

Warren, RI

COASTAL SEA LEVEL RISE AND STORM SURGE: TRANSPORTATION FACT SHEET



PLANNING FOR SEA LEVEL RISE ON YOUR ROADS

This fact sheet aims to provide municipal leaders and practitioners with a survey of Warren's transportation infrastructure elements that may be affected by sea level rise and storm surge. In addition to explaining and presenting the data, this fact sheet will outline strategies that may help in adapting to these conditions, and point towards resources that will enable further investigation.

Relevance

The impacts of Sea Level Rise (SLR) are often perceived as distant, but the assets being built today will still be within their design life when future effects of sea level rise are felt. In addition, sea level rise will magnify the impacts of 100-year storm surge events by raising the water level. Though current federal guidelines only require federally funded assets be built to survive a 100-year storm event, what the impact of a 100-year storm event entails is likely to change during the design life of the assets currently under consideration around Rhode Island.

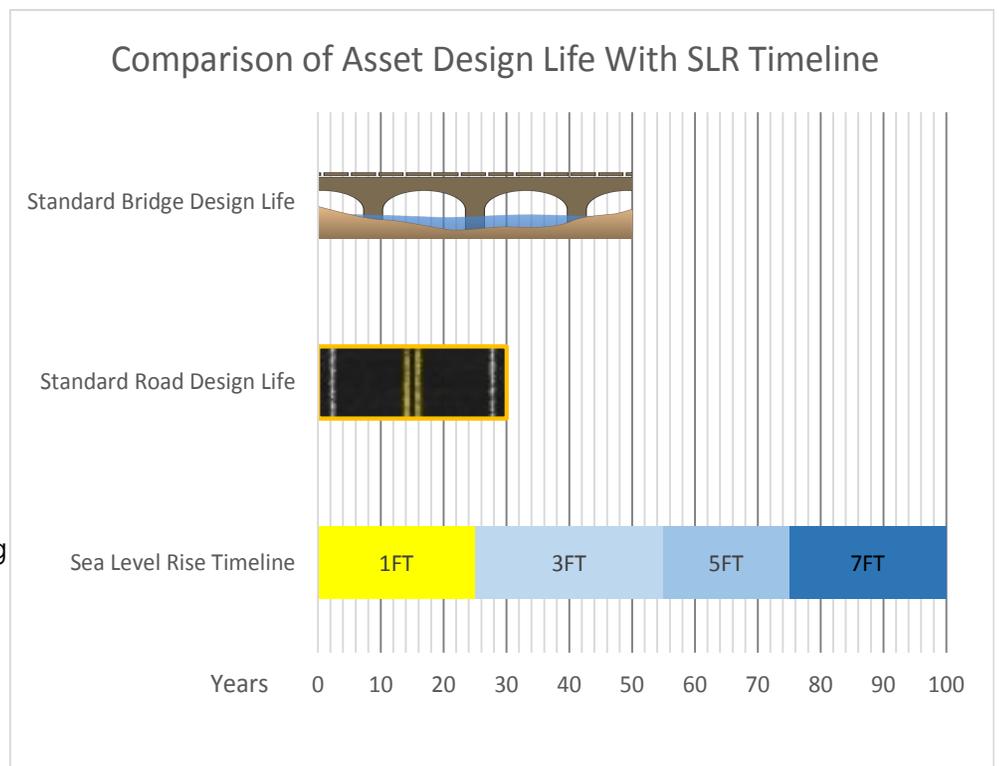


Figure 1

Data and Methodology



Figure 2: Flooding near Sauchest Point: June 2013

To help Rhode Island's cities and towns prepare for these changing conditions, the Statewide Planning Program (SPP) has engaged in an effort to analyze the potential impacts created by the sea level rise and storm surge. Using data developed under the name "STORMTOOLS" by the Coastal Resources Management Council and the University of Rhode Island, SPP identified the assets that could be impacted (exposure), and their vulnerability. As a result of this analysis, SPP identified the roads and bridges most likely to be impacted by Sea Level Rise, and scored their relative vulnerability based on the severity of the hazard they faced and the potential impact of asset damage on the transportation system as a whole.

