WEKIVA BASIN ONSITE SEWAGE TREATMENT AND DISPOSAL SYSTEM STUDY

Bureau of Onsite Sewage Programs
Division of Environmental Health
Florida Department of Health

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John O. Agwunobi, M.D., M.B.A., M.P.H.
Secretary, Department of Health

Jeb Bush
Governor

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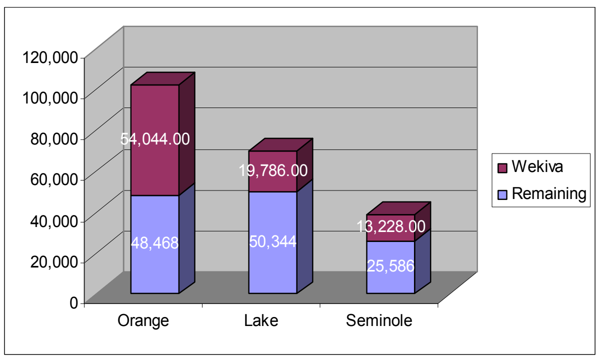
EXECUTIVE SUMMARY

This study was prepared for the Governor and the Florida Department of Community Affairs in response to section 369.318, *Florida Statutes* (*F.S.*). The statute requires the Department of Health to study onsite disposal system standards needed to achieve nitrogen reductions protective of groundwater quality within the Wekiva Study Area. The department is required to consider a more stringent level of wastewater treatment to reduce the level of nitrates and implementation of a maintenance and inspection program, including the upgrading of existing systems and funding mechanisms.

The Wekiva Study Area is underlaid by a karst geology characterized by limestone or dolostone bedrock with caves and springs. Conventional septic tank and drainfield systems have been used in the area as a relatively low-maintenance, low-cost method of safely treating and disposing of human waste. The estimated numbers of septic systems by county are shown in Figure 1.

Figure 1: Total numbers of septic tanks by county and the number of systems within the Wekiva Study Area



Based on recent in-state research it is now known that conventional septic tank and drainfield systems discharge nitrogen into the ground waters of karst regions like the Wekiva basin. Using existing Florida research data, a family of four will discharge 25 pounds of nitrogen per year into the drainfield of a conventional onsite sewage treatment and disposal system. A conventional system costs from $5,500 to $7,500. A comparable nutrient reduction system costs from $7,500 to $9,000. In areas where development densities are low, the overall costs of onsite sewage treatment and disposal systems are less than sewering. Onsite sewage treatment and disposal systems can provide protection of the environment and the public health that is comparable to a central sewer system.

The Department of Health recommends the following:

- Set a discharge limit of 10 milligrams per liter of total nitrogen for new systems, systems being modified, and for existing systems in the primary and secondary Wekiva Study Area protection zones.

- Prohibit the land-spreading of septage and grease trap waste in the Wekiva Study Area. Septage waste would be required to be disposed of at wastewater treatment plants.

- Evaluate the economic feasibility of sewering versus nutrient removal upgrades to existing onsite sewage treatment and disposal systems. A phased-in approach to replacing the remaining existing systems should be developed with a target completion date of 2010.

- Establish new regional wastewater management entities or modify existing ones to oversee the maintenance of all wastewater discharged from onsite sewage treatment and disposal systems in the study area. These programs should take the privatization approach and contract with existing licensed septic tank contractors.

INTRODUCTION

This study was prepared for the Governor and the Department of Community Affairs in response to section 369.318, *Florida Statutes* (*F.S.*). The statute requires the Department of Health, "to study the efficacy and applicability of onsite disposal system standards needed to achieve nitrogen reductions protective of groundwater quality within the Wekiva Study Area including publicly owned lands." By March 1, 2005, it also requires the department to, if appropriate, "initiate rulemaking to achieve nitrogen reductions protective of water quality or recommend legislation for any additional statutory authority needed to implement the report recommendations." The study will consider:

> (a) For new developments within the Wekiva Study Area and any existing development within the Wekiva River Protection Area using onsite disposal systems, a more stringent level of wastewater treatment, including, but not limited to, the use of multiple tanks to combine aerobic and anaerobic treatment to reduce the level of nitrates.
>
> (b) The implementation of a septic tank maintenance and inspection program which includes upgrading certain onsite disposal systems permitted prior to 1982 to meet minimum Department of Health standards; replacement of failing systems and systems not meeting current standards; and providing funding mechanisms for supporting a septic tank inspection and maintenance program.

The Wekiva Study Area is underlaid by karst geology, which is characterized by limestone (Figure 2) or dolostone bedrock with caves and springs.

Figure 2: A sample of Florida limestone from a karst area. Note its porous nature.

Conventional septic tank and drainfield-type onsite sewage treatment and disposal systems have been used in the area for many years as a relatively low maintenance, low cost method of safely treating and disposing of human waste. The estimated numbers of septic systems by county are shown in Figure 1. Based on recent in-state research, it is known that conventional septic tank and drainfield-type onsite sewage treatment and disposal systems discharge nitrogen into the ground waters of karst regions like the Wekiva basin. Using existing research data from Florida, a family of four will discharge just under 25 pounds of nitrogen per year into the drainfield of a conventional onsite sewage treatment and disposal system. Although more expensive than conventional septic tank and drainfield systems, nitrogen–removing, onsite sewage treatment and disposal systems are now available.

Even with the added costs of nutrient removal technologies, onsite sewage treatment systems remain a viable option for wastewater disposal. In areas where development densities are low, the overall costs of onsite sewage treatment and disposal systems are less than sewering. Onsite sewage treatment and disposal systems can provide protection of the environment and the public health comparable to central sewer.

