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Septic Tanks for Sewage Disposal

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Septic Tanks for Sewage Disposal

By EARL G. WELCH and JAMES B. KELLEY*

THE NEED FOR SAFE DISPOSAL OF SEWAGE

In 1930 the Public Service Laboratories at the Kentucky Agricultural Experiment Station analyzed 6,410 samples of water from various parts of the State. Of these, 46.5 percent contained bacillus coli, an organism inhabiting the large intestine of man and animals. Water in which this organism is found is considered unsafe for drinking. Such water may carry the germs of typhoid fever, dysentery, or other intestinal diseases because the presence of the colon bacilli indicates contact with animal or human excrement. It is of utmost importance that human excrement be so disposed of that it cannot reach a source of water used by human beings. This circular contains plans for the safe disposal of sewage under varying conditions found in rural dwellings.

FACTORS CONCERNING THE DISPOSAL OF FARM SEWAGE

The primary purpose of all efforts at sanitary disposal of household sewage is the protection of the health of the people of the community. The greatest danger of improper sewage disposal is in the possible spread of disease thru drinking water. It should be the object of every one to protect not only his own water supply but his neighbor's as well. The limestone region of Kentucky has many underground passages connected with the surface by sinkholes or crevices which carry contamination to underground streams. These streams come to the surface as springs, or are tapped for wells. The careless disposal

*Revised by Earl G. Welch and Howard Matson.

of human excrement is the cause of contamination in many of these wells and springs.

It is well for anyone planning a sanitary sewage disposal system to keep the following principles in mind:

1. The system should be so located that drainage either above or below ground toward a nearby well, cistern or spring is practically impossible.

2. The final disposal should be made in the upper 18 inches of soil where sunlight, air and soil bacteria may accomplish purification.

3. Body excrement should never be permitted to drain or be washed into a small stream, sinkhole or tile drainage system.

4. Outside toilets should be so constructed and screened that animals or flies cannot in any way come in contact with sewage held in the vault.

TYPES OF DISPOSAL SYSTEMS FOR VARIOUS CONDITIONS

1. *Modern Plumbing in the Home.* Houses supplied with running water and modern plumbing should be provided with a septic tank. A septic tank is considered the most satisfactory means of residence sewage disposal as it is water-tight, and the overflow is disposed of in the soil where soil bacteria, air and sunlight purify it.

Frequently cesspools or dry wells are used for the disposal of sewage from houses with running water. As a rule these are condemned by sanitary engineers. The operation of the cesspool depends on the seepage of the liquefied sewage thru the porous walls of the underground tank into the adjoining soil area. In this method of sewage disposal seepage is at a depth of several feet below the surface of the ground where there is little chance of purification by air, sunlight or bacteria in the soil. The sewage may filter into a water supply, which is the greatest objection to the cesspool. If the liquid does not seep thru the walls, the cesspool soon fills to overflowing and becomes a nuisance. A cesspool that is a menace to water supplies should not be tolerated.

2. *Kitchen Sink and Pump.* In many rural houses only a kitchen sink and pump are provided. In such houses a septic privy may be used to advantage. The waste water from the sink may be drained into the septic privy and thus supply the water essential to the liquefaction of the solids in the sewage. The septic privy may be changed to a septic tank if the house later is provided with modern plumbing.

3. *No Running Water.* The sanitary toilet with concrete vault and well screened and ventilated toilet house is the best means of disposing of waste from the human body when running water is not available.

THE SEPTIC TANK AND DISPOSAL SYSTEM

The Action of a Septic Tank. A septic tank is a watertight tank in which sewage is held until the solids become liquefied by the action of anaerobic bacteria*. A scum composed of solids in the sewage forms on the liquid in the tank. This scum obstructs the access of air to the liquid, thus providing ideal working conditions for the anaerobic bacteria. As a result of the bacterial action in the tank, gas, liquid and sludge (material not liquefied) are formed. The sludge settles to the bottom of the tank. The liquid flows from the tank thru the tight-jointed sewer tile to the disposal area where it is distributed in the soil by means of common argricultural drain tile with open joints. The liquid as it comes from a septic tank may be clear but it is far from pure and must be carried into the top soil for final purification. The area that is to receive this liquid must be well drained, either naturally or artificially. If the soil which is to receive the sewage is not properly drained the excess of moisture keeps out the air and the aerobic bacteria which accomplish final purification cannot live and work properly. If the soil is tight and not well drained, special provision must be made for distributing the sewage, as shown in figure 6. The sewage must be admitted and removed from the tank

*Most bacteria live in the presence of air, but some live only where the air is entirely or partially excluded. The former are classed as aerobic bacteria; the latter, that thrive where little or no air is present, are classed as anaerobic bacteria.

without disturbing the scum which normally forms on top of the water. If water laden with any considerable amount of solid matter is permitted to enter the tile lines of the distribution system, the tile lines will soon become clogged and a nuisance will be created.

Usually septic tanks are classified as single-chamber or double-chamber tanks. A single-chamber tank is one that has only one compartment, altho the compartment may contain one or more baffles. In the single-chamber tank, the liquefied sewage runs directly from the single compartment or liquefying chamber to the disposal line. A double-chamber tank has in addition to the liquefying chamber a second compartment called a dosing chamber. The dosing chamber contains an automatic siphon which completely empties it when it becomes filled with the overflow from the liquefying chamber. This construction permits sewage to enter the disposal beds two or three times a day. The double-chamber tank is recommended when the amount of space for the disposal line is limited or when it is necessary to allow some time to lapse between doses of sewage to prevent the soil from becoming water-logged.

