



Scarborough Flood Vulnerability Assessment Town Council Workshop

Leila Pike, P.E.

August 20th, 2025

Presentation Outline

1. Project Background and Project Status
2. Recent Flooding
3. Coastal Flood Vulnerability Assessment
4. Road Prioritization Process
5. Flood Adaptation Recommendations
6. Pilot Projects
7. Town Ordinance Review
8. StoryMap and Next Steps



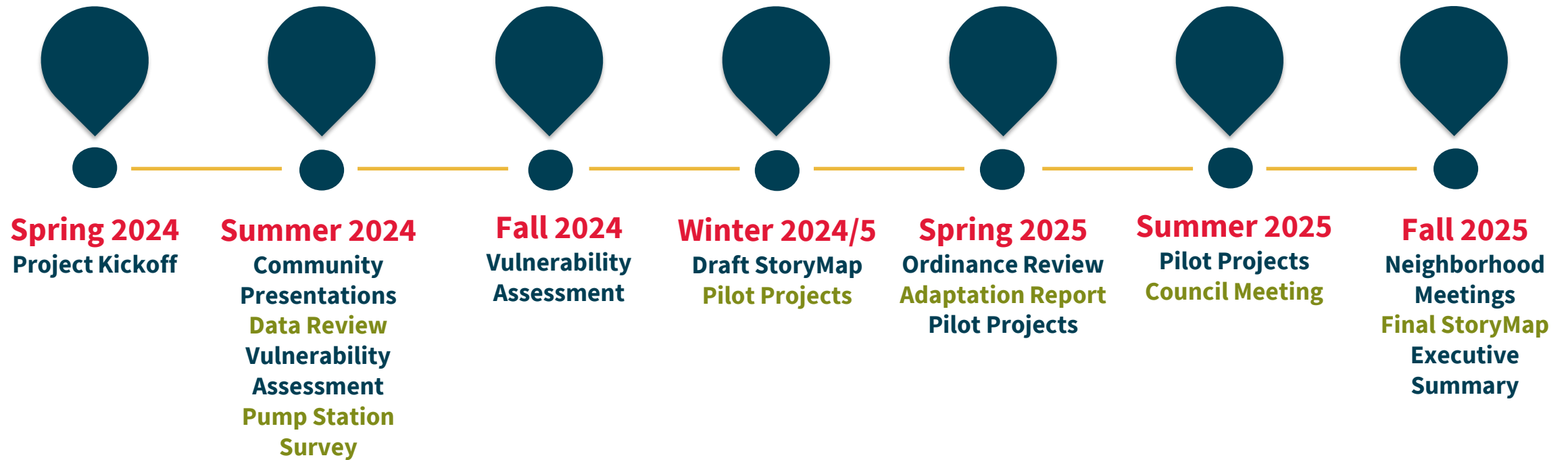
PROJECT PURPOSE

Screening-level **coastal flood risk study** to identify areas and infrastructure at risk to flooding, propose **high-level adaptation** strategies, develop **pilot projects** to dive deeper into adaptation, and **review Town ordinances** to find opportunities to promote resilience.

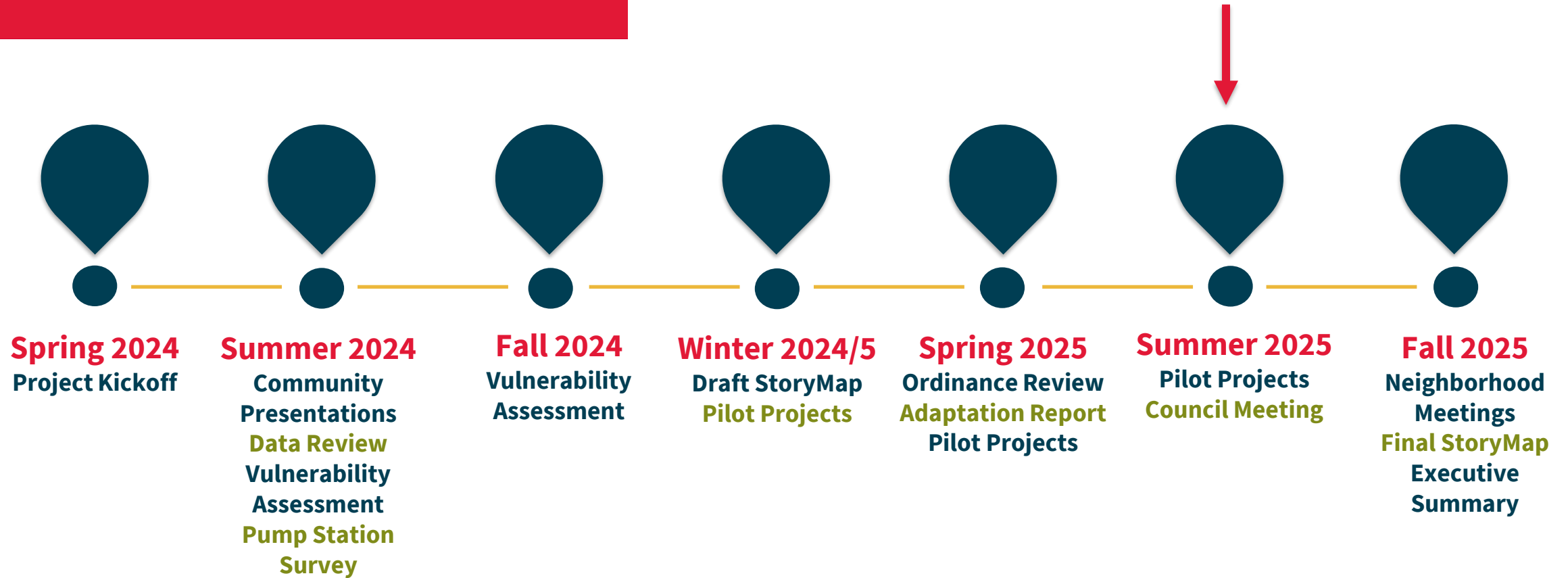
Throughout the project, field work, **public engagement**, working group **meetings**, and draft technical **memos**.



Project Background and Status



Project Background and Status



Recent Flooding

January 13, 2024 Higgins Beach and Bayview Avenue



Recent Flooding

Route 1



Pine Point Road



Photos from WGME and Downeast.com



Which areas and what infrastructure are at risk of **coastal flooding** now and in the future?

*Coastal flooding is flooding due to **high tides** and/or **coastal storm surge**. Coastal flooding will likely worsen with **increasing sea levels**.*



Sea Level Rise		Water Surface Elevations (NAVD88, ft)						
		"High Tides"		Coastal Storm Events				
Planning Scenario	SLR (ft)	MHHW	HAT	10 yr	50 yr	100 yr	Max Tide January 13, 2024	500 yr
Existing Sea Levels	0.0	4.6	6.5	7.9	8.5	8.8	9.3	9.5
2030	0.8	5.4	7.3	8.7	9.3	9.6	10.1	10.3
2050: Commit	1.5	6.1	8.0	9.4	10.0	10.3	10.8	11
2050: Prepare	1.9	6.5	8.4	9.8	10.4	10.7	11.2	11.4
2100: Commit	4.0	8.6	10.5	11.9	12.5	12.8	13.3	13.5
2100: Prepare	7.4	12.0	13.9	15.3	15.9	16.2	16.7	16.9



Today:

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Future:



Sea Level Rise		Water Surface Elevations (NAVD88, ft)						
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Coastal Flood Vulnerability Assessment

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Final Flood Scenarios

Flood Scenario	Water Surface Elevation (ft)	Flood Risk Time Horizon	
		Coastal Storm Event	“High Tide”
1	7.3	Now	2030
2	8.0	Now	2050
3	8.8	Now	2050
4	9.6	Now	2100
5	10.3	2030	2100
6	10.8	2050	2100
7	11.4	2050	2100
8	12.8	2100	2100
9	13.9	2100	2100
10	16.9	2100	2100



Final Flood Scenarios

What isn't included?

- Wave action
- Rain events

Flood Scenario	Water Surface Elevation (ft)	Flood Risk Time Horizon	
		Coastal Storm Event	"High Tide"
1	7.3	Now	2030
2	8.0	Now	2050
3	8.8	Now	2050
4	9.6	Now	2100
5	10.3	2030	2100
6	10.8	2050	2100
7	11.4	2050	2100
8	12.8	2100	2100
9	13.9	2100	2100
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Flood Results in StoryMap



Scarborough Flood Vulnerability Assessment

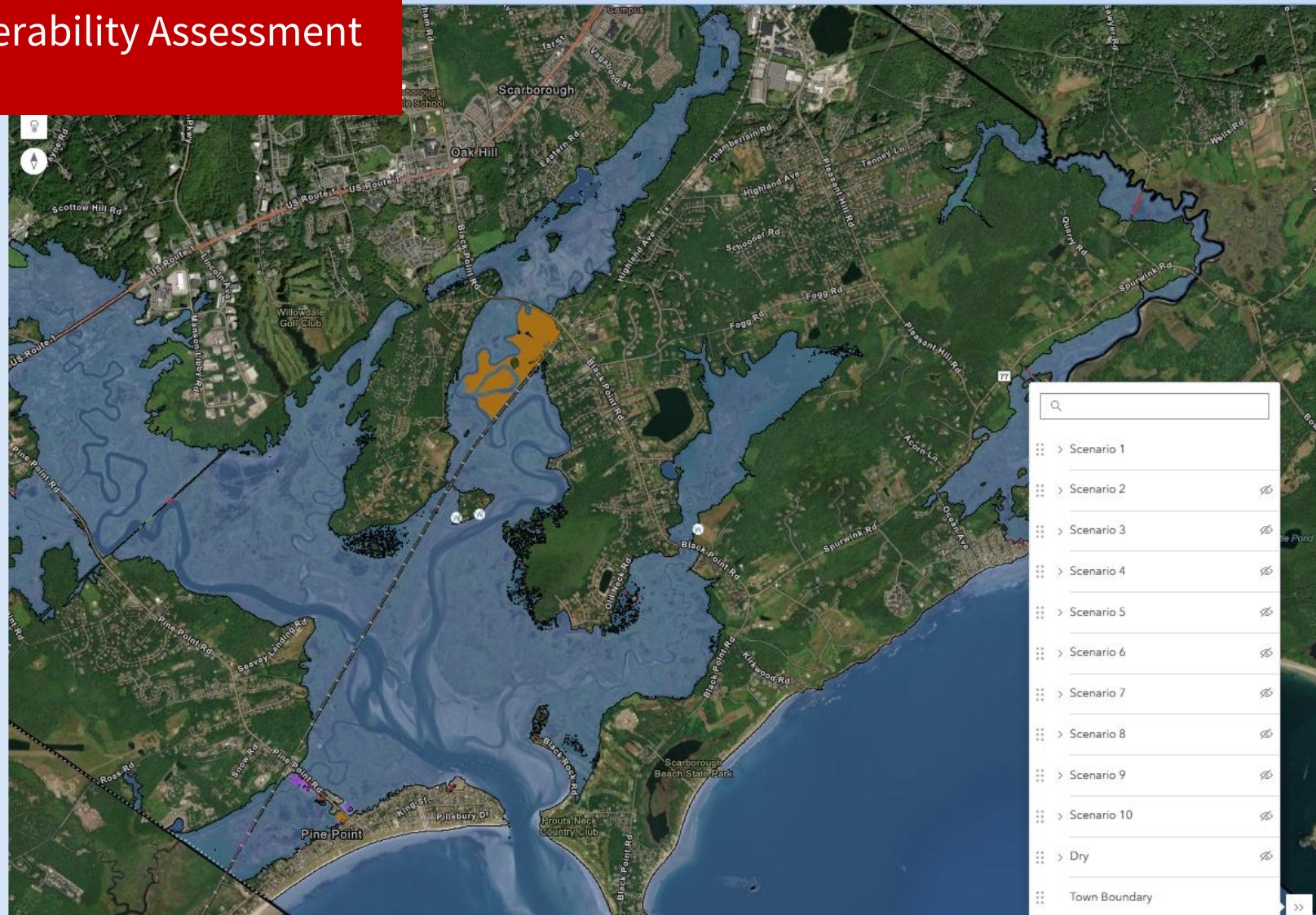
Coastal Flood Vulnerability Assessment

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4	9.6	Now	2100
5	10.3	2030	2100
6	10.8	2050	2100
7	11.4	2050	2100
8	12.8	2100	2100
9	13.9	2100	2100
10	16.9	2100	2100

- To move around the map, click the map and hold and drag your cursor.
- To zoom in and out, use your mouse wheel or click the "+" and "-" buttons in the top left corner of the map.
- To view the the inundation extents from different flood scenarios, click the layer list icon in the bottom right corner of the map and click the eye icon to turn on and off the layer visibility.



