Town of Stonington

Wastewater Facilities Plan

Draft

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Report

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ES.1 Introduction

This purpose of this Wastewater Facilities Plan is to develop a 20-year plan for wastewater collection, treatment and disposal for the Town of Stonington. The Plan has been prepared in conformance with the Connecticut Department of Environmental Protection (CTDEP) guidelines, and is partly funded through the State's Clean Water Fund.

The plan has been developed for the Stonington Water Pollution Control Authority (WPCA) as part of a lengthy and meaningful public process. An initial draft of the Wastewater Facilities Plan report was presented at a public hearing in August 2001, after a year-long development process involving a Citizens Advisory Group representing residents from various locations and interests in the Town. The initial draft was met with significant comment at the Public Hearing, after which WPCA sponsored a second citizens group, the Citizen's Review Panel (CRP). A second draft, containing updated information and revised recommendations, was presented at another public hearing in February 2005. Again, the presented plan generated a very high volume of public comment that was overwhelmingly opposed to the WPCA's recommended plan for wastewater treatment. In the period since the public hearing, WPCA has carefully reviewed the available options, and this third version of the Wastewater Facilities Plan incorporates WPCA's analysis of the comments received throughout the public participation process and contains revised recommendations.

The Wastewater Facilities Plan has been prepared to meet the following goals:

- To provide the Stonington WPCA with a cost-effective, comprehensive plan to meet the Town's wastewater needs for the next 20 years,
- To obtain public and regulatory approval of the Plan, and
- To position the Town for funding opportunities.

ES.2 Wastewater Needs Assessment

Section 2 of this Plan reviews current wastewater disposal methods, their functionality, and identifies areas where improved or alternate facilities are required in order to provide adequate treatment and disposal of the generated wastewater. This assessment is based on the Connecticut Department of Environmental Protection (DEP) guidelines and the United States Environmental Protection Agency (EPA) Publication *Construction Grants 1985 (CG-85)*.

Identification of Wastewater Needs Areas

A wastewater needs analysis was performed, based on the review and evaluation of data from local, state and federal sources. General data included surficial geology, soil suitability for subsurface disposal, zoning, lot sizes, population density, floodplains, wetlands, surface water, groundwater, drinking water supplies and recharge areas, public water service areas, and public sewer service areas. Site-specific information indicating where homes and/or businesses were experiencing difficulties with their wastewater disposal system included septage haulers' pumping records, Board of Health records, and questionnaire responses.

The questionnaire survey was mailed to each unsewered landowner within the Town. Approximately 3,140 questionnaires were mailed, and approximately 50 percent of the questionnaires were completed and returned. The questionnaire included 33 questions designed to determine whether or not a subsurface disposal problem exists, the type of problem, potential causes of the problem, the age of the system, the number of people using the system, whether the system has been rehabilitated, etc. Based on an analysis of the information obtained from the questionnaire responses and the Board of Health Records, the density of failures per unit area was determined. Areas of significant problem density were then characterized as problem areas, to be analyzed in detail.

The final step in the analysis was determination of an implementable, reliable, cost-effective means of resolving onsite disposal system problems. Generally, problems caused by poor maintenance, excessive age and/or hydraulic overload were considered solvable by means of rehabilitation, replacement, or enlargement of existing onsite systems. These are relatively simple corrective measures, assuming that conditions prevail that would allow upgrading of onsite disposal systems in conformance with state requirements. Problem areas subject to high groundwater and/or poor soils were evaluated based on their population density.

Based on the considerations described above, the following 18 wastewater needs areas were identified:

- Area 1 — Marjorie Street Area
- Area 2 — Riverbend Drive
- Area 3 — School Street Area
- Area 4 — Roseleah Drive
- Area 5 — Elm Ridge Road Area
- Area 6 — Pequot Trail Area
- Area 7 — Cronin Avenue/Holly Drive Area
- Area 8 — Millan Terrace Area
- Area 9 — Aimee Drive Area
- Area 10 — Mark Street Area
- Area 11 — Greenhaven Road Area
- Area 12 — Meadow Road Area
- Area 13 — Latimer Point
- Area 14 — Mason's Island
- Area 15 — Marlin Drive Area
- Area 16 — Elm Street Area
- Area 17 — Montauk Avenue Area
- Area 18 — North Stonington Road

Assessment of Wastewater Needs Areas

Each of the 18 wastewater needs areas was assessed to determine the available treatment and disposal alternatives, wastewater conveyance alternatives, and the probable cost of the recommended alternative.

Wastewater Treatment and Disposal Alternatives

The following alternatives were considered for wastewater treatment and disposal for the identified problem areas:

1. Town-Wide No-Action
2. Individual Onsite Wastewater Treatment and Disposal
   - Conventional Septic Systems
   - Innovative/Alternative Technologies
3. Shared Local (Community) Wastewater Treatment and Disposal
   - Conventional Septic System
   - Innovative/Alternative Technologies
4. Package or Small Wastewater Treatment Plants
   - Offsite Disposal at a Municipal Water Pollution Control Facility

Screening of Conveyance Alternatives

The following alternatives are considered for wastewater collection:

1. Conventional Gravity Sewers
2. Pumping Stations and Force Mains
3. Small Diameter Gravity Sewers
4. Pressure Sewers with Septic Tank Effluent Pumps (STEP systems)
5. Pressure Sewers with Individual Grinder Pumps
6. Combinations of the Above

Costs of Wastewater Management Alternatives

Costs of wastewater management alternatives were estimated and compared. The feasible alternatives identified for each wastewater needs area were evaluated on a common fiscal basis.

Assessment Results

Table ES-1 summarizes the recommended alternatives, total capital costs, costs per lot and annual operation and maintenance costs for each of the 18 wastewater needs areas. The 18 needs areas have a variety of problems and issues, including high groundwater, ledge, poor filtration, location within environmentally sensitive areas and small lots. Installing a collection system and connecting to the existing sewer is the most cost-effective and environmentally sound alternative for 15 of the 18 wastewater needs areas. The other three areas, Marjorie Street, Mason's Island and North Stonington Road, are located relatively far from the existing wastewater collection system, and the impacts of constructing the transmission lines would be significant. Recommended alternatives for these three areas are community treatment systems for Marjorie Street and Mason's Island, and individual onsite systems with innovative/alternative technologies for the North Stonington Road area. The proposed collection and transmission systems are shown in **Figure ES-1**.

The WPCA plans on addressing only the critical and high-priority needs areas during the 20-year planning period. These areas are also indicated on Table ES-1. It is WPCA's intent to address problem areas as they arise, and therefore these identified critical and high-priority areas may be re-prioritized at WPCA's discretion.

ES.3 Projected Flows and Loads

Section 3 summarizes the development of projected wastewater flows and loads within the Town of Stonington in 2025. It documents the procedures and methods used to develop the projections.

Review of Previous Reports

The following sources were reviewed and considered in the development of the projects flows and loads:

- Stonington Plan of Development (May 1992),
- 2000 U.S. Census,
- Water and Sewer Needs Analysis, Stonington, CT (November 1997),
- Regional Conservation and Development Policy Guide for Southeastern Connecticut (October 1997),
- 1999 Master Transportation Plan (January 1999),
- Draft Environmental Impact Statement, Route 2/2A/32 (March 1999),
- Conservation and Development Policies Plan for Connecticut 1998-2003 (May 1998), and
- 2004 Plan of Conservation and Development (June 2004).

(See Table ES-1)

(See Figure ES-1)

Population Projections

The goal of the Wastewater Facilities Plan population projection is to develop a reasonable estimate of future population within the Town of Stonington, considering the studies issued by planning agencies, as well as the Town and region's growth patterns, and to use the estimated population to project future wastewater flows and loads.

Population projections for the Wastewater Facilities Plan were developed based on this available data and on information about future development in the town. The resultant population projections are shown in **Table ES-2** and **Figure ES-2**.

Table ES-2
Population Projections

Year	Town of Stonington	Mystic (B 7053)	Borough (B 7052)	Pawcatuck (B 7051)	Remainder (B 7054)
1990	16,919	3,176	3,510	7,871	2,362
2000	17,906	3,377	3,533	8,226	2,770
2005	*18,456*	*3,481*	*3,642*	*8,479*	*2,855*
2010	*19,006*	*3,584*	*3,750*	*8,731*	*2,940*
2015	*19,556*	*3,688*	*3,859*	*8,984*	*3,025*
2020	*20,106*	*3,792*	*3,967*	*9,237*	*3,110*
2025	*20,656*	*3,896*	*4,076*	*9,489*	*3,195*

[1] Numbers in italics are estimated based on historical trends. Numbers below each area (e.g., B 7053) indicate the respective U.S. Census tract number.

Projected Flows and Loads

Estimates were made for domestic, institutional, industrial, commercial, infiltration and inflow and septage. For each category, population growth, future development and sewer system expansion were taken into account.

The projected future flows were used to project future loads to each of the three water pollution control facilities (WPCFs). The overall contributing percentages of constituents of the wastewater flow (e.g., domestic, institutional, commercial, etc.) are not projected to change significantly in proportion to one-another. This indicates that the characteristics of the wastewater should remain similar to the existing conditions. In addition, the projections do not include any additional significant industrial users that could alter the wastewater characteristics. Therefore, the wastewater is expected to be of similar strength, and contain similar concentrations of the important pollutants such as BOD, TSS and nitrogen components as the existing wastewater.

(See Figure ES-2)

Table ES-3 summarizes the projected flows and loads to each of the three WPCFs, assuming that the wastewater quality parameters, and the peaking factors for different loading conditions, would not change.

ES.4 Wastewater Collection Systems

System Description

Stonington has three sanitary sewer systems that discharge to the Mystic, Borough and Pawcatuck WPCFs., as follows:

- The Mystic service area extends eastward from the Mystic WPCF to the intersection of U.S. Route 1 and Chapman Lane, and northerly to North Stonington Road. The Mystic collection system includes approximately 20 miles of gravity sewers, five pumping stations, approximately 1.1 miles of force mains, and the Mystic WPCF. Four of the five pumping stations collect the flow and convey it to the Mystic WPCF. The remaining pumping station is located at the Mystic WPCF and conveys underflow from the plant's primary clarifiers to the Borough WPCF via a separate transmission main.

- The Stonington Borough collection system primarily services the Borough, Lord's Point, and the area immediately north of the downtown Borough area. In addition, the collection system extends north to Deans Mill Road. This system includes approximately 8.5 miles of gravity sewers, seven pumping stations, 0.7 miles of force main, a force main that conveys underflow from Mystic WPCF to the Stonington Borough system, and the Borough WPCF.

- The Pawcatuck collection system services the eastern portion of the town. The Pawcatuck system consists of approximately 20 miles of sewers, 1.4 miles of force main, six pumping stations and the Pawcatuck WPCF.

Capacity Analysis and Recommended Improvements

A hydraulic capacity analysis for the critical components of each of the three wastewater collection systems — including the interceptors and pumping stations — is included in Section 4.

Mystic

All of the interceptors within the Mystic collection system are sufficient for existing peak and projected future wastewater flows. All of the pumping stations within the Mystic collection system have adequate capacity to handle existing and projected future peak wastewater flows. There are no improvements to the Mystic collection system necessary to increase capacity.

Borough

All of the interceptors within the Borough collection system are sufficient for existing peak and future wastewater flows. In addition, all of the pumping stations within the Stonington Borough collection system can adequately handle existing peak wastewater flows. However, in order to adequately handle projected future peak

(See Table ES-3)

wastewater flows, the Shawondasee Drive pumping station would likely need to be upgraded in the future, depending on actual development patterns. The upgrade would include replacing the existing submersible pumps with larger pumps in order to handle the increased flow. The existing 6-inch force main can sufficiently handle the future peak wastewater flow from this pumping station.

Pawcatuck

All of the interceptors within the Pawcatuck collection system are sufficient for existing peak wastewater flows. In addition, all interceptors are sufficient for projected future peak wastewater flows, with two marginal pipe segments. A 24-inch pipe segment of about 2,000 feet in Mechanic Street would theoretically be loaded at 88-percent of capacity at the projected peak flow rate, compared to the typical design criteria of 80 percent, if sufficient development occurs in the areas upstream. Similarly, an 18-inch pipe segment of 250 feet in Mary Hall Road would theoretically flow at 91-percent of capacity at the projected peak flows.

All of the pumping stations within the Pawcatuck collection system can adequately handle existing peak wastewater flows. However, two pumping stations would likely need to be upgraded in the future in order to adequately handle projected future peak wastewater flows, either by pump replacement or addition: Pumping Station No. 3 and the White Rock Road pumping station.

Overall, it is estimated that approximately $341,000 of system improvements would be required in the collection system over the 20-year life of the plan.

ES.5 Water Pollution Control Facilities Evaluation

Section 5 documents the evaluations of the existing water pollution control facilities (WPCFs). These evaluations consist of a summary of the history of each plant, a description of the current facilities and the unit processes at each facility, a summary of recent plant operating data, and a unit process capacity analysis.

Water Pollution Control Facilities

Mystic

The Mystic WPCF provides wastewater treatment services for the villages of Mystic and Old Mystic, in addition to adjacent commercial districts. The plant was built in 1971-72. The Mystic WPCF was designed to treat an average flow of 0.80 million gallons per day (mgd), and a peak flow of 2.35 mgd to secondary treatment standards. The Mystic WPCF has undergone a substantial amount of upgrading and equipment replacement in recent years, and currently employs the following treatment processes:

- Influent comminution (or bypass coarse screening)
- Influent raw sewage pumping
- Primary clarification

- Activated sludge biological treatment
- Disinfection with sodium hypochlorite
- Primary underflow de-gritting
- Diversion pumping of de-gritted primary clarifier underflow to the Stonington Borough WPCF
- Odor control

Stonington Borough

The Stonington Borough WPCF (Borough WPCF) provides wastewater treatment services primarily for the Village of Stonington. The plant was placed into service in 1975. The Borough WPCF was designed to treat an average flow of 0.66 mgd to secondary treatment standards. The Borough WPCF has also undergone a substantial amount of upgrading and equipment replacement in recent years, primarily due to the diversion from the Mystic WPCF, and currently employs the following treatment processes:

- Influent comminution (or bypass coarse screening)
- Influent raw sewage pumping
- Primary clarification, with waste activated sludge (WAS) co-settling
- Activated sludge biological treatment
- Disinfection with sodium hypochlorite
- Sludge thickening and thickened sludge storage
- Odor control

Pawcatuck

The Pawcatuck WPCF provides wastewater treatment services for all of the sewered areas of Pawcatuck. The plant was placed into service in 1980. The Pawcatuck WPCF was designed to treat an average flow of 1.3 mgd to secondary treatment standards. The plant discharges to the Pawcatuck River. The plant is currently treating flows below its original design capacity. The Pawcatuck WPCF currently employs the following treatment processes:

- Primary clarification, with waste activated sludge (WAS) co-settling
- Septage receiving
- Activated sludge biological treatment

- Disinfection with sodium hypochlorite
- Sludge thickening and thickened sludge storage
- Odor control

ES.6 Water Quality Analyses

Section 6 examines the water quality implications of various wastewater treatment options under consideration by the Town of Stonington. Currently, Stonington's three WPCFs – Mystic, Stonington Borough, and Pawcatuck – discharge to the Mystic River, Stonington Harbor, and Pawcatuck River, respectively.

CTDEP performed water quality analyses of the Mystic River from 1988-1990. The results of these analyses are summarized in a report entitled "*Water Quality Analysis of Mystic Harbor - A Water Quality Model and Waste Load Allocation*" (June 1990). This report indicated that, although the Mystic Harbor generally exhibits excellent water quality, nutrient loadings intermittently cause algae blooms. Since state *Water Quality Standards* require that Mystic Harbor's water quality not be allowed to degrade, increases in flow to the Mystic WPCF outfall would be accompanied by tighter restrictions on effluent quality such that nutrient loading would not increase above existing levels. As a result of the findings of this report, future discharges from Mystic WPCF would also be limited to levels existing at the time of the study. Because of the existence of this study by CTDEP, Section 6 of this Wastewater Facilities Plan included analyses of only Stonington Harbor and the Pawcatuck River. No additional analysis of the Mystic River/Harbor was performed.

The NPDES permits for the Stonington Borough and Pawcatuck WPCFs were renewed in 2005. The NPDES permit for the Mystic WPCF will be renewed in 2006. The permits included limits for BOD, TSS, coliform bacteria, chlorine, and whole effluent toxicity testing. They also included monitoring requirements for metals and phosphorus compounds. Future permits could include limits for these compounds if they are shown to be a potential water quality concern. with the three WPCFs are also required to comply with the *General Permit for Nitrogen Discharges*. Thus, the water quality investigation focuses on determining if future discharges can meet water quality standards for (1) conventionals (i.e., dissolved oxygen) and (2) toxics.

For both the Pawcatuck River and Stonington Harbor, existing water quality information was obtained and analyzed. Then the dissolved oxygen and toxics analyses were completed. The results of the analyses are as follows:

- Water quality in the northernmost portion of the Pawcatuck River estuary is highly degraded. This condition appears to be a function of physical constraints of the estuary.
- Pawcatuck River water quality is only somewhat degraded near the Pawcatuck WPCF outfall. This appears to be because there is much better tidal exchange

lower in the estuary at its mouth. The Pawcatuck WPCF discharge is a small contributor to the deficit of oxygen found in the estuary.

- Stonington Harbor is better suited than the Pawcatuck River for assimilating wastewater flows because:
  - It has greater mixing/flushing for conventional pollutants, and
  - It offers greater dilution potential for meeting water quality criteria for toxic pollutants.
- Stonington Harbor should be able to handle the combined discharge from all three treatment plants and meet the state's water quality standard for dissolved oxygen.
- The Borough WPCF's outfall diffuser has sufficient hydraulic capacity to handle the combined flow from all three plants.
- The Town should investigate whether influent copper concentrations in the wastewater could be reduced by improved corrosion control of the water supply.
- If the WPCA implements a one-plant solution utilizing the existing Borough WPCF outfall to Stonington Harbor, then the outfall should be modified by opening two additional ports on the existing diffuser.

ES.7 Alternatives Evaluation

The configuration of the existing Stonington WPCA facilities — consisting of three separate collection systems and WPCFs — is complex. The complexity of the existing systems provides a tremendous amount of flexibility when considering the numerous options available for upgrading the systems to meet the Town's future wastewater needs. In Section 7, a limited number of feasible "big picture" overall alternatives are selected. These alternatives are then evaluated in detail and compared to determine the recommended alternative.

WPCF Effluent Quality

The final effluent from each of the three existing WPCFs, and/or from a new WPCF, would be required to meet the current NPDES secondary treatment levels. It is anticipated that future permits would require a dechlorination process be provided, for all facilities disinfecting by addition of either chlorine gas or liquid sodium hypochlorite (as at all three existing WPCFs).

Nitrogen Removal

In addition to the NPDES permit requirements, the upgraded or new facilities would be required to comply with the nitrogen wasteload allocation (WLA) assigned to Stonington by CTDEP's *General Permit for Nitrogen Discharges*, either by treatment or by use of Connecticut's nitrogen trading program. The *General Permit for Nitrogen Discharges* includes WLAs for each of Stonington's three WPCFs. These WLAs decline over time through 2014. Stonington's need to purchase (or ability to trade) nitrogen credits is determined annually based on these WLAs and plant performance. As Stonington looks toward the future, the sum of these WLAs would become the basis for nitrogen discharge compliance.

Table ES-4 summarizes the anticipated effluent quality requirements that are critical to the alternatives evaluation. All of the alternative treatment process trains evaluated in this section are designed to meet these treatment goals, with the exception of Alternative G (see description below), which would not be designed with the intent of meeting the nitrogen limits, and would only provide the degree of nitrogen removal that can be achieved while using the Symbio™ process. Compliance with the nitrogen wasteload allocation would be attained by utilization of the nitrogen trading program.

Table ES-4

Anticipated WPCF Effluent Quality Requirements

Condition	Mystic WPCF	Borough WPCF	Pawcatuck WPCF
BOD_5 (mg/L)	30 (avg. monthly) 50 (max. daily)	25 (avg. monthly) 45 (max. daily)	25 (avg. monthly) 45 (max. daily)
TSS (mg/L)	30 (avg. monthly) 50 (max. daily)	30 (avg. monthly) 50 (max. daily)	30 (avg. monthly) 50 (max. daily)
TN (mg/L)[1]	8.1 mg/L (2006) 5.1 mg/L (2014) 4.5 mg/L (2025)	10.9 mg/L (2006) 6.6 mg/L (2014) 5.6 mg/L (2025)	8.5 mg/L (2006) 4.2 mg/L (2014) 3.1 mg/L (2025)
Total residual chlorine (TRC) (mg/L)[2]	0.2 (minimum) 1.5 (maximum)	0.2 (minimum) 1.5 (maximum)	0.2 (minimum) 1.5 (maximum)

[1] TN concentrations are based on the *General Permit for Nitrogen Discharges* allowable WLA (lbs/day) and the projected annual average flow in the indicated year. TN WLAs may be traded among the Stonington WPCFs; it is possible that one WPCF can discharge a higher effluent TN concentration, but an increase in effluent wasteload would have to be made up by an equal decrease in discharge quantity at another WPCF. TN WLAs for 2006 and 2014 are based on the General Permit. It is assumed that the WLA for 2025 is the same for 2014. More stringent treatment would be needed (in terms of concentration) because of the projected flow increases over time.

[2] Existing effluent TRC limits shown. It is anticipated that stricter limits on TRC would be permitted in the future, requiring that dechlorination be provided following chlorine disinfection.

Alternatives

Seven alternatives were evaluated in detail, as described below. The alternatives include both construction of new plants and upgrading the existing WPCFs.

Alternative No. 1

Alternative No. 1 involves upgrading each of the three existing WPCFs to handle the future flows and loads from their respective collection systems, without diversion of flow from the Mystic WPCF to the Borough WPCF (which is evaluated separately as Alternative 1A).

Alternative No. 1A

Alternative No. 1A involves the upgrading of each of the three existing WPCFs to handle the future flows and loads from their respective collection systems, and includes flow transfer of 0.28 mgd of primary clarifier underflow from the Mystic WPCF to the Borough WPCF.

Alternative No. 1B

Alternative No. 1B involves the upgrading of each of the three existing WPCFs to handle future flows and loads from their respective collection systems, and includes a 0.28 mgd diversion from the Mystic WPCF to the Borough WPCF. However, unlike Alternative 1A, the diversion would be either raw influent or primary effluent, but not the primary clarifier underflow.

Alternative No. 2

Alternative No. 2 involves abandoning the Mystic WPCF and pumping the entire flow currently treated at the Mystic WPCF to the Borough WPCF for treatment. The Borough WPCF would be upgraded to handle the future flows and loads from both the Mystic and Borough collection systems. The Pawcatuck WPCF would be upgraded to handle its locally generated flow.

Alternative No. 3

Alternative No. 3 involves abandoning both the Mystic and Borough WPCFs and pumping the entire flow currently treated at the two plants to the Pawcatuck WPCF for treatment. The Pawcatuck WPCF would be upgraded to handle the future flows and loads from the entire Town. A portion of the treated effluent would be piped back to the existing Borough WPCF outfall for discharge to Stonington Harbor.

Alternative No. 4

Alternative No. 4 involves abandoning the Mystic and Borough WPCFs and pumping the entire flow currently treated at the Mystic WPCF and the Borough WPCF to a new WPCF at a new site. The treated effluent would be piped back to the existing Borough WPCF outfall for discharge to Stonington Harbor. The Pawcatuck WPCF would be upgraded to handle its locally generated flow.

Alternative No. 5

Alternative No. 5 involves abandoning the Mystic, Borough and Pawcatuck WPCFs and pumping the entire flow currently treated at the three plants to a new WPCF at a new site. The treated effluent would be piped back to the existing Borough WPCF outfall for discharge to Stonington Harbor.

Alternative G

Alternative G involves upgrading each of the three existing WPCFs only when and as necessary to handle the future flows and loads from their respective collection systems. Upgrades under this alternative would not provide nitrogen removal, except as may be accomplished by installing the Symbio™ process at each plant. This option would ultimately require improvements at all three plants in order to accommodate future flows and loads, and to comply with NPDES permit requirements. Stonington would then purchase nitrogen credits through the state's nitrogen trading program to comply with the requirements of the *General Permit for Nitrogen Discharges*.

The "Groton Alternative"

During the preparation of the Wastewater Facilities Plan, CTDEP suggested that WPCA also evaluate another option, which is known as the "Groton Alternative." This evaluation was completed and was documented in a separate report. The Groton alternative would be a regional solution and would involve the transfer of wastewater from the Mystic and Borough collection systems to the Groton system for treatment. The *Groton Analysis* is included in Appendix F of this Facilities Plan. It was found that the Groton Alternative was not a feasible option.

Siting Study

Two of the alternatives (Alternatives Nos. 4 and 5) would require that a new water pollution control facility (WPCF) be constructed at a new site to treat some or all of the projected wastewater flow within the Town of Stonington. An evaluation was conducted to determine appropriate sites suitable for construction and operation of a new WPCF and included:

- An outline of the methodology used to identify potential sites,
- A description of the initial, secondary and final screening processes, and
- The recommended site for new WPCFs under Alternatives No. 4 and 5.

Screening Considerations

The first step in the site-selection process was to narrow the list of all properties within the Town of Stonington. The following criteria were considerations in screening suitable sites for new WPCFs.

- Area Requirements
- Current Zoning Requirements and Site Location

- Current Land Use
- Property Ownership
- Access
- Proximity to Existing or Proposed Sewer Systems
- Proximity to Existing or Projected Development
- Physical Characteristics
- Site Configuration
- Historic and Archeological Features
- Rare or Endangered Species

Site Selection Process

There are a total of approximately 8,200 parcels within the Town of Stonington. Of this total, 382 parcels have areas of at least 10 acres. Although the number of potential sites is considerably reduced in this step, additional steps were required to narrow down the sites even further. Parcels that are owned and reserved by the State of Connecticut, Avalonia, or other conservancies were screened out of contention. In addition, sites located north of Interstate 95 are not considered feasible, and were screened out.

Finalist Site Ranking

After several screening steps, an order of ranking was conducted on ten finalist sites to identify the most suitable site for a new WPCF. A list of factors was applied to the remaining sites to establish the most suitable site for a new facility, as follows:

- Implementability (ownership, “fatal flaws,” key advantage, etc.)
- Compatibility with Site and Surrounding Areas
- Site Characteristics
- Engineering/Technical Feasibility
- Vehicle Access
- Environmental Features (wetlands, flood hazards, presence of threatened species, etc.)
- Historical/Archeological Features

- Land Acquisition

Upon completing the final site ranking, the town-owned site on U.S. Route 1 and Spellman Drive was identified as the most suitable location for a new WPCF (see **Figure ES-3**). For the purpose of developing cost information, this site was used for Alternative No. 4 and Alternative No. 5.

Economic Comparison

The eight alternatives were evaluated in detail to facilitate comparison, in terms of economic and non-economic criteria. **Table ES-5** summarizes the capital cost, annual operation and maintenance (O&M) cost and 20-year present worth of the eight overall alternatives. Note that the cost summaries do NOT include estimated costs for property acquisition, nor to they include possible credits (total cost reductions) due to potential sale of existing properties.

Table ES-5

Overall Economic Comparison

Description	Capital	Annual O&M	Present Worth
Alternative No. 1	$25.8 million	$1.77 million	$46.7 million
Alternative No. 1A	$25.3 million	$1.86 million	$47.3 million
Alternative No. 1B	$25.7 million	$1.86 million	$47.7 million
Alternative No. 2	$28.3 million	$1.45 million	$45.4 million
Alternative No. 3	$42.0 million	$1.22 million	$56.4 million
Alternative No. 4 (preferred site)	$49.8 million	$1.44 million	$66.8 million
Alternative No. 5 (preferred site)	$50.9 million	$1.23 million	$65.4 million
Alternative G	$19.1 million	$1.76 million	$39.9 million

Table ES-5 shows that on a capital cost basis, Alternative G is the least costly, followed by Alternative Nos. 1, 1A, and 1B. Alternative No. 2 is slightly more costly. Alternatives Nos. 3, 4 and 5 are more costly. On an annual O&M basis, Alternative Nos. 3 and 5 are the least costly, because they involve operation of only one plant. Alternative Nos. 2 and 4 are somewhat more costly to operate and maintain, and the alternatives with three plants (Alternative Nos. 1, 1A and G) are the most expensive to operate.

(See Figure ES-3)

On a 20-year present worth basis, Alternative G is the most economical, followed closely by Alternative Nos. 1, 1A, 1B and 2. Alternative Nos. 3, 5 and 4 are the most costly.

Non-Economic Comparison

The alternatives are compared versus several non-economic criteria in the following paragraphs. It is understood that comparing the alternatives against these criteria is, by necessity, subjective. However, by evaluating each criterion separately, a preferred alternative can often be identified.

Constructability

This criterion seeks to measure the ease or difficulty with which the alternative can be physically constructed. Alternative Nos. 1, 1A, 1B and G involve considerable construction at each of the three existing plant sites, but involve a negligible amount of pipeline construction work. Construction at the Mystic and Borough WPCFs will be difficult due to the small amount of available area for staging, though at the Pawcatuck site this is not an issue. Alternative No. 2 involves extensive construction at the Borough WPCF site, and the quantity of work to be performed would make that construction difficult. Alternative Nos. 3, 4 and 5 require an extensive amount of pipeline work. The necessary work at a new treatment plant site would be relatively simple in comparison to the pipeline work.

Implementability

This criterion seeks to measure the ease or difficulty with which the alternative can be implemented, and is meant to address factors such as regulatory and public acceptance, potential stumbling blocks and the political climate. Based on the public comment received to date, the alternatives that involve continued use of the three existing plant sites (Alternatives 1, 1A, 1B and G) are the most likely to be approved and successfully implemented by the Town. Alternative 1A, which involves continued diversion of primary underflow from the Mystic WPCF to the Borough WPCF, appears to be less acceptable to the public than Alternatives 1, 1B, and G. The other alternatives all involve some degree of consolidation of either treatment facilities and/or discharge, and public acceptance of those options seems dubious. Alternative Nos. 4 and 5 include one significant additional hurdle: a new site is needed, and though the preferred site is already owned by the Town, obtaining the public's approval of a new site is not easy.

Impacts during Construction

All of the alternatives will impact the community to some extent during construction. The three-plant alternatives will each require heavy construction at three sites. Visual proximity to neighbors seems most direct at the Borough WPCF, as the Mystic WPCF and Pawcatuck WPCF are somewhat more isolated visually. For this reason, Alternative No. 2 is probably the least preferable. Alternative Nos. 3, 4 and 5 involve significant pipeline work in busy streets, and will therefore have impacts.

Land Impact
Alternative Nos. 1, 1A, 1B and G will have minimal land impact (positive or negative), as the current use at the existing sites would continue. Alternative 2 would have a slightly positive impact on the Mystic WPCF site and a negative impact at the Borough WPCF site due to the amount of construction needed. Alternative No.3 will have minimal land impact, as the existing site is large enough to support plant expansion without directly impacting neighbors. Alternative Nos. 4 and 5, which include new sites, will have a significant land impact.

Reliability
All of the alternatives involve either upgraded or new treatment facilities, provided with reliable and redundant systems, and therefore all of the alternatives are approximately equal against this criterion.

Flexibility
The alternatives that involve the continued use of the three existing treatment plant sites (Nos. 1, 1A, 1B and G) provide the most flexibility, in terms of both long-term operations, and in terms of initial implementation of the alternative. The three-plant options provide the option of project phasing, and would provide the flexibility to implement phases at the optimal time. Purely in terms of operational flexibility after construction is complete, the new plants in Alternative Nos. 4 and 5 would be designed with the most up-to-date, proven technology, and would be optimally flexible.

O&M Complexity
Alternative Nos. 3 and 5 would be preferred over the other alternatives for this criterion, because one plant is simpler to operate and maintain than two or three. Alternative No. 5 would have an advantage over Alternative No. 3, because a new facility would be streamlined for efficiency. The three-plant options would be the most complex to operate and maintain.

Proximity to Neighbors
Alternative No. 5 would rank highest against this criterion, followed by Alternative No. 3, then Alternative No. 4. Fewer facilities translate into fewer neighbors, which is an advantage. The preferred site for Alternative No. 5 is isolated from its neighbors, more so than the existing Pawcatuck site. The three-plant alternatives maximize the plants' exposure to neighbors.

Odor Control
Similar to the above criterion, Alternative No. 5 would rank highest against this criterion, followed by Alternative No. 3, then the other alternatives. Fewer facilities translate into fewer potential odor problems, which is an advantage. It must be noted that the cost figures included earlier in this section include maintenance, or in some cases, improvements over the odor control measures provided by the 2003 odor control project, so all alternatives should be more than satisfactory from an odor-control perspective.

Water Quality (Impact from Outfalls)
Except for Alternative G, the alternatives can be considered equal against this criterion, although it should be noted that not all interested stakeholders agree on this for all alternatives. All alternatives include continued use of the existing outfalls, either all three (as in Alternative Nos. 1, 1A, 1B and G), the Pawcatuck River and the Stonington Harbor outfalls (Alternative Nos. 2 and 4), or just the Stonington Harbor outfall (Alternative Nos. 3 and 5). The effluent quality resulting from the upgrades will result in an overall lower impact than either of these outfalls has today. The public has expressed a strong concern with significantly increasing the quantity of effluent discharged through any specific outfall, therefore making the alternatives that involve consolidation (Alternatives 2, 3, 4 and 5) least preferred.

Alternative G, by definition, will not provide the same level of nitrogen removal as the other alternatives, and therefore is least preferred for this criterion.

Ambient Noise
None of the alternatives will have any particular advantage or disadvantage regarding ambient noise, and all are approximately equal.

Water Supply
All of the alternatives include discharge through existing outfalls, and will not impact the water supply.

Floodplain
The Mystic and Borough WPCFs are located within the floodplain, and thus must be designed to maintain operation during floods. This is not an unusual design criterion for treatment plants. Neither the existing Pawcatuck WPCF site, nor the preferred new plant site for Alternative Nos. 4 and 5, are in the floodplain. Construction at none of the existing or new sites will have any impact on flooding conditions. None of the alternatives will have any particular advantage or disadvantage regarding floodplain issues, and all are approximately equal.

Wetlands
The existing treatment plant sites have no wetland issues, though construction at the Mystic WPCF will have to consider the nearby wetlands. The preferred site for the new plant in Alternative Nos. 4 and 5 is partially surrounded by wetlands, but disturbing the wetlands will not be required to build or operate the plant. Proper permitting procedures will have to be followed regardless of the alternative. Therefore, no alternative has an advantage against this criterion.

Public Health and Safety
All of the alternatives will provide environmental benefits, and none of the alternatives is favored.

Aesthetics
The three-plant alternatives will have an aesthetic impact at the existing Mystic WPCF and Borough WPCF sites, although the proximity to neighbors at Mystic is less of a

concern. The Pawcatuck WPCF site is visually isolated from neighbors, so expansion at the site will not have negative aesthetic impact. Alternative No. 2 would have a considerable negative impact at the Borough WPCF site. The preferred site for Alternative Nos. 4 and 5 would be isolated. The new plant road that would be required to enter the new plant will have a minor impact.

Energy Use (Other than Cost)

This criterion seeks to ascertain if one alternative is significantly more energy-efficient or consuming than the others, because of the overall environmental impact that this has. The alternatives measure approximately equally.

Farmland (Preserve)

None of the alternatives impact preserved farmlands.

Historical/Cultural/Recreational

None of the alternatives has any known impact on historical or cultural resources. Alternative Nos. 1, 1A, 1B, 2 and 3 have no impact on recreational resources. Alternative Nos. 4 and 5 would have some negative, and possibly other positive, impacts. On the positive side, the new plant alternatives could make at least parts of the existing Mystic WPCF, Borough WPCF and Pawcatuck WPCF sites available for other uses. The new plant alternatives impact the hiking trails that currently exist at the preferred site — the trails would have to be relocated. In the case of Alternative No. 5, which will include the closure of the Pawcatuck WPCF, there might be a corresponding positive impact. Alternative No. 4 is slightly less preferred than Alternative No. 5 because this option would not be available.

Summary

Upon review of the discussion in Section 7.5.3, it seems obvious that the three-plant alternatives offer some significant non-economic advantages during the construction and implementation phase, and that the one-plant alternatives may offer some advantages during the long-term operations.

Recommendation

WPCA is authorized by the Town of Stonington to provide wastewater collection and treatment services within the Town. While performing these services, the WPCA balances the community interests in water quality and cost effectiveness with those interests and standards of the regulatory authorities like the DEP and the EPA.

These considerations suggest that only those options that maintain continued operation at the three existing treatment plant sites can be feasibly implemented with public support. Through the facilities planning efforts and the public comment received as the project has advanced, WPCA believes that alternatives that include consolidation of plants (Alternative Nos. 2, 3, 4 and 5) are not acceptable to the Town. Among the reasons that these alternatives cannot be successfully implemented are: 1) the capital and present-worth (life cycle) costs of those options are unaffordable, and are much higher than the other options; and 2) the consolidation of treatment sites, resulting in an increase in the amount of flow discharged into any single receiving water body, is unacceptable to the citizenry. In addition, Alternative Nos. 4 and 5 require a new treatment plant at a new site, and there are complex hurdles associated with the siting issues.

By process of elimination, only those options that involve continued operation of the three existing plants (Alternatives 1, 1A, 1B and G) remain for consideration. Of these four remaining alternatives, WPCA feels that Alternative G is least preferred, because it does not provide the same level of treatment as the others, and would therefore not provide the same degree of environmental benefit. In fact, Alternative G would require Stonington to purchase nitrogen credits through the *General Permit for Nitrogen Discharges* indefinitely to stay in compliance. WPCA does not consider Alternative G to be an acceptable long-term wastewater treatment solution.

Alternatives 1 and 1B are preferred over Alternative 1A, because Alternative 1A includes continuation of the current primary clarifier underflow diversion from the Mystic WPCF to the Borough WPCF. Alternatives 1 and 1B do not include this underflow diversion. The WPCA supports restoration of the original design concept for Stonington – three treatment plants treating the sewage from their respective collection systems. The upgraded facilities provide levels of treatment consistent with DEP requirements and eliminate the need for the underflow diversion (installed per DEP order) at Mystic. Alternatives 1 and 1B are equally feasible both economically and non-economically to Alternative 1A, and therefore WPCA does not consider Alternative 1A the best option.

Continuing on this line of thinking, Alternative 1 is preferred to Alternative 1B. Alternative 1 involves no planned diversion of any kind, and is therefore expected to be the most acceptable to the citizens of Stonington. It is also a cost-effective, feasible option that will meet the 20-year performance goals of the WPCA. Therefore, WPCA recommends implementation of Alternative 1. WPCA also notes that the existing diversion infrastructure, consisting of the pumping system at the Mystic WPCF and the forcemain system that allows the transfer of flow to the Borough WPCF, is in-place infrastructure and is an asset that should not be abandoned or removed. Rather, it should be maintained in-place to maximize the Town's operational flexibility and available options to handle unexpected emergencies at Mystic WPCF after the upgrades are complete. In such emergencies, WPCA envisions that that the diversion infrastructure could be used to transfer either raw influent or primary effluent (not primary clarifier underflow) from the Mystic WPCF to the Borough WPCF if necessary to avoid a non-compliance event.

ES.8 Recommended Plan

Section 8 summarizes the recommended plan for wastewater collection, disposal, and treatment for the Town. The recommended plan combines recommendations from Sections 2 through 7. The recommended plan is phased over time, based on the relatively urgent need to upgrade the Town's wastewater treatment facilities, and the long-term need to implement solutions to the critical and high-priority sewer needs areas.

ES.9 Environmental Assessment

CTDEP must prepare either a *Finding of No Significant Impact* or an *Environmental Impact Evaluation* for the review and approval by the Connecticut Office of Policy and Management for the recommended plan. Section 9 addresses the required evaluation criteria for the recommended treatment and collection system improvements. The environmental impacts of these recommendations are evaluated for the following parameters:

Soils

Existing soils were found to have little impact with the exception of potential impacts with new collection system facilities construction.

Geology and Topography

Existing geology and topography at the existing WPCF sites would not have an impact on construction activities. It is unclear what impact geology will have on construction of collection system expansion.

Hydrology

Construction at the existing WPCF sites would not have an impact on local hydrology. However, collection system expansion into the sewer needs areas could have a positive impact on the quality of groundwater in those areas with cessation of onsite disposal.

Wetlands

Construction activities at the existing WPCFs could result in temporary wetland impacts. Additionally, collection system expansion activities could involve construction in close proximity to wetlands. Soil erosion control measures would be required to mitigate impacts.

Floodplains

The existing Mystic and Borough WPCFs are presently located within the 100-year floodplain. Portions of six of the sewer needs areas are also located within the 100-year floodplain. Construction at these locations will have to be protected against the 100-year flood. The planned construction will have no impact on flood levels.

Vegetation and Wildlife

There are no known rare or endangered species at the existing WPCF sites.

Air Quality

Expansion at the WPCFs would include, at a minimum, maintenance of odor controls equal to the existing. During construction, there would be emissions and/or dust from construction activities. Mitigation measures would be in place to minimize these impacts.

Operational modifications are proposed for Pumping Station No. 3 to minimize odor generation at that site. If odors continue, after these changes are implemented, odor control equipment should be installed at that location as well.

Noise

Temporary noise impacts, associated with construction activities, would occur during implementation of the recommended improvements. Noise impacts are expected to be minimal once the recommended improvements are operational.

Traffic

Temporary traffic impacts, associated with construction activities, would occur during implementation of the recommended improvements. These impacts would be significantly reduced once the recommended improvements are operational. Of greatest concern are potential impacts at the Stonington High School (resulting from vehicles entering/leaving the proposed WPCF site) and in the Borough (resulting from vehicles entering/leaving the Borough WPCF). Mitigation measures, including traffic control plans, would be required to minimize traffic impacts in these areas.

Visual Impacts/Aesthetics

The aesthetics of the Mystic, Borough and Pawcatuck WPCF sites would be largely unchanged after the plant upgrades. The proposed expansion at the Borough WPCF would be notable from the neighboring properties. Process selection and layout, architectural features and landscaping can be designed to improve the aesthetic quality and minimize impacts at this site.

Cultural/Recreational/Historical/Archeological Resources

The recommended construction work at the three existing WPCF sites would not have an impact on any cultural or historic resources. However, the Borough WPCF is located within an area of historical significance. The proposed WPCF site is not listed on the National Register of Historic Places and does not have any cultural, historical or archaeological resources.

Land Use

The recommended plan will have negligible impact on land use.

Zoning

The existing Pawcatuck and Mystic WPCFs are zoned as residential. The existing Borough WPCF is zoned by the Borough as Reserved Land — for use by public or semi-public agencies for public purposes.

Conservation and Development Plan Conformance

CTDEP facilities plan approval requires that facility planning conform to the Office of Policy and Management's state-wide *Conservation and Development Policies Plan for Connecticut 1998-2003* (OPM Plan). An important concept of the OPM Plan is protection of "areas of critical environmental concern" (e.g., existing preserved open space, preservation areas, conservation areas, level A/B aquifer protection areas and historic areas). Similarly, Stonington has recently adopted its *2004 Plan of Conservation and Development* (Stonington Plan), which is intended to provide guidance for Town conservation and development activities. The recommended plan complies with the Stonington Plan and the OPM Plan.

ES.10 Financial Considerations

The Town of Stonington faces a major capital improvement program to rehabilitate and upgrade its existing wastewater treatment and collection systems. Section 10 presents the financial aspects related to implementation of the recommended plan for wastewater collection, disposal and treatment for the Town of Stonington.

Implementation of the recommended plan would be phased over time, based on the need to provide improved wastewater treatment, implement solutions to the sewer needs areas, and make minor improvements to the existing collection systems. The initial phases of the recommended plan include upgrading the three existing WPCFs. Once these improvements are complete, collection system improvements (i.e., recommended collection system modifications, expansion into sewer needs areas, etc.) would occur.

The impact of the recommended plan on revenue requirements and user rates has been evaluated for two implementation plans, as follows:

- Implementation Plan No. 1 includes wastewater treatment improvements, collection system modifications, a community system for Marjorie Street area, and extension of the collection system into the Elm Ridge Road area.

- Implementation Plan No. 2 is the full recommended plan as outlined in Section 8 and includes wastewater treatment improvements, collection system modifications, a community system for Marjorie Street area, and extension of the collection system into the Elm Ridge Road, Roseleah Drive, Pequot Trail, Cronin Avenue/Holly Drive, Latimer Point, Marlin Drive, Greenhaven Road, and Mark Street areas.

Either plan is expected to have a significant impact on the Town's taxpayers and the sewer ratepayers. This impact has been evaluated in two stages. The first stage projected the impact of the wastewater treatment and collection system upgrades on operating and maintenance expenses. These costs would be recovered through sewer user fees. The second stage determined the impact of anticipated debt service. Debt service is allocated to tax payers through the general fund and to collection system project beneficiaries through special assessments. Debt service issued for facilities benefiting the entire system (treatment plant upgrades, major interceptors and pump stations) is borne entirely by the general fund. Debt service for projects extending service to new areas are paid half by the general fund and half by a special assessment allocated to the benefiting properties.

Sewer Rate Impact

Today, a household connected to the sewer system using 12,000 cubic feet of water per year (approximately 90,000 gallons per year) would pay approximately $408 per year in sewer use fees to cover sewer system operation and maintenance costs. This rate would be expected to rise at an average rate of about 5 percent per year to $1,135 per year for Implementation Plan No. 1 — or $1,240 per year for Implementation Plan No. 2 — by FY 2025.

Property Tax Impact

Property taxes are used to recover sewer system capital costs financed from the general fund. Existing sewer debt service is approximately $60 per thousand dollars (assessed property value); stepping down to almost nothing by FY 2020. In FY 2010, new sewer debt would add approximately $10 per thousand dollars of assessed value to the existing taxes. Tax impacts for the recommended plan would peak near FY 2012 as the WPCF upgrades are completed and reduce over time.

The amount of property tax support for sewer improvements (new and existing) would increase significantly. For a property assessed at $250,000, the tax contribution would increase from approximately $150 in FY 2005 to nearly $290 in FY 2015 and then decline to $180 in FY 2025 for Implementation Plan No. 1 – or from $ 150 in FY 2005 to nearly $290 in FY 2015 and decline to about $260 in FY 2025.

In addition, if a property benefits from one of the sewer needs area improvement projects, a special (betterment) assessment would also be made ranging from $10,000 to $25,000 depending on the project's details and the value of the benefiting property.

ES.11 Public Participation

Section 11 of the Wastewater Facilities Plan describes the public participation aspect of the facilities planning process. The process is not complete, and this section will not be finalized until the entire process is finished. This section does include detailed accounting of the public participation efforts conducted to date, including the following:

Preliminary Public Participation

A series of public meetings was held in July 2000, to introduce the residents of Stonington to the wastewater facilities planning process. Background on the project was reviewed, and goals of the facilities planning process were outlined.

Citizen's Advisory Group

A citizen's advisory group (CAG) was formed to provide ongoing public participation during development of the draft facilities plan. The CAG was comprised of concerned citizens from throughout Stonington. The CAG attended monthly meetings to offer advice and comment as the planning work proceeded.

Summary of Public Meetings (2/6/2001 and 7/16/2001)

The first public meeting for the project was held on February 6, 2001 to describe the progress to date on the project, and to outline the next steps. The two primary topics of presentation included the sewer needs analysis (which eventually became integral to Section 2 of this draft report), and flow and load projections (Section 3).

A second public meeting was held on Monday, July 16, 2001 at the Stonington Police Station to discuss the wastewater treatment alternatives evaluation (Sections 5, 6 and 7).

Summary of Public Hearing (8/20/2001)

A public hearing was held on Monday, August 20, 2001 at Stonington High School. A presentation was made that described the Draft Wastewater Facilities Plan recommendations. Many questions were asked at the conclusion of the presentation. Section 11 contains a paraphrased record of the questions and answers from the public hearing. A verbatim transcript of the Public Hearing is available for review at the WPCA office in Town Hall.

Public Comment Period (8/20/2001 – 3/31/2002)

Due to the considerable public comment received at the Public Hearing, WPCA kept the public comment period open until March 31, 2002. During this period, a Citizen's Review Panel (CRP) was formed to evaluate the Draft Wastewater Facilities Plan in detail (see discussion below). Also during this period, WPCA received several additional comments in the form of letters and meetings. These comments are included in Section 11.

Citizen's Review Panel

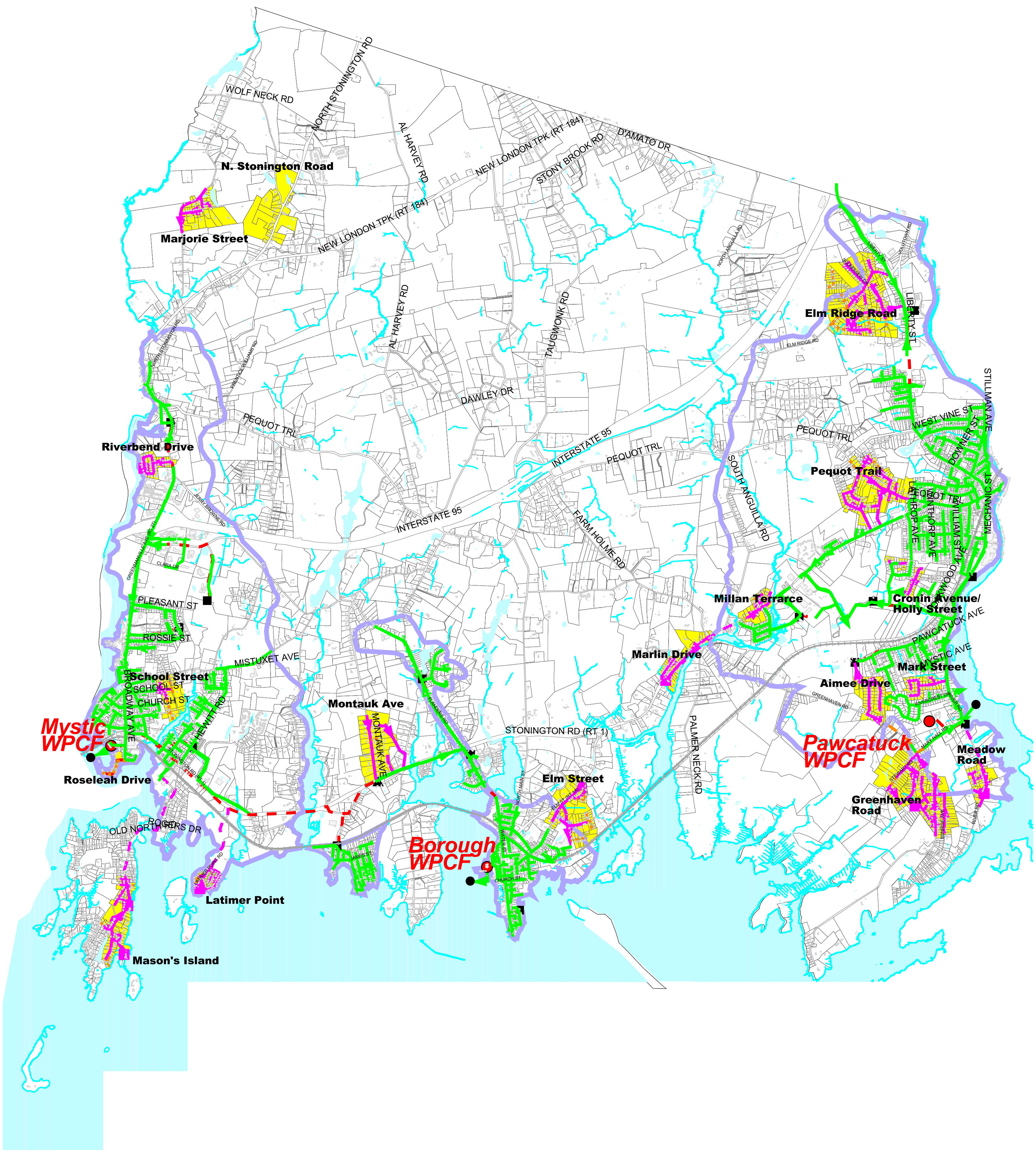
A second group of concerned citizen's, the Citizen's Review Panel (CRP) was formed subsequent to the August 20, 2001 Public Hearing. The purposes of the CRP were to assess and evaluate the draft Wastewater Facilities Plan, and to develop conclusions and recommendations to WPCA. WPCA carefully considered the CRP's recommendations in the development of a revised draft Wastewater Facilities Plan. WPCA agreed with most of the CRP's recommendations, except for the wastewater treatment alternative. The CRP recommended Alternative G, and for the revised draft Wastewater Facilities Plan, WPCA recommended Alternative No. 5.

Summary of Public Hearing (2/5/2005)

A public hearing was held Wednesday, February 5, 2005, at the Mystic Middle School, to present the revised draft Wastewater Facilities Plan. Many questions and comments were received at the hearing, and Section 11 contains a paraphrased record of the questions and answers from the hearing. A verbatim transcript of the Public Hearing is available for review at the WPCA office in Town Hall.

Public Comment Period (2/5/2005 – 4/15/2005)

During the public comment period following the hearing, WPCA received many additional comments on the revised draft Wastewater Facilities Plan, in the form of letters and at meetings. These comments are documented in Section 11 and are included in Appendix E.



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November 2004

Source: Basemap data and existing sewer facilities from Stonington GIS, 2001. Well locations and aquifer zones downloaded from UCONN GIS.

0 5000 Feet

CDM

Drainage Area
Wastewater Needs Area

Proposed Sewer System
- Pump Station
- Force Main
- Gravity Sewer
- Low-Pressure Sewer

NOTE: TRANSMISSION SYSTEMS ARE NOT SHOWN FOR AREAS WHERE COMMUNITY PACKAGE TREATMENT SYSTEMS ARE PROPOSED (TREATMENT SITES ARE NOT YET KNOWN)

Existing Sewer System
- Treatment Plant
- Pump Station
- Outfall
- Odor Control Facility
- Force Main
- Gravity Sewer
- Planned Sewer

Stonington, CT

Figure ES-1

Wastewater Needs Areas
Proposed Collection & Transmission Systems

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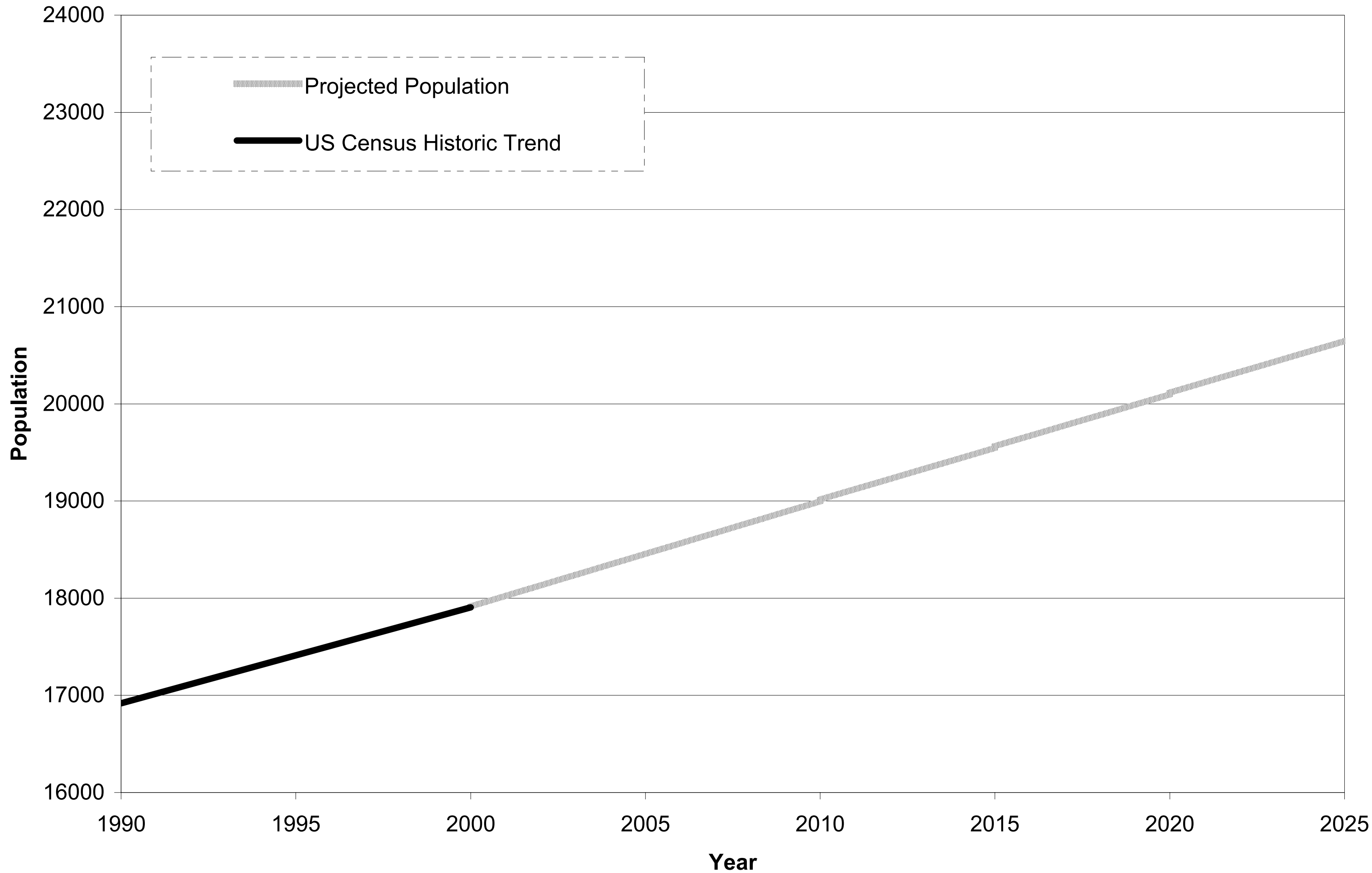
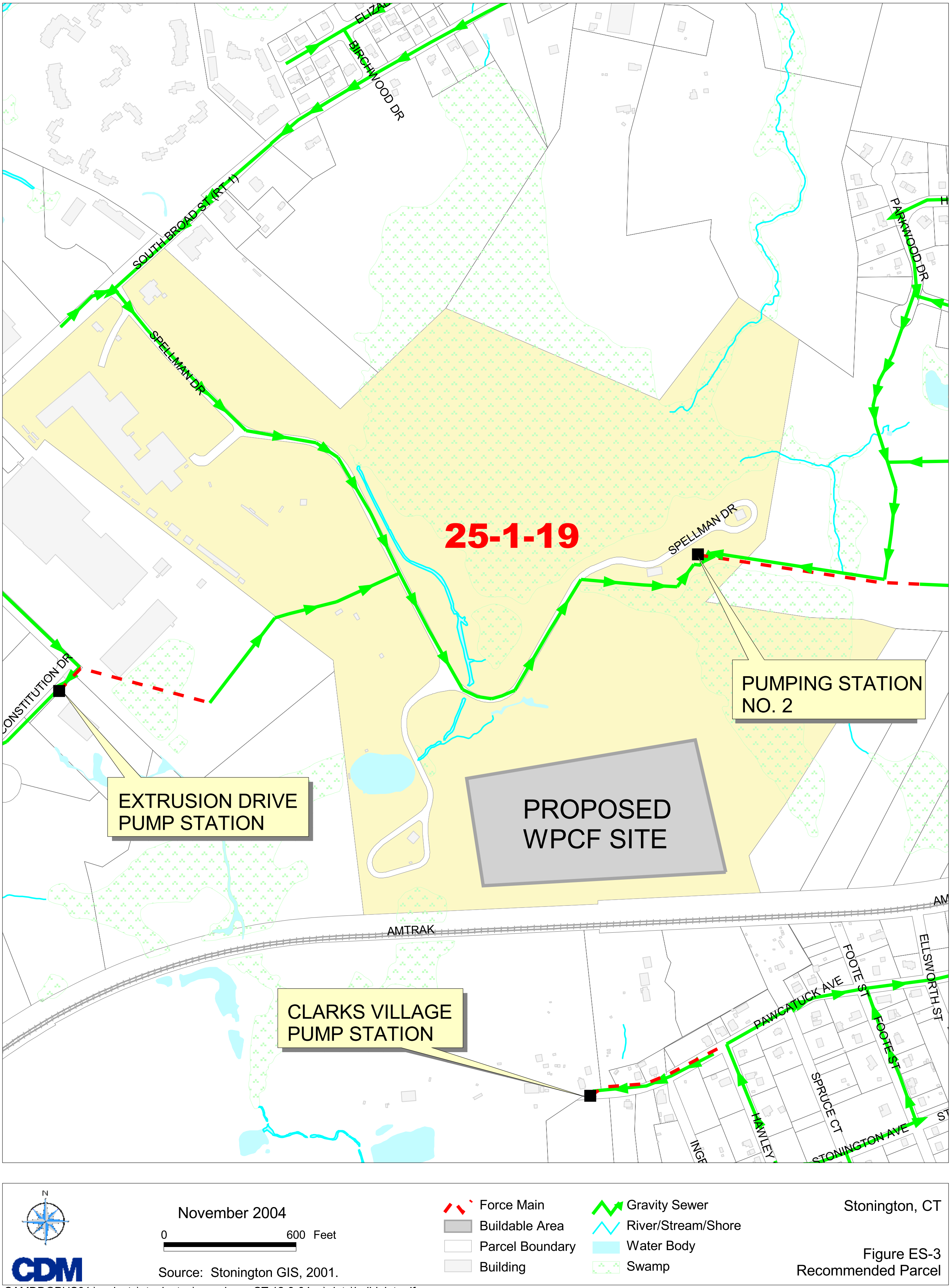


CDM

Figure ES-2
Comparison of Population Projections



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	Area	Priority Ranking	Average Flow (gpd)	District	Recommended Treatment Alternative	Recommended Collection Alternative	Capital Cost[2]	Cost per Lot[3]	Annual O&M
1	Marjorie Street Area	Critical	7,000	Not Applicable	Community Innovative/ Alternative Technologies	Gravity Sewers, Pump Station and Force Main	$2,086,000	$52,200	$58,600
2	Riverbend Drive	Moderate	6,762	Mystic WPCF	Town Water Pollution Control Facility	Gravity Sewers, Pump Station and Force Main	$1,476,000	$35,100	$14,200
3	School Street	Moderate	5,474	Mystic WPCF	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers	$1,044,000	$30,700	$17,000
4	Roseleah Drive	High	3,325	Mystic WPCF	Town Water Pollution Control Facility	Grinder Pumps and Low-Pressure Sewers	$384,000	$24,000	$11,000
5	Elm Ridge Road Area	Critical	35,875	Pawcatuck WPCF	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers, Pump Station and Force Main	$5,247,000	$25,600	$85,700
6	Pequot Trail Area	High	19,775	Pawcatuck WPCF	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers	$3,720,000	$32,900	$36,800
7	Cronin Avenue/ Holly Street	High	5,250	Pawcatuck WPCF	Town Water Pollution Control Facility	Gravity Sewers	$650,000	$21,700	$8,600
8	Millan Terrace	Moderate	6,650	Pawcatuck WPCF	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers	$1,152,000	$30,300	$15,400
9	Aimee Drive Area	Moderate	9,625	Pawcatuck WPCF	Town Water Pollution Control Facility	Gravity Sewers	$1,655,000	$30,100	$18,900
10	Mark Street Area	High	7,175	Pawcatuck WPCF	Town Water Pollution Control Facility	Gravity Sewers	$1,123,000	$27,400	$11,700
11	Greenhaven Road Area	High	25,025	Pawcatuck WPCF	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers, Pump Station and Force Main	$5,310,000	$37,100	$50,700
12	Meadow Road Area	Moderate to High	5,950	Pawcatuck WPCF	Town Water Pollution Control Facility	Gravity Sewers, Pump Station and Force Main	$1,842,000	$54,200	$12,900
13	Latimer Point	High	12,880	Mystic WPCF	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers, Pump Station and Force Main	$2,632,000	$32,900	$27,000
14	Mason's Island	Moderate	10,304	Mystic WPCF	Community Innovative/ Alternative Technologies	Combination of Gravity and Low-Pressure Sewers, Pump Station and Force Main	$4,214,000	$52,700	$76,500
15	Marlin Drive Area	High	12,600	Pawcatuck WPCF	Town Water Pollution Control Facility	Gravity Sewers, Pump Station and Force Main	$2,285,000	$31,700	$23,700
16	Elm Street Area	Low	11,396	Borough WPCF	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers	$2,526,000	$34,100	$29,500
17	Montauk Road Area	Low	5,236	Borough WPCF	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers	$1,837,000	$54,000	$9,200
18	North Stonington Road	Low	5,250	Not Applicable	Individual Onsite Systems with Innovative/Alternative Technologies	Not Applicable	$1,817,000	$60,600	$28,200

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to July 2002, Engineering News Record (ENR) Construction Cost Index 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for lots within wastewater needs area.

Table ES-1
Recommended Alternatives
Cost Summary[1]

Table ES-3

Stonington WPCA Facilities Plan
Projected WPCF Influent Flows and Loads

Mystic WPCF

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	NH3-N (ppd)	TN (ppd)
Average Annual	0.702	2224	1801	175	249
Maximum Month	0.951	3724	3762	236	336
Maximum Day	1.448	5478	4467	360	512

Borough WPCF

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	NH3-N (ppd)	TN (ppd)
Average Annual	0.298	516	419	66	97
Maximum Month	0.477	1109	815	130	188
Maximum Day	0.6705	1302	1017	157	230

Pawcatuck WPCF

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	NH3-N (ppd)	TN (ppd)
Average Annual	0.928	1534	2174	184	290
Maximum Month	1.366	1911	3239	271	426
Maximum Day	1.801	2199	3906	357	561

Section 1
Introduction

1.1 Background

This *Wastewater Facilities Plan* presents a 20-year plan for wastewater collection, treatment and disposal for the Town of Stonington. The plan has been prepared in conformance with the Connecticut Department of Environmental Protection (CTDEP) guidelines, and has been partly funded through the State's Clean Water Fund.

The plan has been developed for the Stonington Water Pollution Control Authority (WPCA) as part of a public process. WPCA presented an initial draft of the plan at a public hearing in August 2001. Due to the volume and character of public comment, WPCA provided an extended public comment period, and commissioned a Citizens Review Panel to thoroughly review the draft plan and develop comments and recommendations. After careful consideration of the public comments received on the initial draft, a complete re-evaluation of the recommendations contained in the initial draft, the WPCA endorsed an alternative to construct a new wastewater treatment facility to replace the three existing plants in fall 2002.

Similarly, a *Facilities Plan Update for the Town of Groton, Connecticut* was prepared by Fuss & O'Neill Inc. in 1996. This included recommendations for collection, treatment and disposal improvements for the Town of Groton system. Given that these neighboring towns were about to make substantial improvements to their respective treatment facilities, the CTDEP suggested that a regional solution including the transfer of all or a portion of Stonington's wastewater flows to the Groton system for treatment and disposal might be advantageous for both communities and should be investigated. As a result, the Stonington WPCA entered into an agreement with CDM, in association with Fuss & O'Neill Inc., to investigate the feasibility of a regional solution. In January 2004, the draft *Groton Analysis* indicated significant capital and operational costs for the regional alternative. After significant discussion, both towns agreed that it was no financial advantage to pursue this option further. A copy of the *Groton Analysis* is included as Appendix F.

WPCA presented its revised draft of the plan at a public hearing in February 2005. Again, WPCA received a high volume of public comment, most of it against the draft's recommendation to construct a new treatment facility. Subsequent to the hearing, WPCA withdrew the recommendation for a new treatment facility and in the period since the hearing has been re-evaluating the alternatives. During this period, WPCA was formally notified by the Town of Groton that the regional alternative involving transfer of flow to the Groton system is not a viable option.

Additionally, the Town of Stonington has prepared and adopted the *2004 Plan of Conservation and Development*. This plan generally confirms/substantiates the assumptions made during preparation of this Wastewater Facilities Plan. To the extent possible, the assumptions of this plan have been merged with previous facilities plan assumptions to present a unified approach to addressing the Town's future needs.

1.2 Purpose and Scope

1.2.1 Purpose

The Wastewater Facilities Plan has been prepared to meet the following goals:

- To provide the Stonington WPCA with a cost-effective, comprehensive plan to meet the Town's wastewater needs for the next 20 years.
- To obtain public and regulatory approval of the Plan.
- To position the Town for funding opportunities.

Facilities planning must be performed in order to obtain Grant Assistance from the Connecticut Department of Environmental Protection (CTDEP) for wastewater collection and treatment system improvements. The information contained in this Wastewater Facilities Plan is consistent with state and federal regulations regarding Clean Water funding (i.e., funding provided pursuant to the Clean Water Act and the Connecticut Environmental Protection Act), and the Plan of Study previously approved by CTDEP.

Facilities planning determines wastewater collection and treatment system needs over a 20-year planning period and develops strategies for meeting those needs. The Wastewater Facilities Plan provides the basis for subsequent design and construction, substantiates the need for new or upgraded facilities, examines the cost-effectiveness of a number of feasible alternatives, and demonstrates that the selected alternative is implementable from legal, institutional, financial, and management perspectives.

In addition to a comprehensive evaluation of existing facilities and future system needs within the study area, the Wastewater Facilities Plan also evaluates existing and projected demographic characteristics, and topographic, hydrologic, and institutional features of the study area and assesses their impact on wastewater collection and treatment needs.

1.2.2 Scope

The Wastewater Facilities Plan has been organized as described in the following paragraphs.

Executive Summary
The Executive Summary provides an overview of the findings, conclusions, and recommendations of the Wastewater Facilities Plan. Detailed analysis and discussion of these topics are contained in the body of the report. The Executive Summary is provided for those readers requiring a cursory knowledge of the facilities plan's

contents and provides a concise reference, presenting a condensed version of the major ideas contained in the body of the report.

Section 1 Introduction

Section 1 of the Wastewater Facilities Plan introduces the project. Project goals and approaches are described, and the framework for the technical sections to follow is presented.

Section 2 Wastewater Disposal Needs

Section 2 presents the evaluation of wastewater disposal needs within the Town. The first part of the evaluation involves identification of those areas in Town that are in need of solutions to wastewater disposal problems, because of failing on-lot systems and poor local conditions, such as soil type or high groundwater. The second part of Section 2 includes an evaluation of alternatives to address these problems in the identified areas, and includes recommended solutions.

Section 3 Projected Flows and Loads

Section 3 presents the development of design flow and load projections for use in the Wastewater Facilities Plan. The section documents the sources of information used, the projection methodology, and the results. Flow and load projections include the following sources of wastewater: domestic (from residents), institutional, commercial, industrial, and infiltration and inflow of extraneous wastewater.

Section 4 Wastewater Collection Systems

Section 4 presents an evaluation of Stonington's existing wastewater collection systems, including the interceptor sewers, pump stations, and forcemains. The section documents the results of an inspection of the existing facilities, and a capacity analysis of each major segment of the system.

Section 5 Water Pollution Control Facilities Evaluation

Section 5 presents an evaluation of Stonington's three existing water pollution control facilities (the Mystic, Borough and Pawcatuck WPCFs). Each WPCF is described in detail, and the current operating criteria are summarized. The capacity of each WPCF is determined for varying treatment requirements, and mass balances are developed for each of the WPCFs.

Section 6 Water Quality Analyses

Section 6 presents an evaluation of receiving water issues associated with the discharge of treated wastewater effluent to Stonington Harbor and the Pawcatuck River. The section documents the fieldwork conducted to develop the analysis, and the conclusions. The Mystic River is not evaluated in the Plan because this receiving water was previously evaluated by CTDEP.

Section 7 Alternatives Evaluation

Section 7 presents the evaluation of alternatives available to Stonington for the treatment and disposal of wastewater. The section presents the methodology used in the evaluation, a discussion of wastewater process alternatives, a siting analysis for those options requiring a new treatment plant site, identification of "finalist" alternatives, and a comparison of the finalist alternatives based on economic and non-economic criteria. This section includes a recommended alternative, based on the evaluation.

Section 8 Recommended Plan
Section 8 contains a summary of the recommendations from the previous sections, and presents an implementation plan, including schedule, describing how these recommendations can be developed over the 20-year duration of the Plan.

Section 9 Environmental Assessment
Section 9 presents a review of the environmental impacts associated with implementing the recommended plan. In addition, the Plan's conformity with Connecticut's Conservation and Development Plan is verified and documented.

Section 10 Financial Considerations
Section 10 presents and evaluation of the financial impacts of the recommended plan, and describes alternative mechanisms for funding the recommendations. Grants and low-interest loans from Connecticut are included in the evaluation, as well as phasing opportunities to reduce the impact on the residents of Stonington.

Section 11 Public Participation
Section 11 presents a description of the public participation aspect of the facilities plan development process. The public participation efforts completed to date throughout the course of the plan development are recorded, and the public's comments, as received at the public meetings and during the comment period, are documented and addressed. By necessity, this section will not be completed until the WPCA's evaluation and the public participation aspect of the project is completed.

1.3 Planning Area

The Town of Stonington is located in the southeast-most corner of Connecticut. The Town is bordered by Westerly, Rhode Island to the east, Groton to the west, and North Stonington to the north, and its southern border consists entirely of shoreline. The Wastewater Facilities Plan study area is solely the Town of Stonington, with two additional, minor contributors, both in North Stonington. In the past, the Town of Stonington has reserved a capacity of 200,000 gallons per day of wastewater from North Stonington in its Pawcatuck collection and treatment systems; however, as a result of evaluating the impacts of holding this reserve and the Stonington public's comments regarding these impacts, this 200,000 gallon per day flow is no longer included in WPCA's planning.

1.4 Existing Water Pollution Control Facilities

Stonington currently owns and is responsible for three separate wastewater collection systems and water pollution control facilities (WPCFs). The existing system was the result of the last Town-wide facilities plan for Stonington, which was prepared in 1967.

1.4.1 Mystic WPCF

Prior to construction of the Mystic WPCF, local residences and businesses were serviced by on-site septic systems, and it was known that many of these systems were not operating correctly due to soil conditions. In 1970, the Town of Stonington was granted approval to construct the Mystic WPCF as a 0.88-mgd conventional, secondary-treatment plant, utilizing the activated sludge process, and chlorination for disinfection. Construction of the plant was completed in 1972, and the plant was placed into operation.

In 1987, flows to the Mystic plant began to exceed 90 percent of its design capacity. In January 1988 CTDEP issued an Order which required Stonington to: 1) evaluate the capacity of the Mystic WPCF; 2) prepare 20-year flow projections for the service area; and 3) institute a sewer connection moratorium on the plant's service area.

In 1993 and 1994, WPCA completed a study for improving the operation and performance of the Mystic WPCF. The planned approach included a short-term upgrade program comprised of either operational or minor equipment or structural changes that would immediately improve treatment at the Mystic WPCF. The study also included recommendations for longer-term improvements, key among them being construction of a new double-barrel forcemain between the Mystic and Borough WPCFs, to allow a portion of the Mystic flow to be diverted to the Borough WPCF for treatment. This, together with other improvements at both the Mystic and Borough WPCFs, allowed for removal of the new connection moratorium in the Mystic WPCF service area. The plant upgrade and forcemain construction work was completed in 1999.

The Mystic WPCF was designed to treat an average flow of 0.80 million gallons per day (mgd), and a peak flow of 2.35 mgd. It appears that the permitted average flow of 0.88 mgd, rather than 0.80 mgd, resulted from a clerical error when the permit was originally issued.

The Mystic WPCF employs the following treatment processes:

- Influent comminution (or bypass coarse screening)
- Influent raw sewage pumping
- Primary clarification, with waste activated sludge (WAS) co-settling
- Activated sludge biological treatment
- Disinfection with sodium hypochlorite
- Primary underflow (sludge) de-gritting

- Diversion pumping of de-gritted primary clarifier underflow (to Borough WPCF)
- Odor control
- Digesters (abandoned)

1.4.2 Borough WPCF

Construction of the Borough WPCF was completed in 1975, and the plant was placed into operation.

The Borough WPCF was designed to treat an average flow of 0.66 million gallons per day (mgd). The plant discharges to Stonington Harbor.

The Borough WPCF currently employs the following treatment processes:

- Influent comminution (or bypass coarse screening)
- Influent raw sewage pumping
- Primary clarification, with waste activated sludge (WAS) co-settling
- Activated sludge biological treatment
- Disinfection with sodium hypochlorite
- Sludge thickening and thickened sludge storage
- Odor control

As described earlier, in 1993 and 1994, a study was completed for improving the operation and performance of the Mystic WPCF. A key recommendation from the study was construction of a new double-barrel forcemain between the Mystic and Borough plants, to allow a portion of the Mystic flow to be diverted to the Borough WPCF for treatment. Implementation of this diversion required that upgrade work be conducted at the Borough WPCF. The work at the Borough WPCF included installation of a fine-bubble aeration system, retrofit of the plant's existing digesters into new primary clarifiers, and conversion of one of the plant's existing primary clarifiers into a secondary clarifier. The diversion from the Mystic WPCF began in September 1999.

1.4.3 Pawcatuck WPCF

Construction on the Pawcatuck WPCF was completed in 1978, and the plant was placed into operation. The Pawcatuck WPCF utilizes the same unit processes as the other two plants, but is comprised of a different layout because of the available space.

The Pawcatuck WPCF was designed to treat an average flow of 1.3 million gallons per day (mgd). The plant discharges to the Pawcatuck River. The plant is currently treating flows well below its original design capacity. The Pawcatuck WPCF receives all of its influent flow from a discharge forcemain from the nearby Pump Station No. 3. There are no influent pumping or preliminary treatment (comminution, screening or grit removal) facilities at the Pawcatuck WPCF site.

The Pawcatuck WPCF currently employs the following treatment processes:

- Primary clarification, with waste activated sludge (WAS) co-settling
- Septage receiving
- Activated-sludge biological treatment
- Disinfection with sodium hypochlorite
- Sludge thickening and thickened sludge storage
- Odor control
- Digesters (abandoned).

1.5 Water Quality Objectives

1.5.1 Legislative/Regulatory Background

The *Federal Water Pollution Control Act Amendments of 1972* and the 1977 *Clean Water Act* are the key federal regulations controlling activities which affect surface water. The overall objective of the *Clean Water Act* is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters". Section 106, 205(j), 208 and 303 of the Act provide the basis for state and regional Water Quality Management. Water Quality Management is aimed at achieving the water quality goals contained in the Act through designation of Water Quality Standards, development of wasteload allocations, and initiation of non-point water quality studies.

The Water Quality Management planning process is implemented through a number of State and federal environmental programs. The following components of the *Clean Water Act* are essential to the Water Quality Management and planning process:

1. **Development of Water Quality Standards (WQS) and regulations necessary to enforce them.**

   Section 303 of the federal *Clean Water Act* requires states to adopt surface water quality standards and review and modify these standards at least once every three years.

   Section 22a-426 of the Connecticut General Statutes further requires the Commissioner of Environmental Protection to adopt standards of water quality for all the State's waters. These standards are enforceable under a number of state regulations.

Federal law defines water quality-based standards as the identification and assignment of intended uses to be made of the water and establishing the criteria necessary to protect those uses. Federal regulations require that water quality standards should, wherever attainable, provide water quality for the protection and propagation of fish, shellfish and wildlife and for recreation in and on the water. The state's water quality classifications, based upon the adopted WQS, establish designated uses for surface and ground waters in Connecticut. Mystic Harbor, Stonington Harbor, and the Pawcatuck River have been classified SA/SB or SC, meaning the existing water quality is Class SC and the goal is Class SB.

Class SB water quality designated uses include recreation, fish, and wildlife habitat, agricultural and industrial water supply, and other legitimate uses including navigation. It is CTDEP's goal to attain these conditions in the three receiving water bodies such that Class SB Water Quality Standards are met.

2. **Formulation of state and area wide Water Quality Management (WQM) Plans, including comprehensive analysis of the actions necessary to meet the WQS.**

   Water Quality Management Plans are required by the *Clean Water Act* to provide a basis for regulatory control and enforcement of water pollution abatement activities. In Connecticut, WQM Plans for specific river basins and other geographic planning areas generally take on the form of a wasteload allocation. A wasteload allocation acts to translate water quality criteria into wastewater discharge effluent limitations which are incorporated into a National Pollutant Discharge Elimination System (NPDES) permit.

   A wasteload allocation, as its name implies, allocates pollutant loadings and concentration limits to the major contributors of wastewater to a waterbody, up to the determined "Total Maximum Daily Loading" (TMDL). The TMDL is the estimated maximum pollutant loading which a waterbody can receive and still achieve in-stream water quality conditions identified in the state's Water Quality Standards.

   The major pollutants of concern for a municipal wastewater facility, and accordingly those for which TMDLs are usually determined, are biochemical oxygen demand, nutrients (nitrogen and phosphorous), and solids. Aesthetic quality may also be considered in this determination.

3. **Issuance of permits for point and non-point source discharges.**

   Connecticut is delegated by the Environmental Protection Agency (EPA) to administer the National Pollutant Discharge Elimination System (NPDES) permitting program for wastewater discharges to surface waters in the state. This program is authorized under Section 402(b) of the federal *Clean Water Act* and Section 22a-430 of the Connecticut General Statutes. NPDES permits are typically issued for a five year period and specify operating restrictions, physical and chemical discharge limitations, and monitoring and reporting requirements.

The Mystic WPCF, Borough WPCF and Pawcatuck WPCF are currently operating under NPDES Permit Nos. CT0100544, CT0101281 and CT0101290, respectively and all are operating under the General Permit for Nitrogen Discharges. A copy of the permits is contained in Appendix D. **Table 1-1** is a summary of the existing permit and anticipated effluent limitations.

Table 1-1

Anticipated WPCF Effluent Quality Requirements

Condition	Mystic WPCF	Borough WPCF	Pawcatuck WPCF
BOD_5 (mg/L)	30 (avg. monthly) 50 (max. daily)	25 (avg. monthly) 45 (max. daily)	25 (avg. monthly) 45 (max. daily)
TSS (mg/L)	30 (avg. monthly) 50 (max. daily)	30 (avg. monthly) 50 (max. daily)	30 (avg. monthly) 50 (max. daily)
TN (mg/L)[1]	8.1 mg/L (2006) 5.1 mg/L (2014) 4.5 mg/L (2025)	10.9 mg/L (2006) 6.6 mg/L (2014) 5.6 mg/L (2025)	8.5 mg/L (2006) 4.2 mg/L (2014) 3.1 mg/L (2025)
pH range	6 to 9	6 to 9	6 to 9
Fecal Coliform (per 100 ml)	200 (30-day mean) 400 (7-day mean)	200 (30-day mean) 400 (7-day mean)	200 (30-day mean) 400 (7-day mean)
Total residual chlorine (TRC) (mg/L)[2]	0.2 (minimum) 1.5 (maximum)	0.2 (minimum) 1.5 (maximum)	0.2 (minimum) 1.5 (maximum)

[1] TN concentrations are based on *the General Permit for Nitrogen Discharges* allowable WLA (lbs/day) and the projected annual average flow in the indicated year. TN WLAs may be traded among the Stonington WPCFs; it is possible that a WPCF can discharge at a higher effluent TN concentration, but an increase in effluent wasteload will have to be made up by an equal decrease in discharge quantity at another WPCF. TN WLAs 2006 and 2014 are based on the General Permit. It is assumed that the WLA for 2025 is the same as for 2014. More stringent treatment would be needed (in terms of concentration) because of the projected flow increases over time.

[2] Existing effluent TRC limits shown. It is anticipated that stricter limits on TRC will be permitted in the future, requiring that dechlorination be provided following chlorine disinfection.

1.5.2 Required Degree of Wastewater Treatment

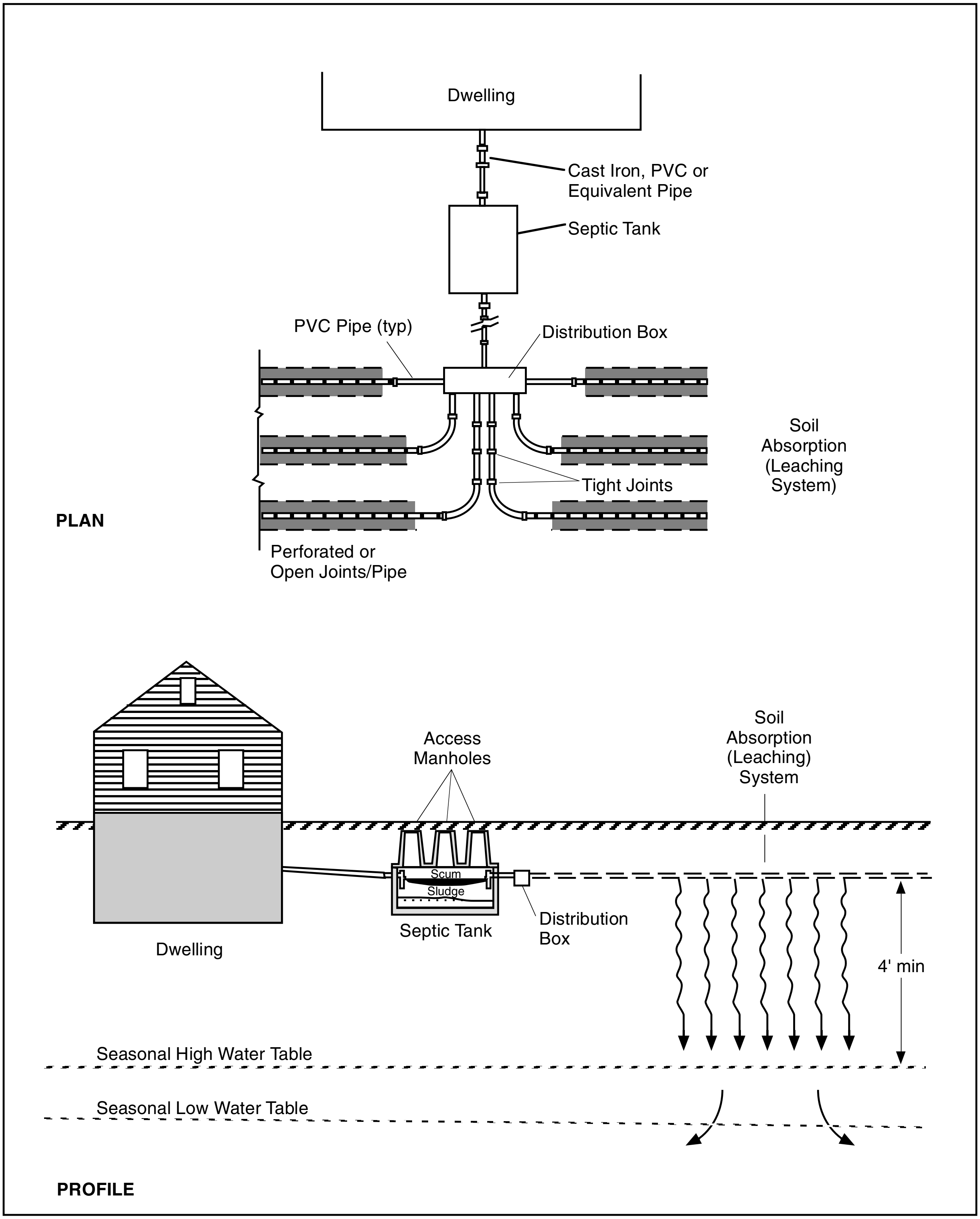
Table 1-1 summarizes the anticipated levels of treatment that would be required for each WPCF. These are based on the current permits for the three existing plants, with the added requirement to eventually provide nitrogen removal. By taking advantage of the nitrogen trading program, the level of treatment shown for effluent nitrogen can be delayed and/or reduced.

1.5.3 Nitrogen Removal

CTDEP, together with the New York State Department of Environmental Conservation (NYSDEC) and the EPA, has been investigating water quality problems in Long Island Sound. The study has identified nitrogen as a primary pollutant that is causing low dissolved oxygen (DO) levels in the Sound's bottom waters each summer. Nitrogen fuels the growth of algae, and when the algae eventually dies and decays, dissolved oxygen is consumed. The problem is severe enough that the DO levels in some areas of the Sound fall below 1 or 2 milligrams per liter (mg/L), well below Connecticut's water quality standard of 6 mg/L.

To address the low DO problem, Connecticut has developed a state-wide total maximum daily load (TMDL) analysis for nitrogen. The TMDL specifies the maximum amount of nitrogen that can be discharged to the Sound without significantly impairing the health of the Sound. The dominant source of nitrogen is wastewater treatment plant effluent. To meet the statewide TMDL, CTDEP enacted a *General Permit for Nitrogen Discharges* which assigns each wastewater treatment plant a wasteload allocation (WLA) for nitrogen. These WLAs decline over time through 2014 and require that the facilities eventually be able to provide nitrogen removal to a low discharge concentration, as summarized in Table 1-1.

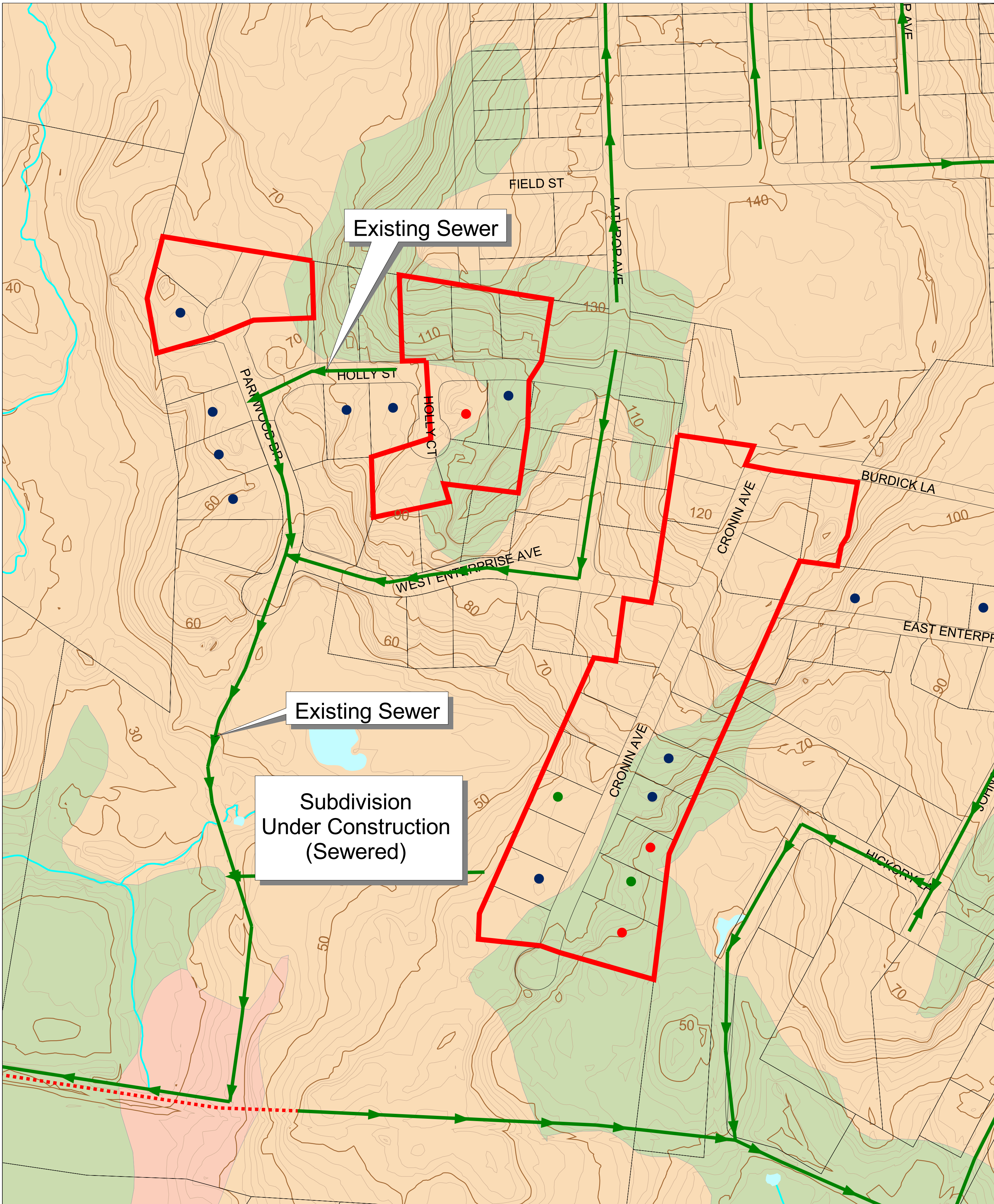
The state's nitrogen removal program includes a nitrogen-trading aspect that allows treatment plant owners to buy and sell nitrogen credits, depending on their plant's annual performance versus their WLA. This trading program provides some flexibility in upgrading treatment plants, in terms of schedule and effluent criteria, especially for small treatment plants on the eastern end of Long Island Sound (such as Stonington).



NOT TO SCALE

Figure 2-1
Typical Septic System

A



Soil Suitability
- S
- D
- D/W
- W
- X

Figure 2-10
Area 7
Cronin Avenue / Holly Street

- Response (Symptoms But No Problem Identified)
- Response (Yes) Problem
- Response (No) Problem

300 0 300 600 Feet

N

CDM

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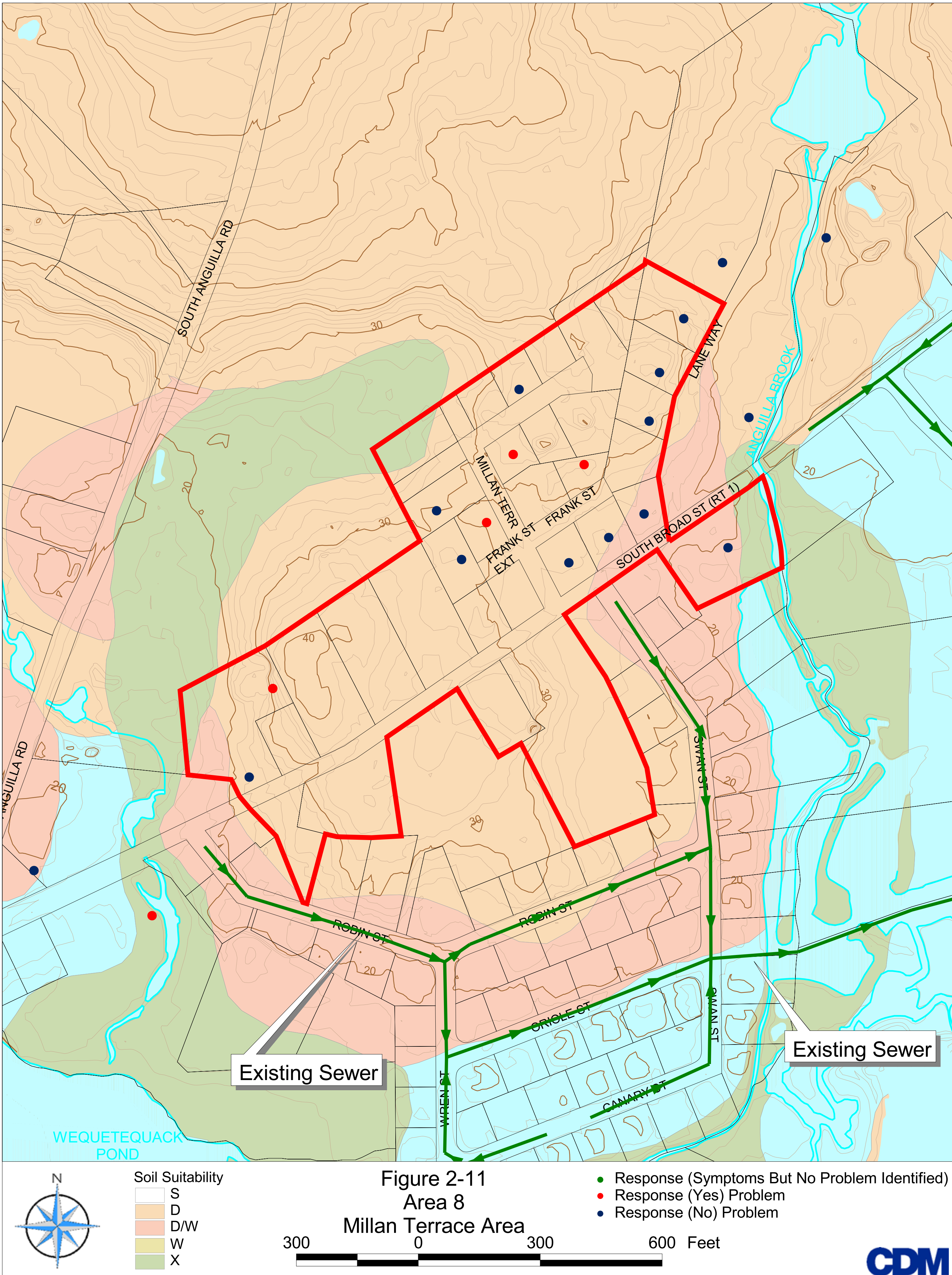

Figure 2-11
Area 8
Millan Terrace Area

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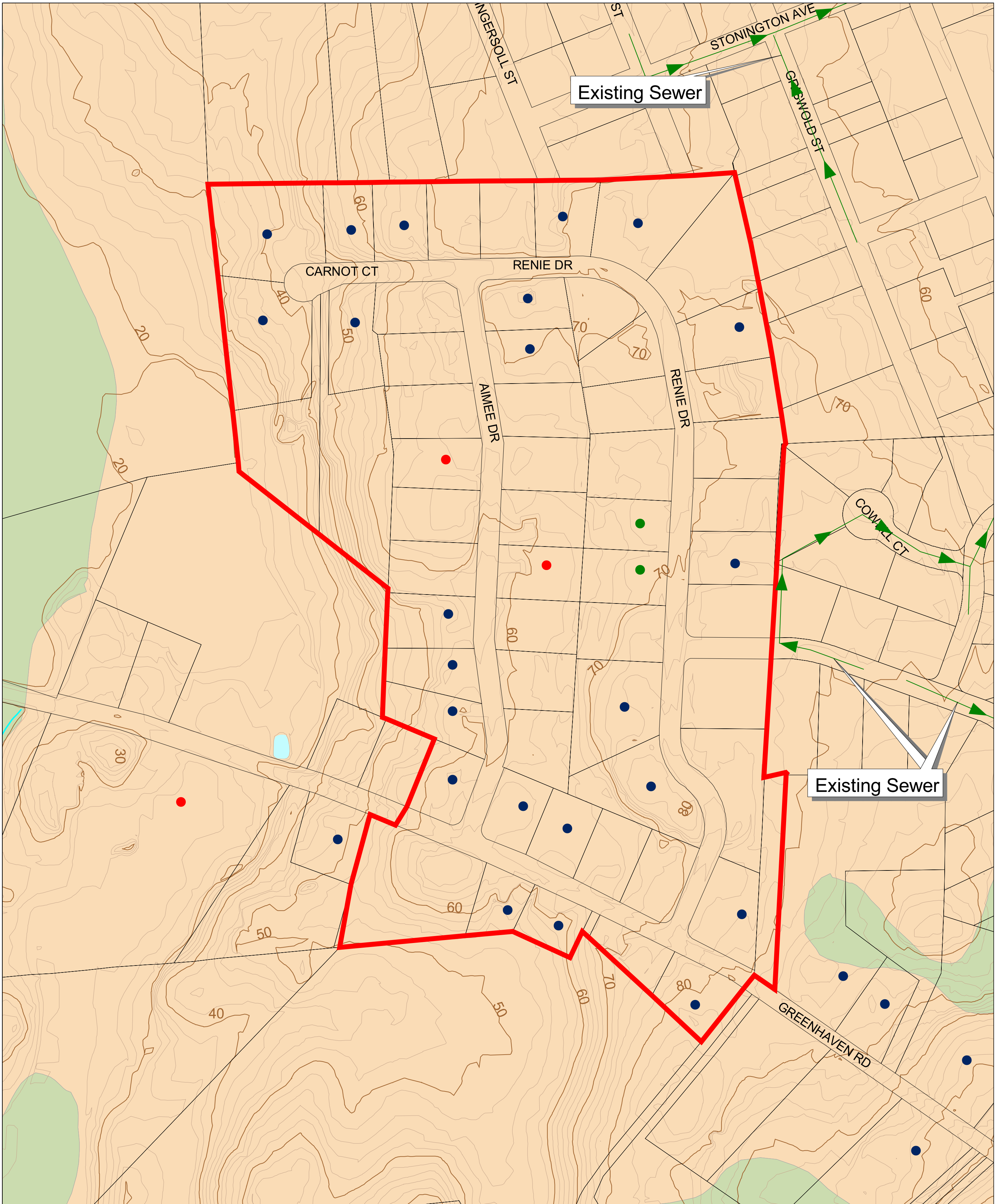


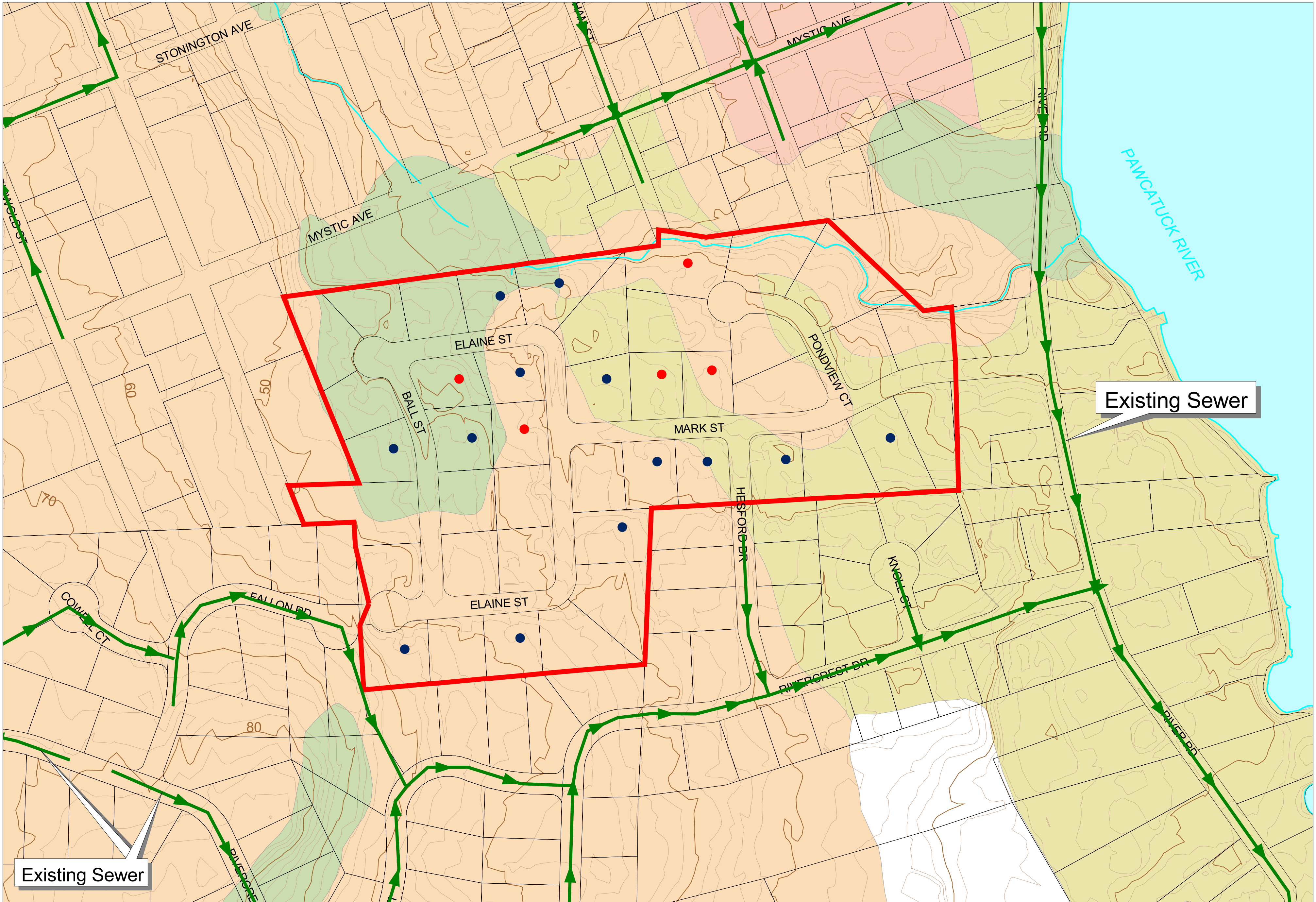
Soil Suitability
- S
- D
- D/W
- W
- X

Figure 2-12
Area 9
Aimee Drive Area

300 0 300 600 Feet

- Response (Symptoms But No Problem Identified)
- Response (Yes) Problem
- Response (No) Problem

CDM



N

Soil Suitability
- S
- D
- D/W
- W
- X

Figure 2-13
Area 10
Mark Street Area

300 0 300 600 Feet

- Response (Symptoms But No Problem Identified)
- Response (Yes) Problem
- Response (No) Problem

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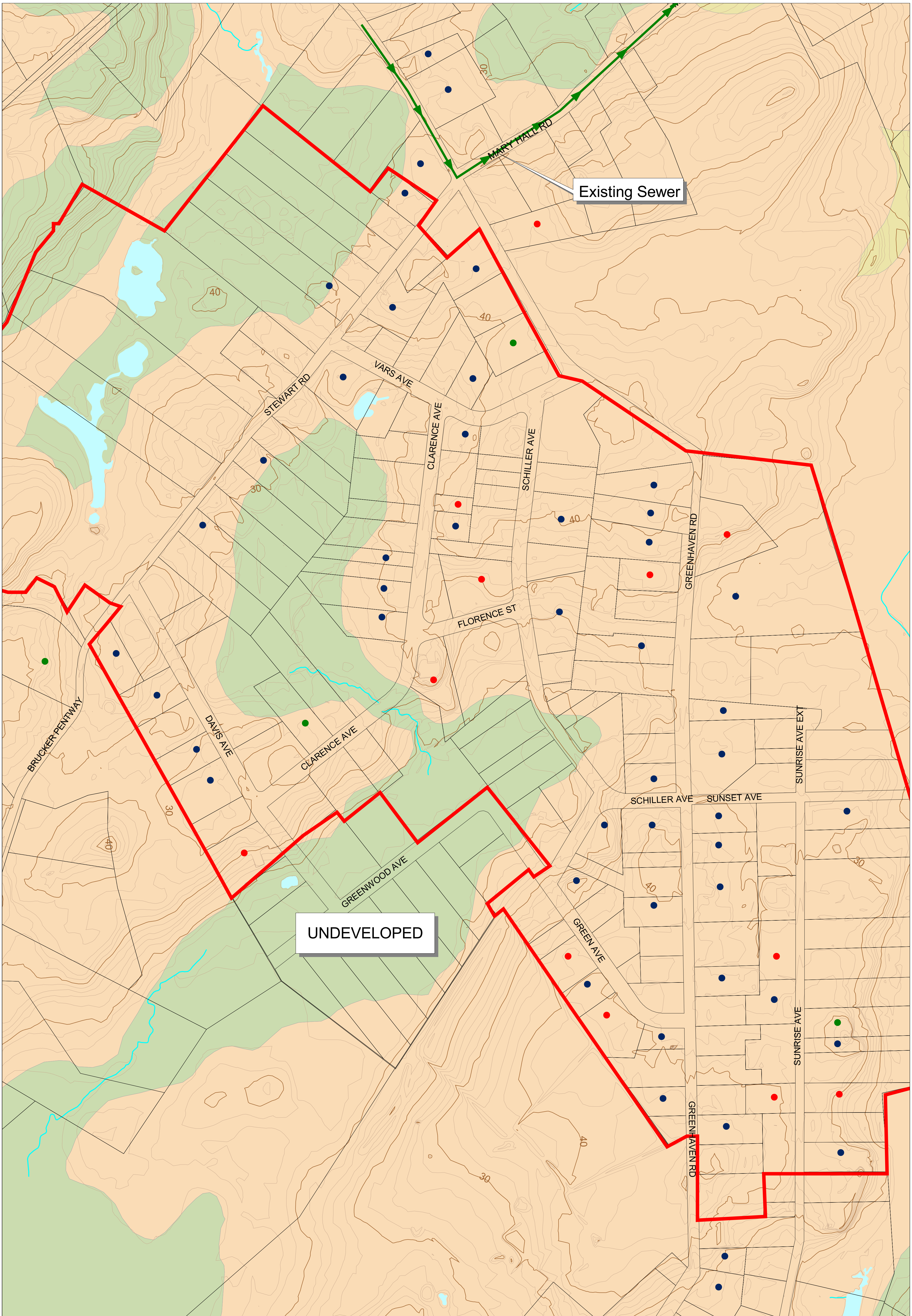

Figure 2-14
Area 11
Green Haven Road Area

N

Soil Suitability
- S
- D
- D/W
- W
- X

- Response (Symptoms But No Problem Identified)
- Response (Yes) Problem
- Response (No) Problem

300 0 300 600 Feet

CDM

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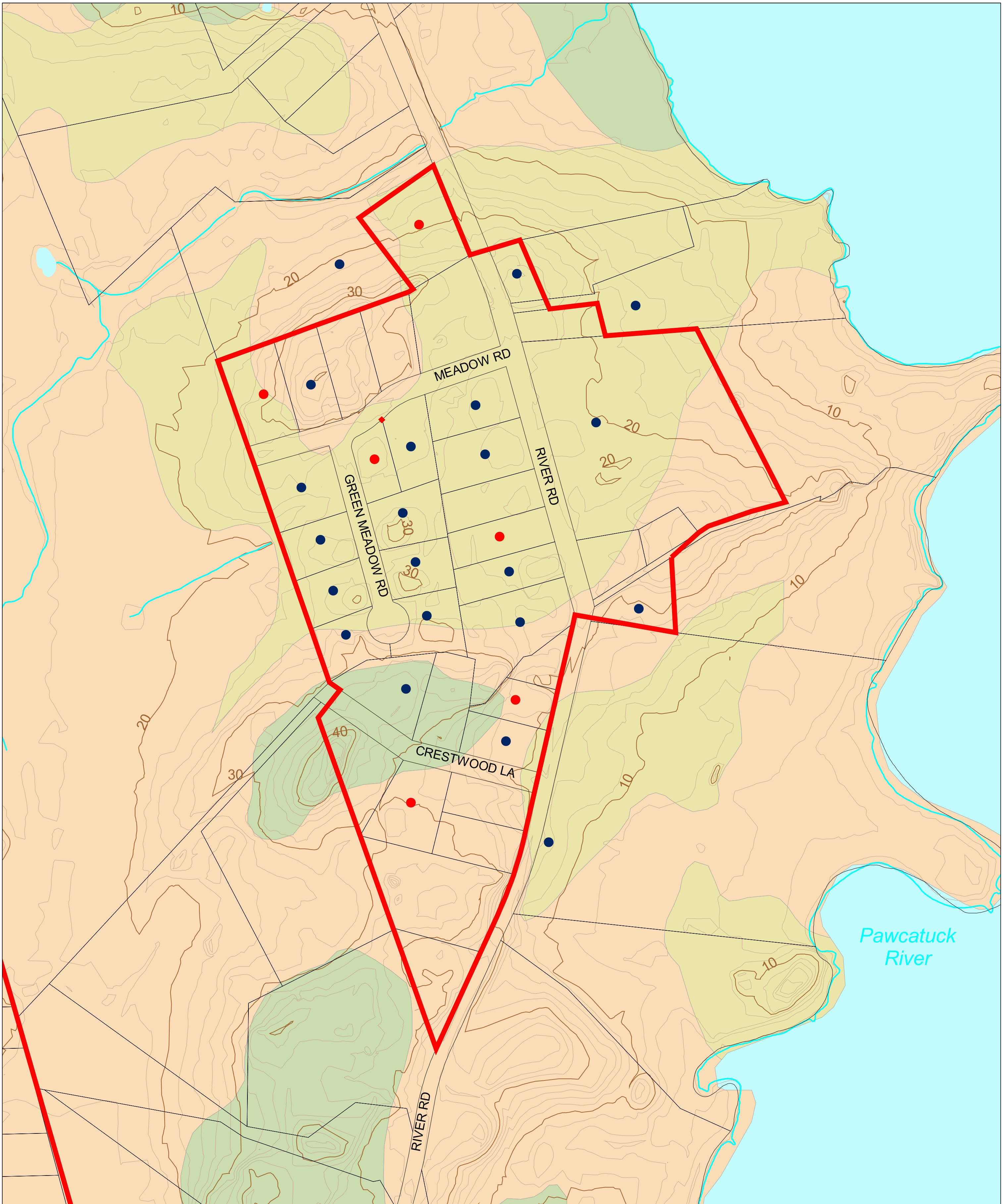

Soil Suitability
- S
- D
- D/W
- W
- X

Figure 2-15
Area 12
Meadow Road Area

- Response (Symptoms But No Problem Identified)
- Response (Yes) Problem
- Response (No) Problem

300 0 300 600 Feet

CDM

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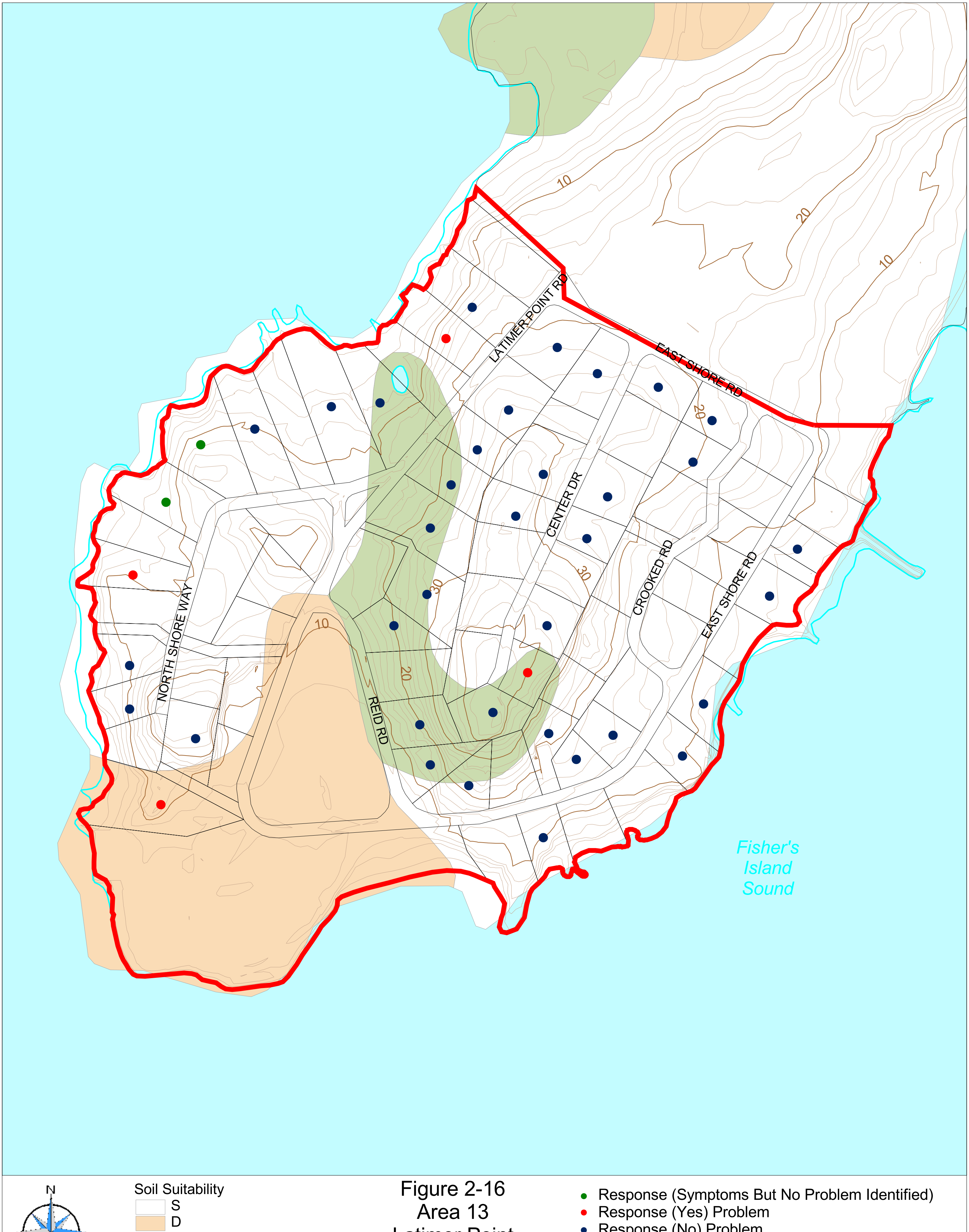

Figure 2-16
Area 13
Latimer Point

CDM

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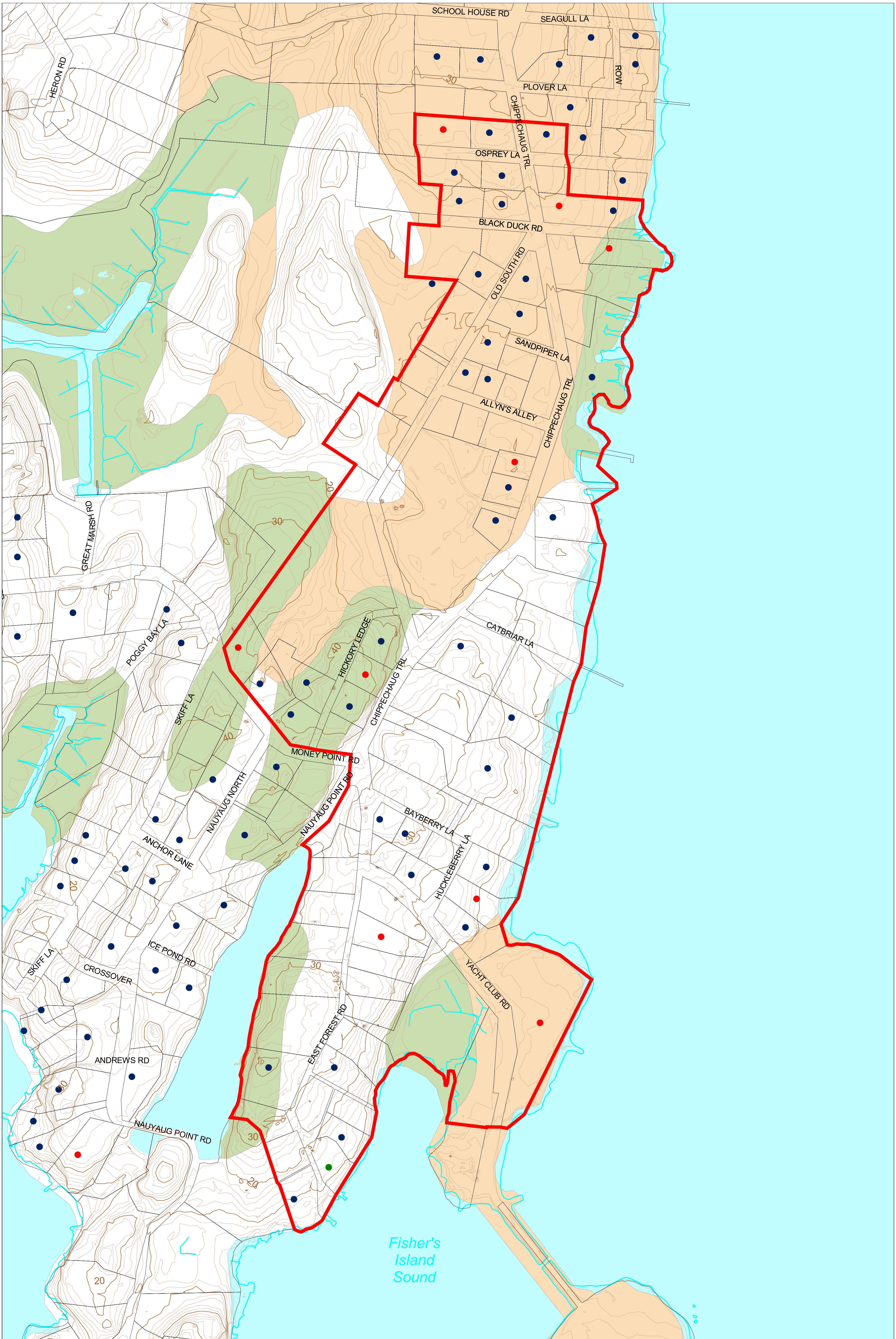

