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TECHNICAL MEMORANDUM NO. 1 (TM-1)

To: Jerry Potamis, P.E., Falmouth Wastewater Superintendent
CWMP Review Committee

From: Nathan C. Weeks, P.E.
Andrew Ochs, EIT

Date: October 7, 2010

Re: Assistance to CWMP Review Committee
Task 12-1: Cost Summaries for Alternative Wastewater Management Scenarios
S&W File No.: 8612163
Document No.: 71045.7

This memorandum is prepared to summarize costs for wastewater collection, treatment, and recharge scenarios for the Town of Falmouth (Town) Comprehensive Wastewater Management Plan (CWMP) Project. It is prepared to complete Task 12-1 as detailed in the Task 12 Project Scope attached in Appendix A.

BACKGROUND

The Town of Falmouth initiated a Comprehensive Wastewater Management Planning Project for its South Coastal Watersheds to Little Pond, Great Pond, Green Pond, Bournes Pond, Eel Pond, and Waquoit Bay Watersheds in early 2007. The location map for this Planning Area is illustrated on Figure 1. The following documents have been prepared to date:

- Needs Assessment Report, October 2007
- Alternatives Screening Analysis Report, November 2007
- Environmental Notification Form Document, December 17, 2007 (This document summarizes the main findings of the Needs Assessment Report and Alternatives Screening Analysis Report to initiate the Massachusetts Executive Office of Energy and Environmental Affairs Massachusetts Environmental Policy Act (MEPA) review process as well as the Cape Cod Commission Development of Regional Impact review process.)
- Draft Comprehensive Wastewater Management Plan and Draft Environmental Impact Report (CWMP/DEIR) and Notice of Project Change, December 2009

All of these documents are located on the Town's Wastewater Department website at www.falmouthmass.us/depart.php?depkey=wastewater as well as at the CWMP Project site at www.falmouthwastewaterprojects.org with additional background information.

These documents have summarized the need to remove existing and future wastewater nitrogen loadings to meet the nitrogen Total Maximum Daily Load (TMDL) limits. Figures 2 and 3 illustrate the existing and future wastewater nitrogen removals needed to meet the TMDLs.

In February 2010, the Town's Board of Selectmen formed a CWMP Review Committee to review the Draft CWMP/DEIR. That committee has met several times and has requested additional cost development and technical evaluations as detailed in the Project Scope in Appendix A.

The purpose of this technical memorandum is to summarize the cost-summary findings of Task 12-1 for five (5) alternative wastewater management scenarios. The potential treatment and recharge sites which are part of the scenarios are illustrated on Figure 4, and the scenarios are briefly listed below.

- **Scenario 3C** includes the following components:
  - Advanced treatment at the Massachusetts Military Reservation (MMR) site with a treatment performance of less than 1 milligram per liter (mg/L) Total Organic Carbon and 1 mg/L Total Nitrogen on average.
  - Recharge of the treated water through injection wells placed in the Route 151 right-of-way (ROW) to distribute the recharge to the planning area watersheds.
- **Scenario 3D** includes the following components:
  - Enhanced Nitrogen Removal treatment with treatment performance of 3 mg/L Total Nitrogen on average at the MMR site.
  - Discharge of the treated water at an outfall to the Cape Cod Canal.
- **Scenario 2A Modified** includes the following components:
  - Enhanced Nitrogen Removal treatment at the Falmouth Country Club (FCC) site.
  - Subsurface recharge at the following sites:
    - Western portion of Falmouth Country Club site (Site 2B)
    - Southwest portion of Allen Property (Site 4)
    - Dupee Ball Field Property (Site 5)

- **Scenario 1A Modified** which includes the following components:
  - Advanced treatment at Blacksmith Shop Road (BSR) WWTF site to meet a treatment performance of 2 mg/L Total Nitrogen on average and less than 3 mg/L Total Organic Carbon.
  - Recharge of the treated water through injection wells placed at the northern edge of the BSR WWTF site (Site 7) and at the Land Swap Parcel (Site 10) located north of the BSR WWTF site.
- **Scenario 1D** which includes the following components:
  - Enahnced Nitrogen Removal treatment at the BSR WWTF.
  - Discharge of the treated water at an outfall to Vineyard Sound at Nobska Point.

These five scenarios are described in detail below; advantages and disadvantages are provided for each scenario; and their costs are summarized in a prescribed format at the end of this section to allow cost distribution evaluations by Town staff and volunteers.

DETAILED DESCRIPTION OF THE FIVE ALTERNATIVE WASTEWATER SCENARIOS AND COST SUMMARY

Scenario 3C. This scenario is unchanged from Scenario 3C as presented in the Draft CWMP/DEIR starting on page 4-14. It would provide the highest level of treatment and would meet the state's new requirements for Total Organic Carbon removal which have recently been promulgated to minimize risks to drinking water supplies from the contaminants of emerging concern that include pharmaceuticals, endocrine disrupting compounds, and personal care products. It also would utilize well injection technology to return the treated water to the aquifer. This scenario is comprised of the following components:

- Wastewater collection from the Planning Area (Original Phase 1 and 2 Area) through a combination of gravity and low pressure sewers and pump stations to convey the wastewater to the MMR through forcemains.
- Advanced treatment of wastewater to less than 1 mg/L Total Organic Carbon and 1 mg/l Total Nitrogen on average including the following treatment components:
  - Pretreatment processes of screening and grit removal.
  - Fine screening.
  - Membrane bioreactor (MBR) process configured as a Bardenpho process for nitrogen and phosphorus removal.

