

Table of Contents

Section 1 - Introduction

1.1	Project Identification	1-1
1.2	Project Location	1-2
1.2.1	Existing Conditions	1-2
1.2.2	Massachusetts Estuaries Project Watersheds.....	1-6
1.2.3	Harwich Village Centers.....	1-6
1.3	Harwich Wastewater Management Subcommittee.....	1-6
1.4	Purpose and Scope	1-8
1.4.1	Purpose.....	1-8
1.4.2	Scope	1-9
1.5	Water Quality Discussion	1-9
1.6	Organization of this Phase I CWMP	1-12

Section 2 - Public Participation Programs and Coordination with Other Projects

2.1	Introduction.....	2-1
2.2	Local Initiatives	2-1
2.2.1	Local Comprehensive Plan – Villages.....	2-1
2.2.2	Water Quality Management Task Force.....	2-2
2.2.3	Citizens Advisory Committee.....	2-3
2.2.4	Wastewater Implementation Advisory Committee	2-3
2.3	Public Presentations and Hearings	2-4

Section 3 - Summary of Relevant Data

3.1	Introduction.....	3-1
3.2	Past Reports and Studies.....	3-1
3.3	GIS Data	3-2
3.4	CCC Data	3-3
3.5	Groundwater	3-3
3.6	Wetlands.....	3-3
3.7	Floodplains.....	3-7
3.8	Natural Heritage and Endangered Species Program	3-7
3.9	Soils	3-7
3.9.1	MassGIS Soils Data	3-7
3.9.2	Natural Resources Conservation Service Data	3-11
3.10	Town Planning Data.....	3-11
3.10.1	Town and Parcel Zoning Data.....	3-11
3.10.2	Lot Density and Size.....	3-11
3.11	Water Department Data.....	3-15
3.11.1	Water Pumping Records.....	3-17
3.11.2	Water Use Records	3-17
3.12	Present Wastewater Management Data.....	3-17
3.12.1	Title 5 – State Environmental Code.....	3-17
3.12.2	Local Sewage Disposal Guidelines and Regulations	3-18
3.12.3	Board of Health Data.....	3-18

3.12.4	Areas of Known Title 5 Concern	3-20
3.12.5	Package Treatment Systems in Harwich	3-20
3.13	Water Quality Data.....	3-22
3.14	Affordable Housing In Harwich.....	3-27
3.15	Summary of Relevant Data.....	3-31

Section 4 - Existing Water Quality Data

4.1	Introduction.....	4-1
4.2	Drinking Water Supply and Groundwater Quality	4-1
4.2.1	Harwich Public Water Supply Wells and Treatment	4-1
4.2.2	Harwich Public Drinking Water Supply Quality	4-3
4.2.3	Nitrate in Drinking Water	4-5
4.2.4	USGS Groundwater Monitoring Wells.....	4-6
4.3	Harwich Beaches	4-6
4.3.1	Water Quality of Harwich Beaches.....	4-9
4.3.2	Harwich Water Quality Management Task Force Bacterial Data.....	4-11
4.3.3	Allen Harbor Fecal Coliform Study	4-13
4.3.4	Conclusion for Bacterial Contamination.....	4-13
4.4	MassDEP Eelgrass Mapping Program	4-13
4.5	Water Quality Classifications and Impaired Waterways	4-14
4.5.1	Massachusetts Water Quality Classifications.....	4-14
4.5.2	Impaired Waterways and Waterbodies	4-15
4.6	Conclusions.....	4-16

Section 5 - Assessment of Freshwater Ponds

5.1	Introduction.....	5-1
5.2	Pond Health Assessment	5-1
5.2.1	Water Quality in Kettle Ponds	5-4
5.2.2	Indicators of Pond Health.....	5-5
5.2.3	Assessment of Pond Health.....	5-7
5.3	Summary.....	5-19

Section 6 - Massachusetts Estuaries Project

6.1	Introduction.....	6-1
6.2	Massachusetts Estuaries Project (MEP)	6-1
6.2.1	MEP Approach to Estuary Studies	6-2
6.2.2	Harwich MEP Water Resources.....	6-5
6.3	Results of Published MEP Studies	6-5
6.3.1	Allen Harbor Watershed Results	6-7
6.3.2	Wychmere Harbor Watershed Results.....	6-14
6.3.3	Saquatucket Harbor Watershed Results	6-20
6.3.4	Pleasant Bay Watershed and Sub-Embayment Results	6-28
6.3.5	Herring River Watershed Results	6-42
6.4	Summary.....	6-49