Soil Suitability
- S
- D
- D/W
- W
- X

Figure 2-17
Area 14
Mason's Island Area

- Response (Symptoms But No Problem Identified)
- Response (Yes) Problem
- Response (No) Problem

CDM

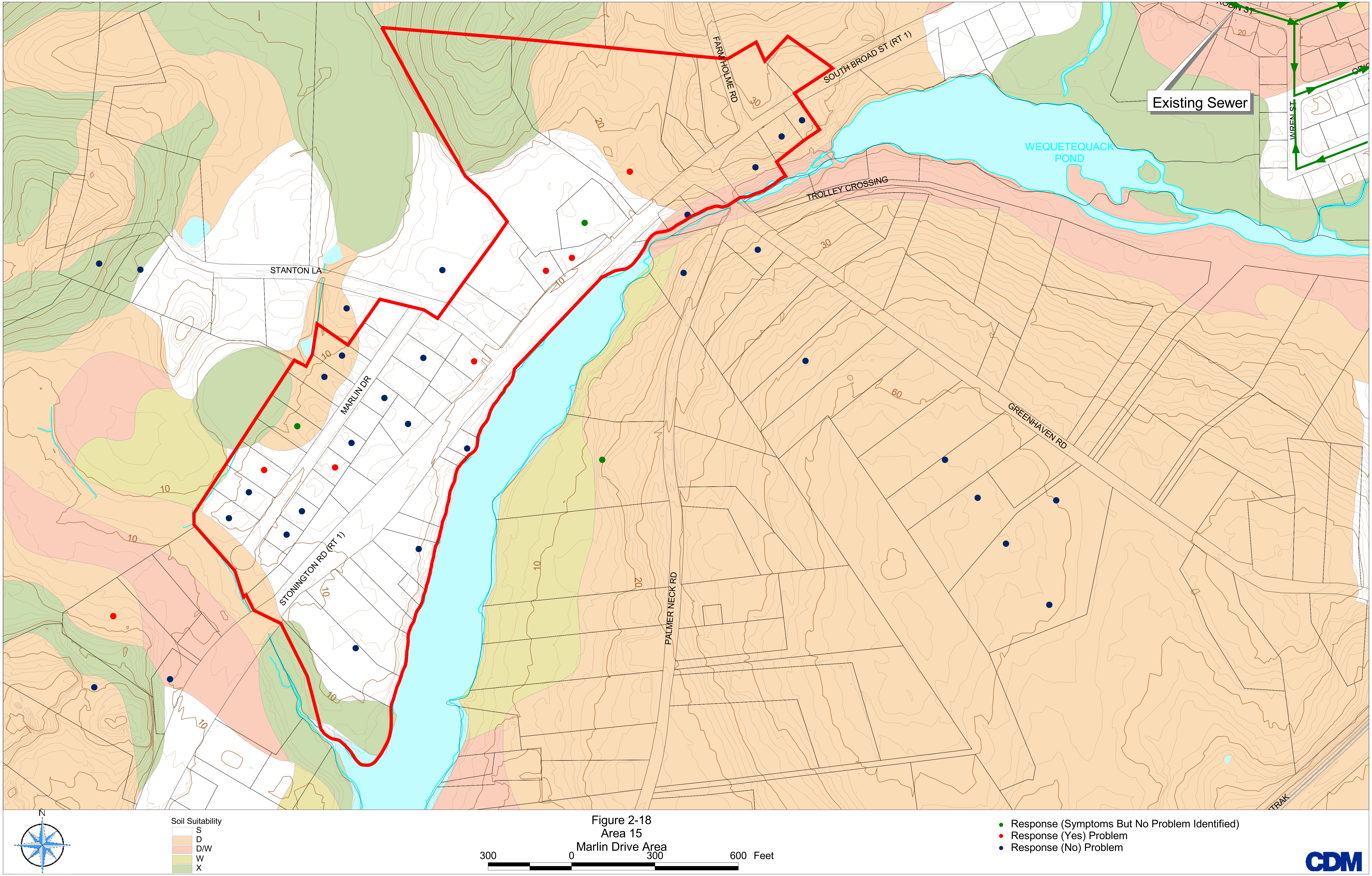

Figure 2-18
Area 15
Marlin Drive Area

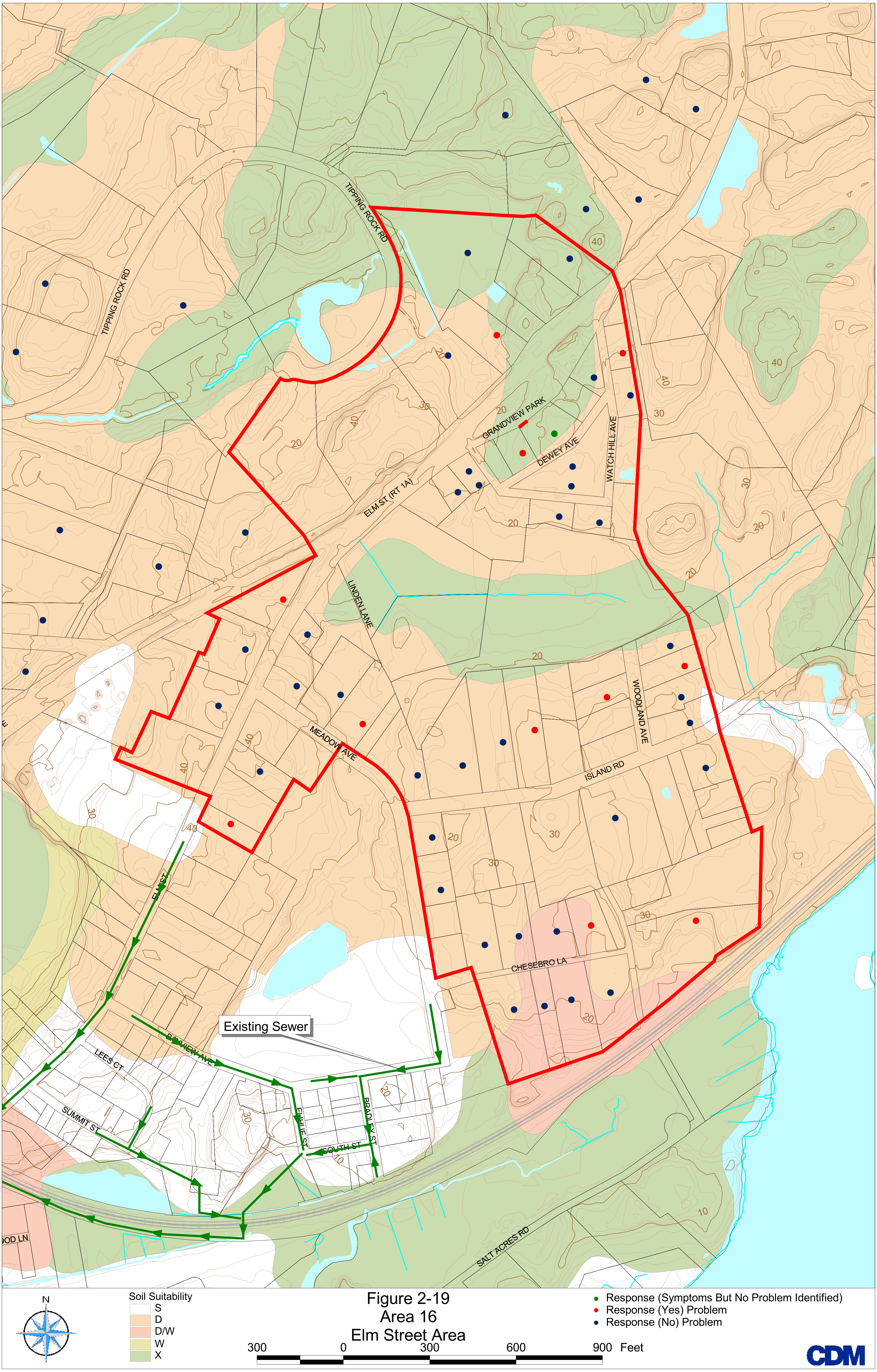

Figure 2-19
Area 16
Elm Street Area

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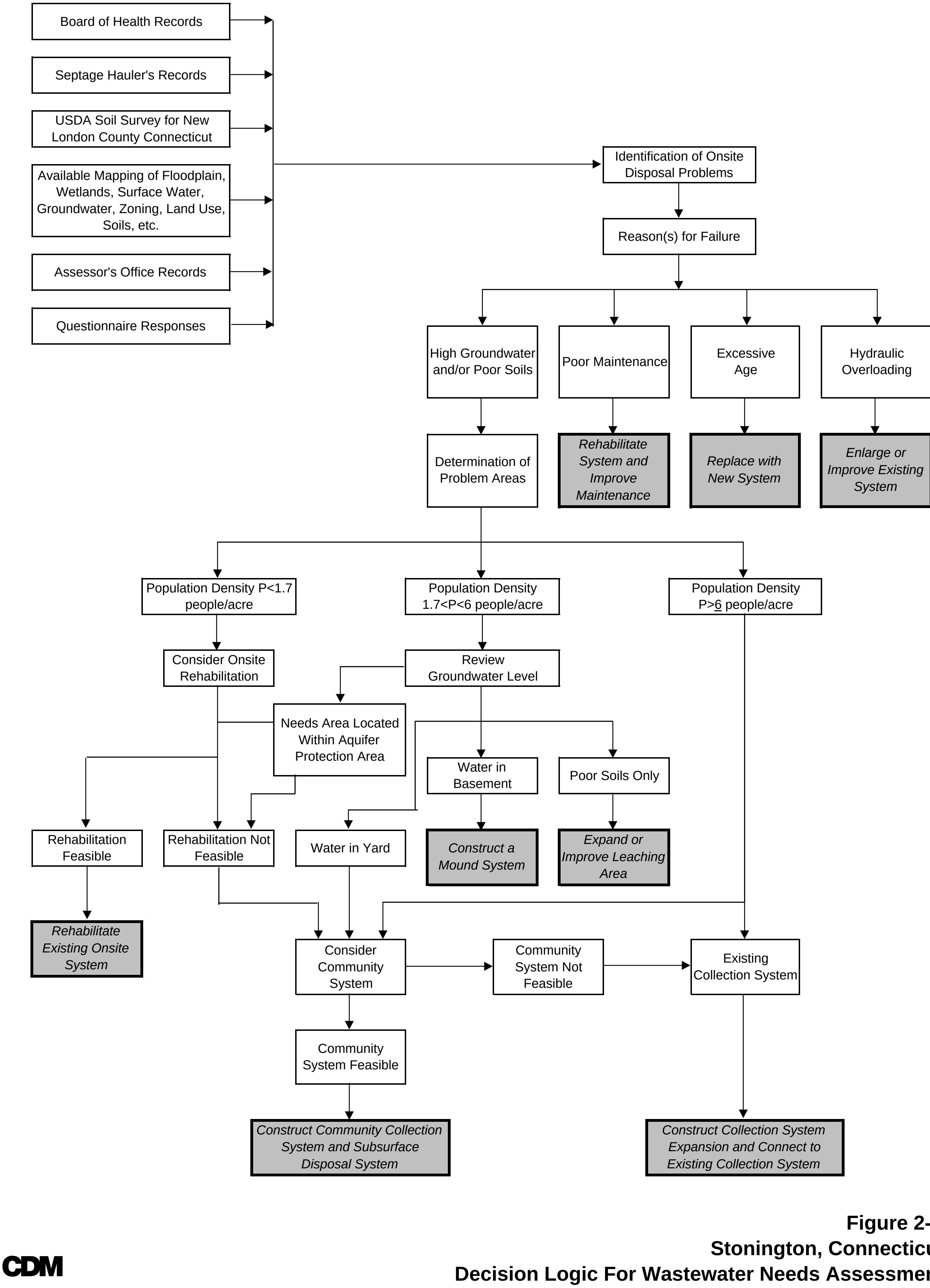

Figure 2-2
Stonington, Connecticut
Decision Logic For Wastewater Needs Assessment

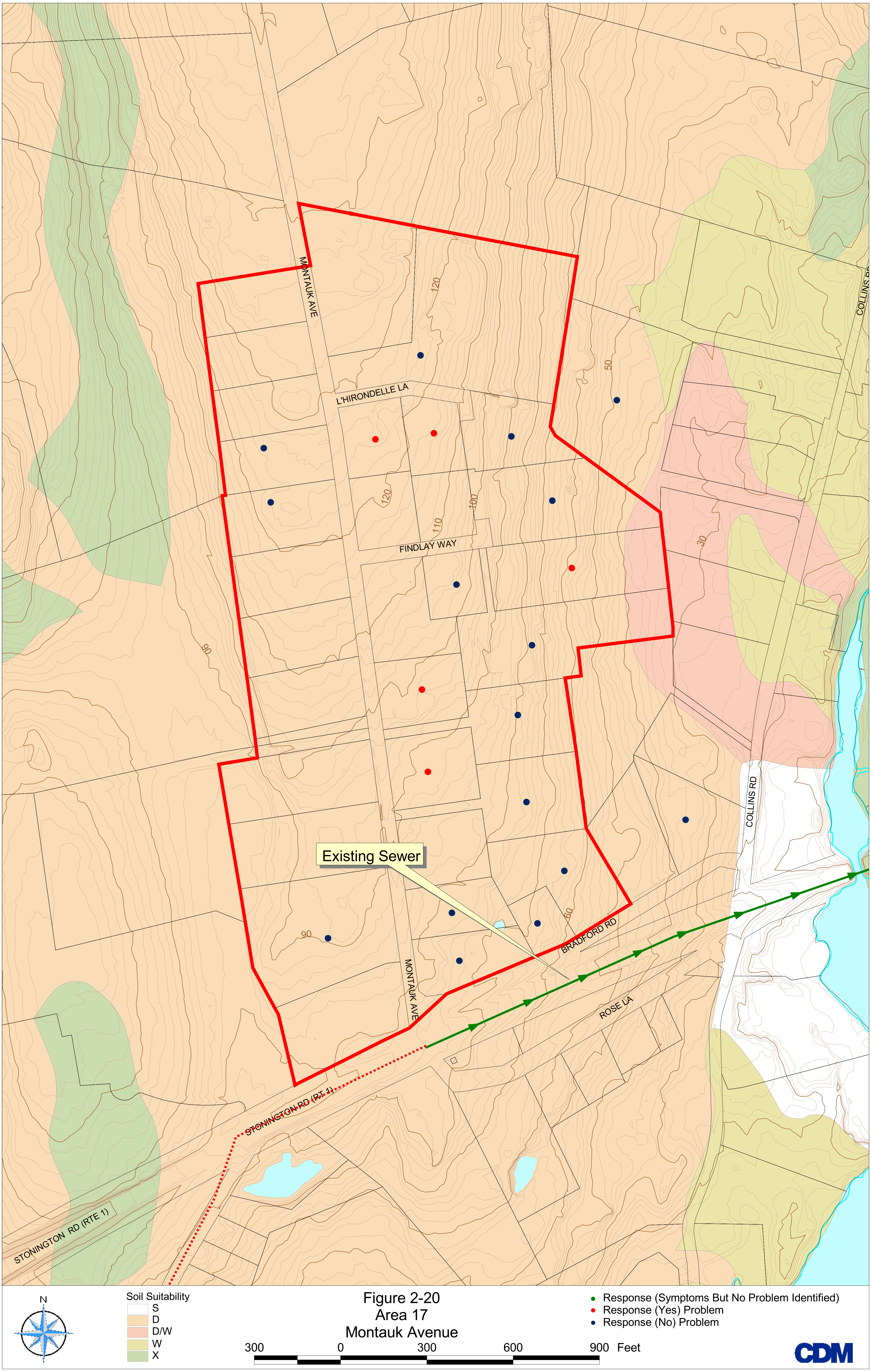

Figure 2-20
Area 17
Montauk Avenue

CDM

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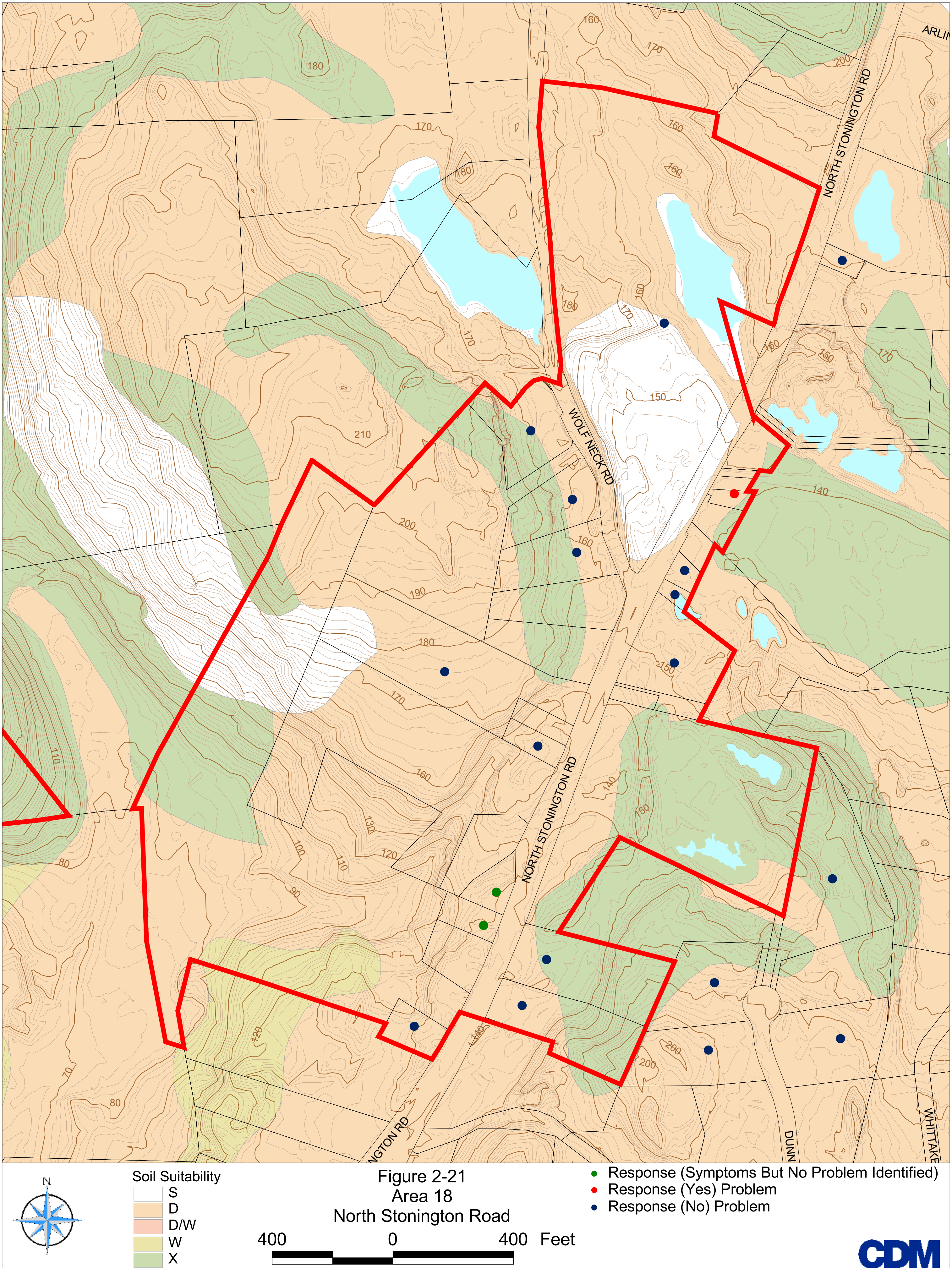

Figure 2-21
Area 18
North Stonington Road

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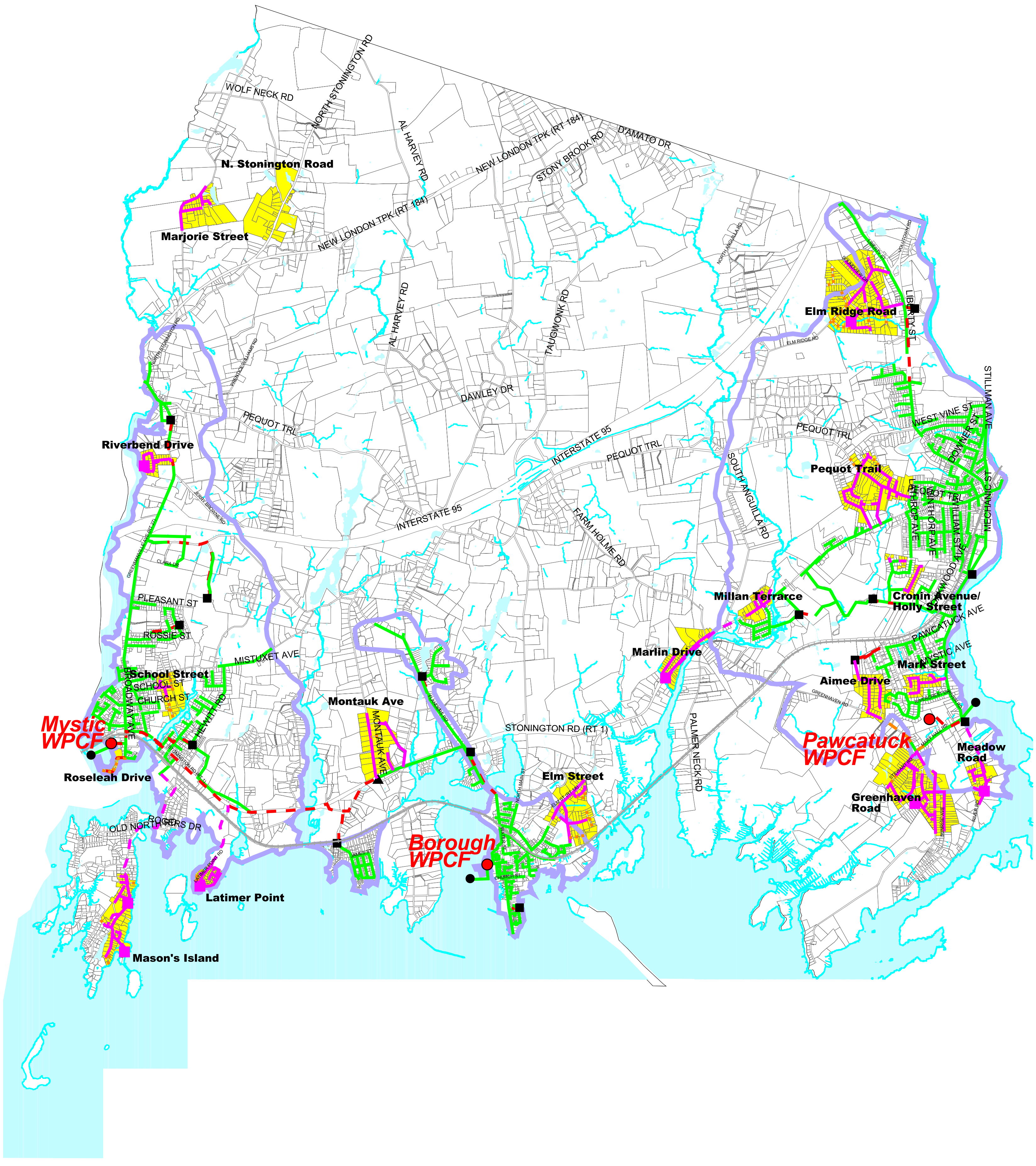

November 2004

Source: Basemap data and existing sewer facilities from Stonington GIS, 2001. Well locations and aquifer zones downloaded from UCONN GIS.

5000 0 5000 Feet

CDM

Drainage Area
Wastewater Needs Area

Proposed Sewer System
- Pump Station
- Force Main
- Gravity Sewer
- Low-Pressure Sewer

Existing Sewer System
- Treatment Plant
- Pump Station
- Outfall
- Odor Control Facility
- Force Main
- Gravity Sewer
- Planned Sewer

NOTE: TRANSMISSION SYSTEMS ARE NOT SHOWN FOR AREAS WHERE COMMUNITY PACKAGE TREATMENT SYSTEMS ARE PROPOSED (TREATMENT SITES ARE NOT YET KNOWN)

Stonington, CT

Figure 2-22

Wastewater Needs Areas
Proposed Collection & Transmission Systems

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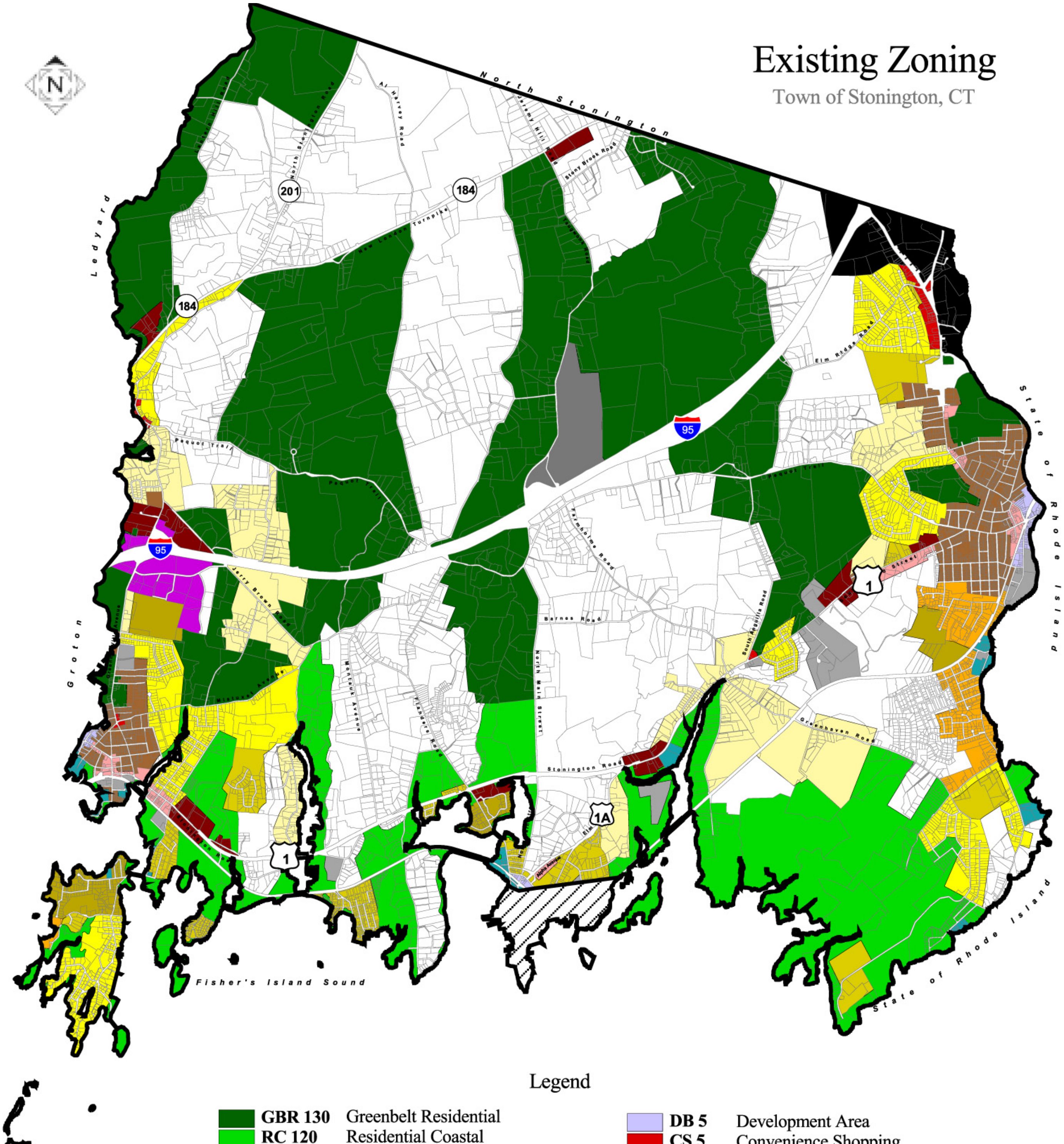

Legend

GBR 130	Greenbelt Residential	DB 5	Development Area
RC 120	Residential Coastal	CS 5	Convenience Shopping
RR 80	Rural Residential	LS 5	Local Shopping
RA 40	Residential Low Density	GC 60	General Commercial
RA 20	Residential Single Family	TC 80	Tourist Commercial
RA 15	Residential Single Family	HI	Highway Interchange
RM 20	Residential Moderate Density	LI 130	Light Industry
RM 15	Residential Moderate Density	M 1	Manufacturing
RH 10	Residential High Density	MC 80	Marine Commercial

Stonington Borough is a Separate Zoning Jurisdiction

0 4000 Feet

Planimetrics

Source: *2004 Plan of Conservation and Development*, Stonington Planning and Zoning Commision

Figure 2-3

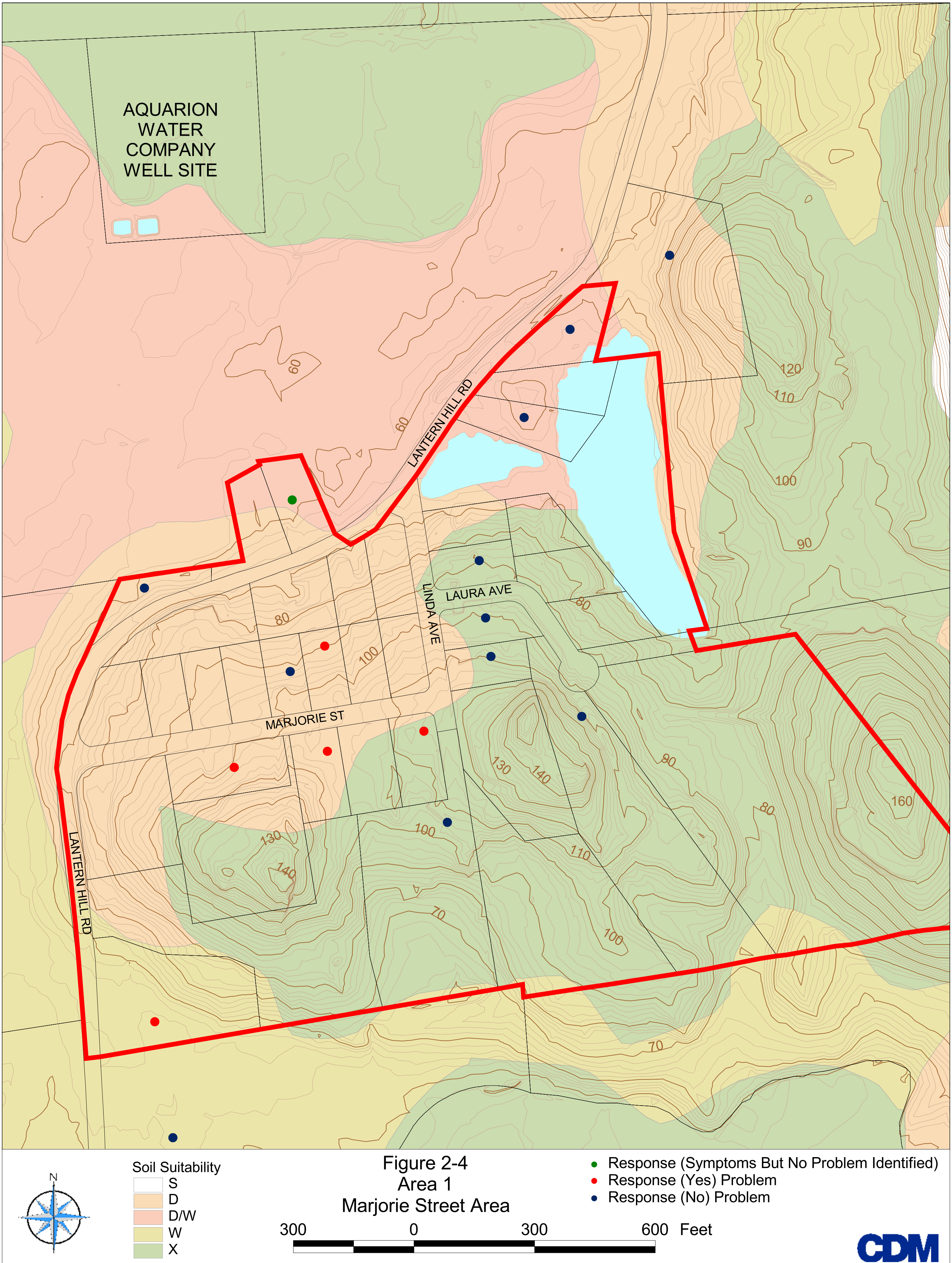

Figure 2-4
Area 1
Marjorie Street Area

CDM

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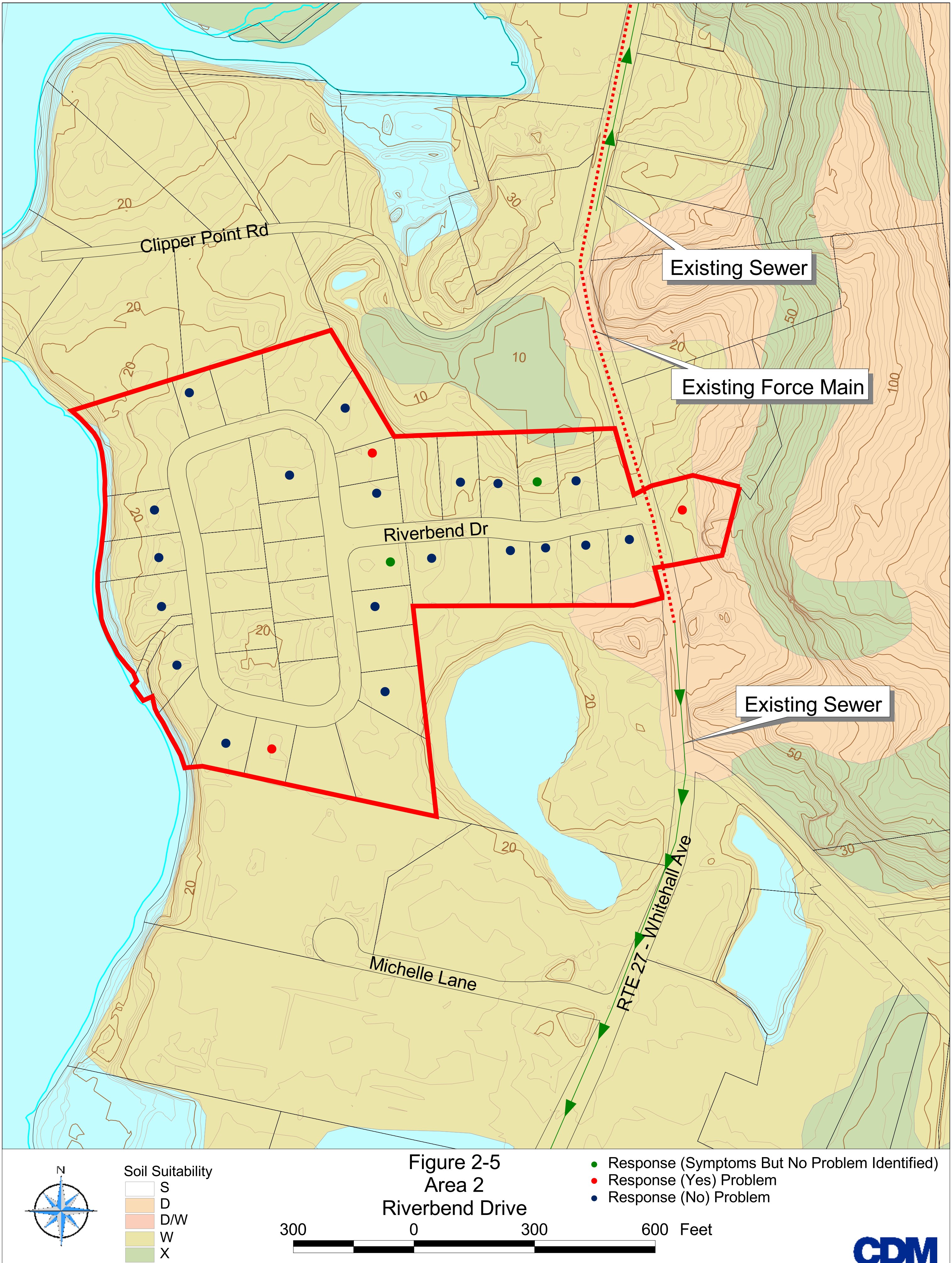
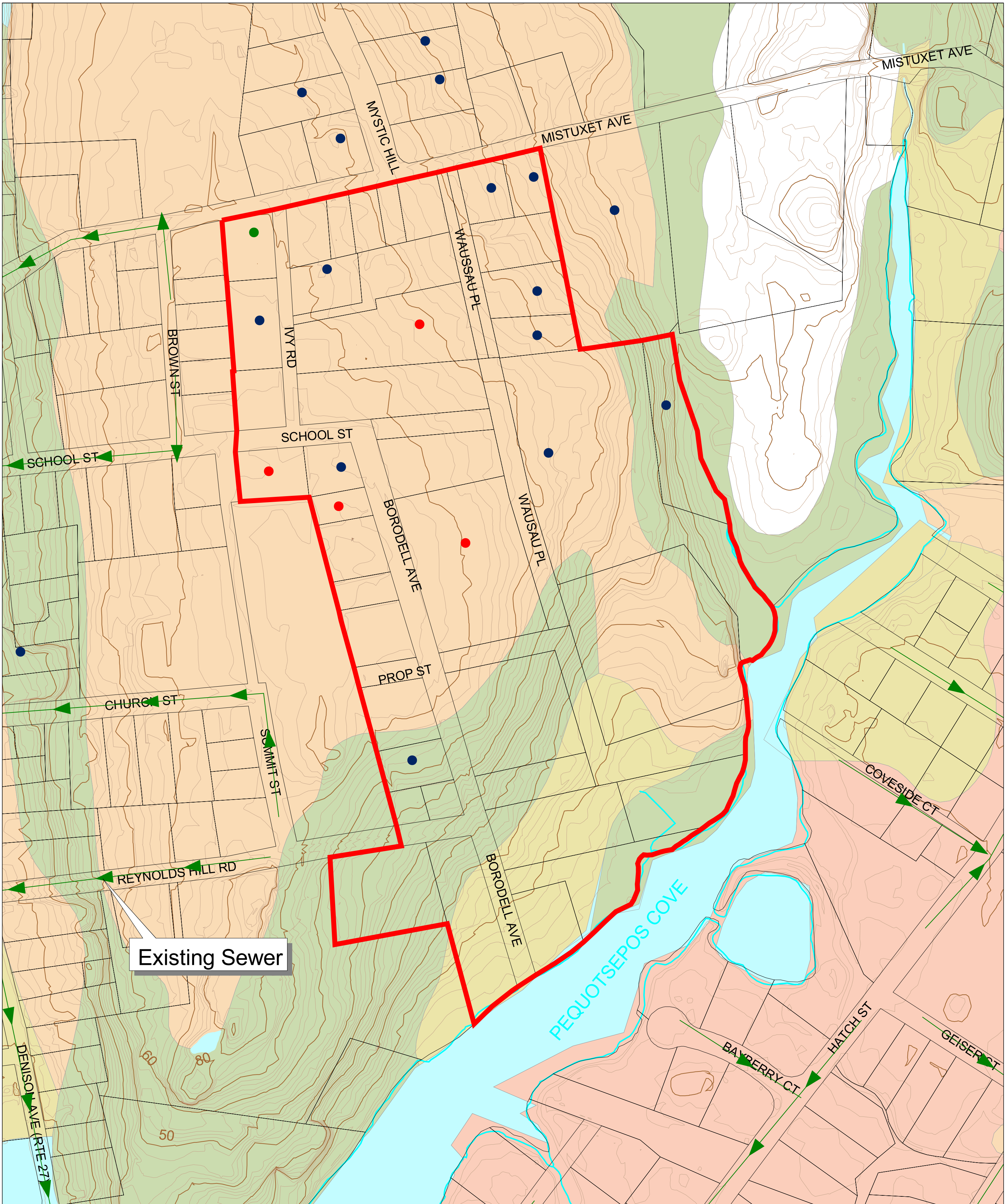


Figure 2-5
Area 2
Riverbend Drive



Soil Suitability
- S
- D
- D/W
- W
- X

Figure 2-6
Area 3
School Street Area

- Response (Symptoms But No Problem Identified)
- Response (Yes) Problem
- Response (No) Problem

300 0 300 600 Feet

CDM

CAMDDGPHS01\ C:\projects\29375-stonington\aprs\sites_c-2004.apr CT 11/8/04 ..\plots\amend4_2004\sites_#.pdf

Figure 2-7
Area 4
Roseleah Drive

CAMDDGPHS01\ C:\projects\29375-stonington\aprs\sites_c-2004.apr CT 11/8/04 ..\plots\amend4_2004\sites_#.pdf

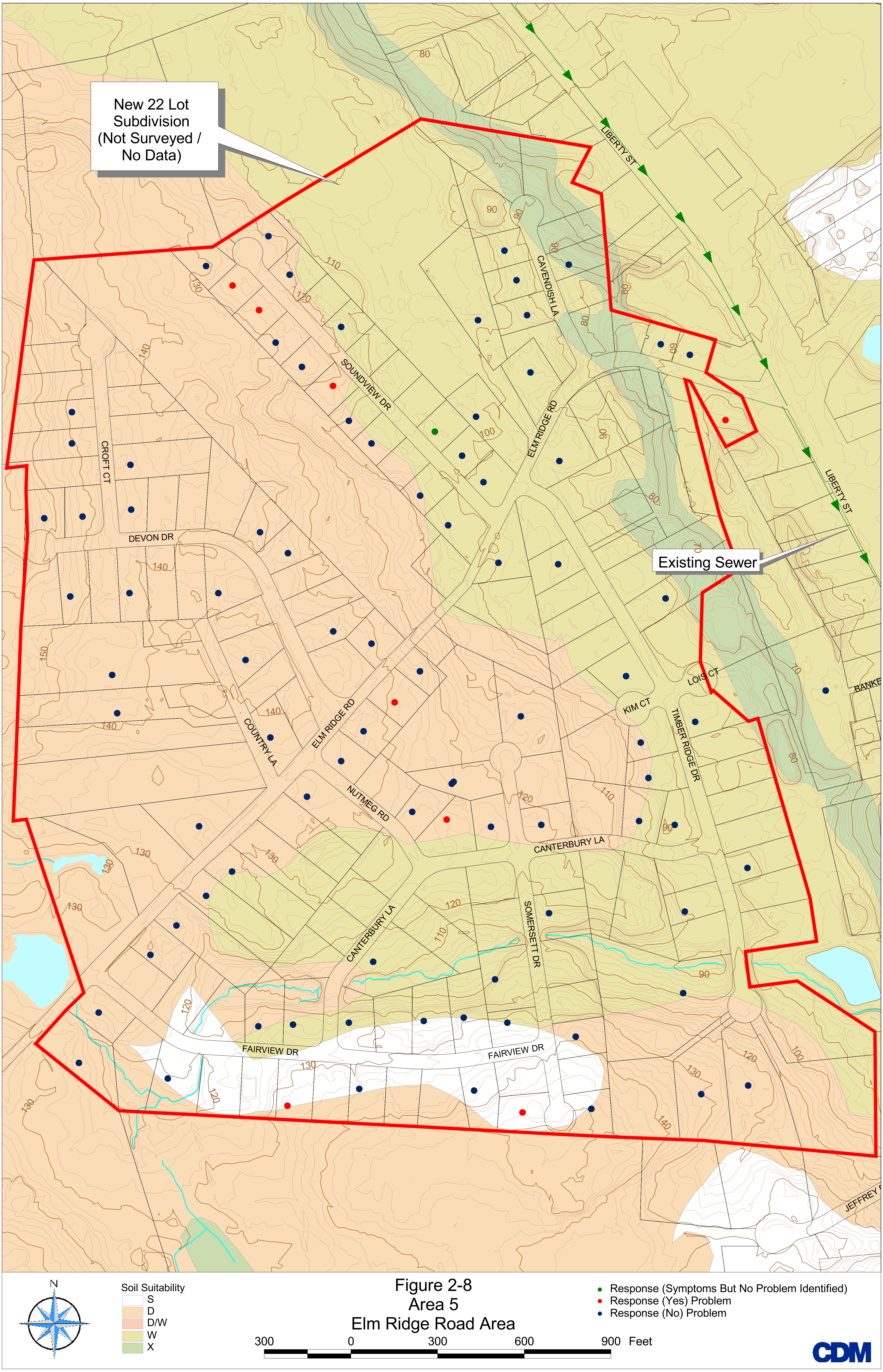
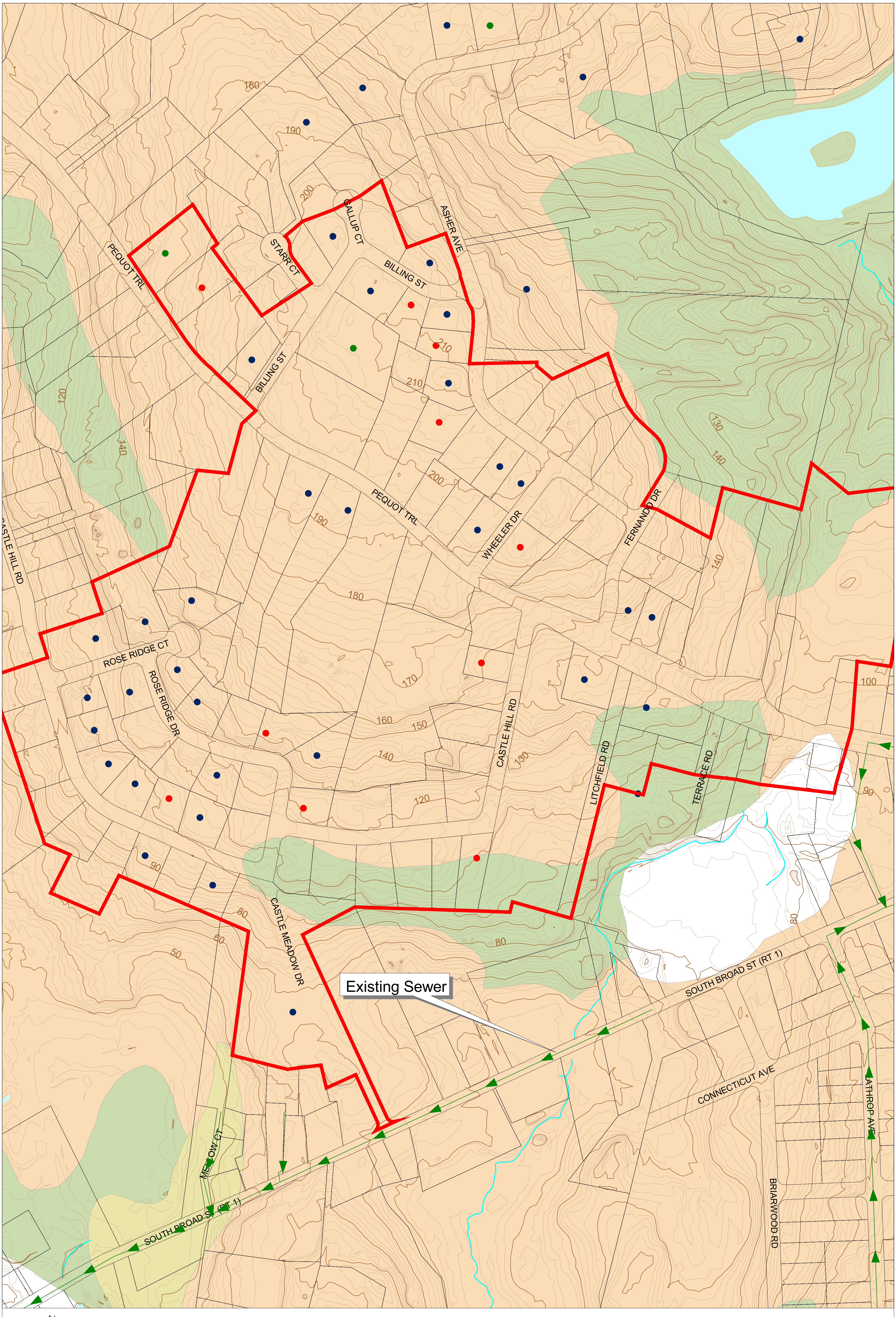


Figure 2-8
Area 5
Elm Ridge Road Area



Soil Suitability
- S
- D
- D/W
- W
- X

Figure 2-9
Area 6
Pequot Trail Area

- Response (Symptoms But No Problem Identified)
- Response (Yes) Problem
- Response (No) Problem

300 0 300 600 900 Feet

CDM

Section 2
Wastewater Disposal Needs

2.1 Introduction

This section summarizes the results of the wastewater disposal needs assessment conducted for the Town of Stonington, Connecticut. This assessment reviews current wastewater disposal methods, their functionality, and where improved or alternate facilities are required in order to provide adequate treatment and disposal of the generated wastewater. This assessment is based on the Connecticut Department of Environmental Protection (CTDEP) guidelines and the United States Environmental Protection Agency (EPA) Publication *Construction Grants 1985 (CG-85)*.

It should be noted that the descriptions in this section depict conditions in 2002. No significant changes have occurred since that time, and none of the recommendations of this section have been implemented. However, there are several new subdivisions within or adjacent to the identified sewer needs areas. These new developments are:

- The Stonington Green (River Crest Drive) subdivision borders Aimee Drive, Mark Drive and River Road. This subdivision is sewered within the Pawcatuck service area.

- The Rock Ridge subdivision is under construction adjacent to the Cronin Avenue and Holly Street. This subdivision will be sewered within the Pawcatuck service area.

- The Croft Court subdivision, off Elm Ridge Road, has now been constructed and is presently unsewered.

As applicable, this new information has been incorporated into the 2002 sewer needs analysis. The discussion below includes these revisions.

2.2 Current Wastewater Disposal Methods

Presently, about one half of the town's population relies on onsite disposal systems to treat and dispose of wastewater. The most common onsite disposal system is a septic system; however, cesspools are also used. Onsite disposal systems are described below.

The remainder of the population discharges to one of three wastewater collection systems within the town. These collection systems are described in Section 4. A general description of collection system components is presented in Section 2.6.

2.2.1 Onsite Disposal Systems

Septic Systems

A typical septic system consists of a septic tank, distribution box and leaching area as shown in **Figure 2-1**. The septic tank is a common component of the conventional septic system, where the pretreatment of wastewater occurs. It is usually constructed of reinforced concrete with compartments for separation of liquids and solids by settling and floatation, and for solids storage and anaerobic stabilization. The settled and skimmed materials build up over time and can only be removed by pumping and cleaning.

Septic tanks are sized based on the number of bedrooms in the building. A 1,000-gallon tank is required for three-bedroom homes or less, and another 250 gallons are added for each additional bedroom. The Connecticut *Public Health Code*, Section 19-13-B103, requires septic tanks to have a minimum capacity of 1,000 gallons.

Distribution boxes are small structures, typically constructed of concrete. These structures are located between the septic tank and the leaching area and evenly distribute the septic tank effluent to the leaching area.

A leaching area usually consists of perforated or open joint pipe bedded within narrow, shallow trenches filled with a porous medium, such as crushed stone. The porous medium maintains the trench integrity, provides partial biological treatment of septic tank effluent, and distributes the effluent to the surrounding soil. The effluent percolates through the soil and is further treated by filtration and decomposition by microorganisms. Unsaturated soils adsorb viruses, bacteria, and some nutrients. Other nutrients, such as nitrate-nitrogen, pass through to the groundwater. According to the regulations, leaching systems must have a minimum of 6 inches of cover, be built 18 inches above the maximum groundwater level, and be at least 4 feet above ledge. Furthermore, the leaching area must be designed in such a manner as to provide a reserve area, in case of failure.

Cesspools

A cesspool is a covered tank with wall perforations. Raw wastewater enters the tank, and the liquid portion leaches into the surrounding soil. Solids settle to the bottom and form a sludge blanket, which partially decomposes with time. Cesspools provide less treatment than septic systems and are more susceptible to clogging and failure. As a result, cesspools are considered an outdated technology.

Cesspools that fail are not considered suitable for upgrade. Failed cesspools are required to be replaced with a conventional septic system complying with Public Health Code, or to be replaced with another wastewater disposal alternative, as outlined in this section.

See Figure 2-1

2.3 Review of Available Information

2.3.1 Introduction

The wastewater needs analysis was based on the review and evaluation of a considerable amount of data from local, state and federal sources. General data included surficial geology, soil suitability for subsurface disposal, zoning, lot sizes, population density, floodplains, wetlands, surface water, groundwater, drinking water supplies and recharge areas, public water service areas, and public sewer service areas. Site specific information indicating where homes and/or businesses were experiencing difficulties with their wastewater disposal system included questionnaire responses, Board of Health records, and septage haulers' pumping records. In order to organize the analysis required to evaluate wastewater needs in the planning area, a systematic methodology was developed. **Figure 2-2** shows the decision logic of this methodology.

The first step in the analysis was the compilation of a database including information about soils, zoning and land use, floodplains and wetlands, surface water, groundwater, public water and sewer service areas, and Board of Health records. This information was supplemented with a questionnaire survey mailed to each unsewered landowner within Town. A copy of the questionnaire used for the survey is included in Appendix C.

The second step in the analysis was the identification of lots experiencing problems with onsite disposal of wastewater. Based on an analysis of the information outlined above, the density of failures per unit area was determined. Areas of significant problem density were then characterized as problem areas, to be analyzed in detail.

The third step was the analysis of problem areas to determine the probable cause for failure according to the following categories: high groundwater, poor soils, poor maintenance, excessive age and/or hydraulic overload.

The fourth and final step in the analysis was determination of an implementable, reliable, cost-effective means of resolving onsite disposal system problems. Generally, problems caused by poor maintenance, excessive age and/or hydraulic overload were considered solvable by means of rehabilitation, replacement, or enlargement of existing onsite systems. These are relatively simple corrective measures, assuming that conditions prevail that will allow upgrading of onsite disposal systems in conformance with state requirements. Problem areas subject to high groundwater and/or poor soils were evaluated based on their population density. This evaluation was based on guidelines developed by the EPA, which indicate the following:

- where population density is less than 1.7 persons per acre, onsite disposal or community systems are normally cost-effective;
- where population density is greater than 6 persons per acre, collection system projects are normally cost-effective; and

See Figure 2-2

- where population density is between 1.7 and 6 persons per acre, more detailed evaluation is required.

Therefore, in problem areas with population densities greater than 6 persons per acre, only collector sewers connected to a community system or to the existing collection system were investigated. Where population densities are less than 1.7 persons per acre, onsite rehabilitation, community systems, and collector sewers were investigated, as necessary. In areas where population densities ranged between 1.7 and 6 persons per acre, the methodology involved a differentiation between high groundwater and poor soils as the probable cause of failure. If the problem was mainly soils-related, expansion or rehabilitation of the existing system was recommended, provided land was available for onsite rehabilitation. If the problem was groundwater-related, an assessment of impact was made to determine whether an onsite system could function properly. For this assessment, groundwater observed in the yard was assumed to preclude the use of an onsite disposal system, while groundwater evidenced in only the basement implied use of a mound system for onsite disposal. Section 2.5 expands upon the high groundwater constraints placed by the state on onsite disposal systems.

2.3.2 Soils

Specific soils properties and site features are critical for the proper functioning of onsite wastewater disposal systems. The suitability of a particular soil was determined using available Geographic Information System (GIS) mapping from the town, state and other sources and soil descriptions provided in the *Soil Survey of New London County Connecticut* (United States Department of Agriculture, Soil Conservation Service, 1983). Information from these documents was used to determine the suitability of soils for onsite wastewater disposal. The soil survey evaluates the soils at depths between 24 and 72 inches for wastewater disposal. The survey evaluates each soil's permeability, ability to filter, depth to seasonal high water table, wetness, ponding, depth to bedrock, susceptibility to flooding, land slope and other factors to determine its suitability for subsurface disposal.

Soils within Stonington fall within five classifications, as follows:

S Suitable for development using typical onsite disposal system design and installation methods.

D Suitable for development, but special onsite wastewater disposal system design and installation methods may be required due to low permeability soils, shallow depth to bedrock, or other factors.

W Suitable for development using typical onsite disposal system design and installation methods, but may pollute groundwater in places due to the inability of high permeability soils to filter system effluent. Care must be taken to adequately separate onsite wastewater disposal systems from drinking water supplies and their recharge zones.

D/W Suitable for development, but special onsite wastewater disposal system design and installation methods may be required due to low permeability soils, shallow depth to bedrock, or other factors. These systems may also pollute groundwater in places due to the inability of high permeability soils to filter system effluent. Care must be taken to adequately separate onsite wastewater disposal systems from drinking water supplies and their recharge zones.

X Not recommended for development where onsite wastewater disposal systems would be utilized. These areas generally include soils with a high groundwater table, bedrock near or at the ground surface, steep slopes, and/or other factors.

Soils found in Stonington and their suitability for subsurface disposal are summarized in **Table 2-1**. Much of Stonington's inland soils are rated "D," indicating that mounded septic systems or other special septic system design may be necessary to provide adequate onsite wastewater disposal. Along the Mystic and Pawcatuck Rivers, a lot of the soils are suited to typical septic system design but effluent from these systems may pollute groundwater in places. If this occurs, effluent from these onsite disposal systems would also tend to place a nitrogen load on the rivers and ultimately Long Island Sound (see Section 1.2). There is also a significant area rated **"X"** where development utilizing onsite wastewater disposal systems is not recommended due to the soils' inability to support subsurface disposal of wastewater.

2.3.3 Zoning, Land Use, Lot Size and Population Density

Townwide zoning and land use information were obtained from the Town's zoning bylaws and from available GIS mapping (See **Figure 2-3**). In general, zoning by-laws have changed over the years with the intent of increasing minimum lot sizes. Larger lots provide easier installation or rehabilitation of onsite disposal systems. This becomes more prudent as the land becomes more developed, and soils in the remaining undeveloped land become less ideal for subsurface disposal.

The Town's zoning by-laws include the following classifications:

- ***Greenbelt Residential (GBR-130):*** Single-family housing, aquaculture/agriculture and livestock with a minimum lot size of 130,000 square feet. Not more than 2.5 percent of the lot can be covered by structures.

- ***Residential Coastal (RC-120):*** Single-family housing, aquaculture/agriculture and livestock with a minimum lot size of 120,000 square feet. Not more than 2.5 percent of the lot can be covered by structures.

- ***Rural Residential (RR-80):*** Single-family or duplex housing, aquaculture/agriculture and livestock with a minimum lot size of 80,000 square feet. Not more than 10 percent of the lot can be covered by structures.

See Figure 2-3

See Table 2-1 (page 1)

See Table 2-1 (page 2)

- ***Residential Low Density (RA-40):*** Single-family or duplex housing, aquaculture/ agriculture and livestock with a minimum lot size of 40,000 square feet. Not more than 15 percent of the lot can be covered by structures.

- ***Residential Moderate Density (RM-20, RM-15):*** There are two moderate density classifications. These classifications allow single-family or duplex housing. Class RM-20 requires a minimum lot size of 20,000 square feet and not more than 15 percent of the lot can be covered by structures. Class RM-15 requires a minimum lot size of 15,000 square feet and not more than 20 percent of the lot can be covered by structures.

- ***Residential Single Family (RA-20, RA-15):*** There are two single family classifications. These classifications allow only single-family housing. Class RA-20 requires a minimum lot size of 20,000 square feet and not more than 15 percent of the lot can be covered by structures. Class RA-15 requires a minimum lot size of 15,000 square feet and not more than 20 percent of the lot can be covered by structures.

- ***I-95/Route 78 Highway Interchange Zone (HI):*** Commercial office, convention center, hotels and motels, light manufacturing and other commercial uses with an overall lot size of 218,000 square feet, requiring that not more than 60 percent of the area be covered with structures. Stonington's *2004 Plan for Conservation and Development* recommends that this zone be modified to promote more diverse development in this area.

- ***Development Area (DB-5):*** Office buildings, residential, and retail/wholesale commercial uses with a minimum lot size of 5,000 square feet and not more than 60 percent of the lot covered with structures.

- ***Convenience Shopping (CS-5):*** Boarding houses, office buildings, residential and retail/wholesale commercial uses with a minimum lot size of 5,000 square feet and not more than 30 percent of the lot covered with structures.

- ***Local Shopping (LS-5):*** Boarding houses, office buildings, residential and retail/wholesale commercial uses with a minimum lot size of 5,000 square feet and not more than 50 percent of the lot covered with structures.

- ***General Commercial (GC-60):*** Boarding houses, office buildings, residential and retail/wholesale commercial uses with a minimum lot size of 60,000 square feet and not more than 25 percent of the lot covered with structures.

- ***Tourist Commercial (TC-80):*** Boarding houses, office buildings, retail/wholesale commercial uses with a minimum lot size of 80,000 square feet and not more than 30 percent of the lot covered with structures.

- ***Marine Commercial (MC-80):*** Boarding houses, office buildings, single-family housing and retail/wholesale commercial uses with a minimum lot size of 80,000 square feet and not more than 25 percent of the lot covered with structures.

- ***Manufacturing (CM-1):*** Assembly, fabricating, warehousing and packing buildings, lumbering, office space and research and development uses with a minimum lot size of 80,000 square feet and not more than 30 percent of the lot covered with structures.

- ***Light Industry (LI-130):*** Assembly, fabricating, warehousing and packing buildings, office space and research and development uses with a minimum lot size of 130,000 square feet and not more than 25 percent of the lot covered with structures.

Lot sizes and years of development within the 18 potential wastewater needs areas were determined from Town Assessor's data. Population densities were reviewed based on information obtained from 2000 United States census data. The various census tracts within the town were sorted by location – roughly coinciding with the sewer service area boundaries. Population density was determined based on population and number of households.

Population trends and densities are presented in detail in Section 3. In general, persons per household for the Town of Stonington are as follows:

Mystic: 2.3 people per household

Stonington Borough: 2.2 people per household

Pawcatuck: 2.5 people per household

Remainder of Town (outside of the above areas): 2.5 people per household

2.3.4 Surface Water and Groundwater

Stonington is located on Long Island Sound and has two harbors, Mystic Harbor and Stonington Harbor. The shoreline is jagged, with several peninsulas and coves. The Town is also bounded by the Mystic River to the west and the Pawcatuck River to the east. Several major brooks also flow through the Town: the Pequotsepos Brook, Copps Brook, Stony Brook and Anguilla Brook.

The Aquarion Water Company of Connecticut's Mystic Reservoir is located on Copps Brook. Silvias Pond is located on Stony Brook and Wequetequock Pond is located on Anguilla Brook.

Groundwater depth is shallow along Stonington's shoreline. In some areas, ledge and low-permeability soils cause groundwater to perch near the ground surface. This is evident in Table 2-1. However, there is little data documenting groundwater elevations within the Town.

2.3.5 Floodplains and Wetlands

Available Geographical Information System (GIS) wetlands and floodplain information was collected and reviewed. Federal Emergency Management Agency (FEMA) flood maps were also reviewed. FEMA mapping indicates that the shoreline area below elevation 10 to 11 — as high as elevation 16 in some areas with wave action — is within the 100-year floodplain. Under this condition, the Mystic River, Pawcatuck River, Pequotsepos Brook, Copps Brook, Stony Brook and Anguilla Brook also become flooded several feet above their normal stage.

2.3.6 Drinking Water

The town receives drinking water from both Aquarion Water Company of Connecticut (Aquarion) and Westerly (Rhode Island) Water Department. Aquarion serves Stonington's Mystic and Borough water districts. Westerly serves the Pawcatuck area. However, a significant portion of the town relies on private wells for its water supply.

Aquarion's system generally serves the Greenmanville Road/Lantern Hill Road corridor, the Pequot Trail/Flanders Road corridor, downtown Mystic and Stonington Borough. Aquarion has a water supply well and surface water reservoir within Stonington. The well is located off Lantern Hill Road in the northwestern corner of the Town, which has a wellhead protection area surrounding the well itself. Mystic Reservoir parallels Dean's Mills Road between Pelligrino Road and Pequot Trail.

The Westerly water system serves the Liberty Street/River Road corridor, downtown Pawcatuck, and South Broad Street (terminating near Greenhaven Road). Available GIS mapping indicates a major aquifer in the northeastern corner of Stonington, which feeds wells for the Westerly water system.

2.3.7 Existing Sewer Service Areas

There are three sewer service areas within the Town of Stonington. These areas — Mystic, Stonington Borough, and Pawcatuck — are described in detail in Section 4.

2.3.8 Wastewater Needs Questionnaire

CDM developed a wastewater needs questionnaire for distribution to all non-sewered landowners within the town. Approximately 3,140 questionnaires were mailed in late August 2000. Approximately 50 percent of the questionnaires were completed and returned.

The questionnaire included 33 questions designed to determine whether or not a subsurface disposal problem exists, the type of problem, potential causes of the problem, the age of the system, the number of people using the system, whether the system has been rehabilitated, etc. Data obtained from responses to this questionnaire were tabulated into a database and used to help determine wastewater needs areas. A townwide summary of questionnaire responses is provided in **Table 2-2**. A copy of the questionnaire is included in Appendix C.

See Table 2-2

2.3.9 Onsite Disposal System Pumping and Repair Records

The Town's Department of Health maintains records of septic system installations and repairs. System repairs identified in the town records were added to the database of system repairs noted on the questionnaire responses. The incidence of septic system repairs was considered a wastewater needs assessment criterion.

The Department of Health has little documentation of septic tank pumping trends. Records are kept of septage received at the Pawcatuck WPCF; however, a majority of the town's septage is disposed of at water pollution control facilities in other towns.

Local septage haulers were contacted to discuss trends and/or problem areas, but did not provide specific addresses of their clientele. They identified coastal areas as having higher pumping recurrence rates. Mason's Island and Latimer Point were noted specifically.

2.3.10 Public Input

Data supporting the 18 identified potential wastewater needs areas were presented to the Citizen's Advisory Group, the Water Pollution Control Authority and the public at large at a public meeting on February 6, 2001, to solicit public input and confirmation. Further public input was collected throughout the development of the facilities plan. See Section 11 for a full description of the public participation effort.

2.4 Wastewater Needs Areas

2.4.1 Introduction

Eighteen potential wastewater needs areas were identified for assessment, based on the considerations described above.

- Area 1 — Marjorie Street Area
- Area 2 — Riverbend Drive
- Area 3 — School Street Area
- Area 4 — Roseleah Drive
- Area 5 — Elm Ridge Road Area
- Area 6 — Pequot Trail Area
- Area 7 — Cronin Avenue/Holly Drive Area
- Area 8 — Millan Terrace Area
- Area 9 — Aimee Drive Area
- Area 10 — Mark Street Area

- Area 11 — Greenhaven Road Area
- Area 12 — Meadow Road Area
- Area 13 — Latimer Point
- Area 14 — Mason's Island
- Area 15 — Marlin Drive Area
- Area 16 — Elm Street Area
- Area 17 — Montauk Avenue Area
- Area 18 — North Stonington Road

These areas are described below and have been prioritized, as follows:

1. ***Critical:*** Areas where evidence indicates a potential but not immediate environmental degradation or public health threat.
2. ***High:*** Areas warranting consideration for improved wastewater disposal at the present time due to frequency of problems, but not considered areas of critical concern. Improvements should be made to these areas in later phases of the implementation plan.
3. ***Moderate:*** Areas warranting consideration for improved wastewater disposal at the present time due to frequency of problems, but not considered areas of high concern. Improvements may be made to these areas in the later phases of the implementation plan, should conditions warrant and if the improvements can be afforded.
4. ***Low:*** Areas warranting consideration for improved wastewater disposal in the future because they are showing some problems now and should be monitored for indications of an increase in frequency of problems over time.

Figures showing the boundaries, questionnaire responses, soil suitability for onsite disposal and the adjacent collection system (if any) are included for each wastewater needs area.

2.4.2 Area 1 — Marjorie Street Area

Area 1 includes Marjorie Street, Linda Avenue, Laura Avenue and Lantern Hill Road (see **Figure 2-4**). Marjorie Street, Linda Avenue and Laura Avenue are located on a hill with steep (up to 45 percent) slopes, which rises about 100 feet from Lantern Hill

See Figure 2-4

Road at its peak. At the base of the hill are low-lying croplands and wetlands. Located within the cropland is a well for Aquarion Water Company, which supplies water to this area of Town. This wastewater needs area is comprised of 40 single-family homes. Most of these homes were built in the 1960s. Lot sizes vary, with an average lot size of ½ to ¾ acre.

Soil Types: Soils in this area are predominantly Canton (8 to 35 percent slopes) and Hollis (15 to 45 percent slopes). Hollis soils have approximately 20 percent rock outcrops. The rock outcrops and steep slopes make these soils difficult to develop.

Suitability for Onsite Disposal Systems: Soil characteristics for much of Marjorie Street and Lantern Hill Road suggest that onsite disposal systems may require special design and installation in order to perform properly. Soil characteristics for Linda Avenue and Laura Avenue suggest that these areas are not suited for subsurface disposal. In addition, soils information indicates that effluent from onsite disposal systems in this area may pollute the groundwater - due to insufficient filtration of system effluent as it passes through the soils - as it flows through soils at the base of the hill. This is of critical concern given the proximity of these homes to the adjacent Aquarion Water Company drinking water well site, located approximately 1,000 feet northwest of Lantern Hill Road.

Zoning: Rural Residential, Aquifer Protection Zone

Wetlands and Floodplains: There are two large wetlands located at the base of the hill; one north of the area and one south of the area. Given its elevation, this area is well above the floodplain.

Surface Water: Whitford Brook is located approximately 1,500 feet west of this area. In addition, there are two small ponds located northeast of the area.

Groundwater: This area is within the aquifer recharge zone for the Aquarion Water Company well. As noted above, the groundwater in this area may be influenced by effluent from onsite disposal systems within this wastewater needs area. Several residents on Lantern Hill Road and Marjorie Street indicated a high groundwater table in the area.

Public Water: Yes

Proximity to Public Sewer: Approximately 1.1 miles

Wastewater Need Priority: Critical

2.4.3 Area 2 — Riverbend Drive

Area 2 includes Riverbend Drive and a few of homes on Whitehall Avenue (Route 27). The Mystic collection system conveys wastewater from homes along Whitehall Avenue, both north and south of Riverbend Drive. As shown in **Figure 2-5**, Riverbend Drive is located at a gap in sewer service. This area is relatively flat,

See Figure 2-5

located about 20 feet above the Mystic River. This wastewater needs area is comprised of 42 single-family homes. These homes were built in the late 1960s with an average lot size of ½ acre.

Soil Types: Soils in this area are predominantly Haven with 0 to 3 percent slopes.

Suitability for Onsite Disposal Systems: According to available soil information, soil characteristics for this area suggest that typical onsite disposal systems will perform properly. However, effluent from these onsite disposal systems may pollute the groundwater as it flows through soils to the river, since Haven soils have a poor ability to filter/treat effluent from subsurface disposal systems. If this is the case, onsite systems in this area would contribute to the nitrogen load in the Mystic River and ultimately the Fishers Island Sound.

Zoning: Residential Low Density

Wetlands and Floodplains: There are wetlands to the north and south of the area.

Surface Water: Mystic River flows along the western edge of this area. There are also several wetlands with ponded water in the vicinity of this area.

Groundwater: Several residents indicated a high groundwater table in the area.

Public Water: No

Proximity to Public Sewer: Collector sewers are located within several feet of the Whitehall Avenue/Riverbend Drive intersection. A force main conveys wastewater generated north of this intersection to the collection system located to the south of this intersection.

Wastewater Need Priority: Moderate

2.4.4 Area 3 — School Street Area

The School Street Area includes Mistuxet Avenue, School Street, Ivy Road, Borodell Avenue and Wausau Place. As shown in **Figure 2-6**, this area is located on the edge of the Mystic collection system. However, it is on the opposite side of the ridge line, sloping away from the existing collection system and toward Williams Cove and Pequotsepos Brook. This wastewater needs area is comprised of 34 single-family homes. These homes were built between 1900 and 1950, with an average lot size of ½ to ¾ acre.

Soil Types: Soils in this area are predominantly Paxton (3 to 8 percent slopes), Charlton (3 to 45 percent slopes) and Haven (3 to 15 percent slopes). Paxton soils typically have large stones or boulders covering 8 to 25 percent of the surface. Charlton soils are also rocky (covering up to 8 percent of the surface) with a shallow depth to bedrock. Development is difficult where Charlton soils have slopes greater than 15 percent.

See Figure 2-6

Suitability for Onsite Disposal Systems: Soil characteristics for this hillside suggest that onsite disposal systems may require special design and installation in order to perform properly. A small area near the base of the hill may not be suited for onsite disposal systems due to soil type and slope.

Zoning: Moderate and high density residential

Wetlands and Floodplains: There are wetlands along the edge of Williams Cove and Pequotsepos Brook. Areas below elevation 10 are also within the 100-year floodplain.

Surface Water: Williams Cove and Pequotsepos Brook are located approximately 850 feet east along Mistuxet Avenue and flow along the southeast edge of this area.

Groundwater: Several residents indicated a high groundwater table in the area. Groundwater is likely to be high near the Pequotsepos Cove. Groundwater problems in the remainder of the area may also be related to the low permeability of the Paxton soils.

Public Water: Yes

Proximity to Public Sewer: The existing collection system ends at the ridgeline on Reynolds Hill Road and School Street.

Wastewater Need Priority: Moderate

2.4.5 Area 4 — Roseleah Drive

Area 4 (Roseleah Drive) is a small peninsula called Murphy Point in Mystic Harbor (see **Figure 2-7**). The Mystic collection system is located at the beginning of Roseleah Drive. However, this area is slightly lower than the existing collection system and cannot be serviced by gravity. This wastewater needs area is comprised of 15 small single-family homes. The homes were built in the 1960s with an average lot size of ¼ acre. The large parcel at the end of Roseleah Drive is a marina that is sewered by a pump system and a 2-inch dedicated force main that connects to the existing collection system. Therefore, it is not included in the sewer needs area.

Soil Types: Soils in this area are predominantly Udorthents and Westbrook with slopes less than 3 percent. Udorthents are disturbed soils and therefore cannot be categorized without further study. Westbrook soils are a mucky peat and not suited for development.

Suitability for Onsite Disposal Systems: Available soils information indicates that approximately one half of the soils are considered suitable for development using typical onsite disposal systems, and that the remainder is coastal wetland and unsuitable for development. However, given the relative elevation of this area, its proximity to Long Island Sound and the small lot sizes, the actual effectiveness of subsurface disposal systems may be limited. In addition, these systems are likely contributing to the nitrogen load to Long Island Sound.

See Figure 2-7

Zoning: General commercial and residential coastal.

Wetlands and Floodplains: A significant portion of this peninsula is coastal wetland. The entire peninsula is within the 100-year floodplain. Roseleah Drive is at roughly elevation 5; the 100-year coastal flood (with wave action) is estimated to be elevation 13.

Surface Water: The Roseleah Drive area is surrounded by Mystic Harbor.

Groundwater: Given its low elevation and the extensive wetlands in this area, groundwater is very near to the ground surface.

Public Water: Yes

Proximity to Public Sewer: Intersection of Roseleah Drive and Broadway.

Wastewater Need Priority: High

2.4.6 Area 5 — Elm Ridge Road Area

Area 5 is located in the northeast corner of Stonington, on the edge of the Pawcatuck collection system. As shown in **Figure 2-8**, this area is comprised of Elm Ridge Road, Canterbury Lane, Somerset Drive, Nutmeg Road, Fairview Drive, Timber Ridge Drive, Kim Court, Cavendish Lane, Soundview Drive, Devon Drive, Croft Court and Country Lane. Although Timber Ridge Drive and Cavendish Lane are not indicating onsite disposal problems at the moment, these streets were included because of their elevation — allowing problem areas to connect to the existing collection system by gravity, and because the poor soils in the area suggest an inability to support onsite disposal systems. Devon Drive also is not indicating onsite disposal problems, but it has been included in this sewer needs area due to its close proximity to streets where we are recommending sewers. This wastewater needs area is comprised of 205 single-family homes, including the 22-home Croft Court subdivision constructed during preparation of this Plan between Soundview Drive and Devon Drive. Most of the homes in this area were built in the 1970s and 1980's with an average lot size of ½ to ¾ acre. Timber Ridge Drive and Kim Court were built more recently (1990s), with 1-acre lots.

Soil Types: Soils in this area are predominantly Canton (3 to 8 percent slopes), Hinkley (3 to 45 percent slopes), and Haven (3 to 8 percent slopes). Hinckley soils with slopes greater than 15 percent are difficult to develop.

Suitability for Onsite Disposal Systems: Soil characteristics for a majority of this hillside area suggest that typical onsite disposal systems should perform adequately, but may pollute groundwater. However, onsite disposal systems in the western portion of this area may require special design and installation in order to perform properly.

See Figure 2-8

Zoning: Moderate Density Residential, Aquifer Protection Zone, CTDEP Aquifer Protection Area Level B (partial)

Wetlands and Floodplains: There are no wetlands or floodplain in this area.

Surface Water: A brook flows through this area toward the Pawcatuck River.

Groundwater: A few residents indicated a high groundwater table in the area. However, these seem isolated. In general, the groundwater table should low enough to support onsite disposal systems.

Public Water: Yes

Proximity to Public Sewer: Intersection of Elm Ridge Road and Liberty Street.

Wastewater Need Priority: Critical

2.4.7 Area 6 — Pequot Trail Area

Area 6 includes Pequot Trail (Route 234), Asher Avenue, Billings Street, Gallup Court, Wheeler Drive, Castle Hill Road, Roseridge Drive, Roseridge Court and Castle Meadow Drive. As shown in **Figure 2-9**, this area is located on the edge of the Pawcatuck collection system. This wastewater needs area is predominantly comprised of single-family homes.

These homes were built in 1970s and 1980s with an average lot size of ½ to 1 acre. There are estimated to be 113 homes, a church and a condominium complex within this area.

Soil Types: Soils in this area are predominantly Charlton (3 to 45 percent slopes) and Paxton (3 to 8 percent slopes). Paxton soils typically have large stones or boulders covering 8 to 25 percent of the surface. Charlton soils are also rocky (covering up to 8 percent of the surface) with a shallow depth to bedrock. Development is difficult where soils exceed 15 percent slope. There are many lots within this area with significant ledge visible.

Suitability for Onsite Disposal Systems: Soil characteristics for this hillside area suggest that onsite disposal systems may require special design and installation in order to perform properly.

Zoning: Moderate Density Residential, Aquifer Protection Zone (partial), CTDEP Aquifer Protection Area Level B (partial)

Wetlands and Floodplains: There are no wetlands or floodplain in this area.

Surface Water: There is no surface water in this area.

See Figure 2-9

Groundwater: Many residents indicated a high groundwater table in the area. Groundwater in this area is likely to be perched due to the shallow depth to bedrock or due to low permeability soils.

Public Water: Yes

Proximity to Public Sewer: South Broad Street (Route 1) located approximately 1000 feet south of this area.

Wastewater Need Priority: High

2.4.8 Area 7 — Cronin Avenue/Holly Street

Area 7 (shown in **Figure 2-10**) includes Cronin Avenue, Holly Street and Parkwood Drive. These streets are located within the Pawcatuck collection system; however, the area was apparently developed at a later date than the surrounding areas, and was not connected to the system. This wastewater needs area is comprised of more than 30 single-family homes. These homes were built in 1980s with an average lot size of ½ acre. In addition, development of a subdivision off Cronin Avenue is underway. This subdivision will be sewered.

Soil Types: Soils in this area are predominantly Charlton with 3 to 45 percent slopes. There is a large ledge outcrop at the base of the developed portion of Cronin Avenue. Development is difficult where these soils exceed 15 percent slope.

Suitability for Onsite Disposal Systems: Soil characteristics for this hillside area suggest that approximately one half of the onsite disposal systems may require special design and installation in order to perform properly. The remaining area is located on soils that may be unsuited for onsite subsurface disposal.

Zoning: Moderate Density Residential

Wetlands and Floodplains: There is a large wetland at the base of the hill approximately 750 feet from Cronin Avenue.

Surface Water: There is a small brook and pond located west of Parkwood Drive, and another small brook east of Cronin Avenue.

Groundwater: Several residents indicated a high groundwater table in the area. This is likely due to the shallow depth to bedrock.

Public Water: Yes

Proximity to Public Sewer: Lathrop Avenue, Enterprise Avenue and Parkwood Drive.

Wastewater Need Priority: High

See Figure 2-10

2.4.9 Area 8 — Millan Terrace Area

Millan Terrace, Stanley Street and Frank Street comprise Area 8, as shown in **Figure 2-11**. This area is located on the edge of the Pawcatuck collection system. Ledge outcrops are visible on many of the lots in this area. This wastewater needs area is comprised of 38 single-family homes. These homes were built in 1950s with an average lot size of ¼ to ¾ acre.

Soil Types: Soils in this area are predominantly Canton with 3 to 8 percent slopes.

Suitability for Onsite Disposal Systems: Soil characteristics for this area suggest that onsite disposal systems may require special design and installation in order to perform properly. In addition, onsite systems located near Anguilla Brook may also tend to impact groundwater quality.

Zoning: Moderate Density Residential

Wetlands and Floodplains: There is a large wetland located northeast of this area, but no wetlands within the needs area. The area is above the 100-year flood elevation of 24 feet for the nearby Anguilla Brook.

Surface Water: Anguilla Brook is located approximately 300 feet east of this area. This is likely to be perched groundwater resulting from the shallow depth to bedrock.

Groundwater: Several residents indicated a high groundwater table in the area. These areas are likely near Anguilla Brook.

Public Water: Public water is available only in certain parts of this area.

Proximity to Public Sewer: Swan Street near intersection with South Broad Street (Route 1).

Wastewater Need Priority: Moderate

2.4.10 Area 9 — Aimee Drive Area

The Aimee Drive Area (Area 9) is located off Greenhaven Road (**Figure 2-12**). This wastewater needs area is comprised of 55 single-family homes. These homes were built in 1980s with an average lot size of ½ acre.

Soil Types: Soils in this area are predominantly Paxton with 3 to 8 percent slopes. Ledge is apparent near Greenhaven Road. Boulders are apparent throughout the development.

Suitability for Onsite Disposal Systems: Soil characteristics for this area suggest that onsite disposal systems may require special design and installation in order to perform properly.

Zoning: Rural Residential

See Figure 2-11

See Figure 2-12

Wetlands and Floodplains: There are no wetlands in this area. This area is also above the 100-year flood elevation.

Surface Water: There are no surface water bodies in this area.

Groundwater: Groundwater may be perched in some areas as a result of the shallow depth to bedrock or low permeability soils.

Public Water: No

Proximity to Public Sewer: Approximately 800 feet to Pawcatuck Avenue, or approximately 1,500 feet to the recently constructed sewer in Greenhaven Road. Public sewer is available at the intersection of Renie Drive and River Crest Drive.

Wastewater Need Priority: Moderate

2.4.11 Area 10 – Mark Street Area

The Mark Street Area (Area 10) includes Mark Street, Elaine Street, and Ball Street **(Figure 2-13)**. It is surrounded by the Pawcatuck collection system. It is believed that this area was not sewered because its development occurred at approximately the same time as the construction of the Pawcatuck system.

This wastewater needs area is comprised of 41 single-family homes. These homes were built in 1970s with an average lot size of ½ acre.

Soil Types: Soils in this area are predominantly Canton (3 to 15 percent slopes), Merrimac (3 to 8 percent slopes) and Walpole (0 to 3 percent slopes). Walpole soils characteristically have a high groundwater table and poor draining soils. Ponding and wetness result, especially in the fall and spring.

Suitability for Onsite Disposal Systems: Soil characteristics for the Mark Street area are mixed. Some soils suggest that onsite disposal systems may require special design and installation in order to perform properly. Other areas suggest that typical onsite systems would function properly but may also pollute the groundwater as it flows through soils. The northwest corner of the area also indicates that soils may be unsuited for development.

Zoning: Moderate Density Residential

Wetlands and Floodplains: There are no known wetlands in this area. The intersection of Mark Street with River Road is within the 100-year floodplain (elevation 11 feet).

Surface Water: The Pawcatuck River is located approximately 300 feet west of this area. There is also a small brook that flows along the northern edge of this area.

Groundwater: Ponding and wetness are a problem in this area due to poor soils.

See Figure 2-13

Public Water: Yes

Proximity to Public Sewer: River Road

Wastewater Need Priority: High

2.4.12 Area 11 — Greenhaven Road Area

The Greenhaven Area (Area 11) is located on the edge of the Pawcatuck collection system. This area includes Greenhaven Road, Stewart Road, Vars Avenue, Clarence Avenue, Schiller Avenue, Green Avenue, Sunrise Avenue, and Sunset Avenue. However, as shown in **Figure 2-14**, the area is on the opposite side of the ridge, sloping away from the existing collection system. A small wastewater facilities plan was prepared for this area in the late 1990s. It was recommended that this area, as well as the remainder of the River Road/Greenhaven Road peninsula, be added to the Pawcatuck service area. This wastewater needs area is comprised of 143 single-family homes. These homes were built in 1960s with an average lot size of ½ to ¾ acre.

Soil Types: Soils in this area are predominantly Canton (3 to 15 percent slopes), Adrian (0 to 2 percent slopes), Charlton (3 to 15 percent slopes), Sutton (2 to 8 percent slopes), and Agawam (0 to 3 percent slopes). Sutton soils are very stony with a groundwater depth of approximately 18 inches. Charlton soils are also rocky with a shallow depth to bedrock. Adrian soils are mucky with a high groundwater table making them unsuitable for development.

Suitability for Onsite Disposal Systems: According to the available soil information, soil characteristics suggest that a majority of onsite disposal systems may require special design and installation in order to perform properly. However, a small portion of this area is developed on soils that are suggested to be unsuitable for subsurface disposal.

Zoning: This area is zoned for moderate density residential and coastal residential.

Wetlands and Floodplains: There is a large wetland centered within this area. This wetland and adjacent low-lying lots are within the FEMA 100-year floodplain.

Surface Water: A small brook flows west of this area.

Groundwater: Soils information for this area suggests that groundwater is perched due to poor soils.

Public Water: No

Proximity to Public Sewer: It is approximately 100 feet to the intersection of Greenhaven Road and Mary Hall Road. A collection sewer was recently installed in Mary Hall Road and part of Greenhaven Road.

Wastewater Need Priority: High

See Figure 2-14

2.4.13 Area 12 — Meadow Road Area

The Meadow Road Area (Area 12) is located off River Road (see **Figure 2-15**). This area is comprised of Meadow Road, Green Meadow Road, Crestwood Lane and a small section of River Road. This wastewater needs area is comprised of 34 single-family homes. These homes were built in 1960s with an average lot size of ½ to 1½ acres.

Soil Types: Soils in this area are predominantly Windsor (3 to 8 percent slopes), Charlton (3 to 15 percent slopes) and Hollis (3 to 15 percent slopes). There are numerous ledge outcrops and boulders visible in this area.

Suitability for Onsite Disposal Systems: Available soil information for this hillside area suggest that much of the area can be served by onsite disposal systems; however, these systems may pollute groundwater — and ultimately the Pawcatuck River. A small portion of Meadow Road and River Road may require special design and installation in order to perform properly. Soils information for Crestwood Lane suggests that the soils are unsuited for development where subsurface disposal is proposed.

Zoning: This area is zoned for moderate density residential, coastal residential and marine commercial.

Wetlands and Floodplains: FEMA flood mapping indicate that land this area is elevated above the 100-year floodplain (elevation 11). There are no wetlands in this area.

Surface Water: The Pawcatuck River is located approximately 300 feet east of this area. A small brook flows to the river north of this area.

Groundwater: Many residents indicated a high groundwater table in the area. Groundwater in this area is likely perched due to poor soils.

Public Water: Yes

Proximity to Public Sewer: The Pawcatuck collection system is located approximately 2,000 feet north of this area.

Wastewater Need Priority: Moderate to High

2.4.14 Area 13 — Latimer Point

The Latimer Point Area (see **Figure 2-16**) includes Latimer Point Road, North Shore Way, Reid Road, Center Road, Crooked Road and East Shore Road. This area was originally seasonal housing, but over time many of these houses have been converted to year-round residences. This wastewater needs area is comprised of 80 single-family homes. These homes have an average lot size of ¼ acre.

See Figure 2-15

See Figure 2-16

Soil Types: Soils in this area are predominantly Narragansett (3 to 15 percent slopes), Sutton (2 to 15 percent slopes) and Charlton (3 to 15 percent slopes) soils. Numerous rock outcrops and large boulders are visible, especially within the Charlton soils.

Suitability for Onsite Disposal Systems: Available soils information suggests that typical onsite disposal should perform adequately, with the exception of a small ridge of Charlton and Sutton soils (see Figure 2-16).

Zoning: This area is zoned for moderate density residential and coastal residential.

Wetlands and Floodplains: The 100-year floodplain for this area is below elevation 11 — elevation 14 with wave action. There are no wetlands on Latimer Point.

Surface Water: Latimer Point is surrounded by Fishers Island Sound on three sides.

Groundwater: High groundwater does not appear to be a problem in this area.

Public Water: Spring, summer and fall. Residents rely on private wells during the winter months.

Proximity to Public Sewer: 0.7 miles

Wastewater Need Priority: High

2.4.15 Area 14 — Mason's Island

The Mason's Island area is isolated from the existing collection systems (see **Figure 2-17**). The Mason's Island Area includes Nauyaug Point Road, Yacht Club Road, East Forest Road, Point Road, Hickory Ledge Road, Blind Duck Road, and Osprey Lane. This wastewater needs area is comprised of 64 single-family homes. These homes were generally built in 1970s with an average lot size of ½ to ¾ acre.

Soil Types: Soils in this area are predominantly Narragansett (3 to 15 percent slopes), Hollis (15 to 45 percent slopes), Sutton (2 to 15 percent slopes) and Charlton (3 to 15 percent slopes). Large outcrops are visible in areas classified as Hollis soils. These areas also have steep slopes and are not suited for onsite disposal systems.

Suitability for Onsite Disposal Systems: According to the available soil information, soil characteristics for most of the homes experiencing problems suggest that these areas are not suited to onsite disposal or that systems may require special design and installation in order to perform properly.

Zoning: This area is zoned for moderate density residential and coastal residential.

Wetlands and Floodplains: Marsh/wetlands exist along the low-lying shore areas.

Surface Water: Mason's Island is surrounded by Fishers Island sound, with Mystic Harbor located on its western shore.

See Figure 2-17

Groundwater: Many residents indicated a high groundwater table in the area. Groundwater is likely perched due to the shallow depth to bedrock.

Public Water: Yes

Proximity to Public Sewer: 1.5 miles

Wastewater Need Priority: Moderate

2.4.16 Area 15 — Marlin Drive Area

As shown in **Figure 2-18**, this area includes Marlin Drive and a portion of Stonington Road along Wequetequock Cove. This area is isolated between the Stonington Borough and Pawcatuck collection systems. This wastewater needs area is comprised of 72 single-family homes. These homes were built in 1970s with an average lot size of ¼ to ¾ acre.

Soil Types: Soils in this area are predominantly Agawam (3 to 8 percent slopes) and Charlton (3 to 15 percent slopes).

Suitability for Onsite Disposal Systems: Agawam soils can support typical onsite disposal systems but may pollute groundwater. As a result, effluent from onsite disposal systems in this area may contribute a nitrogen load to the cove and ultimately Long Island Sound.

Zoning: This area is zoned for low density residential and coastal residential.

Wetlands and Floodplains: FEMA estimates the 100-year floodplain to be below elevation 11 in this area.

Surface Water: Wequetequock Cove flows along the southern edge of this area. There is also a small brook flowing to the north of Marlin Drive.

Groundwater: Many residents indicated a high groundwater table in the area. This is expected given its proximity to the cove and brook. Groundwater may also be perched as a result of the shallow depth to bedrock.

Public Water: No

Proximity to Public Sewer: 0.25 miles

Wastewater Need Priority: High

2.4.17 Area 16 — Elm Street

The Elm Street Area is located east of Town Hall on the edge of the Stonington Borough collection system. However, the area is on the opposite side of the ridge, sloping toward Wequetequock Cove. As shown in **Figure 2-19**, this area includes Elm Street, Watch Hill Avenue, Grandview Park, Meadow Avenue, Island Road,

See Figure 2-18

See Figure 2-19

Woodland Avenue and Cheseboro Lane. This wastewater needs area is comprised of 74 predominantly single-family homes. These homes were generally built between 1900 and 1950 with an average lot size of ½ to ¾ acre.

Soil Types: Soils in this area are predominantly Charlton (3 to 15 percent slopes), Hollis (3 to 15 percent slopes), Ninigret (0 to 1 percent slopes), Agawam (0 to 3 percent slopes), Carlisle (0 to 2 percent slopes), and Adrian (0 to 2 percent slopes). Adrian and Carlisle soils are suggested to be unsuited for onsite disposal. Charlton and Hollis soils have bedrock at shallow depths. Ninigret soils have shallow depths to groundwater.

Suitability for Onsite Disposal Systems: According to available soil information, soil characteristics for the hillside area suggest that onsite disposal systems may require special design and installation in order to perform properly. A substantial amount of ledge is visible in the Watch Hill Avenue area, suggesting that more of this area is unsuited for onsite disposal than is reflected by the soils data. Effluent from onsite disposal systems may also pollute the groundwater as it flows through soils at the base of the hill to Wequetequock Cove.

Zoning: This area is zoned for moderate density residential and rural residential.

Wetlands and Floodplains: There is a large wetland on the south side of the railroad right-of-way. There is also a small wetland east of Watch Hill Avenue. Based on FEMA mapping, portions of Cheseboro Lane are within the 100-year floodplain for Wequetequock Cove.

Surface Water: Wequetequock Cove is located southeast of this area.

Groundwater: Many residents indicated a high groundwater table in the area. This is likely a reflection of the poor soils and bedrock.

Public Water: Public water is available only in parts of this area.

Proximity to Public Sewer: Meadow Avenue near Cheseboro Lane.

Wastewater Need Priority: Low

2.4.18 Area 17 — Montauk Avenue Area

The Montauk Avenue Area, as shown in **Figure 2-20**, is located on the edge of the Stonington Borough collection system. This area includes Montauk Road, Findlay Way and L'Hirondelle Lane.

This wastewater needs area is comprised of 34 single-family homes. These homes have an average lot size of 2 acres.

See Figure 2-20

Soil Types: Soils in this area are predominantly Woodbridge with 0 to 8 percent slopes. Woodbridge soils have very low permeability, resulting in ponding and wetness.

Suitability for Onsite Disposal Systems: According to available soil information, soil characteristics for the hillside area suggest that onsite disposal systems may require special design and installation in order to perform properly.

Zoning: Rural residential

Wetlands and Floodplains: There are no wetlands and no floodplain in this area.

Surface Water: A tidal inlet/brook is located approximately 900 feet east of this area.

Groundwater: Many residents indicated a high groundwater table in the area. This is likely a reflection of the poor soils in the area.

Public Water: No

Proximity to Public Sewer: Intersection of Montauk Road and Stonington Road.

Wastewater Need Priority: Low

2.4.19 Area 18 – North Stonington Road

The North Stonington Road Area, as shown in **Figure 2-21**, is located on the north side of town, isolated from the existing collection systems. This area includes a small section of North Stonington Road and Wolfneck Road. This wastewater needs area is comprised of 30 single-family homes. These homes were built in 1960s with an average lot size of 1.4 acres.

Soil Types: Soils in this area are varied. Soils include Agawam (0 to 2 percent slopes), Sutton (2 to 8 percent slopes), Canton (3 to 8 percent slopes), and Adrian (0 to 2 percent slopes). Adrian soils are unsuited for onsite disposal. Sutton soils have high groundwater tables.

Suitability for Onsite Disposal Systems: According to the available soil information, soil characteristics for the hillside area suggest that onsite disposal systems may require special design and installation in order to perform properly. Effluent from onsite disposal systems may also pollute the groundwater as it flows through soils at the base of the hill.

Zoning: This area is zoned for rural residential, Aquifer Protection Zone.

Wetlands and Floodplains: There is a large wetland contiguous to this area. There is no floodplain.

Surface Water: There are no significant bodies of water in this area.

See Figure 2-21

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Groundwater: Several residents indicated a high groundwater table in the area. This is likely the result of the high groundwater tables associated with Sutton soils.

Public Water: No

Proximity to Public Sewer: 1.4 miles

Wastewater Need Priority: Low

2.5 Wastewater Treatment and Disposal Alternatives

2.5.1 Introduction

An analysis of wastewater treatment and disposal alternatives was conducted for each designated wastewater needs area. This section first describes several wastewater disposal alternatives available to the Town. Conveyance alternatives are presented in Section 2.6.

Management practices, including water conservation and onsite disposal system management, were considered as a means of mitigating circumstances that may contribute to solving onsite disposal problems. In many cases, however, problems are related to high groundwater conditions or poor soils, where management practices are inadequate solutions.

The following alternatives were considered for wastewater treatment and disposal for the identified problem areas:

1. Town-Wide No-Action
2. Individual Onsite Wastewater Treatment and Disposal
   - Conventional Septic Systems
   - Innovative/Alternative Technologies
3. Shared Local (Community) Wastewater Treatment and Disposal
   - Conventional Septic System
   - Innovative/Alternative Technology
4. Package or Small Wastewater Treatment Plants
   - Offsite Disposal at a Municipal Water Pollution Control Facility

2.5.2 Town-Wide No-Action

From an immediate capital cost perspective, implementation of the town-wide no-action alternative is most desirable, as no major expenditures would be required. However, in many areas the need for improved wastewater disposal makes the no-action alternative infeasible for public health, environmental, and institutional reasons. If unabated, potential threats to public health from failing onsite disposal systems would persist in many areas. As shown by the wastewater needs investigations described above, many areas have problems with their onsite systems. In some areas, the no-action alternative may prevent homeowners from meeting the requirements of the state's *Public Health Code*. In some cases, compliance with the *Public Health Code* could require a major investment in an innovative or alternative system. Failure to make the necessary investment could possibly prevent home sales. Therefore, a town-wide no-action alternative is not desirable because it does not provide any short or long-term public health or environmental benefits nor does it address disposal systems that do not comply with *Public Health Code* requirements.

2.5.3 Individual Onsite Wastewater Treatment and Disposal

This section describes options for wastewater disposal improvements for individual use systems, and includes conventional replacement or upgrades, innovative/alternative systems, and tight tanks. A general description of these options is provided, as there are numerous technologies available. **Table 2-3** summarizes some of the setback requirements and design criteria for onsite wastewater disposal systems in the State of Connecticut.

Conventional Upgrades or Replacement Systems

Conventional upgrades or replacement of individual onsite systems may be implemented in portions of the town where centralized collection and disposal is cost prohibitive, or where acceptable conditions exist for onsite wastewater disposal. Acceptable conditions include: proper soil percolation, low groundwater table (seasonal high groundwater at least 7 feet below grade), generally flat topography, adequate lot size, adequate depth to bedrock, and proper depth from natural resource areas.

As presented in Section 2.2, a typical *Public Health Code* septic system consists of three components: a septic tank, distribution box, and leaching system. Conventional upgrades can often be used to replace one or more components of an existing onsite septic system to comply with the requirements of a *Public Health Code*. Where conditions are suitable, a failed cesspool or a hydraulically-overloaded septic system should be replaced with a new conventional system. However, if the septic tank and/or distribution box are adequately sized, replacement of these components may not be necessary.

Innovative/Alternative Systems

In locations with high groundwater conditions, poor soil drainage, lot size restrictions and/or within environmentally sensitive areas, conventional upgrades of an onsite system may not be sufficient to meet *Public Health Code* requirements. In these cases, innovative and alternative technologies may be used. The CTDEP approves use of innovative and alternative technologies on a case-by-case basis for each site.

See Table 2-3

Alternative systems are those that provide substitutes or alternatives for one or more of the components of a conventional system, while providing the same degree of environmental and health protection. They include:

- humus or other composting toilets;
- alternative mounding systems;
- intermittent or recirculating sand filters;
- incinerating toilets;
- ozone disinfection;
- ultraviolet disinfection;
- any system designed to chemically or mechanically aerate, separate, or pump wastewater; and
- any system designed to control nitrogenous compounds, phosphorus, or pathogenic organisms.

A summary of the more popular innovative/alternative technologies is provided below and in **Table 2-4**.

Recirculating sand filters typically include a septic tank, a recirculation tank and pump, and an underdrained open sand filter. Effluent from the septic tank overflows to the recirculating tank and mixes with effluent returned from the sand filter. The mixture is periodically pumped onto the sand filter and evenly distributed over the filter surface. The sand filter is placed above grade for ventilation purposes. Oxygen available within the pores allows aerobic decomposition of the wastewater. A drain line at the bottom of the sand filter collects the effluent and returns it by gravity to the recirculation tank. If the tank is full, effluent overflows to the distribution box and leaching field. If properly designed, operated and constructed, recirculating sand filters can produce effluents of very high quality.

Humus/composting toilets have evolved over the years. The most popular type uses wood wastes such as sawdust to provide a composting environment for biodegradation of wastes. These systems are typically equipped with a temperature-controlled fan for aeration. In the past, composters have been used with waterless toilets. Recent innovations include foam flush composting toilets that require one ounce of water and soap per flush, and yard irrigation systems using filtered graywater from sinks, showers, and washing machines.

Mound systems have three principal components: a pretreatment unit, dosing chamber, and an elevated mound. Mounds are pressure-dosed sand filters that discharge directly to natural soil. They lie above the soil surface and are designed to

See Table 2-4

overcome soil permeability problems, shallow soil cover over bedrock, and a high water table. The main purpose of a mound system is to provide sufficient treatment to the natural environment to produce an effluent equivalent to, or better than, a conventional onsite disposal system.

Effluent tee filters are fiber filters installed at the outlet of a septic tank. They enhance treatment and prevent septic tank solids from reaching the leaching system.

Package wastewater treatment facilities may be feasible solutions for individual onsite systems in Stonington. Small below-ground package plants such as Bioclere ™ trickling filter systems, FAST ™ fixed activated sludge treatment, and Amphidrome ™ filter and fixed-film reactor systems can be designed for flows generated by single family homes (300 gpd). These involve proven technologies for large-scale municipal treatment facilities, but are relatively new with respect to small systems.

2.5.4 Community Wastewater Treatment and Disposal

Locally-shared systems may be a viable option for areas where conventional systems and individual innovative/alternative systems are not feasible or are cost prohibitive. Locally shared systems require an available parcel of land with suitable soil, geologic and groundwater conditions for onsite wastewater disposal. Shared systems can be used for a cluster of homes (or businesses) or a small portion of the community. The options for shared onsite systems include: shared leaching systems, locally shared treatment and disposal facilities (e.g., shared septic tank and leaching system), and package treatment plants.

Shared Leaching Systems

Shared leaching systems are designed to use a parcel of land near a group of homes that have characteristics suitable for disposing of septic tank effluent. Shared leaching systems may be desirable where there are lot-size constraints and/or unsuitable soil or groundwater conditions, which may make it difficult for property owners to upgrade their leaching systems to meet *Public Health Code* requirements. Individual homes (or businesses) would retain their existing septic tank or install a new septic tank for wastewater pretreatment, and gravity or pressure sewers would transport the effluent to a locally-sited community leaching system. If flow by gravity to a common leaching system is not possible, septic tank effluent pumping (STEP) systems may be used to pump the effluent to the common leaching system. Shared leaching systems involve facility siting, as well as creating a community organization to oversee related regulatory, administration, repair, operation and maintenance (O&M) activities, and replacement when necessary.

The restrictions and regulations for individual onsite disposal systems also apply to shared leaching systems. A shared leaching system is constructed similarly to a conventional leaching system, with *Public Health Code* design flows less than 5,000 gpd (flow from approximately 16 or less single-family homes), if sited in an area with suitable soil, groundwater, geologic, and topographic conditions. In areas with unsuitable conditions, such as high groundwater, the use of a mound system or an innovative/alternative technology could be used to meet *Public Health Code* design requirements. With flows equal to or more than 5,000 gpd, advanced treatment and a CTDEP groundwater discharge permit are required.

Shared Treatment and Disposal Facilities

Shared treatment and disposal facilities may be used in locations where lot size constraints, setback requirements, and unsuitable environmental conditions make it difficult or infeasible for property owners to upgrade both the septic tank and leaching system. This option is similar to that described for the shared leaching system, except that a large septic tank and distribution box would be installed to provide a centralized facility serving multiple residences or businesses. In this case, pressure or conventional gravity sewers would transport untreated wastewater to a locally-sited community disposal facility. This option would involve facility siting, as well as creation of a community organization to oversee related regulatory, administration, billing, reporting, repair, operation and maintenance activities, and replacement when necessary.

In locations where lot size constraints, setback requirements, and unsuitable environmental conditions make it difficult or infeasible for property owners to upgrade both the septic tank and leaching system, a local community "package" prefabricated treatment plant or a small conventional wastewater treatment plant with subsurface disposal is an option. Package or small wastewater treatment facilities may be feasible solutions for a group of homes, businesses, a small community or an industrial, commercial, or institutional facility that has a *Public Health Code* design flow in excess of 5,000 gpd.

Package Treatment Plants

Package plants can achieve the same degree of treatment as municipal wastewater treatment facilities, provided their operation is monitored effectively. The term "package" refers to the assembly of various individual treatment processes into a compact area. Package plants normally have a capacity less than 100,000 gpd and have a high degree of automation. They are usually offered by a single company that is able to install pre-assembled equipment in buried tanks or in small buildings. Subsurface disposal is usually the preferred method of effluent disposal due to the difficulty of obtaining the required permits/approvals for a surface discharge. Some systems include septic tanks or pretreatment tanks upstream of the package plant units. They also may include dosing tanks and leaching trench systems downstream of the units for effluent disposal.

Various types of package wastewater treatment facilities may be feasible solutions for single-home or community systems in Stonington. Small below-ground package plants such as Bioclere ™ trickling filter systems, FAST ™ fixed activated sludge treatment, Amphidrome ™ filter and fixed-film reactor systems, and Zenon or M-PAC ™ membrane systems can be used for flows up to 100,000 gpd.

Other traditional wastewater treatment processes may be used in larger package facilities depending on the desired degree of wastewater treatment. Sequencing batch reactors (SBR) and rotating biological contactors (RBC) are two common treatment processes. Either method is capable of achieving standard secondary treatment or advanced wastewater treatment. A brief description of these processes follows:

- **The Sequencing Batch Reactor process** consists of a timed series of process steps using one or more tanks. First, an empty tank fills with untreated wastewater. Once the tank is full, aeration is started, supplying enough oxygen to allow stabilization of the organic waste and conversion of ammonia to nitrates (nitrification). This step typically takes 12 to 18 hours. If nitrogen removal is required, the aeration process is stopped for an additional 4 to 6-hour period to create anoxic conditions, which promote the conversion of nitrates to nitrogen gas and, hence, nitrogen removal from the wastewater. During the next step, the treated wastewater is allowed to settle for approximately a 1-hour period, during which time heavier solids (sludge) settle to the bottom of the tank. After settling, the clear effluent is pumped to a disinfection chamber and then discharged to either a surface or subsurface land disposal facility. The settled sludge is re-used in the tank and occasionally excess sludge is removed by tank truck for disposal at a wastewater treatment facility.

- **The Rotating Biological Contactor process** uses a fixed culture of natural microorganisms, which mechanically rotates on a disk through the wastewater to remove pollutants. To achieve nitrogen removal, two RBCs are normally used in series with one RBC submerged to promote anoxic conditions that foster denitrification. The RBCs are followed by a settling tank, and a sand filter is sometimes required depending on effluent limits. Similar to other package wastewater treatment facilities, a disinfection step is required.

Package treatment plants can be installed below or above ground. When below ground, these systems are installed in concrete, metal, or fiberglass compartments or tanks. Most new, below-ground package plants consist of one or more tanks set on a concrete foundation. The tanks are then buried so that only access hatches are visible from the surface. These systems have been in operation throughout the United States for more than 35 years. When installed above ground, they are constructed with fiberglass enclosures, or more commonly, in small buildings. These facilities usually include one or more concrete buried tanks, but most of the equipment is located in a one-story structure that architecturally blends with its surroundings. Above ground package plants typically serve condominium complexes, apartment buildings, and shopping centers.

Costs for package plants vary considerably depending on whether the plant is constructed above or below ground, the type of treatment process selected, the degree of automation, the degree of treatment required, and the method of effluent disposal. Generally, redundant treatment units are provided for design flows over 40,000 gpd.

A package system that is required to have redundant processes becomes increasingly complex, requires substantially more operator attention, and is more expensive.

Small Wastewater Treatment Facilities

A small wastewater treatment plant could be provided instead of a package plant, if flows exceed 100,000 gpd. A sequencing batch reactor (SBR) or an oxidation ditch may be used for secondary treatment in a small wastewater treatment plant. A small wastewater treatment plant requires much more cast-in-place concrete and onsite construction compared to a package plant and, therefore, capital costs for a small wastewater treatment plant tend to be relatively high.

2.5.5 Treatment and Disposal at an Existing Water Pollution Control Facility

The Town of Stonington currently operates three water pollution control facilities — the Mystic, Stonington Borough and Pawcatuck WPCFs. A description and evaluation of these facilities is presented in Section 5.

2.5.6 Other Treatment and Disposal Solutions

Other alternative solutions to onsite wastewater disposal or septage disposal problems are:

- Solar aquatics facilities;
- Tight tanks; and
- Condemnation of property.

Solar aquatics facilities are appropriate for and become more cost-effective at relatively high (>50,000 gpd) design flows. These types of facilities use greenhouses to store solar energy to treat wastewater without the addition of chemicals. They generally include trains of aerated tanks and constructed marshes. The tanks are typically seeded with a mixture of commercially produced bacteria and snails, and are planted with algae, aquatic and woody plants, which remove nitrates from the wastewater. These systems have a large land requirement due to the low application rate. They also have high energy requirements in the winter months.

Tight tank solutions dictate frequent pumping and transportation of wastewater to an approved treatment facility, making this an expensive, last resort alternative. Tight tank owners must set audio and visual alarms to activate at 60 percent of tank capacity. Aeration or another method of odor control may be required. Also, an operation and maintenance plan should be implemented to ensure proper care of the system.

Land taking or condemnation of property is another possible last resort alternative. Issues to consider include:

- Cost of taking property;
- Whether federal or state funds are available for such activities;
- Legal procedures; and
- Documentation that other alternatives, such as innovative/alternative systems, shared systems, or tight tanks are not feasible.

2.6 Screening of Conveyance Alternatives

2.6.1 General

This section identifies various wastewater collection alternatives that may be considered in conjunction with the offsite wastewater disposal alternatives described above. Conveyance alternatives are required for all offsite wastewater disposal options, such as treatment at a water pollution control facility, treatment at a package or small wastewater treatment plant, disposal at a local community leaching field, or disposal using a community innovative/alternative technology. The following alternatives are considered for wastewater collection:

1. Conventional Gravity Sewers
2. Pumping Stations and Force Mains
3. Small Diameter Gravity Sewers
4. Pressure Sewers with Septic Tank Effluent Pumps (STEP systems)
5. Pressure Sewers with Individual Grinder Pumps
6. Combinations of the Above

2.6.2 Conventional Gravity Sewers

Conventional gravity sewers are generally constructed of polyvinyl chloride (PVC) pipe. The minimum pipe size is 8 inches in diameter, with individual residential service laterals being 6 inches in diameter. Pipelines are laid at a slope to maintain a minimum 2 feet per second velocity to minimize solids deposition. Four-foot diameter manholes are placed along gravity sewers, at a spacing of about 300 feet.

Much of the cost of constructing gravity sewers is associated with excavation and surface restoration. Conventional gravity sewers have traditionally been the preferred method of wastewater conveyance combined with pumping stations and force mains. Based on non-economic factors, conventional gravity sewers remain the preferred method of wastewater conveyance. An analysis, based on cost and non-cost considerations, between conventional gravity sewers and other alternate means of conveyance is included later in this section.

2.6.3 Pumping Stations and Force Mains

Pumping stations and force mains are typically used in conjunction with gravity sewer alternatives. Conventional gravity sewer systems collect and convey wastewater by gravity from individual service connections to treatment facilities. If a section of the sewer area is too low to reach a desired location, pumping stations and force mains are used to "lift" the wastewater to a point where the flow can continue by gravity.

Pumping stations are designed for the anticipated peak wastewater flow. Each station has a minimum of two pumps, with one pump capable of pumping the entire flow. The other pump acts as a standby in case of a pump failure. Each station is supplied with an emergency power generator which operates in the event of a power failure.

Force mains are sized to maintain a minimum velocity of 2 feet per second to prevent debris from accumulating, while also minimizing head losses as much as possible. A minimum pipe size of 4 inches in diameter is used for force mains.

2.6.4 Small Diameter Gravity Sewers

Small diameter gravity sewers are used in conjunction with a septic tank at each individual residence. The septic system serves to retain solids thereby allowing the use of a smaller diameter gravity sewer. The minimum diameter is generally 6 inches.

Small-diameter sewers have the disadvantage of requiring that a septic tank be maintained at each individual residence. The septic tanks require periodic pumping, similar to a conventional septic tank, to ensure that solids are not conveyed to the small diameter sewers.

Small-diameter sewers are generally most applicable if:

- The effluent from each home needs to be clarified because conveyance is to a common leaching system.
- The effluent is clarified by a septic tank at each individual home to allow a new treatment plant to be constructed without facilities for settling of primary solids and grit.

2.6.5 Pressure Sewers with Septic Tank Effluent Pumps

STEP (Septic Tank Effluent Pump) systems consist of a septic tank followed by an effluent pump at each service connection. The effluent pump discharges into a pressure sewer system. The sizes of pipelines within the street depend on the number of homes connected.

The slope of pressure sewers is not important since flow is conveyed by pressure, which allows the pipes to follow the natural slope of the land. Pipes are recommended to be buried at a minimum cover of 5 feet to avoid possible freezing in the winter months. This represents a potential capital cost savings compared to gravity sewers. Advantages of pressure sewers over gravity sewers are smaller diameter pipelines, little or no infiltration, shallower burial depths, and corresponding smaller trenches.

STEP systems require that a septic tank be maintained at each individual residence, similar to the small diameter sewers alternative. Also, STEP systems require that a pumping system be located on each individual homeowner's property. The pumping system is subject to potential failure; however, the effluent collection chamber provides storage capacity during a power outage.

Similar to small diameter gravity pipelines, STEP systems are most applicable if:

- The effluent from each home needs to be clarified because conveyance is to a common leaching system.
- The effluent is clarified by a septic tank at each individual home to allow a new treatment plant to be constructed without facilities for settling of primary solids and grit.

Otherwise, pressure sewers with individual grinder pumps, described below, are generally more desirable since they do not require that a septic tank remain in service on each homeowner's lot, eliminating the need for periodic pumping to remove solids from the septic tank.

2.6.6 Pressure Sewers with Individual Grinder Pumps

This alternative considers pressure sewers used in conjunction with an individual grinder pump at each residence. The grinder pump can be located in or outside of the home. The pump is designed to macerate solids (similar to the way that a kitchen garbage disposal grinds solids) so as to allow a small line size for the pressure sewers. There is no septic tank needed for this type of system. Since there is no septic tank requiring regular pumping, this system is preferred to a STEP system unless the effluent needs to be clarified for disposal at a common leaching field or at a treatment facility without grit removal or screening facilities.

Similar to STEP systems, this type of system is generally used to serve a small cluster of homes in a low-lying area that cannot connect by gravity to a conventional sewer. Its main disadvantage is the need to have a pump at each individual service connection, which requires maintenance and is subject to potential breakdown. Similar to a STEP system, the pump will not operate during a power outage. A typical grinder pump system has approximately 60 gallons available for storage during power failures.

2.6.7 Comparison of Conveyance Alternatives

Each of the conveyance alternatives presented in this section is compared based on cost and non-cost factors. The preferred method of conveyance based on non-cost factors is conventional gravity sewers, since this alternative is the simplest and has the least amount of future operation and maintenance requirements. In general, it is recommended that conventional gravity sewers be used in conjunction with pumping stations and force mains. If less than 20 homes in a low-lying area require pumping, low-pressure sewers with individual grinder pumps will be considered.

Following is an analysis of wastewater collection alternatives.

Small Diameter Gravity Sewers

Small diameter gravity sewers are not considered further unless a selected treatment alternative requires a clarified effluent. Small diameter gravity sewers are not favored based on both cost and non-cost factors as described below.

- Small diameter gravity sewers with a conventional septic tank at each service are found to be slightly more expensive than conventional gravity sewers based on capital costs (3 to 8 percent), depending on the density of homes. Based on a 20-year life-cycle cost (present worth cost including O&M for 20 years), small diameter gravity sewers were found to cost approximately 8 to 14 percent more than conventional gravity sewers. The increased cost of small diameter gravity sewers are a result of having to provide a *Public Health Code* compliant septic tank at each home where one currently does not exist.

- Small diameter gravity sewers are not as desirable as conventional gravity sewers since a septic tank would have to remain at each household and would need to be pumped out every two to three years.

STEP Systems

STEP systems with pressure sewers are estimated to be approximately equal in cost to grinder pumps with pressure sewers. Individual grinder pumps are preferred to a STEP system, unless a clarified effluent is required, such as for a leaching system or a package WWTP without screening or grit removal facilities, because maintenance of a septic tank is not required.

STEP systems are not recommended since they require that a septic tank be maintained on each individual's property thereby requiring routine pumping and subsequent disposal of the settled solids from the tank. STEP systems are not considered further since individual grinder pumps are comparable based on capital and life-cycle costs, unless a clarified effluent is required.

Pressure Sewers with Individual Grinder Pumps

The use of pressure sewers with individual grinder pumps was evaluated versus the use of gravity sewers. Two general cases were evaluated.

- ***Case 1***. The street can flow by gravity to an interceptor.

- ***Case 2***. The street cannot flow by gravity to the mainline interceptor requiring that the gravity sewer alternative be supplemented with a pumping station and force main.

