Pressure and Gravity Sewers

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Credit: 2 PDH

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United States
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Wastewater Technology Fact Sheet

Sewers, Pressure

DESCRIPTION

Conventional Wastewater Collection System

Conventional wastewater collection systems transport sewage from homes or other sources by gravity flow through buried piping systems to a central treatment facility. These systems are usually reliable and consume no power. However, the slope requirements to maintain adequate flow by gravity may require deep excavations in hilly or flat terrain, as well as the addition of sewage pump stations, which can significantly increase the cost of conventional collection systems. Manholes and other sewer appurtenances also add substantial costs to conventional collection systems.

Alternative

Alternative wastewater collection systems can be cost effective for homes in areas where traditional collection systems are too expensive to install and operate. Pressure sewers are used in sparsely populated or suburban areas in which conventional collection systems would be expensive. These systems generally use smaller diameter pipes with a slight slope or follow the surface contour of the land, reducing excavation and construction costs.

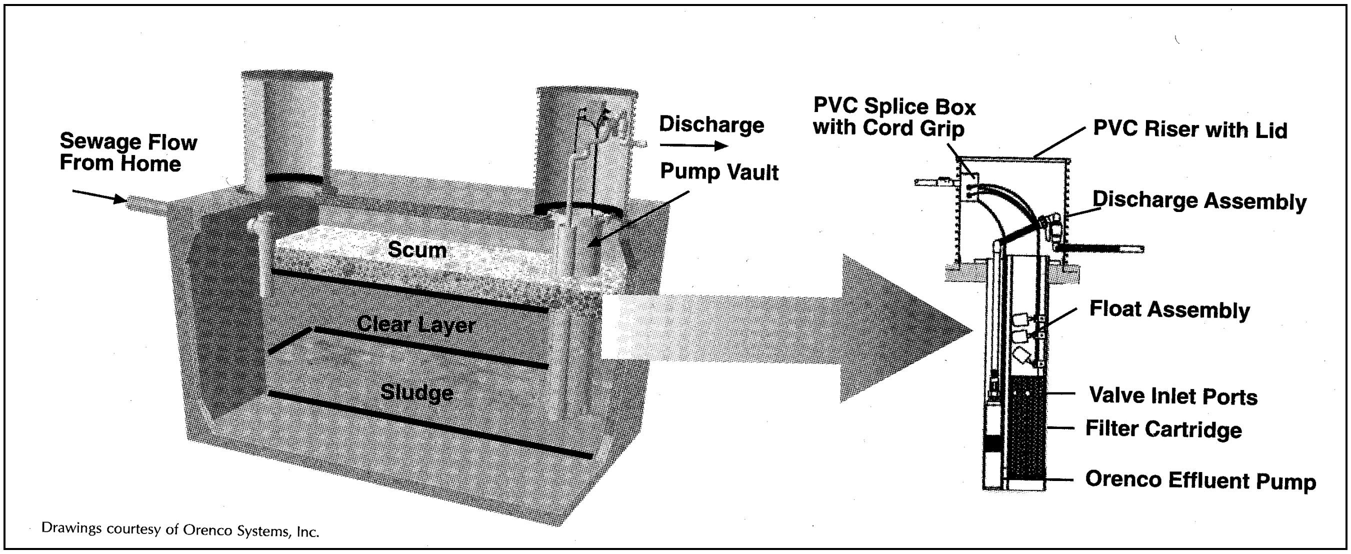
Pressure sewers differ from conventional gravity collection systems because they break down large solids in the pumping station before they are transported through the collection system. Their watertight design and the absence of manholes eliminates extraneous flows into the system. Thus, alternative sewer systems may be preferred in areas that have high groundwater that could seep into the sewer, increasing the amount of wastewater to be treated. They also protect groundwater sources by keeping wastewater in the sewer. The disadvantages of alternative sewage systems include increased energy demands, higher maintenance requirements, and greater on-lot costs. In areas with varying terrain and population density, it may prove beneficial to install a combination of sewer types.

This fact sheet discusses a sewer system that uses pressure to deliver sewage to a treatment system. Systems that use vacuum to deliver sewage to a treatment system are discussed in the *Vacuum Sewers* Fact Sheet, while gravity flow sewers are discussed in the *Small Diameter Sewers* Fact Sheet.

