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Technical Guidelines for Household Latrine Design and Construction

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Contents

PART 1: GENERAL INTRODUCTION

1.1 Introduction of the Household Latrine Design and Construction Guide

The document for household latrine design and construction was developed in the framework of generating demand under the Sanitation Marketing (SanMark) programme for implementing the Rural Sanitation Model and Strategy in Ghana. This document will provide basic knowledge on household latrine design and construction to latrine artisans, Environmental Health Officers(EHOs), Community Led-Total Sanitation (CLTS) Field Facilitators, Technical Service Providers (TSPs), Community Technical Volunteers (CTVs), Natural Leaders and other WASH actors so they can ensure the construction of appropriate latrines.

1.2 Background

Household latrines, when planned, designed, constructed and managed properly can contribute significantly to improved public health. Appropriate and affordable solutions for safe excreta disposal should meet the following criteria;

- Safe to use
- User friendly and promote social inclusiveness with emphasis on acceptance by the both female and male users, physically challenged, infants and the aged.
- Disposal of excreta in a manner that does not pose a health risk
- Provision of adequate privacy.

The document presents a guideline for construction of toilet technologies in Ghana. This technical guideline is intended to provide guidance for practitioners, artisans, engineers, environmental health officers, water and sanitation planning units of district, municipal and metropolitan assemblies in design and construction of latrines.

1.3 What is a latrine?

A latrine is a toilet or an even simpler facility that ensures the total isolation of human faeces, preventing animals or insects' contact with untreated human faeces. A hygienic

latrine is capable of eliminating the pathogens inside the faeces, not creating foul smells or contaminating the environment. In order to achieve these objectives, the latrine must ensure separation of human-faeces contact, decomposition and stabilisation of faeces to eliminate pathogens and must be convenient and accepted by users. It must not contaminate the soil, pollute underground water resources, create foul odour, attract flies and other vectors.

1.4 Why Build a Latrine?

Unsanitary conditions threaten the health of the human population and the sustainability of the environment. Approximately 85% of the Ghanaian population does not have access to improved sanitation. In addition to the indignity suffered by those lacking sanitation facilities, majority of the people are susceptible to diseases contracted through direct and indirect contact with pathogenic bacteria found in human excreta. Inadequate sanitation is one of the key indicators of rural and urban poverty and overcrowded and unhealthy living conditions of the poor in developing countries. A latrine is a safe and private place to be used for defecation. A wide range of latrines are used in households, schools and other agencies. Using an improved latrine provides the following impacts;

- Improves health conditions
- Promotes dignity of living or enhanced quality of life
- Improves productivity
- Poverty alleviation
- Improves water quality
- Protects the environment

1.5 Types of Latrine Technologies

Latrine technologies can be broadly categorized as;

- **Dry Latrines** - A dry toilet is a toilet that operates without flush-water. Dry latrines may have a raised pedestal on which users can sit, or a squat pan over which users squat. In both cases, excreta (both urine and faeces) falls into the excreta containment through a drop hole. Examples of dry latrine systems include simple pit latrine, Ventilated Improved Pit (VIP), Kumasi-Ventilated Improved Pit (KVIP) latrine, Enviro Loo toilet, Ecological Sanitation toilet (Composting and Urine Diverting Dry Toilet),
- **Wet Latrines** – These are systems that rely on water to be functional. Wet systems could be off-site or on-site.

- **On-site systems** – With these systems human excreta are isolated, stored and treated on the site of defecation in a way that is hygienic and does not adversely affect the environment. Examples of on-site systems include Pour-flush toilets, water closet with septic tanks, Biofil toilet, biogas digester, aqua privy etc
- **Off-site systems** – These systems often take on the form of sewerage systems which require a reliable water supply and the provision of wastewater treatment plants. Off-site sanitation systems generally involve the construction of long lengths of permanent infrastructure.

1.6 General Structure of a Latrine

A latrine is made of 3 main components:

1. The substructure: is used to collect and treat human faeces. This component can be built of bricks or simply a pit dug into the soil. The size and structure of this component depends mainly on the type of latrine and number of its users. This is the most important part of a latrine.
2. The User Interface: is used to support the users. It is the pedestal or pan with which the user comes in contact. It is the way by which the user accesses the latrine. Can be made with wood, concrete, Ceramics or other locally available materials
3. The superstructure: is the top and surrounding cover of the latrine that helps protecting the users from sunlight, rainwater and also provides privacy and protection to the user interface. The latrine walls can be built from bricks, bamboo plates or even canvas. The roof can be palm leaves, tiles or fibre cement sheets

1.7 Planning to Construct a Latrine

Before the decision to construct a latrine is made, there are many things to consider.

1. Type of latrine
2. Where to build your latrine
3. Digging and lining the pit
4. The covering slab (sanitation platform)
5. Size of squat hole
6. Including a handwashing station

7. Method of emptying/desludging
8. Possible reuse of faecal sludge

PART 2: CONSIDERATIONS FOR LATRINE CONSTRUCTION

2.1 General Guidelines for Latrine Site Selection

Getting the location right is very important in ensuring the use of the facility, reducing its risk to public health and nuisance to the environment. Right positioning of the facility away from adverse environmental conditions can enhance the operational life, e.g. positioning the toilet system outside the course of run-off can help prevent the effects of erosion. In selecting a site for a latrine, the location of wells and surface water sources, for example ponds, swamps, creeks, rivers etc. must be clearly established. The following guidelines should be used for the siting of latrines

- Identify a suitable place to build the latrine. The location should be chosen based on the preference of the household. The location should be convenient and accessible to all users
- The location should be relatively flat and in case of a sloping site, ensure that the site is levelled before construction
- A latrine must not be located close to a water body (well, river, stream) and should be at least 100 feet (30 m) from the edge of the flood plain of a surface water body.
- Pit should be at least 6 metres away from kitchen and 30 metres from source of water
- Latrines should be sited away from trees to prevent obstruction of vent pipes.
- In the selection of soil conditions on which to construct the latrines, avoid (if possible) rocky outcrops, unstable ground conditions and depressions with shallow water table.

2.2 Design Criteria for Household Latrines

The table below presents basic design criteria for design and construction of on-site household latrine.

Latrine Types	Latrine Technologies	Number of Users	Design Parameters	Standards
Household latrine	KVIP	10 persons per drop hole	Sludge Accumulation Rate	0.06m^3/person/ year (dry latrines
	VIP			0.04m^3/person/ year (wet latrines
	Pour-flush latrines		Desludging Frequency (T)	2 years
	UDDT		Depth of Pit (d)	2-3 m
	Composting Toilets		Free board	0.5m
	WC with Septic Tanks		Siting Distance from water sources	at least 30m down stream
	Biofil Toilet			at least 2m above water table
Institutional Latrines:		50 persons per drop hole		

(Ghana Community Water and Sanitation Agency, 2010)[1]

2.3 Sizing a Household Latrine Pit

To determine the depth of pit required, the total number of people who will use the facility and the desired operation period is needed. Table 1 below indicates various household sizes and based on the desired operation period presents minimum required depths. Pit volumes calculation presented in this manual/handbook is based on a household size of 6 people and design life of 5 years

1 Ghana community Water and Sanitation Agency (2010). Sector Guidelines-General (Rural Community and Small Towns) Volume III

Box 1. Calculating the depth of the pit

Sample Calculation for Sizing of latrine Pits

Solids accumulation

For a household of 6 persons, in one year, the volume of accumulated sludge (using sludge accumulation rate of 60litres /capita/year) = 6 x 60 litres = 360litres = 0.36 m^3

(This allows for materials used for anal cleansing; reduced aerobic and decomposition over the chosen 5-year operational period).

