ON-SITE WASTEWATER TREATMENT - WHAT ARE SOME OPTIONS - SOME OPPORTUNITIES

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Abstract

On-site wastewater treatment systems are recognized as a permanent and essential element of the wastewater infrastructure. To remain an essential element of infrastructure, some degree of professionalisation within the industry is essential and some commitment to long-term management is necessary. This paper reviews some of the criteria for sizing on-site and designing on-site wastewater systems and presents a set of management models proposed by the USEPA to assure long term management. Through these efforts to sustain these systems, they will be accepted as equivalent to the more traditional options for providing wastewater infrastructure.

Keywords

low pressure system, maintenance, mounds, pressure-dosed system, trenches,

1 Introduction

A properly functioning wastewater treatment facility is essential to protect consumer investment, community investment and image, public health and environmental quality in any area where humans congregate. Historically there have been two options available to meet the wastewater management needs of communities and individuals. These options are either the community collection and treatment system, commonly called a public owned treatment works, a cluster type system, or the individual on-site wastewater treatment system, commonly called a septic system.

Throughout the country on-site wastewater management systems are commonly used in rural and urban fringe areas. Presently many state laws (see for example North Carolina Laws and Rules for On-site Sewage Disposal, 15A NCAC .1300) allow a variety of on-site wastewater management options and alternatives. Prior to determining which of the options to utilize on any parcel of land, the local environmental health specialist accomplishes both a comprehensive analysis of the wastewater to be treated on the site and a site and soil assessment to determine the treatment potential of the proposed wastewater receiver. These analyses of the waste and the receiver are essential to assure that the system selected will protect public health, environmental quality, the homeowner investment in the property, local tax base and the community's image and investment potential.

2 Site and Soil Investigation

The site evaluation examines the area available on site for wastewater management, the slope and topography of the site, and the landscape position occupied by the property. This assessment is essential to assure that the property is sufficiently large to host the wastewater system and to insure that when installed, the on-site wastewater system is buffered adequately from wells, surface waters, and the adjoining property.

The soil evaluation is required to determine the soil properties deemed critical for a properly functioning soil absorption system. The properties evaluated include: depth to limiting layers or horizons (such as rock or shallow groundwater) in the soil, soil texture and structure, mineralogy and consistence, the estimated permeability of soil on any receiver site, and whether the native soil is adequate to provide the necessary treatment of wastewater applied. Each of these factors is critical in the design process. The soil depth is critical because state Laws and Rules for On-site Wastewater Treatment Systems generally require a minimum separation distance between the zone of septic waste application and any restriction such as rock or seasonal saturation.

In North Carolina and many other states, the Laws and Rules allow a separation distance of 300 mm (12 in.) to rock or seasonal saturation for heavy textured soils and this distance is increased to 450 mm (18 in.) in coarse sand. In some states, separation distance of as much as 1.2 m (48 in.) between the zone of wastewater application and rock or seasonal saturation is required. Each state has specific laws and rules addressing separation distance and these local rules must be consulted. In several states including North Carolina, wastewater which has been treated to secondary levels can be applied where the separation distance may be as little as 150 mm (6 in.).

