IX. ALTERNATIVES TO IMPROVE TIDAL FLUSHING AND WATER QUALITY

IX.1 PRESENT LOADING WITH WWTF LOAD REMOVED

Due to the significant impact associated with nitrogen load generated by the WWTF, an alternative was developed to assess West Falmouth Harbor under existing development, excluding input from the WWTF. As shown in Table IX-1, this alternative has no effect on the groundwater derived nitrogen to Outer West Falmouth Harbor, Harbor Head, or Oyster Pond. However, the nitrogen plume affects the remaining sub-embayments, with the largest impact on Mashapaquit Creek which has approximately 77% of its nitrogen load derived from the WWTF. To properly model this scenario, benthic flux loads were also modified to account for the relatively large reduction in upland nitrogen load. The loads utilized to model the scenario are shown in Table IX-2.

Table IX-1. Comparison of sub-embayment ***total watershed loads*** (including septic, runoff, and fertilizer, and the WWTF) used for modeling of present loading scenarios of the West Falmouth Harbor system, with and without the WWTF load. These loads do not include direct atmospheric deposition (onto the sub-embayment surface) or benthic flux loading terms.

sub-embayment	present load (kg/day)	scenario load (kg/day)	threshold % change
Outer West Falmouth Harbor	1.690	1.690	0.0%
Inner West Falmouth Harbor	10.386	3.268	-68.5%
Harbor Head	1.085	1.085	0.0%
Oyster Pond	1.359	1.359	0.0%
Snug Harbor	9.570	2.986	-68.8%
Mashapaquit Creek	17.649	3.986	-77.4%

Table IX-2. Sub-embayment loads used for total nitrogen modeling of the West Falmouth Harbor system for present loading scenario with WWTF load removed, with total watershed N loads, atmospheric N loads, and benthic flux.

sub-embayment	watershed load (kg/day)	direct atmospheric deposition (kg/day)	benthic flux net (kg/day)
Outer West Falmouth Harbor	1.690	0.921	-2.868
Inner West Falmouth Harbor	3.268	0.866	-4.731
Harbor Head	1.085	0.153	-0.354
Oyster Pond	1.364	0.079	0.000
Snug Harbor	2.986	0.455	-2.744
Mashapaquit Creek	3.986	0.019	0.000

Total nitrogen modeling results for existing conditions without the WWTF indicate that the West Falmouth Harbor system would meet the nitrogen threshold target within Snug Harbor

(Table IX-3 and Figure IX-1). In addition, significant reductions in nitrogen concentration are achieved in all of the landward sub-embayments (e.g. Oyster Pond and Mashapaquit Creek). Nitrogen concentration reductions range from approximately 4% in Outer West Falmouth Harbor to over 40% in Mashapaquit Creek (the waterbody that receives the greatest load from the WWTF). Overall, this scenario indicates that the West Falmouth Harbor system would be considered a healthy estuarine system under current development, if the WWTF had not been constructed.

Table IX-3. Comparison of model average total N concentrations from present loading scenarios (with and without the WWTF load), with percent change, for the West Falmouth Harbor system. The threshold station is shown in bold print.

Sub-Embayment	monitoring station	present (mg/L)	scenario (mg/L)	% change
Mashapaquit Cr., Nashawena Rd.	PWF1	0.627	0.362	-42.3%
Harbor Head, Chappaquoit Rd.	PWF2	0.437	0.361	-17.4%
Chappaquoit Basin	PWF3	0.382	0.321	-16.1%
Inner West Falmouth Harbor	PWF4	0.370	0.311	-16.0%
Snug Harbor	**PWF5**	**0.464**	**0.329**	**-29.0%**
Outer West Falmouth Harbor	PWF6	0.327	0.302	-7.5%
Outer West Falmouth Harbor	PWF7	0.312	0.299	-4.2%
Oyster Pond	PWF8	0.534	0.460	-14.0%

IX.2 ALTERNATE BUILD-OUT WITH NO SEWERING OF WEST FALMOUTH HARBOR WATERSHED

As described in Section VIII, the recent upgrade of the WWTF will result in a significant reduction in nitrogen load to West Falmouth Harbor. At the present time, the Town of Falmouth plans to sewer part of the West Falmouth Harbor watershed to ensure that nitrogen concentrations within the harbor allow the system return to the high quality habitat of the recent past. Based on the results of the alternative described in Section IX.1, it may not be necessary to sewer a significant portion of West Falmouth Harbor's watershed to ensure protection of this resource from nitrogen overload. Therefore, an alternative was assessed that considered build-out of the remaining parcels in the watershed, with the future anticipated loading from the upgraded WWTF and no sewer construction within the watershed to West Falmouth Harbor. Again, since the major contributor of nitrogen load to the harbor is the WWTF, prior to the recent upgrade, this alternative assesses whether the WWTF upgrade alone can improve water quality within the estuary to a level that meets the threshold, regardless of future build-out within the watershed.