Pressure Sewers

Pressure sewers are particularly adaptable for rural or semi-rural communities where public contact with effluent from failing drain fields presents a substantial health concern. Since the mains for pressure sewers are, by design, watertight, the pipe connections ensure minimal leakage of sewage. This can be an important consideration in areas subject to groundwater contamination. Two major types of pressure sewer systems are the **septic tank effluent pump (STEP)** system and the **grinder pump (GP)**. Neither requires any modification to plumbing inside the house.

In STEP systems, wastewater flows into a conventional septic tank to capture solids. The liquid effluent flows to a holding tank containing a pump and control devices. The effluent is then pumped and transferred for treatment. Retrofitting existing septic tanks in areas served by septic tank/drain field systems would seem to present an opportunity for cost savings, but a large number (often a majority) must be replaced or expanded over the life of the system because of insufficient capacity, deterioration of concrete tanks, or leaks. In a GP system, sewage flows to a vault where a grinder pump grinds the solids and discharges the sewage into a pressurized pipe system. GP systems do not require a septic tank but may require more horsepower than STEP systems because of the grinding action. A GP system can result in significant capital cost



Source: C. Falvey, 2001.

FIGURE 1 TYPICAL SEPTIC TANK EFFLUENT PUMP

savings for new areas that have no septic tanks or in older areas where many tanks must be replaced or repaired. Figure 1 shows a typical septic tank effluent pump, while Figure 2 shows a typical grinder pump used in residential wastewater treatment.

The choice between GP and STEP systems depends on three main factors, as described below:

Cost: On-lot facilities, including pumps and tanks, will account for more than 75 percent of total costs, and may run as high as 90 percent. Thus, there is a strong motivation to use a system with the least expensive on-lot facilities. STEP systems may lower on-lot costs because they allow some gravity service connections due to the continued use of a septic tank. In addition, a grinder pump must be more rugged than a STEP pump to handle the added task of grinding, and, consequently, it is more expensive. If many septic tanks must be replaced, costs will be significantly higher for a STEP system than a GP system.

Downstream Treatment: GP systems produce a higher TSS that may not be acceptable at a downstream treatment facility.

Low Flow Conditions: STEP systems will better tolerate low flow conditions that occur in areas with highly fluctuating seasonal occupancy and those with slow build out from a small initial population to the ultimate design population. Thus, STEP systems may be better choices in these areas than GP systems.

APPLICABILITY

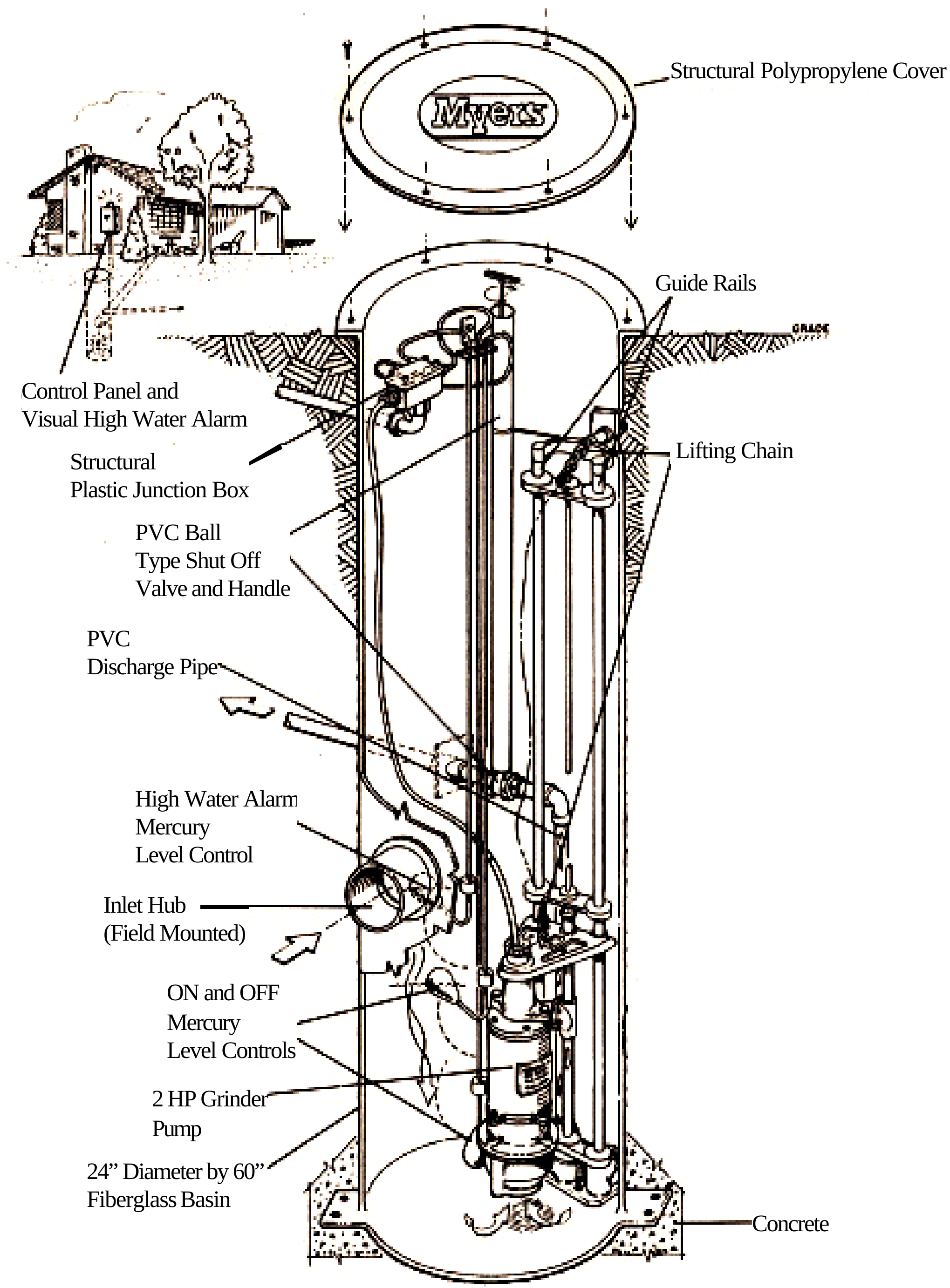
Pressure sewer systems are most cost effective where housing density is low, where the terrain has undulations with relatively high relief, and where the system outfall must be at the same or a higher elevation than most or all of the service area. They can also be effective where flat terrain is combined with high ground water or bedrock, making deep cuts and/or multiple lift stations excessively expensive. They can be cost effective even in densely populated areas where difficult construction or right of way conditions exist, or where the terrain will not accommodate gravity sewers.

