NEW HAMPSHIRE SEACOAST REGION WASTEWATER MANAGEMENT FEASIBILITY STUDY

FINAL ALTERNATIVES REPORT
SUBTASK 4.5

For
NEW HAMPSHIRE
DEPARTMENT OF ENVIRONMENTAL SERVICES

May 2008

FINAL

NEW HAMPSHIRE SEACOAST REGION WASTEWATER MANAGEMENT STUDY

ALTERNATIVES REPORT

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SECTION 1.0 EXECUTIVE SUMMARY

1.1 INTRODUCTION

The primary purpose of the Alternatives Report is to describe the components of the four selected alternatives for wastewater management in the New Hampshire Seacoast Region and to evaluate the environmental, non financial issues, and planning level construction costs associated with their implementation. The alternatives have been developed to address the projected future wastewater flow and loads as well as effluent permit limits.

The four alternatives are as follows:

- Alternative 1 - No Action
- Alternative 2 - Treatment at Existing Wastewater Treatment Facilities (WWTFs) with a Regional Gulf of Maine Discharge
- Alternative 3 - Decentralized Treatment and Continued Use of Existing WWTFs
- Alternative 4 - Treatment at Existing WWTFs and Discharge to Land Application Sites

As agreed with the NHDES, the Great Bay Estuary Commission, and the attendees of the Project Charrette it is not the intent of this report to recommend a specific alternative to carry forward. Rather, the intent of this report is to discuss a number of issues and impacts associated with the implementation of the four alternatives and allow stakeholders to subsequently decide on the next steps.

It should be noted that the development and analysis of the four alternatives are planning level in nature and are intended to provide a relative comparison between alternatives. Many of the analyses are qualitative in nature due to the level of detail available at the feasibility study level. If one or more of these alternatives or a combination of the alternatives were to be carried forward, then significant refinement would need to occur on both the development and analysis of the alternatives.

1.2 REPORT FORMAT

The Alternatives Report is presented in ten report sections and seven appendices.

The ten report sections present the development and analysis of the selected wastewater management alternatives. The appendices include more specific details on methodologies and analyses.

1.3 SUMMARY OF REPORT SECTIONS

The following is a brief summary of the contents of the report sections.

Section 1 – Executive Summary. Section 1 provides an overview of the Alternatives Report and its contents.

Section 2 - Introduction and Background. Section 2 outlines the process used to identify ten wastewater management alternatives and the selection of four alternatives to evaluate. This section highlights the background information used to develop the selected alternatives including the projected future flows and loads for the study area, the septage disposal issues in the study area, and the projected WWTF effluent limits for the different alternatives. This section introduces the methods used to develop the four alternatives and the categories of analyses that were used to evaluate and compare the alternatives in this repot.

Section 3 – Alternatives Description and Components. In Section 3, readers will find a technical description of the components that would be required to implement each of the four alternatives. For each alternative, the components have been developed and described in the following categories:

- Anticipated Wastewater Treatment Facility Upgrade Requirements.
- Anticipated Conveyance Requirements.
- Anticipated Discharge and Disposal Requirements.
- Other Anticipated Components.

The Anticipated Wastewater Treatment Facility Upgrades for each alternative include descriptions of the following upgrade components:

- Types of Process Upgrade Needed.
- Carbon Removal Upgrades.
- Total Nitrogen Removal Upgrades.
- Total Phosphorus Removal Upgrades.
- Other Unit Process and Equipment Upgrades.

The Anticipated Conveyance Requirements include descriptions of the following components as applicable to specific alternatives:

- Pump Stations.
- Pipelines.

The Anticipated Discharge and Disposal Requirements include descriptions of the following components as applicable to specific alternatives:

- No Change in Current Discharge Practice.
- Gulf of Maine Outfall.
- Land Application.

The Other Anticipated Components subcategory includes descriptions of the following alternative components which do not fall into one of the three categories above:

- Regional Post-Treatment Facility.
- Community On-lot Decentralized Systems.

Section 4 – Methods of Analysis. Section 4 identifies and describes the different methods of analysis that were used to evaluate the four wastewater alternatives. The general categories of analysis include the following:

- Environmental Analysis including:
  - Land Use and Growth
  - Air Quality
  - Surface Water Flow, Groundwater Recharge, and Water Quality
  - Wetlands and Terrestrial Resources
  - Aquatic Resources
  - Rare and Endangered Species

- Non-Monetary Factor Analysis including:
  - Complexity
  - Public Testimony
  - Implementation

- Planning Level Construction Costs including:
    - Capital Costs
    - Land Acquisition

Section 5 – Alternative 1 (No Action) Analysis. This section identifies and describes the analysis and evaluation of Alternative 1. This section evaluates and analyzes the alternative components described in Section 3 with the methods identified and described in Section 4.

Section 6 – Alternative 2 (Treatment at Existing WWTFs with a Regional Gulf of Maine Discharge) Analysis. This section identifies and describes the analysis and evaluation of Alternative 2. This section evaluates and analyzes the alternative components described in Section 3 with the methods identified and described in Section 4.

Section 7 – Alternative 3 (Decentralized Treatment and Continued Use of Existing WWTFs) Analysis. This section identifies and describes the analysis and evaluation of Alternative 3. This section evaluates and analyzes the alternative components described in Section 3 with the methods identified and described in Section 4.

Section 8 – Alternative 4 (Treatment at Existing WWTFs and Discharge to Land Application Sites) Analysis. This section identifies and describes the analysis and evaluation of Alternative 4. This section evaluates and analyzes the alternative components described in Section 3 with the methods identified and described in Section 4.

Section 9 – Alternatives Comparison. Section 9 compares the four alternatives against each other based on the analysis performed for each alternative in Section 5 through Section 8.

SECTION 2.0 INTRODUCTION AND BACKGROUND

The New Hampshire Seacoast Wastewater Management Feasibility Study was developed to assess the existing condition and potential future condition of the 17 wastewater treatment facilities (WWTFs) and a number of environmental quality categories in the 44 community Study Area. Four wastewater management alternatives have been chosen to be evaluated. This report summarizes the development of these alternatives, the components of these alternatives, and the financial and non-financial impacts of these alternatives.

2.1 IDENTIFICATION OF ALTERNATIVES

During the Preliminary Findings Report (PFR) stage of the study, nine preliminary alternatives were developed to manage the future wastewater treatment and disposal needs in the study area. Included as Appendix A is a memo entitled *Alternatives Development Methodology* (February 2006) describing the development of the ten alternatives. These alternatives were developed and presented to the public at a Charrette conducted in March 2006. The ten alternatives were also posted on the project website for public review and comment. Based on the input received during the Charrette as well as public testimony received throughout the project via informational meetings, written comments, telephone conversations, etc., the alternatives were screened and four alternatives were selected for further development analysis under future flow and loading conditions, effluent limits, and environmental conditions. The four alternatives selected for further development and analysis are as follows:

- Alternative 1 – No Action
- Alternative 2 – Treatment at Existing WWTFs with a Regional Gulf of Maine Discharge
- Alternative 3 – Decentralized Treatment and Continued Use of Existing WWTFs
- Alternative 4 – Treatment at Existing WWTFs and Discharge to Land Application Sites

The methodology for selecting the four alternatives is contained on the technical memorandum titled *Method for Selecting Wastewater Management Alternatives* (April 2006) and is included as Appendix B.

Figures 2-1 through 2-4 show a graphical representation of each of the four alternatives.

2.2 FUTURE FLOW AND LOADS TO THE STUDY AREA WWTFs

During the development of the PFR (dated December 2005) for this study, flows and loads to the WWTFs in the study area were projected. The methods for their development are included in the appendices of the PFR. The projected flows to the 17 WWTFs in the study area for the years 2025 and 2055 are summarized in Table 2 -1.

2.3 SEPTAGE DISTRIBUTION

For the purpose of this report, it was assumed that the WWTFs that do not currently take septage would not take septage in the future, and that WWTFs that currently take septage would continue to take septage in the future. For these WWTFs, the amount of septage to be received in the future was increased at the same percent as the projected WWTF flow increase.

It was noted in the PFR that septage treatment and disposal is a growing concern for the communities in the study area and more broadly in the entire State of New Hampshire. The desire of the New Hampshire Department of Environmental Services (NHDES) is to provide septage disposal for all of the septage generated in the New Hampshire within New Hampshire.

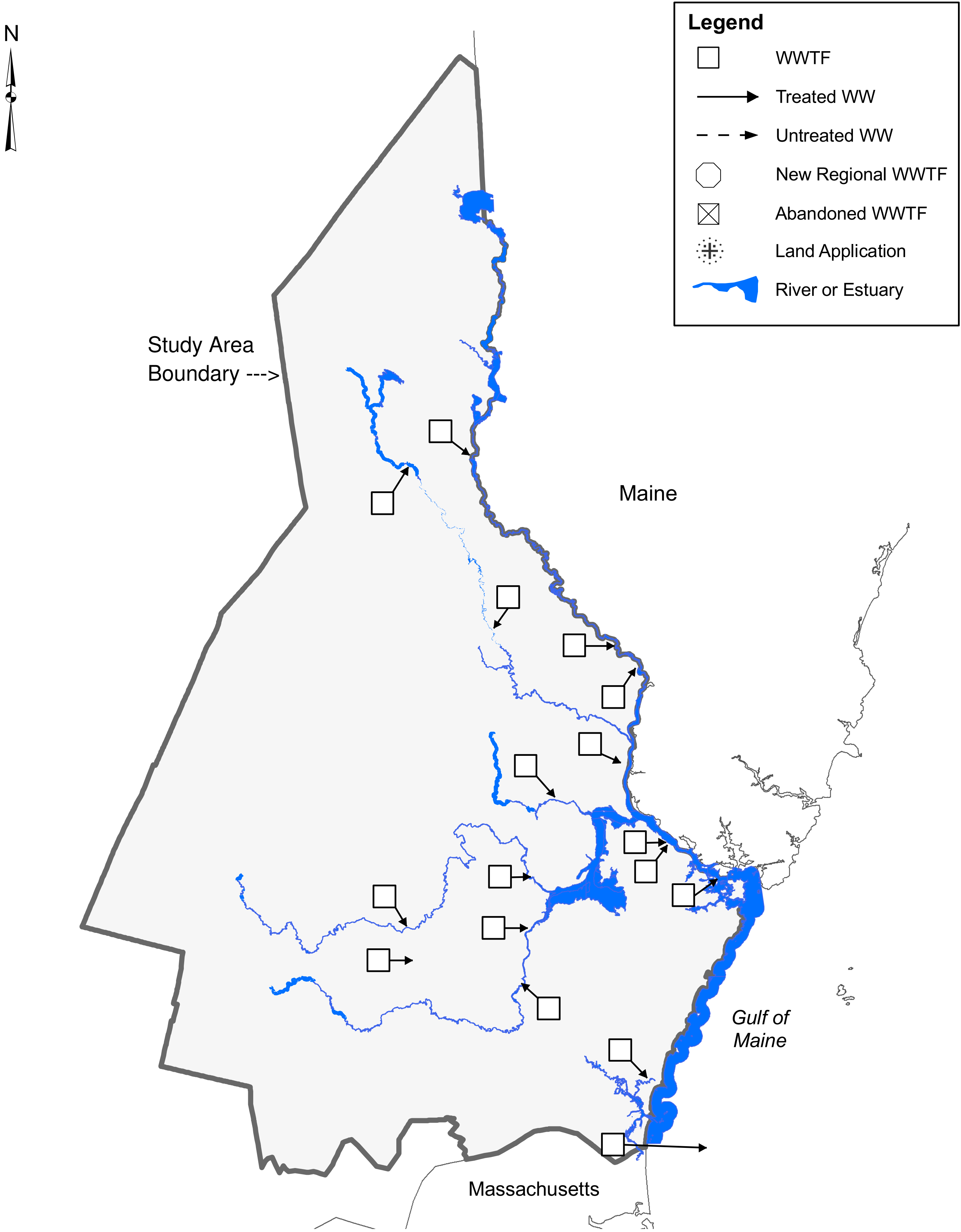

Figure 2-1. Alternative 1 - No Action

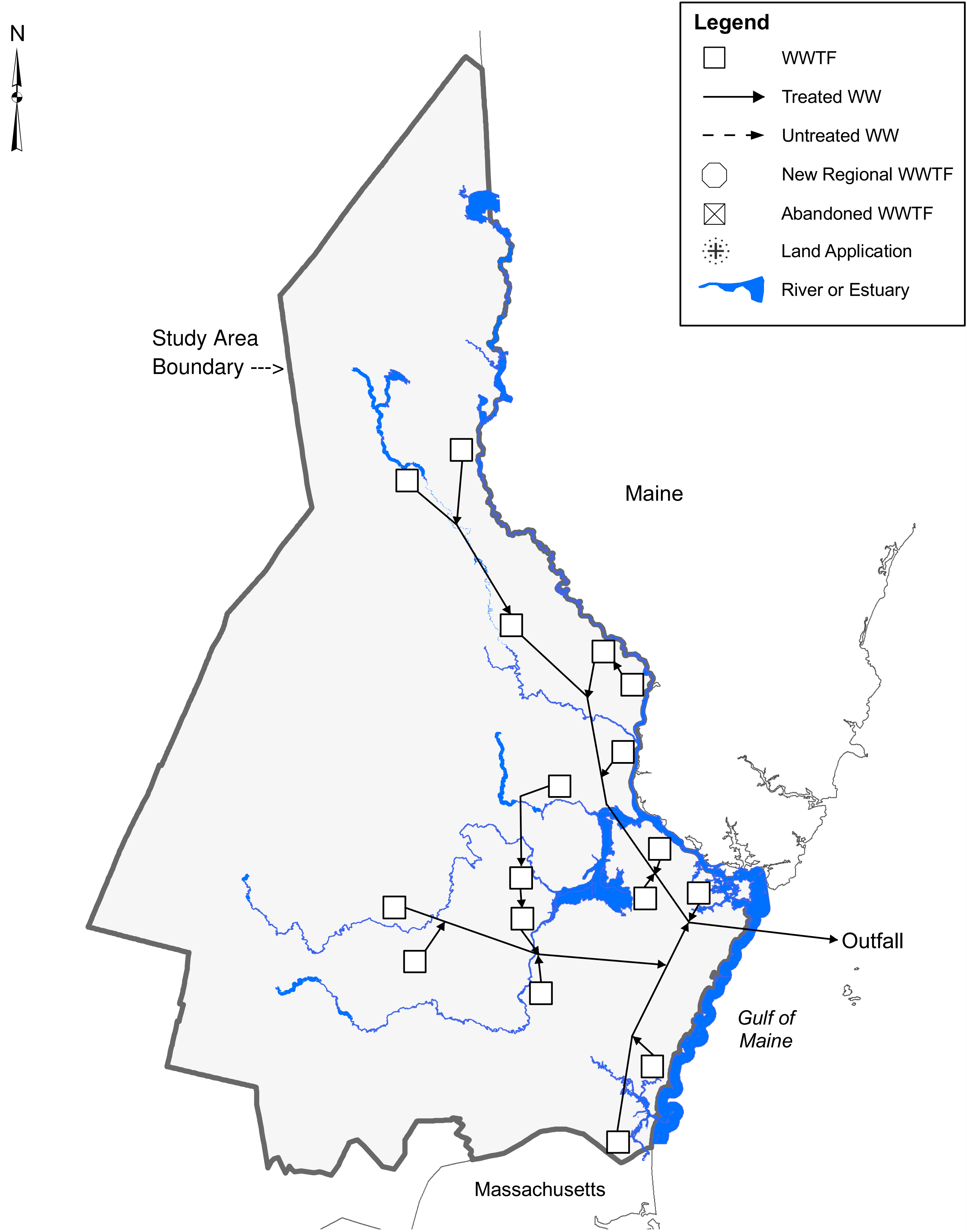

Figure 2-2. Alternative 2 - Treatment at Existing WWTFs with a Regional Gulf of Maine Discharge

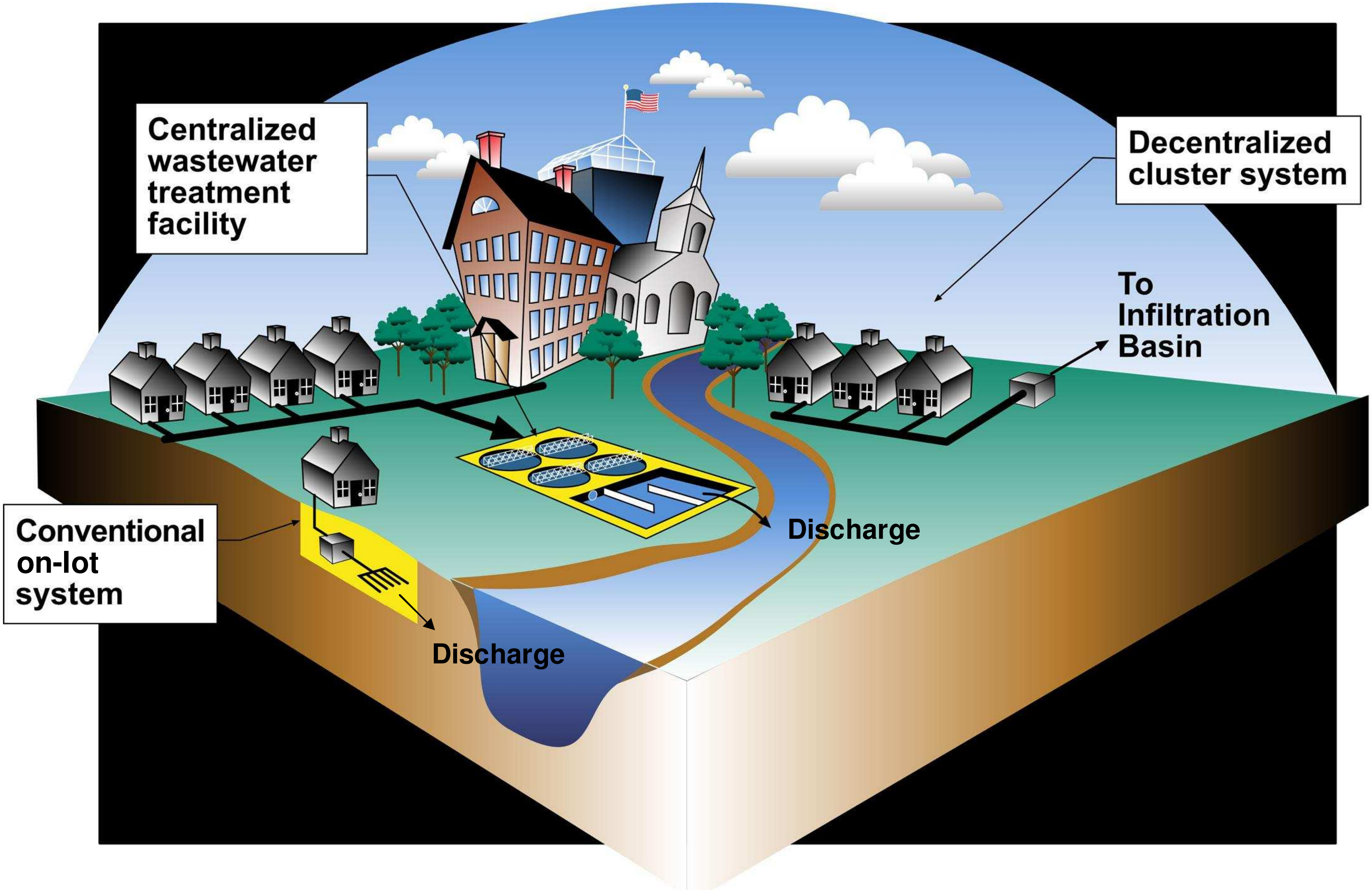

Figure 2-3. Alternative 3 – Decentralized Treatment and Continued Use of Existing WWTFs

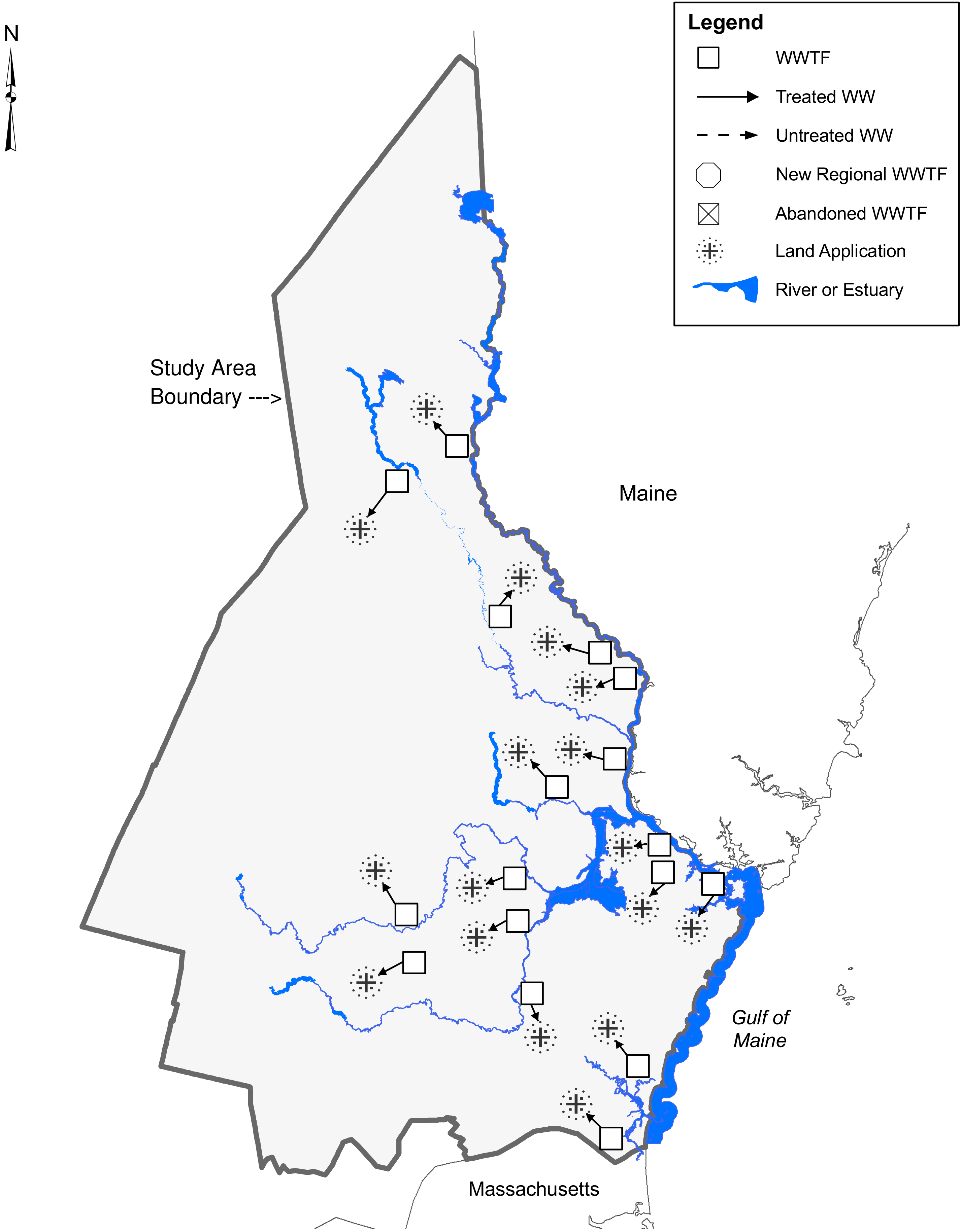

Figure 2-4. Alternative 4 - Treatment at Existing WWTFs with Land Application Discharge

Table 2-1. Current and Projected Flows to Study Area WWTFs in 2004, 2025, and 2055.

	YEAR 2004				YEAR 2025				YEAR 2055			
FACILITY	2004 Annual Ave Flow, MGD	2004 Max Month Flow, MGD	2004 Max Day Flow, MGD	2004 Peak Hour Flow, MGD	2025 Annual Ave Flow, MGD	2025 Max Month Flow, MGD	2025 Max Day Flow, MGD	2025 Peak Hour Flow, MGD	2055 Annual Ave Flow, MGD	2055 Max Month Flow, MGD	2055 Max Day Flow, MGD	2055 Peak Hour Flow, MGD
DOVER WASTEWATER	2.54	4.57	5.07	16.70	2.85	4.87	5.81	18.18	3.05	5.85	6.31	19.16
DURHAM WASTEWATER	1.00	1.71	2.00	7.10	1.10	1.80	2.30	7.80	1.20	2.50	2.50	8.20
EPPING WATER & SEWER	0.20	0.41	0.41	0.59	0.22	0.43	0.43	0.69	0.23	0.62	0.62	0.78
EXETER WASTEWATER	1.86	3.60	3.72	5.58	2.10	3.90	4.50	7.10	2.30	4.10	5.10	8.40
FARMINGTON WASTEWATER	0.21	0.52	0.52	0.64	0.26	0.57	0.57	0.92	0.30	0.61	0.68	1.14
HAMPTON WASTEWATER	2.40	3.30	4.70	7.10	2.80	3.70	5.70	9.10	3.10	4.90	6.50	10.70
MILTON WASTEWATER	0.05	0.08	0.10	0.15	0.06	0.09	0.14	0.23	0.07	0.14	0.17	0.30
NEWFIELDS WASTEWATER	0.05	0.08	0.09	0.14	0.05	0.08	0.11	0.18	0.06	0.11	0.13	0.21
NEWINGTON WASTEWATER	0.13	0.18	0.27	0.40	0.16	0.20	0.34	0.56	0.18	0.26	0.40	0.67
NEWMARKET WASTEWATER	0.64	1.04	1.28	1.93	0.77	1.16	1.66	2.68	0.82	1.45	1.82	3.00
PEASE DEVELOPMENT AUTHORITY	0.38	0.72	0.76	3.00	0.52	0.86	1.18	3.85	0.66	1.00	1.60	4.70
PORTSMOUTH WASTEWATER	4.70	8.23	22.00	22.00	5.20	8.70	22.00	22.00	5.60	11.60	22.00	22.00
ROCHESTER WASTEWATER	2.90	5.51	10.00	10.00	3.50	6.10	10.00	10.00	4.10	9.10	10.00	10.00
ROCKINGHAM COUNTY WWTF	0.08	0.09	0.16	0.23	0.11	0.12	0.26	0.44	0.13	0.15	0.32	0.55
ROLLINSFORD WASTEWATER	0.09	0.15	0.19	0.28	0.11	0.17	0.24	0.38	0.13	0.22	0.27	0.44
SEABROOK WASTEWATER	0.98	1.17	1.96	2.94	1.20	1.39	2.50	4.03	1.35	1.78	2.90	4.81
SOMERSWORTH WASTEWATER	1.10	1.79	3.30	6.00	1.30	1.90	3.70	6.80	1.40	2.40	4.00	7.50
Total	**19.30**	**33.14**	**56.53**	**84.78**	**22.31**	**36.04**	**61.44**	**94.93**	**24.68**	**46.80**	**65.32**	**102.55**

It is recommended that any of the four alternatives that are further refined by additional, subsequent studies include increases in septage handling capacity. This additional septage handling capacity could be provided at the larger WWTFs (>1.0 MGD), at WWTFs that require significant upgrades or activated sludge process upgrades, and regional septage handling facilities.

2.4 DECENTRALIZED SYSTEM FLOWS

As discussed in the *Method for Selecting Wastewater Management Alternatives* (dated April 2006; see Appendix B), the decentralized system alternative was selected to be developed in order to assess the impact of reducing the amount of future flows to the WWTFs and increasing the amount of treated wastewater flow that is recharged to the ground. For this decentralized system alternative, it was assumed that two-thirds of the projected additional future flow would be directed to a decentralized system and not to any of the existing WWTFs. See Section 3.3 for a more detailed description of this alternative and its components.

2.5 EFFLUENT LIMITS

The level of treatment anticipated to be required at each WWTF under each alternative is dependent on the specific discharge location. The possible future effluent limits for each alternative were developed during the preparation of the PFR. The NHDES, New England Intestate Water Pollution Control Commission (NEIWPCC), and the Environmental Protection Agency (EPA) collaborated on establishing possible future effluent limits. The possible future effluent limits also took into account comments received during a public comment process The effluent limits to be used in this study are included in Appendix K and Appendix L of the PFR in memos titled *Methodology for Development of Future WWTF Limits* (August 2005) and *Projected 2025 WWTF Discharge Limits* (August 2005), respectively.

2.6 ALTERNATIVES DEVELOPMENT

The four alternative concepts selected for evaluation were developed. The development included the identification of components anticipated to be required for each alternative. The components identified included the following:

- Anticipated WWTF Upgrade Requirements
- Anticipated Conveyance Requirements
- Anticipated Discharge and Disposal Requirements
- Additional Alternative Specific Anticipated Component Requirements (decentralized systems, regional disinfection facilities, etc.)

Section 3 of this report describes the components anticipated for each alternative as well as the preliminary sizing of these components.

2.7 METHODS FOR ANALYSIS

In order to compare the impact of the four alternatives, a number of methodologies were developed to standardize the analysis of the alternatives. The methodologies included the following:

- Environmental Analysis
- Non-Monetary Analysis

- Planning Level Construction Costs

Section 4 of this report describes the methodologies used to evaluate each alternative.

2.8 ANALYSIS

The four alternatives were analyzed for the following criteria:

- Environmental Analysis including:
    - Land Use and Growth
    - Air Quality
    - Surface Water Flow, Groundwater Recharge, and Water Quality
    - Wetland and Terrestrial Resources
    - Aquatic Resources
    - Rare and Endangered Species

- Non-Monetary Analysis including:
    - Complexity
    - Public Testimony
    - Implementation

- Planning Level Construction Costs

The alternatives are analyzed for these criteria in the following sections:

Section 5	Alternative 1 – No Action
Section 6	Alternative 2 – Treatment at Existing WWTFs with Regional Gulf of Maine Discharge
Section 7	Alternative 3 – Decentralized Treatment and Continued Use of Existing WWTFs
Section 8	Alternative 4 – Treatment at Existing WWTFs and Discharge to Land Application Sites

2.9 ALTERNATIVE COMPARISONS

The four alternatives were compared to each other based on the analysis criteria presented above. It should be noted than a number of evaluation criteria are qualitative in nature and that some professional judgment has been used in the comparisons. It was made clear at the Charrette held in March of 2006 that the public would decide on the relative importance of the analysis criteria. Accordingly we have not weighted or ranked the analysis criteria.

Section 9 of this report presents the comparisons.

SECTION 3.0 ALTERNATIVES DESCRIPTION AND COMPONENTS

The section describes the four alternatives and their components. Each alternative description is divided into the following elements:

- Anticipated Wastewater Treatment Facility (WWTF) Upgrade Requirements – This summarizes the anticipated upgrades for each WWTF to accommodate the year 2025 projected flows and loads. Also described are the anticipated process upgrade requirements to meet the future discharge limits based on the specific discharge locations.

- Anticipated Conveyance Requirements – This summarizes the conveyance components (i.e. pipelines and pump stations) anticipated to convey the treated wastewater from the WWTFs to the discharge location.

- Anticipated Discharge and Disposal Requirements – The anticipated discharge and disposal requirements include any new outfall pipes, pump stations and land disposal methods anticipated for each alternative related to final disposal.

- Other Anticipated Components – This summarizes components that are not included in the categories above but are anticipated for an alternative (decentralized systems, regional disinfection facilities, etc.).

3.1 ALTERNATIVE 1 – NO ACTION

For this alternative, wastewater treatment would continue at each of the 17 WWTFs within the study area, and treated effluent would be discharged at existing surface water discharge locations. Figure 3-1 shows the concept of this alternative.

The No Action alternative has been selected as one of the four alternatives as it sets a baseline for future conditions against which to compare impacts of the other alternatives. The inclusion of a No Action alternative is consistent with requirements for the National Environmental Policy Act (NEPA) process, which may be formally required depending on which alternative(s) may be ultimately implemented. Please note that although this alternative is considered “No Action”, WWTFs would still be required to meet the projected future effluent standards.

3.1.1 Anticipated WWTF Upgrade Requirements

A number of WWTF upgrades are anticipated for this alternative. Some of the upgrades are anticipated as a result of projected 2025 changes in the permit limits for the WWTF. The projected effluent limits for this study are included in Appendix K and Appendix L of the PFR in memos titled *Methodology for Development of Future WWTF Limits* (August 2005) and *Projected 2025 WWTF Discharge Limits* (August 2005), respectively. Other upgrades are anticipated as a result of projected increased flow and loadings to the WWTF and the inability of the existing unit processes to handle the 2025 future flows and loads.

Table 3-1 presents the upgrades anticipated for each WWTF under Alternative 1 and includes the following information:

- Type of Process Upgrade Needed – This includes upgrades for carbon removal, total nitrogen removal, the addition of an activated sludge process, and total phosphorus removal. The various process upgrades also indicate whether the upgrade is anticipated for the incremental flow increase to the WWTF from 2004 to 2025 or for the entire 2025 flow.

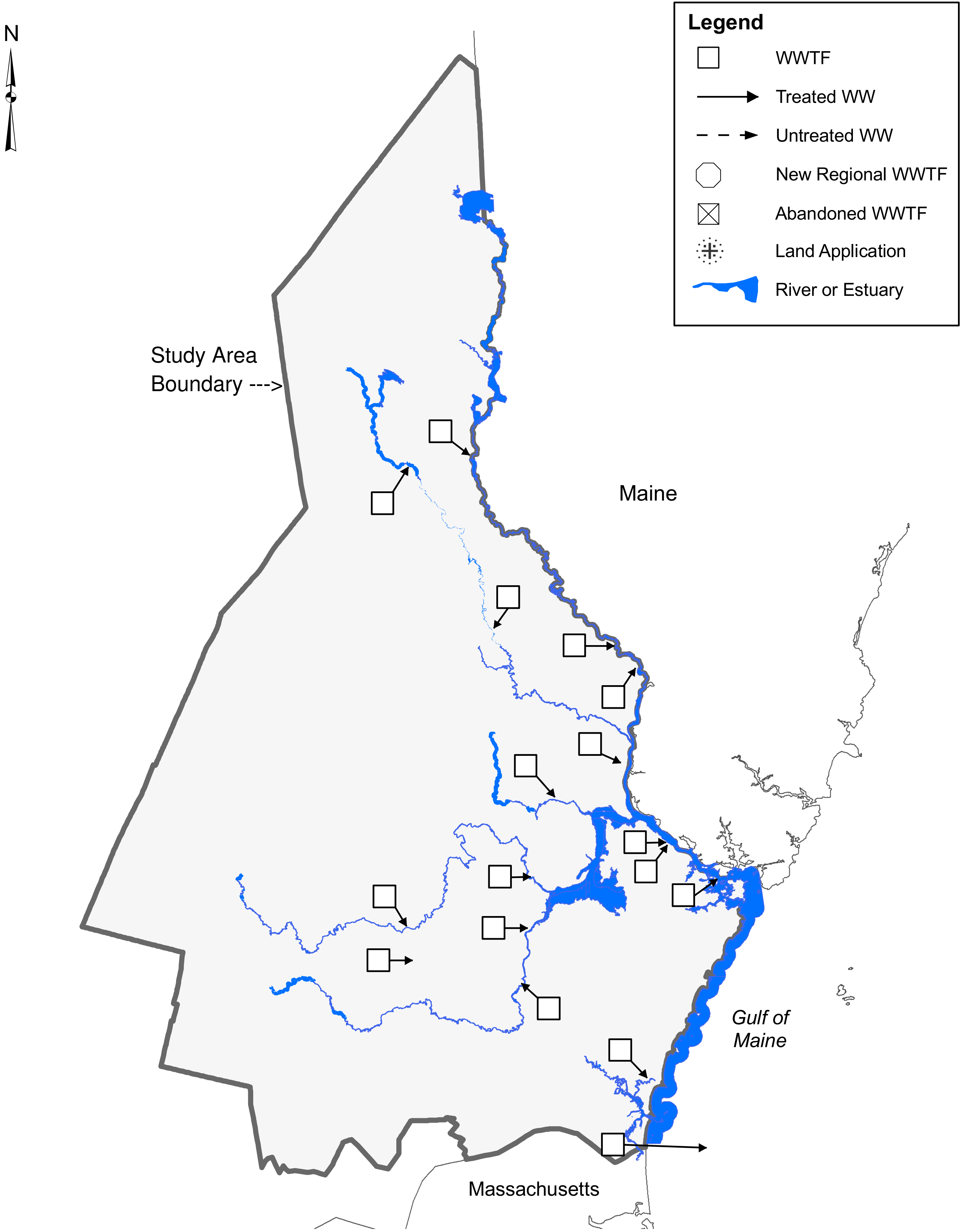

Figure 3-1. Alternative 1 - No Action

Table 3-1. Alternative 1 Anticipated WWTF Upgrade Requirements.

FACILITY	Year 2004 Max Mo. Flow, MGD	Year 2025 Max Mo. Flow, MGD	Upgrades Projected	Incremental Flow Increase, MGD	Carbon Removal Upgrade Anticipated	Carbon Filtration Upgrade Anticipated	Nitrogen Removal Upgrade Anticipated	TP Removal Upgrade Anticipated	Other Upgrades Anticipated
DOVER WASTEWATER	4.57	4.87	C, TN	0.3	yes new flow	no	yes	no	IP, Pre, Dis
DURHAM WASTEWATER	1.71	1.8	TN	0.09	no	no	yes	no	IP, Pre, Dis
EPPING WATER & SEWER	0.32	0.429	C, TN, TP	0.109	yes new flow	no MBR	yes - new flow	new flow chemical only	Pre, Mem, Dis
EXETER WASTEWATER	3.6	3.9	AS, C, TN	0.3	all flow	no	yes	no	Pre
FARMINGTON WASTEWATER	0.52	0.57	C, TN, TP	0.05	yes new flow	no also P	yes	yes	IP, Pre, M
HAMPTON WASTEWATER	3.3	3.7	C, TN	0.4	yes new flow	yes	yes new	no	M, Dis, SH
MILTON WASTEWATER	0.08	0.09	AS, C, TN, TP	0.01	all flow	No for P only	yes	yes	NR
NEWFIELDS WASTEWATER	0.08	0.084	AS, C, TN	0.004	all flow	no	yes	no	NR
NEWINGTON WASTEWATER	0.18	0.2	TN	0.02	no	no	yes	no	NR
NEWMARKET WASTEWATER	1.04	1.16	AS, C, TN	0.12	all flow	no	yes	no	IP, Pre, Dis
PEASE DEVELOPMENT AUTHORITY	0.72	0.86	NR	0.14	no	no	SBR mods only	no	Dis
PORTSMOUTH WASTEWATER	8.23	8.7	AS, C	0.47	all flow	no	no	no	Dis, SH
ROCHESTER WASTEWATER	5.51	6.1	TP	0.59	no	No for P only	yes new flow	new flow	2nd Clarifier
ROCKINGHAM COUNTY WWTF	0.085	0.118	AS, C, TN	0.033	all flow	yes	yes	no	NR
ROLLINSFORD WASTEWATER	0.15	0.17	TP	0.02	no	No for P only	no	yes new flow	NR
SEABROOK WASTEWATER	1.17	1.39	NR	0.22	no	no	no	no	Air
SOMERSWORTH WASTEWATER	1.79	1.9	C, TN, TP	0.11	yes new flow	No for P only	yes new flow	yes new flow	Pre
Totals	**33.06**	**36.04**		**2.99**					

Legend

C = Carbon
TN = Total Nitrogen
TP = Total Phosphorus
AS = Activated Sludge

IP = Influent Pumping
Pre = Preliminary Treatment
Dis = Disinfection
Mem = Membranes

M = Metals
Air = Aeration
SH = Solids Handling
NR= Not Required

- Carbon Removal Upgrades – This includes activated sludge upgrades, additional tankage, or cloth disc filtration for low carbon and total suspended solids limits. In the cases where an activated sludge upgrade is anticipated, it is typically to replace an aerated lagoon or trickling filter system that would not be able to meet the 2025 carbon limits at the 2025 loading. The anticipated activated sludge upgrade requirement may also indicate that the existing WWTF can meet the future carbon limits but cannot meet the total nitrogen limits.

- Total Nitrogen Removal Upgrades – The anticipated requirements for total nitrogen removal upgrades have been standardized to include tankage and process equipment anticipated to implement a Modified Ludzack-Etenger (MLE) process at the WWTFs. This upgrade may include the addition of tankage, installation of internal recycle pumps, and mixers for anoxic zones.

- Total Phosphorus Removal Upgrades – The anticipated requirements for total phosphorus removal upgrades have been standardized to include the addition of cloth disc filters and chemical addition for the removal of total phosphorus.

- Other Unit Process and Equipment Upgrades – Other upgrades are included based on hydraulic limitations or small process upgrades that do not necessitate the construction of additional tankage or separate unit processes. These upgrades include the following:
    - Influent Pumping
    - Preliminary Treatment (screenings or grit removal)
    - Disinfection
    - Membranes – Additional membranes for MBR processes
    - Metals removal evaluation – For WWTFs that have the potential for metals limits in their future permit limits, it has been assumed that a study would be performed in lieu of an upgrade to determine if the permit would include a metals limit.
    - Aeration capacity
    - Solids handling capacity

3.1.2 Anticipated Discharge and Disposal Requirements

For this alternative, the existing WWTF outfalls will be used for disposal.

3.2 ALTERNATIVE 2 – TREATMENT AT EXISTING WWTFs WITH A REGIONAL GULF OF MAINE DISCHARGE

For this alternative, treatment would continue at each of the 17 WWTFs within the study area. Subsequently, the effluent from these WWTFs would be conveyed through new regional infrastructure (e.g. pump stations and pipelines) for discharge to the Gulf of Maine. Figure 3-2 shows the concept of this alternative.

An additional component of this alternative is a Regional Post-Treatment Facility (RPTF). Disinfection at the individual WWTFs will not be performed under this alternative. This is due to the high potential for biological re-growth in the conveyance system as a result of the long conveyance times. Instead of localized disinfection, a RPTF will provide disinfection and sampling of the regionally collected WWTF effluents prior to discharge to the Gulf of Maine Outfall.

This alternative was selected as one of the four alternatives since Senate Bill 70 requires this study to determine the feasibility to remove treated effluent from the coastal drainage area and Great Bay and discharge it through a regional pipe in the Gulf of Maine.

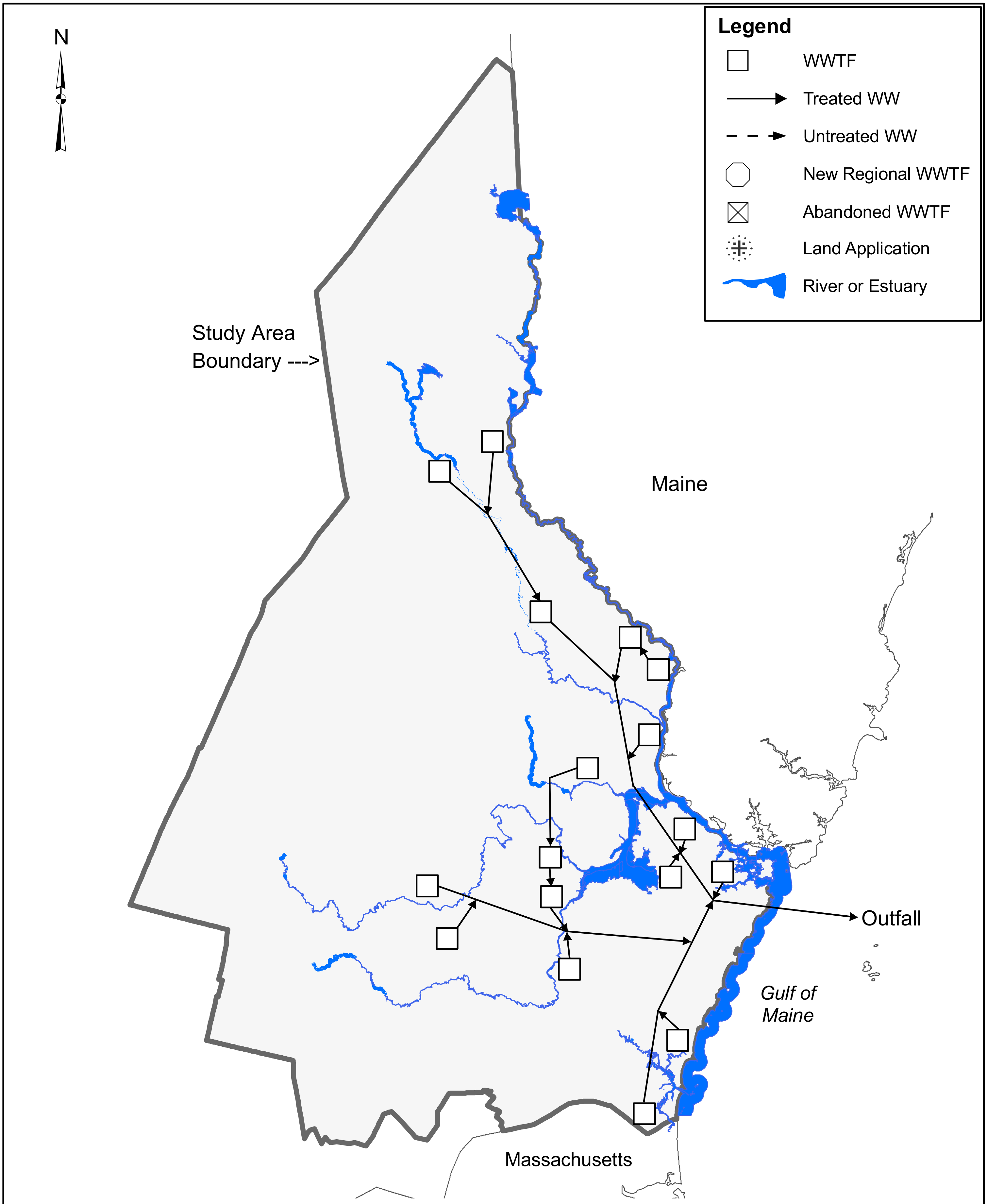

Figure 3-2. Alternative 2 - Treatment at Existing WWTFs with a Regional Gulf of Maine Discharge

3.2.1 Anticipated WWTF Upgrade Requirements

A number of WWTF upgrades are anticipated for this alternative. Some of the upgrades are anticipated as a result of projected 2025 changes in the permit limits for the WWTF. The projected effluent limits for this study are included in Appendix K and Appendix L of the PFR in memos titled *Methodology for Development of Future WWTF Limits* (August 2005) and *Projected 2025 WWTF Discharge Limits* (August 2005), respectively. Other upgrades are anticipated as a result of projected increased flow and loadings to the WWTF and the inability of the existing unit processes to handle the 2025 flows and loads.

Table 3-2 presents the anticipated upgrades required for each WWTF under Alternative 2. The information presented in Table 3-2 is described in Section 3.1.1.

3.2.2 Anticipated Conveyance Requirements

In order to convey the treated effluent from the 17 area WWTFs to one location prior to discharge to a regional outfall, a number of pipelines and pump stations are anticipated to be required. Figure 3-3 shows one possible conveyance route from the 17 WWTFs to the RPTF and ultimately to a Gulf of Maine outfall. It is assumed that all of the WWTF effluent flows will be conveyed via force mains. Force mains will eliminate the use of gravity sewers which need to be installed deeper than force mains, will prevent illegal hook ups to the conveyance system (since all hook ups would need to be pressurized), and will minimize the impact of inflow and infiltration into the conveyance system.

The route shown has been selected to use as many rights-of-way as possible (roads, gas pipeline routes, electrical distribution system routes, etc.) to minimize the quantity of previously undisturbed cross country routes and land acquisition that would be required. It should be noted that the selection of this route is for planning level study purposes only and is not meant to imply that a future conveyance system, if deemed feasible, would follow this routing.

Table 3-3 illustrates some of the anticipated conveyance system components required. It should be noted that these components have been sized to accommodate the average of the projected 2055 peak daily flow and the 2055 peak hourly flow. A fifty year design flow has been selected due to the typical 50 year service life of pipelines. The average of peak day and peak hour was selected due to the anticipated dampening of peak hourly flow through the various unit processes of the WWTFs. These conveyance system components include:

- Pump Stations – It is assumed that a pump station will be required at every WWTF, any place that two conveyance pipelines are joined into one pipeline, and every 10 miles along individual pipe lines. Table 3-3 lists the pump stations and their approximate sizes.

- Pipelines – Table 3-3 provides planning level lengths and sizes of the various conveyance pipelines. The pipelines have been sized to have maximum velocity in the pipelines of 5.0 feet per second at the average of the 2055 peak day flow and the 2055 peak hourly flow. Table 3-3 shows all of the different pipelines that would be anticipated for this routing. Table 3-3 also shows the individual WWTF effluents and the approximate pipeline distances, pipe sizes, and number of pump stations anticipated to combine all of the WWTF flows from their WWTF of origin along the conveyance system.

3.2.3 Regional Post-Treatment Facility

Disinfection at the individual WWTFs will not be performed under this alternative. This is due to the potential for biological re-growth in the conveyance system as a result of the long conveyance times. A Regional Post-Treatment Facility (RPTF) will be provided for disinfection and sampling of the regionally collected WWTF effluent. This facility is assumed to be chlorination and dechlorination facility that will provide a minimum of 30 minutes of chlorine contact time prior

Table 3-2. Alternative 2 Anticipated WWTF Upgrade Requirements.

FACILITY	Year 2004 Max Mo. Flow, MGD	Year 2025 Max Mo. Flow, MGD	Upgrades Projected	Incremental Flow Increase, MGD	Carbon Removal Upgrade Anticipated	Carbon Filtration Upgrade Anticipated	Nitrogen Removal Upgrade Anticipated	TP Removal Upgrade Anticipated	Other Upgrades Anticipated
DOVER WASTEWATER	4.57	4.87	C	0.3	yes new flow	no	no	no	IP, Pre
DURHAM WASTEWATER	1.71	1.8	NR	0.09	no	no	no	no	IP, Pre
EPPING WATER & SEWER	0.32	0.429	C	0.109	yes new flow	no	no	no	Pre, Mem
EXETER WASTEWATER	3.6	3.9	AS, C	0.3	all flow	no	no	no	Pre
FARMINGTON WASTEWATER	0.52	0.57	C	0.05	yes new flow	no	no	no	IP, Pre
HAMPTON WASTEWATER	3.3	3.7	NR	0.4	no	no	no	no	SH
MILTON WASTEWATER	0.08	0.09	C	0.01	yes new flow	no	no	no	NR
NEWFIELDS WASTEWATER	0.08	0.084	C	0.004	yes new flow	no	no	no	Air
NEWINGTON WASTEWATER	0.18	0.2	C	0.02	yes new flow	no	no	no	Air
NEWMARKET WASTEWATER	1.04	1.16	C	0.12	yes new flow	no	no	no	IP, Pre
PEASE DEVELOPMENT AUTHORITY	0.72	0.86	NR	0.14	no	no	no	no	NR
PORTSMOUTH WASTEWATER	8.23	8.7	AS, C	0.47	all flow	no	no	no	SH
ROCHESTER WASTEWATER	5.51	6.1	C	0.59	no	no	no	no	2nd Clarifier
ROCKINGHAM COUNTY WWTF	0.085	0.118	NR	0.033	no	no	no	no	NR
ROLLINSFORD WASTEWATER	0.15	0.17	NR	0.02	no	no	no	no	NR
SEABROOK WASTEWATER	1.17	1.39	NR	0.22	no	no	no	no	NR
SOMERSWORTH	1.79	1.9	NR	0.11	no	no	no	no	Pre, Air
Totals	**33.06**	**36.04**		**2.99**					

<u>Legend</u>

C = Carbon
TN = Total Nitrogen
TP = Total Phosphorus
AS = Activated Sludge

IP = Influent Pumping
Pre = Preliminary Treatment
Dis = Disinfection
Mem = Membranes

M = Metals
Air = Aeration
SH = Solids Handling
NR= Not Required

Table 3-3. Alternative 2 WWTF Effluent Conveyance Components

Pipe Routing and Flow Combining				Conveyance Components and Planning Level Sizing					
From	**To**			**Pipe Length, ft**	**Pipe Length, Miles**	**Year 2055 Flow, MGD**	**Year 2055 Pipe Size, in.**	**Number of Pump Stations Anticipated**	**Approximate Pump Station Size, MGD**
FARMINGTON WWTF	Northeast Main 1	0.91	MGD	35,000	6.63	0.91	8	1	0.91
MILTON WWTF	Northeast Main 1	0.24	MGD	26,000	4.92	0.24	4	1	0.24
From	**To**								
Northeast Main 1	Northeast Main 2	1.15	MGD	20,000	3.79	1.15	10	1	1.15
ROCHESTER WWTF	Northeast Main 2	10.00	MGD	4,000	0.76	10.00	24	1	10.00
From	**To**								
Northeast Main 2	Northeast Main 3	11.15	MGD	35,000	6.63	11.15	30	1	11.15
From	**To**								
ROLLINSFORD WWTF	Rollinsford Submain 1	0.36	MGD	12,000	2.27	0.36	6	1	0.36
SOMERSWORTH WWTF	Rollinsford Submain 1	5.75	MGD	-		5.75	18	1	5.75
From	**To**								
Rollinsford Submain 1	Northeast Main 3	6.11	MGD	19,000	3.60	6.11	20	1	6.11
From	**To**								
Northeast Main 3	Northeast Main 4	17.25	MGD	28,000	5.30	17.25	36	1	17.25
From	**To**								
DOVER WWTF	Northeast Main 4	12.74	MGD	4,000	0.76	12.74	30	1	12.74
From	**To**								
Northeast Main 4	Northeast Main 5	29.99	MGD	30,000	5.68	29.99	42	1	29.99
From	**To**								
NEWINGTON WWTF	Northeast Main 5	0.54	MGD	5,000	0.95	0.54	6	1	0.54
PEASE WWTF	Northeast Main 5	3.15	MGD	3,000	0.57	3.15	14	1	3.15
From	**To**								
Northeast Main 5	Ocean Outfall Main	33.67	MGD	13,000	2.46	33.67	48	1	33.67
From	**To**								
DURHAM WWTF	Durham Submain 1	5.35	MGD	31,000	5.87	5.35	18	1	5.35
NEWMARKET WWTF	Durham Submain 1	2.41	MGD	-		0.69	12	1	2.41
From	**To**								
Durham Submain 1	Durham Submain 2	7.76	MGD	14,000	2.65	7.76	24	1	7.76
NEWFIELDS WWTF	Durham Submain 2	0.17	MGD	-		0.17	4	1	0.17
Durham Submain 2	Southeast Inland Main 1	7.928	MGD	8,000	1.52		24	1	7.93
From	**To**								
EPPING WWTF	Epping Submain 1	0.70	MGD	9,000	1.70	0.70	8	1	0.70
ROCKINGHAM CO. WWTF	Epping Submain 1	0.44	MGD	4,000	0.76	0.44	6	1	0.44
Epping Submain 1	Southeast Inland Main 1	1.14	MGD	30,000	5.68	1.14	10	1	1.14
From	**To**								
EXETER WWTF	Southeast Inland Main 1	6.75	MGD	12,000	2.27	6.75	20	1	6.75
Southeast Inland Main 1	Coastal Submain 2	15.81	MGD	43,000	8.14	15.81	30	1	15.81
From	**To**								
SEABROOK WWTF	Coastal Submain 1	3.86	MGD	25,000	4.73	3.86	16	1	3.86
HAMPTON WWTF	Coastal Submain 1	8.60	MGD	6,000	1.14	8.60	24	1	8.60
From	**To**								
Coastal Submain 1	Coastal Submain 2	12.46	MGD	42,000	7.95	12.46	30	1	12.46
From	**To**								
Coastal Submain 2	Ocean Outfall Main	28.27	MGD	12,000	2.27	28.27	42	1	28.27
From	**To**								
Ocean Outfall Main	Post Treatment Facility	61.94	MGD	2,000	0.38	61.94	60	1	61.94
From	**To**								
PORTSMOUTH WWTF	Post Treatment Facility	22.00	MGD	8,000	1.52	22.00	36	1	22.00
From	**To**								
Post Treatment Facility	Gulf of ME Outfall	**83.94**	MGD	22,700	4.30	83.94	72	1	83.94
			Totals	**502,700**	**95.21**			**31**	

Notes:
- All flows in MGD
- All flows are the average of Year 2055 peak hour and peak day flows
- See Figure 3-3 for planning level conveyance routes used to develop this table

🟨 - Indicates flow originating from individual WWTFs

Figure 3-3. Potential Effluent Conveyance Route for Alternative 2.

G:\Projects\STATE\36800545GBY\Maps\Great Bay Basemap 03rev.mxd to dechlorination, and subsequent discharge into the Gulf of Maine outfall. At this time a site for a RPTF has not been identified. Its location on Figure 3-3 is not intended to imply that this location is either feasible or infeasible but only to show that the facility is to be located at the downstream terminus of the conveyance system. If Alternative 2 is deemed feasible, then additional studies would need to be performed to identify a suitable site for this facility.

3.2.4 Anticipated Discharge and Disposal Requirements

This alternative would include an outfall to the Gulf of Maine. Some of the components of the outfall would include: the outfall pipe from the RPTF, the outfall diffuser which would consist of a number of diffuser ports spread out along a length of pipe (to increase the dilution of the discharged effluent), and the diffuser ports themselves. Three candidate outfall sites were developed for evaluation. The location of the candidate outfall sites are shown in Figure 3-4, and some of the details of these locations are included in Table 3-4. More detailed information about the candidate outfall site evaluations and designs can be found in Appendix D. These sites were selected to provide a range of distances from shore and water depths. The selection of these sites is for study purposes only and is not intended to indicate the feasibility of those sites.

