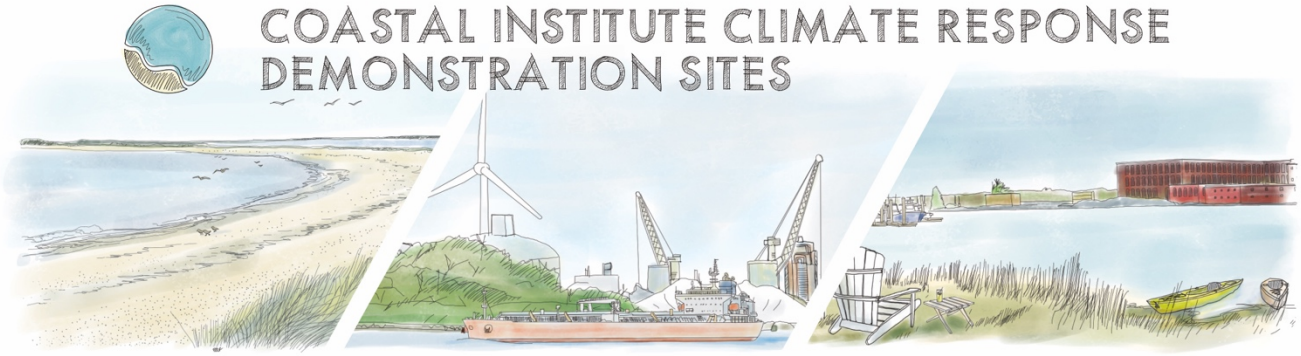
COASTAL INSTITUTE

PREPARING FOR RESILIENCE

BARRINGTON and WARREN MIXED-USE CLIMATE RESPONSE DEMONSTRATION SITE

Fall 2019

THE UNIVERSITY OF RHODE ISLAND



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ACKNOWLEDGEMENTS

Funding for the Barrington-Warren Climate Response Demonstration Site has been provided by the URI Coastal Institute and The Sounds Conservancy with in-kind support and collaboration from the towns of Barrington and Warren, Save The Bay, the RI Coastal Resources Management Council, and the URI Coastal Resources Center. Teresa Crean, affiliated with the URI Coastal Resources Center and RI Sea Grant, was provided with financial support from the URI Coastal Institute for her involvement in the Demonstration Site program. Jeff Hollister (URI Coastal Institute senior fellow) prepared the maps for the transportation workshops. Thanks are extended to the graduate class from the University of Pennsylvania (UPenn), School of Design, for committing their fall 2018 semester to evaluating sea level rise adaptation strategies for Barrington and Warren, with special thanks to Kristen Scudder for continuing to collaborate with our team on transportation issues during her spring 2019 semester. UPenn expresses its appreciation to the van Beuren Charitable Foundation for supporting their efforts. URI graduate student Kelly Medeiros (Dept. of Natural Resources Science, Master's in Environmental Science and Management) is gratefully acknowledged for her summer and fall 2018 semester projects to review and assess adaptation techniques that are being considered by communities and agencies throughout the northeastern US and beyond. The town of Warren and the demonstration site team thank the URI Department of Landscape Architecture undergraduate class and Professor Richard Sheridan for their study and presentation of landscape designs intended to evolve with sea level rise and storm surge. Since the beginning of the demonstration site project there has been exceptional participation from town employees, town council and board members, interested citizens, and program managers from state agencies and environmental organizations; our deep appreciation to all for your generous contributions and ongoing involvement.

INTRODUCTION

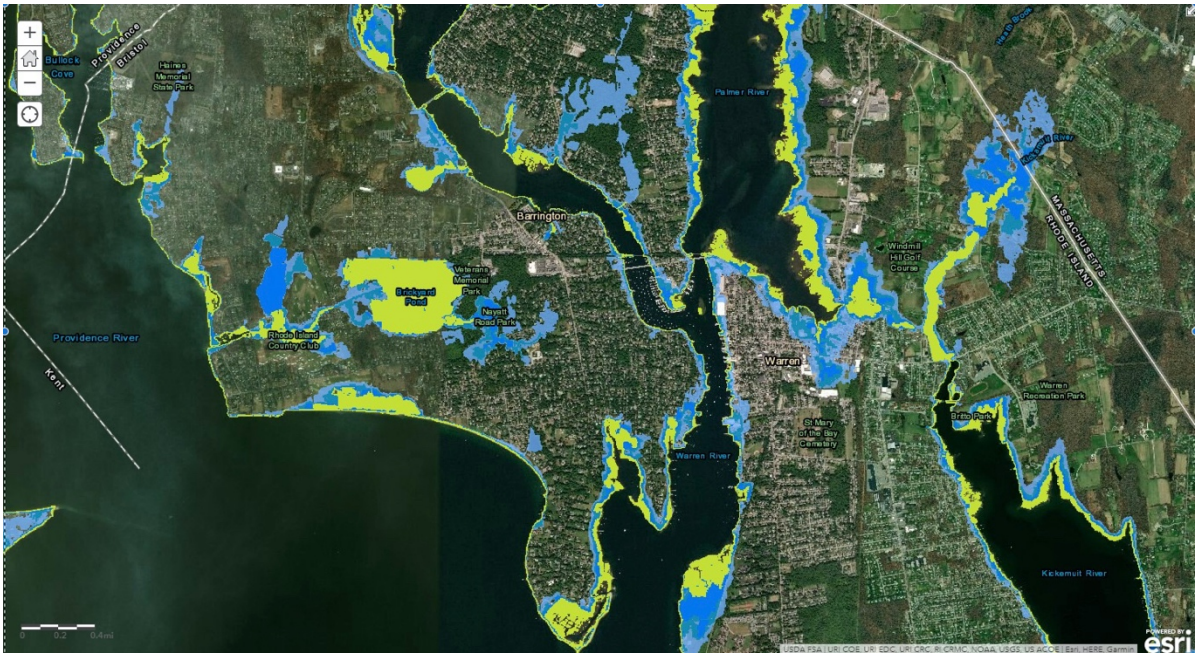
Perhaps the greatest challenge confronting environmental managers and community planners throughout coastal Rhode Island is flooding associated with accelerated rates of sea level rise and storm surge, both of which are exacerbated by projected increased precipitation and storm intensity. Recent NOAA projections suggest that in 25 years sea level in Narragansett Bay could rise by over 3 feet with a projection of 11 feet by 2100 (Sweet et al. 2017; RI Coastal Resources Management Council http://www.beachsamp.org/stormtools/). This trending increase is astounding when compared to a seemingly mere 10 inches of rise over the past 87 years. Buildings and infrastructure are now flooding during extreme tides and storms, while marshes are getting wetter, a sign of not keeping pace with rising sea level (e.g., Roman 2017). With higher sea levels and more intense storms, changes to environmental and infrastructure conditions of the coastal margin will be alarming. Agencies and the public are taking actions and planning for the future; but given the severity of the challenge, transformative adaptation strategies must be considered (Kates et al. 2012).