Since pressure systems do not have the large excess capacity typical of conventional gravity sewers, they must be designed with a balanced approach, keeping future growth and internal hydraulic performance in mind.

ADVANTAGES AND DISADVANTAGES

Advantages

Pressure sewer systems that connect several residences to a "cluster" pump station can be less expensive than



Source: F.E. Meyers Company, 2000.

FIGURE 2 TYPICAL GRINDER PUMP

conventional gravity systems. On-property facilities represent a major portion of the capital cost of the entire system and are shared in a cluster arrangement. This can be an economic advantage since on-property components are not required until a house is constructed and are borne by the homeowner. Low front-end investment makes the present-value cost of the entire system lower than that of conventional gravity sewerage, especially in new development areas where homes are built over many years.

Because wastewater is pumped under pressure, gravity flow is not necessary and the strict alignment and slope restrictions for conventional gravity sewers can be relaxed. Network layout does not depend on ground contours: pipes can be laid in any location and extensions can be made in the street right-of-way at a relatively small cost without damage to existing structures.

Other advantages of pressure sewers include:

Material and trenching costs are significantly lower because pipe size and depth requirements are reduced.

Low-cost clean outs and valve assemblies are used rather than manholes and may be spaced further apart than manholes in a conventional system.

Infiltration is reduced, resulting in reductions in pipe size.

The user pays for the electricity to operate the pump unit. The resulting increase in electric bills is small and may replace municipality or community bills for central pumping eliminated by the pressure system.

Final treatment may be substantially reduced in hydraulic and organic loading in STEP systems. Hydraulic loadings are also reduced for GP systems.

Because sewage is transported under pressure, more flexibility is allowed in siting final treatment facilities and may help reduce the length of outfall lines or treatment plant construction costs.

Disadvantages

Requires much institutional involvement because the pressure system has many mechanical components throughout the service area.

The operation and maintenance (O&M) cost for a pressure system is often higher than a conventional gravity system due to the high number of pumps in use. However, lift stations in a conventional gravity sewer can reverse this situation.

Annual preventive maintenance calls are usually scheduled for GP components of pressure sewers. STEP systems also require pump-out of septic tanks at two to three year intervals.

Public education is necessary so the user knows how to deal with emergencies and how to avoid blockages or other maintenance problems.

The number of pumps that can share the same downstream force main is limited.

Power outages can result in overflows if standby generators are not available.

