Texas On-Site Insights

Information about On-Site Wastewater Treatment Systems in Texas

Volume 3, Number 2, Fall 1994

Texas A&M Scientists Install Low Pressure Pipe System at Weslaco

Texas A&M University System researchers recently installed a low-pressure pipe (LPP) wastewater treatment system at Weslaco. Texas A&M University (TAMU) professionals involved in the project include Bruce Lesikar and Guy Fipps of the Texas Agricultural Extension Service and the TAMU Agricultural Engineering Department, and Bob Wiedenfeld of the TAMU Research and Extension Center at Weslaco.

The system may be useful in areas where conventional systems are likely to fail. That's because LPP systems provide relatively uniform distribution of effluent; dosing and resting cycles for wastewater discharge, and the shallow placement of pipe in trenches. LPP systems can be designed to fit the needs of specific sites by modifying hole size and spacing, water pressure, spacing between distribution pipes and laterals, and the dosage volume and time between applications.

System Design

The site is located at the TAMU Center at Weslaco. The soil is a sandy loam, with a loading rate of 0.3 -0.4 gallons per day. The system is designed to treat up to 300 gallons per day. Effluents from two mobile homes flow through a microbial reed rock filter to a pump tank. From the pump tank, they are pumped through supply lines and distributed to lateral lines. Wastewater flows from lateral lines (which contain small holes) into trenches that are filled with gravel or chipped tires. Soil surrounding the trenches absorbs effluents and completes the treatment process as wastewater percolates into the soil.

Bruce Lesikar (above) installs a pump that will provide a source of wastewater for supply and lateral lines.

The surface elevation was measured at 5-foot intervals, and a topographic map was developed using SURFER computer software. The location for the LPP field was plotted, using information from the topographic map. The lateral lines were curved along contour lines of equal elevation, so that the full length of each line is at the same elevation. Earthen dams were constructed in the lateral trenches to hold the wastewater until it infiltrates. This also ensures that effluents will be applied evenly. Supply lines (the center pipe) distribute effluent to each lateral line and are not perforated.

System Installation

The system was laid out on the soil surface and the sites for trenches and pump were marked. Then, the lateral lines and distribution trenches and the site for the pump tank were dug. Trench lines were dug 18" deep and 6" wide, and lateral lines were 12" deep and 6" wide. The hole for the pump tank was 6' deep and 5.5' square. The pump tank was connected with PVC pipe to the microbial rock filter. Sixteen pieces of 1.25" diameter PVC pipe were cut to a length of 13 feet. Risers were built and attached to the lateral lines. Holes were punched in the lateral lines, according to design specifications. A 1.5" supply line was made to connect the pump tank and the supply trench. Fourth, 3" of gravel or chipped tires were placed in trenches above and below the lateral lines. They were topped with 3" of hay and soil.

Workers in Weslaco install lateral lines. The trenches are curved so that each lateral line is at a constant elevation.

Future plans

Lesikar and the other scientists are now operating the system and will monitor water quality results. For more information, call Lesikar at (409) 845-7453, Fipps at (409) 845-7454, or Wiedenfeld at (210) 968-5585.

Harris County Evaluates Trickling Sand Filters, Surface Irrigation to Treat Wastes On-Site

The Harris County Engineer's Office is now evaluating low cost, low maintenance methods to treat and dispose of wastewater onsite.

John Blount of the Engineers' Office is testing systems that rely on a high rate trickling filter and wastewater irrigation. Although a significant amount of research has been conducted previously on high rate trickling filters, this project is unique because it will evaluate filters with very high recirculation rates. The initial system was installed earlier this year, and is now being evaluated. Additional units are being designed for unincorporated areas of Harris County.

The overall goal of the project is to determine if effluents can be treated to a secondary level using a high rate trickling filter. Effluent from the filter would then be discharged through a reliable and inexpensive surface irrigation system.

