Appendix D: Alternative Wastewater Systems

What are alternative wastewater systems?

Alternative wastewater systems provide additional stages of treatment and/or substitute methods of disposal. The basic components of a conventional septic system (septic tank and drain field) are often essential components of appropriate alternative systems as well. Generally, a septic tank performs preliminary treatment of wastewater followed by an alternative system such as an aeration treatment unit or sand filter that perform more advanced treatment. The treated effluent can be disposed of in a traditional drain field or, if site conditions do not allow for a soil absorption field, then alternate methods such as a mound or non-discharging system can be employed. Figure D-1 describes some alternative wastewater options using a septic tank for pre-treatment. Figure D-2 illustrates two example alternative systems: 1) a septic tank with an aerobic treatment unit and a conventional soil absorption field and 2) a septic tank with a filter unit and a conventional soil absorption field. Many variations and combinations of these options are possible, and custom and experimental systems are continually being developed and tested.

Finding the appropriate alternative system depends on the performance standard requirements, costs, operation and maintenance considerations, and feasibility. Suitability, design, and performance of alternative wastewater systems are affected by the soil, slope, available space, anticipated wastewater flow and contents, and operation and maintenance procedures. All wastewater systems can be severely hampered by discharging inappropriate materials, surpassing design specifications, and not performing maintenance requirements. Remember, all products must be approved by the County and installed by certified contractors. Moreover, a licensed professional engineer must design some alternative systems, and custom and experimental systems must comply with additional conditions.

The cost of an alternative system will depend on the manufacturer, the installer, the site conditions, and the characteristics of the wastewater (estimated flow, treatment unit and disposal capacities, and setback requirements). Keep in mind, however, that conditions on some sites will only allow for an alternative system. Also, the cost of a conventional system in some applications can far exceed the cost of an alternative system.

Note: Existing systems are considered functional if they meet Class 1 performance standards. If an existing system is not functional, then the appropriate class of performance standards must be identified and complied with. Alternative systems may be required to reduce or remove organic matter, solids, nutrients, disease-causing organisms and other pollutants from wastewater beyond the ability of conventional septic systems.
Figure D-1. Treatment and disposal options for alternative wastewater systems.

Figure D-2. Examples of two alternative wastewater treatment systems.
What types of alternative wastewater systems are available?

Many alternative wastewater systems are available and all are intended to provide higher levels of effluent treatment or provide wastewater treatment for sites limited by size, geology, soils, and other conditions. As long as appropriate performance standards are complied with, alternative wastewater treatment systems can replace, or, as is commonly done, be installed in addition to conventional septic tank systems.

The following is a brief description of some of the main alternative wastewater systems including aerobic treatment units, filter units, constructed wetlands, enclosed systems, pressure dosing systems, and mound systems. As noted these systems are often used in conjunction with conventional septic systems and various combinations of alternative systems are possible. Off the shelf onsite treatment systems are increasingly available, and the County is currently evaluating several proprietary alternative treatment systems and plans to provide recommendations of these systems effectiveness under certain site conditions.

Aerobic Treatment Units

The proposed ordinance defines aerobic treatment units as wastewater treatment units that can maintain a minimum level of dissolved oxygen (2 mg/l) on a continuous basis to provide aerobic biochemical stabilization within a treatment receptacle and any additional oxygen to provide mixing.

Aerobic treatment units can be used in addition to, or instead of, a septic tank and include an aeration chamber with a mechanical aeration device, and a method of final clarification (see Figure D-3). Basically, wastewater and air mix in a tank promoting the growth of bacteria that break down the waste. Aeration units can be combined with other treatment and disposal components that provide other biological processes (anoxic conditions) and accomplish higher levels of treatment.

Note: Biological processes include aerobic and anaerobic processes where pollutants are transformed into gases and biological solids by microbial activity. Many other alternative wastewater systems including constructed wetlands, filter systems, and absorption fields use aerobic treatment processes. The aerobic nature of the process breaks down the wastes and prevents nuisance odors.

