City of Biddeford
Sustainability Commission

August 18, 2025 at 5:30 PM

City Hall Second Floor Conference Room & Zoom

Join Zoom Meeting Online
Or call in by phone: +1 312 626 6799
Meeting ID: 918 3877 0971
Passcode: 220405

1. Declaration of Quorum/Voting Members
2. Approval of Meeting Minutes
   - 2.a Approval of Meeting Minutes from August 4, 2025
3. Old Business
   - 3.a Continue Evaluation of Landscape Ordinance
4. Discussion
   - 4.a Newsletter Update-Joie
   - 4.b Bike/Ped Plan Funding
   - 4.c Municipal Building Energy Audit Funding
   - 4.d Site Walks/Field Work-Ideas
   - 4.e Update to Council-September or October
   - 4.f Coastal Planning-Nantucket MA-A Case Study of Managed Retreat
5. Adjourn

Sustainability Commission Minutes

8-4-25 at 5:30

1. Present: Brad, Jeff, Sam, Max, and Patrick. One city staffer, two guests. Quorum is not present.
2. Approval of minutes from July 21st, 2025 tabled because quorum isn't present.
3. Presentation by Scott Clemons-Baker, UNE graduate and city intern, on GHG Emissions Inventory Results.

The analysis is based on 2023 data. SMPDC vetted this inventory.

The first part of the inventory is on community-wide emissions, which includes government emissions, as well as all others. Emissions increased 7.5%, or 18,000MtCO2e, since 2019. Co2e is carbon dioxide equivalent. The key takeaway is that transportation is the biggest source of emissions for the city.

Transportation accounts for almost half of emissions. Passenger car emissions increased 10,000MtCO2e, or 27Mill VMT. Diesel vehicles increased 5,000MtCO2e, or 16Mill VMT. A significant part of this change can be attributed to the fact that between 2019 and 2023, Streetlight, the program used to measure VMT, was updated. It now tracks non-stop trips from anywhere in the continental US to Biddeford, whereas before it only tracked non-stop trips from Southern Maine and parts of New Hampshire to Biddeford. The increase in transportation emissions is also because of an increase in residential buildings. Rail traffic was not included for the sake of consistency, as it wasn't included in 2019. In addition, Amtrak doesn't account any emissions to Biddeford, since there's not a stop here.

Residential energy makes up around a quarter of emissions. It has decreased 4% from 2019. Electricity use is up 2,000MtC02e, and heating oil is down 6,000MtC02e. Natural gas use and propane is also down. The decrease can be contributed to things like heat pumps, EVs, electric appliances, and electrification overall.

Commercial energy has essentially no significant difference from 2019; it's up by 1%. Electricity use has increased slightly. Natural gas usage is down. Given that there's been an increase in commercial activity since 2019, it's good that there wasn't more of an increase in emissions from this sector.

No significant change in industrial energy use; it was down slightly.

Solid waste has decreased by .8%, which isn't a significant change. Can be attributed to a decrease in waste and an increase in compost. Not good enough recycling data to comment on recycling waste, but the decrease in waste indicates better recycling data.

The population of Biddeford is fairly stable year-over-year according to the American Community Survey, so it's not much of a factor.

The second part of the inventory is about municipal government emissions. Emissions have increased a little over 300MtCO2e since 2019.

The largest section is from buildings and facilities' electricity and natural gas consumption. It's grown 5%. Fixing windows and increasing natural light are two ways to reduce these emissions. Over half of the category is from energy use in the school department, which had an over 100MtCO2 increase from 2019, including an increase in natural gas as well. The other significant increase was from the police station. Street lights and traffic signals should be viewed as in a group with this, because the emissions from these categories were attributed differently in the two different years. Some of the decrease in street lights and traffic signals can be attributed to electrification and use of LEDs.

34% of emissions come from the municipal fleet. Emissions have increased by 165MtCO2e, or 1%. However, the emissions from and VMT of gas-powered cars has decreased due to electrification of the fleet. Diesel trucks and public works vehicles have caused the increase in emissions. There are at least 40 new diesel vehicles since 2019. Other devices like weed wackers and snow blowers are included in the data, but they make up a negligible amount of emissions. Joie and Scott note that Casella trucks are counted in the community inventory, not the government inventory.

Water and wastewater emissions has decreased. The emissions from the wastewater plant have decreased.

Brad notes that the commissions has begun to address both of the biggest sectors in the community and government inventories with our 2025 work plan.

The city plans to do another inventory in 2027 or 2028.

To put the report in context, the city has committed to reducing GHG emissions by 62% from 2019 levels by 2030.

Max notes that renewable energy growth and electrification will probably decrease now that federal incentives are gone, so the city will need to take action to incentivize it.

Max and Jeff talk about how the landscaping ordinance relates to this inventory; there's one part of the ordinance that incentivizes electrification.

Members discuss sharing the graphic and the report in the Sustainability Commission's newsletter, as well as other ways to share the inventory with the community.

4. Members briefly discuss plans for Riverjam. The Sustainability Commission has a table at the event, and several members have volunteered to table along with Brad.
5. Update from SMPDC and Update to Council are both postponed.

Draft landscaping ordinance

To do:

- Find or create a list of preferred plantings
    - Check Maine Urban & Community Forestry Council
- Find or create a list of discouraged plantings (Bradford pear trees, kentucky bluegrass, etc.)
- Amend parts of site plan and subdivision plan ordinance to reference landscaping ordinance (need code blocks from city planner)
- Incorporate any existing landscaping standards elsewhere in the code (need code blocks from city planner)
- Create specific regulations for each district (needs input from city planner)
- Tweak landscaping per district table (with input from city planner)

Purpose

A. The intent of this ordinance is to provide minimum requirements for landscaping of future development to maintain a base standard of quality of life and general appearance for private and public properties in the City. It is also the purpose of this ordinance to encourage the use of landscaped areas to promote low impact development (LID) stormwater management systems and to reduce the amount of impervious surface heat islands in urban areas, both of which are recommended strategies in the Biddeford Climate Action Plan.

B. Landscaping shall be designed as an integral part of an overall site or subdivision plan with the purpose of enhancing building design, public views, and spaces, while also providing buffers, transitions, and screening.

Landscaping plan

A. For any proposed development that requires a landscaping plan and has not had such requirement waived, a landscaping plan must be presented and approved prior to issuance of a building permit. Additionally, any Planning Board projects with

landscaping requirements must include a landscaping plan with their plan submission prior to final approval.

B. Unless otherwise waived or modified, a landscaping plan must be included for:

1. The construction or replacement of structures large enough to trigger site plan review per this Title
2. Any residential development large enough to trigger subdivision review per this Title
3. An expansion or addition to an existing structure large enough to trigger site or subdivision plan review per this Title
4. A change of use in an existing site or structure large enough to trigger site plan or subdivision review per this Title
5. The creation of 15 or more parking spaces, or 20,000 square feet of impervious surface
6. The expansion of an existing parking space by more than 50% of total spaces (unless the proposal is for less than 5 spaces)
7. The expansion of an existing impervious surface area, such as gravel or pavement, by more than 50% of the total square footage (unless the proposal is for less than 2,000 square feet or impervious surface)

C. For projects that require landscaping, this ordinance grants the authorized reviewing body (Planning Board or Planning Director) the authority to waive specific requirements or impose additional requirements in special circumstances to ensure the fulfillment of the stated purposes of this chapter and to allow for flexibility and innovation of design. Said special circumstances or a reasoning for a modification should be documented in writing with the full plan application. Examples of what might constitute special circumstances may include but are not limited to:

1. The preservation of unique wildlife habitat
2. The preservation of mature vegetation or natural areas
3. Compliance with easements such as those providing public access, conservation, or utility maintenance.

