The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

The Nature Conservancy
Devil's Den Preserve &
The Saugatuck Forest Lands
P.O. Box 1162
Weston, CT 06883

tel: [203] 226-4991
fax: [203] 226-4807
e-mail: theden@tnc.org

nature.org

ALTERNATIVE ON-SITE SEWAGE TREATMENT SYSTEMS: WATERSHED IMPLICATIONS

The Nature Conservancy

WHITE PAPER
JANUARY 2007

Summary

The Nature Conservancy believes that decisions regarding the design, siting and operation of ATS within the Watershed should be made on the basis of accurate scientific data, with proper attention to environmental impacts on local water resources. This paper proposes a framework for evaluation of these systems, based on the following recommendations.

- Decisions as to location, appropriate technology and performance standards for ATS should be based on site-specific soil and hydrological conditions as well as environmental objectives for the Watershed as a whole. A "one size fits all" approach should be avoided.

- ATS should be allowed in Connecticut only if their reliability can be demonstrated on the basis of objectively-collected, quality-assured performance data that measure the long term ability of the ATS to treat effluent to CT Water Quality Standards.

- Review of ATS applications should consider the environmental impacts the operation of the ATS may cause, the maintenance requirements and the required level of operator attention and skill.

- Watershed municipalities should set standards for design, siting, operation and maintenance of ATS. Because taxpayers are potentially liable if private ATS failure causes a pollution problem, municipalities should require financial guarantees from ATS owners to ensure that funds are available for inspection, repair and replacement.

- Funding should be in place for a monitoring program to assess local water quality and habitat and species health to identify baseline conditions and should be carried out for a year prior to approval of any ATS. Continued monitoring of these local resources and water quality should continue as long as the facility is on line.

- Municipalities within a watershed should make decisions based on land use objectives and their plan of conservation and development, not on the basis of what is technologically feasible on the landscape.

Text

Recently, the eleven towns comprising the Saugatuck River Watershed have seen a number of plans for "alternative" on-site sewage treatment systems (ATS) that incorporate commercial technologies to pretreat effluent to remove oxygen demanding materials, suspended solids and pathogenic organisms before release to the environment. The increasing number of proposals calling for use of ATS, particularly for large or clustered developments within the Watershed, reflects several factors: (i) pressure for more intense development of rural areas where municipal sewers are not available; (ii) availability of affordable pre-fabricated "package" ATS for effluent flows under 100,000 gallons per day; (iii) current levels of receptivity at the state level to alternative sewage treatment technology.

ATS are not necessarily inconsistent with the goal of maintaining a healthy Watershed provided they function according to their design specifications. On the other hand, if they are improperly designed, sited or maintained, they may pose a significant threat to the quality of groundwater and streams. The threat is particularly serious because the promise of successful pretreatment is allowing them to be proposed for more intensive development and/or development in environmentally sensitive sites near wetlands and watercourses where conventional septic would not be feasible.

I. ATS Design and Operating Considerations

Under Connecticut's Public Health Code, an "alternative" on-site sewage treatment system is any on-site wastewater collection system other than a conventional septic tank and leaching field. Most alternative technologies available today fall into one of two categories: (1) components designed to be added onto conventional septic systems to enhance treatment for contaminant removal and (2) alternative disposal systems that replace traditional leaching fields.

Enhanced treatment technologies use biological processes, involving aerobic and anaerobic bacteria, to reduce contaminants in effluent prior to discharge to soil, a leach field or a waterway. Pre-fabricated package systems, many employing proprietary technologies, provide an environment for bacterial growth. In suspended growth systems, such as activated sludge and sequencing batch reactors, bacteria are grown in aerated tanks (commercial examples include Amphidrome, Chromaglass and FAST). In fixed film systems, bacteria are grown on media such as rocks, sand or plastic (Waterloo Biofilter). In membrane bioreactor systems, an ultrafiltration filter, often fiber, is immersed in the aerated tank and the effluent is passed though the filter to screen out contaminants (Zenon). Some package systems combine approaches.