THE IMPACT OF ONSITE SEWAGE TREATMENT AND DISPOSAL SYSTEMS ON PUBLIC HEALTH AND THE ENVIRONMENT

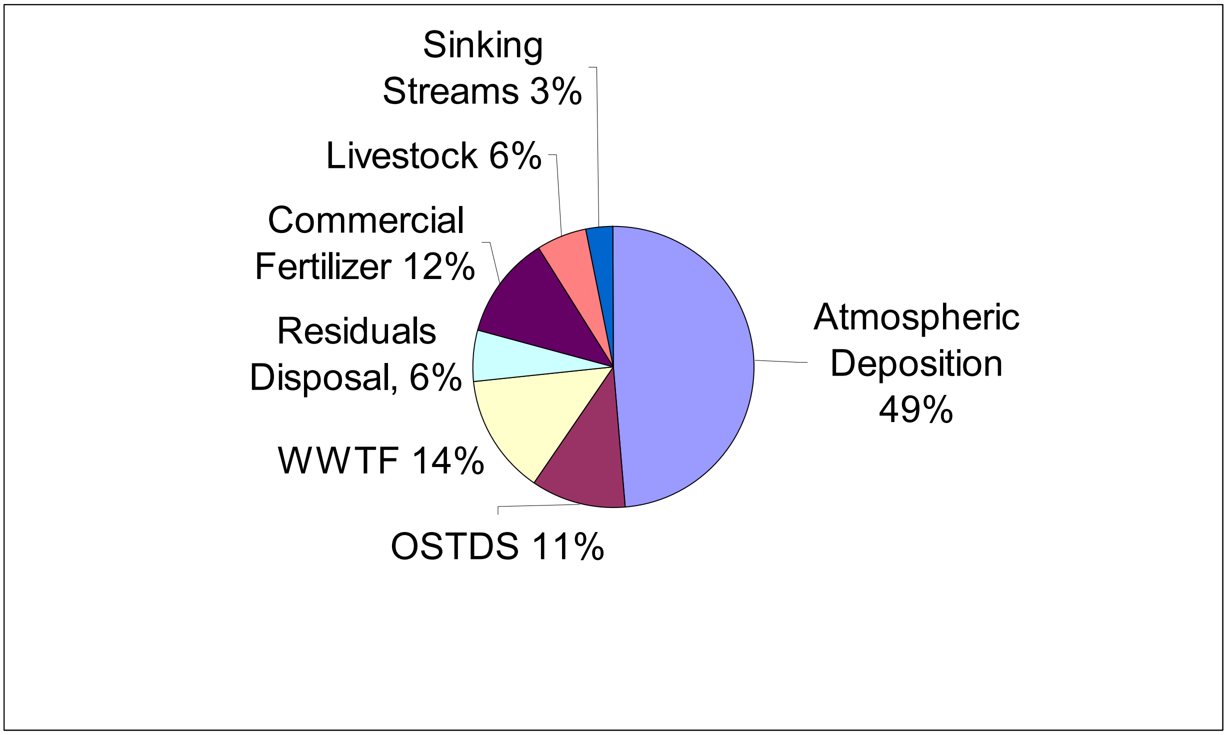
Human sewage waste contains disease-causing viruses, bacteria, and parasites. Preventing sewage contamination of drinking water has been the primary way that public health officials have prevented the epidemics that occurred in early United States (U.S.) history. Sewage also contains nutrients, such as nitrogen and phosphorous, that can adversely impact the ground and surface water quality. Nitrogen levels in the environment as low as one milligram per liter (mg/L) have been shown to degrade the aquatic environment in Florida's springs. Nitrogen levels of 10 mg/L or more have been found to cause blue baby syndrome (methemoglobinemia) in infants.

Onsite sewage treatment and disposal systems have been used for many years as a relatively low maintenance, low cost method of safely treating and disposing of human waste. The typical, conventional onsite sewage treatment and disposal system consists of a septic tank distribution piping, and drainfield. The treatment process begins in the septic tank. The septic tank is designed to skim off fats, oils, and greases; settle out the larger solids; and partially treat the sewage through breakdown by anaerobic bacteria. The waste then leaves the tank through the distribution piping and is distributed into the soil by the drainfield. Unsaturated soil surrounding the drainfield is extremely effective at removing disease-causing viruses, bacteria, and parasites. In 1983, the department adopted a requirement that there be two feet of unsaturated soil beneath the drainfield to achieve effective removal of these disease-causing agents.

The conventional septic system is generally less effective at removing nutrients, particularly nitrogen. Onsite sewage system treatment and disposal system research has shown that certain environments have a higher capability of naturally removing the nitrogen once it leaves the drainfield. In a 1999 study done by the department, nitrogen levels reached the ambient background levels before reaching surface waters surrounding Saint George Island. In the karst environment, such as the Wekiva Study Area, nitrogen responds differently. The department just concluded a study designed to measure the influence of a conventional onsite sewage treatment and disposal system on the groundwater in Karst areas. In this study, nitrogen levels were found as high as 60 mg/L in the groundwater adjacent to the drainfield, indicating that there was little or no removal.

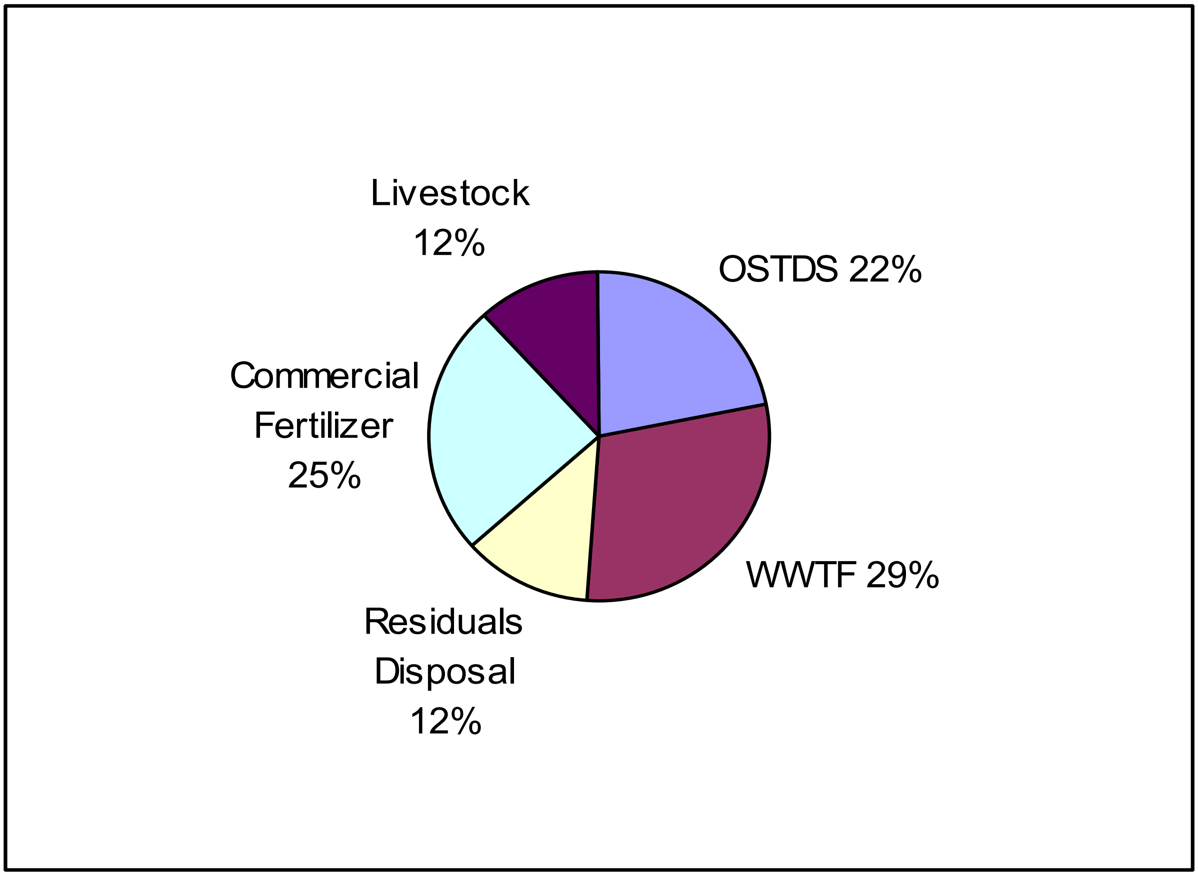
Figures 3 and 4 show the relative nitrogen contribution of onsite sewage treatment and disposal systems in a karst environment that is similar to the Wekiva Study Area.[1]

Figure 3: Relative contribution from inventoried nitrogen sources to 1990-1999 average nitrogen loading in semi-confined and unconfined portions of Leon and Wakulla Counties.



