MUNICIPAL ON-SITE WASTEWATER MANAGEMENT PLANNING - CASE HISTORIES IN NEW ENGLAND (USA)

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Abstract

In the northeastern corner of the United States of America (USA) are three New England towns that have selected different levels of management for on-site soil absorption systems in their communities. The common aspects of the projects have been extensive use of community involvement, databases and Geographical Information Systems (GIS) to inventory and manage on-site systems on a community-wide and potential problem area basis.

Jericho, Vermont, USA is an inland suburban/rural town with 5,000 residents located in the foothills of the Green Mountains of northwestern Vermont. The town began their soil absorption system management with an integrated wastewater needs assessment in current and historic growth areas. Ten years of permit data and parcel mapping enabled the town to clearly evaluate the conditions for on-site systems in the community. The soil suitability for on-site systems based on Natural Resources Conservation Service soils mapping and the environmental sensitivity of groundwater and surface waters was evaluated. The locations of failed on-site systems were compared to the soil suitability and environmental sensitivity to determine the appropriateness of on-site systems in Jericho.

Duxbury, Massachusetts, USA is a coastal community with approximately 14,000 residents and 6,000 soil absorption systems. The town developed a Community Septic Management Plan to manage these on-site systems with the following components:

1. A database to keep track of site evaluation, permitting, installation, maintenance, repairs and complaints regarding each on-site system;
2. An in-house GIS system to utilize existing parcel mapping and other digital data available from the state and other agencies;
3. Identification and prioritization of environmentally sensitive areas for ranking applicants to a low-interest loan program to finance repairs of failed systems;
4. A public outreach/education program to inform residents about their soil absorption systems and the community management program,
5. A loan program for residents to finance upgrades of failed on-site systems.

Tisbury, Massachusetts, USA is an island community with approximately 3,000 year-round residents, 10,000 summer visitors, and 2,400 on-site septic systems. The town is taking a very pro-active approach to on-site system management. The local Board of Health and Wastewater Planning Committee is developing a management program with required inspections for every system and requiring pump-outs of septic tanks based on expected rates of solids accumulation for the specific tank size and system usage. GIS has been used to delineate environmentally sensitive areas and parcels; a ground water flow model has been used to determine water table contribution to surface waters; and a database is being developed to track the management program and notify residents of compliance requirements. This approach enables the residents to easily see the relationship between the areas that utilized on-site systems and environmentally sensitive areas such as aquifers, streams, coastal ponds and wetlands using a risk-based management strategy.

Keywords

databases, Geographic Information Systems, Local Government, management, on-site systems

1 Overview

Decentralized wastewater management is a growing trend in the United States. Faced with soaring costs for large centralized treatment systems, communities are increasingly turning to the smarter management philosophy associated with the decentralized approach. Traditionally, one expensive solution has been available to communities that have outgrown or outlived their on-site septic systems — a sewer system and an expensive treatment facility. With federal funds becoming increasingly scarce, most small communities can not afford this type of conventional centralized approach.

By definition, decentralized wastewater management employs all available treatment and disposal technologies. The appropriate technologies, in a measure that meets current needs and takes into consideration future growth, are matched with the treatment and disposal requirements that have been identified. The end result is a unique municipal wastewater management solution that includes a program of preventive maintenance designed to identify weaknesses or potential failures before they become a problem.

This approach also simplifies future maintenance and planning. Community-wide decentralized wastewater management offers an opportunity to track the condition of individual systems, the relationship of those systems to other community infrastructure, like drinking water sources, and to the environment.

2 The Role of Geographic Information Systems

Geographic Information Systems (GIS) are a powerful tool for identifying and examining problem areas to display information for public understanding. GIS played a significant role in supporting a number of elements in each of the following case histories. The overlay capability of GIS was used to show environmentally sensitive areas, soil suitability for on-site systems, and areas of the community using subsurface disposal for prioritizing replacement systems. GIS was used for mapping soil types to determine suitability for siting systems, mapping community infrastructure and existing systems, tracking plans for future development, mapping environmentally sensitive areas, and tracking maintenance, repair and upgrade information for an entire community. Maps can be readily generated from the GIS to make decision making more timely and public education more effective. The maps effectively communicate complex information at-a-glance in a graphical format that is easily understood.

