Coastal Resilience Grant Case Study

Municipality/Organization: Town of Plymouth
Project Title: Plymouth Long Beach Mixed Sediment Nourishment – Design and Permitting
Grant Award: $142,000
Match: $49,740.68

Community/organization overview:
Plymouth Long Beach is a barrier spit approximately 3 miles in length that encloses Plymouth Harbor. Long Beach provides storm damage protection and flood control for the harbor, approximately 4.5 miles of developed coastline, and the economic, environmental, and historic resources located there. The coastline consists of both residential and commercial development, including the downtown waterfront area, which is an economically important area for the Town. The harbor is important for both recreational and commercial boaters. Long Beach provides protection for a marina and yacht club, as well as the Town wharf and pier, and the state boat ramp and pier, and approximately 700 moorings for recreational boats. Commercial boating includes whale watching, fishing charters and a fishing fleet with the third highest lobster landings in the state. Historic resources such as Plymouth Rock and the Mayflower II are also located within the harbor area.

Approximately 90% of the beach is owned by the Town of Plymouth, and there are 20 private properties, including 16 homes, and a gravel access road known as Ryder Way that runs approximately 2 miles along the beach. The beach is a popular recreational area and is also an important breeding and staging area for coastal waterbirds, including piping plovers as well as several species of terns that are also protected under state and/or federal law.

Long Beach has a long history of shoreline management going back several hundred years. The most significant efforts include a stone dike running the length of the beach that was built by the Army Corps of Engineers in the early 1900's. Some portions of the structure have been maintained or rebuilt. Although the location of the shoreline is stable in the area where the stone dike was rebuilt, the negative impacts typically observed with a hard structure, including loss of the beach and scouring of landward areas does occur over some of its length. These effects are exacerbated by armoring of upcurrent areas that results in sand starvation of the southern part of the barrier system. The area where the dike has deteriorated is particularly vulnerable to and has experienced significant erosion during coastal storms.

Description of climate impact(s):
Severe storms, particularly over the last decade, have significantly impacted the project area, which is an approximately 2,000ft long area located where the stone dike has deteriorated. Major coastal storms, including the February 2013 blizzard, January 2015 blizzard, and March

2018 nor'easters, as well as other less severe storm events, have resulted in lowering of the beach elevation and shoreline retreat in the project area.

The March 2018 nor'easters caused severe erosion in the project area. The elevation of the project area was lowered 8-10 ft in some areas, and the gravel access road, known as Ryder Way, washed out completely in the southern portion of the project area. In addition, two private homes in the area sustained some damage, including exposing their septic systems. The road was repaired with beach-compatible mixed sediment material, however, it continues to need minor repairs throughout the year during spring high tides and minor storm events, and more significant repairs annually following the winter storm season so that vehicles can safely pass through the area.

Ryder Way is the only vehicle route for access to 20 private properties as well as public recreational areas, including for evacuation and for police, fire and emergency medical services.

Piping plover and least tern nesting habitat is located within the project area. As many as 3 pairs of piping plovers per season have nested in or near the project area and a small colony of least terns uses this area each season. The erosion in this area has narrowed and lowered the available nesting habitat making it more vulnerable to flooding and nest loss.

Continued erosion in the project area will result in degradation of natural resources including piping plover and least tern nesting habitat, vegetated and dune areas and saltmarsh along the harborside. The road will continue to require repairs to maintain vehicle access. If erosion were to become severe enough, a breach could open up in this area, which would negatively impact the barrier beach's ability to provide storm damage and flood control for Plymouth Harbor and the downtown waterfront areas.

The erosion and storm damage occurring at Long Beach is even more concerning in light of climate change and sea level rise. Sea level rise and increased erosion rates will lead to increased susceptibility of barrier beaches to erosion, overwash and breaching, putting the developed shorelines behind the barrier beaches at risk. Barrier beaches are particularly vulnerable because they are generally low-lying areas within a few feet of current sea levels.

Even the most conservative sea level rise projections will result in increased coastal erosion and storm damage. The documented trend of more frequent and higher intensity storm events will compound the problems of sea level rise in the future. Maintaining Long Beach as a functioning barrier beach that can continue to provide flood control and storm surge protection is important to long term protection of the harbor and adjacent coastline.

Climate change projection(s):

For the nourishment design for Long Beach a specific sea level rise scenario was not utilized but was examined and accounted for as the littoral response at varying still water elevations and

wave conditions was analyzed. Mixed sediment beaches, or in this case nourishment, naturally offer a flexible landform that can continuously adapt and adjust to changes in sea level and wave climate. Therefore, the nourishment will naturally adapt to low and intermediate sea level rise projections. If at some point in the future, a rapid intensification of sea level rise occurs, the nourishment can be quickly adapted to the changing conditions by adding additional sediment to increase the elevation of the nourishment crest to allow for natural response to higher water levels and increases in wave energy at higher elevations along the barrier beach.

Project goals:

The goal of the project was to increase the resilience of Long Beach with a nature-based solution, specifically, to design and permit a nourishment project for a vulnerable portion of the beach that will increase resiliency to coastal storm damage and sea-level rise, enhance barrier beach function, including providing storm damage protection and flood control, and protect the infrastructure on Long Beach.

Approach and result:

The project team began by surveying existing conditions, including topography, resource areas, jurisdictional areas and structures, as well as conducting a shellfish survey and sediment sampling. The project team met with reviewers from different permitting agencies several times during the analysis and project design phase to identify specific design elements required in the presence of endangered species, wetland habitats and other resources. The engineers analyzed the existing sediment for compatibility of mixed sediment nourishment material including sand, gravel and cobble. Coastal modeling was performed to identify a nourishment design that would have some longevity and would accomplish the goal of enhancing resiliency and protecting infrastructure. Three scenarios were considered in the alternatives analysis: A) dune nourishment at a 12' elevation, B) dune nourishment with 10' elevation, and C) dune nourishment with 12' elevation along with beach nourishment. Through the alternatives analysis, alternative A was determined to be the alternative that would have the greatest longevity and would accomplish the project goals.

Prior to preparing permit applications, the project team met with the permitting agencies to receive feedback on project design, permitting process and to identify additional information required with application submittals.

Lessons learned:

Reaching out to the abutters and the homeowners association early on in the project was beneficial. Town staff reached out prior to submitting the grant application to talk about the project and gather support, and the project team met with them onsite to review the project design alternatives and address questions and concerns.

Tapping into the Town staff's knowledge and experience reduced costs. The Natural Resources staff conducted the shellfish survey and prepared the survey report, which reduced the cost of that project task and contributed to the Town's grant match.
Pre-application meetings with regulatory agencies allowed the project team to get feedback on project direction and design and identify additional information that needed to be provided for a complete and more efficient permit application submission.

Partners and other support:
The Massachusetts Office of Coastal Zone Management provided grant funding and technical assistance for the project.
The Town worked with two engineering firms on this project. Foth Infrastructure and Environment, LLC focused on project management, field survey, plans and environmental permitting, while Applied Coastal Research and Engineering, Inc. focused on sediment compatibility assessment, coastal modeling and alternatives analysis.
The direct abutters as well as the Long Beach Homeowners Association and the Town's Natural Resources and Coastal Beaches Committee provided feedback and letters of support.

Next steps:
The grant funding and timeline provided for design and preparation of the applications for the permits required for the nourishment project. The next steps include following through to complete the permitting process and securing funding for the construction phase of the project.