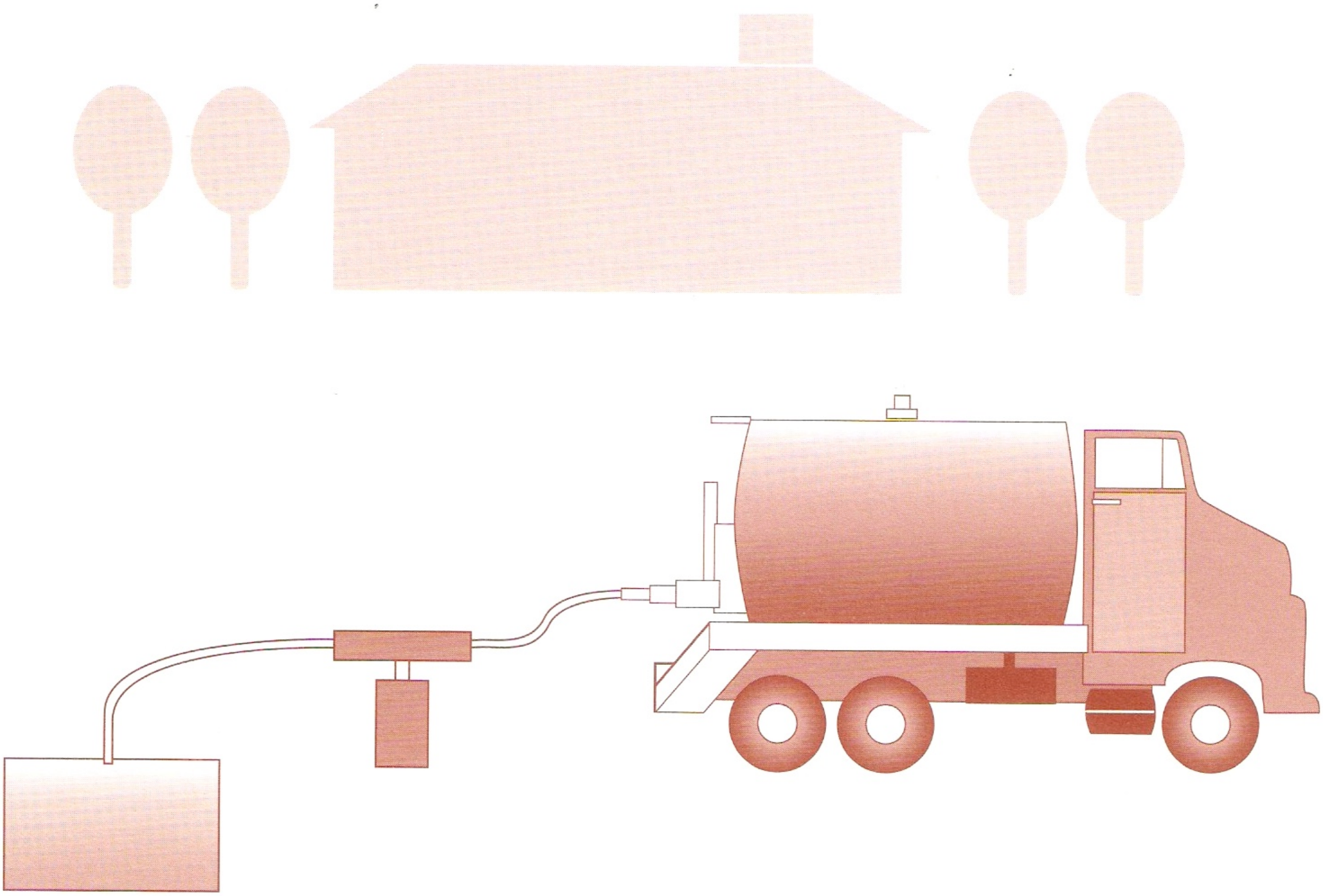
Bulletin 854

Septage Management in Ohio



THE OHIO STATE UNIVERSITY EXTENSION

Septage Management in Ohio

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Introduction

In Ohio, 980,000 households dispose of their wastewater in septic systems. Periodic pumping of septic tanks is essential to the long-term operation of septic systems. The material pumped out of the tank is called septage. What happens to the septage after it is removed is often a mystery to the homeowner.

Septage disposal has varied across the nation and even across Ohio. With new regulations (40CFR503) adopted in 1993 by the U.S. Environmental Protection Agency, more uniform requirements for septage management are being adopted nationwide.

In Ohio, approximately 100 million gallons of septage are pumped each year. While not the largest waste disposal concern for the state, septage disposal affects people in every county. Because of the unlikelihood of sewer lines and treatment plants being constructed to serve every Ohio residence, management of septage will continue to be a concern for many years to come.

Safe, practical, and acceptable use and disposal of septage is the goal in septage management. This bulletin guides pumpers and regulatory officials in developing a local septage management program.

What Is Septage?

Septage is the liquid and solid material periodically removed from a septic tank, cesspool, or portable toilet. Septage is similar to other wastes, such as sewage sludge and swine manure (Table 1). Septage is from 96 percent to 99 percent water and low in heavy metals, nitrogen, and phosphorus.

Specific characteristics of septage should be considered when handling, treating, and disposing of it to avoid nuisance and public health violations. Untreated septage has an offensive odor. Septage usually contains higher levels of grit and grease than sludge or livestock manure. When agitated, septage tends to foam and is difficult to dewater. Disease-causing organisms in untreated septage are also an important concern.

Materials pumped from commercial and industrial wastewater treatment systems are not considered septage. Restaurant grease traps; dump stations at campgrounds, RV parks, and marinas; or wastes from industrial facilities should not be mixed with septage.

Does Septage Have Value?

The organic matter in septage makes it valuable as a soil conditioner. Some nutrients found in septage may be used as crop fertilizer. The nutrient content of the septage should be considered when developing an overall nutrient management plan.

To minimize the aspects of septage that are a nuisance, it is often incorporated into the soil. Lime may also be added to septage to reduce odors. Both tilling the soil and adding lime to septage may benefit crop production.

How Can Septage Be Used Safely?

Several successful approaches use septage safely. Careful land application and incorporation into soil on a non-public access site maximizes the value of septage while minimizing the odors and the exposure of humans to disease-causing organisms.

Adjusting septage pH is another way to reduce or eliminate odors and disease-causing organisms before land application.

Table 1. Characteristics of septage, sewage sludge, and swine manure

	Waste characteristics (mg/l)		
	Septage	**Sewage sludge**	**Swine manure**
Total suspended solids	15,000	30,000	12,950
Volatile suspended solids	10,000	23,100	10,000
BOD_5	7,000	18,500	3,700
Total nitrogen	700	750	613
Total phosphorus	250	480	212
Grease	8,000	–	–
pH	6	–	–
	Metal content mg/kg (dry basis)		
Arsenic	4	10	–
Cadmium	3	7	0.002
Chromium	14	120	–
Copper	140	740	0.11
Lead	35	130	0.007
Mercury	0.15	5	–
Molybdenum	–	4	0.002
Nickel	15	43	–
Selenium	2	5	–
Zinc	290	1,200	0.45

Source: ASAE Standards. D384.1 and U.S. EPA Domestic Septage Regulatory Guidance.

PART I
Land Application of Septage

Careful land application of septage follows four general guidelines:
1) Reduce odors and fly attraction.
2) Reduce human contact with disease-causing organisms.
3) Protect ground and surface water.
4) Maximize absorption of plant nutrients.

1) Reducing Odors and Fly Attraction

Reducing odors and fly attraction is an important consideration in land application of septage. Odors, which are emitted from septage when it is agitated and exposed to the air, are carried from the application site by the wind. Flies and other vectors (insects that carry disease-producing organisms to noninfected hosts) are attracted to moist puddles of waste on the ground surface.

