3 2008 Initial Alternative Scenarios and Model Results

3.1 Introduction

Following the release of the Needs Assessment Report, the Mashpee Sewer Commission identified five different management scenarios for evaluation and analysis. This chapter identifies the general characteristics of each scenario and discusses the basic methodology for evaluating each scenario.

The five scenarios are:

- Scenario 1—No expansion of existing wastewater treatment facilities
- Scenario 2—Upgrade and expansion of existing facilities to a practical extent
- Scenario 3/3R—Cluster—prepared by Lombardo Associates, Inc. (LAI)
- Scenario 4—Fair Share Reduction
- Scenario 5—Centralized approach

The term “Scenarios” in this report will refer to those evaluated by GHD—Scenarios 1, 2, 4, and 5. Scenario 3R has been developed by others, and presented to the Sewer Commission under separate cover is included on CD as Appendix F. However the findings of Scenario 3R regarding the MEP Model results are included in this Chapter.

Scenarios 1, 2, 4, and 5 all incorporate some degree of sewer construction and the use of an “effluent pipeline” that carries treated effluent outside of the watershed for discharge. The pipeline concept is based on the assumption that a portion of the New Seabury Golf Course (Site 7) is used for subsurface infiltration. This property is privately owned and located at the southern-most tip of the Town, and could therefore pose management issues further along in the process in transporting and recharging flows there. For this reason, each of the scenarios (1, 2, 4, and 5) was initially analyzed with and without consideration of the use of Site 7.

Preliminary scenarios developed as part of this effort were presented to the Sewer Commission for review and discussion. Issues associated with Site 7 including ownership and natural habitats were identified; however, due to its location outside of the watershed and the continued interest in the Site by the Sewer Commission, it remains under consideration. Following additional evaluation of scenarios, it was determined that the use of Site 7 will likely be necessary to achieve the Total Nitrogen TMDL goals. Therefore the remaining discussions on Scenarios 1, 2, 4, and 5 will be based on the consideration of using this site for treated water recharge and, as drafted, is currently a component of each of the four scenarios described in this Chapter.

Each scenario evaluated by GHD is described and includes information on proposed treatment facilities, estimated lengths of sewers, force mains, grinder pumps/vacuum valve pits, and number of pumping stations. Technologies are not being selected as part of this evaluation; however, technologies considered for costing purposes are based on the recommendations of the Technologies Screening Report.

Scenarios 1, 2, 4, and 5 were evaluated under build-out conditions. The associated costs that were developed for these four scenarios as part of the 2008 report and their associated flows were estimated based on achieving build-out conditions. If build-out conditions are never attained, it is possible that fewer

areas will need to be addressed to meet the total nitrogen TMDLs. Therefore, through an adaptive management approach, the extent of wastewater facilities can be modified.

Each of the five main scenarios (including Scenario 3—Cluster, by LAI) was developed so that it can be run through the MEP Model to identify its ability to meet the TMDL and sentinel station threshold concentration in both the Popponesset Bay and Waquoit Bay East estuaries. The findings of these model results are discussed later in this Chapter and were used to help form the basis for identifying the options discussed in Chapter 4.

Several workshops and presentations on the development of these scenarios were made to the Mashpee Sewer Commission in the fall and winter of 2007. Initially, the use of data by Planning Zones was the basis of all scenarios, as was done for the identification of areas of need in developing the Needs Assessment Report. Planning Zones, although useful for identifying demographics, are often not the most effective way to plan wastewater infrastructure. Topography must also be considered. Watersheds are also excellent for use in the evaluation of the nitrogen impacts; however they often do not coincide with efficient wastewater infrastructure planning. Both watershed boundaries and Planning Zones provide the basis for identifying where wastewater infrastructure is necessary, and therefore are still very important in the process of scenarios development.

After the preliminary analysis based on Planning Zones, “sewersheds” were laid out for the entire Project Planning Area. Sewersheds are developed to provide a reasonable estimation of the area that could effectively be served by a single pumping station. For example, all the properties that could flow by gravity to one pumping station (where wastewater is collected and pumped to a WWTF) would be grouped together in a sewershed. However, not all sewersheds consist of properties served entirely by gravity sewer; some sewersheds will require a combination of technologies. The sewersheds are used as the basis for the calculations performed in developing the various scenarios.

