Alternative Sewer Systems

Alternative sewer collection systems are often implemented in situations where conventional sewer collections systems are not feasible. These alternative systems include pressure sewers, small diameter gravity sewers and vacuum sewers. An alternative sewer system may be a good option if any of the following apply:

- Conventional gravity sewers and onsite wastewater treatment technologies have been determined to be inappropriate or too expensive.
- The population in an unsewered area is such that there would be 50 to 100 homes or less per mile of sewer line.
- Homes are located in hilly, rocky, low-lying or very flat areas, or areas with shallow bedrock, a high water table or other site conditions that would make installing gravity sewers impractical.
- Areas where small lot sizes, poor soil conditions, or other site-related limitations make on-site wastewater treatment options inappropriate or expensive.

Advantages

- These systems use plastic pipes much smaller in diameter than conventional sewer pipes. Small diameter plastic pipes are less expensive and easier to install.
- Alternative sewers don't need to rely on gravity to operate and don't have to continuously slope downward. They can be buried at very shallow depths and can follow natural contours of the land.

Disadvantages

- These technologies are not widely used and may be poorly designed or installed if engineers or contractors have little experience.
- Operation and maintenance costs may be high due to septic tanks that need to be inspected and pumped and mechanical parts that use electricity.
- There is the possibility of disruption in service due to mechanical breakdowns and power outages.

Costs
The average unit costs for alternative sewer system mainlines 2-inch to 8-inch range from $19-36 per lineal foot with an extra $13/ft for asphalt concrete pavement (adjusted to February 2014). The Water Environment Research Foundation (WERF) provides a cost tool for wastewater planning.
http://www.werf.org/c/DecentralizedCost/Model.aspx

Common Suppliers
National Rural Water Association Online Buyer's Guide - http://nrwa.officialbuyersguide.net/

Conclusion
There are a variety of factors that can help determine which technology could work best:

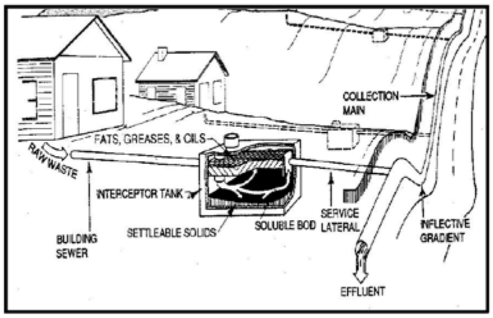
- Certain site conditions make some alternative sewer technologies more appropriate and cost effective than others. Consider the elevations of the homes or businesses being served versus and of the final treatment facility. Also consider the overall terrain of the land.
- Operation and maintenance requirements and community planning issues need to be considered when choosing an alternative sewer system.
- Alternative system technologies can sometimes be used together or combined with other technologies. Communities can take advantage of gravity where it's available to save money.

Although alternative sewer technologies can be flexible, systems must be properly designed to fit each individual situation. Minimum velocity requirements and other design considerations require the expertise of a wastewater or sanitary engineer who has experience with a particular system.

Source:
National Small Flows Clearinghouse – Pipeline Fall 1996 Issue, "Alternative Sewers: A Good Option for Many Communities"
http://www.nesc.wvu.edu/pdf/WW/publications/pipline/PL_FA96.pdf?_sm_au_=iVVVQ8N90LQsDs8F

Small Diameter Gravity Sewers

Small diameter gravity sewer (SDGS) systems use gravity as the main force to collect and transport wastewater to a facility for final treatment or to empty into a conventional sewer main. A typical SDGS system is depicted in the figure below. SDGS systems use septic tanks to provide primary treatment and to allow most suspended solids to be removed, allowing for smaller diameter piping in the lateral downstream of septic tank and in the sewer main. Cleanouts are used to provide access for flushing.



Source: U.S. EPA, 1991.

Advantages

- Elimination of manholes reduces a source of inflow.
- Trenches for SDGS pipelines are typically narrower and shallower due to small diameters and flexible slope and alignment. This results in lower excavation costs.
- Minimum pipe diameters can be three inches and plastic pipe is typically used.
- Operation and maintenance requirements are usually low.