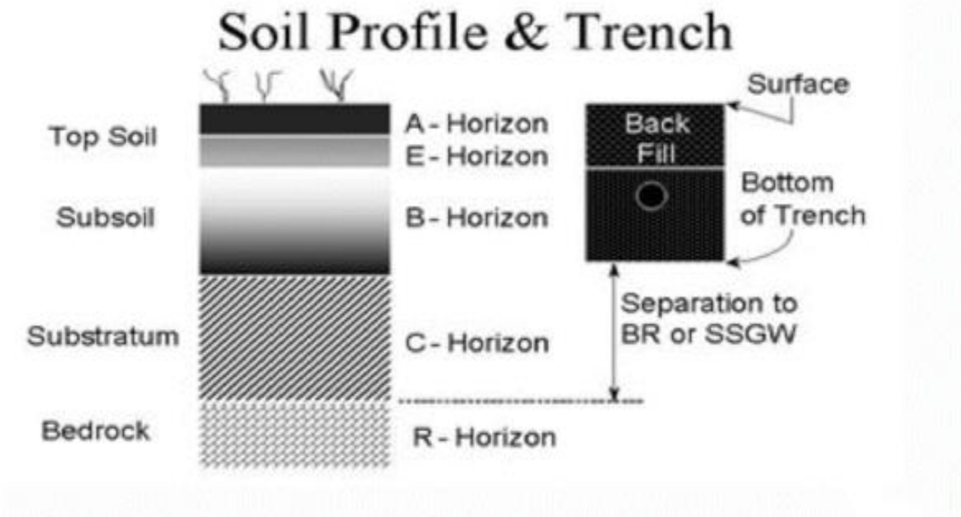

Figure 1 Diagram of soil profile and trench layout

The selection of the wastewater management option or alternative is dependent on maintaining the appropriate separation distance between the zone of waste application and any restriction that will reduce treatment capacity of a site. These are summarized in Table 1, based on North Carolina Laws and Rules. Each state and many local jurisdictions have similar requirements, however many states and local jurisdictions have requirements that are significantly more stringent. Local rules must be consulted prior to design and specification for any on-site wastewater treatment system.

Table 1. Separation distances with restrictions that reduce site treatment capacity

SOIL TEXTURE	SEPARATION DISTANCE
Coarse Sands	450 mm (18 in.)
Loams to clays	300 mm (12 in.)
Loam to clay with secondary treated effluent	150 mm (6 in.)

3 Wastewater Treatment Options

Maintenance of these separation distances is important. Where soil is deep, a conventional or traditional gravity dosed soil absorption wastewater treatment system is often adequate as shown in Figure 2. These traditional systems are typically placed in a 760 - 900 mm (30 - 36 in.) wide by 750 - 900 mm (30 - 36 in.) deep trench. The trench is typically filled with approximately 300 - 450 mm (12 -18 in.) of gravel, expanded polystyrene, or a chamber type system all of which serve to support a trench type system and allow gravity to facilitate the distribution of wastewater to the soil. Soil material is used to fill and close the trench.

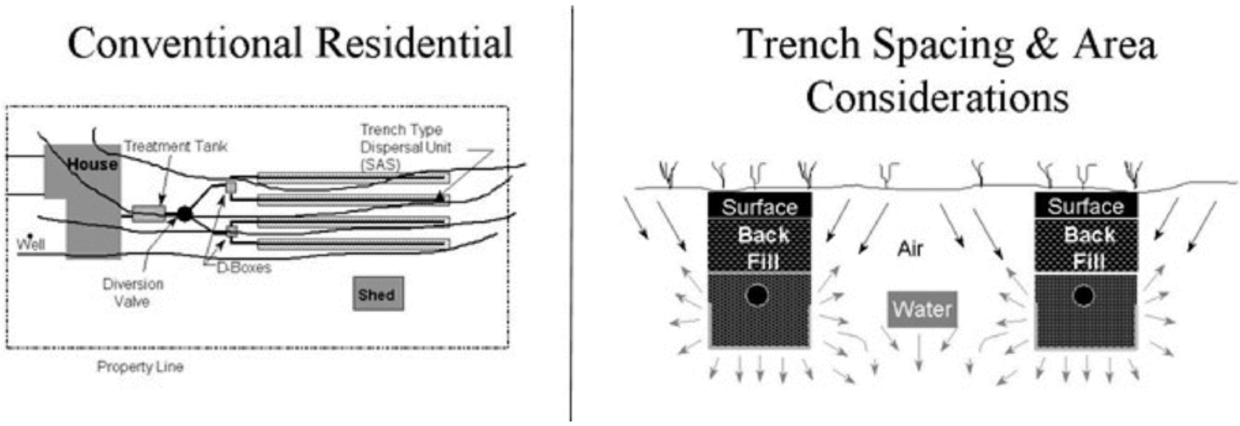

Figure 2 Conventional systems on deep soil profiles

These traditional systems require a soil at least 1.1 m (42 in.) in depth to maintain adequate soil cover over a system and adequate separation distances to a restriction. In some jurisdictions around the country, the soil depth required to install a traditional, gravity dosed wastewater soil absorption system is as much as 1.8 m (6 ft).

