

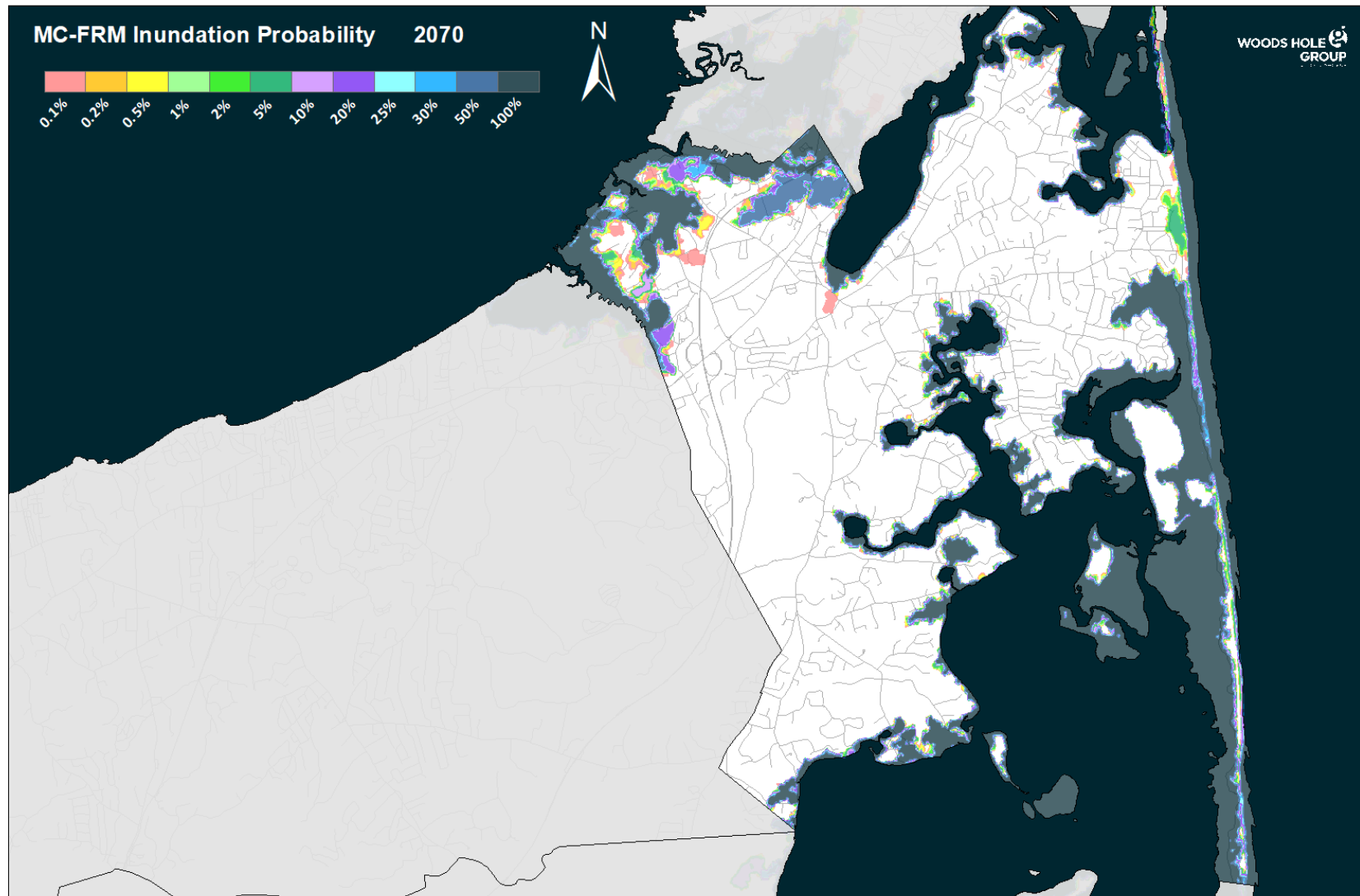
Massachusetts Coast Flood Risk Model (MC-FRM)