Blount explains that trickling filters typically produce reliable results, even when under stressful conditions. However, levels of biochemical oxygen demand (BOD) and total suspended solids (TSS) are often too high (30 to 50 parts per million or ppm). Sand filters produce extremely high quality effluent (TSS and BOD levels of only 5 to 10 ppm). The problem with sand filters is that often only a small amount of wastewater (1.5 to 3 gallons per day) can be treated per square foot of surface area. This makes these systems large and uneconomical. Surface irrigation is inexpensive and reliable, but adding extended aeration to improve water quality often increases costs substantially.

System Design and Operations

Primary treatment will be accomplished with the use of a septic tank followed by a high rate trickling filter. The organic loading rate is expected to be 45 lbs. of BOD per day per 1,000 square feet. Hydraulic loading rates will average 235 gallons per day per square foot. The effluents will be recycled through the filter several times a day to prevent odor problems. A recirculating tank will hold 1.5 times the average daily flow rate.

Filtered effluent will be pumped into an elevated 18" diameter concrete or plastic pipe chamber. Effluents will be treated as they flow through the media and will be recycled within the system.

Effluents will exit the recirculating tank through a "T" and will be routed to a chlorinator. If suspended solids are greater than 20 ppm, the "T" will be replaced with a commercial effluent filter. When more effluents enter the system, the treated effluent will be forced out of the tank, chlorinated, and sent to a pump tank. An automatic irrigation system will distribute the effluents in early morning hours to water lawns. Hard limestone and crushed tires will be evaluated as filter media.

For details, call Blount at (713) 956-3000.

Dewatering Septage with Wood Chips to Produce Compost

By Susan Parten
Community Environmental Services, Inc.
Austin, TX

In many areas, properly disposing of septage is a difficult problem. Many wastewater treatment plants don't accept septage because of its physical and chemical characteristics. New Federal rules have created strict requirements about how septage must be treated before it can be land applied. Illegal dumping of septage is a major environmental problem.

This paper summarizes the activities of a research project to promote beneficial reuse of septage. The study was funded by the Texas On-Site Wastewater Treatment Research Council in 1993. The goal is to demonstrate a method to dewater and filter septage with wood chips. The method converts spent batches of wood chips and sludge (biosolids) to a compost product. Effluent from the wood chip filtration process may be suitable for some water reuse projects, with very little additional treatment.

Domestic septage from the Austin area was delivered to the research site in Manor, TX (just east of Austin). The septage was dewatered, filtered, and blended with wood chips to produce compost.

The pilot scale septage treatment unit has three components: 1) a 40 cubic yard solid waste roll-off unit; 2) a pump tank with pipes and valves that lead to two additional tanks; and 3) two 2,100 gallon tanks which can be used to store wastewater to be cycled through the wood chips and to contain final effluent.

The system is now operating in Manor, TX (just east of Austin). Domestic septage is transported to the site from the Austin area. Final effluents from the pilot plant are sent from Manor to an Austin wastewater plant for final treatment. The spent wood chips and sludge are now being composted at an Austin area landfill.

The project works this way. Raw septage is applied to the surface of the wood chips through a perforated pipe. Effluent is collected from the bottom of the wood chips and can be pumped to the recycling tank or the final effluent storage tank. Currently, the wastewater is recycled only once through the wood chips. Effluent quality is being monitored and analyzed for total suspended solids (TSS), total solids (TS), biochemical oxygen demand (BOD), and other parameters to evaluate the treatment process.

Performance of the System

The treatment process appears to behave much like a ripening sand filter. As septage continues to be applied, a layer of sludge begins building up on the surface of the chip bed. When septage is applied to the surface of fresh wood chips, the amount of TSS that is removed increases significantly. This enhances solids removal. As large amounts of sludge (4 to 6 inches) accumulate on the surface, the time needed to filter and dewater septage also increases.

When raw septage flows through the chips and is recycled once, 83 to 99% of TSS is removed. The average BOD of the filtered effluent is 360. The filtrate has little odor.