Given the trend of increased flooding associated with sea level rise and more intense storms, and other climate change factors, the University of Rhode Island (URI) Coastal Institute has identified three **Climate Response Demonstration Sites** representing the range of Rhode Island's coastal landscape types; natural areas, urban ports and heat island refuges, and mixed-use sites. ***The aim of this initiative is to explore adaptation strategies that will promote resilience of coastal municipalities and enhance ecosystem sustainability. The demonstration sites will draw from adaptation practices currently being implemented in RI and other coastal regions and will strive to test, monitor, and "demonstrate" the resiliency response to adaptation actions. Collaboration with state and municipal governments, planners and policymakers, businesses, homeowners, community groups, conservation organizations, academia, and others, is fundamental to the success of this effort.***

Responses to climate change and implementation of appropriate adaptation strategies will vary depending on coastal setting, development type, and development intensity, thus the selection of natural, urban, and mixed-use sites. This brief document reports on activities and accomplishments of the Barrington–Warren Mixed-Use Demonstration Site since inception in late 2016, followed by a discussion of planned directions over the next 12-18 months. Barrington and Warren are currently taking strides to enhance resiliency and it is anticipated that the activities of the demonstration site will serve to further highlight the urgency to plan **now** for nuisance and catastrophic flooding and implement bold adaption measures. This document will be periodically updated as the demonstration site initiative continues to move forward.

BARRINGTON AND WARREN: BRIEF SITE DESCRIPTION

Collectively, the neighboring towns of Barrington and Warren are characterized by dense residential development, associated schools, medical facilities, government buildings, churches, small businesses, historic and maritime heritage, parks and recreation areas, extensive natural resources, and diverse demographics and socio-economic conditions. These "mixed-use" communities are common throughout RI and the northeast coastal zone. An important reason leading to the selection of Barrington and Warren is inundation modeling showing that the extensive low elevation areas of high-density development in this area of Narragansett Bay are especially vulnerable to flooding associated with sea level rise and storm surge (e.g., http://www.beachsamp.org/stormtools/). Based on STORMTOOLS (e911 Exposure Assessment), it is noted that in Barrington and Warren, 40% of residential structures could be flooded with a 3-ft rise in sea level, while during a moderate intensity 25-yr storm event flooding could impact 27% of residential structures. Further, Barrington and Warren have some extensive salt marshes, but those in Hundred Acre Cove and the Palmer River are converting from vegetated meadows to open water or intertidal flats, with sea level rise as a contributing factor (Watson et al. 2017).



Stormtools map showing inundation caused by 5-feet of sea level rise. Key: Yellow, 1-ft Sea Level Rise; Dark Blue, 2-ft; Blue-Green, 3-ft; Light Blue, 5-ft.

Sunny day flooding in Barrington, RI[45]

Sunny day flooding in Warren, RI[46]

ACCOMPLISHMENTS AND ONGOING EFFORTS

Topic-focused workshops, student engagement projects, and public outreach panels and presentations have been the primary means of gathering, sharing and synthesizing information, and facilitating a wide collaborative network.

Topic-Focused Workshops

When evaluating vulnerability to coastal flooding and suggesting adaptation strategies, there are numerous topic areas to consider, each intended to keep group discussion and deliberation focused. These topic areas can include public infrastructure (transportation network, utilities, sewer lines and pump stations, emergency response routes, etc.), vulnerable populations, historic properties, land-use policies, and natural resources, among others. Based on conversations among the demonstration site project team members, the first two topic-focused workshops were convened to address "land use planning" and "transportation." Depending on the workshop topic the project team invited appropriate municipal officials, town boards, state agency personnel, citizen groups, stakeholders, and others to participate.

Topic-focused workshops were convened in the evening and limited to a two-hour duration. The goal of the workshops was to initiate the consensus-building process, recognizing that the discussion topics are complex and require more extensive deliberation. In fact, as noted below, the workshops served to trigger follow-up discussions in the form of work sessions and student projects. Further, workshop findings will be useful as Barrington and Warren begin their efforts in association with

"Resilient Rhody: Municipal Resilience Program," an initiative of the RI Infrastructure Bank in partnership with The Nature Conservancy. Two workshops have been conducted: Land Use Planning Strategies and Transportation Network. The demonstration site team also facilitated work sessions on buyouts as an adaptation tool and participated in a "Building a Resilient Community" workshop sponsored by Barrington. For each workshop, the climate response team provides details on the specific workshop goals, workshop structure, and outcomes/findings from the deliberations.

Public meeting to discuss resilience strategies at Warren Town Hall

Workshop: Land Use Planning Strategies

Date: October 4, 2018 (Barrington Public Library)

Workshop Goals:

- Analyze selected sites that are vulnerable to sea level rise or storm surge
- Use available on-line tools and explore existing and new land use planning strategies necessary for adapting to changing conditions

