

TECHNOLOGY CHOICES FOR WATER & WASTEWATER
Albemarle County's Rural Areas Discussion
Department of Engineering & Public Works
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Any sufficiently advanced technology is indistinguishable from magic.
--Arthur C. Clarke

The technology of water supply and wastewater treatment exists in the mundane world of everyday lives. Perhaps, though, there is some magic to it. Water rises mysteriously from the ground through a well shaft. We cannot see or completely understand the world where it originates. Likewise, our wastewater returns to the ground, and we are equally unaware of its pathways and ultimate fate. The only thing we are sure of is that we, as humans and human communities, are part of a larger cycle of rain falling, finding its way into creeks and underground crevices, and rising back up to start the cycle over again. Technology is the tool we use to live within that cycle, and, if done well, can allow us to live there for a long time without destroying the life support system the cycle represents.

This document is about technologies for rural water supply and wastewater treatment in the context of Albemarle County's update of the Comprehensive Plan for Rural Areas. While exploring technology approaches, it became apparent that technology choices cannot be divorced from the policy and management contexts that encourage, support, or frown upon various technology choices. As such, some discussion is also given to management approaches.

The paper addresses the following:

- Our current technologies of choice – individual wells and septic systems — can be considered the “default option.” What does this mean for the future of Albemarle's rural areas?
- Alternatives for wastewater treatment, disposal, and reuse abound, and some are becoming more widespread. This paper offers a very quick and generally nontechnical review.
- While there are a growing number of technologies for wastewater, there are only so many ways we can extract water from the ground for water supply. The paper outlines several newer technologies for finding where the water is.
- We know that even the best technology is prone to failure if not properly managed. The paper offers some insights on management options based on new guidance from the Environmental Protection Agency, and attempts to frame this issue for Albemarle County's Rural Areas.

Let's Consider the Default Option

The default option for Rural Area water and wastewater is individual wells and septic systems. We must consider what this default option means for water resources if and when the Rural Areas continue to be subdivided for residential lots.

Based on data from the Department of Planning & Community Development, there were 16,398 dwelling units in RA areas in the year 2000. Based on the 1996 TJPDC build-out analysis, another 54,867 dwelling units are possible. Let's say, for the sake of argument, that the Rural Areas must accommodate water supply and wastewater assimilation for 66,000 dwelling units sometime in the future.

At 250 gallons per day per residence (current demand figures from the ACSA), this amounts to an overall water demand of 16.5 million gallons of water provided by individual wells, and 13.2 million gallons of wastewater disposed into conventional septic tanks and drainfields (or 80% of water demand). If this wastewater were disbursed evenly over the County's 730 square miles, that would amount to around 18,000 gallons per square mile per day of wastewater. Of course, population and households are not evenly distributed, so some areas would get a much higher loading while others would get less.

In order to understand if and how the County's natural resources could meet these demands, we must understand a few things about conventional technologies.

Water From Individual Wells

- These wells are, by-and-large, randomly sited based on the lot in question and applicable setback rules. Randomly sited means that geologic conditions, fractures, and other science-based clues are not used to select the most promising well location. Often, landscape clues (such as low spots or swales) are used if setbacks can be met.
- Currently, there are no requirements for a minimum flow rate, although most homeowners would consider 1 –3 gallons per minute as an acceptable minimum (as long as the well is reasonably deep so that the shaft has adequate storage volume).

Wastewater and Conventional Septic Systems

- Conventional systems utilize a septic tank that holds the wastewater for 24 – 48 hours to separate out solids and scum, and a drainfield, which depends on gravel-filled trenches, perforated pipes, and the surrounding soil to disperse and treat the liquid portion of the wastewater.
- Drainfield soils are selected by Health Department personnel and certified private soil scientists based on the best available soils on a given lot (which is different from the best available treatment). Of the 222 soil units listed in the Albemarle County Soil Survey, only 1 is considered to have "slight" limitations for septic tank absorption fields (slight meaning that soil properties and site features are generally favorable for

absorption fields). Eighty (80) are considered moderately unsuitable (soil properties and site conditions are not favorable) and 128 have “severe” limitations based on poor permeability or filtering, high water table, shallow depth to bedrock, excessive slope and/or flooding (13 soil units are unrated). Does this mean that drainfields are rarely permitted in Albemarle County? This obviously is not the case since the soil survey is a guide, and Health Department sanitarians and private soil scientists try to find the best available soils on a lot for septic absorption.

