City of Portsmouth, New Hampshire

Wastewater Master Plan

Technical Memorandum
TM 5

Supplemental Update

WWTF PROCESS AND SITING AND CSO ABATEMENT EVALUTIONS

Tasks:	5.1 through 5.11	
Status:	**Submitted to EPA/DES**	March 1, 2010

The following is a supplement to the DRAFT TM 5 - WWTF Process and Siting and CSO Abatement Evaluations submitted on December 1, 2009. After the December submission additional data provided by the New Hampshire Department of Environmental Services (NH DES) cast doubt on the feasibility of the proposed alternative at the Pease International Tradeport (PIT). The results of the DES/EPA dye tracer study completed in October 2009 suggested that significant increases in flow would cause a loss of use due to impacts on shellfish beds. That new information cast doubt on the use of the PIT Wastewater Treatment Facility (WWTF) outfall for higher flows. To utilize the PIT WWTF location additional infrastructure would need to be constructed to convey effluent from the PIT WWTF to the existing Peirce Island (PI) WWTF outfall. This additional regulatory information and added cost has required the City to reevaluate the use of the PIT WWTF as the preferred solution.

To address this new situation, an additional scenario, Scenario 4, has been developed. This new scenario is based in part upon a Value Engineering exercise completed in February 2010. Scenario 4 utilizes the PI WWTF to treat wastewater generated within the City and from existing regional users, the towns of Rye, Greenland and New Castle. The PIT WWTF will remain active and will treat wastewater generated at the PIT. An expansion of the PIT WWTF may be required in the future for growth within the PIT.

This supplement is intended to serve as an update / bridge between the DRAFT TM 5 submitted December 1, 2009 and the DRAFT Wastewater Master Plan to be submitted on June 1, 2010. The Executive Summary contained herein reflects the most recent data available and supersedes the Executive Summary included with the DRAFT of TM 5.

Submitting this supplement to TM 5 in lieu of a complete resubmission of TM 5 was discussed and approved at a meeting with the Environmental Protection Agency (EPA) and the New Hampshire Department of Environmental Services (NH DES) on February 16, 2010.

This supplement to Technical Memorandum 5 (TM 5) includes the following:

1. Attachment 1, an updated Executive Summary to TM 5
2. Attachment 2, new Section 5.11 Scenario 4: Preliminary Process Evaluation, and revised Section 5.12 Findings and Recommendations
3. Attachment No. 3, updated TM 5 tables
4. Attachment No. 4, responses to New Hampshire Department of Environmental Services comments to the draft TM 5 which was submitted to EPA and DES in December of 2009

ATTACHMENT 1

UPDATED TECHNICAL MEMORANDUM 5
EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Technical Memorandum 5 (TM 5) is one in a series of interim deliverables prepared as part of the Wastewater Master Plan (WMP) for the City of Portsmouth, New Hampshire (the City). Subsequent to the filing of the draft of TM 5, the New Hampshire Department of Environmental Services (NHDES) communicated its preliminary findings from a dye study conducted in the October of 2009. Those preliminary findings have had a substantial impact on the WMP process and the recommendations of this TM. The dye study findings and a recent value engineering exercise have required the City to revisit the preferred compliance scenario outlined in the draft of TM 5.

Given the uncertainty surrounding the regulatory requirements for total nitrogen as well as the affordability of the alternatives presented in this TM the final compliance program may vary from the new preferred alternative presented as Scenario 4 in this TM.

An overview of the WMP background, and TM 5 in particular, is as follows:

- The City of Portsmouth currently owns and operates two wastewater treatment facilities (WWTF):
    - The Peirce Island (PI) WWTF is designed to treat 4.8 million gallons per day (MGD) on an average daily basis with peak wet weather capacity of 22 MGD and provides advanced-primary treatment.
    - The Pease International Tradeport (PIT) WWTF is designed to treat 1.2 MGD and is a secondary treatment facility that uses the sequencing batch reactor (SBR) process which provides Biological Nutrient Removal (BNR). The treated wastewater is discharged through an outfall shared with Newington, New Hampshire whose average daily design flow is 0.29 MGD.
- In 2007, the US Environmental Protection Agency (EPA) denied the renewal of the 301(h) waiver under which the PI WWTF was operating and issued a new National Pollutant Discharge Elimination System (NPDES) permit requiring secondary treatment. An Administrative Order was issued to set interim limits which the PI WWTF must meet until such time that a new secondary treatment process is constructed at the PI WWTF, or a new secondary treatment WWTF is constructed elsewhere.
- In addition to the new Secondary NPDES permit for the PI WWTF, it is anticipated that EPA will include a total nitrogen (TN) limit in future NPDES permits for both the PI WWTF and the PIT WWTF.
- The WMP includes an evaluation of required WWTF upgrades and combined sewer overflow (CSO) abatement measures. The WWTF upgrade evaluation consists of two parts: one evaluation of potential WWTF sites and a second evaluation of secondary treatment and potential nutrient removal processes. The evaluation of

CSO abatement measures involves screening and selection of appropriate abatement controls and technologies.

- While the evaluations of WWTF upgrades and CSO abatement measures are independent of one another; they are both highly dependent on the following potential flow scenarios:
  - Scenario 1: City wastewater continues to be treated on Peirce Island.
  - Scenario 2: City wastewater is split between the PI WWTF and the PIT WWTF
  - Scenario 3: City wastewater is not treated on Peirce Island; all wastewater is redirected to PIT or a new site

- Site selection was the first step in the evaluation of WWTF upgrades. The space available at the PI WWTF site is limited. The existing PIT WWTF site could be expanded and upgraded to treat full build-out flow, but would require significant flow re-direction in the collection system. Therefore, locating a new WWTF at other sites in the Portsmouth area was also evaluated. Sites qualified for further evaluation were:
  - Peirce Island
  - Pease International Tradeport
  - PSNH/Sprague

- Treatment process selection was the second step in the evaluation of WWTF upgrades. Process selection was focused on meeting secondary treatment and potential future TN effluent limits. Biological nutrient removal (BNR) processes can be used to meet both effluent treatment limits for secondary treatment and nutrient limits of 8 mg/L or better.