Layer list icon



Scenario 1

Dams

Evacuation Routes

Municipal Property

Railroads

Remediation Sites

Roads

Structures

Walking Trails



Coastal Flood Vulnerability Assessment

The StoryMap is paired with technical **memos and reports** detailing methods and results. Links to these documents are (or will be) **provided in the StoryMap.**



Technical Memorandum

5 Milk Street • Portland, ME 04101 • 207.797.8901

Via Email: jfitch@scarboroughmaine.org

To: Jami Fitch, Town of Scarborough

From: Leila Pike, P.E. (GEI), Ilan Gasko, E.I. (GEI)

Date: March 27, 2025

Re: Data Review Memo
Flood Vulnerability Assessment
Scarborough, Maine

Project No.: 2403961

GEI Consultants, Inc. presents this memo summarizing data reviewed that will be used to evaluate flood risk as part of the flood vulnerability assessment for the Town of Scarborough, Cumberland County, Maine (the "Town") (Figure 1). This work was based on Task 2.1 of our proposal dated April 1, 2024.

The flood vulnerability assessment will evaluate flood risk to assets (i.e., roads, pump station, structures, etc.) based on flood inundation boundaries that represent a range of coastal storm surge and sea level rise scenarios. The inundation boundaries will be created using a digital elevation model (DEM) representing the topography of the Town of Scarborough. The DEM is included in the Data Review Memo. The DEM is used to calculate elevation and flooding from heavy precipitation events. The DEM is used for this study to the

Data sources include water levels, NOAA, the United States Geological Survey (USGS), the Maine Department of Environmental Protection (MEDEP), and the Maine Department of Transportation (MaineDOT). These sources were consulted to develop flood scenarios and inundation boundaries for the flood vulnerability assessment.

Elevations in this report are referenced to the North American Vertical Datum of 1988 (NAVD88) in feet unless otherwise specified. Elevations in feet NAVD88 for the Town of Scarborough can be converted to elevations referenced to Mean Lower-Low Water (MLLW), which is often used on navigational charts, by adding 4.9 ft. For example, an elevation within this document of 8.8 ft NAVD88 would be the same as 13.7 ft referenced to MLLW.



GEI Consultants, Inc. www.geiconsultants.com



Technical Memorandum

5 Milk Street • Portland, ME 04101 • 207.797.8901

Via Email: jfitch@scarboroughmaine.org

To: Jami Fitch, Sustainability Coordinator, Town of Scarborough

From: Leila Pike, P.E. (GEI), Ilan Gasko, E.I. (GEI)

Date: March 27, 2025

Re: Flood Vulnerability Analysis Results
Flood Vulnerability Assessment
Scarborough, Maine

Project No.: 2403961

GEI Consultants, Inc. conducted a coastal flood vulnerability study to evaluate risk of infrastructure and open spaces to flood inundation due to coastal storm surge and sea level rise (SLR) in the Town of Scarborough, Cumberland County, Maine (the "Town") (Figure 1). The study evaluated present-day flood risk and projected future flood risk under various sea level rise scenarios. The study evaluated present-day flood risk and projected future flood risk under various sea level rise scenarios. The study evaluated present-day flood risk and projected future flood risk under various sea level rise scenarios.

The flood scenarios evaluated as part of this study represent static water levels (i.e., no wave action). Areas anticipated to be subject to wave action will be shown on the ArcGIS StoryMap that will accompany this project and will be considered in asset prioritization for adaptation. Areas where wave action is likely to occur will be based on the Limit of Moderate Wave Action from the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) study for Cumberland County (FEMA, 2024).



GEI Consultants, Inc. www.geiconsultants.com

Coastal Flood Vulnerability Assessment

The StoryMap is paired with technical **memos and reports** detailing methods and results. Links to these documents are (or will be) **provided in the StoryMap.**

Table 2-1. Buildings Flood Exposure Summary

Scenario	1	2	3	4	5	6	7	8	9	10	Number in Study
Number of Buildings Inundated	61	112	220	321	422	499	588	924	1,091	1,369	12,853

Table 2-25. Public Roads Flood Exposure Summary

Scenario	1	2	3	4	5	6	7	8	9	10	Length/ Number in Study
Length Inundated, miles	0.5	1.2	2.7	4.1	5.4	6.5	8.2	14.6	18.5	25.1	194.5
Number of Roads Impacted	7	13	29	38	47	53	62	93	99	111	433



Road Prioritization

Over **100 public roads** were identified as at-risk to coastal flooding, with **38** at-risk for present-day water levels and **62** at-risk by 2050.



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A **risk-based prioritization** process was used to rank the roads in order of prioritization, based on **flood exposure** and **consequences**.



Road Prioritization

Over **100 public roads** were identified as at-risk to coastal flooding, with **38** at-risk for present-day water levels and **62** at-risk by 2050.

A **risk-based prioritization** process was used to rank the roads in order of prioritization, based on **flood exposure** and **consequences**.

Consequences included: **area** impacted, impact to **public safety**, **damage** potential, **environmental** impact, and **economic** impact.



Road Prioritization

Consequences Matrix
developed in
consultation with the
project working group

Table 2-1. Consequence Score Guidance Matrix

Consequence Score	Area Impact (# Buildings) ¹	Public Safety Impact ²	Damage Potential ³	Environmental Impact ⁴	Economic Impact ⁵
5 (Very High)	>150	Official evacuation route	- Has experienced damage in the past - In FEMA VE Zone - Utility infrastructure below roadway	>= 8 habitats impacted	In TCV1, Industrial Zone, Industrial Overlay; or AADT > 5,000
4 (High)	75-150	- Access to critical infrastructure or services - Unofficial evacuation route	In FEMA VE Zone	6-7 habitats impacted	AADT > 1,000
3 (Medium)	25-75	No alternate route	Revetment along roadway with scour potential	4-5 habitats impacted	In Beach Mixed Use or Town and Village Center Zone 4
2 (Low)	5-25	- Alternate route - No alternate access, but impacts property that would already be flooded	Stillwater inundation	1-3 habitats impacted	In Town and Village Transition and Fringe Zones or Coastal Mixed Use
1 (None)	<5	No impact (e.g., end of dead-end street)	High-tide inundation, no revetment, or other coastal structures	No habitats impacted	In Residential and Rural Farming Zones

Road Prioritization

Table 3-2. Top 30 Ranked Roads Based on Weighted Risk Score, Alphabetical Order

Road Name		
Avenue 1	E Grand Ave	Pine Point Rd*
Avenue 2	Ferry Rd	Route 1
Avenue 5	Jones Creek Dr	Route 9*
Avenue 6	Kent St	Sawyer St
Avenue 7	King St	Shipwreck Rd
Bayview Ave	Milliken Rd	Snow Canning Rd
Black Point Rd	Morning St	Spurwink Rd
Champion St	Ocean Ave	Vesper St
Clay Pits Rd	Old Neck Rd	Winnocks Neck Rd
Driftwood Ln	Payne Rd	Winnocks Neck to Plummer Island

Note: Route 9 refers to the section of Route 9 near the Scarborough Marsh Audubon Center currently planned for adaptation as part of the MaineDOT Route 1 and Route 9 Adaptation Project. Pine Point Road refers to the section of Route 9 near Jones Creek.



Road Prioritization

Adaptation Projects Underway

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Road Prioritization

Methods and results detailed in the **Adaptation Prioritization Methodology for Public Roadways** memo



Technical Memorandum

5 Milk Street • Portland, ME 04101 • 207.797.8901

Via Email: jfitch@scarboroughmaine.org
To: Jami Fitch, Sustainability Coordinator, Town of Scarborough
From: Leila Pike, P.E. (GEI), Ilan Gasko, E.I. (GEI)
Date: Revised August 6, 2025 (June 9, 2025)
Re: Adaptation Prioritization Methodology for Public Roadways
Flood Vulnerability Assessment
Scarborough, Maine
Project No.: 2403961

GEI Consultants, Inc. (GEI) conducted a risk-based prioritization assessment for roadways identified as at-risk of coastal flooding as part of the flood vulnerability assessment for the Town of Scarborough, Cumberland County, Maine (the "Town") (Figure 1). This work builds off the data review and flood vulnerability analysis efforts that were documented in previous memos provided to the Town (GEI, 2025a,b). The prior memos detail the data, methods, and results of the flood exposure analysis for the Town. The goal of this memo is to document the method used to prioritize roadways for adaptation based on their flood exposure and consequences.

The flood exposure study identified 111 publicly owned roads that would be at risk of coastal flooding under the flood scenarios included in this study. Through the risk-based prioritization process, the roads were ranked for adaptation prioritization based on their flood exposure and agreed upon consequence metrics. The top 30 "ranked" roads are presented within this memo and the full list of ranked roads is provided in Appendix A.

Estimating the risk for the roads was based upon the probability of flood exposure and the consequence of flood exposure, using the following standard risk-based formula:

$$\text{Risk} = \text{Probability of Flooding} \times \text{Consequence}$$

The prioritization process used the following four steps:

1. Identify roads subject to flooding.
2. Estimate probability of exceedance.
3. Calculate consequence of flooding score.
4. Calculate risk.

This memo focuses on Steps 2 through 4. Refer to the Flood Vulnerability Analysis Results Memo for more information on Step 1 (GEI, 2025b).



Road Prioritization

Roads in StoryMap



Scarborough Flood Vulnerability Assessment

[Project Overview](#)

[Coastal Flood Risk](#)

[Flood Exposure Results](#)

[Scarborough Adaptation Strateg...](#)

[Higgins Beach and Pine Point](#)

[General Adaptation Strategies](#)

[Community Engagement](#)

[Provide Feedback](#)



Avenue 1



Avenue 2



Avenue 5



Avenue 6



Avenue 7



Bayview Avenue



Black Point Road (North)



Black Point Road (Central)



Black Point Road (South)



