Water for the World

Designing Cesspools

Technical Note No. SAN. 2.D.2

A cesspool is a covered pit with open-joint walls that receives piped sewage. The solids settle to the bottom and the effluent passes through the walls into the surrounding soil. Designing a cesspool involves selecting a location; calculating the size of the cesspool; and determining the labor, materials, and tools needed for construction. The products of the design process are: (1) a location map, (2) a plan view of the cesspool, and (3) a detailed materials list.

This technical note describes how to design a cesspool and arrive at these three end-products. Read the entire technical note before beginning the design process.

Useful Definitions

ALLOWABLE RATE OF APPLICATION - The amount of effluent that the soil in a particular area will absorb in one day expressed in liters per square meter per day (1m^2/day).

EFFLUENT - Settled sewage.

GROUNDWATER LEVEL - The level to which subsurface water rises during any given time of year.

IMPERVIOUS - Not allowing liquid to pass through.

SEWAGE - All washwater, excreta, and water used to flush excreta that flows from a building or buildings through a sewer pipe and into a septic tank, cesspool, or stabilization pond.

Materials Needed

Measuring tape - To obtain accurate field information for a location map.

Ruler - To draw a location map.

Location

A cesspool should be downhill and at least:

60m from the nearest water supply,
6m from the nearest dwelling,
6m from any property line,
6m from bushes or trees.

Do not locate the cesspool in an area where surface water will stand on it or flow over it. After a proposed site has been selected, it must be tested for soil suitability as described in "Determining Soil Suitability," SAN.2.P.3. The test is conducted in two steps and can be generally described as follows.

Step 1. Determine if the highest groundwater level and level of impervious layer are suitable for the cesspool. The bottom of the cesspool must be at least 1.0m above these levels. If these conditions are not acceptable, select another site. If no acceptable site can be found, it will be necessary to design a non-conventional system, (see "Designing Non-Conventional Washwater and Excreta Disposal Systems," SAN.2.D.8), or a sewer system (see "Designing Sewer Systems," SAN.2.D.4, and "Designing Stabilization Ponds," SAN.2.D.5). If the groundwater and impervious layers are acceptable for the cesspool, proceed to the second step.

Step 2. Determine the allowable rate of sewage application by conducting soil percolation tests as described in "Determining Soil Suitability," SAN.2.P.3. The tests should be conducted both at approximately one-half the depth and the total depth of the proposed pit. If the results of the test are unacceptable for the proposed system, select another site and repeat Step #1. If no acceptable site can be found, it will be necessary to design a non-conventional system or a sewer system.

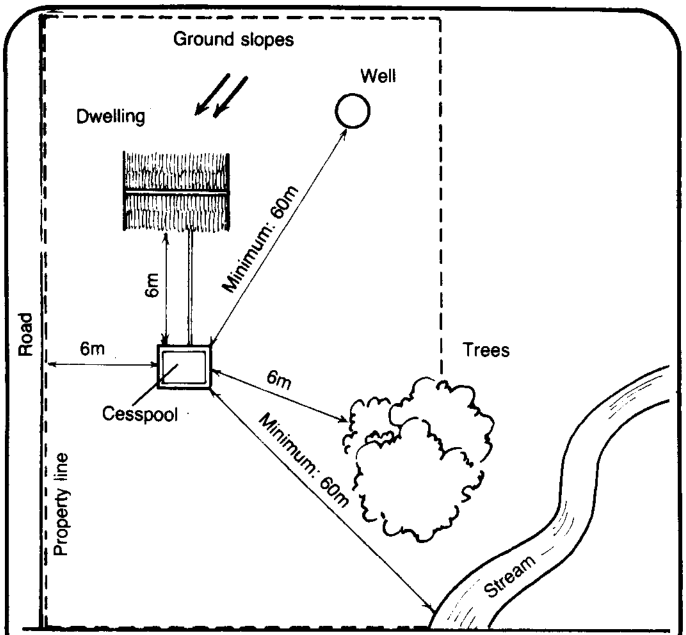

Figure 1. Location Map

When an acceptable site for a cesspool has been found, draw a location map similar to Figure 1, showing distances from the site to water supplies, dwellings, property lines and trees. Give the map to the construction supervisor before construction begins.