Disadvantages

- Where the SDGS system begins must always be higher than where it ends, and no part of the system can be higher in elevation than the starting point.
- Limited experience with SDGS technology can result in poor performance
- SDGS systems do not have a large excess capacity typical of conventional gravity sewers.
- SDGS systems cannot handle commercial wastewater with high grit or settleable solids levels.
- General easement agreements are needed to permit access to components such as septic tanks.
- The SDGS system carries odorous septic tank effluent and can result in odor problems.

Costs
Average unit costs for SDGS appurtenances (adjusted to February 2014) were: cleanouts, $590 each; service connections, $18/foot. The average total cost per connection was $10,900 and the major O&M requirement for SDGS systems is the pumping of the tanks. Other O&M activities include gravity line repairs from excavation damage, supervision of new connections, and inspection and repair of mechanical components and lift stations.

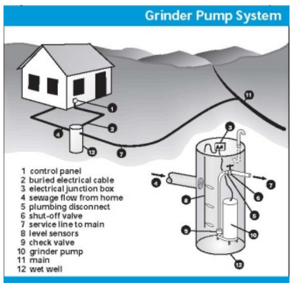
Source:
National Small Flows Clearinghouse – Pipeline Fall 1996 Issue, "Alternative Sewers: A Good Option for Many Communities"
http://www.nesc.wvu.edu/pdf/WW/publications/pipline/PL_FA96.pdf?_sm_au_=iVVVQ8N90LQsDs8F

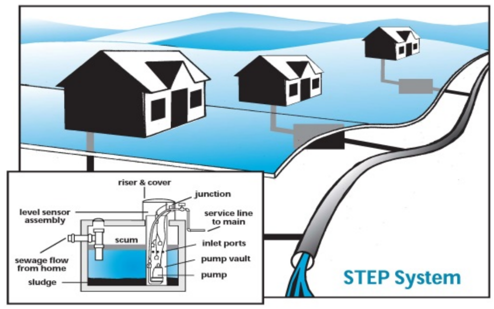
United States Environmental Protection Agency – Decentralized Systems Technology Fact Sheet September 2000, "Small Diameter Gravity Sewers"
http://water.epa.gov/scitech/wastetech/upload/2002_06_28_mtb_small_diam_gravity_sewers.pdf?_sm_au_=iVVVQ8N90LQsDs8F

Pressure Sewers

A pressure sewer is a small-diameter pipe into which partially-treated wastewater is pumped and then transported under pressure for final treatment. Small-diameter pipes can be used with pressure sewers because large and solid materials in the wastewater are separated out or ground up in initial treatment. The pressure in pressure sewers is created by the wastewater being pumped into the pipes at several connections. There are two main types of pressure sewer systems: the septic tank effluent pump (STEP) system and the grinder pump system.

A STEP system consists of a septic tank to pretreat the wastewater and a submersible, low-horsepower sump pump to push the wastewater through the system. In a grinder pump system, there is no septic tank. Preliminary treatment is performed by the grinder pump itself, which sits in a plastic chamber called a wet well. Solid materials in the wastewater are cut up and ground into tiny pieces. All of the wastewater is then pumped out into the pressurized line.





Advantages

- Sewers can be as small as 1.5 inches in diameter for the pipes leading from the service connection, and two or three inches for the mains.
- Pipes are usually made of plastic, which are flexible and more likely to remain watertight.
- Pressure sewers eliminate the need for gravity as a force. The pipe can be laid to follow the natural contour of the land in shallow trenches.
- Both effluent pumps and grinder pumps are very reliable.
- Both types of pressure sewer systems use cleanouts instead of manholes as access points for cleaning and monitoring the lines.

Disadvantages

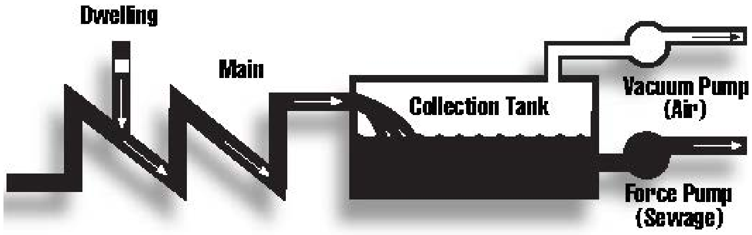
- Pressure sewers do not have the large excess capacity typical of conventional gravity sewers.
- The operation and maintenance cost for a pressure system is often higher due to the high number of pumps in use.
- Power outages can result in overflows if standby generators are not available.
- Life cycle replacement costs are expected to be higher.
- Odors and corrosion are potential problems because the wastewater in the collection sewers is usually septic.

