



Low-lying Roads: Barnstable

Project funded by the
Municipal Vulnerability
Preparedness Program

Purpose and Objectives of Public Meeting

- **Overview of Low-lying Roads Project**
- **Review adaptation alternatives for priority low-lying roads**
- **Discuss advantages and disadvantages of green, gray, and hybrid alternatives**

Agenda

- Project Overview
- Presentation of conceptual design alternatives
 - Bridge Street, Osterville
 - Ocean Street, Hyannis
- Questions, comments, and discussion
- Next Steps

Low Lying Roads

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10

TOWNS

Barnstable
Bourne
Brewster
Dennis
Eastham

Orleans
Sandwich
Truro
Wellfleet
Yarmouth



Flooding vulnerability assessment of low-lying roads and transportation infrastructure



Support municipal road segment prioritization



Identify range of potential design solutions, costs

Work performed by Cape Cod Commission and Woods Hole Group

PROJECT TIMELINE



Additional Context & Information

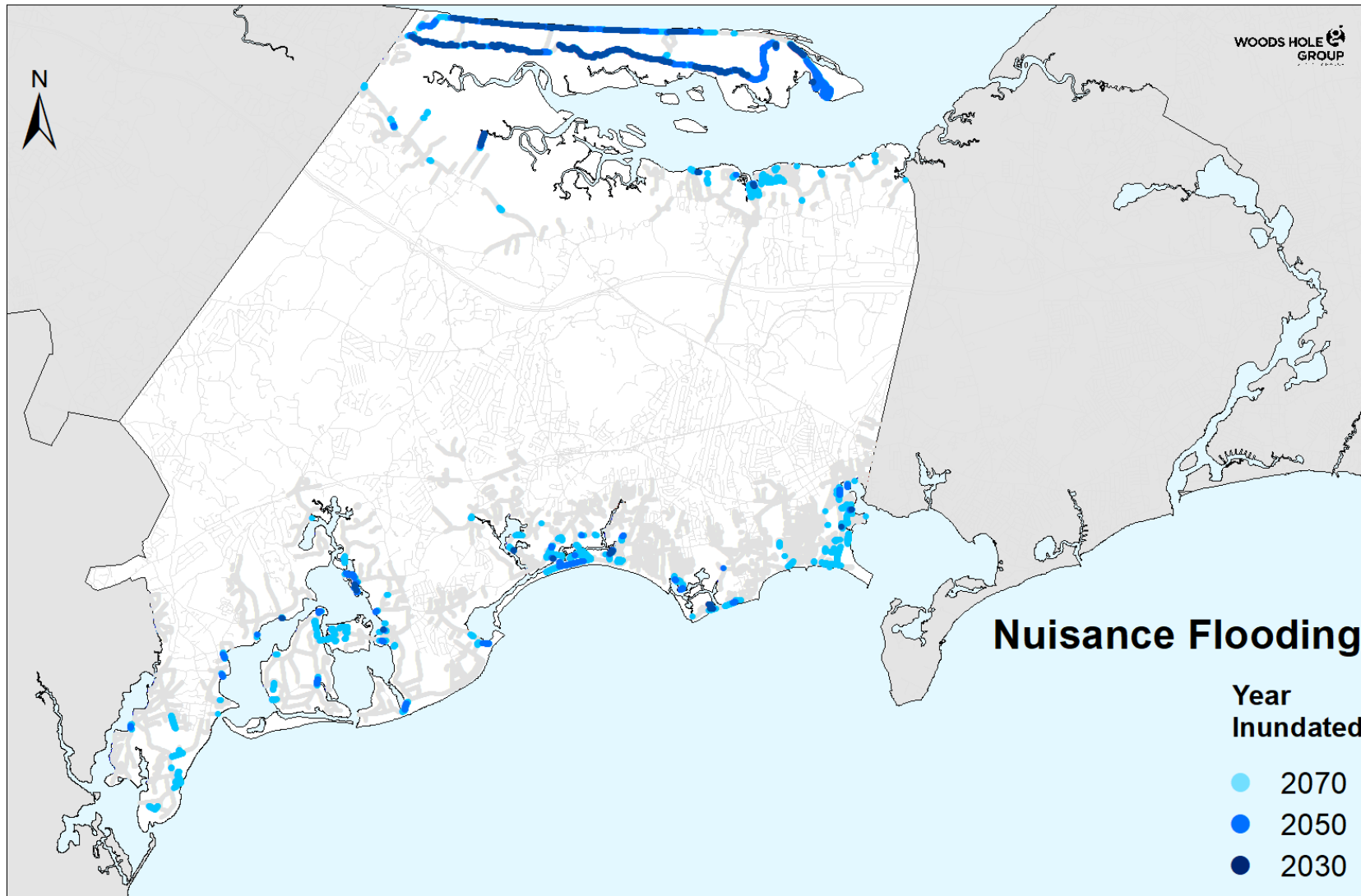
- **Detailed information on webpages:**

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

- **Clarifying questions**
- **Format for meeting**



Low Lying Roads Nuisance Flooding (Barnstable)