Enhanced treatment is intended to remove biochemical oxygen demand (BOD), suspended solids and nitrogen from wastewater. Nitrogen removal occurs through a two-step process. Initially, bacteria in an aerobic environment oxidize ammonia to nitrite and nitrate. This chemical reaction is highly temperature dependent, with decreased performance when water temperatures approach 10 degrees Celsius (50 degrees Farenheit) (Tighe & Bond, 2005). **Therefore, regardless of the specific technology employed, maintaining bacterial health in winter will present operating challenges for any ATS in this Watershed that relies on enhanced treatment to remove nitrogen.**

In the next step, nitrates are converted to gas and released. This process occurs in an anaerobic environment, and bacterial survival requires the introduction of carbon, in the form of methanol, ethanol or glucose. **If the prior nitrification process has failed to oxidize the ammonia in the wastewater, this denitrification process cannot occur.**

In conventional septic systems, contaminant removal occurs naturally by microbial action in the leaching fields at the system/soil interface. When wastewater is discharged to the ground, organics in the water form a "biomat" that is consumed by aerobic bacteria in the oxygenated environment below the leaching fields. Anaerobic bacteria in the biomat perform denitrification. Pretreatment of effluent removes the organic materials needed to form the biomat. As a result, little additional contaminant removal will take place in the leaching fields.

Traditional leaching fields use trenches filled with gravel or stone as receiving media for effluent. Alternative disposal systems use more efficient, high density materials such as plastics that are less prone to hydraulic failure. These systems require less excavation and a smaller footprint than gravel or stone trenches, so they may be installed where lack of space or environmental concerns preclude installation of conventional leaching fields.

In theory, ATS promises better contaminant removal than a conventional septic with the same design flow. Nevertheless, **this does not mean that ATS is always superior to conventional septic**. There are special risks associated with **any** ATS that decision makers must take into account in evaluating these systems for use, particularly in environmentally sensitive sites in the Watershed:

- **ATS is likely to be proposed for sites where, because of limited setbacks, high water tables or sensitivity to contaminants such as nitrogen, conventional septic is not an option.** In developed areas experiencing conventional septic failure, ATS offers an alternative to costly sewering. But, in many cases, ATS is proposed in applications for new buildings on land that otherwise could not be developed as densely, or at all. For Watershed municipalities that rely on "sewer avoidance policies" to limit development in rural areas, ATS is removing a de facto barrier to large commercial and multi-unit residential development. (Under C.G.S. 7-246(b) local Water Pollution Control Authorities may designate areas where the municipality has decided that sewers "are to be avoided"). This is a major change that has significant implications for infrastructure needs and conservation goals within the Watershed. The state Office of Policy and Management has cautioned that sewage collection systems should not be extended to rural areas or areas of environmental concern unless "the design and capacity will not induce further intensive structural development with attendant non-point source pollution threats to water quality" (OPM, 2001). However, the state may not deny a permit to an ATS on the grounds that it is inconsistent with the State Plan of Conservation and Development (C.G.A. 22a-430(k)).

- **The risk of improper design is greater for ATS than for conventional septic.** Although package systems are pre-fabricated, engineers hired by the developer are free to incorporate several "optional" manufactured components into their designs. The manufacturers may have no knowledge of or control over how their products will be installed or integrated with other components. If a component is installed in the wrong location or sequence or is not properly sized to handle actual flow and loading, it will not perform to specifications. System performance is directly linked to the design engineer's skill, familiarity with ATS and design choices that may be driven by pressure to control capital costs rather than performance itself.

- **ATS is only as good as its operation and maintenance.** Although package ATS is often marketed as "simple," requiring "little operator attention" and having "few moving parts," ATS poses greater operating challenges than a large waste treatment facility. Package systems are typically used for developments with flows under 100,000 gallons a day, such as schools, condominiums, recreational facilities and restaurants whose effluent volumes vary seasonally or even daily. When flows are low and variable, small systems are particularly sensitive to temperature variations, dissolved oxygen levels, nutrient loading, pH, hydraulic and shock loading (Lindsay, 2004). Although this suggests the need for daily monitoring by professionals, most ATS owners do not employ full time licensed operators, and operators are hired only after the ATS has been designed and installed by different engineers who have no responsibility for maintenance. A recent study of ATS found that systems performed better when designed and operated by the same engineering firm (Peterson, 2006).