Costs
Average unit costs for pressure sewer appurtenances (adjusted to February 2014) were: cleanouts, $590 each; isolation valves (2 to 8-inch), $640-1500 each; grinder pump, $3,100 each; single package pump system and installation, $11,700 each; air release stations, $2,600 each. The user pays for the electricity to operate the pump unit.

Source:
National Small Flows Clearinghouse – Pipeline Fall 1996 Issue, “Alternative Sewers: A Good Option for Many Communities”
http://www.nesc.wvu.edu/pdf/WW/publications/pipline/PL_FA96.pdf?_sm_au_=iVVVQ8N90LQsDs8F
United States Environmental Protection Agency – Wastewater Technology Fact Sheet September 2002, “Sewers, Pressure”
http://water.epa.gov/infrastructure/septic/upload/presewer.pdf
Other Link: http://www.werf.org/c/DecentralizedCost/C2_Pressure_Sewers.aspx

Vacuum Sewers

Vacuum sewers rely on the suction of a vacuum, created by a central pumping station and maintained in the small diameter mains, to draw and transport wastewater through the system to final treatment. The vacuum in the vacuum sewer is drawn by one or more vacuum pumps located in a central vacuum station. Wastewater flows from the house by gravity to a holding tank. When the wastewater in the holding tank reaches a certain level, usually 3 to 10 gallons, a sensor prompts a pneumatic valve to open, and the entire plug of wastewater is violently sucked into the lines by the vacuum in the sewer main. The valve stays open a few seconds to also allow some air to be sucked in after the wastewater. This plug of wastewater and air will then travel through the mains, drawn by the vacuum, to the central pumping station.



The pipe is designed to follow the contour of the land where the ground slopes naturally, and is most economical in flat terrain. Small lifts in the pipe may be used when necessary to keep excavation shallow. At the pumping station, the mains empty into a collection tank. The wastewater is then treated nearby or pumped to another location for treatment.

Advantages

- Because the initial force of the vacuum breaks up any solids in the wastewater, small-diameter plastic pipe can be used for vacuum systems. Usually 3 to 4-inch diameter pipes from the service connection and 4 to 10-inch mains are used for vacuum systems, depending on the flow and design.
- The vacuum keeps the lines very clean, so manholes and cleanout points are generally unnecessary.

Disadvantages

- This technology is not widely used. There are several different manufacturers of vacuum systems, and although the basic technology is the same, some manufacturer's designs work a little differently than others.
- Vacuum systems require a working emergency generator at the pumping station.
- The vacuum valves and parts of the valve pit require regular maintenance and need to be rebuilt or replaced every 5 to 10 years.
- Noise and odor problems at the central vacuum station.

Costs
Communities interested in installing a vacuum sewer system or investigating vacuum sewers as an option should contact manufacturers regarding the design, costs, installation, and proper system operation and maintenance. WERF estimated the costs (2009 dollars) to build a vacuum collection network, including the on-lot components for a 200 connection community using 100 vacuum pits to be: materials and installation, $1.9 to $2.8 million; annual electricity, $9,500 to $14,000; and annual O&M $82,000 to $123,000.

Source:
National Small Flows Clearinghouse – Pipeline Fall 1996 Issue, "Alternative Sewers: A Good Option for Many Communities"
http://www.nesc.wvu.edu/pdf/WW/publications/pipline/PL_FA96.pdf?_sm_au_=iVVVQ8N90LQsDs8F
Water Environmental Research Foundation (WERF) – Performance and Cost of Decentralized Unit Processes, April 2010, "Vacuum Sewer Systems"
http://www.werf.org/c/DecentralizedCost/C4_Vacuum_Sewers.aspx