TABLE 3-4. CANDIDATE OUTFALL DETAILS

Outfall Details	Site 1	Site 2	Site 3
Distance from Shore, miles	4.3	8.0	11.6
Depth at Low Water, ft.	60	120	160
Outfall Length, miles	4.3	15.5	20.0
Outfall Diameter, ft.	6.0	6.0	6.0
Diffuser Design			
Length, ft	1,290	2,580	3,440
Number of Ports	44	44	44
Port Diameter, in.	6.0	6.0	6.0

Depending on the outfall location, as well as the location and elevation of the RPTF, there is the potential that a pump station may be required at the RPTF to provide sufficient head to discharge the effluent through the Gulf of Maine outfall (especially under peak flow and high tide conditions). In general, the further the outfall is away from the RPTF, the greater the chance that a pump station will be required. The head requirements of the different sites at various flow rates are shown in Table 2 of Appendix D. For the purpose of this study, it is assumed that an effluent pump station would be required.

3.3 ALTERNATIVE 3 – DECENTRALIZED TREATMENT AND CONTINUED USE OF EXISTING WWTFs

For this alternative, the existing WWTFs would continue to be used; however, it is assumed that the existing 2004 flow and one-third of the 2025 projected increase in wastewater flow would be treated at the existing WWTFs and discharged at the existing surface water discharge locations. The remaining two-thirds of the projected incremental flow increase would go to decentralized systems for treatment and subsurface land application. Figure 3-5 shows the concept of this alternative.

Specific identification of decentralized system locations will not be conducted as part of this alternative. Although this alternative was not one of the ten preliminary alternatives, it was developed and chosen to be carried forward for further study largely in response to the many comments received requesting that decentralized treatment be included as part of a regional solution.

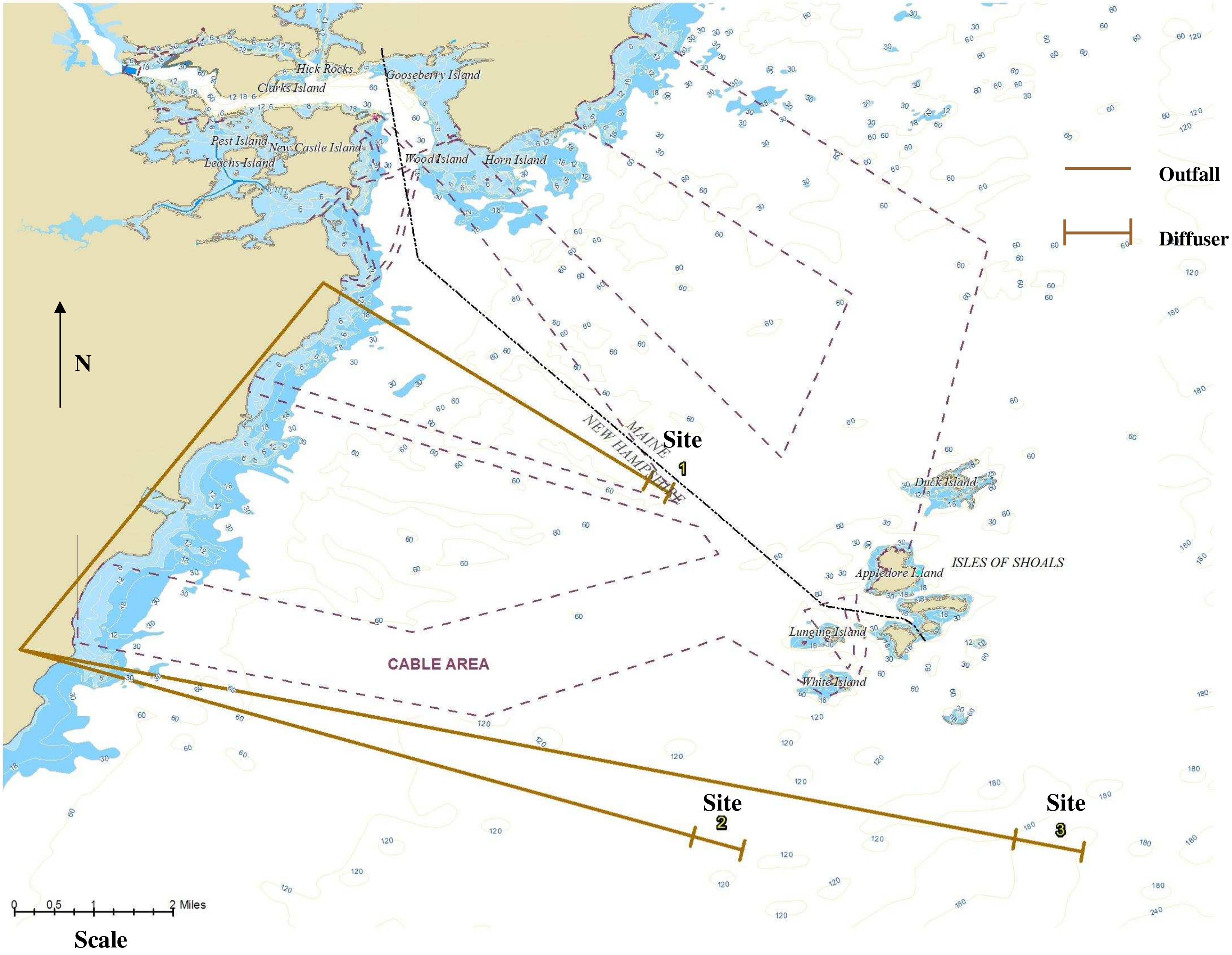

Figure 3-4. Candidate Outfall Sites

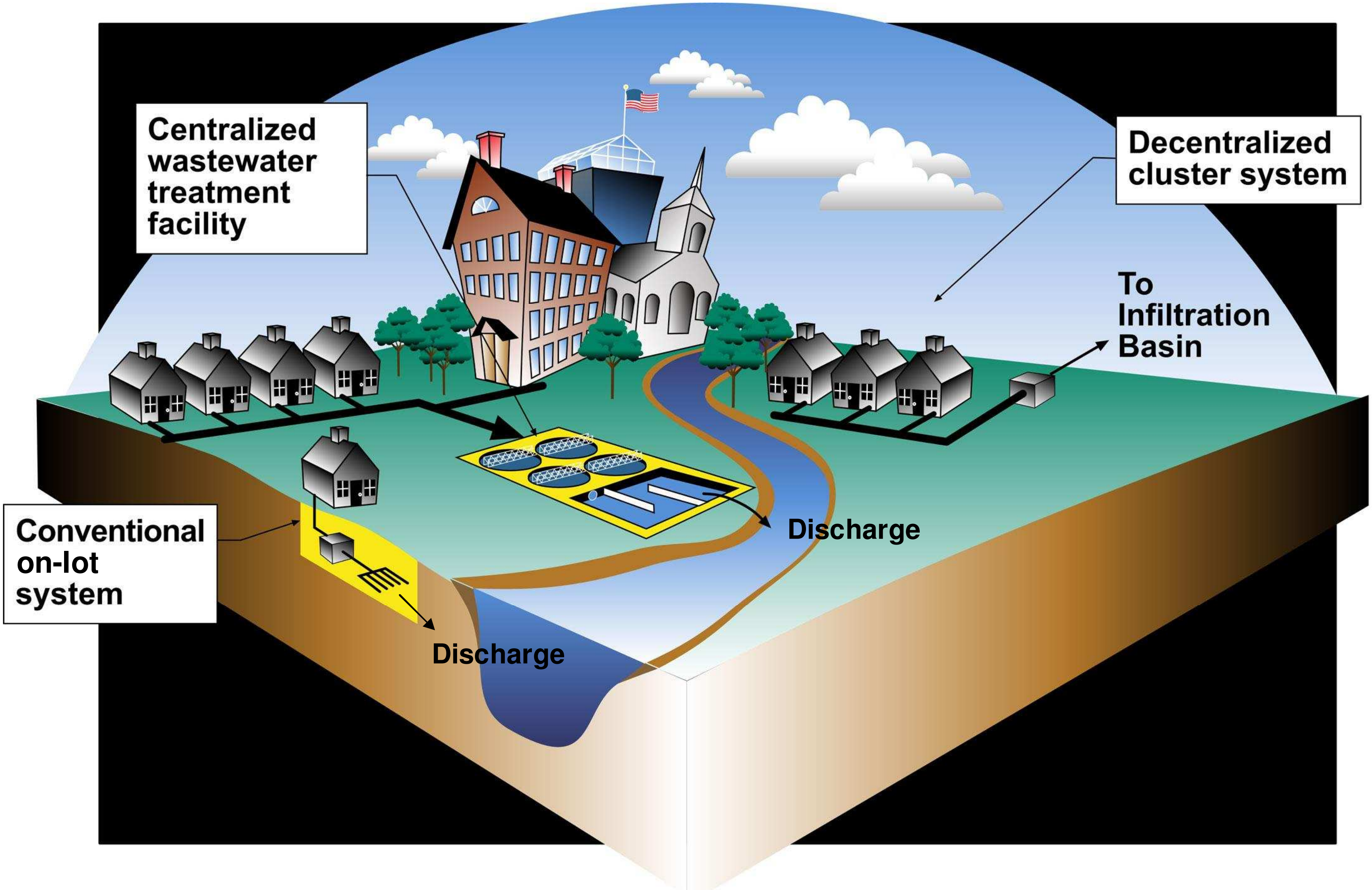

Figure 3-5. Alternative 3 – Decentralized Treatment and Continued Use of Existing WWTFs

3.3.1 Anticipated WWTF Upgrade Requirements

A number of WWTF upgrades are anticipated for this alternative. Some of the upgrades are anticipated as a result of projected 2025 changes in the permit limits for the WWTFs. The projected effluent limits for this study are included in Appendix K and Appendix L of the PFR in memos titled *Methodology for Development of Future WWTF Limits* (August 2005) and *Projected 2025 WWTF Discharge Limits* (August 2005), respectively. Other upgrades are anticipated as a result of projected increased flow and loadings to the WWTF and the inability of the various unit processes to handle the 2025 flows and loads.

Table 3-5 presents the upgrades anticipated for each WWTF under Alternative 3. The information presented in Table 3-5 is described in Section 3.1.1.

3.3.2 Anticipated Discharge and Disposal

For this alternative, the existing WWTF outfalls will be used for disposal of the effluent from each WWTF. For disposal of the effluent from the decentralized systems see Section 3.3.3.

3.3.3 Decentralized Systems

For decentralized systems, a number of sizes and configurations are possible. These systems can range from the typical single family residential on-lot septic system with a capacity of under 2,000 gallons per day (gpd), to community (shared) on-lot systems with capacities between 2,000 gpd to 10,000 gpd, and finally satellite systems which can range from 10,000 gpd to 1,000,000 gpd.

For this study, a single decentralized system size/type was assumed to accommodate the projected two-thirds increase in 2025 wastewater flow for each community with a WWTF. A decentralized treatment system with the capacity to handle 10,000 gpd was assumed. Figure 3-6 shows the typical configuration of a community on-lot system. Table 3-6 shows some of the system characteristics for a typical 10,000 gallon per day community on-lot system.

TABLE 3-6. CHARACTERISTICS OF A TYPICAL 10,000 GPD COMMUNITY ON-LOT SYSTEM

General		
	Average Daily Flow Capacity	10,000 gpd
	Number of Homes Served	20 -30
	Discharge Type	Pressure dosing system to a Soil Absorption System (SAS)
System Design		
	First Tank Volume	20,000 gallons
	Second Tank Volume	10,000 gallons
	Dosing Pump Station	Required
	Dosing Pump Station Volume	10,000 gallons of emergency storage above pump operating levels
	Dosing Cycles	4 – 8 time per day
Soil Absorption System (SAS) Requirements		
	Typical Percolation Rates	5 – 10 minutes per inch
	Typical Land Area Required	2.5 acres
	Minimum separation between high groundwater and bottom of SAS	4 ft.
	Depth of naturally occurring soil below bottom of SAS	4 ft.

Table 3-5. Alternative 3 Anticipated WWTF Upgrade Requirements.

FACILITY	Year 2004 Max Mo. Flow, MGD	Year 2025 Max Mo. Flow, MGD	Upgrades Projected	Incremental Flow Increase, MGD	Carbon Removal Upgrade Anticipated	Carbon Filtration Upgrade Anticipated	Nitrogen Removal Upgrade Anticipated	TP Removal Upgrade Anticipated	Other Upgrades Anticipated
DOVER WASTEWATER	4.57	4.87	C, TN	0.100	yes new flow	no	yes	no	IP, Pre, Dis
DURHAM WASTEWATER	1.71	1.8	TN	0.030	no	no	yes	no	IP, Pre, Dis
EPPING WATER & SEWER	0.32	0.429	C, TN, TP	0.036	yes new flow	no MBR	yes new flow	new flow chem only	Pre, Mem, Dis
EXETER WASTEWATER	3.6	3.9	AS, C, TN	0.100	all flow	no	yes	no	Pre
FARMINGTON WASTEWATER	0.52	0.57	C, TN, TP	0.017	yes new flow	no also P	yes	yes	IP, Pre, M
HAMPTON WASTEWATER	3.3	3.7	C, TN	0.133	yes new flow	yes	yes new	no	M, Dis, SH
MILTON WASTEWATER	0.08	0.09	AS, C, TN, TP	0.003	all flow	P only	yes	yes	NR
NEWFIELDS WASTEWATER	0.08	0.084	AS, C, TN	0.001	all flow	no	yes	no	NR
NEWINGTON WASTEWATER	0.18	0.2	TN	0.007	no	no	yes	no	NR
NEWMARKET WASTEWATER	1.04	1.16	AS, C, TN	0.040	all flow	no	yes	no	IP, Pre, Dis
PEASE DEVELOPMENT AUTHORITY	0.72	0.86	NR	0.047	no	no	SBR mods only	no	Dis
PORTSMOUTH WASTEWATER	8.23	8.7	AS, C	0.157	all flow	no	no	no	Dis, SH
ROCHESTER WASTEWATER	5.51	6.1	TP	0.197	no	P only	yes new	yes new flow	2nd Clarifier
ROCKINGHAM COUNTY WWTF	0.085	0.118	AS, C, TN	0.011	all flow	yes	yes	no	NR
ROLLINSFORD WASTEWATER	0.15	0.17	TP	0.007	no	P only	no	yes new flow	NR
SEABROOK WASTEWATER	1.17	1.39	NR	0.073	no	no	no	no	Air
SOMERSWORTH	1.79	1.9	C, TN, TP	0.037	yes new flow	P only	yes new	yes new flow	Pre
Totals	**33.06**	**36.04**		**1.00**					

Legend

C = Carbon
TN = Total Nitrogen
TP = Total Phosphorus
AS = Activated Sludge

IP = Influent Pumping
Pre = Preliminary Treatment
Dis = Disinfection
Mem = Membranes

M = Metals
Air = Aeration
SH = Solids Handling
NR= Not Required

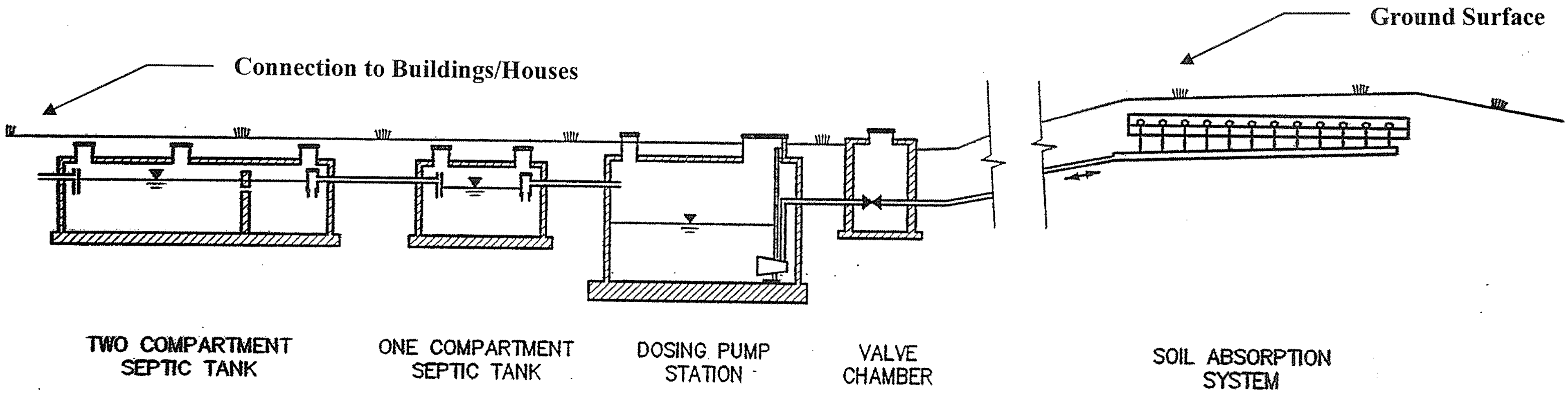

Figure 3-6. Typical Configuration of a Community On-Lot Decentralized System

For the purpose of this study, siting of these on-lot systems has not been performed. If this alternative is deemed feasible, then additional studies would need to be performed to identify the type and size of systems to be used based on the land available, ability of homes to combine discharges, and the soil characteristics adjacent to those homes.

It should be noted that these community on-lot systems are on-lot septic systems and the septic tanks need to be pumped out on a regular basis. This resulting septage would ultimately need to be disposed of at either a WWTF or another septage receiving facility.

3.4 ALTERNATIVE 4 – TREATMENT AT EXISTING WWTFs WITH LAND APPLICATION DISCHARGE

For this alternative, treatment would continue at the existing WWTFs. Treated effluent from individual WWTFs would be discharged at WWTF specific land application sites. Figure 3-7 shows the concept of this alternative.

This alternative was selected as one of the four alternatives for further study since it focuses on local land application and, thus, helps to round out the four alternatives by considering all the possible disposal options (i.e. existing receiving waters, Gulf of Maine, and land application).

This alternative assumes that all of the WWTFs will have an acceptable land application site. A two phase effort has to assess the potential availability of land application sites in the study area was conducted. The Phase 1 effort consisted of a favorable zone identification study. Phase 1 located areas that had favorable characteristics for land application while eliminating areas that did not have favorable characteristics (away from urban areas, out of well head protection areas, etc.). The Phase 1 methodology and its resulting study area maps are included in Appendix E. The Phase 2 effort consisted of a feasibility ranking of the areas identified in Phase 1. These areas were ranked to identify the relative feasibility or potential of providing a land application site in these areas. The Phase 2 methodology, its results, and WWTF specific maps are included in Appendix F.

It should be noted that based on the feasibility ranking methodology used in Phase 2, a number of WWTFs do not appear to have favorable land application sites. In a case where the Phase 2 methodology did not identify a favorable land application site in an area close to the WWTFs, the maps developed in Phase 2 were used to identify the closest land application areas possible. If an individual WWTF were to consider a land application discharge in the future, a number of additional steps would be required going forward. These include the further evaluation and identification of specific land application sites. Once identified, each discharge would require a groundwater discharge permit. Application for a New Hampshire Groundwater Discharge Permit requires the evaluation of a number of items including:

- Hydro-geologic studies of the site and the surround areas.
- A groundwater monitoring plan.
- An inventory of abutters and potential receptors.
- A hydro-geologic design and operation parameters.
- A facility plan.
- A site access and control plan.
- A contamination migration study.
- Design approval from the NHDES Wastewater Engineering Bureau.

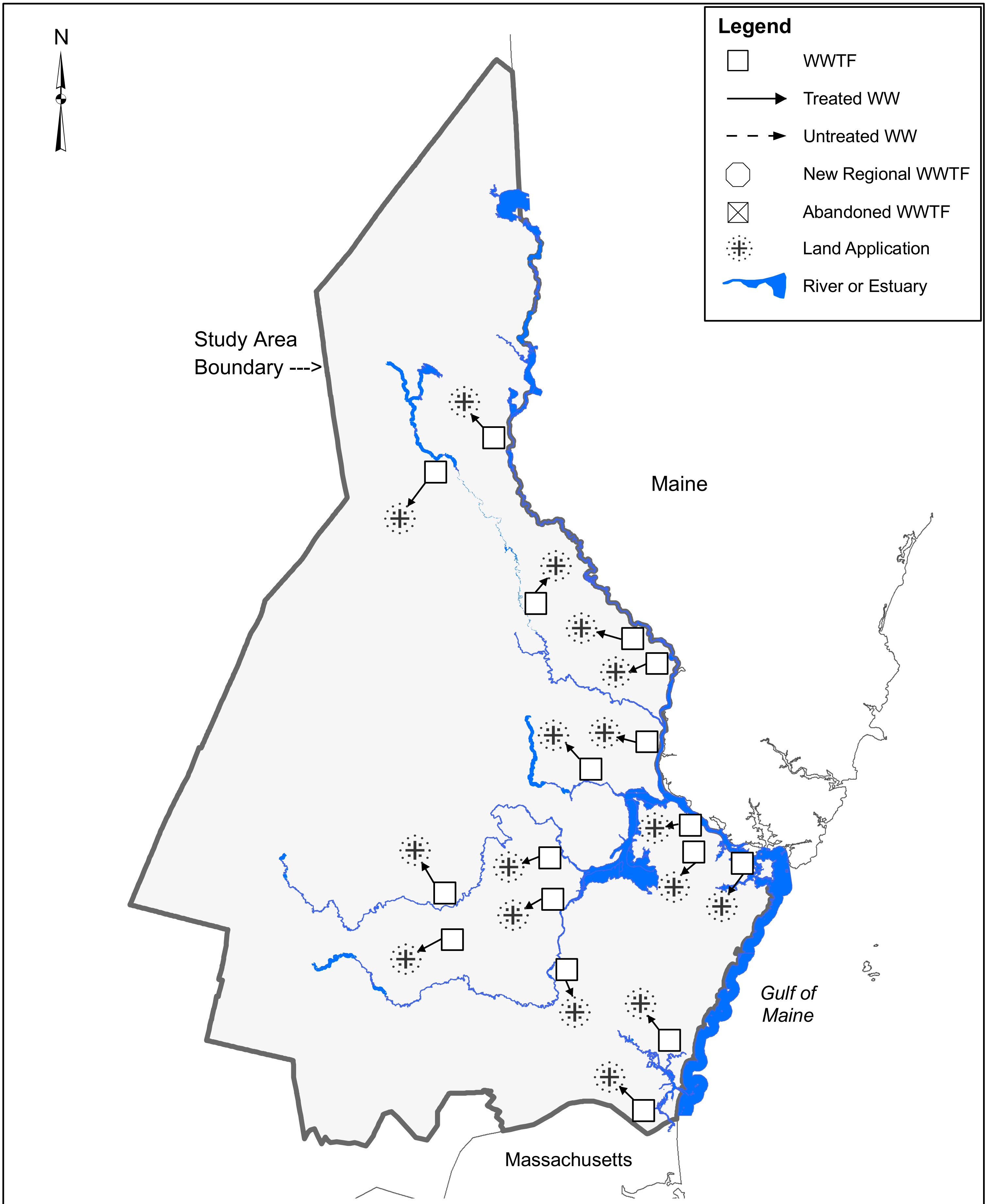

Figure 3-7. Alternative 4 - Treatment at Existing WWTFs with Land Application Discharge

3.4.1 Anticipated WWTF Upgrade Requirements

A number of WWTF upgrades are anticipated for this alternative. Some of the upgrades are anticipated as a result of projected changes in the 2025 permit limits for the WWTF due to the land application of the effluent. The projected effluent limits for this study are included in Appendix K and Appendix L of the PFR in memos titled *Methodology for Development of Future WWTF Limits* (August 2005) and *Projected 2025 WWTF Discharge Limits* (August 2005), respectively. Other upgrades are anticipated as a result of projected increased 2025 flow and loads to the WWTF and the inability of the existing unit processes to handle these future flows and loads.

Table 3-7 presents the upgrades anticipated for each WWTF under Alternative 4. The information presented in Table 3-7 is described in Section 3.1.1.

3.4.2 Anticipated Conveyance Requirements

Similar to the anticipated requirements of Alternative 2, the discharge from the 17 WWTFs will need to be conveyed to a discharge point, in this case a land application site. Similar to Alternative 2, the conveyance will be conducted via force mains. Refer to Section 3.2.2 for a discussion of the components anticipated for effluent conveyance.

Table 3-8 illustrates some of the conveyance system components anticipated for this alternative. It should be noted that these component have been sized to accommodate the average of the projected 2055 peak daily flow and the 2055 peak hourly flow. Table 3-8 shows the following information:

- Pump Stations – Number of stations anticipated and their sizes.
- Pipelines – Lengths and sizes of the various conveyance pipelines.

3.4.3 Anticipated Discharge and Disposal Requirements

For this alternative, a single land application technique was used for all 17 WWTF discharges. As the study did not locate specific land application sites, it would be difficult to determine which land application method / technology would be the most beneficial. The land application method / technology assumed to be used for this alternative was above grade, rapid infiltration basins (without under drains or recovery wells). This method / technology was used for the following reasons:

- Different land application methods require different WWTF effluent limits. In the *Preliminary Findings Report*, the WWTFs were analyzed for rapid infiltration basins effluent limits.
- Rapid infiltration basins typically require the smallest land area compared to other land application methods.
- Rapid infiltration basins can discharge year round (freezing/snow cover issues) without storage and without using both a surface water and land application discharge.

Table 3-9 shows the relative area requirements for the various WWTF effluent flow rates. The area requirements are based on the following:

Table 3-7. Alternative 4 Anticipated WWTF Upgrade Requirements.

FACILITY	Year 2004 Max Mo. Flow, MGD	Year 2025 Max Mo. Flow, MGD	Upgrades Projected	Incremental Flow Increase, MGD	Carbon Removal Upgrade Anticipated	Carbon Filtration Upgrade Anticipated	Nitrogen Removal Upgrade Anticipated	TP Removal Upgrade Anticipated	Other Upgrades Anticipated
DOVER WASTEWATER	4.57	4.87	C, TN	0.3	yes	yes	yes	no	IP, Pre, Dis
DURHAM WASTEWATER	1.71	1.8	C, TN	0.09	Filtration only	yes	yes	no	IP, Pre, Dis
EPPING WATER & SEWER	0.32	0.429	C, TN	0.109	yes new flow	no MBR	yes	no	Pre, Mem, Dis
EXETER WASTEWATER	3.6	3.9	AS, C, TN	0.3	All flow	yes	yes	no	Pre, Dis
FARMINGTON WASTEWATER	0.52	0.57	C, TN	0.05	yes	yes	yes	no	IP, Pre
HAMPTON WASTEWATER	3.3	3.7	C, TN	0.4	yes new flow	yes	yes	no	Dis, SH
MILTON WASTEWATER	0.08	0.09	AS, C, TN	0.01	All flow	yes	yes	no	Dis
NEWFIELDS WASTEWATER	0.08	0.084	AS, C, TN	0.004	All flow	yes	yes	no	Dis
NEWINGTON WASTEWATER	0.18	0.2	C, TN	0.02	Filtration only	yes	yes	no	Air, Dis
NEWMARKET WASTEWATER	1.04	1.16	AS, C, TN	0.12	All flow	yes	yes	no	IP, Pre, Dis
PEASE DEVELOPMENT AUTHORITY	0.72	0.86	NR	0.14	Filtration only	yes	yes SBR mods	no	Dis
PORTSMOUTH WASTEWATER	8.23	8.7	AS, C, TN	0.47	All flow	yes	yes	no	Dis
ROCHESTER WASTEWATER	5.51	6.1	C, TN	0.59	no	yes new flow	yes new flow	no	2nd Clarifier, Dis
ROCKINGHAM COUNTY WWTF	0.085	0.118	AS, C, TN	0.033	All flow	yes	yes	no	Dis
ROLLINSFORD WASTEWATER	0.15	0.17	C, TN	0.02	Filtration only	yes	no	no	Dis
SEABROOK WASTEWATER	1.17	1.39	C, TN	0.22	yes new flow	yes	yes	no	Dis
SOMERSWORTH WASTEWATER	1.79	1.9	C, TN	0.11	yes new flow	yes new flow	yes	no	Pre, Dis
Totals	**33.06**	**36.04**		**2.99**					

<u>Legend</u>

C = Carbon
TN = Total Nitrogen
TP = Total Phosphorus
AS = Activated Sludge

IP = Influent Pumping
Pre = Preliminary Treatment
Dis = Disinfection
Mem = Membranes

M = Metals
Air = Aeration
SH = Solids Handling
NR= Not Required

Table 3-8 Alternative 4 Anticipated WWTF Effluent Conveyance Components

Conveyance Components and Planning Level Sizing						
FACILITY	Year 2055 Flow, MGD	Pipe Length, ft	Pipe Length, Miles	Year 2055 Pipe Size, in	Pump Stations Required	Pump Station Size, MGD
FARMINGTON WWTF	0.91	1,000	0.19	8	1	0.91
MILTON WWTF	0.24	500	0.09	4	1	0.24
ROCHESTER WWTF	10.00	1,000	0.19	24	1	10.00
ROLLINSFORD WWTF	0.36	4,224	0.80	6	1	0.36
SOMERSWORTH WWTF	5.75	2,000	0.38	18	1	5.75
DOVER WWWTF	12.74	2,000	0.38	30	1	12.74
NEWINGTON WWTF	0.54	14,520	2.75	6	1	0.54
PEASE WWTF	3.15	9,000	1.70	14	1	3.15
DURHAM WWTF	5.35	13,200	2.50	18	1	5.35
NEWMARKET WWTF	2.41	9,240	1.75	12	1	2.41
NEWFIELDS WWTF	0.17	10,560	2.00	4	1	0.17
EPPING WWTF	0.70	750	0.14	8	1	0.70
ROCKINGHAM CO. WWTF	0.44	10,560	2.00	6	1	0.44
EXETER WWTF	6.75	12,672	2.40	20	1	6.75
SEABROOK WWTF	3.86	22,176	4.20	16	1	3.86
HAMPTON WWTF	8.60	18,480	3.50	24	1	8.60
PORTSMOUTH WWTF	22.00	15,840	3.00	36	1	22.00
Total	**83.94**	**147,722**	**27.98**		**17**	**83.94**

Notes:

- All flows in MGD
- All flows are the average of 2055 peak hour and peak day flows

Table 3-9 Alternative 4 Anticipated WWTF Effluent Land Application Acreage Requirements

FACILITY	Year 2004 Flow	Year 2055 Annual Ave Flow, MGD	Land Anticipated at 30 acres /MGD	Additioanl Land Anticipated for Buffers, Roads, and Ditches	Year 2055 Total Land Anticipated
DOVER WASTEWATER	2.54	3.05	91.50	4.58	96.08
DURHAM WASTEWATER	0.996	1.20	36.00	1.80	37.80
EPPING WATER & SEWER	0.197	0.23	7.02	1.05	8.07
EXETER WASTEWATER	1.86	2.30	69.00	3.45	72.45
FARMINGTON WASTEWATER	0.21	0.30	9.00	1.35	10.35
HAMPTON WASTEWATER	2.4	3.10	93.00	4.65	97.65
MILTON WASTEWATER	0.05	0.07	2.10	0.32	2.42
NEWFIELDS WASTEWATER	0.045	0.06	1.80	0.27	2.07
NEWINGTON WASTEWATER	0.13	0.18	5.40	0.81	6.21
NEWMARKET WASTEWATER	0.64	0.82	24.60	2.46	27.06
PEASE DEVELOPMENT AUTHORITY	0.38	0.66	19.80	1.98	21.78
PORTSMOUTH WASTEWATER	4.7	5.60	168.00	8.40	176.40
ROCHESTER WASTEWATER	2.9	4.10	123.00	6.15	129.15
ROCKINGHAM COUNTY WWTF	0.078	0.13	3.90	0.59	4.49
ROLLINSFORD WASTEWATER	0.09	0.13	3.90	0.59	4.49
SEABROOK WASTEWATER	0.98	1.35	40.50	2.03	42.53
SOMERSWORTH WASTEWATER	1.1	1.40	42.00	2.10	44.10
Totals	**19.30**	**24.68**	**740.52**	**42.56**	**783.08**

- For this study, 30 acres per/MGD based on 2025 average daily flow were assumed for infiltration beds not including buffer area, roads, or ditches. References indicate between 2 and 56 acres/MGD are required for rapid infiltration systems not including buffer area, roads or ditches (*Cost of Land Treatment System, EPA 1979 and Land Treatment of Municipal Wastewater EPA, Army Corps. of Engineers 1980.)*

- For buffer, road, and ditch area requirements, the following was assumed:

    - Additional 15% for flows under 0.5 MGD.

    - Additional 10% for flows between 0.5 MG and 1.0 MGD.

    - Additional 5% for flows greater than 1.0 MGD.

Table 3-10 includes some of additional assumptions and design standards typically used for rapid infiltrations basins.

TABLE 3-10. RAPID INFILTRATION BASIN DESIGN ASSUMPTIONS AND STANDARDS

	Design Criteria	**Value**
System Operation	Hydraulic Loading rate	Assumed to be 200ft/year (typical range 20-600 feet/year (6-90 meters/year.
	Wastewater application period	4 hrs to 2 weeks
	Dying period	8 hrs to 4 weeks
	Application method	Flooding
Soil Requirements	Soil Depth	At least 10-15 ft. (3-4.5 m)
	Soil permeability	At least 0.6 in/hr (1.5 cm/hr)
	Soil texture	coarse sands and sandy gravels
Basin Characteristics		
	Individual Basin Size	1-10 acres (0.4-4 ha) at least 2 basins in parallel
	Height of dikes	0.5 ft (0.15 m) above maximum expected water level

SECTION 4.0 METHODS OF ANALYSIS

This Section identifies and describes the different methods of analysis that were used to evaluate the four wastewater management alternatives described in Section 3. The general categories of analysis include the following:

- Environmental Analysis including:
    - Land Use and Growth
    - Air Quality
    - Surface Water Flow, Groundwater Recharge, and Water Quality
    - Wetlands and Terrestrial Resources
    - Aquatic Resources
    - Rare and Endangered Species

- Non-Monetary Factor Analysis including:
    - Complexity
    - Public Testimony
    - Implementation

- Planning Level Construction Costs including:
    - Capital Costs
    - Land Acquisition

4.1 ENVIRONMENTAL ANALYSIS

The following provides a summary of the methods that will be used to assess potential impacts associated with implementation of the alternatives under consideration. For those environmental parameters for which methods and criteria have been developed, discussions of potential impacts are provided in subsequent analysis chapters for the alternatives. Given the limited amount of site specific information available at this stage of the study, it is difficult to assess the significance of impacts. Thus, the variation in significance of potential impacts is discussed qualitatively. A more detailed assessment of significance of impacts should be completed as part of subsequent evaluation of selected alternatives.

For some of the environmental parameters, no significant distinguishing factors are anticipated for the alternatives, or meaningful evaluation would require specific site information. These parameters include: Environmental Justice, Noise, Traffic, and Floodplain. For these parameters, no methods have been developed for this alternatives report, and general discussions of the types of impacts anticipated are provided below. In addition, construction impacts are also not discussed individually by parameter for each alternative. Anticipated types of construction effects that could be expected regardless of the alternative are noted below. It is understood that the geographic extent, duration, and significance of construction effects will vary depending on the alternative selected, and that this analysis should be conducted in subsequent environmental impact analyses for any selected alternatives.

Environmental Justice. Environmental justice is based on the principle that all people, regardless of race, color, or socioeconomic status, have a right to be protected from environmental pollution (see Executive Order 12898). The purpose of environmental justice is to protect high-minority and/or low-income populations from having a disproportionate share of negative environmental impacts resulting from implementation of projects or policies. Environmental justice is largely related to siting issues and involves analysis using geographic units such as U.S. Census tracts or block groups. Since specific siting information with regard to the proposed alternatives is not available at the time of preparation of this report, this issue would need to be addressed in subsequent analyses concerning implementation of an alternative and is not included in the alternatives analysis of this report.

Noise. Noise effects will vary depending on the nature of the activity being conducted, whether the activity is stationary or mobile, and the proximity of noise receptors. Noise thresholds are often set by community, and limitations may include decibel levels that cannot be exceeded. Noise effects can be mitigated through use of certain best management practices including mufflers on equipment, and implementation of noise barriers.

Traffic. Traffic volumes are generally not expected to be significant for any of the alternatives' operation; however, the nature of the traffic would be expected to vary in terms of employee trips and heavy equipment including truck trips for chemical usage or residuals removal. The extent of the impact on area roadways will depend on the type of roadway and the traffic volumes currently experienced. These types of issues would need to be addressed in more detail in subsequent environmental evaluations depending on the alternative selected.

Floodplain. Construction of above grade structures or fill may have short-term impacts in areas that are located in the 100-year floodplain. Construction equipment located within the 100-year floodplain could potentially pose an obstacle to floodwaters and displace a small amount of flood storage capacity. Above ground structures within the 100-year floodplain may become obstacles to floodwaters and impact flood storage capacity in the long-term. Locating floodplains involves analysis using geographic aids such as Federal Emergency Management Agency flood maps. Similar to environmental justice, this issue would need to be addressed in subsequent analyses concerning implementation of an alternative when specific siting information is available and is not included in the alternatives analysis of this report.

Construction Activities. Construction of the proposed project would result in temporary increases in noise levels as a result of operation of construction equipment and vehicles. Construction vehicles would be equipped with proper muffler systems, and, where necessary, noise barriers could be constructed to reduce noise impacts in sensitive areas. Construction equipment used during the proposed work has the potential to produce engine emissions that could temporarily affect air quality in localized areas in the vicinity of construction. Additionally, construction vehicles and excavation would generate fugitive dust during construction activities. However, the extent of these impacts would be minimized by use of best management practices, such as proper engine maintenance, covering stockpiles, and wetting disturbed areas. Construction will potentially result in localized impacts to roadway capacity including reduction of the existing number of lanes, reduction of lane widths, and local road closures requiring detours. These temporary reductions in roadway capacity could lead to traffic delays. Those alternatives requiring more intensive construction activities could experience these impacts for a longer duration or greater magnitude.

4.1.1 Land Use and Growth Method of Analysis

The land use and growth impact analysis is performed to assess the direct and indirect effects of the alternatives on existing land uses and development. Direct effects include land uses displaced by the area disturbed during construction and/or operation of a project. Indirect effects include the addition or removal of constraints that may affect development or land use patterns in an area or region. The impact analysis focuses on three major areas of concern described below.

Land Use Compatibility and Aesthetics. The alternatives were considered with respect to whether or not the proposed facilities or infrastructure would be compatible with existing land use. The alternative was considered to result in an impact if the action had the potential to displace an existing use or result in a change in view or detrimental change in neighborhood or local character. The potential for disruption to surrounding land uses was also considered (e.g. impacts on noise levels, access, odors). While the degree of impact for this area of concern is rather site dependent, a general comparison of distinguishing factors for the alternatives is provided.

Land Area Impacted. Each alternative was assessed based on the extent of land area that would be altered. This assessment considered the amount of land disturbed for the proposed components for each alternative and the potential for disturbed areas to be restored to existing conditions.

Indirect Growth. The potential for indirect growth was assessed with respect to long-term effects. The alternatives were assessed as to how they may encourage, or discourage, development and additional population. The potential for indirect growth was evaluated by considering the location of the components of the proposed alternatives in relation to currently developed and sewered areas, as well as how the alternatives would constrain or encourage regional wastewater infrastructure regardless of whether or not the alternatives would provide the opportunity for communities to tie into regional wastewater infrastructure. For those alternatives which are expected to potentially generate more significant levels of indirect growth, a discussion is also presented regarding how this growth may alter historic land use patterns within the study area. For instance, would an alternative encourage segmented or disjointed development in an area that has historically had traditional neighborhoods or downtown centers, or encourage development that is compact in a historically low density, rural area.

4.1.2 Air Quality Method of Analysis

This analysis only addresses long-term air quality impacts resulting from implementation of the proposed alternatives since, as discussed in Section 4.1, short-term air quality impacts resulting from construction activities are anticipated to be similar in nature regardless of the alternative and, thus, there are no distinguishing factors to assess.

Potential long-term impacts to air quality were evaluated qualitatively by considering process or odor emissions from the collection, storage, treatment, or disposal of wastewater associated with operation of the alternatives.

4.1.3 Surface Water Flow, Groundwater Recharge, and Water Quality

The alternatives analyses focus on effects to surface water flow, groundwater recharge, and water quality as a result of long-term implementation of the alternatives. The analysis of long-term effects related to flow generally addresses the issue of water balance as a result of increasing, decreasing, or relocating a wastewater effluent discharge. Effects to the Great Bay receiving waters are discussed followed by effects to the Gulf of Maine, as appropriate. Indirect effects on flow and water quality that may occur as a result of induced growth in the study area are addressed in the land use and growth section.

Surface Water Flow/Groundwater Recharge Changes. The analysis of changes in surface flow or groundwater recharge addresses the potential for an alternative to increase or decrease stream flow or groundwater recharge. This change could affect water supply, wetlands habitat, and aquatic life. The determination of the possible extent of change in stream flow was estimated based on the percentage of stream flow that the WWTF effluent discharge represented during low flow conditions. This estimation was based on low stream flow (7Q10 – flow that occurs over seven consecutive days and has a 10 year return frequency) and average annual flow of WWTFs. Consideration of possible changes in localized groundwater recharge was based on the extent that the alternative may change the current subsurface wastewater conditions (e.g. land application of all WWTF effluent).

Water Quality. Assessment of the surface and groundwater quality impacts focused on the potential effect on water quality of receiving waters due to the WWTF discharges under the different alternatives. The water quality analysis was conducted for the Great Bay for all alternatives as well as for the Gulf of Maine for Alternative 2 (Gulf of Maine discharge). For the Great Bay receiving waters, water quality effects were predicted based on salinity modeling results as well as a qualitative pollutant loading analysis. For the Gulf of Maine, water quality effects were based on dilution analyses of three candidate outfall sites and a comparison of anticipated pollutant concentrations and acute and chronic toxicity level for various species. These evaluation methodologies are described below.

Great Bay Salinity Change Analysis

The Great Bay salinity change analysis considered the degree to which salinity concentrations in the receiving waters may change as a result of increasing or relocating wastewater effluent discharges to/from tidally influenced waters. These tidal influenced waters are identified in Table 4-1.

TABLE 4-1. WWTFs DISCHARGING TO TIDAL RECEIVING WATERS

Wastewater Treatment Facility	Tidal Receiving Waters
Newmarket WWTF	Lamprey River
Durham WWTF	Oyster River
Newfields and Exeter WWTFs	Squamscott River
Dover WWTF, Newington WWTF, Portsmouth Peirce Island WWTF, and Pease Development Authority WWTF	Piscataqua River
Hampton WWTF	Tide Mill Creek

The salinity analysis focused on two alternatives: Alternative 1 (No Action) where discharges to existing receiving waters would continue with some increase in discharge flow (due to increased wastewater generation), and Alternative 2 (Gulf Discharge) where effluent discharges to the Great Bay would be eliminated. The impacts of the alternatives on salinity were estimated quantitatively using a two-dimensional model developed at the University of New Hampshire by Jon P. Scott. The model utilizes the RMA-2 and RMA-4 software (Donnell, Letter and McAnally, 2003; Letter and Donnell, 2003). The model is a finite elements model with triangular and quadrilateral elements of varying sizes. The model extends from the Piscataqua River mouth in Portsmouth to the dams in each of the rivers discharging to the estuary system. Details on the model grid and the calibration of the model are provided in Section 6.1 and Appendix C.

Great Bay Qualitative Pollutant Loading Analysis

A qualitative analysis was performed for all of the alternatives to identify water quality changes that may occur in the Great Bay as a result of changes in pollutant loadings. In all alternatives, the pollutant loadings from the WWTFs to the Great Bay are anticipated to decrease based on the more stringent permit limits proposed. However, in some cases the loadings are anticipated to change more than others. For example, under Alternative 2 all of the pollutant loading to the Great Bay from the WWTFs will be eliminated due to the relocation of the discharge. Some of the pollutant loadings discussed include: BOD, nutrient pathogens, etc. The anticipated effects on water quality in the Great Bay as a result of the changes in pollutant loading are discussed, including changes to dissolved oxygen, eutrophication, etc.

Gulf of Maine Water Quality Impacts

The effects on gulf water quality as a result of relocating WWTF effluent discharges from the existing discharge locations to the Gulf of Maine were evaluated. These evaluations were conducted for Alternative 2 only, and specifically for three candidate outfall locations. The water quality impact of the Gulf discharge was based on project WWTF effluent water quality for this alternative, as well as the dilution performance of the three candidate outfall sites.

Outfall performances are estimated in terms of initial dilution. Initial dilution was estimated for the candidate outfalls using mathematical models developed from theoretical and experimental investigations. The initial dilutions and proposed future permitted WWTF effluent concentrations were used to develop concentration of certain pollutants in the Gulf in the vicinity of the outfalls. These pollutant concentrations were then compared to chronic and acute criteria for selected species.

Far-field transport and dispersion were not evaluated for Alternative 2, since high initial dilutions were obtained. A summary of the findings of the gulf discharge modeling is presented in Section 6.1.3. A complete discussion of the development of the outfall concepts and assumptions in the modeling is presented in Appendix D.

4.1.4 Wetland and Terrestrial Resources

The wetland and terrestrial resources impact analysis focused on long-term impacts, including the indirect impact of changes in flow and salinity on wetlands, and the potential for disrupting or displacing terrestrial habitat.

Wetland Resources. Potential effects to wetlands resource areas are assessed based on potential for relatively substantial alterations to surface or groundwater flow or fairly substantial changes in salinity concentrations, both of which could have an effect on freshwater or estuarine wetland size and/or function in the vicinity of WWTFs.

Terrestrial Resources. Long-term impacts are assessed by considering the potential for the alternatives to permanently displace terrestrial habitat due to operation of the proposed facilities. It was considered an impact if it was determined that considerable extents of land were to be disturbed during operation of the proposed components for each alternative.

4.1.5 Aquatic Resources

Long-term impacts are assessed by considering the potential for the alternatives to permanently change flow or salinity, thereby potentially altering local aquatic resource habitat. Impacts in the vicinity of the Gulf of Maine discharge were assessed by evaluating predicted concentrations of treated wastewater discharges at the alternative discharge locations considering dilution available. Water quality criteria and aquatic life criteria were used to assess the potential for both acute and chronic effects. Impacts in the Great Bay receiving waters were evaluated based on potential for significant change in flow volume, or significant change in salinity concentration or location of the salt wedge.

4.1.6 Rare and Endangered Species. Long-term impacts were assessed by considering the potential for the alternatives to permanently change flow or salinity, thereby potentially indirectly altering rare and endangered species habitat.

4.2 NON-MONETARY TECHNICAL ANALYSIS

The four alternatives were analyzed based on non-monetary factors. These factors included the following:

- Complexity of:
  - Treatment
  - Conveyance
  - Disposal
- Public Testimony
- Implementation

More detailed information related to these non-monetary factors are described below.

4.2.1 Complexity

Treatment Complexity. Complexity of treatment looked at the number of facilities (unit processes) that need to be operated as well as the relative sophistication of each unit process. For example, a WWTF that is running a Modified Ludzack-Ettinger (MLE) process for total nitrogen removal is generally more complex to operate and maintain than an aerated lagoon that is only being used for carbon removal. Some of the complexity is due to the process itself (use of anoxic/aerobic zones/clarification vs. use of a lagoon only), and some of the complexity is due to the number of pieces of equipment needed (mixers/recycle pumps/return sludge pumps/aeration/solids handling vs. aerators only).

Conveyance Complexity. Complexity of conveyance looked at the number of components anticipated to be required to convey the treated effluent to its disposal location. For some alternatives, a number of pump stations and pipelines are anticipated to be required to convey the effluent to the disposal location, while conveyance of effluent is not anticipated to be required for other alternatives.

Disposal Complexity. Complexity of disposal looked at the number of components and the level of sophistication of the components anticipated for disposal. For example, some alternatives will continue to use the existing WWTF outfalls for disposal. In other alternatives, a number of components (e.g. ocean outfall, rapid infiltration basins, etc.) are anticipated to be required for disposal of the effluent. The relative sophistication of the operation and maintenance of these disposal alternatives will also be examined.

4.2.2 Public Testimony

Public testimony of the four alternatives was evaluated to assess the general positive or negative testimony related to each alternative. The public testimony received ranged from very general comments (e.g. how an alternative is wanted or not wanted without supporting reason) to more specific comments on how an alternative my have a positive or negative impact on a specific item (e.g. groundwater recharge, nutrient loading to the estuary, etc.)

4.2.3 Implementation

The ease or difficulty of implementing each alternative was assessed. Some items related to implementation that will be addressed include: the need for a regional sewage agreement, public reaction issues, technical feasibility (e.g. ability to find acceptable land application sites or site the large number of decentralized systems), and operational issues (e.g. regional conveyance system or decentralized systems).

4.3 PLANNING LEVEL CONSTRUCTION COSTS

Planning level construction costs were identified for each of the four alternatives. These planning level construction costs are intended to be comparative costs used for relative comparison only and not be used for budgeting purposes. The purpose of preparing costs for these alternatives is only to compare the relative costs among the four alternatives. These costs have been based on engineering judgment and experience with other projects. If any of these alternatives are carried forward, more detailed evaluations of costs should be performed as the concepts and potential designs become better defined. It should be noted that the planning level costs identified were for capital costs only. Operation and maintenance costs for the alternatives have not been addressed.

The development of planning level construction cost for this study is described below.

4.3.1 Planning Level Construction Cost Estimates

Planning level costs were developed for each alternative. These planning level costs are estimates of the project costs which include design and construction engineering, construction, and contingency. These estimates do not include estimates for some unknown factors including pricing for additional studies, permitting, and legal issues required for implementation.

These planning level cost estimates were split into treatment costs, conveyance costs, disposal costs, and other alternative specific costs. It should be noted that these costs are based on engineering judgment and do not take into consideration many unknown factors including soil conditions, space limitations, and right-of-way or easement issues as these are currently undefined. These factors would be identified in subsequent more detailed studies and refined in design stages of a project. The unit costs and correction factors used for these planning level estimates are described below and are outlined in Appendix G.

Treatment Costs. The treatment costs for the four alternatives were developed based on the anticipated upgrade requirements identified in Section 3. These upgrades include the following:

- Anticipated Carbon Removal Upgrades - Including activated sludge upgrades, additional tankage, or cloth disc filtration as appropriate.

- Anticipated Total Nitrogen Removal Upgrades – Standardized to include tankage and process equipment anticipated to implement a Modified Ludzack-Etenger (MLE) process (unless a WWTF currently employees a process that can be easily converter to another nitrogen removal process (e.g. SBRs at Pease Development Authority).

- Anticipated Total Phosphorus Removal Upgrades – Standardized to include the addition of cloth disc filters and chemical addition.

- Other Anticipated Unit Process and Equipment Upgrades – These upgrades do not necessitate the construction new unit processes but are upgrades or expansions to existing processes. These upgrades/expansions include:

    - Influent Pumping
    - Preliminary Treatment (screenings or grit removal)
    - Disinfection
    - Membranes
    - Metals Removal Evaluations
    - Aeration Capacity
    - Solids Handling Capacity

The planning level cost estimates associated with these upgrades (with the exception of total nitrogen upgrades) are based on a unit price per gallon upgraded. Each of the upgrade types identified (e.g. carbon removal, phosphorus removal, aeration capacity, etc.) has been assigned a dollar value per gallon upgraded. For some alternatives, specific WWTFs are anticipated to require upgrades (for specific processes) for the entire 2025 process flow while other anticipated upgrades are only needed for the new flow (incremental flow increase between the 2004 flow and the projected 2025 flow). The planning level estimates for the upgrades are based on either the entire flow or the incremental flow accordingly.

For the total nitrogen upgrades, the planning level estimates are based on a dollar per pound of nitrogen removed per day over 20 years.

An economy of scale factor has been applied to the WWTF upgrade planning level cost estimates since it is expected that a large upgrade will not cost as much (on a dollar per gallon basis) as a smaller upgrade. For example, a carbon upgrade for various WWTFs was assumed to cost

$7.5/gallon. In order to account for the economy of scale, it is assumed that a small plant (less than 0.5 MGD) would have an economy of scale multiplier on the capital cost of 1.0 ($7.5/gal x 1.0 = $7.5/gal), while a larger WWTF upgrade (greater than 5 MGD) would have a economy of scale multiplier of 0.6 (($7.5/gal x 0.6 = $4.5/gal).

The estimated costs for WWTF upgrades associated with Alternatives 1 through 4 are included in the planning level cost tables in Sections 5 though 8, respectively.

Conveyance Costs. The planning level conveyance costs of the four alternatives were developed based on the anticipated conveyance requirements identified in Section 3. These upgrades include the following:

- Conveyance Pipelines
- Pump Stations

The planning level cost estimates associated with the pipelines have been developed on a unit price per linear foot basis for various pipe diameters.

The planning level cost estimates associated with the pump stations are based on a unit cost per pump station basis for various pump station capacities. The unit costs developed are based a range of pump stations that would be anticipated to convey all WWTF effluent from the WWTFs of origin to a Regional Post-Treatment Facility or to a land application site. The planning level cost estimates for Alternatives 2 and 4 are included in the planning level estimate tables in Sections 6 and 8, respectively.

Effluent Disposal Costs. The effluent disposal costs of the four alternatives were developed based on the anticipated disposal requirements identified in Section 3. The following assumptions have been made for disposal costs associated with the four alternatives:

- Alternative 1 (No Action) – There are no effluent disposal costs as the existing outfalls will continue to be used.
- Alternative 2 (Gulf of Maine Discharge) – The effluent disposal cost will consist of a Regional Post-Treatment Facility (RPTF), a final effluent pump station at the RPTF, and the cost of the outfall. The RPTF and the final effluent pump station planning level costs have been estimated based on the total flow from the 17 WWTFs. The outfall cost has been based on a linear foot unit price for the outfall pipe and a linear foot unit price for the diffuser section of the outfall.
- Alternative 3 (Decentralized Discharge) – There are no effluent disposal costs at the existing WWTFs as the existing outfalls will be used. The price of the decentralized systems for this alternative will be included as a disposal cost. A unit price for the standardized decentralized system has been assumed.
- Alternative 4 (Land Application) – The land application effluent disposal cost is based on the US EPA Wastewater Technology Fact Sheet -*Rapid Infiltration Land Treatment.*

The planning level cost estimates for the disposal components of Alternatives 2, 3, and 4 are included in the planning level cost estimate tables in Sections 6, 7, and 8, respectively.

4.3.2 Land Acquisition Costs

The following assumptions have been made for land acquisition for the four alternatives:

- Alternative 1 – Land acquisition is not anticipated (i.e. assume all of the WWTF upgrades can be accommodated in the existing WWTF property).
- Alternative 2 – All pipelines and pump stations will be constructed in public rights-of-way and no land acquisition is anticipated. Land acquisition is anticipated for the RPTF.

- Alternative 3 – Land acquisition is not anticipated (i.e. all of the WWTF upgrades can be accommodated in the existing WWTF property, and the land required for the decentralized systems will be acquired by the developer constructing the units that will use decentralized systems in lieu of sewer).
- Alternative 4 – Land acquisition is not anticipated for the conveyance pipelines. Land acquisition is anticipated for the disposal sites. These anticipated land requirements are summarized in Section 3.4.3.

A single unit price for an acre of land has been assumed for all land to be acquired. It is recognized that certain locations within the Study Area will have land acquisition costs that are higher or lower than this unit price. However, a single unit price is being used to represent a conservative average price for land within the Study Area. The planning level costs associated with land acquisition anticipated for Alternatives 2 and 4 are included in the planning level cost tables in Sections 6 and 8, respectively.

SECTION 5.0 ALTERNATIVE 1 (NO ACTION) ANALYSIS

This Section identifies and describes the analysis of Alternative 1 (No Action). The different methods of analysis are described in Section 4. The analysis includes the following three major categories:

- Environmental Analysis
- Non-Monetary Analysis
- Planning Level Construction Costs

5.1 ENVIRONMENTAL ANALYSIS

This alternative would result in continued reliance on existing wastewater facilities and current methods of facilities planning, including extension of sewers and increases in discharges from existing wastewater treatment facilities (WWTFs), where current capacity and regulatory requirements allow. The WWTFs would be upgraded to meet the 2025 discharge limits at their existing discharge locations (see Appendix L of the Preliminary Findings Report for a summary of projected 2025 WWTF effluent limits).

Capacity in terms of new sewer connections would be restricted, depending on flow limitations at the existing WWTFs. Therefore, it is expected that a substantial portion of new growth would need to be accommodated by on-lot or other types of decentralized systems. In some parts of the project area, new development may not be feasible due to lack of sewers and unsuitable sites for on-lot systems. The following discussion summarizes the trends that would be likely to continue should the No Action alternative be selected.

5.1.1 Land Use and Growth

Land Use Compatibility and Aesthetics. Under this alternative, minimal direct impacts to land use are anticipated since existing WWTFs would continue to be used and no new facilities or regional infrastructure are proposed. The land use of the sites would remain the same as currently used, i.e. to support waste treatment/disposal for public purposes. Upgrades to the WWTFs may be required for this alternative (see Section 3.1.1) depending on the WWTFs' ability to meet future limits. The effect on aesthetics resulting from any exterior structural modifications or new facility components would be site specific.

