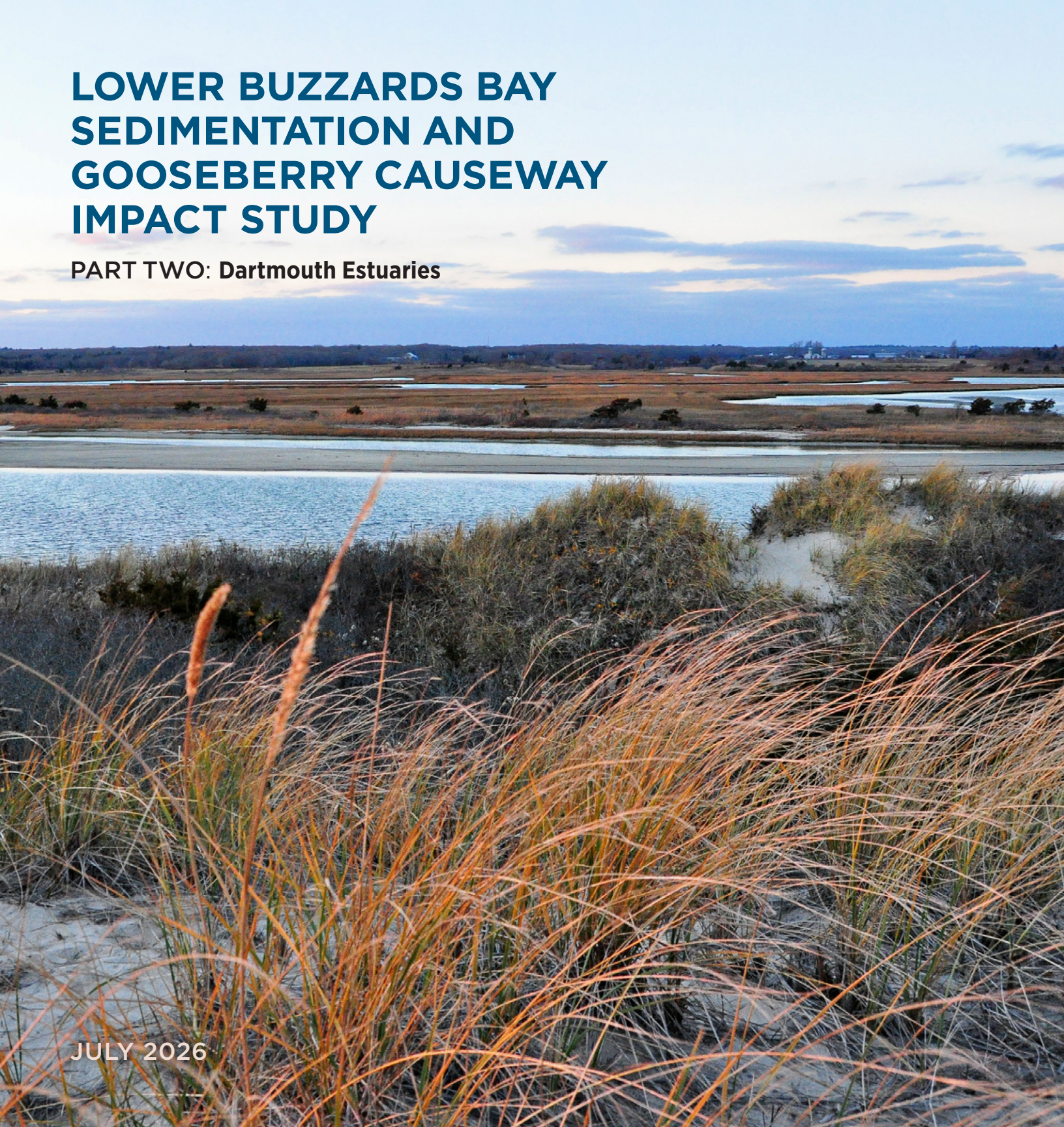
LOWER BUZZARDS BAY SEDIMENTATION AND GOOSEBERRY CAUSEWAY IMPACT STUDY

PART TWO: **Dartmouth Estuaries**



JULY 2026

STUDY OVERVIEW

A little over a hundred years ago, a sandbar that was walkable at low tide joined Gooseberry Island to the Westport mainland. In 1922, a simple causeway was built that was destroyed in the Hurricane of 1938. In 1943, the US Army established a WWII installation on the island and built a fortified causeway of boulders and concrete that remains to this day. Now referred to as Gooseberry Neck, the combined causeway and island extend approximately one mile into Buzzards Bay.

