June 27, 2005

RE: Total Nitrogen Permit Modifications
Woonsocket Wastewater Treatment Facility; RIPDES Permit No. RI0100111
Bucklin Point Wastewater Treatment Facility; RIPDES Permit No. RI0100072
Fields Point Wastewater Treatment Facility; RIPDES Permit No. RI0100315
East Providence Water Pollution Control Facility; RIPDES Permit No. RI0100048

Dear Commenter/Interested Party:

This letter is being written to notify you that the Department of Environmental Management (DEM) has completed its review of all comments received and has issued final Rhode Island Pollutant Discharge Elimination System (RIPDES) permit modifications that establish total nitrogen limits for the above-mentioned wastewater treatment facilities.

DEM has prepared a response to comments document, which summarizes the significant comments received and provides the DEM's response to each of these comments. The response to comments document also includes an analysis of recent work that confirms that wastewater treatment facilities along the Blackstone River, including those located in Massachusetts, are a significant source of nutrients to the Providence and Seekonk Rivers. After careful consideration, the permits were issued as proposed except the Woonsocket WWTF nitrogen limit was modified to commence on May 1st consistent with the other WWTFs.

If you wish to contest any of the provisions of this permit, you may request a formal hearing within thirty (30) days of receipt of this letter. The request should be submitted to the Administrative Adjudication Division at the following address:

Bonnie Stewart, Clerk
Department of Environmental Management
Office of Administrative Adjudication
235 Promenade Street, 3rd Floor
Providence, Rhode Island 02908

Any request for a formal hearing must conform to the requirements of Rule 49 of the State Regulations.

Since the above-mentioned treatment facilities will not be able to immediately comply with the final total nitrogen limits, it is anticipated that they will appeal the final permits and enter a consent agreement with DEM. The consent agreement will provide interim limits and a schedule to complete the planning, design and construction necessary to comply with the final limits. Consistent with state law passed last year, it is anticipated that construction at all facilities will be completed by December 2008.

The final permit modifications and the response to comments document has been placed on DEM's website and may be reviewed at www.state.ri.us/DEM by clicking on Programs, then Water, then Permits, then RIPDES. A copy of the permit modifications and response to comments may also be obtained by calling Joseph Haberek in DEM's Office of Water Resources at 401-222-4700 ext. 7715.

Sincerely,

Angelo S. Liberti, P.E.
Chief of Surface Water Protection

From December 28, 2004 to February 11, 2005, the Rhode Island Department of Environmental Management (DEM) solicited public comment on draft Rhode Island Pollutant Discharge Elimination System (RIPDES) permit modifications for the Fields Point, Bucklin Point, Woonsocket, and East Providence Wastewater Treatment Facilities (WWTFs). The following is a synopsis of the significant written comments and oral (a public hearing was held on February 8th) received and the DEM's response to those comments.

Commenter:

Audubon Society of Rhode Island
Eugenia Marks
Director of Policy and Publications
And
Jennifer West
Policy Assistant
12 Sanderson Road
Smithfield, RI 02917-2600

Comment:

The Audubon Society of Rhode Island (ASRI) extended their support for the proposed permit modifications and indicated that they felt that setting wastewater nitrogen discharge limits is a critical component in reaching the goal of 50-percent reduction of nitrogen as set by the 2004 Rhode Island General Assembly. However, ASRI did have the following comments regarding the proposed permit modifications:

1. ASRI commented that lower nitrogen discharge limits have been set in other regions of the U.S. and cited limits are set at 3.0 mg/l for the Chesapeake Bay and in parts of Florida, and 4 mg/l at a Wareham, MA wastewater treatment plant. The goal should be to reduce nutrient discharges as much as possible through increasingly available technological additions or improvements.

Response:

The document that DEM developed to support the draft permit modifications "Evaluation of Nitrogen Targets and WWTF Load Reductions for the Providence and Seekonk Rivers" (the "DEM evaluation") suggests that limit-of-technology treatment is required to meet water quality standards. Given the high cost of limit-of-technology treatment, performance of available treatment technologies, the degree of uncertainty associated with the analysis and DEM's recent proposal to adopt EPA's recommended changes to the dissolved oxygen criteria, a phased implementation plan was developed. The phased approach is consistent with EPA's guidance document titled Guidance for Water Quality-Based Decisions: The TMDL Process and it includes limits as part of the first phase that, once implemented, will achieve the 50% reductions targeted by RIGL § 46-12-2(f). While it is true that: technology is available to achieve lower WWTF nitrogen concentrations and NPDES permits in other states have been issued with lower limits, Rule 8D(3)10 of the RI Water Quality Regulations states that the Director may assign site specific limits based on reasonable best available technologies and for the reasons noted above it is DEM's position that the proposed implementation approach is

appropriate. An integral component of this phased implementation approach is adequate monitoring and assessment of water quality changes to determine if additional reductions are necessary to meet water quality standards.

Comment:

2. ASRI commented that the 8.0 mg/l limit set for East Providence could prove to be high, particularly due to the East Providence facility's situation farther south than the other three facilities (the higher salinity in that reach of the bay affecting nitrogen impacts), and the characteristic short flushing time of the Providence River. Along the same lines, there was no mention of phosphorus loading in the permit modification, which is particularly important to consider for facilities such as Bucklin Point and Woonsocket, which receive considerable freshwater input due to their location on the landscape. In addition, since wastewater itself is a freshwater input, the effect of phosphorus even at East Providence needs further analysis.

Response:

The East Providence WWTF was assigned a higher nitrogen limit because the benefits to the Providence and Seekonk Rivers of reducing the draft permit limit from 8 mg/l to 5 mg/l is significantly less than other facilities assigned a limit of 5 mg/l. The primary reason is that East Providence WWTF's lower design flow results in an incremental loading reduction, which is not warranted at this time.

The permit modifications did not include phosphorus limits for the Bucklin Point and East Providence WWTFs primarily because these facilities discharge into brackish receiving waters, and nitrogen is the limiting pollutant. Any impacts on salinity caused by the discharge of wastewater aren't expected to result in ecosystem changes that require phosphorus limits to protect these receiving waters. Please note that the Woonsocket WWTF's current permit (issued in 2000) does contain a phosphorus limit which was developed as part of a joint EPA, Massachusetts and Rhode Island analysis of the oxygen conditions in the Blackstone River.

Comment:

3. ASRI commented that, while the proposed permit changes would establish seasonal total nitrogen limits from April through October, and that the wastewater treatment facilities are only required to "continue to operate all available treatment equipment throughout the rest of the year in order to maximize the benefits of the wastewater treatment facility improvements". The fact that nitrogen loading throughout the year contributes to the pool of nitrogen available for uptake for phytoplankton must be taken into consideration. The cycling and fate of nitrogen is the critical factor throughout the year.

Response:

While nitrogen loading throughout the year has the potential to contribute to the pool of nitrogen available during critical periods, the general consensus of participants in the technical advisory committee that DEM established to assist with efforts to develop a water quality model and TMDL for the Providence and Seekonk Rivers was that the winter contribution is not significant. This is also supported by work completed by Doering et. al. (1990) which concluded that their analysis and previous mesocosm experiment data showed that dissolved nitrogen concentrations in the Providence and

Nevertheless, DEM included a permit condition, which requires that the facility continue to operate all available treatment equipment throughout the rest of the year in order to maximize the nitrogen removal benefits. Due to the heavy dependence of biological nutrient removal on temperature, the costs associated with year-round limits would be significantly greater than the cost to achieve the seasonal limits and are not being imposed until information is available to indicate they are necessary.

Comment:

4. The relationship between nitrogen inputs and dissolved oxygen levels in the Bay as well as what standards have been applied is not addressed in the permit modifications. Ultimately, the proposed nitrogen discharge limits are based on cost, not the MERL experiment results or other practical scientific applications. As explained in the permit modifications, because of the aforementioned issues a phased implementation of standards will take place. ASRI commented that they are concerned that future phases may take quite a long time to be implemented.

Response:

For the reasons noted above, DEM believes that a phased approach is prudent and appropriate. Furthermore, the first phase represents a significant reduction and may result in compliance with the recently proposed EPA dissolved oxygen guidelines. RIGL § 46-12-2(f) required that RIDEM issue proposed permit modifications by July 1, 2004, to achieve an overall goal of reducing nitrogen loadings from WWTFs by fifty percent (50%) by December 31, 2008. Upon issuance of the final modifications, it is anticipated that the permittees will appeal the permits and enter a consent agreement with DEM, which will include the December 2008 target date for completion of construction. During the facility planning and design process, DEM will encourage permittees to ensure that the WWTF modifications can be expanded in the future if necessary.

Once construction is completed, an integral component of this phased implementation approach is adequate monitoring and assessment of water quality changes to determine if additional reductions are necessary to meet water quality standards. DEM, in partnership with Narragansett Bay National Estuarine Research Reserve, the Narragansett Bay Commission, University of Rhode Island, and Roger Williams University, will be increasing the number of continuous water quality monitoring stations to at least 13 by the summer of 2005. Monitoring at these stations will be used to determine what additional reductions will be necessary as part of the future phases of nutrient reductions.

It should be noted that progress toward reducing RI WWTF nitrogen reductions has already been accomplished. WWTF modifications that have already been completed or will be completed in the near future are anticipated to produce a 34% reduction of the 95-96 loadings from the 11 targeted WWTFs (the degree of reduction will decline as WWTFs flows increase toward their approved design flows).

Comment:

5. ASRI commented that an integral component of the phased implementation approach is monitoring and assessment of water quality. Thus it is very important

that RIDEM and partners increase the number of continuous water quality monitoring stations in Narragansett Bay.

Response:

DEM agrees that an assessment plan is needed to determine the need for future tighter restrictions. As noted in the DEM evaluation an integral component of this phased implementation approach is adequate monitoring and assessment of water quality changes to determine if additional reductions are necessary to meet water quality standards. DEM, in partnership with Narragansett Bay National Estuarine Research Reserve, the Narragansett Bay Commission, University of Rhode Island, and Roger Williams University, will be increasing the number of continuous water quality monitoring stations to at least 13 by the summer of 2005. EPA is currently seeking a contractor to assist DEM with the development of methods to review continuous time series measurements of dissolved oxygen for compliance with EPA's October 2000 recommended ambient water quality criteria.

Comment:

6. Finally, while RIDEM identified nitrogen discharge from wastewater treatment plants as the primary cause of the historic clam and fish kills of the summer of 2003 and similar events last summer, the primary source of nitrogen in Rhode Island's waters is atmospheric. Both government and industry must take steps to reduce nitrogen emissions to air. It is important to also include a section that educates all Rhode Islanders on other sources (particularly non-point sources) of nitrogen inputs such as fertilizers and animal waste from developed and agricultural lands.

Response:

Besides wastewater treatment facilities, there are many other sources of nitrogen to the Providence and Seekonk Rivers, including storm water, ISDS systems, and atmospheric deposition. However, several available analyses agree that WWTFs represent the major source of nitrogen to the Bay (Pryor 2004). These analyses considered atmospheric deposition, rivers/streams, urban runoff and WWTFs. As required by RI General Law 46-12-3(25) DEM developed a document entitled "Plan for Managing Nutrient Loadings to Rhode Island Waters". The Plan underscores the importance of the several other pollution prevention and treatment measures that are being implemented by DEM, CRMC, and other agencies to reduce nutrients from these other sources.

Water quality restoration plans addressing nutrient impairments are underway for a number of coastal embayments and rivers discharging to the Bay, including Greenwich Bay, Kickemuit River and Reservoir, and Palmer River. These plans identify sources of nutrients and necessary actions to restore water quality, including both point source and non-point sources of pollution.

Also, many efforts are underway to prevent water quality impacts associated with storm water runoff in undeveloped areas, and to enhance the treatment and management of storm water from urban and agricultural areas. These include initiatives such as Grow Smart RI and the Governor's Growth Planning Council; watershed-based project to identify, protect and restore riparian buffers; and public education and municipal assistance efforts to encourage low impact development. In addition, the RIPDES Program is working the state Department of Transportation and 36 municipalities on a major effort to better manage urban storm water through the development and implementation of storm water management plans.

Commenter:

Conservation Law Foundation
Christopher A. D'Ovidio, Esq.
Director of Rhode Island Advocacy
55 Dorrance Street
Providence, RI 02903

Comment:

The Conservation Law Foundation (CLF) commented that, while they generally support the DEM's position to reduce nitrogen loading, CLF believes that:

1. CLF commented that while the DEM acknowledges the need to reduce nitrogen loading to reduce excessive algal growth and maximize dissolved oxygen levels, the DEM also concludes that technology would allow WWTFs to reduce total nitrogen to 3 mg/l. However, the DEM is only requiring reductions to 5 mg/l for Bucklin Point, Field's Point and Woonsocket WWTFs and 8 mg/l for the East Providence WWTF and concedes that these proposed nitrogen reduction limits would not fully comply with existing water quality standards and may not meet Environmental Protection Agency (EPA) dissolved oxygen guidelines established in October 2000. CLF commented that at a minimum, the proposed permit modifications must require these WWTFs to employ the best available technology (BAT), i.e., technology that will reduce nitrogen limits to 3 mg/l.