Land Area Impacted. The extent of land area impacted for this alternative would be limited. The WWTF upgrades would largely occur within or adjacent to existing buildings at the existing WWTF sites, and no land acquisition or displacement of existing land uses would be expected. The exception may be WWTFs that have very limited available space on their property, such as the Portsmouth Peirce Island WWTF. In such instances, adjacent property or alternative facility location may need to be acquired to accommodate the upgrades. In the case of the Peirce Island WWTF, the City of Portsmouth has indicated that expansion of the WWTF is not desirable due to existing and planned recreational activities on the Island.

Indirect Growth. For this alternative, it is anticipated that growth and development would continue to follow existing trends and patterns (see "Section 9.0 Population Future Conditions" in the Preliminary Findings Report). Sewer extensions serving future residential, commercial, and industrial uses would continue as approved locally by municipalities as long as flow and treatment capacity remains in the various WWTFs. In areas without sewers, there would likely be a continued trend toward more spread out development due to on-lot system requirements unless developers can accommodate higher density by implementing cluster and other small treatment systems. Developers would continue to be encouraged and guided by the state's smart growth principles.

5.1.2 Air Quality

Continued operation of the WWTFs, after the required upgrades, is generally anticipated to result in minimal impacts to air quality to communities within the study area. While some of the upgrades may require the addition of open tanks, etc., these components when properly maintained are generally not considered odorous. The facilities will need to include odor control and air emission control in accordance with state and local regulatory requirements and community mandates.

5.1.3 Surface Water Flow, Ground Water Recharge, and Water Quality

Surface Water Flow and Ground Water Recharge. For Alternative 1 (No Action), the WWTF discharge flows in the study area increase by an average of 8.2% from 2004 to 2025. This increase is expected due to an increase in wastewater generation in the study area resulting from increased population and as a result of minor sewer expansions and infilling in those communities with WWTFs. New developments not able to connect to existing WWTFs would rely on on-lot disposal, which would contribute to continued recharge of ground water in localized areas.

During low flow (7Q10) conditions, the total volume discharged by the rivers to the Great Bay is 30.1 cubic feet per second (cfs), while the average WWTF discharge volume to the Great Bay under those low flow conditions (in September when low river flows typically occur) is 21.8 cfs (see Table 2 in Appendix C). This WWTF flow represents 72% of the river flows. Compared to the tidal flows, the volume of water discharged by the rivers during one tide cycle (under normal river flow conditions) is approximately 1% of the tidal prism (volume of water flowing in and out of the estuary during one tide cycle) (Ertürk et al, 2002). During low flow periods, the river flow is an even smaller fraction of the tidal flow.

Under this alternative, ground water recharge is not anticipated to change significantly.

Water Quality. The following is a summary of the water quality analysis for Alternative 1. This includes changes to the Great Bay salinity and a qualitative Great Bay pollutant loading analysis.

Great Bay Salinity Changes

Based on the salinity modeling for the Great Bay (under low flow conditions), the impact of increasing the WWTF effluent discharges on salinity (under low flow conditions) is anticipated to be 1 part per thousand (ppt) or less. This impact is much less than the natural variability of salinity concentrations due to tides, seasons, winds, etc. During high flow periods, the effect of WWTF effluent discharge increase would be less. Calculated salinities for Alternative 1 are shown in Figure 5 in Appendix C for different locations in the estuary system.

Pollutant Loading Analysis

Under this alternative, the pollutant loading to the Great Bay from the WWTFs for biochemical oxygen demand (BOD), total suspended solids (TSS), nitrogen, and phosphorus are all anticipated to decrease due to the new effluent limits projected for this study. This may result in some improvements to the dissolved oxygen (DO) concentrations and decrease potential for eutrophication in the Great Bay. There is anticipated to be a slight increase in toxics discharge to the Great Bay due to increased wastewater generation and incomplete removal during treatment.

It is important to note that while the loading to the Great Bay from the WWTFs will be reduced, other loading inputs to the Great Bay may minimize the improvements of the WWTF loading reductions. These other inputs include non-point sources such as stormwater run-off, atmospheric degradation, and inputs from on-lot systems (e.g. increases in bacterial contribution from malfunctioning or overstressed on-lot systems).

It is assumed that monitoring programs would continue and that trends in water quality and flow would be tracked by governmental and public interest groups. Some Total Maximum Daily Loads (TMDLs) may be prepared or finalized, which could in turn require additional limits on discharges from WWTFs.

5.1.4 Wetland and Terrestrial Resources

As noted above, it is possible that some extension of sewers may occur in those communities with some WWTF capacity remaining. In these cases, there would be minor reduction in ground water recharge that may support ground water fed wetlands resource areas. There would be a corresponding increase in surface water discharges. To the extent that the relocation of discharge occurs within the same sub-basins of a watershed, overall effects to hydrogeology would be expected to be relatively minor. Thus, the impact to wetlands and terrestrial resources as a result of changes in surface water flow or ground water levels related to implementation of the no action alternative is not expected to be significant.

5.1.5 Aquatic Resources

Similar to the anticipated effects to wetlands and terrestrial resources, no significant effects on aquatic life are anticipated, as major changes in stream flow are not anticipated to occur as a result of implementation of this alternative. As long as the WWTFs comply with the permit limits, including more stringent nutrient limits, aquatic life conditions would not be expected to degrade further as a result of WWTF operation. It is assumed that fisheries monitoring will continue in most of the receiving waters, and that these data will be correlated with water quality monitoring data. Implementation of TMDLs and waste load allocations may result in discharge limits which could, in turn, have beneficial effects on aquatic habitats.

5.1.6 Rare and Endangered Species

Effects on rare and endangered species would be related to any changes in habitat, whether wetlands, terrestrial, or aquatic. As noted above, no significant alterations in these habitats are anticipated as long as WWTFs continue to meet permit limits, which may include more stringent nutrient limits. To the extent that insufficient capacity exists at the WWTFs and existing on-lot systems fail or negatively affect water quality, there could be adverse effects to some rare and endangered species. The New Hampshire Natural Heritage Bureau (NHB) maintains records of these species and communities and would be involved in protection efforts in response to impacts related to future growth.

5.2 NON-MONETARY TECHNICAL ANALYSIS

The non-monetary analysis is divided into the following sub-categories:

- Complexity
- Public Testimony
- Implementation

5.2.1 Complexity

The complexity of this alternative has been evaluated as it relates to treatment, conveyance, and disposal. The following is a summary of those evaluations.

In this alternative, the treatment required is more sophisticated than the existing treatment in order to accommodate the new treatment limits that would be required for the existing discharge locations. As a whole, the treatment component of this alternative is considered to be of average complexity.

In this alternative, there is no conveyance component as the existing surface water discharge locations will be used.

The disposal component of this alternative is not complex. In this alternative, the existing WWTF outfalls will be used.

5.2.2 Public Testimony

Little positive or negative public testimony was given for this alternative. However, indirectly there was some public testimony indicating that it would be preferable for the wastewater effluent originating from ground water wells be put back on to the ground from where it came and not be “thrown away”. This could be perceived as a negative comment about this alternative as wastewater effluent is being discharged to surface water and is not being put back into the ground.

5.2.3 Implementation

This alternative would require little or no agreement between the municipalities to implement (each town could maintain its own wastewater autonomy). However, there is a possibility that multiple towns would join together to share resources, leverage their combined purchasing power (for chemicals and other supplies and equipment), and potentially negotiate with the regulators (nitrogen trading, etc.)

5.3 PLANNING LEVEL CONSTRUCTION COSTS

Included herein are estimated planning level costs for Alternative 1 (No Action). The planning level costs have been divided into three sub-categories; treatment, conveyance, and disposal.

The planning level treatment upgrade costs for each WWTF are presented in Table 5-1. There are no conveyance and disposal costs associated with this alternative. Table 5-2 presents the total planning level costs for treatment, conveyance and disposal on a town by town basis.

In summary, the estimated planning level construction costs for Alternative 1 are:

• Treatment Costs	$110,600,000.
• Conveyance Costs	$ -.
• Disposal Costs	$ -.
• **Total Cost**	**$110,600,000.**

Table 5-1. Alternative 1 Estimated WWTF Upgrade Costs

FACILITY	Year 2004 Max Mo. Flow, MGD	Year 2025 Max Mo. Flow, MGD	Economy of Scale $ Factor	Upgrades Anticipated	Incremental Flow Increase, MGD	Carbon Removal Upgrade Anticipated	Carbon removal upgrade @ $7.5/gallon	C only Filtration Upgrade Anticipated	Filtration Upgrade @ $2/gal	Nitrogen Upgrade Anticipated	Influent TN Load , lbs/day	Eff. TN Load (8mg/l), lbs/day	TN removed, lb/day	TN Removal @ $40/lb/day	TP Removal Anticipated	P-Flitration/ Chemical Addition @ $3/gallon	Other Upgrades Anticipated	Cost Assumptions (new flow only unless noted)	Other Upgrades $	Estimated Total Construction Cost
DOVER WWTF	4.57	4.87	0.70	C, TN	0.3	yes new flow	$ 1,580,000	no	$ -	yes	812.3	324.9	487.39	$ 4,980,000	no	$ -	IP, Pre, Dis	$6/gal	$ 1,800,000	**$ 8,360,000**
DURHAM WWTF	1.71	1.8	0.80	TN	0.09	no	$ -	no	$ -	yes	300.2	120.1	180.14	$ 2,100,000	no	$ -	IP, Pre, Dis	$6/gal	$ 540,000	**$ 2,640,000**
EPPING WWTF	0.32	0.429	1.00	C, TN, TP	0.109	yes new flow	$ 820,000	no MBR	$ -	yes new flow	18.2	7.3	10.91	$ 160,000	new flow chemical only	$ 20,000	Pre, Mem, Dis	$6.5/gal	$ 710,000	**$ 1,710,000**
EXETER WWTF	3.6	3.9	0.70	AS, C, TN	0.3	all flow	$ 20,480,000	no	$ -	yes	650.5	260.2	390.31	$ 3,990,000	no	$ -	Pre	$2.5/gal	$ 750,000	**$ 25,220,000**
FARMINGTON WWTF	0.52	0.57	0.90	C, TN, TP	0.05	yes new flow	$ 340,000	no for P only	$ -	yes	95.1	38.0	57.05	$ 750,000	yes	$ 1,540,000	IP, Pre, M	$5/gal + $100K metals study	$ 350,000	**$ 2,980,000**
HAMPTON WWTF	3.3	3.7	0.70	C, TN	0.4	yes new flow	$ 2,100,000	yes	$ 5,180,000	yes new flow	66.7	26.7	40.03	$ 410,000	no	$ -	M, Dis, SH	$6/gal + $100K metals study	$ 2,500,000	**$ 10,190,000**
MILTON WWTF	0.08	0.09	1.00	AS, C, TN, TP	0.01	all flow	$ 680,000	no for P only	$ -	yes	15.0	6.0	9.01	$ 130,000	yes	$ 270,000	NR	na	$ -	**$ 1,080,000**
NEWFIELDS WWTF	0.08	0.084	1.00	AS, C, TN	0.004	all flow	$ 630,000	no	$ -	yes	14.0	5.6	8.41	$ 120,000	no	$ -	NR	na	$ -	**$ 750,000**
NEWINGTON WWTF	0.18	0.2	1.00	TN	0.02	no	$ -	no	$ -	yes	33.4	13.3	20.02	$ 290,000	no	$ -	NR	na	$ -	**$ 290,000**
NEWMARKET WWTF	1.04	1.16	0.80	AS, C, TN	0.12	all flow	$ 6,960,000	no	$ -	yes	193.5	77.4	116.09	$ 1,360,000	no	$ -	IP, Pre, Dis	$6/gal	$ 720,000	**$ 9,040,000**
PEASE DEVELOPMENT AUTHORITY WWTF	0.72	0.86	0.90	NR	0.14	no	$ -	no	$ -	SBR mods only	0.0	0.0	0.00	$ 100,000	no	$ -	Dis	$1/gal	$ 190,000	**$ 290,000**
PORTSMOUTH WWTF	8.23	8.7	0.60	AS, C	0.47	all flow	$ 39,150,000	no	$ -	no	na	na	na	$ -	no	$ -	Dis, SH	$6/gal	$ 2,820,000	**$ 41,970,000**
ROCHESTER WWTF	5.51	6.1	0.60	TP	0.59	no	$ -	no for P only	$ -	yes new flow	98.4	39.4	59.05	$ 520,000	new flow	$ 1,060,000	2nd Clarifier	$1.5 M Clarifier	$ 1,500,000	**$ 3,080,000**
ROCKINGHAM COUNTY WWTF	0.085	0.118	1.00	AS, C, TN	0.033	all flow	$ 890,000	yes	$ 240,000	yes	19.7	7.9	11.81	$ 170,000	no	$ -	NR	na	$ -	**$ 1,300,000**
ROLLINSFORD WWTF	0.15	0.17	1.00	TP	0.02	no	$ -	no for P only	$ -	no	0.0	0.0	0.00	$ -	yes new flow	$ 60,000	NR	na	$ -	**$ 60,000**
SEABROOK WWTF	1.17	1.39	0.80	NR	0.22	no	$ -	no	$ -	no	na	na	na	$ -	no	$ -	Air	$1/gal	$ 220,000	**$ 220,000**
SOMERSWORTH WWTF	1.79	1.9	0.80	C, TN, TP	0.11	yes new flow	$ 660,000	no for P only	$ -	yes new flow	18.3	7.3	11.01	$ 130,000	yes new flow	$ 260,000	Pre	$2.5/gal	$ 280,000	**$ 1,330,000**
Totals	**33.055**	**36.041**			**2.986**		**$ 74,290,000**		**$ 5,420,000**		**2335.4**	**934.1**	**1401.2**	**$ 15,210,000**		**$ 3,210,000**			**$ 12,380,000**	**$ 110,510,000**

Legend

C = Carbon
TN = Total Nitrogen
TP = Total Phosphorus
AS = Activated Sludge

IP = Influent Pumping
Pre = Preliminary Teatment
Dis = Disinfection
Mem = Membranes

M = Metals
Air = Aeration
SH = Solids Handling
NR = Not Required

Table 5-2. Estimated Planning Level Construction Costs for Alternative 1

FACILITY	Treatment Cost	Conveyance Cost	Discharge Costs	Total Estimated Construction Costs
DOVER WWTF	$ 8,400,000	na	na	$ 8,400,000
DURHAM WWTF	$ 2,600,000	na	na	$ 2,600,000
EPPING WWTF	$ 1,700,000	na	na	$ 1,700,000
EXETER WWTF	$ 25,200,000	na	na	$ 25,200,000
FARMINGTON WWTF	$ 3,000,000	na	na	$ 3,000,000
HAMPTON WWTF	$ 10,200,000	na	na	$ 10,200,000
MILTON WWTF	$ 1,100,000	na	na	$ 1,100,000
NEWFIELDS WWTF	$ 800,000	na	na	$ 800,000
NEWINGTON WWTF	$ 300,000	na	na	$ 300,000
NEWMARKET WWTF	$ 9,000,000	na	na	$ 9,000,000
PEASE DEVELOPMENT AUTHORITY WWTF	$ 300,000	na	na	$ 300,000
PORTSMOUTH WWTF	$ 42,000,000	na	na	$ 42,000,000
ROCHESTER WWTF	$ 3,100,000	na	na	$ 3,100,000
ROCKINGHAM COUNTY WWTF	$ 1,300,000	na	na	$ 1,300,000
ROLLINSFORD WWTF	$ 100,000	na	na	$ 100,000
SEABROOK WWTF	$ 200,000	na	na	$ 200,000
SOMERSWORTH WWTF	$ 1,300,000	na	na	$ 1,300,000
TOTAL	**$ 110,600,000**	**$ -**	**$ -**	**$ 110,600,000**

REFERENCES

Ertürk, S.N., Bilgili, A., Swift, M.R., Brown, W.S., Çelikkol, B., Ip, J.T.C. and Lynch, D.R. 2002. Simulation of the Great Bay Estuarine System: Tides with Tidal Flats Wetting and Drying. Journal of Geophysical Research, Vol. 107, No. C5.

SECTION 6.0 ALTERNATIVE 2 (TREATMENT AT EXISTING WWTFs WITH A REGIONAL GULF OF MAINE DISCHARGE) ANALYSIS

This Section identifies and describes the analysis of Alternative 2 (Gulf of Maine Discharge). The different methods of analysis are described in Section 4. The analysis will include the following three major categories:

- Environmental Analysis
- Non-Monetary Analysis
- Planning Level Constriction Costs

6.1 ENVIRONMENTAL ANALYSIS

This alternative would result in continued reliance on existing wastewater facilities; however, treated effluent from individual wastewater treatment facilities (WWTFs) would be conveyed to a Regional Post-Treatment Facility (RPTF) for disinfection of the effluent and discharged through an outfall in the Gulf of Maine. The WWTFs would be upgraded to meet the 2025 ocean/gulf discharge limits (see Appendix L of the Preliminary Findings Report for a summary of projected 2025 WWTF effluent limits). The following discussion summarizes the trends that would be likely to occur should Alternative 2 be selected.

6.1.1 Land Use and Growth

Land Use Compatibility and Aesthetics. Under this alternative, the existing WWTFs would continue to be used. Upgrades to existing WWTFs are anticipated to be required as needed to meet limits for discharge to the Gulf of Maine. Therefore, land use impacts at the WWTFs are expected to be relatively minor in nature. Effluent from these WWTFs would be conveyed through regional infrastructure to a RPTF and discharged to the Gulf of Maine. Specific alignments of the conveyance pipelines have not been determined as part of this study; however, a conceptual alignment has been developed to assist with the analysis of this alternative (see Figure 3-3). It is anticipated that the conveyance route would use as many rights-of-way (roads, gas pipeline routes, electrical distribution system routes, etc.) as possible to minimize the quantity of un-cleared cross country routes and land acquisition that would be required. Land acquisitions and/or easements are anticipated for portions of the conveyance piping crossing private property.

The specific location of the above ground RPTF has not been determined for this study. Depending on the final siting location of the RPTF, the facility could result in an aesthetic impact to adjacent land uses. Effects could be mitigated through aesthetic design and landscaping.

Under this alternative the WWTF effluent flows would be conveyed via force mains rather than gravity sewers. Approximately 31 pump stations are anticipated along the proposed conveyance route. It was assumed that a permanent above ground pump station will be located at each WWTF, any place that two conveyance pipelines are joined into one pipeline, approximately every 10 miles along individual pipelines, and at the RPTF for discharge to the outfall under peak flow and high tide conditions. The pump stations at the WWTFs would be expected result in minimal land use and aesthetic impacts since they would be located adjacent to existing buildings at the WWTF sites and land acquisition or displacement of existing land uses is not anticipated for these pump stations, although this would need to be verified during subsequent design efforts. The pump stations located along the conveyance pipelines and at the RPTF would result in the permanent loss of land and potential aesthetic impact on the surrounding areas and any nearby dwelling units. However, these structures and their associated land requirements are anticipated to be relatively small. Aesthetic impacts would be mitigated by providing screening and landscaping around the pump station sites.

Land Area Impacted. The conveyance pipelines would be below ground, and disturbed surfaces would be restored upon completion of construction to the extent practicable; thus, the permanent land area impacted would be minimal. The RPTF and associated access drive and parking lot would result in a permanent loss of approximately one acre of land. The area of land impacted for each pump station varies depending on the volume of flow handled, ranging from approximately 3,000 square feet for the smallest pump station to approximately 22,500 square feet for the largest pump station.

Indirect Growth. In addition to growth associated with existing trends and patterns in the study area, as previously referenced for Alternative 1 (No Action), this alternative could potentially result in indirect growth and development as a result of the less restrictive treatment requirements for the gulf discharge. These less restrictive treatment requirements may allow the existing WWTFs to process additional flow that they may not be able to accommodate with stricter discharge limits. It is this potential to process additional flow that may result in indirect growth and development.

All effluent flows would be conveyed via force mains. Force mains will limit unapproved hookups to the conveyance system since all hookups would need to be pressurized. However, it is possible that a municipality or developer could tie into the conveyance pipeline if separate treatment and pumping were provided, pending approval by a future regional sewer governing association. These hookups from previously unsewered areas have the potential to induce growth within areas that might previously have been restricted, particularly those restricted due to on-site wastewater disposal limitations. A primary factor in predicting the likelihood for induced growth is the amount of developable land available in the vicinity of the proposed conveyance pipeline. A few communities are anticipated to have limited land available to accommodate projected baseline population growth (i.e. anticipated to approach buildout conditions), and consequently would be anticipated to experience relatively minor induced growth resulting from hookups to the regional conveyance system. These communities include Exeter, Hampton, New Castle, Portsmouth, Dover, and Somersworth. However, undeveloped land that could be subject to development is anticipated to remain available within a majority of study area communities.

6.1.2 Air Quality

Similar to Alternative 1 (No Action), continued operation of the WWTFs under Alternative 2, after the anticipated upgrades, is generally anticipated to result in minimal impacts to air quality to communities within the study area. The proposed conveyance pipelines would be below ground and would operate with little, if any, potential for impacts to air quality. The pump stations as well the RPTF would handle WWTF secondary effluent and odors are not anticipated to be an issue.

6.1.3 Surface Water Flow, Groundwater Recharge, and Water Quality

Under this alternative, flow that is currently discharged from existing WWTFs to various receiving waters would be collected and conveyed to the Gulf of Maine. The effect of this redirection of wastewater flow would impact receiving waters tributary to Great Bay as well as the Gulf of Maine. These receiving waters are discussed separately below.

Surface Water Flow and Groundwater Recharge. In Alternative 2, the WWTFs no longer discharge to the estuary system.

Great Bay

During low flow (7Q10) conditions, the total volume discharged by the rivers to the Great Bay is 30.1 cfs, while the average WWTF discharge volume (in September when low river flows typically occur) is 21.8 cfs (see Table 2 in Appendix C). This WWTF flow represents 72% of the river flows. Compared to the tidal flows, the volume of water discharged by the rivers during one tide cycle (under normal river flow conditions) is approximately 1% of the tidal prism (volume of water flowing in and out of the estuary during one tide cycle) (Ertürk et al, 2002).

As a result of the redirection of WWTF effluent to the Gulf, there would be a reduction in the existing receiving water surface flow and, potentially, groundwater levels downstream and in the vicinity of the existing WWTFs. The extent of this reduction is based on the percentage of flow contribution from the existing WWTFs. Table 6-1 summarizes the percentages of flow that would be redirected, under low flow (7Q10) conditions, for receiving waters within the project area. Low flow data were taken from the existing NPDES permits where available. For several of the receiving waters, there would be a fairly significant reduction in stream flow. WWTFs that contribute substantial flow to receiving waters (for example, greater than 10 percent of stream flow during low flow conditions) include the Farmington WWTF on the Cocheco River, the Newmarket WWTF on the Lamprey River, and the Rochester WWTF on the Cocheco River, which represent 11.6, 16.8, and 48.6 percent of local receiving water flow during low flow (7Q10) conditions, respectively.

TABLE 6-1. WWTF FLOW AS A PERCENTAGE OF TOTAL FLOW DURING LOW FLOW CONDITIONS

WWTF	Receiving Water	WWTF Average Annual Flow in 2004 (MGD)	WWTF Average Annual Flow in 2004 (CFS)	7Q10 (CFS)	Total (WWTF+7Q10) (CFS)	WWTF % of Total Flow
Epping	Lamprey River	0.20	0.30	3.00	3.30	9.1
Newmarket	Lamprey River	0.64	0.99	4.91	5.90	16.8
Farmington	Cocheco River	0.21	0.33	2.52	2.85	11.6
Rochester	Cocheco River	2.90	4.49	4.74	9.23	48.6
Milton	Salmon Falls River	0.05	0.08	25.4	25.48	0.3
Rollinsford	Salmon Falls River	0.10	0.15	28.7	28.85	0.5
Somersworth	Salmon Falls River	1.10	1.70	28.7	30.40	5.6

This reduction in river flow would potentially affect a variety of downstream uses including provision of water supply and sustaining of coastal vegetation and aquatic habitat. For example, the Lamprey River is a designated Wild and Scenic River and protected by Instream Flow Rules. Compliance with flow standards is required, and any reduction in stream flow would jeopardize the ability to comply.

Under this alternative, there would be no increases in groundwater recharge with the exception of discharges from new on-lot systems within the study area. It is possible that with the reduction in stream flows that the migration of groundwater to these streams may increase. The subsequent effect of this increased migration is the possible lowering of groundwater levels which may result in the reduction in groundwater supplies and habitat in the study area. If this alternative is to be carried further, a detailed analysis of the impact on groundwater levels and availability due to the relocation of WWTF effluents will need to be conducted.

Gulf of Maine

The redirection of wastewater flow to any of the three candidate outfall locations is not anticipated to impact flow in the Gulf of Maine.

Water Quality. The following is a summary of the water quality analysis for Alternative 2. This includes changes to the Great Bay salinity, a qualitative Great Bay pollutant loading analysis, and Gulf of Maine water quality impacts.

Great Bay Salinity Changes

As a result of the reduction in freshwater flow, there is a potential for an increase in salinity concentrations and or movement of the salt wedge in the receiving waters that are under tidal influence. These receiving waters include the Lamprey River in the vicinity of the Newmarket WWTF, the Oyster River in the vicinity of the Durham WWTF, the Squamscott River in the vicinity of the Newfields WWTF, and Piscataqua River in the vicinity of the Peirce Island (Portsmouth) WWTF. Modeling was conducted to determine the effect of redirection of flow on salinity in these receiving waters (see Section 6.1.3 and Appendix C). The modeling indicated that salinity the increases on these receiving waters would be fairly minor, on the order of 1 to 2 ppt during extreme low flow (7Q10) conditions. Calculated salinities for Alternative 2 with the WWTF flows removed are shown in Figure 5 in Appendix C.

An increase of 1 to 2 ppt would not likely represent a significant effect on water quality, as this variation in salinity is experienced daily due to tidal fluctuation. However, given the sensitivity of resources in the estuary, should this alternative be selected for possible implementation, more detailed modeling to determine localized effects due to stratification and potential salinity changes should be conducted.

Great Bay Pollutant Loading Analysis

In both the freshwater and tidal receiving waters, the removal of WWTF effluent from the local receiving waters would potentially result in local receiving water quality improvements. As noted in the Preliminary Findings Report, a number of the receiving waters are identified by the Department of Environmental Services as being impaired for a variety of uses. For many of the receiving waters, TMDLs are required to be prepared for a certain number of parameters. Some of these parameters, such as low dissolved oxygen (DO), are possibly related to the discharges from the existing wastewater treatment facilities, in addition to stormwater and other non-point source discharges. The removal of WWTF discharges from the tributaries would likely result in a small increase in DO due to reduced BOD loadings. This alternative would also eliminate the discharge of toxics and reduce the risk of accidental discharge of pathogens from wastewater effluent.

Studies have been prepared documenting the contribution of nutrients to Great Bay from the existing WWTFs. In 2002, WWTFs were estimated to contribute 34 percent of the total amount of nitrogen that entered Great Bay and the Upper Piscataqua Estuary (NHEP, 2006). A report prepared in 2003 summarizing the evaluation of Effects of Wastewater Treatment Discharge on Estuarine Water Quality (Bolster et al, 2003) noted that ammonia nitrogen loading is the most significant nitrogen species being discharged to the Bay. This alternative would result in some reduction in the potential for eutrophication due to elimination of nutrients from WWTF discharges.

One potential concern with regard to water quality in the Great Bay would be the effect that reduction in stream flow would have on downstream dilution for other pollutant sources. In receiving waters where the WWTF flow represents a significant percentage of downstream flow, such as in the Cocheco River downstream of the Rochester WWTF, it is possible that water quality conditions could be degraded to some degree as a result of less dilution for pollutants from other non-point sources, such as on-lot septic systems.

Gulf of Maine Water Quality Impacts

This section presents a summary of the findings of the Gulf of Maine discharge modeling. A complete discussion of the development of the outfall concepts and assumptions in the modeling is presented in Appendix D.

Discharges to the Gulf of Maine would achieve higher initial dilution of the effluent, as compared to discharges to rivers and estuaries. Initial dilution is a function of the discharge flow rate, the instantaneous current speed, and the water column stratification. Note the discharge flow rate used is that of the year 2055 due to the expected 50 year service life of a marine outfall.

Initial dilution primarily controls the acute and chronic toxicity of the discharge. The time of travel in the effluent plume from the discharge point to the end of the zone of initial dilution is usually short enough to avoid toxic impacts to entrained organisms. Therefore, the end of the zone of initial dilution (ZID) is usually selected as the point of application of toxicity criteria. These criteria involve the Criteria Maximum Concentration (CMC) to protect against acute effects and the Criteria Continuous Concentration (CCC) to protect against chronic effects (USEPA, 1991). EPA recommends averaging periods of 1 hour and 4 days respectively for acute and chronic criteria, with an exceedence frequency of once every 3 years (USEPA, 1991).

The lowest initial dilution will be achieved for peak flow, at slack tide, during the summer (with stratified receiving water). Since stratification persists for several months, and slack tide occurs four times a day, coincidence with peak flow can be expected to occur at least once every three years and last for approximately one hour. Therefore, the dilution calculated for peak hour flow, zero current speed and stratified conditions is relevant for comparison with the CMC. The comparison for the CCC is examined under average flow conditions.

Initial dilution estimates were developed using calibrated models for different receiving water regimes (Tian et al, 2004a, 2004b; Daviero et al, 2006). The results are summarized in Table 6-2. The initial dilution values listed are the *minimum* dilution at the end of the zone of initial dilution (ZID). See Appendix D for more detail. The initial dilution increases from Sites 1 to 3. The CMC dilution, which essentially corresponds to the worst case that can be expected to occur in a three-year period, varies from 50 at Site 1 to 116 at Site 3. The CCC dilution varies from 115 at Site 1 to 269 at Site 3.

To determine the probable toxicity effects to marine organisms, the concentrations of wastewater constituents after dilution were compared to acute (CCC) and chronic (CMC) water quality and aquatic life criteria for various marine life species (see Section 6.1.4).

It is expected that continued discharge of treated wastewater effluent to the gulf would increase cumulative contribution of nitrogen and other wastewater constituents to the marine environment, and that monitoring would be needed to ascertain the magnitude of increase and effects on water quality. No adverse effects from changes in salinity are expected to occur in the gulf due to the high dilution at each of the potential outfall sites. Additionally, benthic communities are not anticipated to be impacted since the effluent is expected to rise immediately after discharge as its density is lighter than saltwater; however, it is expected that salinity would need to be monitored over the long-term should this alternative be considered for implementation.

TABLE 6-2. CANDIDATE OUTFALL CHARACTERISTICS AND INITIAL DILUTION PERFORMANCE

Characteristics	Site 1	Site 2	Site 3
Distance from shore (mi)	4.3	8.0	11.6
Depth at low water (ft)	60	120	160
Outfall length (mi)	4.3	15.5	20.0
Diffuser Design			
Length (ft)	1,290	2,580	3,440
Number of ports	44	44	44
Port diameter (inches)	6.0	6.0	6.0
Initial dilution (minimum at edge of Zone of Initial Dilution)			
Summer Conditions			
Slack tide			
2055 Average Flow 24.7 MGD	75	119	166
2055 Max day flow 65.3 MGD	58	94	130
CMC > 2055 Peak hour flow 102.6 MGD	**50***	**84**	**116**
Median Current (0.3 ft/s)			
CCC > 2055 Average Flow 24.7 MGD	**115**	**189**	**269**
2055 Max day flow 65.3 MGD	72	137	194
2055 Peak hour flow 102.6 MGD	57	118	167

* Plume surfaces

6.1.4 Wetland and Terrestrial Resources

Increase/Decrease or Relocation of Flow. The hydrologic changes, including reduction in stream flow and potential reduced groundwater levels that would occur as a result of redirecting wastewater flow to the Gulf of Maine, may result in changed wetland and terrestrial habitat in receiving waters, including reduced wetland acreage. Examples of locations where effects on wetlands and terrestrial resources may be possible include an 83-acre wetland located less than one mile downstream from the Farmington WWTF. This wetland is considered significant for surface and groundwater quality protection (Blue Moon Environmental, Inc. 2004). The Farmington WWTF contributes a significant percentage (greater than 10 percent) of the flow to the Cocheco River during extreme low flow (7Q10) conditions. Other noteworthy wetlands are located on the Squamscott River. Designated prime wetlands adjacent to the Squamscott River immediately upstream and downstream of the Exeter WWTF and wetlands located proximate to the Newfields WWTF would also be sensitive to hydrologic alterations.

It is not expected that the potential increase in salinity due to relocation of freshwater flow would have much if any effect on the composition of vegetation in the coastal area. As noted in Section 6.1.3, the increase in salinity is expected to be on the order of 1 to 2 ppt, which is well within the range of salinity variation the coastal vegetation currently experiences due to tidal influences. Because of the sensitivity of wetlands vegetation and coastal habitat in estuaries, it is recommended, however, that more detailed analysis of salinity be conducted if this alternative is selected for further consideration. For example, a wetland community that may be sensitive to changes in salinity includes the high salt marsh, which is listed as a significant natural community along the floodplains of the Lamprey and Oyster Rivers. High salt marshes are among the most biologically productive systems on earth and support a vast array of plants and animals, including many species of migratory birds (NHNHB, 2005). Another significant natural community that would be sensitive to changes in salinity is the low brackish tidal riverbank marsh, also found along the floodplain of the Lamprey River. This is a habitat inundated by salt and/or brackish tide waters on a daily or irregular frequency.

Improvements/Degradation of Water Quality. Reduced loadings from the WWTFs due to the redirection of flow to the Gulf of Maine may benefit wetland habitat in the estuary. The Hampton/Seabrook Harbor includes approximately eight square miles (more than 5,000 acres) of continuous salt marsh, and reduction of wastewater flow to the harbor could reduce pollutant assimilation in the salt marsh.

The siting of facilities, including conveyance pipelines and pump stations, may require taking of terrestrial habitat. As noted in Section 6.1.1, it is expected that attempts will be made to site these components in public rights-of-way to extent possible. However, some loss of terrestrial/upland habitats would be expected. Terrestrial wildlife may also be indirectly impacted by adverse impacts to aquatic resources and riparian communities.

No wetland and terrestrial resources would be expected to be adversely effected in the Gulf of Maine due to the offshore locations of the candidate outfall sites.

6.1.5 Aquatic Resources

Impacts to aquatic resources due to the redirection of wastewater flow to the Gulf of Maine differ between the Great Bay receiving waters and the Gulf of Maine; therefore, the two areas are discussed separately below.

Great Bay Receiving Waters

Increase/Decrease in Flow. As a result of the modifications in base flow, aquatic resources could potentially be adversely affected in some receiving waters. Great Bay has been designated as Essential Fish Habitat for feeding, breeding, nursing, and protection during juvenile and larval stages for many fish species; thus, alterations in flow that would affect aquatic life would be of concern. Alterations to aquatic resources would be most likely in receiving waters where WWTF discharges comprise close to or greater than ten percent of the base flow during low flow conditions. This includes the Lamprey River, which is designated as a Wild and Scenic River for an 11.5-mile stretch from downstream of the Epping WWTF to upstream of the Newmarket WWTF, and the Cocheco River. As indicated in Table 6-2, the Epping and Newmarket WWTFs on the Lamprey River, and the Farmington and Rochester WWTFs on the Cocheco River, all comprise close to or greater than ten percent of receiving water base flow during 7Q10 conditions. Of these four WWTFs, only the Newmarket WWTF discharges to tidal receiving waters.

There is concern that relocation of Newmarket WWTF discharge from the Lamprey River to the Gulf of Maine could affect downstream salinity concentrations in the river, which could in turn affect resident fish. The Lamprey River is tidally influenced downstream of the Macallen Dam; however, site specific resident fisheries data downstream of the dam are not available. Table 6-3 lists species identified in the Great Bay Estuary in 1980 and 1981, some of which may also occur in this section of the river during certain times of year. Of these species, the twelve freshwater species would be more susceptible to changes in salinity levels if present in the lower section of the river. Freshwater species that could be affected by significant changes in salinity include bluegill, smallmouth bass, and largemouth bass. However, these species are all tolerant to slight changes in salinity. Should the 26 marine and estuarine species occur in the lower section of the river, these species are by definition tolerant of increases in salinity due to their estuarine nature; therefore, changes in salinity would not impact estuarine fish. Anadromous fish would not be affected by changes in salinity, as by nature they migrate between fresh and saltwater.

TABLE 6-3. RESIDENT FINFISH COLLECTED BY FYKE, HAUL SEINES, TRAWLS, AND GILL NETS IN THE GREAT BAY ESTUARY IN 1980 AND 1981.

MARINE		ESTUARINE		FRESHWATER	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**	**Common Name**	**Scientific Name**
American sand lance	*Ammodytes americanus*	Atlantic silverside	*Menidia menidia*	White sucker	*Catastomus commersoni*
Windowpane flounder	*Scopthalmus aquosus*	Grubby	*Myoxocephalus aenaeus*	Pumpkinseed	*Lepomis gibbosus*
Sea raven	*Hemitripterus americanus*	Common mummichog	*Fundulus heteroclitus*	Bluegill	*Lepomis macrochirus*
Lumpfish	*Cyclopterus lumpus*	Striped mummichog	*Fundulus majalis*	Smallmouth bass	*Micropterus dolomieui*
Atlantic cod	*Gadus morhua*	Atlantic tomcod	*Microgadus tomcod*	Largemouth bass	*Micropterus salmoides*
Pollack	*Pollachius virens*	4-spine stickleback	*Apeltes quadracus*	Golden shiner	*Notemigonus crysoleucas*
Red hake	*Urophycis chuss*	3-spine stickleback	*Gasterosteus aculeatus*	Spottail shiner	*Notropis hudsonius*
White hake	*Urophycis tenuis*	9-spine stickleback	*Pungitius pungitius*	Fallfish	*Semotilus corporalis*
Cunner	*Tautogolabrus adspersus*	White perch	*Morone americanus*	Chain pickerel	*Esox niger*
Rock gunnel	*Pholis gunnellus*	Smooth flounder	*Liopsetta putnami*	Brown bullhead	*Ictalurus nebulosus*
Bluefish	*Pomatomus saltatrix*	Winter flounder	*Pseudopleuronectes americanus*	Yellow perch	*Perca flavescens*
Little skate	*Raja erinacea*	Northern pipefish	*Syngnathidae fuscus*	Rainbow trout	*Oncorhynchus mykiss*
Winter skate	*Raja ocellata*				
Black sea bass	*Centropristis striata*				

Source: Nelson 1981, as referenced in Jones 2000.

Shellfish species are not expected to be impacted by localized decreases in flow and resultant changes in salinity. For example, oysters, soft shell clams and mussels are generally tolerant to small changes in salinity. Based on salinity modeling results presented in Section 6.1.3, it is expected that the effects on aquatic resources would be negligible as these portions of the tidal reaches see great fluctuation in salinity depending on tidal cycle, season, and weather conditions. However, as recommended with regard to wetlands and terrestrial species, more detailed evaluation of effects at specific locations would be recommended should this alternative be considered for future implementation.

Improvement/Degradation in Water Quality. Aquatic life would also be affected by potential changes in water quality that may occur as a result of the relocation of WWTF effluent to the Gulf. To the extent that wastewater flow is relocated from receiving waters that currently experience closed shellfishing areas due to potential releases of untreated wastewater from WWTFs, the relocation may allow more areas to be opened to the public for potential harvest. As noted above in Section 6.1.3, some water quality improvements would be anticipated to occur as a result of relocating the flow. A decrease in nutrients and a potential increase in DO would be expected.

For example, the section of the Lamprey River below the Epping WWTF experiences low DO periods in the summer, which may partially be linked to BOD loadings from WWTFs. The elimination of BOD may reduce these low DO conditions in this stretch of river. However, much of the low DO is attributed to non-point sources. This may have beneficial effect on aquatic life downstream of these facilities. However, as was previously noted, the removal of flow from those receiving waters that are heavily dominated by WWTF flow may result in lower dilution ratios downstream, and thus pollutants from other sources such as septic systems may have greater localized effect on water quality.

Gulf of Maine Discharge

Increase/Decrease or Relocation of Flow. No effects on aquatic life in the gulf are anticipated due to increases in flow volume.

Improvement/Degradation of Water Quality. The evaluation of the anticipated concentration of pollutants in the effluent discharge was conducted based on the end of pipe concentration and the anticipated dilution available at the three candidate outfall locations during various tidal conditions (see detailed discussion in Section 6.1.3 and Appendix D). Pollutant concentrations were evaluated at average day, maximum day, and peak hour flow at both slack and median tides during both winter and summer conditions. At the point of discharge at the three candidate outfall locations, dilution would vary due to the discharge flow depth. To determine the probable toxicity effects to marine organisms, the predicted concentrations of wastewater constituents accounting for dilution were compared to water quality criteria or to the aquatic life criteria for either surrogate species or intolerant species which may be founds in the vicinity of the outfall (based on sensitivity level as determined from EPA, 1989).

Table 6-4 compares the diluted ammonia concentrations, anticipated to occur at peak hour flow during summer slack tide conditions at each of the candidate outfall sites, to the aquatic life acute criterion for ammonia based on sensitivity levels as determined from EPA, 1989. It should be noted that the WWTF discharge ammonia concentration has been assumed to be 15 mg/l. This value assumes medium strength wastewater (25 mg/l) and 40 percent removal at the WWTF (M&E, 2003). The highest diluted concentration is expected to occur at Site 1. Even during these conditions, the ammonia concentration anticipated would be less than the acute aquatic life criterion for winter flounder (*Pseudopleuronectes americanus*) larvae, which is considered to be the most susceptible stage of the most sensitive salt water species for ammonia. Larval stages of winter flounder most likely would not occur near the Site 1 outfall location, as their habitat is closer to shore within eelgrass beds. However, winter flounder larvae are a good surrogate species for other benthic and epibenthic species which may occur at the site. The LC-50 concentration for ammonia for American lobster (*Homarus americanus*), which would be present in the Gulf of Maine in the vicinity of the candidate outfall locations, is higher (2.21 mg/l) than the criterion for winter flounder; thus, no toxicity impacts would be expected to occur on lobsters.

TABLE 6-4. AMMONIA CONCENTRATIONS PREDICTED AT THE THREE CANDIDATE OUTFALL SITES COMPARED TO ACUTE AQUATIC LIFE CRITERION FOR AMMONIA IN SALTWATER (1).

	Acute Aquatic Life Criterion(2) (mg/l)	**Concentration at Site 1 (mg/l)**	**Concentration at Site 2 (mg/l)**	**Concentration at Site 3 (mg/l)**
Species: Winter Flounder	LC50-0.492 (un-ionized ammonia)	0.30	0.179	0.129

(1) Ammonia concentrations are based on peak hour flow during summer slack tide conditions

(2) Source: EPA, 1989.

Ammonia concentrations of the diluted effluent at the candidate outfall locations during average flow median current conditions were also compared to chronic toxicity values of ammonia to aquatic life. Only two saltwater species have published chronic criteria for ammonia (US EPA, 1989). These two species are mysid shrimp (*Mysidopsis bahia*) and inland silverside (*Memidia beryllima*), with chronic values of 0.232 mg/l and 0.061 mg/l, respectively. Table 6-5 compares the concentration of ammonia at the three candidate outfall sites to the chronic concentrations.

As noted in Table 6-5, no exceedence of the chronic life criterion for Mysid shrimp would occur at any of the three outfall sites. Mysid shrimp are small, shrimp-like crustaceans found primarily in the Gulf of Mexico and the eastern coast of Florida. They commonly occur at salinities above 15 ppt and are found in greatest abundance at salinities near 30 ppt. Although Mysid shrimp will not be found at the outfall locations, it is a good surrogate species for other species of shrimp or invertebrates that may occur in the vicinity of the outfall locations. Therefore, chronic ammonia toxicity is not expected for other species of shrimp.

The predicted ammonia concentration at two of the three candidate outfall sites would exceed the chronic value for inland silversides (Table 6-5). There would be no exceedence at Site 3, the site most distant from shore. The chronic toxicity values are derived from data collected for the most sensitive life stages (i.e. eggs and larvae). Since inland silversides spawn and typically reside in estuarine habitats (salinity below 15 ppt) (Weinsteid, 1996), it is unlikely that either eggs or larvae would be exposed to the ammonia concentrations anticipated to occur at the candidate outfall locations. Although inland silversides are unlikely to be found in the vicinity of candidate sites 1 and 2, more detailed evaluations of the possible toxicity to other species would be recommended should this alternative be considered for implementation.

TABLE 6-5. AMMONIA CONCENTRATIONS FOR SALTWATER SPECIES AT THE THREE CANDIDATE OUTFALL SITES COMPARED TO CHRONIC AQUATIC LIFE CRITERION FOR AMMONIA IN SALTWATER (1)

	Chronic Aquatic Life Criterion(2) (mg/l)	Concentration at Site 1 (mg/l)	Concentration at Site 2 (mg/l)	Concentration at Site 3 (mg/l)
Species: Mysid Shrimp	0.232	0.130	0.079	0.056
Species: Inland Silverside	0.061	0.130	0.079	0.056

(1) Ammonia concentrations are based on average flow median current conditions
(2) Source: EPA, 1989

Other parameters of concern in WWTF effluent discharges include BOD, TSS, and inorganic nitrogen. Aquatic life criteria or saltwater quality standards specific to these parameters are not available, generally due to the fact that these parameters are not toxic, but instead can contribute to DO deficits, which is detrimental to aquatic life and the smothering of benthic organisms

In addition, locally anticipated changes in salinity are not likely to pose an adverse effect to aquatic species. Effects on salinity levels are expected to be negligible due to the high dilution rate. The WWTF effluent would be lighter than the gulf waters, and would be expected to rise in the water column, entraining ambient water in its travel to the surface. Depending on the season, and the temperature of the gulf waters, the WWTF effluent may rise all the way to the surface or it may rise to an intermediate level, due to temperature stratification in the water column. As explained in Section 6.1.3 and Appendix D, the dilution up to a point just beyond the surface impingement or the final height of the rise is called the “initial dilution” and is the basis for the evaluation of effects to aquatic life described above.

6.1.6 Rare and Endangered Species

The redirection of wastewater flow may have an effect on rare and endangered species in Great Bay receiving waters, but is not anticipated to adversely affect rare and endangered species in the Gulf of Maine. Therefore, each is discussed separately below.

Great Bay Receiving Waters

Increase/Decrease or Relocation in Flow. To the extent that surface water flow and groundwater levels are reduced due to the transfer of WWTF effluent out of the basins to a Gulf of Maine discharge, the habitat of local rare and endangered species may be altered. It is expected that the greatest potential for alteration is in those receiving waters where a high percentage of flow in the river or stream is currently represented by the flow from the WWTF. Based on available data from the existing NPDES permits, sensitive receiving waters include the Lamprey and Cocheco Rivers (refer to Section 6.1.3). Existing data show that in these receiving waters, seven rare and endangered plant species and one exemplary community are identified in the vicinity of the Newmarket WWTF. Rare and endangered species in the vicinity of the Rochester WWTF, which represents the highest percentage of flow contribution of all WWTFs listed in Table 6-1, include three plant and three vertebrate species and two exemplary natural communities. Of these species, endangered plant species including the large salt marsh aster (*Aster tenuifolius)* and the mudwort (*Limosella australis*) on the Lamprey River and the red maple floodplain forest on the Cocheco River would be most likely to be directly affected by alterations in hydrology.

As noted above, the modeling indicates that the change in salinity in tidal receiving waters is expected to be negligible during low flow conditions. However, because of the presence of protected species in several of these receiving waters, it is recommended that the effects during 7Q10 conditions be evaluated in greater detail if this alternative is considered further for implementation.

Improvement/Degradation in Water Quality. While specific modeling results for nitrogen loading are not available, it is expected that the reduced nutrient loading in the Great Bay receiving waters would have a beneficial effect on protected plant and wildlife species. Nitrogen loadings to Great Bay may be linked to algal blooms, macroalgal proliferation, and eelgrass loss during summer months (Jones, 2000). Indirectly, oxygen can become limited and can pose risk to aquatic species. A reduction of nitrogen loadings would reduce algal blooms and DO limitations, and thus provide overall benefit to the estuary.

Gulf of Maine Discharge

Increase/Decrease in Flow. No effects on rare or endangered species would be expected as a result of flow changes.

Improvement/Degradation of Water Quality. It is not expected that any of the rare and endangered species anticipated to be present in the vicinity of the offshore discharges would be adversely affected from the treated effluent discharge. For example, the acute aquatic life criterion for ammonia for winter flounder is above the anticipated concentration of 0.30 mg/l at Site 1, which has the lowest dilution rate under all conditions. However, it is recognized that effects to aquatic species are based on cumulative effects in both inland and offshore environments. Thus, while the discharge itself is not anticipated to adversely affect the species, the existing water quality and the contributions of other contaminants should be evaluated in future studies should this alternative be selected for further consideration.

6.2 NON-MONETARY TECHNICAL ANALYSIS

The non-monetary analysis will be divided into the following sub-categories:

- Complexity
- Public Testimony
- Implementation

6.2.1 Complexity

The complexity of this alternative has been evaluated as it relates to treatment, conveyance and disposal. The following is a summary of those evaluations

In this alternative, all of the WWTFs would maintain the same level of treatment as today with the exception of the Peirce Island WWTF, which would need to be upgraded to provide secondary treatment.

The conveyance component of this alternative is complex. It is anticipated that this alternative would require a large conveyance system. The proposed conveyance system for this alternative (described in Section 3.2) is anticipated to require more than 90 miles of effluent force mains and 30 pump stations. Many of these pump stations and pipelines are located in areas not necessarily adjacent to the existing WWTFs. These force mains and pump stations would require routine operational attention and regular maintenance.

The disposal component of this alternative is also complicated. It is anticipated that this alternative would require the construction of a RPTF. This facility would be used for disinfection and sampling of the regionally collected WWTF effluent prior to discharge. This facility would likely also include an effluent pump station. This pump station is anticipated in order to convey the effluent wastewater though the outfall under peak flow conditions an high tidal conditions (especially for the longer outfalls). A marine outfall pipe and diffusers would have to be constructed, periodically inspected, and potentially maintained. In addition, a significant outfall monitoring program would likely be required by the regulatory agencies.

6.2.2 Public Testimony

This alternative produced a significant amount of negative public testimony throughout the duration of the project. The majority of this negative public testimony can be divided into the following categories:

- Concerns related to inter-basin transfer and the “throwing away” of the wastewater effluent that originated from a groundwater source.

- Concerns of negatively impacting the water quality and environmental quality directly adjacent to the outfall discharge, around the outfall, as well as globally.

- Concern that the development of a regional sewer system would result in a rapid and uncontrolled expansion or secondary growth of the study area.

6.2.3 Implementation

The implementation of this alternative would be relatively difficult. This alternative would require agreement between the municipalities to implement (for construction, maintenance, revenue production and expense sharing). Under this alternative, each community would lose part of its wastewater autonomy. This alternative would also require the siting of the regional conveyance pipelines and pump stations, the RPTF, as well as siting Gulf of Maine outfall. Siting of the components is anticipated to be difficult from environmental and public acceptance points of view. Also, given the negative public testimony received during the feasibility phase, it is anticipated that implementing this alternative would result in additional negative public feedback.

This alternative does allow the possibility that the multiple communities could join together to share resources, leverage their combined purchase power, and potentially negotiate with regulators (nitrogen trading, etc.).

6.3 PLANNING LEVEL CONSTRUCTION COSTS

Included herein are estimated planning level costs for Alternative 2. The planning level costs have been divided into three sub-categories: treatment, conveyance, and disposal.

The treatment upgrade costs for each WWTF are presented in Table 6-6. The conveyance costs associated with this alternative are presented in Table 6-7 and the disposal costs are presented in Table 6-8. It should be noted that the outfall costs presented are for the candidate outfall site that is located closest to the shore (Site 1).

TABLE 6-8. ALTERNATIVE 2 - PLANNING LEVEL EFFLUENT DISPOSAL COST ESTIMATES

Component	Size	Length	Unit Price	Total Estimated Cost
Regional Post-Treatment Facility	30 minutes of detention time @ peak flow		$ 20,000,000	$ 20,000,000
Outfall Pump Station	84 MGD		$ 50,000,000	$ 50,000,000
Outfall Pipe	72 " Diameter	4.3 miles (27,704 ft.)	$ 2,000 / linear feet	$ 45,400,000
Outfall Diffuser Section	72" w/ 44 - 6" ports	1,290 ft	$ 3,000 / linear feet	$ 3,900,000
			Total	**$ 119,300,000**

Table 6-9 presents the total Alternative 2 planning level costs for treatment, conveyance, and disposal on a town by town basis. The costs for conveyance and disposal assume that the costs for conveyance and disposal for an individual town would be proportionate to that community's percentage of the total system flow.

