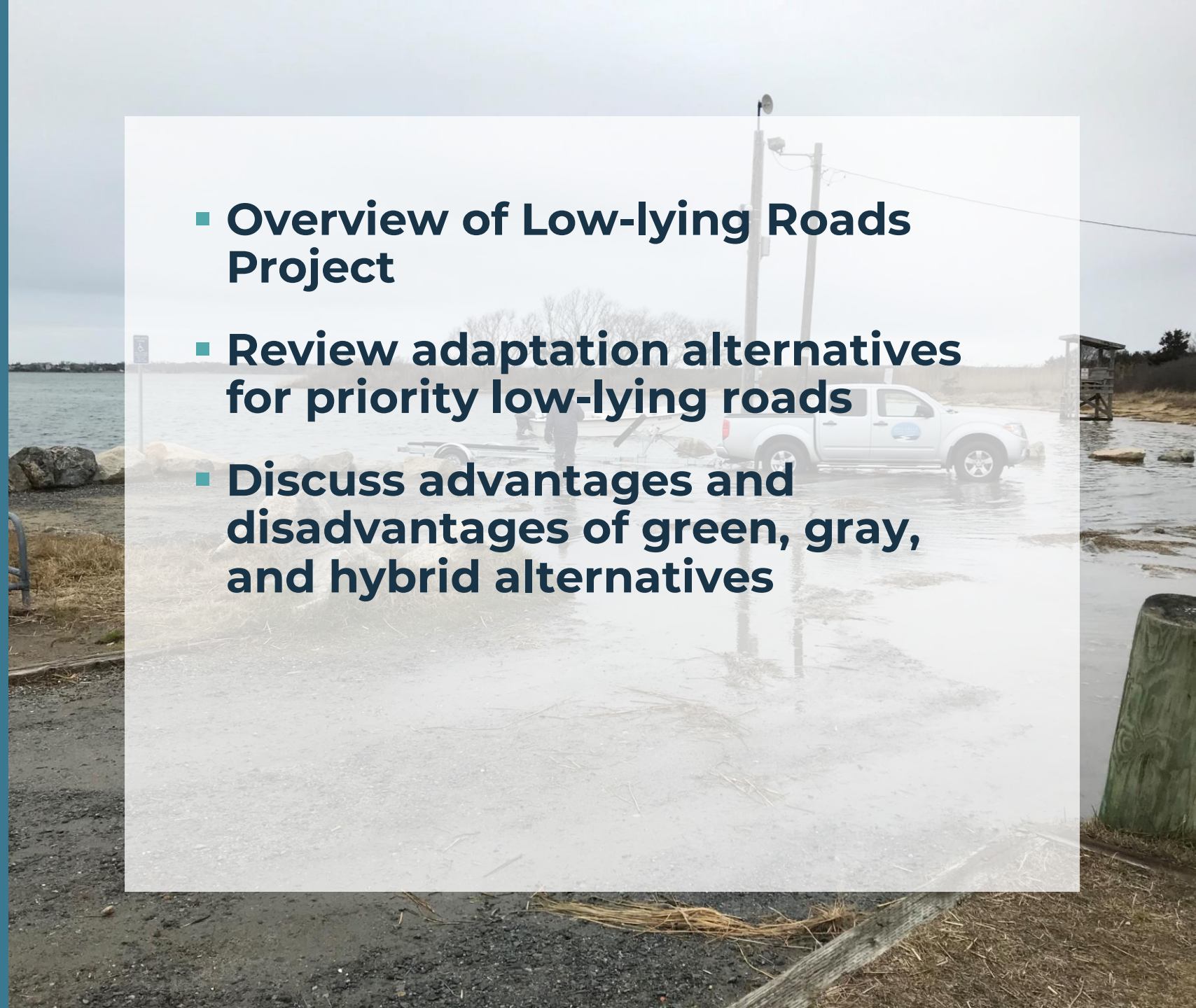
Low-lying Roads: Falmouth

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 – Heather McElroy, CCC and Joe Famely, WHG
- Presentation of conceptual design alternatives – Linnea Laux, WHG
  - Nashawena Street
  - Menauhant Road at Little Pond
- Questions, comments, and discussion
- Next Steps – Heather McElroy

Low-Lying Roads 2

5

TOWNS

Chatham
Falmouth
Harwich
Mashpee
Provincetown

- 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

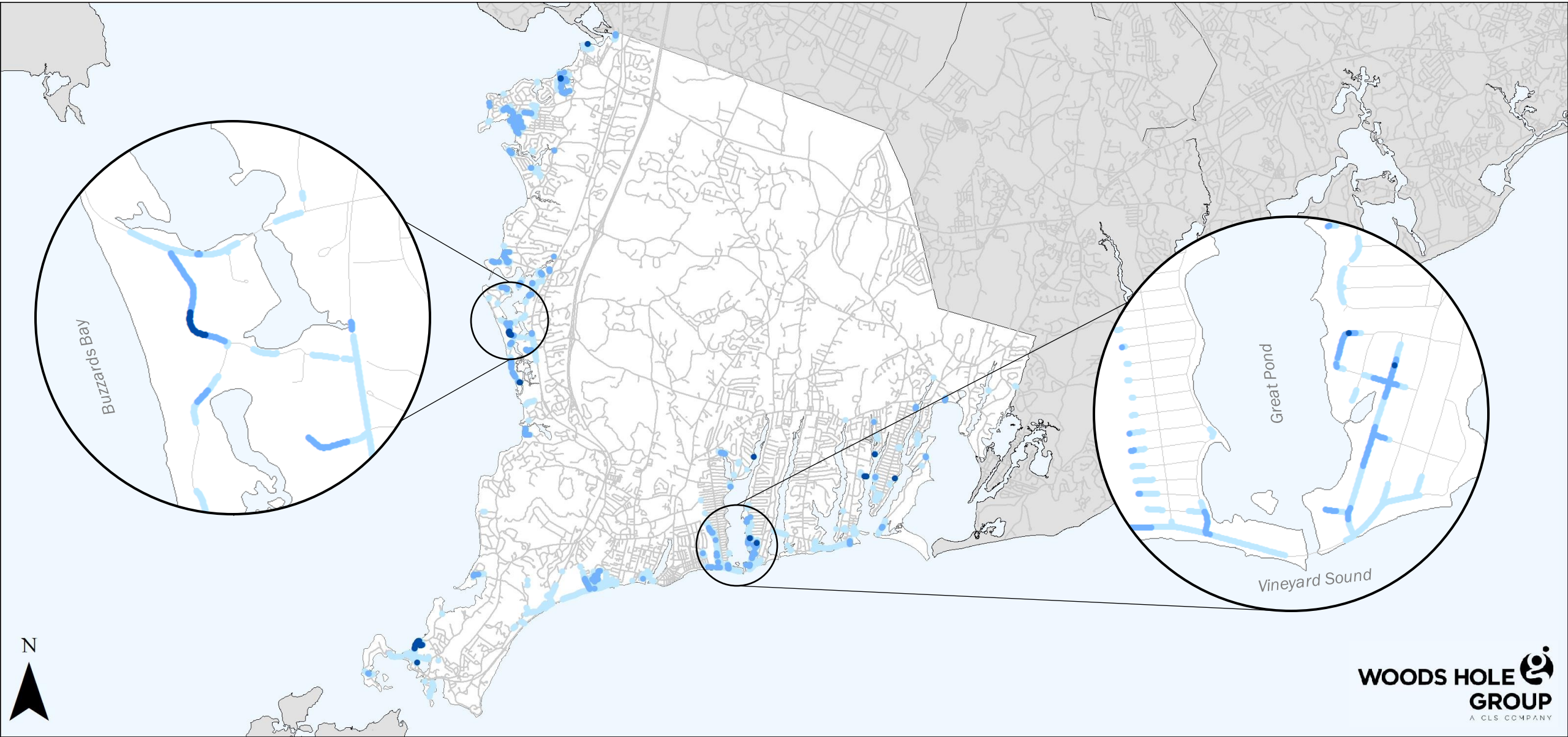
PROJECT TIMELINE & ELEMENTS

March 2023	April 2023	May 2023	Summer 2023	Spring 2024
Vulnerability Assessment: Roads and Bridges 3 Future Time Horizons - 2030, 2050, 2070	Criticality Assessment: Prioritize Roadway Segments	1st Workshop: Vulnerable & At-Risk Roads	Roadway analysis & solutions ID	2nd Workshop: Present alternatives

Additional Context & Information

- **Detailed information on webpages:** https://www.capecodcommission.org/our-work/low-lying-roads-project/
- **Format for meeting**