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Warren Roads Exposed to Sea Level Rise

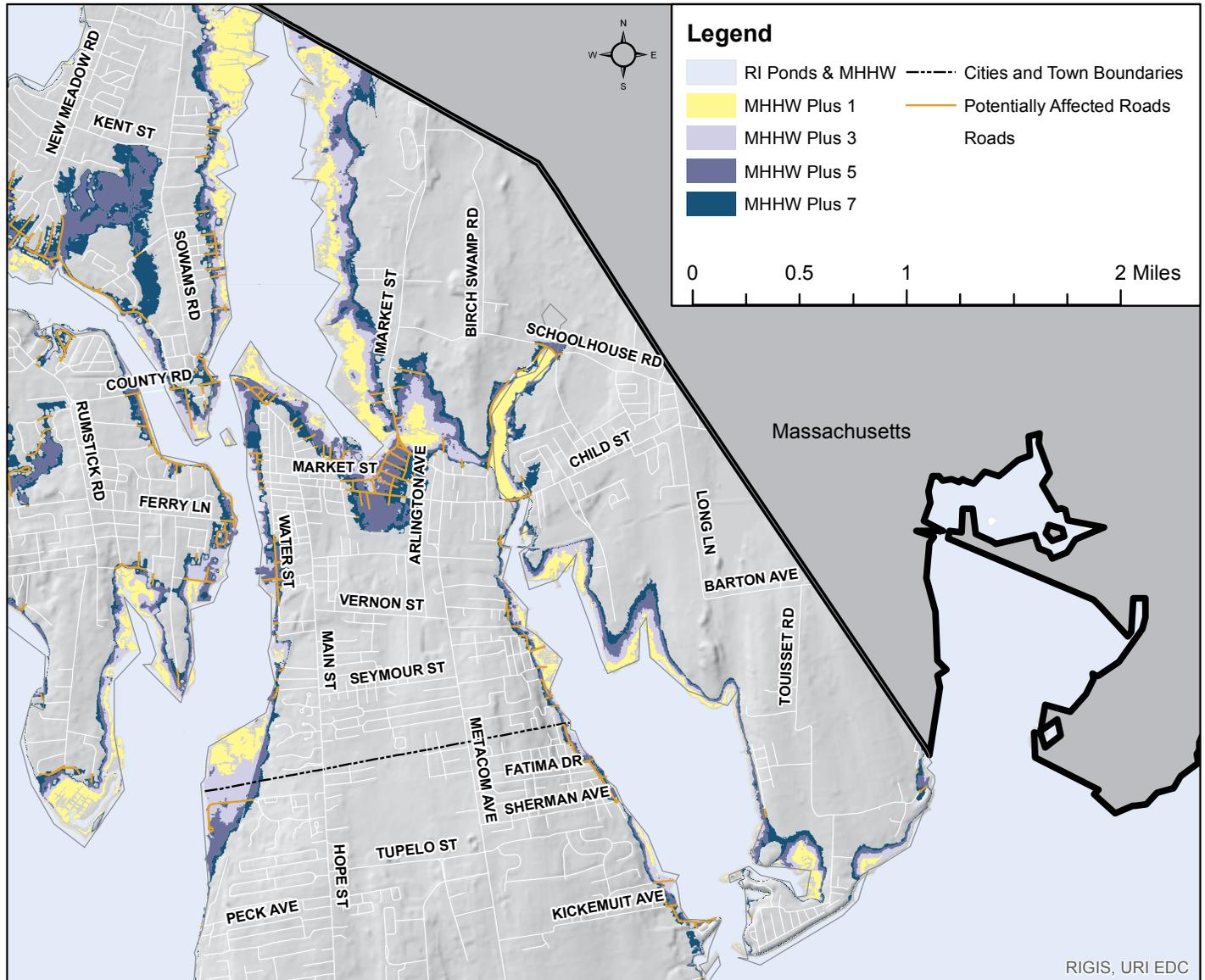


Figure 3

Given seven feet of sea level rise, a total of 156 miles of road in Rhode Island could be exposed to inundation, 70% of which would occur on local roads. For Warren six miles of roadway inundation can be expected. Of this, 71% (4.30 miles) are local. Warren's roads (state and local) are the tenth most vulnerable in the state of Rhode Island to sea level rise.