In summary, the estimated planning level costs for Alternative 2 are:

• Treatment Costs	$ 73,800,000
• Conveyance Costs	$ 396,000,000
• Disposal Costs	$ 119,300,000
• **Total Cost**	**$ 589,100,000**

Table 6-6. Alternative 2 Estimated WWTF Upgrade Costs

FACILITY	Year 2004 Max Mo. Flow, MGD	Year 2025 Max Mo. Flow, MGD	Economy of Scale $ Factor	Upgrades Anticipated	Incremental Flow Increase, MGD	Carbon Removal Upgrade Anticipated	Carbon removal upgrade @ $7.5/gallon	C only Filtration Upgrade Anticipated	Filtration Upgrade @ $2/gal	Nitrogen Upgrade Anticipated	Influent TN Load , lbs/day	Eff. TN Load (8mg/l), lbs/day	TN removed, lb/day	TN Removal @ $40/lb/day	TP Removal Anticipated	P-Flitration/ Chemical Addition @ $3/gallon	Other Upgrades Anticipated	Cost Assumptions (new flow only unless noted)	Other Upgrades $	Estimated Total Construction Cost
DOVER WWTF	4.57	4.87	0.70	C	0.3	yes new flow	$ 1,580,000	no	$ -	no	na	na	na	$ -	no	$ -	IP, Pre	$5/gal	$ 1,500,000	**$ 3,080,000**
DURHAM WWTF	1.71	1.8	0.80	NR	0.09	no	$ -	no	$ -	no	na	na	na	$ -	no	$ -	IP, Pre	$5/gal	$ 450,000	**$ 450,000**
EPPING WWTF	0.32	0.429	1.00	C	0.109	yes new flow	$ 820,000	no	$ -	no	na	na	na	$ -	no	$ -	Pre, Mem	$5.5/gal	$ 600,000	**$ 1,420,000**
EXETER WWTF	3.6	3.9	0.70	AS, C	0.3	all flow	$ 20,480,000	no	$ -	no	na	na	na	$ -	no	$ -	Pre	$2.5/gal	$ 750,000	**$ 21,230,000**
FARMINGTON WWTF	0.52	0.57	0.90	C	0.05	yes new flow	$ 340,000	no	$ -	no	na	na	na	$ -	no	$ -	IP, Pre	$5/gal	$ 250,000	**$ 590,000**
HAMPTON WWTF	3.3	3.7	0.70	NR	0.4	no	$ -	no	$ -	no	na	na	na	$ -	no	$ -	SH	$5/gal	$ 2,000,000	**$ 2,000,000**
MILTON WWTF	0.08	0.09	1.00	C	0.01	yes new flow	$ 80,000	no	$ -	no	na	na	na	$ -	no	$ -	NR	na	$ -	**$ 80,000**
NEWFIELDS WWTF	0.08	0.084	1.00	C	0.004	yes new flow	$ 30,000	no	$ -	no	na	na	na	$ -	no	$ -	Air	$1/gal	$ -	**$ 30,000**
NEWINGTON WWTF	0.18	0.2	1.00	C	0.02	yes new flow	$ 150,000	no	$ -	no	na	na	na	$ -	no	$ -	Air	$1/gal	$ 20,000	**$ 170,000**
NEWMARKET WWTF	1.04	1.16	0.80	C	0.12	yes new flow	$ 720,000	no	$ -	no	na	na	na	$ -	no	$ -	IP, Pre	$5/gal	$ 600,000	**$ 1,320,000**
PEASE DEVELOPMENT AUTHORITY WWTF	0.72	0.86	0.90	NR	0.14	no	$ -	no	$ -	no	na	na	na	$ -	no	$ -	NR	na	$ -	**$ -**
PORTSMOUTH WWTF	8.23	8.7	0.60	AS, C	0.47	all flow	$ 39,150,000	no	$ -	no	na	na	na	$ -	no	$ -	SH	$5/gal	$ 2,350,000	**$ 41,500,000**
ROCHESTER WWTF	5.51	6.1	0.60	C	0.59	no	$ -	no	$ -	no	na	na	na	$ -	no	$ -	2nd Clarifier	$1.5 M Clarifier	$ 1,500,000	**$ 1,500,000**
ROCKINGHAM COUNTY WWTF	0.085	0.118	1.00	NR	0.033	no	$ -	no	$ -	no	na	na	na	$ -	no	$ -	NR	na	$ -	**$ -**
ROLLINSFORD WWTF	0.15	0.17	1.00	NR	0.02	no	$ -	no	$ -	no	na	na	na	$ -	no	$ -	NR	na	$ -	**$ -**
SEABROOK WWTF	1.17	1.39	0.80	NR	0.22	no	$ -	no	$ -	no	na	na	na	$ -	no	$ -	NR	na	$ -	**$ -**
SOMERSWORTH WWTF	1.79	1.9	0.8	NR	0.11	no	$ -	no	$ -	no	na	na	na	$ -	no	$ -	Pre, Air	$3.5/gal	$ 390,000	**$ 390,000**
Totals	**33.055**	**36.041**			**2.986**		**$ 63,350,000**		**$ -**		**0.0**	**0.0**	**0.0**	**$ -**		**$ -**			**$ 10,410,000**	**$ 73,760,000**

Legend

C = Carbon
TN = Total Nitrogen
TP = Total Phosphorus
AS = Activated Sludge

IP = Influent Pumping
Pre = Preliminary Teatment
Dis = Disinfection
Mem = Membranes

M = Metals
Air = Aeration
SH = Solids Handling
NR = Not Required

Table 6-7. Alternative 2 WWTF Effluent Conveyance Planning Level Construction Cost Estimate

Pipe Routing and Flow Combining				Anticipated Conveyance Components, Planning Level Sizing, and Planning Level Costs									
From	To			Pipe Length, ft	Pipe Length, Miles	2055 Flow, MGD	2055 Pipe Size, in	$ per Foot	Estiamted Pipeline Cost	Number of Pump Stations Anticipated	Approximate Pump Station Size, MGD	Estimated Cost Per Pump Station	Total Estimated Conveyance Costs
FARMINGTON WWTF	Northeast Main 1	0.91	MGD	35,000	6.63	0.91	8	$ 250	$ 8,750,000	1	0.91	$ 750,000	$ 750,000
MILTON WWTF	Northeast Main 1	0.24	MGD	26,000	4.92	0.24	4	$ 250	$ 6,500,000	1	0.24	$ 750,000	$ 750,000
From	**To**												
Northeast Main 1	Northeast Main 2	1.15	MGD	20,000	3.79	1.15	10	$ 250	$ 5,000,000	1	1.15	$ 2,000,000	$ 2,000,000
ROCHESTER WWTF	Northeast Main 2	10.00	MGD	4,000	0.76	10.00	24	$ 350	$ 1,400,000	1	10.00	$ 12,500,000	$ 12,500,000
From	**To**												
Northeast Main 2	Northeast Main 3	11.15	MGD	35,000	6.63	11.15	30	$ 350	$ 12,250,000	1	11.15	$ 12,500,000	$ 12,500,000
From	**To**												
ROLLINSFORD WWTF	Rollinsford Submain 1	0.36	MGD	12,000	2.27	0.36	5	$ 250	$ 3,000,000	1	0.36	$ 750,000	$ 750,000
SOMERSWORTH WWTF	Rollinsford Submain 1	5.75	MGD	-	0	5.75	18	$ 300	$ -	1	5.75	$ 5,000,000	$ 5,000,000
From	**To**												
Rollinsford Submain 1	Northeast Main 3	6.11	MGD	19,000	3.60	6.11	20	$ 300	$ 5,700,000	1	6.11	$ 5,000,000	$ 5,000,000
From	**To**												
Northeast Main 3	Northeast Main 4	17.25	MGD	28,000	5.30	17.25	36	$ 400	$ 11,200,000	1	17.25	$ 12,500,000	$ 12,500,000
From	**To**												
DOVER WWTF	Northeast Main 4	12.74	MGD	4,000	0.76	12.74	30	$ 350	$ 1,400,000	1	12.74	$ 12,500,000	$ 12,500,000
From	**To**												
Northeast Main 4	Northeast Main 5	29.99	MGD	30,000	5.68	29.99	42	$ 400	$ 12,000,000	1	29.99	$ 22,500,000	$ 22,500,000
From	**To**												
NEWINGTON WWTF	Northeast Main 5	0.54	MGD	5,000	0.95	0.54	6	$ 250	$ 1,250,000	1	0.54	$ 750,000	$ 750,000
PEASE WWTF	Northeast Main 5	3.15	MGD	3,000	0.57	3.15	14	$ 300	$ 900,000	1	3.15	$ 2,000,000	$ 2,000,000
From	**To**												
Northeast Main 5	Ocean Outfall Main	33.67	MGD	13,000	2.46	33.67	48	$ 500	$ 6,500,000	1	33.67	$ 22,500,000	$ 22,500,000
From	**To**												
DURHAM WWTF	Durham Submain 1	5.35	MGD	31,000	5.87	5.35	18	$ 300	$ 9,300,000	1	5.35	$ 5,000,000	$ 5,000,000
NEWMARKET WWTF	Durham Submain 1	2.41	MGD	-		0.69	12		$ -	1	2.41	$ 2,000,000	$ 2,000,000
From	**To**												
Durham Submain 1	Durham Submain 2	7.76	MGD	14,000	2.65	7.76	24	$ 350	$ 4,900,000	1	7.76	$ 5,000,000	$ 5,000,000
NEWFIELDS WWTF	Durham Submain 2	0.17	MGD	-		0.17	4	$ 250	$ -	1	0.17	$ 750,000	$ 750,000
Durham Submain 2	Southeast Inland Main 1	7.928	MGD	8,000	1.52		24	$ 350	$ 2,800,000	1	7.93	$ 5,000,000	$ 5,000,000
From	**To**												
EPPING WWTF	Epping Submain 1	0.70	MGD	9,000	1.70	0.70	8	$ 250	$ 2,250,000	1	0.70	$ 750,000	$ 750,000
ROCKINGHAM CO. WWTF	Epping Submain 1	0.44	MGD	4,000	0.76	0.44	5	$ 250	$ 1,000,000	1	0.44	$ 750,000	$ 750,000
Epping Submain 1	Southeast Inland Main 1	1.14	MGD	30,000	5.68	1.14	10	$ 250	$ 7,500,000	1	1.14	$ 2,000,000	$ 2,000,000
From	**To**												
EXETER WWTF	Southeast Inland Main 1	6.75	MGD	12,000	2.27	6.75	20	$ 300	$ 3,600,000	1	6.75	$ 5,000,000	$ 5,000,000
Southeast Inland Main 1	Coastal Submain 2	15.81	MGD	43,000	8.14	15.81	30	$ 350	$ 15,050,000	1	15.81	$ 12,500,000	$ 12,500,000
From	**To**												
SEABROOK WWTF	Coastal Submain 1	3.86	MGD	25,000	4.73	3.86	16	$ 300	$ 7,500,000	1	3.86	$ 2,000,000	$ 2,000,000
HAMPTON WWTF	Coastal Submain 1	8.60	MGD	6,000	1.14	8.60	24	$ 350	$ 2,100,000	1	8.60	$ 5,000,000	$ 5,000,000
From	**To**												
Coastal Submain 1	Coastal Submain 2	12.46	MGD	42,000	7.95	12.46	30	$ 350	$ 14,700,000	1	12.46	$ 12,500,000	$ 12,500,000
From	**To**												
Coastal Submain 2	Ocean Outfall Main	28.27	MGD	12,000	2.27	28.27	42	$ 400	$ 4,800,000	1	28.27	$ 22,500,000	$ 22,500,000
From	**To**												
Ocean Outfall Main	Post Treatment Facility	61.94	MGD	2,000	0.38	61.94	60	$ 500	$ 1,000,000	1	61.94	$ 35,000,000	$ 35,000,000
From	**To**												
PORTSMOUTH WWTF	Post Treatment Facility	22.00	MGD	8,000	1.52	22.00	36	$ 400	$ 3,200,000	1	22.00	$ 12,500,000	$ 12,500,000
			Totals	**480,000**	**90.91**				**$ 155,550,000**	**30**			**$ 240,250,000**
												Total Conveyance Cost	**$ 395,800,000**

Notes:
- All flows in MGD
- All flows are the average of 2055 peak hour and peak day flows
- See Figure 3-3 for planning level conveyance routes used to develop this table

🟨 - Indicates flow originating from individual WWTFs

Table 6-9. Estimated Planning Level Construction Costs for Alternative 2

FACILITY	Treatment Cost	Conveyance Cost	Discharge Costs	Total Estimated Construction Costs
DOVER WWTF	$ 3,100,000	$ 50,600,000	$ 15,200,000	$ 68,900,000
DURHAM WWTF	$ 500,000	$ 19,500,000	$ 5,900,000	$ 25,900,000
EPPING WWTF	$ 1,400,000	$ 3,800,000	$ 1,200,000	$ 6,400,000
EXETER WWTF	$ 21,200,000	$ 37,300,000	$ 11,200,000	$ 69,700,000
FARMINGTON WWTF	$ 600,000	$ 4,600,000	$ 1,400,000	$ 6,600,000
HAMPTON WWTF	$ 2,000,000	$ 49,700,000	$ 15,000,000	$ 66,700,000
MILTON WWTF	$ 100,000	$ 1,100,000	$ 300,000	$ 1,500,000
NEWFIELDS WWTF	$ -	$ 1,000,000	$ 300,000	$ 1,300,000
NEWINGTON WWTF	$ 200,000	$ 2,800,000	$ 900,000	$ 3,900,000
NEWMARKET WWTF	$ 1,300,000	$ 13,700,000	$ 4,100,000	$ 19,100,000
PEASE DEVELOPMENT AUTHORITY WWTF	$ -	$ 9,200,000	$ 2,800,000	$ 12,000,000
PORTSMOUTH WWTF	$ 41,500,000	$ 92,200,000	$ 27,800,000	$ 161,500,000
ROCHESTER WWTF	$ 1,500,000	$ 62,100,000	$ 18,700,000	$ 82,300,000
ROCKINGHAM COUNTY WWTF	$ -	$ 2,000,000	$ 600,000	$ 2,600,000
ROLLINSFORD WWTF	$ -	$ 2,000,000	$ 600,000	$ 2,600,000
SEABROOK WWTF	$ -	$ 21,300,000	$ 6,400,000	$ 27,700,000
SOMERSWORTH WWTF	$ 400,000	$ 23,100,000	$ 6,900,000	$ 30,400,000
TOTAL	**$ 73,800,000**	**$ 396,000,000**	**$ 119,300,000**	**$ 589,100,000**

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SECTION 7.0 ALTERNATIVE 3 (DECENTRALIZED TREATMENT AND CONTINUED USE OF EXISTING WWTFs) ANALYSIS

This Section identifies and describes the analysis of Alternative 3 (Decentralized Discharge). The different methods of analysis are described in Section 4. The analysis will include the following three major categories:

- Environmental Analysis
- Non–Monetary Analysis
- Planning Level Construction Costs

7.1 ENVIRONMENTAL ANALYSIS

This alternative would result in continued reliance on existing wastewater facilities; however, two-thirds of the projected increase in wastewater flow would be directed to decentralized systems for treatment and subsurface land application. Under this alternative, the existing wastewater treatment facilities (WWTFs) would be upgraded to meet the 2025 discharge limits at their existing locations (see Appendix L of the Preliminary Findings Report for a summary of projected 2025 WWTF effluent limits). The majority of new growth would need to be accommodated by on-lot or other types of decentralized systems. In some parts of the project area, new development may not be feasible due to lack of sewers and unsuitable sites for on-lot systems. The following discussion summarizes the trends that would be likely to continue should Alternative 3 be selected.

7.1.1 Land Use and Growth

Land Use Compatibility and Aesthetics. Under this alternative, the existing WWTFs would continue to treat current flows and a portion of projected flows. Upgrades to the existing WWTFs are anticipated to meet existing and future discharge limits (see Section 3.3.1), which would result in relatively minor land use impacts similar to those described for Alternative 1 (No Action). Since this alternative assumes that one-third of the projected increase in wastewater flow would be treated at the existing WWTFs and the remaining two-thirds would be treated by decentralized systems, concerted efforts would need to be made by the municipalities to limit growth of a centralized sewer system (e.g. imposing sewer extension restrictions) and plan for and identify areas that could accommodate decentralized systems. Siting decentralized systems may prove difficult in some study area communities that have limited developable land available, such as Portsmouth. Siting factors that would need to be considered as part of further analysis include land availability, ability of homes to combine discharges, and soil characteristics.

The decentralized systems would require the permanent taking of parcels of land within the WWTF communities. Undeveloped land, including forested and agricultural lands, would be the most likely type of land selected for siting the decentralized systems. Thus, operation of these systems would result in a permanent change in land use. The decentralized system components would primarily be located below grade and the surface revegetated, thus changes to aesthetic character in the vicinity of the systems would be somewhat mitigated.

Land Area Impacted. Table 7-1 summarizes the approximate number of decentralized systems required for each community with a WWTF as well as the associated land area. The information in this table is based on engineering criteria presented in Section 3.3 of this report. For several of the communities, a fairly significant amount of land is anticipated to be required to accommodate the decentralized systems. WWTF communities with significant land area requirements (50 or more acres) include Dover, Exeter, Hampton, Portsmouth, and Rochester.

TABLE 7-1. TOTAL LAND AREA ANTICIPATED FOR DECENTRALIZED SYSTEMS

WWTF Community	Number of Decentralized Systems (10K gpd/system)	Total Land Area (2.5 acres/system)
Dover	20.0	50.0
Durham	6.0	15.0
Epping	7.3	18.3
Exeter	20.0	50.0
Farmington	3.3	8.3
Hampton	26.7	66.8
Milton	0.7	1.8
Newfields	0.3	0.8
Newington	1.3	3.3
Newmarket	8.0	20.0
Pease Development Authority	9.3	23.3
Portsmouth	31.3	78.3
Rochester	39.3	98.3
Rockingham County Facility	2.2	5.5
Rollinsford	1.3	3.3
Seabrook	14.7	36.8

Indirect Growth. This alternative could potentially discourage future growth by limiting the ability of new developments in WWTF communities from tying into existing sewer systems. In order for this to occur, action would be required at the local level to minimize extensions to existing sewer systems and to maximize use of decentralized systems. While the use of decentralized systems would result in the direct loss of parcels (to accommodate the decentralized system and their soil absorption systems (SAS)), this alternative may indirectly protect other undeveloped parcels by limiting the ease in which future growth could occur. In areas where decentralized systems are employed, there would be a finite capacity to the treatment system, which in turn would limit the number of possible future connections to the system. Such an alternative, in conjunction with restrictions on sewer connections or limitations for development of individual on-lot systems, would effectively serve as a temporary form of growth management in communities that contain a number of undeveloped parcels or sensitive resource areas the communities would like to protect.

7.1.2 Air Quality

Similar to Alternative 1 (No Action), continued operation of the WWTFs, after the anticipated upgrades, is generally anticipated to result in minimal impacts to air quality to communities within the study area. Operation of the decentralized systems is similarly not anticipated to result in adverse impacts to air quality. A potential source of emission, if necessary, is anticipated to be small vent structures. These vents may release small concentrations of gasses, such as hydrogen sulfide; however, the concentrations generated by a properly operating system would be minimal and would rapidly disperse. Proximity to receptors should be considered during siting to allow for adequate buffer. Although the dosing pump stations would be sized to contain approximately 24 hours of flow in the event of a power outage, the design in some locations may call for an additional safety factor, i.e. standby generator. Operation of, and thus emission from, a standby generator is expected to be infrequent. Therefore, no significant long-term air quality impacts related to the decentralized systems are anticipated.

7.1.3 Surface Water Flow, Groundwater Recharge, and Water Quality

Surface Water Flow and Groundwater Recharge. For Alternative 3, direct WWTF discharges to the estuary would increase by 2.7%. This increase is expected due to an increase in wastewater generation in the study area discharged to the WWTFs (one-third of the projected wastewater generation).

Indirect discharge from the decentralized systems to the estuary (e.g. groundwater flows from the on-lot decentralized systems) would increase by 5.5%. This increase is expected due to the new decentralized systems discharge (two-thirds of the projected wastewater) which would contribute to the recharge of the groundwater. This new wastewater flow to decentralized systems, and ultimately to the groundwater, is anticipated to be approximately 2 million gallons per day. Finally, new developments not able to connect to existing WWTFs would rely on on-lot disposal, which would contribute to continued recharge of groundwater in localized areas.

The maintenance of stream flow and positive contribution to groundwater would be beneficial for maintaining habitat and preserving water supplies, and for maintaining overall water balance in the watershed.

Water Quality. The following is a summary of the water quality analysis for Alternative 3. This includes changes to the Great Bay salinity and a qualitative Great Bay pollutant loading analysis.

Great Bay Salinity Changes

Similar to Alternative 1 (No Action) the majority of the wastewater generated in the communities with WWTFs will be discharged to the existing WWTF discharge locations. The impact on salinity for the two alternatives is anticipated to be similar. The salinity modeling for Alternative 1 indicated the impact of the WWTF discharge on salinity is anticipated to be 1 ppt or less. See Section 5.1.3 and Appendix C for the discussion of the salinity impacts for Alternative 1.

Pollutant Loading Analysis

Water quality would continue to be affected by WWTF discharges. Under this alternative, the pollutant loading to the Great Bay from WWTFs for BOD, TSS, nitrogen, and phosphorus are all anticipated to decrease due to the new effluent limits projected for this study. This may result in some improvements to the dissolved oxygen (DO) concentrations and potential for eutrophication in the Great Bay. There is anticipated to be a slight increase in toxics discharge to the Great Bay due to increased wastewater generation and incomplete removal during treatment.

It is important to note that while the loading to the Great Bay from the WWTFs will be reduced, other loading inputs to the Great Bay may minimize the improvements of the WWTF loading reductions. These other inputs include non-point sources such as stormwater run-off, atmospheric degradation, and inputs from on-lot systems (e.g. increases in bacterial contribution from malfunctioning or overstressed on-lot systems).

Water quality of local receiving waters may also improve as a result of implementation of decentralized systems, which may pick up flow from failing septic systems that may have been prohibited from connecting to a WWTF. The community systems' discharges to groundwater would not be expected to degrade water quality as long as performance standards, such as type of soil and depth to groundwater are met in the siting and operation of these systems.

7.1.4 Wetland and Terrestrial Resources.

Wetland Resources. General wetland resource area conditions would not be expected to change significantly. Existing wastewater flow would continue to be treated at the WWTFs with discharge to existing receiving waters. Flow from future growth would be split, with one-third going to the central treatment facility, and two-thirds going to small or community systems. The split of flow would be beneficial for maintaining needed hydrology to support wetlands resource areas. On-site disposal systems would provide recharge to groundwater fed wetlands and also contribute to recharging stream flow.

Terrestrial Resources. Continued function of the wetlands resource areas would also be expected to provide valuable habitat for some terrestrial wildlife that benefit from water sources and riparian vegetation. While the decentralized treatment systems would result in alteration of surface vegetation available for terrestrial resources, as discussed above in the land use section, the systems would provide some habitat for small mammals or bird life. It is not expected that community systems would necessarily be fenced in any manner, thus wildlife access would likely not be restricted.

7.1.5 Aquatic Resources. It is not expected that there would be any significant effects to aquatic resources as stream flows would be increased by a modest amount and water quality would be improved to the extent the WWTFs must meet more stringent discharge limits. In addition, proper planning and siting of community systems may provide for more reliable on-site disposal than individual on-lot systems which may currently be contributing to localized high bacterial concentrations in receiving waters.

7.1.6 Rare and Endangered Species. It is not expected that there would be any significant effects on rare and endangered species. It is expected that siting of community systems can be done without directly or indirectly displacing any protected species. Maintaining both stream flow and groundwater levels would help to maintain habitat for protected species. In addition, improvements in water quality as a result of imposition of more stringent surface water discharge limits would also help to enhance habitat of rare and endangered species.

7.2 NON-MONETARY TECHNICAL ANALYSIS

The non-monetary analysis is divided into the following sub-categories:

- Complexity
- Public Testimony
- Implementation

7.2.1 Complexity

The complexity of this alternative has been evaluated as it relates to treatment, conveyance, and disposal. The following is a summary of those evaluations.

As described in Section 3.3, there are two components to this alternative: 1) the WWTF improvements and 2) the inclusion of a number of standardized decentralized systems. These components will be discussed separately.

WWTF Component. In this alternative, the anticipated treatment required at the WWTFs is more sophisticated than the existing WWTF treatment in order to accommodate the new treatment limits that would be required for the existing discharge locations. As a whole, the treatment component of this alternative is not considered to be particularly complex.

In this alternative, there is no conveyance component as the existing surface water discharge locations will be used.

The complexity of the disposal component of this alternative is not complex. In this alternative, the existing WWTF outfalls will be used.

Decentralized System Component. This alternative has the added complexity of community on-lot disposal systems. While each individual system may not be complicated, the large number of systems under this alternative makes the disposal portion relatively complicated. As noted in Section 3.3, approximately 200 community on-lot systems are anticipated. These systems will require siting, construction, maintenance, and periodic inspection. These 200 systems will also produce septage that will require periodic removal and disposal.

7.2.2 Public Testimony

This alternative was selected for analysis in this study as a direct result of the amount of public testimony that was given in support of examining a decentralized alternative. The majority of the public comments that were received related to this alternative were in the following categories:

- Concerns related to the benefit of decentralized treatment avoiding inter-basin transfer and the “throwing away” of the wastewater effluent that originated from a groundwater source, and that local/small scale disposal should be examined.

- Concerns of removing as much of the pollutant load from the surface receiving waters by reducing the amount of future flows that would be treated at WWTFs.

- Concern that development of a regional sewer system or the continued growth or tie-ins to the existing 17 sewer systems would result in a rapid and uncontrolled expansion of population and development within the study area.

7.2.3 Implementation

The implementation of the WWTF component of this alternative would be relatively simple. However, it is anticipated that it will be difficult to implement the decentralized system component. Implementation of the decentralized systems component of this alternative would require stricter zoning and sewer tie-in regulations at the local level. These regulations would need to require developers of new residential and commercial units to use decentralized systems in lieu of the existing sewers.

The costs of these decentralized systems would likely be passed on to the buyers. This would probably result in higher costs for the buyers and the potential to reduce the demand for these new units. This reduced demand may in turn limit the amount of growth (population and tax revenue) that a municipality might see over the long run with these regulations.

Another issue affecting the implementation of the decentralized systems is the ability to find and acquire the land required to site these systems. The areas currently sewered are portions of the municipalities that tend to be denser. Finding and siting community on-lot systems may prove difficult in these areas due to the limited land availability. The limited availability, both in total area as well as in proximity to each other, may result in fewer multiple unit developments that would be constructed in these areas (facilitating the use of a community on-lot system) and therefore make decentralized systems in these areas difficult to implement.

Although this alternative does not require an agreement between municipalities for construction or operation of the WWTF upgrades or the decentralized systems, this alternative does allow the possibility that the multiple communities could join together to share resources, leverage their combined purchasing power (for chemical, supplies, and equipment), and potentially negotiate with the regulators (permit limits, etc.).

7.3 PLANNING LEVEL CONSTRUCTION COSTS

Included herein are estimated planning level costs for Alternative 3. The WWTF planning level costs have been divided into three sub-categories; treatment, conveyance, and disposal. The planning level cost for the decentralized systems have also been included.

The planning level treatment upgrade construction costs for each WWTF are presented in Table 7-2. There are no conveyance and disposal costs associated with the WWTF component of this alternative. In summary, the estimated planning level construction cost for the WWTF component of Alternative 3 is:

• Treatment Costs	$ 92,000,000
• Conveyance Costs	$ -
• Disposal Costs	$ -
• **Total Cost**	**$ 92,000,000**

The planning level construction costs for the decentralized system component of each WWTF community are presented in Table 7-3. In summary, the estimated planning level construction cost for the decentralized system component of Alternative 3 is:

• Decentralized Systems	$ 119,500,000
• **Total Cost**	**$ 119,500,000**

It should be noted that the costs associated with the decentralized system component of Alternative 3 can be considered as part of the overall cost of the alternative, or it can be considered separately due to the developer financing the original cost of these systems.

The total estimated planning level construction costs for Alternative 3 for each community are presented in Table 7-4. In summary, the estimated planning level construction costs for Alternative 3 are:

• Treatment Costs	$ 92,000,000
• Conveyance Costs	$ -
• Disposal Costs	$ 119,500,000
• **Total Cost**	**$ 211,500,000**

Table 7-2. Alternative 3 Estimated WWTF Upgrade Costs

FACILITY	Year 2004 Max Mo. Flow, MGD	Year 2025 Max Mo. Flow, MGD	Economy of Scale $ Factor	Upgrades Anticipated	Incremental Flow Increase, MGD	Carbon Removal Upgrade Anticipated	Carbon removal upgrade @ $7.5/gallon	C only Filtration Upgrade Anticipated	Filtration Upgrade @ $2/gal	Nitrogen Upgrade Anticipated	Influent TN Load , lbs/day	Eff. TN Load (8mg/l), lbs/day	TN removed, lb/day	TN Removal @ $40/lb/day	TP Removal Anticipated	P-Flitration/ Chemical Addition @ $3/gallon	Other Upgrades Anticipated	Cost Assumptions (new flow only unless noted)	Other Upgrades $	Estimated Total Construction Cost
DOVER WWTF	4.57	4.87	0.70	C, TN	0.100	yes new flow	$ 530,000	no	$ -	yes	779.0	311.6	467.37	$ 4,780,000	no	$ -	IP, Pre, Dis	$6/gal	$ 600,000	**$ 5,910,000**
DURHAM WWTF	1.71	1.8	0.80	TN	0.030	no	$ -	no	$ -	yes	290.2	116.1	174.14	$ 2,030,000	no	$ -	IP, Pre, Dis	$6/gal	$ 180,000	**$ 2,210,000**
EPPING WWTF	0.32	0.429	1.00	C, TN, TP	0.036	yes new flow	$ 270,000	no MBR	$ -	yes new flow	6.1	2.4	3.64	$ 50,000	new flow chemical only	$ 110,000	Pre, Mem, Dis	$6.5/gal	$ 240,000	**$ 670,000**
EXETER WWTF	3.6	3.9	0.70	AS, C, TN	0.100	all flow	$ 20,480,000	no	$ -	yes	617.2	246.9	370.30	$ 3,780,000	no	$ -	Pre	$2.5/gal	$ 250,000	**$ 24,510,000**
FARMINGTON WWTF	0.52	0.57	0.90	C, TN, TP	0.017	yes new flow	$ 110,000	no for P only	$ -	yes	89.5	35.8	53.71	$ 710,000	yes	$ 1,450,000	IP, Pre, M	$5/gal + $100K metals study	$ 180,000	**$ 2,450,000**
HAMPTON WWTF	3.3	3.7	0.70	C, TN	0.133	yes new flow	$ 700,000	yes	$ -	yes new flow	22.2	8.9	13.34	$ 140,000	no	$ -	M, Dis, SH	$6/gal + $100K metals study	$ 900,000	**$ 1,740,000**
MILTON WWTF	0.08	0.09	1.00	AS, C, TN, TP	0.003	all flow	$ 680,000	no for P only	$ -	yes	13.9	5.6	8.34	$ 120,000	yes	$ 250,000	NR	na	$ -	**$ 1,050,000**
NEWFIELDS WWTF	0.08	0.084	1.00	AS, C, TN	0.001	all flow	$ 630,000	no	$ -	yes	13.6	5.4	8.14	$ 120,000	no		NR	na	$ -	**$ 750,000**
NEWINGTON WWTF	0.18	0.2	1.00	TN	0.007	no	$ -	no	$ -	yes	31.1	12.5	18.68	$ 270,000	no		NR	na	$ -	**$ 270,000**
NEWMARKET WWTF	1.04	1.16	0.80	AS, C, TN	0.040	all flow	$ 6,960,000	no	$ -	yes	180.1	72.1	108.09	$ 1,260,000	no		IP, Pre, Dis	$6/gal	$ 240,000	**$ 8,460,000**
PEASE DEVELOPMENT AUTHORITY WWTF	0.72	0.86	0.90	NR	0.047	no	$ -	no	$ -	SBR mods only				$ 100,000	no		Dis	$1/gal	$ 50,000	**$ 150,000**
PORTSMOUTH WWTF	8.23	8.7	0.60	AS, C	0.157	all flow	$ 39,150,000	no	$ -	no	na	na	na	$ -	no		Dis, SH	$6/gal	$ 940,000	**$ 40,090,000**
ROCHESTER WWTF	5.51	6.1	0.60	TP	0.197	no	$ -	no for P only	$ -	yes new flow	32.8	13.1	19.68	$ 170,000	yes new flow	$ 350,000	2nd Clarifier	$1.5 M Clarifier	$ 1,500,000	**$ 2,020,000**
ROCKINGHAM COUNTY WWTF	0.085	0.118	1.00	AS, C, TN	0.011	all flow	$ 890,000	yes	$ -	yes	16.0	6.4	9.61	$ 140,000	no		NR	na	$ -	**$ 1,030,000**
ROLLINSFORD WWTF	0.15	0.17	1.00	TP	0.007	no	$ -	no for P only	$ -	no	0.0	0.0	0.00	$ -	yes new flow	$ 20,000	NR	na	$ -	**$ 20,000**
SEABROOK WWTF	1.17	1.39	0.80	NR	0.073	no	$ -	no	$ -	no	na	na	na	$ -	no		Air	$1/gal	$ 70,000	**$ 70,000**
SOMERSWORTH WWTF	1.79	1.9	0.80	C, TN, TP	0.037	yes new flow	$ 220,000	no for P only	$ -	yes new flow	6.1	2.4	3.67	$ 40,000	yes new flow	$ 90,000	Pre	$2.5/gal	$ 90,000	**$ 440,000**
Totals	**33.055**	**36.041**			**0.995333333**		**$ 70,620,000**		**$ -**		**2097.8**	**839.1**	**1258.7**	**$ 13,710,000**		**$ 2,270,000**			**$ 5,240,000**	**$ 91,840,000**

Legend

C = Carbon
TN = Total Nitrogen
TP = Total Phosphorus
AS = Activated Sludge

IP = Influent Pumping
Pre = Preliminary Teatment
Dis = Disinfection
Mem = Membranes

M = Metals
Air = Aeration
SH = Solids Handling
NR = Not Required

Table 7-3. Alternative 3 - Decentralized Systems Planning Level Construction Cost Estimate

Flow Increases, Decentralized Systems Required, and Planning Level Construction Cost Estimates

WWTF COMMUNITY	Year 2004 Maximum Month. Flow, MGD	Year 2025 Maximum Month. Flow, MGD	Incremental Flow Increase, GPD	Flow to Decentralized Systems (2/3rds), GPD	Number of Systems Required @ 10K GPD/ system	Estimated Construction Cost @ $600K/ system
DOVER	4.57	4.87	300,000	200,000	20.0	$ 12,000,000
DURHAM	1.71	1.80	90,000	60,000	6.0	$ 3,600,000
EPPING	0.32	0.43	109,000	72,667	7.3	$ 4,360,000
EXETER	3.60	3.90	300,000	200,000	20.0	$ 12,000,000
FARMINGTON	0.52	0.57	50,000	33,333	3.3	$ 2,000,000
HAMPTON	3.30	3.70	400,000	266,667	26.7	$ 16,000,000
MILTON	0.08	0.09	10,000	6,667	0.7	$ 400,000
NEWFIELDS	0.08	0.08	4,000	2,667	0.3	$ 160,000
NEWINGTON	0.18	0.20	20,000	13,333	1.3	$ 800,000
NEWMARKET	1.04	1.16	120,000	80,000	8.0	$ 4,800,000
PEASE DEVELOPMENT AUTHORITY	0.72	0.86	140,000	93,333	9.3	$ 5,600,000
PORTSMOUTH	8.23	8.70	470,000	313,333	31.3	$ 18,800,000
ROCHESTER	5.51	6.10	590,000	393,333	39.3	$ 23,600,000
ROCKINGHAM COUNTY	0.09	0.12	33,000	22,000	2.2	$ 1,320,000
ROLLINSFORD	0.15	0.17	20,000	13,333	1.3	$ 800,000
SEABROOK	1.17	1.39	220,000	146,667	14.7	$ 8,800,000
SOMERSWORTH	1.79	1.90	110,000	73,333	7.3	$ 4,400,000
Total	**33.06**	**36.04**	**2,986,000**	**1,990,667**	**199.1**	**$ 119,440,000**

Table 7-4. Estimated Planning Level Construction Costs for Alternative 3

FACILITY	**Treatment Cost**	**Conveyance Cost**	**Discharge Costs (Decentralized Systems)**	**Total Estimated Construction Costs**
DOVER WWTF	$ 5,900,000	na	$ 12,000,000	$ 17,900,000
DURHAM WWTF	$ 2,200,000	na	$ 3,600,000	$ 5,800,000
EPPING WWTF	$ 700,000	na	$ 4,400,000	$ 5,100,000
EXETER WWTF	$ 24,500,000	na	$ 12,000,000	$ 36,500,000
FARMINGTON WWTF	$ 2,500,000	na	$ 2,000,000	$ 4,500,000
HAMPTON WWTF	$ 1,700,000	na	$ 16,000,000	$ 17,700,000
MILTON WWTF	$ 1,100,000	na	$ 400,000	$ 1,500,000
NEWFIELDS WWTF	$ 800,000	na	$ 200,000	$ 1,000,000
NEWINGTON WWTF	$ 300,000	na	$ 800,000	$ 1,100,000
NEWMARKET WWTF	$ 8,500,000	na	$ 4,800,000	$ 13,300,000
PEASE DEVELOPMENT AUTHORITY WWTF	$ 200,000	na	$ 5,600,000	$ 5,800,000
PORTSMOUTH WWTF	$ 40,100,000	na	$ 18,800,000	$ 58,900,000
ROCHESTER WWTF	$ 2,000,000	na	$ 23,600,000	$ 25,600,000
ROCKINGHAM COUNTY WWTF	$ 1,000,000	na	$ 1,300,000	$ 2,300,000
ROLLINSFORD WWTF	$ -	na	$ 800,000	$ 800,000
SEABROOK WWTF	$ 100,000	na	$ 8,800,000	$ 8,900,000
SOMERSWORTH WWTF	$ 400,000	na	$ 4,400,000	$ 4,800,000
TOTAL	**$ 92,000,000**	**$ -**	**$ 119,500,000**	**$ 211,500,000**

SECTION 8.0 ALTERNATIVE 4 (TREATMENT AT EXISTING WWTFs AND DISCHARGE TO LAND APPLICATION SITES) ANALYSIS

This Section identifies and describes the analysis of Alternative 4 (Land Application). The different methods of analysis are described in Section 4. The analysis will include the following three major categories:

- Environmental Analysis
- Non-Monetary Analysis
- Planning Level Construction Costs

8.1 ENVIRONMENTAL ANALYSIS

This alternative would result in continued reliance on existing wastewater facilities; however, treated effluent from individual wastewater treatment facilities (WWTFs) would be discharged at land application sites. The WWTFs would be upgraded to meet the projected 2025 groundwater discharge limits (see Appendix L of the Preliminary Findings Report for a summary of projected 2025 WWTF effluent limits). The following discussion summarizes the trends that would be likely to continue should Alternative 4 be selected.

8.1.1 Land Use and Growth

Land Use Compatibility and Aesthetics. Under this alternative, the existing WWTFs would continue to be used to treat existing and projected wastewater flows. Upgrades to the existing WWTFs are anticipated for this alternative (see Section 3.4.1), which would result in some potential land use impacts. Impacts would vary by WWTF depending on the availability of land at the WWTFs and proximity to sensitive receptors.

All treated effluent from the individual WWTFs would be discharged at land application sites via rapid infiltration basins rather than the existing surface water discharges. A two-phase process was conducted to examine the feasibility of providing a land application site for each WWTF. This process identified locations within the study area that met land application siting criteria; however, specific sites were not identified as part of this study (see Section 3.4). The land application sites would result in a permanent taking of parcels within the WWTF communities. Similar to decentralized systems, undeveloped land would be the most likely candidates for siting the decentralized systems. Thus, operation of these systems would result in a permanent change in land use. The land application sites would also result in an aesthetic impact since the rapid infiltration basins would be partially above ground and finished as open, gravel-lined beds. The magnitude of the aesthetic impact would be dependant on the final siting and size of the land application sites. If required, screening would be provided to minimize this impact.

Effluent from the WWTFs would be conveyed to the land application sites through pipelines. The exact alignments of the conveyance pipelines have not been determined as part of this study; however, approximate lengths have been developed for each WWTF based on the two-phase land application feasibility process noted above (see Table 3-8). Similar to the regional conveyance route described for Alternative 2, it is anticipated that the pipeline routes would use as many rights-of-way as possible to minimize land use impacts. The pipelines would be below ground, and disturbed surfaces would be restored upon completion of construction to the extent practicable. Land acquisitions and/or easements are anticipated for portions of the conveyance piping crossing private property.

The WWTF effluent flows would be conveyed via force mains rather than gravity sewers, and it is anticipated that one pump station would be required at each WWTF (for a total of 17 pump stations). The pump stations would be expected result in minimal land use and aesthetic impacts since they would be located adjacent to existing buildings at the WWTF sites and land acquisition or displacement of existing land uses is not anticipated, although this would need to be verified during subsequent design efforts.

Land Area Impacted. In addition to land needed for upgrades and pump stations at the WWTFs, there would be a need for land suitable for land application of the wastewater effluent. Table 3-8 summarizes the total anticipated land area required for the application sites for each WWTF, including land anticipated for associated buffers, roads, and ditches. The anticipated land area requirements vary greatly by WWTF based on projected future flows, ranging from less than three acres for the Milton and Newfields WWTFs to well over 100 acres for the Portsmouth and Rochester WWTFs.

Indirect Growth. In addition to growth associated with existing trends and patterns in the study area, as previously referenced for Alternative 1, this alternative could potentially result in indirect growth and development as a result of greater WWTF treatment capacities achieved by directing flow to groundwater. This change could allow additional sewer extensions to areas that might previously have been restricted due to on site wastewater disposal limitations and/or WWTF surface water discharge limitations, provided additional land area is available for application sites. Communities could use this additional WWTF treatment capacity as a way to direct or guide denser development to target areas of growth that otherwise could not accommodate the preferred density by strategically approving sewer extensions. This would require local planning efforts by municipalities and coordination with developers.

8.1.2 Air Quality

Similar to Alternative 1, continued operation of the WWTFs, after the anticipated upgrades, is generally anticipated to result in minimal impacts to air quality to communities within the study area. The proposed conveyance pipelines to the land application sites would be below ground and would operate with little, if any, potential for impacts to air quality. The rapid infiltration basins would handle highly treated wastewater effluent, and odors are not anticipated to be an issue.

8.1.3 Surface Water Flow, Groundwater Recharge, and Water Quality

Surface Water Flow and Groundwater Recharge. For Alternative 4, direct WWTF discharges to the estuary would be essentially eliminated, and indirect discharges (groundwater flows from the land application sites going to the estuary) would increase by 8.2%. This increase in groundwater recharge would help to sustain groundwater levels for both habitat protection and water supply.

Many of the streams in the study area are likely groundwater fed, thus the overall net effect to stream flow in the Great Bay watershed would be expected to be fairly minor. However, there may still be localized changes in stream flow within certain sub-basins, depending on the proximity of the land application discharge site to the existing WWTF discharge location and the time it would takes for this groundwater to recharge the stream flow. It is possible that the location of the land application discharge may be in a different sub-basin, and thus some amount of stream flow reduction might be expected in the downstream flow of the existing receiving water at the point of current discharge. Appendix F describes the ranking and potential availability and proximity of land application sites for the various WWTFs. For some WWTFs, such as Durham, Exeter, Hampton, Newfields, Newington, Portsmouth, and Rockingham County WWTFs, the nearest candidate sites are over two miles from the treatment facility. Table 3-8 summarizes the distances between the WWTFs and the closest identified land application sites. Further analysis would be needed to identify individual sub-basins and determine if cross basin transfer of effluent would occur. Should this alternative be selected for possible implementation, further study of localized effects on stream flow should be conducted.

Water Quality. The following is a summary of the water quality analysis for Alternative 4. This includes changes to the Great Bay salinity and a qualitative Great Bay pollutant loading analysis.

Great Bay Salinity Changes

The impact of the land application the WWTFs on the salinity in the Great Bay is also dependent upon the location of the land application sites and the existing WWTF discharge sites relative to sub-basins. Assuming that the land application sites are all within the same sub-basins as the existing discharges, the impact of the land application of WWTF effluent on the salinity in the Great bay is anticipated to be similar to that of Alternative 1 (No Action) due to their same increase in WWTF effluent discharge. See Section 5.1.3 for a description of the salinity impacts expected for Alternative 1.

Pollutant Loading Analysis

The extent to which the treated effluent may affect groundwater quality in the vicinity of a land application site is dependent on treatment level, and also on soil and other hydro-geologic conditions. As indicated in Section 3.4, the WWTF effluent will be required to meet proposed discharge limits for land application, including total nitrogen limits. There is the potential for land application to actually improve the quality of groundwater fed streams, as the groundwater will have the additional treatment of passing through the unsaturated zones of the soil. Long-term groundwater monitoring would be recommended if this alternative is implemented.

The elimination of the direct discharge of WWTF effluent to the Great Bay under this alternative would result in a significant reduction in pollutant loadings. These reduced pollutant loadings are anticipated to improve water quality. The exception might be in those few cases where the WWTF effluent represents such a significant portion of the stream flow that it provides dilution for other pollutant inputs (stormwater and other non-point sources). Further analysis would be needed to confirm if this might be the case for the Rochester WWTF on the Cocheco River, where effluent contribution from the WWTF represents a significant percentage of stream flow during extreme low flow periods (7Q10).

Implementation of this alternative would result in a small increase in dissolved oxygen (DO) due to reduced biological oxygen demand (BOD) loadings. The increase in DO will be small as current DO deficits are generally low and occasional deficits exceeding 25% of saturation may not be related to WWTF discharges (NHEP, 2006). There would be reduced eutrophication due to the nitrogen limit of 10 mg/l for land application and the further reduction in total nitrogen as the land applied WWTF effluent passes through the unsaturated zones of the soil. It is also anticipated that groundwater discharge plumes would take several years to reach the estuary. This alternative would eliminate the risk of accidental discharge of pathogens to the Great Bay. Additionally, toxics would be largely eliminated since many toxics do not travel in groundwater.

8.1.4 Wetland and Terrestrial Resources

Wetland Resources. To the extent that sub-basin hydrology is altered as a result of redirecting treated effluent to land application sites, there could be minor alterations in areal extent and/or function of wetlands resource areas. However, as noted above, the overall effect on hydrology within the basin is not anticipated to be significantly altered as groundwater would be expected to recharge stream flow in many locations. Land application sites would also provide recharge to groundwater fed wetlands. Localized effects would be most pronounced where the treated effluent represents a fairly high percentage of existing discharge to receiving waters, and the land application sites are in a different sub-basin. In order to verify effects more combined surface and groundwater modeling would be needed.

As noted above, this alternative may result in some improvements to surface water quality which would have a beneficial effect on wetlands function in those wetlands that are dependent on surface hydrology.

Terrestrial Resources. There would be a loss of terrestrial habitat for the construction of the land application sites. As noted in Table 3-8, sites of up to 100 acres may be needed for some of the larger WWTFs. Depending on the site characteristics of the land application areas, there may be loss of breeding, nesting, and feeding habitat of terrestrial wildlife. There may also be disruption or loss of portions of wildlife corridors. It is possible that the discharge basins could act as a draw to birdlife, although access by other wildlife would be expected to be fairly minimal as the area is expected to be fenced for security reasons. To the extent that local tributaries maintain stream flow, terrestrial wildlife would be expected to benefit from the water sources.

8.1.5 Aquatic Resources

Similar to the effect on wetland resources, the potential effects to aquatic resources would depend on changes in stream flow, which is essential to aquatic life. Changes in stream flow or stream habitat could affect breeding and nesting. As noted above, it is not expected that there would be any substantial change in stream flow on a basin-wide level. However, several WWTFs (Durham, Exeter, Hampton, Newfields, Newington, Portsmouth, and Rockingham County) are not in close proximity to candidate land application sites, and should the land application sites be in a different sub-basin than the existing receiving water discharge locations, some localized effects on stream flow may occur. At these locations, relocation of the flow from surface water discharge to land application discharge could have an effect on aquatic life immediately downstream of the surface water discharge location. More detailed analysis of localized effects would need to be conducted if this alternative is selected for further consideration.

As with wetland resource areas, improvements to water quality resulting from treatment through land application would be of benefit to aquatic resources. In particular, reduced BOD and nitrogen loading would be expected to result in increase dissolved oxygen, which would be beneficial for aquatic life.

8.1.6 Rare and Endangered Species

The anticipated effects to rare and endangered species are very similar to those described above for both wetland resources and for aquatic life. To the extent that stream flows are maintained, and water quality is improved, there would be a benefit to the species and to the habitats that support them. If, however, there are localized effects to stream flow which could diminish coastal habitat or function, then the species would be adversely affected. It is expected that areas known for presence of protected species would be avoided during the site selection procedure. Coordination would need to occur with the New Hampshire Department of Fish and Game during the site selection and development process if this alternative is selected for further consideration.

8.2 NON-MONETARY TECHNICAL ANALYSIS

The non-monetary analysis is divided into the following sub-categories:

- Complexity
- Public Testimony
- Implementation

8.2.1 Complexity

The complexity of this alternative has been evaluated as it relates to treatment, conveyance, and disposal. The following is a summary of those evaluations.

In this alternative, the WWTFs are anticipated to require significant upgrades to achieve the permit limits for groundwater discharge. In general, the treatment component of this alternative will require a sophisticated treatment process at each of the WWTFs.

The conveyance component of this alternative is relatively complex. It is anticipated that this alternative would require many smaller conveyance systems (one for each WWTF). The proposed conveyance systems (described in Section 3.4) are anticipated to require 28 miles of effluent force mains and 17 pump stations. Many of these pipelines would be located away from the WWTFs and would require regular maintenance.

The disposal component of this alternative is also complex. It was assumed that this alternative would require the construction of a rapid infiltration basins and supporting facilities (buffers, roads, ditches, etc.) at the land application sites. These land application sites and disposal components would be remote to the WWTFs and would require periodic maintenance. In addition, monitoring of the groundwater in the areas around the land application sites would likely be required to confirm that the effluent discharge was not impacting the groundwater quality.

8.2.2 Public Testimony

This alternative received little direct positive or negative public testimony. However, indirectly there was some public testimony that indicated it would be preferable for the wastewater effluent (originating from groundwater wells) to be put back into the ground from where it came and not be “thrown away”. This could be perceived as a positive comment for this alternative as wastewater effluent would be discharged to the ground.

8.2.3 Implementation

The implementation of this alternative would be relatively difficult. A preliminary evaluation of potential land application sites for WWTF effluent found that many alternatives did not have favorable land application sites close to the WWTFs (see Appendix F). More significant studies would need to be performed for each WWTF to determine if possible land application sites could be found (large enough, close enough, and with the proper soil conditions). In addition, this alternative would require that each land application site apply for a groundwater discharge permit (NHDES Env-Ws 1500). Some of the requirements of a New Hampshire groundwater discharge permit application include:

- Basic information (facility name, owners, contacts, location, other permit requirements, etc.)
- Inventory of Abutters and Potential Receptors
- Hydrologic Studies
- Hydrologic Design and Operation Parameters
- Standard Site Control Measures
- Facility Plan

This alternative would also require the siting of the wastewater effluent pipelines.

Although this alternative does not require an agreement between municipalities for construction or operation of these facilities, it does allow the possibility that the multiple towns could join together to share resources, leverage their combined purchasing power (for chemical, supplies and equipment), and potentially negotiate with the regulators (permit limits, etc.).

8.3 PLANNING LEVEL CONSTRUCTION COSTS

Included herein are estimated planning level costs for Alternative 4. The planning level costs have been divided into three sub-categories: treatment, conveyance, and disposal.

The Alternative 4 planning level treatment upgrade costs for each WWTF are presented in Table 8-1. The planning level conveyance costs for each WWTF are presented in Table 8-2, and the planning level disposal costs for each WWTF are presented in Table 8-3. Table 8-4 presents the total planning level costs for treatment, conveyance, and disposal on a WWTF basis.

In summary, the estimated planning level cost for Alternative 4 is:

• Treatment Costs	$ 172,000,000
• Conveyance Costs	$ 113,900,000
• Disposal Costs	$ 26,800,000
• **Total Cost**	**$ 312,700,000**

Table 8-1. Alternative 4 Estimated WWTF Upgrade Costs

FACILITY	Year 2004 Max Mo. Flow, MGD	Year 2025 Max Mo. Flow, MGD	Economy of Scale $ Factor	Upgrades Anticipated	Incremental Flow Increase, MGD	Carbon Removal Upgrade Anticipated	Carbon removal upgrade @ $7.5/gallon	C only Filtration Upgrade Anticipated	Filtration Upgrade @ $2/gal	Nitrogen Upgrade Anticipated	Influent TN Load , lbs/day	Eff. TN Load (8mg/l), lbs/day	TN removed, lb/day	TN Removal @ $40/lb/day	TP Removal Anticipated	P-Flitration/ Chemical Addition @ $3/gallon	Other Upgrades Anticipated	Cost Assumptions (new flow only unless noted)	Other Upgrades $	Estimated Total Construction Cost
DOVER WWTF	4.57	4.87	0.70	C, TN	0.3	yes	$ 1,580,000	yes	$ 6,820,000	yes	812.3	406.2	406.16	$ 4,150,000	no	$ -	IP, Pre, Dis	$5/gal + Dis $1/gal	$ 1,800,000	**$ 14,350,000**
DURHAM WWTF	1.71	1.8	0.80	C, TN	0.09	Fitration only	$ -	yes	$ 2,880,000	yes	300.2	150.1	150.12	$ 1,750,000	no	$ -	IP, Pre, Dis	$5/gal + Dis $1/gal all flow	$ 1,890,000	**$ 6,520,000**
EPPING WWTF	0.32	0.429	1.00	C, TN	0.109	yes new flow	$ 820,000	no MBR	$ -	yes	71.6	35.8	35.78	$ 520,000	no	$ -	Pre, Mem, Dis	$5.5/gal + Dis $1/gal	$ 710,000	**$ 2,050,000**
EXETER WWTF	3.6	3.9	0.70	AS, C, TN	0.3	All flow	$ 20,480,000	yes	$ 5,460,000	yes	650.5	325.3	325.26	$ 3,320,000	no	$ -	Pre, Dis	$2.5/gal + Dis $1/gal all flow	$ 3,480,000	**$ 32,740,000**
FARMINGTON WWTF	0.52	0.57	0.90	C, TN	0.05	yes	$ 340,000	yes	$ 1,030,000	yes	95.1	47.5	47.54	$ 620,000	no	$ -	IP, Pre	$5/gal	$ 250,000	**$ 2,240,000**
HAMPTON WWTF	3.3	3.7	0.70	C, TN	0.4	yes new flow	$ 3,000,000	yes	$ 5,180,000	yes	617.2	308.6	308.58	$ 3,150,000	no	$ -	Dis, SH	$5/gal + Dis $1/gal all flow	$ 4,590,000	**$ 15,920,000**
MILTON WWTF	0.08	0.09	1.00	AS, C, TN	0.01	All flow	$ 680,000	yes	$ 180,000	yes	15.0	7.5	7.51	$ 110,000	no	$ -	Dis	$1/gal all flow	$ 90,000	**$ 1,060,000**
NEWFIELDS WWTF	0.08	0.084	1.00	AS, C, TN	0.004	All flow	$ 630,000	yes	$ 170,000	yes	14.0	7.0	7.01	$ 100,000	no	$ -	Dis	$1/gal all flow	$ 80,000	**$ 980,000**
NEWINGTON WWTF	0.18	0.2	1.00	C, TN	0.02	Filtation Only	$ -	yes	$ 400,000	yes	33.4	16.7	16.68	$ 240,000	no	$ -	Air, Dis	$1/gal + Dis $1/gal all flow	$ 220,000	**$ 860,000**
NEWMARKET WWTF	1.04	1.16	0.80	AS, C, TN	0.12	All flow	$ 6,960,000	yes	$ 1,860,000	yes	193.5	96.7	96.74	$ 1,130,000	no	$ -	IP, Pre, Dis	$5/gal + Dis $1/gal all flow	$ 1,530,000	**$ 11,480,000**
PEASE DEVELOPMENT AUTHORITY WWTF	0.72	0.86	0.90	NR	0.14	Filtation Only	$ -	yes	$ 1,550,000	yes SBR mods		na	na	$ 100,000	no	$ -	Dis	$1/gal all flow	$ 770,000	**$ 2,420,000**
PORTSMOUTH WWTF	8.23	8.7	0.60	AS, C, TN	0.47	All flow	$ 39,150,000	yes	$ 10,440,000	yes	1451.2	725.6	725.58	$ 6,360,000	no	$ -	Dis	$1/gal all flow	$ 5,220,000	**$ 61,170,000**
ROCHESTER WWTF	5.51	6.1	0.60	C, TN	0.59	no	$ -	yes new flow	$ 710,000	yes new flow	1017.5	508.7	508.74	$ 4,460,000	no	$ -	2nd Clarifier, Dis	$1.5 M Clarifier + $1/gal	$ 2,090,000	**$ 7,260,000**
ROCKINGHAM COUNTY WWTF	0.085	0.118	1.00	AS, C, TN	0.033	All flow	$ 890,000	yes	$ 240,000	yes	19.7	9.8	9.84	$ 140,000	no	$ -	Dis	$1/gal	$ 30,000	**$ 1,300,000**
ROLLINSFORD WWTF	0.15	0.17	1.00	C, TN	0.02	Filtation Only	$ -	yes	$ 340,000	no				$ -	no	$ -	Dis	$1/gal all flow	$ 170,000	**$ 510,000**
SEABROOK WWTF	1.17	1.39	0.80	C, TN	0.22	yes new flow	$ 1,650,000	yes	$ 2,220,000	yes	231.9	115.9	115.93	$ 1,350,000	no	$ -	Dis	$1/gal all flow	$ 1,110,000	**$ 6,330,000**
SOMERSWORTH WWTF	1.79	1.9	0.80	C, TN	0.11	yes new flow	$ 820,000	yes new flow	$ 180,000	yes	316.9	158.5	158.46	$ 1,850,000	no	$ -	Pre, Dis	$2.5/gal + Dis $1/gal all flow	$ 1,800,000	**$ 4,650,000**
Totals	**33.055**	**36.041**			**2.986**		**$ 77,000,000**		**$ 39,660,000**		**5839.8**	**2919.9**	**2919.9**	**$ 29,350,000**		**$ -**			**$ 25,830,000**	**$ 171,840,000**

<u>Legend</u>

C = Carbon
TN = Total Nitrogen
TP = Total Phosphorus
AS = Activated Sludge

IP = Influent Pumping
Pre = Preliminary Teatment
Dis = Disinfection
Mem = Membranes

M = Metals
Air = Aeration
SH = Solids Handling
NR = Not Required

Table 8-2. Alternative 4 WWTF Effluent Conveyance Planning Level Construction Cost Estimate

Anticipated Land Application Conveyance Components, Planning Level Sizing and Planning Level Costs											
From	Year 2055 Flow, MGD	Distance from WWTF to Land Application Site, ft	Distance from WWTF to Land Application Site, miles	Year 2055 Pipe Size, in	Cost per Linear Foot	Pipeline Cost	Number of Pump Stations Anticipated	Pump Station Size, MGD	Cost Per Pump Station	Estimated Pump Station Costs	Total Estimated Conveyance Construction Costs
FARMINGTON WWTF	0.91	1,000	0.19	8	$ 250	$ 250,000	1	0.91	$ 750,000	$ 750,000	$ 1,000,000
MILTON WWTF	0.24	500	0.09	4	$ 250	$ 130,000	1	0.24	$ 750,000	$ 750,000	$ 880,000
ROCHESTER WWTF	10.00	1,000	0.19	24	$ 350	$ 350,000	1	10.00	$ 12,500,000	$ 12,500,000	$ 12,850,000
ROLLINSFORD WWTF	0.36	4,224	0.80	6	$ 250	$ 1,060,000	1	0.36	$ 750,000	$ 750,000	$ 1,810,000
SOMERSWORTH WWTF	5.75	2,000	0.38	18	$ 300	$ 600,000	1	5.75	$ 5,000,000	$ 5,000,000	$ 5,600,000
DOVER WWWTF	12.74	2,000	0.38	30	$ 350	$ 700,000	1	12.74	$ 12,500,000	$ 12,500,000	$ 13,200,000
NEWINGTON WWTF	0.54	14,520	2.75	6	$ 250	$ 3,630,000	1	0.54	$ 750,000	$ 750,000	$ 4,380,000
PEASE WWTF	3.15	9,000	1.70	14	$ 300	$ 2,700,000	1	3.15	$ 2,000,000	$ 2,000,000	$ 4,700,000
DURHAM WWTF	5.35	13,200	2.50	18	$ 300	$ 3,960,000	1	5.35	$ 5,000,000	$ 5,000,000	$ 8,960,000
NEWMARKET WWTF	2.41	9,240	1.75	12	$ 300	$ 2,770,000	1	2.41	$ 2,000,000	$ 2,000,000	$ 4,770,000
NEWFIELDS WWTF	0.17	10,560	2	4	$ 250	$ 2,640,000	1	0.17	$ 750,000	$ 750,000	$ 3,390,000
EPPING WWTF	0.70	750	0.14	8	$ 250	$ 190,000	1	0.70	$ 750,000	$ 750,000	$ 940,000
ROCKINGHAM CO. WWTF	0.44	10,560	2.00	6	$ 250	$ 2,640,000	1	0.44	$ 750,000	$ 750,000	$ 3,390,000
EXETER WWTF	6.75	12,672	2.40	20	$ 300	$ 3,800,000	1	6.75	$ 5,000,000	$ 5,000,000	$ 8,800,000
SEABROOK WWTF	3.86	22,500	4.26	16	$ 300	$ 6,750,000	1	3.86	$ 2,000,000	$ 2,000,000	$ 8,750,000
HAMPTON WWTF	8.60	18,480	3.50	24	$ 350	$ 6,470,000	1	8.60	$ 5,000,000	$ 5,000,000	$ 11,470,000
PORTSMOUTH WWTF	22.00	15,840	3.00	36	$ 400	$ 6,340,000	1	22.00	$ 12,500,000	$ 12,500,000	$ 18,840,000
Total	**83.94**	**148,046**	**28.04**			**$ 44,980,000**	**17**			**$ 68,750,000**	**$ 113,730,000**

Flows are average of peak hour and peak day for 2055

Table 8-3 Alternative 4 WWTF Effluent Land Application Disposal Planning Level Construction Cost Estimate

Estimated Planning Level Land Application Disposal Construction Costs

FACILITY	2004 Flow	2055 Annual Ave Flow, MGD	Anticipated Land Required @ 30 acres /MGD, (acres)	Anticipated Additional Land Required for Buffers, Roads, and Ditches, (acres)	2055 Total Anticipated Land Required, (acres)	2025 Construction Costs Disposal System (1)	Estimated 2025 Land Acquisition Costs, Based on $15K/acre	Estimated Total Construction Cost
DOVER WASTEWATER	2.54	3.05	91.50	4.58	96.08	$ 1,870,000	$ 1,440,000	$ 3,310,000
DURHAM WASTEWATER	0.996	1.20	36.00	1.80	37.80	$ 800,000	$ 570,000	$ 1,370,000
EPPING WATER & SEWER	0.197	0.23	7.02	1.05	8.07	$ 190,000	$ 120,000	$ 310,000
EXETER WASTEWATER	1.86	2.30	69.00	3.45	72.45	$ 1,430,000	$ 1,090,000	$ 2,520,000
FARMINGTON WASTEWATER	0.21	0.30	9.00	1.35	10.35	$ 220,000	$ 160,000	$ 380,000
HAMPTON WASTEWATER	2.4	3.10	93.00	4.65	97.65	$ 1,840,000	$ 1,460,000	$ 3,300,000
MILTON WASTEWATER	0.05	0.07	2.10	0.32	2.42	$ 60,000	$ 40,000	$ 100,000
NEWFIELDS WASTEWATER	0.045	0.06	1.80	0.27	2.07	$ 60,000	$ 30,000	$ 90,000
NEWINGTON WASTEWATER	0.13	0.18	5.40	0.81	6.21	$ 150,000	$ 90,000	$ 240,000
NEWMARKET WASTEWATER	0.64	0.82	24.60	2.46	27.06	$ 590,000	$ 410,000	$ 1,000,000
PEASE DEVELOPMENT AUTHORITY	0.38	0.66	19.80	1.98	21.78	$ 410,000	$ 330,000	$ 740,000
PORTSMOUTH WASTEWATER	4.7	5.60	168.00	8.40	176.40	$ 3,190,000	$ 2,650,000	$ 5,840,000
ROCHESTER WASTEWATER	2.9	4.10	123.00	6.15	129.15	$ 2,250,000	$ 1,940,000	$ 4,190,000
ROCKINGHAM COUNTY WWTF	0.078	0.13	3.90	0.59	4.49	$ 110,000	$ 70,000	$ 180,000
ROLLINSFORD WASTEWATER	0.09	0.13	3.90	0.59	4.49	$ 100,000	$ 70,000	$ 170,000
SEABROOK WASTEWATER	0.98	1.35	40.50	2.03	42.53	$ 870,000	$ 640,000	$ 1,510,000
SOMERSWORTH WASTEWATER	1.1	1.40	42.00	2.10	44.10	$ 930,000	$ 660,000	$ 1,590,000
Totals	**19.30**	**24.68**	**740.52**	**42.56**	**783.08**	**$ 15,070,000**	**$ 11,770,000**	**$ 26,840,000**

(1) Based on EPA Technology Fact Sheet

Table 8-4. Estimated Planning Level Construction Costs for Alternative 4

FACILITY	Treatment Cost	Conveyance Cost	Discharge Costs	Total Estimated Construction Costs
DOVER WWTF	$ 14,400,000	$ 1,000,000	$ 3,300,000	$ 18,700,000
DURHAM WWTF	$ 6,500,000	$ 900,000	$ 1,400,000	$ 8,800,000
EPPING WWTF	$ 2,100,000	$ 12,900,000	$ 300,000	$ 15,300,000
EXETER WWTF	$ 32,700,000	$ 1,800,000	$ 2,500,000	$ 37,000,000
FARMINGTON WWTF	$ 2,200,000	$ 5,600,000	$ 400,000	$ 8,200,000
HAMPTON WWTF	$ 15,900,000	$ 13,200,000	$ 3,300,000	$ 32,400,000
MILTON WWTF	$ 1,100,000	$ 4,400,000	$ 100,000	$ 5,600,000
NEWFIELDS WWTF	$ 1,000,000	$ 4,700,000	$ 100,000	$ 5,800,000
NEWINGTON WWTF	$ 900,000	$ 9,000,000	$ 200,000	$ 10,100,000
NEWMARKET WWTF	$ 11,500,000	$ 4,800,000	$ 1,000,000	$ 17,300,000
PEASE DEVELOPMENT AUTHORITY WWTF	$ 2,400,000	$ 3,400,000	$ 700,000	$ 6,500,000
PORTSMOUTH WWTF	$ 61,200,000	$ 900,000	$ 5,800,000	$ 67,900,000
ROCHESTER WWTF	$ 7,300,000	$ 3,400,000	$ 4,200,000	$ 14,900,000
ROCKINGHAM COUNTY WWTF	$ 1,300,000	$ 8,800,000	$ 200,000	$ 10,300,000
ROLLINSFORD WWTF	$ 500,000	$ 8,800,000	$ 200,000	$ 9,500,000
SEABROOK WWTF	$ 6,300,000	$ 11,500,000	$ 1,500,000	$ 19,300,000
SOMERSWORTH WWTF	$ 4,700,000	$ 18,800,000	$ 1,600,000	$ 25,100,000
TOTAL	**$ 172,000,000**	**$ 113,900,000**	**$ 26,800,000**	**$ 312,700,000**

REFERENCES

New Hampshire Estuary Project. 2006. State of the Estuaries.