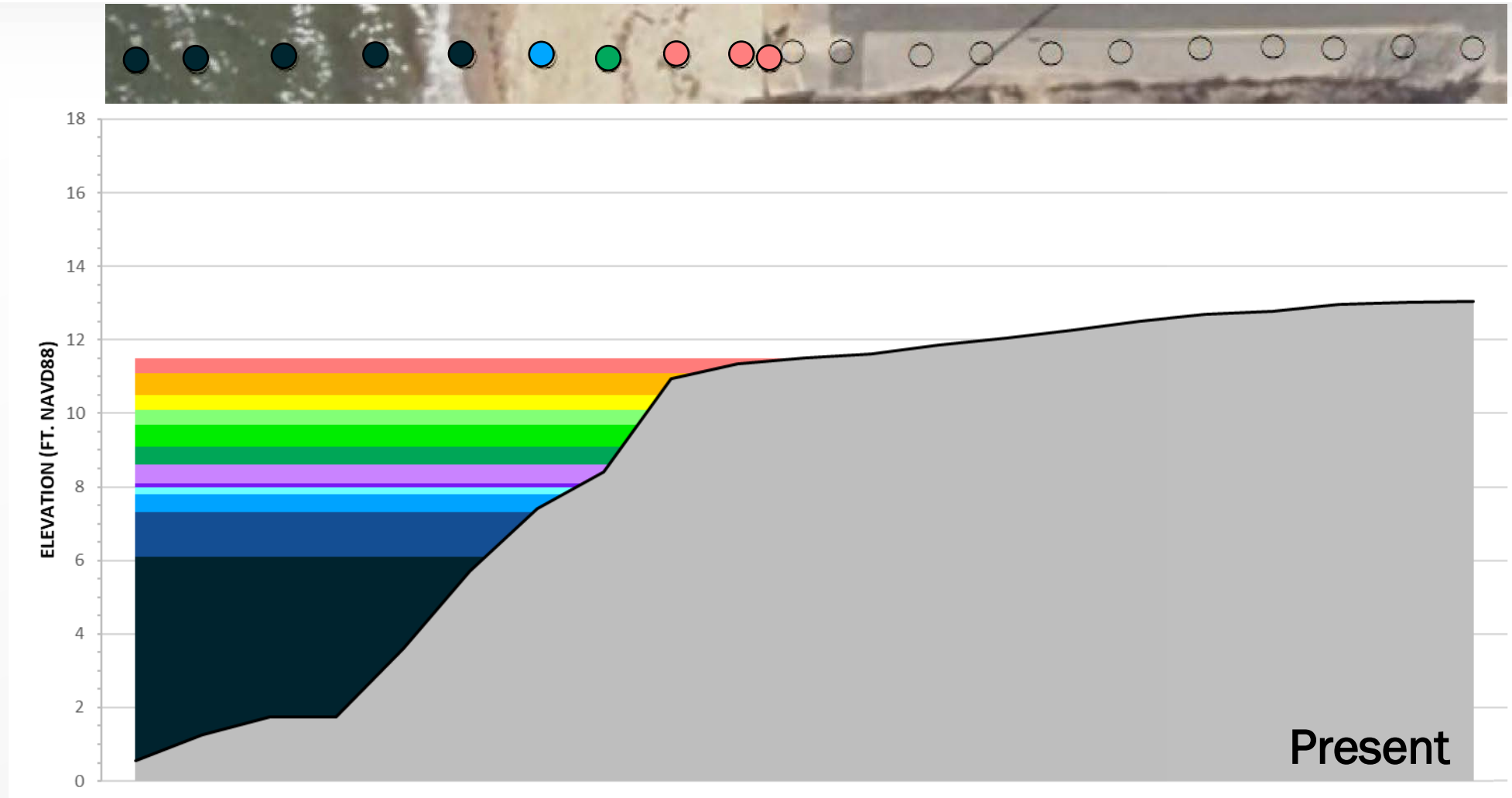
MC-FRM Resolution - Orleans



MC-FRM Coastal Flood Exceedance Probability – Orleans

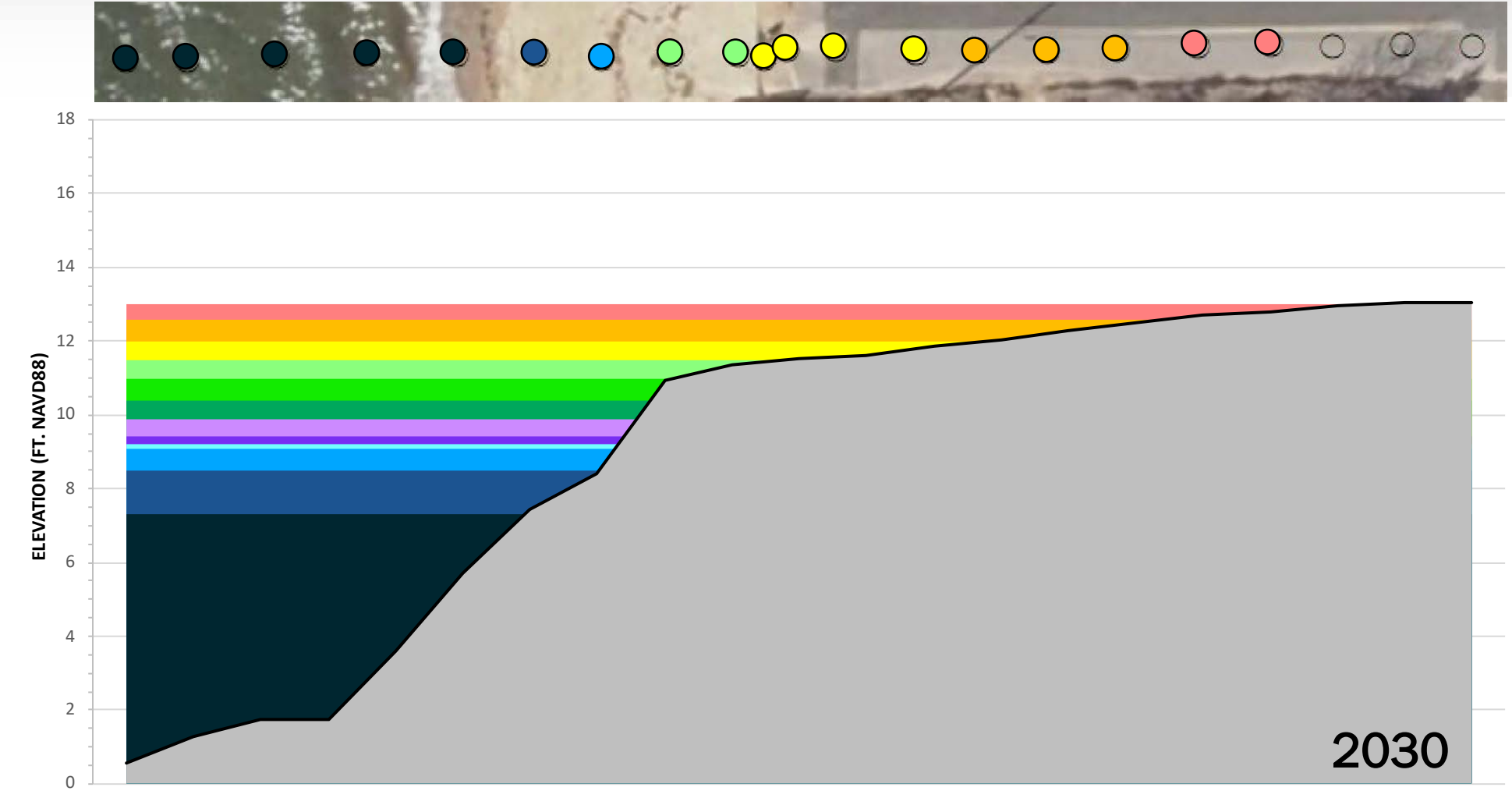


Cape Cod Low Lying Roads Vulnerability Assessment Methods



COASTAL FLOOD EXCEEDANCE PROBABILITY

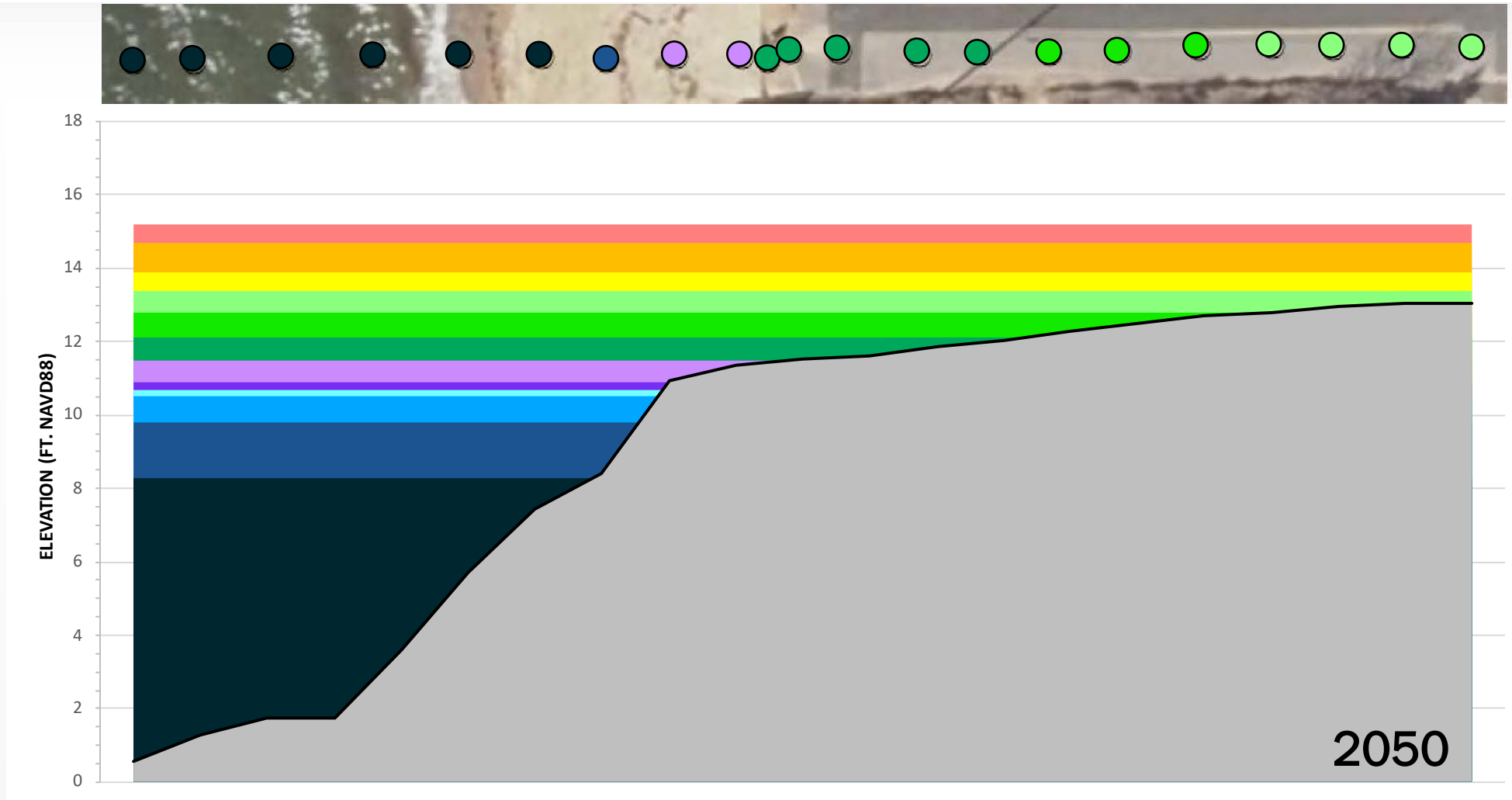
Cape Cod Low Lying Roads Vulnerability Assessment Methods



