Report of the Ashumet Plume Citizens Committee

Water Quality Assessment, Conclusions and Program Options

October 27, 2000

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The Ashumet Nitrogen Plume emanates from a now-closed wastewater treatment plant on the Massachusetts Military Reservation (MMR). The plume is heading toward Great, Green and Bournes Ponds but has not yet reached them.

The nitrogen contained in the plume is too dilute to be treated directly, but will increase nitrogen loading in the ponds by about 2%. Upon the initiative of Falmouth Selectmen, a contract was signed in July 1998 that provides $8.5 million to the Town from the US Air Force to fund measures to offset nitrogen (N) loading to Great, Green and Bournes Ponds (Three Ponds).

The Board of Selectmen appointed a citizens committee to make recommendations for such offset measures. To begin, the Town hired a team of consultants to evaluate the overall N-loading problem, and to identify feasible steps to reduce N-loading and improve water quality. The Committee has studied those evaluations and now offers its assessment of water quality conditions in the Three Ponds, conclusions and program options to improve water quality.

Nitrogen Overload: Algal Mat Close-up

When N-loading is excessive, some unpleasant things occur. Nitrogen is a nutrient, and too much nutrient causes algae to grow, reducing sunlight and using up oxygen in the water. The process of deterioration begins by damaging the most sensitive features of healthy coastal ponds, such as the eel grass beds that provide the essential environment for nurturing scallops. Those effects become evident well before the onset of the type of algal mats shown here in close-up.

As algal growth increases, these algal mats form and, as the mats themselves grow, to float to the surface. Sunlight is blocked off and oxygen begins to disappear; fish kills occur and odor problems become acute and increasingly frequent.

Water Quality Classifications

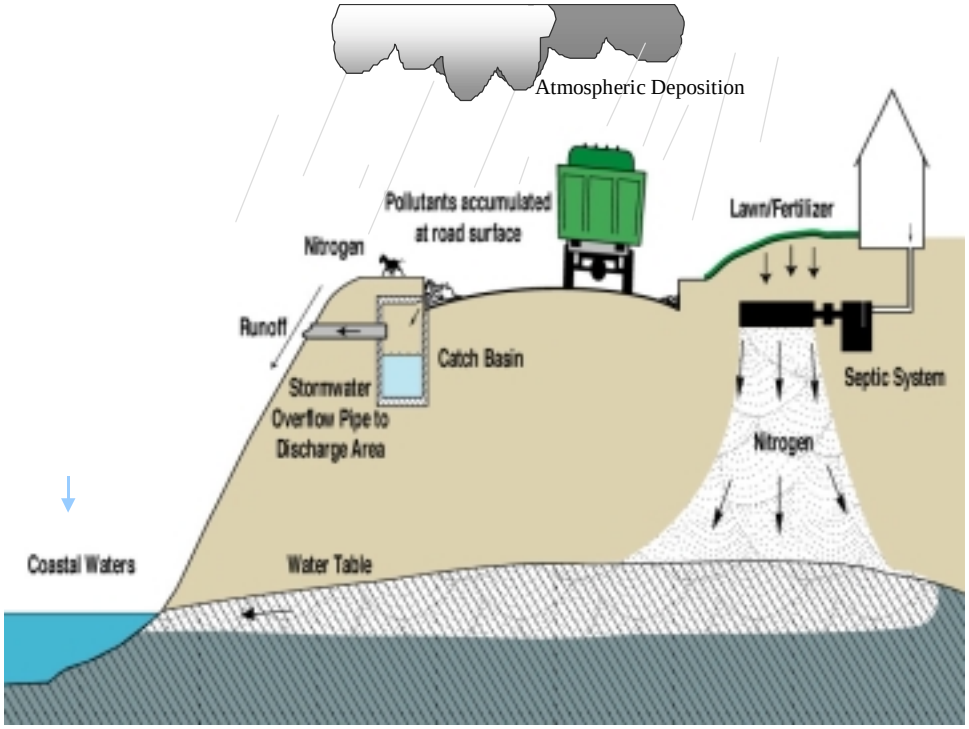
Classification	Nitrogen Concentration (ppm)	Description
Excellent Quality	**<0.30**	Dense eel grass, plentiful scallops and other shellfish, high oxygen levels for fish
Good Quality	**0.30 to 0.39**	Some eel grass/scallops, high productivity of other shellfish; rare oxygen depletion
Moderate Quality	**0.39 to 0.50**	Little eel grass/scallops, high productivity of other shellfish; occasional oxygen depletion; some phytoplankton blooms and macro-algae
Significant Impairment	**0.50 to 0.70**	No eel grass/scallops, limited other shellfish; some large phytoplankton blooms, more frequent oxygen depletion, periodic fish kills, occasional macro-algae accumulation/odors
Severe Degradation	**>0.70**	Near-complete loss of other shellfish/benthic animals; periodic near-complete loss of oxygen in bottom waters, lift-off algal mats, drift algae and increased frequence of odor problems

Dr. Brian Howes of CMAST recommends these quality classifications. Water quality is Excellent when the nitrogen concentration is less than 0.30 parts per million, which corresponds to background levels in Vineyard Sound. Good to Moderate Quality, up to 0.50 ppm of nitrogen, still supports most shellfish and avoids most algal growth.

Higher concentrations of nitrogen cause more serious and offensive effects. Levels of nitrogen greater than 0.70 ppm, for example, represent Severely Degraded Quality, water that most people would not like to be near, let alone swim in.