Section 7 - Estimated Wastewater Flows

7.1	Purpose.....	7-1
7.2	Data Used	7-1

7.2.1	Well Pumping Records.....	7-2
7.2.2	Town Billing Records	7-3
7.2.3	MEP Dataset	7-3
7.3	Town Billing Records Compared to MEP Data.....	7-4
7.4	MEP Watershed Buildout Water Use Estimates.....	7-5
7.4.1	Development of Residential Buildout Flows	7-5
7.4.2	Development of Commercial and Industrial Buildout Flows.....	7-6
7.4.3	Town-Wide Buildout Flows	7-7
7.5	Adjustments for Wastewater Flow.....	7-8
7.5.1	Rainfall and Irrigation Adjustment	7-8
7.5.2	Recommended Irrigation Adjustment for Water Use	7-9
7.5.3	Additional Adjustment to Convert Water to Wastewater Use	7-10
7.6	Seasonal Variations and Peaking Factors	7-12
7.6.1	Seasonal Wastewater Flow Ratios.....	7-12
7.6.2	Maximum Month Wastewater Flow	7-13
7.7	Summary.....	7-13
7.7.1	Town Billing Records and MEP Dataset Conclusion	7-13
7.7.2	Adjustments for Wastewater Flow.....	7-14

Section 8 - Wastewater Needs Assessment

8.1	Introduction.....	8-1
8.2	Drinking Water Supplies	8-1
8.3	Freshwater Lake and Pond Quality.....	8-3
8.4	Onsite (Title 5) System Performance.....	8-6
8.5	Nitrogen Management	8-9
8.6	Socio-Economic Needs	8-18
8.7	Wastewater Needs Categories	8-20
8.8	Summary and Conclusions.....	8-21

Section 9 - Effluent Recharge Site Screening

9.1	Overview.....	9-1
9.2	Initial Site Screening Criteria	9-3
9.2.1	Data Sources.....	9-4
9.2.2	Outside Zone of Contribution.....	9-4
9.2.3	Parcel Size Greater than Five Acres.....	9-4
9.2.4	Outside 100-year Floodplain Zones.....	9-6
9.2.5	Permeable Soils	9-6
9.2.6	Undeveloped Property	9-6
9.2.7	Outside Wetlands.....	9-10
9.2.8	Favorable Depth to Groundwater	9-10
9.2.9	Outside Priority Habitat Areas.....	9-10
9.2.10	Outside Municipal Wellhead Protection Zone II	9-14
9.2.11	Town-owned Property.....	9-14
9.3	Initial List of Potential Effluent Recharge Sites.....	9-14
9.3.1	Herring River Watershed.....	9-19
9.3.2	Outside Watershed Sites	9-22
9.3.3	Saquatucket Harbor.....	9-22

9.3.4	Pleasant Bay	9-23
9.4	Recommended 10 Sites and HR-18	9-24
9.5	Further Evaluation of Ten Recharge Sites	9-26
9.5.1	Available Acreage	9-26
9.5.2	Estimated Recharge Rate	9-38
9.6	Selection of Top Five Sites for Further Investigation.....	9-38

Section 10 - Wastewater Scenarios Assessment

10.1	Purpose and Scope	10-1
10.2	Massachusetts Estuaries Project Impact	10-1
10.3	Wastewater Management Scenarios	10-2
10.3.1	Nitrogen Balancing Methodology.....	10-2
10.3.2	Nitrogen Loading Spreadsheets.....	10-6
10.3.3	GIS Data Obtained from the MEP Data Disks	10-10
10.3.4	Baseline Scenario.....	10-10
10.3.5	Enhanced Natural Attenuation Options	10-10
10.3.6	Baseline Attenuation Scenario	10-12
10.3.7	Justification for Attenuation Scenarios (1A to 8A)	10-14
10.3.8	Effluent Recharge Sites.....	10-14
10.3.9	Wastewater Management Scenarios 1A through 8A.....	10-16
10.4	Comparative Assessment of Scenarios.....	10-22
10.4.1	Cost Analysis	10-28
10.4.2	Cost Results	10-29
10.4.3	Evaluation Criteria	10-31
10.4.4	Matrix Results.....	10-46
10.5	Recommended Scenarios for Further Analysis.....	10-48

Section 11 - Hydrogeologic Evaluations of Effluent Recharge Sites

11.1	Introduction.....	11-1
11.2	Overview of Work.....	11-1
11.3	Groundwater Model Simulations	11-3
11.4	Effluent Recharge	11-4
11.5	Summary and Conclusions.....	11-10