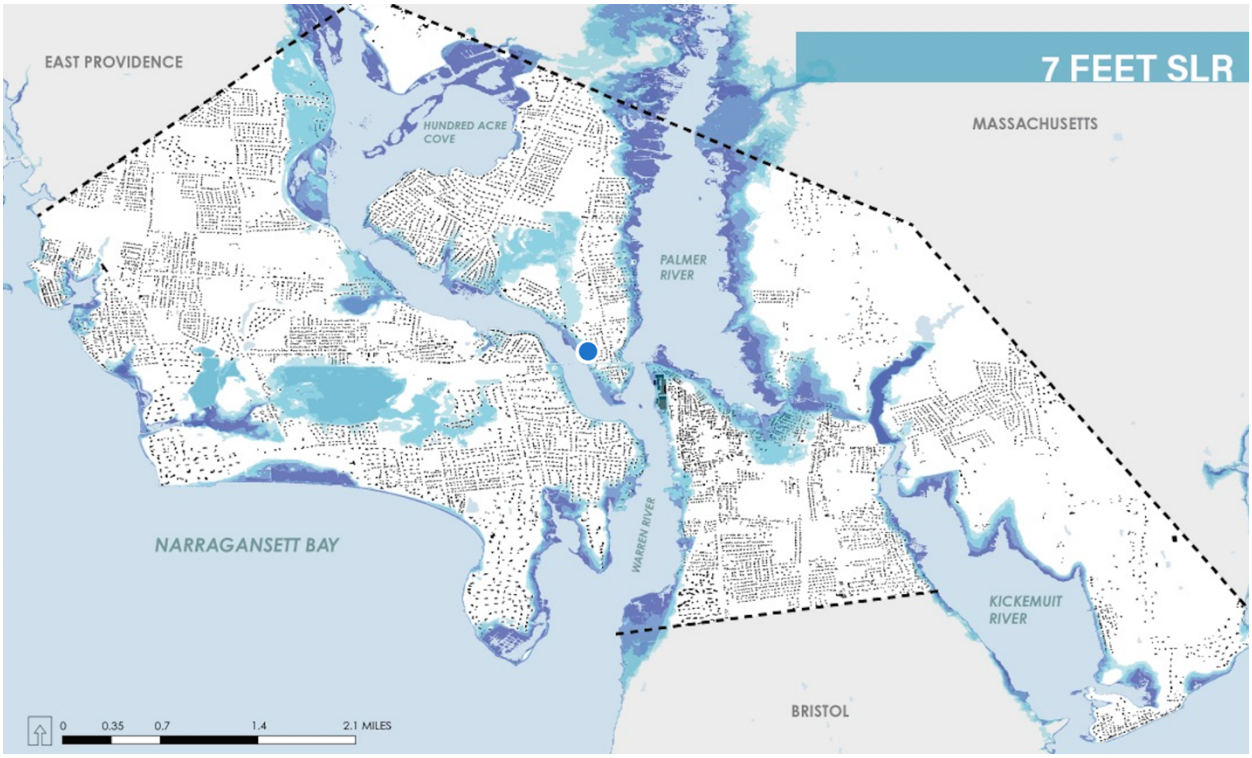
Workshop Structure (Facilitator: Teresa Crean, Community Planner, URI Coastal Resources Center, funded by the URI Coastal Institute):
Following some introductory remarks (see APPENDIX 1 for workshop agenda and map handouts showing future flooding scenarios), the participants were divided into two breakout groups (Barrington and Warren). To keep the discussion focused the Barrington group was charged with addressing the Maple Ave-County Rd commercial area, Bay Spring area, and Tyler Point; Warren addressed the town center area of Water Street/ Market St/ Child St.

Land Use Workshop Outcomes

The following are some of the possible land use planning strategies to consider.

- Zone critical to moderate future flood hazard zones with two purposes: 1) make current and future owners aware of the possible flood scenarios; and 2), serve as areas where new building codes could be recommended for property renovations (e.g., elevate) or serve as areas that could be eligible for government-sponsored buyout programs.
- Identify high elevation upland areas in the towns that could support a greater density of development to accommodate those residences and business that may need to relocate.
- Identify or zone areas as current or future stormwater storage areas or areas where habitats could migrate landward as sea level rises. Warren's Jamiel's Park was suggested as an example of a possible stormwater retention area and salt marsh migration zone.
- The implementation of rolling easements was offered as a planning strategy, whereby the town or other entity, such as a non-profit land trust, obtains or purchases an easement from the property owner with the requirement that the property owner must surrender the property to the town or other entity once it is substantially damaged due to coastal flooding. The surrendered land could then serve as open space, a flood retention area, and corridor for coastal habitats (e.g., salt marshes, beaches, bluffs) to migrate landward in response to sea level rise. The topic of rolling easements is complex and there are many types of rolling easements to consider. The US EPA has provided guidance on this topic through their "Climate Ready Estuaries" program. https://www.epa.gov/cre/climate-ready-estuaries-rolling-easements-primer
- The topic of a government-sponsored "buyout" program received much discussion at the workshop, whereby properties in critical flood-prone areas could voluntarily apply for financial incentives to relocate or retreat to higher elevation areas. Establishing, funding, and implementing such a program in Rhode Island requires input and consensus from multiple state and federal agencies, local municipalities, and others. As follow-up to the workshop, the Barrington-Warren demonstration site team initiated a series of buyout work sessions, inviting broad statewide participation. Details of the work session deliberations follow.
- To be addressed in the "Student Engagement" portion of this document the land use -planning workshop was attended by ten graduate students from the University of Pennsylvania (UPenn), School of Design, as they began their semester-long analysis of storm and sea level rise adaptation responses that could be considered by Barrington and Warren. Further, a graduate student from URI's Department of Natural Resources Science provided background

information on adaptation strategies being implemented in other coastal communities from the northeastern US and assisted with workshop facilitation. The workshop provided an opportunity for the students to become immersed in the issues facing these coastal communities and to meet with town officials and the public, thereby providing a foundation for their research efforts on behalf of the towns and the demonstration site program.



UPenn map shows 459 single family homes and 168 multi-family homes will be lost with 7-feet of sea level rise (light blue)

Work Sessions: Buyouts

Dates: November 13, 2018 (RI Dept of Administration)
December 12, 2018 (URI Coastal Institute, Narragansett)
February 20, 2019 (RI Emergency Management Agency, RIEMA)

Work Session Goals:

- Provide a forum to discuss post-hazard buyouts of properties in RI
- Ask RI cities and towns to share their buyout experiences, challenges, and opportunities
- Invite experts as needed (legal advice, funding issues, scholarly work, experiences from other states and federal agencies)

- Create the foundation for buyouts following future hazard events

Work Session Structure and Participants: (Facilitator: Teresa Crean, URI Coastal Resources Center, funded by the Coastal Institute Demonstration Site program):
As a result of the October 2018 coastal resilience land use workshop in Barrington/Warren, the need was identified to learn more about post-hazard buyouts of properties in Rhode Island—and if/how this strategy might be feasible in the future following hazard events. The three sessions held to date were intended as information sharing meetings. The sessions brought together numerous participants to exchange examples of buyouts that have taken place in Rhode Island, as well as other experts to communicate experiences from places outside of the state. Additional buyout work sessions are planned.