These classifications are in general agreement with the Town's Coastal Pond Bylaw.

Sources of Nitrogen



Nitrogen reaches the coastal ponds from atmospheric deposition and from human activities in the watersheds of the ponds. Such activities include, in particular, home septic systems and fertilized lawns, plus paved surfaces and structures that allow nitrogen from rainwater to pass into ground water or run off into streams and ponds. Freshwater attenuates [lessens concentration of] some of the nitrogen; the rest is carried along with the groundwater flow and discharged into coastal ponds.

In the Three-Pond watershed, the average home has three bedrooms and 5,000 square feet of lawn. Septic systems range from cesspools to mostly-older Title V systems. Even new Title V systems don't remove nitrogen, however, so each year the septic system of an average home loads almost 4 kilograms, or 8-1/2 pounds of nitrogen into the ground water. Lawn fertilizer contributes another 3 pounds.

Rain and snow deposits nitrogen directly onto all types of surfaces, but woods and natural fields keep most of that nitrogen from entering ground water. Elsewhere, pavement, gravel surfaces, roofs and other fertilized surfaces send varying proportions of atmospheric deposition into fresh water and coastal ponds, which also absorb nitrogen directly from rain and snow. In the future, the Ashumet Nitrogen Plume also will add some N-load to Great Pond and Green Pond.

Housing Density: Lower Section of the Watersheds

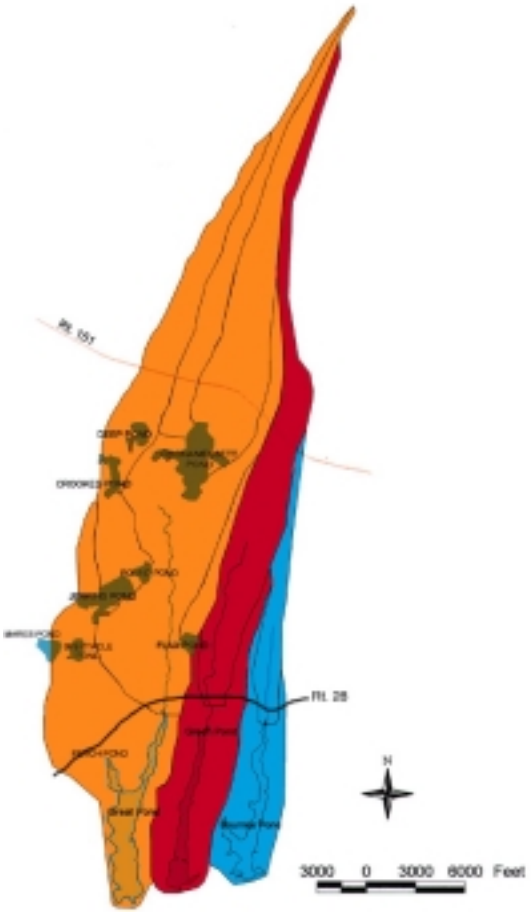
This photo shows the area surrounding the ponds, from Great Pond on the left to Bournes Pond on the right, which makes up the southern or lower section of their watersheds. Vineyard Sound is at the bottom, and Route 28 curves near the top.

Note the inlets that channel tidal flows from the Sound. The amount of flushing that occurs is circumscribed by the tidal rise, which averages only 1-1/2 feet from low to high tide. The shape of the ponds is long and narrowing but they also are mostly shallow, which makes them relatively well-flushed in spite of the small tidal rise. That small rise, however, means deeper dredging would do little to improve flushing [although dredging should continue to maintain the current depths of the inlets].

The southern section of the watersheds is densely developed with homes, as the slide demonstrates. Except near Vineyard Sound, N-loading from septic systems and lawns of all of these homes flows directly into the Three Ponds.

The entire area of the watersheds is considerably larger than the lower section depicted on this slide, as demonstrated in the next slide.

Watersheds of the Three Ponds



The watershed for Great Pond, shown in yellow, is the largest of the Three Ponds and extends north of Route 151 well into the MMR. Great Pond's watershed also contains most of the fresh water ponds that attenuate nitrogen flowing through them. Great Pond contains more than 6300 acres and, at build-out, will have about 4500 homes with a yearly average population of 8400 people.

Green Pond's watershed, in red, contains more than 2300 acres, with more than 2200 homes and 4200 average population at build-out. Bournes Pond, with less than 1000 acres, will have more than 900 homes and 1800 average population.

The upper section of each watershed, the area north of Route 28, is much less developed now, and is expected to remain relatively less-developed at build-out. Nevertheless, most of the increase in number of homes and average yearly population will be in those upper sections, north of Route 28.

Green Pond is in the middle, in location, size, number of homes, and in the quality of its water. So, Green Pond makes a convenient proxy for all three of the ponds.