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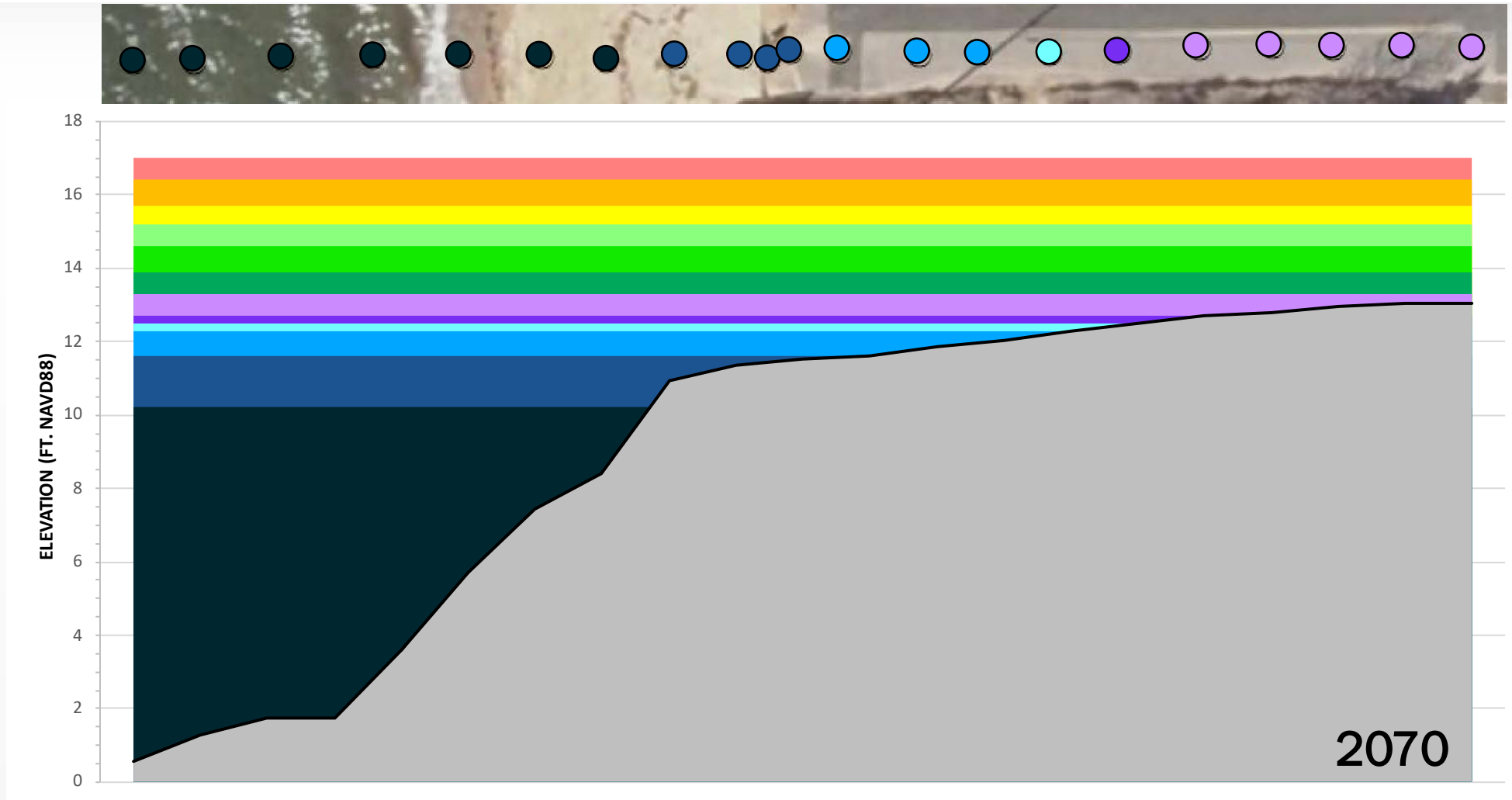
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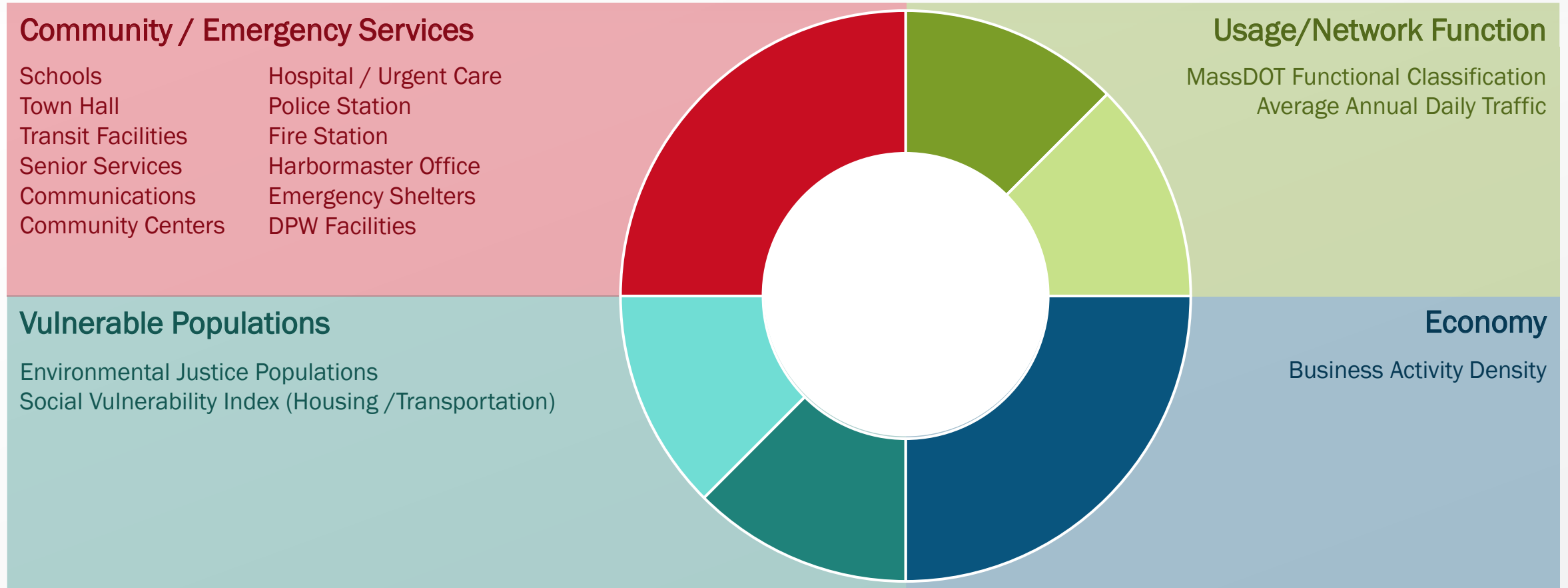
Cape Cod Low Lying Roads Vulnerability Assessment Methods