Road Miles 2030

5.8/168.7

Road Miles 2050

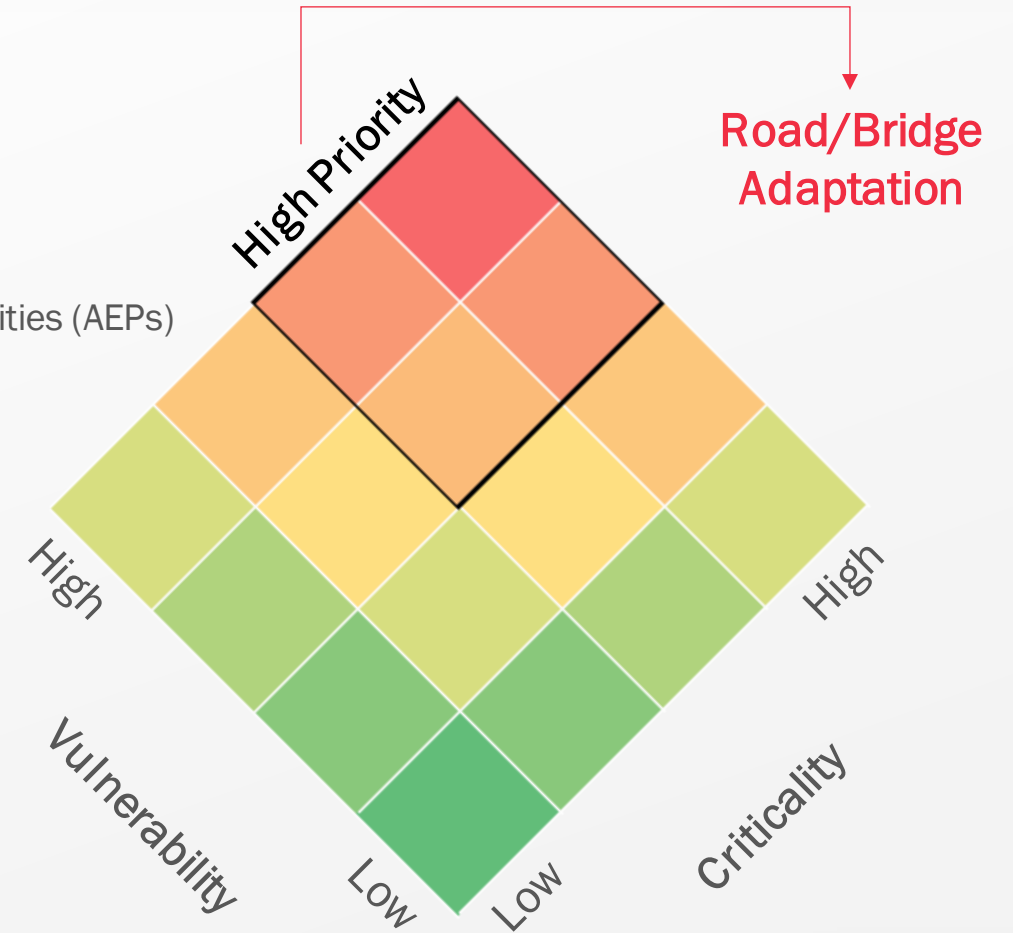
11.3/168.7

Road Miles 2070

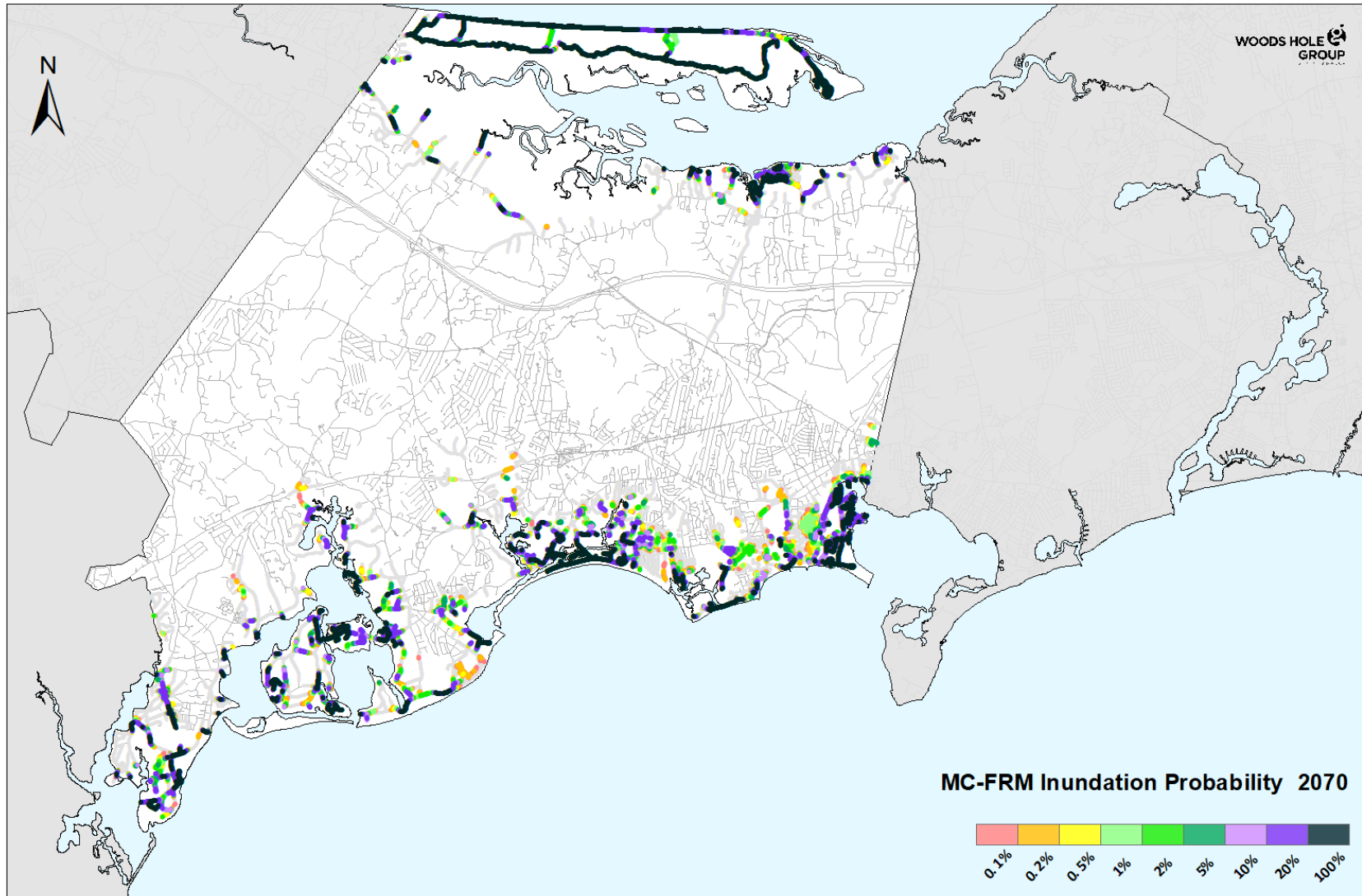
22.0/168.7

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% Annual Exceedance Probabilities (AEPs)
3. Compare CEs 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

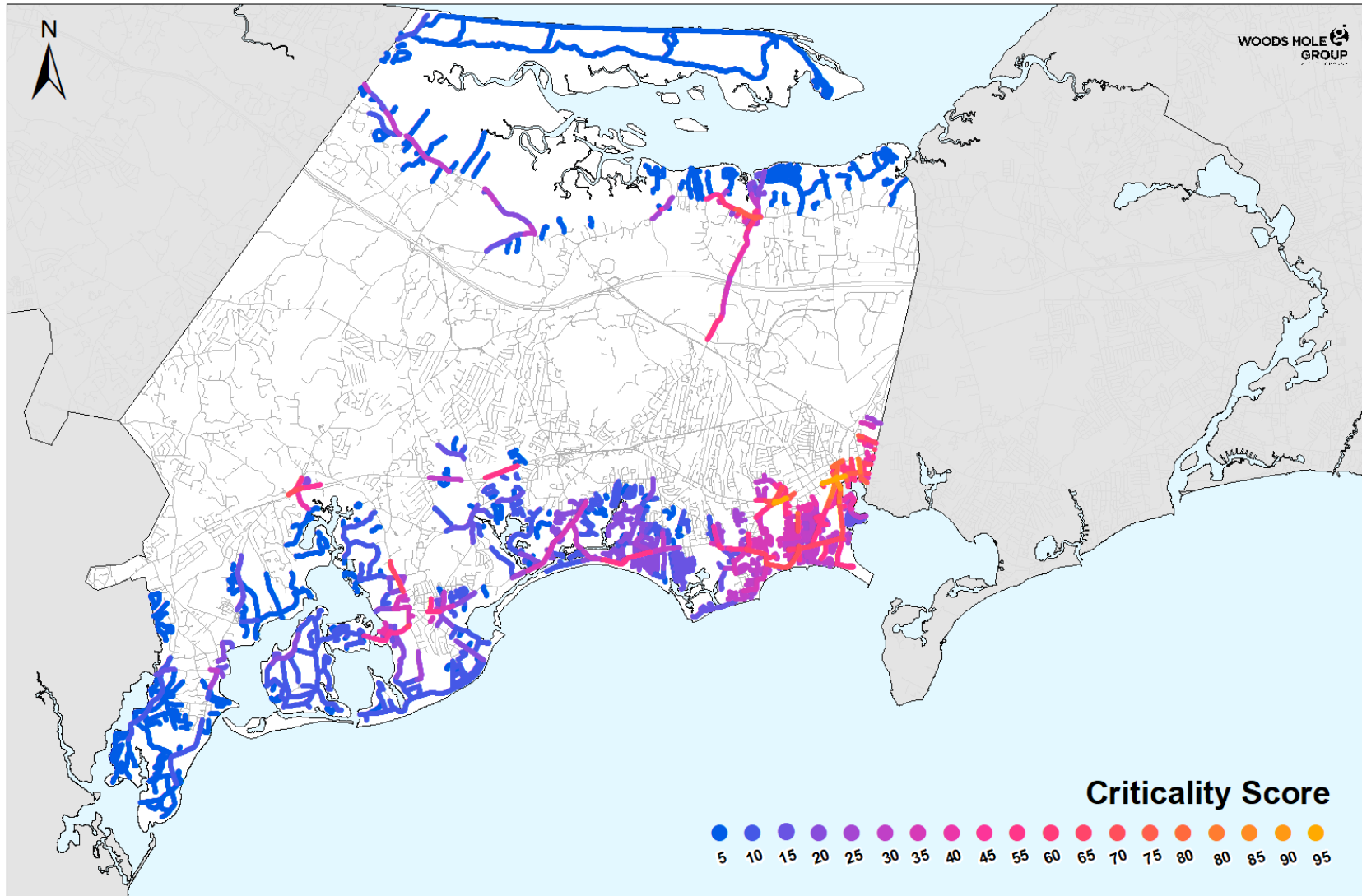


Low Lying Roads 2070 Inundation Probability (Barnstable)

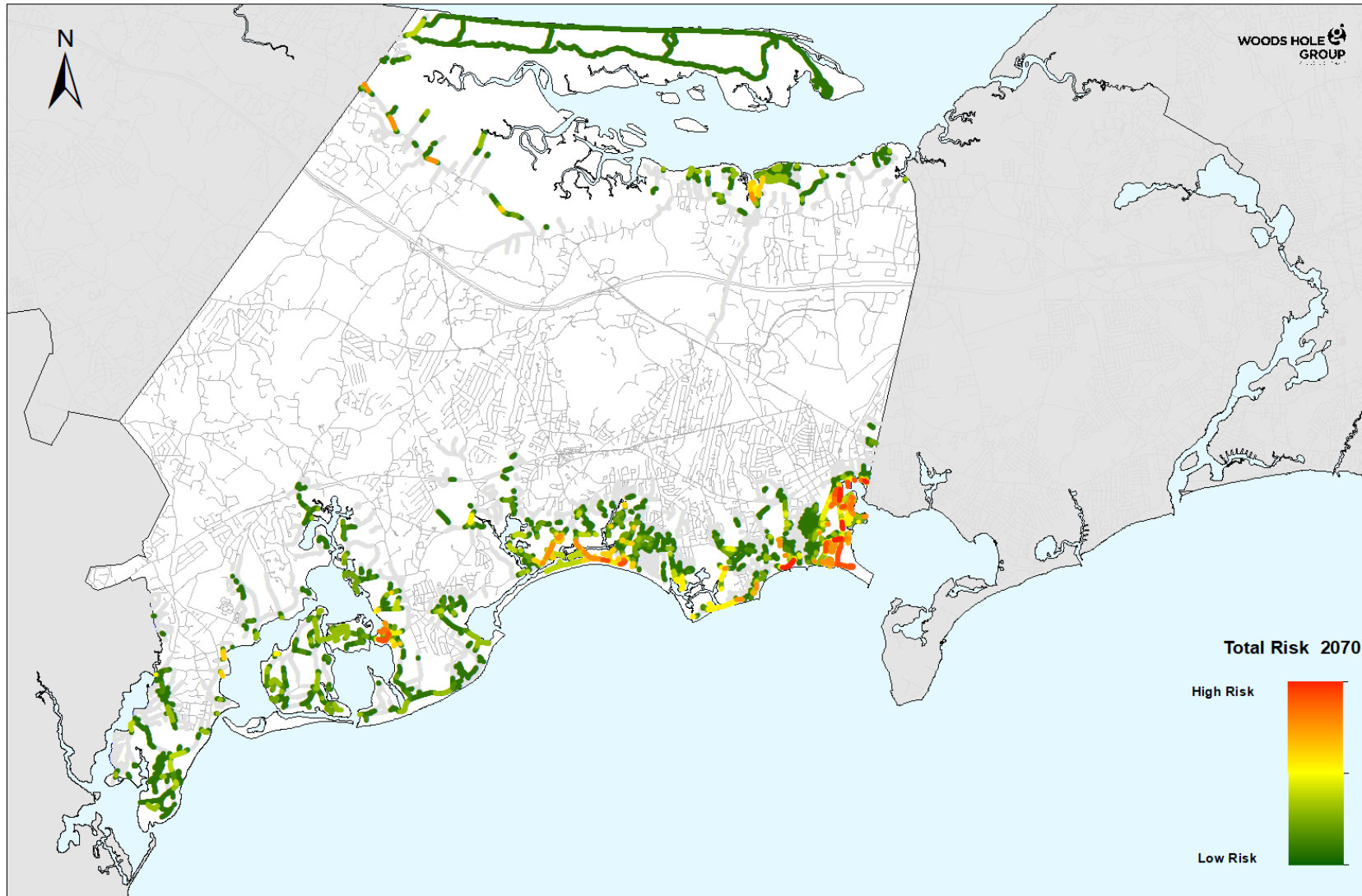


| | % | Road miles |
|--|-----|------------|
| | 0.1 | 85.9 |
| | 0.2 | 82.1 |
| | 0.5 | 75.4 |
| | 1 | 69.8 |
| | 2 | 62.9 |
| | 5 | 55.8 |
| | 10 | 50.1 |
| | 20 | 44.3 |
| | 100 | 29.0 |

Low Lying Roads Criticality Scoring (Barnstable)



Low Lying Roads 2070 Risk Results (Barnstable)



High Risk Road Segments

- Ocean St
 - Pleasant St
 - Bridge St (Osterville/Little Island)
 - West Bay Rd
 - Craigville Beach Rd
-
- Ocean St (Snow's Creek)
 - Ocean Ave (Stewarts Creek)
 - Gosnold St
 - Ocean St (Kalmus)
 - Estey Ave
-
- Willow St & Quinlan Way

Summary of High Priority Road Segments (Barnstable)

