

Project name:
Mill Pond Study**Project ref:**
60550782.21.4**From:**
Tim Harrison**Date:**
August 29, 2025 (Rev. January 16, 2026)**To:**
George Meservey, Town of Orleans**CC:**

Memo

Subject: Orleans Nitrogen Management in Mill Pond Sub-Watershed: Aquaculture

The Town of Orleans (Town) has identified ten options for reduction of nitrogen load in the Mill Pond sub-watershed to improve water quality in this sub-watershed.

This memorandum addresses the option to implement aquaculture to reduce the total nitrogen load within Mill Pond.

Description

The Lonnie's Pond aquaculture site is used as the basis for assumptions about site design and productivity for the purposes of this memorandum. Floating bags with helical anchors and comparable access and operations and maintenance requirements are assumed.

Aquaculture, as applied in Lonnie's Pond, utilizes oysters to reduce the amount of nitrogen in the water body. Nitrogen is sequestered in the oysters and removed from the water body when oysters are harvested; the amount of nitrogen removed is proportional to the growth of the shell and meat. Benthic benefit has not been measured or claimed as nitrogen removal credit to date through the Lonnie's Pond aquaculture site.

Considerations for sizing and siting aquaculture in Mill Pond include:

- **Conflicting uses (such as moorings)** – As a floating system that is tethered to the bottom and will move with the tide and wind, project siting and design will need to consider the full range of motion available to the aquaculture system and whether it would overlap with other uses of Mill Pond.
- **Water quality** – Factors such as salinity, temperature, and dissolved oxygen impact the viability of the site. It's recommended that water quality data be gathered and assessed prior to finalizing an implementation recommendation. It is assumed that Mill Pond is a viable site, although beginning with an initial relatively small test area for aquaculture may be prudent to demonstrate that the Lonnie's concept will generally be transferrable to Mill Pond, in terms of oyster growth and survivability.
- **Accessibility** – Oyster beds require regular tending and maintenance throughout the growing season as well as more intensive access during establishment and harvest season. Tending and maintenance during the season would require small boats, such as 2-4 kayaks. More intensive work periods may require a pontoon-style boat. Mill Pond Landing has a ramp and appears to be big enough to support bringing the aquaculture contractor's boats to the site but this should be confirmed. The aquaculture contractor's vehicles could create some congestion and short-term use limitations at the parking lot, especially during peak season.
- **Navigability around the floating beds** – Mill Pond is an active boating site and a safe harbor for vessels during storms. The aquaculture site should be located and sized to avoid impacts to the existing uses of Mill Pond.

- Water depth – The depth of water could impact the aquaculture technique used. Floating bags require deeper water. As such Little Mill Pond is unlikely to be a suitable location but Mill Pond would be suitable as a deeper water body, as shown in Figure 1.

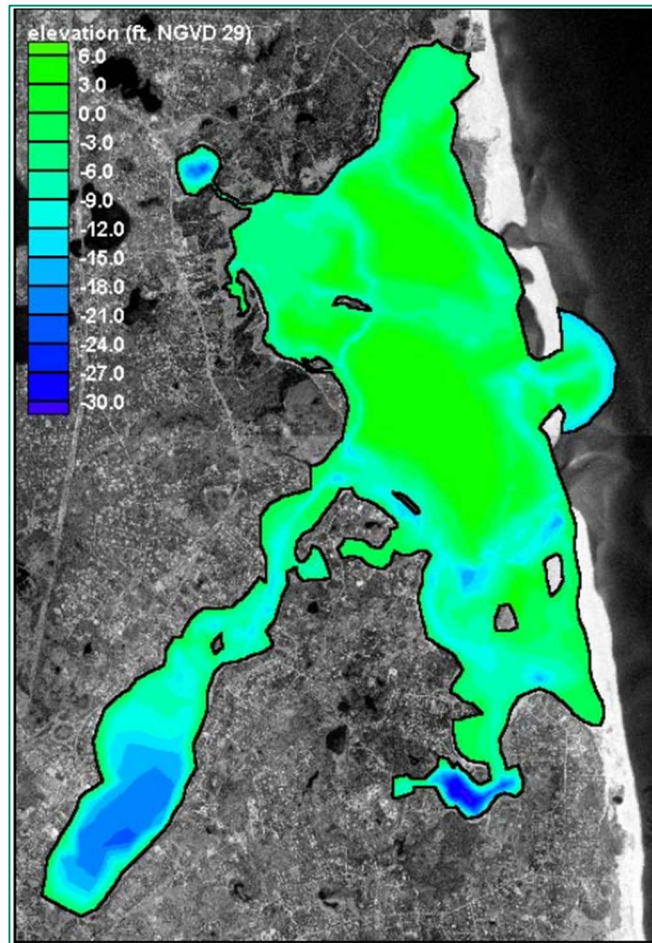


Figure 1: Depth Contour Plot for Nauset Harbor (Figure V-13, MEP Report¹)