Response:

DEM agrees that technology is available to achieve lower WWTF nitrogen concentrations and NPDES permits in other states have been issued with lower limits. However, DEM does not agree that federal laws or regulations require that the proposed permit limits be set at 3.0 mg/l (limit of technology). As noted in the DEM evaluation although it appears that limit of technology may ultimately be required, phase implementation is consistent with the EPA guidance document entitled "Guidance for Water Quality-Based Decisions: The TMDL Process". This is also consistent with the EPA approved TMDL developed to address dissolved oxygen standards in Long Island Sound (NY DEC and CTDEP December 2000. Additional support for phased implementation is provided in the response to ASRI's comments.

Comment:

2. CLF commented that, since these Rivers are listed as impaired based on exceedances of water column criteria, a dilution factor (i.e., a mixing zone) is clearly inappropriate. Because a Total Maximum Daily Load (TMDL) analysis has not been performed and the Wasteload Allocation (WLA) has not assigned an alternative limit, the final WQBELs for these WWTFs must be the numeric objective applied end-of-pipe. CLF further commented that, by issuing a RIPDES permit without a WQBEL for impairing pollutants, the DEM will fail to proceed in a manner required by law and/or abused their discretion.

   CLF contends that the WWTFs' RIPDES permit's limits must contain a WQBEL for impairing pollutants, including but not limited to nitrogen. Any pollutant that may

cause or has the reasonable likely hood of contributing to these impairments shall not be discharged into these water bodies, unless authorized by a permit establishing WQBELs. Moreover, a RIPDES permit may not be issued when the conditions of the permit do not provide for compliance with the applicable requirements of CWA, or regulations promulgated under CWA and when the imposition of conditions cannot ensure compliance with the applicable water quality requirements of all affected States.

Response:

The analysis performed is equivalent to a TMDL and indicates a WQBEL equal to the limit of technology appears necessary. DEM is pursuing a phased implementation approach that is consistent with EPA guidance. Specifically, EPA's guidance document titled Guidance for Water Quality-Based Decisions: The TMDL Process states that "in many cases the degree of certainty cannot be well quantified until more data becomes available to develop sensitivity analyses and model comparisons. For TMDLs involving these non-traditional problems, the margins of safety should be increased and additional monitoring required to verify attainment of water quality standards and provide data needed to recalculate the TMDL, if necessary. EPA regulations provide that load allocations for nonpoint sources and/or natural background 'are best estimates of the loading which may range from reasonably accurate estimates to gross allotments...'. A phased approach to developing TMDLs may be appropriate where estimates are based on limited information. The phased approach is a TMDL that includes monitoring requirements and a schedule for re-assessing TMDL allocations to ensure attainment of water quality standards."

Comment:

3. CLF commented that they recognize that TMDL development may take a number of years, and also recognizes that it may be appropriate to include a time schedule in the permit to give the WWTFs the opportunity to achieve the necessary reductions.

Response:

Upon issuance of the final permit modifications, it is anticipated that the permittees will appeal the permits and enter a consent agreement with DEM. Through this process, interim limitations and an enforceable schedule for completing planning, design and construction will be established. RIGL § 46-12-2(f) required that DEM issue proposed permit modifications to achieve an overall goal of reducing nitrogen loadings from WWTFs fifty percent (50%) by December 31, 2008. These consent agreements will include the December 2008 target date for completion of construction. Based upon the results of planning and design work at each facility, a specific construction schedule will be developed for each facility. Facility plans and final designs must be approved by DEM prior to initiation of construction.

Commenter:

City of East Providence
Stephen H. Coutu, P.E.
Director of Public Works
City Hall
145 Taunton Avenue
East Providence, RI 02914-4505

Comments:

The City of East Providence commented that they recognize the responsible charge of DEM to reduce nutrient loadings in Narragansett Bay as recommended by the Governor's Narragansett Bay and Watershed Planning Commission and that they remain committed to operating a wastewater treatment facility that meets its assigned permit limits. However, the City commented that they are concerned with the costs involved in order to meet a Nitrogen limit of 8 mg/l.

If and when these permit modifications become final, the City commented that it hopes that the DEM has secured sufficient funding mechanisms so that the City is not overburdened with the costs to meet the new permit limits.

Response:

Available and proposed State bond funds are expected to provide sufficient loan capacity to support the treatment facility modifications necessary to achieve the 50 percent nutrient reduction goal. Through the State Revolving Fund (SRF), administered by the RI Clean Water Finance Agency, low-interest loans are made available to eligible communities and sewer commissions for facility upgrades. In November 2004, Rhode Island voters approved a bond measure, proposed by Governor Carcieri and approved by the General Assembly that included $10.5 million to further capitalize the SRF Program. The Governor has also offered his commitment to propose an additional $20.2 million in funding for facility upgrades as part of a follow-up bond referendum on the 2006 ballot. In combination, the two State bonds will equip the SRF Program with the amount necessary to provide full support, via low-interest loans, for all of the remaining work.

Commenter:

Massachusetts Department of Environmental Protection
Executive Office of Environmental Affairs
Commonwealth of Massachusetts
Glenn Haas
Director, Division of Watershed Management
One Winter Street
Boston, MA 02108

Comment:

Massachusetts Department of Environmental Protection (MADEP) commented that they support DEM's statements that an adaptive management approach is needed to set forth a nutrient reduction and cleanup plan that is technically sound, environmentally responsive, and economically achievable. However, MADEP objected to the establishment of permit limits for MA WWTF and recommended optimizing existing operations at UBWPAD, Attleborough and North Attleborough WWTFs to reduce nitrogen to the maximum extent practicable while additional data and analysis is conducted to address the contribution of other sources, establish target concentration in the Bay and rivers, evaluate attenuation in rivers. They suggested that necessity of further nitrogen removal at MA facilities should be re-evaluated once RI facilities are dealt with and UBWPAD completes its upgrade currently under design.

Response:

The Woonsocket, UBWPAD, Attleborough and North Attleborough WWTFs are significant contributors to the most highly enriched estuarine waters in RI, the Seekonk River. While MADEP didn't identify the level of nitrogen control considered best practical treatment at these facilities, UBWPAD recently indicated that they are currently designing WWTF modifications that would achieve a total nitrogen discharge 10 mg/l (Walsh 2005). Using the revised Blackstone River attenuation factor (explained below) this level of nitrogen control, the proposed permit limits for RI facilities, and design flows for all WWTFs, the 3 MA WWTFs represent 74% of the total WWTF loading to the Seekonk River. The largest single source, UBWPAD contributes 62% followed by Bucklin Point 18%. Even using the limits proposed by RIDEM, the 3 MA WWTFs contribute 56% of the total WWTF loading to the Seekonk River, UBWPAD contributes 40% of the load followed by Bucklin Point at 31% and Woonsocket at 14%. Using the refined delivery factors, the limits proposed by DEM will reduce the 95-96 seasonal loading to the Seekonk River by 62% (to the 9X loading condition), while the MADEP proposal would only result in a 35% reduction (the 16X loading condition).

Therefore, it is DEM's position that significant progress toward achieving water quality standards will not be made unless the total nitrogen from UBWPAD is reduced to 5 mg/l (or the equivalent reduction is required from other MA WWTFs in the Blackstone River watershed), and Attleborough and North Attleborough are required to achieve 8 mg/l of total nitrogen. Additional justification for RIDEM's position that implementation of RIDEM's proposed levels of nitrogen control should not be delayed is presented below.

Comment:

MADEP also commented that their review of the data and other supporting documents has raised a number of specific concerns that they felt need to be resolved prior to pushing limit of technology permitting decisions in MA. These concerns fall into several categories, which can be summarized as follows:

1. The analysis completed by DEM did not account for non-POTW loadings and their potential impacts including, but not limited to, combined sewer overflows (CSO's) and storm water contributions.

   MADEP commented that they believe, the identification of all sources and their relative importance have not been well established in the DEM documents, which is the basis for the proposed permit limits. Major omissions not identified in the documents include, but are not limited to, nitrogen loads from local contributing non-point sources such as groundwater (i.e. septic system) and combined CSOs, atmospheric deposition, effect of sediments on nitrogen flux, and effects of tidal ranges and currents within the Bay and River systems on dispersion, dilution, and effective retention time.

   If the results of a computer model cannot be used to replicate this complex system, MADEP questions if a static laboratory study and desktop analysis could justify the proposed specific permit limits. In addition, while the unique aspects of the Seekonk and Providence Rivers currently preclude representing them in a mathematical model, it seems likely that the open water portion of Narragansett Bay could be modeled and such a model would be a useful tool to addressing water quality issues and alternative control strategies.

   The MERL experiment used a dramatically different residence time (27 days) than is likely experienced in the two river systems (on the order of hours or a couple of days). This strongly suggests the need to approach controls through adaptive

the reductions in Nitrogen loads required in the proposed RI DEC permits to its major wastewater treatment plants. MADEP supports this effort, and recommends that the monitoring be expanded to also document the impacts of those changes in both the riverine and marine waters. We also note that funding seems to be for only one year (2005) right now.

The one remaining issue, and potentially most detrimental to the Providence and Seekonk Rivers and possibly the Bay, which is not discussed in the report, are the significant quantity of CSOs in this highly urbanized area. One wet weather aspect, which needs to be highlighted, is the inclusion and clarification of the contribution from the RI CSOs, which in most cases are direct discharges to the rivers and Bay during the May through October time frame. The report needs to factor in and analyze the number of discharge locations, the frequency of discharges, and discuss the Bucklin and Fields Point overflows including projected increases in discharges. According to RIDEM, these presently operate as bypasses during storm events.

It does not seem logical to create an analysis based upon a review of only the dry weather effects from the facilities when periodic CSO discharges and overflows may dwarf these when analyzed on a daily basis.

Response:

MADEP acknowledged that DEM is not recommending limit of technology (LOT) at either MA or RI WWTFs at this time and raised a number of issues, which they believe should be addressed prior to implementation of LOT permitting decisions in MA. The DEM evaluation considered many of the issues raised by MADEP (uncertainty with the accuracy of using experimental data to represent the Providence and Seekonk Rivers, differing residence times, etc), and included them as reasons supporting phased implementation of nitrogen reductions.

DEM expressed river delivery factors for WWTFs along the tributary rivers as the total load measured at the mouth of the rivers in 1995 and 1996 divided by the major WWTF loads. Several available analyses agree that WWTFs represent the major source of nitrogen to the Bay (Pryor 2004). When evaluating implementation of various WWTF nitrogen reduction alternatives, the delivery factors were used to establish loadings at the mouth of the rivers. As a result, any other sources included in the measurements made at the mouth are included in the loading estimates.

As noted in the approved CSO facilities planning documents (Louis Berger & Associates 1998), CSO discharges are responsible for a very small percentage of the annual loading of ammonia (1%) and nitrate (0.2%) discharged to the, Seekonk and Providence Rivers and the Upper Bay. WWTFs that discharge directly account for 69% of the ammonia and 27 % of the Nitrate. Tributary rivers and WWTFs that discharge to the rivers account for 30% of the ammonia and 73% of the nitrate loading.

The approved CSO plan for the Fields and Bucklin Point WWTFs will be constructed in three phases and consists of deep rock tunnel storage and pump back for full treatment and enhanced wet weather treatment WWTFs. The approved phase I operations plan requires that NBC maximize full treatment during the storm and maximize tunnel storage and pumpback to full treatment after the storm. Primary treatment will only be implemented to avoid exceedance of the tunnel capacity either during a storm or when another storm is approaching (to avoid untreated CSO discharges).

However, Upper Blackstone Pollution Abatement District WWTF is planning to treat their CSOs using primary treatment. It is DEM's position that the Narragansett Bay Commission's approved CSO plan adequately addresses MA DEP's concern that CSOs may dwarf effects from the WWTFs plan on a daily basis, however, analysis of the need for further CSO controls at the UBWPAD is warranted.

Comment:

2. The analysis treats all POTW contributions equally rather than considering greater reductions for those facilities located closer to the receiving water where impacts have been observed.