Nitrogen Loading to Green Pond Watershed
(kilograms/year after attenuation)

Sources of Loading	1999 Estimates Upper	Lower	Total	Total at Buildout Amount	Percent
Septic Systems:	1124	5317	6441	7275	51
Fertilizer:					
Home Lawns	382	1699	2081	2350	17
Golf Courses	1008	62	1070	1070	7
Cranberry Bogs	141	1	142	142	1
Other	neg.	23	23	23	neg.
Total Fertilizer	1531	1785	3316	3585	25%
Ashumet Plume	neg.	neg.	neg.	365	3
Residual Atmospheric Deposition	963	1932	2895	3020	21
Total Nitrogen Load	3618	9034	12652	14245	100%
Memo: Number of Homes	474	1491	1965	2245	

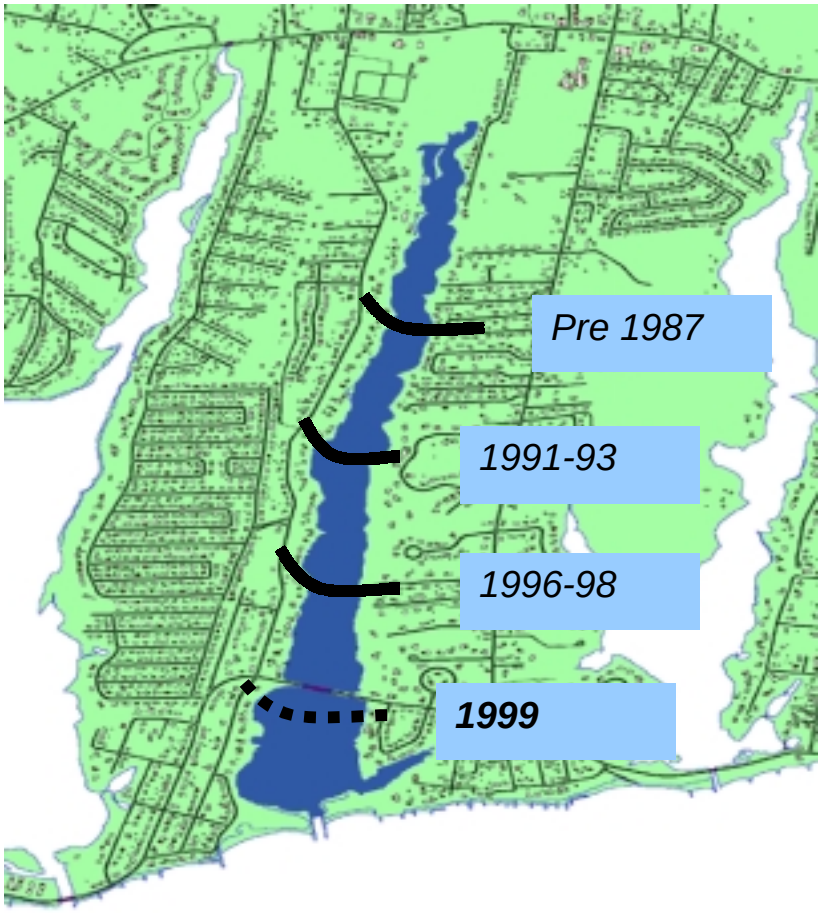
* With existing zoning and historical average annual occupancy rate [1.86 persons]; if that rate were to increase by half, to slightly over the national average, build-out loading would be 25% greater.

For 1999, the annual N-loading of Green Pond from the entire watershed is some 12,652 kilograms, shown in the middle column. That includes 3618 kilograms from the upper section, the left-hand column, and 9034 kilograms from the lower section south of Route 28. When homes are built on the remaining buildable lots, the count will increase from 1965 homes in 1999 to 2245, and N-loading will increase to 14245 kilograms a year (assuming present zoning and occupancy rate).

Looking at the far right column, 51% of the N-load at build-out will come from septic systems and 17% from home lawns. Fertilizer from golf courses and bogs will add another 8%. Septic and fertilizer loads are subject to remedial action.

Conversely, it will be essentially impossible to remedy the 24% of N-loading stemming from the Ashumet Plume (3%) and atmospheric deposition (21%).

Timelines: Degrading Water Quality in Green Pond



Green Pond Progression Map

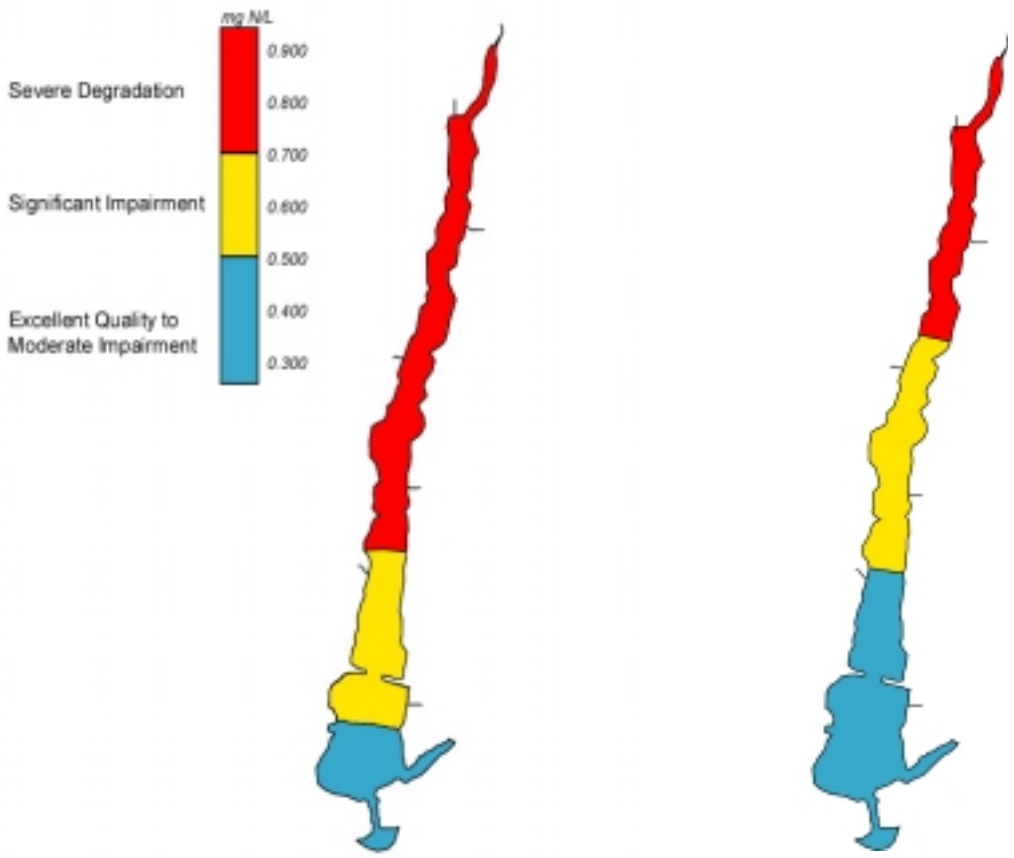
Lines Represent Limit of Zone of Degraded Water Quality Based on Pondwatchers Data