[1] Chelette, Angela and Pratt, Thomas R. "Nitrate Loading as an Indicator of Nonpoint Source Pollution in the Lower St. Marks-Wakulla Rivers Watershed," Water Resources Special Report 02-1, Northwest Florida Water Management District, 2002.

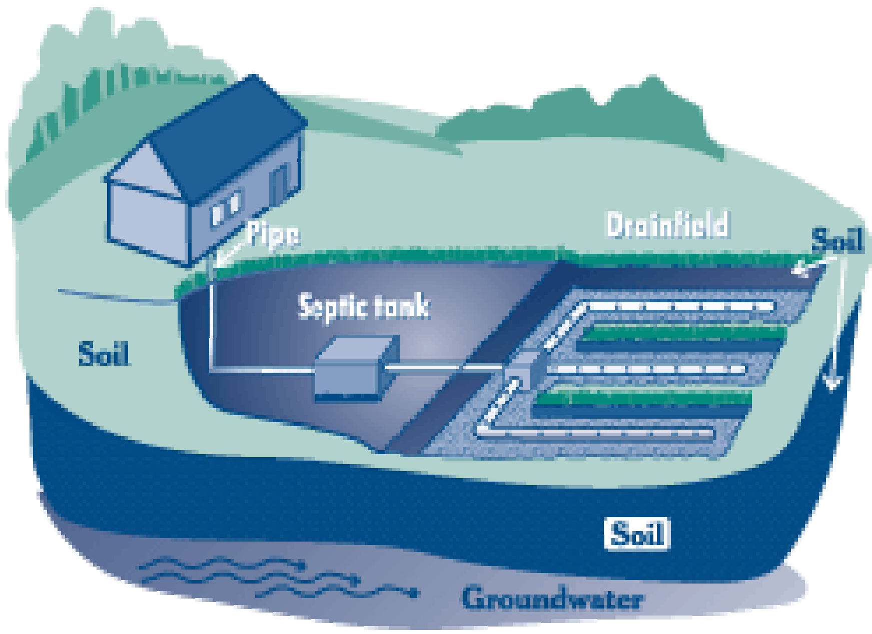
Figure 4: Relative contribution from anthropogenic sources to 1990-1999 average nitrogen loading in semi-confined and unconfined portions of Leon and Wakulla counties.



THE PROCESS OF NITROGEN REMOVAL USING ONSITE SEWAGE TREATMENT AND DISPOSAL SYSTEMS

Removal of nitrogen from the onsite sewage treatment and disposal system waste stream is achieved through the enhancement of natural biological processes. The plumbing from a home delivers waste to the system with nitrogen in the form of ureic acids and proteins. In a conventional septic tank and drainfield system as shown in Figure 5 on the following page, the nitrogen is converted to ammonia in the septic tank. The ammonia in the waste stream is then carried into the drainfield and surrounding soil where it is converted to the nitrate form. This process is called nitrification. Unfortunately, nitrate is highly mobile in groundwater. That mobility is enhanced by the rapid movement of groundwater seen in a karst environment such as the Wekiva Study Area. Nitrate is also a form of nitrogen that is readily available to plants. As discussed earlier, levels of nitrate as low as one mg/L can result in degradation of the aquatic environment of Florida's springs.

Figure 5: Image showing the layout of a conventional onsite sewage treatment and disposal system.



To reduce nitrate from the waste stream, additional treatment is necessary. That step involves taking the nitrified sewage and placing it in an environment where there is no dissolved oxygen present, where facultative anaerobic bacteria live, and where food for bacteria is available. When these conditions occur, the bacteria remove the oxygen from the nitrate as part of their living processes and the nitrogen is converted to a gas. This nitrogen gas escapes from the treatment system into the air where it is harmless to the environment. Nitrogen gas naturally makes up some 78 percent of the air we breathe. A number of different treatment systems that remove nitrogen using these processes are available today, many of which are currently used in the Florida Keys. Some of these processes are described in the following section.

THE TREATMENT RESULTS OF NUTRIENT-REMOVING ONSITE SEWAGE TREATMENT AND DISPOSAL TECHNOLOGIES IN FLORIDA

Extensive research has been conducted on nutrient-removing systems in the state of Florida. These nutrient-removing systems are classified as performance-based treatment systems (PBTS) by current rules. As part of a two-phase research project in the Florida Keys, five different treatment processes were studied to determine their effectiveness at removing nutrients.[2] A synopsis of the study results follows.

[2] Ayres Associates, "Phase 2 Addendum, Florida Keys Onsite Wastewater Nutrient Reduction Systems Demonstration Project," a report prepared for the Florida Department of Health, April 2000.

System Descriptions

<u>Process System 1: Recirculating Sand Filter/Anoxic Biofilter/Subsurface Drip Irrigation</u>

Process Description - System 1 consisted of a septic tank (ST-1) followed by a recirculating sand filter (RSF) and then an anoxic biofilter (ABF). Effluent from the system is discharged to an unlined drip irrigation bed. Treatment occurred through digestion and settling in the septic tank, and physical, chemical, and attached growth aerobic biological processes in the RSF. Adsorption by the RSF media removes limited quantities of phosphorus. The nitrified RSF effluent is mixed with anoxic septic tank effluent in the recirculation chamber (RC) to encourage denitrification. The effluent also undergoes nutrient reduction by plant uptake in the drip irrigation bed, as well as by adsorption on the drip field media.

The unlined drip irrigation bed utilizes a subsurface drip irrigation (SDI) system for effluent distribution to the sod root zone. The SDI consists of 15 5/8-inch drip irrigation lines spaced at four-inch centers. The effluent is discharged via pressure emitters spaced every two feet within the lines. Each emitter discharges at a rate of 0.6 gallons per hour (gph). Three treatment media are evaluated in this treatment unit: 1) locally available sand; 2) an expanded clay aggregate from Norway, commercially known as LECA™; and, 3) crushed brick material from Cherokee-Sanford Brick Company in Sanford, North Carolina. Collection pans are placed at the bottom of each bed. A peristaltic pump is used during sampling to pull water quality samples from each collection pan. Grab samples are collected from each pan and labeled as USAND, ULECA, and UBRICK.

System Modifications - In January 1999 the sand media in the RSF was replaced with 2-4 millimeter LECA™ media. Also, two lines were routed from the recirculation chamber (RC). One line was routed to septic tank 1 (ST-1) and the other one to the anoxic biofilter (ABF). These lines were installed in an attempt to provide enhanced denitrification within ST-1 and add biological oxygen demand (BOD) as a carbon source for additional denitrification in the ABF. Also, two stainless steel suction lysimeters were installed in the unlined sand and unlined crushed brick beds in an effort to improve sample collection from these locations.

<u>Process System 2: Septic Tank/Lined Drip Irrigation Bed</u>

Process Description - This system utilized a relatively passive technology consisting of a septic tank (ST-2) followed by a lined drip irrigation bed. The septic tank effluent is distributed to the root zone via pressurized drip emitters in the same manner as the unlined bed described above. Septic tank effluent, which is not discharged, is recycled back to the influent side of ST-2. Reduction of nutrients and other parameters is accomplished by preliminary digestion and settling in the septic tank with additional physical, chemical, and biological treatment processes occurring in the lined irrigation field and by plant uptake. Under proper conditions, the effluent undergoes nitrification in the upper unsaturated (aerobic) portion of the drip bed and denitrification in the saturated (anaerobic) lower portion of the drip bed.