Life cycle replacement costs are expected to be higher because pressure sewers have a lower life expectancy than conventional systems.

Odors and corrosion are potential problems because the wastewater in the collection sewers is usually septic. Proper ventilation and odor control must be provided in the design and non-corrosive components should be used. Air release valves are often vented to soil beds to minimize odor problems and special discharge and treatment designs are required to avoid terminal discharge problems.

DESIGN CRITERIA

Many different design flows can be used in pressure systems. When positive displacement GP units are used, the design flow is obtained by multiplying the pump discharge by the maximum number of pumps expected to be operating simultaneously. When centrifugal pumps are used, the equation used is $Q = 20 + 0.5D$, where Q is the flow in gpm and D is the number of homes served. The operation of the system under various assumed conditions should be simulated by computer to check design adequacy. No allowances for infiltration and inflow are required. No minimum velocity is generally used in design, but GP systems must attain three to five feet per second at least once per day. A Hazen-Williams coefficient, (C) = 130 to 140, is suggested for hydraulic analysis. Pressure mains generally use 50 mm (2 inch) or larger PVC pipe (SDR 21) and rubber-ring joints or solvent welding to assemble the pipe joints. High-density polyethylene (HDPE) pipe with fused joints is widely used in Canada. Electrical requirements, especially for GP systems, may necessitate rewiring and electrical service upgrading in the service area. Pipes are generally buried to at least the winter frost penetration depth; in far northern sites insulated and heat-traced pipes are generally buried at a minimal depth. GP and STEP pumps are sized to accommodate the hydraulic grade requirements of the system. Discharge points must use drop inlets to minimize odors and corrosion. Air release valves are placed at high points in the sewer and often are vented to soil beds. Both STEP and GP systems can be assumed to be anaerobic and potentially odorous if subjected to turbulence (stripping of gases such as H_2S).

PERFORMANCE

STEP

When properly installed, septic tanks typically remove about 50 percent of BOD, 75 percent of suspended solids, virtually all grit, and about 90 percent of grease, reducing the likelihood of clogging. Also, wastewater reaching the treatment plant will be weaker than raw sewage. Typical average values of BOD and TSS are 110 mg/L and 50 mg/L, respectively. On the other hand, septic tank effluent has virtually zero dissolved oxygen.

Primary sedimentation is not required to treat septic tank effluent. The effluent responds well to aerobic treatment, but odor control at the headworks of the treatment plant should receive extra attention.

The small community of High Island, Texas, was concerned that septic tank failures were damaging a local area frequented by migratory birds. Funds and materials were secured from the EPA, several state agencies, and the Audubon Society to replace the undersized septic tanks with larger ones equipped with STEP units and low pressure sewerage ultimately discharging to a constructed wetland. This system is expected to achieve an effluent quality of less than 20 mg/L each of BOD and TSS, less than 8 mg/L ammonia, and greater than 4 mg/L dissolved oxygen (Jensen 1999).

In 1996, the village of Browns, Illinois, replaced a failing septic tank system with a STEP system discharging to low pressure sewers and ultimately to a recirculating gravel filter. Cost was a major concern to the residents of the village, who were used to average monthly sewer bills of $20. Conditions in the village were poor for conventional sewer systems, making them prohibitively expensive. An alternative low pressure-STEP system averaged only $19.38 per month per resident, and eliminated the public health hazard caused by the failed septic tanks (ICAA, 2000).

GP Treatment

The wastewater reaching the treatment plant will typically be stronger than that from conventional systems because infiltration is not possible. Typical design average concentrations of both BOD and TSS are 350 mg/L (WPCF, 1986).

GP/low pressure sewer systems have replaced failing septic tanks in Lake Worth, Texas (Head, et. al., 2000); Beach Drive in Kitsap County, Washington (Mayhew and Fitzwater, 1999); and Cuyler, New York (Earle, 1998). Each of these communities chose alternative systems over conventional systems based on lower costs and better suitability to local soil conditions.

OPERATION AND MAINTENANCE

Routine operation and maintenance requirements for both STEP and GP systems are minimal. Small systems that serve 300 or fewer homes do not usually require a full-time staff. Service can be performed by personnel from the municipal public works or highway department. Most system maintenance activities involve responding to homeowner service calls usually for electrical control problems or pump blockages. STEP systems also require pumping every two to three years.