Over the past 15 years, measured water quality in Green Pond has deteriorated steadily. The initial impact of excess nitrogen was observed near Route 28. In the period before 1987, water quality in that area, roughly one-fifth of the pond's surface, had become Significantly Impaired [i.e. nitrogen concentration of more than 0.50 ppm] or worse. The line of Significant Impairment moved south in succeeding years, reaching about 60% of the pond's area by the mid-1990s, or about as far north of the bridge as the bridge is north of Vineyard Sound.

Our consultants evaluated Green Pond water quality in 1999. By then, the line of Significant Impairment had reached to just south of the Green Pond bridge (dotted line); from there to the Sound, the water was still of Moderate Quality. From the bridge northward, water quality had deteriorated from bad to worse, reaching Severely Degraded conditions for more than half the pond's length.

Green Pond Water Quality: Risk vs. Potential

At Build-out **No Septic Load**



The N-load in Green Pond at build-out will cut in half the small remaining area of Moderate quality. That projection is shown in the left hand graphic. Further north, more than half of the pond's length will become Severely Degraded, and the upper reaches would become pretty awful (to coin a scientific expression) to live near.

Alternatively, if all the N-load from septic systems is removed, major gains in water quality will result, as shown in the right-hand graphic. Good to Moderate Quality would extend to one-third of the pond's surface, and almost half of that improved area would become Good Quality. The same results will occur if, say, 80% of the septic N-load and half of the fertilizer N-load is removed.

Corresponding improvements will occur further north, where early 1990s conditions of water quality will return — but only by removing most of the N-load from septic systems and applications of fertilizer.

Falmouth Ponds Closed to Shellfishing: Late 1990s

Unfortunately, degrading quality is not unique to the Three Ponds. This map shows areas across Town that the Shellfish Constable typically has been forced to close at least seasonally in the late 1990s. The areas affected extend from North Falmouth, through West Falmouth, to Woods Hole and to all of East Falmouth.

Even more dramatic is the virtual elimination of the scallop harvest [not shown]. From an annual harvest of 10 to 11,000 bushels in the 1960s, scallop landings have declined to such a low level --- a few dozen bushels --- that Falmouth no longer even bothers to track annual landings of scallops.

Thus, the Committee has come to believe that considerable opportunity exists to start with effective measures to reduce the N-load of the Three Ponds, and then apply that lesson to every one of Falmouth's other endangered ponds and harbors. Indeed, discussions in public forums and with home-owner and other groups have indicated that many folks in Falmouth would like to see that opportunity realized.

Conclusion 1: Water Quality Outlook

- **Present N-loading causes most areas of The Three Ponds to be Significantly Impaired to Severely Degraded**
- **Build-out N-loading will be at least 15% worse; even more areas will be Significantly Impaired or Severely Degraded**
- **Home septic systems and fertilizer use causes 2/3rds of the N-load**
- **Eliminating the great majority of that N-load will restore reasonably-acceptable quality to The Three Ponds**

From the outset, the committee knew that water quality was a serious problem, but it was a very unpleasant surprise to find how much deterioration already has occurred. Water quality in large areas of the Three Ponds is Significantly Impaired or Severely Degraded. As the consultants emphasized, our coastal ponds are very sensitive to nitrogen, and it doesn't take much to overload them.

As more homes are built, water quality in the Three Ponds will only get worse unless measures are taken to limit home septic systems and fertilizer as sources for about 2/3rds of the N-loading. Reasonably-acceptable quality conditions can be achieved by eliminating the great majority of those sources.

We also recognized that Air Force funding presents the Town with a unique chance to formulate such measures. Thus, our consultants explored a full range of actions, however costly, so as to identify their cost and effectiveness. By taking a comprehensive approach to remedial measures, we hoped to outline the type of program that will restore conditions of reasonably-acceptable quality, and then to identify uses of Air Force funds that can begin to put that program into effect.