Figure 4

Top 10 Road Assets in Warren Vulnerable to Sea Level Rise (SLR)												
Mun. Rank	Road Name	1 Ft of SLR	3 Ft of SLR	5 Ft of SLR	7 Ft of SLR	Total Linear Feet	Evac. Route	Intermodal Facility	Functional Classification	Vuln. Score	State Rank	
1	MAIN ST	13	343	521	154	1,031	Yes	Yes	Principal Art.	7.58	9	
2	MARKET ST	0	1,104	1,381	361	2,846	Yes	No	Minor Art.	6.07	33	
3	CHILD ST	27	324	892	903	2,147	Yes	No	Principal Art.	5.08	95	
4	KICKEMUIT RD	0	60	1,001	362	1,423	Yes	No	Minor Art.	5.08	97	
5	REDMOND ST	0	363	0	0	363	No	No	Local	4.10	199	
6	SERPENTINE RD	0	2	1,444	1,683	3,129	No	No	Local	4.10	203	
7	BENEFIT ST	0	0	588	8	596	No	No	Local	4.07	207	
8	HARDING AVE	200	17	99	51	368	No	No	Local	4.00	221	
9	WATER ST	0	391	1,030	324	1,746	No	No	Minor Coll.	3.73	273	
10	METACOM AVE	0	234	75	66	375	No	No	Local	3.35	350	

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Warren Bridges Exposed to Sea Level Rise

