

# APPLICATION OF THE LONGSHORE TRANSPORT CURVE AS AN ENGINEERING TOOL FOR DESIGN OF COASTAL STRUCTURES

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## INTRODUCTION

Beach nourishment projects can develop localized, high erosion areas known as erosional hotspots. These regions are likely to pose a recurring beach management issue requiring either additional fill in future nourishments or stabilization with structures. In some instances, coastal structures have been viewed with a poor reputation for being overused and misunderstood. It is commonly known that they can result in trapping sand at the expense of the downdrift beach. This is also true of other coastal structures such as breakwaters that slow the transport of sand, and seawalls or revetments that contain it in the uplands. However, when employed in conjunction with beach nourishment and designed with consideration of the longshore transport, the use of coastal structures can effectively address hotspot erosion. By stabilizing the section of beach with accelerated erosion and spreading the erosion over a wider area, the design life of a beach project can be prolonged. The concept of using the shape of the alongshore sediment transport curve to strategically place coastal structures on an eroding section of the beach was originally introduced at ICCE by Campbell and Jenkins (2002). With the increasing costs of placing sand on beaches to keep pace with erosion and climate change, controlling hotspots with coastal structures is becoming a more economically feasible approach. These structures, however, need to be designed with a focus on regional coastal management and rigorous scientific basis.

In this presentation, the historical perspective and engineering analyses completed for coastal structure improvements along a beach segment on the southwest coast of Florida in the U.S. will be discussed. The project is located along Coquina Beach in Manatee County, spanning the southern mile of Anna Maria Island from Cortez Beach to the jetty at Longboat Pass (APTIM & CPE, 2021). The presentation will focus on a particular aspect of the analysis employing the use of the Longshore Transport Curve (LST), and its importance as a key tool for engineering analyses in considering sediment transport rates in the design process for coastal structures. This project case study represents a real-world application of the LST analysis first suggested in the work of Campbell and Jenkins (2002) and applied by Pierro, et al. (2014, 2015, & 2023) in recent work on the strategic use of coastal structures. The longshore transport curve utilized in this analysis was derived from field measurements and numerical modeling analyses utilizing Delft3D as presented by APTIM and CPE (2021).

## LONGSHORE TRANSPORT

The LST curve is a powerful tool that coastal engineers can use to assess a coastal system based on volume changes in a regional area by illustrating the accretion

and erosion trends along a stretch of coastline. When a field of erosion control structures (series of groins or breakwaters) is to be designed in a discrete section of the beach where the longshore transport curve presents a bell curve shape, the erosional area is reflected as increasing transport on the upslope of the curve, neighboring a depositional area of decreasing transport on the downslope. This bell shape of the LST curve can be “flattened” by the strategic placement, or modification, of coastal structures as the shoreline is stabilized along that section of beach. If the structure field can be designed such that transport exiting is equal to the pre-project transport, then the regional sediment transport balance of the system is preserved. The application of the LST curve presented herein provides a demonstration of the method in seeking this balance with the evaluation of various structural alternatives considered for the project area.

## STUDY AREA

The study area is located on the west coast of Florida in Manatee County at the south end of Anna Maria Island at Coquina Beach (Figure 1). Coquina Beach is a public beach and recreation facility stabilized by an existing terminal groin known locally as the Longboat Pass jetty and a series of aging shore-perpendicular groins. The beach provides protection to upland infrastructure, public recreational beach facilities, and State Road 789, the main road and evacuation route for the island.

