DRAFT REPORT

Comprehensive Wastewater Management Plan; Phase II – Alternatives Analysis

Prepared for:
Town of Wellfleet, Massachusetts

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EXECUTIVE SUMMARY

1. INTRODUCTION

1.1 Background

The Town of Wellfleet is located on the outer arm of Cape Cod, has a classic seaside village character, and is surrounded with abundant natural resources. Bounded on the east by the Atlantic Ocean and on the west by Cape Cod Bay, 61% of the land area of Wellfleet is within the Cape Cod National Seashore. Wellfleet has a total upland area of approximately 13,100 acres (20.47 square miles). Of this total, about 8,000 acres (12.5 square miles) are within the Seashore boundaries, leaving 5,100 acres (8 square miles) outside. During the summer, the population increases six-fold from 2,750 year-round residents.

At the present time, on-site wastewater systems serve as the sole means of wastewater treatment and disposal management in Wellfleet, dominated by conventional Title 5 systems. Sampling and nitrate analysis of private drinking water supply wells obtained from the Board of Health indicate that the number of private wells with elevated nitrate levels has increased over the years. These data indicate that groundwater quality is declining, and on-site septic systems are believed to be the principal nitrate source. Therefore, to protect public health, the Town has developed a long-term water system plan that is expanding the municipal water system to areas in need of protection.

The Massachusetts Department of Environmental Protection (MassDEP) is concerned about possible eutrophication in coastal estuaries, and has undertaken the Massachusetts Estuaries Project (MEP) in Southeastern Massachusetts. This project develops nitrogen limits for the coastal estuaries located within their study area, including Wellfleet Harbor. These nitrogen limits will then become the regulatory limits that will be enforced by the State. The proposed Total Maximum Daily Load (TMDL) Report for Wellfleet Harbor is expected in 2014.

Water quality testing has shown that Wellfleet Harbor water quality is not impaired except for some impairment within the inner harbor. The state list of impaired waters, the 303(d) list, does not include Wellfleet Harbor as in need of a TMDL. Instead, Wellfleet Harbor is listed as Category 2, defined as meeting some designated uses and not assessed for others. Wellfleet's focus will remain on the harbor water quality, instead of specific nutrient load goals, to reach the designated Class SA water quality and meet the Clean Water Act goals.

The objectives for this Comprehensive Wastewater Management Plan (CWMP) include the following:

- Protect and enhance the harbor ecosystem and aquaculture base. The harbor is the life-blood of Wellfleet's shell fishing industry, and its protection and enhancement are paramount.

- Understand the nature of anthropogenic and natural sources of contamination/pollution from within the harbor and upstream (land side) including streams, storm water runoff, and groundwater impacted by septic systems.

- Collect sufficient information from the harbor and land/upstream sources to characterize the water quality and develop a reliable database of knowledge (using Geographic Information Systems (GIS)).

- Gain a meaningful understanding of the relationship between nitrogen concentrations and the overall health of shellfish populations.

- Based on solid science, promote aquaculture-based water quality management solutions as a practical and cost-effective approach, thus enhancing harbor water quality and the aquaculture industry.

- Evaluate the water quality in the Town's inland kettle ponds to determine their overall health and identify potential threats from anthropogenic and natural nutrient sources.

- Conduct the town-wide comprehensive wastewater management planning process in a measured and step-by-step fashion to present a clear understanding of wastewater management needs of the Town.

- Identify low cost and sustainable remedies (better storm water management, seasonal summer home education program) as warranted.

- Develop least-cost approaches to address identified sources, expedite water quality improvements, and establish a road map for future water quality enhancements initiatives.

- As a final resort only, engage in structured solutions (i.e. pipes, pumps, treatment systems).

1.2 Phase I Summary

The interim Needs Assessment and Alternatives Analysis Report was completed and delivered in June 2012 . The Needs Assessment compiled previous studies and an extensive amount of data related to harbor water quality, septic systems, wells, and groundwater. Based on data entered into the GIS database and subsequent data base querying, watersheds within the town were evaluated using five (5) parameters.

1. Wastewater loads
2. Well samples tested >2 mg/L for nitrates
3. Septic systems within 100' of drinking water supply well
4. Septic system located where water table <10' deep
5. Percent of I/A systems

Based on these parameters, and the receiving water quality, four watersheds have been identified for evaluation of alternatives. Figure 1-1 shows the delineation of watersheds Chipmans Cove, Duck Creek, Wellfleet Harbor A, and Wellfleet Harbor B. Table 1-1 provides the parameters of concern for each watershed.

Table 1-1: Parameters of Concern and Ranking of the Four Study Watersheds

	Wastewater Loads (> 200 gpd/acre)	Nitrates (>2 mg/l)	Septic System w/in 100 ft. of Well	Septic System located where Water Table Water Table is < than 10 ft.	% of Systems that are I/A Systems	Total Score
Chipmans Cove	1	1	0	0	1	3
Duck Creek	1	1	1	0	1	4
Wellfleet Harbor A	1	1	0	0	1	3
Wellfleet Harbor B	1	1	0	1	1	4

The primary concern in the level of nitrates in the groundwater, likely caused by the density of the wastewater loads. Existing loadings for each watershed are presented in Table 1-2

Table 1-2: Wastewater Loading per Acre from Onsite Wastewater (Septic) Systems

Marine Estuary	Area (acres)	Title 5 Design flow (gpd)	Flow/acre (gpd/ac)
Chipmans Cove	597	148,422	249
Duck Creek*	565	211,446	374
Wellfleet Harbor A	118	50,939	432
Wellfleet Harbor B	79	25,960	329
Total	**1,359**	**436,767**	**321**

*Subtracted 305 acres of CCNS from watershed

Nitrates are a threat to harbor water quality and drinking water quality. Harbor water sampling data showed relatively low dissolved oxygen coupled with some high chlorophyll *a* levels, suggesting that nutrient enrichment is degrading water quality in inner Wellfleet Harbor near the outlet of Duck Creek and Mayo Creek. The groundwater and the discharge from Mayo Creek appear to be sources of nitrogen to this location.

The Phase 1 Report screened alternative solutions and technologies, and recommends a multifaceted approach to wastewater management to provide the most cost-effective, sustainable, and least intrusive solution. Work completed to date indicates that the optimum approach for meeting Wellfleet's core wastewater management needs and long-term harbor water quality and drinking water quality goals would be a combination of the first four elements listed below. Only if that approach is insufficient should the subsequent, more structured solutions be considered. Regardless, this report evaluates all approaches to develop the costs, benefits, and impacts of each.

1. Natural Systems Remediation and Mitigation Solutions
    a. Aquaculture - Oyster Reefs
    b. Estuary and Salt Marsh Restoration and Flushing
2. Stormwater Management

3. Water System Expansion
4. On-Site Innovative/Alternative Systems
5. Cluster Systems
6. Central Wastewater Collection and Treatment

1.3 Projects Update

1.3.1 Natural Systems

The Wellfleet Comprehensive Wastewater Planning Committee and EPG have placed a high priority on pursuing natural remediation and mitigation solutions for wastewater management challenges that may exist. Salt marsh and oyster reef habitats are the main consumers and recyclers of nitrogen in the coastal environment as well as a critical link in addressing eutrophication from both anthropogenic and natural sources.

Harbor wide application of the pilot project results could produce one of the nation's first large scale TMDL compliance success stories; and attainment of the EPA "excellent" water quality classification by using aquaculture and salt marsh restoration in Wellfleet Harbor. Initial costs are on the order of 1/100th the cost of traditional alternatives.

1.3.1.1 *Wellfleet Harbor Sustainable Oyster Propagation Project*

Purpose and Scope

Oysters provide essential and important ecosystem services that healthy, coastal ecosystem require. Healthy oyster reefs provide the following ecological services:

- buffer erosion and sedimentation forces created by waves, currents and boat wakes;
- serve as habitat and substrate for dozens of forms of marine life;
- serve as a source of food for birds, marine organisms and humans;
- filter suspended solids, phytoplankton, and nutrients, which improves water quality and enhances conditions for other organisms such as eel grass.

In 2011, Wellfleet initiated a careful and measured approach that explores natural systems solutions. The first step in this approach was an oyster reef restoration/demonstration project located at the mouth of Duck Creek in the inner reaches of Wellfleet Harbor. MEP sampling indicted that this area of the inner harbor had relatively high nutrient levels. It is important to note that no federal or state designation lists the inner harbor as needing a TMDL (total maximum daily load), but water quality concerns have prompted the community to be proactive in the management of these waters.

Criteria for selecting this location included: it was relatively unproductive for shell fishing; was accessible and observable; was protected from potential storm damage; and could contribute to improving local water quality over time. Project planning and execution were carried out in cooperation with Dr. Anamarija Frankic from the University of Massachusetts in Boston, and the affiliated Green Boston Harbor project, as well as the Provincetown Center for Coastal Studies (PCCS), Wellfleet Shellfish Department, the Department of Public Works, and the Harbormaster.

The initial two acre demonstration project has achieved significantly higher oyster densities than reported in many other study areas, including Chesapeake Bay, Long Island, Narragansett and New Hampshire studies, and reduced nitrogen by 20% in the study area.

The goals of this project were as follows:

1. to establish a reef and sustainable oyster population over a roughly 2-acre area;

2. realize a new oyster population of up to 2 million within the project area, with water filtration rates as high as 100 million gallons per day;

3. reduce nitrogen content in the local waters by as much as 2,200 pounds per year;

4. provide a model for expansion of the reef complex to other areas of the harbor; and

5. demonstrate that reconstructed and sustainable oyster reefs can play a meaningful, and potentially significant role in meeting the Town's future nutrient loading goals.

Project Startup Activities (2011)

The pilot oyster propagation site shown in Figure 1-2 consists of approximately two acres at the mouth of Mayo and Duck Creeks. Several years of cultching (clam shell cultch) prepared a suitable hard substrate on which oyster spat settled and attached. In the Wellfleet oyster habitat restoration project, wild spawning brood stock was used to develop the oyster reef. The natural abundance of local wild seed lowers the restoration costs and helps maintain native oyster stock genetics, which is believed to support more locally disease resistant oyster strains.

Transects were established at the outset, and the study area was monitored regularly by the Green Boston Harbor staff. Within four months, multiple sets had occurred from native spawning cycles, and approximately 2-3 million oyster spat were growing on the cultch within the study area.

In support of the project's goals, a multi-parameter water quality monitoring plan was initiated in the harbor water surrounding the study site. In September 2011, a YSI Model 6600V2-4 unit was installed at the end of the marina pier as shown in Figure 1-2. The YSI unit was equipped with probes for the following parameters:

temperature	chlorophyll a	blue-green algae
dissolved oxygen	pH	conductivity
redox	salinity	total dissolved solids
turbidity		

Two monitoring wells were installed on the shoreline to the north-northwest of the oyster reef in order to monitor groundwater quality prior to discharging to Wellfleet Harbor. Subsurface geology at the monitoring well location consisted of fine to coarse sand from 0 to 12 feet below ground surface (bgs) underlain by gray clay with little sand and trace silt from 12 to 35 feet bgs, and then underlain by more fine to coarse sand from 35 to 40 feet bgs. The total depth of the boring was 40 feet. The water table was encountered at a depth of 7 feet bgs. The location stratigraphy indicated that groundwater from two discrete zones may be discharging into Wellfleet Harbor, a shallow and a deep. As a result, two observation wells were installed, one well was installed across the water table and was screened from 4 to 14 feet bgs (designated MW-1S) and a deep well was installed with a well screen from 35 to 40 feet bgs (designated MW-1D).

The oyster demonstration project data from 2011 indicated that two to three years of monitoring and data collection and analyses would be needed to develop a sufficient baseline of data upon which solid scientific conclusions can be drawn.

The Oyster Propagation Project also includes provisions for a sustainable source of cultch for growth and expansion of the oyster beds, including specific efforts by contributing organizations:

- Oysterfest Shell Recycling; NOAA/SPAT
- Sea Clam Cultch Program; Wellfleet/USDA/MOP/SPAT
- Town-wide Shell Recycling; DPW/Transfer Station Collection

Ongoing Project Activities (2012-2013)

<u>Oyster Reef Development</u>

In 2012 and 2013, extensive monitoring of the oyster reef was performed to monitor reef development and effects on water quality in the study area. 2012 activities included:

1. Water samples were collected from a micro-grid of 7 sites as shown on Figure 1-3, including Mayo Creek, Mayo Creek Duck Bill, Channel, Transects 1-2-5, YSI probe.
2. YSI probe for water quality was activated on July 7, 2012.
3. Biodiversity assessment: counting common species, including predators/oyster drill.
4. Oyster count, abundance, survival and density – counting all oysters (alive and dead 'boxes"), using a quadrat.
5. 0.25m² square; manual counter and photographs.
6. Oyster measurements for the ground-truthing data – using quadrat 1 m²; and photographs.

Figure 1-4 shows photographs of the oyster reef development from 2011 through 2013 and Figure 1-5 is a graphic plot of the oyster population seasonally for 2012 and 2013. In 2011 the monitoring results estimated oyster abundance to be at 2 million oysters in the two acre project area. The 2012 monitoring results indicate that the current oyster abundance (including oyster spat) in the two acre project area was approximately 3.9 million oysters or about 494 oysters/m². The 2013 monitoring results indicate a continued increase in the oyster abundance, although not as large an increase as anticipated. Estimated oyster abundance in 2013 is 4.4 million oysters. This may in part be due to the harsh 2012-2013 winter storm conditions damaging or depositing sediment on the oyster reef.

With the re-establishment of oyster reefs in the Duck Creek area of Wellfleet Harbor, an increased abundance and appearance of other reef species was observed throughout the project site (Figure 1-6), including mussels, crabs, clams, snails, oyster drills, mud worms, horseshoe crab, barnacle, mite, and whelk. In addition, an increased abundance and appearance of other species was observed, including terrapins, grey heron, gulls, juvenile fish, shrimp and oyster catchers. These are summarized in more detail in the 2013 Report in Appendix A. While oysters are the largest remover of nitrogen from the water, the complete reef community of organisms is necessary to effectively improve water quality.

Water Quality Results

The Providence Center for Coastal Studies (PCCS) collected bi-monthly, water quality data from June through November, and once in May and October, in 2012 and 2013. Surface water and groundwater quality sample locations are shown on Figure 1-7 and include:

- Two groundwater monitoring wells at the point by the Wellfleet Harbor Cottages (one shallow water table well and one screened from 25-35 feet below ground surface, beneath a semi-confining silty and clay layer from 15-25 feet bgs)
- Three locations near the mouth of Mayo Creek;
- One location at the mouth of Duck Creek;
- Three locations across the oyster propagation zone (T-1, T-2, and T-3);
- Two locations along the marina channel;
- Two locations near the YSI site at the end of the marina pier;
- Three locations in the inner Wellfleet Harbor; and
- Two locations in the outer Wellfleet Harbor

Data collected included field or laboratory measurement of water quality parameters, including: Temperature, Specific Conductance, Salinity, Dissolved Oxygen, pH, Nitrate+Nitrite, Ortho-Phosphate, Ammonium, Silicate, Total Nitrogen, Total Phosphorous, Chlorophyll, Pheophytin, and Turbidity. The dedicated YSI 6600 meter multi-parameter meter was also deployed at the east end of the marina pier to collect insitu water quality measurements every 15 minutes.

Total nitrate concentrations at each sample location for spring and fall 2013 are shown on Figures 1-8. Groundwater quality monitoring results show that the three primary sources of nutrients to the Duck Creek Estuary are:

1. Groundwater discharging to surface water (Wells 1 and 2);
2. Surface water discharge from the duck bill at the mouth of Mayo Creek; and
3. Surface water from upstream Duck Creek.

The total nitrogen maps (Figure 1-8) show improvement in water quality from spring to fall 2013, which corresponds to the increased oyster population at the test site. Bar graphs showing the average total nitrogen concentrations at each sample location for 2012 and 2013 are presented in Figure 1-9. These data show that:

- The lowest total nitrogen concentrations are found in the transect locations over the oyster reef (T1, T2, and T3) and total nitrate concentrations in surface water over the oyster reef are consistent with or below concentrations in the outer Wellfleet Harbor locations.

- Nitrogen concentrations are lowest over the oyster reef propagation site and are at or below the MEP water quality threshold of 27 µM.
- Although source concentrations of nitrogen were higher in 2013 than 2012, concentrations of nitrogen over the oyster reef were only slightly higher in 2013 (Figure 1-10), indicating that the oysters are able to sequester the additional nitrogen concentrations.

Nitrogen monitoring data document improvement in water quality with continued development of the oyster reef. Other water quality parameters, including chlorophyll and blue-green algae were monitored to determine oyster reef development effects on water quality. Algal blooms can result from increased nutrients in the water column. Figure 1-11 shows the levels of chlorophyll measured at each monitoring station for 2012 and 2013. Chlorophyll concentrations (algal blooms) are lowest at the oyster reef propagation sites. Figure 1-12 shows the changes chlorophyll, blue-green algae and turbidity concentrations between 2012 and 2013. Although chlorophyll and blue-green algae concentrations at the duck bill source area have increased between to 2012 and 2013, these concentrations decreased over the oyster reef locations. In addition, chlorophyll levels are lowest at over the oyster reef propagation sites, even when compared with the open harbor sample locations (WH) and other locations within Cape Cod Bay (Figure 1-13).

1.3.1.2 *Oyster Reef Propagation Study Conclusions*

Nutrient degraded water quality is entering the Duck Creek estuary from two primary sources, the duck bill valve at the mouth of Mayo Creek and groundwater discharge to surface water. Duck Creek itself is a less significant source of nutrients.

Nutrient enrichment water quality data and oyster propagation monitoring results indicate that the development of an oyster reef at the mouth of Duck Creek in Wellfleet Harbor has had an immediate benefit on water quality within the estuary. Water quality, as indicated by low concentrations of nitrogen, chlorophyll and dissolved oxygen, is highest over the oyster reef, compared with surrounding monitoring locations. Water quality over the oyster reef is comparable with water quality in the outer Wellfleet Harbor area, where open circulation maintains water quality.

Coupled with upstream and land-side strategies, oyster propagation and reef restoration is a critical element to the Wellfleet CWMP. Compared to structured solutions, the natural systems approaches is a far more cost-effective solution for watersheds with marginal water quality degradation, such as Wellfleet and will have an immediate benefit to water quality.

As this pilot study has already shown, with healthy native populations of oysters, the startup costs are minimal, and the system requires very little, if any, maintenance. Lifecycle cost savings and socio-economic benefits associated with such natural systems are potentially enormous compared to traditional wastewater management systems. For this reason alone, the pilot project needs to continue and expand in scope.