- **ATS owners must have the financial resources to bear maintenance costs that over the life of the system are likely to exceed initial investment.** Predictable expenses include regular inspection, repair and replacement of all component parts, supplies (such as alkalinity and carbon additions), sludge removal, energy costs (including backup generators), contract with licensed operator, insurance and legal costs. But there are also less predictable costs. Achieving optimal environmental conditions for bacterial growth is a delicate process that often requires operator attention, adjustments and upgrades over a period of years. ATS failure may result from improper siting, design or use; flushing even small amounts of cleaning agents down a toilet may kill the bacteria, a common ATS problem. Any time the system is off line, the sludge must be removed by truck, sometimes daily, at great expense.

- **The municipality is dependent on ATS owners to monitor, make timely repairs and notify authorities of problems**. Local health departments have no way of knowing that an ATS is malfunctioning until it causes pollution. If the pollution problem is serious and the ATS owner is unable or unwilling to fund remediation, the state may, and has, ordered local taxpayers to pay for pollution abatement (C.G.A. 22a-428; In the Matter of Town of Brookfield, 2002).

- **Special attention should be given to travel time and local site conditions to promote removal of viruses and bacteria.** Like conventional septic, ATS rely upon natural attenuation of pathogens as the effluent moves through the groundwater. The standard rule in Connecticut is that the effluent must have at least 21 days of travel time before it reaches a point of concern (drinking water well or surface water). This determination is based on site-specific soil conditions and groundwater flows. Since ATS are often proposed for small or environmentally sensitive sites, decision makers should be certain that transport times are sufficient to perform necessary pathogen removal. If any doubt exists, pathogen removing technology, such as a UV disinfection system, is a cost effective addition to ATS design.
.
- **The best of currently available package ATS technology cannot promise perfect contaminant removal.** According to Susan Rask, environmental health specialist with the Barnstable, Massachusetts County Department of Health and the Environment, the main problem with current package technology is variable performance: "Even the systems that generally perform have periods of nonperformance" (O'Malley, 2006). Alternative systems may not be appropriate in situations where proposed design flow, siting or sensitivity of the receiving environment to a particular contaminant requires that the system meet performance standards on a consistent basis.

To address the special design, operating and maintenance risks associated with ATS, it is recommended that Watershed municipalities take the following steps:

- Develop rules governing the design of ATS, including a requirement that manufacturers of component parts and a licensed operator approve system design before installation.

- Adopt a regulation or ordinance requiring ATS owners and operators to enter into a maintenance agreement with the WPCA or other appropriate municipal authority that provides for the owner to place in escrow sufficient funds for future monitoring, operation, maintenance, repair and replacement costs.

- Revise wetlands regulations to include provisions governing appropriate setbacks for ATS.

- Plan for ATS when revising local zoning regulations and Plans of Conservation and Development.

- For environmentally sensitive sites that require consistent contaminant removal to preserve water quality, consider prohibiting ATS installation. “Excessive levels of reactive nitrogen in water bodies, including rivers and other wetlands, frequently leads to algal blooms and eutrophication in inland waters and coastal areas.” (Millennium Ecosystem Assessment, 2005)

II. ATS Permitting

For years, the Connecticut Department of Environmental Protection (DEP) has been viewed by developers and municipalities as the ultimate authority for all matters relating to water quality, including sewage treatment. Many municipalities do not know the extent of their authority to regulate ATS. They assume CT DEP has full oversight and responsibility for ATS systems. In fact, DEP oversight is limited by law and budget constraints.