The lined bed is constructed in a similar manner and with the same treatment media as the unlined bed. The exception is that each treatment media is hydraulically separated from each other and the groundwater by an impermeable liner. The final effluent from the lined beds is collected by an underdrain system, which flows, by gravity into three effluent chambers for sampling and flow monitoring.

System Modifications - In January 1999, the original drip irrigation system was replaced with a system by Geoflow™. The design details of the Geoflow™ system include the following:

- Eleven, 33-foot long, subsurface, drip irrigation lines.
- Drip-line spacing = 0.5 foot.
- Total number of emitters = 681.
- Emitter flow rate = 0.5 gallons per hour.
- 24 doses per day at approximately two minutes per dose.

In addition, the system is equipped with flush valves to flush the lines and filters on a scheduled basis.

The LECA™ Material in the lined drip irrigation bed was replaced with Filterlite-P, an advanced form of LECA™. The old sod was removed and new sod was placed on top of the lined, drip irrigation bed. In July 1999, a trickling filter was installed in association with the ST-2 to aid in denitrification.

Process System 3: Bio-Microbics FAST™/Anoxic Biofilter

Process Description - The principal treatment unit in this system is a proprietary unit known as the Bio-Microbics FAST™ aerobic unit. This unit utilizes fixed-film activated sludge treatment (FAST), which uses a combination of suspended growth and attached growth aerobic biological processes. The aeration process also provides circulation of wastewater to increase contact with aerobic bacteria. Also, anaerobic zones within the FAST chamber result in denitrification. This system provides a nitrified effluent prior to discharge.

The FAST treatment tank is separated into two chambers. The first chamber receives dosed influent and provides primary treatment. Wastewater overflows via a six-inch diameter orifice in the partition wall to a second chamber where secondary treatment is provided by the FAST unit. A blower mounted outside on top of the treatment tank provides the air source for the FAST aeration. Treated wastewater then flows by gravity into an effluent chamber where it is pumped to an anoxic biofilter treatment unit.

System Modifications
In May 1998, the FAST system was modified replacing the original mushroom shaped top of the unit with a low profile top, which can be buried to provide a more aesthetic appearance. In addition, during the course of the operation the timing sequence for aeration was modified three times. The modified timing sequences were:

- Initial timing sequence: 4.5 hours of aeration followed by 1.5 hours off.
- June 1999: 1.0 hour aeration followed by 1.0 hour off.
- August 1999: 1.0 hour of aeration followed by 1.5 hours off.

Supplemental Carbon Feed Process (an add-on treatment process)

Process Description - This system consists of a proprietary treatment unit known as the “NiteLess” denitrification system. The technology of this system is based on the automatic addition of dry-carbon and freeze-dried denitrifying bacteria. Delivery of the products is via a closed product hopper with opening and closing valves, a vibrator, drop-tube drier, a hopper desiccant, and a master timer. The unit is adjustable from one to 15 dosing cycles per day and the volume of product dispensed may be increased or decreased based on system requirements. The “Niteless” system was added to the anoxic biofilter located downstream from the FAST unit to provide additional denitrification of effluent received from the FAST. These samples were labeled FAS-ABF.

Process System 4: Advanced Environmental Systems BESTEP

Process Description - This system consists of a proprietary treatment unit known as the AES BESTEP-IDEA™ system, an aerobic/anaerobic, suspended growth biological treatment process, which operates as a continuous feed cyclic reactor (CFCR). The process operates similarly to a sequencing batch reactor (SBR), but is unique in that it allows continuous flow while using only one process tank. Aeration to the system is cyclical, which causes alternating aerobic and anoxic conditions. This process results in nitrification followed by denitrification for nitrogen removal and promotes uptake of phosphorus by the activated sludge biomass.

System Operation Performance/Observations - This system operated on a limited basis during the Phase II test period. Problems encountered with this system included erratic controls and failure of the system to properly decant the wastewater during the settling period.

Process System 5: Klargester Biodisc™/ABF

Process Description - This system consists of a proprietary treatment unit known as the Klargester Biodisc™, which is a rotating biological contactor (RBC), followed by an anoxic biofilter (ABF). The RBC is an attached growth, aerobic, biological treatment process that provides biochemical oxygen demand and suspended solids removal and limited nitrogen removal via an internal cycle of nitrified effluent to the primary clarifier for denitrification. It produces nitrified effluent, which is discharged to an ABF for additional nitrogen removal.

Influent from the dose pot is directed down into a primary settling tank. The wastewater flows up into the secondary treatment area where the RBC is located. The RBC is divided into three media disk banks with eight disks in each bank. As the wastewater flows through the RBC it empties into a final settling tank, which discharges by gravity into the ABF. A pump placed in the final settling tank recycles sludge to the primary tank every hour for 30 seconds, at a flow rate of 10 gallons per minute. The RBC effluent flows through three stages of submerged plastic filter media in the ABF and then into a sump area.

System Modifications - Modifications were made to this system to allow the second stage of the RBC rotor to receive flow from the first stage at a fixed rate, and provide a stable organic and hydraulic load to the treatment process. This modification was achieved by modifying the opening between the first and the second stage of the unit.

The modifications also incorporated a carbon-feed arrangement whereby a small amount of wastewater containing biochemical oxygen demand was collected from the front of the RBC rotor and fed to the submerged anoxic reactor of the denitrification module. This organic carbon, in the form of biochemical oxygen demand provides nutrient to the bacteria performing the denitrification.

