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Ind. Study
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Madison Surf Club Beach Resilience Plan

1. Introduction

The purpose of this plan is to assess various strategies to implement at the Surf Club to reduce vulnerability and increase resiliency to coastal hazards and climate change.

The goal is to preserve the assets of the Surf Club and ensure that it is contributing recreational assets into the future. Varying projections of climate change-related impacts, specifically levels of erosion and sea level rise, must be taken into consideration when determining the best course of action. This project will be considering the time scale of 2019-2050. Preparing for the range of possible scenarios can help to reduce future disaster related response and recovery costs, and improve recovery time following hazard events. Taking uncertainty into account is crucial because having strategies for different levels of severity will help to protect people and structures from harm and destruction.

Erosion and rising sea levels threaten coastlines through shoreline change. Climate change is increasing shoreline vulnerability because of increased storm frequency and intensity. The result is increased risk of damage from storms and higher levels of erosion, reducing beach area. Direct and indirect costs from disasters continue to rise. This increases the importance of preparing for the potential damages from future events and climate change impacts in order to reduce the magnitude of direct and indirect impacts of damage. Implementing strategies to improve the coastline's ability to resist change and reduce the recovery time following hazard events can decrease the shoreline's vulnerability and increase its resiliency.

2. Objectives

The objectives of this plan include sustainability in relation to maintaining the amount of sand on the beach and preserving the dunes. Dunes serve the important role of protecting the inland against storms and sea level rise. Maintaining/improving the ecological integrity of native species is also important. Increasing the amount of beach grass and removing invasive species is beneficial for dune stability as well as encouraging pollinators and increasing habitat for birds and other native species. Maintaining/improving human benefits is important for preserving the Surf Club's assets. The Surf Club is used for recreation including various sports, swimming, walking, sunbathing, water activities (i.e. kayaking), children's recreation, and parties/gatherings. Maintaining a natural but well-kept, attractive appearance is important for preserving the aesthetic appeal of the beach.

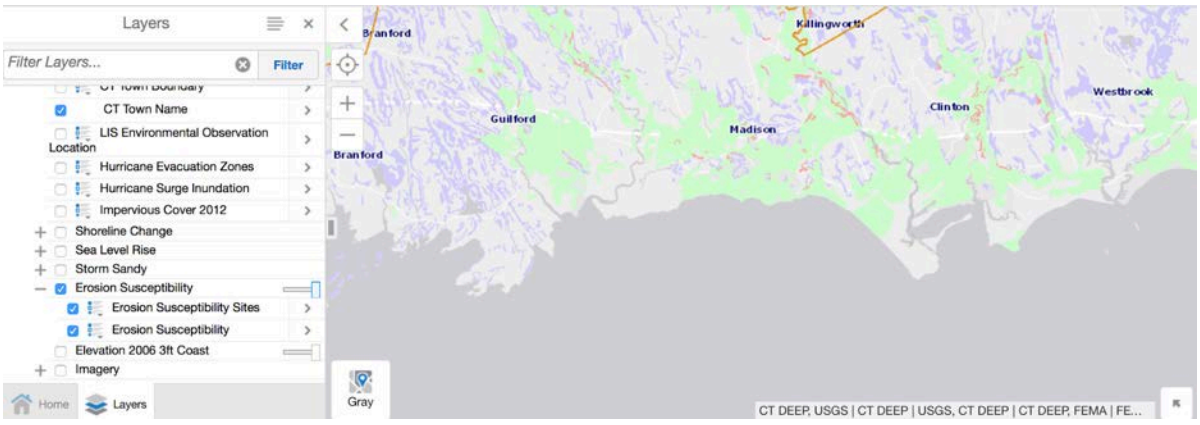
3. Physical Location and Setting

The Surf Club is a 45-acre park on the coast of Madison, Connecticut. It features a 1,200 foot beach, open picnic area with tables and grilles, playground area, bocce courts, horseshoe pits, sand volleyball courts, basketball courts, athletic fields, boating area, and Surf Club building. The area behind the Surf Club features a golf course, as well as tidal wetlands.

