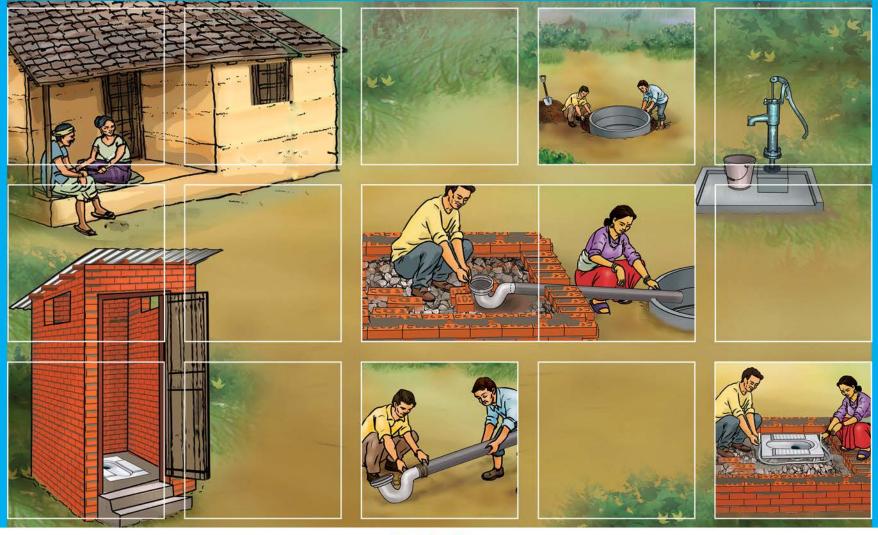
# **Toilet Construction Handbook for Masons**









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# **1. Introduction**

#### Rationale

With the aim of becoming an "Open Defecation Free" country by the end of 2017, Nepal has seen a rapid increase in the construction of toilets in recent years. These toilets generally comply with the national definition of an improved toilet and have a permanent structure up to the plinth level. Assessments of toilets have however shown that quality of construction remains a challenge in all parts of the country which leads to leakages, smell, and disrepair. Poorly constructed toilets may also be uncomfortable for the users. A key factor of poor quality is the inadequate technical knowledge of masons, many of whom have developed their own skills through experience.

The aim of this handbook is to provide technical details on the key steps of toilet construction which can guide masons on making quality toilets and upgrading existing toilets. The handbook has been finalised after testing with masons in three terai districts (Siraha, Mahottari, and Sarlahi).

#### **Target audience**

The intended primary audience of this book is masons and sanitation technicians who are engaged in toilet construction. Although the pit construction is oriented toward the ringed structures found in the terai, other parts of construction (pan and pipe, superstructure etc.) also respond to the typical mistakes found in the hill and mountain areas. This handbook can also be used by social mobilisers and field supervisors to monitor quality of construction.

#### Toilet

The Sanitation and Hygiene Master Plan (NSHMP 2011) has defined an improved toilet as one that hygienically separates human excreta from human contact. It further recommends all toilets to have a permanent structure up to the plinth level. Therefore, all toilet options in this handbook meet these criteria, are durable, and minimise the risk of disease transmission.

## In Nepal the following, options are considered as an improved toilet:

- a. Flush or pour-flush to:
  - Piped sewer system
  - Septic tank system
  - A pit
- b. Ventilated improved pit (VIP) toilet

#### **Basis for toilet selection**

There are a number of factors that play an important role in selecting a desired toilet. Some key factors are as follows:

- Cost/affordability
- Water availability
- Geological condition: soil type, water table
- Cleansing habit
- Space availability

- Social norms, cultural habit
- Faecal sludge emptying systems
- Availability of sanitation products and services

# 2. Tools and materials



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# 3. Site selection and orientation

