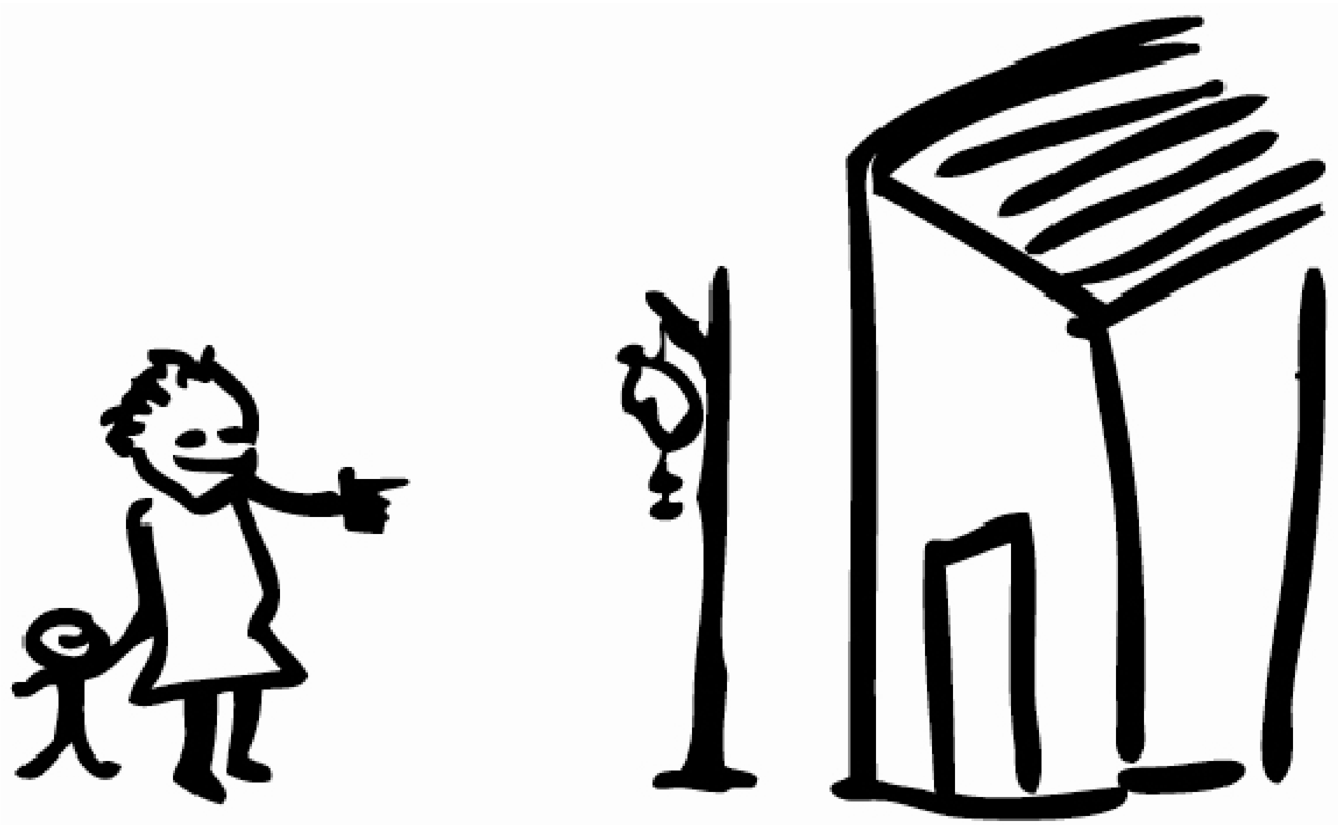

Latrine Design and Construction

Making Culturally-Appropriate Latrines

Second Edition
April 2011

Lifewater International

Lifewater International is a Christian nonprofit organization established in 1977 that demonstrates God's love by helping communities in Africa, Asia, and Latin America gain safe water, adequate sanitation, and effective hygiene practices that they will enjoy for generations. Focusing on sustainability, Lifewater and its qualified volunteer field trainers train and equip in-country partner organizations in the three crucial components of water development: water, sanitation, and hygiene (WASH). Lifewater's partner organizations then use the training and resources to help **local communities** meet their basic water and sanitation needs. Through this, both partners and local communities **gain confidence in their ability** to nurture the health and well-being of their people.