- Reverse osmosis polishing for approximately two-thirds of the treated flow.
- Granular activated carbon polishing for approximately one-third of the flow.
- Advanced oxidation of the reject water from the reverse osmosis process to break apart refractory organic compounds separated by the reverse osmosis process before it is recycled to the MBR.
- Combination of the product water from the reverse osmosis and granular activated carbon process and disinfection.
- Reconditioning of the product water for pH control.

This treatment process is described in the Draft CWMP/DEIR report starting on page 4-17.

- Well injection at up to twelve (12) wells located in the Route 151 ROW. This treated water recharge system is described in the DCWMP/DEIR starting on page 4-14.

The scenario 3C treatment and recharge sites are illustrated in Figures 5 and 6 respectively.

The main advantages of this scenario include:

- It provides the greatest level of treatment and produces a highly purified water that can be recharged into Zone 2 Areas and other areas with the least risk to human and environmental health.
- The treatment process is located at the Otis WWTF/MMR site which would promote a regional approach to wastewater management with the neighboring towns of Bourne, Mashpee, and Sandwich. Due to the regional approach and location at a state and federal site, it may have a greater potential to receive funding from regional, state, or federal sources.
- The treatment site is in a remote location with a large buffer area to any residential properties. It is also located next to other waste management facilities.
- The well injection recharge technology has a minimal footprint and would minimize land disturbance. It also allows flexible groundwater management by allowing recharge into all of the watersheds at well sites along Route 151.

The main disadvantages include:

- It has high capital and operation and maintenance (O&M) costs.
- Well injection recharge has not been supported by MassDEP in the past for municipal wastewater management and it is expected to need performance testing (pilot studies) to satisfy MassDEP concerns as the technology is implemented.

- The MMR site is not in the Town's control. Coordination meetings have been convened with MMR staff as well as with representatives of the neighboring towns of Bourne, Mashpee, and Sandwich but the site's availability is uncertain.
- The recharge site is in a Zone 2 and would require special review by MassDEP. Also this site is in a groundwater protection area and would need a variance from town zoning.
- A minimal amount of additional sewer extension would be needed in Phase 3 to account for return flow at 1 mg/L Total Nitrogen into the watersheds.

The feasibility of the well injection at this location is being initiated with ongoing groundwater modeling. The expected groundwater rise at the well sites will be indicated by the modeling. If the modeled groundwater rise indicates feasibility, more detailed investigations are expected.

Costs for Scenario 3C are detailed in Table 1 and are summarized at the end of this section for Phase 1 and 2.

Scenario 3D. This is a new scenario that would utilize an ocean outfall into Cape Cod Canal after enhanced nitrogen removal treatment at the Otis WWTF/MMR site. This scenario is comprised of the following components:

- Wastewater collection from the Planning Area (Original Phase 1 and 2 Area) through a combination of gravity and low pressure sewers and pump stations to convey the wastewater to the MMR through forcemains.
- Enhanced nitrogen removal treatment to 3 mg/L total nitrogen on average including the following treatment components:
  - Pretreatment processes of screening and grit removal
  - Sequencing batch reactor (SBR) treatment process similar to existing treatment process at Blacksmith Shop Road WWTF
  - Effluent polishing with denitrification filter similar to existing treatment process at Blacksmith Shop Road WWTF
  - Disinfection
- Ocean outfall at the Cape Cod Canal with final disinfection to include chlorination and dechlorination facilities.

A SBR WWTF at the MMR site is illustrated on Figure 7. The forcemain from the treatment site to the canal would follow the existing forcemain to the Otis WWTF infiltration beds; this is illustrated on Figure 8. The proposed outfall would extend into the canal as illustrated on Figure 9.

The main advantages of this scenario include:

- By eliminating recharge of treated water to the south coastal watersheds, this scenario would reduce the amount of upper watershed sewering required to meet the TMDLs.
- The treatment process is located at the Otis WWTF/MMR site (similar to Scenario 3C) which would promote a regional approach to wastewater management and may have a greater potential to receive funding from federal, state, or regional sources.
- The SBR process followed by dentrification filters is the enhanced nitrogen removal treatment configuration with the lowest capital costs.

The main disadvantages include:

- As discussed for Scenario 3C, the MMR site is not in the Town's control. Coordination meetings have been convened with MMR staff as well as with representatives of the neighboring towns of Bourne, Mashpee, and Sandwich but the sites availability is uncertain.
- An outfall at this location with water treated to the low nitrogen levels would most likely not have an adverse environmental impact on the marine environment, but additional scientific studies would be needed to address questions and concerns of the local, regional, state, and federal stakeholders that would need to approve it. (It is noted that Appendices 4-2 and 4-3 of the Draft CWMP/DEIR summarized previous outfall evaluations to Cape Cod Canal.)
- The outfall could slightly lower groundwater elevations of the Sagamore flow lens at the existing septic systems in the Planning Area. This effect has been modeled and findings are presented in Technical memorandum No. 2.
- New ocean outfalls are not typically allowed by the Ocean Management Act and Ocean Sanctuaries Act, though a variance to this prohibition is possible. As discussed in the Draft CWMP/DEIR (starting on page 4-24), a variance request and associated studies could add six more years to the project approval.