The timing of the Gooseberry Causeway construction coincides with the beginning of dramatic changes to this stretch of coastline, leading government officials, coastal scientists and residents to question whether this manmade structure may be contributing to some or all of these changes.

The Buzzards Bay Coalition convened a research team with partners from Boston University, Woods Hole Group, and the Virginia Institute of Marine Science who set out to study a series of scientific questions that focused on the Gooseberry Causeway and its effects on the beaches and water quality of Buzzards Bay between the Westport and Slocums Rivers.

To do this, a dynamic area of coastline stretching from Little Compton to Mishaum Point would need to be assessed using the most up to date oceanographic science and models. The primary aim was to improve the understanding of how the causeway interacts with the land and water around it and whether changes to the shoreline are due to the causeway.

In May 2025, we released Part One of the study findings, which focused on the impact of Gooseberry Causeway on Westport River water quality and East Beach erosion.

In Part Two of the release of these study findings, we answer the final three questions here:

- **What is causing sand to be deposited into the mouth of the Slocums River and is the sand build-up degrading river water quality?**
- **Is the Gooseberry Causeway causing or accelerating the cycle of inlet closure to Allens Pond?**
- **What is the impact of climate change on these questions?**

STUDY AREA

FIGURE 1 *Location of study region highlighting the focus area of this report from Little Beach to Mishaum Point*

CONTENTS

The Science Behind the Study

Retrieving a sensor after a months-long deployment in Allens Pond (top)
Deployment frame containing a sensor that measured currents and water levels in the Slocums River (bottom)

The Buzzards Bay Coalition assembled a top-tier team of researchers to evaluate the questions. The team had significant experience in studying the Massachusetts coastline and was composed of scientists from Boston University, the Virginia Institute of Marine Science, and the Woods Hole Group. The United States Geological Survey provided technical guidance during project formulation and during periodic discussions over the course of the study.

The research team used a multi-pronged approach beginning in 2022. First, they compiled information from previous scientific work around Gooseberry, including high resolution ground surface elevation surveys collected with laser instruments (LiDAR).

The researchers conducted a rigorous field campaign during the summers of 2022 and 2023. They collected data along coastal sand dunes and interior marshes using techniques including ground penetrating radar and radioisotopic dating. In the waters offshore, currents and wave conditions were measured using acoustic doppler current profilers, high frequency wave sensors, and conductivity and temperature sensors. Underwater sediments were collected from the seafloor using grab samplers. Their measurements updated previous studies on changes in shoreline position, bathymetry, and water flow. Finally, they paired the physical measurements with sophisticated computer models that simulated how sand and water move under different conditions, including if the causeway did not exist.

The field campaign was designed to:

1. **Understand how the coastline of the region has been shaped over time since the retreat of the glaciers,**
2. **Provide inputs to the modeling effort (underwater terrain data, sediment data, water levels, waves and current measurements), and**
3. **Calibrate and test the model to ensure the model accurately represents reality.**