Sewersheds, like Planning Zones, do not necessarily conform to watershed lines. The sewersheds were used to refine the preliminary analyses and determine more realistic sewer scenarios. Because sewersheds are based on potential infrastructure layout and not watershed boundaries, use of nitrogen loadings generated by a “sewershed” could overestimate the effective nitrogen that reaches the estuary. Therefore the sewersheds were used as a guide and a means to estimate infrastructure; however, in each of the scenarios, nitrogen loading was refined using parcel-by-parcel data to determine in which sewershed and subwatershed each parcel lays. The final scenarios were developed based on this analysis. Since attenuation is best determined through the MEP analysis methods, it complicates the ability to assign an “attenuated” nitrogen load to each parcel. Depending on the analysis approach, if a general “attenuation” factor is applied, it will differ from the results of attenuation when the MEP “rainbow” spreadsheets are used. As a result, general attenuation factors were used to provide a reasonable approximation of the nitrogen loading; each scenario’s load was estimated based on parcels within MEP subwatersheds and, for the MEP modeling, input into the “rainbow” spreadsheets to achieve the goal.

This chapter summarizes the characteristics of each scenario as well as some potential variations on the scenarios, summarizes the infrastructure components of each scenario, and discusses the advantages and disadvantages of each alternative. Order of magnitude costs of the various scenarios were presented in Chapter 4 of the Draft Alternative Scenarios Analysis and Site Evaluation Report in March 2008. Cost

development of scenario evaluations will be compiled in the Draft Recommended Plan; this is discussed further in Chapter 5.

Table 3-1 summarizes the wastewater flows and loads for all portions of the Project Planning Area. In addition, the number of wastewater-generating parcels is presented. The table is divided by both town and watershed.

Table 3-1 Summary of Project Planning Area Estimated Flows[(1)]

Location	Wastewater Generating Parcel	Build-out Wastewater Flow (mgd)
Popponesset Bay		
Mashpee	4,200	1.2
Barnstable	790	0.18
Sandwich	1,600	0.28
Falmouth	No Contribution (no parcels in watershed)	
Total	**6,600**	**1.7**
Waquoit Bay East		
Mashpee	2,200	0.65
Barnstable	No Contribution (no parcels in watershed)	
Sandwich	530	0.11
Falmouth	530	0.12
Total	**3,300**	**0.88**
Outside Popponesset or Waquoit Bay Watersheds		
Mashpee	1,500	0.31
Barnstable	No Contribution (no parcels in Planning Area)	
Sandwich		
Falmouth		
Total	**1,500**	**0.31**
Project Planning Area Total		
Mashpee	7,900	2.2
Barnstable	790	0.18
Sandwich	2,100	0.39
Falmouth	530	0.12
Total	**11,000**	**2.9**

Notes:

1. Values rounded to two significant figures.

Information developed as part of this chapter and the final results of the MEP modeling analysis were used to formulate recommendations for the options discussed in Chapter 4.

Although nitrogen comes from many sources, wastewater is the primary source and is also the most controllable. As a result, it was decided early on in the development of the scenarios that the entire

nitrogen load to be removed would be achieved by addressing wastewater nitrogen. The Technology Screening Report discussed a variety of options to reduce the other sources of nitrogen. However, because of the variability in the concentration of nitrogen from non-wastewater sources and the difficulty in controlling the other sources, any reduction achieved by other nitrogen management alternatives will not be considered as part of this analysis. It is understood that the value of these additional reductions and their contributions in achieving a lower nitrogen load to the watershed will be considered as part of the development of any recommended plan. These additional nitrogen mitigation efforts will be part of adaptive management. The effectiveness of any recommendation will be determined through a monitoring program developed to validate the recommended plan's performance in achieving the goals of the TMDLs.

In order to compare the different scenarios, it is necessary to estimate sewer coverage area and the size of any additional treatment facilities. This was initially done on a planning zone level but was then refined by creating sewersheds. The total nitrogen loads that need to be removed for each watershed are based on the MEP technical reports and total nitrogen TMDLs. As the scenarios were developed and sewersheds were identified for sewering, the wastewater nitrogen load from each selected sewershed was subtracted from the total nitrogen identified to be removed. Sewersheds were connected to treatment facilities until the necessary amount of nitrogen was removed. Recharge from these facilities was then introduced at specific recharge sites within and outside of each watershed as shown in Appendix E. The flow charts were originally presented in Chapter 3 of the draft report, and are now included in Appendix E of this report. Scenarios were then iteratively readjusted based on the impacts of recharge.