Costs for Scenario 3D are detailed in Table 2 and are summarized at the end of this section for Phase 1 and 2:

Scenario 2A Modified. This scenario is a modification of Scenario 2A as presented in the Draft CWMP/DEIR starting on page 2-8 and 4-1. It would use a WWTF located at the eastern end of the Falmouth Country Club (FCC) site for enhanced nitrogen removal and subsurface recharge at the western end of the FCC site as well as at two additional Town sites west of the FCC site. This scenario is composed of the following components:

- Wastewater collection from the Planning Area (Original Phase 1 and 2 Area) through a combination of gravity and low pressure sewers and pump stations to convey the wastewater to the MMR through forcemains.
- Enhanced nitrogen removal treatment to 3 mg/L total nitrogen on average including the following treatment components:
  - Pretreatment processes of screening and grit removal
  - Sequencing batch reactor (SBR) treatment process similar to existing treatment process at Blacksmith Shop Road WWTF
  - Effluent polishing with denitrification filter similar to existing treatment process at Blacksmith Shop Road WWTF
  - Disinfection
- Treated water recharge through subsurface leaching facilities (drip dispersal or conventional leaching beds) at the following sites:
  - Site 2B; western portion of FCC site
  - Site 4; southwest portion (14 acres) of Allen property
  - Site 5; parking area and current vacant portion of Dupree Ball Field Property (use of the ball field area would be possible as well but may not be needed depending on Phase 3 flows and MassDEP approvals)
- Evaluations on these two main types of subsurface recharge are summarized in the Alternatives Screening Analysis Report starting on pages 5-3 and 5-7.

Figures 12 and 13 illustrate sites 2B and 5 respectively.

The SBR WWTF at the FCC site is illustrated on Figure 10.

Preliminary evaluations were completed to investigate the possible recharge flows into the Green Pond and Great Pond Watersheds in which these sites are located; and the following items are noted:

- The Green Pond lower watershed needs approximately 74% wastewater nitrogen removal (existing conditions) to meet the nitrogen TMDL (illustrated in Figure 2).
- In the future conditions the lower watershed needs approximately 78% wastewater nitrogen removal as illustrated in Figure 3. This figure also indicates that the Phase 1 and 2 sewers will extend over 100% of the lower watershed; therefore 100% of the wastewater nitrogen will be removed with the Phase 1 and 2 sewers providing excess capacity.
- The Green Pond watershed will then have approximately 12.5 kilograms per day (kg/d) of nitrogen assimilation capacity after the Phase 1 and 2 sewers are installed. This capacity would accommodate up to 1.1 mgd recharge flow at site 2B at 3 mg/L total nitrogen.
- If Phase 3 sewers are extended into the upper portion of the watershed to encompass the FCC site, the assimilation capacity would increase to approximately 19.3 kg/d which would accommodate up to 1.7 mgd recharged at site 2B at 3 mg/L total nitrogen.
- For the Great Pond watershed, both the existing and future conditions require 100% sewering of the lower watershed of Great Pond and a significant portion of the upper watershed (approximately 72% of the upper watershed needs sewering in the future conditions as illustrated in Figure 3).
- If Phase 3 sewers are extended into 100% of the Great Pond Watershed (upper and lower), there would be a resulting assimilative capacity of 13.2 kg/d which would accommodate up to 1.2 mgd at sites 4 and 5 at 3 mg/L total nitrogen.
- These two capacities total to 2.9 mgd which is very close to the projected future flow for this scenario at the end of Phase 3, therefore treatment to 3 mg/L total nitrogen and recharge at these sites appears to be feasible to meet the nitrogen TMDLs in the future condition.
- If additional recharge flow is needed at these sites, greater treatment performance would be needed to attain 2 mg/L total nitrogen or less.

Evaluations were also completed on the use of an existing leaching trench west of Sandwich Road currently used by the MMR groundwater cleanup program. This is site 6 as illustrated on Figure 4 and it is also located in the upper watershed to Great Pond. Also, the site is located in a Water Protection District as illustrated in Figure 11. A permanent municipal recharge at this location would need a variance from the Town's zoning requirements. This trench was designed by AFCEE and their engineers to recharge a flow of 0.86 mgd treated groundwater based on a design infiltration rate of 360 gallons per day per square foot (gpd/sf). This design rate is two orders of magnitude larger than the typical 3 gpd/sf allowed by MassDEP for treated municipal wastewater recharge. This recharge system failed in 2002 and the trench area was expanded to 1,350 feet in length with approximately 6,400 sq ft of leaching area. This area would allow a recharge flow of 0.02 mgd based on MassDEP sizing

criteria. MassDEP typically allows increased hydraulic loading through performance testing with the treated waters that are produced which could occur during the early years of implementation. Based on this site's location in a Water Protection District and its relatively low capacity based on MassDEP loading criteria, it was not used for cost development of this scenario but could be considered in the future.