4. Redevelopment of existing properties where the requirements in this title are impossible to meet
5. Insufficient distance between an existing structure and a property line for required landscaping
6. Unique site uses

D. The Planning Board or Planning Director may grant modifications to minimum landscaping requirements or open space minimums if the applicant proposes to do at least one of the following:

1. Plant primarily native and drought-resistant species, excluding lawn grass and any plantings in the prohibited planting list
2. Provide a plan for the removal and prevention of any invasive plant species on the site
3. Provide a conservation easement for any critical habitat currently on the site
4. Donate a portion of the site as conserved open space to the City or a land holder
5. Provide public amenities such as a park as part of the development
6. Provide an easement for public access on the site, primarily via a park or trail
7. Provide significant improvements to stormwater management on the site

Enforcement

A. For any building permit issued, occupancy will be withheld until all required plantings on a landscaping plan are added, unless requirements are modified by the relevant reviewing authority.
B. Code Enforcement and Planning staff may issue temporary occupancy prior to installation of required plantings. Failure to install required plantings within 6 months of occupancy will constitute a code violation

a. If temporary occupancy is granted, it shall be the responsibility of the project manager or business owner to contact planning or code enforcement staff upon completion of the landscaping work and request an inspection. Staff may inspect landscaping upon request by the developer or property owner.

C. Modifications to originally approved landscaping plans must be made as a written request to planning staff.

1. Changes to landscaping plan that do not reduce the number of originally approved plantings may be considered a field change and reviewed by the City Planner.
2. Changes to a landscaping plan that would reduce the number of originally approved plantings are considered a modification to an approved plan, which will require approval from the Planning Director or Planning Board.

General requirements

A. Landscaping development requirements

1. All portions of a lot undergoing development review not devoted to buildings, future buildings, parking, storage, or accessory uses shall be landscaped in a manner appropriate to the stated purposes of this chapter.
2. All ingress or egress easements that provide corridors to a subject lot, and are not adjacent to a public right-of-way, shall be considered the same as a public right-of-way. Landscape requirements for easement corridors shall be the same as those required for areas adjacent to public rights-of-way.
3. When landscaping is required along the frontage of a right-of-way, landscaped areas shall extend to the curbline or to the street edge.

4. If a landscape plan includes plantings located within a public right-of-way, said plan must clearly notate that maintenance of plantings remains the responsibility of the property owner in perpetuity.
5. Pedestrian infrastructure (including but not limited to sidewalks, walkways, trails, bike lanes, multi-use paths, pocket parks, and seating areas) may be included when calculating the required dimensions for landscaped areas, such as width of landscaped area along the frontage of a road.
6. Landscaped areas required to front inappropriate features (such as railways) may be relocated to other portions of the site, to the satisfaction of the reviewing authority.
7. Required landscaping may be integrated with LID stormwater management facilities, where feasible. LID facilities shall not compromise the purpose or intent of required landscaping, and landscaping shall not result in the disruption of the function of the LID facilities.
8. The configuration and plant species of landscape areas on a site shall be designed so as to not disrupt the functions of stormwater systems.

B. Buffering and Screening Requirements
    1. For the purposes of screening and buffering, existing mature vegetation can be used to meet the standard, so long as the existing vegetation is determined to not be an invasive species
    2. All parking, maneuvering, and loading areas of over twenty thousand (20,000) square feet shall have a minimum of ten (10) percent of the parking area, maneuvering area, and loading space landscaped with Type 5 landscaping as a means to reduce the amount of stormwater runoff and uninterrupted impervious surface area. Perimeter

landscaping, such as screening along property lines, shall not be included as part of the ten (10) percent figure.

3. The perimeter of all parking lots that abut residential zones or uses shall be landscaped in a manner that shields residential zones or uses from lights and provides aesthetic separation between uses. This shall include at minimum a depth of five (5) feet of Type 2 landscaping, unless otherwise provided by this chapter, or otherwise approved by the planning director.
4. All property abutting Interstate 295 shall be landscaped with Type 3 landscaping to a minimum depth of ten (10) feet unless otherwise modified by the Planning Director or Planning Board
5. All property abutting the portion of Alfred Road west of Route 1, and the portion of Route 1 south of Alfred Road, shall be landscaped with Type 3 landscaping to a minimum depth of ten (10) feet unless otherwise modified by the Planning Director or Planning Board
6. All dumpsters or outside storage areas shall be screened by fencing and landscaping a minimum of five (5) feet in depth unless it is determined by development plan review that such screening is not necessary, due to storage area location, existing fencing or landscaping, or because stored materials are not visually obtrusive.
7. Landscaping shall be placed outside of sight-obscuring fences, unless it is determined by the Planning Director or Planning Board that such arrangement would be detrimental to the stated purposes of this chapter or would compromise site safety.
8. The perimeter of all stormwater detention ponds shall be landscaped to a minimum depth of ten (10) feet of Type 2 landscaping. If perimeter fencing is required based on public works department standards, it shall be constructed of vinyl-coated chain link or solid screen fencing. The fencing shall be located between the pond and the landscape area.

C. Planting requirements

1. Bark mulch, gravel, or other non vegetative material shall only be used in conjunction with landscaping to assist vegetative growth and maintenance or to visually complement plant material. Non vegetative material is not a substitute for plant material.
2. Required landscape areas shall be provided with adequate drainage. All new landscape areas shall incorporate soil amendments as follows: the uppermost twelve (12) inches of soil shall be tilled and two (2) inches of composted material shall be fully incorporated into the tilled soil; or to specifications proposed by a landscape architect that meet the satisfaction of the relevant reviewing authority.
3. Slopes shall not exceed a three (3) to one (1) ratio (width to height), in order to decrease erosion potential and assist in ease of maintenance.
4. Landscape plans shall include a diversity of native and drought tolerant, low water use plant species, and shall promote native wildlife habitat where feasible.
5. Irrigation systems incorporated into a landscaping area shall include rain sensors to promote water conservation.
6. Trees planted along rights-of-way or driveways should be ornamental or “medium” sized trees to avoid future degradation of overhead or underground utilities

Incentives

A. To help facilitate the goal of the Climate Action Plan, development review applications may receive modifications to density, setback, open space and height requirements if the development provides one of the following additional benefits as part of their landscaping plan:

a. Adherence to only native and climate-resistant plants from the City's preferred planting list, with a condition of approval that discouraged plantings will not be added as part of future landscaping

b. Utilization of open space areas for food production such as greenhouses, community gardens, or food plots

c. Provision of public access easements, conservation easements, or public access trails on the site.

d. Donation of a portion of the land to be conserved open space or a public amenity, such as a park.

e. Landscaping proposed beyond the scope of what is required by this title, to the satisfaction of the Planning Board or Planning Director

Types of Landscaping

Category	Type 1 Solid Screen	Type 2 Visual Screen	Type 3 Visual Buffer	Type 4 Low Cover	Type 5 Open Area
Purpose	Intended to provide a solid sight barrier to totally separate incompatible uses.	Intended to create a visual separation that is not necessarily one hundred (100) percent sight-obscuring between incompatible	Intended to provide visual separation of uses from streets and main arterials and between compatible uses so as to soften the	Intended to provide visual relief where clear sight is desired or as a complement to larger, more	Intended to visually interrupt large open spaces of parking areas.

		uses.	appearance of streets, parking lots, and building facades.	predominant planting materials.	
Description	Shall consist of evergreen trees or tall shrubs with a minimum height of six (6) feet at planting, which will provide a one hundred (100) percent sight-obscuring screen within three (3) years from the time of planting; or a combination of evergreen and deciduous trees and shrubs backed by one hundred (100) percent sight-obscuring fence	Shall be evergreen or a mixture of evergreen and deciduous trees with large shrubs and ground cover interspersed with the trees. A sight-obscuring fence may be required if determined by development plan review that such a fence is necessary.	Shall be evergreen and deciduous trees planted not more than thirty (30) feet on center interspersed with large shrubs and ground cover. Where used to separate parking from streets, plantings must create a visual barrier of at least forty-two (42) inches in height at time of planting and form a solid screen three (3) years after planting.	Shall consist of a mixture of evergreen and deciduous shrubs and ground cover, to provide solid covering of the entire landscaping area within three (3) years of planting and to be held to a maximum height of three and one-half (3 1/2) feet.	Shall consist of trees planted with supporting shrubs or ground cover. Each landscape area shall be of sufficient size to promote and protect growth of plantings, with a one hundred (100) square foot minimum area and no dimension less than five (5) feet.

