Technical Note 02 | August 2025

Equitable and Sustainable WASH services in Bangladesh Delta Plan Hotspots

Sanitation options for Haor areas | Septic tanks

The Equitable and Sustainable WASH services in Bangladesh Delta Plan Hotspots Project implemented by BRAC aims to enhance WASH services in four climate hotspots, covering 45 sub-districts across 14 districts. The project has incorporated innovative approaches and strategies to reach about one million people with access to safe water and sanitation in communities and schools in climate-vulnerable hard-to-reach areas. The overarching goal of the project is to promote and deliver safe water and sanitation services by increasing access to finance (repayable finance and grants), introducing sustainable and climate-resilient technologies and service delivery models, and by strengthening local institutions. The Project is expected to not only serve the people of the four climatic hotspots but also to generate substantial knowledge for similar other efforts in Bangladesh and beyond.

The Project, implemented by BRAC with the support from IRC WASH, is funded by the Embassy of the Kingdom of the Netherlands in Bangladesh. It runs from November 2022 till October 2026.

Important points

Existing situation

- ➔ The sanitation facilities found in Haor settlements are poor compared to other parts of the country.
- ➔ Most toilets are of a temporary nature which require rebuilding on a regular (seasonal) basis.
- ➔ The current situation is far from ideal, and the prevalence of diarrhoea and other waterborne diseases is expected to be high.

Solutions

- ➔ The Project will adopt, and where necessary improve or modify, 'low-cost' technologies that have proven to be functional under 'normal' conditions.
- ➔ The Project will at this stage only consider household level sanitation technology options to avoid complex community management models.
- ➔ This paper proposes several different septic tank designs.

Introduction

The Technical Note 01 (July 2025) Sanitation options for Haor areas explained the harsh sanitation situation found in Haor areas. It furthermore presented a number of (affordable) pit latrines modified to cope with the specific conditions found in these areas.

This paper will present a number of small-sized septic tanks that may serve one to five families. Their appropriateness for adoption in Haor areas will be tested in the first half of 2025.

Background

Technical Note 01 provides the complete background and sketches the current situation. Some key issues are copied below.

Haor is a wetland ecosystem in the northeastern part of Bangladesh. A Haor is a bowl-shaped shallow depression that, during the rainy season, collects massive volumes of surface runoff water, transforming into a vast stretch of open water . The area comprises of a mosaic of wetland habitats, including rivers, streams and irrigation canals, large areas of seasonally flooded cultivated plains, and hundreds of smaller and larger Haor settlements (known as Hatis). This area remains under water for up to six months of the year, turning Haor settlements mostly built on embankments or dikes, into islands.

The sanitation facilities found in Haor settlements are poor compared to other parts of the country[1]. Most toilets are located on land that gets flooded during the rainy season. The content of these toilet pits often overflows into the surrounding areas when flash floods occur. People often build temporary rudimentary toilets during the dry season, but these then have to be abandoned during the rainy season. This means that people may have to revert to using hanging toilets or defecating in the open.

Appropriate sanitation options

The Project has decided to adopt, and where necessary improve or modify, (affordable) technologies that have proven to be functional under 'normal' conditions. This because it is expected that it will be easier to introduce technologies that are commonly known and accepted by the targeted users.

Whereas Technical Note 01 dealt with household level sanitation options in the form of different types of pit latrines, this paper will deal with septic tanks that may serve one to five households.

It is expected that the options presented in this paper can be introduced in other areas with similar contexts. This may be with or without minor modifications.

Intro to septic tanks

A septic tank is a watertight chamber made of concrete, fibreglass, PVC, or plastic, for the storage and treatment of blackwater (and possibly greywater). A toilet that uses water for flushing can be attached to the inlet pipe of a septic tank.

The most common septic tank typically has two chambers. Most of the solids settle in the first chamber. The baffle, or the separation between the chambers, is to prevent scum and solids from escaping with the effluent.

The main function of a septic tank is to remove solids , allowing particles to either sink or float and develop a stratification of separate layers – a bottom sludge layer, a middle liquid layer, and a top layer of scum made up of grease and fine particles.

