Cape Cod Commission
P.O. Box 226
Barnstable, MA 02630

November 10, 1999

re: Comments on the Falmouth Wastewater Facilities Planning Study, DRI/MEPA joint review

Honorable Commission Members:
The Buzzards Bay Project National Estuary Program (BBP) has reviewed the report "Alternatives Screening Analysis Report for the Wastewater Facilities Planning Study" (October 1999) prepared by the Town of Falmouth's consultant Stearn's & Wheler, as part of the proposed upgrades to the town's sewage treatment facility. Pursuant to the joint review by the Cape Cod Commission as a Development of Regional Impact (DRI) and Massachusetts Environmental Policy Act (MEPA), the BBP provides the following comments.

In general, the Buzzards Bay Project supports the efforts by the Town of Falmouth to upgrade its wastewater facility, and we find the report adequately addresses many of the issues required in this phase of the facility planning process. In this comment letter, however, we have largely limited our comments to the issue of what nitrogen limits may need to be imposed upon the facility, and how those limits should be determined.

Background
In 1991, the Buzzards Bay Project National Estuary Program, a unit of Massachusetts Coastal Zone Management, developed a management plan[1] for Buzzards Bay that included recommendations to protect water quality and living resources of coastal embayments from excess inputs of nitrogen from human land-based sources. Many of our coastal nitrogen management approaches are now being employed by regulatory agencies, including the EPA and the Cape Cod Commission.

Since 1994, the Buzzards Bay Project (BBP) has worked with the Town of Falmouth and the Cape Cod Commission to document nitrogen sources in the West Falmouth Harbor watershed. In 1994, the Buzzards Bay Project provided a $10,000 grant to the town to partially pay the costs of the West Falmouth Harbor flushing study. In 1995 and 1996, the Buzzards Bay Project worked with the Falmouth planning department to conduct a parcel level nitrogen loading and buildout analysis for the West Falmouth Harbor watershed. In 1995, 1996, and 1997, the Buzzards Bay Project sent to the town reports of its findings. These reports and other information can be found at our website www.buzzardsbay.org

The Buzzards Bay Project's objective in this endeavor was to help the Town of Falmouth to develop a nitrogen management strategy for West Falmouth Harbor. When the Town agreed to

[1] The Buzzards Bay Comprehensive Conservation and Management Plan

pursue the facilities planning process in 1997 for its wastewater facility upgrade, we felt that the nitrogen management issues of West Falmouth Harbor could be best addressed in this process.

Comments on the Alternatives Screening Analysis Report

This report is the second of four reports planned for the Facilities Plan process. Included in this report are references to the Buzzards Bay Project's nitrogen management strategy, and the use of sewering and other wastewater disposal options to manage nitrogen. Our principal comments are as follows:

1) Whether or not a particular area of Falmouth can be sewered will depend upon economic feasibility and other factors laid out in the report. In general, the Buzzards Bay Project supports the Town of Falmouth's efforts to correct environmental health issues and reducing pollutant loads in unsewered portions of the town through sewer extensions. In particular, wastewater facilities with tertiary nitrogen designs are far superior to conventional septic systems in terms of pollutant removal. However, since sewer extensions may make some lands buildable, that are presently difficult to build on, the town should ensure that it has the necessary zoning bylaws and other local management tools are in place to minimize environmental impacts of new growth that may be promoted by sewer extensions. The facility must also be designed to accept increased septage inputs from additional septic system pumpouts that will result from both population growth and increased public awareness of the value of septic system pump-outs.

2) To whatever degree of sewer expansion occurs at the plant, wastewater treatment levels must be commensurate with protecting the environment. In this case, the most sensitive resource affected by the discharge is water quality and living resources in West Falmouth Harbor. For coastal waters, nitrogen is the pollutant of greatest concern for treated sewage discharges to groundwater. Presently, the Town of Falmouth has a Class III discharge permit, the most lenient permit allowed, and one of the few remaining in the state for a municipal wastewater facility. Whether a Class I permit (10 ppm), or a more stringent discharge limit is required will depend on the outcome of Agency review of subsequent reports by the Town's consultant and other factors. However, the loading limit should be based principally on what level of nitrogen loading West Falmouth Harbor can accept without adverse impacts to water quality and living resources. This limit may be different than the 5 ppm and 10 ppm discussed.

3) Whatever discharge limit is selected, the Town of Falmouth will face appreciable expenditures in the upgrade of the facility and expansion of the sewer system. While there is an expense for advanced nitrogen removal to 5 ppm or beyond, technologies and sewage processing systems have improved considerably during the past decade, and discharges of 5 ppm total nitrogen and below have been achieved by several wastewater facilities around the state. These cost benefit analyses will undoubtedly be included in a subsequent report by the consultant.