Planting requirements

A. Deciduous trees shall be a minimum of one and one-half (1 1/2) inch caliper at the time of planting. Evergreen trees shall be six (6) feet high at planting. Tree spacing shall be as appropriate for the species.

B. *Ground cover* means low-growing vegetative materials with a mound or spreading manner of growth. Spacing is dependent on the type and size of the plant material and must be adequate to provide total coverage of the landscape area within three (3) years. Ground cover plants, other than grasses, must be at least the four (4) inch pot size at time of planting.

C. Shrubs shall be a minimum of eighteen (18) inches in height, or two (2) gallon container size, at the time of planting.

D. The plantings and fence must not violate the sight area safety requirements at street intersections.

E. Exclusive of the B-1 District, commercial and industrial uses shall maintain the first 25 feet from the edge of the right-of-way (excluding driveways) in front of all buildings, structures and impervious areas as a green strip. The green strip shall consist of a maintained vegetated area (e.g., lawn, garden, landscaped shrubbery), with a two-and-one-half-inch diameter or larger deciduous shade tree, spaced every 25 feet, or a shrub, two to three feet in height, minimum, placed the equivalent of one per 10 feet, along the green strip and parallel to the right-of-way. In order to ensure proper visibility for entering and departing vehicles, all driveway entrances and exits shall be kept free from visual obstructions higher than three feet above street level for a distance of 25 feet measured along the intersecting driveway and street lines.

F. All uses in the Institutional Zone shall maintain a landscaped green strip in front of all buildings, structures, and parking lots adjacent to any public street. The width of the green strip as measured from the

edge of the right-of-way shall be 40 feet for the Pool Road (Route 9) and the new Hills Beach bypass road if such a road is constructed and 25 feet for all other public streets. This green strip shall be treated and maintained as set forth in the approved institutional master plan and may include pedestrian facilities and amenities such as walkways, plazas, sitting areas, fountains, bus stops, passenger loading and unloading areas, porticos information kiosks, and similar improvements.

Regulations for specific districts:

Zone(s)	Abutting street (front yard)	Side yard	Rear yard	Abutting residential district or use	Zone specific requirements
R1a - R1b	NA	NA	NA	NA	NA
R2 - R3	Five feet Type 4	NA	NA	NA	NA
SR	NA	NA	NA	NA	NA
CR	NA	NA	NA	NA	NA
B1	Five feet Type 4	NA	NA	NA	NA
B2	Ten feet Type 3	Five feet type 3	Five feet type 3	Ten feet type 2	Parking areas that front the road require Five feet of Type 5

					landscapin g
I1 - I3	Fifteen feet type 1	Five feet type 2	Five feet typ 2	Fifteen feet type 1	
W1 - W3	NA	NA	NA	NA	NA
R-F	NA	NA	NA	NA	NA
LR-F	NA	NA	NA	NA	NA
M	Ten feet Type 3	Five feet type 2	Five feet type 2	Ten feet Type 3	
CZ					Determined by Council and Planning Board
IN					See note below
OR	Five feet type 4	NA	NA	Five feet type 4	
MSRD1 - MSRD 3					

Maintenance of Landscaping

A. Whenever landscaping is or has been required in accordance with the provisions of this title or any addition or amendments to this title, or in accordance with the provisions of any previous code or ordinance of the city, the landscaping shall be permanently maintained in such a manner as to accomplish the purpose for which it was initially required. All landscaping which, due to accident, damage, disease, lack of maintenance, or other cause, fails to show a healthy appearance and growth shall be restored, or replaced with the same type of landscaping elements and in the same location as required in the approved landscape plan. These requirements also apply to

landscaping for LID stormwater management systems, such as bioretention swales. Failure to restore or re-plant landscaping within one year of removal or damage will result in a code violation against the property.

B. *Maintenance assurance*. To ensure the maintenance of new landscaping, the planning director may require a performance and maintenance bond or other acceptable maintenance assurance device, such as an irrevocable letter of credit, set-aside letter, assignment of funds, or certificate of deposit, prior to permit issuance. In determining whether to require an assurance device, the planning director may consider elements such as the size and complexity of the project, the likelihood of plant survival, and the likelihood of adequate maintenance. The value of the maintenance assurance device shall equal at least one hundred ten (110) percent of the total landscape materials plus installation. If a maintenance assurance device is required, the property owner shall comply with the following provisions:

    1. If the landscaping is not being properly maintained, the planning director shall notify the property owner that the owner must restore the landscaping to its required condition, to the satisfaction of the director, within thirty (30) days. If the property owner does not restore the landscaping to the satisfaction of the director within thirty (30) days of the notification, then the city may use the proceeds of the assurance device to perform any type of maintenance or replacement necessary to ensure compliance with this ordinance.
    2. The maintenance assurance device shall be accompanied by an agreement granting the city and its agents the right to enter the property and perform any necessary work. The agreement shall also hold the city harmless from all claims and expenses, including attorney's fees.
    3. Upon completion of the development, and inspection by the city to determine that the landscaping has been maintained to the satisfaction of the planning director, the city shall release the

maintenance assurance device, less any proceeds previously used by the city pursuant to this section.

4. The property owner is responsible for all costs incurred by the city in doing any work covered by the assurance device. The property owner shall reimburse the city for any amount expended by the city that exceeds any proceeds of the assurance device actually used by the city. The city shall have a lien against the subject property for the amount of any excess.

Maine cities are promoting native plants. Here’s how you can too.

pressherald.com/2025/08/03/maine-cities-are-promoting-native-plants-heres-how-you-can-too

August 3, 2025

Matt Bilodeau of Longfellow’s Greenhouses in Manchester points out native shrubs at the greenhouses Tuesday. (Rich Abrahamson/Staff Photographer)

Buy Image

As the city of Augusta moves to use native plants on city property when possible, other cities and people are doing the same for their gardens.

Native plants, such as the cardinal flower, highbush blueberry and red maple tree, adapt best to Maine’s climate and provide natural food for insects and animals.

After an increase in people choosing “showy, unique plants,” plant sellers are reporting more people turning to native plants.

“The showy, unique plants have their place in landscaping for sure, but it’s also nice to incorporate natives in the mix and we are seeing an increase in people reincorporating those plants into their gardens,” said Matt Bilodeau of Longfellow Greenhouses in Manchester.

Want to get more in your yard? Here's what you need to know.

What are native plants?

Native plants are plants that would grow naturally in a particular area, said Bilodeau.

"Native plans are best known for their support for wildlife and pollinators and their ability to withstand harsh winters, our hot, dry summers, and also wet seasons as well," he said. "They are plants best suited for our environment."

Andrew Tufts, program manager of Bringing Nature Home at Maine Audubon, said the organization has helped several cities, including South Portland and Bangor, as well as schools across the state incorporate native plants into their landscapes or as an educational opportunity for schools.

The Bringing Nature Home program at Audubon started around 10 years ago and was inspired by the book "Bringing Nature Home" by Douglas Tallamy.

The main focus of the book and the program is to restore Maine's biodiversity by growing and disrupting native plants that provide a wide array of wildlife benefits.

"Most folks who live in Maine live here because of the natural beauty, and the image of the state is its natural beauty, and in that are the native plants. As we continue to be faced with development, we want to make sure we are doing it in a way that is thoughtful and with consensus, and landscaping with native plants is a way to do it," Tufts said.

A bee pollinates a wild aster flower in Hallowell in September 2023. Many people and some communities are now making it a point to plant only native species that will in turn provide a better food source for wildlife and pollinators. (Joe Phelan/Staff Photographer)

Buy Image

Why are native plants good for the environment?

Native plants provide food for native insects and animals that in return support a healthy ecosystem.