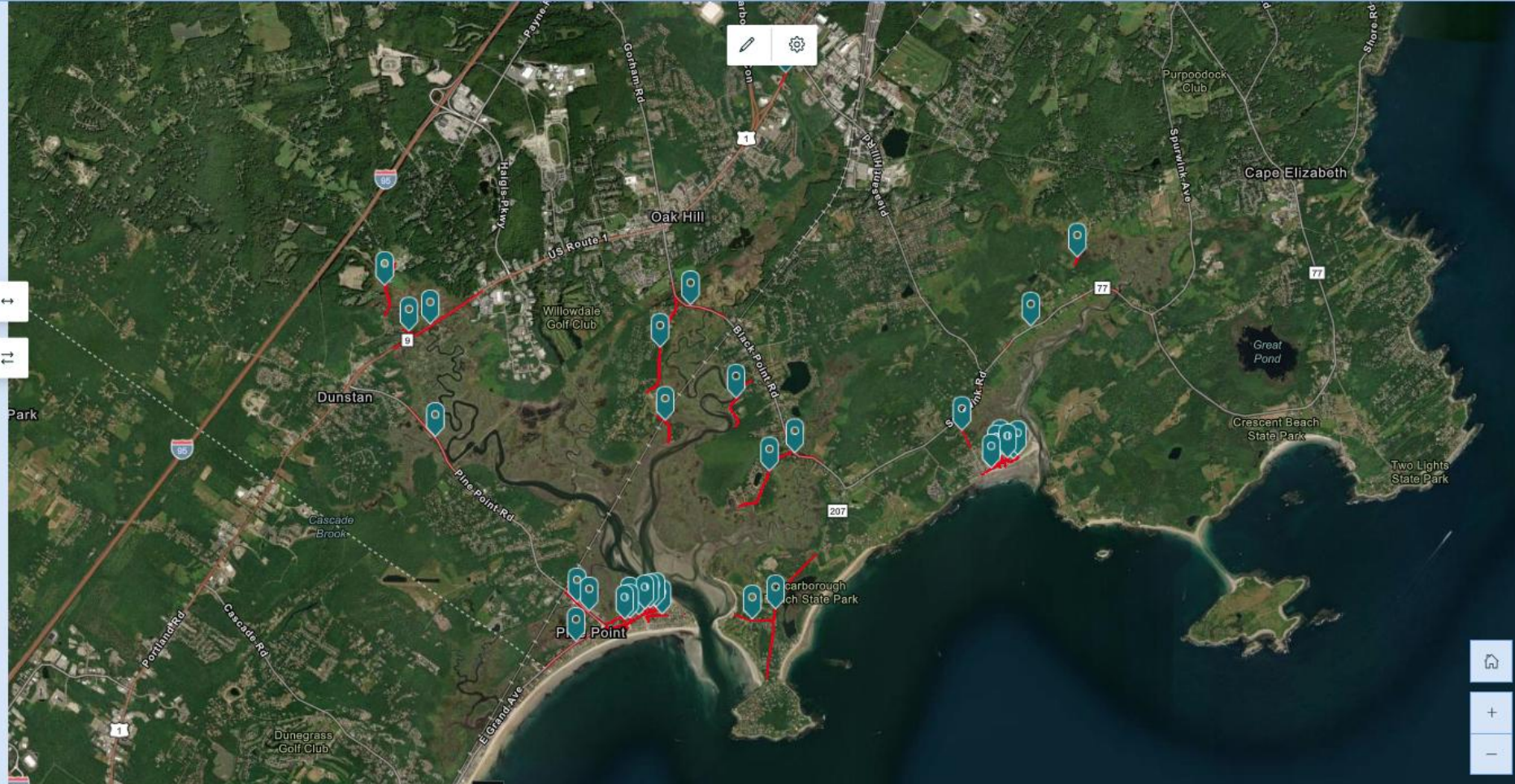
Champion Street



Clay Pits Road

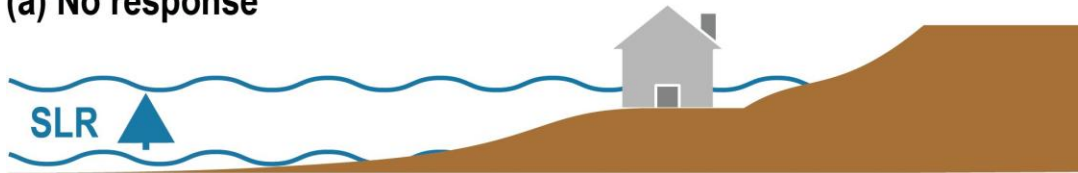


Driftwood Lane



Flood Adaptation Recommendations

(a) No response



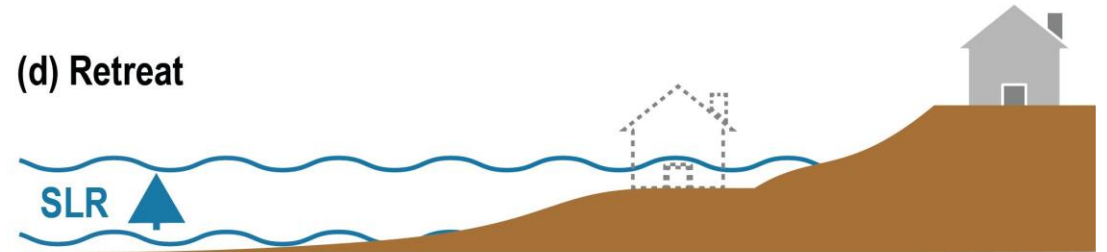
(b) Advance



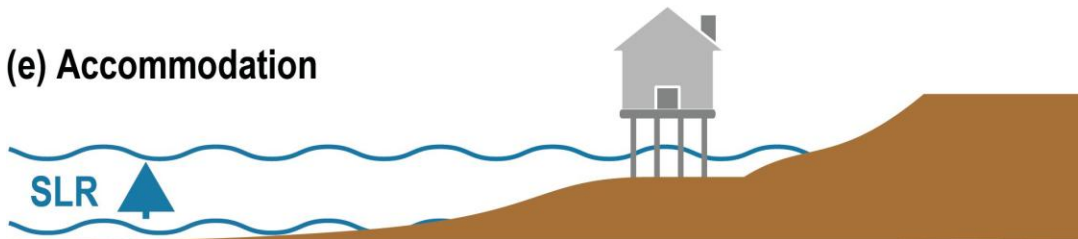
(c) Protection



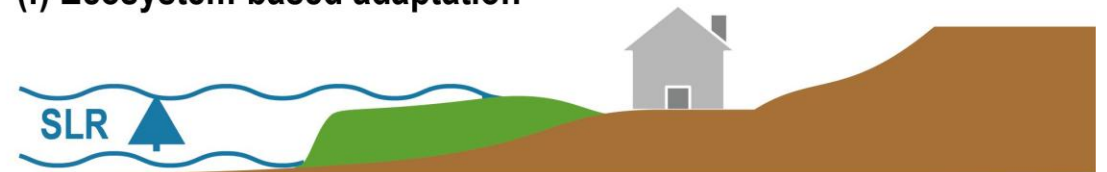
(d) Retreat



(e) Accommodation



(f) Ecosystem-based adaptation



Flood Adaptation Recommendations

The Scarborough Marsh is the **largest contiguous salt marsh system in Maine**

- Home to diverse wildlife species
- Source of blue carbon
- Threatened by sea level rise

~~Challenge~~ **Opportunity for Adaptation**

- Increased tidal transparency
- Space to adapt/migrate



Flood Adaptation Recommendations

Beaches are a Valuable Asset to the Town

- Sand dune system + nesting habitat
- Public recreational areas
- Cooling opportunity on hot days

~~Challenge~~ Opportunity for Adaptation

- Dune protection and migration
- Continued recreational access



Flood Adaptation Recommendations

High-level, specific, adaptation recommendations for:

- Top Roads
- Pump Stations
- Select Town Facilities
- Higgins & Pine Point Neighborhoods

General adaptation recommendations for:

- Buildings
- Beaches/Dunes
- Non-Structural Measures



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- \$\$\$** High-cost measures requiring substantial funding or a multi-year implementation approach.
- \$\$\$\$** Very high-cost measures likely requiring multiple funding sources and long-term planning.



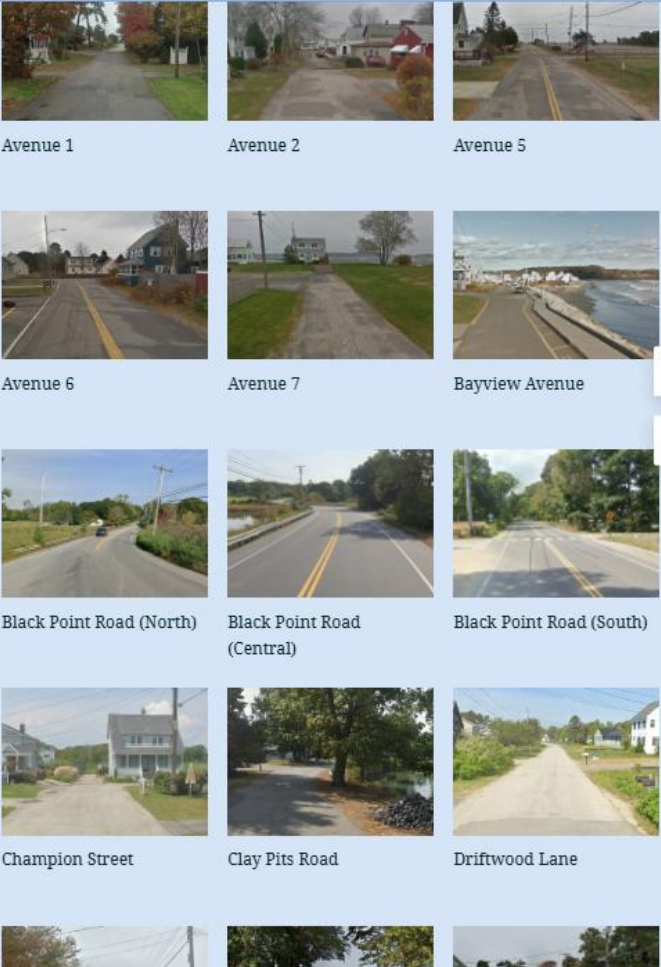
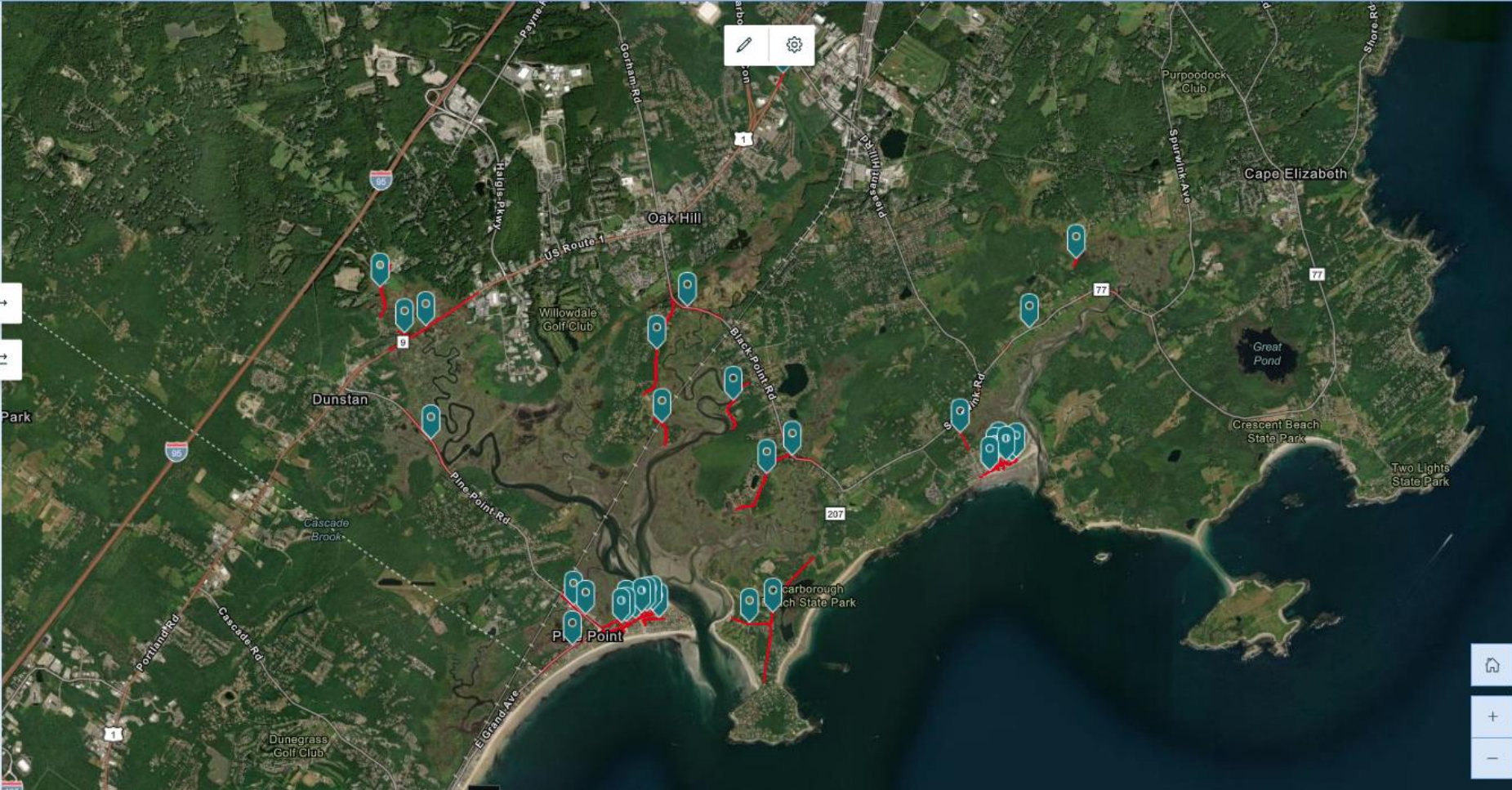
Flood Adaptation Recommendations

Roads in StoryMap



Scarborough Flood Vulnerability Assessment

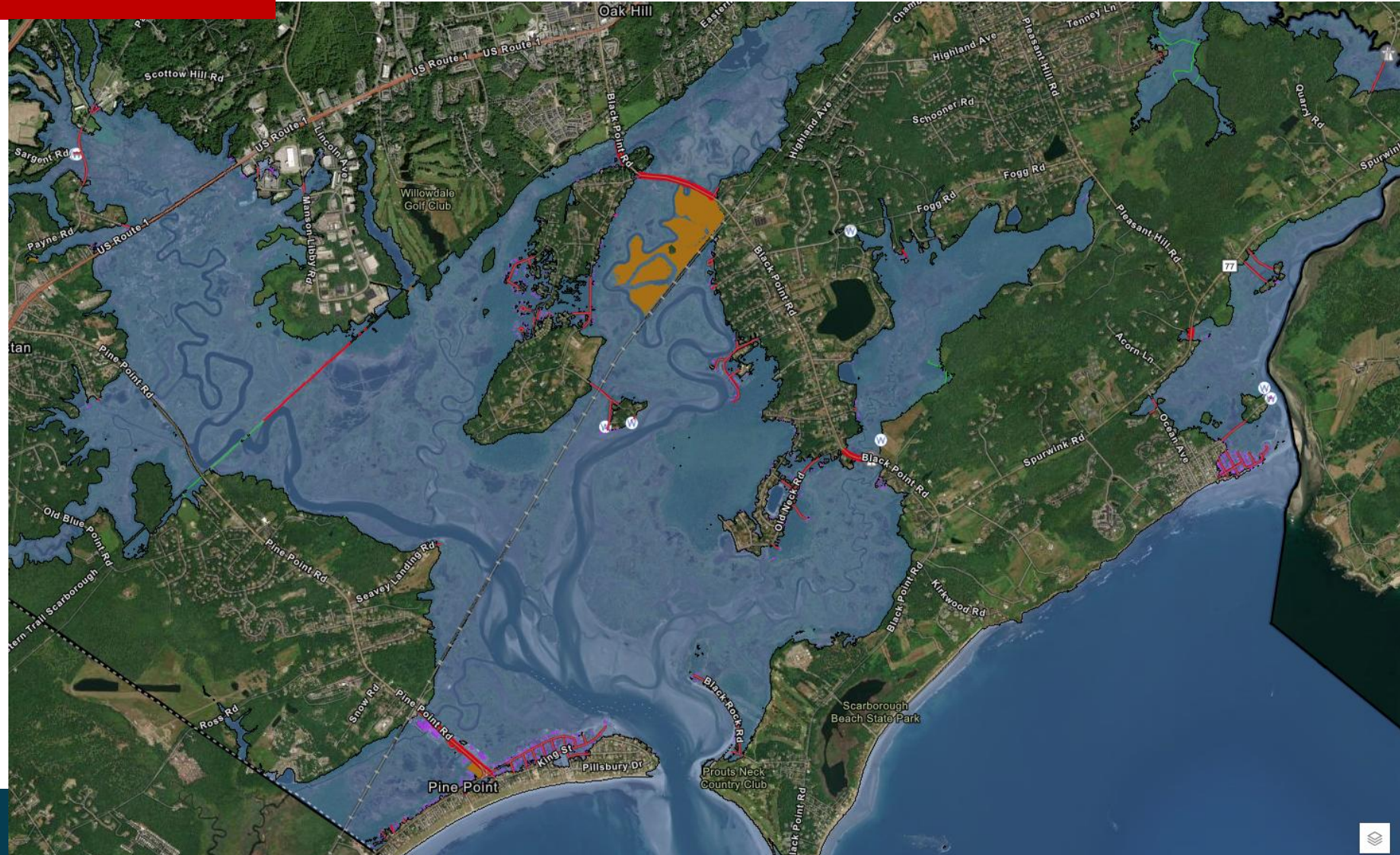
Project Overview Coastal Flood Risk Flood Exposure Results Scarborough Adaptation Strateg... Higgins Beach and Pine Point General Adaptation Strategies Community Engagement Provide Feedback