Section 12 - Collection and Treatment System Evaluations

12.1	Purpose and Scope	12-1
12.2	Collection System Technologies	12-1
12.2.1	Types of Sewer Collection System Technologies.....	12-1
12.2.2	Recommended Collection System Technology – Hybrid System	12-6
12.3	Wastewater Flow Estimates	12-6
12.3.1	Infiltration and Inflow.....	12-7
12.3.2	Summary of Flows	12-8
12.3.3	Peaking Factors.....	12-9
12.4	Sewer System Layouts for Scenarios 3A, 4A, and 5A	12-9
12.4.1	Sewer Collection System for Scenario 3A.....	12-9
12.4.2	Sewer Collection System for Scenario 4A.....	12-10
12.4.3	Sewer Collection System for Scenario 5A.....	12-13
12.5	Proposed Pumping Stations	12-15

12.6	Collection System Costs.....	12-18
12.6.1	Collection System Capital Costs.....	12-18
12.6.2	Collection System O&M Costs	12-19
12.7	Treatment Technology Evaluations.....	12-20
12.7.1	Key Evaluation Criteria	12-20
12.7.2	Biological Treatment Technology Comparison.....	12-25
12.7.3	Recommended Technology	12-28
12.8	Estimated Wastewater Treatment Flows and Loads.....	12-29
12.9	Treatment Facility Costs	12-31
12.10	Estimated Costs for Scenarios 3A, 4A and 5A.....	12-31

Section 13 - Recommended Program

13.1	Introduction.....	3-1
13.2	CWMP Recommended Program to Meet MEP Requirements, Traditional Resource Management Needs and Other Town Needs	3-1
13.2.1	Recommended Sewer System Master Plan.....	3-2
13.2.2	Neighboring Towns with Shared MEP Watersheds.....	3-5
13.2.3	Recommended Collection System Technology	3-6
13.2.4	Recommended Treatment Technology.....	3-7
13.2.5	Revised System Wide Flows	3-7
13.2.6	Treatment Facility Flows and Nitrogen Limits.....	3-10
13.3	Updated Capital and O&M Costs.....	3-11
13.3.1	Collection System Capital Costs.....	3-11
13.3.2	Treatment Facility Capital Costs.....	3-12
13.3.3	Treatment and Collection System Capital Cost Summary.....	3-12
13.3.4	Chatham Treatment Facility O&M Costs.....	3-12
13.3.5	Harwich Collection System O&M Costs	3-13
13.3.6	HR-12 Treatment Facility O&M Costs	3-14
13.3.7	Treatment and Collection System O&M Costs Summary.....	3-14
13.3.8	Recommended Program Cost Summary	3-15
13.4	Wastewater Phasing Plan	3-15
13.4.1	Wastewater Phasing Plan Issues	3-16
13.4.2	Wastewater Phasing Program by Phase.....	3-18
13.4.3	Wastewater Phasing Plan Costs by Phase	3-23
13.4.4	MEP issues related to wastewater phasing.....	3-24
13.4.5	Effluent Recharge Related to Wastewater Phasing	3-24
13.5	Natural Attenuation Projects Cold Brook and Muddy Creek	3-25
13.5.1	Saquatucket Natural Attenuation Project (Cold Brook)	3-26
13.5.2	Pleasant Bay Natural Attenuation Project (Muddy Creek).....	3-27
13.6	Recommended Cost Recovery Plan.....	3-27
13.7	Other Recommended Program Components.....	3-29
13.7.1	Public Outreach	3-29
13.7.2	Fertilizer Education.....	3-30
13.7.3	Stormwater BMP's.....	3-31
13.7.4	Freshwater Ponds Evaluation, Sampling and Restoration	3-32
13.7.5	Continued Salt Water Sampling	3-34
13.7.6	Low Impact Landscaping	3-34

13.7.7	Water Conservation Programs	3-34
13.7.8	Inflow Prevention Programs.....	3-35
13.7.9	On-site System Support.....	3-35
13.7.10	School Education Programs.....	3-36
13.7.11	Board of Health Regulatory Review	3-36
13.7.12	Innovative and Alternative Technologies Committee.....	3-36
13.7.13	Land Use	3-36
13.8	Adaptive Management Plan (AMP).....	3-37
13.8.1	Adaptive Management Plan Scope	3-37
13.9	Alternative Technologies.....	3-39
13.9.1	Solar Photovoltaic Array.....	3-40
13.10	Alternatives to the Recommended Program.....	3-40
13.10.1	No-Build Alternative	3-40
13.10.2	Regional Solutions	3-42
13.10.3	Construct a Smaller or Larger Sewer Service Area	3-42