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All of our materials are designed for use as lessons for participatory learning. They are by their very nature better used within training sessions. To make the most of the information provided here, we recommend that you attend our course trainings. Access Lifewater's training schedule and purchase hard copies of all our training materials on our website – www.lifewater.org.

Lifewater International, April 2011
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Acknowledgements

For their outstanding contributions to the sanitation program, Lifewater International would like to acknowledge Samuel Moore, Lon Stuebinger, Linda and Bart Bergquist. Many thanks to Andre Schmidt, Lois Andrews, and Jason Holland for the hours spent reviewing lessons and technical instructions. Finally, we must express gratitude to the countless volunteer field trainers who have combined their gifts and talents with these materials to make the program and living work of art. These saints have proven that a small group of people can indeed change the world

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Facilitator Information

The objective of this course is to equip partners with the necessary knowledge, skills and attitudes to effectively assist communities in designing and constructing culturally appropriate latrines. This course is meant to be implemented in conjunction with additional Lifewater; together these courses will build the capacity of partners and communities to achieve adequate sanitation.

The elements of this course build on one another to train Lifewater Partners in crucial elements of Latrine Design and Construction. Lessons, a community visit, construction of latrine components, and a latrine design project work to accomplish this.

Lessons
The lessons in this manual were created with Lifewater's in-country partners as the audience. This means that each has been scripted as though a field trainer is teaching the material to a partner. Lesson scripting is meant as a guide for field trainers and helps maintain consistency among trainings.

Field Visit Activity
The field visit is meant to take place at the location where construction of the latrine will occur. At times this will be in a community; however it may also occur at the Partner's compound. Wherever the location, this activity is meant to give Partners a chance to practice assessment for latrine siting. It involves paying attention to cultural and environmental issues before construction begins. Seek the Partner's guidance regarding the planning for this activity and for any challenges that arise during the visit.

Latrine Design Activity
Following the field visit, Partners will have an opportunity to design an appropriate latrine for the context of the planned location. This design is meant to be the latrine they construct during the course; however if throughout the course the Partner decides on a different route for construction, use this time to plan and design according to the Partner's plan.

Latrine Construction
The technical section of this manual should work hand-in-hand with the Latrine Design planned by the Partner. In other words, the components built should be connected to the latrine designed by the partners. Other components constructed may serve as examples for more affordable options.

> For example, the partner may decide to construct a VIP latrine, with a lined pit and concrete slab. It may be good to also build a wooden slab or unreinforced concrete sanplat as well to demonstrate low-cost alternatives.

Discretion should be used when planning for construction. Too many projects can derail the lessons and focus of the training. **The objective of construction is to train the partner in options that are both desirable and sensible for their specific projects.** Decisions made for construction should be a dialogue between the Partner and Lifewater staff or field trainers. LI staff and field trainers should default to the desires of the Partner. If construction possibilities are numerous, decide on an **appropriate number** of tasks for the given time, being certain to account for time required to complete the lessons and the field visit.

Latrine Design Project

This project comes at the end of the course and serves as a final "test" of Partner's knowledge and skills to design a latrine. The objective of this project is to provide the time necessary for Partners to design a latrine taking into consideration the context of their own communities. If needed, facilitators may create scenarios for Partners to design latrines for. Partners will not be constructing these latrines during the course; rather they will present their latrines to the class and share why they chose their specific design.

Facilitation Tips

General Facilitation Activities

- Develop a list of classroom rules in the beginning of the course
  - Ask the class to list what rules they would like to have during the course
- Give clear directions
  - If needed, write numbered directions on a flipchart
- Arrange participants so they face each other
  - A circle or half circle works best
- Speak clearly
  - If working with a translator, use short sentences and pause often
- If you ask a question no one answers, reword it and ask again.
- Give people time to think.