Flood Adaptation Recommendations

Roads and Tidal Transparency

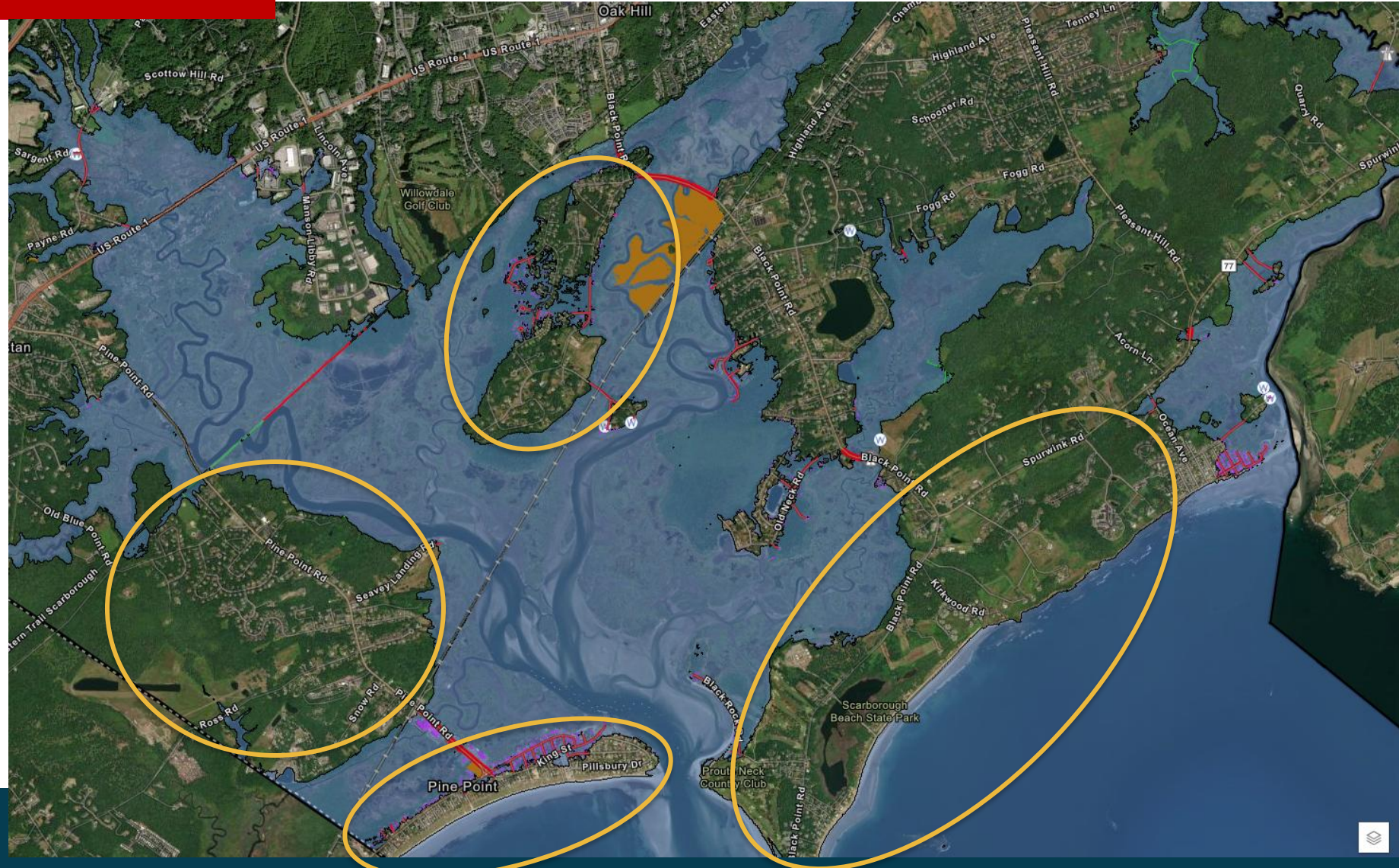
The marsh creates separate, **isolated areas** throughout Scarborough



Flood Adaptation Recommendations

Roads and Tidal Transparency

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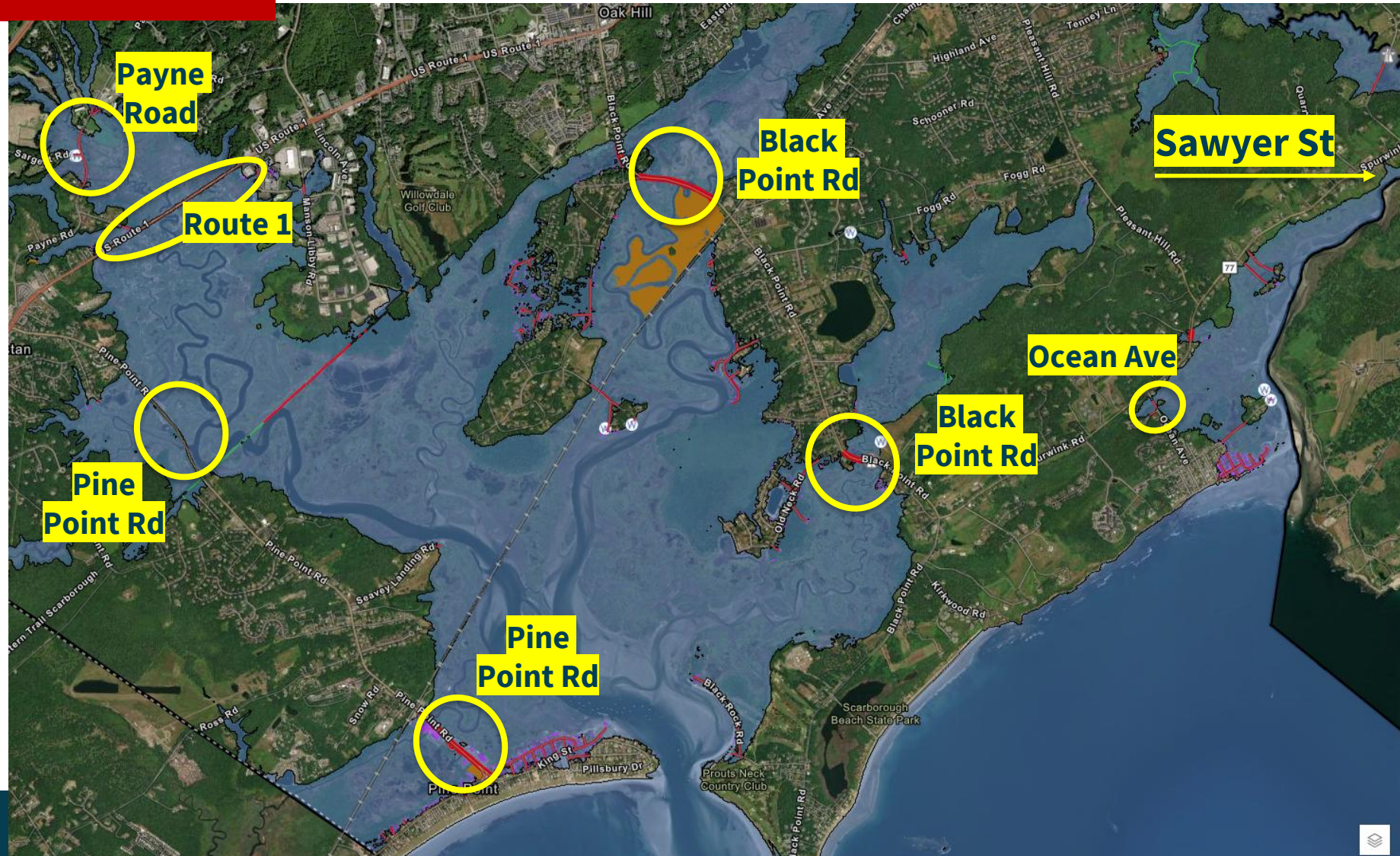


Flood Adaptation Recommendations

In many cases, **elevating a road** used for evacuation or sole access to an area offers an **opportunity** to increase culvert/bridge size and **promote salt marsh growth**.

“Win-Win”

Roads and Tidal Transparency



Roads and Tidal Transparency

Flood Adaptation Recommendations

Tidally Restricted Culvert under Ocean Ave / Higgins Creek



Example Box Culvert from the Maine CoastWise Approach Manual



FIGURE B.4 - A reinforced concrete box structure with prefabricated wingwalls and an installed channel bed. Structure size in this example was five feet rise by ten feet span. Eel River, Plymouth, MA. Image source: Inter-Fluve.



Flood Adaptation Recommendations

Select Town Facilities in StoryMap



Scarborough Flood Vulnerability Assessment

[Project Overview](#)