Tufts gave the example of the monarch butterfly. The monarch exclusively eats plants in the milkweed family, lays its eggs on the plant and later creates a cocoon that will hatch on the milkweed.

“If you want to attract and see these butterflies and all you have is turf grass and a variety of non-native oriental plants, you’ll never be able to support these insects,” Tufts said.

Tufts added that the main source of food for baby birds are insects, commonly caterpillars that feed almost exclusively on native plants. Without the native plants, that entire chain can be disrupted.

Native plants have coevolved with native insects for thousands of years, he said, so planting native plants can create a habitat for wildlife.

I don’t have a green thumb. Where do I start?

Bilodeau said native plants are very easy to take care of and most people already have them in their yard or surrounding yards.

He suggested making sure the plants are well-watered in their first year until the roots are established in the soil.

“A plant climatized and suited for this area should take to the ground well,” he said.

Where can I purchase or learn more about native plants?

Most plant stores, such as Longfellow Greenhouses, sell native plants which should be marked if they are a native or pollinator-safe plant. If not, ask a salesperson, Bilodeau said.

The Maine Audubon is in the process of building a native plant education center at its location in Falmouth as a way to educate the public more about native plants. People can also purchase plants on the Maine Audubon’s Native Plant website.

Is Maine experiencing a ‘wedding gap’?: Less tradition, lower budget
Portland’s Back Cove music festival hits the right note on inaugural weekend

frontiers | Frontiers in Climate

TYPE Community Case Study
PUBLISHED 29 July 2025
DOI 10.3389/fclim.2025.1510802

OPEN ACCESS

EDITED BY
Charles Krishna Huyck,
ImageCat (United States), United States

REVIEWED BY
David Casagrande,
Lehigh University, United States
Christopher Jones,
CPJA, United States

*CORRESPONDENCE
Devon J. McKaye
✉ devon.mckaye@arcadis.com

RECEIVED 13 October 2024
ACCEPTED 15 July 2025
PUBLISHED 29 July 2025

CITATION
McKaye DJ, Murphy V and Hill L (2025) Retreat in real time—Nantucket's balancing act along a changing coast.
Front. Clim. 7:1510802.
doi: 10.3389/fclim.2025.1510802

Retreat in real time—Nantucket's balancing act along a changing coast

Devon J. McKaye[1]*, Vincent Murphy[2] and Leah Hill[2]

[1]Arcadis, U.S., Inc., Wakefield, MA, United States, [2]Town of Nantucket Natural Resources Department, Nantucket, MA, United States

Nantucket, an island about 30 miles off the coast of Massachusetts, has long embraced retreat in response to coastal hazards. This community case study examines how Nantucket is enhancing its resilience by adapting to increasing coastal storms, erosion, and sea level rise through strategic retreat and relocation. Nantucketers have historically moved structures such as lighthouses and homes away from the coastline, but the increasing frequency and intensity of storms demand more comprehensive and adaptable solutions. Through resilience planning and policy efforts, the Town of Nantucket is addressing these challenges by balancing short- and long-term objectives, public and private interests, and equity considerations. Lessons learned from Nantucket's experiences are applicable to other communities facing similar coastal risks, highlighting the importance of strategic planning, community support, and capacity building for effective retreat and relocation.

KEYWORDS

retreat, Nantucket, resilience, climate change, coastal hazards

Introduction

Nantucket is no stranger to the concept of retreat. Since the island was settled, Nantucketers have been grappling with coastal hazards which, in many ways, are an accepted part of island life. Formed after the retreat of the Laurentide ice sheet, most of the island is composed of glacial outwash materials, including sand and gravel, which are especially prone to erosion (USGS, n.d.). Over time, Nantucketers have adapted to coastal hazards by moving lighthouses, homes, roads, utilities, and other structures away from the coastline in both managed (i.e., planned) and emergency situations. However, with climate change, coastal storms are increasing in frequency and intensity and erosion of the island's bluffs, dunes, and beaches is becoming more rapid with sea level rise, bringing storm surge impacts to Nantucketers' front doors and threatening their homes, infrastructure, and natural resources.

This community case study explores how, in the context of broader resilience planning and policy, the Town of Nantucket (the Town) is navigating the complexities of managed retreat. Different coastal hazards dominate across the island, necessitating a variable approach to planning for retreat and relocation. Along Nantucket's Baxter Road, atop the Siasconset ('Sconset) bluffs, retreat is unfolding in real time. Over time, the area on top of the bluffs has been developed and now faces an uncertain future. While the debate over the best long-term plan for erosion along Baxter Road continues, the Town is balancing varied and competing interests including near- and long-term objectives, public and private priorities, and considerations including equity and evolving science. In the historic Downtown, nuisance flooding is a regular reminder of the vulnerability of Nantucket's economic core, prompting near- and long-term planning efforts and challenging conversations about the balance between preservation and adaptation. Meanwhile, on the south shore, erosion imminently threatens

the island's wastewater treatment facility, triggering emergency responses while a long-term approach is developed. Though the relatively high ground found mid-island may, in some ways, be ideal for relocation, the island's history of conservation and fraught relationship with densification pose challenges.

To build a resilient future that embodies Nantucket's unique history and built heritage, supports healthy coastal and ecological resources, and bolsters thriving communities, a comprehensive, adaptable, and community-supported approach is necessary. Beginning with the 2019 update of their local hazard mitigation plan, 2021 release of the Town's first *Coastal Resilience Plan* (CRP), and with half of the CRP's recommendations complete or underway as of July 2024, the Town has laid the groundwork for upcoming strategic retreat and relocation planning efforts. Lessons learned so far on Nantucket are widely applicable to other communities as they build the policy and funding pathways, capacity, and community support required of coastal retreat.

Island context

More recently known as a vacation spot for the wealthy and elite, Nantucket's focus on tourism is a relatively new chapter in its rich history. Home to indigenous peoples for thousands of years, the island was more recently home to the Wampanoag. After the island was settled by the English in 1659, the settlers turned to whaling, learning from and utilizing the labor of the Wampanoag who had long harvested stranded whales as a valuable source of fat and meat (Harrison, n.d.). From the 1690s until the 1850s, whaling was the primary business on Nantucket, enabling the growth of industry, accumulation of wealth and expansion of the island's population. In the mid-1800s, a variety of factors led to the whaling industry's decline, notably including the formation of sand bars near the entrance to Nantucket Harbor which made passage difficult for the larger vessels necessary for offshore whaling following the collapse of nearshore populations (Stackpole and Harrison, n.d.).

For nearly 50 years after the decline of the whaling industry, the island experienced significant population decline, leaving Colonial-era residences and other structures neglected. In 1894, the Nantucket Historical Association was founded and began leading efforts to preserve the island's historic structures, establishing the foundation of the island's ongoing legacy of historic preservation. In 1955, Nantucket established a local historic district which was ultimately expanded to cover Nantucket County including Nantucket, Muskeget and Tuckernuck islands. In 1966, the local historic district was designated a National Historic Landmark.

Though tourism initially helped support the island's recovery after the fall of the whaling industry, preservation efforts in the mid-20th century supported further growth of the industry as visitors were attracted to the island's natural beauty and historic charm. Today, tourism dominates Nantucket's seasonal identity with nearly two-thirds of housing units in the County considered "for seasonal, recreational, or occasional use" (US Census Bureau, 2020a).

Though Nantucket's year-round population is only 14,255 (US Census Bureau, 2020b) the population can swell to over 80,000 during the summer season (Town of Nantucket, n.d.). The racial composition of Nantucket County is analogous to the state of Massachusetts, though the Asian population is smaller (2% on Nantucket vs. 7% in Massachusetts) and a larger share of Nantucketers identify as two or more races or another race (US Census Bureau, 2020b). The median household income for Nantucket County is higher ($135,590 on Nantucket vs. $99,858 in Massachusetts), and the cost of living on island is also higher. Though only 1.1% of Nantucket's households are classified as limited-English speaking, rates may be much higher during the summer months with the influx of seasonal workers. Nantucket also has higher rates of educational attainment of bachelor's degrees or higher, higher rates of employment, and lower rates of poverty than Massachusetts (US Census Bureau, 2022).

