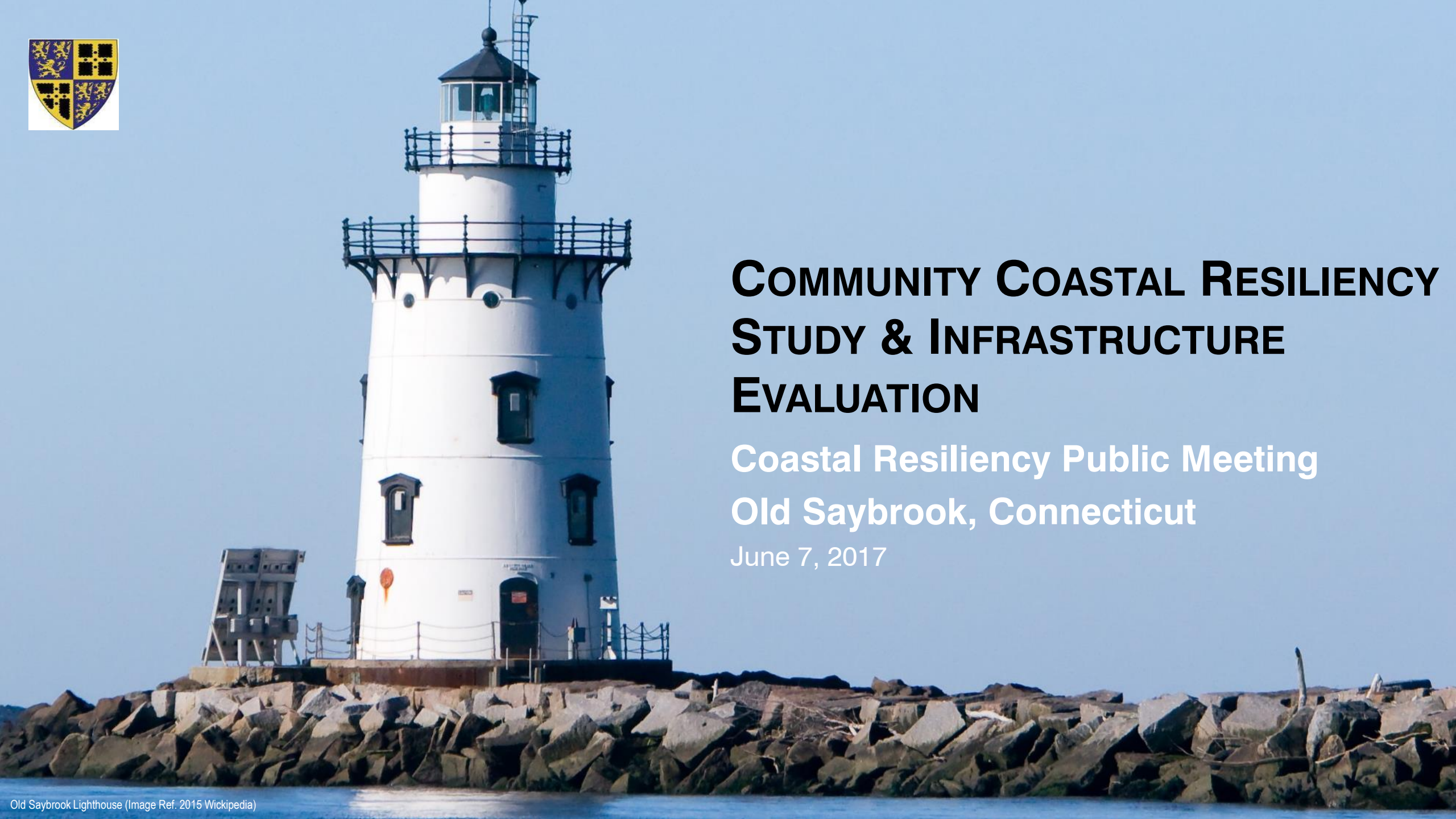


# COMMUNITY COASTAL RESILIENCY STUDY & INFRASTRUCTURE EVALUATION

Coastal Resiliency Public Meeting  
Old Saybrook, Connecticut  
June 7, 2017



# Project Consulting Team



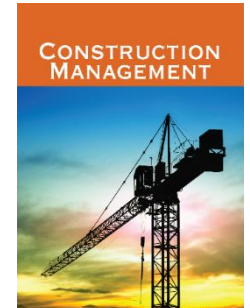
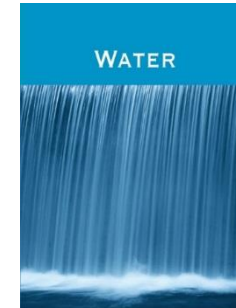
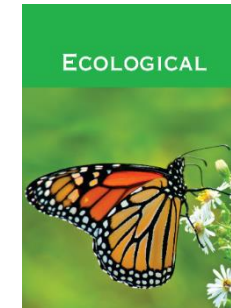
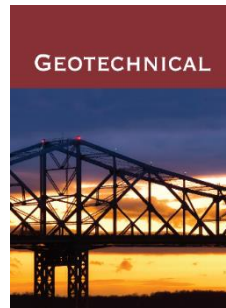
Dr. Alex Felson  
and Beth  
Greenleaf



GZA at a glance...

## About us

*28 offices, 600 Engineers, Scientists, Planners and Technical Specialists providing expert, risk-informed and pragmatic advice and solutions in the following **Core Service** areas....*



# Public Meetings

## ✓ Today's Meeting

- Project Overview
- Vulnerability Assessment
- Next Steps

## ✓ Second Public Meeting: Saybrook Point Pavilion (September 2017)

# Project Overview



# Development of the Community Coastal Resilience Study and Infrastructure Evaluation



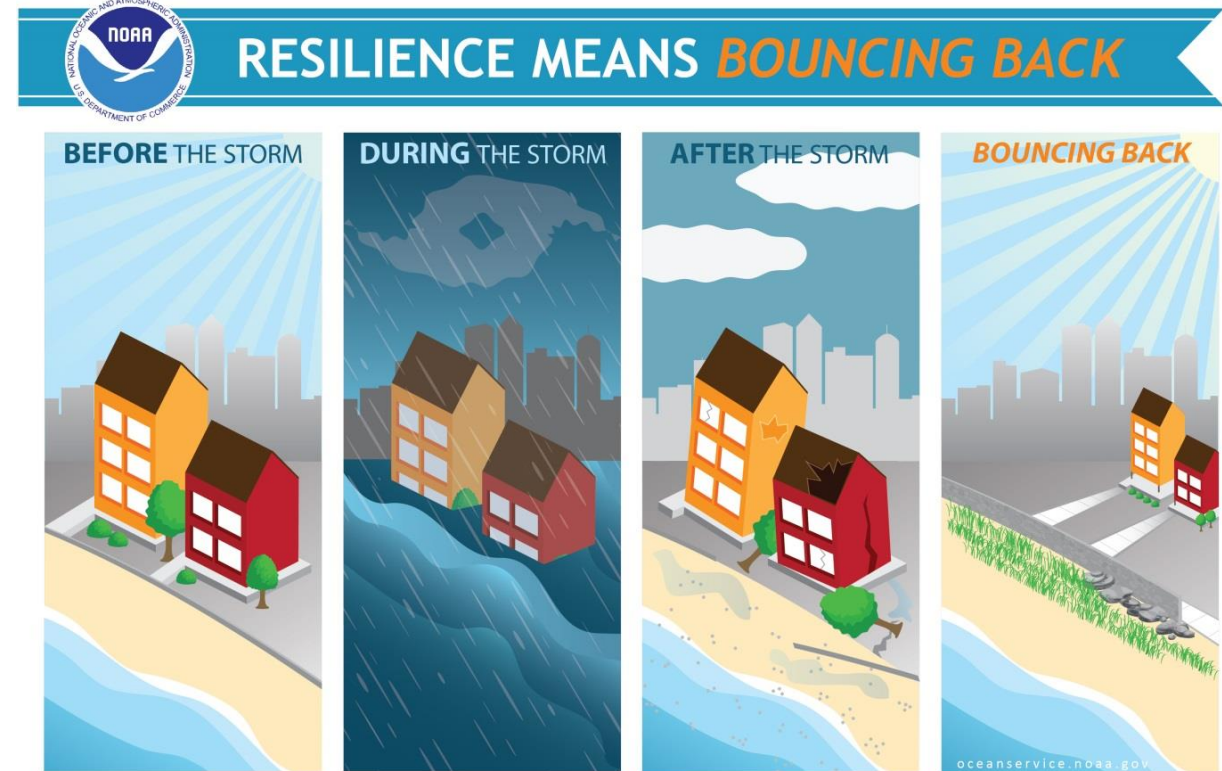
## Goals:

- ✓ Build upon SLRCAC Findings
- ✓ Detailed assessment of SLR risks
- ✓ Develop strategies to mitigate these risks

# Project Overview

## Task 1. Coastal Resilience Study

1. Existing Town Programs, Plans and Capabilities
2. GIS Data
3. Vulnerability Assessment
4. Risk Assessment
5. Adaptation Options
6. Public information meetings and charrettes
7. Implementation Process
8. Coastal Resilience Study Document





# Project Overview

## Task 2. Neighborhood Resiliency

1. Select Sandy-Impacted Neighborhoods
2. Neighborhood Workshops
3. Neighborhood Data Collection (completed in Task 1)
4. Preliminary Conceptual Designs
5. Final Conceptual Designs

Old Saybrook is home to 15 National Register sites



# Project Overview

## Task 3. Mitigation Feasibility Study

1. Roads, Bridges and Culverts
2. Individual Wastewater Treatment Systems
3. Stormwater Systems
4. Land Acquisition
5. Ecosystem Resources
6. Final Report

Harvey's Beach

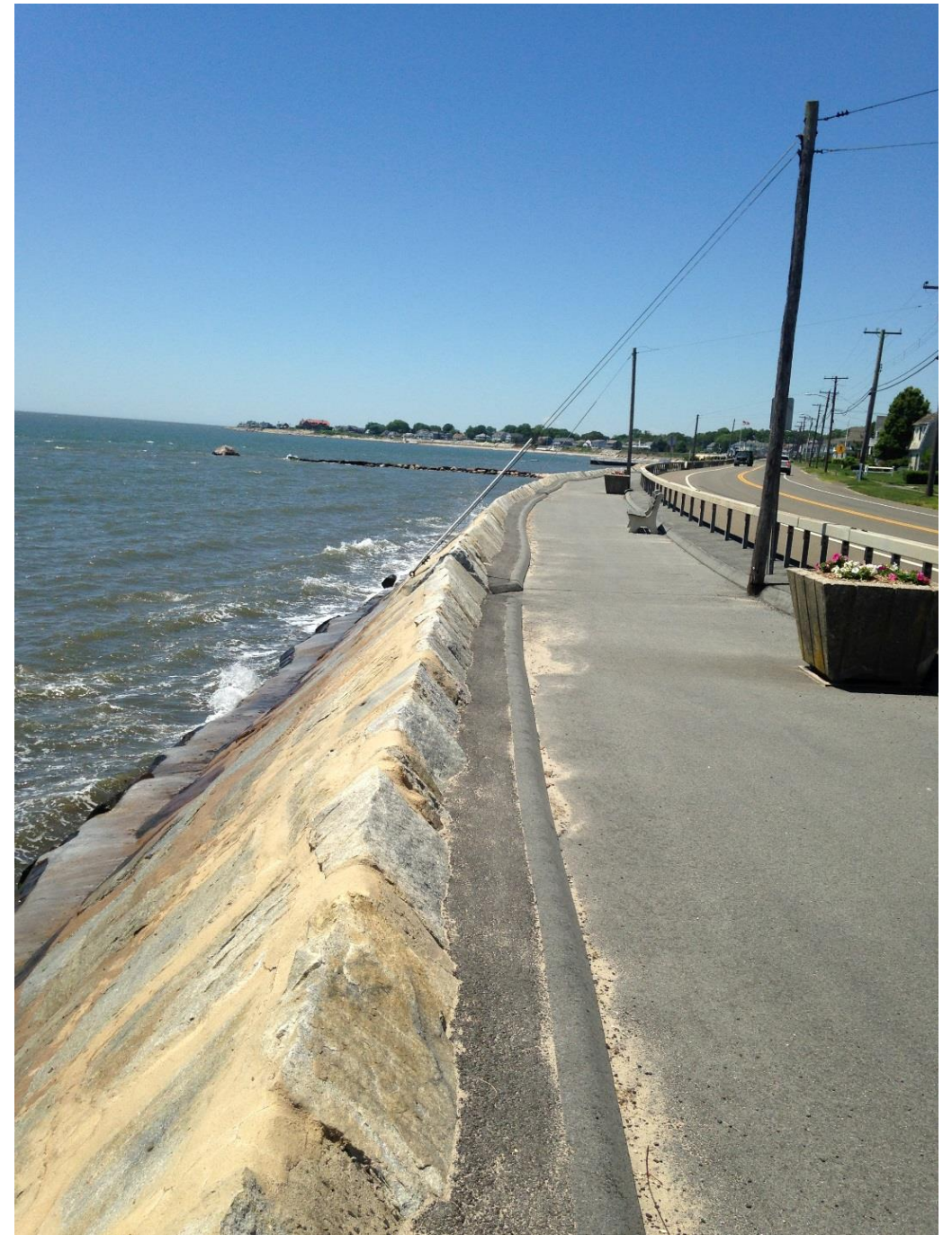




# Project Overview

## Task 4. Coastal Structures

1. Infrastructure Inventory/Evaluation
2. Historic Data Review
3. Adaptation Strategies
4. Final Report



# Coastal Hazard Vulnerability Assessment



# Coastal Hazard Vulnerability Assessment



The causeway between Old Saybrook and Fenwick Point during Hurricane Irene in 2011 (Ref. Mara Lavitt/New Haven Register 8/28/11 )



Plum Bank Road Flooding after Hurricane Sandy in 2012 (Cloe Poisson, Hartford Courant)

## Take Away 1 ▲

Use “Risk-Informed Decision Making”

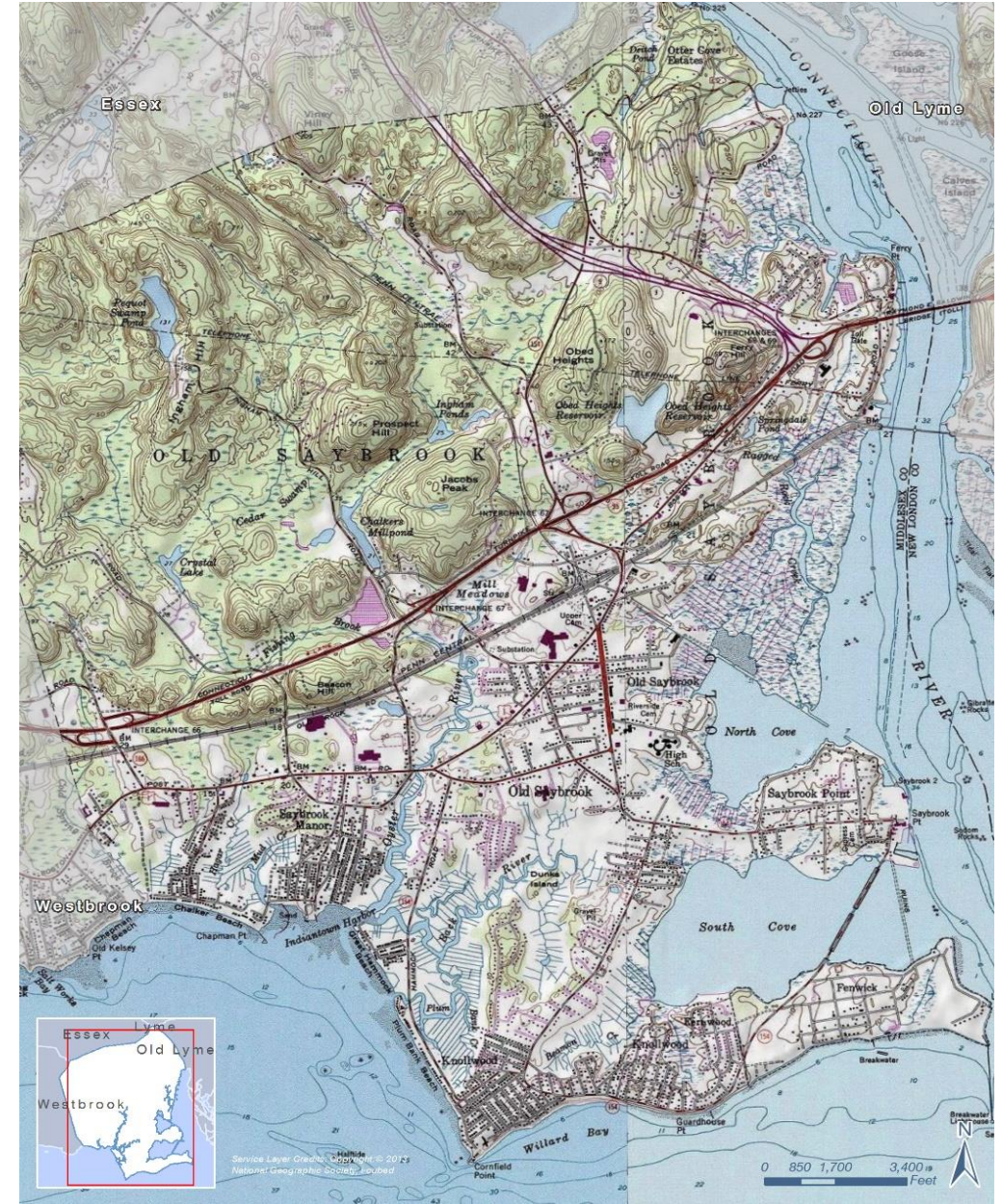
Risk = An event x probability of occurrence x resulting consequences



