Texas On-Site Insights
Information about On-Site Wastewater Treatment Systems in Texas
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Conference Provides Opportunity to Learn About New Regulations, Trends in On-Site Systems

More than 400 people from throughout Texas gathered in Plano, TX, in April for the Fifth Annual Conference of the Texas On-Site Wastewater Treatment Research Council. The conference convened at the Plano Convention Centre.

"This conference was noteworthy for many reasons," says Warren Samuelson, who is the Executive Secretary of the Council and who works for the Occupational Certification and Training Section of the Texas Natural Resource Conservation Commission (TNRCC). "Because the TNRCC recently passed a new set of regulations concerning on-site systems there was a lot of interest. The timing of the conference was excellent because it gave us a chance to answer many of the questions individuals have about the new rules. This was the first time we've sponsored a conference in North Texas. As a result, we attracted an audience that included people from many regions who may not have previously had the opportunity to easily attend."

Sessions of the conference focused on such issues as sand filters, small business needs, soil characterization and evaluation, operations and maintenance, treatment of high-strength wastes, treatment and disposal systems, septic tank technologies, the use of cluster systems, and inspection of existing systems. The conference featured two question and answer sessions that focused on the new TNRCC rules. Sessions dealt with changes in technical standards brought about by the rules, and new developments in training and certification programs.

Texas speakers featured on the program included Warren Samuelson, James McCaine, and Ken Graber of the TNRCC on-site wastewater staff in Austin, Glenn Turner of the TNRCC Beaumont Region, Richard Gerard of the Trinity River Authority, Tom Hallmark of the Texas A&M University (TAMU) Soil and Crop Sciences Department, Bruce Lesikar of the TAMU Agricultural Engineering Department, John Blount of the Harris County Engineering Department, and Terry Hoage of the Sam Houston State University Biology Department.

The conference featured many related activities. Hallmark helped participants handle different soil types and use the properties of these soils (how well the soils formed a ribbon, for example) to determine the proper soil classifications. Many of the roughly 30 exhibits featured interactive displays and demonstrations.

NOTE: The conference was organized by Mary Garrett and Associates of Corpus Christi, which prepared a 346-page proceedings that was distributed at the conference. Their phone number is (512) 225-4500. The proceedings contains many of the papers that were given at the conference and a limited number of copies are available by contacting Annette Maddern or Warren Samuelson of the TNRCC at (512) 239-4799. In the future, the table of contents from the conference will be posted on the Council's World Wide Web site (http://towtrc.tamu.edu) and articles about the conference will be linked to that site.

UT Studies if Increasing Number of On-Site Systems May Contaminate Barton Springs

The goal of this study was to examine if increased numbers of on-site wastewater systems may lessen water quality in the Springs and the Barton Springs (above) portion of the Edwards Aquifer.

A recent study by researchers at the University of Texas at Austin (UT) sheds new light on the potential impact of locating additional on-site wastewater treatment systems over the Barton Creek watershed, which provides recharge to Barton Springs and the Edwards Aquifer.

The study, titled "Current and Potential Impacts of Septic Systems on a Karst Aquifer," was conducted by Michael Barrett and Randall Charbeneau of the UT Center for Research in Water Resources (CRWR) and was completed in December 1996.

The study was undertaken because of concerns that many new residential developments in the Barton Creek watershed would likely utilize on-site wastewater treatment and disposal systems. Potentially, those systems could increase the nitrogen levels in the Barton Springs portion of the Edwards Aquifer.

Methodology

The current level of nitrogen in the aquifer was determined by analyzing the water quality discharged from Barton Springs, wells, and baseflow to Barton Creek. Data collected from 1983-93 were utilized to determine average levels of nitrogen in the Springs, which was assumed to represent average concentrations in the aquifer. The mean concentration for total nitrogen was 1.6 parts per million (ppm).