COASTAL FLOOD EXCEEDANCE PROBABILITY

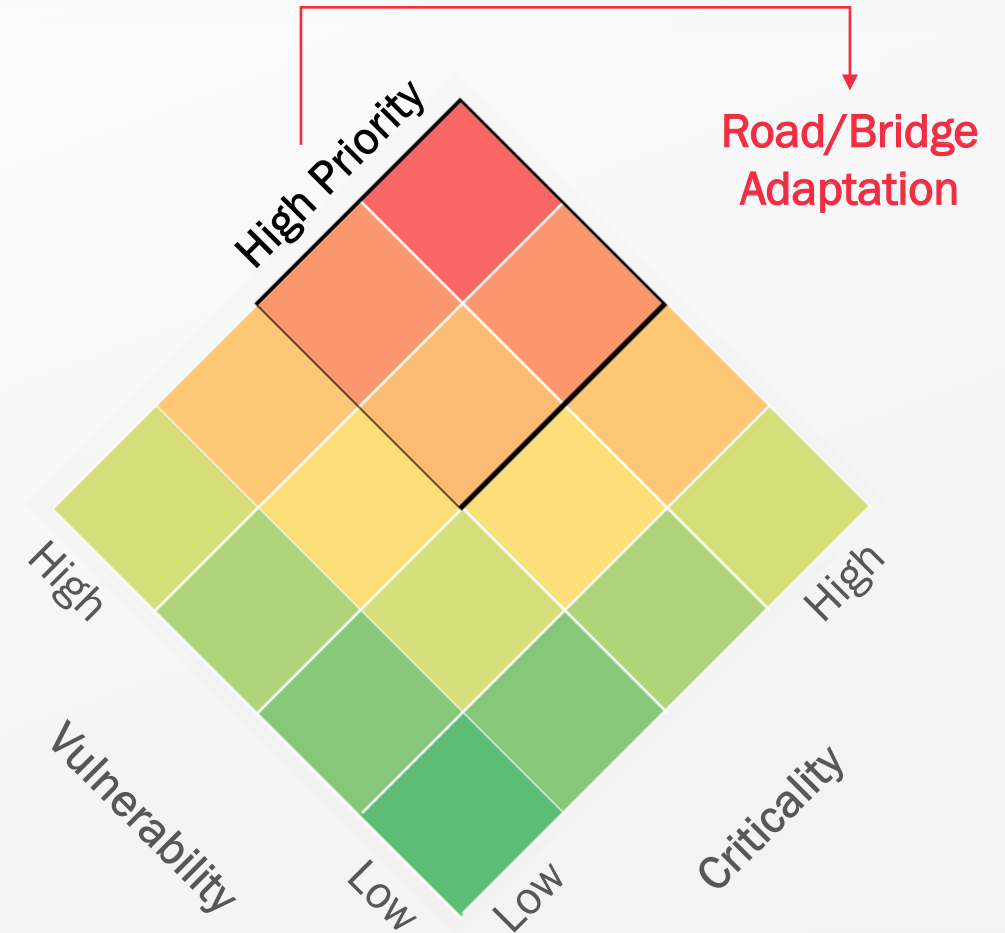


Cape Cod Low Lying Roads Criticality Scoring Framework

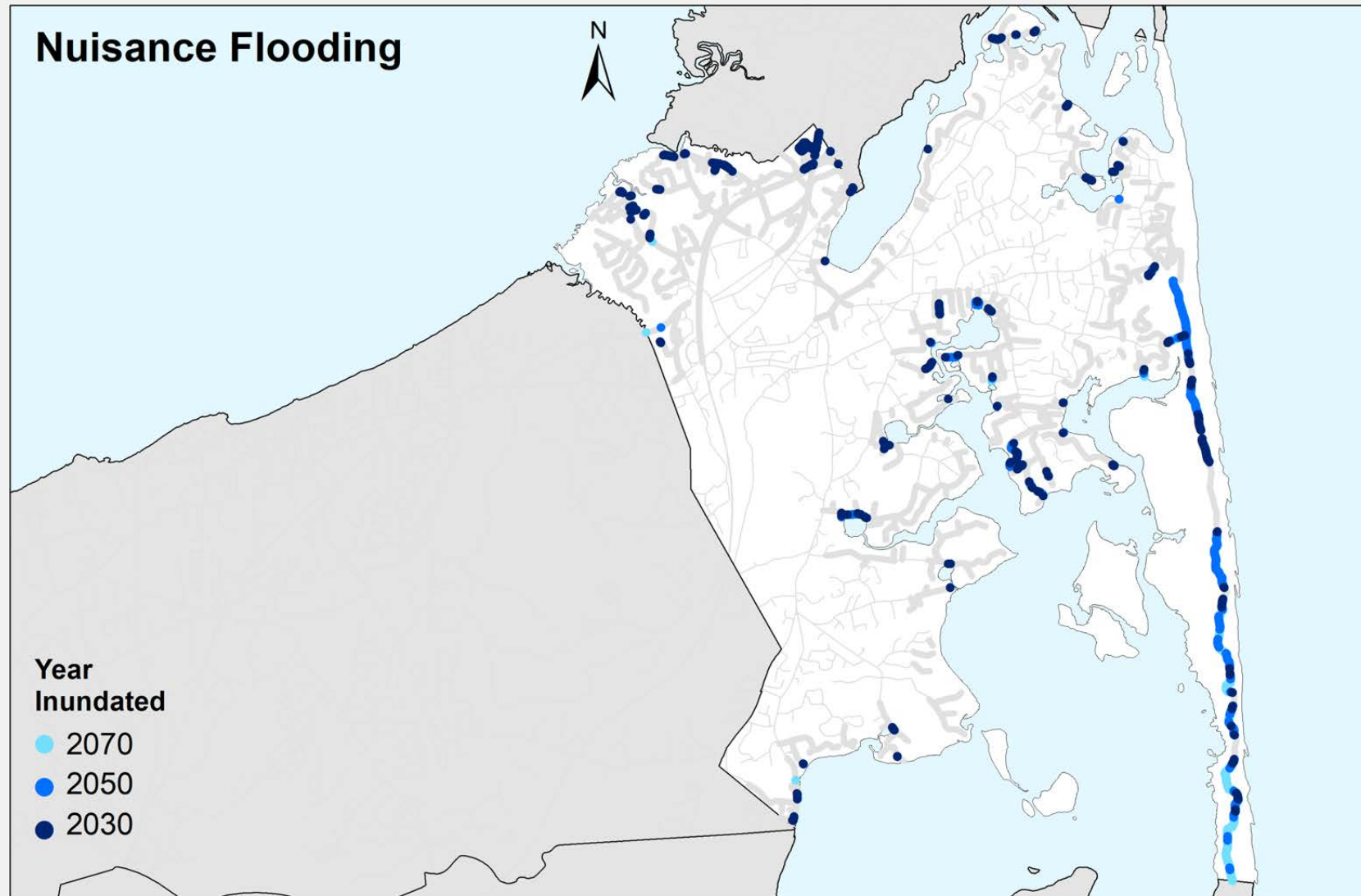


Cape Cod Low Lying Roads Risk Assessment Approach

1. Extract roadway/bridge critical elevations (CEs)
 - › From LiDAR at 20m interval along surface
2. Compile 2030/2050/2070 MC-FRM water surface elevations (WSEs)
 - › 0.1%, 0.2%, 0.5%, 1%, 2%, 5%, 10%, 20%, 100%
3. Compare CE to WSEs to determine vulnerability
 - › Highest probability WSE exceeding CE
4. Score road segment criticality
 - › Usage/Network Function
 - › Economy
 - › Vulnerable Populations
 - › Community and Emergency Services
5. $\text{Probability} * \text{Criticality} = \text{Risk}$
6. Prioritize high-risk road segments for community consideration



Low Lying Roads Nuisance (MHW) Flooding (Orleans)