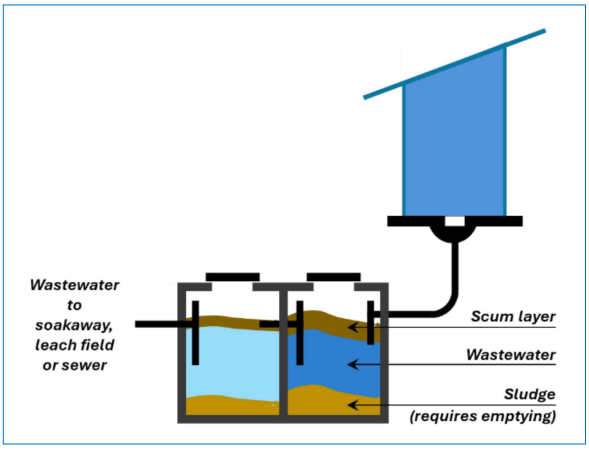


Figure 1: Simple septic tank design

The sewage (wastewater or effluent) enters the tank, where the heavy particles (inorganic solids and the by-products of bacterial digestion) sink to the bottom and the scum (fats, oils and greases) floats to the top. With time, the solids that settle at the bottom are degraded anaerobically. However, if the rate of accumulation is faster than the rate of decomposition, the accumulated sludge must be removed at some point. Generally, septic tanks should be emptied every two (2) to five (5) years.

The wastewater exiting the septic tank percolates or disperses directly into the subsurface soil or alternatively indirectly via a leach field, naturally removing harmful coliform bacteria, viruses, and nutrients.

The septic tank can be connected to a soak pit, infiltration trench, or a sewer system. Access covers are needed so that the tank can be inspected and emptied periodically.

[1] At the time of the baseline, the proportion of households that had access to safely managed sanitation was only 29%, compared to 51% for the entire Project area.

Larger, multi-chamber septic tanks are ideal for groups of houses and/or public buildings (i.e. schools).

Septic tanks should be adequately sized so that digestion processes inside the tank can develop fully. The biological processes which take place in a septic tank – which determine the extent to which solids are broken down and, in turn, influence the sludge accumulation rate – are slow to start initially .

Sludge accumulation rate in a septic tank refers to the amount of sludge that builds up in the tank over a certain period of time.

The rate at which sludge accumulates in a septic tank is determined by i) the number of users, ii) the amount of material entering the pit (human waste as well as other (non-degradable) material), and iii) the rate and extent to which the sludge degrades through biological processes.

Studies have found average sludge accumulation rates from as low as 21 litres per person per year (l/p/y) to as high as 100 l/p/y. In Bhutan, sludge accumulation rates were found to be in the range of 25-40 l/p/y. We have applied a rate of 40 l/p/y, but this needs to be substantiated during the trials.

The biochemical processes linked to methanogenic fermentation may only become effective after two (2) years of operation with the reduction in sludge accumulation becoming optimal only after 2.5–3 years. Studies have shown a declining trend in accumulation rates over time suggesting more efficient digestion of waste as biological processes are allowed to develop within the tank over time.

It is a rather complex science to determine accurate sludge accumulation rates. A range of geophysical and climatic factors, as well as biological processes, influence sludge accumulation and degradation. The rate of digestion of solid matter in septic tanks is also related to temperature. Septic tanks located in warmer climates have higher digestion rates than those in colder climates, impacting on sludge accumulation rates.

Septic tanks should ideally not be emptied during the first couple of years. However, if emptying is not done in time, the accumulated sludge within the septic tank will increase and as a consequence the hydraulic retention time[2] will get shorter, resulting in shorter treatment periods. The retention time should be 48 hours to achieve moderate treatment.

Single-family septic tank

This is a simple concept: one family, one toilet, one septic tank. Septic tanks can be made out of concrete, brick work, PVC, fibreglass, or plastic. This design makes use of prefabricated concrete rings as these are relatively inexpensive and widely available throughout Bangladesh.

The single-family septic tank is depicted in Figure 2.