The main advantages of this scenario include:

- The SBR process followed by denitrification filters is the enhanced nitrogen removal treatment configuration with the lowest capital costs.
- The FCC site is closer to the collection area, therefore pipeline and pumping costs will be less.
- The Town controls the FCC site and it was purchased for wastewater management purposes.
- Use of subsurface recharge would allow recreational/scenic benefits on top of the facilities as listed below:
  - Continued golfing at site 2B
  - Open meadow for habitat diversification and possible recreation at site 4
  - Increased recreational use and parking at site 5

The main disadvantages include:

- The FCC site is relatively small as compared to the other WWTF sites evaluated. It has adjoining residential properties, and it has relatively poor access.
- The FCC site is currently zoned for agricultural use and the treatment plant portion would need to be re-zoned for mixed use or municipal use.
- The sewering of Great Pond and Green Pond upper watershed would need to be nearly maximized to develop the assimilative capacity for 2.9 mgd at the end of Phase 3. if additional recharge is needed in the future, a treatment upgrade for greater nitrogen removal would be needed.
- Subsurface recharge has higher land area requirements and higher costs than open infiltration beds. It is also more difficult to maintain and/or repair because it is buried. Additional soils evaluations are needed to determine sizing requirements.

Costs for Scenario 2A Modified are detailed in Table 3 and are summarized at the end of this section for Phase 1 and 2:

Scenario 1A Modified. This scenario is a modification of Scenario 1A as presented in the Draft CWMP/DEIR. It would upgrade and expand the WWTF at the Blacksmith Shop Road (BSR) site for advanced treatment (Treatment Scenario B as discussed on page 4-17 of the Draft CWMP/DEIR) to allow well injection north of the BSR site. This scenario is composed of the following components:

- Wastewater collection from the Planning Area (Original Phase 1 and 2 Area) through a combination of gravity and low pressure sewers and pump stations to convey the wastewater to the BSR WWTF site through forcemains.
- Advanced treatment of the wastewater to stringent discharge requirements of less than 3 mg/L total organic carbon and approximately 2 mg/L total nitrogen on average including the following treatment components:
  - Pretreatment processes of screening and grit removal
  - Fine screening
  - Membrane Bioreactor (MBR) process configured as a Bardenpho process for nitrogen and phosphorus removal
  - Granular Activated Carbon polishing
  - Disinfection
- Continued recharge at the existing sand infiltration beds at the BSR WWTF for flows up to 1 mgd (or the flows allowed by the proposed effluent discharge permit and watershed loading limit).
- Well injection recharge north of the current BSR WWTF at the following sites illustrated on Figure 11:
  - Site 7 on the north end of the BSR site outside of the West Falmouth Harbor watershed
  - Site 10 which is a 7.4 acre Land Swap Parcel

The BSR WWTF would be upgraded and expanded to become a facility similar to the WWTF facility illustrated in Figure 5 for Scenario 3C but would make use of the existing tankage and facilities.

Preliminary evaluations were also completed for two additional recharge sites for this scenario as proposed in the Project Scope of Appendix A:

- Site 11, Route 28 ROW
- Site 12, westerly end of Thomas B. Landers Road and Route 28 ROWs.

These sites were visited and the following items observed:

- Site 11 is in the state road ROW and state permission for use of this area would be required with possible special legislation due to Massachusetts Highway Department policies.
- Site 12 has very little space for the recharge facilities.
- Both sites are close to the western end of the BSR WWTF site (site 7) and site 7 offers better access, more space, and Town ownership.
- It was decided to investigate the feasibility of site 7 as a surrogate to sites 11 and 12. If sites 11 and 12 are determined at a later time to be more desirable than site 7; cost development and groundwater modeling findings from sites 7 and 10 could be applied to sites 11 and 12.

The main advantages of this scenario include:

- The BSR WWTF would be expanded; therefore a new WWTF would not need to be sited or constructed.
- Treatment system operations would be more efficiently centered out of one WWTF.
- Treatment performance would be improved at the WWTF site.
- Costs savings would occur due to the ability to build upon existing site development and facilities.
- The existing wastewater collection system leads to this site; therefore portions of the sewer extensions to the Planning Area could build upon and utilize the existing collection system.
- The well injection technology has a minimal footprint and would minimize land disturbance.
- Groundwater flow from these new recharges is not expected to be into estuaries with nitrogen TMDLs as verified by groundwater modeling evaluations summarized in Technical Memorandum No. 2.
- By eliminating recharge of treated water to the south coastal watersheds, this scenario would reduce the amount of upper watershed sewering required to meet the TMDLs.

The main disadvantages include:

- Well injection recharge has not been supported by MassDEP in the past for municipal wastewater management and it is expected to need performance testing (pilot studies) to satisfy MassDEP concerns as the technology is implemented. Additional subsurface investigations will be needed to determine its feasibility in these locations.