   MADEP would also like to note that their review of the supporting documents indicates that final decisions as to the level of nitrogen reduction required at each facility appear to be based on both the size of the facility and the cost to achieve the desired limits rather than the proximity and combined impact these facilities have on the receiving waters. MADEP questions the validity of this approach for several reasons. First, a footnote to DEM's cost analysis clearly states that that cost evaluation incorporated should not be used for facilities over 30.0 mgd yet it appears it was for the three larger facilities. Second, MADEP believes RIDEM needs to justify why the UBWPAD needs to achieve a discharge of 5.0 mg/l TN when it is 50 miles away and receives significant dilution and possibly significant attenuation before getting to RI while the remainder of the facilities in RI, that total well in excess of the UBWPAD (more than 50 mgd) and discharge directly to the impacted waters only have to achieve 8.0 mg/l.

   DEM has assumed that some attenuation is taking place in tributary rivers and that the instream attenuation from Massachusetts' facilities to the specified rivers and Bay would be 13%. This is significantly lower than an earlier value provided by RIDEM of 40%. The Long Island Sound study indicated attenuation was in the range of 50-60% in the Connecticut River from MA to Long Island Sound and recent data collected by Dr. Ray Wright from URI appears to show attenuation rates ranging from 21% to 60% (average 36%) for 3 surveys conducted during 2000 and 2001 data. Mixing the two data sets is at best questionable since, in general, as the flow goes up, the concentration of a parameter goes down through dilution and in-stream flows can vary greatly from year to year.

   MADEP believes that the attenuation is significantly greater and therefore data is required to determine the percentage and range rather than relying on general assumptions. In support of this, MADEP is in the process of developing a work plan for the evaluation of nitrogen attenuation in the Massachusetts portion of the Blackstone River.

Response:

It is not clear why MADEP believes that all POTW contributions are treated equally in the DEM evaluation. The report indicates that greater reductions are appropriate for those facilities located closer to the portion of the receiving water where impacts have been observed. The section "Consideration Regarding WWTF loading reductions" specifically identifies and accounts for attenuation during tributary river transport and from the edge of the Providence and Seekonk Rivers to the area of most significant degradation.

To further address concerns raised about attenuation of nitrogen in tributary rivers, DEM reviewed additional water quality data and modeling analyses available for the MA

portion of the Blackstone River that was not included in the DEM evaluation. Detailed sampling surveys of the Massachusetts portion of the Blackstone River were conducted in October 2001, June 2001 and August 2002 (Michaelis 2005). Each survey was conducted during dry weather and consisted of 4 samples per day (at approximately equal time intervals) over a one-day period. Samples were collected at twenty-four in stream locations (six of which were located on tributary rivers). In addition 24-hour composite samples for five successive days prior to the River sampling surveys were collected from UBWPAD, Millbury WWTF, Grafton WWTF and Uxbridge WWTF. This sampling data was used to calibrate and validate the water quality model Qual2e (Michaelis 2005).

In order to provide a better estimate of the attenuation of nitrogen the fate and transport of sources and sinks along the River must be quantified. To track the fate and transport of nitrogen sources to MA/RI state line, Michaelis 2005 used the model to perform a reach-by-reach mass balance (as necessary, inputs were adjusted to match the loads measured downstream). Based on the mean of the three surveys, 95 percent of the DIN loading (NH3+ NO3) measured at the MA/RI state line is from 4 MA WWTFs (UBWPAD, Millbury WWTF, Grafton WWTF and Uxbridge WWTF).

The primary mechanism for nitrogen attenuation in the Blackstone River is algae uptake and retention of the algae in the water column or sediment. Therefore, attenuation will be reduced as algae levels are controlled. In 1997 MADEP, USEPA and RIDEM completed a WLA for ammonia and phosphorus to address dissolved oxygen conditions in the Blackstone River (USEPA et. al 1997). As a result, the Woonsocket, WWTF, UBWPAD and four smaller MA WWTFs (Millbury, Grafton, Northbridge and Uxbridge) were required to reduce ammonia and phosphorus. Since the MA facilities had not achieved the required reductions during the 2001-2002 sampling events, the dry weather survey three (DWS3) model was re-run to simulate the attenuation which will result with implementation of the WLA (including design WWTF flows). First the mass balance analysis by Michaelis 2005 was repeated using downstream model predictions for dry weather survey three (to quantify the difference between the use of downstream model predictions versus measurements). This will allow a direct comparison of the change in nitrogen attenuation due to the currently required ammonia and phosphorus controls. Next, the model was run with WWTF design flows and currently required permit limits for ammonia and phosphorus. Consistent with the WLA and the UBWPAD's compliance efforts (Walsh 2005), it was assumed that UBWPAD would denitrify to achieve total nitrogen of 10 mg/l. Nitrogen levels for the minor facilities were set at those used in the WLA. It should be noted that the minor facilities should also be able to attain lower nitrogen levels. As indicated in the Table 1 below, between 68% and 92 % of the individual MA WWTF loadings are delivered to the state line under DWS3 conditions, increasing to between 92 and 98% when current permit requirements are met. This confirms the expectation that attenuation will be reduced as WWTFs meet current permit requirements, demonstrates that attenuation will be minimal and underscores the point that further study of attenuation factors prior to implementation of nitrogen controls is not appropriate.

Table 1. Delivery of DIN (Ammonia and Nitrate) of MA WWTFs from the point of input to the state line.

WWTF	% Delivered to State Line DWS3	% Delivered to State Line DWS3 adjusted to current permit limits
UBWPAD	69	92
Millbury	69	93
Grafton	68	92
Uxbridge	92	98

The fate and transport from the MA/RI state line to the mouth of the River expected when WWTFs meet their current permit limits, was evaluated by applying the methods described above to the results of the 1997 WLA model. It was determined that 79% of the MA loading at the state line and 86% of the Woonsocket WWTF load will be delivered to the mouth of the Blackstone River when the required WLA is met. By combining the delivery from each MA WWTF to the state line with that from the state line to the mouth of the river, refined deliver factors were computed for each MA WWTF. It was determined that between 71 and 77% of the individual MA WWTFs nitrogen loading will be delivered to the mouth of the River (72% for UBWPAD) and 86% of the Woonsocket WWTF. In the DEM evaluation, the Woonsocket and UBWPAD WWTFs were both assigned a river delivery factor equal to 87%.

Of the nitrogen load predicted at the mouth of the River, WWTFs represent 98%: UBWPAD and Woonsocket represent 83% (64 % and 19 %, respectively). In the DEM evaluation, the Woonsocket and UBWPAD WWTFs were used to represent 100% of the load at the mouth of the Blackstone River. A detailed description of the recent analysis is presented in Appendix A.

MADEP has commented that existing operations at UBWPAD, Attleborough and North Attleborough WWTFs should be optimized to reduce nitrogen to the maximum extent practicable until additional information is gathered to support permit limitations for MA facilities. Using the refined delivery factors, the limits proposed by DEM will reduce the 95-96 seasonal loading to the Seekonk River by 62% (to the 9X loading condition), while the MADEP proposal (assuming total nitrogen of 10 mg/l) would only result in a 35% reduction (the 16X loading condition). Furthermore, if the MADEP proposal were adopted, UBWPAD would represent 62% of the loading to the Seekonk River as opposed to 40%.

After consideration of this information, it is even more apparent that implementation of the loading reductions proposed by DEM are necessary to ensure substantial progress toward achieving water quality criteria in the Seekonk River and should not be delayed. It is prudent to address these requirements at the UBWPAD, which is currently in the process of designing WWTF improvements necessary to comply with the 1997 WLA requirements.

Comment:

3. The model used by DEM didn't account for all sources and sinks of nitrogen to the impacted water bodies nor did it consider the importance of detention time and hydrodynamics of both the river and embayment systems.

   In lieu of the computer model, the physical model developed by MERL (Marine Ecosystem Research Laboratory) of an enrichment gradient experiment was used. However, this is primarily a static laboratory system which tries to replicate in a simple tank, the complexities of a dynamically active area with currents, stratification, atmospheric wind patterns, local nonpoint source impacts, sediments, etc.

   Also, it appears that two other major nutrients were increased during the MERL experiment along with nitrogen so it is unclear which nutrient was actually responsible for algal growth. The additional nutrients added included phosphorus and silica. The MERL tank comparison is a good first step, but needs to be modified and expanded to include the other sources, which may be significant contributors of nitrogen.

   In calculating nitrogen loads from the WWTFs, the average daily flows were used with the maximum concentrations. Use of the maximum concentrations severely overestimates the contribution of sources as outlier values are used in place of average values. This will provide a much closer picture of actual loads.

   Some sources not only closest to the Bay, but with potentially the highest non-treated loads, (i.e. the wet weather sources and effects) are not included. The DEM report includes the time frame of May through October, during which there will be numerous and periodic inputs from wet weather point sources, as well as local nonpoint sources both overland and through septic systems from this highly urbanized area. A full evaluation and ranking of these sources is needed. Even while the point sources are undergoing upgrades, these upgrades could be offset by wet weather effects of local sources directly to the impacted waterways.

Response:

There are many sources of nitrogen to the Upper Bay, including WWTFs, storm water (particularly with respect to agricultural and residential fertilizers), ISDS systems, and atmospheric deposition. Since the late 80s it has been recognized that WWTFs are a significant source of nutrients to the Seekonk River, Providence River and Upper Bay (including the Palmer River and Greenwich Bay). As noted in the Initial Report by the Nutrient and Bacteria Panel of the Governor's Narragansett Bay and Watersheds Planning Commission, all analyses of the Bay conditions indicate that WWTFs are the largest source of nitrogen to the Bay. These analyses considered atmospheric deposition, rivers/streams, urban runoff and WWTFs In addition, many WWTFs discharge to shallow poorly flushed areas such as the head of the Upper Bay, either directly to the Providence or Seekonk River or to freshwaters rivers that flow into these waters (e.g. Blackstone, Ten Mile and Pawtuxet Rivers), which exacerbates the impact of nutrients.

For these reasons, past and present efforts to reduce nitrogen discharges to the Bay have been principally focused on WWTFs. As noted in the approved CSO facilities planning documents, CSO discharges are responsible for a very small percentage of the annual loading of ammonia (1%) and nitrate (0.2%) discharged to the, Seekonk River, Providence River/ Upper Bay. WWTFs that discharge directly account for 69% of the ammonia and 27 % of the Nitrate. Tributary rivers and WWTFs that discharge to the rivers account for 30% of the ammonia and 73% of the Nitrate.

The approved CSO plan for the Fields and Bucklin Point WWTFs will be constructed in three phases and consists of deep rock tunnel storage and pump back for full treatment and enhanced wet weather treatment at the Bucklin Point WWTF. The approved phase I operations plan requires that NBC maximize secondary treatment during the storm and maximize tunnel storage and pumpback to secondary treatment after the storm. Primary treatment will only be implemented to avoid exceedance of the tunnel capacity either during a storm or when another storm is approaching (to avoid untreated CSO discharges). It is DEM's position that the Narragansett Bay Commission's approved CSO plan adequately addresses MA DEP's concern that CSOs may dwarf effects from the WWTFs plan on a daily basis, however, analysis of the need for further CSO controls at the ~~UBWPAD is~~ warranted.

Daily maximum WWTF data were used since only 3 facilities collected data more than once a month. When facilities collect data once a month the value is reported as a daily maximum. As such, use of this daily maximum data is more representative of average conditions and is not expected to severely overestimate the contribution of sources.

Commenter:

Narragansett Bay Commission
Mr. Paul Pinault, P.E.
Executive Director
One Service Road
Providence, RI 02905

Comment:

The Narragansett Bay Commission (NBC) indicated that they do not consider the results of the MERL tank studies to be an acceptable substitute for a TMDL to establish nitrogen effluent limits. Therefore, the NBC requests that DEM complete the federally required TMDL and that, until a TMDL is complete, they are opposed to the proposed nitrogen permit modifications for the following reasons:

- Without a TMDL, the current phased approach lacks (a) clear, scientific justification, (b) a definite schedule or endpoint, and (c) a clear assessment plan to determine the need for future tighter restrictions.
- Nitrogen loading to Narragansett Bay is a regional inter-state issue that needs a comprehensive plan, as was implemented in Long Island Sound. Such a plan cannot be developed without a working TMDL.
- Researchers at URI/GSO, including the late Dr. Dana Kester, were able to predict the hypoxic events that lead to the August 2003 fish-kill, based on a water column stratification from warm temperatures and periods of minimal tidal amplitude, among other factors. New research is currently underway to investigate the role of nitrogen in these hypoxic events more fully. A joint project between the Narragansett Bay Estuary Program and GSO, sponsored by Sea Grant, is investigating the physical, biological, and chemical processes that lead to seasonal hypoxia in the upper Narragansett Bay. The results of this research effort are needed to clarify the role of nutrients in these events along with a TMDL that can replicate the physical and chemical conditions observed in the Bay.
- Dr. Scott Nixon of URI/GSO has analyzed historical data and made recent measurements in 2003-04 (Nixon et. al. 2005), determining that total nitrogen loading to the Bay has been essentially level in the past three decades. These findings emphasize the need for a TMDL to determine the appropriate relationship and

- As was mentioned by a number of presenters at the Sea Grant sponsored Nutrient Symposium in November 2004, NBC is concerned about the unanticipated effects of a dramatic nitrogen reduction on the Upper Bay. It will certainly reduce and change primary production, yet it may also have a detrimental effect on fisheries and shell fishing. Decreased primary productivity as a result of nutrient loading reductions has been linked to decreased secondary productivity in Tampa Bay, despite increases in water clarity, eelgrass coverage, and overall habitat quality (Workshop Proceedings, Galveston, TX).
- With multiple plant upgrades under construction, the total nitrogen loading to the Upper Bay will decrease by 20 – 35%, depending on the use of Dr. Nixon's or DEM's figures. This reduction is significant and should be monitored and assessed as part of completing a TMDL.
- Any attempt to nitrify and denitrify wastewater will result in extremely high operating costs to acquire additional, non-renewable resources such as chemicals (for alkalinity and carbon sources) and electricity. For the new Bucklin Point Facility upgrades, the additional electrical use alone is expected to cost our ratepayers $1,000,000/year more. Passing the higher operating and capital costs off to our ratepayers without the benefit of a scientific basis would be irresponsible.

