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SMALL SCALE WASTE MANAGEMENT PROJECT

An Alternative Public Wastewater Facility for a Small Rural Community

by

R.J. Otis

1978

Part of the Small Scale Waste Management Project, University of Wisconsin-Madison

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FOR A SMALL RURAL COMMUNITY

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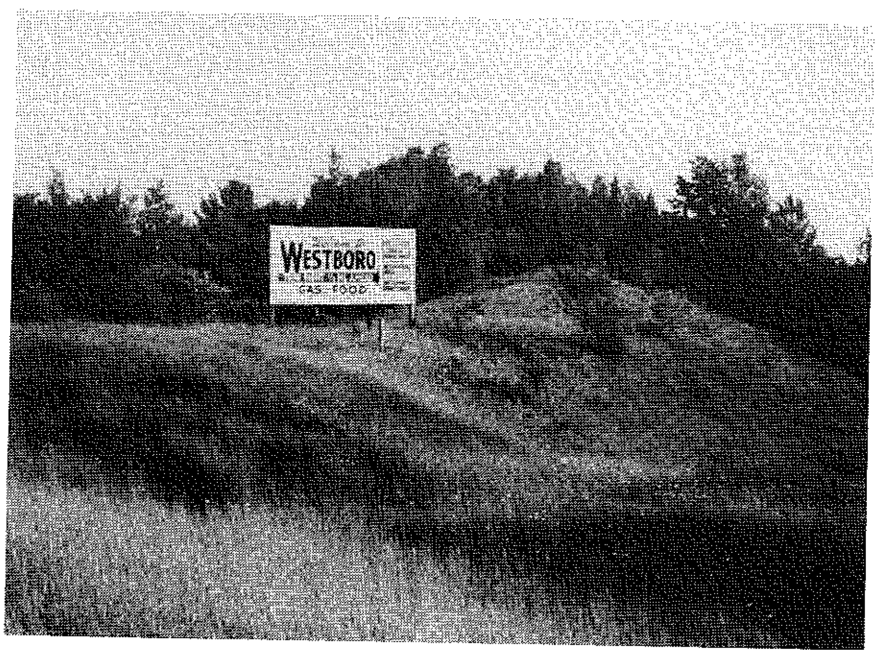

The work upon which this publication is based was supported by funds provided by the Upper Great Lakes Regional Commission, University of Wisconsin-Extension (Grant Numbers 10620294 and 10820377)

Preface

The accepted approach to abate water pollution resulting from inadequately treated sewage is to provide central sewerage with a common treatment facility. For small communities where homes are typically scattered, this is an impractical approach because of the high per capita costs involved to extend sewers to each home. In many cases, the cost of the system approaches the total equalized value of the community.

To relieve this financial burden, state and federal aid programs provide money to qualified communities for construction of pollution abatement projects. However, the costs can become so great that in spite of the financial aid, the local share of construction costs is still more than some communities can afford. Thus, the pollution problem continues, often impeding or halting economic development in their area.

Because this is a common problem throughout Michigan, Minnesota and Wisconsin, the Upper Great Lakes Regional Commission granted money to the Small Scale Waste Management Project through the University of Wisconsin-Extension to determine whether more cost-effective solutions to water pollution abatement in small communities could be developed (Small Scale Waste Demonstration, Phase III and IV). The specific objectives of the UGLRC project were to develop an alternative facilities plan for a small rural community in need of sewerage facilities, to compare construction and operating costs to the costs of a conventional system and to evaluate the facility's effectiveness to maintain water quality in the area. The Sanitary District No. 1 of the Town of Westboro, in Taylor County, Wisconsin was selected for this study.

An alternative facilities plan was prepared which indicated that a significant cost savings could be made over conventional sewerage. The recommended facility was a large central soil absorption field to treat and dispose of septic tank effluent collected from each home via small diameter gravity and pressure sewers. The residents of Westboro voted to implement this plan with construction grants and loans provided by the Farmer's Home Administration and the Wisconsin Department of Natural Resources.

Construction of the facility was completed in September, 1977. Final construction costs indicate that at least a 13 percent savings was realized over conventional sewerage. Operation since that time has demonstrated that these savings could be substantially increased through design modifications.

This report summarizes the history of the project.

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The expertise provided by others is also recognized. Carl C. Crane, Inc., employed as consulting engineers by Westboro, provided the technical assistance needed to implement the facilities plan. The Wisconsin Department of Natural Resources and Health and Social Services, and the Northwest Wisconsin Regional Planning and Development Commission contributed technical, financial and planning advice.

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INTRODUCTION

The accepted approach to abate water pollution problems resulting from failing on-site wastewater disposal systems in developed areas is to construct a public facility consisting of gravity collection sewers which convey all the wastes to a central treatment plant. This solution works well in urban areas where the density of homes is high, but in many small rural communities, the costs of constructing the conventional collection system alone frequently is found to be prohibitive. It is not unusual for the cost of the facility to exceed the total equalized value of the community.

State and federal aid programs exist to relieve the financial burden placed on communities when constructing wastewater facilities. However, the local share of construction costs is more than many communities can afford in spite of the financial assistance. Where this is the case, pollution abatement efforts are delayed. The deterioration of water quality continues and economic development of the area is impeded. Lower cost alternatives for small communities are needed.

CONVENTIONAL PUBLIC FACILITIES

The belief by engineers, regulatory agencies and the public that gravity sewers with a common treatment plant is the best wastewater facility is due to several factors. First, this facility is tried and proven. There is much technical expertise in the theory, design and operation of conventional sewerage. Second, central sewerage is usually more cost-effective because of economies of scale. In densely populated areas, it is less costly to serve many people with one system than each one individually. Third, central sewerage allows ready application of central management which is responsible for the proper functioning of the system. This is quite desirable from a regulatory agency's point of view because there is only one entity against whom the authorities can bring administrative or judicial action to abate water pollution problems. The public prefers this as well since the responsibility for the facility is placed on others.

For small unsewered communities, however, conventional sewerage often is not a realistic solution because of the high costs of installing the collection sewers. Smith and Eilers (1970) computed the 1968 average costs of all operating municipal wastewater collection and treatment facilities in the United States. Their study showed that 65 percent of the averaged total annual costs is for amortization and maintenance of the collection sewers. A more recent study of 16 small communities in Oklahoma by Sloggett and Badger (1975) showed a similar distribution (Table I), but that the proportionate cost increased significantly as the density of homes decreased. It is clear that the collection system is the most costly component of central sewerage and it can become excessively so in small communities where homes are typically scattered. Thus, if an alternative is to be found, it must be one which can reduce the cost of the collection system.

ALTERNATIVE WASTEWATER FACILITIES

Onsite Systems as Alternatives

One obvious method of reducing the costs of collection is to eliminate the sewers altogether and treat and dispose of the wastes where they are generated. This might be accomplished by the use of onsite systems. However, septic tank systems which are the most commonly used onsite system, are usually thought to be the cause of the problem rather than as the solution. This is because the septic tank system has developed a reputation for rapid failure.

The reputation of septic tank systems is not due to inherent shortcomings of the system itself, but rather to its misapplication and misuse. Where soils are only one entity against whom the authorities can bring administrative or judicial action to abate water pollution problems. The public prefers this as well since the responsibility for the facility is placed on others.

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Table 1. Distribution of Total Annual Costs for Municipal Sewerage

	Amortization		Current Costs			Total
			Operation & Maintenance		Overhead	
	Collection	Treat-ment	Collection	Treat-ment		
Smith & Eilers (1968)	60.3%	15.3%	4.7%	8.4%	8.4%	100.0%
Slogget & Badger (1970)	- - - 72.6% - - -		14.2%	3.2% (lagoons)	10.0%	100.0%

are suitable, the septic tank-soil absorption field is an excellent method of onsite disposal of wastewater. If the soil is moderately permeable, unsaturated to a depth of 4 to 5 feet and not located on steep slopes, the system provides trouble-free operation when properly maintained for up to 20 years or more. However, housing development is not restricted to areas with these optimum site conditions. Approximately only 32 percent of the total land area of the United States has soils suitable for the installation of septic tank systems (Wenk, 1971). Since alternative systems are rarely permitted, septic tank soil-absorption fields are often installed where they are unsuited because of the pressure to develop new lands. Even where soils are suitable, failures often occur because of poor design, installation or maintenance of the system. Thus, all onsite systems are thought to be failure prone and to be avoided where possible. This attitude is unfortunate because if small unsewered communities are forced to abate water pollution problems, the use of septic tank systems and alternatives to them could provide an acceptable facility at a much lower cost (Figure 1).

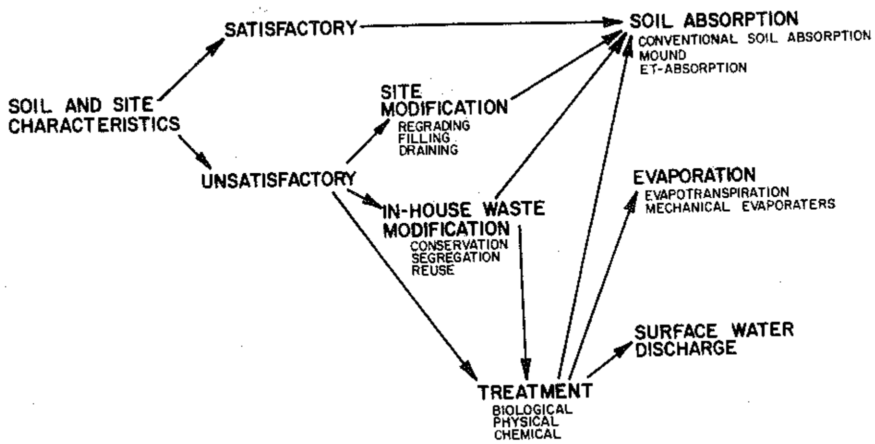
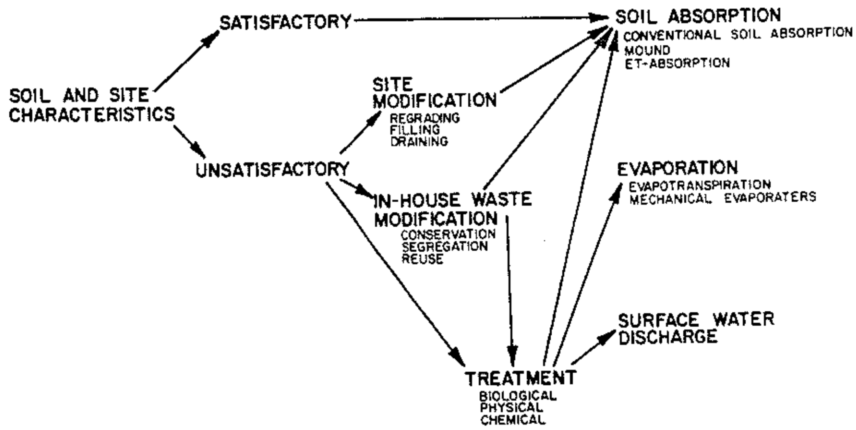


Figure 1. Alternative Strategies for Onsite Wastewater Treatment and Disposal

Management of Onsite Systems

Onsite systems can be designed to provide acceptable wastewater treatment and disposal if properly installed and maintained. However, the failure to maintain systems has severely limited the application of onsite technology. Experience has shown that homeowners frequently fail to maintain their septic tank system which requires only that the septic tank be pumped periodically. If he cannot be relied upon to perform this simple task, then he certainly cannot be expected to maintain more complex onsite systems which more restrictive sites demand. Therefore, regulatory agencies usually do not permit alternatives to septic tank systems to be installed. Holding tanks or sewers become the only alternatives where septic tank systems fail.



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This objection could be overcome if the responsibility for onsite systems could be taken out of the hands of the homeowner. Public management districts have been proposed which would have the authority to own, operate and maintain onsite systems located on private property (Winneberger and Anderman, 1972). The district would employ only trained personnel whose responsibilities would be to site, design, construct, operate and maintain all onsite systems within its jurisdiction. Such a concept is similar to a telephone utility which own and maintain telephones located within the home for a monthly service charge.

Implementation of management districts offer several advantages:

1. Costly public sewers could be avoided by maintaining onsite systems in good working order. If failures occur, the district would have the option to repair the systems or construct other facilities.

2. More complex alternative systems could be used to serve homes in areas with soil and site conditions unsuitable for conventional septic tank systems.

3. To take advantage of economies of scale or to avoid adverse sites, nearby areas might be used for construction of joint systems to serve a cluster of homes.

4. Usually, less costly treatment facilities can be constructed because of smaller flows collected from limited areas.

5. Strip growth, which is encouraged by the construction of interceptor sewers used to collect wastes from isolated clusters of homes can be avoided.

6. Onsite systems are more ecologically sound because the many scattered systems dispose of the wastes over wider areas for better assimilation by the environment.

7. Pollution abatement would proceed more rapidly because of the lower costs and less homeowner opposition.

Though relatively untried, there are several methods of exerting public (or in some cases, private) management over onsite facilities. The powers needed by an entity to properly manage onsite systems are similar to those powers needed to manage a municipal sewerage district. Some of the methods have been successfully applied in the United States (Otis and Stewart, 1976).

Any management entity which endeavors to effectively administer onsite wastewater disposal systems must have the power and authority to perform vital functions. These functions are to (Otis and Stewart, 1976):

1. Own, operate and manage and maintain all wastewater systems within its jurisidiction.

2. Enter into contracts to undertake debt obligations either by borrowing and/or by issuing bonds and to sue and be sued.

3. Raise revenue by fixing and collecting user charges and levying special assessments and taxes.

4. Plan and control how and at what time wastewater facilities will be provided to those within its jurisdiction.

5. Make rules and regulations regarding the use of onsite systems and provide for their enforcement through express statutory authorization.

6. Meet the eligibility requirements for both loans and grants in aid of construction from both federal and state governments.

The types of entities which could manage onsite systems vary from state to state. The various state constitutions, state statutes, administrative agency rules and regulations must be examined on a state by state basis, to determine which types of entities are authorized to manage onsite systems. In addition, the case law (essentially interpretations of state law made by the courts) must be checked to determine if the courts have construed the constitution, statutes or regulations

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to give or remove the authority to manage such a system from a possible entity. Various entities which may be permitted by states include: municipalities, counties and townships, special purpose districts, private non-profit corporations, rural electric cooperatives and private profit-sharing businesses. For a discussion of acceptable entities in Michigan, Minnesota and Wisconsin see Otis and Stewart (1976).

WESTBORO DEMONSTRATION STUDY

To determine if onsite technology could be employed under central management to significantly reduce the total annual costs of public wastewater facilities, a small rural community was sought for a demonstration study. The unincorporated community of Westboro, Wisconsin was selected because it is typical of hundreds of small rural communities in the Midwest which are in need of improved wastewater facilities but are unable to afford conventional sewerage.

Description of Westboro

Westboro is located in Taylor County, Wisconsin adjacent to Silver Creek within the upper Chippewa River drainage basin (Figure 2). It was established as a permanent community in the late 1850's as a result of the lumbering industry. In 1873, the Wisconsin Central Railroad reached Westboro on its way north bringing more people and jobs. The population reached about 900 in 1900, but with the decline of the lumber industry the large sawmill in town closed and the population declined. By 1976, the population was approximately 205 people. Of 94 buildings located in the community only 69 were occupied which included a school, four churches and several commercial establishments. The total assessed valuation of the property within the district was $824,230. A cheese warehouse, a small machine tool company and a sawmill remain in town employing a total of about 10 to 15 people.

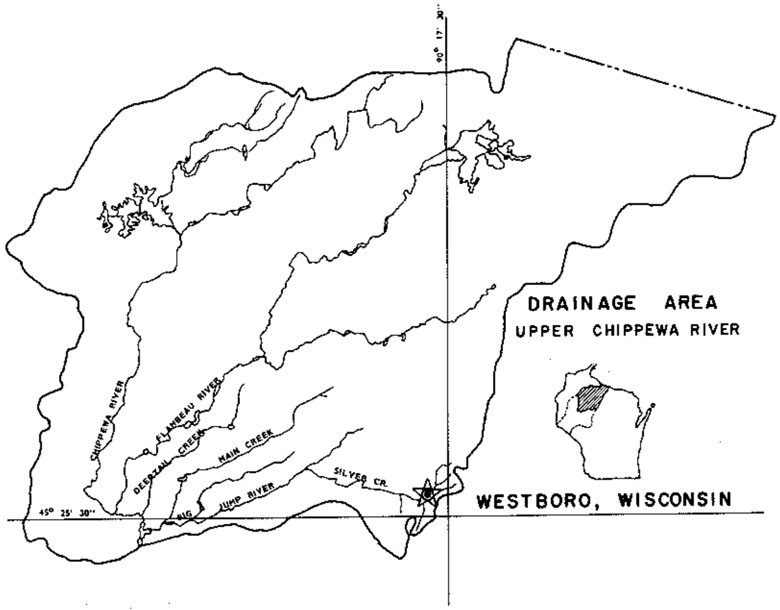


Figure 2. Geographic Location of Westboro, Wisconsin

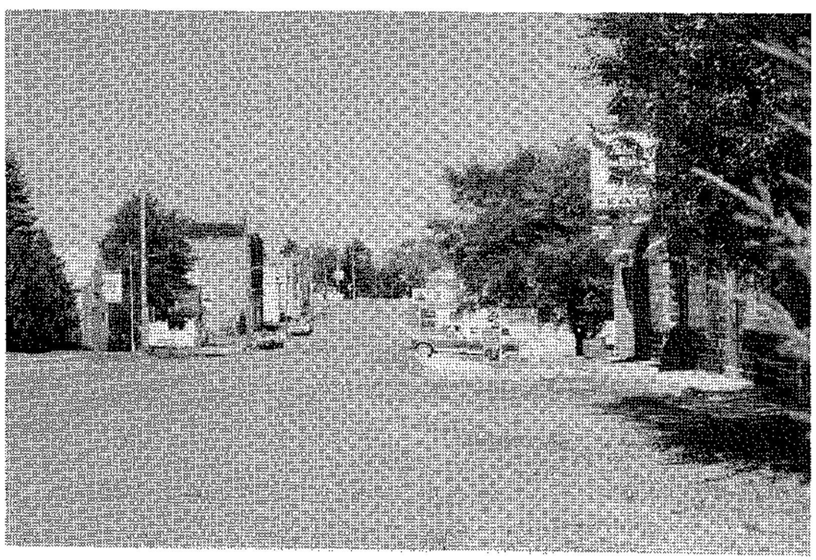
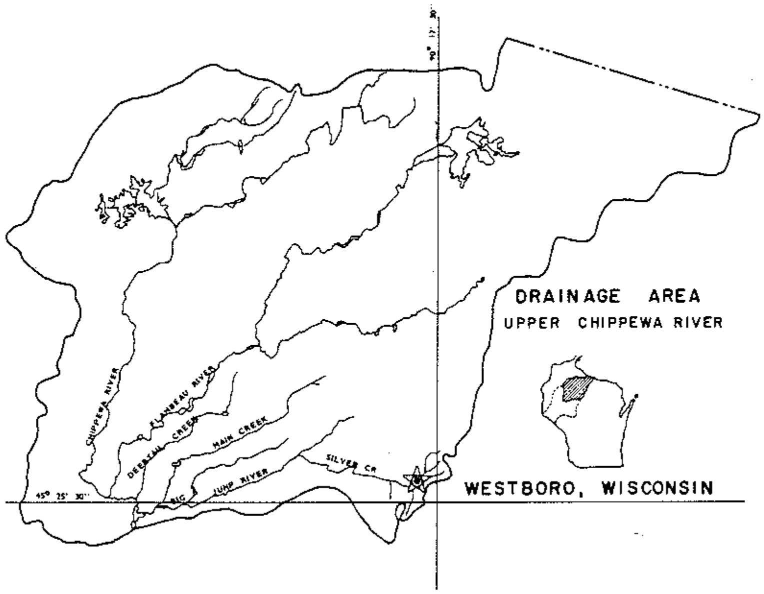