#### a. Location



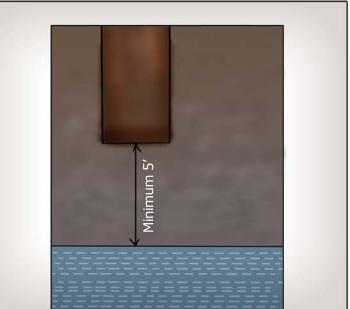
- Toilet should be constructed close to the house for easy access by all members
- Horizontal distance between toilet pit and groundwater source (e.g. well) should be minimum 33 ft
- In case groundwater source is less than 33 ft away, the inner side of the pit wall should be sealed

#### c. Orientation

• Toilet door should not face directly towards the house, courtyard, or public path so that female members can use the toilet with privacy (not illustrated)

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#### **b.** Distance to groundwater

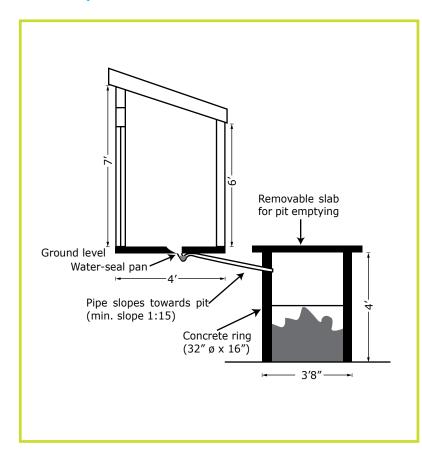


 Minimum vertical distance (safety gap) between bottom of pit and groundwater table should be 5 ft

# 4. Construction of single-pit, offset, water-seal toilet

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#### 4.1 Layout and schematic





#### 4.2 Features

#### Suitability: Low groundwater table

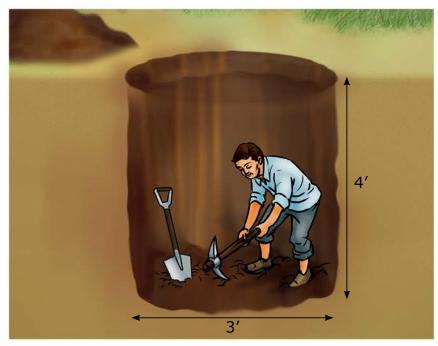
Advantage	Disadvantage
Odour free	Water is needed for flushing excreta
Easy to clean	Skilled mason is needed for construction
Easy access to pit for faecal sludge emptying	Risk of ground or surface water contamination if constructed near water points
Possible to upgrade to a double-pit, offset toilet	Requires more land for construction than a direct pit toilet
	Faecal sludge needs to be emptied from pit every 3-5 years

#### 4.3 Required estimation (up to plinth level)

SN	Items	Unit	Qty.	Rate	Amount
Α.	Materials				
1	Concrete ring (32" ø x 16")	Nos.	3		
2	Ring cover	Nos.	1		
3	Cement	Bag of 50 kg	2		
4	Sand	Cement bag	10		
5	Gravel	Cement bag	3		
6	Brick	Nos.	280		
7	Pan with siphon	Set	1		
8	HDPE pipe 4"	ft	3		
В.	Human resources				
1	Skilled mason	Person-days	2		
2	Labour	Person-days	3		

#### **4.4 Pit construction**

#### a. Excavation



- Diameter of excavated pit should be 4 in. bigger than the ring diameter (i.e. 2 in. gap between ring and pit wall)
- Depth of excavated pit depends on the number of rings used and the height of the groundwater table (maintain minimum safety gap)
- For standard-size concrete rings (32" ø x 16") and a 3-ring pit, pit dimensions should be:

Diameter: 3 ft

Depth: 4 ft

• A layer of sand and fine gravel should be spread across the bottom of the pit to help disperse flow