Potential Remedies Examined

- **Administrative measures, chiefly bylaws and regulations:**
  - **zoning, subdivision, health and wetlands rules; and**
  - **voluntary and other related measures.**

- **Engineered measures, chiefly wastewater treatment:**
  - **home-based septic systems, including innovative;**
  - **neighborhood and larger cluster systems;**
  - **sewers with central treatment plant(s); and**
  - **constructed wetlands.**

Our team of consultants identified dozens of possible measures, ranging from administrative action such as changes to bylaws and regulations, to engineered structures such as home-based and neighborhood de-nitrifying septic systems. Our standard for evaluation was effectiveness in reducing N-load and the cost per source being controlled. In the case of wastewater treatment, we eliminated un-approved technologies because of permitting concerns. We'll discuss wastewater treatment later; let's focus here on administrative measures.

Some two dozen administrative measures were identified under the Cape Cod Commission Act, Falmouth Zoning Bylaws and Subdivision Regulations, Board of Health Regulations, and State and Falmouth Wetlands Acts and Regulations. Some of those steps should be examined more closely if major wastewater treatment projects are undertaken [e.g. to discourage sewers from acting inadvertently as development incentives], but most regulatory actions seemed to address future construction and other activity rather than existing sources of N-loading.

Recognizing the extent of water quality deterioration that already exists, our focus inevitably shifted to engineered measures that address existing N-sources as well as those from further development. The single exception is a blend of voluntary and perhaps regulatory steps in a program to curb fertilizer use (discussed later).

Wastewater Treatment: Cost and N-Removal Efficiency

Type of System	Number Homes (approx)	Cost/ Home ($000)	N-Remove Percent (%)
Central Treatment Plant:			
Large [1.2 mil gal/day]	2700	$16.5	90%
Medium [O.5 mgd]	1100	$18.0	90
Small [0.2 mgd]	400	$18.5	90
Neighborhood Cluster:			
Small [10,000 gd]	25	$19.0	80%
Single Family Title V:			
Denitrifying [440 gpd]	1	$18.0	65%*
Conventional [440 gpd]	1	$10.0	neg.

* Assuming regular maintenance and year-round use; otherwise efficiency could fall by half that shown.

We looked at a variety of wastewater treatment systems to identify comparative cost and performance. Shown here are three types of systems, comparing approximate costs per home serviced and efficiency rates of nitrogen removal.

Starting at the bottom of the Wastewater Treatment table, conventional Title V systems now cost about $10,000 for a complete installation, but do not remove nitrogen. Home-based systems that do remove nitrogen cost nearly twice as much, but at best remove only 65% of the nitrogen; they also are fairly expensive to maintain.

A neighborhood cluster system, roughly $19,000 per home, is similar to the per home cost of central treatment plants, the smallest of which shown here would serve about 400 homes. Central plants, however, demonstrate greater N-removal efficiencies, 90% vs. 80%. Given the urgency of reducing N-loading as much as possible, the attraction of central treatment (and sewers) seems inescapable.

Costs for the central treatment plants shown here reflect the cost of building sewer and collection systems for densely-populated areas, like those south of Route 28. The cost/efficiency equation shifts for less densely-settled areas in sections of the watersheds north of Route 28, where small de-nitrification systems seem optimum.

Conclusion 2: The Risks of Doing Nothing

- **New and replacement Title V systems are costly [perhaps $75 million for the Three-Pond watershed as a whole] without reducing any N-load.**
- **Property values may suffer; water factors [next to or in view of water] account for 40% of single-family home tax valuations in Falmouth.**
- **The tax base could be undermined; water factors now generate 30% of the Town's real estate tax revenues.**
- **Our quality of life, our ability to attract visitors and new residents, our very economy could be at risk if our coastal ponds cease to be healthy.**

Wastewater treatment is expensive, but that expense cannot be avoided. Watersheds of the Three-Ponds now contain 6300 homes. Build-out will add 1200 more. New homes require new Title V systems. Further, about half the present homes use cesspools, which will have to be replaced with Title V systems over the next 20 to 25 years as ownership transfers; most existing Title V systems also will be have to be replaced (their design life is 20 years). So, over the next 20 to 25 years, owners in these watersheds could spend $50 to $75 million for new Title V systems that will not remove the nitrogen that's destroying their ponds.

Another significant cost is the impact degrading water quality could have on real estate values and tax rates. Water factors make up 40% of the assessed valuation of all single-family homes in Falmouth. Degraded water quality eventually will result in shrinking premiums for water factors and falling values of those homes.

The cost of that decline will go beyond those home-owners, however. Water factors also generate 30% of all of Falmouth's revenues from real estate taxes. If our coastal waters cease to be attractive, Falmouth taxpayers — wherever they live — will have to make up the loss through higher tax rates.

So, it's not just our quality of life that's at risk if our coastal ponds are allowed to deteriorate. Ultimately, we may put at risk the very economy of the Town.

Conclusion 3: Long-Term Goals

- **Falmouth needs a comprehensive, long-term plan to solve nitrogen and other nutrient loading of our ponds, town-wide.**

- **That plan should integrate the following elements:**
  - **sewers in densely-populated, N-sensitive areas, and mostly small de-nitrifying units elsewhere; discharge returns to originating watershed;**
  - **fertilizer practices that limit quantities and areas applied; and**
  - **constructed wetlands if they can demonstrate effective N-removal from streams and rivers feeding coastal ponds.**

- **Each watershed to be considered an interdependent neighborhood, naturally connected by nutrient sources, groundwater flows and resulting water quality that all watershed owners may enjoy or destroy.**

Too much depends on preserving our coastal ponds to allow them to atrophy. Falmouth needs a comprehensive plan to sharply reduce nutrient loading, one that integrates: (a) effective and economically-efficient treatment of wastewater; and (b) practices that effectively limit where and how much fertilizer is applied.