Rapid incorporation of raw septage into the soil reduces odors and vector attraction. Immediate incorporation through subsurface injection keeps the septage from being agitated or exposed to the air.

If septage is applied to land in a remote area, where odors are not a concern, surface application may be an alternative. If untreated septage is sprayed onto the ground surface, however, it needs to be incorporated into the soil within six hours to avoid attracting flies and other vectors.

pH-treatment of septage before land application is another way to reduce odors and vector attraction. In areas where odors are a concern and/ or incorporation into the soil is not practical, pH-treatment of septage before application is an option. Adding an alkaline material to the septage raises the pH. Alkaline materials commonly used to raise the pH of septage are hydrated lime (calcium hydroxide) and quicklime (calcium oxide). To achieve the benefits of raising the pH, the septage must reach a *pH of 12 or greater and remain above pH 12 for at least 30 minutes*. This can be accomplished by adding from 20 to 40 pounds of lime per 1,000 gallons of septage. The amount of lime required to raise the pH depends on the solids content of the septage. The higher the solids content, the more lime needed. *Do not substitute ground agricultural limestone for hydrated lime or quicklime.*

To ensure that the pH has risen to 12 or greater for at least 30 minutes, monitor it. pH meters suitable for field use are available for $50 to $150. pH paper can also be used to measure the pH. A 50-foot roll costs less than $10.

Do not raise the pH too high. Because wastes with a high pH are considered hazardous, using too much lime is both costly and inefficent. Be careful not to raise the pH of the septage above 12.5.

Quicklime is more reactive than hydrated lime. Because heat is

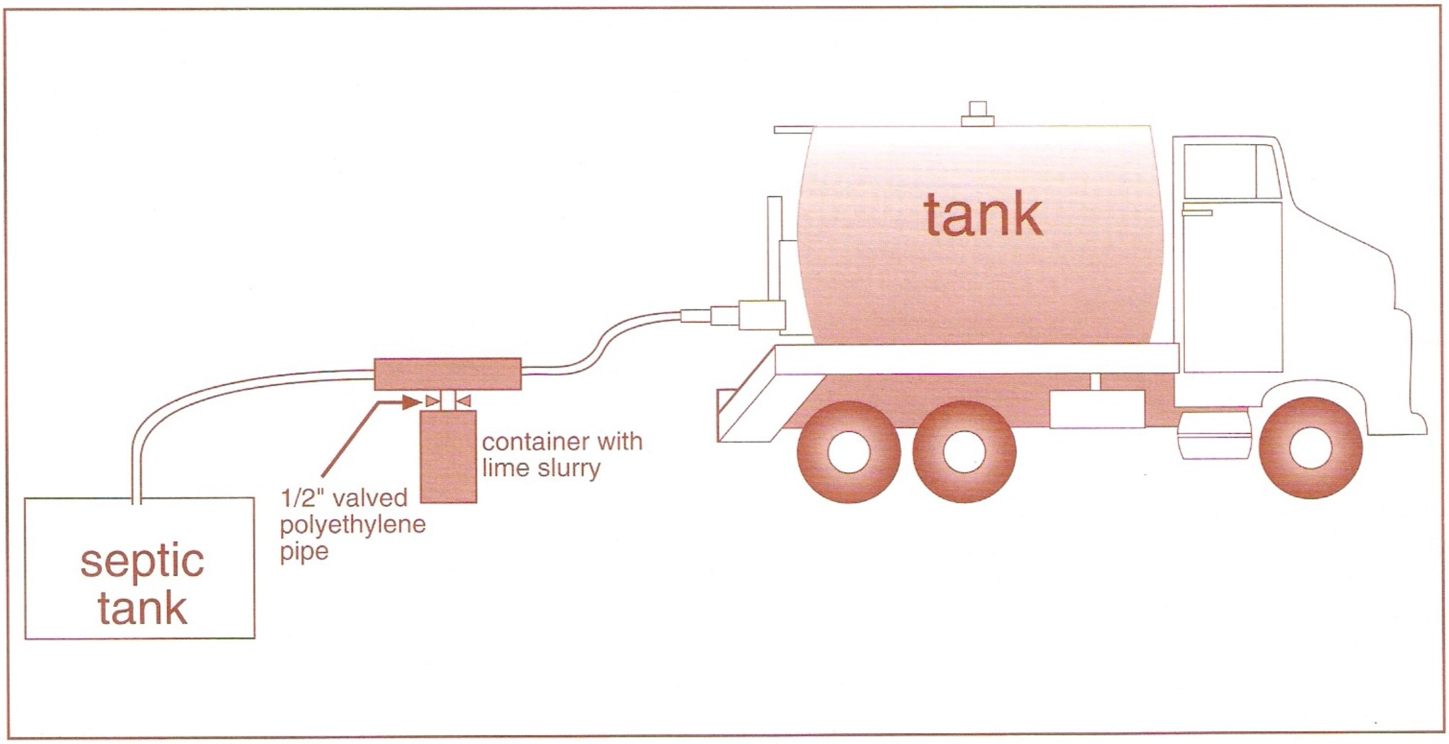

Figure 1. Simple system for adding lime slurry to septage as it is being pumped from a septic tank

released when water is added to quicklime, the following safety precautions must be taken when using quicklime:

- Avoid contact with skin or eyes to avoid severe burns.
- Keep bags of quicklime dry. A wet bag can start a fire.
- Do not put water on a fire involving quicklime. The water will react with the quicklime and cause it to release more heat.

The following safety equipment should be used when handling quicklime:

- Safety goggles
- Half-mask respirator with cartridge
- Shoulder-length, fully coated neoprene gloves
- Emergency eyewash, in case lime gets on the face or in the eyes
- Carbon dioxide fire extinguisher, in the event of a fire

Successful techniques for adding lime to septage include:

- Adding dry lime to the septage in the truck;
- Adding lime slurry to the septage in the truck;
- Adding lime at a septage holding facility.

The simplest method of adding lime to septage is to pour 20 to 40 pounds of lime per 1,000 gallons of septage directly into the pumper truck tank *before filling it with septage*. As the septage is pumped in, it will mix with the lime and raise the pH. The septage must remain in the truck for at least 30 minutes before it is applied to a field. One limitation to this method is that dry lime may clump in the bottom of the truck and mix poorly into the septage.

Lime may also be drawn into the truck through the vacuum hose. This method, however, has many limitations. For example, dry lime may work its way into the pump, or the lime may react with moisture in the hose and cause heat damage.

Adding a lime slurry to the septage in the truck involves advance preparation. In a plastic drum or tank, mix 13 gallons of water with 50 pounds of hydrated lime–an electric paddle mixer works well for this. The result will be a thick lime slurry, with 5 gallons of slurry equal to 20 to 30 pounds of dry lime. Pour five gallons of lime slurry into the pumper truck tank for every 1,000 gallons of septage pumped.

The lime slurry may also be drawn into the tank with the septage through the vacuum line. The line must first be modified with a "T" fitting, as shown in Figure 1. Insert the "T" fitting into the vacuum hose and attach it to a valved, 1/2-inch-diameter polyethylene pipe. As the septage is pumped into the tank, place the small valved pipe into a bucket or container with 5 gallons of lime slurry for each 1,000 gallons of septage. When you open the valve, the lime slurry will be slowly drawn into the vacuum line and mix with the incoming septage.

When field conditions make immediate land application of septage difficult, treat septage with lime at the storage site. Position a receiving tank, large enough to hold an entire truckload, in the unloading area. As the septage is unloaded into the receiving tank, pour dry or slurried lime into the tank. After 30 minutes, discharge the septage into a septage storage basin.