# Vulnerability Assessment Approach

## Four Step Approach:

1. Define Coastal Setting
2. Inventory Assets
3. Characterize Coastal Hazards
4. Assess Vulnerability





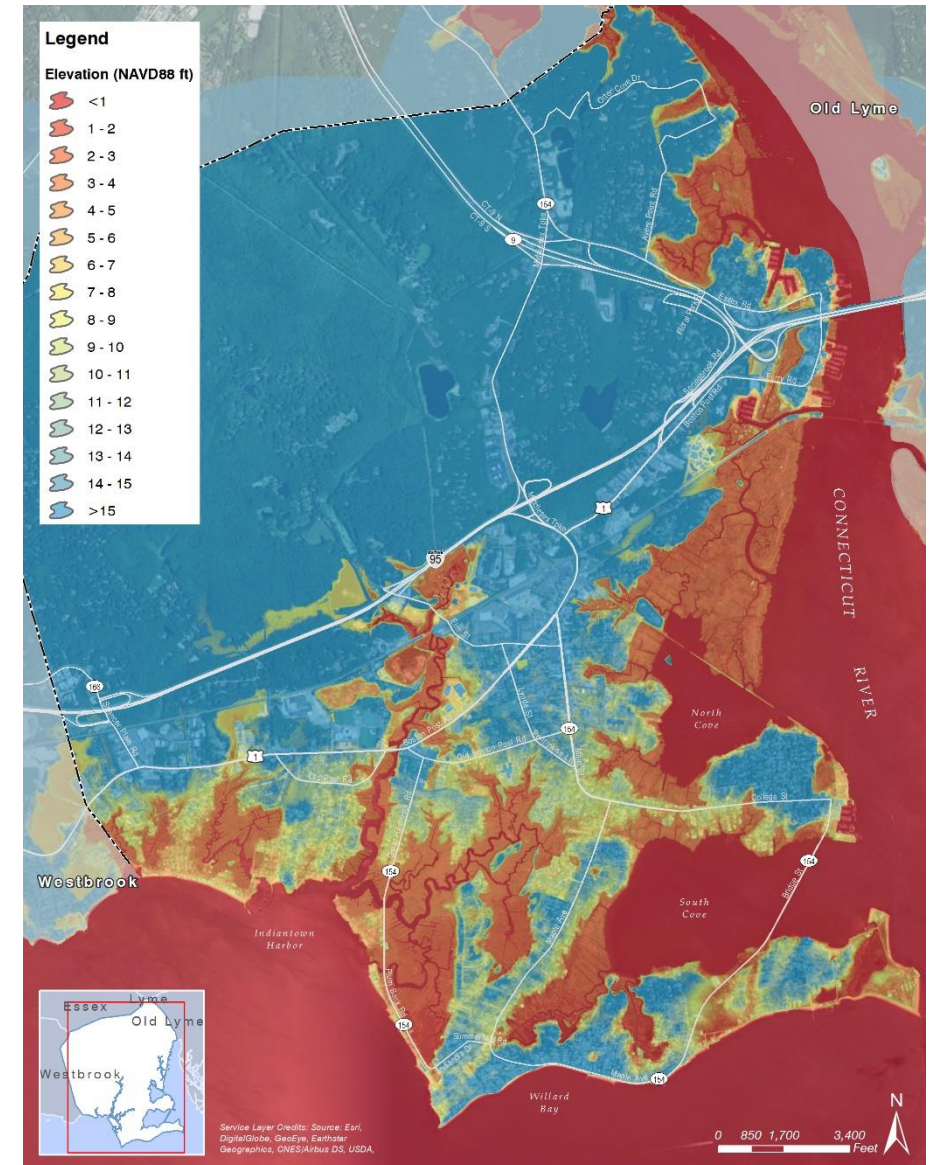
# Coastal Hazard Vulnerability Assessment

## Step 1 – Define Coastal Setting:

- ✓ topography/bathymetry
- ✓ shoreline features
- ✓ land cover
- ✓ geology
- ✓ natural resources
- ✓ ecology

Take Away 2 ▲

Manage information using GIS  
(e.g., GZA GeoTool©)



# Old Saybrook – Coastal Setting



USDA FSA, Microsoft | Source: Historical Topographic Map Collection courtesy of the U.S.

1. Uplands bordered by low-lying areas
2. 10 miles of coastline
3. Beaches – southern shoreline
4. Tidal Wetlands and Marshes
5. Connecticut River
6. Brooks and Creeks
7. 21.6 sm: 15.0 sm land, 6.6 sm water





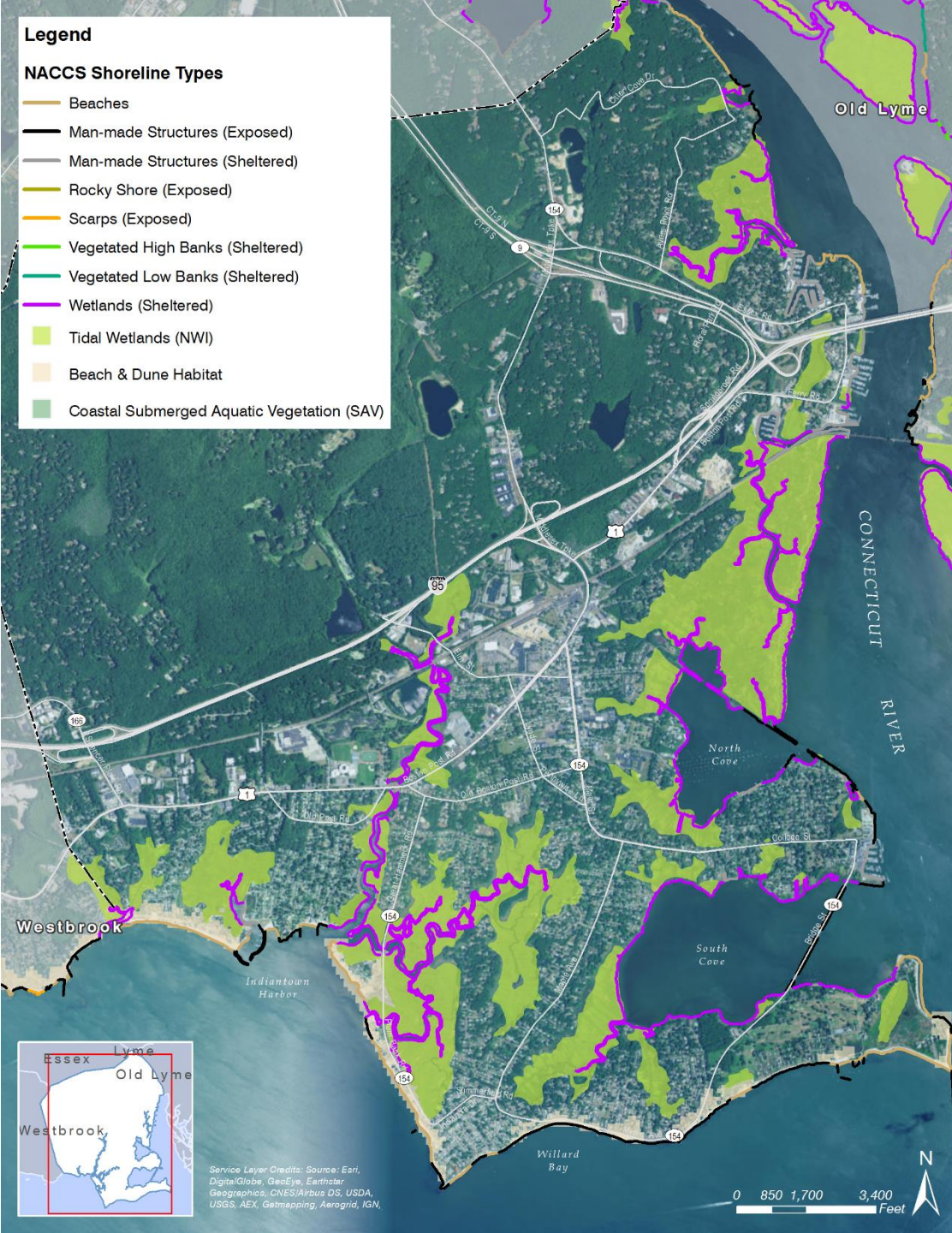




# Natural Resources







# Shoreline Features

# Coastal Hazard Vulnerability

## Step 2 – Inventory Town Assets:

- ✓ Essential Facilities
- ✓ Lifeline Utilities
- ✓ Transportation
- ✓ High Potential Loss Facilities
- ✓ Hazardous Material Facilities
- ✓ High Occupancy/Vulnerable Population Facilities
- ✓ Private and commercial property
- ✓ Natural Resources



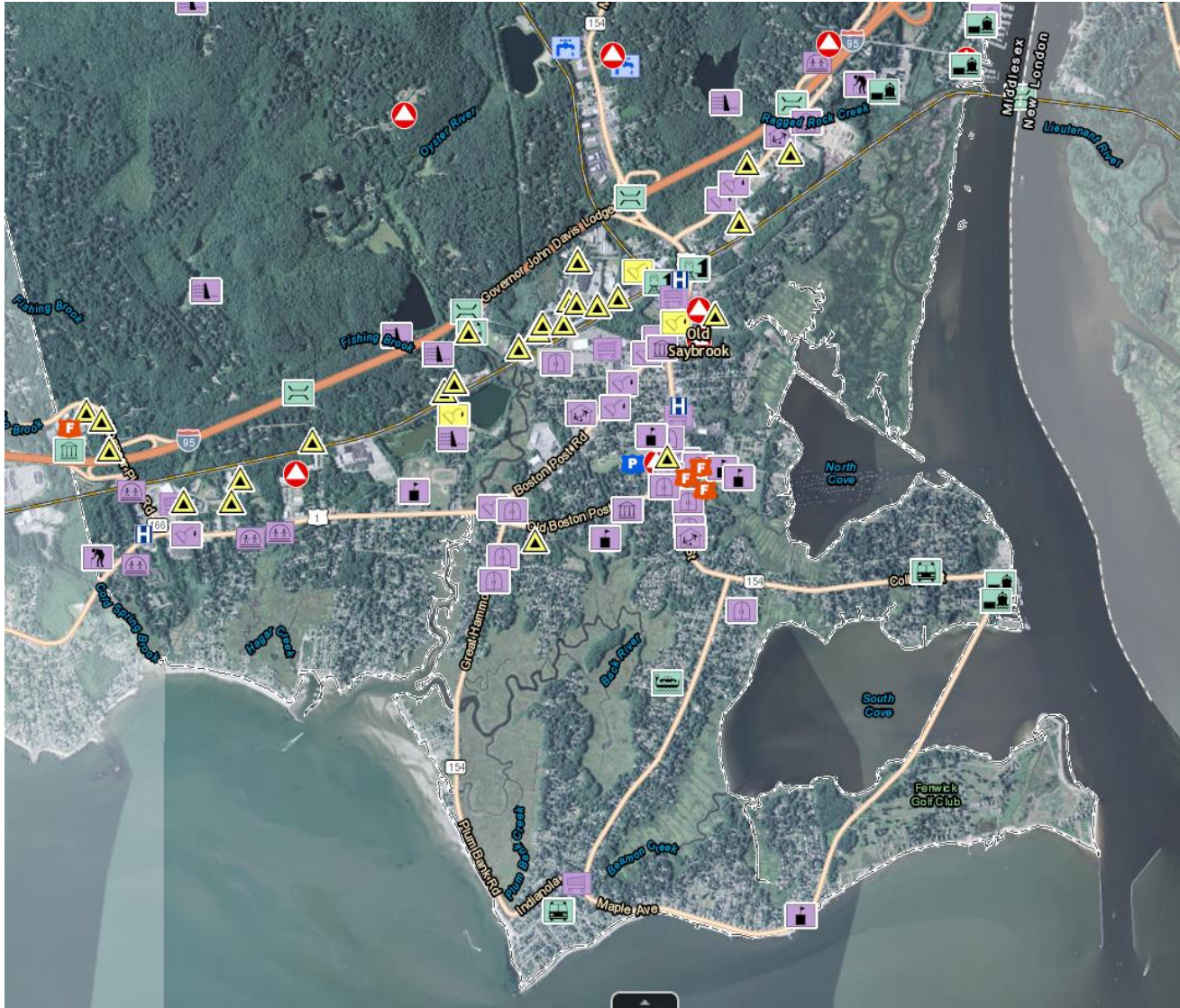
Old Saybrook Fire Department



St. John Church



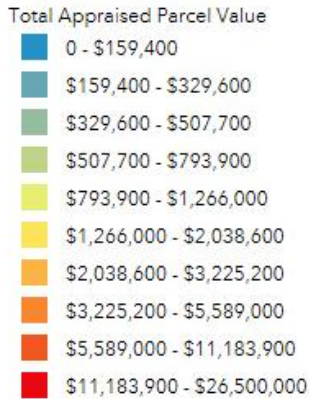
# Assets and Infrastructure



1. Essential Facilities
2. Hazardous Material Facilities
3. High Potential Loss Facilities
4. Transportation Systems
5. Lifeline Utility Systems
6. Support, High Occupancy and Vulnerable Populations
7. Natural Resources
8. Shoreline Structures



# Property





# Coastal Hazard Vulnerability/Risk Assessment

## Step 3 – Characterize Coastal Hazards:

### Take Away 3 ▲

Accurate, scientifically sound and probabilistic characterization of coastal hazards is important

- ✓ Coastal flooding:
  - tides
  - storm surge
  - waves
- ✓ Salt Water and Spray
- ✓ Coastal erosion/sediment transport
- ✓ Precipitation (river flood, stormwater, building damage)
- ✓ High wind
- ✓ Effects of climate change



Flooding in Saybrook Point during Hurricane Sandy (image ref. <http://www.wfsb.com>)

# Rising Tides

## Observed Rate of Change Near Old Saybrook

2.55 +/- 0.23 mm/yr

## Projected Sea Level Rise Near Old Saybrook

2040: 0.05 to 1.23 feet

2065: 0.24 to 2.96 feet

2100: 0.5 to 6.46 feet

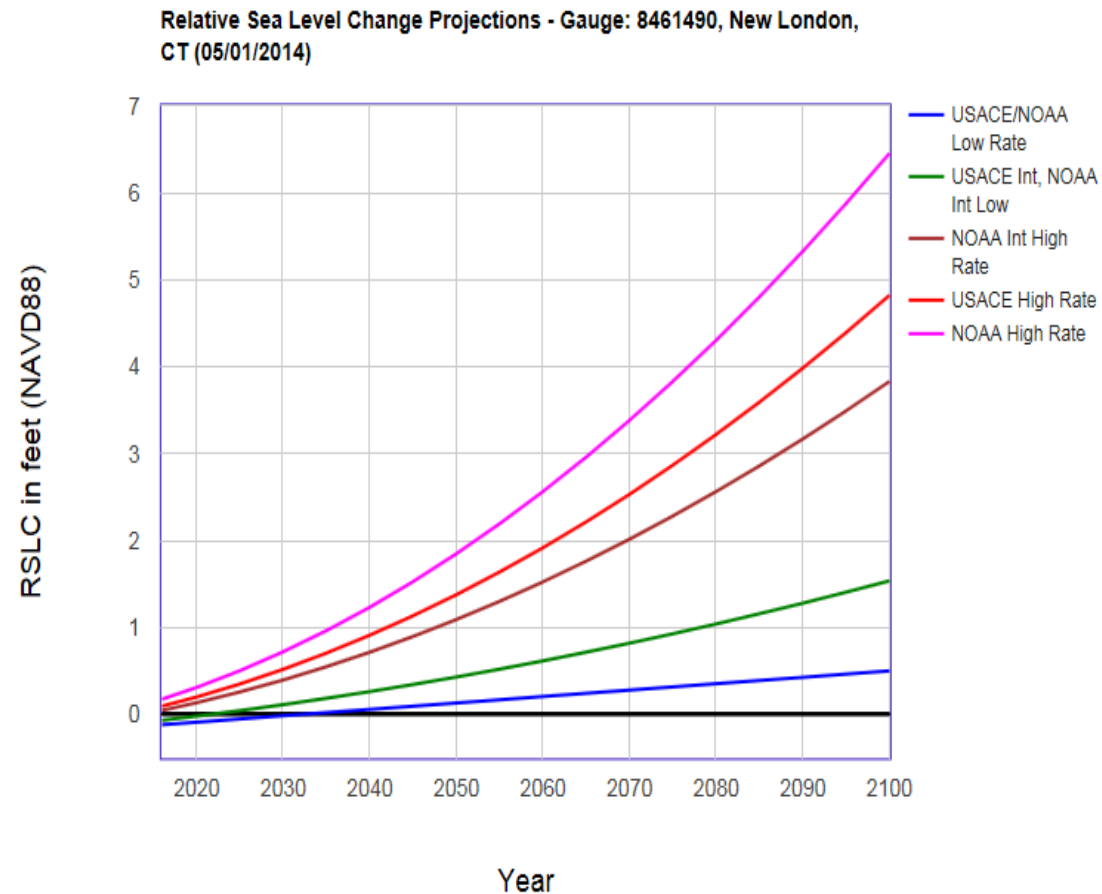
	Current	2042			2067			2117		
		High SLR	Int SLR	Low SLR	High SLR	Int SLR	Low SLR	High SLR	Int SLR	Low SLR
Mean Sea Level (MSL)	-0.3	0.7	-0.01	-0.23	2.04	0.45	-0.05	6.12	1.71	0.32
Mean High Water (MHW)	0.92	1.92	1.21	0.99	3.26	1.67	1.17	7.34	2.93	1.54
Mean Higher-High Water MHHW)	1.21	2.21	1.5	1.28	3.55	1.96	1.46	7.63	3.22	1.83
Highest Astronomical Tide	2.04	3.04	2.33	2.11	4.38	2.79	2.29	8.46	4.05	2.66
Mean Low Water (MLW)	-1.65	-0.65	-1.36	-1.58	0.69	-0.9	-1.4	4.77	0.36	-1.03
Mean Lower-Low Water MLLW)	-1.84	-0.84	-1.55	-1.77	0.5	-1.09	-1.59	4.58	0.17	-1.22