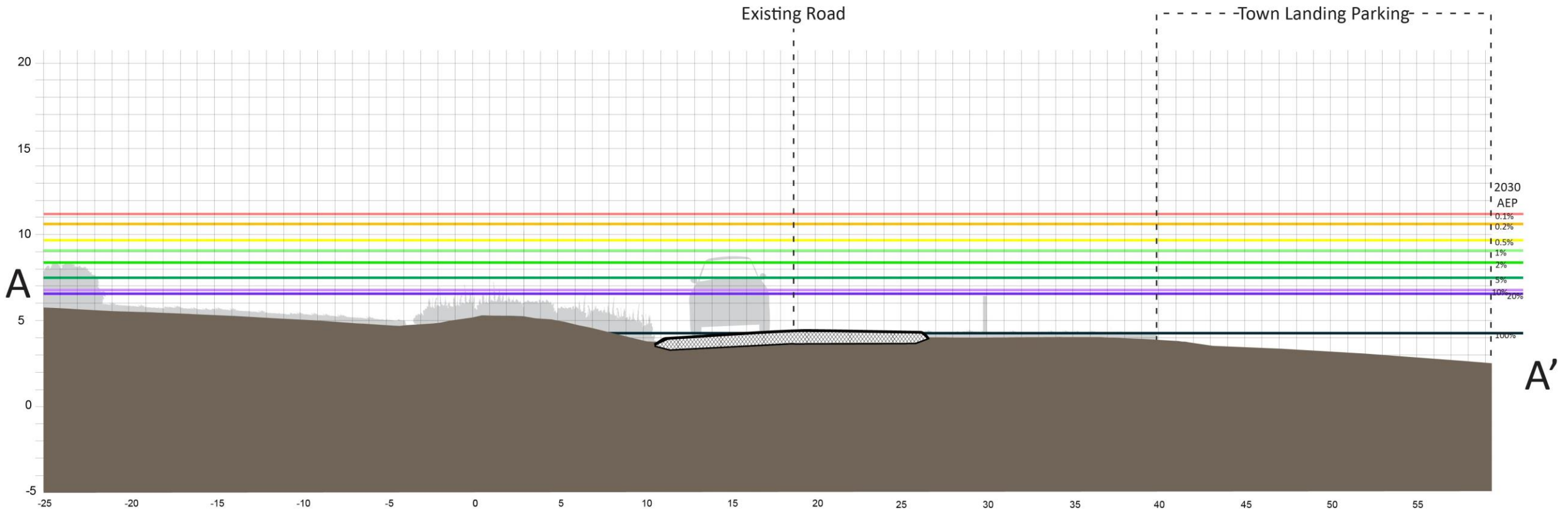
| | Name | Length (ft) | Description | Segment Storm Probability (%) | | | Nuisance Length (ft) | | |
|-------------------------------------|--|-------------|--|-------------------------------|--------|--------|----------------------|------|------|
| | | | | 2030 | 2050 | 2070 | 2030 | 2050 | 2070 |
| <input checked="" type="checkbox"/> | A Ocean St | 1300 | Adjacent to Hyannis Harbor | 0-100 | 2-100 | 10-100 | 0 | 280 | 740 |
| | B Pleasant St | 940 | Adjacent to Hyannis Harbor Park | 0.1-100 | 5-100 | 10-100 | 0 | 200 | 300 |
| <input checked="" type="checkbox"/> | C Bridge St (Osterville and Little Island) | 2100 | Access to Three Bays and Little Island | 0-100 | 2-100 | 10-100 | 0 | 140 | 500 |
| | D West Bay Rd | 420 | Access to North/West Bay waterfront | 2-100 | 20-100 | 100 | 40 | 120 | 260 |
| | E Craigville Beach Rd | 4500 | Access to Craigville Beach | 0-100 | 2-100 | 10-100 | 0 | 0 | 1100 |
| | F Ocean St (Snow's Creek) | 860 | Culvert over Snow's Creek adjacent to JFK Memorial | 0-20 | 2-100 | 10-100 | 0 | 0 | 380 |
| | G Ocean Ave (Stewarts Creek) | 1340 | Culvert over Stewarts Creek | 0.1-20 | 10-100 | 20-100 | 0 | 0 | 420 |
| | H Gosnold St | 1220 | West of Ocean Street | 0-20 | 10-100 | 10-100 | 0 | 0 | 400 |
| | I Ocean St (Kalmus) | 2480 | Access to Kalmus Park Beach | 0-20 | 2-100 | 10-100 | 0 | 0 | 1620 |
| | J Estey Ave | 860 | Access to neighborhood | 0-20 | 2-100 | 10-100 | 0 | 0 | 260 |
| | K Willow St & Quinlan Way | 800 | Hyannis Harbor and Cape Cod Hospital area | 0.1-10 | 5-20 | 10-100 | 0 | 0 | 0 |
| | L Dale Ave & Squaw Island Rd | 2760 | Access to Hyannis Point and Squaw Island | 0.5-100 | 5-100 | 20-100 | 0 | 200 | 1760 |
| | M South Main St | 2700 | Access to Centerville River neighborhoods | 0-20 | 2-100 | 5-100 | 0 | 100 | 860 |
| | N East Bay Rd | 2740 | Access to Dowes Beach | 0.2-100 | 5-100 | 20-100 | 0 | 560 | 1200 |
| | O Sea View Ave | 1360 | Access to Wianno Head | 0-100 | 2-100 | 10-100 | 0 | 360 | 840 |
| | P Millway | 2320 | Access to Barnstable Harbor and Millway Beach | 0.2-100 | 2-100 | 20-100 | 0 | 0 | 1360 |
| | Q Rte 6A (Scorton Creek)* | 720 | Route 6A low lying segment at Sandwich Town Line | 0-100 | 1-100 | 5-100 | 0 | 0 | 60 |
| | R Bridge St (Osterville Grand Island) | 3040 | Access to Oyster Harbors | 0-20 | 2-100 | 10-100 | 0 | 0 | 1120 |
| | S Commerce Rd | 1800 | Access for neighborhood north of Maraspin Creek | 0.1-100 | 2-100 | 10-100 | 0 | 0 | 1380 |
| | T Rte 6A (Smith Creek)* | 920 | Route 6A low lying segment | 0.1-20 | 2-100 | 10-100 | 0 | 120 | 500 |
| | U Rte 6A (Boat Cove Creek)* | 620 | Route 6A low lying segment with culvert | 0.5-20 | 5-100 | 20-100 | 0 | 0 | 140 |
| | V Rte 6A (Bridge Creek)* | 720 | Route 6A low lying segment with culvert | 0.2-10 | 2-20 | 20-100 | 0 | 0 | 260 |
| | W Main St (Rushy Marsh Pond) | 1060 | Access for neighborhood at Meadow Point | 0.1-100 | 5-100 | 20-100 | 0 | 0 | 820 |