- Wind, waves, and debris – Town experience is that wind and waves are set up from the northeast to southwest and debris in the water, either from land or water, accumulates accordingly. Debris build-up and high winds and waves can be harmful to the aquaculture contractor's gear and the oysters themselves. Siting the aquaculture beds should take this into account.

With the above considerations, the Town's Harbor Master recommended an aquaculture site location and footprint as shown in Figure 2 below. The aquaculture site in Figure 2 is approximately 70,000 square feet, which is approximately 4.4 times the size of the Lonnie's Pond aquaculture operation. Mill Pond between the race and Little Mill Pond is approximately 1.7 million square feet, so the assumed aquaculture site is about 4-5% of the total surface area.

It is important to note that the viability of this site may be limited by the presence of oyster drills. Past work that evaluated Mill Pond for aquaculture identified potential issues with predation². The presence of oyster drills

¹ *Linked Watershed-Embayment Approach to Determine Critical Nitrogen Loading Thresholds for the Nauset Harbor Embayment System, Towns of Orleans and Eastham, Massachusetts – Final Report, Massachusetts Estuaries Project, December 2012*

² *Technical Memorandum on final Site characterization and Evaluation for Aquaculture/Shellfish Propagation (evaluation criteria and ranking), AECOM for Town of Orleans, MA, March 13, 2016.*

would preclude the possibility of locating the oysters on the bottom of Mill Pond. Updated information regarding the likelihood and impact of oyster drill predation should be developed prior to implementation recommendation.



Figure 2: Assumed Mill Pond Study Aquaculture Site

Ownership and Control

Following the same model as Lonnie's Pond, the aquaculture would be owned and operated by a commercial aquaculture contractor. The Town would permit the operation and would be responsible for monitoring the nitrogen removal based on growth and nitrogen content of the shell and meat, and reporting results to Massachusetts Department of Environmental Protection (MassDEP) for nitrogen removal credit.

Performance

The Lonnie's Pond aquaculture site is providing at least 67 kg/yr of nitrogen removal. This value is included in the Pleasant Bay Watershed Permit assumptions and has been recognized by MassDEP as a suitable estimate for benefit. Since the proposed Mill Pond site, is 4.4 times the size of the Lonnie's Pond site, it is assumed that the nitrogen removal could be up to 295 kg/yr. For comparison purposes for this study, it is assumed that the yield would be slightly smaller, 270 kg/yr or approximately four times the Lonnie's Pond operation, to account for additional access requirements (approximately 10% of the area) between the bags. The actual space required should be confirmed in a later phase of this study as appropriate.

Costs

Town costs once the aquaculture system has been established are limited to the monitoring, analysis, and reporting of nitrogen removal. For Lonnie's Pond the Town was able to provide the equipment to the aquaculture contractor for the operation of the site since the pilot project had been completed. For aquaculture at Mill Pond, it is unclear whether the aquaculture contractor or the Town would provide the gear – this should be confirmed later in the planning or design phases. It should be anticipated that the cost of this alternative is very low compared to the other alternatives.

Speed in Water Quality Improvement

Nitrogen will be removed from Mill Pond as soon as the oysters start growing. This is one approach, and perhaps the fastest option, to improve water quality within Mill Pond. There is no groundwater travel time between the nitrogen reduction mechanism and Mill Pond that delays the water quality benefit.

Predictability of Performance

Nitrogen is only sequestered during the oyster growing and then removed during harvest seasons. This traditionally has occurred at Lonnie's Pond between May and November. Maintaining this schedule maximizes nitrogen removal (i.e. more growth leads to more nitrogen removal). Operations of the oyster aquaculture will be highly dependent upon the commercial aquaculture contractor.