4) The use of the Buzzards Bay Project's loading limits are included in the report. We wish to point out that, that in September, the Buzzards Bay Project released a report based on a review of seven years of data in 28 coastal embayments. Based on these findings, the Buzzards Bay Project is recommending more stringent limits for embayments like West Falmouth Harbor. These new recommended limits should be reviewed in the next phase of the facility planning study.

5) The Buzzards Bay Project would not support converting Oyster Pond to freshwater as a mechanism for managing impacts from nitrogen entering that receiving water. Currently the Pond is salt to brackish with a sizeable shellfish resource.

6) The BBP nitrogen strategy may not have been correctly applied to the calculation of the whole bay nitrogen loading limit. To establish nitrogen loading limits with the BBP methodology, requires a calculation of the volume of the bay at mid-tide, and the flushing rate for the upper third of the embayment. In our 1996 report on West Falmouth Harbor, we calculated that the weighted average flushing time for the upper 1/3 of West Falmouth Harbor (from the Aubrey flushing study) as 2.4 days. This, and the other values in that report should be used for calculating the whole bay loading limit, instead of the values currently cited in the Stearns and Wheler report.

Stearns and Wheler noted that nitrogen loads to the harbor are estimated at 24,415 kg/yr with a potential to 32,227 kg/yr under full buildout. We basically agree with these estimates, but the BBP is currently considering an upper bay attenuation loss term of 30% for non-point sources. In our 1996 report to the town, we recommended that the nitrogen limit for the bay be set at either 17,300 kg/yr if the bay were designated an Outstanding Resource Water or 34,600 kg/yr if it were designated an "SA" water. Based on our revised limits, SA would be set at 24,000 kg/y, and 8,000 kg/yr for ORW. These new ORW limits for West Falmouth Harbor would be difficult to achieve because of the combined nitrogen inputs from the Wastewater Treatment Plant, Landfill, and former septage lagoons exceeds 17,000 kg/year. However, with landfall capping and improved wastewater treatment, and with application of an upper watershed attenuation loss, loadings to West Falmouth Harbor could approach the ORW limit if the facility were highly efficient at nitrogen removal. As the Buzzards Bay Project finalizes its recent technical report we will send to the Town and the Cape Cod Commission a summary of how the new proposed limits and method changes would apply to West Falmouth Harbor, and what specific nitrogen discharge concentrations would be need to protect water quality according to our management approach. These recommendations will have more relevance in the next phase of the wastewater facility planning process.

7) When the Buzzards Bay Project developed its nitrogen management strategy in 1991, the approach and limits were defined to apply and manage entire embayments, not small coves within an entire embayment. At some subdivision of an embayment, these limits may not apply. For West Falmouth Harbor, these limits are applied to Oyster Pond, which has an area of only 7 acres. While such an approach is useful for planning purposes, and while we do not specifically object to such an application, limitations of the applicability of this management approach for small embayment sub-units should be acknowledged.

8) During the student presentations organized by Dr. Ivan Valiela of the Boston University Marine Program on West Falmouth Harbor, differences among nitrogen loading models employed by different investigators became apparent. When establishing a Total Maximum Annual Load for a coastal embayment using the BBP's recommended nitrogen limits to establish a discharge concentration limit for the wastewater facility, it is inappropriate to use other watershed nitrogen loading models with different loading assumptions than those used by the

BBP and Cape Cod Commission. This is because the BBP recommended loading limits are based on the empirical relationship between our assumed nitrogen loadings from septic systems, lawns and other sources, and observed water quality and ecosystem response in 28 Buzzards Bay embayments. If the BBP had used the Valiela nitrogen loading model, our recommended nitrogen limits for West Falmouth Harbor and other embayments would be considerably lower than the 24,000 kg y^{-1} SA or 8,000 kg y^{-1} ORW limits we now propose.

These differences have caused some confusion among some managers and members of the public. The differences between the loading coefficients used by the Valiela et al. and the BBP and Cape Cod Commission loading models are appreciable, and are summarized in Table 1. By far, the most significant difference in the two loading models is that Valiela et al. assumes cumulative soil and groundwater losses of 60% of nitrogen during transit for some nitrogen sources, which in turn results sizeable differences of loadings to the bay. For example, the Valiela model of watershed loading and precipitation directly to the bay (excluding plumes from the landfill and sewage treatment plant) is 4,197 kg y^{-1} according to the Lowensteiner report. In contrast, in the 1996 BBP report to the Town of Falmouth, watershed loading, excluding plumes was estimated to be 7,031 kg y^{-1}. The 40% lower estimate by Valiela is the net result of the different loading and watershed attenuation coefficients in Table 1. The Buzzards Bay Project is in the process of applying the Valiela loading model to Buzzards Bay watersheds, but if West Falmouth Harbor loading assessment is representative of the discrepancy of the two approaches, SA and ORW annual nitrogen loading limits for West Falmouth Harbor using the Valiela model would be 14,400 and 4,800 kg y^{-1} respectively.