1934 Aerial Image

1934 Aerial Image
Short Term Shoreline Change 1934-2016
Net Shoreline Movement: pink (-), blue (+)

2016 Imagery
Short Term Shoreline Change 1934-2016



Erosion Susceptibility

Hurricane Surge Inundation

Sea Level Rise Inundation: Mean High Water Scenario (+6 inches)

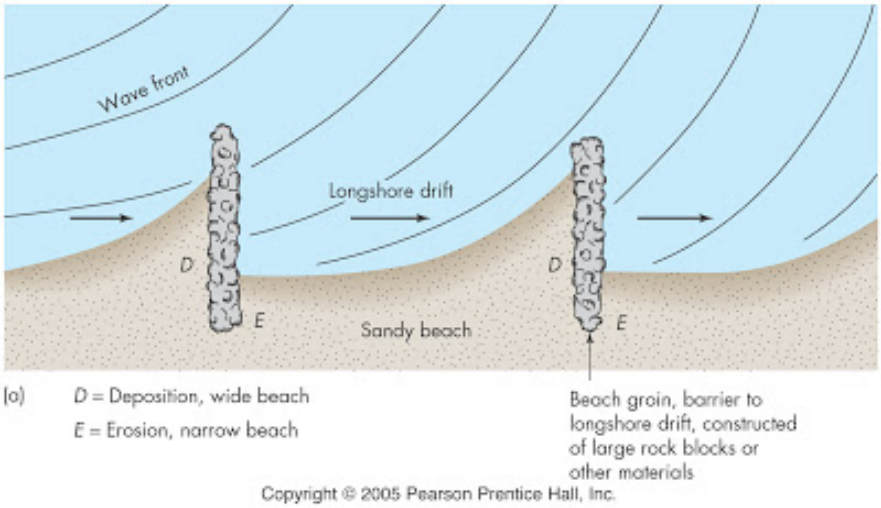
Sea Level Rise Inundation: Mean High Water Scenario (+12 inches)

Sea Level Rise Inundation: Mean High Water Scenario (+24 inches)

4. Situation Analysis

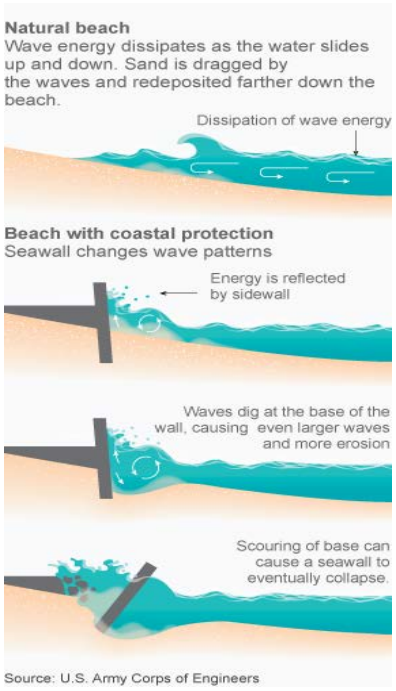
Coastal shorelines are constantly changing in response to wind, waves, tides, sea level rise, and human modifications. Beaches and dunes are particularly vulnerable to erosion from wind, currents, tides and coastal storms. Shoreline stabilization strategies are commonly used to combat erosion and protect shorelines. However, the appropriate method must be carefully considered because inappropriate stabilization methods may create more problems than they solve. In some cases, shoreline stabilization methods may increase beach erosion, damage neighboring properties, and negatively impact marine habitats. The result is a reduction in the beach's ability to protect the inland from storm damage and flooding.

The Surf Club currently has two shoreline stabilization methods in place to control erosion. There are two groins, which are hard structures located perpendicular to the shore. They are designed to trap the sand carried horizontally down the beach by longshore drift. Sand accumulates on one side of the groin and forces the water to slow down and change direction. Unfortunately, this alters natural shoreline processes by causing increased erosion on the other side of the groin and reduces the amount of sand transported down the shoreline.