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Eastern Trail



Ferry Beach Parking Lot



Hurd Beach Parking Lot



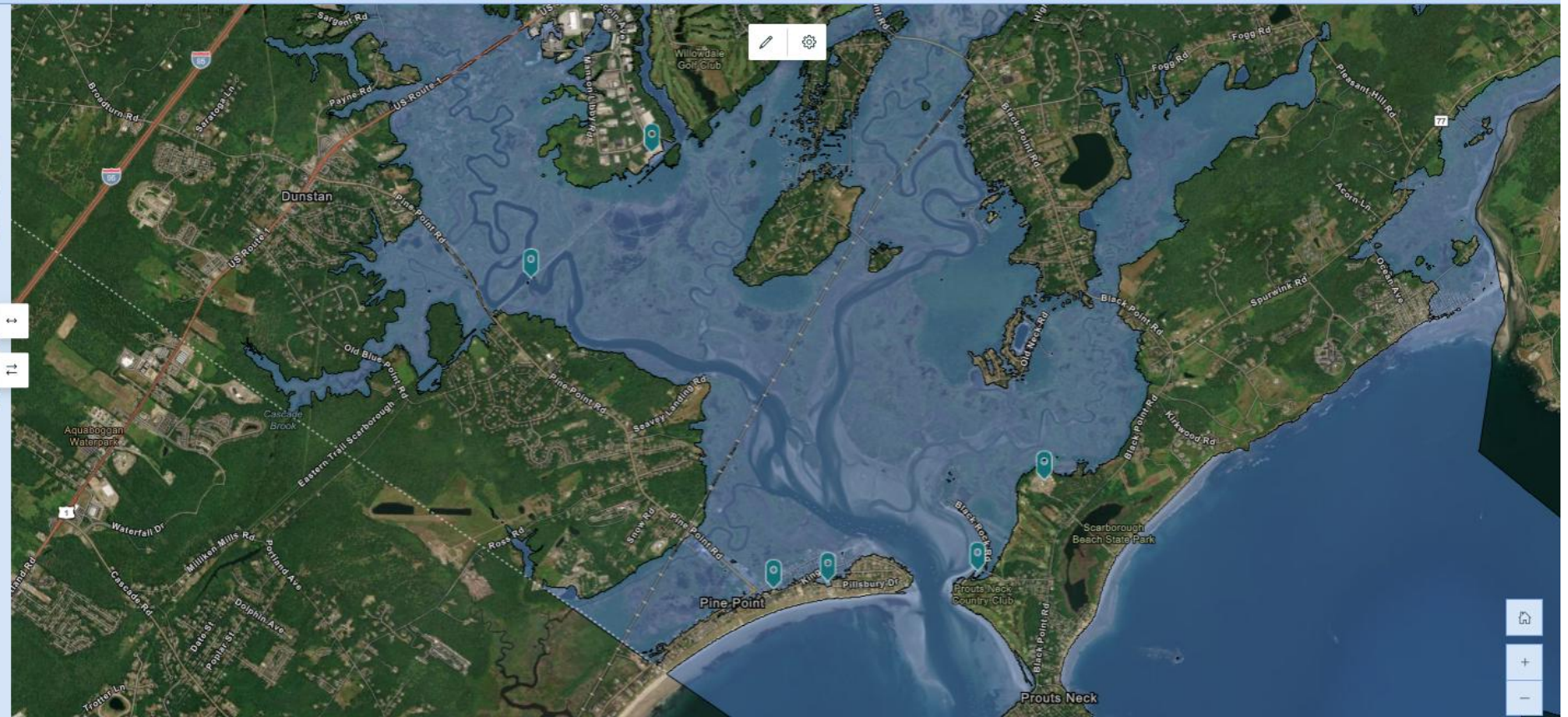
Pine Point Fire Station



Public Works Facility



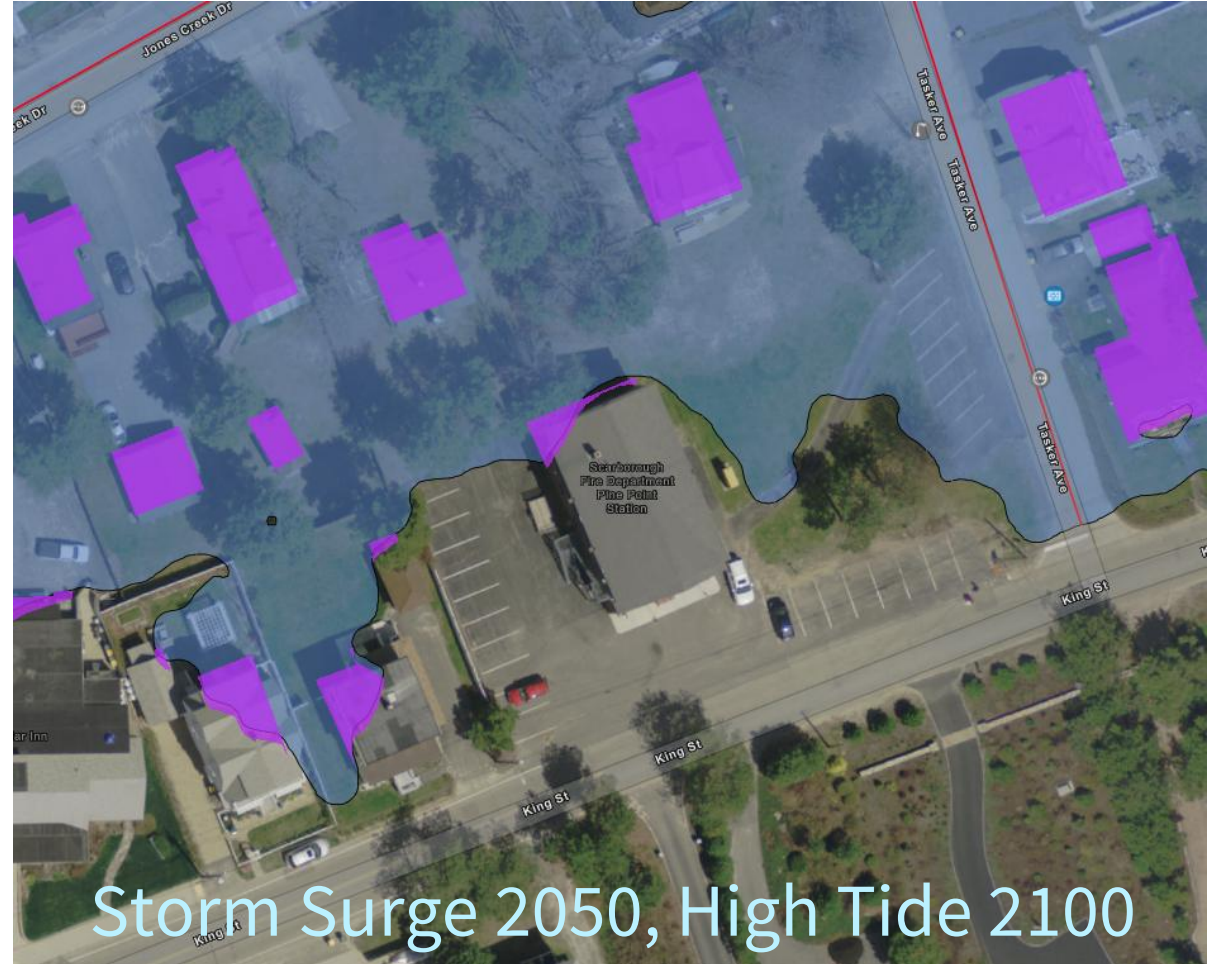
Wastewater Treatment Plant



Flood Adaptation Recommendations



Pine Point Fire Station

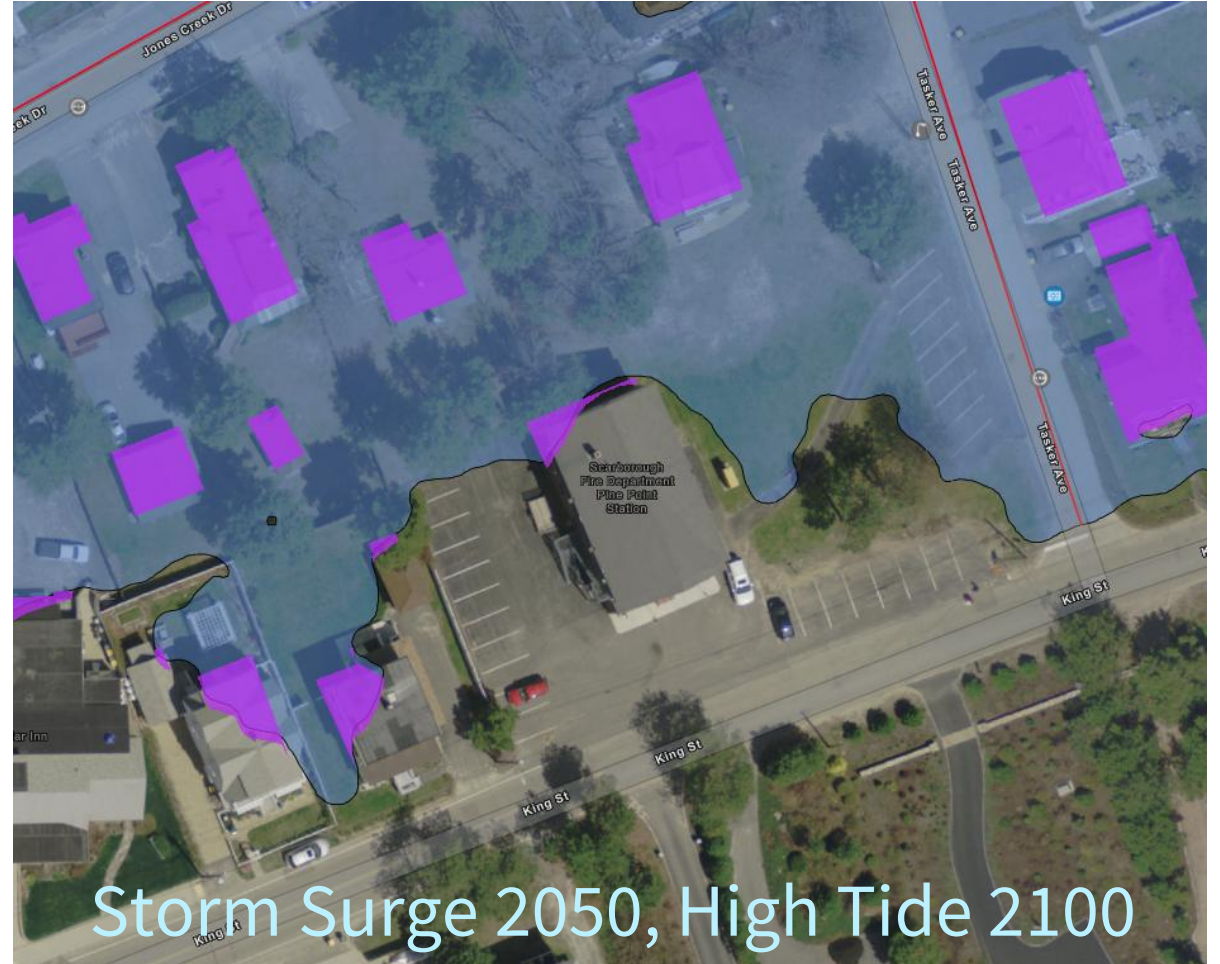


Flood Adaptation Recommendations



Option 1: Floodproof first floor of building, elevate sensitive systems

Pine Point Fire Station



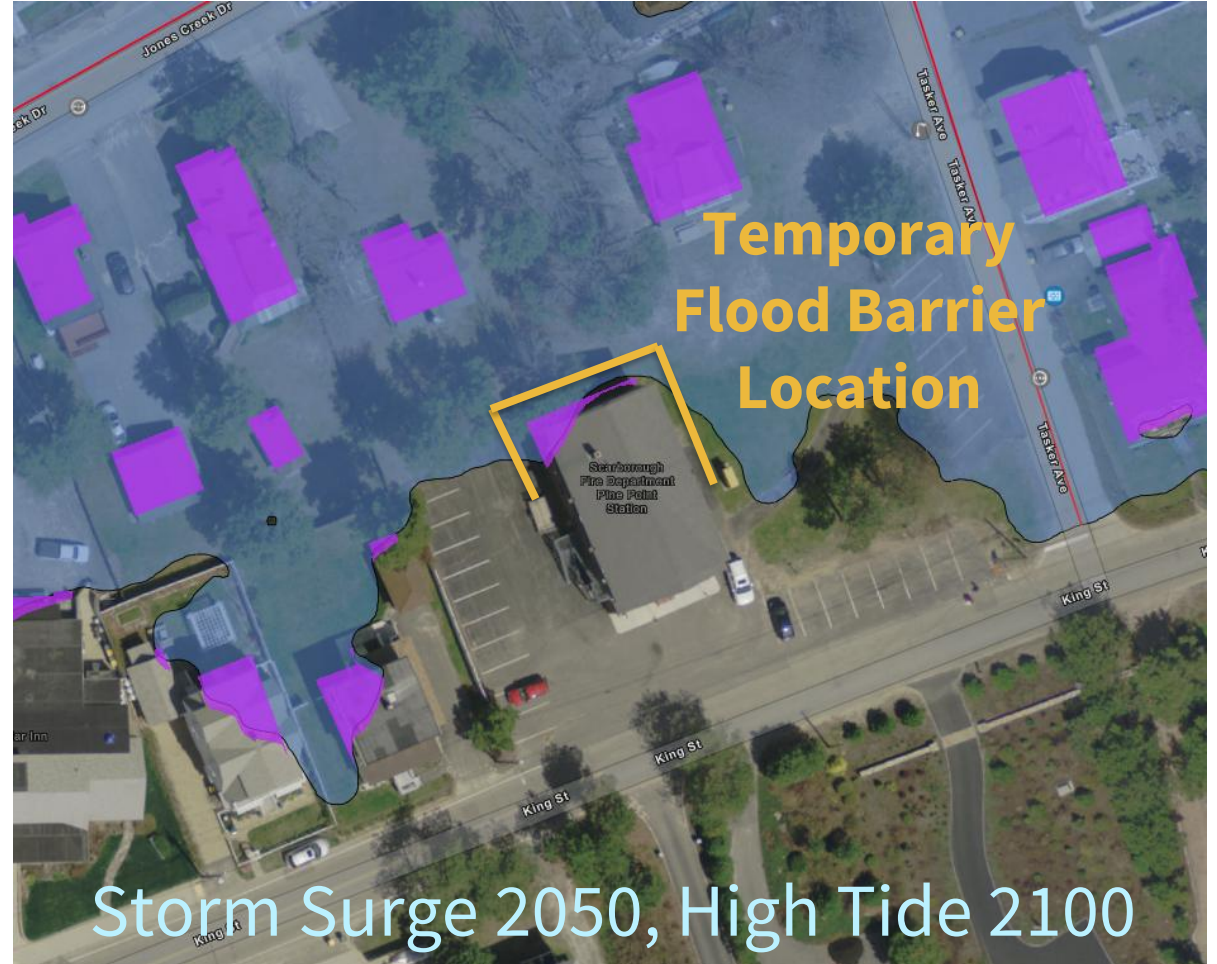
Flood Adaptation Recommendations



Option 1: Floodproof first floor of building, elevate sensitive systems

Option 2: Temporary flood barrier around north side of building

Pine Point Fire Station



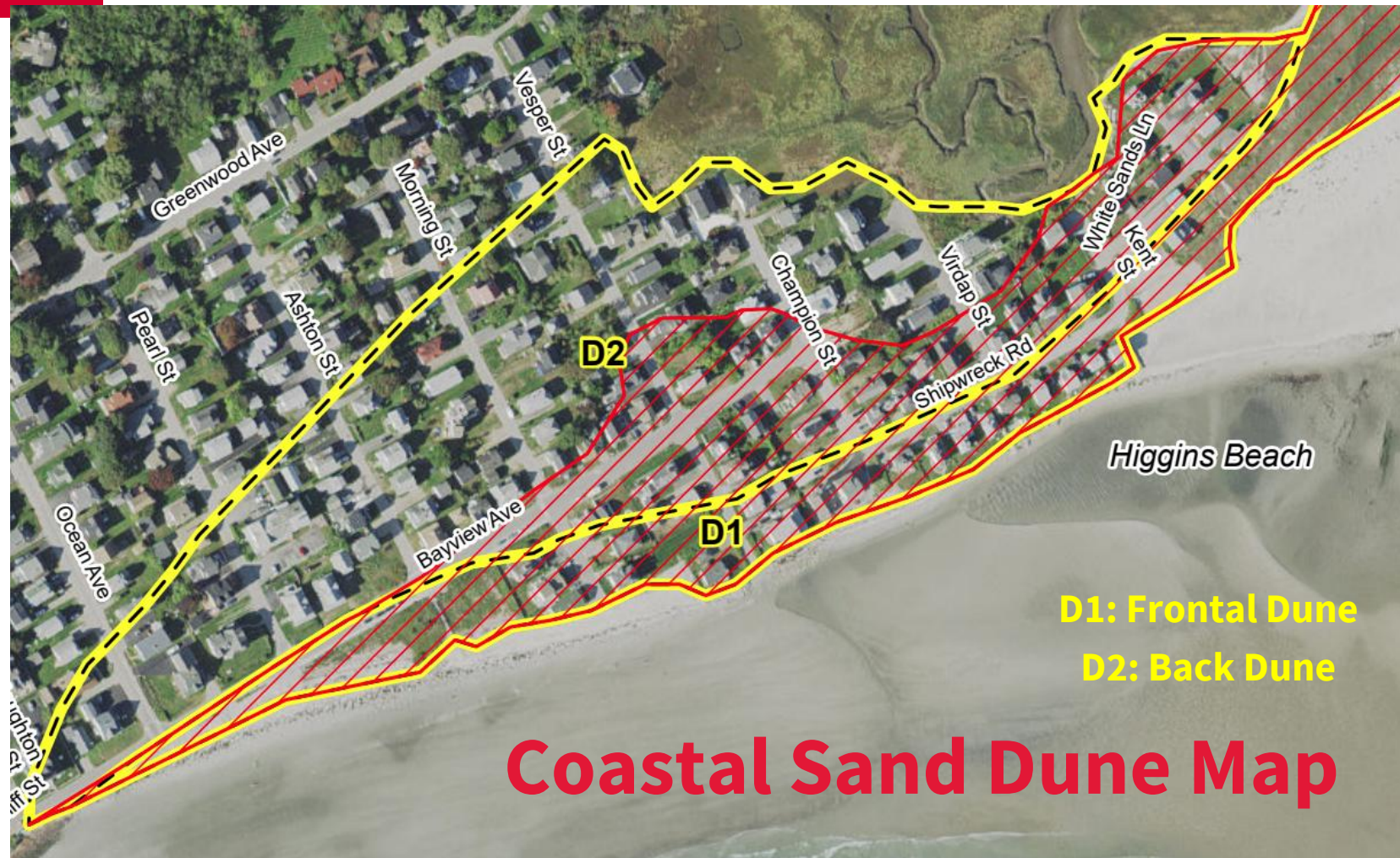
Flood Adaptation Recommendations

Roads within frontal dunes face **strictest regulations** around elevation projects

Roads and parking lots within back dunes could be elevated