* = MassDOT roadway

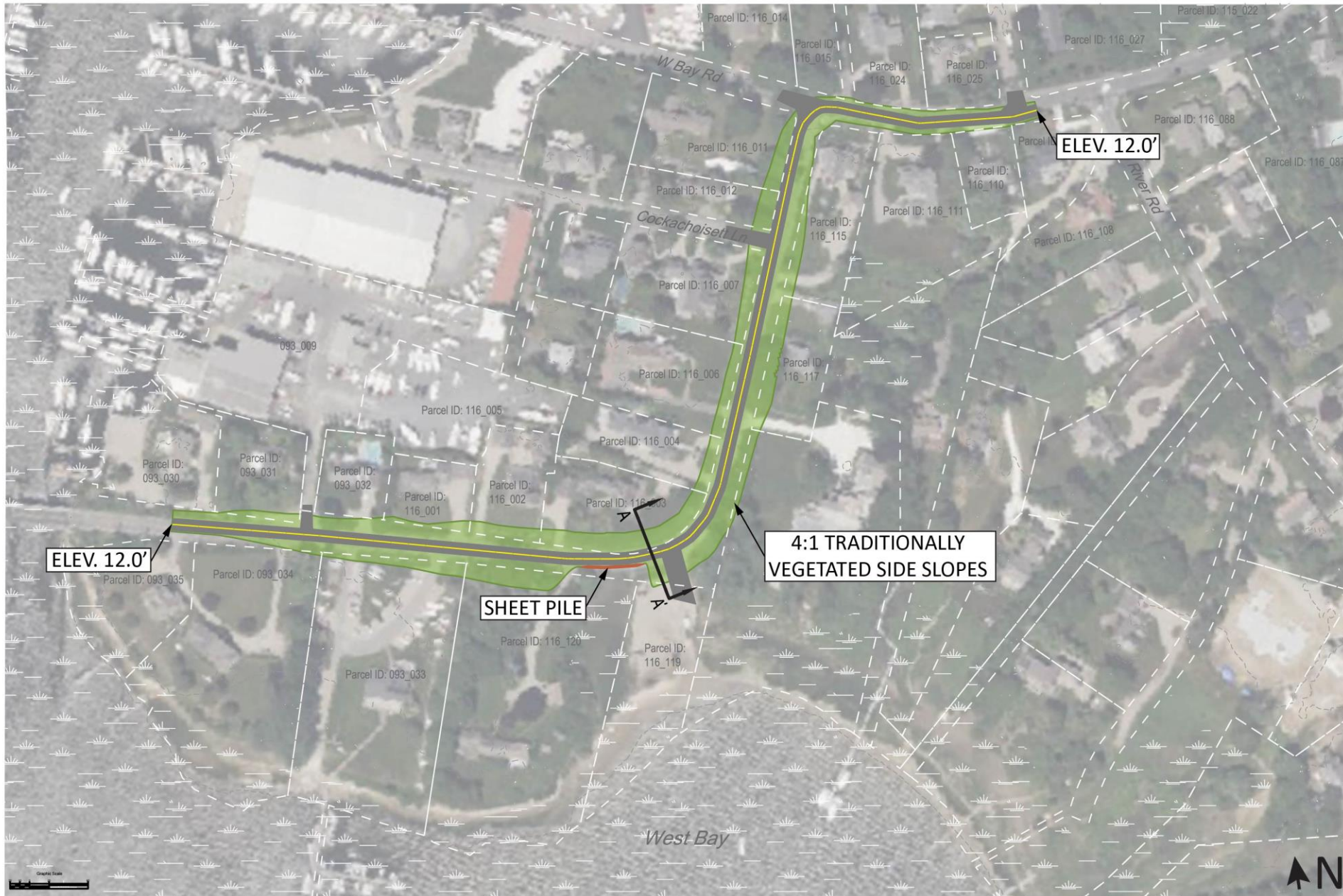
Bridge Street



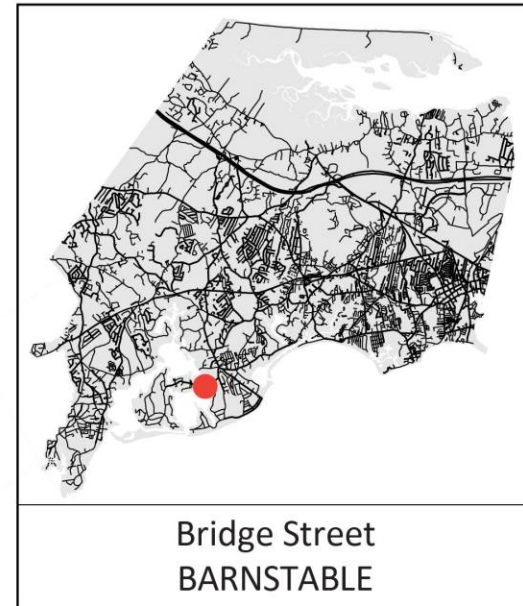
Bridge Street



EXISTING CONDITIONS
Bridge Street, Barnstable



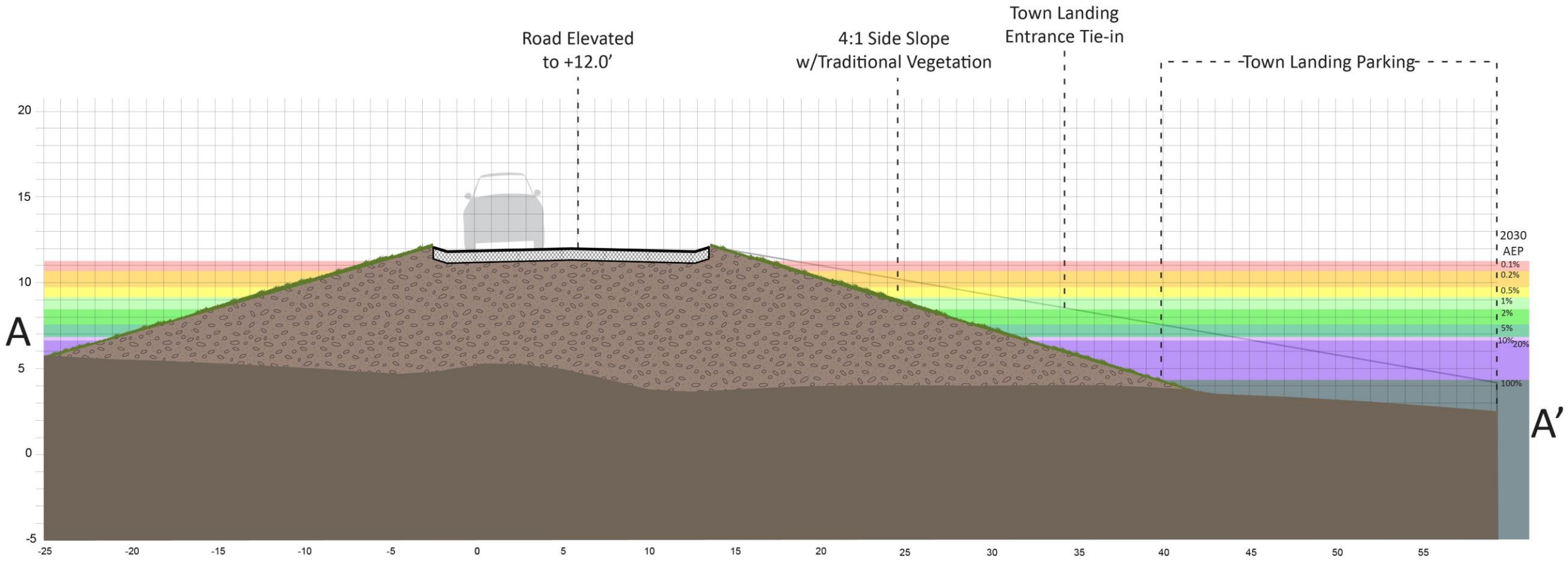
Note: Project overlap with wetland areas, rights of way and property lines is approximate and needs confirmation with a site survey



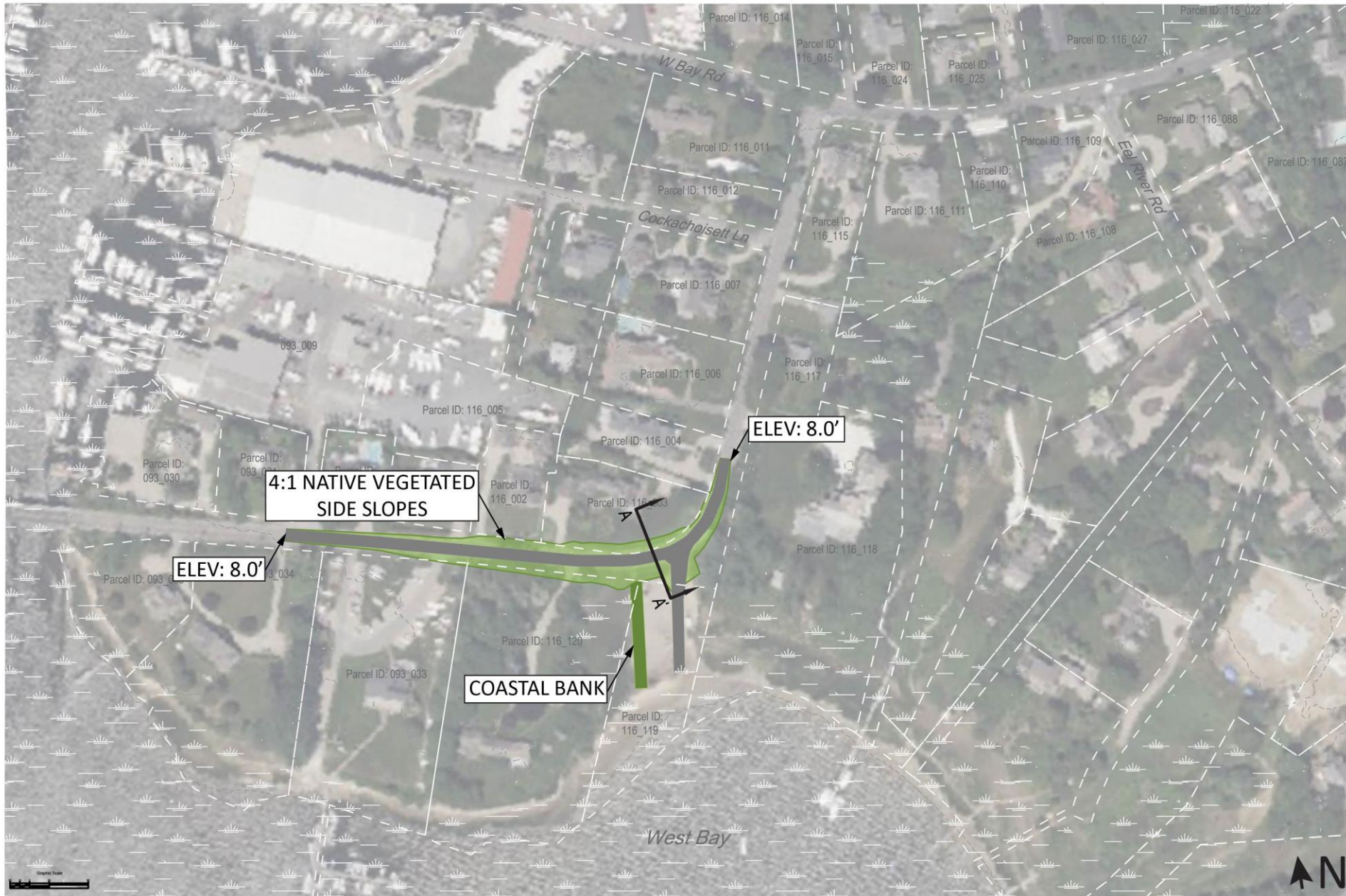
ALTERNATIVE 1: GRAY

1711 linear feet of town-owned road is elevated to 12.0 feet with 4:1 traditionally vegetated side slopes. The road slopes to parking lots, side streets, and the town landing.

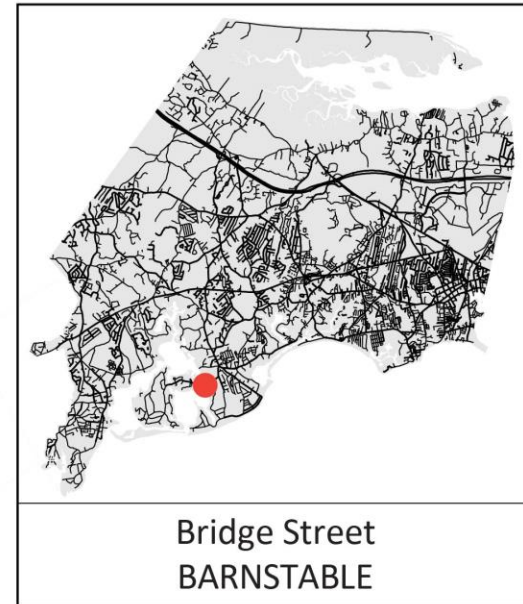
Bridge Street



ALTERNATIVE 1: GRAY
Bridge Street, Barnstable



Note: Project overlap with wetland areas, rights of way and property lines is approximate and needs confirmation with a site survey