Beach groins- locations of accumulation and erosion of sand

The Surf Club also has a seawall, which is a hard structure positioned parallel to the shore. Seawalls serve as a protective barrier, reducing erosion in the area behind the wall and protecting structures from possible wave damage. However, unlike dunes, seawalls reflect wave energy. This causes increased erosion in front of the wall, a process called scouring, which weakens the area holding the base of the seawall. As the sea level rises to meet the wall, scouring will strengthen. Eventually, enough erosion takes place in the area at the base of the wall that it becomes unstable and the wall collapses.



Seawalls- erosion, scouring and eventual collapse

5. Threat Identification

The major threats at the Surf Club fall under the broad category of shoreline change. This can take place slowly and gradually through natural coastal processes involving long-term continuous erosion. Alternatively, episodic erosion caused by the storm surge associated with hurricanes, tropical storms, and nor'easters can cause rapid and severe damage. Storms can flatten dunes and create extensive erosion in very short time periods of hours to days. Coastal flooding is commonly associated with the storm surge and high tides caused by these storms.

Hurricanes and tropical storms are characterized by strong winds, heavy precipitation, wind-driven waves, storm surge, and coastal flooding. Tropical storms are storms with winds over 39 miles per hour, and become hurricanes if wind speeds exceed 74 miles per hour. The typical "hurricane season" lasts from June to November. Winter storms along the coast, referred to as nor'easters in the Northeast, are characterized by strong winds, heavy surf, storm surge, and coastal flooding.

Climate change is likely to amplify the effects of these coastal hazards moving into the future. Some of the many attributes of climate change include increased frequency and intensity of storms, heavy precipitation, strong winds, and increased rate and severity of sea level rise.

Sea level rise is likely to increase the extent and frequency of storm surge and coastal flooding, and increase long-term coastal erosion. Long-term sea level rise is caused by thermal expansion from the warming of the oceans, and melting of land-based ice like glaciers and polar ice caps. The International Panel on Climate Change (IPCC) predict global average sea level to rise between 0.6 and 2 feet in the next century. An important note is that sea level is not rising uniformly around the world, and there are local variations. Sea level is predicted to rise between 12 and 23 inches along the Connecticut shoreline by 2100. Local sea level is a particularly important concern for coastal communities like Madison because of the combination of sea level rise and change in land elevation. Areas experiencing coastal erosion and land subsidence can accelerate the rate of sea level rise locally. Increases in mean sea level make coastal communities more vulnerable to coastal hazards as natural buffers like dunes are lost, exposing the inland area to increased frequency and severity of storm surge and coastal flooding.

5. Alternatives Analysis

Business as Usual

One alternative for the Surf Club is to not implement any additional action and rely on the pre-existing hard structures for shoreline protection. The seawall will reflect and redirect waves back toward the beach and to neighboring properties. The design of a seawall determines how much wave energy is reflected. Vertical walls, like the seawall at the site, reflect more energy than sloping revetments. These waves will erode the beach in front of the wall and on either side. This erosion will reduce the amount of dry beach at high tide, reducing the area

available for recreation and storm damage protection. Erosion around the wall will reduce the effectiveness of the structure and eventually lead to expensive repairs when the wall collapses. The groins will lower the energy of waves and therefore reduce impact of waves on the shoreline. The groins will impact longitudinal sediment transport, altering where sand is deposited and where it is eroding. The groins will accumulate sand on the updrift side, reducing the amount of sand transported down the beach. Accelerated erosion will occur on the downdrift side of the groins.

Plant Beachgrass & Remove Invasive Species

Planting vegetation is a strategy used to reduce erosion and storm damage. Salt-tolerant plants with extensive root systems can hold sediment/sand in place, helping to stabilize the areas where they are planted. Unlike hard structures, plants absorb the energy of waves, effectively slowing the speed and diffusing the flow of water. Plants can trap windblown sand, helping to build dune volume and increase the dune's ability to buffer inland areas from waves, erosion, and flooding. Dunes and vegetation are very sensitive to disturbances like pedestrian traffic. Therefore, designated walkways and/or fencing can be used to limit foot traffic in erosion-prone areas. Posting signs to keep off the dunes are a useful option to inform pedestrians of the importance the dunes and to protect the dunes and vegetation from disturbance.