- Potential WWTF alternatives were identified for each of the three WMP flow scenarios based on the WWTF site and process technology selections. WWTF alternative layouts for each scenario for the MLE, IFFAS, and SBR process technologies were created for the PI WWTF, PIT WWTF, and Sprague/PSNH sites. These layouts were used to identify space limitations and to develop capital costs. Following the submission of the draft TM5 in December, the City conducted a value engineering (VE) of these process technologies as well as the capital costs to construct them. The results of this VE indicate that certain high rate technologies may be more cost effective and warrant further evaluation. These technologies include Moving Bed Bioreactors (MBBR), Biological Aerated Filters (BAF) and Biological Membrane Reactors (MBR).

- The build-out flow rates associated with the four scenarios are presented in Table 5-5.

Table 5-5 Build-out Condition Flows for WMP Flow Scenarios

WWTF	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Design Year	2060	2060	2060	2030
Peirce Island	8.0 MGD	4.4 MGD	0 MGD	6.2 MGD
PIT[1]	1.2 MGD	4.8 MGD	9.2 MGD	2.3 MGD

[1] PIT or Sprague/PSNH site for Scenario 3.

- The evaluation of CSO abatement measures showed that the most suitable options for the South Mill Pond CSOs (010A/010B) were:
    - Scenario 1 – 2.9 million gallon Off-line Storage Tank or additional sewer separation
    - Scenario 2 – Debottleneck Line between CSOs 010A/010B and Mechanic St. PS or additional sewer separation
    - Scenario 3 – Debottleneck Line between CSOs 010A/010B and Mechanic St. PS plus miscellaneous PI WWTF improvements or additional sewer separation

- Based on the modeling completed as part of TM 4, the Islington 1 (Bartlett Street area) rehabilitation work will bring the Deer Street CSO (013) into compliance.

- Present worth estimates were used to compare alternatives for WWTF upgrades, collection system flow redirection, and CSO abatement measures. The present worth costs for the initial alternatives prior to the VE are summarized in Table 5-18. These costs are based on a TN of 8 mg/L. Initial indications are that a TN of 5 mg/L or lower will result in an additional 30 to 40 percent increase in capital cost as well as additional operation and maintenance costs. Preliminary rate impact estimates for any of these scenarios show user rates exceeding 2.5% of the median household income and therefore, not practicable for the City.

Table 5-18 Present Worth Estimates for WMP Scenarios for a TN limit of 8 mg/L

	PI WWTF Scenario 1	PI/PIT WWTFs Scenario 2	PSNH Scenario 3			PIT Scenario 3		
Technology:	SBR	SBR	SBR	MLE	IFFAS	SBR	MLE	IFFAS
	M$	M$	M$	M$	M$	M$	M$	M$
WWTF	158[1]	238	152	152	154	150	150	151
Redirect/Shed	0	13	22	22	22	22	22	22
CSOs	27.2	4.2	29	29	29	29	29	29
Total	185.2	255.2	204	204	206	201	201	202

[1] WWTF option not feasible since available technologies cannot fit within the setback limits on PI.

- Of the pre-VE alternatives, Scenario 1 presented the lowest present worth costs. However, Scenario 1 did not meet the goal of using the PI WWTF as a wet weather only treatment facility. Therefore, Scenario 3 was selected for further evaluation, since it did meet this critical goal.

- During the process of finalizing this TM, a major issue affecting the feasibility of Scenario 3 was identified relative to permitting. NHDES has verbally stated that it is extremely unlikely that a permit will be issued for the PIT WWTF outfall at the flows previously presented due to anti-degradation related to Food and Drug Administration's national shellfish sanitation requirements. Without a permitted outfall for the PIT WWTF the final effluent would need to be pumped back to the PI WWTF outfall which comprises a capital cost of approximately $12 to $15 million. Operations and maintenance costs associated with this pumping is estimated at $1.18 million for 20 years at 5% interest.

- Due to the inability to use the PIT WWTF outfall location for the full design flow, coupled with affordability issues with Scenarios 1 through 3, an additional scenario was developed, Scenario 4. Scenario 4 focuses on keeping all wastewater treatment on Peirce Island (with the exception of PIT), reusing as much of the existing infrastructure as possible and achieving secondary treatment for wastewater flows projected through year 2030, as presented in Table 5-5
- One approach to Scenario 4 was proposed during a recent value engineering (VE) study by AECOM, which suggested a denitrification moving bed biofilm reactor (MBBR) followed by a combined carbonaceous and nitrifying biological aerated filter (BAF) with a 100-percent recycle for denitrification as an affordable and small-footprint alternative likely to be imposed due to historical resource and other restrictions. The approach represented by this alternative has merit. However, without modification, this alternative may not be able to meet a total nitrogen limit of 8 mg/L. In addition, meeting permit limits below 8 mg/L may require the addition of carbon and final clarification by filters or another polishing step.

- Building on the approach put forward by AECOM the following three alternatives were identified for Scenario 4:

  - Denitrification MBBR followed by BAF. Post-denitrifying filters would be provided if a TN limit lower than 8 mg/L is imposed.