New **sea walls would not be allowed** in these areas

Higgins Beach Neighborhood



Higgins Beach Neighborhood

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Flood Adaptation Recommendations

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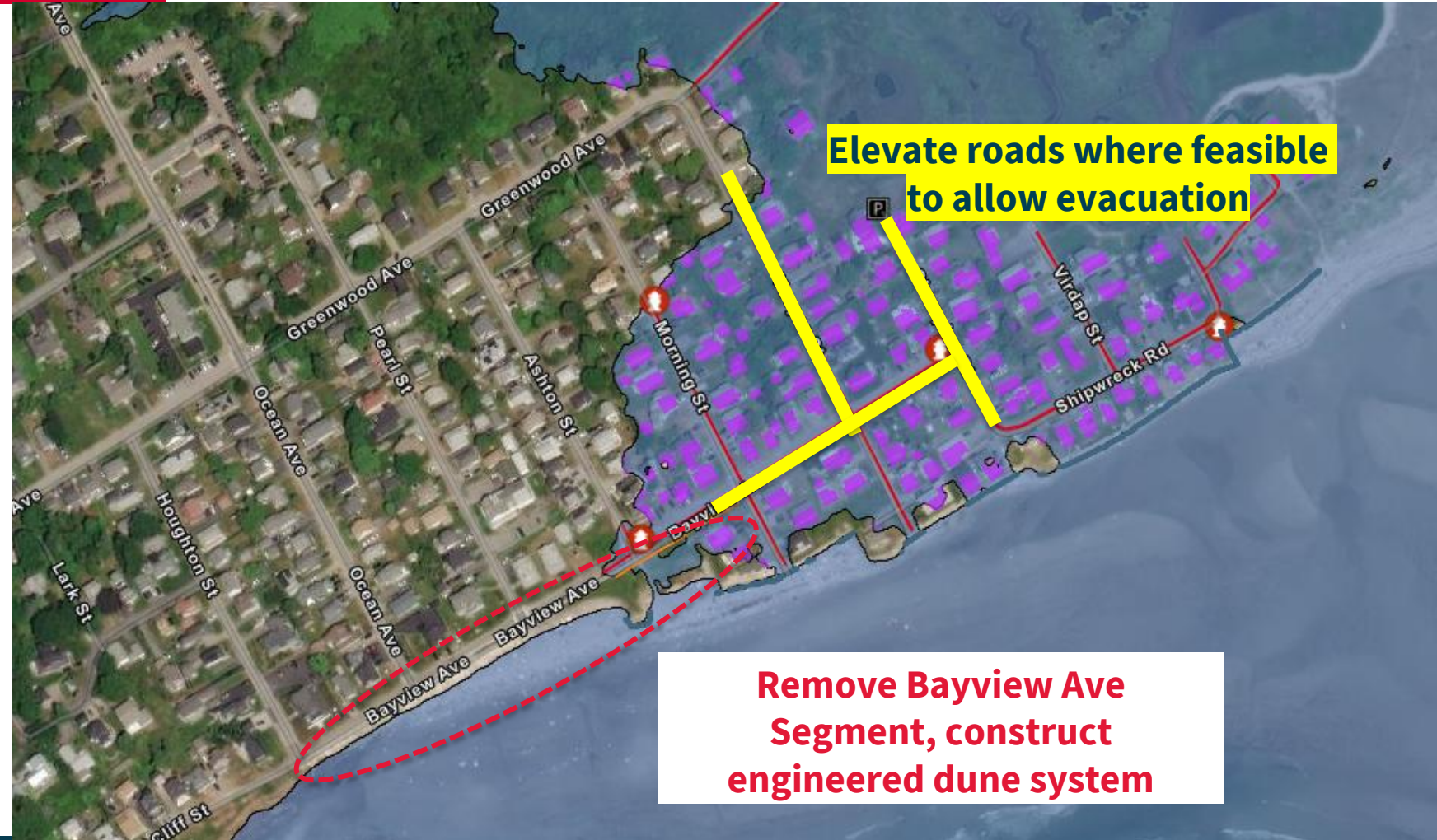
Flood Adaptation Recommendations

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Flood Adaptation Recommendations

Higgins Beach Neighborhood

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Do Nothing:
\$2.75M spent by Town on storm response, debris removal, and road and bridge repairs following Jan 2024 storm events



Flood Adaptation Recommendations

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Pine Point Neighborhood

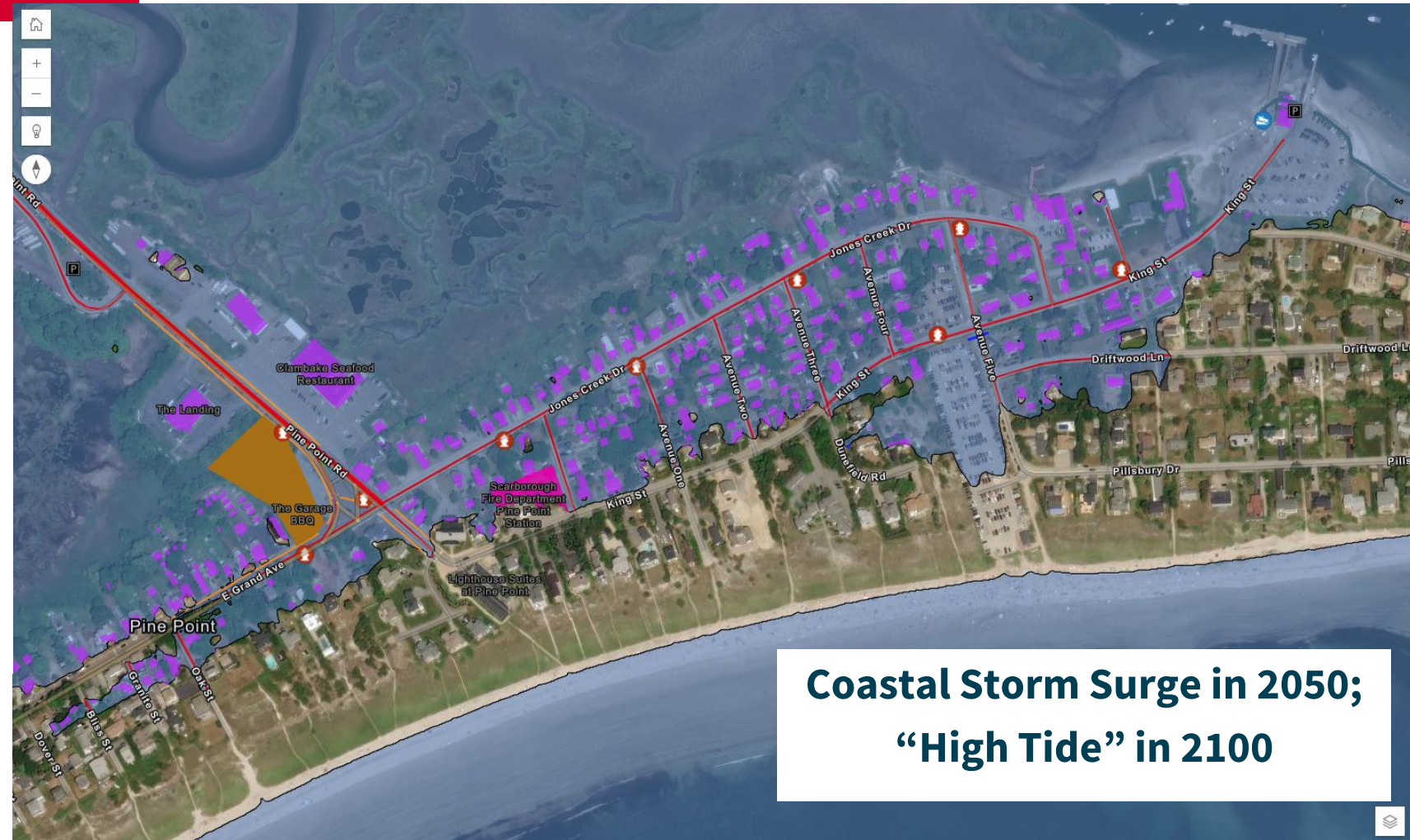


Pine Point Neighborhood

Similar **regulatory constraints** to Higgins Beach Neighborhood

Certain roads in back dune could be elevated to **prioritize evacuation and safety**

