

TABLE OF CONTENTS

Page

EXECUTIVE SUMMARY
TABLE OF CONTENTS
GLOSSARY OF COMMON ACRONYMS

CHAPTER 1 - INTRODUCTION

1.1	Report Background and Purpose	1-1
1.2	Project Purpose and Planning Area.....	1-1
1.3	Project Issues and Background	1-2
1.4	Town of Barnstable Vision and Goals as Articulated in the Barnstable Comprehensive Plan	1-12
1.5	Project Scope	1-14
1.6	Summary of Phase I Activities	1-17
1.7	Summary of Phase II Activities	1-18
1.8	Planned Public Review	1-22
1.9	Planned Environmental Review.....	1-23
1.10	Planning Period.....	1-23
1.11	Purpose and Organization of the Alternatives Screening Analysis Report	1-23

CHAPTER 2 - SCREENING APPROACH AND CRITERIA

2.1	Introduction.....	2-1
2.2	Methodology for Identification and Screening of Alternative Technologies	2-1

CHAPTER 3 – INDIVIDUAL ON-SITE SYSTEM AND CLUSTER SYSTEM ALTERNATIVES

3.1	Introduction.....	3-1
3.2	Individual On-Site Systems	3-4
3.3	Cluster Treatment Systems	3-34
3.4	Screening of Alternative Decentralized Technologies	3-35

CHAPTER 4 - ALTERNATIVES FOR CENTRALIZED AND SATELLITE WASTEWATER TREATMENT FACILITIES AND SITES

4.1	Introduction.....	4-1
4.2	Overview of Barnstable’s Existing Municipal Wastewater Treatment Facilities	4-2
4.3	Secondary/Advanced Wastewater Treatment Technologies	4-3
4.4	Technologies to Achieve Less Than 3 mg/L Total Organic Carbon	4-29
4.5	Technologies to Achieve Less Than 3 mg/L Total Nitrogen.....	4-43
4.6	Considerations on Treatment Alternatives for Phosphorus	4-45
4.7	Disinfection Alternatives	4-46
4.8	Residuals Management	4-49
4.9	Satellite Wastewater Treatment Facilities Incorporating Nitrogen Removal	4-59
4.10	Identification of Wastewater Treatment Sites.....	4-65
4.11	Alternatives for Treatment System Expansion and Upgrade at the Hyannis WPCF.....	4-65

TABLE OF CONTENTS (continued)

	<u>Page</u>
CHAPTER 5 - TREATED WATER RECHARGE TECHNOLOGIES AND ALTERNATIVE SITES	
5.1 Introduction.....	5-1
5.2 Identification of Treated Water Recharge Technologies	5-2
5.3 Screening of Treated Water Recharge Technologies.....	5-10
5.4 Wastewater Treatment Issues and Requirements for Treated Water Recharge at New Remote Sites	5-12
5.5 Site Identification for Treated Water Recharge and New Treatment Facilities	5-13
CHAPTER 6 - COLLECTION SYSTEM TECHNOLOGIES	
6.1 Introduction.....	6-1
6.2 Collection System Alternatives.....	6-1
CHAPTER 7 - FLOW AND LOADING REDUCTION ALTERNATIVES	
7.1 Introduction.....	7-1
7.2 Infiltration and Inflow (I/I) Reduction.....	7-1
7.3 Reduction of Household Water Consumption	7-2
7.4 Pricing Policy for Water and Wastewater Service.....	7-2
7.5 Wastewater Reuse and Recycling.....	7-3
7.6 Reduction of Wastewater Loadings	7-3
7.7 Waterless Toilets.....	7-4
7.8 Growth Management Regulation.....	7-4
7.9 Summary	7-5
CHAPTER 8 - ADDITIONAL NON-WASTEWATER NUTRIENT MITIGATION ALTERNATIVES	
8.1 Introduction.....	8-1
8.2 Reduction of Nitrogen from Fertilizers and Pet Wastes	8-1
8.3 Watershed Modifications and Constructed Wetlands for Nutrient Attenuation ..	8-4
8.4 Stormwater Management and Treatment.....	8-5
8.5 Estuarine Inlet Modifications for Increased Tidal Flushing	8-6
8.6 Mechanically Induced Tidal Flushing	8-7
8.7 Pond Treatment Options	8-8
8.8 Modified Zoning or Sewer Use Regulation	8-9
8.9 Nitrate Barrier Wall Considerations	8-10
8.10 Phosphorus Barrier Wall Considerations.....	8-10
8.11 Aquaculture to Harvest Nitrogen and/or Algae from the Estuaries.....	8-12

TABLE OF CONTENTS (continued)

	<u>Page</u>
CHAPTER 9 - ALTERNATIVE PLAN IDENTIFICATION AND FUTURE EVALUATIONS	
9.1 Introduction.....	9-1
9.2 No Action Alternative.....	9-1
9.3 Non-Wastewater Nitrogen Management Recommendations.....	9-2
9.4 Alternative Plan No. 1 – Decentralized Plan A	9-2
9.5 Alternative Plan No. 2 – Decentralized Plan B.....	9-3
9.6 Alternative Plan No. 3 – Centralized Plan A	9-3
9.7 Alternative Plan No 4 – Centralized Plan B	9-3
9.8 Alternative Plan No. 5 – Development of New Public Water supply Sites to Mitigate Impacts to Current Water Supplies from Septic Systems and from the Hyannis WPCF, and Use of Improved Decentralized and/or Centralized Facilities	9-4
9.9 Future Evaluations to Identify a Recommended Plan.....	9-4