Response:

Beginning in the 1980s various researchers have developed water quality models for the Providence and Seekonk Rivers; the Narragansett Bay Project funded many of these. Several meetings of academic, private consulting and government officials were held to discuss monitoring data and technical approaches most likely to result in a successful circulation and water quality model. In addition, two national modeling experts reviewed the status of modeling efforts and met with the committee to discuss recommendations for future monitoring and modeling techniques. In 1992, it was concluded that over a 50% reduction was needed to produce observable response (higher levels for significant response and that reliability in the screening level model was substantial and provides a good indication of the impact of reduced nitrogen loads on phytoplankton levels (Limno-Tech 1992).

Since the early to mid 1990s, DEM hired a consultant and has been working with a technical advisory committee (TAC), consisting primarily of scientists and engineers representing, academic, municipal, state and federal organizations, to calibrate a model and develop a water quality restoration plan, or TMDL. Based on previous recommendations, a data collection and modeling approach was developed. Meetings were held throughout the model development process and suggested modifications to the approach were implemented in the hopes of producing the best scientific tool for predicting the impact of various nitrogen reduction alternatives. Despite these efforts, it was concluded that the hydrodynamic model formulation could not adequately simulate conditions due to the relatively severe changes in the bathymetry in the Providence River. Although a computer-based numerical model is typically used, the DEM evaluation documents the basis for using a physical model (the MERL tank experiments) as the analog for the Providence and Seekonk rivers.

The modeling scope of work that NBC is pursuing has not been subjected to the intense peer review process that DEM utilized. At this point, there is no reason to believe the NBC funded modeling effort will be successful or that it is of sufficient spatial detail to support a TMDL or provide any better understanding of the response to nutrient reduction strategies.

It is important to note that even though a successful model was developed to support the Long Island Sound TMDL, it was not used to establish WWTF permit limits. The model suggested that limit-of-technology treatment was required to meet water quality standards. Given the high cost of LOT treatment and the uncertainty associated with model predictions, a phased implementation plan was developed. This is the same approach being used by DEM.

DEM agrees that an assessment plan is needed to determine the need for future tighter restrictions. As noted in the DEM evaluation, an integral component of this phased implementation approach is adequate monitoring and assessment of water quality changes to determine if additional reductions are necessary to meet water quality standards. DEM, in partnership with Narragansett Bay National Estuarine Research Reserve, the Narragansett Bay Commission, University of Rhode Island, and Roger Williams University, will be increasing the number of continuous water quality monitoring stations to at least 13 by the summer of 2005. EPA is currently seeking a contractor to assist DEM with the development of methods to review continuous time series measurements of dissolved oxygen for compliance with EPA's October 2000 recommended ambient water quality criteria.

Although not specifically documented in the permit modifications or the DEM report cited above, DEM agrees that a validated water quality model or other predictive tool would be useful to evaluate the need for additional nitrogen reductions. However, it is DEM's position that additional resources should not be devoted to development of such tools until input regarding the most promising approaches, based on consideration of past experience, has been received by a technical advisory committee. It would not be appropriate to delay implementation of the proposed permit modifications since it is not reasonable to expect that higher limits are appropriate or that the improvement in predictive capabilities will be sufficient to determine whether LOT treatment is necessary.

The federal Clean Water Act and implementing regulations do not require development of a TMDL prior to imposition of pollution controls. The preamble to EPA's regulation at 40 CFR 122.44(d)(1)(vii) explain, "Although subparagraph (viii) requires the permitting authority to use a wasteload allocation [note: at TMDL consists of a load allocation and a wasteload allocation] if one has been approved by EPA under Part 130, today's regulations do not allow the permitting authority to delay developing and issuing a permit if a wasteload allocation has not already been developed and approved. " 54 Fed Reg. 23868, 13879 (June 2, 1989). In accordance with 40 CFR 130.7(b)(1), a TMDL is not required if effluent limitations or other pollution controls required by local, State, or Federal authority are stringent enough to implement applicable water quality standards. Furthermore, EPA's guidance on TMDLs states: "... if there are not adequate data and predictive tools to characterize and analyze the pollution problem with a known level of uncertainty, a phased approach may be necessary. The phased approach provides for further pollution reduction without waiting for new data collection and analysis." USEPA NPDES Permit writers manual December 1996 EPA-883-B-96-003 "For other waterbody segments, a TMDL may not be available at the time the permit must be issued, or a TMDL may not be required at all. In such cases, permitting authorities have historically developed a single WLA for a point source discharging to the waterbody segment". USEPA Office of Water, EPA/505/2-90-001 March 1991 TECHNICAL SUPPORT DOCUMENT FOR WATER QUALITY-BASED TOXICS CONTROL "Permits should be issued based on TMDLs where available."

NBC has indicated that some have expressed concern that a dramatic nutrient reduction may have unanticipated effects on secondary productivity. Given the highly degraded condition of the Providence and Seekonk River and the reductions proposed, the ecosystem benefits of the nutrient reductions are expected to far exceed potential negative impacts to secondary productivity. Oxygen levels in the Seekonk and Providence Rivers routinely drop to levels that are lethal to aquatic organisms. As noted above, the "DEM evaluation" suggests that limit-of-technology treatment is required to meet water quality standards. Several scientists supported the proposed permit modifications commenting that the proposed reductions would have positive impacts on the Bay by making it more resilient and increasing DO levels and that further reductions may be required. The Nutrient and Bacteria Panel of the Governor's Narragansett Bay and Watershed planning commission recommended a 40-50% reduction in nitrogen from WWTFs that discharge to the Upper Bay and its tributaries.

The draft report by Dr. Scott Nixon (Nixon et al 2005) that NBC submitted with their comments, notes that there is limited data available to analyze changes in nutrient inputs to the Bay over the past three decades and concludes that the evidence available does not indicate that nitrogen inputs to Narragansett Bay from the sewage treatment plants or the rivers examined have increased in recent decades. While we question whether loadings to the Bay have increased, sampling data has documented that the dissolved oxygen and algae conditions resulting from nitrogen inputs to the Providence and Seekonk Rivers have been unacceptable since at least the mid 1980's. In addition, DEM has never maintained that water quality conditions in the Providence and Seekonk Rivers or nitrogen loadings from WWTFs have changed dramatically in recent years. Below are the findings from historic studies:

- "Available data show a marked lowering of dissolved oxygen levels in surface and bottom waters in the Providence River at least during the warmer months Reduced oxygen levels at times extend down Bay. (Olsen and Lee 1979)
- "The lowest oxygen values throughout the channel bottom were recorded on the August 8, 1980 sampling, those values were 0 to 3 mg/l all the way to Conimicut Pt." (Oviatt 1979-1980)
- SPRAY& SQUIRT Cruises – 7 surveys (high and low tide samples), 3 summer surveys of DO, June and August 1987, September 1989 Ave bottom oxygen concentration using data from all Providence and Seekonk River Stations: 3 mg/l –4 mg/l.

Specific concerns with the data available for the Nixon analysis include: tributary river loadings were primarily based on limited sampling programs in 1975-1976, 1983, 1991, 1992 and in 2003-2004. The WWTF data used was collected 1976-1977, 1983, 2002 and 2003. A better source of information to evaluate WWTF trends would be DMR data which has been collected since the late 1980s (this data is also limited since certain facilities data may only be collected once per month).

Nixon et al 2005, also conclude that between the mid 1970s and early 1980s, improvement of secondary treatment at the WWTFs discharging to the Providence and Seekonk Rivers has resulted in a shift from organic to the more biologically accessible inorganic forms and any ecological impact has been manifested for the last twenty years. This is consistent with the research cited above which documents that the Providence and Seekonk Rivers have exhibited impacts from excessive nitrogen for over twenty years.

DEM has developed a plan to achieve the 50% reduction goal when current loads (95-96) are compared to proposed treatment requirements at approved WWTF design flows.

Although the nearly complete Bucklin Point WWTF modifications will initially achieve a nitrogen reduction of approximately 58%, it will drop to 38% at design flow. DEM has developed a plan that achieves an overall reduction of 50% from the WWTFs impacting the Providence and Seekonk Rivers and the Upper Bay. The treatment necessary varies with the relative environmental impact of each discharge.

Comment:

In addition to challenging the MERL tank studies, the NBC also commented on the basis for the permit limits. Specifically, the NBC requested that the proposed limit for both the Field's Point and Bucklin Point WWTFs be changed to either a TN monthly load limit only or, if a concentration limit is also to be included, that it be 5 mg/l Total Biodegradable Nitrogen (i.e. TN minus refractory N).

In establishing the 5 mg/l TN permit limit, RIDEM has assumed that 1.95 mg/l is refractory N. RIDEM also claimed in its 12/23/2004 letter that the average value for effluent organic nitrogen is 1.4 mg/l, while the data for 1995 and 1996 are 2.3 ± 3.8 ppm organic nitrogen for Bucklin Point and 2.1 ± 1.8 ppm for Field's Point (calculated as TKN minus ammonia). Due to improvements in the analytical methods used as well as operational improvements, both Field's Point and Bucklin Point effluent organic nitrogen data for 2004, which are thought to be more reliable, show an organic nitrogen component of 3.6 and 3.2 ppm for Field's Point and Bucklin Point respectively, with significant variability. DEM's loading estimations assume a 1.95 mg/l organic nitrogen component for WWTFs where data was not available to make this calculation. This value does not accurately represent WWTF effluent for a facility with secondary treatment, and does not support the calculations that DEM has made. DEM's DIN loading calculations are perhaps 20% greater than what is actually observed, and the literature value used is inappropriate to secondary treatment WWTFs. Also, this generalization may not apply to NBC's effluent and/or may vary significantly at various times. We reiterate our request for a TN monthly load limit only or, if a concentration limit is also to be included that it be 5 mg/l Total Biodegradable Nitrogen.

Response:

As noted earlier, MERL tank experiments LOT treatment is required to meet water quality standards. However, based on a comparison of technology, costs and reductions in the nutrient loading factors for the Providence and Seekonk River Systems DEM has established a phased reduction strategy. The Report acknowledges that loadings will increase as WWTF flows increase to their design flows, but follow-up monitoring and possibly water quality modeling will be needed to determine whether additional reductions are required. Because LOT is presently indicated, it is DEM's position that it is appropriate to express WWTF permit requirements as a concentration limit, which will enhance the near-term environmental improvement, rather than a monthly load limit that would allow higher concentrations to be discharged during periods of lower WWTF flows.

The analysis of WWTF load reductions versus resulting Providence/Seekonk River loading factors was based on DIN, consistent with the MERL tank experiments. As noted in the Report, the technology-based WWTF technology limits, expressed as Total Nitrogen, were reduced by 2 mg/l when evaluating DIN levels. Therefore, the loading condition that will result from a TN discharge of 5 mg/l is in fact based on a DIN discharge of 3 mg/l. The refractory nitrogen value of 2 mg/l is consistent with the upper range of the values reported in the literature (see the WEF and ASCE. 1992 reference cited in the Report). The average value for refractory nitrogen (TN-DIN) based upon

Bucklin Point 1.5 mg/l, Fields Point 1.4 mg/l and East Providence 1.5 mg/l. (see worksheet "Mean C Summary" of the excel file "19951996 loadings from WWTF and Tribs" which was provided to the WWTFs during the public comment period). In response to NBC's comment that data collected in 2004 demonstrates that the organic nitrogen component is approximately twice the value used by DEM (2.0 mg/l), DEM has reviewed the 2004 Discharge Monitoring report data. Based upon May through October organic nitrogen component (TKN – ammonia) are 2.8 mg/l for Bucklin Point, and 2.1 mg/l for Field's Point (when the highly suspect June value of 7.0 mg/l is removed).