Showing Positive Attitudes

- Repeat or summarize participant's answer
- Praise participants
- Ask for volunteers to respond rather than choosing someone to respond
- Show interest to responses by nodding and smiling

Working with Groups

- Pay attention to how groups are formed.
  - Certain activities my work well with groups of all women or men, or a mix might work best. Likewise, large groups may work better for some activities, while other activities may be best for groups of two or three.
- Visit each small group as they do activities to clarify, help and encourage
- If possible, place one English-speaking participant in each group

Handling Disruptions

- Create a list of off-topic questions
  - If questions come up that are off-topic, list them on a flipchart and do your best to make time to address them during the class.
- Assign time keepers
  - Time keepers can help the class stay on topic by reminding everyone of the limited amount of time for activities. Let time keepers know that if a discussion gets lengthy they are free to encourage the class to stay on track.
- Discuss disagreements during breaks or lunch
  - If disagreements or arguments occur during class, acknowledge the need to work through the problem but remind the individuals that time for the activities is limited. Suggest that further discussion be saved until break or lunch time and, if appropriate, offer to assist with the discussion.

Course Materials List *for a class of 20 Construction materials excluded	
Materials	**Quantity**
Manuals	11
Certificates	11
Flipcharts	2 (40 sheets each)
Markers	3-4 sets
Tape	2
Index cards	1 pack
2 liter plastic bottles	4
500ml plastic bottles	3
Sharp tool to cut bottles	1
Scissors	2
String or rope	1 (15m or 49 ft long)
Large basin to catch water from Groundwater lesson	1
Fine sand	2 liters or .5 gal
Coarse sand	2 liters or .5 gal
Clay	2 liters or .5 gal
Gravel	2 liters or .5 gal
Sandy soil, bits of grass and paper	1 liter or .25 gal
Water	about 2 liters

Sample Latrine Design and Construction Schedule

Session	Day 1	Day 2	Day 3	Day 4	Day 5
9:00 – 10:30	Introduction - intro to team- 10 - devotions- 30 - Self portraits or other intro game- 30-60	Devotions- 30 Review- 15 Construction Introduction - review instructions for constructing a concrete slab	Devotions- 30 Review- 15 (Debrief construction- review questions)	Devotions- 30 Review- 15 Latrines and Groundwater 2- 45 Homework 1 & 2	Devotions- 30 Review- 30- debrief field visit
10:30- 11:00	**Break**	**Break**	**Break**	**Break**	**Break**
11:00- 12:30	Course Description- 10 Identifying Expectations- 30 Community groups – 5 A Clean Camp- 30 Sanitation and Disease (start)	Concrete Slab construction	Arborloo- 45 Latrine Location- 30	Soils and Drainage- 45 Field visit preparation- 45	Designing pit latrines- 75 Latrine Design Project (design for construction site)
12:30 – 1:30	**Lunch**	**Lunch**	**Lunch**	**Lunch**	**Lunch**
1:30 – 3:00	Finish Sanitation and Disease Sanitation Perceptions- 45 Pit latrines- 45	SanPlat Construction	Groundwater- 45 Pathways- Latrine to Water Source- 45	Field Visit - siting latrine - assessment	Latrine design project- cont. Review field visit assessment, design latrine for site in small groups
3:00– 3:30	**Break**	**Break**	**Break**	**Break**	**Break**
3:30 – 4:30	VIP Latrines- 45	(Wood slab construction if time)	Latrines and Groundwater 1- 45		Review designs- decide on 1 -2 for construction
4:30 – 5:00	**Community Groups**	**Community Groups**	**Community Groups**	**Community Groups**	**Community Groups**

Session	Day 6	Day 7	Day 8	Day 9	Day 10
9:00 – 10:30	Devotions- 30 Review- 15 Construct Latrine(s)	Devotions- 30 Review- 15	Devotions- 30 Review- 15 Construction Debrief	Devotions- 30 Review- 15 Latrine Design Project (design for construction site)	Devotions- 30 Review- 15 What have I learned? Closing, Certificates
10:30-11:00	**Break**	**Break**	**Break**	**Break**	**Break**
11:00-12:30			Planning for Implementation		
12:30 – 1:30	**Lunch**	**Lunch**	**Lunch**	**Lunch**	**Lunch**
1:30 – 3:00				Present Design Projects	
3:00–3:30	**Break**	**Break**	**Break**	**Break**	**Break**
3:30 – 4:30					
4:40-5:00	**Community Groups**	**Community Groups**	**Community Groups**	**Community Groups**	

Latine Design and Construction Stateside Course Description

(for Lifewater Field Trainers only)

Sanitation plays a primary role in preventing diarrheal disease, yet one-fifth of the world's population lacks even a simple latrine. This hands-on course teaches partners to work with communities to construct culturally appropriate latrines. Participants learn about the biblical mandate for sanitation; how soil and groundwater influence proper latrine location; the construction, operation, and maintenance of various latrine designs; and how to adapt designs to accommodate people with special needs.