Participants from the following agencies, organizations or institutions included;

- RI Emergency Management Agency
- RI Office of Housing and Community Development
- RI Coastal Resources Management Council
- Rhode Island Infrastructure Bank
- Marine Affairs Institute, Rhode Island Sea Grant Legal Program
- URI Masters in Environmental Science & Management (MESM) Program
- Town of Barrington
- Town of South Kingstown
- Town of Johnston
- Town of Warren
- City of Cranston
- City of East Providence
- Punchard Consulting
- URI Coastal Institute

Buyout work session held at the Rhode Island Emergency Management Agency

Workshop Outcomes:

- A URI graduate student prepared a summary of several buyout programs and technical guidance documents and included a list of links to many additional documents/websites from throughout the US. Work session participants were provided with this information as a resource. See APPENDIX 2
- In Rhode Island, there are no guidebooks or centralized procedures for administering a buyout program. Grants have come from Federal Emergency Management Agency (FEMA)/Rhode Island Emergency Management Agency

(RIEMA), the Community Development Block Grant/Disaster Recovery (CDBG-DR) program, and the Natural Resources Conservation Service (NRCS) /RI Conservation District
- Process can take several to many years, and is extremely complicated. Having an experienced consultant is important to manage all the moving parts.
- Topics addressed: Uniform Relocation Act; severe repetitive loss properties; relocating residents; housing vouchers; relocation fees; fair-market value compensation; low-mod income assistance programs; owners vs. renters; ownership/deed restrictions; foreclosures; management and decommissioning of utilities; site remediation; returning land to open space; eminent domain; distinction between buyouts (piecemeal) and land acquisitions (managed program); role of municipal, state, and federal entities
- Follow up / future sessions are needed with the Natural Resources Conservation Service (NRCS) and US Army Corps of Engineers, and a RI state agency or office to lead this effort.
- Rhode Island would benefit from a central office that serves as a resource and knowledge center on buyouts for municipalities to better manage these efforts.

Workshop: Building a Resilient Community

Date: August 14, 2018 (Barrington Public Library)

Workshop Organization and Goals:
As part of Barrington's Emergency Preparedness Week, a hands-on workshop facilitated by Barrington's planning office (Philip Hervey, Kim Jacobs) and Save The Bay (Wenley Ferguson) was conducted with attendees focused on evaluating and suggesting mitigation measures for a number of Barrington's coastal areas prone to flooding. The activities of Emergency Preparedness Week were developed by the Barrington Program for Public Information ad-hoc committee, with which the demonstration site team participated.

Workshops: Transportation Network

Dates: May 16, 2019 (Warren Town Hall)
May 23, 2019 (Barrington Public Library)

Workshop Goals:
- Analyze the transportation network for vulnerability to sea level rise or storm surge in Barrington and Warren

- Use maps, data, and local expertise to explore existing and new strategies necessary for making the transportation network more resilient to changing conditions

Workshop Structure (Facilitator: Teresa Crean, URI Coastal Resources Center, funded by the Coastal Institute Demonstration Site program):
The project team decided to convene separate workshops for each town (unlike the Land Use approach) because many, but not all, of the transportation issues, alternative strategies, and challenges were unique to the individual towns. The workshop agenda, introductory PowerPoint presentation, and map handouts are presented in the APPENDIX 1.

The transportation workshop discussions benefitted greatly from the findings of the UPenn School of Design technical report that provided extensive recommendations regarding reinforcing or abandoning portions of the town's major transportation and emergency routes (*A Future with Water: Sea Level Rise in Rhode Island*; https://www.design.upenn.edu/city-regional-planning/graduate/work/future-water-sea-level-rise-rhode-island). Following an overview of the UPenn findings and brief presentations by the town planners offering their perceptions of transportation network issues, the workshop participants were charged with the following tasks:

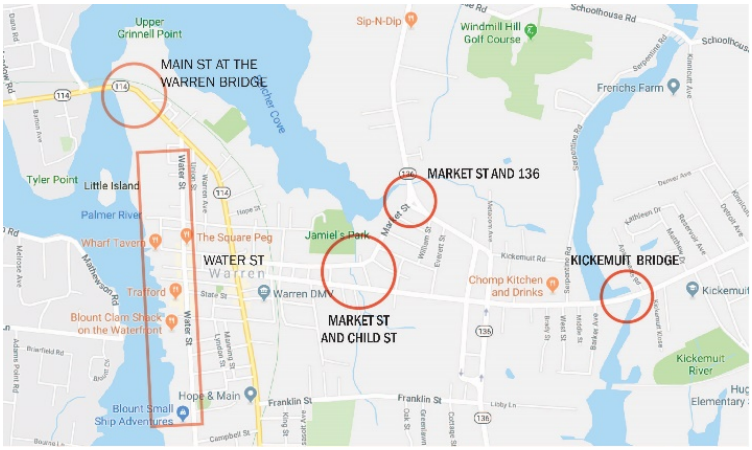
- Rank the highest 3-5 priority transportation areas of concern in the town
- Identify the local consequences of a flooded transportation network
- Delineate alternatives for adaptation to future flooding and the challenges to implementing these alternatives

The Barrington Bridge was one of the sites visited during the UPenn School of Design study tour of Rhode Island.

Transportation Workshop Outcomes:

WARREN

- Rank the highest priority transportation areas of concern in the town
  -- Intersection of Market Street and Metacom Avenue (Route 136)
  -- Market Street and Child Street South of Jamiel's Park
  -- Kickemuit Bridge (Child Street over the Kickemuit River)
  -- Main Street (Route 114) at the Warren Bridge
  -- Water Street



- Identify the local consequences of a flooded transportation network in town
  -- During flooding, limited access to Metacom Avenue for access to medical services
  -- Unclear who is responsible for maintenance of culverts that help prevent flooding
  -- Threat to businesses, especially waterfront businesses on Market Street
  -- Flooding threatens overall viability of the future transportation network
  Regional: -- Overflow of traffic to Metacom Avenue when other towns have impacts
  -- Congestion on Metacom Avenue may also affect regional access to medical facilities

- Delineate alternatives for adaptation to future flooding and identify the challenges to implementing these alternatives
  Water Transportation: as an option for emergency services, especially during storm surge events that impact a larger amount of the road network
  Challenge: Only viable for emergency services
  Raise Transportation Infrastructure**:** raise roads threatened by sea level rise
  Challenge: This may be short sighted since it would also require that the structures around these roads be elevated to provide them access to the raised road
  Identify Alternative Routes**:** use routes that are not under threat of permanent inundation
  Challenge: This would divert congestion/traffic to other routes
  RIPTA Bus Service on Metacom Avenue**:** provide bus service along Metacom, which is mostly safe from sea level rise
  Challenge: This is not currently where most of the population lives

Relocate Water Street Businesses**:** relocate businesses at the heart of the Warren economy along Water Street through a buyout program and abandon portions of Water Street

Challenge: FEMA floodplains don't address sea level rise, so state might need to consider its own buyout program

Challenge: Significant revenue stream is at risk, total abandonment not seen as an option

