CHAPTER 5

CONSIDERATIONS FOR NON-WASTEWATER NITROGEN MANAGEMENT

5.1 INTRODUCTION

The nitrogen TMDLs for these estuaries in the Planning Area are for the controllable nitrogen that enters the watersheds including:

- Septic tank effluent.
- Fertilizers.
- Stormwater.

For these watersheds, septic tank effluent comprises approximately 80% of the controllable nitrogen load, and fertilizer and stormwater comprise approximately 10% each. Remediating the current septic tank effluent loading is the main focus of this project but the other sources should be managed as well.

Also, there are two additional ways to manage the nitrogen that does not involve nitrogen source control:

- Enlargement of the coastal pond inlet to increase tidal flushing of the estuaries.
- Watershed modifications to enhance natural nitrogen attenuation.

From February to July 2008, research was conducted and a series of technical memoranda were prepared on the following topics:

- Evaluation of Recommended Fertilizer Management
- Evaluation of Recommended Stormwater Management
- Evaluation of Potential Watershed Modifications for Increased Nitrogen Attenuation
- Evaluation of Potential Coastal Pond Inlet Modifications for Little and Bournes Pond

These technical memoranda are contained in Appendices 5-1, 5-2, 5-3, and 5-4 respectively.

This chapter summarizes the main findings of those evaluations.

5.2 EVALUATIONS OF RECOMMENDED FERTILIZER MANAGEMENT

A. **Introduction.** The fertilizer loadings to the South Coast Watersheds to Little Pond, Great Pond, Green Pond, Bournes Pond and the Waquoit East watersheds were identified in Massachusetts Estuaries Project (MEP) Technical Reports and subsequent total maximum daily loading (TMDL) reports prepared by Massachusetts Department of Environmental Protection (MassDEP). The loadings to the Waquoit West watershed have not yet been developed by the MEP and were estimated by Stearns & Wheler using the same loading factors used by the MEP. These factors include:

- Golf course applications as researched from the individual courses with 20% of the applied nitrogen leaching to the groundwater system.
- Residential lawn size of 5,000 sf and groundwater loadings of 1.08 pounds per year of nitrogen per residential lawn (based on 20% leaching rate).

The existing fertilizer nitrogen loadings to these watersheds are summarized below:

TABLE 5-1

SUMMARY OF FERTILIZER NITROGEN LOADINGS TO THE PLANNING AREA

WATERSHED	NITROGEN LOADING RATES (KG/YR)
Little Pond	700
Great Pond	1,700
Green Pond	900
Bournes Pond	500
Waquoit West	900
Waquoit East	2,000

A summary of the nitrogen loads to the watersheds from all sources is attached in Appendix 5-1 with

report figures that illustrate the percent contributed from the various sources.

The figures indicate that fertilizers contribute 5-10% of the controllable nitrogen sources entering these watersheds while wastewater contributes 74-84% of the controllable nitrogen sources entering the watersheds. (The atmospheric deposition source falling on ponds, bays, and natural forest/shrub areas are not considered controllable by local management options.) Management of the wastewater load is the focus of the Comprehensive Wastewater Management Plan (CWMP) project, but the fertilizer load should also be managed (at least with education) so that it does not increase over time or possibly could be reduced to help meet the TMDL.

From 2002 through 2005, the Falmouth Ashumet Plume Committee conducted the Falmouth Friendly Lawn (FFL) campaign to investigate ways that fertilizers could be managed and to promote more appropriate lawn care. The campaign rewarded the organizations and individuals that followed the FFL guidelines and limited their use of fertilizer nitrogen.

In 2006, the Falmouth Ashumet Plume Committee recommended that the Town take over the FFL campaign and the Town Selectmen are still considering future actions. The Committee estimated the cost of administering the current campaign at approximately $80,000 for a 3-year period; and the cost of expanding the campaign to include three additional initiatives at an additional $54,000 per 3-year period.

B. **Alternative Approaches to Manage Fertilizers.** The following fertilizer management approaches have been evaluated:

- Town Administration of the Falmouth Friendly Lawn Campaign.
- Town Adoption of Bylaws that would Ban Lawn/Turf Fertilizer use in Nitrogen Sensitive Watersheds.
- Development of a Regional County Service to Provide Educational Information and Technical Support.

Each of the approaches is described below with advantages and disadvantages, documentation of several communications with key stakeholders, and the main findings of the evaluation.

1. **Town Administration of the Falmouth Friendly Lawn Campaign.** This approach includes the following components that are detailed in the February 2006 report given to the Falmouth Selectmen.

a. Continuation of the FFL based program, including:

- Maintain support for the 100± existing certified participants with public-relations and "honor-roll" events.
- Program administration.
- Program advertising and printing.

b. Implementation of additional effort (Initiative #1) to support an additional 25 certified participants.

c. Implementation of additional effort (Initiative #2) to add joint point-of-sale promotions to help fertilizer distribution recruitment efforts.

d. Implementation of additional effort (Initiative #3) to expand the campaign to additional types of participants such as homeowner associations and to support a group of FFL ambassadors.

As discussed above, the estimated cost for this program would be $80,000 to $134,000 for a 3-year period depending on the number of new initiatives added.

This approach has the following advantages:

- It continues and expands a visible public education campaign that has been developed with Town funds.
- It is very Town and local focused and fosters "grass roots" support.