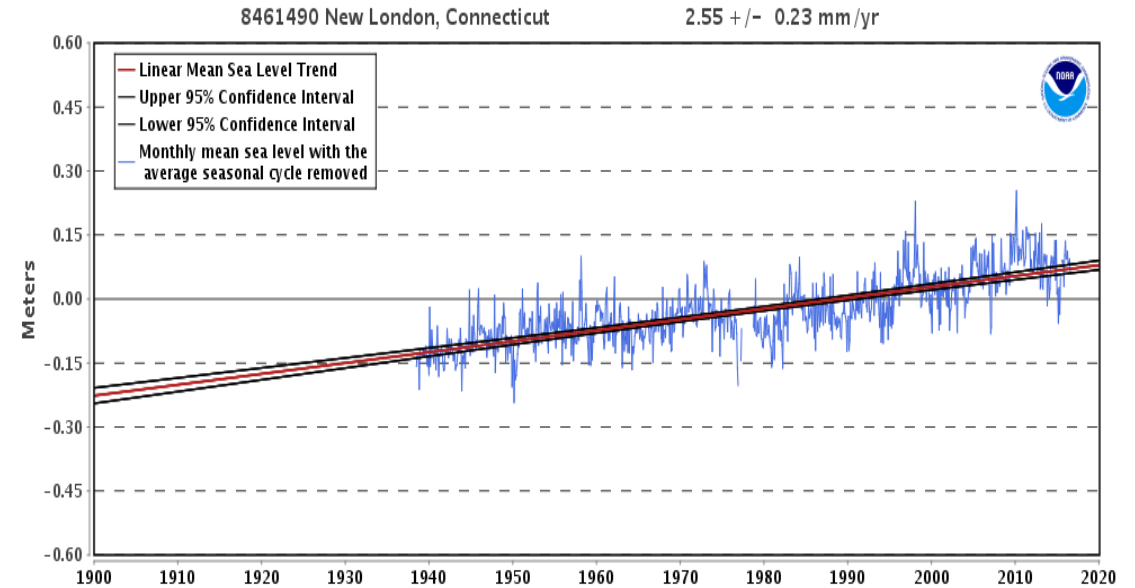
# Sea Level Rise

## Rate of Change Near Old Saybrook

2.55 +/- 0.23 mm/yr



# Sea Level Rise



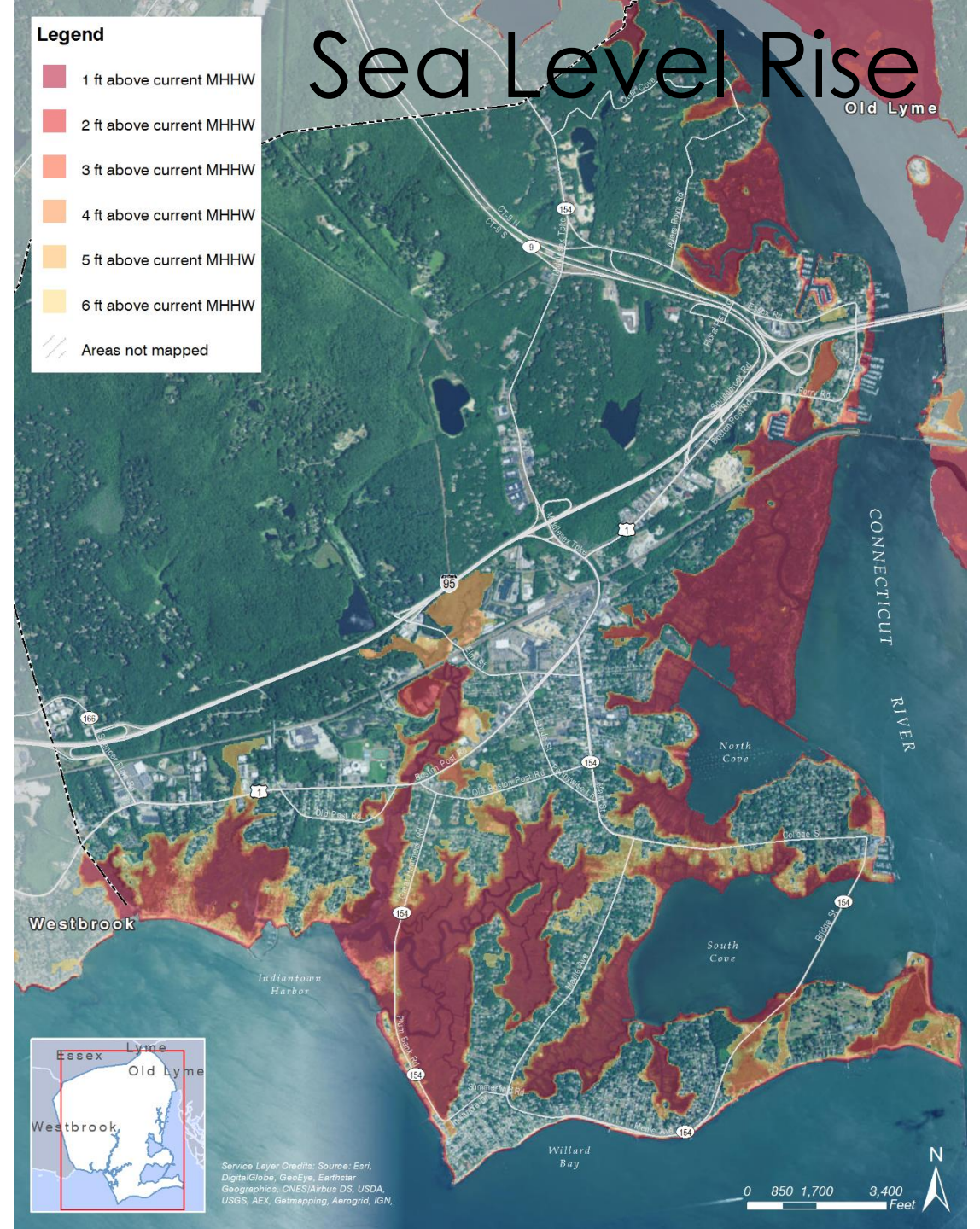
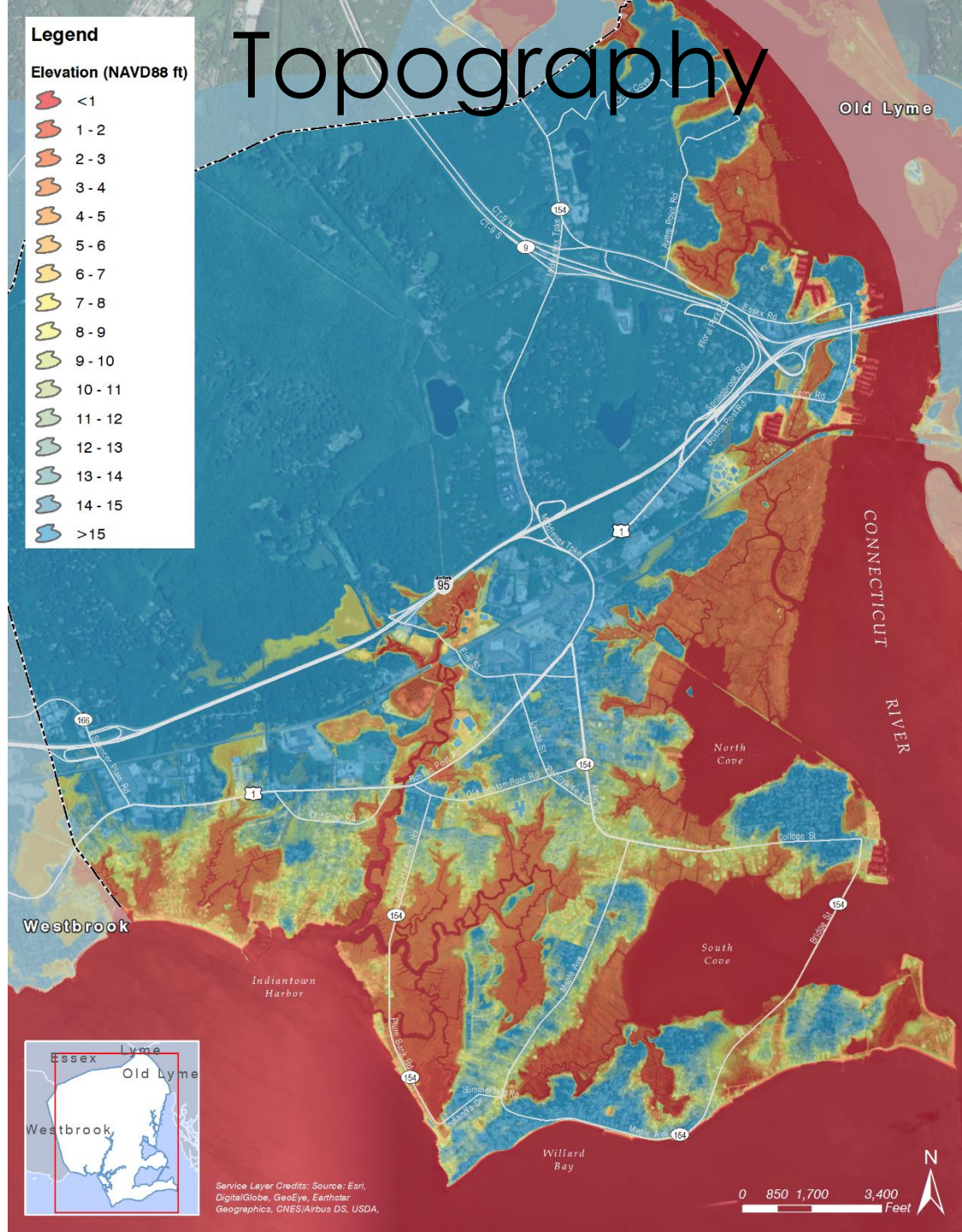
## Projected Sea Level Rise Near Old Saybrook

2040: 0.05 to 1.23 feet

2065: 0.24 to 2.96 feet

2100: 0.5 to 6.46 feet



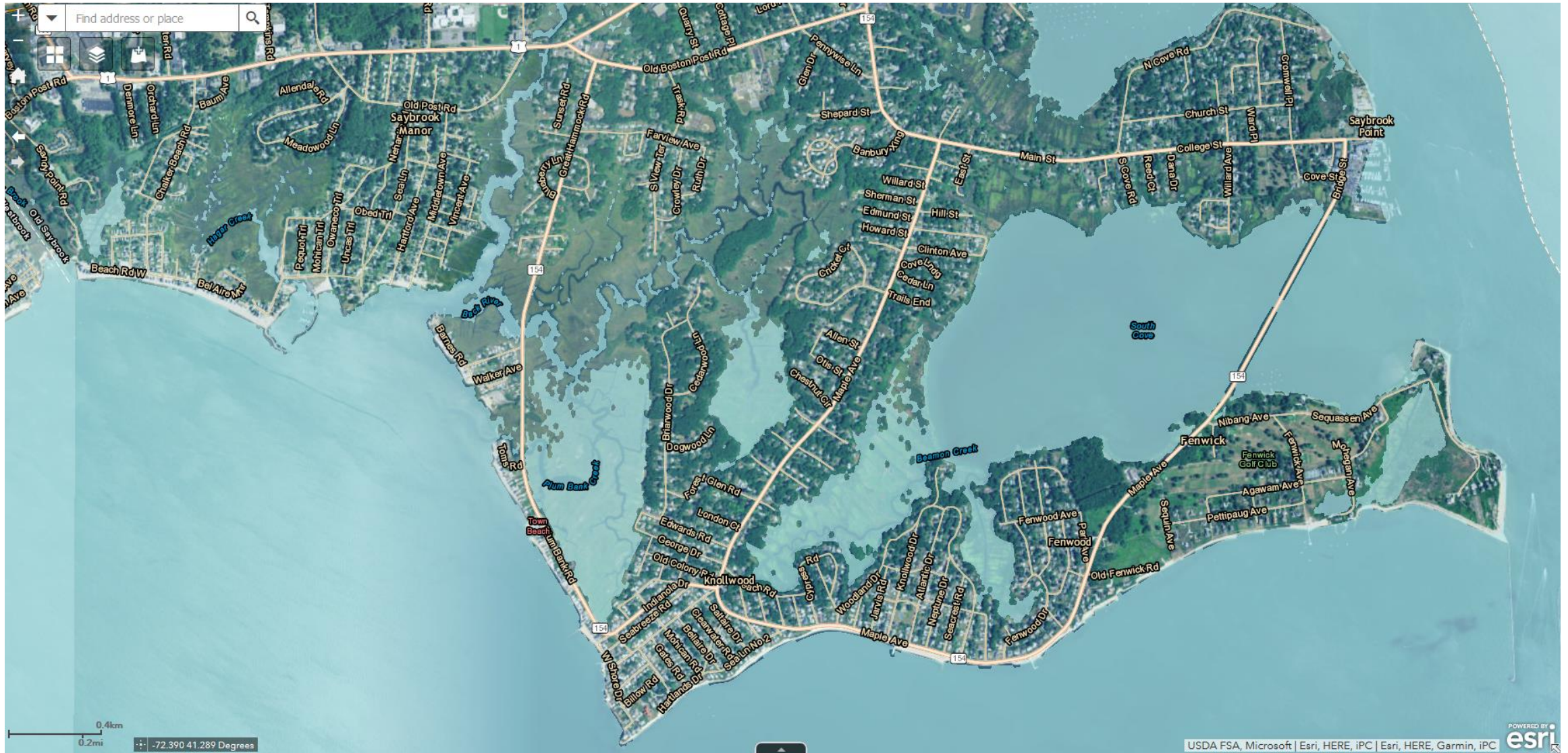




## This is a detailed aerial map of Saybrook, Connecticut. The map shows a coastal town with numerous streets, including Main St, Old Post Rd, and various residential streets like Birchwood Dr and Cedarwood Ln. Water bodies such as Saybrook River, Plum Bank Creek, and South Cove are visible. A search bar at the top left contains the text "Find address or place". The map is overlaid with a grid of latitude and longitude coordinates. The bottom left corner shows a scale bar (0.4km, 0.2mi) and the coordinates -72.391 41.261 Degrees. The bottom right corner features the Esri logo and the text "POWERED BY esri".