Low Lying Roads Nuisance Flooding

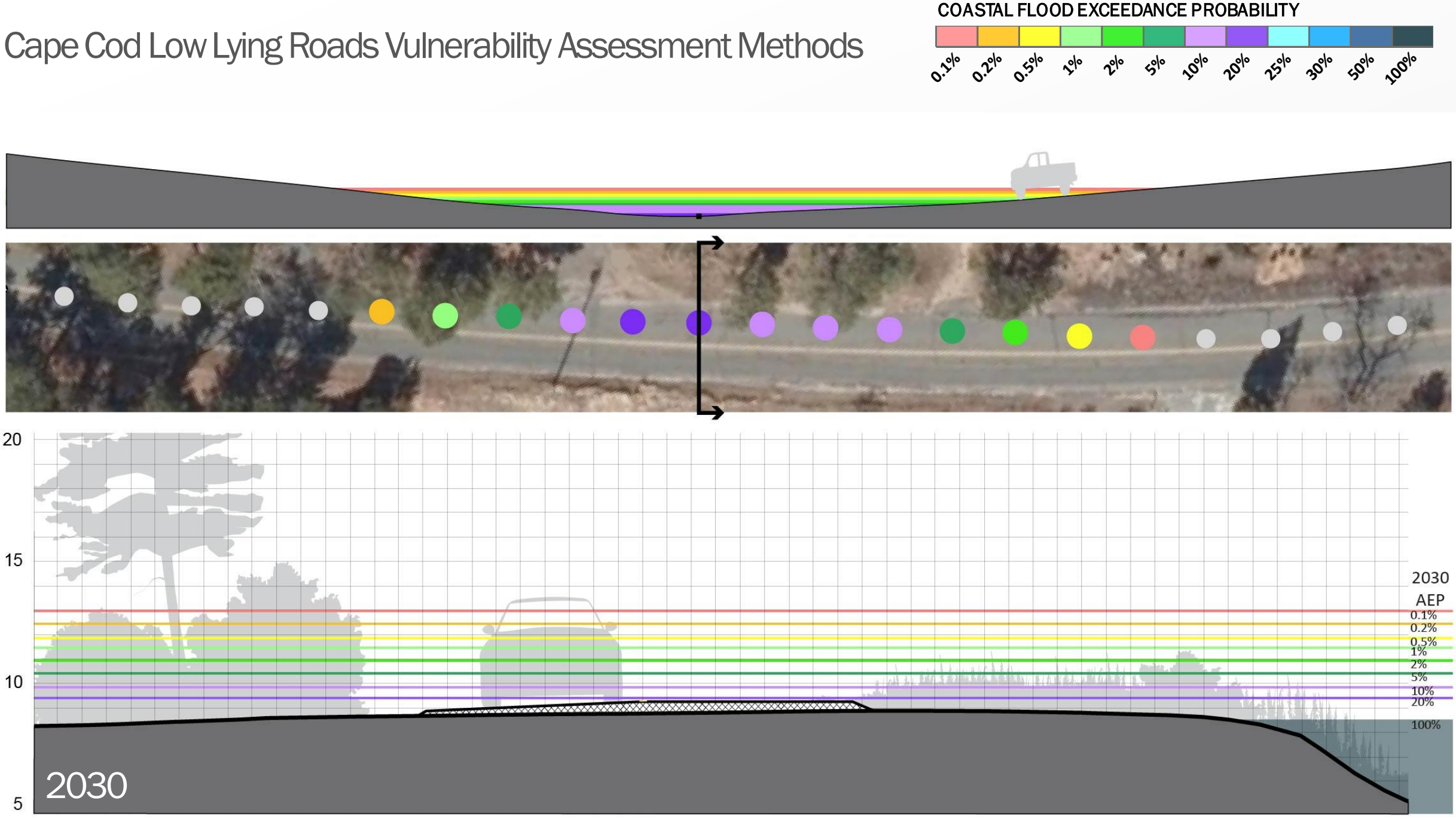


Cape Cod Low Lying Roads Vulnerability Assessment Methods

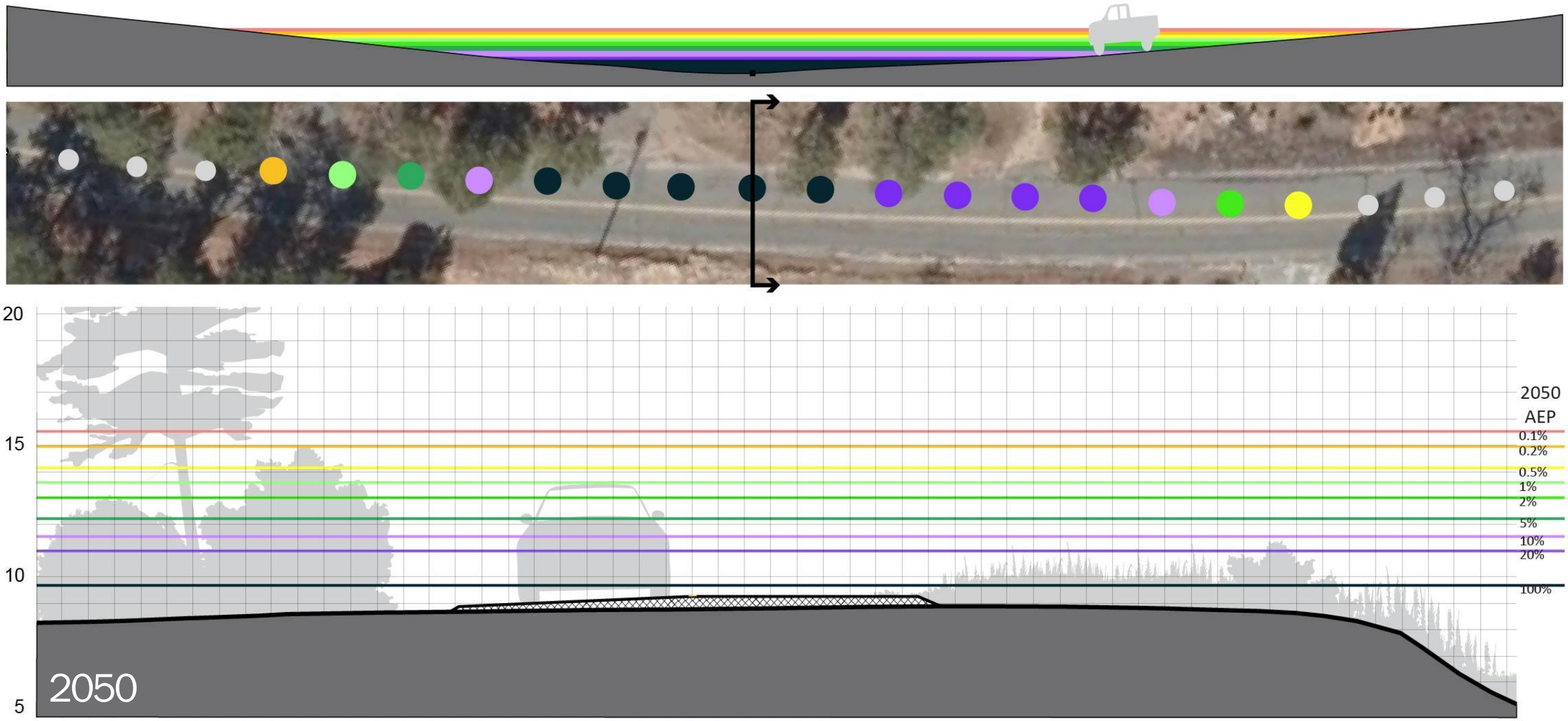
COASTAL FLOOD EXCEEDANCE PROBABILITY

0.1% 0.2% 0.5% 1% 2% 5% 10% 20% 25% 30% 50% 100%

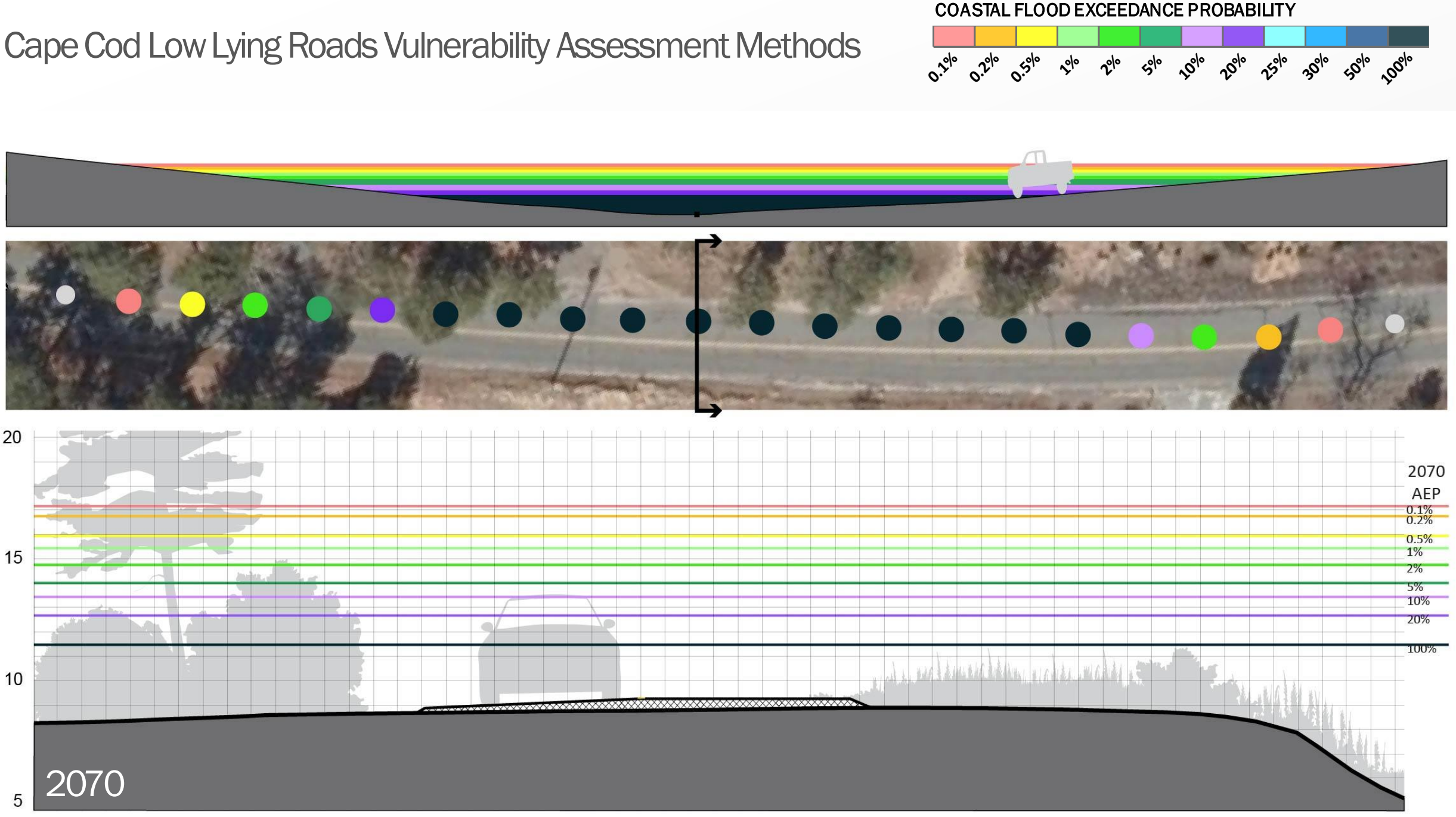
Cape Cod Low Lying Roads Vulnerability Assessment Methods



Cape Cod Low Lying Roads Vulnerability Assessment Methods

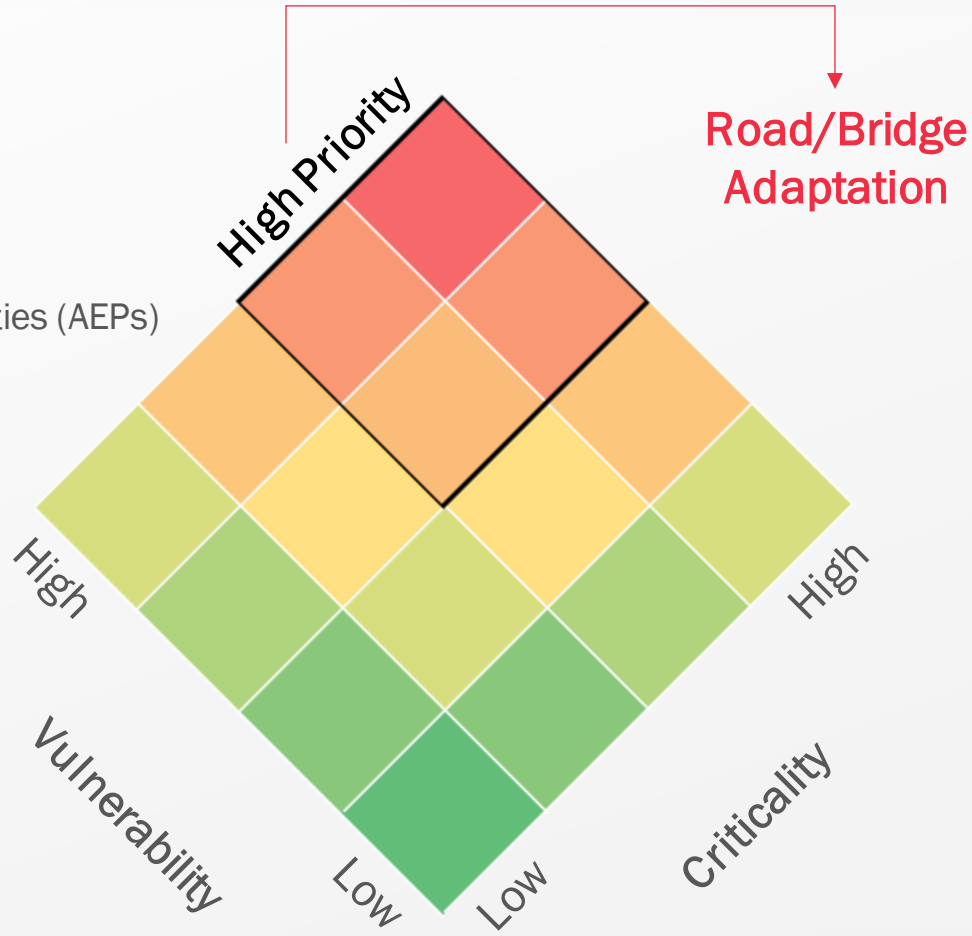


Cape Cod Low Lying Roads Vulnerability Assessment Methods

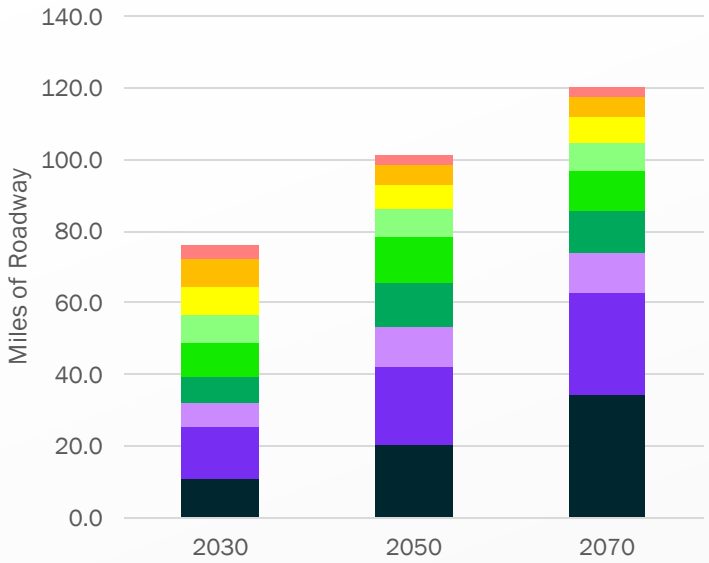


Cape Cod Low Lying Roads Risk Assessment Approach

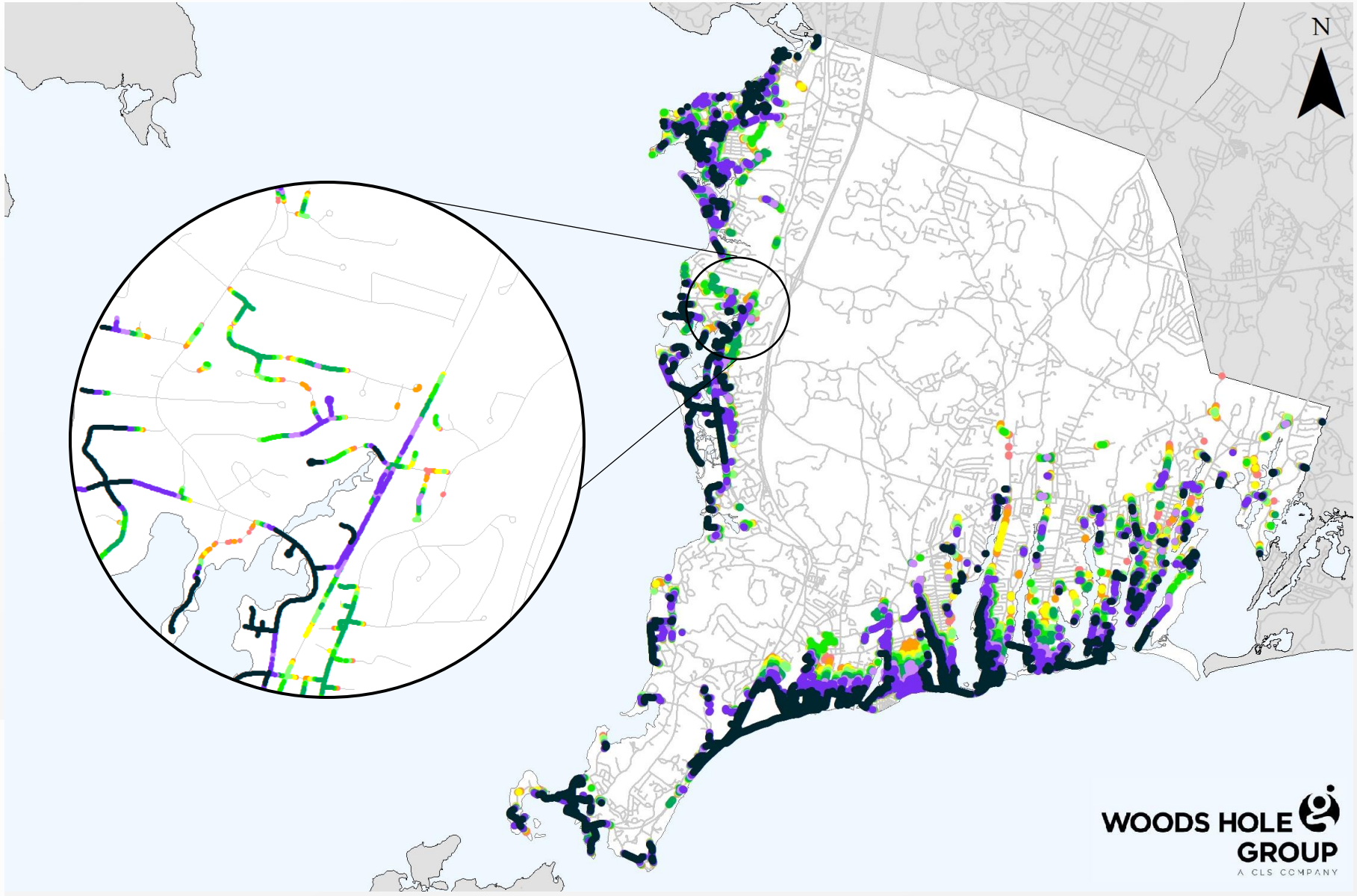
1. Extract roadway/bridge critical elevations (CEs)
   - From LiDAR at 20m interval along surface
2. Compile 2030/2050/2070 MC-FRM water surface elevations (WSEs)
   - 0.1%, 0.2%, 0.5%, 1%, 2%, 5%, 10%, 20%, 100% Annual Exceedance Probabilities (AEPs)
3. Compare CEs to WSEs to determine vulnerability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



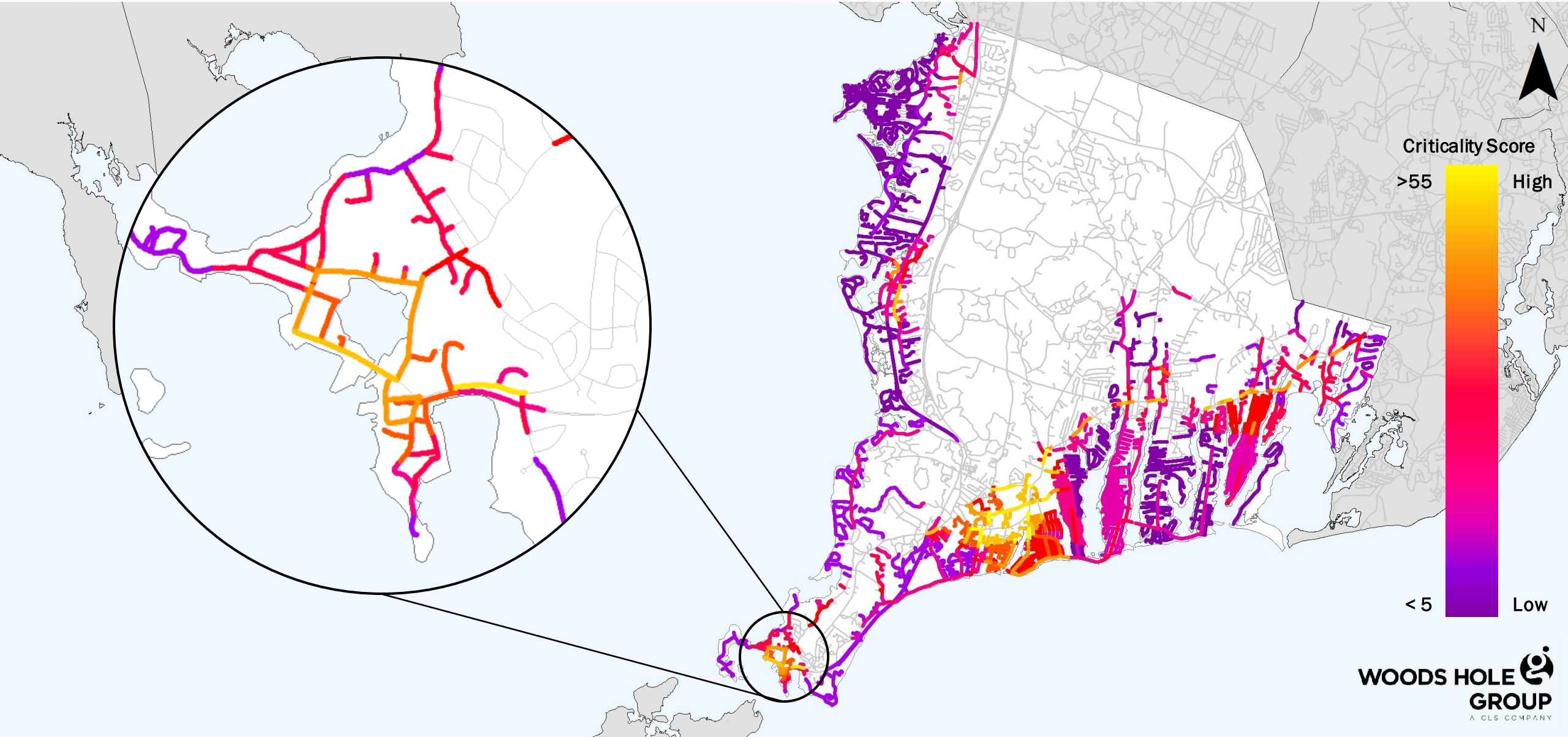
Low Lying Roads 2070 Flood Probability (Annual Exceedance Probability)



Flood Probability	Total Road Miles
0.1%	120.4
0.2%	117.7
0.5%	112.1
1%	104.9
2%	96.8
5%	85.4
10%	74.1
20%	62.4
100%	34.0