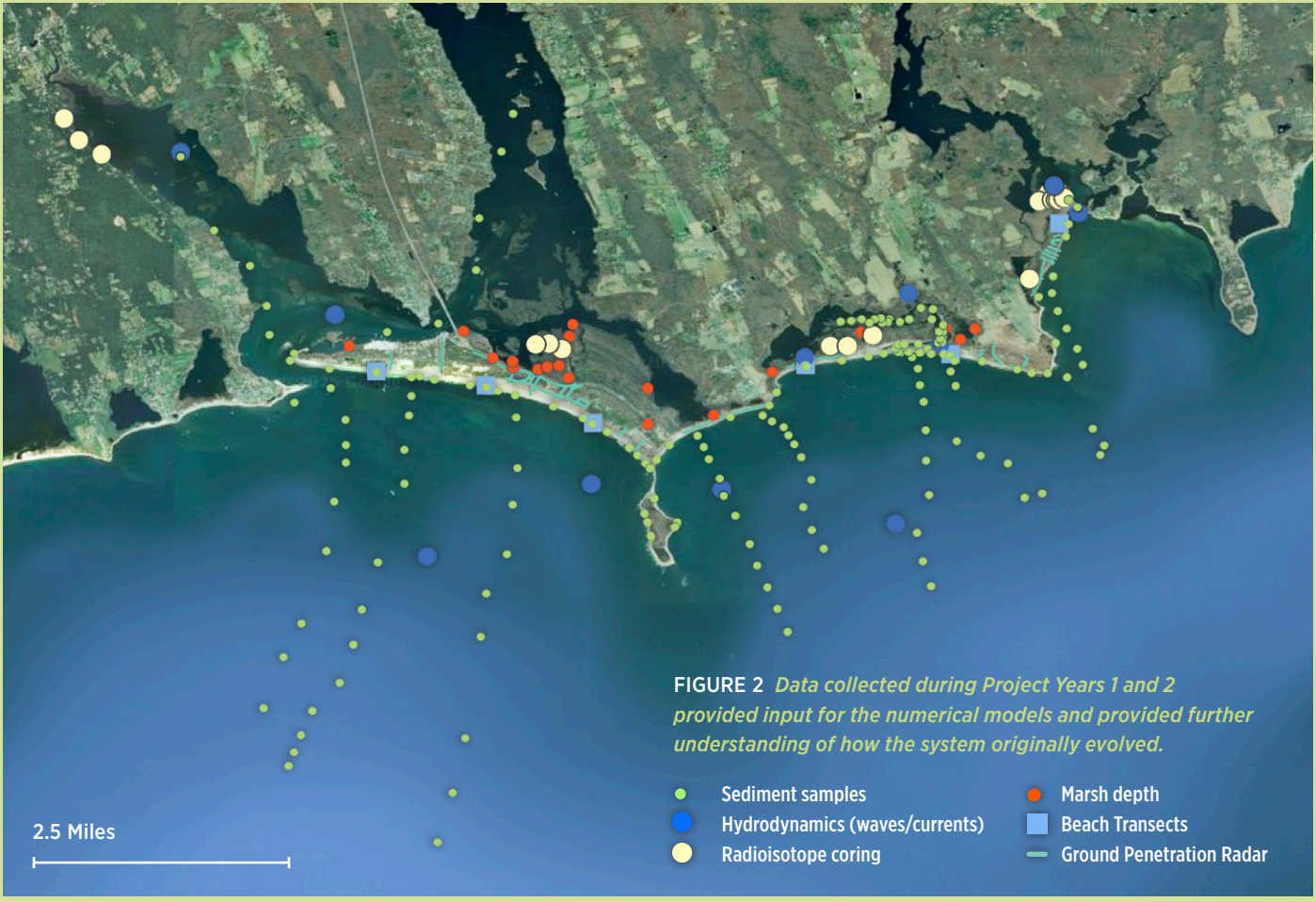


FIGURE 2 *Data collected during Project Years 1 and 2 provided input for the numerical models and provided further understanding of how the system originally evolved.*

Field and historic data were assessed geospatially using Geographic Information System (GIS) techniques. This allowed the scientists to view spatial patterns including shoreline evolution and the effects of major storms.

It was crucial to consider how storm and high-wave activity affect the area because storm conditions can cause dramatic changes to the coastline. Storm waves (~10 ft) expend much greater energy along the shore compared to normal conditions (2-3 ft waves), which is why storms cause dramatic changes.

Storm surges create deep water close to shore, allowing large storm waves to break further up on the beach and impact human structures. Additionally, the greater wave energy during storms means that sand moves at exponentially higher rates than under normal conditions. Examining how much sand moves to different areas during different types of storms is, therefore, critical for understanding the long-term evolution of the shoreline.

The researchers used paired models that simulate currents from tides and meteorology (Delft3D-FLOW) and waves (Delft3D-WAVE) in concert, which allowed the examination of the complex interactions of waves and currents over small distances. The models have been widely used in scientific studies of sediment transport by the study team and by the world scientific community.

What is causing sand to be deposited into the mouth of the Slocums River?

Short answer: Gooseberry Causeway is not causing the build up of sand at the mouth of the Slocums River. The sand in the Slocums mouth is not primarily coming from East Beach but rather comes from offshore and to a lesser extent from Little and Barneys Joy Beach.