  - Denitrification MBBR followed by aerated MBBR. Either a clarifying dissolved-air flotation or secondary clarifiers could be provided for effluent clarification. Post denitrification MBBRs would be provided (before the clarifiers) if a TN limit lower than 8 mg/L is imposed.

  - Membrane Biological Reactor (MBR) system with reactor zones arranged in a Bardenpho configuration. Post treatment would be required if TN limits less than 5 mg/L were required. The advantages and disadvantages of these three alternatives are summarized as follows:

Table 5-17 Results of Preliminary Process Evaluation for Scenario 4

ALTERNATIVE	REQUIREMENTS	ADVANTAGES	DISADVANTAGES	OPINION OF COST
1 MBBR-BAF	Anoxic MBBR (New) BAF (New) Deep-Bed Deniterification Filters for TN less than 8 (Filter Building)	Low-cost MBBR tankage BAF provides adequate TSS filtration and relatively high solids storage capacity	Most susceptible to fats, oil and grease (FOG) fouling Additional process units necessary for TN less than 8 Significant methanol use in denitrification filters for TN less than 8 mg/L.	$ 35 Million
2 MBBR-MBBR-DAF	Anoxic MBBR (Filter Building) Aerobic MBBR (New) Second Anoxic MBBR for TN less than 8 (NEW) DAF/ Alternative Clarification Method (New)	Low-cost MBBR tankage DAF is effective point of removal for grease/floating material that made its way through the process units.	Susceptible to FOG fouling Additional process units necessary for TN less than 8 Significant methanol use in secondary anoxic MBBR for TN less than 8	$ 37 Million
3 MBR	Pre Anoxic and Aerobic Reactors (New) Secondary Anoxic Zone (Filter Building) MBR System (Filter Building)	Superior effluent quality Nitrification and Denitrification achieved within a single set of reactors Additional process units not necessary Least methanol requirements for TN less than 8	Susceptible to FOG fouling Life span of membranes is not well defined Highest operating and maintenance costs	$ 40 Million[1]

[1]May be lower since utilization of the existing filter building was not factored in for the MBR in the MLE configuration.

- The preferred treatment option cannot be identified until wastewater characterization testing is completed. As noted above, fats, oils and grease which have historically been a concern in Portsmouth, can affect the operation of the high rate processes being considered for Scenario 4. Therefore, testing to evaluate grease carryover to the secondary process is required, and must be completed during a wide range of flow events.

- To properly size the alternative processes and select the process type and configuration, a complete wastewater characterization must be completed. With the results of the wastewater characterization, a more detailed comparison of the advantages and disadvantages of each alternative, the feasibility of constructing each at the PI WWTF, their ability to meet future nitrogen limits, and more precise opinion of cost can be developed to determine a recommended alternative to carry forward into preliminary design.

- Once the process type and configuration is complete a pilot testing of the preferred configuration is recommended prior to preliminary design of the system.

- Based on the above evaluations and the fact that unit process sizing and related cost estimates are feasibility level at this stage, all of the high rate alternatives should be carried forward for further evaluation. The MBR cost is shown as 15-percent higher than the other alternatives, but potential cost savings of not requiring additional unit processes for the lower TN limit is an advantage.

ATTACHMENT 2
SECTION 5.11 SCENARIO 4: PRELIMINARY PROCESS EVALUATION

SECTION 5.12 FINDINGS AND RECOMMENDATIONS

5.11 SCENARIO 4: PRELIMINARY PROCESS EVALUATION

5.11.1 Development of Scenario 4

As part of the City of Portsmouth Wastewater Master Plan (WMP) *Technical Memorandum 5: Process, Siting and CSO Abatement Evaluation* (TM 5), several treatment alternatives were evaluated to replace the existing treatment facilities in the city. The initial processes evaluated for the WMP were the Modified Ludzack-Ettinger (MLE); Four-Stage Bardenpho; Sequencing Batch Reactor (SBR); and Integrated Fixed Film Activated Sludge (IFAS). This initial process evaluation, in conjunction with the sitting evaluation, was used to develop the original flow scenarios and treatment alternatives presented in TM 5. Throughout the process of compiling TM 5, and performing the alternative evaluation, a number of constraints were identified for the WMP which ruled out many of these original flow scenarios and treatment alternatives. The constraints that were identified during the TM 5 evaluation process are summarized as follows:

- The Peirce Island WWTP will be upgraded to treat an annual average flow of 6.2 MGD and a peak flow of 9.2 MGD, which would serve the City through year 2030 projections.
- During certain wet weather conditions, the chemically-enhanced primary effluent in excess of 9.2 MGD will be diverted to disinfection under the CSO Bypass Provisions of the EPA CSO Control Policy.
- Initial permit limits have been assumed to be an average total nitrogen (TN) limit of 8 mg/L. However, based on indications from the New Hampshire Department of Environmental Services (NHDES), has advised that provisions should be made for a TN limit below 8 mg/L.
- Capital expenditure, including design, construction, and construction management should be limited in order to keep the project affordable to the community. For this purpose the existing, but unused, filter building on Peirce Island should be utilized when possible. The maximum available volume of the existing building within the filter area is estimated to be approximately 0.5 million gallons with a surface area of approximately 3,800 ft^2.

Based on these decisions and limitations, it is clear that the original three scenarios would either not fit within the site constraints of the Peirce Island WWTP, or would be too capital intensive. For this reason Scenario 4 was developed, which takes into account the aforementioned constraints and requires a new approach focusing on compact, lower cost options.