The following sections identify each Scenario and identify the estimated infrastructure required for its implementation within the Project Planning Area. Sewer layouts as presented only represent a preliminary layout and approach; only after detailed surveys and pumping/vacuum station site selection can a final layout be determined. All lengths are considered approximations and are provided for cost and scenario comparison purposes. All GHD scenarios assumed the same lengths of gravity and pressure sewer within a particular sewershed. Force main lengths varied from scenario to scenario based on the location of sewersheds selected, and on the WWTF and treated water recharge sites recommended.

The following Table 3-2 summarizes the number of sewersheds and properties that would be served by sewer or onsite/cluster I/A systems in the future. Table 3-3 from the 2008 report and included in Appendix E summarizes the estimated flows for each treatment facility and treated water recharge site under each scenario.

Table 3-2 Estimated Number of Properties Served Under Each Scenario (1, 2, 4, and 5)

Location	Total Wastewater Flow Addressed (mgd)[1, 2]	Number of Sewersheds Served	Number of Properties Served by Sewer[1]	Number of Properties Served by I/A Systems
Scenario 1				
Mashpee	1.9	45	5,700	347
Barnstable	0.11	4	570	
Sandwich	0.30	6	1,300	28
Falmouth	0.10	17	530	
Total	**2.4**	**72**	**8,100**	**375**
Scenario 2				
Mashpee	1.7	41	5,500	36
Barnstable	0.11	4	570	
Sandwich	0.22	5	1,100	16
Falmouth	0.10	17	530	
Total	**2.1**	**67**	**7,700**	**52**
Scenario 4				
Mashpee	1.7	41	5,500	130
Barnstable	0.09	3	300	
Sandwich	0.27	6	1,300	
Falmouth	0.09	15	480	
Total	**2.1**	**65**	**7,700**	**130**
Scenario 5				
Mashpee	1.5	37	5,300	111
Barnstable	0.11	4	570	
Sandwich	0.15	3	700	12
Falmouth	0.10	17	530	
Total	**1.9**	**61**	**7,100**	**123**

Notes:

1. Values rounded to two significant figures.
2. Includes build-out flows from existing WWTFs, which is approximately 0.5 mgd.

3.2 Scenario 1—No Expansion of Existing Treatment Plants

Scenario 1 involves the continued operation of existing private WWTFs and construction of additional treatment facilities as needed to achieve the nitrogen TMDLs. Existing WWTFs were identified and discussed in detail as part of the Needs Assessment Report, and are as follows:

- New Seabury
- Willowbend
- Southport

- Mashpee Commons
- Mashpee High School
- Windchime Point
- Stratford Ponds
- South Cape Village
- Forestdale School (Sandwich)

Under this scenario, these existing WWTFs are expanded only to include areas that were identified as future connections in each of the WWTFs facility plan and included in their existing Groundwater Discharge Permits (GWDP). New Seabury is the only exception to the no-expansion consideration. New Seabury is expected to have considerable capacity and is in close proximity to portions of Mashpee that are not near other WWTFs or the potential sites discussed in Chapter 2. Wastewater treatment requirements for the existing facilities are based on those limits stipulated in their GWDP at the time of this report. Therefore the effluent total nitrogen limits for these facilities are 10 mg/L or 5 mg/L, depending on their permit. The only exception is the Forestdale School WWTF, which does not have a nitrogen limit stipulated in their GWDP. Because proposed additional WWTFs have not been designed, an effluent nitrogen concentration of 3 mg/L (the current limit of technology) is used for future facilities due to the requirements of reducing total nitrogen within the Popponesset Bay and Waquoit Bay East watersheds.

For Falmouth, under this option, essentially any wastewater removed from the Project Planning Area and treated in Falmouth will stay outside of the Waquoit Bay East and Popponesset Bay watersheds, resulting in no nitrogen recycling from those areas.

This scenario was developed by first determining how much nitrogen reduction would be achieved by assuming all WWTFs are operating at build-out flows and treating to their respective GWDP nitrogen limit. The next step was to identify “clusters” within the Project Planning Area that would be suitable for small package WWTFs. The clusters were chosen by selecting sewersheds that could logically be connected together and that had relatively dense development. The clusters were generally selected based on the nearness to potential effluent recharge sites as discussed in Chapter 2.

The following are the basic characteristics of Scenario 1. New treatment facilities are identified *in italics*.