Calculating the Size

A cesspool may be square, rectangular, or circular. Its size is based on the area of absorbent soil needed. The required area depends on the allowable rate of application (see "Determining Soil Suitability," SAN.2.P.3) and the estimated daily flow of effluent (see "Estimating Sewage or Washwater Flows" SAN.2.P.2). A factor of two is inserted for safety. Thus, the required area equals two times the estimated daily flow expressed in liters per day divided by the allowable rate of application expressed in liters per square meter per day:

$$\text{area} = 2 \times \frac{\text{estimated daily flow}}{\text{allowable rate of application}}$$

$$\text{area} = 2 \times \frac{\text{liters per day}}{\text{liters per square meter per day}} = \text{square meters}$$

For example, suppose that the estimated daily flow is 850 liters per day and the allowable rate of application is 61.1 liters per square meter per day. Then the required area equals:

$$2 \times \frac{850 \text{ liters/day}}{61.1 \text{ liters/m}^2\text{/day}} = 27.8\text{m}^2$$

(Worksheet A, Lines 1-3).

The required area of absorbent soil is $27.8m^2$. For a cesspool, this must be the area of the sidewalls below the inlet. The bottom area is not included, because the bottom of a cesspool will rapidly clog with settled solids and become nearly impervious. If the pit is square or rectangular, find the total area by adding the areas of the four earth walls below the inlet. For a circular pit, determine the area by calculating the area of the circular wall below the inlet. When calculating the area of a circular pit, use the following equation: circumference = 3.1 times diameter.

Some examples of cesspool sizes, assuming that the area of absorbent soil is $27.8m^2$:

A square cesspool could be 3.0m on each side and 2.32m deep below the inlet. The area of each side is 3.0m x 2.32m = $6.96m^2$. The effective area of the cesspool is the sum of all four sides, or 4 x $6.96m^2$ = $27.8m^2$ (see Worksheet A, Lines 4-6).

A rectangular cesspool could be 2.23m wide by 2.4m long by 3.0m deep below the inlet. The area of the two ends equals 2 x 2.23m x 3.0m = $13.4m^2$. The area of two sides equals 2 x 2.4m x 3.0m = $14.4m^2$. The effective area of the cesspool is the sum of the areas of the ends and the sides or $13.4m^2$ + $14.4m^2$ = $27.8m^2$ (Worksheet A, Lines 7-10).

A circular cesspool could be 3.0m in diameter and 3.0m deep below the inlet. The circumference is 3.0m x 3.1 = 9.3m. The effective area of the cesspool equals the area of the circular wall, which is the circumference times the depth below the inlet or 9.3m x 3.0m = $27.9m^2$ (Worksheet A, Lines 11-13). It is permissible for the effective area of the cesspool to be greater than the required area of absorbent soil.