Low Lying Roads Criticality Scoring



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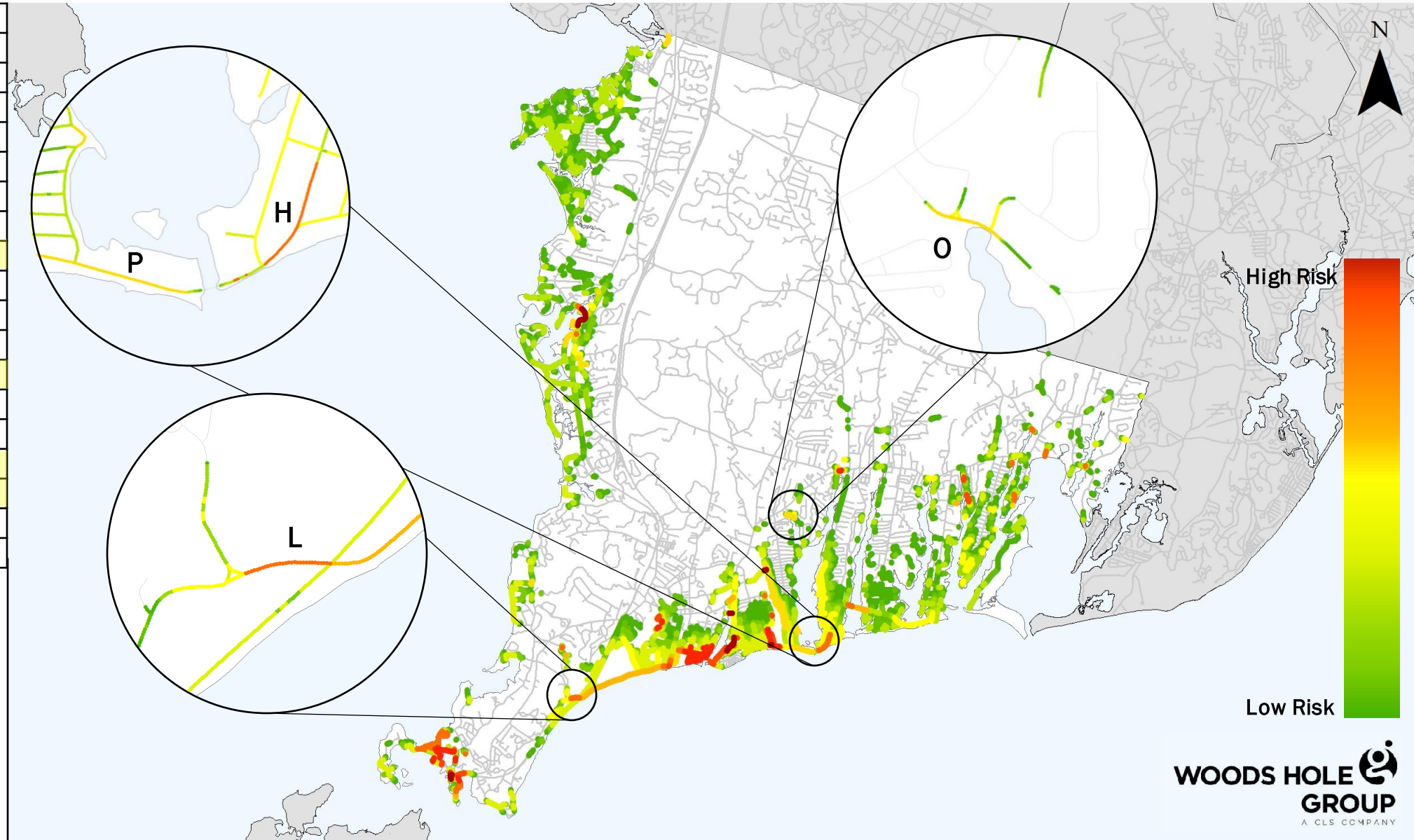
Low Lying Roads 2070 Risk Results

	High Risk Road Segments
A	Nashawena St
B	Millfield St West
C	Millfield St East
D	Clinton/Scranton Ave corner
E	Menauhant Rd at Little Pond
F	Jericho Path
G	Surf Dr East
H	Menauhant Rd at Acapesket Neck
I	Little Harbor Rd
J	Gardiner Rd
K	Gosnold Rd
L	Surf Dr West
M	Surf Dr Center
N	Menauhant Rd at Green Pond
O	Teaticket Path
P	Menauhant Rd at Great Pond
Q	Old Dock Rd
R	Garnet Ave



Summary of High Priority Road Segments

	Road Name	Length (ft)	Description	AEP 2030	Criticality Score		2030 Risk Score		Tidal Flooding Length (ft)		
									2030	2050	2070
A	Nashawena St	2140	along Snug Harbor	100	39		3900		0	180	1120
B	Millfield St West†	1520	west of Bell Tower including Spencer Baird Rd	100	38		3800		0	0	1400
C	Millfield St East†	480	east of Bell Tower to School St	100	38		3800		0	0	440
D	Clinton/Scranton Ave corner	1910	at Falmouth Harbor Entrance	100	35		3500		0	0	1300
E	Menauhant Rd at Little Pond	1200	behind Bristol Beach between Grand Ave and Maravista Ave	100	35		3500		0	540	1200
F	Jericho Path	500	at Little Pond between Lucerne Ave and Grand Ave	100	32		3200		0	20	340
G	Surf Dr East†	1310	corner of Surf Dr and Shore St at Town Beach	100	28		2800		0	0	440
H	Menauhant Rd at Acapesket Neck	1420	east of Great Pond Bridge to Bayview Ave	100	23		2300		0	0	900
I	Little Harbor Rd†	650	behind USCG Woods Hole	100	22		2200		0	0	460
J	Gardiner Rd†	1140	between Gosnold Rd and Park St	100	22		2200		360	480	1100
K	Gosnold Rd†	770	behind Stoney Beach	100	22		2200		0	0	440
L	Surf Dr West†	2090	between Oyster Pond Rd and Elm Rd	100	22		2200		0	0	1180
M	Surf Dr Center†	3820	along Salt Pond between Elm Rd and Bywater Ct	100	19		1900		0	20	4220
N	Menauhant Rd at Green Pond	1320	bridge between Acapesket Rd and Green Harbor Rd	100	17		1700		0	0	720
O	Teaticket Path	500	at top of Perch Pond between Norris Path and Seabrook Dr	100	17		1700		0	340	540
P	Menauhant Rd at Great Pond	1420	west of Great Pond Bridge to Maravista Ave	100	17		1700		0	40	1160
Q	Old Dock Rd	1260	by West Falmouth Harbor landing	100	17		1700		0	260	580
R	Garnet Ave	630	along Squeteague Harbor at Bourne line	100	17		1700		0	160	520

†Existing planning work underway

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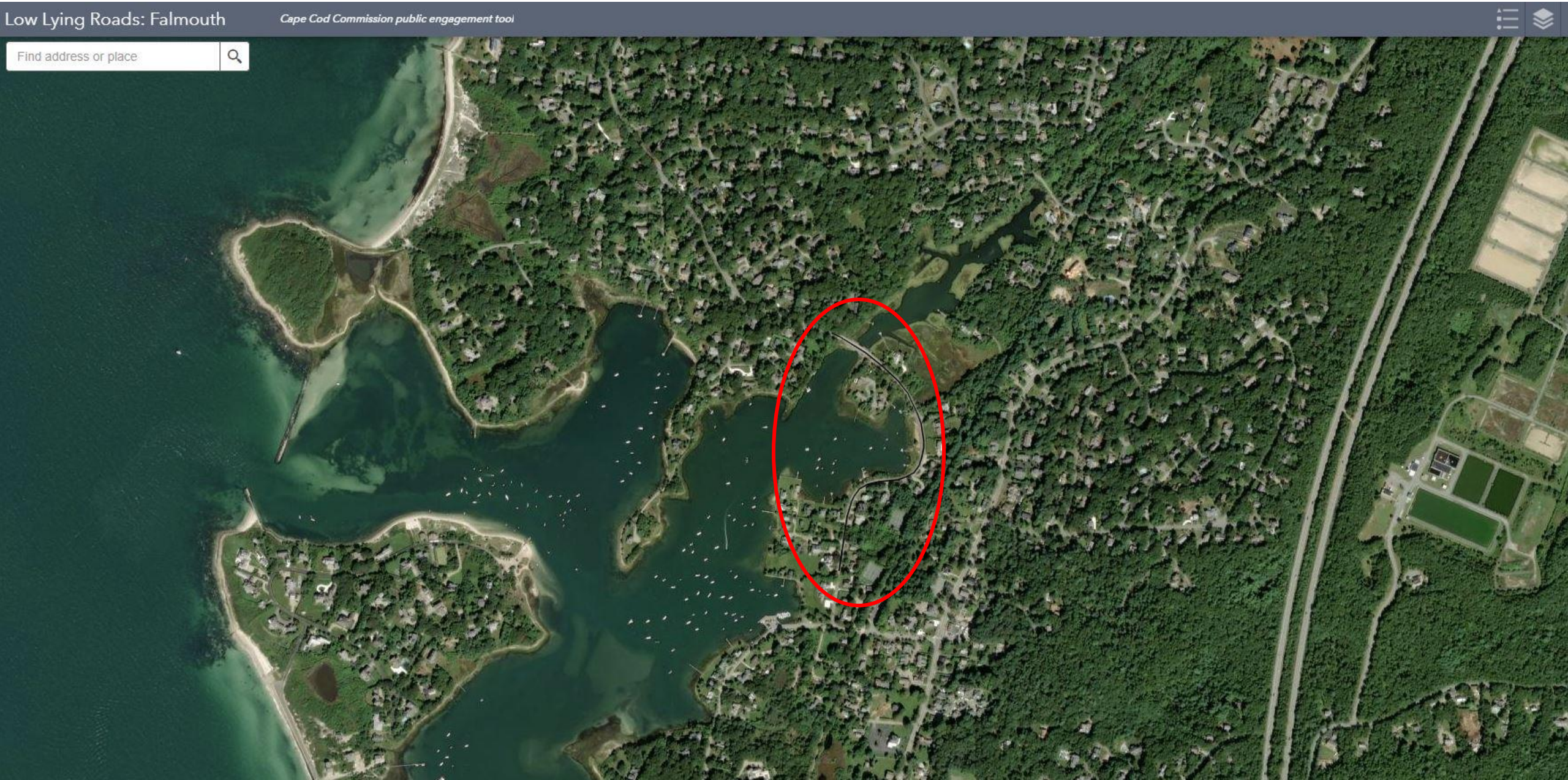
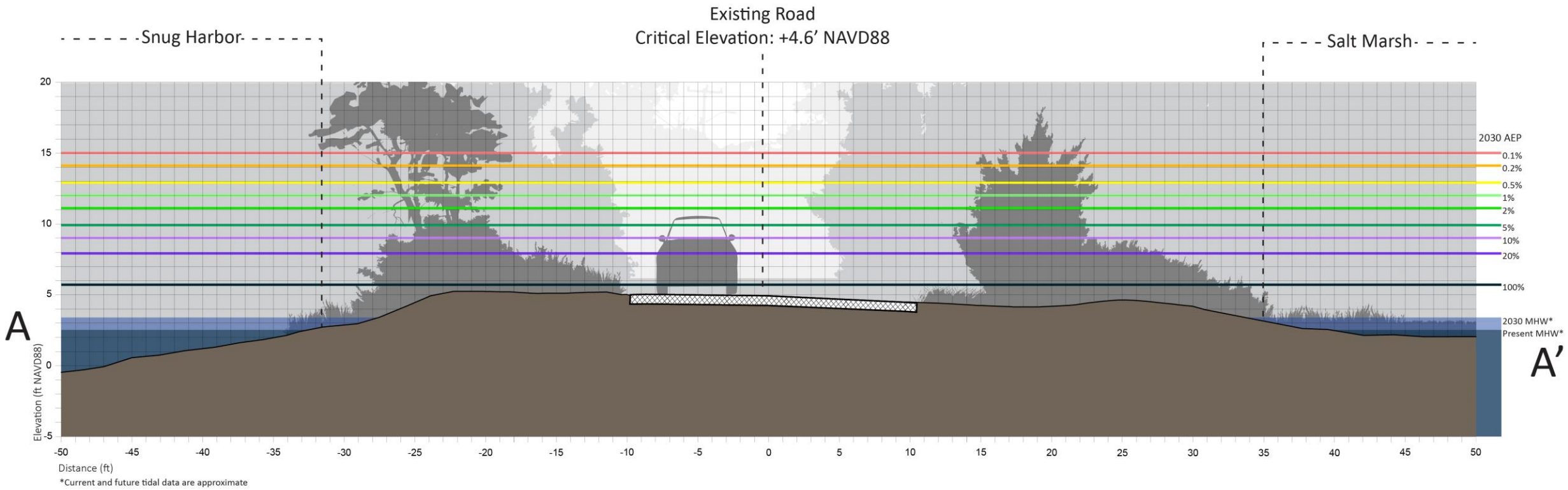
Nashawena Street





EXISTING CONDITIONS

Nashawena Street, Falmouth

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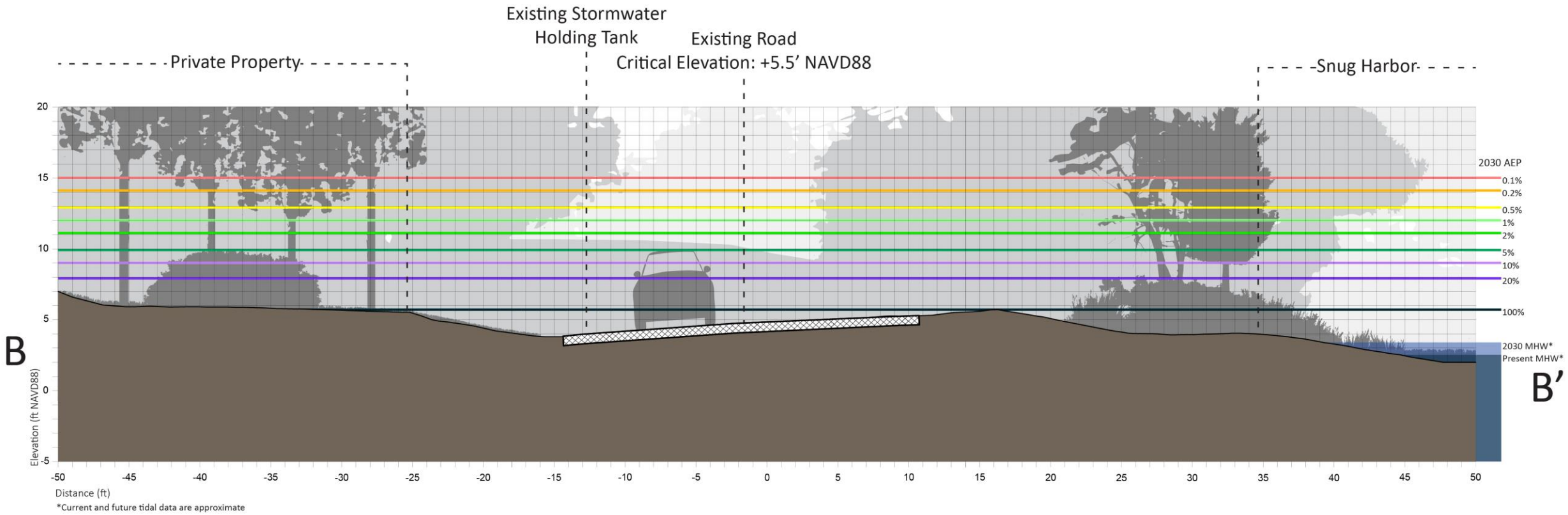