<u>Scenario 1</u>

- WWTF at Forestdale School
- WWTF at Southport
- WWTF at Mashpee High School
- WWTF at Mashpee Commons
- WWTF at South Cape Village
- WWTF at Windchime Point
- WWTF at Willowbend
- WWTF at Stratford Ponds
- WWTF at New Seabury (expanded)
- *WWTF at Site 11—168 Route 130 (Sandwich)*

- *WWTF at Site 2—Ashumet Road (recharge at Site 1 and at Site 2)*
- *WWTF at Site 4—Transfer Station*
- *WWTF at Site 6—Keeter Property (recharge at Site 7—New Seabury Country Club)*
- Sewersheds 11 and 23 on I/A systems (to 10 mg/L)
- All parcels in the Waquoit Bay East watershed that are outside sewersheds are on I/A systems (to 10 mg/L)
- Falmouth would remove and treat all Falmouth wastewater

Treated water would be recharged at each of the existing WWTF sites. The Falmouth recharge would occur outside of both the Waquoit Bay East and Popponesset Bay watersheds. Figures in Appendix E (Figures 3-1 and 3-2) provide a flow chart of the proposed facilities and illustrate this scenario with a layout of the Project Planning Area. Sewersheds that are treated at a common WWTF are coordinated by color. Parcels that are connected to the existing WWTFs are highlighted with a red outline.

A new WWTF is proposed for Site 2 under this scenario. However, due to the amount of wastewater nitrogen that needs to be removed from Waquoit Bay East, treated water recharge occurs on both Sites 1 and 2. Site 1 will receive approximately 60-percent of the recharge and Site 2 would receive the remaining 40-percent.

Because Site 6 is located upgradient of a drinking water supply well, no treated water is proposed to be recharged at this site under this scenario. For this reason, treated water is expected to be recharged at Site 7—New Seabury Country Club. If Site 7 does not continue as a feasible option, Site 6 may be reconsidered. The preference of the Sewer Commission is for any recharge at Site 6 to be located within the Popponesset Bay watershed boundary to promote groundwater flow toward Popponesset Bay rather than the wells that are south of the property.

Sewersheds 11 and 23, which are located in the southwestern and southeastern corners of Mashpee, are proposed to be treated with individual onsite I/A systems or cluster systems, with a goal of achieving an annual average concentration of 10 mg/L total nitrogen in their effluent. This approach was considered for these sewersheds because of their locations—Sewershed 11 is an island and Sewershed 23 is not contiguous with the other parts of Mashpee. In order to connect these sewersheds to collection systems in Mashpee, water bodies would have to be crossed. This type of construction would involve significant permitting and construction obstacles. In addition to Sewersheds 11 and 23, all parcels in the Waquoit Bay East watershed that are *not* included in sewersheds are proposed to be on I/A systems.

It should be noted that the number of properties served by sewers does not include properties that were originally planned to be connected or already have been connected to the existing private WWTFs.

Several of the sewersheds that are proposed to be connected to WWTFs within the Town of Mashpee are located partially or completely in either Barnstable or Sandwich. If this scenario proceeds, there would be the need for an inter-municipal agreement or regional sewer district to facilitate wastewater treatment outside of respective town boundaries.

Appendix E Table 4-1 summarizes the infrastructure components of this scenario.

Under this scenario, 62 sewersheds were identified for sewering. This equated to approximately 70 miles of gravity and 100 miles of low pressure collection sewers; an additional 40 miles of force mains are

required to connect potential pumping stations to the proposed WWTFs and to connect these WWTFs to treated water recharge sites. New WWTFs are identified at Sites 2, 4, 6, and 11 with new treated water recharge at Sites 1, 2, 4, 7, and 11. The Falmouth treatment and recharge is not included in these sites. The scenario also includes approximately 380 properties on new I/A systems.

3.3 Scenario 2—Expansion of Existing Treatment Facilities

Development of this scenario began in a method similar to that used in Scenario 1—Falmouth wastewater is considered to be treated and recharged outside of the Project Planning Area and existing WWTFs address those properties originally identified as being connected (now or in the future) to that WWTF.

This scenario varies from the first one in that the existing WWTFs are expanded to the extent feasible to address neighboring sewersheds, and the treatment process is improved to achieve an effluent nitrogen concentration of 3 mg/L under the future condition. Construction of new WWTFs is considered only after the expansion potential of each existing WWTF is considered. The WWTFs that were not considered for expansion included the Forestdale School, Stratford Ponds, Windchime Point, and South Cape Village. These facilities have either limited space for expansion, will approach the facility's capacity under build-out conditions, or use a technology that is not easily expandable or reliable to treat to 3 mg/L on a consistent basis.