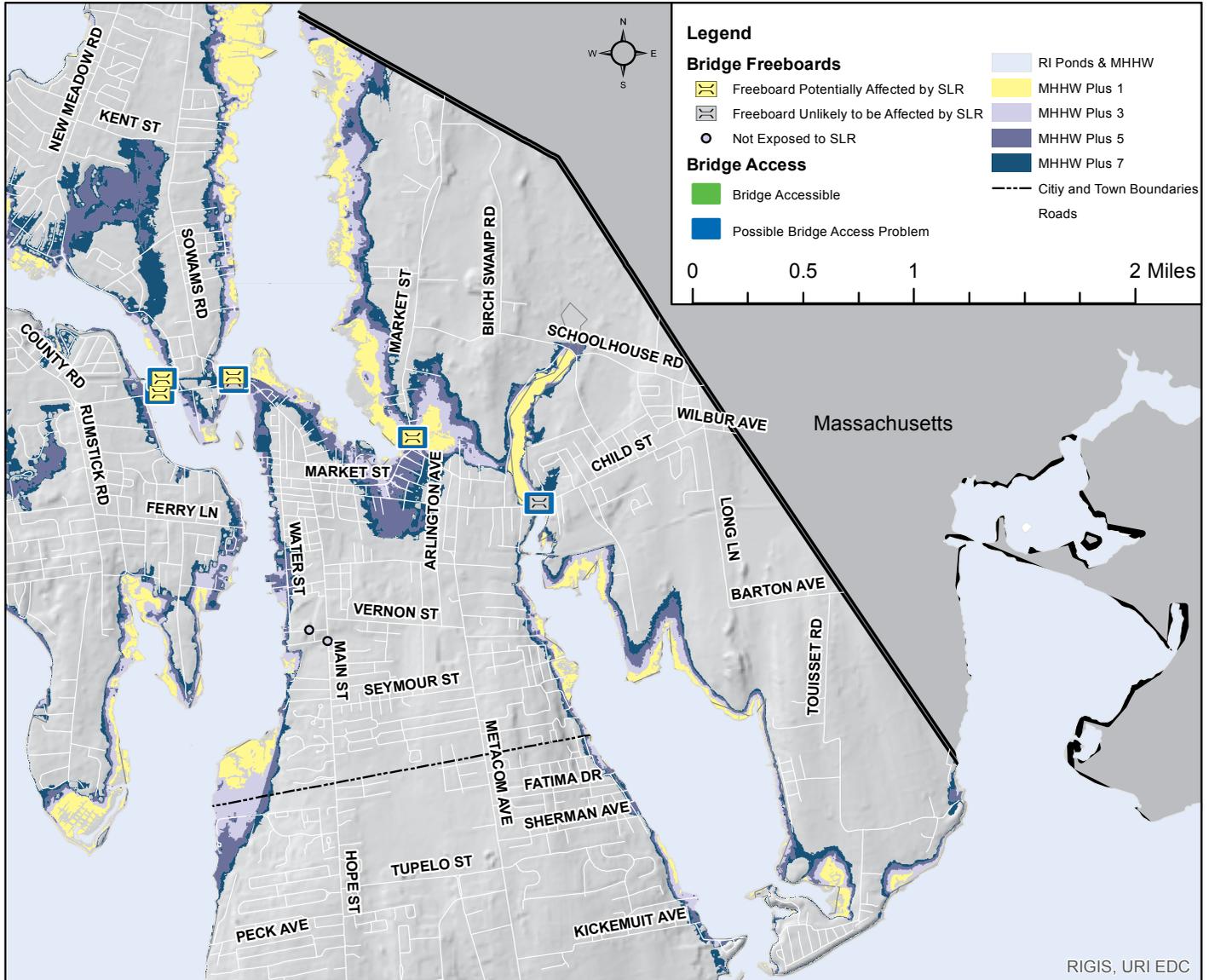


Figure 5

Given seven feet of sea level rise, a total of 90 bridges in Rhode Island cause concern either due to potential freeboard height or accessibility problems. In Warren there are two bridges of concern. Warren's bridge infrastructure is the 13th most vulnerable in the state of Rhode Island to sea level rise.

Figure 6

Top 10 Warren Bridge Assets Vulnerable to Sea Level Rise											
Mun. Rank	Bridge Name	Facility Carried	Feature Intersected	Inches of Freeboard Relative to 7ftSLR	Terrain Crossed	Landing Access	Intermodal Facility	Evac. Route	AADT	Vuln. Score	State Rank
1	Belchers Cove Bridge	MARKET ST	BELCHERS COVE	-18	Water	Problem	No	Yes	10,000	7.60	13
2	Kickamuit	RI 103 CHILD ST	KICKAMUIT R	0	Water	Problem	No	Yes	7,800	7.20	20

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Warren Roads Exposed to 100-Year Storm Surge Events

