Resilience and Durability Pilot Projects 2018 – 2020

The Federal Highway Administration (FHWA) partnered with eleven pilot project teams to assess and deploy resilience solutions. This case study is part of a series that summarizes the pilot projects and highlights transportation system resilience efforts at other agencies across the country. For more information, visit https://www.fhwa.dot.gov/environment/sustainability/resilience/pilots/extweatherpilot.cfm.

Summary

The Corpus Christi Metropolitan Planning Organization (MPO) evaluated and designed nature-based shoreline protection features to enhance the resilience of an important local roadway.

Key Takeaways

- A riprap breakwater with coastal marsh would reduce the impact of coastal waves and inundation, limit erosion, and provide habitat for local species.
- The Corpus Christi MPO engaged multiple stakeholders in the project planning and research processes, including students whose assistance was mutually beneficial.
- The processes used to evaluate options and determine a shoreline protection feature can apply to other projects where the infrastructure experiences similar wave-based damage.

Objectives

The primary objective of Corpus Christi MPO’s pilot was to identify, design and monitor the performance of an appropriate nature-based shoreline protection feature to enhance the resilience of a roadway along the western shore of the Laguna Madre in Corpus Christi, Texas. Periodic inundation and shoreline erosion has undermined the roadway in multiple locations and resulted in negative impacts to roadway lifecycle, maintenance costs, and public safety. The nature-based feature would be added along one stretch of the roadway to pilot an approach to help address these issues.

Scope

The scope of the pilot covered part of Laguna Shores Road, which extends along the western shoreline of the Laguna Madre and is a major north-south thoroughfare in Corpus Christi, Texas (Figure 1). The road is vulnerable to erosion and other chronic and acute impacts from rising sea levels and coastal storm activity. The road was scheduled to be rebuilt by the city to improve its level of service and reduce its susceptibility to inundation. The Corpus Christi MPO pilot focused on exploring nature-based shoreline protection for a portion of the southernmost segment of the road, where there was no buffer between the road and the open water, making it particularly vulnerable to extreme weather. The site is representative of other parts of Laguna Shores Road, making it an ideal location to pilot an approach that could potentially be implemented elsewhere in the future.

Approach

The Corpus Christi MPO led a collaborative interdisciplinary team for its pilot. The overall project entailed four key components: assessing baseline habitat and shoreline conditions; identifying shoreline protection strategies; constructing a pilot shoreline protection project; and monitoring project effectiveness to evaluate the applicability of pilot techniques to enhance the durability of other vulnerable roadway segments or transportation assets.
Stakeholder Engagement

To conduct this pilot, the Corpus Christi MPO partnered with Texas A&M University-Corpus Christi, the City of Corpus Christi, and the MPO’s consultant team. The pilot’s costs were split between the MPO, federal and local governments, and the university. The MPO’s consultant team helped to identify innovative shoreline protection strategies, generate engineering plans and specifications, determine baseline conditions, estimate erosion rates for the study area, and gather and review existing reports and data for understanding site conditions. The MPO worked with local university students to identify the elevations of seagrass growth and develop potential solutions. The MPO engaged multiple other stakeholders throughout the pilot process, such as local government public works and planning staff who develop projects and maintenance plans for coastal infrastructure, citizens impacted by storms along the coast, environmental advocates for coastal ecosystem enhancements, and academic researchers for coastal mitigation strategies and applications.

Assess Baseline Conditions

Corpus Christi MPO and its partners gathered a variety of data about historical and existing conditions for the Laguna Shores Road project area. Partners determined the frequency of roadway inundation at the project location and reviewed reports, data (e.g., tide, wind, and storm surge), historical aerial photographs, surveys, and geophysical data for initial characterization of the project site conditions. Partners also surveyed the annual high tide line and the mean low water line. The MPO worked with habitat specialists to develop a standardized monitoring protocol and assess baseline habitat condition, which included characterizing the dominant vegetative community. The project team identified the limits of seagrass growth and the percentage of seagrass coverage. Additionally, the project team conducted bathymetric and topographic surveys, identified soil types for foundational recommendations, and modeled wave conditions at the project site.
Identify Shoreline Protection Strategies

After performing a baseline conditions assessment, the Corpus Christi MPO considered shoreline protection alternatives. During high tide events, water levels reach and disturb the current erosion control feature, which is an articulated mat. In moderate and extreme storm events, waves can approach or reach the roadway and land areas. The MPO wanted the shoreline protection feature to avoid impacts to existing seagrass beds, provide room for marsh fill, and be constructed with land-based equipment.