Where the depth of the soil is restricted, one of the pressure-dosed options may be designated. The low-pressure pipe (LPP) system was developed in North Carolina in the late 1970's and has been utilized extensively where the soil depth measures between 600- 900 mm (24 - 30 in.). A typical LPP system consists of a narrow (300-450 mm, 12 - 18 in. wide) shallow (300-450 mm, 12 -18 in. deep) trench with approximately 150-200 mm (6 - 8 in.) of gravel fill over which the pressure distribution pipe is placed, as shown in Figure 3. Once the pipe is placed in the trench, soil material is used to cover the trench.

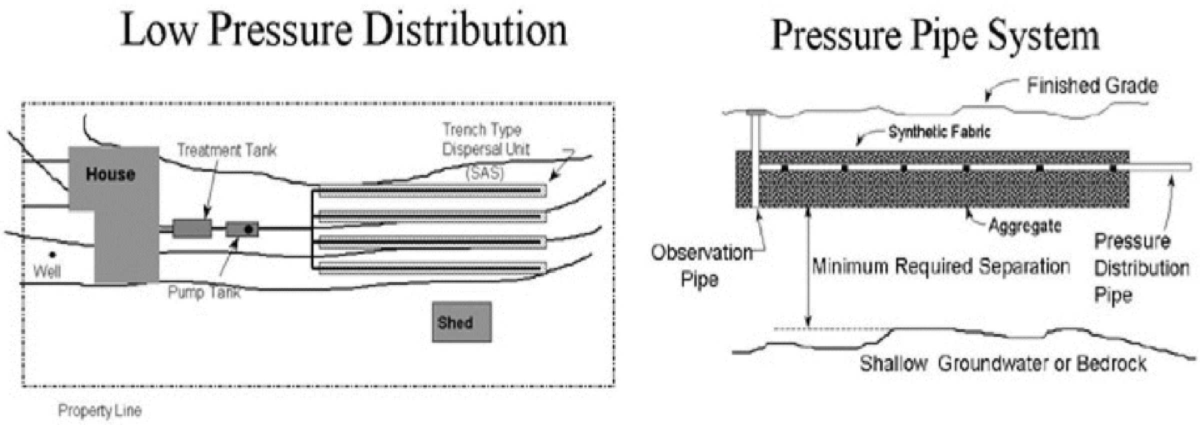

Figure 3 Pressure distribution systems on shallow soils

In some instances, soil depth may be a serious limitation. Here soil material can be imported onto a site to construct an elevated at-grade or mound wastewater treatment system.

The at-grade or mound system utilizes the pressure distribution network. At-grade systems may be utilized where the separation distance between the natural soil surface and a restrictive layer is as little as 450 mm (18 in.). Mound systems can be placed in areas where the separation distance to shallow groundwater is as little as 300 mm (12 in.). Mound systems are not well suited for areas with very slowly permeable soils and site geometry strongly influences potential for treatment.

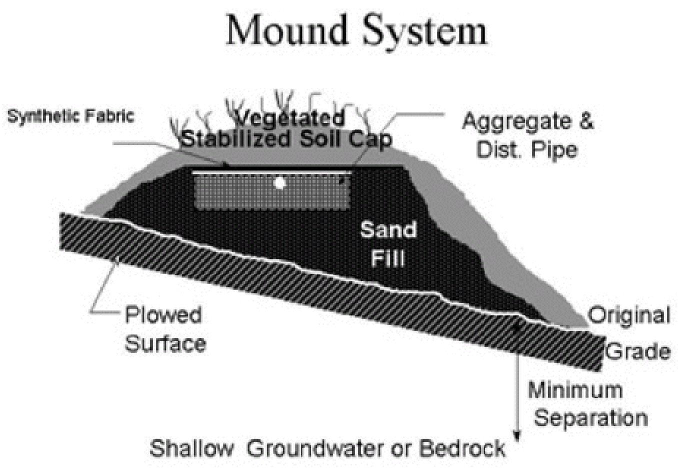

Figure 4 Layout of mound system

At-grade and mound systems are expensive because of the need to develop a pressure distribution system and the need to import a large volume of suitable fill. Ideally these systems are placed with a long on-contour dimension and a minimum cross contour dimension. Up-gradient drainage may be beneficial to facilitate the proper functioning of these systems.