Worksheet A. Calculations for Cesspool

1. Allowable rate of application (from "Determining Soil Suitability," SAN.2.P.3) 61.1 liters/m^2/day

2. Estimated daily flow of effluent (from "Estimating Sewage or Washwater Flows," SAN.2.P.2) 850 liters/day

3. Required area of absorbent soil = $\frac{\text{Line 2}}{\text{Line 1}}$ = 27.8 m^2

Type of cesspool (check one): [X] square [X] rectangular [X] circular

Square Cesspool

4. Proposed length of each side = 3.0 m

5. Circumference of pit = 4 x Line 4 = 4 x 3.0 m = 12.0 m

6. Depth below inlet = $\frac{\text{Line 3}}{\text{Line 5}}$ = $\frac{(27.8m^2)}{(12.0m)}$ = 2.32 m

Rectangular Cesspool

7. Proposed length = 2.4 m

8. Proposed width = 2.23 m

9. Circumference of pit = (2 x Line 7) + (2 x Line 8) = (2 x 2.4 m) + (2 x 2.23 m) = 9.26 m

10. Depth below inlet = $\frac{\text{Line 3}}{\text{Line 9}}$ = $\frac{(27.8m^2)}{(9.26m)}$ = 3.0 m

Circular Cesspool

11. Proposed diameter = 3.0 m

12. Circumference of pit = 3.1 x Line 11 = 3.1 x 3.0 m = 9.3 m

13. Depth below inlet = $\frac{\text{Line 3}}{\text{Line 12}}$ = $\frac{(27.8m^2)}{(9.3m)}$ = 3.0 m

14. Approximate quantity of sidewall materials = 0.3m x Line 3 = 0.3m x 27.8 m^2 = 8.34 m^3

15. Approximate quantity of filler material = 0.2m x Line 3 = 0.2m x 27.8 m^2 = 5.56 m^3

When the size and configuration of the cesspool have been determined, prepare a plan view similar to Figure 2 showing the correct length, width (or diameter), and depth below the inlet. Give the drawing to the construction supervisor before constuction begins.

Selecting Materials

All materials should be locally available and should meet the design criteria described for them.