When a street can flow by gravity to an interceptor, gravity sewers are preferred unless the area being sewered is very sparsely populated. Gravity sewers are estimated to be less costly when housing is relatively dense. The higher cost of pipe in a gravity system is offset by not needing a pump at each individual service connection. If housing is relatively sparse; however, the cost of the individual grinder pumps at each home is offset by the less expensive pressure sewer piping in the street. Most streets anticipated for sewers as part of this facilities plan are relatively densely populated and; therefore, gravity sewers will be used when the connection to the interceptor can be made by gravity.

If a street or neighborhood is at an elevation too low to connect to an interceptor by gravity, cost comparisons of using gravity sewers with a pumping station versus pressure sewers with individual grinder pumps show that there is a breakpoint depending on the number of homes and the density of homes. On a present worth cost basis, gravity sewers with a pumping station are generally less expensive for 40 or more homes. Between 20 and 40 homes, the present worth cost comparison of gravity sewers with a pumping station versus pressure sewers depends on the density of homes. For 20 or fewer homes, present worth costs generally favor pressure sewers with individual grinder pumps.

Based on non-cost considerations, the use of pressure sewers with grinder pumps is less desirable than gravity sewers and a central pumping station. Pressure sewers require that a pump be located at each individual residence thereby requiring individual maintenance at each residence. Eventually, pumping units at each of the residences may require major maintenance or replacement. In addition, during a power outage, there is a fixed volume of storage available in the grinder pump unit.

The recommendations, based on this analysis, is that for low lying areas with:

- less than 20 homes pressure sewers with individual grinder pumps be used;
- 20 to 40 homes, consideration be given to using individual grinder pumps; and
- more than 40 homes be served with conventional gravity sewers and a pumping station and force main be used.

2.7 Evaluation of Wastewater Management Alternatives for Wastewater Needs Areas

2.7.1 Introduction

The following are evaluations of the wastewater management alternatives for each wastewater needs area. These alternatives were determined based on the screening methodology presented in Figure 2-2 and described in Section 2.5. **Table 2-5** presents a summary of the suitable wastewater collection and treatment alternatives for each area. **Figure 2-22** shows a preliminary layout of proposed wastewater collection and transmission systems for each of the wastewater needs areas. The layout of sewers and pumping stations is based on the Town's five-foot contour plans.

Recommended wastewater management solutions are based on feasibility of implementation, the nature of the onsite disposal problems, expected environmental benefits, and cost considerations. Some of the alternatives discussed in Sections 2.5 and 2.6 were not selected as feasible options for the wastewater needs areas in Stonington. These include:

- No-Action Alternative—As discussed in Section 2.5.2, the no-action alternative is not an option for the areas investigated. Each area was selected specifically because all of its wastewater needs are not being met. Therefore, some action will have to be taken to resolve the area's issues.

- Individual Onsite Systems without Treatment —All 18 areas have issues with one or a combination of the following: shallow bedrock, perched groundwater, small lots, proximity to surface water or other sensitive resource area, and poor/unsuitable soils for septic disposal. Therefore, conventional septic systems will not provide adequate wastewater treatment to meet *Public Health Code* and/or CTDEP requirements. -

- Community System without Treatment (<5,000 gpd)—The only area that has flows less than 5,000 gpd is the Roseleah Drive Area. This area consists of small, developed lots surrounded by Mystic Harbor. Due to its proximity to Mystic Harbor, a community septic system with no additional treatment is not an option.

2.7.2 Costs of Wastewater Management Alternatives

Costs of wastewater management alternatives were estimated based on recent CDM projects, bid tabulations and manufacturers' estimates. Capital costs include a 40 percent allowance for construction contingencies, engineering, borings and survey. Costs do not include land acquisition and easement costs. The feasible alternatives identified for each wastewater needs area were evaluated on a common fiscal basis using a present worth analysis.

The initial base year for the present worth analysis is 2002 with all costs referenced to July 2002, *Engineering News Record* (ENR) Construction Cost Index 6605. The costs herein have been escalated to reflect an ENR cost index of 7763 for August 2006. A 20-year planning period is used, and the fiscal year 2004 EPA discount rate is 5.625 percent. Alternatives with the lowest present worth are the most cost-effective over the life of the project.

See Figure 2-22

See Table 2-5

Cost estimates for the package treatment facilities include costs to treat effluent to 10 mg/L total nitrogen, and BOD and TSS to 30 mg/L. Annual operation and maintenance costs include power, operator inspections, maintenance, sample testing and septage/sludge disposal. All package treatment plants considered in this report are assumed to be within a 1,000-foot radius of the wastewater needs area.

Life expectancies of equipment and structures were estimated to determine future replacement costs and salvage values at the end of the project planning period. The life expectancies used in the analysis are 20 years for pumps, package treatment facilities, instrumentation and equipment, and 50 years for pipes.

2.7.3 Evaluation by Wastewater Needs Area

Area 1 - Marjorie Street Area

Recommendation: Install a gravity collection system, pumping station, force main and community wastewater treatment facility.

As discussed in Section 2.4, the Marjorie Street Area is a critical needs area with 40 homes. Half of the Marjorie Street Area is within a drinking water aquifer recharge zone. The other half of the needs area has soil that is considered unsuitable for onsite disposal because of the existence of bedrock at shallow depths. Feasible alternatives for this area are:

<u>Treatment:</u>

- Individual onsite treatment systems with innovative/alternative technologies
- Community innovative/alternative technologies (package treatment plant)
- Town water pollution control facility

<u>Collection:</u>

- Gravity sewers
- Pump station and force main

Locating onsite wastewater treatment systems within an aquifer recharge zone should be considered only if there is no other practical and feasible alternative. Connecticut Public Health Code stipulates that onsite treatment systems “located within the drawdown area of an existing public water supply well with a withdrawal rate in excess of 50 gpm, or within 500 feet of land owned by a public water supply utility and approved for a future well site by the Commissioner of Public Health” are considered an Area of Special Concern and require special permitting.

A package treatment plant located outside of Area 1 is a viable option. Depending on the location of the plant, Area 1 may be able to be served using gravity sewers. The Connecticut *Public Health Code* may restrict the location of a package treatment plant (system receiving flows greater than 5,000 gpd) within a public water supply watershed; permission must be granted by the Commissioner of Public Health. Furthermore, sewer piping must be at least 100 feet from, and discharge of raw or treated sewage must be 200 feet, away from any well withdrawing over 50 gpm. Hence, similar to individual onsite wastewater treatment systems, locating community treatment systems within an aquifer recharge area is a last resort alternative.

The Marjorie Street Area will require about 4,300 feet of gravity piping for a wastewater collection system. Area 1 is approximately 5,700 feet from an existing sewer and will require a pumping station and approximately 3,300 feet of force main to connect to the sewer.

Table 2-6 compares the present worth costs for the Area 1 wastewater management alternatives. The capital cost of installing a gravity collection system and a package treatment plant is significantly less than the cost of connecting to the closest sewer. When operation and maintenance costs are included in the equation, the present worth costs are close, with a package treatment facility slightly more cost-effective than connecting to the sewer. Considering the environmental and public impacts of constructing more than a mile of transmission lines to connect to the nearest sewer, the package treatment facility is the recommended alternative.

Area 2 - Riverbend Drive Area
Recommendation: Install a gravity collection system, pumping station and force main to connect to the nearest sewer.

Riverbend Drive is a moderate needs area adjacent to the river. The soil has poor filtration capabilities. Appropriate alternatives for the Riverbend Drive Area are:

<u>Treatment:</u>

- Individual onsite treatment systems with innovative/alternative technologies
- Community innovative/alternative technologies (package treatment plant)
- Town water pollution control facility

<u>Collection:</u>

- Gravity sewers
- Pump station and force main

Area 2 is small and will require only 2,800 feet of gravity collection pipe. Riverbend Drive is immediately adjacent to the existing sewer, but it is at a low point so a pumping station and 1,700 feet of force main will be required to connect a local

See Table 2-6

collection system. The sewage from this area will be conveyed to the Mystic collection system.

A package treatment plant can also be used to provide wastewater treatment; however because the area is small and is close to the existing sewer, this is not a cost-effective solution, as shown in **Table 2-7**.

Based on cost and environmental factors, a gravity collection system, pumping station and force main to the existing sewer is the recommended solution for the Riverbend Drive Area.

Area 3 - School Street Area
Recommendation: Install 23 grinder pumps, low-pressure sewers and a gravity collection system, and connect to the nearest sewer.

The School Street Area is a moderate needs area where the topography is steep and bedrock is shallow. Furthermore, the area contains wetlands and sections within the 100-year floodplain. The following are the possible wastewater collection and treatment options for Area 3:

<u>Treatment:</u>

- Individual onsite treatment with innovative/alternative technologies
- Community innovative/alternative technologies (package treatment plant)
- Town water pollution control facility

<u>Collection:</u>

- Gravity sewers
- Grinder pumps and pressure sewers
- Combination of Gravity and Low-pressure Sewers

A package treatment plant is not cost-effective because the area is comprised of only 34 homes and is immediately adjacent to the existing sewer system. The north section of the area can be connected to the existing sewer using about 1,750 feet of gravity pipe, 14 grinder pumps and approximately 950 feet of low-pressure sewer. Due to low elevation, pumping is also needed in the south section of the School Street Area. As this section has only 9 homes, grinder pumps and approximately 650 feet of low-pressure sewer is more cost-effective than a pumping station and force main.

Based on the cost analysis shown in **Table 2-8**, the recommendation for this area is to install a combination of grinder pumps, low-pressure sewers, and gravity sewers. The sewage will be conveyed to the Mystic collection system.

See Table 2-7

See Table 2-8

Area 4 - Roseleah Drive

Recommendation: Install grinder pumps and a low-pressure sewer system, and connect to the nearest sewer.

Roseleah Drive, a high needs area, is a small road on Mystic Harbor with soils that are unsuited for onsite treatment due to wetlands and the proximity to Long Island Sound. The following are feasible collection and treatment alternatives for this area:

Treatment:

- Town water pollution control facility

Collection:

- Grinder pumps and pressure sewers

Table 2-9 summarizes the costs for this area. The 15-home area are low-lying and will require pumping to connect to the existing sewer. Grinder pumps are more cost-effective than a pumping station and force main. The existing sewer extends to the beginning of Roseleah Drive, so connection to the existing sewer with 1,300 feet of low-pressure pipe is a viable option. The sewage from Roseleah Drive will be sent to the Mystic collection system.

Area 5 - Elm Ridge Road Area

Recommendation: Install 68 grinder pumps, low-pressure sewers, a pumping station and force main, and a gravity collection system to connect to the nearest sewer.

The Elm Ridge Road is a critical needs area comprised of 205 homes. The soil in Area 5 is poor for septic systems. The following are possible alternatives to handle wastewater in the area:

Treatment:

- Individual onsite treatment with innovative/alternative technologies
- Community innovative/alternative technologies (package treatment plant)
- Town water pollution control facility

Collection:

- Gravity sewers
- Pump station and force main
- Combination of gravity and low-pressure sewers

See Table 2-9

The majority of the Elm Ridge Road Area can be connected to the existing sewer collection system using 10,000 feet of gravity sewers. However, a small pumping station and approximately 500 feet of force main will be needed to collect wastewater from 43 homes on the south end of the area. Furthermore, grinder pumps and approximately 5,500 feet of low-pressure sewer are required for 68 low-lying homes. The area is close to the Pawcatuck collection system. As shown in **Table 2-10**, connecting Area 5 to the closest sewer is the most cost-effective alternative.

Area 6 - Pequot Trail Area
Recommendation: Install 13 grinder pumps, low-pressure sewers and a gravity collection system to connect to the nearest sewer.

The Pequot Trail Area, a high needs area, is a fairly large area consisting of 113 homes, a church and a condominium. Area 6 is characterized by shallow bedrock and steep hills. Based on the screening criteria, the following collection and treatment alternatives can address the Pequot Trail Area's wastewater needs.

Treatment:

- Individual onsite treatment with innovative/alternative technologies
- Community innovative/alternative technologies (package treatment plant)
- Town water pollution control facility

Collection:

- Gravity sewers
- Combination of gravity and low-pressure sewers

The Pequot Trail Area is immediately adjacent to the Pawcatuck WPCF collection system, and the area can be connected to the existing sewer via approximately 10,750 feet of gravity pipe. Thirteen grinder pumps and about 1,000 feet of low-pressure sewer may be necessary at the north end of the area. As shown in **Table 2-11**, this is the most cost-effective solution.

Area 7 - Cronin Avenue/Holly Street
Recommendation: Install a gravity collection system and connect to the nearest sewer.

In general, the soil, wetlands and ledge outcrops in the Cronin Avenue/Holly Street Area are not suitable for onsite disposal. The following wastewater collection and treatment alternatives are possible options for this high needs area:

Treatment:

- Individual onsite treatment with innovative/alternative technologies

See Table 2-10

See Table 2-11

- Community innovative/alternative technologies (package treatment plant)
- Town water pollution control facility

Collection:

- Gravity sewers
- Combination of gravity and low-pressure sewers

The Cronin Avenue/Holly Street Area is located within the existing Pawcatuck WPCF collection system but was not connected when it was developed. The area can be connected to the existing sewer system via 1,750 feet of gravity pipe. As shown in **Table 2-12**, this option is more cost-effective than installing community or individual treatment systems.

Area 8 - Millan Terrace Area
Recommendation: Install four grinder pumps, low-pressure sewers and a gravity collection system to connect to the nearest sewer.

The Millan Terrace area is a moderate needs area located at the edge of the Pawcatuck collection system and adjacent to Anguilla Brook. Area 8 is comprised of 38 homes on small lots (about 1/2 acre) and includes wetlands, ledge, high groundwater and a nearby brook. The following are feasible alternatives to meet this area's wastewater needs.

Treatment:

- Individual onsite treatment with innovative/alternative technologies
- Community innovative/alternative technologies (package treatment plant)
- Town water pollution control facility

Collection:

- Gravity sewers
- Pump Station and force main
- Grinder pumps and pressure sewers
- Combination of gravity and low-pressure sewers

Approximately 3,300 feet of gravity sewer will be needed to collect wastewater in the Millan Terrace Area. The area is located on the edge of the existing Pawcatuck WPCF collection system. Two grinder pumps and approximately 200 feet of low-pressure

See Table 2-12

sewers will be needed for two homes on Stanley Street, and two grinder pumps may be needed on South Broad Street to connect to a gravity sewer.

A community package treatment plant is an option, but is not the most cost-effective solution because the area is adjacent to an existing sewer. As shown in **Table 2-13**, connecting to the existing sewer is the least costly feasible alternative.

Area 9 - Aimee Drive Area
Recommendation: Install a gravity collection system and connect to the existing wastewater pumping station in Pawcatuck Avenue.

The Aimee Drive Area is a moderate needs area located just outside the Pawcatuck collection system. The area has ledge and poor soils. Based on the screening criteria, the following are feasible alternatives to meet the wastewater needs of the area:

Treatment:

- Individual onsite treatment with innovative/alternative technologies
- Community innovative/alternative technologies (package treatment plant)
- Town water pollution control facility

Collection:

- Gravity sewers
- Pump station and force main
- Combination of gravity and low-pressure sewers

If a collection system is installed, it will require about 4,200 feet of gravity sewer. Since the lowest area of the system is the northern end, a pumping station and 1,200 feet of force main would be needed to connect to the recently installed sewer in River Crest Drive. The area is too large (55 homes) for grinder pumps to be cost-effective. A less costly alternative is to install a gravity collection system and connect by gravity to the existing pumping station in Pawcatuck Avenue.

A community package treatment plant is feasible, but is not the most cost-effective approach, as shown in **Table 2-14**. The recommendation for this area is to connect to the existing wastewater pumping station in Pawcatuck Avenue by gravity.

Area 10 - Mark Street Area
Recommendation: Install a gravity collection system and connect to the nearest sewer.

See Table 2-13

See Table 2-14

The Mark Street Area is a small area with high priority needs. Area 10 has poor soils for onsite treatment. The following are the feasible wastewater collection and treatment options for this area:

<u>Treatment:</u>

- Individual onsite treatment with innovative/alternative technologies
- Community innovative/alternative technologies (package treatment plant)
- Town water pollution control facility

<u>Collection:</u>

- Gravity sewers

Approximately 3,300 feet of gravity sewer will be required for a collection system in this area.

The Mark Street Area is adjacent to the existing Pawcatuck WPCF collection system. The area can be served via gravity sewers and was not connected to the sewer originally because construction of the sewer preceded development of the area.

Because the Mark Street Area is next to the existing sewer system and can be connected by gravity, connecting to the existing system is the most cost-effective solution (**Table 2-15**).

Area 11 - Greenhaven Road Area
Recommendation: Install 19 grinder pumps, low-pressure sewers, a gravity collection system, pumping station and force main to connect to the nearest sewer.

The Greenhaven Road Area is a large area with many small lots (143 homes). The area has a high groundwater table and shallow bedrock. A significant wetland, which is unsuitable for development, is within the area. This area is a high priority needs area with the following potential wastewater treatment alternatives:

<u>Treatment:</u>

- Individual onsite treatment with innovative/alternative technologies
- Community innovative/alternative technologies (package treatment plant)
- Town water pollution control facility

<u>Collection:</u>

- Gravity sewers

See Table 2-15

- Pump station and force main
- Grinder pumps and pressure sewers
- Combination of gravity and low-pressure sewers

If a collection system is constructed in the Greenhaven Road area, about 14,100 feet of gravity pipe will be needed. Because of the topography, some areas (about 19 homes total) will require grinder pumps and about 350 feet of low-pressure sewers. The Greenhaven Road Area is close to the existing Pawcatuck collection system, but a pumping station and 1,700 feet of force main will be required to connect to the system.

Table 2-16 shows that connecting to the existing system is the most cost-efficient option.

Area 12 - Meadow Road Area
Recommendation: Install a gravity collection system, pumping station and force main to connect to the nearest sewer.

The Meadow Road Area is a moderate to high priority needs area. It is a small area (34 homes) located next to the Pawcatuck River. Although the majority of the soils are characterized as suitable for conventional onsite treatment systems, onsite treatment systems may pollute the groundwater and add nutrient loading to the river. Furthermore, the ground is characterized by ledge outcrops and boulders. Based on the screening process, the following are feasible alternatives for this area.

<u>Treatment:</u>

- Individual onsite treatment with innovative/alternative technologies
- Community innovative/alternative technologies (package treatment plant)
- Town water pollution control facility

<u>Collection:</u>

- Gravity sewers
- Pump station and force main
- Grinder pumps and pressure sewers

The Meadow Road Area 1 is located approximately 1,500 feet from the Pawcatuck collection system. Connecting to the Town's existing collection system will require 3,900 feet of gravity pipe. A small pumping station and 3,100 feet of force main will be needed as well. As shown in the cost analysis in **Table 2-17**, connecting to the Town's

See Table 2-16

See Table 2-17

system is more cost-effective than individual onsite treatment or a package treatment plant.

Area 13 - Latimer Point
Recommendation: Install eight grinder pumps, low-pressure sewers, a gravity collection system, pumping station and force main to connect to the nearest sewer.

Latimer Point is a small peninsula that has a large number of homes (80) on small lots (1/4 acre). Latimer Point is currently restricted from development due to inadequate sewage disposal. Implementation of the recommended improvements would remove this obstacle to development.

<u>Treatment:</u>

- Community innovative/alternative technologies (package treatment plant)
- Town water pollution control facility

<u>Collection:</u>

- Gravity sewers
- Pump station and force main
- Combination of gravity and low-pressure sewers

Approximately 4,350 feet of gravity sewer, 1 pumping station, 375 feet of force main, 8 grinder pumps and 500 feet of low-pressure sewers will be needed to create a collection system in the Latimer Point Area.

A package treatment plant can be installed to treat this area's wastewater or this area can connect to the existing wastewater collection system. About 3,700 feet of transmission force main is needed to connect the area to the existing sewer system. The route of the transmission line is not densely populated (Figure 2-22). Hence, constructing the force main will not have a large impact on residents of the Town. The route of the transmission line includes a railroad crossing, which adds to the cost of this alternative. However, as shown in the cost analysis in **Table 2-18**, connection to the Town's collection system is the least costly alternative.

Area 14 - Mason's Island
Recommendation: Install 10 grinder pumps, low-pressure sewers, a gravity collection system, two pumping stations, force mains, and community wastewater treatment facility.

The Mason's Island Area is a moderate needs area consisting of 64 homes on small lots. This peninsula on Fishers Island Sound has wetlands, high groundwater and shallow ledge. Feasible wastewater management options are listed below:

See Table 2-18

Treatment:

- Individual onsite treatment with innovative/alternative technologies
- Community innovative/alternative technologies (package treatment plant)
- Town water pollution control facility

Collection:

- Gravity sewers
- Pump station and force main
- Grinder pumps and low-pressure sewers
- Combination of gravity and low-pressure sewers

To construct a collection system, 8,150 feet of gravity sewer will be needed. Due to topography, a small area will require a pumping station and 1,200 feet of force main. Ten homes will need grinder pumps and approximately 300 feet of low-pressure sewers.

Mason's Island is over a mile away from the existing wastewater collection system, and 7,000 feet of transmission force main, including a bridge crossing, will be needed to connect the area to the existing system. The route of the transmission main is through very densely populated areas (Figure 2-22), subject to significant construction impacts.

A package treatment plant is a viable option for Mason's Island. The cost analysis in **Table 2-19** indicates connecting to the existing sewer is slightly more cost-effective than constructing a community treatment facility due to annual operation and maintenance costs; however, considering the impacts of constructing 7,000 feet of force main through the densely-populated area north of Mason's Island, the recommended alternative is a community treatment system.

Area 15 - Marlin Drive Area
Recommendation: Install a gravity collection system, pumping station and force main to connect to the nearest sewer.

The Marlin Drive Area is a high needs area. This area has high groundwater and onsite systems may pollute several nearby surface water bodies. Also, any pollution may increase the nitrogen loading to the cove and Long Island Sound. The Marlin Drive Area contains environmentally sensitive areas and the lots are small. Based on the screening process in Section 2-5, the following are feasible wastewater management alternatives:

Treatment:

See Table 2-19

- Individual onsite treatment with innovative/alternative technologies
- Community innovative/alternative technologies (package treatment plant)
- Town water pollution control facility

Collection:

- Gravity sewers
- Pump station and force main
- Combination of gravity and low-pressure sewers

Approximately 4,000 feet of gravity sewers are needed to construct a collection system. The Marlin Drive Area is relatively close to the Pawcatuck collection system; however, a pumping station and 4,100 feet of force main will be required because the area is on the other side of a ridge line.

Table 2-20 indicates connecting to the existing sewer is the least expensive alternative.

Area 16 - Elm Street Area
Recommendation: Install thirty-one grinder pumps, low-pressure sewers and a gravity collection system to connect to the nearest sewer.

The Elm Street Area is a high needs area with 74 homes. It is characterized by shallow and exposed bedrock, high groundwater, and soil unsuitable for onsite disposal. The following are feasible alternatives to meet the needs of this area:

Treatment:

- Individual onsite treatment with innovative/alternative technologies
- Community innovative/alternative technologies (package treatment plant)
- Town water pollution control facility

Collection:

- Gravity sewers
- Pump station and force main
- Combination of gravity and low-pressure sewers

The Elm Street Area is located adjacent to the Borough wastewater collection system, and a portion of this area may be served by connecting a new 5,900-foot gravity collection system to the existing system at Meadow Avenue. There are three small,

See Table 2-20

separate areas that cannot be served by gravity sewer. These areas can be served by a total of 31 grinder pumps and 2,050 feet of low-pressure sewers. **Table 2-21** indicates connecting to the existing sewer is the most cost-effective solution.

Area 17 - Montauk Avenue Area
Recommendation: Install two grinder pumps, low-pressure sewers and a gravity collection system to connect to the nearest sewer.

The Montauk Road Area is a high priority needs area with 34 homes. Although lot sizes are large enough (2 acres on average) for individual onsite treatment, the soil is poor. Below are possible options to address their wastewater management needs.

Treatment:

- Individual onsite treatment with innovative/alternative technologies
- Community innovative/alternative technologies (package treatment plant)
- Town water pollution control facility

Collection:

- Gravity sewers
- Pump station and force main
- Grinder pumps and low-pressure sewers
- Combination of gravity and low-pressure sewers

The Montauk Avenue Area is located immediately adjacent to the Borough wastewater collection system. Several homes in this area are located at a lower elevation than the street. Extensive easements will be required to provide a gravity collection pipe to service the area, or the wastewater will have to be pumped from the homes to a collection pipe in the public way. Costs in **Table 2-22** are for a mostly gravity collection system and only two grinder pumps with 300 feet of low-pressure sewers.

Given the proximity of the Montauk Avenue Area to the existing sewer, connecting to the existing collection system is the recommended option, as shown in Table 2-22.

Area 18 - North Stonington Road Area
Recommendation: Install individual onsite systems with innovative/alternative technologies.

The North Stonington Road Area is a moderate needs area with 30 homes. Soils in this area are poor for onsite treatment and may pollute the naturally high groundwater. The following are feasible alternatives for this area:

See Table 2-21

See Table 2-22

Treatment:

- Individual onsite treatment with innovative/alternative technologies
- Community innovative/alternative technologies (package treatment plant)
- Town water pollution control facility

Collection:

- Gravity sewers
- Pump station and force main
- Grinder pumps and low-pressure sewers
- Combination of gravity and low-pressure sewers

Approximately 3,100 feet of gravity pipe will be required to construct a collection system in this area.

The North Stonington Road Area is located more than a mile (approximately 7,700 feet) from the existing wastewater collection system, which makes connecting to an existing sewer costly. A pumping station and approximately 3,200 feet of force main will be needed to connect the area to the Mystic collection system.

The cost analysis in **Table 2-23** shows that the present worth costs for individual and community systems are very close. Most of the lots in this area are relatively large (greater than one acre), which allows room for siting individual systems. As shown on Figure 2-21, only one resident reported problems with their septic system. Based on the large lot sizes and the low number of reported problems in this area, the recommended alternative for the North Stonington Road area is individual onsite systems with innovative/alternative technologies.

2.7.4 Summary of Recommended Alternatives

Tables 2-24 and 2-25 summarize the recommended alternatives, total capital costs, costs per lot and annual operation and maintenance costs for each of the 18 wastewater needs areas. The needs areas have a variety of problems and issues, including high groundwater, ledge, poor filtration, environmentally sensitive areas and small lots. Installing a collection system and connecting to the existing sewer is the most cost-effective and environmentally sound alternative for 15 of the 18 wastewater needs areas. The other three areas, Marjorie Street, Mason's Island and North Stonington Road, are located relatively far from the existing wastewater collection system, and the impacts of constructing the transmission lines will be significant. Recommended alternatives for these three areas are community treatment systems for Marjorie Street and Mason's Island, and individual onsite systems with innovative/alternative technologies for the North Stonington Road area.

See Table 2-23

See Table 2-24

See Table 2-25

The proposed collection and transmission systems are shown in Figure 2-22. Based on the recommendations and the locations of the wastewater needs areas, four areas will be connected to the Mystic collection system. In addition, nine areas will be connected to the Pawcatuck collection system. The Borough collection system will receive flows from two wastewater needs areas.

2.8 Implementation of Recommendations

2.8.1 Introduction

The recommendations described in Section 2.7 for each of the 18 needs areas represent a very large capital improvements program. Taken together, the capital cost of implementing the recommended improvements for all 18 areas would be approximately $41 million in August 2006 dollars (ENR 7763), and this total cannot be feasibly afforded by the Town of Stonington over the 20-year planning period. Therefore, the Town plans on implementing the recommended improvements only for those areas of highest need.

2.8.2 Ranking of Needs Areas

As described in Section 2.4, each of the needs areas has been prioritized into one of four categories: critical, high, moderate and low. **Table 2-26** summarizes these rankings. As shown, two areas are rated critical: the Marjorie Street and Elm Ridge Road areas; and seven areas are rated high: Roseleah Drive, Pequot Trail, Cronin Avenue, Mark Street, Greenhaven Road, Latimer Point and Marlin Drive. The other areas are ranked either moderate or low.

2.8.3 Scheduling and Budgeting of Selected Areas

The critical and high priority areas should be addressed during the 20-year planning period, in such a way to minimize impacts on the Town's citizens. Two phases of implementation are recommended: the critical areas should be addressed early in the 20-year period, and the high-priority areas addressed later. This implementation would result in a planned capital expenditure of approximately $7.3 million in the first phase, and $16.1 million in the second phase (ENR 7763). A proposed implementation schedule is presented in Section 8.

The moderate and low priority areas should be monitored for increased incidence of problems, which could result in re-prioritizing the areas.

2.8.4 Flexibility of Implementation

WPCA will plan on the two-phased approach for addressing the critical and high-priority needs areas within the 20-year planning period. However, WPCA has the right and responsibility to continuously review the sewer needs of the Town, and respond to the highest-priority needs as the public health demands and as budgetary constraints allow. Therefore, it is possible that the timing of implementing the recommended improvements may change, either by accelerating or delaying the

See Table 2-26

schedule, and it is also possible that the needs areas priorities will change. This planning approach is acceptable to CTDEP.

However, CTDEP requires that the projected flows and loads at the treatment plants, as presented in Section 3, be developed under the assumption that ALL of the sewer needs areas are connected during the 20-year planning period. The projections presented in Section 3 include the projected flows from all 18 areas.

Soil Classification	Slope	Permeability	Adequate Ability to Filter	Depth to Seasonal High Water Table	Depth to Bedrock	Wetness and/or Ponding	Susceptible to Flooding	Suitability for Subsurface Wastewater Disposal
Adrian	0-2%	Moderately Rapid	Poor	Shallow	-	Yes	No	X
Agawam	0-3%	Moderately Rapid	Poor	-	-	No	No	W
	3-8%	Moderately Rapid	Poor	-	-	No	No	W
Beaches	0-8%	-	-	Shallow	-	No	Yes	-
Broadbrook	3-8%	Slow	Percs Slowly	-	-	Yes	No	D
Canton	3-8%	Moderately Rapid	-	-	-	No	No	D
	8-15%	Moderate	-	-	-	No	No	D
	15-25%	Moderately Rapid	-	-	-	No	No	D
	3-15%	Moderate	-	-	-	No	No	D
	15-35%	Moderately Rapid	-	-	-	No	No	D
Carlisle	-	Moderately Rapid	-	Shallow	-	Yes	Yes	X
Charlton	3-15%	Moderate	Moderate	-	Shallow	No	No	D
	15-45%	Moderate	-	-	Shallow	No	No	X
Dumps	-	-	-	-	-	No	No	X
Haven	0-3%	Moderate	Poor	-	-	No	No	S
	3-8%	Moderate	Poor	-	-	No	No	W
Hinkley	0-3%	Rapid	Poor	-	-	No	No	W
	3-15%	Rapid	Poor	-	-	No	No	W
	15-35%	Rapid	Poor	-	-	No	No	X
Hollis	3-15%	Moderate	-	-	Shallow	No	No	D
	15-45%	Moderate	-	-	Shallow	No	No	X
Ipswich	-	Moderate	Poor	Shallow	-	Yes	Yes	X
Limerick	-	Moderate	Poor	Shallow	-	Yes	Yes	X
Merrimac	0-3%	Moderately Rapid	Poor	-	-	No	No	W
	3-8%	Moderately Rapid	Poor	-	-	No	No	W
	8-15%	Moderately Rapid	Poor	-	-	No	No	W
Narragansett	3-8%	Moderate	Slight	-	Shallow	No	No	S
	3-15%	Moderate	Slight	-	Shallow	No	No	D
	15-25%	Moderate	-	-	Shallow	No	No	X
Ninigret	-	Moderately Rapid	Poor	Shallow	-	Yes	No	W
Pawcatuck	0-1%	Moderate	Poor	Shallow	-	Yes	Yes	X
Paxton	3-8%	Very Slow	Percs Slowly	-	-	No	No	D
	8-15%	Very Slow	Percs Slowly	-	-	No	No	D
	15-25%	Very Slow	-	-	-	No	No	X
	3-15%	Very Slow	Percs Slowly	-	-	No	No	D
	15-35%	Very Slow	-	-	-	No	No	X

Table 2-1
Suitability For Onsite Wastewater Disposal

Soil Classification	Slope	Permeability	Adequate Ability to Filter	Depth to Seasonal High Water Table	Depth to Bedrock	Wetness and/or Ponding	Susceptible to Flooding	Suitability for Subsurface Wastewater Disposal
Pootatuck	-	Moderate	Poor	Shallow	-	Yes	Yes	X
Rainbow	0-3%	Very Slow	Percs Slowly	Shallow	-	Yes	No	D
	3-8%	Very Slow	Percs Slowly	Shallow	-	Yes	No	D
	0-8%	Very Slow	Percs Slowly	Shallow	-	Yes	No	D
Raypol	-	Moderate	Poor	Shallow	-	Yes	No	D/W
Ridgebury	-	Moderate	Percs Slowly	Shallow	-	Yes	No	D
Rippowam	-	Moderate	Poor	Shallow	-	Yes	Yes	D
Rock Outcrop	-	-	-	-	Shallow	No	No	X
Scarboro	-	Rapid	Poor	Shallow	-	Yes	No	D
Sudbury	-	Moderately Rapid	Poor	Shallow	-	Yes	No	D/W
Sutton	0-3%	Moderate	Poor	Shallow	-	Yes	No	D
	3-8%	Moderate	Poor	Shallow	-	Yes	No	D
	0-8%	Moderate	Poor	Shallow	-	Yes	No	D
Udorthents	-	Slow	-	Shallow	-	No	No	-
Walpole	-	Moderately Rapid	Poor	Shallow	-	Yes	No	D/W
Westbrook	-	Moderate	-	Shallow	-	Yes	Yes	X
Windsor	0-3%	Rapid	Poor	-	-	No	No	W
	3-8%	Rapid	Poor	-	-	No	No	W
Woodbridge	0-3%	Very Slow	Percs Slowly	Shallow	-	Yes	No	D
	3-8%	Very Slow	Percs Slowly	Shallow	-	Yes	No	D
	8-15%	Very Slow	Percs Slowly	Shallow	-	Yes	No	D
	0-8%	Very Slow	Percs Slowly	Shallow	-	Yes	No	D
	3-15%	Very Slow	Percs Slowly	Shallow	-	Yes	No	D

Source: *Soil Survey for New London County Connecticut*

Legend

S = Suitable for typical onsite disposal system
D = May require special onsite disposal system design
W = May tend to pollute groundwater
D/W = May require special onsite disposal system design and may tend to pollute groundwater
X = Not suitable for onsite disposal system

Table 2-1
Suitability For Onsite Wastewater Disposal

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Individual Onsite Systems with Innovative Alternative Technologies	**$8,871,000**	**$12,419,000**	**$60,600**	**$128,800**	**$13,942,000**
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$3,537,000	$4,952,000	$24,200	$24,000	$4,833,000
Transmission system	$269,000	$377,000	$1,800	$6,400	$437,000
Treatment system	$1,549,000	$2,169,000	$10,600	$113,300	$3,509,000
Total Cost	**$5,355,000**	**$7,497,000**	**$36,600**	**$143,700**	**$8,779,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$3,537,000	$4,952,000	$24,200	$24,000	$4,841,000
Transmission system	$211,000	$295,000	$1,400	$61,700	$1,025,000
Total Cost	**$3,748,000**	**$5,247,000**	**$25,600**	**$85,700**	**$5,866,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

Table 2-10
Area 5 - Elm Ridge Road Area
Constrruction Cost Summary[1]

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Individual Onsite Systems with Innovative Alternative Technologies	**$4,890,000**	**$6,846,000**	**$60,600**	**$94,000**	**$7,958,000**
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$2,504,000	$3,506,000	$31,000	$4,600	$3,197,000
Transmission system	$269,000	$377,000	$3,300	$3,200	$399,000
Treatment system	$857,000	$1,200,000	$10,600	$80,100	$2,147,000
Total Cost	**$3,630,000**	**$5,082,000**	**$45,000**	**$87,900**	**$5,743,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$2,541,000	$3,557,000	$31,500	$4,600	$3,258,000
Transmission system	$116,000	$162,000	$1,400	$32,200	$543,000
Total Cost	**$2,657,000**	**$3,720,000**	**$32,900**	**$36,800**	**$3,801,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

Table 2-11
Area 6 - Pequot Trail Area
Construction Cost Summary[1]

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Individual Onsite Systems with Innovative Alternative Technologies	**$1,298,000**	**$1,817,000**	**$60,600**	**$28,200**	**$2,151,000**
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$433,000	$606,000	$20,200	$0	$535,000
Transmission system	$269,000	$377,000	$12,600	$3,200	$399,000
Treatment system	$233,000	$326,000	$10,900	$51,800	$939,000
Total Cost	**$935,000**	**$1,309,000**	**$43,600**	**$55,000**	**$1,873,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$433,000	$606,000	$20,200	$0	$550,000
Transmission system	$31,000	$43,000	$1,400	$8,600	$145,000
Total Cost	**$464,000**	**$650,000**	**$21,700**	**$8,600**	**$695,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

Table 2-12
Area 7 - Cronin Avenue/Holly Street
Construction Cost Summary[1]

CDM

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Individual Onsite Systems with Innovative Alternative Technologies	**$1,644,000**	**$2,302,000**	**$60,600**	**$35,700**	**$2,724,000**
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$721,000	$1,009,000	$26,600	$0	$893,000
Transmission system	$240,000	$336,000	$8,800	$3,200	$358,000
Treatment system	$293,000	$410,000	$10,800	$54,700	$1,057,000
Total Cost	**$1,254,000**	**$1,756,000**	**$46,200**	**$57,900**	**$2,308,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$784,000	$1,098,000	$28,900	$1,400	$1,007,000
Transmission system	$39,000	$55,000	$1,400	$14,000	$221,000
Total Cost	**$823,000**	**$1,152,000**	**$30,300**	**$15,400**	**$1,228,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

CDM

Table 2-13
Area 8 - Millan Terrace Area
Construction Cost Summary[1]

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Individual Onsite Systems with Innovative Alternative Technologies	**$2,380,000**	**$3,332,000**	**$60,600**	**$51,700**	**$3,943,000**
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$977,000	$1,368,000	$24,900	$0	$1,219,000
Transmission system	$269,000	$377,000	$6,900	$3,200	$399,000
Treatment system	$421,000	$589,000	$10,700	$60,100	$1,300,000
Total Cost	**$1,667,000**	**$2,334,000**	**$42,400**	**$63,300**	**$2,918,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$977,000	$1,368,000	$24,900	$0	$1,235,000
Transmission system	$205,000	$287,000	$5,200	$18,900	$500,000
Total Cost	**$1,182,000**	**$1,655,000**	**$30,100**	**$18,900**	**$1,735,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

CDM

Table 2-14
Area 9 - Aimee Drive Area
Construction Cost Summary[1]

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Individual Onsite Systems with Innovative Alternative Technologies	**$1,774,000**	**$2,484,000**	**$60,600**	**$38,600**	**$2,941,000**
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$760,000	$1,064,000	$26,000	$0	$943,000
Transmission system	$240,000	$336,000	$8,200	$3,200	$358,000
Treatment system	$316,000	$442,000	$10,800	$55,800	$1,102,000
Total Cost	**$1,316,000**	**$1,842,000**	**$44,900**	**$59,000**	**$2,403,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$760,000	$1,064,000	$26,000	$0	$959,000
Transmission system	$42,000	$59,000	$1,400	$11,700	$197,000
Total Cost	**$802,000**	**$1,123,000**	**$27,400**	**$11,700**	**$1,156,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

Table 2-15
Area 10 - Mark Street Area
Construction Cost Summary[1]

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Individual Onsite Systems with Innovative Alternative Technologies	**$6,188,000**	**$8,663,000**	**$60,600**	**$116,600**	**$10,042,000**
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$3,646,000	$5,104,000	$35,700	$6,700	$4,716,000
Transmission system	$93,000	$130,000	$900	$3,200	$152,000
Treatment system	$1,083,000	$1,516,000	$10,600	$91,500	$2,598,000
Total Cost	**$4,822,000**	**$6,751,000**	**$47,200**	**$101,400**	**$7,466,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$3,646,000	$5,104,000	$35,700	$6,700	$4,704,000
Transmission system	$147,000	$206,000	$1,400	$44,000	$726,000
Total Cost	**$3,793,000**	**$5,310,000**	**$37,100**	**$50,700**	**$5,430,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

Table 2-16
Area 11 - Greehaven Road Area
Construction Cost Summary[1]

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Individual Onsite Systems with Innovative Alternative Technologies	**$1,471,000**	**$2,059,000**	**$60,600**	**$32,000**	**$2,437,000**
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$1,142,000	$1,599,000	$47,000	$0	$1,459,000
Transmission system	$93,000	$130,000	$3,800	$3,200	$152,000
Treatment system	$263,000	$368,000	$10,800	$53,300	$998,000
Total Cost	**$1,498,000**	**$2,097,000**	**$61,700**	**$56,500**	**$2,609,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$1,142,000	$1,599,000	$47,000	$0	$1,450,000
Transmission system	$174,000	$244,000	$7,200	$12,900	$373,000
Total Cost	**$1,316,000**	**$1,842,000**	**$54,200**	**$12,900**	**$1,823,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

Table 2-17
Area 12 - Meadow Road Area
Construction Cost Summary[1]

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$1,383,000	$1,936,000	$24,200	$2,800	$1,809,000
Transmission system	$93,000	$130,000	$1,600	$3,200	$152,000
Treatment system	$609,000	$853,000	$10,700	$68,100	$1,658,000
Total Cost	**$2,085,000**	**$2,919,000**	**$36,500**	**$74,100**	**$3,619,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$1,383,000	$1,936,000	$24,200	$2,800	$1,819,000
Transmission system	$497,000	$696,000	$8,700	$24,200	$923,000
Total Cost	**$1,880,000**	**$2,632,000**	**$32,900**	**$27,000**	**$2,742,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

Table 2-18
Area 13 - Latimer Point
Construction Cost Summary[1]

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Individual Onsite Systems with Innovative Alternative Technologies	**$3,462,000**	**$4,847,000**	**$60,600**	**$65,800**	**$5,625,000**
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$2,132,000	$2,985,000	$37,300	$3,500	$2,748,000
Transmission system	$269,000	$377,000	$4,700	$6,400	$437,000
Treatment system	$609,000	$853,000	$10,700	$66,600	$1,641,000
Total Cost	**$3,010,000**	**$4,214,000**	**$52,700**	**$76,500**	**$4,826,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$2,132,000	$2,985,000	$37,300	$3,500	$2,745,000
Transmission system	$1,065,000	$1,491,000	$18,600	$23,200	$1,654,000
Total Cost	**$3,197,000**	**$4,476,000**	**$56,000**	**$26,700**	**$4,399,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

Table 2-19
Area 14 - Mason's Island
Construction Cost Summary[1]

	Category	Number	Percentage of Total Responses	Percentage of Problems
I.	Total Responses	1623	100%	-
II.	Disposal System Problems	133	8%	100%
	Problem Symptoms*	93	6%	70%
	High Groundwater (≤ 5 feet below ground surface)	14	1%	11%
	Poor Soils / Ledge	76	5%	57%
	Proximity to Water Supply / Private Well	41	3%	31%
	Frequency of Pumping (more than once per year)	50	3%	38%
	Age of Disposal System			
	> 50 years	1	0%	1%
	20-40 years	63	4%	47%
	Neighbors with Problems	32	2%	24%

* Problem symptoms include slow drainage in sink and other water using appliances, toilet backing up, outside odors, and standing water on ground surface above septic system.

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Table 2-2
Summary of Questionnaire Responses

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Individual Onsite Systems with Innovative Alternative Technologies	**$3,116,000**	**$4,362,000**	**$60,600**	**$67,700**	**$5,163,000**
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$1,437,000	$2,012,000	$27,900	$0	$1,869,000
Transmission system	$93,000	$130,000	$1,800	$3,200	$152,000
Treatment system	$549,000	$769,000	$10,700	$65,900	$1,548,000
Total Cost	**$2,079,000**	**$2,911,000**	**$40,400**	**$69,100**	**$3,569,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$1,437,000	$2,012,000	$27,900	$0	$1,841,000
Transmission system	$195,000	$273,000	$3,800	$23,700	$533,000
Total Cost	**$1,632,000**	**$2,285,000**	**$31,700**	**$23,700**	**$2,374,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

CDM

Table 2-20
Area 15 - Marlin Drive Area
Construction Cost Summary[1]

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Individual Onsite Systems with Innovative Alternative Technologies	**$3,202,000**	**$4,483,000**	**$60,600**	**$40,400**	**$4,961,000**
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$1,651,000	$2,311,000	$31,200	$10,900	$2,214,000
Transmission system	$269,000	$377,000	$5,100	$3,200	$399,000
Treatment system	$564,000	$790,000	$10,700	$65,700	$1,567,000
Total Cost	**$2,484,000**	**$3,478,000**	**$47,000**	**$79,800**	**$4,180,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$1,670,000	$2,338,000	$31,600	$10,900	$2,254,000
Transmission system	$134,000	$188,000	$2,500	$18,600	$408,000
Total Cost	**$1,804,000**	**$2,526,000**	**$34,100**	**$29,500**	**$2,662,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

CDM

Table 2-21
Area 16 - Elm Street Area
Construction Cost Summary[1]

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Individual Onsite Systems with Innovative Alternative Technologies	**$1,471,000**	**$2,059,000**	**$60,600**	**$30,100**	**$2,415,000**
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$1,250,000	$1,750,000	$51,500	$700	$1,551,000
Transmission system	$240,000	$336,000	$9,900	$3,200	$358,000
Treatment system	$263,000	$368,000	$10,800	$52,900	$994,000
Total Cost	**$1,753,000**	**$2,454,000**	**$72,200**	**$56,800**	**$2,903,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$1,250,000	$1,750,000	$51,500	$700	$1,567,000
Transmission system	$62,000	$87,000	$2,600	$8,500	$188,000
Total Cost	**$1,312,000**	**$1,837,000**	**$54,000**	**$9,200**	**$1,755,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

CDM

Table 2-22
Area 17 - Montauk Avenue Area
Construction Cost Summary[1]

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Individual Onsite Systems with Innovative Alternative Technologies	**$1,298,000**	**$1,817,000**	**$60,600**	**$28,200**	**$2,151,000**
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$683,000	$956,000	$31,900	$0	$842,000
Transmission system	$240,000	$336,000	$11,200	$3,200	$358,000
Treatment system	$233,000	$326,000	$10,900	$51,800	$939,000
Total Cost	**$1,156,000**	**$1,618,000**	**$53,900**	**$55,000**	**$2,139,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$683,000	$956,000	$31,900	$0	$858,000
Transmission system	$1,216,000	$1,702,000	$56,700	$11,800	$1,730,000
Total Cost	**$1,899,000**	**$2,659,000**	**$88,600**	**$11,800**	**$2,588,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

CDM

Table 2-23
Area 18 - North Stonington Road
Construction Cost Summary[1]

	Area	Average Flow (gpd)	District	Treatment Alternatives			Collection Alternatives			
				Individual Onsite Systems with Innovative/Alternative Technologies	Community Innovative/Alternative Technologies	Town Water Pollution Control Facility	Gravity Sewers	Pump Station and Force Main	Grinder Pumps and Low Pressure Sewers	Combination of Gravity and Low-Pressure Sewers
1	Marjorie Street Area	7,000	Not near WPCF	X	**X**	X	**X**	**X**		
2	Riverbend Drive	6,762	Mystic WPCF	X	X	**X**	**X**	**X**		
3	School Street	5,474	Mystic WPCF	X	X	**X**	X	X	X	**X**
4	Roseleah Drive	3,325	Mystic WPCF			**X**			**X**	
5	Elm Ridge Road Area	35,875	Pawcatuck WPCF	X	X	**X**	X	**X**		**X**
6	Pequot Trail Area	19,775	Pawcatuck WPCF	X	X	**X**	X			**X**
7	Cronin Avenue/Holly Street	5,250	Pawcatuck WPCF	X	X	**X**	**X**			X
8	Millan Terrace	6,650	Pawcatuck WPCF	X	X	**X**	**X**		X	**X**
9	Aimee Drive Area	9,625	Pawcatuck WPCF	X	X	**X**	**X**	X		X
10	Mark Street Area	7,175	Pawcatuck WPCF	X	X	**X**	**X**			
11	Greenhaven Road Area	25,025	Pawcatuck WPCF	X	X	**X**	X	**X**	X	**X**
12	Meadow Road Area	5,950	Pawcatuck WPCF	X	X	**X**	**X**	**X**	X	
13	Latimer Point	12,880	Mystic WPCF		X	**X**	X	**X**		**X**
14	Mason's Island	10,304	Mystic WPCF	X	**X**	X	X	**X**	X	**X**
15	Marlin Drive Area	12,600	Pawcatuck WPCF	X	X	**X**	**X**	**X**		X
16	Elm Street Area	11,396	Borough WPCF	X	X	**X**	X			**X**
17	Montauk Road Area	5,236	Borough WPCF	X	X	**X**	X		X	**X**
18	North Stonington Road	5,250	Not near WPCF	**X**	X	X	X		X	X

X (shaded) = Recommended Alternative

Area		Average Flow (gpd)	District	Recommended Treatment Alternative	Recommended Collection Alternative	Capital Cost[2]	Cost per Lot[3]	Annual O&M
1	Marjorie Street Area	7,000	Not Applicable	Community Innovative/Alternative Technologies	Gravity Sewers, Pump Station and Force Main	$2,086,000	$52,200	$58,600
2	Riverbend Drive	6,762	Mystic WPCF	Town Water Pollution Control Facility	Gravity Sewers, Pump Station and Force Main	$1,476,000	$35,100	$14,200
3	School Street	5,474	Mystic WPCF	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers	$1,044,000	$30,700	$17,000
4	Roseleah Drive	3,325	Mystic WPCF	Town Water Pollution Control Facility	Grinder Pumps and Low-Pressure Sewers	$384,000	$24,000	$11,000
5	Elm Ridge Road Area	35,875	Pawcatuck WPCF	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers, Pump Station and Force Main	$5,247,000	$25,600	$85,700
6	Pequot Trail Area	19,775	Pawcatuck WPCF	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers	$3,720,000	$32,900	$36,800
7	Cronin Avenue/ Holly Street	5,250	Pawcatuck WPCF	Town Water Pollution Control Facility	Gravity Sewers	$650,000	$21,700	$8,600
8	Millan Terrace	6,650	Pawcatuck WPCF	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers	$1,152,000	$30,300	$15,400
9	Aimee Drive Area	9,625	Pawcatuck WPCF	Town Water Pollution Control Facility	Gravity Sewers	$1,655,000	$30,100	$18,900
10	Mark Street Area	7,175	Pawcatuck WPCF	Town Water Pollution Control Facility	Gravity Sewers	$1,123,000	$27,400	$11,700
11	Greenhaven Road Area	25,025	Pawcatuck WPCF	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers, Pump Station and Force Main	$5,310,000	$37,100	$50,700
12	Meadow Road Area	5,950	Pawcatuck WPCF	Town Water Pollution Control Facility	Gravity Sewers, Pump Station and Force Main	$1,842,000	$54,200	$12,900
13	Latimer Point	12,880	Mystic WPCF	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers, Pump Station and Force Main	$2,632,000	$32,900	$27,000
14	Mason's Island	10,304	Mystic WPCF	Community Innovative/Alternative Technologies	Combination of Gravity and Low-Pressure Sewers, Pump Station and Force Main	$4,214,000	$52,700	$76,500
15	Marlin Drive Area	12,600	Pawcatuck WPCF	Town Water Pollution Control Facility	Gravity Sewers, Pump Station and Force Main	$2,285,000	$31,700	$23,700
16	Elm Street Area	11,396	Borough WPCF	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers	$2,526,000	$34,100	$29,500
17	Montauk Road Area	5,236	Borough WPCF	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers	$1,837,000	$54,000	$9,200
18	North Stonington Road	5,250	Not Applicable	Individual Onsite Systems with Innovative/Alternative Technologies	Not Applicable	$1,817,000	$60,600	$28,200

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to July 2002, Engineering News Record (ENR) Construction Cost Index 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for lots within wastewater needs area.

Table 2-25
Recommended Alternatives
Cost Summary[1]

	Area	Priority Ranking
1	Marjorie Street Area	Critical
5	Elm Ridge Road Area	Critical
4	Roseleah Drive	High
6	Pequot Trail Area	High
7	Cronin Avenue/Holly Street	High
10	Mark Street Area	High
11	Greenhaven Road Area	High
13	Latimer Point	High
15	Marlin Drive Area	High
12	Meadow Road Area	Moderate to High
2	Riverbend Drive	Moderate
3	School Street	Moderate
8	Millan Terrace	Moderate
9	Aimee Drive Area	Moderate
14	Mason's Island	Moderate
16	Elm Street Area	Low
17	Montauk Road Area	Low
18	North Stonington Road	Low

Table 2-26
Needs Areas Priority Ranking

Item	Separating Distance	Special Provisions
Well, spring or domestic water suction pipe Withdrawal Rate: <10 gpm 10 to 50 gpm >50 gpm	 75 feet 150 feet 200 feet	1) Separation distance will be doubled where soil percolation rate is > 1min./inch and there is < 8 feet between proposed leach field and ledge rock. 2) Separation distance can be increased as necessary to protect PWS well.
Human habitation on adjacent property	15 feet	No footing drains
Building served	15 feet	No footing drains
Open watercourse	50 feet	If not in PWS watershed, this distance can be lowered to not less than 25 feet on existing lots.
Public water supply reservoir	100 feet	
Groundwater collection drains	25-50 feet	
Surface or groundwater drain	25 feet	
Property line	10 feet	
Potable water and/or irrigation pressure lines	10 feet	
Below ground swimming pool	25 feet	
Above ground swimming pools	10 feet	Includes hot tubs
Top of cut or filled embankment	10 feet	Down gradient and all sides
Accessory structure	10 feet	No footing drains
Reserve Area	Required	
Distance from maximum groundwater	18 inches	
Distance from ledge	4 feet	
Minimum design flow	300 gpd	
Minimum septic tank capacity	1,000 gallons	
Leaching trenches	Min. width: 18 inches Max. width: 48 inches Max. length: 75 feet or 100 feet if dosed	

gpm = gallons per minute

gpd = gallons per day

PWS = public water supply

Table 2-3
Setback Requirements and Design Criteria for Subsurface Sewage Disposal Systems

Name	Description	Design Flows	Limitations	Typical Cost (Un- Installed)
Amphidrome F.R. Mahony & Assoc.	A fixed-film, sequencing batch biofilter	200 to 100,000 gpd	Below-grade, so ledge may be a factor	440 gpd: $12,000 40,000 gpd: $325,000
Bioclere AWT Environmental	Modified trickling filter over a clarifier	200 to 100,000 gpd	Excessive organic loads may require pretreatment	$5,000 to $7,000 per home
FAST Bio-Microbics, Inc.	Fixed activated sludge treatment	500 to 9,000 gpd	Requires a small amount of electricity	$3,000 to $23,000
FAST Modular	Fixed activated sludge treatment	10,000 to 90,000 gpd	None given	Site specific
Puroflo Bord Na Mona	Passive biofiltration using peat media	200 to 10,000 gpd	For domestic waste only	$9,000/home
Enviro-Septic Presby Environmental	Post-septic tank biofiltration	single residence	None given	30% to 70% less than conventional leaching systems
Presby Maze Presby Environmental	Filter addition to inside septic tank	single residence	Difficult to retrofit	< $1,000
Polylok Effluent Filter United Concrete/Polyok, Inc.	Media for septic effluent filtration placed at tank outlet	single residence	None given	
Equalizer United Concrete/Polyok, Inc.	Maintains equal flow out of distribution box	single residence	None given	
NITREX University of Waterloo	Media that converts nitrate to nitrogen gas	N/A	Requires oxidative pretreatment, for instance a sand filter	$1,500/home
ZeeWeed ZENON Environmental Inc.	Membrane Technology	N/A	None given	
M-PAC Enviroquip, Inc.	Membrane Technology	6,500 to 125,000 gpd	None given	

Source: New England EPA Center for Environmental Industry and Technology

gpd = gallons per day

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Table 2-4
Summary of the Innovative /Alternative Wastewater Treatment Systems

	Area	Average Flow (gpd)	District	Treatment Alternatives			Collection Alternatives			
				Individual Onsite Systems with Innovative/Alternative Technologies	Community Innovative/Alternative Technologies	Town Water Pollution Control Facility	Gravity Sewers	Pump Station and Force Main	Grinder Pumps and Low Pressure Sewers	Combination of Gravity and Low-Pressure Sewers
1	Marjorie Street Area	7,000	Not near WPCF	X	X	X	X	X		
2	Riverbend Drive	6,762	Mystic WPCF	X	X	X	X	X		
3	School Street	5,474	Mystic WPCF	X	X	X	X	X	X	X
4	Roseleah Drive	3,325	Mystic WPCF			X			X	
5	Elm Ridge Road Area	35,875	Pawcatuck WPCF	X	X	X	X	X		X
6	Pequot Trail Area	19,775	Pawcatuck WPCF	X	X	X	X			X
7	Cronin Avenue	5,250	Pawcatuck WPCF	X	X	X	X			X
8	Millan Terrace	6,650	Pawcatuck WPCF	X	X	X	X		X	X
9	Aimee Drive Area	9,625	Pawcatuck WPCF	X	X	X	X	X		X
10	Mark Street Area	7,175	Pawcatuck WPCF	X	X	X	X			
11	Greenhaven Road Area	25,025	Pawcatuck WPCF	X	X	X	X	X	X	X
12	Meadow Road Area	5,950	Pawcatuck WPCF	X	X	X	X	X	X	
13	Latimer Point	12,880	Mystic WPCF		X	X	X	X		X
14	Mason's Island	10,304	Mystic WPCF	X	X	X	X	X	X	X
15	Marlin Drive Area	12,600	Pawcatuck WPCF	X	X	X	X	X		X
16	Elm Street Area	11,396	Borough WPCF	X	X	X	X			X
17	Montauk Road Area	5,236	Borough WPCF	X	X	X	X		X	X
18	North Stonington Road	5,250	Not near WPCF	X	X	X	X		X	X

X =Suitable Alternative

gallons per day

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Table 2-5
Suitable Wastewater Management Alternatives

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$942,000	$1,319,000	$33,000	$0	$1,167,000
Transmission system	$240,000	$336,000	$8,400	$3,200	$358,000
Treatment system	$308,000	$431,000	$10,800	$55,400	$1,086,000
Total Cost	**$1,490,000**	**$2,086,000**	**$52,200**	**$58,600**	**$2,611,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$942,000	$1,319,000	$33,000	$0	$1,183,000
Transmission system	$981,000	$1,373,000	$34,300	$14,600	$1,463,000
Total Cost	**$1,923,000**	**$2,692,000**	**$67,300**	**$14,600**	**$2,646,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

Table 2-6
Area 1 - Marjorie Street Area
Construction Cost Summary[1]

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Individual Onsite Systems with Innovative Alternative Technologies	**$1,818,000**	**$2,545,000**	**$60,600**	**$39,500**	**$3,012,000**
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$975,000	$1,365,000	$32,500	$0	$1,260,000
Transmission system	$93,000	$130,000	$3,100	$3,200	$152,000
Treatment system	$323,000	$452,000	$10,800	$55,800	$1,112,000
Total Cost	**$1,391,000**	**$1,947,000**	**$46,400**	**$59,000**	**$2,524,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$975,000	$1,365,000	$32,500	$0	$1,249,000
Transmission system	$79,000	$111,000	$2,600	$14,200	$279,000
Total Cost	**$1,054,000**	**$1,476,000**	**$35,100**	**$14,200**	**$1,528,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

CDM

Table 2-7
Area 2 - Riverbend Drive
Construction Cost Summary[1]

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Individual Onsite Systems with Innovative Alternative Technologies	**$1,471,000**	**$2,059,000**	**$60,600**	**$10,300**	**$2,181,000**
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$682,000	$955,000	$28,100	$8,100	$959,000
Transmission system	$240,000	$336,000	$9,900	$3,200	$358,000
Treatment system	$263,000	$368,000	$10,800	$53,000	$995,000
Total Cost	**$1,185,000**	**$1,659,000**	**$48,800**	**$64,300**	**$2,312,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$682,000	$955,000	$28,100	$8,100	$975,000
Transmission system	$64,000	$90,000	$2,600	$8,900	$195,000
Total Cost	**$746,000**	**$1,044,000**	**$30,700**	**$17,000**	**$1,170,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

Table 2-8
Area 3 - School Street
Construction Cost Summary[1]

	Construction Cost	Capital Cost[2]	Cost per Lot[3]	Annual O&M Costs	Present Worth Costs[4]
Community Innovative/ Alternative Technologies (Package Treatment)					
Collection system	$235,000	$329,000	$20,600	$6,000	$368,000
Transmission system	$240,000	$336,000	$21,000	$3,200	$358,000
Treatment system	$128,000	$179,000	$11,200	$47,100	$736,000
Total Cost	**$603,000**	**$844,000**	**$52,800**	**$56,300**	**$1,462,000**
Town Water Pollution Control Facility (Connecting to Nearest Sewer)					
Collection system	$235,000	$329,000	$20,600	$5,600	$379,000
Transmission system	$39,000	$55,000	$3,400	$5,400	$119,000
Total Cost	**$274,000**	**$384,000**	**$24,000**	**$11,000**	**$498,000**

[1]Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

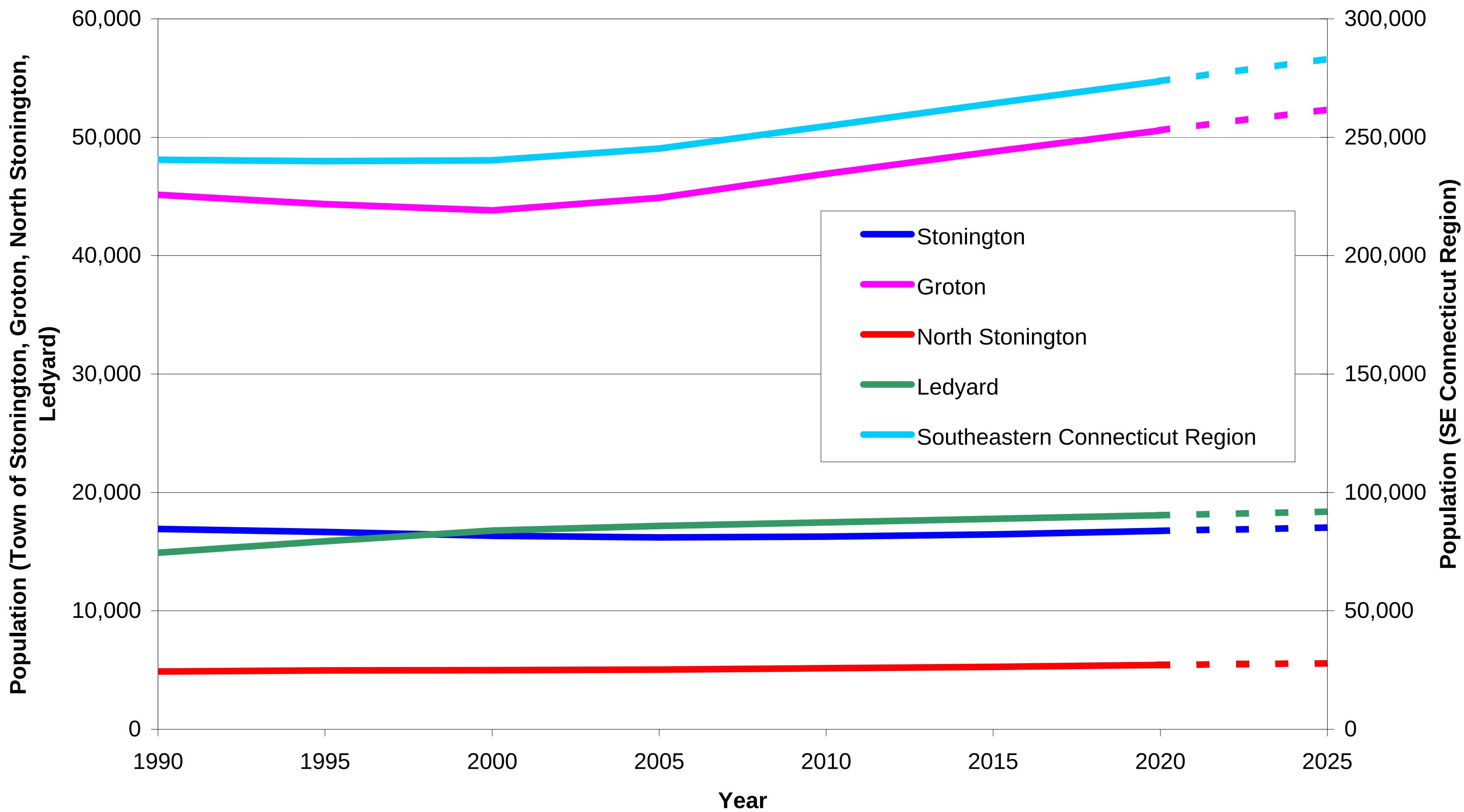
[2]Capital Costs include allowances for project contingencies, engineering, borings, and survey.

[3]Cost per lot for developed lots within wastewater needs area.

[4]Present Worth Analysis based on the escalated (2006) construction cost and 20-year planning period at an interest rate of 5.625 percent.

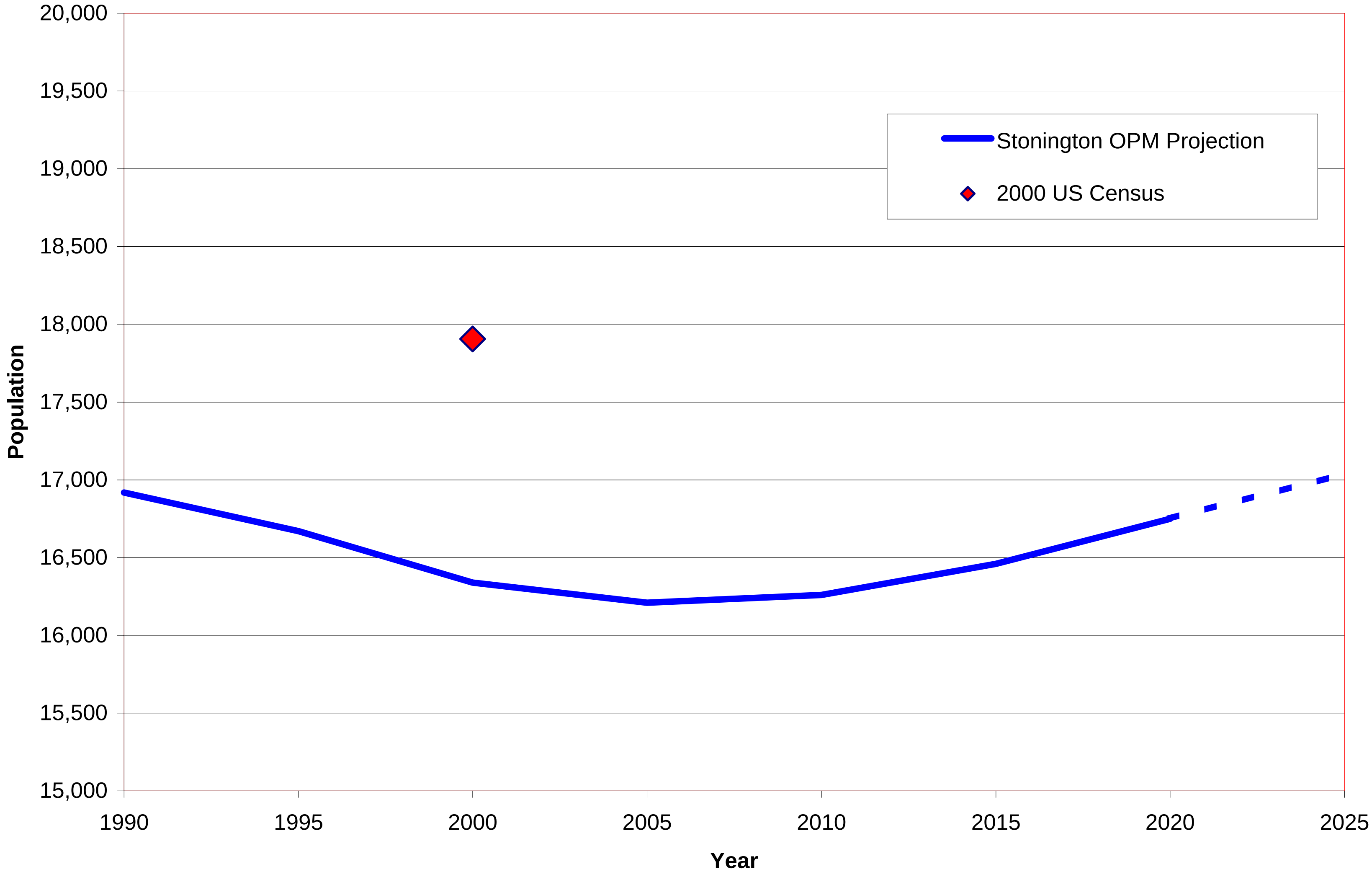
CDM

Table 2-9
Area 4 - Roseleah Drive
Construction Cost Summary[1]



CDM

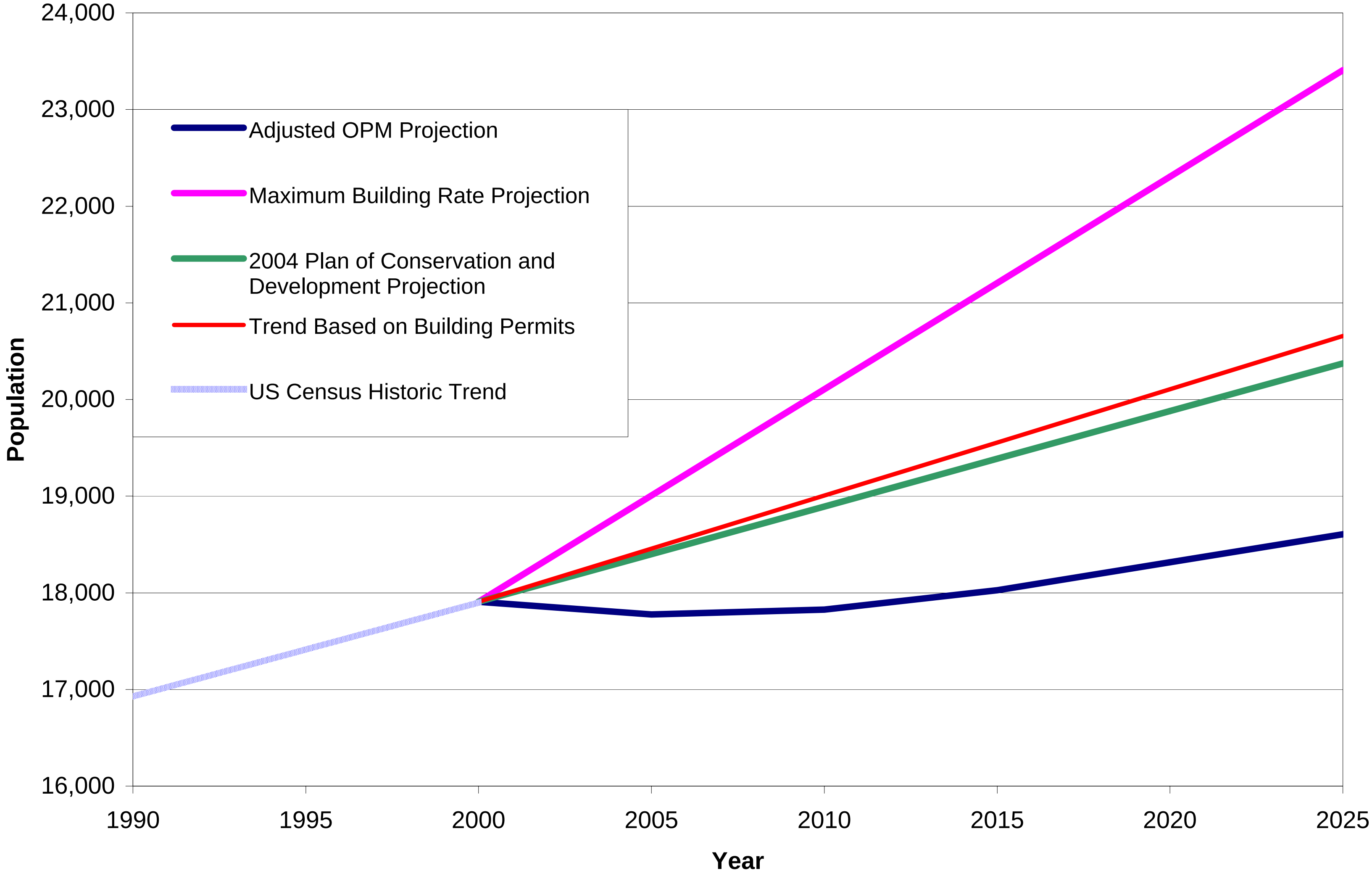
Figure 3-1
OPM Population Projections
(Based on 1990 U.S. Census)



Note: Projections beyond 2020 are estimated based on historical trends.

CDM

Figure 3-2
OPM Population Projections and US Census 2000 Data



CDM

Figure 3-3
Comparison of Population Projections

Section 3
Projected Flows and Loads

3.1 Introduction

This section summarizes the development of projected wastewater flows and loads within the Town of Stonington in 2025. This evaluation was initially completed in July 2002, based on plant data from July 1999 to June 2002. Some minor changes in flows and loads have occurred since our analysis was initially performed. However, plant data beyond June 2002 was not reviewed because it would not change the previous conclusions. Changed conditions are largely related to the following:

- Mystic Color Labs in the Mystic service area has closed. This was the only permitted industrial use in Town. There are redevelopment plans for the site which include a 45-unit condominium development.

- The Stonington Green (River Crest Drive) subdivision that borders River Road, Aimee Drive, and Mark Drive has been constructed. This subdivision is sewered within the Pawcatuck service area.

Table 3-6 reflects the existing flow and load assumptions made in July 2002. These flows and loads are the basis for the collection system evaluation in Section 4 and the wastewater facilities evaluation in Section 5. Tables 3-7 through 3-14 reflect the minor existing conditions changes noted above. Tables 3-7 through 3-14 also project flows and loads for year 2025. These revised 2025 flows and loads are the basis for future planning including the water quality analysis (Section 6), the wastewater treatment alternatives evaluation (Section 7), and the recommended plan (Section 8).

This section documents the procedures and methods used to develop the flow and load projections used in this Wastewater Facilities Plan, and is separated into several sections:

- Section 3.2 presents a review of previous reports, studies and data;

- Section 3.3 presents the available population planning data that apply to the Town of Stonington, and develops population projections that are separated into the following areas of Stonington: Mystic, Borough, Pawcatuck, and "Remainder";

- Section 3.4 summarizes water consumption data for the water districts that provide service within the Town of Stonington;

- Section 3.5 summarizes recent flow and load data at each of Stonington's three wastewater treatment plants – the Mystic, Borough and Pawcatuck Water Pollution Control Facilities (WPCFs); and

- Section 3.6 develops and summarizes the projected future flows and loads.

3.2 Previous Reports, Plans and Studies

The following sources were reviewed as part of this task.

3.2.1 Plan of Development (May 1992)

The Town of Stonington Planning and Zoning Commission adopted a *Plan of Development* on May 21, 1992. This *Plan of Development* is a precursor of the *2004 Plan of Conservation and Development* and recommends the principles that should be followed as the Town develops. It outlines several goals, including short and long-term economic growth, preservation of the environment, management of housing construction, and infrastructure improvements. Among the items outlined in the *Plan of Development* that are pertinent to growth, development, and projections of future wastewater collection and treatment needs are:

- Goals for economic development include: 1) identification of potential sites for industrial and commercial expansion; 2) redevelopment and revitalization of the three downtown commercial areas of the Town; and 3) redevelopment and revitalization of the existing industrial sites of the Town.

- To manage growth of residential housing units in the Town to not more than 100 units per year.

- To designate areas of the Town where sewers will eventually be provided, and to develop a sewer avoidance program. No Town-wide subsequent work has been conducted regarding sewer planning prior to the Wastewater Facilities Plan, though a sewer avoidance program is in place.

3.2.2 Water and Sewer Needs Analysis, Stonington, CT (November 1997)

Prepared by Marin Environmental, Inc., this report analyzes the full build-out water and sewer needs for the Highway Interchange (HI) Zone, the MAN-Roland property, and the Rosalini's restaurant site. All three of these sites are located within the drainage area of the Pawcatuck WPCF. The following items outlined in this *Water and Sewer Needs Analysis* are pertinent to the Wastewater Facilities Plan:

- Commercial development, influenced heavily by tourism demands, was projected to be the most likely future use within the HI Zone. This zone consists of 257 acres in the northeast corner of Stonington, and is located along the Route 2 corridor. Full development of this area was expected by 2017. Most of the development was anticipated by 2007.

- The Town had reserved 200,000 gallons per day (gpd) of wastewater treatment capacity at the Pawcatuck WPCF to treat flow from North Stonington. This document noted that North Stonington's potential use of this capacity could be impacted by a potential 600-acre development in North Stonington for use as an amusement park. However, since publication of the *Water and Sewer Needs Analysis*, the amusement park project is no longer projected to go forward.

- Projected average daily sewage flow, including the 200,000 gallon per day allotment from North Stonington, from the HI Zone, the MAN-Roland property, and the Rosalini's Restaurant site was as follows:
  - Five-year projection (2007): 620,000 gpd
  - Ten-year projection (2012): 910,000 gpd
  - Build-out projection (2017): 1,020,000 gpd

It should be noted that North Stonington has recently indicated that there are no plans to use the 200,000-gpd allotment. Stonington, with CTDEP's consent, will not continue to reserve this allotment in its planning effort.

3.2.3 Regional Conservation and Development Policy Guide for Southeastern Connecticut (October 1997)

The Southeastern Connecticut Council of Governments (SCCOG) prepared this report to provide guidance for coordinating land use planning at the municipal level, and to assist in planning efforts such as this Wastewater Facilities Plan. The following items outlined in this document are pertinent to the Wastewater Facilities Plan:

- The Southeastern Connecticut region has undergone some significant changes in recent years. These include the reduction in defense-related employment, and the boom in development and employment resulting from the Foxwoods and Mohegan Sun casinos. Much of the area's future development will be impacted by these fundamental changes.

- A land use map is included in the plan. The region's existing and planned sewer systems were used as a basic factor for locating future intensive urban uses, and these areas are projected if they are within 1,000 feet of existing or planned sewer lines.

3.2.4 1999 Master Transportation Plan (January 1999)

The State of Connecticut Department of Transportation (ConnDOT) prepared the *1999 Master Transportation Plan*, which presents ConnDOT's plans for the state's transportation services and facilities for the period from 2000 to 2009. Major projects are described. One major project will impact future growth of the Town of Stonington: improvements to the Route 2/2A/32 corridor. This project will upgrade the corridor between Norwich and Stonington, increasing the capacity of Routes 2 and 2A. Aspects of this project have already been completed.

The Master Plan also includes recommendations that may impact future growth in Stonington: 1) increased promotion of commuter parking lots; 2) expanded marketing efforts for the use of rail service; and 3) expansion of two-lane segments of Interstate 95 from the Rhode Island border to the Branford/East Haven town line to three lanes. All of these recommendations indicate that access between Stonington and neighboring towns will be upgraded in the future, perhaps reducing commuting times and making Stonington a more attractive place to live or work.

3.2.5 Draft Environmental Impact Statement, Route 2/2A/32 (March 1999)

ConnDOT completed a *Draft Environmental Impact Statement* for the Route 2/2A/32 Corridor project described above. The draft EIS evaluates six alternatives for improving the anticipated traffic congestion and associated safety problems. Although no final alternative is recommended in the draft EIS, it is now known that the project involves major improvements to Routes 2, 2A, 32 and 164. A portion of the project will be the expansion or relocation of Route 2 from Norwich to the interchange with Interstate 95 in northeast Stonington.

Stonington is not subject to most of the direct impacts of this project. However, the fact that increased highway capacity will be available from the Stonington Route 2/Interstate 95 interchange to Norwich will decrease commuting time between the two areas, and may tend to encourage residential growth in Stonington as a result. Commercial land use in the vicinity of the interchange could also be impacted.

3.2.6 Conservation and Development Policies Plan for Connecticut 1998-2003 (May 1998)

The *Conservation and Development Policies Plan for Connecticut* — prepared by the Connecticut Office of Policy Management (OPM) — is a statement regarding Connecticut's policies on growth, resource management and public investment. Among the items outlined in this document that are pertinent to this Wastewater Facilities Plan are the following:

- The statewide population is expected to grow slowly from 2000 to 2010 (1.5 percent), but more rapidly between 2010 and 2020 (6.4 percent).

- This document reinforces the probable impacts due to the boom in development and employment resulting from the Foxwoods and Mohegan Sun casinos, and the importance in considering these impacts in planning efforts.

- The use of community wastewater systems should become part of development schemes, since on-lot systems have considerable impact on allowable lot sizes (and therefore, land and housing costs).

- The plan encourages adoption of municipal ordinances that will encourage proper functioning of septic systems.

This Wastewater Facilities Plan should conform to the guidelines described in the *Conservation and Development Policies Plan for Connecticut*. However, there are significant conservation and development policy differences between this plan and town's plan (see Section 3.2.7 below). See Section 9 for additional discussion.

3.2.7 2004 Plan of Conservation and Development (June 2004)

The Town of Stonington's Planning and Zoning Commission adopted the *2004 Plan of Conservation and Development* on June 29, 2004. This plan is "intended to provide a framework for consistent decision-making by Town boards, commissions and residents with regard to conservation and development" through the year 2020. The report includes population, demographic and economic trends; land use and zoning issues; plans to protect important community resources (e.g., open space, natural resources, historical resources and scenic resources) and to preserve and/or enhance the three village areas (i.e., Mystic, Stonington Borough and Pawcatuck); guidelines that attract desired development in key areas along Interstate 95 and other desired areas within the Town; recommendations for management of residential growth and housing needs; suggested community facilities and infrastructure needs and management practices; and an implementation guide. This plan was prepared with considerable community input including workshops, public meetings, telephone surveys and working meetings.

Topics presented in the plan that are pertinent to this Wastewater Facilities Plan are:

- Population projections for 2010 and 2020 indicating approximately 5.5 percent growth rate per decade.
- Estimation of about 1,300 new housing units (each housing 1.5 persons) constructed between 2000 and 2020.
- Community philosophy to "protect and enhance Stonington's community character and high quality of life", including a desire for more open space.
- Suggested modifications to the Highway Interchange (HI) Zone and surrounding area to modify permitted uses, increase lot coverage, reduce area/frontage requirements, protect natural resources and encourage consolidated (mixed use) development.
- Suggested possible extension of wastewater collection facilities to service land on Jerry Brown Road south of Interstate 95.
- Discussion of Stonington's wastewater treatment and collection facilities, which notes construction of new in-town facilities as well as the possible connection to the Town of Groton for treatment of the town's wastewater.

There are significant conservation and development policy differences between the OPM plan outlined in Section 3.2.6 above and this plan. See Section 9 for additional discussion.

3.3 Population Projections

3.3.1 State

In September 1995, the Connecticut Office of Policy and Management (OPM) released population projections for each town in the state. Projections were made for the years 1995 through 2020 at 5-year intervals, based on the 1990 U.S. Census. OPM has not yet updated its projections using the 2000 U.S. Census as a baseline. **Table 3-1** summarizes the OPM projections for the Town of Stonington, as well as the three surrounding towns (Groton, North Stonington and Ledyard) and the entire southeastern Connecticut region, which includes 17 towns in southeast Connecticut, framed by Colchester, Salem and East Lyme to the west, and Franklin, Sprague, Lisbon, Griswold and Voluntown to the north. The southeastern Connecticut planning region encompasses all of New London County, except for the towns of Lyme, Old Lyme, and Lebanon.

The OPM projections do not provide more detailed breakdowns within Stonington (i.e., there are no published separate projections for the Mystic, Borough or Pawcatuck areas).

Figure 3-1 graphically presents the OPM projection for the Town of Stonington, and the additional OPM projections for Groton, North Stonington, Ledyard and the entire 17-town southeastern region of Connecticut. As shown in Figure 3-1, OPM projects no net growth in the Town of Stonington by 2020, and in fact projects a temporary decreasing trend until 2005, when the population is projected to climb again, ending in a 1.0 percent decrease from 1990 to 2020. Figure 3-1 also shows projected population growth by 2020 in Groton (12 percent), North Stonington (11.2 percent) and Ledyard (21.2 percent). Region-wide, OPM projects a significant increase in population between 2000 and 2020 (13.8 percent), after a period of no growth. **Table 3-2** summarizes the OPM-projected percentage population growth of these areas, using the 1990 U.S. Census as a baseline.

Similarly, by extrapolation, OPM's projections would suggest a population growth between 2000 and 2025 of less than one percent for Stonington while it's neighboring communities, and the southeastern region as a whole, would continue to see double digit growth rates. Extrapolated growth estimates are shown as dashed extensions of each OPM projection shown in Figure 3-1.

3.3.2 Federal

U.S. Census data for 2000 has become available since the development of the 1995 OPM projections. These data indicate that the population growth within Stonington was faster than projected by OPM from 1990 through 2000. **Figure 3-2** presents the OPM projection, and the 2000 U.S. Census data point for Stonington. As shown in the chart, the 2000 U.S. Census population in Stonington is 17,906, significantly higher than projected by OPM in 1995 (16,340).

See Table 3-1

See Figure 3-1

See Table 3-2

See Figure 3-2

3.3.3 Regional

The regional planning authority (SCCOG) has not developed its own population projections. SCCOG uses the projections developed by OPM, as tabulated and described above.

3.3.4 Local

Stonington's recently adopted *2004 Plan of Conservation and Development* includes population projections for the entire Town. However, there is no breakdown of population by area (e.g., Mystic, Stonington Borough, Pawcatuck, etc.) This plan notes the historical U.S. Census data through 2000 and projects a 5.5 percent growth rate through 2020, which is higher than the state average of approximately 4 percent. Population projections for 2010 and 2020 are 18,893 and 19,880, respectively.

The plan notes a decreasing average household size. The average household size in 1990 was 2.4 persons, whereas, the average household size in 2000 was 2.31 persons. The plan also suggests that new housing units would house approximately 1.5 persons. This rate is consistent with the trend toward condominium development but appears too conservative to reflect town-wide development trends.

3.3.5 Wastewater Facilities Plan

The goal of the Wastewater Facilities Plan population projection is to develop a reasonable estimate of future population within the Town of Stonington, considering the studies issued by planning agencies, as wells as the town and regional growth patterns, and to use the estimated population to project future domestic wastewater flows and loads. Planned future infrastructure improvements will be based on these projected needs. The following paragraphs describe the methodology and results used to develop projections for use in this Wastewater Facilities Plan.

The 1995 OPM projections had forecast essentially no population growth within the Town of Stonington until the year 2020. However, OPM also projected that the 2020 population of the southeastern region of Connecticut would increase significantly, by 13.8 percent. With the anticipated growth in the commercial areas of the Town, the tourism industry, and the planned infrastructure projects expected to improve access between Stonington and other towns in the region, it is prudent to assume that the Town of Stonington will share in some of the region's population growth. Therefore, the OPM projection for Stonington is considered to be the lower boundary of potential population growth. This is especially true considering the 2000 U.S. Census data.

A reasonable upper boundary on population growth within Stonington can be estimated by the Town's ordinance limiting new home construction to no more than 100 units per year on average. The assumed 100 new households per year with 2.2 persons per household provides an upper limit on population growth. This average household size estimates town-wide development trends and is consistent with the observed decrease in household size.

To refine projections, it is necessary to make assumptions regarding the rate of population growth in each area of the Town, taking into consideration the current development patterns, the Town's *2004 Plan of Conservation and Development*, and the requirements of Connecticut's Conservation and Development (C&D) Plan. Stonington is presently issuing building permits for new home construction at a rate of approximately 50 units per year. This suggests a rate of growth of approximately one-half that allowed by the Town ordinance. Assuming a household size of 2.2 persons, the resultant rate of growth would be slightly higher than, but consistent with, the Town's *2004 Plan of Conservation and Development*. Historic growth patterns suggest that the Borough area of the Town of Stonington will experience a slow rate of population growth. The Mystic and Pawcatuck areas can be expected to grow in population faster than the Borough area, and the remaining area of the Town, not within the three village areas and primarily the north of Interstate 95, will be the fastest-growing area, percentage-wise.

Tables 3-3 and 3-4 and **Figure 3-3** summarize the projected growth rates and populations based on the following information:

- Projections provided by the Connecticut Office of Policy and Management (The OPM projections are based on projected growth rates building upon the 2000 U.S. Census population.)
- Projections provided in Stonington's *2004 Plan of Conservation and Development*
- Maximum Buildout Rate of 100 Units per Year
- Trend Based on Building Permits Issued

Tables 3-3 and 3-4 also include an estimated distribution of population within the Town's four U.S. Census tracts. Anticipated growth is consistent with the OPM *Conservation and Development Policies Plan for Connecticut*.

The population projection based on building permit trends has been selected as the basis for this Wastewater Facilities Plan. This rate of growth reflects town-wide development trends as well as the declining household size shown in the U.S. Census data. This rate of development is slightly higher than, but consistent with, the Town's *2004 Plan of Conservation and Development*. Table 3-3 shows that, by 2025, the projected percentage of growth in the Town of Stonington would be 15.4 percent based on the 2000 U.S. Census population. Population growth in the Borough area of Stonington is projected to be only 1.6 percent. The Mystic area is projected to grow rapidly, at 16.0 percent. The projected 2025 populations in Pawcatuck and the "Remainder" areas of Town are projected to increase by 11.4 and 43.8 percent, respectively. Table 3-4 shows the projected populations in each of the Town's areas, at five-year intervals, with a town-wide projected population of 20,656 by 2025.

Figure 3-3 shows that the projected population growth to be used for the development of flows and loads — based on the trend of building permits issued —

See Table 3-3

See Table 3-4

See Figure 3-3

is a moderate rate between the lower limit (the OPM projection) and upper limit (the maximum building rate of 100 homes per year) of growth. Figure 3-3 also shows the projected population based on the Town's *2004 Plan of Conservation and Development*. As shown, these projected population growth rates are very close. Note that the pre-2000 historical data, and the post-2000 projections, are virtually identical in slope. This indicates that the growth rate projected in the future is consistent with the growth experienced in Stonington between 1990 and 2000.

3.4 Review of Existing Data

3.4.1 Review of Water Consumption Data

Two separate water suppliers service Stonington: the Aquarion Water Company of Connecticut (formally the Connecticut American Water Company) supplies water to portions of the Mystic and Borough drainage areas, and the Town of Westerly, Rhode Island provides water to the Pawcatuck area. Water consumption data was obtained from both suppliers to determine the total water demand within these three areas, and the approximate usage by category (domestic, institutional, industrial and commercial). These data are summarized on **Table 3-5.**

Referring to Table 3-5, billing record data from each customer within each of the three drainage areas was first evaluated to determine the total water usage for the billing period (Row A). It is assumed that 90 percent of the water used eventually flows into the sewer collection system as wastewater, which is within the typical range of observed conditions, to calculate wastewater flow. Rows B and C illustrate this calculation. The 2000 U.S. Census data was reviewed, together with mapping of the existing service areas, to estimate the population served by public sewer within each area (Row D). A per-capita average daily wastewater flow rate of 70 gpd was then used to determine total domestic wastewater flow (Rows E and F).

The total non-domestic wastewater flow was calculated as the difference between total wastewater flow minus domestic (Row G). Water billing records were then reviewed, together with typical factors for wastewater generation, to categorize this non-domestic flow as institutional, industrial and commercial (Rows H, I and J). The results of this evaluation are used in the flow projections presented in Section 3.5.

3.4.2 Review of Recent WPCF Flow and Load Data

Section 5 contains an evaluation of the three existing water pollution control facilities (WPCFs), and plant data are analyzed in detail in that section. **Table 3-6** summarizes the influent flows and loads to the three plants, based on plant data from July 1999 through June 2002. Parameters include flow, biochemical oxygen demand (BOD), total suspended solids (TSS), ammonia-nitrogen (NH_3-N), and total nitrogen (TN).

Note that in September 1999, the Stonington WPCA implemented a 280,000 gallon-per-day pumping process that diverts flow from the Mystic WPCF to the Borough WPCF. The influent flows and loads summarized in Table 3-6 do NOT consider this

See Table 3-5

See Table 3-6

diversion (i.e., the influent flow and load to the Mystic WPCF includes the 280,000 gpd, and the influent flow and load to the Borough WPCF does NOT include the 280,000 gpd). The influent flows and loads to each plant, therefore, represent the flow and load from within the service area contributing to each plant. The impacts of the diversion on current loadings to the plants are evaluated in Section 5.

The pollutant concentrations evidenced by the flows and loads, and the peaking factors resulting from the ratios of maximum-month and maximum-day loading to average loading, will be used in Section 3.5 to project future flows and loads for these conditions.

3.5 Projected Flows and Loads

3.5.1 Domestic Flows

Wastewater flow generated in homes, apartments, condominiums, etc. is defined as domestic flow. **Table 3-7** summarizes the existing and projected future domestic average wastewater flow estimates for the sewered and unsewered areas. Separate summaries are provided for each of the Mystic, Borough, Pawcatuck, and remaining areas.

Existing Sewered Areas

As shown in Table 3-5, the 2000 U.S. Census population within the Mystic drainage area is 2,566. An average wastewater flow of approximately 179,600 gpd is estimated, based on a per-capita wastewater flow of 70 gpd.

Similar analyses can be conducted to determine the domestic wastewater flow to the Borough and Pawcatuck WPCFs. For the Borough area, a population of 1,151 is estimated to be within the service area, resulting in an average of approximately 80,570 gpd of domestic sewage flows to the Borough WPCF, based on a per-capita wastewater flow of 70 gpd.

The Pawcatuck area U.S. Census data shows that 4,323 people within the service area, resulting in a flow of 302,610 gpd from residential customers. This represents a per-capita wastewater flow of 70 gpd.

Existing Unsewered Areas

The sewer needs analysis described in Section 2 identifies five unsewered problem areas within the Mystic WPCF drainage area: Riverbend Drive, School Street, Roseleah Drive, Latimer Point and Mason's Island. These areas are itemized on Table 3-7, along with their associated design average flows, which are based on an assumed per-capita flow of 70 gpd. The current population within these five areas is about 553 people. Table 3-7 also itemizes "Other Areas" within the Mystic drainage area. These "Other Areas" are within the Mystic drainage area, but are not currently connected to the sewer system, and are also not accounted for in the five problem areas. The estimated current population within these areas is 811 people. Using the 70 gallons

See Table 3-7

per capita per day design criterion, the estimated wastewater flow from these areas is 56,770 gpd.

For the Borough drainage area, the sewer needs analysis in Section 2 identifies two existing unsewered problem areas: Elm Street and Montauk Road. These areas are itemized on Table 3-7, along with their associated design average flows, again based on an assumed per-capita flow of 70 gpd. The current population within these two areas is about 237 people. Table 3-7 also itemizes "Other Areas", which is comprised of the remaining areas within the Borough WPCF drainage area that are not currently connected to the sewer system, and are not accounted for in the two problem areas. The estimated current population within these areas is 129 people. Using the 70 gallons per capita per day design criterion, the estimated wastewater flow from these areas is 9,000 gpd.

For the Pawcatuck drainage area, the sewer needs analysis identifies nine existing unsewered problem areas, and these areas are itemized on Table 3-7, along with their associated design average flows. The current population within these nine areas is about 1,827 people. Table 3-7 also itemizes "Other Areas", as described above, that are within the Pawcatuck WPCF service area. The estimated current population within these areas is 379 people. Using the 70 gallons per capita per day design criterion, the estimated wastewater flow from these areas is 26,500 gpd.

Finally, the remaining area of Stonington is entirely unsewered. The estimated 2000 population in this remaining area is 2,770 people. There are two identified problem areas: Marjorie Street and North Stonington Road. The estimated 2000 population in these two areas is 175 people, and the design flows from these areas are tabulated. The rest of the remaining area has an approximate population of 2,595 people, and a total wastewater flow rate of approximately 181,650 gpd.

Projected Sewered Areas

As shown on Table 3-3, the population within the Mystic WPCF drainage area is projected to increase 16.0 percent by the year 2025. It is assumed that this growth rate will be uniform throughout the Mystic district, and that the per-capita wastewater flow rate will remain the same, for the purpose of projecting future flows. In addition, the former Mystic Color Labs site is being developed as condominiums with projected flow of 13,500 gpd. The existing sewered area flow will therefore increase from 179,600 to 221,800 gpd. Based on the analysis described in Section 2, if all of the identified problem areas with the exception of Mason's Island are connected to the sewer system, the projected flow would be 254,700 gpd in 2025.

The population within the Borough WPCF drainage area is projected to increase 1.6 percent by the year 2025. It is assumed that this growth rate will be uniform throughout the Borough district, and that the per-capita flow rate will remain the same, for the purpose of projecting future flows. The existing sewered area flow will therefore increase from 80,570 to 81,900 gpd. In addition, based on the analysis described in Section 2, if the Elm Street and Montauk Road problem areas are connected to the sewer system the projected flow would be 98,800 gpd in 2025.

The population within the Pawcatuck WPCF drainage area is projected to increase 11.4 percent by the year 2025. It is assumed that this growth rate will be uniform throughout the Pawcatuck district, and that the per-capita flow rate will remain the same, for the purpose of projecting future flows. The existing sewered area flow will therefore increase from 302,610 to 337,100 gpd. Based on the analysis described in Section 2, if all of the identified problem areas are connected to the sewer system, the projected flow would be 479,500 gpd in 2025.

The population within the remaining area is projected to increase 43.8 percent by the year 2025. It is assumed that this growth rate will be uniform, and that the per-capita flow rate will remain the same, for the purpose of projecting future flows. The flow will therefore increase by the same rate.

3.5.2 Institutional Flows

Wastewater generated in schools, hospitals, nursing homes, medical centers, correction facilities, public rest rooms, marine pump-out facilities, etc. is defined as institutional flow. **Table 3-8** summarizes existing and projected future average institutional wastewater flow estimates.

There are currently six public schools in the Town of Stonington, with a total student enrollment of approximately 2,400. The Mystic Middle School (2002-2003 enrollment of 457 students) is connected to the Mystic WPCF. The Dean's Mill School is within the Borough WPCF drainage area. The Dean's Mill School had an enrollment of 506 students for the 2002-2003 academic year. The remaining four schools (the West Vine Street School, the West Broad Street School, and Pawcatuck Middle School and the Stonington High School) are within the Pawcatuck WPCF drainage area. The total enrollment of students in these four schools was 1,414 in the 2002-2003 academic year. Wastewater flows from these schools are estimated using a per student flow rate of 15 gpd.

Future student enrollment projections do not extend beyond 2010. For the purpose of estimating future flow from the schools, it is assumed that the student enrollment will increase by 15.4 percent, the average town-wide population growth estimate, by 2025. The projections of future wastewater flow from the schools reflect this estimated enrollment increase.

There are no hospitals, large medical centers, or prisons within the Town of Stonington. The Pendleton nursing and rehabilitation center on Maritime Drive has a flow of 28,100 gpd, and this is not expected to increase. The Stone Ridge retirement community on Jerry Browne Road is within the Mystic WPCF drainage area, and is planned to be built in two phases. According to a previous projection, reported by PARE Engineering, the flow from this facility will be approximately 37,000 gpd after all phases of the community are complete.

See Table 3-8

The Connecticut Department of Environmental Protection has suggested that marine pump-out facilities be upgraded and/or improved in capacity, as a way of protecting harbor water quality. Each of the Mystic, Borough and Pawcatuck areas has pumpout facilities connected to the sewer systems. These pumpout facilities are privately owned, and are associated with the Town's many marinas. Since the neighboring towns of Groton and Westerly, Rhode Island also have public pump-out facilities, increased flows within the Mystic and Pawcatuck WPCF service areas associated with public pumpout facilities are assumed to be minor, at 5,000 gpd. CTDEP has suggested that a public pumpout facility be located in the Borough area, and it is anticipated that a new facility will be in place within the Borough WPCF area within the planning period. A projected future allowance of 10,000 gpd is allocated for this public pump-out facility, in addition to the allowances shown for the existing commercial pump-out operations provided by the numerous marinas located along the water line in all three areas of the Town.

3.5.3 Industrial Flows

Wastewater generated in manufacturing facilities and other major processing facilities is defined as industrial flow. **Table 3-9** summarizes existing and projected future average commercial wastewater flow estimates.

Existing Sewered Areas

There are no permitted industrial users in the Town of Stonington at this time. However, there are three un-permitted industries with discharges to the sewer system; namely:

- Mystic Aquarium
- Davis Standard Corp.
- MAN-Roland site (Mashantucket Pequot Tribe)

The Mystic Aquarium discharges to the Mystic WPCF system. An average of approximately 10,000 gpd is discharged from the animal pool filters at the aquarium, and the aquarium visitors, food service, and other sanitary uses generate an additional flow of approximately 24,200 gpd. The pool filter discharge is similar to typical domestic sewage, with higher concentrations of ammonia-nitrogen, alkalinity, and higher pH, and lower concentrations of BOD and COD. The Stonington WPCA has reviewed the aquarium discharge water quality and determined that it is acceptable for treatment at the Mystic WPCF.

The Davis Standard Corp. is a manufacturing facility located on Extrusion Drive, and discharges to the Pawcatuck WPCF system. Permitted discharges from this facility include an average of 1,000 gpd resulting from the manufacturing process, and 5,600 gpd from non-contact cooling water and domestic uses. However, recent water consumption data indicates that the facility is only discharging about 4,900 gpd.

See Table 3-9

The 41.92-acre MAN-Roland property, located on Liberty Street north of Interstate 95, is part of the Highway Interchange (HI) zone. Currently this site is owned by the Mashantucket Pequot Tribe and is used as an ancillary facility for its Foxwoods casino operations. Current flows average 4,000 gpd. Since the property may be used for manufacturing in the future, the projection includes a 1,000-gallon per acre per day allotment for this property. Note: this property was previously evaluated in the Marin Environmental report described in Section 3.2.2. The Marin Environmental report conservatively assumed a per-acre flow of 2,400 gpd. However, given the site's historical use, the 1,000 gallons per acre per day criterion is appropriate and used for this Wastewater Facilities Plan.

Projected Sewered Areas

It is assumed that flow from the Mystic Aquarium will increase in the future due to a likely increase in visitors, and perhaps growth of the facility. It is assumed that by 2025, the flow from the aquarium will increase by 10 percent over the current permitted flow rate.

The old airport property within the Borough district has been identified for a partial development as a vineyard. The developable portion of this property is approximately 19.8 acres. Since the wastewater collection and treatment needs for this property are not clearly defined, a planning per-acre flow rate of 1,000 gpd was assumed, resulting in a projected flow of 19,800 gpd from this area.

The Pawcatuck WPCF drainage basin includes two areas where industrial development may occur. There already is some industrial activity at the Extrusion Drive area, as described earlier. An assumed increase in activity from current levels is appropriate for planning purposes. The total acreage of this manufacturing area is about 90 acres, and the maximum allowable coverage is 30 percent, or 27 acres. Using 1,000 gallons per acre per day as a planning-level flow, 27,000 gpd is projected.

One light industry zone is located in the remaining area of Stonington, outside the drainage basins of the three plants, in the vicinity of Interstate 95 (Exit 90), the Pequot Trail and Taugwonk Road. The total area zoned as light industry in this area is about 95 acres, and 30 percent, or about 29 acres, is usable. By applying a per-acre flow of 1,000 gpd for this area, results in a projected flow of 29,000 gpd. It is assumed that this area will not be sewered.

3.5.4 Commercial Flows

Wastewater generated in stores, restaurants, motels, etc. is defined as commercial flow. **Table 3-10** summarizes existing and projected future average commercial wastewater flow estimates.

Existing Sewered Areas

The estimated current commercial wastewater flows are estimated by the water consumption data presented in Table 3-5. The table shows that the total commercial

See Table 3-10

water consumption for the Mystic area is approximately 159,805 gpd. For the Borough area, the commercial water consumption is approximately 74,900 gpd. For the Pawcatuck area, the total commercial water consumption is approximately 76,100 gpd.

Projected Sewered Areas

The predominant commercial area within the Mystic WPCF service area is the area around the seaport and harbor. Stonington and Groton have plans to increase activity in this area, and are projecting significant economic development as a result. Specific components of this increase are not known at this time, although with increased tourism, additional flow from hotels and restaurants are expected. Commercial flow within the Mystic WPCF service area will increase, and the projection includes a 20 percent increase on existing commercial flow.

Stonington also has a stated goal of increasing the economic vitality of the Borough area. Specific proposals have not been developed, but increased commercial flow will result from revitalization of the area. The projections include a 10 percent increase on existing commercial flow.

In addition, a new development — Stonington Commons — is under construction within Stonington Village, involving redevelopment of the Monsanto property on Water Street. It will primarily be single-family and condominium residential, and includes a yacht club and a small amount of potential commercial office space. The entire development's projected flow based on the developer's intended land use is approximately 21,300 gpd. Though some of this flow will be from residential sources, the overall development flow is accounted for in the commercial category.

Within the Pawcatuck service area, the Highway Interchange (HI) zone is the major area where commercial growth is expected. As described in Section 3.1, this area has previously been studied in detail as described in the Marin Environmental *Water and Sewer Needs Analysis*. The land use assumptions used in the *Water and Sewer Needs Analysis* are very ambitious. As part of the review of the original draft of this Wastewater Facilities Plan report, it was the consensus view of a Citizens Review Panel, WPCA, the Stonington Planning and Zoning Department, and CDM that the HI Zone will not become more commercially developed than the Coogan Boulevard/Whitehall Avenue area. It follows from this judgment that the projected wastewater flow from the commercial area should not exceed actual measured flow from the Coogan Boulevard/Whitehall Avenue area. The projected commercial flow from the HI-zone is thus 159,800 gpd.

Stonington WPCA has, in the past, reserved capacity at the Pawcatuck WPCF, and in the interceptor system that feeds the plant, of 200,000 gpd for use by North Stonington. North Stonington presently does not have plans to use this reserve, and does not foresee use in the future. WPCA has no obligation to reserve this capacity, and a reserve is NOT included in the future wastewater projections.

There are no areas zoned for commercial use in the remaining area of the Town.

3.5.5 Infiltration and Inflow

Groundwater that leaks into the sewer system is defined as infiltration, and inflow is extraneous flow that enters the sewer system via roof leaders, sump pumps or other means. **Table 3-11** summarizes existing and projected future extraneous flow due to infiltration and inflow within the three existing drainage basins.

Existing Sewered Areas

Estimates of existing wastewater flow due to infiltration/inflow are made based upon data collected at the three wastewater treatment plants. Evaluation of the daily average, daily maximum and especially the daily minimum flow rates at each plant results in a reasonable estimate of existing extraneous flow to each plant. These records should also compare well with the observed difference between the water use within the service area and the actual wastewater flows at the plants.

Data collected at the Mystic WPCF indicates that during dry-weather periods (mainly late summer and fall of each year), the daily minimum flow rate was typically approximately 200,000 gpd. Since the daily minimum flow rate occurs in the early morning hours, when actual wastewater flow is close to zero, it is likely that most of this flow is infiltration. Assuming that only about 25 percent of this flow is wastewater, the extraneous flow during dry-weather periods is estimated at about 150,000 gpd.

The same type of data evaluation was conducted to estimate infiltration flow to the Borough and Pawcatuck WPCFs. The Borough WPCF data shows that the minimum daily flow to the plant varies between 40,000 gpd and 100,000 gpd. It is assumed that 90 percent of this minimum flow rate is infiltration. A typical value of 50,000 gpd is used. At the Pawcatuck WPCF, a typical value of 70,000 gpd is used.

Proposed Sewered Areas

It is assumed that the existing service area will not experience a change in the infiltration/inflow rates, neither an increase nor a decrease. No major reduction program is planned to decrease extraneous flows, and routine maintenance will be conducted to keep infiltration and inflow from increasing as the piping system ages.

Additional infiltration and inflow can be expected from those areas that will be provided with new sewer systems. The areas identified in the Section 2 will contribute flow as shown on Table 3-11. Infiltration rates for these areas are estimated based on a preliminary layout of sewers in the area, assuming that 1) the sewers will be 8-inches in diameter, and 2) an infiltration rate of 500 gpd per inch-mile of pipe.

3.5.6 Septage Wastes

In this section, an estimate is developed of the total quantity of septage wastes produced from on-site wastewater systems. Septage volume is assumed to be a function of the population in unsewered areas, because the majority of the unsewered areas are residential.

See Table 3-11

Table 3-12 summarizes the estimated existing and projected future septage volumes generated throughout Stonington. For each of the four areas, the total existing septage volume is calculated based on the estimated 2000 population within each area NOT provided with sewer service, assuming an average number of persons per household, an average septic tank volume of 1,200 gallons, and an average pumpout interval of 3 years. The projected future septage volume from within the existing sewered areas is calculated the same way, except using the projected future populations. Those areas that will be provided with sewers are then subtracted from this amount, resulting in a total estimated septage volume.

The Pawcatuck WPCF is the only Stonington WPCA facility that can receive septage. Current records indicate that about two loads per week are currently hauled to the plant, amounting to a weekly volume of about 3,500 gallons (500 gpd). Most of the septage generated within the Town of Stonington is hauled to other plants, so an increase in hauling to the Pawcatuck WPCF is not expected.

3.5.7 Flow Summary

Table 3-13 summarizes and sums the components of flow described in Sections 3.5.1 through 3.5.6.

3.5.8 Flows and Loads

The projected future flows summarized in Table 3-13 can be used to project future loads to each of the three WPCFs. A review of the table indicates that the overall contributing percentages of constituents of the wastewater flow (e.g., domestic, institutional, etc.) are not changing significantly in proportion to one-another. This indicates that the characteristics of the wastewater should remain similar to the existing conditions. In addition, the projections do not include any additional significant industrial users that could alter the wastewater characteristics. Therefore, the wastewater is expected to be of similar strength, and contain similar concentrations of the important pollutants such as BOD, TSS and nitrogen components as the existing wastewater.

Table 3-6 presented a summary of the existing flows and loads to the three WPCFs, for average day, maximum month, and peak day conditions. Peaking factors on flows and loads can be calculated by comparing different loading conditions. It is assumed that these peaking factors will not change in the future, e.g., the ratio of maximum month flow to average flow to the Mystic WPCF (0.772 mgd/0.570 mgd = 1.35) will remain the same in the year 2025.

Table 3-14 summarizes the flows and loads to each of the three WPCFs, assuming that the wastewater quality parameters, and the peaking factors for different loading conditions, will not change. The flows and loads presented in Table 3-14 are used for the Alternatives Evaluation presented in Section 7.

See Table 3-12

See Table 3-13

See Table 3-14

References

- *Town of Stonington Plan of Development*, Planning and Zoning Commission, Adopted May 21, 1992.
- *1990 Census, Census Designated Places (CDP), Census Tracts*, Draft Report by Charles A. Boster, Planning Director, January 16, 1996.
- *Water and Sewer Needs Analysis Stonington Connecticut*, Marin Environmental, Inc., November 1997.
- *Regional Conservation and Development Policy Guide for Southeastern Connecticut*, Southeastern Connecticut Council of Governments, Adopted October 15, 1997.
- *Background Material for the Updating of the Regional Conservation and Development Policy Guide Southeastern Connecticut Region,* Southeastern Connecticut Council of Governments, July 1997.
- *1999 Master Transportation Plan*, State of Connecticut Department of Transportation, January 1999.
- *Draft Environmental Impact Statement Route 2/2A/32*, State of Connecticut Department of Transportation, March 1999.
- *Stonington Harbor Management Plan*, Adopted May 3, 2000, by both the Town and Borough of Stonington.
- *Conservation and Development Policies Plan for Connecticut 1998-2003*, State of Connecticut.
- *Population and Housing 1990 Southeastern Connecticut Region*, Southeastern Connecticut Regional Planning Agency, March 1992.
- *Estimated Populations in Connecticut as of July 1, 1998*, State of Connecticut Department of Public Health.
- *1999 U.S. Census Bureau Estimates for Connecticut*, October 2000.
- *Telephone Call Report, Groton Office of Planning*, October 31, 2000.
- *Telephone Call Report, Stonington Board of Education*, November 1, 2000.
- *Telephone Call Report, North Stonington Selectman's Office*, November 7, 2000.
- *Telephone Call Report, Conn.-Amer. Water Company*, November 14, 2000.
- *Telephone Call Report, Westerly Water Department,* November 14, 2000.
- Excerpt from *Report on Maritime Drive Pump Station*, PARE Engineering.
- *Report of the Citizen's Review Panel on the Stonington Water Pollution Control Facilities Plan*, March 2002.
- *Student Enrollment Report*, Fax from Department of Education, August 13, 2002.
- 2000 U.S. Census website, www.census.gov
- *2004 Plan of Conservation and Development,* Planning and Zoning Commission, Adopted June 29, 2004.

Area	Description	Wastewater Flow Estimates (gallons per day)			
		Existing		Projected	
		Sewered	Unsewered	Sewered	Unsewered
Mystic	Existing Sewered Areas	159,800		159,800	
	Mystic Seaport Increase			32,000	
	Subtotal (Mystic)	**159,800**	**0**	**191,800**	**0**
Borough	Existing Sewered Areas	74,900		74,900	
	Downtown Revitalization			7,500	
	Stonington Commons			21,300	
	Subtotal (Borough)	**74,900**	**0**	**103,700**	**0**
Pawcatuck	Existing Sewered Areas	76,100		76,100	
	HI-Zone	8,000		159,800	
	Subtotal (Pawcatuck)	**84,100**	**0**	**235,900**	**0**
Remainder	Existing Sewered Areas	0		0	
	Subtotal (Remainder)	**0**	**0**	**0**	**0**
	TOTAL COMMERCIAL FLOW	**318,800**	**0**	**531,400**	**0**

CDM

Table 3-10
Commercial Wastewater Flow Projections

Area	Description	Infiltration Flow Estimates (gallons per day)			
		Existing		Projected	
		Sewered	Unsewered	Sewered	Unsewered
Mystic	Existing Sewered Areas	150,000		150,000	
	Riverbend Drive			2,200	
	School Street			2,100	
	Roseleah Drive			1,000	
	Latimer Point			3,300	
	Subtotal (Mystic)	**150,000**	**0**	**158,600**	**0**
Borough	Existing Sewered Areas	50,000		50,000	
	Elm Street Area			4,800	
	Montauk Avenue Area			3,000	
	Subtotal (Borough)	**50,000**	**0**	**57,800**	**0**
Pawcatuck	Existing Sewered Areas	70,000		70,000	
	Elm Ridge Road Area			8,000	
	Pequot Trail Area			7,100	
	Cronin Ave./Holly St.			2,500	
	Millan Terrace Area			1,900	
	Almee Drive Area			3,700	
	Mark Street Area			2,700	
	Greenhaven Road Area			10,100	
	Meadow Road Area			3,100	
	Marlin Drive Area			4,200	
	Subtotal (Pawcatuck)	**70,000**	**0**	**113,300**	**0**
	TOTAL INFILTRATION/INFLOW	**270,000**	**0**	**329,700**	**0**

Table 3-11
Infiltration/Inflow Projections

Area	Description	Septage Estimates (gallons per day)			
		Existing		Projected	
		Sewered	Unsewered	Sewered	Unsewered
Mystic	Existing Areas		386		435
	Riverbend Drive				-46
	School Street				-46
	Roseleah Drive				-17
	Latimer Point				-88
	Mason's Island				0
	Subtotal (Mystic)	**0**	**386**	**0**	**238**
Borough	Existing Areas		1,209		1,224
	Elm Street Area				-83
	Montauk Road Area				-38
	Subtotal (Borough)	**0**	**1,209**	**0**	**1,103**
Pawcatuck	Existing Areas		810		871
	Elm Ridge Road Area				-132
	Pequot Trail Area				-96
	Cronin Ave./Holly St.				-55
	Millan Terrace Area				-43
	Almee Drive Area				-64
	Mark Street Area				-47
	Greenhaven Road Area				-163
	Meadow Road Area				-39
	Marlin Drive Area				-82
	Subtotal (Pawcatuck)	**0**	**810**	**0**	**150**
Remainder	Existing Areas		3,340		3,708
	Subtotal (Remainder)	**0**	**3,340**	**0**	**3,708**
	TOTAL SEPTAGE	**0**	**5,745**	**0**	**5,199**

Table 3-12
Septage Flow Projections

		Wastewater Flow Estimates (gallons per day)			
		Existing		Projected	
Area	Description	Sewered	Unsewered	Sewered	Unsewered
Mystic	Domestic	179,600	95,500	254,700	77,900
	Institutional	39,955	0	83,000	0
	Commercial	159,800	0	191,800	0
	Industrial	34,200	0	37,600	0
	Septage	0	0	0	0
	Infiltration/Inflow	150,000	0	158,600	0
	Subtotal (Mystic)	**563,555**	**95,500**	**725,700**	**77,900**
Borough	Domestic	80,570	25,600	98,800	9,100
	Institutional	10,090	0	18,800	0
	Commercial	74,900	0	103,700	0
	Industrial	0	0	19,800	0
	Septage	0	0	0	0
	Infiltration/Inflow	50,000	0	57,800	0
	Subtotal (Borough)	**215,560**	**25,600**	**298,900**	**9,100**
Pawcatuck	Domestic	302,610	154,400	479,500	29,500
	Institutional	26,360	0	34,600	0
	Commercial	84,100	0	235,900	0
	Industrial	8,900	0	75,600	0
	Septage	500	0	500	0
	Infiltration/Inflow	70,000	0	113,300	0
	Subtotal (Pawcatuck)	**492,470**	**154,400**	**939,400**	**29,500**
Remainder	Domestic	0	193,900	0	278,800
	Institutional	0	0	0	0
	Commercial	0	0	0	0
	Industrial	0	0	0	29,000
	Septage	0	0	0	0
	Infiltration/Inflow	0	0	0	0
	Subtotal (Remainder)	**0**	**193,900**	**0**	**307,800**
	TOTAL FLOW	**1,271,585**	**469,400**	**1,964,000**	**424,300**

CDM

Table 3-13
Summary of Wastewater Flow Projections

Mystic WPCF

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	NH_3-N (ppd)	TN (ppd)
Average Annual	0.726	2300	1862	181	257
Maximum Month	0.983	3852	3891	245	348
Maximum Day	1.498	5665	4620	372	530

Borough WPCF

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	NH_3-N (ppd)	TN (ppd)
Average Annual	0.299	518	421	66	97
Maximum Month	0.479	1113	818	130	188
Maximum Day	0.673	1307	1020	158	231

Pawcatuck WPCF

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	NH_3-N (ppd)	TN (ppd)
Average Annual	0.939	1552	2200	187	294
Maximum Month	1.382	1934	3278	274	431
Maximum Day	1.822	2225	3953	361	568

Table 3-14
Projected WPCF Influent Flows and Loads

Year	Stonington	Groton	North Stonington	Ledyard	Southeastern Connecticut Region
1990	0.00%	0.00%	0.00%	0.00%	0.00%
1995	-1.47%	-1.74%	1.56%	6.48%	-0.20%
2000	-3.42%	-2.95%	2.38%	12.52%	-0.05%
2005	-4.19%	-0.58%	3.40%	15.20%	2.01%
2010	-3.90%	3.91%	5.45%	17.21%	5.96%
2015	-2.71%	8.05%	8.11%	19.22%	9.90%
2020	-1.00%	12.00%	11.18%	21.24%	13.82%
2025	*0.72%*	*15.94%*	*14.25%*	*23.25%*	*17.75%*

[1] OPM made projections through the Year 2020 based on the 1990 U.S. Census baseline. Year 2025 growth rates are estimated based on historical trends.