A mass balance equation was utilized to determine how changes in nitrogen loadings could impact groundwater quality. Nitrogen inputs include septic tank effluent, recharge from creeks, infiltration from rainfall, runoff and leaching from fertilized crops and landscapes, and leaking sewer pipes. Outputs consist of springflows, well pumpage, and discharges to Barton Creek as baseflow.

1990 information from the U.S. Census Bureau and the Barton Springs/Edwards Aquifer Conservation District was used to estimate that there are roughly 5,900 on-site systems over the recharge zone (2,050 in Hays County and 3,850 in Travis County). Septic tank effluents were assumed to have relatively high levels of nitrogen (40 ppm) , but very little nitrate (less than 1 ppm). Based on previous studies, the researchers assumed that nitrogen in effluents from on-site wastewater systems consist of 75% ammonia and 25% organic nitrogen. Outputs of nitrogen from on-site systems include runoff, sedimentation, plant uptake, crop yields, leachate, and denitrification.

A computer simulation model, GLEAMS (Groundwater Loading Effects of Agricultural Management Systems), was used to estimate the input of nitrogen to the aquifer from on-site wastewater systems. In real life, nitrogen enters drainfields from septic tank effluent and rainfall. In the GLEAMS model, outflows from septic tanks were modeled as injected fertilizer so the researchers could specify the nitrogen level. National Weather Service (NWS) data from the Austin airport were used for rainfall, while other climate data (solar radiation and mean temperatures) were obtained from a NWS site in San Antonio. Runoff was calculated based on curve numbers developed by the U.S. Department of Agriculture Natural Resource Conservation Service. Total nitrogen levels in rainfall averaged 1.5 ppm. Actual rainfall volumes were increased by 0.2 inches per day to account for water associated with septic tank influent, because GLEAMS does not account for extra water added by fertilizers. This amount was based on the assumption that wastewater flows from septic systems serving a four-person household are roughly 176 gallons per day, and that the size of the average drainfield was roughly 500 square feet. The researchers also assumed that drainfields used clay loam soils, and that Bermuda grass covered the fields.

Simulations performed with these assumptions predicted that an average nitrate-nitrogen level of 12 ppm would be leached to the aquifer during the 20-year study period. This is roughly the same concentration that has been reported in regional monitoring studies. The study suggests that only 15% of the nitrogen introduced into drainfields is leached to the aquifer. Other major losses include plant uptake (36%), denitrification (6%), and nitrogen retained in vegetation and soils (43%). The total nitrogen load from an individual septic system was estimated to be 3.5 pounds annually. The total mass of nitrogen introduced into the aquifer by septic systems is 10.1 tons annually, based on a total water volume of 200 million gallons.

The researchers also performed a sensitivity analysis to assess which variables were most critical in contributing nitrogen to the aquifer. These studies suggest that the most sensitive parameter is the total nitrogen concentration of effluent applied to the drainfield.

Results and Discussion

The study shows that the smallest nitrogen load to the aquifer is derived from on-site wastewater systems (10%), while diffuse recharge contributed 50% and creek recharge 37%. The total amount of nitrogen entering the aquifer is roughly 116 tons annually. The average level of nitrogen from all known sources is about 1.5 ppm, which is roughly the same as average concentrations at Barton Springs.

The researchers also examined if an increase in the number of on-site systems would increase the nitrogen concentration. Average nitrogen levels were computed for different numbers of on-site systems using loading estimates from 1979-93. The impact of increasing the number of septic tanks was estimated by calculating the increased nitrogen level in the aquifer that would result from additional systems. Average levels in the aquifer were calculated by dividing the estimated total annual nitrogen load by the estimated volume of recharge. A mathematical equation was developed that uses data on the number of septic systems, masses of nitrogen in creeks and diffuse recharge, the annual amount of nitrogen per septic system, and average recharge from creeks and diffuse sources to predict the average total nitrogen in recharge waters. Results of these experiments suggest that only relatively small changes in nitrogen loadings will result if significantly more (5,000) new on-site wastewater systems are utilized in the region. Another implication of the research is that use of substantially greater numbers of on-site systems will not likely create significant water quality problems or health risks.