Native, salt-tolerant species with extensive root systems are ideal for coastal vegetation projects focused on erosion control because they are well adapted to harsh conditions and require minimal maintenance to grow and thrive. American beachgrass is commonly used for initial plantings on dunes, particularly those closest to the beach where wave and wind action are strongest. Beachgrass quickly establishes a dense root system for dune stabilization, quickly accumulates sand for dune growth, and is resilient to being overwashed by waves. American

beachgrass grows 6-10 feet annually via underground rhizomes, stems that spread beneath the sand and create new plants. The plants grow quickly and are able to grow up through the sand that deposits above them. Beachgrass generally grows up to 2-3 feet tall, and can accumulate up to a foot of sand annually. Its ability to quickly colonize makes beachgrass ideal for dune stabilization. In order for beachgrass to effectively build dune volume, it must be planted where windblown sand will reach the plants. Detailed planting information can be found at https://plants.usda.gov/plantguide/pdf/pg_ambr.pdf.

Invasive species are an ecological concern for dunes. Therefore, they should be removed and replaced with appropriate native plants if they are preventing the establishment of erosion-control vegetation. Ideally, invasive plants should be removed by hand to avoid damaging the dunes with heavy equipment. Removal of invasive plants can be time consuming due to their tendency to return. Therefore, maintenance and monitoring is necessary to successfully remove them from the area. Invasive species identified at the Surf Club that should be removed include phragmites and Japanese knotweed. Although Rosa rugosa is considered invasive, it provides erosion-control and aesthetic benefits, and therefore does not require removal.

Dune Nourishment

Dune nourishment involves bringing in additional sediment/sand from outside sources to build a new dune or add volume to an existing dune. It is important that the sand used has size and texture compatible to the natural sand to avoid rapid erosion of the new sand. A dune already exists at Surf Club Beach, but it has been repeatedly washed out and degraded by large storms. Dune nourishment will restore the dune to its full extent and provide more area to plant beachgrass for stabilization. This will effectively reduce erosion and prevent high waters from

overtopping the shoreline. Dune nourishment must be repeated periodically to maintain the size of the dune as natural processes redistribute sand.

Seawall Repair

When the seawall base becomes destabilized, it will collapse and require repair or complete reconstruction. Minor repairs includes patching concrete and applying a skim coat to the surface of the seawall. Any repairs to the structure should include design improvements to reduce environmental impacts, improve the longevity of the structure, and minimize future maintenance costs. Any alterations to the original design of the seawall, including changes in location or size, will require additional permits.

6. Uncertainties

There is consensus among the scientific community that climate change has influenced natural systems and will continue to do so in the future. Identified climate change impacts include increased temperatures, sea level rise, increased frequency and intensity of storms, and many others. While there is a high likelihood that we will be forced to deal with the consequences of these impacts, there are still many uncertainties about the timing and magnitude of what will actually occur. It is difficult to predict exactly how the system will react to climate change, but using various projections of various levels of severity we can generate plans of action for the range of scenarios. It is crucial that we prepare for the range of possible scenarios we may experience to reduce the amount of time, resources and costs of recovery following hazardous events like storms. Climate change will only exacerbate the current issues shorelines are experiencing. This makes it important to put measures in place to attempt to reduce whatever magnitude of change will actually occur, increasing the resilience of the coast to hazards.

7. Adaptive Management

The preferred alternative to increase the resiliency of the Surf Club Beach is to plant beachgrass along the dune. The organizations involved include the Surf Club management staff and the Madison Beach and Recreation, Public Works, Land Use, and Planning and Zoning Departments. The public can also be involved through community planting events. The Surf Club maintenance staff will be needed for maintenance and monitoring of the project.

The factors that influence the costs of a vegetation project are the severity of erosion, the size of the area that needs stabilization, and the type and number of plants selected. Fortunately, planting projects have relatively low design and permitting, construction, and maintenance costs. Construction costs can be further decreased through public planting programs, so only purchase of the plants is necessary.