Using a basic internal pit area of 1.2 m wide x 2.15 m long = 2.58 m^2

*Resulting depth of sludge = (0.36 * 5)/ 0.28 = 0.814 m*

Free board

Additional safe space above solid and liquid below the slab; minimum free board = 0.3m

Total depth of pit = 0.814 + 0.3 = 1.1 m

Table 1: Various depths of latrine pit and corresponding Household sizes and operational periods

Number of Persons in Household	Operational Period (years)									
	1	2	3	4	5	6	7	8	9	10
4	0.4	0.5	0.6	0.7	0.8	1	1.1	1.2	1.3	1.4
5	0.4	0.6	0.7	0.8	1	1.1	1.2	1.4	1.5	1.7
6	0.5	0.6	0.8	1	1.1	1.3	1.4	1.6	1.8	2
7	0.5	0.7	0.9	1.1	1.2	1.4	1.6	1.8	2	2.2
8	0.5	0.7	1	1.2	1.4	1.6	1.8	2	2.3	2.5
9	0.5	0.8	1	1.3	1.5	1.8	2	2.3	2.5	2.8
10	0.6	0.8	1.1	1.4	1.7	1.9	2.2	2.5	2.7	3.1
11	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3	3.4
12	0.6	1	1.3	1.6	1.9	2.3	2.6	2.9	3.2	3.6
13-20	0.73 - 0.96	1.1 - 1.5	1.4 - 2.1	1.8 - 2.6	2.2 - 3.1	2.1 - 3.7	2.9 - 4.2	3.2 - 4.8	3.6 - 5.3	3.9 - 5.9
21-30	1.0 - 1.3	1.6 - 2.1	2.1 - 2.9	2.7 - 3.7	3.3 - 4.6	3.8 - 5.4	4.4 - 6.2	5.0 - 7.0	5.6 - 7.8	6.1 - 8.6

Depth of latrine pit has been calculated based on an area of 2.58 m^2. All dimensions are in metres(Source; Latrine Technology Manual, 2016)

2.4 Special Design Considerations

- Household latrines should be designed and constructed for ease of use by all categories of individuals including very small children and the physically challenged.
    - All toilets should be disability friendly. An access ramp should be provided into the toilet.
    - Drop holes should be designed to accommodate seats for use by children and people with disabilities.
    - The size of the drop hole should ensure that householders' including children are comfortable when using the latrine.
    - Special grips, guiding systems and proper lighting should be provided for poor-sighted children.
    - Railings should be provided at the sides and back of the latrine cubicle to enable children sit or squat and use the facilities safely.

2.5 General Construction Process of Household Latrines

2.5.1 Site Preparation

As all other construction works, it is important to secure the site for construction from the rest of the household or community. For this reason, it is a requirement that all latrine construction sites must be secured by simply driving pegs into the ground and hoarding of with red bands (usually old red cloths can be cut into bands for this purpose).

In preparing the site for latrine construction the following activities should be carried out;

- Clear and level the ground where the latrine is to be located and remove the top soil and debris.
- As a part of site preparation, the trees should be cut off and their roots are totally uprooted
- Make sure all of the materials and tools are at the site before each construction step is started.
- Before starting the work, permanent bench marks must be established at a suitable point in the construction site.
- The orientation and trench lines of the latrine should be correctly laid out in the construction site

Tools and equipment required:

- Measuring tape
- Balls of string
- Wooden stakes
- 2" x 4" nails
- A level
- Carpentry square

Activities

- Clear the latrine construction site of any bushes and thickets.
- Drive demarcation pegs into the ground using a hammer in an excavation area.
- Ensure that the pegs are at a right-angle (90^0) to each other by tying a builder's line around the pegs.

2.5.2 Developing the Pit

In developing latrine pits the following must be taken into consideration

- The level of the ground water table,
- The soil type (stable and unstable; sandy etc.),
- Terrain (rocky ground/ flood prone) and
- Availability of lining material,

Tools and equipment required

- Measuring tape
- Shovel
- Pick axe
- Gloves

Activities

- The depth of the pit is determined by the calculations detailed in Box 1
- Carefully dig pit within the set-out range
- Ensure that dug out soil is kept at a considerable distance from the pit to prevent them from falling bag into the pit
- Excavate to the required depth

Precautions

- Avoid standing on the edges of the ditches as they might collapse. Protect the
- areas already excavated to prevent accidents.
- Do not increase or decrease the dimensions of the ditch.

2.5.3 Lining of Pit

The purpose of lining latrine pits is to

- Prevent collapse of the pit
- Provide stable support for the slab and superstructure
- Reduce the risk of surface water infiltration, erosion and undercutting of the slab

At the very least, the top 0.5 metres of all pit latrines should be lined. The pit can also be fully lined. The decision to line the total depth of a pit depends on the ability of the ground to support itself. Full lining is always recommended if the pit will be emptied.

In lining the pit, masonry walls can be done out of bricks, stones, or concrete bricks joined by mortar made out of sand, cement and water. As a general rule bricks must be of good quality without visible cracks, be of true size and shape and with straight edges and even surfaces to improve workmanship and reduce mortar wastage during laying. Good building stones on the other hand must be hard, tough and compact grained and uniform in texture and colour. In the case on concrete blocks, its use will determine its size and quality.

Tools and equipment required

- Trowels
- Buckets
- Shovels
- Scaffolding
- S-shaped rebar tool
- Plumb-line
- Level
- Gloves

Activities

- *Transporting Materials -* Move blocks, sand, cement closer to the house. Hand up buckets full of the concrete mixtures when the masons request them, but be careful not to overload the scaffolding.
- *Preparing Cement Mixtures -* Make mortar for laying blocks, cement mixture for filling the U-shaped blocks and cement mixture for filling the holes in the blocks where vertical rebar has been placed. The cement mixture should be runny.
- *Filling Holes in The Blocks -* Fill the holes in the blocks where vertical rebar has been placed, pushing the cement mixture down into the crack with a small piece of rebar as you proceed to make sure that no air bubbles or empty spaces are created.
- *Cleaning the Mortar Joints -* Use the S-shaped rebar tool to clean the mortar joints of excess cement before the mortar dries.

Precautions

- Do not spread the mortar across long sections of that wall. Otherwise it will dry before the blocks are laid.
- The four walls will be built simultaneously, row by row
- The blocks must be clean and completely dry.
- Make sure that the vertical rebar stays correctly placed in the center of the blocks as they are filled with cement.
- Wear gloves when carrying the blocks.

2.5.4 Constructing the Superstructure

The superstructure should provide adequate privacy and security for latrine users. It can be built of any appropriate local material. Some examples of materials that can be usedare wood, grass, bamboo, concrete, brick and plastic. The following is a list of recommendations for superstructure:

- A typical toilet room has a floor area of 1.2 m x 1.6 m with door opening inwards; in cases where it is preferred that the door opens outwards, the room dimensions is relatively smaller i.e. 1.2 m x 1.2 m.
- The door should of standard size 2.05 m x 0.7 m and normally made of 0.1 m thick timber. Door with a lock or one that opens inward gives privacy to the user
- The walls of the cubicle could be made of timber, concrete blocks, burnt bricks, sandcrete, compressed soil brick, wattle and dub etc. If concrete blocks

(preferably hollow blocks) are used the 20cm x 20cm x 40cm blocks are recommended.

- The roof of the superstructure should drain away from the front of the superstructure to prevent erosion at the front passage or entry area. Better still a roof gutter can be provided to harness rain water to be used for hand washing for example.
- A light or a space for a lamp to be placed if users need to use latrine at night
- Any modifications required for special needs users (e.g. elderly, disabled)

Roofing

The main function of the roof is to keep users from the elements of weather. But the most important of this is to keep away water. In this regard one key principle in roof design and construction is to get water of the roof as quickly as possible without allowing it any opportunity to stand on the roof. As such pitched roofs are preferred to flat roofs.

Tools and Equipment required:

- Hummer
- Plumb-line
- Level
- Gloves

Activities

- Determine the pitch/slope of the roof
- Layout the trusses on the ground
- Hoist the trusses into pace and align them using the level and plumb-line
- Fix the purlins on the trusses depending on the roofing material
- Fix the roofing sheets using roofing nails and the hammer

Precautions

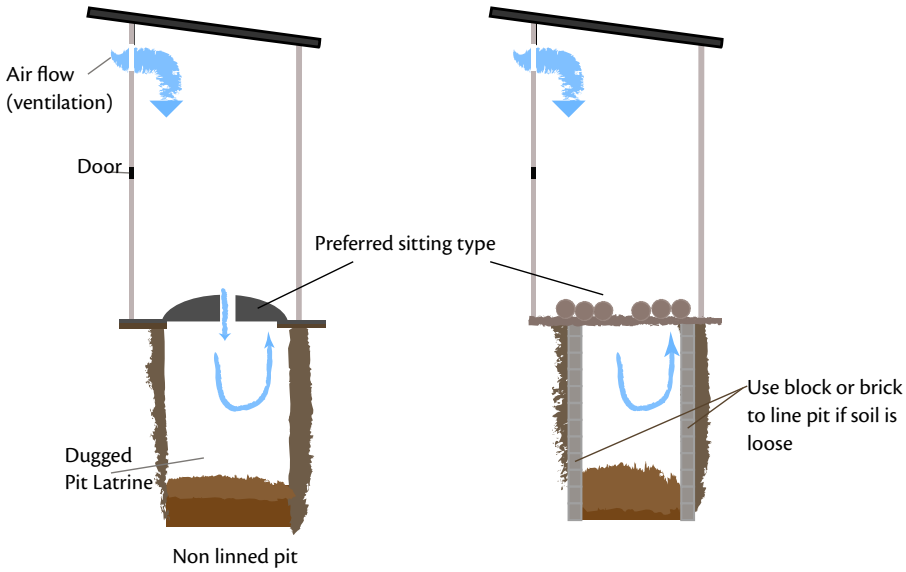
- Be careful when hoisting the trusses into place to avoid accidents
- Wear gloves when transporting the roofing sheets to reduce the possibility of cuts
- Do not drive the nails in the roof valleys

PART 3: INSTRUCTIONS FOR LATRINE CONSTRUCTION

3.1 Ventilated Improved Pit (VIP) toilet

3.1.1 Description of Technology

Ventilated Improved Pit (VIP) latrines are an improvement over traditional latrines in two important respects: they mitigate the noxious odour and reduce the number of flies and other insects that plague users of traditional latrines. In a VIP toilet, a vent pipe allows fresh air to flow through the latrine, reducing odour. The vent also allows light into the latrine, attracting insects into the pipe, where they are trapped by the fly screen at the top of the pipe. The screen also keeps out insects looking to enter the pipe from the outside.



