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Septage Disposal Alternatives in Rural Areas

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Septage Disposal Alternatives in Rural Areas[1,2]

D. V. BROWN and R. K. WHITE[3]

INTRODUCTION

Until recently, little attention has been given to the disposal of septage. Septage refers to the settled solids, scum, and liquids pumped from septic tanks and usually includes the wastes from other on-site treatment units. These tanks are called "sewage tanks". A low priority is typically given to septage management due to the general unawareness that the disposal practices being used in many communities adversely affect the quality of the environment and are potential health hazards.

It is recommended that sewage tanks be pumped every 3 to 5 years. Figure 1 shows the hauler scraping the bottom of a septic tank while pumping to insure complete removal of septage. The effectiveness of a sewage tank will be reduced when the accumulation of solids and scum occupies an increasingly larger volume of the tank. The reduced detention period of the tank will allow solids to be discharged to the soil absorption (leaching) system. These solids can clog the soil absorption system, causing the water to back up in the home or to come to the surface and flow into a stream.

CURRENT SITUATION

An enormous amount of septage, 4.5 billion gallons, must be handled and disposed of each year in the United States. According to the 1970 census, 16.6 million housing units rely on some form of on-site wastewater treatment. This is more than 24.5% of the total population of the United States.

Many areas in the United States do not have regulations pertaining specifically to septage disposal. Many rural areas lack a septage disposal plan. A large number of local sewage treatment plants cannot accommodate septage. The responsibility for septage disposal is then left to the haulers. Sometimes the haulers will discharge septage into a roadside ditch or stream.

Septage is composed partly of soluble and particulate organic matter and other material which resists microbial decay. The properties of septage are highly variable and are dependent on family size and habits, how often the tank is pumped, and the type of disposal system. Some average values of the characteristics of septage are listed in Table 1. The heavy metal concentration of septage is normally very low.

Septage disposal regulations have been established mainly in states with areas that have a concentration of septic tanks. Connecticut, Massachusetts, Vermont, Florida, Pennsylvania, Illinois, Michigan, and Wisconsin advocate or require the disposal of septage into sewage treatment plants. Vermont, Florida, and Massachusetts prohibit the disposal of septage in a sanitary landfill. New Jersey requires all septic tank wastes to be discharged in a sanitary

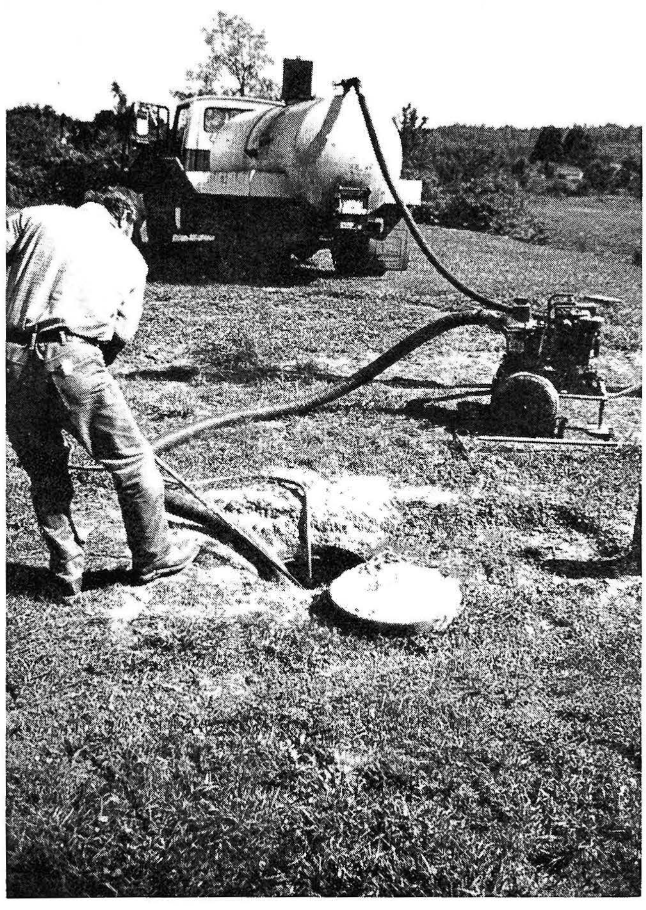

FIG. 1.—Pumping a septic tank.

[1]This report summarizes a project supported by Title V Research Funds of the U. S. Dept. of Agriculture, pursuant to the Rural Development Act of 1972 as part of the GROW effort in Southeast Ohio, administered by the Ohio Agricultural Research and Development Center, Wooster, Ohio.