While the research conducted by Valiela and his colleagues is important in expanding our understanding of coastal ecosystems, watershed loadings, and nitrogen processes, several of his conclusions are the subject of debate by scientists and managers. In particular, Valiela has challenged long held assumptions in the scientific and management community, that nitrogen, particularly as nitrate, travels great distances in groundwater without attenuation or loss. He also employs nitrogen loading rates from septic systems considerably lower than that employed by managers and some other investigators. Some of these conclusions appear to be at odds with findings of other studies based on traditional approaches of modeling groundwater and monitoring groundwater plumes. It is unlikely this issue will be resolved in the scientific community within the time frame of the facility planning process for the Town of Falmouth.

9) In general, the Boston University Marine Program student reports provide valuable insight into conditions of West Falmouth Harbor, and impacts of nitrogen loading to that bay. However, their conclusions and findings need to be put into the proper context as to what information gaps exist, what assumptions were made, and what methodologies were used. Examples of the limitations of these reports with respect to nitrogen loading are touched upon below.

a) Valiela uses his nutrient loading model to compare relative nitrogen loading rates to embayments based on loading per unit area of receiving waters without accounting for bay volume or flushing rates. There is a large body of evidence that suggests that embayments with less flushing are far more susceptible to nitrogen impacts than well-flushed embayments. In the most recent review of 28 Buzzards Bay embayments, Costa et al. (1999) found that ecosystem response and water quality indicators show the best correlation when bay flushing and bay

volume are considered. The importance of flushing as a factor in Oyster Pond was acknowledged by the Burgess et al. student paper.

b) In the student reports, evaluation of Valiela nutrient loading model was based on characterizing nitrogen loading estimates via groundwater nitrogen concentrations nearshore. In the Lowensteiner et al. report, 58 sites around the bay were sampled. Loadings to the bay appear to be the result of multiplying average concentrations for all sites these sites times assumed freshwater recharge, although the precise methodologies are not explained. Presumably this was done also with the subwatershed evaluation. Loadings for the Snug Harbor and Mashapaquit Creek were based on about 10 nearshore groundwater sampling sites in each subwatershed. These samples were taken over a three-day period in early September 1999. This sampling followed a prolonged summer drought, but it is unclear how a drought and low groundwater conditions would affect their loading analysis without more information.

This effort contrast with other studies evaluating pollutant loadings in groundwater plumes which are typically based on drilling a large number of multilevel wells to develop a three-dimensional picture of plume dimensions and concentrations. This is the method required by state and federal agencies when defining cleanup remediation strategies for large contamination sites. On Cape Cod in particular, managers, public officials, and the public have become acutely aware of the difficulty of finding and defining the extent of groundwater plumes through their experiences with the Superfund investigations at the Mass Military Reservation. Even more difficult than characterizing the extent and pollutant loads in a plume is any effort to monitor entry of a plume into coastal waters as evidenced by the effort to identify the sites of entry of the LF1 superfund plume into Red Brook Harbor. In general, pollutant loads from land base sources enter bays and harbors through complex pathways including underwater springs, groundwater fed streams, and diffuse infiltration nearshore. Most managers would find plume characterization based upon a relatively small number shallow groundwater samples nearshore as an inadequate information base for decision making.

The watershed loads and inference as to the plume loads in the student reports appeared to be based on a mean of all these groundwater levels which were extremely variable ranging 10 fold or more, and including samples taken on opposite shores from the presumed plume entry point. While mean groundwater concentration over **many** points has utility in evaluating numerous diffuse sources like septic systems, it may inadequately capture sewage treatment plume loadings to West Falmouth Harbor. For example, nitrate + ammonia concentrations in four groundwater sites in Snug Harbor exceed 250 uM with one sample above 300 uM (4.2 ppm). If this upper value represents the core of the wastewater plume (this cannot be concluded), one could presumably multiply this concentration times the flow of the plant. Since this is presumably the leading edge when the plant was only discharging about 200,000 gpd, this flow could be considered the base flow of the plume. However, with rainwater infiltration at the spray irrigation area and infiltration lagoons, and diffusion of the plume by groundwater during its 7-year transit to West Falmouth Harbor could mean that the 4.2 ppm concentration could be indicative of a 400,000 gallons per day groundwater discharge or more at that concentration. Thus, the leading edge of the plume could conceivably be contributing 2,320 kg annually based on the Lowesteiner data. Since the plant averages 440,000 gpd today (more than 700,000 gpd in the summer), this current presumed nitrogen loading rate of the plume could be expected to at