It should be noted that true refractory nitrogen is the component of total nitrogen that can't be broken down by biological nitrogen removal and is expected to be lower than that estimated from available secondary effluent data. A review of six municipal BNR treatment facilities (where the final step is secondary clarification) presented in (Randall 1992) offers the following conclusions.

There has been considerable confusion regarding the lower limit of nitrogen concentrations possible with BNR, which provides an abundance of substrate as compared to available nitrogen.

Effluent from BNR plants typically contains soluble organic (i.e. refractory) nitrogen concentrations of 1.0 to 1.5 mg/l. However, effluent TKN concentrations of less than 1.5 are possible.

The levels of refractory nitrogen levels should be considered in the planning and design of BNR to achieve compliance with permit limitations but is not anticipated to substantially change the treatment necessary to achieve a the Total Nitrogen summer season permit limit of 5 mg/l. This is supported by other literature, which indicates that organic nitrogen (i.e. refractory) must be taken account particularly when total effluent nitrogen limits are less than 3 mg/l (WEF and ASCE 1992).

For these reasons, DEM has not modified the permit limitations.

Comment:

The NBC also commented on the total nitrogen limits as they apply to wet weather events. Specifically, the NBC requested that consideration be given to providing a higher concentration limit during wet weather events.

Maximizing wet weather flow treatment and simultaneously minimizing effluent nitrogen loads can be competing goals and provisions should be made in the permit to acknowledge different limits during wet weather events. US EPA Region I (New England) has acknowledged this issue and issued "two tiered" permit limits to account for wet weather events in many locations including, New Haven, Ct., Bangor, ME, and Boston, MA. New York City, in Region II, has similar accommodations for wet weather in their permits, as does Ohio, in Region V.

Response:

DEM has reviewed permits issued to these facilities and while they include monitoring of flows that bypass secondary treatment in wet weather, limits on the secondary treatment discharge are not tiered.

Comment:

The NBC commented on the application of MERL data to the nitrogen loading of the receiving water. Specifically, the NBC indicated that DEM's evaluation should clearly state that the appropriate comparison to the MERL experiments is the concentration of nitrogen and not the loading rate per surface area. Thus the target for establishing effluent limits should be on the nitrogen concentration and not loading rate. The conclusion that loading rates based on surface area are appropriate is challenged by NBC. Nutrient concentrations can be met in a phased approach, but surface area loading rates can never be met and should be significantly qualified in the final version of the Nitrogen Evaluation.

Response:

As noted in the Report, when evaluating comparable surface area loading rates the behavior of dissolved oxygen and algae (chlorophyll a) observed in the Providence and Seekonk Rivers is very similar to that observed in the MERL experiments. However, this cannot be said for comparisons based on water column DIN concentrations. Low dissolved oxygen and excessive chlorophyll levels are observed in the Providence and Seekonk Rivers at much lower DIN levels than those measured in the MERL tanks. It is DEM's position that variations in flushing time, uptake by macro algae, and denitrification in the bottom waters are reasons why the MERL surface area loading factors are a better predictor of conditions in the Providence and Seekonk River system than water column DIN levels.

Comment:

The NBC also commented on the estimated costs associated with nitrogen removal at the treatment facilities. Specifically, NBC indicated that the cost table accompanying DEM's communication indicates a capital cost of $13.9 M to reach a seasonal limit of 5 mg/l nitrogen. However, the cost of meeting a seasonal 5 mg/l total nitrogen effluent limit from the Fields Point WWTF is estimated to be $20 M capital cost. This capitol cost estimate includes a necessary methanol building within the concept plan. Operating costs must be considered as well.

Response:

The DEM recognizes that there will be significant capital and increased operational costs associated with upgrading WWTFs to comply with the proposed limits. Capital costs were used to compare the cost of WWTF nitrogen controls to the reduction in nitrogen loads. Unless facility specific information was available, capital costs were estimated using the cost versus nitrogen discharge concentration relationships developed for WWTFs in the Chesapeake Bay watershed were used in the DEM evaluation. As noted, the $13.9 M cost to achieve 5 mg/l total nitrogen at the Fields Point WWTF was based on the planning level Technical Memorandum that was prepared by NBC's consultant. NBC most recent estimate of $20 M would not alter the cost versus nitrogen reduction analysis such that a different effluent limit would be appropriate for the Fields Point WWTF.

State bond funds are expected to provide sufficient loan capacity to support the treatment facility modifications necessary to achieve the 50 percent nutrient reduction goal. Through the State Revolving Fund (SRF), administered by the RI Clean Water Finance Agency, low-interest loans are made available to eligible communities and sewer commissions for facility upgrades. In November 2004, Rhode Island voters approved a bond measure, proposed by Governor Carcieri and approved by the General Assembly that included $10.5 million to further capitalize the SRF Program. The

Governor has also offered his commitment to propose an additional $20.2 million in funding for facility upgrades as part of a follow-up bond referendum on the 2006 ballot. In combination, the two State bonds will equip the SRF Program with the amount necessary to provide full support, via low-interest loans, for all of the remaining work.

Comment:

The NBC also commented on that the Phased Implementation approach should include provisions for technically justified modification during the Facilities Planning process as long as the overall objectives are maintained. With so much uncertainty associated with establishing limits and the variables of winter limits, wet weather conditions, and combined effects of Bucklin and Fields Points plants there should be opportunities to achieve maximum water quality value for every dollar spent. This could be achieved during the facilities planning process.

Response:

Upon consideration of previous efforts noted above, it is not anticipated that capability to predict water quality changes can be significantly improved during the Facilities Planning process. Given the highly nitrogen enriched and impaired status of the Providence and Seekonk Rivers, it is not reasonable to expect that higher limits will result in appropriate progress toward achievement of water quality standards.

Commenter:

University of Rhode Island
Graduate School of Oceanography
Candace Oviatt
Professor of Oceanography
Narragansett Bay Campus
Narragansett, RI 02882-1197

Comments:

The University of Rhode Island (URI) commented that better scientific information could be obtained to justify the proposed permit levels of an effluent nitrogen limit of 5 mg/l at the Fields Point and the Bucklin Point WWTFs. URI indicated that they would be pleased to work with DEM and NBC to design experiments, which would evaluate the impact on receiving waters of effluent nitrogen levels of 5 mg/l, 8 mg/l and other levels in systems designed to mimic the condition of those receiving waters.

The results of such experiments could also be used to verify the mathematical simulation models for Bay hydrodynamics and ecology. These powerful tools could provide a sound scientific basis for effluent nitrogen levels in the Seekonk and Providence Rivers and Narragansett Bay.

Response:

It is not anticipated that additional MERL tank experiments would provide data that result in a significant modification to the proposed phased approach. It would not be appropriate to delay implementation of the proposed permit modifications since it is not reasonable to expect that higher limits are appropriate or that the improvement in predictive capabilities will be sufficient to support a decision to proceed directly to LOT treatment.

DEM agrees that a validated water quality model or other predictive tool would be useful to evaluate the need for additional nitrogen reductions after implementation of the first phase. However, it is DEM's position that additional resources should not be devoted to development of such tools until input regarding the most promising approaches, based on consideration of past experience, has been received by a technical advisory committee. An integral component of this phased implementation approach is adequate monitoring and assessment of water quality changes to determine if additional reductions are necessary to meet water quality standards.

Of particular concern are the establishment, maintenance and data processing for a system of continuous dissolved oxygen, chlorophyll, temperature and salinity monitors strategically located throughout the Bay. DEM, in partnership with NERRS, the Narragansett Bay Commission, University of Rhode Island and Roger Williams University increased the Narragansett Bay continuous water quality monitoring system from 7 to 9 stations during the summer of 2004. DEM has also obtained funding from the federal Bay Window grant to increase the number of stations to at least 13 by the summer of 2005. This monitoring network will provide the data necessary to evaluate compliance with water quality standards, particularly temporal detail needed to evaluate compliance with EPA's dissolved oxygen guidelines. The United States Environmental Protection Agency (EPA), Office of Water's, Office of Science and Technology EPA is currently seeking a contractor to assist DEM with the development of methods to review continuous time series DO measurements for compliance with EPA's October 2000 recommended ambient water quality criteria. The contractor will also assess monthly transect surveys of the bay to determine whether modifications are needed to the existing and planned monitoring network based and provide technical support to establish guidelines for evaluating the response to changes in nitrogen loads.

Commenter:

City of Woonsocket
Michael A. Annarummo
Director of Administration/Public Works
Woonsocket City Hall
169 Main Street
Woonsocket, RI 02895

Comment:

The City of Woonsocket commented that DEM's evaluation fails to present a cohesive analysis of dissolved oxygen dynamics of the Providence and Seekonk Rivers, is in consistent with prior studies, and ignores the significant differences in conditions between the River system and the Bay. In addition, the strategy implicit in the proposed limits ignores the significant nitrogen reduction programs in many Rhode Island communities and the substantial reductions achieved by the City.

The City indicated that the draft permit modification, if put into effect, would require that the City invest well in excess of another $20 million in plant improvements in DEM's phased approach to reduce nutrients in Narragansett Bay. This investment would be required despite the small reduction in nitrogen discharge and despite a lack of evidence, and even consensus within the scientific community, about the impact of nitrogen reduction on the Providence/Seekonk River System.

The City also indicated that, while the literature is quite clear that the nutrient over-enrichment can lead to low dissolved oxygen, it is imperative that one fully understands the reasons for low dissolved oxygen before one launches a nitrogen reduction program based on the DO in the Providence River. Careful attention must be given to these other DO sinks that may be as important or more important than the nitrogen flux in order to avoid the inappropriate expenditure of limited public funds.

Given the controversy surrounding the proposed nitrogen limits, the City intends to request that the General Assembly pass legislation to establish a state construction grants program funded by a state bond issue to pay for improvements to wastewater treatment plants to enhance nitrogen removal necessitated by the proposed permit modifications.

Response:

Beginning in the 1980s various researchers have developed water quality models for the Providence and Seekonk Rivers; the Narragansett Bay Project funded many of these. Several meetings of academic, private consulting and government officials were held to discuss monitoring data and technical approaches most likely to result in a successful circulation and water quality model. In addition, two national modeling experts reviewed the status of modeling efforts and met with the committee to discuss recommendations for future monitoring and modeling techniques. In 1992, it was concluded that over a 50% reduction was needed to produce observable response (higher levels for significant response and that reliability in the screening level model was substantial and provides a good indication of the impact of reduced nitrogen loads on phytoplankton levels (Limno-Tech 1992).

Since the early to mid 1990s, DEM hired a consultant and has been working with a technical advisory committee (TAC), consisting primarily of scientists and engineers representing, academic, municipal, state and federal organizations, to calibrate a model and develop a water quality restoration plan, or TMDL. Based on previous recommendations, a data collection and modeling approach was developed. Meetings were held throughout the model development process and suggested modifications to the approach were implemented in the hopes of producing the best scientific tool for predicting the impact of various nitrogen reduction alternatives. Despite these efforts, it was concluded that the hydrodynamic model formulation could not adequately simulate conditions due to the relatively severe changes in the bathymetry in the Providence River.

It is important to note that even though a successful model was developed to support the Long Island Sound TMDL, it was not used to establish WWTF permit limits. The model suggested that limit-of-technology treatment was required to meet water quality standards. Given the high cost of LOT treatment and the uncertainty associated with model predictions, a phased implementation plan was developed. This is the same approach being used by DEM.

The consensus of participants at the Sea Grant Nutrient Symposium was that the nutrient reductions being proposed for the upper Bay would have positive impacts on fisheries and shell fishing. As noted in the Initial Report From the Nutrient and Bacteria Pollution Panel of the Governor's Bay and Watershed Planning Commission, several analyses have been conducted which agree that wastewater treatment plants are the major source of nitrogen to Narragansett Bay (Nutrient and Bacteria Pollution Panel, 2004). This panel, comprised of many university, state and federal agency scientists

recommended implementation best practical treatment from RI WWTFs to achieve a 40-50% reduction in nitrogen.

State bond funds are expected to provide sufficient loan capacity to support the treatment facility modifications necessary to achieve the 50 percent nutrient reduction goal. Through the State Revolving Fund (SRF), administered by the RI Clean Water Finance Agency, low-interest loans are made available to eligible communities and sewer commissions for facility upgrades. In November 2004, Rhode Island voters approved a bond measure, proposed by Governor Carcieri and approved by the General Assembly that included $10.5 million to further capitalize the SRF Program. The Governor has also offered his commitment to propose an additional $20.2 million in funding for facility upgrades as part of a follow-up bond referendum on the 2006 ballot. In combination, the two State bonds will equip the SRF Program with the amount necessary to provide full support, via low-interest loans, for all of the remaining work.