Metcalf & Eddy, Inc. 2006. *Water Reuse, Issues, Technologies, and Applications*. Published by McGraw Hill.

SECTION 9.0 ALTERNATIVES COMPARISON

This Section provides a relative comparison of the four alternatives based on the evaluation criteria used. It should be noted than a number of evaluation criteria are qualitative in nature and that some professional judgment has been used in the comparisons.

The general categories of analysis included the following:

- Environmental Analysis including:
    - Land Use and Growth
    - Surface Water Flow, Groundwater Recharge, and Water Quality
    - Air Quality
    - Wetland and Terrestrial Resources
    - Aquatic Resources
    - Rare and Endangered Species

- Non-Monetary Factor Analysis including:
    - Complexity
    - Public Testimony
    - Implementation

- Planning Level Construction Costs

The following is a summary of these comparisons.

9.1 ENVIRONMENTAL

The following provides a comparison of the environmental findings for the four alternatives. The comparison is organized by the same environmental parameters that were assessed for each alternative in Section 5.0 through Section 8.0. The comparisons are fairly broad in nature and summarize the general characteristics of the alternatives with regard to the different environmental parameters. As indicated in the previous sections, more detailed evaluation of environmental effects, including site specific effects, will need to be conducted for any alternative selected for further consideration.

9.1.1 Land Use and Growth

Alternative 1 (No Action) would result in the least amount of direct impacts to land use since no new facilities or infrastructure are proposed and upgrades would largely occur within WWTF properties. The Regional Post-Treatment Facility (RPTF) and conveyance pump stations anticipated to be required for Alternative 2 (Gulf of Maine Discharge) would result in relatively minor direct impacts to land use, whereas the decentralized systems and land application sites required for Alternative 3 (Decentralized Discharge) and Alternative 4 (Land Application), respectively, would directly impact hundreds of acres of land.

It is anticipated that growth and development patterns would continue to follow existing trends and patterns under Alternative 1. Alternative 2 would potentially result in indirect growth and development as a result of the less restrictive treatment anticipated achieved by directing flow to the gulf. Also, it is possible that a municipality or developer could tie into the conveyance pipeline proposed for this alternative if separate treatment and pumping were provided, pending approval by a future regional sewer governing association. These hookups and associated provision of sewers to previously unsewered areas would have the potential to induce growth within areas that might previously have been limited due to poor soils or lot size restrictions for on-site wastewater disposal. Alternative 4 could potentially result in some indirect growth as a result of greater WWTF treatment capacities achieved by discharging treated effluent to groundwater if land is available, while the Alternative 3 could potentially limit growth by restricting new development from tying into existing sewer systems. Since wastewater from two-thirds of new development would need to be directed to decentralized systems, the amount of growth would depend on the availability of suitable discharge sites.

9.1.2 Air Quality

Minimal impacts to air quality are anticipated regardless of the alternative. For all alternatives, treated wastewater would be of fairly high quality, and odor control is not anticipated to be needed at pump stations or at the RPTF (anticipated to be required for Alternative 2). Facilities would need to comply with relevant state and local regulatory requirements and community mandates, as appropriate.

9.1.3 Surface Water Flow, Groundwater Recharge, and Water Quality

Minimal impacts to surface water flow are anticipated for the Alternative 1 (No Action), Alternative 3 (Decentralized Discharge), and Alternative 4 (Land Application). While there may be localized reduction in surface water flow just downstream of WWTFs as a result of relocation of flow to land application sites or decentralized discharge sites, the overall water balance of the watershed should be maintained as groundwater would be recharged, providing indirect recharge to streams. Alternative 2 (Gulf of Maine Discharge) would result in a reduction in receiving water surface flow and also, potentially, groundwater levels downstream of some WWTFs. This reduction in stream flow and groundwater level would potentially affect a variety of downstream uses including provision of water supply and protection of coastal vegetation and aquatic habitat.

All alternatives, including Alternative 1, which assumes that WWTFs will need to comply with more stringent discharge standards in the future, would result in some potential improvements to water quality in Great Bay receiving waters, such as increased DO and reduced eutrophication. The potential water quality impacts of the different alternatives on the Great Bay estuary are summarized qualitatively in Table 9-1.

For Alternative 2, the redirection of wastewater flow to any of the three candidate offshore outfall locations is not anticipated to impact flow in the Gulf of Maine. However, the effluent from the regional outfall would increase cumulative contribution of nitrogen and other wastewater constituents to Gulf of Maine. The other alternatives would have minimal, if any, effect on the Gulf's water quality.

9.1.4 Wetland and Terrestrial Resources

Minimal impacts to wetland and terrestrial resources are anticipated for Alternative 1 (No Action), Alternative 3 (Decentralized Discharge), and Alternative 4 (Land Application) since overall hydrology is not anticipated to be significantly altered. As noted above, there may be localized effects in some sub-basins as a result of the relocation of flow from existing surface water discharge locations to land application sites or to decentralized discharge sites. This has the potential to alter some wetlands habitat, particularly downstream of those WWTFs that discharge high volumes of treated effluent that represent a significant percentage of flow to the stream during low flow periods. It is expected that additional groundwater recharge resulting from decentralized treatment and discharge and land application of treated effluent for Alternatives 3 and 4, respectively, would help support wetlands in the project area. Some upland/terrestrial habitat would be lost to accommodate the land application sites in Alternative 4.

TABLE 9-1. WATER QUALITY IMPACTS OF ALTERNATIVES ON GREAT BAY

Parameter	Alternatives			
	1 No Action	2 Regional Gulf of Maine Discharge	3 Decentralized Treatment plus Existing WWTFs	4 Existing WWTFs with Land Application
Flows	WWTF flows are projected to increase by an average of about 8.2% from 2004 to 2025.	WWTF flows to the estuary would be entirely eliminated.	Direct WWTP discharges to the estuary would increase by about 2.7%, and indirect discharge would increase by about 5.5%[1].	Direct WWTF discharges to the estuary would be eliminated. Indirect discharges would increase by about 8.2%[1].
Salinity	Decreased salinity due to increased WWTF flows to river.	Increased salinity due to decreased WWTF flows to rivers.	Slightly decreased salinity when decentralized systems wastewater reaches the estuary[1].	Decreased salinity when land applied wastewater reaches the estuary[1].
Dissolved oxygen	Small changes, due to reductions in BOD and nutrient loadings, where regulatory requirements become more stringent[2].	Small increase in DO levels due to reduced BOD and nutrient loadings[3].	Small changes, due to reductions in BOD and nutrient loadings, where regulatory requirements are strengthened[2].	Increase in DO levels due to reduced BOD and nutrient loadings[3].
Eutrophication[4]	Some changes due to reductions nutrient loading where regulatory requirements become more stringent[2].	Reduced eutrophication due to eliminated nutrient load[5].	Some changes due to reductions nutrient loading where regulatory requirements are strengthened[2].	Reduced due to nitrogen limit of 10mg/l for land application, and travel time[6].
Pathogens	No change.	Eliminated risk of accidental discharge.	No change.	Eliminated risk of accidental discharge.
Toxics	Slight increase due to increased flow and incomplete removal during treatment.	Eliminated.	Slight increase due to minor increases in future flows.	Largely eliminated, since many toxics do not travel in groundwater.

Notes:

[1] Indirect discharges to the Great Bay are for land application discharges that will eventually reach the estuary through groundwater flow.

[2] Regulatory limits are projected to be more stringent for some plants.

[3] The increase in DO will be small inasmuch as current DO deficits are generally low and occasional deficits exceeding 25% of saturation may not be related to the WWTF discharges (NHEP, 2006).

[4] Eutrophication effects include increased turbidity and algae and reduced eelgrass.

[5] Nitrogen loadings from WWTFs will be eliminated representing about 34% of all nitrogen loadings to Great Bay and Upper Piscataqua River.

[6] Some additional nitrogen reduction would occur in groundwater as the effluent plume travels. Plumes would take several years to reach the estuary.

The hydraulic changes for Alternative 2 (Gulf of Maine Discharge) that would result from the redirection of wastewater flow to the Gulf of Maine may result in changed wetland and terrestrial habitat in the Great Bay receiving waters, including reduced wetland acreage. It is expected that the potential increase in salinity in estuary receiving waters due to relocation of freshwater flow would be in the order of 1 to 2 ppt, well within the normal range of salinities experienced in the tidal waters, and thus would not be expected to significantly alter the composition of vegetation in the coastal area. Siting of facilities anticipated for this alternative, including force mains and pump stations, would result in the loss of some terrestrial/upland habitat.

9.1.5 Aquatic Resources

For Alternative 1 (No Action) and Alternative 3 (Decentralized Discharge), no significant effects on aquatic life are anticipated, as major changes in stream flow are not anticipated to occur as a result of implementation of either of these alternatives. It is not expected that there would be any substantial change in stream flow on a basin-wide level for Alternative 4 (Land Application). However, in some instances the land application sites anticipated for this alternative may be in a different sub-basin than the existing receiving water discharge locations, and some localized effects on stream flow may occur that could have an effect on aquatic life immediately downstream of the surface water discharge location. All alternatives have the potential to result in some improvements to water quality in Great Bay receiving waters that would benefit aquatic resources

Alternative 2 (Gulf of Maine Discharge) would result in a reduction in base flow to Great Bay receiving waters, which would have potential adverse effect on aquatic resources. The regional outfall proposed under Alternative 2 would result in minimal salinity changes to the Gulf of Maine. While no exceedence of the acute aquatic life criterion for ammonia is expected with regard to discharges of treated wastewater to the Gulf, there is the potential for exceedence of chronic values for certain highly sensitive saltwater species at two of the candidate outfall locations. According to published chronic toxicity values for saltwater species, the chronic value for inland silversides would be exceeded at outfall candidate sites 1 and 2. While inland silversides would not be expected to be located at the outfall locations, as they are typically found in more estuarine environments, they do serve as a surrogate for other sensitive saltwater species. Thus, further study of species present at any candidate outfall location would need to be conducted if Alternative 2 is selected for further consideration.

9.1.6 Rare and Endangered Species

Alternative 1 (No Action), no significant alterations to rare and endangered species habitat are anticipated. Similarly, no significant effects are anticipated for Alternative 3 (Decentralized Discharge) since it is expected that siting of community systems could be done to avoid impacting protected species. Under Alternative 2 (Gulf of Maine Discharge), rare and endangered species habitat in Great Bay receiving waters may be altered due to reduction of surface water flow and resulting effects on groundwater levels. Localized effects to stream flow resulting from Alternative 4 (Land Application) could diminish coastal habitat or function immediately downstream of the existing WWTF discharges if those discharges currently represent a significant percentage of stream flow. However, it is anticipated that sensitive habitat would be avoided during site selection for the land application sites required for this alternative.

9.2 NON-MONETARY FACTOR COMPARISON

The four alternatives were evaluated for a number of non-monetary factors. The paragraphs below describe the comparisons of the alternatives as they relate to these factors.

9.2.1 Complexity. The four alternatives were evaluated for their level of complexity as it relates to the treatment, conveyance, and disposal components of each alternative.

Treatment. The treatment complexity is based on the effluent limits required for the different alternatives. In general, Alternative 4 (Land Application) has the most stringent effluent limits. Alternative 1 (No Action) and Alternative 3 (Decentralized Discharge) will have the same WWTF effluent limits, which are the second most stringent limits of the alternatives evaluated. Finally Alternative 2 (Gulf of Maine Discharge) has the least stringent effluent limits of the four alternatives evaluated.

As a result of these effluent limits is expected that Alternative 4 will have the most complex treatment. Alternative 1 and Alternative 3 are expected to have the second most complex treatment. Finally Alternative 2 will have the least complex treatment.

Conveyance. The conveyance complexity of the alternatives were evaluated based on the number of components anticipated to be required to convey the treated WWTF effluent to its disposal location.

Alternative 1 (No Action) and Alternative 3 (Decentralized Discharge) are not anticipated to require the addition of any conveyance components and therefore have the least complex conveyance of the alternatives. Alternative 4 (Land Application) is anticipated to require the addition of 17 pump stations and approximately 30 miles of effluent force mains. This alternative has the second most complex conveyance. Finally Alternative 2 (Gulf of Maine Discharge) has the most complex conveyance of the alternatives evaluated. The potential conveyance routing proposed for Alternate 2 (see Figure 3-3) is anticipated to require the addition of 30 pump stations and more than 90 miles of effluent force mains.

Disposal. The disposal complexity of the alternatives was evaluated based on the number of components and the level of sophistication anticipated to be required for the disposal of the WWTF effluents.
Alternative 1 (No Action) and the WWTF portion of Alternative 3 (Decentralized Discharge) will use the existing WWTF outfalls for the disposal of WWTF effluents. However, Alternative 3 will use a number of community on-lot decentralized systems to dispose of two-thirds of the new wastewater generated between the year 2004 and the year 2025. Approximately 200 decentralized systems are anticipated to be required to dispose of this flow. These systems will need to be sited, constructed, and maintained. While the decentralized systems are not complex individually, it is the large number of these systems and their operation, inspection, and maintenance (whose responsibility often lies with the WWTF utility) that is complicated. The disposal component of Alternative 2 (Gulf of Maine Discharge) would be complex. This alternative is anticipated to require the siting and construction of a RPTF and a marine outfall. The RPTF would provide disinfection of all of the study area WWTF effluent prior to discharge to the Gulf of Maine outfall as well as an effluent pump station to allow discharge under high tidal and peak flow conditions. The disposal component of Alternative 4 (Land Application) would also be complex. This alternative is anticipated to require the construction of rapid infiltration basins and supporting facilities at 17 different land application sites.

9.2.2 Public Testimony. Public testimony of the four alternatives was evaluated to assess the general positive or negative testimony related to each alternative. The following is a comparison of the public testimony for the four alternatives.

Alternative 1 (No Action) received little direct positive or negative public testimony. However, indirectly there was some public testimony that indicated that it would be preferable for the wastewater effluent originating from groundwater wells be put back on to the ground from where it came and not be “thrown away”. This could be perceived as a negative comment against this alternative.

Alternative 2 (Gulf of Maine Discharge) produced the majority of negative public testimony throughout the duration of the project. The majority of this negative public testimony was related to either inter-basin water transfer issues, concerns of negatively impacting the water quality and environmental quality outside of the Great Bay estuary, and concern that the development of a regional sewer system would result in a rapid and uncontrolled population growth within the study area.

Alternative 3 (Decentralized Discharge) was included as an alternative as a direct result of the amount of public testimony that was in support of examining a decentralized system alternative. The support of this alternative was due to this alternative addressing, in part, the concerns inter-basin water transfer, reduction of pollutant loading to the Great Bay, and reducing secondary growth potential.

Alternative 4 (Land Application) received little direct positive or negative public testimony. However, indirectly there was some public testimony that indicated that it would be preferable for the wastewater effluent (originating from groundwater wells) be put back into to the ground from where it came and not be “thrown away”. This could be perceived as a positive comment about this alternative as wastewater effluent would be discharged to the ground.

9.2.3 Implementation. The ease or difficulty of implementing each alternative was addressed. Some items related to implementation that were addressed included: the need for a regional sewage agreement, public reaction issues, technical feasibility (e.g. ability to find acceptable land application sites or site the large number of decentralized systems), and operational issues (ex. ownership and operation of the regional conveyance system or decentralized systems). The following is a comparison of the ease or difficulty of implementing the four alternatives.

Alternative 1 (No Action) would be the easiest alternative to implement as each WWTF would remain with some plant specific upgrades. This alternative would require little or no agreement between the municipalities and is anticipated to require the least amount of construction to implement. For Alternative 3 (Decentralized Discharge), the WWTF component of the alternative would be relatively easy to implement, similar to Alternative 1. However, it is anticipated that it will be difficult to implement the decentralized system component. Implementation of the decentralized systems component of this alternative would require strict zoning and sewer tie-in regulations at the local level. These regulations would need to require developers of new residential and commercial units to use decentralized systems in lieu of the existing sewers. Another issue affecting the implementation of the decentralized systems is the ability to find and acquire the amount of land required to site these systems. The areas currently sewered are areas of municipalities that tend to be more congested. Finding and siting community on-lot systems in these areas may prove difficult due to the limited land available.

The implementation of Alternative 4 (Land Application) would be difficult. A preliminary evaluation of potential land application sites for discharge of WWTF effluent found that many WWTFs did not have favorable or large enough land application sites close to the WWTFs (see Appendix F). More detailed studies would need to be performed for each WWTF to determine if possible land application sites could be found (large enough, close enough to WWTFs, and with the proper soil conditions). In addition, this alternative would require that each land application site apply for a groundwater discharge permit (NHDES Env-Ws 1500). The implementation of this alternative would also require the siting of the wastewater effluent pipelines.

The implementation of Alternative 2 (Gulf of Maine Discharge) would be the most difficult of the four alternatives evaluated. This alternative would require agreement between the municipalities to implement (for construction, maintenance, revenue production and expense sharing). Under this alternative each town would lose part of its wastewater autonomy. This alternative would also require the siting of the regional conveyance pipelines and pump stations, the RPTF as well as siting Gulf of Maine outfall. Siting of the components is anticipated to be difficult from environmental and public acceptance points of view. Also, as a result of the negative public testimony received during the feasibility study, it is anticipated that this alternative would produce significantly more negative public feedback in reaction to taking further steps to implement this alternative.

9.3 PLANNING LEVEL CONSTRUCTION COSTS

Planning level cost estimates were developed for the treatment, conveyance and disposal components each of the four alternatives. These planning level costs are intended to be comparative costs used for relative comparison only and not be used for budgeting purposes. The purpose of preparing costs for these alternatives is only to compare the relative costs among the four alternatives. These costs have been based on engineering judgment and experience with other projects. If any of these alternatives are carried forward then more detailed evaluations of costs would be preformed as the concepts and component details become better defined. Table 9-2 summarizes the planning level costs for the four alternatives.

TABLE 9-2 ALTERNATIVE TREATMENT, CONVEYANCE, AND DISPOSAL PLANNING LEVEL ESTIMATED CONSTRUCTION COST ESTIMATES

Alternative	Treatment Cost	Conveyance Cost	Disposal Costs	Total
Alternative 1 – No Action	$ 110,600,000	$ -	$ -	**$ 110,600,000**
Alternative 2 – Treatment at Existing WWTFs with a Regional Gulf of Maine Discharge	$ 73,800,000	$ 396,000,000	$ 119,300,000	**$ 589,100,000**
Alternative 3 – Decentralized Treatment and Continued Use of Existing WWTFs	$ 92,000,000	$ -	$ 119,500,000	**$ 211,500,000**
Alternative 4 – Treatment at Existing WWTFs with Land Application Discharge	$ 172,000,000	$ 113,900,000	$ 26,800,000	**$ 312,700,000**

It should be noted that the discharge cost associated with Alternative 3 (Decentralized Discharge) is the estimated costs of the decentralized systems. This cost may or may not be considered as part of the overall cost of the Alternative 3 depending on who (i.e. municipality or property developer) would bear the costs of the decentralized systems. In some cases, developers of new residential and commercial units would pay for the installation of decentralized systems and would pass the cost of the decentralized systems on to the buyers. In other cases, the wastewater utility would bear the cost of the installation of the decentralized systems and would pass the cost of the decentralized systems on to its sewer users.

In general, the treatment costs are larger for alternative that have more stringent WWTF effluent requirements and therefore require sophisticated treatment. The conveyance costs are larger for alternatives that have greater distances of conveyance (long pipelines and more pump stations). Finally, the disposal costs are more expensive for alternatives with the most complicated or highest number of discharge components.

Respectfully Submitted,

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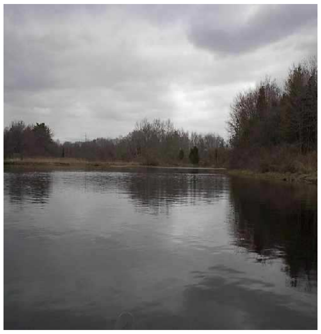
APPENDIX A

ALTERNATIVES DEVELOPMENT METHODOLOGY



NEW HAMPSHIRE SEACOAST REGION WASTEWATER MANAGEMENT FEASIBILITY STUDY

ALTERNATIVES DEVELOPMENT METHODOLOGY

Date: 2/6/06

To: NHDES, Great Bay Estuary Commission

From: Metcalf & Eddy

Subject: Alternatives Development Methodology

Distribution: Cc: ENSR, GC&G, Appledore Engineering, Steve Jones, TF Moran, File

PURPOSE

The purpose of this memorandum is to summarize the methodology used to establish the preliminary alternatives for consideration for the NH Seacoast Wastewater (WW) Management Feasibility Study. The objective of the methodology is to develop and conduct a preliminary screening of potential alternatives to provide wastewater management for the communities of the Great Bay Watershed. The development of alternatives is based on the information collected during preliminary data collection efforts as summarized in the *Final Preliminary Findings Report (December 2005),* although it should be noted that additional relevant information regarding existing conditions will be obtained as available.

INTRODUCTION

A summary of the data collected on current wastewater management practices and conditions in the seacoast study area was presented in the *Final Preliminary Findings Report*. The presentation included a discussion of existing wastewater treatment facilities (WWTFs) and septage handling, population served, development trends in the study area communities, and water quality and natural resource conditions in the receiving waters. Figure 1-1 (attached) shows the communities and WWTFs in the study area. The purpose of this next stage of the effort is to identify alternative concepts for wastewater management in the study area communities. These alternative concepts will be presented at a Charrette scheduled for March 25, 2006 to solicit input from the communities, regulatory agencies, the general public, and other interested stakeholders as to the key issues that should be addressed when evaluating which four wastewater management alternatives will be carried forward for more detailed analysis in the subsequent evaluation phase of the project.

Each of the alternatives for wastewater management must contain three components for the existing 17 WWTFs:

- Treatment: how the wastewater is treated to reduce pollutants
- Conveyance: how or where the treated (or untreated) wastewater is conveyed to final discharge (or in the case of untreated wastewater, final treatment and subsequent discharge) location
- Discharge location: the final discharge location for treated wastewater

More detail on each of these components is provided below.

Treatment

There are several categories of treatment available for the wastewater flow from the study area communities. These include conventional secondary and advanced wastewater technologies, constructed wetlands, composting toilets or other on-site alternatives, and decentralized treatment system (cluster and satellite systems). The type of treatment to be employed is dependent upon the permitted discharge limits of various wastewater constituents. The permitted discharge limits are dependent upon the discharge location. See Appendix L of the Final Preliminary Findings Report for the Methodology for Development of Future WWTF Permit Limits.

Conveyance

There are two primary concepts for conveyance of wastewater. The first is local discharge to either a surface water or land application disposal point. In this concept the locally treated wastewater from a WWTF would be conveyed to a discharge location handling the flow from that community only. The second option would be to convey the treated or untreated wastewater flow from various communities to a regional facility. In the case of receiving untreated wastewater the regional facility would provide treatment and subsequent discharge of the wastewater, or in the case of the wastewater being treated at the local facilities the treated wastewater would be conveyed to a regional facility for disposal.

Discharge

There are three discharge concepts under consideration. The first would be to maintain the current surface water discharge locations (river, estuary or Gulf of Maine) for each local facility. The second option would be to discharge treated flow (from either local facilities or a regional facility) to the Gulf of Maine. The third option would be to discharge the treated effluent (from the individual facilities or from a regional facility) to the land (spray irrigation, infiltration beds, etc.).

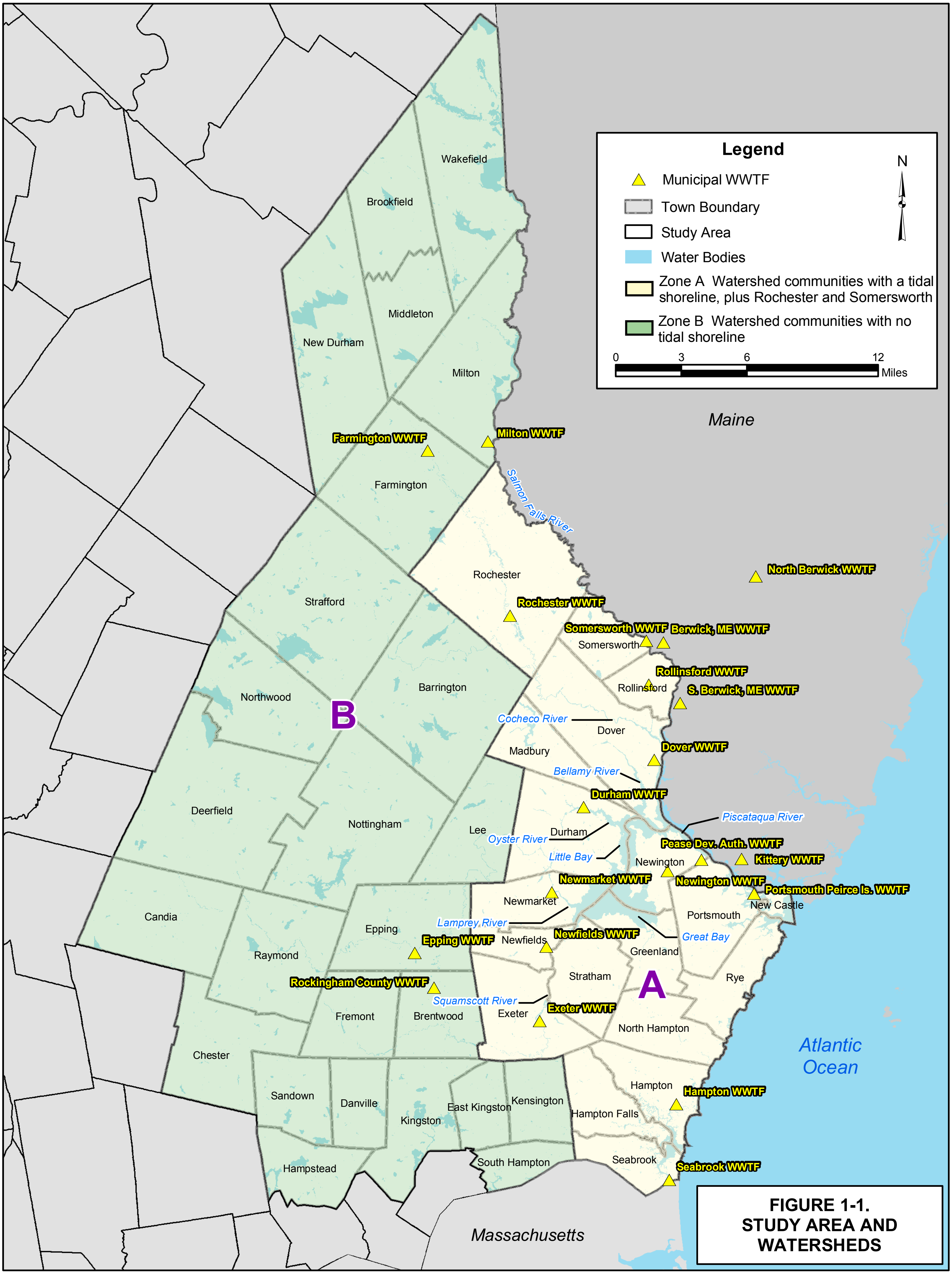


**FIGURE 1-1.
STUDY AREA AND
WATERSHEDS**

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DEVELOPMENT OF PRELIMINARY ALTERNATIVES

Each preliminary alternative should contain all three of the aforementioned components (i.e. treatment, conveyance, and discharge). A combination of the components noted above, is presented below in nine basic alternatives. These alternatives assume that all communities would select the same general treatment, conveyance, and disposal methods. It should be noted that all flow from a specific WWTF would be handled in the same manner (i.e. there would be no splitting of flows for different treatment, conveyance, or discharge from a specific WWTF).

Alternative 1. Treatment at existing facilities, discharge at existing surface water discharge locations.
Alternative 2. Treatment at existing facilities, discharge at local individual land application sites if deemed reasonable* or at existing surface water discharge locations.
Alternative 3. Treatment at existing facilities, conveyance to a regional discharge facility for discharge to the Gulf of Maine
Alternative 4. Treatment at existing facilities and conveyance to a regional discharge facility(s) for land application*.
Alternative 5. Collection of untreated wastewater from existing facilities, and conveyance to a regional treatment facility and subsequent discharge to the Gulf of Maine
Alternative 6. Collection of untreated wastewater from existing facilities and conveyance to a regional treatment facility and subsequent discharge to a regional discharge facility(s) for land application*.
Alternative 7. Constructed wetlands alternatives.
Alternative 8. Composting toilets or other on-site alternatives.
Alternative 9. Decentralized wastewater system alternatives (e.g. satellite or cluster systems).

> *The general locations of land application sites for treated wastewater will be attempted to be identified in the alternatives development and analysis stage of the study. The reasonableness and favorability of these sites relative to the WWTF location and total estimated wastewater flow will be evaluated in light of the land application area available and volume of flow that area can accommodate.

Alternative Number 1 is essentially the “No Action” alternative, where each individual community would continue to treat and dispose of its own wastewater flow in accordance with existing and future discharge limits imposed by the regulating agencies.

Also, septage disposal for the study area in 2025 (i.e. the 20-year planning period) will be addressed in the alternatives analysis phase of the study. For a discussion on future septage generation and disposal issues in 2025 please see Section 11 of the *Final Preliminary Findings Report*.

BASIS FOR SCREENING

The basis for the screening criteria of the alternatives presented above and in the subsequent text was the application of professional engineering judgment. It is noted that there are impacts and concerns regarding planning and environmental issues related to all of these potential alternatives. Also, it should be noted that the four alternatives selected after the Project Charrette for analysis in subsequent phases of the study will be examined for a number of issues (e.g. cost, environmental, water quality) in addition to engineering. However, professional engineering judgment will be the primary screening criteria used to develop a number of possible alternatives to be considered prior to the Charrette.

Screening Level I Criteria

Screening Level I Criteria addressed treatment, conveyance, and discharge. Primary consideration in Screening Level I was given to the following factors: whether the treatment technology had a proven track record in this part of the country, whether this technology has been used for this size application, and whether required discharge standards could be reasonably achieved.

Screening Level II Criteria

Screening Level II criteria addressed the practicality of collecting and conveying the flow from the more remote WWTFs to an adjacent or a regional facility. To accomplish this, a core and independent set of WWTFs was identified. Alternatives in addition to those that passed the level I screening will be developed once the set of core and independent WWTFs are identified.

Collection and conveyance of flow from WWTFs were examined to determine the ratio of flow to distance (i.e. millions of gallons per day divided by miles) for conveyance. This ratio of flow to distance considered the amount of flow that would need to be conveyed over a distance to combine with other plant flows. A higher ratio would indicate a more cost effective conveyance of flow than a lower ratio. For example it is more cost effective to convey 5 MGD of flow over 1 mile (ratio = 5) than 1 MGD of flow over 5 miles (ratio = 0.20). WWTFs with low flow to distance ratios were considered to be potential independent facilities while those with higher ratios were identified as potential core WWTFs. However, some WWTFs with low flow to distance ratios were still considered for core WWTFs if they were surrounded or “bookended” by WWTFs with more favorable ratios. Adjacent WWTFs with more favorable flow to distance ratios could potentially convey flow from adjacent WWTFs with less favorable ratios as part of a regional solution if desired.

Screening Level III Criteria

Screening Level III addressed the identification of core vs. independent WWTFs based on the relative need for specific WWTFs to provide upgrades to their treatment processes to meet assumed discharge limits at future 2025 flow and loads. WWTFs that had predicted capacity to meet future 2025 limits with minimal improvements were identified and were considered to be potential independent facilities. WWTFs that would require significant upgrades (e.g. additional tankage, significant process changes (ex. upgrade from an aerated lagoon to an activated sludge process), a new treatment process (addition of filters, etc.) were identified as WWTFs that might benefit from a regional solution in lieu of conducting upgrades at the local level.

RESULTS OF SCREENING

Screening Level I Results

Level I screening considered the following factors: whether the technology has a proven track record in this part of the country, whether this technology has been used for this size application, and whether required discharge standards could be reasonably achieved.

Three of the alternatives noted above (i.e. Alternatives Numbers 7-9) were eliminated from future consideration based on the application of these screening factors. These included the constructed wetlands, composting toilets and other on-site systems, and decentralized wastewater system alternatives.

Constructed Wetlands. Constructed wetlands were not considered to be a viable alternative for use in all communities since some type of conventional or advanced wastewater treatment would still be required because constructed wetlands typically only remove 75 percent of total suspended solids, 45 percent of phosphorus, and 25-35 percent of total nitrogen (*NHEP Management Plan 2000*); nitrogen removal is impaired by cold temperatures (*EPA 9/00*), thus use of constructed wetlands may be seasonally restricted and storage facilities may be required. Additionally, size requirements are variable and can range from as low as 2 acres per mgd to as high as 200 acres per mgd of flow (*EPA Constructed Wetlands Treatment of Municipal Wastewater 9/00*). However, it is generally recognized that treatment via constructed wetlands is a fairly land intensive venture. For these reasons, constructed wetlands are not recommended for further consideration for community wide wastewater treatment. There may, however, be an opportunity for use on a small scale within an individual community if that community is not part of a regional strategy.

Composting Toilets or Other On-Site Systems. Implementation of composting toilets as well as other on-site systems (septic tanks, etc.) would result in substantial burden for individual users to install and/or retrofit existing plumbing or service connections. Additionally the operation and maintenance of these systems would fall on the users including a significant number of issues that would need to be resolved for institutional users. Additionally, composting toilets were eliminated from further consideration since it would not provide treatment for all wastewater currently generated in a community, and thus some treatment facilities would still be required to handle industrial flow and grey water from residential and non-residential uses. For these reasons, it was determined that composting toilets or other on-site systems would not be a viable alternative for communities in the study area. However, as with constructed wetlands, individual communities or institutional users (such as universities) may want to consider implementation on a small scale basis.

Decentralized Wastewater Systems. Decentralized wastewater systems include individual on-lot systems, cluster systems and satellite systems. Cluster or satellite systems typically handle flow from smaller systems. A cluster system typically handles between 1,000 gpd and 10,000 gpd, while satellite systems generally handle flows in excess of 10,000 gpd. The discharges from these facilities are typically sub-surface. These systems are typically employed for new development (housing, nursing homes, and shopping centers). It would not be practical to separate the existing wastewater collection and treatment systems in the study area into a large number of cluster or satellite systems or into individual on-lot systems. While cluster, satellite, and on-lot systems should be considered for new growth areas in the study area communities, as conditions permit, they are not likely to be used in currently sewered areas. It should be noted that none of the study area communities indicated their desire to provide major sewer extension or the addition of sewer to an unsewered community in the future.

After the Level I screening of alternatives, alternatives numbers 7 through 9 were eliminated from further consideration.

DEVELOPMENT OF ADDITIONAL ALTERNATIVES

Other alternatives were developed in addition to, and as variations of, alternative numbers 1 through 6 based on identifying “core” WWTFs and “independent” WWTFs. The core WWTFs would be included in a regional solution (treatment, conveyance, discharge) while the independent WWTFs would provide treatment, conveyance and discharge on a WWTF specific basis. WWTFs were eliminated from the core WWTF group by using Screening Level II and III screening criteria.

Screening Level II Results

Screening Level II criteria looked at the practicality of collecting and conveying the flow from the more remote WWTFs to an adjacent or regional facility. Collection and conveyance of flow from facilities were examined to determine the ratio of flow to distance for conveyance. This ratio of flow to distance looked at the amount of flow that would need to be transported over a distance to be combined with flows from other WWTFs. Ratios less than 0.15 were considered to be unreasonable unless WWTFs with more favorable ratios surrounded that WWTF. Table 1 shows the flow to distance ratios for the study area WWTFs relative to adjacent WWTFs.

Results. After the Level II screening was performed the following WWTFs were determined to be eliminated from the core WWTFs and were put into the independent WWTFs category.

- **Epping WWTF**
- **Farmington WWTF**
- **Milton WWTF**
- **Rockingham County WWTF**

Table 1 - Screening Level II Results

	FACILITY	Projected 2025 Flow, MGD	Closest WWTF	Distance, mi	Flow Per Mile, MGD/mi	Next Closest WWTF	Distance, mi	Flow Per Mile, MGD/mi	Comments
1	DOVER WWTF	2.8	Durham	4	0.70	Rollinsford / Newington	5	0.56	
2	DURHAM WWTF	1.1	Dover	4	0.28	Newmarket	4.5	0.24	
3	EPPING WWTF	0.216	Rockingham	2	**0.11**	Newfields	6.5	**0.03**	< 0.15
4	EXETER WWTF	2.1	Newfields	4.0	0.53	Rockingham	5.5	0.38	
5	FARMINGTON WWTF	0.26	Milton	4	**0.07**	Rochester	9	**0.03**	< 0.15
6	HAMPTON WWTF	2.8	Seabrook	4	0.70	Exeter	7	0.40	
7	MILTON WWTF	0.06	Farmington	4	**0.02**	Rochester	7.5	**0.01**	< 0.15
8	NEWFIELDS WWTF	0.054	Newmarket	2.5	**0.02**	Exeter	4	**0.01**	< 0.15, but between Exeter and Newmarket
9	NEWINGTON WWTF	0.16	Pease	1 (shared outfall)	-	Peirce Island	3.5	**0.05**	< 0.15, but between Dover, Pease and Peirce Island
10	NEWMARKET WWTF	0.77	Newfields	2.5	0.31	Durham	4.5	0.17	
11	PEASE DEVELOPMENT AUTHORITY WWTF	0.52	Newington	1 (shared outfall)	-	Peirce Island	3	0.17	
12	PEIRCE ISLAND WWTF	5.2	Pease	3	1.73	Newington	3.5	1.49	
13	ROCHESTER WWTF	3.5	Somersworth	6	0.58	Rollinsford	7	0.50	
14	ROCKINGHAM COUNTY WWTF	0.112	Epping	2	**0.06**	Exeter	5.5	**0.02**	< 0.15
15	ROLLINSFORD WWTF	0.11	Somersworth	1.5	**0.07**	Dover	5	**0.02**	< 0.15, but between Somersworth and Dover
16	SEABROOK WWTF	1.2	Hampton	4	0.30	NA			
17	SOMERSWORTH WWTF	1.3	Rollinsford	1.5	0.87	Dover	6	0.22	

Note – WWTFs in bold had flow to distance rations less than 0.15 and were considered to be independent WWTF

Screening Level III Results

Level III screening looked at the relative need for the remaining “core” WWTFs to provide upgrades to their treatment processes to meet discharge limits at future 2025 flow and loads. WWTFs that had sufficient capacity to meet future limits with minimal facility improvements were identified and were considered to be potential independent facilities. WWTF that require significant upgrades (additional tankage, significant process changes, etc.) to meet the future 2025 limits were identified as WWTF that might benefit from a regional solution instead of conducting upgrades at the local level. These WWTFs were identified as “core” WWTFs with some exceptions. Table 2 summarizes the Screening Level III results.

Results. After the Level III screening was performed the following WWTFs were identified as requiring minor or no upgrades and were put into the independent WWTF category.

- **Newington WWTF**
- **Pease Development Authority WWTF**
- **Rochester WWTF**
- **Rollinsford WWTF**
- **Seabrook WWTF**

Exceptions. There were some exceptions to the results of Level III screening that changed the grouping of some identified “core” WWTFs to or independent WWTFs or vice versa. These exceptions are described below.

Peirce Island WWTF – It is anticipated that this WWTF will need a major upgrade to meet the assumed effluent limits in year 2025. Site space is limited. Due to space limitations, if a new facility was built on site it would likely not be designed to accommodate flow from other WWTFs as it could use any additional capacity to help maximize its peak flow capacity. This WWTF is also located at a considerable distance from the identified core WWTFs (in many cases on the opposite side of the Great Bay). Therefore, this WWTF is being grouped with the independent WWTFs.

Somersworth WWTF - Although the analysis of the Somersworth WWTF predicted that the WWTF may not be able to meet 2025 effluent limits it should be noted that the WWTF has recently undergone a significant upgrade. The criteria developed to evaluate the different WWTFs were developed to provide a general uniform analysis of the different WWTFs for the purposes of comparison. These criteria may be underestimating the capacity of this facility, potentially due the specialized MUCT (modified University of Cape Town) treatment process being used for nutrient removal. Therefore, it is reasonable to assume that due to the WWTF recently undergoing a major upgrade (design year 2020) that this facility will have capacity to meet the 2025 effluent limits. This WWTF will be regrouped with the independent WWTFs.

Hampton WWTF – Hampton was identified as a WWTF requiring some upgrades to meet 2025 discharge limits. This criterion would categorize this WWTF in the independent category. However, if a Gulf of Maine discharge was considered for a core WWTF alternative, the pipeline route to an outfall would likely need to pass through a coastal area. Therefore, in the case of the alternatives with the core WWTFs discharging to the Gulf of Maine, the Hampton WWTF will be considered part of the core

Table 2 - Screening Level III Results

	FACILITY	Projected 2025 Flow, MGD	Projected 2025 Existing Surface Water and Land Application Discharge Upgrade Requirements	Upgrade Significance
1	DOVER WWTF	2.8	Secondary Tankage (Aeration and Clarifiers), Total Nitrogen Removal Modifications	Significant
2	DURHAM WWTF	1.1	Primary Tankage, Aeration tankage, disinfection upgrade, Total Nitrogen Removal Modifications, Filtration	Significant
3	EPPING WWTF	0.216	Screened out in Level II	-
4	EXETER WWTF	2.1	Major Secondary Process Upgrade w/ Total Nitrogen Removal Capability	Major
5	FARMINGTON WWTF	0.26	Screened out in Level II	-
6	HAMPTON WWTF	2.8	Secondary Tankage (Aeration), Sludge Processing Capacity	Minor
7	MILTON WWTF	0.06	Screened out in Level II	-
8	NEWFIELDS WWTF	0.054	Major Secondary Process Upgrade w/ Total Nitrogen Removal Capability	Major
9	NEWINGTON WWTF	0.16	Total Nitrogen Removal Modifications and Aeration Capacity	Minor
10	NEWMARKET WWTF	0.77	Major Secondary Process Upgrade w/ Total Nitrogen Removal Capability, Additional Secondary Clarifier Capacity, Disinfection Capacity	Major
11	PEASE DEVELOPMENT AUTHORITY WWTF	0.52	Disinfection capacity	Minor
12	PEIRCE ISLAND WWTF	5.2	Major Secondary Process Upgrade w/ possible Total Nitrogen Removal Capability, limited collection system capacity (CSOs)	Major
13	ROCHESTER WWTF	3.5	Secondary Clarifier Capacity (already have filters)	Minor
14	ROCKINGHAM COUNTY WWTF	0.112	Screened out in Level II	-
15	ROLLINSFORD WWTF	0.11	None	None
16	SEABROOK WWTF	1.2	Aeration Capacity	Minor
17	SOMERSWORTH WWTF	1.3	Analysis indicated need for significant upgrade	Assumed Minor

Note: The upgrade requirements is the most to the least significant in the following order Major > Significant > Minor > None

WWTFs. However, for core WWTF alternatives that do not include a Gulf of Maine discharge, the Hampton WWTF will be grouped with the independent WWTFs.

ADDITIONAL ALTERNATIVES

Table 3 shows Alternative numbers 1- 6, which resulted from the Level I screening in which all communities would select the same general treatment, conveyance, and disposal methods. Table 3 also summarizes additional alternative (Alternative numbers 7-10) which resulted from the Level II and III Screening. Alternatives numbers 7-10 were developed based on placing the individual WWTFs into either a core WWTF group or an independent WWTF group. In Alternatives 7-10 the core WWTFs would employ a regional solution with all of the core WWTFs employing the same treatment, conveyance and discharge solution on a regional level and the independent WWTFs would provide their own treated discharge to either their existing receiving water or to a land discharge. Table 4 provides a summary list of the core and independent WWTFs for Alternatives numbers 7-10.

It is noted that there are concerns regarding planning and environmental issues related all of these potential alternatives. The four alternatives selected after the Project Charrette for analysis in subsequent phases of the study, will be examined for a number of issues in addition to engineering that will address these concerns. Should additional information relative to the various issues examined indicate that a specific WWTF should or should not be in the currently identified group of either core or independent WWTFs, then that WWTF's group may be adjusted at that time.

SUMMARY OF ALTERNATIVES

The 10 alternatives presented are categorized and summarized as follows:

- Alternative Numbers 1 and 2 – All study area WWTFs provide treatment and discharge independently.
    - Alternative 1 is essentially a "No-Action" alternative (current discharge location).
    - Alternative 2 will examine land application of individual WWTF discharges.

- Alternative Numbers 3-6 – All study area WWTFs will employ a regional solution combining the following components:
    - Treatment at either all local WWTFs or at regional WWTF.
    - Regional effluent discharge to the Gulf of Maine or via land application.

- Alternative Numbers 7 -10 – All study area WWTFs will be identified as either core or independent WWTFs
    - The independent WWTFs will provide treatment and discharge independently and;
    - The core WWTFs will employ a regional solution combining the following components:
        - Treatment at either all the core WWTFs or at a regional WWTF.

- Regional effluent discharge to the Gulf of Maine or via land application.

Table 3—Preliminary Wastewater Management Alternatives

<table>
<tr><th>Alternative Number</th><th colspan="3">Description</th></tr>
<tr><td>1</td><td colspan="3">Treatment at existing facilities, discharge at existing surface water discharge locations.</td></tr>
<tr><td>2</td><td colspan="3">Treatment at existing facilities, discharge at local individual land application sites if deemed reasonable* or at existing surface water discharge locations.</td></tr>
<tr><td>3</td><td colspan="3">Treatment at existing facilities, conveyance to a regional discharge facility for discharge to the Gulf of Maine</td></tr>
<tr><td>4</td><td colspan="3">Treatment at existing facilities and conveyance to a regional discharge facility(s) for land application*.</td></tr>
<tr><td>5</td><td colspan="3">Collection of untreated wastewater from existing facilities, and conveyance to a regional treatment facility and subsequent discharge to the Gulf of Maine</td></tr>
<tr><td>6</td><td colspan="3">Collection of untreated wastewater from existing facilities and conveyance to a regional treatment facility and subsequent discharge to a regional discharge facility(s) for land application*.</td></tr>
<tr><th>Alternative Number</th><th>Core Community Treatment</th><th>Core Community Discharge</th><th>Independent Community Treatment and Discharge</th></tr>
<tr><td>7</td><td>Existing WWTF</td><td>Regional Gulf of Maine Discharge</td><td>Treatment at existing WWTF with discharge to either existing surface water or land application site if reasonable*.</td></tr>
<tr><td>8</td><td>Existing WWTF</td><td>Regional Land Discharge</td><td>Treatment at existing WWTF with discharge to either existing surface water or land application site if reasonable*.</td></tr>
<tr><td>9</td><td>Regional WWTF</td><td>Regional Gulf of Maine Discharge</td><td>Treatment at existing WWTF with discharge to either existing surface water or land application site if reasonable*.</td></tr>
<tr><td>10</td><td>Regional WWTF</td><td>Regional Land Discharge</td><td>Treatment at existing WWTF with discharge to either existing surface water or land application site if reasonable*.</td></tr>
</table>

*The general locations of land application sites for treated wastewater will be attempted to be identified in the alternatives development and analysis stage of the study. The reasonableness and favorability of these sites relative to the WWTF location and total estimated wastewater flow will be evaluated in light of the land application area available and volume of flow that area can accommodate.

Table 4 – WWTF Grouping for Alternatives 7-10

Core WWTFs	Independent WWTFs
Dover Durham Exeter Hampton (for ocean discharge only) Newfields Newmarket	Epping Farmington Hampton (land discharge core alternatives only) Milton Newington Pease Development Authority Peirce Island Rochester Rockingham County Rollinsford Seabrook Somersworth

APPENDIX B

METHOD FOR SELECTING WASTEWATER MANAGEMENT ALTERNATIVES

NEW HAMPSHIRE SEACOAST REGION WASTEWATER MANAGEMENT FEASIBILITY STUDY

METHOD FOR SELECTING WASTEWATER MANAGEMENT ALTERNATIVES

Date: 04/19/06

To: NHDES, Great Bay Estuary Commission

From: Metcalf & Eddy

Subject: Identification of Four Wastewater Management Alternatives for Further Study

Distribution: cc: ENSR, GC&G, Appledore Engineering, Steve Jones, TF Moran, Wright Pierce, File

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INTRODUCTION

The purpose of this memorandum is to present the four wastewater management alternatives that will be considered in further detail in the alternatives analysis phase of the New Hampshire Seacoast Region Wastewater Management Feasibility Study. Ten preliminary alternatives were initially developed and presented in the *Alternatives Development Methodology (February 2006)*. These ten alternatives were the focus of an all-day charrette that was held on March 25, 2006 in Stratham, New Hampshire. The following items were considered to narrow the ten alternatives down to four alternatives:

- Findings from the *Final Preliminary Findings Report (December 2005)*;
- Comments received from the Great Bay Estuary Commission, stakeholders, and the public on project reports and at the charrette and other public meetings;
- Written correspondence from stakeholders, special interest groups, and the public;
- Senate Bill 70; and
- Implications of the alternatives in the following areas: land use and planning, ecology and water quality, technical and engineering aspects, and institutional and implementation issues.

The four alternatives presented in this memorandum are the result of this process.

SUMMARY OF THE FOUR WASTEWATER MANAGEMENT ALTERNATIVES

A description of each alternative is provided below, as well as a brief explanation of why each alternative will be carried forward for further analysis. For all alternatives, upgrades to the wastewater treatment facilities (WWTFs) would occur as needed to comply with the future effluent limits previously established and presented in the Final Preliminary Findings Report. Also, the alternatives analysis portion of this study will address wastewater management needs for study area communities without WWTFs or sewers.

1. **No Action (formerly presented as Alternative Number 1).** For this alternative, treatment would continue at each of the 17 WWTFs within the study area, and treated effluent would be discharged at existing surface water discharge locations (see Figure 1).

   The No Action alternative will be carried forward since it sets a baseline of future conditions against which to compare impacts of the other project alternatives. Inclusion of a no action alternative is consistent with requirements for the National Environmental Policy Act (NEPA) process, which may be formally required depending on what alternatives are ultimately implemented. Please note that although this alternative is considered "no action," WWTFs would still be required to meet all future effluent standards.

2. **Treatment at Existing WWTFs with a Regional Gulf of Maine Discharge (formerly presented as Alternative Number 3).** This wastewater treatment alternative involves continuing treatment at the existing WWTFs and conveyance of treated effluent through regional infrastructure (e.g., pump stations and pipelines) for discharge to the Gulf of Maine (see Figure 2).

   This alternative has been selected for further study since Senate Bill 70 requires this study to determine the feasibility to remove treated effluent from the coastal drainage area and Great Bay and discharge it through a regional pipe in the Gulf of Maine.