Figure 3. Front Street, Westboro, Wisconsin



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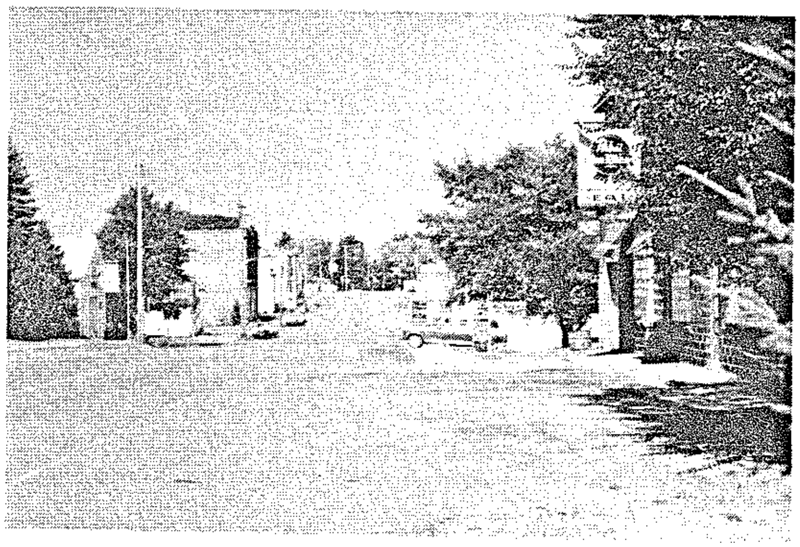

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The 1970 census showed that the population of the township had declined 40-percent during the previous ten years, but since that time new ball field facilities and sidewalks had been constructed and a grocery store was reopened which indicated the population was stabilizing. But while the population of Taylor County was increasing above that of Wisconsin and the U.S. averages, growth was prevented in Westboro because of inadequate wastewater facilities.

Until 1977, the community of Westboro had no public wastewater collection or treatment facility. All the buildings were served by private septic tank systems. A survey by the Wisconsin Department of Natural Resources (DNR) showed that 80-percent of these systems were discharging wastes above ground. Many of the systems were found to be interconnected by drains which discharged directly into Silver Creek. This situation was declared a nuisance and a menace to health and comfort, as well as the public rights in the Upper Chippewa River Basin. Consequently, DNR issued an order to the Town of Westboro to upgrade the existing septic tank systems or construct a public wastwater collection and treatment facility.

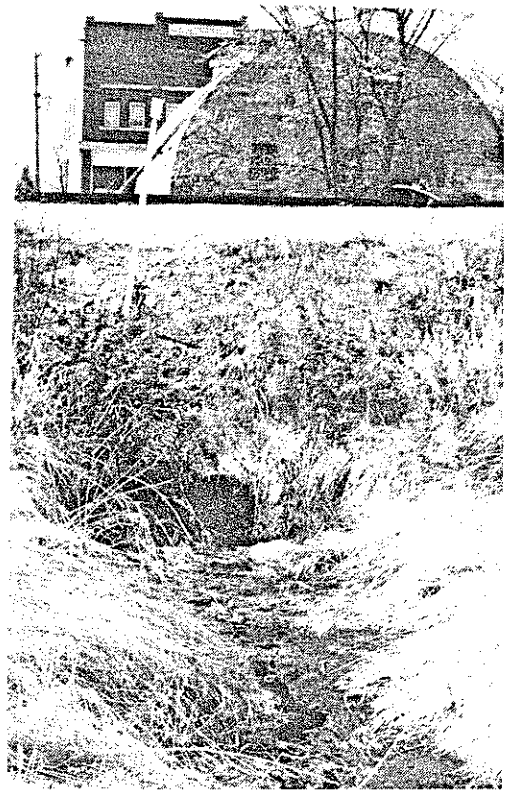
Initially Proposed Conventional Facility

Because the soils and small lot sizes prevented the replacement of most of the failing septic tank systems, public sewerage was necessary. The Town Sanitary District #1 of the Town of Westboro was formed to incorporate all the buildings with failing systems which were endangering the water quality of Silver Creek (Figure 5) and an engineering firm was hired to complete a facilities plan.

The firm investigated two treatment alternatives; an extended aeration package treatment plant and a two cell lagoon. Conventional gravity sewers were proposed to collect the wastewater in both alternatives. Both plans would serve only 60 of the 69 occupied buildings. Homes to the north of Westboro near

Figure 4. Westboro Storm Drain Discharging Septic Tank
Wastes to Silver Creek

Appaloosa Lane and those east of Silver Creek in Queenstown would not be served because of the excessive costs of extending sewers to them. Though higher in initial cost, the engineering firm recommended the lagoon alternative because of the lower operation and maintenance costs (Figure 6). The estimated construction costs for this facility in 1967 were $124,900 for the collection system and $109,000 for the lagoon, or a total cost of $234,800 excluding engineering fees and contingencies. This amounted to approximately $3900 per unit plus an estimated $450 hookup charge. The district residents were unable to afford this cost so the plan was never implemented. When Federal construction grants became available through the Water Pollution Control Act of 1972, Westboro applied, but



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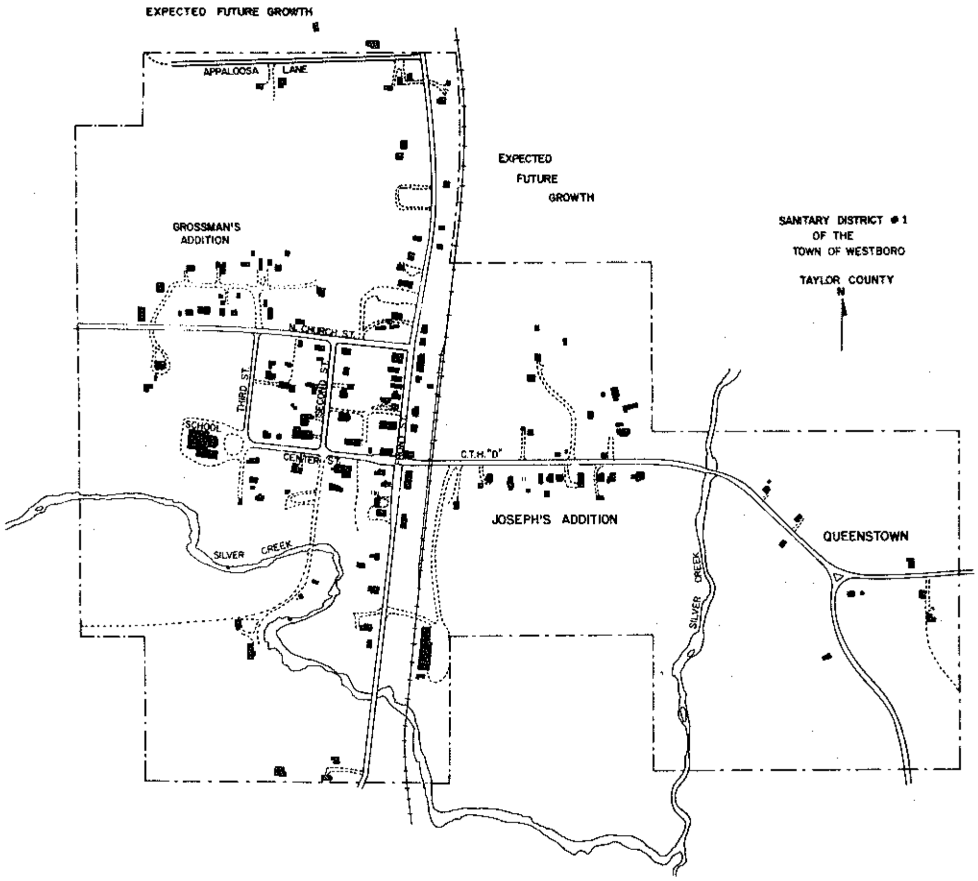


Figure 5. Sanitary District #1 of the
Town of Westboro

as of February of 1976 their priority to receive a 75-percent grant was 318 for the treatment plant and 398 for the sewers out of 420 eligible communities. This virtually ruled out the possibility of constructing the facility for several years.

ALTERNATE FACILITY PLANNING IN WESTBORO

The Small Scale Waste Management Project (SSWMP) at the University of Wisconsin had developed several onsite treatment and disposal alternatives for individual homes (University of Wisconsin, 1978) and it was felt that these systems could be utilized in small communities to reduce costs of public wastewater

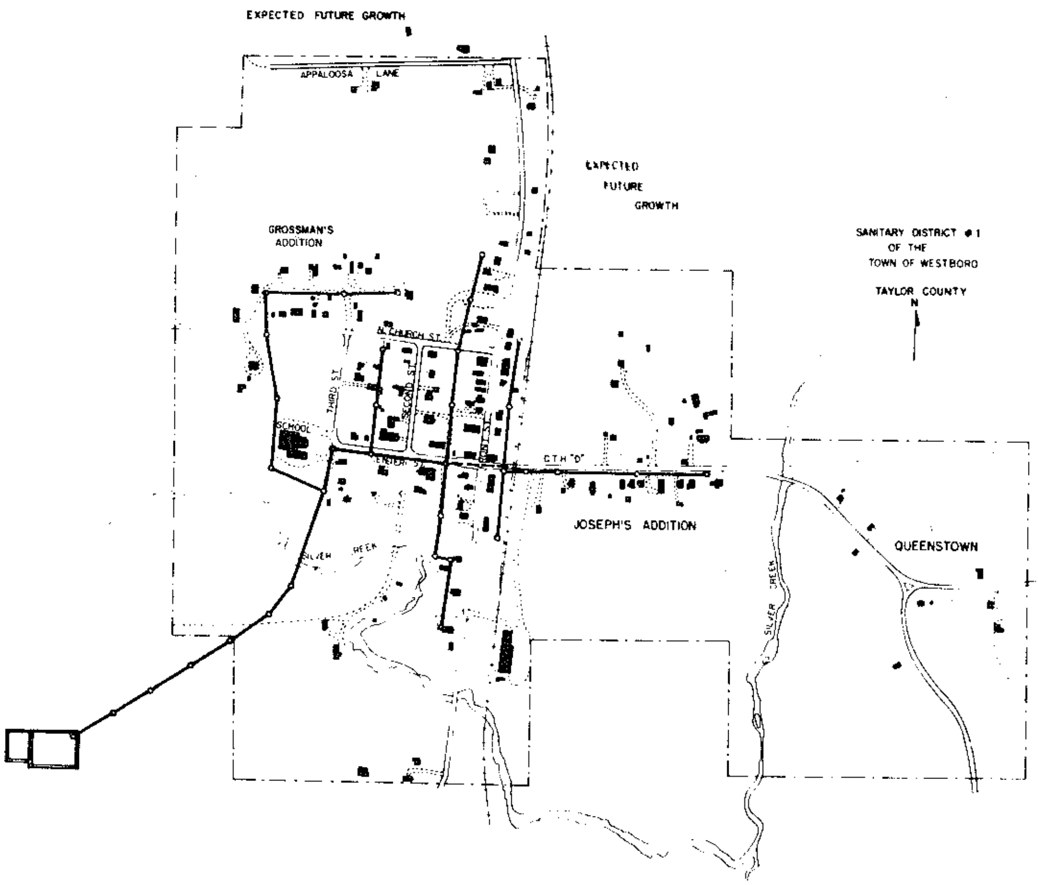
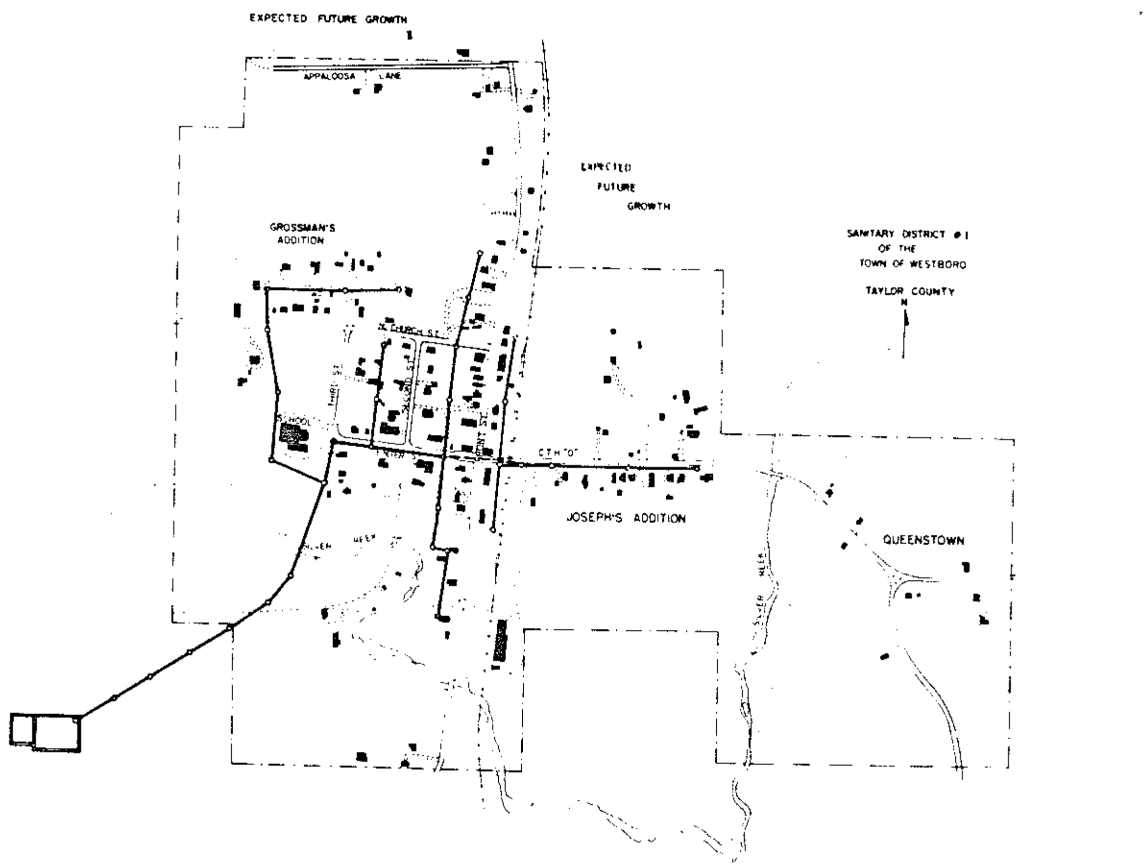


Figure 6. Originally Proposed Conventional Lagoon Facility (Alternate #2)

facilities. To demonstrate if a less expensive public facility could be designed utilizing some of these alternatives, the Upper Great Lakes Regional Commission granted funds to University of Wisconsin-Extension to develop such a facilities plan for a small community. The Town Sanitary District #1 of Westboro agreed to cooperate with SSWMP in this demonstration study because the residents of Westboro were sincerely interested in correcting their problem.

Information Gathering

The first step in the study was to gather information concerning the physical features of the community. Soil, topographic and plat maps of the area included



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in the District were obtained. A detailed soil survey had been completed for the area and was available from the Taylor County Soil and Water Conservation District (Sandleback, 1974). The survey described the type and location of the soils and their potential for wastewater disposal. A topographic map of the area in and around Westboro, with contours at two foot intervals, had been prepared by the State Department of Transportation because the state highway passing through town had recently been rerouted west of town. This map not only provided accurate topographic data, but also accurate location of existing buildings. Plat maps were obtained from the County Tax Assessor's Office to determine lot sizes and boundaries.

In addition to the maps, a survey of all buildings in the District was made by two District residents. Information was collected relating to the size of the buildings, the number of occupants, the type, location and condition of the existing waste disposal system, the time the system was built and the location of the water supply (See Appendix A).

The information from the maps was used to make preliminary planning decisions. While soils suitable for conventional septic tank systems exist in the District, most homes are located on poorly suited soils (Figure 7). The small lot sizes, particularly in the center of the District, preclude the use of alternative individual sysetms as well. Therefore, it appeared that the wastewater would have to be collected from most of the homes in the District for treatment and disposal in some other area. The results from the survey confirmed the need for off-lot disposal.