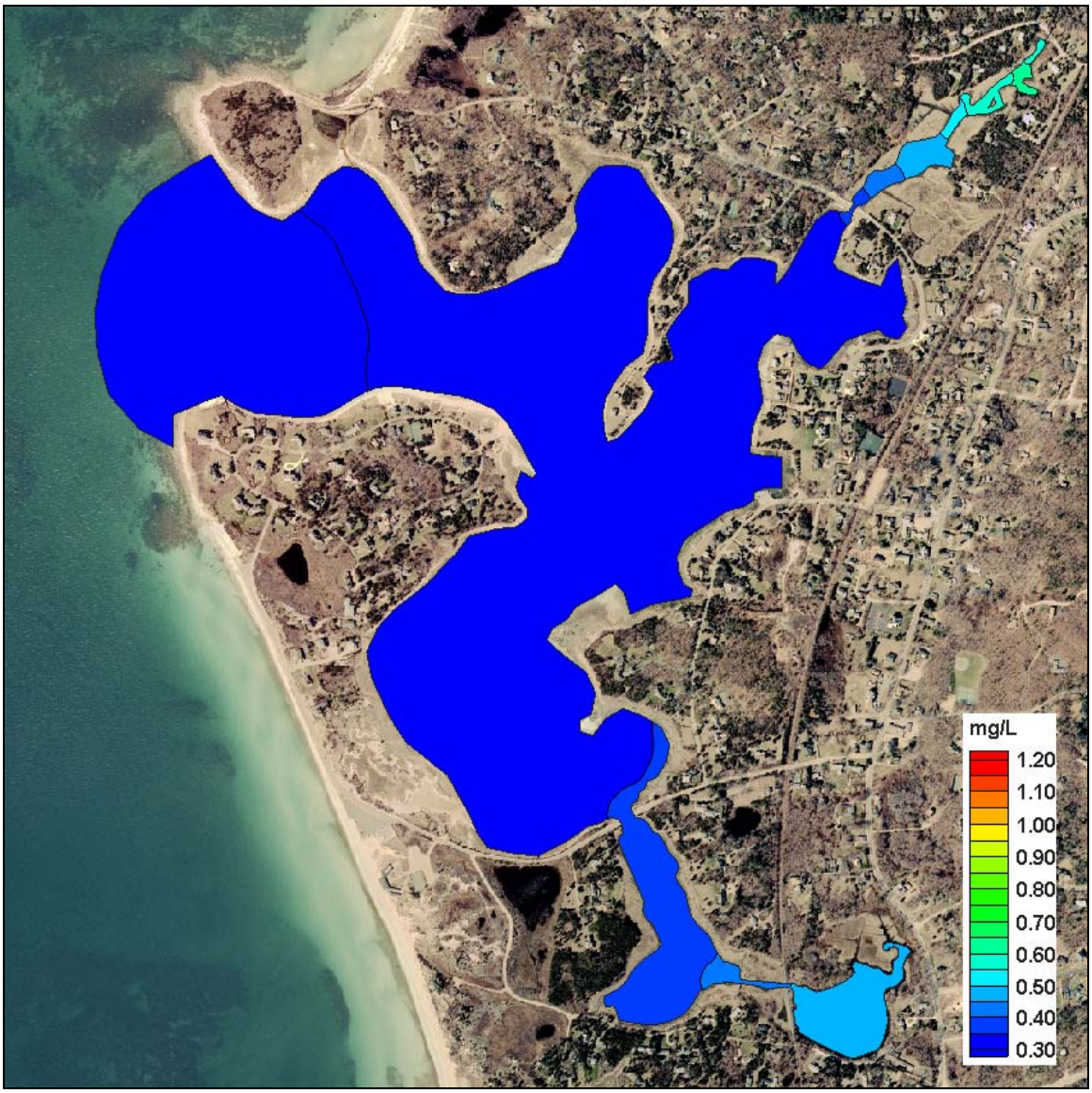

Figure IX-1. Contour plot of modeled total nitrogen concentrations (mg/L) in the West Falmouth Harbor system, for present loading conditions and WWTF loads removed from the system watershed.