During this stateside training Lifewater hopes to prepare you, a field trainer, to teach this course to overseas partners. We will cover the majority of lessons in this manual and at the end of the training, you will have the opportunity to practice teaching one of the lessons we have covered.

It is our overall hope that by the completion of this training you will have:

- become familiar with the Latrine Design and Construction manual;
- learned new concepts and information regarding sanitation;
- constructed a concrete slab;
- explored different facilitation skills;
- practiced facilitating a lesson and received feedback.

➢ What are your thoughts regarding this information?

Latrine Design and Construction International Course Description

(for Lifewater Field Trainers and Partners)

During this course, Lifewater hopes to equip you with the knowledge, skills and attitude to effectively assist communities in designing and constructing latrines. We will learn about different latrine designs, how latrines affect soil and groundwater, how to properly site a latrine, and how to design a latrine.

As a class we will practice what we have learned during a visit to the site planned for latrine construction, and through designing and constructing a latrine for that site.
At the end of the course you will design a latrine for your context and present that design to the class.

- Are there any questions?

Introductory Activities

Self-Portraits

Purpose
This lesson is a fun way to introduce participants to each other.

Objectives
By the end of this lesson, participants will have:
- **Drawn** an artistic rendition of themselves
- **Indicated** three reasons why they want to learn more about sanitation
- **Communicated** these things to the rest of the group

Materials
- Markers
- Flipchart paper

Preparation
- None

Time
30 minutes

Steps
1. Draw yourself -10 minutes
2. Share about yourself- 20-30 minutes

1. Draw yourself - 10 minutes

On a piece of paper **draw** a portrait of yourself with your name on the top. You can use any type of drawing style you wish.

At the bottom of the portrait, **write:**

1. A short description of your family
2. What your profession is
3. Why you want to learn more about sanitation

Your written answers do not need to be detailed.

Give each participant paper and markers to draw.

2. Share about yourself – 20-30 minutes

We'll walk around and everyone will have an opportunity to **share** about his/her drawing.

The time needed for this activity will vary based on how many people need to share. If needed, limit participants to one or two minutes for sharing.

Identifying Expectations

Purpose

Participants will discuss their expectations for the training.

Objectives

By the end of this lesson, participants will have:

- **Identified** their expectations for this training
- **Written** these expectations on a tracing of their hand

Materials

- Markers
- Flipchart paper (enough for each group)
- Tape

Preparation

- **Go over the Latrine Design and Construction International Course Description with the group.**
- Decide how the participants will be divided into community groups.
- Review Community Group information page
- Draw the community group activity calendar on a piece of flipchart paper and post it where the class can see.

Time

20-45 minutes

Steps

1. Discuss your expectations -10 minutes
2. Review Expectations- 15-20 minutes
3. Community Group Introduction- 5 minutes

1. Discuss your expectations - 10 minutes

Divide the participants into their community groups.

In a small group, **discuss** your expectations for this course.

Using an expectations hand, **write out** 5 of your group's expectations with a marker. Then, **decide** on a name for your group and **write** it on the same paper as your expectations.

Post your group's hand on a wall with other groups' expectation hands.

2. Review expectations – 15-20 minutes

Read the other groups' expectations. We'll hear what stands out to you.

3. Community group introduction - 5 minutes

The small groups you are in right now are called your "community groups". Each day your community group will have certain tasks assigned to it. Your group will also meet at the end of each day to evaluate the day's activities.

Review the community group information with the participants. Assign tasks to each group for the week.

Community Group Information

Community Groups are the small groups that you will meet in for discussion and feedback at the end of each day.

Daily Review

With your Community Groups, discuss the following:

- What went well during the day?
- What could have gone better during the day?
- What suggestions do you have for the rest of the training workshop?

After small group discussion, write down your group's comments in **complete thoughts** on an index card, then give the card to a facilitator.

Other Activities

The Community Groups will also take turns doing the following activities throughout the course:

1. **Prayer and worship**: The responsible group will lead the class in 5-10 minutes of worship and prayer in the morning.
2. **Energizer**: The responsible group will prepare a short energetic activity to do one time in the morning and one time in the afternoon. It should involve the whole group and go no longer than 5 minutes.
3. **Time Keeping and Clean Up**: The responsible group will make sure the class returns from breaks and lunch on time. This group will also make sure the room is in order at the end of the day.