Economic and efficient design for wastewater treatment should specify where sewers should be constructed and where small de-nitrifying and other systems would be sufficient, particularly in conjunction with constructed wetlands --- if it can be demonstrated that they are effective in removing low concentrations of nitrogen from streams, rivers and freshwater ponds that feed our coastal ponds. Small de-nitrifying systems could be home-based units in some areas and cluster systems in others, depending on relative costs to build and maintain them.

Treating each watershed as an interdependent neighborhood seems to make sense. It's good science to put discharges back where they originate, and that also eliminates having to accept "somebody else's" discharge. It also seems equitable because everyone in the watershed is linked to everybody else via nutrient inputs, groundwater flows and the resulting impact on pond water quality. Those taxpayer-neighbors should have a strong voice in deciding what that quality will be.

An Organizing Concept: N-Management District

- **Form a public entity [Falmouth Coastal Ponds N-Management District] to plan, launch, administer and fund actions to achieve quality goals.**
  - **A technical planning and design process delineates district boundaries and what types of wastewater treatment to use, where, within the district; the District is responsible for all wastewater treatment whether centralized or on-site, newly-constructed or existing.**
  - **A finance and legal planning process develops a plan to fund waste-water treatment facilities and other District expenses. Funding is expected to come from fees paid on an equitable basis by all district property owners. Fees could vary by whether or not the property is connected to a sewer, the condition of existing septic systems, assessed value of the property, now much N-load it generates, etc.**
- **Authorization of the District involves approval by Town Meeting, a Town-wide vote and a likely Home Rule bill by the State Legislature. Final plans for facilities, financing, water quality goals and methods to set fees and operate would be voted by district property owners.**
- **Ongoing operation of the District would be provided by employees and contracted services, supervised by a locally-elected board of trustees.**

A method used elsewhere to organize resources to plan, construct and operate such a comprehensive program is the Management District. The concept is outlined here. A new public entity is formed to plan wastewater treatment for the district, and also to provide an equitable basis to raise capital for construction and operating costs. After the district is authorized, all property owners in the district vote on final plans, including water quality goals and the basis for fees to be paid by all owners.

For the most part, construction of new wastewater treatment facilities, central plant and small units alike, would be financed by capital assessments spread over many years. A reasonable and equitable schedule of payments could vary by whether or not the property is connected to a sewer, the condition of existing on-site systems when the district is formed, assessed value of the property [or location relative to a pond being protected] how much N-load the property generates, etc.. With voter approvals, such payments would be outside the limits of Proposition 2-1/2.

After one district is formed, owners in other watersheds wanting to improve their own water quality could vote to be annexed. Unless the Town votes otherwise, property owners who remain outside a district would not pay for that district.

Proposed Budget for the $8.5 Million

	Millions
Before Spring Town Meeting	
Present Consultant Contract	$ 0.2
Fertilizer Reduction Program	$0.2-0.4
Constructed Wetlands Demo.	$0.2-0.3
Education & Contingency	$0.1-0.3
Subtotal Pending Actions	$ 1.0
At Spring Town Meeting:	
Wastewater Treatment	$ 7.5 *
Total Air Force Funding	$ 8.5

* Plus any additional effort the Town may decide to undertake [see later slides]

We believe the work done to date and the opportunity for further development of a nitrogen management plan for the Three Ponds will have value beyond these watersheds. Through the work of our consultants, we now have in hand a classification system that categorizes coastal water quality, and also estimates of the cost and effectiveness of a range of remedial actions, all of which are applicable to Falmouth's other coastal ponds, bays and harbors.

A successful fertilizer program also would have broad application. So would a demonstration of the ability of constructed wetlands to remove nitrogen where fresh water enters coastal ponds. With the approval of Selectmen, the Committee hopes to initiate those programs in the near future. There also is a need for public education about the causes of pollution and remedies for our coastal ponds. In total, then, actions accomplished or expected to be underway before Spring Town Meeting next year have a proposed budget of $1 Million.

That budget allows $7.5 Million to be applied to wastewater treatment. A critical question now is whether to develop a project limited to what $7.5 million will buy, or to use those funds to begin a larger-scale and more expensive program that will have a meaningful impact on water quality. We are asking for that direction in a resolution to be voted at Fall Town Meeting. If that resolution is adopted, we will present a larger-scale proposal for Town Meeting to consider next Spring.