List of Figures

Figure 1-1	Locus Map	1-3
Figure 1-2	Harwich & Surrounding Towns	1-4
Figure 1-3	Land Use 1951 and 1999.....	1-5
Figure 1-4	Watershed Boundaries.....	1-7
Figure 3-1	Groundwater Contours	3-4
Figure 3-2	Depth to Groundwater.....	3-5
Figure 3-3	Defined Wetlands.....	3-6
Figure 3-4	Overview of Flood Zones.....	3-8
Figure 3-5	National Heritage and Endangered Species Program	3-9
Figure 3-6	Surficial Geology.....	3-10
Figure 3-7	NRCS Soil Classification	3-12
Figure 3-8	Parcel and District Zoning 2007	3-13
Figure 3-9	Lot Development Density.....	3-14
Figure 3-10	Drinking Water Supplies.....	3-16
Figure 3-11	Title 5 Environmentally Sensitive Areas	3-19
Figure 3-12	Areas of Title 5 Concern	3-21
Figure 3-13	Package Treatment Sites.....	3-23
Figure 4-1	Public Water Supply and Wells	4-2
Figure 4-2	Nitrate Results for All Public Drinking Water Supply Wells	4-7
Figure 4-3	USGS and Groundwater Wells	4-8
Figure 4-4	Long Term Fecal Coliform Sampling Results	4-12
Figure 5-1	Harwich Ponds.....	5-2
Figure 5-2	Impairment Status of Fresh Water Ponds in Harwich.....	5-3
Figure 5-3	Pond Water Quality.....	5-23
Figure 6-1	Flow Chart of MEP Study Assessment Allen Harbor Algae Bloom Summer, 2007	6-6

Figure 6-2	Town of Harwich Estuary Watersheds	6-7
Figure 6-3	Allen Harbor System.....	6-8
Figure 6-4	Total Nitrogen Loading in the Allen Harbor Watershed, Including Natural Deposition	6-9
Figure 6-5	Total Controllable Nitrogen Loading in the Allen Harbor Watershed.....	6-9
Figure 6-6	Allen Harbor Monitoring Stations	6-11
Figure 6-7	Wychmere Harbor System	6-15
Figure 6-8	Total Nitrogen Loading in the Wychmere Harbor Watershed Including Natural Deposition	6-16
Figure 6-9	Total Controllable Nitrogen Loading in the Wychmere Harbor Watershed	6-16
Figure 6-10	Wychmere Harbor Monitoring Stations.....	6-18
Figure 6-11	Saquatucket Harbor System.....	6-22
Figure 6-12	Total Nitrogen Loading in the Saquatucket Harbor Watershed, Including Natural Deposition	6-23
Figure 6-13	Total Controllable Nitrogen Loading in the Saquatucket Harbor Watershed	6-23
Figure 6-14	Saquatucket Harbor Monitoring Stations	6-25
Figure 6-15	Pleasant Bay Sub-Watersheds in Harwich	6-30
Figure 6-16	Total Nitrogen Loading in the Pleasant Bay Watershed, Including Natural Deposition	6-32
Figure 6-17	Total Controllable Nitrogen Loading in the Pleasant Bay Watershed	6-32
Figure 6-18	Total Nitrogen Loading in the Muddy Creek Subwatershed, Including Natural Deposition	6-33
Figure 6-19	Total Controllable Nitrogen Loading in the Muddy Creek Subwatershed	6-34
Figure 6-20	Water Quality Monitoring Stations in Pleasant Bay	6-37
Figure 6-21	Harwich Sub-Watershed Boundaries in Pleasant Bay.....	6-41
Figure 6-22	Herring River System.....	6-44
Figure 6-23	Total Nitrogen Loading in the Herring River Watershed, Including Natural Deposition	6-45
Figure 6-24	Total Controllable Nitrogen Loading in the Herring River Watershed.....	6-45
Figure 6-25	Herring River Monitoring Stations	6-47
Figure 6-26	Watershed Septic Load Reductions	6-52
Figure 7-1	Average Annual Totals for Monthly Pumpage from the Harwich Municipal Water System between 2001 and 2007.....	7-2
Figure 7-2	Monthly Water Use and Wastewater Estimate – 2004 to 2007	7-11
Figure 8-1	Drinking Water Sources	8-2
Figure 8-2	Pond Water Quality.....	8-5
Figure 8-3	Title 5 Summary	8-8
Figure 8-4	Allen Harbor Watershed Development.....	8-11
Figure 8-5	Wychmere Harbor Watershed Development	8-12
Figure 8-6	Saquatucket Harbor Watershed Development.....	8-13
Figure 8-7	Pleasant Bay Watershed Development	8-1
Figure 8-8	Herring River Watershed Development.....	8-15