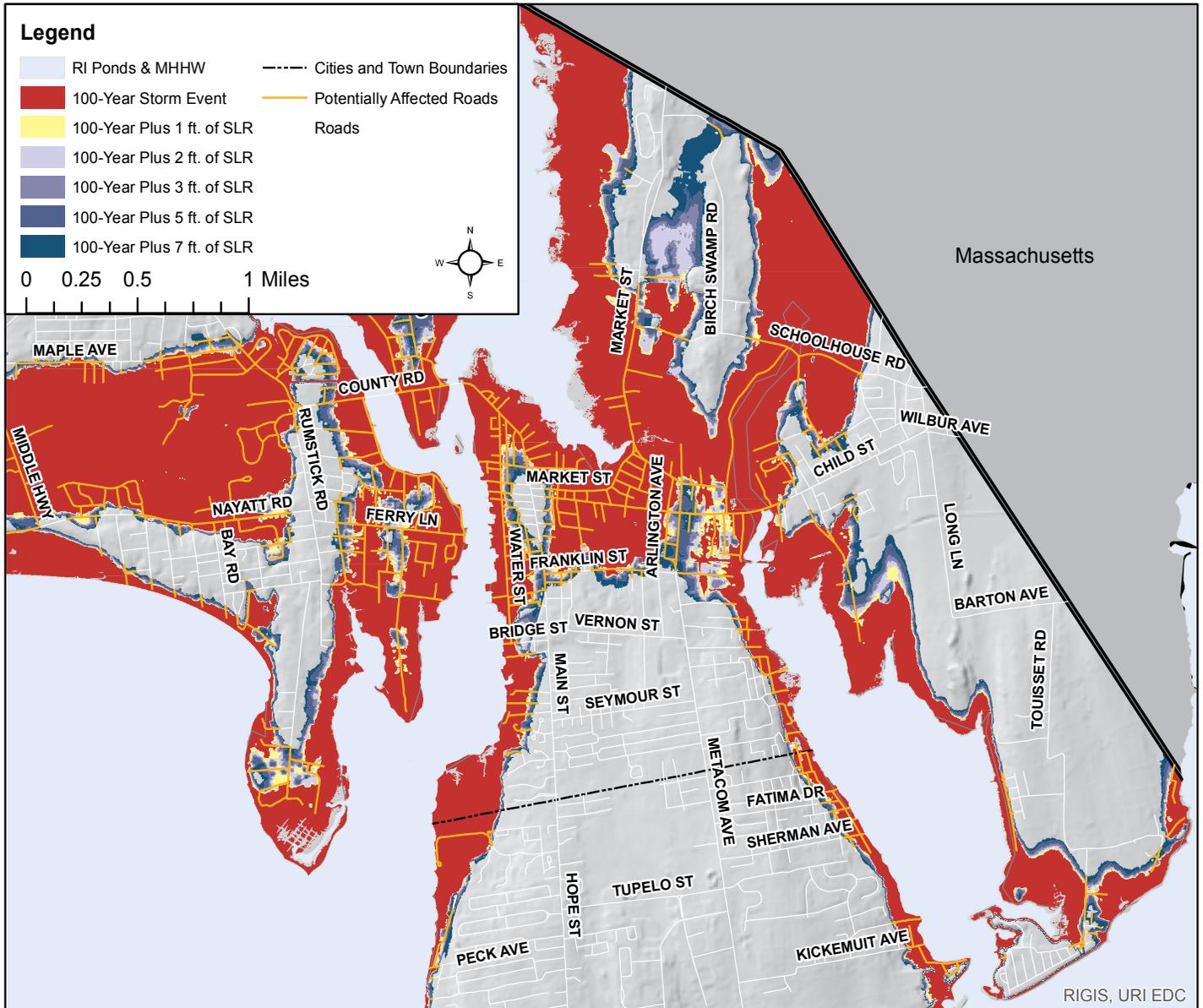


Figure 7

Given seven feet of sea level rise and a 100-year storm surge event, a total of 573 miles of road in Rhode Island will potentially be exposed to inundation, 73% of which will occur on local roads. For Warren, 23 miles of roadway inundation can be expected, 70% (~16 miles) of which are local. Warren's roads are the ninth most vulnerable in the state of Rhode Island to storm surge.

Figure 8

Top 10 Road Assets in Warren Vulnerable to 100-Year Surge Events												
Mun. Rank	NAME	No SLR	1 Foot of SLR	3 Feet of SLR	5 Feet of SLR	7 Feet of SLR	Total Linear Feet	Evac. Route	Intermodal Facility	Functional Classification	Vuln. Score	State Rank
1	MAIN ST	2,363	120	447	535	517	3,982	Yes	Yes	Principal Art.	8.58	9
2	MARKET ST	5,669	218	419	191	158	6,655	Yes	No	Minor Art.	7.75	36
3	CHILD ST	4,196	551	420	571	122	5,860	No	No	Principal Art.	7.15	70
4	KICKEMUIT RD	2,225	178	545	0	0	2,948	Yes	No	Major Coll.	6.73	98
5	METACOM AVE	795	59	760	1,152	152	2,917	Yes	No	Minor Art.	6.29	149
6	ARLINGTON AVE	1,242	233	181	461	407	2,525	No	No	Minor Art.	5.85	213
7	FRANKLIN ST	378	506	628	384	313	2,209	No	Yes	Major Coll.	5.67	241
8	SERPENTINE RD	4,229	200	0	0	0	4,429	No	No	Local	5.60	255
9	BRADY ST	744	215	0	0	0	959	No	No	Local	5.60	260
10	RIVERVIEW ST	348	145	0	0	0	493	No	No	Local	5.60	261

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Warren Bridges Exposed to 100-Year Storm Surge Events