Technique	Relative Costs				
	Design and Permitting	Construction	Expected Maintenance Frequency[1]	Average Annual Maintenance Costs[2]	Average Annual Mitigation Costs[3]
Artificial Dunes & Dune Nourishment	Low	Low	1-5 years	Low	None
Controlling Overland Runoff	Low	Low	5-20 years	Low	None
Planting Vegetation	Low	Low	1-3 years	Low	None
Bioengineering - Coir Rolls on Coastal Banks	Low-Medium	Medium-High	1-3 years	Low-Medium	Low
Bioengineering - Natural Fiber Blankets on Coastal Banks	Low	Low	1-3 years	Low	None
Sand Fencing	Low	Low	3-5 years	Low	None
Beach Nourishment	Medium	Low-Medium	5-10 years	Low	Low
Rock Revetments - Toe Protection	High	High	10-20 years	Low	Low- Medium
Rock Revetments - Full Height (up to predicted flood zone elevation)	Very High	Very High	20-25 years	Low	Medium
Seawall	High-Very High	Very High	25-40 years	Low	Medium-High

COST ESTIMATES *(average cost per linear foot of shoreline)*
Low: <$200
Medium: $200-500
High: >$500-1,000
Very High: >$1,000

[1]The frequency of required maintenance is highly dependent on storm severity and frequency and shoreline exposure. See StormSmart Properties fact sheets for details on maximizing longevity.
[2]Estimated, annual costs averaged over the life of the project to maintain project components, assuming the project is designed and installed properly.
[3]Estimated, annual costs averaged over the life of the project to compensate for the technique's adverse effects.

Relative Costs of Shoreline Protection Strategies

A variety of grants can be used to fund this project. Several organizations provide grants for projects designed towards coastal resiliency/mitigation including: the Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant Program (only available in the months

subsequent to a federal disaster declaration), the FEMA Pre-Disaster Mitigation Program, the Connecticut Institute of Resilience and Climate Adaptation (CIRCA) Municipal Resilience Grant Program, the Northeast Regional Ocean Council (NROC), the National Oceanic and Atmospheric Administration (NOAA) Regional Coastal Resilience Grants, and the U.S. Army Corps of Engineers.

A vegetation project can take as few as 2-3 months to design, permit, and install (depending on the number of permits required). Most vegetation should be planted in early spring to promote successful plant establishment and root growth. American beachgrass does best when the culms are planted in unfrozen ground between mid-November and April, so the grass grows by summer. The spatial scale for this project is the primary dune located adjacent to the Surf Club.

The indicators chosen for monitoring are plant establishment success and dune growth. Plant establishment success can be observed through the progress of beachgrass growth by summer. Ways to improve the likelihood of beachgrass establishment include limiting access to the area where it is planted to keep people from walking on it. Beachgrass cannot withstand being trampled and once it starts to die-off, the dune stability is threatened. Signs to keep people off the dunes and/or fencing around the dunes are options for protecting the plants and dunes. Dune growth can be measured in annual sand accumulation, and can be directly attributed to beachgrass establishment success.

Maintenance requirements vary depending on the rates of erosion and frequency of coastal storm damage. Dead plants may need to be replaced regularly to ensure establishment success, especially when not combined with other shoreline stabilization strategies. The area should be inspected frequently and plants should be replaced as needed. If erosion or plant die-

off occurs during winter, replanting may have to wait until the growing season starts in spring. Areas damaged by storms should be restored as soon as possible to the previous conditions. Eroded areas can quickly expand if left unvegetated exposed to the wind, tides, runoff, and storms. A schedule and plan for replacing vegetation should be included in the original permit application for the project so that maintenance can be conducted without additional permitting.

The next management cycle will depend on the progress of this planting progress and the impact it has on erosion control and dune growth. If this plan is successful, maintenance of the beachgrass and invasive species removal should continue as needed. If the beach and dune continue to erode, dune nourishment is an alternative that will add more sand to the area and restore the dune. Planting can also be used to stabilize the dune once more sand is brought in to reduce erosion rates, allowing more time before dune nourishment will need to be repeated. Eventually, the seawall will need repair as the sea level rises and erosion destabilizes the base. Thinking longer-term, there is sufficient space for the beach to move back as the sea level continues to rise. As this occurs, the other amenities of the Surf Club will need to relocate further inland.

9. References

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