For most conditions in Kentucky a single-chamber tank is recommended because of its simplicity and smaller cost. Single-chamber tanks vary somewhat in construction but the essential requirements are the same. Aside from the proper capacity, the important features are an elbow to direct the entering sewage downward, under the scum, an arrangement to permit the liquefied sewage to flow from the tank without carrying solids into the disposal line and a form of baffle to keep the incoming sewage from disturbing the scum on top of the liquid in the tank. In the plan recommended in this circular the T's at the inlet and outlet serve as baffles as well as means of directing the sewage at the inlet and outlet openings. The gas formed by the bacterial action enters the soil thru the upper opening in the T at the outlet. The gas can not enter the sewer from the house because of the plug in the upper opening of the inlet T.

THE SEPTIC TANK INSTALLATION

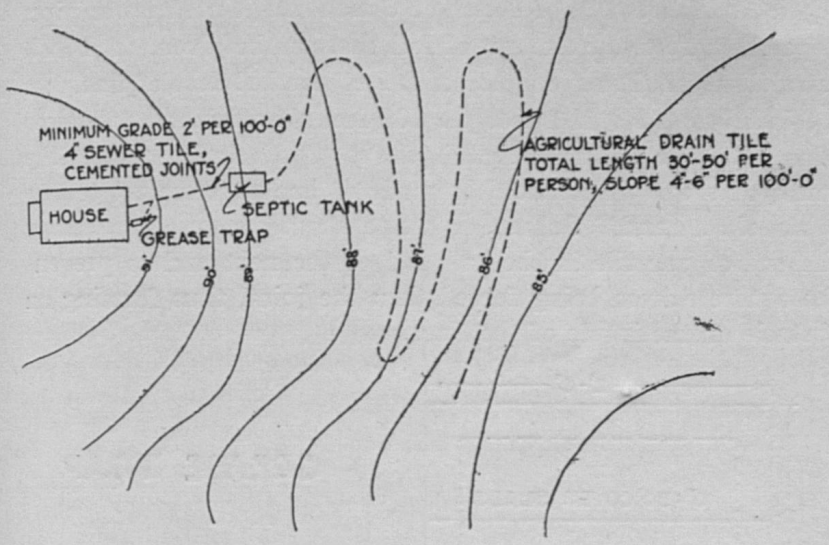


Fig. 1. A septic tank sewage disposal system.

The septic tank sewage disposal system for farm houses shown in figure 1 consists of (1) a line of sewer tile to carry sewage from the house to the septic tank; (2) a grease trap to remove excessive quantities of grease from the water draining from the kitchen sink; (3) the septic tank where the solids in the sewage are liquefied; and (4) a disposal system which may consist of a sewer line to carry the liquefied sewage to the disposal line and the disposal line composed of agricultural drain tile.

Location. In planning the location of septic tanks and disposal beds it should be kept in mind that unless the sewer lines and septic tank are absolutely tight there will be the possibility of leakage entering a nearby well or cistern. The septic tank may be as close as 25 feet to the house but neither sewer lines nor tanks should be closer than 50 feet to a well or cistern. The disposal bed should be in ground draining away from the farmstead and water supplies. It may be in a lawn but it is not considered safe to run the disposal line thru a vegetable garden.

Sewer Line. The sewer line leading from the house to the septic tank should be of 4-inch or 6-inch bell-jointed sewer pipe, depending upon the amount of fall that can be given. A 4-inch sewer line should have a fall of 2 feet per 100 feet of line. In a 6-inch line a fall if 1 foot per 100 feet is sufficient. All sewer pipe should be laid with sealed joints. Concrete for sealing the joints of sewer pipe should be made of one part cement to two parts clean sand. Oakum or waste should be used to center the end of one tile in the bell end of the next and to prevent the concrete from being forced thru the joint, thus forming an obstacle on the inside of the line.