3.1.2 Construction Techniques

Site selection

- Convenient location accessible to users).
- Well drained land where the groundwater level is more than 2 metres deep (otherwise a raised pit may be needed).
- At least 30 metres from any existing water source e.g. a well or stream used for drinking or cooking.
- If possible, the door should face the wind direction and the vent pipe should face the sun.

Tools Required

Tools List	Construction Use
Hammers	Nailing wood & using chisel
Handsaws	Cutting wood
Trowels & wooden floats	Working concrete
Shovels	Preparing site, mixing concrete
Spirit Level	Levelling blocks and concrete
Plumb Bob and String Line	Levelling blocks and concrete
String Line	Marking out dimensions
Measuring Tape	Measuring dimensions
Large bucket or wheelbarrow	Mixing concrete
Carpenter's square	Accurate measurements

The Pit

Developing the pit

- Dig a pit in the ground
- The size of the pit mouth should be 2.35m x 1.2m for rectangular and diameter of 1.35m for circular pits with depth not less than 2.5m. However, the depth should be dependent on the type of soil but should not exceed 3m deep.
- For circular pits, the diameter must be uniform throughout and the walls must be vertical

- Add small concrete foundation (sub foundation) to support the top edge of pit to support the toilet slab
- The sub foundation at the top 50cm of the pit must be lined with concrete bricks/ blocks or stones
- Line pit above ground level to at least one line of concrete bricks/blocks. About 24 bricks are needed for the top 0.5m and the above ground level part
- If the soil is unstable, line the whole pit with timber, rubble stones, concrete bricks/blocks or old drums to support walls
- Vertical joints between the concrete bricks/blocks or stones of the walls below the top 50cm must not be filled

The Substructure

Building the toilet slab

- Toilet slab must be made of reinforced concrete to give it more strength and safe to use
- For rectangular slabs, dimensions of 2.45m x 1.5m with thickness of 75 mm with reinforcement is adequate
- The circular concrete slab has a dome form to give it more strength

The dimensions are:

Diameter	1.35m
Tickness:	60mm
Height of the dome	80mm
Squatting hole	400x120/200mm

Preparing the form

Rectangular slab

- Cut long pieces of purlin
- Make a wooden formwork by nailing together 4 pieces of purlin so that inner dimensions of wooden formwork are 2.45m x 1.5m x 75mm. Use 10cm nails, two on each side.

Circular slabs

- Make a wooden gap mould for the squatting hole. Thickness 6 cm. The bottom side should be all around1 cm smaller than the topside in order to get a conical section
- Put two big nails in the bottom side in order to keep the mould in situ
- Make a slope mould out of a board
- Make a triangle mould fitting from 27 x 40 x 2 cm between the footrests.
- Coat all the moulds with (old) oil in order to prevent sticking them onto theconcrete.
- Look for a nice level place to work on.
- Put a small pole in the middle and let it stand out 8 cm. above the ground and signaround the pole a circle with a beam in the ground
- Make outside the circle a ring of bricks.
- Make a dome of soil in the circle from the outside towards the pole. The top of the pyramid has to be flat in a diameter from 40 cm.
- Put a strip of strong plastic against the inward side of the bricks in order to prevent seaming the mortar and the bricks together.
- Moisten the soil inside the bricks to avoid leaking away later on the cement water out of your mortar.
- Place the gap mould in the centre on the flat part of the soil.

Preparing the Reinforcement for Rectangular Slabs

Cut pieces of 12mm diameter steel bars to the following dimensions for reinforcing eachslab.

- 118 cm 8 pieces
- 83cm 6 pieces

Preparing the reinforcement for Circular slabs

Cut 12mm diameter steel bars into the following pieces

- 2 x 35 = 70 cm.
- 2 x 115 =230 cm.
- 2 x 87.5 = 175 cm.
- 2 x 67.5 = 135 cm.

- 2 x 105 = 210 cm.
- 4 x 40 = 160 cm.

Tie the bars together with iron wire

Preparing mortar with gravel (Concrete)

- Make a concrete mixture of ratio 1:2:3 which means: 1-part cement to 2 parts sand to 3 parts gravel.
- Prepare about 80 litres wet mortar. In order to get this;
    - use about 125 litres dry materials.
    - Put the next quantities on a hard-even surface and mix them very well (first mix the sand and the gravel than add cement)
        - o One head pan of cement (half a bag of cement)
        - o Two head pans of sand
        - o Tree head pans of gravel
- Add as much clean water as necessary to get a uniform and workable mix

Making the rectangular slab

- Place a template mould for the seat slab or a vent pipe ring for the vent-pipe hole in the appropriate place within the wooden frame.
- Lay mortar in the frame to a depth of about 37.5mm and compact well.
- Place steel bars on the layer of concrete. Make sure that the bars do not touch any side of the wooden frame (allowance should be at least 10mm). 1f any bars overlap holes, trim accordingly.
- Tie the steel handles to the bars with wire (only for cover and vent pipe slabs).
- Place wood inserts in seat slab to enable installation of seat cover.
- Cover steel bars with concrete to level with frame.
- Make the slab surfaces smooth
- Allow the slab to cure by covering with wet paper or wet sand or wet jute sack after one day.
- Remove wooden frame after one day but allow slab to stay on the ground for at least 7 days.
- 10.Sprinkle with water two or three times each day for at least 7 days until after 4 weeks

Making the circular slab

- Put the concrete on the slope of soil, divide it equal in a layer of 37.5mm thickness.
- Place the iron bars on the concrete. Make sure using the correct distance between the bars themselves and between the bars and the outside surface of the concrete. The bars need at least 2 cm. concrete all around them in order to protect them against aggressive moisture (pee and cleaning water).
- Put the rest of the concrete on the bars. Knock gently with a wood float on the surface to drive away all the air bubbles out of the concrete.
- Throw some hands full of pure cement powder on the surface of the slab and polish it carefully into the surface with a steel trowel until you get a nice smooth surface.
- After some hours, when the concrete has hardened a little bit, release the gap mould from the concrete but let it in situ.
- Make two footrests near the squatting hole. The height of the steps is 2 cm. above the centre plate
- Finally cover the slab with a sheet of plastic in order to avoid drying out the fresh concrete. To prevent blowing away the sheet by the wind put some stones on the sheet. If there is no sheet available, use paper, grass or something else.
- The next day you can remove carefully the gap mould, the surrounding bricks and the plastic strip.
- Clean the three moulds very thorough and coat them again with oil for the next slab you are going to make.
- Now you have to wait 4 weeks until the slab has totally hardened. Don't move it sooner! The first two weeks you have to sprinkle the slab at least 3 times a day with sufficient water to keep the concrete wet. The concrete will harden sooner and better in wet circumstances. After sprinkling replace the plastic cover all the

Test Vent Pipe and Cover Slabs for Strength

Test vent pipe and cover slabs for strength after 14 days.

- Place slab on 4 pieces of bricks (or wood) at the corners.
- Allow 4 men to stand on the slab.
- Check that the slab is not broken.

Placing the slab

- After 4 weeks the slab can be removed carefully. Put it upwards and roll it to its destination
- Handle the slab with enough strong people.
- Put the slab carefully over the pit.
- Slab must be well centered and well seated on the sub foundation
- Earth up soil around the sub foundation to avoid stagnant water accumulating around the toilet

The Superstructure

The toilet house can be any design that meets the local and use locally available materials. Internal dimensions of latrine superstructure

- Length - 1.4m
- Width - 1.2cm
- Height - 2.4m at front and 1.8m at rear
- Assemble door frame and place in the entrance of the superstructure. Ensure that it is straight and vertically plumb.
- Erect 10cm thick wall from floor to flush with proposed front bottom edge of seat slab.
- Continue laying blocks/bricks for superstructure walls.
- When rear wall reaches height of about 1.6m, insert pieces of wire (4mm diameter) into this wall and install rear rafter. Secure rafter with wires.
- Construct roof and install door.
- Tie fly-screen on vent-pipe and install vent pipe in hole as follows:
- Check whether vent-pipe hole is clear
    - Carefully drive a 15 cm nail into vent pipe about 15 cm from the bottom end.
    - Place vent pipe firmly in hole
    - Top of vent pipe should extend a minimum of 300mm above the roof and covered with fly screen/mesh
- Build toilet wall so pipe is exposed to the sun
- Ensure that the vent-pipe:

- Is truly vertical
- Fasten securely with wire to the rear rafter at the back of the roof.
- Seal vent-pipe hole edges with cement.