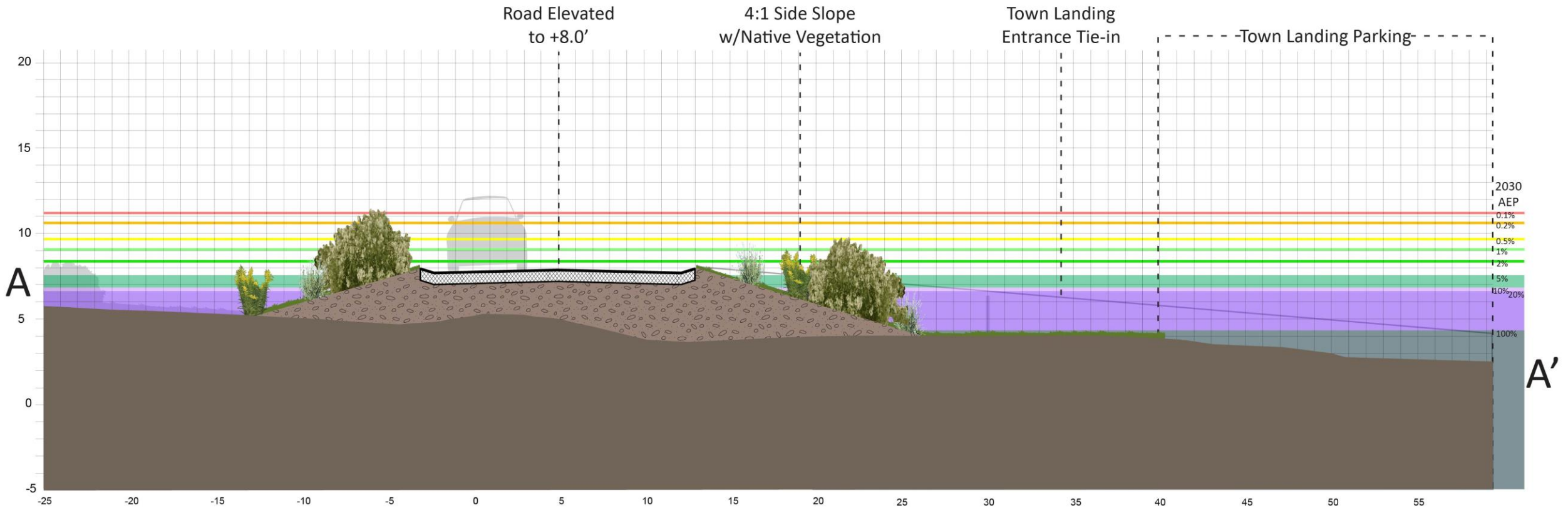


Bridge Street
BARNSTABLE

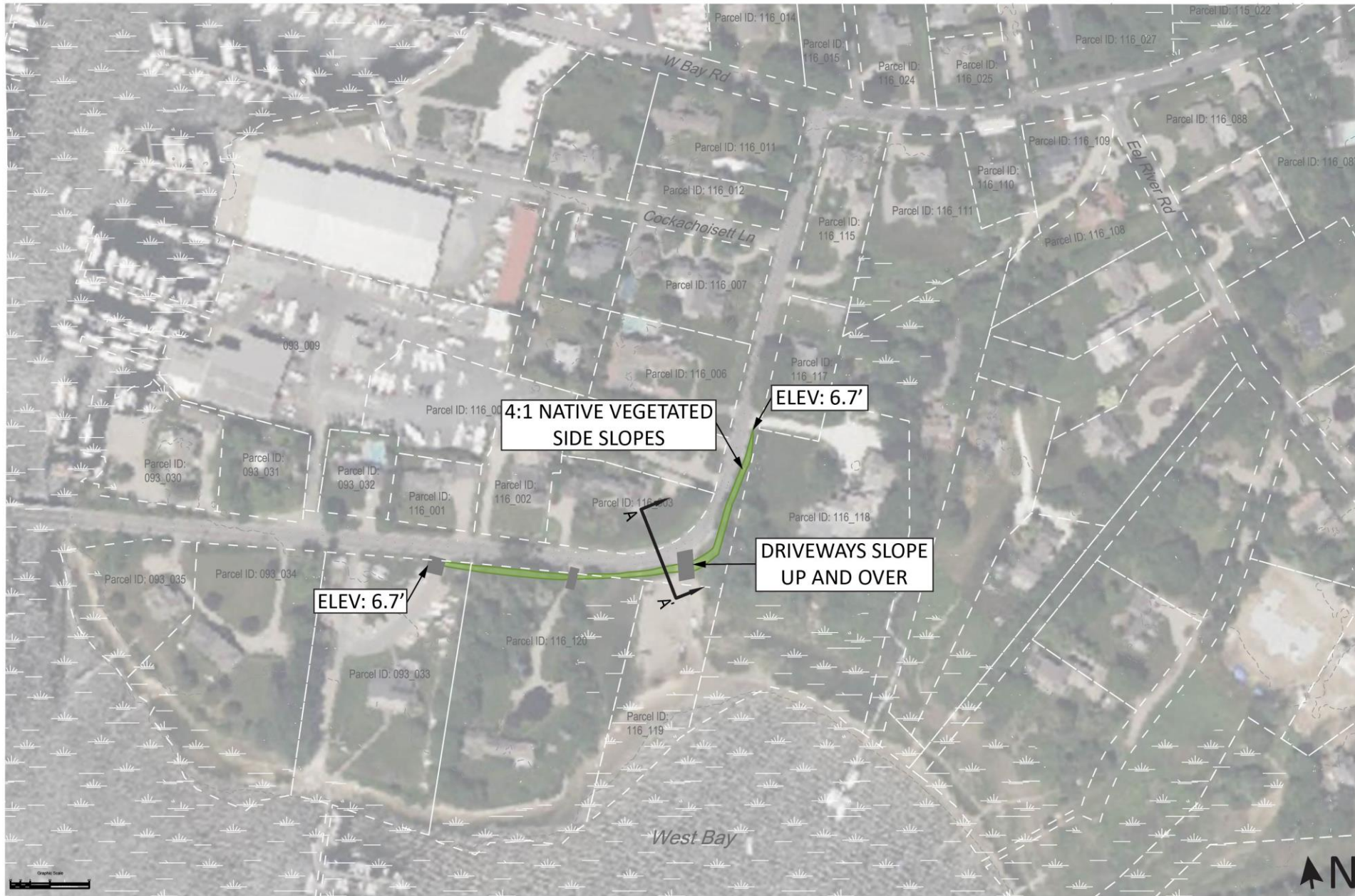
ALTERNATIVE 2: HYBRID

611 linear feet of town-owned road is elevated to 8.0 feet with 4:1 traditionally vegetated side slopes. The town landing is narrowed slightly and a gently sloping coastal bank is restored next to the existing salt marsh.

Bridge Street



ALTERNATIVE 2: HYBRID
Bridge Street, Barnstable



Note: Project overlap with wetland areas, rights of way and property lines is approximate and needs confirmation with a site survey

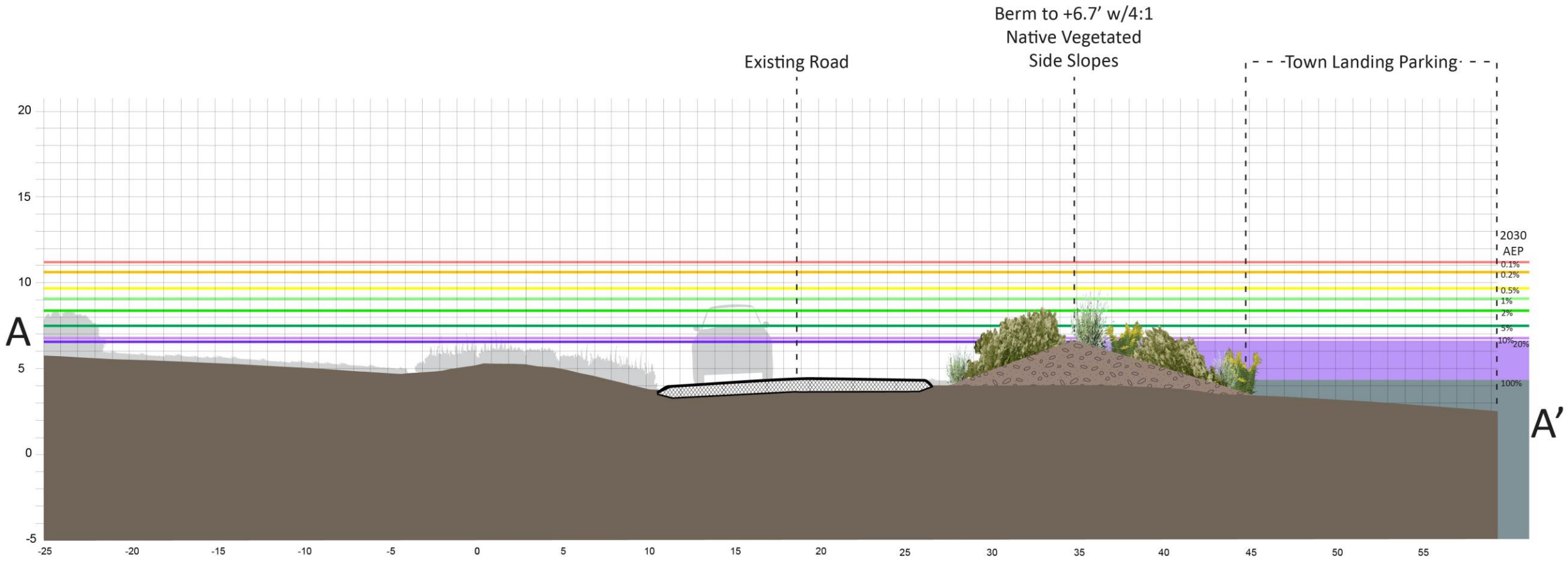


**Bridge Street
BARNSTABLE**

ALTERNATIVE 3: GREEN

A small berm to +6.7 feet with 4:1 side slopes and native vegetation is added at the curve of the road. Two driveways and the town landing entrance slope up and over the berm to prevent the need for deployable barriers.