[2]Based on a summary of a thesis submitted by David Victor Brown in partial fulfillment of the requirements for the M. S. degree, The Ohio State University, 1977. Title of the thesis was: Feasibility Study for Septage Disposal in Jackson and Vinton Counties.

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TABLE 1.—Average Values of Septage Characteristics.

Parameter	Concentration
Total Solids (TS)	4.0 %
Total Volatile Solids (TVS)	2.6 %
Total Suspended Solids (TSS)	1.5 %
Volatile Suspended Solids (VSS)	1.8 %
Biochemical Oxygen Demand (BOD)	5,000 mg/1
Chemical Oxygen Demand (COD)	45,000 mg/1
Total Kjeldahl Nitrogen (TKN)	600 mg/1
Ammonia Nitrogen (NH_3 - N)	150 mg/1
Nitrate/Nitrate Nitrogen (NO_2/NO_3)	3.9 mg/1
Total Phosphorus (P)	150 mg/1

Source: Kreissel, J. F. 1976. Septage Analysis. National Environmental Research Center, USEPA, Cincinnati, Ohio.

landfill. Wisconsin requires septage to be disposed in a sanitary landfill licensed to handle septage when disposal in a sewage treatment plant is not possible. The disposal of septage in a properly operated sanitary landfill is permitted in Illinois. Maine has set guidelines for land disposal of septage. Many states, including Ohio, prohibit certain types of septage disposal but do not prescribe acceptable disposal methods.

DISPOSAL ALTERNATIVES

The general categories of septage disposal are: 1) land disposal, 2) biological and physical treatment, 3) chemical treatment, and 4) treatment in a sewage treatment plant.

Land Disposal

The two basic types of land disposal are: 1) methods which optimize nutrient recovery such as application of septage to cropland and pastures, and 2) methods of land application in which there is no concern for the recovery of nutrients in septage. Landfills and trenches are disposal alternatives that do not involve nutrient recovery and are not generally recommended.

Septage can be considered a form of fertilizer because of its nutrient value when applied to the soil. Nitrogen, phosphorus, and micronutrients are contained in septage. The septage application rate is usually dependent upon the amount of nitrogen available to the crop. Septage is primarily from an anaerobic environment and has a relatively high proportion of ammonia-N. It is low in nitrites and nitrates. Most of the ammonia will be rapidly converted to nitrate in the soil and will be available to plants the first year.

The nitrogen application should not exceed the crop requirements because excess nitrogen in the nitrate form will leach downward through the soil into the ground water. The average nitrogen concentration of 600 mg/1 is equivalent to 5 lb of nitrogen per 1,000 gallons of septage. Nitrogen loss due to storage, hauling, and application should be taken into consideration. Surface application will allow the ammonia-N to be lost.

The major concern when septage is applied to the land is the possible contamination of water with pathogens. This problem exists because of the uncertainty of the die-off rate of human pathogens on or in the soils. This potential problem is associated mostly with surface spreading of septage because of the chance of direct contact with the pathogens that can be transported by animals or by surface runoff waters.

The die-off of pathogens in septage which is surface spread is quicker than that of pathogens in septage injected into the soil. If septage is applied in a thin layer on the soil surface, there will be more than 99% die-off of pathogens after a few days of direct sunlight. Septage incorporated into the top 3 inches of the soil will generally have a 99% die-off of all pathogens within 1 month.

The surface spreading of septage should occur only in isolated locations due to potential fly and odor problems. However, both problems can be minimized by applying the septage in a thin, uniform layer, or by soil incorporation.

Septage should not be applied to land:

- Used for vegetable crops
- Frozen, snow covered, saturated, or located within a flood plain
- Located near dwellings, wells, springs, streams, bodies of water, or land adjacent to bodies of water where there is a chance of pollution due to runoff
- Steeper than 8%
- Sandy (due to pathogen transmission to ground water).

The advantages of direct cropland application of septage are: the recycling of nitrogen and phosphorus; the low technology, maintenance, and cost of the system; and the hostile environment which the sun and soil create for pathogens and parasites.

The major problem with direct septage disposal on land is that the material cannot be safely applied to certain types of soil conditions. Saturated soils generally restrict field access with disposal equipment. In addition to getting equipment stuck, soils are compacted and ruts are formed. Septage runoff is a problem if the waste is applied to frozen soils or steep slopes. Low temperatures and saturated soil moisture conditions will lengthen the die-off period of pathogens.

Septage has been disposed of by filling a trench and allowing as much water as possible to be removed by evaporation and percolation. The trench is then covered with soil and the site abandoned. Septage taken to a sanitary landfill is mixed with solid waste which is being landfilled. The poor dewatering properties of septage pose a problem for the disposal of this material in trenches and sanitary landfills.