- There is not a consistent definition of failure for convention drainfields. It is universally accepted that a system is failing if septage pools on the surface or backs up into the house. However, if septage moves down through the soil too quickly, receives inadequate treatment in the soil, and/or eventually contaminates a creek or well, there is no criteria or “red flag” to say that a system, or a grouping of systems, is failing. Some of the common contaminants in domestic septage include nutrients (nitrogen and phosphorus), bacteria, biochemical oxygen demand, sulfates, and solids.

Given these characteristics of conventional technologies and the build-out scenario noted above, we cannot predict with any accuracy the impact on wells, streams, and reservoirs. However, we can outline some possible scenarios:

Best Case Scenario: The best case would hold that 66,000 residences with their water and wastewater needs does not exceed any carrying capacity variables, or the ability of Albemarle’s landscape to provide these services. Groundwater is generally abundant enough to support randomly sited individual wells, and soil characteristics can provide adequate treatment for wastewater effluent. Adverse impacts to wells, streams, and reservoirs are spotty and resolvable.

Worst Case Scenario: The worst case is that carrying capacity variables are exceeded over large areas of the County. Many wells become contaminated with improperly treated drainfield effluent. Unfortunately, many owners of private wells don’t know that they, their families, and guests may be drinking contaminated water. Over large areas, drainfield effluent also causes a “tragedy of the commons” whereby streams and drinking water reservoirs are impacted, even as we are increasing reliance on resources such as the South Fork Rivanna Reservoir. In terms of well yields, the trend is lower yields and a higher incidence of dry holes because recharge areas are compromised by development activity.

The realistic scenario is very likely to be somewhere in between the best case and worst case scenarios. If we try to rely on science alone to help us draw the line on how many conventional systems are too many, we will likely never arrive at an answer, due to the limitations of current knowledge and large-scale scope of the question.

We are left then with a policy question. If we consider conventional technologies to be unacceptable at build-out, we are left with several alternatives, which are not mutually exclusive:

- Reduce the overall level of residential development through ACE and similar programs.
- Establish regulatory approaches that increase performance and/or design standards for wells and septic systems to ensure protection of public health and water resources, especially in areas of high sensitivity (e.g., close proximity to a reservoir or community well supply). This approach would likely be attended by an enhanced program for inspection and maintenance.
- Utilize alternative technologies that can pinpoint sustainable water supplies and provide better treatment for wastewater, either through onsite (per lot) options or small-scale utilities serving clustered lots. An allied strategy would be to protect groundwater recharge by preserving forest and vegetative cover and separating wastewater disposal from important recharge areas.
- Encourage and support technologies that decrease water demand and wastewater output, including greywater reuse, water conservation, and rainwater harvesting. These technologies decrease the impact per household, and thus can help abate the tragedy of the commons.

In considering our options for the future, we cannot ignore the issues of management and maintenance. All of the options discussed require some level of management and maintenance in order for various technologies to perform as designed and avoid environmental and public health problems.

The remainder of this paper will discuss technologies available for wastewater and water in a rural setting, as well as various management models to consider.

Alternative Technologies for Wastewater

Why do some individuals and communities resort to alternative wastewater technologies in lieu of conventional on-site systems? In order to develop clear policy guidance, it is important to understand the motivations others have had to pursue the alternatives. Based on a limited literature review, it appears that the chief reasons include:

- A conventional system cannot be used due to site constraints, such as poor soils, high water table, shallow bedrock, or slopes. Alternatives allow a particular parcel to be developed.
- In some cases, communities have desired to decrease the area needed for soil absorption fields by using alternative treatment and dispersal methods.
- Some communities promote alternatives that achieve a higher level of pollutant removal than conventional systems, especially in locations with highly valued or sensitive environmental resources (e.g., Puget Sound region).

These reasons appear to achieve different and sometimes conflicting objectives: from allowing development to occur when conventional systems cannot be used to ensuring a higher level of environmental protection when valuable resources are at stake. It is clear that cost is not a driving force, since alternatives can be substantially more expensive than conventional systems. It seems that each community must clarify the particular

reasons and underlying values that would lead it to promote or not promote the use of these technologies.