Bridge Street



ALTERNATIVE 3: GREEN
Bridge Street, Barnstable

BRIDGE STREET, BARNSTABLE

Summary of alternatives

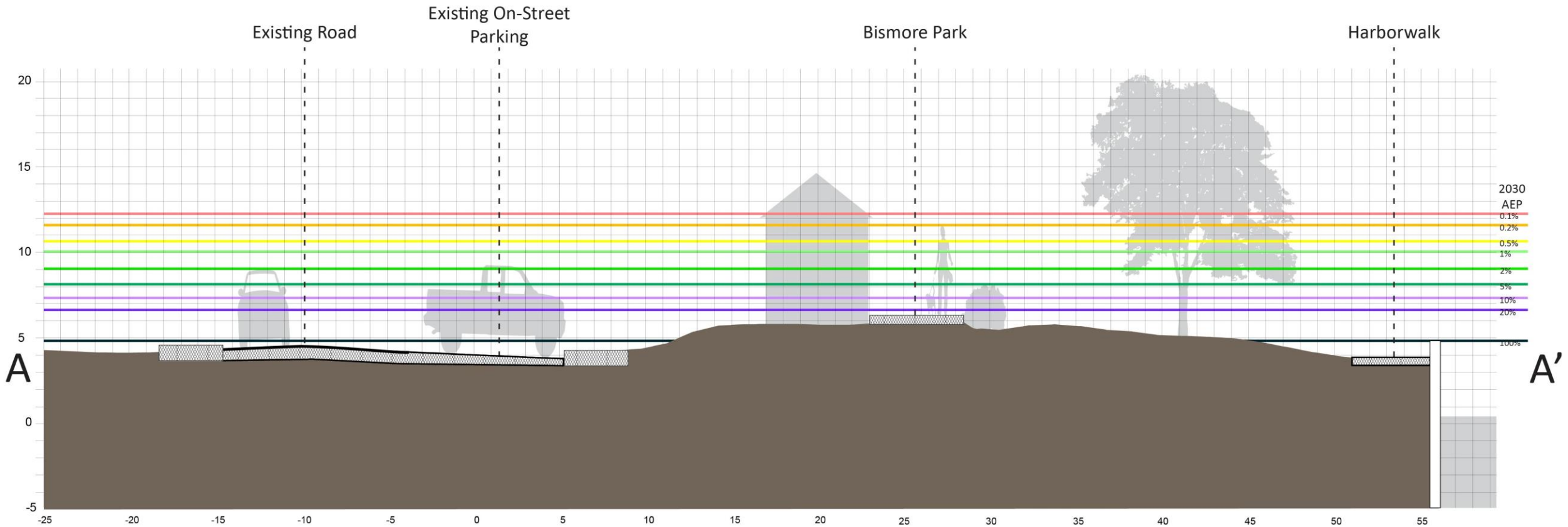
| | Description | Critical Elevation | Annual Exceedance Probability | | | Vulnerable to Tidal Flooding | Impacts to Wetlands | Impacts to Private Property | Estimated Cost* |
|------------------------------|---|--------------------|-------------------------------|------|------|------------------------------|---------------------|-----------------------------|-----------------|
| | | | 2030 | 2050 | 2070 | | | | |
| EXISTING | A segment of 20 foot wide road with a marina, town landing, and bridge. | 3.8 feet | 100% | 100% | 100% | 2050 | N/A | N/A | N/A |
| ALTERNATIVE 1: GRAY | 1711 linear feet of town-owned road is elevated to 12.0 feet with 4:1 traditionally vegetated side slopes. The road slopes to parking lots, side streets, and the town landing. | 12.0 feet | 0% | 2% | 5% | N/A | Minor | Yes | \$847,000 |
| ALTERNATIVE 2: HYBRID | 611 linear feet of town-owned road is elevated to 8.0 feet with 4:1 traditionally vegetated side slopes. The town landing is narrowed slightly and a gently sloping coastal bank is restored next to the existing salt marsh. | 8.0 feet | 2% | 20% | 20% | N/A | Possible Positive | Yes | \$316,000 |
| ALTERNATIVE 3: GREEN | A small berm to 6.7 feet with 4:1 side slopes and native vegetation is added at the curve of the road. Two driveways and the town landing entrance slope up and over the berm to prevent the need for deployable barriers. | 6.7 feet | 20% | 20% | 100% | 2070 | N/A | Minor | \$24,000 |

*Installed material cost +20% contingency. Excludes design, permitting, mobilization, stormwater and wastewater infrastructure, and site controls. Costs based on RSMMeans 2021 cost book and adjusted for inflation and region.

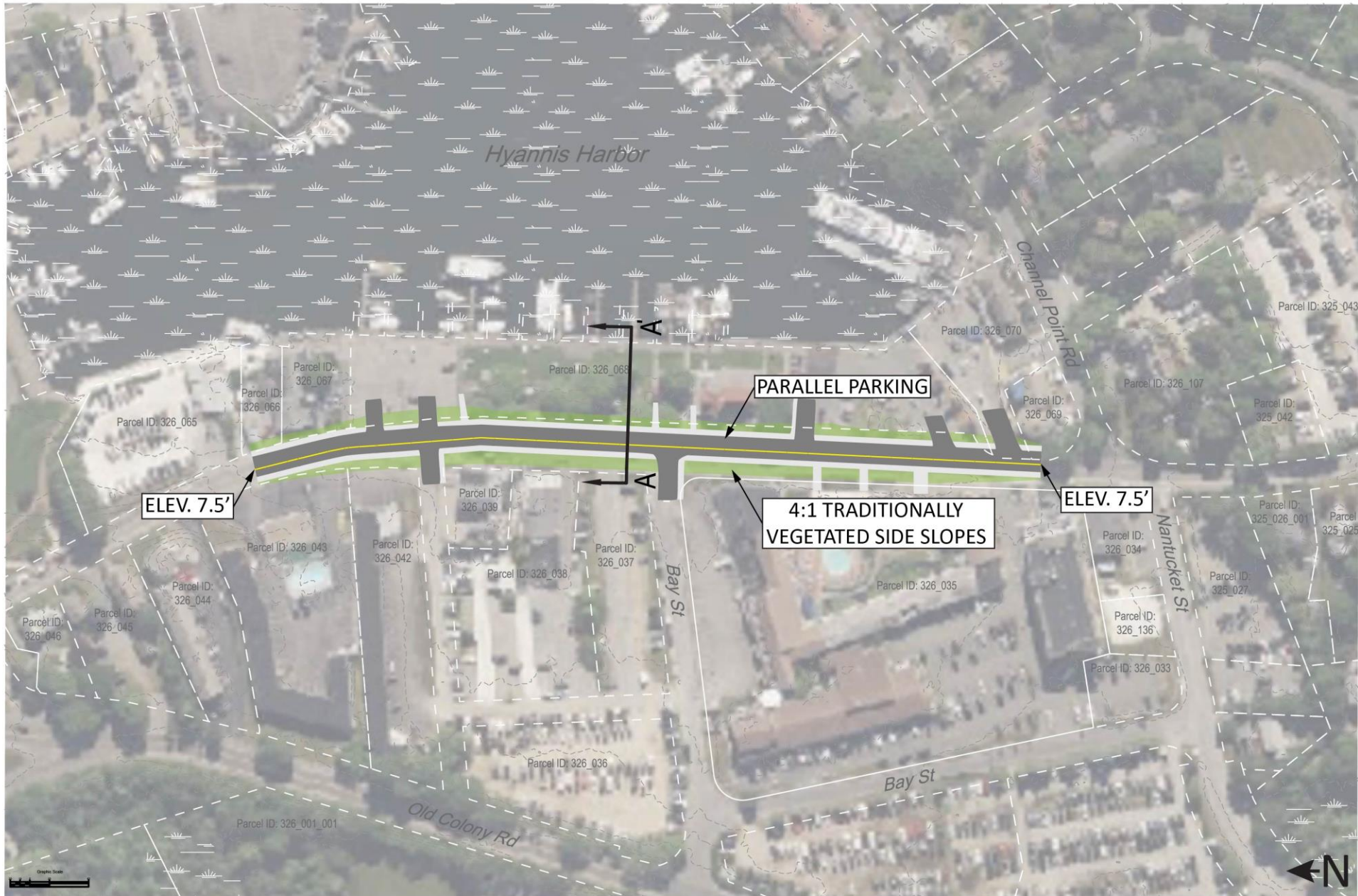
Ocean Street



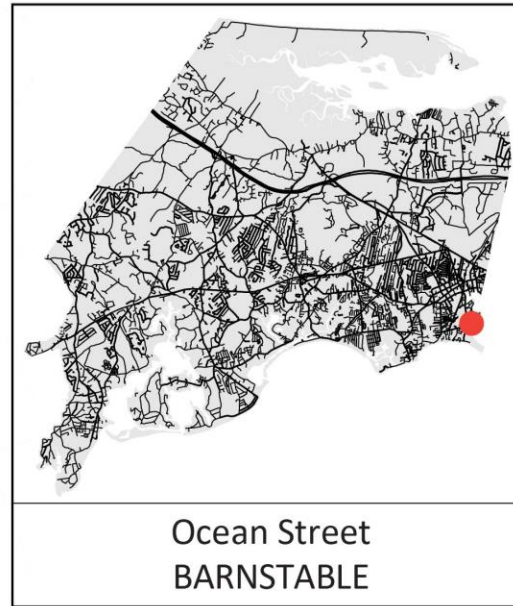
Ocean Street



EXISTING CONDITIONS
Ocean Street, Barnstable



Note: Project overlap with wetland areas, rights of way and property lines is approximate and needs confirmation with a site survey