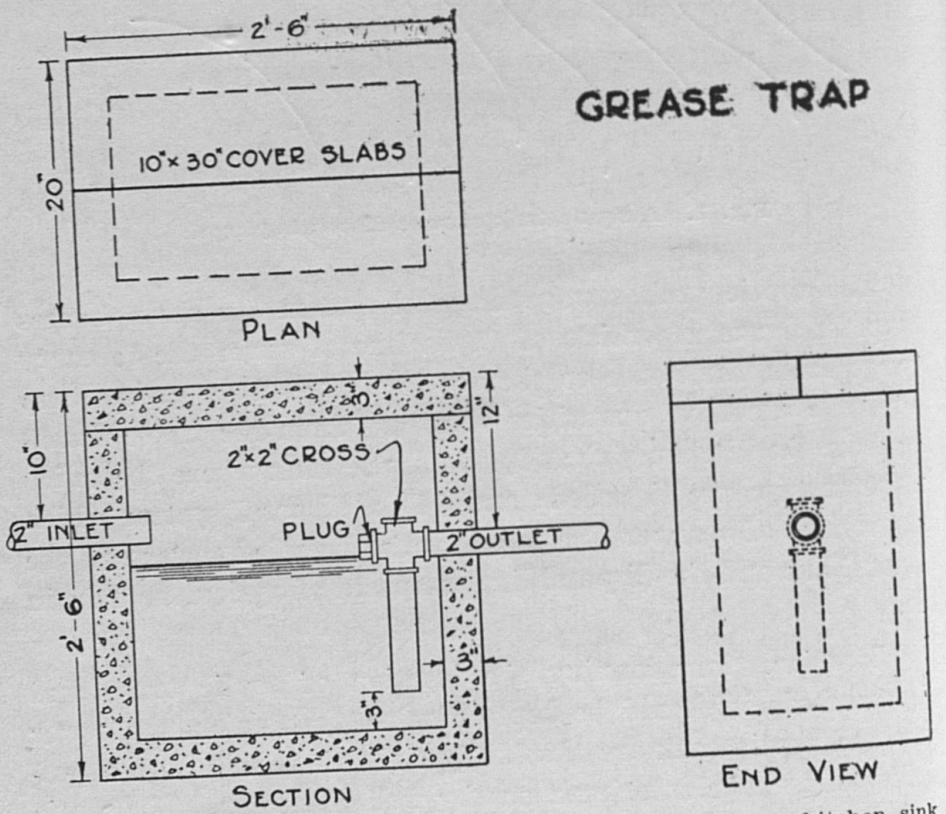


Fig. 2. A grease trap as shown above is used between kitchen sink and sewer to prevent excessive amounts of grease from entering the septic tank.

Grease Trap. The grease trap usually is placed just outside the kitchen where it can be examined easily and the grease removed when necessary. The drain from the sink empties

directly into the trap and the overflow from the trap enters the sewer line leading to the septic tank. The purpose of the grease trap is to prevent grease from the dish water entering the septic tank and disposal lines. An excessive amount of grease tends to decrease the efficiency of the tank by retarding bacterial action and may clog the disposal lines. The use of grease traps is advised altho septic tanks have been operated successfully without them. They add little to the cost of an installation. Plans for making a concrete grease trap are shown in figure 2.

Dimensions for Single-Chamber Septic Tank

	Inside Dimensions in feet		
Number of persons	Length	Width	Depth below water line
2— 6	5	2½	3¾
7—10	6	3	4
11—14	8	3	4

Size of Tank. The tank shown in Fig. 3 is the size required for a family of two to six persons. Dimensions for tanks with a greater capacity are given in the accompanying table. A septic tank gives the best results if the capacity below the overflow pipe is sufficient to hold a 2-days' flow of sewage, allowing 25 gallons of water per person per day. No tank should be constructed smaller than that for 6 persons. When a septic tank is to be built for the use of a school, hotel, or similar institution, special plans should be obtained from a sanitary engineer.

Excavation. The earth may be used as the outside form for the tank. The walls of the excavation should be smooth and plumb so as to give a uniform thickness to the walls. The width and length of the excavation should be the same as the corresponding outside dimensions of the tank. The depth should be 6 inches greater than the total overall depth of the tank to permit a fill of 6 inches of earth over the top of the tank. The depth of the excavation may be influenced by the depth of the house sewer outside of the house foundation, the amount of fall in the ground between the house and the septic tank and the minimum amount of fall required in the sewer from the house to the tank as recommended on page 8 under the heading

"Sewer Line". It is always advisable to take level readings for the purpose of securing the necessary information exactly before the depth of the excavation is permanently fixed.

Inside Form. The inside form for the septic tank should be made so that it may be removed easily after the concrete has set. Plans for its construction are shown in Fig. 3. The form should be assembled above ground and lowered into place in the excavation where it is held by cross-pieces resting on the top of the ground. The bottom of the form should be 6″ above the bottom of the excavation. The inlet and outlet T's and their connecting pipes should be set in place before the concrete is poured into the forms. In order that the inside form may be removed easily the top five boards at each end should not be nailed in place, otherwise the ends will be hard to remove because of the inlet and outlet T's. The cross braces at the top, center and bottom of the tank should be carefully placed so as to avoid spreading of the form which would cause a thicker wall than necessary. Before the form is lowered into place the outside surfaces should be well oiled. This will make the removal of the form less difficult and prevent the concrete from adhering to the wood. The inside form may be used for several tanks if the work of assembling and taking apart is done properly.

Top Slabs. The slabs for the concrete top should be cast in special forms and moved to the top of the septic tank after the tank form has been removed. Three ¼″ steel reinforcing rods are required in each 24-inch slab, to prevent cracking. These rods are embedded in the concrete, 1 inch above the bottom of the slab, as shown in the section view of a septic tank, Fig. 3.

Mixing and Placing Concrete. If the sides of the excavation are to be used as an outside form, care must be taken to prevent dirt from falling into the concrete as it is being placed. A frame of 1-inch boards around the top of the excavation, as illustrated in the isometric drawing, Fig. 3, will keep dirt out. These boards may be placed before the work of excavation is begun.

The walls of the septic tank must be water-tight; therefore considerable care should be taken to make a water-tight concrete. Both fine and coarse aggregate should be free from sediment. The fine aggregate or sand may contain particles as large as ¼″ in their greatest dimensions and the coarse aggregate or rock should not contain pieces larger than 1 inch. The concrete should be mixed until all particles are covered with a cement-sand paste.

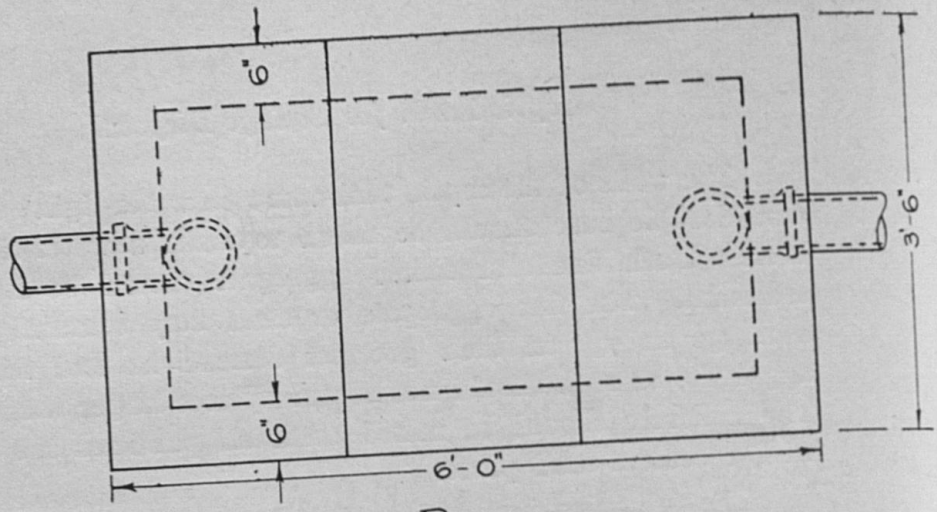
The following instructions for making water-tight concrete for a septic tank were prepared by the Portland Cement Association. They apply to mixing concrete for the top slabs as well as for the walls and bottom.