When using this technique, two things happen. First, because ammonia is released quickly from the septage, the receiving tank area must be well ventilated. Second, the septage solids will begin to settle out. An agitator may be needed in the receiving tank to resuspend the solids. The settling of solids will continue to occur in the septage

Table 2. Recommended waiting time for crop harvest and public access after land application of septage

Crop	Waiting time raw septage	Waiting time pH-treated septage
Animal feed	30 days	30 days
Pasture	30 days	0 days
Fiber crop	30 days	30 days
Food crop that does not touch ground (example: corn)	30 days	30 days
Food crop that touches ground (example: melons)	14 months	14 months
Food crop that grows below ground (example: potatoes)	38 months	20 months (if *not* incorporated within 4 months) 38 months (if incorporated within 4 months)
Public access–high	1 year	1 year
Public access–low	30 days	0 days

Source: Domestic Septage Regulatory Guidance. EPA/832/B-92/005.

storage basin requiring agitation before pump-out.

2) Reducing Human Contact With Disease-causing Organisms

Limiting public access to a site is one way to reduce the chance of people coming into contact with the disease-causing organisms in septage. Another way is to *allow sufficient waiting time* for the disease-causing organisms to die in the soil or be washed off food crops. The recommended number of days or months between septage application and crop harvest are listed in Table 2.

3) Protecting Ground and Surface Water

Avoiding water pollution from septage is not difficult—using common sense is the best rule of thumb. Ammonia, organic matter, nutrients, bacteria, and color from septage may contaminate water supplies. The problems caused when septage accidentally enters a stream are described in Box 1.

Maintain an adequate separation distance and buffer area between the land used for septage application and surface water drainage. A vegetated buffer strip at least 33 feet (10 meters) wide is needed along all streams and ditches. Septage should not be applied within 50 feet of a well.

Restrict application of septage on frozen ground. Hard, frozen ground makes incorporation of untreated septage impossible. Even if septage is treated with lime, application on frozen ground increases the likelihood of septage running off before it has a chance to soak into the soil.

Limit septage application on extremely wet soils. Applying septage to soils already saturated with water can result in contaminated runoff or drainage. Check soil moisture before applying septage and adjust application rates to wet soils to avoid runoff. Before applying septage to a field with artificial subsurface drainage or in an area prone to runoff, check the soil moisture conditions using the procedure described in Box 2.

Apply septage carefully to fields with subsurface drainage, espe-

Box 1

Avoiding Stream Pollution

Although the ammonia in septage is a valuable fertilizer, it is also a water pollutant. Ammonia is toxic to fish and, if conditions are right, the effects are recognizable within a few minutes. Even a small amount of ammonia released to a stream may cause a fish kill.

The toxicity of ammonia to fish depends on three factors: pH, oxygen content, and water temperature. The higher the pH of the water, the smaller the amount of ammonia needed to kill fish. The lower the dissolved oxygen content of the water, the smaller the amount of ammonia needed to kill fish. The higher the temperature of the water, the smaller the amount of ammonia needed to kill fish. Because temperature fluctuates with the seasons, the amount of ammonia discharged to a stream in the winter may not kill fish, but the same amount discharged in the summer would.

Organic matter in septage is also considered a water pollutant. When organic matter decomposes, oxygen in the water is consumed, leaving less available for fish and other aquatic life.

The rate at which a stream can recover from a discharge of organic matter depends on its volume, flow rate, turbulence, and water temperature. Larger streams can accept more organic matter without adverse affects than smaller streams. Rapidly flowing, turbulent streams can recover more quickly from a discharge of organic matter because reaeration occurs as the water moves downstream. Cold water can hold more oxygen than warm water, leaving more oxygen available for decomposition. Also, decomposition of organic matter occurs more slowly at colder temperatures. The worst possible situation is discharge of organic matter into a small, slowly moving stream on a hot day.

Nutrients in septage, such as nitrogen and phosphorus, stimulate plant growth both on land and in water. The major impact, however, occurs when the nutrients reach a stagnant part of a stream, lake, or pond. Eutrophic lakes (lakes rich in nutrients) are green with algae and aquatic plants.

Bacteria in septage can spread disease to people through a contaminated water supply. Diseases are often transmitted through the fecal-to-oral route. Disease-causing organisms may be present in the waste of an infected person. If the organism is passed to others through contaminated water, they are exposed and risk being infected. Fortunately, disease-causing organisms do not thrive in surface or ground water and eventually die. It is, therefore, important to maintain adequate separation distances between potential pollutants and water sources. This provides an opportunity for disease-causing organisms to be filtered or die before they reach drinking water supplies.

Color is a property of septage that is not often considered. Water stained by septage appears black. The color itself may not pose a water quality problem, but may alarm people using the water for recreation or as a water supply.

Box 2

Checking Soil Moisture to Determine Application Rates for Wet Soils

Limit one-time septage application to the water-holding capacity in the top 24 inches of the soil profile. The moisture capacity of different soils is listed in the *Ohio Irrigation Guide* available from the Natural Resources Conservation Service. Estimate the available soil moisture by the feel and appearance of the soil as listed in Table 3 .

Example

A Kokomo soil (medium soil) has a moisture capacity of 4.5 inches in the top 24 inches of the soil profile. In checking the field condition of the soil prior to applying septage, you learn that this soil ribbons out easily and has a slick feel. Table 3 indicates that soil moisture is about 75 percent of field capacity. Available holding capacity is therefore 25 percent of 4.5 inches, or 1.1 inches of available moisture storage. The maximum amount of liquid septage that may safely be applied at one time is 1.1 inches. Applications greater than that amount are subject to pooling, runoff, or seepage into the drainage system.

Table 3. Practical interpretation chart of soil moisture for various soil textures and conditions*

Available soil moisture	Coarse fine sand loamy fine sand	Moderately coarse sandy loam fine sandy loam	Medium sandy clay loam loam, silt loam	Fine clay loam silty clay loam
0–25%	Dry, loose, will hold together if not disturbed, loose sand grains on finger.	Dry, forms a very weak ball,[1] aggregated soil grains break away easily from ball.	Dry, soil aggregations break away easily, no moisture staining on fingers, clods crumble with applied pressure.	Dry, soil aggregations easily separate, clods are hard to crumble with applied pressure.
25–50%	Slightly moist, forms a very weak ball with well defined finger marks, light coating of loose and aggregated sand grains remain on fingers.	Slightly moist, forms a weak ball with defined finger marks, darkened color, no water staining on fingers.	Slightly moist, forms a weak ball with rough surfaces, no water staining on fingers few aggregated soil grains break away.	Slightly moist, forms a weak ball, very few soil aggregation break away, no water stains clods flatten with applied pressure.
50–75%	Moist, forms a weak ball, loose and aggregated sand grains remain on fingers, darkened color, heavy water staining on fingers, will not ribbon.[2]	Moist, forms a ball with defined finger marks, very light soil-water staining on fingers, darkened color, will not slick.	Moist, forms a ball, very light water staining on fingers, darkened color, pliable, forms a weak ribbon between thumb and forefinger.	Moist, forms a smooth ball with defined finger marks, light soil water staining on fingers, ribbons between thumb and forefinger.
75–100%	Wet, forms a weak ball, loose and aggregated sand grains remains on fingers, darkened color, heavy water staining on fingers, will not ribbon.	Wet, forms a ball with wet outline left on hand, light to medium water staining on fingers, makes a weak ribbon between thumb and forefinger.	Wet, forms a ball with well defined finger marks, light to heavy soil water coating on fingers, ribbons between thumb and forefinger.	Wet, forms a ball uneven medium to heavy soil water coating on fingers ribbons easily between thumb and forefinger.
Field Capacity (100%)	Wet, forms a weak ball, light to heavy soil-water coating on fingers, wet outline of soft ball remains on hand.	Wet, forms a soft ball, free water appears briefly on soil surface after squeezing or shaking, medium to heavy soil water coating on fingers.	Wet, forms a soft ball, free water appears briefly on soil surface after squeezing or shaking, medium to heavy soil water coating on fingers.	Wet, forms a soft ball, free water appears on soil surface after squeezing or shaking, thick soil water coating on fingers, slick and sticky.