The MPO considered two living shoreline protection options to address erosion along the existing project shoreline and provide increased protection to the road. These options included either a riprap or a reef ball breakwater system with imported fill for a spartina grass marsh planting to provide reduction of wave impacts and increased habitat (Figure 2). A riprap breakwater option could reduce wave height, be effective in high or low energy environments, and provide hard substrate habitat for encrusting species and habitat for juvenile fish, crabs, and other invertebrates. Alternatively, a reef ball breakwater option would involve hollow, hemispherical-shaped artificial reef units made from concrete with holes to allow for wave energy dissipation and habitat creation. Reef balls are excellent habitat for marine animals but vary in effectiveness at reducing wave transmission.

The MPO also evaluated marsh fill options. The MPO looked at existing conditions for marsh creation, including site location and orientation, benthic and bottom conditions, and meteorological and oceanographic conditions. The MPO also considered project site access, constructability, construction cost, and material availability.

Key Results & Findings

The MPO decided to pursue and construct a riprap breakwater with imported fill for marsh grass placed along the landward side of the breakwater. The riprap breakwater was chosen because riprap breakwaters generally provide greater wave attenuation than reef ball breakwaters and can be built on uneven or sloped surfaces, whereas reef balls require flat surfaces. Also, the MPO found that the probable construction cost of a riprap breakwater was within the project budget. Construction on the protection feature began in October 2020 and is anticipated to be complete in August 2021. The construction is currently being implemented by the City of Corpus Christi.

Lessons Learned

A few lessons learned emerged from the project. First, the data collection process required a thoughtful allocation of resources to determine what information existed and what new information would be required. By incorporating students into the data collection phase, students gained a good learning experience and provided the MPO with inexpensive yet expeditious labor. Second, the condition of the roadway and the wave and tide damage to the roadway and drainage infrastructure helped the MPO to narrow the focus of this resilience pilot to the location selected. It was advantageous that the City was already preparing to raise and reconstruct the roadway and upgrade its drainage systems because the City’s effort could be combined with the MPO’s resilience solution. Lastly, the process used in this project could be easily applied to other local projects along the water with similar constant damage from rising tides and wave action. This project helped identify the possible area and likely applications to make portions of nearby infrastructure more resilient. This is useful information for local governments in this coastal region.
Next Steps

**Remaining Construction Tasks for End of Pilot**

At the end of the initial pilot period, there are some additional construction-related actions that need to be complete (Figure 3). The MPO will need to secure final Texas General Land Office permits and US Army Corps of Engineers approvals. The project team will also need to make a schematic of the barrier and begin planting selected vegetation. Finally, the project team will need to continue to perform and monitor the construction of the installed resilience application.

**Monitor and Evaluate Shoreline Protection Feature**

Once the shoreline protection feature is fully constructed, estuarine habitat specialists will use the habitat assessment protocol defined during the preconstruction baseline habitat assessment to monitor the success of the shoreline based on habitat development and shoreline stabilization. The specialists will conduct an initial post-construction assessment within 60 days of construction completion and will repeat their evaluation annually at one- and two-years post-construction.

**Generate and Disseminate Findings**

The MPO will submit annual monitoring reports for four years after shoreline protection feature construction is complete. In the fourth year, the monitoring report will be part of a final report of findings for FHWA. All member agencies in the MPO will be presented with findings to inform future shoreline protection projects along Laguna Shores Road and other transportation facilities. The MPO will also identify potential opportunities to share findings with other community members and other stakeholders.

---

For More Information

**Resources**


Corpus Christi MPO Website for Shoreline Protection Feature Pilot Project: [https://www.corpuschristimpo.org/05_projects_rdewpp.html](https://www.corpuschristimpo.org/05_projects_rdewpp.html).

**Contacts**

Robert MacDonald, Transportation Planning Director, Corpus Christi MPO, mrmacdonald@cctxmpo.us, 361-884-0687

Becky Luples, Sustainable Transportation and Resilience Team, Federal Highway Administration, Rebecca.Luples@dot.gov, 202-366-7808

---

Figure 3. Construction at Laguna Shores Road in the vicinity of the future breakwater. Source: Corpus Christi MPO.