Chapter 5. SMALL COMMUNITY COLLECTION SYSTEMS

When developing a collection and treatment system for wastewater, communities are often surprised to find out that the collection part of the system can be much more expensive than the treatment facility. The bigger, deeper, and longer a sewer is, the more expensive it will be. Small communities, because they may have lower population densities than larger towns, often need more length of pipe per home so the cost per home is greater. Methods of designing and building collection systems have been developed that provide alternatives to gravity sewers. There are tradeoffs between the different systems, the major one usually being that large gravity sewers are much more expensive to build but less expensive to maintain while the alternatives are often less costly at the beginning but require more maintenance and more frequent replacement of equipment. Evaluation of collection systems requires looking at the total costs (construction, replacement, operation, and maintenance) over a long period of time to make a satisfactory selection.

A. Gravity Flow

Large Diameter

Large-diameter gravity sewer systems are high capital cost, low operating and maintenance cost systems. They are most cost effective in densely populated areas. The design of gravity sewers is based on the interrelationships of slope, velocity, and the size and roughness of the inside of the pipe. To allow for cleaning, an 8-inch pipe is the smallest diameter used for gravity-flow sewers carrying sewage, but that is often much larger than is needed to carry the flow. Gravity sewers have manholes at each change in direction, slope, pipe size, intersections of collecting sewers, and every 400 feet or less (for sewers 18 inches or less in diameter), if there isn't another reason for having one. These manholes allow access for inspection, some maintenance, and cleaning. Figure1 shows a cross-section of a large-diameter gravity sewer.

B. Alternative Collection Systems

Alternative collection systems are sewer systems that do not convey unsegregated wastewater by gravity. They operate either by pump or vacuum pressure, or if they do utilize gravity, it is only used to convey septic tank effluent so that most of the solids have been removed before reaching the pipe. Because of these differences, smaller diameter pipes can be used for alternative collection systems than can be used for conventional gravity sewers.

The basic types of alternative collection systems are STEG (Septic Tank Effluent Gravity) which is exactly like a conventional onsite system except that the effluent flows to a sewer instead of an absorption field, STEP (Septic Tank Effluent Pump) which uses a pump to move the septic tank effluent into a pressurized sewer, grinder pumps which chop up the sewage into small particles so that it can be pumped easily and so that it will not block small pipes, and vacuum sewers which pull the wastewater through pipes by a central vacuum unit. STEP, grinder pump, and vacuum systems are shown in Figures 2 through 4.

In systems using pressure or vacuum, the wastewater does not need to flow constantly downhill, so the alternative collection systems can follow the surface topography of the ground as it goes up and down hill. Figures 5 and 6 illustrate the difference. This can cost less in construction, especially where bedrock nears the surface. Figures 7 and 8 show that an alternative sewer can reduce the amount of rock that needs to be removed during construction – an additional cost and time saver.

The Fall 1996, Vol. 7, No.4 issue of Pipeline is included at the end of this chapter which describes alternative sewers/collection systems in more detail.

KDHE includes large-diameter gravity sewers in “Minimum Standards of Design for Water Pollution Control Facilities,” 1978. Grinder pump systems are briefly mentioned and the other alternative collection systems are not included. KDHE will evaluate alternative collection systems and other innovative wastewater system projects on a case by case basis.

C. Selection Criteria

The following are criteria to be considered in selecting a collection system:

1. Building Density
2. Slope
3. Soil type
4. Depth to Bedrock
5. Depth to Water Table
6. Operation and Maintenance Requirements
7. Management Requirements
8. Availability of Equipment and Parts
9. Availability of Operators and Repairmen
10. Costs

D. Special Considerations in Design

Corrosion and Odor

Wastewater in pressure or vacuum collection systems has low levels of dissolved oxygen. When this wastewater contacts air, there is potential for both corrosion and odor. Sulfur compounds are the most frequent culprits in both cases. Approaches to corrosion and odor control are to keep the wastewater away from air as far through the system as possible and to provide corrosion resistance equipment such as plastic, stainless steel, or coated products, and to add odor control devices. This anaerobic to aerobic transition can occur in the manhole where a pressure sewer feeds into a gravity sewer or at the beginning of the treatment facility. Corrosion protection is especially important for electrical wiring.

Power Availability and Adequate Wiring

Anywhere that electrical equipment is used, power must be provided. If the central administrative agency is paying all electrical bills, separate metering of the wastewater units may be required. If the homes in an area are old, the wiring may not be adequate to supply pumps or other equipment, so some degree of home rewiring may be needed.

Component Standardization

These systems can be designed with many combinations of methods and equipment.

However, the more standardized the systems are, the less expensive it is to have an inventory of spare parts. Having fewer different components also makes it simpler to train operators to run and maintain the equipment.

Grease

Grease is not a problem in properly maintained STEP or STEG systems because it is removed by the septic tank. It flows with the wastewater in the other systems and has the potential to build up or clog parts. Consequently, grease can be particularly noticeable in grinder pump systems.

Flow Rates (Including Infiltration and Inflow)

Flow rate assumptions are discussed in Chapter 4, Section N, **Special Considerations in Design**.

Air Relief Valves

Pressure lines that have higher sections than the ones adjacent to them need air relief valves at the high points so that high segments don't fill up with air, blocking flow. Odor control devices may be needed at these valves.

Depth

Because pressure sewers can follow the contours of the surface, (if that is the most desirable route) they can be relatively shallow. The sewer depth should be below the frost depth. They should also be deep enough that shallow excavations are unlikely to reach and damage them.

Power Failures/Restart Protection

If there is a power outage, and wastewater continues to flow into the pump vaults, many of the units will have reached the high water level by the time the power comes on. Thus many of the units will try to start at the same time, causing system overload problems. Some provision in the pumps, power supply, or other part of the system should provide protection from these problems. This will be less of a problem at homes with a private well and pump, because water will not be pumped into the home without power either, reducing the problem of high water levels.

Pump Chamber Capacity/Other Storage Capacity

Several factors go into selecting the available storage capacity: cost; type of system; availability of spare parts and repairmen; reliability of power, etc. An effluent pump may be installed in a septic tank or a separate pump chamber. Some pump vaults have as little as 30 gallons of storage capacity while other system designs allow for a day or more of storage.

Length of Sewers Versus Costs

The cost share of sewers for an individual homeowner depends on two factors: the cost of the length of sewer required and the number of homeowners which that length of sewer serves. The number of homeowners served by a sewer is determined by the sizes and layout of the lots.

For instance, to build 1,000 feet of 8-inch diameter gravity sewer, the cost per homeowner would depend on how many homeowners are served by that 1000 feet. If the sewer is in a town with lots that are 100 wide and there are houses on both sides of the sewer, then the number of homes served would be 2 x 1,000 / 100 = 20 homes (assuming no cross streets or other things that would take up space). See Figure 9. However, if the lots are 1 acre lots (square-shaped ones), then they would be 209 feet wide and only 2 x 1,000 / 209 = 9.6 homes (less than 10) can be served in the same 1000 feet. See Figure 10. That means that the cost per homeowner would be twice as much for the larger lots. To bring the costs down, the total cost of the sewer must be reduced (look at less expensive alternatives) or reduce the size of the lots. (Another possibility for an area to be developed is to design the layout so that the houses are closer together even though the lots themselves are large.) See Figure 11.