TNRCC Publishes Guidance Documents, Reports, About New On-Site Wastewater System Regulations

The Texas Natural Resource Conservation Commission (TNRCC) Field Operations Division has recently published many reports, regulatory guidance documents (RGDs), and fact sheets with detailed information about new regulations concerning on-site wastewater systems (OSSFs).

In April 1997, TNRCC published two RGDs that provide clarification on the new rules. The fact sheets are titled *OSSF: Pipe Specifications between Treatment Tanks and from Treatment Tanks to Disposal Headers* and *OSSF: Permitting OSSFs Inside the Regulated Floodway*.

The RGD on floodways describes the conditions under which local governments can grant variances to the rules, which generally do not allow new on-site wastewater systems or substantial improvements to existing systems within regulated floodways. Regulated floodways are designated by maps produced by the Federal Emergency Management Agency and by studies conducted by professional engineers. The RGD states that, in order to obtain a variance, a professional engineer or registered sanitarian must demonstrate the following: 1) the location of the system will not result in damage to the system during a flood; 2) the location of the system will not result in contamination from the system during a flood; and 3) the tank will not float away during a flood.

On-Site Sewage Facilities Workshops (RG-276/EV) provides comprehensive information about the new rules. It includes RGDs on permitting and permit fees, soil analysis for OSSF site evaluation, use of the American Society for Testing and Materials standard specification for precast concrete septic tanks, use of pretreatment and trash tanks with aerobic wastewater treatment units, the use of the climatic atlas of Texas, electrical wiring, treatment and disposal of greywater, conditions for permit fee waivers, real estate inspections, and certification of OSSF installers, apprentices, designated representatives, and site evaluators. The report also includes a copy of the new rules and side-by-side comparisons of the old versus the new regulations.

To order these publications, contact the TNRCC at (512) 239-0028. For more information on the OSSF program, contact Warren Samuelson of the TNRCC at (512) 239-4799.

Texas Panhandle is Site of Many Innovative On-Site Systems

In the Texas Panhandle, conditions are near perfect for on-site wastewater treatment systems. The soils often don't pose a problem in treating wastewater, the groundwater is often deep enough that contaminating an aquifer is unlikely, and the long, hot, arid summers promote evaporation and transpiration to dispose of effluents. In this largely rural environment, many innovations in on-site wastewater treatment are being implemented that may have application in other parts of the state.

Jim McWilliams (left) and Mike Baker of the TNRCC Amarillo Region identify lakeshore on-site wastewater systems in the Tanglewood subdivision near Palo Duro Canyon.

The Panhandle area is served by the Texas Natural Resource Conservation Commission (TNRCC) regional office in Amarillo and other authorized entities. For example, the TNRCC service area covers 26 counties and stretches over 19,000 square miles. Everything north of a line from Parmer to Childress counties is included. TNRCC handles permitting and inspections in the counties that don't have their own programs. Typically, the TNRCC processes about 120 permits a year. TNRCC uses a three-person staff which is assigned to work with on-site wastewater systems and other duties.

Four counties in the region (Dalham, Hartley, Randall and Potter) and a few lake management agencies have their own authorized programs, and the TNRCC backs them up. For example, the Randall-Potter County Health Department, which serves the Amarillo-Canyon area, deals with as many as 600 permits annually.

"The area from Amarillo to Canyon is growing rapidly and much of that growth is served by on-site systems," says Don Manning, who manages the on-site program in the region. "Many people want a home in the country on a large lot that's still convenient to both cities."

Major On-Site Issues in the Region

Manning says the Panhandle region is very fortunate that many of the ideal conditions for on-site systems already exist in the region. "The area is land rich, but many of our residents are cash-poor. The result is that we can use larger tracts of land for treatment and provide effective treatment at a low cost," he says.