3. **Decentralized Treatment and Continued Use of Existing WWTFs.** Existing WWTFs would continue to be used under this alternative. However, this alternative assumes only one-third of the future projected wastewater flow (above the current flow) for each community would be treated at the existing WWTFs, and the remaining two-thirds of the projected flow would go to decentralized (e.g., on-lot, cluster) systems for treatment and land application (see Figure 3). This alternative would include regional guidance for communities to use for establishing sewer service areas (beyond which sewer extensions would be discouraged) and promoting installation of on-lot/community systems for future developments. Specific identification of decentralized system locations will not be conducted as part of this alternative.

   Although this alternative was not one of the ten preliminary alternatives, it was developed and chosen to be carried forward for further study largely in response to the many comments received requesting that decentralized treatment be included as part of a regional solution. This alternative has the potential to limit or control growth in the study area communities, and it would not result in inter-basin transfer of wastewater.

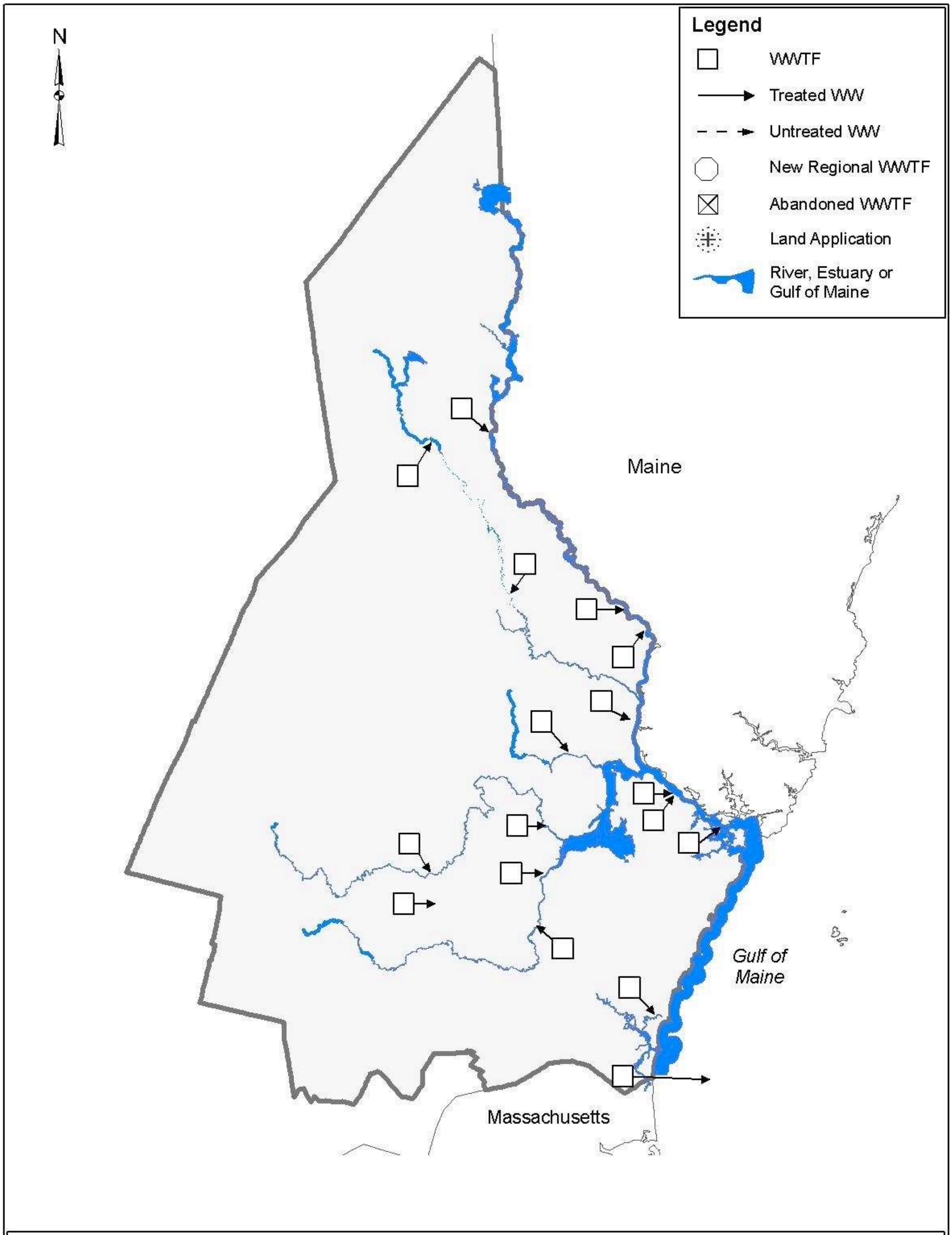


FIGURE 1. NO ACTION ALTERNATIVE

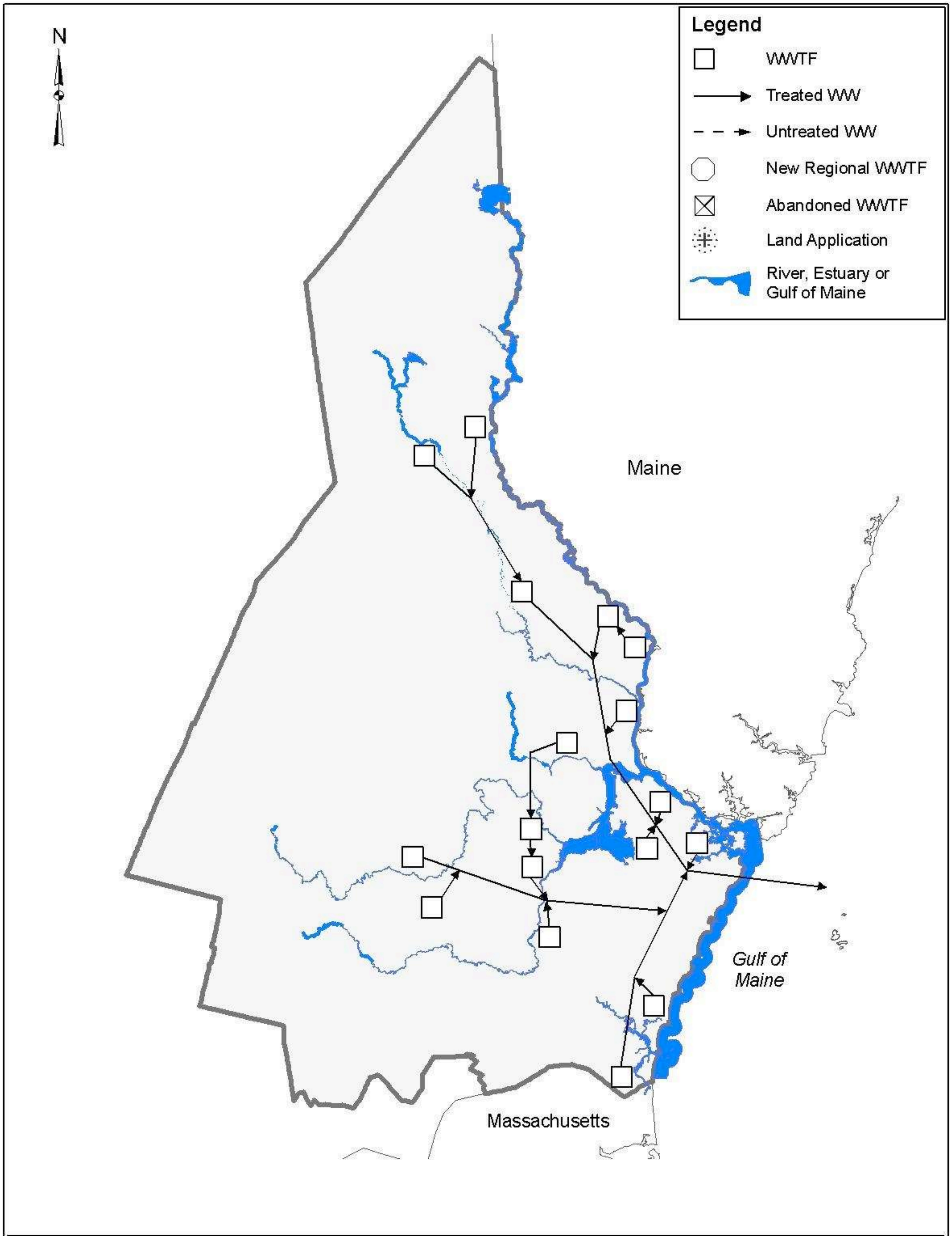


FIGURE 2. TREATMENT AT EXISTING WWTFs WITH A REGIONAL GULF OF MAINE DISCHARGE

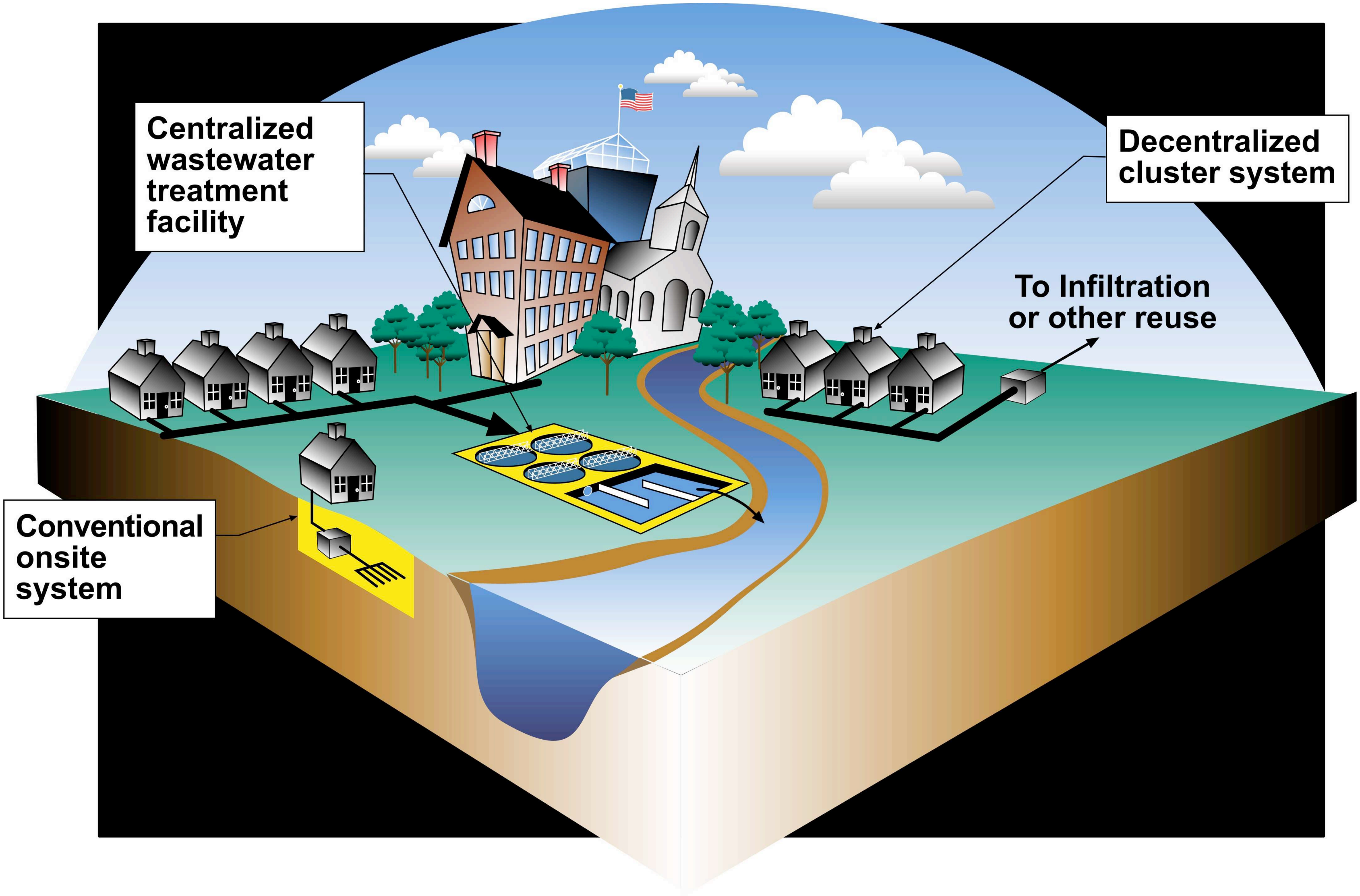


FIGURE 3. DECENTRALIZED TREATMENT AND CONTINUED USE OF EXISTING WWTFs

4. **Treatment at Existing WWTFs and Discharge at Land Application Sites (formerly presented as Alternative Number 2).** This alternative involves continuing treatment at the existing WWTFs; however, effluent treatment would be upgraded as needed to meet groundwater discharge standards, and treated effluent would then be discharged at local individual land application sites (see Figure 4). All attempts would be made to make this alternative "all or nothing," meaning that all treated wastewater discharged in the study area would be to land application sites. This could mean that some communities may need to collaborate and share a land application site that is in a practical location relative to the WWTFs. In the rare case that land application is not found to be feasible for a WWTF, treated effluent would continue to be discharged at the existing surface water discharge location (i.e., "business as usual").

   This alternative was selected as one of the four alternatives for further study since it focuses on local land application and, thus, helps to round out the four alternatives by allowing all possible disposal options (i.e., existing receiving waters, Gulf of Maine, and land application) to be analyzed more closely in the next stage of this study.

Common to All Alternatives

As previously stated, all septage generated from within the study area would be handled and treated within the study area. Also, biosolids (the solids that remain after wastewater is treated) would be disposed of in conjunction with the ongoing disposal methods currently practiced within the study area.

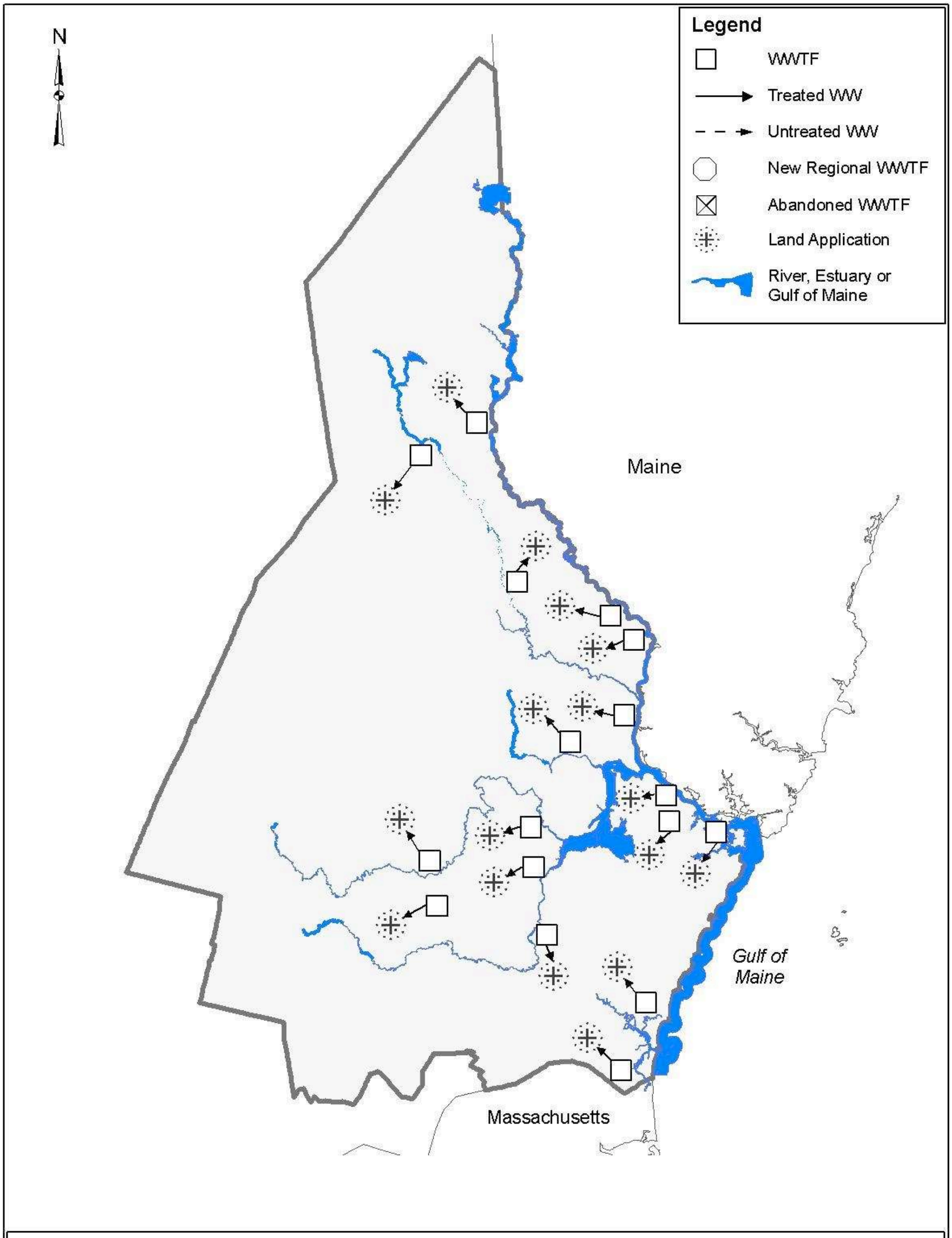


FIGURE 4. TREATMENT AT EXISTING WWTFs AND DISCHARGE AT LAND APPLICATION SITES

APPENDIX C

ESTUARY IMPACT ASSESSMENT

ESTUARY IMPACT ASSESSMENT

Potential Great Bay estuary water quality impacts by alternatives are summarized qualitatively in Table 1.

Table 1 – Potential Great Bay Estuary Water Quality Impacts by Alternative

Parameter	**Alternatives**			
	1 No Action	2 Regional Gulf of Maine Discharge	3 Decentralized Treatment plus Existing WWTFs	4 Existing WWTFs with Land Application
Flows	WWTF flows are projected to increase by an average of about 8.2% from 2004 to 2025.	WWTF flows to the estuary would be entirely eliminated.	Direct WWTP discharges to the estuary would increase by about 2.7%, and indirect discharge would increase by about 5.5%[1].	Direct WWTF discharges to the estuary would be eliminated. Indirect discharges would increase by about 8.2%[1].
Salinity	Decreased salinity due to increased WWTF flows to river.	Increased salinity due to decreased WWTF flows to rivers.	Slightly decreased salinity when decentralized systems wastewater reaches the estuary[1].	Decreased salinity when land applied wastewater reaches the estuary[1].
Dissolved oxygen	Small changes, due to reductions in BOD and nutrient loadings, where regulatory requirements become more stringent[2].	Small increase in DO levels due to reduced BOD and nutrient loadings[3].	Small changes, due to reductions in BOD and nutrient loadings, where regulatory requirements are strengthened[2].	Increase in DO levels due to reduced BOD and nutrient loadings[3].
Eutrophication[4]	Some changes due to reductions nutrient loading where regulatory requirements become more stringent[2].	Reduced eutrophication due to eliminated nutrient load[5].	Some changes due to reductions nutrient loading where regulatory requirements are strengthened[2].	Reduced due to nitrogen limit of 10mg/l for land application, and travel time[6].
Pathogens	No change.	Eliminated risk of accidental discharge.	No change.	Eliminated risk of accidental discharge.
Toxics	Slight increase due to increased flow and incomplete removal during treatment.	Eliminated.	Slight increase due to minor increases in future flows.	Largely eliminated, since many toxics do not travel in groundwater.

Notes:

[1] Indirect discharges to the Great Bay are for land application discharges that will eventually reach the estuary through groundwater flow.

[2] Regulatory limits are projected to be more stringent for some plants.

[3] The increase in DO will be small inasmuch as current DO deficits are generally low and occasional deficits exceeding 25% of saturation may not be related to the WWTF discharges (NHEP, 2006).

[4] Eutrophication effects include increased turbidity and algae and reduced eelgrass.

[5] Nitrogen loadings from WWTFs will be eliminated representing about 34% of all nitrogen loadings to Great Bay and Upper Piscataqua River.

[6] Some additional nitrogen reduction would occur in groundwater as the effluent plume travels. Plumes would take several years to reach the estuary.

Methodology

The impacts of the alternatives on salinity were estimated quantitatively using a two-dimensional model developed at the University of New Hampshire by Jon P. Scott. The model utilizes the RMA-2 and RMA-4 software (Donnell, Letter and McAnally, 2003; Letter and Donnell, 2003). The model is a finite elements model with triangular and quadrilateral elements of varying sizes. The model extends from the Piscataqua River mouth in Portsmouth to the dams in each of the rivers discharging to the estuary system. The model grid is shown in Figure 1.

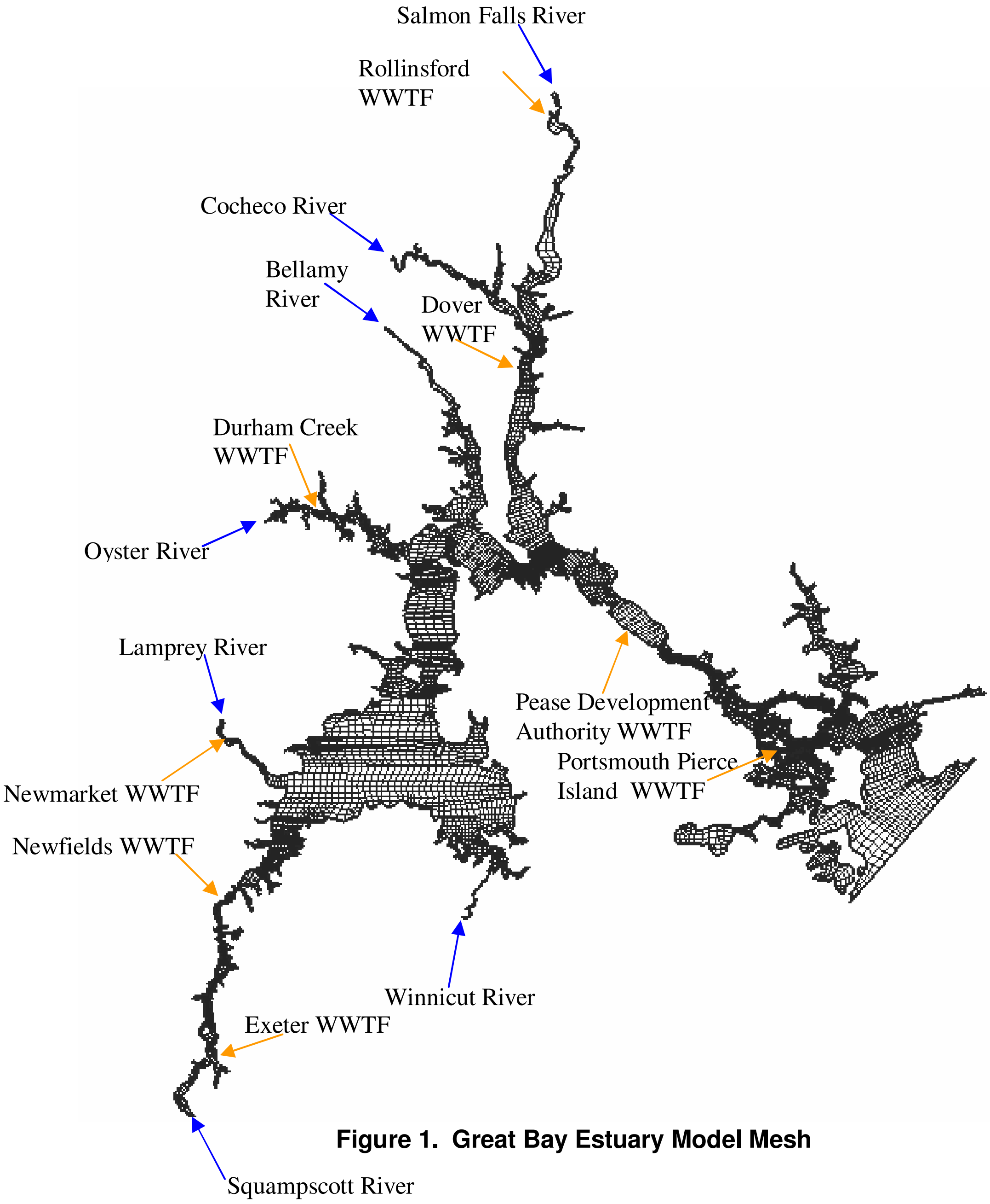


Figure 1. Great Bay Estuary Model Mesh

The hydrodynamic model, RMA2, was calibrated to tide levels at various points in the Great Bay estuary by Jon Scott. The water quality model, RMA4 was calibrated to salinity data in this study. The primary data that were used for the calibration are continuous salinity measurements at a number of monitoring locations throughout the Great Bay system, as shown in Figure 2. The data were collected as part of the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET) Great Bay Real-Time Environmental Monitoring Network. The data are available on the Internet at http://www.greatbaydata.org/arc_port.php.

Figure 2. Model Calibration Points

The CICEET monitoring has salinity data at 15-minute intervals from April 2004 to December 2005, with some interruptions. These data are plotted in Figure 3. Because of the compressed time scale, details are not visible, but general features are apparent. Considerable variations of salinity occur during the tide cycle as well as seasonally. The larger tidal variations are observed at the stations in the tributaries. A possible reason for this observation is that at least during some parts of the year, the rivers are vertically stratified with less saline river water near the surface and denser saline waters near the bottom. Since the monitoring instruments are typically located near the bottom, the variations they record are a combination of temporal and depth variations of salinity. At the Great Bay Monitoring Buoy, salinity variations during the tide cycle are more muted, likely because the instruments are attached to the buoy and therefore at a fixed depth below the surface.

On a seasonal basis, salinity is highest in the fall when the river lows are low and lowest in the spring and other times when the river flows are high.

The impact of removing the wastewater treatment plant discharges on salinity would be greatest during periods of low river flows, when the WWTF discharge flows represent a higher fraction of the river fresh water discharge to Great Bay. Therefore, the model was calibrated for a period of low flows – September 15-17, 2005. For this period, the flow at the Oyster River USGS gauge was on the order of 2.4 cfs, which is low, but somewhat above the 7Q10 flow of 0.45 cfs for this gauge. Comparable relationships with 7Q10 can be assumed for the other rivers. The 7Q10 river flows are compared to the plant flows in Table 2.

The transport model, RMA-4, was run for several tide cycles repeated for about 60 days, to allow calculated salinities to stabilize. A salinity of 31.5 ppt was specified at the estuary mouth. During the model calibration process, the diffusion coefficient, E, and Manning's coefficient, n, were varied, but they were found to have little effect on the calculated salinities. The final values that were used were E = 1 m^2/s and n = 0.02.

The measured and calculated salinities at the CICEET stations for the calibration period are shown in Figure 4. Also shown on these plots are salinity measurements made in September 1975 (Silver and Brown, 1979). The calculated salinities are lower than the 2005 measurements for the river stations, but very close to the measurements for the Great Bay station. The difference for the river stations is attributed to the fact that the model calculates depth averaged salinities, while the measurements are at depth, in the lower, more saline layer. At the Great Bay Station, stratification can be expected to be less, and the model closely matches the measurements. The 1975 data are generally closer to the model predictions.

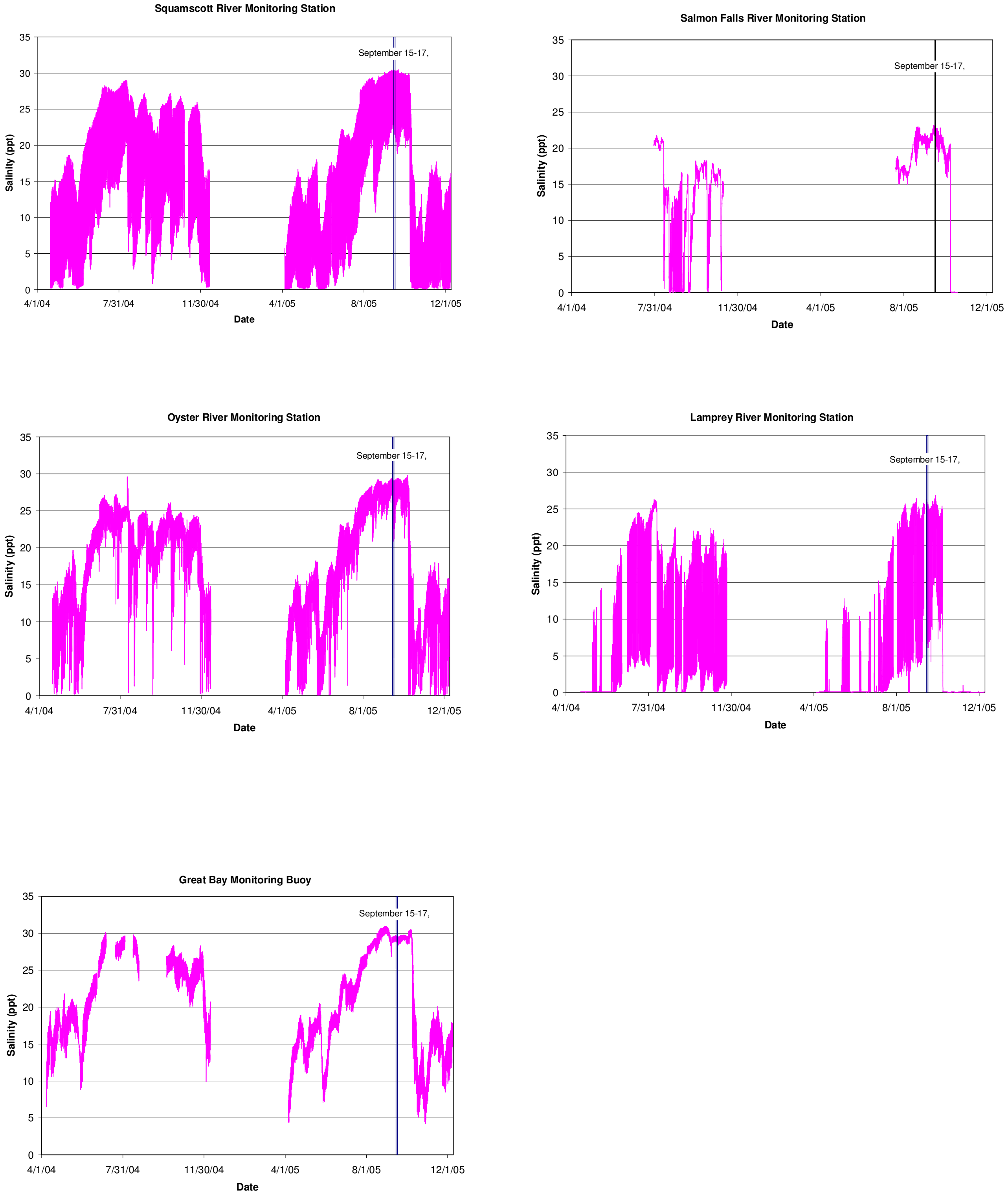


Figure 3. CICEET Salinity Data

Table 2. River and Plant Flows

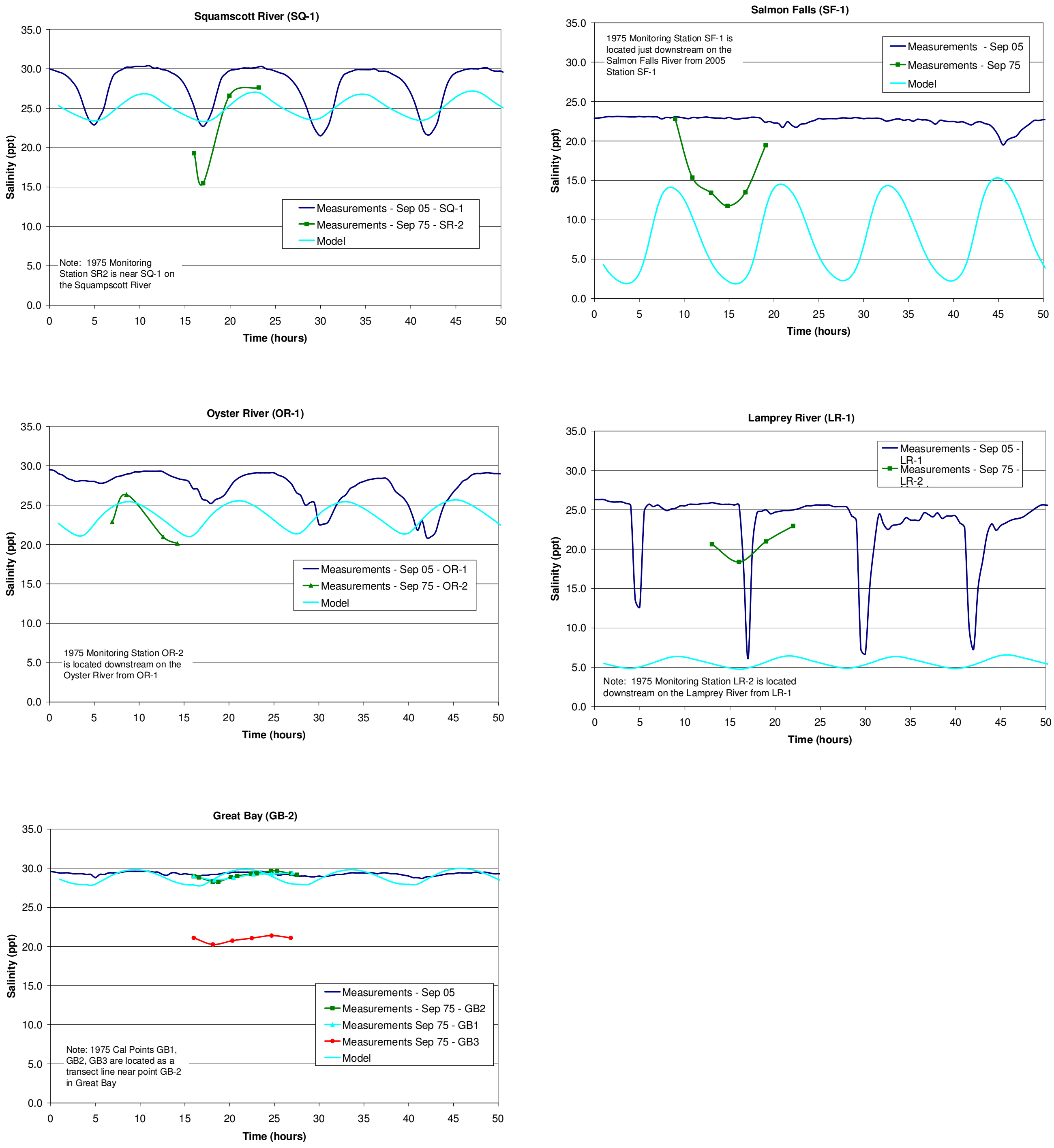
River			River Flow				Plant Flow		
			Reported 7Q10 (cfs)	Drainage Basin Area (mi^2)	7Q10/mi^2 (cfs/mi^2)	Calculated 7Q10 (cfs)	Permit (cfs)	Annual Average (cfs)	September Average (cfs)
Salmon Falls River	USGS Gauge	No. 01072100 - SF River @ Milton		108					
	Dam	Rollinsford Dam		238		9.52 (2)			
	Downstream Plant	Rollinsford WWTF	28.7 (1)				0.23	0.15	0.14
	Upstream Plants	South Berwick Maine WWTF							
		Somersworth WWTF	28.7 (1)				3.72	1.72	1.47
		Milton WWTF	25.4 (1)				0.15	0.09	0.09
Cocheco River	USGS Gauge	No. 01072800 Cocheco River		85.7					
	Dam	Central Avenue Dam		107.5		6.07			
	Downstream Plants	None							
	Upstream Plants	Rochester WWTF	4.74 (1)	85.7	0.055		6.08	4.66	3.99
		Farmington WWTF	2.52 (1)	43.8	0.058		0.54	0.33	0.27
Bellamy River	USGS Gauge	None							
	Dam	Sawyer Mill Dam		81.3		3.252 (2)			
	Downstream Plants	None							
	Upstream Plants	None							
Oyster River	USGS Gauge	No. 01073000 Oyster River	0.45	12.1	0.037				
	Dam	Mill Pond Dam		33		1.22			
	Downstream Plant	Durham Creek WWTF					3.87	1.58	1.62
	Upstream Plants	None							
Lamprey River	USGS Gauge	No. 01073500 Lamprey River		183					
	Dam	Macallen Dam		190.6		5.06			
	Downstream Plant	Newmarket WWTF	4.9 (1)	183.0	0.027		1.32	0.98	0.84
	Upstream Plant	Epping WWTF	3.0 (1)	114.0	0.026		0.77	0.29	0.26
Squamscott River	USGS Gauge	None							
	Dam	Exeter River Dam		105		4.20 (2)			
	Downstream Plant	Exeter WWTF					4.64	3.49	3.00
		Newfields WWTF					0.18	0.27	0.25
	Upstream Plants	None							
Winnicut River	USGS Gauge	None							
	Dam	Winnicut River Dam		19.9		0.80 (2)			
	Downstream Plants	None							
	Upstream Plants	None							
Plants discharging directly to Great Bay		Dover WWTF					7.27	4.25	3.46
		Pease & Newington WWTFs (3)					2.31	0.95	0.80
		Portsmouth Pierce Island WWTF					6.96	7.31	5.60
		Portsmouth Schiller WWTF							
Total						30.12	38.05	26.06	21.80

Notes

(1) From NPDES Permit

(2) 7Q10 flow calculated as drainage basin area multiplied by average ratio of 0.040 cfs/mi^2

(3) Pease Development Authority WWTF and the Newington WWTF are entered into the model as a single flow



Note: 1975 Monitoring Station SR2 is near SQ-1 on the Squampscott River

1975 Monitoring Station SF-1 is located just downstream on the Salmon Falls River from 2005 Station SF-1

1975 Monitoring Station OR-2 is located downstream on the Oyster River from OR-1

Note: 1975 Monitoring Station LR-2 is located downstream on the Lamprey River from LR-1

Note: 1975 Cal Points GB1, GB2, GB3 are located as a transect line near point GB-2 in Great Bay

Figure 4. Salinity Model Calibration and Application

Impact Evaluation

Model simulations were conducted for current WWTF discharge conditions, as well as Alternatives 1 (No Action) and 2 (Gulf of Maine Discharge). In Alternative 1, the WWTF flows increase by an average of 8.2% compared to current conditions. In Alternative 2, the WWTFs no longer discharge to the estuary system. As shown in Table 2, during 7Q10 conditions, the total flow discharged by the rivers is 30.1 cfs, while the average WWTF discharge in September (when low river flows typically occur) is 21.8 cfs, or 72% of the river flows.

Compared to the tidal flows, the volume of water discharged by the rivers during one tide cycle is on the order of 1% of the tidal prism (volume of water flowing in and out of the estuary during one tide cycle) (Ertürk et al, 2002). During low flow periods, the river flow is an even smaller fraction of the tidal flow.

Calculated salinities for the three simulations (existing conditions, Alternative 1 and Alternative 2) are shown in Figure 5 for different locations in the estuary system under 7Q10 flow conditions. In general, the impact of increasing the plant flows (in Alternative 1) or removing them (in Alternative 2) on salinity is quite small, on the order of 1 ppt or less. This impact is much less than the natural variability of salinity concentrations. During high flow periods, the effect of WWTF flow changes would be even less.

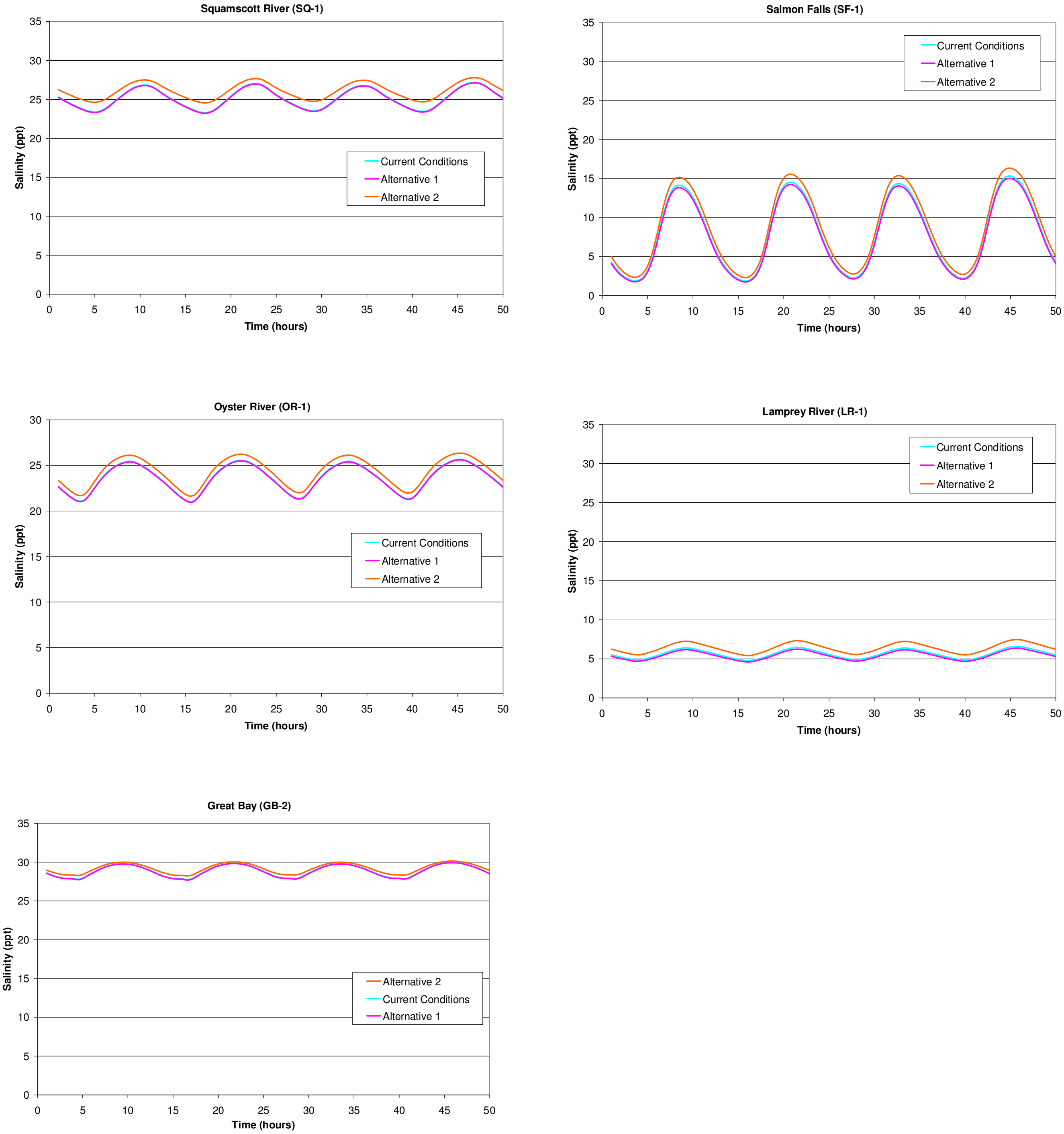


Figure 5. Model Salinity Predictions for Current Conditions and Alternatives 1 and 2 for 7Q10 River Flows

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APPENDIX D

GULF OF MAINE DISCHARGE MODELING

GULF OF MAINE DISHARGE MODELING

Gulf of Maine Outfalls

Discharges to the Gulf of Maine would achieve higher initial dilution of the effluent, as compared to discharges to rivers and estuaries. For the purpose of this study, it was anticipated that the outfall would be a conduit laid in a trench up to a certain water depth (say 30 feet), to protect against wave action. Beyond the 30-foot water depth, the outfall pipe could be laid on the ocean floor with intermittent coverage by rocks to hold it in place. The outfall terminus would be a multiport diffuser, to maximize the initial dilution of the effluent with ambient seawater (see Figure 1).

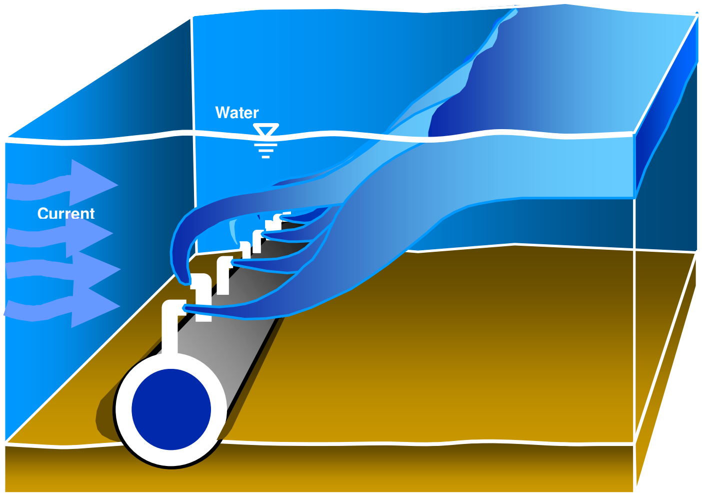

Figure 1. Multiport Diffuser Schematic

Wastewater discharged into the ocean is buoyant (i.e. lighter than the receiving water). As a result, the effluent rises in the water column as a buoyant jet, entraining ambient water in its travel towards the surface. The jet trajectory and amount of entrainment is affected by ambient currents. During the winter, when the receiving water is not stratified, the effluent rises all the way to the surface where it impinges and spreads horizontally. Additional entrainment of ambient water occurs in the impingement area. During the summer, when the water column is stratified, the effluent plume may reach the surface or become trapped at an intermediate depth, depending on the strength of the stratification and the discharge flowrate. The dilution up to a point just beyond surface impingement or the final height of rise is called the “initial dilution”.

Beyond the zone of initial dilution (ZID), the diluted effluent is carried by ambient currents and undergoes further, albeit slower mixing with ambient water. This zone is called the discharge farfield, and the effluent plume is controlled by advection (passive transport) and dispersion.

Initial dilution controls the toxicity of the discharge to marine organisms, while farfield transport and dispersion affects longer term phenomena such as dissolved oxygen depletion, algae growth, benthic impacts and shoreline contact.

For this evaluation, concept designs of three candidate outfall locations were developed. Oceanographic characteristics of the Gulf of Maine that affect the outfall design and performance are first presented. Factors relevant to outfall design are then discussed briefly, including the siting of the outfalls. Outfall performances are estimated next in terms of initial dilution. Initial dilution was estimated using mathematical models developed from theoretical and experimental investigations. Farfield transport and dispersion was not evaluated, since high initial dilutions were obtained.

Gulf of Maine Characteristics

The oceanographic characteristics of importance for wastewater discharges are the currents, large scale circulation, and vertical density stratification. Instantaneous currents affect initial dilution; large scale circulation affects farfield transport and impacts on remote points; and stratification affects initial dilution and to a smaller extent farfield transport. Both currents and stratification are driven by tides, winds, surface heating and cooling and river discharges.

There have been a number of investigations of oceanographic conditions in the Gulf of Maine, and hourly current data are available at 10 moorings through the GoMOOS program. One of the moorings (B) is approximately 5 miles offshore and 10 miles upcoast of the Piscataqua River. To obtain data that was more detailed and site specific, results of the University of Maine model of the Gulf of Maine was used (Xue et al, 2000), and the assistance of Dr. Huijie Xue in providing these data is gratefully acknowledged. This model, based on the Princeton Ocean Model, is three-dimensional with 19 layers in the vertical direction. The model is run in real time with forcing from measured boundary tide levels, wind speeds, surface heat transfer and evaporation, and river discharges. The model covers the entire Gulf of Maine and extends approximately 550 km offshore to a depth of about 4,500 m. The grid spacing is approximately 3 km x 4 km near shore to about 6 km x 7 km offshore. The model calculates water levels, currents, salinity and temperature.

Model data were provided by Dr. Xue at three points on two normal transects about 10 km north and 20 km south of the Piscataqua River mouth. The data covered two one-month periods (December 2004 and May 2005). The data included water surface elevations as well as north and south velocity components, salinity and temperature at 15-minute intervals for each of the 19 model layers. This large amount of data was analyzed in different ways and also used to drive the more refined model described below.

<u>Tides.</u> The predominant tidal constituent in the Gulf of Maine is the M_2 semi-diurnal lunar tide, with a period of 12.42 hours. The tidal amplitude in the project area varies from 7 to 13 feet.

<u>Instantaneous Currents.</u> Tidal ellipse plots are presented in Figures 2 and 3 for December 04 and May 05 2004 at points on the north and south transect, based on vertically averaged velocities. Tidal ellipses are plots of the end of the velocity vector at one point as a function of time. The axes are the velocity components perpendicular and parallel to the general alignment of the shoreline in the area. For both December and May, the ellipses show clear onshore-offshore flow, particularly on the south transect. There, the onshore component was on the order of 10 cm/s, which gives an onshore excursion of about 1.4 km (0.9 mi). This would imply that material discharged offshore would move up to 1.4 km (0.9 mi) towards shore during one tide cycle. The offshore component was about 20 cm/s. The differences between the north and south transects may be due to bathymetry, as well as to the discharge from the Piscataqua River, which may tend to flow south after it enters the Gulf of Maine. On the north transect, the ellipses are more circular, with smaller velocities in the onshore-offshore direction.

The current component that most influences initial dilution is the component perpendicular to the diffuser barrel. And because the diffuser designs considered here are symmetrical, currents from either direction have the same effect. Therefore, the current characteristic relevant to initial dilution is the absolute value of the current component perpendicular to the barrel. Median values of this parameter are summarized in Table 1, as well as simple averages of the current components, which are discussed below relative to large scale circulation patterns.

As the tidal ellipses, Table 1 indicates a significant difference between the north and south transects. Median absolute velocities are much higher on the south transect, which is more representative of the areas where the diffusers would be located.

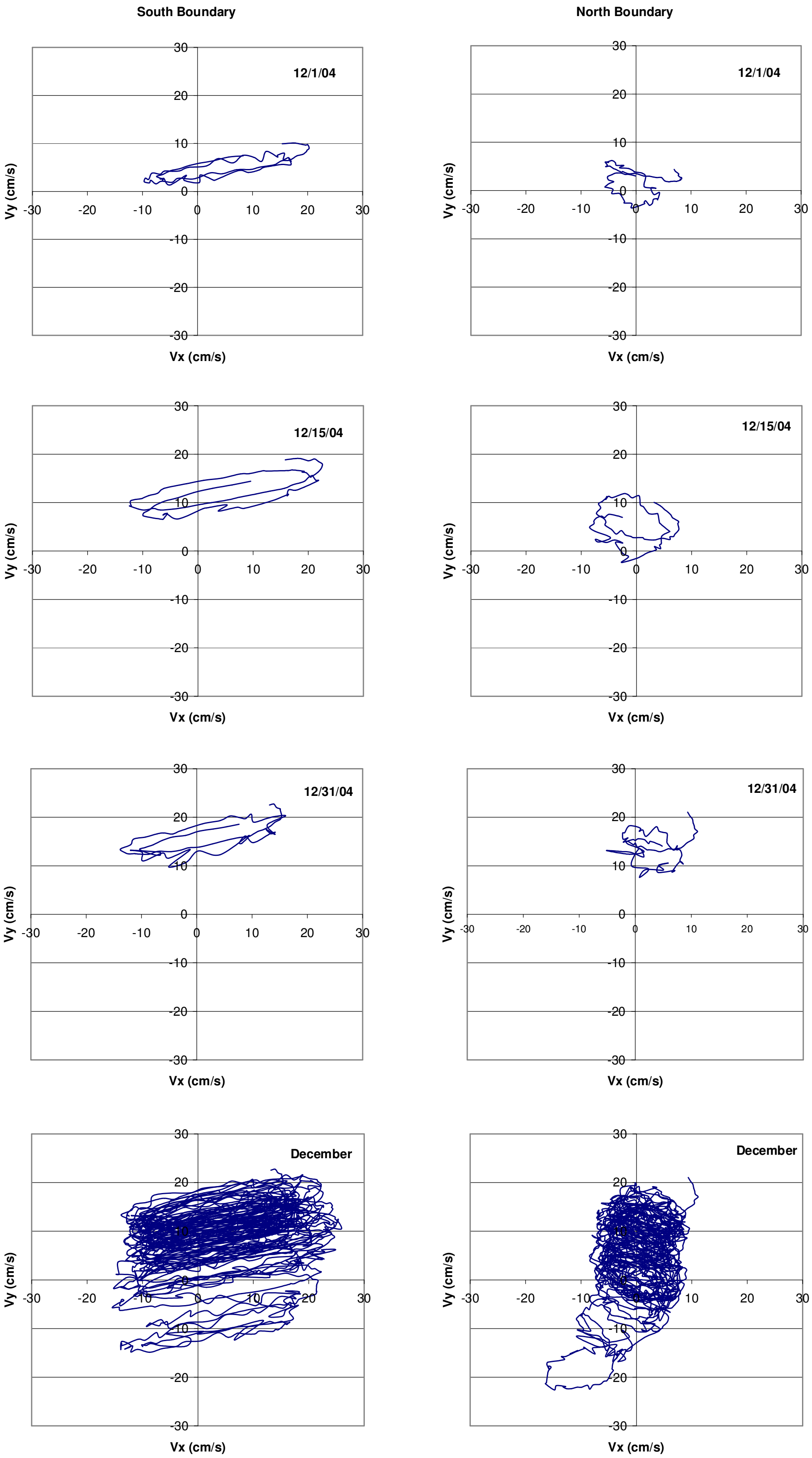

Figure 2. Tidal Ellipses for December 2004

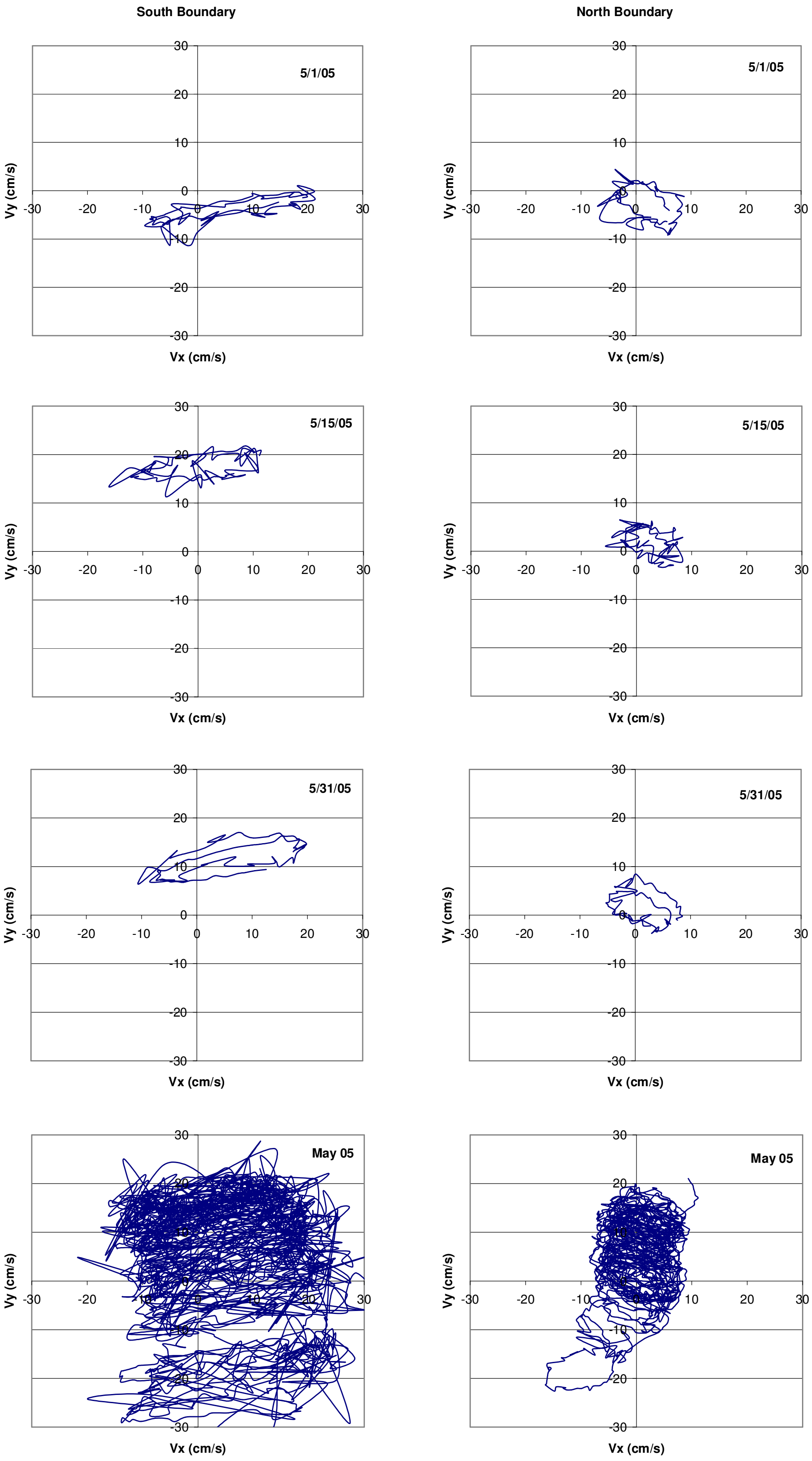

Figure 3. Tidal Ellipses for May 2005

Table 1. Current Averages

Current component	Onshore-offshore (positive offshore)				Alongshore (positive towards north)			
Time period	December		May		December		May	
Transect	North	South	North	South	North	South	North	South
Median absolute (ft/s)	0.12	0.31	0.13	0.30	0.25	0.33	0.15	0.38
Average (ft/s)	0.02	0.16	0.02	0.16	0.18	0.29	-0.17	0.17

<u>Large Scale Circulation.</u> Superimposed on tidal currents are net currents that are part of large scale circulation patterns in the Gulf of Maine. A prominent feature is a counter-clockwise gyre which develops in the summer and was first identified by Bigelow (1927). There have since been a number of investigations of large scale circulation patterns in the Gulf of Maine, which have identified a more complex situation with several gyres that develop and subside seasonally (Brown and Irish, 1992; Pringle, 2006).