Evaluation of Alternative Facilities

Since the most expensive portion of conventional sewerage is the collection system, methods of reducing the cost of collection were investigated. The most

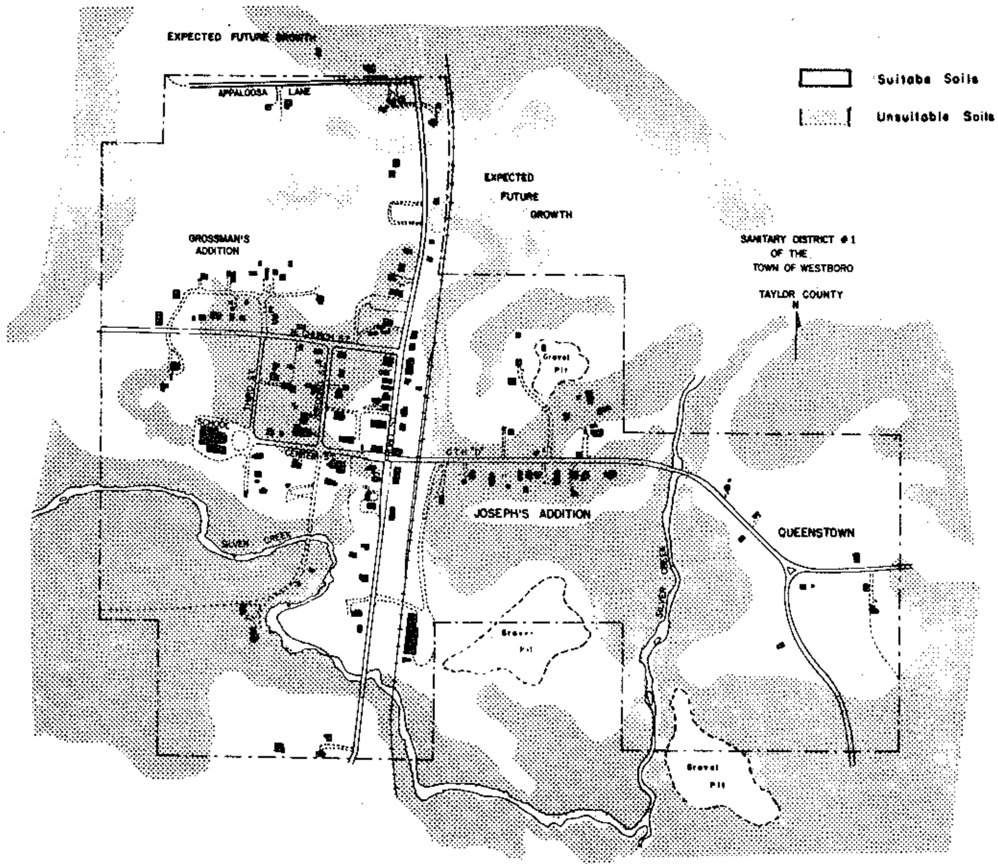
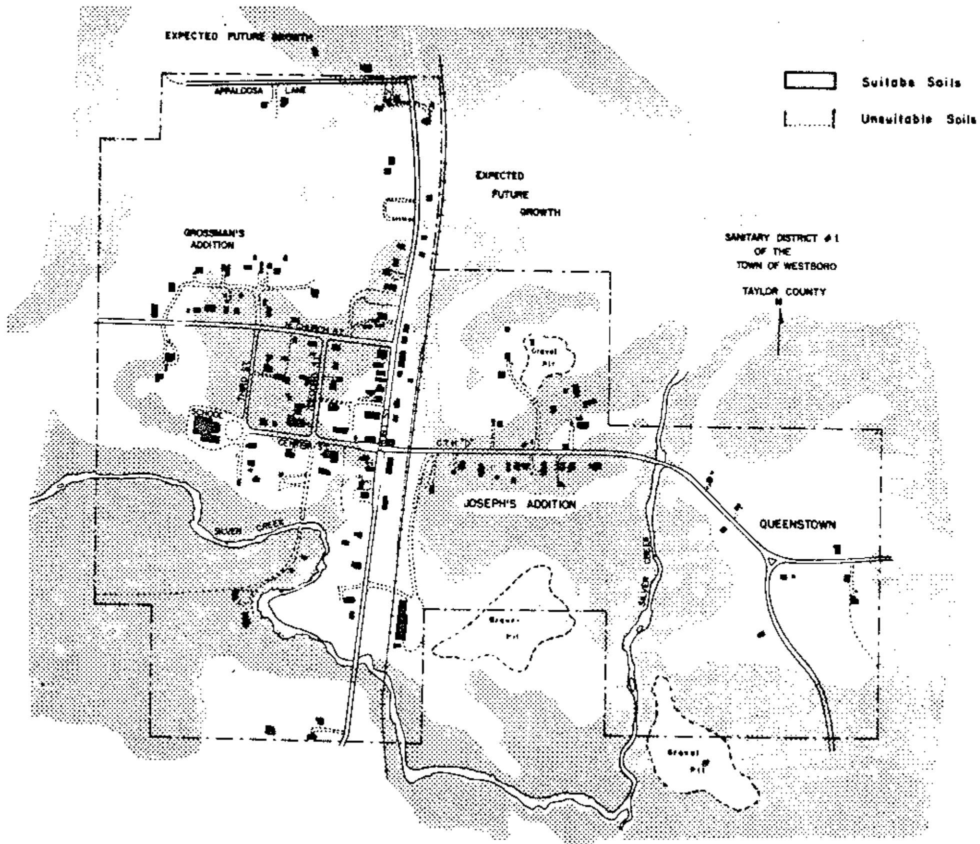


Figure 7. Suitability of Soils Within Westboro for Conventional Septic Tank Systems

obvious means to reduce costs was to reduce the extent of the sewers. Collection sewers can be cost-effective because a common treatment facility is usually cheaper than providing individual systems. However, this cost advantage holds only where the density of connections is sufficiently great for the given site conditions to offset the cost of collection. In small rural communities where development is often scattered, extending sewers to isolated homes becomes very costly. Clusters of buildings should be identified in which sewering can be cost-effective providing disposal sites can be found nearby.

Five natural groupings of buildings in Westboro were identified. They were 1) Front Street area extending from Silver Creek north to the cemetery and from Second Street



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to the railroad tracks, 2) Grossman's Addition including the area west of Second Street and the school, 3) Joseph's Addition, 4) Queenstown and 5) the area of scattered houses north of the Front Street area. Each of these areas was considered separately and with adjacent areas to develop the most cost-effective system.

The next step was to identify potential disposal sites. Methods of disposal via soil absorption or stream discharge were investigated. Since discharge to Silver Creek, a Class III trout stream, would require a rather high level of treatment, methods of soil disposal were preferred.

The soils in and around Westboro are primarily loams and silt loams of the Amery, Freer, Santiago and Comstock series. These are deep, well to somewhat poorly drained soils lying over sandy glacial till. Along the western bank of Silver Creek, north to County Trunk D, deposits of well graded sands exist. Borings conducted for a proposed dam in the area showed these deposits to be over 20 feet deep on top of glacial till (Warzyn Engineering, 1972). These comprise a bench rising approximately 25 feet above the stream. South of County Trunk D the land is low with mucky peat soils predominating. Similar soils are also found in the southwest corner of the District.

A common disposal system was considered to be the best alternative for the Front Street area which includes the business district. This area is divided into small 50-foot x 150-foot lots. Most of these are developed leaving little area to construct new individual septic tank systems. Joseph's Addition is a low lying area with poorly drained soil. Individual mound systems could be installed, but a common system would be more cost-effective. Individual systems could also be constructed in Grossman's Addition, but because of the density of homes, a common system appeared to be a better alternative. However, the soils surrounding Grossman's Addition were silt loams which would require a rather large soil absorption field. Therefore, intermittent sand filters followed by disinfection with discharge to Silver Creek was an additional alternative considered for this area.

The remaining homes to the north and in Queenstown were too scattered to warrant common disposal facilities. It was determined these homes should remain on either conventional septic tank systems or mound systems.

Because the collection systems required to collect the wastewater from the various clusters would be extensive, alternative methods of collection were investigated to keep the costs down. Small diameter gravity sewers and pressure sewers were compared. While untried in this country, small diameter gravity sewers have been used successfully in Australia for many years (Otis and Stewart, 1976). Pressure sewers are also new but are already gaining widespread use throughout the United States (Kreissl, et al., 1977). These alternative collection systems offer several advantages over conventional gravity sewers. Both can collect septic tank effluent rather than raw wastewater. Since all treatment and disposal methods under consideration require a settled waste, existing septic tanks could be used eliminating the need for constructing sedimentation facilities at the disposal site. Also, less excavation is required for sewer installation. Because grit and settleable solids are removed in the septic tank, scouring velocities do have to be maintained in the gravity sewers which allows the pipe to be laid on a flatter grade. Pressure sewers, on the other hand, can follow the topography with the only requirement that the lines be placed below the frost line. A further advantage of these alternatives is that less infiltration occurs. Small diameter pipe comes in longer lengths and is easier to work with. Thus, there are fewer and tighter joints. Pressure sewers eliminate infiltration altogether by maintaining positive pressure within the pipe.

Several alternative systems for the various areas were considered. Because of the limited disposal sites available, it was appropriate to combine the Front intermittent sand filters followed by disinfection with discharge to Silver Creek was an additional alternative considered for this area.

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Several alternative systems for the various areas were considered. Because of the limited disposal sites available, it was appropriate to combine the Front

Street and Joseph's Addition areas, disposing of the wastewater in a conventional soil absorption field to be located on the sand bench along Silver Creek east of town. Both small diameter and pressure sewers were evaluated for these combined areas. In Grossman's Addition, the topography is well suited for gravity collection for conveyance of the wastewater to the area southwest of the school. Treatment and disposal alternatives considered were soil absorption, sand filtration with chlorination before discharge to Silver Creek, and pumping to the Front Street/Joseph's Addition gravity system for disposal in the soil absorption field. A pressure sewer combined with Front Street/Joseph's Addition pressure sewer with disposal in the sand bench was also looked at.

In summary, the alternative facilities evaluated were:

Alternate 1: Conventional gravity sewers conveying raw wastewater to an extended aeration package plant followed by a 30-day holding pond (as required by DNR) discharging to Silver Creek south of Joseph's Addition.

Alternate 2: Conventional gravity sewers conveying raw wastewater to a stabilization pond located southwest of the District discharging into Silver Creek (Figure 6).

Alternate 3: Grossman's Addition: Small diameter gravity sewers discharging to a soil absorption field west of the school.

Front Street and Joseph's Addition: Small diameter gravity sewers discharging to a soil absorption field northeast of Joseph's Addition.

Alternate 4: Grossman's Addition: Small diameter gravity sewers discharging to a soil absorption field west of school.

Front Street and Joseph's Addition: Pressure sewers discharging to a soil absorption field northeast of Joseph's Addition.

Alternate 5 (Figure 8): Grossman's Addition: Small diameter gravity sewers discharging to intermittent sand filters west of the school with chlorine disinfection prior to discharge into Silver Creek.

Front Street and Joseph's Addition: Small diameter gravity sewers discharging to a soil absorption field northeast of Joseph's Addition.

Alternate 6 (Figure 9): Grossman's Addition: Small diameter gravity sewers discharging onto intermittent sand filters west of the school with chlorine disinfection prior to discharge into Silver Creek.

Front Street and Joseph's Addition: Pressure sewers discharging to a soil absorption field northeast of Joseph's Addition.

Alternate 7 (Figure 10): Small diameter gravity sewers serving all areas discharging to a soil absorption field northeast of Joseph's Addition.

Alternate 8 (Figure 11): Pressure sewers serving all areas discharging to a soil absorption field northeast of Joseph's Addition.

It was planned that these homes within the District not connected to the collection systems described in the alternatives would be served by individual septic tank systems.

Facility Selection

Each of the alternatives were evaluated and compared on the basis of reliability, environmental impact and present worth costs. After weighing each criterium, Alternate 7 was recommended as the most cost-effective wastewater facility. This facility would be a system of small diameter gravity sewers collecting the wastes from each cluster and conveying them to a single area for soil absorption northeast of Joseph's Addition (Figure 10). Pretreatment would be provided by individual septic tanks already in place at each home. Homes to the north and in Queenstown

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would be given new individual onsite systems if the existing systems were determined to be inadequate.

The District would be responsible for the operation and maintenance of all components of the facility, including those located on private land commencing from the inlet of the septic tank. The property owner would be responsible for providing and maintaining the lateral drain from his home or establishment to the septic tank and any power costs associated with lifting his effluent into the collection sewer if necessary.

Though the reliability of this type of facility has not been established, its selection was warranted because it was designed from extensive experience with smaller systems (University of Wisconsin, 1978). In addition, it was felt that its cost and environmental impact were a significant improvement over a conventional facility.

Cost comparisons between all alternates were made using present worth analysis. These included operation and maintenance costs as well as capital costs. Hookup costs of $450 per service connection were included as a separate item in the conventional alternatives since the other alternatives include hookups as part of the construction costs. Individual onsite system construction estimates were also included for those homes within the District not served by the collection system. A system life of 20 years with an annual interest rate of 7-percent was used in the analysis (Carl C. Crane, Inc., 1976). These costs are summarized in Table 2.

The environmental impact of this facility would be minimal. Only nitrogen in the form of nitrate and chlorides are expected to leach through the soil to the groundwater in amounts that may be significant. With the field's location near Silver Creek, much of the nitrate would flow into Silver Creek. Phosphorus, however, would be removed through adsorption and precipitation reactions in the soil (University of Wisconsin, 1978).

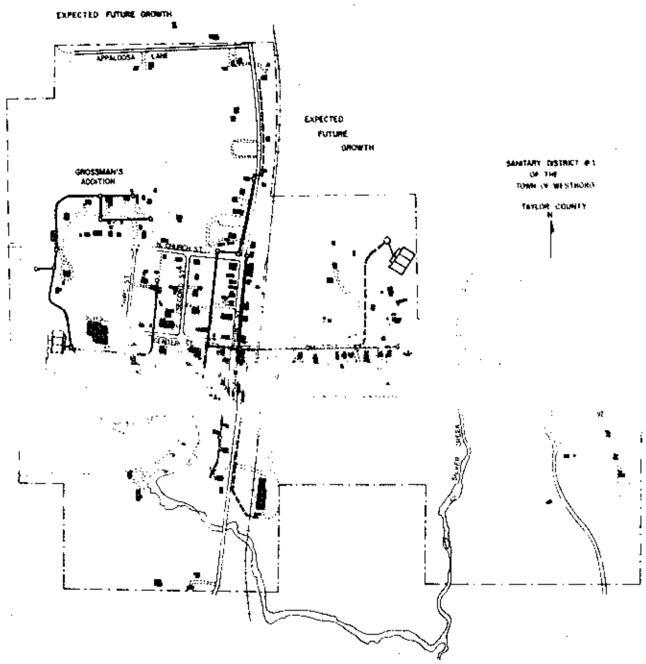


Figure 8. Alternative Facility 5

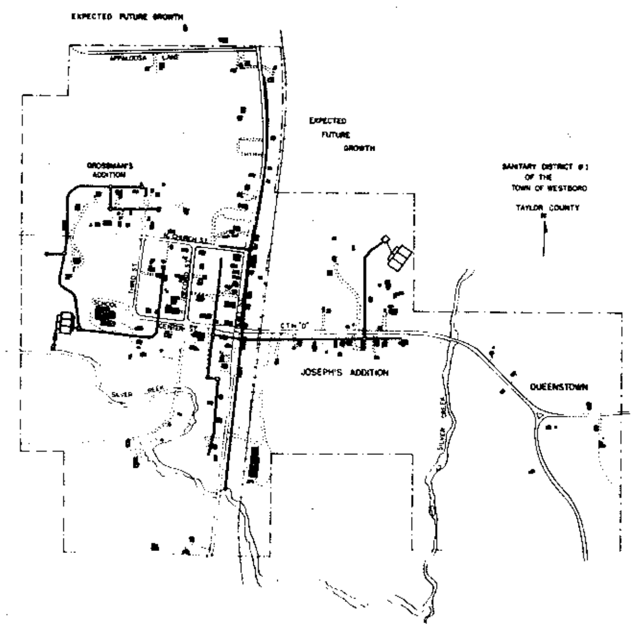
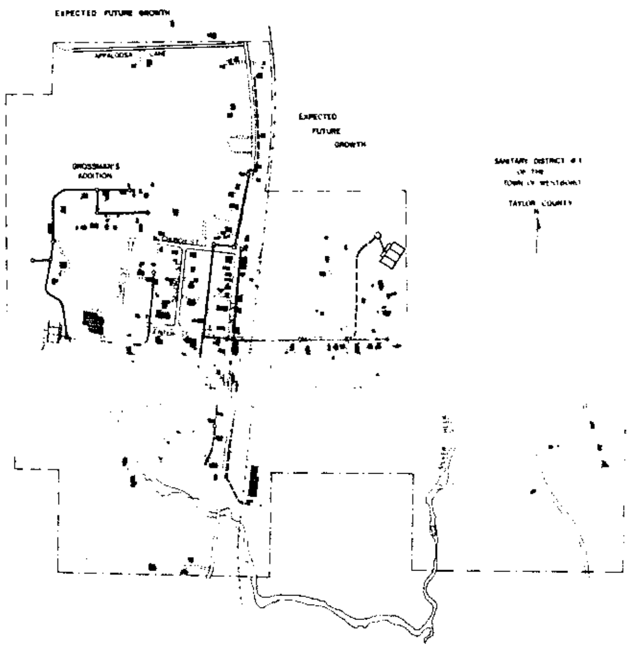


Figure 9. Alternative Facility 6



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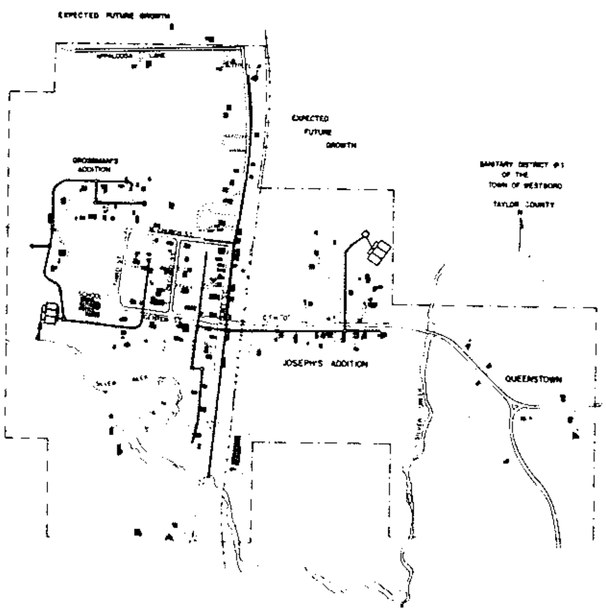