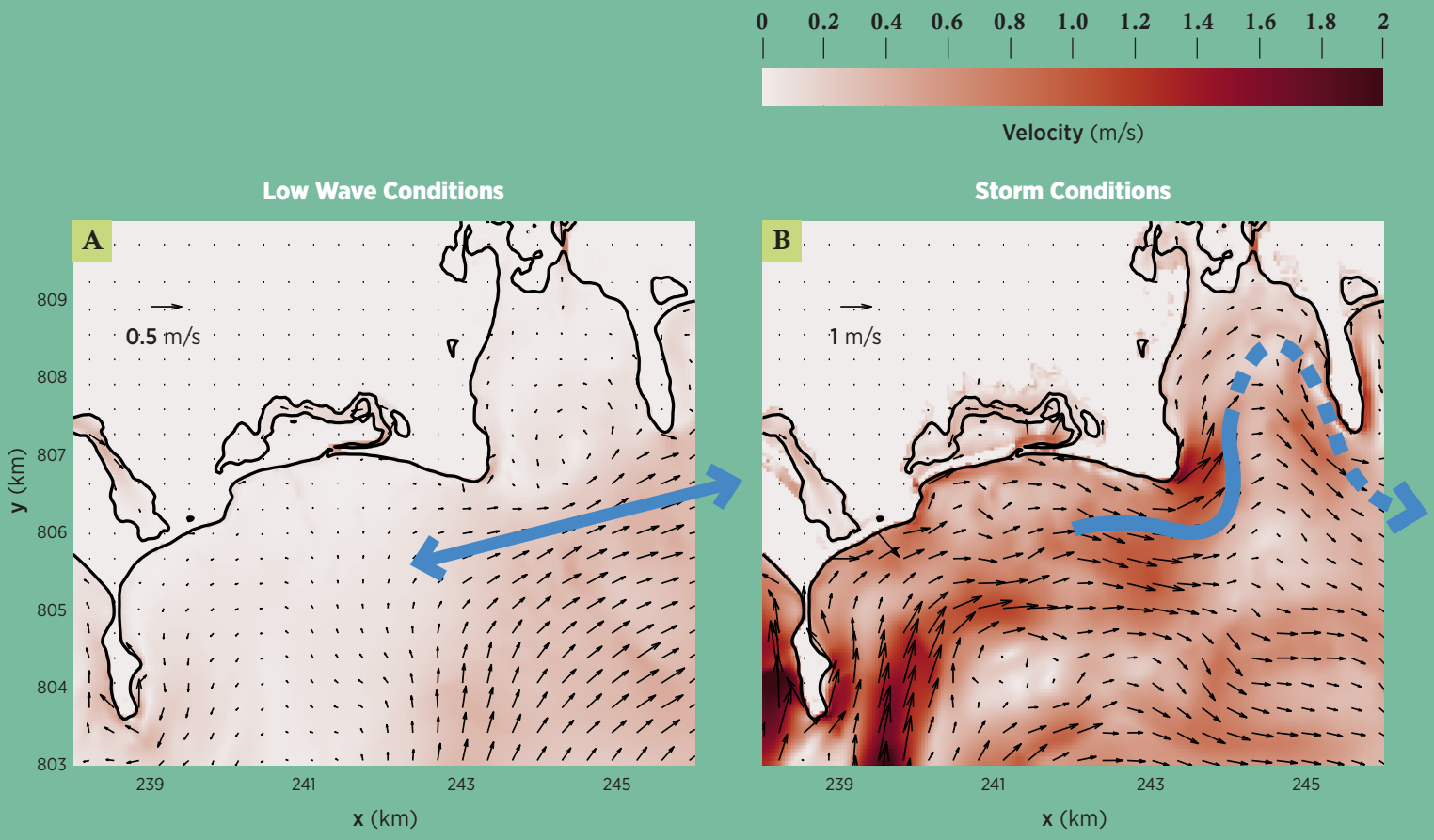


FIGURE 3 **Low Waves** (A) **Storm Conditions** (B) *The modeled direction and speed of water flow is shown with arrows and color. Larger arrows and darker reds indicate faster water flow. The blue arrows highlight how when there are low wave conditions, flows bypass the mouth of the Slocums, whereas during storm conditions water carries sediment into the mouth of the Slocums River.*

In other parts of the country where there are large river systems, sand is often washed off from the land into the rivers and is deposited at the mouth. That pattern is not observed in Dartmouth estuaries. There are only small amounts of sediment coming into the river from the land. Most of the sand in the systems comes either from offshore or from nearby beaches and dunes.

