Texas On-Site Insights
Information about On-Site Wastewater Treatment Systems in Texas
Volume 10, Number 2, August 2001

TTU Engineers Examine Designs of Sprinkler Systems Used for On-Site Wastewater Irrigation

A research project now underway at Texas Tech University (TTU) is evaluating current procedures used to design sprinkler systems used to distribute effluents from on-site wastewater treatment systems.

Project leaders include TTU Civil Engineering researchers Cliff Fedler and John Borrelli, graduate students Josh Wheeler and Martin Phlanz, and undergraduate student Michael Thomas. This study is funded by the Texas On-Site Wastewater Treatment Research Council.

The goal of this project is to develop a procedure or methodology that professionals can use to design and lay out sprinkler irrigation systems that are very effective at applying effluents, while minimizing the risk of groundwater contamination.

According the Fedler, the main effort of this project will be to examine published data from manufacturers about the characteristics of sprinkler heads and the patterns or areas that they cover. Once this information is examined, Fedler and Borrelli hope to propose designs that will achieve a high degree of uniformity of distribution.

“The basis of our studies is that we want to ensure that effluents are not being applied unevenly,” Fedler said. “If effluents are being distributed evenly over a lawn or landscape, we can greatly reduce the likelihood that areas of the field will be over- or

under-irrigated. As a result, we should be able to lessen the chance that some portions of a landscape will receive too much effluent, and thus pose a risk of applying excess nitrate or other nutrients into the soil profile."

Borrelli says a guiding principle in this project is that they want to design irrigation layouts that will achieve a uniformity of distribution of 80% or more – substantially greater than the performance of systems now being used. One way of doing this, he said, is to make sure that the areas or patterns wetted by individual sprinkler heads overlap.

"The idea is to develop designs that use more sprinklers and achieve greater uniformity without recommending so many sprinklers that the systems would not be cost-effective," he said. "We are now modeling and evaluating system designs on computers. We are using the linear uniformity coefficient developed by Karmeli Approach to estimate whether excess nitrogen is applied to a field."

According to Borrelli, preliminary results suggest that using these new guidelines could mean that homeowners would have to employ 10 to 20 additional sprinklers to dispose of effluents from a typical four-bedroom house.

Both Fedler and Borrelli say there will be a number of benefits that result from this project. For example, results of this project could be used to develop training materials or a curriculum to show sanitarians or professional engineers how to better design treatment fields for on-site wastewater treatment systems. In addition, information could be used to help regulators verify that irrigation systems have been properly designed.

"We're trying to help the onsite wastewater treatment industry make a transition to more efficient design of irrigation systems," Fedler said. "Many of the people working in on-site wastewater treatment will benefit from the step-by-step recommendations about system design that we will outline in this final report. If we can help them develop better irrigation designs and protect groundwater, this project will be very worthwhile."

NOTE: For details, contact Fedler at Clifford.Fedler@coe.ttu.edu, or Borrelli at john.borrelli@coe.ttu.edu. We will feature updates about this project in future issues of the newsletter.

TWRI Publishes Fact Sheet Describing Financial, Technical Assistance

The Texas Water Resources Institute (TWRI) has recently published a fact sheet that details financial and educational resources that may be available to replace failing on-site wastewater treatment systems in Texas.

The fact sheet, "Resources to Replace On-Site Wastewater Treatment Systems in Texas," was written by TWRI Information Specialist Ric Jensen. Publication of the fact sheet was provided by the Texas On-Site Wastewater Treatment Research Council (TOWTRC).

"I wanted to create this fact sheet because I ran into so many circumstances where local agencies that have to deal with replacing on-site systems were frustrated," Jensen says. "They simply didn't know where to turn for possible financial and educational assistance. I hope this fact sheet will at least point them to some agencies and organizations that may be of some help. It should make people aware of the many sources of help that are available."

Major sections of the fact sheet detail resources that can assist communities throughout Texas, as well as assistance that may be available specifically for entities serving the Texas–Mexico border. The fact sheet also includes resources about education and information providers. Contacts are provided for the 26 agencies that are listed in the fact sheet.