Biological and Physical Treatment

Septage may be treated biologically in anaerobic lagoons, aerobic lagoons, or digesters. Some advantages of aerobic treatment are that it reduces the offensive odor of the septage, produces a sludge with good dewatering characteristics, and produces a supernatant with a lower Biochemical Oxygen Demand (BOD) than anaerobic supernatants. The major disadvantage of aerobic treatment compared to anaerobic treatment is the higher operation and maintenance cost. Advantages of anaerobic treatment systems are that the waste undergoes stabilization of organic solids and they have relatively low operating and maintenance costs. A disadvantage of anaerobic treatment is the high BOD_5 of the effluent and the potential for odor nuisance.

Species of salmonella are found in anaerobic and aerobic lagoons containing waste material. There is usually more than 99% reduction of salmonella after 20 days in anaerobic or aerobic lagoons.

Chemical Treatment

Treatment of septage involving the addition of a chemical is used to improve the dewaterability, reduce the odor, or kill the pathogens. Chemical treatment processes include addition of coagulants, rapid chemical oxidation, or lime stabilization.

Chemical coagulants such as ferric chloride, alum, or polyelectroytes are added to septage for the purpose of improving the dewatering characteristics of septage. Coagulant addition takes place in a rapid mix tank. The coagulant reacts with water molecules in the flocculator to form polymers. These polymers trap suspended solids and the mass precipitates out in the settling tank.

A process utilizing rapid chemical oxidation by chlorine addition to stabilize organic compounds and control the odor of the material is available. Septage is pretreated, equalized and oxidized with chlorine, then mechanically dewatered or lagooned to separate liquid and solids. This treatment produces a highly acidic material which needs chemical addition to raise the final pH.

Lime stabilization of septage involves the addition of a lime slurry to raise the pH of the material. At a pH between 10.5 and 11.5, 99% of the fecal coliform bacteria are killed upon contact and fecal streptococci are reduced 99% after 5 days at an initial pH of 11.5.

Some advantages of chemical treatment of septage are:

- A good reduction of the pollutant concentration can be achieved.
- The dewaterability of septage is improved so the waste can be dewatered on sand beds.
- There is effective control of the pathogenic organisms.

Disadvantages of chemical treatment of septage are:

- High costs are usually associated with chemical treatment and in many instances these alternatives are only feasible where relatively large quantities of septage are produced.
- Large quantities of chemicals are needed.
- A relatively high level of technology is needed.

Sewage Treatment Plant

A properly operated sewage treatment plant (STP) can be an adequate treatment system for septage. Both the activated sludge or the trickling filter type sewage treatment plants are used to treat septage.

Septage is discharged into the liquid stream or sludge stream of a sewage treatment plant. If septage is handled as a slurry, the possible addition points at a STP are the upstream sewer, the bar screen, the grit chamber, the primary settling tank, or the aeration tank. Discharge into the upstream sewer has the problem of trash settling out in the sewer, particularly at periods of low flow. Also, there is no way to prevent toxic material from being discharged into the sewer.

The septage addition points in the sludge handling processes are the aerobic or anaerobic digester, the sludge conditioning process, or the sand drying beds. It is recommended that septage undergo screening, degritting, and equalization when added to a STP. Septage added to a STP at 2% or less of the total flow will have little impact on the treatment processes.

Advantages of treating septage in a sewage treatment plant are:

- Septage is diluted with sewage and easily treated.
- Few aesthetic problems are associated with this type of septage handling.
- Skilled personnel are present at the site.

Some disadvantages of septage disposal in a STP are:

- A shock effect can occur in the unit processes of the STP if septage is not properly metered into the sewage flow.

- The waste should undergo separation, degritting, and equalization before treatment, hence requiring additional equipment and facilities.
- Possible high cost to haulers for dumping septage.

A CASE STUDY

What then is the best septage disposal alternative for a particular rural area? A concerted effort was made to answer this question for a two-county area in southern Ohio (Fig. 2). Jackson and Vinton County Health Department officials, faced with the problem of finding a safe disposal method, sought the assistance of the Ohio Cooperative Extension Service. An ad hoc committee consisting of local and state health departments, Environmental Protection Agency, Extension personnel, OARDC researchers, and others was formed to find the answer.

The populations of Jackson and Vinton counties are 28,700 and 10,700, respectively, according to a 1974 census. Approximately 16,500 people (57%) in Jackson County and 9,160 people (86%) in Vinton County are served by on-site sewage disposal systems. The problem is not likely to improve, as both counties have experienced population increases since 1970.