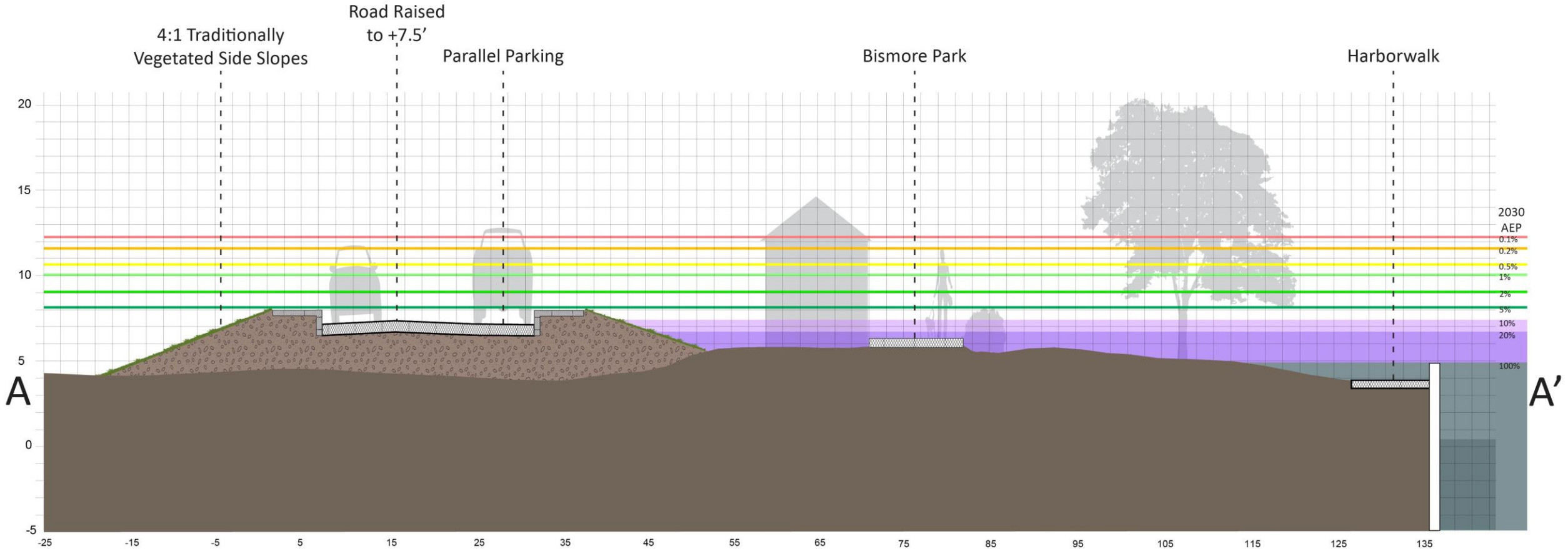


Ocean Street
BARNSTABLE

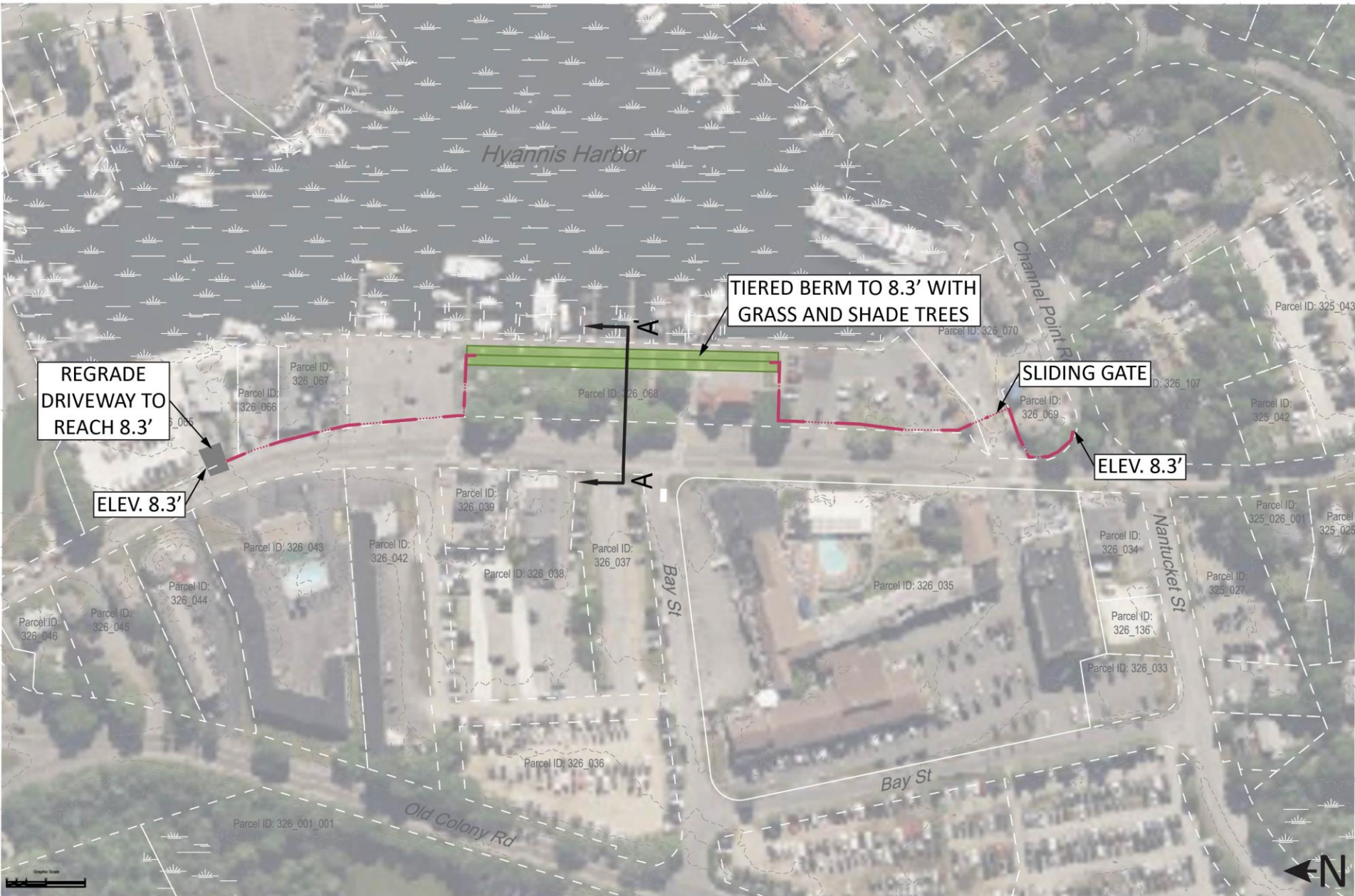
ALTERNATIVE 1: GRAY

944 linear feet of town-owned road is elevated to 7.5 feet with 4:1 traditionally vegetated side slopes. The road slopes to parking lots and side streets, and the current perpendicular parking on the east side of the road becomes parallel parking.

Ocean Street



ALTERNATIVE 1: GRAY
Ocean Street, Barnstable



Note: Project overlap with wetland areas, rights of way and property lines is approximate and needs confirmation with a site survey

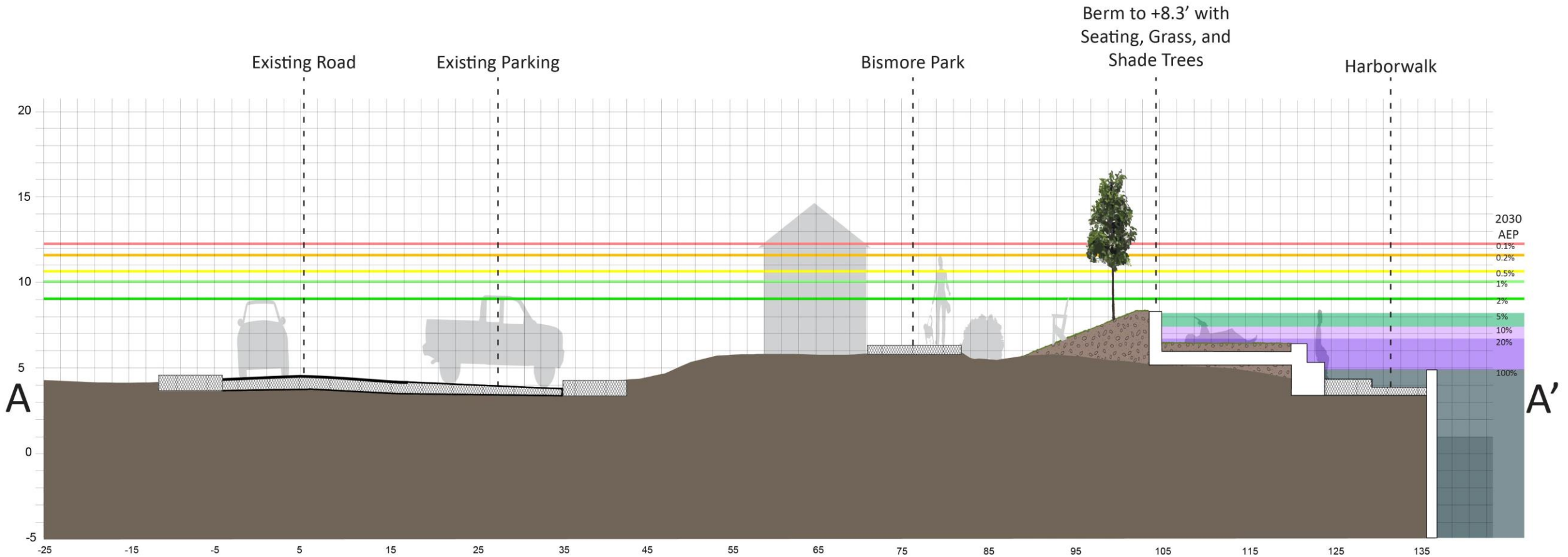


Ocean Street
BARNSTABLE

ALTERNATIVE 2: HYBRID

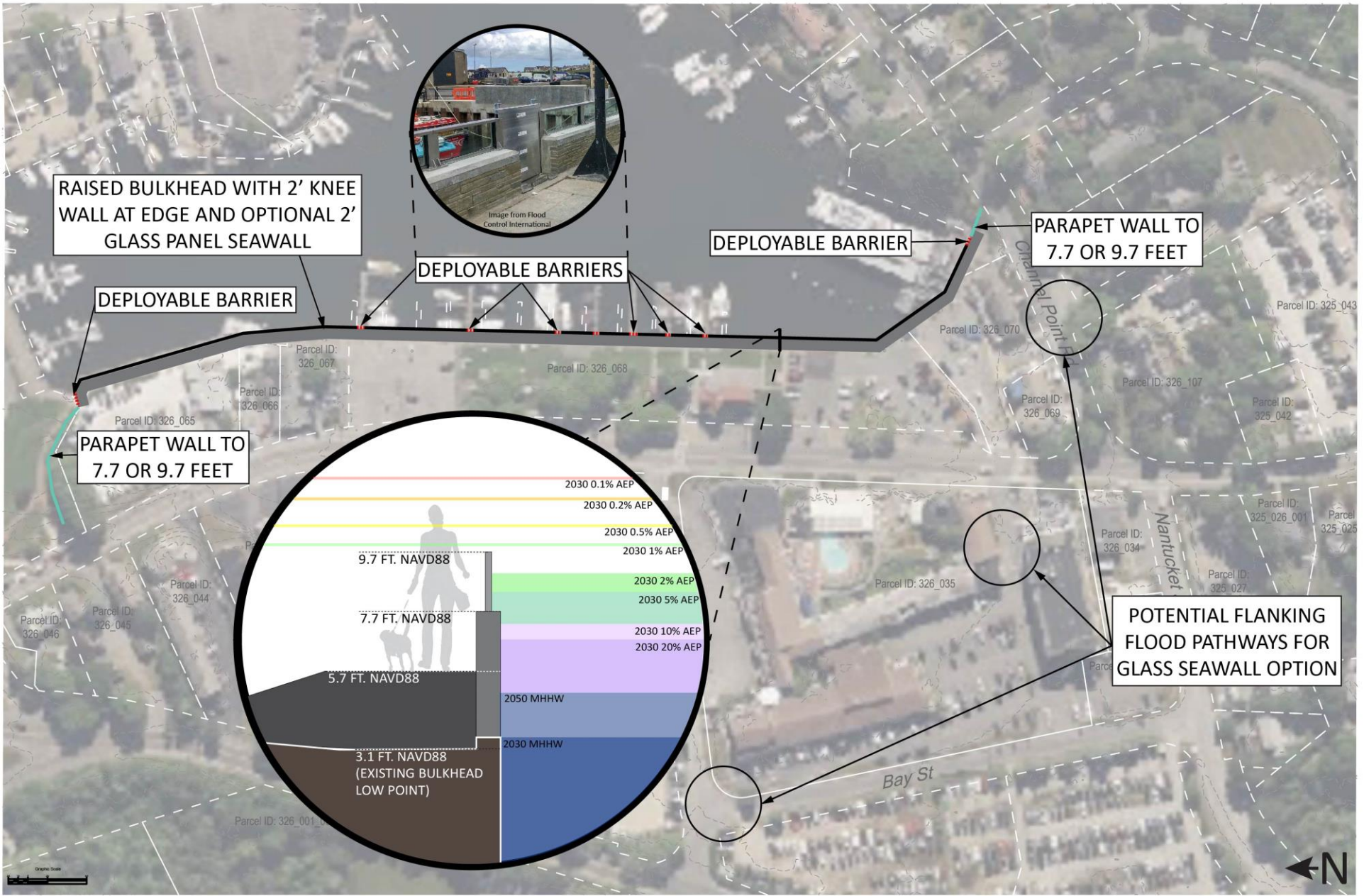
A system of parapet walls, berms, and sliding gates protect the road to 8.3 feet. Some negotiation with private property owners is necessary.