TWRI is now mailing the fact sheet to several agencies and organizations. In the near future, the fact sheet will be available from the TOWTRC WWW site as a PDF file.

If you would like a copy, contact Jensen at (979) 845-8571 or rjensen@tamu.edu. The fact sheets are free while supplies last.

HGAC Works with GLO to Propose Community Wastewater Systems for Towns on the Bolivar Peninsula

Often, finding a workable solution to remedy failing on-site wastewater treatment systems is something that can be done rather easily.

On the other hand, there are cases like the ones facing the small adjoining towns of Gilchrist and Canal City, where 548 homes sit on the Bolivar Peninsula that faces Galveston Bay.

Recently, the Houston–Galveston Area Council (HGAC) supervised an effort to determine if there were problems associated with septic systems on small lots that may be failing in this area. The project was led by Scott Bean of HGAC, and the engineering work was conducted by Allan Sims of Carroll and Blackmon of Beaumont. Funding was provided by the Coastal Conservation, which is a program administered by the Texas General Land Office and the National Oceanic and Atmospheric Administration.

Background Information

Certainly, there was enough evidence to suspect that on-site systems had some problems. These communities were identified as areas that may have wastewater problems, in an assessment HGAC had performed a few years earlier. Soils are sandy to a depth of 1.5' and are underlain by clay. There were reports that pipes from drainfields flowed directly into bar ditches. Lots are small, often only 50' x 70.' After a heavy rain, levels of fecal coliforms in nearby coastal waters rose to more than 2,000 fecal colony-forming units.

On the other hand, Bean says, there were factors that made the project difficult. Many of the houses at these sites are only used on the weekends, thus making it harder to convince the owners of these sites of the need to invest in repairs. Equally frustrating was the fact that contamination from existing OSSFs could not be proved. According to Bean, the problem may be that the sandy soils drain quickly. "If that's the case, you may not see much surfacing of effluents, even if there were failing systems.

As a result, it was difficult to find much enthusiasm among community members to solve a problem that it couldn't be conclusively shown really existed. "We proposed town hall meetings and met with the homeowner's association and the Bolivar Special Utility District, but until you can really convince people there is a compelling need to invest in change, it's very difficult to get them to do so."

Finding solutions

One of the main findings of the engineering study is that failing systems could not be replaced with new onsite systems because the lot sizes were too small to meet current state regulations.

Once new on-site systems were ruled out, the engineers then examined two community-scale systems – constructed wetlands, and a system that uses low-pressure grinder pumps to collect wastes followed by a package plant.

The cost of these systems was remarkably similar. The wetland would have cost $2.9 million to build and $22,000 annually to maintain. The grinder pump system would have cost $2.8 million to build and $75,000 to maintain. "In the meantime, we now require that property owners have to own or lease two or three small lots for disposal, if they want to spray irrigate effluents," Bean said.

Summary

"Before you start a project like this, you have to have evidence that there are water quality concerns," Bean said. "In the future, maybe we could use something like DNA testing to prove whether failing systems in this and other coastal areas are resulting in pollution."

Note: For more information, contact Bean at bean@hgac.cog.tx.us or (713) 627-3200.

Investigating Extent of OSSF System Failures is Emphasis of TOWTRC-Funded Project

Determining the extent to which on-site wastewater treatment systems may be failing throughout Texas is the emphasis of a study now being carried out for the Texas On-Site Wastewater Treatment Research Council.

The project is being conducted by Scott Pasternak and Kristen Keeling of the consulting firm of Reed, Stowe, & Yanke LLC of Austin.

Background Information

According to Pasternak, the project is using data from a variety of sources to determine the number of on-site wastewater treatment systems (OSSF) that are malfunctioning in Texas. They are also analyzing reasons systems may be malfunctioning. Several of the categories to consider as reasons systems may be malfunctioning include soils, climate, the age of systems, and maintenance practices.

In the initial phase of the study, the researchers conducted a thorough literature review (including articles presented in this newsletter) to attempt to quantify the extent of system failures. “We found some reports of system failures, but they only covered limited geographic areas,” Pasternak said.