The quantity of septage for these two counties that should be disposed each year is given in Table 2. These values were determined by estimating the quantity of waste from each type of disposal system which haulers pump. The quantity of waste from on-site systems was obtained by estimating the number of homes with on-site treatment systems in the two counties. An average tank size of 800 gallons was assumed, with each tank pumped every 4 years.

At the time of the study, there were six licensed haulers in each county. Four of the haulers were licensed in both counties, resulting in eight different haulers operating in the two-county area. The truck capacities of the haulers ranged from 1,000 to 1,500 gallons. Based on the number of loads that each

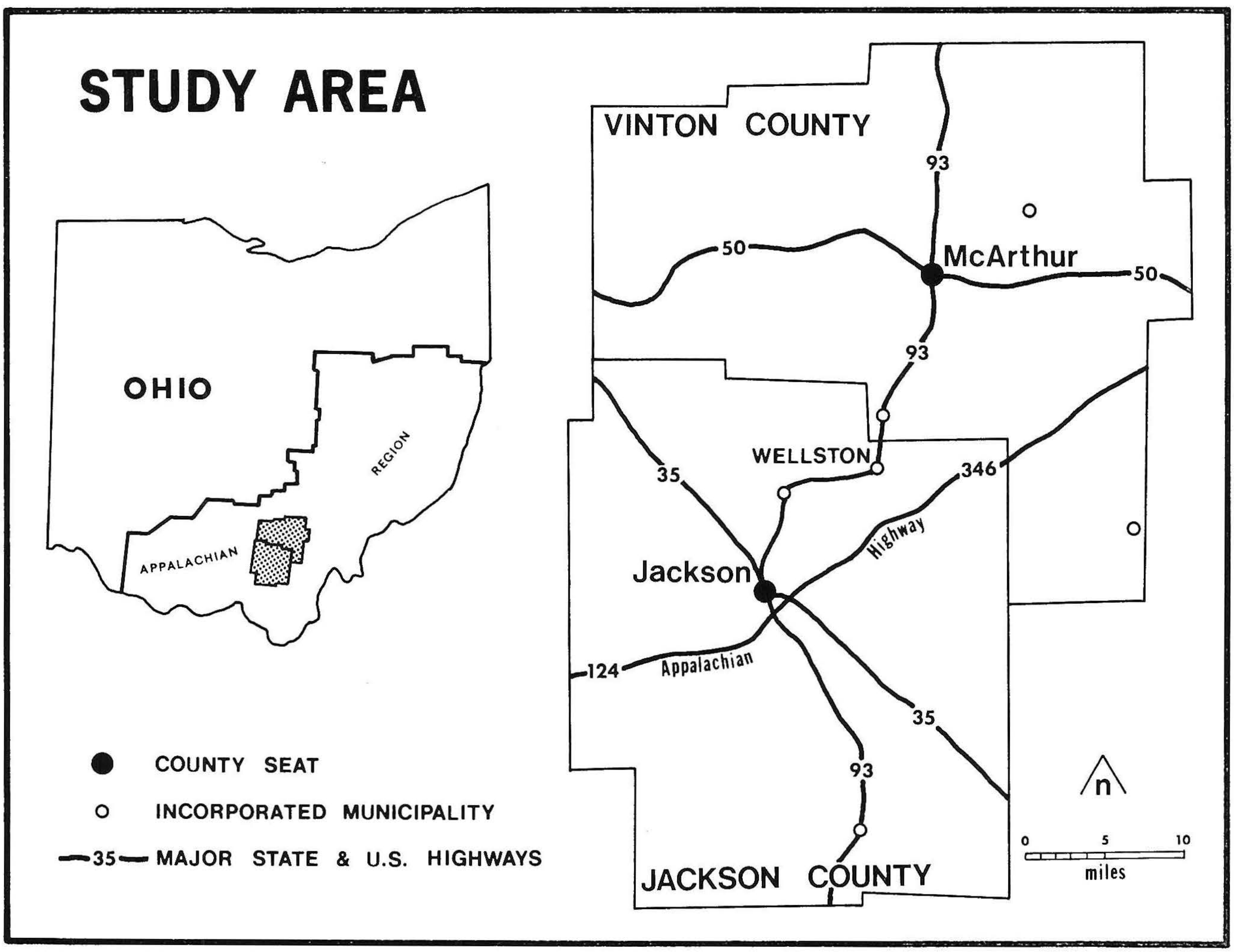

FIG. 2.—Ohio's Jackson and Vinton counties—the study area.