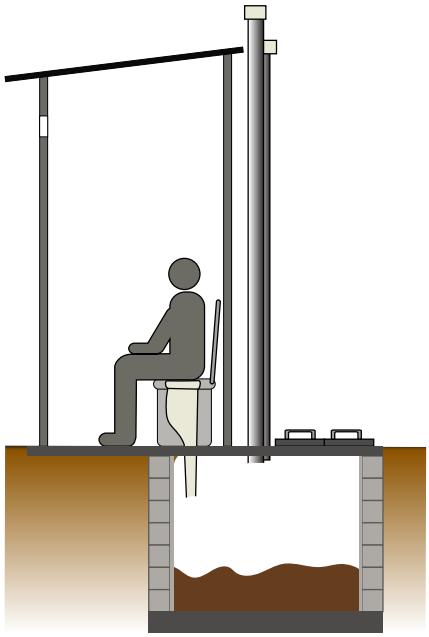
Approximate Material Estimate

I. No.	Item	Qty	Unit
1	Pipe 100mm or 150mm diameter (3mlong)	1	Number
2	Sliding bolt	1	Number
3	Roofing Nails	0.5	Kilograms
4	Handle	2	Number
5	Nails 4" and 3"	2	Kilograms
6	Hinges	3	Number
7	Wood 1 x 8	3	Pieces
8	Wood 2 x 3	5	Pieces
9	Stone	2	Cubic meters
10	3 feet roofing sheet	2	Pieces
11	Sand	3	cubic meters
12	Skilled labour	2	Work-day
13	Unskilled labour	2	Work-day
14	Cement (50 kilograms bag)	6	Bags
15	12 mm diameter mild steel reinforcement bar	2	Number

3.2 Kumasi Ventilated Improved Pit(KVIP) Toilet

3.2.1 Description of Technology

An improvement to the traditional VIP is the Kumasi Ventilated Improved Pit(KVIP) which is designed with double pits. The double pit VIP has almost the samedesign as the single pit VIP with the added advantage of a second pit that allowsit to be used continuously and permits safer and easier emptying. By using twopits, one pit can be used, while the content of the second rests, drains, reduces involume, and degrades.



3.2.2 Construction Techniques

Site Selection

- Convenient location accessible to users).
- Well drained land where the groundwater level is more than 2 metres deep (otherwise a raised pit may be needed).
- At least 30 metres from any existing water source e.g. a well or stream used for drinking or cooking.
- If possible, the door should face the wind direction and the vent pipe should face the sun.

Tools Required

Tools List	Construction Use
Hammers	Nailing wood & using chisel
Handsaws	Cutting wood
Trowels & wooden floats	Working concrete
Shovels	Preparing site, mixing concrete

Tools List	Construction Use
Spirit Level	Levelling blocks and concrete
Plumb Bob and String Line	Levelling blocks and concrete
String Line	Marking out dimensions
Measuring Tape	Measuring dimensions
Large bucket or wheelbarrow	Mixing concrete
Carpenter's square	Accurate measurements

Steps to Construct KVIP

1. Mark Layout and dig the pit to a depth of between one and two metres. These are internal dimensions. It is therefore necessary to dig a slightly bigger pit. The actual size will be determined by the materials to be used for the sub foundation.
2. Cast three slabs (2 cover slabs and one seat slab). The seat slab has 2 seat holes and each of the two cover slabs has a vent-pipe hole
3. Line the pit walls from top to bottom
4. Pit dividing wall and pit lining should be constructed at the same time so that they could bond properly.
5. Dividing wall must be well sealed with cement plasterto ensure that It is watertight. Allow the pit lining to project at least 20 cm aboveground level. Pit dividing wall should be 15 to 23 cm thick.
6. Install the cover slabs and construct foundation for the superstructure
7. Place a lintel across edge of the slabs and start constructing superstructure.
8. Install seat slab when superstructure wall reaches height of about 35 cm.
9. Complete superstructure construction.
10. Tie fly-screen on vent-pipe and install in one of the vent-pipe holes after checking that the hole is done. Ensure that the vent-pipe is straight and then fasten securely with wire to the rear rafter at the back of the roof.
11. Seal vent-pipe edges with mortar.
12. Place covers on the other vent-pipe hole and corresponding seat hole

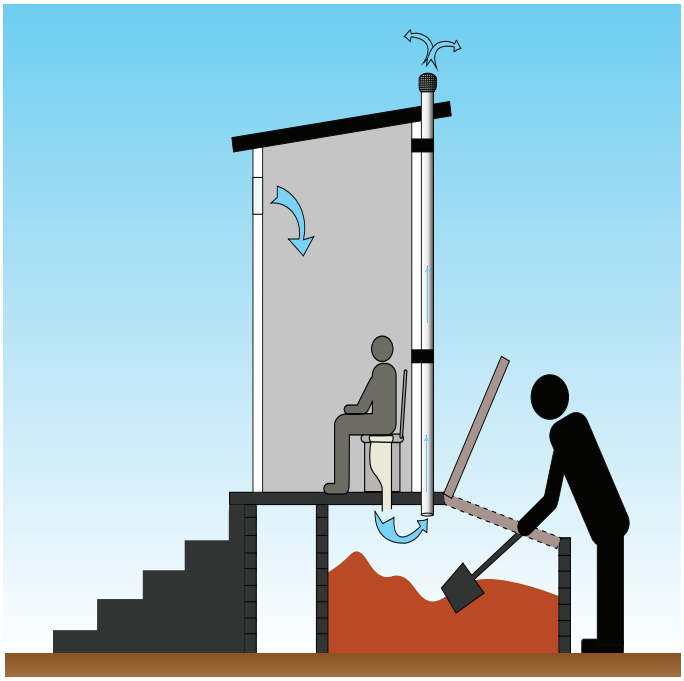
Approximate Material Estimate

Sl. No.	Item	Qty	Unit
1	Cement (50 Kilograms bags)	10	Bags
2	Pipe 100mm or 150mm diameter (3m long)	2	Number
3	Sliding bolt	1	Number
4	Tower bolt	2	Number
5	Roofing nails	0.5	Kilograms
6	Handle	2	Number
7	Nails 4" and 3"	2	Kilograms
8	Hinges	3	Number
9	Wood 1 x 8	3	Pieces
10	Wood 2 x 3	5	Pieces
11	Stone	2	Cubic meters
12	3 feet roofing sheet	2	Pieces
10	Sand	1.5	Cubic meters
11	Skilled labour	2	Work-day
12	Unskilled labour	2	Work-day
13	12 mm diameter mild steel reinforcement bar	3	Number

3.3 The Compost Toilet

3.3.1 Description of Technology

In this toilet technology, excreta fall into a watertight tank to which ash or vegetable matteris added. If the moisture content and chemical balance are controlled, the mixturewill decompose to form a good soil conditioner in about four months. Pathogensare killed in the dry alkaline compost, which can be removed for application tothe land as a fertilizer.



3.3.2 Construction Techniques

Construction steps

- Construct footings and base slabs
- Construct chamber walls
- Prepare the inside of chamber
- Cast the chamber roof (Which is the toilet room floor)
- Prepare the false chamber
- Prepare the rear door and baffle boards
- Construct riser
- Construct the superstructure

Site Selection

A significant advantage of compost toilets is that their location is not dependent on the location of an existing water source, and they do not require level land or land with good drainage. They can be established in a confined space close to a house. Therefore, in selecting the site for its constructions;

- Select a suitable location where the family will be comfortable using the toilet.
- It needs about 1 metre of space at the back or sides to construct the soak pit or evapotranspiration beds for treating the urine/liquid.
- Level ground is good, but sloping ground is better as it allows the chamber to be recessed into the hill with level access to the top floor, avoiding the need for steps.
- The compost toilet can be built connected to a house, provided that the vent pipes extend 500 mm above the roof of the dwelling and toilet house.
- Remove grass and topsoil and if the ground slopes, dig a level space for the chamber construction

Tools Required

Tools List	Construction Use
Hammers	Nailing wood & using chisel
Handsaws	Cutting wood
Trowels & wooden floats	Working concrete
Shovels	Preparing site, mixing concrete
Spirit Level	Levelling blocks and concrete
Plumb Bob and String Line	Levelling blocks and concrete
String Line	Marking out CT dimensions
Measuring Tape	Measuring CT dimensions
Cold Chisel	Breaking concrete blocks
Fly Screen	Separating sand from coral
Chicken Wire w/ 25mm holes	Separating small coral from large
Large bucket or wheelbarrow	Mixing concrete
No. 10 & 15 block mould	Making blocks for substructure
Bolt cutters or hacksaw	Cutting rebar to size
Pliers	Cutting and fastening tie wire
Carpenter's square	Accurate measurements
Drill	Drilling holes in wood for bolts