Table IX-4 shows the change in septic nitrogen loads from present day conditions associated with full build-out conditions. At first glance, the increases associated with build-out appear large relative to existing septic loads; however, these loads are relatively small when compared to the nitrogen loads generated by the WWTF prior to the 2005 upgrade. Table IX-5 illustrates the overall change to watershed loads resulting from this alternative, where significant reductions are realized in the up-gradient or landward sub-embayments of the system. The primary reason for the reductions in total watershed loads results from the WWTF upgrade. Based on the assumptions developed for this alternative, Table IX-6 presents the various components of nitrogen loading for the West Falmouth Harbor system.

Table IX-4. Comparison of sub-embayment watershed ***septic loads*** (attenuated) used for modeling of present and buildout loading scenario with no sewering of the West Falmouth Harbor watershed. These loads do not include direct atmospheric deposition (onto the sub-embayment surface), benthic flux, runoff, or fertilizer loading terms.

sub-embayment	present septic load (kg/day)	scenario septic load (kg/day)	threshold septic load % change
Outer West Falmouth Harbor	1.274	2.216	74.0%
Inner West Falmouth Harbor	2.085	3.334	59.9%
Harbor Head	0.811	1.060	30.7%
Oyster Pond	0.984	1.093	11.1%
Snug Harbor	1.912	2.397	25.4%
Mashapaquit Creek	2.975	3.272	10.0%

Table IX-5. Comparison of sub-embayment ***total watershed loads*** (including septic, runoff, and fertilizer, and the WWTF) used for modeling of present and buildout loading scenario with no sewering of the West Falmouth Harbor watershed. These loads do not include direct atmospheric deposition (onto the sub-embayment surface) or benthic flux loading terms.

sub-embayment	present load (kg/day)	scenario load (kg/day)	threshold % change
Outer West Falmouth Harbor	1.690	2.633	55.8%
Inner West Falmouth Harbor	10.386	6.734	-35.2%
Harbor Head	1.085	1.334	23.0%
Oyster Pond	1.359	1.468	8.1%
Snug Harbor	9.570	5.523	-42.3%
Mashapaquit Creek	17.649	8.466	-52.0%

Table IX-6. Sub-embayment loads used for total nitrogen modeling of the West Falmouth Harbor system, with total watershed N loads, atmospheric N loads, and benthic flux, for buildout loading scenario with no sewering of the West Falmouth Harbor watershed.

sub-embayment	watershed load (kg/day)	direct atmospheric deposition (kg/day)	benthic flux net (kg/day)
Outer West Falmouth Harbor	2.633	0.921	-2.950
Inner West Falmouth Harbor	6.734	0.866	-5.329
Harbor Head	1.334	0.153	-0.407
Oyster Pond	1.468	0.079	0.000
Snug Harbor	5.523	0.455	-3.147
Mashapaquit Creek	8.466	0.019	0.000

The water quality model for the alternative incorporating the upgraded WWTF, with no sewering within the West Falmouth Harbor watershed and build-out of existing parcels in the watershed, yielded the results shown in Table IX-7 and Figure IX-2. As described in Section VIII, the nitrogen concentration threshold within Snug Harbor was established at 0.35 mg/l. The results of the selected alternative indicate a modeled nitrogen concentration of approximately 0.38 mg/l, which does not meet the threshold level established by the MEP for full restoration of this estuarine system. While the scope of the modeling scenarios developed for this report was not intended to be exhaustive, model results indicate that the Town of Falmouth can meet their nitrogen loading targets at build-out by following the proposed sewering plan of the West Falmouth Harbor watershed, as described in Section VIII. If no sewers are constructed in the watershed and all parcels are developed, the total nitrogen levels in the estuarine system will exceed the threshold value selected for Snug Harbor.

Table IX-7. Comparison of model average total N concentrations from present loading and for buildout loading scenario with no sewering of the West Falmouth Harbor watershed, with percent change, for the West Falmouth Harbor system. The threshold station is shown in bold print.