TABLE 2.—Estimated Quantity of Waste to be Pumped in Jackson and Vinton Counties Annually.

Source	Jackson (gal)	Vinton (gal)	Total (gal)
On-site Systems	1,120,000	582,000	1,702,000
Package Plants	286,000	133,000	419,000
State Parks	10,000	856,000	866,000
Roadside Rests	24,000	6,000	30,000
City Parks and Campgrounds	9,000	10,000	19,000
Portable Privies	2,000	1,000	3,000
		TOTAL	3,039,000

hauler reported he pumped annually, there were only about 1 million gallons of septage pumped each year. This amount is much less than the estimated quantity of 3 million gallons in Table 2. Most homeowners do not have their septic tanks pumped every 4 years.

Seven of the haulers dispose the septage on the land. The other hauler is permitted to discharge in the Wellston sewage treatment plant because he does some pumping for the city at no charge.

Generally, the soil material in Jackson and Vinton counties includes alluvial and terrace soils developed from glacial outwash material from northern and western Ohio. The soil texture is a silt loam surface to a depth of 10 to 12 inches. Finer material such as silt clay loam extends below the silt loam.

Disposal Alternatives for Jackson and Vinton Counties

Septage disposal alternatives considered feasible for Jackson and Vinton counties were evaluated on the basis of need, pathogen and parasite control, water pollution control, odor potential, social acceptance, state and local regulations, and cost. The drop charge should cover the capital, operating, and maintenance costs. Also, since haulers in Jackson and Vinton counties are only collecting about 1 million gallons of septage annually, a disposal system to treat this relatively small quantity of waste must have low capital, operating, and maintenance costs if it is going to be economically feasible.

Three septage disposal alternatives were selected to be feasible for the Jackson-Vinton area. These alternatives are: 1) three storage basins in parallel with land spreading of dried sludge, 2) lime stabilization prior to land application, and 3) discharge into a sewage treatment plant.

Parallel Storage Basins

Septage from trucks would enter the holding basin by gravity flow through a bar screen and pipe extending from the receiving tank to the interior portion of the holding basin. A sluice gate would cover each pipe and only the pipe that empties into the basin currently being filled would be open. The other two sluice gates would be closed and locked. The system is designed to have one basin in the filling stage, another basin in the resting stage, and the third basin in the drying stage to allow for a continuously operating system. Figure 3 shows the parallel storage basin system.

The three parallel storage basins system would function as follows. During a certain year, all septage would go into one basin. The second year this waste would be in a resting state where it would undergo some biological decomposition and physical settling of solids. The purpose of the 1-year resting period is to allow separation of liquid and solids and to eliminate pathogenic organisms. In the third year, the supernatant would be decanted from the basin in the spring and discharged into a grassed infiltration area. The remaining sludge would be allowed to dry. In the fall of the third year, the sludge would then be surface spread on cropland, pasture, or incorporated into surface-mined soils. The basin would then be ready for re-use.

The usable volume of each holding basin is designed at 470,000 cu ft, with 1 foot freeboard. The basins are designed to hold the 2-year net rainfall (annual precipitation minus evaporation). The bottoms of the holding basins must be constructed to prevent infiltration.

The treatment site would be fenced and have a key card controlled entry. Each registered hauler would have a card permitting access to the treatment site so he could dump the waste at his convenience. The key card control system would keep a record of time of entry and identify haulers. This is necessary since oils, industrial, or toxic wastes would not be accepted at the treatment site. If unauthorized wastes are discharged, the supervisor can check the entry records to identify the offender.

A major advantage of this system is the simplicity of technology involved. No energy input is required for the treatment process. One man is needed to periodically check the operation of the system, the records, and do routine maintenance.