Summary of Treatment Process Results

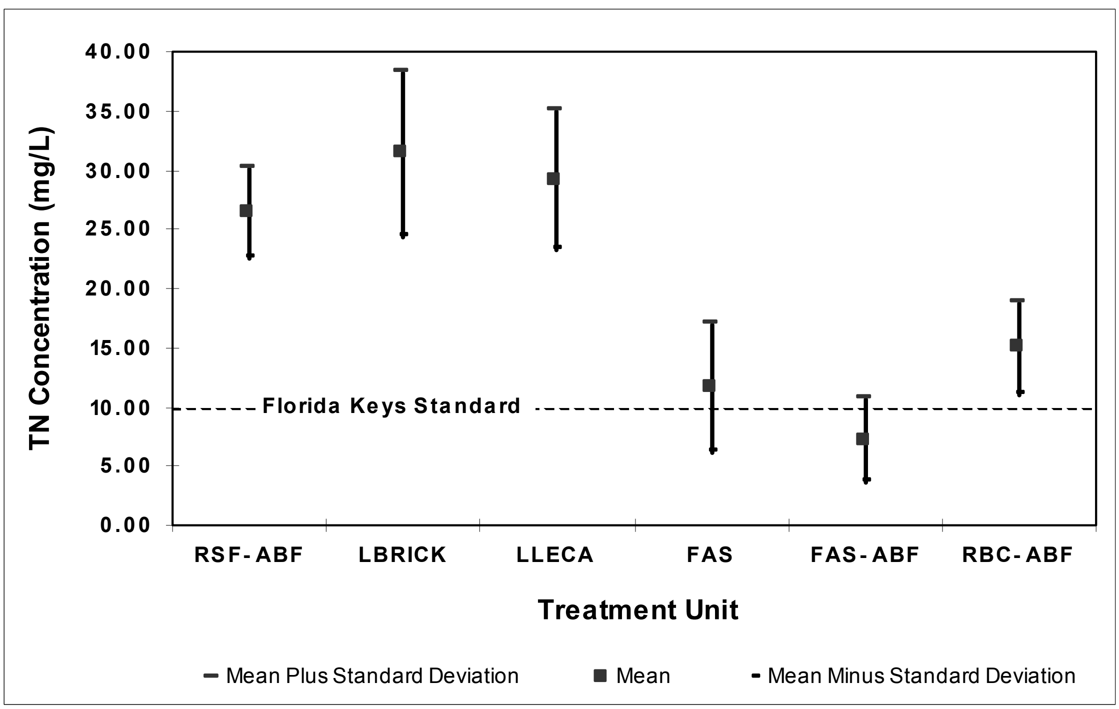
The concentrations of nitrogen and phosphorus in sewage effluent showed significant variation among the different processes. The influent total nitrogen (TN) concentration during Phase II testing was significantly higher than Phase I with a mean concentration of 47.98 mg/L, representing an approximately 25 percent increase in TN. This, in combination with increased flow, resulted in a much higher loading of TN to the systems in Phase II of the study. The increases in untreated sewage concentrations of TN, however, were insignificant in comparison to the increase in loading rate. This indicated that the systems achieved a higher removal percentage under increased nitrogen loading.

The FAST system showed the best efficiency with mean effluent TN concentration of 11.51 mg/L, followed by the RBC-ABF system with a mean value of 14.9 mg/L. These results are encouraging as they were obtained without supplemental carbon addition to enhance denitrification. The effluent concentrations for the other three systems ranged from 26.23 mg/L for RSF/ABF to 31.29 mg/L for the SDI system with LECA™ media (LLECA).

The results obtained from the "Niteless" denitrification unit (FAS-ABF) used in series after the FAST indicated that the Florida Keys' standard of 10 mg/L could be achieved with the addition of supplemental carbon. Phase II results indicated a mean effluent TN concentration of 7.09 mg/L for this system.

Figure 6 presents the mean plus or minus (±) the standard deviation for the nitrogen data. The FAST unit provided the most consistent nitrogen removals over the study period. Supplemental nitrogen removal processes would be required for all the systems tested for effluent TN concentrations to meet the Florida Keys' effluent standard of 10mg/L.

Figure 6: The mean (±) the standard deviation for nitrogen data.



<u>Other Technologies:</u> The summary above is not a comprehensive list of all available technology. Many treatment options are available with new processes being developed continuously. Some examples include: peat biofilters, fixed-film vertical-downward filtration, vertical-upward filtration, fluidized-bed sand filtration, and constructed wetlands.

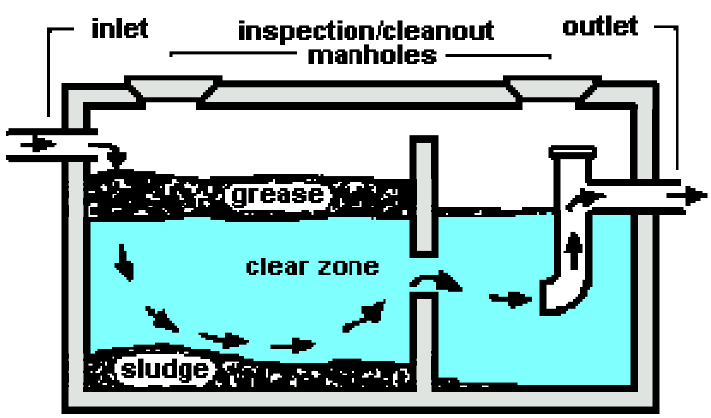
OPERATIONAL MANAGEMENT OF ONSITE SEWAGE TREATMENT DISPOSAL SYSTEMS, COSTS, AND MANAGEMENT PROGRAM MODELS

The purpose of a maintenance and inspection management program is to ensure that onsite systems continuously meet their performance requirements, especially in an environmentally sensitive area such as the Wekiva Study Area. A maintenance and inspection program would provide for continuous oversight to ensure systems are properly functioning and operating.

Currently, an operational management program already exists in all portions of the state for aerobic treatment units (ATU) and performance-based treatment systems (PBTS). Owners of ATU and PBTS are required by statute to have a contract with an approved maintenance entity. The approved maintenance entity is required to obtain a two-year operating permit for a fee of $100.00 from the local county health department for each system under maintenance contract. The state operational management program is limited in the fact that it does not require mandatory pumping for these types of systems. No maintenance requirements are mandated by law or rule for conventional septic tank systems.

However, the department recommends a septic tank should not require pumping more than once every 3 to 5 years based on the daily sewage flow and individual household wastewater characteristics. It is also recommended that the tank be inspected to determine the depth of the accumulated sludge and grease, which could have an adverse effect on the functioning of the system, if excessive. (See Figure 7)

Figure 7: A typical, conventional septic tank.



The current procedures require the county health department to inspect the systems with operating permits on an annual basis for residences and two times per year for commercial business. In addition, the approved maintenance entity must inspect the system two times per year for residences and four times per year for commercial businesses. These systems require regular routine monitoring, because they are more advanced than the simple septic tank and have filters and moving parts, such as motors and pumps that require routine servicing and a greater level of user knowledge.

In addition, commercial wastewater systems, such as those serving restaurants, and systems located in industrial/manufacturing zones or the equivalent require operating permits from the department and are inspected annually. It is estimated that less than 0.5 percent of the systems located in the Wekiva Study Area currently have an operating permit. It is also estimated that this number would increase 25 to 50 percent if systems located in the primary and secondary protection areas are required to be retrofitted with nitrogen-reducing systems.

National Model Management Programs

The U.S. Environmental Protection Agency (EPA) has developed five model guidelines for management of systems. The state has already incorporated some of these guidelines into the onsite sewage system laws and regulations. These models are represented as a progressive series in which the management requirements of onsite systems become more important as the system technologies become more complex and/or as the sensitivity of the environment increases. The EPA believes that these goals are best achieved through the performance standards for individual systems that have been developed to protect the water quality of the receiving watershed and/or aquifer. The models list management objectives and are benchmarks for a state or local unit of government. These models are listed and summarized to indicate more options that are available for management of onsite systems as follows:

Model Program 1: System Inventory and Awareness of Maintenance Needs
This model relies on educating the system owner about how to properly maintain their system. It is designed as a minimum level of management. Model Program 1 is a suitable management program where conventional onsite systems are owned and operated by individual property owners in areas of low environmental sensitivity, that is, no restricting site or soil conditions such as drinking-water wells in close proximity. This level of management is being met through the state of Florida with Chapter 64E-6, *Florida Administrative Code* (*F.A.C.*), and Section 381.0065, *F.S.*

Model Program 2: Management Through Maintenance Contracts
This model is designed as the minimum necessary where more complex system designs are employed to enhance the capacity of conventional systems to accept and treat wastewater, because of small lots, slowly permeable soils, or shallow seasonal water tables. This program may also be appropriate for areas that supply water to public water systems (for example, source-water or wellhead protection areas). The objectives of this program build on Model Program 1 by ensuring that maintenance contracts with trained operators are maintained by the property owner. This level of management is being met through the state of Florida with Chapter 64E-6, *F.A.C.,* and Section 381.0065, *F.S.,* for aerobic treatment units and performance-based treatment systems.