WWTFs typically have a design life of 20 years; therefore, any improvements for the WWTFs will likely be phased. As the flows increase and each facility approaches its design life or GWDP expiration date, improvements will be proposed to achieve greater nitrogen reduction (3 mg/L nitrogen concentration is estimated under the build-out condition), including considerations for replacement with a new wastewater process.

Table 3-3 presents the estimated design-life (based on 20 years) and "current" GWDP renewal year for those facilities under consideration for expansion. This information is based on the permit information available at the time of this report. These dates will be taken into consideration when evaluating potential phasing scenarios in the future.

Table 3-3 Existing WWTF Design Life and Permit Expiration Years

WWTF	Estimated Design Life Year	Year GWDP Expires(1)
Southport	2017	2011
Mashpee Commons	2010(2)	2009
Willowbend	2013	2008
Mashpee High School	2015	2012
New Seabury	2020	2006

Notes:

1. Based on MassDEP information as updated in January 2008.
2. Mashpee Commons was planning an upgrade to the facility in 2008.

The following are the basic characteristics of Scenario 2. New treatment facilities are identified *in italics*.

Scenario 2

- WWTF at Forestdale School
- WWTF at Southport (expanded)
- WWTF at Mashpee High School (expanded)
- WWTF at Mashpee Commons (expanded)
- WWTF at South Cape Village
- WWTF at Windchime Point
- WWTF at Willowbend (expanded)
- WWTF at Stratford Ponds
- WWTF at New Seabury (expanded)
- *WWTF at Site 2—Ashumet Road (recharge at Site 1 and Site 2)*
- *WWTF at Site 4—Transfer Station*
- *WWTF at Site 6—Keeter Property (recharge at Site 7)*
- *WWTF at Site 11—168 Route 130*
- Falmouth would remove and treat all Falmouth wastewater
- All parcels in the lower portions of the Waquoit Bay East watershed (Hamblin Pond, Jehu Pond, and Quashnet River subwatersheds) that are not served by sewers are on I/A systems (to 10 mg/L)

As in Scenario 1, treated water from a new WWTF at Site 6 is recharged at Site 7 in order to remove the nitrogen from the watersheds and to eliminate recharge upgradient from drinking water supply wells. Also, recharge from a WWTF at Site 2 is recharged mostly at Site 1 (90-percent), with the remainder being recharged at Site 2.

Figure 3-3 (in Appendix E) provides a schematic of the sewersheds, WWTFs, and treated water recharge sites. Figure 3-4 (in Appendix E) illustrates the layout of this scenario. Sewersheds that are treated at a common WWTF are color coordinated. Figures can be found in Appendix E.

Table 4-2 (in Appendix E) summarizes the components of this scenario.

Under this scenario, 61 sewersheds were identified for sewering. This scenario requires approximately 70 miles of gravity and 90 miles of low pressure collection sewers; 40 miles of force mains would be required to connect potential pumping stations to proposed WWTFs and to connect these WWTFs to treated water recharge sites. New WWTFs are identified at Sites 2, 4, 6, and 11 with new treated water recharge at sites 2, 4, 7, and 11. The Falmouth treatment and recharge is not included in these sites. The scenario also includes approximately 50 properties on new I/A systems.

3.4 Scenario 3/3R—Cluster

Lombardo Associates, Inc. (LAI) prepared a “Cluster Scenario” for the Mashpee Sewer Commission for the Project Planning Area of the East Waquoit and Popponesset Watersheds to achieve the MassDEP

TMDL requirements. This was completed independently of the work performed by GHD. The following is a brief description of the Cluster Scenario.

By its memorandum of November 13, 2009, MEP determined that Scenario 3 for the Popponesset Bay watersheds and Scenario 3R, a refinement of Scenario 3 solely in the East Waquoit watershed, met the TMDL requirements for the seven subwatersheds for which TMDL requirements exist in Popponesset Bay and East Waquoit Bay.

The Cluster Scenario consisted of the following approaches using the Nitrex™ technology:

1. Cluster Systems
2. Individual Onsite Nitrex™ Treatment Systems for application as:
    a. Retrofit to properties
    b. New systems
3. Nitrex™ Groundwater Treatment System(s)
    a. Pump and Treat
    b. Permeable Reactive Barrier

Potential solution scenarios of individual onsite systems and the groundwater treatment systems were developed for cost comparison purposes only. Cluster Scenario 3/3R relies solely upon the use of cluster systems. Sole use of individual systems and groundwater treatment would not achieve TMDL requirements.