Comment:

DEM's analysis incorrectly assigns all the nitrogen discharged from the Blackstone River to two wastewater treatment plants (WWTP) and makes conceptual and computational errors in estimating the delivery of these loads to the Seekonk River. These errors and inaccuracies magnify the potential impacts of the City's discharge on the Seekonk and Providence River system.

RIDEM attributes essentially all the N discharged at the mouth of the Blackstone River to the UBWPAD and Woonsocket WWTPs. Virtually all studies in which RIDEM participated indicated that in dry weather, these large plants represent between 40 and 60% of the N load. The Governor's Panel on Nutrient and Bacteria Pollution recognized the importance of other sources when it says..."Other analyses show general agreement regarding total loading but decompose the "river/stream" component to provide more insight into sources by recognizing that it is, in large part, due to wastewater treatment facilities (WWTFs) and atmospheric deposition. Alexander et al. (2001) estimated that 62% of the total came from point sources.

DEM makes reference to studies conducted on Long Island Sound to support its analysis of River Delivery Factors. RIDEM cites studies conducted on the Long Island Sound system, and suggests that river delivery factors in that study ranged from 52 to 90%. This is apparently intended to justify DEM's use of an 87% river delivery factors.

A more complete discussion of the Long Island Sound Studies, would however, show that the report actually says that "...losses during river transport are generally modest except for the highly impounded Housatonic River where long travel times allow for almost a 50% loss from the upper reaches to Long Island Sound". Since the Blackstone is a highly impounded river system, it is logical to expect that some greater attenuation of discharging into the Seekonk and Providence rivers.

Finally, studies conducted by the USGS indicate that the Providence River system, approximately 68% of the total nitrogen load is from municipal wastewater treatment plants, with the remainder attributed to nonpoint sources.

Response:

As noted in the response to comments submitted by MADEP, Blackstone River nitrogen delivery factors have been refined based upon more detailed data collected in the MA

portion of the River and validated water quality models. Use of the models enables one to evaluate the fate and transport of all sources to the river.

The primary mechanism for nitrogen attenuation in the Blackstone River is alga uptake and retention of the algae in the water column or sediment. In 1997 MA, USEPA and DEM completed a WLA for ammonia and phosphorus to address excessive algae growth and dissolved oxygen conditions in the Blackstone River (USEPA et. al 1997). The response to comments submitted by MADEP also, explains how the water quality models were used to evaluate the reduction in attenuation associated with the control of algae levels. It was determined that between 71 and 77 % of the individual MA WWTFs nitrogen loading is delivered to the mouth of the River (72% for UBWPAD) and 86% of the Woonsocket WWTF when the required WLA is met. Of the load predicted at the mouth of the River, WWTFs represent 98%: UBWPAD and Woonsocket represent 83 % of the load delivered (64 % and 19 %, respectively). This confirms the expectation that attenuation will be reduced as WWTFs meet current permit requirements, demonstrates that attenuation will be minimal and underscores the point that further study of attenuation factors prior to implementation of nitrogen controls is not appropriate.

DEM has also acknowledged that researchers agree that WWTFs represent the majority of the annual nitrogen loading to Narragansett Bay. The impact of WWTF is especially pronounced during critical dry weather periods. Also, non point source inputs are typically highest during high flow periods. While nitrogen loading throughout the year has the potential to contribute to the pool of nitrogen available during critical periods, the general consensus of participants in the technical advisory committee that DEM established to assist with efforts to develop a water quality model and TMDL for the Providence and Seekonk Rivers was that the winter contribution is not significant. This is also supported by work completed by Doering et. al. (1990) which concluded that their analysis and previous mesocosm experiment data showed that dissolved nitrogen concentrations in the Providence and Seekonk Rivers result form external sources, while lower portions of the bay are largely driven by internal recycling.

Besides wastewater treatment facilities, there are many other sources of nitrogen to the Upper Bay, including storm water, ISDS systems, and atmospheric deposition. The Plan underscores the importance of the several other pollution prevention and treatment measures that are being implemented by DEM, CRMC, and other agencies to reduce nutrients from these other sources.

Water quality restoration plans addressing nutrient impairments are underway for a number of coastal embayments and rivers discharging to the Bay, including Greenwich Bay, Kickemuit River and Reservoir, and Palmer River. These plans identify sources of nutrients and necessary actions to restore water quality, including both point source and non-point sources of pollution.

Also, many efforts are underway to prevent water quality impacts associated with storm water runoff in undeveloped areas, and to enhance the treatment and management of storm water from urban and agricultural areas. These include initiatives such as Grow Smart RI and the Governor's Growth Planning Council; watershed-based project to identify, protect and restore riparian buffers; and public education and municipal assistance efforts to encourage low impact development. The state Department of Transportation and 36 municipalities are working on a major effort to better manage urban storm water through the development and implementation of storm water management plans.

Comment:

DEM's analysis of the conditions of the Providence and Seekonk Rivers is based on data from May 31, 1995 through September 21 of 1995 and from May 2, 1996 through November 14, 1996. Although the period of DO problems is typically the summer, DEM has established total nitrogen limitations for the period of April 1 through October 31, without any specific justification as to these specific dates. This is an issue for wastewater treatment facilities (especially the early April time frame) because this is often a period of high flow and temperatures, which requires facilities to be constructed larger than otherwise needed to accommodate the biological kinetics of nitrification and de-nitrification processes.

Response:

While nitrogen loading throughout the year has the potential to contribute to the pool of nitrogen available during critical periods, the general consensus of participants in the technical advisory committee that DEM established to assist with efforts to develop a water quality model and TMDL for the Providence and Seekonk Rivers was that the winter contribution is not significant. This is also supported by work completed by Doering et. al. (1990) which stated that their analysis and previous mesocosm experiment data showed that dissolved nitrogen concentrations in the Providence and Seekonk Rivers result form external sources, while lower portions of the bay are largely driven by internal recycling.

Nevertheless, the DEM included a permit conditions, which requires that the facility continue to operate all available treatment equipment throughout the rest of the year in order to maximize the nitrogen removal benefits. Due to the heavy dependence of biological nutrient removal on temperature, the costs associated with year-round limits would significantly greater than the cost to achieve the seasonal limits and are not being imposed until information is available to indicate they are necessary. With the exception of the Woonsocket WWTF, the proposed permit modifications require that seasonal limits commence May 1st to mitigate water quality impacts associated with excessive algae growth. The draft modification for the Woonsocket WWTF required compliance with the nitrogen limits on April 1st, consistent with the ammonia and nitrogen limits in the existing permit. During the development of the current permit, it was determined that ammonia limits were necessary to ensure compliance with water quality impacts of ammonia (dissolved oxygen and ammonia toxicity) on the Blackstone River, and nitrogen limits were required at that time. The final permit modification has been changed to commence the modified nitrogen limit on May 1st consistent with the other WWTFs. The seasonal nitrogen limits proposed were established and the seasonal nutrient removal limits that are typically assigned in RIPDES permits.

Comment:

The proposed permit modification imposes limits of 667 pounds per day of total nitrogen, and a concentration limit of 5 mg/l. For the period from April through October of 2004, monthly data submitted to DEM by the City shows that the City discharged an average of only 364 pounds per day of Nitrogen, which is 55% of the mass allowed by the proposed modification. The average concentration was approximately 6.5 mg/l. Although slightly above the 5.0 mg/l limit of the permit, the City is well within the far more important mass emission rates. DEM appears not to have considered these facts at all in developing its approach for nitrogen control.

As noted earlier, MERL tank experiments suggest LOT treatment is required to meet water quality standards. However, based on a comparison of technology, costs and reductions in the nutrient loading factors for the Providence and Seekonk River Systems DEM has established a phased reduction strategy. The Report acknowledges that loadings will increase as WWTF flows increase to their design flows, but follow-up monitoring and possibly water quality modeling will be needed to determine whether additional reductions are required. Because LOT is presently indicated, it is DEM's position that it is appropriate to express WWTF permit requirements as a concentration limit, which will enhance the near-term environmental improvement, rather than a monthly load limit that would allow higher concentrations to be discharged during periods of lower WWTF flows. Rule 17.02(a) of the RIPDES Regulations specifies that "In the case of POTWs, permit limitations, standards or prohibitions shall be calculated based on design flow."

Comment:

DEM's permitting strategy establishes permit limits of 5 mg/l for the Woonsocket facility, as well as for those of the Narragansett Bay Commission. For four other plants, East Providence, Cranston, West Warwick and Warwick, the 2004 Evaluation sets limits at 8 mg/l. No rationale is presented for this difference, and none is readily apparent from the technical information presented.

Before DEM proceeds any further with the proposed nitrogen reduction limits and new discharge permit requirements, I would urge you to require the following:

1. First, that DEM should commission a scientific peer review of the studies and conclusions reached by DEM with respect to the appropriateness of the scientific/analytical techniques used by DEM and the appropriateness and necessity of creating new nitrogen discharge standards, as required by the new legislation, based upon the DEM analysis.

2. Second, the costs of achieving the standard at each of the wastewater treatment facilities in Rhode Island where the standard would be applied should be carefully estimated and should include both capital and operating cost impacts for the necessary facilities.

3. Third, completion of a comprehensive, scientific study of the impacts of implementation of the nitrogen standard utilizing currently relevant data of water quality of the Blackstone River, Seekonk River, Providence River and Narragansett Bay should be completed and subjected to the appropriate level of peer review.

4. Fourth, DEM should establish a Technical Advisory Committee ("TAC") with active City participation and should meet jointly with representatives of all the affected communities and authorities that operate wastewater treatment plants to discuss the cost and methods of financing the necessary improvements required to achieve the desired water quality in the Bay for the benefit of the State of Rhode Island.

Response:

DEM has developed a plan to achieve the 50% reduction goal when current loads (95-96) are compared to proposed treatment requirements at approved WWTF design flows. Although the WWTF modifications will initially achieve a greater percent nitrogen

reduction, it will drop to 50% at design flow. DEM has developed a plan that achieves an overall reduction of 50% from the WWTFs impacting the Providence and Seekonk Rivers and the Upper Bay. The treatment necessary varies with the relative environmental impact of each discharge. It is not clear why the City commented that: No rationale is presented for this difference, and none is readily apparent from the technical information presented. The report indicates that greater reductions are appropriate for those facilities located closer to the portion of the receiving water where impacts have been observed. The section "Consideration Regarding WWTF loading reductions" specifically identifies and accounts for attenuation during tributary river transport and from the edge of the Providence and Seekonk Rivers to the to the area of most significant degradation. Specific excerpts are presented in the response to comments received from MADEP.

Beginning in the 1980s various researchers have developed water quality models for the Providence and Seekonk Rivers; the Narragansett Bay Project funded many of these. Several meetings of academic, private consulting and government officials were held to discuss monitoring data and technical approaches most likely to result in a successful circulation and water quality model. In addition, two national modeling experts reviewed the status of modeling efforts and met with the committee to discuss recommendations for future monitoring and modeling techniques. In 1992, it was concluded that over a 50% reduction was needed to produce observable response (higher levels for significant response and that reliability in the screening level model was substantial and provides a good indication of the impact of reduced nitrogen loads on phytoplankton levels (Limno-Tech 1992).

Since the early to mid 1990s, DEM hired a consultant and has been working with a technical advisory committee (TAC), consisting primarily of scientists and engineers representing, academic, municipal, state and federal organizations, to calibrate a model and develop a water quality restoration plan, or TMDL. Based on previous recommendations, a data collection and modeling approach was developed. Meetings were held throughout the model development process and suggested modifications to the approach were implemented in the hopes of producing the best scientific tool for predicting the impact of various nitrogen reduction alternatives. Despite these efforts, it was concluded that the hydrodynamic model formulation could not adequately simulate conditions due to the relatively severe changes in the bathymetry in the Providence River.

The Governor's Narragansett Bay and Watershed Planning Commission included a Nutrient and Bacteria Pollution Panel with representation from private consulting firms, environmental groups, WWTFs and regulatory agencies. The primary recommendation of the Panel was to reduce nitrogen discharges from RI wastewater treatment facilities that discharge in the upper by or its tributaries by 40 to 50%. The full commission also endorsed this recommendation.

DEM agrees that an assessment plan is needed to determine the need for future tighter restrictions. As noted in the DEM evaluation, an integral component of this phased implementation approach is adequate monitoring and assessment of water quality changes to determine if additional reductions are necessary to meet water quality standards. DEM, in partnership with Narragansett Bay National Estuarine Research Reserve, the Narragansett Bay Commission, University of Rhode Island, and Roger Williams University, will be increasing the number of continuous water quality monitoring stations to at least 13 by the summer of 2005. EPA is currently seeking a contractor to assist DEM with the development of methods to review continuous time series

measurements of dissolved oxygen for compliance with EPA's October 2000 recommended ambient water quality criteria.