** From the USDA—Natural Resources Conservation Service, National Irrigation Guide. Part 652.*

[1] Ball is formed by squeezing a handful of soil very firmly with one hand.

[2] Ribbon is formed when the soil is squeezed out of the hand between thumb and forefinger.

cially when the soil is dry and cracked. Septage can follow cracks in the soil and move quickly through drainage pipes to ditches or streams. If deep cracks are visible, till the soil before applying septage. All "blow holes" in the drainage system must be repaired prior to application. Surface inlets and french drains must be avoided.

Limit application of septage nutrients to meet crop needs. Excess application of septage results in the buildup of soil nutrients. Excess application of phosphorus or nitrogen increases the chance for nutrients to be carried into streams with surface runoff. Excess applications of nitrogen increase the possibility of nitrate leaching into groundwater.

4) Maximizing Plant Nutrients

For maximum use of nutrients, match septage application to crop needs. Use the following guidelines to achieve maximum nutrient use with minimal environmental hazard:

1) Test soil to establish existing fertility levels.
2) Establish nutrient content of septage. Typical nutrient content is listed in Table 1.
3) Select an application rate that does not exceed crop nutrient requirements.
4) Calibrate equipment to obtain desired application rate. Rain gages or straight-sided cans and containers placed in the field before application work well to measure the depth of liquid applied. Table 4 lists the gallons per acre for different liquid depths.
5) Incorporate raw septage to reduce nitrogen losses.

Services for soil testing, septage testing, and calculation of application rates are provided through the Ohio State University Research-Extension Analytical Laboratory (REAL) at the Wooster campus. Calculations to determine application rate require a soil sample, a waste sample, and crop

Table 4. Liquid depth to gal/acre conversions (use to calibrate liquid application equipment and determine application rates)

Inches applied	Gallons/acre
1/8	3,394
1/4	6,789
3/8	10,183
1/2	13,577
5/8	16,971
3/4	20,366
7/8	23,760
1	27,154
1 1/8	30,548
1 1/4	33,943
1 3/8	37,337
1 1/2	40,731
1 5/8	44,125
1 3/4	47,520
1 7/8	50,914
2	54,308
2 1/8	57,702
2 1/4	61,097
2 3/8	64,491
2 1/2	67,885
2 5/8	71,279
2 3/4	74,674
2 7/8	78,068
3	81,462

Table 5 . Example of annual nitrogen application(expressed as lb N/acre/year) recommended for corn

	Yield goal (Bu/acre)		
	120	150	180
Previous crop	Annual application (lb N/acre)		
Forage legume	60	110	150
Grass crop	65	170	200
Soybeans	85	190	200
Continuous corn or other crops	115	200	200

Source: Ohio Agronomy Guide, Bulletin 472, Ohio State University Extension.

information. REAL testing forms are available at county Extension offices. A computer program available from Ohio State University Extension can also assist in selecting appropriate application rates. ECP 102, *Crop Nutrient Management,* is available from your local county Extension office.

Nitrogen (N) is required for crop growth, but nitrogen applied in excess runs off into surface water or leaches into groundwater. The amount of nitrogen from septage, fertilizer, manure, and other sources should be matched to the needs of the crop. The nitrogen needs of specific crops are listed in the *Ohio Agronomy Guide,* Bulletin 472, available from your local county Extension Office. An example of the nitrogen recommendations for corn are listed in Table 5.

Estimate the annual application rate of septage based on the nitrogen needs of the crop using Formula 1.

All of the nitrogen and about one-third of the organic nitrogen in septage is available to crops during the year of application. The remaining two-thirds of the organic nitrogen, or residual organic nitrogen, becomes part of the soil organic matter. The organic forms of nitrogen found in septage, manure, and sludge will mineralize at a rate of about 5 percent per year for several years, making it available to crops. If a field receives septage, sludge, or manure every year, you should account for this slowly released nitrogen when calculating application rates. Box 3 describes how to account for residual nitrogen.

Formula 1

$$\text{Annual application rate (gallons/acre/year)} = \frac{\text{Nitrogen required for crop yield (pounds N/acre)}}{0.0026}$$

Box 3

Accounting for Residual Organic Nitrogen

Septage contains an estimated 700 mg/l total nitrogen where 80 percent (560 mg/l) is organic nitrogen and 20 percent (140 mg/l) is ammonia. In the first year of application all of the ammonia and 33 percent of the organic nitrogen are available for crop growth (140 mg/l + 0.33 * 560 mg/l = 325 mg/l available nitrogen). In the second year, 5 percent of the remaining nitrogen (Table 6) is available ((700 - 325) * 0.05 = 20 mg/l available nitrogen). A small amount of residual nitrogen will be available in the third year ((700 - 325 - 20) * 0.047 = 17 mg/l). 1000 mg/l is equal to 0.0085 lb /gallon.

Table 6 . Percent of residual organic nitrogen made available from organic materials applied in previous years

Years after application	Percent of residual nitrogen available
1	5.0
2	4.7
3	4.5
4	4.3
5	4.1
6	3.9
7	3.7
8	3.6
9	3.4
10	3.2

Source: Ohio Livestock Manure and Wastewater Management Guide, Bulletin 604, Ohio State University Extension.

Phosphorus (P) is also required for crop growth, but phosphorus applied in excess accumulates in the soil. The amount of phosphorus applied should match the needs of the crop. The phosphorus needs of specific crops are listed in the *Ohio Agronomy Guide,* Bulletin 472, available from your county Extension office. Examples of the annual phosphorus removal rates for corn, wheat, and oats are listed in Table 7.

Agronomic crops grown in Ohio rarely respond to applications of additional phosphorus when soil-test levels exceed 60 pound of phosphorus per acre. Crops grown in soils with high phosphorus levels may actually produce a lower yield because of nutrient imbalances. Therefore, septage should not be applied to a field with high phosphorus soil-test level (measured as Bray P_1). Test the top 8 inches of soil when determining phosphorus levels. If septage is applied to fields with soil test level above 60 pounds per acre, follow the precautions described in Box 4.

The annual application rate for septage based on the phosphorus needs of the crop can be calculated using Formula 2.

Consider the following guidelines when determining how much septage should be applied to meet the nutrient needs of the crop.

- Because excess nitrogen easily runs off or leaches, do not exceed the nitrogen needs of the crop.
- Do not exceed the phosphorus needs of the crop if soil tests reveal P levels in excess of 60 pounds per acre (measured as Bray P_1).

Table 7. Examples of phosphorus (expressed as lb P_2O_5/acre/year) crop removal rate for corn, wheat, and oats

	Yield goal (Bu/acre)								
Crop	**50**	**70**	**90**	**100**	**120**	**130**	**150**	**160**	**180**
	Crop removal (lb P_20_5/acre/year)								
Corn					45		60		70
Wheat		35	45	60					
Oats				35		45		60	

Source: Ohio Agronomy Guide, Bulletin 272, Ohio State University Extension.