Right of way and interior drainage could present challenges

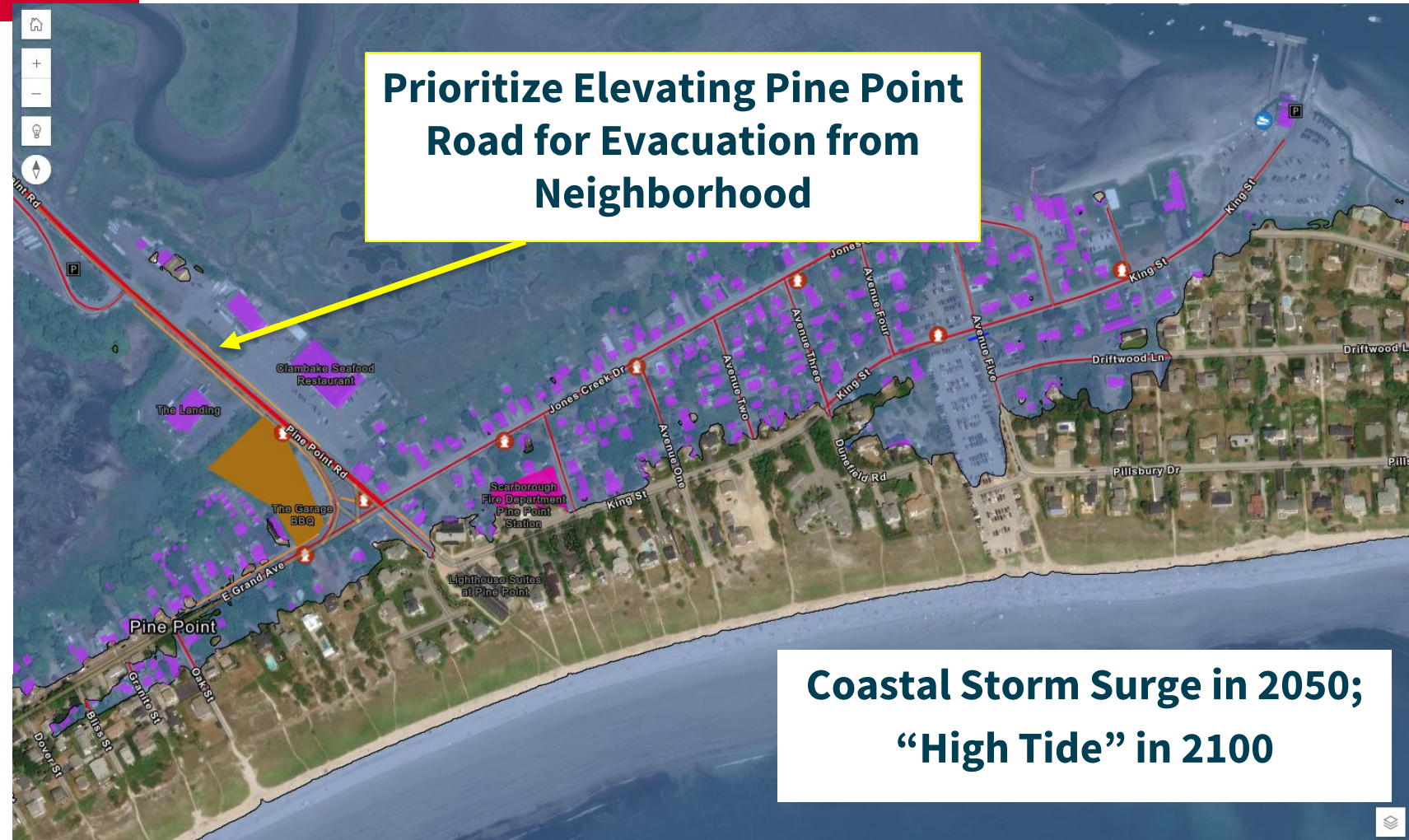


Pine Point Neighborhood

Similar **regulatory constraints** to Higgins Beach Neighborhood

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Non-Structural Adaptation



Non-Structural Adaptation

Temporary Flood Barriers & Road Barricades



Non-Structural Adaptation

Temporary Flood Barriers & Road Barricades

Flood Alert Systems and Early Warning



Emergency Alert

National Weather Service: A FLASH FLOOD
WARNING is in effect for this area until 2:00 PM



Non-Structural Adaptation

Temporary Flood Barriers & Road Barricades

Flood Alert Systems and Early Warning

Dune Restoration Efforts



Non-Structural Adaptation

Temporary Flood Barriers & Road Barricades

Flood Alert Systems and Early Warning

Dune Restoration Efforts

High Water Rescue Vehicles



Source: Skeeter Emergency Vehicles



Non-Structural Adaptation

Temporary Flood Barriers & Road Barricades

Flood Alert Systems and Early Warning

Dune Restoration Efforts

High Water Rescue Vehicles

Continued Public Education and Outreach



Higgins Beach residents discuss adaptation options



Flood Adaptation Recommendations

Non-Structural Adaptation

Temporary Flood Barriers & Road Barricades

Flood Alert Systems and Early Warning

Dune Restoration Efforts

High Water Rescue Vehicles

Continued Public Education and Outreach

Discuss Long-Term Managed Retreat



Mean-Higher-High-Water in 2100



Flood Adaptation Recommendations

Non-Structural Adaptation

Temporary Flood Barriers & Road Barricades

Flood Alert Systems and Early Warning

Dune Restoration Efforts

High Water Rescue Vehicles

Continued Public Education and Outreach

Discuss Long-Term Managed Retreat

Policy Measures



Technical Memorandum

5 Milk Street • Portland, ME 04101 • 207.797.8901

Via Email: jfitch@scarboroughmaine.org
To: Jami Fitch, Town of Scarborough
From: Leila Pike, P.E. (GEI), Ilan Gasko, E.I. (GEI)
Date: June 9, 2025
Re: DRAFT Ordinance Review Memo
Flood Vulnerability Assessment
Scarborough, Maine
Project No. 2403961

GEI Consultants, Inc. (GEI) conducted a review of four ordinances from the Town of Scarborough, Cumberland County, Maine (the "Town") (Figure 1), to identify opportunities within the ordinances for enhancing the Town's resilience to flood risks. This memorandum is organized by each ordinance reviewed, highlighting specific section where revisions may be beneficial. The review was conducted as part of Task 4 of our proposal dated April 1, 2024.

While specific ordinance language from other ordinance examples of regulations in the greater Boston area, Planning and Development Ordinance Language Code (Portland, 20

The ordinances used are intended to serve as Ordinance language for local boards, stakeholders, and legal counsel, as applicable.

Ordinance Review Memo (Draft)

cluded example s. Many of these), which compiled strategies in the southern Maine resilience: Model d, ME Land Use

these examples are adoption. staff, state staff,

1.0 Overview of Town Ordinances Reviewed

At the request of the Town, the following four ordinances were reviewed:

- Chapter 405, Zoning Ordinance
- Chapter 405B, Site Plan Review Ordinance
- Chapter 405C, Shoreland Zoning Ordinance
- Chapter 406, Subdivision Ordinance



Town Ordinance Review

Four Ordinances were Reviewed:

Chapter 405, Zoning Ordinance

Chapter 405B, Site Plan Review Ordinance

Chapter 405C, Shoreland Zoning Ordinance

Chapter 406, Subdivision Ordinance

Identified **opportunities for increasing the Town's resilience** to flood risks. Examples of regulatory language, policies, and land use strategies from other New England municipalities was provided, but **specific ordinance language was not developed**.



Technical Memorandum

5 Milk Street • Portland, ME 04101 • 207.797.8901

Via Email: jfitch@scarboroughmaine.org
To: Jami Fitch, Town of Scarborough
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Three Pilot Projects Were Developed:

- 1. Payne Road:** Flood Risk and Adaptation Recommendations
- 2. Higgins Beach** Shoreline Stabilization Measures
- 3. Pine Point** Homeowner Adaptation Guide



Pilot Projects

Existing flood risk during coastal storms

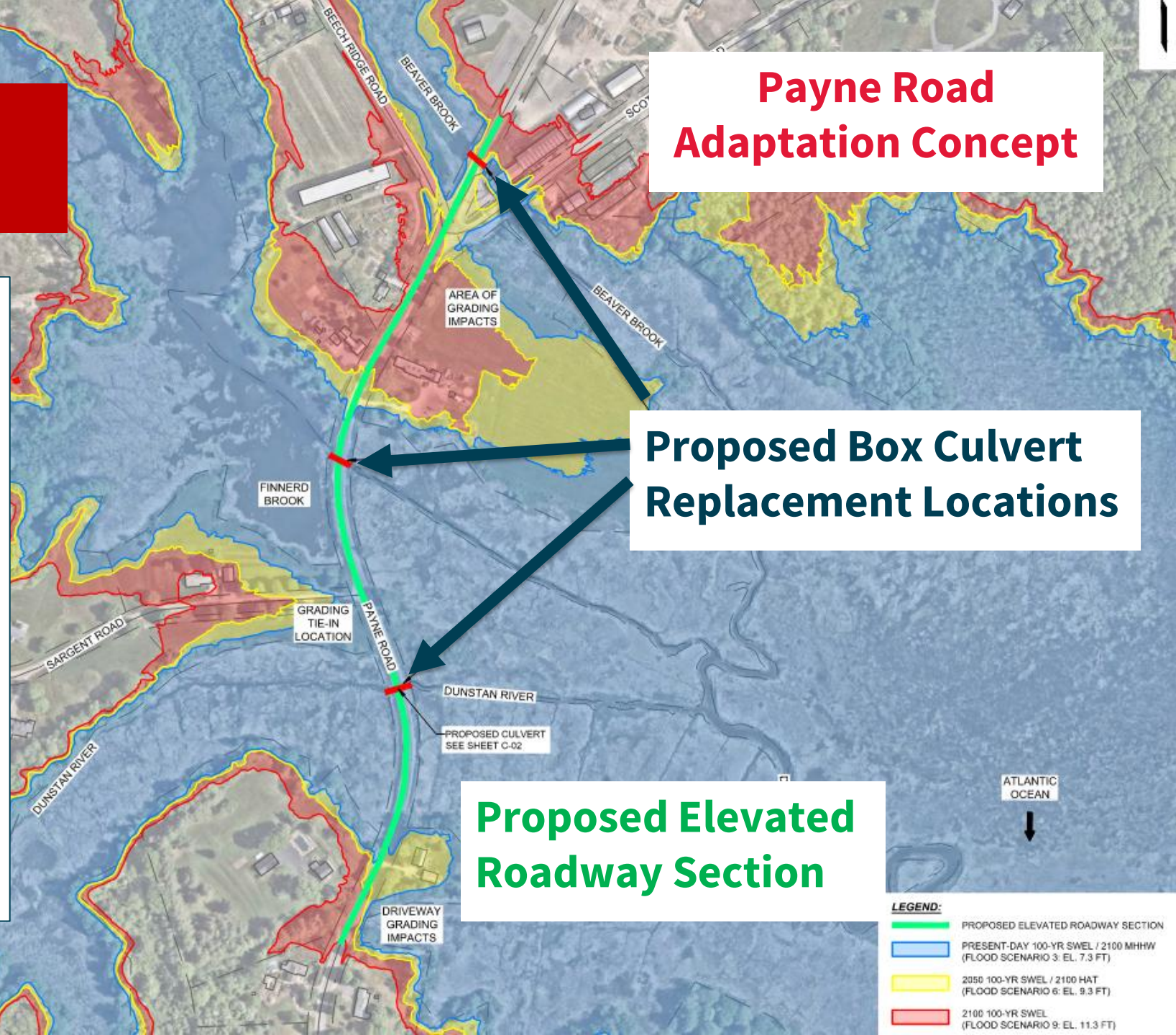
Could be **funded, designed, and constructed** before **Route 1** is complete

