WRIGHT-PIERCE
Engineering a Better Environment

Memorandum

Date: September 19, 2025 (Revised October 19, 2025)

Project No.: 20985

To: George Meservey

From: Mike Giggey

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

Ten options have been identified for reduction of nitrogen load in the Mill Pond sub-watershed. One of those options is the improved management of stormwater runoff to reduce watershed nitrogen loads. This option is described and evaluated in this memo.

Description

This option involves the improvement of stormwater management systems and procedures to reduce the runoff-associated nitrogen load to Mill Pond. Stormwater contains nitrogen compounds, and certain stormwater management facilities and activities can capture some of that nitrogen. This approach involves building and enhancing existing stormwater control systems. It also includes more intensive use of non-structural practices such as catch basin cleaning and street cleaning.

Ownership and Control

Stormwater management is largely a municipal function. The construction and maintenance of stormwater systems and the more intensive use of non-structural practices are both within the control of the Town, at least on Town roads.

Performance and Extent

The reports from the Massachusetts Estuaries Project include stormwater nitrogen loads in all of their watershed loading estimates. Based on 1990s work by the Cape Cod Commission, a standardized MEP approach was developed that accounts for the actual amount of impervious surface in a given sub-watershed, and estimated rainfall and runoff nitrogen concentrations of 0.75 mg/l and 1.5 mg/l respectively. The MEP estimate of runoff load in the Mill Pond sub-watershed is about 140 kg/yr, or about 8% of the total controllable load.

In its 208 plan, the Cape Cod Commission suggested that towns take credit for 25% reduction in runoff loads in part because of existing town facilities and because many towns are addressing MS4 stormwater requirements imposed by EPA. In the Pleasant Bay watershed, the four towns reached the collective decision not to take that 25% credit, but instead to have towns measure and report the performance of specific projects aimed at stormwater management. Given the relatively dense development in the four towns, it was thought that there is very little room to implement vegetated control systems (such as grassed swales or rain gardens) that might remove nitrogen from stormwater runoff.

The Pleasant Bay Alliance obtained EPA funding to further explore the possibility of nitrogen removal credits from various stormwater management techniques. That March 2023 study found that the 25% credit is not supportable, and that even very aggressive measures might achieve about 17% nitrogen removal, with about half of that not formally creditable because it is theoretical and cannot be effectively measured. The report found that much of the nitrogen removal traditionally associated with approaches that capture and infiltrate stormwater flows might indeed remove nitrogen from "stormwater", but they merely transfer that nitrogen load to the groundwater that readily flows to surface waters on Cape Cod.

The PBA report explored three scenarios to predict nitrogen removal from stormwater, using data from the Meetinghouse Pond sub-watershed.

- 2020 conditions and practices
  - Annual street sweeping
  - Biennial catch basin cleaning
  - No leaf pick-up
  - 6 structural BMPs
  - 7.7% removal of stormwater nitrogen load (2.0% creditable load removal)
- Moderately enhanced program
  - Semi-annual street sweeping
  - Annual catch basin cleaning
  - Fall leaf pick-up
  - 8 structural BMPs
  - 13.2% removal of stormwater nitrogen load (5.7% creditable load removal)
- Significantly enhanced program
  - Monthly street sweeping
  - Annual catch basin cleaning
  - Fall and spring leaf pick-up
  - 10 structural BMPs
  - 17.7% removal of stormwater nitrogen load (8.3% creditable load removal)

This analysis showed that a very aggressive program might remove 18% of the stormwater nitrogen, only two-thirds of the 208-recommended 25%. Due to the inability to measure the captured nitrogen, only one-third to one-half of the predicted removal could be credited against a TMDL in a watershed permit. The PBA report notes that the aggressive program might have costs that outweigh the benefits.

While the PBA study used Meetinghouse Pond data to quantify possible nitrogen removals, it is instructive to generally apply those percentages to the Mill Pond sub-watershed:

• 2020 program	12 kg/yr removal	3 kg/yr credit
• Enhanced program	20 kg/yr removal	9 kg/yr credit
• Aggressive program	27 kg/yr removal	12 kg/yr credit

Compared with the sewering alternative, even the aggressive program would avoid only 2 homes connected to the sewer system. These figures are based on the estimated stormwater nitrogen loads

from all roadways in the Mill Pond watershed, and do not reflect the fact that only about 40% are Town roads.

Costs

The costs of enhanced stormwater management involve construction and maintenance costs for structural options (like vegetated swales) and long term-operational costs for more frequent street sweeping, catch basin cleaning and leaf removal. The referenced PBA study did not estimate costs, but it is expected that this option will be less expensive than traditional nitrogen removal approaches such as sewering, but have higher costs than fertilizer controls or shellfish harvesting. Even with a strong Town program, this can be considered a moderate-cost nitrogen control option.