"In order to produce water-tight concrete it is necessary to regulate the amount of water that is used with each sack of cement, as it has been proved that not only the strength but also the watertightness of concrete is controlled by the proportion of water and cement in the mixture.

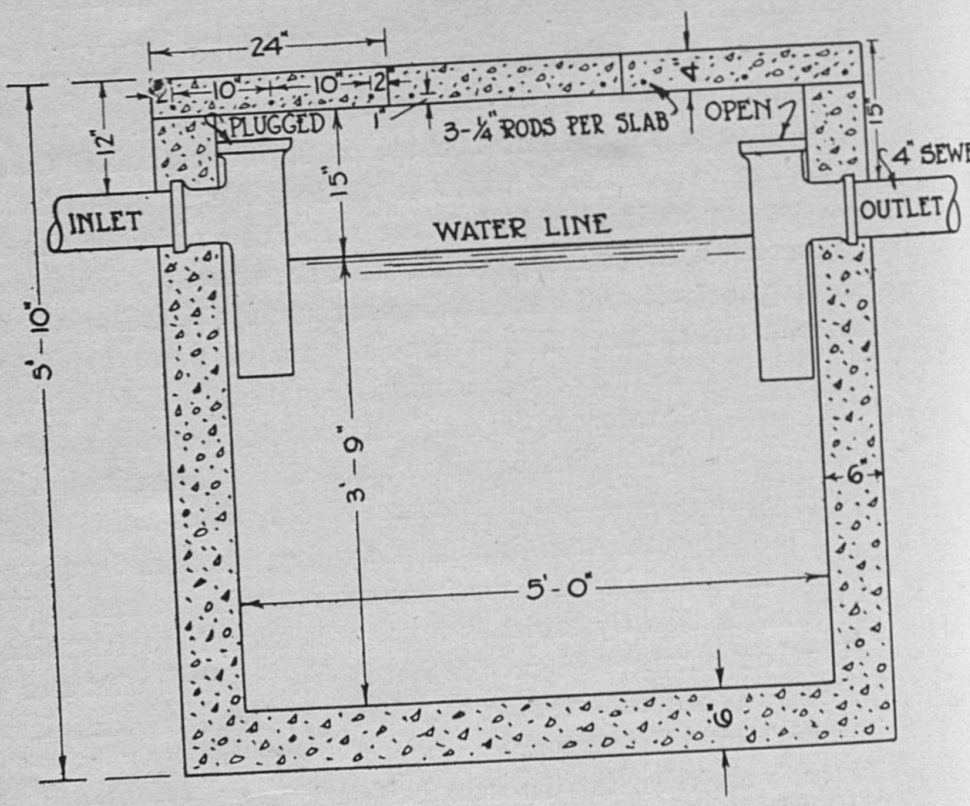
"For a water-tight mixture it is recommended that not more than 6 gallons of water be used with each one-sack batch. This water includes the moisture which is carried in the sand, as this moisture is free to react with the cement. Usually sand is damp or wet and contains approximately ½ gallon of water in each cubic foot. The correct amount of water to add in a one-sack batch, using wet sand, is 5 gallons. This allows for one gallon of water in the sand that would be used in the mix. This gallon, plus the 5 gallons added to the mix, makes a 6-gallon paste which is recommended for water-tight concrete.

"If the sand used is absolutely dry the full 6 gallons of water are added, since there is no moisture in the sand. When the sand is slightly moist but not wet enough to form into a ball when compressed in the hand, 5½ gallons of water are added for each one-sack batch. Usually, however, sand is wet, in which case the proper amount of water to add is 5 gallons for each sack batch. In case half-sack batches are used only 2½ gallons of water are added.

"As a trial mix with ordinary wet sand use one sack of portland cement, 2¼ cubic feet of sand, 3 cubic feet of pebbles,