EXISTING CONDITIONS

Nashawena Street, Falmouth

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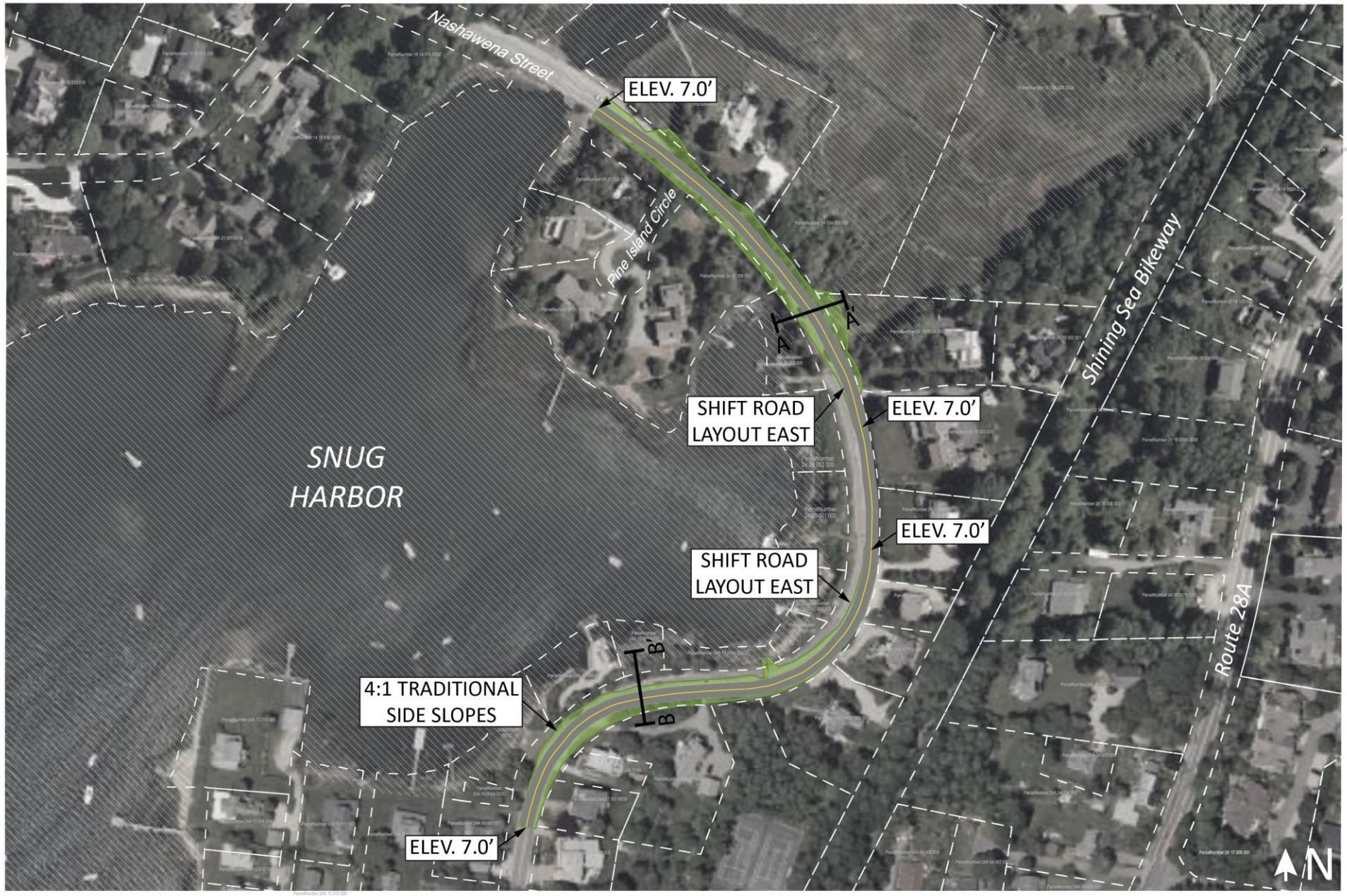

Note: Project overlap with wetland areas, rights of way and property lines is approximate and needs confirmation with a site survey

Nashawena Street
FALMOUTH

ALTERNATIVE 1: GRAY

1350 linear feet of town-owned road are elevated from a lowest point of +4.6' NAVD88 to a lowest point of +7.0' NAVD88 using 4:1 traditionally vegetated side slopes. The road layout is shifted eastward to take advantage of higher elevation areas already within the road layout. Short segments of sheet pile may be necessary to avoid impacts to wetlands. This elevation accommodates a variety of bank angles or a flat roadway.

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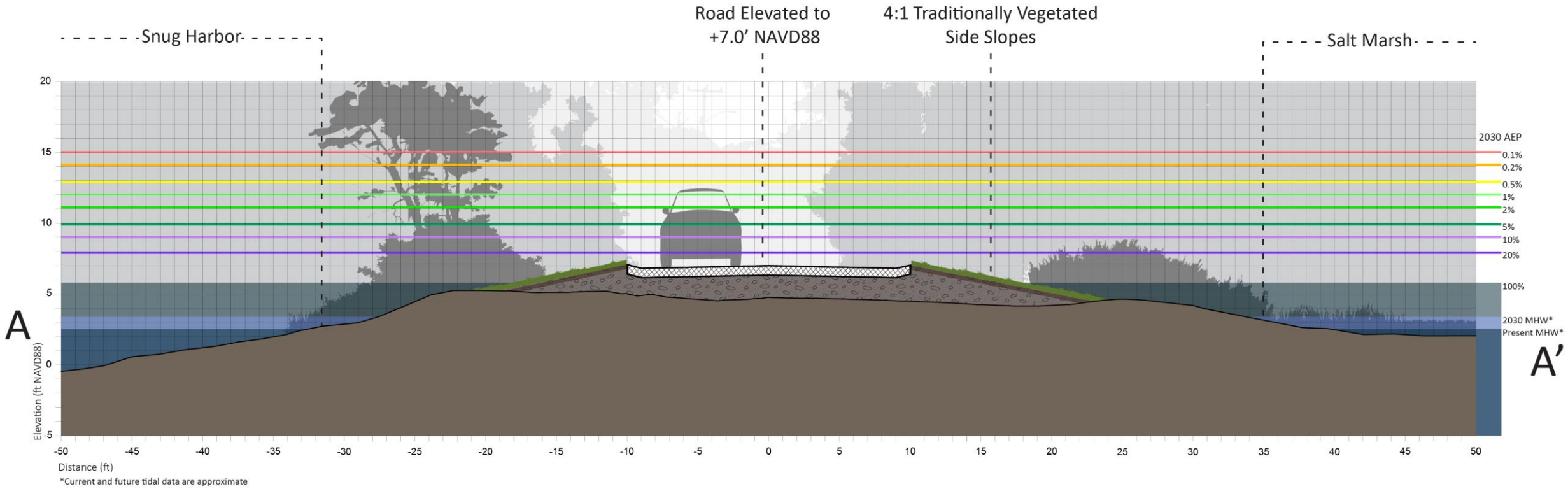

ALTERNATIVE 1: GRAY

Nashawena Street, Falmouth

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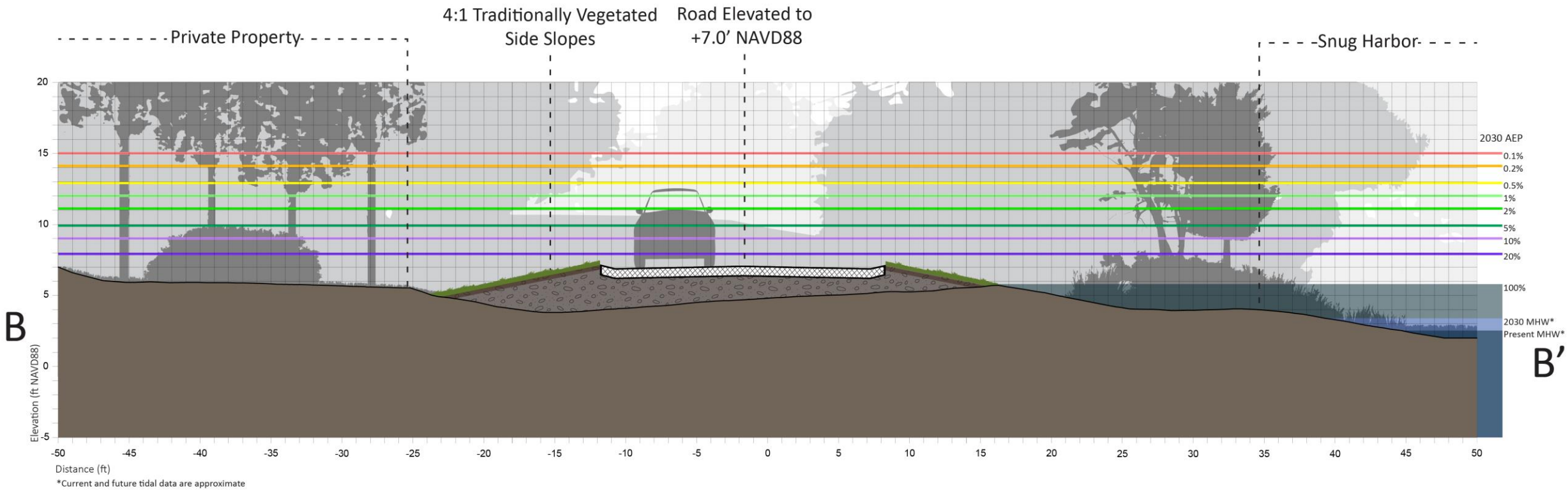

ALTERNATIVE 1: GRAY

Nashawena Street, Falmouth

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Nashawena Street
FALMOUTH

ALTERNATIVE 2: HYBRID

600 linear feet of town-owned road are elevated from a lowest point of +4.6' NAVD88 to a lowest point of +7.0' NAVD88 using 4:1 native vegetated side slopes. The road layout is shifted eastward to take advantage of higher elevation areas already within the road layout. In the southern segment of the road, a small flood wall and berm meet the critical elevation of +7.0' NAVD88.

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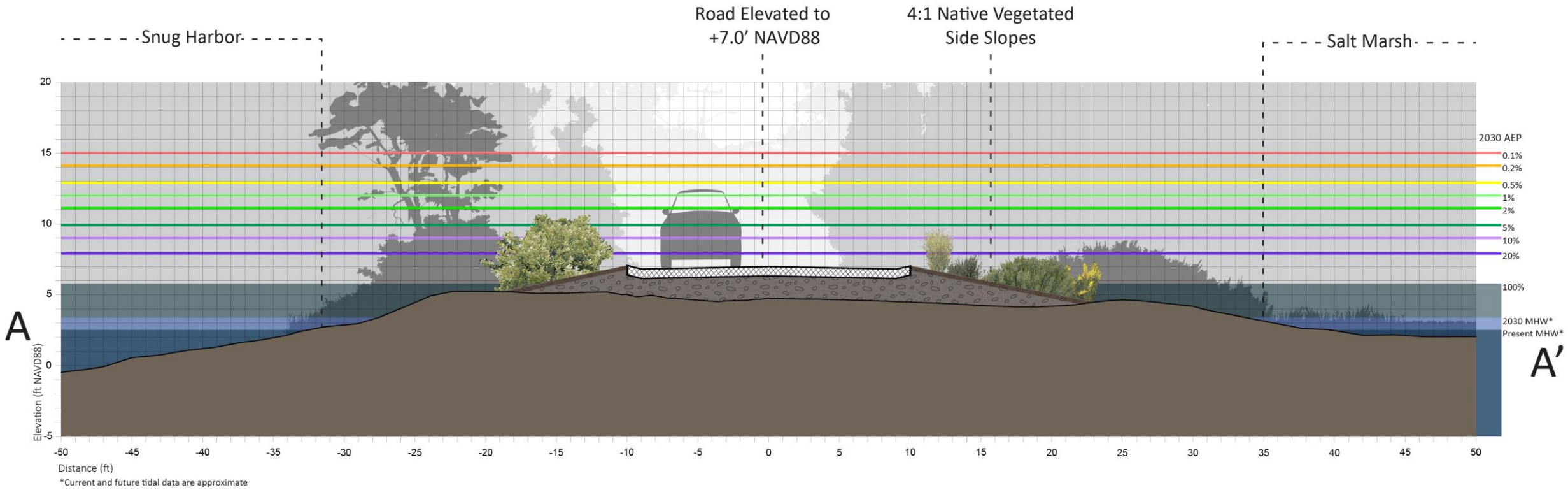

*Current and future tidal data are approximate

ALTERNATIVE 2: HYBRID

Nashawena Street, Falmouth

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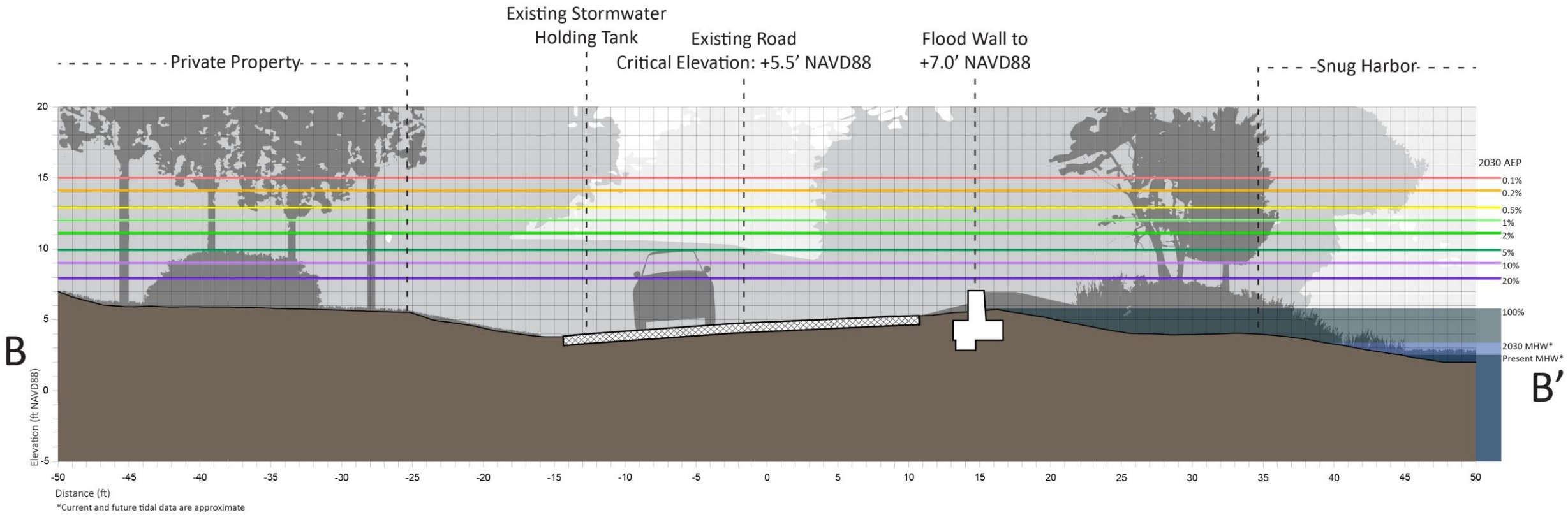

ALTERNATIVE 2: HYBRID

Nashawena Street, Falmouth

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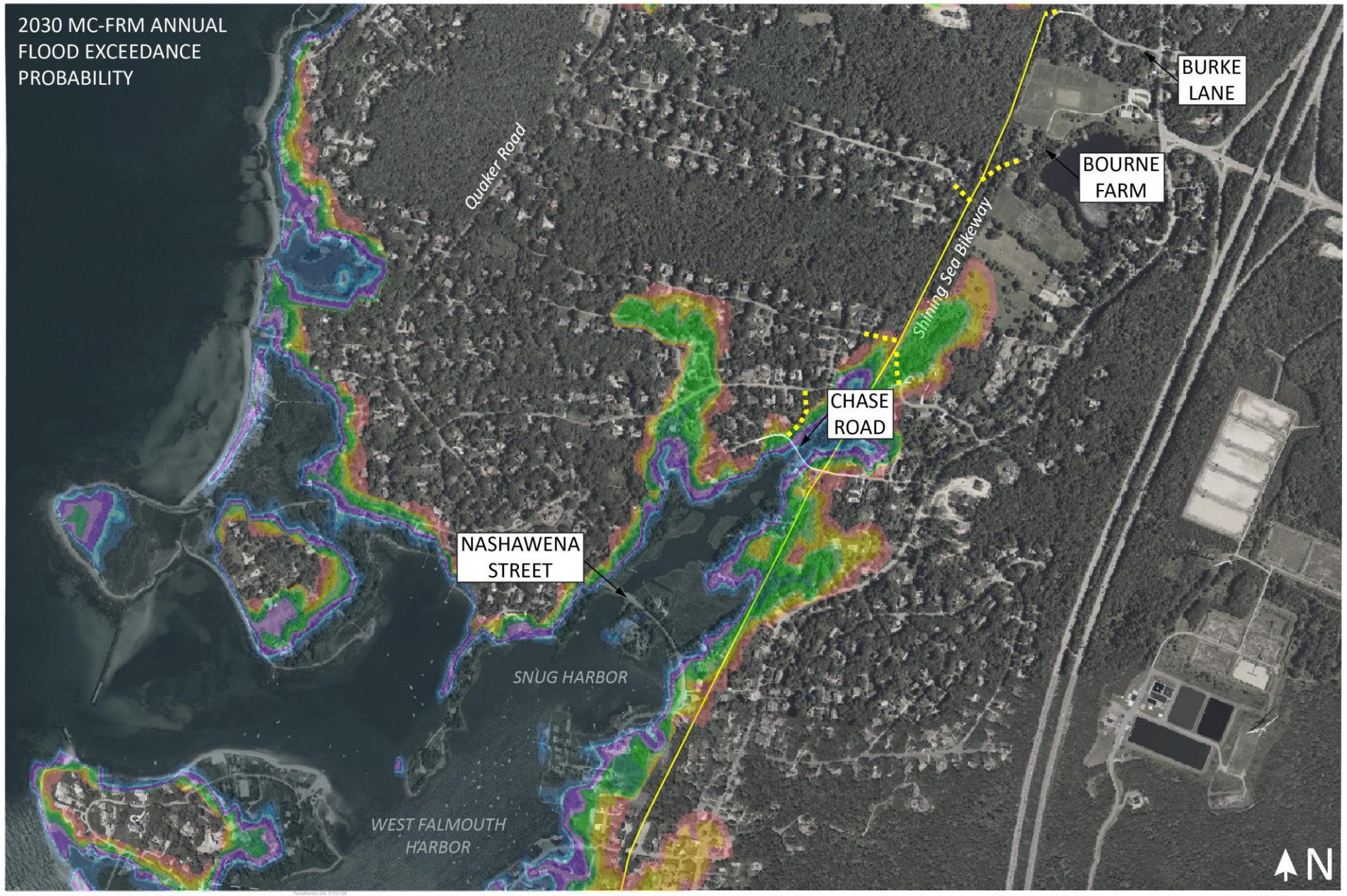

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Nashawena Street
FALMOUTH

ALTERNATIVE 3: REROUTING

Alternate emergency access routes to residential areas between Old Silver Beach and West Falmouth Harbor are established. Possible higher elevation access routes include Chase Road (with adaptations), and the Shining Sea Bikeway (if connections are established to roads to the east and west). If an alternate access road were successfully implemented, the neighborhood could be accessed during all storm conditions.