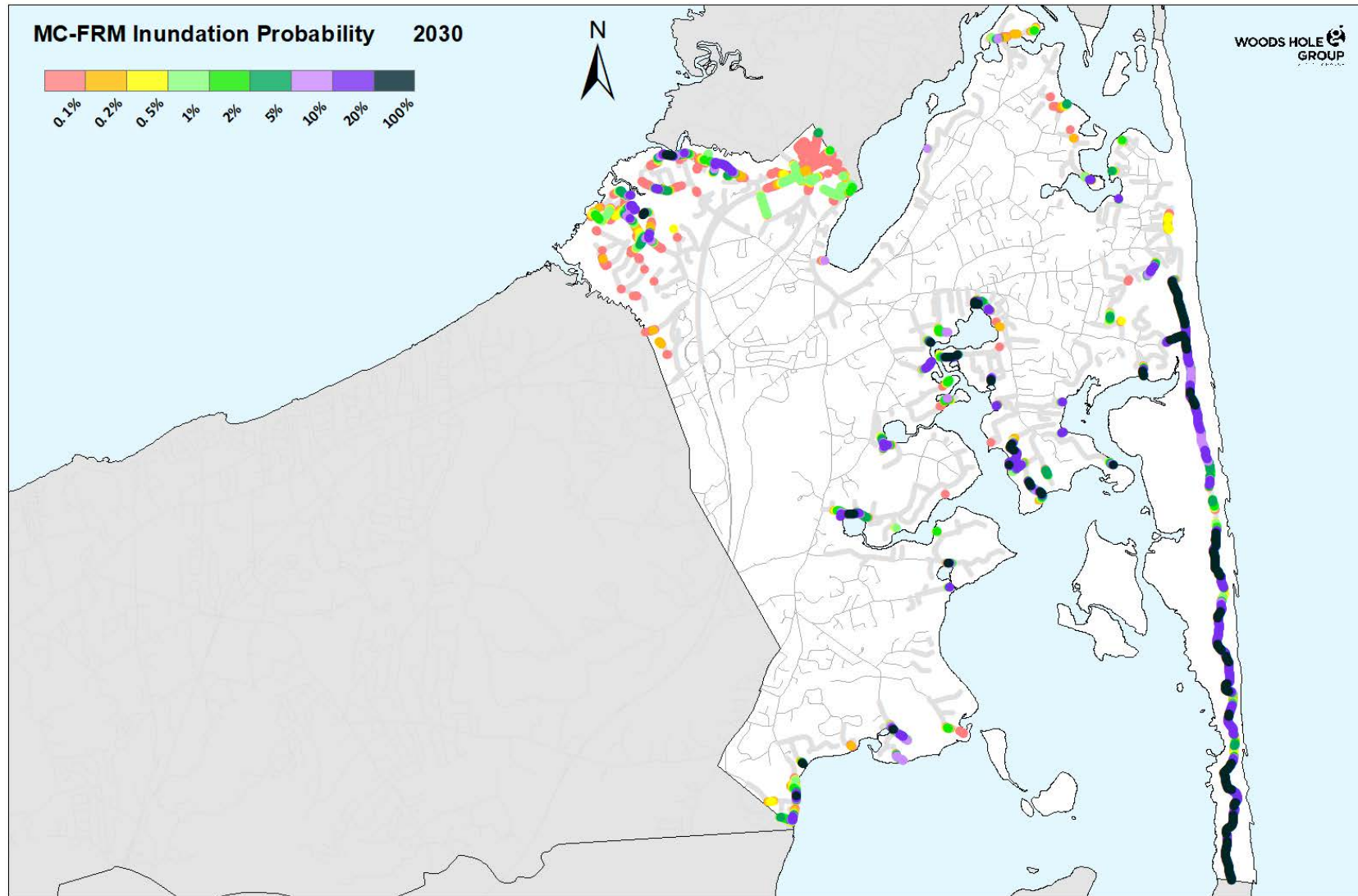


Road Miles 2030
1.3/143.2

Road Miles 2050
3.9/143.2

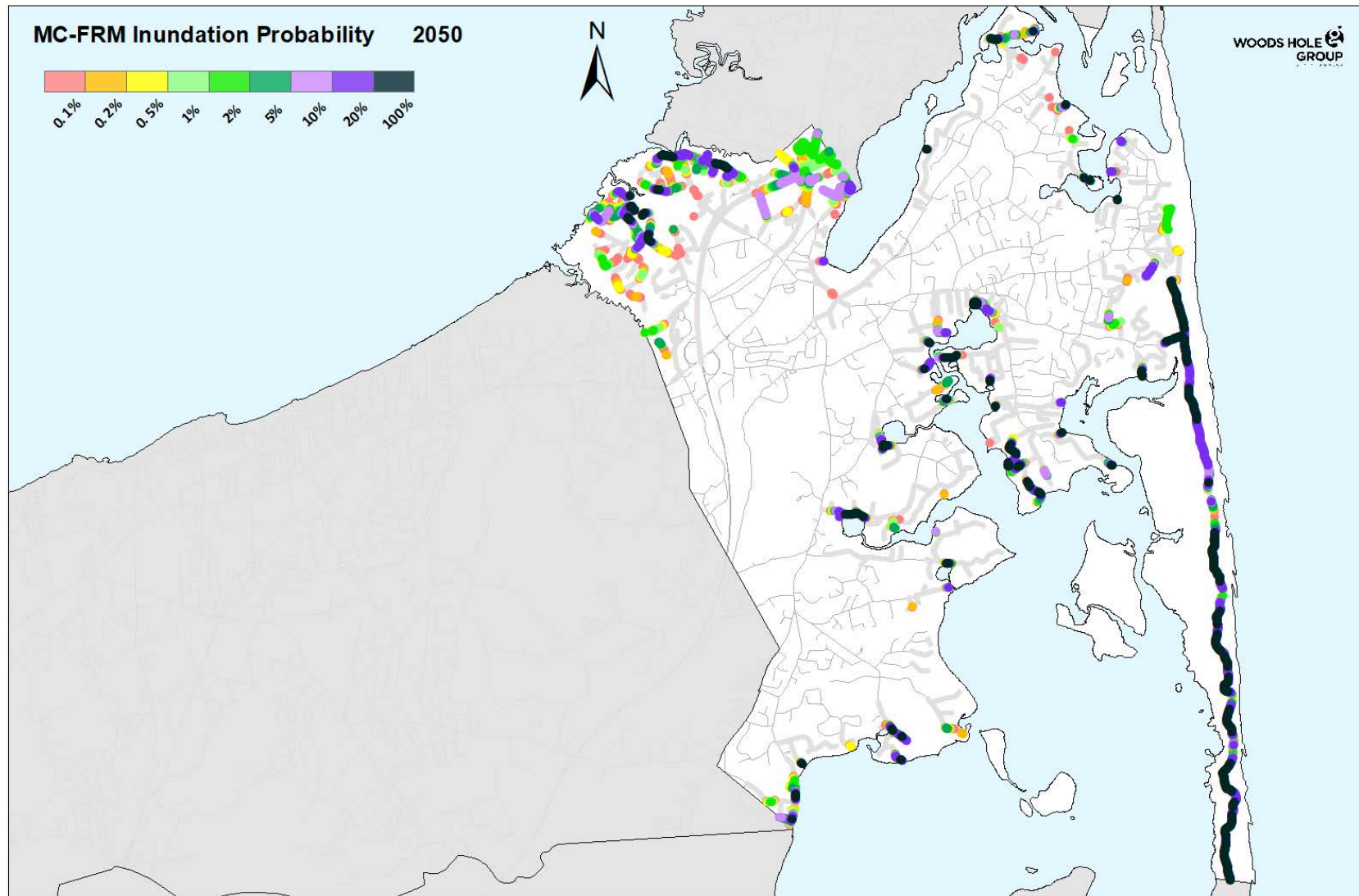
Road Miles 2070
6.7/143.2

Low Lying Roads 2030 Inundation Probability (Orleans)



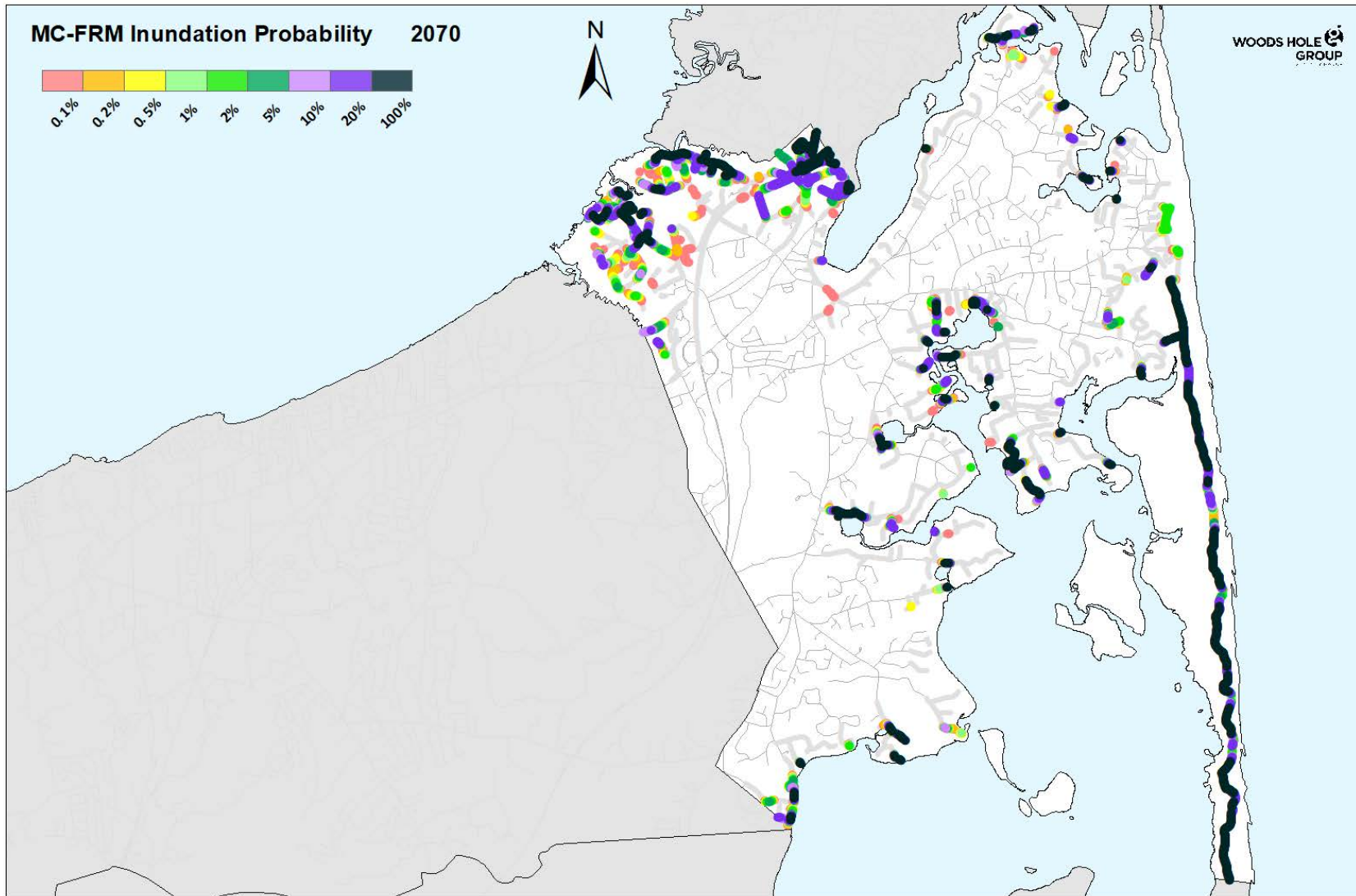
	%	Road miles
	0.1	14.7
	0.2	11.4
	0.5	10.3
	1	9.4
	2	7.9
	5	6.9
	10	6.0
	20	5.0
	100	2.2