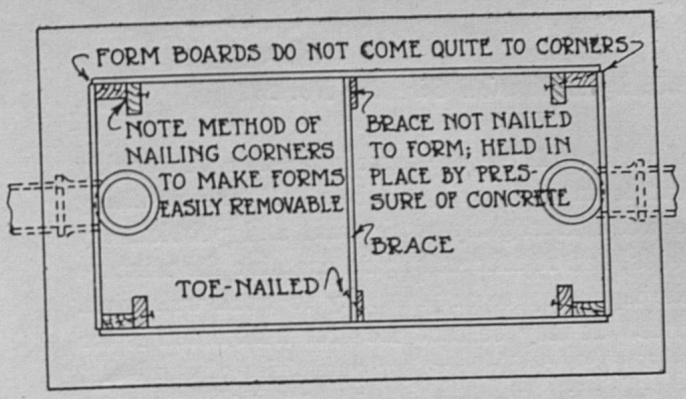
PLAN



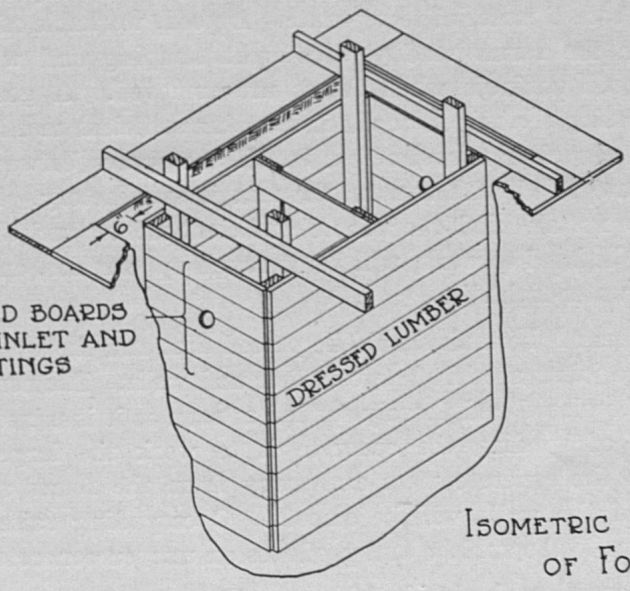
SECTION

Fig. 3. Plans for a single-chamber tank to acco

Capacity No. of Persons	Ins Len
2-6	5
7-10	6
11-14	6



PLAN OF INSIDE FORMS



ISOMETRIC DRAWING OF FORMS

DIMENSIONS AND MATERIALS
FOR SINGLE CHAMBER SEPTIC TANK

Capacity	Inside Dimensions in Feet			Concrete Materials			Reinf.
No. of Persons	Length	Width	Depth Below Water Line	Cement (Sacks)	Sand Cu. Ft.	Stone Cu. Ft.	¼" Steel Rod (Ft.)
2-6	5	2½	3¾	16	32	48	32
7-10	6	3	4	20	40	60	44
11-14	8	3	4	24	48	72	56

e-chamber tank to accommodate a family of not more than six persons.

and 5 gallons of water. These are mixed together thoroughly at least two minutes in a drumtype mixer. If the resulting mixture is quite wet add slightly more sand and pebbles, say ½ cubic foot of each, and re-mix and again examine the mixture to see if it has the right degree of plasticity to work well when placed in the forms. It may be that the first trial batch is too stiff to handle readily, then slightly less quantities of sand and pebbles should be used in the next batch. In this way, the correct proportions of sand and pebbles for the job are determined.

"In a good, workable mix there is sufficient cement and mortar to fill all spaces between the pebbles or crushed stone. Such a mixture holds together and there is little tendency for the fine and coarse material to separate. A good, workable mix will place in the forms readily with light tamping and will produce smooth surfaces when forms are removed. A good method of testing the mix to see if it contains sufficient mortar is to draw a shovel or trowel across it. If the spaces between the pebbles are filled with mortar the mix is satisfactory. If the spaces are not all filled, there is not sufficient mortar and the concrete will be hard to work, will be of rough appearance, and will not be water-tight."

The bottom of the tank should be placed first and the walls last so that no joints are left between floor and walls. The concrete should be placed and thoroly spaded as soon as it is mixed. The purpose of spading the concrete is to work the larger particles into the concrete mass and away from the forms so the surface of the walls will be smooth. Overspading raises coarse particles to the surface and produces an uneven concrete.

In warm weather the inside form may be removed after 24 hours. If the form is left in place too long the boards may swell and be hard to remove.

THE DISPOSAL SYSTEM

The disposal system is a line of agricultural drain title into which the overflow from the septic tank is conducted,

usually thru a line of sewer pipe. Sewage enters the soil thru the open joints of agricultural drain tile.

Sewer Line. The water-tight sewer line between the septic tank and disposal line is needed when the sewage must run within 50 feet of a well or cistern. If no special precautions are necessary to protect a source of water the sewer line may be omitted and the disposal line connected directly to the tank. The sewer line leading from the septic tank usually is composed of 4″ pipe with calked and cemented joints. As this line carries no solid matter the grade need not exceed 6″ to a hundred feet.

Disposal Line. The disposal line or absorption system should be located on well drained soil at least 150 feet from any well, spring or cistern. The land on which the disposal bed is located should slope away from all sources of drinking water. The disposal line should consist of 4-inch agricultural drain tile laid with open joints at a depth of 14 to 18 inches and to a grade of from 4 to 6 inches per 100 feet, depending on the ability of the soil to absorb water. In the tighter soils a grade of 4 inches per 100 feet is ample whereas a grade of 6 inches per 100 feet is needed in the more porous soils. The disposal line should consist of one continuous line rather than a main with lateral lines leading from it. It is difficult to effect an even distribution of the liquid thruout a disposal bed composed of a number of short lines as a very slight difference in levels at a junction point in a line will determine the course the liquid will follow. This is especially true when the volume is small. The continuous disposal line may be laid on any slope by changing the direction of the line, as illustrated in Fig. 1.

It has been found that in Kentucky soils from 30 to 50 feet of tile are needed in the disposal bed for each person using the system. Where the soil is tight, 50 feet of tile per person should be laid, whereas in more porous soils 30 feet per person is sufficient. The straight-edge may be used in grading the trench as shown in figure 4. A strip of tarred paper should be placed over each joint between tile in the disposal bed, in order to prevent earth from entering the line and clogging it.

The paper strips should be about 6 x 12 inches and placed as indicated in figure 5.

