United States
Environmental Protection
Agency

Water Engineering
Research Laboratory
Cincinnati OH 45268

Research and Development

EPA/600/S2-86/022 May 1986

EPA

Project Summary

Small Diameter Gravity Sewers: An Alternative for Unsewered Communities

Richard J. Otis

A 3-year laboratory and field study was undertaken to evaluate small diameter gravity sewers as a wastewater collection alternative to conventional sewers. The objective of the study was to develop design criteria that would minimize costs and construction and yet maintain reliable, trouble-free operation. The study included a review of the design, construction, operation, and costs of operating systems, detailed characterization of the small diameter gravity system in Westboro, Wisconsin, and a laboratory investigation to develop hydraulic design criteria. Study results indicate that small diameter gravity sewers or effluent drains are a viable and less costly alternative to conventional gravity sewers in unsewered areas.

This Project Summary was developed by EPA's Water Engineering Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Many unsewered communities are facing severe financial hardships in providing proper wastewater facilities for their citizens because of the high costs of conventional sewerage. The most costly component is the installation of the wastewater collection system, which can represent as much as 90 percent of the total capital costs of the facilities. To reduce these costs, communities have pursued development of less costly collection alternatives such as pressure and vacuum sewers.

The most recently introduced collection alternative is the small diameter gravity (SDG) sewer. Unlike conventional sewers, SDG sewers only collect the liquid portion of the wastewater. Grit, grease, and other troublesome solids that might obstruct the sewer are separated from the flow in interceptor tanks upstream of each connection. Thus, the hydraulic design need not be based on water carriage of solids. This feature could permit significant cost savings in construction.

A field and laboratory study was undertaken to assess the potential of effluent drains as a less costly alternative to conventional sewers in small communities and urban fringe developments. The objectives of this study were to:

- Review current effluent drain design practices,
- Evaluate unit costs of construction for effluent drain components,
- Monitor and characterize an operating system,
- Evaluate the effects of drain diameter, flow velocity, and depressed drain sections on the operating characteristics, and
- Develop design guidelines and maintenance procedures.

Results

A review of 10 operating systems in the United States revealed that the experience with SDG sewers has been very favorable. Construction cost savings are estimated to range from 0 to 50 percent over conventional gravity

sewers. The use of fewer and smaller appurtenances were possible to facilitate maintenance by less skilled personnel and to reduce replacement costs. At the treatment plants, headworks and primary sedimentation were eliminated or reduced in size. Reported problems with the operation of SDG sewers were few and easily corrected. The most frequently reported disadvantages was the need to enter private property to install and maintain the interceptor tanks.

No significant inherent problems have appeared with SDG sewers. Obstructions have not occurred in any of the systems, despite the lack of routine cleaning. Slime growths do adhere to the pipe, but they slough off continuously and are easily carried by the flow. Odors can be a problem where turbulent flow occurs, such as in lift stations or in lines on steep gradients; but odor control measures have been effective. Building sewers that are in poor condition and cracked interceptor tanks with poorly fitting covers are a major potential source of infiltration and grit. The use of existing tanks should be carefully considered, and new tanks should be thoroughly inspected.

Routine maintenance needs of SDG sewers appear to be fewer than those for conventional sewers. Because SDG sewers do not carry larger solids and other debris, lift stations and conduits do not need regular cleaning. Only the interceptor tanks require regular cleaning. If cleaning of the SDG sewer becomes necessary, mechanical equipment or hydraulic jetting equipment is appropriate. Simple flushing with clear water is very effective. Flush volumes of 4 to 5 pipe volumes at a sufficient head to create a 1.5- to 2-ft/sec flow velocity is sufficient. Such volume can be supplied by a fire tank truck.

The costs of SDG sewer construction were significantly less than those of conventional gravity sewer construction. Bid costs from the projects reviewed averaged $39.92/ft of drain installed and $4,335 per connection (May 1982 dollars). These costs include service connections but exclude all non-construction costs. The national average for conventional gravity sewer construction (adjusted to May 1982) is $46.68/ft, which excludes service connections but includes all non-construction costs. Installed pipe and interceptor tank installation accounted for more than 50 percent of the effluent drain construction costs.

Recommended Design Guidelines

Based on this work, design criteria were recommended for SDG sewers and appurtenances (Tables 1 and 2).

The full report was submitted in partial fulfillment of Contract No. 68-03 3057 by Rural Systems Engineering Inc., under the sponsorship of the U.S Environmental Protection Agency.

Table 1. *Recommended Design Guidelines for SDG Sewers*

Parameter	*Recommendation*	*Comments*
Design flow	*1.0 gpm/connection*	*May be reduced if "forced storage" is provided.*
Pipe diameter		
Open channel flow	*2 in. minimum*	*No connection may be larger in diameter than the collector pipe.*
Pressure conduit flow	*4 in. minimum*	
Slope	*No minimum*	*Inflection gradients are permitted, but overall gradient must be sufficient to carry design flow.*
Velocity		
Open channel flow	*No minimum*	
Pressure conduit flow	*0.5 fps minimum*	
Pipe roughness coefficient		
Manning's m	*0.015*	
Hazen-Williams C_n	*100*	
Alignment	*Curvillinear*	*Horizontal and vertical planes*

Table 2. *Recommended Appurtenances for SDG Sewers*

Appurtenance	*Recommendation*	*Comments*
Interceptor tank size	*1,000 gal minimum*	*Liquid surface area should be 40 ft^2 minimum.*
Inlet/outlet	*Baffled with 0.25 ft minimum drop across tank*	*Outlet is larger than pipe diameter.*
Material	*Concrete*	*Must be watertight and structurally sound to withstand anticipated loads.*
Access	*Manhole over inlet with watertight cover to grade*	*May be buried if necessary to prevent tampering.*
Cleanouts	*At junctions, termini, high points, major changes in direction, and regular intervals*	*Because of their low cost, liberal use is suggested. Aids in locating pipe.*
Manholes	*Major junctions and inspection points*	*Use should be limited and covers should be watertight.*
Lift stations	*Drop inlets and air vent to buried gravel bed for odor control*	*Large solids-handling sewage pumps are not required.*

Richard J. Otis is with RSE Group, Madison, WI 53706.
***James F. Kreissl** is the EPA Project Officer (see below).*
The complete report, entitled "Small Diameter Gravity Sewers: An Alternative for Unsewered Communities," (Order No. PB 86-167 335/AS; Cost: $16.95, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
The EPA Project Officer can be contacted at:
Water Engineering Research Laboratory
U.S. Environmental Protection Agency
Cincinnati, OH 45268

United States
Environmental Protection
Agency

Center for Environmental Research
Information
Cincinnati OH 45268

BULK RATE
POSTAGE & FEES
EPA
PERMIT No G-

Official Business
Penalty for Private Use $300

EPA/600/S2-86/022