Low Lying Roads 2050 Inundation Probability (Orleans)



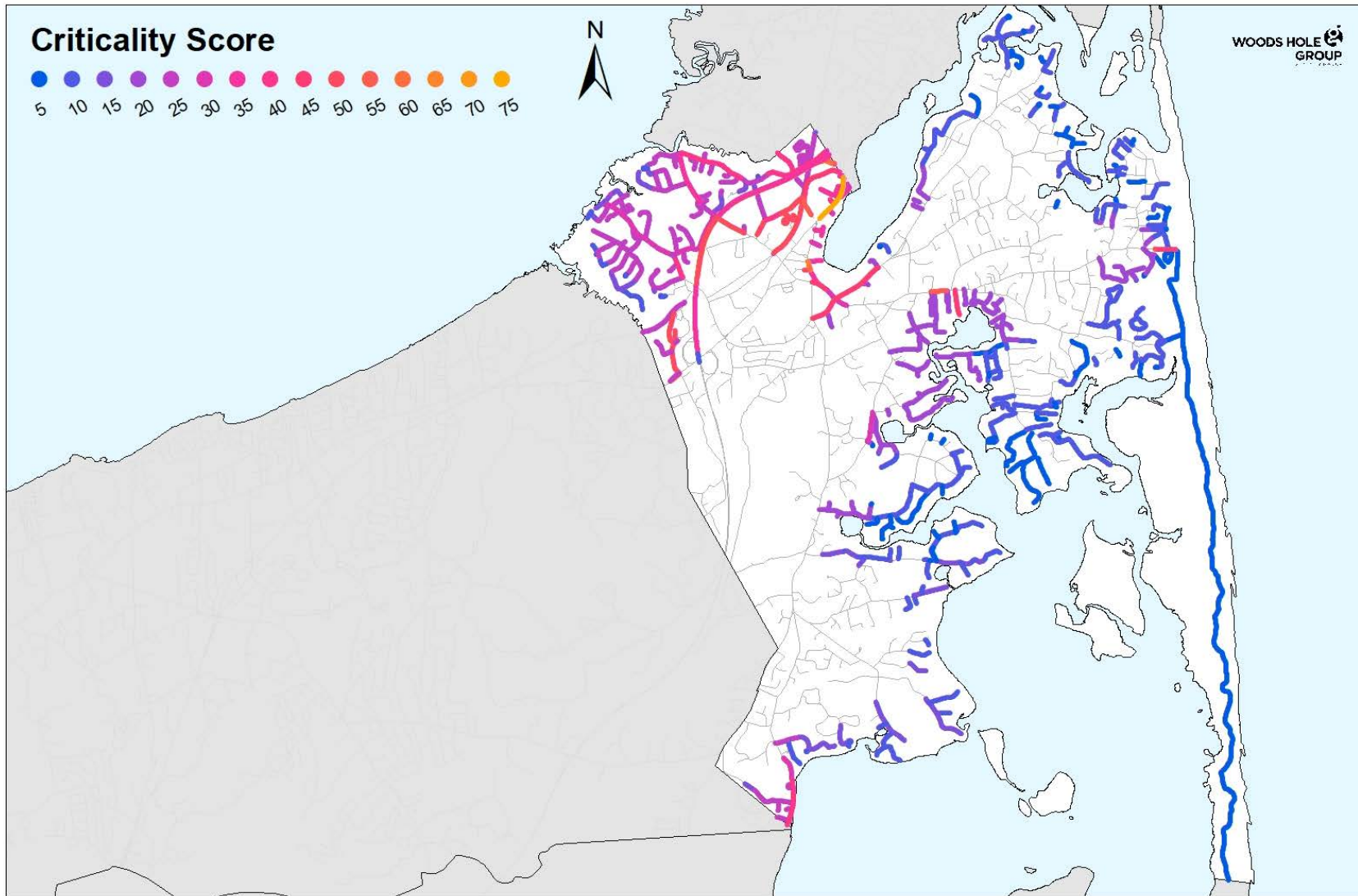
	%	Road miles
	0.1	18.9
	0.2	17.0
	0.5	15.7
	1	14.4
	2	12.6
	5	10.2
	10	8.9
	20	7.1
	100	3.9

Low Lying Roads 2070 Inundation Probability (Orleans)

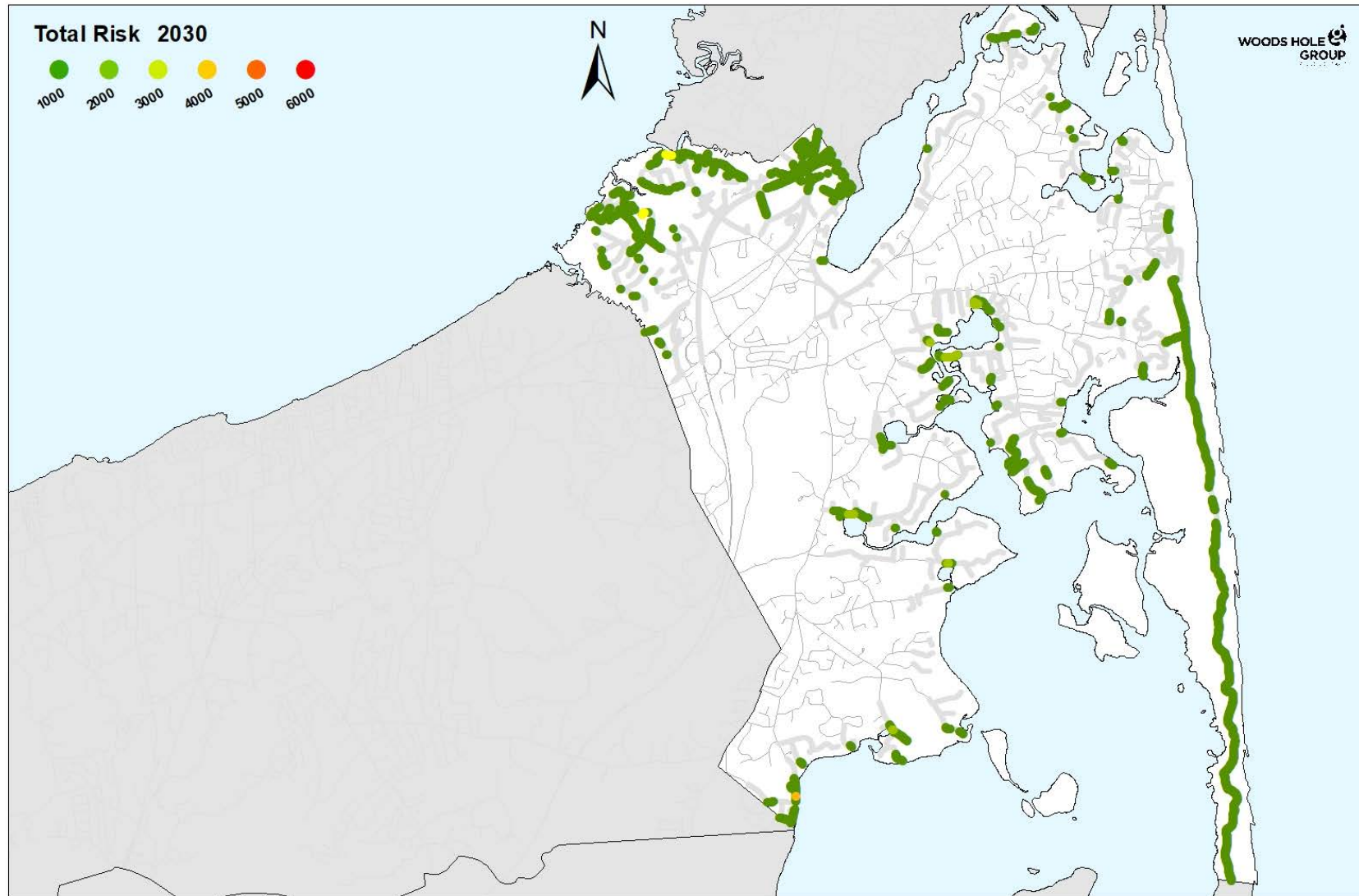


	%	Road miles
	0.1	22.1
	0.2	20.0
	0.5	18.7
	1	17.7
	2	16.6
	5	14.9
	10	13.7
	20	12.4
	100	7.8

