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Project Summary

Evaluation of Alternative Wastewater Collection and Treatment Methods for Three Small Kansas Communities

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Alternative wastewater management systems were evaluated for the three small communities of Corning, Furley, and Havana, Kansas. All three communities are rural, agriculturally-oriented settlements with populations of less than 200. Numerous failures of onsite systems have been reported. Soil conditions are such that individual wastewater systems such as septic tank/soil absorption alternatives are not feasible on a widespread basis. The wastewater collection alternatives considered included conventional gravity sewers, small diameter gravity sewers (conveying septic tank effluent), and pressure and vacuum sewers; the treatment alternatives included package plants, spray irrigation, and continuously discharging lagoons.

For Corning and Havana, wastewater collection by pressure sewers using individual and clustered septic tank effluent pumps and treatment via continuously discharging lagoons were found to be the most cost-effective wastewater management solutions. Although the pressure sewer collection alternative was also found to be most cost effective for Furley at the projected future population, the cost effectiveness of pressure versus gravity sewers was found to be sensitive to projected growth. It was thus recommended that population projections for Furley be reassessed, which may affect choice of alternatives. Overall, wastewater collection via small diameter pressure conveyance of septic tank effluent was found to be the least costly collection alternative for the three small communities investigated. Compared with various pressure sewer configurations as well as with small diameter gravity sewers, conventional gravity sewers had the highest total present worth cost.

This Project Summary was developed by EPA's Municipal Environmental 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

The Clean Water Act of 1977 (PL 95-217) requires that alternatives to conventional wastewater treatment be considered—alternatives that potentially may reduce capital and operation/maintenance costs or reduce energy consumption. For communities with populations of less than 3500, both alternative collection and treatment systems may qualify for increased Federal grant assistance of up to 85% of the eligible project costs. Before 1977, the plans for many facilities did not adequately evaluate alternative wastewater technologies, many of which are particularly applicable to small communities.

Methodology

The original facility plans for the three communities, prepared in 1977, were analyzed in detail. Site visits were made to the communities to review the validity of cost assumptions used in the plans and to document existing conditions at each location.

Present and projected populations for the Kansas communities are shown in Table 1.

Soil conditions in the area, as confirmed by district geologists, local sanitarians, and observations during field visits, are described as "slowly permeable and unsuitable for septic tank systems." Soils in the area are predominately silty clay underlain by clays with moderate-to-high shrink/swell potential. Bedrock and groundwater are deep and do not present a problem with sewer construction or maintenance of adequate separation distance between subsurface disposal systems and bedrock or groundwater. Soil permeability, however, precludes virtually all onsite treatment/disposal alternatives throughout most of the planning areas. Near each community, land is available that could be used for siting treatment facilities (e.g., package plants or lagoons) or land application systems.

Because of unsuitable soil conditions throughout most of the planning areas, further analysis focused on alternative collection and treatment systems. Treatment alternatives evaluated for each community included package plants, lagoons with spray irrigation of effluent, and conventional discharging lagoons. For Corning, collection systems analyzed were:

(1) Septic Tank Effluent Pump (STEP) pressure sewers; (2) small diameter gravity sewers conveying septic tank effluent; and (3) conventional gravity sewers. For Furley: (1) STEP pressure sewers (one STEP unit per user); (2) clustered STEP pressure sewers (more than one user per STEP unit); and (3) conventional gravity sewers. For Havana: (1) clustered STEP pressure sewers; (2) partial sewering (approximately one half the planning area) with STEP pressure sewers, with the remainder of the homes served by upgraded onsite systems; and (3) conventional gravity sewers.

A present worth cost analysis was performed for the various alternatives for each community based on future populations. Assumptions used for the analysis are listed below:

- Planning period = 20 years
- Interest rate = 7%
- Service life = 20 years for STEP unit components
- Salvage value = value at end of planning period
- User costs = calculation based on an EPA grant:
  85% of eligible costs for alternative collection and treatment systems, and 75% for conventional collection and treatment systems

Unit cost assumptions for collection alternatives were critical for performing an accurate cost-effective analysis. The unit cost assumptions used in the evaluations are summarized (Table 2).