Still, there are some concerns and challenges. Many sites still dispose of wastewater in boreholes in which wastewater is simply sent down a large shaft. Typically, boreholes are dug 40' deep in the ground in a 4-foot-wide hole. Surprisingly, among the current users of boreholes are two county court houses and many schools and private residences. In one instance, a public school had installed 18 boreholes on its site. Problems showed up when a public drinking water well on the site exhibited signs of fecal bacteria contamination. "Boreholes can often be a non-polluting way to treat wastewater on-site if conditions are right," Manning says, "and we really can't require they be switched out unless and until a problem occurs. We want to stress that it is not legal to install boreholes today, but it is OK to utilize properly functioning existing systems."

Another challenge that is unique to the Panhandle is the regular occurrence of cold, freezing, winter weather. For example, the ground typically freezes to a depth of 2' in Dallam and Lipscomb counties (near the Oklahoma border) and to a depth of 1' near Amarillo. As a result, drainfields are often built deeper in the ground to provide additional insulation. "We advise that leaching chambers be installed at a depth of 5' in this region, even though the rules say that 2' is adequate. We do this both for freeze protection, as well as to make sure that the soil profile is really going to provide the treatment that homeowners want."

Along many parts of scenic Palo Duro Canyon, the challenge is to provide proper wastewater treatment on small lots built on steep slopes that sometimes, as in the case of

the Tanglewood subdivision, drain into sensitive lakes. Many homes are sited in a stair-stepped fashion where two or three lots virtually sit in a row going down a hillside. Some of the innovations being used near the lake include drip irrigation and the use of drainfield designs that use as much of the landscape as possible for wastewater disposal. Another potential problem near this lake, which cannot be remedied easily, is that many of the lakefront homes may have been built on lots that are too small to provide proper treatment. No studies have been performed to assess if these systems are failing and contaminating lake waters.

Innovations in On-Site Treatment

In many cases in the region, individuals and organizations have used creativity to develop innovative on-site systems.

In the 1980s two small towns in the region (Umbarger and Lazbuddie) were faced with failing systems and have sought alternatives. They worked with TNRCC staff and consultants to develop what is basically a huge septic tank and drainfield in each town. "There were a lot of very small (50' x 75') lots in each town which all had individual boreholes or conventional on-site systems," Manning says. "Our solution in Umbarger was to install a 44,000-gallon septic tank and a 30,720-square foot drainfield that sits on a 5-acre tract of land outside of town. The system works well because the natural conditions are conducive to conventional systems. We think this approach may be appropriate for other small towns in the region."

Much of the research and training in leaching chamber systems has originated in the region. For example, on-site officials worked with Bo Burroughs, an on-site professional who lives in the region, to evaluate and monitor the performance of leaching chambers and other on-site systems in the region. Since then, leaching chambers have become widespread in many parts of Texas. "We see a lot of benefits from the use of various leaching chamber technologies because they are easy to install, and they allow you to treat wastes more effectively and reduce the size of your drainfield," says Lezlie Cooper of the TNRCC. "Another advantage is that Childress and other towns in our region that are not located close to rivers and streams have a difficult time obtaining high-quality gravel from nearby sources. Because leaching chambers are gravel-less, they can represent a significant cost savings."

Other unique wastewater treatment strategies are also being used in the Panhandle. In the early 1990s, for example, an operator of a motel and restaurant in the small town of Conway was faced with a failing system. He worked with professionals to design and install a large evapotranspiration pond that works in combination with a conventional

septic tank. The system functions well and is designed to accommodate future growth when the operation expands.

Other sites in the region are incorporating water conservation and reuse into on-site wastewater treatment systems. For example, a mobile home park in Amarillo uses septic tanks and drainfields to serve groups of two to four trailers. Effluents leaving these on-site systems are used to water grassy medians and landscaped areas within the mobile home park. This provides opportunities for additional treatment, lessens the amount of water needed for irrigation, and produces a pleasing landscape.

NOTE: For more information, contact Don Manning of the TNRCC at (806) 353-9251.