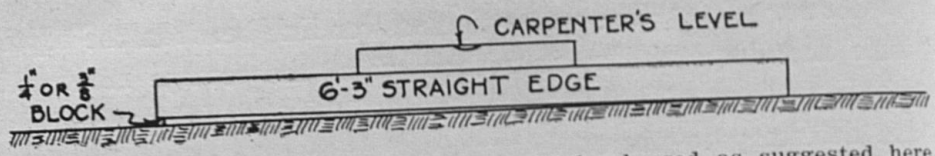


Fig. 4. A straightedge and carpenter's level used as suggested here will help in making an even grade. A ¼" block gives a grade of 4" per 100 ft. and a ⅜" block a grade of 6" per 100 ft.

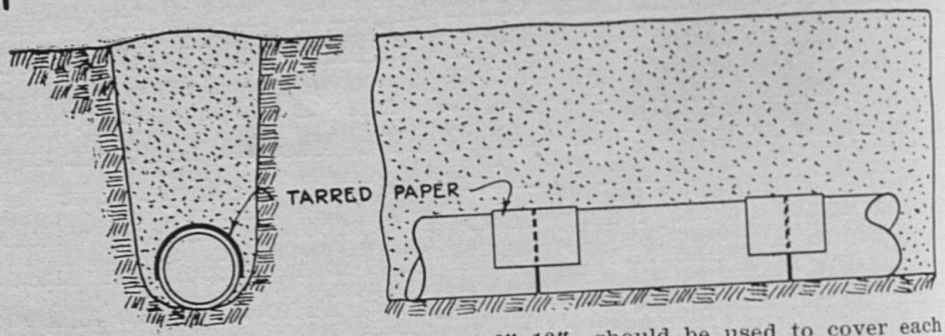


Fig. 5. A strip of tarred paper, 6"x12", should be used to cover each joint in the disposal line so as to prevent the line from becoming filled with soil.

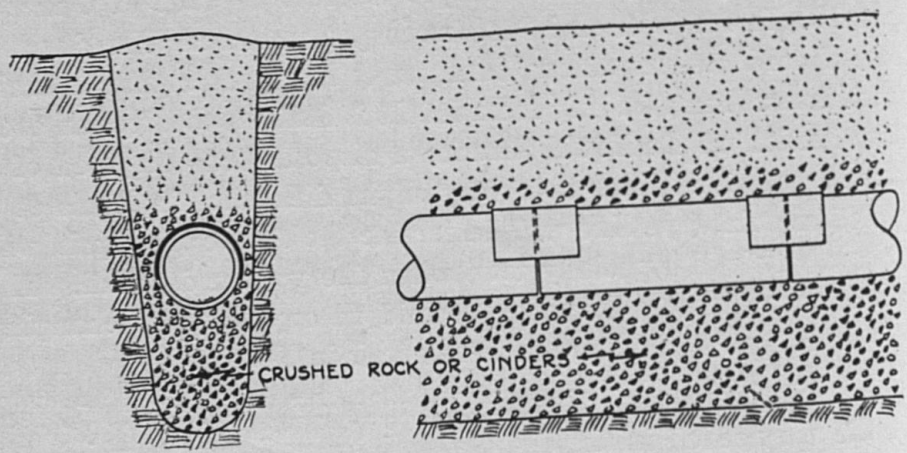


Fig. 6. Method of laying tile in a tight soil.

If the soil in which the disposal line is laid is not open and porous, the rate of absorption by the soil may be increased by laying the tile on a bed of gravel, crushed rock or cinders as shown in figure 6. To prevent the drain tile from getting out

of line because of uneven settling the bed of porous material should be well tamped before the tile is placed on it. The bottom of the trench should be graded and the cinders placed to an even depth thruout the length of the trench.

Care of a Septic Tank. After the form has been removed, the tank should be filled with water. It is then ready for use. An erroneous idea exists that a "starter" in the form of horse manure should be put into the septic tank. This is not necessary. Chemicals of all kinds should be kept out of the tank. The ordinary amounts of cleaning and washing compounds used about the house do no harm. Nothing more substantial than toilet paper should be permitted to enter the tank as resistant materials may pass thru the tank and cause the sewer or disposal line to become clogged.

A septic tank may need cleaning after six or seven years' operation or when the sludge has attained a depth of 18 inches. The scum, water and sludge may be removed by a diaphragm pump, and buried or plowed under in a field or pasture but never emptied into an open stream or deposited in a garden.

THE SEPTIC PRIVY

In Fig. 7 plans are shown for a septic privy which serves as an outside toilet where inside toilet fixtures are not used but where a kitchen sink and pump are in use. The waste from the kitchen sink after passing thru a grease trap, as shown in Fig. 2, is drained into the vault of the septic privy. This disposes of waste water and provides water to promote the liquefaction of solids in the vault.

Where the house over the privy vault is kept clean and well screened, this plan provides a very satisfactory method of disposing of waste from the human body. All the precautions for the location of the disposal line and septic privy given on page 7, under the heading "Location" should be observed. The disposal line should consist of 4-inch agricultural drain tile laid to a grade of 4 to 6 inches per hundred feet as in a disposal bed for a septic tank. Seventy-five feet of tile in the disposal bed will be sufficient for the average installation.