It has the following disadvantages:

- Based on discussions with Jack Barnes (a founder of the program), a campaign such as this requires a passionate dedication by volunteers and Town staff for it to succeed. It is uncertain if this program could maintain that level of dedication over time.
- It would create a new Town service at a time when other Town services are stressed by level funding and budget costs. There may not be long-term support for this service.
- There is no way to monitor its performance or success in improving groundwater or surface-water quality.

2. **Town Adoption of a Bylaw that would Ban Lawn/Turf Fertilizer Use in Nitrogen Sensitive Watersheds.** This opinion would have the following components:

- Adoption of a Town Bylaw to ban lawn/turf fertilizer use in specific nitrogen sensitive areas.
- Adoption of a variance system to allow fertilizer use in specific (approved) applications.

Administration of the management and variance system (funded at a quarter-time to half-time staff position). This would be administered by the Health, Conservation, Building, and/or Natural Resources Department(s).

Advantages of this concept include:

- The Town could gain potential control over the lawn fertilization.
- Implementing a by-law and variance system would provide clear direction on fertilizer use in these watersheds.

Disadvantages of this concept include:

- There is no way to monitor its success.
- Enforcing compliance with the by-law would be difficult.
- Experience with MassDEP (during the 2001 Falmouth Wastewater Planning Project and evaluations for the West Falmouth Harbor Watershed) indicates that they would support

a by-law but probably would not provide a nitrogen reduction credit because the reduction would be difficult to monitor or verify.

3. **Development of a Regional County Service to Manage Fertilizer.** This concept is proposed because all of the Towns on Cape Cod will be (are) faced with the problem of fertilizer management, and this problem may be best addressed at the county level. The Cape Cod Water Protection Collective (CCWPC) has been formed to find regional solutions to the nitrogen loading problems on Cape Cod and could provide a role in implementing such a county service.

Recent discussions between Stearns & Wheler and Andrew Gottlieb, Executive Director of the CCWPC indicate:

- That the CCWPC might be the appropriate agency to facilitate such a service.
- The proponent (Stearns & Wheler or Town of Falmouth) should prepare a brief summary of the service that would be desired with a listing of the main components and identification of the County Department that would be best to administrate it.

Subsequent discussions between Stearns & Wheler and George Heufelder, (County Health and Environment Department Director) and William Clark (County Cooperative Extension Department Director) indicated that both departments would have background and an interest in providing such a service. They would both be willing to discuss the possibility with Mr. Gottlieb. The County Service would have the following components:

- Educational component to conduct training sessions on the proper application and use of fertilizers.
- Outreach and coordination with the professional organizations that are included with fertilizer management such as the:
  - Cape Cod Gulf Course Managers Association.
  - Cape Cod Landscape Contractors Association
  - Massachusetts Association of Lawn Care Professionals
- Technical support to prepare and disseminate guidance information.
- Coordination with Town staff such as Natural Resources Department Directors.

This alternative has the following advantages:

- It provides uniform information to the whole Cape which avoids conflicts between individual Town programs.
- It would be the most cost-effective program when considered on a County-wide basis.

It has the following disadvantages:

- The County may not be willing to take on this service and thereby it could be unfeasible.

4. **Evaluation Summary and Recommendation.** Stearns & Wheler believes that fertilizer management and education is best facilitated at the County level because all the Towns face a similar issue. This alternative is expected to be the lowest cost even though each Town may need to contribute to the program.

Based on this recommendation, the Town sent a letter to the CCWPC to request county help on this issue and briefly described the needed services. Discussions with the County continue through the CCWPC.

5.3 EVALUATIONS OF RECOMMENDED STORMWATER MANAGEMENT

A. **Introduction.** The stormwater nitrogen loadings to the South Coast are summarized below:

TABLE 5-2

SUMMARY OF STORMWATER NITROGEN LOADINGS TO THE PLANNING AREA

WATERSHED	NITROGEN LOADING RATES (KG/YR)
Little Pond	500
Great Pond	2,300
Green Pond	700
Bournes Pond	500
Waquoit West	3,300
Waquoit East	2,900

A summary of all the nitrogen loadings to the watersheds is attached in Appendix 5-2 with report figures that illustrate the percent contributed from the various sources.

The figures indicate that stormwater runoff contributes 5 - 9% of the controllable nitrogen sources entering the Little, Great, Green and Bournes Ponds watersheds, and 15 - 17% of the controllable nitrogen sources entering the Waquoit West and Waquoit East watersheds. Wastewater contributes 74 - 84% of the controllable nitrogen sources entering the watersheds. (The atmospheric deposition source falling on ponds, bays, and natural forest/shrub areas are not considered controllable by local management options.) Management of the wastewater load is the focus of the Comprehensive Wastewater Management Plan project, but the stormwater runoff load should also be managed so that it does not increase over time, or possibly could be reduced to help meet the TMDL.

The stormwater loading factors and loading values may be a bit conservative based on the following considerations:

- The loading values assume that all of the nitrogen in the runoff is transported to the groundwater system
- No nitrogen removal (attenuation) credit is given for nitrogen uptake by vegetated areas.
- No nitrogen removal credit is given for nitrogen attenuation by stormwater leaching systems.

It is also noted that there is no practical way to monitor if the stormwater nitrogen loads calculated by MEP are really occurring, and there will be no way to monitor if there are quantified improvements with future stormwater management procedures. As a result, there may not be the ability to quantitatively utilize stormwater management to meet a nitrogen TMDL.