The DEP has permitting authority over all septic systems with design flows in excess of 5,000 gallons per day. The DEP has delegated permitting authority for smaller systems to the Department of Public Health, which acts through local health officials. This delegation applies only to "household and small commercial subsurface disposal systems." The Public Health Code defines ATS as a system using a method of treatment other than a subsurface disposal system (PHC 19-13-B104b(a)). This suggests that ATS that incorporate special pretreatment technology may require DEP approval, regardless of size.

As part of the permitting process, the DEP determines that the discharge will not "cause pollution of any of the waters of the state" (C.G.S. 22a-430). Although this language seems broad, in practice, the DEP's review is limited:

- Required treatment of effluent (to meet drinking water standards of 10 milligrams per liter for the nitrate or nitrite form) discharged to groundwater as in the case of ATS systems using leach fields may not adequately protect local wetlands and watercourses. “Exceeding critical loads for nitrogen and sulfur can cause ecosystem acidification, nitrogen saturation, and biotic community changes. Critical loads are widely used to set policy for resource protection in Europe and Canada, yet the United States has no similar national strategy.” (Porter, 2005)

- **To ensure protection of sensitive Watershed resources, a better approach is to tailor pretreatment performance requirements for each ATS to the sensitivity of the receiving waters**. Municipal as well as state regulatory authorities do not ordinarily consider the cumulative impact of contaminant loading on the receiving environment. Loading is a concern for areas where ATS is proposed because the promise of successful pretreatment allows ATS to be approved to handle larger daily effluent flows, in more environmentally sensitive locations, than would be permitted for conventional septic. A system that handles 10,000 gallons of effluent per day releases a greater volume of contaminants into the receiving environment than a system that handles 1000 gallons per day, even if both treat effluent to the same dilution standard. In theory, treatment of effluent to a relatively stringent maximum concentration standard may be sufficient to protect environmental resources. In a nitrogen sensitive site, however, the 10 mg/l treatment standard may not be stringent enough when large effluent flows are producing significant nitrogen loads to ponds and streams. In these cases, nitrogen loading may impact water quality, and eventually threaten aquatic species, year round: in the summer, by facilitating excessive algae growth that, as it decays, will deplete dissolved oxygen levels, and, in the winter, by adding toxic ammonia to the waterway.

- **On-site monitoring is up to the local community**. DEP does not have resources for on-site monitoring of ATS. The DEP has just three field inspectors for 105 conventional wastewater treatment plants, another 50 or so package plants and community septic systems.

- **DEP permitting authority does not preempt local authority to protect environmental resources.** Three local agencies have a potential role in regulating ATS:

Local health departments exercise the powers of the Department of Public Health and may comment to the DEP on permitting applications and enforce public health regulations applicable to ATS, including setbacks from drinking water supply sources (PHC 19-13-B104d). They also have the duty to protect public health from pollution problems caused by any septic failure.

Water Pollution Control Authorities may make rules for the supervision, management, control, operation and use of any "sewerage system" (C.G.S. 7-247). Sewerage systems include any device for treating sewage (C.G.S. 7-245).

Inland wetlands/conservation commissions and departments have an important role in the regulation of ATS if dispersal of the effluent, either directly or through groundwater flows, is likely to affect adversely the physical characteristics of wetlands and watercourses (C.G.S. 22a-42).

Local agencies should review their regulations and application procedures with their town attorneys to determine the scope of their authority and how best to use that authority to have a voice in the regulatory process. Agencies should have staff with sufficient expertise in ATS or hire knowledgeable consultants to advise their boards and commissions. (Municipalities may be able to recover costs associated with consultants, through their application fee structure). Because ATS affect every town in the Watershed, Watershed municipalities should work together in making decisions on long term management strategies to protect Watershed resources.

In the short term, local decision makers will be faced with applications for new ATS construction that may pose a risk to Watershed resources. In evaluating these applications, it is recommended that Watershed municipalities take the following steps:

- Require applicant to pay for a year-long baseline analysis of the receiving environment as a precondition to approval, particularly if the ATS is sited near a major waterway or sensitive habitats. Analysis should include existing levels of dissolved oxygen, *E coli* bacteria, ammonia, nitrate, phosphorous, pH, conductivity and temperature.