1.3.2 Estuarine and Salt Marsh Restoration/Flushing

Salt marshes are one of the most productive ecosystems on earth. Salt marshes provide both environmental and economic benefits, including:

- Nutrient attenuation and cycling
- Nursery area for fish, crustacea, and insects
- Protection against waves and sea level rise
- Mosquito Control

From an environmental standpoint, salt marshes play a key role in estuarine health by aiding in nutrient attenuation and cycling; water quality improvement; and shoreline stabilization. In densely developed areas where stormwater runoff or septic system discharge can have high concentrations of pollutants and nutrients, salt marshes absorb the nutrients as they pass through estuary.

The critical role of salt marshes in maintaining and improving water quality in coastal embayments has been studied for decades. A 2007 study for MassDEP entitled: ***"Natural Attenuation of Nitrogen in Wetlands and Waterbodies"*** by the Woods Hole Group Inc. and Teal Partners concluded that: "…denitrification in wetlands was the most effective nitrogen removal mechanism from surface and ground water, followed in effectiveness by small ponds, large ponds and streams." Nitrogen attenuation percentages for salt marshes are reported to be between 40-50%, depending on site-specific conditions. The MEP uses nitrogen attenuation (removal) factors of 50% for ponds, 30% for streams and 40% for salt marshes for systems where site-specific information is not available.

For coastal salt marshes, the authors emphasized that the marshes be freely connected to tidal exchange so that they maintain pH and anoxic sediments that promote denitrification. The process occurs when low oxygen and high pH (low acidity) occur simultaneously, such as in marsh peat. When salt marshes are isolated by culverts or bridges they can become dominated by freshwater inputs, and the marsh environment can become aerated, with acidic soils. These conditions kill native vegetation and valuable organisms, significantly reducing the marsh's treatment value.

Two significant wetland areas in Wellfleet Harbor have been flow-restricted for decades, severely diminishing their potential effectiveness in the Wellfleet Harbor nutrient budget equation. They are the 1,100 acre Herring River estuary, and the 20 acre Mayo Creek estuary. Both areas are shown on Figure 1-14. The CCC *Technology Matrix* (January 2014) estimates a nitrogen removal rate of between 75% and 95% through culvert widening, which is defined as "Re-engineering and reconstruction of bridge or culvert openings to increase the tidal flux through the culvert or inlet". The actual removal rate would be site specific and dependent on the initial condition of the marsh. The CCC analysis assumes a freshwater wetland is restored to a salt water marsh. A more functional marsh under initial conditions would result in less improvement on a percentage basis.

<u>Herring River</u>

The Herring River has been the subject of an extensive Town and National Park Service (NPS) study, with the goal of substantially opening the mouth of the river to restore its large and diverse estuarine habitats. A Draft Environmental Impact Statement/Report (NPS, et al., 2012) issued in 2012 presents the overall plan to gradually increase the tidally influenced marsh area to approximately 900 acres in an adaptive management approach.

Neither the EIS/R nor the previous Herring River Tidal Restoration Project Conceptual Restoration Plan (Herring River Technical Committee, October 2007) evaluated the potential nitrogen removal mechanisms in the Herring River estuary restoration. Except for a response to a public comment about the effect of short term nitrogen load on phytoplankton (Restoration Plan Appendix C, p. 24), the ability of the estuary to remove nitrogen long-term was not evaluated:

> There would be little change in nutrient flux, and dependent phytoplankton, on the seaward side with tidal restoration. In greenhouse microcosm experiments NPS did observe that resalination of acid sulfate soils, typical of the drained wetlands above High Toss Road, mobilized ammonium-nitrogen; however, this should be a short-term phenomenon. The ammonium is presently adsorbed to clay particles. To the extent that seawater reaches these sediments, ammonium will desorb and will be available as a nitrogen source to primary producers, both phytoplankton and wetland vascular plants. However, with an incremental and slow restoration of tidal exchange, any increases in ammonium will be gradual, i.e. not a large pulse. Also, with the high flushing rate in Wellfleet Harbor proper, this nitrogen is not expected to cause excess algae blooms.

Mayo Creek

The Mayo Creek estuary has also been the subject of recent study, with the goal of restoring some tidal flushing to reverse the deterioration of that salt marsh, which is now stagnant and choked with invasive vegetation. The duck bill valve on the culvert pipe prevents any tidal influx from occurring. The valve only allows outflow discharge to occur after storm events. Studies have demonstrated that water quality in outgoing stream flows is poor.

The Herring River and Duck Creek estuaries, within which these wetlands lie, receive approximately 42% of the Title V flows for the entire Town. Duck Creek watershed contributes 48% of the Title V flows from the four watersheds under study. Wetland/salt marsh restoration projects in these estuaries could significantly reduce nitrogen loads to the harbor and improve water quality there. Implementation of these two restoration projects should be pursued vigorously and considered in the overall water quality management program for Wellfleet Harbor.

1.3.2.1 *Summary*

Detailed and controlled monitoring performed at the Duck Creek oyster reef pilot site has shown that oyster propagation is a viable and economical approach to addressing nitrate loading to the watersheds in Wellfleet Harbor, and has shown immediate results improving water quality in the Duck Creek estuary.

In addition to nitrogen removal, re-establishment of oyster reefs and saltmarshes in the Wellfleet Harbor watersheds has the additional benefits of:

- Immediate water quality improvement (unlike land based solutions, the results are not delayed by the slow pace of groundwater flow);
- Buffering shoreline erosion and ocean acidification;
- Enhancing biodiversity, including fish and shrimp; and
- Economic benefits to the shellfish and fishing industry.

1.3.3 Stormwater Management

The Town has already taken steps to abate direct runoff into Duck Creek from the Central District. In 2011/2012, stormwater collection with deep sump catch basins and subsurface infiltration structures were installed along Commercial Street, between Bank Street and Howland Avenue.

Although this project significantly reduces direct stormwater runoff into Duck Creek, MassDEP does not consider subsurface infiltration systems to be nutrient reducing mechanisms. Therefore, future town drainage projects should review the ability to incorporate vegetative uptake and/or biofiltration for nitrogen and phosphorus reduction.

1.3.4 Water System Expansion

Municipal water (PWS ID: #4318094) is sourced in Wellfleet from two well fields: the Coles Neck Well Field, with three deep wells, and the Boy Scout Camp Well Field, with two 10-inch deep gravel pack wells. The overall system is also comprised of 4”, 8” and 12” water mains and a 500,000 gallon water storage tank on Lawrence Road.

The water system’s Phase II Expansion construction, as shown on Figure 1-15, began in December 2013. Work is expected to be completed by the end of May of 2014. The water system expansion addresses the remainder of the most densely developed lots with moderate to high nitrate levels in the groundwater. Loop #1 completes the connection between the Holbrook Ave area and Kendrick Ave via Chequessett Neck Road, Summit Street, and Hiller Ave, and includes Freeman Avenue, Highland Street, Baker Avenue, Railroad Avenue and Whit’s Lane, encircling the Mayo Creek estuary.

The current expansion of the water system will protect public health by offering high quality drinking water in place of private drinking wells that have marginal water quality, providing more land area on small lots for on-site wastewater disposal, and potentially reducing the complexity and cost of I/A systems in environmentally sensitive areas.

1.3.5 On-Site Innovative/Alternative Systems

Wellfleet has historically required I/A systems to address specific conditions. The Town’s enhanced Title 5 regulations prohibit conventional septic systems within 100 feet of water bodies and within 50 feet of drinking wells. As part of this alternatives analysis, the continued use and possible expansion of I/A technologies will be evaluated in relation to improved water quality. Table 1-3 shows the number of I/A systems in each study watershed.

Table 1-3: Innovative / Alternative Systems on Private Lots in Each Study Watershed

Marine Estuary	Septic Systems	I/A Systems	% I/A Systems
Chipmans Cove	352	14	4.0
Duck Creek*	436	31	7.1
Wellfleet Harbor A	116	5	4.3
Wellfleet Harbor B	62	5	8.1
Total	**966**	**55**	**5.7**

*Subtracted 305 acres of CCNS from watershed

For Wellfleet Harbor A, situated north and west of Mayo Beach, the high density of septic systems is further impacted by the low number of I/A systems that can reduce nitrogen loading. The high density is due to the number of seasonal cottage developments, which mostly have multiple conventional septic systems on each lot. Many of these are located on parcels adjacent to the shore line. Of the 116 systems in this watershed, 56 are designed for a flow greater than 440 gpd, but only one I/A system in included in those systems.

Being seasonal in nature, the year-round loading is less of a concern than the summer loading. However, surface water sampling in this area by MEP has not yielded concerning nitrogen levels, likely because of the short term loading and the open nature of the coast that enables open tidal flushing. Groundwater data reveals sporadic samples of nitrate greater than 4.0 mg/L, though the extension of the water system through Loop #1 makes public water supply available to properties with the highest nitrate concentrations.

1.3.5.1 *Cluster Wastewater Collection and Treatment Systems*

At the request of the Town, an accelerated study of the Mayo Beach and Marina area was initiated in the latter part of 2011, and completed in February 2012. The purpose of this study was to evaluate the concept of constructing a local cluster system to serve the Marina, Beach Sticker Shack, Shellfish Building, Mayo Beach and Baker Field. The Town was presented with several alternatives and chose a composting toilet approach.

The Town decided to leave the existing Marina/Pier restroom, Sticker Shack, and Shellfish Building as they are for the present time and focus on the Mayo Beach and Baker Field needs. The Town concluded that a higher priority needed to be placed on providing bathhouses that could serve the Baker Field activities, and the summer beach users at Mayo Beach, while still providing wastewater treatment in a more efficient and compact footprint through the use of composing toilets (which provide 100% nitrogen removal) in this critical waterfront area. These new facilities will reduce the hydraulic overloading at the existing marina complex bathroom and I/A system beneath the marina parking lot.

1.4 Water Quality Update

Five parameters define Class SA coastal marine habitats:

1. Dissolved Oxygen > 6.0 mg/L
2. Water temperature <29.4 ◦C
3. pH between 6.5 and 8.5
4. Blue-green algae <70,000 cells per ml
5. Chlorophyll *a* < 10 ug/l

Water quality monitoring, performed in support of the Duck Creek oyster reef restoration project, has included bi-monthly monitoring of water quality in Duck Creek; at the Mayo Creek culvert discharge; in the oyster reef propagation area; and the Inner Wellfleet Harbor and Wellfleet Harbor. Water quality monitoring was performed in 2012 and 2013 from May through October and included the above listed parameters. These data are used to evaluate water quality. In general, water quality at these locations are in compliance with Class SA surface water requirements with only infrequent and localized exceedences.

<u>Dissolved Oxygen</u>

Figure 1-16 is a graph of dissolved oxygen (DO) sampling data for 2012 and 2013. In 2013, DO concentrations in the Wellfleet Harbor and Inner Wellfleet Harbor locations were above 6 mg/L between May and October, except for the early September sampling event, where DO concentrations were less than 6 mg/L. DO concentrations in the source area monitoring locations (the Duck Bill and to a lesser extent Duck Creek) were less than 6 mg/L beginning in July 2013 through early September 2013, with concentrations dropping to less than 3 mg/L. DO concentrations over the oyster reef (locations T1, T2 and T3) were above 6 mg/L except in late August and early September, when concentrations were around 5 mg/L. The 2013 monitoring data indicate that the oyster reef is able to maintain higher DO concentrations throughout the year, despite the influx of oxygen depleted water.

DO data from 2012 is generally lower than 2013, with more sample locations below 6 mg/L between July and September 2012. The overall increase in DO from 2012 to 2013 demonstrates improved water quality, despite, as indicated in Figure 1-9, increased nitrogen discharge to the harbor from groundwater and Mayo Creek.

<u>Water Temperature < 29.4</u>

Water temperatures in Wellfleet Harbor, Duck Creek and at the mouth of Mayo Creek are consistently below 29.4 degrees C as shown on Figure 1-17, except one sample collected from the mouth of Duck Creek on July 19, 2013, where the water temperature was 29.45 degrees C.

<u>pH between 6.5 and 8.5</u>

The pH levels in Wellfleet Harbor, Wellfleet Inner Harbor, Duck Creek and at the mouth of Mayo Creek is consistently between 6.5 and 8.5 (Figure 1-18). Only two pH readings were observed outside this range on June 6, 2013 (Wellfleet Harbor and in the channel downstream of the Mayo Creek duck bill).

<u>Blue-green algae <70,000 cells per ml</u>

Blue-green algae data from 2011 through 2012 are shown on Figure 1-19. In general blue-green algae levels were below 70,000 cells/ml with only local exceedences in October and December 2011 and July and August 2012. Blue-green algae data are not available for 2013 due to equipment errors; however, development of the oyster reef should reduce the frequency of blue-green algal blooms in the Harbor.

Chlorophyll a < 10 ug/l

Water quality in Wellfleet Harbor, Wellfleet Inner Harbor, and Duck Creek are generally in compliance with Class SA surface water criteria. Chlorophyll data in Wellfleet Harbor, Duck Creek and Mayo Creek for 2012 and 2013 (Figure 1-11) indicate that the average of chlorophyll concentrations at all monitoring locations are consistently less than 10 µg/L and are in compliance with Class SA coastal marine habitats.

Figure 1-20 shows all chlorophyll sampling data for 2012 and 2013. In 2013 chlorophyll levels were below 10 µg/L at all locations, and all sampling events, except one location on July 3, 2013 (Wellfleet Harbor). Similarly, chlorophyll levels only exceeded 10 µg/L in three sampling events in 2012, as follows: August 8, 2012 sampling event (at the Mayo Creek duck bill and in the channel downstream of the duck bill), September 18, 2012 (Wellfleet Harbor location) and September 26, 2012 (Duck Creek).

1.5 Nitrogen Loading Update

1.5.1 Basis of Analysis for Wastewater Load

EPG used the 2010 census to establish the population and housing data, which show negligible change in population since 2000 and minor changes in housing statistics. Septic system data for the four watersheds under study provided specifics for existing treatment and load calculations. The nitrogen loading update for the Inner Harbor is based on the following parameters from the *208 Plan Technology Fact Sheets*, by the Cape Cod Commission:

- Typical raw (upstream of the septic system) load rate for nitrogen = 40 mg/L
- Title 5 nitrogen removal rate = 34%, or 26.25 mg/L N to groundwater
- Wastewater flow is based on 55 gpcd

Nitrogen loading varies considerably by season. Although nitrogen loading from wastewater occurs year round, the greatest impact on eutrophication and aquatic growth is the level of nitrogen in the coastal waters during the growing season. While stormwater runoff can directly and immediately impact surface water, nitrogen sources from wastewater to groundwater do not provide instantaneous nitrogen to coastal waters, but are essentially continuous and can be highly variable. Therefore we have to understand the nitrogen loading rates year-round and adjust for seasonal variations to estimate the total load to the waters of interest.

Adjustments are necessary to properly apply the CCC 208 Plan parameters to Wellfleet. The year-round occupancy (residential and commercial) is much less than full occupancy, and the average wastewater flow per housing unit is less than the assumed Title 5 flow rates of 330 gpm. Relative comparisons:

- Population and Occupancy:

- Wellfleet's seasonal (summer) population, as described by various sources, is approximately six (6) times its year-round population due to summer rentals.
    - Approximately two-thirds of housing units are seasonal rentals. One-third of housing units are occupied year-round.
    - Approximately 5 persons occupy each summer rental.
    - Persons per all occupied households when averaged town-wide increases from 2.01 permanent residents to 3.83 in the summer rental season.
- Wastewater Flow Rates:
    - Off-season *daily* flow is 17% of the summer *daily* flow (151,000 gpd to 907,500 gpd).
    - Average flow from year-round properties is 110 gpd based on 55 gpd per person.
    - Summer occupancy produces an average of 275 gpd for the seasonal rental properties.
    - Extrapolating the total flow to every occupied parcel gives an average wastewater flow of 210 gpd per parcel town-wide.

Table 1-4 presents the nitrogen load to groundwater from on-site wastewater treatment systems using the town-wide rental and occupancy trends applied to the individual watershed/drainage areas under study. (Numbers are rounded for readability.)

Table 1-4: Estimated Existing Wastewater Nitrogen Loads

Marine Estuary	On-Site Wastewater Units	Raw N Load (ppy)	N Load to Groundwater (ppy)
Chipmans Cove	352	3,450	**2,160**
Duck Creek	436	4,170	**2,670**
Wellfleet Harbor A	116	1,140	**740**
Wellfleet Harbor B	62	540	**340**
Total	**966**	**9,300**	**5,910**

In the Chesapeake Bay watershed, EPA estimates that only 40% of the groundwater borne nitrogen reaches the bay primarily due to denitrification (EPA, November 2012). In a series of studies in various Cape Cod watersheds, Kroeger, et al. (2006) and Westgate, et al. (2000), measured reductions in nitrate in soil conditions similar to Wellfleet. However, the rate of reduction was highly variable and dependent on local conditions such as the depth of the water table and the biochemical gradient. For conservative planning, EPG will proceed with the evaluation of wastewater alternatives to reduce the load to groundwater and not expect subsurface conditions beyond the disposal fields to immediately impact the nitrogen removal effectiveness.

1.5.2 Basis of Analysis for Stormwater Load

The stormwater load is based on stormwater runoff as determined by land uses in the watershed. Impervious cover increases the total and peak runoff from any parcel as compared to natural conditions. And nutrients applied or otherwise deposited on the watershed are carried by the runoff to local waterways or leached into the groundwater if not taken up by vegetation or converted through soil chemical means.

The dominant method of managing runoff throughout Massachusetts is through the EPA's NPDES MS4 program. However, Wellfleet is not included in that program as it lacks an "Urbanized Area" as defined by EPA and the Bureau of Census. The definition of an Urbanized Area provided on the Bureau of Census website is:

> An urbanized area is a land area comprising one or more places -- central place(s) -- and the adjacent densely settled surrounding area -- urban fringe -- that together have a residential population of at least 50,000 and an overall population density of at least 1,000 people per square mile.

According to the CCC, the primary controllable mechanism of nitrogen loading is from fertilizer application. Residential land uses are the largest contributor of these loads and the largest active land use by total area in Wellfleet. Fertilizer usage estimates from CCC *Tech Bulletin 91-001* and Horsley Witten Group Inc., (September 2013) assumes 57% of homeowners fertilize lots with lawns averaging 5,000 square feet, using fertilizer comprised of 25% N content, to total 3 lb N / 1,000 square feet per year. EPG has reduced the percentage of homeowners that fertilize to 47% to account for the number of seasonal properties and the more natural condition of lots in Wellfleet as compared to more inland properties on the Cape. With a 25% leaching rate, the total load from the four study areas equates to approximately 1,660 lb of N per year. However, the CCC *Technology Matrix* (January 2014) bases its calculations on an influent load of 5 mg/L N per acre. EPG therefore evaluates both approaches to approximate the future impact of fertilizer management.

1.6 Planning Period – Future Conditions

The planning period is 20 years from the initiation of this project, to 2030. Wastewater needs and solutions are based on the expected conditions over the course of this planning period. A fundamental first step is to understand the growth in population and development, followed by correlating the estimates for the specific study watersheds based on historic population trends, development pressure, availability of buildable land, zoning, and special regulations that may limit or encourage growth.

