The author compares on-site and centralized options, provides analogies with residuals composting, and what it will take to achieve increased use of decentralized approaches.

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THE TERM, “decentralized wastewater management,” refers to the process of treating and discharging treated wastewater in the local vicinity where it is generated. Decentralized systems typically use the soil as the final receptor of the treated wastewater instead of discharging to surface waters, which are generally the receptors of treated wastewater from larger centralized treatment plants. Wastewater is further treated in the soil; some is utilized by plants and, in many environments, much of it will recharge groundwater locally. These systems are different from the land application programs discussed in the April, 2001 issue of BioCycle in that they usually involve subsurface application of the wastewater as it is produced and do not involve storing for use during crop growth cycles. Also, the soil is considered as part of the treatment process, not just the receptor of treated water.

In the past, local community decision-makers have basically been given two alternatives for wastewater management. They have been told by their engineers and state regulators that they can either utilize individual home septic systems, which will fail after a time, or develop conventional gravity sewer collection systems that convey all of the wastewater to a single location for treatment and subsequent discharge to surface water. Decentralized technologies are often not considered seriously as an option for wastewater infrastructure because of inadequate information and experience within the engineering and regulatory community.

INDIVIDUAL HOME SEPTIC SYSTEMS LACK MANAGEMENT

Individual on-site septic systems have been typically considered second class. They have been utilized without any form of organized management, and since they are typically totally subsurface, they have been victims of an out-of-sight, out-of-mind attitude. The less than first class reputation that individual on-lot septic systems have is largely because most systems have never been provided with any significant level of management.

Systems are typically scrutinized initially, at the time of site evaluation, for suitability of soil absorption and on-site system construction. The local regulatory authority, commonly the local health department, issues a construction permit; but after the system is installed, there is no further oversight or requirement that it is cared for. It is amazing that septic systems function as well as they do with very little maintenance. The primary maintenance required is to pump the septic tank(s) before the solids begin to wash through the tank and into the soil absorption system. Septic system management should also include observations of the soil absorption system to ascertain whether it is functioning adequately under the applied wastewater load.

All too often tanks are not pumped until the solids level begins to cause problems — either in the rate of flow accepted from the house or problems in the yard due to solids accumulated in the drainfield causing soil...
Many analogies exist between the decentralized wastewater industry and the residuals recycling, or compost, industry.

clogging and surfacing of effluent. When this occurs, the soil system may already be experiencing extensive damage that only costly renovation or replacement will solve. If systems are carefully monitored, problems of this nature can be avoided because tanks will be pumped before they begin to discharge higher concentrations of solids; and drainfields that are not accepting the effluent at a rate to keep up with the wastewater generation rate will be identified and can be fixed or enlarged before there is a failure and development of a public health hazard.

CENTRALIZED SYSTEMS ALSO HAVE PROBLEMS

Centralized collection and treatment systems are not without flaw. Most gravity-flow sewers are leaky systems that suffer from storm water and groundwater infiltration during periods of wet weather and leak raw sewage into the soil along the path of conveyance during dry weather. Occasional treatment plant upsets result in catastrophic impacts on receiving waters. Discharge or overflow of raw or partially treated sewage during periods of wet weather is common. However, centralized systems remove wastewater from the consumer's field of view, and the municipal authority accepts responsibility in return for a service fee paid by the homeowner. This puts the control of the wastewater under a single, usually public, entity where it can be more easily monitored and regulated.

ACCEPTANCE OF DECENTRALIZED REQUIRES NEW THINKING

The homeowner attitude about wastewater is analogous to the general attitude about solid waste and organics residuals. As long as the material is conveyed away from the point of generation and the municipal authority accepts responsibility, homeowners are happy because the material is out of their sight and they no longer have to deal with it.

Decentralized wastewater systems require the public to accept a new way of thinking. They must accept that their wastewater treatment system will, in part or totally, remain within the local community and be subject to management there. Decentralized systems may involve a combination of managed individual on-lot systems and small clusters of homes grouped together with common, locally sited treatment and soil discharge systems where the treated wastewater is recycled back into the environment.