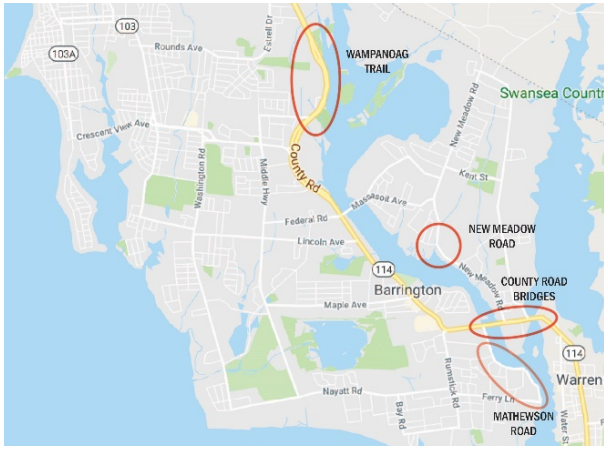
Water Street Barrier**:** build a barrier to protect the businesses on Water Street

Challenge: RI CRMC (Coastal Resources Management Council) currently has a permit restriction regarding coastal hardening

- What is the bigger concern: storm surge or sea level rise?
  -- From an emergency perspective, sea level rise with twice per day high tides is a larger problem
  -- Storm surge affects are episodic, but recovery of the town's vitality impaired by surge impacts is more difficult

BARRINGTON

- Rank the highest priority transportation areas of concern in the town
  -- Wampanoag Trail- north of the White Church
  -- County Road Bridges - Barrington Bridge and Warren Bridge
  -- New Meadow Road - at intersection with Meadowbrook Drive
  -- Mathewson Road- along the Barrington River



- Identify the local consequences of a flooded transportation network in town
  -- Loss of a major artery along Wampanoag Trail and County Road Bridges
  -- During flooding the Hampton Meadows neighborhood, which includes two schools, loses evacuation route on New Meadow Road
  -- If the state dedicates funds to maintaining roads, they may be serving abandoned or vacant lots
  -- Traffic redirected from one area might create bottlenecks or congestion elsewhere
  -- Lack of access for emergency and medical services

- Delineate alternatives for adaptation to future flooding and identify the challenges to implementing these alternatives

  Route 103: as an alternative emergency route and main highway through East Providence

  Challenge: This is not a direct route and there are many houses on this route. Would this be able to handle the increased traffic?

  New Routes on Higher Land**:** consider new roads on higher ground not flooded by sea level rise

  Challenge: May be difficult as this land is already owned and might require eminent domain in order to acquire.

  Elevate Wampanoag Trail**:** Re-angle for drainage, elevate, or build a causeway to keep Wampanoag Trail as a main thoroughfare

  Challenge: If the state spends millions of dollars on this project, will Wampanoag Trail be serving vacant lots?

  Buyouts**:** Provide buyouts for homes, starting with those that are most vulnerable

  Challenge: Buyouts are expensive and the source of funds is uncertain.

  Abandonment of Flooded Roads**:** Abandon roads flooded by permanent sea level rise

  Challenge: Homeowners along these roads may sue the state for not maintaining these roads that lead to their property. Homes may need to be vacated before roads can be abandoned.

  Communicating the Risk of SLR**:** Notify many residents and organizations of the risks and planning being done to adapt to sea level rise challenges

  Challenge: There are many community members, groups, and leaders that would need to be at the table for these discussions

  Challenge: These meetings can be illuminating, but engender pessimism. There is little precedent for the best way to convey this message.

STUDENT ENGAGEMENT

The demonstration site project team is pleased to serve as mentors for university students with an interest in working on real-world issues and interacting with program managers, policy-makers, and scientists from multiple disciplines. Student involvement is a valued strength of the demonstration site program. In this section we provide brief overviews of the outcomes/findings from the student projects – the reader is encouraged to review the technical reports and PowerPoint presentations for details.

URI Department of Landscape Architecture (Faculty Lead, Professor Richard Sheridan)

As the Barrington-Warren demonstration site was in its formative stages, Professor Sheridan was seeking a project related to sea level rise planning for his undergraduate "design studio" class. Collaboration with the mixed-use demonstration site seemed ideal, with a focus on Warren to keep the class project manageable. The class had several field trips to the town and meetings with the Warren town planner, university faculty, RI coastal management personnel, and the demonstration site team. The project culminated with a public presentation held in Warren and a detailed PowerPoint presentation.

Catch basin rendering by URI Department of Landscape Architecture students

Dates: Fall 2016 semester
Presentation: December 6, 2016 (Warren Town Hall)

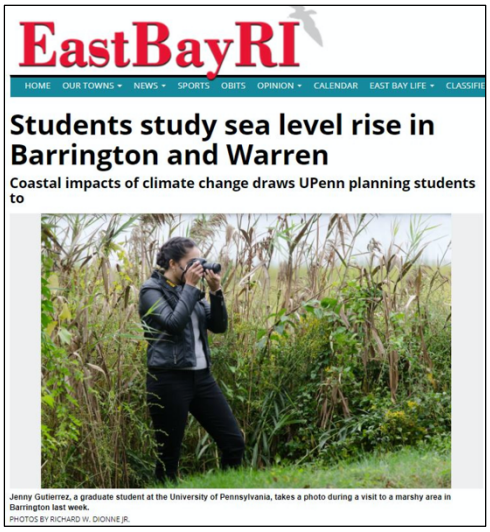
Outcomes:
The overall objective of the semester-long project was to prepare landscape designs, specific to Warren, that are able to adapt and evolve with sea level rise and storm surge. Some of the concept designs were as follows, with details and additional findings from the class found on the student's PowerPoint presentation (APPENDIX 2).

- To enhance flood storage and infiltration along the Water Street waterfront, replace parking lots and driveways with pervious pavers or grass pavers (made of 100% recycled plastic). Grass pavers will reduce the heat island effect.
- Create a natural coastal buffer, augmented with native vegetation, along the waterfront for flood and erosion control, provide wildlife habitat and a natural transition to higher elevation areas, and add an aesthetically pleasing element

- Revitalize Burr's Hill Park so it can maintain the open space and recreation needs, while serving a flood storage and erosion control role. Install impervious pavement, bioswales, larger beach area, expand salt marsh shoreline.
- Design recreational fields at Jamiel's Park for storm surge flood protection.