Table 3-2
OPM Projected Population Growth Rates[1]

Year	Town of Stonington	Mystic (B 7053)	Borough (B 7052)	Pawcatuck (B 7051)	Remainder (B 7054)
OPM Projected Growth					
2000	0.0%	0.0%	0.0%	0.0%	0.0%
2005	-0.7%	*-0.8%*	*-0.1%*	*-0.5%*	*-2.1%*
2010	-0.4%	*-0.5%*	*0.0%*	*-0.3%*	*-1.3%*
2015	0.7%	*0.7%*	*0.1%*	*0.5%*	*1.9%*
2020	2.3%	*2.4%*	*0.2%*	*1.7%*	*6.5%*
2025	*3.9%*	*4.1%*	*0.4%*	*2.9%*	*11.2%*
2004 Plan of Conservation and Development Projections					
2000	0.0%	0.0%	0.0%	0.0%	0.0%
2005	*2.8%*	*2.9%*	*0.3%*	*2.0%*	*7.9%*
2010	5.5%	*5.7%*	*0.6%*	*4.1%*	*15.7%*
2015	*8.3%*	*8.6%*	*0.9%*	*6.1%*	*23.6%*
2020	11.0%	*11.5%*	*1.2%*	*8.2%*	*31.5%*
2025	*13.8%*	*14.3%*	*1.5%*	*10.2%*	*39.3%*
Maximum Buildout Projection					
2000	0.0%	0.0%	0.0%	0.0%	0.0%
2005	*6.1%*	*6.4%*	*0.7%*	*4.6%*	*17.5%*
2010	*12.3%*	*12.8%*	*1.3%*	*9.1%*	*35.1%*
2015	*18.4%*	*19.1%*	*2.0%*	*13.7%*	*52.6%*
2020	*24.6%*	*25.5%*	*2.6%*	*18.2%*	*70.1%*
2025	*30.7%*	*31.9%*	*3.3%*	*22.8%*	*87.6%*
Trend Based on Building Permits Issued					
2000	0.0%	0.0%	0.0%	0.0%	0.0%
2005	*3.1%*	*3.2%*	*0.3%*	*2.3%*	*8.8%*
2010	*6.1%*	*6.4%*	*0.7%*	*4.6%*	*17.5%*
2015	*9.2%*	*9.6%*	*1.0%*	*6.8%*	*26.3%*
2020	*12.3%*	*12.8%*	*1.3%*	*9.1%*	*35.1%*
2025	*15.4%*	*16.0%*	*1.6%*	*11.4%*	*43.8%*

[1] Numbers in italics are estimated based on historical trends. Numbers below each area (e.g., B 7053) indicate the respective U.S. Census tract number.

Table 3-3
Assumed Population Growth per Area[1]

Year	Town of Stonington	Mystic (B 7053)	Borough (B 7052)	Pawcatuck (B 7051)	Remainder (B 7054)
OPM Projected Growth					
1990	16,919	3,176	3,510	7,871	2,362
2000	17,906	3,377	3,533	8,226	2,770
2005	17,776	*3,352*	*3,507*	*8,166*	*2,750*
2010	17,826	*3,362*	*3,517*	*8,189*	*2,758*
2015	18,026	*3,400*	*3,557*	*8,281*	*2,789*
2020	18,316	*3,454*	*3,614*	*8,414*	*2,833*
2025	*18,606*	*3,509*	*3,671*	*8,548*	*2,878*
2004 Plan of Conservation and Development Projections					
1990	16,919	3,176	3,510	7,871	2,362
2000	17,906	3,377	3,533	8,226	2,770
2005	*18,400*	*3,474*	*3,543*	*8,394*	*2,989*
2010	18,893	*3,570*	*3,554*	*8,563*	*3,207*
2015	*19,387*	*3,667*	*3,564*	*8,731*	*3,424*
2020	19,880	*3,764*	*3,575*	*8,899*	*3,642*
2025	*20,374*	*3,861*	*3,585*	*9,067*	*3,861*
Maximum Buildout Projection					
1990	16,919	3,176	3,510	7,871	2,362
2000	17,906	3,377	3,533	8,226	2,770
2005	*19,006*	*3,584*	*3,750*	*8,731*	*2,940*
2010	*20,106*	*3,792*	*3,967*	*9,237*	*3,110*
2015	*21,206*	*3,999*	*4,184*	*9,742*	*3,280*
2020	*22,306*	*4,207*	*4,401*	*10,247*	*3,451*
2025	*23,406*	*4,414*	*4,618*	*10,753*	*3,621*
Trend Based on Building Permits Issued					
1990	16,919	3,176	3,510	7,871	2,362
2000	17,906	3,377	3,533	8,226	2,770
2005	*18,456*	*3,481*	*3,642*	*8,479*	*2,855*
2010	*19,006*	*3,584*	*3,750*	*8,731*	*2,940*
2015	*19,556*	*3,688*	*3,859*	*8,984*	*3,025*
2020	*20,106*	*3,792*	*3,967*	*9,237*	*3,110*
2025	*20,656*	*3,896*	*4,076*	*9,489*	*3,195*

[1] Numbers in italics are estimated based on historical trends. Numbers below each area (e.g., B 7053) indicate the respective U.S. Census tract number.

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Table 3-4
Facilities Plan Population Projections[1]

Row	Description	Mystic Area	Borough Area	Pawcatuck Area	Comments
A.	Total average water use (gpd)	474,330	183,960	455,520	From water billing records
B.	Assumed percentage of water used that is collected in sewer system	90%	90%	90%	Based on typical data.
C.	Total average wastewater flow (gpd)	426,900	165,600	410,000	(Row A) x (Row B)
D.	Sewered population within district	2,566	1,151	4,323	Based on 2000 US Census Data at Block level
E.	Domestic (residential) wastewater per capita flow (gpcd)	70	70	70	Assumption, based on typical per capita flow rate
F.	Domestic (residential) wastewater flow (gpd)	179,600	80,570	302,610	(Row D) x (Row E)
G.	Total non-residential wastewater flow (gpd)	247,300	85,030	107,390	(Row C) - (Row F)
H.	Total institutional wastewater flow (gpd)	39,955	10,090	26,360	From water billing records
I.	Total industrial wastewater flow (gpd)	47,540	0	4,900	From water billing records
J.	Total commerical wastewater flow (gpd)	159,805	74,900	76,100	From water billing records

Table 3-5
Summary of Water Consumption Data

Mystic WPCF

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	NH_3-N (ppd)	TN (ppd)
Average Annual	0.570	1806	1462	142	202
Maximum Month	0.772	3024	3055	192	273
Maximum Day	1.176	4448	3627	292	416

Borough WPCF

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	NH_3-N (ppd)	TN (ppd)
Average Annual	0.216	374	304	48	70
Maximum Month	0.346	804	591	94	136
Maximum Day	0.486	944	737	114	167

Pawcatuck WPCF

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	NH_3-N (ppd)	TN (ppd)
Average Annual	0.473	782	1108	94	148
Maximum Month	0.696	974	1651	138	217
Maximum Day	0.918	1121	1991	182	286

Table 3-6
Existing WPCF Influent Flows and Loads
July 1999 through June 2002

Area	Description	Wastewater Flow Estimates (gallons per day)			
		Existing		Projected	
		Sewered	Unsewered	Sewered	Unsewered
Mystic	Existing Sewered Areas	179,600		221,800	
	Riverbend Drive		6,762	7,800	
	School Street		5,474	6,300	
	Roseleah Drive		3,325	3,900	
	Latimer Point		12,880	14,900	
	Mason's Island		10,304		12,000
	Other Areas		56,770		65,900
	Subtotal (Mystic)	**179,600**	**95,500**	**254,700**	**77,900**
Borough	Existing Sewered Areas	80,570		81,900	
	Elm Street Area		11,396	11,600	
	Montauk Avenue Area		5,236	5,300	
	Other Areas		9,000		9,100
	Subtotal (Borough)	**80,570**	**25,600**	**98,800**	**9,100**
Pawcatuck	Existing Sewered Areas	302,610		337,100	
	Elm Ridge Road area		35,875	40,000	
	Pequot Trail Area		19,775	22,000	
	Cronin Ave./Holly St.		5,250	5,800	
	Millan Terrace Area		6,650	7,400	
	Aimee Drive Area		9,625	10,700	
	Mark Drive Area		7,175	8,000	
	Greenhaven Road Area		25,025	27,900	
	Meadow Road Area		5,950	6,600	
	Marlin Drive Area		12,600	14,000	
	Other Areas		26,500		29,500
	Subtotal (Pawcatuck)	**302,610**	**154,400**	**479,500**	**29,500**
Remainder	Existing Sewered Areas	0		0	
	Marjorie Street Area		7,000		10,100
	N. Stonington Road		5,250		7,500
	Other Areas		181,650		261,200
	Subtotal (Remainder)	**0**	**193,900**	**0**	**278,800**
	TOTAL DOMESTIC FLOW	**562,780**	**469,400**	**833,000**	**395,300**

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Table 3-7
Domestic Wastewater Flow Projections

		Wastewater Flow Estimates (gallons per day)			
		Existing		Projected	
Area	Description	Sewered	Unsewered	Sewered	Unsewered
Mystic	Mystic Middle School	6,855		7,900	
	Marina Pump-Outs	5,000		10,000	
	Pendleton Retirement Comm.	28,100		28,100	
	Stone Ridge Retirement Comm.			37,000	
	Subtotal (Mystic)	**39,955**	**0**	**83,000**	**0**
Borough	Dean's Mill School	7,590		8,800	
	Marina Pump-Outs	2,500		10,000	
	Subtotal (Borough)	**10,090**	**0**	**18,800**	**0**
Pawcatuck	Schools (4 schools)	21,360		24,600	
	Marina Pump-Outs	5,000		10,000	
	Subtotal (Pawcatuck)	**26,360**	**0**	**34,600**	**0**
Remainder	none	0		0	
	Subtotal (Remainder)	**0**	**0**	**0**	**0**
	TOTAL INSTITUTIONAL FLOW	**76,405**	**0**	**136,400**	**0**

Table 3-8
Institutional Wastewater Flow Projections

Area	Description	Wastewater Flow Estimates (gallons per day)			
		Existing		Projected	
		Sewered	Unsewered	Sewered	Unsewered
Mystic	Mystic Aquarium	34,200		37,600	
	Subtotal (Mystic)	**34,200**	**0**	**37,600**	**0**
Borough	Existing Sewered Area	0			
	Airport site			19,800	
	Subtotal (Borough)	**0**	**0**	**19,800**	**0**
Pawcatuck	Davis Standard Corp.	4,900		6,600	
	Extrusion Drive Area			27,000	
	MAN-Roland Site	4,000		42,000	
	Subtotal (Pawcatuck)	**8,900**	**0**	**75,600**	**0**
Remainder	Existing Sewered Areas	0		0	
	Pequot Trail/Taugwonk Rd		0		29,000
	Subtotal (Remainder)	**0**	**0**	**0**	**29,000**
	TOTAL INDUSTRIAL FLOW	**43,100**	**0**	**133,000**	**29,000**

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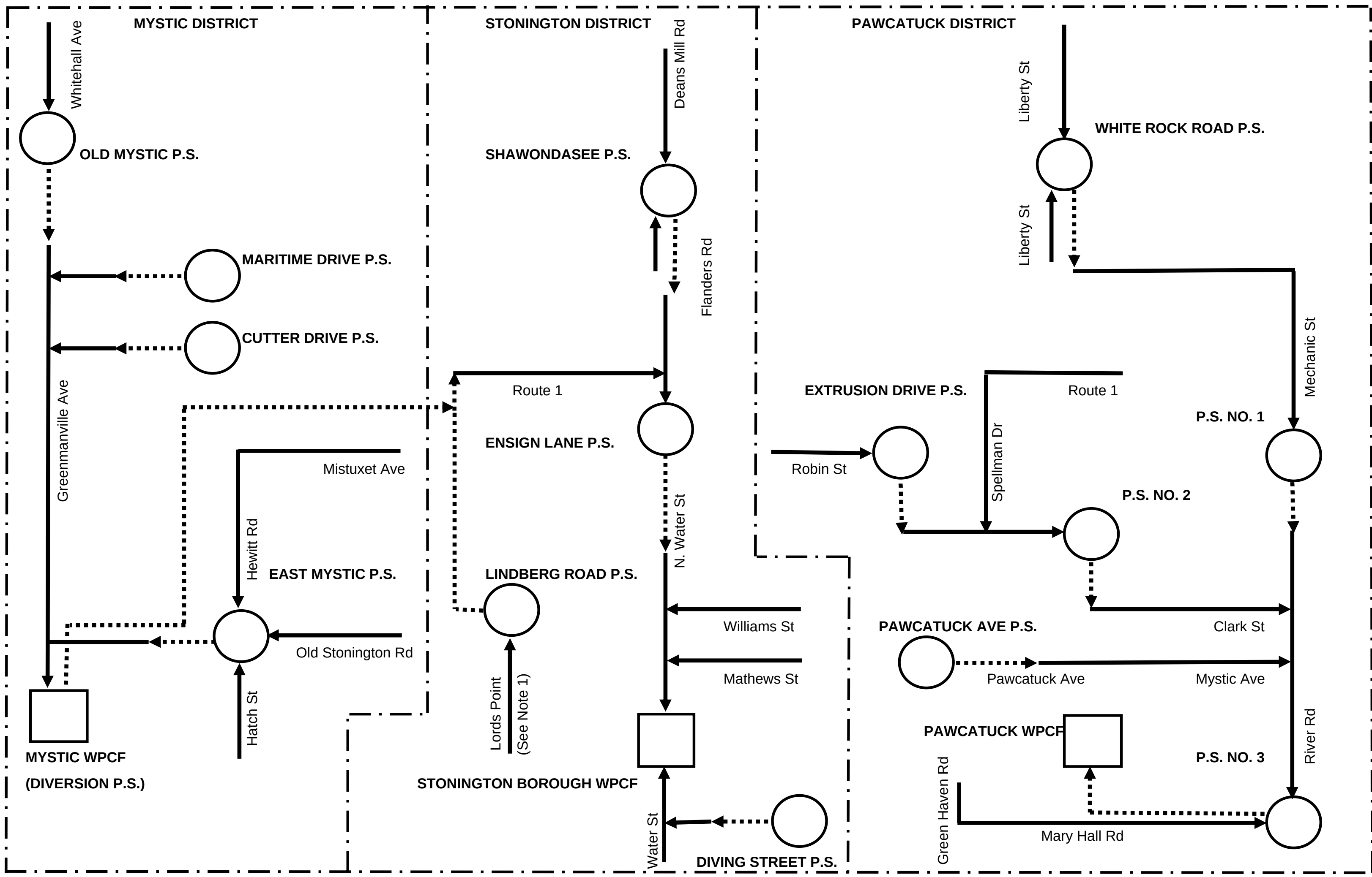
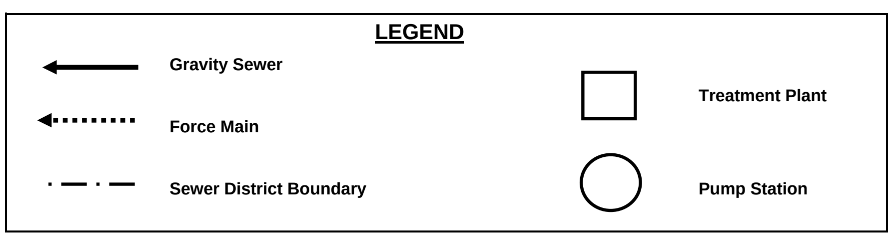
Table 3-9
Industrial Wastewater Flow Projections





NOTES:

1. **Boulder Avenue, Wolcott Avenue and Quarry Path Pumping Stations are not shown for clarity.**

Figure 4-1
Collection System Schematic

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Section 4
Wastewater Collection Systems

4.1 System Description

Stonington has three sanitary sewer systems that discharge to the Mystic, Stonington Borough and Pawcatuck WPCF's. These systems are schematically shown on **Figure 4-1.** This section provides a brief description of each system based on a review of records provided by the Stonington Water Pollution Control Authority (WPCA).

It should be noted that the system descriptions in this section depict the collection system in July 2002. No significant improvements have been made since that time. However, the following minor improvements have been made:

- The Stonington Green (River Crest Drive) subdivision has been constructed that borders the Aimee Drive and Mark Drive sewer needs areas. This subdivision is sewered within the Pawcatuck service area.

- The Rock Ridge subdivision is nearly completed adjacent to the Cronin Avenue/Holly Street sewer needs area. This subdivision will be sewered within the Pawcatuck service area.

- Sewers were extended along Coogan Boulevard and Jerry Browne Road to service the Stone Ridge Development and vacant land on the north side of Jerry Browne Road.

4.1.1 Mystic

The Mystic collection system includes approximately 20 miles of gravity sewers, five pumping stations, and the WPCF. The Mystic WPCF, placed on-line in 1972, is located on Edgemont Street and overlooks the Mystic River. Of the 20 miles of sewers in Mystic, there are approximately 12 miles of interceptors and eight miles of lateral sewers. The sizes of the sewers in this system range from 8 inches to 30 inches in diameter. In addition, there are approximately 1.1 miles of force main ranging in size from 4 inches to 10 inches in diameter. Most of the system was constructed during the 1970s. The service area extends eastward from the Mystic WPCF to the intersection of U.S. Route 1 and Chapman Lane, and northward to North Stonington Road. Four of the five pumping stations collect the flow and convey it to the Mystic WPCF via a combination of force mains and gravity sewers. The fifth pumping station (Diversion P.S.) is located at the Mystic WPCF and conveys underflow from the plant's primary clarifiers to the Borough WPCF via a separate transmission main.

4.1.2 Stonington Borough

The Stonington Borough collection system primarily services the Borough and the area immediately north. In addition, the collection system extends north to Deans Mill Road, and the Lord's Point area is also within this system. The Stonington

See Figure 4-1

Borough WPCF, which went on-line in 1975, is located at the end of High Street overlooking Stonington Harbor. Constructed in the 1970s, this system originally included approximately 8.5 miles of gravity sewers, of which four miles are interceptors. The sizes of the sewers in this district range from 8 inches to 30 inches in diameter. There are seven pumping stations located throughout this collection system. These pumping stations convey flow to the Borough WPCF via a combination of force mains and gravity sewers. There is approximately 0.7 miles of force main within this system ranging from 4 inches to 6 inches in diameter, not including Lord's Point or the transmission main from the Mystic WPCF.

In 1999, a transmission force main was placed into service to convey underflow from the Mystic WPCF primary clarifiers to the Stonington Borough system. This transmission main discharges to a gravity sewer at the biofilter odor-control system located on Stonington-Westerly Road (U.S. Route 1) near Rose Lane. From the biofilter, the wastewater flows by gravity to the Ensign Lane Pumping Station, and ultimately to the Borough WPCF.

In addition to the Mystic WPCF underflow, the transmission main also conveys wastewater from the Lords Point area. This flow enters the transmission main at the force main connection from the Lindberg Road Pumping Station at Noyes Avenue.

4.1.3 Pawcatuck

The Pawcatuck collection system services the eastern portion of the town. The Pawcatuck WPCF, placed in service in 1980, is located at the southern end of the collection system along Mary Hall Road. The system extends north along the Pawcatuck River to Interstate 95 (I-95). The western end of the collection system begins near the intersection of U.S. Route 1 and Anguilla Road. The Pawcatuck system consists of approximately 20 miles of sewers. Six miles of these sewers are interceptors, while the remaining 14 miles are laterals. The sizes of the sewers in this district range from 8 inches to 30 inches in diameter. An additional 1.4 miles of force main in this system consist of 2- to 20-inch diameter pipe. These force mains are supplied flow by the six pumping stations operating within the Pawcatuck collection system.

4.2 Capacity Analysis

A hydraulic capacity analysis was conducted for the critical components of each of the three wastewater collection systems, including the interceptors and pumping stations. The interceptors are major "spines" of each system that convey flow from its outer periphery to either the WPCF or a pumping station.

4.2.1 Interceptors

A capacity analysis was performed on the existing interceptors for each of the three collection systems. Manning's equation was used to calculate the capacity of a gravity pipe flowing full, but not surcharged. A roughness coefficient of 0.013, appropriate for cement-lined pipe, was used to estimate hydraulic capacity. This value is generally accepted engineering practice for design of gravity sewers.

Interceptor capacities for the Mystic, Stonington Borough, and Pawcatuck systems are presented in **Tables 4-1 through 4-3**, respectively.

Each interceptor is divided into major segments between 136 and 5,985 feet in length. The segments were determined based on the location of major connections, changes in pipe size, and/or significant changes in pipe capacity. Within each segment, the hydraulic capacity was calculated for every reach (i.e. manhole to manhole). The capacities listed in Tables 4-1 through 4-3 represent the minimum capacity for any reach within the segment. The actual capacity of each segment may, however, be higher than the capacity listed in Tables 4-1 through 4-3 due to this calculation technique, particularly where the length of the limiting reach is short. This will be discussed in detail for individual segments in the following sections.

Mystic

Interceptors from Mystic WPCF to North Stonington Road

This system includes two major interceptors. The first interceptor starts at the Mystic WPCF on Edgemont Street and runs north in Greenmanville Avenue to a point just south of Riverbend Drive. At this point, it receives flow discharged by the force main from the Old Mystic Pumping Station. The second interceptor extends north from the Old Mystic Pumping Station to the intersection of Main Street and North Stonington Road.

The first interceptor begins as 30-inch pipe at its downstream end at the Mystic WPCF, and decreases to a 24-inch pipe at Roosevelt Street. This interceptor continues as a 24-inch until it reaches Pleasant Street, where it reduces to an 18-inch pipe and continues north to the connection with the 8-inch force main from the Old Mystic Pumping Station. The interceptor has an inverted siphon crossing under a culvert at the I-95 interchange. The second interceptor is an 18-inch pipe extending north from the pumping station to the intersection of Main Street and North Stonington Road.

The estimated hydraulic capacities of each sewer segment are summarized in Table 4-1 and as follows:

- 7.6 million gallons per day (mgd) between the Mystic WPCF and Roosevelt Street
- 3.9 mgd between Roosevelt Street and Hinckley Street
- 4.0 mgd in Greenmanville Avenue (Route 27) between Hinckley Street and Pleasant Street
- 2.5 mgd in Greenmanville Avenue between Pleasant Street and Olde Mistick Village

- **See Table 4-1**

See Table 4-2 (page 1)

See Table 4-2 (page 2)

See Table 4-3 (page 1)

See Table 4-1 (page 2)

- 2.5 mgd in Greenmanville Avenue between Olde Mistick Village and Riverbend Drive
- 2.3 mgd in Whitehall Avenue (Route 27) between Clipper Point Road and the intersection of Main Street and North Stonington Road

The above capacities are the same as shown in Table 4-1, except for the segment between Roosevelt Street and Hinckley Street. This segment includes one reach of 185 feet with a capacity of about 2.6 mgd. The capacity is based on Manning's Equation, assuming that the pipe is flowing full, but not surcharged. However, greater hydraulic throughput can be achieved if the pipe is allowed to surcharge (surcharged pipes are hydraulically similar to pressurized pipe). Surcharging may be acceptable over short lengths of pipe because the surcharging is not large enough to significantly impact flow in upstream pipe reaches. Therefore, based on upstream and downstream flow capacities, the segment can handle approximately 3.9 mgd, when slightly surcharged, without any adverse impacts.

Interceptor along Hinckley Street from Greenmanville Avenue to Cutter Drive Pumping Station

The 8-inch sewer in Hinckley Street discharges to the 24-inch interceptor in Greenmanville Avenue. A 4-inch force main from the Cutter Drive Pumping Station supplies the primary flow to the interceptor. The estimated full pipe capacity is 0.5 mgd at both the upstream and downstream ends of the interceptor with no intermediate capacity restrictions.

Interceptor along Roosevelt Street from Broadway Avenue to west of Peqoutsepos Cove

The downstream end of the 24-inch interceptor along Roosevelt Street connects to the 24-inch Broadway Avenue interceptor. The upstream end of the interceptor is located on the west side of the Pequotsepos Cove where it connects to the 10-inch force main from the East Mystic Pumping Station. The estimated full pipe capacity of the interceptor is 4.0 mgd.

Interceptor from the East Mystic Pumping Station to Allen Street

This interceptor is one of three major interceptors' tributary to the East Mystic Pumping Station and provides service to the area south of the pumping station. The interceptor is an 18-inch pipe from the pumping station to Hatch Street and has capacity of about 2.9 mgd. The interceptor reduces to a 15-inch pipe in Hatch Street and Allen Street and has a 1.6 mgd capacity.

Interceptor from the East Mystic Pumping Station to Mistuxet Avenue

This interceptor is also tributary to the East Mystic Pumping Station and provides service to the area north of the station. The interceptor is a 15-inch pipe from the pumping station to Golden Road Extension and has capacity of about 1.6 mgd. The interceptor reduces to a 12-inch pipe from Golden Street to Mistuxet Avenue with a

1.1 mgd capacity and then to an 8-inch pipe in Mistuxet Avenue to its end with a 0.5-mgd capacity.

The above capacities are the same as shown in Table 4-1, except for the segment between the East Mystic Pumping Station and Golden Road Extension. This segment includes a 130-foot reach with a capacity of 1.4 mgd. However, the segment can handle about 1.6 mgd when slightly surcharged, without any adverse impacts.

Interceptor from the East Mystic Pumping Station to Old Stonington Road
This interceptor is also tributary to the East Mystic Pumping Station and provides service to the area east of the station. The interceptor is an 18-inch pipe extending cross-country east and south to Route 1 and has capacity of about 1.9 mgd.

Stonington Borough

Interceptor from the Borough WPCF to Deans Mill Road
The main interceptor serving the area north (upstream) of the Borough begins at the Borough WPCF as a 24-inch pipe with an approximate capacity of 4.0 mgd. The interceptor then continues north on Front Street and then merges onto Water Street. The interceptor reduces to an 18-inch pipe as it crosses under the railroad tracks, and then reduces again to a 12-inch pipe in North Water Street. The 12-inch interceptor continues to a point just downstream from Quanaduck Cove, at which point a 6-inch force main from the Ensign Lane Pumping Station connects into it.

According to record drawings, the Ensign Lane Pumping Station and the interceptor heading north from the station were built under a separate contract in the early 1990's. The interceptor begins at the pumping station as an 18-inch pipe and continues north to Stony Brook. At this point, the interceptor changes to an 8-inch pipe. The 8-inch sewer continues to a location just upstream from Collins Road, at which point a 6-inch force main from the Shawondasee Drive Pumping Station connects into it. The interceptor upstream from the Shawondasee Drive Pumping Station is an 8-inch pipe, and terminates in Deans Mill Road.

The estimated hydraulic capacities of each sewer segment are summarized in Table 4-2 and as follows:

- 4.0 mgd between the Borough WPCF and the railroad tracks
- 2.3 mgd through the pipe jacking under the railroad tracks
- 1.8 mgd in Water Street and N. Water Street between the railroad tracks and a point just north of Palmer Street
- 2.1 mgd in Flanders Road from the Ensign Lane Pumping Station to Stony Brook
- 0.5 mgd in Flanders Road from Stony Brook to a point just north of Collins Road

- 0.5 mgd in Flanders Road and Deans Mill Road from the Shawondasee Pumping Station to the end of the pipe

The above capacities are the same as shown in Table 4-2, except for the segment between the railroad tracks and a point just north of Palmer Street. This segment includes one reach of 231 feet with a capacity of about 1.3 mgd, which is shown in Table 4-2. However, the segment can handle about 1.8 mgd, when slightly surcharged, without any adverse impacts.

Interceptor along Water Street from the Borough WPCF to Omega Street

This interceptor begins at the WPCF as a 24-inch and continues south (upstream) into the Borough along Northwest Street as a 15-inch pipe. At Water Street, it continues south changing to a 12-inch pipe, and then reduces to a 10-inch pipe. At the intersection of Water Street and Diving Street, the 10-inch interceptor changes to an 8-inch pipe and continues upstream until it terminates just south of Omega Street. The analysis does not show any evidence of capacity restrictions along the interceptor.

A short section of 8-inch sewer branches off this main interceptor and continues east along Diving Street toward the Diving Street Pumping Station. A 4-inch force main from the pumping station connects into this gravity sewer approximately halfway up the street. The capacity of this sewer is approximately 0.6 mgd.

The estimated hydraulic capacities of each sewer segment are summarized in Table 4-2 and as follows:

- 1.6 mgd between the Borough WPCF and Water Street
- 1.1 mgd in Water Street between Church Street and Harmony Street
- 0.8 mgd in Water Street between Harmony Street and Diving Street
- 0.5 mgd in Water Street between Diving Street and Omega Street

Interceptor along Mathew Street and Railroad Tracks from Water Street to Bayview Avenue

The 18-inch interceptor along Mathew Street connects to the 18-inch interceptor in Water Street at the downstream end. As the interceptor continues easterly (upstream) along the railroad tracks, it reduces to a 15-inch pipe just north of the tracks. The pipe terminates at Bayview Avenue.

The estimated hydraulic capacities of each sewer segment are summarized in Table 4-2 and as follows:

- 2.1 mgd in Mathew Street between Water Street and the railroad tracks
- 2.5 mgd from the railroad tracks to Bayview Avenue

Interceptor along Williams Street from North Water Street to Elm Street
This interceptor branches off of the trunk line, or main interceptor, at North Water Street and services the area to the east. The interceptor starts as a 12-inch pipe in Williams Street and continues east along Cutler Street. In Cutler Street, the interceptor changes from a 12-inch pipe to a 10-inch pipe, and changes again to an 8-inch pipe further upstream. The 8-inch interceptor continues north on Elm Street and terminates at Town Hall.

The estimated hydraulic capacities of each sewer segment are summarized in Table 4-2 and as follows:

- 1.1 mgd in Williams Street between North Water Street and North Main Street
- 0.7 mgd in Cutler Street from North Main Street to Trumbull Avenue
- 0.5 mgd in Cutler Street from Trumbull Avenue to Elm Street
- 0.5 mgd in Elm Street from Cutler Street to the end of the pipe

Interceptor along North Main Street from Williams Street to Palmer Street
The downstream end of this 10-inch interceptor connects to the Williams Street interceptor, and travels about 1,000 feet north (upstream) to collect flow from several streets. The pipe capacity is approximately 0.75 mgd throughout the interceptor.

Interceptor along U.S. Route 1 from North Water Street to the Biofilter
This interceptor branches off of the trunk line, or main interceptor, at North Water Street as an 18-inch pipe and services the area to the west. As the interceptor continues westerly (upstream) along U.S. Route 1, it reduces to a 15-inch pipe just east of Collins Road. The pipe terminates at the biofilter near Rose Lane.

The estimated hydraulic capacities of each sewer segment are summarized in Table 4-2 and as follows:

- 2.2 mgd in U.S. Route 1 between North Water Street and a location east of Collins Road
- 4.4 mgd from east of Collins Road to the biofilter near Rose Lane

Pawcatuck

Interceptor from Pumping Station No. 3 to Interstate I-95
This system includes three major interceptors. The first starts at Pumping Station No.3 and runs north in River Road to a point just south of Burdick Lane where it receives flow discharged by the 12-inch force main from Pumping Station No. 1. The second extends north from the Pumping Station No. 1 to the intersection of Liberty Street and Glasgow Road where it receives flow discharged by the 6-inch force main from White Rock Road Pumping Station. The third extends north from the White Rock Road Pumping Station to I-95.

The first interceptor begins as 30-inch pipe at its downstream end at the Pawcatuck WPCF and decreases to a 24-inch pipe at Clark Street. The interceptor continues as a 24-inch pipe in Mechanic Street until it reaches a point just south of Burdick Lane and connects to the 12-inch force main from Pumping Station No. 1.

The second interceptor begins as a 24-inch pipe at Pumping Station No.1 and extends north in Mechanic Street and West Broad Street to Liberty Street. The interceptor decreases to a 21-inch pipe in Liberty Street. The interceptor continues north cross country along the Pawcatuck River as a 20-inch pipe, and increases to a 21-inch pipe where it intersects Walnut Street. The 21-inch pipe continues north to Stillman Avenue. At River Street, the pipe size decreases to 18-inch diameter and continues south in Antoinette Street, and then west in West Arch Street to Liberty Street continuing north to Glasgow Road.

The third interceptor is a 21-inch diameter pipe extending north from the White Rock Road Pumping Station.

The estimated hydraulic capacities of each sewer segment are summarized in Table 4-3 and as follows:

Interceptor 1:

- 7.5 mgd in River Road between Pumping Station No. 3 and Clark Street
- 5.1 mgd in River Road between Clark Street and Pumping Station No. 1

Interceptor 2:

- 4.2 mgd in Mechanic Street between Pumping Station No. 1 and Liberty Street
- 3.3 mgd in Liberty Street between West Broad Street and cross country
- 2.3 mgd in the 20-inch cross-country segment along the Pawcatuck River
- 2.8 mgd in the 21-inch cross-country and Stillman Avenue segment to the intersection of River Street
- 6.4 mgd in River Street/Antoinette Street/West Arch Street between Stillman Avenue and Woodlawn Street
- 3.2 mgd in West Arch Street between Woodlawn Street and Liberty Street
- 3.2 mgd in Liberty Street between West Arch Street and Glasgow Road

Interceptor 3:

- 2.4 mgd in Liberty Street between White Rock Road to the end of the pipe (intersection with Interstate 95)

The above capacities differ from those shown in Table 4-3 in five of the ten segments. Two of these segments are in Interceptor 1, two are in Interceptor 2, and one is in Interceptor 3.

The first segment that differs in capacity is located in River Road between Pumping Station No. 3 and Clark Street. This segment includes one reach of 84-feet with a capacity of about 7.1 mgd, which is shown in Table 4-3. However, the segment can handle about 7.5 mgd, when slightly surcharged, without any adverse impacts.

The second segment that differs in capacity is located in Mechanic Street between Clark Street and Pumping Station No. 1. This segment includes a 114-foot reach with a capacity of 3.1 mgd, which is shown in Table 4-3. However, the segment can handle about 5.1 mgd, when slightly surcharged, without any adverse impacts.

The third segment is the 21-inch cross-country interceptor along the Pawcatuck River. This segment includes one reach of 177 feet with a capacity of about 1.5 mgd, which is shown in Table 4-3. However, the segment can handle about 2.8 mgd, when slightly surcharged, without any adverse impacts.

The fourth and fifth segments are located in Liberty Street. The fourth segment extends from West Arch Street to Glasgow Road. This segment includes a 299-foot reach with a capacity of 2.9 mgd, as shown in Table 4-3. However, the segment can handle about 3.2 mgd without any adverse impacts. The fifth segment extends from White Rock Road to the end of the pipe at Interstate 95. This segment includes a 359-foot reach with a capacity of 2.4 mgd. However, the segment can handle about 3.2 mgd, when slightly surcharged, without any adverse impacts.

Interceptor along Mary Hall Road and Greenhaven Road from Pumping Station No. 3

This 8-inch interceptor, which runs along a small section of Greenhaven Road and Mary Hall Road to Pumping Station No. 3, is about 2,800 feet long. Table 4-3 shows a minimum capacity of 0.4 mgd in a 250-foot reach of this segment in Mary Hall Road. However, this segment can handle additional flow, when slightly surcharged, without any adverse impacts.

Interceptor along Mystic Avenue from River Road to Pawcatuck Avenue

The 10-inch interceptor along Mystic Avenue serves a small area west of the trunk line and slightly north of the WPCF. The interceptor has an approximate pipe capacity of 0.6 mgd. The 10-inch pipe continues upstream along Trumbull Street to the intersection of Pawcatuck Avenue. At this location, the interceptor decreases to an 8-inch pipe and continues west along Pawcatuck Avenue to Hawley Street, where the pipe ends. However, there is a 2-inch force main from the Pawcatuck Avenue Pumping Station that connects into this pipe terminus.

This 8-inch segment includes a 240-foot reach with a pipe capacity of 0.7 mgd, as shown in Table 4-3. However, this segment can handle about 1.0 mgd, when slightly surcharged, without any adverse impacts.

Interceptor along Clark Street and cross-country from River Road to Pumping Station No. 2

This interceptor receives flow from the Pumping Station No. 2 force main and serves an area west of the railroad tracks and south of Burdick Lane. The interceptor runs west from River Road in Clark Street, crosses the railroad tracks and continues west cross-country to Pumping Station No. 2. The pipe is 15-inch diameter from its connection to the 30-inch trunk line in River Road for about 325 feet, 18-inch diameter for about 1,250 feet, 15-inch diameter for about 630 feet and 18-inch diameter for about 425 feet.

The estimated hydraulic capacities of each sewer segment are summarized in Table 4-3 and presented below:

- 7.2 mgd in Clark Street between River Road and Pawcatuck Avenue
- 3.4 mgd in the cross-country segment between Pawcatuck Avenue and a location just west of the railroad tracks
- 7.2 mgd in the 15-inch cross-country segment west of the railroad tracks
- 3.7 mgd in the remaining 18-inch cross-country segment to Pumping Station No. 2

Interceptor along Spellman Drive and South Broad Street (US Route 1)

This interceptor receives flow from the Extrusion Drive Pumping Station force main and serves the area along Spellman Drive and South Broad Street. The interceptor extends west from Pumping Station No. 2 to Spellman Drive as an 18-inch pipe. The connection from the Extrusion Drive Pumping Station force main is about 600 feet upstream from the end of Spellman Drive, which is where the interceptor turns north. The pipe continues north as an 18-inch pipe for another 740 feet, and reduces to a 15-inch pipe for the remainder of Spellman Drive. The pipe is 8-inch diameter for about 625 feet east in South Broad Street. A relatively new 18-inch interceptor extends east along South Broad Street from the 8-inch pipe.

The estimated hydraulic capacities of each sewer segment are summarized in Table 4-3 and presented below:

- 2.4 mgd in Spellman Drive between Pumping Station No. 2 and manhole 6-24 (15-inch connection)
- 1.8 mgd in Spellman Drive between manhole 6-24 and South Broad Street
- 0.5 mgd in South Broad Street between Spellman Drive and manhole 6-30 (18-inch connection)
- 2.1 mgd in South Broad Street between manhole 6-31 and the end of the pipe

The above capacities are the same as shown in Table 4-3, except for two of the segments. The first segment that differs in capacity between Table 4-3 and the previous discussion is located in Spellman Drive between Pumping Station No. 2 and manhole 6-24. This segment includes a 116-foot reach with a capacity of about 1.3 mgd, which is shown in Table 4-3. However, the segment can handle about 2.4 mgd, when slightly surcharged, without any adverse impacts.

The second segment that differs in capacity is located in South Broad Street between manhole 6-30 and the end of the pipe, also shown in Table 4-3 as the 18-inch segment. This segment includes a 230-foot reach with a capacity of 1.6 mgd. However, the segment can handle about 2.1 mgd, when slightly surcharged, without any adverse impacts.

Cross-country Interceptor from Spellman Drive to Force Main from the Extrusion Drive Pumping Station

The downstream end of the interceptor connects to the 15-inch interceptor in Spellman Drive as an 18-inch pipe. The upstream end of the pipe is 10-inch and connects to the 6-inch force main from the Extrusion Drive Pumping Station. The pipe capacity is approximately 0.7 mgd.

Interceptor along Constitution Avenue from the Extrusion Drive Pumping Station to South Broad Street (U.S. Route 1)

The downstream end of the 10-inch interceptor connects to the suction side of the Extrusion Drive Pumping Station. The interceptor continues west along Constitution Avenue and Oriole Street to Wren Street. The pipe then travels north on Wren Street. Finally, the interceptor continues onto Robin Street where it terminates just south of South Broad Street (U.S. Route 1). The pipe capacity is approximately 0.6 mgd.

Interceptor along Burdick Lane from Pumping Station No. 1 to West Broad Street

The interceptor begins at Pumping Station No. 1 as a 10-inch pipe, and serves the area west of the trunk line and north of Clark Street. The interceptor continues west cross-country to Burdick Lane. The interceptor then changes to a 12-inch pipe and continues north along Moss Street. The pipe makes several bends before turning onto Palmer Street, where it becomes a 10-inch pipe. After continuing north on Courtland Street for a short distance, the interceptor decreases to an 8-inch pipe and travels cross-country to Mayflower Avenue. The interceptor increases to a 10-inch pipe along Mayflower Avenue, but then decreases again to an 8-inch pipe while continuing north through an easement north of South Broad Street before terminating at West Broad Street.

The estimated hydraulic capacities of each sewer segment are summarized in Table 4-3 and as follows:

- 1.5 mgd in Burdick Lane between Mechanic Street and the railroad tracks
- 1.3 mgd between the railroad tracks and Palmer Street

- 0.8 mgd as a 10-inch pipe in Palmer Street and Courtland Street
- 1.0 mgd in the right-of-way (ROW) easement between Courtland Street and Mayflower Avenue
- 0.8 mgd as a 10-inch pipe in Mayflower Avenue and South Broad Street
- 0.5 mgd in the ROW easement between South Broad Street and West Broad Street

Interceptor along West Broad Street from Liberty Street to Wilcox Manor
The 10-inch interceptor in West Broad Street serves the area west of the trunk line and north of the Burdick Lane area, and has a capacity of about 1.1 mgd. The interceptor changes to an 8-inch pipe at the intersection of Lincoln Avenue, and continues as such along West Broad Street to its terminus at Wilcox Manor. The approximate pipe capacity of this segment is 1.0 mgd.

4.2.2 Pumping Stations

Data such as pump motor horsepower, dimensions and configuration of wet wells and backup power capability was obtained from the WPCA and via station inspections conducted by CDM. This information will be used in evaluating the present operating efficiency of the stations and determining the upgrades necessary to provide adequate capacity for projected flows from new development and sewer system extensions for the planning period.

The stations are described in the following sections.

Mystic

The Mystic sewer system includes five pumping stations.

<u>The East Mystic Pumping Station</u> is located on Hewitt Road near Judd Avenue. The service area includes the sewer system east of the Pequotsepos Cove and south of Mistuxet Avenue. The station is a built in place structure with separate enclosures for the wet well and pumps and a single story above grade structure. A hatch outside the building provides access to the wet well.

The station has two pumps, each driven by a close coupled, 10 hp, 1170 RPM constant speed motor. The pumps are vertical, non-clog dry pit type with mechanical seals and have a design capacity of 800 gallons per minute (gpm). Pump control is based on wet well liquid level provided by an ultrasonic level indicator with a mercury type float switch back-up and alarm system. On-site standby power is provided by a 45KW, 6.3KVA diesel engine generator located in the building. Diesel fuel is stored in an above ground tank outside the building.

<u>The Cutter Drive Pumping Station</u> is located at the east end of Cutter Drive. The station provides local service to houses on five streets in the area. The station is a factory built prefabricated reinforced concrete below ground station with separate

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enclosures for the wet well valve vault. Access to both wet well and valve vault is provided by hatches.

The station has two submersible pumps each driven by an 11.3 hp, 1750 RPM constant speed motor. The pumps have a design capacity of 110 gpm. The discharge piping of each pump has a check valve in the valve vault. The control panel is located in a pedestal cabinet on the site. Pump control is based on wet well liquid level provided by an ultrasonic level indicator with a mercury type float switch back-up and alarm system. On-site standby power is provided by a diesel engine generator located on the site in a weather tight cabinet. Diesel fuel is stored in an above ground tank.

The Maritime Drive Pumping Station is located on Maritime Drive and serves commercial establishments south of Coogan Boulevard. The station is a factory built prefabricated reinforced concrete below ground station with separate enclosures for the wet well valve vault. Access to both wet well and valve vault is provided by hatches.

The station has two submersible pumps each driven by a 24 hp, 1750 RPM constant speed motor. The pumps have a design capacity of approximately 320 gpm. The discharge piping of each pump has a check valve in the valve vault. The control panel is located in a pedestal cabinet on the site. Pump control is based on wet well liquid level provided by an ultrasonic level indicator with a mercury type float switch back-up and alarm system. On-site standby power is provided by an 80KW, 100KVA diesel engine generator located on the site in a weather tight cabinet. Diesel fuel is stored in an underground tank.

The Old Mystic Pumping Station is located on Greenmanville Avenue (Route 27) south of Pequot Trail. The service area includes the sewer system north of Clipper Point Road. The station is a reinforced concrete below ground structure with separate enclosures for the wet well and pumps. Access to both the wet well and pump chamber is provided by hatches.

The station has two pumps each driven by a close coupled, 7.5 hp, 1150 RPM constant speed motor. The pumps are vertical, non-clog dry pit type with mechanical seals and have a design capacity of 450 gpm. Pump control is based on wet well liquid level provided by an ultrasonic level indicator with a mercury type float switch back-up and alarm system. On-site standby power is provided by a 45KW, 56.2KVA propane engine generator located in the station. Propane cylinders are located on a concrete slab at grade.

The Diversion Pumping Station is at the Mystic WPCF. It is unique in that it pumps underflow from the treatment plant's primary clarifiers to the Stonington Borough WPCF. The pumps are vertical, non-clog dry pit and have a design capacity of 230 gpm.

Stonington Borough

The Stonington Borough sewer system includes seven pumping stations.

The Diving Street Pumping Station is located at the east end of Diving Street. The station provides service to a small area on Stonington Point. The station is a factory built prefabricated reinforced concrete below ground station with separate enclosures for the wet well valve vault. Access to both wet well and valve vault is provided by hatches. The pumps were recently replaced.

The Ensign Lane Pumping Station is located on Flanders Road at Ensign Lane. The service area includes the sewer system north of Stonington Road (US Route 1) including the flow pumped by the Shawondasee Pumping Station. The station also receives the underflow from the Mystic WPCF Diversion Pumping Station.

The original submersible pumps were recently replaced to provide capacity for the Mystic WPCF underflow. Additional improvements were also made including a new building containing a chemical feed system for sulfide control and carbon scrubber odor control system. The pumps are located in a 7-foot diameter wet well.

The station has two submersible pumps each driven by a 40 hp, 1800 RPM motor with variable speed drive. The pumps have a design capacity of 590 gpm. Pump control is based on wet well liquid level provided by a transducer type level indicator with a mercury type float switch back-up and alarm system. The pump control panel and standby power generator are located in the building. The generator is an 80KW, 100KVA diesel engine generator with a skid mounted fuel storage tank.

The Shawondasee Pumping Station is located on Flanders Road at Shawondasee Drive. The service area includes the sewer system in Shawondasee Drive, Meadowlark Road, Carriage Drive and Hillcrest Drive, and the sewer system in Flanders Road extending north into Deans Mill Road. The station is a factory built prefabricated reinforced concrete below ground station with separate enclosures for the wet well valve vault. Access to both wet well and valve vault is provided by hatches.

The station has two submersible pumps each driven by a 3.7 hp, 1750 RPM constant speed motor. The pumps have a design capacity of 125 gpm. The discharge piping of each pump has a check valve in the valve vault. The control panel is located in a pedestal cabinet on the site. Pump control is based on wet well liquid level provided by an ultrasonic level indicator with a mercury type float switch back-up and alarm system. On-site standby power is provided by a 25KW, 31KVA diesel engine generator located on the site in a weather tight cabinet. Diesel fuel is stored in a below ground tank.

The Lindberg Road Pumping Station is located on Lindberg Road near Noyes Street. The service area includes all of Lords Point including the flow from the three other pumping stations on Lords Point. The station is a factory built prefabricated reinforced concrete station with an above grade wood frame structure built over the wet well. Separate enclosures are provided for the wet well valve vault. Hatches inside the wood frame building provide access to both the wet well and valve vault. The station also has a recently constructed wood frame building containing a chemical feed system for sulfide control.

The station has two submersible pumps each driven by a 15 hp, 1750 RPM constant speed motor and have a design capacity of 180 gpm. Pump control is based on wet well liquid level provided by an ultrasonic level indicator with a mercury type float switch back-up and alarm system. On-site standby power is provided by a 50KW, 62.5KVA diesel engine generator located in the building. Diesel fuel is stored in an above ground tank outside the building.

<u>The Boulder Avenue, Wolcott Avenue and Quarry Path Pumping Stations</u> are located on Lords Point and provide service to houses on Lords Point. The stations are 6-foot diameter factory built prefabricated reinforced concrete below ground stations. Access to the wet well is provided by a hatch.

Each station has two submersible pumps driven by 2.8 hp, 1750 RPM constant speed motors. The pumps have a design capacity of 100 gpm. Pump control is based on wet well liquid level provided by an ultrasonic level indicator with a mercury type float switch back-up and alarm system. The control panel is located in a pedestal cabinet on the site. The pedestal cabinet has an externally mounted receptacle for a portable generator connection to provide standby power.

Pawcatuck

The Pawcatuck sewer system includes six pumping stations.

<u>Pumping Station No. 3</u> is located on the east side of River Road near Mary Hall Road. All flow to the Pawcatuck WPCF is pumped at this station. The station is a built in place structure with separate enclosures for the wet well and pumps and a single story above grade structure. Recent improvements have been made to the station including replacement of the pumps and motors.

The station has two pumps each driven by a close coupled, 25 hp, 1190 RPM motor with variable speed drive. The pumps are vertical, non-clog dry pit type with mechanical seals and have a design capacity of 1,500 gpm. Pump control is based on wet well liquid level provided by a compressed air system with a mercury type float switch back-up and alarm system. A 40KW diesel engine generator located inside the building provides on-site standby power. Diesel fuel is stored outside the building in a below ground tank. The wet well influent channel has a newly installed comminutor (September 2002), similar to those installed at the Mystic and Borough WPCF's.

<u>Pumping Station No. 2</u> is located east of Spellman Road. The station serves the western part of the sewer system extending north to the streets along Stonington Road (US Route 1) and west to Robin Street including flow from the Extrusion Drive

Pumping Station. The station is a built in place structure with a single story above grade structure and separate wet well containing the pumps. Access to the wet well is provided by a hatch at grade.

The station has two submersible pumps each driven by a 29 hp, 1150 RPM constant speed motor. The pumps have a design capacity of 800 gpm. Pump control is based on wet well liquid level provided by an ultrasonic level indicator with a mercury type float switch back-up and alarm system. On-site standby power is provided by a 70KW, 88KVA diesel engine generator located in the building. Diesel fuel is stored outside the building in an underground tank.

<u>The Extrusion Drive Pumping Station</u> is located at the southern end of Extrusion Drive. The station serves the westernmost part of the Pumping Station No. 2 service area. The station is a factory built prefabricated reinforced concrete below ground station with separate enclosures for the wet well valve vault. Access to both wet well and valve vault is provided by hatches.

The station has two submersible pumps each driven by a 7.5 hp, 1750 RPM constant speed motor. The pumps have a design capacity of 350 gpm. The discharge piping of each pump has a check valve in the valve vault. The control panel is located in a pedestal cabinet on the site. Pump control is based on wet well liquid level provided by an ultrasonic level indicator with a mercury type float switch back-up and alarm system. A diesel engine generator located on the site in a weather tight cabinet provides on-site standby power. Diesel fuel is stored in a below ground tank.

<u>The Pawcatuck Avenue Pumping Station</u> is located on Pawcatuck Avenue west of Ingersoll Street. The station provides service to several houses west of Ingersoll Street. The station is a 5-foot diameter factory built prefabricated reinforced concrete below ground station. Access to the wet well is provided by a hatch.

The station has two submersible grinder pumps each driven by a 3.0 hp, 3450 RPM constant speed motor. The pumps have a design capacity of 70 gpm. Pump control is based on wet well liquid level provided by an ultrasonic level indicator with a mercury type float switch back-up and alarm system. The control panel is located in a pedestal cabinet on the site. The pedestal cabinet has an externally mounted receptacle for a portable generator connection to provide standby power.

<u>Pumping Station No. 1</u> is located on the east side of River Road near Prospect Street. The service area includes the sewer system north of the station including the flow pumped by the White Rock Road Pumping Station. The station is a built in place structure with a single story above grade structure and separate wet well containing the pumps. Access to the wet well is provided by a hatch at grade.

The station has two submersible pumps each driven by an 18 hp, 860 RPM constant speed motor. The pumps have a design capacity of 1,125 gpm. Pump control is based on wet well liquid level provided by an ultrasonic level indicator with a mercury type float switch back-up and alarm system. On-site standby power is provided by a

70KW, 88KVA diesel engine generator located in the building. Diesel fuel is stored in a tank inside the building.

The White Rock Road Pumping Station is located on White Rock Road east of Liberty Street (Route 2). The station provides service to local commercial establishments. The station is a factory built prefabricated reinforced concrete below ground station with separate enclosures for the wet well valve vault. Access to both wet well and valve vault is provided by hatches.

The station has two submersible pumps each driven by a 30 hp, 1750 RPM constant speed motor. The pumps have a design capacity of 300 gpm. The discharge piping of each pump has a check valve in the valve vault. The control panel is located in a pedestal cabinet on the site. Pump control is based on wet well liquid level provided by an ultrasonic level indicator with a mercury type float switch back-up and alarm system. On-site standby power is provided by a 100KW, 125KVA natural gas engine generator located on the site in a weather tight cabinet.

Present Condition and Capacity

Table 4-4 lists all of the WPCA's wastewater pumping stations and their existing capacity. The capacity reported in this study is "firm" capacity, defined as the maximum station capacity with the largest pump out of service.

The general structural and mechanical condition of the pumping stations is good. Deficiencies identified from the data review and site inspections are summarized below.

Pumping Station No. 1

The cycle time between pump starts is less than the recommended minimum of 15 minutes for motors of the size at this station. Presently the operating range of the wet well is 2-foot, which provides 668 gallons of storage and results in a minimum cycle time of 4.75 minutes per pump. If the storage were to be maximized by operating the pumps over the full vertical distance between the invert of the influent pipe to the wet well and the pump cut out elevation, the minimum cycle time would increase to 10.3 minutes.

The minimum recommended cycle time could be met by installing variable frequency drives, as was done recently at Pumping Station No. 3, and should be considered.

Pumping Station No. 2

The cycle time between pump starts is less than the recommended minimum of 15 minutes for motors of the size at this station. Presently the operating range of the wet well is 1.25 feet, which provides 655 gallons of storage and results in a minimum cycle time of 6.55 minutes per pump. If the storage were to be maximized by operating the pumps over the full vertical distance between the invert of the influent pipe to the wet well and the pump cut out elevation, the minimum cycle time would increase to 18.3 minutes. Revising the pump operating range should be considered at this station.

See Table 4-4

Pumping Station No. 3
A new comminutor was installed in the station in September 2002. Prior to this improvement, clogging of the pumps was a common problem due to passing of large solids through the influent channel. The new comminutor is expected to alleviate this problem.

Extrusion Drive Pumping Station
The manufacturer of the existing standby generator is no longer in business, and therefore replacement parts and manufacturer assistance are unavailable. Replacement of this generator should be considered.

4.3 Wastewater Flow Analysis

An analysis of both existing and future peak wastewater flow from each area was conducted to determine the impacts to the collection system, and to identify pipe segments that are or may be inadequate to handle projected peak flows, depending on actual development. The existing and future wastewater flow information for each collection system is based upon the system-wide flow projections presented in Section 3.

Existing and future peak wastewater flows, in addition to corresponding interceptor capacities for the Mystic, Stonington Borough, and Pawcatuck systems are presented in **Tables 4-5 through 4-7**.

4.3.1 Interceptors

A wastewater flow analysis was performed on the existing interceptors for each collection system. Each collection system was broken down into smaller sub-areas, in a manner similar to the capacity analysis discussed previously. Existing and future flow information for domestic flow, presented in Section 3, was apportioned to each sub-area based on the number of residential lots. The number of lots was determined by the total acreage of each collection sub-area and its minimum lot size specified in the zoning designation. Institutional, industrial, and commercial flows were attributed directly to the sub-areas where they are projected to occur. A cumulative flow for each sub-area was calculated by adding the flow contributed by the particular sub-area with all of the flow entering the sub-area from upstream reaches of the collection system. Infiltration and inflow (I/I) was apportioned by sub-area size and then peaked based on historical WPCF flow records. A cumulative peak I/I flow was determined for each sub-area. The cumulative peak I/I was then added to the cumulative flow for each sub-area to determine the total cumulative peak flow that is projected to occur in that particular interceptor reach. The highest cumulative flow occurred in the most downstream sub-area of each collection system and equaled the peak instantaneous flow at the WPCF.

The future wastewater flow analysis was performed similar to the existing wastewater flow analysis, except that it accounted for future residential, institutional, industrial, and commercial flows, and the sewer needs areas.

See Table 4-5

See Table 4-6 (page 1)

See Table 4-6 (page 2)

See Table 4-7 (page 1)

See Table 4-7 (page 2)

Tables 4-5 through 4-7 present the results from both the wastewater flow analysis for existing and future conditions and the capacity analysis. Comparison of the pipe capacity and the projected peak flow allow determination of whether the pipe will be adequate. The pipes can sufficiently handle existing and future flows if projected peak flows do not exceed 80 percent of the pipe's capacity.

The results from this analysis are discussed below.

Mystic

All of the interceptors within the Mystic collection system are sufficient for existing peak wastewater flows. In addition, all interceptors are sufficient for projected future peak wastewater flows, as shown in Table 4-5.

The existing peak wastewater flows vary between 6 percent of capacity at the most upstream reaches of the collection system and 56 percent of capacity near the Mystic WPCF, whereas the future peak wastewater flows vary between 7 percent and 73 percent of capacity, respectively.

Stonington Borough

All of the interceptors within the Stonington Borough collection system are sufficient for existing peak wastewater flows. In addition, all interceptors are sufficient for projected future peak wastewater flows, as shown in Table 4-6.

The existing peak wastewater flows vary between 2 percent of capacity at the upstream reaches of the collection system and 47 percent of capacity in Flanders Road. In addition, the future peak wastewater flows vary between 4 percent and 62 percent of capacity, respectively.

Pawcatuck

All of the interceptors within the Pawcatuck collection system are sufficient for existing peak wastewater flows. In addition, all interceptors are sufficient for future peak wastewater flows except for two pipe segments, as shown in Table 4-7.

The existing wastewater flows vary between 5 percent of capacity at the upstream reaches of the collection system and 49 percent of capacity in Mechanic Street near the southern portion of the collection system.

The projected future peak wastewater flows vary between 13 percent of capacity at the upstream reaches of the collection system and 88 percent of capacity in Mechanic Street near the southern portion of the collection system. There are two pipe segments within the Pawcatuck collection system that exceed theoretical 80 percent capacity, based on Manning's Equation.

A 24-inch pipe segment of about 115 feet in Mechanic Street is the limiting segment in this 2,000-foot pipe reach and will theoretically be loaded at 88 percent of capacity at the projected peak flow. Although typical design criteria use 80 percent capacity as a guideline, at 88 percent capacity this pipe will still have sufficient excess capacity to allow for proper venting and buffer capacity. In addition, the pipe segments upstream and downstream of this 115-foot limiting pipe segment are capable of handling significantly higher flows. The wastewater flow is based upon future population projections and proposed development in this area. If actual growth exceeds these projections, consideration should be given to replace this pipe segment with a larger diameter pipe in the future.

During projected peak flows, there is a limiting pipe segment in Mary Hall Road that exceeds the 80 percent capacity design criteria. The 250-foot pipe segment in Mary Hall Road is expected to flow at 91 percent capacity during projected peak flows. Since downstream pipe segments can handle significantly higher flows, the projected peak flow through this pipe segment should not have any impacts to the rest of the pipe reach in Mary Hall Road. However, if actual growth exceeds the population projections and development in this area, consideration should be given to replace this 250-foot pipe segment with a larger diameter pipe in the future.

4.3.2 Pumping Stations

A comparison of pumping station capacities and wastewater flows, for both existing and future peak flow conditions, was performed for each collection system. **Table 4-8** shows the results of this comparison.

The results of this comparison are discussed below.

Mystic

All of the pumping stations within the Mystic collection system have adequate capacity to handle all existing and future peak wastewater flows.

Stonington Borough

All of the pumping stations within the Stonington Borough collection system can adequately handle existing peak wastewater flows. However, in order to adequately handle projected future peak wastewater flows, the Shawondasee Drive pumping station must be upgraded. The upgrade would include replacing the existing submersible pumps with larger pumps in order to handle the increased flow. The existing 6-inch force main can sufficiently handle the future peak wastewater flow from this pumping station. This improvement can be timed to coincide with the actual pace of development in the area.

Pawcatuck

All of the pumping stations within the Pawcatuck collection system can adequately handle existing peak wastewater flows. However, two pumping stations must be upgraded in order to adequately handle projected future peak wastewater flows, including Pumping Station No. 3 and the White Rock Road pumping station.

See Table 4-8

Pumping Station No. 3 can easily be upgraded to handle future peak wastewater flows by adding another pump to the station. The station is designed to allow another pump to be added within the existing dry well. In addition, the existing 20-inch force main can sufficiently handle the projected peak wastewater flows.

The White Rock Road Pumping Station can be upgraded to handle future peak wastewater flows by replacing the existing submersible pumps with two larger pumps. The existing 6-inch force main can sufficiently handle the projected peak flows.

4.4 Infiltration / Inflow Program Summary

As part of the facilities planning process, limited collection system monitoring was performed to understand the extent of infiltration/inflow (I/I) flows. Infiltration is defined as water, other than wastewater, that enters a sewer system through such means as leaky pipes, pipe joints, connections, or manholes. Inflow is defined as water, other than wastewater, that enters a sewer system from sources such as roof gutters and downspouts, cellar drains, basement sump pumps, manhole covers, and others.

The monitoring program performed for each of the three separate collection systems included:

- Identify ratio of flow monitoring locations for each of the three collection systems. Locations were chosen so that flows could be attributed to sub-areas situated off of the main interceptors. See Table 4-1.
- Two nights of flow monitoring (night sticking) at each location.
- Determine if excessive I/I flows exist. (Excessive I/I is that flow which is less economic to transport and treat than to remove).
- Prioritize key subsystems exhibiting high I/I requiring additional evaluation.
- Conduct additional flow monitoring in locations identified based on the first round of monitoring.

A collection system study was performed to define the extent and problem areas of Infiltration /Inflow (I/I) in the wastewater collection system. The first part of the program involved identifying sub-areas located off of the main interceptors for each of the three sewer districts. Flow monitoring locations were then selected so that extraneous flows measured in a length of sewer pipe could be attributed to a specified sub-area upstream of the monitoring point. Flow monitoring was conducted for the purpose of targeting and prioritizing the subsystems exhibiting excessive I/I.

As a result of the flow monitoring, inflow was found to be excessive in seven study areas, all of which are located within the Mystic drainage basin. **Table 4-9**

See Table 4-9

summarizes the areas that exceeded an I/I rate of 5,000 gpd per inch-mile of pipe, which in CDM's experience is symptomatic of excessive flow.

Table 4-9 lists the seven areas that may be contributing excessive I/I into the Mystic collection system. The I/I program was conducted over three late night/early morning periods, with each location being monitored twice. The three monitoring dates were April 11, April 17, and April 19, 2001. The first night of testing for each location provided the most useful data, in that the flow results from each location correlated well with monitored flows upstream and downstream of each location. All of the results listed above are based upon data from April 11, 2001.

Based on the results shown in Table 4-9, four of the worst areas were targeted for additional flow isolation. The additional flow-isolation program took place during the week of May 14, 2001. Dry weather over the previous several weeks had already diminished the amount of groundwater entering the system. However, most of the target areas were located along the Mystic River, which lessened the impact of dry weather to the groundwater levels in these areas.

4.5 Odor Control Facility at Rose Lane

In 1998, construction of the transmission main carrying underflow from the Mystic WPCF to the Borough WPCF was completed. The purpose of the force main is to allow diversion of a portion of the Mystic WPCF flow in order to alleviate overload conditions at the Mystic facility. The underflow is a combination of raw wastewater and sludge from the primary clarifiers. The force main system consists of one 6-inch and one 12-inch pipe arranged in parallel, from the Mystic WPCF to the new odor control facility near the intersection of Rose Lane and U.S. Route 1. The force main from the Mystic WPCF ends at the odor control facility, and feeds into a gravity sewer that continues to the Stonington Borough collection system. The underflow is pumped through the 6-inch pipe only, while the 12-inch pipe is reserved for future flows.

When the system was put into service in August/September 1999, the underflow was treated with sodium hypochlorite at the Mystic WPCF for hydrogen sulfide control and to prevent odor formation in the transmission system. The Town switched from sodium hypochlorite to Bioxide™ shortly after start-up, after experiencing treatment problems at the Borough facility associated with excess sodium hypochlorite. Bioxide™ is also added at the Lindberg Road Pumping Station.

The odor control facility is located on a small parcel adjacent to a high point on U.S. Route 1 near the intersection of Rose Lane. The facility consists of a small building, which houses a blower and controls, and a chemical feed system, and the outdoor biofilter. The biofilter is located adjacent to the building, and consists of perforated PVC pipe system covered by wood chips. The blower draws air from the manhole at the terminus of the force main and forces the air up through the biofilter via the perforated piping. The chemical feed system is used to dose hydrogen peroxide in the gravity sewer downstream of the station, but it is only used when necessary.

According to the WPCA, there is no standard operation and maintenance (O&M) program in effect for the odor control facility. The biofilter design documents recommend replacing the filter media every 2 to 3 years, which is consistent with typical biofilter O&M programs. The life of a biofilter is a function of the surface area, type of media, odor producing gas(es) and its concentration entering the filter.

4.6 Summary of Recommended Improvements

Based upon the information presented in this section, CDM's recommendations regarding improvements to the Town's wastewater collection system are as follows. These improvements are needed regardless of the overall town-wide wastewater treatment alternative implemended.

- **Existing Interceptor and Pumping Station Improvements**
  - *Mystic Collection System:* No recommended improvements.
  - *Stonington Borough Collection System:* No recommended improvements.
  - *Pawcatuck Collection System:*
    - *Pumping Station No. 1*: Installation of variable frequency drives should be considered to increase the cycle time between pump starts.
    - *Pumping Station No.* 2: Revision of the pump operating range at this station should be considered to increase the cycle time between pump starts.
    - *Pumping Station No.* 3: A new comminutor was installed in this station in September 2002 to prevent clogging of the pumps.
    - *Extrusion Drive*: Replacement of the existing generator at this station should be considered before maintenance requirements increase with age, and also because the manufacturer is no longer in business.
- **Pipe Capacity Upgrade**
  - *Mystic Collection System*: No recommended improvements.
  - *Stonington Borough Collection System*: No recommended improvements.
  - *Pawcatuck Collection System*:
    - One segment of pipe in Mechanic Street is barely sufficient to handle projected future peak wastewater flows. If actual development of this area exceeds the future projections presented in this report, conveyance capacity of this pipe segment should be augmented to handle the projected flows.

    - The projected peak flow of one segment of pipe in Mary Hall Road was calculated to exceed the 80 percent capacity design criteria. However, additional capacity in downstream pipe sections will allow this segment to sufficiently handle the projected peak flows without any adverse impacts to the pipe reach in Mary Hall Road.

- **Future Pumping Station Capacity Upgrades**

  - *Mystic Collection System:* No recommended improvements.

  - *Stonington Borough Collection System:*

    - Shawondasee Drive Pumping Station: Consideration should be given to replacing the existing submersible pumps with larger pumps to meet the projected future peak wastewater flows, as actual development dictates.

  - *Pawcatuck Collection System:*

    - *Pumping Station No. 3*: Consideration should be given to adding another pump within the existing dry well to meet the projected future peak wastewater flows, as actual development dictates.

    - *White Rock Road Pumping Station*: Consideration should be given to replacing the existing submersible pumps with larger pumps to meet the projected future peak wastewater flows, as actual development dictates.

- **Future Force Main Upgrades**

  - *Mystic Collection System*: No recommended improvements.

  - *Stonington Borough Collection System*: No recommended improvements.

  - *Pawcatuck Collection System*: No recommended improvements.

- **Inflow / Infiltration (I/I)**

  - Several days of night sticking were conducted to determine areas of high I/I. A more detailed evaluation of the sewer system should be implemented to target direct causes of I/I in the collection systems.

- **Costs**

  - Probable costs for implementing the recommended improvements are presented in **Table 4-10**.

See Table 4-10

Location / Street	From	To	Diameter (inches)	Length (feet)	Capacity (mgd)
Mystic District					
1) Interceptor from Mystic WPCF to N. Stonington Road					
Edgemont Street / Broadway Avenue Extension	Mystic WPCF	Roosevelt Street	30	1,309	7.62
Broadway Avenue / Greenmanville Avenue (Route 27)	Roosevelt Street	Hinckley Street	24	4,262	2.63
Greenmanville Avenue	Hinckley Street	Pleasant Street	24	1,286	3.98
Greenmanville Avenue	Pleasant Street	Olde Mistick Village	18	3,040	2.54
Greenmanville Avenue	Olde Mistick Village	Riverbend Drive	18	3,007	2.52
Whitehall Avenue (Route 27)	Old Mystic P.S.	Main Street / N. Stonington Rd.	18	2,174	2.29
2) Hinckley Street from Greenmanville Avenue to Cutter Drive P.S.					
Hinkley Street	Greenmanville Avenue	Cutter Drive P.S.	8	1,226	0.49
3) Roosevelt Street from Broadway Avenue to West of Pequotsepos Cove					
Roosevelt Street	Broadway Avenue	West of Pequotsepos River	24	1,301	4.03
4) Interceptor from East Mystic Pumping Station to Allen Street					
Judd Street	East Mystic P.S.	Hatch Street	18	552	2.94
Hatch Street	Judd Street	Allen Street	15	1,394	1.58
5) Interceptor from East Mystic Pumping Station to Mistuxet Avenue					
Hewitt Road	East Mystic P.S.	Golden Road Extension	15	2,898	1.42
Hewitt Road	Golden Road Extension	Mistuxet Avenue	12	830	1.07
Mistuxet Avenue	Hewitt Avenue	End of Pipe	8	2,206	0.49
6) Interceptor from East Mystic Pumping Station to Old Stonington Road					
Cross Country / Old Stonington Road	East Mystic P.S.	Old Stonington Road (Rte. 1)	18	1,939	1.88

CDM

Table 4-1
Estimated Sewer Hydraulic Capacities
Mystic District

Recommended Improvement	Sewer District	Probable Cost
Existing Interceptor and Pumping Station Improvements		
Install VFD's at Pumping Station No. 1	Pawcatuck	$ 118,000
New Generator at Extrusion Drive Pumping Station	Pawcatuck	$ 35,000
Future Pumping Station Capacity Upgrades		
Replace 2 Submersible Pumps at Shawondasee Pumping Station	Stonington Borough	$ 35,000
Add 3rd Pump at Pumping Station No. 3	Pawcatuck	$ 83,000
Replace 2 Submersible Pumps at White Rock Road Pumping Station	Pawcatuck	$ 70,000
Total (Rounded):		***$ 341,000***

Costs are based on related CDM projects, construction bids, and vendor's estimates. All costs are referenced to the July 2002 Engineering News Record (ENR) Construction Cost Index of 6605, escalated to the August 2006 Construction Cost Index of 7763.

Table 4-10
Probable Costs for
Recommended Improvements

Location / Street	From	To	Diameter (inches)	Length (feet)	Capacity (mgd)
Stonington Borough District					
1) Interceptor from Borough WPCF to Deans Mill Road					
Front Street to RR Tracks in Water Street	Borough WPCF	Railroad Tracks	24	1,522	3.98
Pipe Jacking under RR Tracks			18	264	2.33
Water Street / North Water Street	RR Tracks	Just north of Palmer Street	12	1,181	1.31
Flanders Road	Ensign Lane P.S.	Stony Brook	18	1,979	2.13
Flanders Road	Stony Brook	Just north of Collins Road	8	929	0.49
Flanders Road / Deans Mill Road	Shawondasee P.S.	End of Pipe	8	2,531	0.49
2) Water Street from Borough WPCF to Omega Street					
High Street / Northwest Street / Cross Street / Gold Street / Church Street	Borough WPCF	Water Street	15	1,115	1.58
Water Street	Church Street	Harmony Street	12	402	1.06
Water Street	Harmony Street	Diving Street	10	890	0.75
Water Street	Diving Street	Omega Street	8	791	0.49
3) Interceptor along Mathews Street and RR Tracks from Water St. to Elm St.					
Mathew Street	Water Street	Pipe Jacking under RR Tracks	18	2,648	2.10
Cross Country to Elihu Street	Pipe Jacking under RR Tracks	Bayview Avenue	15	591	2.46
4) Williams Street from North Water Street to Elm Street					
Williams Street	North Water Street	North Main Street	12	490	1.08
Cutler Street	North Main Street	Trumbull Avenue	10	480	0.74
Cutler Street	Trumbull Avenue	Elm Street	8	770	0.49
Elm Street	Cutler Street	End of pipe	8	1,156	0.46
5) North Main Street from Williams Street to Palmer Street					
North Main Street	Williams Street	Palmer Street	10	963	0.74

CDM

Table 4-2
Estimated Sewer Hydraulic Capacities
Stonington Borough District

Location / Street	From	To	Diameter (inches)	Length (feet)	Capacity (mgd)
6) U.S. Route 1 from North Water Street to the Biofilter					
U.S. Route 1	North Water Street	East of Collins Road	18	2,489	2.23
U.S. Route 1	East of Collins Road	Biofilter	15	1,443	4.39

CDM

Table 4-2
Estimated Sewer Hydraulic Capacities
Stonington Borough District

Location / Street	From	To	Diameter (inches)	Length (feet)	Capacity (mgd)
Pawcatuck District					
1) Interceptor from Pumping Station No. 3 to Interstate I-95					
River Road	P.S. No. 3	Clark Street	30	4,549	7.10
Mechanic Street	Clark Street	P.S. No. 1	24	1,979	3.06
Mechanic Street	P.S. No. 1	Liberty Street	24	3,485	4.23
Liberty Street	West Broad Street	Cross-country	21	156	3.28
Cross-country along Pawcatuck River			20	1,370	2.33
Cross-country along Pawcatuck River and along Stillman Avenue		River Street	21	2,675	1.54
River Street / Antoinette Street / West Arch Street	Stillman Avenue	Woodlawn Street	18	2,415	6.36
West Arch Street	Woodlawn Street	Liberty Street	18	1,029	3.13
Liberty Street	West Arch Street	6-inch Force Main	18	2,241	2.88
Liberty Street	White Rock Road	I-95 (end of pipe)	18	5,985	2.42
2) Interceptor along Mary Hall Road from P.S. No. 3					
Mary Hall Road	P.S. No. 3	Greenhaven Road	8	2,300	0.44
Greenhaven Road	Mary Hall Road	End of Pipe	8	550	0.52
3) Mystic Avenue from River Road to Pawcatuck Avenue					
Mystic Avenue / Trumbull Street / Pawcatuck Avenue	River Road	Cleveland Street	10	2,610	0.62
Pawcatuck Avenue	Cleveland Street	Howley Street (2-inch Force Main)	8	1,316	0.68
4) Clark Street and cross-country from River Road to Pumping Station No. 2					
Clark Street	River Road	Pawcatuck Avenue	15	326	7.21
Cross-country	Pawcatuck Avenue	West of RR Tracks	18	1,256	3.43
Cross-country	West of RR Tracks		15	631	7.20
Cross-country			18	423	3.72
5) Interceptor along Spellman Drive and South Broad Street (US Rt. 1)					
Spellman Drive	P.S. No. 2	Manhole 6-21	18	2,814	1.26
Spellman Drive	Manhole 6-21	South Broad Street	15	1,172	1.75
South Broad Street	Spellman Drive	East to Manhole 6-30	8	625	0.49
South Broad Street	Manhole 6-30	East to end of pipe	18	3,379	1.55

Table 4-3
Estimated Sewer Hydraulic Capacities
Pawcatuck District

Location / Street	From	To	Diameter (inches)	Length (feet)	Capacity (mgd)
6) Cross-country Interceptor from Spellman Drive to force main from Extrusion Drive P.S.					
Cross-country	Spellman Drive		18	633	2.34
Cross-country		6-inch Force Main Connection	10	450	0.71
7) Constitution Avenue from Extrusion Drive P.S. to South Broad Street					
Constitution Avenue / Oriole Street / Wren Street	Extrusion Drive P.S.	South Broad Street	10	3,019	0.62
8) Interceptor along Burdick Lane from P.S. No. 1 to West Broad Street					
Burdick Lane / Cross-country	Mechanic Street	RR Tracks	10	430	1.45
Cross-country / Locust Street / Williams Street	RR Tracks	Palmer Street	12	1,798	1.25
Palmer Street / Courtland Street	Williams Street	Right of Way (ROW)	10	804	0.75
ROW	Courtland Street	Mayflower Avenue	8	1,303	0.99
Mayflower Avenue / South Broad Street	ROW	South Broad Street	10	431	0.75
ROW	South Broad Street	West Broad Street	8	563	0.49
9) West Broad Street from Liberty Street to Wilcox Manor					
West Broad Street	Liberty Street	Chase Street	10	440	1.09
West Broad Street	Chase Street	Wilcox Manor	8	2,537	1.03

Table 4-3
Estimated Sewer Hydraulic Capacities
Pawcatuck District

Pumping Station Name	Sewer District	Capacity (mgd)
Pumping Station No. 1	Pawcatuck	1.62
Pumping Station No. 2	Pawcatuck	1.15
Pumping Station No. 3	Pawcatuck	2.16
White Rock Road	Pawcatuck	0.43
Extrusion Drive	Pawcatuck	0.50
Pawcatuck Avenue	Pawcatuck	0.10
Ensign Lane	Stonington Borough	0.85
Shawondasee Drive	Stonington Borough	0.18
Lindberg Road	Stonington Borough	0.26
Wolcott Avenue	Stonington Borough	0.14
Boulder Avenue	Stonington Borough	0.14
Quarry Path	Stonington Borough	0.14
Diving Street	Stonington Borough	-
Hewitt Road (East Mystic)	Mystic	1.15
Cutter Drive	Mystic	0.16
Maritime Drive	Mystic	0.46
Old Mystic	Mystic	0.65
Diversion Pump @ Mystic WPCF	Mystic	0.33

Table 4-4
Pump Station Capacities

Location / Street	Capacity [1] (mgd)	Existing Peak Flow (mgd)	Existing Peak Flow % of Capacity	Existing Peak Flow Sufficient (yes/no)	Projected Peak Flow (mgd)	Projected Peak Flow % of Capacity	Projected Peak Flow Sufficient (yes/no)
Mystic District							
1) Interceptor from Mystic WPCF to N. Stonington Road							
Edgemont Street / Broadway Avenue Extension	7.62	1.98	26%	Yes	2.65	35%	Yes
Broadway Avenue / Greenmanville Avenue (Route 27)	2.63	1.46	56%	Yes	1.93	73%	Yes
Greenmanville Avenue	3.98	1.02	26%	Yes	1.35	34%	Yes
Greenmanville Avenue	2.54	0.86	34%	Yes	1.12	44%	Yes
Greenmanville Avenue	2.52	0.52	21%	Yes	0.70	28%	Yes
Whitehall Avenue (Route 27)	2.29	0.14	6%	Yes	0.17	7%	Yes
2) Hinckley Street from Greenmanville Avenue to Cutter Drive P.S.							
Hinkley Street	0.49	0.09	18%	Yes	0.12	24%	Yes
3) Roosevelt Street from Broadway Avenue to West of Pequotsepos Cove							
Roosevelt Street	4.03	0.48	12%	Yes	0.66	16%	Yes
4) Interceptor from East Mystic Pumping Station to Allen Street							
Judd Street	2.94	0.10	3%	Yes	0.13	4%	Yes
Hatch Street	1.58	0.09	6%	Yes	0.12	8%	Yes
5) Interceptor from East Mystic Pumping Station to Mistuxet Avenue							
Hewitt Road	1.42	0.19	13%	Yes	0.24	17%	Yes
Hewitt Road	1.07	0.10	9%	Yes	0.12	11%	Yes
Mistuxet Avenue	0.49	0.04	8%	Yes	0.05	10%	Yes
6) Interceptor from East Mystic Pumping Station to Old Stonington Road							
Cross Country / Old Stonington Road	1.88	0.14	7%	Yes	0.22	12%	Yes

Notes:
1.) The pipe capacities listed are minimums for each segment, and are based on non-surcharged gravity flow.

Table 4-5
Peak Wastewater Flows vs.
Estimated Sewer Hydraulic Capacities
Mystic District

CDM

Location / Street	Capacity [1] (mgd)	Existing Peak Flow (mgd)	Existing Peak Flow % of Capacity	Existing Peak Flow Sufficient (yes/no)	Projected Peak Flow (mgd)	Projected Peak Flow % of Capacity	Projected Peak Flow Sufficient (yes/no)
Stonington Borough District							
1) Interceptor from Borough WPCF to Deans Mill Road							
Front Street to RR Tracks in Water Street	3.98	1.00	25%	Yes	1.45	36%	Yes
Pipe Jacking under RR Tracks	2.33	1.00	43%	Yes	1.45	62%	Yes
Water Street / North Water Street	1.31	0.60	46%	Yes	0.80	61%	Yes
Flanders Road	2.13	0.55	26%	Yes	0.74	35%	Yes
Flanders Road	0.49	0.23	47%	Yes	0.29	59%	Yes
Flanders Road / Deans Mill Road	0.49	0.18	37%	Yes	0.22	45%	Yes
2) Water Street from Borough WPCF to Omega Street							
High Street / Northwest Street / Cross Street / Gold Street / Church Street	1.58	0.11	7%	Yes	0.16	10%	Yes
Water Street	1.06	0.08	8%	Yes	0.13	12%	Yes
Water Street	0.75	0.04	5%	Yes	0.08	11%	Yes
Water Street	0.49	0.03	6%	Yes	0.03	6%	Yes
3) Interceptor along Mathews Street and RR Tracks from Water St. to Elm St.							
Mathew Street	2.10	0.13	6%	Yes	0.27	13%	Yes
Cross Country to Elihu Street	2.46	0.05	2%	Yes	0.17	7%	Yes
4) Williams Street from North Water Street to Elm Street							
Williams Street	1.08	0.12	11%	Yes	0.16	15%	Yes
Cutler Street	0.74	0.11	15%	Yes	0.15	20%	Yes
Cutler Street	0.49	0.05	10%	Yes	0.09	18%	Yes
Elm Street	0.46	0.05	11%	Yes	0.08	17%	Yes
5) North Main Street from Williams Street to Palmer Street							
North Main Street	0.74	0.03	4%	Yes	0.03	4%	Yes

Table 4-6
Peak Wastewater Flows vs.
Estimated Sewer Hydraulic Capacities
Stonington Borough District

CDM

Location / Street	Capacity [1] (mgd)	Existing Peak Flow (mgd)	Existing Peak Flow % of Capacity	Existing Peak Flow Sufficient (yes/no)	Projected Peak Flow (mgd)	Projected Peak Flow % of Capacity	Projected Peak Flow Sufficient (yes/no)
6) U.S. Route 1 from North Water Street to the Biofilter							
U.S. Route 1	2.23	0.20[2]	9%	Yes	0.31 [2]	14%	Yes
U.S. Route 1	4.39	0.14	3%	Yes	0.24	5%	Yes

Notes:

1.) The pipe capacities listed are minimums for each segment, and are based on non-surcharged gravity flow.

2.) This value does not include the 0.28 mgd diversion flow from the Mystic WPCF.

Table 4-6
Peak Wastewater Flows vs.
Estimated Sewer Hydraulic Capacities
Stonington Borough District

CDM

Location / Street	Capacity [1] (mgd)	Existing Peak Flow (mgd)	Existing Peak Flow % of Capacity	Existing Peak Flow Sufficient (yes/no)	Projected Peak Flow (mgd)	Projected Peak Flow % of Capacity	Projected Peak Flow Sufficient (yes/no)
Pawcatuck District							
1) Interceptor from Pumping Station No. 3 to Interstate I-95							
River Road	7.10	1.64	23%	Yes	2.93	41%	Yes
Mechanic Street	3.06	1.51	49%	Yes	2.70	88%	No
Mechanic Street	4.23	0.92	22%	Yes	1.53	36%	Yes
Liberty Street	3.28	0.38	12%	Yes	0.88	27%	Yes
Cross-country along Pawcatuck River	2.33	0.38	16%	Yes	0.88	38%	Yes
Cross-country along Pawcatuck River and along Stillman Avenue	1.54	0.36	23%	Yes	0.85	55%	Yes
River Street / Antoinette Street / West Arch Street	6.36	0.32	5%	Yes	0.80	13%	Yes
West Arch Street	3.13	0.28	9%	Yes	0.75	24%	Yes
Liberty Street	2.88	0.26	9%	Yes	0.74	26%	Yes
Liberty Street	2.42	0.14	6%	Yes	0.59	24%	Yes
2) Interceptor along Mary Hall Rd. and Greenhaven Rd. from P.S. No. 3							
Mary Hall Road	0.44	0.04	9%	Yes	0.40	91%	No
Greenhaven Road	0.52	0.04	8%	Yes	0.40	77%	Yes
3) Mystic Avenue from River Road to Pawcatuck Avenue							
Mystic Avenue / Trumbull Street / Pawcatuck Avenue	0.62	0.09	15%	Yes	0.11	18%	Yes
Pawcatuck Avenue	0.68	0.05	7%	Yes	0.06	9%	Yes
4) Clark Street and cross-country from River Road to Pumping Station No. 2							
Clark Street	7.21	0.57	8%	Yes	1.14	16%	Yes
Cross-country	3.43	0.57	17%	Yes	1.13	33%	Yes
Cross-country	7.20	0.57	8%	Yes	1.13	16%	Yes
Cross-country	3.72	0.57	15%	Yes	1.13	30%	Yes

CDM

Table 4-7
Peak Wastewater Flows vs.
Estimated Sewer Hydraulic Capacities
Pawcatuck District

Location / Street	Capacity [1] (mgd)	Existing Peak Flow (mgd)	Existing Peak Flow % of Capacity	Existing Peak Flow Sufficient (yes/no)	Projected Peak Flow (mgd)	Projected Peak Flow % of Capacity	Projected Peak Flow Sufficient (yes/no)
5) Interceptor along Spellman Drive and South Broad Street (US Route 1)							
Spellman Drive	1.26	0.45	36%	Yes	0.93	74%	Yes
Spellman Drive	1.75	0.45	26%	Yes	0.93	53%	Yes
South Broad Street	0.49	0.13	27%	Yes	0.34	69%	Yes
South Broad Street	1.55	0.09	6%	Yes	0.29	19%	Yes
6) Cross-country Interceptor from Spellman Drive to force main from Extrusion Drive P.S.							
Cross-country	2.34	0.23	10%	Yes	0.30	13%	Yes
Cross-country	0.71	0.23	32%	Yes	0.30	42%	Yes
7) Constitution Avenue from Extrusion Drive P.S. to South Broad Street							
Constitution Avenue / Oriole Street / Wren Street	0.62	0.06	10%	Yes	0.23	37%	Yes
8) Interceptor along Burdick Lane from P.S. No. 1 to West Broad Street							
Burdick Lane / Cross-country	1.45	0.22	15%	Yes	0.26	18%	Yes
Cross-country / Locust Street / Williams Street	1.25	0.22	18%	Yes	0.26	21%	Yes
Palmer Street / Courtland Street	0.75	0.15	20%	Yes	0.18	24%	Yes
ROW	0.99	0.07	7%	Yes	0.08	8%	Yes
Mayflower Avenue / South Broad Street	0.75	0.05	7%	Yes	0.06	8%	Yes
ROW	0.49	0.01	2%	Yes	0.02	4%	Yes
9) West Broad Street from Liberty Street to Wilcox Manor							
West Broad Street	1.09	0.13	12%	Yes	0.16	15%	Yes
West Broad Street	1.03	0.13	13%	Yes	0.16	16%	Yes

Notes:

1.) The pipe capacities listed are minimums for each segment, and are based on non-surcharged gravity flow.

Table 4-7
Peak Wastewater Flows vs.
Estimated Sewer Hydraulic Capacities
Pawcatuck District

CDM

Pumping Station Name	Sewer District	Capacity (mgd)	Wastewater Flows Existing (mgd)	Future (mgd)
Pumping Station No. 1	Pawcatuck	1.62	0.92	1.53
Pumping Station No. 2	Pawcatuck	1.15	0.45	0.93
Pumping Station No. 3	Pawcatuck	2.16	1.68	3.33
White Rock Road	Pawcatuck	0.43	0.14	0.59
Extrusion Drive	Pawcatuck	0.50	0.06	0.23
Pawcatuck Avenue	Pawcatuck	0.10	0.05	0.06
Ensign Lane	Stonington Borough	0.85	0.55	0.74
Shawondasee Drive	Stonington Borough	0.18	0.18	0.22
Lindberg Road	Stonington Borough	0.26	0.14	0.24
Wolcott Avenue	Stonington Borough	0.14	-	-
Boulder Avenue	Stonington Borough	0.14	-	-
Quarry Path	Stonington Borough	0.14	-	-
Diving Street	Stonington Borough	-	0.03	0.03
Hewitt Road (East Mystic)	Mystic	1.15	0.48	0.66
Cutter Drive	Mystic	0.16	0.09	0.12
Maritime Drive	Mystic	0.46	-	-
Old Mystic	Mystic	0.65	0.14	0.17
Diversion Pump @ Mystic WPCF	Mystic	0.33	0.28	-

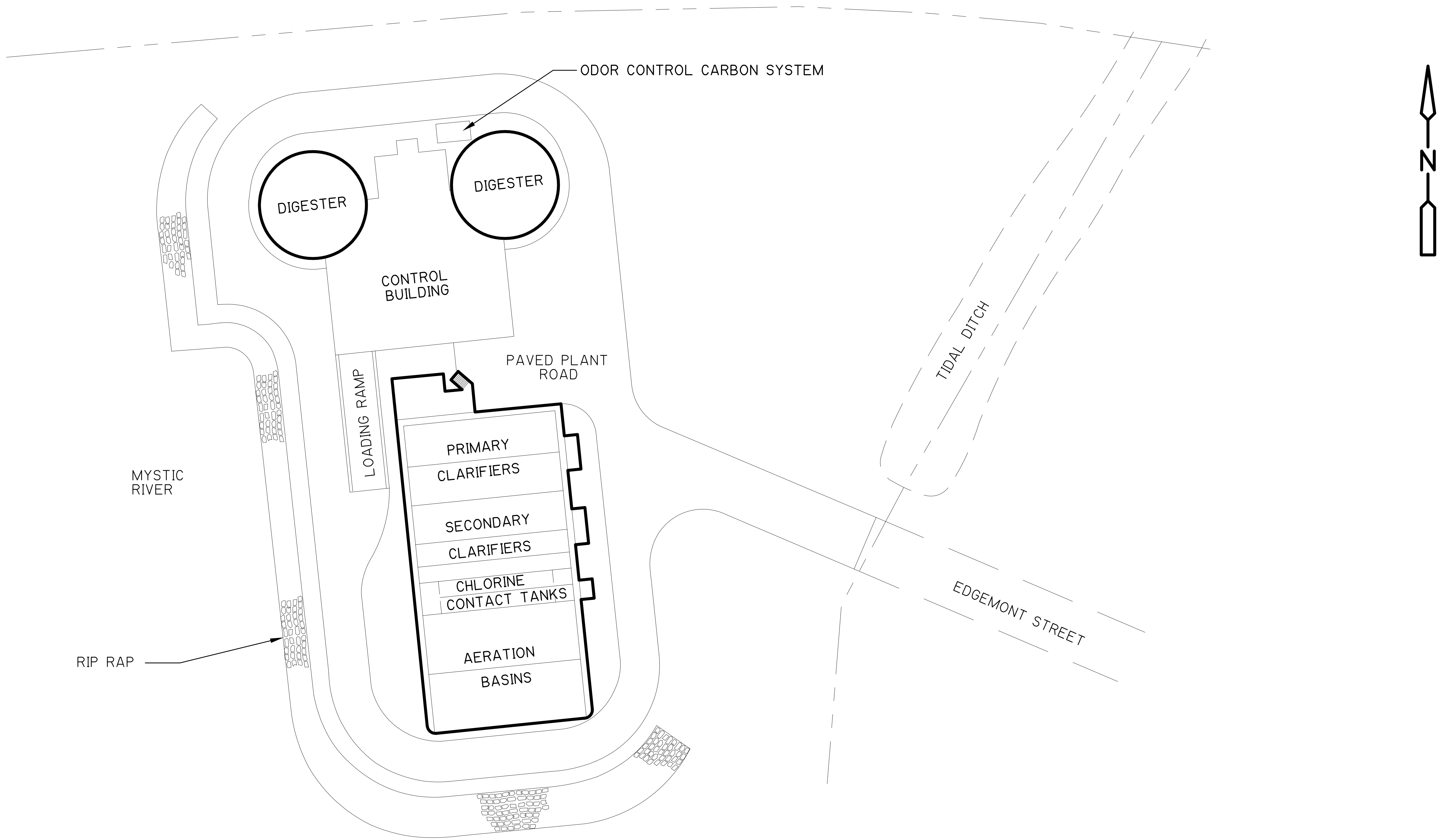
CDM

Table 4-8
Comparison of Pump Station Capacities and Peak Wastewater Flows

Monitoring Location ID	Description of Contributing Area	Monitored Flow (gpd)	Monitored Flow (approx. gpd/in-mile)
M-2B	Easement just north of Coogan Boulevard heading toward Olde Mistick Village	28,800	6,040
M-2	Greenmanville Avenue from Rossie Pentway to south of Coogan Boulevard	99,360	7,220
M-1B-2	School Street and Denison Avenue from Mistuxet Avenue to Church Street	23,040	5,240
M-1A-1	Broadway from Washington Street to Mistuxet Avenue	277,200	13,540
M-1A-2	Washington Street area west of Broadway	59,040	7,960
M-1-1	Small section of 24-inch pipe in Broadway from Roosevelt Street to Washington Street	126,430	113,900*
M-1-2	24-inch pipe in Roosevelt Street and 8-inch pipe in Hewitt Avenue south of pumping station	74,795	10,510
* Data needs further investigation			

CDM

Table 4-9
Flow-Monitoring Program



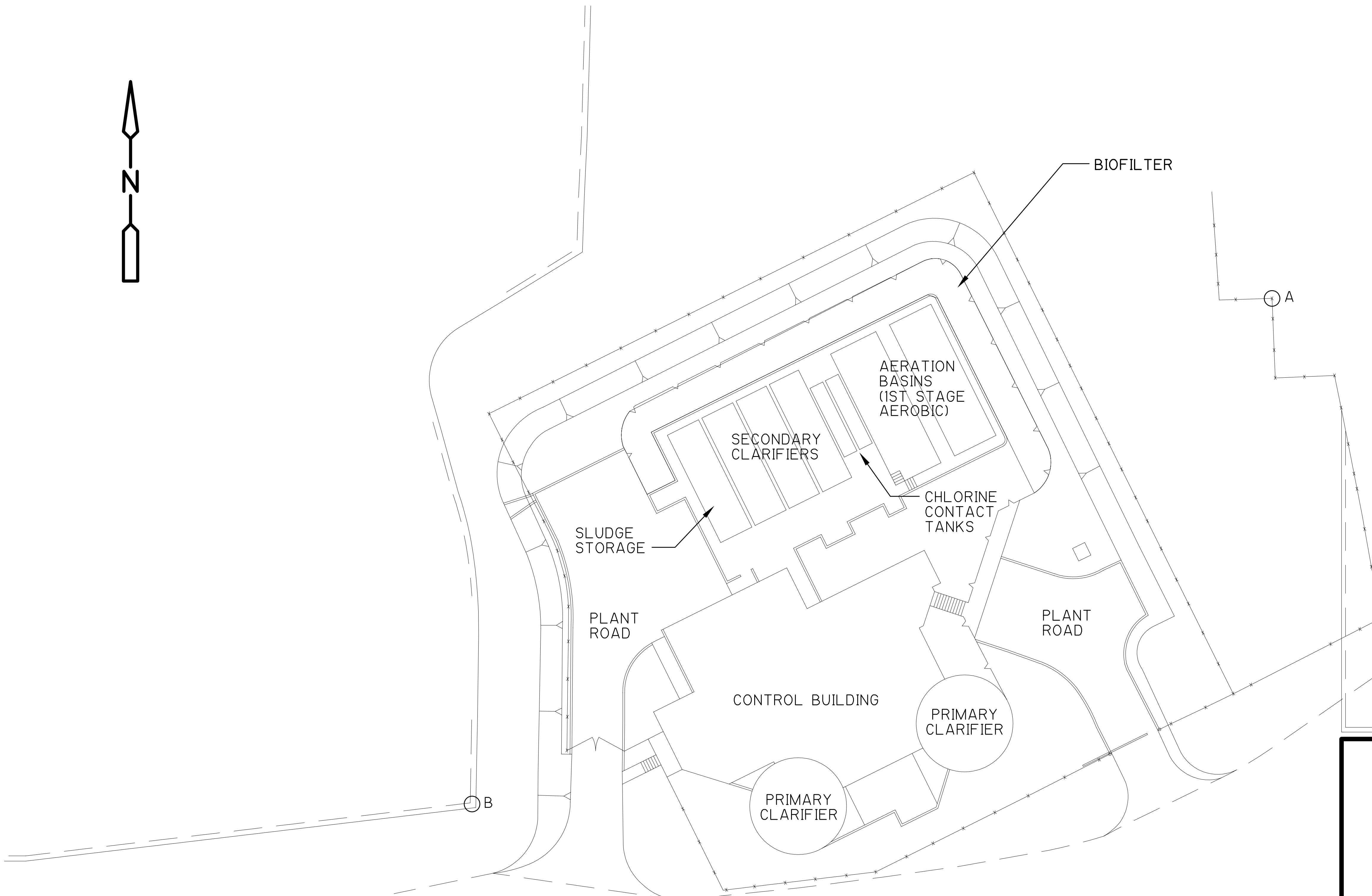
PLAN
1"= 40'

STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN

MYSTIC WPCF EXISTING SITE PLAN

CDM

Figure 5-1



PLAN
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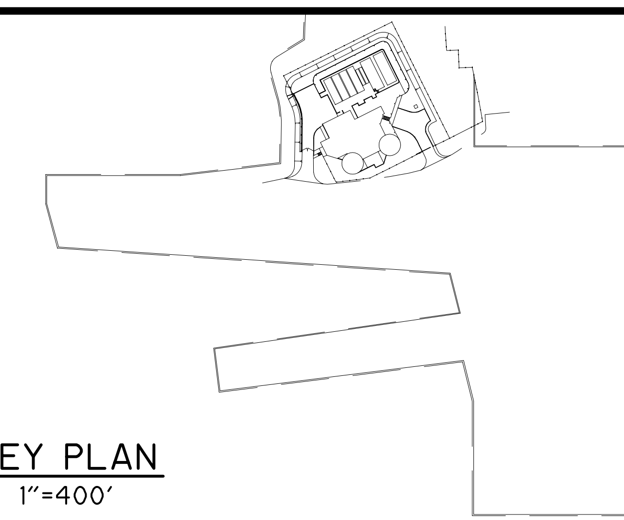


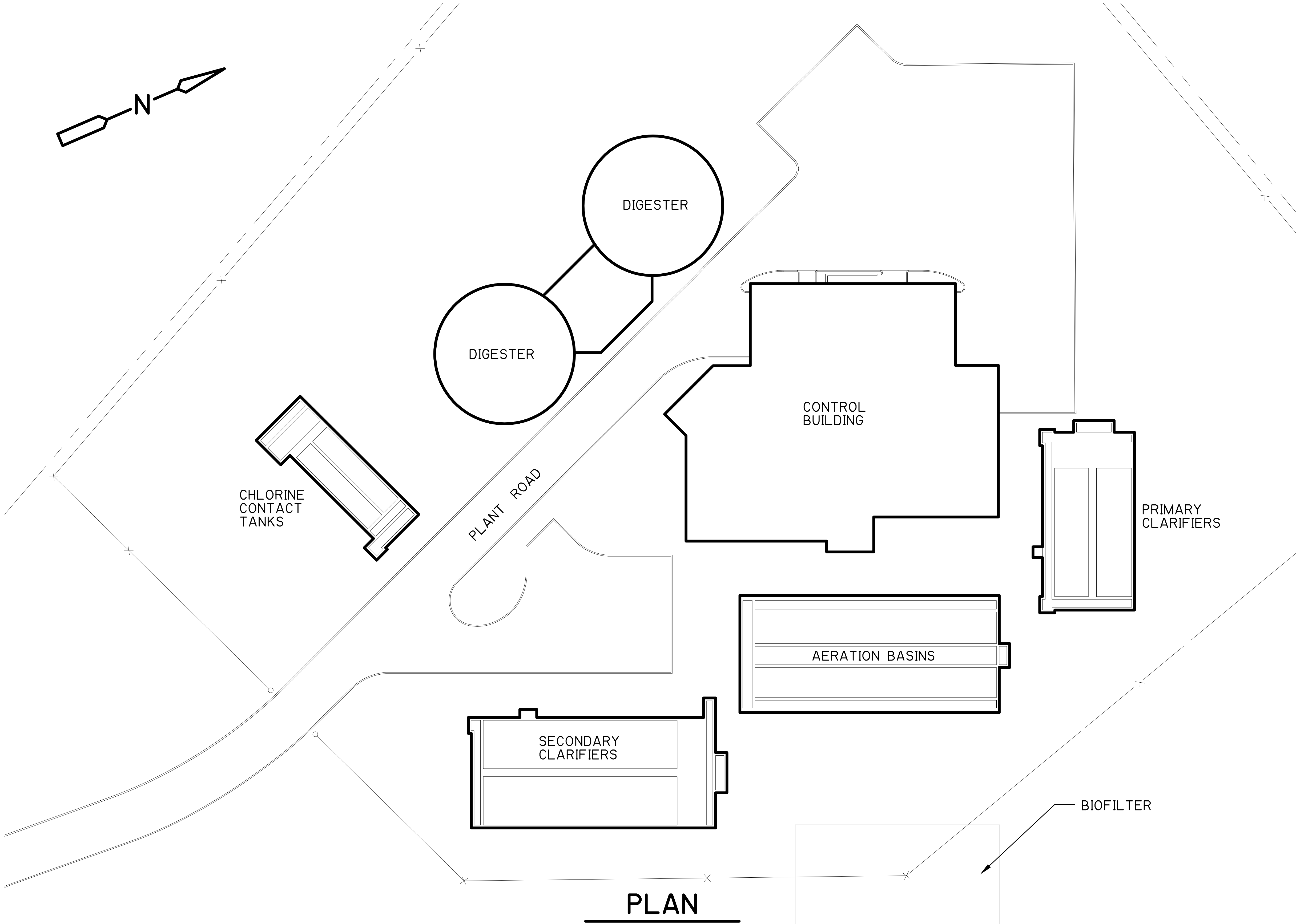
KEY PLAN
1"=400'

STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN-ADDITIONAL SCENARIO

BOROUGH WPCF EXISTING SITE PLAN

CDM

Figure 5-2



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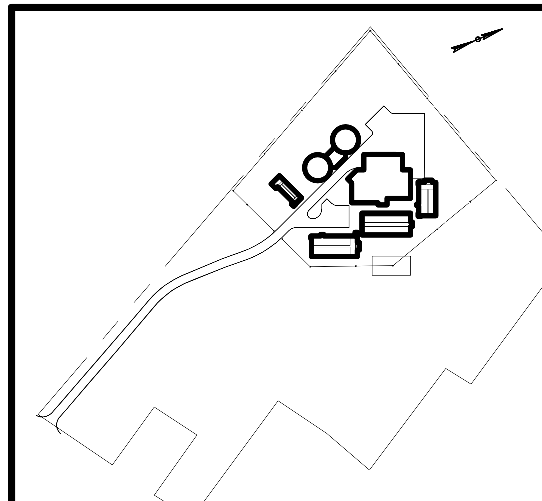


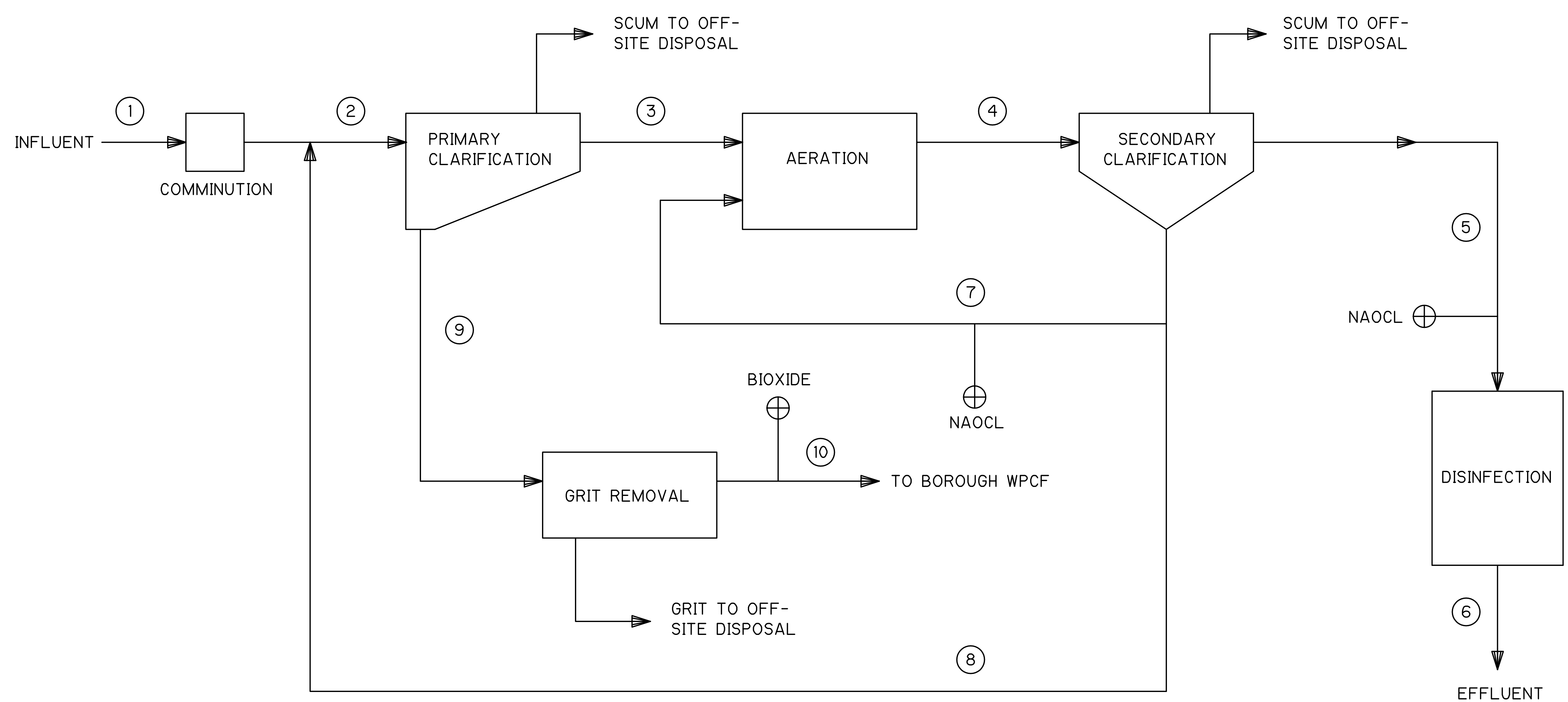
KEY PLAN
1"=400'

CDM

STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN

PAWCATUCK WPCF EXISTING SITE PLAN

Figure 5-3



I.D.#	STREAM DESCRIPTION	FLOW (MGD) AVG. ANNUAL	FLOW (MGD) MAX. MONTH	FLOW (MGD) PEAK DAY	BOD (LBS/DAY) AVG. ANNUAL	BOD (LBS/DAY) MAX. MONTH	BOD (LBS/DAY) PEAK DAY	TSS (LBS/DAY) AVG. ANNUAL	TSS (LBS/DAY) MAX. MONTH	TSS (LBS/DAY) PEAK DAY	AMMONIA-NITROGEN (LBS/DAY) AVG. ANNUAL	AMMONIA-NITROGEN (LBS/DAY) MAX. MONTH	AMMONIA-NITROGEN (LBS/DAY) PEAK DAY	TKN (LBS/DAY) AVG. ANNUAL	TKN (LBS/DAY) MAX. MONTH	TKN (LBS/DAY) PEAK DAY
1.	RAW INFLUENT	0.57	0.772	1.18	1810	3030	4460	1470	3050	3630	143	193	294	200	271	412
2.	PRIMARY INFLUENT	0.58	0.79	1.21	2150	3810	5890	1930	4020	5270	143	194	297	243	371	596
3.	PRIMARY EFFLUENT	0.30	0.493	0.909	735	1450	2630	178	292	538	74	121	223	100	164	308
4.	MIXED LIQUOR	0.42	0.713	1.28	4490	10400	18900	6100	12800	21600	4.0	22	91	573	1340	2490
5.	SECONDARY EFFLUENT	0.29	0.475	0.878	18	59	370	18	61	390	2.8	15	62	6.0	24	111
6.	FINAL EFFLUENT	0.29	0.475	0.878	18	59	370	18	61	390	2.8	15	62	6.0	24	111
7.	RETURN ACTIVATED SLUDGE	0.12	0.220	0.37	4130	9600	17100	5610	11800	19500	1.2	6.8	26	524	1220	2190
8.	WASTE ACTIVATED SLUDGE	0.01	0.018	0.031	344	785	1440	468	962	1640	0.1	0.6	2.2	44	100	184
9.	PRIMARY UNDERDRAIN	0.28	0.297	0.298	1415	2360	3260	1752	3728	4732	69	73	74	143	207	288
10.	DIVERSION TO BOROUGH WPCF	0.28	0.297	0.298	1415	2360	3260	1752	3728	4732	69	73	74	143	207	288

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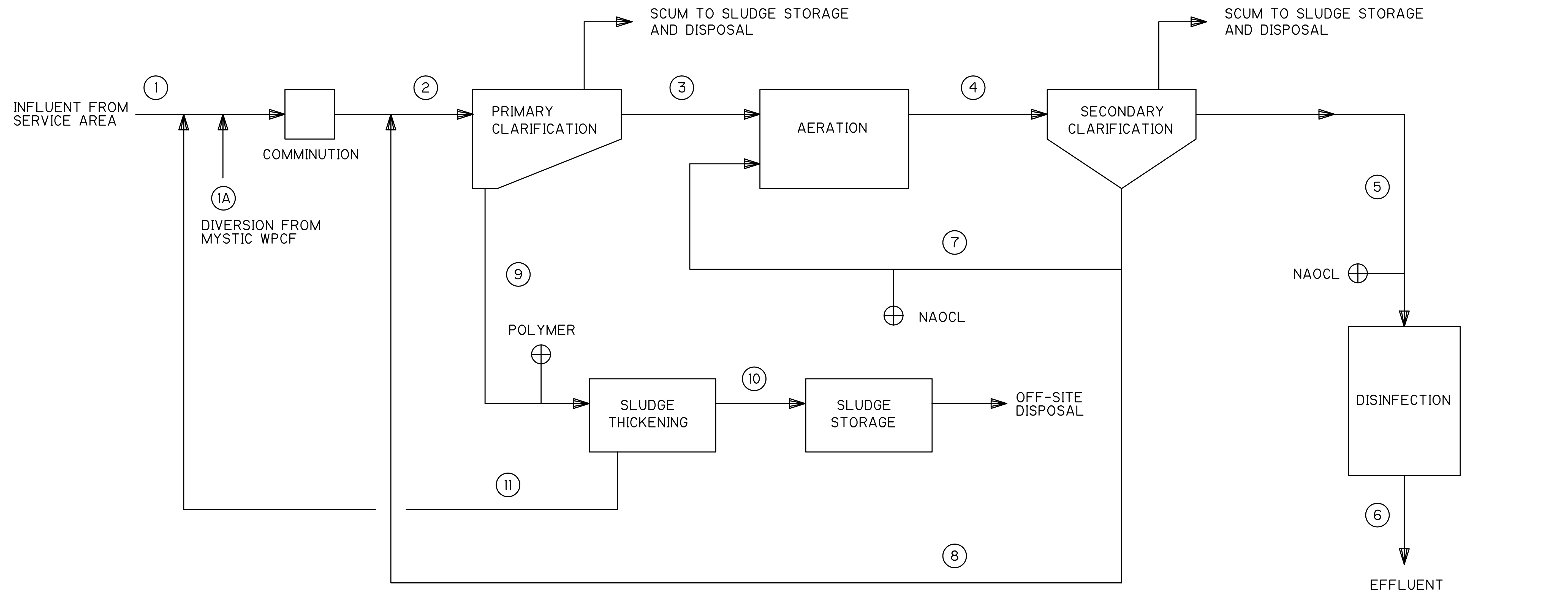
STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN

MYSTIC WPCF MASS BALANCE
(EXISTING CONDITIONS)

Figure No. 5-4



I.D.#	STREAM DESCRIPTION	FLOW (MGD) AVG. ANNUAL	FLOW (MGD) MAX. MONTH	FLOW (MGD) PEAK DAY	BOD (LBS/DAY) AVG. ANNUAL	BOD (LBS/DAY) MAX. MONTH	BOD (LBS/DAY) PEAK DAY	TSS (LBS/DAY) AVG. ANNUAL	TSS (LBS/DAY) MAX. MONTH	TSS (LBS/DAY) PEAK DAY	AMMONIA-NITROGEN (LBS/DAY) AVG. ANNUAL	AMMONIA-NITROGEN (LBS/DAY) MAX. MONTH	AMMONIA-NITROGEN (LBS/DAY) PEAK DAY	TKN (LBS/DAY) AVG. ANNUAL	TKN (LBS/DAY) MAX. MONTH	TKN (LBS/DAY) PEAK DAY
1.	RAW INFLUENT	0.216	0.346	0.486	375	806	945	305	592	738	49	95	114	70	136	166
1A.	DIVERSION FROM MYSTIC WPCF	0.280	0.280	0.280	804	804	804	925	925	925	65	65	65	126	126	126
2.	PRIMARY INFLUENT	0.510	0.626	0.788	1780	2530	2810	2190	2870	3200	115	162	180	271	377	425
3.	PRIMARY EFFLUENT	0.505	0.639	0.781	1070	1460	1640	552	699	854	114	160	178	196	266	301
4.	MIXED LIQUOR	0.793	1.00	1.23	13200	18300	23000	19900	25500	31900	7.0	14	21	1680	2330	2930
5.	SECONDARY EFFLUENT	0.493	0.622	0.762	25	40	59	26	41	64	4.3	8.7	13	9.6	16	24
6.	FINAL EFFLUENT	0.493	0.622	0.762	25	40	59	26	41	64	4.3	8.7	13	9.6	16	24
7.	RETURN ACTIVATED SLUDGE	0.288	0.364	0.445	12600	17400	22000	19100	24300	30500	2.5	5.1	7.6	1600	2210	2790
8.	WASTE ACTIVATED SLUDGE	0.012	0.017	0.019	526	813	938	795	1130	1300	0.105	0.24	0.3	67	103	119
9.	PRIMARY SLUDGE	0.005	0.0065	0.007	713	1070	1170	1630	2170	2350	1.1	1.6	1.6	75	111	123
10.	THICKENED SLUDGE	0.00271	0.0036	0.004	639	962	1050	1470	1950	2110	0.61	0.9	0.9	67	99	110
11.	THICKENER SUPERNATENT	0.00218	0.0029	0.003	74	111	121	163	217	235	0.5	0.73	0.7	8.1	12	13

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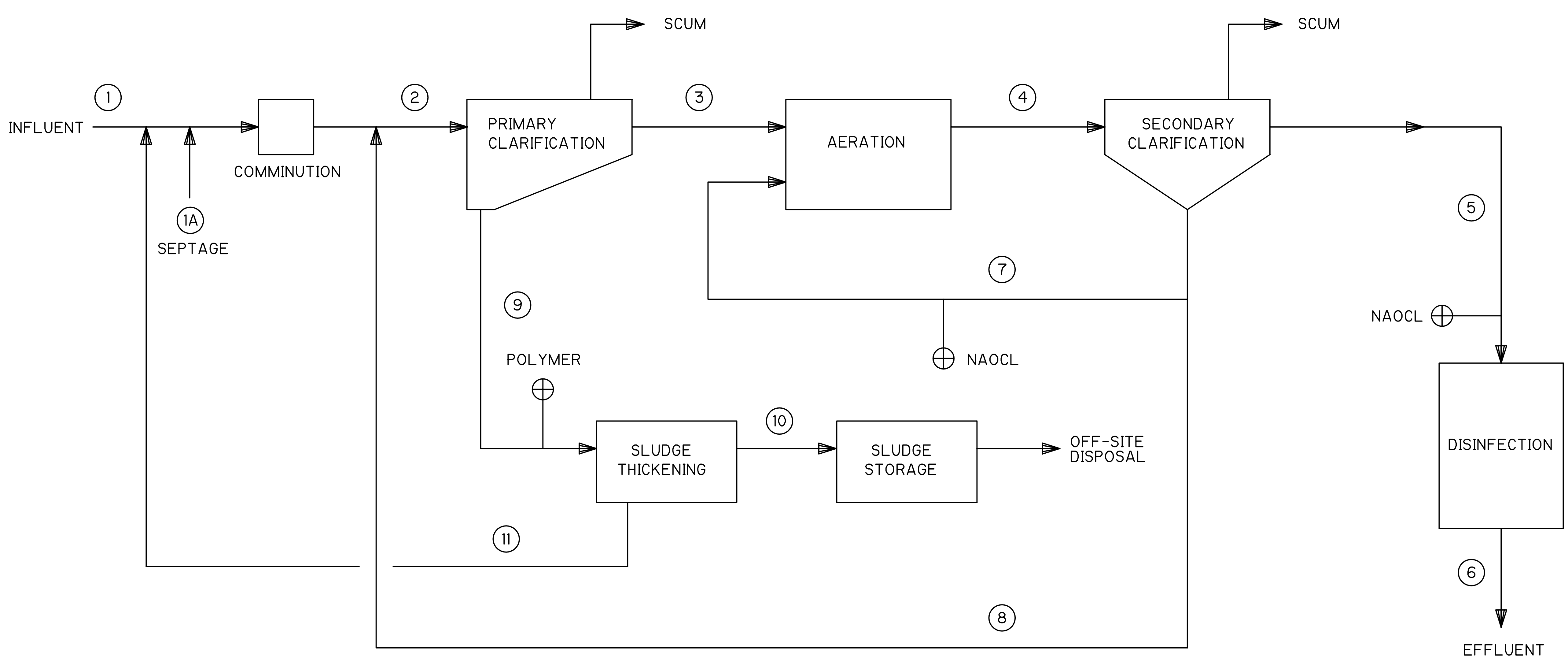
STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN

BOROUGH WPCF MASS BALANCE
(EXISTING CONDITIONS)

Figure No. 5-5



I.D.#	STREAM DESCRIPTION	FLOW (MGD) AVG. ANNUAL	FLOW (MGD) MAX. MONTH	FLOW (MGD) PEAK DAY	BOD (LBS/DAY) AVG. ANNUAL	BOD (LBS/DAY) MAX. MONTH	BOD (LBS/DAY) PEAK DAY	TSS (LBS/DAY) AVG. ANNUAL	TSS (LBS/DAY) MAX. MONTH	TSS (LBS/DAY) PEAK DAY	AMMONIA-NITROGEN (LBS/DAY) AVG. ANNUAL	AMMONIA-NITROGEN (LBS/DAY) MAX. MONTH	AMMONIA-NITROGEN (LBS/DAY) PEAK DAY	TKN (LBS/DAY) AVG. ANNUAL	TKN (LBS/DAY) MAX. MONTH	TKN (LBS/DAY) PEAK DAY
1.	RAW INFLUENT	0.473	0.696	0.918	782	976	1120	1110	1650	1990	95	139	184	150	215	283
1A.	SEPTAGE	0.00036	0.00036	0.00036	21	21	21	45	45	45	0.5	0.5	0.5	2.1	2.1	2.1
2.	PRIMARY INFLUENT	0.484	0.708	0.935	1010	1300	1580	1590	2340	2910	96	140	185	177	255	341
3.	PRIMARY EFFLUENT	0.480	0.702	0.929	493	808	954	309	451	597	95	139	272	132	204	184
4.	MIXED LIQUOR	0.759	1.11	1.47	5080	11800	15000	9950	21100	25400	3.4	5.7	10	649	1500	1910
5.	SECONDARY EFFLUENT	0.471	0.693	0.915	15	32	55	18	44	73	2.1	3.5	6.4	5.8	10	17
6.	FINAL EFFLUENT	0.471	0.693	0.915	15	32	55	18	44	73	2.1	3.5	6.4	5.8	10	17
7.	RETURN ACTIVATED SLUDGE	0.279	0.407	0.539	4910	11500	14600	9620	20600	24700	1.3	2.1	3.8	623	1460	1850
8.	WASTE ACTIVATED SLUDGE	0.009	0.009	0.014	159	254	379	311	456	642	0.04	0.05	0.9	20	32	48
9.	PRIMARY SLUDGE	0.0038	0.0057	0.0069	521	493	629	1280	1880	2310	0.8	1.1	1.4	45	50	70
10.	THICKENED SLUDGE	0.0021	0.0031	0.00383	468	442	564	1150	1700	2080	0.4	0.6	0.8	41	45	62
11.	THICKENER SUPERNATENT	0.00171	0.0025	0.00309	53	51	65	128	188	231	0.3	0.5	0.76	4.9	5	7.6

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STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN

PAWCATUCK WPCF MASS BALANCE
(EXISTING CONDITIONS)

Figure No. 5-6

Section 5
Water Pollution Control Facilities Evaluation

5.1 Introduction

This section documents the evaluations of the existing water pollution control facilities (WPCFs). These evaluations consist of a summary of the history of each plant, a description of the current facilities and the unit processes at each facility, a summary of plant operating data, and a unit process capacity analysis. Section 5.2 presents a review of the Mystic WPCF, Section 5.3 presents the Borough WPCF evaluation, and Section 5.4 presents a review of the Pawcatuck WPCF. Section 5.5 presents process flow and mass balances for each of the existing WPCFs, as they are currently operated.