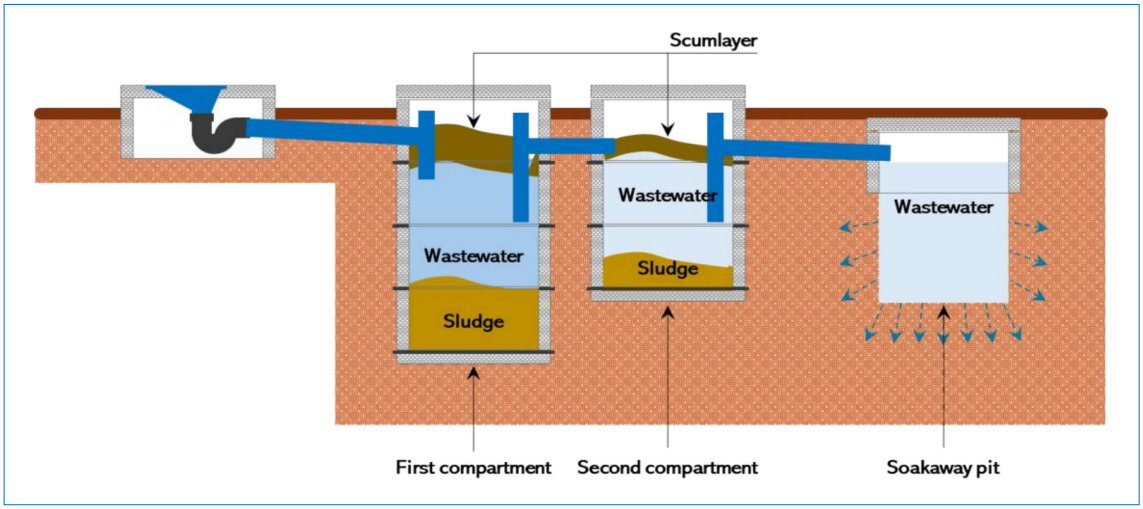


Figure 2: Single-family septic tank made from prefabricated concrete rings

The size of the septic tank can be adjusted to the exact requirements of the household by adding more or less concrete rings. The number of concrete rings required depends on the number of toilet users (number of family members[3]), the average annual sludge accumulation rate, and the average number of years the septic tank is to be emptied.

In Table 1 the calculations have been shown for a 4-rings and 5-rings septic tank. With an average annual sludge accumulation rate of 40 litres per person per year and a desludging frequency of a minimum of 2 years, a 4-ring septic tank would be adequate for a family of 3.9 persons, and a 5-ring septic tank for a family of 5.3 persons.

[2] Hydraulic retention time is the working liquid layer of the tank divided by the daily discharge of wastewater from the household.

[3] The average rural family size in Bangladesh is 4.5 persons.

Table 1: Pit calculations

	Effective pit volume	Time to fill up tank	Sludge production	Sludge accumulation rate	Family size
	In ltrs	In yrs	In ltrs/yr	In ltrs/pax/yr	In # of pax
3 rings	210	2	105	40	2,6
4 rings	**315**	**2**	**158**	**40**	**3,9**
5 rings	**421**	**2**	**211**	**40**	**5,3**
6 rings	526	2	263	40	6,6

A septic tank is suitable in a location where there is a reliable method for dispersing or transporting the effluent. In the case of the Haor areas, an onsite infiltration system – in the form of a soakaway pit or a leach field – is to be installed. However, it is unsure how these systems will perform during the rainy season as it is plausible that the ground will become oversaturated during that period. The test phase will therefore be used to determine the functionality of septic tanks during the rainy season.

If effectively used, with suitable handwashing facilities, these types of toilets can help prevent the spread of many excreta-related diseases.

This type of toilet does not automatically qualify as safely managed sanitation. This depends on what happens when the pit is full. Only when the contents of the pit are safely contained onsite, or safely removed, transported, treated, and disposed of or reused elsewhere, will this toilet qualify as safely managed sanitation.

Table 2: Pros and cons of septic tank

Pros	Cons
▪ Provides odour control because it is a sealed system ▪ Toilet parts (e.g. slab and rings) are easily available ▪ Simple and robust technology ▪ Durable and provides a long service life	▪ More expensive than the pit latrine options ▪ Requires skilled labour to construct ▪ Effluent requires appropriate discharge through an infiltration system in permeable soil ▪ Periodic emptying of sludge required ▪ Excreta being emptied is fresh and thus unsafe to handle

Design and construction considerations

1) Select a location suitable for the construction of the septic tank. Consider, for example, distance from own and neighbours' dwellings, stability of the soil, distance from water sources.
2) Dig two separate pits, one for each of the two compartments. The depth depends on the number of concrete rings required.
3) Install the two tanks. Start with placing a concrete slab at the bottom. Then, stack the first concrete rings on top of the concrete slab. Ensure that cement mortar (1:4) is used to fix the concrete ring to the concrete slab. Continue placing the concrete rings on top of each other. Seal the joints between all the rings to ensure a watertight fit.