- Once a scientific baseline is in place, obtain an independent environmental analysis to determine what level of additional contaminant loading can be added to the receiving water without causing significant impairment to biological resources. Analysis should not be limited to chemical and physical parameters, but should include aquatic vertebrates, invertebrates and plant life to determine whether an increase in nutrient loading is possible without significant biological damage (loss of species) to existing wildlife.

- **Watershed municipalities should recognize that determining exactly how contaminant loading will affect the quality of a particular watercourse requires scientific analysis to determine the critical load (the biological point of species loss or advanced eutrification).** Nevertheless, experience has demonstrated that escalating pollution inputs to even marginally impaired receiving waters will eventually manifest itself in lower dissolved oxygen levels (hypoxia=D.O. levels below 3 ppm).

- Designate a representative from the Public Works Department to receive and review monthly or bi-monthly performance reports from ATS operators. This representative must be sufficiently versed in all aspects of water quality monitoring and sewage treatment plant operation to be able to assess the test results, and must be given access to the ATS premises and its records on at least a monthly basis in order to judge its state of compliance. The municipality should have the authority to shut down the ATS when non-compliance cannot be readily corrected. An emergency shut down plan should be required by the municipality, updated annually and placed on file with the appropriate local regulatory agency. For an ATS that discharges to groundwater, there will be few if any visible signs of failure. Given the financial risk to the town in the event of a pollution problem, the town has no choice but to take immediate action whenever an ATS operates out of specification.

- **Watershed municipalities should be aware that, if large numbers of ATS are installed within the Watershed, the burden on local Public Works Departments to oversee these systems will**

increase, with serious implications for future personnel needs and municipal budgets.

- Monthly monitoring of receiving surface and/or ground water for nutrients (N and P), immediately upstream and downstream of ATS should be required. Excessive nitrogen and phosphorous pollution are colorless and can only be detected by testing.

III. Performance of Package ATS

CT DEP does not field test different package ATS to determine their reliability under various environmental and operating conditions. The only performance data available to the CT DEP and the municipalities come from actual installations. Existing data suggest that actual performance is not living up to manufacturers' claims, yet failing package systems continue to operate, and new applications for the same technology receive DEP permits:

- **To date, there is no clear evidence that FAST, a package ATS that is touted as among the simplest ATS to operate, can remove contaminants to the DEP's specifications.** The DEP has records on six FAST installations to date (Daha letter, 12/7/06, attached). Four of these (Walmart at Old Saybrook Plaza, Valley Shore YMCA, Chestelm and Stop & Shop in Madison) are without permits, but have been operating from one to five years while the DEP waits for preliminary permit compliance issues to be resolved. Two units have final permits--Between the Bridges LLC and the Gunnery School in Washington (Daha letter, 12/07/06).

The Between the Bridges LLC system is rated at 10,540 gallons per day, with a reported average daily flow of 7000 gallons. This system, according to DEP records, has been operable since September 2003. Averaging the actual total volumes shown on submitted Discharge Monitoring Reports (DMRs) shows a throughput of only 2454 gallons per day. During the period 9/03 through 5/06, six of the required reporting days show no data recorded (ND), which indicates a 20 percent rate of under reporting. The maximum flow category is blank for the entire report. There are also ten days when none of the required chemical data are reported to include TSS, TN and TP. It appears that the attached DEP "Summary for Alternative Treatment Technology" is based on incomplete DMRs as the operator failed to submit reports for five months, and therefore does not provide reliable information on actual plant performance. The summary sheet however concludes that "no action" is recommended (Daha letter, 12/07/06).

The other permitted FAST system at the Gunnery School appears to be fraught with operating problems. In the "compliance summary," the total nitrogen category shows only a 47 percent "in spec" rate. No DMRs were submitted to the DEP after February 2006. Reference is made to a possible Notice of Violation to be issued by the DEP (Daha letter, 12/07/06).