Model Program 3: Management Through Operating Permits
This model is designed for areas where the onsite system must provide treatment to achieve specific water quality criteria. Examples include shellfish growing areas, situations where a source-water assessment has identified onsite/decentralized systems as threats to drinking water supplies. The objective of the management program, in addition to the previous levels, is to ensure that the onsite systems continuously meet their performance requirements. Treatment systems that are designed to meet specific effluent limits are less dependent on site

characteristics and condition. Therefore, they can be used safely in more sensitive environments, but only if their performance can be ensured continuously. Limited term operating permits are issued to the property owners, which are renewable for another term if the owner demonstrates that the system is in compliance with the terms and conditions of the permit. The permit provides the management program a mechanism for continuous oversight of system performance, and negotiating corrective actions or levying penalties if compliance with the permit is not maintained. To comply with these performance standards, the property owner should contract with a maintenance provider, as in Model Program 2. This level of management is being met through the state of Florida with Chapter 64E-6, *F.A.C.,* and Section 381.0065, *F.S.*, for aerobic treatment units and performance-based treatment systems.

Model Program 4: Utility Operation and Maintenance

This model is designed for performance-based systems where the sensitivity of the environment is high, and there is a need for continuous monitoring and reliable operation and maintenance. For example, this approach may be applicable where monitoring of a drinking-water supply has detected pathogens or elevated levels of nutrients, and a source-water assessment has identified onsite/decentralized systems as sources of concern. The objective of the program is to achieve greater control over compliance by issuing the operating permit to a utility instead of the property owner. This allows the use of performance systems in more sensitive environments than Model Program 3. The utility takes responsibility of the operation and maintenance of systems owned by subscribers for a service fee. This reduces the number of permits and the necessary administration by the management program. System failures are also reduced as a result of routine maintenance. Ownership of the system remains with the property owner. The operating permit system is identical to Model Program 3 except that the permittee is a public or private utility.

Model Program 5: Utility Ownership and Management

This model is a variation of the utility operation/maintenance concept in Model Program 4, except ownership of the facilities is no longer with the property owner. The designated management entity both owns and operates the onsite systems in a manner analogous to a conventional wastewater utility. Under this approach, the utility maintains total control of all aspects of management, not just operation and maintenance. The model is appropriate in similar environmental or public health conditions as is Model Program 4, but provides a somewhat higher level of control and reduces the likelihood of disputes between the system operator and the property owner. The utility can also more readily replace existing systems with high-performance units where necessary. The EPA recommends implementation of Model Program 5 in cases where new, high-density development is proposed in the vicinity of sensitive receiving waters.

Existing Management Programs in Florida

Several counties in Florida have enacted local ordinances requiring management of onsite systems on a limited basis. Polk and Lake Counties have ordinances requiring all onsite systems located in the Green Swamp to be pumped and inspected every five years. Escambia and Santa Rosa Counties have similar ordinances requiring septic tanks to be pumped, inspected, and upgraded to repair standards at the time of real estate transactions or prior to the sale of an existing house. To encourage routine maintenance, the City of Tallahassee provides septic tank pump-out services without charge. Charlotte County has currently drafted a local ordinance to require mandatory maintenance pumping every five years in a specific environmentally sensitive area of the county located near Charlotte Harbor. In Monroe County the state law requires advanced nutrient reduction systems (nitrogen and phosphorus) to protect the sensitive ecosystem from nutrients. These systems are performance-based treatment systems and require an annual operating permit, maintenance contract, and annual inspection from the county health department. Brevard, Charlotte, Citrus, Franklin, and Volusia Counties have county ordinances requiring aerobic treatment units in specific circumstances and in environmentally sensitive areas. As with the performance-based treatment systems, these systems require annual operating permits from the county health department, maintenance contracts, and annual inspections from the department.

System Installation Maintenance and Operational Costs

Installation Costs – The department contacted licensed contractors and engineers that design and install nutrient-reducing systems in the area. They reported that a conventional septic tank and drainfield costs from \$5,500 to \$7,000 for a three-bedroom home. A comparable nitrogen-reducing system with a drip irrigation drainfield costs from \$7,500 to \$9,000.

Operational Costs – Many of the nitrogen removing systems use pumps or blowers to treat the sewage. Nitrogen reducing systems also require an operating permit from the department. Operating permit fees are \$100 every two years and partially cover the costs of conducting an annual inspection. In addition to the operating permit, nitrogen-removing systems require additional routine maintenance and, in some cases, electricity to operate properly. For reference, the operational costs of nitrogen-removing systems in the Florida Keys are shown in Table 1 on the following page. The systems described are the same as those described previously. An electricity cost of \$0.10/kilowatt-hour was used to determine the daily electric cost.

Chemical/Material Consumption Results – The "Niteless" denitrification unit located in series after the FAST™ unit was the only process tested during Phase II that required a chemical addition. This process required the addition of a carbon/bacteria-media mixture to an ABF unit and was tested on the FAST™ effluent stream. It was observed that an application rate of 20 ounces or 0.57 kilograms (kg) of media per day resulted in an average of 7.1 mg/L, or less, of total nitrogen in the effluent during Phase II testing. Based on this, the cost of the carbon/bacteria media is estimated to be approximately \$100.00 per year.

Operation and Maintenance Cost – At the onset of the study a list of recommended operation and maintenance activities was prepared based on the experience with the treatment systems and review of the manufacturers' installation guidelines, operation manuals, and sales information. A summary of semi-annual and annual operation and maintenance activities for the systems comparing Phase I and Phase II is presented in Table 2 on page 15. Also, an estimate of time to perform the activities is presented.

In addition to the operation and maintenance activities listed in Table 2, the following activities are also anticipated for the treatment systems:

- Removal of accumulated sludge every five years for septic tanks and approximately every three years for aerobic units.

- Effluent water quality monitoring of advanced waste treatment (AWT) parameters [chemical biological oxygen demand$_5$ ($CBOD_5$), total suspended solids, total nitrogen, total phosphorus) for compliance with treatment performance requirements.