Low Lying Roads Criticality Scoring (Orleans)



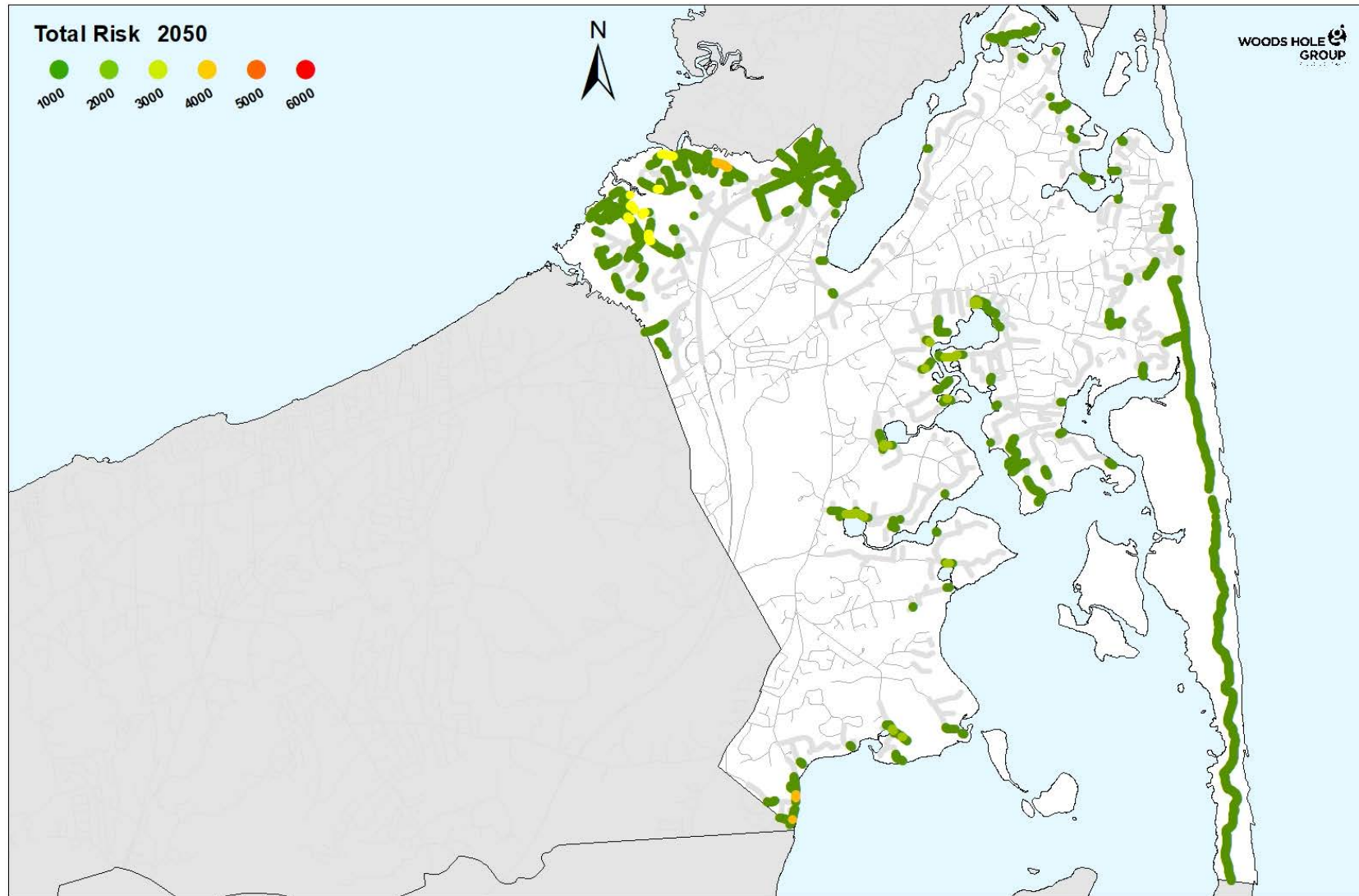
Low Lying Roads 2030 Risk Results (Orleans)



High Risk Road Segments

- South Orleans Road
- Bay View Drive
- Arey's Lane
- River Road
- Quanset Road
- Namequoit Road
- South Orleans Road
- Rock Harbor Road
- Skaket Beach Road
- Defiance Lane
- Herring Brook Way
- Rock Harbor Road
- Skaket Beach Road
- Bridge Road
- Mid-Cape Highway
- Rock Harbor Road
- Eastham Rotary
- Old Country Road
- Captain Linnell Road

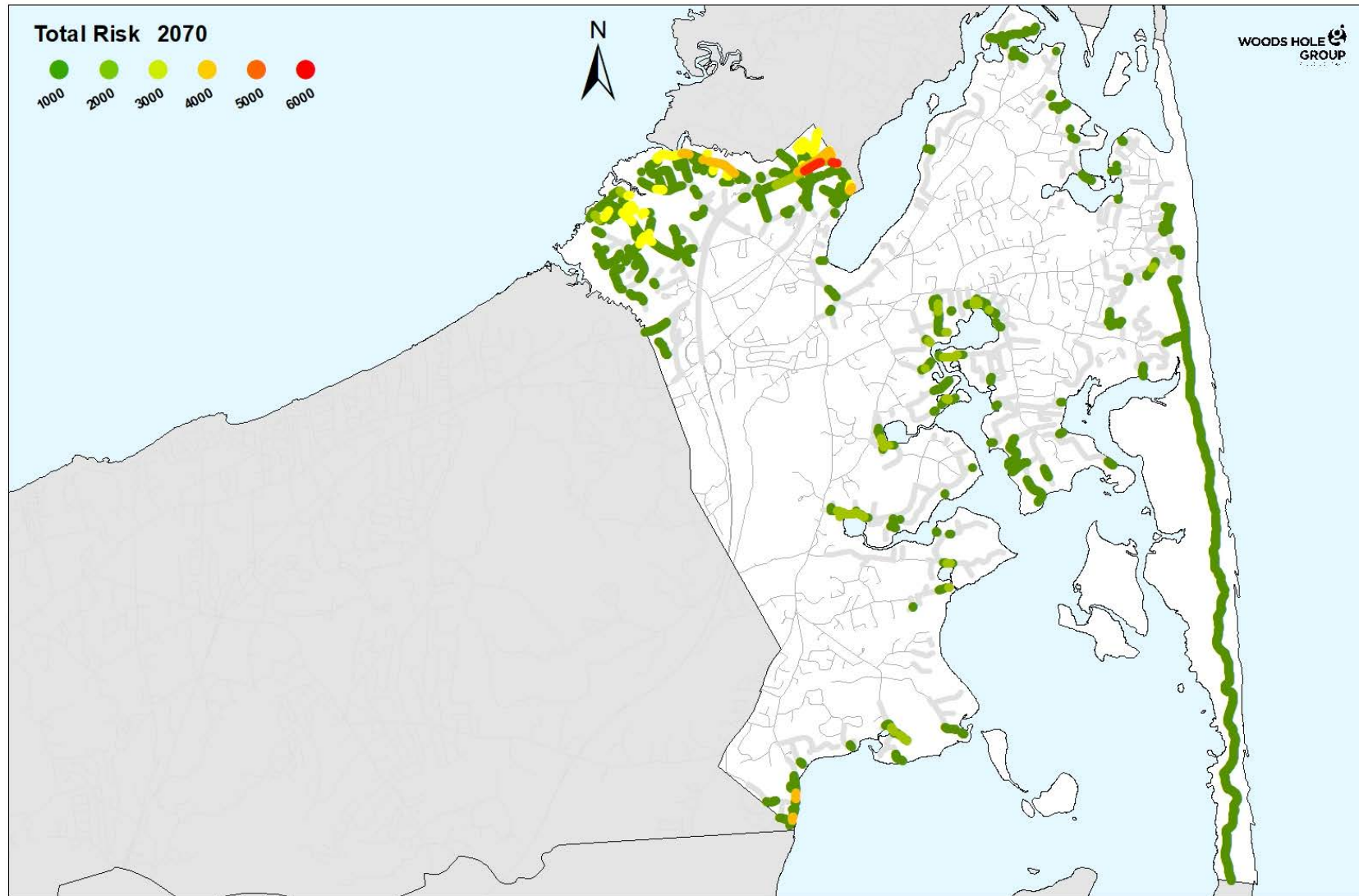
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Low Lying Roads 2070 Risk Results (Orleans)