TABLE 1 RELATIVE CHARACTERISTICS OF ALTERNATIVE SEWERS

Sewer Type	Slope Requirement	Construction Cost in Rocky, High Groundwater Sites	Operation and Maintenance Requirements	Ideal Power Requirements
Conventional	Downhill	High	Moderate	None*
Pressure				
STEP	None	Low	Moderate-high	Low
GP	None	Low	Moderate-high	Moderate

* Power may be required for lift stations
Source: Small Flows Clearinghouse, 1992.

The inherent septic nature of wastewater in pressure sewers requires that system personnel take appropriate safety precautions when performing maintenance to minimize exposure to toxic gases, such as hydrogen sulfide, which may be present in the sewer lines, pump vaults, or septic tanks. Odor problems may develop in pressure sewer systems because of improper house venting. The addition of strong oxidizing agents, such as chlorine or hydrogen peroxide, may be necessary to control odor where venting is not the cause of the problem.

Generally, it is in the best interest of the municipality and the homeowners to have the municipality or sewer utility be responsible for maintaining all system components. General easement agreements are needed to permit access to on-site components, such as septic tanks, STEP units, or GP units on private property.

COSTS

Pressure sewers are generally more cost-effective than conventional gravity sewers in rural areas because capital costs for pressure sewers are generally lower than for gravity sewers. While capital cost savings of 90 percent have been achieved, no universal statement of savings is possible because each site and system is unique. Table 1 presents a generic comparison of common characteristics of sanitary sewer systems that should be considered in the initial decision-making process on whether to use pressure sewer systems or conventional gravity sewer systems.

Table 2 presents data from recent evaluations of the costs of pressure sewer mains and appurtenances (essentially the same for GP and STEP), including items specific to each type of pressure sewer. Purchasing pumping stations in volume may reduce costs by up to 50 percent. The linear cost of mains can vary by a factor of two to three, depending on the type of trenching equipment and local costs of high-quality backfill and pipe. The local geology and utility systems will impact the installation cost of either system.

The homeowner is responsible for energy costs, which will vary from $1.00 to $2.50/month for GP systems, depending on the horsepower of the unit. STEP units generally cost less than $1.00/month.

Preventive maintenance should be performed annually for each unit, with monthly maintenance of other mechanical components. STEP systems require periodic pumping of septic tanks. Total O&M costs average $100-200 per year per unit, and include costs for troubleshooting, inspection of new installations, and responding to problems.

Mean time between service calls (MTBSC) data vary greatly, but values of 4 to 10 years for both GP and STEP units are reasonable estimates for quality installations.

TABLE 2 AVERAGE INSTALLED UNIT COSTS FOR PRESSURE SEWER MAINS & APPURTENANCES

Item	Unit Cost ($)
2 inch mains	9.40/LF
3 inch mains	10.00/LF
4 inch mains	11.30/LF
6 inch mains	15.80/LF
8 inch mains	17.60/LF
Extra for mains in asphalt concrete pavement	6.30/LF
2 inch isolation valves	315/each
3 inch isolation valves	345/each
4 inch isolation valves	440/each
6 inch isolation valves	500/each
8 inch isolation valves	720/each
Individual Grinder pump	1,505/each
Single (simplex) package pump system	5,140/each
package installation	625 - 1,880/each
Automatic air release stations	1,255/each

Source: U.S. EPA, 1991.

REFERENCES

Other Related Fact Sheets

Other EPA Fact Sheets can be found at the following web address:

http://www.epa.gov/owm/mtb/mtbfact.htm

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Decentralized Systems Technology Fact Sheet
Small Diameter Gravity Sewers

DESCRIPTION

Alternative wastewater collection systems are often implemented in situations where conventional wastewater collection systems are not feasible. Typically, it is desirable to use conventional wastewater collection systems based on a proven track record. However, in areas of hilly or flat terrain, the use of conventional wastewater collection systems may require deep excavation, significantly increasing the cost of conventional collection systems.

Conventional Wastewater Collection Systems

Conventional wastewater collection systems are the most popular method to collect and convey wastewater. Pipes are installed on a slope, allowing wastewater to flow by gravity from a house site to the treatment facility. Pipes are sized and designed with straight alignment and uniform gradients to maintain self-cleansing velocities. Manholes are installed between straight runs of pipe to ensure that stoppages can be readily accessed. Pipes are generally eight inches or larger and are typically installed at a minimum depth of three feet and a maximum depth of 25 feet. Manholes are located no more than 400 feet apart or at changes of direction or slope.