“We needed a statewide study,” Pasternak said. “We learned about how OSSFs have failed in some cases, but we couldn’t find enough information to develop any statewide trends,” Pasternak said. “In fact, the literature search told us no comprehensive statewide studies had been done that satisfied the Council’s research goals.”

The next step of the project was to develop a survey instrument that could be sent to all the designated representatives in Texas. This would provide a statewide data source. To develop the questions that would be used on the final survey, the research team interviewed 10 to 20 OSSF professionals. The survey was pre-tested on selected members of the Council as well as others in the on-site wastewater treatment field.

Once the final survey was developed, it was mailed to 281 authorized agents and designated representatives in January 2001. Most of the surveys were returned by February 2001. After following up with phone calls, the research team obtained a final response rate of 64%.

Currently, Pasternak and Keeling are evaluating the data, both on a statewide basis and according to regions based on common soils and climatic characteristics.

Summary

According to Pasternak, this project will provide an indication of what people in the field believe are some of the critical issues that influence system failure, and will suggest areas where additional policy studies may be needed.

"We know problems are out there, since many people have commented about the problems of failing on-site systems, but no one has ever profiled the extent to which failures may occur or the reasons why for the entire state," Pasternak said. "We hope this project will shed some light on this issue and such related concerns as the pros and cons of grandfathering existing systems that may not be up to code, or the need for educational efforts."

Note: Pasternak can be contacted at (512) 450-0991 or spasternak@rsyllc.com. This project ends on August 31, 2001. Once the project is complete, information about the final results will be presented both in the newsletter and on the Council's WWW site.

New CD Published by Small Flows Clearinghouse

For more than 20 years, the National Small Flows Clearinghouse (NSFC) has been helping America's small communities deal with their wastewater issues. To allow greater access to its vast collection of materials, the NSFC is providing its most useful information on a CD-ROM titled "Wastewater Resources for Small Communities."

These resources will be of use to anyone who works with or has an interest in small community wastewater issues, including professional engineers and operators, government agencies, local officials, researchers, and homeowners. The CD puts a wealth of helpful information at the user's fingertips, such as:

- Statistics on the status of septic systems in the U.S. detailed by state;
- A series of septic system brochures in both English and Spanish;
- General and technical versions of fact sheets about 13 different technologies for treating and disposing of wastewater;
- An educational section that includes the poster, Onsite Wastewater Treatment for Small Communities and Rural Areas, which describes 23 different wastewater treatment technologies;
- More than 300 articles from NSFC's publications since 1989, including information from the "Small Flows" newsletter, the Small Flows Quarterly magazine, and the Pipeline newsletter; and
- The complete text of EPA's Response To Congress On Decentralized Wastewater Treatment Systems, which analyzes the costs and benefits of decentralized wastewater treatment alternatives and EPA's plans for implementing the alternatives.

The cost of the CD is $14.95 plus shipping. To order, call the NSFC at (800) 624-8301 or (304) 293-4191 or e-mail nsfc_orders@mail.nesc.wvu.edu.

Texas Tech Researchers Complete Study of Use of Evaporation, Evapotranspiration Rates

Researchers at Texas Tech University (TTU) are now wrapping up work on a research project to determine the combined effects of evaporation and evapotranspiration on the amount of effluents that can be removed from drainfields used for on-site wastewater treatment systems.

Background Information

The project, which was funded by the Texas On-Site Wastewater Treatment Research Council, began in August 1999 and runs through August 2001. The project involves a number of TTU researchers and graduate students. It is being coordinated by Lloyd Urban, the Director of the Water Resources Center at TTU.

In broad terms, the overall goal of this project has been to examine the effects of climate on rates of evaporation and evapotranspiration, in order to determine the volume of effluents the disposal fields can accept. Date from this study could potentially be useful in revising guidelines about drainfield sizing for arid portions of West Texas that experience significant water losses through evaporation and evapotranspiration.

According to Urban, some of the ancillary benefits of this project are that it brought together a large number of researchers and graduate students in the Civil Engineering Department to work on a challenging project, and that it presented an opportunity to develop a framework others may wish to follow in establishing a research design for field studies of on-site wastewater treatment systems.