TAMU Scientists Investigate Microbial Levels Near On-Site Wastewater Systems

Researchers at Texas A&M University (TAMU) are studying the microbiological components of on-site wastewater treatment systems. Project goals are to gain information about how wetlands plants and the microorganisms associated with them may enhance the performance of constructed wetlands used for on-site wastewater treatment, and to determine how various factors in drip irrigation systems influence microbiological populations in on-site drainfields. The scientists hope that the research may eventually provide insights on the role of plants and soils in wastewater treatment, the performance of specific on-site systems, the impact of these systems on water and environmental quality, and public health concerns.

Srinivasan Neralla (left) and Rick Weaver sample soils and microbial populations from this wetland used for domestic wastewater treatment near College Station.

The studies are led by researcher Richard Weaver and graduate student Srinivasan Neralla of the TAMU Soil and Crop Sciences Department. Many scientists and regulatory personnel are cooperating in the research, including George Sabbagh and Bruce Lesikar of the TAMU Agricultural Engineering Department. The project is funded through the Texas Natural Resource Conservation Commission Section 319 Program and by the Texas Agricultural Experiment Station.

"The overall goal for these studies is to determine the role of plants, or phytoremediation, in improving the microbiological properties of effluents from on-site systems, and to study the role of plants and microbiological organisms in reducing the biochemical oxygen demand (BOD) of wastewaters from on-site systems," Weaver says. "We also want to study how such factors as soil types, drip emitter flow rates, and water quality should be managed to retard the movement of potentially disease-causing microorganisms and lessen their survival rates."

Studying Microbiological Populations in Constructed Wetlands

Part of the studies involve monitoring of constructed wetlands and other systems used for residential on-site wastewater treatment in Bryan-College Station, Houston, and Stephenville. For example, a subdivision in rural Brazos County that is being studied contains a constructed wetland, a sand filter, a drip irrigation system, and a conventional septic tank and drainfield.

Samples are being taken at locations where wastewater enters and exits the treatment system. At some sites, soil, water and microbe samples are collected daily for a week or so while at other locations samples are gathered monthly. Most of the samples are taken near the surface. The soils are later brought back to Weaver's laboratory where they are analyzed for many parameters of nitrogen and microbiological types and populations. In addition, tensiometers are being utilized to gather information on subsurface moisture levels near the drip irrigation emitters.

"We want to determine the effect of plants on the survival of human-based intestinal microorganisms, BOD levels, and dissolved organic matter," Weaver says. "We know that different plant types vary widely in the numbers and types of microorganisms supported on their roots, and we know that fecal coliform bacteria levels are much lower in soils that have healthy microbial populations. We hope to identify the best plants for treatment and learn how to best manage them to improve water quality by reducing the organic matter load, nutrient content, and populations of disease-causing organisms. We also want to determine the

amount of organic matter microbes can consume." Preliminary research results from this project suggest that constructed wetlands with healthy growing plants may reduce BOD levels by roughly 70%, in part because microbes aid the treatment process. Already, Weaver and colleagues have evaluated the suitability of canna lilies and other plants for wastewater treatment systems.

Microbial Issues Associated with Drip Irrigation Weaver is studying the survival and movement of microorganisms around the emitters of subsurface drip irrigation systems. Residential drip irrigation systems utilized for on-site wastewater treatment are being studied in Brazos County and other sites. Various management strategies, including whether drip irrigation fields can be alternately wetted and dried, will be evaluated to determine if they can result in lower survival rates for microorganisms.

"We want to evaluate the movement and survival of microorganisms in various soils, with a special emphasis on how these systems can be managed to restrict the movement of these microorganisms and lessen their survival," Weaver says. In general, higher levels of these microorganisms survive when soils are moist and temperatures are relatively low, and the populations decline significantly when soils dry out and temperatures increase. "Our preliminary data indicate that the populations of fecal coliform bacteria next to drip irrigation emitters may be as much as 100 times higher than populations near the soil surface," Weaver says. "We want to specifically investigate how the flow rates and the amount of time flows are applied in these drip irrigation systems may influence microbial populations."