The performance of aerobic treatment units varies; however, properly functioning systems can be very successful in removing BOD and TSS, and in reducing some nitrogen species. Units capable of anaerobic processes can significantly reduce nitrate. There are many ways to create anoxic conditions within the wastewater system. Some systems turn off the aeration units for short periods, some circulate wastewater back to tanks under anoxic conditions (the primary settling tank), and others dispose of the wastewater in sub-surface irrigation systems.
Aerobic treatment units require professional and routine maintenance, electrical power, and regular pumping of waste solids (once every 8 to 12 months).

Aerobic treatment units can cost from approximately $6,000 to more than $10,000, not including operation and maintenance costs.

Filter Units

There are a variety of alternative systems that use filter units to treat wastewater. Most often these systems are used in combination with septic systems or other alternative systems. In general, these systems involve the movement of wastewater through some type of fixed media like sand or peat, although other media including anthracite, mineral tailings, and bottom ash can be used.

Typically, wastewater is intermittently applied to the surface of the filter and as it percolates through the filter bed, pollutants are removed through physical, chemical and biological transformations. Some of the most common filter units are sand filters with beds of granular material up to 3 feet deep underlain by gravel and collection tiles (see Figure D-4). Systems can be buried or above ground, and some systems allow for wastewater to be recirculated back through the system.

Performance varies, but these systems too can remove the majority of BOD, TSS, and some nitrogen species. Furthermore, sand filters can be relatively low cost and mechanically simple. Operation and maintenance is generally less than with aerobic systems, however, the filter media
does need to be maintained with raking and may need to be replaced. Additionally, pumps and control systems need to be monitored.

Typical costs, not including operation and maintenance, range from $7,000 to $10,000.

Figure D-4. An example of a recirculating sand filter treatment system.

**Constructed Subsurface Wetland System**

A constructed subsurface wetland system consists of a lined excavation filled with permeable media (gravel, soil, or coarse sand) and planted with emergent plants. The water in the bed flows below the surface of the media (see Figure D-5). A free-water constructed wetland is similar, except that the wastewater is exposed to the atmosphere as it flows through the treatment cell. The treatment mechanism for both systems is biological decomposition of organic matter in the wastewater. Basically, wastewater from a septic tank or other pre-treatment component flows horizontally through the bed media contacting a mixture of aerobic, anaerobic, and facultative microbes living in association with the permeable media and roots.

Note: The most common wetland plants are cattails, bulrushes, and reeds. It is important to use species that are native to your region.

The performance of constructed wetlands varies, however, correctly operating and maintained systems can remove BOD and TSS effectively. Onsite systems have relatively mediocre pollution removal for nitrogen species.
The cost of constructed wetland depends on site conditions and flow characteristics. Generally, these systems are considered custom systems that must be designed by a licensed professional engineer and can cost over $10,000. Maintenance can be intensive, particularly to ensure proper flow rates and plant growth.

![Diagram of constructed wetland wastewater system](image)

Figure D-5. An example of a constructed wetland wastewater system.

**Non-discharging systems**

This is an important category because some sites are not suitable for any subsurface discharge. A simple non-discharging system is a holding tank. Wastewater is stored in a leak-proof tank that must be pumped and removed off the site. Equivalent to a septic tank without a disposal field, this system must be pumped frequently and operational costs can be very high.

An evapotranspiration bed is another type of non-discharging system. An evapotranspiration bed consists of a lined excavated pit filled with sand overlaying perforated pipes in a gravel mound or layer. Wastewater from a septic system or some other type of pre-treatment system, is evaporated into the atmosphere and transpired by roots. Wastewater must be prevented from seeping into the ground, and pan evaporation rates must exceed precipitation rates during every month of operation.