Use of individual and groundwater treatment technologies in a hybrid scenario were presented as cost-saving techniques.

The Cluster Systems Scenario is a sewer system using innovative but well proven techniques for collection and treatment. The following assumptions were made concerning parcels that will not initially be served by a cluster system:

1. Any non-sewered parcel that has a future expansion in flow, either by developing an undeveloped lot or by expanding an existing development, will either be connected to an existing cluster system or will be required to install an I/A system capable of removing 90-percent of the influent TN load.
2. Any non-sewered parcel that does not have an increase in future TN load will remain with its existing onsite system—no future upgrade is assumed for these properties.

The Cluster Scenario consists of:

1. Septic tanks on individual properties—either salvaging the existing tank or replacing it with a new septic tank.
2. Septic tank effluent collection system from the served properties to a cluster treatment facility.
3. Cluster treatment facility—a wastewater treatment facility that will treat the flows from the collection system relying upon the Nitrex™ technology.

4. Treated water recharge either at treatment site or other location, outside of watershed where necessary, to meet TMDL requirements.

LAI determined the total attenuated nitrogen removal required to meet the TMDL threshold and the natural attenuation occurring along the flow path to the sentinel station for each property in the PPA. Using this information, 16 cluster systems were delineated to capture the total amount of attenuated nitrogen required within each subwatershed in the PPA to achieve TMDL compliance. Appendix (xx) Figure 1 illustrates the locations of the 16 cluster systems and the proposed associated dispersal locations.

It is noted that Scenario 3/3R was developed with the guideline that connection to an existing WWTF was not available. Use of existing WWTF and strategic use of on-site systems and PRB would reduce the cost of the decentralized option and would be performed in the next planning step during which an optimized plan is to be developed. LAI determined areas that had the highest potential for PRB application, which are illustrated in Appendix F Figure 2.

A complete copy of this report is available online at http://www.mashpeewaters.com/documents.html, and in Appendix F.

3.5 Scenario 4—Fair Share Reduction

This scenario is based on evaluations initially considered as part of the MassDEP-funded Mashpee Pilot Project. The Pilot Project team determined that a 49.2-percent reduction of all existing (2001) nitrogen sources (not including benthic flux or atmospheric deposition directly onto the embayment) throughout the entire Popponesset Bay watershed would achieve the nitrogen reduction necessary to restore estuary health. Once this homogeneous reduction rate was decided upon, the scenario was evaluated by the MEP, and it was concluded that this reduction would achieve the MEP goals. A similar analysis that attempted to mimic the Popponesset Bay “fair share reduction” scenario was applied to the Waquoit Bay East watershed as well. The calculations for that watershed (under existing conditions) resulted in a fair share reduction of approximately 63-percent.

There are some differences between the approach taken by the Pilot Project and the approach taken as part of the WNMP that should be noted.

1. The Pilot Project analysis included a 49.2-percent reduction in nitrogen from all sources, with the exception of atmospheric deposition on the estuary surface. The WNMP analysis does not consider a reduction in nitrogen loading to natural surfaces (forests, fields, etc.) or atmospheric deposition to freshwater body surfaces to achieve the nitrogen limits. Instead, a nitrogen mass equivalent to the amount removed based on the MEP analysis is achieved through reduction of wastewater nitrogen *only*. This is the most controllable source of nitrogen, and is therefore the easiest to quantify and achieve.

2. The Pilot Project analyzed a 49.2-percent nitrogen reduction for only the Popponesset Bay watershed, which is the focus of that effort. The WNMPs goal is to determine management plans for the entire Project Planning Area. The Waquoit Bay East watershed is estimated to require a 63-percent nitrogen reduction.

3. Wastewater was assumed to be completely removed from the watershed for the Pilot Project analysis. A more likely situation will include effluent recharge somewhere within the watershed. This will result in some recycling of nitrogen, which is considered as part of the WNMP evaluation.

4. The original Pilot Project and MEP work was based on 2001 “existing” conditions; however the analysis used for this project is based on the future (build-out) nitrogen load being removed, and therefore the amount of nitrogen to be removed will be larger.