Constructing footings and base slabs

- Layout and level the base sides using pegs and string lines
- Use the 150 x 25 rough sawn timber to build formwork for the concrete base slab. The formwork should be sized to match the size of the chamber
- Dig a 200mm deep footing under the position of each block wall
- Square and level the formwork
- Use 12mm mesh reinforcing steel in the floor and set vertical 10mm reinforcing bars at correct spacing for concrete block walls
- Prepare concrete, pour and trowel the base slab and footings smooth

Constructing Chamber walls

- Lay four (4) courses of sandcrete blocks (or five (5) for larger chamber) to form the two (2) compost chambers
- Fill the hollow cores in the sandcrete blocks with mortar

Preparing the inside of chamber

- Cast a 100mm high and 100mm wide concrete step along the floor against the back wall and cast a 50mm high by 150mm wide step across the front of the step
- Use mortar to plaster and seal the inside of the walls and floor

Casting the Chamber Roof (Toilet room floor)

- Using plywood or local materials prepare formwork to cast the top floor 75mm thick
- Use polythene to prevent concrete sticking to formwork
- Make round formwork for an opening to match the toilet pedestal
- Place 100mm/150mm PVC insert for vent at the back edge of the floor over each chamber
- Use 12mm mesh reinforcing steel in the floor and set vertical 10mm reinforcing bars at correct spacing for concrete block walls
- Prepare concrete, pour and trowel the chamber roof smooth

Preparing the false chamber floor

- Make a 50mm x 50mm hardwood slat floor using galvanized nails. The floor will sit inside the chamber to support solid waste and allow urine drain. An alternate to hardwood is using bamboo. Tis will reduce the cost but the bamboo will need

a replacing each time a chamber is emptied. Make this floor in two pieces for ease of installation

Preparing the rear door and baffle boards

- Fix 100mm x 50mm hardwood or treated pine around the door opening with masonry nails to support a rear door cover and baffle boards.
- Fit 50mm x 25mm hardwood to make a guide for the super flex plank baffle boards.
- Cut marine ply to match the door opening, place against the frame and drill four holes for the rear door bolts.
- Install the bolts from the inside to the marine ply door can be fixed from the outside

Constructing the seat riser

- Use either a fiberglass or PVC seat riser or construct your own cement seat riser
- Inside the toilet house, provide a place to store biodegradable material that is added each time the toilet is used

The superstructure

- Concrete blocks, sawn timber framing, iron wall cladding or other local materials can be used for the superstructure
- Gutters can be made from PVC pipe or locally available bamboo.

Note: If adding a seat insert bolts into the floor before the cement set to attach the seat riser and wall base plate

Mixing the Concrete

- Make a concrete mixture of ratio 1:2:3 which means: 1-part cement to 2 parts sand to 3 parts gravel.
- Prepare about 240 litres wet mortar. In order to get this, put the quantities on a hard-even surface and mix them very well (first mix the sand and the gravel than add cement)
    - Tree head pans of cement (one and half bags of cement)
    - Six head pans of sand
    - Nine head pans of gravel
- Add as much clean water as necessary to get a uniform and workable mix.

Note: Water should not be saline or contain organic materials. Don't add too much water, because it will be leaking out of your slab into the soil before the mortar is hardened and it will take with it a part of the expensive cement

Approximate Material Estimate

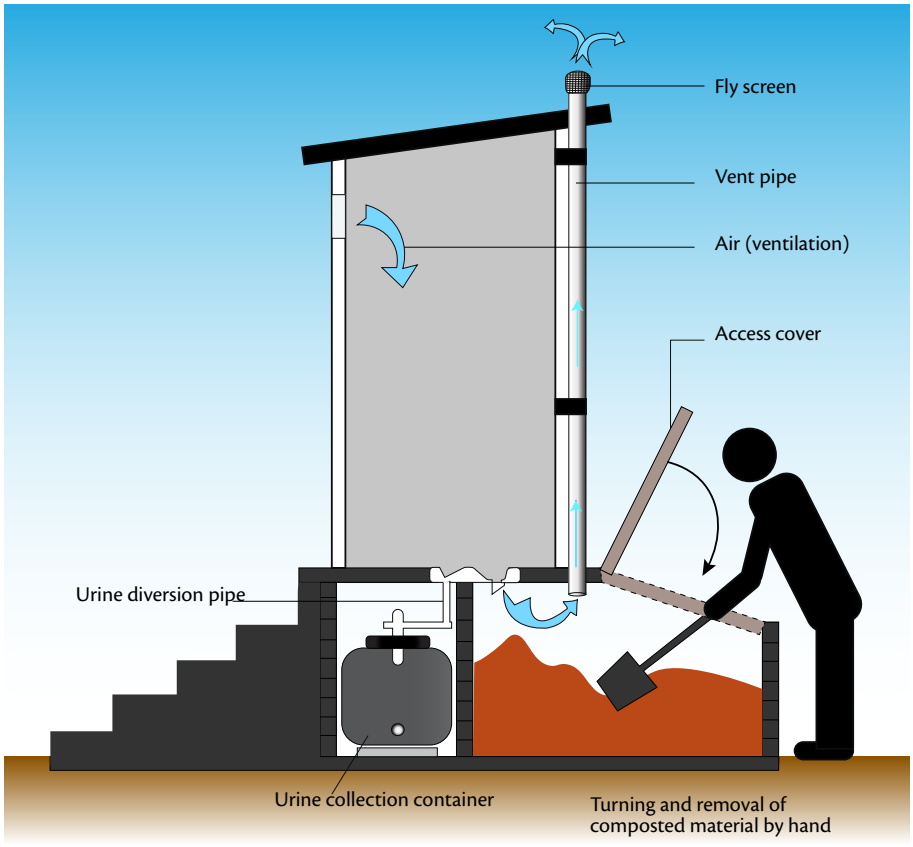
Sl. No.	Particular	Qty	Unit
1	Cement (50 Kgs bags)	15	Bags
2	Pipe 100mm or 150mmdiameter (10'long)	2	No
3	Sliding bolt	2	No
4	Tower bolt	1	No
5	Handle	1	No
6	Nails	5	Kgs
7	Hinges	3	No
8	Wood 1 x 12	3	pcs
9	Wood 2 x 3	10	pcs
10	Sand	2.5	Cubic meters
11	Gravel	1	Cubic meters
12	Stone	3.5	Cubic meters
13	Skilled labour	2	work-day
14	Unskilled labour	2	work-day
15	12mm diameter mild steel reinforcement bars	3	Number

3.4 The Urine Diversion Dry/Dehydration Toilet (UDDT)

3.4.1 Description of Technology

Dehydration systems separate urine and faecesusing a special pedestal or urine diversion pan.Urine is diverted into a holding pot or into asoak field, while a watertight vault collects thefaeces. After defecation, ash or another absorbent(e.g., lime, dry soil, husks, organic matter) issprinkled into the vault. Material used for analcleansing is put into another container ratherthan dropped into the vault. Once the vault isthree-quarters full, the faeces is covered with dryearth. Both the urine and the dehydrated fecescan be

reused as fertilizer. Urine is often usedimmediately, but it should ideally sit for sixmonths to ensure that nematode eggs aredestroyed. Dehydrated feces should not be usedfor at least a year.



The basic design rules for constructing UDDTs

- The interior walls of the vaults MUST be plastered to minimize infiltration ofmoisture.
- The vault doors must close well to keep the faecal matter safely contained andprevent water from entering the vault.
- The vaults must have good air circulation via vertical ventilation pipes that remove moisture and odour above the level of the roof.