This evaluation was initially completed in July 2002. Since that time:

- Odor control improvements have been made at each of the three WPCFs,
- CTDEP implemented a *General Permit for Nitrogen Discharges*, which includes nitrogen load limits for each WPCF, and
- The Symbio™ process has been in operation at the Stonington Borough WPCF since January 2002.
- A second inspection of the Mystic WPCF site was conducted in 2006 to evaluate the condition of the facilities.

Descriptions and flow and load summaries are largely based on data available at that time with some updated information. Review of updated plant data from June 2002 to present would not impact the conclusions of this planning evaluation. It is recommended, however, that subsequent phases of this project, starting with conceptual design, re-visit pertinent aspects of this evaluation.

5.2 Mystic Water Pollution Control Facility

The Mystic WPCF provides wastewater treatment services for the villages of Mystic and Old Mystic, in addition to adjacent commercial districts. The plant was built in 1971-1972.

5.2.1 Plant History

Prior to construction of the Mystic WPCF, local residences and businesses were serviced by on-site septic systems, and it was known that many of these systems were not operating correctly due to soil conditions. In addition, some untreated wastewater was directly discharged to the Mystic River. In a study published in 1959 by Charles A. MaGuire and Associates, it was recommended that Stonington construct the three existing wastewater treatment facilities (the Mystic, Borough and Pawcatuck plants). In 1970, the Town of Stonington was granted approval to construct the Mystic WPCF as a 0.88-mgd conventional, secondary treatment plant, utilizing the activated sludge process, and chlorination for disinfection. Construction of the plant was completed in 1972, and the plant was placed into operation.

In 1987, flows to the Mystic plant began to exceed 90 percent of its design capacity. In January 1988, the Connecticut Department of Environmental Protection (CTDEP) issued an Order which required Stonington to: 1) evaluate the capacity of the Mystic WPCF; 2) prepare 20-year flow projections for the service area; and 3) institute a sewer connection moratorium on the plant's service area. In 1988, the firm of Cummings & Lafayette developed a modified facilities plan for the Mystic WPCF. Among the recommendations contained in the plan was to expand the Mystic WPCF to a design flow of 1.3 mgd to accommodate anticipated flows.

In 1990, in response to a request from Stonington to increase the plant's permitted flow from 0.88 mgd to 1.3 mgd, CTDEP issued a report entitled "*Water Quality Analysis of Mystic Harbor - A Water Quality Model and Waste Load Allocation*". In the report, CTDEP indicated that the pristine quality of water in the Mystic Harbor cannot be allowed to degrade, and thus increases in flow will necessarily be accompanied by tighter restrictions on effluent quality. In addition, CTDEP indicated that nutrient removal would likely be required in the future.

In 1993 and 1994, Wright-Pierce conducted a study for improving the operation and performance of the Mystic WPCF. Wright-Pierce conducted the study in phases, and likewise recommended that improvements to the Mystic WPCF, as well as needed improvements to other WPCA facilities, be implemented in phases. Phase 1 of the planned approach included an upgrade program comprised of either operational or minor equipment or structural changes that would immediately improve treatment at the Mystic WPCF. Phase 2 recommendations were for longer-term improvements (within five years of report acceptance), key among them being construction of a new double-barrel forcemain between the Mystic and Borough WPCFs, to allow a portion of the Mystic flow to be diverted to the Borough WPCF for treatment. This, together with other improvements at both the Mystic and Borough WPCFs, allowed for removal of the new connection moratorium in the Mystic WPCF service area. It was recognized at the conclusion of the Wright-Pierce study that a long-term facilities plan would be required to put a plan in place to handle WPCA's sewage treatment needs. Plant improvements and the forcemain construction work were completed in 1999.

In November 1999, the Stonington WPCA contracted U.S. Water Service Company to operate, maintain, and manage the Mystic WPCF, along with the other two treatment facilities and their respective collection systems. In September 2002, the Town of Stonington approved an odor-control program for the three treatment plants. Improvements at the Mystic WPCF included improved ventilation of the influent wet well, and treatment of the ventilated air with a package carbon system. These improvements were completed in 2003.

5.2.2 Plant Description

The Mystic WPCF was designed to treat an average flow of 0.80 million gallons per day (mgd), and a peak flow of 2.35 mgd. It appears that the permitted average flow of 0.88 mgd, rather than 0.80 mgd, resulted from a clerical error when the permit was originally issued. The original design of the plant was to handle biochemical oxygen demand (BOD) and total suspended solids (TSS) influent loads of 1,400 and 1,700 pounds per day (ppd), respectively. The plant is permitted to discharge an average flow of 0.88 mgd, and discharges to the Mystic River. **Figure 5–1** presents a site plan of the existing Mystic WPCF.

Flow and load to the Mystic WPCF vary seasonally due to the tourism industry in Mystic. Loading in the summer months is higher than average for a sustained period, due to the higher contributing population. Flow variation is not as extreme, because the increase in sanitary flow during the tourism season is offset somewhat by a decrease in infiltration flow during the summer months. Section 5.2.3 describes existing flows and loads in detail.

The Mystic WPCF has undergone a substantial amount of upgrading and equipment replacement in recent years, and currently employs the following treatment processes:

- Influent comminution (or bypass coarse screening)
- Influent raw sewage pumping
- Primary clarification, with waste activated sludge (WAS) co-settling
- Activated sludge biological treatment
- Disinfection with sodium hypochlorite
- Primary underflow (co-settled sludge) de-gritting
- Diversion pumping of de-gritted primary clarifier underflow (to Borough WPCF)
- Odor control
- Digesters (abandoned)

Raw sewage enters the plant through a 30-inch diameter gravity sewer. Flow normally passes through a comminutor before entering the influent wet well. If the comminutor is out-of-service, flow is directed to a manually-cleaned coarse bar rack for screenings removal. The comminutor currently in place was installed in 1997/1998.

See Figure 5-1

Raw influent is pumped from the wet well by two influent pumps. The pumps are vertical, centrifugal, non-clog type, and are driven by variable frequency drives (VFDs). Each pump was installed in the late 1980s, and has a design capacity of 2,100 gpm at 34 feet total dynamic head (TDH).

The influent pumps discharge to a flow channel that precedes the plant's liquid-treatment tankage. WAS removed from the activated sludge process is also pumped to this channel. The channel feeds flow to two rectangular primary clarifiers. The primary clarifiers are equipped with chain-and-flight mechanisms for conveying settled sludge toward the front end of each tank. The chains and flights also are used for conveying primary scum and grease toward rotating scum troughs located toward the effluent end. Primary scum is conveyed to a pit equipped with a mixer and pump, and is pumped to tanker trucks for transport off site. Primary effluent flows over v-notch weirs and enters a channel that directs flow southward toward the plant's two aeration basins.

The aeration basins are typically operated in conventional, plug-flow mode, and are equipped with coarse-bubble diffusers that impart a spiral-roll pattern in the tanks. The aeration system is currently operated to provide BOD removal, and for nitrification, as a step to remove as much nitrogen as possible with the existing facilities. Return activated sludge (RAS) that is settled in the secondary clarifiers is returned to the front end of the basins.

The mixture of wastewater and microorganisms (the mixed liquor) from the aeration basins flows to two rectangular secondary clarifiers. The secondary clarifiers have the same length and width as the primary clarifiers, but have a shallow side water depth (SWD) of 8.25 feet. Chain-and-flight sludge removal mechanisms direct settled mixed liquor to the front of the secondary clarifiers, from which operators control the amount of sludge withdrawn. RAS is pumped back to the aeration basins. A portion of the settled mixed liquor (the WAS) is routed to a wet well for the diversion pumping system.

Secondary effluent is directed to the two chlorine-contact tanks for disinfection. Liquid sodium hypochlorite is used to disinfect the effluent wastewater. Dosage is based on plant flow and total residual chlorine (TRC) concentration in the disinfected effluent. Final effluent is discharged through an outlet v-notch weir, which is used for plant flow measurement, and to the Mystic River outfall through a 24-inch pipe. A 3,000-gpm effluent lift pump is installed to allow the plant to continually discharge to the outfall even during high backwater conditions, such as might occur during a hurricane. This pump is rarely used.

Primary sludge is removed from the bottom of the primary clarifiers at an estimated concentration of less than 0.1 percent solids. The sludge is pumped to a new grit removal system located in the old Dewatering Room in the Control Building. The grit system was installed in 1999, and consists of one cyclone and one grit classifier. Removed grit is deposited into a bin for transport off-site. Degritted sludge flows by gravity to a wet well that feeds a diversion pumping system. An odor-control system is installed to ventilate and treat the air from above the grit classifier.

Two diversion pumps remove the degritted sludge from the wet well and pump it to the Borough WPCF for treatment. A double-barrel forcemain connects the Mystic WPCF to the Borough WPCF's gravity collection system. Currently, the smaller, 6-inch diameter forcemain is used to protect against solids deposition in the pipe. The second, 12-inch diameter forcemain was installed to handle a possible increase in the diversion flow rate. The 12-inch diameter forcemain has not yet been connected to the diversion wet well, so in order to use it, approximately 100 feet of forcemain would have to be installed.

The diversion pumps are each sized to pump approximately 230 gpm to the Borough WPCF. This entire flow is from the primary clarifier underflow, after de-gritting. This pumping process is designed to reduce loading to the secondary treatment process at the Mystic WPCF by utilizing "excess" capacity at the Borough WPCF, and was implemented in September 1999. Up to 300,000 gallons per day can be diverted to the Borough WPCF. To provide control of hydrogen sulfide generation in the diversion forcemain (for odor-control purposes at the air-release valves along the force main, at the transition to gravity flow, and at the Borough WPCF), a bioxide agent is pumped into the forcemain at a rate of about 33 gallons per day.

The Control Building houses the plant office and laboratory, as well as the aeration blowers, sludge pumps, and other equipment. Two centrifugal RAS pumps (including one spare) are used to return sludge from the secondary clarifiers to the aeration basins. The RAS pumps are provided with VFDs, although the operators cannot vary the speed too much because of solids deposition problems in the pipelines at low speeds. One pump is used to pump WAS from the secondary clarifier underflow to the channel that feeds the primary clarifiers. The WAS pump is operated on a timed basis (i.e., a certain number of minutes per hour). Two primary sludge pumps (including one spare) are used to withdraw sludge from the primary clarifiers and pump it to the grit classification system, prior to the diversion pumping system.

Three blowers provide air for the activated sludge system. The blowers are positive-displacement type, and each has a capacity of 825 icfm at 20.7 psia discharge pressure. A VFD drives one of the units, and two-speed motors drive the other two. The blowers have been operating since the plant went on-line in 1972.

The new sodium hypochlorite feed system is also housed in the Control Building. The system consists of a 1,600-gallon storage tank, and three chemical feed pumps. One chemical feed pump is dedicated to each of the following: disinfection; odor control; and RAS chlorination. The pumps are connected by a manifold, which allows backup service to each application should one of the pumps fail.

A new supervisory control and data acquisition (SCADA) system has been installed at the Mystic WPCF by U.S. Water, as part of a system-wide control system.

The Mystic WPCF originally included a two-stage digestion process to stabilize the sludge removed from the liquid-side treatment processes. This system was taken out-of-service in 1993, and the gas-handling, mixing and other equipment necessary to operate the process was removed. The two digester tanks are still on-site, though they are currently not in use.

A summary table of the existing design and operating criteria for the Mystic WPCF is included in Appendix A.

5.2.3 Plant Inspection

CDM has conducted site visits to the Mystic WPCF to compliment our understanding of the plant operation based on previous reports, and to ascertain operational, structural or other deficiencies that will be considered as the alternatives evaluation process proceeds. Many of our observations are incorporated into Section 5.2.2. Additional observations are noted in the following sections, and are broken down into the following categories:

- Process/Mechanical/Equipment
- Site
- Structural/Architectural
- Electrical
- Miscellaneous (if applicable)

Safety problems noted during the inspections are included in the following list. However, a full safety and code-compliance audit was not conducted as part of this effort.

Process/Mechanical/Equipment

- The plant has a problem in handling the grease load. It was estimated by plant operators that about 30 restaurants contribute to the plant loading.
- Operators report that care must be taken to make sure that the non-metallic chain and flight collectors on the primary clarifiers do not experience accelerated wear due to grit loads.
- There is an uneven flow-distribution problem to the aeration basins.
- It is difficult to maintain proper dissolved oxygen (DO) concentrations in the aeration basins. Operators report that the two basins are rarely balanced (i.e., when one basin has a proper DO concentration, the second basin is usually too

high or too low). There is no automatic control of DO concentration. The imbalance problem is likely a result of the poor influent flow split to the tanks.

- A significant scum layer was noted on the top of the chlorine contact tanks. This can lead to maintenance problems and potential effluent quality problems if not routinely handled.

Site

- The Mystic WPCF site is confined by the Mystic River water line to the west and south, and a tidal swale and wetlands to the east.
- Neighboring properties include a Bed and Breakfast inn and other residences.

Structural/Architectural

- The structures are not exhibiting major structural deterioration, but are showing local signs of deterioration not uncommon for concrete structures of this age and service.
- The noted deterioration, primarily surface cracking, delineation, and spalling, will require repair.
- There are several code non-compliance areas to be addressed, including egress from basement areas, fire protection, and thermal insulation.
- The main building roof system is in need of replacement.
- The main building doors and several other architectural features are in need of replacement.
- The layout of the main building should be renovated as part of any upgrade project at the site.

Electrical

- The Mystic WPCF has a new electrical service, rated at 600 V, 800 amps.
- A new 300-amp emergency generator is installed in the plant. The generator is not provided with an adequate means of dispelling radiator heat, and when operational, the generator quickly heats up the pump room in which it is located. Its current location also may render it vulnerable to flooding, and relocating the generator to above the flood level would improve plant reliability.

5.2.4 Data Evaluation

Plant discharge monitoring reports for July 1999 through June 2002 are used in this analysis. Daily data from the entire period was used for flow. BOD and TSS loads are based on weekly data from July 2001 through June 2002, and NH_3-N and TN loads are based on monthly data from July 2001 through June 2002. The loading data are based only on one calendar year because in March 2001, WPCA modified its sampling protocol to 24-hour composites, and the data collected from this protocol is considered to be more accurate than the previous data, which was collected using 4-hour composites from 7:00 am to 11:00 am. This change in sampling protocol has led to the discovery that the Mystic WPCF influent loads are much higher than previously believed. For example, the average influent BOD concentration measured in the three years prior to the sampling protocol change was 219 mg/L (which is within the typical range of domestic influent wastewater), and the average BOD concentration measured since the sampling protocol change is 380 mg/L, a 74 percent increase. This corrected influent data in part explains the performance difficulty the plant has had, even at less than its rated flow capacity.

Influent Flows and Loads

Table 5-1 summarizes the existing influent flow —in million gallons per day (mgd) — and mass loadings — in pounds per day (ppd) — to the Mystic WPCF. The data show that the influent to the Mystic WPCF is more highly concentrated than is typical for domestic wastewater. The full reason for this variance is not known, although factors contributing to the highly concentrated influent may include the many restaurants within the collection system, and extensive water conservation efforts at the hotels within the system.

Table 5-1
Mystic WPCF Influent Wastewater Data

Condition	Flow (mgd)	BOD_5 (ppd)	TSS (ppd)	NH_3-N (ppd)	TN (ppd)
Average Annual[(1)]	0.570	1,806	1,462	142	202
Maximum Month[(2)]	0.772	3,024	3,055	192	273
Peak Day[(2)]	1.176	4,448	3,627	292	416
Peak Instantaneous	2.0				

Notes:
[(1)] Annual average values based entirely on plant records.
[(2)] Maximum month, peak day and peak instantaneous values for flow, BOD_5 and TSS loading base entirely on plant records. TN and NH_3-N based on average record data, and peaking factors based on flow.

Process Operating Data

Primary Clarification

Plant operating data was reviewed to determine the typical performance of the primary clarification process at the Mystic WPCF. BOD_5 removal averaged 30 percent, and decreased to close to 20 percent during higher flow periods. TSS removal ranges between 60 and 65 percent over the range of flows experienced. Total nitrogen (TN) and total Kjeldahl nitrogen (TKN) removal was about 17 percent, and ammonia-nitrogen (NH_3-N) removal was about 11 percent. Note that these percentages represent removals from the plant influent to the primary effluent, and do not consider the influent WAS load to the primary clarifiers.

Secondary Treatment
The following are noted upon review of the plant's operating data.

- Monthly average mixed liquor suspended solids (MLSS) concentration averages 1,417 mg/L and typically varies between 960 mg/L and 1,820 mg/L.

- Average monthly wastewater temperature averages 61 degrees F, and varies between 52 deg. F and 71 deg. F.

- Secondary clarifier underflow concentration averages 5,200 mg/L, and varies between 7,600 mg/L and 2,800 mg/L.

- The mean pH of the influent wastewater is 7.2. Influent pH is very consistent, and ranges only from 7.0 to 7.3.

Disinfection
- The average chlorine dosage for disinfection is 12.3 mg/L.

- The typical total residual chlorine concentration is about 1.0 mg/L.

Solids Handling
Before the diversion of primary underflow to the Borough WPCF was implemented, the Mystic WPCF thickened the co-settled primary sludge and WAS for hauling and off-site disposal. Records from the period prior to the diversion indicate that the thickened sludge was typically 2.25 percent solids. An average of 7,700 dry pounds per month was hauled. Once the diversion started, solids-handling processes at the Mystic WPCF were suspended, because the primary sludge and WAS are now pumped to the Borough WPCF as part of the diversion.

Permit Compliance Review

Plant operating data was reviewed to evaluate compliance and performance of the Mystic WPCF with respect to its current discharge permit (see Section 1.5.2 and Appendix D). Plant operating data from July 1997 to June 2002 was evaluated and compared to discharge permit requirements. It was noted that the Mystic WPCF experienced intermittent violations of its permit limits for BOD_5 and TSS and slightly more violations for settleable solids concentrations and coliform violations. It was noted that most of the intermittent violations occurred in 1997 and 1998.

With regard to nitrogen load, the Mystic WPCF has discharged less than its allocated annual discharge for 2002 and 2003. This is largely because the allocated discharge limits included in the *General Permit for Nitrogen Discharges* (see Section 1.5.3 and Appendix D) are based on historical flows prior to the diversion to the Borough WPCF. However, as time passes, the discharge requirements become more strict. It is expected that nitrogen discharges from the Mystic WPCF will be close to the 2004 limit of 46 ppd.

5.2.5 Process Capacity Evaluation

As described earlier, the overall treatment process at the Mystic WPCF consists of a series of unit processes that together enable the plant to meet its treatment goals. The design and operating criteria of each of these unit processes can be compared to typical design standards, as applicable, to determine their nominal capacity. **Table 5-2** summarizes this evaluation for the Mystic WPCF.

As shown in Table 5-2, the unit processes are separated into the following categories: influent pumping, preliminary treatment, primary treatment, secondary treatment (conventional), secondary treatment (nitrification), disinfection, and outfall.

For each unit process, typical design parameters and the related Mystic WPCF criteria are listed. These typical design parameters are based on the requirements of *TR-16, Guides for the Design of Wastewater Treatment Works*, when applicable, as well as WEF's *Manual of Practice No. 8*, and CDM's internal design standards. The nominal unit process capacity is indicated, based on each individual design parameter. The limiting unit process capacity is the lowest calculated capacity based on the list of parameters. Table 5-2 indicates that the influent pumping process has a peak capacity of 3.02 mgd with one pump out of service (the "firm" capacity). The Mystic WPCF has no preliminary treatment processes on-line. The capacity of the primary clarification process is calculated based on detention time and surface overflow rate. The table shows that the surface overflow rate is the limiting criterion for the Mystic WPCF, limiting the nominal capacity of the process to 0.81 mgd for average flow conditions, and 1.62 mgd under peak flow conditions.

The secondary treatment process is evaluated for two sets of criteria. First, the capacity of the secondary treatment processes to provide conventional biological treatment is summarized. This condition represents the existing plant's ability to remove approximately 85 percent of the influent BOD and TSS load, in accordance with the current NPDES permit, but not to provide ammonia removal (nitrification). Assuming that the mixed liquor suspended solids (MLSS) concentration is maintained at 1,420 mg/L (based on typical plant data), the aeration basins and secondary clarifiers are evaluated based on the parameters shown. Table 5-2 shows that the aeration basins' nominal capacity is 0.63 mgd (average), based on maintaining a maximum food-to-microorganism (F:M) ratio of 0.6, and that the secondary clarifiers limit the capacity of the secondary clarification process to an average of 0.76 mgd, based on the solids-loading rate limited allowable surface overflow rate of 560 gallons per day per square foot (gpd/sf).

In order to provide year-round ammonia removal (nitrification), which is a necessary step to provide nitrogen removal, the design MLSS concentration must be increased to approximately 4,000 mg/L. This substantially increases the solids load to the secondary clarifiers, and assuming that the typical sludge volume index (SVI) is about

See Table 5-2

200 mL/g (based on plant data), the capacity of the secondary treatment process is limited to a *maximum day* flow of about 0.50 mgd. The Mystic WPCF is not configured to provide any degree of biological denitrification, so there is no process capacity tabulated. New tankage and/or equipment would be used to provide denitrification.

The existing chlorine contact tanks have a nominal capacity of 0.70 mgd, based on the *TR-16* requirement to provide a minimum of 30 minutes of contact time at peak flow. WPCA has reported that this has been allowed by CTDEP in the past, because the additional contact time provided by the outfall pipe. The outfall's hydraulic discharge capacity is approximately 8.7 mgd, based on the average receiving water surface elevation, and the maximum allowable effluent water level before triggering the effluent lift pump. This hydraulic capacity does not consider outfall mixing or dilution requirements needed to meet water quality standards.

In summary, the nominal capacity of the existing WPCF is limited to a peak 0.70 mgd by the contact time available in the chlorine contact tanks. To meet conventional treatment standards, the F:M ratio in the secondary clarifiers limits the nominal capacity of the WPCF to an average of 0.63 mgd. If year-round nitrification is desired, as it will be in the future to obtain nitrogen removal, the nominal capacity of the existing WPCF is limited to a *maximum day* of 0.50 mgd.

5.3 Stonington Borough WPCF

The Stonington Borough WPCF (Borough WPCF) provides wastewater treatment services primarily for the Village of Stonington. A small area extending northward from the Village, and an area of Lord's Point are also served, and the plant now also treats up to 300,000 gallons per day of primary clarifier underflow from the Mystic WPCF, as described earlier. The plant was placed into service in 1975.

5.3.1 Plant History

In the 1959 MaGuire study, it was recommended that Stonington construct the three-wastewater treatment facilities (Mystic, Borough and Pawcatuck). It was also recommended that all three plants utilize similar layouts, processes and equipment to the extent possible. Construction of the Borough WPCF was completed in 1975, and the plant was placed into operation.

As described earlier, in 1993 and 1994, Wright-Pierce conducted a study for improving the operation and performance of the Mystic WPCF. A key recommendation from the study was construction of a new double-barrel forcemain between the Mystic and Borough plants, to allow a portion of the Mystic flow to be diverted to the Borough WPCF for treatment. Implementation of this diversion required that upgrade work be conducted at the Borough WPCF. The work at the Borough WPCF included installation of a fine-bubble aeration system, retrofit of the plant's existing digesters into new primary clarifiers, and conversion of one of the plant's existing primary clarifiers into a secondary clarifier. The diversion from the Mystic WPCF began in September 1999.

In November 1999, the Stonington WPCA contracted U.S. Water Service Company to operate, maintain, and manage the Borough WPCF, along with the other two treatment facilities and their respective collection systems. In September 2002, the Town of Stonington approved an odor-control program for the three treatment plants. Improvements at the Borough WPCF included improved ventilation of the influent wet well, covers over all of the treatment tankage, and treatment of the ventilated air with a biofilter. These improvements were completed in 2003.

5.3.2 Plant Description

The Borough WPCF was designed to treat an average flow of 0.66 million gallons per day (mgd). The plant discharges to Stonington Harbor. **Figure 5-2** presents a site plan of the existing Borough WPCF. The site plan includes a conceptual footprint of the biofilter to be constructed in 2003

The Borough WPCF has undergone a substantial amount of upgrading and equipment replacement in recent years, primarily due to the diversion from the Mystic WPCF, and currently employs the following treatment processes:

- Influent comminution (or bypass coarse screening)
- Influent raw sewage pumping
- Primary clarification, with waste activated sludge (WAS) co-settling
- Activated sludge biological treatment
- Disinfection with sodium hypochlorite
- Sludge thickening and thickened sludge storage
- Odor Control

Raw sewage, including up to 300,000 gpd of primary clarifier underflow diversion from the Mystic WPCF, enters the plant through a 24-inch diameter gravity sewer. Flow normally passes through a comminutor before entering the influent wet well. The comminutor currently in place was installed in 1999, and replaced a unit that was installed during the original plant construction.

Raw influent is pumped from the wet well by two influent pumps. The pumps are vertical, centrifugal, non-clog type, and are driven by variable frequency drives (VFDs). These pumps are the original pumps, but were modified with new impellers, motors and drives to enable them to pump to the higher elevation of the new primary clarifiers. Each pump has a design capacity of 970 gpm at 37 feet total dynamic head (TDH).

The influent pumps discharge to two new primary clarifiers, which were constructed in 1999 by modifying the abandoned sludge digesters. The 30-foot diameter primary

See Figure 5-2

clarifiers are equipped with center-feed scraper mechanisms for conveying settled sludge toward a well at the center of the tanks. Scum and grease collected on the surface of the primary clarifiers is drained to a scum pit for later mixing with the primary sludge. Primary effluent flows over inboard, v-notch weirs around the circumference of the tanks and towards the plant's two aeration basins. The primary clarifiers are covered with domes to allow capture of the headspace air for odor control.

The aeration basins are operated in conventional, plug-flow mode. The basins are equipped with fine-bubble membrane diffusers. Operators are currently utilizing the Symbio™ process in the aeration basins, attempting to achieve simultaneous nitrification and denitrification. The Symbio™ process has been in operation since January 2002. The process has shown only occasional success in providing simultaneous nitrification and denitrification, and the goal of achieving consistent success has not been achieved. Since startup of the process, the effluent total nitrogen concentration has been lees than 10 mg/L lass than 15 percent of the time, which indicates that the process is not reliably removing nitrogen to the levels needed. However, the Symbio™ process has resulted in some "side" benefit for the plant, in terms of operational stability and settling. Return activated sludge (RAS) that is settled in the secondary clarifiers is returned to the front end of the basins.

The mixed liquor effluent from the aeration basins flows to three rectangular secondary clarifiers. Two of the secondary clarifiers are from the original plant construction, and the third secondary clarifier was constructed and installed by modifying one of the plant's original rectangular primary clarifiers, before the digester conversion. The third secondary clarifier is identical in dimensions to the original two tanks. Chain-and-flight sludge removal mechanisms direct settled mixed liquor to the front of the secondary clarifiers, from which operators control the amount of sludge withdrawn from the clarifiers by varying the RAS pumping rate. RAS is then pumped back to the aeration basins. A portion of the settled mixed liquor (the WAS) is pumped to the influent wet well, for subsequent co-settling in the primary clarifiers.

Secondary scum is skimmed from the secondary clarifiers manually, and flows to the thickened sludge storage tank, for mixing with the thickened sludge prior to hauling.

Secondary effluent is directed to the two chlorine-contact tanks for disinfection. Liquid sodium hypochlorite is used to disinfect the effluent wastewater. The sodium hypochlorite is added in a mixing chamber at the influent end of the chlorine contact tanks, and is dosed based on plant flow and total residual chlorine (TRC) concentration in the disinfected effluent. Final effluent is discharged through an outlet v-notch weir, which is used for plant flow measurement, and to the Stonington Harbor outfall. An effluent lift pump is installed to allow the plant to continually discharge to the outfall even during high backwater conditions. Plant staff report that this pump is currently in inoperable condition, and is scheduled for repair or replacement in the near future.

Co-settled primary sludge and WAS is removed as the underflow from the primary clarifiers at a typical concentration of about 2 percent solids. The sludge is pumped by two plunger pumps to a rotary-drum sludge thickener. The on-line thickener is used about 45 to 50 hours per week, and thickens the sludge to about 6 to 7 percent solids. A liquid polymer system, consisting of a holding tank, mixer and two chemical feed pumps, is used to aid coagulation.

Thickened sludge is deposited into a small holding tank, and then is pumped to a larger sludge holding tank that was constructed by modifying the second original rectangular primary clarifier. The existing thickened sludge transfer pump is a double-disk type pump.

The new odor-control process installed in 2003 consists of a system of tank covers, improved ventilation, and treatment of captured odors through a biofilter. Odor Control is provided for all of the plant's process tankage and the influent wet well. The biofilter was built into the plant's previously-existing landscape features to minimize visual impact to the site.

The Control Building houses the plant office and laboratory, as well as the aeration blowers, sludge pumps, and other equipment. Three centrifugal RAS pumps are used to return sludge from the secondary clarifiers to the aeration basins. Two of the RAS pumps are driven by VFDs, and the third is a constant-speed pump. One WAS pump, with a capacity of 200 gpm, is used to pump WAS from the secondary clarifier underflow to the influent wet well. The WAS pump operates automatically on timer. Two primary sludge pumps are used to withdraw sludge from the primary clarifiers and pump it to the thickener.

Three blowers provide air for the activated sludge system. The blowers are positive-displacement type, and each has a capacity of 800 icfm at 7.2 psig discharge pressure. All three of the units are driven by VFDs. The blowers were all installed in 1999, and operators generally run two units in the summer and one in the winter to maintain adequate air to the aeration basins.

The new sodium hypochlorite feed system is also housed in the Control Building. The system consists of a 1,600-gallon storage tank, and two chemical feed pumps. Plant staff is also able to dose sodium hypochlorite to the RAS line for nocardia control.

A 230-kW emergency generator set is also housed in the Control Building.

A new supervisory control and data acquisition (SCADA) system has been installed at the Borough WPCF by U.S. Water, as part of a system-wide control system.

A summary table of the design and operating criteria for the Borough WPCF is included in Appendix A.

5.3.3 Plant Inspection

CDM has conducted site visits to the Borough WPCF to compliment our understanding of the plant operation based on previous reports, and to ascertain operational, structural or other deficiencies that will be considered as the alternative evaluation process proceeds. Many of our observations are incorporated into Section 5.3.2. Additional observations are noted in the following sections. Safety problems noted during the inspections are included in the following list. However, a full safety and code-compliance audit was not conducted as part of this effort.

Process/Mechanical/Equipment

- The thickened sludge pump, which is designed to pump sludge from the rotary-drum thickener to the sludge storage tank, is problematic in this application. The pump is a double-disk type, installed in 1999, and it appears that the thickened sludge is too thick for the pump to operate as planned.

- The effluent lift pump is in poor condition and is currently inoperable, according to plant staff.

Site

- The existing site is constrained by Stonington Harbor to the west. Residential housing is located in close proximity to the north and east.

- WPCA had noted an increase in the number of odor complaints at the Borough WPCF when the diversion from the Mystic WPCF was implemented in August 1999, and again during the public participation aspect of the wastewater planning effort. However, since the recent odor control improvements were completed in 2003, no complaints have been received.

Structural/Architectural

- The Borough WPCF is in generally good, structurally sound condition.

Electrical

- No recorded field observations.

5.3.4 Data Evaluation

Plant discharge monitoring reports for July 1999 through June 2002 are used in this analysis. For flow, daily Borough influent data from the entire period was used, and from August 2000 through June 2002, the daily diversion flow from Mystic was subtracted from the daily Borough influent flow to obtain the flow from the Borough collection system. BOD and TSS loads are based on weekly concentration data from the pre-diversion period, and applied to the flows. NH_3-N and TN loads are based on monthly concentration data from the pre-diversion period, and applied to the flows. Plant operating data used includes the influent wastewater temperature, the mixed liquor suspended solids (MLSS), the sludge volume index (SVI), and sludge removal records. The Borough WPCF samples are 24-hour composites.

Influent Flows and Loads

Table 5-3 summarizes the influent flow and mass loadings to the Borough WPCF from the Borough collection system only. The loading from the Mystic diversion is not included in Table 5-3.

Table 5-3
Stonington Borough WPCF Influent Wastewater Data

Condition	Flow (mgd)	BOD_5 (ppd)	TSS (ppd)	NH_3-N (ppd)	TN (ppd)
Average Annual[1]	0.216	374	304	48	70
Maximum Month[2]	0.346	804	591	94	136
Peak Day[2]	0.486	944	737	114	167
Peak Instantaneous	1.52				

Notes:
[1] Annual average values based entirely on plant records.
[2] Maximum month, peak day and peak instantaneous values for flow, BOD_5 and TSS loading base entirely on plant records. TN and NH_3-N based on average record data, and peaking factors based on flow.

Process Operating Data

Primary Clarification

Plant operating data was reviewed to determine the typical performance of the primary clarification process at the Borough WPCF. Prior to the Mystic diversion, BOD_5 removal averaged 39 percent. TSS removal ranges between 60 and 70 percent. TN, TKN and ammonia-nitrogen removals were about 17, 14 and 13 percent, respectively. After the Mystic diversion, BOD_5 removal has decreased to an average of about 30 percent. TSS removal has continued to be between 60 and 70 percent over the range of flows experienced. TN, TKN and ammonia-nitrogen removals were about 17, 14 and 13 percent, respectively. These percentages represent removals from the plant influent to the primary effluent, and do not consider the influent WAS load to the primary clarifiers.

Secondary Treatment

The following are noted upon review of the plant's operating data. This data does not include (pre-dates) the impacts from the pilot Symbio™ process.

- Monthly average MLSS concentration averaged about 1,200 mg/L and varied between 1,100 mg/L and 1,500 mg/L prior to the Mystic diversion. Since the diversion started, the monthly average MLSS concentration has been about 3,000 mg/L.

- Average monthly wastewater temperature averages 61 degrees F, and varies between 52 deg. F and 71 deg. F.

- The mean pH of the influent wastewater is 7.0. Influent pH is very consistent, and ranges from 6.7 to 7.4.

Disinfection

- The average chlorine dosage for disinfection is 6.2 mg/L.

- The typical total residual chlorine concentration is about 0.7 mg/L.

Solids Handling

The Borough WPCF thickens and stores co-mingled WAS and primary sludge. The thickened sludge, which is also mixed with primary and secondary scum, is then pumped to trucks for hauling. Since the diversion from the Mystic WPCF began, the Borough WPCF has produced approximately 1,500 pounds (dry weight) per day of solids.

Permit Compliance Review

Plant operating data was reviewed to evaluate compliance and performance of the Borough WPCF with respect to its current discharge permit. Plant operating data from July 1997 to June 2002 was evaluated and compared to discharge permit requirements. The Borough WPCF experienced intermittent violations of its permit limits for BOD_5 and TSS. These violations constitute the largest percentage of violations at the Borough plant over the period of study. The BOD violations at the Borough plant occurred in 1997 and 1998. No BOD violations were noted after 1998.

With regard to nitrogen load, the Borough WPCF discharged more than its allocated annual discharge for 2002 and 2003. This is largely because the allocated discharge limits included in the *General Permit for Nitrogen Discharges* (see Section 1.5.3 and Appendix D) are based on historical flows prior to the diversion from the Mystic WPCF. As time passes, the discharge requirements become more strict, thus, requiring additional nitrogen trading at a cost.

5.3.5 Process Capacity Evaluation

As described earlier, the overall treatment process at the Borough WPCF consists of a series of unit processes that together enable the plant to meet its treatment goals. The design and operating criteria of each of these unit processes can be compared to typical design standards, as applicable, to determine their nominal capacity. Table 5-4 summarizes this evaluation for the Borough WPCF. As shown in Table 5-4, the unit processes are separated into the following categories: influent pumping, preliminary treatment, primary treatment, secondary treatment (conventional), secondary treatment (nitrification), disinfection, and outfall. For each unit process, typical design parameters and the related Borough WPCF criteria are listed. These typical design parameters are based on the requirements of *TR-16, Guides for the Design of Wastewater Treatment Works*, when applicable, as well as WEF's *Manual of Practice No. 8*, and

CDM's internal design standards. The nominal unit process capacity is indicated, based on each individual design parameter. The limiting unit process capacity is the lowest calculated capacity based on the list of parameters.

Table 5-4 indicates that the influent pumping process has a peak capacity of 1.40 mgd with one pump out of service (the "firm" capacity). The Borough WPCF has no preliminary treatment processes on-line. The capacity of the primary clarification process is calculated based on detention time and surface overflow rate. The table shows that the surface overflow rate is the limiting criterion for the Borough WPCF, limiting the nominal capacity of the process to 0.85 mgd for average flow conditions, and 1.70 mgd under peak flow conditions.

The secondary treatment process is evaluated for two sets of criteria. First, the capacity of the secondary treatment processes to provide conventional biological treatment is summarized. This condition represents the existing plant's ability to remove approximately 85 percent of the influent BOD and TSS load, in accordance with the current NPDES permit, but not to provide ammonia removal (nitrification). Assuming that the MLSS concentration is maintained at 1,200 mg/L (based on typical plant data), the aeration basins and secondary clarifiers are evaluated based on the parameters shown. Table 5-4 shows that the aeration basins' nominal capacity is 0.86 mgd, based on maintaining a maximum F:M ratio of 0.6. Under this operating scenario, this limits the secondary treatment capacity, because the secondary clarifiers' limiting flow rate is an average of 1.05 mgd, based on the allowable surface overflow rate of 560 gallons per day per square foot (gpd/sf).

In order to provide year-round ammonia removal (nitrification), which is a necessary step to provide nitrogen removal, the design MLSS concentration must be increased to approximately 3,750 mg/L. This substantially increases the solids load to the secondary clarifiers, and assuming that the typical SVI is about 200 mL/g (based on plant data), the capacity of the secondary treatment process is limited to a *maximum day* flow of about 0.80 mgd. Except for the possible capabilities of the Symbio™ process, the Borough WPCF is not configured to provide any degree of biological denitrification, so there is no process capacity tabulated.

The existing chlorine contact tanks have a nominal capacity of 0.64 mgd, based on the *TR-16* requirement to provide a minimum of 30 minutes of contact time at peak flow. The outfall's hydraulic discharge capacity is approximately 7.5 mgd, based on the average receiving water surface elevation, and the maximum allowable effluent water level before triggering the effluent lift pump. This hydraulic capacity does not consider outfall mixing or dilution requirements needed to meet water quality standards.

In summary, the nominal capacity of the existing WPCF is limited to a peak 0.64 mgd by the contact time available in the chlorine contact tanks. To meet conventional treatment standards, the nominal capacity of the existing WPCF is limited to a peak 0.86 mgd by the allowable maximum F:M ratio in the aeration basins, assuming a

See Table 5-4

MLSS concentration of 1,200 mg/L to meet conventional treatment standards. If year-round nitrification is desired, the nominal capacity of the WPCF is limited to a *maximum day* of 0.80 mgd, because the solids loading rate to the secondary clarifiers increases and becomes the limiting criterion.

5.4 Pawcatuck WPCF

The Pawcatuck WPCF provides wastewater treatment services for all of the sewered areas of Pawcatuck. The plant was placed into service in 1980.

5.4.1 Plant History

The 1959 MaGuire study recommended construction of the Pawcatuck WPCF. The Pawcatuck WPCF utilizes the same unit processes as the other two plants, but is comprised of a different layout because of the available space.

In 1991, the Stonington WPCA was sued by a number of neighbors of the Pawcatuck WPCF, as a result of odors from the plant. Legal matters pertaining to the settlement of this suit, and ongoing additional action, have made odor control a vital consideration in the operation and maintenance of the plant. Modifications to the plant's processes are all made with odor control as a primary design consideration. In September 2002, the Town of Stonington approved an odor-control program for the three treatment plants. Improvements at the Pawcatuck WPCF included new covers over the primary clarifiers and aeration basins, improved ventilation of the solids processing and septage receiving areas, and treatment of the ventilated air with a biofilter. These improvements were completed in 2003.

In November 1999, the Stonington WPCA contracted U.S. Water Service Company to operate, maintain, and manage the Pawcatuck WPCF, along with the other two treatment facilities and the collection system.

5.4.2 Plant Description

The Pawcatuck WPCF was designed to treat an average flow of 1.3 million gallons per day (mgd). The plant discharges to the Pawcatuck River. The plant is currently treating flows well below its original design capacity. **Figure 5-3** presents a site plan of the Pawcatuck WPCF.

The Pawcatuck WPCF receives all of its influent flow from a discharge forcemain from the nearby Pump Station No. 3. There is no influent pumping or preliminary treatment (comminution, screening or grit removal) facilities at the Pawcatuck WPCF site.

The Pawcatuck WPCF has undergone a substantial amount of upgrading and equipment replacement in recent years, primarily due to replacement of aged equipment and currently employs the following treatment processes:

- Primary clarification, with waste activated sludge (WAS) co-settling

See Figure 5-3

- Septage receiving
- Activated-sludge biological treatment
- Disinfection with sodium hypochlorite
- Sludge thickening and thickened sludge storage
- Odor control
- Digesters (abandoned)

The influent flow from Pump Station No. 3 bypasses an abandoned aerated grit chamber, and discharges to the inlet channel to the two primary clarifiers. Only one primary clarifier is used under normal operation, because only one tank is typically needed to treat current flows. The inlet channel and both primary clarifiers are covered for odor control purposes, and the enclosed area is vented to the new biofilter system. The primary clarifiers are equipped with chain-and-flight sludge removal mechanisms. Scum and grease are manually skimmed from the surface of the clarifiers with rotating skimmers. The scum and grease flows to a pit, from which it is pumped to the thickened-sludge holding tank for eventual hauling. Primary effluent flows over v-notch weirs at the effluent end of the tanks and towards the plant's two aeration basins.

Septage is received in the garage area of the Pawcatuck WPCF, and is discharged into an underground, 10,000-gallon holding tank. The septage-receiving tank is not equipped with mixers or aeration, but does have a coarse bar rack at the inlet end. Septage is metered into the plant flow by pump. The septage storage tank is vented to a biofilter odor-control system. Septage is received intermittently, with between one and two 2,000-gallon trucks per week the typical range.

The aeration system is operated in conventional, plug-flow mode. Only one of the two basins is typically in operation. Both basins are equipped with fine-bubble membrane diffusers. The aeration system is currently operated to provide BOD removal, and as much nitrogen removal as possible. Operators currently create an anoxic zone at the front end of the aeration basins, by shutting off the air flow to that diffuser grid, and recycling a portion of the mixed liquor with a submersible pump from the effluent end of the basins to the front end. Return activated sludge (RAS) that is settled in the secondary clarifiers is returned to the front end of the basins. The aeration basins were covered and the headspace ventilated to a biofilter as part of the 2003 odor control improvements.

The mixed liquor from the aeration basins flows to two rectangular secondary clarifiers. Both tanks are typically in service to provide efficient settling. Chain-and-flight sludge removal mechanisms direct settled mixed liquor to the front of the secondary clarifiers, from which RAS is pumped back to the aeration basins. A portion of the settled mixed liquor (the WAS) is pumped to the channel that feeds the primary clarifiers. Scum is removed from the surface of the secondary clarifiers similarly to the primary clarifiers, and the scum drains to the same pit as the primary scum and grease. Secondary effluent flows over straight-edge finger weirs at the effluent end of the tanks.

Secondary effluent is directed to the two chlorine-contact tanks for disinfection. Liquid sodium hypochlorite is used to disinfect the effluent wastewater. The sodium hypochlorite is dosed based on plant flow and total residual chlorine (TRC) concentration in the disinfected effluent. Final effluent is discharged through an outlet v-notch weir, which is used for plant flow measurement, and to the Pawcatuck River outfall.

Co-settled primary sludge and WAS is removed as the underflow from the primary clarifiers. The sludge is pumped to one rotary-drum sludge thickener. A polymer system, consisting of three polymer mixing and aging tanks, and an in-line-mixing tank upstream of the thickener, is used to aid coagulation. Thickened sludge is deposited into a sludge holding tank, from which it is pumped to trucks for hauling offsite. A chopper pump is also used to pump the thickened sludge to the trucks. Odor control is provided for the thickener and for the truck when loading. The thickened sludge storage tank is covered, and all components are ventilated to the odor-control system.

Primary scum and grease, and secondary scum, are also hauled off site. A chopper pump moves the scum from the pit to the thickened sludge holding tank, where it mixes with the thickened sludge prior to hauling.

The Control Building houses the plant office and laboratory, as well as the aeration blowers, sludge pumps, and other equipment. Two centrifugal RAS pumps (one in service at a time) are used to return sludge from the secondary clarifiers to the aeration basins. One WAS pump, with a capacity of 225 gpm and driven by a VFD, is used to pump WAS from the secondary clarifier underflow to the channel that feeds the primary clarifiers. Operators currently run the WAS pump on a timer. Two primary sludge pumps (one in service at a time) are used to withdraw sludge from the primary clarifiers and pump it to the thickener.

Three blowers provide air for the activated sludge system, two new units, installed in 1999 and 2001, and one older unit from the original plant construction. The older blower is in poor condition, and is not suitable for operation with a fine-bubble diffusers.

The new sodium hypochlorite feed system is also housed in the Control Building. The system consists of a 1,600-gallon storage tank for use in disinfection, one 50-gallon tank for use in chlorinating the RAS stream, and one spare 30-gallon tank. Three chemical feed pumps are used to feed sodium hypochlorite to these processes.

The Pawcatuck WPCF originally included a two-stage digestion process to stabilize the sludge removed from the liquid-side treatment processes. This system was taken out-of-service in 1993, and the gas-handling, mixing and other equipment necessary to operate the process was removed.

The new odor control process installed in 2003 consists of a system of tank covers, improved ventilation, and treatment of the odors through a biofilter. Odor control is provided for the plant's primary clarifiers, aeration basins, and all sludge handling processes.

A backup power generator is housed in the Control Building. The generator was manufactured by Cummins-Onan, and is rated at 250 kW.

A new supervisory control and data acquisition (SCADA) system has been installed at the Pawcatuck WPCF by U.S. Water, as part of a system-wide control system.

A summary table of the design and operating criteria for the Pawcatuck WPCF is included in Appendix A.

5.4.3 Plant Inspection

CDM has conducted site visits to the Pawcatuck WPCF to compliment our understanding of the plant operation and to ascertain operational, structural or other deficiencies that will be considered as the alternatives evaluation process proceeds. Many of our observations are incorporated into Section 5.4.2. Additional observations are noted in the following sections. Safety problems noted during the inspections are included in the following list. However, a full safety and code-compliance audit was not conducted as part of this effort.

Process/Mechanical/Equipment

- The plant is currently operating with an internal recycle flow in the aeration basins, and in shutting off air to the front end of the basins, in an attempt to create an anoxic zone. A significant amount of nitrogen removal occurs as a result of this process.

- WPCA has reported that there may be too long a delay time in the control loop for the sodium hypochlorite dosing system, and relocating the feed system is under consideration. The chlorine residual monitors have been problematic in terms of the amount of maintenance required.

Site

- The Pawcatuck WPCF sits on only a portion of WPCA's existing property. There is a significant amount of site footprint available for expansion, if required (see Figure 5-3).

Structural/Architectural

- The mixing tank inlet to the chlorine contact tanks is not provided with guardrail.

- The digester building back room has a leaking roof.

Electrical

- No recorded field observations.

Miscellaneous

- There is a mechanics shop located in the Control Building. This shop serves the needs of all three of WPCA's facilities.

- The Pawcatuck WPCF was originally designed and laid out with the consideration that the plant tankage could double at some point in the future (i.e., a "mirror" process footprint could be constructed to expand capacity).

5.4.4 Data Evaluation

Plant discharge monitoring reports for July 1999 through June 2002 are used in this analysis. Daily data from the entire period was used for flow. BOD and TSS loads are based on weekly data from July 2001 through June 2002, and NH_3-N and TN loads are based on monthly data from July 2001 through June 2002. The loading data are based only on one calendar year because in March 2001, WPCA modified its sampling protocol to 24-hour composites, and the data collected from this protocol is considered more accurate than the previous data, which was collected using 4-hour composites from 7:00 am to 11:00 am. Plant operating data used includes the influent wastewater temperature, the mixed liquor suspended solids (MLSS), the sludge volume index (SVI), and sludge removal records.

Influent Flows and Loads

Table 5-5 summarizes the existing influent flow and mass loadings to the Pawcatuck WPCF. The data show that the influent to the Pawcatuck WPCF is typical municipal wastewater, similar to the other two plants.

Table 5-5
Pawcatuck WPCF Influent Wastewater Data

Condition	Flow (mgd)	BOD_5 (ppd)	TSS (ppd)	NH_3-N (ppd)	TN (ppd)
Average Annual(1)	0.473	782	1,108	94	148
Maximum Month(2)	0.696	974	1,651	138	217
Peak Day(2)	0.918	1,121	1,991	182	286
Peak Instantaneous	1.68				

Notes:
(1) Annual average values based entirely on plant records.
(2) Maximum month, peak day and peak instantaneous values for flow, BOD_5 and TSS loading base entirely on plant records. TN and NH_3-N based on average record data, and peaking factors based on flow.

Process Operating Data

Primary Clarification

Plant operating data was reviewed to determine the typical performance of the primary clarification process at Pawcatuck. BOD_5 removal averaged about 40 percent. TSS removal ranges from about 70 percent at typical flow rates, to about 60 percent at high flows. TN and TKN removal were about 18 percent, and ammonia-nitrogen removal was about 12 percent. As with the other plants, these percentages represent removals from the plant influent to the primary effluent, and do not consider the influent WAS load to the primary clarifiers.

Secondary Treatment

The following are noted upon review of the plant's operating data. These items will be considered during the alternatives evaluations that will be developed in a subsequent section:

- Monthly average MLSS concentration averages 1,575 mg/L and varies between 500 mg/L and 3,129 mg/L.

- Average monthly wastewater temperature averages 58 degrees F, and varies between 51 deg. F and 67 deg. F.

- The mean pH of the influent wastewater is 7.1. Influent pH is very consistent, and ranges only from 6.8 to 7.3.

Disinfection

- The average chlorine dosage for disinfection is 6.1 mg/L.

- The typical total residual chlorine concentration is about 0.7 mg/L.

Solids Handling

The Pawcatuck WPCF thickens and stores co-mingled WAS and primary sludge. The thickened sludge, which is also mixed with primary and secondary scum, is then pumped to trucks for hauling. The Pawcatuck WPCF has produced an average of approximately 1,060 pounds (dry weight) per day of solids.

Permit Compliance Review

Plant operating data was reviewed to evaluate compliance and performance of the Pawcatuck WPCF with respect to its current discharge permit. Plant operating data from July 1997 to June 2002 was evaluated and compared to discharge permit requirements. The Pawcatuck WPCF experienced intermittent violations of its permit limits for BOD_5 and TSS. These violations constitute the largest percentage of violations at the Pawcatuck plant over the period of study. Most of the violations occurred in 1998 and 1999.

With regard to nitrogen load, the Pawcatuck WPCF has discharged less than its allocated annual discharge for 2002 and 2003. This is largely because the allocated discharge limits included in the *General Permit for Nitrogen Discharges* (see Section 1.5.3 and Appendix D) are based on historical flows, which were higher. However, as time passes, the discharge requirements become more strict. It is expected that nitrogen discharges from the Pawactuck WPCF will be close to the 2004 limit.

5.4.5 Process Capacity Evaluation

As described earlier, the overall treatment process at the Pawcatuck WPCF consists of a series of unit processes that together enable the plant to meet its treatment goals. The design and operating criteria of each of these unit processes can be compared to typical design standards, as applicable, to determine their nominal capacity. Table 5-6 summarizes this evaluation for the Pawcatuck WPCF.

As shown in Table 5-6, the unit processes are separated into the following categories: influent pumping, preliminary treatment, primary treatment, secondary treatment (conventional), secondary treatment (nitrification), and disinfection. For each unit process, typical design parameters and the related Pawcatuck WPCF criteria are listed. These typical design parameters are based on the requirements of *TR-16, Guides for the Design of Wastewater Treatment Works*, when applicable, as well as WEF's *Manual of Practice No. 8*, and CDM's internal design standards. The nominal unit process capacity is indicated, based on each individual design parameter. The limiting unit process capacity is the lowest calculated capacity based on the list of parameters.

Table 5-6 indicates that the Pawcatuck WPCF has no on-site influent pumping, or preliminary treatment processes on-line. The capacity of the primary clarification process is calculated based on detention time and surface overflow rate. The table shows that the surface overflow rate is the limiting criterion for the Pawcatuck WPCF, limiting the nominal capacity of the process to 1.01 mgd for average flow conditions, and 2.02 mgd under peak flow conditions.

The secondary treatment process is evaluated for two sets of criteria. First, the capacity of the secondary treatment processes to provide conventional biological treatment is summarized. This condition represents the existing plant's ability to remove approximately 85 percent of the influent BOD and TSS load, in accordance with the current NPDES permit, but not to provide ammonia removal (nitrification). Assuming that the MLSS concentration is maintained at 1,575 mg/L (based on typical plant data), the aeration basins and secondary clarifiers are evaluated based on the parameters shown. **Table 5-6** shows that the aeration basins' nominal capacity is 2.05 mgd, based on maintaining a minimum detention time of 5 hours. However, the secondary clarifiers limit the capacity of the secondary treatment process to an

See Table 5-6

average of 1.93 mgd, based on the allowable surface overflow rate of 560 gallons per day per square foot (gpd/sf). The return sludge pumping capacity further limits treatment capacity to 1.87 mgd, but this constraint could be readily eliminated.

In order to provide year-round ammonia removal (nitrification), which is a necessary step to provide nitrogen removal, the design MLSS concentration must be increased to approximately 3,100 mg/L. This increases the solids load to the secondary clarifiers, and assuming that the typical SVI is about 200 mL/g (based on plant data), the capacity of the secondary treatment process is limited to a *maximum day* flow of about 2.10 mgd. The Pawcatuck WPCF is not configured to provide any degree of biological denitrification, so there is no process capacity tabulated. It is assumed that new tankage and/or equipment would be used to provide denitrification.

The existing chlorine contact tanks have a nominal capacity of 1.64 mgd, based on the *TR-16* requirement to provide a minimum of 30 minutes of contact time at peak flow. The outfall's hydraulic discharge capacity is approximately 11.5 mgd, based on the average receiving water surface elevation, and the maximum allowable effluent water level before backflow interferes with the effluent weir flow meter. This hydraulic capacity does not consider outfall mixing or dilution requirements needed to meet water quality standards.

In summary, the nominal capacity of the existing WPCF is limited to a peak 1.64 mgd by the contact time available in the chlorine contact tanks. To meet conventional treatment standards, the overflow rate from the secondary clarifiers limits the nominal capacity of the WPCF to an average of 1.93 mgd. If year-round nitrification is desired, the nominal capacity of the WPCF is limited to a *maximum day* of 2.10 mgd.

5.5 Mass Balances

Process flow and mass balances have been developed for each the three WPCFs, for the existing average annual day, maximum month average day, and peak day loading conditions. These mass balances are presented in **Figures 5-4, 5-5 and 5-6.**

5.5.1 Calculation Tool

The mass balances were developed using Plan-It STOAT, a computer program that incorporates the most up-to-date and proven wastewater process models to mimic and predict actual plant performance given a certain set of inlet and operating conditions and model performance parameters. Plan-It STOAT was developed by Water Research Center (WRC) with technical support by CDM, and is used by CDM in the facilities-planning stages of a project, as it allows for the efficient evaluation of different process options. 5.5.2 Assumptions

General

Mass balances for each of the three plants are described separately. The following assumptions apply to all three mass balances. Additional assumptions that apply only to a specific plant are as noted in the following sections.

See Figure 5-4

See Figure 5-5

See Figure 5-6

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1. Plant operating data as described earlier in this section were used to develop influent loadings to the plants, in terms of flow, BOD, TSS, ammonia-nitrogen, and TKN.

2. Wastewater temperature is equal to the annual average as indicated by plant records.

3. Aeration basin DO is always maintained at 2.0 mg/L. This assumption impacts the model's prediction regarding the ability of the plant to achieve nitrification, and the mass balance nitrogen component data reflect that nitrification occurs. It is understood that lack of aeration control can interfere with the ability to maintain a DO concentration of 2.0 mg/L at all times, and hence the degree of nitrification actually observed.

4. Mixed liquor concentration, RAS flow, RAS concentration, WAS removed and effluent quality were matched as closely as possible to average annual data. For maximum monthly and peak day conditions, RAS and WAS rates were adjusted to maintain similar mixed liquor concentrations as during the average annual conditions. This approach assumes that operators attempt to maintain relatively constant MLSS levels, except for when the target MLSS is modified for seasonal purposes.

5. The amount of material removed by the plants' current scum skimming operation has negligible impact on the plant mass balance, and is ignored. This applies to both the total gallons and the pounds of solids.

Mystic WPCF

The following assumptions were used in developing the mass balance for the Mystic WPCF:

1. Primary underflow was targeted at approximately 300,000 gallons per day.

2. All available process tankage is in service.

3. Grit removed from the primary clarifier underflow has negligible impact on the mass balance, and is ignored. Grit washwater recycle to the influent wet well is also ignored.

Borough WPCF

The following assumptions were used in developing the mass balance for the Borough WPCF:

1. All available process tankage is in service.

2. The diversion from the Mystic WPCF is in place.

3. Thickened sludge is approximately 6.5 percent solids when pumped to the trucks for hauling. The thickening process recovers 90 percent of the solids, and the remaining is recycled to the front of the plant.

Pawcatuck WPCF

The following assumptions were used in developing the mass balance for the Pawcatuck WPCF:

1. The total septage received at the Pawcatuck WPCF averages 2,500 gallons per day. Since no quality data was available for the septage received at the plant, typical septage data, as tabulated in the *EPA Handbook, Septage Treatment and Disposal*, 1984, was used.

2. It was assumed that the following number of tanks was in service: one primary clarifier, one aeration basin, two secondary clarifiers, and two chlorine contact tanks.

3. Thickened sludge is approximately 6.5 percent solids when pumped to the trucks for hauling. The thickening process recovers 90 percent of the solids, and the remaining is recycled to the front of the plant.

5.6 Conclusions

The data described in this section will be used in developing the alternatives evaluation presented in Section 7. General conclusions of the existing WPCF evaluations that have a significant impact on the direction of the alternatives evaluation are as follows:

- The Mystic WPCF is the oldest of the three existing plants, and is not currently capable of efficiently treating all of the flow to the plant from the collection system. For this reason, a significant portion of the plant’s influent flow (up to 300,000 gpd) is currently diverted to the Borough WPCF.

- The Mystic WPCF site is constrained, and expansion of the Mystic WPCF would be very difficult.

- The Borough WPCF is capable of successfully treating flows and loads from its local collection system, as well as the diversion from the Mystic WPCF. The usable Borough WPCF site is constrained, and expansion of the Borough WPCF would be very difficult.

- The Pawcatuck WPCF is underloaded at current flows and loads to meet existing treatment goals. The plant site is large, with a significant amount of available space for expansion.

- The WPCA has placed a high priority on avoiding nuisance odors from the three plant sites, and recently completed a significant odor control improvements program at all three sites.

References

Report on Sewerage and Sewage Disposal for the Town of Stonington, Connecticut, by Charles A. MaGuire & Associates, December 1959.

Sewerage and Sewage Disposal Study Town of Stonington Connecticut, by Philip W. Genovese & Associates, November 1967.

Report on The Mystic Sewer District, by Cummings & Lafayette, 1985.

Mystic Modified Facilities Plan, by Cummings & Lafayette, April 1988.

Water Quality Analysis of Mystic Harbor A Water Quality Model and Waste Load Allocation Final Report, by State of Connecticut Department of Environmental Protection Water Management Bureau Planning and Standards Division, June 1990.

Mystic Water Pollution Control Plant Upgrading Phase 1 Immediate Improvements Draft Report, by Wright-Pierce, February 15, 1994.

Mystic Water Pollution Control Plant Upgrading Phase 2 Plan for Short-Term Improvements Final Report, by Wright-Pierce, April 15, 1994.

Odor Control Considerations for the Transport of Wastewater from the Mystic WWTP to the Stonington (Boro) WWTP, by Bowker & Associates, Inc., August 1994.

Wastewater Treatment Plant Improvements and Wastewater Transmission System Preliminary Design Documentation Final Report, by Wright-Pierce, March 29, 1995.

Process/Component	Parameter	Criterion	Existing Facilities	Capacity
Influent Pumping				
Comminution				
Influent Pumps	Capacity (firm)	N/A	2,100 gpm	3.02 mgd
Preliminary Treatment				
None				
Primary Treatment				
Primary Clarifiers	Detention Time (avg)	2 hrs	108,714 gallons	1.30 mgd
	Surface Overflow Rate (avg)	600 gpd/sf (w/WAS)	1,352 sf	0.81 mgd
	Surface Overflow Rate (peak)	1,200 gpd/sf (w/WAS)	1,352 sf	1.62 mgd
Secondary Treatment (Conventional) (Assumed MLSS = 1,420 mg/L)				
Aeration Basins	Detention Time (avg)	5 hrs	216,456 gallons	1.04 mgd
	Volumetric Loading (avg)	60 lb BOD/d/1000 cu. ft	28,938 cu. ft	0.71 mgd
	F:M Ratio (avg)	0.6 lb BOD applied/d/lb MLVSS	1,420 mg/L MLSS	0.63 mgd
Secondary Clarifiers	Surface Overflow Rate (avg)	560 gpd/sf	1,352 sf	0.76 mgd
	Surface Overflow Rate (peak)	1240 gpd/sf	1,352 sf	1.68 mgd
	Solids Loading Rate (peak)	36 ppd/sf	1,352 sf	2.70 mgd
Return Sludge Pumping	Recycle Ratio (avg)	1.0	800 gpm	1.15 mgd
Secondary Treatment (Year-Round Nitrification) (Assumed MLSS = 4,000 mg/L)				
System-Wide (max day)	SRT	10.5 days		0.50 mgd
Disinfection				
Chlorine Contact Tanks	Contact time (peak)	30 min	14,586 gallons	0.70 mgd
Outfall				
Outfall Discharge	Hydraulic Capacity	N/A		8.7 mgd

References:

Design of Municipal Wastewater Treatment Plants: WEF Manual of Practice No. 8 Fourth Edition, Vol 2. Water Environment Federation; 1998. (MOP 8)
TR-16 Guides for the Design of Wastewater Treatment Works. New England Interstate Water Pollution Control Commission; 1998. (TR-16)
Activated Sludge Guidelines. Camp, Dresser and McKee; 1996. (CDM Guidelines)

CDM

Table 5-2
Mystic WPCF Unit Capacity Evaluation

Process/Component	Parameter	Criterion		Existing Facilities		Capacity	
Influent Pumping							
Comminution							
Influent Pumps	Capacity (firm)	N/A		970	gpm	1.40	mgd
Preliminary Treatment							
None							
Primary Treatment							
Primary Clarifiers	Detention Time (avg)	2	hrs	121,546	gallons	1.46	mgd
	Surface Overflow Rate (avg)	600	gpd/sf (w/WAS)	1,413	sf	0.85	mgd
	Surface Overflow Rate (peak)	1,200	gpd/sf (w/WAS)	1,413	sf	1.70	mgd
Secondary Treatment (Conventional) (Assumed MLSS = 1,200 mg/L)							
Aeration Basins	Detention Time (avg)	5	hrs	201,960	gallons	0.97	mgd
	Volumetric Loading (avg)	60	lb BOD/d/1000 cu. ft	27,000	cu. ft	1.14	mgd
	F:M Ratio (avg)	0.6	lb BOD applied/d/lb MLVSS	1,200	mg/L MLSS	0.86	mgd
Secondary Clarifiers	Surface Overflow Rate (avg)	560	gpd/sf	1,872	sf	1.05	mgd
	Surface Overflow Rate (peak)	1240	gpd/sf	1,872	sf	2.32	mgd
	Solids Loading Rate (peak)	36	ppd/sf	1,872	sf	3.65	mgd
Return Sludge Pumping	Recycle Ratio (avg)	1.0		1,400	gpm	2.02	mgd
Secondary Treatment (Year-Round Nitrification) (Assumed MLSS = 3,750 mg/L)							
System-Wide (max day)	SRT	10.5	days			0.80	mgd
Disinfection							
Chlorine Contact Tanks	Contact time (peak)	30	min	13,371	gallons	0.64	mgd
Outfall							
Outfall Discharge	Hydraulic Capacity	N/A				7.5	mgd

References:

Design of Municipal Wastewater Treatment Plants: WEF Manual of Practice No. 8 Fourth Edition, Vol 2. Water Environment Federation; 1998. (MOP 8)
TR-16 Guides for the Design of Wastewater Treatment Works. New England Interstate Water Pollution Control Commission; 1998. (TR-16)
Activated Sludge Guidelines. Camp, Dresser and McKee; 1996. (CDM Guidelines)

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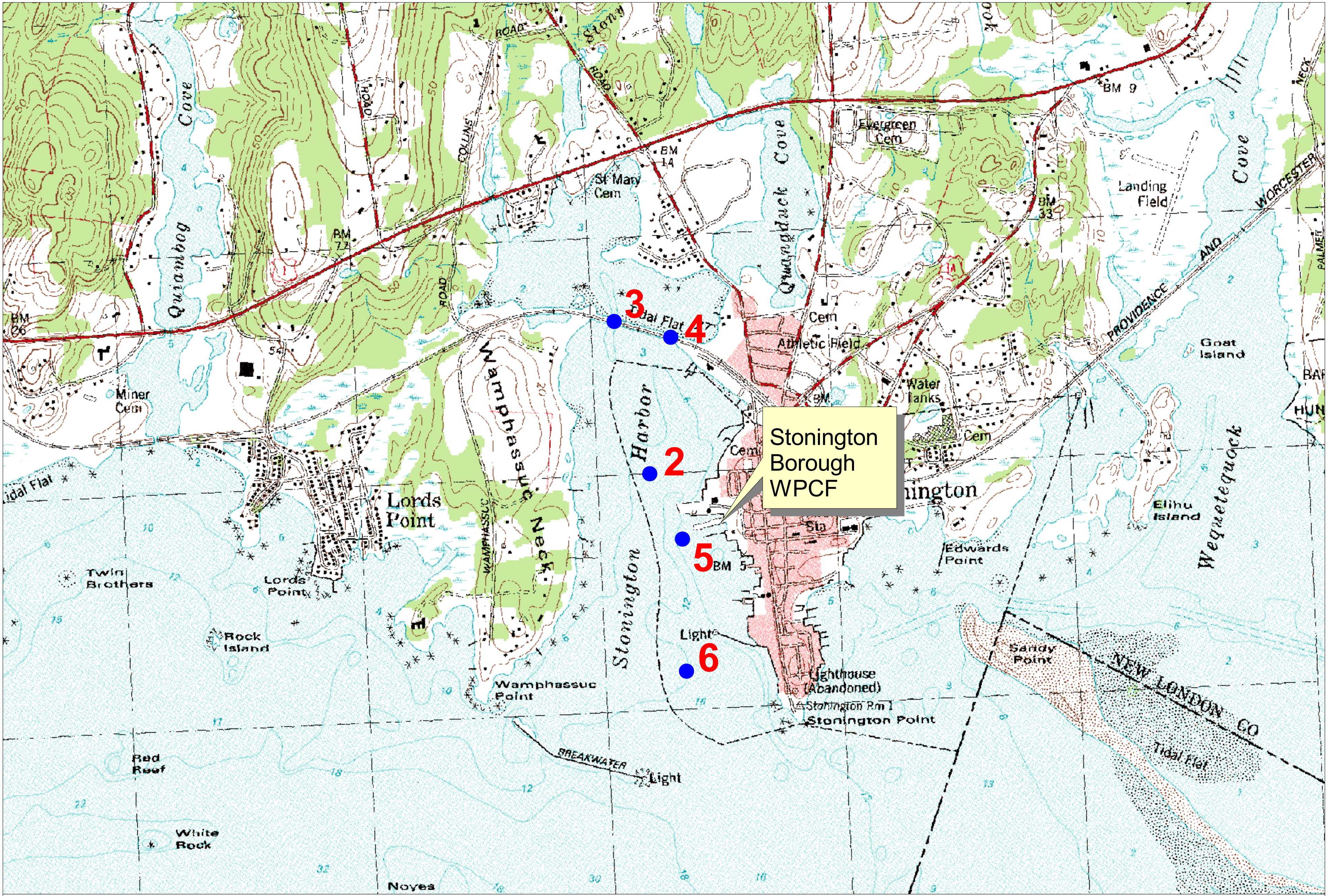
Table 5-4
Stonington Borough WPCF Unit Capacity Evaluation

Process/Component	Parameter	Criterion	Existing Facilities	Capacity
Influent Pumping				
None				
Preliminary Treatment				
None				
Primary Treatment				
Primary Clarifiers	Detention Time (avg)	2 hrs	100,531 gallons	1.21 mgd
	Surface Overflow Rate (avg)	600 gpd/sf (w/WAS)	1,680 sf	1.01 mgd
	Surface Overflow Rate (peak)	1,200 gpd/sf (w/WAS)	1,680 sf	2.02 mgd
Secondary Treatment (Conventional) (Assumed MLSS = 1,575 mg/L)				
Aeration Basins	Detention Time (avg)	5 hrs	426,360 gallons	2.05 mgd
	Volumetric Loading (avg)	60 lb BOD/d/1000 cu. ft	57,000 cu. ft	3.65 mgd
	F:M Ratio (avg)	0.6 lb BOD applied/d/lb MLVSS	1,575 mg/L MLSS	3.60 mgd
Secondary Clarifiers	Surface Overflow Rate (avg)	560 gpd/sf	3,440 sf	1.93 mgd
	Surface Overflow Rate (peak)	1240 gpd/sf	3,440 sf	4.27 mgd
	Solids Loading Rate (peak)	32 ppd/sf	3,440 sf	4.82 mgd
Return Sludge Pumping	Recycle Ratio (avg)	1.0	1,300 gpm	1.87 mgd
Secondary Treatment (Year-Round Nitrification) (Assumed MLSS = 3,100 mg/L)				
System-Wide (max day)	SRT	10.5 days		2.10 mgd
Disinfection				
Chlorine Contact Tanks	Contact time (peak)	30 min	34,181 gallons	1.64 mgd
Outfall				
Outfall Discharge	Hydraulic Capacity	N/A		11.5 mgd

References:

Design of Municipal Wastewater Treatment Plants: WEF Manual of Practice No. 8 Fourth Edition, Vol 2. Water Environment Federation; 1998. (MOP 8)
TR-16 Guides for the Design of Wastewater Treatment Works. New England Interstate Water Pollution Control Commission; 1998. (TR-16)
Activated Sludge Guidelines. Camp, Dresser and McKee; 1996. (CDM Guidelines)



Sampling Stations

6000 0 6000 Feet

N

Figure 6-1
Stonington Harbor

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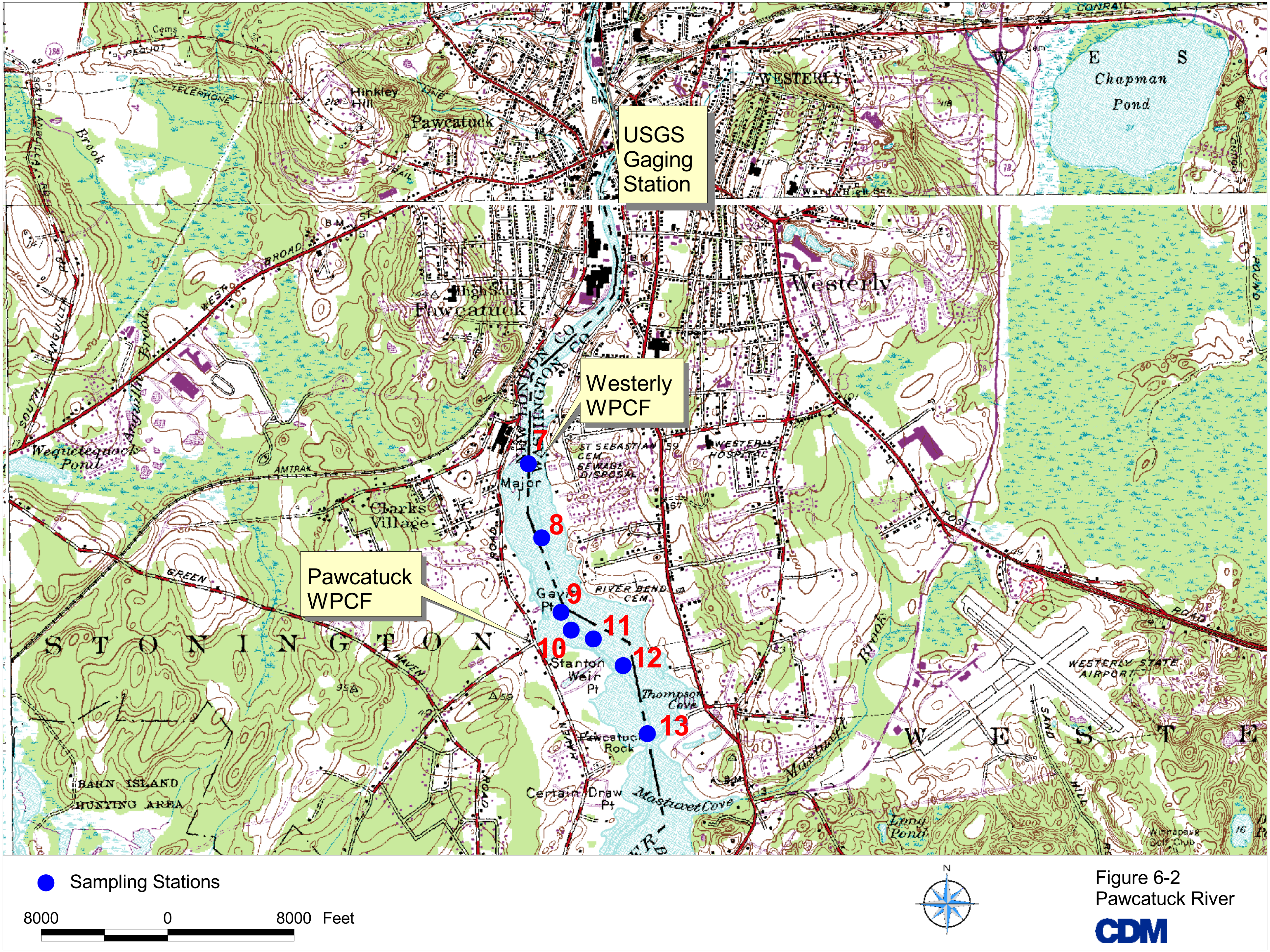

Figure 6-2
Pawcatuck River

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Section 6
Water Quality Analyses

6.1 Introduction

The section examines the water quality implications of various wastewater treatment options considered by the Town of Stonington. Currently, Stonington operates three WPCFs – Mystic, Stonington Borough, and Pawcatuck – discharging to the Mystic River, Stonington Harbor, and Pawcatuck River, respectively.

6.1.1 Mystic River

The Connecticut Department of Environmental Protection (CTDEP) performed water quality analyses of the Mystic River from 1988-1990 in response to a request from Stonington to increase the Mystic WPCF's permitted flow from 0.88 mgd to 1.3 mgd. The results of these analyses are summarized in a report entitled "*Water Quality Analysis of Mystic Harbor - A Water Quality Model and Waste Load Allocation*" (June 1990). The report states that:

"The Department's data shows that Mystic Harbor exhibits excellent water quality, exceeding Class SB Standards and Criteria. The estuary has high recreational value and is an important resource for wildlife, aquatic vegetation, finfish, and shellfish. Connecticut's anti-degradation policy, contained in the Water Quality Standards, specifies that surface waters with a classification goal of B or SB, with existing quality better than established standards for that Class, will be maintained at their existing high quality. For such waters, the Commissioner of Environmental Protection may require of the discharge permit applicants, a minimum level of treatment which exceeds the applicable standards of performance for new sources, or other special treatment requirements deemed necessary to prevent pollution and which will maintain existing uses made of, or presently possible in such waters. The anti-degradation policy clearly applies to the Mystic Harbor due to its classification and high water quality.

The Harbor has experienced nuisance algae blooms, most recently in May of 1989, when a signicant portion of the inner harbor was comverted with matted algae. The algae posed an aesthetic problem, caused noxious odors, and interfered with recreational boating activity.

Expansion of the Stonington-Mystic STP without additional treatment would result in a marked increase in nutrient loading to Mystic Harbor. Therefore, the Department concluded that nitrogen removal should be required at the Mystic STP to protect the water quality of Mystic Harbor. During the prime growth season for algae, nutrient loadings have been limited to levels currently input to the estuary by the STP."

As noted above, the report indicated that, although the Mystic Harbor generally exhibits excellent water quality, nutrient loadings intermittently cause algae blooms. Since Water Quality Standards require that Mystic Harbor's water quality not be allowed to degrade, increases in flow to the Mystic WPCF outfall would be accompanied by tighter restrictions on effluent quality such that nutrient loading would not increase above existing levels. In addition, the report indicated that nutrient removal would likely be required in the future as a result of the Long Island Sound Study.

As a result of the findings of this report, a portion of the flow from the Mystic WPCF was diverted to the Borough WPCF for treatment in lieu of expansion of the Mystic WPCF. Additionally, future discharges from Mystic WPCF would also be limited to levels existing at the time of the study.

6.1.2 Stonington Harbor and Pawcatuck River

Because of the Mystic Harbor study by CTDEP, the scope of this section of the Wastewater Facilities Plan includes analyses only of Stonington Harbor and the Pawcatuck River. The wastewater treatment alternatives are described in detail in Section 7. **Table 6-1** describes the possible water quality scenarios that would result from these treatment alternatives.

Table 6-1

Description of Treatment Conditions

Water Quality	*Description of Water Quality Scenario*
Existing	Representative of current flows and loads to each of the three WPCF outfalls.
WQ Scenario 1	Representative of projected flows and loads at each of the three WPCF outfalls.
WQ Scenario 1a	Represents projected flows with a 0.28 mgd diversion from the Mystic WPCF to the Borough WPCF with the Pawcatuck WPCF operating normally.
WQ Scenario 2/4	Represents projected flows with all flow from the Mystic WPCF transferred to the Borough outfall for discharge. Mystic outfall would be abandoned with the Pawcatuck WPCF discharging normally.
WQ Scenario 3	Represents projected flows with all flow from the Mystic and Borough WPCFs transferred to the Pawcatuck WPCF for treatment. Mystic and Borough facilities would be abandoned.
WQ Scenario 5	Represents projected flows with all flow from the entire Town transferred to the Borough WPCF outfall for discharge after treatment. Mystic and Pawcatuck facilities would be abandoned.

The NPDES permits for the Stonington Borough and Pawcatuck WPCFs were renewed in 2005. The NPDES permit for the Mystic WPCF is up for renewal. WPCA has filed a renewal application and expects the permit to be removed in 2006. The permits included limits for BOD, TSS, coliform bacteria, chlorine, and whole effluent toxicity testing. They also included monitoring requirements for metals and phosphorus compounds. Future permits could include limits for these compounds if they are shown to be a potential water quality concern. The three facilities are also required to comply with the *General Permit for Nitrogen Discharges*. Thus, this water quality investigation focuses on determining if future discharges can meet water quality standards for (1) conventionals (i.e., dissolved oxygen) and (2) toxics.

The remainder of this section is organized as follows:

- Section 6.2 describes the two study areas and the existing discharge structures.
- Section 6.3 presents and discusses existing water quality data available for these assessments.
- Section 6.4 describes the dissolved oxygen analysis.
- Section 6.5 presents the results of the toxics analysis, including the results of the initial dilution modeling.

6.2 Description of Study Areas and Outfalls

Stonington Harbor is the receiving water for the Stonington Borough WPCF. The study area for Stonington Harbor is illustrated in **Figure 6-1**. This harbor is a well-mixed estuary, receiving saltwater from the Long Island Sound tide and freshwater from its watershed. Design drawings for the outfall indicate it should be a 185-foot long, 24-inch diameter diffuser pipe, with ten T-shaped, 10-inch risers of two 4-inch ports each. The ports are "not less than one foot" above the top of the main line, according to the plans provided. This description differs somewhat from that found during an outfall inspection by Shoreline Diving of Noank, Connecticut performed on April 30, 2001. While the divers verified the dimensions of the riser pipes and port outlets, they reported that the outfall pipe had only eight riser pipes spaced 25 feet apart. Further, they reported that only the last two risers are currently active; the remaining six having been capped. The active risers are those at the end of the diffuser pipe. The 2001 inspection also indicated that the next to last riser had broken off and was discharging from a 10-inch diameter orifice. This was fixed in May 2005, when the broken riser was capped and another opened.

The diffuser is located approximately 415 feet from the shore at its closest point, and 600 feet at the farthest point. The Borough WPCF discharges its effluent into the harbor near location 5 (see Figure 6-1). While the coastal chart for Stonington Harbor indicates the water depth should be about 12 feet deep, the diver inspectors provided a water depth of 8 feet deep at mean low water (MLW); the 8-foot depth was used for initial dilution modeling (see Section 6.5).

The Pawcatuck River, the receiving water for the Pawcatuck WPCF, is illustrated in **Figure 6-2**. This river is typically a stratified estuary, receiving saltwater from the

See Figure 6-1

See Figure 6-2

Rhode Island and spans all the way to the mouth of the river. The Pawcatuck WPCF discharges its effluent into the estuarine portion of the Pawcatuck River. The Pawcatuck outfall is a single 24-inch diameter pipe, and according to the dive inspection the terminus appears to be encased in a concrete box. The outfall discharges horizontally into a dredged section next to the navigation channel approximately at location 10 (see Figure 6-2). As noted in this figure, an additional WPCF - the Westerly WPCF - discharges to the river about 1 kilometer upstream of the Pawcatuck WPCF.

6.3 Data Used in This Study

CDM used several sources of data to conduct the analyses in this study:

- Water quality data collected in the harbor and river by the Town on September 7, September 22, and October 6, 2000.
- Water quality data from April to October 1993 published in *An Assessment of the Current Status of Water Quality and Pollution Sources in the Pawcatuck River Estuary and Little Narragansett Bay* (Desbonnet, 1990).
- Water quality data from *Dissolved Oxygen Concentrations in the Northern Pawcatuck River Estuary: A Seasonal Characterization* (Desbonnet and Banister, 1994).
- Water quality data for the Pawcatuck River collected each September from 1993 to 2000 by the students of Pine Point School (Banister, unpublished data).
- Water quality and flow data collected by the United States Geological Survey at their gauging station (01118500) located in Westerly, Rhode Island on the Pawcatuck River, as indicated in Figure 6-2.
- Effluent data from each of the treatment plants from their Data Monitoring Reports (DMRs) from March 2000 to February 2001.
- Effluent data for the Westerly, RI WPCF was gathered from the Internet at EPA's Surf Your Watershed Website (www.epa.gov/surf) using the Permit Compliance System (PCS). These were data collected from January 2000 to December 2000.

As a part of this study, receiving water quality data (temperature, depth, dissolved oxygen, and conductivity) were collected by the Town on three dates in Stonington Harbor and the Pawcatuck River. The data are shown in **Tables 6-2 and 6-3**, along with some calculated parameters (salinity, dissolved oxygen saturation and percent dissolved oxygen saturation). These data were used to describe the estuaries to create input to the various model and analytical scenarios that were used. The sampling locations for each of the study areas are illustrated in Figures 6-1 and 6-2.

The temperature and salinity data for Stonington Harbor show that the harbor is relatively uniform both horizontally and vertically. This well-mixed characteristic is

See Table 6-2

See Table 6-3 (page 1)

See Table 6-3 (page 2)

due to the wide mouth between the harbor and Long Island Sound and the harbor's relatively small watershed. Dissolved oxygen (DO) levels in the harbor were good with almost all readings above 80 percent saturation. The exception was Station 3 on September 22, 2000, which showed declining oxygen with depth (bottom value 72 percent saturation). Since the data were collected on an outgoing tide, the profile represents water quality from the embayment north of the railroad tracks and is likely not attributable to the discharge of effluent in the harbor.

The water quality data collected by the Town in the Pawcatuck River estuary indicate very different conditions from Stonington Harbor (all data collected north of Pawcatuck Rock). The estuary is complex both in terms of hydrodynamics and dissolved oxygen dynamics. All samples were taken in the dredged channel; because most of the width of the estuary is quite shallow, the low oxygen concentrations are only found in a small area of the estuary.

While temperature profiles indicate weak thermal structure (likely because of the shallow water depth), salinity profiles show strong salt stratification. In the two September data sets, the stratification was accompanied by depleted oxygen in the lower saline layer. Further, the oxygen levels in this lower layer declined with depth, suggesting that the sediments could be a significant source of oxygen demand. Several of the September 7, 2000 profiles had hypoxic oxygen levels (DO < 3 mg/L) near the bottom, levels that would cause stress to aquatic life. The data also indicate a horizontal variation in water quality, with the lowest oxygen conditions found at the head of the estuary.

Because of the low oxygen concentrations found in the Town's data, CDM researched additional sources of water quality data for the river. These data sets (Desbonnet, 1990; Desbonnet and Banister, 1994; Banister, unpublished data) confirmed the data collected by the Town. These data present a consistent picture of water quality in the estuary.

Stratification is seasonal and related to freshwater flows in the Pawcatuck River. In the spring, high river flows result in the whole depth of the upper end of the estuary being freshwater; dissolved oxygen values are near saturation. The drop in dissolved oxygen in the bottom waters occurs shortly after the arrival of the lower salt water layer at the top of the estuary. Oxygen in this lower layer drops throughout the summer, and in 1993 reached hypoxic levels in late July. These very low levels only occur in about the upper third of the northern estuary. In the vicinity of the Pawcatuck WPCF outfall (about two-thirds of the way down the northern estuary – Figure 6-2), oxygen in the bottom waters is also depressed (typically 4 to 5 mg/L) but not as significantly as in the head of the estuary.

Desbonnet and Banister (1994) conclude that their data suggest that the occurrence of low dissolved oxygen concentrations in the northern Pawcatuck River estuary are the result of physical constraints – the lack of tidal exchange and stratification of the water column. Hypoxic oxygen levels were found over half of the stratified season in

1993. At the other end of the estuary (in the vicinity of Pawcatuck Rock), the exchange of new water during tidal changes is sufficient to allow oxygen to be at levels that are non-stressful to aquatic life on a continual basis.

Conditions near the outfall discharge are intermediate of these extremes; there is some tidal exchange that allows for a replenishment of oxygen in the bottom waters. Initial dilution modeling (Section 6.5) indicates that the discharge from the Pawcatuck outfall will remain trapped in these waters. The dissolved oxygen analysis (Section 6.4) indicates that even if this did occur, the oxygen demand from the Pawcatuck effluent is a minor contributor to the oxygen demand in the estuary.

6.4 Dissolved Oxygen Analysis

6.4.1 Approach

The approach taken to assess future dissolved oxygen conditions in Stonington Harbor and the Pawcatuck River was to:

- review existing data in the harbor and the river (see Section 6.3),
- develop current and future flows and loads, and
- apply an analytical technique to estimate DO deficit for current and future scenarios.

The goal of the analytical technique is not to predict actual DO deficits (as this would require model calibration for which data do not exist), but to select a method that would allow for a valid comparison among the scenarios.

6.4.2 Flows and Loads

Flow and loads were developed for the Stonington Borough and Pawcatuck WPCFs, the freshwater inflow to the river, and the Westerly, Rhode Island WPCF.

Tables 6-4 and 6-5 summarize the loads for the Borough and Pawcatuck WPCFs, respectively, for each of the water quality scenarios described in Table 6-1. The flows are as presented in Section 3. The equivalent biochemical oxygen demand (BOD) load is a sum of the BOD loads presented in Section 3 plus the additional BOD load caused by ammonia nitrogen. The additional ammonia nitrogen BOD load is calculated by multiplying the ammonia nitrogen concentration by a factor of 4.57. This additional ammonia nitrogen load comprises a much larger portion of the equivalent BOD load than the BOD load itself.

Table 6-4
Flows and Loads for Stonington Borough WPCF Outfall

WQ Scenario	WPCF Flow (mgd)	BOD (mg/L)	Ammonia (mg/L)	Equivalent BOD Load (lb/day)
Existing	0.496	10	15	325
WQ Scenario 1	0.299	10	1	36
WQ Scenario 1a	0.579	10	1	70
WQ Scenario 2/4	1.025	10	1	125
WQ Scenario 3	--	--	--	--
WQ Scenario 5	1.964	10	1	239

Table 6-4 shows that future equivalent BOD loads will be less than the existing conditions because the ammonia nitrogen concentrations for the future scenarios (WQ Scenarios 1-5) are to be reduced significantly. This occurs because in every scenario the discharge is assumed to meet the nitrogen removal requirements of the Long Island Sound Study and the *General Permit for Nitrogen Discharges*. Effluent meeting these requirements will have significantly reduced the ammonia nitrogen concentrations, leading to a significant reduction in the combined BOD loading.

Table 6-5
Flows and Loads for Pawcatuck WPCF Outfall

WQ Scenario	WPCF Flow (mgd)		BOD (mg/L)		Ammonia (mg/L)		Equivalent BOD Load (lb/day)	
	Paw	West	Paw	West	Paw	West	Paw	West
Existing	0.493	2.34	13	17	13	14	297	1580
WQ Scenario 1	0.939	2.34	10	17	1	14	114	1580
WQ Scenario 1a	0.939	2.34	10	17	1	14	114	1580
WQ Scenario 2/4	0.939	2.34	10	17	1	14	114	1580
WQ Scenario 3	1.964	2.34	10	17	1	14	239	1580
WQ Scenario 5	0	2.34	10	17	1	14	0	1580

Paw = Pawcatuck WPCF; West = Westerly RI WPCF

As in Table 6-4, Table 6-5 shows that even though the future flow from the Pawcatuck WPCF is planned to increase under the future scenarios, the equivalent BOD loading is actually going to decrease.

For both the existing and future conditions, CDM assumed that the freshwater inflow from the Pawcatuck River had a background equivalent BOD loading rate of 1.17 mg/L (1 mg/L of BOD and .037 mg/L of ammonia nitrogen). These data were based on the annual average (1998-99) of the water quality data collected by the USGS at the Westerly gauging station. In addition, the future freshwater input into each of the estuaries was assumed to be 7Q10, again providing a "worst case scenario."

For this evaluation we also developed flows and loads for the Westerly RI WPCF using data gathered from EPA's Permit Compliance System at the time out evaluation was conducted. For the future scenarios (Scenarios 1-5) we assumed that the Westerly plant would continue to operate under present conditions. This is a conservative estimate because the Westerly plant has implemented denitrification since this work was completed, reducing the ammonia nitrogen concentrations and significantly reducing the additional ammonia nitrogen-associated BOD load.

6.4.3 Analytical Technique

The Streeter Phelps equation describes the dissolved oxygen deficit caused by the BOD loadings to receiving waters. We chose to use this analytical technique because it could provide reasonable relative DO deficits to compare the results of the scenarios. The Streeter Phelps equation was applied for the full water depth at both Stonington

Harbor and the Pawcatuck River even though we know that the Pawcatuck River is a two-layer system during critical summer DO months. We believe this approach is valid because the goal of the study was to make a relative comparison among the scenarios (and other sources of BOD).

CDM used the following Streeter Phelps relationship, as described in S*urface Water-Quality Modeling* (Chapra, 1997) to estimate the dissolved oxygen deficit in the Pawcatuck River and Stonington Harbor:

DO deficit $D = f(k_d, k_a, k_r, W, Q, j_r, j_a, \alpha_r, \alpha_a)$ Equations 21.26 – 21.34

where:

$j_r = f(U, E, \alpha_r)$
$j_a = f(U, E, \alpha_a)$
$\alpha_r = f(U, E, k_r)$
$\alpha_a = f(U, E, k_a)$

The following are definitions of the parameters used:

W = loading rate
Q = flow rate of source
U = mean estuarine velocity
E = dispersion rate
k_d = deoxygenation rate
k_r = BOD removal rate
k_a = aeration rate

Using the receiving water quality data gathered, the following equations were used to estimate the dispersion rates for the Pawcatuck River and Stonington Harbor:

$E = f(\Delta S, U, x)$ Equation 15.13
$k_d = f(H, T)$ Equation 19.28
$k_r = f(k_d, v_s, H)$ Equation 19.27
$k_a = f(U, U_w, H, T)$ Equation 20.52

where:

S = salinity
x = distance
H = depth
T = temperature
v_s = settling velocity of effluent
U_w = wind velocity

Conservative estimates were used for the deoxygenation rate (k_d), BOD removal rate (k_r), reaeration rate (k_a), and settling velocity (v_s) to provide a realistic "worst case scenario" for each of the estuaries. The dispersion rate was estimated using the salinity data collected in each of the receiving waters. The values are shown in **Table 6-6**. These estimates were representative of dispersion rates observed in other similar estuaries.

Table 6-6
Parameters used in Streeter Phelps Equations

Parameter	Stonington Harbor	Pawcatuck River
Deoxygenation Coefficient, k_d	0.38/day	0.38/day
BOD Removal Rate, k_r	0.41/day	0.42/day
Reaeration Coefficient, k_a	0.005/day	0.10/day
Settling Velocity, v_s	0.1 m/day	0.1 m/day
Dispersion Coefficient	448,000 cm^2/s	16,600 cm^2/s

For existing condition, the freshwater input into each of the estuaries was based on the flow observed at the USGS gauging station in Westerly, Connecticut. To estimate the flow observed in the Pawcatuck River at the point of discharge of the Pawcatuck WPCF, the flow observed at the USGS gauging station was increased proportionally to the additional watershed upstream of the Pawcatuck WPCF not incorporated at the gauging station. The gauging station accounted for approximately 295 square miles (mi^2). The additional contributing watershed upstream of the Pawcatuck WPCF was approximately 4 mi^2. The flow observed at the USGS gauging station was multiplied by a factor of 299/295.

The freshwater inflow into Stonington Harbor is not gauged. This inflow was estimated by transposing the flow from the Pawcatuck River onto the Stonington Harbor watershed. The Stonington Harbor watershed is approximately 5.5 mi^2. The Pawcatuck River flow was multiplied by a ratio of 5.5/295 to estimate the freshwater inflow into Stonington Harbor, observed at the Borough WPCF.

For future conditions, the freshwater flow into each of the estuaries was based on the 7Q10 flow observed at the USGS gauging station, which was calculated to be 65.3 cubic feet per second (cfs). This flow was then transposed by the same ratios described above to estimate the 7Q10 flow observed at each of the WPCFs. Using the

7Q10 flow will provide a conservative estimate of the response of the estuary to the future changes in WPCF operations.

The reaeration rate is highly dependent upon the observed wind speed. For present conditions, CDM assumed an average wind speed of 1 meter per second (approximately 2 miles per hour). For the future condition, CDM assumed a much more conservative estimate of 0 meter per second. This reduced the reaeration rate from approximately 0.35/day to 0.10/day.

6.4.4 Application and Results of the Dissolved Oxygen Analysis

Because there are insufficient data for calibration of the Streeter Phelps equation to the conditions in Stonington Harbor and the Pawcatuck River, the application of this technique relied on use of typical parameters for the model coefficients. We did attempt to match the model to the existing data (the "Existing" scenario in **Table 6-7**). This effort was reasonably successful in Stonington Harbor; it was not successful in the Pawcatuck River estuary most likely due to (1) use of a single layer model in a two-layer system and (2) absence of other potential significant sources of oxygen demand, such as sediment oxygen demand.

The dissolved oxygen deficits predicted by the Streeter-Phelps analysis are shown in Table 6-7. Again, the results are not meant to be actual predictions of DO deficit, but rather to permit a relative comparison among the scenarios.

Table 6-7

Predicted Relative DO Deficits (mg/L)

	Borough WPCF	Pawcatuck WPCF			
	Stonington Harbor	*Pawcatuck WPCF*	*Westerly WPCF*	*Background From River*	*Total for Pawcatuck River*
Existing	1.3	0.08	0.41	0.34	0.8
WQ Scenario 1	0.3	0.09	1.27	0.33	1.7
WQ Scenario 1a	0.5	0.09	1.27	0.33	1.7
WQ Scenario 2/4	0.6	0.09	1.27	0.33	1.7
WQ Scenario 3	--	0.19	1.27	0.33	1.8
WQ Scenario 5	0.9	--	1.27	0.33	1.6

For Stonington Harbor, the model shows that DO deficits will be lower in the future than under existing conditions. Since the harbor currently has high DO, water quality conditions under any of the discharge scenarios should meet DO water quality criteria.

Predicted DO deficits for the Pawcatuck River indicate that the discharge from the Pawcatuck River is only a small (less than 10 percent) portion of the predicted maximum DO deficit. The largest source of oxygen demand is the Westerly WPCF discharge, though as noted above we did not assume an upgrade in treatment to control nitrogen at this plant.

6.4.5 Dissolved Oxygen Summary

These analyses indicate the following:

- Stonington Harbor has greater ability to assimilate treated wastewater discharges than the Pawcatuck River estuary.
- It appears that the harbor can handle combined flow from all WPCFs and meet state dissolved oxygen criteria.
- The Pawcatuck River estuary has existing water quality problems largely due to its physical setting. The role that wastewater effluent plays in the existing dissolved oxygen problems is unclear compared to other sources of DO demand (e.g., sediment oxygen demand).
- The effluent from the Pawcatuck WPCF is only a small contributor to the DO deficit seen in the estuary.
- Because of the existing dissolved oxygen levels in the estuary, it is possible that a future total maximum daily load (TMDL) study could require even more stringent treatment levels than are currently envisioned for the discharge from the Pawcatuck outfall.

6.5 Toxics Analysis

6.5.1 Introduction

While limits on toxic parameter discharges are not currently included in the NPDES permits for Stonington’s treatment plants, there are likely to be considered for conclusion in the next round of permitting. Thus, it is prudent to evaluate toxics as part of these water quality impact analyses. The approach to a toxics analysis is to:

1. establish the appropriate water quality criteria,
2. review current effluent data to determine potential parameters of concern,
3. assess whether these effluent data have higher concentrations than the water quality criteria, and if they do determine the dilution needed to meet the criteria, and

4. determine the dilution available in the receiving waters.

In the case of Stonington's treatment plants, the toxics analysis focuses on metals and ammonia because these are the most common toxics of concern at small municipal treatment plants. They are also the parameters for which data are available.

6.5.2 Establishing the Appropriate Water Quality Criteria

The State of Connecticut has established numerical water quality criteria for most of the constituents tested at each of these plants. These acute and chronic criteria are reported in the State's Water Quality Standards. These limits are described as follows:

- **Acute limit:** Biological integrity is impaired by an exposure of one hour or longer to a concentration that exceeds the acute criteria more frequently than once every three years.

- **Chronic limit:** Biological integrity is impaired when the four-day average concentration exceeds the chronic criteria more frequently than once every three years.

The acute and chronic criteria are specific to fresh and salt water. The appropriate set of numerical criteria for each WPCF depends on whether the plant's receiving water is fresh or salt water. For this analysis the salt water criteria were used for Stonington Harbor and the Pawcatuck River, for the following reasons:

- The State of Connecticut has defined the receiving water for all three of the WPCFs to be saltwater (SA/SB or SC).

- Salinity data collected from Stonington Harbor during September and October 2000 indicate that the Borough plant's receiving water ranged from 24.7 to 29.3 parts per trillion (ppt), clearly estuarine.

- Salinity data collected from the Pawcatuck River during the same sampling period indicate that the receiving waters near the Pawcatuck plant discharge vary from 7.6 to 27.0 ppt, again clearly estuarine.

In addition to the salt and freshwater guidelines, the numerical criteria set for ammonia-nitrogen are dependent upon temperature. **Table 6-8** presents the temperature-dependent ammonia-nitrogen numerical criteria.

Table 6-8
Temperature Dependent Numerical Criteria for Ammonia Nitrogen

	0^0C	*5^0C*	*10^0C*	*15^0C*	*20^0C*	*25^0C*	*30^0C*
Acute Criteria (mg/L)	29.0	20.0	14.0	9.8	6.7	4.8	3.3
Chronic Criteria (mg/L)	4.4	3.0	2.1	1.5	1.0	0.72	0.31

Based on seasonal variations in temperature data collected from the New London NOAA tide buoy (#8461490), CDM designated the appropriate numerical criteria for ammonia nitrogen for each of the metal data sets. Long-term temperature data were not available for each of the WPCF's receiving water; therefore comparisons were made between intermittent receiving water data and the data from the New London tide buoy, located approximately 10 miles southwest of Stonington. The temperature data from the tide buoy, along with the average temperatures recorded in the Pawcatuck River and Stonington Harbor, during the sampling rounds conducted in September and October 2000 are illustrated in the Figure 6-1. The comparison indicates that the New London temperatures are representative of both the Pawcatuck River and Stonington Harbor data and are approximately 1°C greater than those recorded at either location. The appropriate temperature dependent numerical criteria for ammonia nitrogen for each month of the year are listed in **Table 6-9**.

Table 6-9

Monthly Ammonia Nitrogen Numerical Criteria

Month	Acute Criteria (mg/L)	Chronic Criteria (mg/L)
January	29.0	4.4
February	29.0	4.4
March	29.0	4.4
April	20.0	3.0
May	14.0	2.1
June	9.8	1.5
July	6.7	1.0
August	6.7	1.0
September	6.7	1.0
October	9.8	1.5
November	14.0	2.1
December	20.0	3.0

6.5.3 Effluent Data and Comparison to Water Quality Criteria

Stonington's WPCFs monitor for metal concentration in treated effluent on a quarterly basis and results are reported in the monthly data monitoring reports (DMRs), listed under monitoring location "T". Monitoring location "T" is located in the effluent stream, prior to chlorination upstream of discharge. In addition to the quarterly metals testing, the Borough WPCF was required to test monthly for the first quarter of 2000, as reflected in the data. The Pawcatuck WPCF did not have metals data at location "T" for the month of December 2000. The data are shown in Tables **6-10 through 6-12**.

Connecticut's numerical criteria were compared to the metal effluent data collected at the three WPCFs. The results are also given in the Tables 6-10 through 6-12.

Copper and ammonia levels exceeded both the acute and chronic criteria for some of the sampling dates at each WPCF. There was also one exceedence of the chronic criteria for zinc for the Borough and Mystic WPCF's effluent. Copper, zinc, and ammonia are therefore the parameters of potential concern in the existing discharges.

The upgraded treatment plant(s) will nitrify the effluent, and ammonia concentrations will be significantly reduced to an estimated 1 mg/L. This is also the lowest water quality criterion for ammonia (Table 6-9) so it is reasonable to drop ammonia from further consideration.

It should also be noted that the detection limits for many of the analyses were above the chronic criteria limits, which does not allow for the data to be assessed against these criteria. This occurred for total cadmium, total copper, total cyanide, total lead, total mercury, and total nickel.

6.5.4 Determining Required Initial Dilution Ratios

The CTDEP allows initial dilution, rapid mixing that occurs at end of the effluent pipe, to be included in the assessment of whether water quality criteria for toxics are met. To determine the minimum initial dilution needed to meet the State's water quality criteria, we divided the effluent concentration by the chronic numerical criteria (the strictest criteria) for each of the metals. The highest of these ratios would correlate to the minimum initial dilution ratio required to meet these numerical criteria. The minimum dilutions required are shown below.

Total Copper

- Pawcatuck WPCF would require a 12.5:1 initial dilution ratio (0.03/0.0024 = 12.5)
- Borough WPCF would require a 25:1 initial dilution ratio (0.05/0.0024 = 25.0)
- Mystic WPCF would require a 21:1 initial dilution ratio (0.05/0.0024 = 20.8)

Total Zinc

- Mystic WPCF would require a 2:1 initial dilution ratio (0.09/0.0081 = 1.1)
- Borough WPCF would require a 2:1 initial dilution ration (0.09/0.0081 = 1.1).

See Table 6-10

See Table 6-11

See Table 6-12

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No dilution rate for the Pawcatuck WPCF is specified because zinc levels at this plant were not above the established water quality criterion for zinc (see Table 6-11).

Of these calculations, the initial dilution ratios required to meet the total copper chronic criteria correspond to the largest ratios needed for compliance. Based on these calculations, the following initial dilution ratios are needed at each WPCF:

- Pawcatuck WPCF -- 12.5:1
- Borough WPCF -- 25:1
- Mystic WPCF -- 21:1

Future scenarios assuming discharge of a mixed effluent through the Pawcatuck outfall would be required to meet more than 12.5:1 dilution.

6.5.5 Initial Dilution Analysis

Introduction

CDM used the EPA program CORMIX to determine initial dilution for many river/ocean conditions. The Cornell Mixing Zone Expert System (CORMIX) is an EPA-supported, software system for the analysis, prediction, and design of aqueous toxic or conventional pollutant discharges into diverse water bodies. Use of the program helps to determine what dilution can be expected from given outfall configurations, discharge concentrations, and receiving water characteristics.

Of interest for this study are the "near-field" dilutions. The near field is the region of the receiving water where the initial jet characteristics of momentum flux, buoyancy flux and outfall geometry influence the jet trajectory and mixing of the effluent discharge (*User's Manual for CORMIX*, September 1996). The near field gives way to the far field, which is the region of the receiving water where buoyant spreading motions and passive diffusion control the trajectory and dilution of the effluent discharge plume. The dilutions calculated and reported for this study are at the end of the near-field region.

For the Borough plant discharge, we also used the EPA-approved model UM described in *Initial Mixing Characteristics of Municipal Ocean Discharges* (EPA, 1985).

Data

The data described in previous sections were used to define input parameters for the receiving waters: effluent flow rate (Table 6-4 and 6-5) and stratification (Tables 6-1 and 6-2). Because no data on ambient current speed were available, this parameter was examined through a sensitivity analysis. Characteristics of the outfalls were provided by the Town: the Stonington Borough Plant and Pawcatuck River Plant drawings from February 1971, and supplemented by the dive inspection conducted in mid-2001.

Stonington Borough Outfall

The Borough WPCF discharges directly into Stonington Harbor. The riser configuration reported by the dive inspection team (see Section 6.2) was used for initial dilution modeling, though we assumed that the broken riser would be fixed.

The diffuser is located approximately 415 feet from the shore at its closest point, and 600 feet at the farthest point. The total width of the harbor was taken as 1,500 feet. Manning's coefficient of the harbor bottom is 0.025. Wind speed was taken to be 0 feet per second (ft/s).

No data were available regarding the local tidal velocities, so a range of velocities was modeled. Ambient tidal velocities of 0.0033 to 0.033 ft/s, one hour after the slack tide, with maximum tidal velocities of 0.33 to 3.3 ft/s, resulted in approximately 2 percent difference in the dilution calculated at the near-field boundary. Greater ambient tidal velocities, 1.1 ft/s one hour after the slack tide, resulted in an expanding of the near-field region, and a subsequent increase in the dilution at the outside boundary of the near-field region. An instantaneous velocity of 0.033 ft/s and a maximum velocity of 3.3 ft/s were used in the reported results.

Stratification was not observed in the harbor near the discharge. The water column was modeled as 8 feet deep at MLW with a constant density of 63.9 pounds per cubic foot (lb/ft^3).

Pawcatuck Outfall

The Pawcatuck WPCF outfall is a single 24-inch diameter pipe, which discharges into a dredged section next to the navigation channel. For modeling purposes, local shallow areas west of the outfall were ignored, and dilution in the channel only was considered. The width of the channel is approximately 180 feet. The depth of the channel is 10.5 feet.

Manning's coefficient of the channel was taken as 0.025 recommended for earth channels with some stones and weeds (page 31, *User's Manual for CORMIX*, September 1996). Wind speed was taken as 0 ft/s.

The Pawcatuck River is tidal, and stratified, so that a fresh water lens was seen lying over heavier salt water in the field data. As the effluent is released into the bottom of the channel, the ambient flow is heavily dependent upon the tidal velocity rather than on the freshwater flow in the river. Tidal velocities at one hour after slack tide from 0.03 ft/s to 0.15 ft/s, and maximum tidal velocities of 1.6 ft/s to 16 ft/s were considered. The variation in velocities resulted in a 6 percent variation in dilution. An instantaneous velocity of 0.03 ft/s and a maximum velocity of 1.6 ft/s were used in the reported results.

Densities of 62.4 pounds per cubic foot (lb/ft^3) for the surface fresh water and 64.0 lb/ft^3 for the bottom salty water were used. The interface between the fresh and salt water layers was modeled at 6 feet above the bottom of the channel, 4.5 feet from the water surface. This approximates the stratification seen during the fall of 2000 sampling rounds.

Results

Stonington Borough Outfall

The dilutions expected in the harbor under the various scenarios described above are shown in Table 6-13 for both CORMIX and UM.

We initially modeled the discharge with CORMIX2, which simulates dilution from multiport diffusers. CORMIX2, however, makes simplifying assumptions about the diffuser ports that while reasonable for a well-designed diffuser in deep water are not reasonable for Stonington's existing diffuser. Specifically, in CORMIX2 the diffuser ports are treated as an equivalent slot and the discharge is directed vertically upward. Stonington's existing diffuser has such widely spaced ports that the individual effluent plumes do not merge prior to the end of the near-field region. Thus, CORMIX2 does not adequately simulate the initial dilution from the diffuser.

To more accurately model the dilution from the diffuser, we used CORMIX1, which simulates discharge from an individual port. This port was assumed to discharge one-fourth of the total flow and the discharge from the port was downstream (which describes Stonington's actual diffuser).

To add a measure of confidence for the use of CORMIX1 to determine initial dilution, we also simulated a single port and multiport diffuser in UM. UM does not simplify either direction or port shape for either the single or multiport diffusers. **Table 6-13** shows the same dilution for each scenario using both the single and multiport diffuser cases. In addition, the UM results compare well with the dilution predicted from the single port CORMIX results.

Table 6-13
Borough Outfall: Initial Dilution Results

			CORMIX	*UM Model*	
	Number of Ports	*Plant Flow, mgd*	*Single port Near-Field Dilution*	*Multiport Near-Field Dilution*	*Single port Near-Field Dilution*
Existing	4	0.496	10.0	9.8	9.9
WQ Scenario 1	4	0.299	11.6	12.7	12.7
WQ Scenario 1a	4	0.579	9.7	9.4	9.4
WQ Scenario 2/4	4	1.025	9.4	8.6	8.6
WQ Scenario 3	4	0	-	-	-
WQ Scenario 5	4	1.964	3.7	8.9	8.9
WQ Scenario 5a	6	1.964	9.7	8.6	8.6

The lower dilution (3.7:1) resulting from the CORMIX1 simulation of WQ Scenario 5 was unexpected. The lower dilution occurs because the higher velocity jet attaches to the seabed limiting the available water to be entrained into the plume. This phenomenon is called a Coanda bottom attachment. In general, plumes incorporate or "entrain" ambient seawater, resulting in increasing dilution farther from the discharge. The Coanda attachment occurs when the entrainment is strong due to high velocity and turbulence in the plume and when the discharge port is near the seabed. The attachment results in much lower dilution than would have otherwise been expected, because the bottom of the plume is located on the seabed preventing entrainment of seawater.

Because of this low dilution result, we simulated the same discharge as Scenario 5 through 6 ports on the Stonington diffuser (Scenario 5a); currently the diffuser has 4 active ports and the remaining are capped. With the additional two diffusers the additional flow rate is sufficiently reduced to preclude the Coanda attachment. The dilution with 6 diffusers is predicted to be more than twice that of Scenario 5. Thus, if Scenario 5 is selected, we would also recommend that Stonington open additional ports on its existing diffuser.

Pawcatuck Outfall

The Pawcatuck WPCF has a 24-inch diameter outfall. The effluent flow seen in existing conditions, and even the flow expected under future scenarios, results in very small discharge velocities. Consequently, the ambient salt water may intrude up the pipe.

The effluent velocities modeled are low enough that the stratification seen in the river is important, and the effluent is trapped in the lower, salt-water layer, under the freshwater lens at the surface. In effect, this reduces the depth of water available for dilution.

Table 6-14 lists the water quality scenarios and results for the Pawcatuck River outfall. Near-field dilution achieved at the Pawcatuck outfall is very low. Dilution could be improved by increasing the velocities at the outfall pipe, either by reducing the diameter of the pipe (*i.e.*, adding a duck bill type valve to the outfall), or by pumping or otherwise increasing the discharge head. Increasing the exit velocity extends the near-field distance, and also therefore the volume available for dilution.

Table 6-14

Pawcatuck Outfall: Initial Dilution Results

	Plant Flow, mgd	*Near-field Dilution*	*Near-field Distance, feet*
Existing	0.493	2.7:1	5.3
WQ Scenario 1	0.939	2.1:1	5.3
WQ Scenario 1a	0.939	2.1:1	5.3
WQ Scenario 2/4	0.939	2.1:1	5.3
WQ Scenario 3	1.964	1.8:1	5.2
WQ Scenario 5	--	--	--

6.5.6 Toxics Summary

The toxic parameter of concern appears to be copper. To meet water quality criteria with the current level of copper in the effluent, the dilution in the receiving water would need to be between 12.5:1 and 25:1 depending on which water quality scenario is selected. Planned upgrades to the treatment plants will not alter effluent copper concentrations appreciably.

While ammonia is a parameter of concern at concentrations found in the existing effluent, the nitrification/denitrification processes to be added as part of the facilities upgrade will reduce ammonia levels to 1 mg/l, which is the same as the lowest water quality criterion for ammonia.

The Borough outfall gets greater dilution than the discharge to the Pawcatuck outfall estuary due to the increased depth of water available for mixing and the diffuser design. The lack of stratification in the harbor also allows mixing through the entire water column.

While initial dilution is larger in Stonington Harbor than in the Pawcatuck River estuary, none of the scenarios simulated would appear to have sufficient initial dilution to allow for the copper water quality criterion to be met.

In municipalities with little industry, corrosion household plumbing is typically the largest source of copper to the wastewater treatment plant. The best approach for lower copper levels is often to improve the level of corrosion control for the water supply.

If this does not prove adequate, it is possible that sufficient initial dilution can be obtained at the Borough plant's outfall by opening some of the capped risers. For example, a CORMIX simulation of Scenario 5 flows with 3 risers operational (6 ports open) resulted in an initial dilution of 22:1.

Dilution at the Pawcatuck outfall is primarily limited by the stratification in the estuary. It is possible, however, that additional dilution could be obtained by increasing the exit velocity of the pipe. Even with this sort of improvement, it is much less likely that the copper water quality criteria could be met at the Pawcatuck discharge location.

Lastly, we note again that the detection limits for several parameters were higher than the water quality criteria; the detection limits for total cadmium, copper, cyanide, lead, mercury and nickel are higher than the chronic criteria and may need to be lowered. The State could require these detection limits to be lowered to at or below the chronic criteria for each parameter. In addition, lowering the detection limits will also lead to more reliable data. A good rule of thumb is that the detection limit should be about one-third of the anticipated minimum value.

6.6 Water Quality Findings and Recommendations

Following is a list of findings and conclusions, based on the analyses described in this section:

- Water quality in the northernmost portion of the Pawcatuck River estuary is highly degraded. This condition appears to be a function of physical constraints of the estuary.
- Pawcatuck River water quality is only somewhat degraded near the Pawcatuck WPCF outfall. This appears to be because there is much better tidal exchange lower in the estuary than its mouth. The Pawcatuck WPCF discharge is a small contributor to the deficit of oxygen found in the estuary.
- Stonington Harbor is better suited for assimilating wastewater flows because:
  - It has greater mixing/flushing for conventional pollutants and
  - It offers greater dilution potential for meeting water quality criteria for toxic pollutants.
- Stonington Harbor should be able to handle the combined discharge from all three treatment plants and meet the State's water quality standard for dissolved oxygen.
- The Borough WPCF outfall diffuser has sufficient hydraulic capacity to handle the combined flow from all three plants.
- The Town should investigate whether influent copper concentrations in the wastewater could be reduced by improved corrosion control of the water supply.

- If the Town selects to implement Scenario 5 at the Stonington Harbor, then two additional ports should be opened on the existing Borough WPCF's outfall diffuser. This would not be required for the other scenarios.