Also, each of the technologies discussed can be used for individual homes or small cluster or community systems. Of course, overall management and maintenance concerns would differ based on these arrangements.

The technologies outlined below are divided into: (1) pretreatment and advanced treatment, (2) dispersal options, (3) wastewater reduction and reuse, and (4) package plants.

1. Pretreatment & Advanced Treatment

Pretreatment describes technologies designed to replace the function of a conventional septic tank: initial settling of solids and removal of scum

- Aerobic Treatment Unit: ATUs can provide better treatment than septic tanks. Oxygen is mixed with the wastewater to allow aerobic bacteria to break down or remove some of the solids. The unit also has a settling chamber.

Secondary or advanced treatment describes technologies designed to provide additional pollutant removal after wastewater passes through a septic tank or alternative pretreatment.

- Sand Filtration: Wastewater enters the filter in intermittent doses and slowly filters through the sand media. Pollutant removal relies on physical, chemical, and biological processes. Units can involve a single-pass of waste through the filter or include a recirculating system (multi-pass filtration). Sand filters have been shown to do an excellent job at removing biochemical oxygen demand, solids, fecal coliform bacteria, and ammonia, with lower performance for phosphorus removal.
- Other Type of Filters: Alternative filter media include peat, foam, crushed glass, and textile. Some alternative filters are still in the experimental phase, but peat has been shown to achieve excellent pollutant removal.
- Constructed Wetland: Wetlands have been used as a wastewater treatment method for single-family applications up to community-wide facilities (e.g., Monterey, Virginia; Arcata, California; and many others). Wetlands can be either subsurface flow (water flows through a gravel base layer) or surface flow. Wetland plants function to take up nutrients and trap solids.

2. Dispersal Options

Various dispersal technologies are designed to enhance the functioning of a conventional drainfield, or allow adequate treatment where soil, slope, water table, and/or bedrock conditions would compromise a conventional drainfield.

- Pressurized Systems: These systems utilize pumps and small-diameter piping to “dose” partially treated wastewater into the underlying soil. These systems can be used on sloping ground or where there is a high water table.

- Contour System: A single trench, filled with gravel and sand, runs along the contour of the land, increasing the surface area for effluent to disperse. The trench is often shallower and longer than a conventional drainfield trench.
- Drip Irrigation: Wastewater is applied slowly and uniformly through a network of thin, flexible tubes with designed orifices. The system is designed to be placed at a shallow depth so that the effluent can be absorbed by plant roots.
- Spray Irrigation: Treated and disinfected effluent is sprayed onto vegetated or landscaped areas at set loading rates. Most systems require large setbacks from residences and adjacent properties. This is a method to reuse effluent for landscape irrigation.
- Mound System: Treated effluent is pumped at a particular rate onto a mound of suitable material, such as sand.
- Evapotranspiration System: Treated effluent is applied to a sand bed area where evaporation and plant uptake (evapotranspiration) allow for a zero-discharge system. This can be used in areas where the evaporation rate exceeds precipitation.

3. Wastewater Reduction & Reuse

- Alternative Toilets: Composting and incinerating toilets are alternatives to using clean or potable water for sanitary needs. This reduces the wastewater stream requiring treatment and disposal. Composting toilets create a fertilizer than can be used for landscaping.
- Greywater Reuse: Several demonstration projects are taking place with systems that separate blackwater (toilet) from greywater (washing machine, bathtub, sink, etc.). Concerns persist about possible public health impacts from bacteria and pathogens. Greywater reuse is an age-old technique that is receiving new interest as a water conservation and efficiency measure. In most cases, greywater is diverted for outside uses, such as irrigation, but is also being used for indoor uses, such as toilet flushing, to a lesser degree.
- Other Reuse Technologies: Some advanced treatment and dispersal technologies, such as living machines (see below under package plants) and spray irrigation, can be adapted for specific wastewater reuse applications.

4. Package Treatment Plants

Package treatment plants cover a range of technologies that can treat small flows (2,000 gallons per day) to higher flows (500,000 gallons per day). Most of these technologies rely on physical screening and settling, microbiological processes (“bugs” digest organic wastes in an aerobic tank), disinfection, and sludge removal and disposal. Different types of systems are designed to meet varying effluent limitations for bacteria, nitrogen, phosphorus, and biological oxygen demand (constituents in water that consume oxygen).