Formula 2

$$\text{Annual application rate (gallons/acre/year)} = \text{Phosphorus required for crop yield (pounds } P_2O_5\text{/acre)} \times 103$$

Box 4

Precautions for Septage Application on Fields with Phosphorus Levels in Excess of 60 Pounds P per Acre

Always test soils to determine phosphorus levels. If phosphorus levels exceed 300 pounds per acre in the top 8 inches of soil, do not apply septage. If a test reveals a phosphorus level greater than 60 pounds, but less than 300 pounds, per acre (measured as Bray P_1) in the top 8 inches of soil, the following special precautions must be taken when applying septage:

1) No additional commercial phosphorus fertilizer should be used.
2) Crops should be monitored for nutrient deficiencies using plant-tissue analysis. Increasing soil-test phosphorus and potassium levels above recommended levels increases the probability of yield-reducing nutrient imbalances.
3) Control erosion and minimize runoff.
4) Septage should be applied in quantities such that the long-term phosphorus level at the soil surface does not increase appreciably. This can be accomplished by observing one of the following guidelines:
   a. Ensure that applications supply no more nitrogen or phosphorus (whichever is lower) than will be removed by the next crop in one season. This amount can be calculated with the following formulas.

$$\text{Annual application rate (gallons/acre/year)} = \text{Phosphorus required for crop yield (pounds } P_2O_5\text{/acre)} \times 103$$

$$\text{Annual application rate (gallons/acre/year)} = \frac{\text{Nitrogen required for crop yield (pounds N/acre)}}{0.0026}$$

   b. Incorporate septage below the depth of tillage, generally deeper than 8 inches, using rates great enough to satisfy nitrogen requirements for a succeeding grass crop. If more than 250 pounds of P_2O_5 per acre are applied, soil at the depth of application should not be brought to the surface for three years unless low-runoff conditions are maintained. Moldboard plows should be set to two-thirds the depth of incorporation during this three-year period, and noninvasive tillage tools, such as chisel plows, should be set no deeper than the depth of application. Deep incorporation of less than 250 pounds of P_2O_5 per acre may be conventionally tilled the following year.

Based on soil testing, shallow tillage may be necessary to reduce surface phosphorus levels that have increased because of crop-residue deposition. Producers should be aware that incorporation of septage deeper than 8 inches may promote development of a soil zone with extreme nutrient concentrations. If this layer is brought to the surface, phosphorus runoff may occur. On soils with high nutrient levels, septage application should be skipped for one or more seasons to allow depletion of accumulated nutrients.

Recommended application rates for various soil test levels are summarized in Table 8.

Table 8. Recommended maximum septage application rates at different soil test levels

Bray P_1 Level	Surface applied on high runoff potential sites (1)	Incorporated or low runoff potential sites (2)
0–60 lb P/A	N needs of non-legume crops. N removal rate of legume crops.	N needs of non-legume crops. N removal rate of legume crops.
60–250 lb P/A (3)	N needs or P removal rates for non-legume crops, whichever is less. N or P removal rates for legume crops, whichever is less.	N needs of non-legume crops. N removal rate for legume crops.
250–300 lb P/A (3)	Septage application for crop production purposes not recommended.	N needs or P removal rate for non-legume crops, whichever is less. N or P removal rate for legume crops, whichever is less.
more than 300 lb P/A (3)	Septage application for crop production purposes not recommended.	Application of septage for crop production purposes is not recommended. If application is necessary, apply no more septage than supplies N or P removal for the next crop, whichever is less. A site plan which addresses erosion control and runoff is recommended.

(1) Surface application is any application at a depth that would be disturbed by tillage within the next three years. High runoff potential refers to sites where surface movements of septage and/or phosphorus are likely to occur from the field of application.

(2) Incorporation is any application at a depth that would NOT be disturbed by tillage within the next three years. Low runoff potential refers to sites where surface movement of septage and/or phosphorus from the field of application is not likely to occur under normal weather conditions.

(3) Yearly plant tissue and soil analysis recommended.

PART II
Facilities for Septage Storage

Ohio's varied climate and cropping patterns make year-round land application of septage difficult. Storage facilities provide management flexibility for scheduling field application that reduces the risk of pollution. Adequate storage facilities allow pumping operations to continue until field conditions are suitable for land application. Septage storage is regulated by the County Health Department. The Ohio Environmental Protection Agency and the Ohio Department of Natural Resources have requirements for large storage facilities.

Facilities for septage storage are similar to the facilities used to store liquid manure. A storage facility should be designed by a professional engineer. A properly planned storage facility should include:

- Easy access for loading and unloading septage
- All-weather access
- Diversion provisions for clean surface runoff
- Water-tight construction to prevent septage leaks and clean water infiltration
- Fencing to prevent unauthorized entry
- Signs warning of the potential danger of drowning and hazardous gases
- Enough storage capacity to schedule field application only when field conditions, labor availability, weather, and local regulations permit
- Design to minimize odor
- Earthwork and landscaping to reduce the visual impact of the storage

Septage may be stored properly in constructed earthen storage basins, below-ground concrete tanks, or above-ground concrete or steel, glass-lined tanks.

Earthen Storage Basins

Earthen storage basins are earth-walled structures formed by excavation and berming of soil. They are usually partly above and partly below grade. Earthen storage basins provide long-term storage at a low to moderate cost. Proper site selection and soil conditions are necessary to prevent ground and surface water contamination. Evaluate the soil and geology for suitability before constructing an earthen basin. The soil must provide a stable foundation for the storage and not shift or settle after construction. The movement, settling, and shifting of an earthen structure, such as an embankment, could result in a total failure of the storage system.

Soil characteristics and geology of the proposed site should be studied by an engineer or soil scientist to determine soil sealing requirements, appropriate basin-wall sideslopes and dike construction, depth to bedrock, and water-table level. Keep the bottom of the storage at least 10 feet above bedrock and 4 feet above the water table.

In areas with high water tables, you may need to construct an embankment above ground to form the storage. Thoroughly investigate the construction area for existing or abandoned subsurface drainage systems. Remove or seal any existing subsurface drains in the construction area. An overlooked drainage tile can either fill the storage with excess drainage water or drain the storage into a nearby stream.

The soil used to construct an earthen storage basin must provide a seal and have low permeability. The permeability of the soil determines the ability of water to seep out of or into the basin. The coefficient of permeability of the soil lining the bottom and sidewalls of the basin should exceed 1×10^{-7} cm/sec (2.83×10^{-4} ft/day). A field or laboratory test will be needed to determine permeability. Ensure a good seal is provided before the storage is used. Locating and correcting leaks after the storage has been put into service is extremely difficult. If the naturally occurring soils cannot be compacted to the desired permeability, clay may be brought in to form a soil liner. Typically, compacted soil liners for waste ponds are 1-foot thick for impoundments up to 8-feet deep. If the impoundment is between 8- and 13-feet deep, a 2-foot thick soil liner is recommended. A 3-foot thick soil liner is recommended for impoundments from 13- to 18-feet deep. If enough suitable clay soil is not available locally to construct a seal, synthetic liners are available.

Keep clean surface water runoff and groundwater out of the storage to maximize the storage capacity of the basin. Provide surface water diversions around the structure to prevent runoff from entering the storage. Excess runoff reduces the working volume and may cause the storage to "top over" and flow into a ditch, stream, or pond.

The required capacity of a septage storage depends on its intended use. A small storage limits the amount of business a pumping operation can conduct when land application is not possible. The storage must account for the working volume, precipitation, clearance for pumping, freeboard, and the septage that will remain in the storage after pumping. Recommended storage volumes are illustrated in Figure 2.

To determine the working volume:

1) Estimate the number of days in a row land application will be limited by weather, soil conditions, crop, labor, and equipment availability.