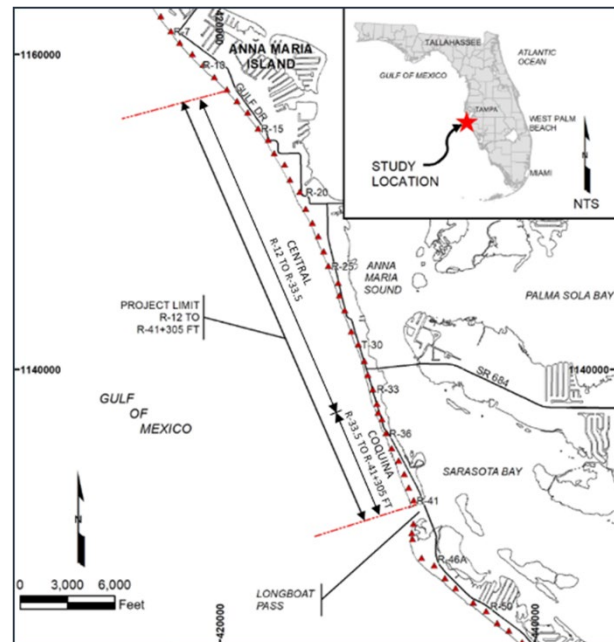


Figure 1 - Study Area Location Map

The jetty was initially installed in 1957 to stabilize the southern portion of the island when Coquina Beach was created to shorten the bridge span to Longboat Key to the south. The existing jetty is approximately 500 feet long and is composed of wooden crib and concrete pilings filled with limestone boulders. Around the same time the jetty was built, a groin field consisting of about twenty structures was installed in 1959 to control erosion along the beach. The existing groins are approximately 90 feet in length and are spaced about 250 feet apart.

These structures have deteriorated since installation and as a result, sand from Coquina Beach migrates around, over the top of, and through the structures, which contributes to the erosion of Coquina Beach and shoaling in Longboat Pass. Periodic maintenance of the beach has occurred to offset the erosion; however, the structures have deteriorated over time, no longer function as intended, and present a safety concern. The shore perpendicular nature of the existing structures has also created challenges for lifeguard monitoring and emergency operations, such that an alternate method of stabilization that improves alongshore line of sight and beach accessibility is desired by the County.

#### METHODS AND APPLICATION

The method described herein was developed as a practical application of the LST curve to stabilize the shoreline without significant changes to the net sediment transport through the project area. The use of several engineering tools are presented such as analysis of measured shoreline and volume changes based on beach profile data, conceptual design analyses, and development of a project area sediment budget used to demonstrate the importance and utility of the LST curve derived from numerical modeling as shown in Figure 2.

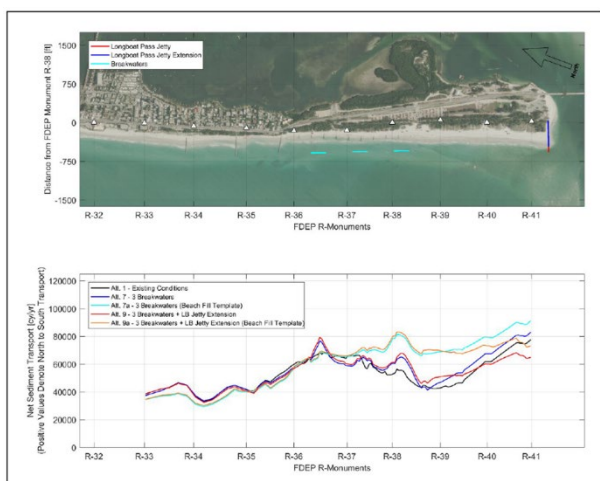


Figure 2 - LST curve analysis for project alternatives.

In support of the engineering assessments conducted for the study, the primary tool in this investigation is the process-based morphology model Delft3D. The model included a regional wave and a flow grid covering the area of influence and nested domains with refined grids

for flow, sediment transport, and morphology focused on the area of structural installations.

The primary objective of the modeling study was to evaluate conceptual structural alternatives for performance in stabilizing Coquina Beach without disrupting the net sediment transport balance through the project area. Ten (10) preliminary alternatives were developed in a stepwise manner. These included seven (7) designs for shoreline stabilization with groins and breakwaters in various configurations, simulated with three (3) different Longboat Pass jetty repair options.

#### FINDINGS

Based on the results of numerous longer-term numerical simulations, the alternative consisting of removal of the existing groins, installation of breakwaters, rehabilitation of Longboat Pass jetty, and continued beach nourishment was selected for further development. The selected alternative provides the best balance of targeted stability along the erosional hotspot segment of the beach, combined with the preservation of the overall sediment transport gradient through the study area.

Based on the engineering analyses and numerical modeling of the LST, the study findings are being carried forward to final design and permitting. Manatee County has appropriated funds for the project and secured a matching funding grant from the State of Florida to support construction in 2024-2025. The main findings from the numerical modeling and engineering design study will be presented along with the most recent design refinements to support continued advancements in the practice of coastal engineering.

#### REFERENCES

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