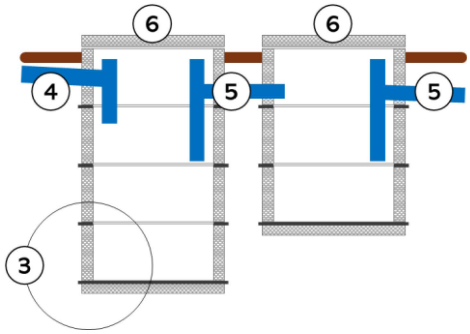


Figure 3.1: Specifications of single-family septic tank

4) Fit the inlet pipe into the top concrete ring of the first compartment. This a T-shaped inlet so that the scum layer cannot block the entrance.
5) Fit the outlet pipes also in the top concrete ring of the first and second compartment. These are also T-shaped outlets to prevent the sludge and scum from leaving the tank and blocking up the soakaway pit or leach or drainage field. These outlets should be placed 100-150 mm lower than the inlet pipe.

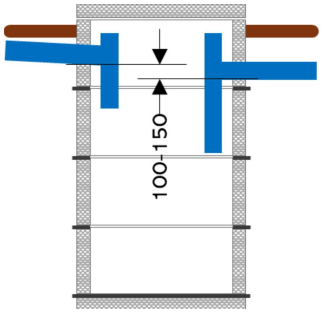


Figure 3.2: Specifications of single-family septic tank

6) Place the covers (concrete slabs) on the two compartments. Use a lean cement mortar mix (1:5 or 1:6) to seal the joint. This will make it possible to remove the covers for inspection and emptying purposes.
7) It may be wise to fit a screened ventilation pipe in the two compartments. This will allow the gases produced during anaerobic digestion to escape.

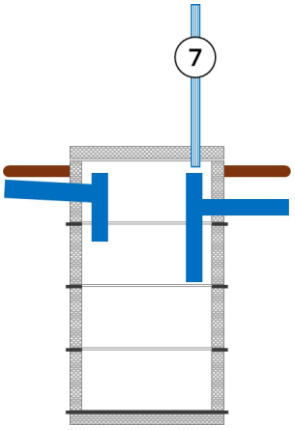


Figure 3.3: Specifications of single-family septic tank

The ventilation pipe should be at least 5 cm in diameter. It should have mesh covering the top to control flies and mosquitoes.

8) Install a separate soakaway pit. A soakaway pit is probably the easiest option although it is not entirely certain how this pit will function during the rainy season. This is something that needs to be tested during the trial phase. A soakaway is basically an unlined pit that stores the wastewater exiting the septic tank and gradually allows it to percolate into the surrounding soil. Alternatively, leaching or drainage fields can be used to dispose of the wastewater.

9) After the septic tank has been installed, the toilet can be connected to it. Use a pan with a functioning water seal to reduce smells and prevent mosquitoes and flies from exiting the pit and entering the toilet cubicle.

Alternatively, in case of insufficient space to install the two-compartment septic tank and soakaway pit, it might be possible to place them somewhere further away as shown in Figure 4. The cover slab needs to be properly sealed if and when the pits are situated at a lower level to avoid flood water from entering the pit.