One alternative for Scenario 4 was proposed during a recent value engineering (VE) study by AECOM. This alternative comprises a denitrification moving bed biofilm reactor (MBBR) followed by a combined carbonaceous and nitrifying biological aerated filter (BAF) with a 100-percent recycle for denitrification. This alternative was proposed without final clarification by filters or other polishing step. The approach represented by this alternative has merit. With the wastewater characterization data available to date, it is questionable if this alternative would be able to meet a TN limit of 8 mg/L without carbon addition and/or additional polishing steps. Carbon addition and additional unit processes would be required to meet a TN limit of 5 mg/L or lower.

5.11.2 Treatment Alternatives

Recognizing the merits of the approach put forward by AECOM, a number of additional alternatives were identified which have been evaluated for Scenario 4. The alternatives identified are as follows:

1. Denitrification moving bed biofilm reactor (MBBR) followed by biological aerated filter (BAF). Post-denitrifying filters would be provided if a TN limit below 8 mg/L is imposed.

2. Denitrification MBBR followed by aerated MBBR. Either a clarifying dissolved-air flotation or secondary clarifiers would be provided for effluent clarification. Post denitrification MBBRs would be provided (before the clarifiers) if a TN limit below 8 mg/L is imposed.

3. Membrane bioreactor (MBR) system with reactor zones arranged in a Bardenpho configuration. No post treatment will be required to meet 5 mg/L TN in this alternative however, future limits below 5 mg/L may require additional treatment.

Each of these alternatives are discussed below in terms of process configuration, meeting the potential TN limits, siting considerations, and cost of implementation.

MBBR-BAF

This basic treatment combination, put forward by AECOM during the VE study, has the primary advantage of incorporating relatively low-cost MBBR tankage for denitrification in the modified Ludzack-Ettinger (MLE) configuration.

In an MLE configuration, the anoxic MBBR must be followed by an aerobic reactor in which BOD is reduced, and nitrogen is converted to nitrates. The nitrates formed in the aerobic reactor are returned via a recycle flow back to the anoxic MBBR for denitrification. To meet a TN limit of 8 mg/L or less, the recycle rate and supplemental carbon requirements must be determined based on the wastewater characteristics.

There are a number of options for the aerobic reactor (including aerated MBBRs) but, since the effluent quality from an MBBR system is relatively high in total suspended solids (TSS), some form of clarification is required. When an aerated BAF is used as the aerobic reactor for both BOD reduction and nitrification, this unit process then also has the added advantage of rough (but adequate) filtration and TSS retention, as well as a relatively high solids storage capacity between backwashes.

Due to the BAFs ability to handle some solids removal, it is likely that no additional clarification processes would be required to meet a TN limit of 8 mg/L. However, in the event that it is necessary to meet a TN limit below 8 mg/L, post denitrification would be required. Because they provide a high degree of clarification, deep-bed denitrification filters are proposed as the most appropriate for this process alternative. Methanol would need to be added to these filters for final denitrification.

At an approximate loading rate of 2 gpm/ft^2 and an average design flow of 6.2 MGD, a total deep-bed filter area of approximately 2,200 ft^2 would be required. There are existing filters on the site, with a total area of 3,800 ft^2. Therefore, the existing filter infrastructure would be adequate for the denitrification filters. Therefore, the MBBR and BAF tankage would be new construction. A preliminary estimate of the anoxic MBBR volume, assuming a 1.5-hour average retention time, is approximately 0.4 MG. Assuming an average application rate of approximately 0.7 gpm/ft^2 for a secondary nitrifying BAF, the process area is estimated at approximately 6,500 ft^2.

The Opinion of cost for, an anoxic MBBR is approximately $8 million, including engineering and construction. The opinion of cost for the nitrifying BAFs is approximately $17 million. Therefore, the cost of the process units for this alternative is estimated at approximately $25 million. In addition to the biological treatment process, additional upgrades including headworks, sludge storage tanks, dewatering equipment and Ultra Violet disinfection add $10 million dollars to upgrades necessary at the Peirce Island Wastewater Treatment Facility, the total capital cost of this project is estimated to be $35 million.

MBBR-MBBR-DAF

This treatment configuration includes an anoxic MBBR, followed by an aerobic MBBR for nitrification, followed by a DAF system for effluent clarification. The nitrates formed in the aerobic MBBR are returned via a recycle flow back to the anoxic MBBR for denitrification. To meet a TN limit of 8 mg/L the recycle should be at least 300-percent.

To meet an average TN limit below 8 mg/L, an additional anoxic MBBR reactor would be installed after the aerobic MBBR, but before the clarification DAF unit. Methanol would be added to this second anoxic MBBR for final denitrification. Either of the anoxic MBBRs could be housed in the existing filter building with appropriate modifications.

The total volume of the new MBBR tankage which would include the aerobic and one of the anoxic tanks, assuming a total average retention time of approximately 5 hours, is estimated at approximately 1.3 MG.

The total area of the DAF units, assuming an average hydraulic loading of 4 gpm/ft^2, would be approximately 1,100 ft^2. Other alternatives for clarification are possible, and include plain sedimentation, accelerated (ballasted) sedimentation, and filtration. The DAF is proposed here due to its relatively compact footprint.

The opinion of cost for the MBBR system is $25 million. The DAF system is estimated at approximately $2 million. Therefore, the total process unit cost for this alternative is estimated at approximately $27 million. In conjunction with the $10 million dollars previously identified as necessary to upgrade the existing Peirce Island facilities, the approximate capital cost of this project is estimated to be $37 million.

MBR

This alternative utilizes membrane bioreactors within a Bardenpho treatment configuration. The process would consist of pre-anoxic and aerobic process reactors, followed by a secondary anoxic zone and finally the MBRs as the final aerobic process.