Although not specifically documented in the permit modifications or the DEM report cited above, DEM agrees that a water quality model or other predictive tool may also be necessary to evaluate the need for additional nitrogen reductions. However, it is DEM's position that additional resources should not be devoted to development of such tools until input regarding the most promising approaches, based on consideration of past experience, has been received by a technical advisory committee.

Comment:

The Superior Court Consent Order entered on May 19, 2000, resolving the Superior Court suit provides within Section 8 that the City and DEM agreed to a permit limit of 10 mg/l of total nitrogen in the 2000 RIPDES permit with the proviso that "both parties understand that RIDEM reserves the right to modify the permit limit of 10 mg/l through RIDEM's administrative rules of practice and procedure". Part G.1 of the existing RIPDES permit also references that the permit may be re-opened or modified in accordance with rule 23 of the RIDEM Regulations for the Rhode Island Pollutant Discharge Elimination System (June 26, 1984, amended February 5, 2003, effective February 25, 2003 (RIPDES Regulations)).

Rule 23 allows the Department to modify a permit in circumstances where the Department has received new information (other than revised regulations, guidance, or test methods) which was not available at the time the permit was issued and would have justified the application of different permit conditions at the time of issuance. (Rule 23(b)(2)). In addition, Rule 23 allows a permit or a permit condition to be modified after promulgation of new or amended water quality standards, effluent limitation guidelines by EPA or judicial decisions where a permit or permit condition was based on a prior water quality standard or effluent limitation guidelines which have been altered or revoked (Rule 23(b)(3)(i)). The RIPDES Regulations also provide for modification of the RIPDES permit under Rule 36 at the initiation of the Department within 90 days of the adoption of new limitation guidelines and authorize the Department to provide a schedule for compliance in accordance with Rule 20 (rule 23(3)).

It is difficult to determine from either DEM's July 2, 2004 letter, or the subsequent December 23, 2004 Public Notice of the proposed permit modification whether the proposed modification is based on a waste load allocation (G.1. (b)) or modification of water quality standards for the receiving waters of the Providence and Seekonk Rivers (G.1(a)). It appears that the Department is not specifically proposing a total maximum daily load (TMDL) for the area, but rather is relying on DEM's extrapolation of experiments conducted at URI on Narragansett Bay to reach a conclusion that the existing water quality standards for the Seekonk and Providence Rivers (minimum 5.0 mg/l "except as naturally occurs") cannot be achieved without significant reductions in total nitrogen discharges from wastewater treatment facilities.

In all respects the proposed limit appears to be a water quality based effluent limit based on the new legislation, rather than based on a TMDL, as required by the 2000 Superior Court Consent Decree and RIPDES permit and the RIPDES Regulations (Rules 3 and 17) and without complying with TMDL regulations and guidance documents or obtaining EPA approval.

In effect, DEM has exceeded its authority under the 2000 Superior Court Consent Decree and RIPDES permit and applicable RIPDES regulations in proposing this permit modification.

For all the foregoing reasons DEM should withdraw the proposed permit modifications.

Response:

As noted by the commenter, the current Woonsocket WWTF RIPDES Permit, and the 2000 Superior Court Consent Decree both recognize the Department's authority under Rule 23 of the RIPDES Regulations to modify the current permit. By entering the Superior Court Consent Decree, the City explicitly stated their understanding that DEM reserved its rights to modify the current permit limit of 10 mg/l through RIDEM's administrative rules of practice and procedure. The current RIPDES permit also states that the permit may be modified in accordance with Rule 23 of the RIPDES regulations for reasons that include but are not limited to those specifically listed in the permit.

As provided in Rule 23(b)(2) of the RIPDES Regulations, the proposed permit modifications are based upon new information: namely the DEM evaluation and the amendments to Chapter 46-12-2-(f) signed into law in 2004. The promulgation of the proposed permit modifications is proceeding in accordance with RIDEM's administrative rules of practice and procedure. Therefore, in proposing this permit modification, DEM has not exceeded its authority under the 2000 Superior Court Consent Decree, RIPDES permit or the applicable RIPDES regulations.

Below is a summary of the more significant specific comments that were submitted in support of the proposed permit modifications.

Commenter:

The Blackstone River Coalition
Donna M. Williams, Conservation Advocacy Coordinator
414 Massasoit Road
Worcester, MA 01604

Comments:

- The Blackstone River Coalition (BRC) commented that they applaud the DEM for its proposed limits for nitrogen on the four wastewater treatment plants under consideration (Bucklin Point, Field's Point, East Providence and Woonsocket), and urged immediate implementation of those limits. They also commented that of particular interest to the BRC is the limit for the Woonsocket wastewater treatment plant, which, based on the Blackstone River Initiative, is one of the overwhelming sources of nutrients to the Blackstone River. Specifically, the Upper Blackstone Water Pollution Abatement District in Millbury, Massachusetts and the Woonsocket plant have been identified as the major sources of nutrients to the Blackstone River. In setting limits for these plants, the BRC indicated that DEM is leading the way for Massachusetts to do the same. The BRC urged DEM to move forward with the proposed limits and stated that appeals and further study only push the goal of a fishable/swimmable Blackstone River by 2015 further from reach.

Commenter:

Blackstone River Watershed Council
Frank Matta, Chairman
P.O. Box 8068
Cumberland, RI 02864

Comment:

The Blackstone River Watershed Council (BRWC) commented that they are collectively convinced that the WWTFs are major contributors to certain water quality impairments that are experienced along the Blackstone River. Specifically, the WWTFs are significant contributors to water quality impairments (such as ammonia, induced predominantly from nutrient (nitrogen) enrichment from these discharge outfalls) and which contribute heavily to water quality violations in the river. The BRWC agreed with the DEM that nutrient (nitrogen) reductions must be established for these WWTFs now and that, by implementing these permit modifications in an expedited fashion, water quality improvements will be measurably observed in the short term. The BRWC also stressed the importance and need for bi-state actions to take place in an expedited fashion.

Commenter:

Jan H. Reitsma
58 Third Street
Barrington, RI 02806

Comment:

Mr. Reitsma commented that by focusing first on discharges from WWTFs to reduce nitrogen loading to the receiving waters, the DEM has set the appropriate priority, and strengthened its ability to require or advocate for nutrient loading reduction in other locations and from other sources. Mr. Reitsma commented that there is no disagreement that nutrient loading involves nonpoint as well as point sources, and that sources further upstream in the tributaries also contribute to the problems in the Bay, however, he indicates that it would be a terrible mistake to delay the proposed regulatory actions until more information has been developed on nonpoint source pollution or until the DEM and agencies in other jurisdictions are ready and able to address the other sources as decisively as is now being proposed for these WWTFs.

Mr. Reitsma commented that it would be inaccurate to suggest that the problems would occur regardless of nutrient loading, or that reducing the load won't do any good. He indicated that the DEM deserves credit for analyzing the cost issues carefully, and for its effort to strike the appropriate balance by not limiting the WWTFs at this time to what is technologically possible (3 mg/l) but taking the phased approach instead. Mr. Reitsma commented that further efforts, by the DEM and other state entities, are needed to help the facilities financially, but also to find ways to implement the new limits most cost-effectively.

Commenter:

Save The Bay
Marci L. Cole, Ph.D.
Coastal Ecologist
434 Smith Street
Providence, RI 02908

Comments:

Dr. Cole presented written comments on behalf of Save the Bay in which it was indicated that they strongly support the nitrogen limits proposed by DEM in the permit modifications. She cited the fact that, in June of 2004, the Rhode Island Legislature passed an act stating that "the (RIDEM) shall implement measures to achieve an overall goal of reducing nitrogen loadings from waste water treatment facilities (the dominant point sources of nitrogen to Narragansett Bay) by fifty percent (50%) by December 31, 2008".

The next step in this process is the implementation of nitrogen reduction at RI wastewater treatment facilities (WWTFs) to meet the mandated 50% reduction goal. The four permit modifications put forward by the RIDEM, along with ongoing and completed construction at other WWTFs, will reach this 50% reduction goal. Therefore, Save The Bay expressed their full support for the nitrogen limits presented in the four permit modifications.

Commenter:

Save The Bay
John Torgan
Narragansett BayKeeper
434 Smith Street
Providence, RI 02908

Comments:

Mr. Torgan presented oral comments on behalf of Save The Bay in which he indicated that Save the Bay has reviewed the draft permits and offers its full and unqualified support for the permits. He indicated that Save the Bay felt that the permit limits are necessary to comply with the Clean Water Act and the Rhode Island Water Quality Standards and that they are well founded and based on the best available science. A full-blown, total, maximum daily load study is not necessary to recognize that reductions are needed immediately to reduce the risk of further habitat degradation and the death of more fish and plants.

Mr. Torgan also indicated that, since the 70's, there have been dramatic water quality improvements in the Providence River and Narragansett Bay seen from the significant reductions in toxic metals that are discharged. These improvements have resulted in pollution sensitive marine life, such as oysters, winter flounder, blue crab, and striped bass, being found well up into downtown Providence. However, Mr. Torgan indicated that Save the Bay feels that the single greatest present threat to the health of the Providence River and Narragansett Bay is the discharge of excessive levels if nitrogen from wastewater. Mr. Torgan cited studies conducted in 2003 that documented low dissolved oxygen levels during the summer throughout the Upper Bay and the Providence River, which are important areas for spawning winter flounder and many other estuarine species. Mr. Torgan further cited fish kills and other adverse impacts caused by excessive nutrients, including the July and August 2003 fish kills.

Mr. Torgan indicated that Save the Bay agrees that the fish kills were caused by excessive nutrients discharged by the WWTFs in combination with other contributing environmental factors such as high temperatures, low tides, and light wind. However, since it is impossible to control the other factors, Save the Bay feels that it is appropriate

what is already known today. Mr. Torgan indicated that Save the Bay does not agree that, since nitrogen levels have remained constant over the past 30 years no change is required. If this is true, Save the Bay points out that the nutrient and DO levels were unacceptable in the 70's and they remain unacceptable today and do not meet the minimum standards established by the Clean Water Act. Mr. Torgan indicated that Save the Bay does not expect that there will be any adverse impacts caused by implementing these limits today, to the contrary, Save the Bay expects that the new limits would improve shellfish habitats and restore the nutrient balance in the Bay to a more natural and healthful state.

Mr. Torgan closed by indicated that Save the Bay feels that, by implementing these limits, Rhode Island is sending a strong message to Massachusetts that reductions in the nitrogen levels at the WWTFs that are located in Massachusetts but discharge to the Bay are required and delay in the form of additional studies, appeals, or other legal intervention will only serve to detract from the strong, urgent, and necessary improvements to be made at the WWTFs.

Commenter:

Steven Hamburg
Brown University
Box 1943
Providence, RI 02912

Comments:

Dr. Hamburg, a professor at Brown University, indicated that he is an ecosystem ecologist and that, for the past 3 or 4 years, he has been working on anthropogenic nutrient inputs into the Narragansett Bay. Based upon his research, Dr. Hamburg indicated that there is an unequivocal negative impact on the Bay due to anthropogenic nitrogen loads and that there is not an open scientific question about this. There is a preponderance of scientific evidence regarding serious ecosystem health issues regarding Nitrogen loading that we need to acknowledge. There has been, um, some question about the scientific basis for the proposed permit limits, and I would argue that that is an error. There is strong scientific consensus I said that has led to this comparable, action across the country. There is no evidence that Narragansett Bay is different from these ecosystems and thus, should not be subject to the same weight of scientific evidence that has been brought to bear elsewhere

In terms of the Upper Bay, Dr. Hamburg indicated that these nitrogen loads increase the risk of hypoxic events, invasion of non-native species, and the poor health of eelgrass. Dr. Hamburg also indicated that the increased nitrogen loading exacerbates the impacts of climate change. However, since we are unable to control the climate, Dr. Hamburg indicated that the future health of the Bay depends upon reducing the nitrogen discharged from WWTFs, since that is the variable for which we have the largest control over. Dr. Hamburg also indicated that nitrogen discharges are the most significant stress to the Bay and that a 50% reduction would have positive impacts on the Bay by making it more resilient and increasing DO levels. Dr. Hamburg indicated that he does not feel that there is any advantage to doing additional scientific studies and that we should be focusing on how to achieve the 50% reduction. In his opinion further reductions are warranted.