Even with the above stated problem of quantitatively managing stormwater nitrogen loading, the Town (Town public and Town institutions) should take steps to improve stormwater controls for nitrogen management.

B. **Summary of Previous Evaluations of Current Stormwater Surface Discharges.** In the past, the main focus of stormwater management was to eliminate direct discharges to surface waters. This focus was to reduce sediment and fecal coliform loading to the surface waters. A draft final

report was developed in October 1995 by Muramoto and Polloni Wetland Studies titled "Inventory of Falmouth's Wetlands Damaged by Direct Road Runoff conducted for the Town of Falmouth." This report identified 117 potential direct discharge sites and prioritized 20 sites based on discussions with Town personnel and remediation feasibility (see Appendix 5-2). In addition to this study, the Town Department of Public Works (DPW) through the Town Engineering Department also maintains an "Inventory of Direct Stormwater Discharges" through its Coastal Drainage Program which tracks dates of completion as they occur (see Appendix 5-2). The DPW also maintains an ongoing DPW Drainage List which tracks locations where improvements to the collection systems that connect to the discharges are necessary as well as the date of completion as they occur (see Appendix 5-2).

The Town also holds a NPDES Phase II Stormwater General Permit which is designed to prevent harmful pollutants from entering local water bodies. A copy of the most recently completed annual report for this permit is attached in Appendix 5-2. The Town has made a strong commitment to the NPDES Phase II requirements by filling an engineering position that will be in charge of implementing the Phase II requirements. Also progress has been made relative to highway garage improvements and equipment procurement. Implementation of a Public Participation Program is being organized as well as the development and near completion of a GIS mapping program.

C. **Recommendations for Stormwater Management.** Stormwater management is a town-wide issue and requires action on both the part of the government and its residents.

Homeowners need to provide stormwater management at their respective properties. Small changes such as directing rain runoff from roofs and driveways to lawn areas or other biologically active areas such as gardens or flowerbeds can benefit the environment. Rain barrels can also be utilized to store runoff from roofs for use in watering landscaping or other non-potable activities. Driveway runoff can be mitigated through the use of stone, porous pavement or by installing vegetated filter strips.

The Town Building Department and local Conservation Commission can assist in stormwater management by reviewing their current bylaws for stormwater management related sections. Local officials can require new development or any planned growth incentive areas to utilize stormwater BMPs and integrate low-impact development (LID) features into designs prior to local approval. Treatment BMPs such as bioretention areas, rain gardens, constructed stormwater wetlands,

extended dry detention basins, sand and organic filters and wet basins should be utilized where possible. Examples of LID include porous pavement sidewalks and swales, bioretention parking dividers, and permeable paving. Where space limitations exist, infiltration BMPs such as infiltration basins, infiltration trenches, leaching catch basins and subsurface structures should be incorporated into the design where possible to mitigate stormwater runoff.

The Town Highway Department has a significant opportunity to manage stormwater and reduce nitrogen loading to the groundwater, and subsequently to the coastal estuaries. The Highway Department is responsible for providing safe passage on Town roads and that has resulted in efficient drainage of water from the roads to locations that do not impact neighboring properties. Typical Stormwater management utilizes stormwater settling/separation in catch basins and then subsurface infiltration in leaching facilities. (This type of management may provide nitrogen removal that is not properly accounted by the MEP calculations as stated previously). A better method (if space allowed) would be to direct the pretreated stormwater to a vegetated (biologically active) area where the nitrogen can be attenuated.

Some older roads have stormwater discharges directly from roads (or catch basins) to coastal estuaries. This type of discharge transports the most nitrogen load and can also transport high sediment and fecal coliform loadings as documented by the reports discussed previously. The Highway Department and the Towns DPW maintain budget line items for mitigating these problems in the following categories (see Appendix 5-2):

- Coastal Drainage at $50,000 for FY-08 with stepped increases to $150,000 in FY-12.
- NPDES at $25,000 in FY-08, $50,000 for FY-09 through FY-10 and $75,000 for FY-11 through FY-12.

Funds have been cut for these categories in the past.

Stearns & Wheler recommends restoring and possibly increasing funding to the above categories for each fiscal year. Also a follow-up (to the previous stormwater-management cost assessments) is required to estimate the total cost for mitigating all the direct stormwater discharges. Expected assessment tasks include:

- Visit all surface discharge sites.

- Identify the contributing stormwater-sheds to the discharge points, and calculate their areas.
- Estimate stormwater design flows for the needed new stormwater management facilities.
- Identify possible locations for the new facilities near the discharge point or higher up in the stormwater-shed.
- Identify soil conditions based on USDA soil maps and test pits.
- Development of preliminary designs.
- Estimate remediation costs for each discharge point.

This type of cost assessment could be completed by the Highway or Engineering Department staff with the assistance of a consultant at an estimated cost of $20,000 to $40,000 depending on the level of assistance needed.

Once the total cost to remediate the surface discharges is estimated, it can provide a more accurate funding level for the budget line items listed above.