The advantages of the MBR system over the other alternatives are that nitrification and denitrification is achieved within one set of reactors, and that no additional unit processes are required to meet the limit of 5 mg/L TN. Of the three alternatives the methanol requirements to meet 5 mg/L TN would be the least with an MBR system.

The membrane tanks and secondary anoxic zone could be housed in the existing filter building structures. However, additional new tankage will be required to house the process reactors. The estimated total volume of the additional tankage is approximately 0.80 MG. The new tankage would be arranged in a number of baffled zones:

- Anoxic-1 (mixed)
- Anoxic-2 (mixed)
- Aerobic-1 (aerated)
- Aerobic-2 (aerated)

The existing filter boxes would be modified to remove the false floor and to allow flow-through the eight filter cells. Four of the cells would be the secondary anoxic zones with mixers, and the remaining four cells would house the membranes. The existing filter gallery would be used to house permeate pumps, and other MBR appurtenant equipment.

Based on recent projects and cost information, for the opinion of cost for the MBR system is approximately $30 million. The actual cost may be somewhat lower because the cost advantage of utilizing the existing filter structure has not been taken into account at this time. In conjunction with the $10 million dollars previously identified as necessary to upgrade the existing Peirce Island facilities, the approximate capital cost of this project is estimated to be $40 million.

5.11.3 Additional Considerations

One issue of concern for all of these high rate systems is the impact of high fats oils and grease (FOG) loads on each of the alternatives. Based on past experience grease loads to the the Peirce Island plant can be significant at times. Quantification of these loads will be necessary prior to final alternative selection.

The MBBR-BAF option is likely to be the most susceptible to grease fouling since the BAF is essentially a coarse filter. Mitigating this is the presence of the MBBR reactor upstream of the BAF filters which may help in coagulating the FOG. However, it would be important to include scum and grease traps in the MBBR reactors to ensure that any surface accumulated material is removed from treatment before passage to the BAFs.

The MBBR-MBBR-DAF alternative would be less susceptible to grease and, in fact, the presence of the DAF would be a very effective point for removal of any floating material that made its way through the process units.

Based on experience and engineering judgment it is believed that the MBR system would be least susceptible to grease.

5.11.5 Scenario 4 Summary

The results of this preliminary process evaluation for Scenario 4 are summarized in the table below.

Table 5-17 Results of Preliminary Process Evaluation for Scenario 4

ALTERNATIVE	REQUIREMENTS	ADVANTAGES	DISADVANTAGES	OPINION OF COST
1 MBBR-BAF	Anoxic MBBR (New) BAF (New) Deep-Bed Deniterification Filters for TN below 8 mg/L (Filter Building)	Low-cost MBBR tankage BAF provides adequate TSS filtration and relatively high solids storage capacity	Most susceptible to grease fouling Additional process units necessary for TN below 8 mg/L Significant methanol use in denitrification filters for TN below 8 mg/L	$ 35 Million
2 MBBR-MBBR-DAF	Anoxic MBBR (Filter Building) Aerobic MBBR (New) Second Anoxic MBBR for TN below 8 mg/L (NEW) DAF/ Alternative Clarification Method (New)	Low-cost MBBR tankage DAF is effective point of removal for grease/floating material that made its way through the process units.	Susceptible to grease fouling Additional process units necessary for TN below 8 mg/L Significant methanol use in secondary anoxic MBBR for TN below 8 mg/L	$ 37 Million
3 MBR	Pre Anoxic and Aerobic Reactors (New) Secondary Anoxic Zone (Filter Building) MBR System (Filter Building)	Superior effluent quality Nitrification and Denitrification achieved within a single set of reactors Additional process units not necessary Least methanol requirements for TN below 8 mg/L	Susceptible to grease fouling Life span of membranes is not well defined Highest operating and maintenance costs	$ 40 Million*

*May be lower since utilization of the existing filter building was not factored in for the MLE

The MBBR-BAF and MBBR-MBBR-DAF costs are very close together and cannot be reasonably distinguished at this stage. The MBR cost is shown as 15-percent higher than the other alternatives, but potential cost savings of not requiring additional unit processes for the lower TN limit is an advantage.

Based on the above evaluations and the fact that unit process sizing and related cost estimates are feasibility in nature at this stage, all three alternatives should be carried forward in a further evaluation of Scenario 4. To properly size the alternative processes, a complete wastewater characterization must be completed. With the results of the wastewater characterization, a more detailed comparison of the advantages and disadvantages of each alternative, the feasibility of constructing each at the Peirce Island facility, their ability to meet future nitrogen limits, and more precise opinion of cost can be developed to determine a recommended alternative to carry forward into preliminary design.

The design of the unit process reactor tanks, chemical requirements, and recycle rates must be based on the wastewater characterization. In addition, pilot testing of the preferred process and configuration is recommended prior to preliminary design of the system. As noted in Table 5-17, FOG can have adverse affects on all the processes proposed and for specific processes such as the BAF, design loading rates must be determined via pilot testing.

5.12 FINDINGS AND RECOMENDATIONS

5.12.1 Alternatives Cost Summary

The present worth and capital costs for scenarios 1, 2 and 3 are summarized in Tables 5-18 and 5-19. These costs are based on a TN of 8 mg/L. Initial indications are that a TN of 5 mg/L or lower will result in an additional 30 to 40 percent increase in capital cost as well as additional operation and maintenance costs. The detailed spreadsheets for capital and O&M costs used to develop these present worth costs are included in Appendix E. Table 5-20 summarizes the capital costs for the various alternatives for Scenario 4.