Though census data offer one lens for understanding the composition of the Nantucket community, it fails to capture the many nuances of year-round Nantucketer's lived experiences. While Nantucketers face many of the same challenges as communities across the country, including high housing costs and food insecurity, Nantucket's unique island context exacerbates some of these challenges and introduces others.

With the five-year average median sale price of single-family homes coming in at $2.75 million (Allen, 2023), high housing costs are a consistent challenge for Nantucketers. When considering the high cost of housing, it is notable that on Nantucket there are nearly three times as many homes as there are year-round households. Though supply outpaces year-round demand, housing demand overall is largely divorced from the island's year-round population due to the substantial demand for vacation homes (University of Massachusetts Amherst Donahue Institute of Economic Public Policy and Research, 2023). Housing prices are subsequently divorced from local salaries, with teachers, police officers, and firefighters earning $70,000–$100,000 annually. Fifteen percent of the fire department lives off-island due to the lack of affordable housing (Lindner, 2023), exposing another layer of the island's vulnerability and highlighting the challenge of being located 30 miles off the mainland. During the summer season, the issue is further exacerbated with a significant portion of seasonal employees and labor force necessary to support the tourism industry living off-island, commuting approximately 2 h each day via ferry from Hyannis, a port town on Cape Cod. High housing costs also help drive widespread food insecurity. Nationally, one in eight households faces food insecurity. For year-round households on Nantucket, this number is one in three (Lindner, 2024).

Nantucket, named by the Wampanoag tribe, translates to "the faraway land." 30 miles from the southern coast of Cape Cod, the many cascading risks associated with isolation are a major challenge for Nantucketers, especially within the context of emergency preparedness and response. The island is only reachable by boat or aircraft, with most vehicles, individuals and freight, including essential supplies like food and fuel, arriving via ferry from the mainland. At best, travel from the mainland via ferry takes about 1 h. In the event an emergency on island surpasses the capacity of emergency responders present, there is no immediate lifeline or additional capacity available. Travel time forces the island to be largely self-reliant in emergency situations. When severe weather shuts down operation of the ferries and aircraft, the island is essentially cut-off from the mainland, except for limited emergency services offered by the U.S. Coast Guard and other first responders. Due to the size of the year-round population and the ballooning of the population during the largely concurrent tourism and hurricane seasons, evacuation off the island is not practical or feasible (Town of Nantucket, 2019a).

History of retreat

Since the early days of Nantucket's inhabitance, the natural environment and coastal hazards have been a consideration in where and how the built environment is established. Traditional indigenous homes on the island were often built into the landscape with reinforcements that offered protection against strong coastal winds (Nantucket Historical Association, n.d.). Sherburne, Nantucket's original settlement, was once located west of the current Downtown along the north shore near what is now Capaum Pond. By 1730, the Capaum Harbor entrance closed due to longshore drift, spurring the relocation of Downtown to its current location.

More recently, several structures on the island have been relocated in response to coastal hazards (Figure 1). Notably, in 2007 the Sankaty Head Lighthouse was moved over 400 feet away from the shoreline after decades of storms and erosion claimed hundreds of feet of the bluff. Though the lighthouse's relocation was planned, most of the island's previous retreats have been unmanaged and reactionary. For example, portions of roadways including Madaket Road and Sheep Pond Road have been retreated following erosion-induced breaches. Though not well-documented, numerous residences, predominantly along the south shore, have also been relocated. Anecdotally, residential relocations have increased over time as erosion rates rise.

Currently, the Town is exploring questions related to proactive, managed retreat and relocation in three diverse contexts across the island: bluff erosion threatening a roadway and homes along Baxter Road, nuisance flooding threatening the historic Downtown neighborhood, and erosion threatening a critical facility along the south shore (Figure 1). Since 2019, hazard mitigation and resilience planning efforts undertaken by the Town have laid the foundation for productive community conversations around retreat and relocation.

Laying the foundation for retreat and relocation

With approximately 88 miles of shoreline, coastal hazards like flooding, erosion and high winds are, in many ways, an accepted part of island life on Nantucket. While this mindset has influenced how Nantucketers approach emergency preparedness, hazard mitigation, and long-term resilience, recent storms and a growing awareness of climate change impacts have resulted in the increasing recognition that the solutions of the past may not be adequate in the future. The planning efforts described herein are building awareness and capacity within the Town, and the community more broadly, to support conversations about the impacts of coastal hazards on Nantucket and the mounting need for strategic planning around retreat and relocation.

Before 2019, limited efforts explicitly addressed coastal hazards on Nantucket. In 2014, the Town released a *Coastal Management Plan* to establish priorities and procedures for protecting and managing Town-owned infrastructure and public access points (Town of Nantucket, 2014). In early 2018, Nantucket experienced two major nor'easters and a blizzard. At the time, five of the top 10 flood elevations ever observed on Nantucket were measured in the first 3 months of 2018 (Town of Nantucket, 2019b). Around this time, the Town was in the process of updating their local hazard mitigation plan, as required by 44 CFR 201.6, and recent flood experiences

FIGURE 1
Locations of select historic and anticipated Town-led retreat efforts [Basemap by Esri, "World Imagery." Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community].

helped shape recommendations to create a new staff position to lead coastal resilience efforts and to develop an island-wide coastal resilience plan.

In early 2019, the Town hosted a Community Resiliency Building workshop to solicit stakeholder participation and input as a part of the Massachusetts Municipal Vulnerability Preparedness (MVP) program. Funding for this workshop was provided by the MVP program. A key recommendation realized by this effort was the establishment of a municipal resilience coordinator position to facilitate resiliency initiatives across departments and conservation groups on island (Town of Nantucket, 2019a).

As a result of recent flood impacts, ongoing planning efforts, and growing public recognition of increasing climate impacts, the Town appointed a Coastal Resilience Advisory Committee (CRAC) and hired a full time Coastal Resilience Coordinator in spring 2019. Both the CRAC and Coastal Resilience Coordinator played key roles in development of the *CRP*, as recommended by the *2019 Natural Hazard Mitigation Plan*, and continue to drive the implementation of coastal resilience efforts across the island (Town of Nantucket, 2019b).

In January 2020, Nantucket released the *Coastal Risk Assessment and Resiliency Strategies Report* which provided a cursory review of current and future coastal hazards, evaluated risks within each neighborhood, and made broad recommendations for adaptation (Town of Nantucket, 2020). The report highlighted the range of global and local sea level rise projections available from Federal and State sources. In response, in July 2020, Nantucket's Select Board adopted the use of National Oceanic and Atmospheric Administration (NOAA) high sea level rise projections for planning purposes at the recommendation of the CRAC. Recommendations made in this plan also suggested the development of a managed retreat policy, consisting of regulatory and zoning tools, to empower and encourage residential retreat from eroding shorelines.

Building on previous planning efforts, Nantucket launched the *CRP* planning process in September 2020 to develop a united vision and roadmap for advancing coastal resilience across the island. After a comprehensive resilience planning process, including broad stakeholder engagement and completion of a risk assessment which considers multiple hazards over several time periods, the *CRP* was released in November 2021. The plan ultimately recommends 40 near- and longer-term resilience approaches and strategies at various scales from island-wide to site-specific. As of July 2024, half of these recommendations have been implemented, are currently underway, or are actively under development.

One of the *CRP* high priority recommendations is the development and administration of an island-wide approach for pursuing strategic retreat and relocation in areas of highest risk. To help guide near-term decision-making with respect to this recommendation, an island-wide risk framework was developed within the *CRP*. Recognizing that coastal risk can be complicated, the island-wide risk framework is a decision-making tool developed to guide near-term resilience decisions made on Nantucket based on the results of the risk assessment conducted for the *CRP*. The framework can be used by private property owners, Town officials, and other decision-makers to determine whether a particular type of resilience approach is appropriate given what is known about the project area's current and future coastal risk. The goal of this framework is not to prevent new construction across the island but to direct future investment to areas of the island with the lowest coastal risk (Town of Nantucket, 2021).