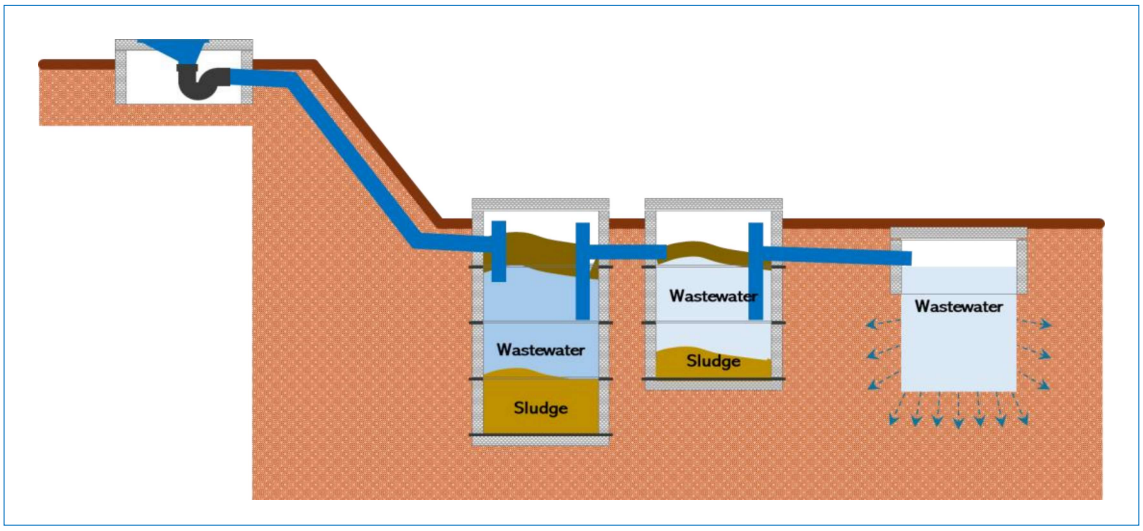


Figure 4: Alternative location of septic tank

Operation and maintenance considerations

1) Clean the slab and the inside of the toilet cubicle regularly to ensure the toilet is hygienic and safe to use.
2) Unblock the water seal if solid materials are accidentally dropped into the toilet or if it becomes blocked by faeces or wiping materials.
3) Septic tanks should be checked regularly (twice a year) to make sure they are working correctly and to check if they are full.
4) Caution should be taken when opening access covers, as potentially dangerous gases may be released from the tank.
5) Sludge must be emptied periodically, approximately every 2-5 years, depending on the size of the tank.
6) Septic tanks should ideally be emptied using a machine, such as a hand-operated gulper.

Note:
Septic tank emptying considerations are provided towards the end of this paper.

Multi-family septic tank

Larger, multi-compartment septic tanks are ideal for groups of houses. Decentralized wastewater treatment systems (DEWATS) have been installed for use by 50-100 rural or peri-urban households. However, since the Project has less than two (2) years to go, it was decided not to pilot potentially complex community management systems.

Smaller systems, on the other hand, that serve two (2) to five (5) households are an interesting alternative that will be explored. Septic tanks can be made out of concrete, brick work, PVC, fibreglass, or plastic. Two different options will be explored: rectangular shaped septic tanks made of concrete and brick, and round prefabricated septic tanks made out of plastic (or polyethene).

The rectangular septic tank made out of concrete and brick is depicted in Figure 5.

