Municipal Vulnerability Preparedness Program Action Grant Case Study

Municipality: Town of Salisbury
Project Title: Resilient Ring's Island: Preventing a Neighborhood from Being Stranded by Flooding
Grant Award: $157,500
Match: $52,500

Community Overview:

The Town of Salisbury, Massachusetts borders the Atlantic Ocean and is bounded between the Merrimack River and the Massachusetts-New Hampshire state line. Amesbury borders Salisbury on the West and Newburyport to the south. Salisbury is located in Essex County and has a total area of approximately 17.9 square miles. The Town is primarily land based with 15.4 square miles of land and 2.4 square miles of water. The Town's land is made up of forest, salt marsh and wetlands, and residential development.

The median household income in Salisbury is $72,828, slightly below the median statewide income of $74,167 (2013-2017 American Community Survey 5-Year Estimates), 9.7% of the Town's residents live below the poverty level, and 36.5% are low- to moderate-income.

Description of Climate Impact:

Salisbury is a coastal town located on the North bank of the Merrimack River with 3.8 miles of coastal beach and dunes backed by a salt marsh. Away from the beachfront and coastal erosion, coastal flooding presents challenges to developed areas, including the Ring's Island area, during storms and extreme high tides when roadways at low elevations and undersized culverts force floodwaters onto roads and cause damage to homes and businesses. Approximately 8 to 10 times per year, flooding occurs at the Ring Island neighborhood's southwest evacuation route – at the intersection of 1st Street and March Road – leaving only the northern evacuation route, along Ferry Road, open. The Ferry Road evacuation route floods during King Tides and significant storms, stranding residents of the neighborhood and causing municipal resources, such as staff and emergency vehicles, to be diverted from other flooded areas so they can provide assistance to the neighborhood.

There are approximately 75 residential units and 15 businesses in the affected project area. The Town Pier and Harbormaster are headquartered on Ring's Island, the Town's only historic district. Ring's Island becomes completely closed off during storm events when the area roads

are flooded due to the failure of the culverts and the low elevations of the roadways. Also, due to undersized culverts, tidal flow to the upstream marsh is severely restricted. This limits proper flushing of the marsh and has resulted in the invasive Phragmites overtaking a large portion of the marsh, reducing ecological diversity, water quality and overall habitat health. Tidal restrictions can alter water levels and chemistry, diminish sources of ocean nutrients, and degrade entire upstream aquatic systems.

Flooding in this area is becoming less of an inconvenience and more of an urgent problem demanding solutions. According to the Massachusetts Climate Change Projections (Northeast Climate Adaption Science Center 2018), sea level rise in Boston Harbor could be as much as 4.0 to 10.2 feet in 2100. This is in addition to the nearly one foot of sea level rise that has occurred over the past century. With climate change causing sea levels to rise and storms and surge to increase, the flooding of roadways and properties in Ring's Island will happen more frequently and damages to infrastructure, buildings and the environment, as well as threats to public safety will increase.

The Town of Salisbury proposes to increase the resilience of the coastal neighborhood of Ring's Island by raising its access/egress roads and by improving tidal flushing through culvert replacements at both 1st Street/March Road and Ferry Road. The proposed project will increase the resilience of the Ring's Island neighborhood, which becomes isolated during extreme flooding events. The proposed MVP Action project involves a ***redesign and retrofit*** of infrastructure as well as an ***ecological restoration to increase resiliency***. The project will increase the resiliency of the roadway, reduce upland flooding in current and future climates, and enhance the resiliency of over 30 acres of salt marsh.

Project Goals:

This project addresses three of the highest priorities/goals identified in Salisbury's MVP Summary of Findings Report (February 2019), summarized below:

- Protect roads as municipal investments and as access/evacuation routes for residents, tourists, and workers. Strategies could include raising roads; improving flushing at road-water crossings; and protecting areas along, or in the vicinities of March Road and Ferry Road.
- Evaluate and study the addition of flood protection measures, as appropriate, on flood-prone streets/areas.
- Protect the marsh by implementing strategies that eliminate restrictions.

Replacement of the Ferry Road culvert was also selected by the Ipswich River Watershed Association based on a hydraulic and ecological screening assessment conducted in the

aftermath of Super Storm Sandy, as part of the Great Marsh Resiliency Project. The Merrimack Valley Region Hazard Mitigation Plan (updated 2016) identified the Ferry Road culvert as a high priority project, recommending adjusting the culvert sizes and consideration of "tidal control structures to increase tidal flows (for marsh restoration) while providing increased protection from flooding during coastal storms." Finally, the Great Marsh Coastal Adaptation Plan (2017) called for a comprehensive assessment of the Ferry Road area culverts, recommending consideration of raising the elevation of the road and implementation of a marsh restoration project.

Approach and Result:

To meet the Project goals and complete the scope items, the project team and its subconsultants:

1. Met with residents of the community as part of survey efforts, the Director of Public Works, the Director of Planning and Development, and other town staff.
2. Visited the project area; conducted topographic survey of the culverts, marsh, and roadway.
3. Reviewed available information provided.
4. Performed the necessary evaluation.