Table 1: Treatment process power consumption and cost data, Phase II (January 27, 1999 to December 17, 1999)

	Process System 1: Recirculating Sand Filter	Process System 2: Septic Tank/ Lined Irrigation Bed	Process System 3: Fast System	Process System 5: Rotating Biological Contactor
Number of Days in Monitoring Period	270	324	324	324
Net Electric Use (kw-hrs)	1006	309	1514	821
Average Daily Electric Use (kw-hrs/day)	3.7	1.0	4.7	2.5
Average Daily Electric Cost ($/day)[1]	$0.37	$0.10	$0.47	$0.25
Average Monthly Electric Cost ($/month)[2]	$11.18	$2.86	$14.02	$7.60
Average Yearly Electric Cost ($/year)	$136.00	$34.81	$170.56	$92.49

[1] Mean electrical use is based on the period of time from March 22, 1999 to December 17, 1999.
[2] Average Electrical Costs Calculated on $0.10/kw-hr.
[3] Monthly costs calculated on a 30-day cycle.
Notes: Process System 4 values are not included due to the system being inoperative. Net power usage for the five process streams was monitored following system modifications for a period of 324 days. The average daily power use ranged from 1.0 kw-hr/day for the SDI (Process Stream 2) to 4.7 kw-hr/day for the FAST™ (Process Stream 3). The average electrical usage for Process System 1 was calculated based on 270 days (March 22, 1999, to December 17, 1999). An unusual spike in electrical usage was observed during the period between February 17, 1999, to March 22, 1999, for Process System 1, and data collected on power usage during this period was not considered. The cause of the electrical spike, however, could not be determined. Process System 2 showed a decrease in power cost due to the installation of a smaller blower unit in Phase II. The blower was also connected to a timer that cycled on and off in an effort to increase nitrogen removal. These items reduced energy consumption considerably from Phase I.

Table 2: Operation and Maintenance Activities Needed

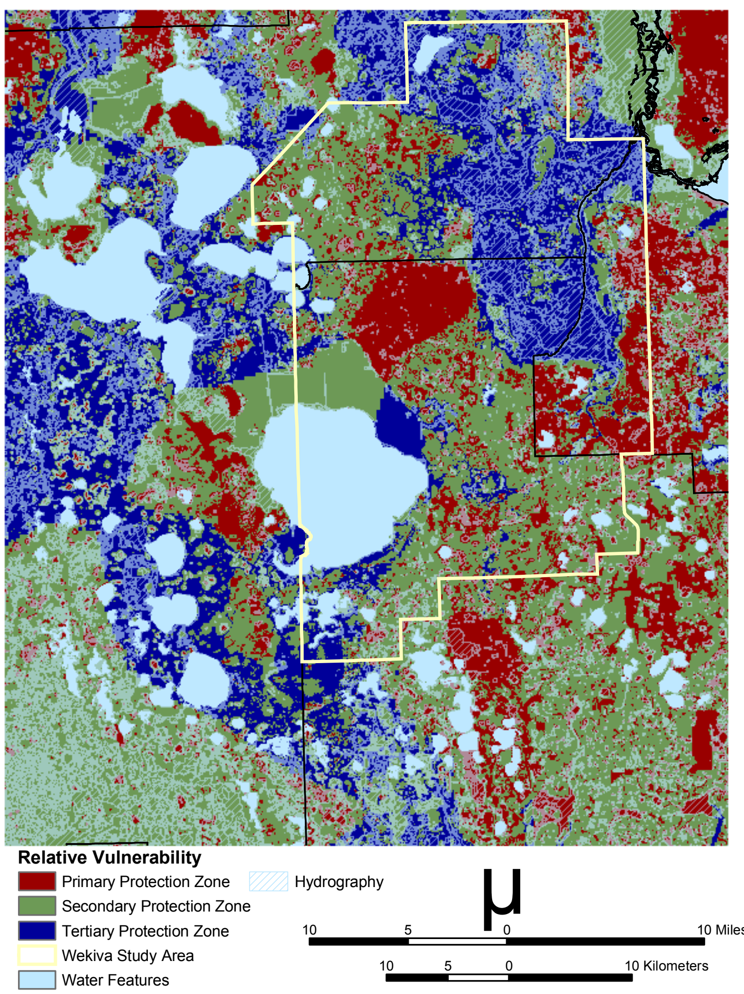
System	Activity Performed	Semi-Annual* (2X/year)	Annual* (1X/year)	Estimated Minutes to Perform Activity Per Visit
RSF	Inspect recirculation pump operation, high water alarm system, and float operation.	X		10
	Inspect sand filter surface (LECA™ surface, during Phase II).	X		10
	Observe sprayer operation. Clean spray heads. Flush out distribution lines.		X	10
	Record operational data (pump run time, dosing meter). Compare data to past records.	X		15
	Calibrate pump and recirculation ratio.		X	20
	Check sludge depth in septic and recirculation tanks.		X	10
SDI	Inspect irrigation pump operation, high water alarm system, and return flow from irrigation beds.	X		15
	Increase return flow and pressurize lines to flush out emitters and dripper lines.		X	15
	Clean effluent screen in septic tank and filter cartridges in SDI pump unit.		X	20
	Check pressure differential across dripper line. Adjust.		X	10
	Inspect bed surface for exposed dripper lines and signs of effluent surfacing. Check sludge depth in septic tank and SDI tanks.	X		10
	Record operational data (flow meters and pump timers). Measure return and forward flow rates. Compare data to past records.	X		15
FAS	Check sludge depth, primary tank.		X	10
	Check inspection port for aeration and blower screen. Clean filter.	X		20
	Check system performance with respect to blowers, controls, mixed liquor color, and system odors. Measure DO and collect mixed liquor sample and conduct settleable matter test.	X		30
CFCR	Check timer clock and decant pump operation.	X		10
	Check alarm system and float operations.	X		15
	Remove cover; observe air compressor aeration and mixer operation. Measure DO and collect mixed liquor sample and conduct settleable matter test.	X		30
	Wash off control floats and decant float.		X	10
	Clean air compressor filter and effluent screen from flow inducer tube.		X	15
RBC	Remove cover, check disk operation, and biomass growth.	X		15
	Check sludge recirculation pump in secondary tank and recycle dipper bucket.	X		15
	Remove surface scum from primary tank.		X	10
	Check sludge depth in primary and secondary tanks.		X	20
	Replace nylon bushings on rotator gear.		X	20
ABF	Check biomass growth and DO in the tank.	X		15

*Number of times required by manufacturer.
RSF = recirculating sand filter; SDI = subsurface drip irrigation; FAS = fixed activated sludge; CFCR = continuous feed cyclic reactor; RBC = rotating biological contactor; DO = dissolved oxygen

PRIORITY AREAS WITHIN THE WEKIVA BASIN, CHARACTERIZATION OF ENVIRONMENTAL SENSITIVITY, AND SEWERING DECISION-MAKING

The Florida Geological Survey developed a groundwater sensitivity map for nitrogen in the study area called the Florida Aquifer Vulnerability Assessment (FAVA). The map shows less vulnerable, vulnerable, and more vulnerable protection zones. The Wekiva Study Area falls in the vulnerable and more vulnerable FAVA protection zones. A more detailed Wekiva Aquifer Vulnerability Assessment (WAVA) of the groundwater sensitivity in the Wekiva Study Area further breaks down the sensitivity to three categories, the primary protection zone, the secondary protection zone and the tertiary protection zone. Figure 8 shows the WAVA protection zones. The department has nearly completed a spatial inventory of existing onsite sewage treatment and disposal systems within the study area. This information will be combined with the WAVA protection zone map to highlight priority areas for sewering. When completed, the mapping will be available for local land-use planners. The highest priority for sewering should be given to areas with high densities of systems in the primary and secondary protection zones. Areas where densities are too low to support a viable central sewer system should use nitrogen-removing onsite sewage treatment and disposal systems.