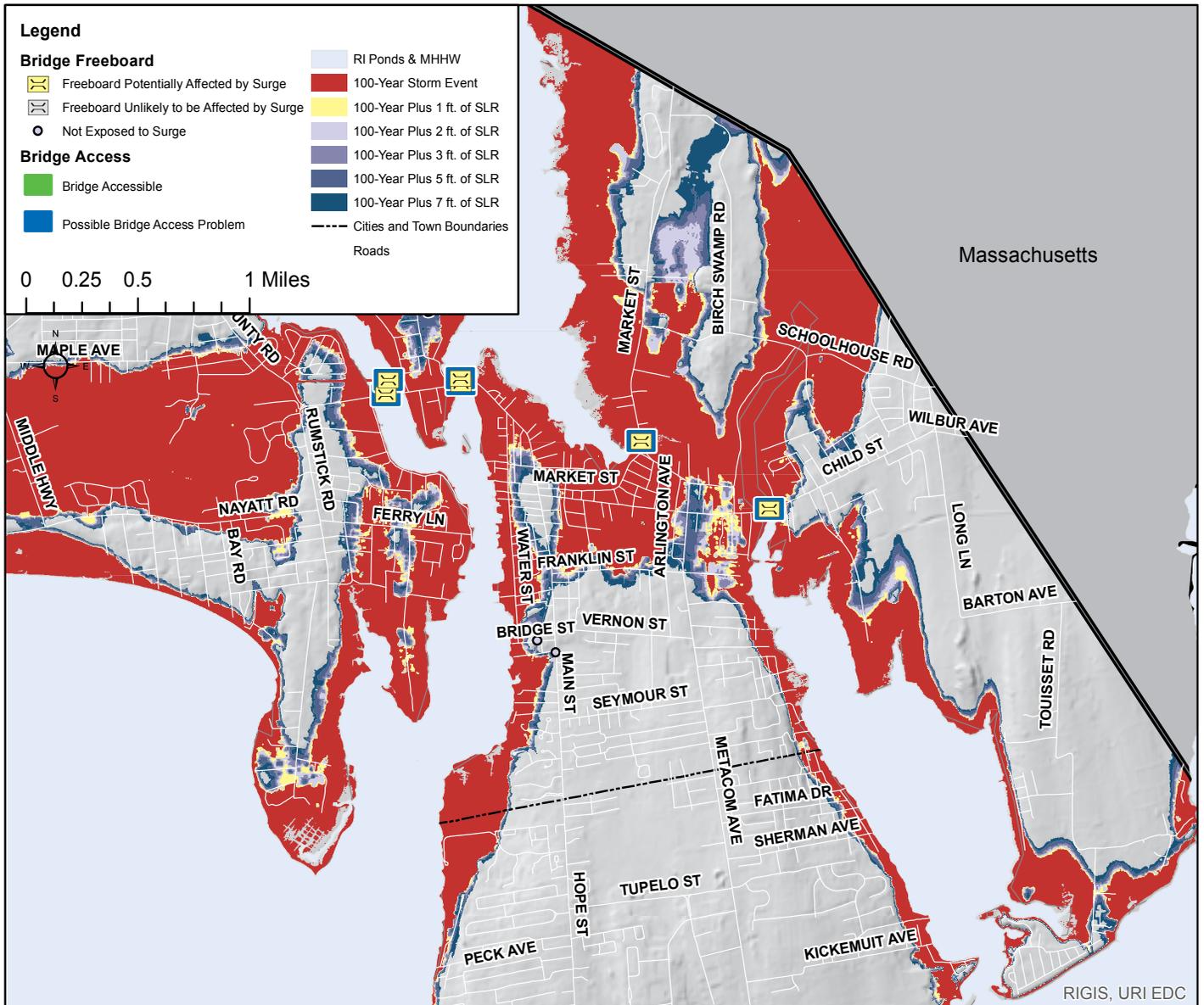


Figure 9

Given seven feet of sea level rise plus a 100-year storm surge event, a total of 148 bridges statewide cause concern either because of potential free-board height or accessibility problems. In Warren there are two bridges of concern. Warren's bridge infrastructure is the 16th most vulnerable to storm surge in the state of Rhode Island.

Figure 10

Top 10 Warren Bridge Assets Vulnerable to Sea Level Rise Plus a 100-Year Storm Surge Event											
Mun. Rank	Bridge Name	Facility Carried	Feature Intersected	Inches of Freeboard Relative to 7FtSLR	Terrain Crossed	Landing Access	Intermodal Facility	Evac. Route	AADT	Vuln. Score	State Rank
1	Belchers Cove Bridge	MARKET ST	BELCHERS COVE	-194	Water	Problem	No	Yes	10,000	7.30	35
2	Kickamuit	RI 103 CHILD ST	KICKAMUIT R	-172	Water	Problem	No	Yes	7,800	7.30	36

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Next Steps



Given the potential scale of the impacts of sea level rise and storm surge on local transportation infrastructure, local communities will need to find a way to prepare. A variety of approaches are available, and programs exist to help communities execute these strategies. Finding preparedness strategies will require undertaking further analysis, formulating a clear adaptation strategy, and then taking advantage of planning opportunities that may present themselves.

Further Analysis

The most important step is the pursuit of further analysis. The data contained in this factsheet serves as introduction to municipal level transportation issues associated with sea level rise and storm surge. The data contained here and in Technical Paper #167: Vulnerability of Municipal Transportation Assets to Sea Level Rise and Storm Surge (published by SPP and available at <http://www.planning.ri.gov/geodeminfo/data/slr.php>) should allow local decision makers to prioritize the assets that may require an engineering analysis. Decision makers would also be advised to consult The methodology for STORMTOOLS, a key source of data for this project, which is available on-line at <http://www.beachsamp.org/the-science-behind-stormtools/>.