3 Database Applications

Databases are considered essential to enable the efficient management of on-site systems at the local government level. Databases can be used to track permits, inspections, pump-outs and failures of on-site systems, maintain on-site system records, and prepare mailings for necessary system maintenance. The database should be capable of storing, retrieving and reporting all data pertinent to all of the on-site systems. The foundation of the database should consist of the following key data areas:

1. System related information including components, septic tank size, application and permit numbers, maintenance (septic tank pump-out dates, inspection dates and inspection results), plans, and images.
2. Parcel map and lot designation, related information including soil test data and structures, number of bedrooms and design flow.
3. People related information. Names and addresses of people used for lookup in various sections of the database.
4. Easy linkage to GIS. Any database characteristic can be displayed graphically through GIS.

4 Jericho, Vermont, USA

The Town of Jericho is a suburban and rural community located in the Lake Champlain Valley area of northwestern Vermont, USA. The town includes 92 square kilometers (35 square miles) of land. The

5,000 residents rely on individual and cluster type on-site wastewater treatment and disposal systems (septic systems).

Town officials recognized the potential for treatment and disposal problems to develop as the town grows and existing septic systems age. The Jericho Board of Selectmen hired consultants to determine the most appropriate means of addressing short-term and long-term wastewater disposal needs for the town. The process involves assessing existing systems, characterizing environmental conditions, and analyzing the community's future options.

The study focused on 3 areas:
1. Jericho Center — a traditional 19th century New England village.
2. Jericho Village — a traditional village with some commercial properties.
3. Route 15 district — a recently developed commercial zone.

The study team conducted a thorough assessment of existing systems and conditions. They identified environmentally sensitive areas and parcels with special conditions or limitations. Using available GIS data from the State of Vermont and local municipal databases, the team conducted analyses and developed maps showing:
1. Parcel boundaries.
2. Potential soil suitability for on-site systems.
3. Environmentally sensitive areas.
4. Characterization of existing on-site wastewater conditions.

The analysis revealed that soils in the study areas are generally suitable for on-site systems on terraces in the major stream valleys where the densest residential and commercial development is typically located. In individual neighborhoods, a 2 to 30 percent rate of on-site system failure in a 10-year period was evaluated. The failures were predominantly due to age, design and construction of systems. Most of these failures have been effectively resolved by on-site replacement of the septic tank and/or soil absorption system with conventional technologies. Due to the low density of development, centralized collection systems do not appear to be cost-effective. Due to existing use of the river nearest the most densely developed areas in town for swimming, direct discharge of treated wastewater was not an option either.

The consultants identified specific options for community wastewater management based on the town's current needs and plans for future growth. They concluded that existing septic systems and a locally developed septic system management program would be the most cost-effective option. To implement this as a sustainable option, Jericho has established a local Wastewater Planning Committee with three objectives:
1. Develop a decentralized wastewater management plan based on a town wide assessment of need.
2. Develop a community homeowner and student education program to increase the local understanding of on-site systems.
3. Demonstrate the effectiveness of septic tank risers and septic tank effluent filters in facilitating the inspection and maintenance of on-site systems.

Jericho's forward-thinking approach to decentralized wastewater management is saving the town money by using existing wastewater infrastructure, protecting homeowners' investments in their current systems, and avoiding the high cost of developing a centralized sewer and wastewater treatment facility.

5 Duxbury, Massachusetts, USA

The coastal community of Duxbury, is located 35 miles south of Boston. Duxbury has a population of approximately 14,000 and a land area of approximately 61 square kilometers (24 square miles). Greater than 95 percent of the residents rely on individual on-site sewage systems and the community is committed to using on-site systems as a long-term solution to wastewater management. The Town relies on an extensive sand and gravel aquifer for community drinking water supplies. In addition to aesthetic and recreational value of the freshwater and saltwater resources of the community, there are

numerous cranberry bogs in commercial cultivation and a significant potential for shellfish harvesting in the coastal embayments.

Over the past three decades, Duxbury has been making substantial efforts to protect their groundwater and surface water quality with a permitting program for on-site wastewater disposal systems. In 1996, the town dedicated two shared soil absorption systems designed to address severe problem areas along Duxbury Bay. These shared systems (each with less than 37,800 litres per day design flows) handled wastewater from three parcels along the Bluefish River and 18 parcels in the Snug Harbor area by conveying the wastewater to sites located inland that are suitable for soil absorption systems. The establishment of these systems has enabled the opening of shellfish harvesting areas due to a decrease in bacteria in the coastal embayments. The town has recently voted to design and build another 37,800 litres per day cluster on-site system to serve approximately 30 households in a residential area along Kingston Bay to improve water quality in a historic shellfish harvesting area. To continue their on-going efforts in this area, the town has recently completed a Community Septic Management Plan (CSMP) to provide a clear process for decentralized wastewater management.