According to the Town's 2008 Comprehensive Plan (CP), "buildout" is the maximum level of development permitted by the current Wellfleet Zoning By-laws. The CP identified approximately 550 buildable residential parcels as identified in the Assessor's database by Land Use Code. Development limitations, such as frontage and access, limit this to approximately 400 new single family residents. This represents approximately 10% of the total developed and developable residential parcels in Town. Less than 10% of the 100 commercial parcels may be developable. It is unlikely that all of the parcels will be developed, but an allowance should be set aside for redevelopment and expansion of existing developed parcels.

The CP's "Section 1 - Land Use" cites the following goal: "Provide for planned growth to meet the needs of the Town for housing, recreation, community facilities, open space and economic development in a manner that maintains the rural and historic character of the Town and does not degrade the environment."

Section 1 describes development pressures and limitations that could impact the achievement of this goal. Development pressures may include:

- Subdivision and redevelopment of large parcels such as the two campgrounds in Town.
- "Tear downs" where small homes are being replaced by much larger houses.
- As municipal water becomes available in greater quantity, increased density could be allowed on developed properties. This could have a significant impact on the historic Central Village District.
- In 2002, the Town adopted the Affordable Accessory Dwelling Unit by-law to encourage more affordable year-round rental housing. Additional housing units may be added if there is adequate Title 5 capacity and if already existing requirements for lot coverage and setbacks are met.
- State initiatives and regulations such as 40B and 40R affordable housing.

Development limitations may include:

- 61% of the Town is permanently protected open space
- Flood zones and wetlands setbacks
- Title 5 restrictions within 100 feet of water bodies may prevent additional development on existing parcels and undeveloped parcels
- Local goals seek to provide additional access to the waterfront, which may secure private property for municipal ownership
- Seasonal nature of the community limits commercial opportunities

1.6.1 Population Trend analysis

Table 1-5 shows that growth has slowed for the Town of Wellfleet, with zero percent growth from 2000 to 2010 according to US Census data.

Table 1-5: Historic Population Growth in Wellfleet

Year	Wellfleet Population	% growth per decade
1950	1123	
1960	1404	25.0%
1970	1743	24.1%
1980	2209	26.7%
1990	2493	12.9%
2000	2749	10.3%
2010	2750	0.0%

This is reflective of recent economic conditions, but also because of limited available land and other development limitations listed above. Table 1-6 summarizes EPG's projected population growth for the planning period, finding that two methods of line trending, polynomial and logarithmic, provide the best curve fits for predicting population in 2030. Figure 1-21 and Figure 1-22 present each projection method.

Table 1-6: Population Projections for the Planning Period

Year	Projected Population	% growth per decade
Polynomial Curve		
2020	2829	2.9%
2030	2945	7.1%
Logarithmic Curve		
2020	2744	-0.2%
2030	3033	10.3%

Figure 1-21: Polynomial Curve Fit of Population Projection - 2030

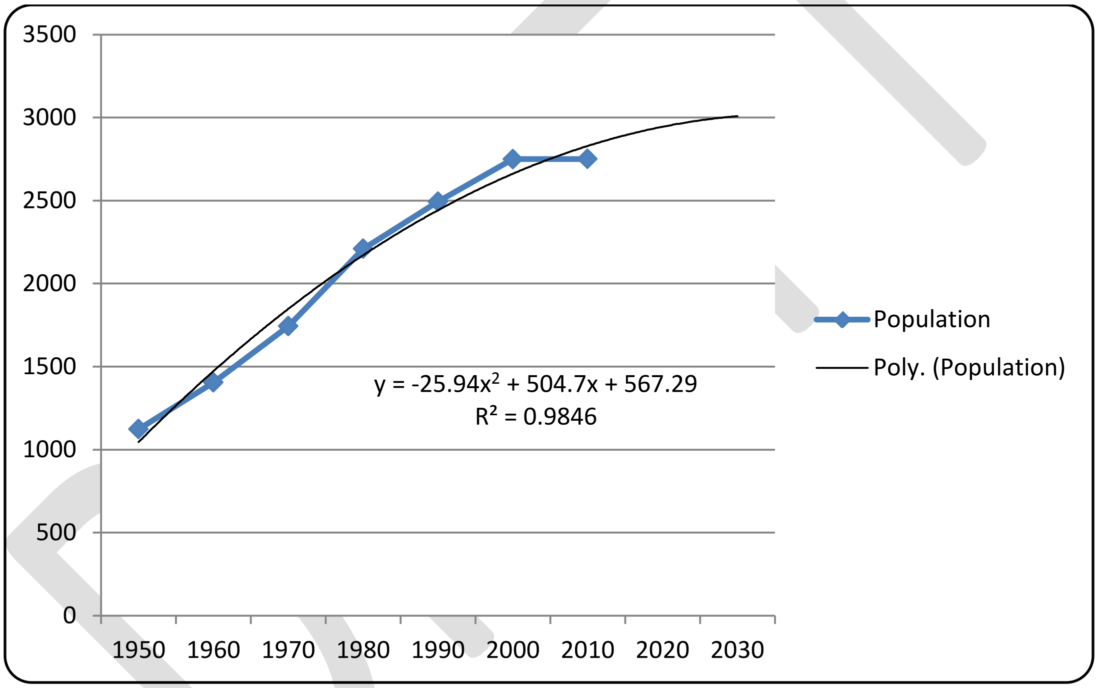
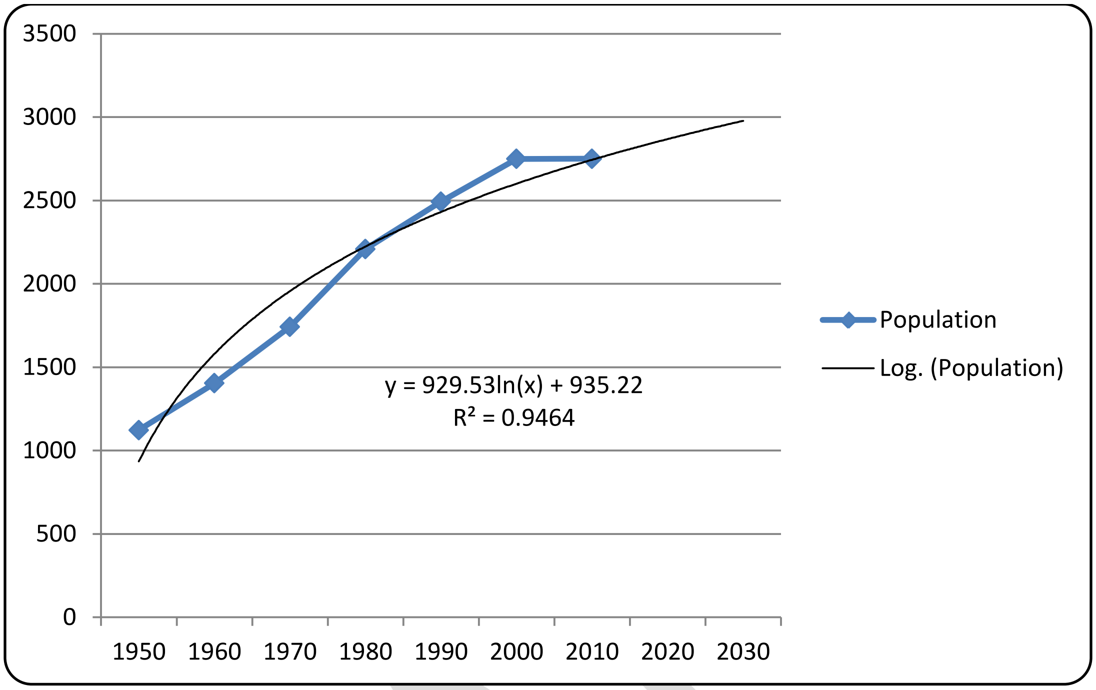


Figure 1-22: Logarithmic Curve Fit of Population Projection - 2030



The polynomial method, Figure 1-21, has the best fit line, though both methods are accurate within the bounds of future uncertainty. The logarithmic approach population trend analysis closely matches the developable parcel analysis with 10% population growth estimated by 2030 compared to 10% of the total assessed parcels available for development.

Previous needs analysis completed by Woodard & Curran (2001) estimated zero or negligible growth in the area identified as the Center Village District, which encompasses the commercial and municipal center in the Duck Creek watershed. Therefore, the slow rate of growth for the planning period appears to be appropriate. The estimate of 10% overall population gain by 2030 will be applied, with a comparable increase in summer residents to maintain the 6:1 ratio.

For the study areas without mitigation, the new projected nitrogen load from on-site wastewater systems will increase proportionately, by 10%, as summarized in Table 1-7. Values are rounded for readability:

Table 1-7: Projected Future (2030) Nitrogen Load to Groundwater from the Four Study Areas

Marine Estuary	On-Site Wastewater Units	Raw N Load (ppy)	N Load to Groundwater (ppy)
Chipmans Cove	387	3,770	**2,360**
Duck Creek	478	4,660	**2,995**
Wellfleet Harbor A	127	1,400	**910**
Wellfleet Harbor B	68	630	**405**
Total	**1,060**	**10,460**	**6,670**

1.7 Outreach Effort

In addition to multiple academic, nonprofit, regional, and state government organizations, involved in the water quality improvement efforts, the Wastewater Planning Committee has conducted outreach to the following groups through meetings, presentations, and programmed events:

- Cape Cod Commission
- DEP
- Wellfleet Forum
- Shellfish Advisory Board/Planning
- Board/FinCom/ConsCom/Natural Resources Advisory
- Harbor Master/Health Department/Shellfish Department/DPW
- Board of Selectmen
- Cape Cod National Seashore
- Division of Marine Fisheries
- Non-Resident Taxpayer's Association
- WOMR/WHAT Theatre/Preservation Hall/LCAT/Newspapers
- OysterFest – yearly promotion and shell recycling event

Wellfleet makes use of the internet to disseminate information and keep citizens connected to the various natural resources projects. The Wastewater Planning Committee has an online presence through a link on the main page of the town website at:

http://www.wellfleetma.org/Public_Documents/WellfleetMA_Wastewater/index

The Herring River project has two links on the main page of the town website: Friends of the Herring River: http://www.friendsofherringriver.org/; and Herring River Restoration Project: http://www.wellfleetma.org/Public_Documents/WellfleetMA_Herring/index

2. DEVELOPMENT OF ALTERNATIVES

Optimum performance of the existing infrastructure, both green and built, should serve as the baseline against which other alternatives are compared. This baseline assumes optimizing the use of septic systems by improving maintenance, repair, upgrade, management and inspection of systems. Other systems are not solely on-site wastewater systems, but also the natural systems that play an important part in nitrogen reduction, and also the municipal drinking water system that alleviates potential negative interactions between septic systems and private wells.

2.1 Baseline Alternative: Optimize Existing Facilities / Conditions

The Wellfleet Comprehensive Wastewater Planning Committee has maintained a determination to thoroughly explore the feasibility of enhanced natural systems such as oyster reef propagation and salt marsh restoration and enhancement before structured solutions are considered. This approach is reasonable in areas where the water quality has been marginally impacted, and where excess nutrients are the principal water quality concern. In this context, the issue is one of an over-abundance of food and a shortage of consumers. If a more natural balance between food quantities and consumer organisms can be restored and maintained, the water quality concerns can be minimized or eliminated.

There remains an evaluation of the alternatives available to the Town of Wellfleet beyond returning the inner harbor and adjacent marshes to a more natural balance. Alternatives are presented in the CCC *208 Plan Technology Matrix* and can be described in two classifications, (1) Source Control and (2) Receptor Protection. With source control, nutrients and other pollutants are addressed prior to release to the natural environment. Source control includes septage (wastewater) management plans, innovative/alternative onsite wastewater systems, sewers and treatment facilities, and green infrastructure to reduce runoff. With Receptor Protection, nutrients and other pollutants are mitigated in the natural environment, or other measures are taken to protect receptors from the impacts of the pollutants in the natural environment. Receptor Protection includes centralized water systems to protect human health, aquaculture to restore coastal waters, and permeable reactive barriers to reduce groundwater nutrients.

1.7.1 Aquaculture

It has been well documented that an adult oyster can filter between 25 and 50 gallons of seawater per day. The nitrogen absorbed into the flesh and shell of adult oysters has been measured in a number of studies, and is widely accepted to be approximately 0.375 to 0.50 grams per oyster per year. Other removal mechanisms through the pseudo feces and the other organisms within the oyster bed and supporting soil matrix further reduce nitrogen. For this study EPG used a nitrogen removal rate of 1.425 grams per oyster per year for the most assertive estimate and 0.375 grams per oyster per year for the most conservative estimate.

Table 2-1 shows that at 6,670 pounds of N per year contributed to the inner harbor from the septic systems with the study area, the placement and growth of 8 million oysters in the inner harbor would process (remove/assimilate) the entire wastewater N load even without nitrogen attenuation in the groundwater. If one includes the documented nitrogen functions contributed by associated reef biota and biochemical mechanisms, only 2 million oysters are needed to remove the total load of N from study area wastewater sources.

Table 2-1: Oyster Bed Processes and Removal of Nitrogen Load from Wastewater

Process	Grams of N removed per year	Oysters Required
Oyster Assimilation	0.375	8,060,000
Plus pseudo feces	0.725	4,170,000
Plus other organisms	1.475	2,050,000

The initial pilot study is a 2 acre (8,094 m²) site with a target of approximately 2-3 million oyster spat, with a goal to remove 2,200 pounds of N per year from harbor water. In 2011 the monitoring results estimated oyster abundance to be at 2 million oysters in the project area. The 2012 monitoring results indicate that the oyster abundance in the two acre project area was almost 4 million oysters. The 2013 monitoring results indicated a continued increase in the oyster population to approximately 4.4 million.

The population growth dynamics suggest the original plot of oysters and their supporting ecosystem will be able to consume the necessary N load from wastewater systems in the four study areas within the foreseeable future. Furthermore, the quantity of oysters in the inner harbor and surrounding waters far exceeds the quantity in the pilot study, meaning that commercially grown and naturally occurring oyster quantities further reduce the nitrogen concentration in the harbor.

Assuming additional oysters dedicated to water quality improvements are necessary to provide some buffer for uncertainties, mitigate attrition in the overall population, and secure regulatory agency confidence, we can provide a multiplier to the quantity of oysters, and/or create a redundant propagation area. The Town should expect to provide an expanded area, or other cultch areas, dedicated to reducing a nitrogen load greater than the wastewater load.

1.7.1.1 *Future Oyster Propagation Zones*

The Town is seeking approval from the Division of Marine Fisheries (DMF) to establish six (6) additional Propagation Zones shown on Figure 2-1. The zones are strategically located to maximize ecological services and biogeochemical benefits while also increasing the spawning biomass in areas of intense commercial harvest.

Selected Propagation Zones would consist of a few acres in open areas that would be clearly identified as “No Take” zones. Based on extensive field assessments and historical records, these areas are known to be highly productive, but are subject to commercial fishing and have experienced disease pressure creating an unsustainable or very low shellfish productivity compared to the historic record. Therefore, these areas will be bolstered with additional cultch with the goal to establish a minimum biomass to maintain a highly productive oyster population, improve biodiversity, support a healthier ecosystem and benefit water quality.

The intent of these No Take Zones is to increase the survival time of the oyster populations beyond the three (3) year limit established for standard management closure under the shellfish planting guidelines. Establishing a longer life span will assist in determining if disease resistance can be achieved by exposing the oysters to cyclical die-offs which are locally believed to occur in 7-9 year cycles. This is based on a large body of scientific literature that cite slow progress on developing disease resistance in the lab setting, which may be due in part to the complexity of water chemistry and possible benefits conferred by co-dependent species. This approach of establishing small and clearly marked Propagation Zones protects the public investment and eases enforcement. The Town plans to determine the ultimate size of these areas subject to on-going work based on research monitoring and positive evaluation of their impacts on commercial and recreational shellfishing.

This project is supported by the Wellfleet Board of Selectmen, Natural Resources Advisory Board, Shellfish Advisory Board, Shellfish Department, Board of Health, Health and Conservation Department, DPW, Harbormaster, Conservation Commission, Wastewater Planning Committee, Barnstable County, USDA NCRS, SPAT, Massachusetts Oyster Project, UMass Boston, Provincetown Center for Coastal Studies, and NOAA.

1.7.2 Estuary and Marsh Restoration and Flushing

Because of its outlet location, Mayo Creek has a more direct effect on the inner harbor than the Herring River. MEP sampling in the outer harbor indicates water quality meeting state standards. And the sheer size of the Herring River estuary and freshwater flow, seven (7) times the freshwater flow rate through Mayo Creek (The Herring River Technical Committee, October 2007), gives the Herring River estuary the ability to convert and sink a significant nitrogen load.

The opening of the culvert to Mayo Creek has been discussed for some time, and the benefits of returning the marsh have been evident for esthetic and wetlands health perspectives. However, there has been concern that returning the estuary to natural tidal flushing may negatively impact local drinking water wells from salt water intrusion, and bordering properties from inundation.

The Woods Hole Group (2011) report addressed the tidal elevation concerns: “Actual observed high water levels in the existing system corresponding to rainfall events are significantly higher than the modeled maximum water surface elevation resulting from tidal forcing only…the duckbill severely restricts draining from the marsh, particularly when a large area of the marsh is flooded. As such, although the duckbill offers flood protection from coastal storm events, the combined duckbill valve and culvert also inhibit draining that may result in unwarranted flooding as well.”

The intrusion of salt water into private wells can be addressed by extending the municipal water system to lots surrounding the marsh that are at risk or concerned about a loss of drinking water. Furthermore, relatively high nitrates in the groundwater in this area indicate that a new source of drinking water would be beneficial to reduce the risk of nitrates and associated wastewater organics in the groundwater. EPG reviewed the private well data from Howland Lane, Chequessett Neck Road, and Holbrook Ave within the Mayo Creek (Duck Creek) watershed to represent nitrate values up gradient and adjacent to the Mayo Creek marsh. The 29 samples had a median value of 4.3 mg/L nitrate (mean = 4.6 mg/L). The Cape Cod Commission recommended limit for nitrogen in groundwater is 5.0 mg/L.

The MEP uses nitrogen attenuation (removal) factors of 50% for ponds, 30% for streams and 40% for salt marshes for systems where site-specific information is not available. Because of the ability of a salt marsh to reduce nitrogen loads, and the relatively high levels of nitrogen in the groundwater adjacent to the Mayo Creek marsh, restoring the Mayo Creek marsh should be a priority for Wellfleet.