Three Wastewater Treatment Options

1. Launch an N-District:
Use $7.5 Million for: professional services; land for treatment and discharge sites; and plans to the point of readiness for consideration by Town voters, the State Legislature and district property owners. To remove 50% of the N-load, total cost would be $75 to $100 million, funded by district property owners [unless the Town votes otherwise]

2. Sewer 400 Homes:
Fund a $7.5 Million sewer/central treatment system for some 400 homes at the upper ends of the ponds, to remove about 5% of the N-load at no cost to those home-owners (except hook-up) or the Town; all other watershed property owners fund Title V systems as needed

3. Sewer 1100 Homes:
Use $7.5 million to pay for part of a $20 million sewer/central treatment system for more homes at the upper ends of the ponds to remove 15% of the N-load; connecting home-owners to fund the remaining cost; all other watershed property owners fund Title V systems as needed

Option 1 uses $7.5 million to plan and launch a N-Management district for the watersheds of the Three Ponds. The funds pay for professional services, purchase of land for treatment and discharge sites, and development of district plans to the point of readiness for consideration by Town voters, the State Legislature and district property owners. All District property owners to be responsible for the balance of cost to construct wastewater treatment facilities (unless the Town votes otherwise). The long-term capital cost would be perhaps $75 to $100 million, implying an average cost per district property owner of less than $1,000 a year. By also reducing the use of fertilizers, the goal is to remove half the N-load and restore reasonably-acceptable levels of quality to coastal ponds in the district.

Option 2 uses $7.5 million to sewer the area with the greatest opportunity to improve water quality per dollar of sewer/plant construction. There would be no cost to homeowners (except hook-up) or Town taxpayers. Only 5% of the N-load would be removed, about twice the Plume's contribution, but only a third of the N-load growth from build-out. The rate of water quality deterioration would slow. The other 7100 watershed property owners in the watersheds fund Title V as needed.

Option 3 constructs a traditional sewer/central treatment system and funds the amount over $7.5 million with traditional betterments paid by connecting properties. Air Force funding is not available indefinitely, so Option 3 requires an early vote to adopt betterment funding. A $20 million program removes about 15% of the N-Load, offsets buildout growth and avoids a further decline in water quality from already-degraded conditions. The other 6400 property owners in the watersheds fund Title V systems as needed.

Committee Report: Summary

- **Nutrient over-loading has severely polluted our coastal ponds; build-out growth will cause further degradation.**
- **Eliminating a great majority of N-loading from septic systems and fertilizer will restore reasonably-acceptable quality.**
- **N-removing treatment systems are expensive, but Title V requires expensive investment without removing N-loads.**
- **If we do not rescue our coastal ponds, we risk property values, our tax base, our quality of life and perhaps the foundation of our economy.**
- **US Air Force funding presents a unique chance to start correcting N-load impacts, but only if the Town leverages that funding to undertake larger-scale measures that will achieve meaningful improvement.**

Citizens of Falmouth know our coastal ponds are in trouble. Now we know how severe that trouble has become, and what it will take for recovery. Wastewater treatment is expensive, but doing nothing to change also is expensive and risks becoming even more costly in the future.

The Committee believes the contract negotiated by the Selectmen with the Air Force presents a unique chance to start reclaiming the quality of our pond waters. To make the most of that chance, we need to augment those funds with substantial local resources and undertake the larger-scale measures required to start reversing the un-relenting deterioration of coastal water quality. We hope Fall Town Meeting agrees and votes to support Article #70 of the Warrant.

Appendix A

Nitrogen Loading to Great & Bournes Pond Watersheds
(kilograms/year after attenuation)

	1999 Estimates			Total at Buildout*	
	Upper	Lower	Total	Amount	Percent
Great Pond Watershed:					
Septic Systems	3534	6783	10317	12221	50%
Fertilizer:					
Home Lawns	1195	2211	3406	4035	16
Golf Courses	627	0	627	627	3
Cranberry Bogs	118	0	118	118	1
Other	14	48	62	62	neg.
Total Fertilizer	1954	2259	4213	4842	20%
Ashumet Plume	neg.	neg.	neg.	415	2
Residual Atmos. Deposition	2667	3948	6615	6931	28%
Total Nitrogen Load	8155	12990	21145	24409	100%
Memo: Number of Homes	1741	1948	3689	4522	
Bournes Pond Watershed:					
Septic Systems	182	1984	2166	2750	48%
Fertilizer:					
Home Lawns	62	672	734	930	16
Golf Courses	324	16	340	340	6
Cranberry Bogs	49	0	49	49	1
Other	neg.	neg.	neg.	neg.	neg.
Total Fertilizer	435	688	1123	1319	23%
Ashumet Plume	neg.	neg.	neg.	neg.	neg.
Residual Atmos. Deposition	260	1285	1545	1645	29
Total Nitrogen Loading	877	3957	4834	5714	100%
Memo: Number of Homes	78	591	669	969	

*With current zoning and annual average occupancy rate [1.86 persons/home].

Appendix B

Great and Bournes Pond Water Quality: Risk vs. Potential

At Build-out **No Septic Load**

Great Pond

At Build-out **No Septic Load**

Bournes Pond

Appendix C

Fertilizer Management Program Goals

- To reduce Falmouth fertilizer use by at least 50%, mainly by voluntary action similar to the Town's successful approach to reducing water consumption

  - Use reductions would be aimed at *all forms of nitrogen* because it appears that lawns reach steady state, after which any form of N-fertilizer will leach

  - The goal for a typical lawn [5000 sq ft], for example, would be to limit annual use to less than 10 pounds of fertilizer containing 20% nitrogen

- Contract proposals should encompass program design, launch and operation for 2 years or more to validate effectiveness. The program should address:

  - *Education* initiatives, e.g. school programs, workshops, point of sale posters, bulletins to landscapers and home owners, and demonstrations

  - *Cultural change* to wean former suburbanites and others away from expanses of lawn to "CapeScapes" that preserve our unique environment