In the early stages of the project, TTU researcher Andrew Jackson and graduate student Wesley Ingram performed a thorough literature review and developed a layout and design of the 2-acre research site at the Reese Center in Lubbock. As the project progressed, TTU researchers Andrew Jackson, Lloyd Urban, Heyward Ramsey, and Ken Rainwater worked with lab manager Brad Thornhill to develop a layout and design of the research site. Ingram and graduate students Amandeep Kang and Chang Yong Lee operated the site, collected samples, and analyzed data.

Anticipated Results from this Project

The project has already resulted in Master's theses by Ingram and Lee. Urban anticipates the project will result in journal articles and a technical report that will be submitted to the Council and publicized in this newsletter.

"Another important aspect of this project is the experience gained in the design, construction, and operation, of a carefully-controlled research facility that lets us simulate the performance of on-site wastewater treatment systems," Urban said. "We think that the system will give us results that fall in the range of values that can be expected in systems used in the real-world."

Besides providing technical data about evaporation and evapotranspiration, Urban says the project may provide insights into related issues. He is especially interested in the potential effect of newly constructed systems on smaller lots in suburbs on groundwater quality.

Summary

Note: Technical details of this project have been thoroughly described in previous issues of this newsletter. Once this project is completed, TWRI will distribute journal articles that result from this study as well as the technical report that will be presented to the Council. You can contact Urban at (806) 742-3597 or Lloyd.Urban@coe.ttu.edu

TNRCC Publishes Report Describing New OSSF Rule Changes

The Texas Natural Resource Conservation Commission has published a new book that summarizes the changes that were recently made to the state's OSSF rules for on-site wastewater treatment systems. The book, "On-Site Sewage Facilities Workshops," is report number rg-276/ EV-01 and was published July 1, 2001.

The bulk of the book features copies of presentation slides that were prepared by TNRCC staff to be used in workshops about the rules changes. The book also contains a copy of the new version of Title 30 Chapter 285, of the Texas Administrative Code, which governs OSSFs in Texas.

Note: In order to obtain a copy, I would suggest that you contact the TNRCC Publication Office at (512) 239-0028. Their fax number is (512) 239-4488. It should also be noted that there is a limited supply of these books, so contact the TNRCC early to get yours.

Meetings and Conferences; Training Opportunities

The Texas Engineering Extension Service (TEEX) offers many excellent continuing education classes related to on-site wastewater treatment. The Installer I class will be taught August 7–8 in Mesquite. Operation and Maintenance of Surface Irrigation Systems with Aerobic Treatment will meet August 14 in Midland and August 16 in Austin. Other courses taught by TEEX include the Installer II class, and training for Designated Representatives. To learn more, visit their web site at http://teexweb.tamu.edu, or call them at (877) 833-9638.

The WWW site of the Texas Natural Resource Conservation Commission (TNRCC) contains an list of resources describing opportunities for training and continuing education (CE). The WWW site lists approved providers for education relating to on-site sewerage facilities (OSSF), including educational institutions, governmental entities, and private companies. Dates and places classes are offered and the number of CE units available for participants are listed. For details, call the TNRCC OSSF Section at (512) 239-4799, or visit their WWW site at http://www.tnrcc.state.tx.us/enforcement/csd/ics/ossf_ceu.html.

The Texas Agricultural Extension Service is teaching a class, "Overview of On-Site Wastewater Treatment Systems." The class will be meet August 15 in El Paso, August 16 in Fort Stockton, and August 21 in Bryan. To learn more, visit their WWW site at http://ossf.tamu.edu.

The National Small Flows Clearinghouse (NSFC) is a tremendous resource for all kinds of information regarding on-site wastewater treatment and disposal. Free products available from NSFC include magazines, newsletters, and fact sheets. NSFC has published many reports on specific topics relating to this field. For details, visit them at http://www.nsfc.wvu.edu, or call (800) 624-8301.