Net currents are important relative to wastewater discharges, as they are the mechanism whereby the treated effluent is removed from the discharge area. Net currents in the project area can be further gauged from long term averages of currents, as those provided in Table 1. A more visual evaluation is provided by the progressive vector plots presented in Figure 4. These plots indicate the paths that particles would take if subjected to the point velocities. Real paths would be different as the velocities would vary as the particle moves from the original point. Nevertheless, progressive vector plots have the advantages of clearly showing net currents. On the south transect, for both December and May, the net currents are towards the north, which is opposite to the counter-clockwise gyre. On the south transect, net currents are towards the north in December and towards the south in May.

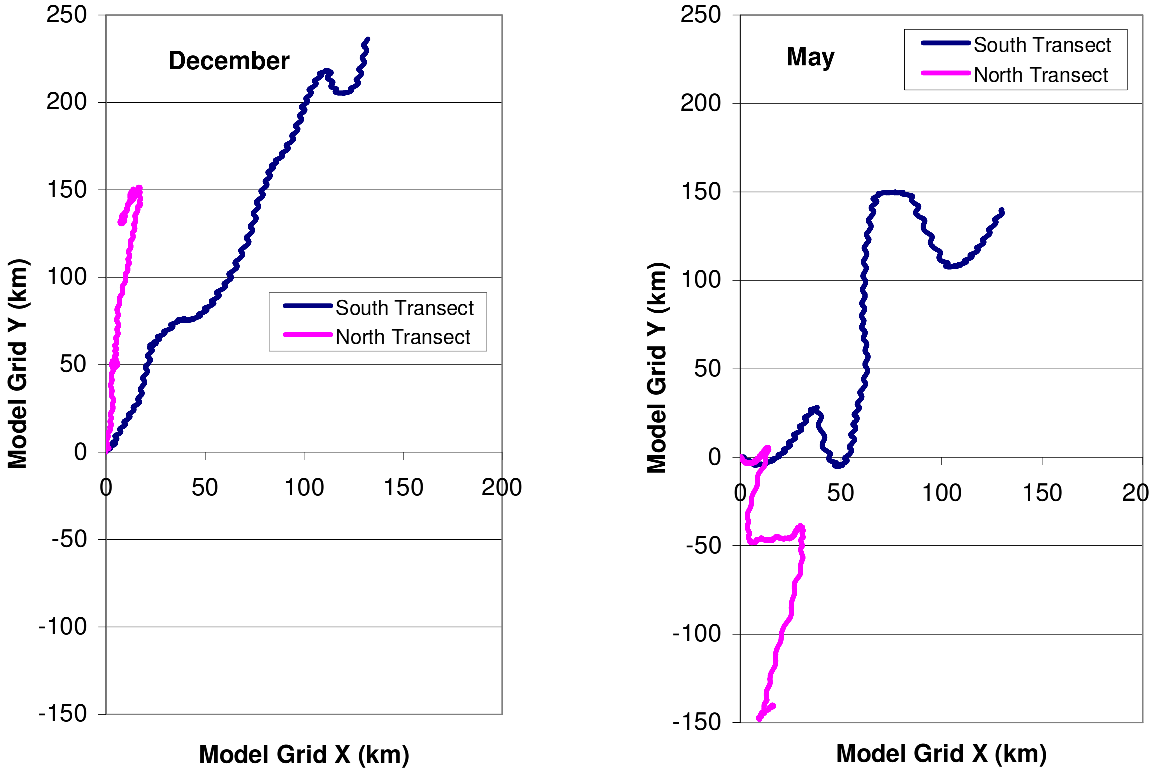

Figure 4. Progressive Vector Plots

Stratification. Vertical profiles of temperature and salinity in the potential outfall area are presented in Figure 5 for different times of the year. Temperatures are approximately uniform vertically in December and May, but a clear stratification has developed in August with a temperature difference of about 10°C between the surface and the 180 ft depth. Salinities exhibit vertical variations throughout the year, with lower values at the surface, due to fresh water discharges from rivers. The salinity difference between the surface and the 180-ft depth is about 2 ppt in December and May and only about 1 ppt in August.

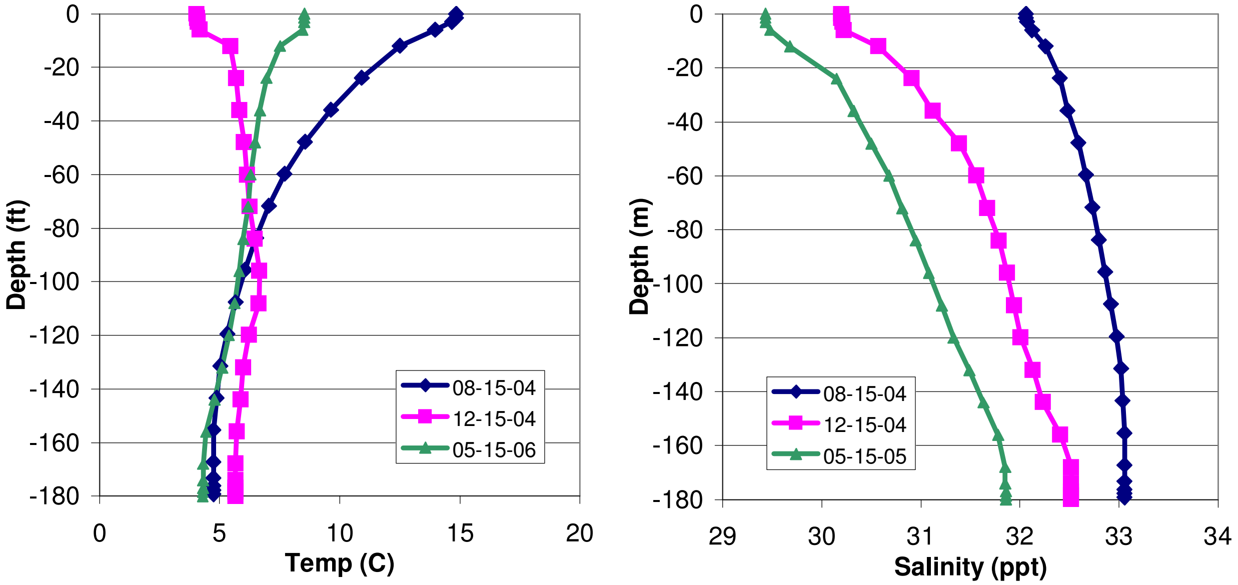

Figure 5. Temperature and Salinity Profiles in Project Area

Outfall Siting

Offshore outfalls are meant to achieve high dilution of the effluent with ambient water and minimize contact of the plume with shorelines. Both goals tend to push the discharge point far offshore, where greater depths and currents yield higher initial dilution and stratification may keep the effluent from surfacing. The counterpart is obviously cost, for outfall construction and possibly for pumping if sufficient head is not naturally available, as with a plant high above sea level.

For this project, three candidate discharge locations were evaluated at different distances from shore. These sites are shown in Figure 6, and some of their characteristics are summarized in Table 2. These sites were selected to provide a range of distances from shore and water depths. These sites were selected for evaluation purposes only and additional studies would be required to establish their feasibility. A factor in the selection of the sites was the presence of cable areas, which should be avoided if at all possible. Site 1 was selected to allow direct access from the shore just south of the Piscataqua river mouth. Sites 2 and 3 would require a leg along the shore to avoid crossing the cable areas.

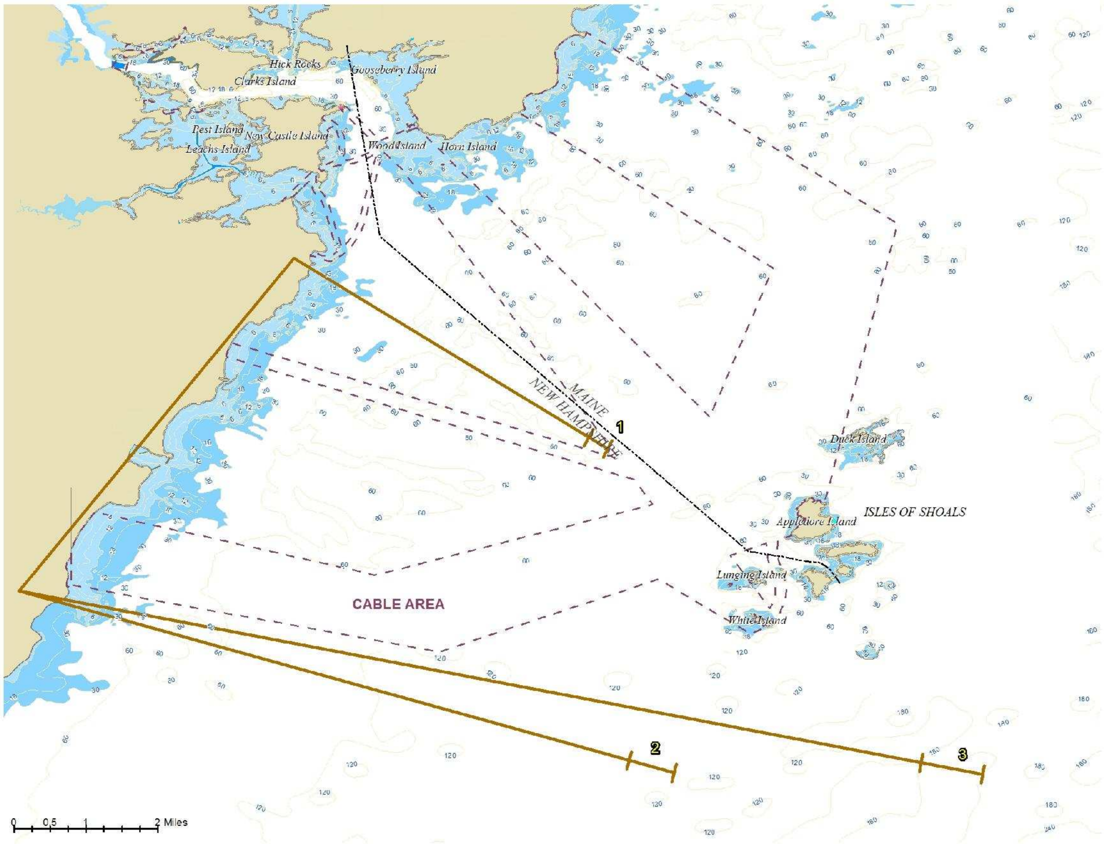

Figure 6. Candidate Outfall Sites

Outfall Design

Design objectives include maximizing initial dilution, satisfactory performance over the range of expected flows, and long term operation without need for maintenance.

Dilution. For deep discharges of wastewater in seawater, the plume dynamics are dominated by the effluent buoyancy. In general terms, initial dilution increases with diffuser length and depth, and decreases with the effluent flowrate. Therefore, to maximize dilution both diffuser depth and length should be maximized. In general, depth increases with distance from shore, therefore increasing depth will likely involve increasing the outfall length and hence its cost. Increasing the diffuser length, however, does not necessarily entail increasing the overall length of the outfall, considering that the end point can be kept the same and the beginning of the diffuser brought closer onshore. When the overall outfall length is much greater than that of the diffuser, starting the diffuser earlier does not bring it substantially closer to land and hence does not increase plume contact with the shore. The number of ports, however, cannot be indefinitely increased – see below – and increasing the diffuser length therefore entails increasing the port spacing and after a point, the plumes from the individual ports behave independently and further increase of length does not result in increased dilution.

The angle of the diffuser with the predominant currents also affects dilution, with the largest dilution obtained when the diffuser is perpendicular to the current. The discharge velocity has an effect on dilution, but for wastewater discharges in deep water, buoyancy is the main driving force.

Flow Distribution. Another goal in diffuser design is to distribute the flow uniformly over the length of the diffuser. This requires that the sum of the area of the ports downstream of any point along the diffuser be less than the diffuser barrel area. When the diffuser is sloping, and the effluent is buoyant, the flow distribution will vary with the magnitude of the flow. Therefore, when possible, it is preferable to site the diffuser in an area where the sea floor is horizontal.

Minimum port size. To avoid blockage, ports should not be too small. Values of 2.5 to 8 inches have been suggested as minimal port sizes, for filtered to primary treated effluent (Wood et al, 1993). For this application, a port size of 6 inches was selected.

Seawater Intrusion. Because of the density difference between the effluent and receiving water, there is the potential at low flows for seawater to flow into the diffuser at the bottom of the ports, at the same time as effluent flows out of the ports at the top. To avoid this counterflow situation, the discharge densimetric Froude number[1] should be greater than 1.0. For safety, a minimum value of 2.0 is often used.

Seawater intrusion will occur during flow stoppages, which cannot be avoided, and may also occur during periods of extreme low flows. But seawater intrusion should be minimized and velocities should be sufficient during normal operation to flush any material that may have entered the diffuser during periods of intrusion. Another option is to use duck bill valves, which prevent backflow but increase the cost.

Combined with the minimum port size guideline, the seawater intrusion criterion limits the number of ports that can be used. For a given port size, increasing their number decreases the discharge velocity and would eventually violates the Froude number criterion.

Diffuser Barrel Velocity. The velocity in the diffuser barrel should be kept high enough to prevent accumulation of suspended solids. A criterion to achieve this goal is to ensure that velocities exceed the scouring velocity – on the order of 3 ft/s – at least once a week. To meet this criterion over the length of the diffuser, in which the flow is gradually decreasing, the design often includes one or more reductions of the barrel diameter along the diffuser. This aspect is addressed during the final diffuser design using manifold calculations.

Diffuser Alternatives. A conceptual diffuser design was developed for each of the discharge sites. For wastewater discharges in deep water, tee-port or alternating-port diffusers are typically used. Initial dilution is mainly driven by the effluent buoyancy and no attempt is made to use the discharge momentum to enhance dilution, as is done for cooling water discharges which have lower buoyancy and higher flows. The alternating-port configuration was selected for the designs, but tee-ports would give essentially the same initial dilutions.

Because of the large distances from shore, there is no restriction on the diffuser length, and those were selected based on a port spacing sufficient to avoid plume interaction under stationary, non-stratified ambient conditions. This results in a port spacing equal to half the water depth. Thus, diffusers in deeper water achieve larger dilution because of the increased length, as well as the increased depth. The other diffuser design parameters are listed in Table 2.

Initial Dilution

For a given multiport diffuser design, initial dilution is a function of the discharge flowrate, the instantaneous current speed, and the water column stratification. Therefore, initial dilution varies with time following the variation of these parameters. The effluent flowrate varies with the diurnal pattern and the occurrence of storms; the instantaneous current is primarily dependant on the tide, with a period of 12.4 hours; and stratification is a seasonal phenomenon.

Initial dilution primarily controls the acute and chronic toxicity of the discharge. The time of travel in the effluent plume from the discharge point to the end of the zone of initial dilution is usually short enough to avoid toxic impacts to entrained organisms. Therefore, the end of the zone of initial dilution is usually

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[1] $F = U / [(\Delta\rho/\rho)\ g\ d]^{1/2}$, where U = discharge velocity, Dr/r = relative discharge density difference, g = acceleration of gravity and d = port diameter.

selected as the point of application of toxicity criteria. These criteria involve the Criteria Maximum Concentration (CMC) to protect against acute effects and the Criteria Continuous Concentration (CCC) to protect against chronic effects (USEPA, 1991). EPA recommends averaging periods of 1 hour and 4 days respectively for acute and chronic criteria, with an exceedence frequency of once every 3 years (USEPA, 1991).

The lowest initial dilution will be achieved for peak flow, at slack tide, during the summer (with stratified receiving water). Since stratification persists for several months, and slack tide occurs four times a day, coincidence with peak flow can be expected to occur at least once every three year and last for approximately one hour. Therefore, the dilution calculated for peak hour flow, zero current speed and stratified conditions is relevant for comparison with the CMC.

During any 4-day period, initial dilution will vary considerably in particular because of the variation of current speeds. A condition which can reasonably be assumed to correspond to the average of a critical 4-day period involves stratified conditions, average day flowrate and median current speed.

Initial dilution estimates were developed using calibrated models for different receiving water regimes (Tian et al, 2004a, 2004b; Daviero et al, 2006). These models neglect the effect of the port discharge momentum, and are thus conservative relative to initial dilution. The results are summarized in Table 2. The initial dilution values listed are the *minimum* dilution at the end of the zone of initial dilution (ZID). For cases where the plume impinges on the surface, the ZID extends a short distance downstream of the impingement point. For the stratified, stationary ambient case, the ZID extends to the point where the plume reaches its final height of rise and spreads horizontally. The distance from the diffuser to the edge of the ZID is on the order of one to two times the water depth. When there is a current, the ZID extends to a point where the plume becomes passively conveyed by the current.

As expected, initial dilution increases from Sites 1 to 3. The CMC dilution, which essentially corresponds to the worst case that can be expected to occur in a three-year period, varies from 50 at Site 1 to 116 at Site 3. The CCC dilution varies from 115 at Site 1 to 296 at Site 3.

Head Requirements

Estimates of the heads required to convey the flows through the three candidate outfalls are also listed in Table 2. These heads assume a Manning's n of 0.015 for the outfall and a head loss coefficient of 3.0 for the diffuser, based on the discharge velocity.

The heads required for the average day flow are modest and may not require an effluent pumping station. For the peak hour, however, the required heads are considerably higher, up to 214 ft for the outfall at site 3. The bulk of this head is the friction loss in the outfall conduit, which was assumed to have a diameter of 6 ft. The corresponding velocity is 1.4 ft/s for average day flow and 5.6 ft/s for peak hour. Using a 7 ft diameter outfall would reduce the head required for the site 3 outfall to 84 ft for peak hour, but the velocity at average day would drop to 1.0 ft/s, which is somewhat low to avoid suspended solids deposition.

The heads required to convey the peak hour flows through the candidate outfalls may require an effluent pumping station, unless the Regional Post-Treatment Facility can be situated at a sufficient elevation to allow flow by gravity. The dilemma with an effluent pumping station is that it would need to have a large flow and head, but would operate only a fraction of the time. The head requirements are also aggravated for Sites 2 and 3 by the assumed outfall leg along the shore to avoid crossing the cable areas. If outfalls at Sites 2 or 3 are seriously considered, the possibility of crossing the cable areas should be evaluated, but at the planning stage this cannot be assumed to be less costly than the increased outfall length and effluent pumping station.

Table 2. Outfall Alternatives and Initial Dilution Performance

			Site 1	Site 2	Site 3
Distance from shore (mi)			4.3	8.0	11.6
Depth at low water (ft)			60	120	160
Outfall length (mi)			4.3	15.5	20.0
Outfall Diameter (ft)			6.0	6.0	6.0
Diffuser Design					
Length (ft)			1,290	2,580	3,440
Number of ports			44	44	44
Port diameter (inches)			6.0	6.0	6.0
Initial dilution (minimum at edge of Zone of Initial Dilution)					
Winter Conditions					
Slack tide					
	2055 Average Flow	24.7 MGD	240*	759*	1233*
	2055 Max day flow	65.3 MGD	126*	397*	641*
	2055 Peak hour flow	102.6 MGD	93*	294*	474*
Median Current (0.3 ft/s)					
	2055 Average Flow	24.7 MGD	334	1,337	2,377
	2055 Max day flow	65.3 MGD	126	506	899
	2055 Peak hour flow	102.6 MGD	93	322	572
Summer Conditions					
Slack tide					
	2055 Average Flow	24.7 MGD	75	119	166
	2055 Max day flow	65.3 MGD	58	94	130
CMC >	2055 Peak hour flow	102.6 MGD	50*	84	116
Median Current (0.3 ft/s)					
CCC >	2055 Average Flow	24.7 MGD	115	189	269
	2055 Max day flow	65.3 MGD	72	137	194
	2055 Peak hour flow	102.6 MGD	57	118	167
Required Head					
	2055 Average Flow	24.7 MGD	5	11	14
	2055 Max day flow	65.3 MGD	25	70	87
	2055 Peak hour flow	102.6 MGD	60	170	214

* Plume surfaces

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APPENDIX E

GROUNDWATER RECHARGE AND REUSE,

PHASE 1 – FAVORABLE ZONE IDENTIFICATION

ENSR INTERNATIONAL

ENSR International

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April 25, 2005

Method of Transmittal
Federal Express

New Hampshire Seacoast Project Team
c/o Matthew Formica
Metcalf & Eddy, Inc.
701 Edgewater Drive
Wakefield, MA 01880

RE: New Hampshire Seacoast Wastewater Management Study, Task 4.2.3 Groundwater Recharge and Reuse, Phase 1 – Favorable Zone Identification Task, ENSR Project Number 04632014

Dear Team Members:

This letter summarizes the process and results of the Phase 1 - Favorable Zone Identification task presented in the proposed approach letter to the team from Jack Donohue, ENSR, dated March 8, 2005. If the team determines further study is warranted after the Phase 1 results are reviewed, the Phase 2 ranking analysis, as detailed in the March 8th letter and refined below, will be performed by ENSR. A CD containing the Phase 1 resultant Geographic Information System (GIS) polygon data, in ESRI-Shapefile format, is included for your review and use.

The purpose of this Phase 1 GIS analysis is to determine if any potentially favorable areas for wastewater recharge or reuse remain in the Study Area after a set of exclusionary criteria are applied. These exclusionary criteria are a set of identified GIS data layers that indicate whether or not a compatible land use and land type exists in a given point in the Study Area. The Study Area consists of the 46 seacoast New Hampshire towns listed as an attachment and presented on the Phase 1 Favorable Zone Maps.

All of the GIS data used for this analysis were provided to ENSR by Metcalf & Eddy, Inc. on January 12, 2005. The sources of these data are NH GRANIT and the New Hampshire Department of Environmental Services (NHDES).

The analysis comprised two primary steps. First, the creation of a base map, showing mapped "aquifer materials"; second, the application of a suite of exclusionary criteria to eliminate portions of the mapped aquifers from further consideration. A description of this process follows.

BASE-MAP DATA

Aquifer Boundaries

The base-map data layer was derived from the Aquifer Boundaries polygon data obtained from NH GRANIT. This data layer was automated by NH GRANIT from maps generated as part of a state-wide groundwater resource study performed under a cooperative agreement between United States Geological Survey (USGS) and the NHDES Water Resources Division. The reports from this study identify the mapped aquifer boundaries as the contact between stratified drift and till or bedrock valley walls. Existing surficial geologic maps, soils maps, well logs and field mapping were used to determine the locations of these contacts.

The specific GIS data sets used for the base-map data layer consist of the Cocheco, Bellamy, and Salmon Falls Area (NH GRANIT Code: "cc"), the Lamprey, Exeter, and Oyster River Area (NH GRANIT Code: "la"), and the Lower Merrimack Area (NH GRANIT Code: "lm") aquifer boundaries data. These data sets were merged for use as the base-map data layer, from which the exclusionary criteria were removed.

Surficial Materials

The New Hampshire Geological Survey (NHGS) has automated 14 USGS quadrangle-size maps of Surficial Materials within the Study Area for use with GIS. This covers approximately 50% of the study area (14 of the 29 quadrangles). The polygon features in the Surficial Materials data coded with surficial units representing sand or sand and gravel materials were selected for consideration in the Phase 1 Favorable Zone Identification Task. Due to the limited coverage across the Study Area, these data are displayed separately from the Aquifer Boundary data on the Phase 1 Favorable Zone Map 1. These data layers were only available for USGS Quadrangles (NH GRANIT quad ID): 126, 140, 154, 155, 156, 166, 167, 168, 169, 170, 184, 185, 186, and 202. See the attached list of study area quadrangle names and ID's.

The areas of sand or sand and gravel identified in the Surficial Materials data are primarily coincident with the areas delineated for the Aquifer Boundaries data. However, the identified sand and sand and gravel areas outside of the mapped aquifer areas are included in this phase of the study to ensure consideration is given to any areas with evidence of potentially well drained materials.

EXCLUSIONARY CRITERIA

The base-map data layer was modified by applying the following exclusionary criteria. The areas generated from the exclusionary criteria were removed from the aquifer data layer. The resultant aquifer areas, provided in ESRI-shapefile format, are presented on the Phase 1 Favorable Zone Maps. The exclusion process assumes that if any one of these criteria is present in a given area, the area is not suitable for the recharge or reuse disposal option.

Urban or Developed Areas

Urban or developed areas were identified using the New Hampshire Land Cover Assessment, 2001, with classifications based on Landsat Thematic Mapper(TM) imagery. Grid cells coded as 110 - Residential/Commercial/Industrial, were selected for this exclusionary criterion. This is the only code in the attribute table that applies to developed areas. It does not conclusively identify all developed areas, but provides a good initial estimate of areas with urban, industrial, and dense residential development.

Wetlands

Wetland areas were derived from the hydrographic polygon data generated from USGS 1:24,000 Digital Line Graphs, automated by NH GRANIT, and the National Wetlands Inventory

(NWI) data, automated by US Fish and Wildlife Service. All of the delineated areas in the NWI data with an attribute code other than "U" ("upland") were considered wetland areas not favorable for groundwater recharge applications. The wetland areas identified by either of these sources were removed from the Aquifer Boundary base-map data.

Roads (50 foot buffer)

A 50-foot buffer along all of the line features of the "Roads" data layer was generated and subtracted from the aquifer base-map layer. The "Roads" GIS data were digitized by NH GRANIT from USGS Digital Line Graphs at a scale of 1:24,000.

Drinking Water Reservoirs (1,000 foot buffer)

Drinking water reservoirs were selected from the hydrographic polygon data by their NH GRANIT code for reservoir and by the water supply 'source-type' code in the water-user point data layer (watuse.shp) for surface water withdrawals.

100-year Flood Plain (limited coverage)

Digitized FEMA flood-plain data were available for 26 of the 46 towns located in the study area. Polygons coded as 100-year flood-plain areas were removed from the aquifer base-map data layer.

Wellhead Protection Areas (a) All Public Supplies, b) Community Supplies Only)

The GIS wellhead protection area (WHPA) polygon data used for this criterion were generated by the NHDES Drinking Water Source Protection Program, Water Supply Engineering Bureau. The data used for this task was created in October 2004.

There are 1,056 public water supplies located within the study area based on the GIS database records. Of these public water supplies, 494 are community supplies, 196 are non-community/non-transient supplies, and 366 are non-community/transient supplies. There are 306 WHPA's established for community water supplies, 105 WHPA's for non-community/non-transient water supplies and 8 WHPA's for non-community/transient supplies. The remaining 637 water supplies do not have established WHPA's delineated in the NHDES GIS database.

In order to identify the influence of protective setbacks from public water supply wells on the potentially favorable areas identified in this task, three wellhead protection criteria were applied. 500-foot setbacks from all public water supplies in the Study Area were applied to reflect the setback criteria identified for non-irrigation, groundwater recharge through ground-surface application, in the table "Wastewater Discharge Land Application Reuse and Recharge Effluent Permit Limits for Plant Evaluations", provided by Metcalf & Eddy, Inc. This setback was selected since it is the most conservative distance referenced for land application in this table. The WHPA's for the public water supplies were also applied as potential exclusionary criteria. One scenario eliminates the aquifer areas underlying the WHPA's for the community water supplies; the other scenario eliminates the aquifer areas underlying the WHPA's for all of the public water supplies (community and non-community). These scenarios are displayed on the accompanying maps.

PHASE 1 FAVORABLE ZONE IDENTIFICATION RESULTS

The Phase 1 Favorable Zone Map 1 illustrates the aquifer areas remaining after the exclusionary criteria and the WHPA's for community public water supplies were removed. This area is displayed as the light red/salmon color. The map also displays the features that represent the exclusionary criteria. The resultant GIS file generated by this scenario is titled "aq-dvlp-flp-wtld-nwi-rsvr-rds-comwhpa.shp". The file is named to represent the aquifer boundary data (aq) minus the developed land (dvlp), flood plains (flp), wetlands (wtld), National Wetlands Inventory areas (nwi), reservoir buffers (rsvr), roads (rds), and the community wellhead protection areas (comwhpa). Where available, the sand and sand and gravel areas from the Surficial Materials data are displayed for reference. These areas fall primarily within the mapped aquifer areas, however the areas beyond the aquifer boundaries may be potentially favorable zones.

The Phase 1 Favorable Zone Map 2 illustrates the aquifer areas remaining after the exclusionary criteria are removed (light red/salmon color). The WHPA's for all of the community and non-community water supplies are displayed in a manner that allows for a visual evaluation of the underlying aquifer area. The resultant favorable-area GIS file generated by scenario is titled "aq-dvlp-flp-wtld-rsvr-rds.shp". The WHPA file, "SeacoastWHPA_Oct04.shp", is used to fade the aquifer areas excluded by all of the WHPA's. The Phase 1 Favorable Zone Map 2 also displays areas that are identified to be either cleared land, hay/pasture land, or row crops, based on the 2001 Landsat Imagery. These are areas can help target and rank favorable areas in the Phase 2 Zone Ranking Process as more detailed evaluations of the recharge and reuse option proceed.

Generally, the aquifer areas that may be suitable for groundwater recharge were considerably fragmented by the roads and development criteria. However, many potentially favorable areas are still present and may prove to be viable locations for wastewater reuse and groundwater recharge applications. For example, there are many unfragmented areas of sufficient size (e.g. greater than 20 acres) that were identified through this Phase 1 Favorable Zone Identification process. There are many factors that need to be considered to assess the potential of any of the remaining areas.

PHASE 2 ZONE RANKING PROCESS

In order to prioritize the aquifer areas identified in Phase 1 in terms of their favorability for groundwater recharge, a number of additional factors might be assessed. Essentially a ranking of each of the potential areas can be developed to objectively determine the most promising areas by scoring these factors in a systematic manner.

The factors that might be evaluated for each of the areas identified in Phase 1, at a minimum, should include:

- Area of Unfragmented Land
- Current Land Use
- Transmissivity
- Unsaturated Thickness
- Proximity to Nearest Surface Water

- Proximity to Existing Water Supply (Public and Domestic)
- Land Protection Status
- Topography
- Distance from Wastewater Treatment Plant

Each of these criteria can be evaluated with available GIS data, though some limited ground-truthing would help to ensure accuracy with respect to the current land use, although budgetary constraints may preclude this.

The WHPA's applied in Phase 1 should be used as a factor in the ranking process. The large areas removed by the established WHPA's may be excessively restrictive at this point in the evaluation process. According to the Metcalf & Eddy table, "Wastewater Discharge Land Application Reuse and Recharge Effluent Permit Limits for Plant Evaluations", a 500-foot setback for groundwater recharge through ground-surface application may be all that is required. A thorough assessment of the flow paths to water supply wells from ground-surface application of wastewater would need to be performed at a later time in the evaluation process.

The Phase 2 Zone Ranking Process will result in a prioritized list of potential areas that will ultimately need a Preliminary Site Evaluation (Phase 3). Factors that will need to be assessed further include property parcel sizes, ownership, property availability, and sensitive receptors (endangered/threatened species, protected watersheds, Prime wetlands, etc...).

As a next step, we would like to review this process and the results with the project team and as appropriate, finalize the Phase 2 criteria and approach. Dave Mitchell will be in touch to make these arrangements. In the interim, please do not hesitate to call with any questions or comments.

Sincerely,

John J. Donohue, IV /d

Albert N. Pratt
Water Resources Specialist

John J. Donohue IV
Vice President
Hydrogeology and Water Supply

j:\01 ensr projects\nh seacoast wastewater management study\phase 1 summary letter.doc

Enclosures: Phase 1 Favorable Zone Map 1
Phase 1 Favorable Zone Map 2
Attachments: Study Area Towns and USGS Quadrangle Names and ID Codes

cc: Dave Mitchell, ENSR

New Hampshire Seacoast Wastewater Management Study
GIS Data Provided by Metcalf Eddy, Inc.
Source: NH GRANIT

April 25, 2005

STUDY AREA TOWNS

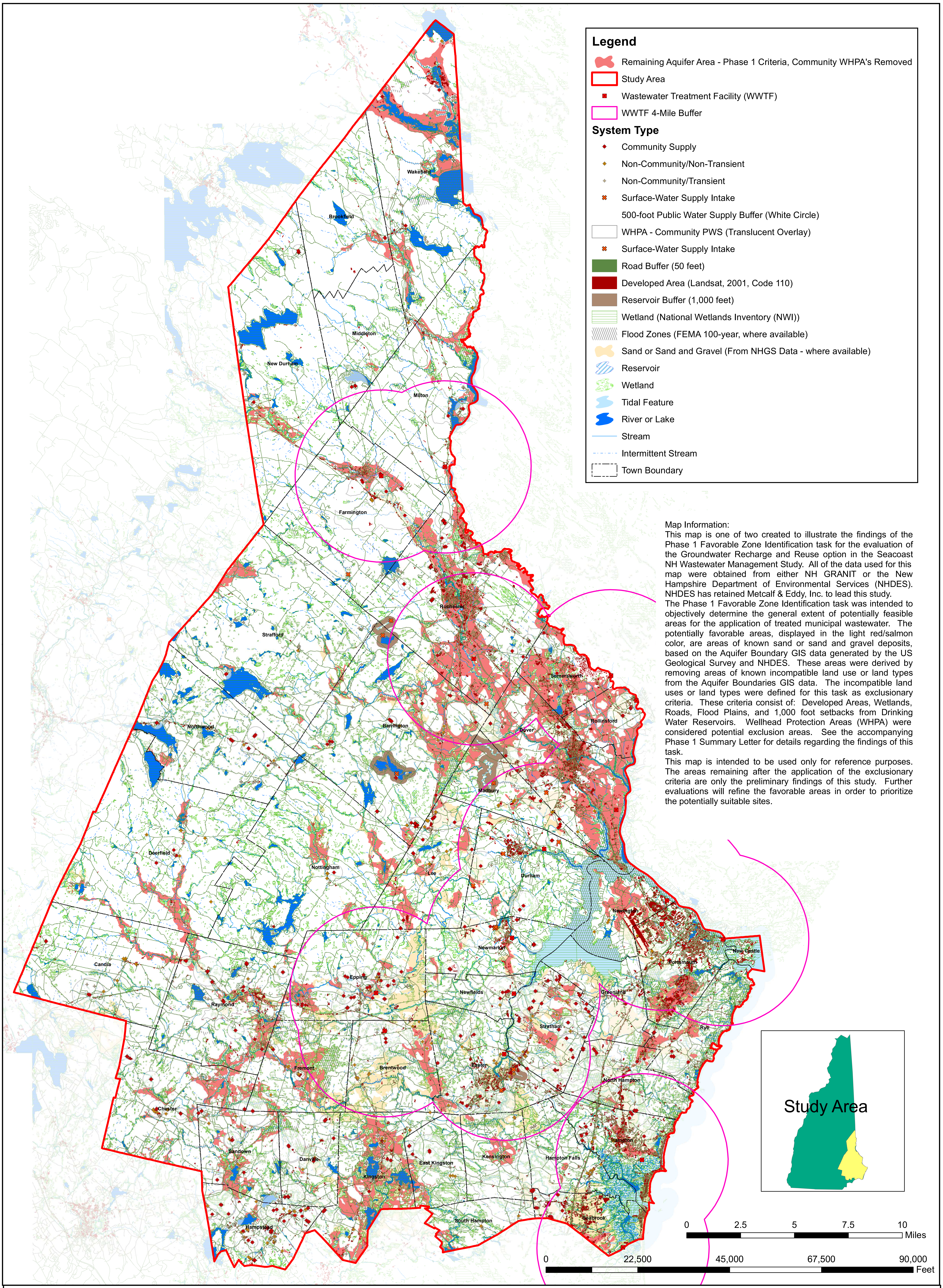
NAME	FIPS	Flood Data Available
Alton	1005	
Barrington	17005	X
Brentwood	15015	X
Brookfield	3015	X
Candia	15020	
Chester	15025	X
Danville	15030	
Deerfield	15035	
Derry	15040	X
Dover	17010	X
Durham	17015	X
East Kingston	15045	X
Epping	15050	
Exeter	15055	X
Farmington	17020	X
Fremont	15060	X
Greenland	15065	
Hampstead	15070	
Hampton	15075	
Hampton Falls	15073	
Kensington	15085	X
Kingston	15090	X
Lee	17025	
Madbury	17030	X
Middleton	17035	X
Milton	17040	X
New Castle	15100	
New Durham	17045	
Newfields	15105	
Newington	15110	X
Newmarket	15115	
North Hampton	15125	X
Northwood	15130	
Nottingham	15135	
Portsmouth	15145	X
Raymond	15150	X
Rochester	17050	X
Rollinsford	17055	X
Rye	15155	X
Sandown	15165	X
Seabrook	15170	
Somersworth	17060	X
South Hampton	15175	
Strafford	17065	
Stratham	15180	
Wakefield	3090	X

New Hampshire Seacoast Wastewater Management Study
GIS Data Provided by Metcalf Eddy, Inc.
Source: NH GRANIT

April 25, 2005

USGS Quadrangle Names and ID Codes

NAME	NH Quad ID
ALTON	126
BARRINGTON	154
BAXTER LAKE	140
CANDIA	166
DERRY	182
DOVER EAST	156
DOVER WEST	155
EPPING	168
EXETER	185
FARMINGTON	127
GILMANTON IRON WORKS	125
GOSSVILLE	152
GREAT EAST LAKE	115
HAMPTON	186
KINGSTON	184
KITTERY	171
MILTON	128
MT PAWTUCKAWAY	167
NEWMARKET	169
NORTHWOOD	153
OSSIPEE	101
PARKER MOUNTAIN	139
PORTSMOUTH	170
ROCHESTER	141
SANBORNVILLE	114
SANDOWN	183
WEST ALTON	112
WEST NEWFIELD	102
WOLFEBORO	113



Map Information:
This map is one of two created to illustrate the findings of the Phase 1 Favorable Zone Identification task for the evaluation of the Groundwater Recharge and Reuse option in the Seacoast NH Wastewater Management Study. All of the data used for this map were obtained from either NH GRANIT or the New Hampshire Department of Environmental Services (NHDES). NHDES has retained Metcalf & Eddy, Inc. to lead this study.

The Phase 1 Favorable Zone Identification task was intended to objectively determine the general extent of potentially feasible areas for the application of treated municipal wastewater. The potentially favorable areas, displayed in the light red/salmon color, are areas of known sand or sand and gravel deposits, based on the Aquifer Boundary GIS data generated by the US Geological Survey and NHDES. These areas were derived by removing areas of known incompatible land use or land types from the Aquifer Boundaries GIS data. The incompatible land uses or land types were defined for this task as exclusionary criteria. These criteria consist of: Developed Areas, Wetlands, Roads, Flood Plains, and 1,000 foot setbacks from Drinking Water Reservoirs. Wellhead Protection Areas (WHPA) were considered potential exclusion areas. See the accompanying Phase 1 Summary Letter for details regarding the findings of this task.

This map is intended to be used only for reference purposes. The areas remaining after the application of the exclusionary criteria are only the preliminary findings of this study. Further evaluations will refine the favorable areas in order to prioritize the potentially suitable sites.

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Prepared For:

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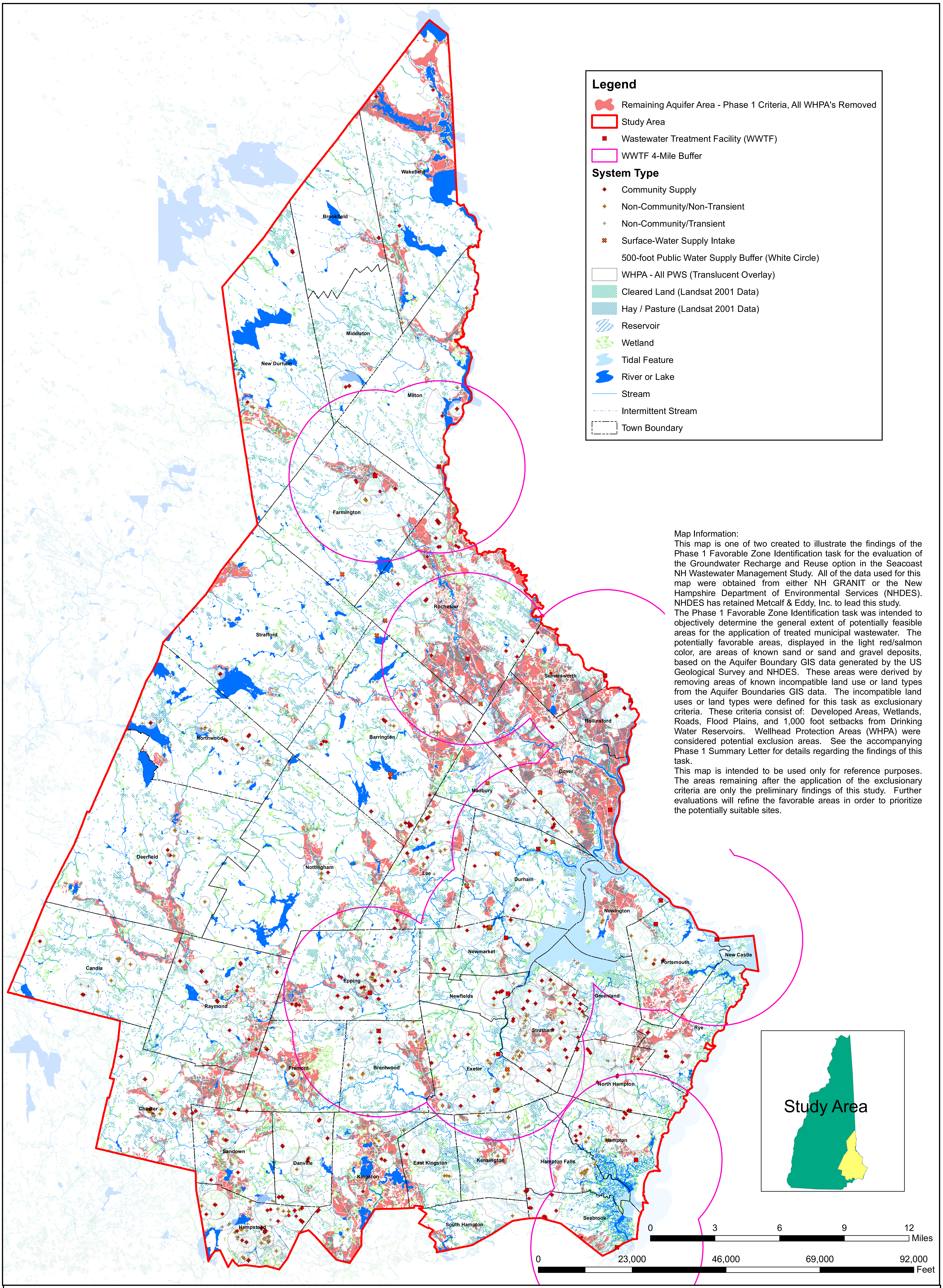
Wakefield, MA 01880-5371

May 31, 2005

PHASE 1 FAVORABLE ZONE MAP 1

Groundwater Recharge and Reuse Option

New Hampshire Seacoast Region
Wastewater Management Study



Map Information:
This map is one of two created to illustrate the findings of the Phase 1 Favorable Zone Identification task for the evaluation of the Groundwater Recharge and Reuse option in the Seacoast NH Wastewater Management Study. All of the data used for this map were obtained from either NH GRANIT or the New Hampshire Department of Environmental Services (NHDES). NHDES has retained Metcalf & Eddy, Inc. to lead this study.
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May 31, 2005

PHASE 1 FAVORABLE ZONE MAP 2

Groundwater Recharge and Reuse Option

New Hampshire Seacoast Region
Wastewater Management Study

APPENDIX F

GROUNDWATER RECHARGE AND REUSE,

PHASE 2 – LAND APPLICATION FEASIBILITY RANKING

November 6, 2006

Method of Transmission

Via E-Mail

New Hampshire Seacoast Project Team
c/o Matthew Formica
Metcalf & Eddy, Inc.
701 Edgewater Drive
Wakefield, MA 01880

Subject: **Phase 2 Methodology, Land Application Feasibility Ranking,**
New Hampshire Seacoast Wastewater Management Study
Groundwater Recharge and Reuse Option

Dear Team Members:

ENSR is proposing the following revised Phase 2 Methodology, Land Application Feasibility Ranking, as part of its support for the New Hampshire Seacoast Wastewater Management Study overseen by Metcalf & Eddy, Inc. (M&E). This proposed Phase 2 Methodology, which addresses and incorporates the comments provided by M&E on the July 22, 2006 draft methodology, will be used to further evaluate wastewater management alternatives selected in the March 25, 2006 "Charette" meeting facilitated by M&E; specifically, *Alternative 4 – Treatment at Existing WWTFs and Discharge at Land Application Sites* (formerly presented as Alternative No. 3 in the *Scope of Work for Feasibility Study for a Regional Outfall Sewer System, May 27, 2004*).

The Phase 1 Favorable Zone Identification Study conducted by ENSR in April 2005 resulted in maps of areas in the study area that may be suitable for the land application alternative. The Phase 1 Study excluded areas within mapped sand and gravel aquifers that were identified to be urban areas, wetlands, roads, within a flood plain, within an established well-head protection area, or within 1,000 feet of a drinking-water reservoir. The areas that remained after this exclusionary criterion was applied are considered candidate areas worthy of further study.

In order to further evaluate the candidate areas identified in Phase 1, the following prioritization method is proposed as the Phase 2, Land Application Feasibility Ranking.

The proposed evaluation process consists of:

1) The scoring and ranking of candidate areas based on the following characteristics:

   a) Distance from wastewater treatment facility (WWTF)
   b) Distance to surface water
   c) Transmissivity
   d) Distance to water supplies

2) The development of a map layer that identifies developed areas that were not excluded in Phase 1. This layer will be generated from the aerial photos taken in 2003 for the National Agricultural Imagery Program. These developed areas will be removed from the ranked candidate areas.
3) The minimum amount of land required by each wastewater treatment facility to make land disposal a feasible option will be used to remove the unsuitably small isolated fragments of land from the candidate areas. Minimum land area requirements are to be provided to ENSR from M&E.
4) Summaries of the candidate areas around each wastewater treatment facility will be provided in table and map forms, and will include a brief description of the remaining candidate areas around each WWTF, sizes of the areas and their respective ranking scores.

The results of this evaluation are not intended to determine the actual feasibility of the candidate areas for the land application disposal alternative. It is intended to generally assess the overall potential for this disposal alternative within the Study Area. Considerably more detailed investigations would be required to accurately assess the feasibility of individual candidate areas; however, this level of site-specific investigation is not within the scope of this project.

1) SCORING AND RANKING METHODOLOGY

Using the Geographic Information System (GIS), candidate areas will be scored using the following numbering scheme and ranked in order to evaluate the favorability of the areas near each of the wastewater treatment facilities with respect to their potential for the land application alternative. Scores for each of the characteristics, a through d, listed above will be applied to each of the candidate areas. The sums of the scores reflect the relative favorability of each of the areas. The areas will then be ranked by their overall score in order to prioritize the areas for further consideration. Study area maps and tables will be generated to assist with the feasibility evaluation. The candidate areas will be divided into three score categories, high, medium, and low, based on an equal division of the total range of scores. This division of the relative feasibility ranking will be referenced in the summaries.

The justification for the specific characteristic divisions and ranking values is presented below.

a) Distance from WWTF

The three ranking divisions are based upon the distances deemed appropriate for the geographic scale of study area. The distance categories were developed by Metcalf & Eddy, Inc. to account for the relative feasibility of pumping treated wastewater effluent with respect to its volume (projected average daily flow). Ranking scores were derived specifically for each WWTF based on distance/flow ratios. One point will be applied to candidate areas that are located beyond the distance that is calculated by multiplying 0.66 times the projected average daily flow (MGD). The resultant distance in miles is converted to feet in the attached table. Candidate areas located beyond these distances are considered to have low feasibility. For the eight smallest WWTF's in the study, the computed areas are unrealistically small, ranging from 188 feet to 1,812 feet, to be considered the only areas with a potentially high favorability. For these WWTF's, the final feasibility evaluation will consider candidate areas located within 4,000 feet of the facilities.

Three points will be applied to candidate areas that are located closer than the distance calculated by multiplying 0.33 times the projected average daily flow (MGD). These areas are considered to have the highest with respect to their distance from the WWTF. Two points will be applied to areas located between the 0.33x and 0.66x distances. These areas are considered to have moderate feasibility with respect to their distance from the WWTF.

See the attached table, *Phase 2 Land Application Alternative, Proposed Scoring for the Distance Criterion*, for specific distances used for scoring each candidate area with respect to each WWTF.

_b)_ Distance to Surface Water

The four ranking divisions are based upon the concept that the closer the site is to a surface water-body, the higher the likelihood that the groundwater flow direction is toward the water-body. The divisions also reflect the greater desirability of sites that have the potential receiving surface water-body within their property boundary, thus avoiding compliance issues regarding achievement of the groundwater quality standard at the property boundary.

o *Greater than 2,000 feet*	0
o *Between 2,000 and 1,000 feet*	1
o *Between 1,000 and 500 feet*	2
o *Within 500 feet*	3

c) Transmissivity

Category divisions are based on the "range" attribute codes that are published in the USGS stratified drift aquifer maps from which the GIS data was derived. The codes are grouped into three categories to simplify the scoring system while maintaining the inherent favorability of areas with higher transmissivities.

Values are assigned with a linear scale by generalized ranges of transmissivity.

o *Low Transmissivity*	*1*
o *Medium Transmissivity*	*2*
o *High Transmissivity*	*3*

d) Distance to Existing Water Supply *(Public)*

In Phase 1, properties within established well-head protection areas associated with community water supplies were eliminated. In Phase 2, the remaining candidate areas will be scored by their proximity to public water supplies. The category divisions are intended to promote areas that are further from public water supplies.

The categories are based on the 1,300 feet and 2,050 foot radii which relate to the NHDES proposed WHPA's for a 0 to 7,200 gallon per day withdrawal and a 14,401 to 28,800 gallon per day withdrawal, respectively. Actual withdrawal rates for these users are not available so these buffers are applied as a preliminary recognition of their potential influence on the candidate areas.

o *Within established WHPA*	Excluded in Phase 1
o *Less than 1,300 feet from PWS**	0
o *Between 1,300 and 2,050 feet from PWS**	1
o *Greater than 2,050 feet from PWS**	2

**Public Water Supply (PWS), including community, non-community, transient and non-transient sources. A 500 foot buffer area around all of the wells in the inventory, and areas within established wellhead protection areas have been removed from consideration during the Phase 1 process.*

2) LAND DEVELOPMENT DATA

In the Phase 1 Favorable Zone Study, the developed land areas that were removed from consideration were based on Landsat Thematic Mapper(TM) imagery collected between 1990 and 2001. This data was developed from satellite images and has a pixel size of 30 meters. More accurate developed land data is necessary to truly evaluate the candidate areas in this study. A preliminary review of the candidate areas overlaid upon a 2003 aerial photo revealed many areas that would be infeasible due to presence of buildings and pavement. In order to revise the candidate area boundaries, GIS polygons will be generated where development is apparent in the 2003 aerial photos (National Agricultural Imagery Program).

3) ELIMINATION OF SMALL ISOLATED AREAS

Using the minimum land area requirements for each of the WWTF's, that are to be provided to ENSR from M&E, the candidate areas will be modified by eliminating the isolated insufficiently small areas and the grouping of otherwise small areas that are within close proximity (i.e., cut by a 100 ft road buffer). Comparisons with the minimum land area requirements will also be made to evaluate the feasibility of the candidate areas surrounding the WWTF's.

4) SUMMARY MAPS AND TABLES

The final products of the Phase 2 ranking process will include:

a) 1 Study Area Map Including:
    i. Study Area Boundaries
    ii. Town Boundaries
    iii. Major Roads
    iv. WWTF Locations (Color coded to indicate whether any candidate areas are located within the ‘0.66x’ distance, or 4,000 feet (which ever is further) from the WWTF.)

b) Maps of Individual WWTF’s Including:
    i. 2003 Aerial Base Map
    ii. WWTF Location
    iii. Final Candidate Areas (Color coded by relative feasibility (high, medium, and low))

c) Summary Table Including:
    i. WWTF Name
    ii. Total Size (in acres) of Candidate Areas within the ‘0.66x’ distance or 4,000 foot radius (which ever is greater) around the WWTF
    iii. Minimum land area required for the land disposal alternative (to be provided by M&E).
    iv. Percents of Candidate Areas around the WWTF categorized by high, medium, and low feasibility based on their ranking.
    v. Brief Description of Candidate Areas around each WWTF
    vi. Total Size of Candidate Areas within Study Area

Thank you for your consideration of this proposed approach to Phase 2. Any comments or suggestions would be appreciated before we proceed.

Sincerely,

Albert N. Pratt Water Resources Specialist	John J. Donohue IV Vice President Hydrogeology and Water Supply

cc: Dave Mitchell, ENSR
Project Files

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CANDIDATE AREA TABLE 1

NEW HAMPSHIRE SEACOAST REGION WASTEWATER MANAGEMENT STUDY

SUMMARY OF LAND AREAS POTENTIALLY SUITABLE FOR LAND APPLICATION OF TREATED WASTEWATER

					Ranking of Land Application Favorability					
					Highest Ranked Areas Score 10 & 11 points		Medium Ranked Areas Score 8 & 9 points		Lowest Ranked Areas Score 2 through 7 points	
	FACILITY	2055 Total Land Needed (Acres)	Total Land Area Remaining Near WWTF (Acres)*	Radius used for Facility Specific Ranking Summaries (Feet)	Acres	Percent of Total Area Remaining Near WWTF	Acres	Percent of Total Area Remaining Near WWTF	Acres	Percent of Total Area Remaining Near WWTF
1	DOVER WASTEWATER	96.1	1,731.3	9,932	165.3	9.5%	1,260.7	72.8%	305.2	17.6%
2	DURHAM WASTEWATER	37.8	0.0	4,000						
3	EPPING WATER & SEWER	8.1	56.8	4,000	0.0	0.0%	1.5	2.6%	55.3	97.4%
4	EXETER WASTEWATER	72.5	0.0	7,318						
5	FARMINGTON WASTEWATER	10.4	33.6	4,000	0.0	0.0%	5.1	15.2%	28.5	84.8%
6	HAMPTON WASTEWATER	97.7	0.0	9,757						
7	MILTON WASTEWATER	2.4	66.0	4,000	0.0	0.0%	21.1	32.0%	44.9	68.0%
8	NEWFIELDS WASTEWATER	2.1	0.0	4,000						
9	NEWINGTON WASTEWATER	6.2	0.0	4,000						
10	NEWMARKET WASTEWATER	27.1	26.5	4,000	0.0	0.0%	1.9	7.2%	24.6	92.8%
11	PEASE DEVELOPMENT AUTHORITY	21.8	29.7	4,000	0.0	0.0%	0.0	0.0%	29.7	100.0%
12	PORTSMOUTH WASTEWATER	176.4	230.4	18,121	0.0	0.0%	113.3	49.2%	117.1	50.8%
13	ROCHESTER WASTEWATER	129.2	3,169.0	12,197	809.3	25.5%	1,943.7	61.3%	415.8	13.1%
14	ROCKINGHAM COUNTY WWTF	4.5	0.0	4,000						
15	ROLLINSFORD WASTEWATER	4.5	24.9	4,000	0.0	0.0%	9.6	38.6%	15.3	61.4%
16	SEABROOK WASTEWATER	42.5	13.1	4,182	0.0	0.0%	11.2	85.5%	1.9	14.5%
17	SOMERSWORTH WASTEWATER	44.1	164.2	4,530	6.4	3.9%	134.7	82.0%	23.1	14.1%
		sum**:	5,545.5							

* Total land area remaining within 4,000 feet or the 0.66x distance factor, whichever is larger. The 0.66x distance factor is derived by multiplying 0.66 times the projected average daily flow in MGD, and converting the resultant value from miles to feet. This factor is intended to represent the maximum distance reasonable for transporting treated wastewater for disposal.

** The total candidate land area within the study area that remained after the Phase 1 criteria were applied totals 37,902 acres. Of this area, 5,545.5 acres were located within the radii used for the facility ranking process.