- MBR and granular activated carbon treatment technology has higher capital and O&M costs as compared to SBR technology.

The feasibility of the well injection at this location has been initiated with groundwater modeling as summarized in Technical Memorandum No. 2.

Costs for Scenario 1A Modified are detailed in Table 4 and are summarized at the end of this section for Phase 1 and 2.

Scenario 1D. This scenario is unchanged from Scenario 1D as presented in the Draft CWMP/DEIR starting on page 4-20, and is comprised of the following components:

- Wastewater collection from the Planning Area (Original Phase 1 and 2 Area) through a combination of gravity and low pressure sewers and pump stations to convey the wastewater to the BSR WWTF site through forcemains.
- Expansion of the BSR WWTF at the current standards (advanced nitrogen and solids removal) followed by filtration and disinfection.
- Possible discontinuance of the current groundwater recharge at the BSR WWTF site.
- Conveyance to an ocean outfall at Nobska Point and discharge approximately 2,000 feet off shore into Vineyard Sound.

Figure 14 illustrates the outfall location.

The main advantages of this scenario include:

- The BSR WWTF would be expanded; therefore a new WWTF would not need to be sited or constructed.
- Treatment system operations would be more efficiently centered at one WWTF.
- The existing wastewater collection system leads to this site; therefore portions of the sewer extensions to the Planning Area could build upon and utilize the existing collection system.
- By eliminating recharge of treated water to the south coastal watersheds, this scenario would reduce the amount of upper watershed sewering required to meet the TMDLs.

The main disadvantages include:

- An outfall at this location with water treated to the low nitrogen levels would most likely not have an adverse environmental impact on the marine environment, but additional scientific studies would be needed to address questions and concerns of the local, regional, state, and federal stakeholders that would need to approve it.
- The outfall could slightly lower groundwater elevations of the Sagamore flow lens at the existing septic systems in the Planning Area. This effect has been modeled and findings are presented in Technical memorandum No. 2.
- New ocean outfalls are not typically allowed by the Ocean Management Act and Ocean Sanctuaries Act, though a variance to this prohibition is possible. As discussed in the Draft CWMP/DEIR (starting on page 4-24), a variance request and associated studies could add six more years to the project approval.

Costs for Scenario 1D are detailed in Table 5 and are summarized at the end of this section for Phase 1 and 2:

Cost Summary. The Phase 1 and 2 costs for these scenarios are presented in the following summary. More detailed costs for each Scenario are presented in the attached Tables 1 – 5.

SUMMARY OF PHASE 1 AND 2 COSTS

CAPITAL COST ITEM	SCENARIO NO. 3C [1]	3D [2]	2A [3] MODIFIED	1A [4] MODIFIED	1D [5]
	(MILLION $)				
Capital Cost Summary					
◗ Land purchase costs[6]	1	1	2	1	1
◗ Construction costs	259	244	261	251	256
◗ Construction contingency (25%)	66	61	65	63	64
◗ Fiscal, legal & engineering (25%)	66	61	65	63	64
Total[7]	390	370	390	380	380
Capital Costs Categorized for Possible Cost Distribution					
◗ 100% support by property tax					
- Land Purchase	1	1	2	1	1
- Fiscal, legal & engineering	66	62	66	63	64
- Major PS and forcemain construction and contingency	49	49	39	54	54
- Treatment and recharge construction and contingency	78	59	94	63	69
◗ 50/50 support by property tax/betterments					
- Peninsular main lines and pump station and contingency[2]	44	44	44	44	44
◗ 100% support by betterments					
- All other laterals, lines, and pump station in road ROW and contingency	150	150	150	150	150
Total[7]	390	370	400	380	380
OPERATION & MAINTENANCE (O&M) COST ITEM	**(MILLION $/YEAR)**				
Treatment and recharge systems					
◗ Electricity	1.6	0.27	0.27	0.31	0.27
◗ Treatment operations/repairs	2.5	0.38	0.76	2.7	0.38
◗ Recharge operations/repairs	0.13	0.10	0.1	0.10	0.10
◗ Sludge disposal	0.30	0.30	0.30	0.30	0.30
Collection system					
◗ Electricity	0.21	0.21	0.16	0.29	0.29
◗ Operations/repairs	1.5	1.5	1.3	1.5	1.5
Marine water quality monitoring	0.10	0.10	0.10	0.1	0.1
Total	6.3	2.9	3.0	5.3	2.9
HOUSE CONNECTION COST	**(MILLION $)**				
Payment by Property Owners for House Connections[9]	42	42	42	42	42

Notes:

1. Treatment at Otis WWTF/MMR site with MBR, reverse osmosis, and carbon adsorption technologies, and well injection in Route 151 right-of-way (ROW).
2. Treatment at Otis WWTF/MMR site with SBR and denitrification filter technologies, and ocean discharge/outfall to Cape Cod Canal.
3. Treatment at Falmouth Country Club (FCC) site with SBR and denitrification filter technologies, and subsurface recharge at 3 sites west of FCC WWTF site.
4. Treatment at Blacksmith Shop Road (BSR) site with MBR and carbon adsorption technologies, and well injection at 2 sites north of BSR WWTF Site.
5. Treatment at Blacksmith Shop Road (BSR) site with SBR and denitrification filter technologies, and ocean discharge/outfall at Nobska Point.
6. An allowance of $1M is provided for pump stations in the collection area, and $1M is provided for land purchase to provide access to the FCC WWTF site (Scenario 2A).
7. This cost would decrease by $19 million if sewers are not extended to Falmouth Heights.
8. All costs rounded to 2 significant digits except construction costs which are rounded to 3 significant digits to reduce rounding error. Costs are referenced to January 2010 (Engineering News Record Index 8660).
9. Based on 8,400 future connections and $5,000 per connection