Figure 9. Alternative Facility 6

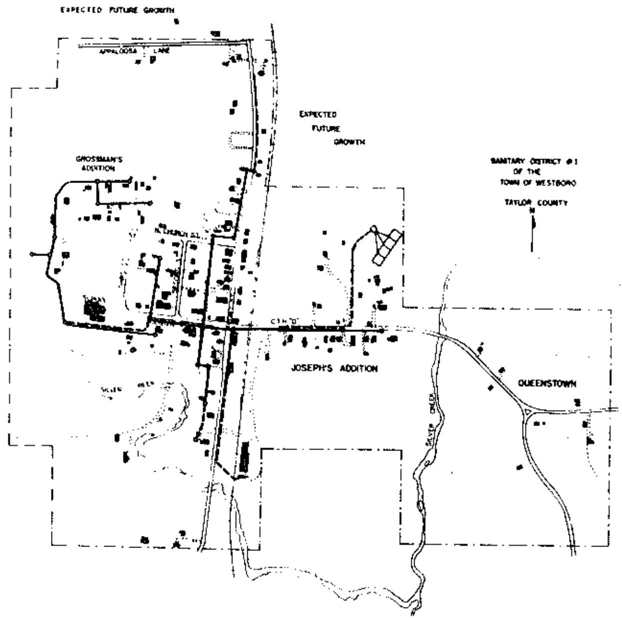

Figure 10. Alternative Facility 7

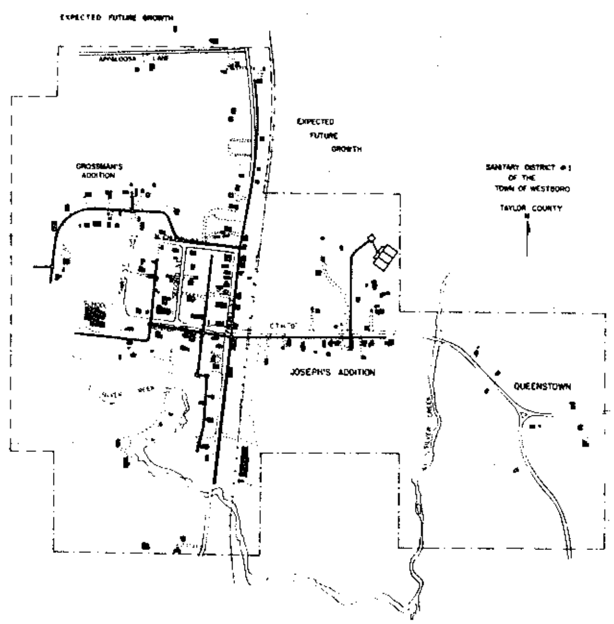

Figure 11. Alternative Facility 8

Table 2. Summary of Present Worth Costs of Alternate Facilities

ALTERNATE #1		
Extended Aeration Treatment Plant		
Collection	$136,295.00	
Treatment	170,065.17	
Hookup	31,050.00	
Individual Systems	11,976.23	
		$349,386.40
ALTERNATE #2		
Raw Sewage Stabilization Pond		
Collection	$136,295.00	
Treatment	185,528.00	
Hookup	31,050.00	
Individual Systems	11,976.23	
		$384,849.23
ALTERNATE #3		
Grossman's Add: S.D. Gravity Sewers to Soil Absorption	$124,454.64	
Front St. & Joseph's Add: S.D. Gravity Sewers to Soil Absorption	145,229.00	
Individual Systems	11,976.23	
		$281,659.87
ALTERNATE #4		
Grossman's Add: S.D. Gravity Sewers to Soil Absorption	$124,454.64	
Front St. & Joseph's Add: Pressure Sewers to Soil Absorption	185,308.00	
Individual Systems	11,976.23	
		$321,738.87
ALTERNATE #5		
Grossman's Add: S.D. Gravity Sewers to Sand Filters	$148,038.00	
Front St. & Joseph's Add: S.D. Gravity Sewers to Soil Absorption	145,229.00	
Individual Systems	11,976.23	
		$305,243.23
ALTERNATE #6		
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Front St. & Joseph's Add: Pressure Sewers to Soil Absorption	185,308.00	
Individual Systems	11,976.23	
		$345,322.23
ALTERNATE #7		
Total Gravity Sewers to Soil Absorption		
Joint System	$254,440.00	
Individual Systems	11,976.23	
		$266,416.23
ALTERNATE #8		
Total Pressure Sewers to Soil Absorption		
Joint System	$294,154.00	
Individual Systems	11,976.23	
		$306,130.23

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To properly manage its non-central system, the Westboro Town Sanitary District would have to regulate all individual and jointly used onsite disposal systems operating within its boundaries. While no Town Sanitary District has attempted this in Wisconsin, it is within their power to do so (Otis and Stewart, 1976).

IMPLEMENTATION OF THE SELECTED ALTERNATE

On October 16, 1975, a public meeting was held in Westboro to present the results of the facility planning. After a discussion of each alternative and their associated costs, the recommended Alternative #7 was approved unanimously by those present. The district commissioners voted to proceed with the project if construction grants could be obtained.

Because of Westboro's low priority to obtain EPA construction grants, other funding sources were sought. The Farmer's Home Administration (FmHA) showed little interest at first because of the experimental nature of the project and the fact that they thought that Westboro was a dying community. However, FmHA agreed to seriously consider Westboro for funding when it was shown that the estimated construction costs were less than $4000 per connection. The Wisconsin Department of Natural Resources also indicated that if the project were to proceed within the next year, Westboro could be considered for a 25-percent state grant. Together, these two funding sources could provide up to a 50-percent grant with the remaining financed by a 5-percent 40-year loan through FmHA. Based on the preliminary present worth estimates, the cost for each connection would be approximately $8 per month plus a $200 assessment. The commissioners felt this would be within the community's financial capability so they voted to continue with the project. Carl C. Crane, Inc. of Madison, Wisconsin was retained by the District to prepare final drawings and specifications.

Final Facility Design

During the preparation of the final drawings some changes in the original plan were necessary. Soil testing in the Queenstown area indicated that the soils were not suitable to construct conventional or mound disposal systems on each individual lot. Soils to the north were suitable but the owner of the adjacent land was not willing to sell. Therefore, a small diameter gravity sewer was extended across Silver Creek to collect the wastes for disposal in the large absorption field west of the stream. This change was further justified by the fact that several lots could be developed along this line. A sewer was also extended north along Front Street to service the homes on Appolosa Lane. This line was extended further north when three homeowners north of Appolosa Lane petitioned the District for annexation. The soils and lot sizes were suitable in this area for conventional onsite systems, but because all the systems would have to be reconstructed and several undeveloped lots were along this route, sewering was more cost-effective. Because these extensions were at a lower elevation than the other sewered areas of town, pressure collection sewers were used (See Figure 12).

Septic Tanks: At homes where new septic tanks were necessary, State-approved prefabricated 1000 gal capacity tanks were specified regardless of the home size. The tank volume used for commercial establishments was determined from the sizing criteria given in the Wisconsin State Plumbing Code (Wisconsin Administrative Code, Section H62.20, 1976).

Reinforced concrete, steel and fiberglass are approved materials for septic tank construction in Wisconsin but reinforced concrete was the preferred material because of its durability and structural strength. A bituminous compound coating was put on the outer wall of the concrete tank in areas of high water tables to prevent infiltration.

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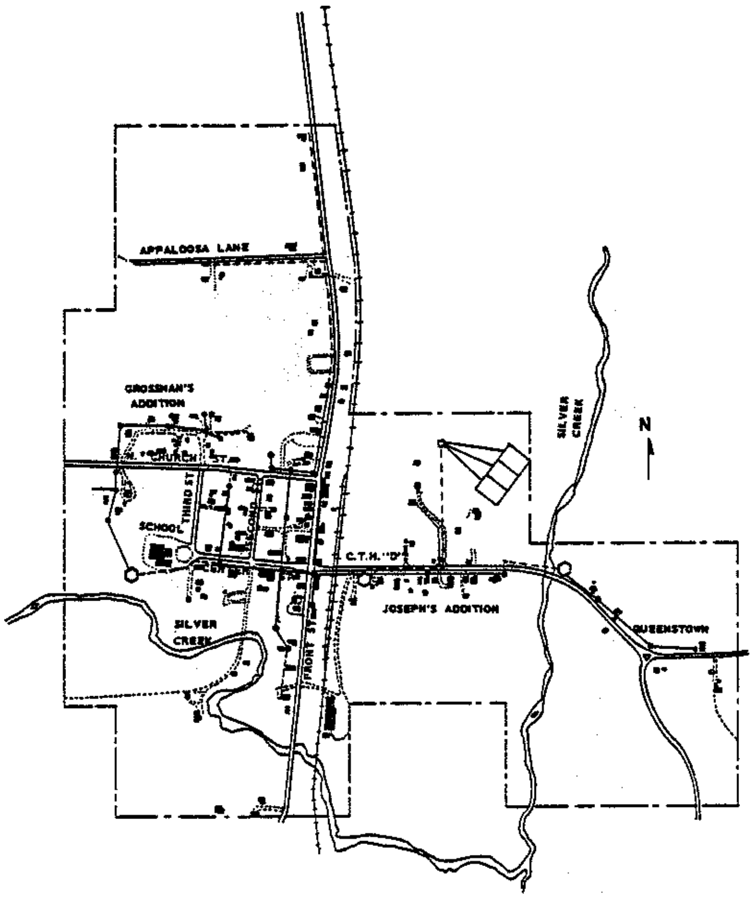


Figure 12. Plan of the Constructed
Wastewater Facility

Effluent Sewers: Both small diameter gravity sewers and pressure sewers were used to collect the septic tank wastes. Experience with small diameter gravity sewers has been limited to Australia. Guidelines used for their design were ones developed by the South Australia Department of Public Health (1968). These guidelines are summarized in Table 3.

Four-inch diameter mains were specified set at a minimum gradient of 0.67 percent. Assuming a peak flow of 3 gpd per person (Siegrist, et al., 1976) this size sewer can serve approximately 600 persons flowing half full. Half full conditions are recommended by South Australia (1968) to maintain ventilation of the sewers. This is a very conservative design because peak flows are dramatically

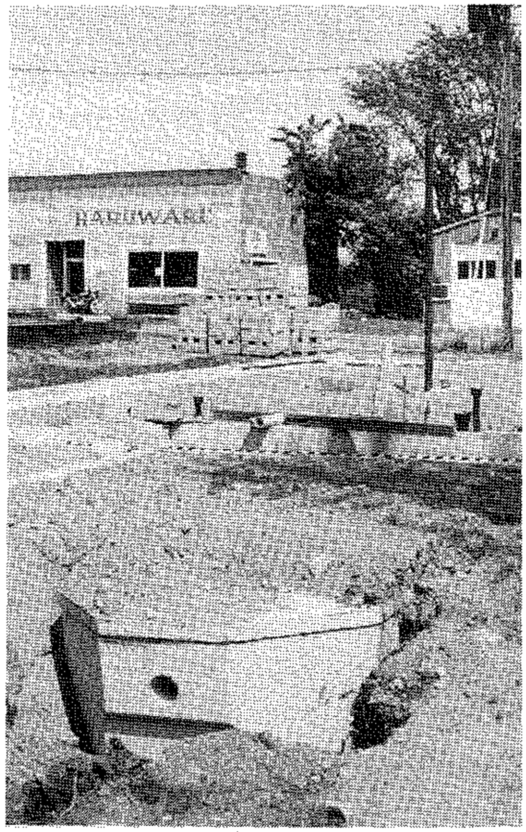
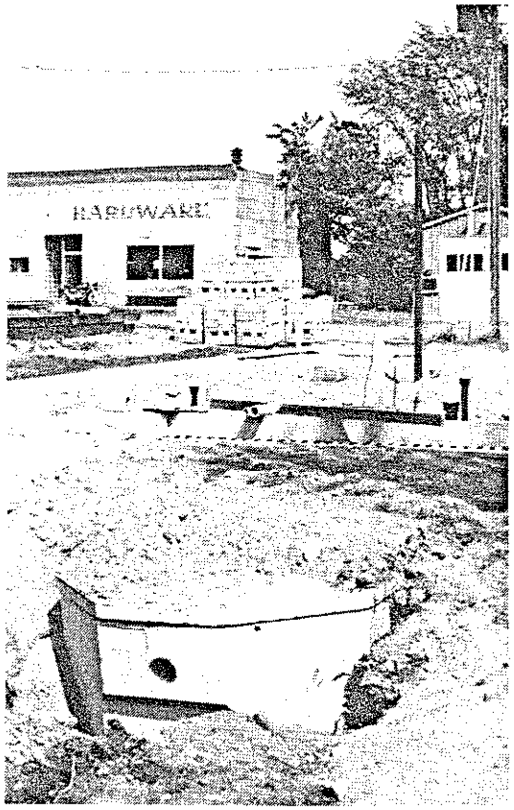


Figure 13. Septic Tank Installation at New Westboro Post Office

attenuated through the septic tank (Baumann, et al., 1978; University of Wisconsin, 1978). Peak flows of 1 gph per capita are more likely, which increases the design capacity of each sewer line to 1800 persons.

Manholes were placed at the upstream end of each line and at spacings up to 600 feet. Greater than 400 foot spacing was permitted because hydraulic jetting equipment is available which can reach more than 300 feet. Because settleable and floatable solids are exluded from the sewers, curvilinear alignments both in the horizontal and vertical plans were permissible. Manholes were only required at junctions and at locations necessary to maintain the maximum 600 foot spacing.



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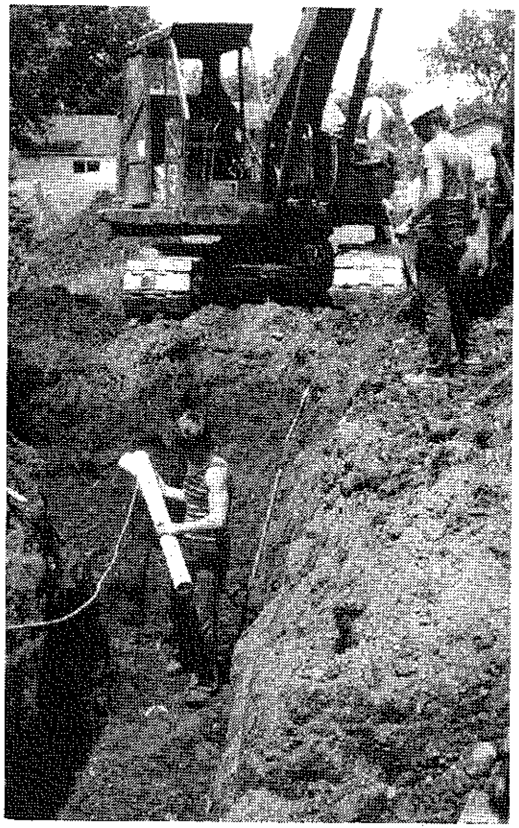

Figure 14. Installation of Four-Inch Collector Sewers

Table 3. South Australia Guidelines for Small Diameter Gravity Sewers (South Australia, 1968)

Minimum Pipe Diameter	4 Inches
Minimum Velocity (1/2 Full)	1.5 fps
Minimum Gradient	
4-Inch Conduit	0.67%
6-Inch Conduit	0.40%
8-Inch Conduit	0.33%

Design of the pressure sewers followed established criteria developed from experience in the United States (Bowne, 1974; Kreissl, et al., 1977). Small lift stations were placed after each septic tank served by a pressure sewer. Thirty six-inch diameter concrete pipe with a poured concrete bottom and a styrofoam insulated fiberglass cover was used. Mercury float switches were installed to operate the pumps and a high water alarm was placed just above the pump on switch so the homeowner would be alerted to a pump failure immediately by a visual and audible alarm. A sufficient volume above the high water alarm was provided to allow one day's continued use of water fixtures within the home while the problem is corrected (see Figure 15). The pumps discharge into 1 1/2-inch pressure sewers installed below the frost line following the topography.

Three community lift stations were necessary in the collection system. One is located southwest of the school where the wastes from Grossman's Addition are collected. These are pumped into the gravity main along Center Street. Another collects the wastes from the Queenstown area and pumps them across Silver Creek to the gravity main along CTH D. The third, located on CTH D, receives all the septic tank effluent collected and pumps it to the siphon chamber where it is dosed onto the soil absorption fields.

Due to the nature of the facility, some savings were made in the design of these lift stations. Because septic tank wastes are being collected, large solids handling pumps are not necessary. Also standby electricity generation equipment is not necessary because each home is on its own private well. In case of power outage, only water stored in the pressure tanks is discharged. Wastewater storage is provided in the lift stations, sewer mains and septic tanks (due to the three inch drop between the inlet and outlet of the tanks) which is sufficient to prevent backups. If not, a pumper can be called in to pump down the lift stations.

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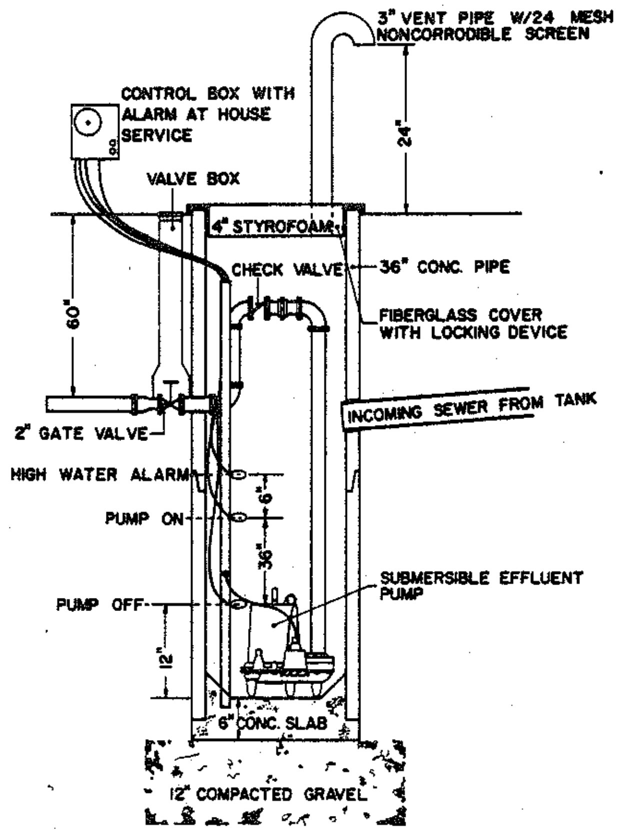

Figure 15. Design of Residential Lift Stations for Pressure Sewer Routes

Soil Absorption Fields: The soil absorption field was divided into three beds. Two are in service at any one time with the third acting as a standby. Every Spring, the standby bed is rotated into service so that each bed receives wastewater for 2 years and rests for 1 year. The resting period allows the bed's infiltrative surface to dry out and rejuvenate (University of Wisconsin, 1978).

Operating in this manner, the field should last indefinitely if not overloaded. However, if one of the beds unexpectedly fail, the standby bed would be rotated in immediately. The failed bed could then be chemically treated with hydrogen peroxide for immediate rejuvenation (Harkin and Jawson, 1977) or rested for several months to allow biochemical rejuvenation. Sufficient land was purchased so the beds could be reconstructed if necessary.

Uncertainty arose as to what should be the design capacity of the beds. In 1976, the population of Westboro was approximately 200 people and reasonably stable, but growth had been prevented because most of the soils in the area are unsuitable for individual septic tank systems. This is true for most of Taylor County. The provision of a public wastewater facility in Westboro would open up suitable building sites which are in great demand. This could stimulate rapid growth but too much excess capacity were to be included, the costs would become excessive. Therefore, it was decided that the field would be designed for maximum development within the present District boundaries only. Areas which potentially could be developed outside the District were not included in the planning area. If these areas were to be developed, however, and annexed to the District, separate cluster systems serving only the new developments would be necessary.

The total design capacity selected for the absorption field was 30,000 gpd. Each bed was designed to absorb half of this or 15,000 gpd. The design flow was estimated by assuming 250 gpd per home plus commercial flow. Commercial flows were estimated by using criteria provided in the Wisconsin State Plumbing Code (Wisconsin Administrative Code Section H62.20, 1976). Undeveloped lots and vacant buildings were included in this estimate.