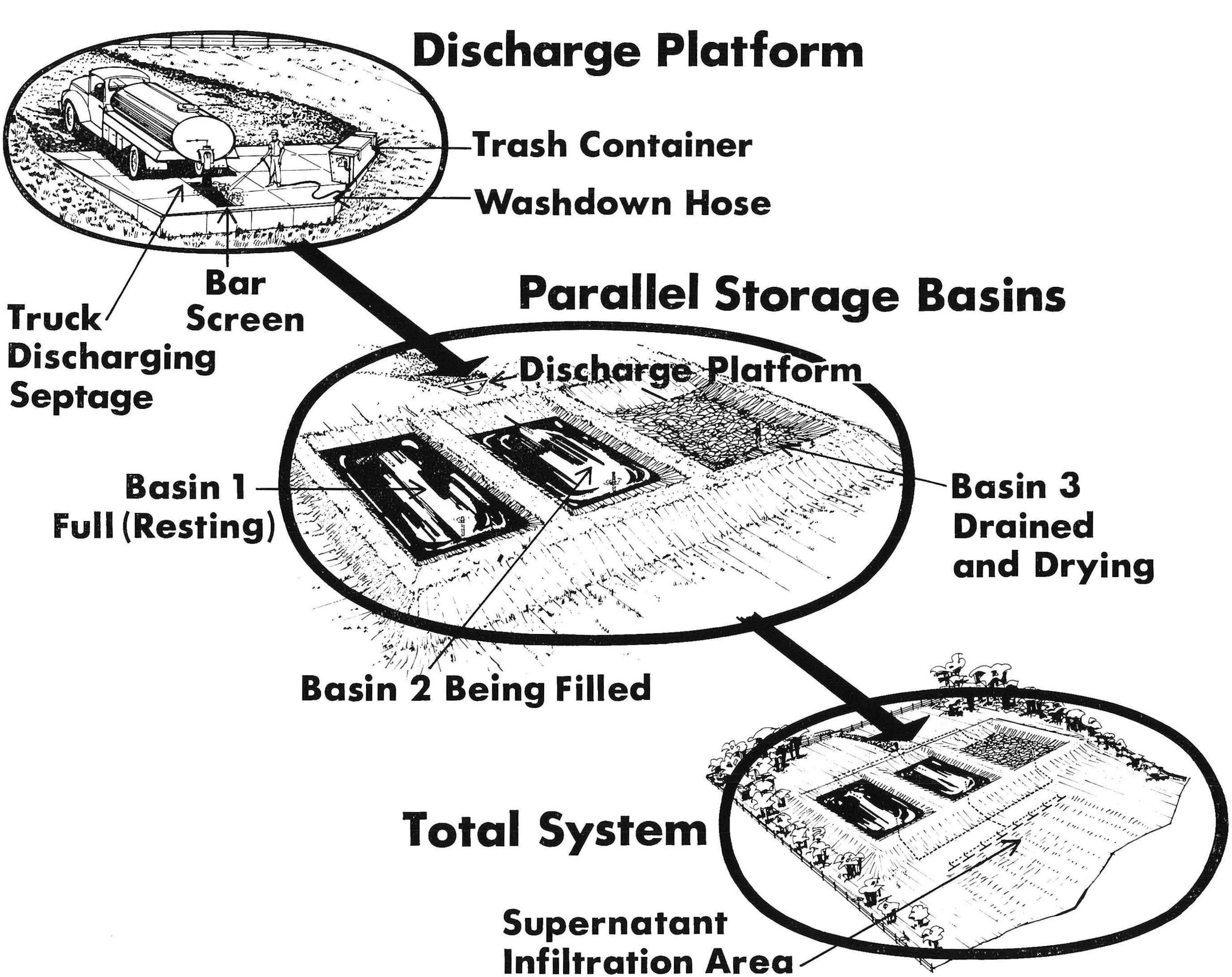

FIG. 3.—Parallel storage basin system for handling septage.

TABLE 3.—Annual Costs of the Parallel Storage Basins Alternative.

Quantity of Waste Collected Million gal/yr.	Annual Costs Fixed ($)	Variable ($)	Total ($)	Cost/Load ($/1,000 gal)
1.0	6,200	3,900	10,100	10.15
1.5	6,200	5,400	11,600	7.75
2.0	6,200	7,000	13,200	6.50
2.5	6,200	8,400	14,600	5.80

The estimated costs of the parallel storage basin alternative appear in Table 3. Costs are calculated for four different annual quantities of waste ranging from what is presently being pumped to what would be pumped if the septic tanks were pumped every 4 years. The fixed annual costs are independent of the quantity of waste that would be handled and the variable annual costs are dependent on volume. The fixed annual costs include earth moving, grading of the infiltration channel, receiving tank and screen, dumpster, fence, controlled access equipment, water supply, concrete apron, access road, and land. The variable costs include labor, trash disposal, sludge removal, and spreading.

Lime Stabilization

A second feasible alternative for Jackson and Vinton counties is chemical treatment of septage by lime addition, with land disposal of the treated waste.

The operation would include a receiving tank and concrete apron identical to those used for the parallel storage basins. The waste would flow by gravity from the receiving tank to a storage basin where it would be agitated and pumped into a mixer tank. The purpose of the mixer tank is to bring lime into contact with the waste. Lime from a storage building would be mixed with water in a slurry tank. The slurry (25% by weight) would be metered into the mixer tank where air pumped through diffusers in the bottom of the tank would mix the septage and lime slurry. When the desired pH was reached, the material would be pumped into a tank truck which would surface spread the waste onto the land.