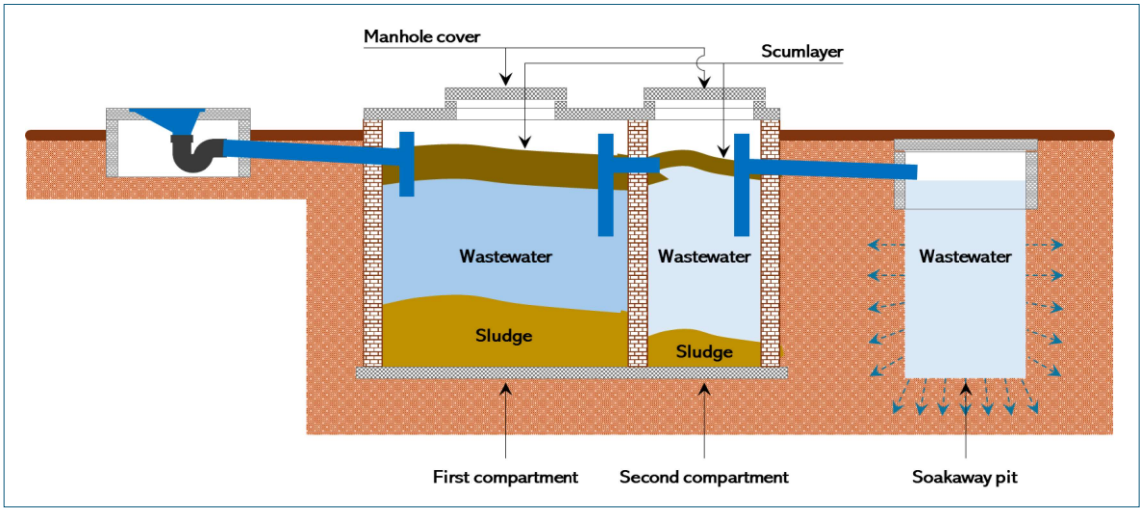


Figure 5: Rectangular septic tank | Two compartments (for four to five families)

The size of the septic tank can be adjusted to meet the requirements of the number of households that are to be connected to it. The actual size can be calculated once the number of households, the average annual sludge accumulation rate, and the average number of years the septic tank will need to be emptied are known.

Table 3 presents the calculations for septic tanks for 2, 3, 4 and 5 families. These are based on an average family size of 4.5 persons, an annual sludge accumulation rate of 40 litres per person per year, and desludging frequency of a minimum of 2 years have been used.

Table 3: Septic tank volume calculations

Sludge production				Required pit volume
# of families	# of pax	Ltr/pax/year	Ltr/year	2 yr (in m3)
2,0	4,5	40	360	**0,7**
3,0	4,5	40	540	**1,1**
4,0	4,5	40	720	**1,4**
5,0	4,5	40	900	**1,8**

When the required volumes are known, it is possible to calculate the dimensions of the different septic tanks. The size and shape of the septic tank are critical for its functionality. Therefore, the minimum effective depth should be at least 1 metre, the minimum width should be 0.75 metre, and the length should be at least twice the width of the tank. The size calculations are shown in Table 4.

Table 4: Septic tank size calculations

		Size of septic tank		
# of families	Capacity	Depth	Breadth	Length
2,0	0,7	1,00	0,60	1,20
3,0	1,1	1,00	0,73	1,47
4,0	1,4	1,00	0,85	1,70
5,0	1,8	1,00	0,95	1,90

The 4- and 5-family sized septic tanks should be constructed with two compartments (as shown in Figure 5). The 2- and 3-family sized septic tanks, on the other hand, can best be constructed as one compartment septic tanks as they are relatively small in size (as shown in Figure 6).

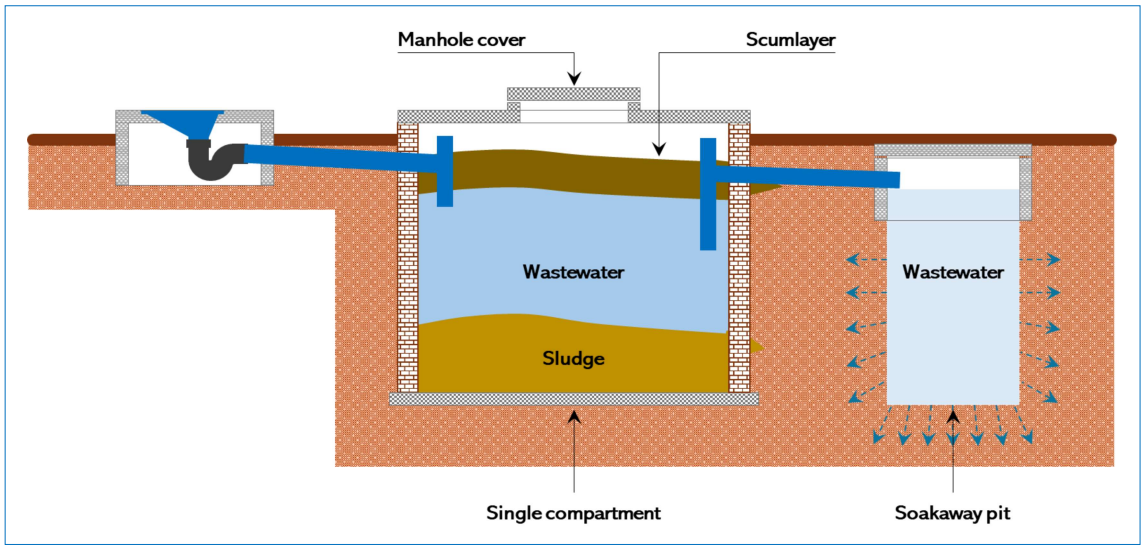
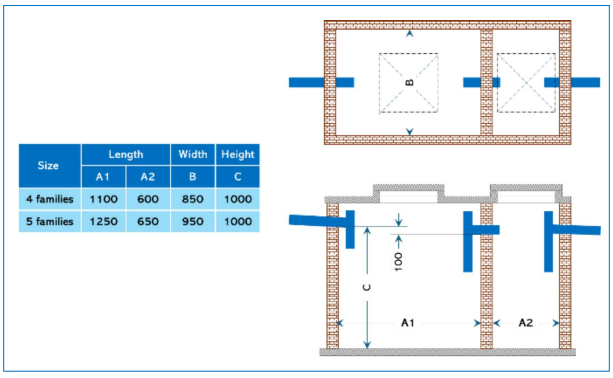