Figure 8: The Wekiva Area Aquifer Vulnerability Assessment map for nitrogen



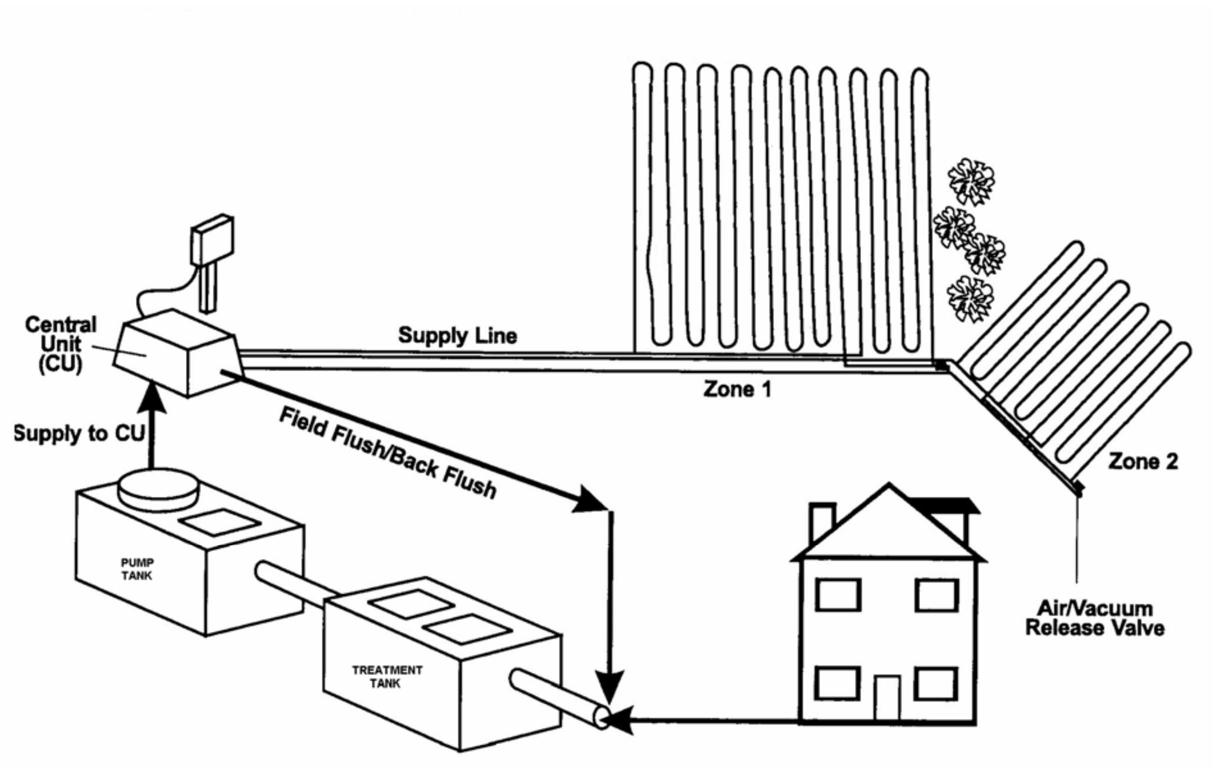
RECOMMENDATIONS

The department is required by section 369.318, *F.S.*, to make recommendations about a number of items including a more stringent level of wastewater treatment to reduce levels of nitrates, the replacement of failing systems, and the implementation of a maintenance program:

<u>Nitrate Treatment Levels:</u>

The Department recommends a discharge limit of 10 mg/L of total nitrogen for new systems, systems being modified, and for existing systems in the primary and secondary WAVA protection zones. This level of treatment has been shown to be achievable through existing wastewater treatment technologies and would reduce the levels of nitrogen introduced into the environment by onsite sewage treatment and disposal systems by approximately 75 percent. In addition, the department also recommends that wastewater be discharged into a shallow drip irrigation drainfield (Figure 9) to maximize plant uptake of nitrogen, to reduce lawn fertilization, and to reduce lawn watering needs.

Figure 9: A conceptual view of the recommended nitrogen treatment and drip irrigation disposal system



The department recommends that to protect the aquifer confining layer, the practice of removing severely limited soil layers (dig outs) be prohibited in the entire study area.

The department recommends the prohibition of the land-spreading of septage and grease-trap waste in the study area. Septage waste would be required to be disposed of at wastewater treatment plants.

The department recommends that state and local planning agencies evaluate the economic feasibility of sewering versus nutrient-removal upgrades to existing onsite sewage treatment and disposal systems. Areas with high densities of development will be better suited to central sewering, and lower density areas more suitable for nitrogen-removing onsite sewage treatment and disposal systems. Since environmental and public health protection can be achieved by both options, sewage disposal costs should be the determining factor as to which disposal method is used. Existing systems in the primary and secondary WAVA protection areas should not be required to upgrade to the 10 mg/L nitrogen limit if central sewer will be made available by 2010.

A policy for a phased-in approach to replacing the remaining existing systems should be developed after opportunity for citizen and local government input. A target date for phase-out would be 2010.

Replacement of Failing Systems:
The department recommends that failed or modified systems located in the Wekiva Study Area be upgraded to meet new system standards**.**

The department's permit program currently addresses the repair-permitting for systems that are malfunctioning, defective, and "failing" or creating a sanitary nuisance. The department's permitting program also addresses the inspection of, or modification to, existing systems. A failure is defined in Chapter 64E-6, *F.A.C.*, as; "a condition existing within an onsite sewage treatment and disposal system, which prohibits the system from functioning in a sanitary manner and which results in the discharge of untreated or partially treated wastewater on the ground surface, into surface water, into ground water, or which results in the failure of building plumbing to discharge properly." Current repair standards are less stringent than new standards. The year of the original installation determines the permitting requirements with regard to the septic tank capacity, drainfield size, and set-backs to wells, surface water, and property lines.

An existing system inspection is conducted, or permit issued, when an applicant is changing like-for-like residences on their property, such as the replacement of a mobile home with one that has the same number of bedrooms and building area. If this is a system that was previously approved by the department, it has remained in satisfactory operating condition, and it does not show signs of failure, it would be approvable without modifications. A modification permit is required when there is an increase in sewage by adding bedrooms or square footage to the building. Where modifications are proposed, the existing system is evaluated to determine if the tank and drainfield would need to be upgraded due to the increased flow.

Establishment of a Maintenance Program:
The department recommends that new regional wastewater management entities be established or that existing ones be modified to oversee the maintenance of all wastewater discharged from onsite sewage treatment and disposal systems in the study area. The management entities would be a part of county or city governments, or a special taxing district. The management entities would be responsible for implementing a Program Model 4 management program as described previously. Maintenance of nitrogen-removing systems is critical to assure that the recommended 10 mg/L discharge limit is met.

It is further recommended that these programs take the privatization approach to the maintenance of onsite sewage treatment and disposal systems. Under this approach, the governmental management entity would contract with existing registered septic tank contractors, licensed plumbers, or licensed wastewater treatment plant operators for inspection and maintenance services. The management entity would be responsible for assuring that required inspections and maintenance are conducted and that the discharge limits specified by the operating permits issued by the Department of Health are met. Funding for the management entity program would be generated through user service fees, much the same as central sewer users pay a monthly sewer bill.

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