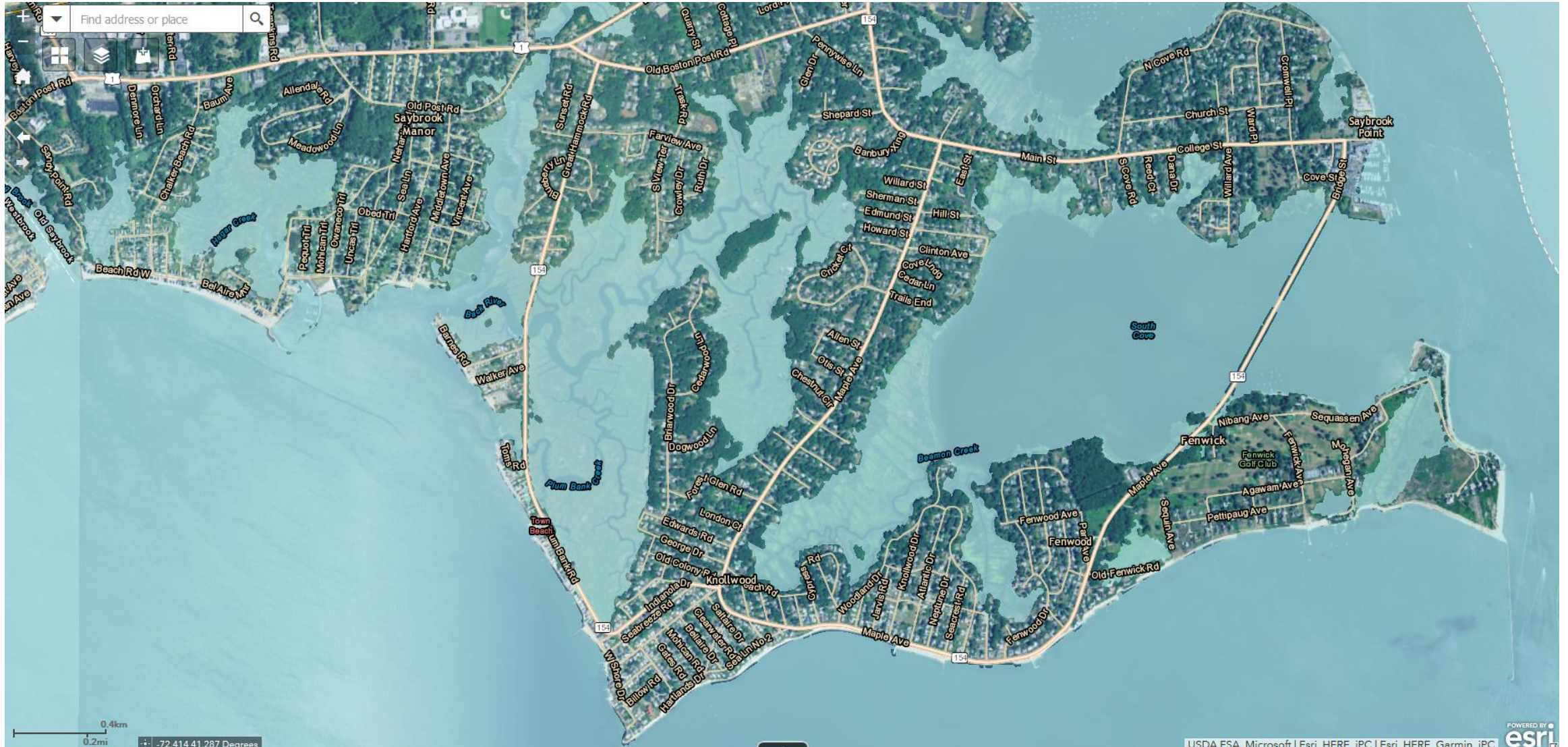


# Mean High Tide: 2066 Intermediate SLR

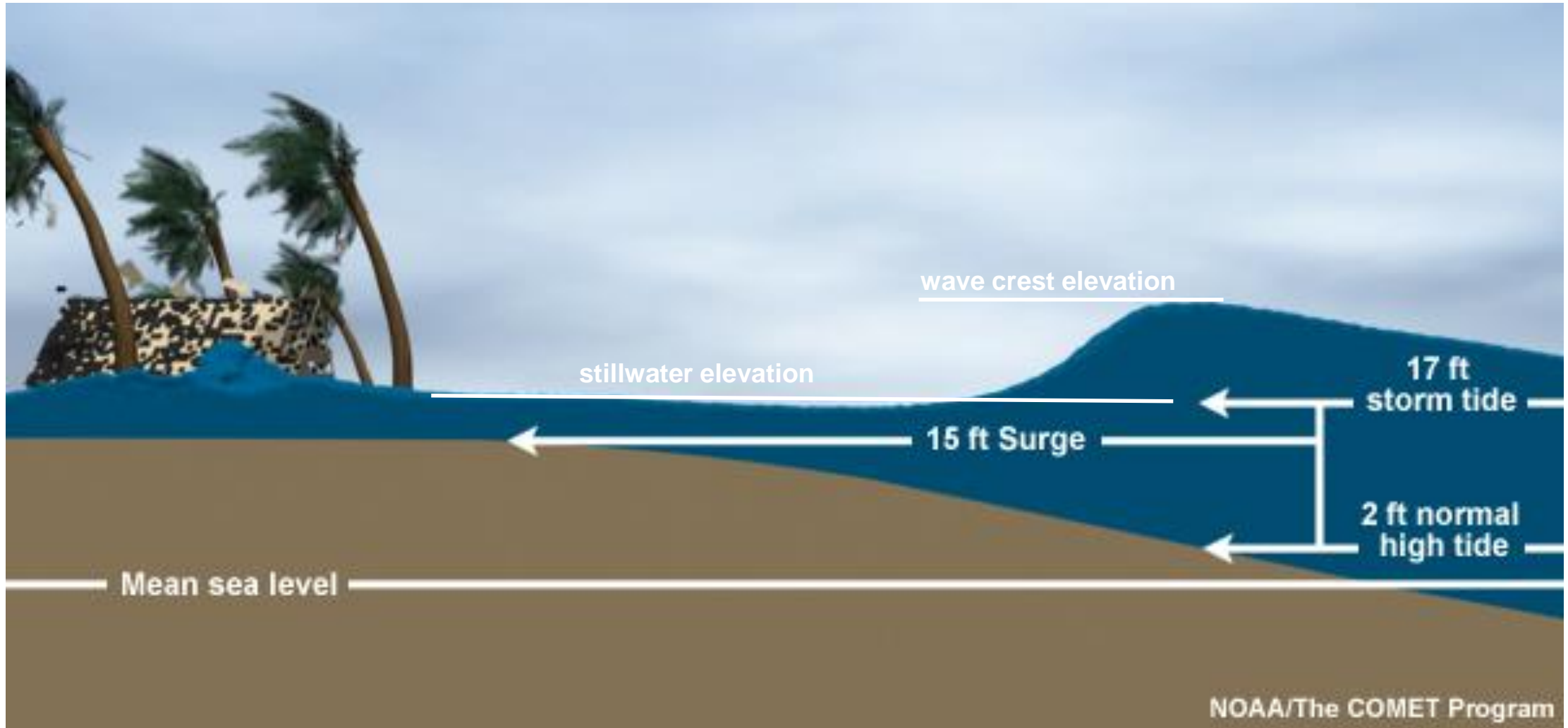




# Mean High Tide: 2116 Intermediate SLR



# Coastal Flooding

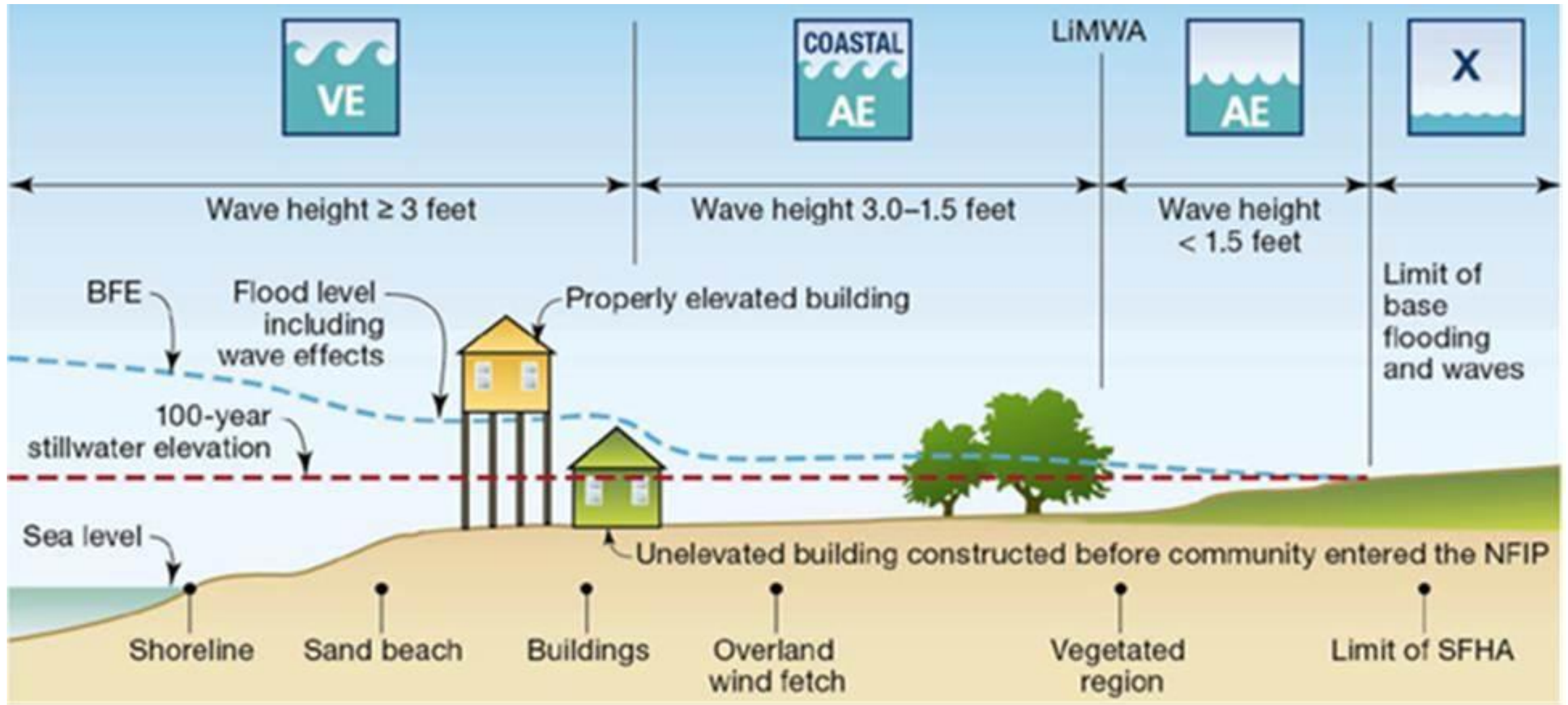


**GEOGRAPHICAL FACTORS**

**STORM FACTORS**

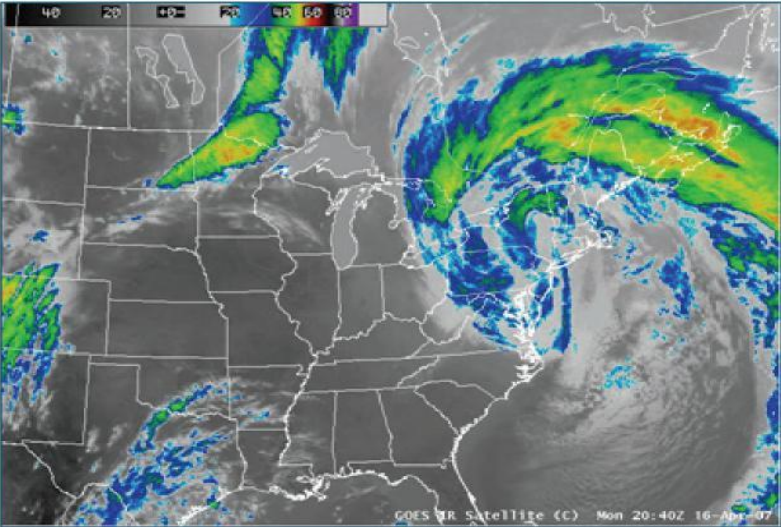


# FEMA Flood Hazard Zones



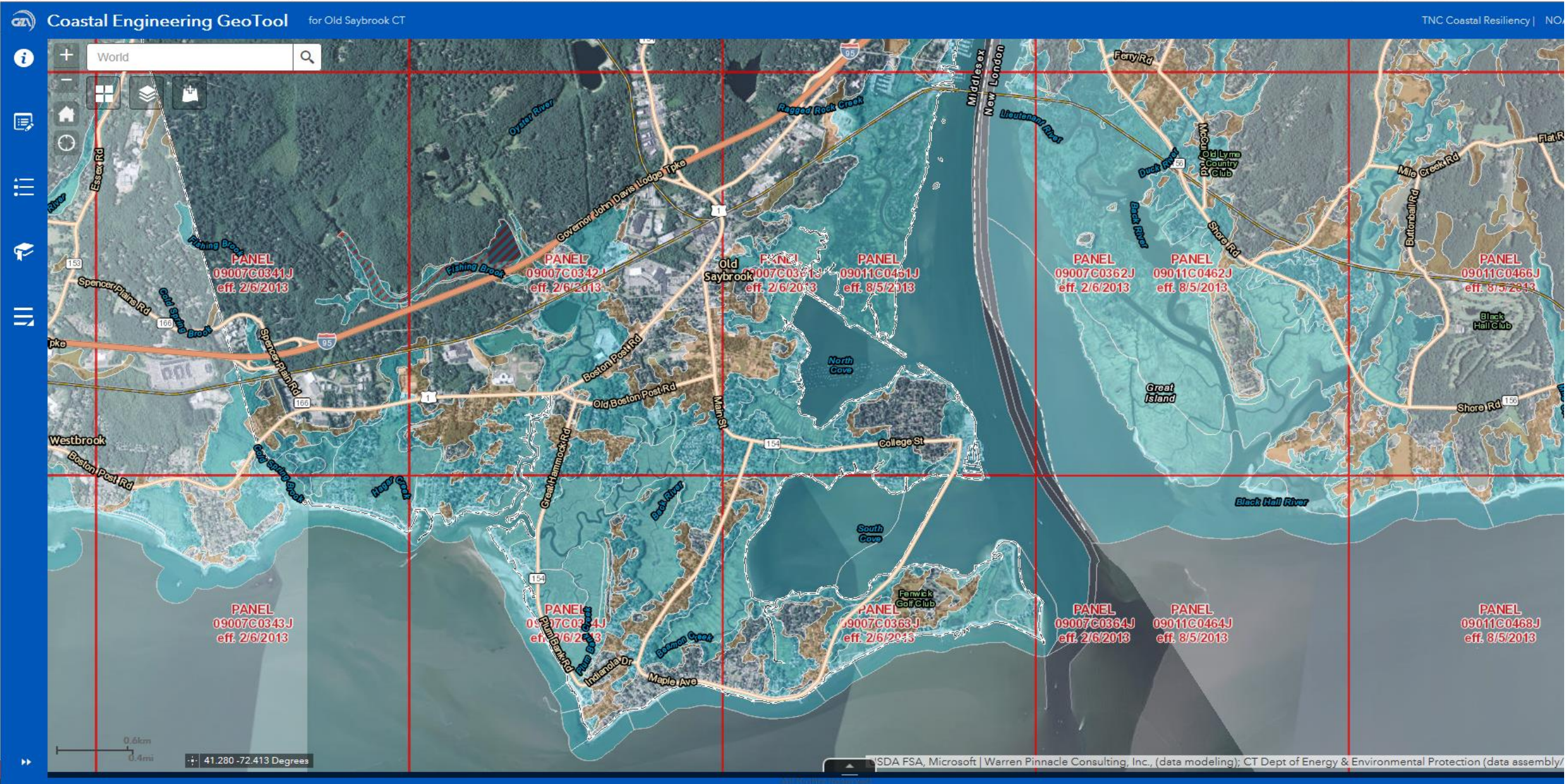
# Task 1: Extreme Water Levels

Recurrence Interval	1-yr	2-yr	5-yr	10-yr	20-yr	50-yr	100-yr	200-yr	500-yr	1,000-yr
2017:										
NOAA MEAN	2.3	3.5	4.4	5.0	5.6	6.6	7.5	8.4		
NOAA UB	2.3	3.7	4.7	5.7	6.7	8.6	10.3	12.6		
NOAA LB	2.3	3.3	4.1	4.5	5.0	5.7	6.2	6.8		
FEMA				5.5		7.7	9.2		15.3	
USACE MEAN	3.9	4.8	5.9	6.7	7.4	8.3	9.2	10.3	11.8	12.8
USACE UB	6.9	7.7	8.7	9.6	10.4	11.8	12.9	14.1	15.6	16.6
USACE LB	0.9	2.0	3.1	3.7	4.3	4.9	5.5	6.4	7.9	9.0
2042:										
USACE MEAN (LOW SLR)	3.97	4.87	5.97	6.77	7.47	8.37	9.27	10.37	11.87	12.87
USACE MEAN (INT SLR)	4.19	5.09	6.19	6.99	7.69	8.59	9.49	10.59	12.09	13.09
USACE MEAN (HIGH SLR)	4.9	5.8	6.9	7.7	8.4	9.3	10.2	11.3	12.8	13.8
2067:										
USACE MEAN (LOW SLR)	4.15	5.05	6.15	6.95	7.65	8.55	9.45	10.55	12.05	13.05
USACE MEAN (INT SLR)	4.65	5.55	6.65	7.45	8.15	9.05	9.95	11.05	12.55	13.55
USACE MEAN (HIGH SLR)	6.24	7.14	8.24	9.04	9.74	10.64	11.54	12.64	14.14	15.14
2117:										
USACE MEAN (LOW)	4.52	5.42	6.52	7.32	8.02	8.92	9.82	10.92	12.42	13.42
USACE MEAN (INT SLR)	5.91	6.81	7.91	8.71	9.41	10.31	11.21	12.31	13.81	14.81
USACE MEAN (HIGH SLR)	10.32	11.22	12.32	13.12	13.82	14.72	15.62	16.72	18.22	19.22