3.4.2 Construction Techniques

Site selection

- Select a suitable location where the family will be comfortable using the toilet.
- It needs about 1 metre of space at the back or sides to construct the soak pit or evapotranspiration beds for treating the urine/liquid.
- Level ground is good, but sloping ground is better as it allows the chamber to be recessed into the hill with level access to the top floor, avoiding the need for steps.
- The compost toilet can be built connected to a house, provided that the vent pipes extend 500 mm above the roof of the dwelling and toilet house.
- Remove grass and topsoil and if the ground slopes, dig a level space for the chamber construction

Construction steps

- Construct the foundation slab
- Construct the vaults taking into consideration the position of the urine container
- Construct the superstructure
- Complete the plumbing works

Tools required

Tools List	Construction Use
Hammers	Nailing wood & using chisel
Handsaws	Cutting wood
Trowels & wooden floats	Working concrete
Shovels	Preparing site, mixing concrete
Spirit Level	Levelling blocks and concrete
Plumb Bob and String Line	Levelling blocks and concrete
String Line	Marking out dimensions
Measuring Tape	Measuring dimensions
Cold Chisel	Breaking concrete blocks
Fly Screen	Separating sand from coral
Chicken Wire w/ 25mm holes	Separating small coral from large

Tools List	Construction Use
Large bucket or wheelbarrow	Mixing concrete
No. 10 & 15 block mould	Making blocks for substructure
Bolt cutters or hacksaw	Cutting rebar to size
Pliers	Cutting and fastening tie wire
Carpenter's square	Accurate measurements
Drill	Drilling holes in wood for bolts

The Substructure

Construction of foundation slab

- Set the profiles at the four corners of the toilet.
- Using a string set at a parallel line to an existing facility or fence (Making sure you leave >1.5m between vault door and obstruction) and mark on the profiles with a nail.
- Set the other dimensions with above being the baseline.
- Check the diagonals and make sure the structure is perfectly square.
- Transfer the dimensions to the ground using a plumb bob.
- Construct a wooden shuttering box with inner design dimensions (refer to specific drawings attached) with a depth of 10cm for casting the foundation slab.
- Mark the foundation area for excavation. The marks are excavated at 15 mm deep and 25 mm wide.
- Excavate 600mm wide foundation trench within the marks until hard surface is reached. This may vary from place to place depending on the type of soils.
- Place a blinding layer of concrete mix 1:3:6)1 at the bottom of the excavated trench.
- Build foundation using quarry stones/concrete blocks using 1:3 mortar to the dimensions in the specific drawing.
- Backfill the slab formation
- Hand compact the foundation area.
- Place the dump proof membrane (DPM).

- Place concrete mix of 1:2:4 and 8mm reinforcement steel bar or BRC A98 mesh where necessary (e.g. black cotton soil).
- Backfill the area around foundation with excavated soil.

Construction of vaults

The foundation slab should dry and cure for at least 2 days.

- Build the vault using bricks/concrete blocks/stones/concrete panel. For other prefabricated options see the specific manufacturer's user instructions.
- Build the vault walls using mortar of mix 1:3 (cement: sand).
- Use the design drawing to set the height, length and width of the vault.
- Plaster the inside of the vault with a thin coat (2-3mm) mortar of mix 1:1.
- Cast the top slab and fix the squatting pan and anal cleansing pan where necessary.

Note: The top slab should dry and cure for at least 3 days

The Superstructure

- Select the preferred material for the superstructure (concrete panels/bricks/concrete blocks/stones/prefabricated panels).
- Select the appropriate tools to construct the superstructure.
- For in-situ options, build the walls with 1:3 mortar, reinforcing alternate layers with hoop iron.
- For prefabricated options assemble as per the manufacturer's manual.
- Build the roof as per specification in the technical drawings.
- Fix the main doors and vault doors as per provided technical drawings. Make sure the vault doors are watertight. The door should be level etc.
- Fix the ventilation pipe(s), PVC/steel/concrete min. diameter 100mm, class B.
- The pipe should rise 50cm above the roof. Avoid bends. Cover the end with a cap to prevent rain water from entering. Make sure that the joints of the pipe and the toilet construction are watertight, to avoid water from entering the vault.
- Fix the urine diverting pipes with diameter of at least 50mm. Use rigid piping or semi-rigid hoses (plasticized PE/ polypropylene PP/PVC/uPVC). Do NOT use metal pipes due corrosive properties of urine. Use appropriate glue for joining the pipes.

- Construct the urine soak pit where necessary or collect; store/sanitize urine for use as fertilizer in agriculture. For detailed connection to soak pits see the provided technical drawings.
- Beautify where necessary (e.g. internal plastering, painting and external keying).
- Test and adjust all fixtures and fittings for ease of operation and use.

Plumbing work

- Final work of toilet is plumbing i.e. urine container, vent pipe, black water pipe etc fitting works. Plumber must be careful to control leakage.

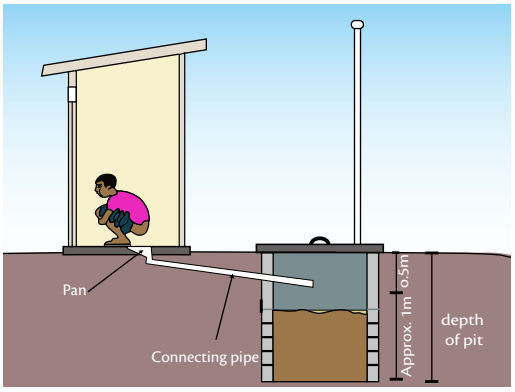
Approximate Material Estimate

Sl. No.	Item	Qty	Unit
1	Cement (50 Kilograms bags)	15	bags
2	Eco-san squatting pan	2	Number
3	Pipe 100mm or 150mm diameter (3m long)	3	Number
4	Sliding bolt	2	Number
5	Tower bolt	1	Number
6	Handle	1	Number
7	Nails	5	Kilograms
8	Hinges	3	Number
9	Wood 1 x 8	3	Pieces
10	Wood 2 x 3	10	Pieces
10	Sand	2.5	Cubic meters
11	Gravel	1	Cubic meters
12	Stone	3.5	Cubic meters
13	Skilled labour	2	Work-day
14	Unskilled labour	2	Work-day
15	12mm diameter mild steel reinforcement bars	3	Number

3.5 Flush Toilets (Cistern or Pour-flush)

3.5.1 Description of Technology

A pour flush latrine consists of a cover slab and aspecial pan that provides a water seal. A U-shapedpipe is used to maintain the water seal.Approximately 1–3 liters of water are needed foreach flush. The latrines can be constructed withpits directly underneath or offset, or with two pits.They can also be built inside a dwelling, with thepit located outside. If properly built and maintained, pour flush latrines reduce odors and flies.They are suitable in communities whereanal cleansing habits require the use of water.



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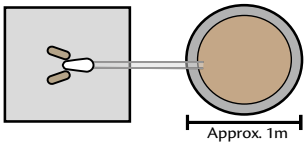


Top view

The basic design rules for Cistern Flush

- Ensure that there is proper gradient to allow waste water flow by gravity to a sewer or septic tank via manholes.
- The manhole chambers must be built to the technical standards to avoid stagnation and blockage.
- Use a qualified plumber to install appropriate piping for wastewater.
- All replaceable valves and fittings should be fitted in a way that allow for easy repairs and maintenance. NEVER cover them with wall tiles or plaster

3.5.2 Construction Techniques

Site selection

- The location of the toilet should be close to the house and accessible to users all
- Well drained land where the groundwater level is more than 2 metres deep (otherwise a raised pit may be needed).

- At least 30 metres from any existing water source e.g. a well or stream used for drinking or cooking.
- The location should be chosen considering wind and sunlight direction.

The Substructure

Construction of foundation slab

- In case built separately, excavate the foundation area, 15 cm deep and 25 cm.
- Place concrete mix of 1:2:4 and 8mm reinforcement steel bar or BRC A98 mesh where necessary (e.g. black cotton soil).
- Fit the necessary piping, low level pans or leave holes.
- Construction of cistern and toilet pans

Note: The foundation slab should dry and cure for at least 3 days to be strong enough forthe installation of either sitting or squatting pan.

- Fix the low-level squatting pan before plastering the floor and sitting pan after plastering.
  - Use mortar of mix 1:3 (cement: sand).
  - Fix the sitting pan after plastering the floor according to the type and specification of the supplier. Tis has to be done by a qualified plumber. Fix the pan tightly with screws on the floor.
  - Plaster the walls with a thin coat (2-3mm) mortar of mix 1:1 before fixing the cisterns/relevant pipes.

Note: Ensure that the plaster works do not hinder the plumbing/fitting works

The Superstructure

- Select the preferred material for the super structure (concrete panels/bricks/ concrete blocks/stones/prefabricated panels).
- Select the appropriate tools to construct the superstructure.
- Build the walls and beautify where necessary (e.g. keying).
- Build the roof according to the provided technical drawings.
- Fix the main doors. Fix the door frames first and then the door shutters. The door should be level and open freely.
- Fix the ventilation pipes, PVC/steel/concrete min. diameter 100mm, class B

- The pipe should rise 50cm above the roof. Avoid bends. Cover the end with a cap to prevent rain water from entering. Make sure that the connection of the pipe and the toilet construction is watertight, to avoid water from entering.
- Fix the necessary sewage pipes/fittings leading to manhole chambers