University of Pennsylvania, School of Design
(Studio Leads, Scott Page and Jamie Granger)

Scott Page, UPenn Department of City and Regional Planning, was aware of the excellent work being done by the RI Coastal Resources Management Council with regard to coastal flood risk modeling and planning for sea level rise/storm surge. He approached his colleague, Teresa Crean—currently supported as a team member of the demonstration site project, expressing an interest in engaging his graduate-level students in a Rhode Island focused study. All demonstration site team members considered this to be a worthwhile opportunity for Barrington and Warren. The ten students of the studio team visited Rhode Island for a week in early October 2018, traveling to Barrington and Warren, along with Newport and Warwick, to visit vulnerable sites, and as important, to meet with state and town leaders that are addressing issues related to sea level rise and storm surge planning. This trip coincided with the demonstration site Land Use Planning topic-focused workshop. The demonstration site team (T. Crean, A. Neville) also met with the class in Philadelphia to comment on the preliminary findings of the class and provide their insights. The studio team produced an impressive comprehensive technical report suggesting many adaptation strategies and offered their findings at a public presentation.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Students study sea level rise in Barrington and Warren

Coastal impacts of climate change draws UPenn planning students to

Jenny Gutierrez, a graduate student at the University of Pennsylvania, takes a photo during a visit to a marshy area in Barrington last week.

PHOTOS BY RICHARD W. DIONNE JR.

Local newspaper coverage of UPenn site visits.

Dates: Fall 2018 semester
Site Visit; October 1-5, 2018
Demonstration Site Team, mid-term review at UPenn; November 1, 2018
Public Presentation; January 28, 2019

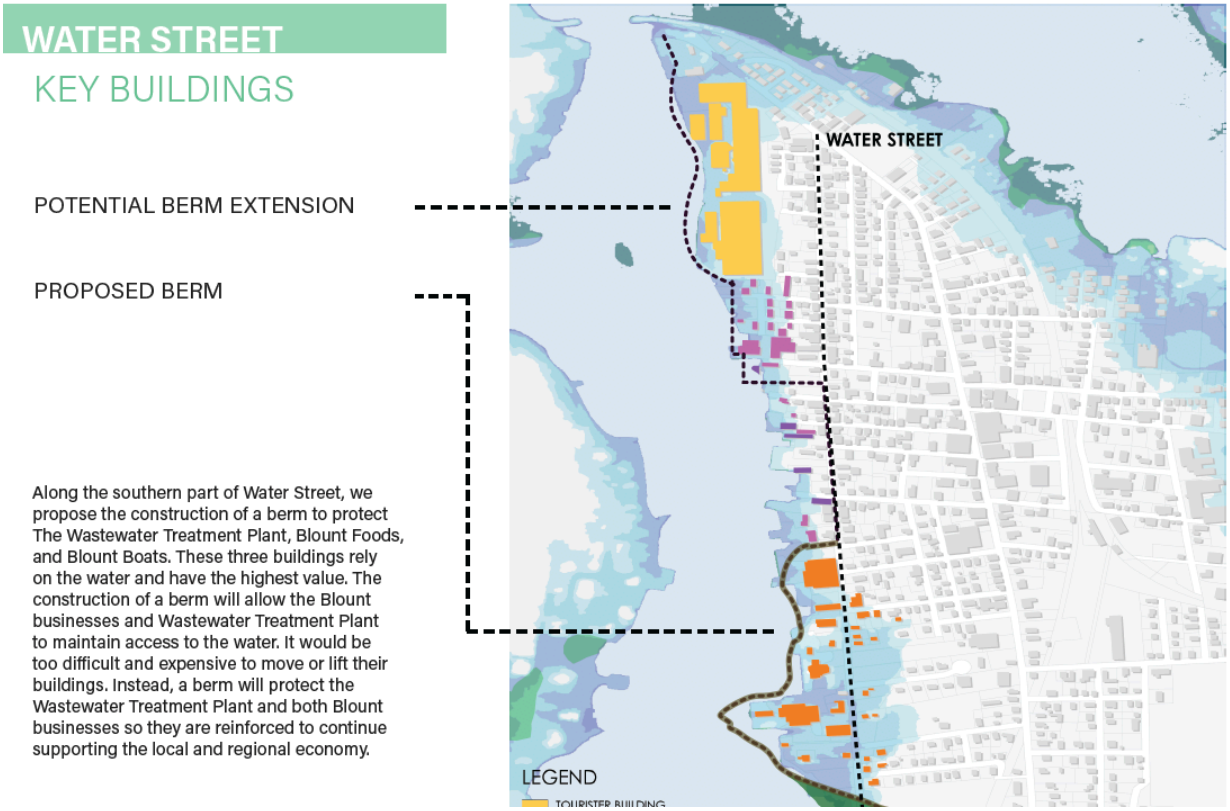
Technical Report: *A Future with Water: Sea Level Rise in Rhode Island*; https://www.design.upenn.edu/city-regional-planning/graduate/work/future-water-sea-level-rise-rhode-island

Outcomes:
This report will not provide all the details of the findings from *A Future with Water: Sea Level Rise in Rhode Island*, but will offer brief summaries of the key sections of the report. The 200+ page report is filled with insightful observations and suggestions accompanied by informative graphics.

- Synopsis of characteristics of Barrington and Warren, including demographics, community assets (e.g., historic structures, open space, recreation areas, town centers, etc.), and economic drivers
- Review of current and future sea level rise and storm surge scenarios (derived from STORMTOOLS), including an assessment of residential and commercial buildings, infrastructure (e.g., roads, utilities, pump stations, etc.), and habitats (e.g., salt marshes, inland wetlands, ponds) threatened under each scenario.
- The remainder of the report addressed adaptation actions developed around this theme; "*Instead of resisting the rising sea, Barrington and Warren must evolve to live with water – to give room to the rising sea and to inhabit a landscape of wetness. Our vision for these communities is to embrace the inevitability of sea level rise and to become leaders in adaptive excellence.*"
- Suggested adaptation actions are categorized as;
  -- *Reinforce* (e.g., elevate buildings, building code enforcement, risk communication)
  -- *Retreat* from vulnerable areas (establish a "coastal risk overlay zone" where no new non-floodable structures would be permitted and existing homes would be eligible for government-sponsored buyout programs)
  -- *Restore* inundated lands to natural habitat and open space
- Four adaption sites were then identified and the planning tools of reinforce, retreat and restore were applied.
  -- *Wampanoag Trail (Rt. 114)* is a critical transportation corridor in the East Bay region. Under a modest 3-ft rise in sea level, portions of Rt 114 will need to be reinforced (elevated), bridges along Rt. 114 and bridges and roads that provide access to Rt 114 will need to be elevated. With 5-7 feet of sea level rise, the report suggests retreat from portions of Wampanoag Trail will be necessary and roadways realigned throughout Barrington and Warren to maintain routine transportation corridors and emergency routes. Abandoned roads will be restored to natural habitats.
  -- *Water Street* is a commercial, residential and historic center of Warren and is particularly vulnerable to flooding. The report suggests that this area be preserved and details are provided where the reinforce strategies could be implemented as necessary for water-dependent businesses and retreat for residences. A berm at the water's edge is suggested to protect some portions of Water Street.