Significant labor was required to load and unload the wood chips. Mechanical and structural modifications are being considered for the treatment unit, which will reduce the amount of labor.

Conclusion

To reuse filtrate from this process, it would be desirable to dispose of it in some type of surface or subsurface treatment system. Additional treatment would be needed before the compost could be used for land disposal projects.

Based on the results obtained to-date, the compost may meet municipal pretreatment requirements and could be discharged and treated at a municipal wastewater treatment plant. If it were not possible to dispose of the waste in a land treatment and disposal system, this process could still be used to pretreat septage prior to final treatment.

Ideally, the spent wood chips and biosolids would be composted and beneficially reused. Further data from the project will answer such questions as the average septage loading rate for a given area of wood chips before clogging will occur, and designs that could be used to configure units to increase effluent quality.

NOTE: This project was featured in the April 1994 issue of *Biocycle* magazine. Parten can be reached at Community Environmental Services in Austin at (512) 443-2733.

Problem Soils of Galvestion Island Limit Use of On-Site Systems

By Bobby L. Carlile
B. L. Carlile and Associates
Bryan, TX

Coastal soils of Galveston Island and Bolivar Peninsula are characterized by several problems, including seasonally high water tables, rapidly percolating sands, and even some shrink-swell clays. The soil problems are compounded by the development of many near-coastal lots with less than 10,000 square feet.

If conventional septic tanks, soil absorption trenches or evapotranspiration beds are used in these conditions, they should be placed in mounds of fill material that are 2 to 3 feet above grade. This will provide a minimum of 2 feet of separation between the disposal field and groundwater. If pre-treatment is provided, the separation distances can be reduced and groundwater can still be protected.

Such characteristics as high population density; small lots; sites near coastal waters; high groundwater tables, and highly permeable sands; can all make it difficult to successfully operate an on-site wastewater treatment system. Unfortunately, all these limitations are present in Galveston Island and Bolivar Peninsula. An additional obstacle is that large numbers of visitors use the Island for contact recreation, thus increasing loads during peak seasons and creating a need for very high quality effluents.

According to a recent soil survey, soils of Galveston Island and the Bolivar Peninsula all have "severe limitations" for septic tanks due to wetness, surface runoff, ponding, and poor filtering. Twenty-one of the 25 soils mapped on the island are classified as hydric or wetlands soils. The other four are all less than 3 feet away from the water table. The only exception is for beach-front dunes, which cannot be used for waste systems under current rules. The bottom line is that there are no significant areas on Galveston Island or Bolivar Peninsula that have soils or water table depths that are suitable for a conventional septic tank and soil absorption system.

Soils on which development occurs are typically divided into Class A, B, and C groups. The classifications are used to determine which type of on-site systems can be approved. A list of the soil types in Galveston County and their impact on the potential use of on-site systems is shown in table 1.

Designing Systems for Galveston Island

I believe the key to designing conventional systems that will work on Galveston Island is to treat wastewater through at least 2 feet of aerobic, unsaturated soils. The addition of sandy soils; a 2-foot separation between the on-site system and groundwater tables; controlled waste loadings and wastewater pretreatment may be needed to protect water quality.

Systems have been designed and installed in beach areas of Galveston County that offer maximum water quality protection. These systems provide the following: 1) Wastewater is applied in the upper soil zones or in fill material; 2) Distribution of wastewater is improved to prevent overloading of the soils; 3) Wastewater is dosed to allow resting and drainage of the disposal field to enhance aerobic processes; and 4) Wastewater is pretreated and disinfected before it is applied to the soil.

By accomplishing all of these criteria, soil separation distances may be reduced from 2 feet to 1 foot, while still protecting the environment. I have designed systems that meet these requirements. One unit uses anaerobic and aerobic pretreatment and disinfection. It disposes of effluents with trickle irrigation at a depth of 6 to 8 inches. This system is now being used by 8 single family homes and 3 businesses on lots as small as 5,000 square feet and has functioned with little or no problems for more than a year. I have designed a system that uses anaerobic and aerobic pretreatment, and disinfection. It disposes of effluents using pressure dosing in a mound system. Two homes and one business are now using this system.