Figure 8-9	Percent Nitrogen Removal in Typical Nitrogen Treatment Systems.....	8-16
Figure 8-10	Typical Nitrogen Effluent Levels by Treatment System	8-16
Figure 8-11	Town of Harwich Village Centers	8-18
Figure 8-12	Harwich Wastewater Needs Summary	8-21
Figure 9-1	Flowchart of Site Screening Selection Process.....	9-2
Figure 9-2	Site Screening Criterion 1 Zone of Contribution	9-5
Figure 9-3	Site Screening Criterion 2 Minimum Parcel Size	9-7
Figure 9-4	Site Screening Criterion 3 100-year Flood Zone.....	9-8
Figure 9-5	Site Screening Criterion 4 Soil Permeability.....	9-9
Figure 9-6	Site Screening Criterion 5 Undevelopable Town Owned Property	9-11
Figure 9-7	Site Screening Criterion 6 Wetlands	9-12
Figure 9-8	Site Screening Criterion 7 Depth to Groundwater	9-13
Figure 9-9	Site Screening Criterion 8 NHESP Areas	9-15
Figure 9-10	Site Screening Criterion 9 Zone II Areas	9-16
Figure 9-11	Site Screening Criterion 10 Town Owned Parcels.....	9-17
Figure 9-12	Initial Site Screening Summary.....	9-20
Figure 9-13	Comprehensive Wastewater Management Plan Preliminary Site HR-1	9-28
Figure 9-14	Comprehensive Wastewater Management Plan Preliminary Site HR-6	9-29
Figure 9-15	Comprehensive Wastewater Management Plan Preliminary Site HR-7	9-30
Figure 9-16	Comprehensive Wastewater Management Plan Preliminary Site HR-12	9-31
Figure 9-17	Comprehensive Wastewater Management Plan Preliminary Site OW-2.....	9-32
Figure 9-18	Comprehensive Wastewater Management Plan Preliminary Site SH-1.....	9-33
Figure 9-19	Comprehensive Wastewater Management Plan Preliminary Site SH-2.....	9-34
Figure 9-20	Comprehensive Wastewater Management Plan Preliminary Site SH-3.....	9-35
Figure 9-21	Comprehensive Wastewater Management Plan Preliminary Site PB-3.....	9-36
Figure 9-22	Comprehensive Wastewater Management Plan Preliminary Site PB-9.....	9-37
Figure 10-1	Nitrogen Balance for a Typical Nitrogen Limited Watershed: 10 Households.....	10-4
Figure 10-2	Nitrogen Balance for a Typical Nitrogen Limited Watershed: Multiple Watersheds	10-5
Figure 10-3	Saquatucket Harbor Groundwater Flow and Natural Attenuation.....	10-9
Figure 10-4	Baseline Scenario (No Attenuation)	10-11
Figure 10-5	Baseline Scenario (With Attenuation).....	10-13
Figure 10-6	Effluent Recharge Sites for Scenarios 1A – 8A.....	10-15
Figure 10-7	Scenario 1A.....	10-19

Figure 10-8	Scenario 2A.....	10-20
Figure 10-9	Scenario 3A.....	10-21
Figure 10-10	Scenario 4A.....	10-23
Figure 10-11	Scenario 5A.....	10-24
Figure 10-12	Scenario 6A.....	10-25
Figure 10-13	Scenario 7A.....	10-26
Figure 10-14	Scenario 8A.....	10-27
Figure 11-1	Effluent Recharge Sites.....	11-2
Figure 11-2	Mounding Simulation 1	11-5
Figure 11-3	Mounding Simulation 2	11-6
Figure 11-4	Mounding Simulation 3	11-7
Figure 11-5	Percent Recharge Change	11-9
Figure 12-1	Sewer Scenario 3A	12-11
Figure 12-2	Sewer Scenario 4A	12-12
Figure 12-3	Sewer Scenario 5A	12-14
Figure 12-4	All Sewer Scenarios	12-16
Figure 12-5	Schematic Diagram of the SBR Process.....	12-21
Figure 12-6	Schematic Diagram of an Oxidation Ditch Process	12-23
Figure 12-7	Schematic Diagram of the MBR Process	12-24
Figure 13-1	Recommended Areas to be Sewered.....	13-3
Figure 13-2	Watershed ?Septic load Reductions	13-4
Figure 13-3	Recommended Phasing Plan.....	13-21
Figure 13-4	Recommended Phasing Plan Buildout Parcels.....	13-22
Figure 13-5	Percent Nitrogen Removal For Several Treatment Technologies	13-41

List of Tables

Table 3-1	Summary of GIS Data Sources	3-2
Table 3-2	Data Obtained from the Cape Cod Commission	3-3
Table 3-3	Prevalence of Densely Developed Lots by Size	3-15
Table 3-5	FAST Systems in Harwich.....	3-25
Table 3-6	Bioclere Systems in Harwich	3-26
Table 4-1	Harwich Drinking Water Wells	4-3
Table 4-2	Data Reported on Harwich’s Annual Water Quality Reports, 2007 through 2011	4-4
Table 4-3	Harwich Beach Sampling Results, 2007 through 2011.....	4-9
Table 5-1	Harwich Ponds Sampled by the PALS Program	5-1
Table 5-2	Carlson Trophic Status Index Metrics.....	5-6
Table 5-3	CCC Pond Water Quality Guidelines.....	5-7
Table 5-4	Harwich Ponds Health Assessment Summary and Recommendations.....	5-21