# FEMA Flood Insurance Rate Map: Base Flood

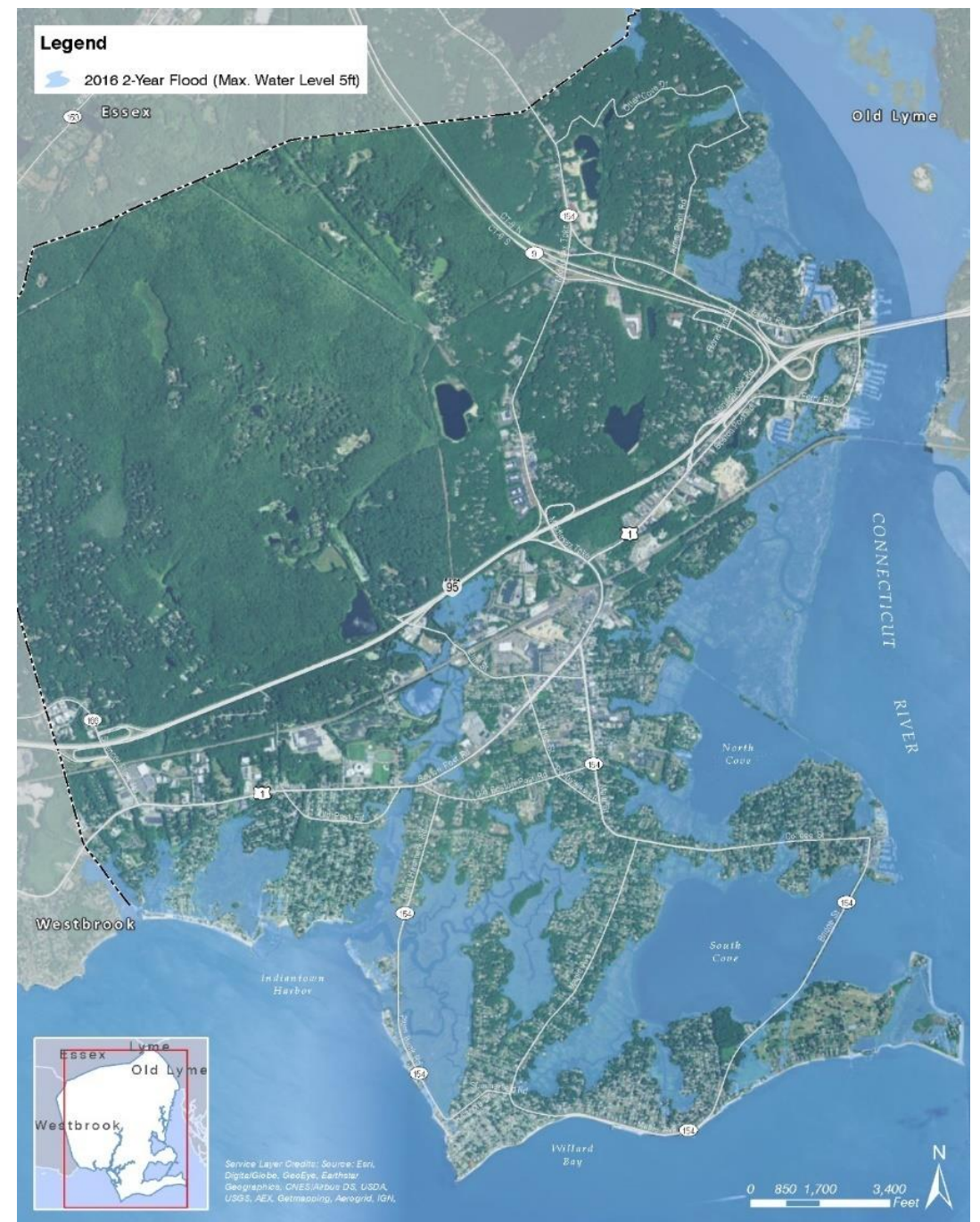




# 100 Year (2016)

Stillwater

- ✓ 2 year
- ✓ 10 year
- ✓ 50 year
- ✓ 100 year
- ✓ 500 year





# 100 Year (2016)

Stillwater

- ✓ 2 year
- ✓ **10 year**
- ✓ 50 year
- ✓ 100 year
- ✓ 500 year



# 100 Year (2016)

Stillwater

- ✓ 2 year
- ✓ 10 year
- ✓ **50 year**
- ✓ 100 year
- ✓ 500 year





# 100 Year (2016-2116)

## Stillwater

- ✓ 2 year
- ✓ 10 year
- ✓ 50 year
- ✓ **100 year**
- ✓ 500 year





# 500 Year (2016-2116)

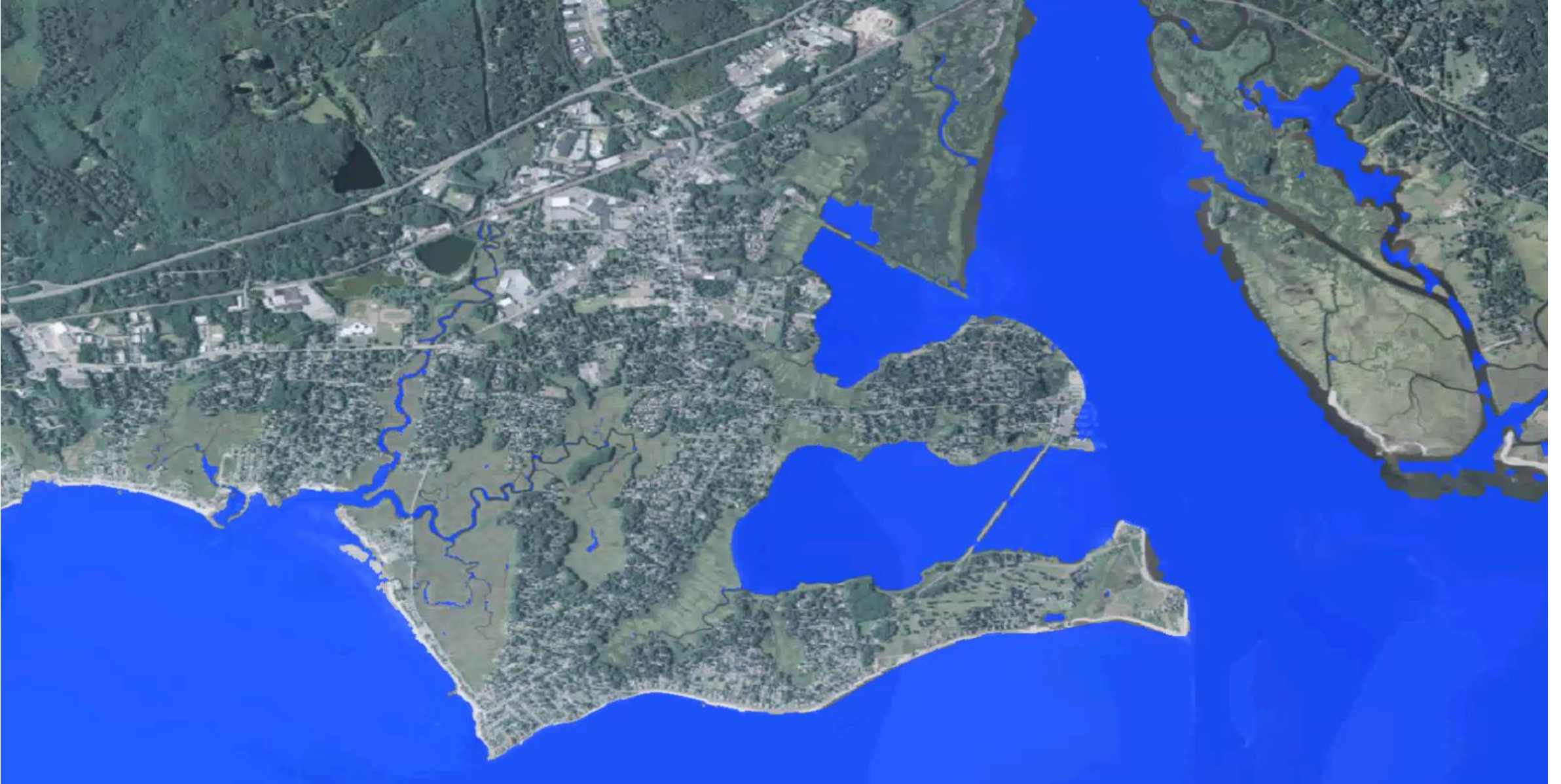
## Stillwater

- ✓ 2 year
- ✓ 10 year
- ✓ 50 year
- ✓ 100 year
- ✓ **500 year**





# GZA High Resolution Modeling – 2016 100-yr





# Coastal Hazard Vulnerability Assessment

## Step 4 – Characterize Vulnerability and Impacts:

- ✓ Essential Facilities
- ✓ Lifeline Utilities
- ✓ Transportation
- ✓ High Potential Loss Facilities
- ✓ Hazardous Material Facilities
- ✓ Neighborhoods
- ✓ High Occupancy/Vulnerable Population Facilities
- ✓ Private and commercial property
- ✓ Natural Resources



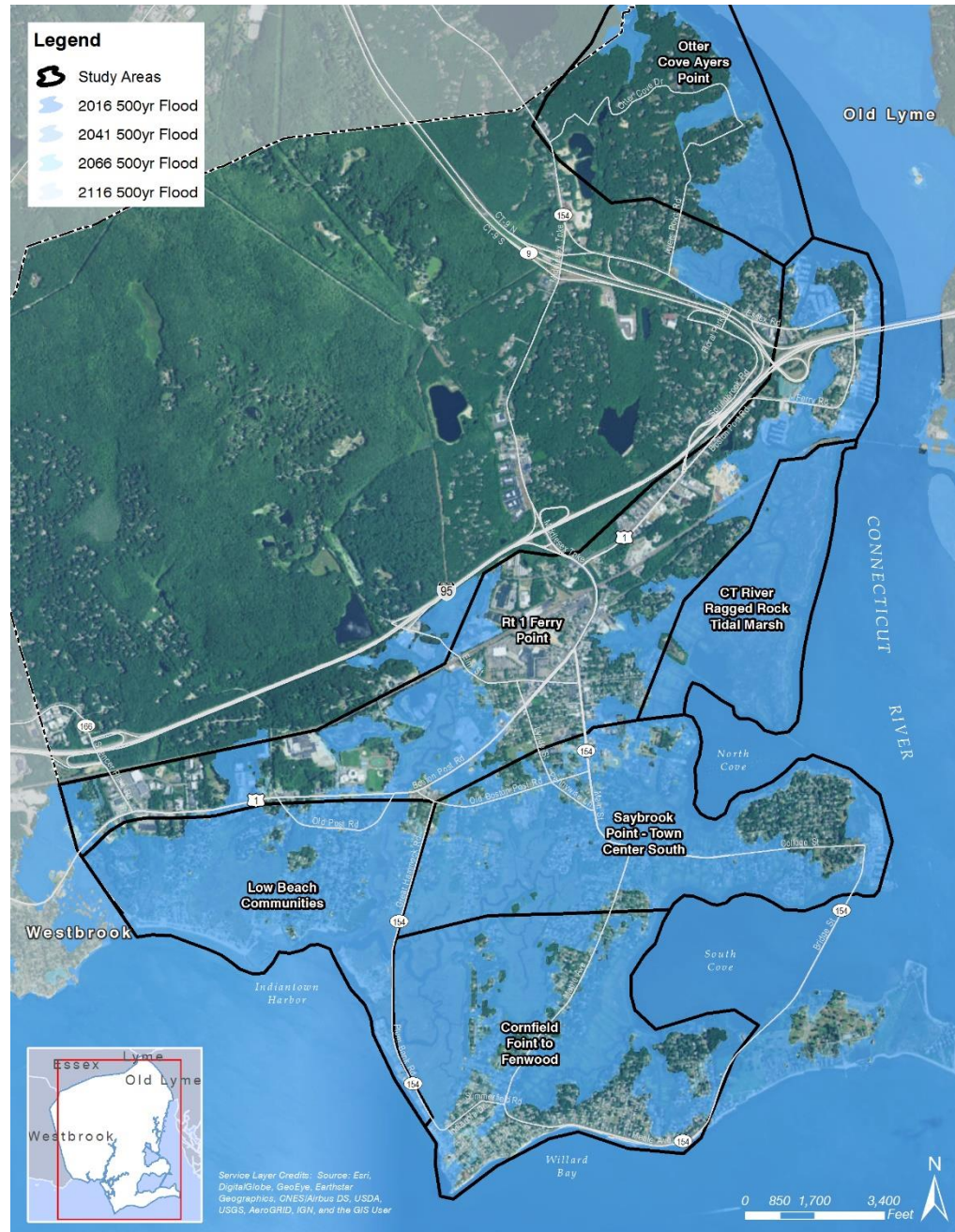
Impacts from sand accumulation at beach homes after Sandy  
image from (Marilee Caliendo/FEMA)

# Vulnerability Summary

- ✓ Essential Facilities – Low Risk
- ✓ Lifeline (Wastewater) – Significant Impact
- ✓ Neighborhoods – Significant Impact
- ✓ Natural Resources - Significant Impact
- ✓ Roadways – Significant Impact
- ✓ Property – Moderate to Significant Impact







# Old Saybrook – Neighborhoods/Study Areas

1. Otter Cove Ayers Point
2. Rt 1 Ferry Point
3. Ct River Ragged Rock Tidal Marsh
4. Low Beach Communities
5. Saybrook Point – Town Center South
6. Cornfield Point to Fenwood

# Old Saybrook – Neighborhood Vulnerability



	Saybrook Point/Town Center		Low Beach Communities		Cornfield Point to Fenwood		Connecticut River/Ragged Rock Tidal Marsh		Route 1 to Ferry Point		Otter Cove/Ayers Point	
	Flood Risk	Priority	Flood Risk	Priority	Flood Risk	Priority	Flood Risk	Priority	Flood Risk	Priority	Flood Risk	Priority
Current	High	High	High	High	Low to Moderate	Moderate	High	High	Low to Moderate	High	Low	Low
2041	High	High	High	High	Moderate	Moderate	High	High	Low to Moderate	High	Low	Low
2066	High	High	High	High	Moderate	Moderate	High	High	Low to Moderate	High	Low	Low
2116	High	High	High	High	High	High	High	High	Moderate	High	Low	Low



# Old Saybrook – Critical Assets/Natural Resources

	Essential Facilities		Lifeline Facilities: Sanitary Sewer		Lifeline Facilities: Stormwater Management & Tide Gates		Hazardous Materials Facilities		Transportation: State and Primary Roads		Natural Resources	
	Flood Risk	Priority	Flood Risk	Priority	Flood Risk	Priority	Flood Risk	Priority	Flood Risk	Priority	Flood Risk	Priority
Current	Low	Low	High	High	High	High	Moderate	High	High	High	High	High
2040	Low	Low	High	High	High	High	Moderate	High	High	High	High	High
2065	Low	Low	High	High	High	High	Moderate	High	High	High	High	High
2115	Low	Low	High	High	High	High	High	High	High	High	High	High