ESTIMATED FUTURE SEWER UNITS FOR PHASE 1 AND 2 AREA

As discussed in the Draft CWMP/DEIR (starting on page 4-4), the number of future sewer units has been estimated for the Phase 1 and 2 area based on estimated future (buildout) flows for the area and projected residential water consumption of 170 gpd estimated as part of the buildout conditions. The Phase 1 and 2 area was divided into the main peninsular areas A through F as illustrated in Figure 15.

Estimated future (buildout) wastewater flows and estimated future sewer units are summarized below.

SEWER SERVICE AREAS A – F FUTURE FLOWS AND FUTURE SEWER UNITS

SEWER SERVICE AREA	FUTURE WASTEWATER FLOW[1] (MGD[2])	FUTURE SEWER[(3)] UNITS
A	0.08	470
B	0.51	3,000
C	0.22	1,290
D	0.30	1,760
E	0.24	1,410
F	0.08	470
Allowance for I/I[(4)]	0.4	N/A
Total	**1.8**	**8,400**

Notes:
(1) Based on buildout projection developed in the Needs Assessment Report and projected average water consumption of 170 gpd for residential properties, existing water consumption for existing commercial properties, and average consumption values for future commercial land use.
(2) Million gallons per day.
(3) Based on "Future Wastewater Flow" divided by 170 gpd/residential property and rounded to the nearest 10 units.
(4) Estimated at 30% as discussed in the Needs Assessment Report.

As discussed in the Draft CWMP/DEIR special consideration will be needed when betterments are estimated for this area. Recent research by the Town's Wastewater Department identified a previous town method for defining betterments as attached in Appendix B.

Tables

TABLE 1

Summary of Costs for Scenario 3C
Treatment at the Otis WWTF/MMR Site with
MBR, RO and GAC Treatment, and Well Injection Recharge at Rt 151 Corridor

Cost Component	Phase 1 and 2	Addl. Costs for Phase 3
Capital Costs		
Collection System	*$200,000,000*	*$110,000,000*
Major PS and FM	$39,000,000	
Peninsular Main Lines and Pump Stations	$35,000,000	
Right-of-Way Laterals, Pump Stations, and Collection Lines	$123,000,000	
Allowance for land purchase	$1,000,000	
Treatment Site and Systems	*$54,000,000*	*$17,000,000*
Site Development	$8,900,000	
WW Treatment Systems	$41,000,000	
Sludge Management System	$3,600,000	
Recharge System	*$8,000,000*	*$1,500,000*
Pump Station and Injection Well System	$2,900,000	
Treated Water Force Main to Injection Wells	$4,600,000	
Backup 0.5 mgd Infiltaration Bed System at FCC or MMR Site & FM	$530,000	
Total Construction Costs	**$262,000,000**	**$129,000,000**
Contingency (25%)	$66,000,000	$32,000,000
Fiscal, Legal and Engineering (25%)	$66,000,000	$32,000,000
Total Capital Costs (3)	**$390,000,000**	**$190,000,000**

Cost Component	Phase 1 and 2	Addl. Costs for Phase 3
O&M Costs		
Electrical Costs		
Collection System Lift Stations	$210,000	$100,000
Treatment Site	$1,600,000	$900,000
WWTF operations & repairs	$2,500,000	$1,200,000
Collection system operations & repairs	$1,500,000	$620,000
Sludge Disposal	$300,000	$160,000
Treated Water Recharge System	$130,000	$36,000
Marine Water Quality Monitoring Allowance	$100,000	$100,000
Total O&M Costs per year	$6,300,000	$3,100,000
Discount Rate of 5% (P/A for 5% and 20 yr = 12.4622)		
Present Worth of O&M Costs	**$79,000,000**	**$39,000,000**
Total Present Worth Costs	**$470,000,000**	**$230,000,000**

Notes:

1. All Phase 1 and 2 costs are rounded to two significant digits except total construction costs which are rounded to the nearest $1 million to reduce rounding error.
2. All cost are referenced to January 2010 costs (Engineering News Record Index 8660) and will need to be adjusted for inflation in the future.
3. These costs would be decreased by approximately $19 M if sewers were not extended to Falmouth Heights
4. These costs do not include house connection costs observed at $2,000 to $5,000 per connection at the New Silver Beach Project.