Alternative Wastewater Collection Systems

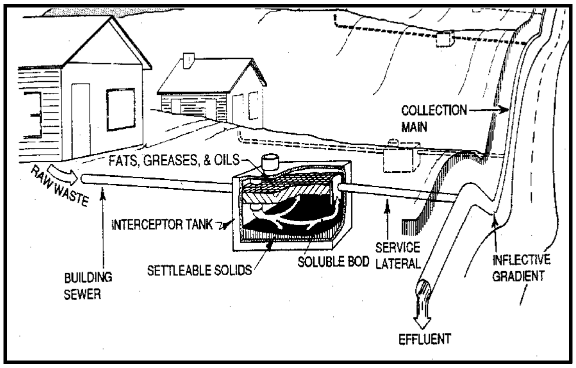
Where deep excavation is a concern, it may be beneficial to use an alternative wastewater collection system. These systems generally use smaller diameter pipes with a slight slope or follow the surface contour of the land, reducing the amount of excavation and construction costs. This is illustrated in Figure 1, which shows a pipe following an inflective gradient (the contours of the ground). As long as the head of the sewer is at a higher invert elevation than the tail of the sewer's invert elevation, flow will continue through the system in the intended direction. Alternative collection systems may be preferred in areas with high groundwater that may seep into the sewer, increasing the amount of wastewater to be treated. Areas where small lot sizes, poor soil conditions, or other site-related limitations make on-site wastewater treatment options inappropriate or expensive may benefit from alternative wastewater collection systems.

This Fact Sheet discusses small diameter gravity sewers.

Small Diameter Gravity Sewers

Small diameter gravity sewers (SDGS) convey effluent by gravity from an interceptor tank (or septic tank) to a centralized treatment location or pump station for transfer to another collection system or treatment facility. A typical SDGS system is depicted in Figure 1.

Most suspended solids are removed from the wastestream by septic tanks, reducing the potential for clogging to occur and allowing for smaller diameter piping both downstream of the septic tank in the lateral and in the sewer main. Cleanouts are used to provide access for flushing; manholes are rarely used. Air release risers are required at or slightly downstream of summits in the sewer profile. Odor control is important at all access points since the SDGS carries odorous septic tank effluent. Because of the small diameters and flexible slope and alignment of the SDGS, excavation depths and volumes are typically much smaller than with conventional sewers. Minimum pipe diameters can be three inches. Plastic pipe is typically used because it is economical in small sizes and resists corrosion.



Source: U.S. EPA, 1991.

FIGURE 1 SDGS SYSTEM

APPLICABILITY

- Approximately 250 SDGS systems have been financed in the United States by the EPA Construction Grants Program. Many more have been financed with private or local funding. These systems were introduced in the United States in the mid-1970s, but have been used in Australia since the 1960s.

- SDGS systems can be most cost-effective where housing density is low, the terrain has undulations of low relief, and the elevation of the system terminus is lower than all or nearly all of the service area. They can also be effective where the terrain is too flat for conventional gravity sewers without deep excavation, where the soil is rocky or unstable, or where the groundwater level is high.

- SDGS systems do not have the large excess capacity typical of conventional gravity sewers and should be designed with an adequate allowance for future growth.

ADVANTAGES AND DISADVANTAGES

Advantages

- Construction is fast, requiring less time to provide service.

- Unskilled personnel can operate and maintain the system.

- Elimination of manholes reduces a source of inflow, further reducing the size of pipes, lift/pumping stations, and final treatment, ultimately reducing cost.

- Reduced excavation costs: Trenches for SDGS pipelines are typically narrower and shallower than for conventional sewers.

- Reduced material costs: SDGS pipelines are smaller than conventional sewers, reducing pipe and trenching costs.

- Final treatment requirements are scaled down in terms of organic loading since partial removal is performed in the septic tank.

- Reduced depth of mains lessens construction costs due to high ground water or rocky conditions.

Disadvantages

Though not necessarily a disadvantage, limited experience with SDGS technology has yielded some situations where systems have performed inadequately. This is usually more a function of poor design and construction than the ability of a properly designed and constructed SDGS system to perform adequately.

While SDGS systems have no major disadvantages specific to temperate climates, some restrictions may limit their application:

- SDGS systems cannot handle commercial wastewater with high grit or settleable solids levels. Restaurants may be hooked up if they are equipped with effective grease traps. Laundromats may be a constraining factor for SDGS systems in small communities. No reports could be found on the use of SDGS systems as a commercial wastewater collection option.