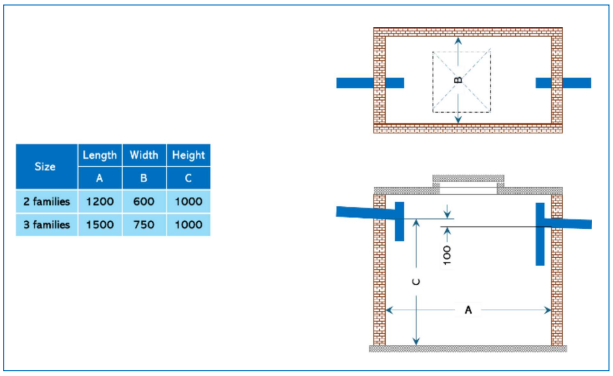
Figure 6: Rectangular septic tank with one compartment (for two to three families)

The different types of tanks with their individual dimensions are shown in Figures 7 and 8.



Size	Length		Width	Height
	A1	A2	B	C
4 families	1100	600	850	1000
5 families	1250	650	950	1000

Figure 7: Dimensions for 4 and 5 family's septic tank



Size	Length	Width	Height
	A	B	C
2 families	1200	600	1000
3 families	1500	750	1000

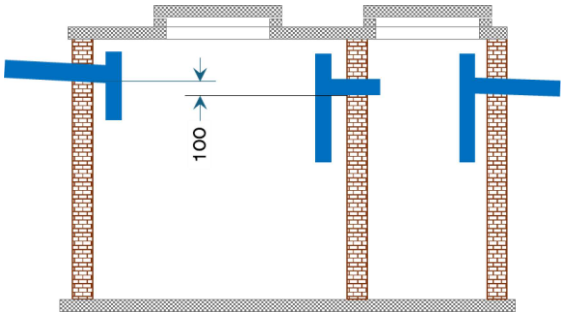
Figure 8: Dimensions for a 2 and 3 family septic tank

If effectively used, and with suitable handwashing facilities, these types of toilets can help prevent the spread of many excreta-related diseases.

This type of toilet does not automatically qualify as safely managed sanitation. That depends on what happens when the pit is full. Only when the contents of the pit are safely contained onsite or safely removed, transported, treated, and disposed of or reused elsewhere will this toilet qualify as safely managed sanitation.

Design and construction considerations

1) Select a location suitable for the construction of the septic tank. Consider, for example, distance from own and neighbours' dwellings, stability of the soil, distance from water sources.
2) Dig a pit big enough to accommodate the septic tank. Dimensions are provided in figures 7 and 8. The pit must be large enough for at least two people to work in.
3) First, pour the concrete floor. Make sure the concrete floor is slightly bigger than the dimensions of the tank.
4) After that you can build the tank. The walls are best built using bricks, with a recommended thickness of one brick. Ensure that the walls are watertight.
5) Fit the inlet pipe into the first compartment. This is a T-shaped inlet, so that the scum layer cannot block the entrance. Take note of the dimensions and the height, it needs to be fitted above the concrete floor.
6) Fit the outlet pipes also in walls of the first and second compartments. These should also be T-shaped outlets to prevent the sludge and scum from leaving the tank and blocking up the soakaway pit or drainage field. These outlets should be placed 100-150 mm lower than the inlet pipe.