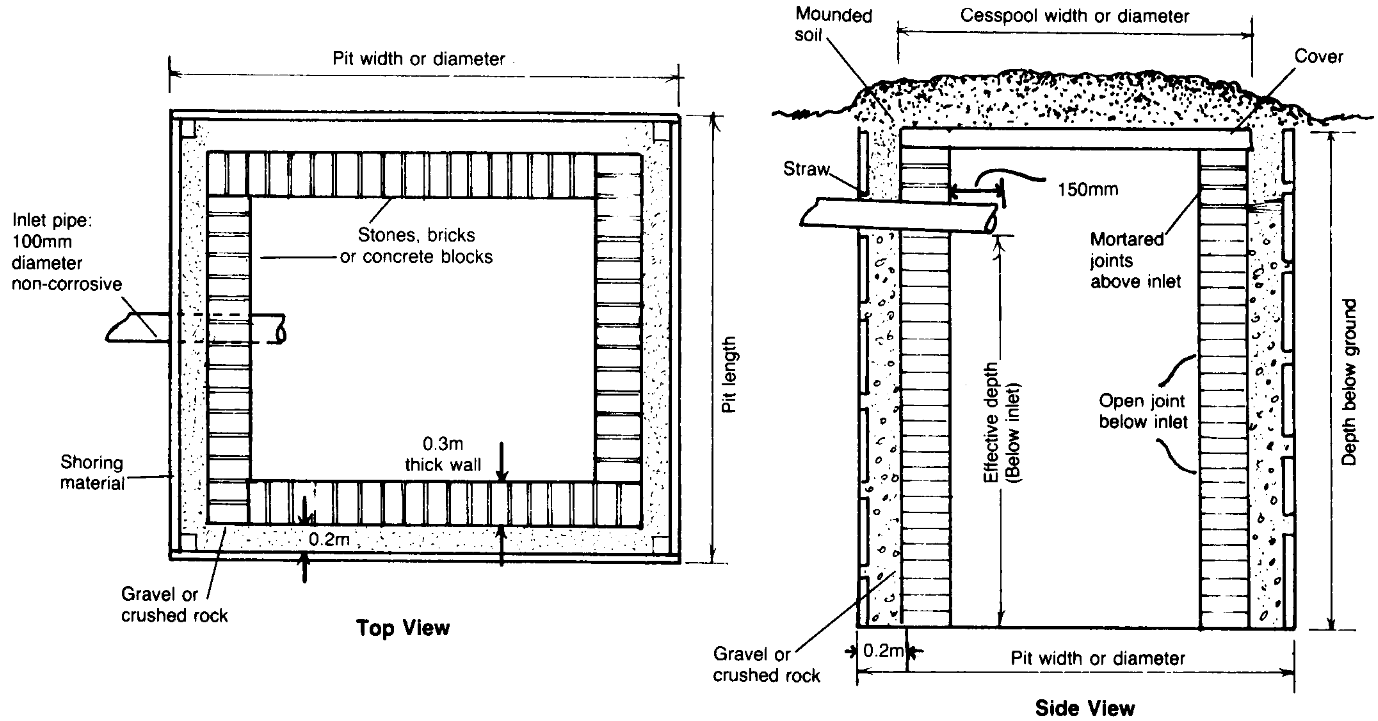

Figure 2. Cesspool

Sidewalls. These can be made of bricks, concrete blocks, select field stones, or similar material. The walls should be about 0.3m thick and are laid up about 0.2m from the earth walls of the pit. They are open-jointed below the inlet and mortared together above the inlet for strength. The quantity of sidewall material depends on the size of the cesspool and the type of material used. The quantity is approximately equal to the required area of absorbent soil times 0.3m, the thickness of the walls. For example, if the required area is $27.8m^2$, the approximate quantity is $27.8m^2 \times 0.3m = 8.34m^3$ (see Worksheet A, Line 14).

Filler. The space between the sidewalls and the earth walls must be filled with gravel, pebbles, or crushed rock. The quantity needed is approximately equal to the required area of absorbent soil times 0.2m, the space between the sidewalls of the cesspool and the earth walls of the pit. For example, if the required area is $27.8m^2$, the approximate quantity of filler material is $27.8m^2 \times 0.2m = 5.56m^3$ (Worksheet A, Line 15).

Sewer pipe. This pipe carries sewage from the dwelling to the cesspool. It is generally 100mm in diameter, and it must be made of non-corrosive material such as vitrified clay, concrete, or special plastic. The length of the pipe is approximately equal to the distance from the dwelling to the cesspool.

Cover. The cover can be made of metal or concrete and can be in one piece or in sections. It must be strong enough to support the weight of the approximately 0.3m of soil that will cover it and to prevent a person from falling into the cesspool. It must be waterproof. If the cover is made of concrete, see "Designing Septic Tanks," SAN.2.D.3, for information.

Shoring. For pits deeper than 1.5m, the sides must be shored with bamboo, boards, logs, poles, or similar material to prevent a cave-in that could be fatal to a worker in the pit.

Selecting Tools

Use locally available tools such as picks and shovels to excavate the pit.

A wheelbarrow will be useful to haul materials to the site and haul excavated soil away. A hammer, saw and nails may be needed to construct shoring. Containers will be needed to mix mortar for sidewalls above the inlet.

Selecting Labor

At least two, and preferably more, able-bodied workers will be needed to excavate the pit. At least one worker should have some experience with mixing and applying mortar. When all necessary materials, tools and labor have been determined, draw up a materials list similar to Table 1 and give it to the construction supervisor before construction begins.

In summary, give the construction supervisor a location map similar to Figure 1, a plan view of the cesspool similar to Figure 2, and a materials list similar to Table 1.

Table 1. Sample Materials List

Item	Description	Quantity	Estimated Cost
Labor	Foreman	1	____
	Laborers	3	____
Supplies	Bricks for sidewalls	____	____
	Gravel for filler	____	____
	Concrete for cover	____	____
	Mortar or tar for waterproofing	____	____
	Inlet pipe (100mm, non-corrosive)	____	____
	Straw	____	____
	Shoring material	____	____
	Nails	____	____
	Other	____	____
Tools	Measuring tape	1	____
	Shovels	4	____
	Picks	1	____
	Wheelbarrow	1	____
	Containers for mixing concrete	2	____
	Hammer	1	____
	Saw	1	____
	Other	____	____

Estimated Cost = ____