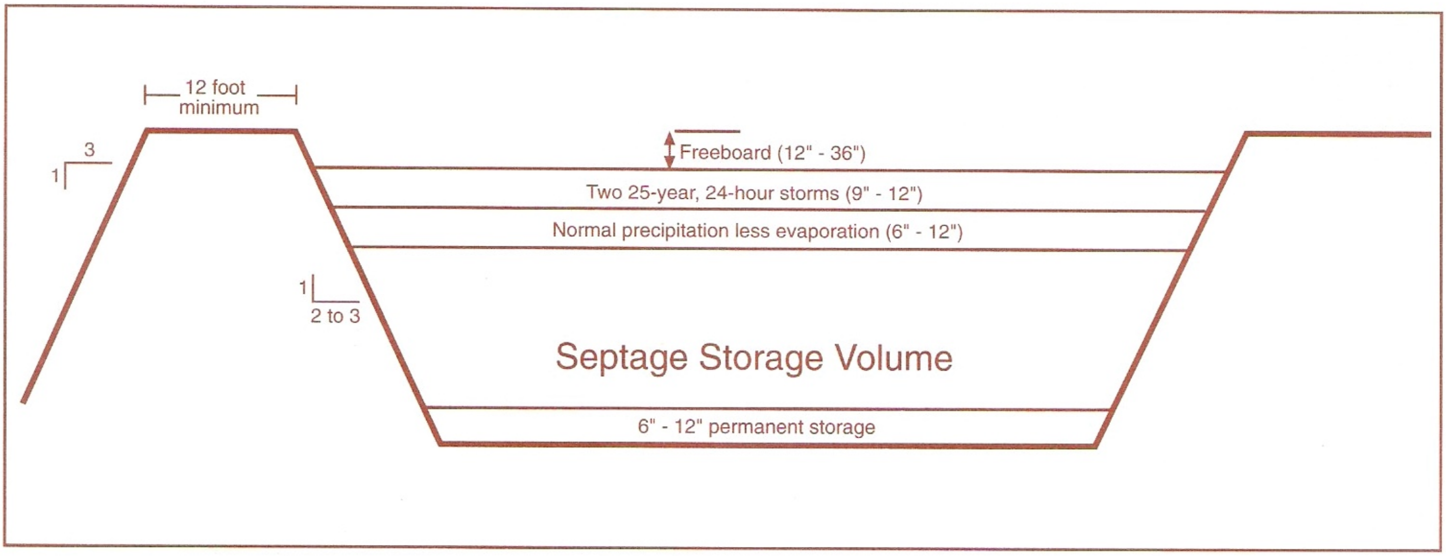

Figure 2. Recommended volumes for earthen septage storage basin

2) Estimate the volume of septage pumped during that period.

Plan for one to three months of septage storage in Ohio. Storage capacity for precipitation should include the expected average precipitation less evaporation for the storage period and two emergency storms (25-year, 24-hour storms). The average annual rainfall for Ohio varies from 44 inches in southwestern Ohio, to 40 inches in southeastern Ohio, to 32 inches in northwestern Ohio, to 36 inches in northeastern Ohio. Evaporation also varies throughout the state. The annual free water surface evaporation for Ohio ranges from 30 inches in southeastern Ohio; to 32 inches in northwestern, northeastern, and southwestern Ohio; to 34 inches in west central Ohio. Given these figures, the precipitation less evaporation in Ohio may be between 12 and 0 inches. Since most septage storages are used only a few months out of the year—when high precipitation and low evaporation is most likely—at least 6 to 12 inches of depth for rainfall storage should be included in the plan.

Additional storage depth must be provided in case of storms. Provide storage for two 25-year, 24-hour storms. In Ohio, a 25-year, 24-hour storm ranges from 3.7 to 4.8 inches. Incorporate at least 9 inches of storage depth to hold rain from storm events.

A minimum additional freeboard depth of 1 foot is needed for access while pumping and as an additional safety factor. Storage structures permitted by the Ohio Department of Natural Resources (ODNR) require a 3-foot freeboard.

Even a careful pumper has difficulty removing septage from the bottom of a storage facility. An additional 6 to 12 inches of permanent storage volume should be included to allow for a difficult-to-remove liquid and sludge layer at the bottom.

The final storage depth is determined after considering the site, storage volumes needed, groundwater conditions, and pumping equipment requirements. A deeper basin requires less area for the same capacity. A deeper basin also reduces the surface area exposed to precipitation and available for odor release.

The Ohio Department of Natural Resources (ODNR) regulates dam safety requirements for the state of Ohio. Any large impoundment, including earthen storage basins, requires a dam safety permit. A large impoundment is classified as any storage with an embankment height greater than 6 feet or a total volume greater than 15 acre-feet (4.9 million gallons).

A comparison of the requirements for large and small impoundments is listed in Table 9.

With the primary emphasis on ensuring that adequate storage volumes are planned into an earthen basin, sometimes the area around the storage is overlooked. Using the storage as a point of reference and moving out, consider the important components of the berm and storage site (Figure 3).

Access by loading and unloading equipment and maintenance of the berm and embankment are important. Make the berm at least 12-feet wide to provide a minimum area to maneuver equipment. Slope the berm away from the storage to reduce the amount of runoff entering the storage. Because loading the storage is likely to occur during bad weather, a well-compacted gravel or paved loading area should be provided to reduce access problems and breakdown of the berm or embankment.

Mowing and maintenance of berms and embankments is important to the appearance of the site. Grade the outside berm of the storage to a sideslope no steeper than 3:1 (run:rise) for easier maintenance. Plant the sideslope in grass or other ground cover to minimize erosion.