Summary

It is possible to design on-site wastewater systems that function properly, even in areas with problem soils such as Galveston Island and Bolivar Peninsula. However, special considerations need to be made to assure that water quality is not degraded. Although these systems were designed for extreme circumstances, they are also applicable to other regions of Texas.

Hydraulic Properties of Bed Media for Constructed Wetlands

By Glenn Turner, Bruce Lesikar and Guy Fipps
Agricultural Engineering Dept., Texas A&M University, College Station, TX

Subsurface flow constructed wetlands typically use emergent aquatic plants that are grown in beds of porous media. Effluents flow through the bed and remain below the surface of the media. Pollutants are removed by microbes and plant roots that are attached to the media, and by precipitation and adsorption.

Texas A&M graduate student Glenn Turner plants umbrella palms in a trough being used as a filter bed.

More data is needed on proper hydraulic designs for subsurface flow systems. The hydraulic properties of beds must be known to prevent problems with surface runoff, incomplete treatment, odors, mosquitoes and vectors. The growth of plant roots and the maturation of beds need to be considered. Constructed wetlands are inexpensive and the use of shredded tires makes them more economical by reducing the cost of the filter bed.

The goal of this project was to determine the hydraulic properties of various types of porous media that can be used in subsurface flow wetlands. The objective was to evaluate the hydraulic conductivity and porosity of five types of media; and to assess the suitability of shredded tires in subsurface flow constructed wetlands.

Design and Construction

The types of media evaluated in this project were: 1) coarse sand, 2) 3/8ths" pea gravel, 3) 1" river rock, 4) "bull rock" or graded 3" to 5" river rock, and 5) 2" shredded tires. The sand, gravel, bull rock, and medium rock samples were purchased from a contractor and pre-washed. The shredded tires were obtained from a plant in Cleveland, TX, but the steel and iron fragments were not removed.

Sieve analyses were conducted on the sand, pea gravel, medium rock, and bull rock to determine their size distributions and effective particle diameters. The media were placed in 10 troughs that served as bench scale subsurface flow systems. The dimensions of the troughs are 2' wide, 8' long, and 18" high. The troughs were built and arranged so that their bed slopes could be changed by lifting one end with a forklift. The troughs were constructed with plywood and lumber, were lined with fiberglass resin, and were caulked with silicone. They were installed on the Texas A&M University campus in College Station. The troughs were filled to a depth of 1' with each type of media.

Simulated effluents were stored in a 2,000 gallon holding tank and flowed by gravity from the tank into a header pipe and the troughs. Flow was evenly dispersed by a distribution well in both ends of each trough. Water levels were maintained just below the media surface in each trough by using adjustable stand pipes. Dwarf umbrella palm was the only plant species used for vegetation, because it is hardy and fast growing, has extensive root systems, and is not sensitive to changes in sunlight. The plants were purchased from a local greenhouse and 14 plants were placed in each bed.

The researchers simulated the biochemical oxygen demand (BOD) and nutrient levels in domestic sewage effluent by adding dry dog food and water-soluble fertilizer to tap water. The dog food was used as a source of organic matter. The water was tested periodically to ensure that nutrient and BOD levels were within the range of typical domestic septic tank effluent. Actual domestic wastewater was not used because of problems in obtaining, transporting and storing it. The hydraulic conductivity of each trough was measured by removing its stand pipe and allowing water to flow freely. Porosity was measured by draining each trough and measuring the volume of water needed to refill it.

Operation, Results, and Discussion

The operation of this project was successful, but there were problems with leaks from the troughs, excessive solids in the water and plant die-off. All the wooden troughs leaked. The wood shrank and swelled and the resin pulled away from the wood and cracked as the weather changed. The use of dog food may have caused high levels of solids in the water. During the first month of the study, dry dog food was poured into a tank, but it did not break down, remained suspended, and clogged the system. The problem was solved by allowing the dog food to break down before it was added to the system. Although 140 dwarf umbrella palms were planted, 23 died. Cuttings from some of the healthier plants showed that roots were long enough to reach the bottom of the media.