LIST OF TABLES

<u>Table No.</u>	
3-1	Summary of Individual On-Site System and Cluster System Treatment Technologies
4-1	Summary of Secondary/Advanced Treatment Process Alternatives
4-2	Summary of Treatment Technologies to Achieve Less Than 3 mg/L TOC
4-3	Summary of Disinfection Technologies
4-4	Summary of Sludge Disposal Alternatives
4-5	Summary of BNR Capacity Addition Alternatives in Existing Footprint
4-6	BNR & ENR Capacity Upgrade Alternatives with TOC Removal Options
5-1	Summary of Treated Water Recharge Technologies
6-1	Summary of Sewer System Collection System Technologies

LIST OF FIGURES

<u>Figure No.</u>	
1-1	Location Map
1-2	Existing Septic System Nitrogen Removals to Meet Nitrogen TMDLs
3-1	Conventional Title 5 Septic System
3-2	Septic Tank Diagram
3-3	Infiltration Chamber Diagram
3-4	Leaching Trench Diagram
3-5	Composting Toilet Diagram

TABLE OF CONTENTS (continued)

LIST OF FIGURES (continued)

Figure
No.

3-6	Incinerating Toilet Diagram
3-7	Urine Source Separation
3-8	Recirculating Sand Filter
3-9	RUCK System Diagram
3-10	FAST Treatment System (Bio-Microbics)
3-11	Bioclere Treatment Units
3-12	Modular FAST Systems (Smith & Loveless)
3-13	Amphidrome System
3-14	Waterloo Biofilter
3-15	Advantex
3-16	Nitrex System
3-17	Septitech System
3-18	Singulair System
3-19	RUCK CFT System
3-20	Cromaglass System
3-21	Omni-Cycle System
3-22	Bio-Barrier MBR System
3-23	Nitrex Plus
3-24	Red Lily Pond Cluster System Site
4-1	Existing WPCF Site
4-2	Marstons Mills WWTF
4-3	Treatment System Components
4-4	Multiple-Stage Process Schematic
4-5	Multiple-Stage Processes for Nitrogen Removal
4-6	Multiple-Stage Cyclical Aeration
4-7	Membrane Bioreactor System
4-8	Oxidation Ditch
4-9	Sequencing Batch Reactor
4-10	Multiple Sludge Processes
4-11	Rotating Biological Contactor
4-12	Denitrifying Filter
4-13	Biological Aerated Filter
4-14	Amphidrome System
4-15	Integrated Fixed Film Activated Sludge (IFAS)
4-16	Constructed Wetlands
4-17	Solar Aquatics System
4-18	Coagulation and Filtration Process
4-19	Activated Carbon Contactors
4-20	Powdered Activated Carbon Contactors
4-21	Relative Spore Size of the Membrane Filtration Processes
4-22	Membrane Filtration
4-23	Sidestream Treatment for Membrane Reject Flows
4-24	MIEX Process

TABLE OF CONTENTS (continued)

LIST OF FIGURES (continued)

Figure No.

- 4-25 Sludge Processing and Disposal Alternatives
- 4-26 Example Layout for 10,000 gpd Satellite Sewage Treatment Facility
- 4-27 Example Layout for 35,000 gpd Satellite Sewage Treatment Facility
- 4-28 Example Layout for 110,000 gpd Satellite Sewage Treatment Facility
- 4-29 Satellite WWTF at New Silver Beach North Falmouth, MA
- 4-30 Private WWTF at Cotuit Landing Stop & Shop
- 4-31 Potential Expansion Areas at Hyannis WPCF
- 4-32 Biomag Process

- 5-1 Sand Infiltration Bed
- 5-2 Subsurface Infiltration
- 5-3 Spray Irrigation
- 5-4 Injection Well
- 5-5 Wick Well
- 5-6 Drip Irrigation
- 5-7 Wetland Restoration
- 5-8 Wastewater Facility Site Considerations
- 5-9 Treated Water Recharge Sites Identified in 2007 WWFP for Continued Evaluation

- 6-1 Existing Wastewater Collection System
- 6-2 Implementation Phasing of Sewer Extensions Proposed in Draft November 2008 Memorandum
- 6-3 Gravity Collection System
- 6-4 Typical Pump Stations
- 6-5 Low Pressure Grinder Pump System
- 6-6 Low Pressure Septic Tank Effluent Pumps (STEP) System
- 6-7 Vacuum Sewer System

LIST OF APPENDICES

Appendix

- 1-1 Town of Barnstable Wastewater Facilities Plan and Final Environmental Impact Report, Executive Summary and Table of Contents
- 1-2 Town of Barnstable Nutrient Management Project Scope, August 2008

- 4-1 Annotated Bibliography of Technologies to Remove Total Organic Carbon, Endocrine Disruptors, and Pharmaceuticals and Personal Care Products

- 5-1 Summary of Evaluations for Treated Water Recharge/Reuse Sites Evaluated in the 2007 WWFP

- 8-1 Summary of Pond Treatment Options
- 8-2 Research and Literature Review Papers on Shellfish Aquaculture and Reduced Nitrogen Impacts on Coastal Waters