One 60,000 cu ft earthen storage basin would be needed, assuming 6 months of storage during the winter months when land application is not possible. The size of the storage basin is based on the quantity of waste that would be pumped if septic tanks were pumped every 4 years. All surface runoff would be diverted from the holding basin. Other components of this system include a fresh water well, lime storage building, and a key card controlled entry.

Labor costs are based on one man at the site during lime treating operations, with one part-time helper.

Lime addition to septage reduces the odor of the material to be land spread, improving the social acceptability of this alternative. Soils in the Jackson-Vinton area are generally lime deficient, so farmers would likely be more willing to accept the material. There is a significant portion of unreclaimed strip-mine land in the two counties and lime-treated septage could be used to raise the pH of the soils so vegetation would grow.

The annual fixed and variable costs for this system are shown in Table 4. Annual fixed costs include receiving tank, bar screen, storage basin construction, lime storage building, slurry tank and mixer, diffuser air system, mixer tank, dumpster, well, controlled access equipment, and land. Variable costs include labor, trash disposal, treated waste disposal, lime, and electricity.

Discharge into a Sewage Treatment Plant

The cities of Jackson and Wellston have sewage treatment plants which could be possible alternatives for receiving septage. The Jackson sewage treatment plant would require considerable upgrading before septage could be handled. Also, Jackson is located too far from Vinton County to be convenient for

TABLE 4.—Annual Costs for the Lime Stabilization Alternative.

Quantity of Waste Collected Million gal/yr.	Annual Costs Fixed ($)	Variable ($)	Total ($)	Cost/Load ($/1,000 gal)
1.0	3,800	13,200	17,000	17.80
1.5	3,800	18,800	22,600	15.00
2.0	3,800	24,500	28,300	14.16
2.5	3,800	26,400	30,200	12.10

TABLE 5.—Annual Costs for Septage Disposal in a Sewage Treatment Plant.

Quantity of Waste Collected Million gal/yr.	Annual Costs			
	Fixed ($)	Variable ($)	Total ($)	Cost/Load ($/1,000 gal)
1.0	1,000	13,100	14,100	14.14
1.5	1,000	19,400	20,500	13.70
2.0	1,000	25,800	26,800	13.40
2.5	1,000	32,100	33,100	13.25

haulers to travel from Vinton County to use the facility. Therefore, the Jackson sewage treatment plant is not considered a feasible septage disposal alternative.

Wellston has two wastewater treatment plants. The North plant serves Wellston and the South plant serves Banquet Foods. The Ohio Environmental Protection Agency reports that neither plant meets its present effluent limitations. The Ohio EPA reported that it could approve the disposal of septage in the South plant after necessary repairs are made. Wellston has received a grant for the Step I plan of study of its sewage disposal system. A Step II grant application is to be filed which will determine if one plant will be reconstructed or if both plants should be abandoned and a new facility constructed. However, there will be a minimum of 5 years before a new facility will be serving Wellston. Figure 4 shows the current method of discharging septage into the North STP at Wellston.

Assuming that a new plant is built, or the South plant receives the necessary repairs and is permitted to accept septage, this disposal alternative would consist of septage being discharged into the grit chamber of the STP. The hauler would discharge septage into a receiving tank covered with a bar screen. Water would be available for washing down any spillage and for clean-up. From the receiving tank, septage would be metered into the grit chamber of the sewage treatment plant.

The receiving tank would have a 20,000 gallon capacity. A key card controlled access is included in this cost analysis. Septage disposal at the STP may only be permitted when an operator is on hand to