		Numerical Saltwater Criteria		DMR Data						
Parameter	***Units***	***Acute Criteria***	***Chronic Criteria***	***1/19/2000***	***2/2/2000***	***3/7/2000***	***4/19/2000***	***7/6/2000***	***10/13/2000***	***1/17/2001***
Total Antimony	mg/L	--	--	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02
Total Arsenic	mg/L	0.069	0.036	<0.002		<0.005	<0.002	<0.005	<0.005	<0.005
Total Beryllium	mg/L	--	--	<0.02		<0.001	<0.001	<0.001	<0.001	<0.001
Total Cadmium	mg/L	0.042	0.0093	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Hexavalent Chromium	mg/L	1.1	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Chromium	mg/L	--	--	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02
Total Copper	mg/L	0.0024	0.0024	**0.05**	**0.06**	**0.03**	**0.02**	**0.03**	**<0.02**	**0.05**
Free Cyanide	mg/L			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Cyanide	mg/L	0.001	0.001	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Lead	mg/L	0.21	0.0081	0.005	0.004	<0.002	<0.002	<0.002	<0.002	0.005
Total Mercury	mg/L	0.0018	0.000025	<0.0002		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Total Nickel	mg/L	0.074	0.0082	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Total Nitrate Nitrogen	mg/L	--	--	1.21	10.6	1.8	7.07	0.2	0.17	4.27
Total Nitrite Nitrogen	mg/L	--	--	0.37	0.8	0.28	1.93	0.27	0.63	1.83
Phenols	mg/L	--	--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Selenium	mg/L	0.29	0.071	<0.002		<0.002	<0.002	<0.002	<0.002	<0.002
Total Silver	mg/L	--	--	<0.02				<0.02	<0.02	<0.02
Total Thallium	mg/L	--	--	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02
Total Zinc	mg/L	0.09	0.081	**0.09**		0.08	0.04	0.04	0.03	0.07
Appropriate Total Ammonia Nitrogen Acute Criteria[1] (mg/L)				29	29	29	20	6.7	9.8	29
Appropriate Total Ammonia Nitrogen Chronic Criteria[1] (mg/L)				4.4	4.4	4.4	3	1	1.5	4.4
Total Ammonia Nitrogen (mg/L)				1.3	0.22	**16**	**17**	**13.6**	**15**	**16.5**

[1] - Total ammonia nitrogen criteria are based on temperature and salinity. The criteria chosen for each sampling period are based on the guidelines set forth in the Connecticut Water Quality Standards.

	Detection limit above the numerical chronic criteria
0.12	Measured value above the numerical chronic citeria
0.05	Measured value above the numerical acute citeria

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Table 6-10
Stonington Borough WPCF: Comparison of Metal Effluent Data and Water Quality Criteria

		Numerical Saltwater		DMR Data		
Parameter	***Units***	***Acute Criteria***	***Chronic Criteria***	***3/8/2000***	***6/7/2000***	***9/5/2000***
Total Antimony	mg/L	--	--	<0.002	<0.02	<0.02
Total Arsenic	mg/L	0.069	0.036	<0.002	<0.002	<0.002
Total Beryllium	mg/L	--	--	<0.002	<0.02	<0.02
Total Cadmium	mg/L	0.042	0.0093	<0.01	<0.01	<0.01
Hexavalent Chromium	mg/L	1.1	0.05	<0.01	<0.01	<0.01
Total Chromium	mg/L	--	--	<0.02	<0.02	<0.02
Total Copper	mg/L	0.0024	0.0024	**0.03**	<0.02	<0.02
Free Cyanide	mg/L			<0.01	<0.01	<0.01
Total Cyanide	mg/L	0.001	0.001	<0.01	<0.01	<0.01
Total Lead	mg/L	0.21	0.0081	<0.002	<0.002	<0.01
Total Mercury	mg/L	0.0018	0.000025	<0.0002	<0.0002	<0.0002
Total Nickel	mg/L	0.074	0.0082	<0.02	<0.02	<0.02
Total Nitrate Nitrogen	mg/L	--	--	5.4	1.6	2.6
Total Nitrite Nitrogen	mg/L	--	--	2.12	<0.5	<0.5
Phenols	mg/L	--	--	<0.05	<0.05	<0.05
Total Selenium	mg/L	0.29	0.071	<0.02	<0.02	<0.002
Total Silver	mg/L	--	--	<0.02	<0.02	<0.02
Total Thallium	mg/L	--	--	<0.02	<0.02	<0.02
Total Zinc	mg/L	0.09	0.081	0.06	0.03	<0.04
Appropriate Total Ammonia Nitrogen Acute Criteria[1] (mg/L)				29	9.8	6.7
Appropriate Total Ammonia Nitrogen Chronic Criteria[1] (mg/L)				4.4	1.5	1
Total Ammonia Nitrogen (mg/L)				**5.8**	**23.8**	0.9

[1] - Total ammonia nitrogen criteria are based on temperature and salinity. The criteria chosen for each sampling period are based on the guidelines set forth in the Connecticut Water Quality Standards.

	Detection limit above the numerical chronic criteria
0.12	Measured value above the numerical chronic cirteria
0.05	Measured value above the numerical acute cirteria

Table 6-11
Pawcatuck WPCF: Comparison of Metal Effluent Data and Water Quality Criteria

Parameter	Units	Numerical Saltwater Acute Criteria	Numerical Saltwater Chronic Criteria	DMR Data 3/7/2000	DMR Data 6/1/2000	DMR Data 9/6/2000	DMR Data 12/14/2000
Total Antimony	mg/L	--	--	<0.02	<0.02	<0.02	<0.02
Total Arsenic	mg/L	0.069	0.036	<0.002	<0.002	<0.002	<0.002
Total Beryllium	mg/L	--	--	<0.02	<0.02	<0.02	<0.02
Total Cadmium	mg/L	0.042	0.0093	<0.01	<0.01	<0.01	<0.01
Hexavalent Chromium	mg/L	1.1	0.05	<0.01	<0.01	<0.01	<0.01
Total Chromium	mg/L	--	--	<0.02	<0.02	<0.02	<0.02
Total Copper	mg/L	0.0024	0.0024	0.05	0.02	0.04	0.02
Free Cyanide	mg/L			<0.01	<0.01	<0.01	<0.01
Total Cyanide	mg/L	0.001	0.001	<0.01	<0.01	<0.01	<0.01
Total Lead	mg/L	0.21	0.0081	<0.02	<0.002	<0.002	<0.002
Total Mercury	mg/L	0.0018	0.000025	<0.0002	<0.0002	<0.0002	<0.0002
Total Nickel	mg/L	0.074	0.0082	<0.02	<0.02	<0.02	<0.02
Total Nitrate Nitrogen	mg/L	--	--	3.6	0.52	3.68	0.2
Total Nitrite Nitrogen	mg/L	--	--	1.4	0.07	0.23	0.1
Phenols	mg/L	--	--	<0.05	<0.05	<0.05	<0.05
Total Selenium	mg/L	0.29	0.071	<0.002	<0.002	<0.002	<0.002
Total Silver	mg/L	--	--	<0.02	<0.02	<0.02	<0.02
Total Thallium	mg/L	--	--	<0.02	<0.02	<0.02	<0.02
Total Zinc	mg/L	0.09	0.081	0.08	0.06	**0.09**	0.05
Appropriate Total Ammonia Nitrogen Acute Criteria[1] (mg/L)				29	9.8	6.7	20
Appropriate Total Ammonia Nitrogen Chronic Criteria[1] (mg/L)				4.4	1.5	1	3
Total Ammonia Nitrogen (mg/L)				**21**	**13.5**	**2**	**22**

[1] - Total ammonia nitrogen criteria are based on temperature and salinity. The criteria chosen for each sampling period are

(yellow box)	Detection limit above the numerical chronic criteria
0.12	Measured value above the numerical chronic cirteria
0.05	Measured value above the numerical acute cirteria

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Table 6-12
Mystic WPCF: Comparison of Metal Effluent Data and Water Quality Criteria

		9/7/2000						9/22/2000						10/6/2000					
Station 3	Depth (feet)	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity
	2	19	7.8	25.67	7.96	98%	35000	19.34	6.87	24.72	7.96	86%	34130	17.58	6.77	28.78	8.03	84%	37,419
	4	19	8	26.50	7.92	101%	36000	19.41	6.5	24.79	7.94	82%	34275	17.55	6.62	28.78	8.04	82%	37,394
	6	19	8.1	26.50	7.92	102%	36000	19.59	6.1	24.96	7.91	77%	34630	17.49	6.52	28.85	8.04	81%	37,418
	7	19		24.84	8.00		34000												
	8		8.1					19.63	5.96	25.01	7.90	75%	34720	17.51	6.48	28.86	8.04	81%	37,441
	9.5		8																
	10							19.52	5.7	25.29	7.90	72%	34980	17.5	6.46	28.87	8.04	80%	37,447

Station 4	Depth (feet)	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity
	2	18	8	27.23	8.04	99%	36000	19.7	6.9	25.16	7.88	88%	34970	17.55	6.62	28.86	8.03	82%	37,482
	4	19	7.8	26.50	7.92	98%	36000	19.65	6.67	25.29	7.88	85%	35085	17.54	6.28	28.87	8.03	78%	37,484
	6	19	7.7	26.50	7.92	97%	36000	19.52	6.68	25.85	7.88	85%	35660	17.53	6.15	28.90	8.03	77%	37,508
	7	19		26.50	7.92		36000	19.52	6.62	26.01	7.87	84%	35855						
	8		8											17.54	6.15	28.89	8.03	77%	37,505
	9.5		8.3																
	10													17.54	6.23	28.89	8.03	78%	37,508

Station 2	Depth (feet)	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity
	2	19	7.5	26.50	7.92	95%	36000	19.59	6.79	25.88	7.87	86%	35760	17.6	7.35	28.88	8.02	92%	37,552
	4	19	7.8	26.50	7.92	98%	36000	19.55	6.72	25.90	7.87	85%	35750	17.56	7.28	29.12	8.02	91%	37,791
	6	19	7.4	27.33	7.89	94%	37000	19.44	6.73	26.17	7.87	85%	35980	17.52	7.47	29.21	8.02	93%	37,850
	7	18		28.09	8.00		37000												
	8		7.5					19.41	6.77	26.39	7.87	86%	36223	17.52	7.39	29.23	8.02	92%	37,871
	9.5		7.6																
	10													17.56	7.28	29.20	8.02	91%	37,872

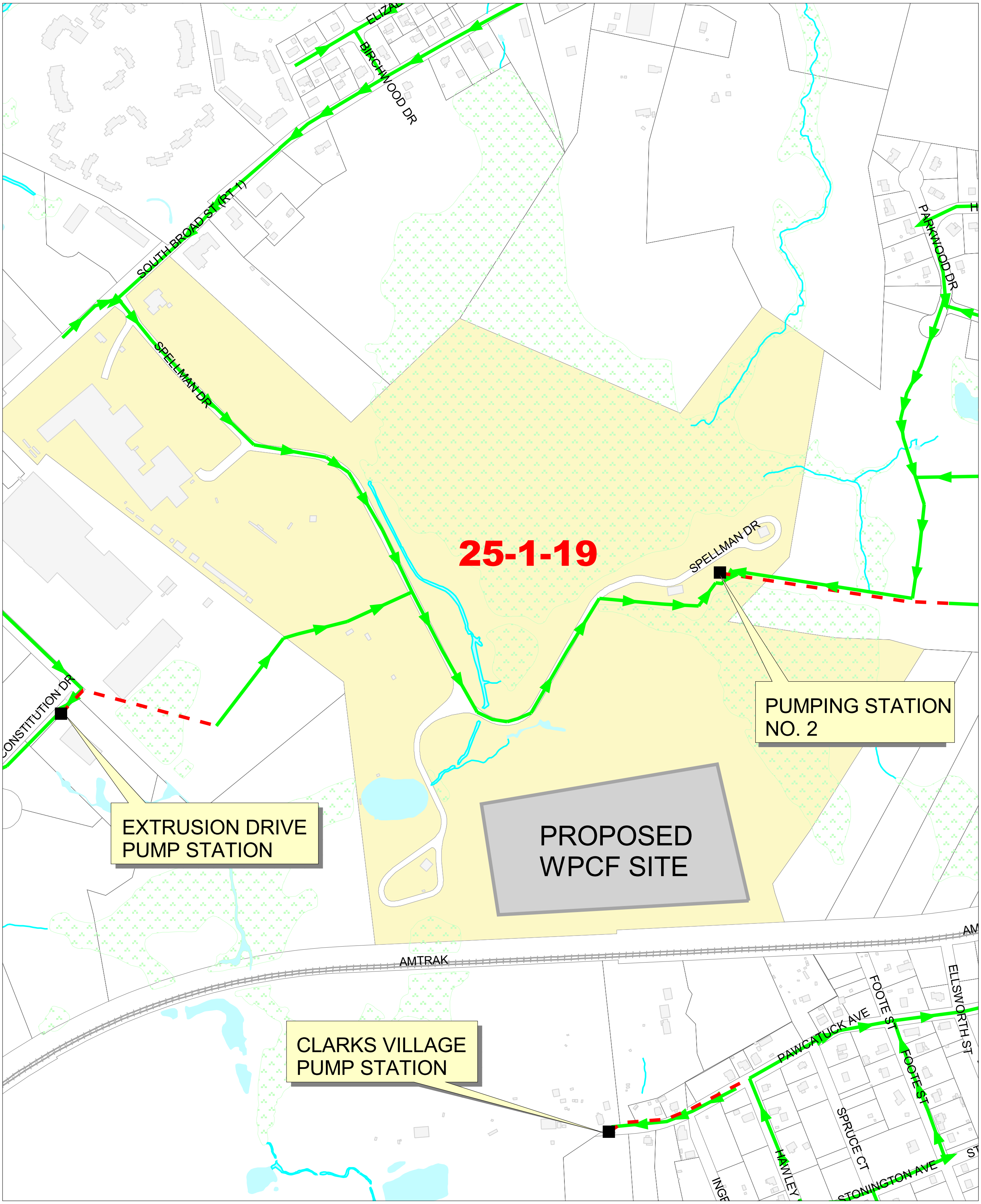
Station 5	Depth (feet)	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity
	2	19	8.5	27.33	7.89	108%	37000	19.35	6.84	25.92	7.90	87%	35600	17.6	7.35	28.88	8.02	92%	37,552
	4	19	8.2	27.33	7.89	104%	37000	19.39	6.73	26.04	7.89	85%	35785	17.59	7.28	29.10	8.02	91%	37,791
	6	19	5.9	27.33	7.89	75%	37000	19.44	6.78	26.23	7.87	86%	36060	17.56	7.47	29.18	8.02	93%	37,850
	7	19		27.33	7.89		37000												
	8		6.7					19.26	6.81	26.50	7.89	86%	36225	17.56	7.39	29.19	8.02	92%	37,871
	9.5		6.4																
	10													17.56	7.28	29.20	8.02	91%	37,872

Station 6	Depth (ft)	Temp (oC)	Dissolved Oxygen (mg/l)	Salinity (ppt)	DO Sat	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/l)	Salinity (ppt)	DO Sat (mg/l)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/l)	Salinity (ppt)	DO Sat (mg/l)	% DO Saturation	Conductivity
	2	17		28.88	8.12		37000	19.45	7.37	25.99	7.88	94%	35769	17.57	7.45	29.13	8.02	93%	37,806
	4	18		28.09	8.00		37000	19.44	7.36	26.00	7.88	93%	35780	17.54	7.43	29.15	8.02	93%	37,800
	6	18	8.6	28.09	8.00	107%	37000	19.28	7.19	26.18	7.90	91%	35860	17.51	7.39	29.20	8.02	92%	37,835
	7	18		28.09	8.00		37000												
	8		8.4					18.33	6.99	26.86	8.01	87%	35857	17.51	7.36	29.20	8.02	92%	37,834
	9.5		8.4																
	10													17.5	7.33	29.26	8.02	91%	37,888

		9/7/2000						9/22/2000						10/6/2000					
Station 7	Depth (feet)	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity
	2	18	8.7	9.00	9.0	97%	13,000	18.6	7.85	1.61	9.3	85%	2,460	15.7	8.5	3.92	9.7	88%	5,514
	4	21	6	18.25	8.0	75%	27,000	18.6	7.6	2.55	9.2	83%	3,885	17.2	5.6	25.44	8.3	68%	33,210
	6	21	5.7	23.56	7.8	73%	34,000	19.5	3.13	20.93	8.1	39%	29,540	17.5	5.76	26.75	8.1	71%	35,045
	7	21		23.56	7.8		34,000												
	8		5.1											17.8	6.28				36,011
	9.5		2.2																
Station 8	Depth (feet)	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity
	2	19	8.2	5.91	9.0	92%	8,900	18.8	7.65	2.45	9.2	83%	3,755	16.4	7.31	13.02	9.0	81%	17,720
	4	21	5.8	18.99	8.0	73%	28,000	18.8	7.17	3.62	9.1	79%	5,500	17.3	5.82	24.57	8.3	70%	32,315
	6	21	5.4	22.02	7.8	69%	32,000	19.4	4.06	16.25	8.4	49%	23,400	17.7	6.21	26.99	8.1	77%	35,475
	7	21		23.56	7.8		34,000	19.6	2.99	21.97	8.1	37%	30,865						
	8		3.4											17.9	6.59	27.64	8.0	82%	36,360
	9.5		1.9																
Station 9	Depth (feet)	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity
	2	19	8.4	8.77	8.8	95%	13,000	19.1	7.51	3.29	9.1	83%	5,040	16.7	7.73	9.68	9.2	84%	13,504
	4	21	6	19.74	7.9	76%	29,000	19.2	6.36	7.15	8.8	72%	10,750	17.5	6.12	25.21	8.2	74%	33,194
	6	21	5.2	22.79	7.8	67%	33,000	19.7	3.3	22.06	8.0	41%	31,050	17.7	6.09	27.02	8.1	75%	35,507
	7	21		23.56	7.8		34,000												
	8		4.8											17.9	6.64	27.58	8.0	83%	36,289
	9.5		4.2																
	10													17.9	6.8	27.66	8.0	85%	36,393
Station 10	Depth (feet)	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity
	2	19	7	8.77	8.8	79%	13,000	19.7	7.63	2.79	9.0	85%	4,350	16.5	8.21	7.57	9.3	88%	10,624
	4	20	6.6	20.26	8.1	82%	29,000							17.5	6.49	24.36	8.3	79%	32,198
	6	21	5.4	22.79	7.8	69%	33,000							17.5	6	25.97	8.2	73%	34,128
	7	21		23.56	7.8		34,000												
	8		2.1											17.7	6.21	26.94	8.1	77%	35,443
	9.5		1.7																

		9/7/2000						9/22/2000						10/6/2000					
Station 11	Depth (feet)	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity
	2	19	8.1	7.36	8.9	91%	11,000	19.5	7.6	3.02	9.0	84%	4,675	16.4	7.91	9.36	9.2	86%	12,987
	4	21	6	18.25	8.0	75%	27,000	19.2	6.89	4.70	9.0	77%	7,160	17.5	6.23	25.33	8.2	76%	33,351
	6	21	5.4	20.50	7.9	68%	30,000	19.8	3.36	22.22	8.0	42%	31,340	17.7	6.09	26.65	8.1	75%	35,070
	7	21		21.25	7.9		31,000	19.8	3.29	22.39	8.0	41%	31,570						
	8		4.1											17.9	6.59	27.47	8.1	82%	36,163
	9.5		3.6																
	10																		
Station 12	Depth (feet)	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity
	2	19	8.1	5.29	9.0	90%	8,000	19.5	7.65	3.00	9.0	85%	4,650	16.9	7.43	17.10	8.7	85%	23,049
	4	20	5.9	20.26	8.1	73%	29,000	19.1	7.09	3.71	9.1	78%	5,670	17.6	6.18	25.44	8.2	75%	33,589
	6	20	5.3	23.39	7.9	67%	33,000	19.8	3.63	22.26	8.0	45%	31,420	17.8	6.39	27.08	8.1	79%	35,672
	7	21		24.34	7.7		35,000	19.9	3.58	22.61	8.0	45%	31,910						
	8		4.8											17.9	6.85	27.67	8.0	85%	36,427
	9.5		4.5																
	10													18.0	7.09	27.88	8.0	88%	36,717
Station 13	Depth (feet)	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity	Temp (oC)	Dissolved Oxygen (mg/L)	Salinity (ppt)	DO Sat (mg/L)	% DO Saturation	Conductivity
	2	19	7.5	9.48	8.8	86%	14,000	19.7	7.8	2.79	9.0	87%	4,350	16.9	7.75	13.99	8.9	87%	19,179
	4	20	6	19.49	8.1	74%	28,000	19.2	7.4	4.28	9.0	82%	6,540	17.8	6.73	26.19	8.1	83%	34,594
	6	21	5.2	22.79	7.8	67%	33,000	19.9	3.91	22.42	8.0	49%	31,690	17.9	6.85	27.70	8.0	85%	36,473
	7	21		23.56	7.8		34,000												
	8		4.8					20.0	3.79	22.82	8.0	48%	32,260	18.0	7.08	27.95	8.0	88%	36,803
	9.5		4.4																
	10													18.0	7.17	27.98	8.0	90%	36,849

Table 6-3
Water Quality Data for Pawcatuck River



November 2004

0 600 Feet

Source: Stonington GIS, 2001.

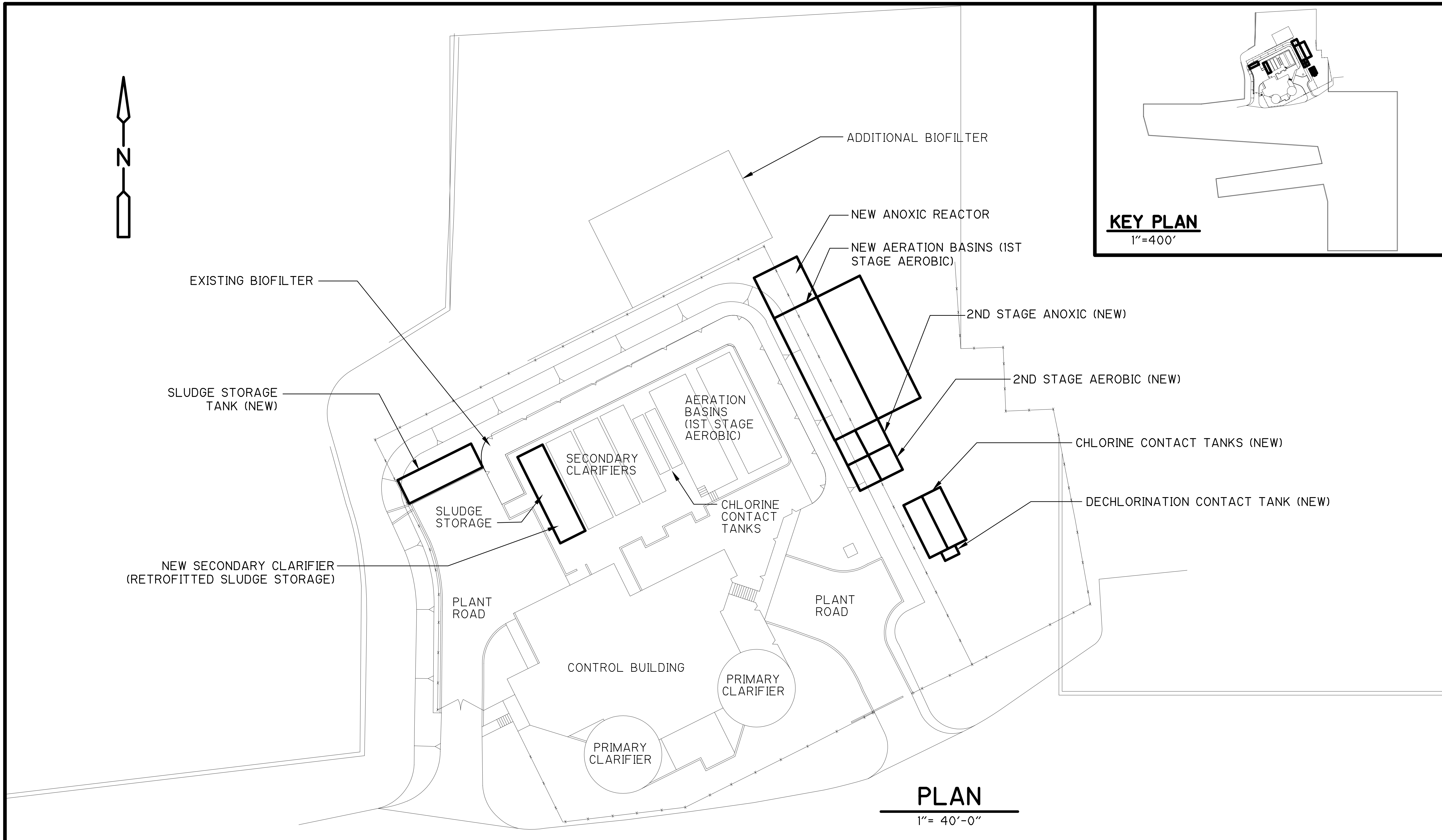
CDM

Force Main
Buildable Area
Parcel Boundary
Building
Gravity Sewer
River/Stream/Shore
Water Body
Swamp

Stonington, CT

Figure 7-1
Recommended Parcel

CAMDDGPHS01 \projects\stonington\parcel.apr CT 12-9-04 ..\plots\build_lot.pdf

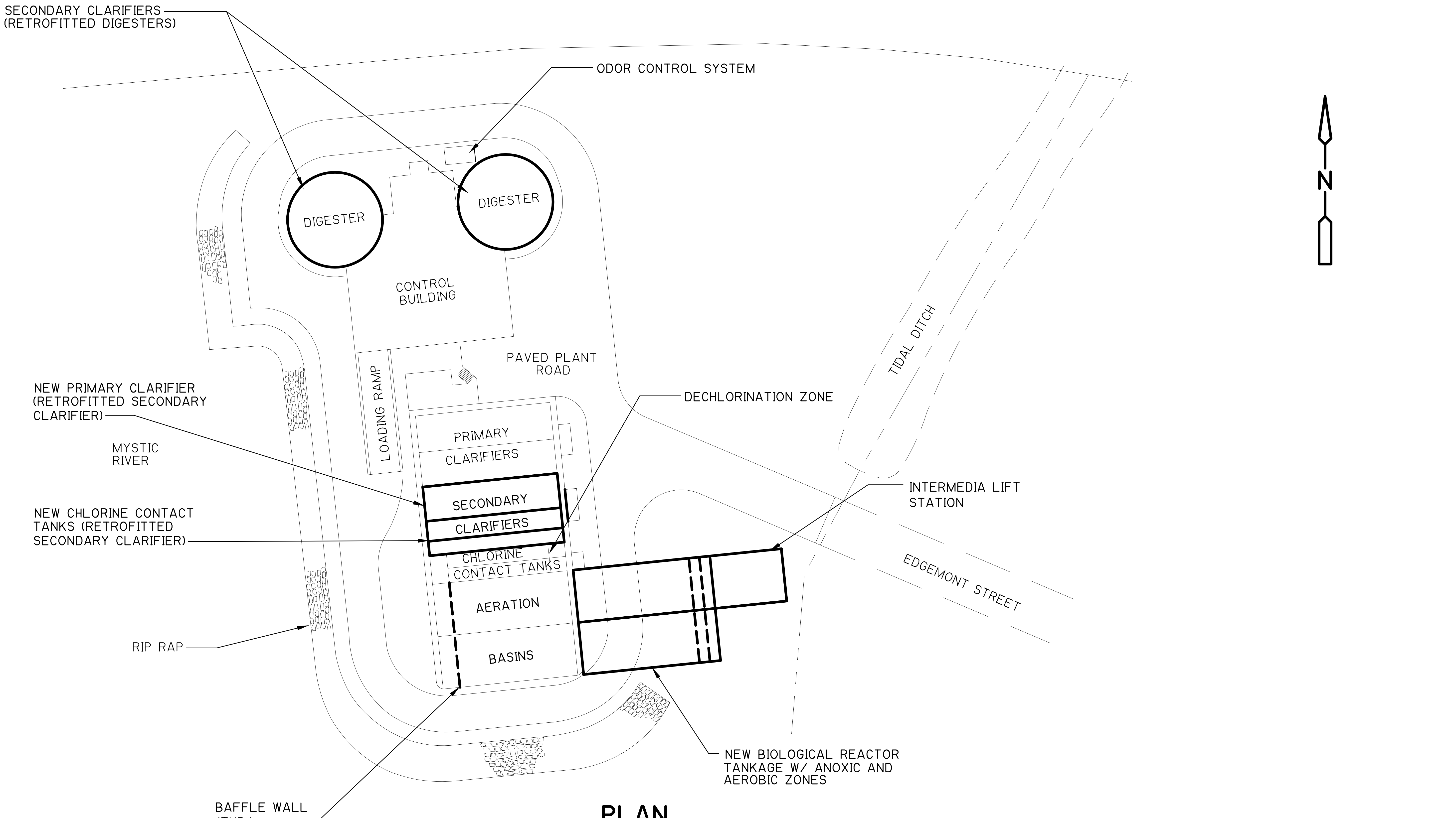


STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN-ADDITIONAL SCENARIO

ALTERNATIVE NO.1A: UPGRADED BOROUGH WPCF
(WITH DIVERSION FROM MYSTIC WPCF)

Figure 7-A1A-B

CDM



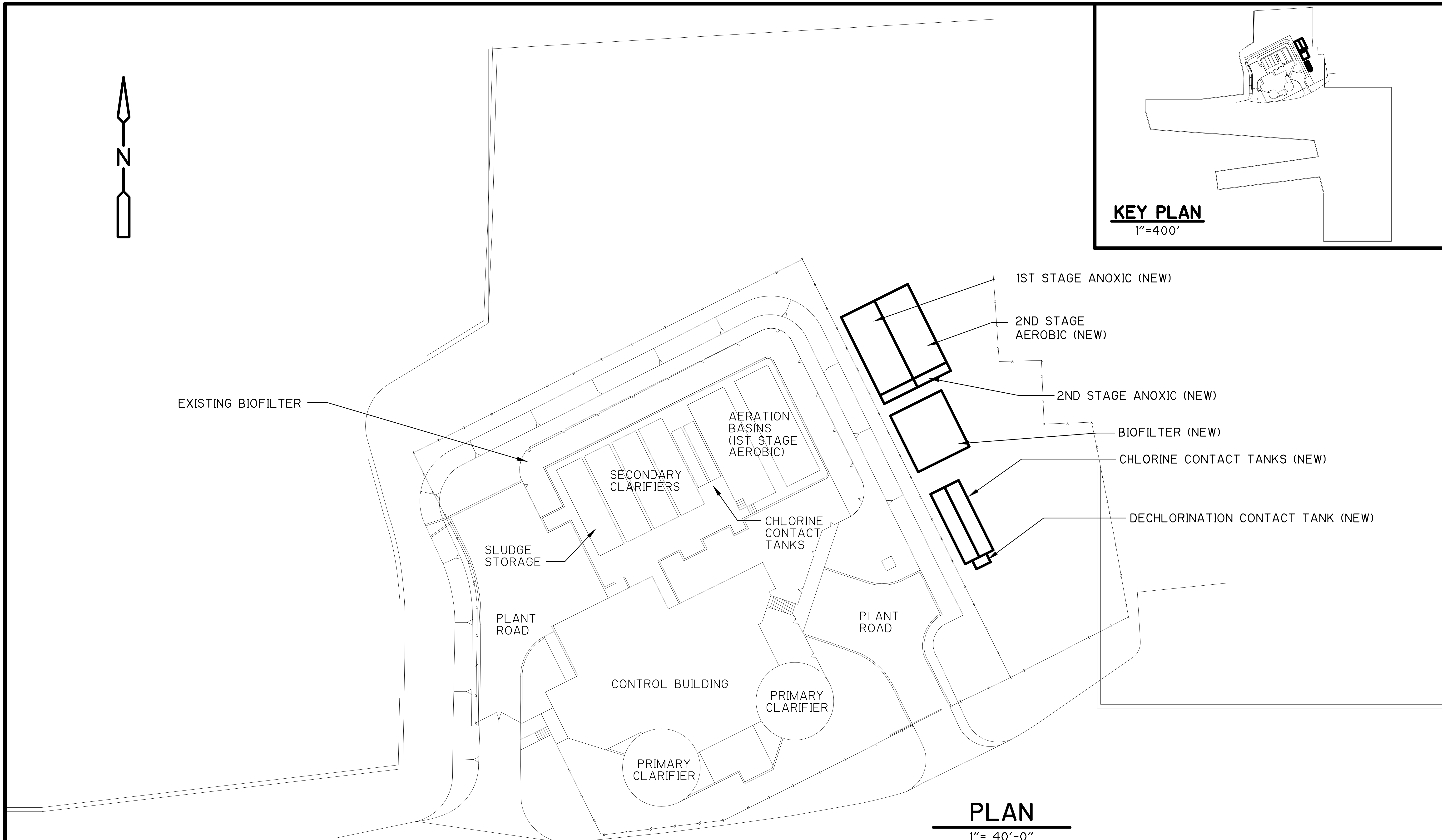
PLAN
1"= 40'

STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN-ADDITIONAL SCENARIO

ALTERNATIVE NO.1A: UPGRADED MYSTIC WPCF
(WITH DIVERSION TO BOROUGH WPCF)

CDM

Figure 7-A1A-M



PLAN

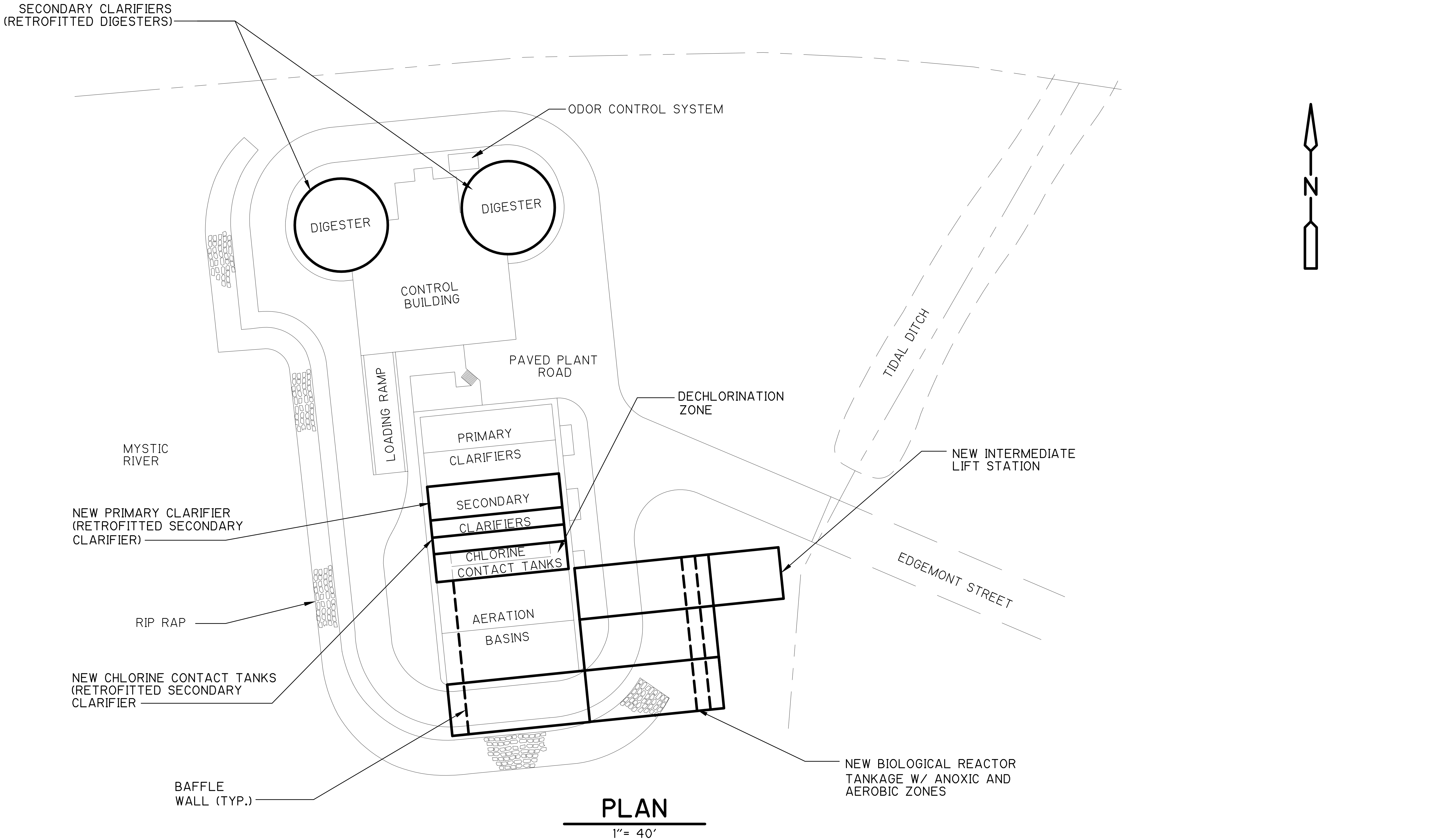
1"= 40'-0"

STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN-ADDITIONAL SCENARIO

ALTERNATIVE NO.1 UPGRADED BOROUGH WPCF
(NO DIVERSION FROM MYSTIC WPCF)

CDM

Figure 7-A1-B



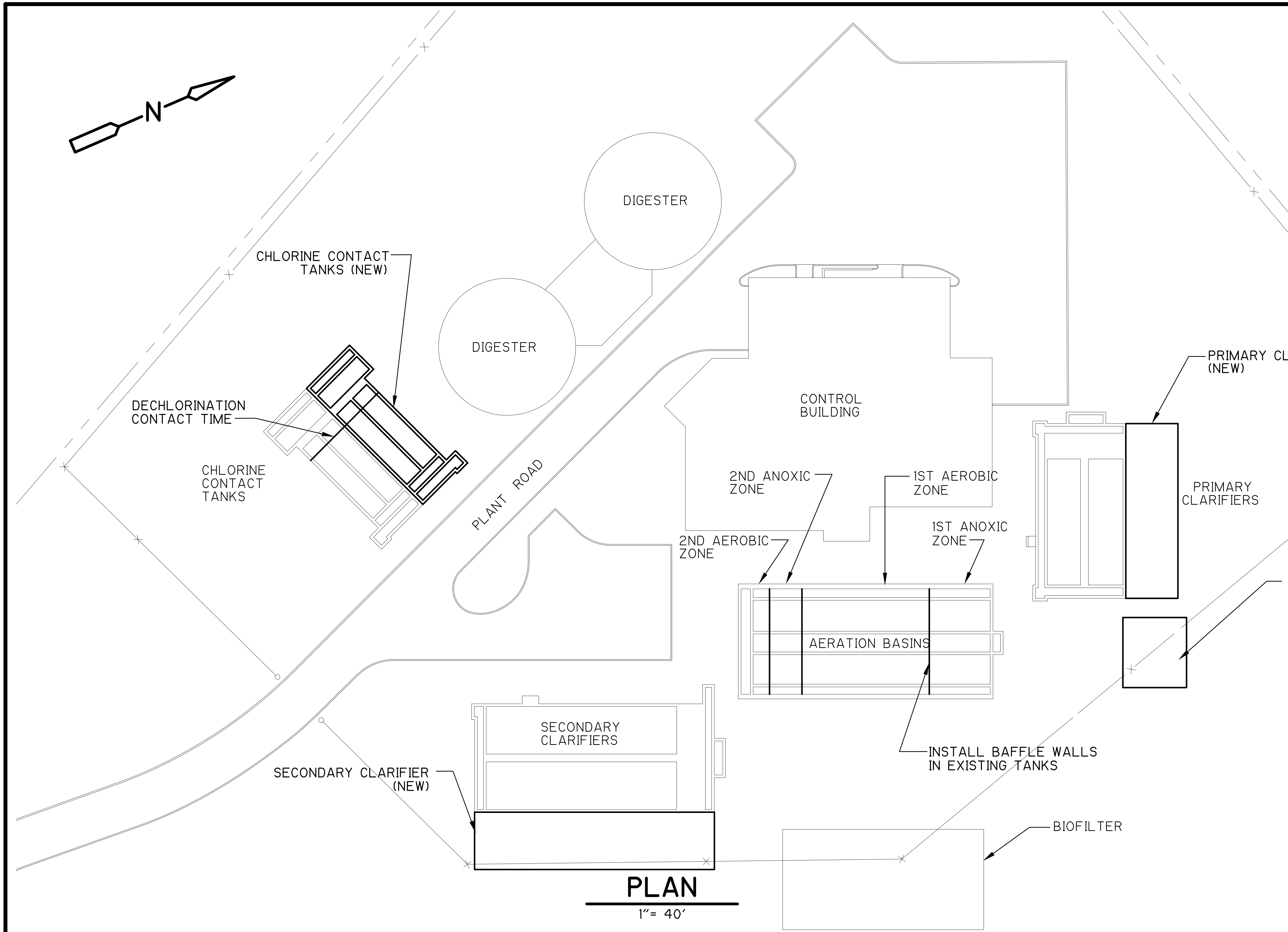
PLAN
1"= 40'

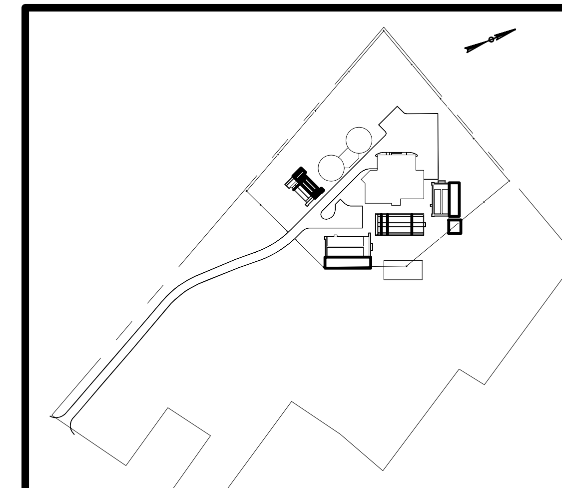
STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN-ADDITIONAL SCENARIO

ALTERNATIVE NO.1: UPGRADED MYSTIC WPCF
(NO DIVERSION TO BOROUGH WPCF)

CDM

Figure 7-A1-M



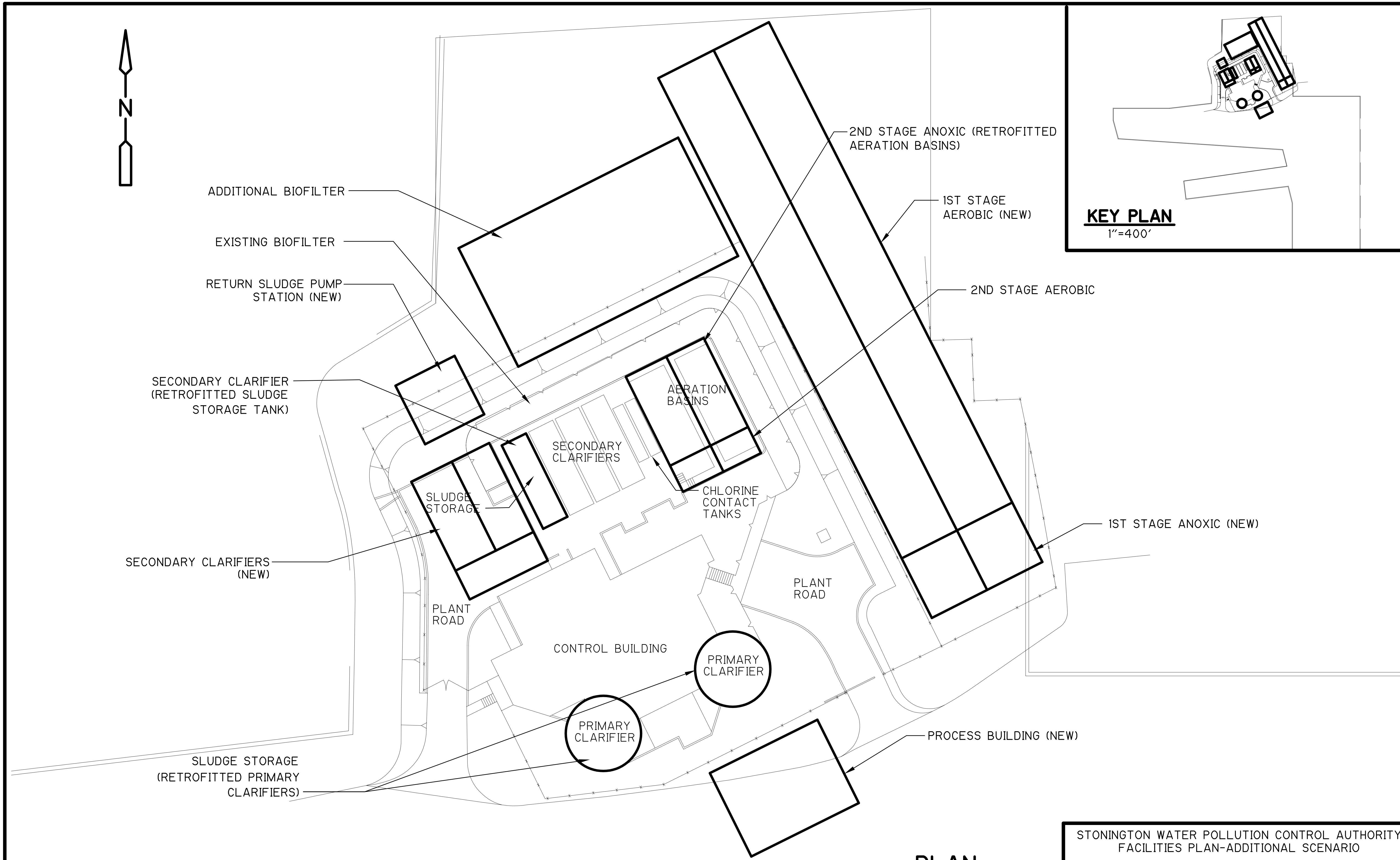


STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN

CDM

ALTERNATIVE NO.1: UPGRADED PAWCATUCK WPCF

Figure 7-A1-P



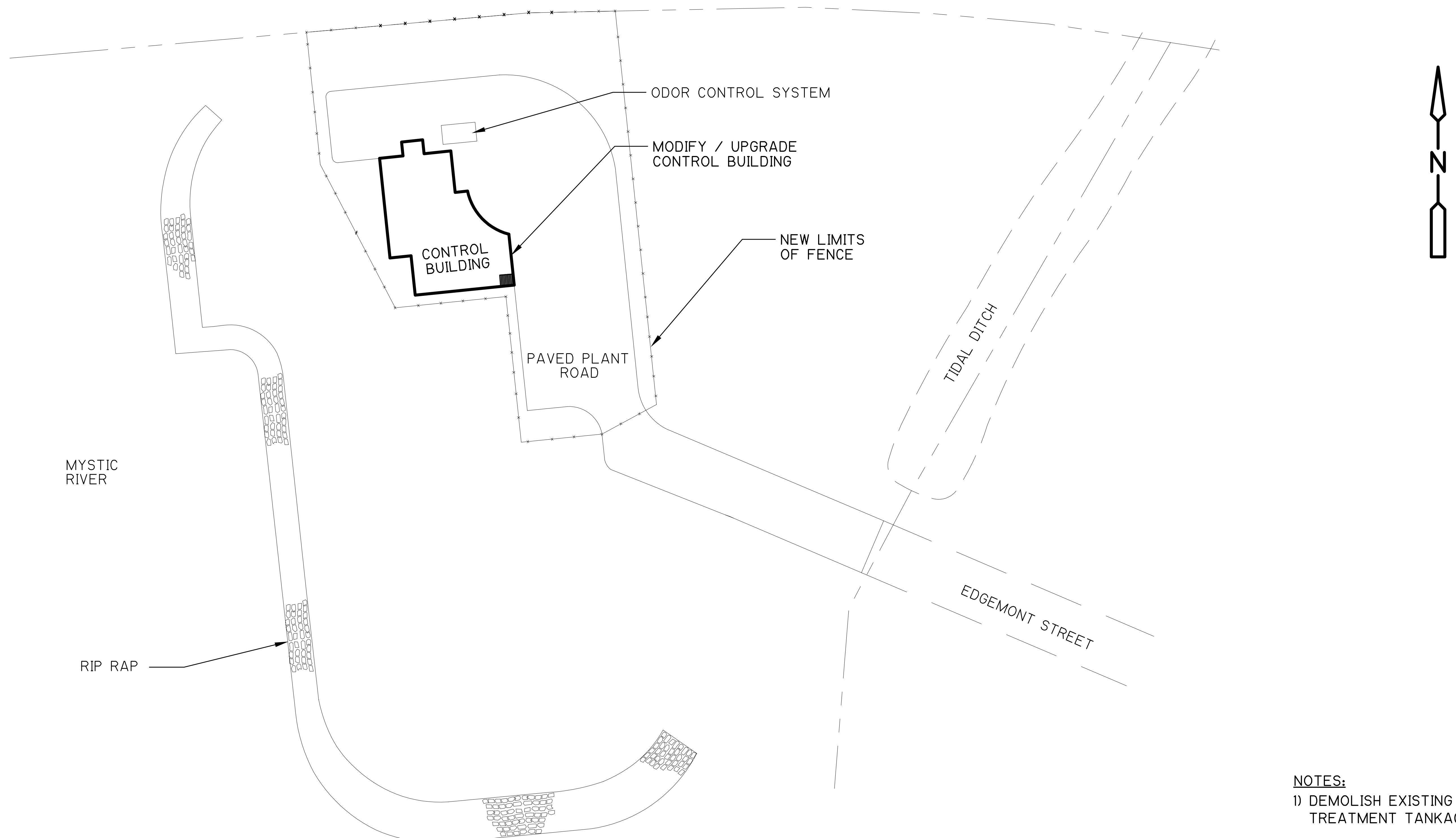
PLAN
1"= 40'-0"

CDM

STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN-ADDITIONAL SCENARIO

ALTERNATIVE NO.2: UPGRADED BOROUGH WPCF

Figure 7-A2-B



PLAN
1"= 40'

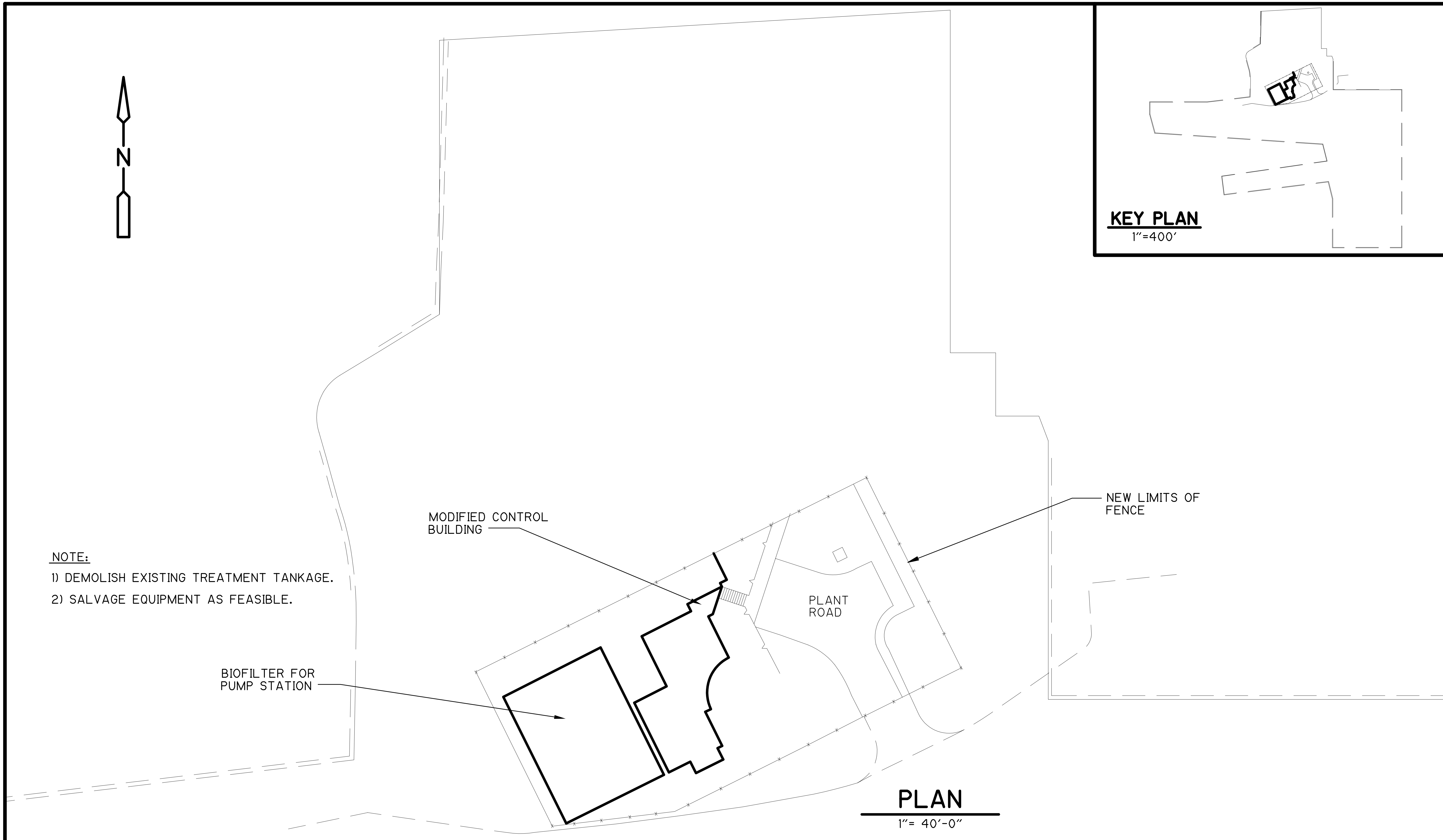
NOTES:
1) DEMOLISH EXISTING TREATMENT TANKAGE.
2) SALVAGE EQUIPMENT AS FEASIBLE.

STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN-ADDITIONAL SCENARIO

ALTERNATIVE NO.2 : IMPROVED MYSTIC WPCF SITE

Figure 7-A2-M

CDM

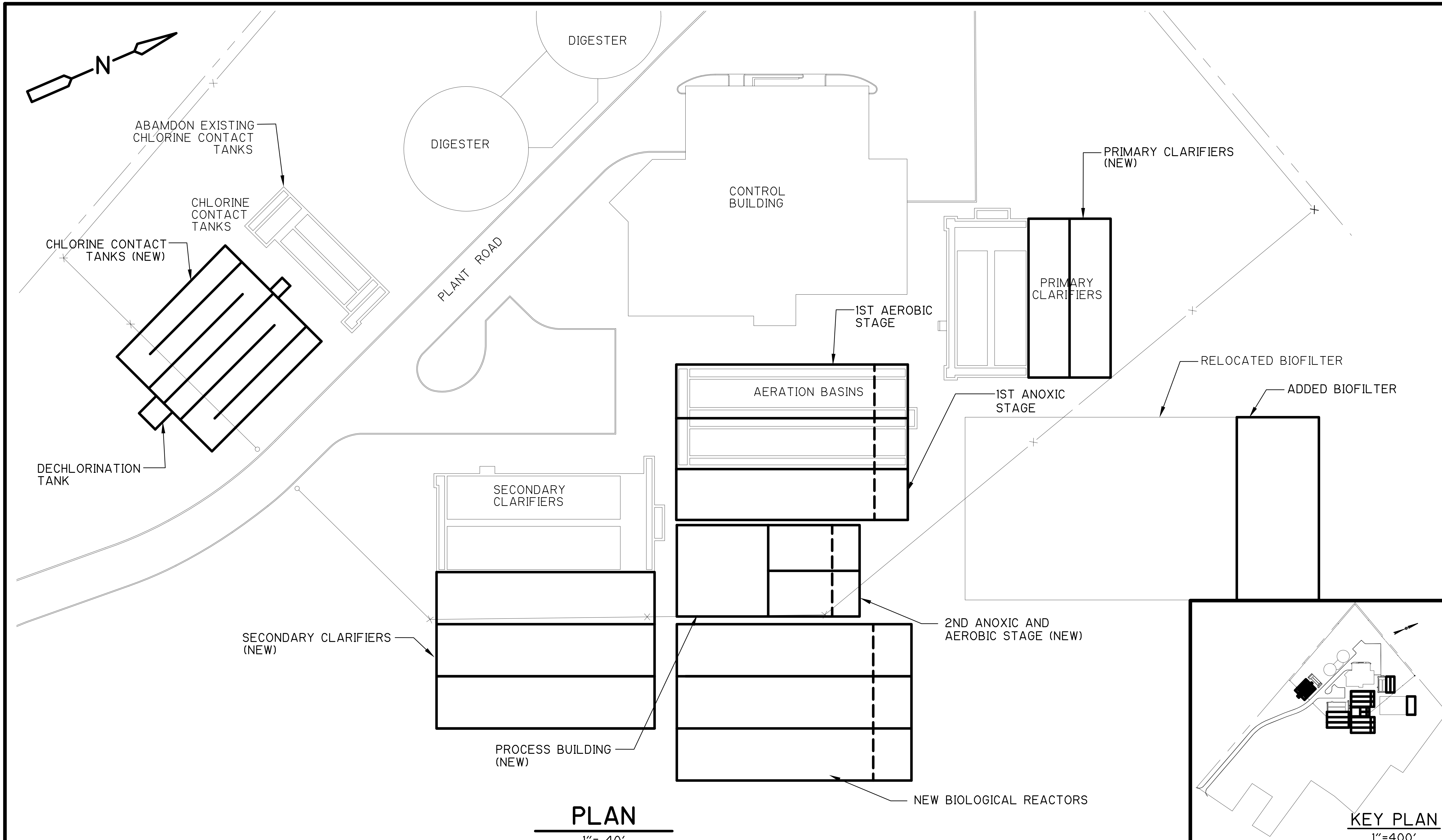


STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN-ADDITIONAL SCENARIO

ALTERNATIVE NO.3: IMPROVED
BOROUGH WPCF SITE

Figure 7-A3-B

CDM

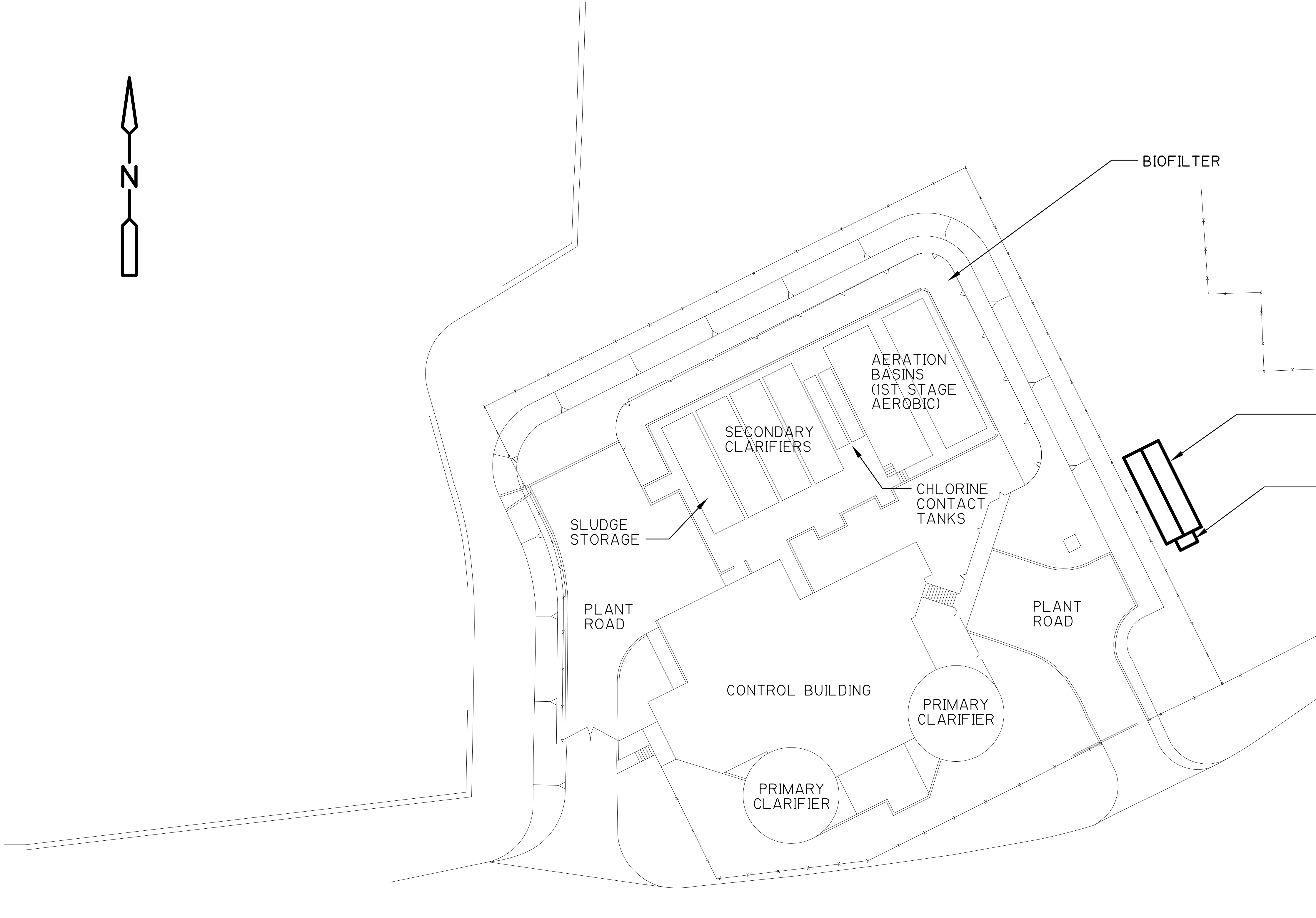


STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN

ALTERNATIVE NO.3: UPGRADED PAWCATUCK WPCF

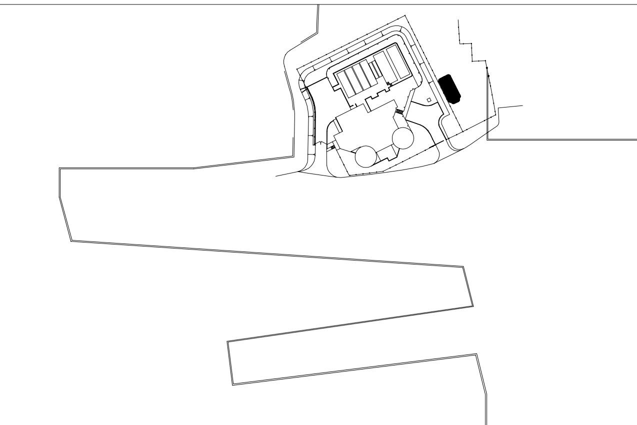
CDM

Figure 7-A3-P



PLAN

1"= 40'-0"



KEY PLAN

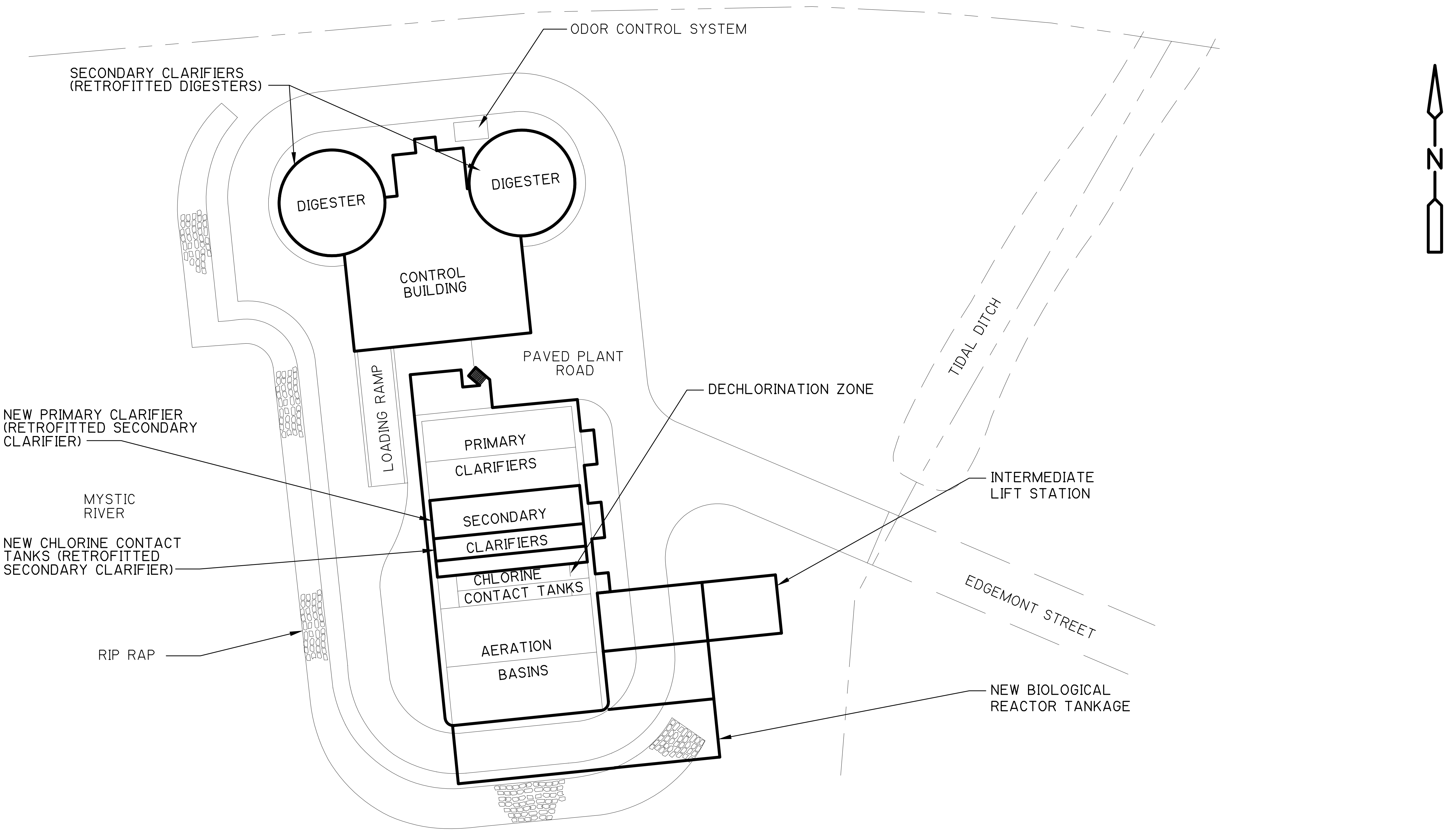
1"=400'

STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN-ADDITIONAL SCENARIO

ALTERNATIVE G: UPGRADED BOROUGH WPCF

CDM

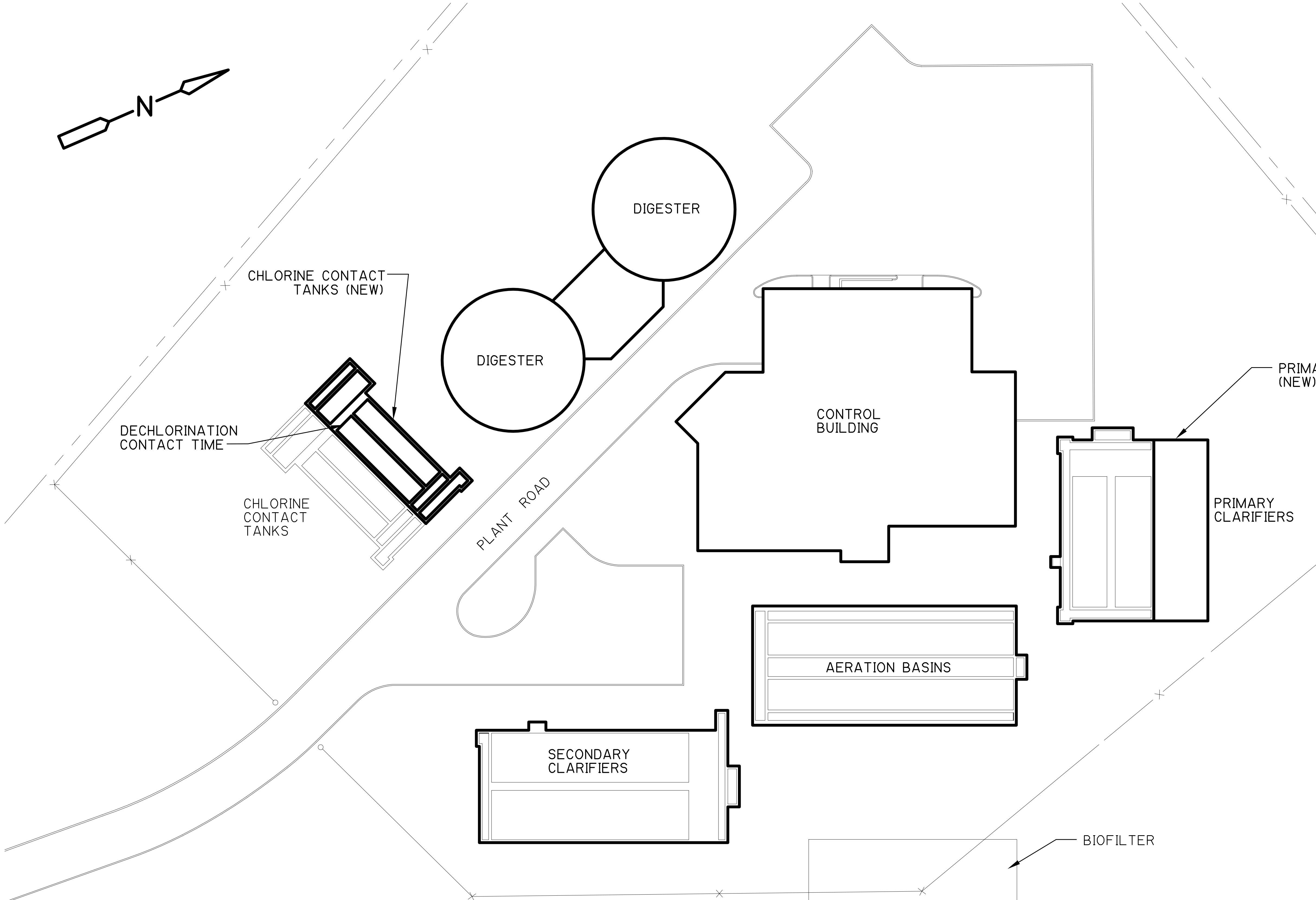
Figure 7-AG-B



PLAN
1"= 40'

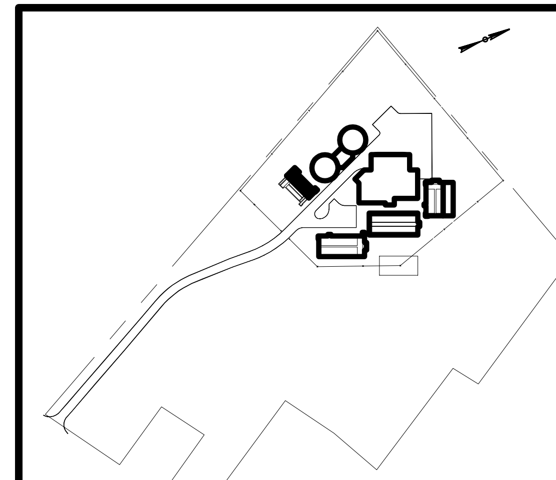
STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN
ALTERNATIVE G: UPGRADED MYSTIC WPCF, NO ANOXIC ZONES (NO DIVERSION TO BOROUGH WPCF)
Figure 7-AG-M

CDM



PLAN

1"= 40'



KEY PLAN

1"=400'

STONINGTON WATER POLLUTION CONTROL AUTHORITY
FACILITIES PLAN

ALTERNATIVE G: UPGRADED
PAWCATUCK WPCF

CDM

Figure 7-AG-P

Section 7
Alternatives Evaluation

7.1 Identification and Screening of Alternatives

7.1.1 Introduction

The configuration of the existing Stonington WPCA facilities (three separate collection systems and WPCFs) is complex. The complexity of the existing systems provides a tremendous amount of flexibility when considering the numerous options available for upgrading the systems to meet the Town's future wastewater needs. The purpose of Section 7.1 is to reduce the number of possibilities to a limited number of feasible "big picture" overall alternatives. These limited overall alternatives would then be evaluated in detail in Sections 7.2, 7.3 and 7.4, to determine the recommended alternative. Section 7.2 presents a siting alternative evaluation, for the big-picture alternatives that would require a new site. Section 7.3 presents a technology screening evaluation. Section 7.4 presents an evaluation of the detailed process alternatives that would be implemented under each of the big-picture alternatives. Finally, Section 7.5 summarizes the results of the alternatives evaluation.

The alternatives evaluation presented in this Section was initially performed in 2002. Several changes in the assumed conditions have occurred since that time, including:

- As a result of the Long Island Sound Study, CTDEP issued the *General Permit for Nitrogen Discharges*, which establishes wasteload allocations for all 79 publicly-owned wastewater treatment facilities in Connecticut. Wasteload allocations were established for each of Stonington's three WPCFs, which become more stringent with time. Coupled with this permit is a nitrogen trading program by which WPCF owners can "buy" or "sell" nitrogen credits from other WPCF owners to meet their permitted wasteload allocation. (See Section 1.5 for additional information.)

- As the Wastewater Facilities Plan evaluations were concluding in 2002, CTDEP requested that Stonington further evaluate Alternative D described below in Section 7.1.2. Alternative D — later termed the "Groton Alternative" — assumes that the Mystic and Borough WPCFs are abandoned and that flow from these collection systems is transferred to the Town of Groton system for treatment. This evaluation is attached to this Wastewater Facilities Plan as Appendix F. More recently, the Groton Alternative has become formally non-viable, per the Town of Groton, and Stonington WPCA has received a letter to that affect. This letter is also included in Appendix F.

- Land development is continually changing. Since 2002, there have been development and changes in land use that modify the outcome of initial alternatives evaluation. These changes have been indicated, as appropriate, in the following sections.

- Integrated Fixed-Film Activated Sludge (IFAS) and Membrane bioreactors (MBRs) are becoming more accepted treatment technologies. Although these technologies were not fully assessed in this section, they should be considered during the design phase for new treatment facilities.

- The Town of Stonington's Planning and Zoning Commission adopted the *2004 Plan of Conservation and Development* on June 29, 2004. This plan is "intended to provide a framework for consistent decision-making by Town boards, commissions and residents with regard to conservation and development" through the year 2020 (see Section 3.2.7 for additional information).

- Construction and operation/maintenance costs have risen. This evaluation was initially performed in 2002. Costs have been escalated to a 2006 Engineering News Record (ENR) cost index of 7,763 to reflect current costs.

7.1.2 List of Possible Alternatives

Brainstorm of Alternatives

A brainstorm of overall alternatives was developed after review of Sections 3, 4 and 5, and revised as a result of the public comments received. The initial brainstorm list does not consider feasibility or other criteria, but represents a starting point to the alternatives evaluation. **Table 7-1** presents the result of the initial list.

Alternatives Screening

Alternative A

The WPCA has an extensive investment in the existing collection systems and WPCFs. Continuing to utilize all three existing WPCFs would minimize required upgrades to the collection system, and would maximize the use of existing facilities. Alternative A is an obvious candidate for detailed evaluation.

Alternative B

Similar to Alternative A, this potential option maximizes the use of the existing infrastructure, and may be a more feasible solution due to the existing shortcomings at the Mystic WPCF. The Borough and Pawcatuck WPCFs would be upgraded as part of this option.

Alternative C

It is anticipated that the Mystic WPCF would require substantial upgrading to efficiently handle even a portion of the flow collected in the Mystic collection system. The Borough WPCF is not as overloaded, and it may be more feasible and cost effective to transfer all of the flow from the Mystic area to the Borough WPCF, and to abandon the Mystic WPCF. The Pawcatuck WPCF would be upgraded to handle flows from its contributing collection system. This appears to be a feasible option, and will be included in the detailed evaluation.

See Table 7-1

Alternative D

This alternative was initially believed to be infeasible due to the significant construction, operating, logistical and regulating hurdles that would have to be solved. However, CTDEP requested that this option be evaluated in detail to determine its feasibility. WPCA implemented this evaluation, subsequent to completion of this alternatives evaluation. The evaluation of the "Groton Alternative" is therefore documented separately and is made a part of this Wastewater Facilities Plan as Appendix F. The evaluation of the Groton Alternative confirmed that this option is not feasible, and WPCA has also received formal notification from the Town of Groton that this option is not viable.

Alternative E

One possibly underused aspect of WPCA's infrastructure is the ample site available at the Pawcatuck WPCF. This is in contrast with the Mystic and Borough WPCF sites, which are very constrained. Abandoning the Mystic and Borough WPCFs, and treating all of the Town's wastewater at the Pawcatuck WPCF, would take advantage of this available space, and would allow the WPCA to operate a single plant, rather than three. There are disadvantages to this option, including the need to pump all of the Town's flow to the Pawcatuck WPCF site and to re-pump at least a portion of the treated effluent to discharge. This option will be evaluated in detail.

Alternative F

As mentioned, both the Mystic and Borough WPCF sites have limited available area. It may not be feasible or cost effective to meet the Town's future needs at these two sites. In addition, both of these two sites are in areas where the land could potentially serve another purpose to the benefit of residents and the Town. It may be feasible to construct a new WPCF to handle the flow from the Mystic and Borough collection systems, and to re-use the existing sites. Ideally, the new site would be located somewhat near the Mystic and Borough collection systems. In this option, the Pawcatuck WPCF would be upgraded to treat flow from its local collection system. This is a feasible alternative and will be included in the detailed evaluation.

Alternative G

As described in Section 5, the three WPCFs would need to be upgraded within the 20-year planning period for three reasons: 1) to meet future flows and loads under existing permitted water quality conditions; 2) to replace/refurbish aged equipment and systems; and 3) to provide nitrogen removal, in accordance with the WPCA's wasteload allocation limits included in the CTDEP *General Permit for Nitrogen Discharges*. As part of its nitrogen removal program, CTDEP has implemented a nitrogen trading program that would allow system owners that do not provide sufficient nitrogen removal at their WPCFs to buy "credits" from other WPCF owners in the state that are removing more nitrogen than required. As described in the project's public participation documentation in Section 11, this alternative was identified as the preferred option by a Citizen's Review Panel (CRP), after review of a earlier draft version (dated August 2001) of this Wastewater Facilities Plan. The CRP slightly modified the description of this alternative, to include significant odor control systems installed at all three plants, consideration of the Symbio™ process at all three plants, if necessary, and to take advantage of potential opportunities to delay upgrades at the plants (especially the Pawcatuck WPCF) if the projected flow increases do not occur. This alternative will be included in the detailed evaluation.

Alternative H

This option would involve abandoning all three existing WPCFs and constructing a new WPCF at a new site to handle the entire Town's wastewater needs. This option has several advantages, including efficiency of operation, and ease of construction. However, a new site would be required, as would transfer pumping to and from the new site. Because of the potential advantages associated with this alternative, it will be considered in detail.

Alternative I

In implementing the no-action alternative, WPCA would not upgrade any of the three WPCFs or collection systems to meet future flows and loads, replace old or worn out equipment and systems, or to provide nitrogen removal. The up-front capital cost of implementing any improvements would be avoided, but at a high price. The WPCFs would begin to routinely violate their NPDES discharge permits (which result from the Clean Water Act) for many parameters as flows and loads increase, and the cost of complying with the nitrogen limits would continually increase. Ongoing maintenance costs would also continue to increase. At some point, WPCA would be subjected to fines and eventual legal action by CTDEP and possibly third parties. Enforcement action would likely include a moratorium on sewer connections (development), and eventually WPCF improvements, possibly not cost-effective or those preferred by the Town, would be enforced by CTDEP. Aside from the legal and financial damage, not pursuing a solution to the Town's wastewater disposal needs would subject the environment to damage. For all of these reasons, the no-action alternative will not be pursued.

Alternative J

Similar to Alternative A and B, this potential option maximizes the use of existing infrastructure. However, this alternative is different in that instead of primary underflow, which contains all of the solids and residuals removed at the Mystic WPCF, the diversion instead would be either primary effluent or raw influent. This would have two significant impacts: 1) it would reduce to load on the Borough WPCF compared to Alternative B; and) it would require solids-handling processes to be installed and operated at the Mystic WPCF. Because of the potential benefits associated with this alternative, it will be considered in detail.

Final Candidate Alternatives

As discussed above, eight alternatives have been selected for detailed evaluation in the following sections. These are summarized in **Table 7-2**. Note that the naming convention for Alternative G is maintained to avoid confusion.

See Table 7-2

7.2 Water Pollution Control Facility Siting

7.2.1 Introduction

As discussed above, two of the final eight alternatives (Alternative Nos. 4 and 5) would require that a new Water Pollution Control Facility (WPCF) be constructed at a new site, to treat some or all of the projected wastewater flow within the Town of Stonington. This section outlines the process used to screen appropriate sites suitable for construction and operation of a new WPCF, and includes:

- An outline of the methodology used to identify potential sites.
- A description of the initial, secondary and final screening processes.
- The recommended site for new WPCFs under Alternative Nos. 4 and 5.

7.2.2 Screening Considerations

The criteria presented in the following paragraphs were considerations in identifying suitable sites for new WPCFs.

Area Requirements

A candidate site should be a preferred minimum of approximately 10 acres for construction of the WPCF. This land area is considered the minimum site size necessary to construct a WPCF that would economically meet Stonington's planning needs, is sufficient for future expansion beyond the 20-year planning period of this Wastewater Facilities Plan, and provides some buffering to adjacent parcels. Though not preferred, if no ideal candidate sites were found with at least this amount of acreage, smaller sites larger than 5 acres could be considered with the understanding that construction of the WPCF could be more difficult, and future expansion of the facility may be limited.

Current Zoning Requirements and Site Location

The current zoning regulations were reviewed during the site screening process. Generally, sites in industrially-zoned areas were preferred over sites in commercially-zoned areas. Commercially-zoned areas were preferred over residentially-zoned areas.

Current Land Use

Sites that are already developed are not candidate sites. Areas that are reserved, by the State of Connecticut, Avalonia, or other conservancy, are also not considered candidate sites. In addition, land use characteristics of surrounding sites were considered in the analysis.

Property Ownership

Sites that are owned by the Town of Stonington and are large enough to accommodate a WPCF were preferred over privately-owned land for which the Town would incur acquisition costs.

Access

If the candidate site already had an access road, it was preferred to a site where additional land acquisition or land clearing would be required to construct a new road. Likewise, sites that already allow truck access via existing roadways are preferred over sites that would require constructing or modifying roads to handle truck traffic.

Proximity to Existing or Proposed Sewer Systems

The proximity of the potential site to the existing sewer systems, or to the areas recommended for sewering, was also a factor. It is not cost-effective to construct a treatment plant on the opposite side of town from the sewered areas, if an equally qualified candidate site can be identified in close proximity. Therefore, sites in close proximity to the sewer system were preferred.

Proximity to Existing or Projected Development

No matter how well operated, WPCFs can be perceived as a nuisance to neighbors regarding the potential for odors, noise, and truck traffic. For this reason, isolated sites were preferred to sites near existing or projected development.

Physical Characteristics

The physical limitations of each site were also considered. Factors such as elevation, topography, and soil type all have an impact on the feasibility of a site. Whether or not the candidate site is within the floodplain, or contains wetlands or surface water bodies is also a consideration.

Site Configuration

The configuration of each site was a factor in the analysis. A site that meets the acreage limit and is rectangular in shape may be better able to accommodate a treatment facility better than a site that is the same size, but is long and narrow in shape.

Historic and Archeological Features

Destroying or altering sites that have historic or archeological significance must be avoided. Therefore, sites meeting these criteria are not considered candidate sites.

Rare or Endangered Species

Sites for which there are known rare or endangered species habitats were considered candidate sites with the understanding that permitting a new WPCF could be time consuming and expensive, and special mitigation measures may be required. Our evaluation did not include on-site surveys, which provide more site-specific information and are required as part of an environmental assessment prior to proposed construction activities.

7.2.3 Site Selection Process

The site selection process consisted of the following three steps:

1. Initial screening of all lots based on parcel size, location and zoning.

2. Secondary screening based on land use, existing and proposed development, proximity to existing and proposed sewers, and the size and configuration of each site.

3. Final ranking was conducted on the remaining viable sites, and involved an individual analysis on physical conditions, engineering and technical feasibility, environmental features, and the other criteria described in Section 7.2.2.

If the initial and secondary screening criteria were found to be too restrictive and no potential sites remained for the final screening analysis, then the sites would be re-evaluated with less stringent criteria.

Initial Screening

The objective of the initial site screening process was to identify land parcels that may qualify as candidates for siting the WPCF. Several of the considerations outlined in Section 7.2.2 serve to screen out those sites that are not good candidates. The initial screening process involved several steps, which are described below.

There are a total of approximately 8,200 parcels within the Town of Stonington (based on Town GIS data from spring 2001). Of this total, 382 parcels have areas of at least 10 acres. Although the number of potential sites is considerably reduced in this step, additional steps were required to narrow down the sites even further. Parcels that are owned and reserved by the State of Connecticut, Avalonia, or other conservancies were screened out of contention.

The next step in screening candidate sites was to determine limitations on feasible geographical locations. For example, it was noted that there are very few existing sewers in Stonington north of Interstate 95. Further, this Wastewater Facilities Plan does not propose any additional sewers north of Interstate 95. Therefore, sites located north of Interstate 95 are not considered feasible, and were screened out.

Secondary Screening

A second round of screening criteria was applied to the 155 sites that passed the initial screening process. The secondary screening process was based on existing or projected land use and development, proximity to existing or proposed sewers, and the size and configuration of each site. The objective of this process was to refine the screening process and identify finalist candidate sites that are suitable for siting a WPCF.

Since it is not cost-effective to construct transmission mains and a treatment plant in areas isolated from existing or proposed sewered areas, one large centralized locale was identified within the Town of Stonington in which the WPCF would ideally be located. The area was chosen to generally represent a geographically feasible treatment facility location for Alternative No. 4 or Alternative No. 5.

The general locale for a new treatment facility is roughly bounded to the north by Mistuxet Avenue, Pelligrino Road, and Pequot Trail; to the west by Hewitt Road; to the east by Castle Hill Road, Spellman Drive, and Aimee Drive; and to the south by U.S. Route 1, Greenhaven Road and the railroad tracks. This area, which is located south of Interstate 95, encompasses many properties that are potentially acceptable for a new WPCF under Alternative No. 4 or Alternative No. 5.

Land uses considered to preclude construction of a WPCF within this locale were identified as follows:

- Existing residential, commercial, industrial, or institutional development.
- Land committed to development.

After screening out those lots that don't qualify under these criteria, a total of ten parcels remained.

Final Ranking

A final round of analysis was conducted on the ten remaining sites to find the most suitable site for a new WPCF. A list of suitability factors, summarized below, was applied to the remaining sites to establish the most suitable site for a new facility. Some suitability factors may also have been applied as criteria in the initial and secondary screening analyses, but are more stringent in this final screening process. The suitability factors include the following:

- Implementability
  - Ownership
  - Legal Issues
  - "Fatal Flaws"
  - Distinguishing Characteristic or Key Advantage
- Compatibility with Site and Surrounding Areas
  - Site land use and zoning
  - Surrounding land use and zoning
  - Community disruption
- Site Characteristics
  - Size and configuration
  - Flexibility for expansion
  - Topography
- Engineering/Technical Feasibility
  - Effluent pipe length

- Compatibility with existing system
- Site preparation

- Vehicle Access
  - Proximity of site to truck routes
  - Opportunities for direct access to site

- Environmental Features
  - Impacts to wetland areas
  - Proximity of site to flood hazard areas
  - Proximity of site to surface water bodies
  - Proximity of site to State and Federally listed endangered, threatened, and special concern species and significant communities

- Historical/Archeological Features

- Land Acquisition

7.2.4 Site Selection Results

Upon completing the final site ranking, the town-owned site adjacent to the existing WPCA Pumping Station No. 2, off U.S. Route 1 and Spellman Drive, was identified as the most suitable location for a new WPCF. For the purpose of developing cost information in Section 7.4, this site — the "Pumping Station No. 2 site" — was used for Alternative No. 4 and Alternative No. 5. **Table 7-3** shows the ranking of the ten finalist sites and **Figure 7-1** shows the recommended parcel.

Recommended Site

The final ten sites were ranked based upon the criteria discussed in Section 7.2.3. The Pumping Station No. 2 site received the highest ranking due to several factors. Since the Town already owns this site, the legal issues and acquisition costs associated with acquiring the other privately owned sites make this site especially attractive for siting a new WPCF. The following advantages also contributed in identifying this site as the most suitable location for a WPCF:

- The parcel is large enough for future expansion and has adequate buffering capacity from residential areas

- The surrounding wooded area would allow the facility to be visually unnoticeable from residential areas

- Surrounding wetlands on three sides would prevent residential development from encroaching on the site

See Table 7-3

See Figure 7-1

The main disadvantage of this site is that it is not centrally located within the entire town. Therefore, the use of this site would require constructing significant lengths of additional raw wastewater and treated effluent transmission mains. However, the costs of constructing these transmission mains are thought to be comparable to the costs of acquiring other privately owned property.

Other Finalist Sites

The remaining sites did not rank as high as the Pumping Station No. 2 site based on the criteria discussed in Section 7.2.3, however, may qualify as potential back-up sites if for some reason the town-owned site cannot be utilized.

Though no longer available as of this writing due to alternate development plans, the lower portion of the airport site ranked second at the time the evaluation was conducted, and was considered a viable back-up site if a potential problem arose with the preferred site. The site is adjacent to the existing Borough collection system and centrally located within the Town. The size of this site had some advantages; it provided flexibility for future expansion and buffering from residential areas. Wetlands surrounding the site on three sides would prevent residential development from encroaching on the site. Since the property is level and already cleared, very little site preparation would have been required prior to constructing a WPCF. Access to the site from U.S. Route 1 is an advantage. A disadvantage would have been that the site is located within a floodplain and is surrounded on three sides by water, therefore requiring special flood protection for the treatment facility.

The upper portion of the airport site ranked third overall in the evaluation. This site is no longer available, but it did have sufficient size for future expansion of a WPCF, as well as considerable buffer to nearby neighborhoods. The site is adjacent to the existing Borough collection system and centrally located to the Town. The site is not located within the floodplain and has very good access. Unlike the lower portion of this site, the upper portion would require considerably more site preparation due to clearing woodlands and excavating bedrock. Although it has some buffer, it is closer than the upper portion to residential areas, which may encroach on the site in the future.

Palmer Neck Road has two sites that ranked very closely in the final screening (Site No. 34 and Site No. 32). Site No. 34 ranked slightly higher due to a larger area, which would provide better flexibility for future expansion and greater buffer to nearby homes. All or parts of these sites are located within the floodplain and may require special design and construction measures to prevent impacts to a treatment facility at these locations. Wetland impacts during construction at these sites are also a concern.

The five remaining sites that round out the ten finalists scored relatively close to each other with regards to the criteria, but are not considered the most suitable WPCF sites. However, Site No. 24 is no longer available as it is now owned by Avalonia Land Conservancy. The remaining four sites can be reconsidered as feasible alternatives if problems are discovered with the higher ranked sites. Several criteria contributed ranking these sites lower than the others and include:

- difficulties with conveyance of sewage,
- awkward site configuration,
- impacts to wetlands, and
- land acquisition issues.

7.3 WPCF Process Alternatives Screening

7.3.1 Introduction

This section presents an evaluation of process alternatives to implement as part of the overall alternatives described in Section 7.1. The effluent from the water pollution control facilities (WPCFs) would be required to comply with federal and state NPDES requirements, and effluent quality requirements are described. An initial screening of process alternatives is then presented, in order to screen out the alternatives that do not appear to be feasible. The initial screening process would result in a small number of feasible process alternatives that would then be evaluated in detail. The narrowed list of process alternatives would be developed in detail in Section 7.4, and would be compared in terms of general feasibility, cost, and important non-economic factors in Section 7.5.

7.3.2 WPCF Effluent Quality

The final effluent from each of the three existing WPCFs, and/or from a new WPCF, would be required to meet the current NPDES secondary treatment levels. In addition, the upgraded or new facilities would be required to remove total nitrogen (TN) in accordance with the general permit for nitrogen removal and the wasteload allocation (WLA) assigned to Stonington by CTDEP. It is also anticipated that future permits would require a dechlorination process be provided, for all facilities disinfecting by addition of either chlorine gas or liquid sodium hypochlorite (as at all three existing WPCFs, as described in Section 5). **Table 7-4** summarizes the anticipated effluent quality requirements that are critical to the alternatives evaluation.

All of the alternative treatment process trains evaluated in this section are designed to meet these treatment goals, with the exception of Alternative G, which would not be designed with the intent of meeting the nitrogen limits, and would only provide the degree of nitrogen removal that can be achieved while using the Symbio™ process.

7.3.3 Initial Screening of Process Alternatives

The initial screening of alternatives is divided into two separate analyses: one for the overall alternatives that involve upgrading of the existing WPCFs (Alternative Nos. 1, 1A, 1B, 2, 3, 4 and G), and one for the overall alternatives involving construction of a new WPCF (Alternative Nos. 4 and 5). The basis for this division is that one of the primary advantages in upgrading an existing WPCF is to re-use the existing system configurations and tankage to the full extent possible. For example, the three existing WPCFs all utilize the activated sludge process for secondary treatment, and expansion of the secondary treatment process at the existing plants would very likely involve expansion and/or modification of the activated sludge process in some manner. In this case, other secondary treatment alternatives are not considered feasible and would not be evaluated. In contrast, alternative process technologies may be appropriate for the alternatives involving construction of a new WPCF, and would be evaluated.

Table 7-4

Anticipated Stonington WPCF Effluent Quality Requirements

Condition	Mystic WPCF	Borough WPCF	Pawcatuck WPCF
BOD_5 (mg/L)	30 (avg. monthly) 50 (max. daily)	25 (avg. monthly) 45 (max. daily)	25 (avg. monthly) 45 (max. daily)
TSS (mg/L)	30 (avg. monthly) 50 (max. daily)	30 (avg. monthly) 50 (max. daily)	30 (avg. monthly) 50 (max. daily)
TN (mg/L)[1]	8.1 mg/L (2006) 5.1 mg/L (2014) 4.5 mg/L (2025)	10.9 mg/L (2006) 6.6 mg/L (2014) 5.6 mg/L (2025)	8.5 mg/L (2006) 4.2 mg/L (2014) 3.1 mg/L (2025)
Total Residual Chlorine (TRC) (mg/L)[2]	0.2 (minimum) 1.5 (maximum)	0.2 (minimum) 1.5 (maximum)	0.2 (minimum) 1.5 (maximum)

[1] TN concentrations are based on the *General Permit for Nitrogen Discharges*, allowable WLA (lbs/day) and the projected annual average flow in the indicated year. TN WLAs may be traded among the Stonington WPCFs; it is possible that one WPCF can discharge at a higher effluent TN concentration, but an increase in effluent wasteload would have to be made up by an equal decrease in discharge quantity at another WPCF. TN WLAs for 2006 and 2014 are based on the General Permit. It is assumed that the WLA for 2025 is the same as for 2014. More stringent treatment would be needed (in terms of concentration) because of the projected flow increases over time.

[2] Effluent TRC limits shown. It is anticipated that stricter limits on TRC would be permitted in the future, requiring that dechlorination be provided following chlorine disinfection.

Upgrade of Existing WPCFs

As described in Section 5, all three of the existing WPCFs employ the following processes: influent comminution (grinding), primary clarification, the activated sludge process, and disinfection using sodium hypochlorite. The Mystic WPCF utilizes a grit removal process on the flow that is diverted to the Borough WPCF. The Borough and Pawcatuck WPCFs utilize a sludge thickening process, and all three plants utilize odor control processes at various locations in each plant. WPCA recently completed a major odor control improvements project at all three WPCFs, utilizing biofilters at the Borough and Pawcatuck WPCFs, and a carbon system at the Mystic WPCF.

The overall alternatives that involve upgrading of the existing WPCFs would, to the extent feasible, utilize these existing process technologies. Introduction of a new or replacement process technology at the existing sites would be evaluated in select circumstances, when required to meet treatment goals. The following paragraphs describe these considerations in detail.

Preliminary Treatment

The three existing WPCFs utilize influent comminution, or grinding, as the first process in the treatment train (the Pawcatuck WPCF's comminution and influent pumping process is actually off site at Pumping Station No. 3). The use of these grinders has not caused any chronic operational problems, and any upgrades to the existing WPCFs would include grinders. Depending on the peak flow associated with the overall alternative, the existing grinders may have to be replaced with higher-capacity units.

The process alternative to grinders, which is a type of bar screen that removes debris and other larger particles from the influent, would require reconfiguration of the pump stations at each facility, and would also require that a screenings handling system be installed. Increased odor control capacity would also have to be incorporated to treat odors that would emanate from a screenings handling room.

None of the three existing WPCFs currently employ an influent grit removal process. Instead, grit is removed in the downstream primary clarifiers, with the primary sludge. This has proven to be satisfactory from a process efficiency and maintenance standpoint, and therefore any upgrades to the existing facilities would not include grit removal as a separate process. Exception to this evaluation would be made if a process train alternative is developed that does not include primary clarification, as might be the case in certain nitrogen removal facility process trains. Grit removal would be necessary in any process train that does not include primary clarification.

The Pawcatuck WPCF currently utilizes a septage receiving facility. Upgrades to the Pawcatuck WPCF would continue this process, and the existing system at Pawcatuck requires improvements. Septage receiving would not be included in the evaluation of upgrades to the Mystic and Borough WPCFs.

Primary Treatment

The three WPCFs all provide primary treatment with primary clarifiers. The primary clarifiers are rectangular at the Mystic WPCF and the Pawcatuck WPCF, and are circular at the Borough WPCF. Upgrades to the existing WPCFs would involve use, and upgrading if necessary, of the primary clarification process. The only exception to this evaluation would be if primary clarification is not required or compatible with a downstream nitrogen removal process.

Secondary Treatment/Nutrient Removal

The three WPCFs utilize the activated sludge process to provide secondary treatment. The existing tankage, air supply and sludge pumping systems are in place, and it is not feasible to replace these facilities with another secondary treatment process, such as rotating biological contactors (RBCs) or trickling filters. Increasing secondary treatment capacity would be accomplished by upgrading the existing activated sludge processes.

Aeration basins and secondary clarifiers are used in the existing secondary-treatment process, and while they are sized to meet secondary treatment goals (BOD and TSS removal), they are not adequately sized to provide year-round nitrification (ammonia removal) at projected flow rates. The nitrification process is a necessary step in nitrogen removal. The existing secondary treatment processes would therefore need to be upgraded to provide year-round nitrification, and this would require expansion of the aeration tankage and/or the secondary clarification capacity.

The existing WPCFs would be required to provide nitrogen removal, to increasingly stringent levels, or be dependent on the State's nitrogen trading program. The most feasible alternative to achieve nitrogen removal at the existing WPCFs is a single-sludge biological nitrogen removal (BNR) process. This process involves utilizing the existing activated sludge systems, and expanding the process to provide tankage for alternating aerobic and anoxic zones. This type of single-sludge BNR process, utilizing aerobic and anoxic zones with internal recycle pumping, will be evaluated at the existing WPCFs, and will be the recommended process to implement at the existing WPCFs unless the extent of upgrade and modification is significant enough to warrant review of other processes.

WPCA is currently utilizing the Symbio™ process at the Borough WPCF. In theory, the Symbio™ process would eliminate the need to provide separate aerobic and anoxic zones, and thereby would reduce the cost of constructing the tankage. As of publication of this *Wastewater Facilities Plan* report, the Symbio™ process has had only sporadic success at removing nitrogen to an effluent concentration of 10mg/L or less at the Borough WPCF. The process has not yet demonstrated consistent success, and is therefore still considered to be an unproven process. Experience at the few other facilities nation-wide that employ Symbio™ process indicates performance better than has been demonstrated at Stonington. However, for planning purposes, WPCA cannot rely on the Symbio™ process as the recommended nitrogen removal process alternative on which to base the success of the 20-year facilities plan, or on which to base and plan for the costs of meeting the goals of the Wastewater Facilities Plan. However, if in the time between submittal of this facilities plan and the next phase of the project (detailed design) the Symbio™ process demonstrates long-term successful performance, WPCA should re-consider its use as a possible cost-savings measure.

The IFAS and MBR technologies described earlier are generally designed to be compatible with retrofit into activated sludge systems, and their use would reduce the overall footprint needed to upgrade the biological processes at the existing WPCFs.

At this planning stage, the alternative footprints are shown without use of these innovative technologies, and therefore can be considered as worst-case layouts. WPCA should consider these process alternatives in the next phase of the project (detailed design).

Disinfection

The existing WPCFs all provide disinfection by addition of sodium hypochlorite to the secondary effluent, and by providing contact time to allow the sodium hypochlorite to kill the pathogens before discharge to the receiving waters. The sodium hypochlorite storage and feed systems are already in place at the WPCFs, so expansion of the disinfection systems at the existing WPCFs would involve upgrades that continue to utilize sodium hypochlorite. This would be the recommended upgrade alternative at the existing WPCFs unless the extent of upgrade necessary (such as construction of new, large contact tanks to meet future peak flow requirements) warrants review of other process alternatives.

It is anticipated that dechlorination would be required after disinfection. The companion process to disinfection with sodium hypochlorite is dechlorination with sodium bisulfite, and this would be the "default" dechlorination process at the existing WPCFs.

Effluent Discharge

The existing WPCFs all discharge to surface waters, through existing effluent outfalls. For the alternatives utilizing the existing WPCFs, the existing outfalls would be used to the extent possible. If the overall alternative results in discharge that exceeds the allowable discharge through a certain outfall, transfer pumping would be provided to utilize all three of the existing outfalls as necessary.

WPCA has not investigated the potential for groundwater discharge, to replace all or part of the existing outfall capacity. Such an investigation is a significant endeavor, and was not included in DEP-approved scope of the facilities plan project.

WPCA would be open to discussing the possible reuse of its treated effluent for beneficial use, if and when any opportunities arise. WPCA does not anticipate an effluent reuse demand sufficient to eliminate the need to use the existing outfalls.

Solids Handling

The Mystic WPCF does not have any solids handling systems in place. Sludge generated at the Mystic WPCF is pumped to the Borough WPCF as part of the diversion flow. The Borough WPCF and the Pawcatuck WPCF both employ sludge-thickening processes prior to hauling the thickened sludge for off-site disposal. Alternatives involving upgrades to the three WPCFs would continue these processes. No additional solids handling processes, such as dewatering or digestion, will be evaluated.

Odor Control
All three of the existing WPCFs currently employ new odor control systems, which went on-line in 2003. Provision of odor control for typical odor sources is vital, and additional odor control facilities, to at-a-minimum maintain the same level of control as provided by the recently completed program, will be included in all alternatives involving upgrade of the existing facilities.

New Water Pollution Control Facilities

Alternative Nos. 4 and 5 involve construction of a new WPCF. Feasible process alternatives for a new WPCF are not constrained as in the alternatives involving upgrade of the existing three WPCFs.

Preliminary Treatment
The preliminary treatment processes alternatives considered include the following:

- Septage Receiving
- Bar Screens
- Comminutors (grinders)
- Grit removal

Septage Receiving. Since the majority of the Town would remain unsewered, a septage receiving facility provides a local option to dispose of septic system wastes, and may encourage maintenance of those systems. The Pawcatuck WPCF's septage receiving facility provides minimal capability to handle septage. Therefore, both Alternative No 4 and Alternative No. 5 should include a septage receiving facility at the new plant to enable the WPCA to continue to receive septage.

Bar Screens. Coarse material, such as sticks, stones, bottles, and large rags must be removed or otherwise handled in order to protect downstream mechanical equipment from damage. These materials may be removed by bar screens, which are common in WPCFs. There are many different types of bar screens, and the best equipment selection for each application is largely a function of operator preference.

Provision of bar screens can be beneficial, because the debris is removed from the influent, alleviating maintenance requirements. A disadvantage of the use of screens is that a new waste-stream, the screenings, now must be handled separately. The use of screens will be compared to the use of comminutors in the detailed evaluation of each overall alternative.

Fine Screens. Fine screens operate in a similar manner to bar screens, except that the openings that the wastewater must pass through are much smaller. As a result, much more potentially damaging material is removed. While this can improve operation and maintenance requirements for downstream processes, it also requires more materials handling.

Comminutors (grinders). Comminution, or grinding, is provided at many WPCFs (including the three existing Stonington WPCFs) as a method for crushing or grinding solid debris into smaller sizes, such that it would not damage downstream equipment. Historically grinders do not provide the same level of protection as screens, but they are simpler to operate and they do not generate a new waste-stream to be handled. Grinders will be compared to bar screens in the detailed evaluation of each alternative.

Grit Removal. Grit is defined as heavy, dense, inorganic material (such as sand and gravel) that settles rapidly from the influent waste stream. Grit removal is accomplished in a tank where the flow velocity is controlled to be low enough to allow the grit to settle, but high enough such that the organic material in the influent is maintained in suspension for removal by a downstream process. Grit removal systems can also be configured to accomplish scum and grease removal, which could be a significant benefit to Stonington, in regards to the heavy scum and grease load currently experienced.

Grit removal is generally employed to protect downstream equipment. Grit removal has not historically been required for Stonington's wastewater, and therefore will not be included in a new WPCF process train unless primary clarifiers are omitted (as may be the case, depending on the BNR removal alternative selected). *Technical Report #16, Guides for the Design of Wastewater Treatment Works (TR-16)*, requires that facilities not provided with a grit removal process be designed, site footprint-wise and hydraulically, such that a grit removal process can be added at a later date if necessary.

Primary Treatment

Primary treatment, utilizing appropriately sized primary clarifiers, would be included in any new WPCF process train, except if the recommended BNR alternative does not require upstream primary clarifiers. Primary clarifiers can be either rectangular or circular, and both options perform similarly. Rectangular clarifiers have two advantages: 1) space efficiency, due to the ability to utilize common-wall construction, and 2) cost efficiency, for the same reason. When primary clarifiers are recommended as part of the process train, rectangular clarifiers will be implemented.

Secondary Treatment/Nutrient Removal

All of the biological treatment alternatives would be required to accomplish the same treatment objectives (i.e., BOD and TSS removal to secondary treatment standards) and nitrogen removal to the levels tabulated in Table 7-1. Several process options were evaluated, as listed below. Though not all options are evaluated in detail in this Wastewater Facilities Plan, it is recommended that technology selection be re-visited during the early stages of the design of the project to identify the best long-term technology for Stonington.

- Modified Ludzack-Ettinger (MLE) Process followed by denitrification filters

- Bardenpho™ Process
- Sequencing Batch Reactors (SBRs)
- Oxidation Ditches
- Simultaneous Nitrification/Denitrification
- Integrated Fixed-Film Activated Sludge (IFAS) systems.
- Membrane bioreactors

MLE Process (w/denitrification filters). The MLE process is a variation of the activated sludge process, except that an anoxic reactor is located upstream of the aeration basin. The two-zone system includes a mixed liquor recycle from the discharge end of the aerobic zone to the anoxic zone. The internal recycle is in the range of 4 to 6 times the influent flowrate, and therefore involves a substantial amount of pumping. The purpose of the mixed liquor recycle is to take advantage of the organic carbon that enters the anoxic zone with the wastewater, to achieve denitrification. The MLE process can typically achieve effluent TN concentrations in the 7 to 10 mg/L range. While this process may be sufficient to allow Stonington to meet the total nitrogen wasteload allocation (WLA) for the first several years, it is not sufficient to meet the eventual 2014 TN limit. It would therefore be necessary to plan on a companion downstream denitrification process such as denitrification filters to meet future limits.

Denitrification filters can be used in series with a process like the MLE process, as a final treatment step in providing nitrogen removal. These filters are a fixed-film process, in which effluent from the MLE process is filtered through a granular media like sand. Denitrification bacteria grow and form a film on the media, and the wastewater is denitrified. When following another biological process such as the MLE process, a supplemental carbon source such as methanol must be added to the wastewater to allow denitrification to proceed. The MLE process, followed by denitrification filters, will be evaluated in detail for each of the new WPCF alternatives.

Bardenpho™ Process. The Bardenpho™ process is similar to the MLE process, except that the Bardenpho™ process includes an additional, second anoxic zone that is followed by a second aerobic zone. This last anoxic-aerobic pair allows the process to denitrify the nitrates that are not recycled through the first anoxic and aerobic zones, and typically allows the process to achieve effluent TN concentrations in the 2 to 4 mg/L range. The Bardenpho™ process is a proven technology, and will be evaluated in detail for each of the new WPCF alternatives.

Sequencing Batch Reactors. SBRs are a variation of the activated sludge process that employs a phased-in-time approach to meeting treatment requirements, and accomplishes biological treatment and secondary clarification in the same tank. The timing of the anoxic and aerobic periods can be controlled to duplicate the conditions experienced in the MLE or Bardenpho™ process. In the fill phase, influent wastewater is fed to the SBR tank, which is partially filled with mixed liquor. Varying aerobic and anoxic conditions are achieved by cycling the air supply system on and off. Denitrification is achieved during the anoxic phases, and nitrification and carbon oxidation occur during the aerobic phases. After the anoxic/aerobic treatment phases are complete, a quiescent environment, like a secondary clarifier, is provided in the tank, and the mixed liquor settles. After sufficient settling time, the clear effluent is decanted from the top of the tank, and excess mixed liquor is removed. The SBR is then ready to receive and treat another batch of wastewater.

Influent wastewater is fed to SBRs only during the fill cycle, and therefore multiple units must be provided to handle the continuous feed of wastewater at the plant. Operation of the multiple SBRs is coordinated such that one unit is always ready to receive wastewater. SBRs have successfully been operated to achieve effluent TN limits of less than 3 mg/L, and this process will be evaluated in detail for each of the new WPCF alternatives. SBRs are typically not preceded by primary treatment processes.

Oxidation Ditches. Oxidation ditches are essentially activated sludge processes, but are configured in a racetrack layout in which flow proceeds in a continuous loop. Oxidation ditches are easily configured to provide alternating anoxic and aerobic zones, such as the Bardenpho™ or MLE processes, by controlling the locations and amount of air added to the system. Aerobic conditions are achieved in the vicinity of aerators, and anoxic zones are achieved between the aerators. No pumping is required for the mixed liquor recycle because of the racetrack configuration of the ditch. Oxidation ditches provide a potentially efficient, and easy to operate, biological system configuration, and will be evaluated in detail for each of the new WPCF alternatives. Oxidation ditches are typically not preceded by primary treatment processes.

Simultaneous Nitrification/Denitrification. Simultaneous nitrification and denitrification can be implemented in biological systems, if the proper environmental conditions can be continually maintained by plant operators. Several types of process may accomplish this. Alternating aeration processes achieve the necessary combination of aerobic and anoxic conditions in one basin, by carefully controlling the sequence and timing of aeration. The dissolved oxygen (DO) concentration in the tank must be tightly controlled to provide the right conditions for each process, and to provide adequate time for each process to occur. The aeration tanks must be large enough to provide the necessary aerobic reaction time for the conversion of ammonia-nitrogen to nitrate-nitrogen (the nitrification process), and the necessary anoxic reaction time for the conversion of nitrate-nitrogen to nitrogen gas.

Of particular note to Stonington is the Symbio™ process. This process is essentially a variation of the simultaneous nitrification/denitrification process, whereby special instrumentation is used to maintain the ideal DO concentration to obtain simultaneous nitrification and denitrification in one tank. The advantage of this tight control is that separate, additive detention time would theoretically not be required for nitrification and denitrification. The same type of biological process is targeted in the Orbal™ oxidation ditch configuration. The Orbal™ system is designed to provide conditions that result in simultaneous nitrification and denitrification in the same reactor volume, by slowly increasing the DO concentration in the oxidation ditch from essentially 0 mg/L at the influent end to 2 mg/L at the effluent end.

Processes that provide simultaneous nitrification and denitrification are becoming more common, but are not as widespread as those systems that provide separate zones for provision of anoxic and aerobic conditions, and therefore these processes will not be evaluated in detail for each of the overall alternatives. The ongoing operational experience at the Borough WPCF indicates that the Symbio™ process is not yet a technology on which to base the nitrogen removal success of the Wastewater Facilities Plan, as described earlier.

Note that the use of Symbio™ is a key component of Alternative G, which does not, by definition, require nitrogen removal upgrading to allow the plants to achieve the effluent concentrations shown in Table 7-4. In the case of Alternative G, the Symbio™ process is proposed to achieve some degree of nitrogen removal, but not necessarily to the levels required by the CTDEP *General Permit for Nitrogen Discharges*.

Integrated Fixed-Film Activated Sludge (IFAS) System. The IFAS system is a variation of the activated sludge process, in which a fixed-film medium is installed within the aeration basins to increase the biological mass in the system. The media, which can be in the form of sponges, looped chords, plastic packing, or other configuration, is held in the aeration basin, and a biological film develops on the media. Since the biomass is held in the aeration tanks, and is not transferred to the downstream secondary clarifiers, a higher biological mass can be developed without overloading the secondary clarifiers. Nitrification and denitrification can therefore be provided with less tankage.

The IFAS process is feasible, but there are very few full-scale facilities on which to base a design, though the installation list is growing quickly. Though this increase in actual installations is a good indicator of process success, this process is not yet equivalent to the proven processes described above, and will not be evaluated in detail. It is anticipated that in the period between this planning document and the next stage of the project, the IFAS process may become prevalent, and economical as well. Therefore, the IFAS process should be reevaluated early in design.

Membrane Bioreactors (MBRs). Membrane Bioreactors (MBRs) are a relatively new technology that utilizes many aspects of activated sludge biological systems, but include ultrafiltration (UF) or microfiltration (MF) membranes, replacing conventional gravity clarifiers and return activated sludge (RAS) systems in conventional activated sludge biological treatment systems. The membranes are immersed directly in bioreactor tanks, or mixed liquor can be pumped to external pressure driven membrane units. MBRs exhibit a number of unique advantages:

- Secondary clarifiers and RAS pumping systems are not needed. Biological processes can be operated at much higher suspended solids concentrations and thereby provide greater treatment capacity per unit volume.
- MF and UF membranes provide essentially complete removal of protozoan cysts, suspended solids and bacteria, and partial removal of viruses.
- Effluent from an MBR is of higher quality than for secondary clarifiers.

Submerged membrane assemblies, either MF or UF, are typically made up of bundles of hollow-fiber or flat sheets of microporous membranes. Filtrate is drawn through the membrane assemblies by means of a vacuum applied to the effluent side of the membrane. Turbulence on the exterior (feed side) is maintained by diffused aeration to reduce fouling.

The MBR process is feasible, and the process is becoming increasingly widespread. Costs for MBRs have tended to be higher than other options in the past, although they are becoming more competitive. At this time, MBRs are not evaluated in detail, although the technology should certainly be re-visited at the start of the design phase of the project.

Disinfection

There are several process alternatives available to provide disinfection at a new facility. These alternatives include the following:

- Chlorination with gaseous chlorine/dechlorination with gaseous sulfur dioxide
- Disinfection with sodium hypochlorite/dechlorination with sodium bisulfite
- UV disinfection
- Ozone disinfection

The most feasible alternatives are disinfecting with sodium hypochlorite (as at the existing WPCFs), followed by dechlorination with sodium bisulfite, and ultraviolet (UV) irradiation. These technology alternatives are described below.

Ultraviolet Disinfection. An ultraviolet (UV) disinfection system is composed of UV lamps arranged in banks. The banks are placed into a channel, through which the wastewater flows. As wastewater flows through the channel, the lamps transfer electromagnetic energy to the microorganisms' genetic material. The UV radiation penetrates the organisms' cell walls and destroys the cells' ability to reproduce.

Several factors can affect the performance of UV systems. These factors include the quality of water being treated and the UV dose, measured as the product of light intensity times the exposure time. One of the main advantages of UV disinfection is that it is a physical rather than a chemical disinfection process. This means that there are no hazardous chemicals to transport, store or handle. Another advantage to UV is that the contact time required is less than that of chlorination, so UV systems require smaller tanks.

Sodium Hypochlorite/Sodium Bisulfite. Chlorination is a well-established and widely used disinfection technology. Chlorine destroys pathanogenic microorganisms by oxidizing cellular material. Chlorine compounds used in disinfection come in many forms including chlorine gas, powder and liquid. Sodium hypochlorite is the recommended form for use in Stonington because it is easier and safer to handle than chlorine gas, because it is the most common chlorination method for plants within the size range that applies to Stonington, and because all three of Stonington's existing plants currently use it.

Chlorine residual remaining in the effluent after disinfection can negatively impact aquatic life in the receiving water. Discharge permits are trending toward strict residual chlorine concentrations in the effluent, and it is expected that Stonington's plants will eventually required to meet tighter limits. For this reason, the chlorinated wastewater would go through a dechlorination process. Dechlorination removes the chlorine residual from the wastewater. Common dechlorination chemicals include gaseous sulfur dioxide and liquid sodium bisulfite. For plants in the size range of the needed Stonington facilities, sodium bisulfite is the preferred dechlorination agent.

Effluent Discharge

Once the wastewater is treated, it must be disposed in an environmental sound, permitted manner. The three existing WPCFs each discharge to surface water through permitted outfalls. Details of the efficiency and capabilities of each of these outfalls are described in Section 6.

Existing Outfalls. The existing WPCF outfalls are capable of handling the peak flow projected in Section 3, and would therefore be used to the extent possible for all of the overall alternatives. As described in Section 6, the Borough WPCF outfall is the most suitable for a significant increase in flow. The Pawcatuck WPCF outfall is not as ideal, though it can be utilized. The impacts of the Mystic WPCF outfall on the Mystic River were previously evaluated by CTDEP, which determined that an increase in flow from the outfall must not be allowed to increase the loading (i.e., more efficient treatment would be required). The overall alternatives for final selection were selected with these considerations.

Groundwater Discharge. An alternative to discharging through an outfall to surface waters is to return the effluent to groundwater. For Stonington, this option is considered infeasible due to the land requirements, the topography and soil types, and the fact that the Town has three permitted outfalls in place.

Water Reuse. Beneficial reuse of effluent wastewater is becoming a more common method of disposing of wastewater, especially in Florida and California, where water resources are scarcer than in Connecticut. Previously approved applications of reused wastewater are typically for irrigation of golf courses. However, the volume of effluent wastewater generated by Stonington far exceeds the projected amount of water that could be reused in Town, and therefore the water reuse option does not provide an alternate disposal option. The environmental benefits of water reuse can be pursued separately, but will not be incorporated into the Wastewater Facilities Plan.

Solids Handling

The WPCA currently thickens the sludge that is generated by the wastewater treatment processes, and the thickened sludge is then hauled off-site for incineration. This process has been successful and is beneficial for WPCA, as it limits the solids handling requirements and its associated headaches. A new WPCF would also necessarily include a sludge thickening process. Due to the success of the existing systems, a similar process, using rotary-drum thickeners, would be implemented.

Odor Control

Odors are always a concern at wastewater treatment facilities, and in locations where neighbors can be impacted, provisions for odor control must be included. In order to minimize odors, the target process units should be contained and individually covered, or contained in a building with ventilation through an odor control system.