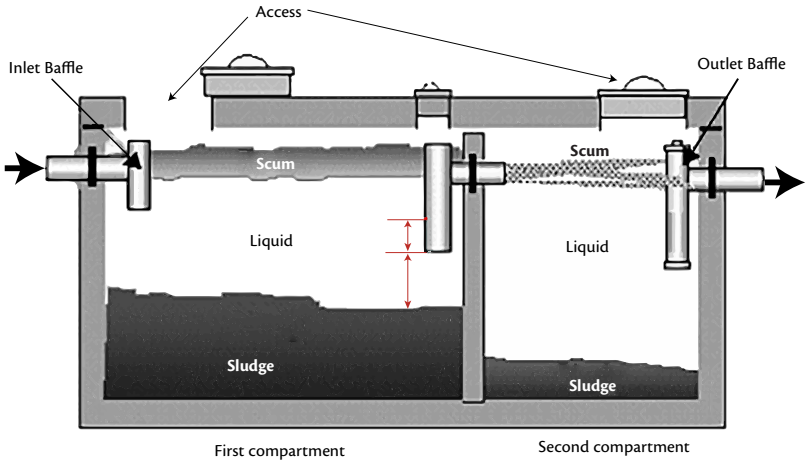
Approximate Material Estimate

Sl. No.	Item	Qty	Unit
1	Cement (50 Kilograms bags)	6	Bags
2	Pour-flush squatting pan without water seal	1	Number
3	Pipe 100mm or 150mm diameter	1	Number
4	Sliding bolt	1	Number
5	Tower bolt	1	Number
6	Handle	2	Number
7	Nails 4" and 3"	4	Kilograms
8	Hinges	3	Number
9	Timber	5	Pieces
10	Sand	3	Cubic meters
11	Gravel	2	Cubic meters
12	Stone	2	Cubic meters
13	Roofing nails	0.5	Kilograms
14	Wood 1 x 8	3	Pieces
15	Wood 2 x 3	5	Pieces
16	3 feet (900mm) roofing sheet	2	Pieces
17	Skilled labour	2	Work-day
18	Unskilled labour	2	Work-day
19	12mm diameter mild steel reinforcement bar	3	Number

3.6 The Septic Tanks

3.6.1 Description of Technology

A septic tank is similar to an aquaprivy, except that aseptic tank can be located outside the house. The toilet used with a septic tank also has a U-trap waterseal. As with the aquaprivies, septic tanks can be usedto dispose of greywater and must be periodicallyemptied of sludge. They also require the use of a soakfield for the secondary treatment of effluent. Septictanks may have two chambers to separate and promote further settlement of liquid and solid excreta.



The basic design rules for Septic tanks

- A septic tank must have at least two compartments, with T-shaped inlet baffle (100mm) and outlet baffle (100mm). Each compartment must have an access manhole which is air tight
- All septic tanks shall discharge to a soak away
- There must be adequate and reliable water supply at all times
- Should be water tight
- A septic tank should have a minimum size (about 1,700 litres) to be capable of receiving one day's max. Sewerage flow from a dwelling.
- A septic tank shall have a means of access for the purpose of emptying and cleaning
- The depth in such a tank should be below the outlet invert level, not less than 1m and there is an air space of not less than 200mm between the surface of the liquid contained therein and the underside of the top cover.

- Inspection chambers must be installed at all bends and junctions of the drains

3.6.2 Construction Technique

Site Selection

- Septic tanks are not suitable for all locations and soil types
- The soil should have a good soakage ability (not clay). Problems often occur when trenches are too short and there is not enough room for liquid to soak away quickly enough.
- The ground should not get flooded or waterlogged.
- Level ground is good, but sloping ground is better as it allows the soak away to be recessed
- Remove grass and topsoil and if the ground slopes, dig a level space for the chamber construction

The Substructure

Construction of Foundation Slab and Wall

- The foundation slab should be made from concrete 150 mm thick
- Walls should be constructed from materials like concrete, bricks and mortar/ durable substances which are not subject to excessive corrosion.
- The interior of bricks tanks should be plastered with waterproof mortar.
- Use mortar of mix 1:3 (cement: sand).
- Ensure that the plaster works do not hinder the plumbing/fitting works.
- Fix the T-pieces for inlets and outlet and seal properly with mortar.

Construction of top slab

- Prepare the form work for the top slab with the necessary steel reinforcement.
- Cast the concrete slab with the frames for the manholes.
- Use concrete mix of 1:2:4.
- Cure for at least 3 days.
- Fix the manhole covers.

The Soakaway Pits

Minimum Standard for Soakaway

- The basic design rules for soak pits.
- Soak away pits are built circular from cement blocks, two meters in diameter andto such depth as circumstances dictate. Reinforced slab over the top to contain a600mmx450mm inspection cover.
- They should be constructed in such a way not to cause any kind of pollution.
- They should be more than 3m from any building.
- They should not be constructed where the water table is high

Site selection for Soakaway

- The soil and subsoil must be suitable and the size of the plot adequate.
- A simple percolation test should be done for the soils above 30 minutes notallowed.

Construction Techniquefor circular soak away

- Top slab is made of reinforced concrete with manhole.
- Is made from 450mm rubble fill (outer core).
- Inner side: honeycomb blocks.
- Inner bed of rubble, and the above blocks, make 2m.
- Covered with a standard manhole cover.
- Inlet pipe 100mm (from septic tank).

Fitting Pipes and Appurtenances

Setting and fixing the U-trap and the drain

- The pan and the U-trap should be fixed in place and set in lean concrete 1:3:5 mixand the floor around the pan carefully screeded and smoothed with 1:3 cementmortar.
- Lay the drain pipe connecting the U-trap to the pit. The fall on the pipe shouldbe at least 1 in 25.
- Cement the pipe through the pit walls and backfill around the pipe

Setting and fixing a Vent pipe

- The vent pipe should be fixed in place vertically and made to go above the roof ofthe latrine superstructure.

- The lower end of the vent pipe should be fixed directly on top of the pit to allowfor the gases to easily escape through the pipe.
- Set the lower end of the vent pipe in the vent slab and ft it in place with leanconcrete 1:3:5 mix and carefully smooth the floor around the pipe with 1:3cement mortar.

Approximate Material Estimate

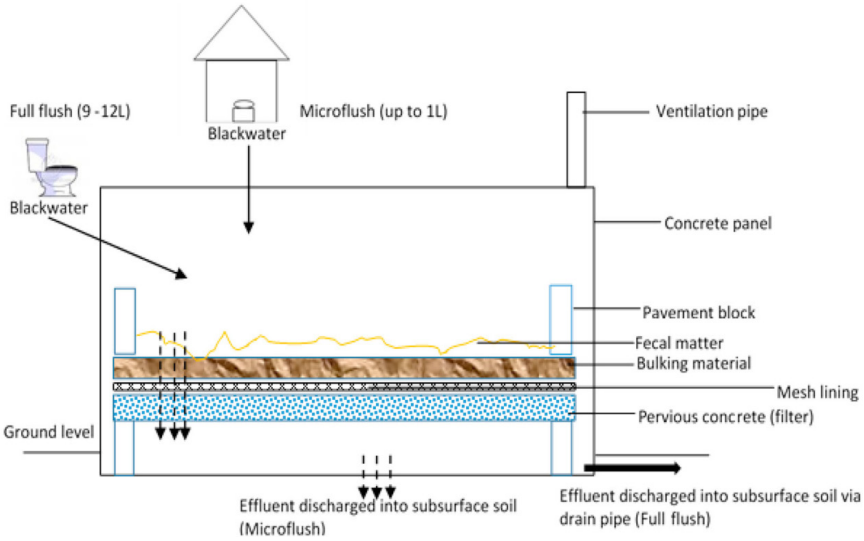
Sl. No.	Item	Qty	Unit
1	Cement (50 Kilograms bags)		Bags
2	Water closet bowl (with water trap)	1	Number
3	Pipe 100mm or 150mm diameter (10'long)	4	Number
4	6" Blocks	Number	
5	Tower bolt	1	Number
6	Handle	2	Number
7	Nails	3	Kilograms
8	Hinges	3	Number
9	Sand	8	Cubic meters
10	Gravel	3	Cubic meters
11	Stone	9	Cubic meters
12	12mm Steel reinforcement bars	13	Number
13	Skilled labour	2	Work-day
14	Unskilled labour	2	Work-day
15	12mm diameter mild steel reinforcement bars	10	Number

3.7 The Biofil Toilet

3.7.1 Description of Technology

It is mainly a special containment called "digester" which contains natural organisms. These organisms' breakdown faecal matter in such a manner that the faeces does not pollute the environment. The Biofil Digester is a simple compact on-site organic waste treatment system that uniquely combines the benefits of the flush toilet system and those of the composting toilets and eliminates the disadvantages and drawbacks of both

systems. The digester is essentially a biological filter consisting of a medium of soil and pervious concrete. Bacteria, other organisms degrade solid faecal matter. All liquids are organically filtered out of the bottom of the digester and drained into the soil where further and final decomposition occurs. Other solids (toilet paper & all degradable anal cleaning material) are decomposed and converted into rich & safe soil. The digester can be laid above ground or below ground depending on the groundwater level of the location.