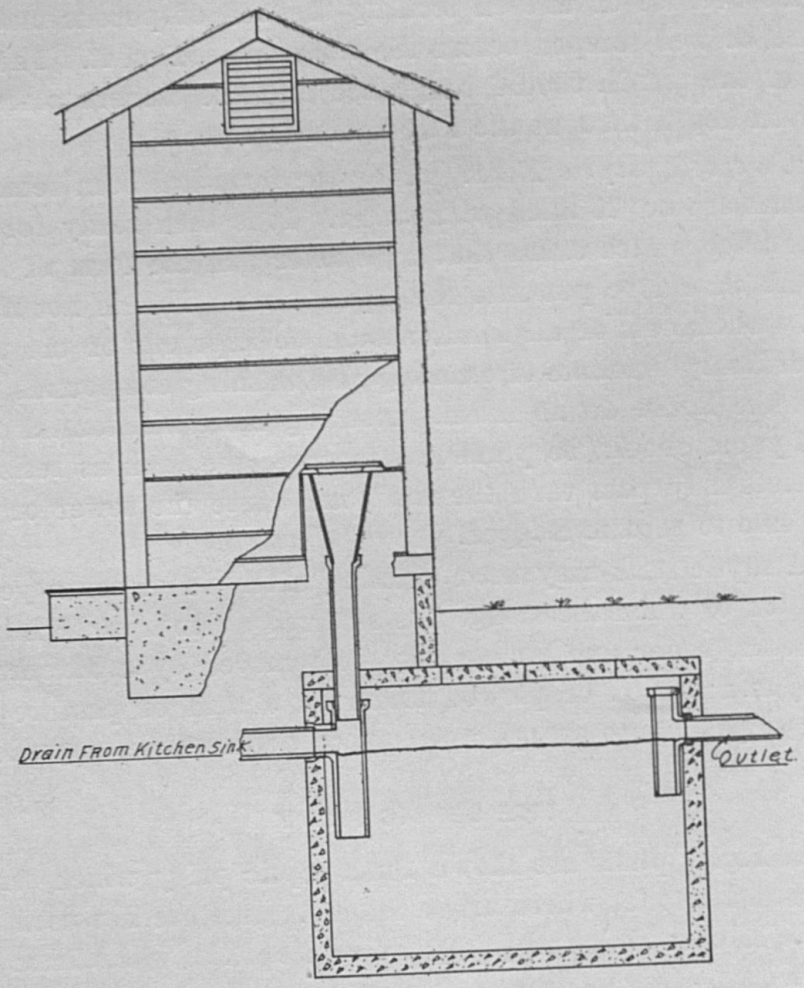


Fig. 7. A septic privy.

The plans and instructions for constructing a septic tank as given in this circular should be followed for constructing the septic privy. The vault for a septic privy should be of such capacity that it may be used as a septic tank, if a system with running water and complete plumbing fixtures is put in later. If such changes are made it will be necessary only to add tile to the disposal bed, as the drain from the grease trap will serve as a sewer leading to the tank. The house over the septic privy may be removed or left in place as desired after the new plumbing has been completed.

Disposing of Sewage in Homes Without Running Water

The problem of the sanitary disposal of sewage from a house without running water is of as great importance as the sanitary disposal of sewage from a house with all modern plumbing conveniences. Because outdoor toilets, cisterns and wells usually are located near the residence, they frequently are not far enough apart to eliminate the hazard of seepage from an open privy vault to a source of water used by the household. The open-vault privy has been condemned for a great many years by sanitary engineers and state, county and city Boards of Health.

The Sanitary Privy. The sanitary or concrete-vault privy has a water-tight compartment to receive human excreta so that the possibility of seepage from the compartment is prevented. When properly screened and ventilated the objectionable, unsanitary features of the ordinary outdoor toilet are eliminated. The human wastes are from time to time removed and buried in the top soil of an open field. Plans for a concrete-vault privy, as designed and recommended by the United States Department of Agriculture, are shown in the accompanying drawing, Figs. 8 and 9.