Woods Hole Group (2011) refers to the United States Geological Survey, Masterson (2004), for a freshwater base (groundwater) flow of 0.51 cfs to Mayo Creek. The total groundwater load of nitrate to the marsh is therefore 4,315 ppy, assuming the private wells concentration of nitrate-N is consistent and continuous. The current ability of the marsh to attenuate N is unknown, but the deteriorated condition of the marsh and a lack of frequent flushing indicates a malfunctioning system, and therefore much less nitrate attenuation. Table 2-2 shows that ***applying the MEP attenuation factor of 40% gives 1,730 ppy N removed through attenuation in the Mayo Creek marsh, leaving 2,590 ppy N to the harbor.***

This load seems disproportionate to the overall inner harbor load as compared to the estimated overall nitrogen load to groundwater from all four study areas, but it will include some stormwater runoff from the immediate area. To bracket the possible N load in the groundwater, we can assume the actual groundwater concentration over an entire year could be less and possibly more approximate to the concentration found in the monitoring well (210). As shown in Table 2-2, ***515 ppy N is removed through 40% attenuation in the Mayo Creek marsh, leaving 775 ppy N to the harbor.*** These values likely present the range of possible loads and mitigation from a well-functioning salt marsh at Mayo Creek.

Frankic (January 2012), quotes values by Nixon (1980) for optimal nitrogen sink values, which differ from marsh to marsh, of 5-20gN/m2/y. This value is dependent on actual conditions in the marsh and the actual load of nitrogen to the marsh. Therefore, given ideal conditions and climate, 20 acres of Mayo Creek salt marsh could optimally sink about 3,750 ppy of nitrogen. To be able to remove up to 3,750 ppy, we assume the N load to the marsh will be at least the 4,315 ppy based on the on-site well data.

The N load and removal rate are likely towards the lower end of this range, in agreement with the measured nitrogen concentrations in groundwater and the MEP removal percentage, which is the accepted planning level estimate indicative of conditions on Cape Cod. Regardless, these values fall within the expected uncertainty that can only be refined with more precise modeling and actual monitoring.

Table 2-2: Potential Nitrogen Mitigation by Mayo Creek Salt Marsh

Nitrogen in Groundwater	**On-site Wells**	**Monitoring Well 210**	**Frankic/Nixon (2012)**
Median N Concentration (mg/L)	4.3	1.29	--
Number of Samples	29	19	--
Groundwater Base Flow (cfs)	0.51	0.51	--
N Load to Marsh (ppd)	12	4	--
(ppy)	4,315	1,290	4,315
N Load to Harbor (ppy)	**2,590**	**775**	**745 – 3,420**
N Load Removed (ppy)	**1,730**	**515**	**895 – 3,570**

For further analysis, EPG will select a range of nitrogen removal between 745 ppy and 1,730 ppy to reflect the initial condition of the marsh to restored condition.

1.7.3 Bylaws and Regulations

1.7.3.1 *Septage (Wastewater) Management*

Wellfleet has several options for management of onsite wastewater systems to control nitrogen and phosphorus discharges (source control) to groundwater. Regulatory control models are available for application at the local, state and federal levels.

Existing Local Regulatory Control Mechanisms
310 CMR 15.000 - The State Environmental Code Regulating Septic Systems (Title 5) mandates that onsite wastewater systems serving new construction in Nitrogen Sensitive Areas and serving new residential construction in areas with on-site wells are subject to a 440 gallon per day (gpd) per acre design flow limitation. Nitrogen Sensitive Areas have been determined by MassDEP to be sensitive to nitrogen in sewage. Interim Wellhead Protection Areas and Zone IIs of public water supplies are specifically identified as Nitrogen Sensitive Areas. The regulation does not explicitly apply to existing systems.

Title 5, however, gives the local approving authority the discretion, where "*necessary to protect public health and safety and the environment,*" to require a system owner to install a nitrogen reducing technology or to obtain a groundwater discharge permit. Additionally, Title 5 states, "*Specific site or design conditions, however, may require that additional criteria be met in order to achieve the purpose and/or intent of 310 CMR 15.000*." Therefore, when an existing system is located in a nitrogen sensitive area or on a residential lot with an on-site well, and no increase in flow is proposed, Boards of Health may require enhanced nitrogen removal because of specific situations.

Pertinent Wellfleet Board of Health regulations that enhance the State Title 5 regulations and restrict nitrogen loading to groundwater are found in Section 600 - Subsurface Sewage Disposal Systems:

601 Sewage Disposal Works Construction Permits will be issued when the proposed system fully meets the physical (i.e. hardware and spatial) requirements of the State Sanitary Code (Title 5), and the following specific requirements of the Wellfleet Board of Health:

A. The leaching field must be at least 100 feet, and the septic tank at least 50 feet, from any water-course.

B. The septic tank and the leaching facility must be at least 1 foot below the existing natural grade when in the 100 year floodplain.

C. A minimum 1500 gallon septic tank is required for single family dwelling units.

D. Inspection and approval by the Board of Health or its Agent at the time of installation is required by the Board.

E. The applicant must provide evidence that the property to be served by the system has an acceptable water supply before a Sewage Disposal Works Construction Permit will be issued.

607 The use of a nitrogen reducing system is required when there is a variance to the required 100 feet separation between a drinking water supply well and a soil absorption system, or when a soil absorption system is located less than 100 feet from a salt marsh or any marine surface water.

Variances to this section may take into account the following mitigating factors: direction of groundwater flow, topography, soil conditions, well depths, water quantity/availability, water quality of the locus and surrounding lots, and feasible location of structure and septic system.

Any property served by an innovative/alternative system, or recirculating sand filter system approved by the Board of Health shall have notice of the presence of this system recorded on the property deed at Barnstable County Registry of Deeds.

Zoning By-Laws regulate use of wastewater systems in cluster development and wellhead protection overlay districts:

6.6.8 Wastewater Disposal - The provisions for wastewater disposal shall meet all requirements of the Wellfleet Board of Health and the Commonwealth of Massachusetts. No private septage or sewage treatment facility or advanced wastewater treatment equipment shall be used in cluster development.

Paragraphs 19 and 21 of the Wellhead Protection Overlay District prohibit:

19. Treatment or disposal works that are subject to 314CMR 5.00, Groundwater Discharge Permit Program, except the following:

(a) the replacement or repair of an existing system(s) that will not result in a design capacity greater than the design capacity of the existing system(s);

(b) the placement of an existing subsurface sewage disposal system(s) with wastewater treatment works with a design capacity no greater than the design capacity of the existing system(s);

(c) treatment works approved by the Department of Environmental Protection (DEP) designed for the treatment of contaminated ground or surface waters.

21. Individual sewage disposal systems that are designed to receive more than 110 gallons of sewage per quarter acre under ownership per day, or 440 gallons of sewage on any one acre under one ownership per day, whichever is greater, provided that:

(a) replacement or repair of a system, which will not result in an increase in design capacity over the original design capacity of 310 CMR 15.00, whichever is greater, shall be exempted, and

(b) in cluster subdivisions the total sewage flow shall be calculated based on the number of percable lots in the entire parcel;

(c) lots which are protected by the provisions of MGL c. 111 Section 127P as of the effective date of this bylaw shall be permitted to install individual sewage disposal systems in accordance with the applicable provisions of the State Sanitary Code during the period of protection if any;

(d) alternative sewage disposal systems meeting the requirements of and approved by the Board of Health.

State Management Models

MassDEP provides funding and guidance through its Septic System Management Program. The program provides funds for replacement of onsite systems with one of two management strategies, a Community Inspection Plan or a Local Septic Management Plan. These two programs are described in detail in the Massachusetts DEP Community Septic Management Program Final Project Manual (September 21, 2003). With either strategy, communities must create and implement a plan to protect environmentally sensitive areas from septic system contamination.

A Community Inspection Plan requires the regular inspection of all septic systems at least once every 7 years, but allows the systems to waive the inspection upon property transfer. The Local Septic Management Plan does not require periodic system inspection and still requires a system inspection upon transfer of the property, but requires the community to identify and prioritize areas containing onsite systems that warrant more attention. Communities are eligible for a planning grant and a SRF loan of $200,000 with either option. The SRF loan proceeds may be used to provide betterment loans to homeowners and for eligible administrative costs.

The participation of homeowners in areas identified as environmentally sensitive (to failed septic systems) is not mandatory. However, if the local Board of Health considers a property owner’s septic system a pending health hazard, the owner can be given priority for assistance. Communities can also be provided with a pre-loan grant used to identify and prioritize environmentally sensitive areas and to create a plan to protect these areas from onsite wastewater system contamination.

At its full implementation, either management model will allow Wellfleet to identify, monitor, and address the proper operation and maintenance and upgrade of septic systems in a comprehensive manner. As part of any management program the Town should institute a requirement for minimal pumping frequencies and reporting of pumping. Properties identified as having abnormal pumping frequencies can be targeted for inspection. Neighborhoods with a large number of abnormal pumping frequencies could be designated for inclusion in future wastewater disposal planning.

The following Table 2-3, by EPA (1993), provides the recommended pumping intervals for conventional residential septic systems. Wellfleet requires a minimum septic tank size of 1,500 gallons.

Table 2-3: Suggested Septic Tank Pumping Frequency – Years Between Pumping (Copied from EPA, 1993)

Tank size (gal)	Household size, number of people									
	1	2	3	4	5	6	7	8	9	10
500	5.8	2.6	1.5	1	0.7	0.4	0.3	0.2	0.1	-
750	9.1	4.2	2.6	1.8	1.3	1	0.7	0.6	0.4	0.3
1,000	12.4	5.9	3.7	2.6	2	1.5	1.2	1	0.7	0.7
1,250	15.6	7.5	4.8	3.4	2.6	2	1.7	1.4	1.2	1
1,500	18.9	9.1	5.9	4.2	3.3	2.6	2.1	1.8	1.5	1.3
1,750	22.1	10.7	6.9	5	3.9	3.1	2.6	2.2	1.9	1.6
2,000	25.4	12.4	8	5.9	4.5	3.7	3.1	2.6	2.2	2
2,250	28.6	14	9.1	6.7	5.2	4.2	3.5	3	2.6	2.3
2,500	31.9	15.6	10.2	7.5	5.9	4.8	4	4	3	2.6

The table was originally published as Table 4-24. Suggested Septic Tank Pumping Frequency (Years) (Cooperative Extension Service -University of Maryland, 1991)

The full plan should include the following activities as described in the DEP Project Manual:

- Creation of an administrative structure to manage the program;
- Prioritization of environmentally sensitive or threatened areas;
- Public notification;
- Priority list of systems;
- Homeowner selection criteria for loans;
- Development of betterment agreements;
- Project administration for repair of septic systems; and
- Administration of loan repayment.

The Town would provide financial assistance to homeowners for the repair, replacement or upgrade of failed septic systems using betterment agreements under G.L. c. 111 s. 127B 1/2. Each betterment project must have a separate account, and homeowners will be charged either 2% or 5% interest at the discretion of the community. The accrued interest can be used to pay for administrative costs. All money used for the project must be credited to a special 'receipt reserve' account and cannot go towards the community's general fund. Money in the receipt reserve account, once approved, can be used to fund other betterment projects.

EPA Management Models

Table 2-4 presents the five onsite system management models developed by EPA (EPA, 2003) for communities to manage onsite systems. The models represent varying levels of government oversight and management, from basic outreach programs to ownership of onsite systems by a management entity. For systems designed to treat nitrogen, EPA (EPA, 2013) recommends Models 3-5, or some combination, for the nitrogen reduction goals (of Chesapeake Bay communities).

Table 2-4: EPA Developed Onsite System Management Models (Copied from EPA, 2013)

Model #	Description	Comments
1	Homeowner Awareness	Homeowner management of existing systems is promoted through outreach and education programs. Appropriate for conventional systems which provide very limited nitrogen removal.
2	Maintenance Contracts	A property owner contracts with a qualified service provider to ensure O&M is conducted and nitrogen removal goals are met.
3	Operating Permits	The regulatory agency issues a limited-term operating permit to the property owner that requires sustained performance levels for nitrogen reduction. O&M is performed by a qualified service provider with regular monitoring. This provides a greater level of oversight and accountability compared to Model #2.
4	Responsible Management Entity (RME) O&M	Frequent and highly reliable O&M is the responsibility of a management entity, further increasing the level of accountability. This approach is appropriate for clustered systems or complex treatment systems providing high levels of nitrogen reduction.
5	RME Ownership	Ownership passes to the management entity which is responsible for all management aspects, similar to publicly owned treatment works, providing a high level of assurance that nitrogen removal goals are met.

Particularly in New England, the most accepted management models are the least intrusive to private property ownership. Variations of Models 1-3 are in place in several Rhode Island communities (New Shoreham, Glocester, South Kingstown) that seek to regulate nitrogen. The common elements of these programs are periodic inspections of the onsite systems, maintenance contracts for more advanced systems, and performance and treatment thresholds based on the proximity to groundwater and surface water. The choice of a management approach depends on public acceptance and the needs of the community, balanced with overall costs.

Potential Local Regulatory Control Mechanisms

The majority of soils in Wellfleet are identified by the NRCS as Map Unit 252 (Carver coarse sand) soils, classified as Hydrologic Group A, and typified by excessively drained (poor filter) sand and gravel. Poor filter relates to the soil's lack of ability to slow the progression of a pollutant plume or provide a supporting environment to remove pollutants. Considering the very high capacity for these soils to accept and convey water, additional control should be considered for onsite wastewater systems. EPA (November 2012) has recommended further setbacks for onsite wastewater systems in the Chesapeake Bay watershed, which could be applicable in areas with very permeable soils such as Wellfleet:

…EPA provides the following recommended nitrogen treatment approach that could be adopted in whole or in part by each state. This suggested approach (see Table EX-1) recognizes the comparatively higher pollution risk posed by onsite systems that are closer to the Bay or its tributaries. Using this approach, a state would adopt higher levels of treatment in areas in close proximity to the Bay, including tidal portions of the tributaries to the Bay, with less treatment recommended higher up within the watershed (Table EX-1).

Table EX-1: Summary of Recommended Onsite System Nitrogen Treatment Approach

Horizontal Distance from the Bay or a tributary	**Recommended Nitrogen Treatment**
0 - 100 feet	No discharge of onsite system effluent
100 - 200 feet	5 mg/L for total nitrogen
200 - 1,000 feet	10 mg/L for total nitrogen
Beyond 1,000 feet	20 mg/for total nitrogen

EPA further recommends drip irrigation and permeable reactive barriers (PRBs), which could be incorporated into an onsite treatment system to meet the 10 mg/L and 5 mg/L treatment levels respectively. According to EPA, a drip irrigation effluent dispersal system can provide an additional 5 mg/L of nitrogen removal beyond that provided by an advanced treatment system. Although PRBs are not approved by MassDEP for use with onsite wastewater systems, except for provisional use of the Nitrex system and piloting the Nitrex-plus proprietary systems, the Cape Cod Commission lists PRBs as applicable for use with an average N removal rate of 85-97%.

The Town could increase the allowed distance of leaching fields from water bodies for conventional (non-denitrifying) systems to account for the poor filtering soils, especially in areas that surpass the DEP's maximum loading rate of 440 gpd per acre for Nitrogen Sensitive Areas (NSAs) and areas with onsite wastewater systems and wells. In 2030, only the Wellfleet Harbor A watershed is projected to exceed the 440 gpd per acre threshold, assuming the projected town-wide growth of 10%. Although no area in Wellfleet is formally designated as an NSA for embayment protection, using a loading threshold for areas known to have nitrogen impacted water and groundwater may be a useful tool in minimizing future impacts of nutrients to the embayment.

Another alternative would be to require the existing large conventional septic systems in areas with compromised groundwater or surface water to provide nitrogen reduction. For example, conventional systems within a specified distance, say approximately 300 feet, from the saltwater marshes or marine waters in the four study watersheds can be ranked as to risk or threat to water quality based on use, age and capacity.

Any system currently at least 20 years old was designed based on a version of Title 5 that has been revised twice, with a major revision in 1995 and minor changes in 2006. Of the 48 parcels within 300 feet of the shoreline and with conventional systems greater than 550 gpd, 19 have systems at least 20 years old. Table 2-5 presents the N load reduction that would be possible if the larger and older systems were converted to nitrogen reducing systems. These systems are often comprised of several septic systems on one parcel, serving one entity. Any regulation should clearly apply to the total design capacity for each parcel, or multiple parcels are if under common ownership. A tiered approach similar to the EPA's Chesapeake Bay recommendations, based on system design capacity, age, and distance to marine waters, would reduce summer season nitrogen loads.

Most of the larger systems near the shoreline serve seasonal cottages, condominiums or similar seasonal housing, or are infrequently used, such as the Adams Lodge at 2 Bank Street, so their year-round nitrogen load is not as severe as the system capacity would leave a casual observer to believe. For the vast majority of these systems, nitrogen loading occurs primarily during the summer season. Table 2-5 reflects this seasonal use.

Table 2-5: Additional Nitrogen Reduction to Groundwater from Converting Older and Larger Conventional Systems Within 300 Feet of Marsh/Marine Waters

Systems Currently > 20 years old	**System Design Capacity**		
	>550 gpd	**>660 gpd**	**>1000 gpd**
Total Design Flow Based on Title 5 (gpd)	26,175	21,775	17,160
Number of Systems	19	12	6
Equivalent 3 Bedroom Homes	79	66	52
Raw N Load in Summer* (ppd)	7.0	6.1	4.8
Raw N Load in Summer Only* (ppy)	585	485	383
N Load Reduced from Title 5 System to I/A (ppy)	**105**	**86**	**67**

*Nitrogen loads are based on the calculated average daily water use per seasonal unit of 275 gpd for 80 days

The reduction in nitrogen is based on a 52% reduction from a standard I/A system, as compared to the 34.4% reduction in a conventional system. Further restrictions could be implemented, but the additional cost for advanced systems may not warrant the effort. The intent of new wastewater regulations would be to better monitor and manage wastewater treatment and disposal in sensitive areas.

The majority of the nitrogen load to groundwater from the 20 year old systems originates from six (6) larger systems at over 1,000 gpd capacity. Extending the 100 foot buffer requirement for nitrogen reducing systems in Section 607 of the Board of Health regulations to 300 feet, specifically for these large systems, could be implemented without significant management requirements.

At the end of the 20-year planning period, all the conventional onsite systems will be at least 20 years old if not replaced. The total flow from all the systems greater than 550 gpd within 300 feet of the shore (47 parcels) is almost 80,000 gpd per Title 5 conventions, with 39,000 gpd from systems of 1,000 gpd capacity or more on 13 parcels.

Wellfleet should apply the Local Septic Management Plan, at a minimum, to enable residents to take advantage of low interest loans for upgrading, improving, or replacing onsite wastewater systems. Furthermore, Wellfleet should take advantage of the provision within Title 5 to apply nitrogen reduction technology in areas of environmental and public health risk. To minimize the initial impact on property owners, but create a consistent plan of improvement, the town can set parameters for performance requirements similar to Table EX-1, with design capacity and age limits setting the framework for improvements to conventional septic systems within identified sensitive areas.