The degree of odor control necessary depends primarily on four factors; characteristics of incoming sewage, proximity to residential areas, presence of natural buffers, and local microclimates (i.e., wind direction, temperature, etc.). The basic components of an odor control facility include a process or building containment structure, an air collection and ventilation system, and an odor removal system.

The degree of odor control provided is the result of evaluating the potential improvements due to the odor control systems, versus the cost, which can be high. Typical problem areas at WPCFs include any areas where raw sewage is exposed, such as preliminary and primary treatment facilities, and pump wet wells or other holding tanks at the front end of the plant. The other very common problem area is the solids handling area, such as where sludge thickening, dewatering, digestion or storage occurs. Areas that are less likely to be a source of problem areas include secondary treatment processes, such as aeration basins and secondary clarifiers, and disinfection processes. It is prudent to plan for possible covering of these areas (such as designing tank walls to eventually support a cover), but committing up-front to covering these areas at considerable cost, with perhaps minimal benefit, is not typically recommended. For the alternatives involving a new plant, the following areas would be covered and ventilated through odor control systems:

- Raw sewage exposure areas

- Preliminary treatment
- Primary treatment
- Solids Handling

There are several process alternatives available to provide control of odors. These alternatives include the following:

- Biofilters
- Trickling Filters
- Absorption and Chemical Oxidation (scrubbers)
- Adsorption Systems
- Thermal Oxidation
- Gas-Phase Systems

Of these alternatives, biofilters, such as those implemented at the Borough and Pawcatuck WPCFs in 2003, are preferred for use in Stonington. Bulk media biofilters have been widely used for odor control. Biofilters can be either open or closed systems. Soil, peat, and compost biofilters are effective in removing odorous compounds.

Biofilters are typically constructed by placing perforated piping in a trench and covering it with gravel to evenly distribute airflow (open biofilter system). A layer of soil, peat, compost or other bulk media is then placed over the piping and acts as the filter. Most biofilters are open systems, but covered (closed) biofilter systems are available. The media in the biofilter provides contact surfaces for microbiological activity to remove odors. Odor reduction is removed primarily by biological oxidation of sulfide to sulfate. The proper moisture level in the biofilter is necessary to sustain life in the filter, and to dissolve sulfide gas to facilitate utilization by the bacteria.

Biofilter performance is based on filter loading, type of media, moisture content, air temperature and the concentration of odorous compounds. Studies suggest that filters can actually regenerate when there are no odorous gases passing through. Biofilters are typically one of the least expensive odor control technologies in use. A disadvantage is that they require a larger construction footprint than other methods. Biofilters are the technology that was implemented as part of the 2003 odor control program, and WPCA anticipates that this technology would be implemented at any new plant location.

7.4 Development of Detailed Alternatives

7.4.1 Introduction

This section contains the detailed descriptions and analysis of the eight overall alternatives. The required upgrade work for each alternative is described, together with a conceptual layout of the facilities. Features of the alternative are discussed, and then conceptual costs of the alternatives are presented for comparison purposes. The assumptions shown in **Table 7-5** were used in developing the cost opinions presented. *(Note: Costs were initially developed in 2002 and have been escalated to an August 2006 ENR index of 7763 to reflect current costs. Costs have not been further escalated to mid-point of construction.)*

Table 7-5

Cost Development Assumptions

Type	Parameter	Assumption
Capital Cost	Currency	2006 dollars (ENR 7763)
	Escalation Factor	Not included in alternatives evaluation.
	Property Acquisition/Resale	NOT included
Annual O&M Cost	Labor	$48/hour, including benefits
	Power Cost	$0.055 per KwH
	Sodium hypochlorite	$0.60 per gallon
	Sodium bisulfite	$1.65 per gallon
	Maintenance Cost (new)	2 percent of new equipment costs/
		Allowance for existing equipment
Present Worth	Service Life	20 years
	Average annual interest rate	5.625 percent

7.4.2 Alternative No. 1

Alternative No. 1 involves the upgrading of each of the three existing WPCFs to handle the future flows and loads from their respective collection systems, and does not include a diversion of flow from the Mystic WPCF to the Borough WPCF (which is evaluated in later sections as Alternatives 1A and 1B). As described earlier, the anticipated process alternatives for upgrading the existing WPCFs are as follows:

- Comminution (grinding)
- Septage receiving (Pawcatuck WPCF only)
- Primary clarifiers

- Activated Sludge
- BNR utilizing a single-sludge process
- Disinfection with sodium hypochlorite and dechlorination with sodium bisulfite
- Sludge thickening
- Odor control

The following sub-sections describe development of this alternative in detail.

Mystic WPCF

Projected Flows and Loads

The projected flows and loads to the Mystic WPCF under this alternative are as shown in **Table 7-6**.

Table 7-6
Alternative 1: Mystic WPCF Influent Flows and Loads

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	TKN (ppd)	NH_3-N (ppd)
Average Annual	0.726	2,300	1,862	257	181
Maximum Month	0.983	3,852	3,891	348	245
Peak Day	1.498	5,665	4,620	530	372
Peak Instantaneous	2.45				

Description

As described in Section 5, the limiting unit treatment capacities at the Mystic WPCF are the secondary treatment process and the disinfection process. In addition, the existing secondary clarifiers are shallower than is generally considered good practice. Implementation of the secondary treatment process upgrade and the integrated BNR system upgrade necessary to meet performance requirements "steers" the direction of the overall plant upgrade requirements and layout. This would generally be true for all of the alternatives. Hence, the required biological system upgrade is discussed first. Refer to **Figure 7-A1-M** for a conceptual layout of this alternative.

The new biological system must be upgraded to achieve not only BOD removal, but also nitrification and denitrification. A four-stage, single-sludge system would be required to reliably achieve the 2025 TN limits shown in Table 7-4. The four stages would consist of a first-stage anoxic zone, a first-stage aerobic zone, a second-stage anoxic zone and a second-stage aerobic zone, similar in nature to the Bardenpho ™

See Figure 7-A1-M

process described in Section 7.3.3. The two existing aeration basins would provide the needed volume for the first anoxic zones, and would also continue to be used to provide aerobic detention time, to accomplish nitrification in the first aerobic stage. The two, 0.11-million gallon per day (MG) basins do not provide adequate volume, so four additional aerobic basins would be required, resulting in a total first-stage aerobic volume of 0.57 MG. The first-stage anoxic volume required is about 0.035 MG. The second-stage anoxic volume required is about 0.024 MG, and this would be provided by new tankage. The second aerobic zone volume of about 0.020 MG would also be new tankage. New anoxic recycle pumping facilities would be required to achieve denitrification in the anoxic zones.

The upgraded biological system requirements, and the tankage conversion described above, require that new secondary clarification capacity be constructed to handle the future hydraulic and solids loading. The two, 35-foot diameter digesters can be retrofitted into secondary clarifiers, and would provide the required capacity. A new intermediate lift station would be required to pump the effluent from the biological reactors to the retrofitted secondary clarifiers, which are at a higher elevation. This lift station would be a two-level structure (basement and ground level).

The existing aeration blowers do not have the capacity to provide sufficient air to meet future demands due to increasing flows, and the requirement to nitrify. It is estimated that three new blowers, each rated at about 2,250 actual cubic feet per minute (acfm) at about 21 pounds per square inch atmospheric pressure (psia) would be needed to replace the existing smaller units. A new, fine-bubble aeration system would need to be installed in the aeration basins to provide adequate air transfer to the wastewater.

Additional primary clarification capacity would be required, and this would be accomplished by converting one of the existing secondary clarifiers into a third primary clarifier.

The existing chlorine contact tank volume of 14,600 gallons does not provide adequate contact time for the future projected peak flow. A volume of 51,000 gallons is required to meet the 30-minute requirement. The remaining needed volume can be obtained by converting the second existing secondary clarifier into additional chlorine contact tankage, with a dechlorination zone at the effluent end.

The Mystic WPCF does not currently process solids. Sludge generated at the Mystic WPCF is currently pumped to the Borough WPCF. In this overall alternative, the Mystic WPCF would require installation of a sludge thickening process. The anticipated thickening system would be similar to those in place at the other plants, including a rotary-drum thickener, a polymer system, and sludge storage. This solids processing can be odorous, and additional odor controls would be provided. It is anticipated that long-term odor control needs at the Mystic WPCF would be similar to those provided at the Borough and Pawcatuck WPCFs in the 2003 odor control project.

The Mystic WPCF facility has been in service for more than 30 years, and as indicated in section 5, is in need of renovation. There are several areas that require structural repair, and the Main Building will require a replacement roof, new doors and other architectural features, and improvements to the working spaces to make them suitable for continued long-term use.

Features

The Mystic WPCF upgrade alternative described above has the following notable features:

- Use of existing tankage is maximized.
- A substantial amount of work is required at the Mystic WPCF.
- The existing marginal secondary clarifiers are replaced.
- The required new facilities use the majority of the remaining site, and the resulting site plan is very tight and constrained.
- This alternative requires re-installation of new solids-thickening equipment, similar to the type recently removed from the plant when the diversion pumping process was placed into service. Additional odor controls would also be required.

Costs

The estimated planning-level capital cost of constructing these improvements to the Mystic WPCF is $15.0 million.

Borough WPCF

Projected Flows and Loads

The projected flows and loads to the Borough WPCF under this alternative are as shown in **Table 7-7.**

Table 7-7
Alternative 1: Borough WPCF Influent Flows and Loads

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	TKN (ppd)	NH_3-N (ppd)
Average Annual	0.299	518	421	97	66
Maximum Month	0.479	1,113	818	188	130
Peak Day	0.673	1,307	1,020	231	158
Peak Instantaneous	1.52				

Description

As in Section 7.4.2, implementation of the secondary treatment process upgrade and the integrated BNR system upgrade at the Borough WPCF "steers" the direction of the overall plant upgrade requirements. As before, the required biological system upgrade is discussed first. (Refer to **Figure 7-A1-B**.) As discussed earlier, this alternative presumes that Symbio™ is not implemented as part of the long-term plan.

The biological system must be upgraded to achieve nitrification and denitrification. A four-stage, single-sludge system would be required to reliably achieve the 2025 TN limits shown in Table 7-4. The two existing aeration basins would continue to be used to provide aerobic detention time, to accomplish nitrification in the first aerobic stage. The two, 0.10-MG basins provide adequate volume for this purpose. The first-stage anoxic volume required is about 0.084 MG, the second-stage anoxic volume required is about 0.042 MG, and the required second aerobic zone volume is about 10,000 gallons. These new reactor volumes can be provided by constructing new tankage, adjacent to the existing aeration basins. New anoxic recycle pumping facilities would be required to achieve denitrification in the anoxic zones. The existing three secondary clarifiers are adequate, as is the existing blower capacity.

The plant's existing primary clarification capacity is adequate. The existing chlorine contact tank volume is not adequate, and must be increased by addition of two new, 9,100-gallon tanks. One small, new contact tank is required to provide dechlorination contact time downstream of the chlorine contact tanks.

The Borough WPCF currently has two rotary drum thickeners on line. Miscellaneous work would be conducted to improve the sludge pumping and storage facilities.

The new odor control system for the existing plant includes provisions to cover and treat odors from all of the existing liquid tankage. It is presumed that this same level of treatment would be maintained. Therefore, the new biological reactor and chlorine contact tankage would be covered and ventilated to the biofilter system.

Features

The Borough WPCF upgrade alternative described above has the following notable features:

- Use of existing tankage is maximized.
- The upgrade requirements consist primarily of the BNR upgrade, except for the increased chlorination contact time.
- The required new facilities use much of the existing site within the fence, and some additional existing site footprint, not including the additional property south of the plant along the town dock or most of the park dog-walking area. Future expansion

See Figure 7-A1-B

at this site using conventional technologies would require use of these additional areas.

Costs

The estimated planning-level capital cost of implementing these improvements to the Borough WPCF is $3.6 million.

Pawcatuck WPCF

Projected Flows and Loads

The projected flows and loads to the Pawcatuck WPCF under this alternative are as shown in **Table 7-8**, as developed in Section 3.

Table 7-8
Alternative 1: Pawcatuck WPCF Influent Flows and Loads

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	TKN (ppd)	NH_3-N (ppd)
Average Annual	0.939	1,552	2,200	294	187
Maximum Month	1.382	1,934	3,278	431	274
Peak Day	1.822	2,225	3,953	568	361
Peak Instantaneous	3.30				

Description

The projected increase in flow to the Pawcatuck WPCF, and the criterion to provide a high level of nitrogen removal, result in required upgrades to most of the plant's processes. (Refer to **Figure 7-A1-P**.)

A four-stage, single-sludge system would be required to reliably achieve the 2025 TN limits shown in Table 7-4. The two existing aeration basins would continue to be used as reactor volume for the BNR system. The two, 0.21-MG basins provide adequate volume, and additional reactor volume would be required. The first-stage anoxic volume required is about 0.098 MG, the first-stage aerobic volume required is about 0.27 MG, the second-stage anoxic volume required is about 0.035 MG and the second aerobic zone volume requirement is about 0.03 MG. As shown in the figure, this new biological reactor volume can be constructed using existing volume and building new baffle walls in the existing tankage. This would minimize the cost of the new anoxic recycle pumping facilities required to achieve denitrification in the anoxic zones.

The existing aeration blowers do not have the capacity to provide sufficient air to meet future demands due to increasing flows, and the requirement to nitrify. It is estimated that two new blowers, each rated at about 1,610 acfm would be needed in addition to the two existing 800-acfm units.

See Figure 7-A1-P

The upgraded biological system requires that one new secondary clarifier be constructed adjacent to the two existing tanks, to handle the future hydraulic and solids loading. A new process building is recommended, to house new return activated sludge (RAS) pumps, the new blowers, and associated equipment. In addition, one new primary clarifier would be required to treat the projected flows to within *TR-16* guidelines. The new primary clarifier would be covered for odor containment, along with the two existing primary clarifiers, which were covered as part of the 2003 odor control program.

The existing chlorine contact tank volume of 37,700 gallons does not provide adequate contact time for the future projected peak flow. A volume of about 68,700 gallons is required to meet the 30-minute requirement. New chlorine contact tanks can be constructed adjacent to the existing units. A new dechlorination contact zone would be installed on the downstream end of the chlorine contact tanks, to provide about 5 minutes of detention time at average flow.

Features
The Pawcatuck WPCF upgrade alternative described above has the following notable features:

- Use of existing tankage is maximized.
- The required new facilities fit comfortably on the existing site. Sufficient site area is available for future expansion at this site, if necessary.

Costs
The estimated planning-level capital cost of implementing these improvements to the Pawcatuck WPCF is $7.1 million.

Flow Transfer Improvements

Alternative No. 1 does not require transfer of flows from one drainage district to another, and therefore there are no significant improvements necessary to transfer either influent raw sewage from one plant to another, or treated effluent from a plant to a remote outfall.

Summary of Alternative Costs

Table 7-9 presents a summary of costs for Alternative No. 1. These would be compared with the other overall alternatives in Section 7.5. Note that the cost summaries do NOT include estimated costs for property acquisition, nor to they include possible credits (total cost reductions) due to potential sale of existing properties.

Table 7-9
Alternative No. 1: Summary of Costs

Major Component	Capital	Annual O&M	Present Worth
Mystic WPCF Upgrade	$15.0 million	[redacted]	[redacted]
Borough WPCF Upgrade	$3.6 million		
Pawcatuck WPCF Upgrade	$7.1 million		
Flow Transfer Improvements	$ 0		
TOTAL	$25.8 million	$1.77 million	$46.7 million

7.4.3 Alternative No. 1A

Alternative No. 1A involves the upgrading of each of the three existing WPCFs to handle the future flows and loads from their respective collection systems, and accounts for a continued diversion of 0.28 mgd of flow, consisting of underflow from the primary clarifiers, from the Mystic WPCF to the Borough WPCF. The anticipated process alternatives for upgrading the existing WPCFs are as follows:

- Comminution (grinding)
- Septage receiving (Pawcatuck WPCF only)
- Primary clarifiers
- Activated Sludge
- BNR utilizing a single-sludge process
- Disinfection with sodium hypochlorite and dechlorination with sodium bisulfite
- Sludge thickening (Borough and Pawcatuck WPCFs only)
- Odor control

The following sub-sections describe development of this alternative in detail.

Mystic WPCF

Projected Flows and Loads

The projected flows and loads to the Mystic WPCF under this alternative are as shown in **Table 7-10**. These are the same as Alternative No. 1, although due to the diversion of primary clarifier underflow, the flows and loads that be treated by the Mystic WPCF biological process and disinfection, are less than Alternative No. 1.

Table 7-10
Alternative 1A: Mystic WPCF Flows and Loads

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	TKN (ppd)	NH_3-N (ppd)
Average Annual	0.726	2,300	1,862	257	181
Maximum Month	0.983	3,852	3,891	348	245
Peak Day	1.498	5,665	4,620	530	372
Peak Instantaneous	2.45				

Description

Implementation of the 0.28-mgd diversion to the Borough WPCF reduces the flow and loading to the secondary, BNR and disinfection processes at Mystic WPCF, and therefore less-extensive improvements would be necessary at the Mystic WPCF. As before, the required biological system upgrade is discussed first. Refer to **Figure 7-A1A-M** for a conceptual layout of this alternative.

A four-stage, single-sludge system would still be required to reliably achieve the 2025 TN limits shown in Table 7-4. The two existing aeration basins would continue to be used, to provide anoxic and aerobic detention time, to accomplish the first anoxic zone and aerobic nitrification in the first aerobic stage. The first-stage anoxic volume required is about 0.023 MG, and would be provided by constructing a baffle wall within the existing aeration tankage. The first stage aerobic volume needed is 0.38 MG, and would require additional tankage. The second-stage anoxic volume required is about 0.016 MG, and the second aerobic zone volume of about 0.010 MG would be provided toward the effluent end of the new biological tankage. New anoxic recycle pumping facilities would be required to achieve denitrification in the anoxic zones.

The existing aeration blower capacity would need to be upgraded, with two new 1,350-acfm units. A new, fine-bubble aeration system would need to be installed in the aeration basins to provide adequate air transfer to the wastewater.

The upgraded biological system requirements, and the tankage conversion described above, require that new secondary clarifiers be constructed to handle the future hydraulic and solids loading. As in Alternative No. 1, the two, 35-foot diameter, digesters, converted to secondary clarifiers, would provide the required capacity. A new intermediate lift station would be required to pump the aeration basin effluent to the secondary clarifiers.

See Figure 7-A1A-M

Similar to Alternative No. 1, new primary clarification capacity would be required and this would be accomplished by converting an existing secondary clarifier. The existing chlorine contact tank volume of 14,600 gallons still would not provide adequate contact time for the future projected peak flow. A volume of 45,300 gallons is required to meet the 30-minute requirement. This volume can be accommodated by converting the second existing secondary clarifier into chlorine contact volume. A small dechlorination contact zone would be required at the downstream end of the chlorine contact tanks.

As in Alternative No. 1, the Mystic WPCF would be provided with more substantial odor control system, as part of the upgrade work, and the Main Building's systems would be renovated.

Features
The Mystic WPCF upgrade alternative described above has the following notable features:

- Use of existing tankage is maximized.
- The existing diversion forcemain is utilized, to reduce the construction required at the Mystic WPCF.
- The existing marginal secondary clarifiers are replaced.
- The required new facilities still use the majority of the remaining site. Future expansion at this site would not be feasible.

Costs
The estimated planning-level capital cost of constructing these improvements to the Mystic WPCF is $10.4 million.

Borough WPCF

Projected Flows and Loads
The projected flows and loads to the Borough WPCF under this alternative are as shown in **Table 7-11**.

Table 7-11
Alternative 1A: Borough WPCF Influent Flows and Loads

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	TKN (ppd)	NH_3-N (ppd)
Average Annual	0.579	1,668	1,818	233	161
Maximum Month	0.759	2,444	3,339	317	221
Peak Day	0.953	3,233	3,938	451	312
Peak Instantaneous	1.80				

Description

As in earlier sections, the required biological system upgrade is discussed first. (Refer to **Figure 7-A1A-B**.) The biological system must be upgraded to achieve nitrification and denitrification, and the extent of the upgrade is significantly impacted by the 0.28-mgd diversion from the Mystic WPCF. The two existing aeration basins would continue to be used to provide aerobic detention time, to accomplish nitrification in the first aerobic stage. The two, 0.10-MG basins do not provide adequate volume for this purpose, and two additional aerobic tanks are needed, for a total aerobic volume of 0.42 MG. The first-stage anoxic volume required is about 0.03 MG, the second-stage anoxic volume required is about 0.037 MG, and the required second aerobic zone volume is about 20,000 gallons. These new reactor volumes can be provided by constructing new tankage, adjacent to the existing aeration basins. New anoxic recycle pumping facilities would be required to achieve denitrification in the anoxic zones. The existing three secondary clarifiers are not adequate for peak day loads, and a fourth secondary clarifier would be constructed by converting the existing sludge storage tank (previously a primary clarifier). Existing blower capacity is not adequate for the future loads, and two 1,200 acfm units would replace two of the three existing units. A new, 25,000-gallon sludge storage tank would be constructed adjacent to the plant road.

The plant's existing primary clarification capacity is adequate. The existing chlorine contact tank volume is not adequate, and must be increased by addition of two new, 12,000-gallon tanks. A small, new contact tank is required to provide dechlorination contact time downstream of the chlorine contact tanks.

The Borough WPCF solids thickening and odor control systems would be upgraded similarly to as described in Alternative No. 1. Odor control would be provided to maintain the same level as provided by the 2003 upgrade (i.e., all open tanks would be covered and ventilated to the biofilter system).

See Figure 7-A1A-B

Features
The Borough WPCF upgrade alternative described above has the following notable features:

- Use of existing tankage is maximized.
- The upgrade requirements consist primarily of the BNR upgrade, except for the increased chlorination contact time.
- The required new facilities use the majority of the existing remaining site, not including the additional property south of the plant along the town dock. Future expansion at this site would require use of this additional property.
- Alternative No. 1A essentially transfers some construction required from the Mystic WPCF to the Borough WPCF.

Costs
The estimated planning-level capital cost of implementing these improvements to the Borough WPCF is $7.8 million.

Pawcatuck WPCF

For the Pawcatuck WPCF, Alternative No. 1A is identical to Alternative No. 1. Refer to Section 7.4.2 for a description.

Flow Transfer Improvements

Alternative No. 1A requires that 0.28 mgd of wastewater be diverted from the Mystic WPCF to the Borough WPCF. This diversion is equivalent to the existing diversion (see Section 5), and therefore there are no significant improvements necessary to transfer this flow.

Summary of Alternative Costs

Table 7-12 presents a summary of costs for Alternative No. 1A. These would be compared with the other overall alternatives in Section 7.5. Note that the cost summaries do NOT include estimated costs for property acquisition, nor to they include possible credits (total cost reductions) due to potential sale of existing properties.

Table 7-12
Alternative No. 1A: Summary of Costs

Major Component	Capital	Annual O&M	Present Worth
Mystic WPCF Upgrade	$10.4 million	[redacted]	[redacted]
Borough WPCF Upgrade	$7.8 million	[redacted]	[redacted]
Pawcatuck WPCF Upgrade	$7.1 million	[redacted]	[redacted]
Flow Transfer Improvements	$0	[redacted]	[redacted]
TOTAL	$25.3 million	$1.86 million	$47.3 million

7.4.4 Alternative No. 1B

Alternative No. 1B is a variant on Alternative No. 1A, in that it also involves the upgrading of each of the three existing WPCFs to handle the future flows and loads from their respective collection systems, and accounts for a diversion of 0.28 mgd of flow from the Mystic WPCF to the Borough WPCF. However, in Alternative No. 1B, the diversion flow is not the primary clarifier underflow from the Mystic WPCF, but instead would be either the raw influent or the treated primary effluent from the Mystic WPCF. The general impacts of this variation are that the Mystic WPCF would have to be provided with solids-processing (thickening) facilities, and a degree of redistribution of the wastewater loading to each the Mystic and Borough WPCFs. The anticipated process alternatives for upgrading the existing WPCFs are as follows:

- Comminution (grinding)
- Septage receiving (Pawcatuck WPCF only)
- Primary clarifiers
- Activated Sludge
- BNR utilizing a single-sludge process
- Disinfection with sodium hypochlorite and dechlorination with sodium bisulfite
- Sludge thickening (all three WPCFs)
- Odor control

The following sub-sections describe development of this alternative in detail.

Mystic WPCF

Projected Flows and Loads

The projected flows and loads to the Mystic WPCF under this alternative are as shown in **Table 7-13**. These are the flows and loads that would be treated at the Mystic WPCF if the 0.28-mgd diversion taken from the raw influent stream. If the diversion was instead taken from the primary effluent stream, the influent flow and load would instead be identical to Alternative No. 1. In either variation, the loading to the biological and disinfection processes would be approximately the same.

Table 7-13
Alternative 1B: Mystic WPCF Influent Flows and Loads

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	TKN (ppd)	NH_3-N (ppd)
Average Annual	0.446	1,413	1,144	158	111
Maximum Month	0.703	2,754	2,783	249	175
Peak Day	1.218	4,606	3,756	431	302
Peak Instantaneous	2.17				

Description

Implementation of the 0.28-mgd diversion of raw influent or primary effluent to the Borough WPCF reduces the flow and loading to the primary clarifiers (if raw influent) and the secondary, BNR and disinfection processes at Mystic WPCF (if the diversion is either raw influent or primary effluent). It therefore requires less-extensive improvements at the Mystic WPCF when compared with Alternative No. 1. In addition, the liquid-treatment upgrade requirements for the Mystic WPCF are virtually the same as required for Alternative No. 1A, because the flow and load to the secondary/BNR and disinfection systems is the same. The layout presented previously in Figure 7-A1B-M, and the accompanying description, applies to this alternative.

Features

The Mystic WPCF upgrade alternative described above has the following notable features:

- Use of existing tankage is maximized.
- The existing diversion forcemain is utilized, to reduce the construction required at the Mystic WPCF.
- The existing marginal secondary clarifiers are replaced.

- This alternative requires re-installation of new solids-thickening equipment, similar to the type removed from the plant when the existing primary clarifier underflow diversion was placed into service. Additional odor controls would also be required.

- The required new facilities still use much of the remaining site. Future expansion at this site would likely not be feasible without further evaluation of innovative technologies.

Costs

The estimated planning-level capital cost of constructing these improvements to the Mystic WPCF is $10.4 million.

Borough WPCF

Projected Flows and Loads

The projected flows and loads to the Borough WPCF under this alternative are as shown in **Table 7-14**. These are the flows and loads that would be treated at the Borough WPCF if the 0.28-mgd diversion is taken from the Mystic WPCF raw influent stream. If the diversion was instead taken from the primary effluent stream, these values would be somewhat less. For the purposes of evaluating the upgrade needs at the Borough WPCF, a raw influent diversion is used, as this results in a "worst case" process footprint at the Borough WPCF for this alternative.

Table 7-14

Alternative 1B: Borough WPCF Influent Flows and Loads

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	TKN (ppd)	NH_3-N (ppd)
Average Annual	0.579	1,405	1,139	196	136
Maximum Month	0.759	2,211	1,926	287	200
Peak Day	0.953	2,366	1,926*	330	228
Peak Instantaneous	1.80				

* Note that maximum month and peak day TSS loads to the Borough WPCF are the same due to the nature of the diversion from Mystic WPCF under a peak day loading.

Description

The biological system must be upgraded to achieve nitrification and denitrification, and the extent of the upgrade is significantly impacted by the 0.28-mgd diversion from the Mystic WPCF. The nature and process sizing of the necessary upgrade is very similar to Alternative No. 1A, except the necessary biological tankage sizes are only slightly smaller due to the slightly reduced loading from the diversion. Refer to **Figure 7-A1A-B**, previously presented. For Alternative No. 1B, the two existing aeration basins would be used to provide aerobic detention time, to accomplish nitrification in the first aerobic stage. Two additional aerobic tanks are needed, for a total aerobic volume of 0.40 MG. The first-stage anoxic volume required is about 0.04 MG, the second-stage anoxic volume required is about 0.027 MG, and the required second aerobic zone volume is about 20,000 gallons. These new reactor volumes can be provided by constructing new tankage, adjacent to the existing aeration basins. New anoxic recycle pumping facilities would be required to achieve denitrification in the anoxic zones. The existing three secondary clarifiers are not adequate for peak day loads, and a fourth secondary clarifier would be constructed by converting the existing sludge storage tank (previously a primary clarifier). Existing blower capacity is not adequate for the future loads, and two 1,200 acfm units would replace two of the three existing units. A new, 25,000-gallon sludge storage tank would be constructed adjacent to the plant road.

The plant's existing primary clarification capacity is adequate. The existing chlorine contact tank volume is not adequate, and must be increased by addition of two new, 12,000-gallon tanks. A small, new contact tank is required to provide dechlorination contact time downstream of the chlorine contact tanks.

The Borough WPCF solids thickening and odor control systems would be upgraded similarly to as described in Alternative No. 1. Odor control would be provided to maintain the same level as provided by the 2003 upgrade (i.e., all open tanks would be covered and ventilated to the biofilter system).

Features

The Borough WPCF upgrade alternative described above has the following notable features:

- Use of existing tankage is maximized.
- The upgrade requirements consist primarily of the BNR upgrade, except for the increased chlorination contact time.
- The required new facilities use the majority of the existing remaining site, not including the additional property south of the plant along the town dock. Future expansion at this site would require use of this additional property.
- Like Alternative No. 1A, Alternative No. 1B essentially transfers some construction required from the Mystic WPCF to the Borough WPCF.

Costs

The estimated planning-level capital cost of implementing these improvements to the Borough WPCF is $7.4 million.

Pawcatuck WPCF

For the Pawcatuck WPCF, Alternative No. 1B is identical to Alternative No. 1. Refer to Section 7.4.2 for a description.

Flow Transfer Improvements

Alternative No. 1B requires that 0.28 mgd of wastewater be diverted from the Mystic WPCF to the Borough WPCF. This diversion is equivalent to the existing diversion (see Section 5), and therefore there are no significant improvements necessary to transfer this flow.

Summary of Alternative Costs

Table 7-15 presents a summary of costs for Alternative No. 1B. These would be compared with the other overall alternatives in Section 7.5. Note that the cost summaries do NOT include estimated costs for property acquisition, nor to they include possible credits (total cost reductions) due to potential sale of existing properties.

Table 7-15

Alternative No. 1B: Summary of Costs

Major Component	Capital	Annual O&M	Present Worth
Mystic WPCF Upgrade	$11.2 million	[redacted]	[redacted]
Borough WPCF Upgrade	$7.4 million	[redacted]	[redacted]
Pawcatuck WPCF Upgrade	$7.1 million	[redacted]	[redacted]
Flow Transfer Improvements	$0	[redacted]	[redacted]
TOTAL	$25.7 million	$1.86 million	$47.7 million

7.4.5 Alternative No. 2

Alternative No. 2 involves taking the Mystic WPCF out-of-service, and pumping the entire flow currently treated at the Mystic WPCF to the Borough WPCF for treatment. The Mystic facility would be transformed into a pump station. The Borough WPCF would be upgraded to handle the future flows and loads from both the Mystic and Borough collection systems, and the Pawcatuck WPCF would be upgraded to handle its locally generated flow. As before, the anticipated process alternatives for upgrading the existing WPCFs are as follows:

- Comminution (grinding)
- Septage receiving (Pawcatuck WPCF only)

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- Primary clarifiers
- Activated Sludge
- BNR utilizing a single-sludge process
- Disinfection with sodium hypochlorite and dechlorination with sodium bisulfite
- Sludge thickening (Borough and Pawcatuck WPCFs only)
- Odor control

The following sub-sections describe development of this alternative in detail.

Mystic WPCF

Projected Flows and Loads
The Mystic WPCF would not be in service under this alternative. The average and peak projected flows that would be pumped to the Borough WPCF are 0.726 mgd, and 2.45 mgd, respectively.

Description
Implementation of this alternative would allow Stonington to shut down wastewater treatment at the Mystic WPCF. The plant's influent pump system would be modified to pump all of the flow to the Borough WPCF. The pump station would be provided with comminution. The odor control system completed in 2003 would be sufficient for the future pumping operations. (See **Figure 7-A2-M**.)

It is anticipated that the remaining Mystic WPCF equipment would be salvaged to the extent feasible. There are several pieces of equipment that appear to be in good condition, and could possibly be re-used by Stonington at another location, or sold to other users, including the grit classification equipment, and the sodium hypochlorite storage and feed equipment. It is anticipated that the existing concrete tankage and other plant structures would be filled and covered, and the site improved. The layout shown in Figure 7-A2-M, and costs presented below, assumes that much of the existing building, including the old digester tanks, would be demolished, and the existing building would be renovated to minimize its size, while keeping the vital functions intact: the pumping systems, the electrical system, other utilities (e.g., heat, controls, etc.). The remaining facility would be fenced in for security, to allow the remaining open space to be used for another purpose.

Transferring all of the Mystic flow to the Borough WPCF would likely result in closure of the existing Mystic WPCF outfall.

Costs
The estimated planning-level capital cost of implementing these improvements at the Mystic WPCF site is $4.0 million.

See Figure 7-A2-M

Borough WPCF

Projected Flows and Loads

The projected flows and loads to the Borough WPCF under this alternative are as shown in **Table 7-16**, as developed in Section 3.

Table 7-16

Alternative 2: Borough WPCF Influent Flows and Loads

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	TKN (ppd)	NH_3-N (ppd)
Average Annual	1.03	2,818	2,283	354	247
Maximum Month	1.46	4,965	4,709	536	375
Peak Day	2.17	6,972	5,640	761	530
Peak Instantaneous	3.97				

Description

As in earlier sections, the required biological system upgrade is discussed first. (Refer to **Figure 7-A2-B**.) The two existing aeration basins would continue to be used to provide biological system detention time, but the total volume of 0.20 MG would be used as the second anoxic and aerobic stages. Two new aerobic tanks are needed, for a total aerobic volume of 2.43 MG. The first-stage anoxic volume required is about 0.17 MG. These new reactor volumes can be provided by constructing new tankage, adjacent to the existing aeration basins. New anoxic recycle pumping facilities would be required to achieve denitrification in the anoxic zones. The existing three secondary clarifiers are not adequate for peak day loads, and three added secondary clarifiers would be constructed. A new return sludge pump station would be required to adequately control operation of these clarifiers.

The existing aeration blowers do not have the capacity under this alternative to provide sufficient air to meet future demands due to increasing flows, and the requirement to nitrify. It is estimated that two new blowers, each rated at about 3,700 acfm would be needed in addition to two of the existing 800-acfm units. A fine-bubble aeration system would need to be installed in the aeration basins to provide adequate air transfer to the wastewater.

The plant's existing primary clarifiers would be removed from service, and would instead be used as sludge storage tanks, to maximize the use of the existing facilities. The biological system sizing discussed above takes into account that no primary treatment would be required. Instead of primary treatment, a new grit removal system would be construction within a new process building. This grit removal

See Figure 7-A2-B

system would remove grit, scum and grease from the influent flow prior to treatment in the biological system. Odor control would be provided for the grit removal system.

The existing chlorine contact tank volume is not adequate, and would have to be upsized substantially. Instead of constructing this new tankage, a new UV system would be a cost-effective, feasible alternative, to be installed within the new process building. This system would eliminate the need to add sodium hypochlorite for disinfection and sodium bisulfite for dechlorination.

The new process building that houses the grit removal system and the new process tankage would be provided with odor control. This new odor control system would be in addition to the system completed in 2003, and would be substantial to provide the same degree of odor containment and treatment.

Features
The Borough WPCF upgrade alternative described above has the following notable features:

- Use of existing tankage is maximized. To make best use of existing tankage, there would be no primary clarifiers. The BNR system is sized to handle the wastewater load without primary treatment.

- The necessary layout of these facilities uses up essentially all of the footprint of the available site, north of the town dock. Review of the site plan indicates that this alternative is only marginally feasible, and would not allow for any future expansion at the site.

Costs
The estimated planning-level capital cost of implementing these improvements to the Borough WPCF is $13.9 million.

Pawcatuck WPCF

For the Pawcatuck WPCF, Alternative No. 2 is identical to Alternative No. 1. Refer to Section 7.4.2 for a description.

Flow Transfer Improvements

Alternative No. 2 requires that the entire flow that drains to the Mystic WPCF be pumped to the Borough WPCF for treatment. This flow rate is much higher than the current 0.28-mgd diversion, and would require a significant amount of improvements. When the existing diversion forcemain for the Mystic WPCF was installed, a second, larger 12-inch forcemain was also installed, anticipating that this full flow transfer might be desirable. However, this forcemain only provides sufficient capacity as far as the Ensign Lane Pump Station. This pump station, its 2,000-foot forcemain and about 1,100 feet of gravity sewer, from the Pine Point Bridge to the Railroad tracks, would require upgrading to convey the peak flow necessary.

Summary of Alternative Costs

Table 7-17 presents a summary of costs for Alternative No. 2. These would be compared with the other overall alternatives in Section 7.5. Note that the cost summaries do NOT include estimated costs for property acquisition, nor to they include possible credits (total cost reductions) due to potential sale of existing properties.

Table 7-17

Alternative No. 2: Summary of Costs

Major Component	Capital	Annual O&M	Present Worth
Mystic WPCF Upgrade	$4.0 million	[redacted]	[redacted]
Borough WPCF Upgrade	$13.9 million	[redacted]	[redacted]
Pawcatuck WPCF Upgrade	$7.1 million	[redacted]	[redacted]
Flow Transfer Improvements	$3.1 million	[redacted]	[redacted]
TOTAL	$28.3 million	$1.45 million	$45.4 million

7.4.6 Alternative No. 3

Alternative No. 3 involves taking both the Mystic WPCF and Borough WPCF out-of-service, and pumping the entire flow currently treated at the two plants to the Pawcatuck WPCF for treatment. The Pawcatuck WPCF would be upgraded to handle the future flows and loads from the entire Town. As before, the anticipated process alternatives for upgrading the existing Pawcatuck WPCF are as follows:

- Comminution (grinding)
- Septage receiving
- Primary clarifiers
- Activated Sludge
- BNR utilizing a single-sludge process
- Disinfection with sodium hypochlorite and dechlorination with sodium bisulfite
- Sludge thickening
- Odor control

The following sub-sections describe development of this alternative in detail.

Mystic WPCF

Projected Flows and Loads

The Mystic WPCF would not be in service under this alternative. The average and peak projected flows that would be pumped to the Pawcatuck WPCF are 0.726 mgd, and 2.45 mgd, respectively.

Description

For the Mystic WPCF, this alternative is essentially the same as described for Alternative No. 2, except that the detailed pumping equipment specifications may be different to suit modified pumping conditions. See the description in Section 7.4.5.

Borough WPCF

Projected Flows and Loads

The Borough WPCF would not be in service under this alternative. The average and peak projected flows that would be pumped from the Borough WPCF collection system to the Pawcatuck WPCF are 0.299 mgd, and 1.52 mgd, respectively. These flows are in addition to the flows from the Mystic WPCF collection system.

Description

Implementation of this alternative would allow Stonington to shut down the Borough WPCF. The plant's influent pump system would be modified to pump all of the flow to the Pawcatuck WPCF. Given the existing forcemain system from the Mystic WPCF to the Ensign Lane Pumping Station, it is likely that either the Borough WPCF's influent pumping system would have to be sufficient to handle the entire peak flow from both the Mystic and Borough collection systems (a total peak flow of 3.97 mgd), or the Ensign Lane Pumping Station and the station at the Borough WPCF could share the task of pumping the flow to the Pawcatuck system. The pump station would be provided with comminution and odor control. (See **Figure 7-A3-B**.)

It is anticipated that the remaining Borough WPCF equipment would be salvaged to the extent feasible. There are several pieces of equipment that appear to be in good condition, and could possibly be re-used by Stonington at another location, or sold to other users; the sodium hypochlorite storage and feed equipment, and the rotary drum sludge thickeners. It is also anticipated that the existing concrete tankage would be filled and covered and other plant structures would be demolished, and the site prepared for another use. The existing building would be renovated and minimized to reduce visual impacts on neighbors. The layout shown in Figure 7-A3-B, and costs presented below, assumes that the modified building would be reused in this manner. The biofilter completed in 2003 could be reduced in size and relocated close to the building, and new site fencing would isolate the facility from the rest of the site. The space opened up by the reduced site footprint needed for pumping operations could potentially be used for another purpose.

See Figure 7-A3-B

As described further below, it is likely that the Borough WPCF outfall would be remain in service, to discharge up to 3.97 mgd of the flow treated at the Pawcatuck WPCF.

Costs

The estimated planning-level capital cost of implementing these improvements at the Borough WPCF site is $4.1 million.

Pawcatuck WPCF

Projected Flows and Loads

The projected flows and loads to the Pawcatuck WPCF under this alternative are as shown in **Table 7-18**, as developed in Section 3:

Table 7-18

Alternative 3: Pawcatuck WPCF Influent Flows and Loads

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	TKN (ppd)	NH_3-N (ppd)
Average Annual	1.96	4,370	4,483	648	434
Maximum Month	2.84	6,899	7,987	967	649
Peak Day	3.99	9,197	9,593	1,329	891
Peak Instantaneous	7.27				

Description

Treating all of the Town's wastewater at the Pawcatuck WPCF requires a substantial amount of upgrading to the plant. (Refer to **Figure 7-A3-P**.)

The two existing aeration basins would continue to be used to provide biological system reactor volume, but provide only a fraction of the volume needed. A total of six aerobic basins would be required, resulting in a total aerobic volume of 1.06 MG. The first-stage anoxic volume required is about 0.21 MG, and the second-stage anoxic volume required is about 0.104 MG. The second aerobic zone volume requirement is about 0.06 MG. As shown in the figure, these new biological zones can be constructed adjacent to the existing tankage, progressing southward. This would minimize the cost of the new anoxic recycle pumping facilities required to achieve denitrification in the anoxic zones, and would allow for additional expansion in the future, if needed. The new pumping facilities would be installed in a new process building. The process building can also house the new blowers that would be required to meet aeration requirements. Up to three, 4,100-acfm blowers would be needed, together with a fine bubble diffuser system, to meet future aeration demands. Consistent with the 2003 odor control program, this biological tankage would be covered and ventilated to an odor control system.

See Figure 7-A3-P

The upgraded biological system requires that three new secondary clarifiers be constructed adjacent to the two existing tanks, to handle the future hydraulic and solids loading. Two new primary clarifiers would be required to treat the projected flows to within *TR-16* surface overflow rate guidelines. As is the other alternatives, these new primary clarifiers would be covered, and the contained air would be treated through an odor control system.

The existing chlorine contact tank volume of 37,700 gallons does not provide adequate contact time for the future projected peak flow. A volume of about 314,000 gallons is required to meet the 30-minute requirement. New chlorine contact tanks can be constructed adjacent to the existing units. A dechlorination zone is also necessary.

After treatment, up to 3.97 mgd of effluent would be returned to the Borough outfall for discharge.

Features

The Pawcatuck WPCF upgrade alternative described above has the following notable features:

- Use of existing tankage is maximized.
- The required new facilities fit comfortably on the existing site. Sufficient site area is available for future expansion at this site.
- The Pawcatuck River would not be loaded at higher rates than the other alternatives, due to the plan to pump some of the treated effluent back to the Borough outfall.

Costs

The estimated planning-level capital cost of implementing these improvements to the Pawcatuck WPCF is $22.2 million.

Flow Transfer Improvements

Alternative No. 3 requires that the entire flow that drains to both the Mystic WPCF and the Borough WPCF be pumped to the Pawcatuck WPCF for treatment. While facilities exist to transfer the flow from the Mystic WPCF to the Ensign Lane Pumping Station with minimal improvements, a new forcemain system would be required to transfer the combined flow from the Borough WPCF (perhaps with the Ensign Lane Pumping Station in tandem). The peak flow rate to be transferred is 3.97 mgd. To accomplish this transfer, a 16-inch diameter forcemain would have to run a total length of approximately 5 miles, via Elm Street, Stonington Road, Greenhaven Road and Mary Hall Road. In addition, once treated, at least a portion of this flow would have to be pumped back along the same route, for discharge at the Borough outfall. The alternative evaluation assumes that the entire flow pumped to the Pawcatuck WPCF from the Borough WPCF would be pumped back to the Borough outfall.

Summary of Alternative Costs

Table 7-19 presents a summary of costs for Alternative No. 3. These would be compared with the other overall alternatives in Section 7.5. Note that the cost summaries do NOT include estimated costs for property acquisition, nor to they include possible credits (total cost reductions) due to potential sale of existing properties.

Table 7-19

Alternative No. 3: Summary of Costs

Major Component	Capital	Annual O&M	Present Worth
Mystic WPCF Upgrade	$4.0 million	[redacted]	[redacted]
Borough WPCF Upgrade	$4.1 million	[redacted]	[redacted]
Pawcatuck WPCF Upgrade	$22.2 million	[redacted]	[redacted]
Flow Transfer Improvements	$11.7 million	[redacted]	[redacted]
TOTAL	$42.0 million	$1.22 million	$56.4 million

7.4.7 Alternative No. 4

Alternative No. 4 involves taking the Mystic and Borough WPCFs out-of-service, and pumping the entire flow currently treated at the Mystic WPCF to the Borough WPCF for treatment at a new site. The Pawcatuck WPCF would be upgraded to handle its locally generated flow.

The following sub-sections describe development of this alternative in detail.

Mystic WPCF

For the Mystic WPCF, this alternative is essentially the same as described for Alternative No. 2. See the description in Section 7.4.5.

Borough WPCF

For the Borough WPCF, this alternative is essentially the same as described for Alternative No. 3, except that the specific pumping equipment specifications may be different to suit modified pumping conditions. See the description in Section 7.4.6.

Pawcatuck WPCF

For the Pawcatuck WPCF, Alternative No. 4 is identical to Alternative No. 1. Refer to Section 7.4.2 for a description.

New 1.03-mgd Water Pollution Control Facility

Projected Flows and Loads

The projected flows and loads to the new WPCF under this alternative are as shown in **Table 7-20**, as developed in Section 3. These flows and loads represent the sum of the projected flows and loads to the Mystic and Borough WPCFs.

Table 7-20

Alternative 4: New 1.03-mgd Water Pollution Control Facility

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	TKN (ppd)	NH_3-N (ppd)
Average Annual	1.03	2,818	2,283	354	247
Maximum Month	1.46	4,965	4,709	536	375
Peak Day	2.17	6,972	5,640	761	530
Peak Instantaneous	3.97				

Secondary Treatment/BNR Process Alternatives Evaluation

Four secondary treatment/BNR alternatives were evaluated in detail: 1) MLE process with denitrification filters; 2) Bardenpho™ process; 3) SBRs; and 4) oxidation ditches. For each technology, a conceptual system was designed using the projected flow rates summarized in Table 7-17. Each of the four proposed options was evaluated to compare capital costs, operation and maintenance (O&M) costs and present worth. In addition, the alternatives were compared against a series of non-economic factors.

State Guidelines. *Technical Report #16 (TR-16)* establishes guidelines for the design of activated sludge processes, and BNR systems. These guidelines include unit process loading criteria, redundancy and reliability requirements, and detention time requirements. These guidelines were followed in the conceptual design of the alternative biological systems.

MLE Process with Denitrification Filters. The MLE process would consist of two biological reactors, followed by two secondary clarifiers. The biological reactors each include an anoxic zone, followed by an aerobic zone. An internal recycle pumping system is required to recycle effluent from the aerobic zone back to the front of the anoxic zone. Two secondary clarifiers are also needed to settle the activated sludge from the MLE process effluent, which would have a total nitrogen concentration of approximately 8 mg/L. The effluent then flows to the denitrification filters, which are sized to remove remaining nitrogen in the wastewater to a concentration of about 3 mg/L. A primary clarification step precedes the MLE process. The MLE process with denitrification filters' design criteria are summarized in **Table 7-21**.

Table 7-21
Alternative No. 4: MLE Process with Denitrification Filters Design Criteria

Attribute	Value
Primary Clarifiers	
- Number of Tanks	3
- Length	88 feet
- Width	18 feet
- Side Water Depth	12 feet
MLE Process	
- Number of Reactors	2
- Anoxic Volume per Reactor	0.06 million gallons
- Aerobic Volume per Reactor	0.48 million gallons
- Number of Secondary Clarifiers	2
- Diameter	55 feet
- Side Water Depth	14 feet
Denitrification Filters	
- Number of Filters	4
- Loading Rate @ Average Flow	1.33 gpm/sf
- Filter area	540 square feet
- Filter Bed Depth	6 feet

Bardenpho™ Process. The Bardenpho™ process would consist of two biological reactors, followed by two secondary clarifiers. The biological reactors each include four zones: a first-stage anoxic zone, a first-stage aerobic zone, followed by a second anoxic and aerobic zone. An internal recycle pumping system is used to return flow from the first aerobic zone back to the first anoxic zone, similar to the MLE process. Two secondary clarifiers are also needed to settle the activated sludge from the Bardenpho™ process effluent, which would have a total nitrogen concentration of approximately 4 mg/L. The second stages provided in the Bardenpho™ process eliminate the need for further downstream nitrogen removal. A primary clarification step precedes the Bardenpho™ process. The Bardenpho™ process design criteria are summarized in **Table 7-22**.

Table 7-22
Alternative No. 4: Bardenpho™ Process Design Criteria

Attribute	Value
Primary Clarifiers	
- Number of Tanks	3
- Length	88 feet
- Width	18 feet
- Side Water Depth	12 feet
Bardenpho™ Process	
- Number of Reactors	2
- Anoxic (1st stage) Volume per Reactor	0.06 million gallons
- Aerobic (1st stage) Volume per Reactor	0.48 million gallons
- Anoxic (2nd stage) Volume per Reactor	0.04 million gallons
- Aerobic (2nd stage) Volume per Reactor	0.015 million gallons
- Number of Secondary Clarifiers	2
- Diameter	55 feet
- Side Water Depth	14 feet

Sequencing Batch Reactors. The SBR process would consist of two biological reactors, followed by a flow-equalization step. The biological reactors each are used to provide both the anoxic and aerobic conditions needed to achieve nitrogen removal, by controlling air provided to the tanks, and also to provide secondary settling, which eliminates the need for secondary clarifiers. The flow equalization is needed to reduce the peak flow rate to the downstream processes, such as disinfection. The SBR process design criteria are summarized in **Table 7-23**.

Oxidation Ditches. Oxidation ditches would involve the same biological process as the Bardenpho™ process, described above, but are configured in a manner that eliminates the need for internal recycle pumping in the reactors. Primary clarifiers are typically not included in the process train upstream of oxidation ditches. The process would consist of two biological reactors, followed by two secondary clarifiers. The biological reactors each include four zones: a first-stage anoxic zone, a first-stage aerobic zone, followed by a second anoxic and aerobic zone. Two secondary clarifiers are also needed. The oxidation ditch process design criteria are summarized in **Table 7-24**.

Table 7-23

Alternative No. 4: Sequencing Batch Reactor Process Design Criteria

Attribute	Value
SBR Process	
- Number of Reactors	2
- Volume per Reactor	1.14 million gallons
- Length	100 feet
- Width	100 feet
- Side Water Depth (maximum)	22 feet
- Flow Equalization Volume	0.18 million gallons

Table 7-24

Alternative No. 4: Oxidation Ditch Process Design Criteria

Attribute	Value
Oxidation Ditch Process	
- Number of Reactors	2
- Anoxic (1st stage) Volume per Reactor	0.85 million gallons
- Aerobic (1st stage) Volume per Reactor	1.2 million gallons
- Anoxic (2nd stage) Volume per Reactor	0.08 million gallons
- Aerobic (2nd stage) Volume per Reactor	0.02 million gallons
- Number of Secondary Clarifiers	2
- Diameter	55 feet
- Side Water Depth	14 feet

Comparison of Secondary Treatment/BNR Alternatives. Each of the four biological process options was evaluated to compare capital costs, O&M costs and present worth. In addition, each alternative was evaluated to compare ratings against a series of non-economic factors.

Capital Costs. Capital cost estimates were developed for each system, based on the systems described earlier. With the exception of the MLE and denitrification filter option, the capital costs of the options are comparable. Estimated comparative capital costs for these processes are summarized in **Table 7-25**.

Table 7-25 Alternative No. 4: Secondary Treatment/BNR Processes Capital Cost Comparison	
Process Technology	**Capital Cost**
MLE with Denitrification Filters	$12,300,000
Bardenpho™	$9,800,000
Sequencing Batch Reactors	$8,800,000
Oxidation Ditches	$8,400,000

Operations and Maintenance. Annual O&M costs were estimated for each biological process, as summarized in **Table 7-26**. Comparative O&M costs are similar, though there are some differences. Among them are: the MLE process with denitrification filters requires addition of methanol; the SBR and oxidation ditch systems have no internal recycle pumping requirement and the SBR system has no return sludge pumping; the oxidation ditch uses surface aerators for providing oxygen to the system, instead of blowers and submerged diffusers.

Table 7-26 Alternative No. 4: Secondary Treatment/BNR Processes Annual O&M Cost Comparison				
Category	**MLE w/Denitrification**	**Bardenpho™**	**SBRs**	**Oxidation Ditch**
Operations				
- Labor	$117,300	$88,000	$76,300	$76,300
- Power	$40,200	$40,200	$35,200	$43,500
- Chemicals	$12,000	$0	$0	$0
Total Operations	*$169,500*	*$128,200*	*$111,500*	*$119,800*
Maintenance Materials	*$34,000*	*$22,700*	*$21,800*	*$18,200*
Total	**$203,500**	**$150,900**	**$133,300**	**$138,000**

Present Worth. Present worth for each option was estimated as summarized in **Table 7-27**. As the table shows, the MLE process with denitrification filters has the highest present worth. The other three options are fairly close, with SBRs and oxidation ditches separated by less than 5 percent of their total value.

Table 7-27 Alternative No. 4: Secondary Treatment/BNR Processes Present Worth Comparison				
Category	**MLE w/Denitrification**	**Bardenpho™**	**SBRs**	**Oxidation Ditch**
Capital Cost	$12,300,000	$9,800,000	$8,800,000	$8,400,000
Annual O&M Cost	$203,500	$150,900	$133,300	$138,000
Present Worth	**$14,700,000**	**$11,600,000**	**$10,400,000**	**$10,000,000**

Non-Economic Factors. Each process was also evaluated for nine non-economic factors. The processes were given a score of 1 to 5 for each non-economic factor, 5 being the highest. The processes are approximately equal in terms of these factors, except for the MLE process, as shown in **Table 7-28**.

Table 7-28 Alternative No. 4: Secondary Treatment/BNR Processes Non-Economic Criteria Comparison				
Factor	**MLE w/ Denitrification**	**Bardenpho™**	**SBRs**	**Oxidation Ditch**
Constructability and Implementability	4	5	5	5
Reliability	3	5	5	5
Operational Flexibility and Expandability	5	5	5	4
Space Requirements	2	4	5	4
Odor	4	4	4	4
Water Quality	5	5	5	5
Noise Level	3	3	3	4
Public Health and Safety	5	5	5	5
Energy Use	3	3	5	4
Total Score	**34**	**39**	**42**	**40**

Rationale for each factor is also provided below:

- *Constructability and Implementability* — Building all of these processes requires the same type of heavy construction work and mechanical expertise. The MLE process with denitrification filters would be slightly more complicated to construct due to the additional equipment.

- *Reliability* — Each of these biological processes depends on the same basic operating knowledge, and the same type of equipment. Again, due to its "extra" filtration equipment, it is more likely that a mechanical problem occur with the MLE process with denitrification filters.

- *Operational Flexibility and Expandability* — Again, each of these processes is similar in operation. Oxidation ditches do not use an internal recycle pumping system, relying instead on the racetrack formation of the tankage. This can limit the system's operational flexibility by a minor amount. All of these systems can be constructed to allow for future expansion.

- *Space Requirements* — The MLE process, with denitrification filters, uses the most process footprint. The Bardenpho™ and oxidation ditch processes are similar, and the SBR process uses the least amount of footprint, because secondary clarifiers are not required.

- *Odor* — Odors are seldom a problem in properly operated secondary treatment systems. All of these processes have the same degree of odor potential.

- *Water Quality* — All of these alternatives would provide secondary effluent water quality that meets Stonington's future permit limits.

- *Noise Level* — None of these processes typically result in problematic levels of noise for off-site receptors. The aeration blowers required for all but the oxidation ditch option can be loud, and plant personnel would have to wear ear protection.

- *Public Health and Safety* — These processes pose no threat to public health. Each of these processes includes deep, open tanks, and plant personnel must take care to avoid accidents.

- *Energy Use* — SBRs use no return sludge pumping system or internal pumping system, and use the least amount of energy. Oxidation ditches use no internal pumping system. The other processes include this pumping equipment.

*Recommended Secondary Treatment/BNR Process***.** Oxidation ditches is the recommended biological process to be incorporated into Alternative No. 4. It was found to be equal, or slightly more cost-effective than the other alternatives regarding both capital costs and present worth. It was also found to score comparably with the alternatives regarding non-economic criteria. It should be noted that both the costs and the non-economic comparison of these process alternatives are very close — such that if Alternative No. 4 is selected, in the next phase of the development of this project (preliminary design of the facilities), it is recommended that these process alternatives, as well as the others described previously, in Section 7.3.3, be reviewed and compared again. Site-specific factors, or advancements in technology, may tend to favor one process over another.

Disinfection System Process Alternatives Evaluation

Two disinfection alternatives were evaluated in detail: 1) Ultraviolet (UV) disinfection and 2) Chlorination/Dechlorination. For each technology, a conceptual system was designed using state guidelines for the projected flow rates summarized in Table 7-17. Each of the two proposed disinfection options was evaluated to compare capital costs, operation and maintenance (O&M) costs and present worth. In addition, the alternatives were compared against a series of non-economic factors.

State Guidelines. Technical Report #16 (TR-16) establishes guidelines for the design of both UV and chlorination/dechlorination disinfection systems. These guidelines include redundancy requirements, minimum dosage requirements (in UV radiation and chemical dosage), and detention time requirements. These guidelines were followed in the conceptual design of the disinfection systems.

Ultraviolet (UV) Disinfection. Vendors were contacted to provide preliminary design and budget pricing information for UV equipment to meet the projected flows and loads for Alternative No. 4. Recommended channel dimensions were used to layout the proposed process, and to develop capital costs. Vendors also provided estimates of lamp life, replacement lamp cost and power consumption to aid in developing O&M costs. The UV system conceptual design criteria are summarized in **Table 7-29.**

Table 7-29

Alternative No. 4: Ultraviolet System Design Criteria

Attribute	Value
Channel Dimensions:	
- Number of Channels	1
- Length	39 feet
- Width	19 inches
- Depth	48 inches
Lamps:	
- Number of Lamps	149
- Typical Lamp Life	13,000 hours
Banks:	
- Number of Banks	3
- Banks Required to Disinfect Peak Flow	2

The UV system would consist of three banks of lamps, all installed in one channel. The channel and UV equipment would be enclosed in a building to facilitate maintenance and repairs as needed. A channel bypass would be provided for emergencies. For process reliability and redundancy, the power fed to the UV system would be from two separate sources, such that if one power source were to fail, the system would remain operational.

Chlorination/Dechlorination. For the chlorination/dechlorination system, *TR-16* guidelines were followed to design estimates of contact tank size, chemical use, and storage needs, and chemical pump capacity requirements. **Table 7-30** summarizes the conceptual design criteria.

The sodium hypochlorite and sodium bisulfite would be stored inside, in two dedicated enclosed areas. Secondary containment would be provided for the chemical storage tanks. Sodium hypochlorite would be delivered in bulk and stored in two long-term storage tanks. The larger storage tanks would feed into a smaller day tank, from which the hypochlorite would be dosed into the contact tanks. Sodium bisulfite would be delivered in totes of 220 gallons each. These totes would be stored inside, and would feed into a day tank that would feed the pumps. There would be two contact tanks for both the chlorination and dechlorination systems.

Table 7-30

Alternative No. 4: Chlorination/Dechlorination System Design Criteria

Attribute	Chlorination	Dechlorination
Tank Dimensions:		
- Number of Tanks	2	2
- Length	57 feet	6 feet
- Width	12 feet	3 feet
- Depth	8 feet	5 feet
Chemical Requirements:		
- Storage	2- 1400 gallon storage tanks	1-220 gallon totes
	1- 155 gallon day tank	1- 60 gallon day tank
Pump Requirements:	2 @ 3.3 GPH (max)	2 @ 1.3 GPH (max)

Comparison of Disinfection Alternatives. Each of the two disinfection options was evaluated to compare capital costs, O&M costs and life cycle costs. In addition, each alternative was evaluated to compare ratings against a series of non-economic factors.

Capital Costs. Capital cost estimates were developed for each system, based on the systems described earlier. Overall, the capital costs of UV and chlorination alone are comparable, but including dechlorination makes UV look more economical. Estimated comparative capital costs for these processes are summarized in **Table 7-31**.

Table 7-31 **Alternative No. 4: Disinfection Processes Capital Cost Comparison**	
Process Technology	**Capital Cost**
Chlorination/Dechlorination	$1,110,000
Ultraviolet	$940,000

Operations and Maintenance. Annual O&M costs were estimated for each disinfection system as shown in **Table 7-32**. Estimates of lamp life and power consumption were used along with local electricity rates to estimate the operating costs of the UV system. The O&M costs of the chlorination/dechlorination system include the costs of the chemicals and labor. It is assumed that 4 hours of labor per week will be required to operate and maintain the UV and chlorination systems, and that 2 hours per week will be needed to operate and maintain the dechlorination system.

Table 7-32 **Alternative No. 4: Disinfection Processes** **Annual O&M Cost Comparison**		
Category	**Chlorination/Dechlorination**	**Ultraviolet**
Operations		
Labor	$14,600	$9,800
Lamps	NA	$1,400
Power	negligible	$2,700
Chemicals	$27,600	NA
Total Operations	*$42,200*	*$13,900*
Maintenance	*$500*	*$2,800*
Total	**$42,700**	**$16,100**

Present Worth. Life cycle costs were estimated as summarized in **Table 7-33**. The higher O&M costs coupled with the extra step of dechlorination make the life cycle cost of chlorination/dechlorination almost twice as high as UV.

Table 7-33 Alternative No. 4: Disinfection Processes Present Worth Comparison		
Category	**Chlorination/Dechlorination**	**Ultraviolet**
Capital Cost	$1,110,000	$940,000
Annual O&M Cost	$42,700	$16,100
Present Worth	**$1,620,000**	**$1,130,000**

Non-Economic Factors. Each technology was also evaluated for nine non-economic factors. The disinfection technologies were given a score of 1 to 5 for each non-economic factor, 5 being the highest. The two disinfection systems came out even as shown in the scores summarized in **Table 7-34**.

Table 7-34 Alternative No. 4: Disinfection Processes Non-Economic Criteria Comparison		
Factor	**Chlorination/Dechlorination**	**Ultraviolet**
Constructability and Implementability	5	5
Reliability	5	4
Operational Flexibility and Expandability	5	3
Space Requirements	3	5
Odor	5	5
Water Quality	4	5
Noise Level	5	5
Public Health and Safety	3	4
Energy Use	5	3
Total Score	**40**	**39**

Rationale for each factor is also provided below:

- *Constructability and Implementability* — Chlorination is the most widely used of the disinfection technologies, and is currently in use in all three of Stonington's existing plants. UV is a well-established disinfection technology. Constructing the UV system should be relatively simple. The UV system is easy to operate.

- *Reliability* — The chlorination/dechlorination process is a well-established technology, which is reliable and effective against a wide spectrum of pathogenic organisms. Operators at Stonington's three existing plants are familiar with the chlorination technology. UV is a reliable technology, but its effectiveness is lessened with turbidity or high total suspended solids in the wastewater.

- *Operational Flexibility and Expandability* — The chemical dose for both chlorination and dechlorination can be adjusted easily. With two tanks, one can be completely shut down for cleaning or repairs. If the flow rate were to increase significantly, it would be necessary to construct another tank to handle the flow. In the UV system banks of lamps can be turned on or off depending on the flow rate. Modules of lamps can be removed for cleaning. In order to expand the system due to an increase in flow rate, additional banks and/or a longer channel would be required.

- *Space Requirements* — The contact time for chlorination required by *TR-16* is 30 minutes at peak flow. This means that the chlorination system requires relatively large tanks. Also, because dechlorination is also required there are two sets of contact tanks and two chemical storage areas to site. UV has a very short contact time required when compared to chlorination, only 30 seconds. This means that the UV system requires a much smaller tank size than chlorination/dechlorination.

- *Odor* — Odor should not be a problem by the time the wastewater reaches the disinfection stage. Chlorine has been shown to eliminate some odors during disinfection. UV has no effect on odor.

- *Water Quality* — After chlorination, chlorine residual is left in the effluent, and has the potential to harm aquatic life in receiving waters. Dechlorination does neutralize much of that risk. One of the main advantages to UV disinfection is that there is no residual effect that could be harmful to human or aquatic life.

- *Noise Level* — Noise is not an issue with either technology.

- *Public Health and Safety* — Chlorination/dechlorination will eliminate any public health risk to people exposed to the effluent. The chlorination/dechlorination chemicals sodium hypochlorite and sodium bisulfite are highly corrosive and toxic, and handling these chemicals poses a risk to the plant employees. UV disinfection will eliminate any public health risk to people exposed to the effluent. Ultraviolet light may pose a risk to the eyes of plant operators, and operators are instructed not to look directly at the lamps.

- *Energy Use* — The chlorination/dechlorination system uses minimal electricity to pump the chemicals into the contact tanks. UV uses significantly more electricity to power the lamps.

Recommended Disinfection Process. Ultraviolet disinfection is the recommended disinfection process to be incorporated into Alternative No. 4. It was found to be more cost effective with both capital costs and O&M costs. It was also found to be similar to chlorination/dechlorination using a series of non-economic factors.

Preliminary/Primary Treatment Process Alternatives Evaluation

The appropriate preliminary and primary treatment processes are dependent on the secondary/BNR process to be used. As described in the previous evaluations, oxidation ditches are recommended for BNR. This process does not require that primary clarifiers be placed upstream, and the tank size criteria previously tabulated are based on no primary clarification.

Because the influent wastewater will not be processed through primary clarification upstream of the secondary/BNR process, it is essential that a grit removal process be utilized. To also allow this process to remove much of the influent scum and grease, an aerated grit chamber with parallel grease removal chamber should be provided.

All of the flow to this new WPCF will be pumped. The pump stations that will feed the plant will all be provided with comminution, so that the wastewater that reaches the plant will not have a significant amount of large or stringy material. Bar screens would have minimal benefit, because the previously ground materials would pass right through. In some cases, ground materials can “re-agglomerate”, and thus it is prudent to install comminutors at the new plant site, to assure adequate protection of downstream equipment and to minimize maintenance problems.

As stated earlier, the new WPCF should include septage receiving.

In summary, the preliminary/primary treatment processes to be utilized at the new WPCF will include comminution, followed by grit and grease removal. Septage receiving will also be provided.

Description of New Water Pollution Control Facility

The new WPCF would be designed to treat an annual average flow of 1.03 mgd, and would provide nitrogen removal in addition to meeting the other permit requirements currently in place at the existing Stonington WPCFs. Influent flow would be pumped to the new WPCF primarily from the pump stations at the existing Mystic WPCF and Borough WPCF sites. Each of the pump stations would be provided with comminutors.

Once at the new plant, the flow would again be passed through a comminutor before flowing through an aerated grit chamber. In this chamber, heavy particles in the wastewater would be removed, and pumped to a grit hopper for hauling off site. The grit chamber would be equipped with a side channel that will collect much of the influent scum and grease, to also be deposited in a hopper and hauled. This process would be enclosed in a building, and the enclosed space will be ventilated to an odor control system.

From the grit chamber, the influent wastewater will flow to the two oxidation ditches, which will be configured to provide secondary treatment and nitrogen removal. Two secondary clarifiers will be downstream of the oxidation ditches. A building will be placed adjacent to the oxidation ditches and the secondary clarifiers, to house the return activated sludge pumping system, the waste activated sludge pumps, electrical equipment, and other ancillary equipment needed to adequately operate the secondary/BNR process.

Downstream of the secondary clarifiers, a UV system will be used to disinfect the wastewater prior to discharge. An effluent pumping system will be required to pump the effluent to a point from which it can flow to the existing Borough outfall by gravity.

A new building will house the solids-handling equipment that will be necessary to thicken the sludge and store it prior to hauling off-site. Equipment will include two rotary-drum thickeners, a polymer system, and associated pumping equipment. Depending on the final site layout, these processes can be accommodated in the same building as the return activated sludge pumping system described above. The entire solids-processing area will be ventilated to an odor control system.

Costs
The estimated planning-level capital cost of constructing the new 1.03-mgd WPCF is $24.1 million.

Flow Transfer Improvements

Alternative No. 4 requires that the entire flow that drains to both the Mystic WPCF and the Borough WPCF be pumped to the new WPCF site for treatment. A new forcemain system would be required to transfer the flow. The peak flow rate to be transferred is 3.97 mgd. It is anticipated that to accomplish this transfer, a 16-inch diameter forcemain would have to run a total length of approximately 4.3 miles from the Borough WPCF to the preferred new plant site (the Pumping Station No. 2 site), via Elm Street and Stonington Road. In addition, once treated the entire new WPCF flow (peak of 3.97 mgd) would have to be pumped back along the same route, for discharge at the Borough outfall.

Summary of Alternative Costs

Table 7-35 presents a summary of costs for Alternative No. 4. These will be compared with the other overall alternatives in Section 7.5. Note that the cost summaries do NOT include estimated costs for property acquisition, nor to they include possible credits (total cost reductions) due to potential sale of existing properties.

Table 7-35 Alternative No. 4: Summary of Costs			
Major Component	**Capital**	**Annual O&M**	**Present Worth**
Mystic WPCF Upgrade	$4.0 million	[redacted]	[redacted]
Borough WPCF Upgrade	$4.1 million	[redacted]	[redacted]
Pawcatuck WPCF Upgrade	$7.1 million	[redacted]	[redacted]
New 1.03-mgd WPCF	$24.1 million	[redacted]	[redacted]
Flow Transfer Improvements	$10.5 million	[redacted]	[redacted]
TOTAL	**$49.8 million**	**$1.44 million**	**$66.8 million**

7.4.8 Alternative No. 5

Alternative No. 5 involves taking the Mystic, Borough and Pawcatuck WPCFs out-of-service, and pumping the entire flow currently treated at the three plants to a new site.

The following sub-sections describe development of this alternative in detail.

Mystic WPCF

For the Mystic WPCF, this alternative is essentially the same as described for Alternative No. 2, except that the specific pumping equipment specifications may be different to suit modified pumping conditions. See the description in Section 7.4.5.

Borough WPCF

For the Borough WPCF, this alternative is essentially the same as described for Alternative No. 3, except that the specific pumping equipment specifications may be different to suit modified pumping conditions. See the description in Section 7.4.6.

Pawcatuck WPCF

Description

Implementation of this alternative would allow Stonington to shut down the Pawcatuck WPCF. The Pawcatuck WPCF site would be bypassed by the upgraded Pumping Station No. 3, and none of the existing facilities would need to remain in service.

It is anticipated that the existing Pawcatuck WPCF equipment would be salvaged to the extent feasible. There are several pieces of equipment that appear to be in good condition, and could possibly be re-used by Stonington at another location, or sold to other users, including the emergency generator set, the aeration blowers and the sodium hypochlorite storage and feed equipment. It is also anticipated that the existing concrete tankage would be demolished, and the site prepared for another use. The existing main building could serve many other municipal uses, and is not anticipated to be demolished, though that would be the Town's decision.

Costs
The estimated planning-level capital cost of implementing these improvements at the Pawcatuck WPCF site is $3.6 million.

New 1.96-mgd Water Pollution Control Facility

Projected Flows and Loads
The projected flows and loads to the new WPCF under this alternative are as shown in **Table 7-36**, as developed in Section 3. These flows and loads represent the sum of the projected flows and loads to the Mystic, Borough and Pawcatuck WPCFs.

Table 7-36
Alternative 5: New 1.96-mgd Water Pollution Control Facility

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	TKN (ppd)	NH_3-N (ppd)
Average Annual	1.96	4,370	4,483	648	434
Maximum Month	2.84	6,899	7,987	967	649
Peak Day	3.99	9,197	9,593	1,329	891
Peak Instantaneous	7.27				

Secondary Treatment/BNR Process Alternatives Evaluation
The same four secondary treatment/BNR alternatives evaluated as part of Alternative No. 4 were also evaluated in detail for Alternative No. 5: 1) MLE process with denitrification filters; 2) Bardenpho™ process; 3) SBRs; and 4) oxidation ditches. For each technology, a conceptual system was designed using the projected flow rates summarized in Table 7-36. The evaluation follows the same approach at that used for Alternative No. 4.

State Guidelines. As under Alternative No. 4, *Technical Report #16 (TR-16)* establishes that were used for the design of activated sludge processes and BNR systems.

MLE Process with Denitrification Filters. The MLE process will consist of two biological reactors, followed by two secondary clarifiers, the same configuration as Alternative No. 4, although due to the different design flows and loads, the processes are sized differently. The MLE process with denitrification filters' design criteria are summarized in **Table 7-37**.

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Table 7-37
Alternative No. 5: MLE Process with Denitrification Filters Design Criteria

Attribute	Value
Primary Clarifiers	
- Number of Tanks	4
- Length	78 feet
- Width	18 feet
- Side Water Depth	12 feet
MLE Process	
- Number of Reactors	2
- Anoxic Volume per Reactor	0.11 million gallons
- Aerobic Volume per Reactor	0.53 million gallons
- Number of Secondary Clarifiers	2
- Diameter	65 feet
- Side Water Depth	16 feet
Denitrification Filters	
- Number of Filters	4
- Loading Rate @ Average Flow	1.33 gpm/sf
- Filter Area	1,020 square feet
- Filter Bed Depth	6 feet

Bardenpho™ Process. The Bardenpho™ process will consist of two biological reactors, followed by two secondary clarifiers, similar to Alternative No. 4. The Bardenpho™ process design criteria for the Alternative No. 5 flows and loads are summarized in **Table 7-38**.

Table 7-38 Alternative No. 5: Bardenpho™ Process Design Criteria	
Attribute	**Value**
Primary Clarifiers	
- Number of Tanks	4
- Length	78 feet
- Width	18 feet
- Side Water Depth	12 feet
Bardenpho™ Process	
- Number of Reactors	2
- Anoxic (1st stage) Volume per Reactor	0.11 million gallons
- Aerobic (1st stage) Volume per Reactor	0.53 million gallons
- Anoxic (2nd stage) Volume per Reactor	0.05 million gallons
- Aerobic (2nd stage) Volume per Reactor	0.03 million gallons
- Number of Secondary Clarifiers	2
- Diameter	65 feet
- Side Water Depth	16 feet

Sequencing Batch Reactors. The SBR process will consist of two biological reactors, followed by a flow-equalization step. The SBR process design criteria for Alternative No. 5 flows and loads are summarized in **Table 7-39**.

Table 7-39 Alternative No. 5: SBR Process Design Criteria	
Attribute	**Value**
SBR Process	
- Number of Reactors	2
- Volume per Reactor	2.37 million gallons
- Length	120 feet
- Width	120 feet
- Side Water Depth (maximum)	22 feet
- Flow Equalization Volume	0.33 million gallons

Oxidation Ditches. Oxidation ditch process design criteria for Alternative No. 5 flows and loads are summarized in **Table 7-40**.

Table 7-40

Alternative No. 5: Oxidation Ditch Process Design Criteria

Attribute	Value
Oxidation Ditch Process	
- Number of Reactors	2
- Anoxic (1st stage) Volume per Reactor	0.11 million gallons
- Aerobic (1st stage) Volume per Reactor	1.2 million gallons
- Anoxic (2nd stage) Volume per Reactor	0.10 million gallons
- Aerobic (2nd stage) Volume per Reactor	0.03 million gallons
- Number of Secondary Clarifiers	2
- Diameter	65 feet
- Side Water Depth	16 feet

Comparison of Secondary Treatment/BNR Alternatives. Each of the four biological process options was evaluated to compare capital costs, O&M costs and present worth. In addition, each alternative was evaluated to compare ratings against a series of non-economic factors.

Capital Costs. Capital cost estimates were developed for each system, based on the systems described earlier. With the exception of the MLE and denitrification filter option, the capital costs of the options are comparable. For Alternative No. 5, the SBR option has the lowest capital cost. Estimated comparative capital costs for these processes are summarized in **Table 7-41.**

Table 7-41

Alternative No. 5: Secondary Treatment/BNR Processes

Capital Cost Comparison

Process Technology	Capital Cost
MLE with Denitrification Filters	$10,800,000
Bardenpho™	$9,000,000
Sequencing Batch Reactors	$8,300,000
Oxidation Ditches	$8,600,000

Operations and Maintenance. Comparative Annual O&M costs were estimated for each biological process, as summarized in **Table 7-42**.

Table 7-42
Alternative No. 5: Secondary Treatment/BNR Processes
Annual O&M Cost Comparison

Category	MLE w/ Denitrification	Bardenpho™	SBRs	Oxidation Ditch
Operations				
Labor	$230,000	$180,000	$160,000	$160,000
Power	$48,000	$39,000	$39,000	$50,000
Chemicals	$23,000	$0	$0	$0
Total Operations	*$301,000*	*$219,000*	*$199,000*	*$210,000*
Maintenance Materials	*$43,000*	*$27,000*	*$27,000*	*$25,000*
Total	**$344,000**	**$246,000**	**$226,000**	**$235,000**

Present Worth. Present worth for each option was estimated as summarized in **Table 7-43**. As the table shows, the SBR process has the lowest present worth, the MLE process with denitrification filters has the highest present worth, and the other two options are fairly close to the SBR option.

Table 7-43
Alternative No. 5: Secondary Treatment/BNR Processes
Present Worth Comparison

Category	MLE w/ Denitrification	Bardenpho™	SBRs	Oxidation Ditch
Capital Cost	$10,800,000	$9,000,000	$8,300,000	$8,600,000
Annual O&M Cost	$344,000	$246,000	$226,000	$235,000
Present Worth	**$14,900,000**	**$11,900,000**	**$11,000,000**	**$11,400,000**

Non-Economic Factors. The non-economic factor analysis is the same for Alternative No. 5 as for Alternative No. 4. As shown in Table 7-28, the four processes score fairly closely, with SBRs having the slightly better rating.

Recommended Secondary Treatment/BNR Process. The SBR process the recommended biological process to be incorporated into Alternative No. 5. It was found to be equal, or slightly more cost effective than the other alternatives regarding both capital costs and present worth. It was also found to score slightly better than the alternatives regarding non-economic criteria. As for Alternative No. 4, it should be noted that both the costs and the non-economic comparison of these process alternatives are very close — such that in the next phase of the development of this project (preliminary design of the facilities), it is recommended that these process alternatives, as well as the others described previously in Section 7.3.3, be reviewed and compared again. Site-specific factors, or advancements in technology, may tend to favor one process over another.

Disinfection System Process Alternatives Evaluation

As with Alternative No. 4, two disinfection alternatives were evaluated in detail: 1) Ultraviolet (UV) disinfection and 2) Chlorination/Dechlorination. Each of the two proposed disinfection options was evaluated to compare capital costs, operation and maintenance (O&M) costs and present worth. In addition, the alternatives were compared against a series of non-economic factors.

State Guidelines. *Technical Report #16 (TR-16)* guidelines were followed in the conceptual design of the disinfection systems, as with Alternative No. 4.

Ultraviolet (UV) Disinfection. The UV system conceptual design criteria for Alternative No. 5 are summarized in **Table 7-44**. The UV system will consist of three banks of lamps, all installed in one channel. The channel and UV equipment will be enclosed in a building to facilitate maintenance and repairs as needed. A channel bypass will be provided for emergencies. For process reliability and redundancy, the power fed to the UV system will be from two separate sources, such that if one power source were to fail, the system would remain operational.

Table 7-44

Alternative No. 5: Ultraviolet System Design Criteria

Attribute	Value
Channel Dimensions:	
- Number of Channels	1
- Length	36 feet
- Width	34 inches
- Depth	48 inches
Lamps:	
- Number of Lamps	308
- Typical Lamp Life	13,000 hours
Banks:	
- Number of Banks	3
- Banks Required to Disinfect Peak Flow	2

Chlorination/Dechlorination. For the chlorination/dechlorination system, *TR-16* guidelines were followed to design estimates of contact tank size, chemical use, and storage needs, and chemical pump capacity requirements. **Table 7-45** summarizes design criteria for the Alternative No. 5 flows.

Table 7-45

Alternative No. 5: Chlorination/Dechlorination System Design Criteria

Attribute	Chlorination	Dechlorination
Tank Dimensions:		
Number of Tanks	2	2
Length	68 feet	9 feet
Width	17 feet	4 feet
Depth	8 feet	5 feet
Chemical Requirements:		
Storage	2- 3000 gallon storage tanks	2-220 gallon totes
	1- 320 gallon day tank	1- 60 gallon day tank
Pump Requirements:	2 @ 4.5 GPH (maximum)	2 @ 1.6 GPH (maximum)

Comparison of Disinfection Alternatives. As for Alternative No. 4, each of the two disinfection options was evaluated to compare capital costs, O&M costs and life cycle costs. In addition, each alternative was evaluated to compare ratings against a series of non-economic factors.

Capital Costs. Capital cost estimates were developed for each system, based on the systems described earlier. Overall, the capital costs of UV and chlorination alone are comparable, but including dechlorination makes UV look more economical. Estimated comparative capital costs for these processes are summarized in **Table 7-46**.

Table 7-46

Alternative No. 5: Disinfection Processes

Capital Cost Comparison

Process Technology	Capital Cost
Chlorination/Dechlorination	$1,500,000
Ultraviolet	$1,300,000

Operations and Maintenance. Annual O&M costs were estimated for each disinfection system as shown in **Table 7-47**, using the same assumptions as for Alternative No. 4.

Table 7-47
Alternative No. 5: Disinfection Processes
Annual O&M Cost Comparison

Category	Chlorination/Dechlorination	Ultraviolet
Operations		
Labor	$14,600	$9,800
Lamps	NA	$2,800
Power	negligible	$4,700
Chemicals	$46,200	NA
Total Operations	*$60,800*	*$17,300*
Maintenance	*$770*	*$4,100*
Total	**$61,600**	**$21,400**

Present Worth. Present worth was estimated as summarized in **Table 7-48**.

Table 7-48
Alternative No. 5: Disinfection Processes
Present Worth Comparison

Category	Chlorination/Dechlorination	Ultraviolet
Capital Cost	$1,500,000	$1,300,000
Annual O&M Cost	$61,600	$21,400
Present Worth	**$ 2,200,000**	**$1,600,000**

Non-Economic Factors. The non-economic factor analysis is the same for Alternative No. 5 as for Alternative No. 4. As shown in Table 7-34, the two processes score very closely, with UV having the slightly better rating.

*Recommended Disinfection Process***.** Ultraviolet disinfection is the recommended disinfection process to be incorporated into Alternative No. 5. It was found to be more cost effective with both capital costs and O&M costs. It was also found to be similar to chlorination/dechlorination using a series of non-economic factors.

Preliminary/Primary Treatment Process Alternatives Evaluation

The appropriate preliminary and primary treatment processes are dependent on the secondary/BNR process to be used. As described in the previous evaluations, SBRs are recommended for BNR for Alternative No. 5. This process does not require that primary clarifiers be placed upstream, and the tank size criteria previously tabulated are based on no primary clarification.

Because the influent wastewater will not be processed through primary clarification upstream of the secondary/BNR process, it is essential that a grit removal process be utilized. To also allow this process to remove much of the influent scum and grease, an aerated grit chamber with parallel grease removal chamber should be provided.

All of the flow to this new WPCF will be pumped. The pump stations that will feed the plant will all be provided with comminution, so that the wastewater that reaches the plant will not have a significant amount of large or stringy material. Bar screens would have minimal benefit, because the previously ground materials would pass right through. In some cases, ground materials can "re-agglomerate", and thus it is prudent to install comminutors at the new plant site, to assure adequate protection of downstream equipment and to minimize maintenance problems.

As part of the overall Alternative No. 5, the new WPCF must include a septage receiving process.

In summary, the preliminary/primary treatment processes to be utilized at the new WPCF will include comminution, followed by grit and grease removal. A septage-receiving station will also be required.

Description of New Water Pollution Control Facility

The new WPCF would be designed to treat an annual average flow of 1.96 mgd, and would provide nitrogen removal in addition to meeting the other permit requirements currently in place at the existing Stonington WPCFs. Influent flow would be pumped to the new WPCF primarily from the pump stations at the existing Mystic WPCF and Borough WPCF sites, and from existing Pumping Station No. 3 in the Pawcatuck district. Each of the pump stations would be provided with comminutors.

Once at the new plant, the flow would again be passed through a comminutor before flowing through an aerated grit chamber. In this chamber, heavy particles in the wastewater would be removed, and pumped to a grit hopper for hauling off site. The grit chamber would be equipped with a side channel that will collect much of the influent scum and grease, to also be deposited in a hopper and hauled. This process would be enclosed in a building, and the enclosed space will be ventilated to an odor control system. A septage receiving station will also be required, and provided with odor control.

From the grit chamber, the influent wastewater will flow to the two SBRs, which will be configured to provide secondary treatment and nitrogen removal. A building will be placed adjacent to the SBRs, to house the blowers and associated equipment, the waste activated sludge pumps, electrical equipment, and other ancillary equipment needed to adequately operate the SBR process.

Downstream of the SBR equalization tanks, a UV system will be used to disinfect the wastewater prior to discharge. It is likely that depending on the final layout of the new WPCF, an effluent pumping system will be required to pump the effluent to a point from which it can flow to the existing Borough outfall by gravity.

A new building will house the solids-handling equipment that will be necessary to thicken the sludge and store it prior to hauling off-site. Equipment will include two rotary-drum thickeners, a polymer system, and associated pumping equipment. Depending on the final site layout, these processes can be accommodated in the same building as the SBR equipment described above. The entire solids-processing area will be ventilated to an odor control system.

New building space, either attached to one of the buildings described above, or in a separate building, would be required to support administrative offices and a laboratory. New building space would also be required for a maintenance facility.

Costs

The estimated planning-level capital cost of constructing the new 1.96-mgd WPCF is $27.2 million.

Flow Transfer Improvements

Alternative No. 5 requires that the entire flow that drains to the Mystic WPCF, the Borough WPCF, and the Pawcatuck WPCF (Pumping Station No. 3) be pumped to the new WPCF for treatment. While facilities existing to transfer the flow from the Mystic WPCF to the Ensign Lane Pump Station with minimal improvements, a new forcemain system would be required to transfer the combined flow from the Borough WPCF (perhaps with the Ensign Lane Pump Station in tandem) to the new WPCF. The peak flow rate to be transferred is 3.97 mgd. It is anticipated that to accomplish this transfer to the preferred new site, a 16-inch diameter forcemain would have to run a total length of approximately 4.3 miles, via Elm Street and Stonington Road.

The existing forcemain from Pumping Station No. 3 to the Pawcatuck WPCF will have to be extended along Mary Hall Road, Greenhaven Road, and to the preferred site. A 14-inch diameter forcemain will be required at the future peak flow rate of 3.30 mgd. In addition, it is very likely that once treated, all of the flow would have to be pumped back to the Borough WPCF site, for discharge at the Borough outfall. The total peak flow (7.27 mgd) will require a 20-inch diameter line.

Summary of Alternative Costs

Table 7-49 presents a summary of costs for Alternative No. 5. These will be compared with the other overall alternatives in Section 7.5. Note that the cost summaries do NOT include estimated costs for property acquisition, nor to they include possible credits (total cost reductions) due to potential sale of existing properties.

Table 7-49
Alternative No. 5: Summary of Costs

Major Component	Capital	Annual O&M	Present Worth
Mystic WPCF Upgrade	$4.0 million	[redacted]	[redacted]
Borough WPCF Upgrade	$4.1 million	[redacted]	[redacted]
Pawcatuck WPCF Upgrade	$3.6 million	[redacted]	[redacted]
New 1.96-mgd WPCF	$27.2 million	[redacted]	[redacted]
Flow Transfer Improvements	$12.0 million	[redacted]	[redacted]
TOTAL	**$50.9 million**	**$1.23 million**	**$65.4 million**

7.4.9 Alternative G

Alternative G involves the upgrading of each of the three existing WPCFs to handle the future flows and loads from their respective collection systems, discontinuing the diversion of flow from the Mystic WPCF to the Borough WPCF. It is similar to Alternative No. 1, except that it does not include provisions to enable each plant to meet the long-term total nitrogen limits summarized in Table 7-4. For nitrogen removal, Alternative G includes the use of the Symbio™ process, with the intention of achieving a degree of nitrogen removal, and use of the State's nitrogen trading program to make up for any shortcomings in actual plant performance. Another important part of Alternative G (in fact, the first recommendation of the Citizen's Review Panel), is the provision of significant odor control systems, as a high priority. This odor-control aspect was addressed and completed in 2003. The anticipated process alternatives for upgrading the existing WPCFs are as follows:

- Comminution (grinding)
- Septage receiving (Pawcatuck WPCF only)
- Primary clarifiers
- Activated Sludge
- Nitrogen removal to the extent achievable using the Symbio™ process.
- Disinfection with sodium hypochlorite and dechlorination with sodium bisulfite
- Sludge thickening
- Odor control

The following sub-sections describe development of this alternative in detail.

Mystic WPCF

Projected Flows and Loads

The projected flows and loads to the Mystic WPCF under this alternative are as shown in **Table 7-50**.

Table 7-50

Alternative G: Mystic WPCF Influent Flows and Loads

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	TKN (ppd)	NH_3-N (ppd)
Average Annual	0.726	2,300	1,862	257	181
Maximum Month	0.983	3,852	3,891	348	245
Peak Day	1.498	5,665	4,620	530	372
Peak Instantaneous	2.45				

Description

The limiting unit treatment capacities at the Mystic WPCF are the secondary treatment process and the disinfection process. The existing secondary clarifiers are shallower than is generally considered good practice. Implementation of the secondary treatment process upgrade with the provision for removing nitrogen with the Symbio™ process "steers" the direction of the overall plant upgrade requirements and layout. Hence, the required biological system upgrade is discussed first. Refer to **Figure 7-AG-M** for a conceptual layout of this alternative.

The new biological system must be upgraded to achieve not only BOD removal for the increased flows and loads, but should also be sized to allow simultaneous nitrification and denitrification such that the Symbio™ process can work as intended. The need to achieve nitrification year-round, which is a pre-requisite for the Symbio™ process to work, as intended, requires that the biological system undergo a significant upgrade. The two 0.11-MG basins do not provide adequate volume, so additional aerobic basins will required, resulting in a total aeration tank volume of 0.42 MG. This tankage can be constructed adjacent to the existing tankage as shown in the figure.

The upgraded biological system requirements also require that new secondary clarification capacity be constructed to handle the future hydraulic and solids loading. As in Alternative No. 1, the two 35-foot diameter digesters can be retrofitted into secondary clarifiers, and will provide the required capacity. A new intermediate lift station will be required to pump the effluent from the biological reactors to the

See Figure 7-AG-M

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retrofitted secondary clarifiers, which are at a higher elevation. This lift station would be a two-level structure (basement and ground level).

The existing aeration blowers do not have the capacity to provide sufficient air to meet future demands due to increasing flows, and the requirement to nitrify. It is estimated that three new blowers, each rated at about 2,250 actual cubic feet per minute (acfm) at about 21 pounds per square inch atmospheric pressure (psia) will be needed to replace the existing smaller units. A new, fine-bubble aeration system will need to be installed in the aeration basins to provide adequate air transfer to the wastewater.

Additional primary clarification capacity will be required, and this will be accomplished by converting one of the existing secondary clarifiers into a third primary clarifier.

The existing chlorine contact tank volume of 14,600 gallons does not provide adequate contact time for the future projected peak flow. A volume of 51,000 gallons is required to meet the 30-minute requirement. The remaining needed volume can be obtained by converting the second existing secondary clarifier into additional chlorine contact tankage, with a dechlorination zone at the effluent end.

The Mystic WPCF does not currently process solids. Sludge generated at the Mystic WPCF is currently pumped to the Borough WPCF. In this overall alternative, the Mystic WPCF would require installation of a sludge thickening process. The anticipated thickening system would be similar to those in place at the other plants, including a rotary-drum thickener, a polymer system, and sludge storage. This solids processing can be odorous, and additional odor controls will be provided. As described under Alternative No. 1, the Mystic WPCF is in need of renovations to remain viable throughout the planning period, and this renovation work is also part of Alternative G.

In summary, the upgrade program at the Mystic WPCF for Alternative G is very similar to Alternative No. 1. Somewhat less biological reactor tankage is needed (assuming the Symbio™ process is effective); though a substantial increase from the existing tankage is still required. The other processes require similar upgrades to Alternative No. 1.

Features
The Mystic WPCF upgrade alternative described above has the following notable features:

- Use of existing tankage is maximized.
- A substantial amount of work is required at the Mystic WPCF, despite the intent of Alternative G to not upgrade to full nitrogen removal.
- The existing marginal secondary clarifiers are replaced.

- The required new facilities use the majority of the remaining site, and the resulting layout is marginally feasible. Future expansion at this site will certainly not be feasible.

- This alternative requires re-installation of new solids-thickening equipment, similar to the type recently removed from the plant when the diversion pumping process was placed into service. Additional odor controls will also be required.

Costs

The estimated planning-level capital cost of constructing these improvements to the Mystic WPCF is $14.0 million.

Borough WPCF

Projected Flows and Loads

The projected flows and loads to the Borough WPCF under this alternative are as shown in **Table 7-51**.

Table 7-51

Alternative G: Borough WPCF Influent Flows and Loads

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	TKN (ppd)	NH_3-N (ppd)
Average Annual	0.299	518	421	97	66
Maximum Month	0.479	1,113	818	188	130
Peak Day	0.673	1,307	1,020	231	158
Peak Instantaneous	1.52				

Description

The biological system at the Borough WPCF will not require upgrading under Alternative G. (Refer to **Figure 7-AG-B**.) The biological reactor tankage, secondary clarifier capacity, and blower capacity are all sufficient for the anticipated loads. In addition, the Symbio™ process is already installed.

The plant's existing primary clarification capacity is adequate. The existing chlorine contact tank volume is not adequate, and must be increased by addition of two new, 9,100-gallon tanks. One small, new contact tank is required to provide dechlorination contact time downstream of the chlorine contact tanks.

See Figure 7-AG-B

The Borough WPCF currently has two rotary drum thickeners on line, providing sufficient capacity. It is anticipated that minor miscellaneous work would be conducted to improve the sludge pumping and storage facilities.

The new odor control system for the existing plant was completed in 2003. It includes covers over all of the tankage, and treatment of odors through a biofilter. It is presumed that this same level of treatment would be maintained, and therefore, the new chlorine contact tankage would be covered and ventilated to the biofilter system.

Features
The Borough WPCF upgrade alternative described above has the following notable features:

- Use of existing tankage is maximized.
- The upgrade requirements consist primarily of the chlorine contact tank expansion.

Costs
The estimated planning-level capital cost of implementing these improvements to the Borough WPCF is $1.3 million.

Pawcatuck WPCF

Projected Flows and Loads
The projected flows and loads to the Pawcatuck WPCF under this alternative are as shown in **Table 7-52**, as developed in Section 3.

Table 7-52
Alternative G: Pawcatuck WPCF Influent Flows and Loads

Condition	Flow (mgd)	BOD (ppd)	TSS (ppd)	TKN (ppd)	NH_3-N (ppd)
Average Annual	0.939	1,552	2,200	294	187
Maximum Month	1.382	1,934	3,278	431	274
Peak Day	1.822	2,225	3,953	568	361
Peak Instantaneous	3.30				

Description
The projected increase in flow to the Pawcatuck WPCF results in the following required process upgrades. (Refer to **Figure 7-AG-P**.)

See Figure 7-AG-P

The two existing aeration basins will continue to be used as reactor volume for the Symbio™ nitrogen removal system. The two, 0.21-MG basins provide adequate volume, and additional reactor volume will not be required. The existing aeration blowers do not have the capacity to provide sufficient air to meet future demands due to increasing flows, and the requirement to nitrify. It is estimated that two new blowers, each rated at about 1,610 acfm will be needed in addition to the two existing 800-acfm units.

One new primary clarifier will be required to treat the projected flows to within *TR-16* guidelines. Thee new primary clarifier will be covered for odor containment, along with the two existing primary clarifiers, which were covered as part of the 2003 odor control program.

The existing chlorine contact tank volume of 37,700 gallons does not provide adequate contact time for the future projected peak flow. A volume of about 68,700 gallons is required to meet the 30-minute requirement. New chlorine contact tanks can be constructed adjacent to the existing units. A new dechlorination contact zone will be installed on the downstream end of the chlorine contact tanks, to provide about 5 minutes of detention time at average flow.

Features

The Pawcatuck WPCF upgrade alternative described above has the following notable features:

- Use of existing tankage is maximized.
- The required new facilities fit comfortably on the existing site.

Costs

The estimated planning-level capital cost of implementing these improvements to the Pawcatuck WPCF is $3.8 million.

Flow Transfer Improvements

Alternative G does not require transfer of flows from one drainage district to another, and therefore there are no significant improvements necessary to transfer either influent raw sewage from one plant to another, or treated effluent from a plant to a remote outfall.

Summary of Alternative Costs

Table 7-53 presents a summary of costs for Alternative G. These will be compared with the other overall alternatives in Section 7.5.

Table 7-53
Alternative G: Summary of Costs

Major Component	Capital	Annual O&M	Present Worth
Mystic WPCF Upgrade	$14.0 million	[redacted]	[redacted]
Borough WPCF Upgrade	$1.3 million	[redacted]	[redacted]
Pawcatuck WPCF Upgrade	$3.8 million	[redacted]	[redacted]
Flow Transfer Improvements	$ 0	[redacted]	[redacted]
TOTAL	**$19.1 million**	**$1.76 million**	**$39.9 million**

7.5 Overall Alternatives Evaluation

7.5.1 Introduction

This section contains the evaluation and comparison of the seven overall alternatives developed in detail in Section 7.4.

7.5.2 Economic Comparison

Table 7-54 summarizes the capital cost, annual O&M cost and 20-year present worth of the eight overall alternatives. Note that the cost summaries do NOT include estimated costs for property acquisition, nor to they include possible credits (total cost reductions) due to potential sale of existing properties.

Additionally, Table 7-54 does not show the cost of nitrogen trading that would be an inherent part of Alternative G. This cost cannot easily be estimated given that the unit cost of nitrogen is established annually based on the number of needed versus available credits. It is expected that this cost would rise substantially as 2014 approaches. For all alternatives except Alternative G, it is expected that Stonington would receive a nitrogen credit once the new facilities are on line.

On a capital cost basis, Alternative G is the least costly alternative, followed by Alternative Nos. 1, 1A and 1B, which are all very close. Alternative No. 2 is slightly more costly. Alternatives Nos. 3, 4 and 5 are more costly. On an annual O&M basis, Alternative Nos. 3 and 5 are the least costly, because the involve operation of only one plant. Alternative Nos. 2 and 4 are somewhat more costly to operate and maintain, and the alternatives with three plants (Alternative Nos. 1, 1A, 1B and G) are the most expensive to operate.

On a 20-year present worth basis, Alternative G is the most economical, followed closely by Alternative Nos. 1, 1A, 1B and 2. Alternative Nos. 3, 4 and 5 are the most costly. However, the true cost of Alternative G would be somewhat higher than shown on Table 7-54 when considering the nitrogen trading cost associated with this alternative.

Table 7-54
Overall Alternatives Economic Comparison

Description	Capital	Annual O&M	Present Worth[1]
Alternative No. 1	$25.8 million	$1.77 million	$46.7 million
Alternative No. 1A	$25.3 million	$1.86 million	$47.3 million
Alternative No. 1B	$25.7 million	$1.86 million	$47.7 million
Alternative No. 2	$28.3 million	$1.45 million	$45.4 million
Alternative No. 3	$42.0 million	$1.22 million	$56.4 million
Alternative No. 4 (preferred site)	$49.8 million	$1.44 million	$66.8 million
Alternative No. 5 (preferred site)	$50.9 million	$1.23 million	$65.4 million
Alternative G	$19.1 million	$1.76 million	$39.9 million

[1]The present worth cost does not include any cost/credit associated with the nitrogen trading program.

7.5.3 Non-Economic Comparison

The alternatives are compared versus several non-economic criteria in the following paragraphs. It is understood that comparing the alternatives against these criteria is, by necessity, subjective. However, by evaluating each criterion separately, a preferred alternative can often be identified.

Constructability

This criterion seeks to measure the ease or difficulty with which the alternative can be physically constructed. Alternative Nos. 1, 1A, 1B and G involve considerable construction at each of the three existing plant sites, but involve a negligible amount of pipeline construction work. Construction at the Mystic and Borough WPCFs will be difficult due to the small amount of available area for staging, though at the Pawcatuck site this is not an issue. Alternative No. 2 involves extensive construction at the Borough WPCF site, and the quantity of work to be performed would make that construction difficult. Alternative Nos. 3, 4 and 5 require an extensive amount of pipeline work. The necessary work at a new treatment plant site would be relatively simple in comparison to the pipeline work.

Implementability

This criterion seeks to measure the ease or difficulty with which the alternative can be implemented, and is meant to address factors such as regulatory and public

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acceptance, potential stumbling blocks and the political climate. Based on the public comment received to date, the alternatives that involve continued use of the three existing plant sites (Alternatives 1, 1A, 1B and G) are the most likely to be approved and successfully implemented by the Town. Alternative 1A, which involves continued diversion of primary underflow from the Mystic WPCF to the Borough WPCF, appears to be less acceptable to the public than Alternatives 1, 1B, and G. The other alternatives all involve some degree of consolidation of either treatment facilities and/or discharge, and public acceptance of those options seems dubious. Alternative Nos. 4 and 5 include one significant additional hurdle: a new site is needed, and though the preferred site is already owned by the Town, obtaining the public's approval of a new site is not easy.

Impacts during Construction
All of the alternatives will impact the community to some extent during construction. The three-plant alternatives will each require heavy construction at three sites. Visual proximity to neighbors seems most direct at the Borough WPCF, as the Mystic WPCF and Pawcatuck WPCF are somewhat more isolated visually. For this reason, Alternative No. 2 is probably the least preferable. Alternative Nos. 3, 4 and 5 involve significant pipeline work in busy streets, and will therefore have impacts.

Land Impact
Alternative Nos. 1, 1A, 1B and G will have minimal land impact (positive or negative), as the current use at the existing sites would continue. Alternative 2 would have a slightly positive impact on the Mystic WPCF site and a negative impact at the Borough WPCF site due to the amount of construction needed. Alternative No.3 will have minimal land impact, as the existing site is large enough to support plant expansion without directly impacting neighbors. Alternative Nos. 4 and 5, which include new sites, will have a significant land impact.

Reliability
All of the alternatives involve either upgraded or new treatment facilities, provided with reliable and redundant systems, and therefore all of the alternatives are approximately equal against this criterion.

Flexibility
The alternatives that involve the continued use of the three existing treatment plant sites (Nos. 1, 1A, 1B and G) provide the most flexibility, in terms of both long-term operations, and in terms of initial implementation of the alternative. The three-plant options provide the option of project phasing, and would provide the flexibility to implement phases at the optimal time. Purely in terms of operational flexibility after construction is complete, the new plants in Alternative Nos. 4 and 5 would be designed with the most up-to-date, proven technology, and would be optimally flexible.

O&M Complexity

Alternative Nos. 3 and 5 would be preferred over the other alternatives for this criterion, because one plant is simpler to operate and maintain than two or three. Alternative No. 5 would have an advantage over Alternative No. 3, because a new facility would be streamlined for efficiency. The three-plant options would be the most complex to operate and maintain.

Proximity to Neighbors

Alternative No. 5 would rank highest against this criterion, followed by Alternative No. 3, then Alternative No. 4. Fewer facilities translate into fewer neighbors, which is an advantage. The preferred site for Alternative No. 5 is isolated from its neighbors, more so than the existing Pawcatuck site. The three-plant alternatives maximize the plants' exposure to neighbors.

Odor Control

Similar to the above criterion, Alternative No. 5 would rank highest against this criterion, followed by Alternative No. 3, then the other alternatives. Fewer facilities translate into fewer potential odor problems, which is an advantage. It must be noted that the cost figures included earlier in this section include maintenance, or in some cases, improvements over the odor control measures provided by the 2003 odor control project, so all alternatives should be more than satisfactory from an odor-control perspective.

Water Quality (Impact from Outfalls)

Except for Alternative G, the alternatives can be considered equal against this criterion, although it should be noted that not all interested stakeholders agree on this for all alternatives. All alternatives include continued use of the existing outfalls, either all three (as in Alternative Nos. 1, 1A, 1B and G), the Pawcatuck River and the Stonington Harbor outfalls (Alternative Nos. 2 and 4), or just the Stonington Harbor outfall (Alternative Nos. 3 and 5). The effluent quality resulting from the upgrades will result in an overall lower impact than either of these outfalls has today. The public has expressed a strong concern with significantly increasing the quantity of effluent discharged through any specific outfall, therefore making the alternatives that involve consolidation (Alternatives 2, 3, 4 and 5) least preferred.

Alternative G, by definition, will not provide the same level of nitrogen removal as the other alternatives, and therefore is least preferred for this criterion.

Ambient Noise

None of the alternatives will have any particular advantage or disadvantage regarding ambient noise, and all are approximately equal.

Water Supply

All of the alternatives include discharge through existing outfalls, and will not impact the water supply.

Floodplain

The Mystic and Borough WPCFs are located within the floodplain, and thus must be designed to maintain operation during floods. This is not an unusual design criterion for treatment plants. Neither the existing Pawcatuck WPCF site, nor the preferred new plant site for Alternative Nos. 4 and 5, are in the floodplain. Construction at none of the existing or new sites will have any impact on flooding conditions. None of the alternatives will have any particular advantage or disadvantage regarding floodplain issues, and all are approximately equal.

Wetlands

The existing treatment plant sites have no wetland issues, though construction at the Mystic WPCF will have to consider the nearby wetlands. The preferred site for the new plant in Alternative Nos. 4 and 5 is partially surrounded by wetlands, but disturbing the wetlands will not be required to build or operate the plant. Proper permitting procedures will have to be followed regardless of the alternative. Therefore, no alternative has an advantage against this criterion.

Public Health and Safety

All of the alternatives will provide environmental benefits, and none of the alternatives is favored.

Aesthetics

The three-plant alternatives will have an aesthetic impact at the existing Mystic WPCF and Borough WPCF sites, although the proximity to neighbors at Mystic is less of a concern. The Pawcatuck WPCF site is visually isolated from neighbors, so expansion at the site will not have negative aesthetic impact. Alternative No. 2 would have a considerable negative impact at the Borough WPCF site. The preferred site for Alternative Nos. 4 and 5 would be isolated. The new plant road that would be required to enter the new plant will have a minor impact.

Energy Use (Other than Cost)

This criterion seeks to ascertain if one alternative is significantly more energy-efficient or consuming than the others, because of the overall environmental impact that this has. The alternatives measure approximately equally.

Farmland (Preserve)

None of the alternatives impact preserved farmlands.

Historical/Cultural/Recreational

None of the alternatives has any known impact on historical or cultural resources. Alternative Nos. 1, 1A, 1B, 2 and 3 have no impact on recreational resources. Alternative Nos. 4 and 5 would have some negative, and possibly other positive, impacts. On the positive side, the new plant alternatives could make at least parts of the existing Mystic WPCF, Borough WPCF and Pawcatuck WPCF sites available for other uses. The new plant alternatives impact the hiking trails that currently exist at the preferred site — the trails would have to be relocated. In the case of Alternative

No. 5, which will include the closure of the Pawcatuck WPCF, there might be a corresponding positive impact. Alternative No. 4 is slightly less preferred than Alternative No. 5 because this option would not be available.

Summary

Upon review of the discussion in Section 7.5.3, it seems obvious that the three-plant alternatives offer some significant non-economic advantages during the construction and implementation phase, and that the one-plant alternatives may offer some advantages during the long-term operations.

7.5.4 Recommendation

The WPCA is authorized to provide wastewater collection and treatment services within the Town of Stonington. While performing these services, the WPCA balances the community interests in water quality and cost effectiveness with those interests and standards of the regulatory authorities like the DEP and the EPA.

These considerations suggest that only those options that maintain continued operation at the three existing treatment plant sites can be feasibly implemented with public support. Through the facilities planning efforts and the public input received as the project has advanced, WPCA believes that alternatives that include consolidation of plants (Alternative Nos. 2, 3, 4 and 5) are not the best choices for the Town. Among the reasons that these alternatives cannot be successfully implemented are: 1) the capital and present-worth (life cycle) costs of those options are much higher than the other options; and 2) the consolidation of treatment sites, resulting in an increase in the amount of flow discharged into any single receiving water body, is unacceptable to the citizenry. In addition, Alternative Nos. 4 and 5 require a new treatment plant at a new site, there are complex issues associated with siting, and there would be a significant community impact resulting from construction associated with the network of pipelines needed to service a remote location.

In light of the issues generated by consolidation, only those options that involve continued operation of the three existing plants (Alternatives 1, 1A, 1B and G) remain for consideration. Of these four remaining alternatives, WPCA feels that Alternative G is least preferred, because it does not provide the same level of treatment as the others, and would therefore not provide the same degree of environmental benefit. In fact, Alternative G would require Stonington to purchase nitrogen credits through the *General Permit for Nitrogen Discharges* indefinitely to stay in compliance. Neither would Alternative G provide treatment capacity equivalent to Alternatives 1, 1A, and 1B. WPCA does not consider Alternative G to be an acceptable long-term wastewater treatment solution.

Alternatives 1 and 1B are preferred over Alternative 1A, because Alternative 1A includes continuation of the current primary clarifier underflow diversion from the Mystic WPCF to the Borough WPCF. Alternatives 1 and 1B do not include this underflow diversion. The WPCA supports restoration of the original design concept for Stonington – three treatment plants treating the sewage from their respective collection systems. The upgraded facilities provide levels of treatment consistent with DEP requirements and eliminate the need for the underflow diversion at Mystic. Alternatives 1 and 1B are equally feasible both economically and non-economically to Alternative 1A, and therefore WPCA does not consider Alternative 1A the best option.

Continuing on this line of thinking, Alternative 1 is preferred to Alternative 1B. Alternative 1 involves no planned diversion of any kind. It is also a cost-effective, feasible option that will meet the 20-year performance goals of the WPCA while offering the opportunity to phase construction by working on one plant at a time. Therefore, WPCA recommends implementation of Alternative 1. WPCA also notes that the existing diversion infrastructure, consisting of the pumping system at the Mystic WPCF and the forcemain system that allows the transfer of flow to the Borough WPCF, is in-place infrastructure and is an asset that should not be abandoned or removed. Rather, it should be maintained in-place to maximize the Town's operational flexibility and available options to handle unexpected emergencies at Mystic WPCF after the upgrades are complete. In such emergencies, WPCA envisions that that the diversion infrastructure could be used to transfer either raw influent or primary effluent (not primary clarifier underflow) from the Mystic WPCF to the Borough WPCF if necessary to avoid a non-compliance event.

Option	Description
A	Upgrade each of the three WPCFs to treat flows from local collection systems.
B	Upgrade each of the three WPCFs. Continue the existing Mystic WPCF diversion to the Borough WPCF.
C	Abandon the Mystic WPCF. Pump station to transfer all flow from the Mystic collection system to the Borough WPCF. Upgrade the Borough and Pawcatuck WPCFs.
D	Abandon the Mystic and Borough WPCFs. Pump stations to transfer all flow from the Mystic and Borough collection systems to the nearby Groton system. Upgrade the Pawcatuck WPCF.
E	Abandon the Mystic and Borough WPCFs. Pump all flow from the Mystic and Borough collection systems to the Pawcatuck WPCF. Upgrade the Pawcatuck WPCF.
F	Abandon the Mystic and Borough WPCFs. Construct a new WPCF at a new location, preferably in the vicinity of the Mystic and Borough collection systems. Upgrade the Pawcatuck WPCF.
G	Upgrade all three WPCFs to meet secondary treatment levels only. Do not upgrade for nitrogen removal, except as might be possible with the existing facilities at minimal cost, and instead depend on State's nitrogen trading program.
H	Abandon all three existing WPCFs. Construct a new WPCF at a new location to handle entire Town's flow.
I	No action alternative.
J	Upgrade each of the three WPCFs, and maintain a diversion from the Mystic WPCF to the Borough WPCF. However, unlike option B, this diversion would not consist of the underflow from the Mystic WPCF primary clarifiers, but instead would be either primary effluent or raw influent.

Table 7-1
Initial List of Overall Alternatives

Option	Description
1, 1A, 1B	Upgrade each of the three WPCFs to treat flows from local collection systems. Option 1A includes continuing Mystic WPCF diversion to Borough WPCF. Option 1B includes a diversion, but rather than primary clarifier underflow, the diversion would be primary effluent or raw influent. (Derived from Options A, B and J.)
2	Abandon Mystic WPCF. Pump station to transfer all flow from Mystic collection system to Borough WPCF. Upgrade Borough and Pawcatuck WPCFs. (Derived from Option C.)
3	Abandon Mystic and Borough WPCFs. Pump all flow from Mystic and Borough collection systems to the Pawcatuck WPCF. Upgrade Pawcatuck WPCF. (Derived from Option E.)
4	Abandon Mystic and Borough WPCFs. Construct new WPCF in vicinity of Mystic and Borough collection systems. Upgrade Pawcatuck WPCF. (Derived from Option F.)
5	Abandon all three existing WPCFs. Construct new WPCF in central location to handle entire Town's flow. (Derived from Option H.)
G	Upgrade each of the three WPCFs only as and when necessary for treatment capacity, do not upgrade for nitrogen removal (except as may be accomplished by the Symbio™ process), and provide significant odor control at all three WPCFs.

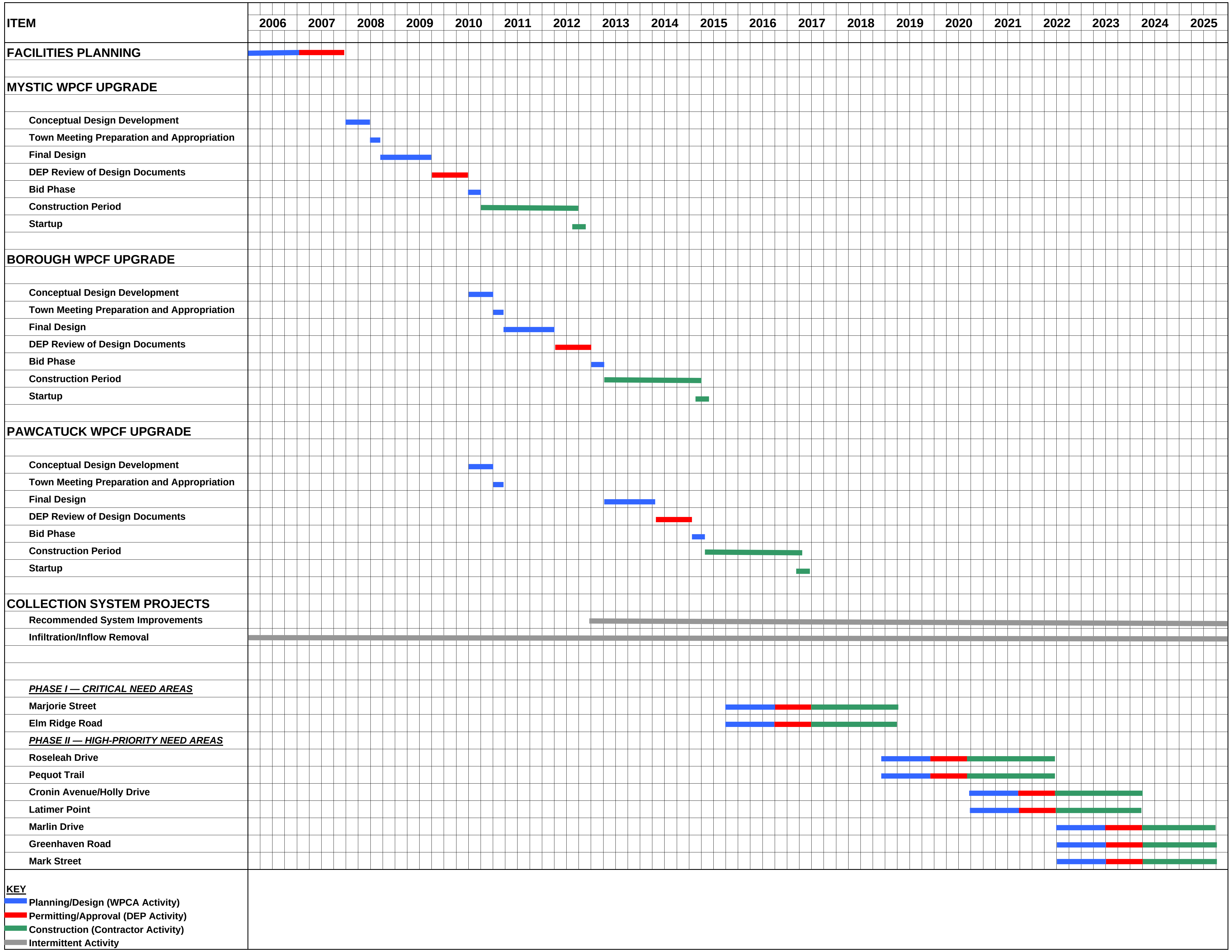
Table 7-2
Candidate List of Overall Alternatives

Site Ranking	Site Reference Number	Buildable Acres	Zoning	Address
1	102	Approx. 24	Rural	South Broad Street Pawcatuck, CT (Pumping Station No. 2)
2*	21 (Air Strip)	Approx. 13	Manufacturing & Coastal	349 Elm Street Stonington, CT (Airport)
3*	21 (Upper Portion)	Approx. 13	Manufacturing & Coastal	349 Elm Street Stonington, CT (Airport)
4	34	32.80	Low Density	Palmer Neck Road Stonington, CT
5	32	13.90	Coastal	Palmer Neck Road Stonington, CT
5	93	16.65	Rural	South Anguilla Road Pawcatuck, CT
6**	24	41.60	Coastal	396 North Main Street Stonington, CT
7	92	35.60	Rural	117 South Anguilla Road Pawcatuck, CT
8	37	55.52	Low Density	Greenhaven Road Pawcatuck, CT
9	3	Approx. 8	Manufacturing	14 Lords Hill Road Stonington, CT (Hubbel)

* Note that this site evaluation was conducted prior to recent events that have resulted in approved development plans for the "airport" site. It is understood that these parcels are no longer available.

** Note that this site evaluation was conducted prior to placement of a conservation easement on this parcel. It is understood that this parcel is now owned by Avalonia Land Conservancy and no longer available.

Table 7-3
Finalist Sites



CDM

Figure 8-1
Recommended Project Schedule

Section 8
Recommended Plan

8.1 Introduction

This section includes the recommended plan for wastewater collection, disposal, and treatment for the Town. The recommended plan for disposal of wastewater is based on the sewer needs assessment and alternatives evaluation described in Section 2, and the collection system evaluation presented in Section 4. The recommended plan for treatment of the wastewater is based on the WPCF evaluation described in Section 5, the receiving water evaluation presented in Section 6, and the alternatives evaluation presented in Section 7.