- **ATS may fail to meet performance standards for long periods of time without being shut down.** The DEP relies on ATS to meet a variety of parameters for concentrations of nutrients, dissolved oxygen, BOD, pH, total settleable solids (TTS), etc. Test results usually are required to be reported monthly or bi-monthly so that the DEP can determine that the ATS is operating within specifications. The samples are taken by the plant operator and analyzed by a laboratory and the results are sent to the DEP. Theoretically, through a regime of specified tests supervised by a conscientious operator, a reasonable operational profile of the plant can be ascertained and adjustments can be made to keep the unit operating within specifications, even without on-site DEP inspection.

In fact, a lapse in data gathering and reporting is allowed (according to Ms. Daha of the DEP) from the time construction of the plant is completed until a final permit is issued. Once the final permit is issued, then the administrative oversight program begins. However, if the ATS does not meet the water quality objectives in the construction (draft) permit, the DEP then pays little attention to the unit and, according to Ms. Daha, the applicant is under "no obligation" to submit any reports (Daha letter, 12/07/06). It appears that these periods of limbo can stretch on for months or many years.

An example of this is the Madison Stop & Shop that has been in a state of failure for five years because a variety of floor cleaning products used by the store have compromised the FAST reactor repeatedly. The store now trucks sewage to another location.

Three other units mentioned in the Daha letter--Walmart (Old Saybrook Plaza) and Chestelm and the Valley Shore YMCA--have never received final permits and are effectively not regulated (Daha letter, 12/07/06).

It is impossible to determine, from available data, whether the poor performance of package ATS is the result of (1) inherent limitations in the ability of the technology to remove contaminants under the physical or climatological conditions in which it must operate in Connecticut; (2) lack of skill and attention in the siting and installation of ATS or (3) prohibitive operating and maintenance requirements associated with these systems. Without more information, further installation of ATS within the Watershed may pose serious risks to Watershed resources. To protect against these risks, it is recommended that Watershed municipalities take the following steps:

- Develop a database of ATS currently operating in the Watershed, including location, test results, performance records and details of any enforcement actions taken by the state.

- Begin a community discussion as to whether citizens in Watershed municipalities want to assume the expense and the responsibility of local monitoring of ATS.

- Urge the DEP not to grant permits for new ATS within the Watershed, except as remediation for failing septic serving existing development, until the reliability and operation and maintenance needs of ATS have been assessed by the DEP based on objective, independent study.

- Until local decision makers are satisfied that ATS can reliably meet performance standards, allow ATS installations for new construction only when the proposed location and design flow would be suitable for a conventional septic system on the site.

References:

Ehui, Wood, Global Assessment Report, Chapter 8, Millennium Ecosystem Assessment, 2005

Letter dated 12/07/06 from Antoanela Daha, DEP Sanitary Engineer, to Alicia Mozian, Conservation Director, Westport CT, enclosing Discharge Monitoring Reports from FAST installations in Connecticut (copy attached).

Lindsay, Understanding Wastewater Operational Problems in Small Treatment Systems, Small Flows Quarterly, Winter 2004.

Office of Adjudications, In the Matter of Town of Brookfield, Order No. WC-5119 (Oct. 2, 2002).

Office of Policy and Management, Environmental Quality: Water Quality Management (Oct. 31, 2001) http://www.opm.state.ct.us/pdpd3/physical/c&dplan-rec/WaterQ.htm.

O'Malley, When Tracking Is Critical, On-Site Water Treatment, Nov./Dec. 2006.

Peterson, Nitrogen Removal in Small Flows Wastewater Facilities in Massachusetts, Small Flows

Quarterly, Summer 2006.

Porter, Blett, Potter, Huber , Protecting Resources on Federal Lands: Implications of Critical Loads for Atmospheric Deposition of Nitrogen and Sulfur, BioOne Online Journal (2005)

Tighe & Bond, Small Community-Size Wastewater Treatment Technologies Evaluation 6-2 (June 2005).