TABLE 2

Summary of Costs for Scenario 3D
Treatment at the Otis WWTF/MMR Site with
SBR and Denitrification Filter and
Discharge Through an Ocean Outfall at Cape Cod Canal

Cost Component	Phase 1 and 2	Addl. Costs for Phase 3
Capital Costs		
Collection System	*$200,000,000*	*$110,000,000*
Major PS and FM	$39,000,000	
Peninsular Main Lines and Pump Stations	$35,000,000	
Right-of-Way Laterals, Pump Stations, and Collection Lines	$123,000,000	
Allowance for land purchase	$1,000,000	
Treatment Site and Systems	*$26,000,000*	*$9,000,000*
Site Development	$8,900,000	
WW Treatment Systems	$13,000,000	
Sludge Management System	$3,600,000	
Ocean Outfall	*$21,000,000*	*$0*
Pump Station and Treated Water Force Main	$15,000,000	
Final Disinfection	$1,200,000	
Ocean Outfall	$6,000,000	
Total Construction Costs	**$247,000,000**	**$119,000,000**
Contingency (25%)	$62,000,000	$30,000,000
Fiscal, Legal and Engineering (25%)	$62,000,000	$30,000,000
Total Capital Costs (3)	**$370,000,000**	**$180,000,000**

Cost Component	Phase 1 and 2	Addl. Costs for Phase 3
O&M Annual Costs		
Electrical Costs		
Collection System Lift Stations	$210,000	$190,000
Treatment Site	$270,000	$140,000
WWTF operations & repairs	$380,000	$200,000
Collection system operations & repairs	$1,500,000	$740,000
Sludge Disposal	$300,000	$200,000
Treated Water Discharge System (4)	$100,000	$67,000
Marine Water Quality Monitoring Allowance	$100,000	$0
Total O&M Costs per year	$2,900,000	$1,500,000
Discount Rate of 5% (P/A for 5% and 20 yr = 12.4622)		
Present Worth of O&M Costs	$36,000,000	$19,000,000
Total Present Worth Costs	$410,000,000	$200,000,000

Notes:

1. All Phase 1 and 2 costs are rounded to two significant digits except total construction costs which are rounded to the nearest $1 million to reduce rounding error.
2. All cost are referenced to January 2010 costs (Engineering News Record Index 8660) and will need to be adjusted for inflation in the future.
3. These costs would be decreased by approximately $19 M if sewers were not extended sewers to Falmouth Heights.
4. Treated water discharge costs includes allowance for pump station O&M, chlorination/dechlorination system O&M, and outfall monitoring.
5. These costs do not include house connection costs observed at $2,000 to $5,000 per connection at the New Silver Beach Project.

TABLE 3

Summary of Costs for Scenario 2A Modified Treatment at Falmouth Country Club Site with SBR and Denitrification Filter Treatment and Subsurface Recharge at Sites 2B, 4, and 5 (Sites West of FCC WWTF Site)

Cost Component	Phase 1 and 2	Addl. Costs for Phase 3
Capital Costs		
Collection System	*$190,000,000*	*$140,000,000*
Major PS and FM	$31,000,000	
Peninsular Main Lines and Pump Stations	$35,000,000	
Right-of-Way Laterals, Pump Stations, and Collection Lines	$123,000,000	
Allowance for land purchase	$1,000,000	
Treatment Site and Systems	*$29,000,000*	*$10,000,000*
Site Development	$8,900,000	
WW Treatment Systems	$13,000,000	
Sludge Management System	$3,600,000	
Phosphorus Removal System	$3,200,000	
Recharge System	*$46,000,000*	*$28,000,000*
Subsurface Recharge Facilities	$44,000,000	
Treated Water Force Main	$1,800,000	
Total Construction Costs	**$265,000,000**	**$178,000,000**
Allowance for land purchase to inprove site access at WWTF site	$1,000,000	
Contingency (25%)	$66,000,000	$45,000,000
Fiscal, Legal and Engineering (25%)	$66,000,000	$45,000,000
Total Capital Costs (3)	**$400,000,000**	**$270,000,000**

Cost Component	Phase 1 and 2	Addl. Costs for Phase 3
O&M Annual Costs		
Electrical Costs		
Collection System Lift Stations	$160,000	$100,000
Treatment Site	$270,000	$160,000
WWTF operations & repairs	$760,000	$200,000
Collection system operations & repairs	$1,300,000	$800,000
Sludge Disposal	$300,000	$200,000
Treated Water Recharge System	$100,000	$14,000
Marine Water Quality Monitoring Allowance	$100,000	$0
Total O&M Costs per year	$3,000,000	$1,500,000
Discount Rate of 5% (P/A for 5% and 20 yr = 12.4622)		
Present Worth of O&M Costs	$37,000,000	$19,000,000
Total Present Worth Costs	$440,000,000	$290,000,000

Notes:

1. All Phase 1 and 2 costs are rounded to two significant digits except total construction costs which are rounded to the nearest $1 million to reduce rounding error.
2. All cost are referenced to January 2010 costs (Engineering News Record Index 8660) and will need to be adjusted for inflation in the future.
3. These costs would be decreased by approximately $19 M if sewers were not extended sewers to Falmouth Heights.
4. These costs do not include house connection costs observed at $2,000 to $5,000 per connection at the New Silver Beach Project.