- In addition to corrosion within the pipe from the wastewater, corrosion outside the pipe has been a problem in some SDGS systems in the United States where piping is installed in highly corrosive soil. If the piping will be exposed to a corrosive environment, non-corrosive materials must be incorporated in the design.

- Disposing of collected septage from septic tanks is probably the most complex aspect of the SDGS system and should be carried out by local authorities. However, many tanks are installed on private property requiring easement agreements for local authorities to gain access. Contracting to carry out these functions is an option, as long as the local authorities retain enforceable power for hygiene control.

- Odors are the most common problem. Many early systems used an on-lot balancing tank that promoted stripping of hydrogen sulfide from the interceptor (septic) tank effluent. Other odor problems are caused by inadequate house ventilation systems and mainline manholes or venting structures. Appropriate engineering can control odor problems.

- SDGS systems must be buried deep enough so that they will not freeze. Excavation may be substantial in areas where there is a deep frostline.

DESIGN CRITERIA

Peak flows are based on the formula Q=20 + 0.5D, where Q is flow (gallons per minute) and D is the number of dwelling units served by the system (EPA 1992). Whenever possible, it is desirable to use actual flow data for design purposes. However, if this is not available, peak flows are calculated. Each segment of the sewer is analyzed by the Hazen-Williams or Manning equations to determine if the pipe is of adequate size and slope to handle the peak design flow. No minimum velocity is required and PVC pipe (SDR 35) is commonly used for gravity segments. Stronger pipe (e.g., SDR 21) may be dictated where septic tank effluent pump (STEP) units feed the system. Check valves may also be used in flooded sections or where backup (surcharging) from the main may occur. These valves are installed downstream of mainline cleanouts.

Typical pipe diameters for SDGS are 80 millimeters (three inches) or more, but the minimum recommended pipe size is 101.6 mm (4 mm) because 80 mm (3 inch) pipes are not readily available and need to be special ordered. The slope of the pipe should be adequate to carry peak hourly flows. SDGS systems do not need to meet a minimum velocity because solids settling is not a design parameter in them. The depth of the piping should be the minimum necessary to prevent damage from anticipated earth and truck loadings and freezing. If no heavy earth or truck loadings are anticipated, a depth of 600 to 750 millimeters (24 to 30 inches) is typical.

All components must be corrosion-resistant and all discharges (e.g., to a conventional gravity interception or treatment facility) should be made through drop inlets below the liquid level to minimize odors. The system is ventilated through service-connection house vent stacks. Other atmospheric openings should be directed to soil beds for odor control, unless they are located away from the populace.

Septic tanks are generally sized based on local plumbing codes. STEP units used for below-grade services are covered in a Fact Sheet on pressure sewers. It is essential to ensure that on-lot infiltration and inflow (l/l) is eliminated through proper testing and repair, if required, of building sewers, as well as pre-installation testing of septic tanks.

Mainline cleanouts are generally spaced 120 to 300 meters (400 to 1,000 feet) apart. Treatment is normally by stabilization pond or subsurface infiltration. Effluent may also be directed to a pump station or treatment facility.

A well operated and maintained septic tank will typically remove up to 50 percent of BOD_5, 75 percent of SS, virtually all grit, and about 90 percent of grease. Clogging is not normally a problem. Also, wastewater reaching the treatment plant will typically be more dilute than raw sewage. Typical average values of BOD and TSS are 110 mg/l and 50 mg/l, respectively.

Primary sedimentation is not required to treat septic tank effluent. Sand filters are effective in treatment. Effluent responds well to aerobic treatment, but odor control at the headworks of the treatment plant should receive extra attention.

PERFORMANCE

Point Royal Estates, Texas

Point Royal Estates is an 80-home subdivision developed in the early 1970s near Lake Ray Hubbard in the northwest part of Rockwall County, Texas. For many years, septic tank and drainfield failures were a great inconvenience to the residents of Point Royal Estates, ultimately causing property values to decrease.

Originally, each home was served by two 250-gallon septic tanks, and gravity absorption field lines were placed in the back yards. The systems began to fail regularly, largely due to infiltration problems since soils in the area are mostly extremely tight clays. Many residents pumped their tanks twice a year but still reported system failures. Some residents resorted to renting “port-a-potties”.

In 1990, the City of Rowlett formed a Public Improvement District to install a conventional sewer system in Point Royal Estates. The final cost estimate for this project was nearly $10,000 per residence. These high costs prompted the city to explore other alternatives.