Refined future flood risk considering **impact of span at Route 1**

Payne Road Adaptation Concept

Proposed Box Culvert Replacement Locations

Proposed Elevated Roadway Section



Pilot Projects

Payne Road
Adaptation Concept

Proposed Box Culvert
Replacement Locations

Proposed Elevated
Roadway Section





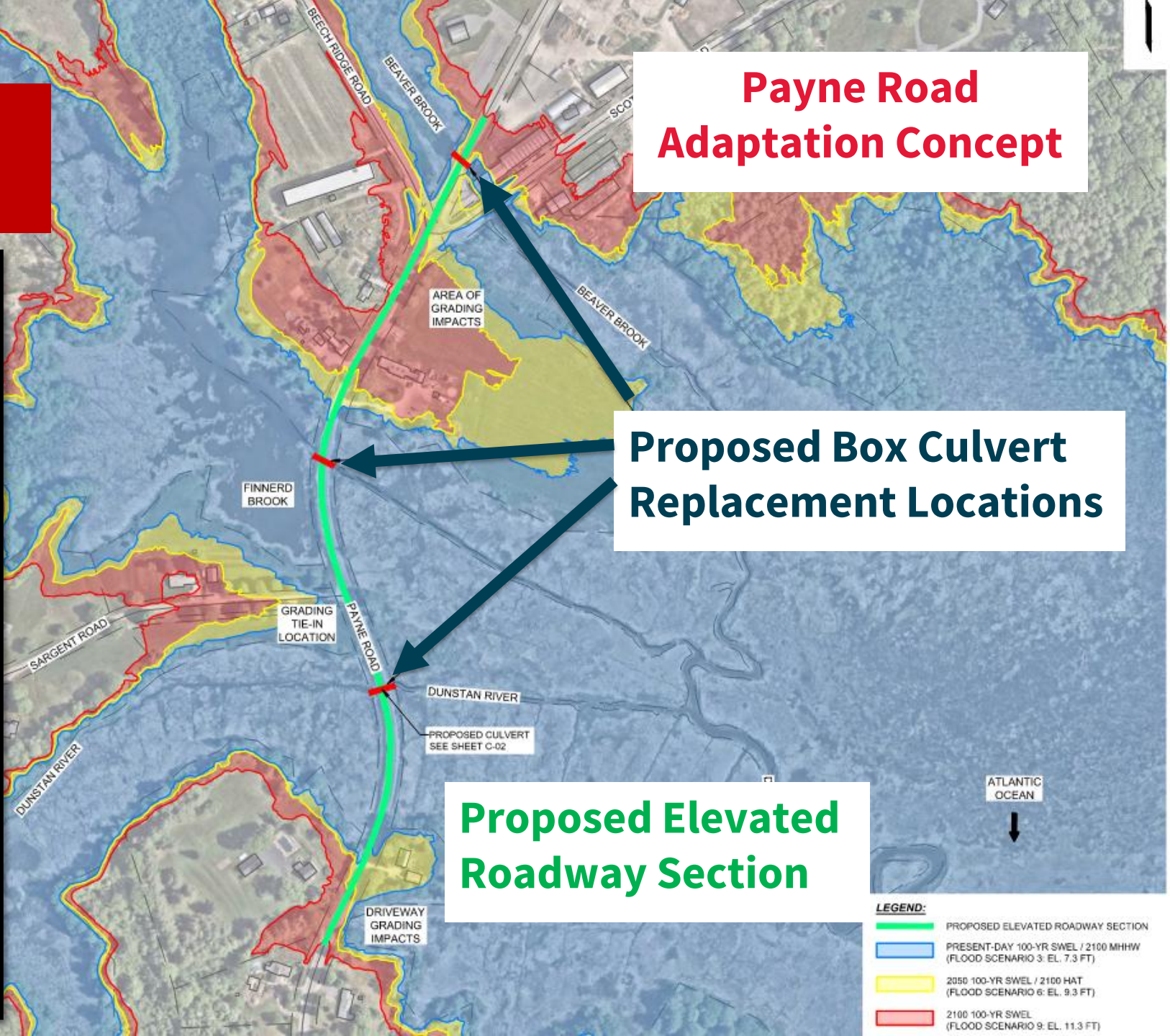
Project Report
Payne Road Adaptation Pilot Project
Scarborough, Maine



Leila Pike, P.E.
Sr. Civil Engineer, Project Manager

Ilan Gasko, E.I.
Staff Professional

Payne Road
Adaptation Pilot
Project
(Draft)



Pilot Projects

Infrastructure (roadway, sewer line) at **risk of storm damage**

An extension of existing revetment could be a **difficult permitting task**

Concept plans presenting multiple options to protect infrastructure

Upcoming **meeting with DEP**

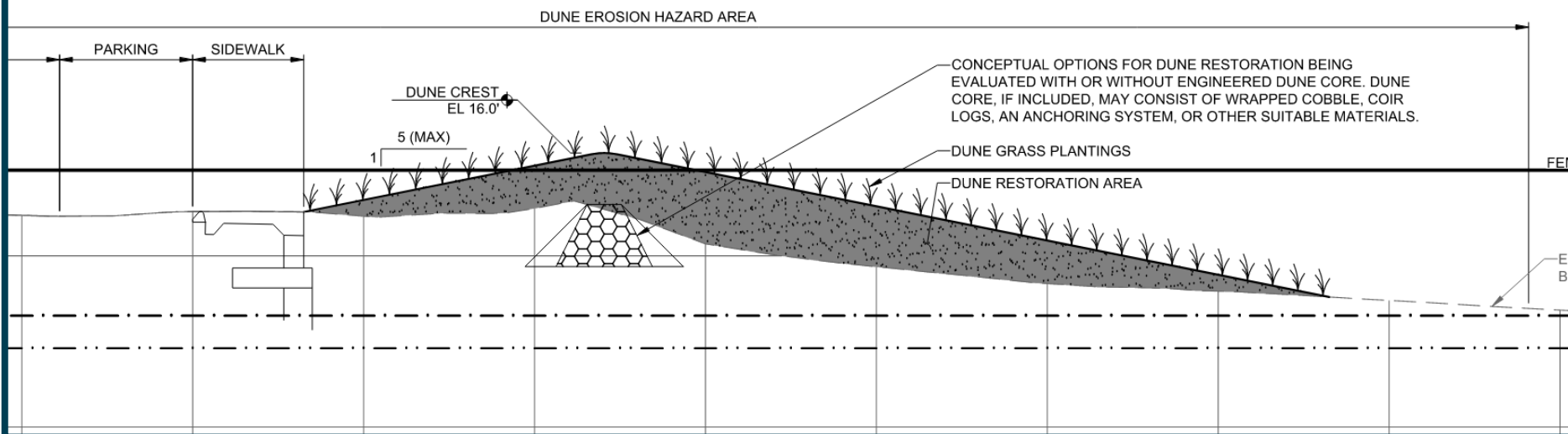
Higgins Beach Seawall/Dune Restoration



Pilot Projects

Higgins Beach Seawall/Dune Restoration

**One proposed concept:
Dune restoration with engineered core**

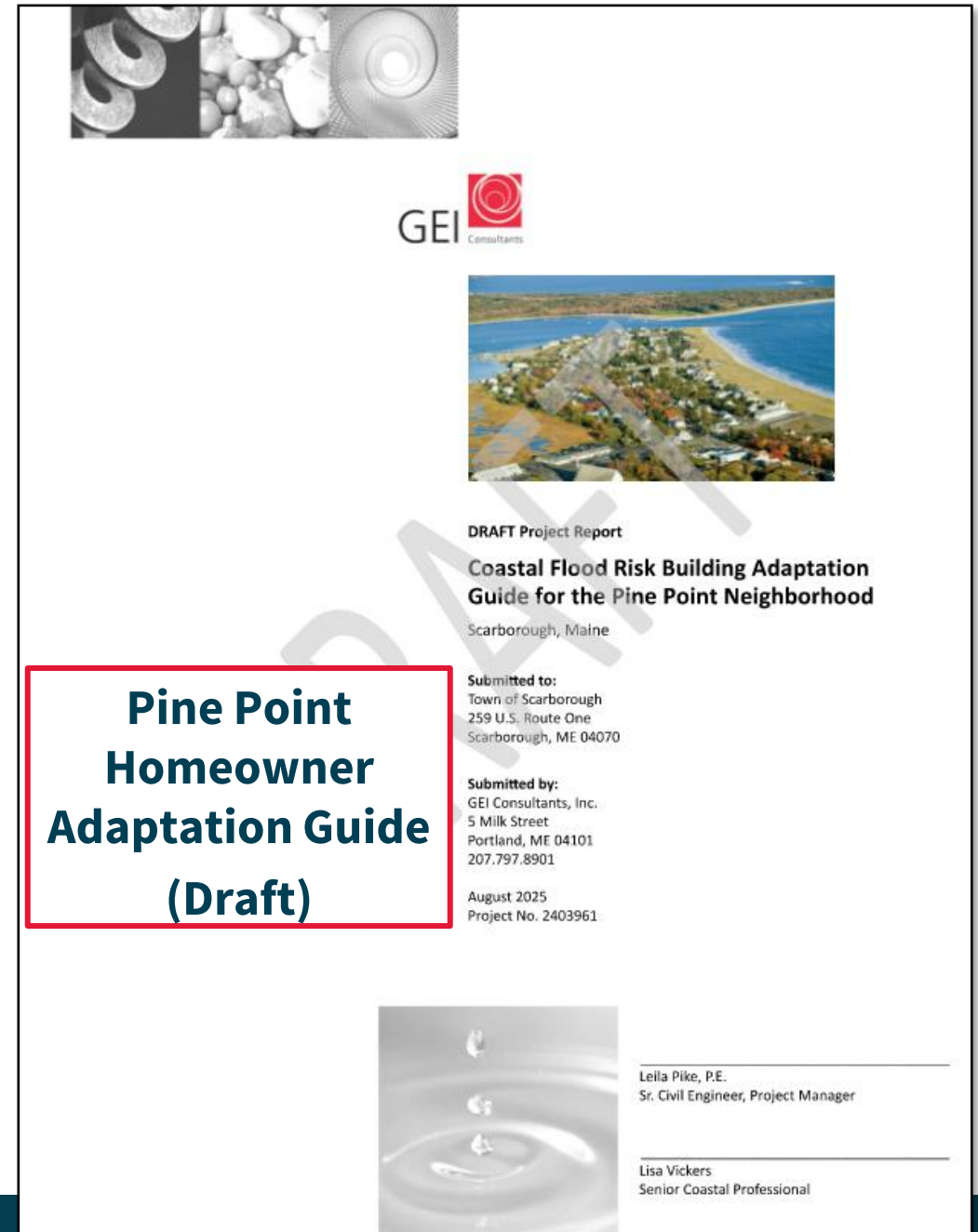


Pilot Projects

PINE POINT HOMEOWNER ADAPTATION GUIDE

Roadmap to elevating a home

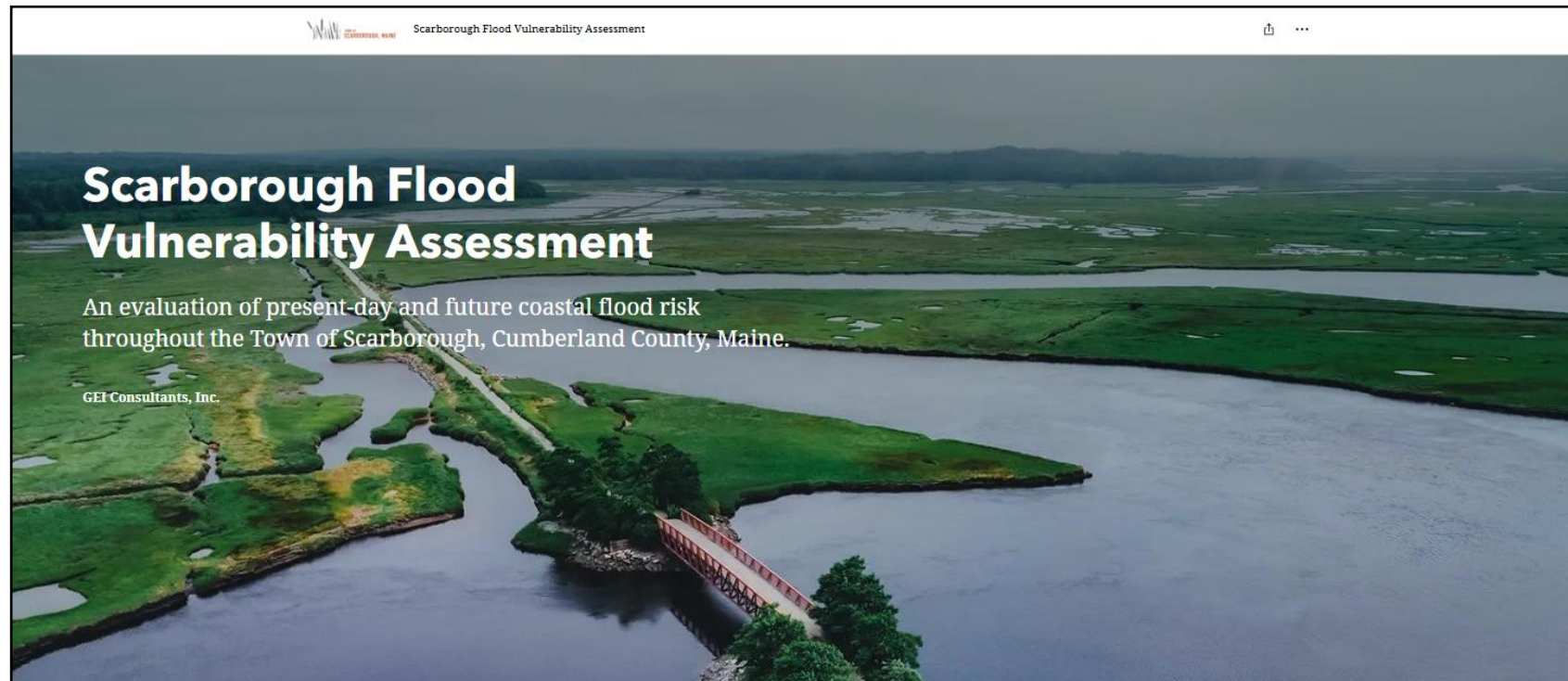
- 1- Review Flood Risk
- 2- Review FEMA Zones
- 3- Check Coastal Sand Dune Zones
- 4- Check Shoreland Zoning Overlay
- 5- Understand Implications
- 6- Contact Code Enforcement
- 7- Hire a Contractor



StoryMap and Next Steps

September: Neighborhood meetings in Higgins Beach and Pine Point

October: Executive Summary and Final Work Products



Thank you!
Questions?



GEI
Consultants

Consulting
Engineers and
Scientists

Leila Pike, P.E.
lpike@geiconsultants.com