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NASHAWENA STREET, FALMOUTH

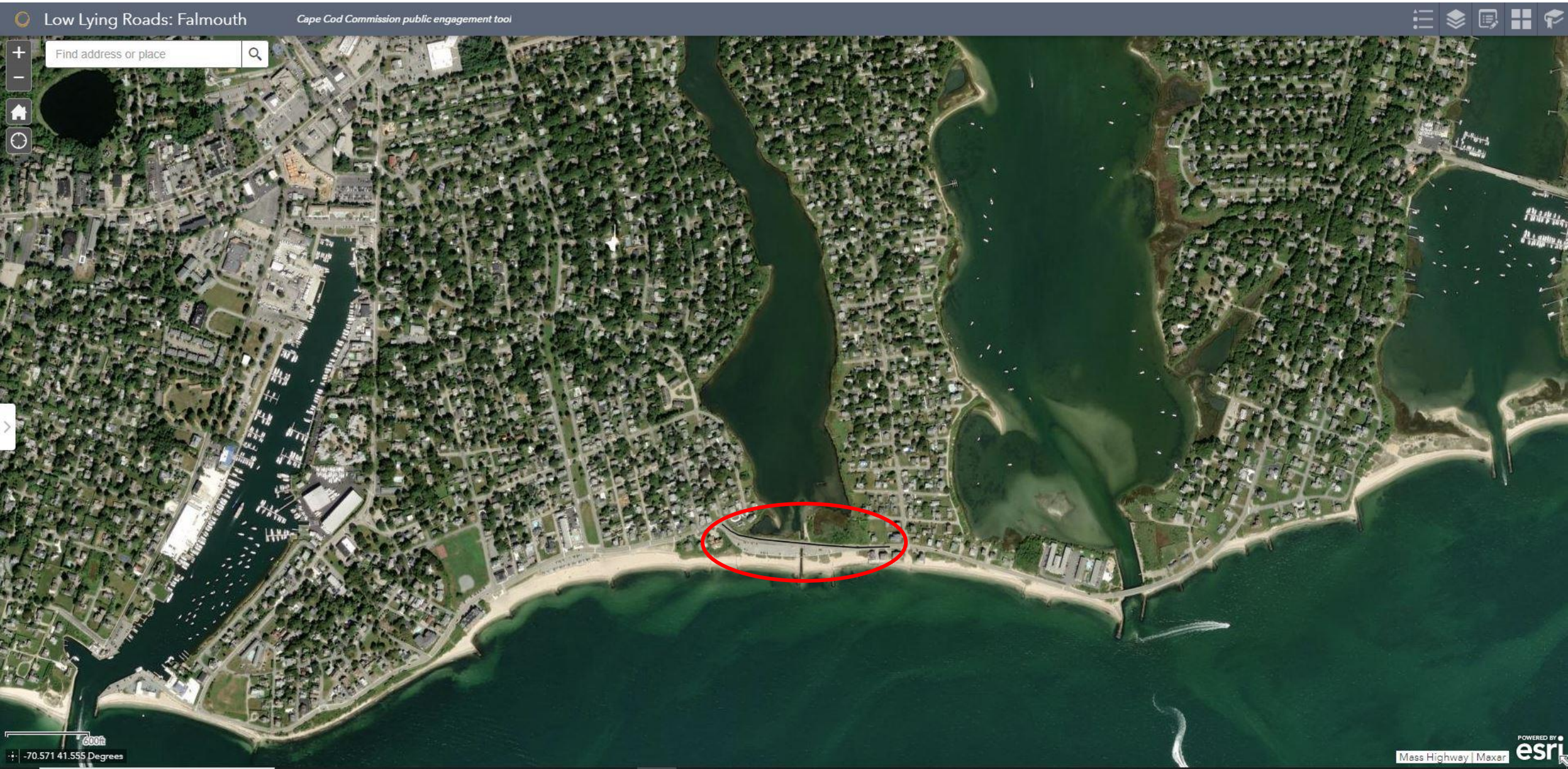
Summary of alternatives

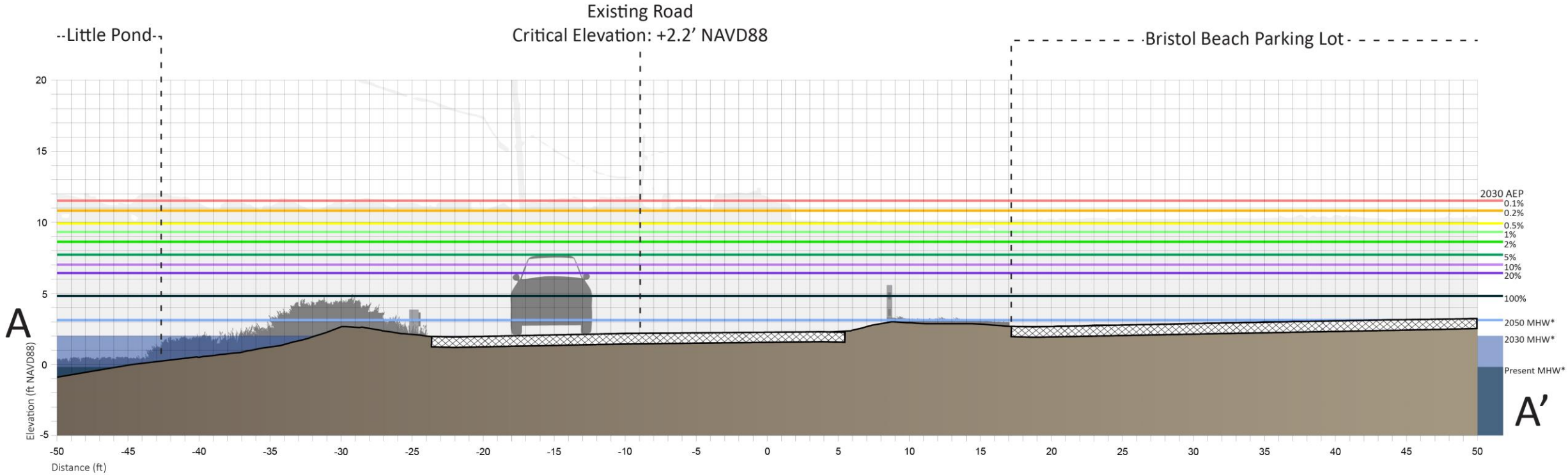
	Description	Critical Elevation (NAVD88)	Annual Exceedance Probability			Vulnerable to Tidal Flooding†	Permitability Concerns	Impacts to Private Property	Estimated Cost*
			2030	2050	2070				
EXISTING	A town-owned road next to a harbor and accessing a residential area.	4.6 feet	100%	100%	100%	2050	N/A	N/A	N/A
ALTERNATIVE 1: GRAY	1350 linear feet of town-owned road are elevated from a lowest point of +4.6' NAVD88 to a lowest point of +7.0' NAVD88 using 4:1 traditionally vegetated side slopes. The road is shifted eastward to take advantage of higher elevation.	7.0 feet	20%	100%	100%	No	Potential for wetland impacts	Minimal	$508,000
ALTERNATIVE 2: HYBRID	600 linear feet of town-owned road are elevated from a lowest point of +4.6' NAVD88 to a lowest point of +7.0' NAVD88 using 4:1 native vegetated side slopes. In the southern segment of the road, a small flood wall and berm meet the critical elevation of +7.0' NAVD88.	7.0 feet	20%	100%	100%	No	Potential for wetland impacts	Minimal	$540,000
ALTERNATIVE 3: REROUTING	One or more alternate access routes is constructed to allow for emergency access to residential areas when Nashawena Street is flooded. Cost is based on the construction of 200 feet of gravel road.	TBD	as low as 0%	as low as 0%	as low as 0%	No	Routing through private property and/or conservation land	Minimal-Moderate	$64,000

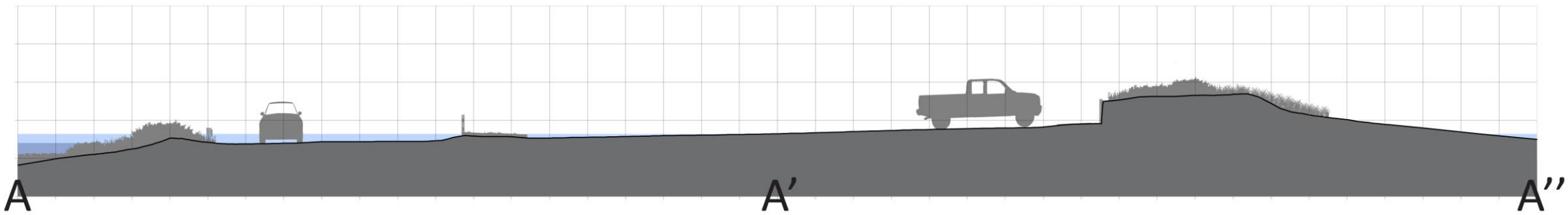
*2023 installed material cost +40% escalation (through 2029) and 15% contingency. Excludes design, permitting, mobilization, stormwater and wastewater infrastructure, and site controls. Costs based on experienced contractor opinion and MassDOT costing data.

†Future tidal data are approximate.

Menauhant Road







EXISTING CONDITIONS

Menauhant Road, Falmouth

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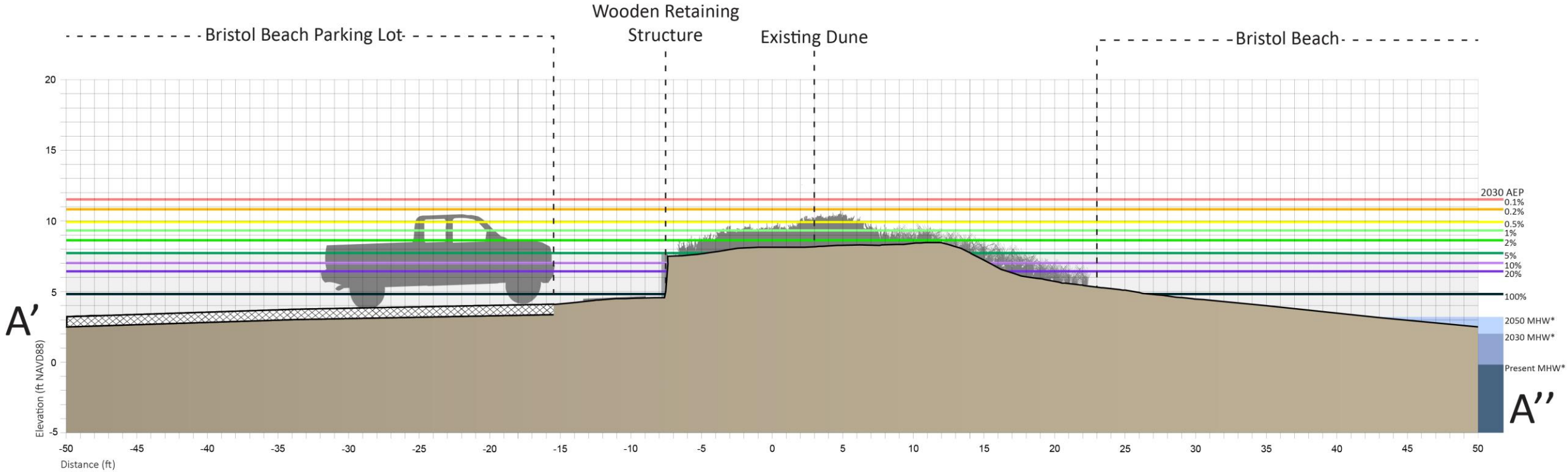

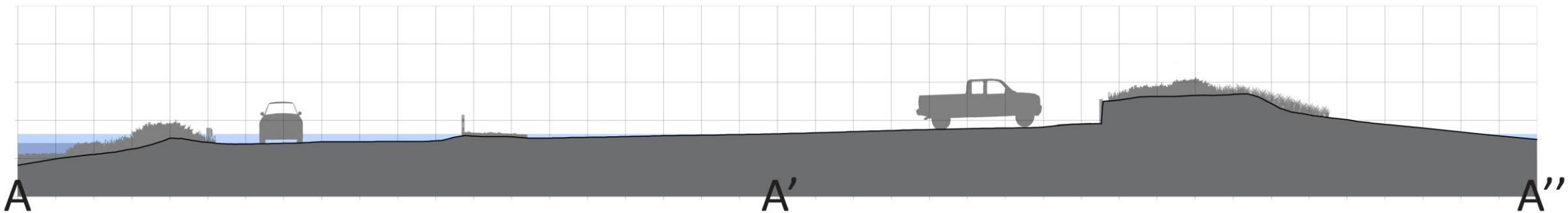

EXISTING CONDITIONS

Menauhant Road, Falmouth

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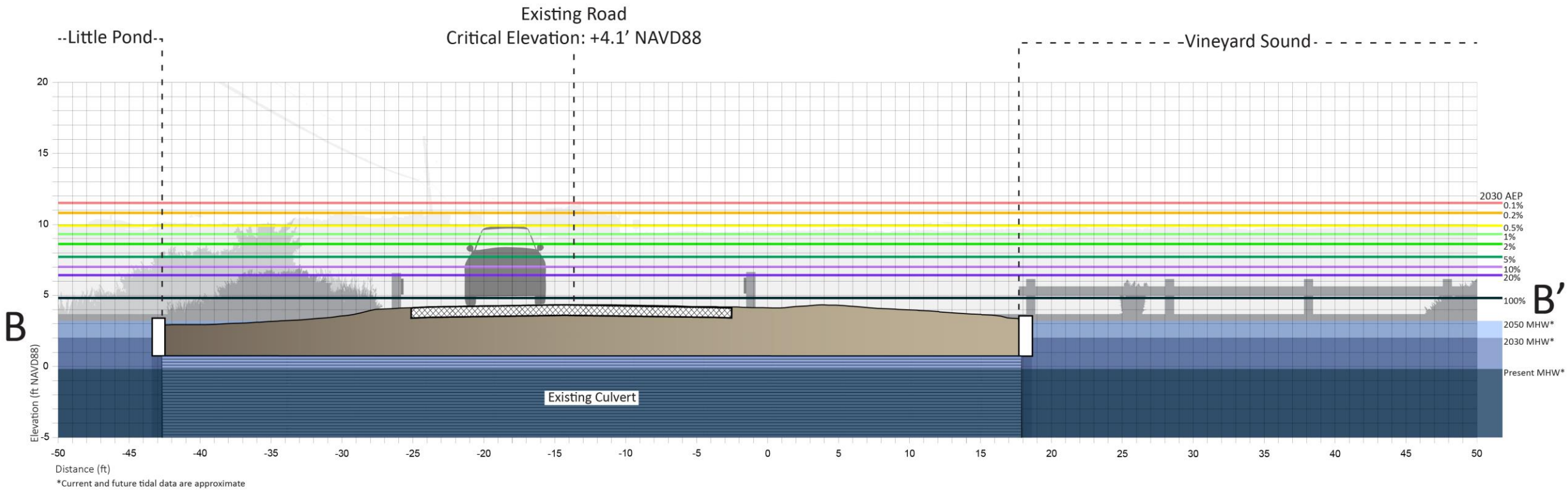