Ocean Street

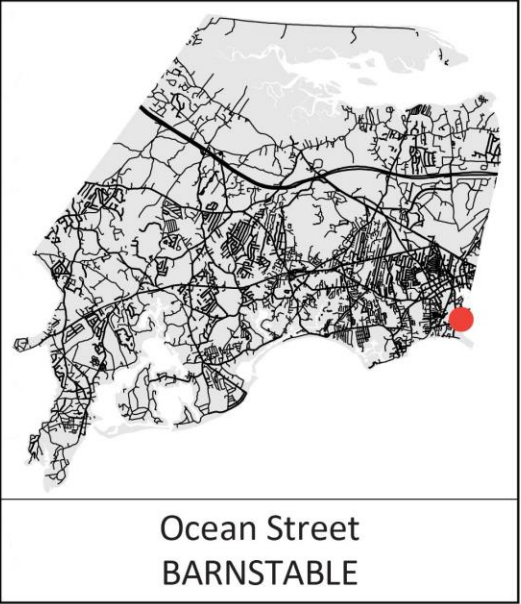


ALTERNATIVE 2: HYBRID

Ocean Street, Barnstable



Note: Project overlap with wetland areas, rights of way and property lines is approximate and needs confirmation with a site survey



ALTERNATIVE 3: BULKHEAD EXTENSION

Land at the existing bulkhead, which has a lowest point of 3.1ft, is raised to 5.7ft to maintain the waterfront’s usability during the approximated highest tides in 2050. The bulkhead edge’s cap is constructed an additional 2.0ft tall to reach elevation 7.7ft and protect against the 10% storm in 2030. A glass panel seawall 2.0ft high can also be added to protect against the 2% storm in 2030, but flanking flood pathways would need to be addressed in order to achieve the full 9.7ft of protection. Deployable barriers or gates are needed at nine locations.

OCEAN STREET, BARNSTABLE

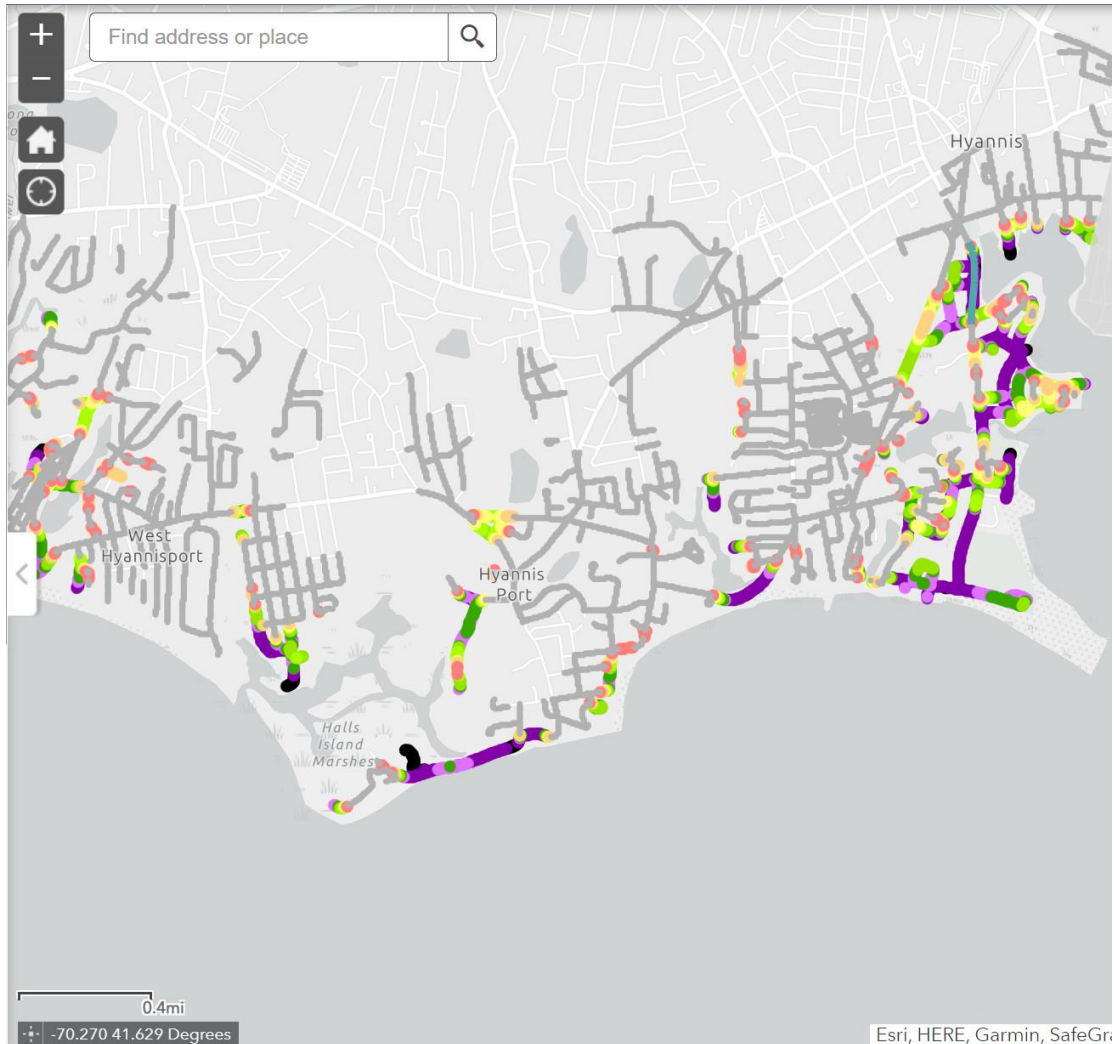
Summary of alternatives

| | Description | Critical Elevation | Annual Exceedance Probability | | | Vulnerable to Tidal Flooding | Impacts to Wetlands | Impacts to Private Property | Estimated Cost* |
|--|---|--------------------|-------------------------------|------|------|-------------------------------------|---------------------|-----------------------------|-----------------|
| | | | 2030 | 2050 | 2070 | | | | |
| EXISTING | A segment of 20 foot wide road adjacent to Hyannis Harbor. | 4.2 feet | 100% | 100% | 100% | 2050 | N/A | N/A | N/A |
| ALTERNATIVE 1: GRAY | 944 linear feet of town-owned road is elevated to 7.5 feet with 4:1 traditionally vegetated side slopes. The road slopes to parking lots and side streets, and the current perpendicular parking on the east side of the road becomes parallel parking. | 7.5 feet | 5% | 20% | 100% | N/A | N/A | Yes | \$621,000 |
| ALTERNATIVE 2: HYBRID | A system of parapet walls, berms, and sliding gates protect the road to 8.3 feet. Some negotiation with private property owners is necessary. | 8.3 feet | 2% | 20% | 100% | N/A | N/A | Yes | \$579,000 |
| ALTERNATIVE 3: BULKHEAD EXTENSION | Land at the existing bulkhead is raised to maintain the waterfront's usability during the highest tides in 2050. The bulkhead edge's cap is raised to protect against the 10% storm in 2030. A glass panel seawall can also be added to protect against the 2% storm in 2030, but flanking flood pathways would need to be addressed. Deployable barriers are needed at nine locations. | 7.7 feet | 5% | 20% | 100% | 2070 (unless adjusted over time) | Possible | Yes | TBD |
| | | 9.7 feet | 1% | 20% | 20% | | | | |

*Installed material cost +20% contingency. Excludes design, permitting, mobilization, stormwater and wastewater infrastructure, and site controls. Costs based on RSMMeans 2021 cost book and adjusted for inflation and region.

LOW LYING ROADS

Discussion



- **Bridge Street, Osterville**
- **Ocean Street, Hyannis**

NEXT STEPS

- Comments! Use form on project webpages
<https://www.capecodcommission.org/our-work/low-lying-roads-project/>
- Town staff to determine which projects, designs
 - Review of community input
 - Engineering, permitting
- Identify funding

FUNDING OPPORTUNITIES

Federal Bipartisan Infrastructure Law (BIL)

Federal Highway Administration

- PROTECT – Competitive Resilience Improvement and Planning grants
- Culvert Aquatic Organism Passage Program - competitive grants for the replacement, removal, and repair of culverts or weirs that meaningfully improve or restore fish passage for anadromous fish

[NEW] PROTECT Grants (discretionary)

| | |
|----------------------|--|
| Purpose | Planning, resilience improvements, community resilience and evacuation routes, and at-risk coastal infrastructure |
| Funding | \$1.4 B (FY 22-26) in Contract Authority from the HTF |
| Eligible entities | <ul style="list-style-type: none">• State (or political subdivision of a State)• MPO• Local government• Special purpose district or public authority with a transportation function• Indian Tribe• Federal land management agency (applying jointly with State(s))• <i>Different eligibilities apply for at-risk coastal infrastructure grants</i> |
| Eligible projects | <ul style="list-style-type: none">• Highway, transit, intercity passenger rail, and port facilities• Resilience planning activities, including resilience improvement plans, evacuation planning and preparation, and capacity-building• Construction activities (oriented toward resilience)• Construction of (or improvement to) evacuation routes |
| Other key provisions | <ul style="list-style-type: none">• Higher Federal share if the eligible entity develops a resilience improvement plan (or is in a State or area served by MPO that does) and the State or MPO incorporates it into its long-range transportation plan• May only use up to 40% of the grant for construction of new capacity |



FUNDING OPPORTUNITIES

Nature Based Solutions, Ecological Restoration, Culverts

- FEMA Building Resilient Infrastructure and Communities (BRIC)
- National Coastal Resiliency Fund (NCRF) through National Fish and Wildlife Fund
- Natural Resources Conservation Service (NRCS) through the Cape Cod Conservation District
- Municipal Vulnerability Preparedness Program (MVP)
- Division of Ecological Restoration (DER) Culvert Replacement Municipal Assistance Grant Program