Table 5-18 Present Worth Estimates for WMP Scenarios for a TN limit of 8 mg/L

	PI WWTF Scenario 1	PI/PIT WWTFs Scenario 2	PSNH Scenario 3			PIT Scenario 3		
Technology:	SBR	SBR	SBR	MLE	IFFAS	SBR	MLE	IFFAS
	M$	M$	M$	M$	M$	M$	M$	M$
WWTF	158	238	152	152	154	150	150	151
Redirect/Shed	0	13	22	22	22	22	22	22
CSOs	27.2	4.2	29	29	29	29	29	29
Total	185.2	255.2	204	204	206	201	201	202

Table 5-19 Summary of Capital Cost Estimates for WMP Scenarios for a TN limit of 8 mg/L

	PI WWTF Scenario 1	PI/PIT WWTFs Scenario 2	PSNH Scenario 3			PIT Scenario 3		
Technology:	SBR	SBR	SBR	MLE	IFFAS	SBR	MLE	IFFAS
	M$	M$	M$	M$	M$	M$	M$	M$
WWTF	77 (1)	131	76	79	81	74	77	78
Redirect/Shed	0	13	22	22	22	22	22	22
CSOs	27.2	4.2	29	29	29	29	29	29
Total	104.2	148.2	127	130	132	125	128	129

1 - WWTF option not feasible since available technologies cannot fit within the setback limits on PI.

Table 5-20 Summary of Capital costs for Scenario 4 (Exclusive of CSO Costs)

ALTERNATIVE	OPINION OF COST
1 MBBR-BAF	$ 35 Million
2 MBBR-MBBR-DAF	$ 37 Million
3 MBR	$ 40 Million*

5.12.2 Recommendations

Prior to the development of Scenario 4, Scenario 3 using SBRs at the PIT WWTF was the preferred option developed and presented in this TM. However, throughout the process of evaluating the original 3 scenarios for TM 5, potential issues were identified which influenced the decision to re-evaluate the preferred option.

The first area of concern was permitting of a 9.2 MGD outfall from the PIT WWTF. The additional flow raised concerns with the NHDES and EPA of shellfish beds impacts. Initial time of travel studies conducted as part of the October 2009 dye study indicate administrative closure areas would be expanded causing a loss of use and anti-degradation issues. The City is waiting for DES to finalize and release their Dye Study results which will define the potential closure areas. In addition, the governing body of the Town of Eliot, Maine and a private shellfish company have gone on record against increasing the flow from the PIT WWTF outfall. The Maine DEP may have some level of legal jurisdiction on this. These concerns are documented in a letter received by the City from Spinney Creek Shellfish, Inc. that is included in Appendix D.

Based on information provided by the NH DES in January and February 2010, the use of PIT outfall for the full design flow will not likely be permitted. In addition, the NH DES has stated that the current PI WWTF outfall is the desired location. Therefore, to use the PIT WWTF site, a new pump station and forcemain would need to be constructed to convey effluent to the PI WWTF outfall. The estimated capital cost for this is $12 to $15 million.

Due to the inability to use the PIT WWTF outfall location for the full design flow, the City determined that it was necessary to develop an alternative scenario, Scenario 4. Scenario 4 focuses on keeping all wastewater treatment on Peirce Island, reusing as much of the existing infrastructure as possible and achieving secondary treatment for an annual average flow of 6.2 MGD and a peak sustained flow of 9.2 MGD with lower cost treatment options. In this scenario the PIT WWTF would continue to operate and may require expansion in the future to meet the demands of the Pease International Tradeport.

The three potential treatment alternatives developed for Scenario 4 have been discussed in Section 5.11 with respect to process configuration, meeting the potential TN limits, siting considerations, and cost of implementation. It is recommended that prior to a finalizing the configuration of Scenario 4 a wastewater characterization should be completed. Once a configuration has been selected a pilot study of the final configuration should be conducted.

Scenario 4 is not without its own regulatory concerns however. Unless all the unit processes identified for the Scenario 4 alternatives can be housed within the existing fence line, setback waivers and or encroachment of historic resources associated with Fort Washington and other resources in the area may be required to site the WWTF on Peirce Island. The US EPA would be the lead agency to participate in the Section 106 process relative to the impacts on the historic structures, should the City choose to modify and expand its treatment facility at Peirce Island.

5.12.4 Next Steps

The City will continue to explore the options identified in Scenario 4 in order to find a solution that best meet regulatory and financial constraints. The City has advised EPA and NHDES that the new information has required a reevaluation and the City may require time and financial resources to development additional information in addition to the WMP process.

The City will develop an affordability analysis and evaluate the impact on the implementation schedule to be developed. Assuming the final solution will be based on a Scenario 4, detailed cost estimates for the potential treatment alternatives must be developed.

A full wastewater characterization, including the identification of fats, oils and grease loading to the secondary process must be completed. These evaluations should be done under varying flow conditions to allow full evaluation of the Scenario 4 treatment processes.