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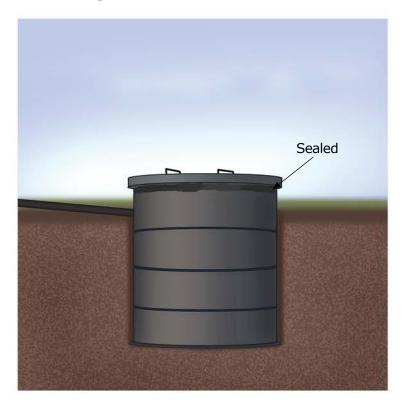
#### **b.** Ring laying



- Rings should be laid one above another carefully
- Top ring should extend at least 8 in. above the ground to prevent surface water from entering the pit
- Gap between ring and pit should be filled with sand. It will soak water from pit (not illustrated)
- In raised pit latrines, any rings fully above the ground should be sealed with cement sand mortar (not illustrated)

#### 4.5 Slab cover

#### a. Sealing of slab



- Top ring should be covered by a RCC slab having two handles (for ease of lifting at the time of emptying)
- Joint of ring and RCC slab should be sealed by using mixture of clay, dung and husk to prevent water from entering inside the pit

b. Soil filling



• Pit should be covered by soil to minimum above the handles of RCC slab for safety purpose

#### 4.6 Plinth construction

#### (For a standard 4 ft x 3.5 ft super structure)

#### a. Foundation



- Foundation size varies with size of super structure
- For standard-size super structure, size of foundation should be:

Base length: 4 ft 10 inBase width: 4 ft 4 inTrench width: 1 ftTrench depth: 1 ft

#### b. Brick work up to plinth level



- A 2 ft high foundation wall should be made starting at the base of the foundation trench (i.e. up to 1 ft above ground level)
- Width of foundation wall in the trench should be one full brick length; bricks should be laid above each other in a perpendicular manner
- Mortar of 1:5 cement, sand ratio should be used for wall construction
- After the foundation wall has set fully, the foundation wall should be filled up with clay or sand up to siphon level (not illustrated)

#### 4.7 Pipe and siphon fitting

#### a. Pipe heating

b. Pipe and siphon joining



- HDPE pipe should be heated to a point so that it can regain its original shape after cooling down (overheating causes loss of elasticity)
- Immediately after heating, the siphon should be inserted inside the heated pipe
- Overlap joint of the pipe and siphon should be tied up with rope so that the pipe will grip the siphon tightly and minimise any chance of leakage
- Cold water should be poured to cool the joint of the pipe and siphon, and help grip the siphon tightly (rope should be removed afterwards)

#### 4.8 Siphon setting

#### a. Siphon placing

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- Siphon with pipe should be placed level on the sand/clay filling of the foundation
- Siphon should be placed in the middle of the toilet widthwise and at least 11 in. far from the rear wall
- Slope of the pipe should be 1:15 (1 ft height for every 15 ft length)

• Water level should be checked inside the siphon (refer to 4.9a)

b. Compacting side of siphon

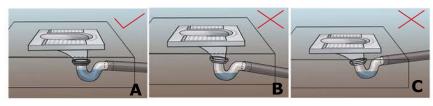
• Sand or clay should be filled up to the collar of the siphon and compacted to prevent the siphon from tilting

#### 4.9 Pan and siphon setting

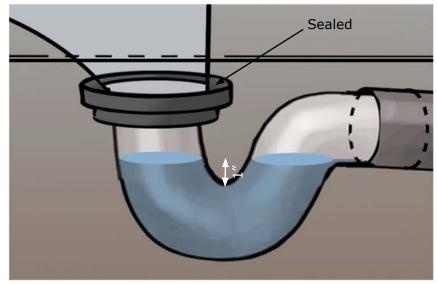
#### a. Pan setting



- Pan should be placed on the collar of the siphon
- Minimum gap between the end of the pan and rear wall should be 8 in
- The level of the pan should be checked by using a level pipe
- Water level should be maintained at least 1 in. above the bend of the siphon (refer to 4.9b)
- The correct position of the pan and siphon, and water level is shown in illustration below