The potential for drowning always exists when liquids are stored. Provide

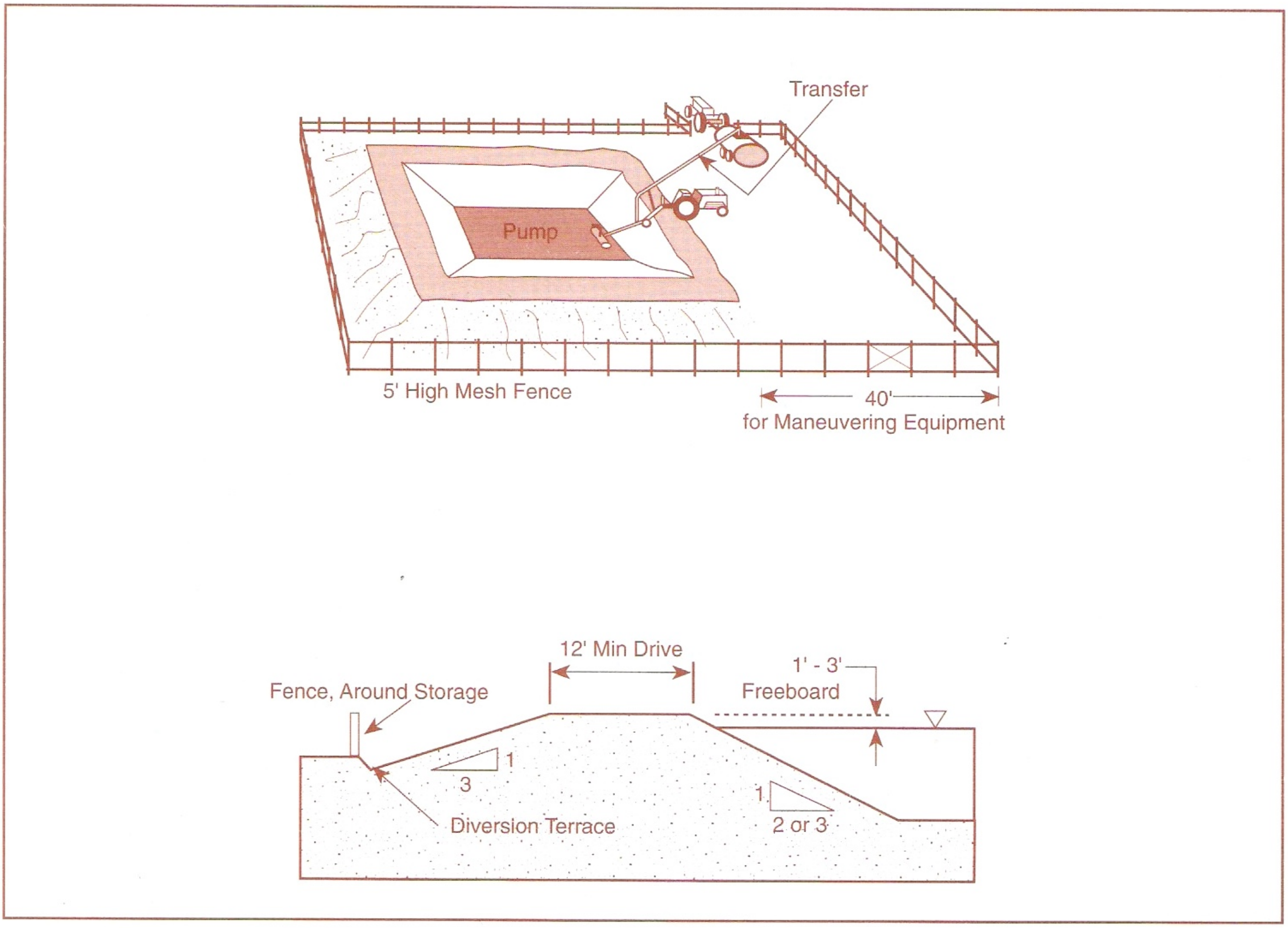

Figure 3. Considerations for septage storage site

Table 9. Impoundment requirements for small and large earthen septage storages

	Small	Large
Embankment height	less than 6 feet	6 feet or greater
Volume	less than 15 acre/feet (less than 4.9 million gallons)	15 acre/feet or greater (4.9 million gal or greater)
Free board	1 foot minimum	3 foot minimum
Storm volume	Two 25-year, 24-hour storms	100 year flood
Regulatory authority	Local Department of Health	Ohio Environmental Protection Agency Ohio Department of Natural Resources

Sources: Ohio Administrative Code. 1981. Dam Permits and Inspection Laws. 1501:21.
USDA-NRCS. 1992. Agricultural Wastes Management Field Handbook. Part 651.

a safety station (Figure 4) with a pole, rope, and flotation device in a visible, well-marked location along the berm. Post the storage site with signs indicating that the area is a septage or waste storage pond and that dangers exist. Signs are available from safety equipment suppliers.

Fence the storage area with at least a five-foot-high fence to keep people and animals away. Position the fence along the base of the embankment allowing enough room to maneuver maintenance equipment around the berm and fence. Set the fence back about 40 feet on the side of the storage used for loading and unloading to provide adequate room to maneuver equipment.

Septage has a foul odor and will create concerns for neighbors. Keeping the storage as far as possible from homes and businesses is the first step in being a good neighbor. Consider the prevailing wind direction and select a site where populated areas are not directly downwind. Wind breaks positioned around the storage help keep odors from being carried off site. Do not plant windbreak trees and shrubs in the storage embankment because the roots can form channels in the soil and weaken the embankment. Discharging septage into the storage below the surface will minimize surface agitation and the release of odors.

Finally, the appearance of the site will have an affect on neighbors' perceptions of odor. Some people "smell with their eyes," thinking that if a site looks bad, it must smell bad. Attractive and well-kept landscaping goes a long way in calming the concerns of neighbors. Trees, shrubbery, and especially flowers should be planned for the storage site. Remember, do not plant trees and shrubs directly on berm.

The appearance of trucks entering and leaving the facility will also reflect on the operation. Provide a gravel or paved lane to the storage to keep mud from being carried by trucks onto the road. Also store a small supply of lime on site to spread on accidental spills to reduce odors.

Tank Storage

Storage tanks are an option when soil characteristics, water table, depth to bedrock, and space limit the use of an earthen storage basin. Tanks can be constructed of reinforced concrete or coated metal. Engineered, premanufactured tanks may be purchased or custom-engineered tanks may be constructed in place by a qualified contractor. Details on the planning, design, and construction of concrete storage tanks is in the *Concrete Manure Storages Handbook,* MWPS-36, available through your county Extension office.

Tanks must be constructed on a stable foundation. Movement, settling, or shifting of the foundation can result in cracks and even complete tank failure. Below-ground tanks must be designed to withstand all anticipated earth, hydrostatic, and storage loads. Uplift forces from groundwater or a high water table can lift a tank out of the ground when empty. Anchor below-ground tanks or maintain a minimum depth of liquid to counteract any uplift forces.

Like earthen basins, below-ground tanks are potentially hazardous. Protect the storage area with a fence and signs. Include the same safety precautions described for earthen basins.

Below-ground tanks may be limited by depth to bedrock, water table elevation, and available space. An above-ground tank may provide the required storage capacity when a

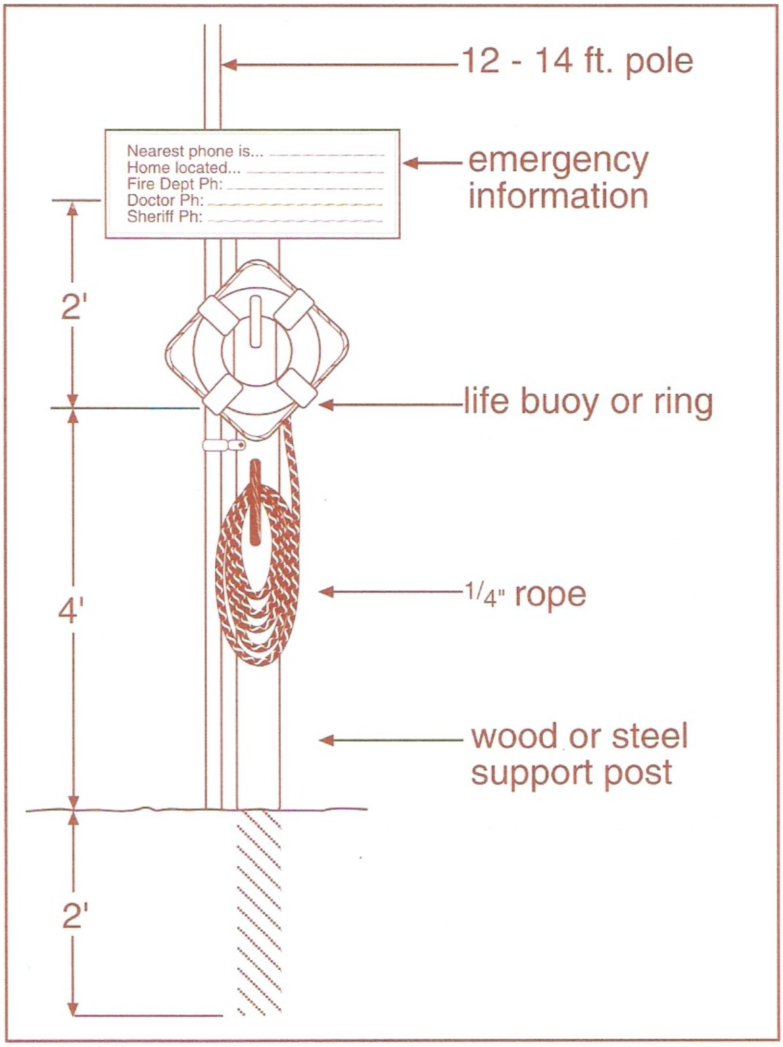

Figure 4. Safety station for liquid storage tanks and basins

below-ground tank or earthen basin is not feasible. Above-ground storage tanks are usually 10- to 20-feet high and 30 to 120 feet in diameter. Carefully locate access ladders to reduce the risk of accidentally falling into the storage. Check valves and a manual safety valve on pump inlets and outlets must be included to prevent accidental emptying of the storage. A secondary containment berm made of earth around the tank storage site should be constructed to protect the area from an accidental tank or valve failure. The bermed containment area should be sized to hold at least 110 percent of the full tank storage capacity. Be sure to take into consideration the space occupied by the tank when sizing the containment.

Another option for septage storage is to investigate the availability of unused tanks or earthen storages at farms or industrial sites. Farm or industrial sites are often located away from residences and have roadways and other waste handling operations that compliment septage management enterprises. Wastewater treatment plants used seasonally (in summer-time recreational areas, for example) may also have empty tanks and clarifiers during the year conducive to storing septage.