The Texas Onsite Wastewater Association (TOWA) provides continuing education programs for installers and designated representatives. TOWA classes help people obtain continuing education credits required by the Texas Natural Resource Conservation Commission (TNRCC). Recently, TOWA has been sponsoring a series of continuing education classes throughout Texas They will offer training in Fort Worth on August 24. To learn more, contact TOWA at (512) 494-1125 or visit them on the WWW at http://txowa.org.

The 10th Annual Conference and Exhibition of the National On-Site Wastewater Recycling Association will meet October 10– 14 in Virginia Beach, VA. For more information, contact them at http://www.nowra.org or (301) 776-7468.

The Water Environment Federation is sponsoring a Conference, titled "Plant Operations and Maintenance of Small & Medium Wastewater Treatment Plants," September 16-18 in Cincinnati, OH. For details, visit the Federation's WWW site, http://www.wef.org.

The University of Minnesota at Duluth (UMD) is sponsoring a Conference titled, "Head of the Watersheds: Decentralized Wastewater Treatment." The Conference meets April 9–11, 2002 in Duluth. For details, contact Barbara McCarthy at UMD at (218) 720-4322 or bmccarth@nrri.umn.edu.

Texas Cooperative Extension offers first on-line course for CEU credit under the TNRCC on-site certification program. The 8-hour credit "Web-based Soil and Site Evaluation Basic Introduction" can be accessed at http://agextonline.tamu.edu, or call Jacque Hand at 979-845-7692 to register. For questions on the course, call John Jacob at 281-333-9216.

A&M Report Focuses on How Subsurface Drip Irrigation Affects Soil Chemistry, Structure

A technical report that describes the properties of soil media at sites where subsurface drip irrigation systems have been used for on-site wastewater treatment systems has been published by researchers at Texas A&M University.

The project was carried out throughout 1999 and 2000. The lead researcher was Bruce Lesikar of the TAMU Agricultural Engineering Department. Graduate students Ihab Jnad and Russell Persyn participated extensively in this project. The study was funded by the Texas On-Site Wastewater Treatment Research Council (TOWTRC).

Background Information

The objective of this study was to evaluate the influence of the application of domestic wastewater treated by septic tanks and constructed wetlands on the chemical and hydraulic properties of soils.

At many locations with problem soils, the use of conventional drainfields may result in continuously saturated soils, the rapid movement of effluents throughout the soil profile, and will limit the amount of treatment soils can provide. As an alternative, subsurface drip irrigation systems have been proposed as a method that will better control application rates, and that will distribute effluents more evenly through the drainfield.

The overall objectives of this project were to evaluate how the application of effluents into subsurface drip dispersal fields may result in changes in soil chemical properties, and to investigate whether this method may change such soil hydraulic properties as water retention, saturated hydraulic conductivity, and pore size distribution in the area around drip emitters.

A particular concern of this investigation was whether effluents with high concentrations of sodium may, in turn, increase sodium levels in soils. Several studies suggest that high levels of sodium, when combined with reductions in calcium and magnesium concentrations, may deteriorate the physical properties of soils.

Research Methods

The project was conducted by examining four residential systems located in different climatic regions of Texas. Systems were located in D'Hanis, Weslaco, Stephenville, and College Station.

The D'Hanis system treats domestic wastewater from a 3-bedroom house. Effluents first flow into a 1,000-gallon septic tank and later to a constructed wetland. From the wetland, effluents are sent to a 550-gallon pump tank and are then distributed to the drip dispersal system. The site uses two areas for subsurface drip dispersal, each measuring 16' x 50.'

The system in Weslaco treats wastewater from a two-bedroom house. Effluents flow into a 750-gallon septic tank and then into a subsurface flow constructed wetland. From the wetland, effluents flow into a 500-gallon pump tank and are then distributed to the subsurface drip field. Each area used for drip application is 20' x 50.'

At the Stephenville site, the system treats effluent from a 3-bedroom home, a recreational vehicle dump station, and a dog kennel. Wastewater from the home flows into a 1,250-gallon septic tank. Effluents from the dump station and the kennel are first sent to a 500-gallon septic tank before flowing into the 1,250-gallon septic tank. From the septic tank, wastewaters flow into a constructed wetland and, later, to a 500-gallon pump tank. The pump tank distributes effluents to two drip disposal areas that each cover an area of 920 square feet.