Weaver is cooperating with other scientists in related studies. For example, Bruce Lesikar and George Sabbagh of the TAMU Agricultural Engineering Department are working with Weaver to develop innovative designs and management strategies for drip irrigation systems that may also be efficient in reducing microbiological risks. In particular, they are investigating how the performance of drip irrigation systems can be enhanced by various designs and configurations.

Public Health and Other Issues Weaver is also investigating public health issues associated with on-site systems. This aspect of the studies will center on inventorying pathogens and microorganisms that may be present near sites used for the on-site

treatment and disposal of wastewater. "By and large, the nature and extent of microorganisms near many types of on-site systems has not been studied. We need to gather baseline data on microbe populations located close to on-site systems to be able to manage them to minimize public health risks."

NOTE: For more information, contact Weaver at (409) 845- 5323 or rw-weaver@tamu.edu or Sabbagh at (409) 845-4973 or gsabbagh@agen.tamu.edu.

First New Installer I Course Offered at Texas A&M University -- Corpus Christi

The first training courses required under new Texas Natural Resource Conservation Commission (TNRCC) regulations were recently offered in Corpus Christi and Tyler. Officials with the TNRCC and the Texas Engineering Extension Service (TEEX), which conducts the classes, say that many more courses will soon be on the way.

Paul Morris of TEEX (above) will teach many of the on-site classes. Here, he adjusts this low pressure dosing unit at the Bryan On-Site Wastewater Training Center.

Training for many types of on-site wastewater professionals was one of the major requirements of new regulations that were recently passed by the TNRCC. For example, the rules specify that persons working in the on-site wastewater field (including installers of basic and alternative systems, designated representatives, and site evaluators) must participate in comprehensive training courses and pass content-based exit exams. Finally, the rules state that required registration and certification be obtained by August 1998.

With these considerations in mind, it's little wonder that training courses have been on the mind of TNRCC staff and many affected parties. It's also a relief that the first course has been held and that many other courses are expected to follow shortly afterwards.

"We are facing a tremendous challenge to rapidly develop training courses for major categories and the manuals and other supporting materials that go along with them," says Warren Samuelson of the TNRCC Certification Section. "A lot of progress has been made in putting these courses together. It feels great to get some of the initial courses off the ground."

The first course was for installers of basic systems and was taught May 19-20 at Texas A&M University -- Corpus Christi by TEEX instructor Paul Morris. The course consisted of classroom lectures and exercises. In addition, a new manual produced specifically for this course was used for the first time. Roughly 34 people participated in the Corpus Christi class while 55 attended the traning in Tyler. Morris says, "The new courses provide more information about soils, which are a critical factor that must be understood if on-site systems are going to work. They provided installers with a basic understanding of which systems may work best in site-specific situations."

The schedule for the Installer I (basic installer) course is as follows: San Antonio (June 10-11), Wichita Falls (June 24-25), Austin (July 2-3), Bryan (July 10-11), Weslaco (July 22-23), and Mesquite (July 29-30).

TEEX plans to begin offering the Installer II course, which is required for those who want to install non-standard on-site systems (not conventional septic tanks and drainfields) as follows: Abilene (July 8-10), San Antonio (July 15-17), Mesquite (July 22-24), and Weslaco (July 29-31). The training schedule will also be posted on the Council's World Wide Web (WWW) site (http://towtrc.tamu.edu) and on the TEEX WWW site (http://www.tamu.edu/teex/).

To register or for more information about the classes, contact the TEEX Public Sector Training Division at (409) 862-8710. You can also contact Samuelson at the TNRCC at (512) 239-4799 for details about the TNRCC certification program.