When properly designed, operated, and maintained, package treatment plants have been shown to achieve good pollutant removal. The obvious downside to these technologies is that they require professional operation with often daily operational requirements. Most of these systems also create a discharge and sludge handling and disposal, so must be

permitted through the Department of Environmental Quality. Permit conditions include monitoring and reporting to DEQ.

Several package treatment plants are in use around the County, including Stone Robinson School, Glenmore, Camelot, Southwood Mobile Home Park, Avionics Specialties, Inc., Ramada Inn Monticello, and the Crossroads Village Center (North Garden), among others. According to RWSA personnel, they have had little problem with the newer and well-operated plants such as the one at Stone Robinson, which requires approximately an hour or two of professional maintenance attention per day. However, other privately operated package plants have created problems when proper maintenance is not adhered to.

The Living Machine is an emerging alternative to a conventional biological package treatment system. Living Machines utilize similar processes, but also include a “treatment train” which includes tanks with plants, snails, microorganisms, and/or fish to enhance pollutant uptake, provide aesthetic appeal, and reduce chemical inputs. Some living machine facilities are located in a greenhouse. Some of these systems have been designed for wastewater reuse and zero-discharge outcomes. Living Machines, Inc. is a private company that has piloted living machine technology at commercial, residential, and institutional setting. Data on performance is not widespread, but EPA has conducted an independent evaluation of two Living Machines, and found good pollutant reduction rates except for phosphorus.

For uses that generate small flows that can be handled by other onsite or clustered alternatives, a package treatment plant would be considered a secondary option due to the cost and increased maintenance complexity.

Technologies for Water Supply

There is a fundamental and critical difference between technology approaches for wastewater and water supply. On the wastewater side, there are many ways to treat the waste stream once it is generated. However, for water supply, there are only so many ways that we can extract water from the ground, and technology cannot compensate for the natural system’s ability to provide this resource. Technology has played a critical role, however, in designing more sustainable water supplies by applying a science-based approach to understanding where groundwater is available.

Groundwater availability is quite variable, depending on geology, fracture patterns, the depth and character of the soil and overburden (layer of decomposed material that sits above bedrock), land cover, and other factors. A detailed description of these relationships can be found in the “Albemarle County Hydrogeologic Assessment: Mechums River & Ivy Creek Basins.”

Due to this variability, groundwater acts quite differently than surface water reservoirs, with known storage volumes, inflow, and withdrawals. For groundwater, it may not be

enough to just drill a hole in the ground, but to drill in the right place to achieve a water supply that can be used sustainably over time based on fracture patterns. Once a certain water supply is achieved, pump tests can help determine an appropriate pumping rate, or a combination of pumping and storage, to meet the anticipated demand. However, there are no guarantees with groundwater, as initial yields can drop over time as fractures get clogged up or area water table levels drop.

For individual wells, the random siting process has historically produced enough water (at least initially) to meet the relatively modest demands of a typical household. For instance, a 6-inch well with 100 feet of storage in the well casing and a yield of 1 gallon per minute can yield over 1,000 gallons per day. However, this type of well may have trouble meeting peak demand periods.

When higher and sustained yields are desired, several technologies are becoming more widespread. Due to the cost of these technologies, they are used more for commercial, industrial, or community water supplies, rather than individual wells, although drought conditions seem to change this dynamic.

Two technologies that are used with some frequency are described below:

1. Aerial Photo Interpretation (Fracture Trace Analysis): Trained professionals can locate linear landscape features from aerial photographs using a stereoscope. These features (straight stream reaches, gaps in ridges, linear swales, etc.) are often places where geologic forces have created a higher degree of fracturing and weathering, and thus higher groundwater storage and movement. Many higher yielding wells have been located using this technique in combination with field analysis by a geologist.
2. Geophysical Studies: Geophysics is an up-and-coming technology that is often used in combination with fracture trace analysis to locate water-bearing zones. A common technique is “electrical resistivity,” whereby an electrical pulse is sent into the ground and the variable resistance of rocks to the pulse is measured. Underground areas with low resistivity, when correlated with fractures, are likely higher water-bearing zones.