Over the last 5 years, these various hazard mitigation and resilience planning efforts by the Town have contributed to the development of broad awareness about increasing coastal risks and growing capacity to address these risks within the Town and among Nantucketers more broadly. Creation and maintenance of the CRAC, an entity devoted to implementing the *CRP*, and the Coastal Resilience Coordinator position have formalized the Town's capacity to act on issues related to coastal resilience. Through these plans, the Town has also started to introduce retreat to the local vernacular, familiarizing staff and the public with both the terminology and the concept. Cumulatively, these efforts have laid the foundation for an ongoing conversation about how strategic retreat and relocation may unfold in an effective and equitable manner on Nantucket.

A tailored approach

A forthcoming island-wide retreat and relocation planning effort led by the Town will build on the previous hazard mitigation and resilience planning efforts to identify priority retreat areas, evaluate potential receiving areas, and codify engagement best practices. Reflecting on the Town's recent experiences will be critical to informing the development of an island-wide approach to managed retreat. This section details how conversations around town-led retreat and relocation are unfolding across the island in real-time, highlighting many nuances that other communities may face as they engage in these topics.

Nantucket's formation due to glacial retreat and the resultant unique geology and topography has caused different coastal hazards to dominate in different areas of the island. Along the island's eastern shore, steep bluffs like those running along Baxter Road are threatened by largely unpredictable episodic erosion. In areas of lower topography and gently sloping shorelines, like the Downtown area, tidal flooding and storm surge are the primary threats to the built environment. On the southern shore, erosion during storm events poses an increasing threat as storms become stronger and more frequent. Its island location, glacial geology and topography allows Nantucket to serve, in many ways, as a real-time case study. In the context of retreat and relocation planning, it provides the opportunity to document and learn from three very different experiences unfolding concurrently within one municipality.

Baxter Road

Along Nantucket's Baxter Road, on top of the 'Sconset bluffs, retreat is unfolding in real time (Figure 2). The 'Sconset bluffs are subject to episodic erosion which can be infrequent and unpredictable. When erosion happens, large pieces of the bluff face can slump off, resulting in the loss of an unpredictable number of feet between a given structure and the bluff's edge. Already, 27 homes along Baxter Road have been relocated as the bluff collapses and more have been demolished. Interestingly, when the land along Baxter Road was originally sub-divided, the alleged intent was for a single parcel to span both sides of the road, extending landward perpendicular to the

FIGURE 2
Homes along Baxter Road on top of 'Sconset bluff in Summer 2023.

bluff face, allowing property owners the opportunity to relocate their property landward if necessary (Brace, 2010).

Between 2013 and 2015, nearly 950 feet of geotubes (large, permeable sand filled tube shaped containers) were installed by the Siasconset Beach Preservation Fund with permission of the Town as an emergency measure to help protect the toe, or base, of the bluff and prevent additional erosion and loss of property along a particularly vulnerable stretch of Baxter Road. Since the geotubes were put in place, proponents have sought to expand the project resulting in an ongoing debate about how to best address erosion in this area in the long-term. In June of 2021, the Nantucket Conservation Commission (local regulatory authority over wetland and environmental permitting) voted to remove the geotubes, triggering a series of events that are still unfolding. As of July 2024, the geotubes have not been removed but the Town has taken steps to identify and begin to implement a practicable long-term plan for this high-risk area.

In October of 2021, in response to the Conservation Commission's vote to remove the geotubes, the Town released the *Baxter Road Long-Term Planning Summary of Findings Memorandum* (Arcadis, 2021). This effort sought to compare technically feasible alternatives for providing bluff protection and develop a prioritized action plan to adapt the area over time based on the results of an alternatives analysis and significant stakeholder engagement. This memorandum served as a conversation starter and was the first time that Baxter Road was framed, publicly, as a retreat area. To support the alternatives analysis, adaptation pathways were developed (Figure 3). Adaptation pathways are sequences of actions implemented progressively and dependent on future dynamics. For Baxter Road, the adaptation pathways illustrate various alternatives, recommend short-term actions, and identify tipping points that may result in changes to the preferred long-term alternative. Prior to introducing the adaptation pathways, many stakeholders felt there was a binary choice to be made between removing the geotubes to allow for an immediate retreat and leaving the geotubes in place to continue providing protection. Stakeholder-informed development and subsequent socialization of this tool provided a common framework for how to think and talk about parallel planning efforts necessary in the short-term regardless of whether the geotubes are removed or not. Further, the tool proved to be effective in demonstrating that all potential pathways eventually lead to strategic retreat from the shoreline. This finding reinforced the importance of continued proactive planning for retreat and relocation along Baxter Road.

To support the eventual retreat of this area, engagement of stakeholders is ongoing as the Town develops an *Alternative Access and Utility Relocation Plan for Continuity of Services for Baxter Road Residents* (Town of Nantucket, n.d.). This plan will provide longer-term alternative access and utility services to residences along the northern, most vulnerable stretch of Baxter Road. As of July 2024, a shovel ready final design is expected in Summer 2025. The plan does not include the relocation of any private residences but does include demolition of Baxter Road and provision of landward alternative access.

Additionally, in January 2024, the Town released an *Emergency Readiness Plan for Baxter Road from the Sankaty Head Lighthouse to*

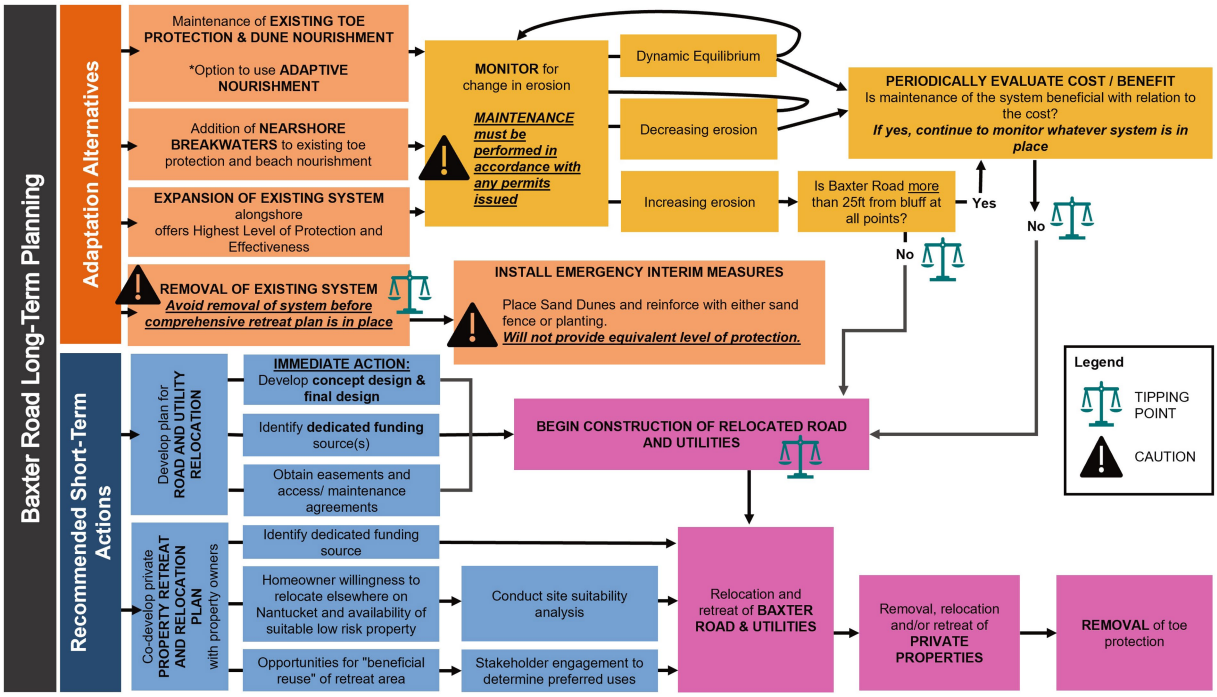

FIGURE 3
Adaptation pathways developed to support retreat and relocation planning along Baxter Road.