Table 6-1	Sentinel and Check Monitoring Stations with Associated Nitrogen Limits For Allen Harbor	6-10
Table 6-2	Attenuated Septic Loading in the Allen Harbor Watershed*	6-12
Table 6-1A	Sentinel and Check Monitoring Stations with Associated Buildout Nitrogen Limits for Allen Harbor	6-13
Table 6-2A	Attenuated Buildout Septic Loading in the Allen Harbor watershed*	6-13
Table 6-3	Sentinel and Check Monitoring Stations with Associated Nitrogen Limits for Wychmere Harbor	6-17
Table 6-4	Attenuated Septic Loading in the Wychmere Harbor Watershed	6-19
Table 6-3A	Sentinel and Check Monitoring Stations with Associated Buildout Nitrogen Limits for Wychmere Harbor	6-20
Table 6-4A	Attenuated Buildout Septic Loading in the Wychmere Harbor Watershed*	6-20
Table 6-5	Sentinel and Check Monitoring Stations with Associated Nitrogen Limits for Saquatucket Harbor	6-26
Table 6-6	Attenuated Septic Loading in the Saquatucket Harbor watershed*	6-26
Table 6-5A	Sentinel and Check Monitoring Stations with Associated Buildout Nitrogen Limits for Saquatucket Harbor	6-27
Table 6-6A	Attenuated Buildout Septic Loading in the Saquatucket Harbor Watershed* with Enhanced Attenuation.....	6-28
Table 6-7	Sentinel and Check Monitoring Stations with Associated Nitrogen Limits for the Pleasant Bay System	6-38
Table 6-7A	Sentinel and Check Monitoring Stations with Associated Nitrogen Limits for the Pleasant Bay System	6-38
Table 6-8	Attenuated Septic Loading in the Harwich Portion of the Pleasant Bay Watershed* with Revised Muddy Creek Opening	6-39
Table 6-9	Attenuated Septic Loading in the Pleasant Bay Watersheds (within the Town of Harwich Boundaries)	6-40
Table 6-8A	Attenuated Buildout Septic Loading in the Harwich Portion of the Pleasant Bay watershed*	6-40
Table 6-9A	Attenuated Septic Buildout Loading in the Pleasant Bay Watersheds (within the Town of Harwich Boundaries)	6-40
Table 6-10	Sentinel Monitoring Station with Associated Nitrogen Limit for the Herring River system	6-46
Table 6-11	Attenuated Septic Loading in the Herring River Watershed*	6-48
Table 6-11A	Buildout Attenuated Septic Loading in the Herring River System.....	6-48
Table 6-12	Unattenuated Buildout Septic Loading in the Herring River System by Community.....	6-49
Table 6-13	Decrease in Present Attenuated Septic Loading Required to Meet Established TMDL Thresholds.....	6-51
Table 6-13A	Decrease in Buildout Attenuated Septic Loading Required to Meet Established TMDL Thresholds.....	6-51
Table 7-1	Town of Harwich GIS Water Use Records (2004-2007).....	7-3
Table 7-2	Water Use Data for Five MEP Watersheds.....	7-4
Table 7-3	Percentage of Water Use Consumption.....	7-4