# Essential Facilities

1. Hospitals/Healthcare
2. Emergency Shelters
3. Fire and Rescue
4. Police
5. Emergency Vehicle Garages

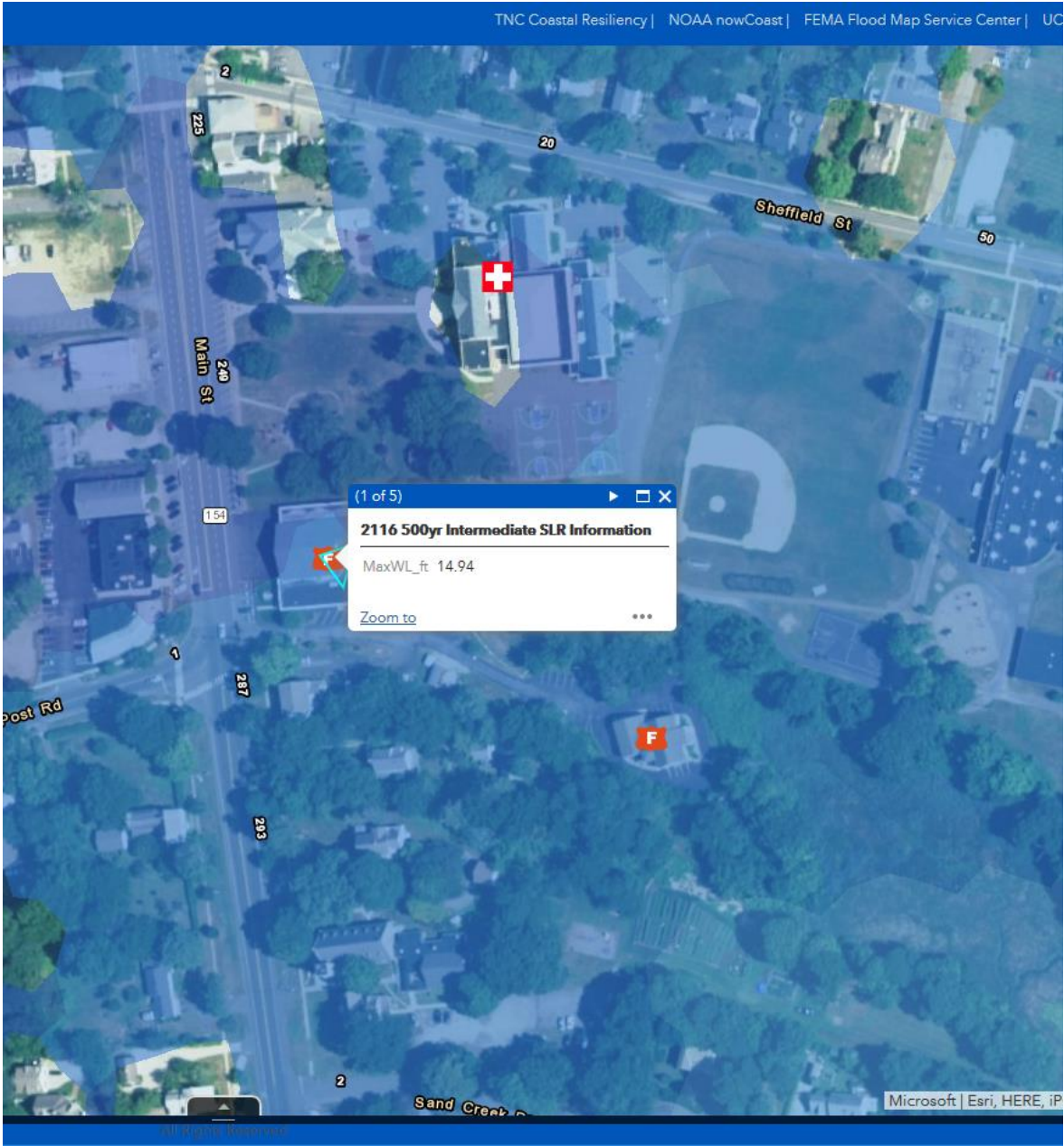




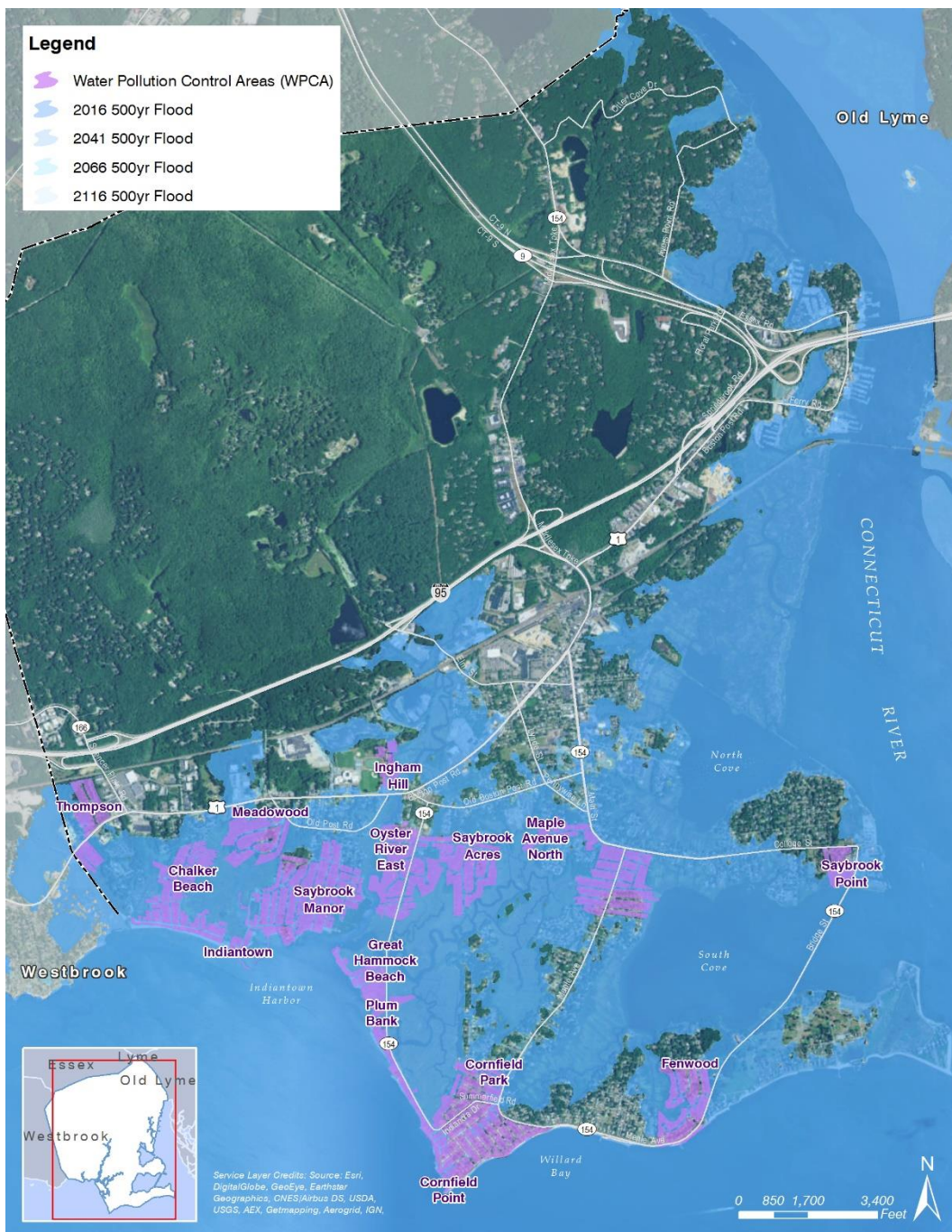
# 500-Year – Flood Depths



	2016	2041	2066	2116
Old Saybrook Fire Department	NI	NI	NI	1.8 feet
Old Saybrook Ambulance Association	2.4 feet	2.7 feet	3.1 feet	3.8 feet







# Lifeline Facilities: Decentralized Wastewater Management

- 15 Wastewater Districts
- 1900 parcels
- 10 of 15 districts upgrades
- 5 remaining are most vulnerable

## Impacts:

- Flooding
- Groundwater elevation increase
- Water chemistry

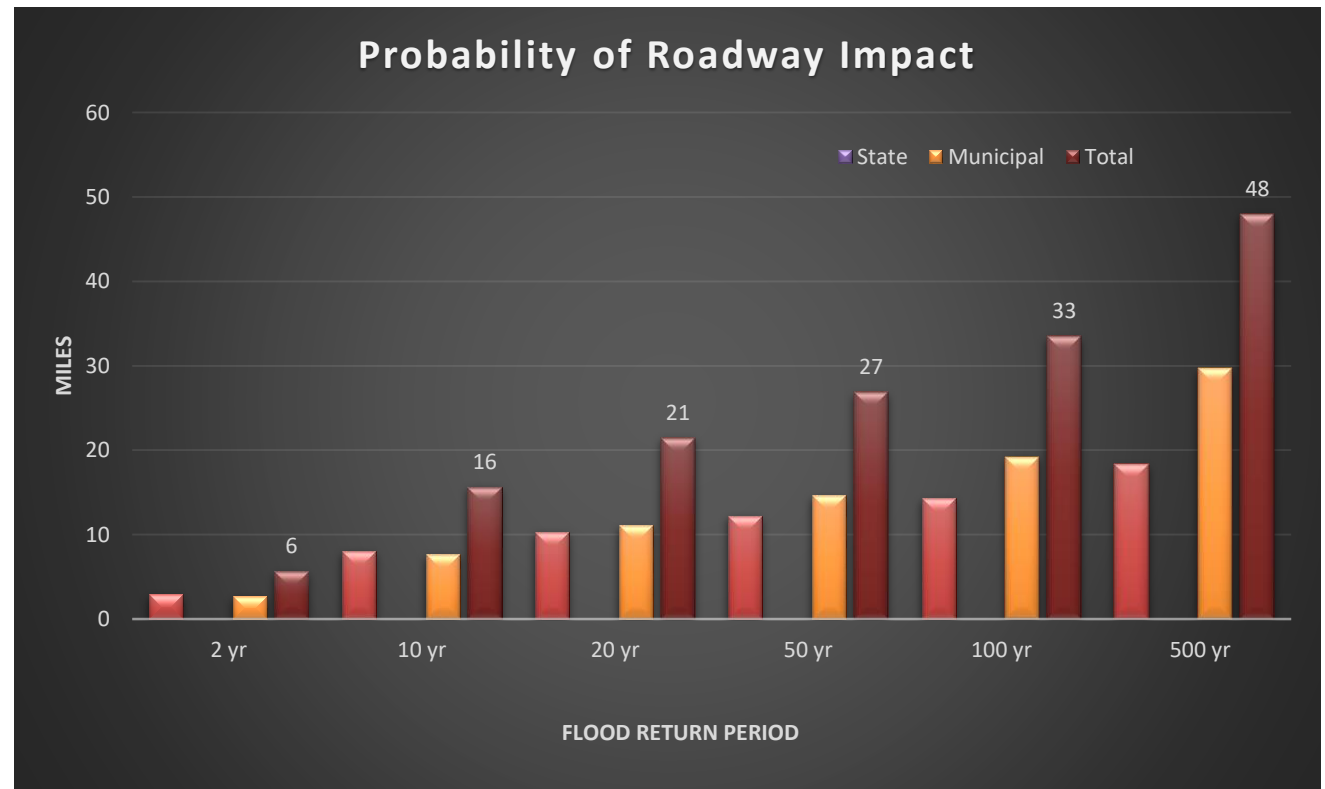


# Transportation Roadway Impacts

	2 yr	10 yr	20 yr	50 yr	100 yr	500 yr
<b>State Highway</b>	6.2%	17%	22%	26%	30.4%	39%
<b>Limited Access Highway</b>	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
<b>Municipal</b>	3.1%	8.7%	12.6%	16.6%	21.8%	33.7%

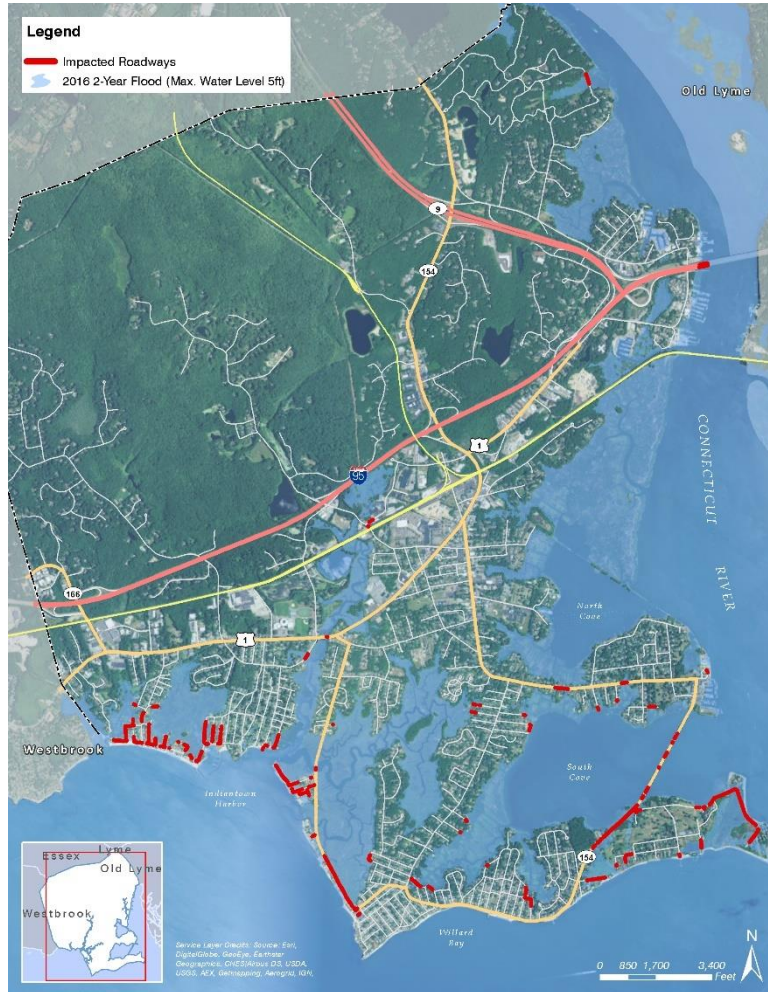
## Summary of Old Saybrook Roads and Bridges

- Roadways – 18 Total
  - 1 Federal
  - 3 State
  - 15 Local Roads
- Bridges – 22 Total
- State/federal Roads: 47 miles
- Municipal: 88 miles



# Transportation Roadway Impacts

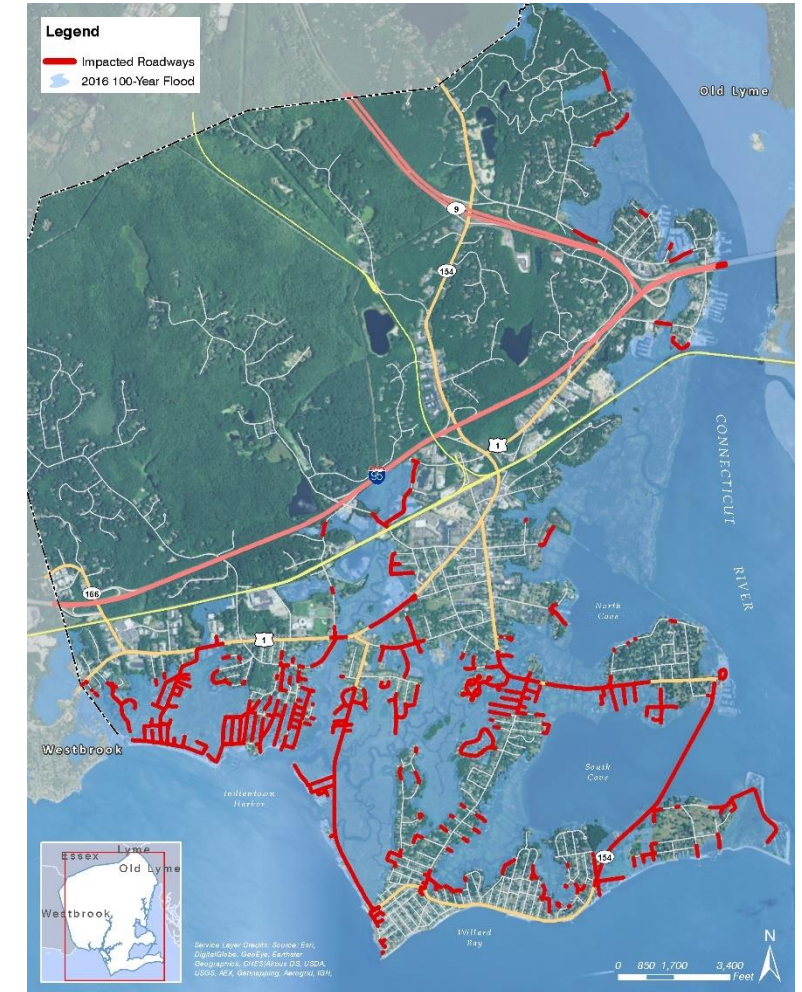
## 2-Year (2016)



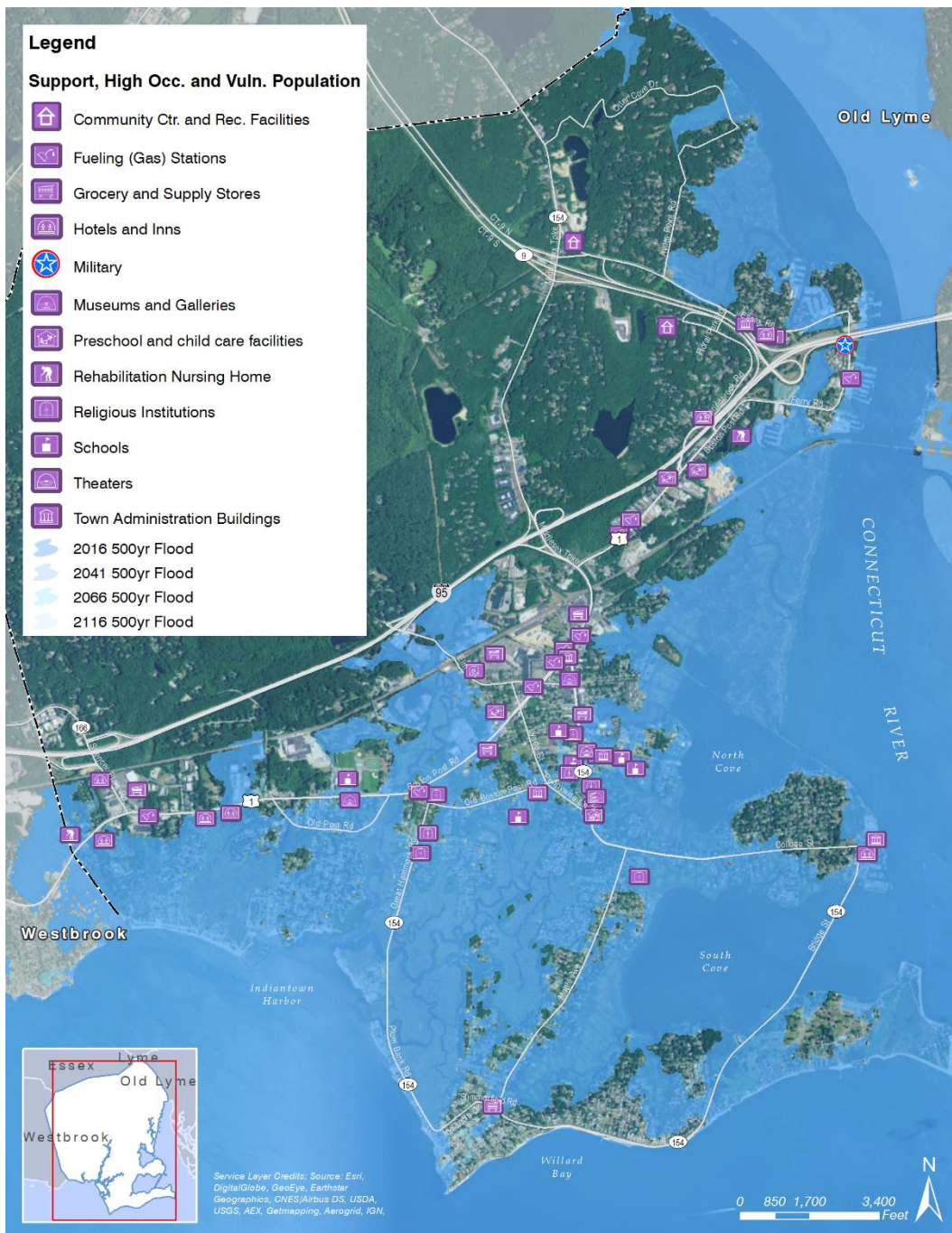
## 10-Year (2016)