This scenario is intended to provide one means of achieving a consistent nitrogen reduction in the various towns that make up the Project Planning Area. Each town is considered separately when presenting methods of nitrogen reduction—i.e. 50 percent of the Barnstable nitrogen is removed by Barnstable, 50-percent of the Sandwich nitrogen (in the Popponesset Bay portion) is removed by Sandwich, etc. Each town will also be responsible for the facilities necessary to reduce the nitrogen loads. Therefore under this scenario, no inter-municipal agreements and no sharing of resources are considered.

Although Falmouth wastewater is still considered to be treated and recharged outside of the watersheds, this scenario involves removal of only the required “fair share” of the Falmouth wastewater generated within the Project Planning Area, unlike the other scenarios where 100-percent of this flow was considered removed. Because this scenario is based on the Fair Share concept, approximately 63-percent of the existing Falmouth wastewater plus build-out is proposed to be treated and recharged outside of the watersheds.

The following are the basic characteristics of Scenario 4. New treatment facilities are identified *in italics*.

Scenario 4

- WWTF at Stratford Ponds
- WWTF at Willowbend
- WWTF at South Cape Village
- WWTF at Windchime Point
- WWTF at Forestdale School
- WWTF at Southport (expanded)
- WWTF at Mashpee High School (expanded)
- WWTF at Mashpee Commons (expanded)
- WWTF at New Seabury (expanded)
- *WWTF at Site 4—Transfer Station*
- *WWTF at Site 6—Keeter Property (recharge at Site 7)*
- *WWTF in Barnstable*
- *WWTF in Sandwich—Site 11*
- Falmouth removes and treats Falmouth’s wastewater
- Sewershed 23 on I/A systems (to 10 mg/L)
- No inter-municipal agreements and no sharing of resources are considered

Under this scenario, wastewater from the various towns within the Project Planning Area are treated and recharged within each town’s boundaries.

Once again, Sewershed 23 is proposed to utilize I/A systems to treat to lower nitrogen levels than are achieved with Title 5 septic systems. This sewershed consists of 130 parcels.

The flow schematic for Scenario 4 is shown in Appendix E, Figures 3-5 and 3-6 which illustrate the layout of the scenario.

Appendix E Table 4-3 summarizes the components of this scenario.

Under this scenario, 58 sewersheds were identified for sewering. This equated to approximately 65 miles of gravity and 90 miles of low pressure collection sewers; an additional 35 miles of force mains would be required to connect potential pumping stations to proposed WWTFs, and to connect these WWTFs to treated water recharge sites. New WWTFs are identified at Sites 4, 6, and 11 with new treated water recharge at Sites 4, 7, and 11. The scenario also includes approximately 130 properties on new I/A systems. Wastewater originating in Barnstable or Falmouth is anticipated to be treated and recharged outside of the Project Planning Area.

3.6 Scenario 5—Centralized Wastewater Treatment

Scenario 5 involves wastewater treatment by means of centralized (municipal) wastewater treatment facilities. Although this scenario proposes that the flow from both watersheds be treated at a WWTF located on Site 4 (in the Popponesset Bay watershed), treated water recharge occurs at multiple sites within the two watersheds, with the intention of reducing the impact of significant changes to the volume of groundwater flow in either watershed.

This scenario includes the conversion of each of the existing private WWTFs (with the exception of New Seabury) within the Popponesset Bay and Waquoit Bay East to a pumping station. Wastewater treatment activities would cease at these facilities. New Seabury has significant capacity, is outside of the watersheds, and has the potential to service sewersheds that are at significant distances from proposed centralized facilities, therefore the continued use of this facility is recommended. The Forestdale School would serve as a pumping station to pump flow to a new WWTF located in Sandwich (Site 11).

The facilities required for this scenario are summarized as follows:

Scenario 5

- WWTF and recharge at Site 4—Transfer Station
- Recharge at Site 5—Mashpee High School
- Recharge at Site 1—Heritage Park Ball Fields
- Recharge at Site 7—New Seabury Country Club
- WWTF and recharge at Site 11—168 Route 130
- WWTF at New Seabury (expanded)
- Falmouth wastewater treated and recharged by Falmouth

This scenario involves one Mashpee sewershed being treated at a Falmouth WWTF and several Barnstable sewersheds being treated and recharged within the Mashpee Town boundaries. For this scenario to work successfully there would need to be agreements or sewer districts to deal with treating wastewater outside of its respective town boundaries.