Results

Treatment alternatives were first evaluated to determine which system(s) provided reasonable service at the least cost and with low operation and maintenance requirements consistent with the financial and technical capabilities of the communities. Table 3 represents a preliminary cost-effective analysis of the package plant, spray irrigation, and continuously discharging lagoon alternatives. Lagoons were selected based on low capital cost and the lack of need for substantial operation and maintenance requirements, such as highly skilled operators, maintenance of mechanical and electrical equipment, and energy utilization. In addition, the State of Kansas considers lagoons to be acceptable, low-cost alternatives that are particularly applicable to small communities. Thus, continuously discharging lagoons were selected as the most viable treatment alternatives for all three Kansas communities. It should be noted that the costs presented in Table 3 are based on treatment of raw sewage. During the final cost-effective analysis, these costs were revised to reflect changes in organic loading that would result from pretreatment by septic tanks for the STEP pressure sewer and small diameter gravity "effluent" sewers.

Various alternative collection systems including small diameter gravity, grinder pump and STEP pressure, vacuum, and conventional gravity sewers were first subjected to preliminary screening. Further detailed analyses were limited to the small diameter, STEP pressure, and conventional gravity sewer alternatives. In addition, consideration was given to the "clustered" STEP collection system, whereby each pumping unit serves two or more homes.

The results of the overall cost-effective analysis are presented in Table 4. For Corning, the most cost-effective alternative was collection via STEP pressure sewers and treatment using a continuously discharging lagoon. For Furley, a "clustered" STEP pressure collection and lagoon treatment system had the lowest present worth cost. For Havana, partial sewering via a STEP pressure sewer with lagoon treatment and upgrading of the

Table 1. *Population Data*

Community	Present		Future (20 yr)	
	No. Units	Population	No. Units	Population
Corning	105	152	124	208
Furley I	40	97	55	140
Furley II*	40	97	165	500
Havana	75	184	87	220

**An additional future population projection was considered to illustrate the impact of potential growth.*

Table 2. *Summary of Unit Cost Assumptions for Wastewater Collection Alternatives*

Item	Total Installed Unit Cost ($)	O&M ($/yr)
4-in. gravity sewer	$15.00/ft	$500/mile
8-in. gravity sewer	20.00/ft	
4-in. gravity service connection	5.00/ft	
1-1/4-in. PVC pressure sewer	3.00/ft	100/mile
1-1/2-in. PVC pressure sewer	3.75/ft	
2-in. PVC pressure sewer	4.00/ft	
2-1/2-in. PVC pressure sewer	4.25/ft	
3-in. PVC pressure sewer	4.75/ft	
4-in. PVC pressure sewer	5.50/ft.	
Conventional septic tank/soil absorption system (installed)	3,000.	15
STEP system (installed, with septic tank)	1,300.	45*
STEP pump	400.	
Grinder pump	1,750.	75
Pump station	—	800

**For each system, not including tank pumping.*

remainder of onsite systems had a slightly lower present worth cost than the completely sewered STEP pressure option. However, because of the predominance of adverse soil conditions in the area, the totally sewered alternative was recommended.

Table 5 summarizes the estimated user charges for each community. The recommended alternatives had associated user costs ranging from $145 to $276 per household per year. With the exception of Corning, user charges are considered within acceptable ranges (as percent of median income) based on EPA recommendations outlined in Program Requirements Memorandum 79-8. Other funding sources (HUD), which will reduce the local share of capital costs and thus user charges, have been secured for Corning.