The recommended plan is phased over time, based on the relatively urgent need to upgrade the Town's wastewater treatment facilities, especially the Mystic WPCF, and the long-term need to implement solutions to the sewer needs areas.

High-priority recommendations include:

- construction of improvements to the Town's wastewater treatment facilities to enable the Town to meet the Town's projected needs for the 20-year life of the Wastewater Facilities Plan,
- provide sufficient treatment capacity, and
- to eventually meet Stonington's effluent total nitrogen wasteload allocation (in accordance with the *General Permit for Nitrogen Discharges*.

Lower-priority recommendations include:

- construction of sewers into those sewer needs areas identified in Section 2, and
- implementing the collection system improvements recommended in Section 4.

The nine sewer needs areas recommended for planned implementation within the 20-year plan period would not be addressed all at once; rather, it is anticipated that the sewer construction program would be spread out over the next 20 years to minimize impacts on the Town. The implementation plan envisions that areas identified as "critical" priority would be addressed first, followed by "high" priority areas. Throughout the 20-year period, each area will be addressed at WPCA's discretion.

Figure 8-1 presents a project schedule for these recommendations, and shows how the construction recommended in the plan would be phased.

See Figure 8-1

8.2 Recommended Plan for Wastewater Treatment

As described in Section 7, it is recommended that Stonington meet its wastewater treatment needs by implementing upgrades at each of its three existing treatment facilities. Each facility will be upgraded to treat all of the influent wastewater from its collection system (i.e., the existing diversion from the Mystic WPCF to the Borough WPCF will be discontinued) and to achieve a high degree of nitrogen removal, enabling WPCA to comply with the *General Permit for Nitrogen Discharges* without requiring the purchase of credits.

As shown in **Figure 8-1**, upgrade of the Mystic WPCF is the highest-priority component of the recommended plan. The Mystic WPCF is the oldest of the three WPCFs, and is in the highest need. Once the Mystic WPCF is upgraded, and the existing diversion to the Borough WPCF is discontinued, the impacts of the Borough WPCF can be fully ascertained before upgrading the Borough WPCF. Due to the current flows and loads to the Borough and Pawcatuck WPCFs, the timing of upgrades to those facilities can be phased to optimize funding opportunities and minimize cost impacts, and to otherwise implement the upgrades at the most feasible time.

The estimated probable present-day project cost for implementing this project is $25.8 million including engineering and contingencies. The estimated annual O&M cost of the completed facilities is $1.77 million. These costs are based on implementing the following treatment processes:

- Influent comminutor and pumping (area provided with odor control)
- Septage receiving (at Pawcatuck WPCF)
- Primary clarification (process provided with odor control)
- Biological process for secondary treatment and nitrogen removal. The technology selected in this report is a conventional single-sludge biological system utilizing anoxic and aerobic zones within the reactors.
- Sodium hypochlorite addition for disinfection.
- Sludge storage and thickening (areas provided with odor control)

During the design phase of the project, process alternatives, including newer technologies such as IFAS and MBR systems for biological treatment, and UV systems for disinfection, should be re-evaluated, in detail, to determine the best, most cost-effective processes to implement.

8.3 Recommended Plan for Collection System

As described in Section 4, there are several minor recommended upgrades to the existing collection system with an estimated value of $340,000 including engineering and contingencies. These improvements are minimal and can be addressed as needed over the 20-year planning period. In addition, infiltration and inflow management should also be employed throughout the 20-year planning period.

8.4 Recommended Plan for Wastewater Disposal

As described in Section 2, alternatives were evaluated to provide solutions to the 18 sewer needs areas identified in this Wastewater Facilities Plan. The WPCA recommends the plan include provisions to provide solutions to nine of these sewer needs areas (only the "critical" and "high" priority areas) within the 20-year planning period. **Table 8-1** presents a summary of these areas, their relative priority, the associated recommended solutions, and costs.

The schedule in Figure 8-1 indicates that the sewer needs areas would be addressed in a phased manner, with the "critical" areas addressed first, followed by the "high" priority areas. All of the sewer needs area projects are shown as delayed until after the treatment plant projects are complete. These projects are then phased throughout the remainder of the planning period. This phasing would minimize cost impacts on the Town's citizens, and inconvenience due to road construction. It should be noted that there is no specific implementation sequence established for any of these projects. WPCA has the responsibility to continuously review the Town's sewer needs, and respond to the highest-priority needs and the public health demands and as budgetary constraints allow. It is possible, even probable, that the timing of the recommended improvements may change from that shown on **Figure 8-1**.

In addition, Section 10 evaluates two implementation options and their financial impact on the Town. Implementation option 1 includes the impact of connecting only the areas designed as "critical," and implementation plan 2 also includes the "high" priority areas.

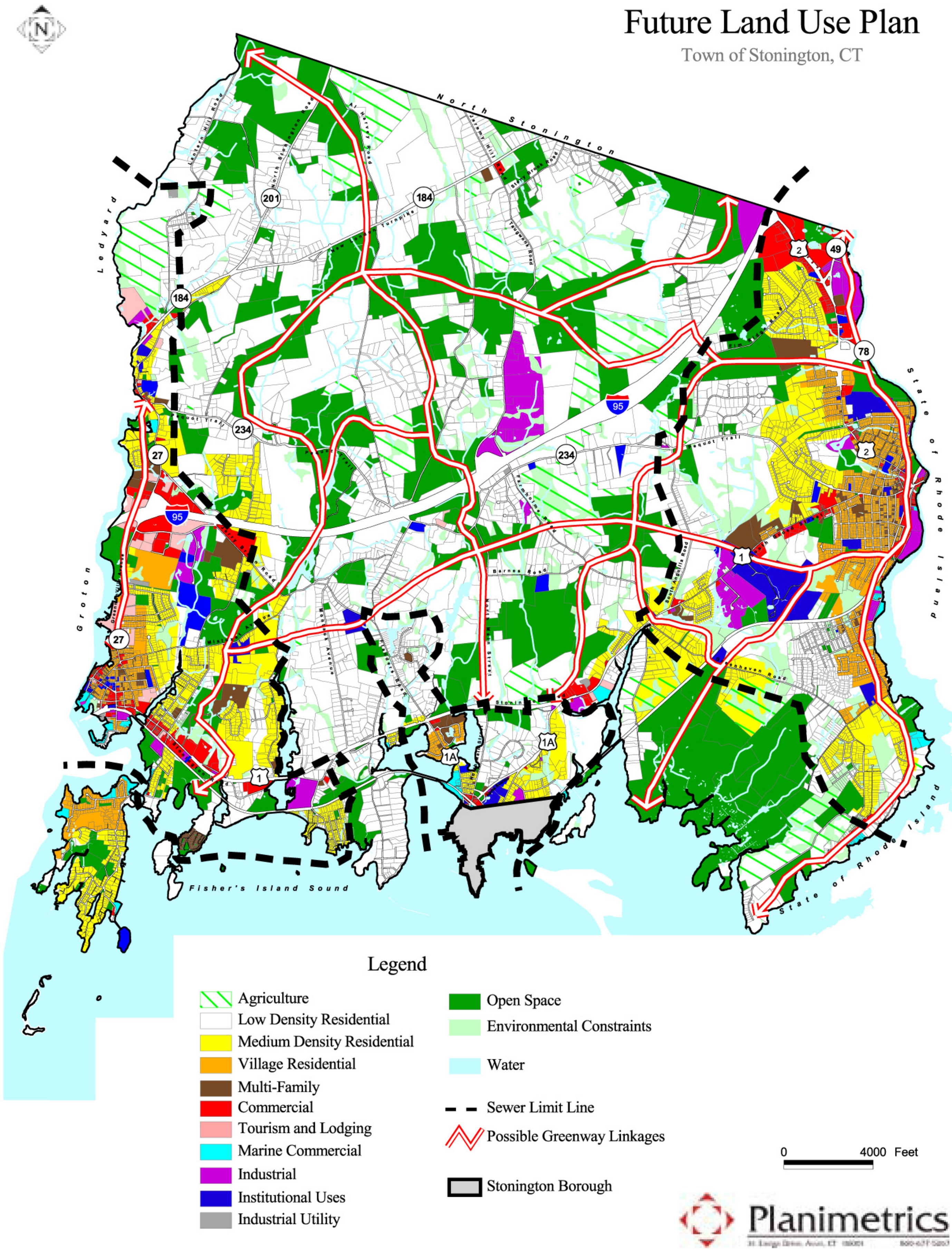
8.5 Recommendations: Onsite Wastewater Management

Appendix B describes the recommended Onsite Wastewater Management Program (OWMP) to assist homeowners with onsite systems.

See Table 8-1

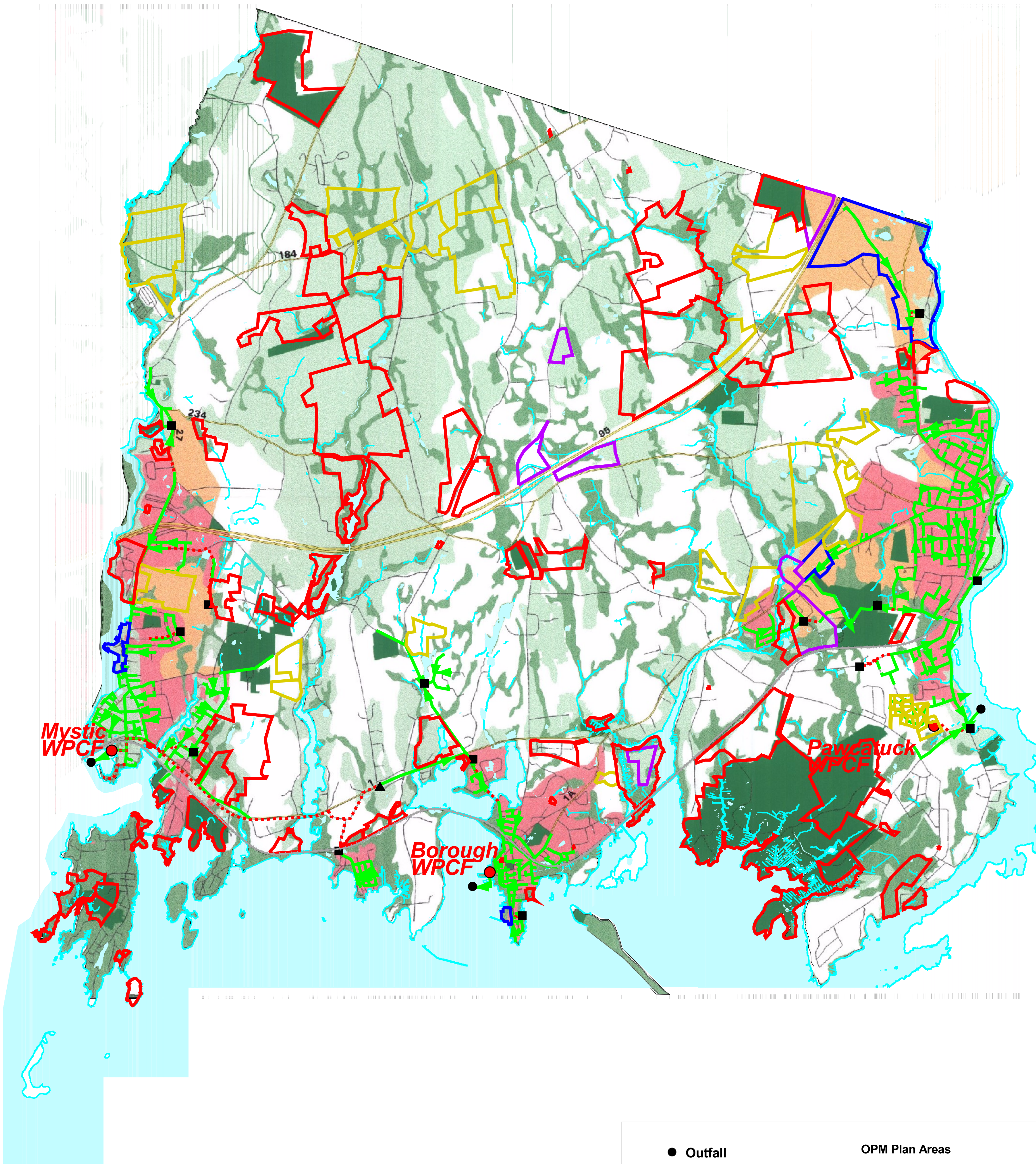
	Area	Priority	Recommended Treatment Alternative	Recommended Collection Alternative	Present Day Capital Cost (ENR=7763)	Annual O&M
1	Marjorie Street Area	Critical	Community Innovative/Alternative Technologies	Gravity Sewers, Pump Station and Force Main	$2,086,000	$58,600
4	Roseleah Drive	High	Town Water Pollution Control Facility	Grinder Pumps and Low-Pressure Sewers	$384,000	$11,000
5	Elm Ridge Road Area	Critical	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers, Pump Station and Force Main	$5,247,000	$85,000
6	Pequot Trail Area	High	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers	$3,720,000	$36,800
7	Cronin Avenue	High	Town Water Pollution Control Facility	Gravity Sewers	$650,000	$8,600
10	Mark Street Area	High	Town Water Pollution Control Facility	Gravity Sewers	$1,123,000	$11,700
11	Greenhaven Road Area	High	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers, Pump Station and Force Main	$5,310,000	$50,700
13	Latimer Point	High	Town Water Pollution Control Facility	Combination of Gravity and Low-Pressure Sewers, Pump Station and Force Main	$2,632,000	$27,000
15	Marlin Drive Area	High	Town Water Pollution Control Facility	Gravity Sewers, Pump Station and Force Main	$2,285,000	$23,700

Table 8-1
Wastewater Disposal Needs
Recommendation Summary



Source: *2004 Plan of Conservation and Development*, Stonington Planning and Zoning Commision

Figure 9-1



- Outfall
- Treatment Plant
- Pump Station
- Odor Control
- Force Main
- Gravity Sewer
- Parcel Boundary

Projected Development

- Commercial
- Conservation
- Institute
- Manufacturing/Industrial
- Residential

OPM Plan Areas

- Growth Areas
- Neighborhood Conservation Areas
- Regional Centers
- Rural Community Centers
- Conservation Areas
- Level A/B Aquifer Protection Areas
- Historic Areas
- Preservation Areas
- Existing Preserved Open Space
- Rural Land
- Tribal Settlement Areas

N

Source: Hydrography from Connecticut DEP.
Basemap data from Stonington GIS, 2001.

OPM Plan - Conservation and Development Policies for Connecticut1998-2003, Connecticut Office of Policy and Management.

CDM

November 2004

5000 0 5000 Feet

Stonington, CT

Figure 9-2
Projected Development and the OPM Plan

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Section 9
Environmental Assessment

9.1 Introduction

Prior to the Wastewater Facilities Plan being granted final approval, the Connecticut Department of Environmental Protection (CTDEP) must prepare either a *Finding of No Significant Impact* or an *Environmental Impact Evaluation* for the review and approval by the Connecticut Office of Policy and Management. The CTDEP utilizes the *Environmental Impact Evaluation* checklist to evaluate whether sufficient information has been provided in the Wastewater Facilities Plan to prepare either of the documents previously mentioned. This section addresses the required evaluation criteria for the recommended collection system improvements and the recommended treatment plant alternative as summarized in Section 8, to assist the CTDEP in preparing the necessary documentation.

9.2 Existing Conditions and Environmental Impacts

The recommended treatment plant alternative includes upgrading and expanding each of the three existing WPCFs at the Mystic, Borough and Pawcatuck sites. The construction work will occur on the existing WPCF properties and will require new or expanded concrete treatment tankage. The expanded plants will treat the wastewater to a higher level of quality than the existing plants. Though the upgrades are planned to meet the projected flows from each service area, the discharge rates from each facility will not exceed the current NPDES permit requirements.

The recommendations also include extensions of the existing wastewater collection systems to the "critical" and "high" priority sewer needs areas identified in this report. The environmental impacts of these recommendations are discussed in the following sections.

9.2.1 Soils

There are four major soils associations that have been identified in Stonington: Woodbridge-Paxton-Montauk; Charlton-Canton-Hollis; Haven-Hinckley; and Westbrook-Pawcatuck (*Soil Survey of New London County, Connecticut*, United States Department of Agriculture, Soil Conservation Service, 1983). These soil types range from well and excessively-drained to poorly-drained. For the purposes of wastewater disposal, it should be noted that well-drained soils might still contain restrictive layers to downward movement of water in the soil profile.

Soil conditions for the sewer needs areas were evaluated for on-site disposal feasibility and are discussed in Section 2.4. Since the collection system would extend to the "critical" and "high" priority sewer needs areas, and on-site disposal would no longer be a concern, soil conditions in these areas would not have an impact. Soil conditions may have an impact on the construction of sewers to these areas.

9.2.2 Geology and Topography

According to the *Soil Survey of New London County, Connecticut*, the topography in Stonington varies from nearly level to steep. Areas with Woodbridge-Paxton-Montauk soils typically exhibit drumloidal upland landforms with stone and boulders commonly found on the surface. This is the predominant type of formation and is found in the central and northern portions of Stonington. Charlton-Canton-Hollis soils formations are typically upland glacial till hills, ridges, and plains. Stone and boulders are common on the surface and many areas have bedrock outcrops. This formation is typically located along the coastal areas of Stonington. Outwash plains, stream terraces, and eskers in valleys are typically found where Haven-Hinckley soil formations are present. There are two areas in Stonington where this topography is found including along Whitford Brook and Anguilla Brook. Finally, tidal flats are typically made up of Westbrook-Pawcatuck soils, and are usually inundated with saltwater two times daily. There is a small area near the Barn Island Wildlife Management Area in Pawcatuck that is comprised of these soils.

The existing sites for all three existing WPCFs are cleared with fairly level terrain. The geology and topography of each site would not have an impact on the construction activities at the existing WPCF sites.

Construction of sewers to the sewer needs areas may be impacted by the geology and topography of each area. The presence of bedrock, stone, or boulders has an impact on the cost of constructing the sewers, while the topography may dictate which type of sewer would be preferred (e.g., gravity, pressure, etc.).

9.2.3 Hydrology

Stonington is located on Fisher's Island Sound and has two harbors, Mystic Harbor and Stonington Harbor. The shoreline is jagged, with several peninsulas and coves. The Town is also bounded by the Mystic River to the west and the Pawcatuck River to the east. Several major brooks also flow through the Town: the Pequotsepos Brook, Copps Brook, Stony Brook and Anguilla Brook.

The Aquarion Water Company of Connecticut's Mystic Reservoir is located on Copps Brook; Silvias Pond is located on Stony Brook; and Wequetequock Pond is located on Anguilla Brook.

Groundwater depth is shallow along Stonington's shoreline. In some areas, ledge and low-permeability soils cause groundwater to perch near the ground surface.

Construction work at the three existing WPCFs would not have an impact on the local hydrology. Surface water bodies would be protected during construction by utilizing soil erosion control measures.

The construction of new sewers in the sewer needs areas could positively impact the quality of groundwater in those areas, since it would replace existing, problematic septic systems. Four of the 18 sewer needs areas, including three of the nine areas identified as “critical” or “high” priority, are all or partially located within a CTDEP Level A/B Aquifer Protection Area. In fact, the Marjorie Street area is located adjacent to an Aquarion Water Company well site. Similarly, five of the 18 sewer needs areas, including three of the nine areas identified as “critical” or “high” priority, are located within the Town’s Aquifer Protection Zone. Resolving wastewater disposal problems in these areas would improve groundwater quality. Some excavations would likely need to be dewatered during construction, but this would only have a short-term affect on the local groundwater or surface water bodies. Utilizing soil erosion control measures can protect surface water bodies or wetlands near the construction areas. A brief description of the hydrology for each sewer needs area is mentioned in Section 2.4.

9.2.4 Wetlands

Construction activity at the Mystic, Borough and Pawcatuck WPCFs could have a temporary impact on nearby coastal wetlands. Expansion at the treatment plant sites will not occur directly in existing wetlands, although some of the work may be in close proximity. Proper soil erosion control measures (i.e., hay bales, silt fences, etc.) would be required to mitigate impacts.

New sewer construction for the proposed sewer needs areas involves construction in close proximity to wetlands. However, since most of the proposed sewers would be constructed in existing roads and right-of-ways, no construction is anticipated to occur directly in the wetlands. Soil erosion control measures would be required in areas where construction activity could impact nearby wetlands.

9.2.5 Floodplains

Available Geographical Information System (GIS) floodplain information was collected and reviewed. Federal Emergency Management Agency (FEMA) flood maps were also reviewed. FEMA mapping indicates that the shoreline area below elevation 10 to 11 — as high as elevation 16 in some areas with wave action — is within the 100-year floodplain. Under this condition, the Mystic River, Pawcatuck River, Pequotsepos Brook, Copps Brook, Stony Brook and Anguilla Brook also become flooded several feet above their normal stage. Therefore, many areas in the Town of Stonington located near the coast and along rivers and streams are prone to flooding. Both the Mystic and Borough WPCFs are located within the 100-year floodplain. The Pawcatuck WPCF is located just outside of the 500-year floodplain.

Although the Mystic and Borough WPCFs are located within the 100-year floodplain, the affect of the floodplain on the recommended alternative of upgrading the existing WPCFs is not a concern. Any new tankage or facilities, like the existing facilities, would be constructed either above the 100-year flood stage or would be otherwise protected from the 100-year flood.. The Pawcatuck WPCF is not located within the 100-year floodplain.

The existing plant sites are not within the floodways of any rivers or streams, and construction at these sites will not impact the flood elevations.

The proposed expansion of the collection system to six of the sewer needs areas would require some construction within the 100-year floodplain. However, the construction and operation of the sewers would not be affected by flooding, nor would it impact the frequency or severity of flooding in any areas.

9.2.6 Vegetation and Wildlife

There are federal and state agencies that require certain forms to be filed prior to construction projects to ensure that certain species of plants and animals are not negatively affected by construction activity. These agencies include the U.S. Fish and Wildlife Service, CTDEP, etc.

Construction at the Mystic WPCF is not expected to affect any threatened or protected vegetation or wildlife, because the existing site vegetation is comprised of plants that typically inhabit previously disturbed areas. Likewise, construction at the Borough WPCF also is not expected to have an impact on threatened or protected vegetation and wildlife, since site work would disturb only the existing site.

The Pawcatuck WPCF is not located on any major waterway, but the property is large enough to accommodate different wildlife species. The existing site is comprised of plants that typically inhabit disturbed areas. There are no known threatened or endangered vegetation or wildlife species at this site. Construction at this site should not directly impact the existing vegetation and wildlife species.

The recommended sewer construction would mostly be located in existing roadways and should not directly impact any flora or fauna located near the work sites. However, it is important that this issue be addressed with the appropriate agencies prior to any of the proposed sewer installations.

9.2.7 Air Quality

Concerns about potential odors from the three WPCFs are a priority to WPCA, and the planned upgrades to the three existing plants include, at a minimum, maintenance of the same level of odor control provided in the 2003 odor control project. During construction, there would be emissions from vehicles and other construction equipment, and dust from construction activities within the sites. Construction equipment and vehicles would likely cause a temporary increase in localized hydrocarbon and carbon monoxide levels, but not to an extent that would cause adverse impacts to air quality. The use of equipment mufflers and typical dust control measures (i.e., water sprinkling, calcium chloride, etc.) can minimize any impacts to air quality.

No new odor control facilities are proposed for Pumping Station No. 3, which currently transfers Pawcatuck system flow to the Pawcatuck WPCF for treatment and would transfer Pawcatuck system flow to the new plant in the future. Review of the pumping station indicates that some operational changes could be made to minimize odors at this facility. Should odors become problematic in the future, a small carbon canister-type system could be installed for odor control.

The installation of sewers would have the same impacts to air quality as the construction activities mentioned above, however, they would likely be on a much smaller scale. The sewer construction process moves quickly, and should not be located within one area for a long period of time. The use of equipment mufflers and typical dust control measures can minimize any impacts to air quality.

9.2.8 Noise

Construction activity and large equipment traffic would be noticeable to nearby neighborhoods and businesses during construction activities at the existing WPCFs. Noise levels in the immediate areas inclusive of each treatment facility would be elevated at times during demolition and construction. The noise created during demolition and construction would be temporary in nature and would be restricted to normal working hours. Once operational, noise levels are not expected to be any different from current levels, and would be minimized by placement of equipment in sealed areas, and/or specifying silencers or mufflers on large equipment.

The sewer construction process moves quickly, and activity is usually not within one area for long periods of time. Construction equipment can be equipped with silencers or mufflers to minimize noise during construction. Therefore, there should not be any significant impact from noise associated with installing sewers to the sewer needs areas.

9.2.9 Traffic

Construction at the existing WPCFs would require the use of heavy equipment including excavators, cranes, rams, and dump trucks. The removal of excavated materials from each site, and the delivery of construction materials and new equipment would involve a steady stream of vehicle traffic entering and exiting the site. Access to the Borough WPCF is especially difficult for heavy equipment and tractor trailers because the streets are extremely narrow. Unfortunately, truck traffic through residential neighborhoods cannot be avoided for work at any of the three WPCFs. Traffic during the construction work may require that traffic patterns be temporarily modified to accommodate these activities. Traffic control plans would need to be prepared prior to construction to address these issues so that traffic impacts are avoided or minimized.

Installation of sewers in the sewer needs areas would be mostly located within existing roads and right-of-ways, and would likely impact traffic patterns. Therefore, traffic patterns would be temporarily modified to accommodate these construction activities. Traffic control plans would need to be prepared prior to construction to address these issues so that traffic impacts are minimized.

9.2.10 Visual Impacts / Aesthetics

The aesthetics of the Mystic, Borough and Pawcatuck WPCFs would not significantly change after the upgrades to the three existing WPCFs. The Mystic WPCF and the

Pawcatuck WPCF are visually isolated from neighbors, and the recommended upgrades will have negligible impacts at those sides.

Construction at the Borough WPCF has the potential to have a more significant aesthetic impact, depending on the final treatment process selected. The process planned in this facilities plan will require a small increase in treatment tankage, requiring an expansion of the existing process footprint. Alternative technologies, requiring less extensive heavy construction, would minimize any aesthetic impact.

Installing sewers may impact the aesthetic quality of certain neighborhoods temporarily during construction.

9.2.11 Cultural/Recreational/Historical/Archeological Resources

The recommended construction work at the existing WPCFs would not have an impact on any cultural or historical resources. The Borough WPCF site is within an area of historical significance. All necessary state and federal regulations should be followed in advance of the construction activities to address this issue.

The proposed installation of sewers would mostly take place in existing roadways, which have been previously disturbed. Therefore, it is unlikely that any cultural or archeological resources would be revealed during construction. However, all applicable federal and state regulations dealing with this issue must be addressed prior to construction.

9.2.12 Land Use

All three WPCF sites are presently used for wastewater treatment. It is proposed these facilities remain in service. The upgrades planned do not require expansion of land area beyond the existing site boundaries.

The land uses surrounding the Mystic WPCF site include a residential neighborhood, a Bed and Breakfast (B&B), and a small marina. The construction at the existing site could temporarily impact the B&B, but it is unlikely to impact the marina. Once the construction is completed, the upgraded plant impact will be equal to the existing site.

The Borough WPCF is located near a residential neighborhood and a large fishing pier. Construction at the site would not have an effect on the use of the fishing pier, but construction activity would likely temporarily impact the surrounding neighborhood. Once the construction is completed, the upgraded plants impact will be very similar to the existing site, though an increase in tankage would extend partially into the existing dog-walk area.

The Pawcatuck WPCF is located near a residential neighborhood. Construction activity during construction would temporarily impact the surrounding neighborhood. The land use impacts at project completion would be minimal.

9.2.13 Zoning

Town-wide zoning and land use information were obtained from the Town's zoning bylaws and from available GIS mapping. The Mystic WPCF is zoned as Residential Coastal, the Borough WPCF is zoned Reserved Land (i.e., land owned by public and semi-public agencies for public purposes), and the Pawcatuck WPCF is zoned for Residential Single Family. The zoning for the sewer needs areas is predominately residential, with some areas zoned for commercial and manufacturing. Zoning would not have an impact on construction activities at the three existing WPCF sites, or within the sewer needs areas.

9.3 Growth Issues

9.3.1 Population Projections

Population projections are discussed in Section 3.3. The Wastewater Facilities Plan recommendations are made in consideration of projected population growth.

9.3.2 Secondary Growth Impacts

Secondary Growth Impacts are impacts that occur as an indirect result of new infrastructure development (e.g., increasing the rate of conversion of undeveloped land to residential land following installation of sewers).

Construction of the recommended upgrades to the existing WPCFs is not expected to create any major secondary growth impacts.

Construction of sewers to the sewer needs areas would have secondary growth impacts to these areas. It is likely that development of vacant lots in these areas would accelerate once sewers are installed, particularly where a lot cannot be developed without the use of innovative or alternative disposal technologies because of poor soils or high groundwater.

9.3.3 Existing Zoning

In general, zoning by-laws have changed over the years with the intent of increasing minimum lot sizes. Zoning for the sewer needs areas is predominantly residential, with some areas zoned for commercial and manufacturing. Town-wide zoning and land use information for Stonington is discussed further in Section 2.3.3.

9.4 Conservation and Development Plans

9.4.1 Stonington Plan of Conservation and Development

The Town of Stonington recently adopted its *2004 Plan of Conservation and Development* (Stonington Plan). The Stonington Plan is "intended to provide a framework for consistent decision-making by Town boards, commissions and residents with regard to conservation and development activities." The plan summarizes existing conservation and development trends, identifies community issues and recommends an approach to future conservation and development.

Key issues addressed include:

- Preserving important resources (e.g., open space, natural resources, coastal resources, historic resources and scenic resources)

- Protecting and enhancing the three village areas (i.e., Mystic, Borough and Pawcatuck)

- Encouraging appropriate development (e.g., residential and business development patterns, changing housing needs, institutional needs, etc.)

- Addressing community needs (e.g., community facilities, transportation, etc.)

The Stonington Plan strikes a balance between development and open space preservation through zoning, acquisition and resource protection.

Open Space Planning

Stonington's open space plan includes maintaining a portion of new developments as open space, enhancing existing open space through acquisition or conservation easements, and creating "greenways" by connecting open space. Stonington's planned open space is shown on **Figure 9-1**. This Wastewater Facilities Plan includes no provision for collection system expansion for future development.

Conservation of Coastal Resources

Enhanced treatment at the existing WPCFs reduce the discharge of nitrogen and other pollutants to the Pawcatuck and Mystic Rivers and to Stonington Harbor.

Protection of Important Natural Resources

The Stonington Plan includes suggested policies to strengthen wetland and wildlife protection policies, as follows:

- This Wastewater Facilities Plan does not propose work resulting in wetland impacts. Sewer extensions into sewer needs areas would largely be constructed in Town streets and should not impact adjacent wetlands.

Water Quality Protection

As noted in Section 9.2.3, five of the 18 identified sewer needs areas are located within CTDEP Level A and/or B Aquifer Protection Areas and/or the Town's Aquifer Protection Zone. Four of these areas have been identified as "critical" or "high" priority areas and have been included in the recommended plan (see Section 8). The Marjorie Street area — the most critical area — is located adjacent to an Aquarion Water Company well site. The "critical" Elm Ridge Road area is within the aquifer area for wells owned and operated by the Town of Westerly, Rhode Island — Pawcatuck's water supplier. Resolving wastewater disposal problems in these areas would improve groundwater quality.

See Figure 9-1

Enhancing the Village Areas

The proposed improvements contained in this Wastewater Facilities Plan would have a negligible impact, neither positive nor negative, on Stonington's plans to enhance the three village areas.

Encouraging Appropriate Development

The proposed Wastewater Facilities Plan complies with the Stonington Plan. The upgraded WPCFs have been sized to accommodate future flows and loads within the existing collection systems and from the sewer needs areas. No additional expansion of the collection system is proposed by the WPCA. The existing Mystic and Pawcatuck collection systems would support controlled development within the existing collection system service area, including desired development along Interstate 95 and planned redevelopment projects.

Addressing Community Needs

The proposed facilities have no impact on the community planning included in the Stonington Plan.

9.4.2 State Conservation and Development Policies Plan

The Connecticut Department of Environmental Protection (CTDEP) requires that any facility planning conform to the Office of Policy and Management's *Conservation and Development Policies Plan* (OPM Plan). The OPM Plan is a statewide plan, developed to guide planning processes in a manner that best suits the future human, environmental, and economic needs of the State of Connecticut. An important concept of the OPM Plan is that areas of environmental concern (existing preserved open space, preservation areas, conservation areas, Level A/B Aquifer Protection Areas and historic areas) not be included in the Wastewater Facilities Plan as proposed future sewer service areas unless there is an existing pollution problem in those areas. The OPM Plan includes a Location Guide Map, which is a geographical representation of the categories, including the "Areas of Critical Environmental Concern."

Figure 9-2 shows the "Areas of Critical Environmental Concern" information provided on the OPM Plan's Location Guide Map and areas within the Town that are projected for possible development within the planning period. According to the OPM Plan:

- "Existing Preserved Open Spaces represent areas in the state with the highest priority for conservation and permanent use as open space." These areas include parks, trails and greenways, preserves, and Class I water utility-owned lands.

- "Preservation Areas are lands that do not reflect the level of permanence of Existing Preserved Open Space but which nevertheless represent significant resources that should be effectively managed in order to preserve the state's unique

See Figure 9-2

heritage." These areas include water supply watersheds, flood zones, inland wetlands, protected species/habitats, and water bodies.

- "Conservation Areas represent a significant portion of the state and a myriad of land resources." These areas include Class II public water supply watershed lands, Level A and B Aquifer Protection Areas (not otherwise classified), scenic areas, agricultural land, historic areas, recreational areas, and conservation easements.

Existing Preserved Open Space has the highest conservation priority; followed by Preservation Areas and Conservation Areas. The OPM Plan includes guidelines for protection of these areas, which become more stringent/limiting as the conservation priority increases. The Location Guide Map (see Figure 9-2) identifies approximately half of the Town as an Area of Critical Environmental Concern. The OPM Plan also identifies areas in Mystic and Pawcatuck, along Interstate 95 and U.S. Route 1, as growth areas.

The sewer needs areas were identified as those areas with an existing pollution problem, and therefore, are consistent with the OPM Plan.

Proposed residential developments shown north of Interstate 95 (I-95) are not projected to be sewered by the WPCA, and thus, are not included in this Wastewater Facilities Plan. All projected residential areas shown south of I-95 are not located entirely within Areas of Critical Environmental Concern. However, where these areas of environmental concern overlap onto a proposed residential area, development may be limited based on the OPM Plan classification and respective guidelines.

Two areas projected for future commercial development/redevelopment are already developed and have existing sewers. These areas are not located within an Area of Critical Environmental Concern, and therefore, comply with the OPM Plan.

Four projected manufacturing/industrial areas identified by the Town are also shown on Figure 9-2 as either being totally or partially within the Areas of Critical Environmental Concern. Where these areas of environmental concern overlap onto a proposed manufacturing/industrial area, development may be limited based on the OPM Plan classification and respective guidelines.

9.4.3 Comparison of the Stonington and State Plans

This Wastewater Facilities Plan complies with the Stonington Plan and with the OPM Plan. According to the Stonington Plan, inconsistencies between these plans include:

- *"differences in definitions of desirable uses or development densities,*
- *local (as opposed to State or regional) desires about how Stonington should grow and change in the coming years, or*
- *the fact that the State [OPM] Plan and the Regional [Conservation and Development Policy Guide for Southeastern Connecticut] Plan make policy recommendations for relative*

intensity and environmental sensitivity while this [Stonington] Plan suggests specific land use types."

As a result, the Town and OPM approaches to conservation and development do not fully agree. The philosophical differences in the two plans can be seen by comparison of Figures 9-1 and 9-2. These differences are predominantly related to the OPM definition of Areas of Critical Environmental Concern, and do not have a significant impact on the Wastewater Facilities Plan.

9.5 Permitting Analysis

Environmental permits and approvals are required whenever proposed work may affect certain environmentally sensitive resources including waterways, wetland resource areas, habitats of rare or endangered species, and historic and archeological sites. Others, such as building permits and planning and zoning approvals are required for proposed work that involves construction activities. The necessary permits required for the recommended alternative including expansion of the treatment facilities at the Mystic, Borough, and Pawcatuck WPCFs, construction of a new WPCF, and extensions of the collection systems to the sewer needs areas are discussed below.

9.5.1 Federal Permits

Permit under Section 404 of the Clean Water Act

The U.S. Army Corps of Engineers (ACOE) regulates the placement of dredged or fill material in waters of the United States, which includes wetlands, pursuant to 33 CFR Parts 320-330.

National Pollutant Discharge Elimination System Permits

The Clean Water Act requires wastewater dischargers to have a permit establishing pollution limits, and specifying monitoring and reporting requirements. The three wastewater treatment facilities in Stonington have individual *Municipal National Pollutant Discharge Elimination System (NPDES) Permits* for discharging treated effluent. The recommended alternative proposes upgrades and expansions to the existing WPCFs. Therefore, the existing NPDES permits would likely need to be updated to include new monitoring, reporting, and discharge limit requirements.

A NPDES *Stormwater Discharge General Permit* is required for the construction activities planned at each site. A *Notice of Intent (NOI) for the General Permit* must be submitted to the Federal Clearinghouse in Virginia and the I.S. Environmental Protection Agency (Region 1) two days before the initiation of construction. In addition, a stormwater pollution prevention plan must be prepared describing the sedimentation and erosion control measures that would be implemented as part of the project. The plan does not need to be reviewed by EPA, but must be kept on file in case EPA requests a copy. Upon construction completion, a Notice of Termination must be submitted to terminate the temporary discharge permit. The General Permit also covers dewatering (of uncontaminated groundwater) during construction.

9.5.2 State Permits / Approvals

Section 401 Water Quality Certification

Under Section 401 of the Clean Water Act, federal permits for projects in wetlands or waterways must be certified by the state to ensure that state water quality standards are met. The Bureau of Water Management's Inland Water Resources Division and the Office of Long Island Sound Programs administer the program. This certificate is required for activities that may discharge dredged and fill material and storm water during construction.

Air Emissions

A CTDEP *Air Emissions Permit* may be required to construct and/or operate a new or existing emergency generator. The general permit pertains to "a stationary reciprocating or turbine engine providing mechanical or electrical power only during periods of routine testing and scheduled maintenance, or during an emergency." This permit may be required for any generators proposed as part of this Wastewater Facilities Plan. Since this plan does not recommend a specific generator, this issue should be addressed during the design phase of the approved alternative.

Connecticut Department of Transportation

The installation of sewers within state highways would require prior approval by the Connecticut Department of Transportation (ConnDOT). Also, any traffic control plans that may impact state highways may require prior ConnDOT approval.

9.5.3 Local Permits / Approvals

The following Town departments must be contacted prior to construction activities for the recommended WPCF improvements and extension of sewers to the sewer needs areas for permits / approvals. They include:

- Building Department
  - Building Permits, Demolition Permits, Electrical Permits
- Planning and Zoning Commission
  - Connecticut Coastal Management Act
  - 8-24 Review
  - Site Plans
  - Inlands, Wetlands and Watercourse
- Stonington Highway Department

9.6 Summary

This environmental assessment of the proposed construction activities at each WPCF, in addition to installing new sewers to the sewer needs areas, addresses the environmental concerns associated with these activities.

The new construction and operations the Mystic, Borough and Pawcatuck WPCFs would likely have minimal impact to most environmental concerns. Improved receiving water quality at all three discharge locations will be a positive impact. Possible impacts that may have temporary negative affects during construction activities include impacts to air quality from emissions and dust, water quality due to erosion, noise levels, traffic patterns, and surrounding land uses. Various mitigation measures utilized during construction can dramatically reduce and possibly eliminate negative impacts to these areas of concern. Mitigation measures for each of these impacts have been discussed.

Installation of new sewers to the sewer needs areas would mostly take place within existing roadways. There would be wetland, air quality, noise, traffic, and visual/aesthetic impacts during construction. However, most of these impacts would be temporary and can be either minimized or eliminated through proper mitigation measures.

Under the OPM Plan, future development should not take place within Areas of Critical Environmental Concern unless there is an existing pollution problem. The sewer needs areas are consistent with the policies of the OPM Plan since all of the areas have potential or existing pollution problems related to onsite septic systems. It was noted that there are philosophical differences in development policy between the OPM Plan and the Stonington Plan, though these differences have no impact on the Wastewater Facilities Plan.

Section 10
Financial Considerations

10.1 Introduction

This section presents the financial aspects related to implementation of the recommended plan for wastewater collection, disposal and treatment for the Town of Stonington. The financial assessments included in this Section are based on the recommended plan presented in Section 8.

Implementation of the recommended plan would be phased over time, based on the need to provide improved wastewater treatment, implement solutions to the sewer needs areas, and make minor improvements to the existing collection systems. The initial phases of the recommended plan include construction of upgrades to the three existing WPCFs that will enable the Town to meet its projected needs for the 20-year life of this Wastewater Facilities Plan, provide sufficient treatment capacity, and to eventually meet its effluent total nitrogen wasteload allocation. Once these improvements are complete, collection system improvements (i.e., recommended collection system modifications, expansion into sewer needs areas, etc.) would occur. The recommended project schedule is shown in Figure 8-1.

Nine sewer needs areas are included in the recommended plan. These areas have been identified as "critical" or "high" priority based on need. Critical area recommendations include a community system for the Marjorie Street area and collection system extension into the Elm Ridge Road area. High priority area recommendations include collection system extension into the Roseleah Drive, Pequot Trail, Cronin Avenue/ Holly Drive, Latimer Point, Marlin Drive, Greenhaven Road, and Mark Street areas. Recommended improvements to the existing collection system are minimal and assumed to occur as needed over the 20-year planning period, likely occurring after completion of the recommended wastewater treatment and flow transfer facilities.

The impact of the improvements on revenue requirements and user rates has been evaluated for two implementation plans.

- Implementation Plan No. 1 includes construction of:
  - wastewater treatment and flow transfer improvements,
  - collection system modifications,
  - a community system for Marjorie Street area, and
  - extension of the collection system into the Elm Ridge Road area.

- Implementation Plan No. 2 is the full recommended plan as outlined in Section 8 and includes construction of:
  - wastewater treatment and flow transfer improvements,
  - collection system modifications,
  - a community system for Marjorie Street area, and
  - extension of the collection system into the Elm Ridge Road, Roseleah Drive, Pequot Trail, Cronin Avenue/Holly Drive, Latimer Point, Marlin Drive, Greenhaven Road, and Mark Street areas.

Expenses, revenue requirements and rates have been projected using standard industry methods. The analysis relies heavily on data and information provided by the Town of Stonington and dates back to 2005. These projections have been based on the total costs of the recommended improvements. Costs have then been allocated to ratepayers and taxpayers in accordance with current town funding principles. The impact on typical households has then been illustrated.

The Town's required revenue has been assessed taking into account likely changes in capital and operating costs, outstanding debt service and likely changes in sewer demand. A calculation model has been developed that allows quick and systematic evaluation of alternatives and development of "what if" scenarios. The model was utilized to project total revenues and expenditures through fiscal year FY 2025. The projected expenses have taken into account the estimated costs of new projects and improvements, financing costs, and alternative financing methods.

10.2 General Assumptions

Projections of the potential impacts of the planned wastewater improvements are based on FY 2005 financial information projected through FY 2025 have been developed using the following key assumptions:

- The cost of operating and maintaining the sewer system would be recovered through sewer user fees assessed to retail customers.
- Operation and maintenance expenses and other expense data used in the water and wastewater rate model have been based on the FY 2005 sewer budget. All Town operating costs for its contract operations are assumed to also follow this inflationary pattern of 4.5 percent except for labor related expenses that are inflated annually by 3 percent. These rates are indicative of current trends given the existing agreement with U.S. Water Service Company and rising energy costs.
- Capital costs are inflated at a three percent average annual rate. It is assumed that no grants are available to defray the capital costs to be incurred by the Town.

- Miscellaneous revenues and other revenue data used in the wastewater rate model have been based on FY 2005 sewer budget.
- Existing debt service has been based on the current debt schedules provided by the Town of Stonington with allocations between betterments and general fund responsibilities.
- Water consumption data used in the wastewater rate model has been based on Table 3-5.
- The Town would fund its capital improvements with general obligation debt assumed to carry a 6-percent interest rate for a 20-year term. The allocation of the resulting debt service costs to customers is discussed in a subsequent subsection.
- There are an estimated 6,800 households in the Town of Stonington, with 4,100 residential sewer customers.
- The number of sewer customers would increase in future years as collection system improvement projects are undertaken. It is projected that the number of customers would grow slightly, approximately 0.04 percent per year. Billable consumption would increase in proportion to the increase in customers.
- As of FY 2004, the WPCA currently bills customers at a rate of $3.40 per hundred cubic feet (hcf).

In addition, it has been assumed that the Town's current funding policy for the sewer system would continue. Under that policy, the capital costs for treatment plant upgrades and modifications and other "back-bone" facilities would be paid through the Town's general fund. That means each resident or business would pay a proportionate share of those costs based on the value of their property relative to the total property tax base in the Town. For sewer collection extension projects, 50 percent of the cost would be paid from the general fund and 50 percent of the cost would be paid through special assessments to benefiting properties. Sewer system operating and maintenance costs would be recovered through user charges.

10.3 Financial Analysis — Implementation Plan No. 1

This section describes the financial impact of Implementation Plan No. 1 as outlined above.

10.3.1 Revenue Requirements and Projections

This section defines revenue requirements for the wastewater treatment and collection systems. The three main components of revenue requirements include: operations and maintenance expenses, capital costs, and miscellaneous revenues. For purposes of this analysis, the total revenue requirement was projected even though a portion of it is assumed to be recovered through general taxes.

The costs associated with operations and maintenance expenses are departmental salaries, operating expenses, and administration and general expenses. The capital costs include existing debt service; capital outlay consists of improvement projects and equipment replacement; and new system improvements. The last main component of revenue requirements is miscellaneous revenues that consist of utility interests and liens and other miscellaneous revenues that offset total expenses.

Table 10-1 summarizes the estimated operations and maintenance costs (O&M) for FY 2005, FY 2010, FY 2015, FY 2020, and FY 2025. The largest element of the Town's O&M expenses is its contractual obligation to U.S. Water Service Company to operate the wastewater treatment system. It is assumed that the substance of that agreement is carried through the forecast period, though a renegotiation of the existing contract would be in WPCA's interest. Total operating and maintenance expenses are projected to increase from approximately $2 million in FY 2005 to $4.7 million in FY 2025.

Table 10-1

Operations and Maintenance Costs – Implementation Plan No. 1

	FY 2005	FY 2010	FY 2015	FY 2020	FY 2025
Labor	$ 132,431	$ 153,524	$ 177,976	$ 206,323	$ 239,185
Contract Operations	$ 1,550,000	$ 1,931,582	$ 2,407,103	$ 2,999,688	$ 3,738,157
Equipment	$ 245,000	$ 305,315	$ 156,229	$ 194,690	$ 242,619
Other Services	$ 17,500	$ 21,808	$ 27,177	$ 33,867	$ 42,205
Manholes set to Grade	$ 12,000	$ 14,954	$ 18,636	$ 23,223	$ 28,941
Wastewater Facilities Plan	$ 2,600	$ -	$ -	$ -	$ -
Permits Fees	$ 3,000	$ 3,739	$ 4,659	$ 5,806	$ 7,235
Purchase Nitrogen Credits	$ 6,309	$ 32,536	$ (8,173)	$ (5,189)	$ (239)
New O&M Expenses	$ -	$ -	$ -	$ 290,412	$ 361,907
Total O&M Expenses	$ 1,968,840	$ 2,463,457	$ 2,783,606	$ 3,748,821	$ 4,660,009

Table 10-2 summarizes the total (existing and new) debt service. The debt service for the Town would increase from $1.2 million in FY 2005 to $4.2 million in FY 2025. Table 10-2 only includes that debt service to be recovered from general revenues and not the amount that may be allocated to properties through betterments. The increase in debt service reflects the construction of the proposed treatment plant upgrades, collection system improvements, and the two critical need areas recommendations. In FY 2015, the planned improvements would increase total debt service by nearly $2.0 million.

Table 10-2					
Debt Service – Implementation Plan No. 1					
	FY 2005	FY 2010	FY 2015	FY 2020	FY 2025
Total Existing Debt Service	$ 1,157,522	$ 854,287	$ 350,072	$ 11,022	$ -
New General Obligation Debt	$ -	$ 841,968	$ 2,787,856	$ 4,049,898	$ 4,180,228
Total Debt Service	$ 1,157,522	$ 1,696,255	$ 3,137,928	$ 4,060,920	$ 4,180,228

Miscellaneous revenues are the third element of revenue requirement. In FY 2005, the Town estimates that it would receive approximately $34,000 from miscellaneous sources including interest and liens and other miscellaneous revenues. It is assumed that miscellaneous revenues remain flat throughout the forecast period. As noted above, the Town uses general taxes or special assessments to support debt service. This is assumed to continue for both currently outstanding and new debt required to finance the treatment plant upgrades and the sewer extensions.

Table 10-3 summarizes the total operational and maintenance costs, miscellaneous revenues, and property tax support to calculate rate revenue requirements for FY 2005, FY 2010, FY 2015, FY 2020, and FY 2025. O&M expenses are projected to increase from $2 million in FY 2005 to $4.7 million in FY 2025. Property tax supported debt service is projected to increase from $1.2 million to $4.2 million. The total revenue requirement is projected to increase from $3.1 million in FY 2005 to $8.8 million in FY 2025. In FY 2025, the bulk of the revenues will be coming from property taxes to meet debt service requirements.

Table 10-3					
Net Rate Revenue Requirement – Implementation Plan No. 1					
	FY 2005	FY 2010	FY 2015	FY 2020	FY 2025
O&M Costs	$ 1,968,840	$ 2,463,457	$ 2,783,606	$ 3,748,821	$ 4,660,009
Miscellaneous Revenues	$ 34,000	$ 34,000	$ 34,000	$ 34,000	$ 34,000
Property Tax Supported Debt Service	$ 1,157,522	$ 1,696,255	$ 3,137,928	$ 4,060,920	$ 4,180,228
Net Rate Revenue Requirement	$ 3,092,362	$ 4,125,712	$ 5,887,534	$ 7,775,741	$ 8,806,237

10.3.2 Impact on Customers

The impact on customers has been evaluated in two stages. The first stage projected the impact of the wastewater treatment and collection system upgrades on operating and maintenance expenses. These costs would be recovered through sewer user fees. The second stage determined the impact of anticipated debt service. As noted previously, the general fund pays for debt service associated with plant upgrades and half of the debt service associated with sewer expansions. The remaining portion of sewer expansion debt service is allocated to project beneficiaries through betterments. Our projections of customer impacts excludes betterments that a particular property may be required to pay.

Sewer Rate Projections

Sewer customers are obligated to pay, through use fees, the costs of operating and maintenance expenses. As described above, operations and maintenance costs are projected to increase from approximately $2 million in FY 2005 to $4.7 million in FY 2025, an average increase of nearly 5 percent per year. This reflects the change in plant costs, inflation over the forecast period and moderate increases in operating costs resulting from system expansion. It is also assumed that there would be a small increase in the number of customers served by the sewer system.

In 2025, sewer use fees would need to generate an average total of $4.7 million to maintain the solvency of the sewer fund. The sewer rate would increase from $3.40 per hcf to approximately $9.20 per hcf.

General Fund Impact

Debt service costs associated with the proposed improvements would be paid out of the general fund. Debt service costs to be paid from the general fund are projected to increase to approximately $8.8 million by the year FY 2025.

10.3.3 Typical Household Bills

The amount a household does pay and would pay for the sewer system is related to whether:

- The household is a sewer customer, or
- The household would be a beneficiary of a collection system project.

In FY 2005, a household connected to the sewer system using 12,000 cubic feet of water per year (approximately 90,000 gallons per year) would pay approximately $408 per year in sewer use fees. That property would also be supporting debt service payments for half of all sewer system expansions and plant upgrade costs. If the property had benefited from a sewer project in the past then it would also be subject to betterments, the amount of its special assessment might range from $10,000 to $25,000 depending on the project's details and the value of the benefiting property. (This special assessment may be paid in a lump sum or spread over several years.)

Table 10-4 displays the impact of the recommended plan on household user bills. In FY 2025, a household connected to the sewer system using 12,000 cubic feet of water per year would pay approximately $1,135 per year compared to approximately $408 currently. On average, the typical bill would increase at an average rate of approximately 5.2 percent per year.

Table 10-4
Household Impact – Implementation Plan No. 1

	FY 2005	FY 2010	FY 2015	FY 2020	FY 2025
Sewer	$ 408	$ 600	$ 677	$ 913	$ 1,135

CDM

10904-29375

Table 10-5 displays the amount paid through property tax bills based on assumed property values and projected grand list totals for FY 2005, FY 2010, FY 2015, FY 2020, and FY 2025. Existing amounts reflect previous improvements to the system and the bills below represent that portion recovered through the general fund. If the property would benefit from one of the two collection system expansion projects it would also face a special assessment — between $10,000 to $25,000 depending on the project's details. (This amount may be paid over several years and is not an annual ongoing payment.)

Table 10-5					
Tax (Existing Debt Service) - Implementation Plan No. 1					
Assessed Property Value	FY 2005	FY 2010	FY 2015	FY 2020	FY 2025
$ 100,000	$ 57	$ 36	$ 13	$ 0	$ -
$ 150,000	$ 85	$ 54	$ 19	$ 1	$ -
$ 200,000	$ 114	$ 72	$ 26	$ 1	$ -
$ 250,000	$ 142	$ 90	$ 32	$ 1	$ -
$ 300,000	$ 170	$ 109	$ 38	$ 1	$ -
$ 350,000	$ 199	$ 127	$ 45	$ 1	$ -
$ 400,000	$ 227	$ 145	$ 51	$ 1	$ -
$ 450,000	$ 256	$ 163	$ 58	$ 2	$ -
$ 500,000	$ 284	$ 181	$ 64	$ 2	$ -

Table 10-6 summarizes the anticipated impact on property tax bills for the anticipated improvements — treatment plant upgrades and a portion of the collection system expansions. In accordance with the Town's existing policy, sewer expansion projects are financed 50 percent from the general fund and 50 percent from betterments paid by directly benefiting properties. It should be noted that a property not connected to the sewer system would also be paying a combined tax bill for all existing and new sewer debt service. If the property had benefited from one of the proposed collection system projects it would also face a special assessment — between $10,000 to $25,000 depending on the project's details.

Table 10-6					
Tax (New Debt Service) - Implementation Plan No 1					
Assessed Property Value	FY 2005	FY 2010	FY 2015	FY 2020	FY 2025
$ 100,000	$ -	$ 36	$ 102	$ 94	$ 68
$ 150,000	$ -	$ 53	$ 153	$ 141	$ 102
$ 200,000	$ -	$ 71	$ 203	$ 188	$ 137
$ 250,000	$ -	$ 89	$ 254	$ 235	$ 171
$ 300,000	$ -	$ 107	$ 305	$ 282	$ 205
$ 350,000	$ -	$ 125	$ 356	$ 329	$ 239
$ 400,000	$ -	$ 143	$ 407	$ 376	$ 273
$ 450,000	$ -	$ 160	$ 458	$ 423	$ 307
$ 500,000	$ -	$ 178	$ 509	$ 470	$ 342

The amount of property tax support for sewer improvements (new and existing) would increase significantly. For a property worth $250,000, the tax contribution would increase from approximately $180 in FY 2010 to nearly $285 in FY 2015 and then decline to $170 in FY 2025.

10.4 Financial Analysis — Implementation Plan No. 2

This section describes the financial impact of Implementation Plan No. 2 as outlined above. This alternative increases total capital costs by approximately $16.1 million above Implementation Plan No. 1. The annual average operating costs would also increase with the implementation of the high priority need areas. These costs would be expected occur toward the end of the 20-year planning period as shown in Figure 8-1.

10.4.1 Net Rate Revenue Requirement

Table 10-7 summarizes the estimated operations and maintenance costs (O&M) for FY 2005, FY 2010, FY 2015, FY 2020, and FY 2025. Total operating and maintenance expenses are projected to increase from approximately $2 million in FY 2005 to $5.1 million in FY 2025.

Table 10-7

Operations and Maintenance Costs – Implementation Plan No. 2

	FY 2005	FY 2010	FY 2015	FY 2020	FY 2025
Labor	$ 132,431	$ 153,524	$ 177,976	$ 206,323	$ 239,185
Contract Operations	$ 1,550,000	$ 1,931,582	$ 2,407,103	$ 2,999,688	$ 3,738,157
Equipment	$ 245,000	$ 305,315	$ 156,229	$ 194,690	$ 242,619
Other Services	$ 17,500	$ 21,808	$ 27,177	$ 33,867	$ 42,205
Manholes set to Grade	$ 12,000	$ 14,954	$ 18,636	$ 23,223	$ 28,941
Wastewater Facilities Plan	$ 2,600	$ -	$ -	$ -	$ -
Permits Fees	$ 3,000	$ 3,739	$ 4,659	$ 5,806	$ 7,235
Purchase Nitrogen Credits	$ 6,309	$ 32,536	$ (8,173)	$ (5,189)	$ (239)
New O&M Expenses	$ -	$ -	$ -	$ 290,412	$ 789,088
Total O&M Expenses	$ 1,968,840	$ 2,463,457	$ 2,783,606	$ 3,748,821	$ 5,087,190

Table 10-8 summarizes the total (existing and new) debt service. The debt service for the Town would increase from $1.2 million in FY 2005 to $4.3 million in FY 2025. Table 10-8 only includes that debt service to be recovered from general revenues and not the amount that may be allocated to properties through betterments. The increase in debt service reflects the construction of the proposed wastewater treatment plant upgrades, collection system improvements, and the two critical need areas recommendations. In FY 2012, the planned improvements would increase total debt service by nearly $3.1 million.

Table 10-8					
Debt Service – Implementation Plan No. 2					
	FY 2005	FY 2010	FY 2015	FY 2020	FY 2025
Total Existing Debt Service	$ 1,157,522	$ 854,287	$ 350,072	$ 11,022	$ -
New General Obligation Debt	$ -	$ 841,968	$ 2,787,856	$ 4,416,055	$ 4,308,106
Total Debt Service	$ 1,157,522	$ 1,696,255	$ 3,137,928	$ 4,427,077	$ 4,308,106

Table 10-9 summarizes the total operational and maintenance costs, existing and new debt service, miscellaneous revenues, and property tax support to calculate rate revenue requirements for FY 2005, FY 2010, FY 2015, FY 2020, and FY 2025. Total O&M are projected to increase from $2 million in FY 2005 to $5.1 million in FY 2025. Property tax supported debt service is projected to increase from $1.2 million to $4.3 million. The total revenue requirement is projected to increase from $3.1 million in FY 2005 to $9.4 million in FY 2025. In FY 2025, the bulk of the revenues will be coming from property taxes to meet debt service requirements.

Table 10-9					
Net Rate Revenue Requirement – Implementation Plan No. 2					
	FY 2005	FY 2010	FY 2015	FY 2020	FY 2025
O&M Costs	$ 1,968,840	$ 2,463,457	$ 2,783,606	$ 3,748,821	$ 5,087,190
Miscellaneous Revenues	$ 34,000	$ 34,000	$ 34,000	$ 34,000	$ 34,000
Property Tax Supported Debt Service	$ 1,157,522	$ 1,696,255	$ 3,137,928	$ 4,427,077	$ 4,308,106
Net Rate Revenue Requirement	$ 3,092,362	$ 4,125,712	$ 5,887,534	$ 8,141,898	$ 9,361,296

10.4.2 Impact on Customers

The impact on customers has been evaluated in two stages. The first stage projected the impact of the wastewater treatment and collection system upgrades on operating and maintenance expenses. These costs would be recovered through sewer user fees. The second stage determined the impact of anticipated debt service. Debt service is allocated to tax payers through the general fund for plant upgrades and half of the sewer system expansion projects. (The balance of sewer expanse projects is allocated directly to benefiting properties.)

Sewer Rate Projections

As described above, operations and maintenance costs are projected to increase from approximately $2 million in FY 2005 to $5.1 million in FY 2025, an average increase of 5.1 percent per year. This reflects the change in plant costs, inflation over the forecast period and moderate increases in operating costs resulting from system expansion. It is also assumed that there would be a small increase in the number of customers served by the sewer system.

In 2025, sewer use fees would need to generate an average total of $5.1 million to maintain the solvency of the sewer fund. The sewer rate would increase from $3.40 per hcf to approximately $9.61 per hcf.

General Fund Impact

Debt service costs associated with the proposed improvements would be paid out of the general fund. Debt service costs are projected to increase to approximately $9.4 million by FY 2025.

10.4.3 Typical Household Bills

Table 10-10 displays the impact of the recommended plan on household user bills. In FY 2025, a household connected to the sewer system using 12,000 cubic feet of water per year would pay approximately $1,240 per year compared to approximately $408 currently. On average, the typical bill would increase at an average rate of approximately 5.7 percent per year.

Table 10-10
Household Impact – Implementation Plan No. 2

	FY 2005	FY 2010	FY 2015	FY 2020	FY 2025
Sewer	$ 408	$ 600	$ 677	$ 913	$ 1,240

Table 10-11 displays the amount paid through property tax bills based on assumed property values and projected grand list totals for FY 2005, FY 2010, FY 2015, FY 2020, and FY 2025. Existing amounts reflect previous improvements to the system and the bills below represent that portion recovered through the general fund. If the property would benefit from one of the nine collection system expansion projects it would also face a special assessment — between $10,000 to $25,000 depending on the project's details. (This amount may be paid over several years and is not annual ongoing payment.)

Table 10-11
Tax (Existing Debt Service) - Implementation Plan No. 2

Assessed Property Value	FY 2005	FY 2010	FY 2015	FY 2020	FY 2025
$100,000	$57	$36	$13	$0	$-
$150,000	$85	$54	$19	$1	$-
$200,000	$114	$72	$26	$1	$-
$250,000	$142	$90	$32	$1	$-
$300,000	$170	$109	$38	$1	$-
$350,000	$199	$127	$45	$1	$-
$400,000	$227	$145	$51	$1	$-
$450,000	$256	$163	$58	$2	$-
$500,000	$284	$181	$64	$2	$-

Table 10-12 summarizes the anticipated impact on property tax bills for the anticipated improvements —treatment plant upgrades and a portion of the collection system expansions. In accordance with the Town's existing policy, sewer expansion projects are financed 50 percent from the general fund and 50 percent from betterments paid by directly benefiting properties. It should be noted that a property not connected to the sewer system would also be paying a combined tax bill for all existing and new sewer debt service. If the property had benefited from one of the proposed collection system projects it would also face a special assessment — between $10,000 and $25,000 depending on the project's details.

Table 10-12					
Tax (New Debt Service) - Implementation Plan No.2					
Assessed Property Value	FY 2005	FY 2010	FY 2015	FY 2020	FY 2025
$ 100,000	$ -	$ 36	$ 102	$ 105	$ 105
$ 150,000	$ -	$ 53	$ 153	$ 158	$ 158
$ 200,000	$ -	$ 71	$ 203	$ 210	$ 210
$ 250,000	$ -	$ 89	$ 254	$ 263	$ 263
$ 300,000	$ -	$ 107	$ 305	$ 315	$ 315
$ 350,000	$ -	$ 125	$ 356	$ 368	$ 368
$ 400,000	$ -	$ 143	$ 407	$ 420	$ 420
$ 450,000	$ -	$ 160	$ 458	$ 473	$ 473
$ 500,000	$ -	$ 178	$ 509	$ 525	$ 525

The amount of property tax support for sewer improvements (new and existing) would increase significantly. For a property worth $250,000, the tax contribution would increase from approximately $180 in FY 2010 to $285 in FY 2015 and then gradually increase to $263 by FY 2025.

10.5 Summary

The Town of Stonington faces a major capital improvement program. This program would have a significant impact on the Town's taxpayers and the ratepayers. The impact on customers is complicated because the system is supported financially from sewer use fees, property taxes and special assessments.

Sewer user fees would increase at 5.2 percent per year, upgrade for the first plan and 5.7 percent per year for the second plan. Due to the Town's policy on debt service, property tax payments for sewer would increase significantly. Between FY 2005 and FY 2015, property tax support would increase by a total of approximately 200 percent for both implementation plans. (This again ignores the potential betterment payments that a particular property owner may be required to pay.)

The sewer rate for Implementation Plan No. 1 will grow from a rate of approximately $3.20 per hcf in 2005 to $9.20 per hcf in 2025. The sewer rate for Implementation Plan No. 2 will grow from $3.20 per hcf in 2005 to $9.61 per hcf in 2025.

Section 11
Public Participation

11.1 Introduction

This section describes and summarizes the public participation aspect of the facilities planning process. The public participation process is not complete, and this section will not be finalized until the entire process is finished. Public participation efforts to date are described.

This Wastewater Facilities Plan has been developed to respond to the comments received thus far in the public participation aspect of the project. The WPCA's recommendations differ from those previously presented in earlier drafts of the report. As such, many of the public comments received on the earlier draft are no longer applicable to the recommendations. These instances are noted in the following sub-sections.

11.2 Preliminary Public Participation

A series of public meetings were held in July 2000, to introduce the residents of Stonington to the wastewater facilities planning process. Background on the project was reviewed, and goals of the facilities planning process were outlined. A copy of a meeting handout is contained in Appendix E.

11.3 Citizen's Advisory Group

A Citizen's Advisory Group (CAG) was formed to provide ongoing public participation during development of the draft facilities plan. The CAG was comprised of concerned citizens from throughout Stonington. The CAG attended monthly meetings to offer advice and comment as the planning work proceeded.

11.4 Summary of Public Meetings (2/6/2001 and 7/16/2001)

The first public meeting for the project was held on February 6, 2001 to describe the progress to date on the project, and to outline the next steps. The two primary topics of presentation included the sewer needs analysis (which eventually became integral to Section 2 of this draft report), and flow and load projections (Section 3). A copy of a meeting handout is contained in Appendix E.

A second public meeting was held on Monday, July 16, 2001 at the Police Station in Stonington to discuss the wastewater treatment alternatives evaluation. A copy of a meeting handout is contained in Appendix E. Many of the comments were similar to those received at the subsequent Public Hearing. For simplicity, comments received at the July 16, 2001 meeting are incorporated into the Public Hearing summary (see Section 11.5). A verbatim transcript of the Public Meeting is available for review at the WPCA office in Town Hall.

11.5 Summary of Public Hearing (8/20/2001)

A public hearing was held on Monday, August 20, 2001 at Stonington High School. A copy of a meeting handout, which was an Executive Summary of the draft Wastewater Facilities Plan, is contained in Appendix E.

A presentation was made that described the draft facilities plan. Many questions were asked at the conclusion of the presentation. The following is a paraphrased record of the questions and answers from the public hearing. The responses also contain added information not available at the public hearing, including information from the first public meeting on July 16, 2001. A verbatim transcript of the Public Hearing is available for review at the WPCA office in Town Hall.

Question: Can we have more time beyond the 45-day comment period to absorb the information [in the draft report] and understand it fully? Answer: The WPCA extended the public comment period to slightly more than 6 months at the request of the public.

Question: What is the discharged effluent waste load and does it affect Stonington Harbor and the Pawcatuck River? Answer: The waste load is measured in pounds-per-day of pollutant. An upgrade to the treatment processes will improve the quality of the treated effluent and decrease the amount of pollutants entering these water bodies.

Question: What is the bacteria level in Stonington Harbor today? Has the bacteria level increased over the past year to two years since Mystic's waste has been brought to Stonington and allowed to discharge? Would an increase in the bacteria level increase odor levels as well? Answer: The bacteria (coliform bacteria) are treated by disinfection. Bacteria levels that are found in the rivers and harbor are not associated with the disinfection process (chlorination). The state has not identified anywhere in Stonington as being a critical problem that needs to be dealt with from a bacterial standpoint. Any bacteria level in the receiving water is not directly related to odor generation at the treatment plant.

Question: Are there any charts in the draft report that indicate effluent flow within the Harbor and down the Pawcatuck River and the sort of general tidal effects of that discharge? Answer: The work that was done within the confines of this study was sampling for dissolved oxygen, temperature, and salinity and trying to model the resulting depletion of the oxygen in the Pawcatuck River and Stonington Harbor. A detailed marine modeling exercise was not included in the project.

Question: What are closure lines? Answer: Closure lines are lines drawn on a map that show areas closed to shellfishing due to proximity to wastewater treatment facility outfalls. The Department of Agriculture maintains and updates these maps. The size of the closure areas is dependent on the tidal effects near the outfall. The Department of Agriculture, Aquaculture Division, requires a six-hour conditional time of travel. Outfall discharges in areas with faster currents require larger closure areas, whereas outfall discharges in areas with less tidal action require smaller closure areas.

Question: Can the Borough outfall be extended out beyond the inner breakwater to improve water quality in the Harbor? What is the primary consideration in not extending the outfall beyond the inner breakwater? Why can't the Pawcatuck outfall be extended further downstream from the constriction near Pawcatuck Rock where there is better flushing in the river? Answer: Stonington Harbor is protected from the stronger currents and heavier wave action in the Long Island Sound by the inner breakwater. Therefore, the six-hour conditional time of travel is less in the Harbor than it would be if the outfall discharged beyond the inner breakwater. Extending the outfall out further will not only add significant cost to the project, it would also close a larger area to shellfishing and require a new NPDES discharge permit. These reasons also hold true for extending the Pawcatuck outfall. Also, identifying alternate outfall locations was not part of this facilities plan. The study only focused on evaluating the use of the existing permitted harbor and river outfalls. Note that the Shellfishing Commission and the state's Division of Aquaculture are on record as opposing extending the Stonington Harbor outfall beyond the breakwater (see Appendix E).

Question: Why can't all three existing outfalls be used to discharge treated effluent from a new, single WPCF? Answer: All three outfalls can be used to discharge treated effluent.

Question: What are the closure lines for each WPCF? What areas are closed to shellfishing? Answer: The current closure lines for each of the three existing treatment facilities are shown on maps that can be obtained from the Division of Aquaculture. The areas near each of the three outfalls are permanently closed to shellfishing and are shown on the maps. The closure line maps have been obtained from the state, and are included in Appendix E.

Question: In the past, there have been discharges in violation of the current permits. If this happens in the future with higher flows to the Borough outfall, the impacts could be devastating to the area? How can these untreated discharges be avoided? Answer: All treatment facilities in New England are required to have redundancy, which are standby parallel trains of processes that can be utilized if one of the active trains needs to be taken offline. These standby trains are designed to maintain the design flow and achieve the same level of treatment.

Question: Why aren't the existing WPCF's staffed 24 hours per day, 7 days per week? Answer: This is not required by regulation, and is unnecessary as long as the proper alarming and notification systems are in place.

Question: If effluent from the Pawcatuck River has such a major impact on the health of the Long Island Sound, then why are we only dealing with the effluent from one side of the river and not the other? What is the Town of Westerly's

current and future plan for dealing with their outfall?" Which states are included in the Long Island Sound Study? Answer: Each Town or municipality that discharges treated effluent to the Long Island Sound or a tributary that flows into the Long Island Sound is responsible for meeting nitrogen removal requirements by a certain time period as required in the Long Island Sound Study. The Long Island Sound Study only includes New York and Connecticut. Since the Town of Stonington is currently addressing their current and future wastewater needs, it makes sense to include the nitrogen removal issue in this process. Regardless, the Town of Westerly recently upgraded and is operating its treatment facilities for nitrogen removal.

Question: Is it legally possible to discharge the entire Town's treated effluent to the Pawcatuck River? Answer: This is not currently permitted and likely could not be permitted, due to the existing water quality in the river.

Question: Where is the sampling point for treated effluent from each of the WPCF's? Answer: The sampling point is after disinfection and just before discharge from the facility.

Question: Where is all of the increased flow coming from that is requiring improvements and capacity upgrades? Answer: The increase in wastewater flows can be attributed to population growth, commercial development, and connection of the sewer needs areas.

Question: Is there a state imposed deadline for implementing nitrogen removal? Answer: The state's nitrogen removal program requires that each wastewater treatment facility comply with its nitrogen wasteload allocation, effective on January 1, 2002. Each facility's wasteload allocation will become gradually more stringent until the lower limit is reached in 2014. Facility owners have the option of upgrading their facilities to meet the wasteload allocation or buying "nitrogen credits" to stay in compliance.

Question: Are we concentrating too much on nitrogen levels? What are the chemicals that can also be discharged into the river? Answer: The three plants use sodium hypochlorite (essentially high-strength bleach) to disinfect the effluent.

Question: What is being incorporated into each of the alternatives for odor control? How much weight was given to the fact that Pawcatuck successfully, recently successfully had two suits against the odor control issues there? Did you budget the lawsuits that are coming from the Borough into these numbers? How are other treatment facilities in the state operating without odor problems? Answer: The WPCA has responded to these questions and has implemented odor control improvements at each of its three plants. These improvements were completed in 2003.

Question: How many acres are necessary for constructing a new WPCF? Is a waterfront location for a new WPCF preferable? Answer: Five acres would be an absolute minimum; 10 acres are preferred for the actual plant footprint. More acreage would provide a larger buffer for neighbors. It is difficult to generalize preferred locations for treatment plants. See Section 7 of this report.

Question: Has CDM taken into consideration tidal effects/flood elevations on proposed upgrades to the Pawcatuck and Borough WPCFs? Answer: Any upgrades will need to be elevated above the 100-year floodplain elevation for protection.

Question: Will the existing fence at the Pawcatuck WPCF need to be moved closer to the property line to accommodate improvements recommended in Alternatives 1 through 4? Answer: Yes.

Question: If Alternative 5 is chosen, which proposes building a new WPCF to replace all three existing WPCF's, will this facility be more advanced and efficient in treating wastewater? Which outfall(s) is utilized for the treated effluent under this alternative? Answer: The technology would not be more advanced per se, though the plant may be more efficient to run. If selected, Alternative 5 envisions all of the effluent to be discharged through the existing Borough outfall, although there would be some flexibility if this disposal option was not approved by the state.

Question: Has the Town-owned property behind the Stonington police station been considered as a possible site for locating a new WPCF? Answer: See Section 7.

Question: How was the Citizen's Advisory Group (CAG) selected? Why isn't there a representative from the Borough on the CAG, especially since most of the future flows will likely be discharged through the Borough outfall? Answer: The CAG represented all areas of the town. In response to this and other concerns about the CAG, the WPCA formed a second group, the "Citizens Review Panel," whose report is attached in Appendix E.

Question: How much time has it taken for CDM to complete the facilities plan? Answer: To complete the August 2001 draft, it took CDM slightly more than one year.

Question: What is the process in approving and instituting the facilities plan both on the State level and on the Town level? Answer: The WPCA will approve and submit the facilities plan to the state for review. The state will review and approve the plan, with comments. After final approval, the plan would become a "blueprint" for the Town to follow over the planning period. The Town will have to approve funding for any improvements prior to implementation.

Question: Has a study been done on the impact of the Mystic Seaport and the Aquarium, which both have plans for expansion? Financially, are those two organizations paying their fair share of taxes to support the wastewater that is coming from their area, which will expand in the next 20 years? Answer: The flow projections include an allowance for increased flow from the Seaport and Aquarium.

Question: Out of the approximate 50-percent response rate to the Sewer Needs Questionnaire, what percentage of the responses came from Mystic, Borough and Pawcatuck? Answer: The response rates are approximately 17-percent from Mystic, 37-percent from Pawcatuck, and 40-percent from other areas. Approximately 5-percent of the responses did not have an address, so it was impossible to determine which part of town they represented. The downtown Borough is already completely sewered so questionnaires were not sent to those residents.

Question: Who will be responsible for paying for either the plant upgrades or building a new WPCF? Will everyone in the Town of Stonington share the cost or will only those people connected to the sewer be responsible? Answer: The optimal funding mechanism is unknown at this time.

Question: Is there any limitation on the number of years that the project can be bonded for? Answer: Projects of this type are typically bonded for either 20-year or 30-year terms.

Question: Why upgrade the Borough WPCF and make it visually worse than it already is? Answer: The Borough WPCF will require upgrading within the 20-year planning period in order to achieve the improved level of treatment required. The extent of the upgrade work will only be as needed to handle wastewater that drains from the Borough's collection system (i.e., no diversion from Mystic), and visual impacts will be minimized to the extent possible.

Question: Is there information readily available this evening on the cost of the expansion at the Borough plant to accomplish [the existing diversion between Mystic and Borough]? (Refers to the completed project that results in a diversion of about 0.28 million gallons of flow per day from the Mystic WPCF to the Borough WPCF) Answer: The cost of improvements at both the Borough and Mystic plants totaled close to $2 million. Construction of the diversion pipeline was an additional $2 million.

Question: How much time is the Town actually buying in regards to upgrading the facilities rather than constructing a new treatment facility, especially since the diversion pipeline was constructed as a sort of temporary fix to allow the Mystic WPCF to continue operating? Answer: The WPCA's recommended plan extends the life of the existing facilities another 20 years, and with technology improvements, it is expected that the facilities will function well beyond that.

Question: If the Pawcatuck WPCF was not originally constructed on Mary Hall Road and a new plant needed to be sited, would this parcel currently be considered as a feasible location for a new WPCF? Answer: It is difficult to say, with the current level of development in the area. See Section 7 for a detailed description of the factors to be considered in selecting a site.

Question: Why did the state let the moratorium stay in effect in Mystic for so long? Years ago, if something was done, wouldn't it have been much cheaper to act?

Answer: The history of the CTDEP's enforcement actions regarding Stonington and decisions made would require a voluminous response, and the response would not have an effect on the present situation.

Question: What will be the increase in truck traffic and impacts to local streets with the different alternatives? Has anyone prepared a traffic control study to evaluate the possible impacts? Answer: The Wastewater Facilities Plan includes an evaluation to determine environmental impacts in general. A detailed traffic study is beyond the scope of the Wastewater Facilities Plan.

Question: How was the non-economic analysis conducted? Who was involved in ranking the alternatives in the economic analysis? Where can the supporting detail be found? Answer: See the revised Wastewater Facilities Plan.

Question: "What is the long-term cost to the community and when does it pay for itself?" Did anyone perform a 30-year projection on the present worth costs for Alternative 5? Answer: See the revised Wastewater Facilities Plan for updated comparisons of capital, O&M and present-worth costs.

Question: Can the Town provide a list of its other major financial obligations (i.e., bonds) so the citizens can get a better idea of how these options will affect them financially? Answer: See the revised Section 10, which contains this information.

Question: Historically, how close has CDM's projected cost estimates been to actual construction costs for similar projects? Answer: CDM has a good record in this area. The costs presented are considered to be realistic and conservative, and include a contingency to cover cost items that are presently unknown.

11.6 Public Comment Period (8/20/2001 – 3/31/2002)

Due to the considerable public comment received at the Public Hearing, WPCA kept the public comment period open until March 31, 2002. During this period, a Citizen's Review Panel (CRP) was formed to evaluate the draft Wastewater Facilities Plan in detail (see Section 11.8). Also during this period, WPCA received several additional comments in the form of letters and meetings. These comments are described below, in chronological order.

Anthony and Julita Inzero, letter dated 8/21/01 (contained in Appendix E). In this letter, Mr. and Mrs. Inzero requested information on the Citizen's Advisory Group (CAG), the needs analysis and air quality. WPCA believes that the Wastewater Facilities Plan provides sufficient information on the CAG; especially since the Citizen's Review Panel (CRP) largely superseded the work of the CAG. The Wastewater Facilities Plan also provides significant background on the information collected in for the needs analysis. For the Wastewater Facilities Plan, WPCA did not collect air quality information.

W.B. Cutler, letter dated 8/22/01 (contained in Appendix E). In this letter, Mr. Cutler comments on three areas: 1) the need for extended public review time; 2) the need for redundancy of the system; and 3) the need to review technologies. In response to the public's request, an extended hearing period was provided. The design and construction of the selected option will be made with process reliability and redundancy as key considerations. Typical features of the project would include redundant mechanical equipment, protection against the 100-year flood, and emergency backup power. It is not necessary to keep a "mothballed" plant available to re-start. This level of redundancy is not required. Finally, the initial and revised reports include a discussion of treatment technologies.

W.B. Cutler, letter dated 8/24/01 (contained in Appendix E). This letter follows up on Mr. Cutler's 8/22/01 letter. In this letter, Mr. Cutler suggests that a task force be impaneled to further evaluate the available technologies and options. He also was critical of the non-economic evaluation contained in the initial draft report. In the extended public comment period, WPCA did sponsor a review panel, the CRP, whose input has substantially impacted the development of the plan. WPCA agreed that the non-economic evaluation was confusing and subjective. The revised Section 7 utilizes a different approach.

Donald R. Maranell, First Selectman, letter dated 8/28/01 (contained in Appendix E). In this letter, Mr. Maranell advocates that WPCA should not consolidate wastewater treatment operations by closing one or more plants, and should not consolidate wastewater discharges, which would increase flow discharged to one or more receiving waters. These matters are addressed in the revised Section 7. Mr. Maranell also states that the project should be provided with considerable funding from the State and Federal governments, and that Stonington should seek to study the actual impacts that the Town's discharges have on Long Island Sound. WPCA agrees regarding the funding, and will do all it can to gain state and federal participation. Stonington's obligation to meet its nitrogen wasteload allocation is now a formal part of the Town's discharge permit requirements.

Mary-Preston Morton, letter dated 8/30/01 (contained in Appendix E). In this letter, Ms. Morton asked three questions, relating to what other towns in Stonington's situation have done, and other experiences. Most towns the size of Stonington that have public sewer service utilize one wastewater treatment facility – operating and maintaining three separate plants is highly unusual (perhaps unique) for a town of Stonington's size and population. There is no "perfect" sewer plant. Many plant owners are very pleased and satisfied with their facilities. The Mashantucket Indian Reservation's wastewater treatment plant utilizes a biological process called "sequencing batch reactors", or SBRs. This technology is one of many that can meet the goals of the treatment process, and is evaluated in this facilities plan (see Section 7).

J.M. Hinchey, letter dated 9/4/01 (contained in Appendix E). In this letter, Mr. Hinchey discusses the need for coordination between Stonington and Westerly, as both towns discharge to the Pawcatuck River. The impacts of both discharges are described in detail in Section 6. WPCA agrees that there was a "disconnect" in the fact that Stonington's Pawcatuck WPCF discharge must comply with a nitrogen wasteload due to water quality impacts, but the Westerly plant had not (note that in the interim period since the public comment period, the Westerly plant has been upgraded and does provide nitrogen removal). Note that the states of Connecticut and Rhode Island are in the process of determining a Total Maximum Daily Load (TMDL) analysis for the Pawcatuck River; however, the results of this analysis will not be available until after Stonington's facilities plan is due to Connecticut DEP.

The Cusson-Abele Family, letter dated 9/17/01 (contained in Appendix E). In this letter, the Cusson-Abele family describes the reasons why they recommend that WPCA implement Alternative No. 5. The letter also contains four questions which address this topic. WPCA's revised recommendation is to implement Alternative No. 1. Features of this alternative include keeping the Borough WPCF in service, and expanded it during the 20-year life of the plan to comply with its discharge requirements. Howvere, this alternative also discontinues the diversion from the Mystic WPCF, minimizing any improvements necessary to the Borough WPCF. In response to the questions in the letter: 1) A survey was not conducted of families living in the areas of the Borough WPCF; rather, the extensive public participation process has allowed WPCA to gain an understanding of all of the issues; 2) No longer relevant with WPCA's revised recommendation; 3) WPCA does have representation from the Borough; and 4) As stated above, impacts to the Borough WPCF will be minimized. The letter also refers to the odor problem at the Borough WPCF. The WPCA implemented a $2 million odor control program that was substantially complete by summer 2003. This program included covering all of the treatment tankage at the Borough WPCF and treating the captured air through an odor control system.

Dr. Bruce MacKinnon, list of questions delivered 9/25/01 (contained in Appendix E). Brief responses to Dr. MacKinnon's list of questions are as follows:

1. WPCA believes that the recommended Alternative No. 1 is the best alternative to minimize impacts to the three sites. There will be less effluent discharged through the Borough WPCF outfall.

2. See WPCA's revised recommendations.

3. This topic was addressed in depth throughout the comment period, as further documented in Section 11.7.

4. See WPCA's revised recommendations.

5. See Section 11.7 of this report.

6. The nitrogen wasteload allocations indicate the required reductions in nitrogen discharges – the nitrogen is being discharged now. Even in the

options where all of the town's wastewater is discharged through one outfall (in Stonington Harbor), the future load will be less than in the past, because of the higher degree of treatment.

7. This topic was addressed in depth throughout the comment period, as further documented in Section 11.7.

8. See the revised facilities plan, Section 7. The technology in place at the Mashantucket reservation is evaluated in that section.

9. See the revised facilities plan, Section 7.

10. The Citizen's Advisory Group (CAG) did have Borough representation. The CRP that has studied the report since the pubic hearing had extensive Borough representation, and the WPCA Board has Borough representation.

11. See the revised facilities plan, Section 7.

12. Of the three existing outfall locations, the Stonington Harbor is the most suitable receiving water. See Section 6.

13. There will be no double assessments.

Alisa Storrow, list of questions delivered 9/25/01 (contained in Appendix E). Brief responses to Ms. Storrow's list of questions are as follows:

1. As described in Section 7, WPCA has investigated Alternative No. 5 and is convinced of its feasibility. There is sufficient acreage available at the preferred site for future expansion if necessary. The land is town-owned, so the cost of the land is not considered.

2. The WPCA implemented a $2 million odor control program that was substantially complete by summer 2003. This program included covering all of the treatment tankage at the Borough WPCF and treating the captured air through an odor control system.

3. There are many "excellent" wastewater treatment plants. WPCA would prefer not to judge one as being better than another without fully understanding the history, goals, and site-specific requirements of each.

4. Many plants in Connecticut have already upgraded, or are in the process of upgrading, their facilities to meet the nitrogen limits imposed by the state. The larger plants have tended to upgrade earlier in the process, and the smaller plants later. Many plant owners are presently using the nitrogen trading program to achieve compliance, as WPCA currently does.

5. The outfall pipe was discovered to be broken during a dive undertaken to verify the outfall configuration on April 30, 2001. The outfall was repaired in May 2005.

6. WPCA is aware that Stonington Harbor has been dye-tested twice, once in 1981, and once in 1991. Copies of both studies are available at the WPCA office in Town Hall. Because of the highly technical nature of the studies and reports, it is difficult to paraphrase the results.

7. This question is somewhat open-ended, and WPCA is not clear on the intent of the question. Discharges from all WPCF's are controlled through their National Pollutant Discharge Elimination System (NPDES) permits. In addition, CTDEP has established nitrogen wasteload limits for all 79 WPCFs in Connecticut under the *General Permit for Nitrogen Discharges*. Refer to Section 1 of the Wastewater Facilities Plan for additional information.

8. WPCA is unaware of an absolute, universal limit on the length of an outfall pipe. Regarding the outfall from the Stonington Borough WPCF, the overall impact of the outfall within the harbor is less than if it was beyond the breakwater, due to the extent of the shellfish beds.

Lance Stewart, letter dated 10/5/01 (contained in Appendix E). In this letter, Mr. Stewart recommends that WPCA implement Alternative No. 1, as the "ecologically responsible course", based on concerns of impacts on water quality in the Pawcatuck River and Stonington Harbor, should the existing discharges from those locations increase. This topic was addressed in depth throughout the comment period, as further documented in Section 11.7. The letter also contains four questions, which are addressed in Section 6 of this revised draft report, or in Section 11.7.

Paul D. Maugle, Mohegan Tribe, letter dated 10/26/01 (contained in Appendix E). In this letter, Dr. Maugle states the Mohegan Tribe's opposition to increasing the existing treated effluent flow into Stonington Harbor, because of potential impacts on the Tribe's aquaculture concerns. This topic was addressed in depth throughout the comment period, as further documented in Section 11.7.

Donald L. Murphy, Chairman, Town of Stonington Shellfish Commission, letter dated 12/13/01 (contained in Appendix E): In this letter, Mr. Murphy and the Shellfish Commission identify several concerns and questions, and requested a meeting among the Commission, the Department of Aquaculture, WPCA and CDM regarding impacts on the Town's shellfishing resources. This meeting was held on January 29, 2002.

John D. Daly, Latimer Point Condominium Association, letter dated 1/24/02 (contained in Appendix E). Mr. Daly addresses the Latimer Point Condominium Association's special circumstance regarding sewage disposal and the restrictions currently in place on constructing improvements. WPCA is requested to work with DEP regarding modification of the current restriction. Addressing this issue is beyond the scope of the Facilities Plan, but including this letter in Appendix E will serve to express this concern to DEP.

Agenda of Shellfishing Resources Impacts Workshop, 1/29/02 (contained in Appendix E). This meeting was held to address many of the comments and questions from the Shellfish Commission, and Department of Agriculture and other concerns.

Timothy Rollins, Purity Processed Shellfish, letter dated 2/4/02 (contained in Appendix E). In this letter, Mr. Rollins states his objection to extending the existing Stonington Harbor outfall beyond the breakwater. This topic was addressed in depth throughout the comment period, as further documented in Section 11.7.

Donald L. Murphy, Chairman, Town of Stonington Shellfish Commission, letter dated 2/21/02 (contained in Appendix E). In this letter, Mr. Murphy and the Shellfish Commission comment on several of the wastewater treatment alternatives and their potential impacts. This topic was addressed in depth throughout the comment period, as further documented in Section 11.7. In the letter, Mr. Murphy and the Shellfish Commission recommend that WPCA adopt either Alternative No. 1 or No. 1A, as having the least potential negative impact to the Commission's goal of managing and improving access to shellfish resources.

James S. Citak, Connecticut Division of Aquaculture, letter dated 2/21/02 (contained in Appendix E). In this letter, Mr. Citak described the Division's comments and concerns with each of the alternatives described in the draft Facilities Plan. This topic was addressed in depth throughout the comment period, as further documented in Section 11.7.

The Speziali Family, letter received 5/15/02 (contained in Appendix E). In this letter, the Speziali family urged WPCA to adopt the alternative that results in a new, Town-wide wastewater treatment facility.

11.7 Impacts on Shellfish Resources

As summarized in Section 11.6, WPCA received significant comment regarding the recommended alternative's impact on the Town's shellfish resources. The draft report presented in August 2001 recommended Alternative No. 2 as described in Section 7. This alternative would involve closing the Mystic WPCF, and diverting all of the flow originating in the Mystic drainage basins to the Borough WPCF for treatment and discharge to the existing outfall in Stonington Harbor.

The bottom-line concern of all commenting parties is that the chosen alternative should not negatively impact the existing shellfish resources or industry surrounding them. In a meeting attended by the Shellfish Commission, the Division of Aquaculture, WPCA and CDM, the Division of Aquaculture indicated that an increase in flow to the Stonington Harbor outfall would increase the size of the restricted zone. This is a negative impact that shellfishing concerns want to avoid.

To address this issue, CDM's project water quality specialist conducted an analysis of the impacts of increasing flow to the Stonington Harbor outfall. This analysis is documented in a memorandum dated February 18, 2002 by Bernadette Kolb (contained in Appendix E). The analysis finds that increasing the volume of discharge should not have a significant impact on coliform concentrations at the restricted/open shellfish boundary, and thus the existing boundary can remain as-is (no expansion). The volume of the potential discharge is relatively small compared to the tidal flushing of Stonington Harbor, and dilution analysis suggests that as the effluent plume travels away from the point of discharge, the differences of initial dilution diminish (as would be expected).

As of the publication of this revised draft Facilities Plan, this issue has not been resolved among all parties. WPCA expects discussions to continue as DEP reviews the draft report. WPCA also notes that the revised recommendation renders many of these concerns moot.

11.8 Citizen's Review Panel

A second group of concerned citizen's, the Citizen's Review Panel (CRP) was formed subsequent to the August 20, 2001 Public Hearing. The purposes of the CRP were to assess and evaluate the draft Facilities Plan, and to develop conclusions and recommendations to WPCA. The full body of the CRP's final report is contained in Appendix E. WPCA has responded to the CRP report in the body of the revised Facilities Plan, either by providing more information, or by incorporating the recommendations.

The CRP's closing recommendations, as contained in the CRP report, are summarized as follows, with WPCA's responses:

Immediate implementation of odor control at the three existing WPCFs. WPCA agreed and implemented $2 million of capital improvements, that was on-line by summer 2003.

Continue to evaluate the Symbio™ process, and incorporate the process into the Facilities Plan if it proves successful. WPCA agreed, and has continued to operate and evaluate the Symbio™ process at the Borough WPCF. It has not proven effective year-round, after five years of operation. Though not recommended for implementation in Section 7, if performance improves, WPCA will re-evaluate the process.

Remove the 200,000 gpd reserve for North Stonington. WPCA agreed, and the revised draft Facilities Plan reflects this change.

Re-evaluate and significantly reduce the scope of the sewer needs portion of the Facilities Plan. WPCA agreed, and the revised draft Facilities Plan reflects this change.

Continue to use some combination of the existing outfalls, and correct any problems with existing diffusers. WPCA agreed, and the revised draft Facilities Plan reflects this change. The Borough outfall was repaired in May 2005.

Utilize the flow projections contained in the CRP report. The flow projections have been revised in the Facilities Plan. WPCA's revised flow projections are not in exact agreement with the CRP, but stem from many of the same assumptions and concepts, with which WPCA agreed.

Adopt Alternative G as the treatment plant option. WPCA disagreed that Alternative G is the best long-term solution for the Town, although the recommended Alternative No. 1 is similar in many ways. See Section 7.

Institute a new public hearing process if the previous recommendation (Alternative No. 2) is changed. WPCA agreed and a new Public Hearing was held.

11.9 Summary of Public Hearing (2/5/2005)

A public hearing was held on Wednesday, February 2, 2005 at the Mystic Middle School. A copy of a meeting handout, which was an Executive Summary of the revised draft Wastewater Facilities Plan, is contained in Appendix E.

A presentation was made that described the revised draft facilities plan. Many questions were asked at the conclusion of the presentation. The following is a paraphrased record of the questions and answers at the public hearing. A verbatim transcript of the Public Hearing is available for review at the WPCA office in Town Hall.

It should be noted that the revised facilities plan presented at the February 2, 2005 hearing included the recommendation that the Town proceed with Alternative No. 5. Alternative No. 5 involves construction and operation of a new treatment plant at a town-owned site near Pumping Station No. 2 with the treated effluent discharged via the existing Stonington Borough treatment plant outfall in Stonington Harbor. Many of the questions and comments were related to that recommendation, which the WPCA subsequently withdrew. The WPCA has considered this input while re-evaluating the options. WPCA has revised its recommendation to Alternative No. 1, which renders many of these questions and comments moot.

Question: Was the presence of encephalitis mosquitoes considered in the selection of the preferred site for the new treatment plant? What about the school children that will be in the vicinity? Were the picnic/recreational areas considered? Answer: Yes.

Question: Why is it not possible to pump all of Pawcatuck's wastewater to Groton, but it is possible to pump it all to the Borough area? Answer: The limit on flow to Groton is not pumping capacity – it is possible to pump all of the flow to Groton. The

CDM

constraint is treatment capacity at Groton. The Groton plant does not have sufficient capacity to handle all of the wastewater generated within Stonington.

Question: The recommended alternative will result in a BOD load increase by a factor of 11 to Stonington Harbor, and a nitrogen increase of 3.8 times existing. Answer: Alternative No. 5 involves an increase in effluent flow discharged to Stonington Harbor, but due to the higher degree of treatment, the overall impact of BOD and nitrogen loading would be less. Please refer to Section 6 for details of this analysis, and Table 6-4 for a summary of the existing equivalent BOD load compared to Water Quality Scenario No. 5. Please note that Alternative No. 5 is no longer the recommended alternative.

Question: Please address the increased discharge to Stonington Harbor from the recommended alternative, and the impact that may have on heavy metals and the fishing industry. Answer: Please refer to Section 7 and WPCA's revised recommendations.

Question: Please indicate which of the WPCA Board supports Alternative 5. Answer: At the time of the hearing, the entire Authority supported Alternative 5. Note that the WPCA has since withdrawn that recommendation.

Question: Please provide more information on the decision-making process behind not selecting the Groton alternative, and comment on the economics of that option, which the report indicates are comparable with Alternative 5. Answer: At the time of the hearing, the decision to not select the Groton alternative was based on economics. Implementation of the Groton alternative required that Stonington fund significant infrastructure improvements within Groton to support the flow transfer, as well as to continue to operate the Pawcatuck plant and an equalization facility at the Mystic WPCF site. Note that since the hearing, Stonington has received a formal correspondence from Groton that eliminates the Groton alternative from consideration. This letter is included in Appendix E.

Question: The report notes that loads cannot be increased to the Mystic River, in order to maintain its high quality, designated use, etc. This same sentiment can be made for Stonington Harbor and the Pawcatuck River, and there needs to be a better solution than discharging all of the Town's effluent into Stonington Harbor. Answer: Please refer to Section 7 and WPCA's revised recommendations.

Question: Please confirm the Pawcatuck WPCF's capacity and current operating flow, compare that to the other facilities. Answer: The Pawcatuck plant's permitted capacity is 1.3 mgd, and it is operating at approximately 50% of that flow. It should be noted that there is a difference between permitted flow and its actual functional capacity. The Mystic and Borough WPCFs are both stressed to near their functional capacity.

Question: The economic impact of the recommended plan are high and funding will be a problem, considering the Town's other costs, including the recent $40

million high school project. Answer: Please refer to Section 7 and WPCA's revised recommendations.

Question: It is surprising that the Town is looking to add sewers, as the report indicates. Answer: It is not WPCA's policy to seek to extend sewers. The report identifies areas where on-site systems are potential problems, and WPCA must plan for eventually sewering those areas in order to solve those potential environmental problems.

Question: The Town should implement the "best" solution, not necessarily the most cost-effective. Answer: Please refer to Section 7 and WPCA's revised recommendations.

Question: Implementation of Alternative No. 5 will require a permit from the Inlands and Wetlands Commission. Answer: The WPCA expects to apply for any and all permits that may be required.

Question: Were the costs for demolition of the existing plants included in the cost figures presented? Answer: Yes

Question: What would be done if the Easton Ribbon snake is located at the proposed new plant site? What about archeological/historical value? Light pollution? What about odor control at the new site? Answer: Each has been considered and will be addressed as part of the design and permitting processes. Please refer to Section 7 and WPCA's revised recommendations.

Question: The Chairman of the Stonington Harbor Management Commission invited a representative from WPCA to attend its next meeting. Answer: None.

Question: Alternative 5 is not the best alternative due to 1) financial impacts and 2) the impact of discharging all of the Town's effluent to Stonington Harbor. Answer: Please refer to Section 7 and WPCA's revised recommendations.

Question: Do the O&M costs in the report include the costs of financing the project? If not, how can the comparison not consider this, because it adds more cost to the selected, highest capital-cost alternative? Answer: The O&M costs presented at the hearing did not include the financing cost. Though it is understood that it costs more to finance a higher capital cost project, assigning a precise figure to the financing cost is not possible at this time, because of the many unknowns associated with the overall implementation schedule, and borrowing costs at the time funding is needed. Nonetheless, the WPCA is aware of this aspect of implementation of each alternative. It should also be noted that the overall alternative project costs presented do include a contingency (as a percentage) that is meant to approximate "soft" costs, such as legal, administrative, etc. costs that are a part of implementation of this type of project. The same percentage contingency is applied to all alternatives, so therefore the highest cost alternatives are assigned larger contingencies.

Question: Alternative 5 is not the best alternative due to 1) financial impacts and 2) the impact of discharging all of the Town's effluent to Stonington Harbor. Answer: Please refer to Section 7 and WPCA's revised recommendations.

Question: The recommended alternative does not consider any increase in traffic and its impacts on the school. Answer: The traffic volume associated with a treatment facility is negligible..

Question: Discharging all of the Town's flow to Stonington Harbor is strongly objectionable. It is suggested that WPCA revisit the Groton alternative, and please consider photo-remediation as an alternative disposal option. Answer: The Groton alternative is not a feasible option, and WPCA has received a letter to that effect from Groton (see Appendix E). Please refer to Section 7 and WPCA's revised recommendations.

Question: Please clarify the statement that the Symbio process has not proven satisfactory. Answer: The Symbio process was put into place at the Stonington Borough WPCF on a trial basis to see if it would allow the plant to achieve an effluent total nitrogen concentration of 10 mg/L or less, and it has not been able to do so. The success of the process depends on very tight control of oxygen levels within the aeration basins, and it just has not proven the ability to provide that level of control.

Question: It seems that the fundamental problem regarding capacity is the Mystic WPCF. The Pawcatuck WPCF is OK; the Borough WPCF, without the diversion, would be OK, and Mystic is overloaded. It makes sense to implement a variation of the Groton alternative whereby only the Mystic flow is pumped to Groton. Has that been evaluated? Answer: When looking at the variations of the Groton alternative, the seemingly most cost-effective option was to pump flow from both the Mystic and Borough WPCFs to Groton, and the option suggested in this question had not been developed. However, the Groton alternative is no longer a feasible option, and WPCA has received a letter to that effect from Groton (see Appendix E).

Question: Please provide clarification of the recommended plan for the sewer needs areas. How many areas will be addressed, and at what cost? Answer: Refer to Sections 2 and 10 of the report.

Question: Is at least a portion of the site recommended for the new treatment plant designated for conservation? Answer: That is a question for the Town as a whole to decide.

Question: Can nitrogen be filtered out of the effluent? Answer: The vast majority of nitrogen loading to treatment plants is in soluble form, so it cannot be filtered. The best, proven, most cost-effective means for removing nitrogen is to use a biological process to convert it into nitrogen gas, for subsequent release to the atmosphere.

Question: Is the value of the abandoned sites for the recommended alternative considered in the cost analysis? Answer: No

11.10 Public Comment Period (2/5/2005 – 4/15/2005)

During the subsequent open comment period after the hearing, WPCA received several additional comments in the form of letters and at meetings. These comments are described below, in chronological order. Though the public comment period was "officially" closed on April 15, 2005, WPCA has continued to accept comments in the period since. Copies of this correspondence are contained in Appendix E.

A petition, signed by 21 residents of Stonington, was submitted to WPCA no later than February 4, 2005. The signatories "[disapprove] of the consolidation of the three water treatment plants in Stonington and discharge of the effluent in Stonington Harbor, as proposed by the Stonington Water Pollution Control Authority." In addition, a collection of 20 e-mails was submitted to WPCA from 2/14/2005 through 2/22/05 endorsing this opinion. The organized group that submitted these, and other comments during the open comment period is known as the *Better Solution* Task Force. Please refer to Section 7 and WPCA's revised recommendations.

James M. Spellman, letter dated February 4, 2005: in this letter Mr. Spellman reviewed a history of wastewater planning in Stonington, and expressed opposition to making a drastic change in the overall treatment philosophy that Alternative No. 5 would represent. He also expressed doubt that discharging all of the Town's effluent to Stonington Harbor could be approved. Please refer to Section 7 and WPCA's revised recommendations.

Emily Lynch, letter dated February 6, 2005: in this letter Ms. Lynch expressed opposition to discharging all of the Town's effluent to Stonington Harbor. Please refer to Section 7 and WPCA's revised recommendations.

Dale D. Brummond Sr., letter dated February 16, 2005: in this letter Mr. Brummond asked that the three receiving waters (Mystic River, Stonington Harbor and Pawcatuck River) be professionally compared regarding ability to flush/assimilate effluent discharge, and that the results be published.

Glenn J. Frishman., letter dated February 18, 2005: in this letter Mr. Frishman, as the Chairman of the Board of Finance for the Town of Stonington indicated that the Board of Finance could not support the recommended alternative No. 5 due to the financial impact of implementing the alternative. Please refer to Section 7 and WPCA's revised recommendations.

Arthur Medeiros, letter dated February 18, 2005: in this letter Mr. Medeiros, on behalf of the Southern New England Fisherman's & Lobsterman's Association, expressed opposition to Alternative No. 5, specifically the discharge of all the Town's effluent into Stonington Harbor. Please refer to Section 7 and WPCA's revised recommendations.

Charles C. Beebe Jr., email dated February 21, 2005: in this email Mr. Beebe endorsed the recommendation to implement Alternative No. 5.

Peter Vermilya, letter dated February 21, 2005: in this letter Mr. Vermilya, on behalf of the Stonington Harbor Management Commission (SHMC), expressed opposition to Alternative No. 5, specifically the discharge of all of the Town's effluent into Stonington Harbor. The letter also indicated that the SHMC must be notified at least 35 days prior to commencement of a pubic hearing on matters concerning development of the harbor, and that no such prior notice was provided. Please refer to Section 7 and WPCA's revised recommendations.

Gail Shea, letter dated February 22, 2005: in this letter Ms. Shea expressed opposition to Alternative No. 5, and suggests that a plan to keep the three existing plants in operation was preferred, and that additional Groton options should be evaluated. In the letter Ms. Shea also expressed opposition to the draft facilities plan recommendations to provide sewers to entire neighborhoods where only one or two properties are truly in need of a resolution to problems. Please refer to Section 7 and WPCA's revised recommendations. Regarding the sewering of "needs areas", as described in the draft wastewater facilities plan: the plan identified areas within the Town that have exhibited wastewater disposal issues, and for which it is proper for WPCA to plan on providing service at some point in the 20-year life of the plan. WPCA may use discretion over the next 20 years on when and how to resolve any wastewater problem areas as they develop, worsen, or improve.

Edward P. Dear, letter date unknown: in this letter Mr. Dear indicated his opposition to the recommended alternative No. 5 due primarily to the financial impact of implementing the alternative. Please refer to Section 7 and WPCA's revised recommendations.

Jon F. Dodd, letter dated March 1, 2005: in this letter Mr. Dodd expressed opposition to discharging all of the Town's effluent to Stonington Harbor. Please refer to Section 7 and WPCA's revised recommendations.

Mary C. Motherway, letter dated March 2, 2005: in this letter Ms. Motherway expressed opposition to Alternative No. 5, both the construction of a new facility and of discharging all of the Town's effluent to Stonington Harbor. Ms. Motherway advocated upgrading all three existing plants, that WPCA further investigate Groton options, and that land disposal be investigated. Regarding the selection of Alternative No. 5, please refer to Section 7 and WPCA's revised recommendations. Groton options have been determined to be not viable (refer to the April 19, 2006 letter from Groton contained in Appendix F). Detailed investigation of land disposal options for treated effluent is not within the scope of the wastewater facilities planning effort.

Dora Hill, letter dated March 3 2005: in this letter Ms. Hill asked if the increase in sewer user fee projected in Section 10 of the draft plan would begin immediately upon an approved referendum to fund the project, and what would the fee be? WPCA responded to Ms. Hill's letter, and this response is included in Appendix E. Regarding the amount of any increase, the revised draft facilities plan will have updated figures in Section 10; calculation of these figures and publication of a revised Section 10 is pending WPCA's recommendations.

William S. Brown, letter dated March 4, 2005: in this letter Mr. Brown, First Selectman, on behalf of the Stonington Board of Selectmen, expressed unanimous opposition to Alternative No. 5, and recommended that WPCA continue to seek a solution that would be acceptable to the Town's residents. Please refer to Section 7 and WPCA's revised recommendations.

Stonington Harbor Yacht Club, resolution dated March 5, 2005: in this resolution the Stonington Harbor Yacht Club, expressed unanimous opposition to Alternative No. 5. Please refer to Section 7 and WPCA's revised recommendations.

Donald L. Murphy, letter dated March 6, 2005: in this letter Mr. Murphy, on behalf of the Town of Stonington Shellfish Commission, expressed opposition to Alternative No. 5, and endorsed Alternative No. l as the most tenable option. Many of the specific technical issues described in this letter are discussed in Section 11.7. Please refer to Section 7 and WPCA's revised recommendations.

Peter F. Moore, email dated March 6, 2005: in this letter the Mr. Moore expressed opposition to Alternative No. 5, both the construction of a new facility and of discharging all of the Town's effluent to Stonington Harbor. Please refer to Section 7 and WPCA's revised recommendations.

Helen W. Brewster, letter dated March 7, 2005: in this letter the Ms. Brewster expressed opposition to Alternative No. 5, both the construction of a new facility and of discharging all of the Town's effluent to Stonington Harbor. Please refer to Section 7 and WPCA's revised recommendations.

Geoffrey Little, email dated March 7, 2005: in this letter the Mr. Little expressed opposition to Alternative No. 5, both the construction of a new facility and of discharging all of the Town's effluent to Stonington Harbor. Please refer to Section 7 and WPCA's revised recommendations.

Patricia Dumke Thomas, email dated March 8, 2005: in this letter the Ms. Thomas expressed opposition to Alternative No. 5. Please refer to Section 7 and WPCA's revised recommendations.

Wendy Lehman Lash, letter dated March 8, 2005: in this letter the Ms. Lash expressed opposition to Alternative No. 5, specifically discharging all of the Town's effluent to Stonington Harbor. The letter recommends further evaluation of the "Groton alternative", and of land disposal of effluent. Please refer to Section 7 and WPCA's revised recommendations. Groton options have been determined to be not viable (refer to the April 19, 2006 letter from Groton contained in Appendix F). Detailed investigation of land disposal options for treated effluent is not within the scope of the wastewater facilities planning effort.

Walter C. Johnsen, letter dated March 9, 2005: in this letter to the First Selectman, William S. Brown, and copied to WPCA, Mr. Johnsen endorses the opposition to Alternative No. 5. The letter also lists several issues at the existing treatment plants as concerns, and asked the Selectmen to direct WPCA to resolve these issues.

Nenaude de Kay, letter dated March 9, 2005: in this letter Ms. de Kay expressed opposition to Alternative No. 5, specifically discharging all of the Town's effluent to Stonington Harbor. The letter recommends further evaluation of the "Groton alternative", or upgrading the three existing plants. Please refer to Section 7 and WPCA's revised recommendations.

Mike Laptew, letter dated March 9, 2005: in this letter Mr. Laptew expressed opposition to Alternative No. 5, specifically discharging all of the Town's effluent to Stonington Harbor, due to its impact on eel grass beds. Please refer to Section 7 and WPCA's revised recommendations.

Ann G. Moore, letter dated March 9, 2005: in this letter Ms. Moore expressed opposition to Alternative No. 5, both construction of a new facility and discharging all of the Town's effluent to Stonington Harbor. The letter recommends further evaluation of land disposal of effluent. Please refer to Section 7 and WPCA's revised recommendations.

Detailed investigation of land disposal options for treated effluent is not within the scope of the wastewater facilities planning effort.

Marjorie Berthasavage, letter dated March 9, 2005: in this letter Ms. Berthasavage expressed opposition to Alternative No. 5, both construction of a new facility and discharging all of the Town's effluent to Stonington Harbor. The letter recommends upgrading the three existing treatment plants. Please refer to Section 7 and WPCA's revised recommendations.

Willis Arndt, letter dated March 9, 2005: in this letter Mr. Arndt expressed strong concern with the facilities planning work done, the approach taken, and the recommendations presented, and asked if the Town wouldn't be better served if the existing WPCA members were replaced.

Andrew C. Wormser, letter dated March 10, 2005: in this letter Mr. Wormser expressed opposition to Alternative No. 5, both construction of a new facility and discharging all of the Town's effluent to Stonington Harbor. Please refer to Section 7 and WPCA's revised recommendations.

William S. Brown, letter dated March 11, 2005: in this letter Mr. Brown, First Selectman, on behalf of the Board of Selectmen, forwarded a record of comments received at the March 9, 2005 Selectmen's meeting. An excerpt of the meeting minutes indicates that 15 people spoke to express opposition to Alternative No. 5, both construction of a new facility and discharging all of the Town's effluent to Stonington Harbor. Please refer to Section 7 and WPCA's revised recommendations.

F. W. Richard, DDS, letter dated March 14, 2005: in this letter Mr. Richard expressed opposition to Alternative No. 5, both construction of a new facility and discharging all of the Town's effluent to Stonington Harbor. Please refer to Section 7 and WPCA's revised recommendations.

James Larkin, letter dated March 14, 2005: in this letter Mr. Larkin expressed opposition to Alternative No. 5, both construction of a new facility and discharging all of the Town's effluent to Stonington Harbor. Please refer to Section 7 and WPCA's revised recommendations.

Harrison and Ellen Buxton, letter dated March 14, 2005: in this letter the Buxtons expressed opposition to Alternative No. 5, specifically discharging all of the Town's effluent to Stonington Harbor. The letter recommends further evaluation of the "Groton alternative", and of land disposal of effluent. Please refer to Section 7 and WPCA's revised recommendations. Groton options have been determined to be not viable (refer to the April 19, 2006 letter from Groton contained in Appendix F). Detailed investigation of land disposal options for treated effluent is not within the scope of the wastewater facilities planning effort.

Anya Larkin, letter dated March 14, 2005: in this letter Ms. Larkin expressed opposition to Alternative No. 5, both construction of a new facility and discharging all of the Town's effluent to Stonington Harbor. Please refer to Section 7 and WPCA's revised recommendations.

Elizabeth Bartholet, letter dated March 16, 2005: in this letter Ms. Bartholet expressed opposition to Alternative No. 5. Please refer to Section 7 and WPCA's revised recommendations.

Sarah and Bob Langman, letter dated March 17, 2005: in this letter the Langmans expressed opposition to Alternative No. 5, in terms of construction of a new facility, discharging all of the Town's effluent to Stonington Harbor and cost. Please refer to Section 7 and WPCA's revised recommendations.

Margaret Field, email dated March 18, 2005: in this email Ms. Field expressed opposition to Alternative No. 5, in terms of construction of a new facility, and discharging all of the Town's effluent to Stonington Harbor. Please refer to Section 7 and WPCA's revised recommendations.

Candace D. Sanford letter dated March 19, 2005: in this letter Ms. Sanford expressed opposition to Alternative No. 5, in terms of construction of a new facility, discharging the entire Town's effluent to Stonington Harbor and cost. Please refer to Section 7 and WPCA's revised recommendations.

J. Stewart and Mary T. McClendon, letter dated March 20, 2005: in this letter the McClendons expressed opposition to Alternative No. 5, in terms of construction of a new facility, discharging the entire Town's effluent to Stonington Harbor and cost. Please refer to Section 7 and WPCA's revised recommendations.

Charles and Ann Buffum, letter dated March 24, 2005: in this letter the Buffums expressed opposition to Alternative No. 5, specifically the discharge of the entire Town's effluent into Stonington Harbor. Please refer to Section 7 and WPCA's revised recommendations.

Marcia and John Fix, letter received March 25, 2005: in this letter Mr. and Mrs. Fix expressed opposition to Alternative No. 5. Please refer to Section 7 and WPCA's revised recommendations.

Jesse S. Diggs, letter dated March 25, 2005: in this letter Mr. Diggs endorses the opposition to Alternative No. 5, and recommends that WPCA recommend Alternative G, or a variant thereof. WPCA recommends Alternative No. 1 for the reasons indicated in Section 7.

Willis Arndt, letter dated March 29, 2005: in this letter Mr. Arndt expressed opposition to Alternative No. 5, specifically discharging all of the Town's effluent to Stonington Harbor. Please refer to Section 7 and WPCA's revised recommendations.

Capt. Bruce S. Anderson, letter dated April 3, 2005: in this letter Capt. Anderson expressed opposition to Alternative No. 5. Please refer to Section 7 and WPCA's revised recommendations.

J. William W. Harsch, Esq., letter dated April 8, 2005: in this letter, Mr. Harsch indicated that the *Better Solution* Task Force will be submitting written comments, and asked that WPCA accept comments received after April 15, 2005, the original date set to close the open comment period. WPCA accepted materials submitted after April 15, 2005.

Thomas Bragdon, letter dated April 12, 2005: in this letter Mr. Bragdon, on behalf of the Stonington Small Boat Association, expressed the Association's unanimous opposition to Alternative No. 5. Please refer to Section 7 and WPCA's revised recommendations.

William Hargreaves, letter dated April 14, 2005: in this letter Mr. Hargreaves, on behalf of the Stonington Village Improvement Association (SVIA), expressed opposition to Alternative No. 5, specifically discharging all of the Town's effluent to Stonington Harbor. SVIA advocates reducing, or even eliminating, effluent discharge to Stonington Harbor. Please refer to Section 7 and WPCA's revised recommendations.

J. William W. Harsch, Esq., letter dated April 15, 2005: In this letter Mr. Harsch is generally critical of the recommendation to proceed with Alternative No. 5. The letter states that the alternatives evaluation did not consider several key factors, including the environmental impact to Stonington Harbor, impacts to several aspects of the community, odors, and aesthetics, and the financial impact of the project. The letter references previous dye studies in Stonington Harbor that indicated that the Harbor is poorly flushed, and recent data indicating that the nitrogen level in Stonington Harbor is high. The letter was also critical in general of the ongoing operation of the treatment plants and the WPCA's handling of the public comment process, and concluded by urging WPCA to withdraw its recommendation to implement Alternative No. 5. The WPCA has withdrawn its recommendation. Please refer to Section 7 and WPCA's revised recommendations.

J. William W. Harsch, Esq., letter dated May 16, 2005: In this letter, Mr. Harsch followed up on his previous correspondence, and this letter contains the technical comments on the draft wastewater facilities plan. The letter reaffirms the *Better Solution* Task Force's opposition to Alternative No. 5, and restates its concern that the WPCA select a plan that considers prior environmental studies, and impacts of the plan to the community in terms of odor, aesthetics, fisheries, etc. Attached to the letter are copies of the following: *Investigation on Nitrogen Distribution and Loading in Stonington Harbor, Preliminary Report*, April 15, 2002; and *Comments Submitted by Penny Vlahos to the Stonington Harbor Commission*, February 14, 2005. Please refer to Section 7 and WPCA's revised recommendations.

Ed Hart, letter dated December 27, 2005: in this letter Mr. Hart asked WPCA to consider six issues, the first three of which are related to completion and funding of the wastewater facilities plan effort. Following are WPCA's responses the first three of Mr. Hart's suggestions:

1. WPCA has discussed the "unofficial" facilities plan sections (Sections 1-6 and partial Section 7, essentially stopping short of a treatment recommendation) that were submitted in June 2005 with CTDEP. As of September 2006, the CTDEP has not reviewed the draft plan sections and WPCA has been given no timetable for this review.

2. The facilities plan work is ongoing, with plans for submittal of a final draft plan to CTDEP in January 2007.

3. WPCA has discussed funding with CTDEP and to date CTDEP has not committed any further funding to the project.

Willis Arndt, letter dated March 28, 2006: in this letter Mr. Arndt asked WPCA, when reevaluating the alternatives, to commit to doing everything possible to eliminate the discharge of effluent into Stonington Harbor, the Mystic River and the Pawcatuck River and any waters without excellent flushing action.

Jack Gorby, presentation to WPCA, April 25, 2006: Mr. Gorby made a presentation at the WPCA regular monthly meeting, at which he encouraged WPCA to evaluate a technology option offered by Global Water Group, as an option while revising the wastewater facilities plan. WPCA agreed to contact Global Water as part of the evaluation, and to consider the viability of package-type treatment systems.