High Risk Road Segments

- South Orleans Road*
- Bay View Drive
- Arey's Lane
- River Road
- Quanset Road
- Namequoit Road
- South Orleans Road*
- Rock Harbor Road
- Skaket Beach Road
- Defiance Lane
- Herring Brook Way
- Rock Harbor Road
- Skaket Beach Road
- Bridge Road
- Mid-Cape Highway*
- Rock Harbor Road
- Eastham Rotary*
- Old Country Road
- Captain Linnell Road

Summary of High Priority Road Segments (Orleans)

	Name	Length (ft)	Description	Segment Storm Probability (%)			Nuisance Length (ft)		
				2030	2050	2070	2030	2050	2070
A	South Orleans Road*	280	North of Tar Kiln Road	10-100	20-100	100		120	240
B	Bay View Drive	740	Rock Harbor parking lot	20-100	100	100			440
C	Arey's Lane	560	West of Cygnet Lane, and Arey's Pond Boat Yard	100	100	100		460	540
D	River Road	100	Boat ramp at end of River Road	100	100	100	40	80	100
E	Quanset Road	100	South of Oyster Trail	100	100	100			80
F	Namequoit Road	100	East of Viking Road	10-20	20-100	100		20	100
G	South Orleans Road*	220	North of Evelyn's Dr, fronting "A little Inn on Pleasant Bay"	10-20	100	100		60	220
H	Rock Harbor Road	1600	Between Smith Brothers Way and Orleans Senior Center	20	20-100	100			740
I	Skaket Beach Road	540	South of Skaket Circle	20	100	100			20
J	Defiance Lane	260	West of Anchor Drive	20	100	100			120
K	Herring Brook Way	260	Fronting Alewife Way	20	100	100			260
L	Rock Harbor Road	340	Corner of Bay View Drive and Rock Harbor Road	20	20-100	100			100
M	Skaket Beach Road	400	Culverted road before Gull Lane	1-10	100	100		20	20
N	Bridge Road	60	Off of Rock Harbor Road	1	20	20			
O	Mid-Cape Highway*	1440	Route 6 Entering rotary, includes segment of rotary	0.1-0.2	1-2	100			
P	Rock Harbor Road	1400	Between Bridge Road and the Rotary	0.1-2	1-5	100			560
Q	Eastham Rotary*	300	Rotary	0.1	2	100			40
R	Old Country Road	280	Between Old State Highway and Ellis Street	0.5-2	10-20	100			280
S	Captain Linnell Road	260	Off of Skaket Beach Road	1-5	10-20	100			

* = MassDOT roadway

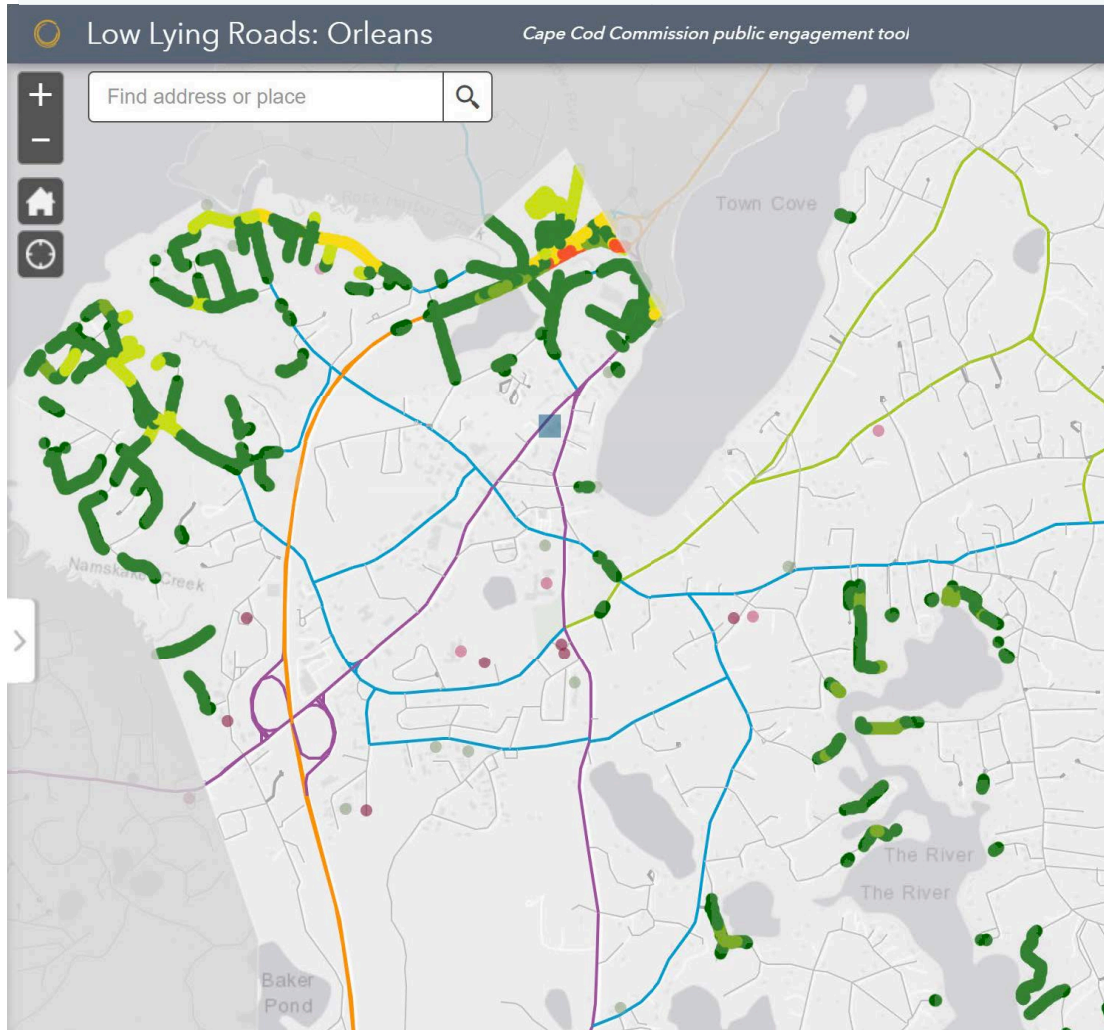
MAP VIEWER

<https://ccom.link/llr-map>

DISCUSSION ORIENTATION

LOW LYING ROADS

Group Discussion



DISCUSSION QUESTIONS

1. Are there roads that we missed?
2. How would you prioritize these roads – what local knowledge or concerns can you bring to the discussion?
3. Can we find agreement on the top 3 – 5 road segments?

Summary of High Priority Road Segments - Orleans

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S	Captain Linnell Road	260	Off of Skaket Beach Road	1-5	10-20	100			

* = MassDOT roadway

NEXT STEPS

Town staff to select 2 road segments

Feasibility analysis

3 solutions + costs per segment

Solutions available to view on Low Lying Road
webpage late spring 2022:

<https://www.capecodcommission.org/our-work/low-lying-roads-project/>

THANK YOU!