Table 7-4	Town of Harwich Billing Records Compared to MEP data by Watershed (2004-2007)	7-4
Table 7-5	Existing and Buildout Wastewater Estimates.....	7-5
Table 7-6	Residential MEP Water Use Estimates	7-6
Table 7-7	Commercial and Industrial MEP Water Use Estimates	7-7
Table 7-8	Rainfall Adjustment – Method 1	7-8
Table 7-9	Rainfall Adjustment – Method 2	7-9
Table 7-10	Rainfall Adjustment – Method 3	7-9
Table 7-11	Recommended Rainfall Adjustment for Dry Years.....	7-10
Table 7-12	2004 to 2007 Monthly annual average water and Wastewater flow (MGD)	7-12
Table 7-13	Seasonal Wastewater Flow Ratios	7-12
Table 8-1	Freshwater Quality and Associated Needs.....	8-4
Table 8-2	Water Quality Determination Based on MEP Findings	8-9
Table 8-3	MEP Nitrogen Reduction Goals by Watershed – Present Conditions	8-9
Table 8-4	MEP Nitrogen Reduction Goals by Watershed – Buildout Conditions.....	8-10
Table 9-1	GIS Database Sources Utilized during Site Screening Analysis.....	9-4
Table 9-2	Preliminary Effluent Recharge Site Screening Criteria Analysis	9-18
Table 9-3	Final Effluent Recharge/WWTF Site	9-27
Table 10-1	Required Attenuated Nitrogen Load Reduction in MEP Watersheds	10-2
Table 10-2	Example Nitrogen Loading Spreadsheet for Saquatucket Harbor	10-7
Table 10-3	Cost Comparison Between Baseline and Baseline Attenuation, Collection System Only.....	10-14
Table 10-4	Summary of Treatment and Effluent Recharge Sites	10-17
Table 10-5 A	Wastewater Scenarios Summary Table : Length of Force Mains.....	10-30
Table 10-5 B	Wastewater Scenarios Summary Table : Collection and Treatment Costs.....	10-30
Table 10-5 C	Wastewater Scenarios Summary Table : Total O&M Costs	10-30
Table 10-5 D	Wastewater Scenarios Summary Table : Equivalent Annual Cost (includes Collection treatment and O&M Costs)	10-30
Table 10-6	Wastewater Scenarios Cost Per Pound of Nitrogen Removed	10-31
Table 11-1	Simulation Results Summary	11-4
Table 11-2	Water Use Data for Five MEP Watersheds.....	11-8
Table 12-1	Scenario 3A Wastewater Flows.....	12-8
Table 12-2	Scenario 4A Wastewater Flows.....	12-8
Table 12-3	Scenario 5A Wastewater Flows.....	12-9
Table 12-4	Summary of Wastewater Flows	12-9
Table 12-4	Town of Harwich Share of the Collection Treatment and O&M System Costs to connect to the Chatham System	12-13
Table 12-6	Pumping Stations and Estimated Flows for Options 3A, 4A and 5A	12-17
Table 12-7	Estimated Collection System Costs	18
Table 12-8	Operation and Maintenance Cost Summary for Buildout Conditions	12-19

Table 12-9 Comparisons of Three Treatment Technologies: Advantages and Disadvantages.....	12-26
Table 12-10 Matrix Assessment for Recommending Harwich WWTP Technology.....	12-28
Table 12-11 Buildout Seasonal Wastewater Flows and Peaking Factors.....	12-30
Table 12-12 Estimated Average Wastewater Concentrations	12-31
Table 12-13 Treatment Facility Construction Costs	12-31
Table 13-1 Recommended Plan Wastewater Flows (Scenario 5A with Additional Areas and Build-out Update).....	13-9
Table 13-2 HR-12 Facility Estimated Design Flows at Build-out.....	13-10
Table 13-3 Estimated Collection System Capital Costs	13-11
Table 13-4 Estimated Treatment Facility Capital Costs.....	13-12
Table 13-5 Estimated Collection and Treatment System and O&M Annual Costs	13-12
Table 13-6 Town of Harwich Share of the Collection and Treatment System Costs to connect to the Chatham System	13-13
Table 13-7 Operation and Maintenance Cost Summary for Build-out Conditions	13-13
Table 13-8 Estimated HR-12 Treatment Facility O&M Costs	13-14
Table 13-9 Estimated Collection and Treatment System Annual O&M Costs	13-15
Table 13-10 Estimated Collection and Treatment System and O&M Annual Costs	13-15
Table 13-11 Wastewater Flows by Phase.....	13-20
Table 13-12 Details of Phasing Plan Costs by Phases 1-8.....	13-23
Table 13-13 Details of Phasing Plan Costs by Phases 1-8.....	13-28
Table 13-14 Timeline for Phasing Plan Costs by Phases 1-8	13-29
Table 13-15 Harwich Ponds Health Assessment Summary and Recommendations.....	13-33

Appendices (CD Map Pocket)

Appendix A	Public Presentations Community Meetings Frequently Asked Questions
Appendix B	MEP Memos Electronic Links for the five MEP reports in Harwich
Appendix C	Nitrogen Loading Spreadsheets Scenarios 1A to 8A detailed cost spreadsheets
Appendix D	Hydrogeological Report
Appendix E	Regional Connection to Chatham Memorandum
Appendix F	Solar Array Contract at Site HR-12

List of Acronyms

A

Adaptive Management Plan (AMP)
Administrative Consent Order (ACO)
Areas of Critical Environmental Concern (ACECs)

B

Best Management Practices (BMP)
Biochemical oxygen demand, decomposition over 5-day period (BOD)
Board of Health (BOH)
Bordering Land Subject to Flooding (BLSF)
Bordering Vegetated Wetland (BVW)

C

Cape and Vineyard Electric (CVEC)
Cape Cod Commission (CCC)
Citizens Advisory Committee (CAC)
Clean Water Act (CWA)
Clean Water State Revolving Fund (CWSRF)
Coastal Zone Management (CZM)
Code of Massachusetts Regulations (CMR)
Community Development Partnership (CDP)
Community Preservation Act (CPA)
Comprehensive Wastewater Management Plan (CWMP)
County Home Ownership Fund (CHOP)

