COMPARISON OF COSTS

FOR

WASTEWATER MANAGEMENT SYSTEMS

APPLICABLE TO CAPE COD

Guidance to Cape Cod Towns Undertaking Comprehensive Wastewater Management Planning

Prepared for:

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EXECUTIVE SUMMARY

The Barnstable County Wastewater Cost Task Force was established to compile and analyze current local information on the costs to build and operate wastewater systems in use on Cape Cod. Based on that information, the Task Force has developed cost estimates for a wide range of wastewater system sizes and types to help Cape Cod towns fairly compare available options. The application of the results will allow towns to identify which options are best for their circumstances and thus streamline their comprehensive wastewater management planning.

Data were compiled and cost estimates prepared for four types of wastewater systems:

- **Individual on-lot systems** with and without nitrogen removal.
- **Cluster systems** serving up to approximately 30 homes with aggregate wastewater flows less than 10,000 gallons per day (gpd).
- **Satellite systems** serving from 30 to 1,000 homes (wastewater flows between 10,000 gpd and 300,000 gpd), intended to treat and dispose of wastewater from one area of a town.
- **Centralized systems** which can provide for most or all of a town's wastewater management needs, and that might be suitable for serving portions of neighboring towns.

Cost estimates were prepared to be inclusive of all aspects of wastewater management: collection, treatment, and disposal. Costs were also included for conveyance between the collection system and the treatment site, and between the treatment and disposal sites if they cannot be co-located. Four measures of cost were considered:

- Capital cost---the cost to design, permit and build the facilities, including land costs.
- Operation and Maintenance (O&M) costs---the ongoing expenses for labor, power, chemicals, monitoring, sludge disposal, etc.
- Equivalent annual costs---a mathematical combination of O&M expenses and amortized capital costs.
- Costs per pound of nitrogen removed---the equivalent annual cost divided by the annual nitrogen load removed from the watershed of a nitrogen-sensitive embayment.

Actual cost information was obtained from over 30 existing wastewater treatment facilities, located largely in southeastern Massachusetts. The data were carefully reviewed to be sure they included all pertinent cost items. "Unit costs" were computed by dividing construction costs and O&M costs by the associated wastewater flows. Graphs of these unit costs show clear trends and demonstrate significant economies of scale, which are summarized here:

Capacity	Unit Construction Cost	Unit O&M Cost
10,000 gpd	$70 per gpd of capacity	$13 per gpd of average flow
100,000 gpd	$35 per gpd of capacity	$ 5 per gpd of average flow
1,000,000 gpd	$17 per gpd of capacity	$ 2 per gpd of average flow

Compared to a satellite facility of 100,000-gpd capacity, a central facility of 1.0-mgd (million gallons per day) capacity costs about 50% less to build and 60% less to operate on a per-gallon basis.

Fourteen scenarios were developed to combine capital and O&M costs for wastewater collection, transport, treatment and disposal and to compare those costs with the nitrogen removal that can be expected. Costs and performance were estimated both for Base Cases (with a uniform set of assumptions for all scenarios) and as part of a sensitivity analysis to determine how costs might change with assumptions that are either more or less favorable for each system size. The results are as follows, expressed as equivalent annual cost per pound of nitrogen removed:

	Low	Base Case	High
Individual N-removing systems	$550	$770	$830
Cluster systems, 8,800 gpd	$500	$710	$790
Satellite systems, 50,000 gpd	$480	$680	$720
Satellite systems, 200,000 gpd	$380	$510	$550
Centralized systems, 1.5 mgd	$250	$305	$319
Centralized systems, 3.0 mgd	$230	$285	$295

The sensitivity analysis allows the identification of the most important cost factors, which are:

- Economies of scale--large systems may be significantly less expensive per gallon treated because many of the cost components do not increase directly with the flow.
- Density of development--wastewater collection costs are the largest component of a complete system and they increase in direct proportion to the lot size served.
- Location of disposal facilities--an effluent disposal site within a nitrogen-sensitive watershed returns some of the collected nitrogen to the watershed in the from of the residual nitrogen remaining in the effluent. Compared to a disposal site that is not in a sensitive watershed, the in-watershed disposal option must be larger to eliminate more septic systems and to remove enough additional nitrogen to offset that returned in the effluent.
- Land costs--land suitable for wastewater management functions is scarce and expensive. Using town-owned parcels is cost-advantageous for any scenario, but particularly if multiple small systems are to be built, each with its own need for set-backs and buffer zones.

From this sensitivity analysis, conclusions can be drawn about the circumstances that favor one size of system over another.

- **Individual systems**. The applicability of these systems is limited by their relatively poor performance and the administrative hurdles associated with using them as the sole means of meeting watershed-wide nitrogen control targets. However, since they are located on

the parcel where the wastewater is generated, they eliminate collection costs and should be considered as adjuncts to other options for remote, sparsely developed neighborhoods within watersheds with relatively low nitrogen removal requirements.

- **Cluster systems**. These systems should be considered for existing neighborhood with small lots that are remote from sewered areas and have publically-owned land nearby. They also are good options for new cluster developments where infrastructure can be installed by the developer and later turned over to the town, or for shore-front areas that may not be connected to larger-scale systems until later phases of a project.
- **Satellite systems**. Satellite facilities make the most economic sense in remote watersheds (more than 5 miles from the existing sewer system or other areas or need), with vacant publically-owned land nearby. These systems are also applicable in the case of an existing or proposed private facility that can be taken over by the town and expanded to provide wastewater service to existing nearby properties currently on septic systems, particularly if the town-wide system may be not be available for many years and the developer is prepared to proceed in the near future.
- **Centralized Systems**. This option is likely to be the most viable when:
    - dense development exists in nitrogen-sensitive watersheds;
    - suitable treatment and disposal sites (outside sensitive watersheds and Zone IIs) are available at no or low cost;
    - a high degree of nitrogen control is required;
    - areas of dense development in sensitive watersheds are within 3 miles of desirable effluent treatment and disposal sites; and
    - opportunities are available for cost reductions through regionalization.

While the cost estimates presented in this report are conceptual and based on a uniform set of assumptions, they are supported by a review of actual data for nine example projects. Those examples indicate costs ranging from about $300 per pound of nitrogen removed for centralized systems up to $700 or more for smaller systems.

One of the goals of this study is to help Cape Cod towns streamline their Comprehensive Wastewater Management Plans by identifying the circumstances that are most favorable for each type of system. For example, if a town owns a site suitable for both treatment and disposal, which is not within a sensitive watershed, and is located near the most densely developed areas needing nitrogen control, then economies of scale will make a centralized system the least expensive by a considerable margin. Nonetheless, this report is intended as general guidance, and specific local conditions must be evaluated to be sure that the most cost-effective solution is determined. The sensitivity analysis conducted in this study should help towns target the most appropriate cost factors.

The estimated costs presented in this report are based on a common set of assumptions about the density of development served by the various systems. Towns with less dense development will be faced with higher collection costs than shown here. Costs for collection systems can be very expensive and towns should investigate alternatives to traditional gravity systems. Cost savings associated with the use of those alternative collection systems may apply to any of the scenarios reviewed in this study and should not be attributed to one option and not another.