The County employed both of these techniques when investigating alternative water sources for the Corville Farms community.

Technology & System Management

The best water and/or wastewater technology in the world will fail without proper management and maintenance. While we have learned some hard lessons locally, this issue is of national prominence. The Environmental Protection Agency (EPA) recently released a publication (*Voluntary National Guidelines for Management of Onsite and Clustered Wastewater Treatment Systems*, March 2003) that calls attention to this issue and suggests several management models based on environmental sensitivity, level of technical sophistication, and other factors.

In this report, EPA describes the public health and environmental consequences of improperly managed onsite systems, and suggests that:

If centralized collections systems [e.g., large centralized utilities such as ACSA] are feasible, decentralized systems [e.g., small-scale alternatives serving small communities or clustered lots] are recommended only where there is assurance of an enforceable management system . . . including long-term financial and technical capacity for operation and maintenance (page 7).

The benefits of an adequate management program include protection of water quality and public health, protection of consumers' investment in home and business ownership, increased onsite system service life and replacement cost savings, avoidance of transfers of water away from the source by conserving ground water, and elimination of the need to use a community's tax base to finance sewers (pages 3-4).

The report outlines five management models, ranging from the simple "Homeowner Awareness" model up to the very sophisticated "Responsible Management Entity Ownership" model, whereby a public or private management entity owns and operates the system (similar to the Albemarle County Service Authority for our urban system). The five models are summarized in the following box.

Summary of Five Management Models, from *Voluntary Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems*, EPA 832-B-03-001, March 2003.

- **Management Model 1 - "Homeowner Awareness"** specifies appropriate program elements and activities where treatment systems are owned and operated by individual property owners in areas of low environmental sensitivity. This program is adequate where treatment technologies are limited to conventional systems that require little owner attention. To help ensure that timely maintenance is performed, the regulatory authority mails maintenance reminders to owners at appropriate intervals.
- **Management Model 2 - "Maintenance Contracts"** specifies program elements and activities where more complex designs are employed to enhance the capacity of conventional systems to accept and treat wastewater. Because of treatment complexity, contracts with qualified technicians are needed to ensure proper and timely maintenance.
- **Management Model 3 - "Operating Permits"** specifies program elements and activities where sustained performance of treatment systems is critical to protect public health and water quality. Limited-term operating permits are issued to the owner and are renewable for another term if the owner demonstrates that the system is in compliance with the terms and conditions of the permit. Performance-based designs may be incorporated into programs with management controls at this level.
- **Management Model 4 - "Responsible Management Entity (RME) Operation and Maintenance"** specifies program elements and activities where frequent and highly reliable operation and maintenance of decentralized systems is required to ensure water resource protection in sensitive environments. Under this model, the operating permit is issued to an RME instead of the property owner to provide the needed assurance that the appropriate maintenance is performed.
- **Management Model 5 - "RME Ownership"** specifies that program elements and activities for treatment systems are owned, operated, and maintained by the RME, which removes the property owner from responsibility for the system. This program is analogous to central sewerage and provides the greatest assurance of system performance in the most sensitive of environments.

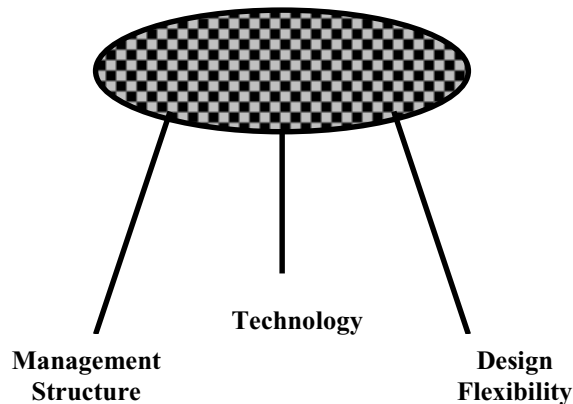
Bringing it Home to Albemarle

It is apparent from EPA's material, that we cannot divorce the issues of technology and management in our Rural Areas Comprehensive Plan discussions. These issues are relevant to:

- Rural Preservation Developments and the discussion of lot sizes and how tight clusters can become. As lot sizes decrease and clusters become tighter (thus increasing overall open space), then technology choices for water and wastewater, and the competency of the management structure, become critical questions.
- Resource Protection throughout the Rural Areas, and especially within drinking water reservoir watersheds. Alternative technologies and enhanced management models may be needed to protect reservoirs and drinking water wells from microbial and nutrient contamination. Traditionally, Albemarle County policy has not looked favorably upon alternative technologies due to a history of centralized water system failures, and because it is believed that these technologies would allow growth where it could not otherwise occur. However, if the growth is taking place anyway, and existing conventional technologies may not provide adequate water resources protection into the future, then alternative technologies are worth exploring.