TABLE 4

Summary of Costs for Scenario 1 A Modified Treatment at Blacksmith Shop Road (BSR) WWTF with MBR and GAC Treatment and Well Injection Recharge at 2 Sites North of the BSR WWTF Site

Cost Component	Phase 1 and 2	Addl. Costs for Phase 3
Capital Costs		
Collection System	*$200,000,000*	*$110,000,000*
Major PS and FM	$43,000,000	
Peninsular Main Lines and Pump Stations	$35,000,000	
Right-of-Way Laterals, Pump Stations, and Collection Lines	$123,000,000	
Allowance for land purchase	$1,000,000	
Treatment Site and Systems	*$46,000,000*	*$18,000,000*
Site Development	$6,200,000	
WW Treatment Systems	$38,000,000	
Sludge Management System	$1,900,000	
Recharge System	*$4,400,000*	*$1,400,000*
Pump Station and Injection Well System	$2,300,000	
Treated Water Force Main to Injection Wells	$2,100,000	
Total Construction Costs	**$250,000,000**	**$129,000,000**
Contingency (25%)	$63,000,000	$32,000,000
Fiscal, Legal and Engineering (25%)	$63,000,000	$32,000,000
Total Capital Costs (3)	**$380,000,000**	**$190,000,000**

Cost Component	Phase 1 and 2	Addl. Costs for Phase 3
O&M Annual Costs		
Electrical Costs		
Collection System Lift Stations	$290,000	$160,000
Treatment Site	$310,000	$160,000
WWTF operations & repairs	$2,700,000	$1,200,000
Collection system operations & repairs	$1,500,000	$740,000
Sludge Disposal	$300,000	$160,000
Treated Water Discharge System	$100,000	$30,000
Marine Water Quality Monitoring Allowance	$100,000	$0
Total O&M Costs per year	$5,300,000	$2,500,000
Discount Rate of 5% (P/A for 5% and 20 yr = 12.4622)		
Present Worth of O&M Costs	$66,000,000	$31,000,000
Total Present Worth Costs	$450,000,000	$220,000,000

Notes:

1. All Phase 1 and 2 costs are rounded to two significant digits except total construction costs which are rounded to the nearest $1 million to reduce rounding error.
2. All cost are referenced to January 2010 costs (Engineering News Record Index 8660) and will need to be adjusted for inflation in the future.
3. These costs would be decreased by approximately $19 M if sewers were not extended sewers to Falmouth Heights.
4. These costs do not include house connection costs observed at $2,000 to $5,000 per connection at the New Silver Beach Project.

TABLE 5

Summary of Costs for Scenario 1D
Treatment at Blacksmith Shop Road (BSR) WWTF with SBR and Denite-Filter and Discharge Through an Ocean Outfall at Nobska Point

Cost Component	Phase 1 and 2	Addl. Costs for Phase 3
Capital Costs		
Collection System	*$200,000,000*	*$110,000,000*
Major PS and FM	$43,000,000	
Peninsular Main Lines and Pump Stations	$35,000,000	
Right-of-Way Laterals, Pump Stations, and Collection Lines	$123,000,000	
Allowance for land purchase	$1,000,000	
Treatment Site and Systems	*$17,000,000*	*$9,000,000*
Site Development	$6,200,000	
WW Treatment Systems	$9,100,000	
Sludge Management System	$1,900,000	
Ocean Outfall	*$38,000,000*	*$0*
Pump Station and Treated Water Force Main	$14,000,000	
Final Disinfection and Pump Station	$1,700,000	
Ocean Outfall	$24,000,000	
Total Construction Costs	**$255,000,000**	**$119,000,000**
Contingency (25%)	$64,000,000	$30,000,000
Fiscal, Legal and Engineering (25%)	$64,000,000	$30,000,000
Total Capital Costs (3)	**$380,000,000**	**$180,000,000**

Cost Component	Phase 1 and 2	Addl. Costs for Phase 3
O&M Annual Costs		
Electrical Costs		
Collection System Lift Stations	$290,000	$190,000
Treatment Site	$270,000	$140,000
WWTF operations & repairs	$380,000	$200,000
Collection system operations & repairs	$1,500,000	$740,000
Sludge Disposal	$300,000	$200,000
Treated Water Discharge System (4)	$100,000	$67,000
Marine Water Quality Monitoring Allowance	$100,000	$0
Total O&M Costs per year	$2,900,000	$1,500,000
Discount Rate of 5% (P/A for 5% and 20 yr = 12.4622)		
Present Worth of O&M Costs	$36,000,000	$19,000,000
Total Present Worth Costs	$420,000,000	$200,000,000

General Notes:

1. All Phase 1 and 2 costs are rounded to two significant digits except total construction costs which are rounded to the nearest $1 million to reduce rounding error.
2. All cost are referenced to January 2010 costs (Engineering News Record Index 8660) and will need to be adjusted for inflation in the future.
3. These costs would be decreased by approximately $19 M if sewers were not extended sewers to Falmouth Heights.
4. Treated water discharge costs includes allowance for pump station O&M, chlorination/dechlorination system O&M, and outfall monitoring.
5. These costs do not include house connection costs observed at $2,000 to $5,000 per connection at the New Silver Beach Project.