Drip and spray irrigation systems can be used to treat wastewater from single-family homes, commercial developments, or communities. These sophisticated effluent treatment systems can be used where site limitations such as slowly permeable soil and shallow groundwater combine to render a site undevelopable with any other technology. Drip and spray irrigation equipment is used to place liquid either on the soil surface or just below the soil surface.

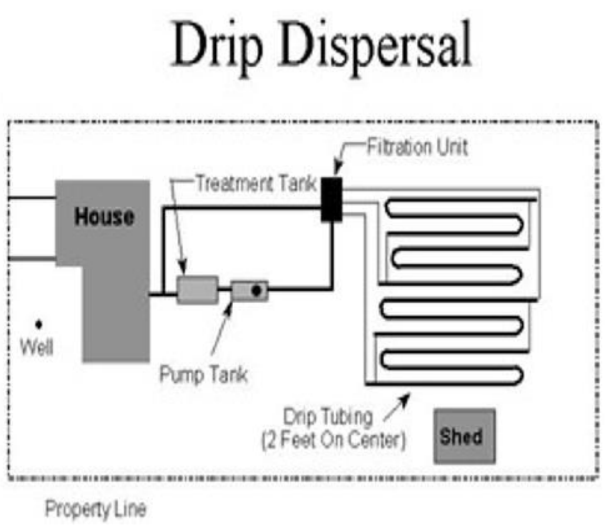

Figure 5 Layout for drip systems for individual homes

These systems have been utilized where soil depth is as little as 300 mm (12 in.) and there is 300 mm of suitable soil material over a shallow watertable or other restrictive horizon. Drip systems can be installed in direct earth contact and no fill is required. Both drip and spray systems are expensive because of the pre-treatment requirements and the electronic controls to disperse effluent into the soil.

In areas where there are serious site or soil limitations, where the environment is particularly sensitive, or where there are sources of drinking water that may be impacted by on-site wastewater systems, some form of advanced treatment may be required before liquid is placed into the soil for final treatment and dispersal. In other instances, there may be no option available to repair an improperly operating on-site wastewater system than a mechanical treatment device. In either of these examples, aerobic treatment units or media filters may be employed to provide extensive pre-treatment of the wastewater before it is placed in the receiver environment. In order for these systems to function properly for the life of the property, continuous, high level operation, maintenance, and management are essential.

4 General Recommendations

Soil based on-site wastewater treatment systems will function most effectively when they are placed with long on-contour dimensions and short cross contour dimensions. This design factor is called system geometry and it does influence system performance. Liquid applied to the soil must move through the soil medium in accordance with Darcy's Law and promote movement of air into the soil through application of Fick's Law. Optimum solutions to the Darcy's Law requirements are achieved with long contour systems and narrow cross contour systems. This system geometry simultaneously optimizes the application of Fick's Law of Gaseous Diffusion. In some instances, the installation of up-gradient drainage will facilitate the long-term performance of a land based on-site wastewater treatment system. Drainage installed to facilitate system performance must drain to the environment. The need for drainage must be included as an element of the site and soil evaluation and the interpretation of critical site and soil information.

5 Management

All on-site wastewater treatment systems will require routine and recurring inspection, operation and maintenance, and management. In order for a county to issue a development or improvement permit which specifies one of these mechanically intensive options, a public or private, certified management entity must be available. This can be accomplished either as contract or service agreement with a private management entity or through an agreement with a county management entity. Both public and private management entities are operating in North Carolina and throughout the country. Recently the USEPA (2003) developed a comprehensive set of management guidelines which, although voluntary at this time, encouraging local units of government to become much more involved in the management of on-site and decentralized wastewater management systems. These systems are a permanent part of the wastewater management infrastructure and they must be managed accordingly. The USEPA has proposed five different models (Model 1 through Model 5) of management for on-site and community wastewater treatment systems. Communities are strongly encouraged to examine management needs associated with on-site wastewater programs.