3.7.2 Construction Technique

Construction of a standard digester involves mainly two processes:

1. The construction of pre-fabricated parts such as wall slabs, cover slab and porous concrete
2. The installation of all components

The Substructure

A standard biodigester has the following dimension:

- Length of 1800mm
- Width of 600mm
- Depth of 600mm

Table 2: Components of the Walls, Quantity, Material, Tools and the construction process of the Biodigester

ITEM	Qty	Materials Required	Tools Required	Unit Process
1800 X 600 mm wall slab	2	*2"x 2" hard wood *1" x 4" hard wood *¾ plywood *3" Nails *Wire mesh *¼ iron rod *Binding wire *Cement *Sand *Water	*Measuring tape *Carpentry square *Hammer *Handsaws *Spirit Level *Shovel *Trowel and wooden floats *Head pan	*A 1800x600mm wood formwork is formed with the base made of ¾ plywood and the wall of 2" x 2" hard wood *4No. 1750mm long ¼ iron rod is then laid on the wire mesh horizontally and another 4No. 580mm long ¼ iron rod is laid across them, each with 100mm intervals *Another 1750 x580mm wire mesh is then laid on top of the iron roods *A concrete mixture of sand, aggregate, cement and water ratio of 3:1:1:2 is then poured in the formwork and compacted and allowed to cure for 3days.
600 X 600mm wall slab	2	*2"x 2" hard wood *1" x 4" hard wood *¾ plywood *3" Nails *Wire mesh *¼ iron rod *Binding wire *Cement *Sand *Water	*Measuring tape *Carpentry square *Hammer *Handsaws *Spirit Level *Shovel *Trowel and wooden floats *Head pan	*A 600x600mm wood formwork is formed with the base made of ¾ plywood and the wall of 2"x 2" hard wood *4No. 580mm long ¼ iron rod is then laid on the wire mesh horizontally and another 4No. 580mm long ¼ iron rod is laid across them, each with 100mm intervals *Another 580 x580mm wire mesh is then laid on top of the iron roods *A concrete mixture of sand, aggregate, cement and water ratio of 3:1:1:2 is then poured in the formwork and compacted and allowed to cure for 3days.

Construction of Cover Slabs

The cover slab is divided into two components. Cover slab 1 has dimension 1200x600mm while cover slab 2 has 600x600mm as the dimension. The table below describes the specifies the material and tools required and the process of constructing the cover slab.

ITEM	Qty	Materials Required	Tools Required	Unit Process
1200 X 600 mm Cover slab 1	1	*2"x 2" hard wood *1" x 4" hard wood *¾ plywood *3" Nails *Wire mesh *¼ iron rod *Binding wire *Cement *Sand *Water	*Measuring tape *Carpentry square *Hammer *Handsaws *Spirit Level *Shovel *Trowel and wooden floats *Head pan	*A 1200x600mm wood formwork is formed with the base made of ¾ plywood and the wall of 2" x 2" hard wood *4No. 1150mm long ¼ iron rod is then laid on the wire mesh horizontally and another 4No. 580mm long ¼ iron rod is laid across them, each with 100mm intervals *Another 1150 x580mm wire mesh is then laid on top of the iron roods *A concrete mixture of sand, aggregate, cement and water ratio of 3:1:1:2 is then poured in the formwork and compacted and allowed to cure for 3days.
600 X 600 mm Cover slab 2	1	*2"x 2" hard wood *1" x 4" hard wood *¾ plywood *3" Nails *Wire mesh *¼ iron rod *Binding wire *Cement *Sand *Water	*Measuring tape *Carpentry square *Hammer *Handsaws *Spirit Level *Shovel *Trowel and wooden floats *Head pan	*A 600x600mm wood formwork is formed with the base made of ¾ plywood and the wall of 2"x 2" hard wood *4No. 580mm long ¼ iron rod is then laid on the wire mesh horizontally and another 4No. 580mm long ¼ iron rod is laid across them, each with 100mm intervals *Another 580 x580mm wire mesh is then laid on top of the iron roods *A concrete mixture of sand, aggregate, cement and water ratio of 3:1:1:2 is then poured in the formwork and compacted and allowed to cure for 3days.

Porous Concrete construction

ITEM	Qty	Materials Required	Tools Required	Unit Process
580 x 580 x5 0 mm Porous Slab	**2**	*2"x 2" hard wood *3" Nails *Wire mesh *Cement *Coarse agregate *Sand *Water	*Measuring tape *Carpentry square *Hammer *Handsaws *Spirit Level *Shovel *Trowel and wooden floats *Head pan	*A 580x580mm wood formwork is formed with 2"x 2" hard wood *A 530x530mm wire mesh is then placed in the formwork. *A concrete mixture of Coarse aggregate, Small aggregate, Cement, Water ratio of 2:1:1:0.3 is then mixed and poured into the formwork. * The concrete is then compacted and allowed to cure for 3 days
290 x 580 x 50 mm Porous slab	**1**	*2"x 2" hard wood *3" Nails *Wire mesh *Cement *Coarse aggregate *Sand *Water	*Measuring tape *Carpentry square *Hammer *Handsaws *Spirit Level *Shovel *Trowel and wooden floats *Head pan	*A 290x580mm wood formwork is formed with 2"x 2" hard wood *A 240x530mm wire mesh is then placed in the formwork. *A concrete mixture of Coarse aggregate, Small aggregate, Cement, Water ratio of 2:1:1:0.3 is then mixed and poured into the formwork. * The concrete is then compacted and allowed to cure for 3 days

ITEM	Qty	Materials Required	Tools Required	Unit Process
100 x 580 x75 mm Porous Beam	**8**	*2"x 2" hard wood *3" Nails *Wire mesh *Cement *Coarse aggregate *Sand *Water	*Measuring tape *Carpentry square *Hammer *Handsaws *Spirit Level *Shovel *Trowel and wooden floats *Head pan	*A 100x580mm wood formwork is formed with 2"x 2" hard wood *A 70x530mm wire mesh is then placed in the formwork. *A concrete mixture of Coarse aggregate, Small aggregate, Cement, Water ratio of 2:1:1:0.3 is then mixed and poured into the formwork. * The concrete is then compacted and allowed to cure for 3 days
100 x 580 x 75 mm Concrete Beam	**4**	*1" x 4" hard wood *¾ plywood *3" Nails *Wire mesh *¼ iron rod *Binding wire *Cement *Sand *Water	*Measuring tape *Carpentry square *Hammer *Handsaws *Spirit Level *Shovel *Trowel and wooden floats *Head pan	*A 100x580mm wood formwork is formed with the base made of ¾ plywood and the wall of 1" x 4" hard wood *A concrete mixture of sand, aggregate, cement and water ratio of 3:1:1:2 is then poured in the formwork and compacted *The concrete is then allowed to cure for 3days.

Installation of precast bio-digester

- Perforate the pipes to ensure you provide openings for water drainage at various points.
- Prepare the mortar for spreading in the digester base.
- Insert and position the concrete beams in the digester whole. Ensure there is a slope for drainage to be easy.
- Connect the concrete beams with the wires at the edge of each concrete beam.
- Use cement mixture to connect the beams to form the digester box.
- Drill the concrete block adjacent to the drainage tunnel.
- Connect the one pipe which connects to the rest of the piping system. Cover the pipes with soil.
- Spread ballast in the piping tunnel already dug up. This prevents clogging of the pipes.
- Make the digester water tight - Cover the corners with the mortar.
- Insert the concrete suspense beams. Insert the porous concrete slab.
- Suspend a net on top of porous beam.
- Add coconut fibre on top of the net.
- Cover the top with concrete slab. Seal completely.

Fitting of pipes and appurtenances

Setting and fixing the Toilet seat, U-trap and the drain

- The toilet seat (pan) and the U-trap should be fixed in place and set in lean concrete 1:3:5 mix and the floor around the pan carefully screeded and smoothed with 1:3 cement mortar
- Lay the drain pipe connecting the U-trap to the digester. The fall (gradient) on the pipe should be at least 1 in 25
- Cement the pipe through the digester walls and backfill around the pipe

Setting and fixing a Vent pipe

- The vent pipe should be fixed in place vertically and made to go above the roof of the superstructure.
- The lower end of the vent pipe should be fixed directly on top of the pit to allow for the gases to easily escape through the pipe.

- Set the lower end of the vent pipe in the vent slab and fit it in place with lean concrete 1:3:5 mix and carefully smooth the floor around the pipe with 1:3 cement mortar.

Constructing of soakaway/soakage pits

The construction of soakaway for the biodigester requires digging and laying of blocks and the cover slabs.

- The soil and subsoil must be suitable and the size of the plot adequate so not to cause any kind of pollution
- Soakaway pits are constructed using cement blocks, 1.5 meters in diameter and to a depth of 2m deep.
- In areas with high water-table, a shallow soakaway about 1.5 sq. and 0.6m deep filled with charcoal is constructed
- Reinforced cover slab over the top to contain a 600mmx450mm inspection cover.
- The soakaway should be more than 3m from any building.

Seeding the bio-digester

At this point, the system is ready for use.

- The system is used for two weeks before the micro-organisms are introduced.
- Microorganisms, mostly earthworms, are introduced into the system about 2weeks after the first use. These organisms feed on the faecal matter and decompose it.

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