Table 2-6 presents the maximum scenario where all large (greater than 550 gpd) conventional systems within 300 feet of the shore are replaced with nitrogen reducing technologies, or if all very large systems (greater than 1000 gpd) are similarly replaced, all over the next 20 years.

Table 2-6: Additional Nitrogen Reduction to Groundwater from Converting Large Conventional Systems Within 300 Feet of Marsh/Marine Waters

	All On-site Systems > 550 gpd	**All On-site Systems > 1,000 gpd**
Design Capacity (gpd)	63,955	38,170
Lots - Systems	48 - 68	13 - 33
Equivalent Homes	194	116
Raw N Load in Summer* (ppd)	17.8	10.6
Raw N Load in Summer Only* (ppy)	1,426	851
N Load Reduced from Title 5 System with I/A (ppy)	**250**	**150**

*Nitrogen loads are based on the calculated average daily water use per seasonal unit of 275 gpd for 80 days

1.7.3.2 *Shellfishing Regulations*

To be completed pending "No Take" propagation zone approval.

The Town of Wellfleet Shellfishing Policy and Regulations, Last Amended 04/09/2013, 06/04/2013, 7/16/2013, and 01/28/2014 provides local regulatory control of shellfishing. Contained within these regulations are specifics regarding oyster management:

- Non-Commercial Catch Limits:
  - The total amount of shellfish, comprising oysters, quahogs, soft-shell clams or razor clams, taken in one (1) week shall not exceed ten (10) quarts.
- Commercial Catch Limits:
  - Hand Picking: no commercial permit holder shall take more than five (5) bushels of oysters, including shells, per day.
  - Dragging / Dredging: No more than five (5) bushels of oysters including shells, per commercial permit holder shall be taken by a vessel in any one (1) given day. No more

than ten (10) bushels including shells, shall be taken by 21 any vessel having two (2) or more commercial permits aboard in any one (1) day. The captain of said vessel shall be cited for each violation.

- Daily Area Oyster Catch Limits (1 bushel = 32 quarts)

Area	Bushels
Herring River	1
Mayo Beach	1
Duck Creek	1
Blackfish Creek	1
Main Harbor	5
Chipmans Cove	1
South Lt. Island	1

- Oyster seed is also regulated with several sections devoted to management. For example:
    - No person who does not hold a state propagation permit or an aquaculture license shall have in his or her possession seed shellfish, defined as; …oysters less than three (3) inches in height (except for aquaculture license holders under certain conditions as specified…
    - The handpicking of oyster seed from the public resource is prohibited with the following exception: from time to time, under special conditions

1.7.3.3 *Stormwater Management*

Land Use Controls

A 0%-interest loan program is available through the MassDEP SRF program and the Water Pollution Abatement Trust (WPAT) to provide support to communities undertaking nutrient management projects. Criteria for eligibility for these funds includes a state approved CWMP and for the community to create land use controls that allow no more growth than would have occurred under zoning rules and wastewater regulations in place at the time of CWMP approval by EOEEA/DEP. Towns seeking 0% eligibility must show that they have adopted “flow neutral” land use controls that will limit wastewater flows to no more than the flows identified in the “Watershed Benchmark Flow”. 310 CMR 44.03 defines the Watershed Benchmark Flow as: “the existing wastewater facility total flow amount in a planning area, including flow amounts from on-site subsurface disposal systems, collection systems, and wastewater treatments plants…”

Zoning

Wellfleet has instituted zoning controls for stormwater management by limiting building coverage and specifying minimum setbacks and yard requirements for each parcel. Paragraph 5.4.2 of the current zoning bylaw sets the minimum yard requirements for front, side and read setbacks. Paragraph 5.4.3 restricts the maximum building coverage to 15% for all zones except commercial with a 25% limit. Additional restrictions on impervious cover and site clearing are applied to Cluster Development and for the Wellhead Protection Overlay District to maintain recharge and limit runoff:

No more than 15% of the total area of any lot shall be rendered impervious by the installation of buildings, structures and paved surfaces.

If all recharge is disposed of on-site, no more than fifty-percent (50%) of the total upland area of any lot shall be made impervious by the installation of buildings, structures, and paved surfaces.

A minimum of thirty (30%) of the total upland area of any lot shall be retained in its natural state.

BMPs

The Massachusetts Stormwater Handbook does not provide a nutrient reduction value for subsurface infiltration systems. A biological treatment process with a carbon (organic) source, or vegetative uptake, will enhance the ability of the BMP to denitrify and remove some of the nitrate-nitrogen before it reaches the groundwater. Examples of nitrogen reducing BMPS are bioretention areas (rain gardens), constructed stormwater wetlands, sand and organic filters, extended dry detention basins, wet basins, and proprietary systems.

Land Use and Fertilizers

Pursuant to Section 10(d) of the Cape Cod Commission Act, the CCC may nominate areas which are of critical value to Barnstable County to preserve and maintain for designation as districts of critical planning concern (DCPC). Barnstable County Ordinance 13-07 establishes a Fertilizer Management DCPC to protect groundwater and water quality due to nutrient concerns. The District encompasses the entire Barnstable County.

This ordinance was approved to allow local control of fertilizer management because of a ruling by the Attorney General's office, which stated that recent amendments to M.G.L. Chapter 128 give the Massachusetts Department of Agricultural Resources (MDAR) exclusive authority to regulate and enforce fertilizer application. One of the exceptions to MDAR's jurisdiction is for regulations adopted pursuant to the Cape Cod Commission Act, if completed prior to January 1, 2014. The enacted ordinance does not require municipalities to enact regulations related to fertilizer management. However, it does provide the municipalities with the tool to establish Implementing Regulations to support the Fertilizer Management DCPC.

The CCC has developed model regulations, from Cape Cod Commission (October 2013), for use by Cape communities that are intended to serve as the Implementing Regulations. The regulations define the restrictions to fertilizer application without an outright ban. For example, the model regulations, Section 5 Standard of Performance, would limit nitrogen fertilizer application to 3.2 pounds per 1,000 square feet, and would prohibit fertilizer application during or immediately prior to heavy rain and by Non-Certified Fertilizer Applicators closer than 100 feet to any water-body without local authority. Single applications must be done at intervals of at least four weeks until the annual maximum is reached.

Fertilizer usage estimates from CCC *Tech Bulletin 91-001* and Horsley Witten Group Inc., (September 2013) assumes 57% of homeowners fertilize lots with lawns averaging 5,000 square feet, using fertilizer comprised of 25% N content to total 3 lb N / 1,000 square feet per year. With a 25% leaching rate, the total load from the four study areas equates to approximately 2,200 lb of N per year.

The proposed Implementing Regulations limit the fertilizer N load to a rate equivalent to the existing rate (~3 lb/1000 ft.); therefore, the expected N reduction based on the CCC assumptions would be through the timing and methods of fertilizer application. An outright ban on nitrogen fertilizer, and perfect enforcement, would eliminate the total N load from fertilizer application. But, the CCC Technology Matrix assumes N removal rates of 6% to 20% using fertilizer management based on 5 mg/L of N per acre as the influent load. With 1,036 parcels in the four watersheds, averaging 5,000 square feet of lawn each per CCC convention, we have 120 acres of lawn area.

Despite the disparate methods of estimating the N reduction from fertilizer management, comparing the 3 pounds per 1,000 square feet of lawn (CCC Tech Bulletin 91-001) to the 5 mg/L per acre (CCC Technology Matrix) means between ***240 and 290 pounds of N is removed from the fertilizer load per year due to implementing the fertilizer bylaw and active management***.

The overall program of fertilizer nutrient control should involve a public education and homeowner awareness program. The Town should also review and promote its practices for Town property and field fertilizer application to set a public example, and evaluate its bylaws and regulations regarding lot clearing and allowable lawn size in critical areas.

1.7.4 Capacity of Existing Cluster / Satellite Systems

Cluster systems are used in Wellfleet generally for single ownership entities with seasonal cottages and trailer parks. Several large Title 5 systems equipped with I/A technology are located in Wellfleet. Two large Title 5 I/A systems are located in the Chipmans Cove Watershed at the town pier, one for the marina and one for a restaurant. Though these are large, they are not designed or permitted as cluster systems, each serving one establishment.

Two privately owned cluster/satellite treatment systems are located in the Town of Wellfleet. Both serve mobile home parks. One is located within the study areas, in the Wellfleet Harbor A watershed on Kendrick Avenue, and serves the Harborside Village mobile home development. Table 2-7 shows relevant data for cluster and satellite systems.

Table 2-7: Cluster/Satellite Wastewater Treatment Systems in Wellfleet

Type / Permit Number	Facility	Location	Flow Rate (gpd)	Notes
Recirculating Sand Filter	Marina (on pier)	Commercial St	Up to 3,000 (designed for 700 gpd)	Overloaded hydraulically
Septitech	Restaurant (near pier)	Commercial St	7,525	Commercial system, sized for proper capacity
873 *	Massasoit Hills	West Rd	33,900	Private trailer park, excessive distance from watersheds
Amphidrome /640 *	Harborside Village	Kendrick Ave	21,600	Private trailer park, capacity limited to its service area

*CCC Regional Wastewater Management Plan Technology Assessment – Conventional Infrastructure (2013)

None of these Title 5 I/A systems or treatment facilities will be useful for reducing nutrient issues from other parcels.

1.7.5 Water Conservation

The Wellfleet Municipal Water Systems Rules & Regulations, as Amended as of June 25, 2013, designates the Board of Water Commissioners (BWC) to oversee and manage the water system though its Water Operator.

At this point, the water demand is modest. The BWC implemented a marketing plan to promote the availability of town water to approximately two hundred (200) abutters to the system that have not yet connected. The BWC is encouraging connections by providing discounts to the connection fees. The discounts are on a declining scale after the first year that water service becomes available.

Water Conservation

The BWC does encourage conservation measures through its Consumer Confidence Report. The BWC provided the following Tips to Help Conserve Water in the 2012 Report:

- Fix leaking faucets, pipes, toilets, etc.
- Replace old fixtures; install water-saving devices, in faucets, toilets and appliances.
- Wash only full loads of laundry.
- Do not use the toilet for trash disposal.
- Take shorter showers.
- Do not let the water run while shaving or brushing teeth.
- Soak dishes before washing.
- Run the dishwasher only when full.

Because of the limited demand from system abutters at this point, emergency restrictions on water use due to drought or other shortage are not considered impending requirements. However, the BWC does have the ability to develop, implement and enforce water restrictions through its regulations. Paragraph 1.5 states:

> The BWC may declare a STATE OF WATER EMERGENCY if it finds there exists a water shortage or an impending water shortage; and/or a Declaration of Water Emergency has been made under Massachusetts General Laws, Chapter 21G as it is deemed essential to the protection of the public health, safety and welfare. In so doing, the BWC may establish priorities for the distribution of water or water use by a specified amount or to share water with other water systems. The BWC may also choose to develop a drought management or contingency plan and institute a conservation program for public and private use.

Tiered Rate Structure

Meters are read semi-annually. Water use charges are billed in accordance with the current fee schedule, Table 2-8, which includes a tiered water rate structure to encourage water conservation. In addition to any water use charges, a Base Service Fee (BSF), currently $76.88, is added to each bill after the initial application for connection to the Water System is received.

Table 2-8: Municipal Water System Rate Tiers

Tier	Cost per Thousand Gallons	Range (gallons)
1	$ 1.28	1000 to 20,000
2	$ 6.15	20,000 to 35,000
3	$ 8.71	35,000 to 60,000
4	$ 10.25	60,000 to 85,000
5	$ 12.81	> 85,000

1.8 *Stormwater Management and Structural Controls*

1.8.1 Drainage Improvements

The Town has already taken steps to structurally abate direct runoff into Duck Creek from the Central District. In 2011/2012, stormwater collection with deep sump catch basins and subsurface infiltration structures were installed along Commercial Street, between Bank Street and Howland Avenue.

Wellfleet is not subject to the EPA Phase 2 NPDES permit for stormwater management and therefore does not require an overarching management plan. However, given the drive to improve harbor water quality, drainage improvements, when needed, should be supplemented by the addition of nitrogen and/or phosphorus removing BMPs if feasible based on location, hydraulics and cost. As a baseline, Wellfleet should investigate requiring nitrogen and/or phosphorus removing BMPs for redevelopment projects subject to Planning Board approval or for other reviewable activities.

1.8.2 Permeable Reactive Barriers (PRBs)

Permeable reactive barriers (PRBs) treat contaminants such as nitrogen contained in shallow groundwater. They can be installed to intercept nutrient enriched groundwater such as from a cluster system drain field, closely spaced onsite systems, or stormwater infiltration devices. They are subsurface trenches installed perpendicular to groundwater flow and filled with a carbon media (such as wood chips or sawdust) to provide an environment for microbes to denitrify the groundwater.

The Cape Cod Commission lists PRBs as having an average N removal rate of 85-97%, but they are subject to regulatory approval. A pilot project is required for nutrient removal credit.

PRBs could be installed along the shoreline, up gradient of wells, or in a roadway ROW down gradient of areas with high nitrate concentrations in the groundwater. The permeability of the PRB must be greater than the surrounding soils to prevent redirection of the treatment plume around the PRB. According to ECMBL (2008), PRBs will continue to remove nitrogen in the presence of seawater, but PRB life expectancy will be significantly reduced if they are continuously exposed to seawater inundation because the carbon based media will be oxidized by anaerobic sulfide reducing bacteria. Intrusion of seawater can also drive the treatment plume below the PRB. Careful siting of the PRB to minimize seawater intrusion and protect against bypassing of the treatment plume is necessary.

The potential for down gradient impacts has been recognized since the earliest PRB column studies and field installations, where such impacts were observed. For example, from the 1998 EPA report *Contaminant Breakthrough/Bypass and Formation of Undesirable Products* (Powell et al. 1998) the report states:

> The primary objective of the compliance sampling program is to determine whether the treatment wall is meeting design goals for remediating the contaminated ground water. The presence of contaminants that exceed target cleanup goals in down gradient water samples is the first compliance measure most people, particularly regulators, will examine…

This same report also specifically refers to:

> *"...potentially undesirable secondary effects in down gradient water quality"*

We anticipate that the reducing nature of a PRB will result in anoxic, low ph water exiting the down gradient side of the PRB. The lack of oxygen in the water could directly impact organisms at the ground water/surface water interface and for some distance out into the mixing zone. Additionally, although certain metals are immobilized under such reducing conditions, others can be mobilized, and sulfide could also be significantly increased. These impacts are expected for all PRBs that create highly reducing conditions due to abiotic reactions or microbial processes; for example, emulsified oils as microbial carbon donors (ETSCP, 2006):

In addition, the reduced groundwater environment in the reactive zone may increase the mobility of some naturally occurring, but regulated, metals (e.g., iron, manganese, and arsenic). While these metals are more soluble under reducing conditions, migration of metals out of the reactive zone is often substantially retarded by adsorption to the aquifer matrix and/or precipitation as insoluble metal sulfides (Butler and Hayes, 1999).

However, as pointed out by Butler and Hays (1999) the metals can be removed by sufficient contact time with down gradient aquifer materials after exiting the PRB. Oxygen levels will usually also gradually increase with travel through the down gradient "normal" aquifer. Therefore, for many types of environmental scenarios, where there is sufficient distance between the PRB and sensitive receiving water bodies for the treated water to again achieve normal equilibrium with oxygen, these PRBs should work well. In Wellfleet the application of the PRB approach must consider the potentially short distances to the shoreline and tidal action.

1.9 Water System Expansion

1.9.1 Resolution of Onsite Wells Nitrate Levels

The water system's Phase II Expansion, as previously discussed and shown on Figure 1-5, addresses the remainder of the most densely developed lots with moderate to high nitrate levels in the groundwater. Loop #1 completes the connection between the Holbrook Ave area and Kendrick Ave via Chequessett Neck Road, Summit Street, and Hiller Ave, and encircles the Mayo Creek estuary.

The current expansion of the water system will protect public health by enabling property owners to replace private drinking wells that have marginal water quality, provide more land area on small lots for on-site wastewater disposal, and potentially reduce the complexity and cost of I/A systems in environmentally sensitive areas.

1.10 Wastewater Treatment Alternatives

The structural solutions available to address wastewater needs range from upgrades for individual on-site systems to centralized collection and treatment systems.

1.10.1 Wastewater Management

Wastewater management, a non-structural approach to pollution prevention and mitigation, involves optimizing the existing systems as described in Section 2.1- Baseline Alternative: Optimize Existing Facilities. No extensive new on-site facilities or technologies are expected to be employed on a wide spread basis. Instead, a program of improvements and management of existing systems is expected to be the focus long term.

1.10.2 On-site, Cluster, Satellite, Central, Regional Technologies

Wellfleet will continue to focus on on-site systems as the primary method of wastewater treatment and disposal. The benefits of this approach and the recommended treatment levels were discussed in detail in Section 2.1 Baseline Alternative: Optimize Existing Facilities. The focus will remain on reducing nitrogen discharged from wastewater systems.

The CCC *Technology Matrix* (2014) describes two (2) types of innovative/alternative (I/A) on site systems, two (2) types of cluster systems, and two (2) types of satellite treatment systems as follows:

Innovative/Alternative (I/A) On-site Systems

The determination as to what I/A system could provide the solution to the existing Title 5 issues would be up to the Board of Health or jurisdiction of any Septic Management Plan the Town chooses to implement. MassDEP maintains a current list of approved I/A systems on their website at http://www.mass.gov/dep/water/wastewater/iatechs.html

On-site denitrifying systems typically consist of standard septic system components augmented to remove nutrients. I/A systems are commercial, proprietary systems intended to be designed as recirculating sand filter (RSF) equivalent by meeting the same treatment limits in a smaller footprint. Total N <19 mg/L.

Enhanced I/A systems for TMDL compliance. Enhanced I/A (RSF Equivalent) would definitely require chemical systems to reliably meet such limits that would target near 10 mg/L for TN to consistently meet a design of 13 mg/L. Nitrogen levels are typically treated to 10 to 13 mg/L.

Cluster Systems

A single-stage cluster system is an I/A system generally treating wastewater flows greater than 2,000 gallons per day. Several homes or businesses discharge to and are treated at a common I/A system. Nitrogen levels are typically treated to below 15 mg/L.

Two-stage cluster systems are similar to a single-stage cluster system, but require a separate denitrifying process and other facilities to reduce nitrogen levels below that of a single-stage system. Two-stage systems may require chemical systems and an operator to run the system. Disinfection may be required if the discharge is located within a Zone II of a public water supply well. Nitrogen levels are typically reduced to below 8 mg/L.

Satellite Treatment Systems

A wide range of technologies were evaluated as part of the Barnstable County Wastewater Cost Task Force (April 2010), including Sequencing Batch Reactors (SBRs), Rotating Biological Contactors (RBCs), Membrane Bioreactors (MBRs), and conventional activated sludge systems. Each of these technologies would be a candidate for Wellfleet, but the final stage of denitrification following the base treatment technology somewhat dictates the base treatment system. The Cape Cod Commission has established a nitrogen effluent limit of 5 mg/L for all treatment facilities permitted through the Massachusetts Groundwater Discharge Program. Therefore, advanced systems that can provide low levels of nitrate to the denitrification stage would be most beneficial to ensure permit limits are met.