  - *Outreach* to organizations; e.g. the Garden Club, Chamber of Commerce, neighborhood associations, service clubs, garden supply stores, landscape designers and operators, golf courses, and farm and bog operators

  - *Monitoring of effectiveness*, starting perhaps with reporting of fertilizer sales and nitrogen content by retail stores and landscape maintenance firms

  - *Regulatory actions*, perhaps with steps similar to water use controls but also considering the effectiveness of fines or licenses to apply fertilizer

- Program administration likely will be contracted initially with the expectation that the Town would manage and fund an on-going effort after prove-out, perhaps with the assistance of a citizens advisory group

Appendix D

Constructed Wetlands Demonstration Program Goals

- Demonstrate if freshwater transporting nitrogen *in low concentrations* from an *upper watershed* can be diverted before reaching a coastal pond and, by exposure to plants and relatively deep pools, effectively *remove significant N-load*; if successful, then establish design parameters for *larger-scale* systems

    - Wetlands *technology exists* to remove up to 80% of nitrogen from waste-water with N-concentrations of *12 ppm* or more, but not for the *2 ppm* or less rates that are typical of freshwater flows into Falmouth coastal ponds

    - Some nitrogen is removed via direct uptake by floating and bottom plants, but mainly by action of anaerobic sediments [harvesting is not effective]

    - If constructed wetlands can act as a sponge for upper watershed nitrogen, they might perform the same function as expensive N-removal hardware for relatively *minor construction cost* and annual maintenance expense [water flows would not be interrupted, so fish-passage should not be an issue]

    - *Upper watersheds* contribute *20 to 40%* of N-load to the Three Ponds; 80% or more of that load is being *transported by freshwater* streams or rivers

- Specific goals would be to determine: how much surface area is required for adequate retention time; how much area to devote to open water vs. emergent and floating vegetation; water depth and other conditions to accumulate low-oxygen sediments, and effective operating procedures and monitoring regimes

    - Those goals apply first to a demonstration project, and then to the *potential to upscale* for greater water flows. Water flows are: 0.8 million gpd for Bournes Brook [Bournes Pond]: 1.7 million gpd for Mill Pond-Backus River [Green Pond]: and 9.6 million gpd for Coonamessett River [Great Pond]. Only Bournes Brook is free of permitting issues

- Other considerations include nearby *cranberry bogs* for Bournes Brook and Coonamessett River [2 or more acres of bogs would have to be converted for a Bourne Brooks project; the area for Coonamessett River is not determined]

    - Also, an evaluation of nitrogen entering and exiting from *Mill Pond* could provide significant insight into N-removal potential of wetland systems without having to acquire land for the pilot [once removed from cultivation, cranberry bogs are not allowed to be re-started to grow berries]

Appendix E

Map of Potential Area for 400-Home Sewer System

Option 20.2 MGD Central Treatment Route 28 Area

Appendix F

Proposed Resolution [Article #70] for Fall Town Meeting

To see if the Town will adopt the following resolution of support for action to substantially reduce nitrogen overloading of Falmouth coastal ponds:

WHEREAS water quality in Great, Green and Bournes Ponds (the Three Ponds) now ranges from significantly impaired to severely degraded because of nitrogen overloading, and those conditions will continue to deteriorate as more homes are built; and

WHEREAS on-site septic systems and fertilizer account for more than eighty percent (80%) of nitrogen overloading to the Three Ponds; and

WHEREAS the Three Ponds are typical of water quality deterioration in every one of Falmouth's coastal ponds and harbors; and

WHEREAS degraded coastal water quality poses a serious threat to shellfish, recreation, tourism, property values and the quality of life of Falmouth's citizens; and

WHEREAS the pledge of US Air Force funding for nitrogen mitigation in the Three Ponds presents a unique opportunity to implement meaningful strategies that could be extended to all of Falmouth's threatened ponds;

THEREFORE, be it resolved that Town Meeting urges the Board of Selectmen to pursue solutions to nitrogen pollution in the Three Ponds to the extent required to achieve meaningful improvements in water quality, recognizing that such solutions will require expenditures substantially in excess of US Air Force funding. Or do or take any other action in this matter. On request of the Ashumet Plume Citizens Committee and the Board of Selectmen.

Explanation by the Committee:
The US Air Force has pledged $8.5 million to fund measures to offset the nitrogen loading to Great, Green and Bournes Ponds from the Ashumet Nitrogen Plume. The Selectmen appointed the Ashumet Plume Citizens Committee [APCC] to make recommendations regarding the most effective use of these funds. APCC working with consultants has determined that the Air Force funds could pay for sufficient wastewater treatment to more than offset the future nitrogen loading from the Ashumet Plume [only 2% of the nitrogen entering the ponds], but that a much more extensive and comprehensive program of wastewater treatment and other measures is necessary to remove sufficient nitrogen to restore and protect the water quality of these three [and other] coastal ponds.

Passage of Article # 70 would direct the Selectmen and APCC to develop a use for the Air Force funds as an initial investment in a comprehensive program. The potential cost of such a program would be several times the $8.5 million; the specific expenditures and/or granting of authority for such a program would be subject to future Town Meeting and/or voter approval.

Defeat of Article #70 would direct the Selectmen and the APCC to buy as much nitrogen reduction as possible with the Air Force funds; such a limited reduction in nitrogen loading would be insufficient to make a meaningful change in the water quality of Great, Green or Bournes Ponds that will continue to degrade as more homes are built.