Sub-Embayment	monitoring station	present (mg/L)	scenario (mg/L)	% change
Mashapaquit Cr., Nashawena Rd.	PWF1	0.627	0.453	-28.8%
Harbor Head, Chappaquoit Rd.	PWF2	0.437	0.402	-8.1%
Chappaquoit Basin	PWF3	0.382	0.349	-8.7%
Inner West Falmouth Harbor	PWF4	0.370	0.334	-9.7%
Snug Harbor	**PWF5**	**0.464**	**0.378**	**-18.6%**
Outer West Falmouth Harbor	PWF6	0.327	0.313	-4.2%
Outer West Falmouth Harbor	PWF7	0.312	0.305	-2.4%
Oyster Pond	PWF8	0.534	0.509	-4.8%

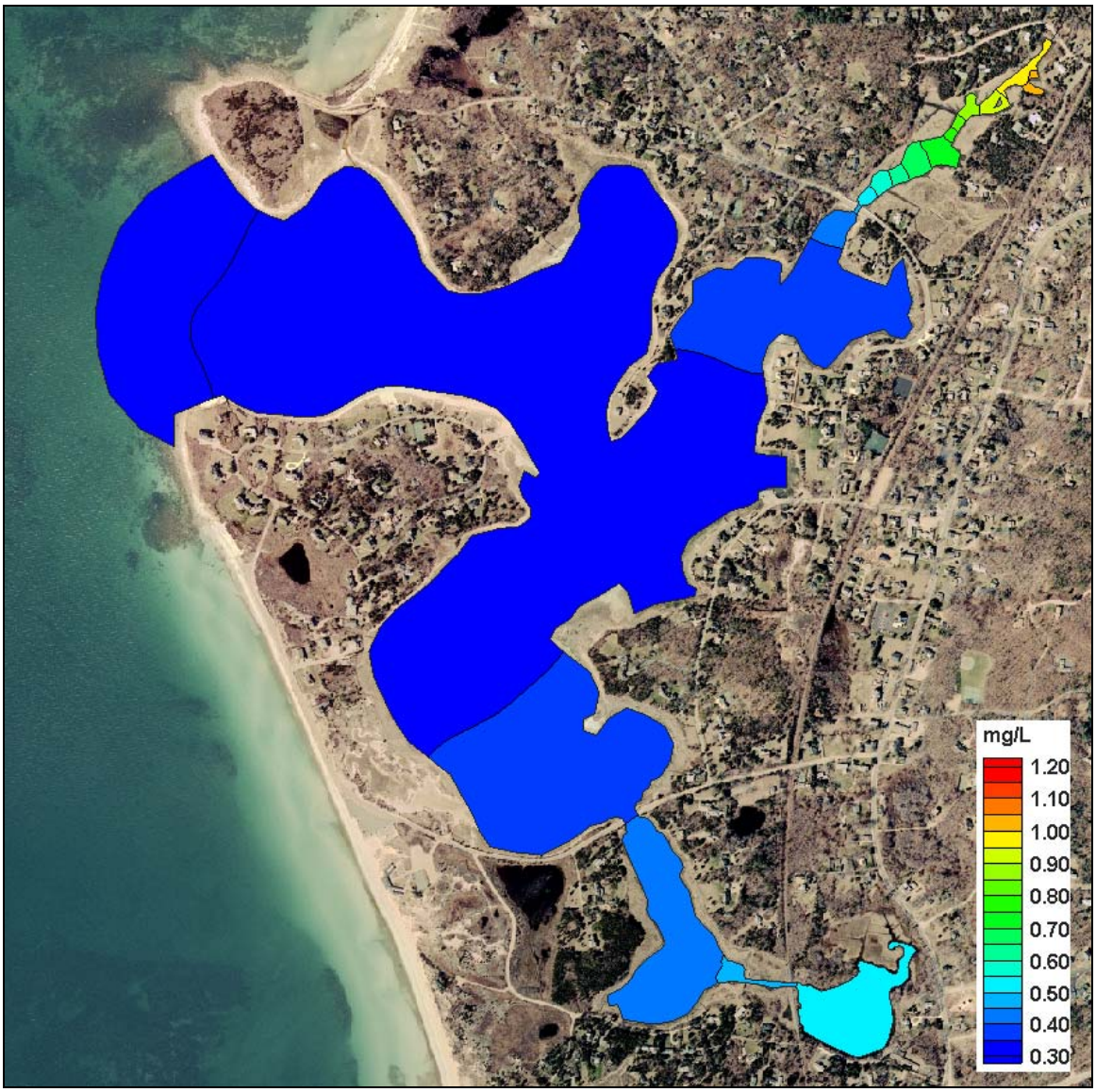

Figure IX-2. Contour plot of modeled total nitrogen concentrations (mg/L) in the West Falmouth Harbor system, for buildout loading conditions with no sewering of the West Falmouth Harbor watershed.