Duxbury's CSMP consists of the following components:

1. Comprehensive inventory of existing systems.
2. Parcel information permit records and septic tank pump-out records stored in a database to track permitting and maintenance.
3. Development of a local GIS system and training of Town personnel to identify:
   Drinking water source protection areas.
   Freshwater wetlands, ponds, vernal pools, rivers and streams.
   Saltwater wetlands, coastal resource zones.
   Buffer zones around these areas.
   Parcel maps to determine environmental sensitivity of particular parcels.
4. Public Education and Information development including a brochure explaining the existing situation and the community septic management plan.
5. Betterment Loan/Upgrade Program.
   Ranking environmental sensitivity to determine priority of parcels for loan program to assist homeowners in upgrading failed systems.
6. Voluntary Maintenance program that recommends setting routine system maintenance in conjunction with the following requirements in local ordinance: detailed reporting of septic tank condition, liquid and solid levels at septic tank pumping.

6 Tisbury, Massachusetts, USA

The Town of Tisbury is a coastal resort community located on the island of Martha's Vineyard located 8 km (5 miles) off the southwestern coast of Massachusetts, USA. The Town covers an area of 54 square kilometers (21 square miles). The population of Tisbury is approximately 3,000 year round residents and 10,000 seasonal residents. Approximately three-quarters of Tisbury's residents rely on groundwater from municipal wells that tap a glacial sand and gravel deposit underlying the western half of the island. The remaining residents utilize individual wells, generally tapping the same aquifer. Currently all properties in town are served by on-site sewage disposal systems. The Tisbury Board of Health estimates that there are currently approximately 2,500 individual on-site systems.

The intent of Tisbury's wastewater management program is to provide an institutional and regulatory framework enabling the long-term viability of the on-site wastewater treatment and disposal facilities in the Town. The program includes a Community Wastewater Management Plan (CWMP), Watershed Management Strategy, Public Outreach and Education, Institutional and Regulatory Requirements, and a Program Implementation Strategy. The CWMP is in the final planning stage and has not been adopted by the community.

6.1 Environmentally sensitive areas and wastewater management districts

Environmentally sensitive areas in Tisbury will be used to identify high priority areas are for the management of on-site systems. Initial wastewater management districts have been defined to address

the downtown Vineyard Haven area, and the low elevation (less than 3 meters (10 feet) above mean sea level) areas with the potential for systems to have the least vertical separation to groundwater.

6.2 Management tools: database, tracking system and long-term maintenance

Periodic maintenance is critical to ensuring the long-term success of even the most basic septic system. An inspection and maintenance program has been designed to assess current infrastructure conditions, ensure proper use and maintenance of on-site systems, and reduce future failures. A relational computer database, the Septic Information Management System (SIMS), will be established to maintain an up-to-date inventory of all on-site systems in town and to track the permitting of new systems, upgrades of existing systems, and inspection and maintenance program. The database will also be useful to ensure that all owners are adequately addressing the unique needs of their system. One of the primary goals of the management plan is to provide for better septage (solids and liquid pumped out of septic tanks) management by creating a predictable and manageable production of septage. This plan pertains to those parcels outside of the area serviced by the centralized wastewater collection and treatment system. While the central service area will have management requirements, they will likely differ from the rest of town and will be addressed in a separate management program.

6.3 Loan program

A low interest loan program has been funded by the Commonwealth of Massachusetts and is administered by the Tisbury Board of Health. This program has been very active in providing individual homeowners with a funding mechanism for necessary upgrades of failed systems.

6.4 Administration and funding

This community wastewater management plan will be administered by the Tisbury Board of Health and can be implemented primarily by local professionals in the on-site industry or by the Board of Health staff. The town still has some decisions to make regarding funding of this plan, dependent upon the level of municipal services to be provided. It is expected that permit fees and possibly a broad-based system fee will fund the administration, and that most installation, inspection, and maintenance costs will be paid directly by the system owner.

6.5 Watershed management strategy

On-site systems are designed to treat domestic wastewater before reaching the groundwater and down-gradient surface waters. The residual components of this treatment process, such as nitrates, have an impact on the environment. However the degree of impact is relative to the sensitivity of the groundwater beneath the on-site systems and the sensitivity of the surface waters where the groundwater discharges. The watershed management strategy is designed to protect the environmental resources of Tisbury at an appropriate level to the sensitivity of the different areas in town.