As designed, wastewater effluent would be completely removed by evaporation and transpiration and thus would not threaten the groundwater. As with constructed wetlands, evapotranspiration beds can be expensive, need to be maintained properly, and must be designed by a licensed professional engineer. Many sites may not have the available space to allow for these systems, especially given the setback requirements of the proposed ordinance.
Pressure Dosing Systems

Pressure dosing systems are an alternative to the conventional soil absorption system. The main difference between the low pressure dosing system and the conventional drain fields is that low-pressure dosing systems have a pumping (dosing) chamber that maintains uniform distribution of effluent. Effluent from a pre-treatment component and sometimes other treatment unit (aerobic treatment unit) enters the pumping chamber. At regular intervals and at regulated pressures the effluent is pumped from the pumping chamber to the distribution lateral. This allows for biological treatment of the effluent and for resting and regeneration of the absorption field between doses.

The performance is based on many variables. These systems tend to be effective in removing BOD, and TSS, and converting ammonia to nitrate, however, unless the system has some way to promote anoxic conditions, they tend to have minimal denitrification.

The systems require electrical power and regular operation and maintenance of pumps and other mechanical parts. The systems can cost between $5,000 and $10,000.

Note: The wastewater ordinance requires pressure dosing distribution systems for sites with certain soil types: I, K, and M (see pg. 63 of the County Ordinance).

Mound Systems

A mound system is a pressure-dosed system in a sand fill that is elevated above the natural soil surface (see Figure D-6). A mound system has three principal components: pre-treatment (usually a septic system), a pumping (dosing) chamber, and an elevated mound containing sand, gravel, and the distribution lateral. Effluent from the pre-treatment component is pumped or siphoned to the elevated absorption area and distributed through a pipe network located in coarse aggregate at the top of the mound. The effluent passes through the aggregate and infiltrates through the sand fill. The effluent can then pass through the natural soil or the bottom of the mound can be lined and the treated effluent can be transported to a separate disposal component.

As with many of the other alternative systems, removal of BOD and TSS is very efficient, and conversion of ammonia to nitrate can be very good. However, reduction of nitrate to nitrogen gas is limited because anaerobic conditions are not built into the system, and because the nitrate can not be taken up by plants.

Operation and maintenance of mound systems are fairly intensive, as with systems that have pumps and other mechanical equipment requiring electrical power and timed distribution. Costs vary, but tend to be higher than some other alternative systems.
Figure D-6. An example of a mound wastewater system.

Other Systems

Besides these common alternative systems, other systems are available including alternating drain fields, split systems for black and graywater, biofilters, fixed film systems, deep trenches, and non-water or low water toilets. The resources listed below provide more information on these and other alternative wastewater systems.

Under the proposed ordinance no effluent can be discharged onto the surface, so the use of graywater systems for irrigation must be through sub-surface irrigation networks. Composting toilets use a biological process in which various types of organisms under controlled conditions biologically degrade human waste to a humus-like end product.

Can my system be repaired or upgraded to meet the requirements of the ordinance?

Repairs include clearing lines and perforations, rebuilding components, refitting the system with new inflows and outlets, mending leaks, correcting the positioning and slope of the system, and fixing pumps and other mechanical equipment. Upgrades may be as simple as getting an effluent filter or be as complicated as enlarging the drain field, creating an alternate drain field, splitting the wastewater stream, or adding an additional treatment and/or disposal components to your system.

Note: See the section “Can I operate my system better…?”
Sources of information:

Proprietary Systems Web Sites:

Aerobic Treatment Units

Whitewater Aerobic Treatment Unit
  http://www.deltaenvironmental.com/
Bio-Microbics (FAST wastewater treatment systems)
  http://www.biomicronics.com/
Cromaglass
  http://www.cromaglass.com/

Intermittent Sand Filter Systems

Orenco Systems Inc.
  http://www.orenco.com
Sand Filtration Inc. (Distributor of Orenco Systems Inc.)
  http://www.limnoterragroup.com/sfi/sfihp.html

Other alternative systems:

Alascan (toilet systems)
  http://www.alascanofmn.com

References