D

Department of Public Health (DPH)
Department of Public Works (DPW)
Development of Regional Impact (DRI)
Digital elevation model (DEM)
District of Critical Planning Concern (DCPC)
Dissolved Oxygen (DO)
Division of Fisheries and Wildlife (DFW)

E

East Harwich Village Center (EHVC)
Engineering News Record (ENR)
Environmental Impact Report (EIR)

Environmental Impact Statement (EIS)
Environmental Notification Form (ENF)
Equivalent Dwelling Units (EDUs)
Equivalent Annual Cost (EAC)
Executive Office of Energy and Environmental Affairs (EOEEA)

F

Fixed Activated Sludge Treatment (FAST)
Federal Emergency Management Authority (FEMA)

G

Gallons per capita per day (gpcd)
Gallons per day (gpd)
Gallons per day per inch-diameter-mile of new pipe (gpd/idm)
Geographic Information Systems (GIS)
Groundwater Discharge Permit (GWDP)

H

Harwich Ecumencial Council for the Homeless (HECH)
Housing Assistance Corporation (HAC)

I

Infiltration and inflow (I/I)
Innovative / Alternative (I/A)
Interim Wellhead Protection Area (IWPA)
Intended Use Plan (IUP)
Isolated Land Subject to Flooding (ILSF)

J

K

potassium hydroxide (KOH)

L

Land Subject to Coastal Storm Flowage (LSCSF)
Leadership in Energy and Environmental Design (LEED)
Local Comprehensive Plan (LCP)

M

Massachusetts Alternative Septic System Test Center (MASSTC)
Massachusetts Cultural Resource Information System (MACRIS)

Massachusetts Department of Environmental Management (MassDEM)
 Massachusetts Department of Environmental Protection (MassDEP)
 Massachusetts Department of Public Health (MDPH)
 Massachusetts Department of Transportation (MassDOT)
 Massachusetts Endangered Species Act (MESA)
 Massachusetts Environmental Policy Act (MEPA)
 Massachusetts Estuaries Project (MEP)
 Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA)
 Massachusetts General Laws (M.G.L.)
 Massachusetts Historical Commission (MHC)
 Massachusetts Office of Geographic and Environmental Information (MassGIS)
 Maximum Contaminant Level (MCL)
 Membrane Bioreactors (MBRs)
 Milligrams per liter (mg/L)
 Million gallons per day (MGD)
 Mixed liquor suspended solids (MLSS)
 Municipal Separate Storm Sewer Systems (MS4)

N

National Pollutant Discharge Elimination System (NPDES)
 Natural Heritage and Endangered Species Program (NHESP)
 Natural Resource Conservation Service (NRCS)
 Natural Resource Protection District (NRPD)
 New England Water Environment Association (NEWEA)
 Nitrogen (N)
 Not Applicable (N/A)
 Notice of Intent (NOI)

O

Operations and maintenance (O&M)
 Oxidation Ditch (OD)

P

parts per million (ppm)
 Permeable Reactive Barrier (PRB)
 Photovoltaic (PV)
 Pond and Lakes Stewards (PALS)

Q

R

Real Estate Transfer (RET)
Right-of-way (ROW)
Rotating Biological Contactor (RBC)

S

Safe Drinking Water Act (SDWA)
Septic Tank Effluent Gravity (STEG)
Septic Tank Effluent Pumping (STEP)
Sequencing Batch Reactor (SBR)
Single Environmental Impact Report (SEIR)
School of Marine Science and Technology at the University of Massachusetts Dartmouth (SMAST)
State Revolving Fund (SRF)
Storm Water Pollution Prevention Plan (SWPPP)

T

Technical Assistance Program (TAP)
Technical Review Committee (TRC)
Total kjeldahl nitrogen (TKN)
Total Maximum Daily Load (TMDL)
Total nitrogen (TN)
Total organic carbon (TOC)
Total suspended solids (TSS)
Trophic Status Index (TSI)

U

United States Geological Survey (USGS)
United States Department of Agriculture (USDA)
United States Environmental Protection Agency (USEPA) or (EPA)
United States Geological Survey (USGS)
University of Massachusetts (UMass)

V

W

Wastewater Implementation Advisory Committee (WIAC)

Wastewater Management Subcommittee (WMS)

Wastewater Treatment Facility (WWTF)

Water Pollution Control Facility (WPCF)

Water Quality Management Task Force in Harwich (WQMTF) or (HWQMTF)

Water Quality Review Committee (WQRC)

X

Y

Z

Zone of Contribution (ZOC)