The study provided extensive data on the hydraulic porosity and conductivity the media types that were studied. Values for hydraulic conductivity were highest for bull rock and tires. Hydraulic conductivity values declined sharply for all the media from April to May. This is probably because the beds matured as solids began accumulating and plant roots were established. This filled void spaces and restricted the amount of water that flows through the system. Porosity values dropped for all media from February to March, when the system began maturing. Small pore spaces were filled first and this reduced open spaces that water can flow through. A few problems were observed with the shredded tires. Some tires contained a thin layer of grease that produced an oily film during the first month of operation. Jagged steel and iron fragments in the tires posed a safety hazard and added iron to the water when they were oxidized. Despite the problems, shredded tires seem to be ideal for use as a bed media in these systems.

NOTE: This project is still being monitored, and is the topic of Turner's M.S. Thesis. For details, call Lesikar at (409) 845-7453.

Brazos River Authority Tests Water Quality at Lake Granbury, Designs Innovative Treatment System

By Dennis Qualls and Tom Coury
Brazos River Authority
Waco, TX

The Brazos River Authority (BRA) has recently initiated two projects that deal with the impact of on-site wastewater systems on Lake Granbury. Lake Granbury is an 8,700 acre reservoir located north of Glen Rose in Central Texas, that can store up to 153,485 acre feet (AF) of water. The lake is long and narrow and has 103 miles of shoreline. The Texas Natural Resource Conservation Commission (TNRCC) has classified the use of lake waters to include "high aquatic life, public water supply, and contact recreation." The TNRCC requires that waters for contact recreation contain less than 200 fecal coliform forming units per 100 milliliters (cfu/ 100 ML), but 10% of the lake's waters exceeded this standard in 1991.

Part of the reason for the high fecal coliform levels is the rapid population growth in the area. Although only 5,000 people live in the town of Granbury, the population around Lake Granbury has grown to roughly 25,000 residents. Most of these are served by septic tanks and on-site wastewater systems.

The BRA projects include a study to assess if on-site systems are adding pollutants to the lake, and a proposal to develop an innovative treatment system that could be useful on lots near the reservoir.

Water Quality Assessment

Because of concerns that failing on-site systems might be a source of nonpoint source pollution to the lake, the BRA conducted a water quality study to determine if on-site wastewater disposal fields were adequate to protect against surface and ground water contamination. The study was conducted by Tom Conry and Dennis Qualls of the BRA, Wilson Snyder and Jim Edwards of the TNRCC, and Rod White of the Hood County Health Unit (HCHU).

Objectives of the study were to: 1) Determine the path that nutrients follow as they migrate from septic systems to the lake; 2) Identify the source of fecal contamination in the lake coves; 3) Evaluate data and recommend solutions to decrease eutrophication in the lake; 4) and supplement water quality data in lake coves.

Monitoring wells were placed at least five feet from the absorption field at a maximum depth of five feet. The function of the wells is to collect any shallow groundwater or effluent near the drain field. A key part of the study was that representative systems were selected for monitoring. Those systems included different soil types, lot sizes, ages of systems, and the regulations that were in place when systems were installed. Initially, it was hoped that 16 systems could be evaluated, but funding constraints and a lack of interest by homeowners reduced the sample size. BRA officials note that many homeowners did not want their system to be monitored because they feared data might show their system was malfunctioning. Many homeowners also commented that they ultimately favored a centralized wastewater treatment and collection system, if it was cost-effective.

The following criteria were used to select the systems that would be studied: 1) Owners must give permission to install the monitoring well; 2) The system must be representative of those near the lake; 3) Each system had to be installed under different State septic regulations; 4) Major soil types should be represented; 5) Systems had to be in use year-round; 6) Sites had to correspond with locations that were identified as having high levels of fecal coliforms in 1991 testing by the TWC; and 6) Systems had to be within 500 feet of the lake.