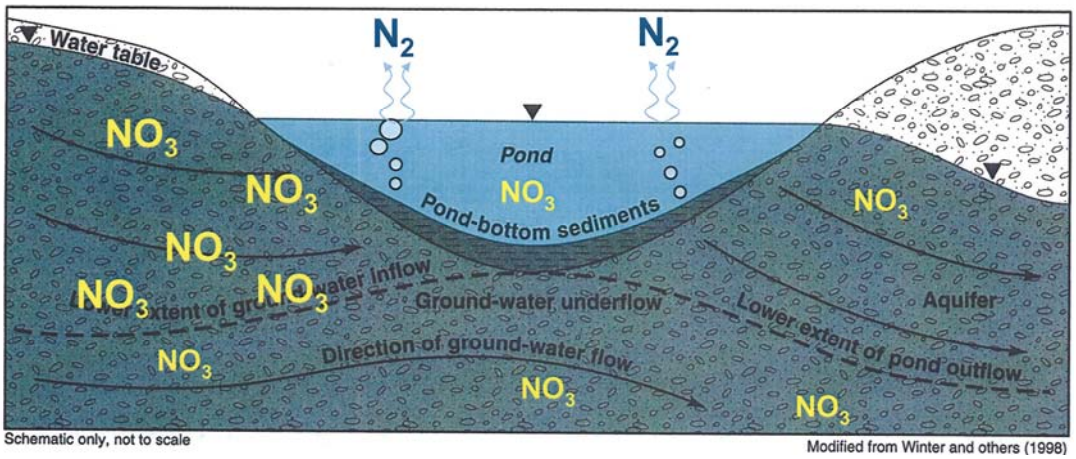
5.4 EVALUATION OF POTENTIAL WATERSHED MODIFICATIONS FOR INCREASED NITROGEN ATTENUATION

A. **Introduction.** Nitrogen discharged to the upper portions of the watershed travels with the groundwater through fresh surface water systems (ponds, streams, wetlands, bogs, etc.) that provide natural nitrogen removal (also called nitrogen attenuation) before the groundwater is recharged into the marine waters where the remaining nitrogen may contribute to water quality problems. Nitrogen recharged to the lower portions of the watershed does not have this benefit, and all of it is recharged into the marine waters. The separation between the upper and lower portions of the watershed is illustrated in Figure 1-3 for the Little, Great, Green, Bournes, Waquoit West, and Waquoit East watersheds by the horizontal line that tends to run across the top of these marine water bodies. This means that some of the nitrogen discharged north of the horizontal line is removed as a function of the groundwater flow through the fresh surface water. It is believed that a greater percentage of nitrogen from the upper watershed could be naturally attenuated if the fresh surface waters were modified or increased in this area.

The nitrogen is removed due to the fundamental biochemistry that exists at the interface of the porous sandy aquifer and the freshwater system. This interface typically has an organic-rich zone

populated with heterotrophic bacteria. These bacteria can use either oxygen or nitrate as their electron donor (oxygen) source for respiration as part of their metabolism. When they use nitrate for respiration, they excrete nitrogen (N_2) gas that goes off to the environment. This organic-rich zone typically has low dissolved oxygen (due to the bacteria consuming it) and the bacteria will then consume the nitrate from groundwater as it flows through the interface. Some aquifer/freshwater system interfaces have better organic-rich conditions than others; therefore, some freshwater systems are better at nitrogen attenuation than others. There are other denitrification mechanisms at work in these freshwater systems; but this is the major one.

Freshwater ponds (especially kettle hole ponds) are very good at removing nitrogen, and a cross section of a pond and the natural attenuation that occurs at the pond/groundwater interface is illustrated below:



CONCEPT OF NITROGEN ATTENUATION IN A KETTLE HOLE POND

The illustration also indicates that the groundwater may flow under the pond if it is not very deep.

Similar nitrogen attenuation is expected to occur in wetlands and streams, as long as there is groundwater recharge through an organic sediment layer.

B. **Findings From the November 2007 Alternatives Screening Analysis Report.** The November 2007 Alternatives Screening Analysis Report for this project identified that significant nitrogen attenuation (40 to 60 percent) has been documented by SMAST as part of the Massachusetts Estuaries Project evaluation for various fresh water bodies. This report also

developed the following three alternatives for more evaluation:

1. Freshwater pond construction and impoundments in the cranberry bog systems.
2. Constructed wetlands in the cranberry bogs.
3. Constructed wetland/reactor with Nitrex™ media.

These alternatives focused on the Coonamessett River area because it is a Town-owned area but they could be applied to the Backus Brook bog system, the Bournes Brook bog system, or other low-lying wetland areas after further study and implementation in the Coonamessett. These alternatives are described below with the main findings of the analysis.

1. **Freshwater Ponds and Impoundments in the Current Cranberry Bog Systems.** This alternative would include the excavation and construction of ponds and/or freshwater impoundments in the Town's cranberry bogs along the Coonamessett River (or in other low-lying areas that could become ponds). These pond/impoundment systems may include the following components:

- A series (two or more) of freshwater ponds in the area of the cranberry bogs surrounded by wetland and upland area.
- Routing of the Coonamessett River with surface water flow controls (berms, fish ladders, stream structure to create eddies, etc.) to control the depth and flow of the river and ponds and to allow flexible management of the system during different seasons of the year.
- Landscape design and stream modifications to meet additional recreational and fishing goals for the Town property.