Several methods for estimating the design flow were investigated. Good design criteria for large soil absorption beds is lacking because so few have been constructed and closely monitored. The usual method for sizing is to assume 150 gpd per bedroom served. The estimate provided by this criterium was 45,000 gpd which was not felt to be appropriate because it represents peak flow. With the large number of homes on the system, substantial evening of flow would be expected. This would months to allow biochemical rejuvenation. Sufficient land was purchased so the beds could be reconstructed if necessary.

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Several methods for estimating the design flow were investigated. Good design criteria for large soil absorption beds is lacking because so few have been constructed and closely monitored. The usual method for sizing is to assume 150 gpd per bedroom served. The estimate provided by this criterium was 45,000 gpd which was not felt to be appropriate because it represents peak flow. With the large number of homes on the system, substantial evening of flow would be expected. This would

allow designing for the average daily flow. If an average of 45 gpd per capita were assumed (Siegrist, et al., 1976) it gives a design flow of 13,000 gpd. However, this estimate does not allow for any inflow or infiltration which may occur. As a compromise 250 gpd per home or 30,000 gpd was assumed.

The application rate chosen for the absorption beds was dependent upon the soil type. The soil is sand and loamy sand. Long term infiltration rates into such soils loaded with septic tank wastes have been determined to be approximately 1.2 gpd/ft^2 (Otis, et al., 1978b). Therefore, each bed would require 12,500 ft^2. This was provided by 100 ft by 150 ft beds (Figure 16).

Pressure distribution networks were designed to distribute the wastewater uniformly over the infiltrative surface to prevent local overloading and premature failure (Otis, et al., 1978a). Two 8-inch PVC manifolds were used in each bed. feeding 4-inch PVC laterals spaced every 5.25 ft (see Figures 17 and 18). The laterals were perforated in the inverts with 15/32-inch holes. Manifolds are fed by a 12-inch PVC pipe leading from the siphon chamber.

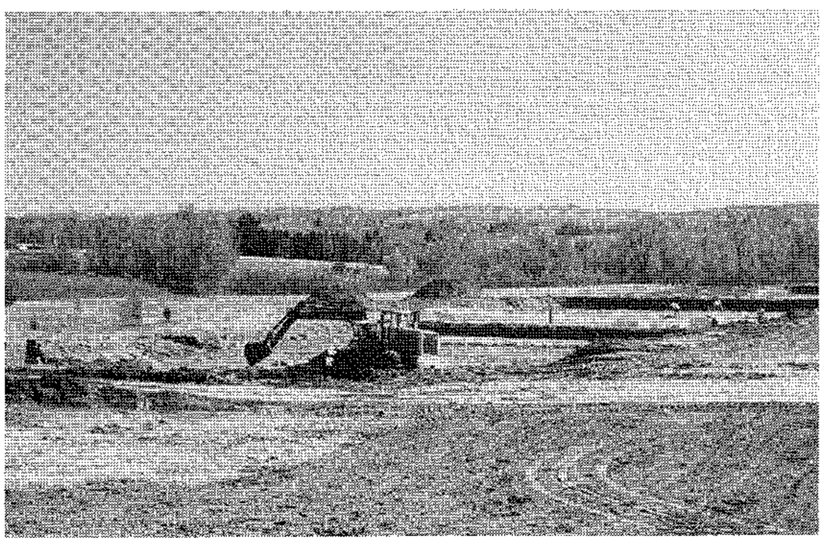


Figure 16. Construction of Two of the
Soil Absorption Beds

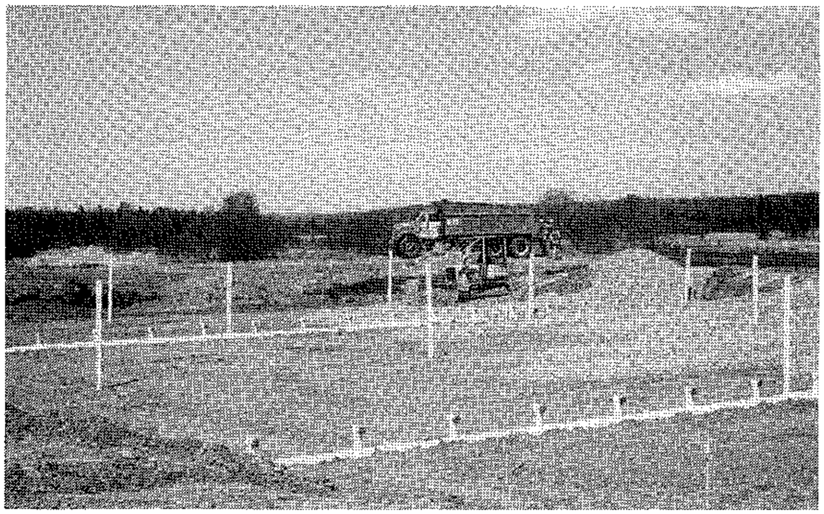


Figure 17. Soil Absorption Bed Construction With Manifold and Lateral Connections In Place (Observation Pipes Are Standing Vertically)

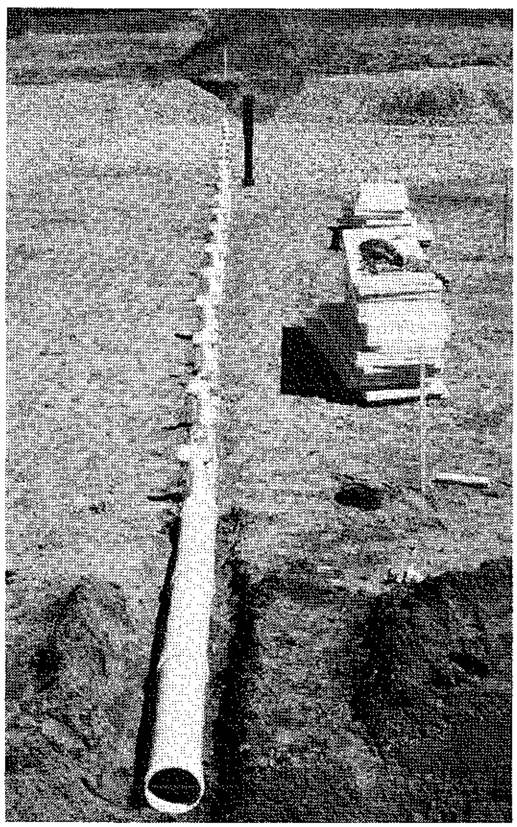
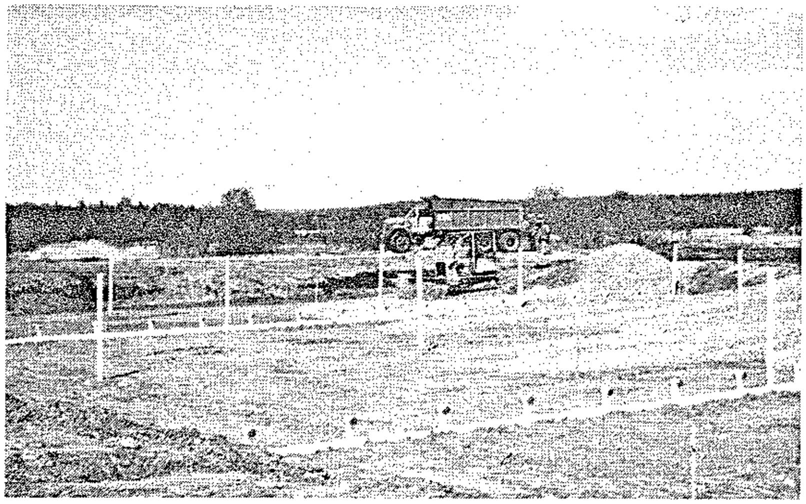


Figure 18. A Single 8-Inch Manifold With 4-Inch Lateral Connections (Black Vertical Pipe is the Manifold Drain Valve)



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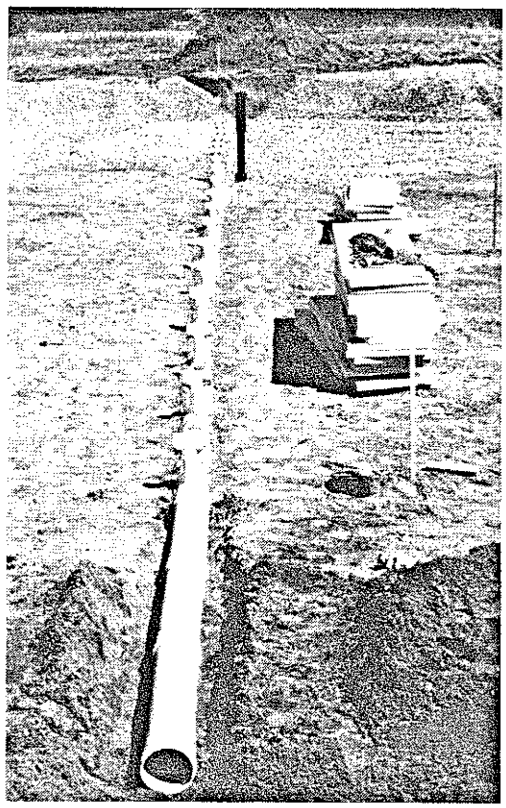

Figure 18. A Single 8-Inch Manifold With 4-Inch Lateral Connections (Black Vertical Pipe is the Manifold Drain Valve)

Three 10-inch siphons were installed, one for each bed. They are capable of discharging an average of 1000 gpm at the design head. The 12-inch pipe into which they discharge is larger than the siphon to permit air in the pipe to vent back out the siphon chambers.

Two siphons are operating at any one time. They automatically alternate operation discharging approximately 8000 gal per dose. At design capacity each bed will receive 2 doses per day. The third siphon is taken out of service by closing a ball valve installed in the siphons blow off vent (see Figures 19-21).

Plan Review

The reviewing agencies were very cooperative in reviewing and approving of this plan. Review was made by both the Department of Natural Resources and the Department of Health and Social Services since DNR has jurisdiction over water quality and DHSS regulates onsite systems. While some reservations were expressed over the design of the small diameter gravity sewers, both Departments accepted the

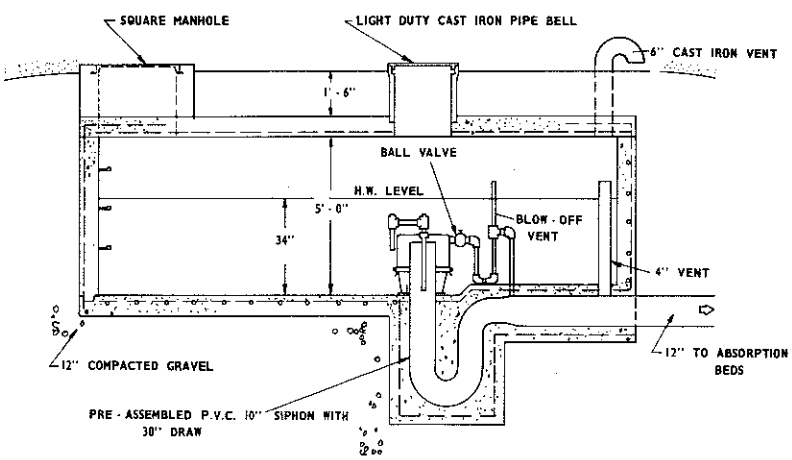

Figure 19. Elevation Drawing of the Siphon Chamber

Figure 20. Installation at the
10-Inch Siphon Legs

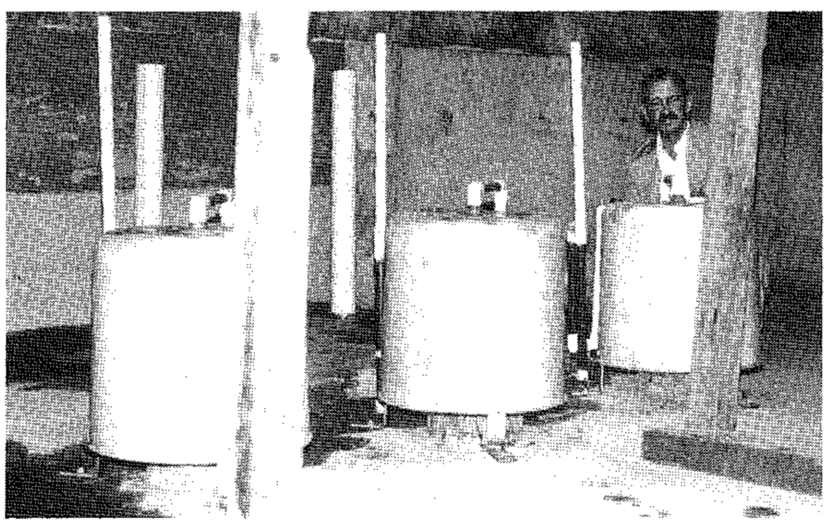

Figure 21. Siphon Bells in Place in the Siphon Chamber
(Blow-Off Vent is 1-Inch Vertical Pipe)

Figure 20. Installation at the
10-Inch Siphon Legs

Figure 21. Siphon Bells in Place in the Siphon Chamber
(Blow-Off Vent is 1-Inch Vertical Pipe)

plan on an experimental basis. With approval in hand, final funding commitments were sought from FmHA and DNR.

At this point, two problems developed which threatened the cost savings the project hoped to realize. The first was that FmHA requested metes and bounds descriptions of all easements which were necessary for the District to retain access to the septic tanks before FmHA would commit itself to the project. To survey each lot would increase the costs of construction markedly because the location of many tanks were unknown and would be located only during construction. After discussions with FmHA, it was finally agreed that a general easement would be satisfactory. The easement which was developed appears in Appendix B. It was delivered to each land owner in the District by the District Commissioners and readily signed by the owners.

The other problem was that of obtaining the land for the soil absorption field. Unlike conventional treatment alternatives, land with rather specific soil and site characteristics was needed. Owners of the land the District wished to purchase were reluctant to sell. The only other suitable land was more than a quarter mile away which would cost an estimated $14,000 for a force main and increase operating costs. Fortunately, the District was able to obtain an option on the primary site.

With these problems overcome, FmHA and DNR committed themselves to the project. Bids were received for construction and Lakewood Mechanical Contractors, Inc. of Rhinelander, Wisconsin was awarded the contract.

Facility Construction

Construction began in April, 1977 and was completed in September, 1977. The soil absorption fields were constructed first. After they were completed, house connections were made and the wastes discharged into the fields as the sewers were installed. Before each connection, however, the septic tank was carefully inspected.

All inadequate tanks were properly abandoned and new ones installed. To facilitate pumping of the tanks, some homeowners chose to relocate their tanks near the road. This usually meant reversing the plumbing in the home which was at the owner's expense.

It was also necessary to inspect the household plumbing to remove any inflow of clear water. It was important to eliminate all inflow sources to reduce the load on the absorption field. Unusually heavy rainfall soon after sewer installation indicated that infiltration and inflow had been successfully avoided.

The total project costs of the Westboro facility were $409,410. Of this, $336,380 were for actual construction. This is nearly $70,000 more than the estimated costs (Table 2) due to extensions, route changes and inflation. The project costs are summarized in Table 4. Detailed construction costs appear in Appendix C.

To determine the actual cost savings realized with this alternative facility, the cost of constructing Alternate #2 was estimated. To obtain a reliable estimate, unit costs were used from a neighboring community which had constructed a gravity collection stabilization pond facility serving 75 connections the same year. This community also constructed a water supply system at the same time which reduces the wastewater construction costs somewhat. Table 5 presents a cost comparison of the two facilities. Detailed cost estimates are presented in Appendix C.

This comparison indicates that a 13 percent savings was made in the cost of construction per connection over a conventional facility. This savings is not as great as hoped. However, it must be noted that the constructed facility serves every home in the District while the conventional alternative was not to serve 13 of the homes because of the high cost of extending sewers to them. The alternative facility average 255 ft of pipe laid per connection, while the conventional collection

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Table 4. Construction Cost Summary

COLLECTION (Includes house lateral, septic tanks, collection mains and lift stations)		
Construction	$245,635	
Land and Rights	0	
Legal Services	4,000	
Engineering and Inspection	43,810	
Interest	2,000	
		$295,445
TREATMENT (Includes siphon chamber and soil absorption field)		
Construction	$90,775	
Land and Rights	4,000	
Legal Services	2,000	
Engineering and Inspection	16,190	
Interest	1,000	
		$113,965
	TOTAL	$409,410

system would have averaged 195 ft per connection. Both these figures include the house laterals. Thus, more than 31 percent of pipe was laid for 13 percent less cost.

To increase savings further, the design of the constructed alternative could be less conservative. If experience with the facility is good, changes might be made in the design which could reduce the costs of future installations substantially. For example, it appears that the gradients of the sewers could be reduced and the manholes replaced with simple cleanouts because the settleable solids have been removed from the waste. Also, the size of the absorption field might be reduced

Table 5. Comparative Costs of Construction For Conventional and Alternative Facilities

	Actual Costs of Alternative #7	Estimated Costs[1] of Alternative #2
Collection	$245,635[2]	$181,315[3]
Treatment	90,775	174,150
Total	$336,410	$355,465
Cost/Connection	$4053 (83)[4]	$4677 (76)[4]
Number of Homes Unserved	0	13

[1] Unit costs obtained from Village of Curtis, Clark County. Gravity collection/stabilization facility serving 75 connections. Constructed 1977.

[2] Includes septic tanks and house laterals.

[3] Includes customer hookup charges of $483 (See Appendix C).

[4] Number of connections.

because infiltration is less than expected and the alternating operation of the fields may reduce clogging significantly increasing the system's capacity.

Construction Funding

Westboro received financial assistance for construction from FmHA and Wisconsin DNR. Farmer's Home Administration has a loan and grant program for construction of water supply and wastewater facilities, storm sewers and landfills for rural communities. Eligible costs in this program are engineering fees, land and easements, and construction costs. Priority is given to communities with stable or growing populations of less than 5500 persons.

At the time of construction, FmHA was held to a maximum grant of 50-percent of the total project costs with the remainder provided through a 5-percent, 40-year loan (the grant ceiling was recently increased to 75-percent). The amount of the

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grant is usually determined by the community's ability to repay the loan. Grants are given to reduce the debt service portion of the user charge to 1 percent of the medium family income within the project area. Grant funds from other sources are taken into account in this calculation.

Wisconsin DNR was closing out a 25-percent construction grant program from which Westboro was able to obtain assistance. Eligible costs included 10-percent of the engineering fees and construction of facilities on public lands. Land costs and portions of the facility located on private property were ineligible. Thus, the septic tanks and residential lift stations necessary to reduce the costs of sewering were considered ineligible despite the fact that the district owns and maintains the tanks through permanent easements.

The local share of construction costs was obtained through special assessments and hookup charges. Those homes which had good tanks were only charged a $100 hookup. If a new tank was installed, an additional $200 assessment was made. Some homes within the district had no indoor plumbing but the owners indicated they intended to install plumbing in the near future. Tanks were installed on these properties and only the $200 was assessed the owners.