ATTACHMENT 3

UPDATED TECHNICAL MEMORANDUM NO. 5 TABLES

UPDATED TM 5 TABLES

Table 5-2 Derivation of Average Daily Flow

Source	Current Plant Rating (MGD)	Increase through Year 2030 (MGD)	2030 Plant Rating (MGD)	Flow Increase through Year 2060 (MGD)	2060 Plant Rating (MGD)
PI WWTF	4.8	0.9	5.7	1.3	6.1
PIT WWTF	1.2	0.5	1.7	1.1	2.3
Regional	N/A	0.5	0.5	0.8	0.8
Combined	6.0	1.9	7.9	3.2	9.2

Table 5-7 Scenario 2 Cost Estimates

TN Limit, mg/L	8		
Technology	SBR		
	Capital Costs, M$	O&M Costs, M$/year	Present Worth, M$
PI/PIT WWTF	131	8.5	238
TN Limit	5		
Technology	SBR		
	Capital Costs, $M	O&M Costs, $/year	Present Worth, $M
PI/PIT WWTF	153	8.9	264
TN Limit	3		
Technology	SBR		
	Capital Costs, M$	O&M Costs, $/year	Present Worth, $
PI/PIT WWTF	153	9.0	266

Table 5-8 Scenario 3 WWTF Cost Estimates

TN Limit, mg/L	8								
Technology	MLE			IFFAS			SBR		
	Capital Costs, M$	O&M Costs, $/year	Present Worth, $	Capital Costs, M$	O&M Costs, $/year	Present Worth, $	Capital Costs, M$	O&M Costs, $/year	Present Worth, $
PIT WWTF	77	5.8	150	78	5.8	151	74	6.0	150
PSNH/ Sprague[1]	79	5.8	152	81	5.9	154	76	6.0	152

Table 5-8 Scenario 3 WWTF Cost Estimates

TN Limit	5								
Technology	MLE			IFFAS			SBR		
	Capital Costs, M$	O&M Costs, $/year	Present Worth, $	Capital Costs, M$	O&M Costs, $/year	Present Worth, $	Capital Costs, M$	O&M Costs, $/year	Present Worth, $
PIT WWTF	98	6.2	175	100	6.2	178	97	6.4	177
PSNH/ Sprague[1]	102	6.2	179	103	6.2	181	99	6.4	179
TN Limit	3								
Technology	MLE			IFFAS			SBR		
	Capital Costs, M$	O&M Costs, $/year	Present Worth, $	Capital Costs, M$	O&M Costs, $/year	Present Worth, $	Capital Costs, M$	O&M Costs, $/year	Present Worth, $
PIT WWTF	98	6.3	176	100	6.3	179	97	6.5	178
PSNH/ Sprague[1]	102	6.3	181	103	6.3	182	100	6.5	181

Table 5-16 CSO Abatement Capital Cost Components

Component	Scenario 1	Scenario 2	Scenario 3
Regulating Structure at CSOs 010A/010B	$0.2	$0.2	$0.2
Off-Line Storage Facility	$27.0M	$4.0M	N/A
Peirce Island WWTF Improvements:	N/A	N/A	$29 M
Total	$27.2M	$4.2M	$29.2

Note: Flow redirection and debottlenecking costs for Scenarios 2 and 3 are included elsewhere.

Table 5-18 Present Worth Estimates for WMP Scenarios for a TN limit of 8 mg/L

	PI WWTF Scenario 1	PI/PIT WWTFs Scenario 2	PSNH Scenario 3			PIT Scenario 3		
Technology:	SBR	SBR	SBR	MLE	IFFAS	SBR	MLE	IFFAS
	M$	M$	M$	M$	M$	M$	M$	M$
WWTF	158	238	152	152	154	150	150	151
Redirect/Shed	0	13	22	22	22	22	22	22
CSOs	27.2	4.2	29	29	29	29	29	29
Total	185.2	255.2	204	204	206	201	201	202

Table 5-19 Summary of Capital Cost Estimates for WMP Scenarios for a TN limit of 8 mg/L

	PI WWTF Scenario 1	PI/PIT WWTFs Scenario 2	PSNH Scenario 3			PIT Scenario 3		
Technology:	SBR	SBR	SBR	MLE	IFFAS	SBR	MLE	IFFAS
	M$	M$	M$	M$	M$	M$	M$	M$
WWTF	77 (1)	131	76	79	81	74	77	78
Redirect/Shed	0	13	22	22	22	22	22	22
CSOs	27.2	4.2	29	29	29	29	29	29
Total	104.2	148.2	127	130	132	125	128	129

ATTACHMENT 4

NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES

Comments on Portsmouth TM 5 Draft Report (December 2009)

Answers to questions posed by the NH DES are provided in ***bold italic*** font.

p.4/Table 5-17 - The dollar values in Table 5-17 (Present Worth Estimates for WMP Scenarios for a TN limit of 8 mg/L) do not match with those in Table 5-8.

Following the submission of the draft Technical Memorandum 5, both Table 5-8 and Table 5-17 were updated with more recent cost data for use by the VE team and are included in the supplement to Technical Memorandum 5.

p.11/Table 5-2 - The Peirce Island WWTF Current Plant Rating should be 4.8 MGD, which is their permitted design flow, not 4.5 MGD. How does this change the 2060 Plant Rating for Peirce Island WWTF (5.8 MGD in Table 5-2) and the 2060 Plant Rating for Combined (8.9 MGD in Table 5-2)? Also, while it is accurate to say that the Pease International Tradeport WWTF Current Plant Rating is 1.2 MGD, it needs to be kept in mind that the Pease International Tradeport WWTF outfall is shared w/ Newington POTW, which has a permitted design flow of 0.29 MGD. When talking about antidegradation and increased flow that will be discharged in future permitting scenarios, all of the permitted flow that will be coming out of discharge pipe is taken into consideration in developing a dilution factor and permit limits.

Table 5-2 has been updated to reflect the permitted design flow for Peirce Island and is included in the supplement to Technical Memorandum 5. Year 2030 and Year 2060 flows for Peirce Island have been updated accordingly.

For all flow analysis, the Regional Flow includes Newington's flows and assumes the Newington WWTF would not be in operation. The Newington flows were included in this manner, as directed by representatives of the NH DES and the EPA at our December 12, 2008, meeting. Therefore, no changes in the flow analysis or antidegradation analysis are required.

p.31 – Under the third advantage for scenario 1, add that the existing outfall at Peirce Island would need to be modified to maintain existing dilution factor for higher flow.