Under normal conditions of calm seas or low waves, currents that are strong enough to move sand flow past the mouth of the Slocums River (Fig. 3A). Only with wave conditions that occur about once every 10 years do the wave-generated currents reach a sufficient size to push sand into the embayment (Fig. 3B). During large storms, pulses of sand move into the mouth of the Slocums River that are then slowly distributed along the western shore of the outer Slocums, moving northward over time. The sand that moves into the Slocums comes primarily from the beach and shallow waters between Allens Pond and Barney's Joy Point. There is not a large amount of sand coming from East Beach to the Slocums River inlet.

The amount of sand in the Slocums' mouth has increased over recent history. This sand is focused along the west side of the river mouth. Between 2008 and 2018, the amount of sand added was about 2% of the existing sand bank. Some of the sand was blown or washed into the dune system. Dating of sand grains in beach ridges near the inlet indicates that there had been cycles of sand deposition pulses that ended about 700 years ago.

In December 2022, Winter Storm Elliot moved large amounts of sand. Sand from the dunes was washed away outside Allens Pond and from Horseneck Beach leaving the beaches about 20 feet wider than before the storms. Image shows eroded dune and newly wider beach at western Horseneck Beach.

Is the Gooseberry Causeway causing or accelerating the cycle of inlet closure to Allens Pond?

Short answer: **The closing of the Allens Pond inlet is driven primarily by how much water is filling Allens Pond at high tide (i.e., the tidal prism). The Gooseberry Causeway is not influencing the amount of water in Allens Pond at high tide or how frequently the inlet closes.**

Allens Pond is an excellent habitat for a variety of shore birds who use its extensive salt marshes for feeding and nesting. Salt marsh habitat requires inundation at high tide and draining at low tide. When the Allens Pond inlet closes, the water trapped in the pond drowns salt marsh plants in place and can greatly reduce the habitat for birds. For at least 100 years, the local community has re-opened the inlet when it closes.

FIGURE 5 *Aerial images show how the Allens Pond inlet has changed positions over time. The inlet completely closed in 2008. In 2016, the inlet was almost closed, and it had to be re-opened in early 2017. The inlet closed again in early 2021, and the 2021 image shows the inlet position after it had been opened.*

Water rushes into Allens Pond on an incoming tide faster than it drains out on an outgoing tide. This imbalance tends to bring sediment into the pond over time. During storms, sand from the beach is transported into Allens Pond — adding sand to channels and sandbars, and sometimes to the marsh.

At the mouth of the inlet, sand on the beach migrates from west to east over time, a pattern that results in part from water flowing in a clockwise motion on the east side of Gooseberry Island. Waves move sand across the Allens Pond inlet gradually building up the east side of the inlet. This builds the spit on the east side of the inlet while the channel carrying the outgoing tide curves west, pushing against and scouring the west side of the inlet. This moves the inlet further to the west. As the inlet moves westward, the water leaving the pond on an outgoing tide has to travel a progressively longer distance along a more and more serpentine route, slowing the speed of the water. Eventually the force of the water leaving the pond on an outgoing tide is not able to maintain the inlet, and sand fills the inlet.

Storms have been continually adding sand into the pond over time. As more and more sand is deposited as sandbars and shoals in the pond, the amount of water filling the pond during high tide is decreasing despite the fact that sea level rise is accelerating. Less water in the pond at high tide means the force of the water leaving the pond at low tide is weakened, which helps explain why the inlet is closing faster. This process would be the same with or without the Gooseberry Causeway. The Allens Pond inlet will continue to require regular human intervention to keep the inlet open.