Bayberry Sias Lane (Town of Nantucket, 2024). This plan establishes recovery procedures for when Baxter Road is no longer passable due to coastal erosion and highlights the Town's responsibilities with respect to maintaining safety and provision of utility services if the roadway is unpassable.

The Town has not yet begun co-development of a private property retreat and relocation plan with property owners in the area. However, engagement has played a critical role in guiding the development of both the alternative access and emergency readiness plans. Given the small and largely seasonal population that may face the decision to retreat, it is anticipated that advancement of this planning is likely to happen in conjunction with the development of an island-wide retreat and relocation strategy.

Downtown

Nantucket's Downtown neighborhood epitomizes the island's unique historic character and is the economic, cultural, and historic hub of the island. Due to the relatively low topography of the area, Downtown is highly vulnerable to flooding (Figure 4). In 2022, a Town report documented a six-fold increase in the frequency of tidal flooding Downtown over the last 40 years (Larson, 2022). Between 1965 and 2023, NOAA tide gauge records indicate that Nantucket Harbor has experienced approximately 9.2 inches of sea level rise (NOAA, 2025). At-risk structures in the Downtown neighborhood include structures designated historically significant, cultural institutions, essential facilities and services (Steamboat Wharf, Hy-Line Cruises Terminal, the Downtown supermarket, and primary electrical substation for utility provider National Grid), in addition to dozens of businesses and services that support the local economy. According to the *CRP*, 325 structures and 3.5 miles of roadway Downtown are within priority action areas of extreme coastal risk per the island-wide risk framework. Assets within these areas are likely to be exposed to high-tide flooding or erosion as soon as 2030. Due to the extreme coastal risks faced in these areas today or within the next decade, the island-wide risk framework generally recommends a proactive reduction of density and minimization of large structural investments (Town of Nantucket, 2021).

However, despite the high level of flood risk Downtown, the Town has determined that, for now, structural protection is justified given the density of critical facilities and economic, social, cultural and historic assets. To preserve and enhance quality of life in Downtown, the Town is pursuing a series of structural approaches that reduce risk to the neighborhood's core while prolonging the service of critical transportation facilities and corridors, as recommended in the *CRP*.

The Easy Street Flood Mitigation project and Washington Street Resilience Framework & Francis Street Beach Improvement Project, both currently underway, represent critical steps in building the long-term resilience of the historic Downtown and the entire island. The projects include the lowest lying roads in Downtown which play an essential role in providing access and egress to and from the island's ferries and the many structures in the vicinity. Completion of these near-term projects will not eliminate flood risk to Downtown but will buy the Town time while determining the appropriate long-term adaptation pathway to transform Downtown in the face of increasing coastal risks, including significant groundwater rise, by the end of the century.

FIGURE 4
Flooding in Downtown Nantucket in Winter 2021.

South shore—Surfside Wastewater Treatment Facility

Along Nantucket's south shore, the Surfside Wastewater Treatment Facility (WWTF), built in the 1970s, is responsible for treating wastewater from the Town Sewer District which services about 60% of the island. When the facility was first built, it is estimated that there was up to 400 feet of beach between the wastewater treatment filter beds and the water. Over the past 2 years, there has been almost 150 feet of erosion. Notably, over the winter of 2023–2024, more than 50 feet of dunes eroded, imminently threatening the southernmost filter bed. While the bed was not operational, there were concerns that saltwater intrusion would impact operations of the other beds. In response, the Town filled in and closed the southernmost bed, allowing it to serve as a sacrificial sand source, buying some time before erosion progresses further inland and threatens facility operations (Treffeisen, 2024).

Now the Town is wrestling with how to protect the WWTF in the long-term. The *CRP* recommends the installation of reinforced dunes in front of the facility to provide additional protection while strategically relocating operative filter beds further back on the facility property. Other ideas discussed include installation of protective steel sheeting and relocation of the facility altogether. With uncertainty around the continued rate of erosion in this area, steep price tags (the *CRP* recommended project was estimated to cost between $33–38 million), the critical importance of this facility, and the dearth of low-risk land available for relocation, the decision is not likely to be straightforward. Communities and other critical assets, including the airport, along the south shore face similar challenges necessitating the assessment of trade-offs and acceptance of compromise in determining the appropriate long-term adaptation approach.

Relocation

As an island with inherently limited space, discussions of retreat on Nantucket are unfolding in parallel with discussions of relocation. Through Nantucket's long-standing commitment to conservation, approximately 16,419 acres, or about 55% of the island's total land area, are managed as conservation lands. These conservation lands are owned by various entities including the Nantucket Conservation Foundation, Massachusetts Audubon Society, Madaket Land Trust, 'Sconset Trust, Nantucket Land Bank, Nantucket Land Council, The Nature Conservancy, the Trustees of Reservations, the Town, State and Federal governmental agencies, and other conservation groups (Town of Nantucket, 2019a). Though the limitations placed on conservation lands vary from property to property, new development is often not feasible for legal reasons or

otherwise. Given the abundance of conservation land located in the relatively low coastal hazard risk areas mid-island, the trade-offs between conservation and opportunities for on-island relocation will need to be considered in the development of Nantucket's strategic retreat and relocation plan. The identification of areas suitable for relocation will also need to consider the growing demand for year-round affordable housing on-island. In a recent affordable housing lottery for local non-profit Housing Nantucket's latest project, 176 lottery applications were received for just six affordable apartments (Graziadei, 2024).

Discussion

Despite a noteworthy lack of guidance at State and Federal levels, since 2019, the Town has made great strides in laying the foundation for an ongoing, inclusive, and productive conversation around strategic retreat and relocation. As the Town prepares to take the next steps by developing an island-wide strategic retreat and relocation plan, there is an opportunity to document the many dimensions of this formidable challenge, as described in the previous sections, and to recognize lessons learned to date.

Through the Town's recent experiences considering retreat in the diverse contexts of Baxter Road, Downtown, and the wastewater treatment facility, it has become clear that there is no one-size-fits-all approach. Retreat and relocation planning must be highly tailored and dynamic. However, there are lessons learned that resonate across these contexts and may be relevant to other communities engaged in conversations around strategic retreat.

- Capacity, support, time and funding are critical to sustain ongoing conversations on strategic retreat. Beginning in 2019, Nantucket gradually built capacity within Town government by demonstrating the need for a coastal resilience coordinator position and developing the public awareness necessary to support establishment of the position. However, the lack of affordable housing on island threatens the Town's ability to maintain and expand staff capacity to lead proactive resilience planning efforts. Support for resilience work broadly, both within Town government and among the public, has been garnered over time through dedicated engagement and establishment of the CRAC as an entity devoted to implementation. Developing a steady funding source for proactive planning is a perennial challenge. On Nantucket, increasing public awareness and demand for action to address coastal hazards has served as a motivating force in the acquisition of funding through municipal, grant, and private sources.
- Engagement is key in all resilience planning but especially when planning for retreat and relocation (Mach and Siders, 2021; Kraan et al., 2021). The work on Baxter Road has demonstrated the necessity of approaching engagement as an enduring conversation, communicating early and often, and the reality of consensus-building as an ongoing process. Across various efforts, the Town has learned that communication, both internally and to the public, can be misinterpreted, highlighting the necessity of checking in consistently to ensure the intent of communication is heard. Education through various engagements has also helped foster shared understanding of climate change, coastal hazards and resilience, and the use of shared terminology across the island. Though engagement inevitably leads to pushback and differing ideas of success, Nantucket has leveraged this as an opportunity to make a better plan moving forward rather than viewing it as a setback or an excuse not to proceed.
- One of the major challenges in discussing retreat and relocation is the lack of certainty around what the future looks like. Nantucket's experiences have demonstrated repeatedly the importance of transparency and expectation setting. To help set expectations, Nantucket has found success in communicating things that are known or can be defined. In the case of Baxter Road, the Town worked with stakeholders to define what failure and success looked like (while acknowledging the necessity of compromise), define the process (recognizing that it may change), and identify key decision points and decisionmakers.