Commenter:

Warren L. Prell
Brown University
Providence, RI 02912

Comments:

Based on the available data, Dr. Prell concluded that the baseline loading of nutrients is too high in the upper bay and that the resulting productivity and oxygen depletion that causes low DO is primarily the result of excess nutrients. He expressed his position that everybody in attendance at the symposium on Block Island agrees that nutrient loading to the Upper Bay is extremely high. And that 60 to 70 percent of all the nutrients coming into the upper bay pass through wastewater treatment facilities, either directly, like Field Point, or indirectly coming through rivers. He indicated that the excessive amounts of nutrients being discharged into the bay are causing low DO levels in the Upper Bay and noted that these low DO levels are independent of particular environmental situations such as storms and winds. Environmental conditions may exacerbate, strengthen a hypoxic event, but the a base line of loading there which is supporting Chlorophyll levels in the upper bay are extremely high (five to 10 times higher than they are in the lower bay). Dissolved oxygen levels are really low, and I don't think people have appreciated just how low they are. He indicated that these reductions are fully warranted, and, we should look at even further reduction because clearly a 50 percent reduction will help the upper bay, but it will not solve it. He commented that he favors the proposal to reduce nutrient flux from the WWTF as the most practical means of reducing nutrients flowing into the Bay.

Commenter:

Donald Pryor
Brown University
Box 1943
Providence, RI 02912

Comments:

Mr. Pryor, Chairman of the Nutrient and Bacteria Panel of the Governor's Narragansett Bay and Watershed Planning Commission, commented on the fact that the Panel's primary recommendation was to reduce nitrogen discharges from RI WWTFs that discharge to the upper Bay or its tributaries by 40-50%. The full commission endorsed that recommendation. Subsequently, the RI General Assembly passed legislation that was enacted into law (46-12-2(f)) calling for reduction of nitrogen loading from WWTFs by 50% by December 31, 2008. Mr. Pryor commented that the proposed permits are essential for DEM to comply with this law.

Mr. Pryor also commented that voters approved a bond issue to assist in financing upgrades to WWTFs to achieve the required reductions and that timely action is necessary to ensure that those funds are used as intended.

Mr. Pryor commented that all of the studies and published literature agree that high nutrient loads drive low oxygen conditions in Narragansett Bay in the summer when mixing is low and that the panel reached its recommendation by consensus. He also

indicated that all of the analyses were consistent in identifying WWTFs as being responsible for 60 – 70 percent of the nitrogen load to the Upper Bay. He commented that Further study should parallel, not delay, action. A numerical process model might provide additional insight and is a worthwhile objective of ongoing work; however, no such model is likely to answer every question to match every aspect of the actual system or to be capable of predicting system behavior perfectly.

As nutrient reductions called for in the proposed permits are implemented, dissolved oxygen levels in the upper parts of the Bay will improve, particularly during conditions that now allow oxygen levels to fall below that needed to support most aquatic life. Dr. Prior indicated that in other areas were nutrient reductions have been implemented, such as Tampa and Sarasota, no negative side effects were reported. Therefore, he indicated that the nutrient load reduction proposed in the draft permits should be implemented without further delay.

Commenter:

Emily Saarman
33 Power Street
Providence, RI 02903

Comments:

Ms. Saarman, a graduate student at Brown University, commented that, based on the dissolved oxygen data that she has been reviewing with Dr. Pell and Mr. Pryor; there is no question that the dissolved oxygen levels are extremely low during the summer. She indicated that, after reviewing the data from the summer of 2002, she found that the dissolved oxygen levels exceed the mortality rates for larvae in the Providence River by a factor of six (6). She also commented that the lowest dissolved oxygen levels are consistently seen just south of the Fields Point WWTF, a phenomenon that she attributes to the nitrogen discharges from the WWTF. She applauded DEM for drafting the proposed permit modifications and supported the modifications.

Commenter:

Senator Elizabeth Roberts
254 Norwood Avenue
Cranston, RI 02905

Comment:

Senator Roberts commented that the nutrient impact on Narragansett Bay is an issue that is very important to both people in her district and to the people of the State. She recognized that there would be significant costs associated with compliance but indicated that she felt that there are times when spending money is necessary. She indicated that she is pleased to see the DEM move so quickly with the drafting of these modifications and gave her full support.

Commenter:

City of Providence
Mayor David N. Cicilline
Providence City Hall

Providence, RI 02903

Comment:

Mayor Cicilline commented that, unquestionably greater restrictions upon wastewater treatment plants would help improve the quality of the receiving waters. Mayor Cicilline further commented that while he fully agrees that a clean Bay is critical to restoring Providence's waterfront and economy, and that he offers his support of the draft wastewater treatment plant permits for Woonsocket, East Providence and the Narragansett Bay Commission, he urges DEM to be mindful of how consumers will be able to shoulder this or any additional cost.

Commenter:

Curt Spalding
2 Norwood Avenue
Cranston, RI 02905

Comment:

Mr. Spalding, Executive Director of Save the Bay, indicated that he was providing comments as a resident of the Providence River and President of the Edgewood Sailing School. Based upon his personal experience, he feels that it is clear that the Upper Bay is impacted by excessive nitrogen discharges. People from all walks of life come to the Providence River to use it and should enjoy the same clean water column enjoyed by a person living in the middle and lower Bay. He specifically referenced, times during the summer season many people fish in the River but an overabundance of ulva algae compromises the ability to cast a bait through the water and that children at the Edgewood Sailing School must sail through inches of macro algae in the Providence River. Mr. Spalding stressed that poor water quality conditions should viewed as an issue of equity, expressed his support for the DEM's proposed permit modifications and applauded DEM for moving so quickly in proposing the modifications.

Commenter:

City of Warwick
Mayor Scott Avedisian
3275 Post Road
Warwick, RI 02886

Comment:

Mayor Avedisian commented that he supports the permits proposed by DEM and that the proposed reductions in nitrogen loading in the Blackstone River, Providence River and the Upper Narragansett Bay are appropriate, necessary and consistent with the Governor's Narragansett Bay and Watershed Planning Commission's findings and recommendations.

Mayor Avedisian also commented that the City of Warwick is fully aware of the impacts that wastewater and other pollutants have on our sensitive environmental resources and that the City has made substantial commitments to improve water quality in Rhode Island as evidenced by the approval of a $130 million general obligation bond by the voters of the City of Warwick, as well as the recent execution of authority for up to $50

million in revenue bonds by the Warwick Sewer Authority. However, Mayor Avedisian commented that Warwick cannot address the pollution in Narragansett Bay alone and that the cities of East Providence and Woonsocket and the Narragansett Bay Commission must continue to invest in Rhode Island's future by upgrading their wastewater treatment facilities to further reduce nutrients.

Commenter:

City of Warwick
Councilman Steve Merolla
229 Castle Rocks Road
Warwick, RI 02886

Comment:

Councilman Merolla commented that he is in support of the new nitrogen limits proposed by the DEM for the City of Woonsocket and the City of East Providence municipal wastewater treatment plants, and the NBC's Bucklin Point and Fields Point wastewater treatment facilities and that these reductions in nitrogen loading in the Blackstone River, Seekonk River, Providence River and the Upper Narragansett Bay are critical steps in the effort to meet both existing USEPA water quality standards and the fifty percent nitrogen reduction goal set by the Rhode Island legislature last year.

Councilman Merolla also commented that, while there is significant cost to municipalities and the NBC to implement the proposed nitrogen limits, the mandated limits have been achieved by other Rhode Island communities who were dedicated to improve the water quality of the State's waters and he urged DEM and the facility operators to work cooperatively to put these new nitrogen limits in place as quickly as possible.

In addition to the specific comments mentioned above, the following organizations and individuals all submitted similar comments that supported the DEM's proposed permit modifications assigning total nitrogen permit limits to the WWTFs, in accordance with the recent legislation that was passed requiring that DEM implement the necessary measures to reduce nitrogen loadings to the Providence River by 50%. Several of these commenters also urged the DEM to work with the State of Massachusetts to implement similar nutrient reductions in the WWTFs that discharge to the Blackstone River but are located in Massachusetts.

Organizations:

1. *Brown Medical School*
   Department of Psychiatry & Human Behavior
   Michael A. Fiori, M.D.
   Assistant Clinical Professor
   345 Blackstone Boulevard
   Providence, RI 02906

2. *Community Boating Center*
   Peter Gengler
   India Point Park
   Providence, RI

3. *The Gordon School*
   Megan Almeida

Zoe Bogus
Blinn Dorsy
Amanda Gaynor
Rachel Gibson
Elliot Green
Chris J
Neil D. Kelly
Christopher Kingdon
Anna Mack
Denyel Monroe
Jessie Parsons
Margaret Sawdy
Karan S. Takhar
Coby Unger
Susannah Wales
Nzingha Williams-Eugene
45 Maxfield Avenue
East Providence, RI 02914

4. *Greenwich Bay Watershed Group*
   Richard Langseth

5. *The Rhode Island Rivers Council*
   Meg Kerr
   P.O. Box 1565
   North Kingstown, RI 02852

6. *Rhode Island Shoreline Coalition*
   Harry L. Staley, President
   P.O. Box 1141
   Westerly, RI 02891

7. *Saltwater Anglers Association*
   Stephen J. Medeiros
   6 Arnold Road
   Coventry, RI 02816

Individuals:

1. Frohman C. Anderson
   170 Adams Point Road

2. Samuel Fisher Babbitt
   81 Benefit Street
   Providence, RI 02904

3. Dana Bourque

4. Roger N. Carlsten, D.D.S.
   433 Lloyd Avenue
   Providence, RI 02906

5. Mike Darowski
   61 Sagamore Street

Warwick, RI 02889

6. Ilana J. Goldstein

7. Arthur J. Latham, Jr.
   and Doris S. Latham

8. Gidget Loomis
   140 Duck Cove Road
   North Kingstown, RI 02852

9. Raymond C. Martinelli
   27 Sabra Street
   Cranston, RI 02910

10. Liam Miner
    50 Elton Street
    Providence, RI 02906

11. Richard N. Morneau
    8 Scott Street
    Pawtucket, RI 02860

13. J. Schempp
    47 Arbor Drive
    Providence, RI 02908

14. Barbara M. Simone
    6 Briarfield Road
    Barrington, RI 02806

15. Marybeth Sulkowski
    3 Brookfarm Road
    North Providence, RI 02904

16. Robert Sumner-Mack, M.D.
    643 East Avenue
    Pawtucket, RI 02860

17. Carolyn R. Swift
    50 Armstrong Avenue
    Providence, RI 02903

18. Kim Ziegelmayer
    206 Adelaide Avenue
    Providence, RI 02907

HEARING REQUESTS

If you wish to contest any of the provisions of this permit, you may request a formal hearing within thirty (30) days of receipt of this letter. The request should be submitted to the Administrative Adjudication Division at the following address:

Bonnie Stewart, Clerk
Department of Environmental Management
Office of Administrative Adjudication
235 Promenade Street, 3rd Floor
Providence, Rhode Island 02908

Any request for a formal hearing must conform to the requirements of Rule 49 of the State Regulations.

STAYS OF RIPDES PERMITS

Should the Department receive and grant a request for a formal hearing, the contested conditions of the permit will not automatically be stayed. However, the permittee, in accordance with Rule 50, may request a temporary stay for the duration of adjudicatory hearing proceedings. Requests for stays of permit conditions should be submitted to the Office of Water Resources at the following address:

Angelo S. Liberti, P.E.
Chief of Surface Water Protection
Office of Water Resources
235 Promenade Street
Providence, Rhode Island 02908

All uncontested conditions of the permit will be effective and enforceable in accordance with the provisions of Rule 49.

Literature cited

Doering, P.H., C.A. Oviatt and M.E.Q. Pilson. December 1990. Control of Nutrient Concentrations in the Seekonk-Providence River Region of Narragansett Bay, Rhode Island. *Estuaries*13:4:418-430

Limno-Tech, Inc. August 6, 1992, Providence and Seekonk Rivers and Upper Narragansett Bay Eutrophication Screening Analysis.

Louis Berger and Associates, April 17, 1998 Narragansett Bay Commission Combined Sewer Overflow Control Facilities Program, Concept Design Report Amendment.

Michaelis, B. (2005). Dissolved oxygen dynamics in a shallow stream system. Dissertation in Civil and Environmental Engineering at the University of Rhode Island (URI).

Nixon, S., B. Buckley, S. Granger, L. Harris, A. Oczkowski, L. Cole and R. Fulweiler, 1995, Draft Report: Anthropogenic Nutrient Inputs to Narragansett Bay: A Twenty-five Year Perspective., A report to the Narragansett Bay Commission and Rhode Island Sea Grant.

Randall, C. W., J.L. Barnard, and H. D. Stensel. 1992. , Design and Retrofit of Wastewater Treatment Plants for Biological Nutrient Removal. Technomic Publishing Company, Lancaster, PA.

USEPA, MADEP and RIDEM, November 1997, Blackstone River Watershed Dissolved Oxygen Wasteload Allocation for Massachusetts and Rhode Island.

Walsh, T. 2005, Presentation entitled "Strategies from a Municipal Perspective" at the seminar "Maximizing Compliance Options: Strategies for Meeting Nutrient Limits in New England" held January 11, 2005