least double.
With this alternate interpretation of the data, the conclusion that 90% of the plume nitrogen is attenuated seems highly questionable. There may also be a discrepancy as to what the nitrogen load the plume starts out with. In the Lowensteiner report, sewage treatment plant nitrogen discharge was stated to be 17,400 kg annually, whereas the BBP 1996 estimate was 9,300 kg based on groundwater concentrations immediately down gradient of the facility. Part of this discrepancy could be attributed to influent concentrations and flows in contrast to concentrations after treatment in the infiltration beds and spray irrigation areas.

The biggest uncertainty, however, in the Lowensteiner study is whether the near shore well sample locations actually captured the core of the sewage treatment plume, and whether this leading edge of the plume is typical of plume characteristics upgradient. These questions can only be answered with a rigorous groundwater monitoring program. Because of the expense and time needed for a comprehensive plume characterization study, regulatory agencies should review nitrogen data associated with the plume of old MMR wastewater treatment plant which used to have a groundwater discharge near Ashumet Pond. This treatment plant was very similar in size and effluent characteristics to the Falmouth wastewater plant, since the bulk of its flow consisted of wastewater from residences, barracks, and offices. Considerable effort has been directed toward evaluating the sewage plume characteristics and dimensions. The studies of LeBlanc and others that evaluate nitrogen concentrations and transformations should be reviewed to help determine the appropriate loading characteristics for the Falmouth wastewater facility and whether there is appreciable nitrogen concentration declines that cannot be explained by simple diffusion processes.

10) Irrespective of what nitrogen loading method is used, it appears that existing development and plumes from the wastewater plant and other sources have contributed to the loss of eelgrass in the inner portions of West Falmouth Harbor, and that nitrogen concentrations and chlorophyll concentrations are becoming elevated. The upgraded wastewater facility's nitrogen removal performance must offset any new inputs from sewer expansion. Moreover, because existing residential development on septic systems may have already approached recommended ORW limits, the highest level of protection for West Falmouth Harbor may only be achieved though both stringent nitrogen performance standards, and sewering of a portion of the West Falmouth watershed. This latter approach is important, since an advanced tertiary treatment plant has a far superior performance at nitrogen removal than conventional septic systems.

The BBP looks forward to working with the Cape Cod Commission and the Town's consultant to help identify that nitrogen discharge limit.

We hope you find these comments useful.

Sincerely,

Joseph E. Costa, Ph.D.

CC: MEPA-EOEA
Falmouth Board of Selectmen

Table 1. Nitrogen loadings to coastal waters from different landscapes and nitrogen sources employed by the Buzzards Bay Project (1991), Valiela et al. (1997, = "NLM" model), and recommended changes to BBP methodology as proposed in Costa et al., 1999).

N loading source reaching coast	BBP	NLM	BBP new	annual rates
Aquifer transit loss term	0.0%	35.0%		
"Upper watershed" loss term	0.0%	44.0%	30.0%	
Septic systems discharge below leach field	2.7	2.9		kg capita^{-1}
Septic System N reaching coastal waters	2.7	1.3[a]		kg capita^{-1}
Septic Systems within 200 m of coast	2.7	1.9[a]		kg capita^{-1}
Lawns 29.3	17.5[a]	kg ha^{-1}		
Lawns adjusted for use of fertilizer	Not Inc.	5.3[a,b]		
Dry/wet precip. on roads reaching coast	15.3[c]	3.8[a]		kg ha^{-1}
Dry/wet precipitation to roof/sidewalk	7.3[d]	1.4[a]		kg ha^{-1}
Dry/wet precipitation on forest /other undevel.	0.0	1.4[a]	0.42	kg ha^{-1}
Cropland (includes dry/wet precip.)	10.0	22.6		kg ha^{-1}
Cranberry bogs (for GIS coverages)	18.0	13.0?	17.6	kg ha^{-1}
Cranberry bogs (actual production area)			24.7	kg ha^{-1}
Precipitation to bay	7.1[e]	15.0		kg ha^{-1}
1 acre residential development, near coast	10.7	9.9		kg ha^{-1}
Tidal Prism loadings	Not Inc.	Not Inc.		

[a] Value includes aquifer losses of nitrogen
[b] Assume that only 34% of lawns are fertilized for a de facto rate of 5.3 kg ha
[c] Assumes 90% recharge volume, and DIN = 1.5 ppm.
[d] Same as note c, but DIN = 0.75 ppm.
[e] 100% recharge, DIN = 0.75 ppm, wet and dry deposition