This is a non-traditional technology and will require a traditional backup such as sewers, similar to how the Town is applying the aquaculture at Lonnie's Pond. A backup approach for nitrogen removal is only required once nitrogen removal is regulated and credits are sought.

Reliability

The benefits of aquaculture are at risk due to many factors. Oysters can be killed due to disease, degraded water quality, predation, vandalism, or extreme weather events. Oyster growth rate is also variable. Crops can be lost due to storms impact on the equipment and oyster communities. Theft is disadvantageous to the farmer and to the reported nitrogen capture and removal.

Need for Large Town Capital Expenditure

The Town has committed to remove large amounts of nitrogen in the Pleasant Bay watershed under the 2018 Watershed Permit. The very high costs of that commitment mean that the Town has limited ability to undertake costly nitrogen removal projects in other watersheds, like the Nauset Harbor system. Aquaculture may be an option to implement in parallel with the other water quality priorities due to the relatively low capital cost and relatively low ongoing Town costs.

Regulatory Acceptability

MassDEP is providing credit for Lonnie's Pond aquaculture contingent upon annual reporting of benefit, measured as amount of nitrogen removed based on laboratory tests of tissue and shell and weighing of oyster mass harvested. It is assumed that MassDEP would implement a similar credit approach for Mill Pond aquaculture once it becomes a regulated area.

Other permitting would be required for a Mill Pond aquaculture system including a MEPA Notice of Project Change, Conservation Commission Order of Conditions, US Army Corps of Engineers General Permit, Annual Harbormaster Permit, and Division of Marine Fisheries certification of the shellfish aquaculture license. The Notice of Project Change is recommended since the Amended Comprehensive Wastewater Management Plan had identified that the Town was not seeking to implement aquaculture outside of Lonnie's Pond.

Public Acceptability

The Town, to our knowledge, has not received negative feedback around aquaculture in Lonnie's Pond. There may be some additional feedback as the usage of Mill Pond is broader and there are additional property owners and stakeholders that might have a perceived impact.

Flexibility in Face of Unknown TMDL and Applicability to a Phased Approach

Aquaculture is an extremely flexible water quality management alternative. The size is scalable and the equipment is not permanent. Aquaculture can be implemented in the short-term and extended as needed. As used in the Pleasant Bay Watershed, aquaculture provides the Town the option to reduce the size of the sewer service area while reserving the ability to expand the sewer system in the future if needed. It is envisioned that Mill Pond aquaculture would be used in the same fashion, especially if the operations had been in place for some time to document nitrogen reduction benefit ahead of detailed sewer planning.

Environmental Impacts

Environmental impacts associated with aquaculture are extremely limited compared to other alternatives. Use of helical anchors minimizes the impact to the communities and habitat on the pond bottom. Lonnie's Pond aquaculture utilizes kayaks for access to the floating beds; limited power boats would be used during establishment and harvest times.

The greatest impact may be as a competing use for the surface area of Mill Pond. This would be mitigated through proper siting and sizing of the aquaculture operation. There could also be some impact to use of the Mill Pond landing, especially the parking lot during more intensive operational times.

Impact on the Orleans WWTF

Aquaculture in Mill Pond would have no adverse impact to the existing Town wastewater treatment facility (WWTF) as flow is not being captured and conveyed to the facility. This project would have no impact on the planned WWTF expansion sizing or design since the Town should assume that the aquaculture is not a permanent nitrogen removal alternative for the reasons identified above. If the Town were to cease receiving MassDEP credit or not be able to continue aquaculture operations, then sewerage and the corresponding flow increase to the WWTF may be required.

Ease of Implementation

After permitting and design, the aquaculture operation would be advertised and bid upon through a Request for Proposal (RFP) process, similar to the Lonnie's Pond RFP. The facility would be operated by the successful aquaculture contractor with the Town responsible for coordination and performance of the monitoring, analysis, and reporting. The Town is well positioned to implement this alternative based on experience from the Lonnie's Pond aquaculture work.

Summary of Advantages and Disadvantages

Aquaculture has these principal benefits:

- Low capital, Town, and property owner costs;
- Rapid realization of water quality benefit; and
- Easily combined with other alternatives.

The principal drawbacks include:

- Would require a traditional contingency plan with nitrogen regulation; and
- Susceptible to loss of oyster crop due to multiple reasons.