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EXISTING CONDITIONS

Menauhant Road, Falmouth

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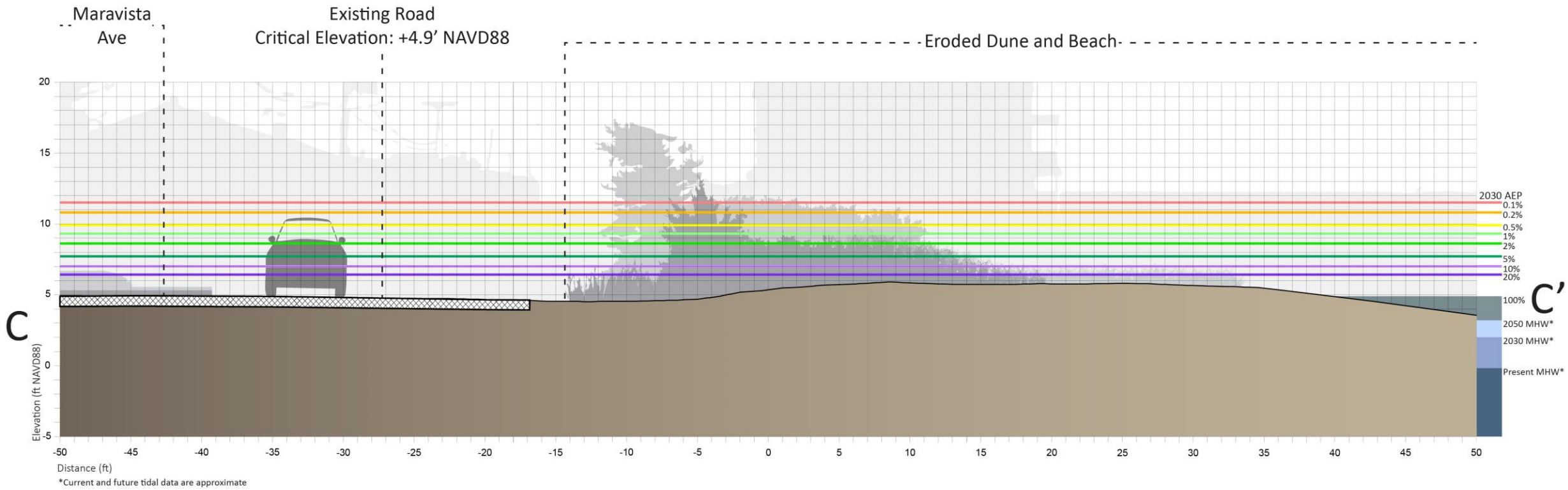

EXISTING CONDITIONS

Menauhant Road, Falmouth

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

Menauhant Road
FALMOUTH

ALTERNATIVE 1: GRAY

1810 linear feet of Town-owned road and parking lot are elevated to +6.0' NAVD88. The road is shifted south, and the parking lot is reconfigured to minimize loss of parking spaces. Space to the north of the road is used for a 4:1 side slope and large stormwater swale. The existing dune is backed by a soft retaining wall in order to minimize further erosion into the road.

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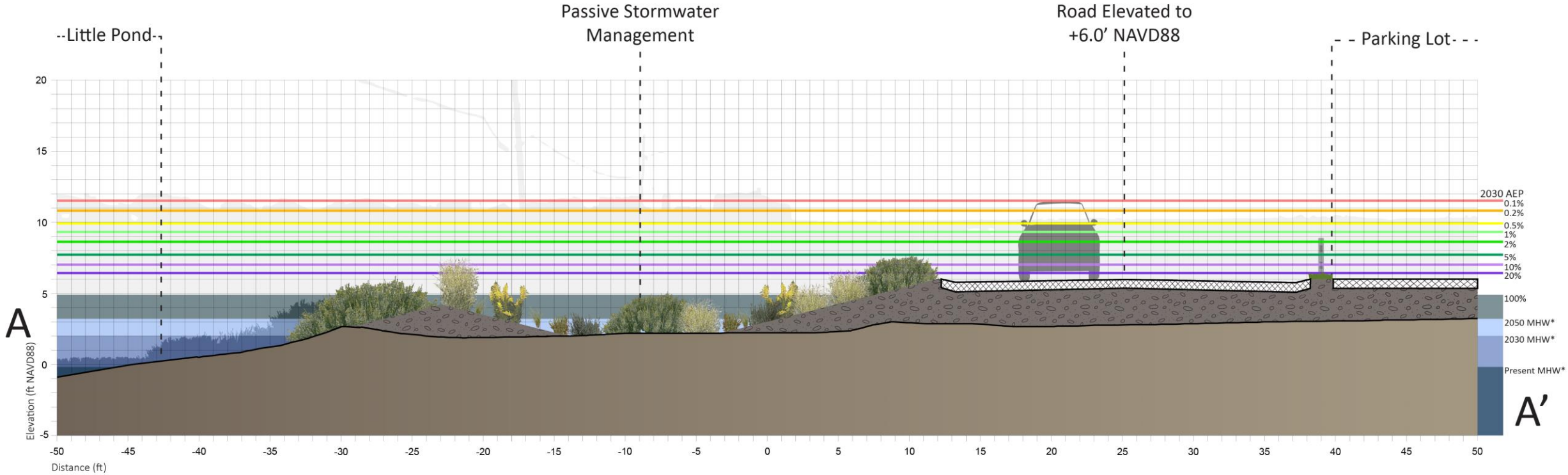

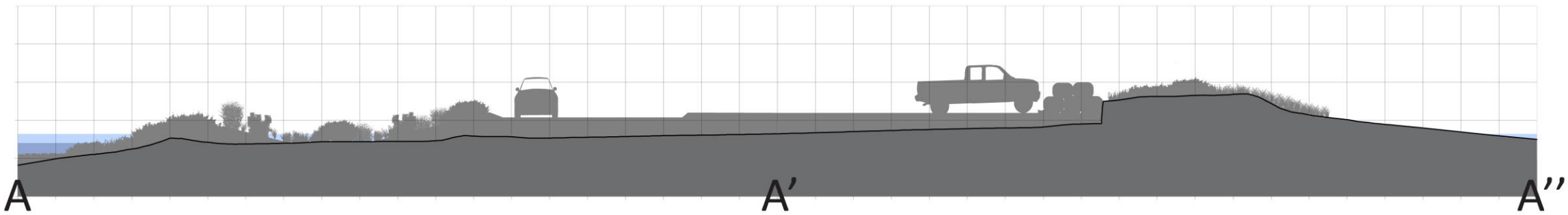

ALTERNATIVE 1: GRAY

Menauhant Road, Falmouth

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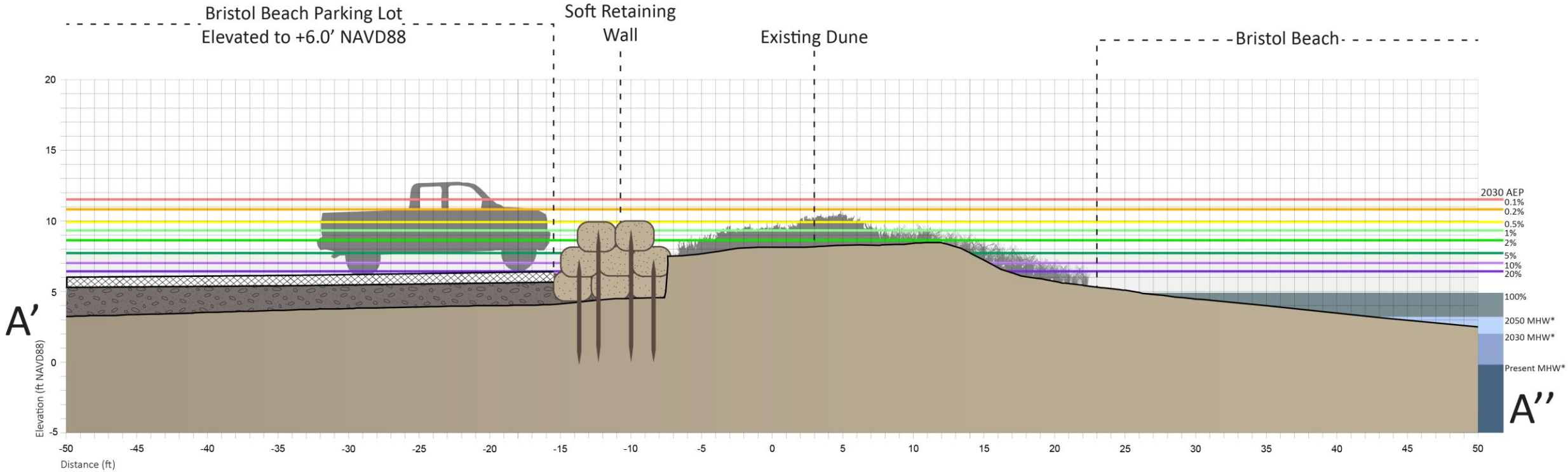

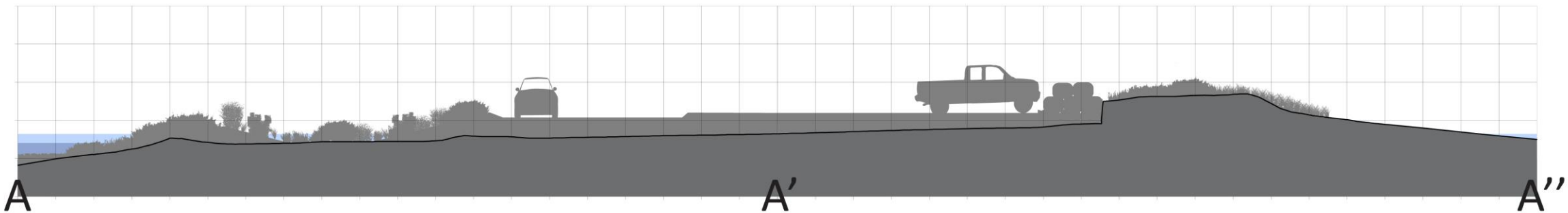

ALTERNATIVE 1: GRAY

Menauhant Road, Falmouth

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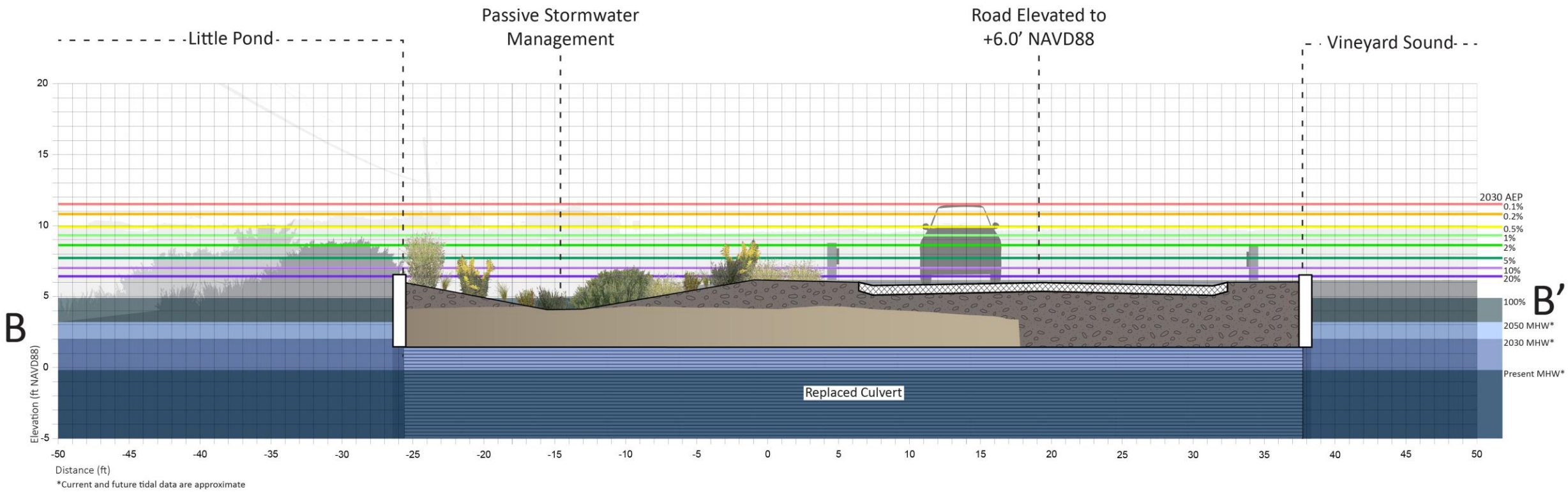

ALTERNATIVE 1: GRAY

Menauhant Road, Falmouth

WOODS HOLE GROUP
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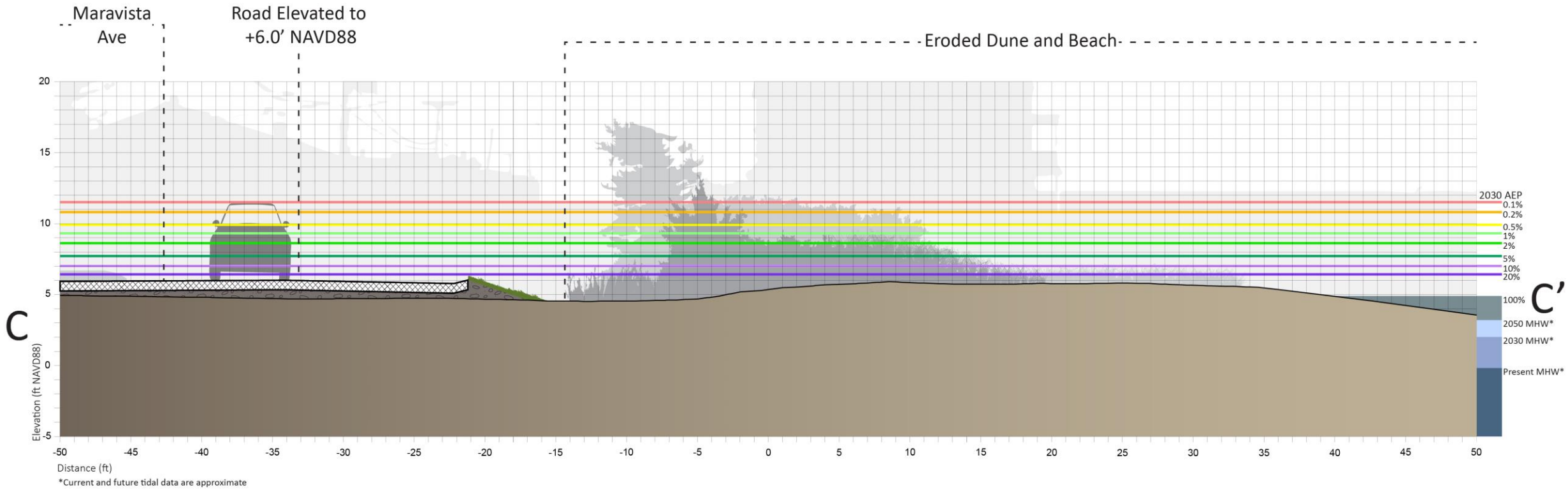