Treated effluent recharge under this scenario is distributed over a number of properties. The proposed WWTF is located at Site 4, where 1,000,000 gpd can be recharged. Another 200,000 gpd can be recharged at Site 7, which removes the nitrogen recycle from the watershed. The remaining recharge is

split between Sites 1 and 5. Site 1 receives 75-percent of the effluent and Site 5 receives the remaining 25-percent. Although Site 5 has the capacity to handle additional flow, the amount of nitrogen removal required for Waquoit Bay East limits the recharge that can occur within that watershed.

A general schematic and a layout of Scenario 5 are shown in Appendix E Figures 3-7 and 3-8.

Table 4-4 (in Appendix E) summarizes the components of this scenario.

Under this scenario 61 sewersheds were identified for sewering. This equated to approximately 70 miles of gravity and 75 miles of low pressure collection sewers; 35 miles of force mains would be required to connect potential pumping stations to proposed WWTFs, and to connect these WWTFs to treated water recharge sites. New WWTFs are identified at Sites 4 and 11 with new treated water recharge at Sites 1, 4, 5, 7, and 11. The scenario also includes approximately 120 properties on new I/A systems. As discussed, an additional treatment and recharge facility outside of the Project Planning Area is used to treat Falmouth wastewater flows.

3.7 MEP Model Runs and Results

In November and December 2009, the University of Massachusetts Dartmouth SMAST issued two technical memoranda summarizing the model results for the five scenarios described above. The results indicated that "all of the scenarios yield water column TN concentrations restorative of infaunal habitat in Ockway and Shoestring Bays, but all but Scenario 3 (and possibly 4) leave excess TN levels in the Mashpee River." The results also indicated that "Scenarios 1, 2, 4, and 5 meet the threshold values at the sentinel station for restoration of eelgrass in Hamblin and Jehu Ponds. Scenario 3 did not meet the threshold for either Hamblin or Jehu Pond. In addition, none of the scenarios (1 through 5) had sufficient nitrogen source reduction to meet the Quashnet River water column TN concentration threshold necessary to restore infaunal habitat, although Scenario 4 may be sufficiently close for planning purposes (0.523 mg/L versus 0.520 mg/L)."

Following the issuing of these findings, at the request of Lombardo Associates, Inc, a revised Scenario 3 was run and MEP issued a follow-up technical memo (dated February 2010) to address the failure of that scenario to meet the limits initially. These updated findings are shown in the summary table below.

The following Table 3-4 summarizes the findings as presented in Tables 3 and 4 from the MEP technical memorandum.

Table 3-4 Summary of Threshold Comparison Results[1]

Watershed/Embayment Section	TMDL/MEP Threshold	Scenario					
		1	2	3	3R[(2)]	4	5
		mg/L					
Popponesset Bay—Head	0.38	**0.394**	**0.386**	0.372		0.378	**0.389**
Mashpee River—Mid to Low	0.4-0.5	**0.601**	**0.570**	0.472		**0.529**	**0.596**
Shoestring Bay—Upper to Lower	0.4-0.5	0.472	0.462	0.461		0.449	0.461
Ockway Bay—Upper	0.4-0.5	0.457	0.449	0.421		0.438	0.453
Jehu Pond	0.446	0.429	0.435	**0.472**	0.429	0.437	0.434
Hamblin Pond	0.380	0.252	0.253	**0.400**	0.251	0.260	0.252
Quashnet River	0.520	**0.536**	**0.547**	**0.585**	0.460	**0.523**	**0.559**

Notes:

1. Data from Tables 5 and 6 from December 15, 2009 MEP Technical Memorandum, except for data regarding Scenario 3R (see Note 2).
2. Revised Scenario 3 (3R) as identified in Table 3 of the February 2010 MEP technical memorandum. This scenario did not include rerunning the model for Popponesset Bay. In summary, flow was moved from Waquoit Bay East watershed to the area identified as "Rock Landing/outside" watershed. Flow changes were also made within the following areas/subwatersheds: Moody Pond, Outside watershed, Ashumet Pond, Mashpee-Wakeby Pond, Quashnet River, Peter's Pond, Santuit River, and Red Brook watersheds, per the report.
3. Blue shading represents those that do not meet the Threshold.

3.8 Summary

As identified in the Draft report issued in 2008, each of the five scenarios described above was compared based on monetary and non-monetary considerations. As the Sewer Commission reviewed the findings of the Draft report, three new options were developed as presented in the next chapter.