Activity	Day 1	Day 2	Day 3	Day 4	Day 5
Prayer and worship	Facilitators				
Energizer – morning and afternoon	Facilitators				
Time Keeping and clean up	Facilitators				

Principles of Sanitation

A Clean Camp

Purpose

Participants will explore one passage in Deuteronomy and discuss the implications to sanitation.

Objectives

By the end of this lesson, participants will have:

- **Explored** why adequate sanitation is important to God

Materials

- Flipchart paper
- Markers
- Tape

Preparation

- Write the scripture below on a piece of newsprint.

Deuteronomy 23:12-14

"Designate a place outside the camp where you can go to relieve yourself. As part of your equipment have something to dig with, and when you relieve yourself, dig a hole and cover up your excrement. For the Lord your God moves about in your camp to protect you and to deliver your enemies to you. Your camp must be holy, so that he will not see among you anything indecent and turn away from you."

Time

30 minutes

Steps

1. Sanitation Scripture-30 minutes

Note: Be sensitive to the religious beliefs of people attending the course. Facilitators may need to ask the Partner is this lesson is appropriate.

1. Sanitation Scripture- 30 minutes

Depending on the group, you may want a volunteer to read the passage.

1. Listen to a Bible passage on sanitation:

Deuteronomy 23:12-14

"Designate a place outside the camp where you can go to relieve yourself. As part of your equipment have something to dig with, and when you relieve yourself, dig a hole and cover up your excrement. For the Lord your God moves about in your camp to protect you and to deliver your enemies to you. Your camp must be holy, so that he will not see among you anything indecent and turn away from you."

As a group, let's **discuss** the following questions:

- What are the similarities between this situation in the Bible and the situation in the communities where you live and work?
- What light does the situation from the Bible cast upon your current situation?
- What should we do as individuals and a group based on these insights?

Sanitation and Disease

Purpose

Participants will discuss the importance of sanitation to breaking the fecal-oral disease route.

Objectives

By the end of this lesson, participants will have:

- **Observed** and **analyzed** a drama on how inadequate sanitation and hygiene negatively impacts health, community participation, and family income
- **Utilized** the Disease Pathways diagram to understand the role of adequate sanitation in blocking the fecal-oral disease route

Materials

- Disease Pathways poster set
- Blocking Posters
- Tape

Preparation

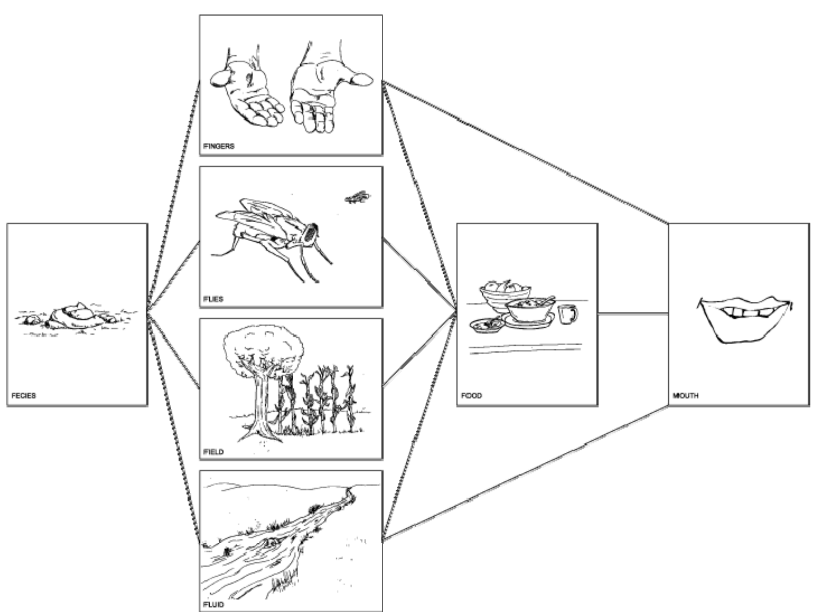
- Find four people to practice the drama. (Mary, Mary's husband, boss, a person coordinating a community water project)

Time

45-60 minutes

Steps

1. Drama: Cycle of Illness- 10 minutes
2. Disease Pathways diagram- 15 minutes
3. Block the Disease pathways- 15 minutes



1. Drama: Cycle of Illness- 10 minutes

Watch the following drama and be prepared to answer questions about what you see.