This concept would be managed to encourage groundwater flow through the ponds and streams where nitrogen attenuation would occur as it flows through the alternating aerobic and anoxic zones into and out of the ponds and streams. Surface water flow would be maintained to meet other recreational and fishing goals of the watershed. This alternative has the following advantages:

- Significant nitrogen attenuation could be achieved through a series of ponds due to an estimated 60 percent nitrogen attenuation per pond that has been documented for previous watershed studies.
- Additional recreational and fishing goals could be met with the landscape design and

stream improvements

- Construction costs would be relatively low compared with wastewater treatment and pump-and-treat alternatives.
- The system would be passive and there would be minimal operation and maintenance costs.
- Minimal re-release of nitrogen from the watersheds would be expected for this alternative as can occur from some plant-dominated, constructed wetland systems.

The disadvantage of this alternative is that it will involve soil and waterway disturbance in wetland areas and will require innovative wetland permitting and design. The permitting and approvals could require many months to complete.

2. **Constructed Wetlands in the Cranberry Bogs.** This alternative would include the excavation and construction of freshwater marshes in the cranberry bog areas along the Coonamessett River. The concept reported by Sustainable Science, LLC as part of the Falmouth Ashumet Plume Citizens Committee (FAPCC) evaluations captures the main components of this alternative as listed below:

- A series of surface flow constructed treatment wetlands would be located in the area now used for cranberry bogs and would be planted with cattails and other emergent wetland plant species.
- Flow control structures would be constructed to channel the groundwater and surface water flow through the series of wetlands and to maintain passage for high flows and for anadromous fish.
- Recycling of flow would be possible through a pump and pipe distribution system.

This concept would be managed to direct surface water and groundwater through the wetlands where nitrogen would be removed by wetland processes and plant uptake. Recycle pumping and plant management may be needed for optimum performance. This alternative would have the following advantages:

- Nitrogen removal would be achieved.
- Additional fishing goals and some recreational goals could be achieved with appropriate landscape design.

- Construction costs would be relatively low compared to wastewater treatment alternatives.

This alternative would have the following disadvantages:

- Significant permitting would be needed as described for the freshwater pond alternative
- Plant-dominated constructed wetland systems can store and then release nitrogen into the environment, providing periodic high and uncontrolled effluent nitrogen concentrations.
- Operations efforts and expense would be incurred for plant management and water recycle.
- Some recreational goals for the property may be compromised by the expansive commitment to constructed wetlands.

The feasibility report and conceptual design from Sustainable Science, LLC was attached as Appendix 9-2 of the Alternatives Screening Analysis Report (available at the Falmouth Library or at the falmouthwastewaterprojects.com website).

3. **Constructed Wetland/Reactor with Nitrex™ Media.** This alternative is the construction of a wetland/reactor on the cranberry bog or on an adjacent property that would be designed to treat the nitrate nitrogen in the Coonamessett River surface water. The concept is detailed in the Lombardo Associates Inc. Feasibility Study Report contained in Appendix 9-3 of the Alternatives Screening Analysis Report (available at the Falmouth Library or at the falmouthwastewaterprojects.com website), and includes the following components:

- Construction of a pumping station to pump approximately two thirds of the Coonamessett River flow from the river channel (pumping location to be a short distance north of the Route 28 culvert) to a constructed wetland/reactor. The remaining one-third river flow would be maintained for fish passage and other uses.
- Construction of a wetland/reactor with a bottom liner to contain the water and reactor media. The reactor would be filled with the patented Nitrex™ reactive media which is comprised of sawdust and wood chips.
- Piping networks to distribute the flow to the wetland/reactor and back to a discharge point on the Coonamessett River downstream of the pump station withdrawal point.

Review of the feasibility report and discussions with Lombardo Associates indicates the following features and design components:

- Approximately 1.3 acres of wetland/reactor footprint area is needed. The total area needed for the wetland site with a 200-foot buffer area would be approximately 10 acres.
- The wetland/reactor would be sized based on the following design factors: (a) 6.5 mgd of flow; (b) Nitrex™ media porosity of 50 to 60 percent; (c) hydraulic retention time of 8 hours; and (d) wetland/reactor depth of 8 to 10 feet.
- The eight-hour water contact with the Nitrex™ media is projected by Lombardo Associates to reduce the dissolved oxygen concentration in the water and provide a carbon source for denitrifying bacteria growing on the media. Effluent nitrate concentration is projected by Lombardo Associates to be in the 0.3 to 0.1 mg/L range based on media performance documented for other applications. The media is projected by Lombardo Associates to last for at least 20 years before it might need to be replaced.

The design concept originates from the University of Waterloo in Ontario, Canada, which is well known for its research and applied science for groundwater treatment with reactive media. This alternative has the following advantages:

- It is an engineered "pump-and-treat" concept with an engineered media, and performance requirements could be specified.

This alternative would have the following disadvantages:

- Significant permitting would be needed for the surface water withdrawals and discharges from, and to, the Coonamessett River as well as pump station construction adjacent to the river.
- Operation and maintenance costs will be highest for the pump station operation and for possible future media replacement.
- The alkalinity and pH of the treated water may change due to the denitrification media used.

4. **Summary of Considerations for the Watershed Modification Alternatives.** The three alternatives identified for the Coonamessett River watershed hold promise for relatively cost-

effective nitrogen mitigation. The "Constructed Wetlands" and the "Constructed Wetland/Reactor with Nitrex™ Media" alternatives both use pump-and-treat technologies that are believed to be unacceptable to the environmental regulators and would have long-term operation responsibilities for the Town that would be costly and problematic. The "Freshwater Ponds Impoundments" alternative is a more passive/natural concept that will be more acceptable to the regulators and it has minimal operation requirements and costs. This is the concept/alternative that should be pursued.