Wastewater collection systems utilized with decentralized technologies often involve utilizing a septic tank at each point of wastewater generation to remove the solids and conveying only the liquid fraction of the wastewater to a central treatment facility. This allows the utilization of sealed, small-diameter plastic piping for wastewater conveyances and minimizes or eliminates manholes and other sites of potential stormwater and groundwater infiltration.

By not requiring the piping system to convey solids, the need for minimum slopes on pipes and even the need for a continuous slope in the direction of flow are eliminated. It is only important that the discharge point be below the inputs. In some cases, pumps are used at some or all of the connection points, and the main conveyance line is kept under pressure continuously or in sections. The use of small diameter pipes conveying liquid only, whether flowing by gravity or under pressure, makes the design of the piping system much simpler and the construction less disruptive and very much lower in cost as well as leak free.

Effluent sewers, as these small-diameter systems are called, can be much shallower and require much less digging and disruption for installation. They can often be inserted over much of their length with no trenching at all using directional boring technology. This is particularly beneficial when sewers are being installed in developed communities.

SOIL ABSORPTION ABILITY

After the majority of the solids are removed at the point of origin, the wastewater treatment system must remove suspended organics and other oxygen-demanding substances, pathogens and nutrients. Most soils have tremendous ability to provide treatment for these parameters as long as the loading rate is low and the wastewater is applied in small, uniformly distributed quantities so that the residence time of the wastewater in the near surface soil is long. Pretreatment systems to remove a high percentage of the organic matter and pathogens can improve the efficiency of the soil system in completing the treatment process.

One of the problems with the soil absorption component of traditional septic systems is that soils have been chosen based on hydraulic characteristics rather than for their treatment abilities. Soils of high permeability have been the first choice. This is because we have thought of the soil absorption system as a "disposal" system rather than a part of the "treatment" process. The most permeable soils may not provide all the treatment that is needed at a particular site.

For the flow quantities generated by a subdivision, cluster of homes, or a small community, the treatment system required ahead of the soil is often rather simple. Treatment systems that are commonly used ahead of soil dispersal for final treatment are small aerobic treatment plants, various fixed film bioreactors such as sand filters, or natural systems such as constructed wetlands.

Effluent quality typically achieved with the low management technologies used for decentralized systems is as good as or better than a management intensive central treatment facility for some of the parameters. Nutrients, particularly phosphorus, and bacte-
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The effluent quality that can be achieved by relatively passive treatment processes, such as manufactured aerobic treatment units, sand filters, synthetic biofilters, or simple constructed wetlands, is recognized.

**MANAGEMENT IS KEY**

A key element in the success of decentralized wastewater systems is good, regular management. The management requirements for a community or cluster decentralized system are low compared to centralized systems. Treatment facilities, particularly some of the more passive ones such as sand filters, may require the attention of a trained maintenance provider only once a month. Others may require attention more often but do not require the continuous presence of an operator. Available remote monitoring technology can minimize need for a site visit. The pipe networks associated with effluent collection systems are almost maintenance-free.

Individual septic tanks at each connection must be either pumped every few years on a set schedule to assure that the solids level in the tanks never reaches the point where solids begin leaving the tanks, or they must be regularly inspected and pumped as needed. Effluent filters (a relatively recent innovation) in septic tanks can provide a significant level of protection against solids discharging from the tanks.

**ANALOGIES BETWEEN DECENTRALIZED WASTEWATER AND RESIDUALS COMPOSTING**

Many analogies exist between the decentralized wastewater industry and the residuals recycling, or compost, industry. A significant level of public education is needed to enhance public acceptance and recognition of both of these technologies as viable and appropriate. In both cases, the benefits and long-term sustainability are neither recognized nor understood by the public and local decision makers. The level of science behind the technology needs to be enhanced both in the composting industry and the decentralized wastewater industry.