#### b. Sealing of pan and siphon joint



- Jute or cotton cloth dipped in cement paste should be placed inside the collar of the siphon to seal the joint of the pan and siphon
- The level of the water inside the siphon should be checked again
- Final sealing should be done by using cement paste around the joint of the pan and siphon above the jute or cotton cloth and left to dry for 24 hours

#### 4.10 Floor construction

#### a. Shoaling and leveling the floor

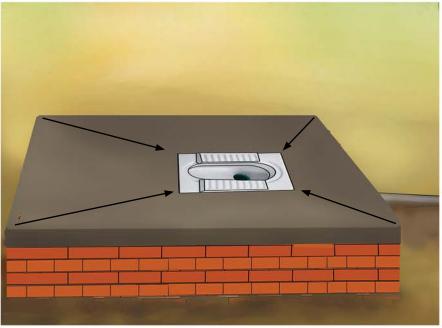


- After the joint seal has set, sand or clay should be filled underneath and to the side of the pan and compacted
- Brick or stone shoaling should be done up to 2 in. below the height of the pan
- A wooden frame of 3-4 in. height should be fixed on the shoaling and outer surface of the brick wall
- A mark should be made on one corner of the wooden frame to determine the thickness of the PCC flooring; this should be 0.5 in. above the pan
- A level pipe should be used to mark the other three corners of the wooden frame

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#### b. Floor concreting and finishing

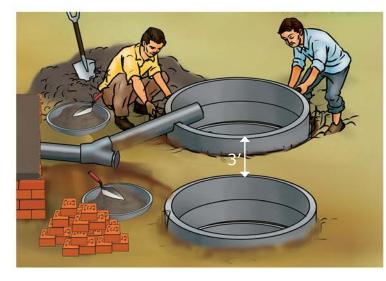


- Concrete of 1:2:4 cement, sand and gravel should be filled up to the mark on the wooden frame and level with the pan
- The concrete should be compacted followed by smooth finishing with a 1:1 cement, sand paste
- The slope of the floor should be be maintained towards the pan from all directions (as shown in illustration)

# 5. Construction of double-pit, offset, water-seal toilet

All the construction processes from pit excavation to floor construction are the same as for a single-pit, offset toilet. Major aspects that need to be considered in the construction of a double-pit toilet are: the distance between the pits and pipe joints for using soak pits alternatively.

#### 5.1 Distance between two pits 5.2 Pipe joining



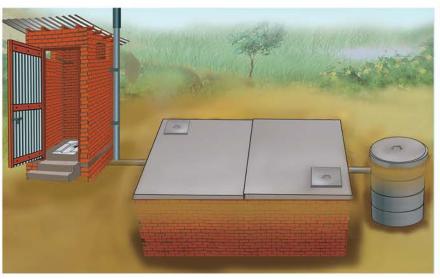
• The distance between two pits should be at least 3 ft to prevent water from one pit infiltrating into the second pit



- A Y or tee joint fitting should be used at the outlet of the sub-structure to connect pipes to the soak pits; the connection should be fixed using cotton or jute cloth with cement paste as an adhesive
- The length of the pipe from the Y or tee joint of the sub-structure up to each soak pit should be at least 3 ft
- A pipe should be connected from the outlet joint to only one pit at a time and the second outlet should be plugged by a joint cap
- After the first pit has filled up, the pipe to this soak pit should be removed and fixed with an adhesive cloth to the outlet for the second pit; the joint cap is then placed on the outlet for the first pit

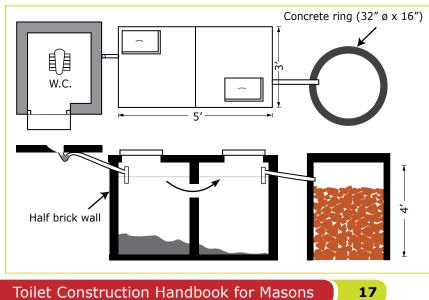
# 6. Toilet with septic tank and soak pit

### 6.1 Schematic and layout



#### 6.2 Size of the septic tank





A septic tank should have minimum two chambers for effective separation of solids and reduction in pollutants. The size of the septic tank varies with the number of users.