C. **Discussions with the Coonamessett River Restoration Committee.** The Coonamessett River Restoration Committee was contacted to consider this water quality improvement goal and the possible implementation of freshwater ponds/impoundments as part of their restoration efforts. Also, Dr. D. Michael Ball of ENSR/AECOM (the environmental consultant engaged by the Coonamessett River Restoration Committee) was contacted in January 2008. He indicated that ENSR/AECOM had recently completed a Draft Restoration Concept Report (December 2007). A conceptual river modification plan from that report is attached in Appendix 5-2. The plan illustrates the addition of flow deflectors and rocks to the stream to improve the fish habitat, and the re-vegetation of the bog to recreate more of a natural wetland. The main goal of this restoration plan was to restore the wetland and fish run.

A meeting was held with Greg Pinto, Chairman of the Coonamessett River Restoration Committee; George Hampson of the Town's Nutrient Management Committee; and Jerry Potamis, Falmouth Wastewater Superintendant on April 15, 2008 to review the findings of these watershed-modification evaluations and to learn if the goals of the watershed modification to improve water quality could be incorporated into the Committee's goals of wetland restoration to restore fisheries habitat. After discussions of how freshwater ponds and impoundments could be utilized to meet these goals, the group agreed to incorporate the water quality goal with the committee's goal to restore fisheries.

It was understood that large ponds could increase the temperature of the water which could defeat the Committee's main goal of trout restoration to the stream. It was believed that this potential conflict of goals could be addressed by keeping the ponds/impoundments small in size, located to the sides of the bog systems and designed to encourage shading through plantings.

The Coonamessett Ruver Restoration Committtee has completed its work ans has been disbanded.

D. **Considerations on Modifications in the Backus Brook Bog System, Bournes Brook Bog System, and Low Lying Areas North of Eel Pond and Childs River.** The Backus Brook Bog system is north of Green Pond, extends from Route 28 to Carriage Shop Road, and is actively farmed (see Figure 3). This bog system has a tail-water pond (Mill Pond) at its southern end and provides significant nitrogen attenuation (67% for the Backus Brook system verses 51% for the Coonamessett River System per MEP, April 2005). This is the type of pond/impoundment that is recommended for bog systems to promote nitrogen attenuation. The nitrogen attenuation through this pond is believed to be a major factor in the lower wastewater nitrogen removal percentage that is needed for this watershed verses the other watersheds in the planning area (see Figure 2). No modifications to the Backus River Watershed are recommended at this time. It is possible that on-going research and water quality monitoring at the pond or at the watershed will indicate benefits of modifying these systems for nitrogen attenuation. At that time (and with the possible benefit of positive findings with the Coonamessett Bog restoration work) possible watershed modifications can be considered for Backus Brook and Mill Pond.

The Bournes Brook Bog system (also called the Hammond Bog) is north of Bournes Pond, extends from Route 28 to the Falmouth Country Club site, and is actively farmed (see Figure 3). The cranberry farmers are currently working with the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) on a resource assessment for the bog and the following items are being considered for water quality and management improvements:

- Route 28 culvert modification
- Modification of the lower bog cell to a natural wetland or to tail water pond

Final determination of these items was not yet made in early 2008, and no further recommendations are made for this system at this time. As with the Backus Brook bog system, it is possible that on-going research and water quality monitoring at the watershed will indicate benefits of further modifying this system for nitrogen attenuation. At that time (and with the possible benefit of positive findings with the Coonamessett River restoration work) possible watershed modifications can be considered for the Bournes Brook bog system.

There are wetland areas north of Eel Pond and Childs River that may be providing significant nitrogen attenuation. These areas are in the Waquoit West watershed that is still being evaluated by the MEP for nitrogen limits. There may be opportunities to enhance nitrogen attenuation in these

areas and MEP should be requested to look at these opportunities as part of their watershed evaluation and limit development.

5.5 EVALUATION OF POTENTIAL COASTAL POND INLET MODIFICATIONS FOR LITTLE AND BOURNES POND

A. **Introduction.** The Massachusetts Estuaries Project (MEP) and Massachusetts Department of Environmental Protection (MassDEP) have completed Technical Reports and Total Maximum Daily Load (TMDL) Reports for Little, Great, Green, and Bournes Pond in the Project planning area. The Technical Reports for Little Pond and Bournes Pond have indicated that less wastewater nitrogen would need to be removed if the inlets to those two ponds were widened to increase tidal flushing of the ponds. This statement indicates that the TMDL could be increased (greater assimilative capacity) for these ponds if the inlets were widened.

The January 2006 Technical Report for Little Pond provides the following information on the amounts of wastewater nitrogen that would need to be removed with the current inlet condition and with an enlarged inlet condition.

TABLE 5-3

ALTERNATIVE AMOUNTS OF WASTEWATER NITROGEN TO BE REMOVED

LITTLE POND WATERSHED	PRESENT [1] SEPTIC LOAD (KG/D)	CURRENT INLET		ENLARGED INLET	
		THRESHOLD [1] SEPTIC LOAD (KG/D)	PERCENT [1] CHANGE FROM PRESENT	THRESHOLD [2] SEPTIC LOAD (KG/D)	PERCENT [2] CHANGE FROM PRESENT
Lower Portion	10.419	0.000	-100 %	0.000	-100 %
Upper Portion	5.496	2.2	-60 %	3.8	-30 %

Notes:

[1] From Table VIII-2 of January Technical Report for Little Pond.