## 100-Year (2016)

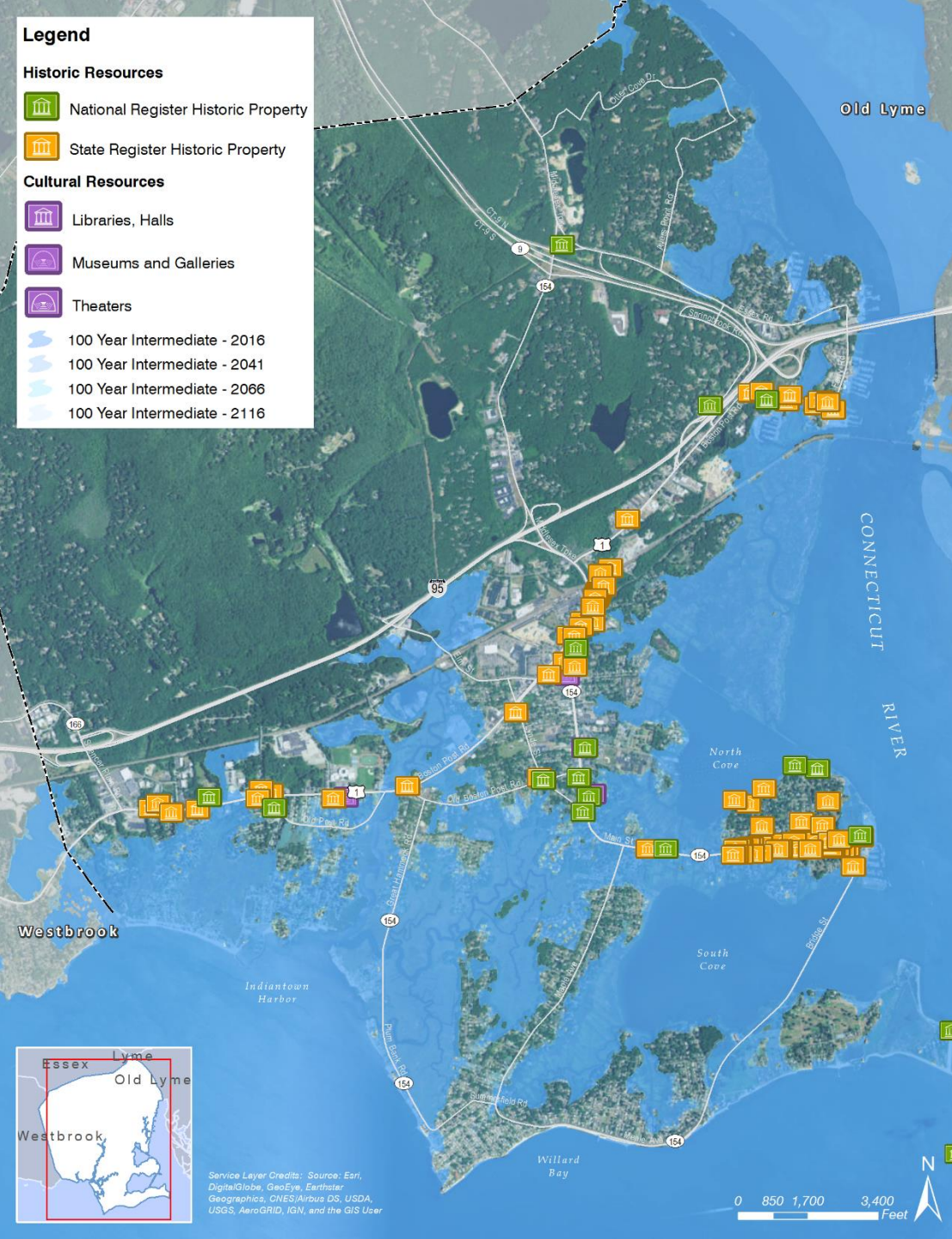






# Support, High Occupancy and Vulnerable Population

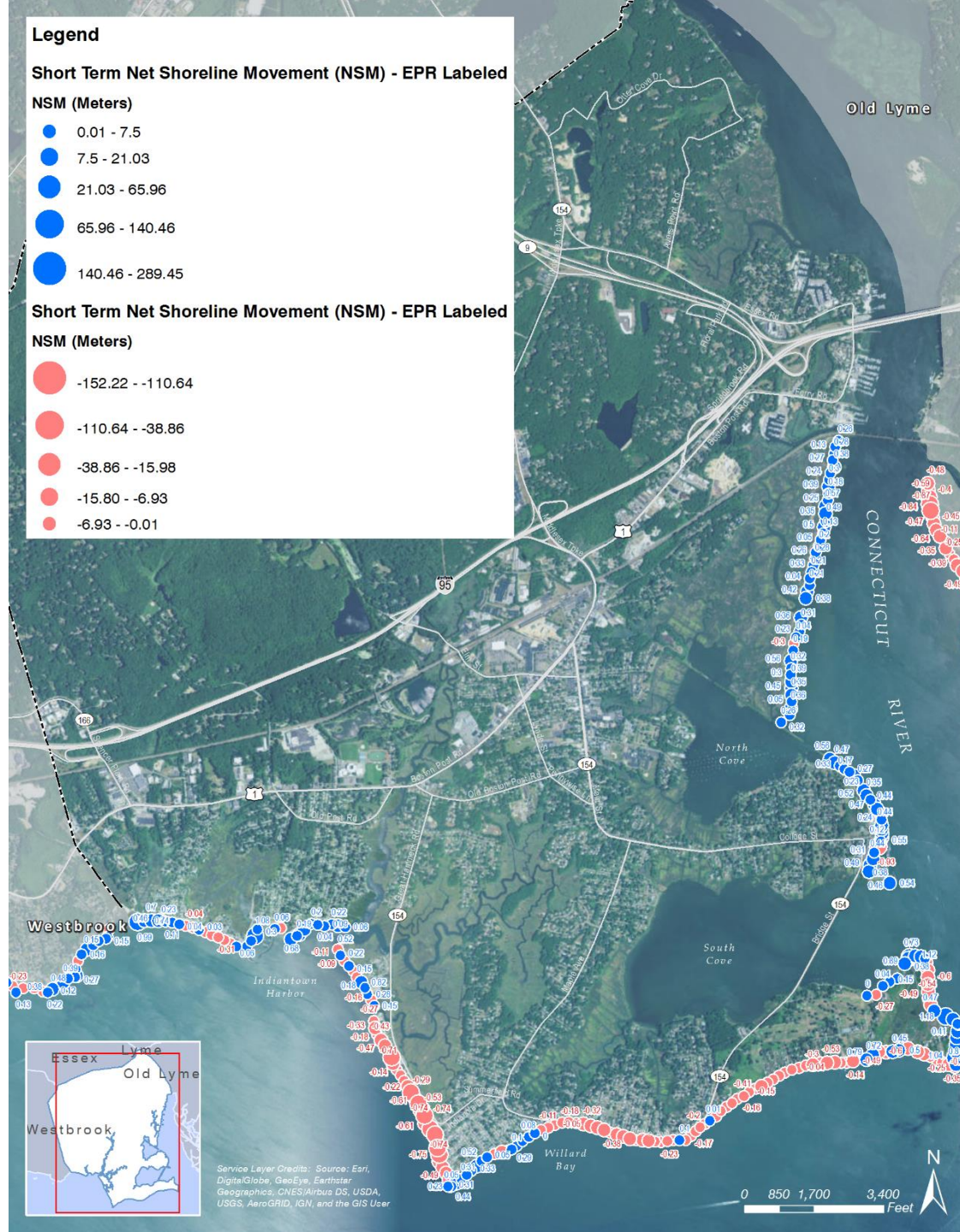
- Community Centers
- Fueling Stations
- Hotels and Inns
- Museums and Galleries
- Pre-school and Childcare Facilities
- Religious Institutions
- Schools
- Theaters
- Town Administration Buildings



# Historic Properties



# Beaches



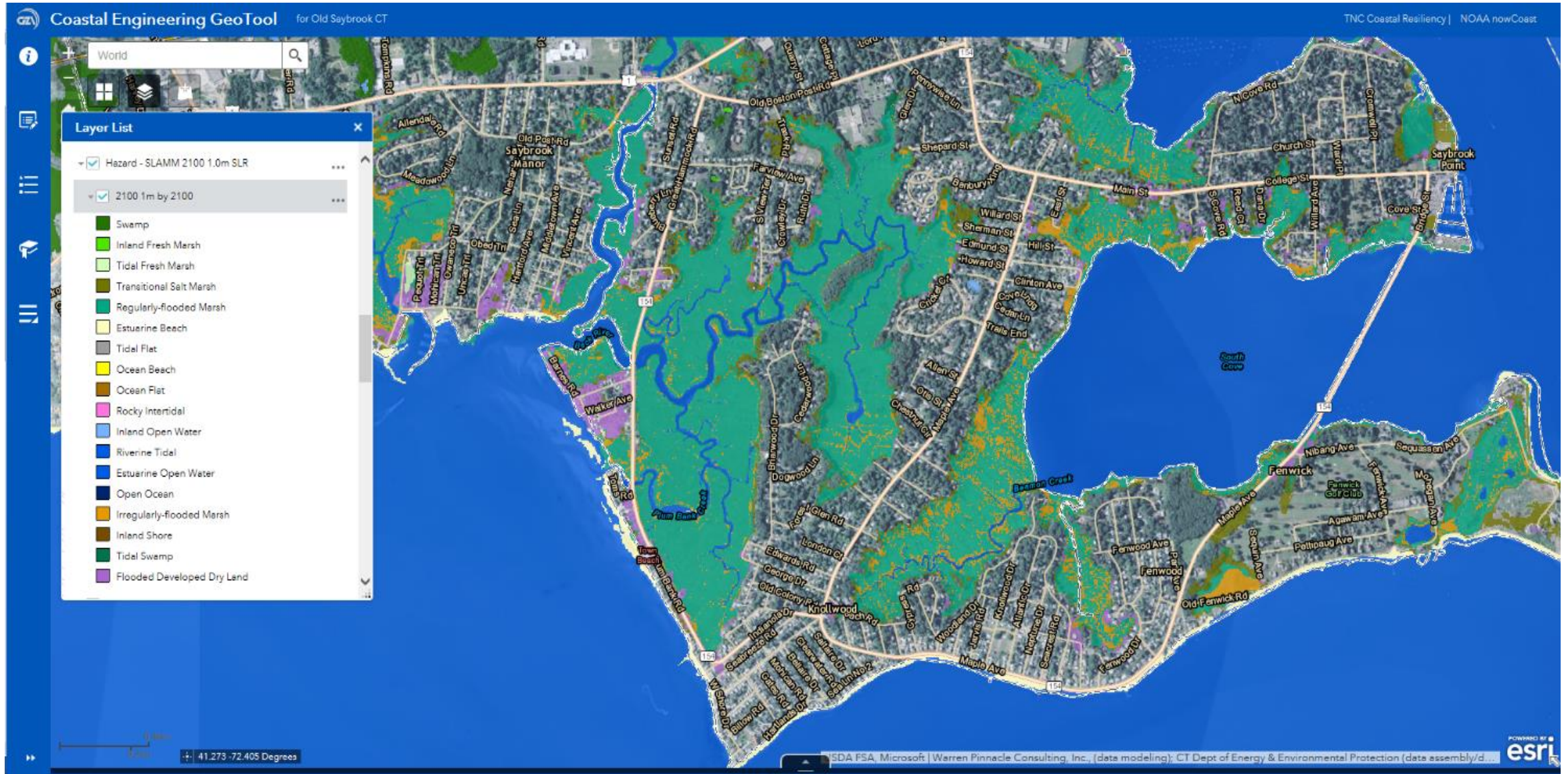


# Ecological Impacts: wetlands



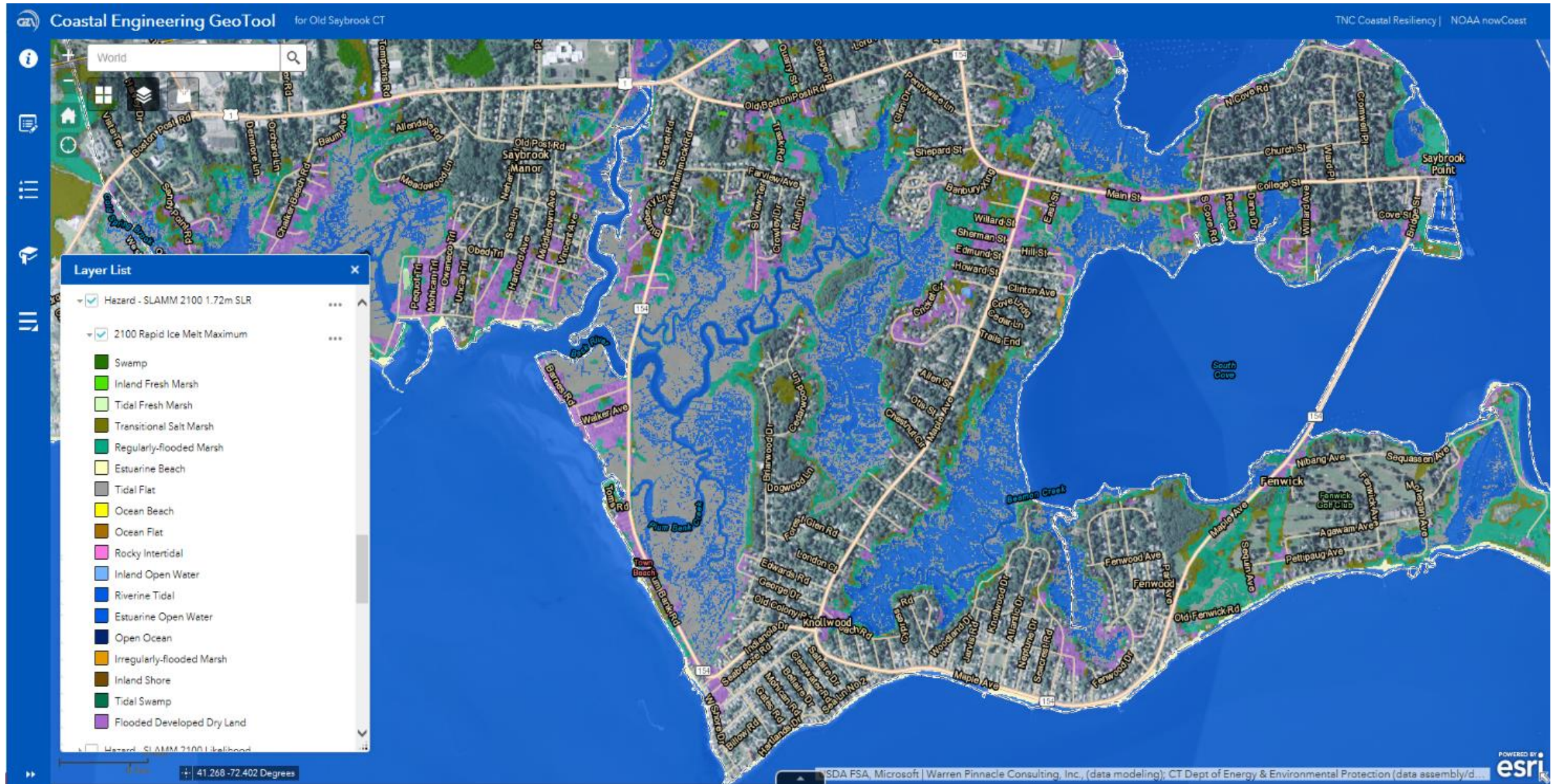


# Ecological Impacts: wetlands





# Ecological Impacts: wetlands





# Ecological Impacts: wetlands

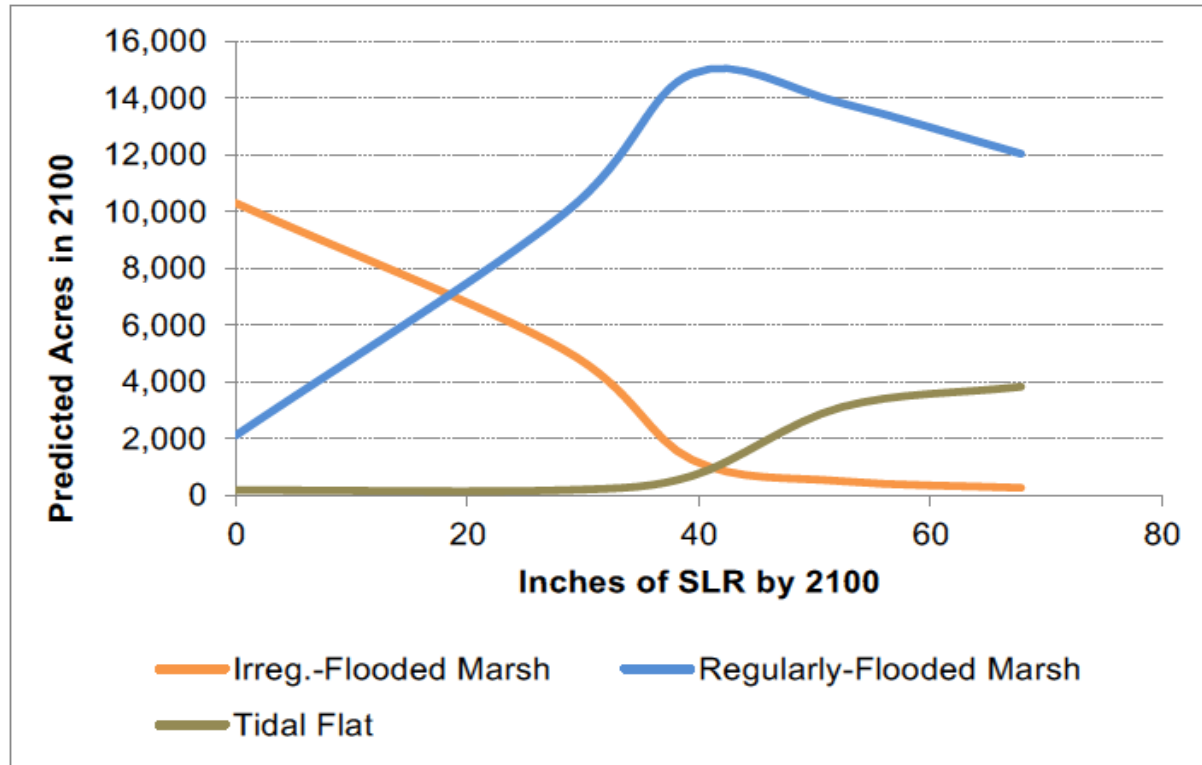
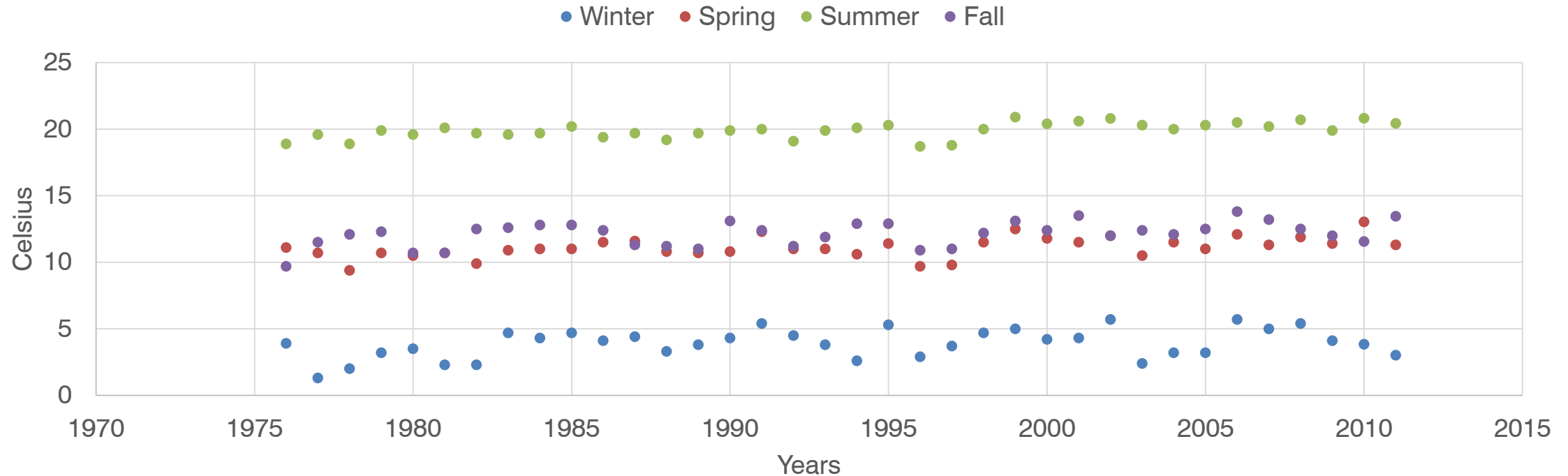