ALTERNATIVE 1: GRAY

Menauhant Road, Falmouth

WOODS HOLE GROUP
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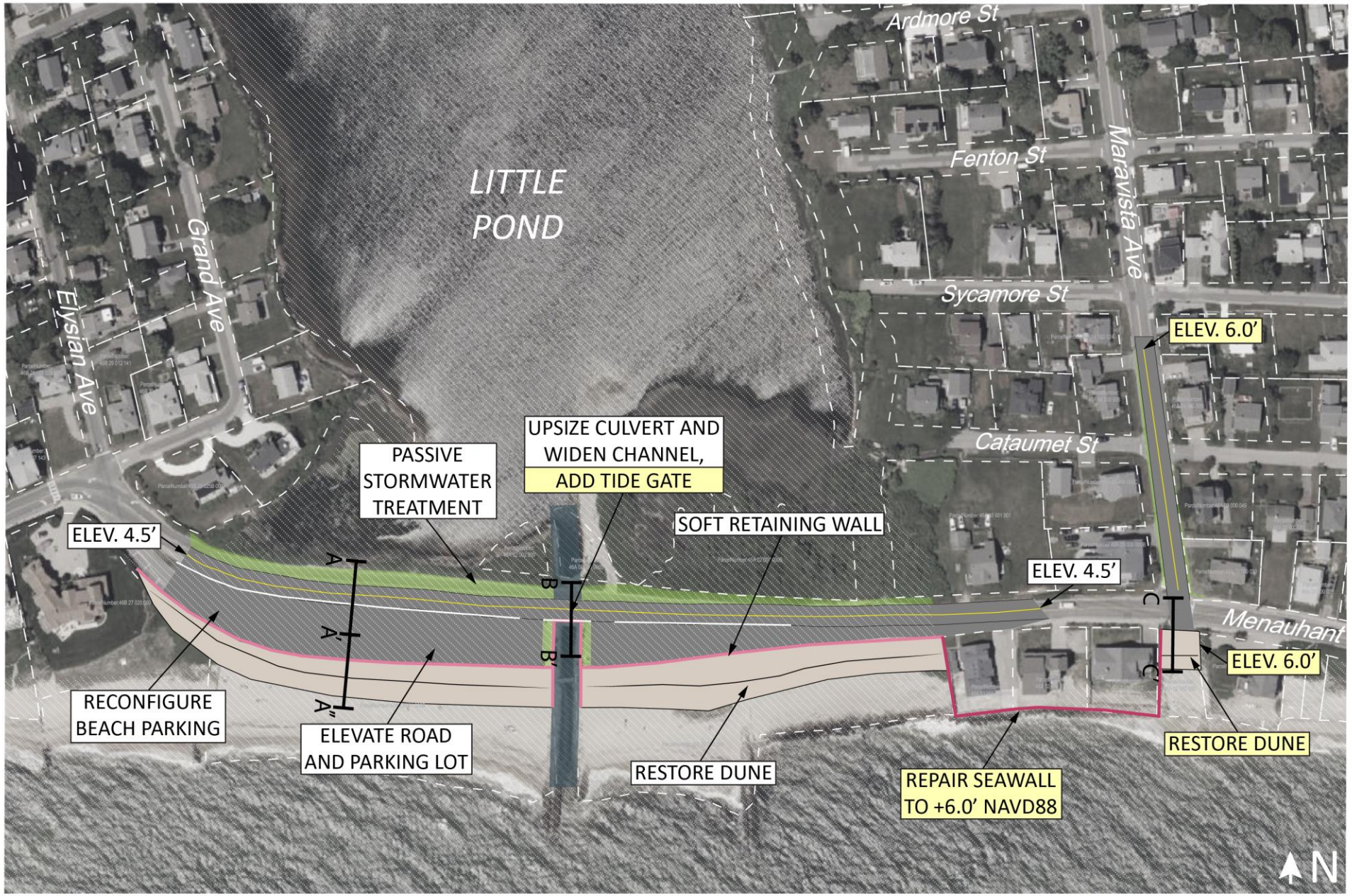

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Menauhant Road
FALMOUTH

ALTERNATIVE 2: HYBRID

1480 linear feet of Town-owned road and parking lot are elevated to +4.5' NAVD88. A dune restoration backed by a soft wall takes over some parking lot space, and the parking lot is reconfigured. Space to the north of the road and near the channel is used for a 4:1 side slope and passive stormwater treatment. The culvert is upsized and the channel is widened. Phase 2 would involve the raising of Maravista Ave, addition of a tide gate, and repair of private seawalls to bring the target elevation to +6.0' NAVD88.

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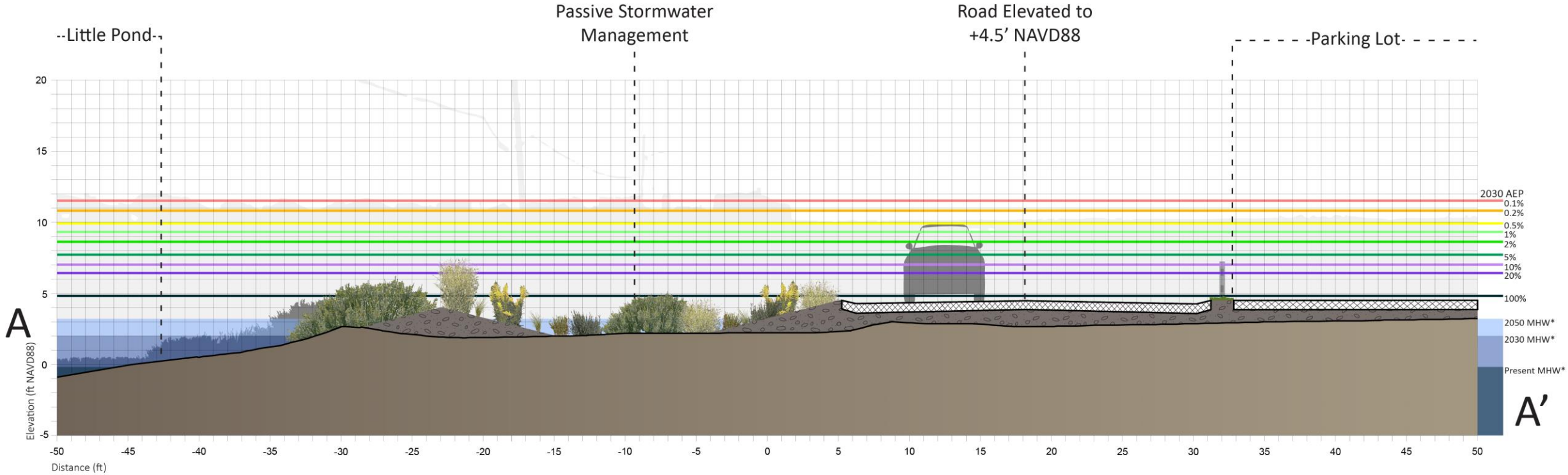

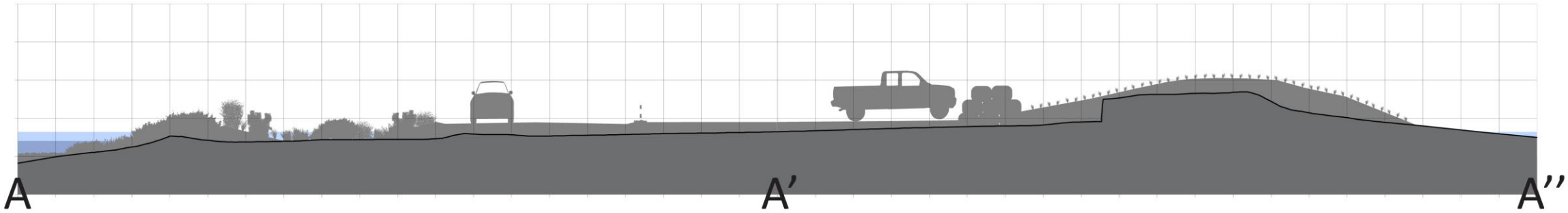

ALTERNATIVE 2: HYBRID

Menauhant Road, Falmouth

WOODS HOLE GROUP
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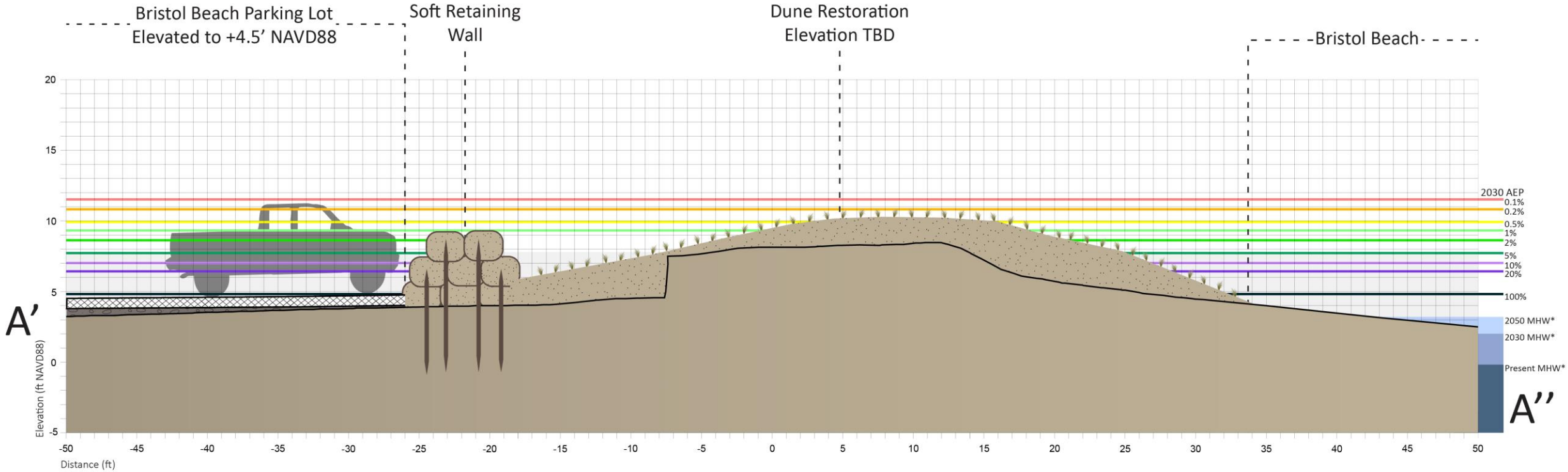

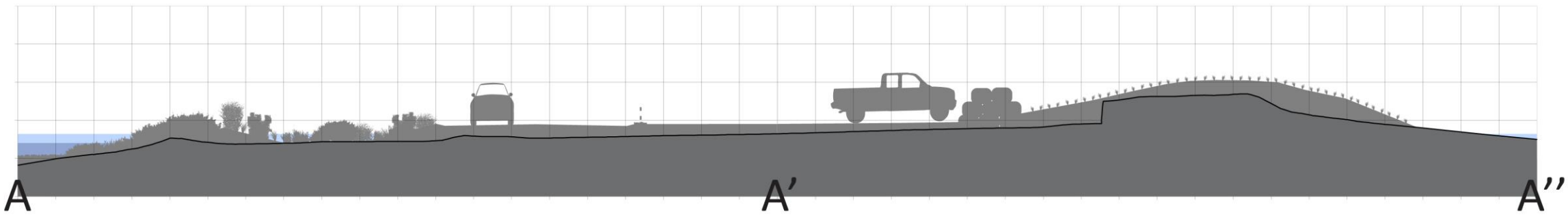

ALTERNATIVE 2: HYBRID

Menauhant Road, Falmouth

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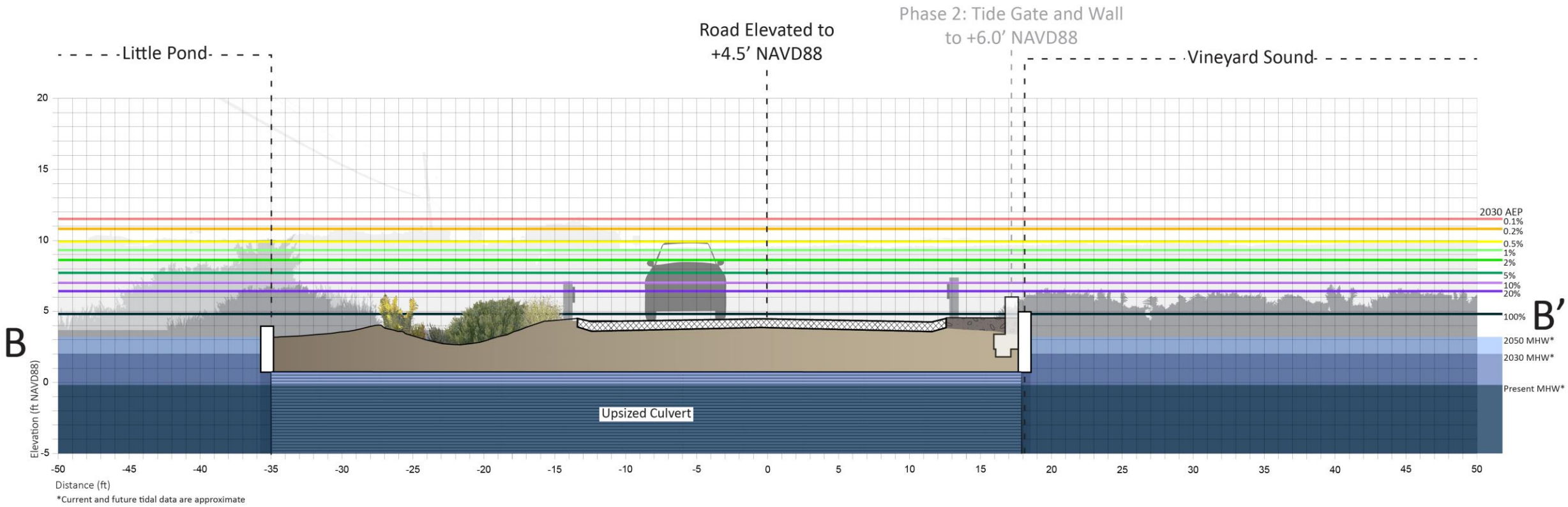

ALTERNATIVE 2: HYBRID

Menauhant Road, Falmouth

WOODS HOLE GROUP
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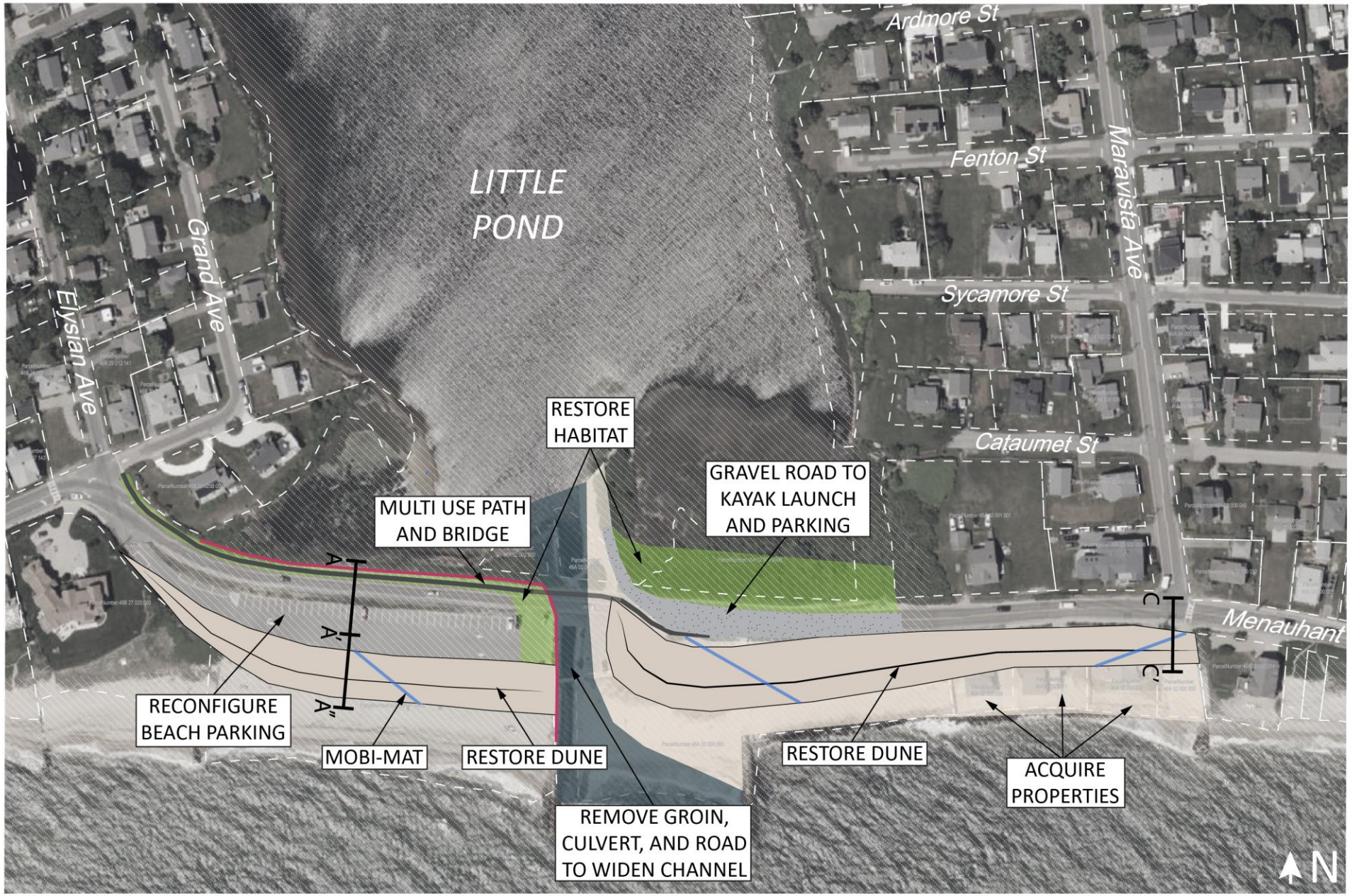

Note: Project overlap with wetland areas, rights of way and property lines is approximate and needs confirmation with a site survey

Menauhant Road
FALMOUTH

ALTERNATIVE 3: GREEN

In the long term, the culvert and surrounding road are removed, and Spring Bars Road (to the north of Little Pond) is adapted and maintained as the Little Pond crossing. Beach parking remains on the west side of a widened inlet. The groin on the east side of the inlet is removed, and the dune is widened and restored. A gravel road and parallel parking remain on the east side of the inlet for kayak launch access. Three vulnerable properties are acquired in order to facilitate a dune restoration, which provides protection from erosion.