Satellite wastewater treatment facilities typically treat wastewater from up to 300 homes and wastewater flow between 25,000 and 330,000 gpd. Nitrogen levels are typically treated to around 10 mg/L. A Groundwater Discharge Permit is needed for flows greater than 10,000 gpd and a licensed operator would be responsible for O&M.

Enhanced satellite wastewater treatment facilities are similar to satellite wastewater treatment facilities, but require a separate denitrifying process and other facilities to reduce nitrogen levels below that of satellite wastewater treatment facilities. Enhanced facilities will require chemical systems. Nitrogen levels are typically reduced to below 8 mg/L. EPG has selected this enhanced technology as the foundation of further analysis because of the CCC limit of 5 mg/L for treatment effluent.

Central / Regional Systems

Centralized and regional systems do not exist currently within a reasonable service distance of Wellfleet. To the north, Provincetown has a 0.75 MGD centralized system, which is approximately 15 miles from Wellfleet Center. To the south, Eastham does not have plans for a centralized or regional facility. No other nearby community has a large scale treatment facility or plans to construct such a facility.

Approach

EPG has characterized Innovative/Alternative (I/A) on-site systems as those applied to individual residential and commercial systems less than 1,000 gpd for the purpose of calculating nitrogen loads. Systems that are rated greater than 1,000 gpd tend to be cluster-type systems associated with seasonal rental parcels comprised of several small separate cottages, townhouses or condominiums. We have characterized these as cluster systems to be able to track the effects separately from the individual system parcels. However, the treatment effectiveness will remain the same as individual I/A systems because most of the “cluster” systems are located on single or co-joined parcels and additional land is not available for larger and more intricate treatment systems.

Although structural wastewater systems are low on the list of preferred solutions for the Town of Wellfleet, satellite wastewater management systems must be evaluated to serve subareas of the community. The treatment technology at either a central treatment facility or smaller satellite facility must provide sufficient treatment to produce effluent that meets the standards for groundwater discharge in the disposal location. Disposal capacity (availability of land with suitable soils) will govern the ability to expand cluster and satellite systems because of the small quantity of vacant (available) parcels not protected for conservation.

1.10.3 Discharge Criteria

Title 5 (310 CMR 15.000) regulates on-site wastewater treatment and disposal for flows up to 10,000 gpd. One provision of Title 5 enables MassDEP to regulate systems serving new construction in a Nitrogen Sensitive Area, which must be designed to receive no more than 440 gallons of design flow per day per acre. For systems designed for 2,000 gpd or more in Nitrogen Sensitive Areas, MassDEP requires that the total nitrogen concentration in the effluent not exceed 25 mg/L. Although MassDEP has not designated a Nitrogen Sensitive Area in Wellfleet yet, these provisions can help guide enhancements to local regulations.

The dominant soil type in Wellfleet has very high rates of drainage comparable to the Class 1 soils as presented in Title 5, which have percolation rates between 8 minutes per inch to less than 5 minutes per inch. These soils with high (fast) percolation rates can receive hydraulic loading between 0.66 gpd/sq.ft. and 0.74 gpd/sq.ft. in accordance with Title 5 regulations.

Hydraulic loading rates for groundwater disposal of effluent from satellite or larger treatment systems are generally much greater than for septic systems. Effluent disposal to the ground is regulated by the MADEP for discharges over 10,000 gpd through a Groundwater Discharge Permit and further restricted by the Cape Cod Commission. From the Cape Cod Commission (March 2013):

> Because of the environmental sensitivity afforded Cape Cod as a Sole Source Aquifer, the MassDEP typically requires that the effluent nitrogen concentration from a wastewater treatment facility cannot exceed 10 milligrams per liter. The Cape Cod Commission has established a more stringent nitrogen effluent limit of 5 milligrams per liter for all treatment facilities that fall under the Massachusetts Groundwater Discharge Program.

Surface water discharges are regulated by the EPA through the NPDES permit program. However, in accordance with the Ocean Sanctuaries Act, MassDEP does not permit surface water discharges for new facilities on Cape Cod.

1.10.4 Design Flows and Loads

The Phase 1 Needs Analysis did not show a need to provide centralized wastewater collection treatment and disposal for every parcel in all four watersheds. The primary areas of concern are located along the shore of the inner harbor and where parcels have variances for septic systems and/or high nitrate levels in groundwater. Table 2-9 presents the total flow and nitrogen loads from the four watersheds under study for the total number of wastewater systems (Parcels are fewer, at 1,036 parcels, because of multiple systems on single parcels).

Table 2-9: 2030 Design Flows and Loads for the Four Study Watersheds

Marine Estuary	On-Site Wastewater Units	Title 5 Design flow (gpd) *	Flow/acre (gpd/ac)	Raw N Load (ppy)	N Load to Groundwater (ppy)
Chipmans Cove	387	159,970	270	3,770	**2,360**
Duck Creek	478	225,970	400	4,660	**2,995**
Wellfleet Harbor A	127	54,900	470	1,400	**910**
Wellfleet Harbor B	68	27,940	350	630	**405**
Total	**1,060**	**468,780**	**345**	**10,460**	**6,670**

*10% growth in developable lots times 330 gpd per lot, plus 2010 flow.

Woodard & Curran (October 2001) evaluated two (2) potential sewer service areas. The Base Service Area included 170 parcels in the Central Village District study area. The Expanded Service Area includes all of the base service area and also includes an additional 177 parcels to the east of this area, for a total of 347 parcels. The Base Service Area (Central Village District) generally corresponds to EPG's review of needs areas for parcels with onsite disposal variances, small parcels, nitrates in drinking water and located along the main commercial routes for the special case of economic sustainability. EPG created the tiered approach shown in Table 2-10 to provide alternatives for wastewater service in the Central Village District. Figure 2-2 presents the areas graphically.

Table 2-10: – Potential Sewer Areas and Wastewater Flow

Area	Parcels	Service Area	Linear Feet of Pipe	Total Flow at 210 gpd per parcel (gpd)	Total Flow at 330 gpd per parcel (gpd)
1	110	Central District – Main St To Holbrook Ave, Commercial St to Holbrook Ave, Bank St	7,800	23,100	36,300
1,2	175	Central District with Holbrook Ave and West Main St to Harland Ln	12,500	36,750	57,750
1,2,3	190	Include route to DPW	12,000	39,900	62,700

Table 2-11 shows the estimated nitrogen load to groundwater that would be removed by sewering with enhanced treatment and disposal outside of the local watershed. The removed load represents the additional nitrogen load beyond the treatment systems in place in 2030 with no other action to upgrade those systems, and not the initial raw load to the systems.

Table 2-11: Additional Nitrogen Load to Groundwater Removed Via Sewers

Area	Parcels	Service Area	N Load Removed from Groundwater (ppy)
1	110	Center District – Main St, Commercial St, Bank St	955
1,2	175	Center District with Holbrook Ave and West Main St	1,320
1,2,3	190	Include route to DPW	1,410

1.10.5 Collection System Alternatives

Gravity sewers with centralized pump stations are the default standard technology for wastewater collection systems. Low pressure sewer (LPS) systems are commonly used in areas with adverse terrain, such as shorefronts, to minimize construction costs. Long-term maintenance of the private grinder pumps used with LPS systems can be problematic if the community does not institute a maintenance program. Some communities buy the pumps, supply the pumps to the residents, and maintain the pumps, accepting emergency calls as well as regular service calls. Issues raised by this approach include obtaining and maintaining easements, private property liability concerns, late night call support, and long-term costs for staffing and supplies. Other communities leave the long-term maintenance of the pumping systems to the private property owners. We recommend that municipalities require pump owners to have a maintenance contract with an approved service provider prior to receiving a sewer permit. Proof of a maintenance contract should be submitted to the municipality on a regular basis.

MassDEP requires that the municipality show that a conventional gravity-based system is not as feasible as a low pressure system prior to approving a Sewer Extension Permit for a low pressure system. In addition, MassDEP requires that the grinder pumps and septic tank effluent pumps (STEP) be registered on the property deed, and requires the municipality to include this provision prior to issuing its municipal sewer connection permit. The following Table 2-12 provides a summary of common pros and cons.

Table 2-12: Collection System Technology Alternatives

Technology	Pros	Cons

Conventional Gravity Sewer System	• Power outage handled with backup power at pump stations for consistent service
	• Provides capacity for future changes
		• Higher capital and overall costs
		• Increases potential for growth
		• Construction
		  ▪ Deep excavations disrupt traffic
		  ▪ Not all properties can easily be served by gravity connections
		  ▪ Creek/Water crossings will be more expensive

Low Pressure Sewer System (STEP / Grinder Pumps)	• Ease of long-term maintenance by municipality
	• Lower capital cost
	• Can be sized to control growth
		• Pumps located on each lot
		  ▪ Increased service call effort
		  ▪ Alarm panels mounted on buildings

	• Construction: shallow excavation ▪ Horizontal directional drilling possible to minimize adverse impacts and cost ▪ Environmental disruption minimized ▪ Duration of construction reduced ▪ Suitable for challenging terrain ▪ Reduces creek/water crossing effort	• Electrical costs paid by property owner • MassDEP requires deed restriction citing grinder pump • Maintenance agreement is recommended • STEP system still requires septic tank pumping • Power failure can disrupt service
STEG & Variable Slope Gravity Sewers	• Construction: shallow excavation ▪ Same as for low pressure systems	• Limited variety of vendors and service providers • Application is limited by terrain unless additional pumping is included • STEG system still requires septic tank pumping
Vacuum Sewer System	• Construction: shallow excavation ▪ Same as for low pressure systems	• Limited variety of vendors and service providers • Application is limited by terrain unless additional pumping is included

1.11 Screening of Alternatives

1.11.1 Summary of Nitrogen Reduction Effectiveness

The effectiveness of each technology to reduce nitrogen varies across the alternatives. As a method of initial comparison, the nitrogen reduction (in ppy) over the base conditions of conventional Title 5 systems can be compared. According to the CCC (Overview, 2012) nitrogen sources are on-site wastewater systems, fertilizers, runoff from impervious areas, runoff from natural surfaces, and water body surface areas. However, this report is focusing on the solutions that can mitigate nitrogen sources in a practical and cost-effective manner. Therefore, addressing generic loading from general runoff is not specifically calculated or included. Instead, these sorts of programs are addressed as general approaches and additional solutions as part of the overall toolbox. Included here are alternatives for which results can be measured or estimated using conventional and defensible methods, namely wastewater systems and fertilizer application.

The total load now reaching the groundwater, and the inner harbor assuming no attrition within the groundwater flow, is approximately 8,500 ppy. The majority of this load originates from on-site wastewater systems. Table 2-13 presents the potential nitrogen reduction from each alternative as compared to the overall load.

- 2030 wastewater load = 6,665 pounds per year
- 2030 fertilizer load = 1,830 pounds per year

- Total load measurable ~ 8,500 pounds per year

Table 2-13: Additional Nitrogen Reduction for Alternatives Applied to the 2030 No Action Scenario

Alternative	Units Existing	Units 2030	Nitrogen Reduction (ppy)	Notes
1. Optimize Existing Systems				
Aquaculture – Oysters in Propagation Zones	4,200,000	10,300,000 minimum needed **	8,500	May remove total measurable load
Marsh Flushing (Mayo Creek)	N/A	1	745 – 1,730	Potential range over complete restoration period
Stormwater Management				
Fertilizer Management	0 lots	1036 lots	240 - 1,830	13% - 100% removal rates.
Wastewater Management				
Individual I/A Systems	54	148	145	Accommodates some build-out and conversion of conventional systems within 100 ft of marine waters
Large I/A Systems	9 lots	33 - 48 lots	150 - 250	Convert conventional systems > 1000 gpd or >550 gpd within 300 ft of marine waters
2. Water System Expansion	N/A	N/A	N/A	Drinking water protection
3. Cluster Systems – Composting Toilets	1	2	70	Summer only: Mayo Beach, Replace systems at Baker Field (portable), Marina, Sticker Shack
4. Satellite System	100 - 170	110 - 190	955 – 1,410	Central District to expanded area
5. Centralized System	966	1,060	6,330	All units in the 4 watersheds

** Does not include the 6 planned propagation zones outside of the inner harbor

1.11.2 Screening of Collection Systems

Both gravity collection and low pressure systems appear to be technically feasible for the Wellfleet area. Figure 2.2 displays the basic areas served by each alternative.

<u>Gravity Collection System</u>

For conventional gravity sewer systems and STEG systems, the general layout of the system would follow the topographic contours of “downtown” Wellfleet, with the gravity pipe laid to direct flow from the Main Street area to the Commercial Street / Kendrick Road area near Mayo Creek. A central pump station is needed to collect the gravity flow and convey it to the treatment facility and discharge area. The central pump station would likely be located near Mayo Creek for all alternatives because it should be able to accommodate future expansion if desired.

Low Pressure Systems

For grinder pump systems and STEP systems, a low pressure collection system can be used to collect the wastewater and convey it to the treatment facility. However, as discussed in the next section, a centralized pump station may be required to address the long distance to the potential treatment/discharge locations. This pump station, however, can be located closer to the facility location and does not need to be located at the lowest elevation in the system. The central pump station would likely be located near the Main Street / West Main Street area, though the operating pressure of the collection system will determine the final elevation and location of the main station.

1.11.3 Site Selection Screening for Effluent Disposal

The principal tool used in identifying Areas of Interest (AOI's) with potential for treated wastewater effluent disposal has been GIS mapping technology linked with databases created specifically for this project. We compiled the database information from the Town of Wellfleet's Board of Health (BOH) records, data layers available from MassGIS, and Natural Resources Conservation Service (NRCS) soils maps. These data sources have provided the important and limiting characteristics of potential sites.

Soil Type

The most significant characteristic in eliminating areas in Town unsuitable for wastewater effluent disposal is soil type. Areas without water-lain deposits of sands and gravels are not expected to be able to infiltrate wastewater effluent quickly enough to be of value in a small municipal disposal program. Thus, areas without these soil characteristics are eliminated from consideration.

Another significant hydrogeologic characteristic for wastewater disposal is the depth to seasonal high groundwater and to the restrictive soil layer. Groundwater is classified by the United States Soil Conservation Service according to their engineering properties for sanitary facilities capabilities along with the associated soil classifications. MassDEP regulations require a minimum of four feet of unsaturated soils below the discharge facility, after any groundwater mounding has occurred. As an initial criterion, to allow for limited mounding and some embedment of the facility, we used GIS tools to reject areas with approximately 7 feet or less from the surface to seasonal high groundwater or restrictive layer.

The sites selected by EPG include the Transfer Station on Coles Neck Road, as did the Woodard & Curran 2001 report. However, Table 2-14 presents two other locations closer the Central District that may be suitable for wastewater treatment and disposal based on soils and town ownership. Potential sites are shown on Figure 2.2.

Table 2-14: Potential Treated Wastewater Effluent Disposal Sites

Site	Lot	Address	Area (acres)	Notes
DPW	13-145 13-146	190 West Main St 220 West Main St	2.83 3.07	190 is vacant 220 has the DPW building
Borrow Pit	12-224	145 Pole Dike Rd	12.45	Excavation altered depth to groundwater
Transfer Station	7-24	266 Coles Neck Rd	28.10	Partially in use. Adjacent and up gradient to landfill

The acceptability of these locations is driven by cost, soil conditions, environmental impact, and ability of the sites to accept the necessary hydraulic load. The capital and O&M costs are affected by the configuration of the collection system and location of facilities. For the gravity collection system, the central pump station will need to be equipped with larger pumps to convey the wastewater a further distance from Mayo Creek to the treatment facility. The length of the force main will require additional valve structures for air release and flushing connections. At the expected length, odor control may be necessary. Table 2-15 shows the lengths expected for the piping infrastructure for each sewer alternative, assuming the treatment facility and discharge location are located at the Borrow Pit, which lies between the closest and furthest disposal options.

Table 2-15: Estimated Pipe Lengths for Selected Sewer Alternatives to Borrow Pit

Parcels	Service Area	Collection Pipe (lf)	Gravity System Force Main (lf)*	Low Pressure System Force Main (lf)*
110	Center District – Main St To Holbrook Ave, Commercial St to Holbrook Ave, Bank St	4,500	7,800	4,100
175	Center District with Holbrook Ave and West Main St to Harland Ln	7,000	7,800	3,500
190	Include route to DPW site	8,500	7,800	2,000

*Force Main to Borrow Pit Location

If the cost of the alternative is justifiable, or no other less expensive solutions exist, the Town would move on to a more detailed hydrogeological analysis of the preferred site(s).

1.11.3.1 *Groundwater Discharge Permit Requirements – Additional Steps*

To move forward with a plan to discharge treated effluent at any site, the Town must conduct a hydrogeologic assessment and submit a hydrogeologic report to DEP before obtaining a permit to discharge. Basic requirements for this process are:

1. Subsurface exploration with test pits, borings, falling head tests, piezometers, and groundwater monitoring wells
2. Determine hydrologic parameters through sieve analysis, permeability testing, pumping tests, and other methods acceptable to DEP.
3. Determine the contributing watershed area

4. Conduct a groundwater mounding test and analysis
5. Install groundwater monitoring wells
6. Determine pre and post groundwater mounding and flow
7. Provide maps and data showing soil and groundwater test/samples, geologic features, sensitive receptors, water quality and groundwater data, wells with ½ mile, previous environmental information, previous and existing uses of the site
8. Final report and recommendations

1.11.3.2 *Soil and Groundwater Conditions*

Soils throughout town are generally identified by the NRCS as Map Unit 252 (Carver coarse sand) type soils, classified as Hydrologic Group A, and typified by excessively drained (poor filter) sand and gravel. Poor filter relates to the soil's lack of ability to slow the progression of a pollutant plume or provide a supporting environment to remove pollutants. Soil properties from the NRCS web site are:

- Slope Categories: A) 3 to 8 percent, B) 8 to 15 percent, C) 15 to 35 percent
- Depth to restrictive feature: More than 80 inches
- Drainage class: Excessively drained
- Capacity of the most limiting layer to transmit water (Ksat): Very high (20.00 to 99.90 in/hr)
- Depth to water table: More than 80 inches
- Frequency of flooding: None
- Frequency of ponding: None
- Available water capacity: Low (about 3.0 inches)

1.11.3.3 *Usable Area for Hydraulic Loads*

The actual usable area of each potential disposal lot should be reduced from the total area to account for buildings, access roads, and setbacks (say by 20%), and again by 50% for siting a reserve disposal area. For a conservative estimate, we can anticipate a standard disposal system of rapid infiltration basins (RIBs) or subsurface infiltration, with infiltration rates of between 1 gallon per day per square foot (worst case loading) and five gallons per day per square foot (best case loading). (Rates as high as 7 gpd/sf are seen on the Cape.) The total potential hydraulic load is based on the Title 5 standard of 330 gpd per unit in the four watersheds.