A summary of the project's financing appears in Table 6. The Wisconsin DNR is presently reviewing the eligibility of the individual septic tanks lift stations and laterals for a construction grant. If they are determined to be eligible, DNR would increase their grant by $11,000,thereby reducing the loan from FmHA.

OPERATION OF THE FACILITY

Routine Operation and Maintenance

The facility requires very little attention by the operator. All duties can be performed by an unskilled laborer. To comply with the Wisconsin Administrative

Table 6. Summary of Construction Financing

Westboro Town Sanitary District		
Tank Assessments (72 tanks x $200)	$14,400	
Hookup Charges (76 hookups x $100)	7,600	
		$ 22,000
Farmer's Home Administration		
Grant		$187,000
Loan		$114,510
Wisconsin Department of Natural Resources		$ 85,900[1]
	TOTAL	$409,410

[1] Includes $11,000 for 25% funding of individual septic tanks, lift stations and laterals.

Code NR 114 (1971), however, the operator must have a Grade IV certification. Three individuals in Westboro have obtained this license by attending an operator's short course and taking the written examination.

Operation of the facility includes the following tasks:

1. Soil absorption beds alternation.
2. Septic tank pumping.
3. Lift station maintenance.
4. Sewer maintenance.
5. Monitoring.

These tasks require no more than an average of 2 to 4 man hours a week. The maintenance schedule is summarized in Table 7.

Once a year in the Spring, the soil absorption beds are alternated to allow one to rest and rejuvenate. This is done by opening the ball valve on the blow off vent of the siphon servicing the bed to be rotated in, closing the valve of the blow off vent of the siphon serving the bed to be taken out of service and opening the drain valve to the manifold of the bed taken out of service. The manifold is

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drained into the bed to prevent it from freezing. This operation is done in the Spring because late Fall start-ups often lead to premature clogging due to lower soil temperatures.

Each year, one-third of the septic tanks are pumped to remove sludge accumulations. This work is contracted out to a local pumper. The pumper is given a pumping route to follow each year. Because the pumpings are regularly scheduled and not emergency runs, the costs of pumping can be much less than usual. The contract the District presently has is for three years at $17.50 per tank. By monitoring the sludge accumulations it may be determined that some tanks may require more frequent pumping than once every three years while others will require less frequent pumping.

Table 7. Facility Maintenance Schedule

Daily

1. Check lift station alarm lights.

Weekly

1. Open lift stations for visual inspection of pump operation float control operation and debris.
2. Record total weekly flow from pump running time meters as per WPDES permit requirement.

Monthly

1. Sample lift station wastewater for BOD_5, suspended solids and pH as per WPDES permit requirement.
2. Inspect observation vents in each bed for ponded water. If the ponding is greater than 12 inches, take the ponded bed out of service.

Annually

1. Each Spring alternate resting bed into service and drain manifold of bed taken out of service.
2. Inspect the surface of the absorption field for holes and depressions. Fill in any that are found.
3. Pump 1/3 of septic tanks each year according to schedule.
4. Pump lift stations and siphon chamber to remove any sludge.
5. Jet any of the sewer lines which have a history of clogging problems.

Regular inspection of the lift stations and sewer lines should be made but after more than one year's operation no maintenance has been necessary. Periodically, it may be necessary to remove sludge accumulations from the lift station's siphon chamber and sewer mains. Spare pumps are kept on hand to replace any pumps which fail to prevent interruption in service.

Standby power generation for the lift stations is not provided in this facility. The water supply in the community is all from private wells. Therefore, if a power failure occurs, the water supply is lost. Sufficient storage is available in the lines and free space of the septic tanks to store any water which might exist in the home plumbing prior to the power failure.

Routine monitoring of the facility is required by law. The facility is defined as a Class III Subsurface Absorption Field Land Disposal System by the DNR (Wisconsin Administrative Code NR 214, 1976) and, therefore, requires a Wisconsin Pollution Discharge Elimination System (WPDES) permit. The permit stipulates that the monitoring specified in Table 8 be performed.

Table 8. Effluent Limitations and Monitoring Requirements As Specified by the WPDES Permit

EFFLUENT CHARACTERISTICS	LIMITATIONS			MONITORING REQUIREMENTS	
	Min	Ave	Max	Sample Frequency	Sample Type
Flow	Daily average design flow of 30,000 gpd			Weekly	Total daily flow
BOD_5	-	-	-	Monthly	Grab
Suspended Solids	-	-	-	Monthly	Grab
pH	6.0	-	9.0	Monthly	Grab

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User Charges

In addition to the special assessments and hookup charges, monthly user charges are billed each customer. These charges are necessary for debt retirement and operation and maintenance costs. Final user rates have not yet been established because the grant and loan arrangements are still pending. In the interim, however, five classes of users have been designated. Each class will be charged flat monthly rates rather than metering individual water use. The classes designated are:

1. Residential
2. Residential w/o hookup (will pay debt retirement portion of charge only)
3. Small commercial (machine shop)
4. Large commercial (taverns)
5. School

The first year's operating expenses were approximately $2800.00. This included wages, utilities and pumping one third of the septic tanks. Based on these actual costs and an assumed FmHA loan of $114,510 an annual budget was estimated (Table 9) and one possible rate structure proposed (Table 10). The proposed monthly residential charge would be $8.75/month.

The $8.75/month user charge is made up of approximately $5.15/month for debt retirement and $3.60 for operation and maintenance. These user charges are 10-to 20-percent less than user charges for conventional stabilization pond facilities in similarly sized communities. Farmer's Home Administration estimates an average $8.00/month debt retirement and $4.00/month operation and maintenance or a total charge of $12/month per user for such facilities in Wisconsin.

Operational Problems

After the facility was fully operative in September, 1977, several problems occurred which were unique to the design. The first of these was siltation in the manholes. Conventional manholes were installed on all the sewer lines which were

Table 9. Proposed Annual Operating Budget

Salaries and Wages	$ 1350.00
Utilities	400.00
Tank Pumping	500.00[1]
Depreciation	600.00[2]
Office Supplies	100.00
Monitoring	360.00[3]
Insurance Bond	200.00
Legal Fees	100.00
Loan Payment	6675.00[4]
TOTAL	$10,285.00

[1] Based on $17.50/tank; $45 for school

[2] Required by FmHA. Must be collected each year until fund accumulates $6000. Once reached, this level must be maintained.

[3] Based on $30/sample for BOD and TSS, 12 times annually.

[4] Based on $114,510 40-year loan at 5% interest

Table 10. Proposed Rate Structure

Residential Users	79 @	$8.75/mo.	$ 8,295.00
Small Commercial Users	1 @	12.75/mo.	153.00
Large Commercial Users	2 @	15.75/mo.	378.00
School	1 @	125/mo.	1500.00
			$10,376.00

found to entrances for sand and silt. If allowed to continue, the sewers could become clogged because the sewers are not designed for a scouring velocity sufficient to remove grit. Also, the manhole covers allow inflow of precipitation adding to the hydraulic loading of the soil absorption field. In future installa-ations of small diameter gravity sewers, 4-inch cleanouts should replace the

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conventional manholes. Cleanouts would be much lower in cost, and would permit the needed access for hydraulic jetting equipment for cleaning. If the manholes must be used, however, they should have sealing covers.

Another problem was septic odors around the main lift station. Agitation of the waste as it spilled into the lift station released the odorous gases. This problem was solved by extending the inlet sewers downward to below the low water mark (Figure 22). This prevented agitation of the waste and solved the problem.

Occasional freeze-ups of the residential lift station occurred during the first winter of operation. The discharge pipe was extended well up into the manhole to facilitate extraction of the pump in case of failure (Figure 15). The units

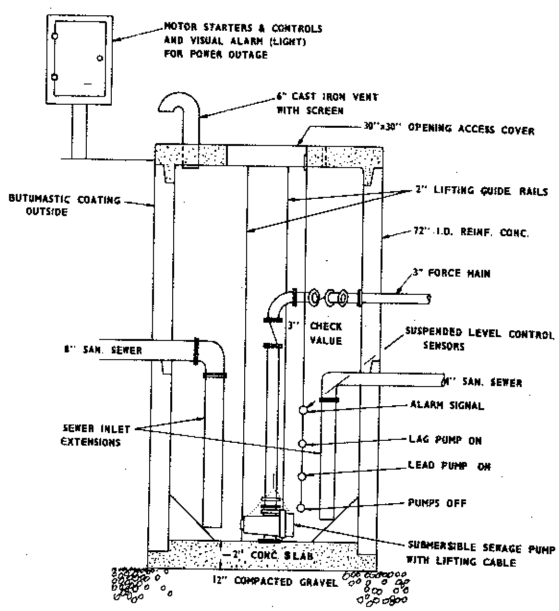

Figure 22. Elevation Drawing of the Main Lift Station
Showing the Inlet Extensions

which froze had insufficient fill around the top of the chamber so the concrete wall was exposed. The 4-inch vents required by the State of Wisconsin on all lift stations may also have contributed to the problem. The homeowners experienced no inconvenience, however. The high water alarm alerted them to the problem and sufficient storage remained in the lift station above the alarm level to hold another day's flow. The pipes were thawed by dropping a small space heater in the lift station for a couple of hours. The discharge pipes have since been insulated, and the stations properly backfilled. If the problem recurs, the discharge pipe could be lowered. Another solution might be to vent the residential lift stations in another manner such as into a subsurface bed of gravel.

A final problem was discovered in the manufacture of one of the dosing siphons. The faulty assembly allowed the siphon to "dribble" so that only one field received the wastewater. As long as this condition existed, proper dosing and alternate loading of the fields could not occur. The faulty siphon was repaired but it could have gone unnoticed for some time. It is important that in such installations the siphon operation must be carefully watched at first to insure they are operating properly.

MONITORING PROGRAM

The Upper Great Lakes Regional Commission provided funds for the University of Wisconsin-Extension to monitor Westboro's facility for the first year of operation. The monitoring includes:

1. Sampling selected private wells
2. Metering water use at selected buildings
3. Monitoring total wastewater flow at the main lift station
4. Monitoring siphon operation
5. Monitoring groundwater quality around the absorption field area
6. Monitoring water quality of Silver Creek

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Private Well Sampling

The private well sampling began in March, 1975, to determine if any wells were contaminated. Thirty-five wells scattered throughout the community were selected for sampling (Figure 23). The samples were collected in sterile bottles after flaming an inside faucet. Analyses for coliforms and nitrates were run within 36 hours by the Wisconsin State Laboratory of Hygiene. Coliforms are detected by the 5-tube MPN test. If one or more tubes were positive for brilliant green, the well was reported as "unsafe." Nitrates were run according to Standard Methods (1976).

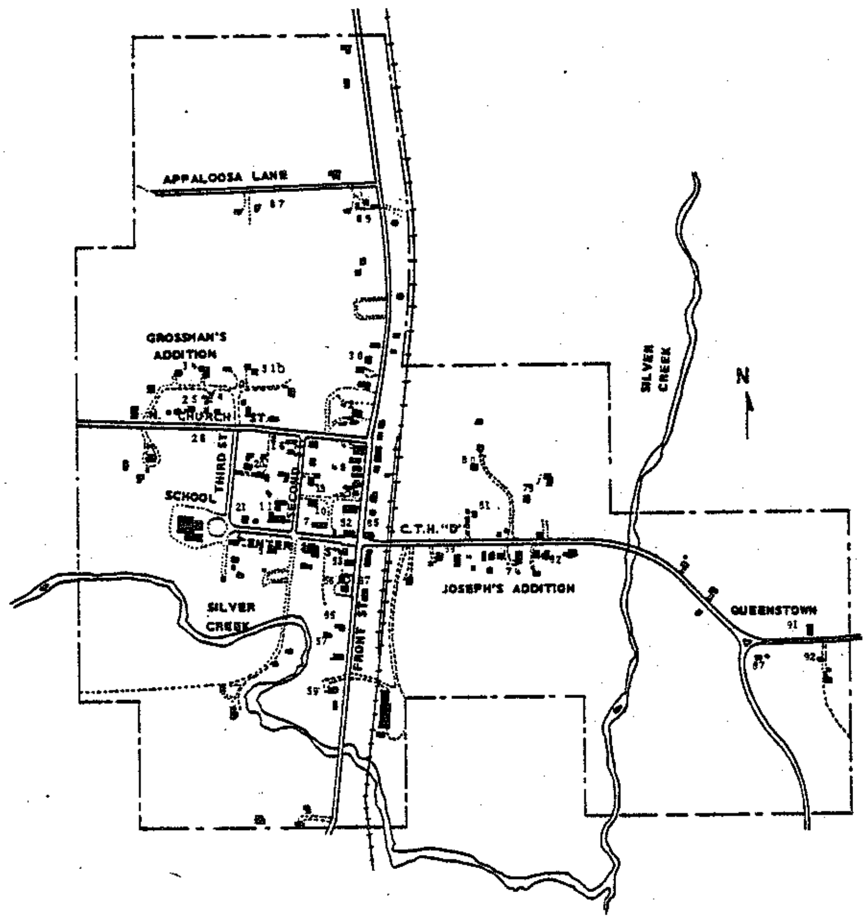

Figure 23. Location of Monitored Private Wells

The results of the testing appear in Table 11. Four samples were taken prior to construction of the facility. The results show that little, if any contamination of the wells by the existing septic tank systems was occurring. Only Well 92 which is a dug well, was consistently bacteriologically unsafe. Well 34 has an unexplained high nitrate level. It remains to be seen if the new wastewater facility will end this contamination. Of particular interest in future sampling will be Wells 74, 79, 80, 81 and 82 because of their proximity to the soil absorption field.

Water Use Metering

Water use has been metered in twenty-five homes and businesses since April, 1977. The objectives of the metering are:

1. To determine if the 250 gpd/home estimate used for design of the soil absorption field is accurate.

2. To observe any increase in water use after the public facility became operational.

The twenty-one homes selected (30 percent of the homes in Westboro) include a variety of family sizes and ages. Homes with and without failing existing private onsite systems were included in this group. The business establishments selected were two taverns and a service station. All three have attached residences. The school is also metered.

The results of the metering appear in Table 12. Meters usually have been read monthly. The difference between monthly readings was divided by the number of days between readings to obtain average daily use for the metered period. Averages were also computed for all residences over each metered period and for each metered connection over all metered periods. Average daily per capita usage was also calculated.

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Table 11. Water Use Metering in Selected Homes and Establishments

Connection No.	Type	No. Occupants	April May 77	June 77	July 77	Aug 77	Sept 77	Oct 77	Nov 77	Dec 77	Jan 78	Feb 78	March 78	April Nov-78	Ave	(GPCPD)
			WATER USE GPD													
1	School[1]	6 Clrms	-	377	488	701	860	883	874	906	681	710	1168	950	782	(-)
3	Res[1]	7	380	316	351	417	423	515	337	428	544	546	406	-	424	(61)
13	Res	5	105	121	112	146	138	119	103	95	110	-	-	-	117	(23)
14	Res[1]	5	183	147	25	57	503	163	120	138	149	121	196	-	164	(33)
20	Res[1]	3	129	124	114	181	189	170	145	176	165	136	182	138	154	(51)
21	Res[1]	7	45	171	77	91	83	90	85	98	150	106	139	102	103	(15)
22	Res[3]	11	-	-	292	341	278	399	344	376	354	-	-	-	340	(31)
25	Res[1]	7	365	281	296	306	248	291	237	266	265	257	379	-	289	(41)
26	Res[1]	2	-	-	76	82	71	79	76	98	211	79	110	-	98	(49)
27	Res[1]	4	-	-	221	151	145	168	182	127	136	130	176	-	160	(40)
28	Res	4	-	-	-	37	32	38	35	31	25	25	-	-	32	(8)
29	Res[1]	5	-	-	96	67	-	-	-	81	-	-	-	-	81	(16)
30	Res	3	-	-	186	165	128	156	134	124	140	125	181	-	149	(50)
33	Res[1]	2	-	-	149	133	-	-	-	-	-	-	-	-	141	(71)
34	Res[1]	4	-	-	185	180	143	180	148	163	154	137	175	-	163	(41)
35	Res	4	-	-	138	69	59	36	52	41	66	36	50	-	62	(15)
42	Res[1]	2	125	62	150	114	99	93	105	84	99	74	129	-	103	(52)
45	Res & Gas Sta	3	202	300	282	254	179	170	116	155	193	177	239	280	212	(-)
52	Res &[1,4] Tavern	8	402	333	364	737	524	538	359	283	314	265	299	257	390	(-)
56	Res[1]	5	309	282	311	-	-	-	-	-	-	-	-	-	301	(60)
59	Res[1]	2	39	41	47	50	44	44	40	43	37	-	-	46	43	(22)
67	Res &[1,5] Tavern	6	287	389	390	321	271	287	260	248	-	-	257	232	294	(-)
73	Res[1]	8	280	218	198	284	266	275	264	281	292	294	379	-	276	(34)
81	Res	4	111	101	114	104	98	104	95	121	81	99	123	-	105	(26)
89	Res	5	323	375	378	299	272	332	265	254	280	241	328	354	308	(62)
AVERAGES[6]		4.7	200	186	160	149	161	155	132	138	212	160	211	160	169	(36)

Public Wastewater Facility Operational September, 1977

[1] Existing onsite system was failing.
[2] School enrollment for 1977-78 100 students; 1978-79 121 students.
[3] Well serves one house and 2 mobile homes, additional mobile home added Oct. 1977.
[4] Tavern changed hands Nov. 1977
[5] Tavern changed hands July 1977.
[6] Excludes connections 1, 45, 52, 67. Connection 22 counted as 3 through Sept. 1977, after Sept. 1977 as 4.