Speed in Water Quality Improvement

Stormwater nitrogen reaches the Pond directly through stormwater piping or indirectly through the groundwater downgradient from infiltrative structures. For treatment systems with infiltrative structures scattered throughout the neighborhood, this option has the same speed of clean-up as other residential source control alternatives, like sewering or I/A systems. If direct stormwater discharges are diverted to treatment systems with infiltrative systems, the Pond will see the impact much more quickly. In the aggregate, the most nitrogen removal would be through street sweeping and catch basin cleaning, so the benefits of better stormwater management would not be achieved for 10 or more years after implementation of enhanced stormwater management activities.

Predictability of Performance

The MEP method of estimating stormwater loads is quite approximate, so any computed credits based on enhanced stormwater activities must also be considered to be rough estimates.

Reliability

Once in place, structural stormwater facilities and more frequent street sweeping and catch basin cleaning should be quite reliable, provided there is routine maintenance of structural systems and diligent application of non-structural measures.

Need for Large Town Capital Expenditure

Town costs would include constructing structural management systems, as well as purchasing and maintaining equipment for street sweeping, catch basin cleaning and leaf pick-up. While more expensive than fertilizer controls and shellfish aquaculture, these would be considered moderate costs when compared to traditional options such as sewering. The Town would need to weigh the additional costs against the small nitrogen removals.

Regulatory Acceptability

In watershed permitting in some towns, DEP has allowed the use of the Commission-recommended 25% stormwater credit to defer the costs of traditional nitrogen control measures, but with the understanding that overall loads must be reduced sufficiently to allow achievement of target nitrogen concentrations in the embayment. Regardless of the estimated reduction of stormwater nitrogen load, the towns may be faced with additional nitrogen control measures if their full programs, including a stormwater credit, is not successful. Unlike fertilizer controls, nitrogen capture though aggressive street cleaning, catch basin cleaning and leaf pick-up can be measured, so the predicted overall removal is only partially attributable to structural systems where removals can only be estimated. At the heart of this approach is the fact that actual nitrogen load reductions cannot be practically measured at structural systems, so actual effectiveness cannot be demonstrated. It would be a town decision to rely solely on the measurable items or to include some removal amount for those structural system where removals cannot be practically measured, but probably occur.

Public Acceptability

Stormwater management is typically widely accepted by the public, due to all of the benefits to water quality, not just nitrogen removal.

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

This option is very amenable to a phased multi-pronged approach. Given that stormwater controls, alone, are unlikely to remove enough nitrogen load to significantly improve water quality, this alternative would be coupled with one or more other alternatives. Those other alternatives could be flexible enough to allow them to be expanded over time if the actual water quality improvements turned out to be less than originally predicted.

Environmental Impacts

The environmental impacts of stormwater control are only positive. In addition to reducing nitrogen loading, the town should expect reductions in phosphorus compounds, heavy metals, petroleum products, pesticides and herbicides, and many other contaminants.

Impact on the Orleans WWTF

The existing Orleans wastewater treatment facility (WWTF) has a finite capacity to treat and dispose of municipal wastewater. It will need to be expanded to handle all of the wastewater that would be collected in the current 16-phase sewer master plan. Reduction in stormwater loads avoids some sewering and thus incrementally reduces the wastewater volume that would otherwise go to the WWTF if this sub-watershed were served by a traditional sewer system, thus helping to forestall the expected large capital expense of WWTF expansion.

Ease of Implementation

The Town Public Works Department is well positioned to implement structural and non-structural aspects of enhanced stormwater management on Town roads. Application of stormwater controls on private road would be more difficult. Some helpful programs may already have been implemented by neighborhood associations.

Summary of Advantages and Disadvantages

The more intensive management of stormwater has these principal benefits:

- This is a moderate-cost option.
- It avoids a small wastewater flow to the WWTF (compared with sewering).
- It provides related benefits of removing other stormwater contaminants such as phosphorus, metals, and petroleum products.
- It is easily combined with other alternatives.

The principal drawbacks include:

- The amount of nitrogen reduction is small.
- Some of the nitrogen removal is not measurable, and thus may not be creditable under a watershed permitting program.
- It may require additional equipment and staffing of the Public Works Department.
- Application on private roads may not be feasible.

The September 19, 2025 draft of this memo was reviewed by the WMAC at its September 25, 2025 meeting. This updated memo reflects comments made by the WMAC and Town staff at that meeting.