[2] From Table IX-3 of January Technical Report for Little Pond.

This table indicates that the threshold septic system load (a component of the TMDL) for the upper watershed would increase from 2.2 kilograms per day (kg/d) for the current inlet to 3.8 kg/d for the enlarged inlet. This increase in the allowable septic system load would reduce the requirements for upper watershed sewering from 60 to 30% in this area. Excerpts from the January 2006 Technical

Report with these findings are attached in Appendix 5-4.

It is noted that this percent reduction (from 60% to 30% for upper watershed sewering) is based on the "existing" and "attenuated" nitrogen loading going to Little Pond. This means that these percentages will need to be increased for the future loads that will occur in this area at buildout and a mass loading based on unattenuated nitrogen loads.

The April 2005 Technical Report for Great, Green, and Bournes Pond does not complete a similar threshold evaluation for an enlarged Bournes Pond inlet. The Report does provide findings of a sewering alternative (Alternative #2) that does not meet the current threshold and TMDL limits. It then evaluates alternative #2 in combination with widening the pond inlet to two times its current size (100' wide which is the width of the Green Pond inlet), and provides findings that this combination meets the nitrogen threshold for Bournes Pond. Excerpts of the April 2005 MEP Technical Report with these findings are attached in Appendix 5-4.

Both Technical Reports state that sewering costs could be saved if the pond inlets were enlarged. Cost savings have been estimated for the inlet opening for Little Pond as summarized below. A similar cost savings evaluation for the Bournes Pond Watershed will need additional information from MEP that would require additional water quality modeling.

B. **Potential Sewering Cost Savings with the Inlet Modifications Proposed by MEP for Little Pond.** Potential cost savings were estimated with the following calculations and findings:

- The current nitrogen load in the upper watershed is 3,377 kg (unattenuated nitrogen)/yr which equates to approximately 103,000 gallons per day (gpd) of wastewater discharge through septic systems to the groundwater system.
- The area drains through a freshwater stream that provides 30% nitrogen attenuation.
- A flow of 41,000 gpd discharge from septic systems is allowed with the current inlet and the need to remove 60% of the attenuated flow.
- A flow of 72,000 gpd discharge from septic systems is allowed with the enlarged inlet.
- Therefore 31,000 gpd more septic system discharge is allowed with the enlarged inlet.
- If each residential unit produces approximately 150 gpd/unit, this additional allowed flow equates to approximately 200 houses (equivalent housing units) that would not need to be connected to a sewer.

- The cost to construct sewers to collect this flow would be approximately $6,000,000 based on a cost of $30,000/house.
- The cost to construct treatment and recharge facilities for this flow would be approximately $500,000 based on the incremental increase of a centralized WWTF sized at approximately 2 mgd capacity.

It is estimated that a total cost of $6.5M could be avoided by enlarging the pond inlet.

C. **Potential Regulatory Approvals and Construction Costs to Widen the Little Pond Inlet.** Gaining regulatory approval to widen an inlet to a coastal pond such as Little Pond is a very difficult and expensive procedure. A separate Environmental Impact Report (separate from the Environmental Impact Report needed for the CWMP) would be needed for the inlet modification.

The inlet to Little Pond was widened in the 1990's and the approval process required several years of evaluations, modeling, meetings, hearings, approvals, design, and finally construction. A similar procedure would be needed if the Town wanted to further modify it.

Several discussions and meetings were completed with the Town Engineer to identify several tasks and costs that would be needed to gain approval for the inlet modification and to construct it. These tasks and costs are based on the concept of doubling the size of the inlet by installing a second box culvert (same size as the existing culvert) and moving one of the jetties to the new total width. The tasks and costs estimated for the Little Pond inlet modification are summarized below.

TABLE 5-4

TASKS AND COST ESTIMATES FOR LITTLE POND INLET MODIFICATIONS

TASK		ESTIMATED COST
1.	Preliminary design including modeling, survey, and drawings	$70,000
2.	Environmental document (EIR) preparation and review	$120,000
3.	Permitting meetings and approvals from US Army Corps., CZM, MassDEP, and Local Conservation Commission	$50,000
4.	Final design and bidding	$80,000
5.	Box culvert construction [1]	$500,000
6.	Jetty relocation and construction	$80,000
	Total [2]	**$900,000**

Notes:

(1) Based on estimate provided by Town Engineer

(2) 2008 dollars

D. **Cost Comparison and Summary for Little Pond Inlet Modification.** Comparison of the $6,500,000 estimated cost to collect the additional wastewater flow if the inlet is not enlarged to the $900,000 estimated cost to design, permit, and build a larger inlet identifies a possible savings of over $5,000,000.

The following additional considerations are also noted:

- Widening of the inlet is expected to improve water quality in the pond more quickly than the sewering option which will take several years to show a benefit.
- The inlet will need to be maintained free of shoaling in the future (possibly 4 times per year and after major storms) at an estimated cost of $10,000/year. Any benefits of improved tidal flushing would be eliminated if shoaling was allowed to occur in the new (widened) inlet.
- There may be strong objections by shoreline residents to a plan to widen the inlet. Significant modeling and evaluation will be needed to verify that no impact will occur to them from this change.
- Up to three years may be needed to complete the approval and construction process.