WOODS HOLE GROUP
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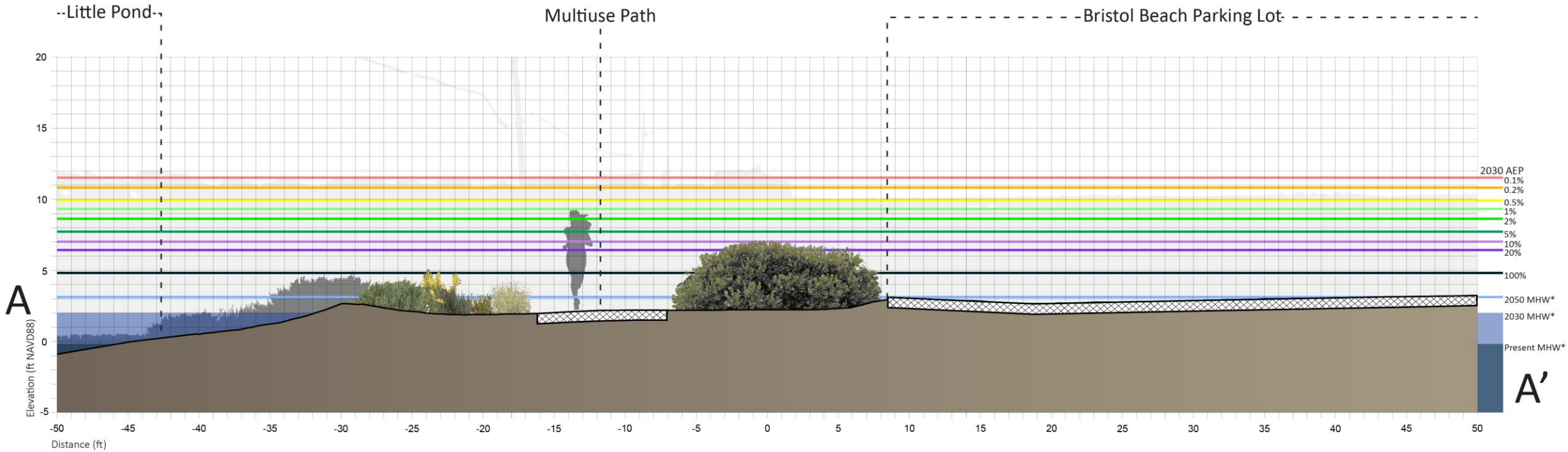

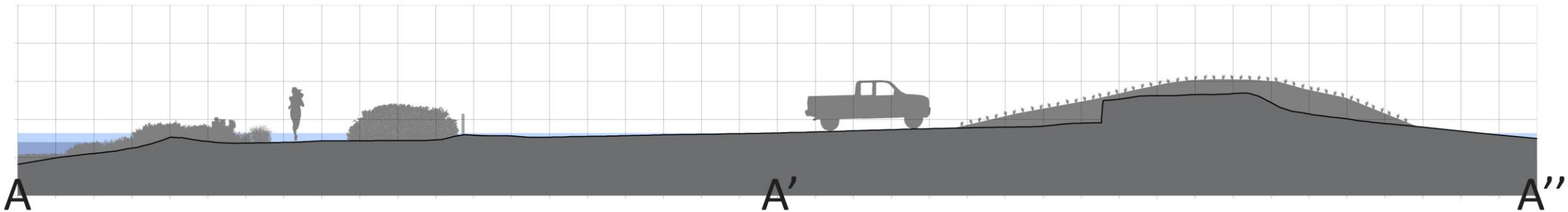

ALTERNATIVE 3: GREEN

Menauhant Road, Falmouth

WOODS HOLE GROUP
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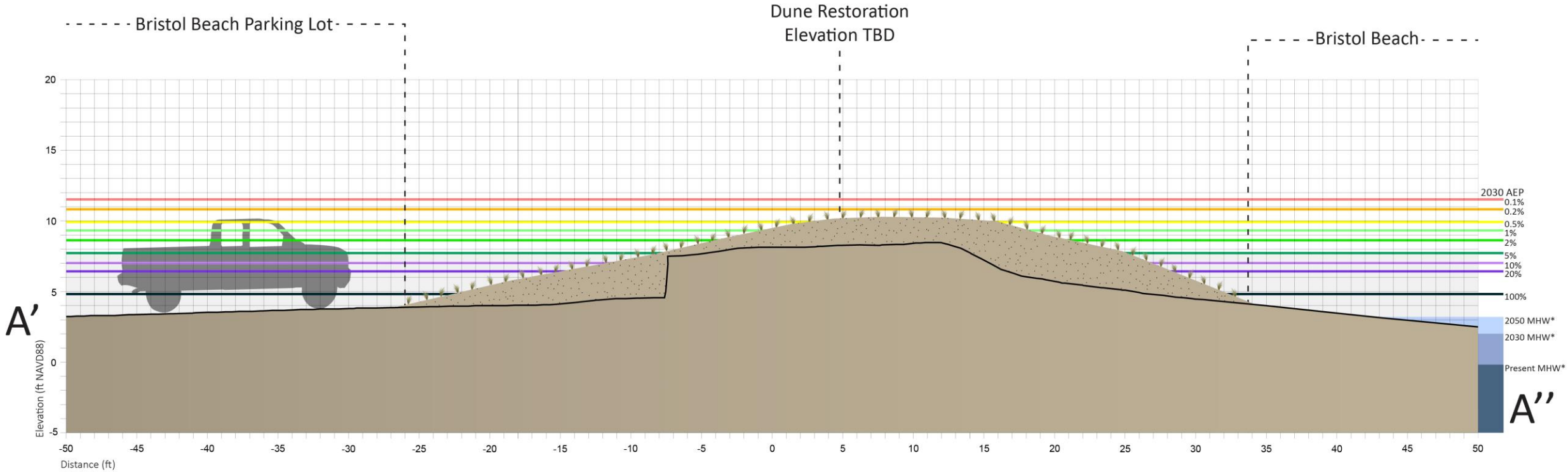

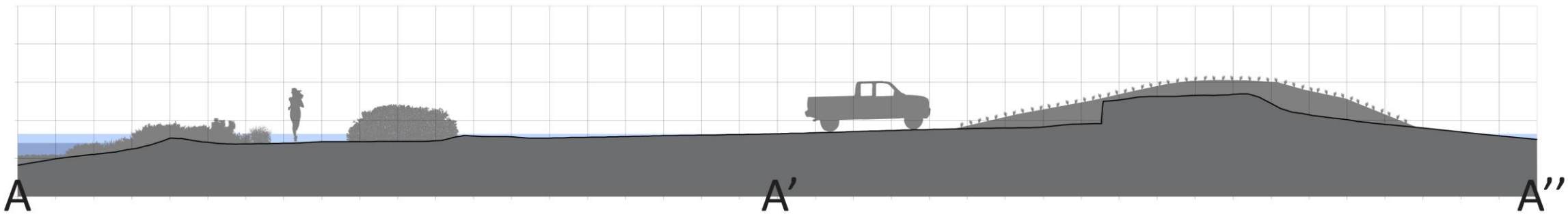

ALTERNATIVE 3: GREEN

Menauhant Road, Falmouth

WOODS HOLE GROUP
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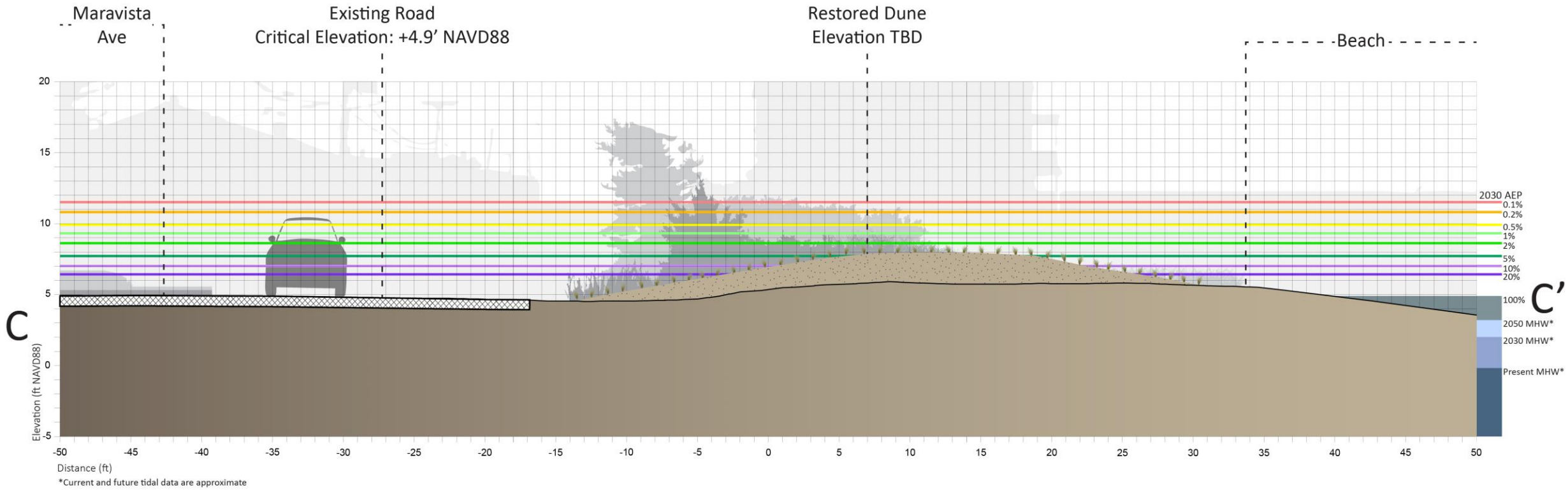

ALTERNATIVE 3: GREEN

Menauhant Road, Falmouth

WOODS HOLE GROUP
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MENAUHANT ROAD, FALMOUTH

Summary of alternatives

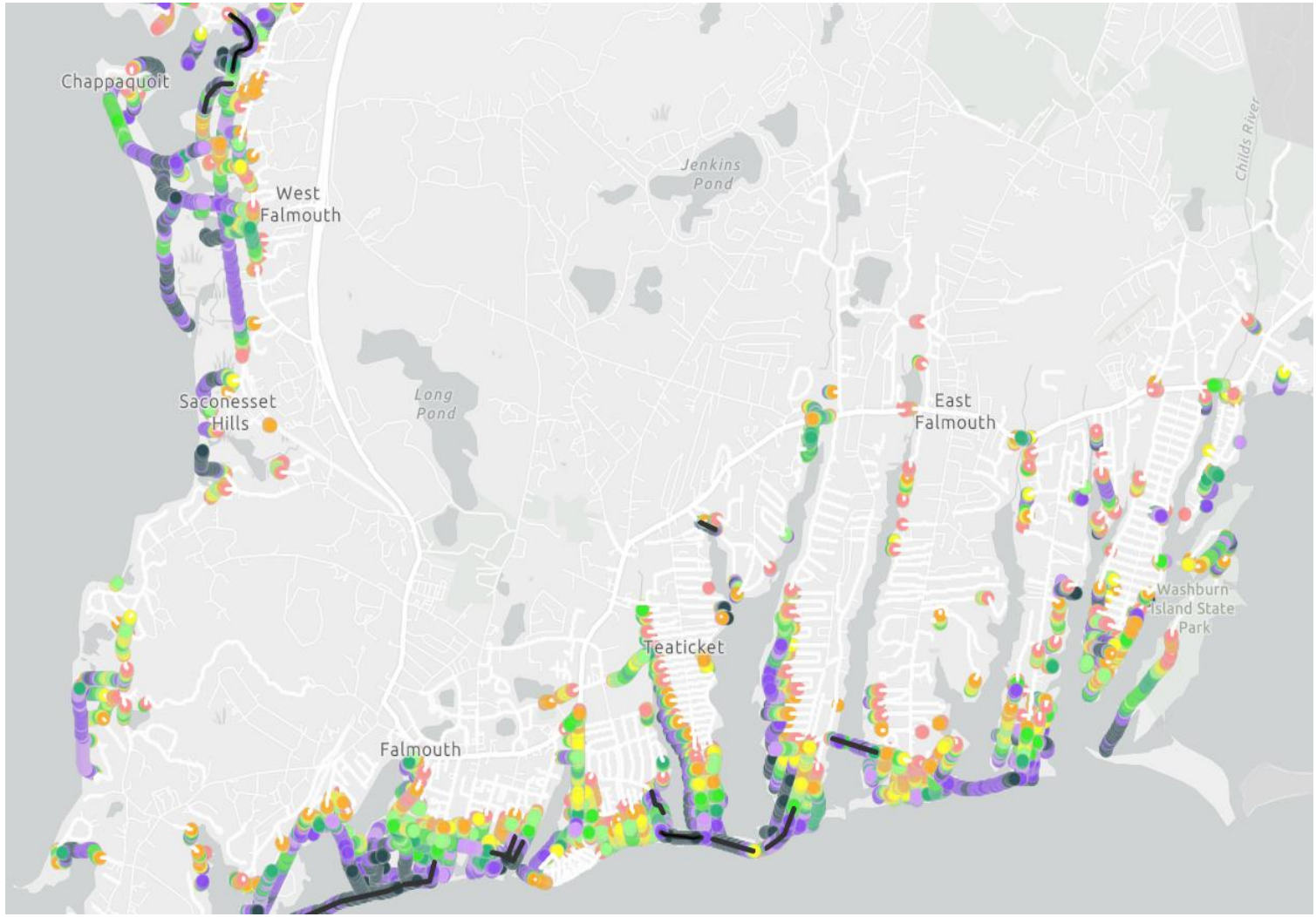
	Description	Critical Elevation (NAVD88)	Annual Exceedance Probability			Vulnerable to Tidal Flooding†	Permitability Concerns	Impacts to Private Property	Estimated Cost*
			2030	2050	2070				
EXISTING	A town-owned road at Bristol Beach, crossing the mouth of Little Pond.	2.2 feet	100%	100%	100%	2050	N/A	N/A	N/A
ALTERNATIVE 1: GRAY	1810 linear feet of Town-owned road and parking lot are elevated to +6.0'. The road is shifted south, and the parking lot is reconfigured. Space to the north of the road is used for passive stormwater management. The existing dune is backed by a soft retaining wall.	6.0 feet	20%	100%	100%	No	Potential for wetland impacts	Minimal	$1,640,000
ALTERNATIVE 2: HYBRID (PHASE 1)	1480 linear feet of Town-owned road and parking lot are elevated to +4.5'. A dune restoration backed by a soft wall takes over some parking lot space The culvert is upsized, a tide gate is added, and the channel is widened.	4.5 feet	100%	100%	100%	2070	Resource area restoration, potential for wetland impacts	Minimal	$2,870,000
ALT. 2 PHASE 2	Optional raising of Maravista Ave and repair of private seawalls for Alt. 2.	6.0 feet	20%	100%	100%	2070	Private seawalls, restoration	Moderate	$880,000
ALTERNATIVE 3: GREEN	In the long term, the vehicle connection at Bristol Beach is eliminated, and Spring Bars Road is targeted for adaptation. Three vulnerable properties are acquired in order to facilitate the dune restoration. A variety of options exist for maintaining recreational use and pedestrian connectivity.	N/A	N/A	N/A	N/A	N/A	Private property acquisition, resource area restoration	Severe	$1,290,000+ (includes only minimum elements and no acquisitions)

*2023 installed material cost +40% escalation (through 2029) and 15% contingency. Excludes design, permitting, mobilization, stormwater and wastewater infrastructure, and site controls. Costs based on experienced contractor opinion and MassDOT costing data.

†Future tidal data are approximate.

LOW LYING ROADS

Discussion



- **Nashawena Street**
- **Menauhant Road at Little Pond**

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	• 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)) • *Different eligibilities apply for at-risk coastal infrastructure grants*
Eligible projects	• 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	• 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

Thank you!

CAPE COD
COMMISSION