Safety is an important concern with existing facilities. Fencing may have to be added or upgraded. Signs should indicate that the tank or basin is used to store liquid. As with all liquid storage facilities, a safety station (Figure 4) should be installed in a convenient location and equipped with a pole, rope, and flotation device.

Septage, like other wastes, produces toxic gases as it decomposes. Entering any confined space that contains even a small amount of waste can be deadly. Eliminate confined, unventilated spaces if an existing facility is being used for septage storage.

PART III
Safely Discharging Septage to a Wastewater Treatment Plant

Sewage treatment plants offer another alternative for septage treatment. Because septage is approximately 50 times as concentrated as domestic sewage, it must be blended with sewage before entering the plant to avoid upsetting the treatment process. The plant must have a method for feeding septage into the system at a controlled rate and have adequate capacity to handle the septage.

Septage may be added to either the liquid stream or solids stream of a wastewater treatment plant. When added to the liquid stream the septage is considered a high-strength wastewater. It should be diluted with the incoming sewage as it enters the treatment plant. The septage may also be combined with sewage sludge as a part of the solids stream. The septage should first be screened and slowly incorporated with the sludge for stabilization and dewatering.

The benefits and concerns of adding septage to a treatment plant must be considered. The treatment plant, septage hauler, and community can all benefit from handling septage. These benefits include:

- Revenue for the treatment plant
- Use of excess treatment plant capacity
- Year-round availability for haulers
- Full-service treatment, serving both sewered and unsewered areas in a community

The concerns of accepting septage into a treatment plant must also be considered and addressed. The daily volume of septage may need to be managed to avoid plant overload. Restricting the hours of septage receiving, or limiting the number of loads per day may be necessary to control the plant loading rate. The source of the material is always a concern. The plant may not be prepared to handle industrial wastes, grease-trap wastes, or other unusual materials. The treatment plant should have a contract with all approved haulers. In that contract, the type of waste accepted at the plant can be restricted. For added protection, the treatment plant may collect a small sample from each load and store it for one to two weeks. In this way, if the treatment system is upset, the samples can be analyzed to reveal the hauler who contributed the "bad" load.

Two approaches for adding septage to a treatment plant have proven successful. One approach is to provide a bar screen and receiving tank at the plant. The septage haulers screen the septage as it is discharged to the receiving tank. The tank then discharges the septage at a slow, constant rate into the treatment plant. Another approach is for the treatment plant to designate and approve septage discharge to a distant access port (sometimes referred to as a manhole). As the septage moves through the sewer system to the plant, it is blended with the incoming sewage.

Spills, odors, and debris are always a concern in a septage receiving area. Provide a water supply with a hose and a covered dumpster for debris to allow each pumper to clean the unloading area after each visit. A contract can be written in such a way, that if a hauler is negligent, they lose access to the plant.

PART IV
Alternative Methods for Handling Septage

Research on septage handling alternatives continues. These research efforts address odor control, volume reduction, and pathogen control. Some septage handling methods that show promise include:

- Polymer additives to enhance dewatering
- Composting
- Aerobic treatment plants
- Reed bed systems

Research and demonstration results of new septage handling methods are reported in trade magazines, journals, and conference proceedings. When considering these new approaches "do your homework."

- Look for controlled studies that compare treatment and non-treatment results.
- Avoid reports based on testimonials.
- Contact and/or visit operations using a new technology to evaluate the system firsthand.
- When adopting a new approach start small. Establish a pilot-scale treatment system or rent new equipment before making an investment.
- Work with licenced or registered engineers and consultants.

PART V
Regulation of Septage Disposal in Ohio

In Ohio, septage management is regulated by the Ohio Department of Health. Registration of septic tank cleaners is required with the local board of health under Ohio Administrative Code section 3701-29-06.

Establishing and maintaining records is a part of every business, including septage pumping and hauling. Records of septage pumping and disposal may be required by the Ohio Administrative Code (3701-29-06). Further, under the new regulations (40CFR503) adopted in 1993 by the U.S. Environmental Protection Agency, a record of septage application must be kept for five years following application. This record must include:

1) Date and time of septage application.
2) Location of septage application site (street address or latitude/longitude).
3) The area, in acres, where septage was applied.
4) The gallons of septage applied.
5) The crop grown on the site and its expected yield.
6) Method used to reduce pathogens.
7) Method used to reduce vector attraction.

Figure 5 shows a sample record form.

Septage Application Report
South Pumping Service

Driver____________________

Date	Time of Application	Location	Number of Acres	Crop	Expected Yield	Gallons Applied	Lime Added	Time to Incorporation
10/15/95	3:00 p.m.	Southfarm 23 South Rd.	1	Corn	100 Bu/acre	1,000	No	Injected

Figure 5. A sample record for recording septage application

References

Refer to the following documents for additional information on septage and waste management.

Ohio State University Extension Fact Sheets and Bulletins

Extension fact sheets and bulletins are available through county Extension offices. Some publications are free for a single copy; others carry a nominal fee.

Fact Sheets

AGF 208	*Land Application of Animal Manure*
AEX 390	*Farm Pond Safety*
AEX 392	*Liquid Manure Storage Safety*
AEX 707	*Land Application of Wastes ... Spreading & Injection*
AEX 708	*Avoiding Stream Pollution from Animal Manure*
AEX 710	*Land Application of Livestock Waste ... Legislation, Regulations, Guidelines, and Standards*
AEX 740	*Septic Tank Maintenance*
AEX 741	*Why Do Septic Systems Fail?*
AEX 742	*Soil Evaluation for Home Septic Systems*
AEX 743	*Septic Tank—Soil Absorption Systems*
AEX 744	*Septic Tank—Mound System*

Bulletins

Bull 472	*Ohio Agronomy Guide*
Bull 604	*Ohio Livestock Manure & Wastewater Management Guide*
Bull 792	*Modern Composting*
Bull 813	*Mound Systems for On-site Wastewater Treatment*
Bull 829	*Mound Systems: Pressure Distribution of Wastewater*

Other

Ohio Irrigation Guide (out of print). Copies on file at Ohio offices of the Natural Resources Conservation Service and the Department of Agricultural Engineering, OSU.

Midwest Plan Service and Northeast Regional Agricultural Engineering Service

The Midwest Plan Service is a cooperative regional program of the Land Grant Universities of the north central United States. The Northeast Regional Agricultural Engineering Service is a similar cooperative program in the northeastern United States. Each group prepares and distributes up-to-date plans and related materials for rural housing, farm service buildings, and related equipment. These publications are sold through county Extension offices and the Department of Agricultural Engineering at Ohio State University. Contact the Extension Agricultural Engineer at 590 Woody Hayes Drive, Columbus, Ohio 43210 for a current price list.

MWPS 18	*Livestock Waste Facilities Handbook*
MWPS 24	*Onsite Domestic Sewage Disposal Handbook*
MWPS 36	*Concrete Manure Storage Handbook*
NRAES 79	*Liquid Manure Application Systems*

U.S. Environmental Protection Agency

Copies of U.S. Environmental Protection Agency (EPA) documents may be checked out at a federal depository library. Most university libraries are depositories for federal documents. To obtain a copy contact the U.S. EPA Region 5, NPDES Permit Section—Water Quality Branch, Water Management Division, WQP-16J, 77 West Jackson Blvd. Chicago, IL 60604.

EPA/625/R-94/002	*Guide to Septage Treatment and Disposal*
EPA/832/B-92/005	*Domestic Septage Regulatory Guidance*
EPA/625/6-84/009	*Septage Treatment and Disposal Handbook*

Related Publications

ASAE. 1993. *Manure Production and Characteristics*. ASAE Standards. D384.1.

Schutz, W.A. 1994. *Septage Disposal at a POTW, Can it Work?* Keystone Water Quality Manager. pp. 37-43.

USDA-NRCS. 1992. *Agricultural Wastes Management Field Handbook*. Part 651.

USDA-NRCS. 1995. *National Irrigation Guide*. Part 652.