-- *Jamiel's Park* and the adjacent densely developed areas of Market Street and Child Street currently experience routine flooding, with future flood risks being extensive. Recommendations are offered regarding widening and restoration of the creek from Belcher's Cove. Buyout of residential properties is an option for this high-risk area. Plans are suggested for removing impermeable surfaces from the park and establishing stormwater retention areas.
-- *Upland Development Zones*. With a 7-ft rise in sea level it was estimated that 365 buildings would be flooded in Warren. Retreat is the most viable option, but to retain the population and economic growth within the town the displaced residents need a place to relocate. The plan identifies possible upland development zones that could accommodate those involved in a retreat and relocate buyout program.

UPenn students present final report at Warren Town Hall



UPenn proposed protective berm for Water Street, Warren, RI

URI Masters in Environmental Science and Management Program (Faculty Mentors, Brett Still and Charles Roman)

Graduate students in the URI Masters in Environmental Science and Management Program (MESM) are required to obtain experience working with mentors in their field of environmental management. A graduate student in the Department of Natural Resources Science, Kelly Medeiros, expressed an interest in learning more about community adaptation to sea level rise, storm surge, and flooding. Collaborating with the demonstration site team, she was charged with two major tasks.

- Summer 2018 semester. K. Medeiros reviewed adaptation practices being considered and/or implemented throughout coastal New England and beyond (e.g., Norfolk, VA).
- Fall 2018 semester. In response to her summer 2018 findings and to buyout discussions at the Land Use Planning workshop, she was then asked to pursue an in-depth review of buyout literature and buyout programs.

K. Medeiros produced two technical reports, presented her findings before the demonstration site team and state agency officials, served as a group co-facilitator at the

Land Use Planning workshop, and participated in some of the buyout work sessions. Her efforts were instrumental in providing background information for the UPenn project team and moving the buyout session discussions forward.

Dates: Summer 2018 semester
Presentation; August 28, 2018 (URI)

Fall 2018 semester
Presentation; December 12, 2018 (URI)

Technical Reports and PowerPoint Presentations (see APPENDIX 2):
Planning for Sea Level Rise and Storm Surge to Protect Coastal Municipalities and Ecosystems: Information Gathering Project (Kelly Medeiros)

Bibliography of Select Buyout Programs (Kelly Medeiros)

Outcomes:

- The "*Planning for Sea Level Rise . . .*" report provided a detailed review of reports on coastal climate change vulnerability assessment and adaptation or resilience planning for three Massachusetts communities (Gloucester, Hingham, East Boston/Charlestown) and Norfolk, Virginia. Common adaptation actions included;
  -- *Protection or Reinforce* solutions, such as, elevate structures and roads, hurricane barrier systems (analogous to Providence, RI or New Bedford, MA), permanent flood walls
  -- *Retreat*; buyout programs, rolling easements
  -- *Zoning* strategies; enhanced performance standards for new construction and renovations, establish coastal zone risk districts, institute buyout programs
  -- *Habitat and flood storage*; marsh and dune restoration and creation, living shorelines, blue and green roofs, berms, permeable pavement, stormwater tree trenches, rain gardens
- It was noted that many communities seem to lack or have limited provisions to monitor the effectiveness of implemented adaptation strategies. Monitoring should be a fundamentally important aspect to adaptation programs.
- The *buyout program review* focused primarily on experiences from Superstorm Sandy (NY-NJ) and Hurricane Harvey (Houston), but also included some more nationally focused assessments. Some important "lessons learned" include;
  -- Buyout programs are most cost effective and receive local support when new housing for those that are relocated is nearby to the destroyed or bought-out dwelling

-- Understanding the programs impact on households and communities is limited, yet it is critical to program success
-- Critical evaluations of successes and failures of existing programs are needed

- Buyout program challenges include;
  -- Funding limitations
  -- Slow process
  -- Strict criteria and the bureaucratic process place buyout programs out-of-reach for many willing participants

OUTREACH AND INFORMATION SHARING

The citizens of Barrington and Warren, and throughout the coastal zone, will need to make difficult, costly, and life-changing decisions as adaptation strategies in response to sea level rise, storm surge and flooding are implemented. It is important that the communities be aware of the threats of climate change and understand the possible adaptation options, their costs, social consequences, and environmental benefits or impacts. To facilitate information exchange and consensus building, the demonstration site program sponsored evening expert panel discussions, open to the public and media, covering a variety of climate threat and adaptation topics. Initial outreach activities that have been conducted were focused on the local communities and broader audiences.

Panel Discussions: Coastal Resilience Topics

Local community outreach is an important aspect of the demonstration site program, so we introduced the program to Barrington and Warren at well-attended public panel discussions. Topics included an introduction to the Demonstration Site objectives, overview of sea level rise and storm surge science, demonstration of STORMTOOLS to identify vulnerable assets, discussion of habitat change issues, and identification of ongoing adaption actions and other policies and strategies to enhance community and ecosystem resilience. Participants were provided with an informative list of websites containing information that focused on climate change in Rhode Island, tools to understand storm and flooding vulnerabilities in coastal RI, relevant hazard planning documents for Barrington, Warren and Rhode Island, and some technical science documents (see APPENDIX 3 for this list).

Panel Members: Charles Roman and Amber Neville (URI Coastal Institute), Teresa Crean (URI Coastal Resources Center), Janet Freedman (RI CRMC), Wenley Ferguson (Save The Bay)

Dates: May 31, 2017 (Barrington Town Hall); preceded by a town-organized walking tour of vulnerable sites
February 1, 2018 (Warren Town Hall)
PowerPoint Presentations (see APPENDIX 3)

Field Trip: Coastal Institute Senior Fellows Annual Meeting

The URI Coastal Institute senior fellows convened their annual meeting and field trip in Warren. Jan Reitsma (former Warren Town Manager) was the luncheon speaker and discussed climate challenges facing the town. A field trip to several vulnerable sites

included discussion among the Warren town planning office and the 30+ scientists in attendance, with possible adaptation strategies offered.