Figure 11: Consideration of Sea Level Rise can be included in regular planning activities



Adaptation

Once the nature of the ongoing changes are understood, a policy should be developed to prepare for the changes holistically. The specific policies to be implemented will vary widely based on the community, the assets under threat, and the resources available. The policies can broadly be described as Protect, Accommodate, Retreat, and Do Nothing.

Protect: Though often popular, this is the most financially expensive option. A municipality can seek to safeguard an asset by building sea walls, or take a slightly more green approach by attempting to artificially recreate the types of dune or wetland structures that naturally stabilize a shoreline. These approaches offer short term security if well designed and implemented, but their effectiveness in the long term may be limited by further changing conditions and the resources required for maintenance.

Figure 12



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Accommodate: Accommodation can imply a number of built solutions that take into account the new conditions. An engineering oriented solution would be to elevate the assets in question above the new waterline, while another option would be to rebuild the asset in a way that suits the new conditions better, for example by rebuilding a road using a new alignment on higher ground.

Retreat: If built solutions are infeasible, a community may decide to simply abandon the asset. Private stakeholders may take over responsibility for the asset, or the need for its maintenance may diminish as users of the asset leave the area. Though undoubtedly the most efficient solution from a fiscal perspective, there are complex legal issues involved that remain unresolved.

Do Nothing: Communities may choose to take no action in response to rising sea levels. In effect this would consist of maintaining the status quo infrastructure, regardless of risk and the increasingly common inundations. In practice this approach may closely resemble retreat, as assets are incapacitated with increasing regularity until all those served by the assets move away. The financial strain of repeated maintenance could have significant fiscal effects on communities.

Planning Opportunities

Once the subject of sea level rise and storm surge have been adequately researched, and an overall municipal adaptation strategy has been decided upon, decision makers should attempt to take advantage of planning opportunities that may allow the city or town to begin implementation of their planning goals. A key first step to this process will be building awareness amongst staff and constituents, either by direct outreach or simply through informal discussions.

As awareness grows, the community would be well served simply by keeping their readiness policy goals in mind when conducting their regular planning activities, such as comprehensive planning, or zoning compliance review. More concrete policies like overlay zones and rolling easements may become important tools for communities seeking a way to realize their policy goals.

Communities that are critically threatened by sea level rise and storm surge may seek to directly invest in readiness measures using municipal funds. Additional funding may be available to aid in this process from state and federal sources. Placing eligible projects for consideration in the State Transportation Improvement Plan, or other sources of Federal and State funding, is a good way to leverage local funding.

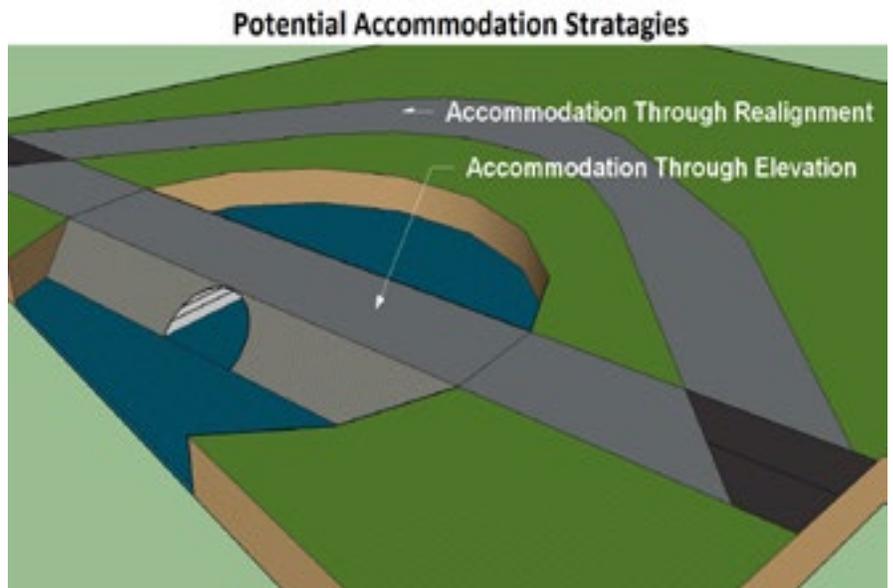


Figure 13

Figure 14