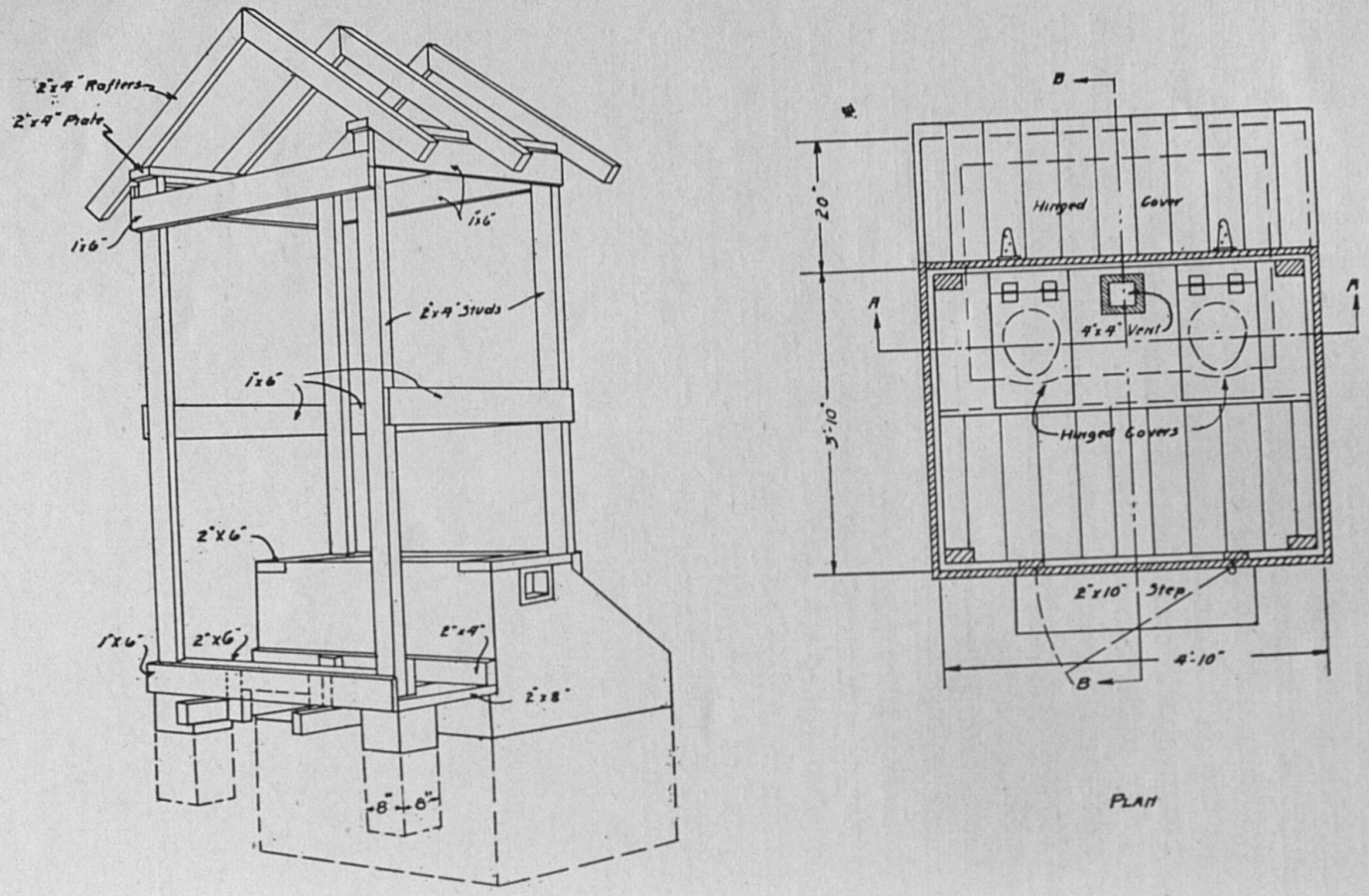


Fig. 8. Plan and perspective views of sanitary privy.

PERSPECTIVE OF FRAMING

Fig. 8. Plan and perspective views of sanitary privy.

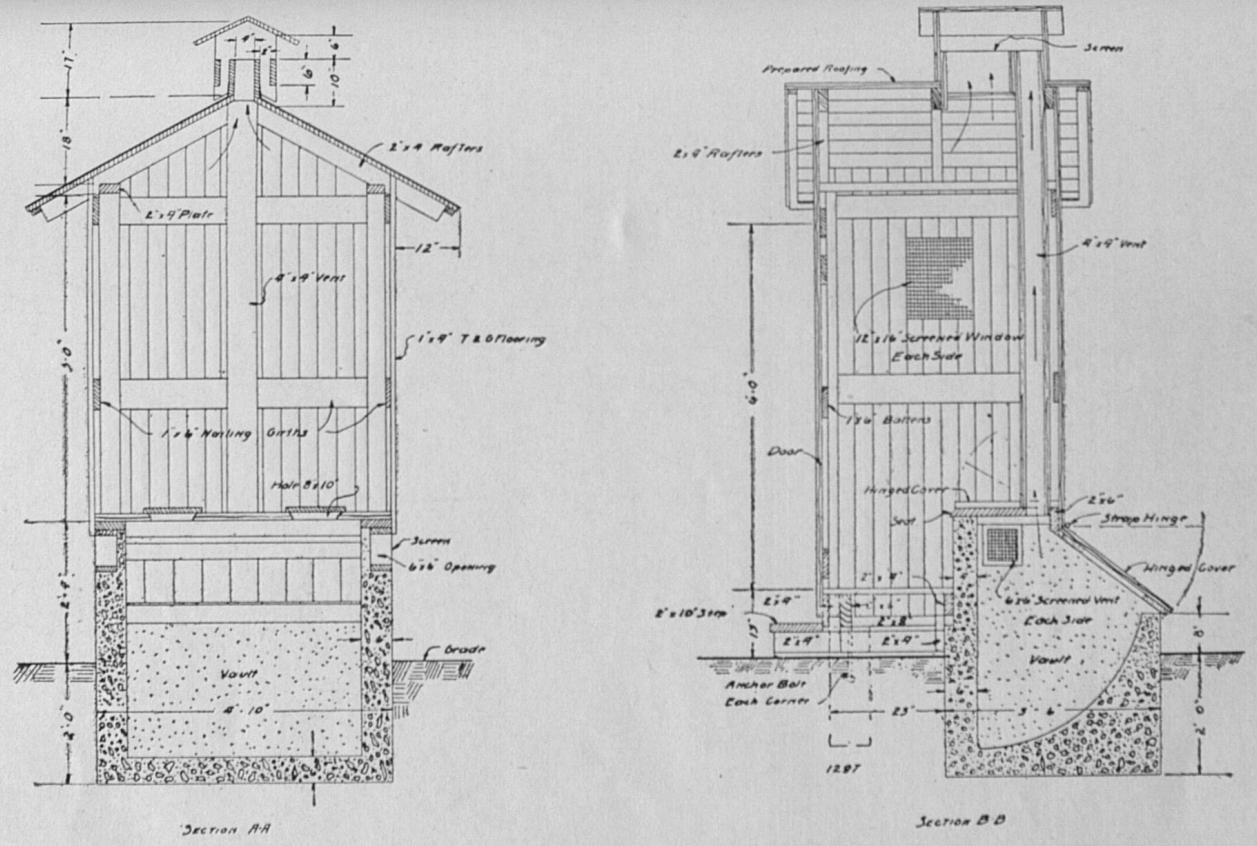


Fig. 9. Sectional views of sanitary privy.