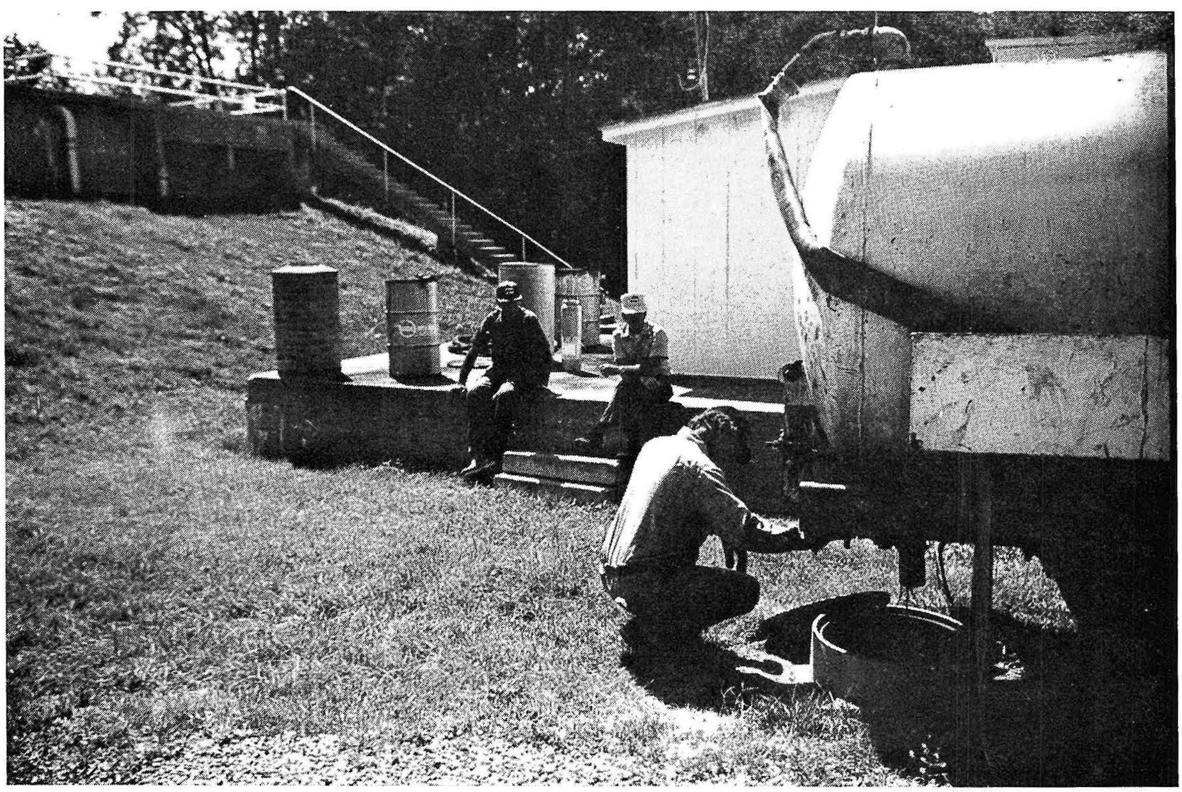

FIG. 4.—Discharging septage into the North Sewage Treatment Plant at Wellston, Ohio.

make sure that no toxic material is added into the system.

The costs of this system appear in Table 5 for four different quantities of septage. The fixed annual costs include the receiving tank, bar screen, metering pump and controls, dumpster, and receiving station. The principal variable cost is a charge by the STP for treating the septage. A septage treatment cost of $76 per dry ton of septage solids is used, based on an estimate of the cost to treat sludge in a 2.0 MGD sewage treatment plant.

SUMMARY

The objective of this study was to evaluate the feasibility of alternative methods of septage disposal in rural areas, considering engineering, environmental, economic, social, and regulatory factors. The parallel storage basins, lime stabilization, and discharge into a sewage treatment plant alternatives were all considered feasible for areas producing a relatively small quantity of septage annually.

Environmental pollution control was considered in each of the three alternatives. Pathogens are virtually eliminated by each alternative, which also reduces many of the problems associated with land disposal of septage. The final material from the parallel storage basins and lime stabilization alternatives would be applied only to land in which there is no problem of runoff and water contamination.

The parallel storage basins have the least amount of technology and management requirements of the three alternatives considered for Jackson and Vinton counties. No moving parts or energy are necessary for the operation of the system. This system involves a lower level of management than the lime stabilization alternative. Disposal of waste into a sewage treatment plant would require no additional management input.

The parallel storage basins have the lowest annual costs ($10.15 to $5.80 per 1,000 gallons) for four annual quantities of septage (Table 3). The cost of a septage disposal system is a determining factor in the feasibility of the system. Haulers would be reluctant to pay a dump charge unless all haulers in the area were required to use the disposal system. Haulers have indicated that a fee of $5 to $10 would then be equitable. An increase in the cost to clean a septic tank may discourage more frequent pumping.

The discharge into a sewage treatment plant alternative does not have the problem of the selection of a treatment site that exists with the other two alternatives. Also, no additional land is required if septage is added to a sewage treatment plant. A potential odor problem exists with the parallel storage basins and lime stabilization alternatives that does not exist with the sewage treatment plant.

Each of the three alternatives involves controlled entry to the treatment facility. Haulers registered in one or both counties would be given a key card permitting access to the treatment facility. Registered haulers would be required to use the disposal system and unregistered septic tank pumpers would not be allowed to operate in Jackson or Vinton counties.

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