In 1993, the Point Royal Water and Sewage Supply Corporation (PRWSSC) was formed to evaluate alternatives for sewage collection. After a series of public meetings, it became obvious that a small diameter sewer might be the best option for the subdivision. The final cost estimate for a SDGS system was about $3,500 per residence.

The system consisted of interceptor tanks ranging in size from 1,000-1,200 gallons installed at each residence. These tanks were installed with baffles and Clemson design tubes to prevent solids buildup and reduce the amount of sludge sent through the downstream sewer piping. Homes were connected to the interceptor tanks with four-inch PVC pipes installed at a 2 percent slope. Effluent was transported from the interceptor tanks to the SDGS collection line by a two-inch PVC gravity sewer. Valves and cleanout ports that could be easily accessed and serviced were installed at most homes. Existing septic tanks were abandoned and crushed, when practical.

Oxytec, Inc. was the general contractor for the installation, which began in April 1994. Final inspections were performed in July 1995 and no operational problems have yet been reported.

OPERATION AND MAINTENANCE

O&M requirements for SDGS systems are usually low, especially if there are no STEP units or lift stations. Periodic flushing of low-velocity segments of the collector mains may be required. The septic tanks must be pumped periodically to prevent solids from entering the collector mains. It is generally recommended that pumping be performed every three to five years. However, the actual operating experience of SDGS systems indicates that once every seven to ten years is adequate. Where lift stations are used, such as in low lying areas where waste is collected from multiple sources, they should be checked on a daily or weekly basis. A daily log should be kept on all operating checks, maintenance performed, and service calls. Regular flow monitoring is useful to evaluate whether inflow and infiltration problems are developing.

The municipality or sewer utility should be responsible for O&M of all of the SDGS system components to ensure a high degree of system reliability. General easement agreements are needed to permit access to components such as septic tanks or STEP units on private property.

COSTS

The installed costs of the collector mains and laterals and the interceptor tanks constitute more than 50 percent of total construction cost (see Table 1 for more detailed listing of component costs). Average unit costs for twelve projects (adjusted to January 1991) were: 10 cm (4 in.) mainline, $3.71/m ($12.19/ft); cleanouts, $290 each; and service connections, $2.76/m ($9.08/ft). A more detailed listing of this information may be found in Table 1. Average unit costs for 440 L (1,000 gal) septic tanks were $1,315, but are not included in Table 1. The average cost per connection was $5,353 (adjusted to January 1991) 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. Most SDGS system users pay $10 to 20/month for management, including O&M and administrative costs.

TABLE 1 SMALL DIAMETER GRAVITY SEWER COMPONENT COSTS

Community (Cost Index)	In-Place Pipe	Man-holes	Clean outs	Lift Stations	Force Main	Bldg. Sewer	Service Conn.	Site Restoration	Total
Westboro, WI	5.27	0.60	-	1.65	0.55	0.76	a	0.75	13.03
Badger, SD	2.67	1.93	-	3.23	0.39	0.03	2.59	b	15.61
Avery, ID	8.57	0.60	0.25	5.11	1.64	-	0.69	b	43.39
Maplewood, WI	17.30	0.44	0.62	10.72	2.92	-	2.79	1.29	45.85
S. Corning, NY #1	13.36	0.44	0.48	-	-	1.62	7.72	3.08	43.63
S. Corning, NY #2	15.11	0.72	0.32	-	-	2.51	11.87	2.11	50.87
New Castle, VA	9.89	2.40	0.78	2.88	2.60	-	b	b	30.58
Miranda, CA	24.36	1.61	1.60	-	0.17	4.94	7.44	0.53	69.33
Gardiner, NY	15.07	1.47	0.37	0.78	0.50	0.72	2.50	0.77	30.84
Lafayette, TN	6.90	0.64	0.14	1.26	0.37	0.11	4.19	b	16.29
West Point, CA	7.26	-	0.35	2.22	1.56	-	6.00	-	38.64
Zanesville, OH	8.09	0.18	1.05	-	-	9.46	8.71	1.12	46.65
Adjusted Average	15.10	1.42	0.79	4.95	1.66	3.22	7.13	2.12	57.89

a Included in septic tank costs.
b Included in pipe costs. Costs are in $/ft pipe installed.

Source: U.S.EPA, 1991.

REFERENCES

Other Related Fact Sheets

Sewers, Pressure
EPA 832-F-00-070
September 2000

Sewers, Lift Stations
EPA 832-F-00-073
September 2000

Other EPA Fact Sheets can be found at the following web address:
http://www.epa.gov/owmitnet/mtbfact.htm

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