For the scenario of a limited area of sewers, all of the sites would be candidates for a disposal area based on hydraulic capacity. Table 2-16 provides the scenarios where each site is acceptable on a hydraulic loading basis.

Table 2-16: Disposal Area Sufficient for Expected Hydraulic Loads

Site	Area (acres)	Usable Acres	Best Case Loading	Worst Case Loading	Best Case Loading	Worst Case Loading
			(110 Properties in Center)		(All four watersheds)	
DPW (2 lots)	2.83 / 3.07	2.36	Yes	Possible	No	No
Borrow Pit	12.45	4.98	Yes	Yes	Yes	No
Transfer Station	28.10	11.24	Yes	Yes	Yes	Yes

1.11.3.4 *Other Considerations for Siting Wastewater Treatment and Disposal*

Each site has other factors to consider.

Availability of Site

When selecting wastewater effluent disposal locations, the potential disruption of nearby residents during construction and frequent resistance and concern about having a nearby facility are important considerations. Thus, our evaluation focused on town-owned parcels with sufficient area to house a treatment and disposal facility without disruption to residential properties.

Sensitive Human Receptors

Sensitive receptors include "at-risk" residents such as schools and elderly facilities, municipal water supply wells sites, wellhead protection areas as mandated by Town zoning and MA DEP regulations, vernal pools, and surface water bodies and wetlands. Sensitive environmental receptors such as well sites, water bodies, and wetlands are unsuitable as potential areas for wastewater effluent disposal and discussed separately. These criteria are included in the evaluations.

Drinking Water Supplies

All sites were screened as to their location in relation to potable water supplies. Wellhead protection areas are a special case where some areas may be acceptable for wastewater which has been treated sufficiently and where no surface water "short circuits" exist to shorten travel time between discharge site and wells. However, the proximity of sites to public drinking water supplies, whether Zone I, Zone II or surface water supplies, is significant and applicable to stringent regulatory restrictions, and therefore, all sites identified for wastewater disposal are not within any of these restrictive zones.

Fisheries

The proximity of potential sites to fishery resources, spawning areas, and adjacent waterbodies is a factor in siting groundwater discharge facilities. The Herring River and estuary is located near two of the proposed disposal areas.

Wetlands and Water Bodies

Proximity to surface water bodies in another factor considered with the siting of groundwater discharge facilities. The Herring River estuary is located near two of the proposed disposal areas and the Pole Dike Creek must be crossed with a pressure force main to reach the Transfer Station.

Floodplains

Construction of groundwater discharge facilities is severely constrained within special flood hazard areas (SFHAs), which are subject to inundation by the 1% annual chance flood. The 1% annual chance flood (100-year flood, or base flood) is the flood that has a 1% chance of being equaled or exceeded in any given year. Proximity to flood plains is a major consideration in the siting of groundwater discharge sites.

Coastal Barrier Resources System (CBRS) Areas are subject to the Coastal Barrier Resources Act (CBRA) of 1982, which designated relatively undeveloped coastal barriers as ineligible for most new federal expenditures and financial assistance.

Natural Heritage and Endangered Species

All sites are screened for proximity to rare and/or endangered species through the NHESP. These sensitive habitats include estimated habitats of rare wildlife, vernal pools, and priority sites of rare species habitats as well as areas of critical environmental concern (ACEC).

The entire project would be located within the Wellfleet Harbor ACEC (designated 5/18/89) encompassing 12,480 acres. The Wellfleet Conservation Commission has jurisdiction over the ACEC through its Environmental Protection Regulations under 2.05 *Land Subject to Coastal Storm Flowage (LSCSF) and Wellfleet Harbor ACEC*:

(3) Presumption of Significance
Where a proposed activity involves work within LSCSF or within the Wellfleet Harbor ACEC the Conservation Commission shall presume that such area is significant to the interests and environmental values of the Wellfleet Environmental Protection Bylaws. This presumption may be overcome only upon clear and convincing proof, provided by the applicant that the area in discussion does not play a role in the protection of said interests and environmental values protected by the bylaw and if the Conservation Commission makes a written determination to that effect.

(4) Performance Standards

(a) Any activity proposed on LSCSF or within the Wellfleet Harbor Area of Critical Environmental Concern shall not:

(1) Reduce the ability of the resource to absorb and contain flood waters;
(2) Reduce the ability of the resource to buffer more inland areas from flooding and wave damage;
(3) Displace or divert flood waters to other areas;
(4) Cause or create the likelihood of damage by debris to other structures on land within the flood plain (collateral damage);
(5) Cause ground, surface or saltate pollution triggered by coastal storm flowage;
(6) Reduce the ability of the resource to serve as a wildlife habitat and migration corridor through activities such as, but not limited to the removal of substantial vegetative cover and/or installation of fencing and other similar structures.

Sites within these mapped areas are limited to their use due to the potential changes in the environment that could adversely affect the natural communities present.

Parklands, Recreational Resource and/or Conservation Lands

Lands designated as parkland, recreational use and/or conservation land use designation present constraints for their use as groundwater discharge sites. There are typically deed restrictions, Article 97 Legislation, and issues with local acceptance and approval due to potential changes in use.

Historic Designation

Historic interests include structures as well as properties and interests. Working with MHC, the CWMP will avoid any potential impact/adverse effects to historic resources.

Other

Other potential impacts screened in this category including state land use code designations on sites, local zoning issues, and conservation land.

In screening the potential sites, consideration was given to the potential impacts and the effort to mitigate impacts. It was evident that if a site appeared to be conducive to groundwater discharge based on one criterion, all criteria need be evaluated before a final decision can be established. Even if all but one criterion was positive for the site's use, just that one criterion could be the basis for elimination of the site's use altogether.

The sites may contain opportunities should the Town need land in the future for constructing a WWTF. The screening analysis for a WWTF is not as difficult as that for groundwater discharge as soil and groundwater conditions are not as limiting. Table 2-17 presents these and other items for consideration.

Table 2-17: Considerations for Potential Wastewater Effluent Disposal Sites

Treatment/Disposal Site	Pros	Cons
DPW (2 lots)	• Shortest force main route	• Wooded lot would need to be cleared • Residential area • Near in-town location
Borrow Pit	• Undisturbed land available • Non-residential area	• Adjacent to Herring River and estuary which may be important for fisheries and water quality • Much of the parcel has been heavily excavated and may no longer be useful for disposal • Undisturbed area to the north of the pit is within a special flood hazard area (SFHA) and adjacent to a CRBS area • Some variable soil types
266 Coles Neck Road – Solid Waste Transfer Station	• Undisturbed land available • Non-residential area • Actively used and accessible • Residents accustomed to waste/recycle function at this location	• Furthest distance from Central District (> 1 mile) • Near Herring River – pipe route along marsh edge • Additional water crossing in roadway (Pole Dike Creek) • Adjacent to and up gradient from the closed landfill – impact has not been assessed

Additional considerations for each potential disposal site, as listed above and per DEP Guidelines, are summarized:

- Soil and Groundwater Conditions – Soils and depth to groundwater appear to be suitable per NRCS mapping. A subsurface investigation and mounding analysis must be conducted to verify.

- Availability of the Site – All parcels are municipally owned.
- Sensitive Human Receptors – None for long-term uses. Potentially during construction.
- Drinking Water Supplies – Each site is outside any designated Zone II or IWPA.
- Fisheries – No direct impacts are readily evident. Groundwater modeling of the effluent would be needed to identify concerns.
- Wetlands and Water Bodies – All sites appear to have sufficient area outside of any regulatory buffers, though creek/river crossings are needed and some force main routes border vegetated wetlands.
- Floodplains – The 100-year flood plain appears to impact the construction of pipelines and the potential treatment facility and disposal field site at the Borrow Pit.
- Natural Heritage and Endangered Species – Each disposal site is located within a NHESP Estimated Habitat of Rare Wildlife, and construction of the facilities would be on the portions of the sites relatively undisturbed. Certified vernal pools are located abutting the potential force main route. Further review would be needed.
- Parklands, Recreational Resource and/or Conservation Lands – None impacted.
- Historic Designation – None at the three sites.
- Wellfleet Harbor ACEC - Designated 5/18/89, 12,480 acres

3. EVALUATE ALTERNATIVES

In this section, the list of alternatives that pass the first level of screening are further evaluated and prioritized.

1.1 Effectiveness of Alternatives

The benefits and challenges from the following direct impacts were evaluated for each alternative:
(a) Historical, archaeological, geological, cultural, conservation and recreation
(b) Wetlands, flood plains, and agricultural lands
(c) Zones of contribution of existing and proposed water supply sources
(d) Surface and groundwater resources
(e) Displacements of households, businesses and services
(f) Noise or air pollution or odor and public health issues associated with construction and operation
(g) Violation of federal, state or local environmental and land use statutes.

In addition, the alternatives were evaluated for the following indirect impacts:
(a) Changes in development and land use patterns
(b) Pollution stemming from changes in land use
(c) Damage to sensitive ecosystems
(d) Socioeconomic pressures for expansion.

Potential impacts to the described direct and indirect criteria were determined for each of the alternatives and collection systems. Only the alternatives which may have impact are included.

The alternatives in the short list are not mutually exclusive. Instead, the alternatives can be considered a menu of solutions to be enacted in a prioritized basis, or each solution can be applied to solve a specific problem as needed. The key to determining the priority is to determine which alternative can provide the needed solution, long-term and sustainably, at the lowest cost. The short list of alternatives is:

1. Optimize Existing Systems
    a. Natural systems remediation and mitigation solutions
        i. Aquaculture - oyster propagation zone (reef) expansions
            1. No take shellfishing zones
        ii. Estuary and salt marsh restoration and flushing – Mayo Creek, Herring River
    b. Non-structural solutions
        i. Stormwater management – nitrogen focus, fertilizer regulations
        ii. Wastewater management – on-site systems regulated and managed to 300 feet from water bodies, I/A nitrogen treatment requirements for large systems (52% removal minimum)
2. Stormwater Controls
    a. Drainage improvements as needed and as completed on Commercial Ave.

   b. Permeable reactive barriers in select locations considering performance concerns related to proximity to salt water
3. Protection of Drinking Water
   a. Water system expansion underway to cover parcels with elevated nitrate levels in private wells
4. On-Site Innovative/Alternative Systems
   a. Combined with wastewater management and regulations (included under Optimize Existing Systems)
5. Cluster Systems
   a. Focused on near-shore seasonal housing with large nitrogen loads (included under Optimize Existing Systems)
6. Composting Toilets for Mayo Beach, Baker Field, Sticker Shack, and the Marina
7. Satellite/Central Wastewater Collection and Treatment - Central Village District

1.2 Effectiveness of Alternatives

1.2.1 Optimize Existing Systems

1.2.1.1 *Aquaculture - Oyster Reefs*

Benefits:

1. Restores historical ecological conditions in marine waters
2. Potentially capable of removing the entire nitrogen load from the Inner Harbor watersheds
3. Manages soil and silt run-off
4. Buffers against coastal erosion
5. Improves water quality through filtration and biogeochemical processes
6. Provides carbon sequestration and help mitigate climate change and ocean acidification
7. Increases biodiversity and supports plant life survivability for eel grass and other species
8. Increases critical commercial and recreational fish populations by providing habitat
9. No construction related disruptions
10. Favorable environment exists in the harbor for oyster propagation based on historical record
11. Greatest removal efficiency occurs in conjunction with greatest load (summer)
12. Measurable results are seen within 1 year
13. Reduces the capital, operating and energy resources that would be associated with hard-piped nutrient solutions for land-based wastewater pumping and treatment.

Challenges:

1. No-take zones must be monitored and secured
2. Long-term species resiliency yet to be determined or measured

1.2.1.2 *Estuary and Salt Marsh Restoration and Flushing*

Benefits:

1. Mayo Creek discharges directly to an impaired location in the Inner Harbor;
   a. With restored function, could remove 40% of nitrogen load from its watershed
   b. Significant potential to remove over 1,500 ppy of nitrogen now discharging to the Inner Harbor

2. Increases biodiversity and supports plant life survivability for salt marsh species
3. Reduces the capital, operating and energy resources that would be associated with hard-piped nutrient solutions for land-based wastewater pumping and treatment
4. Culvert upgrades protect against storm surge and manage tide elevations
5. Results should improve as natural restoration occurs over time
6. Greatest removal efficiency occurs in conjunction with greatest load (summer)
7. DER (2014) estimates that the Herring River restoration will increase the value of over 1,400 properties after tidal wetlands are restored because of improved viewscapes and aesthetics.

Challenges:

1. Concerns about salt water intrusion into drinking water wells
2. Inundation of private property identified as a concern for program management
3. Nutrient removal is dependent of marsh specifics such as depth of groundwater flow below peat layer.
4. Effectiveness of local marsh restoration should be investigated and monitored further for a more precise estimate

1.2.1.3 *Non-Structural – Stormwater Management*

<u>BMP and Fertilizer Regulations</u>

Benefits:

1. No capital costs
2. Fertilizer regulations already drafted by CCC
3. Draft fertilizer regulations provide for local control
4. Greatest removal efficiency occurs in conjunction with greatest load (summer)
5. No increase in cost for property owners

Challenges:

1. Fertilizer application enforcement is difficult
2. Perception of private property infringements

1.2.1.4 *Non-Structural – Wastewater Management*

Extend enhanced treatment requirements setbacks from marine waters for large on-site systems. Non-structural (bylaw) approach will result in structural retrofits of existing conventional septic systems.

Benefits:

1. Directs costs to specific land owners with systems most affecting water bodies
2. Septic Management Plan can provide low cost loans to property owners
3. Use existing state regulations for implementation
4. Source control of near-shore outdated systems
5. Could include a continuous upgrade component to minimize nitrogen impacts long-term
6. Greatest removal efficiency occurs in conjunction with greatest load (summer)
7. Pro-actively addresses source control

Challenges:

1. Individual property owners bear cost, construction, and O&M burden of retrofits
2. Management and enforcement effort for the municipal staff
3. Small increase (18%) in nitrogen reduction as compared to conventional systems
4. Additional regulations may not be publically palatable
5. Perception of private property infringements

1.2.2 Stormwater Controls

1.2.2.1 *Drainage improvements*

Benefits:

1. Can be implemented on a case-by-case basis to address a specific issue

Challenges:

1. Requires a carbon source through surface systems or treatment structures to denitrify
2. Siting of BMPs can be difficult
3. Nitrogen reducing BMPs require long term maintenance

1.2.2.2 *Permeable Reactive Barriers*

Benefits:

1. Highly rated nitrogen removal rates when sited, constructed, and operating properly

Challenges:

1. Performance could be questionable in locations of highly permeable native soils or adjacent to marine (salt) waters
2. Piloting and monitoring required
3. Installation requires deep and often extensive excavation

1.2.3 Protection of Drinking Water

1.2.3.1 *Water System Expansion*

Benefits:

1. Removes threat of nitrates and other pollutants and salt water intrusion from drinking water
2. Improves monitoring to ensure quality of drinking water
3. No additional expansion needed beyond 2014 to serve the most severely impaired private wells
4. Expansion of system is available if conditions change

Challenges:

1. Financial incentives are used to increase participation

1.2.4 On-Site & Cluster Innovative/Alternative Systems

Extend enhanced treatment requirements setbacks from marine waters for large on-site systems, and possibly require new systems to be I/A nutrient reducing technologies. Benefits and Challenges are listed under Wastewater Management.

1.2.5 Composting Toilets at Mayo Beach, Baker Field, Marina

Benefits:

1. Pro-actively addresses source control
2. Complete removal of nitrogen load and other pollutants from near-shore discharge
3. Resolves overloading issue at the Marina RSF system
4. Improves service for recreation areas and tourism
5. Can be a public outreach tool

Challenges:

1. Public appropriation, financing and bidding required

1.2.6 Satellite/Central Wastewater Collection and Treatment

Benefits:

1. Sewers could encourage economic growth in targeted locations for year-round commercial stability
2. Largest potential reduction of nitrogen load through source control

Challenges:

1. Additional work, time and cost needed to verify suitability of disposal locations
2. Significant construction disruption for residents, commercial entities, and environment
3. Sewers could encourage unwanted growth, increasing socioeconomic pressures
4. Potential environmental impacts due to the limited available locations for disposal areas
5. Could be many years before effectiveness can be measured

1.3 Costs Evaluation

1.3.1 Costs Basis

EPG used the CCC *Technology Matrix* (2014) spreadsheet as the general basis for the costs evaluation, supplemented and adjusted wherever more precise costs are available, such as for the Mayo Creek culvert replacement as estimated by Woods Hole Group. Adjustments were made to the Technology Matrix in some cases to include more precise information available for Wellfleet, such as liner feet of pipe, number of stream crossings, and potential construction difficulties. For treatment systems, costs were modified from the Technology Matrix to correspond to the actual flow rates and subsequent capacity of the treatment and disposal systems. These modified costs are based on recent estimates and the backup data provided by the Barnstable County Wastewater Cost Task Force April 2010 report, and adjusted for current costs in February 2014 using the most recent ENR construction cost index value.

The Present Values of future costs are calculated for a 20 year time span at the current discount rate of 3.50 percent as specified in the Federal Register (Vol. 78, No. 218 / Tuesday, November 12, 2013 / Notices) in accordance with the Water Resources Planning Act of 1965 and the Water Resources Development Act of 1974, which require an annual determination of a discount rate for Federal water resources planning. This discount rate applies to the federal fiscal year 2014 from October 1, 2013, through and including September 30, 2014.

Aquaculture – Oyster Propagation

Costs include the town effort for cultching (assuming cultching will continue yearly), efforts during the Oysterfest for shell recycling (yearly cost), and procurement of materials and installation costs for the town to develop the first pilot study and expand the oyster propagation zone. The costs for the pilot study were approximately $50,000 for the current crop of almost 4.5 million oysters. Assuming the need for over 10 million oysters (worst case) plus some multiple of that total (say 100%) one can set a range of two (2) to four (4) times the pilot costs to estimate the overall construction/capital cost. Averaging these values will provide a planning level opinion of construction/capital costs to continue the oyster propagation program.

The CCC Technology Matrix (2014) assigns a range of nitrogen removal rates for Aquaculture/Shellfish of 8% to 15% to account for:

- Low nitrogen removal rates unless there are very large shellfish beds established.
- Requires removal of shellfish in order to take credit for nitrogen removal

The Technology Matrix suggests that oysters will be harvested regularly, causing variation in removal effectiveness, but this will be overcome by the establishment of the No Take zones. Furthermore, we know the range of nitrogen removal/sequestration in oysters, and the vast area of oyster beds possible in Wellfleet Harbor, which will pull nitrogen from the water regardless of its source. Therefore, our approach derives the cost per pound of nitrogen removed by applying the known removal/sequestration rates over the proposed population of oysters and scaling costs for that population from costs actually incurred for the pilot study.