Date: July 20, 2017 (Armory Hall, Warren; field trip sites, Jamiel's Park, Warren wastewater treatment facility, Palmer River/Belcher Cove salt marshes)

Field Trip Leaders: Kate Michaud and Bob Rulli (Town of Warren), Teresa Crean (URI Coastal Resources Center), Charles Roman and Amber Neville (URI Coastal Institute)

URI Coastal Institute trip to Warren Wastewater treatment plant, Warren, RI

Ad-Hoc Committee and Public Presentation: Barrington Program for Public Information

The Program for Public Information Committee, facilitated by Barrington's planning office (Philip Hervey and Kim Jacobs) is composed of a diverse group of stakeholders (including demonstration site team members Teresa Crean and Amber Neville) tasked with developing a comprehensive public information program to disseminate information to the residents on flood hazards, flood safety, and the function and benefits of floodplains. Demonstration site member Teresa Crean provided a public lecture in association with Barrington's Emergency Preparedness Week, an event planned by the ad-hoc committee; the lecture, titled "Health Risks in a Changing Climate," addressed topics of floodplain protection, flood safety, and preparedness.

Committee Meeting Dates: July 9, 2018 (Barrington Peck Center for Adult Enrichment)
July 31, 2018 (Barrington Public Library)
February 11, 2019 (Barrington Public Library)
April 24, 2019 (Barrington Public Library)

Public Lecture: August 18, 2018 (Barrington Public Library)

Program for Public Information facilitated by the Barrington Planning Office

Professional Presentations

An important role for the demonstration site team is to announce the program widely to RI environmental managers, policy-makers, and scientists. The team also sought to reach regional and national audiences. These presentations, followed by discussion, provided an excellent opportunity to exchange ideas regarding sea level rise, storm surge, and options to enhance resilience of the built-community and natural resources.

Professional Meetings and Dates:

"Rhode Island Land and Water Conservation Summit," March 11, 2017 (Univ of RI)

"Rhode Island Flood Mitigation Association Conference: Building Flood Resilience, Naturally", April 6, 2017 (Smithfield, RI)

"Coastal and Estuarine Research Federation, Biennial Conference," November 5-9, 2017 (Providence, RI)

"Rhode Island Flood Mitigation Association Conference: What Works? Implementing Lessons Learned," April 30, 2019 (Smithfield, RI)

Presenters: Leaders of the three Coastal Institute Demonstration Sites;

Napatree Point Conservation Area (natural area)

-- P. August (URI Natural Resources Science), J. Sassi (Watch Hill Conservancy)

Port-of-Providence (urban area)

-- A. Becker (URI Marine Affairs)

Barrington-Warren (mixed-use)

-- C. Roman, A. Neville, J. Swift (URI Coastal Institute)

-- R. Rulli (Town of Warren)

FUTURE DIRECTIONS

The URI Coastal Institute is committed to collaborating with Barrington and Warren as they explore adaptation actions that are necessary to enhance community resilience and sustain natural ecosystems. Over the next 12-18 months, the demonstration site team plans to pursue the following.

- Since the Barrington and Warren joint proposal to be part of the Rhode Island Municipal Resilience Program (MRP) was successful, the demonstration team expects that the workshop findings, student products, and outreach efforts presented here will be useful as the MRP process assesses vulnerability and identifies actions to build community resilience. The demonstration site project team looks forward to sharing its findings and working with the MRP effort. As needs are identified by Barrington and Warren and by the MRP efforts, the demonstration site team is ready to assist with addressing these needs through information gathering and synthesis, organization/facilitation of topic-focused workshops or work sessions, and other tasks.

- The demonstration site team has been successful at attracting students to participate in the Barrington and Warren program. Student engagement will continue to be an important aspect of the demonstration site program. Their commitment to this work is also driven by the reality of these scenarios as their future.

- There has been much interest with the several buyout sessions that have been convened. Facilitation of these sessions will continue. In addition, the URI Coastal Institute is interested in organizing a "buyout strategy conference" with invited speakers to learn of successful programs from other regions (e.g., NY/NJ, Hurricane Sandy; Houston, Hurricane Harvey) and experiences from Rhode Island. Conference presenters and discussion groups may include representation from federal, state, regional, and local governments, as well as stakeholders, citizen groups, academia, and others.

- The demonstration site program has a keen interest in monitoring or assessing, in an objective and quantitative manner, the effectiveness of adaption actions that are implemented or being tested. The demonstration site project team will seek appropriate funding to pursue monitoring and assessment.

- A section of the URI Coastal Institute website and associated social media will be dedicated to the Climate Response Demonstration Site program. The website will highlight the purpose and activities of the demonstration site initiative and serve as a portal for demonstration site products (e.g., reports, publications, PowerPoint presentations, maps, images) and links to other relevant sites that focus on community and ecosystem resilience.

- The Barrington and Warren Mixed-Use Climate Response Demonstration Site is joined by two other demonstration sites; Napatree Point Conservation Area and Port-of-Providence, representing natural and urban areas, respectively. As the findings and approaches from these three sites are compared, the site teams will identify adaptation strategies that are common to the different land use settings and those that are unique, collaborate on research and testing of common adaptation measures, and widely share the demonstration site approach of partnership building, public involvement, student engagement, scientific application, and multidisciplinary synthesis, as a model for communities, agencies, conservation organizations, and academic institutions to adopt.

APPENDICES

View Appendices on-line at: https://web.uri.edu/coastalinstitute-draft/appendices/

APPENDIX 1 (TOPIC-FOCUSED WORKSHOPS)
-- Land Use Workshop; agenda and workshop maps (Oct 4, 2018)
-- Transportation Workshop; agenda, PowerPoint Presentation, and workshop maps (May 16 and 23, 2019)

APPENDIX 2 (STUDENT ENGAGEMENT)
-- URI Department of Architecture; Class PowerPoint Presentation (Dec. 6, 2016)

-- UPenn, School of Design: Link to final technical report;
A Future with Water: Sea Level Rise in Rhode Island; https://www.design.upenn.edu/city-regional-planning/graduate/work/future-water-sea-level-rise-rhode-island

UPenn PowerPoint presentation (Jan 28, 2019)

-- URI MESM student (Kelly Medeiros)
Technical Report and PowerPoint Presentation (Aug 28, 2018): Planning for Sea Level Rise and Storm Surge to Protect Coastal Municipalities and Ecosystems: Information Gathering Project

Technical Report and PowerPoint Presentation (Dec 12, 2018): Bibliography of Select Buyout Programs

APPENDIX 3 (OUTREACH; PANEL DISCUSSIONS ON COASTAL RESILIENCE TOPICS)
-- Handout on "Selected Climate Change Response Resources"

-- PowerPoint presentations from the Barrington (May 31, 2017) and Warren (Feb 1, 2018) panel discussions

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