Table 12. Nitrate Concentrations in Selected Private Wells

Connection No.	Well Depth	Casing Depth	Water Depth	Dist. to ST/SAS	NITRATES March 75	July 75	April 76	September 76	October 78
	mg/L								
1	>100	>100	-		1.2	1.2	1.5	1.6	1.3
2	80	-	-		1.2	1.0	0.8	0.8	
5	65	60	50		0.5	0.5	0.3	0.5	-
7	81	81	28		<0.5	<0.5	<0.2	<0.5	<0.5
11	82	75	-		<0.5	<0.5	<0.2	<0.5	<0.5
13	70	-	-		0.5	<0.5*	0.2	<0.5	
16	75	70	45		-	2.5	3.1	2.8	
20	87	78	-		2.6	1.9	0.8*	1.2	-
21	-	-	-		<0.5	<0.5	<0.2	<0.5	<0.5
25	82	80	50		<0.5	<0.5	0.4	<0.5	
27	-	-	-		-	<0.5	0.3	<0.5	
31B	82	80	62		<0.5	-	-	<0.5	
24	80	75	20		16.4	15.5	14.0	13.6	
38	60	-	20		-	3.4	4.2	4.1	
42	56	54	40		-	2.6	3.1	2.7	
45	-	-	-		-	-	0.3	0.8	<0.5
48	-	-	-		-	-	<0.2	<0.5	
52	54	54	34		<0.5	<0.5	<0.2*	<0.5	<0.5
53	52	52	-		-	<0.5	0.4	<0.5	
56	140	120	45		<0.5	<0.5	<0.2	<0.5	
57	125	125	-		<0.5	<0.5	<0.2	<0.5	
59	>140	138	35	90	<0.5	<0.5	<0.2	-	<0.5
67	100	100	-		<0.5	<0.5	<0.2	<0.5	<0.5
69	87	85	40		<0.5	<0.5	<0.2	<0.5	
70	-	-	-		-	-	-	<0.5	
74	>100	>100	50		-	<0.5	<0.2	<0.5	<0.5
79	100	95	70		<0.5	<0.5	<0.2	<0.5	
80	100	100	17		<0.5	<0.5	0.2	-	
81	90	84	2		<0.5	<0.5	<0.2	<0.5	
82	150	150	70		<0.5	<0.5	-	-	
87	155	136	126		<0.5	0.5	<0.2	<0.5	
89	80	75	55		1.6	1.1	1.1	1.0	
90	-	-	-		-	-	-	<0.5*	
91	75	75	4		<0.5	<0.5	<0.2	<0.5	
92	24	24	-		0.8*	0.7*	-	-	

Public Wastewater Facility Operational September, 1977

* Bacteriologically unsafe.

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13	70	-	-		0.5	<0.5*	0.2	<0.5	
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38	60	-	20		-	3.4	4.2	4.1	
42	56	54	40		-	2.6	3.1	2.7	
45	-	-	-		-	-	0.3	0.8	<0.5
48	-	-	-		-	-	<0.2	<0.5	
52	54	54	34		<0.5	<0.5	<0.2*	<0.5	<0.5
53	52	52	-		-	<0.5	0.4	<0.5	
56	140	120	45		<0.5	<0.5	<0.2	<0.5	
57	125	125	-		<0.5	<0.5	<0.2	<0.5	
59	>140	138	35	90	<0.5	<0.5	<0.2	-	<0.5
67	100	100	-		<0.5	<0.5	<0.2	<0.5	<0.5
69	87	85	40		<0.5	<0.5	<0.2	<0.5	
70	-	-	-		-	-	-	<0.5	
74	>100	>100	50		-	<0.5	<0.2	<0.5	<0.5
79	100	95	70		<0.5	<0.5	<0.2	<0.5	
80	100	100	17		<0.5	<0.5	0.2	-	
81	90	84	2		<0.5	<0.5	<0.2	<0.5	
82	150	150	70		<0.5	<0.5	-	-	
87	155	136	126		<0.5	0.5	<0.2	<0.5	
89	80	75	55		1.6	1.1	1.1	1.0	
90	-	-	-		-	-	-	<0.5*	
91	75	75	4		<0.5	<0.5	<0.2	<0.5	
92	24	24	-		0.8*	0.7*	-	-	

Public Wastewater Facility Operational September, 1977

* Bacteriologically unsafe.

The results indicate that the water use in the selected homes is less than anticipated. To size the soil absorption field, it was estimated that 250 gpd of wastewater would be generated in each home. This estimate was made by assuming 5 persons in each home each generating 50 gpd of wastewater. The metered homes show a range of water usage from 25 gpd to 546 gpd with an average of 169 gpd from April, 1977 to November, 1978. The average number of occupants is 4.7 persons. Per capita usage ranges from 8 gpd to 71 gpd with an average of 36 gpd. Other investigators report daily per capita water usage to be 30 to 45 gal (Siegrist, et al., 1976). The lower per capita usage found in Westboro is probably due, in part, to the fact that most of the residents are employed outside the community.

No significant increase of water use has been observed since the public wastewater facility became operational. It was thought that many residents might be limiting their water use because they owned failing septic tank systems. However, through a series of drains, failing systems generally were not a problem because the wastewater was removed from their lot. Therefore, the construction of the system apparently has not effected water use.

Wastewater Flow Monitoring

The total wastewater processed each day is determined at the main lift station where all the wastewater is pumped to the siphon chamber. The total volume of wastewater is computed from the elapsed time clocks mounted on each pump circuit. Each pump is capable of approximately 60 gpm against the dynamic head of the system. The results of the monitoring appear in Table 13.

The average total daily wastewater volume is substantially below design estimates. The facility was designed to handle a maximum of 105 residences generating 250 gpd or 26,250 gpd plus 3750 gpd of commercial flow for a total capacity of

Table 13. Daily Wastewater Volume

Monitoring Period	Daily Pumpage Volume (gpd)
February 1978	6980
March 1978	11,700[1]
April 1978	6950
May 1978	7560
June 1978	7200
July 1978	7420
August 1978	7960
Sept.-Oct. 1978	7350
AVERAGE	7345[2]

[1] Period of heavy rains and snow melt

[2] Average does not include March, 1978

30,000 gpd. Presently there are 73 residences plus the commercial establishments using the facility. Therefore, the facility has 70 percent of the estimated maximum number of connections but the generated wastewater is only 25 percent of design capacity.

Obviously, the design criteria were too conservative. If the daily wastewater volume generated by the school is subtracted from the total daily wastewater flow and the taverns are considered as residences, then the average daily waste generated in each of the 73 homes is 90 gpd. The present population is approximately 205 persons living in a total of 81 homes (8 of which have not been connected to the facility). Thus, there is an average of 2.5 persons in each home. This results in an average of 36 gpcpd, the same average per capita flow determined by metering (Table 12). This indicates that the design criteria should be based on the population and an average per capita flow as in conventional design rather than on the number of connections. The present facility is oversized by 65-percent, capable of treating wastes from a population of more than 800 persons.

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AVERAGE	7345[2]

1 Period of heavy rains and snow melt

2 Average does not include March, 1978

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The flows received at the siphon chamber indicate that no inflow or infiltration is occurring. In March, 1978, the flow at the lift station nearly doubled. This was a period of heavy rains and snow melt but no source of inflow or infiltration could be found. Unusually high flows have not reoccurred despite above average rainfall during this summer.

Siphon Operation Monitoring

Siphon operation is being monitored to determine flow patterns and confirm that the siphons are operating properly. Magnetic reed float switches were installed in the distribution network manifolds of each bed. The three switches are connected to a 4-channel event recorder powered by a 12-v car battery. When the switches are closed by flow in the manifold, the time of the event is recorded on the channel corresponding to the siphon which is activated.

Results indicate the siphons alternate properly dosing each bed in operation with approximately 8500 gal every 2.5 days. The beds were designed to receive 2 doses per day. No definite pattern has developed except that weekends seem to be periods of lower flow while peak flows usually occur on Tuesdays and Wednesdays.

Groundwater Monitoring

Groundwater observation wells were installed in and around the soil absorption field to monitor how the groundwater in the area is affected by the percolating wastewater. In June, 1977, 28 observation wells were installed prior to the facility becoming operational (Figure 24 and Table 14). The wells are 1 1/4-inch diameter PVC pipe set in an augered 4 1/2-inch diameter hole with a 3 foot PVC well screen to allow the entrance of groundwater. The PVC pipe was chosen because of its relative inertness, inhibiting chemical reactions with the groundwater. Once the casing and

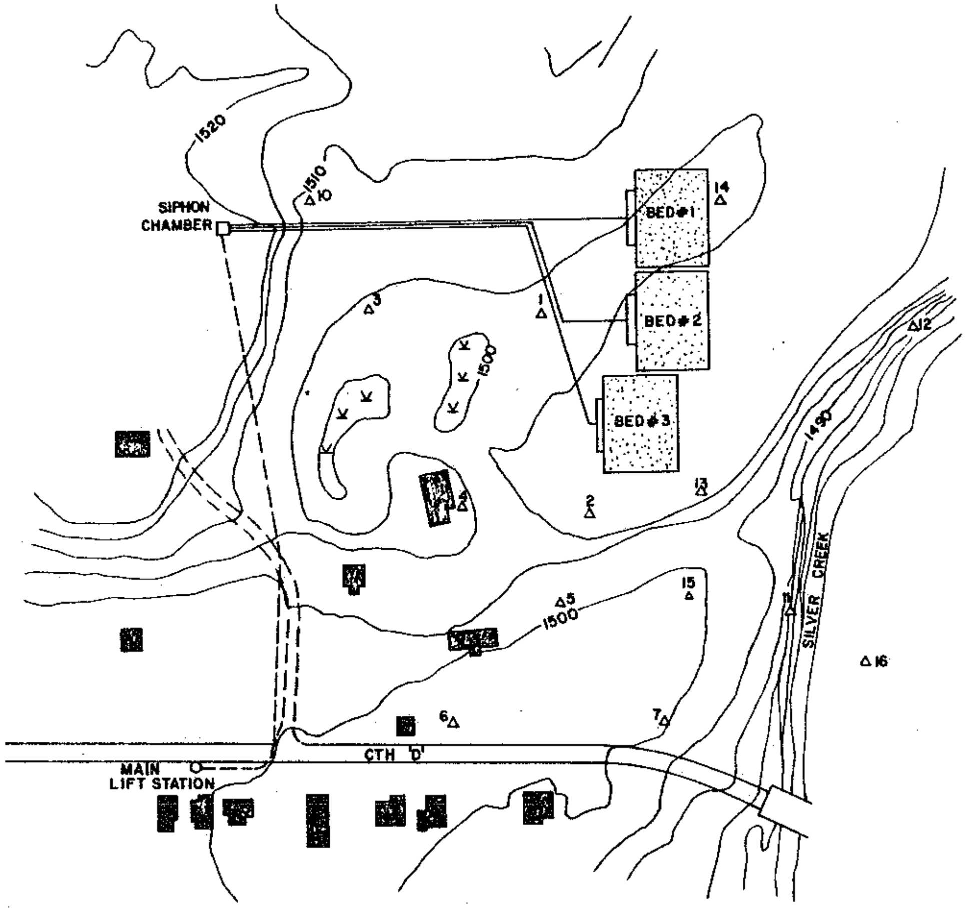

Figure 24. Location of Groundwater Monitoring Wells

screen were placed at the required depths, the auger hole was backfilled with natural soil materials.

Soil samples taken during installation of the wells were used to estimate permeability. The subsurface soils consist of silty sands interbedded with clay lenses. Approximately 85-percent of the soil materials are quartz sand while the remainder are silt and clay. The clay lenses are generally less than 10 feet thick. The sand fraction consists of grains averaging 0.25 to 0.50 mm in diameter. Using the Masch and Denney (1966) method the permeability of the sand was estimated to be 325 gpd/ft^2 ranging from 90 to 950 gpd/ft^2. Because the sands are fluvial deposits, they are stratified. Thus, the horizontal permeability is many times greater than

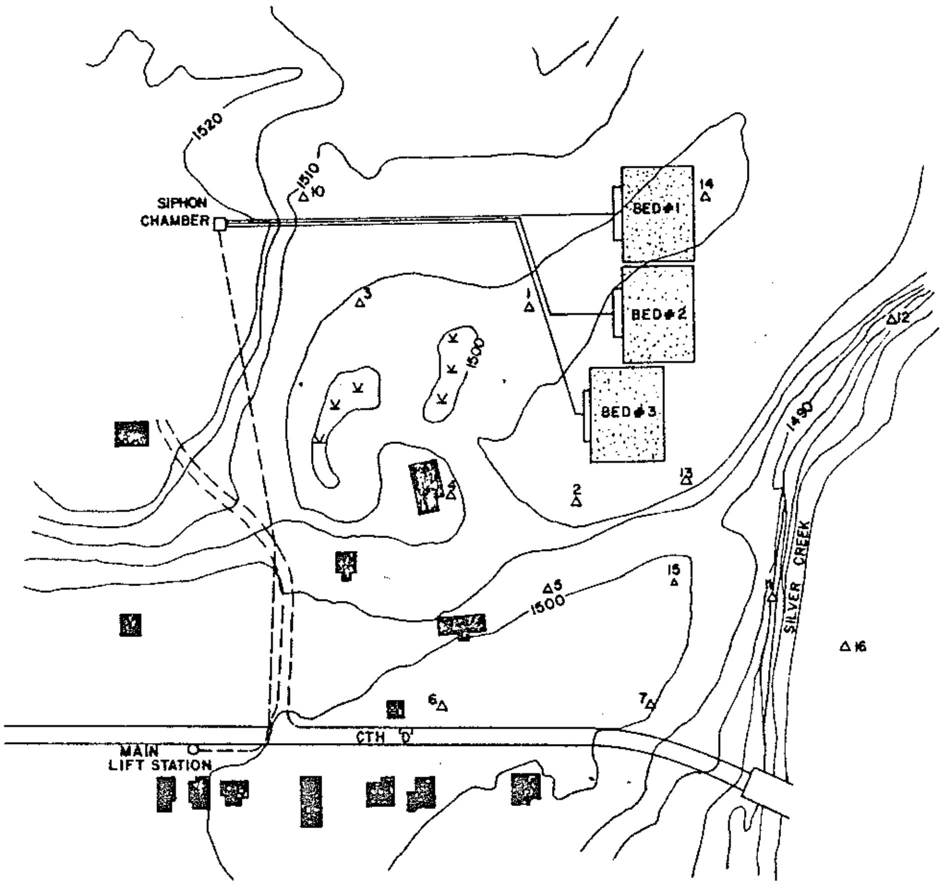

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Table 14. Groundwater Monitoring Well Elevations

Well No.		Surface Elevation	Bottom Elevation[1]	Depth
		ft		
1	(1)	1503.3	1468.7	34.6
	(2)		1490.8	12.5
	(3)		1495.6	7.7
2	(1)	1505.0	1470.2	34.8
	(2)		1482.5	22.5
	(3)		1489.9	15.1
3		1503.2	1492.3	10.9
4	(1)	1505.3	1483.5	21.8
	(2)		1493.1	12.2
5	(1)	1497.3	1474.3	23.0
	(2)		1484.3	13.0
6		1504.2	1487.5	16.7
7		1503.7	1486.6	17.1
8		-	-	15.1
9		-	-	32.8
10	(1)	1507.4	1481.1	26.3
	(2)		1494.6	12.8
11		1484.2	1474.0	10.2
12[2]		1484.8	1475.0	9.8
13	(1)	1502.9	1465.7	37.2
	(2)		1476.2	26.7
	(3)		1487.6	15.3
14	(1)	1506.0	1464.1	41.9
	(2)		1474.7	31.3
	(3)		1487.8	18.2
15	(1)	1502.5	1475.6	26.9
	(2)		1485.8	16.7
16[2]		1485.4	1474.4	11.0

[1] Elevation of absorption field infiltrative surface is 1502.7.

[2] Well abandoned.

the vertical permeability. The horizontal permeability is estimated to be 800 gpd/ft^2 and the vertical permeability to be 100 gpd/ft^2.

The wells are monitored frequently to obtain groundwater elevations and samples for water quality analyses. Groundwater elevations are measured prior to pumping the well to remove stagnant water in the well. Water samples are taken 12 to 24 hours later after the wells have recovered.

A chalked tape and hand bailer were used initially to measure water elevations and to pump the wells. These methods were found to be unsatisfactory because of possible well contamination from lowering the tape and bailer into the well. It also proved difficult in the winter. Therefore, a well head was designed so that compressed air could be used to measure water elevations by a bubble tube and to pump water for samples. The source of compressed air is a hand tire pump.

Using the observed groundwater elevations in each well prior to any wastewater loading, the initial direction at groundwater flow was determined (Figure 25). The groundwater movement in the vicinity of the absorption field is both downward and southeasterly towards Silver Creek. The gradient of the shallow water table is approximately 0.04 ft/ft below the absorption beds. However, a major component of groundwater movement is downward for nested wells near the beds (Wells, 2, 13 & 14) with an average gradient of -0.19 ft/ft, nearly ten times as great as the horizontal gradient.

Because of the high vertical hydraulic gradient and the relatively low wastewater application rate of 1.2 gpd/ft^2 at design capacity, discharges from the beds should not effect the local groundwater flow patterns significantly. Monitoring to date seems to confirm this (Figure 26). However, because of difficulties in developing a good water elevation measuring device, the data are insufficient to make a firm conclusion.

Groundwater samples are analyzed for ammonium, nitrite, nitrate, total phosphorus, chloride, calcium, magnesium, total solids, total coliform, fecal coliforms and fecal streptococcus. Sampling prior to wastewater loading on to the beds pumping the well to remove stagnant water in the well. Water samples are taken 12 to 24 hours later after the wells have recovered.

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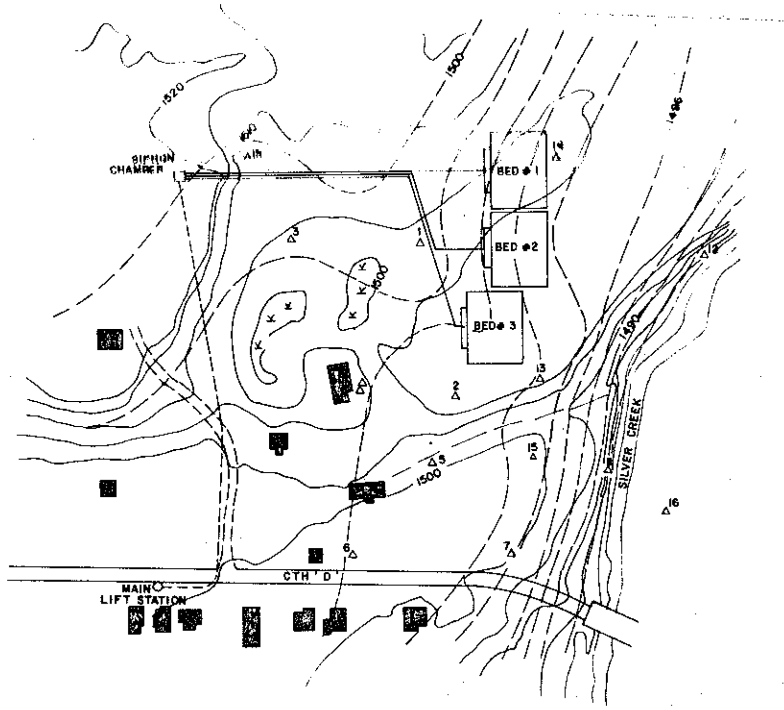

Figure 25. Groundwater Elevation Contours in the Vicinity of the Absorption Field Prior to Loading (June 1977)

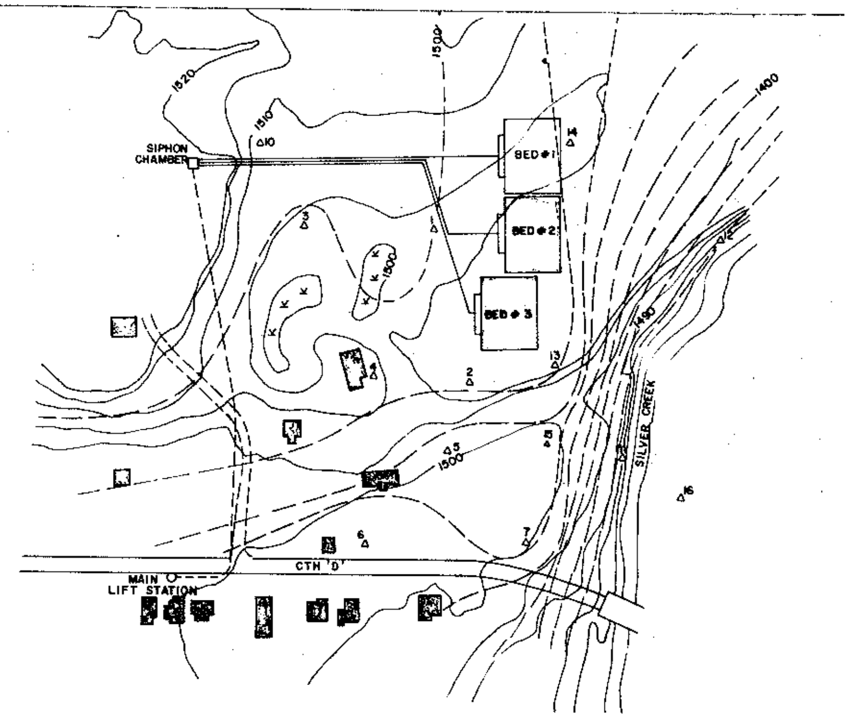

Figure 26. Groundwater Elevation Contours in the Vicinity of the Absorption Field While Loading the Two Southern Beds (November 1978)

indicated low levels of all analytes in most wells. Since the facility became fully operational, there have been no significant changes in any wells except for Well 13(3). This shallow well has increased its total nitrogen content from less than 0.5 mg/L-N to over 15 mg/L-N. Soon after the beds began receiving wastewater, the increase in nitrogen was in the form of nitrate but it has since changed to ammonium while the total nitrogen has remained unchanged. One reason the other wells have not increased in nitrogen concentrations is that the wells seem to be located such that they intercept little or no flow from the beds. Additional wells are being planned to more accurately locate the wastewater plume.