Salt Marsh Restoration - Mayo Creek Culvert Replacement

The project scope will be to replace the existing pipe with a larger circular culvert set to allow full drainage of the Mayo Creek marsh and to correct seepage around the existing culvert that may have degraded the Commercial Street embankment. The culvert would be equipped with a tide gate to regulate tidal inflow and to provide protection from storm surges without reducing drainage functions. Costs are based on the Woods Hole Group (2011) report costs and adjusted using the ENR construction cost index to February 2014.

I/A On-site Systems

Two scenarios are evaluated for costs:

1. I/A systems are commercial, proprietary systems intended to be designed as recirculating sand filter (RSF) equivalent by meeting the same treatment limits in a smaller footprint. Total effluent N is less than 19 mg/L, or 52% nitrogen removal.
2. Enhanced I/A systems for TMDL compliance. Enhanced I/A would require chemical systems to reliably meet such limits that would target near 10 mg/L for TN to consistently meet design of 13 mg/L. Nitrogen levels are typically treated to 10 to 13 mg/L.

Assumptions: All new systems on currently vacant parcels will be I/A systems. Assuming reason for being undeveloped is difficulty in developing under conventional zoning and Title 5 regulations. The complete buildout assumption will likely not occur, but this value should allow for some Title 5 replacements in the regulated area within 100 feet of marine waters.

Cluster Systems

Similar to I/A systems for private, individual lots, these cluster systems are designated for individual large systems, such as for cottages, condominiums and townhouses for seasonal rental. We have characterized these as cluster systems to be able to track the affects separately from the individual parcels. However, the treatment effectiveness will remain the same as individual I/A systems because these "cluster" systems are located on single or co-joined parcels - no additional land is available for larger and more intricate treatment systems.

Two scenarios are evaluated for costs to mirror the I/A on-site systems:

1. Total effluent N is less than 19 mg/L, or 52% nitrogen removal.
2. Enhanced I/A that would target near 10 mg/L for TN to consistently meet a design of 13 mg/L.

Additional Assumptions: Additional local regulations requiring I/A technology will include larger systems within 300 feet of marine waters. The costs reflect replacement of systems on 13 parcels that are currently comprised of 33 separate Title 5 systems.

Compost Toilets

Compost toilets will be installed at Mayo Beach and Baker Field to replace the existing portable unit at Baker Field. Compost toilets will also be installed at the Marina to replace the overloaded recirculating sand filter and replace the conventional system at the Sticker Shack.

Collection Systems

Two technologies are evaluated for costs:

1. Conventional Gravity System with Centralized Pump Station
2. Low Pressure Sewer with Booster Pump Station

For conventional gravity sewer systems and STEG systems, the general layout of the system would follow the topographic contours of "downtown" Wellfleet. Gravity sewers are not expected to exceed 10-inches in diameter. The system will include manholes every 300 feet to 400 feet and at junctions and changes in direction and slope. The location of a submersible type pump station at the lowest elevation available will determine the length of the discharge force main and the size of the pumps.

The pump station would be equipped with two pumps, odor control and backup power. Because of the visibility of the station, cost adjustments include architectural features for any structures above the ground surface. Construction difficulties may include dewatering and permitting.

For grinder pump systems and STEP systems, a low pressure collection system is planned in conjunction with a pump station to overcome the friction due to the long distance to the potential treatment/discharge locations. This pump station, however, can be located closer to the proposed treatment facility than the gravity system's station. The pump station would be a submersible station with two pumps and backup power. Architectural features could be minimized or eliminated with screening of the station from the street. The cost for the individual grinder pumps, or STEP systems, is included in the capital and long-term costs.

For all collection system types, staffing would be needed to operate and maintain the system.

Two scenarios are presented to give the Town alternatives for the extent of the sewer service area. A minimal system for the Main Street and Commercial Ave areas includes 110 parcels, while a more extensive system including Holbrook Ave would include 190 parcels. The two collection technologies are applied to both scenarios to give a range of planning level costs.

<u>Satellite Treatment Systems</u>

Nitrogen levels are typically treated to around 10 mg/L, but EPG assumes enhanced treatment will be necessary to reduce nitrogen discharge in accordance with the CCC policy of 5 mg/L maximum. A Groundwater Discharge Permit is needed for flows greater than 10,000 gpd and a licensed operator would be responsible for O&M.

Enhanced wastewater treatment facilities are similar to satellite wastewater treatment facilities, but require a separate denitrifying process and other facilities to reduce nitrogen levels below that of satellite wastewater treatment facilities. Enhanced facilities will require chemical systems. Nitrogen levels are typically reduced to below 8 mg/L with the intent to meet the 5 mg/L limit imposed by CCC.

For comparison purposes, effluent disposal would be through rapid infiltration basins (RIBs) with an approximate loading of 2 gpd/ sq. ft. Sites selected are either the Borrow Pit on Pole Dike Road or the Town's solid waste transfer facility at the intersection of Pole Dike Road, Bound Brook Road, and Coles Neck Road adjacent to the landfill. Solids will be thickened on site and trucked off site for disposal or incineration.

Additional Assumptions: Treatment facilities would be located on the same parcel as the discharge location. The minimal system is service to 110 parcels and treatment to at least 8 mg/L at the Borrow Pit location. The maximum system is service to 190 parcels and treatment to 8 mg/L at the Transfer Station.

1.3.2 Probable Planning Level Costs

Probable planning level cost tables are presented in this section for each alternative selected for further evaluation, providing details of anticipated present value per parcel and per pound of nitrogen removed.

<u>Town-wide Costs</u>

The Cost (capital, PV, and Annual) per parcel applies to the parcels actually receiving the service. For the Oyster Propagation, Culvert Widening, Fertilizer Management, and Compost Toilets alternatives, the cost is divided among all town parcels.

Table 3-1: Cost Details for Optimizing Existing Conditions

Alternative	Present Value (20 years)	PV20 / Parcel	PV20 / lb N Removed	Average Capital Cost / Parcel	Average Annual Cost / Parcel
Oyster Propagation	$441,000	$ 93	**$ 3**	$45	---
Culvert Widening	$473,000	$100	**$14**	$80	---
Fertilizer Management	$139,000	$132	**$30**	---	$85
Compost Toilets	$256,000	$ 54	**$80**	$50	---

Fertilizer management is the yearly estimated cost with no upfront capital costs

Service Area Costs

For the Individual On-Site Systems, Cluster Systems, Sewer, and Satellite alternatives, only the parcels receiving the service are included.

Table 3-2: Cost Details for Optimizing Existing Conditions – Individual On-Site Systems Upgrades

	Present Value (20 years)	PV20 / Parcel	PV20 / lb N removed	Average Capital Cost / Parcel
Minimum Cost TN <=19mg/L				
I/A Systems	$3,100,300	$ 33,000	$357	$13,400
Cluster Systems	$1,671,000	$129,000	$188	$50,400
Totals	**$4,771,300**		**$271**	
Maximum Cost TN <=13 mg/L				
I/A Systems	$ 7,039,000	$ 75,000	$631	$20,200
Cluster Systems	$ 3,828,000	$294,000	$334	$75,600
Totals	**$ 10,867,000**		**$481**	

Table 3-3: Cost Details for LPS Collection with Enhanced Satellite Treatment

	Present Value (20 years)	PV20 / Parcel	PV20 / lb N removed	Average Capital Cost / Parcel
Minimum Sewer to Borrow Pit				
110 parcels in Central District	$ 3,752,000	$ 34,000	$143	$28,600
Satellite Enhanced Treatment	$ 8,647,000	$ 79,000	$330	$26,600
Totals	$12,399,000	$113,000	**$473**	$55,200
Maximum Sewer to Transfer Station				
190 Parcels in Central District	$ 6,207,000	$33,000	$135	$27,300
Satellite Enhanced Treatment	$11,393,000	$60,000	$248	$29,000
Totals	$17,600,000	$93,000	**$383**	$56,300

LPS costs include the individual grinder or STEP/STEG system on each lot.

Table 3-4: Cost Details for Gravity Collection with Enhanced Satellite Treatment

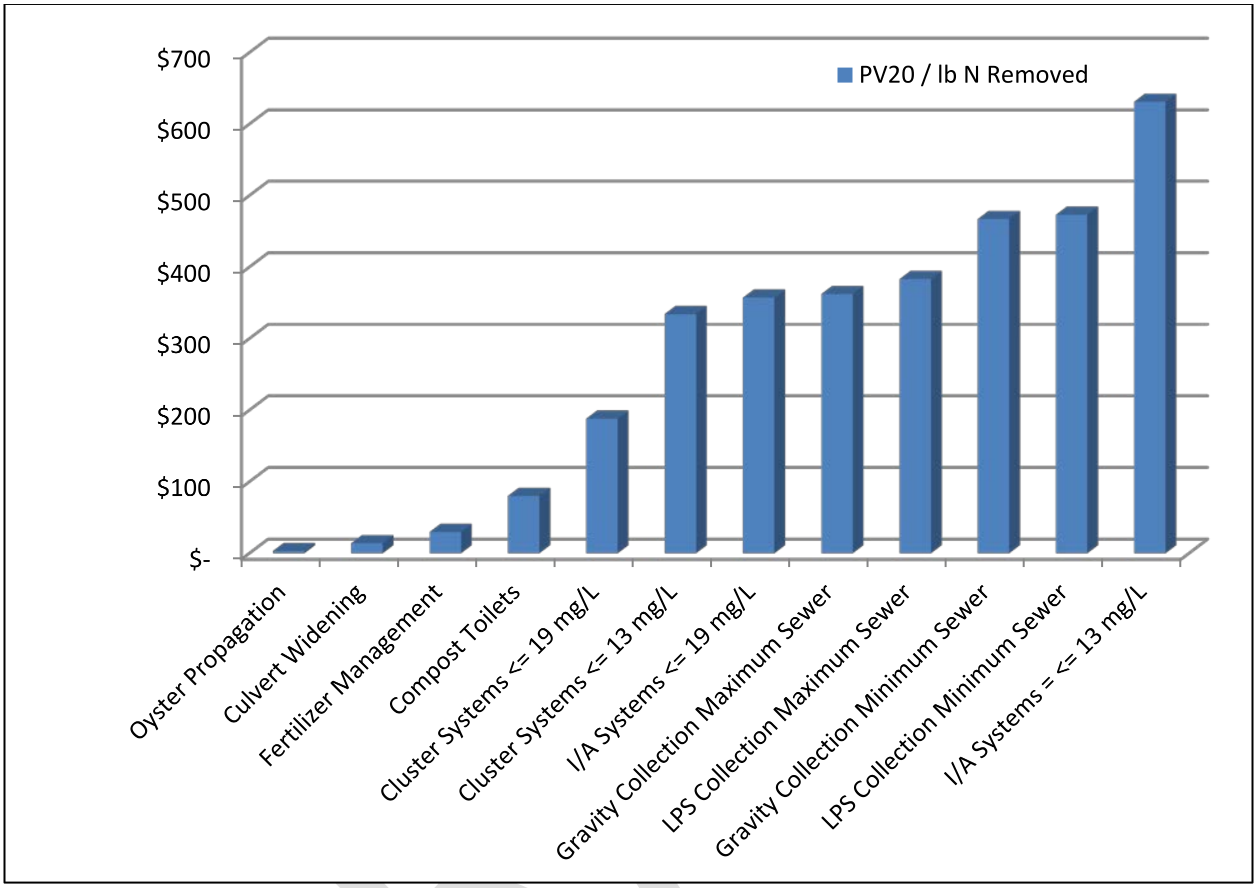
	Present Value (20 years)	PV20 / Parcel	PV20 / lb N removed	Average Capital Cost / Parcel
Minimum Sewer to Borrow Pit				
110 parcels in Central District	$3,403,000	$31,000	$132	$30,400
Satellite Enhanced Treatment	$8,647,000	$79,000	$335	$24,700
Totals	$12,050,000	$109,000	**$467**	$55,100
Maximum Sewer to Transfer Station				
190 Parcels in Central District	$5,245,900	$28,000	$114	$27,200
Satellite Enhanced Treatment	$11,393,000	$60,000	$248	$29,000
Totals	$16,638,900	$88,000	**$362**	$56,200

Table 3-5: Summary Table - Planning Level Cost Estimates

Alternative	Present Value (20 years)	PV20 / Parcel	PV20 / lb N Removed	Average Capital Cost / Parcel
Oyster Propagation	$ 441,000	$ 93	**$ 3**	$ 45
Culvert Widening (Mayo)	$ 473,000	$ 100	**$ 14**	$ 80
Fertilizer Management	$ 139,000	$ 131	**$ 30**	$ 85 (1)
Compost Toilets	$ 256,000	$ 54	**$ 80**	$ 50
I/A <= 19 mg/L	$ 3,100,300	$ 33,000	**$357**	$13,400
Cluster <= 19 mg/L	$ 1,671,000	$129,000	**$188**	$50,400
I/A <= 13 mg/L	$ 7,039,000	$ 75,000	**$631**	$20,200
Cluster <= 13 mg/L	$ 3,828,000	$294,000	**$334**	$75,600
Central District Gravity Sewer to Borrow Pit Satellite WWTF	$12,050,000	$109,000	**$467**	$55,100
Central District LPS to Borrow Pit Satellite WWTF	$12,399,000	$113,000	**$473**	$55,200
Expanded Central District Gravity Sewer to Transfer Station Satellite WWTF	$16,638,900	$ 88,000	**$362**	$56,200
Expanded Central District LPS to Transfer Station Satellite WWTF	$17,600,000	$ 93,000	**$383**	$56,300

(1) Average Annual Cost / Parcel
LPS costs include the individual grinder or STEP/STEG system on each lot.

Figure 3-2: Present Value (20 years) of Alternatives per Pound of Nitrogen Removed



1.3.3 Alternatives Compared to Goals

The findings of this alternatives analysis for this Comprehensive Wastewater Management Plan (CWMP) support the initial goals of the Wastewater Committee and the Town of Wellfleet:

- Protect and enhance the harbor ecosystem and aquaculture base. The harbor is the life-blood of Wellfleet's shell fishing industry, and its protection and enhancement are paramount. *Shellfish propagation restores the ecosystem to more closely resemble historical conditions and further protects the marine environment without damaging the local aquaculture economy.*

- Understand the nature of anthropogenic and natural sources of contamination/pollution from within the harbor and upstream (land side) including streams, storm water runoff, and groundwater impacted by septic systems. *This alternative evaluation allocates nitrogen loads to the specific sources following the guidance provided by the Cape Cod Commission.*

- Collect sufficient information from the harbor and land/upstream sources to characterize the water quality and develop a reliable database of knowledge (using Geographic Information Systems (GIS)). *Phase I of this Comprehensive Plan provided the data gathered related to land* *based contaminant sources and ground water quality, which has been supplemented with updated groundwater and harbor water quality data from long term monitoring.*

- Gain a meaningful understanding of the relationship between nitrogen concentrations and the overall health of shellfish populations. *The Wastewater Planning Committee has collected and disseminated a library of scholarly articles on the relationship between nitrogen and shellfish. These documents and ongoing water quality monitoring form the basis of this reports primary alternative.*

- Based on solid science, promote aquaculture-based water quality management solutions as a practical and cost-effective approach, thus enhancing harbor water quality and the aquaculture industry. *This Phase II provides the data supporting the cost effectiveness of an aquaculture-based solution.*

- Evaluate the water quality in the Town's inland kettle ponds to determine their overall health and identify potential threats from anthropogenic and natural nutrient sources. *Completed in Phase I.*

- Conduct the town-wide comprehensive wastewater management planning process in a measured and step-by-step fashion to present a clear understanding of wastewater management needs of the Town. *The format and scope of services for this Comprehensive Wastewater Management Plan follows a measured approach as defined by MassDEP and relies on input and reporting to the Wastewater Planning Committee to measure the success of the overall understanding of need*s.

- Identify low cost and sustainable remedies (better storm water management, seasonal summer home education program) as warranted. *This is included in the overall scope of services and will be included moving forward with Phase III.*

- Develop least-cost approaches to address identified sources, expedite water quality improvements, and establish a road map for future water quality enhancements initiatives. Least costs are demonstrated in the cost evaluation tables preceding this section. The shellfish / aquaculture recommendation provides more immediate results than a structural wastewater collection system that may take years to reduce nitrogen loads to the inner harbor. *A final recommendation for solution(s) is pending further evaluation by the Wastewater Planning Committee and Wellfleet citizens.*

- As a final resort only, engage in structured solutions (i.e. pipes, pumps, treatment systems). *The ranked alternatives (preliminary status) support this goal, both in nitrogen removal potential and overall cost.*

1.3.4 Next Steps

As with the completed phases of this Comprehensive Wastewater Management Plan, the MassDEP Guidelines provide the prescriptive steps to meet the regulatory requirements for a Phase II Draft Recommended Plan.

A public outreach and education program is included as an integral component of the Plan of Study, as is work with MassDEP to present and review data, plans, findings, conclusions, and recommendations. Once the outreach program is defined with the Wastewater Planning Committee, the components and implementation of the program will be included in this partial Phase II report. The report components will include:

a. Relationship between Proponent and Public
b. Requirement for Public Hearings
c. Summary of Public Participation

The Wastewater Planning Committee must weigh in on the short list of alternatives presented in this draft report, and provide guidance to the selection of a draft recommended plan. The following outline, following DEP Guidelines, includes several steps to be funded and completed before final acceptance of the Draft and Final Recommended Plans by regulators.

1. **Plan Selection and Draft Recommended Plan**
    a. General
    b. Comparison and Ranking of Proposals
    c. MassDEP coordination
    d. Summary of Short Listed Alternatives Evaluation
        i. Flexibility
        ii. Reliability
        iii. Revision of Waste Load Allocation
    e. Additional Evaluation
        i. Addition of monitoring and or investigatory work to plug data gaps
        ii. Institutional Arrangements
        iii. Flow and Waste Reduction

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2. **Final Recommended Plan**
    a. Detailed Recommended Plan
    b. Flow and Waste Reduction
        i. Public Education
        ii. Leak Detection and Repair
        iii. Metering
        iv. Pricing
        v. Residential Water Use
        vi. Public Sector Water Use
        vii. Industrial, Commercial, and Institutional Water Use
        viii. Water Supply System Management
        ix. Reuse
    c. Environmental Impacts
        i. Greenhouse Gas Emissions Policy
        ii. Sustainable Design Standards
    d. Institutional Impacts

e. Permits
f. Preliminary Design Criteria
g. Financing Plan
    i. Household Costs
h. Economic Impacts
    i. Executive Order 385
i. Implementation Plan
j. Phased Construction

3. Phase 3 - Final Permitting and Approval

a. Public notification and hearing
b. MEPA submittal and review
c. MassDEP submittal and review
d. Secretary's Certificate (approval from EOEEA)
e. Modification as necessary and production of Final Plan

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