In thinking about the use of alternative water and wastewater technologies in the Rural Areas, we can think of the "three legs of the stool" analogy. Without all three legs, the stool does not stand. In this case, the three legs are:

1. Design flexibility, such as committed open space for rural subdivisions for use as resource protection (e.g., recharge areas) and/or utilities (e.g., reserve well sites or wastewater treatment areas),
2. Technology choices, as presented in this paper for use in onsite or clustered configurations, and
3. A management structure that can assure proper inspection, maintenance, and management. Management of each individual system by a homeowners' association is not sustainable.



It may be that we cannot tolerate all three legs due to policy, technology, or cost constraints. This is question that will require a great deal of thought and discussion. Perhaps it is useful to conclude this document with several technology/management structures that County decision-makers can discuss. These options are not mutually exclusive, but help to frame various decisions and their consequences.

- Small Lot Clusters With Centralized Management: If, as some have discussed, we desire to have small lots (e.g., 1 acre) in an RPD in order to preserve more open space or agricultural land, then the County must consider embracing all three legs of the stool. Even if design flexibility and technology options are made available, this course of action can only be made sustainable by establishing a responsible management structure, such as a rural utility district or a modified ACSA mandate. This would be very similar to management model 4 or 5 in EPA's document.
- Larger Lot Clusters With Technology Mix: If lot sizes within RPDs do not militate against conventional well and septic systems (e.g., 3 to 6 acres), then both the technology choices and management structure become less pressing. However, the trade-off is that more land is taken up for lots instead of preservation. With this scenario, it may be that selected alternative technologies (centralized or onsite) and design options still make sense to protect sensitive resources or make more efficient use of a site's opportunities and constraints. EPA's management models 1, 2, or 3 might apply to this scenario, whereby the County promotes system maintenance through outreach, operating permits, or maintenance contracts.
- Enhanced Default Option: This scenario suggests continued reliance on private individual well and septic, independent of whether a division is in a cluster or large-lot layout. This option can be enhanced through performance and/or design standards in sensitive areas, such as within the recharge zone of an existing community well or within a fixed distance from a public water supply intake. These standards could promote the use of technologies, such as sand filters, to enhance wastewater treatment in these sensitive areas. On the water supply side, the upcoming proposed groundwater assessment standards for new rural divisions would impose a performance standard to conduct a study and verify an adequate water supply. There is a growing national trend that even dispersed, conventional onsite systems require some level of oversight and inspection to ensure public health and environmental protection. Therefore, EPA's management models 1 and 2 may be relevant for this option.
- System Rescue Option: Even as we consider technologies and management structures for new development, we cannot lose sight of the "problem" situations that have become a significant work load item. These problems include failing community water systems, contaminated water systems, and failing onsite septic systems. There are many reasons for these problems, including lack of maintenance, water source problems, age, a contamination incident, or inadequate soils for septic treatment. However, in many cases, the County, Service Authority, and/or Health Department have been called upon to help fix the problem with a limited toolbox of options at

their disposal. For these problem situations, all three legs of the stool are quite relevant. Design flexibility can provide options for backup water or wastewater systems. Alternative technologies are often needed to replace failed conventional ones. Finally, we have come to realize that some higher level of management could prevent some of these problems from occurring in the first place by ensuring an appropriate level of maintenance and financial accountability. Several of the EPA management models are relevant, depending on the case.

These scenarios are presented not as recommendations, but to spur an important community discussion on these issues. We must keep in mind that the “magic of technology” is a tool that should be wielded to help us achieve an intentional vision for the Rural Areas.

The photo page at the end of the report contains some examples of technologies discussed in the report.