Stream Monitoring

Stream sampling was initiated in July, 1975. Sampling points were selected up stream of the absorption field and at each of the bridges through town. A gaging station was established at CTD D bridge just below the field to measure stream flow. Analyses include the same parameters as for the groundwater samples. The results of the sampling have shown no effects from the facility which would be expected because the wastewater volume is insignificant when compared to the stream flow.

SUMMARY

The alternate wastewater facility constructed in the community of Westboro has been a success. Though the residents were unable to afford conventional sewerage, the costs of constructing small diameter sewers and a common subsurface soil absorption field were within their financial capabilities. At least a 13-percent savings in construction costs and a 10-to 15-percent savings in operating costs over conventional gravity sewers and a stabilization pond facility were realized. These savings are not as great as hoped but operational experience gained thus far indicated low levels of all analytes in most wells. Since the facility became fully operational, there have been no significant changes in any wells except for Well 13(3). This shallow well has increased its total nitrogen content from less than 0.5 mg/L-N to over 15 mg/L-N. Soon after the beds began receiving wastewater, the increase in nitrogen was in the form of nitrate but it has since changed to ammonium while the total nitrogen has remained unchanged. One reason the other wells have not increased in nitrogen concentrations is that the wells seem to be located such that they intercept little or no flow from the beds. Additional wells are being planned to more accurately locate the wastewater plume.

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indicates that changes can be made in the design which would substantially increase the savings in future facilities of this type.

In addition to abating the water pollution and nuisance problems in Westboro, the new facility also has resulted in new growth within the community. Prior to the installation of the facility, economic development had been prevented because the soils are not suitable for individual septic tank systems. With no alternative but an expensive holding tank, property values were declining and vacant lots could not be developed. However, since construction of the facility, there have been several new homes built, a new post office constructed, a sporting goods store and barber shop opened in the business district, vacant homes reoccupied and parcels subdivided and offered for sale. In all, 13 additional connections have been made, 19-percent more than the 69 initially included. Within the next two years, as many as 10 more connections are anticipated. Also, an application has been made to the sanitary district to annex an area to the west to permit the development of a mobile home park.

While this project has been successful, there are several deterrents to widespread implementation of similar plans for other small communities. Biases of engineers, regulatory agencies and funding agencies favor central gravity sewers and treatment plants. One of the greatest deterrents is the lack of knowledge and experience with the design and performance of alternative technologies. The facility built at Westboro demonstrates only one alternative which is not a suitable facility for many areas. Communities with undulating topography will find small diameter gravity sewers as costly as conventional sewers and communities with poor soil will not be able to utilize soil absorption. Other technologies have been developed for such situations but they have not been demonstrated in the small community setting.

Other alternate facilities need to be constructed and carefully monitored to gain confidence to increase their acceptance by engineers and regulatory agencies.

Also, regulatory codes are often too restrictive to permit construction of less costly facilities. The codes are based on design criteria, materials and construction techniques which were developed for urban areas where conventional sewerage is used. Therefore, these favor conventional sewerage. The result is that engineers are more likely to design a conventional facility which would create fewer objections by the reviewing agency.

Another deterrent to acceptance of alternative facilities is the question of whether they would be eligible for federal or state construction grant programs. Certainly there is a bias toward conventional sewerage because of present component eligibility guidelines. Thus, while a conventional facility may be more costly than some other alternatives, the local share may be less because of components' eligibilities for grants. This bias is wasteful of tax dollars. Hopefully, the Clean Water Act of 1977(P.L. 95-217) will end this bias in the EPA construction grants program.

Additional demonstrations of alternative facilities in small communities are needed. Such demonstrations would not only demonstrate the range of technologies available and their performance characteristics, but would also help to develop a planning methodology which could be used by engineers to generate the most appropriate wastewater facility in a given community. If the goals of the Clean Water Act are to be reached, then more practical facilities planning must be encouraged.

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APPENDICES

APPENDIX A: Homeowner Questionnaire

REQUEST FOR INFORMATION ON WASTEWATER DISPOSAL SYSTEM

The following information is being requested for purposes of developing a wastewater facilities plan for your community. It is important that you answer the questions as accurately and completely as possible if the least costly wastewater facility is to be constructed. All information provided will be kept strictly confidential and none will be released for public review. Please return the completed questionnaire using the pre-addressed, stamped envelope.

Name ______________________________

Address ______________________________

1. Was your building constructed prior to October 18, 1972? ________
   Prior to December 27, 1977? ________

2. How many people live in your household? ________

3. How many bedrooms in your house? ________

4. Does your house have a basement? ________ Basement drain? ________

5. Do you have a garbage grinder? ________ Clothes washer? ________

6. What is the approximate size of your lot?

   ________ less than 2500 sq. ft.
   ________ 2500-5000 sq. ft.
   ________ 5000-10,000 sq. ft.
   ________ 10,000-15,000 sq. ft.
   ________ 15,000-20,000 sq. ft.
   ________ 20,000-30,000 sq. ft.
   ________ 30,000-40,000 sq. ft.
   ________ over 40,000 sq. ft.

7. Is your house used on a year-round or seasonal basis?
   year-round ________ seasonal ________

8. What type of water supply do you have?
   municipal supply ________ private well ________

9. If you have a well, please provide the following information.
   Do you share the well with other homes? ________ How many? ________
   What type of well is it?
   drilled ________ driven ________ dug ________
   How deep it it? ________ How deep is the well casing? ________

Is it a flowing well? _______ If not, what is the depth to water? _______

What is its distance from your septic tank? _______; absorption area? ______

Has it ever been tested? _______ What was the result? ______________

10. What type of wastewater disposal system do you have?

septic tank/soil absorption field _______; septic tank seepage pit _______

cesspool _______; drain to surface water or drainage ditch _______;

holding tank _______; other (describe): ___________________________________

11. When was the system installed? _______________

12. What water sources are connected to your disposal system?

	Yes	No	Do not know
Toilet	________	________	________
Kitchen	________	________	________
Laundry	________	________	________
Bathing	________	________	________
Water Softener	________	________	________
Roof Drain	________	________	________
Foundation Drain or Basement Sump	________	________	________

13. If any of the above wastes are not discharged into your disposal system, where are they discharged? ____

14. Have you had any problems with your wastewater disposal system?

Yes ________ No ________

If you answered "no," please skip to question 19.

15. If you answered "yes" to question "14," please check the type of problem that best describes your problem (check more than one if necessary).

Slow drainage in sink or other water using appliance ________

Drains or toilet occasionally back up ________

Odors outside ________

Liquid is visible on the ground surface ________

Other ____

Is it a flowing well? _______ If not, what is the depth to water? _______

What is its distance from your septic tank? _______; absorption area? _______

Has it ever been tested? _______ What was the result? _______________

10. What type of wastewater disposal system do you have?

septic tank/soil absorption field _______; septic tank seepage pit _______

cesspool _______; drain to surface water or drainage ditch _______;

holding tank _______; other (describe): _______________________________

11. When was the system installed? _______________

12. What water sources are connected to your disposal system?

	Yes	No	Do not know
Toilet	________	________	________
Kitchen	________	________	________
Laundry	________	________	________
Bathing	________	________	________
Water Softener	________	________	________
Roof Drain	________	________	________
Foundation Drain or Basement Sump	________	________	________

13. If any of the above wastes are not discharged into your disposal system, where are they discharged? _______________________________

14. Have you had any problems with your wastewater disposal system?

Yes ________ No ________

If you answered "no," please skip to question 19.

15. If you answered "yes" to question "14," please check the type of problem that best describes your problem (check more than one if necessary).

Slow drainage in sink or other water using appliance ________

Drains or toilet occasionally back up ________

Odors outside ________

Liquid is visible on the ground surface ________

Other ____

16. How often do you have problems with your system?

5 to 10 times per year ________ 1 to 5 times per year ________

less than once a year ________

17. When do you generally have problems? (check more than once if appropriate)

spring ________ summer ________ fall ________ winter ________

after periods of frequent or heavy rainfall ________

18. If you still have a problem, how are you coping with it?

pumping ________ how often? weekly ________ monthly ________ quarterly ________

reducing water use ________ how? ____

repairing system ________ how? ____

other ________ describe ____

19. If you have ever repaired your system, please answer the following:

when was it last done? ____

what was done? ____

20. Have you repaired your system more than once?

yes ________ no ________ if yes, how many and when ______________________

____

21. If you have not recently had a problem, how often do you have your system pumped?

once a year ________ once every three years ________

once every two years ________ never ________

other ________

22. If you have a holding tank, how often is it pumped? ________

How much does it cost per pumped? ________

23. Do any of your neighbors have problems with their wastewater disposal system?

yes ________ no ________

if yes, what type of problem is it?

odors ________ frequent pumping ________ liquid visible on ground surface ________ other (describe): ______________________

____

APPENDIX B: Sample Easement for Access to Septic Tanks

EASEMENT

KNOW ALL MEN BY THESE PRESENTS:

That in consideration of One Dollar ($1.00) and other good and valuable consideration paid to (name), hereinafter referred to as GRANTOR, by Sanitary District No. 1 of the Town of Westboro, hereinafter referred to as GRANTEE, the receipt of which is hereby acknowledged, the GRANTORS do hereby grant, bargain, sell, transfer and convey unto the GRANTEE, its successor and assigns, a perpetual easement to erect, construct, install, lay, use, operate, inspect, clean, repair, maintain, replace and remove - septic tanks, - pumps, - discharge pipes over and across and through the land of the GRANTORS situated in Taylor County, State of Wisconsin, said land being described as follows:

(plat description)

together with the right of ingress and egress over the adjacent lands of the GRANTORS, their successors and assigns, for the purposes of this easement.

APPENDIX C: Itemized Construction Costs

CONVENTIONAL GRAVITY SEWERS

			Unit Price	Extension
1.	5630 L.F.	8" Sewer (5'-7')	$ 6.50	$ 36,595.00
2.	2280 L.F.	8" Sewer (7'-9')	7.50	17,100.00
3.	180 L.F.	8" Sewer (9'-11')	10.50	1,890.00
4.	90 L.F.	8" Sewer (11'-13')	14.00	1,260.00
5.	76 each	4" x 8" Wyes	30.00	2,280.00
*6.	6077 L.F.	4" Service lines	5.00	30,385.00
*7.	70 each	Pump septics	40.00	2,800.00
*8.	70 each	Abandon septics	50.00	3,500.00
9.	21 each	Manholes (5'-7')	400.00	8,400.00
10.	12 each	Manholes (7'-9')	450.00	5,400.00
11.	1 each	Boring and jacking under RR	1	3,720.00
12.	570 L.F.	4" Force main (9')	4.85	2,764.50
13.	1 each	Lift station	15,000.00	15,000.00
14.	499 '	Pavement sawing	1.00	499.00
15.	2281'	6" Base course	2.00	4,562.00
16.	2281'	2" Bituminous pavement patch	6.00	13,686.00
17.	6593'	8" Base cover	1.50	9,889.50
18.	12440 TF	Topsoil and seed	1.00	12,440.00
19.	1 each	30 KW generator	7,350.00	7,350.00
20.	1294 ft^2	Replace sidewall	1.00	1,294.00
21.	1 each	Jack hammer Front St. Crossing	500.00	500.00
			TOTAL	$181,314.50

* Hookup $\frac{36,685}{76}$ 482.70 each

GRANT ELIGIBLE 144,630.00

STABILIZATION POND

			Unit Price	Extension
1.	1 each	Siphon inlet structure	$ 1,500.00	$ 1,500.00
2.	419 L.F.	6" C.I. inverted siphon	75.00	31,425.00
3.	2,083 L.F.	10" sewer (5'-7')	13.00	27,079.00
4.	8 each	Manholes (5'-7')	400.00	3,200.00
5.	1200 yd^3	Fill material over 10" sewer	1.50	3,125.00
6.	1 each	Pond and appurtances	101,530.50	101,530.50
7.	960 L.F.	Pond effluent ditch	5.00	4,800.00
8.	1 each	Access road	2.00	1,500.00
			TOTAL	$174,159.00

STABILIZATION POND

			Unit Price	Extension
1.	1 each	Siphon inlet structure	$ 1,500.00	$ 1,500.00
2.	419 L.F.	6" C.I. inverted siphon	75.00	31,425.00
3.	2,083 L.F.	10" sewer (5'-7')	13.00	27,079.00
4.	8 each	Manholes (5'-7')	400.00	3,200.00
5.	1200 yd^3	Fill material over 10" sewer	1.50	3,125.00
6.	1 each	Pond and appurtances	101,530.50	101,530.50
7.	960 L.F.	Pond effluent ditch	5.00	4,800.00
8.	1 each	Access road	2.00	1,500.00
			TOTAL	$174,159.00

SMALL DIAMETER GRAVITY SEWERS

				Unit Price	Extension
1.	952	L.F.	8" Sewer (7'-9')	$ 7.50	$ 7,140.00
2.	10,403	L.F.	4" Sewer (5'-7')	5.00	52,015.00
3.	3,825	L.F.	4" Sewer (7'-9')	6.00	22,950.00
4.	250	L.F.	4" Sewer (9'-11')	9.00	2,250.00
5.	70	each	Pump septics	40.00	2,800.00
6.	57	each	Abandon septics	50.00	2,850.00
7.	62	1000 gal	Septic tanks	327.00	20,274.00
8.	13	1200 gal	Septic tanks	427.00	5,551.00
9.	14	each	Residential lift stations	1,097.00	15,358.00
10.	3	each	Additional residential pumps	180.00	540.00
11.	16	each	Manholes (5'-7')	400.00	6,400.00
12.	11	each	Manholes (7'-9')	450.00	4,950.00
13.	1	each	Boring and jacking under RR	3,720.00	3,720.00
14.	2	each	Lift station	15,000.00	30.000.00
15.	783'	L.F.	3" Force main (5'-7')	3.85	3,015.00
16.	2410	L.F.	3" Force main (7'-9')	4.85	11,689.00
17.	750	L.F.	2" Force main (9')	4.75	3,563.00
18.	1144	L.F.	1 1/2" Force main (5'-7')	3.60	4,118.00
19.	622	L.F.	1 1/2" Force main (9')	4.60	2,861.00
20.	499	L.F.	Pavement sawing	1.00	499.00
21.	2281	L.F.	6" Base course	2.00	4,567.00
22.	2281	L.F.	2" Bit. pavement patch	6.00	13,686.00
23.	6593	L.F.	8" Base course	1.50	9,890.00
24.	40	yd^2	Gravel bases	5.00	200.00
25.	12,780	T.F.	Topsoil and seed	1.00	12,780.00
26.	1294	S.F.	Replace sidewalk	1.00	1,294.00
27.	3 1/2	F	Septic tank extensions	67.00	175.00
28.	1	each	Jackhammer route change	5.00	500.00
				TOTAL	$245,635.00

SOIL ABSORPTION FIELD

			Unit Price	Extension
1.	1 each	Siphon chamber	$11,605.00	$11,605.00
2.	40 yd	Gravel base		205.00
3.	1825 L.F.	12" Drainfield piping (3'-5')	8.95	16,334.00
4.	645 L.F.	8" Drainfield piping (3'-5')	7.00	4,515.00
5.	268 L.F.	6" Drainfield piping (3'-5')	6.75	1,809.00
6.	72 L.F.	4" Drainfield piping (3'-5')	5.50	396.00
7.	6402 L.F.	4" Perforated drainfield piping (3'05')	2.50	16,005.00
8.	4320 yd^2	17" No. 2 stone	7.00	30,240.00
9.	4320 yd^2	Back fill beds	1.50	6,480.00
10.	1 each	Excavation of unsuitable material	2,615.00	2,615.00
11.	3 each	Drain valves in manifolds	190.00	570.00
			TOTAL	$90,774.00

SOIL ABSORPTION FIELD

			Unit Price	Extension
1.	1 each	Siphon chamber	$11,605.00	$11,605.00
2.	40 yd	Gravel base		205.00
3.	1825 L.F.	12" Drainfield piping (3'-5')	8.95	16,334.00
4.	645 L.F.	8" Drainfield piping (3'-5')	7.00	4,515.00
5.	268 L.F.	6" Drainfield piping (3'-5')	6.75	1,809.00
6.	72 L.F.	4" Drainfield piping (3'-5')	5.50	396.00
7.	6402 L.F.	4" Perforated drainfield piping (3'05')	2.50	16,005.00
8.	4320 yd^2	17" No. 2 stone	7.00	30,240.00
9.	4320 yd^2	Back fill beds	1.50	6,480.00
10.	1 each	Excavation of unsuitable material	2,615.00	2,615.00
11.	3 each	Drain valves in manifolds	190.00	570.00
			TOTAL	$90,774.00