CANDIDATE AREA TABLE 2

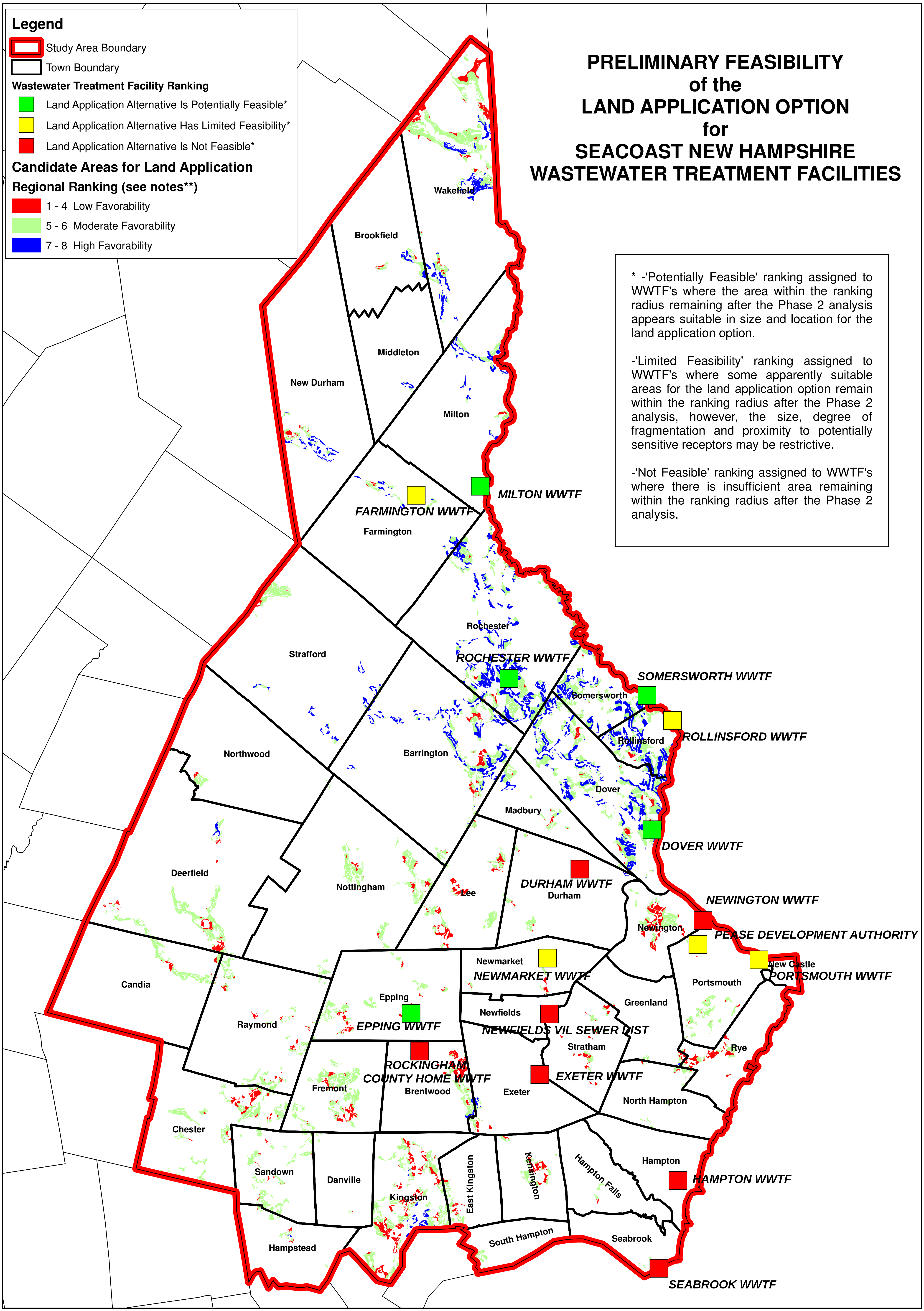
NEW HAMPSHIRE SEACOAST REGION WASTEWATER MANAGEMENT STUDY

SUMMARY OF LAND AREAS POTENTIALLY SUITABLE FOR LAND APPLICATION OF TREATED WASTEWATER

FACILITY		POTENTIALLY SUITABLE AREAS*	DESCRIPTION OF CANDIDATE AREAS
1	DOVER WASTEWATER	Yes	A sufficient area for land disposal appears to exist near the treatment plant. Much of the land appears to be forested or in use for agriculture.
2	DURHAM WASTEWATER	No	No candidate areas are located near WWTF. The nearest potentially suitable area is located between 2 and 3 miles east of the WWTF on conservation land.
3	EPPING WATER & SEWER	Yes	Potentially suitable area surrounds the WWTF, however residential development may limit the feasibility of the land application alternative.
4	EXETER WASTEWATER	No	No candidate areas are located near the WWTF. The nearest potentially suitable area, located approximately 2.4 miles east of the WWTF, was ranked with primarily low scores.
5	FARMINGTON WASTEWATER	Limited	Remaining candidate areas are fragmented and are located on an aquifer may support nearby public water supplies.
6	HAMPTON WASTEWATER	No	No candidate areas are located near the WWTF. The nearest potentially suitable area is located between 2.5 and 4.0 miles southeast of the WWTF.
7	MILTON WASTEWATER	Yes	Potentially suitable area surrounds the WWTF. Potentially suitable areas south of the WWTF are fragmented by residential development.
8	NEWFIELDS WASTEWATER	No	No candidate areas are located near the WWTF. The nearest potentially suitable area is located approximately 2 miles east of the WWTF.
9	NEWINGTON WASTEWATER	No	No candidate areas are located near the WWTF. The nearest potentially suitable area is located 2.5 and 3 miles west of the WWTF.
10	NEWMARKET WASTEWATER	Limited	The suitability of the candidate areas located near the WWTF are limited by their relatively small size and fragmentation due to development. The nearest potentially suitable area is located between 1.5 and 2.0 miles north north-west of the WWTF.
11	PEASE DEVELOPMENT AUTHORITY	Limited	Remaining candidate areas are surrounded by developed areas and are relatively small with respect to the projected land requirements.
12	PORTSMOUTH WASTEWATER	Limited	Remaining candidate areas, located between 2.2 and 3.5 miles southwest of the WWTF, are fragmented and surrounded by developed areas.
13	ROCHESTER WASTEWATER	Yes	Many potentially suitable candidate areas are located within 2 miles of the WWTF.
14	ROCKINGHAM COUNTY WWTF	No	No candidate areas are located near the WWTF. The nearest potentially suitable area is located approximately 2 miles southeast of the WWTF.
15	ROLLINSFORD WASTEWATER	Limited	No candidate areas are located near the WWTF. The nearest potentially suitable area is located approximately 0.8 miles northwest of the WWTF.
16	SEABROOK WASTEWATER	No	No candidate areas are located near the WWTF.
17	SOMERSWORTH WASTEWATER	Yes	Potentially suitable areas are located within 1 mile southwest of the WWTF.

* Preliminary suitability determination based only upon criteria established through this study (see "Phase 2 Methodology, Land Application Feasibility Ranking, NH Seacoast Wastewater Study, Groundwater Recharge and Reuse Option", ENSR, November 2006).

PRELIMINARY FEASIBILITY
of the
LAND APPLICATION OPTION
for
SEACOAST NEW HAMPSHIRE
WASTEWATER TREATMENT FACILITIES



Legend

🟥 Study Area Boundary
☐ Town Boundary

Wastewater Treatment Facility Ranking

🟩 Land Application Alternative Is Potentially Feasible*
🟨 Land Application Alternative Has Limited Feasibility*
🟥 Land Application Alternative Is Not Feasible*

Candidate Areas for Land Application

Regional Ranking (see notes)**

🟥 1 - 4 Low Favorability
🟩 5 - 6 Moderate Favorability
🟦 7 - 8 High Favorability

* -'Potentially Feasible' ranking assigned to WWTF's where the area within the ranking radius remaining after the Phase 2 analysis appears suitable in size and location for the land application option.

-'Limited Feasibility' ranking assigned to WWTF's where some apparently suitable areas for the land application option remain within the ranking radius after the Phase 2 analysis, however, the size, degree of fragmentation and proximity to potentially sensitive receptors may be restrictive.

-'Not Feasible' ranking assigned to WWTF's where there is insufficient area remaining within the ranking radius after the Phase 2 analysis.

**Notes:
This map was prepared for the preliminary feasibility assessment of the Land Application Option in the Seacoast Wastewater Management Study by ENSR for Metcalf & Eddy Inc. (M&E). This identification and ranking of potentially favorable candidate areas is based solely upon the set of criteria used in the study as detailed in the "Phase 2 Methodology, Land Application Feasibility Ranking, New Hampshire Seacoast Wastewater Management Study, Groundwater Recharge and Reuse Option" letter to M&E from ENSR, dated November 6, 2006. See the "Candidate Area Tables 1 and 2" for information regarding the ranked areas.

The displayed ranking does not include the factor associated with the distance from the WWTF.

This map is intended for general reference purposes only within the context of the criteria and data used for its preparation.

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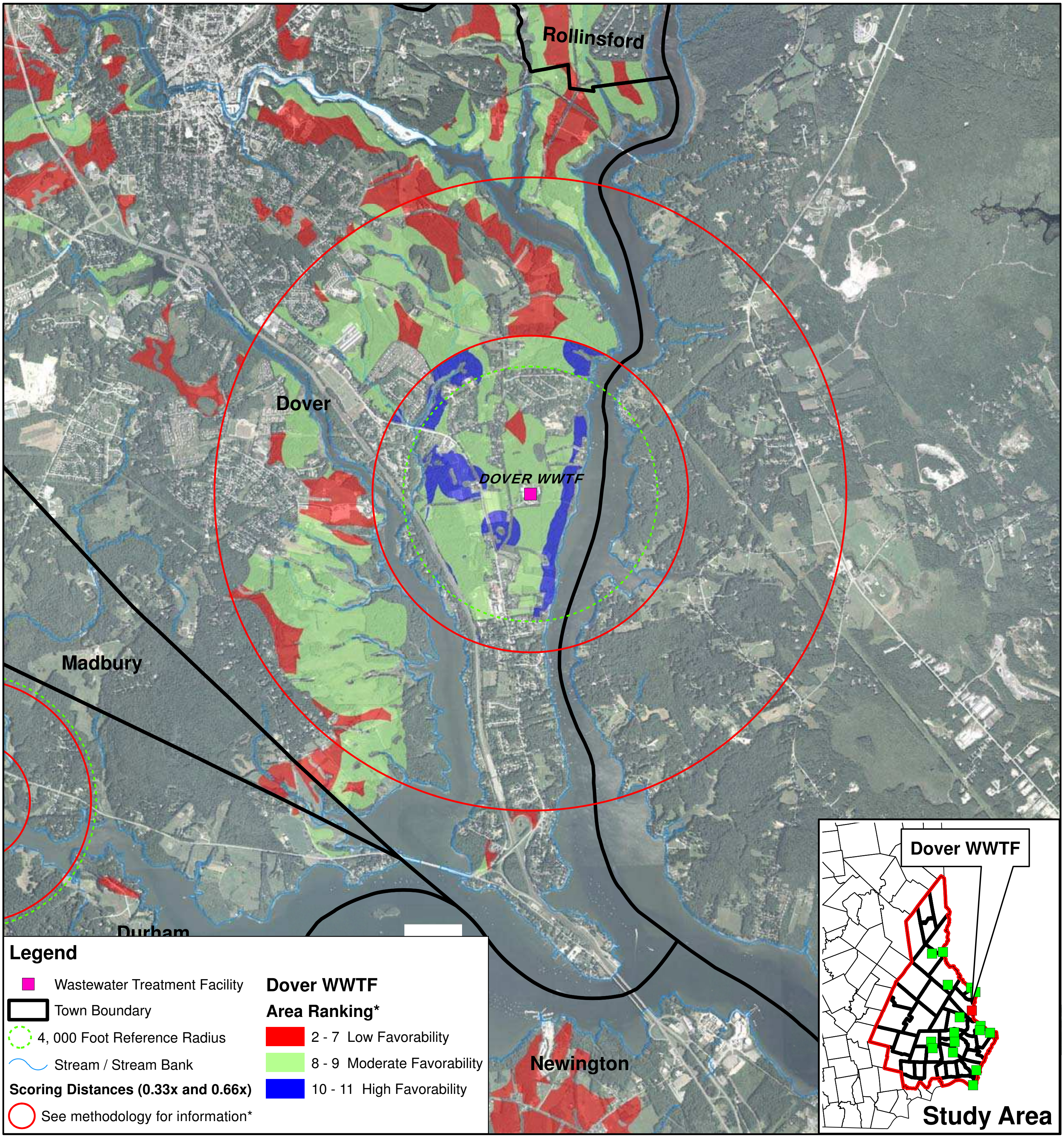

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Aerial photo base map created by the National Agricultural Imagery Program (NAIP), Aerial Photography Field Office, in 2003. Data obtained from NHGRANIT.

N

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DOVER WWTF
CANDIDATE AREAS
for the
LAND APPLICATION OPTION*

Feet
0 2,000 4,000 6,000 8,000

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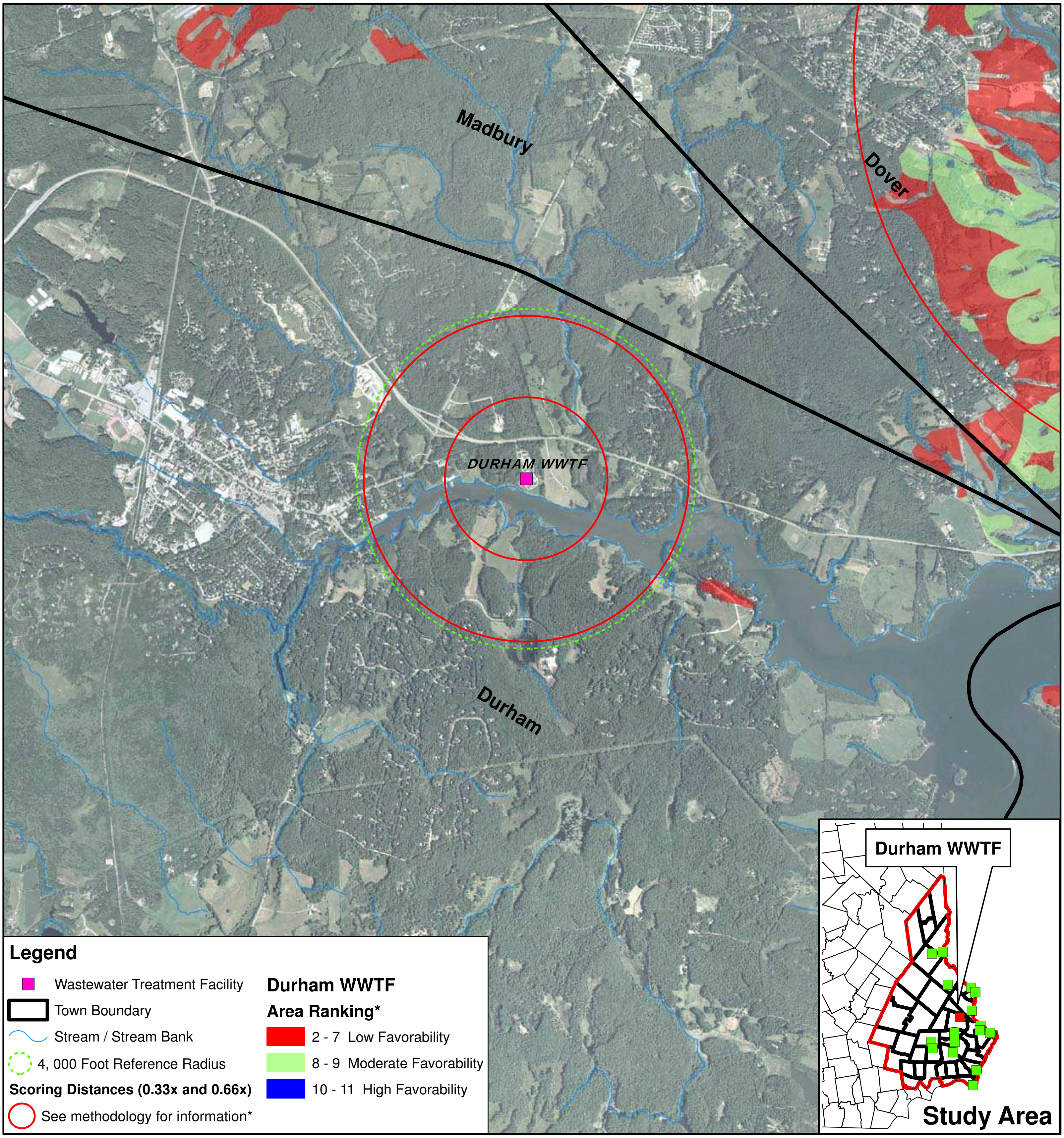

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DURHAM WWTF CANDIDATE AREAS for the LAND APPLICATION OPTION*

Feet
0 1,500 3,000 4,500 6,000

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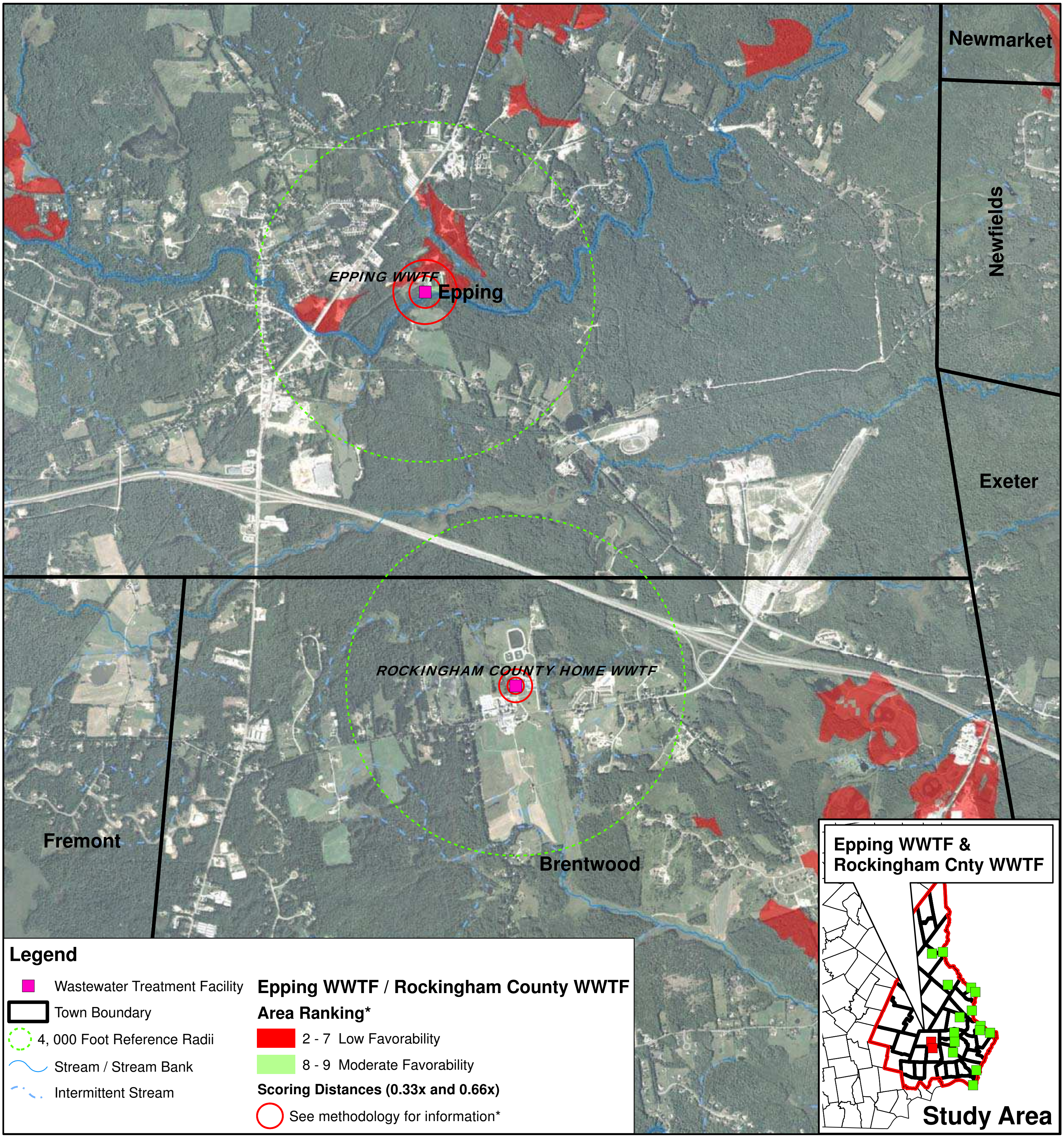

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EPPING WWTF & ROCKINGHAM COUNTY WWTF CANDIDATE AREAS for the LAND APPLICATION OPTION*

Feet
0 1,500 3,000 4,500 6,000

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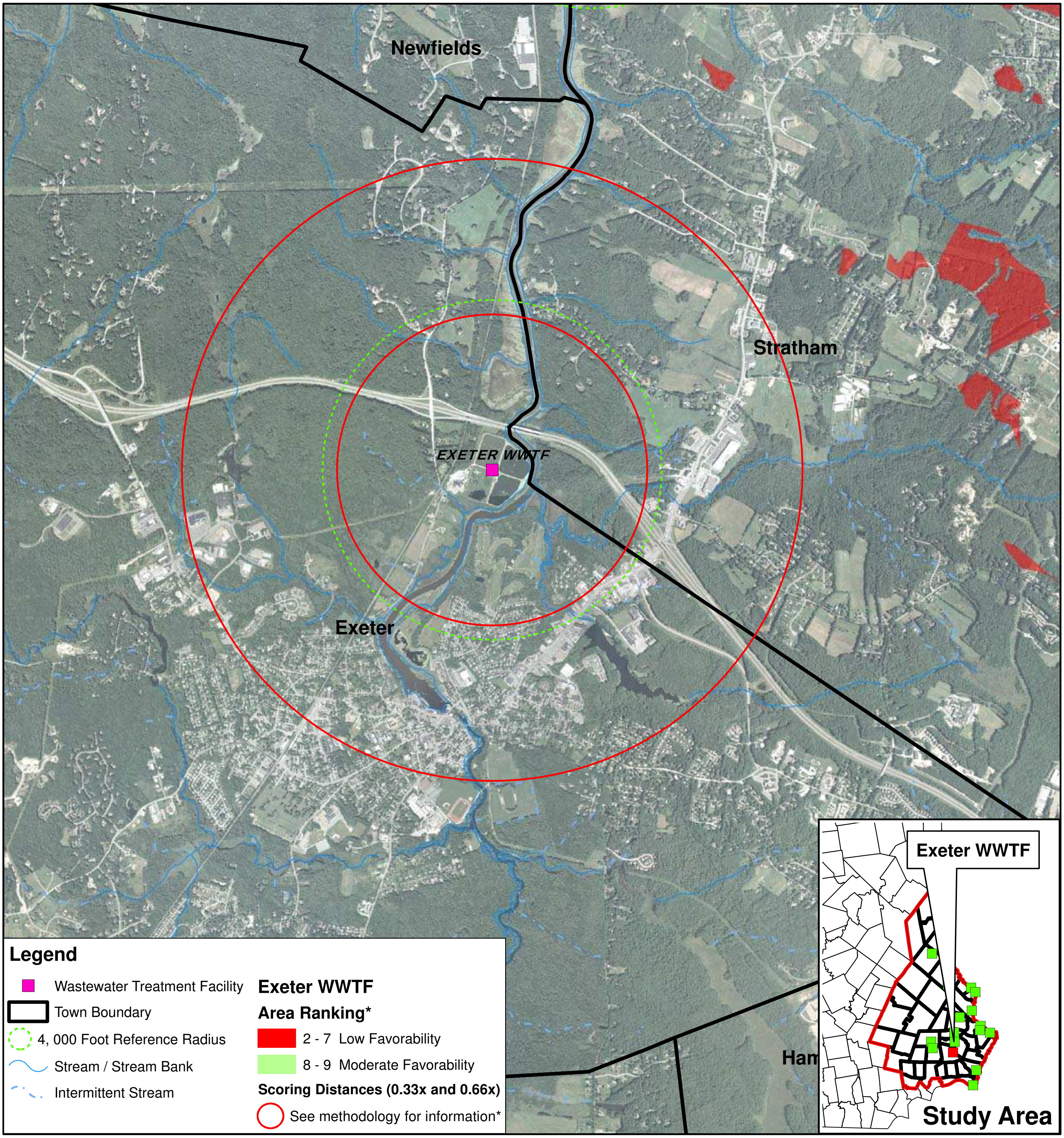

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EXETER WWTF CANDIDATE AREAS for the LAND APPLICATION OPTION*

Feet
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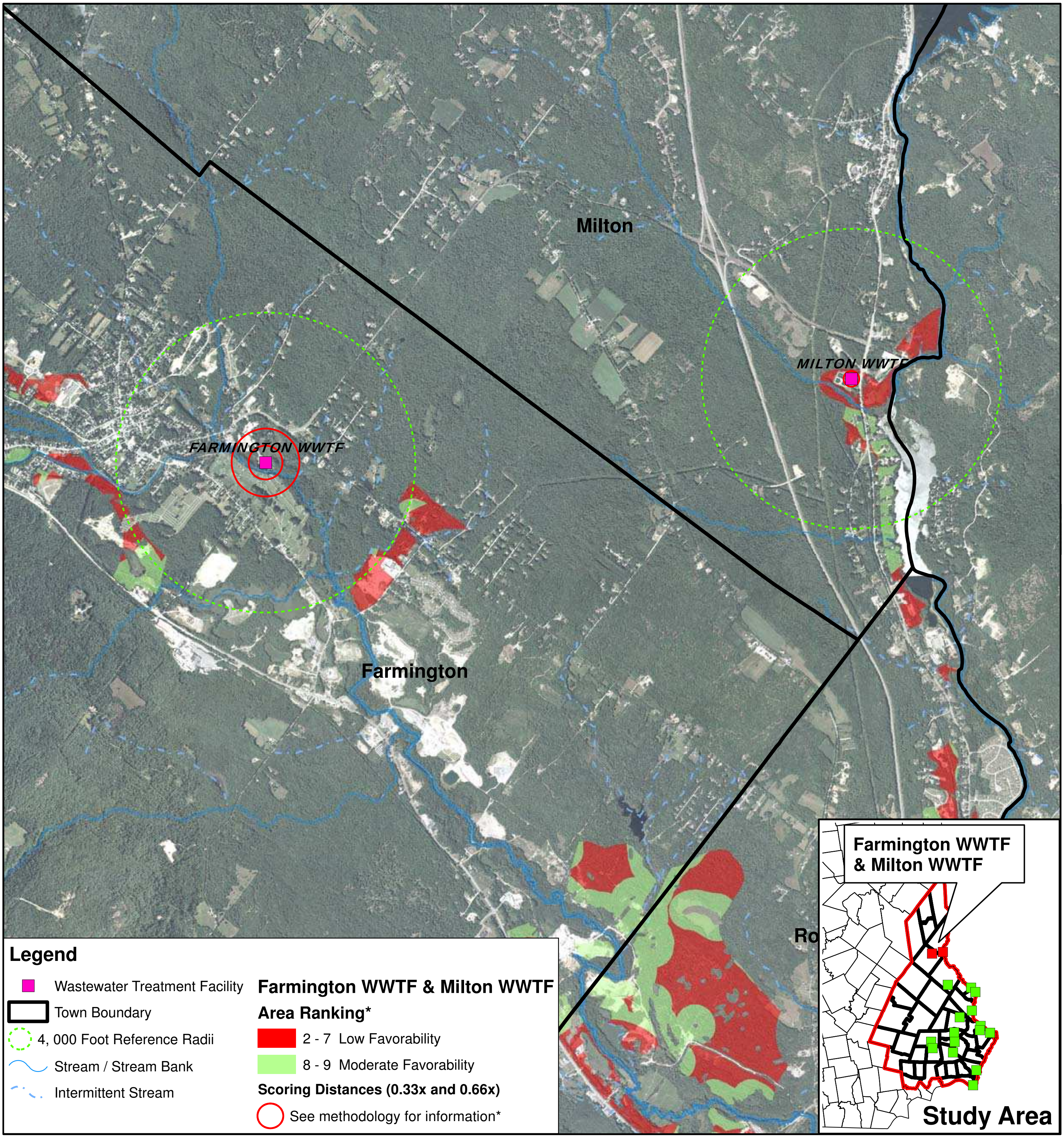

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N

Feet
0 1,700 3,400 5,100 6,800

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FARMINGTON WWTF
& MILTON WWTF
CANDIDATE AREAS
for the
LAND APPLICATION OPTION*

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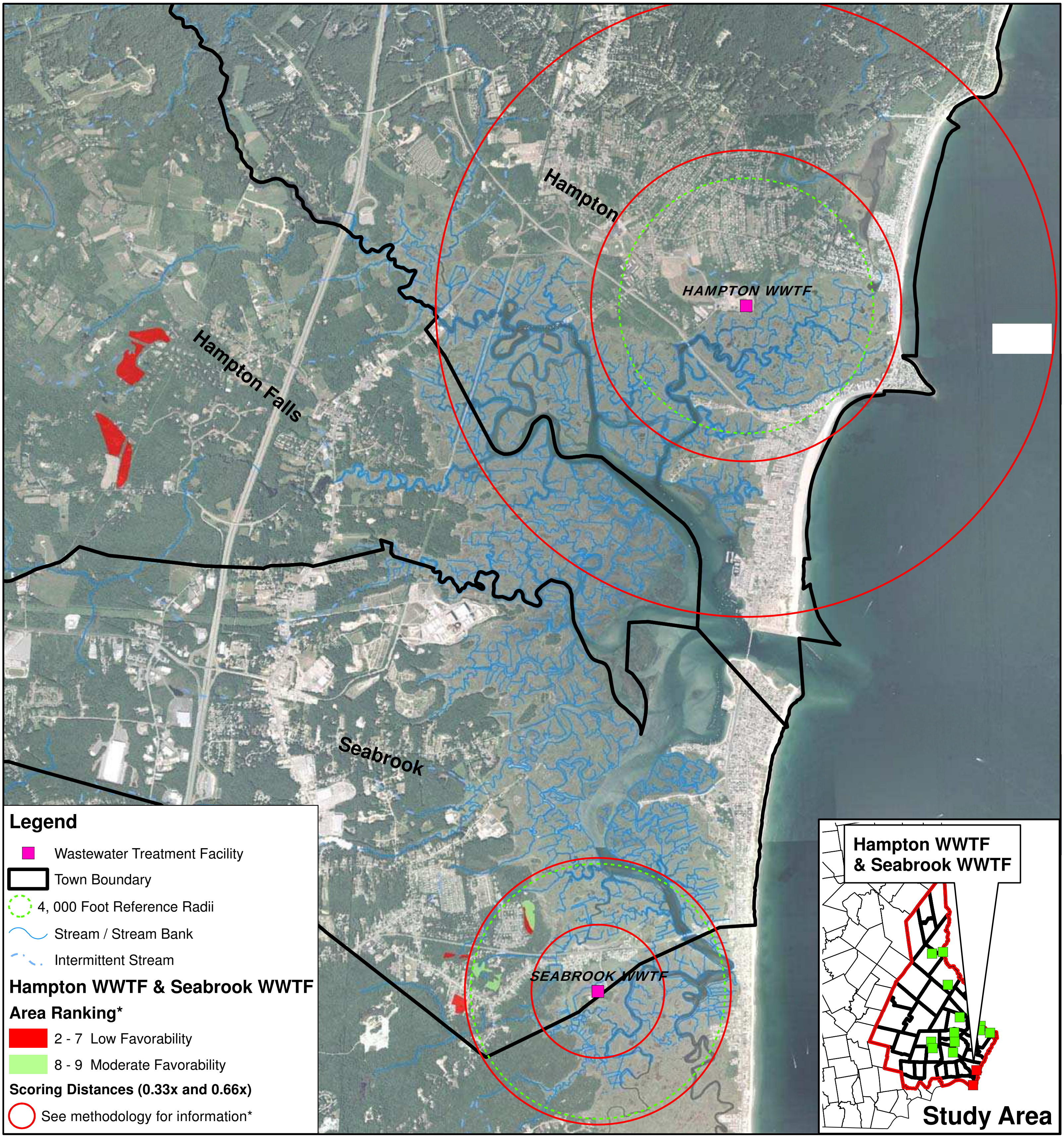

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HAMPTON WWTF & SEABROOK WWTF CANDIDATE AREAS for the LAND APPLICATION OPTION*

Feet
0 2,000 4,000 6,000 8,000

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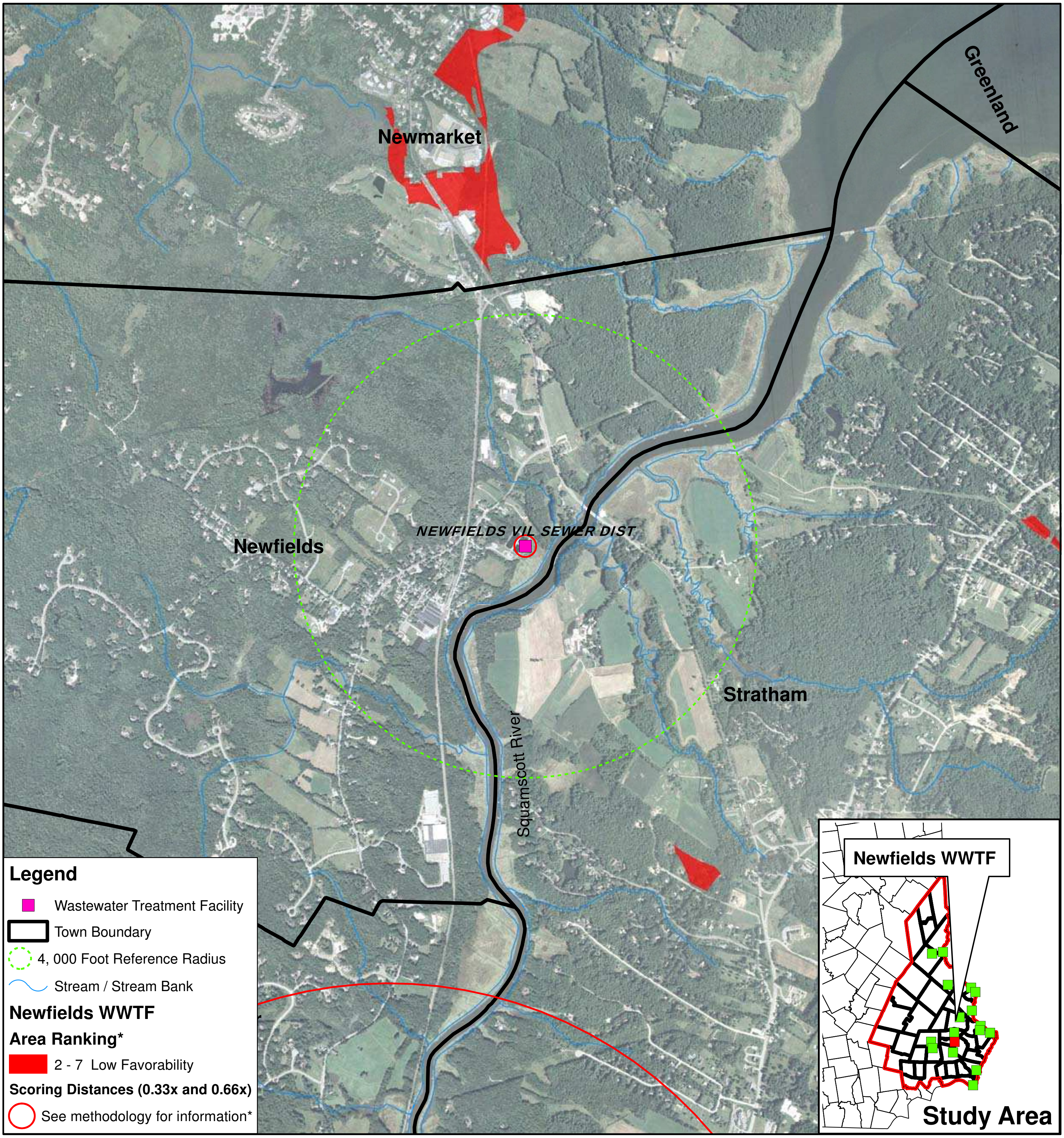

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NEWFIELDS WWTF CANDIDATE AREAS for the LAND APPLICATION OPTION*

Feet
0 1,100 2,200 3,300 4,400

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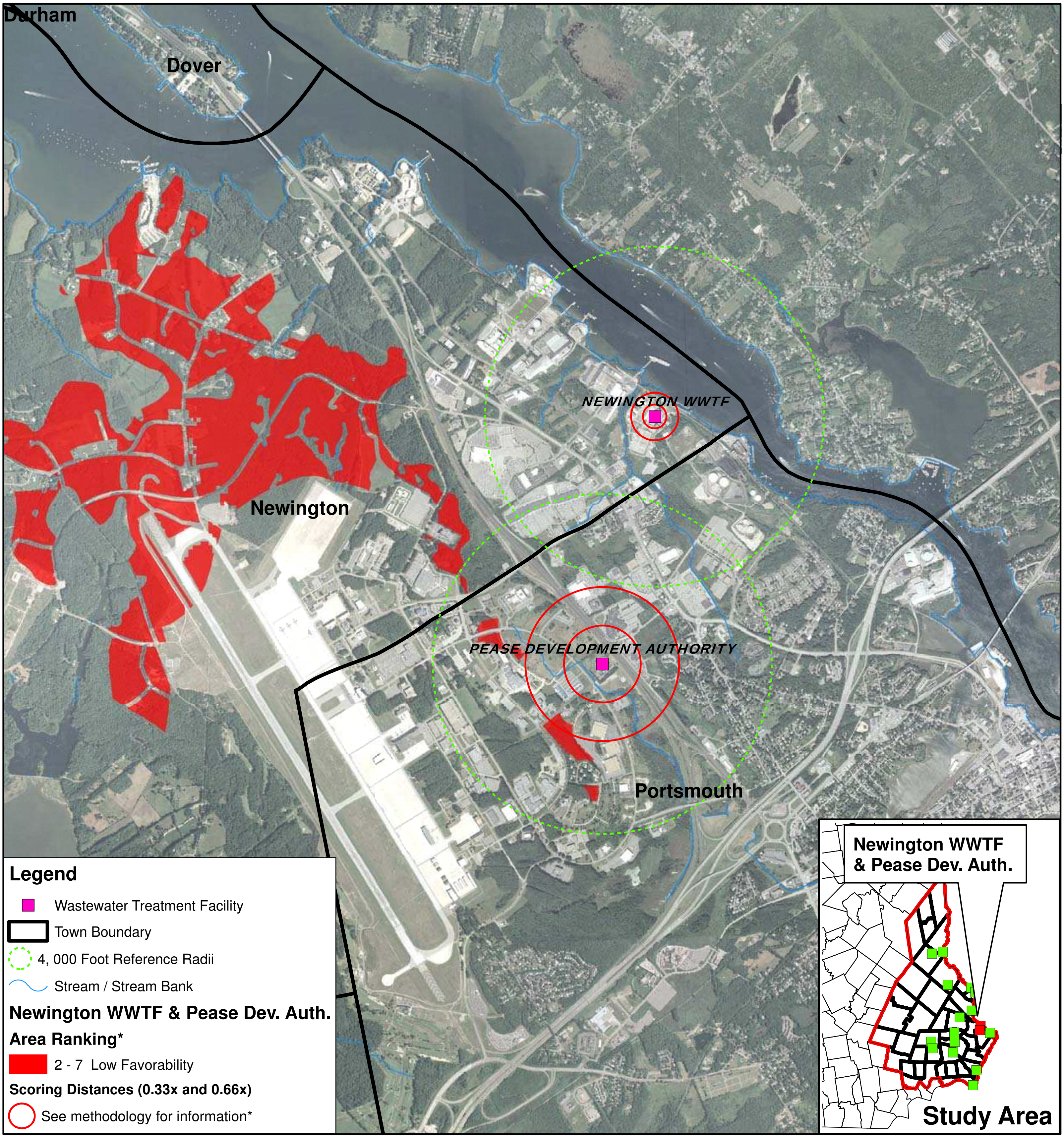

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NEWINGTON WWTF & PEASE DEVELOPMENT AUTHORITY CANDIDATE AREAS for the LAND APPLICATION OPTION*

Feet
0 1,500 3,000 4,500 6,000

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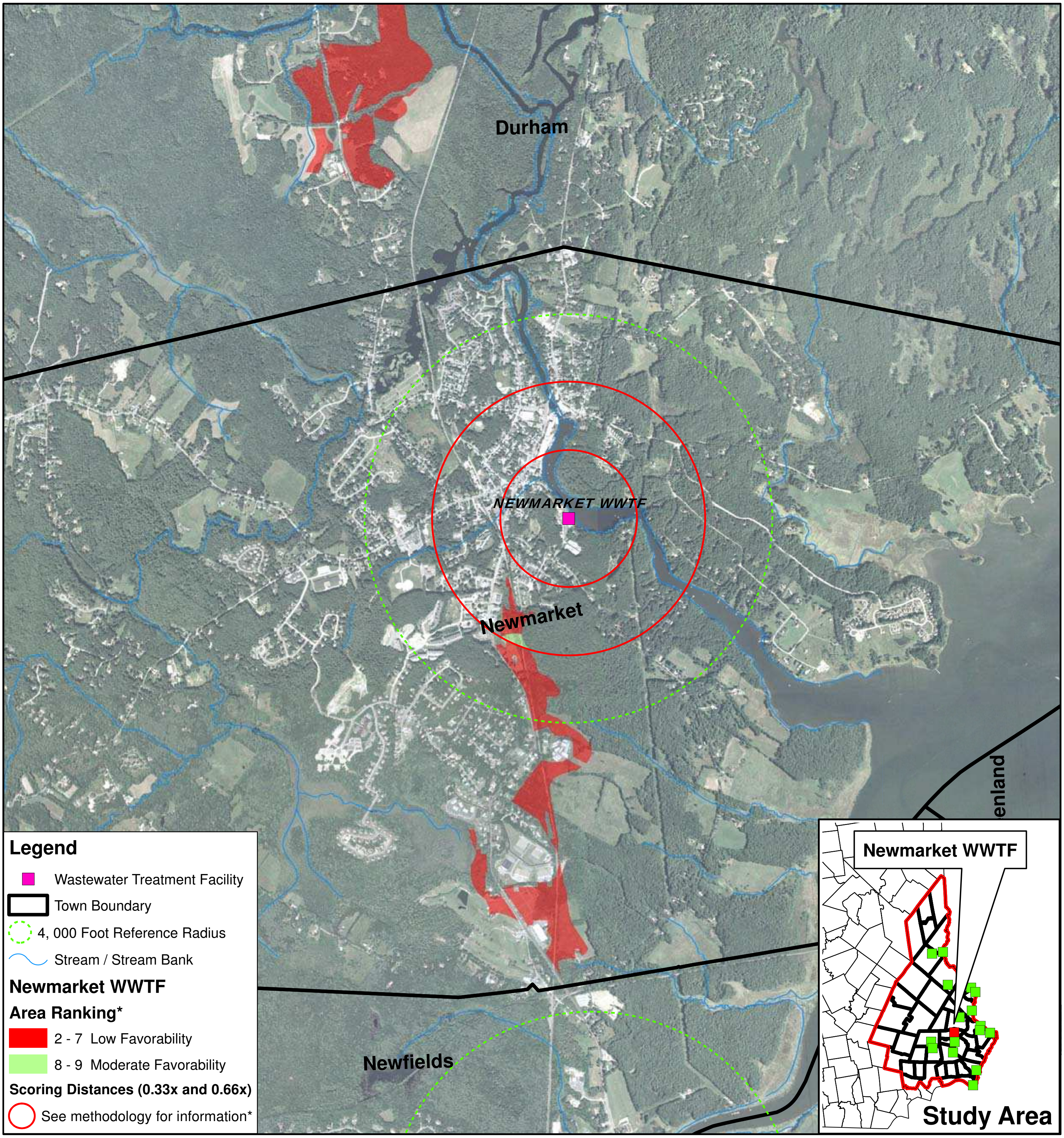

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NEWMARKET WWTF CANDIDATE AREAS for the LAND APPLICATION OPTION*

Feet
0 1,250 2,500 3,750 5,000

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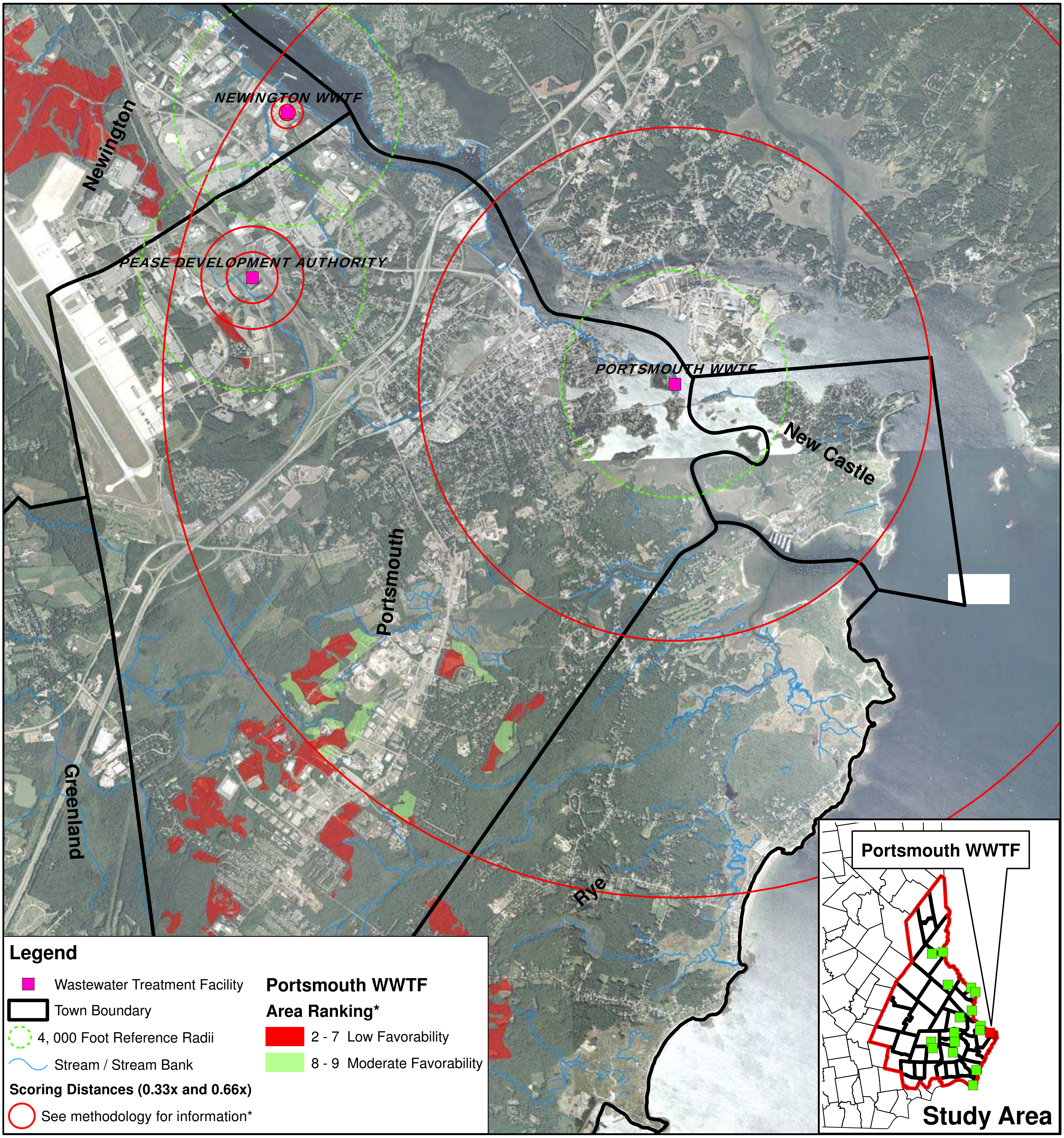

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DRAFT

PORTSMOUTH WWTF CANDIDATE AREAS for the LAND APPLICATION OPTION*

Feet
0 2,250 4,500 6,750 9,000

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February 2007

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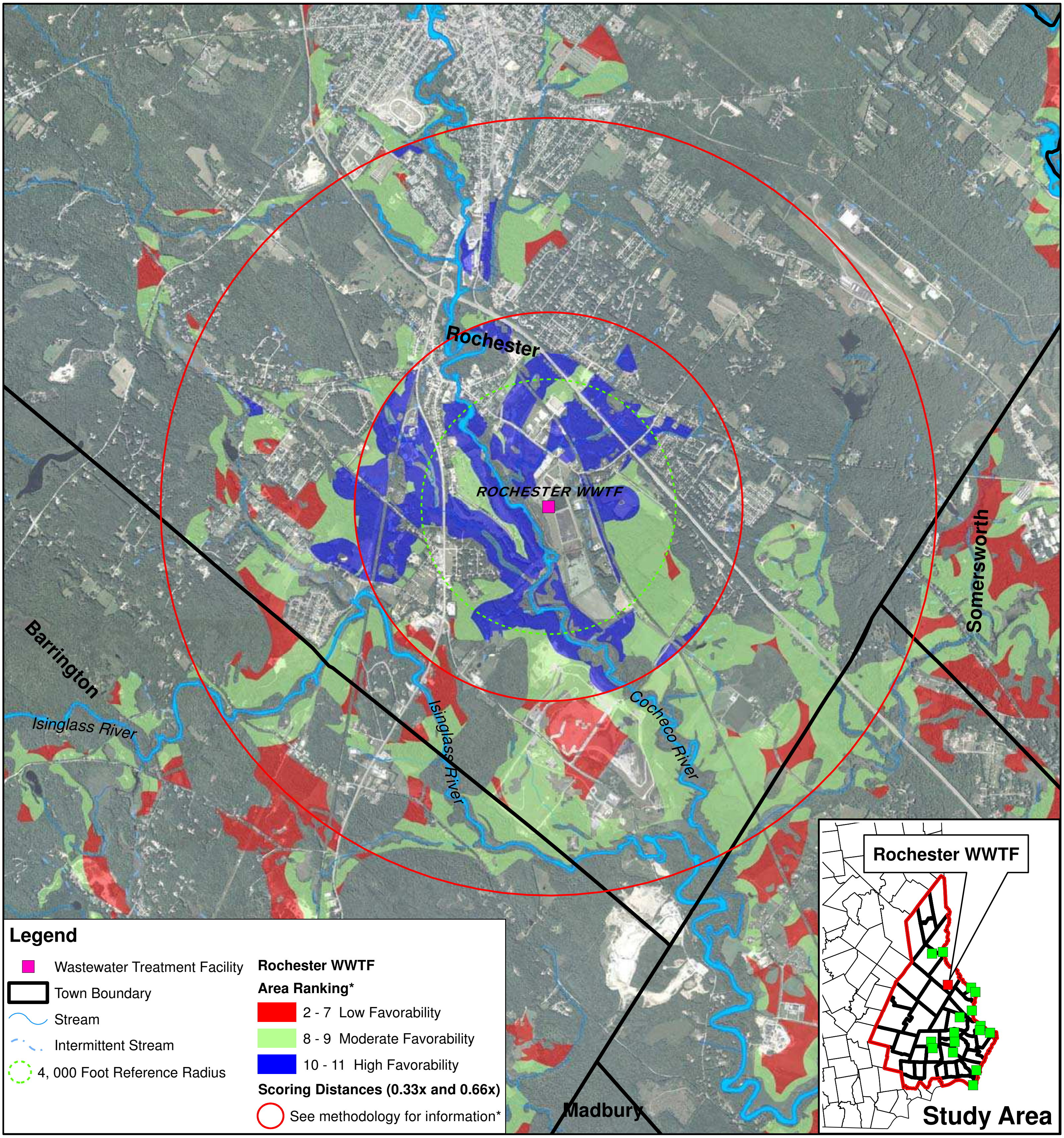

Legend

■ Wastewater Treatment Facility

Town Boundary

Stream

Intermittent Stream

4, 000 Foot Reference Radius

Rochester WWTF

Area Ranking*

🟥 2 - 7 Low Favorability

🟩 8 - 9 Moderate Favorability

🟦 10 - 11 High Favorability

Scoring Distances (0.33x and 0.66x)

○ See methodology for information*

*Note:
This map was prepared for the preliminary feasibility assessment of the Land Application Option in the Seacoast Wastewater Management Study by ENSR for Metcalf & Eddy Inc. (M&E). This identification and ranking of potentially favorable candidate areas is based solely upon the set of criteria used in the study as detailed in the "Phase 2 Methodology, Land Application Feasibility Ranking, New Hampshire Seacoast Wastewater Management Study, Groundwater Recharge and Reuse Option" letter to M&E from ENSR, dated November 6, 2006. See the "Candidate Area Table" for information regarding the ranked areas.

This map is intended for general reference purposes only within the context of the criteria and data used for its preparation.

Aerial photo base map created by the National Agricultural Imagery Program (NAIP), Aerial Photography Field Office, in 2003. Data obtained from NHGRANIT.

N

DRAFT

ROCHESTER WWTF CANDIDATE AREAS for the LAND APPLICATION OPTION*

Feet
0 2,000 4,000 6,000 8,000

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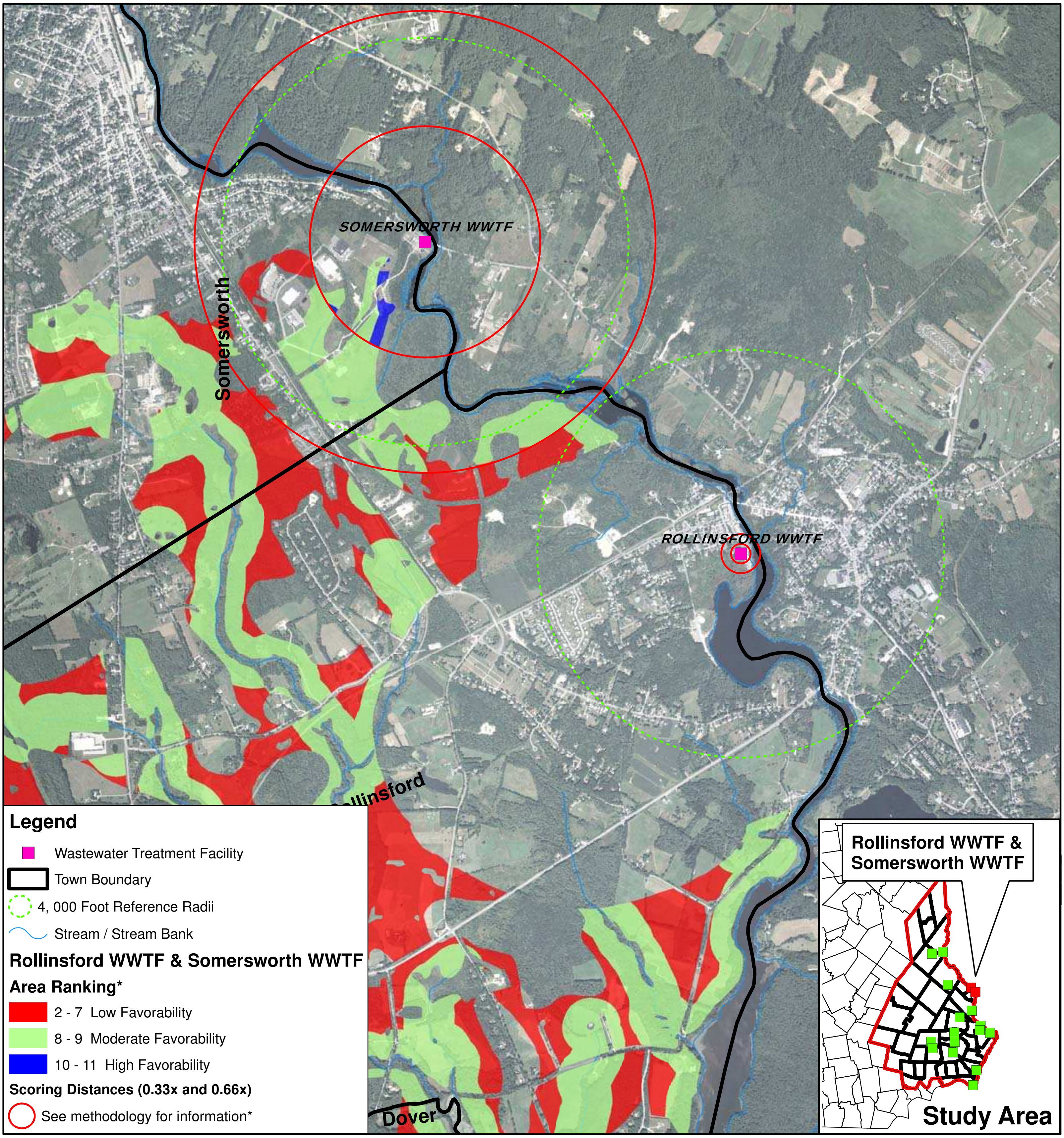

Legend

🟪 Wastewater Treatment Facility

▭ Town Boundary

○ 4, 000 Foot Reference Radii

〜 Stream / Stream Bank

Rollinsford WWTF & Somersworth WWTF

Area Ranking*

🟥 2 - 7 Low Favorability

🟩 8 - 9 Moderate Favorability

🟦 10 - 11 High Favorability

Scoring Distances (0.33x and 0.66x)

○ See methodology for information*

*Note:
This map was prepared for the preliminary feasibility assessment of the Land Application Option in the Seacoast Wastewater Management Study by ENSR for Metcalf & Eddy Inc. (M&E). This identification and ranking of potentially favorable candidate areas is based solely upon the set of criteria used in the study as detailed in the "Phase 2 Methodology, Land Application Feasibility Ranking, New Hampshire Seacoast Wastewater Management Study, Groundwater Recharge and Reuse Option" letter to M&E from ENSR, dated November 6, 2006. See the "Candidate Area Table" for information regarding the ranked areas.

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Aerial photo base map created by the National Agricultural Imagery Program (NAIP), Aerial Photography Field Office, in 2003. Data obtained from NHGRANIT.

N

DRAFT

ROLLINSFORD WWTF & SOMERSWORTH WWTF CANDIDATE AREAS for the LAND APPLICATION OPTION*

Feet
0 1,250 2,500 3,750 5,000

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