Management requirements for the various programs are summarized below.

Model Program 1

SYSTEM INVENTORY AND AWARENESS OF MAINTENANCE NEEDS

To ensure traditional on-site/decentralized systems are sited and installed properly in accordance with appropriate state/local regulations and codes; and are periodically inspected and repaired as necessary. Regulatory agency is aware of the location of systems and periodically provides owners with operation and maintenance information. Ideal for programs that are based upon traditional, prescriptive system designs that rely upon minimum site criteria and system design requirements promulgated in codes. Relatively easy and inexpensive to implement and maintain. No mechanism to ensure operating compliance of systems. No mechanism exists to identify failures when they occur. Limits building sites to those meeting prescriptive requirements.

Model Program 2

PRESCRIPTIVE MANAGEMENT FOR MORE COMPLEX SYSTEMS

To allow the use of more complex mechanical treatment options through the requirement that maintenance contracts be maintained between the owner and equipment manufacturer/ supplier or service provider over the life of the system. For programs that allow enhanced treatment systems as an alternative to traditional systems on sites that are marginally suited for traditional systems. Reduces the risk of failure through the requirement for routine maintenance. State/local agency may have difficulty tracking and enforcing compliance with the maintenance requirements and/or contract. Maintenance of mechanical components performed by skilled personnel.

Model Program 3

MANAGEMENT THROUGH RENEWABLE & REVOCABLE OPERATING PERMITS

To allow the use of on-site/decentralized treatment on sites with a greater range of characteristics than allowed by prescriptive codes through the establishment of specific and measurable performance requirements, renewable operating permits, and regular compliance monitoring reports. For programs that rely upon engineered designs to meet specific performance requirements based on site characteristic. This model increases the range of sites suitable for development with on-site systems. The risk of system failure is reduced since operating permits are required and permit renewal is necessary. Prior to renewal, system performance must be verified by an independent third party.

Model Program 4

RESPONSIBLE MANAGEMENT ENTITY (RME) OPERATION & MAINTENANCE

To ensure that on-site/decentralized treatment systems consistently meet their performance requirements through the creation of public/private utilities that would be responsible for the performance of systems within the service area. For programs that allow public/private operating entities to oversee the day-to-day activities associated with system management. Responsibility for O and M is transferred by contract or other binding document to a professional management entity that has the technical, economic and financial capability to oversee operations and assure compliance with operations permits. Routine inspections may identify obvious structural problems before system failure occurs. The management entity may not have the responsibility or authority to correct structural problems that impair performance.

MODEL PROGRAM 5

RESPONSIBLE ENTITY OWNERSHIP AND MANAGEMENT

This comprehensive model provides professional management of the siting, design, construction, operation and maintenance of on-site/decentralized systems through the creation of public/private management entity that owns and operates individual and decentralized wastewater systems within the service area.

6 Conclusions

On-site wastewater treatment systems have been providing an effective mechanism to protect public health and environmental quality for over 100 years. Today the complexity of systems is increasing and the technologies employed to affect treatment on a variety of sites are more complex than those employed in the past. These more complex systems are required as a result of the increasing sensitivity of receiver sites. Our ability to assess site limitations is improving and with that comes the proliferation of treatment and dispersal technologies necessary to address limitations imposed by site, soil, and receiver environment. As technology is utilized, the need to address long-term management becomes more critical. The USEPA and many state and local regulatory agencies recognize this need for comprehensive programs that address the technology and associated management requirements to sustain this element of the wastewater infrastructure through time.

References

North Carolina Laws and Rules for On-site Sewage Disposal, 15A NCAC .1300 (2001)

USEPA (2003) *Onsite Systems Manual*. United States Environmental Protection Agency

USEPA (2003) *Management Guidelines for Onsite and Decentralized Wastewater Systems* United States Environmental Protection Agency