The site in College Station treated domestic wastewater from a three-bedroom home. Effluents flow into a 1,000-gallon septic tank and then into a subsurface flow constructed wetland. From the wetland, wastewaters are sent to 500-gallon pump tank. They are distributed to two drip dispersal areas that each cover 1,200 square feet.

Throughout the project, soil samples were collected along two transects from a drip emitter, along the drip lateral, and perpendicular to the drip lateral. All this was done to obtain data on the chemical and hydraulic properties of soils.

Grab samples of effluent quality were obtained monthly from the pump tank at each site. A portion of each sample was removed immediately to measure five-day biochemical oxygen demands (BOD-5). The remainder of each sample was frozen and analyzed for chemical oxygen demands (COD), ammonium, total salts, and a variety of nutrients.

Changes in soil chemical properties, saturated hydraulic conductivity, water retention, and pore size distribution were evaluated using an analysis of variance.

Results

One of the major findings of this study, Lesikar says, is that it shows that the quantity and distribution of chemical constituents in soils is influenced by soil properties, the extent to which soil structure affects water movement, the uptake of water and nutrients by plants,

the concentration of chemicals in being applied and in the soil, and the distance from the emitter.

The most important concern was the potential of wastewater application through drip irrigation to increase sodium concentrations in the soil. The project found that there was a slight increase in sodium and phosphorous levels in areas along the drip later, in part because grasses and crops do not take up relatively large amounts of these constituents.

Phosphorus concentrations were significantly increased near drip emitters, and at locations near the soil surface where the drip lines were installed. Lesikar says this could pose a pollution risk, especially if erosion and runoff occur.

No drastic changes were found in the concentrations of total nitrogen, calcium, magnesium, potassium, electrical conductivity, and total organic carbon in soils used for drip irrigation.

Application of treated effluents resulted in an increase in the amount of water that was retained in soils, and a decrease in saturated hydraulic conductivity. The volume of pores with large diameters was also decreased.

The area that will likely be influenced by effluent applications depends on such soil hydraulic properties as effluent quality, the rate at which effluents are applied, and the characteristics of soils.

At both study sites, the greatest impact of applying effluents on soils occurred at areas directly beneath drip emitters. These subsurface drip fields did not exhibit a severely clogged soil layer, like situations which are often found beneath conventional drainfields.

Summary

Lesikar says this research project is a needed first step into better understanding whether the use of subsurface drip irrigation for effluent disposal can be successful. The importance of this project is that it seems to suggest that subsurface drip dispersal may not adversely affect the hydraulic properties of soils and cause them to deteriorate.

Note: The report, "Characteristics of Soil Media Where Subsurface Drip Systems Are Being Used to Distribute Residential Wastewater," was submitted to the Council in June 2001. It will soon be posted on the TOWTRC WWW site, http://towtrc.tamu.edu.

Texas Tech Publishes Guide on Evapotranspiration Rates

A useful manual has been published by Texas Tech University that contains data on mean crop consumptive use and free-water evaporation for many locations throughout Texas. The report, "Mean Crop Consumptive Use and Free-Water Evaporation for Texas," was published in 1998. Authors include John Borrelli, Clifford Fedler, and James Gregory of the TTU Civil Engineering Department. This project was funded by the Texas Water Development Board.

The report includes comprehensive information on mean consumptive water use for agricultural crops and turfgrasses, as well as contour maps of evapotranspiration. It also includes crop coefficients, information on free-water evaporation from shallow ponds, ways to estimate irrigation efficiency, and leaching requirements for salinity control. The report also describes how you can use this information to design center pivot irrigation systems, to estimate evapotranspiration from wetlands, and to estimate water use by native vegetation. Information in this report will be very useful in determining how much effluent could be safely applied over a given area.

Note: This report is being sold by Texas Tech for $25. To place an order, email Clifford Fedler at clifford.fedler@coe.ttu.edu or call him at (806) 742-3597.