No of users	Length	Width	Depth
5	5 ft	3 ft	3 ft 3 in
10	6 ft 6 in	3 ft	4 ft 6 in
15	6 ft 6 in	3 ft	8 ft 6 in
20	7 ft 6 in	3 ft 6 in	8 ft 6 in

#### **6.3 Brick wall construction**



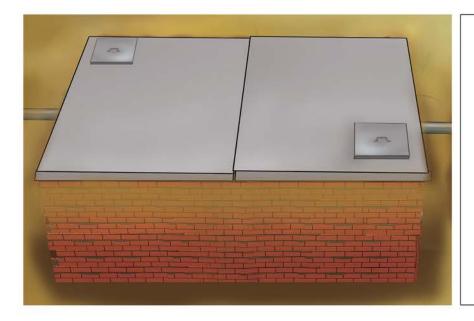
- Shoaling should be done on the floor of the septic tank using brick or stone
- Mortar of 1:5 cement, sand ratio should be used for wall construction
- Concrete of 1:2:4 cement, sand and gravel mixture and 2 in. thickness should be filled on the floor
- The gap in the baffle wall should be two-thirds from the bottom of the tank

#### 6.4 Pipe connection and wall finishing



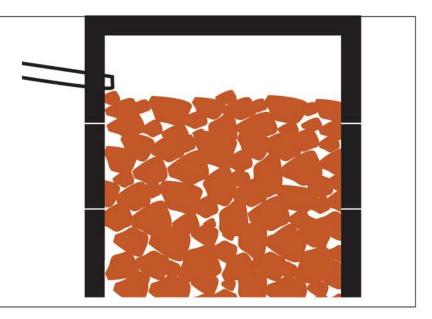
- The inlet and outlet pipes should be connected to the septic tank using tee joints (to prevent scum layer from exiting with the effluent)
- The height of the inlet pipe should be 2 in. above the outlet pipe
- The outlet pipe should be connected to a soak pit
- The walls and floor of the septic tank should be plastered using 1:4 cement, sand mortar from the inside

#### 6.5 Septic tank cover slabs



- The slab covers of the septic tank should be 1 in. larger than the dimensions of the tank
- Each chamber should have a separate slab cover and manhole
- Slab covers should be casted using reinforced concrete of 1:2:4 cement, sand and gravel mixture

#### 6.6 Soak pit construction



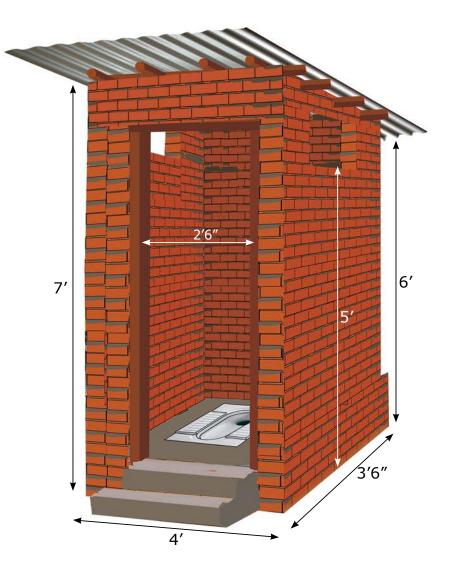
- The soak pit can be lined with concrete rings (not plastered from the inside) or dry brick wall and left empty from inside (optional to fill with coarse rocks or gravel or brick bats)
- Alternatively, the pit can be left unlined and filled with coarse rocks and gravel below the pipe level to prevent it from collapsing
- The minimum vertical distance between the bottom of the pit and groundwater table should be 5 ft to prevent groundwater contamination

# 7. Super structures

## 7.1 Dimension of super structure

Two types of super structures can be built to house the toilet - permanent or temporary. The standard size of a super structure is as follows:

- Floor size (inside toilet): length 3 ft 4 in, width 2 ft 10 in
- Toilet size (outside)\*: length 4 ft, width 3 ft 6 in
- Wall height: front 7 ft, rear 6 ft
- Door size: height 6 ft, width 2 ft 6 in
- Height of door latch: 2 ft 6 in (should be easily reachable for children and people with disabilities)
- Height of ventilation window from floor: 5 ft from floor
- Size of ventilation window: width 1 ft, height 8 in
- Height of vent pipe: 6 in above the highest roof point (not shown)
- Light fixture is recommended inside



\*Outside dimensions of toilet floor will vary depending on the thickness of the material used to construct the toilet wall.

## 7.2 Type of super structure

#### Super structure: wall and roof materials

Structure type	Illustration	Material details	Advantage	Disadvantage
Straw house		<ul> <li>Wall and roof materials: straw/thatch</li> </ul>	<ul> <li>Low cost</li> <li>Local materials</li> <li>Skilled mason not needed for construction</li> <li>Ventilation can be created at the top of the wall by making a space between the roof and the wall</li> </ul>	<ul> <li>Temporary structure</li> <li>Needs regular repair</li> <li>Maintaining privacy is difficult if not constructed properly</li> <li>Placing door latch might be difficult</li> </ul>
Bamboo house		<ul> <li>Wall materials: bamboo</li> <li>Roof materials: straw/thatch</li> </ul>	<ul> <li>Low cost</li> <li>Local materials</li> <li>Skilled mason not needed for construction</li> <li>Ventilation can be created at the top of the wall by making a space between the roof and the wall</li> <li>Can be easily upgraded to clay- or cement- plastered wall structure</li> </ul>	<ul> <li>Temporary structure</li> <li>Roof material needs to be replaced periodically</li> <li>Needs regular repair</li> <li>Maintaining privacy is difficult if bamboo is not fixed properly</li> </ul>
Clay-plastered house		<ul> <li>Wall materials: bamboo or straw wall plastered with clay on both sides</li> <li>Roof materials: straw/thatch</li> </ul>	<ul> <li>Low cost</li> <li>Local materials</li> <li>Skilled mason not needed for construction</li> <li>Privacy can be maintained</li> </ul>	<ul> <li>Temporary structure</li> <li>Roof material needs to be replaced periodically</li> <li>Needs regular repair- clay will erode through contact with water</li> <li>Wall may collapse if not constructed properly</li> </ul>

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Zinc sheet	• Wall and roof materials: CGI sheet	<ul><li>Semi-permanent structure</li><li>Privacy can be maintained</li></ul>	<ul> <li>Semi-skilled mason needed for construction</li> <li>Toilet becomes hot during the summer and noisy during the monsoon rain</li> </ul>
Wooden house	<ul> <li>Wall materials: wood</li> <li>Roof materials: CGI sheet</li> </ul>	<ul> <li>Semi-permanent structure</li> <li>Privacy can be maintained</li> </ul>	<ul> <li>Semi-skilled mason needed for construction</li> <li>Maintaining privacy is difficult if wood is not fixed properly</li> </ul>
Stone house	<ul> <li>Wall materials: stone</li> <li>Roof materials: CGI sheet</li> </ul>	<ul> <li>Permanent structure</li> <li>Privacy can be maintained</li> <li>Maintenance is easy</li> </ul>	<ul> <li>Skilled mason needed for construction</li> <li>Costly</li> </ul>
Brick house	<ul> <li>Wall materials: brick</li> <li>Roof materials: CGI sheet</li> </ul>	<ul> <li>Permanent structure</li> <li>Can use both clay and cement mortar for laying bricks</li> <li>Privacy can be maintained</li> <li>Maintenance is easy</li> </ul>	<ul> <li>Skilled mason needed for construction</li> <li>Costly</li> </ul>

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# DEVELOPMENT WORKS