Four wells were installed at selected sites. A description of the four systems that were monitored is shown on the table. The location of each site is shown in the map (above).

Wells at Holiday Estates, Scenic Vista, and Oak Trail Shores were installed in February, 1992, while the well at Laguna Vista was installed in March, 1992. The Laguna Vista site is located directly on the lake, while the others are situated near coves. It was difficult to properly place the monitoring wells because homeowners kept inadequate records and adsorption trenches could not be located.

Water quality samples were gathered monthly by BRA personnel from February 1992 to April 1993. Grab samples were taken from the monitoring well and from the cove or lake. Samples were analyzed for fecal coliform, dissolved oxygen, pH, specific conductivity, temperature, salinity, phosphate, nitrate, sulfate, nitrate, ammonia, and biochemical oxygen demand (BOD), and carbon oxygen demand (COD). The wells were removed in May 1993. Samples were analyzed by the TNRCC lab in Houston and the HCHU lab in Hood County. Initially, it was planned that tracer tests would be conducted to follow how pollutants flowed from plumbing systems to the lake. The tracer tests were not conducted.

Results show that fecal coliform levels are *inversely* related to lake levels. Lake levels were highest at the beginning of the study and declined through the first eight months. Coliform levels were highest during December for all sites. This suggests that there may be a closer relationship between groundwater and surface waters than was previously understood.

The TNRCC standard for contact recreation (200 cfu/100 Ml) was exceeded four times during the study. Roughly 8% of the samples were greater than this standard. The data also suggest that there are increasing levels and increasing frequencies of fecal coliforms in the main body of the lake. COD levels were slightly elevated, but were twice as high at Holiday Estates than any other site. DO levels in the coves appear to be independent of the overall dynamics of the lake. DO levels from Oak Trail Shores show the most variation, which suggests that flows from the lake are not adding oxygen to cove waters.

Design of an Innovative On-Site Treatment System

The BRA is now in the process of designing an innovative on-site system that will combine a septic tank, an intermittent sand filter, a constructed wetland and ultraviolet disinfection. The system, which is being funded by the Johnson County Electric Cooperative (JCEC), may be ideal for lakeside homes that need on-site treatment. Project leaders include Brent Northcutt, Danny Nichols, and Joe Ballentine of JCEC, Tom Conry and Dennis Qualls of BRA, and Bruce Lesikar of the Agricultural Engineering Department at Texas A&M University.

The general basis of the system is that intermittent sand filters can regularly produce high quality effluent and have a low rate of failure. Most importantly, sand filters change ammonia to nitrate nitrogen. The constructed wetland would be able to utilize the nitrates, while providing additional treatment. Ultraviolet light could serve as an effective and economical way to control microbiological pathogens.

It needs to be stressed that the system is still in the final design stage. However, a few generalizations can be pointed out. Existing septic tanks will be used for primary treatment and settling. This will remove some solids and prevent the sand filter from clogging prematurely. Wastes will flow from the septic tank into a 10,000 gallon holding tank. The holding tank will feed the sand filter. The sand filter will be enclosed but not totally buried to make it easier for researchers to study the system.

The system will initially be designed for a small cluster of about 20 homes. If successful, the system could be expanded to treat wastes from as many as 40 homes. The system is being designed based on a flow of roughly 5,000 gallons per day (3.47 gallons per minute). The system will use very little electric power, because automatic timers will be programmed to provide electricity only when it is needed. The sponsoring agencies also hope that some power can be produced from the project, in the form of methane gas.

Preliminary plans call for the system to be monitored for such standard parameters as ammonia, BOD, COD, ph, nitrogen, nitrate, nitrite, total dissolved solids, total suspended solids, and others.

NOTE: Conry can be reached at (817) 772-1010, and Qualls can be contacted at (817) 776-1441.