E. **Considerations on Widening the Inlet to Bournes Pond.** As discussed previously, additional modeling and the determination of a revised "Threshold Septic Load" must be completed by MEP before a cost savings comparison can be completed for this pond.

The following costs and considerations are noted for an enlarged inlet:

- This is a larger inlet and pond as compared to Little Pond.
- Design, modeling and permitting costs would be similar or possibly up to 50% greater when compared to the costs estimated for Little Pond.
- Construction costs for a second bridge for this inlet are estimated at $5,000,000 (Based on estimate provided by Town Engineer and 2008 costs) based on costs for the last bridge constructed at this inlet and an allowance for moving the existing jetty.

This inlet modification will be more expensive than the Little Pond inlet and should be considered in the future as additional modeling is completed by MEP.

F. **Summary and Recommendations.** Widening the inlet to Little Pond appears to be cost-effective as compared to extending sewers to the complete portion of the Little Pond upper watershed. It also offers the benefit of improved water quality in the shortest period of time.

Gaining regulatory and public approval for the inlet modification will be time consuming and expensive. There may be strong opposition by residents living on the Little Pond shore who believe that coastal erosion will increase at their properties.

The Town should consider the finding of this evaluation and (if desired) proceed with the modeling and preliminary design for the inlet modification at both ponds to provide the following additional information:

- Refined inlet opening size and jetty placement.
- Revised septic load threshold values and the resulting revised TMDLs.
- Refined project costs.

The expected cost for this modeling and initial preliminary design would be $10,000 to $30,000 for both ponds to be completed by MEP and an engineering firm experienced in these evaluations. The

remaining preliminary design tasks could occur after the modeling is completed and reviewed.

5.6 SUMMARY

After septic system discharges, stormwater (water flowing off of impervious surfaces) is estimated to be the second largest source of nitrogen to the estuaries. The best way to manage this water is direct it to vegetated and wetland areas where the nitrogen can be biologically utilized and/or converted to nitrogen gas before the water reaches the estuaries. There is much public information on this general type of best management practice, and the public, local boards and review agencies should continue to implement these practices as part of normal maintenance, repair, and new construction activities. The Town roads maintenance group and engineering division have an ongoing program to implement these best management practices. In recent years, funding for these projects has been cut. Funding for this program needs to be increased to remediate current direct stormwater discharges to the estuaries, as well as upgrade and maintain all road drainage recharges to the groundwater system.

The Town of Falmouth, with the assistance of the Falmouth Association Concerned with Estuaries and Salt Ponds (FACES) and the Falmouth Ashumet Plume Committee, has been a leader in developing public outreach and education materials for proper fertilizer management. It is suggested that the Town utilize this work and support county/regional efforts of fertilizer management through the County Department of Health and the Environment and/or County Cooperative Extension to extend this effort county-wide. It is widely recognized that this type of educational program needs to be applied county-wide because the need extends across Town borders. Communications with Andrew Gottlieb of the Cape Cod Water Protection Collaborative, George Heufelder of the Health and Environment Department, and William Clark of the County Cooperative Extension regarding the establishment of a county-wide fertilizer management program are ongoing.

Evaluations indicate that widening the inlets to Little Pond and Bournes Pond can increase tidal flushing, and thereby reduce the amount of wastewater nitrogen removal (sewering) needed in the watershed. (It is noted that the MEP concluded that inlet widening would not improve tidal flushing or improve water quality for any of the other estuaries in the Planning Area.) These techniques can also result in a more immediate water-quality improvement than sewering. However, they require additional water quality modeling and impact evaluation to determine that properties bordering these ponds will not be adversely impacted by increased tidal ranges. These studies are relatively inexpensive and should proceed as part of an adaptive management approach to improve water

quality in the short term and reduce the total future sewered area.

Evaluations indicate that modifications to watershed components and wetlands, such as abandoned cranberry bogs, can naturally remove nitrogen before the groundwater reaches the estuaries. Several meetings with the Coonamessett Bog Restoration Committee have been used to integrate these nitrogen management goals into the broader goals of the committee. Recommendations have been discussed for this watershed and are proceeding as allowed by funding opportunities. Also, discussions with the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) indicate that they are incorporating these goals into their work with active cranberry bogs in Falmouth.

Capital costs have also been estimated for the non-wastewater recommendations that would proceed as part of an adaptive management strategy. These costs are summarized below:

TABLE 5-5

ESTIMATED CAPITAL COSTS FOR NON-WASTEWATER RECOMMENDATIONS

PHASE 1 AND 2 ESTIMATED COSTS FOR NON-WASTEWATER RECOMMENDATIONS	
Component	**Capital Cost [(1)] ($ millions)**
Stormwater Improvements	
Coastal Drainage Operating Budget	3[(1)]
NPDES Operating Budget	1.5[(2)]
Fertilizer Management	N/A[(3)]
Pond Inlet Widening	
Modelling and Environmental Impact Evaluation for Conceptual Design	0.025
Potential Costs for New Culverts and Bridge	7
Total	**$12**

Notes:

(1) Based on $150,000/year appropriation (for 20 years) for the Coastal Drainage operating budget.

(2) Based on $75,000/year appropriation for 20 years to the NPDES operating budget.

(3) It is assumed that fertilizer management will be implemented at the County level.

(4) July 2008 benchmark.