Table 5. *Summary of Estimated User Costs for Wastewater Collection and Treatment**

Alternative	*Median Household Income, $/yr*	*User Cost, $/yr*	*% of Median Income*
Corning	$4,509		
STEP pressure sewer		*$145*	*3.2%*
Small diameter gravity sewer		*195*	*4.3*
Conventional gravity sewer		*295*	*6.5*
Furley	*17,100*		
STEP pressure sewer		*325*	*1.9*
"Clustered" STEP sewer		*276*	*1.7*
Conventional gravity sewer		*337*	*2.0*
Havana	*14,335*		
STEP pressure sewer		*155*	*1.1*
Partial STEP with onsite systems		*140*	*1.0*
Conventional gravity sewer		*270*	*1.9*

**Treatment via continuously discharging lagoons.*

Conclusions

Alternatives to conventional gravity collection may be more cost-effective for small communities or low-density fringe areas surrounding larger municipalities. Many factors affect the relative costs of collection systems, including housing densities, topography, and soil characteristics. Pressure sewers often have economic advantages for low-density areas, hilly topography, and restrictive soil profiles. The last two conditions may substantially increase the costs of gravity sewer installation because of the requirement for deep cuts and/or lift stations (hilly topography) and the need to provide shoring and trench dewatering (high groundwater) and/or blasting (thin soils over bedrock). Because of their inherent characteristics, pressure sewers can generally be installed at a uniform depth below ground following the natural topography.

In some cases, feasibility of pressure sewers should not be based solely on a cost-effective analysis. Two other important factors are the ability to the community to ensure proper day-to-day operation and maintenance of the system and the impact of prolonged power outages. The latter factor was considered to be a valid consideration for these study areas owing to experiences with extended power outages.

The full report was submitted in fulfillment of Contract No. 68-03-2775 by Roy F. Weston, Inc., under the sponsorship of the U.S. Environmental Protection Agency.

Table 3. *Summary of Costs of Treatment Alternatives (1979 $)*

Treatment	*Capital Cost, $*	*O&M Costs, $/yr*	*Total Present Worth, $*
Corning			
Package plant	*$30,000*	*$6,800*	*$102,039*
Spray irrigation	*98,600*	*5,000*	*151,570*
Discharging lagoon	*53,749*	*1,500*	*69,640*
Furley			
Package plant	*27,000*	*4,760*	*77,427*
Spray irrigation	*98,175*	*3,000*	*129,957*
Discharging lagoon	*71,845*	*2,000*	*93,033*
Havana			
Package plant	*33,000*	*7,480*	*112,243*
Spray irrigation	*72,700*	*3,000*	*104,482*
Discharging lagoon	*39,997*	*1,500*	*55,888*

Table 4. *Summary of Cost-Effective Analysis (1979 $)*
(Includes cost of treatment by discharging lagoon)

Alternative	*Construction, $ (incl. land & salvage)*	*Operation and Maintenance Annual, $/yr*	*Operation and Maintenance Present Worth, $*	*Total Present Worth, $*
Corning				
STEP pressure sewer	*$271,978*	*$7,625*	*$80,780*	*$353,000*
Small diameter gravity sewer	*455,533*	*6,870*	*72,780*	*528,000*
Conventional gravity sewer	*505,339*	*5,010*	*53,075*	*558,000*
Furley				
STEP pressure sewer	*163,550*	*4,935*	*52,280*	*216,000*
"Clustered" STEP sewer	*144,310*	*4,125*	*43,700*	*188,000*
Conventional gravity sewer	*226,000*	*2,190*	*23,200*	*249,000*
Havana				
STEP pressure sewer	*192,785*	*6,185*	*65,520*	*258,000*
Partial STEP with onsite system upgrading	*206,820*	*4,770*	*50,535*	*257,000*
Conventional gravity sewer	*315,387*	*3,405*	*36,070*	*351,000*

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***Robert P. G. Bowker** is the EPA Project Officer (see below).*
The complete report, entitled "Evaluation of Alternative Wastewater Collection and Treatment Methods for Three Small Kansas Communities," (Order No. PB 83-247 197; Cost: $10.00, subject to change) will be available only from:
National Technical Information Service
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The EPA Project Officer can be contacted at:
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