As the Town embarks on the development of a strategic retreat and relocation plan, these lessons learned will be incorporated into the process to support a productive community conversation as critical decisions are made about how retreat and relocation can help realize a resilient island home for all Nantucketers, today and in the future.

Constraints

This community case study is based on the experience of one municipality. Their experience with retreat and relocation may not be representative of other municipalities. Further, Nantucket's approach to retreat and relocation is ever evolving and, as such, may change following publication.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

VM: Conceptualization, Funding acquisition, Writing – review & editing. LH: Conceptualization, Writing – review & editing. DM: Writing – original draft, Writing – review & editing, Conceptualization.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. Funding for development of this article was provided by the Town of Nantucket Natural Resources Department and Arcadis, U.S. Inc.

Acknowledgments

Thank you first and foremost to the Nantucket community and Town staff who drive this important work forward. Thank you also

to Arcadis colleagues Kathryn Edwards, Trevor Johnson and Jennifer Kelly Lachmayr for their support in development of this article.

Conflict of interest

DM was employed by Arcadis, U.S., Inc., a consultancy hired by the Town of Nantucket to support several of the initiatives mentioned in this article.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

References

Allen, Jen Shalley. (2023). "Nantucket Real Estate." A comprehensive real estate analysis - 2023 year in review. Available online at: https://fishernantucket.com/2023-nantucket-real-estate-year-in-review/ [Accessed July 1, 2024].

Arcadis. (2021). Baxter Road Long-Term Planning Summary of Findings Memorandum. Available online at: https://www.nantucket-ma.gov/DocumentCenter/View/40516/Baxter-Road-Long-Term-Planning-Final-Memo-October-20-2021-PDF [Accessed May 15, 2025].

Brace, Peter B.. (2010). "Paradise lost, Baxter road owner moving house to Monomoy." WickedLocal. April 21. Available online at: https://www.wickedlocal.com/story/archive/2010/04/21/paradise-lost-baxter-road-owner/987639007/ [Accessed July 31, 2024].

Graziadei, Jason. (2024). "Nantucket current." Housing Nantucket Sees Huge Demand During Affordable Apartment Lottery. Available online at: https://nantucketcurrent.com/news/housing-nantucket-sees-huge-demand-during-affordable-apartment-lottery [Accessed July 31, 2024].

Harrison, Michael R. (n.d.). When Did Nantucketers Begin Whaling? Available online at: https://nha.org/research/nantucket-history/history-topics/when-did-nantucketers-begin-whaling/ [Accessed July 1, 2024].

Kraan, C. M., Hino, M., Niemann, J., Siders, A. R., and Mach, K. J. (2021). Promoting equity in retreat through voluntary property buyout programs. *J. Environ. Stud. Sci.* 11, 481–492. doi: 10.1007/s13412-021-00688-z

Larson, Charles D. (2022). Easy street: An update on high-tide flooding. February 4. Available online at: https://www.nantucket-ma.gov/DocumentCenter/View/41289/Easy-Street-An-Update-on-High-Tide-Flooding---February-4-2020-PDF [Accessed July 1, 2024].

Lindner, L. (2023). In the Shadows: An update on Nantucket's housing crisis. N Magazine. July 31. Available online at: https://www.n-magazine.com/in-the-shadows [Accessed July 1, 2024].

Lindner, L. (2024). Hunger is no game: A deeper look into Nantucket's food insecurity. N magazine. April 24. Available online at: https://www.n-magazine.com/food-insecurity-nantucket [Accessed July 1, 2024].

Mach, K. J., and Siders, A. R. (2021). Reframing strategic, managed retreat for transformative climate adaptation. *Science* 372, 1294–1299. doi: 10.1126/science.abh1894

Nantucket Historical Association. (n.d.). Native Peoples. Available online at: https://nha.org/research/nantucket-history/history-topic/native-peoples/ [Accessed July 1, 2024].

NOAA. (2025). Tides and Current: Relative Sea Level Trend 8449130 Nantucket Island, Massachusetts. Available online at: https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8449130 [Accessed September 13, 2024].

Stackpole, Matthew, and Harrison, Michael R. (n.d.). Why did Nantucketeers stop whaling? Available online at: https://nha.org/research/nantucket-history/history-topics/why-did-nantucketers-stop-whaling/ [Accessed July 1, 2024].

Town of Nantucket. (n.d.). FAQs. Available online at: https://www.nantucket-ma.gov/Faq.aspx?QID=289 [Accessed July 1, 2024].

Town of Nantucket. (2014). Coastal Management Plan. Available online at: https://nantucket-ma.gov/DocumentCenter/View/6333/Nantucket-Coastal-Management-Plan---2014 [Accessed May 15, 2025].

Town of Nantucket. (2019a). Community Resilience Building Workshop Summary of Findings - Final Report. Available online at: https://www.mass.gov/files/documents/2019/07/11/Nantucket%20Report.pdf [Accessed July 1, 2024].

Town of Nantucket. (2019b). Natural Hazard Mitigation Plan. Available online at: https://www.nantucket-ma.gov/DocumentCenter/View/24719/Town-of-Nantucket-2019-Hazard-Mitigation-Plan [Accessed July 1, 2024].

Town of Nantucket. (2020). Coastal Risk Assessment and Resiliency Strategies Report. Available online at: https://www.nantucket-ma.gov/DocumentCenter/View/35045/Coastal-Risk-Assessment-and-Resiliency-Strategies-Report-January-2020-PDF [Accessed May 15, 2025].

Town of Nantucket. (2021). Nantucket Coastal Resilience Plan - Final Report. Available online at: https://www.nantucket-ma.gov/DocumentCenter/View/40278/Nantucket-Coastal-Resilience-Plan-PDF [Accessed July 1, 2024].

Town of Nantucket. (2024). Emergency Readiness Plan - Baxter Road (Sankaty Head Lighthouse to Bayberry Sias Lane). Available online at: https://www.nantucket-ma.gov/DocumentCenter/View/48240/Emergency-Readiness-Plan-for-Baxter-Road---January-11-2024-PDF [Accessed May 15, 2025].

Town of Nantucket. (n.d.). Baxter Road Alternative Access. Available online at: https://www.nantucket-ma.gov/2654/Baxter-Road-Alternative-Access [Accessed May 15, 2025].

Treffeisen, Beth. (2024). "Beach erosion threatens sewage-treatment plant on Nantucket." Boston Globe. February 22. Available online at: https://www.bostonglobe.com/2024/02/22/science/nantucket-sewer-treatment-plant-erosion-climate-change/#:~:text=So%20drastic%20that%20the%20treatment,left%20from%20a%20nearby%20development [[Accessed July 31, 2024].

University of Massachusetts Amherst Donahue Institute of Economic Public Policy and Research. (2023). An Evaluation of Current Conditions in the Nantucket Housing and Short-Term Rentals Market. Nantucket Current. April. Available online at: https://nantucket-current.nyc3.cdn.digitaloceanspaces.com/assets/An-Evaluation-of-Nantucket-Housing-and-STRs.pdf [Accessed July 1, 2024].

US Census Bureau. (2022). 2022 American Community Survey 1-Year Estimates. Available online at: data.census.gov [Accessed July 1, 2024].

US Census Bureau. (2020a). American Community Survey 5-Year Estimates Detailed Tables. Available online at: data.census.gov [Accessed July 1, 2024].

US Census Bureau. (2020b). 2020 Decennial Census. Available online at: data.census.gov [Accessed July 1, 2024].

USGS. (n.d.). Geologic History of Cape Cod, Massachusetts. Available online at: https://pubs.usgs.gov/gip/capecod/glacial.html [Accessed September 13, 2024].