Society in general does not understand the benefits of composting, nor do we recognize the value of the end product humus. We do not fully understand all of the biological processes involved and exactly how to manipulate those processes for the desired end state of soil health, microbial diversity, and environmental sustainability. However, those who wish to do so can learn enough to know how to produce a desirable product and desirable results by composting and utilizing organic residuals.

The decentralized wastewater industry is at a similar stage of development. The relative benefits of retaining and recycling wastewater locally to make beneficial use of both the water and the nutrients are not well understood, as opposed to conveying it miles away for treatment in some centralized, closely monitored facility where the nutrients are wasted and the water lost to the local environment. The effluent quality that can be achieved by relatively passive treatment processes, such as manufactured aerobic treatment units, sand filters, synthetic biofilters, or simple constructed wetlands, is recognized; but the documented science behind exactly what is happening biologically in the various treatment processes is not completely developed.

Regulators are not completely comfortable with accepting the viability of composting without more detailed research on the fate of each individual contaminant of concern. Similarly in the decentralized wastewater industry, regulators are not entirely comfortable with accepting decentralized technologies until there is more experience.
and detailed science behind the processes. In the cases of both composting and decentralized wastewater treatment systems, the lack of long-term successful programs in virtually any community of interest contributes to reluctance on the part of both the general public and the regulatory community to accept widespread implementation of the technologies.

Another point of analogy is the need to train practitioners to be day-to-day managers of the technologies. It is difficult for widespread training and education to be available until there is sufficient demand; the development of sufficient numbers of installations to generate the demand for training is dependent upon having adequately trained personnel to maintain the system, whether it be a wastewater system or a composting facility.

UNDERSTANDING THE RELATIVE RISKS

Decentralized wastewater systems result in recycling water back into the environment near the point of use where it originated. Residuals are typically applied to soil, treated, and recycled in a disperse fashion within the local environment rather than being concentrated for treatment and then discharged at a single point in the receiving environment. Our experience as a society is that most, if not all, centralized or decentralized wastewater management facilities will have occasions of less than optimum performance.

We must assess the relative environmental risk of having a few small, disperse wastewater treatment systems that are operating at less than optimum performance at any given time compared to having a single wastewater treatment system that operates very well most of the time but occasionally experiences a catastrophic failure.

Many wastewater professionals are beginning to believe that well operated, disperse treatment systems may have less risk to the environment.

Many wastewater professionals are beginning to believe that well operated, disperse treatment systems may have less risk to the environment. Applying wastewater to soils dispersed throughout the environment results in more utilization of nutrients, utilization of much of the water, and utilization of the natural environment for treatment rather than depending upon high energy, high

A MODEL FOR DECENTRALIZED WASTEWATER PROGRAMS

The National Onsite Wastewater Recycling Association (NOWRA) has developed a guide, Model Framework for Unsewered Wastewater Infrastructure (www.nowra.org) that is designed to assist local communities in understanding and developing the required components for a successful decentralized wastewater program. The framework identifies seven components which need to be a part of every successful program.

The NOWRA framework is predicated upon the concept that decentralized wastewater systems must be based upon performance criteria rather than the type of prescriptive codes that have been promulgated and utilized for individual on-lot septic systems. The concept of performance includes performance of the system, performance of the managers of the system, performance of the regulatory process, and adequate education and training for all practitioners. The seven required elements are: Performance-based criteria; Management of all systems; Regulatory oversight to assure performance; Adequate technical criteria; Education and training for all practitioners; Certification of practitioners at all levels; and Periodic program review.

NOWRA is developing a model code built around these seven elements of the framework. The framework and model code will be useful for both local communities and regulatory professionals in developing comprehensive programs for decentralized wastewater management that will result in enhanced public and regulatory acceptance of the decentralized approach for treating and dispersing wastewater back into the environment.

The prospects are bright for increased use of decentralized wastewater infrastructure in the future. The process is becoming better understood and there is an increasing quantity of design, management, and performance information available. The future wastewater infrastructure should include a combination of approaches. Centralized systems will be the choice for densely populated and industrial communities. In other areas, various combinations of onsite and decentralized and centralized technologies should be used as dictated by environmental conditions, economics and the ability to manage.

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