7) Pour the concrete slab on the top of the tank. Make sure you can enter the compartments by constructing two manhole covers (one for each compartment). Place the manhole covers from a lean cement mortar (1:5 or 1:6) to seal the joints. This will make it possible to remove the covers for inspection and emptying purposes.
8) Install a separate soakaway pit. A soakaway pit is probably the easiest option, although it is not completely sure how this pit will function during the rainy season. This is something that needs to be tested during the trial phase. A soakaway is basically an unlined pit that stores the wastewater exiting the septic tank, allowing it to slowly release into the ground. Alternatively, leaching or drainage fields can be used to dispose of the wastewater.
9) After the septic tank has been installed the toilets can be connected to it. Use pans with a functioning water seal to reduce smells and prevent mosquitoes and flies from exiting the pit and entering the toilet cubicle.

Connecting households to the septic tank

To connect households to a multi-family septic tank, a number of issues should be considered:

- Group households that are close together and on a similar slope for a multi-family septic tank.
- Use small-diameter pipes (usually 100–200 mm).
- Use PVC or HDPE pipes for durability and affordability.
- Pipes laid at shallower gradients (e.g., 1 in 100 or flatter).
- Minimum excavation should be done.
- Run lateral pipes along the shortest path to the main line.
- Use gravity flow (no pumping).
- All lateral pipes should lead to a main collection line that enters the septic tank compartment.
- Place an inspection chamber at the junction (where lateral pipes connect to the main collection line).
- Ensure access for maintenance with basic tools.

Operation and maintenance considerations

1) Clean the slab and the inside of the toilet cubicles regularly to ensure the toilet is hygienic and safe to use.
2) Unblock the water seals if solid materials are accidentally dropped into the toilets or if it becomes blocked by faeces or wiping materials.
3) Septic tanks should be checked regularly (twice a year) to make sure they are working correctly and to check if they are full.
4) Caution should be taken when opening access covers, as potentially dangerous gases may be released from the tank.
5) Sludge must be emptied periodically, approximately every 2-5 years, depending on the size of the tank.
6) Septic tanks should ideally be emptied by using a machine, such as a hand-operated gulper.

Septic tank emptying considerations

Emptying septic tanks in a Haor setting would be different from emptying in an urban setting. As proper mechanical emptying and treatment are not possible in Haor settings, the emptying considerations are written to ensure that safe handling and safe disposal are a priority. It is expected that the emptying will be done manually by using locally available pumps. Precautions to ensure the safety of the emptier and thus avoiding human contact with faecal matter, are necessary[4].

The septic tank requires regular and periodic cleaning to avoid the build-up of sludge and eventual escape of the effluent into the soakaway pit or drainage field. If this happens, it may clog the soakaway pit or drainage field.

The periodic time interval at which the tank must be emptied depends on the volume of the tank in relation to the input of solids, the amount of indigestible solids, and the ambient temperature. In general, septic tanks rarely require cleaning more than once a year, and by careful management, many users can limit emptying to every three (3) years[5].

While cleaning the septic tank, care should be taken that only a small residue of sludge should be left in

[4] Septic Tank Emptying Guideline. https://itn.buet.ac.bd/web/resources/training-manual-for-emptying-of-septic-tanks/

[5] Training Module on Design, Construction and Maintenance of Sanitation Containment- Septic Tank, Soak Pit and Pit Latrine. https://itn.buet.ac.bd/web/resources/training-module-on-design-construction-and-maintenance-of-sanitation-containment-septic-tank-soak-pit-and-pit-latrine/

the tank. Anaerobic decomposition is rapidly restarted when the tank refills.

Take note of the following when emptying the septic tank:

- At least two trained personnel should empty a septic tank.
- It is best to empty a septic tank during the dry season, so before the start of rainy season.
- Personnel must take all necessary precautionary measures for health and safety.
- Personnel must carefully open the manhole cover of the septic tank.
- Then the pump hose can be inserted into the tank to empty it.
- In case of manual emptying, a bucket with a rope should be used to empty the tank.
- A hole should be dug nearby where the emptied septage should be deposited.
- The hole should be covered with soil once the emptying is complete.

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