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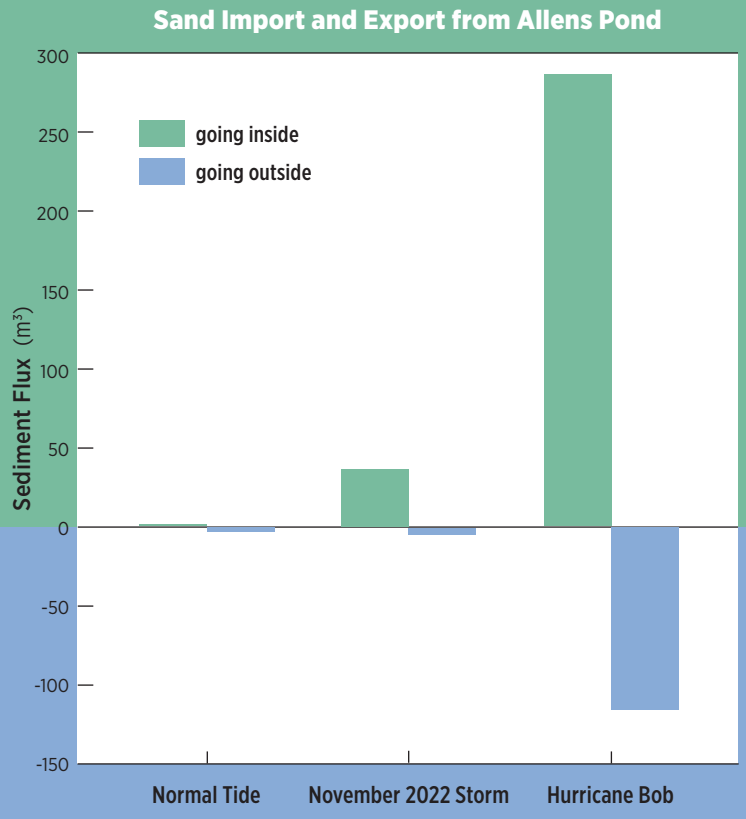
FIGURE 4 *The history of sand movement within Allens Pond is visible in aerial photographs. Lighter colored areas show present day and former washovers of sand from the barrier beach into the marsh. Flood tidal deltas are areas where the sand carried on incoming tides has been deposited. Point bars are areas where sand is deposited as water slows down. Sub-tidal shoals are areas of sand accumulation on the bottom on the pond.*

How will things change with rising sea levels and more intense storms and will the Causeway exacerbate future effects of climate change?

Short answer: Large storm events wash sand into the mouth of the Slocums River and into Allens Pond. These events are likely to be more frequent and intense with climate change, depositing more sand at the mouths and marshes. Sea level rise will flood more of the inner estuaries, which will drown salt marshes but the increased amount of water will also help to keep the inlets open. The Gooseberry Causeway will not alter or worsen these effects of climate change.



Sand that is washed onto or adjacent to salt marshes during large storms helps to build the salt marsh vertically. Marshes have to continually build up to prevent the marsh plants from drowning as sea level rises. As climate change is accelerating sea level rise, the salt marshes in Westport and Dartmouth are not keeping pace. Sand deposited by storms can help marsh health by raising the height of the marsh or providing new shoals that the marsh can grow on to. Historic depositions of sand into the mouth of the Slocums River and Allens Pond have been worked onshore over time and helped to create and sustain the salt marshes in Demarest Lloyd State Park and Allens Pond.

FIGURE 6 ***Bars indicate the amount of sand and sediment that moves into*** (green bars up) ***and out*** (blue bars down) ***of Allens Pond under normal conditions*** (left most bars that are barely visible)***, under moderate storm conditions such as experienced in November 2022*** (middle bars)***, and under severe storm conditions such as Hurricane Bob*** (right most bars)***. While sand moves both in and out of the pond during storms, much more moves into the pond than leaves the pond. Thus, over time, storms act to fill up Allens Pond.***

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LOOKING AHEAD

The Slocums River continues to fill with sediment and water quality remains poor particularly farther up the estuary from the inlet to the Bay. As a next step in addressing this question, the Buzzards Bay Coalition has hired Sustainable Coastal Solutions, a coastal engineering firm based in Falmouth, MA, to further evaluate channel dredging options that might improve tidal circulation, and therefore water quality, within the Slocums River system. This work is anticipated to be completed by the end of 2026.

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IN CASE YOU MISSED IT

In connection with this study, the research team also addressed three additional questions. *Part One: Westport Coastline* was released in May 2025 and covered:

- **Does Gooseberry Causeway negatively affect the flow of water in to the Westport River and thus its water quality?**
- **Is the Gooseberry Causeway causing or accelerating the erosion of East Beach?**
- **What is the impact of climate change on these questions?**

The ***Lower Buzzards Bay Sedimentation and Gooseberry Causeway Impact Study*** was made possible by a generous challenge grant from the Rathmann Family Foundation and private donations to the Buzzards Bay Coalition.