NOWRA National Meeting Will be in College Station

The national meeting of the National Onsite Wastewater Recycling Association (NOWRA) will meet in College Station October 23-25. The theme of the meeting is "Defining and Proving Performance." The meeting will feature separate tracks for individuals in the academic, regulatory, and private sectors. The meeting will also feature exhibits and an awards banquet. For more details about the meeting, contact Pam Franzen of NOWRA at (800) 966-2942.

TNRCC Engineer Develops Method to Combine Soil Absorption, ET, to Reduce Drainfield Sizes

George Witta of Wittaworks Construction of Elgin installs this aerobic drip emitter system that Sherman Hart designed. The system is on a steep slope in West Austin and utilizes drip irrigation to efficiently dispose of effluents.

Combining the two most commonly used methods to dispose of wastewater in on-site systems may be a way to significantly reduce the size of drainfields, according to an engineer with the Texas Natural Resource Conservation Commission (TNRCC).

Sherman Hart is an engineer with TNRCC. He notes that the two ways that have always been used to dispose of effluents in on-site systems are soil absorption and evapotranspiration. Hart's idea is that these two principles can work in concert in designs he calls "evapotranspiration absorptive" or ETA systems. Hart says these systems can be designed to remove as much wastewater as possible.

An emphasis of Hart's work is to develop formulas that on-site wastewater professionals can use to design systems to take advantage of these properties. For example, he has developed relatively easy-to-use equations that can be used to predict the long-term acceptance rate and to determine the area needed for absorption systems. The acceptance rate is the amount of effluent that soils can accept before a layer that restricts infiltration builds up. He has quantified typical infiltration rates for loamy and sandy soils and generated formulas that can be utilized to predict the amount of evaporation that will likely occur from drainfields. Finally, he has developed a formula, based on the ETA process, that can be used to size drainfields that are often significantly smaller than conventional drainfields.

Applying the ETA Concept to Design Systems

Hart has also developed some general guidelines for the design of drainfields that utilize the ETA concept. First, effluents must be uniformly distributed in the drainfield and the site should be as level as possible. Hart suggests that drip irrigation is an ideal technology to use in ETA systems. Secondly, effluents must saturate the soils surrounding the points at which wastewater is applied. This ensures that wastewaters will flow downward into

the soil and be absorbed. Lines used to inject effluents into the soil must be in direct contact with the soil. Porous media widely used in many systems (gravel and rocks) should be avoided. Narrow or wide trenches or excavated beds can all be used in ETA systems. Third, path conductance should be minimized by choosing appropriate soils (loams) that have sufficient capillary height (5 to 15'). Such soils as clays cannot be used because they restrict water movement.

Hart also provides other design guidelines. For example, drainfields should be constructed to prevent surface runoff off the site. Drainfields with slopes of 5 to 10% and mounds are ideal because they help divert runoff. Vegetation can be planted on the drainfield to remove additional wastewater through transpiration, especially if they grow best during periods of high rainfall.

NOTE: The ETA concept has been used as a design method for OSSF systems installed in several arid counties in West Texas and the Panhandle. Hart recently presented a paper that deals with this strategy at an on- site wastewater conference in New Orleans that was sponsored by the American Society for Testing and Materials. The paper will be included in the proceedings from that conference. For details, contact Hart at (512) 239- 6020 or shart@tnrcc.state.tx.us.

Formulas Used in the ETA Process

1. Computing the Long-Term Acceptance Rate (LTAR)

   $$A = Q/R1$$

   "A" is the absorbic area of the drainfield, "Q" is the daily volume of wastewater discharged into the drainfield, and "R1" is infiltration rate.

2. Computing the Evaporative Process

   $$A = Q/R2$$

   "A" is the evaporative area of the drainfield, "Q" is the daily volume of wastewater discharged into the drainfield, and "R2" is the net surface evaporative rate.

3. Computing the ETA Process

   $$A = Q/ (R1 + R2)$$

   "A" is the drainfield area required for the combined impact of evapotranspiration and absorption, "Q" is the daily volume of wastewater discharged into the drainfield, R1 is the infiltration rate and R2 is the net surface evaporative rate.