A key element of the watershed management strategy is to use a risk assessment/risk management approach. During the risk assessment process, the town will develop rankings regarding the value and vulnerability of local receiving environments to impacts from on-site systems, and to define the areas in town which contribute flow to the receiving environments. A steering committee of stakeholders will be established to address the needs of the community in this process. The rankings will be used to determine appropriate levels of treatment and develop a risk management program, in order to protect public health and the environment. For example, specific areas may be delineated where nitrogen removal is required for upgrades and new on-site systems to reduce nitrate loading to a particularly sensitive and valuable receiving environment.

The second program in the watershed management strategy is the development of a long-term groundwater monitoring program. A network of surface and groundwater sampling stations will be established up to monitor trends in water quality.

Environmental professionals, municipal departments, and community environmental groups will conduct the risk assessment/risk management process. The water quality monitoring program will be run in conjunction with the Martha's Vineyard Commission, the University of Massachusetts

Extension program, the Town of Tisbury, and local professionals. Funding for the watershed management program is will be provided through a combination of local and federal sources.

6.6 Public education and outreach

In order for residents of the town to understand the key points in the wastewater management plan the town will provide outreach and education. Public meetings, news releases and a newsletter style fact sheet will be the main focuses of the outreach program. The local Board of Health will coordinate and distribute educational efforts and materials.

6.7 Regulatory and institutional changes

This management program will require institutional and regulatory changes. The Board of Health will need additional staff to administer the plan. This includes using the Septic Information Management System (SIMS) database, processing permits, tracking compliance, assessing fines, and scheduling inspections. The town may also conduct some of the implementation tasks in house, such as inspections or maintenance. Regulatory changes would include updates to the Board of Health ordinances to reflect the needs of the management program, as well as changes to the planning and zoning bylaws. Examples of ordinance updates include the creation of wastewater management districts, and the authority to implement the on-site system inspection and maintenance program.

6.8 Implementation strategy

Regularly scheduled inspections and function checks of on-site systems are proposed to replace the current inspections that are required when property ownership is transferred. The inspection interval for approximately 90% of the systems in town will be six years. More frequent inspections will depend on system type, use and location in an environmentally sensitive area. This program will be implemented with the least intrusion on the residents, landowners, and business people in Tisbury. Initial system inspections, cataloging system information, performing the risk assessment, and scheduling future maintenance needs all require substantial time and labor. After the creation of management districts and projection of labor requirements, the plan will be phased in over a 6 year period. The gradual transition period will allow sufficient time to develop the inventory of all systems, and gives priority to the areas of town with the most critical needs. The Board of Health will coordinate the plan implementation.

6.9 Strategic sewering

The Town of Tisbury has voted to proceed with the design and construction of a small sewerage system to serve the core of the Town's village district. Approximately four percent of the year round population is planning on being served by a 378,000 L/day (100,000 gallons per day) municipal sewer collection system, wastewater treatment, and groundwater discharge facility that will replace 112 of the existing on-site systems. The comprehensive septic management plan will assist the community to avoid the need for additional sewerage. The town realizes that on-site systems will be an integral piece of the wastewater infrastructure for many years to come. This program will enable these systems to be managed effectively, leading to long term satisfactory performance, adequate protection of public health, and preservation of valuable natural resources. It proposes a minimal amount of additional regulation and recommends the minimum amount of government involvement necessary to meet the intent of the program.

7 A Practical Approach

Decentralized wastewater management is a practical option for these three communities. Common aspects of the three examples include both a town-wide perspective on the community wastewater management planning and detailed feasibility studies focusing on the potential problem areas. Each community is considering a range of potential solutions including individual on-site systems; shared systems; clustered systems; innovative and alternative on-site technologies; and in one case, a small centralized system. The most important aspect of decentralized wastewater management is a high level of community involvement throughout the process. The long-term viability of the decentralized approach requires on-going community support and participation, and the commitment of local officials to the process.

The decentralized approach is a new means of addressing wastewater management needs of sewered and unsewered areas in a comprehensive fashion. It allows for the use of individual and shared on-site soil-based systems as long term solutions. Government officials at the local and state level are supporting these programs to make the most of existing infrastructure and avoid the cost of centralized collection and treatment systems.

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