Under Scenario 1, the peak flow through the outfall would remain unchanged from present conditions with up to 22 MGD discharged from the Peirce Island outfall during peak wet weather conditions. Therefore modifications to the outfall are not required. However, if modifications were required, this would be a disadvantage, not an advantage. Therefore, no changes to Technical Memorandum 5 are required.

p.31 – Under disadvantages for scenario 1, and similar to the other two alternative, add that an antidegradation analysis would be required for any pollutants for which the load could not be held to that currently being discharged. This would not be as difficult as with the other two alternatives since the existing water quality isn't as good as at other potential outfall locations.

All of the proposed WWTF options would provide secondary treatment with some level of nitrogen removal. Since the peak flow rate would remain unchanged, the pollutant load would be reduced for all pollutants being treated, as compared to current operations. Therefore, no changes to Technical Memorandum 5 are required.

p.57 – First paragraph of section 5.11.1. Although the final allocation for nitrogen is yet to be finalized, the cost estimates for the different scenarios and outfall locations should reflect the fact that moving the outfall closer to Great Bay will make the necessary nitrogen limits more stringent. This is due to the fact that the critical areas for eelgrass are near Great Bay and tidal flushing decreases (and the detention time of nutrients increases) as you go from the mouth of the Piscataqua River to the head of the estuary.

Since total nitrogen limits have yet to be established for the outfall locations, a range of possible limits (3 mg/L, 5 mg/L and 8 mg/L) have been evaluated. No formal findings have been provided by the NH DES or EPA to suggest that the total nitrogen limit would be more stringent the further up river the outfall is located. Costs for lower total nitrogen limits have been developed, but as presented in the document, it has been assumed that they would not be applicable. Therefore, no changes to Technical Memorandum 5 are required.

p.58 – Recommendations section 5.11.2. It is stated that the City is limited in its future decision making ability until future nitrogen limits are known. Although the nitrogen allocation has not been finalized it should not stop the City from moving forward with value engineering. It is known that nitrogen removal will be required and that the limits will be 3 mg/L, 5 mg/L or 8 mg/L or some combination thereof depending on the outfall location.

Value Engineering has been completed and the preliminary results of that exercise will be submitted under separate cover. However, the City remains constrained in its future decision making ability until the nitrogen limits are known. The size of the unit process reactors varies with varying total nitrogen limits. Also, with a lower total nitrogen limit, additional unit processes may be required to meet that limit.

p.58 – Regulatory Issues section 5.11.3. It is stated that the city is waiting for DES to finalize and release their dye study. Study results have recently become known and it is clear that the proposed flow increase at the Pease International Tradeport outfall would require an administrative closure of shellfish beds near Dover Point and Little Bay if the bacteria loading also increased. ***The discussion regarding the dye tracer study findings will be updated prior to the final submission of the Wastewater Master Plan. Initial findings were provided by the NH DES on February 25, 2010.***

p. 57 – Regulatory Issues section 5.11.3 in last paragraph. Based on the above comment as well as the uncertainty of any antidegradation review for toxics and oxygen demanding pollutants at any relocated outfall, we agree with the City's assessment that if the new/expanded outfall at Pease could not be permitted that Scenario 3 would still be feasible by routing the treated effluent back to the Deer Street CSO area or to the Peirce Island outfall. It would be preferable to keep the outfall at Peirce Island since it would only be necessary to demonstrate that the load will be held, which should be relatively easy considering the fact that the WWTF will be upgraded to an advanced treatment system. Another reason this would be preferable is that the CSO 13 area is approximately one mile closer to Spinney Creek than the Peirce Island outfall. We recommend that the City look further into the costs for this option.

The cost to install a new pump system and outfall line to Peirce Island has been estimated to be $12M to $15M. The final Wastewater Master Plan will be updated to reflect this information.

p.59 - Is the $5.8M a net present worth (consisting of capital and O&M costs)?

The $5.8M is capital cost only. Present worth of O&M costs are estimated at $1.18M over 20 years at 5% interest.

p.59 - Next Steps section 5.11.4. Discharging treated wastewater with additional pollutant loadings from the expanded Pease International Tradeport WWTF to the Pease International Tradeport outfall location may no longer be viable. If the City chooses to reroute the discharge back to Peirce Island the requirements for the antidegradation review will be simplified significantly as discussed above. For next steps the City will need to collect the information described in Appendix H (antidegradation modeling data needs) for the chosen outfall location. If the City chooses to move the outfall away from Peirce Island it will also be necessary to select a model to address antidegradation for oxygen demanding pollutants. DES will need to review and comment on a sampling and analysis plan for both modeling efforts. We recommend that as soon as the City has selected a consultant to help it with the modeling that a meeting be scheduled between the City, EPA and DES. We also recommend that a schedule for sampling and modeling effort be agreed to as soon as possible.

Supplemental information for Technical Memorandum 5 includes the option to construct a high rate process on Peirce Island, negating the need to relocate Peirce Island WWTF outfall upstream of its current location. Under this Scenario, the Pease International Tradeport WWTF would continue to operate in tandem with the Peirce Island WWTF. The above statement, "*It would be preferable to keep the outfall at Peirce Island since it would only be necessary to demonstrate that the load will be held, which should be relatively easy considering the fact that the WWTF will be upgraded to an advanced treatment system*" supports the City's assertion that an antidegradation analysis at the Peirce Island outfall is not necessary. However, if an outfall location other than Peirce Island were pursued, the City will arrange a meeting with the EPA and DES as soon as practicable to address the questions as stated above.