Figure 4. Marsh and tidal flat fate as a function of SLR by 2100

- ✓ Decreased Irregularly Flooded Marsh
- ✓ Increased Regularly flooded Marsh
- ✓ Increased Tidal Flats

# Ecological Impacts: water temperature



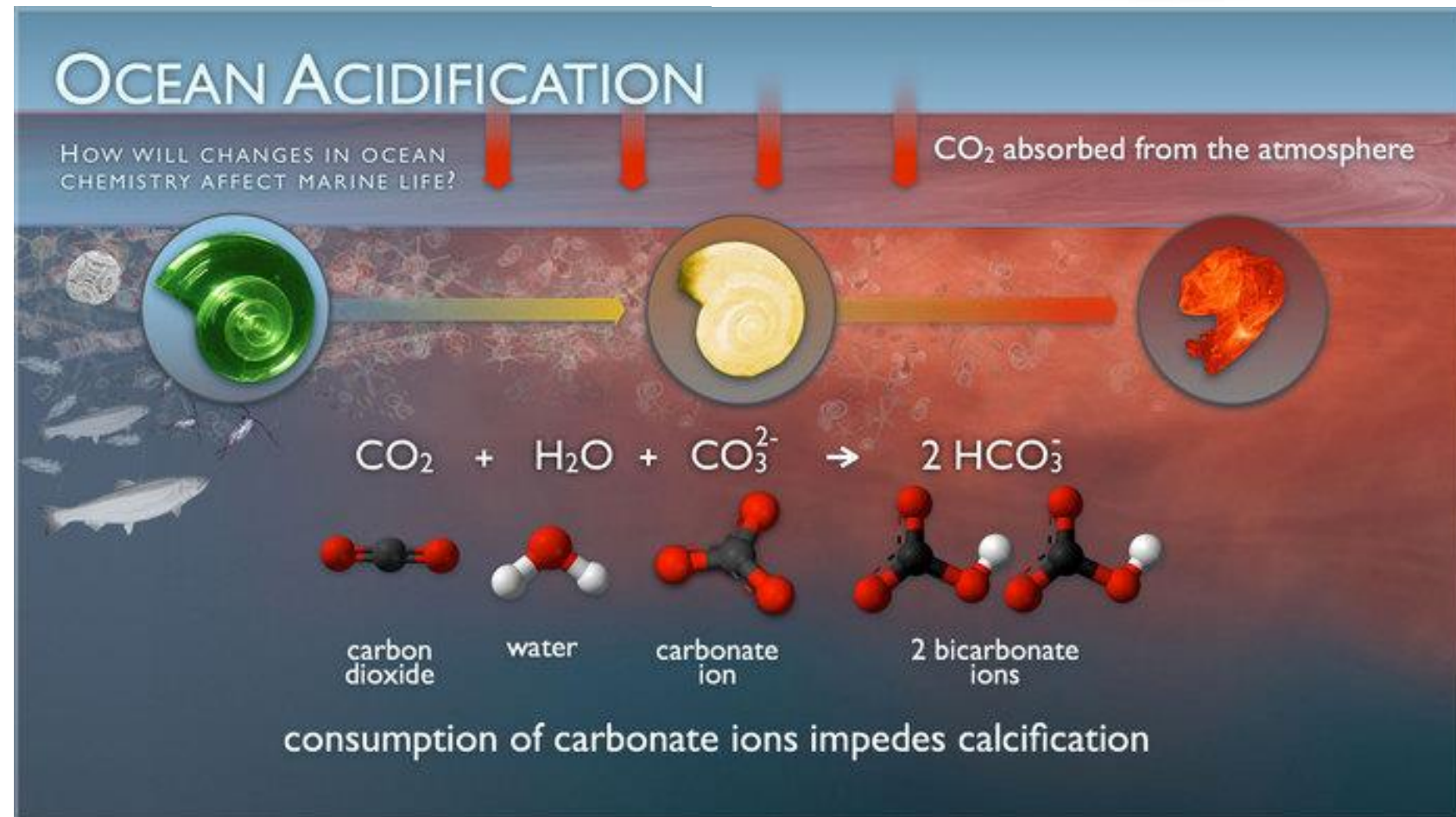
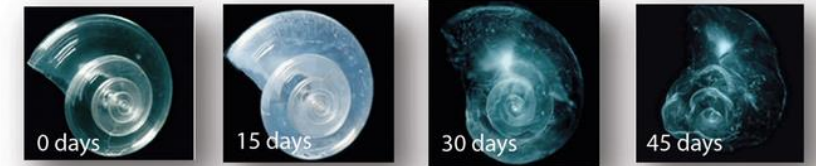
## Long Island Sound:

- Slow steady increase in average water temperature (moving toward mid-Atlantic)
- Winter temperature rise is more dramatic
- Cold water fish observed less frequently (winter flounder, American Lobster)
- Warm water species increasing (black sea bass, northern kingfish, scup, blue crab)



# Ecological Impacts: water acidity

- Acidity change in LIS is uncertain
- \$30M/yr Connecticut Shellfishing Industry



# Quantify Loss: Cumulative Community Assets



## POTENTIAL LOSS ESTIMATES ANALYZED IN HAZUS :

- ✓ **DIRECT COSTS**
  - **Physical damage** to critical facilities and infrastructure.
- ✓ **CONSEQUENTIAL COSTS**
  - **Economic loss** including lost jobs, business interruptions, repair and reconstruction costs;
  - **Social impacts**, including estimates of shelter requirements and displaced households
  - **Environmental impacts**, including loss of wetlands, riparian and open space.



Fire damage to beach home on Saye Street in Old Saybrook after Sandy (Image from <http://www.theday.com/article/20121030/NWS01/121039993>)





Dock and Dine on Saybrook Point one week after Sandy  
image from <https://gardendaze.wordpress.com/2012/11/09/storm-sandy-one-week-later-old-saybrook-ct/>

## Recent Hurricane Sandy Building Damage

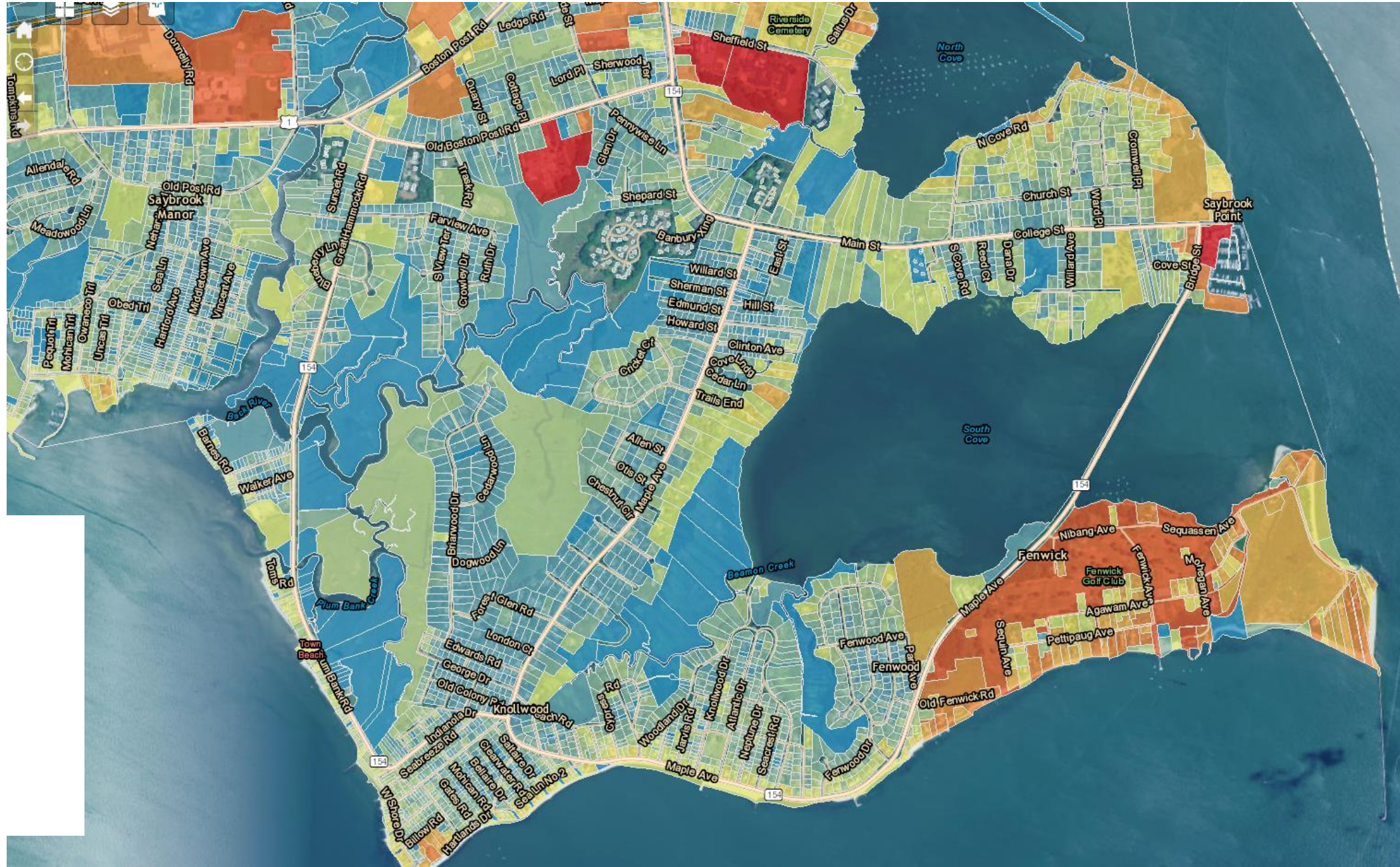
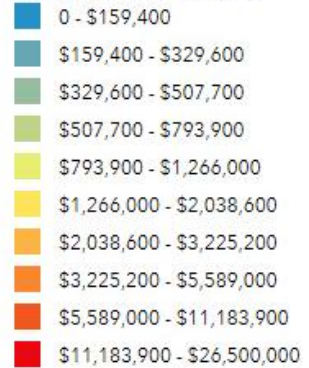


Demolition of Dock and Dine on Saybrook Point after Sandy  
image from <http://www.wfsb.com/story/24398944/demolition-begins-at-dock-dine-in-old-saybrook>



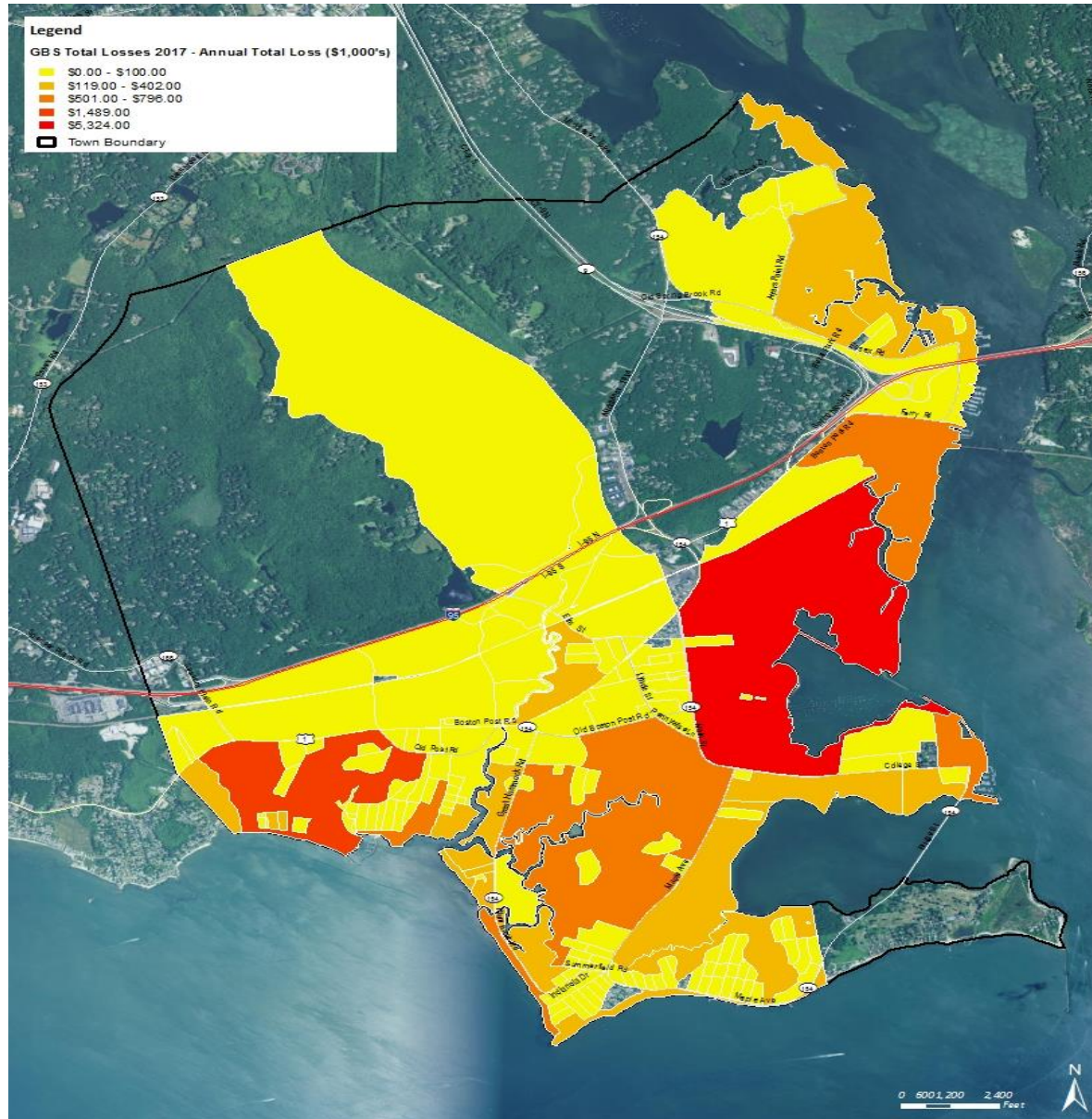
# Property

Total Appraised Parcel Value





# Old Saybrook Building Loss Exposure



Occupancy	Loss Exposure (\$1000)	Percent of Total
Residential	1,485,236	72.4%
Commercial	404,804	19.7%
Industrial	92,785	4.5%
Agricultural	4,762	0.2%
Religion	28,859	1.4%
Government	19,222	.9%
Education	14,444	.7%
<b>Total</b>	<b>2,050,112</b>	<b>100%</b>

## Estimated Average Annualized Losses:

- Middlesex County: \$77.4 (\$467/person)
- Old Saybrook: \$16M (\$1,569/person)
- Old Saybrook 2040 (\$1,800/person)
- Old Saybrook 2065 (\$2,000/person)

Next Steps



# Next Steps

1. Neighborhood Workshops
  - June 20<sup>th</sup>
  - August 1<sup>st</sup>
2. Develop Suitable Resiliency Recommendations
3. Draft Coastal Resilience Study
4. Draft Mitigation Feasibility Study
5. Draft Coastal Structures Evaluation



# Thank you for attending!

Questions? Comments?

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