Criteria used in the evaluation included computer modeled flooding projections, ease of construction, necessity for land acquisition, environmental factors included permitting requirements, structural and subsurface reliability, and cost.

Understanding how important cost comparison is for municipal projects, detailed cost opinions for each of the viable alternatives for the project areas was completed.

Culvert Alternative Recommendations

Table 2.1: Culvert Design Alternatives

Alternative Scenarios	Culvert Type	Existing Height (ft)	Existing Width (ft)	Proposed Height (ft)	Proposed Width (ft)
Ferry Road 5' x 5'	Box	2.95	2.70	5.0	5.0
Ferry Road 5' x 8'	Box			5.0	8.0
Ferry Road 8' x 8'	Box			8.0	8.0

March Road	Concrete Pipe	1.6	1.6	2.5	2.5
First Street	Concrete Pipe	2.95 (Collapsed)	2.95 (Collapsed)	2.5	2.5

Raised Roadway Proposed Elevation

The sea level rise (SLR) projections were evaluated to be +2.3 feet by 2070. The SLR condition modeled with the existing road conditions, allows for overtopping of Ferry Road and inhibits an evacuation route for the Rings Island community. To accommodate the SLR projection and to prevent overtopping of the roadways during typical tides, a proposed road elevation of at least 9.0 feet NAVD88 is recommended.

Raised Roadway Proposed Options

Option 1 utilizes a raised earthen berm to elevate the access/egress roads to elevation 9.0 feet NAVD88. The modelling results indicated that Ferry Road, Second Street and March Road are recommended to be raised, while First Street may remain as is. This approach would limit residents from evacuating the neighborhood to only Ferry Road or around March Road to Bridge Road access. Due to this limitation and that there are no modelled issues with including First Street in the recommendation, First Street is included and would be raised. The recommended culvert types and sizes under First Street and March Road remain the same.

The earthen berm is to consist of lightweight fill and grading installed at a 2:1 slope to existing ground elevation and around each culvert headwall and wingwalls to promote stabilization.

Option 2 utilizes a concrete block wall approach to raise the roadways to elevation 9.0 ft NAVD88. Two material options were considered in this alternative of roadway improvements. These options consisted of vinyl sheet piles and precast concrete blocks. Based on the results of the geotechnical analysis and estimated costs, the precast concrete block wall option was advanced. This approach achieves the proposed roadway elevations as well as minimizes the impact to the surrounding wetlands. The project extents remain consistent as is proposed for Option 1, and the proposed culvert design parameters are consistent with the recommendations.

Option 3 includes a spanned bridge approach allowing for unrestricted flow of tidal movement. This approach would remove the existing culverts and would not require culvert replacement. Installation of the spanned bridge would entail precast concrete pile columns to suspend the

roadway at elevation 9.0 ft NAVD88. This alternative removes the need for a culvert redesign, as the elevated roadway would allow for unrestricted flow of tidal movement through the salt marsh which ultimately would flood a greater area in the future.

The following link is the presentation to the community:
https://m.facebook.com/SCTVMC/videos/495849571317748/

Salisbury DPW Project Homepage:
https://www.salisburyma.gov/home/events/45544

Lessons Learned:

Each alternative design option had been evaluated for four (4) different variables, including impacts to protected environmental resources, required permits, permit costs, and permit approval schedule.

Due to the significant impacts to wetland resource areas a Permitting Strategy Matrix had been developed based on the four variables.

Based on the results of the Permitting Strategy Matrix, Option 2 without sidewalk would result in the least amount of environmental impacts, lowest level of environmental permitting effort, costs and approval schedule **but higher capital cost**. The least preferred option is Option 1 with sidewalk which is the **lowest cost alternative**. Both Option (1) and Option (2) were carried through the preliminary design phase which increased the amount of work overall.

Partners and Other Support:

The project was managed and performed by Weston & Sampson with collaboration from the Woods Hole Group (WHG), and town personnel. Weston & Sampson managed all aspects of the preliminary design and data gathering through the development of the design drawings, preliminary design report and engineer's opinion of probable construction cost for each alternative.

WHG, Weston & Sampson's subconsultant, collected and analyzed environmental data associated with the Ring's Island project area. This analysis was conducted to evaluate the current dynamics of the existing culverts and if the existing culverts are sized sufficiently to handle future tidal events. A tidal hydrology survey was conducted by installing data loggers at four locations around the project area to record water level, conductivity, and temperature

time series. In addition, a topographic survey was conducted to collect elevation data to define the marsh surface, the existing culverts, and to capture existing roadway characteristics at each of the culverts. Once the data was collected and analyzed, WHG developed a hydrodynamic-culvert model based primarily on tide and salinity data. Culvert and road elevation alternative simulations were evaluated through the model to develop overall recommendations for design parameters to accommodate predicted sea level rise (SLR) scenarios and large storm events.

Project Photos: Ferry Road (Photo 1), First Street (Photo 2)