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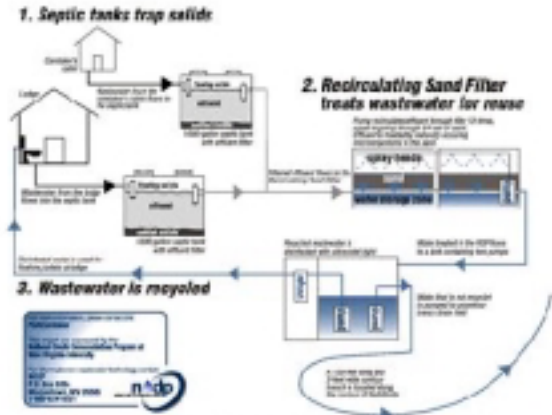
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ALTERNATIVE TECHNOLOGIES PHOTO PAGES



Schematic of a Recirculating Sand Filter
 Source: National Onsite Demonstration Project, U.S. EPA



Peat Filter With Distribution Manifolds
 Source: *Performance Evaluation of a Recirculating Sand Filter and Peat Filter in West Virginia, Small Flows Quarterly*, Winter 2003, Volume 4, Number 1.



Recirculating Sand Filter
 Source: U.S. EPA Wastewater Website, Virginia Department of Health



Small Activated Sludge Package Plant at Stone-Robinson Elementary School, operated by the Rivanna Water & Sewer Authority.
 Source: Albemarle County Department of Engineering & Public Works





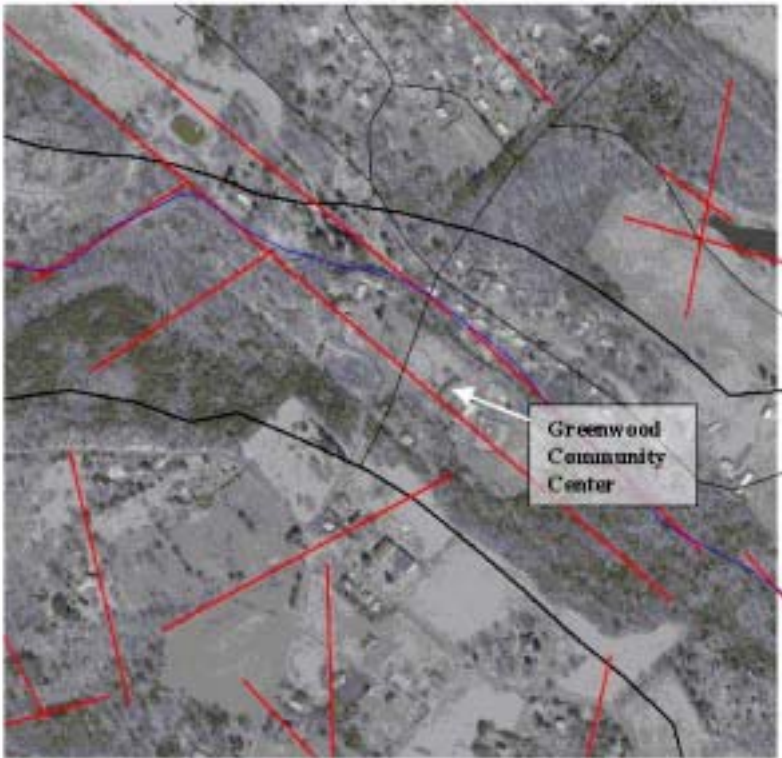
Living Machines, Inc. Technology is an adaptation of a conventional package plant
Source: www.livingmachines.com; U.S. EPA, 832-F-02-025



Source: U.S. EPA., 2001.



Members of the Albemarle County Groundwater Committee visit a community well system, operated by the Loudoun County Service Authority, January 27, 2003
Source: Albemarle County Department of Engineering & Public Works



Fracture Trace Analysis is a type of air photo interpretation used to locate potential high yielding groundwater zones. This analysis was done for the vicinity surrounding Corville Farms Subdivision (red lines are linear features that may be fractures).

Source: ENSAT Corporation, Albemarle County Department of Engineering & Public Works

Geophysics produces a picture of underground zones and their water-bearing potential based on the resistance to an electrical pulse.

Source: Albemarle County Department of Engineering & Public Works