> ***Drama***
> Three people are standing on the corners of an imaginary triangle, about 2 meters away from each other. One person is the husband at home, another person is the boss at work, and the third a person coordinating a community water project. A fourth person, Mary, is sick with diarrheal disease and, starting at home, walks around the triangle interacting with people. Mary goes to work but cannot work long because of her illness; her boss refuses to pay her. She walks past the community development project but when asked to participate, she declines because of her illness. At home, she cannot do her household activities because of illness. She walks the loop one more time, interacting with the others again. She is discouraged that she can't earn her wages, participate in community projects, or care for her family because of the long-term diarrheal illness.

With a partner, **discuss** the following questions:

- What happened to Mary and why did it happen?
- What might your organization do to improve situations like this?

After a few minutes, we'll **hear** your ideas.

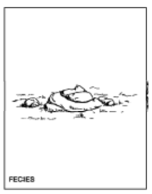
In the drama we saw that Mary was caught in a cycle of illness, discouragement, and poverty due to inadequate sanitation and poor hygiene practice. Let's **look** at a diagram that shows how most diarrheal disease is spread and then we'll **consider** some ways to prevent its spread.

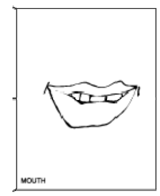
2. Disease pathways diagram- 15 minutes

Examine the disease pathways diagram as the components are laid out on the floor.

This diagram represents the transmission of pathogens (disease-causing organisms) from feces to the mouth.

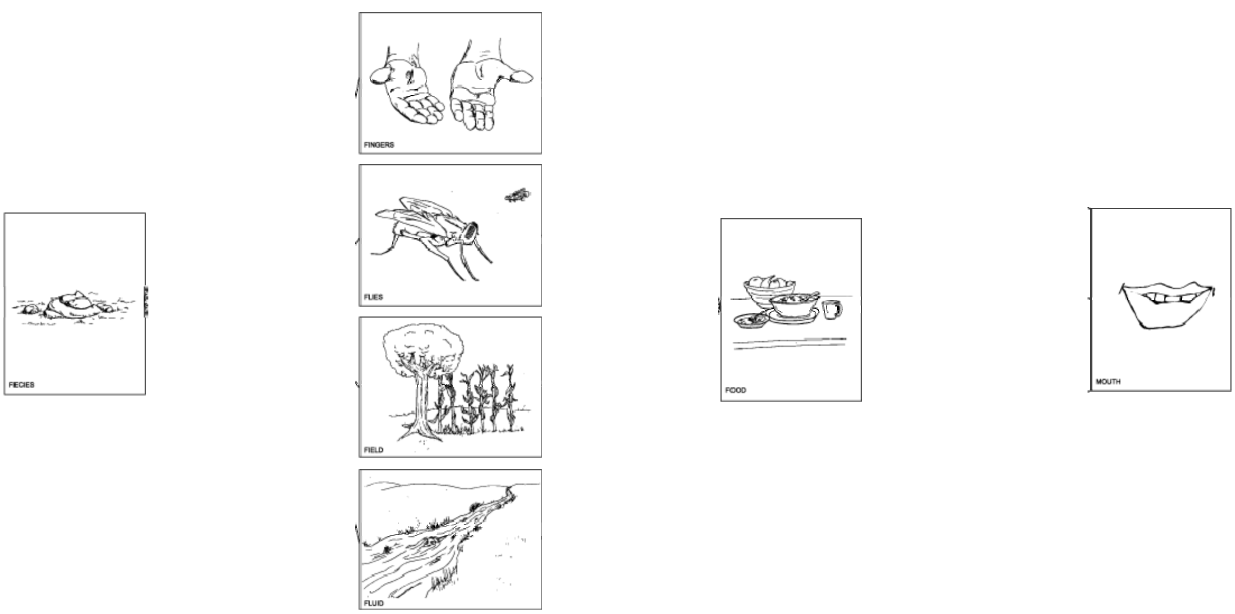
Show feces and mouth posters to the participants before setting them on the ground. It may be helpful for participants to stand during this activity.





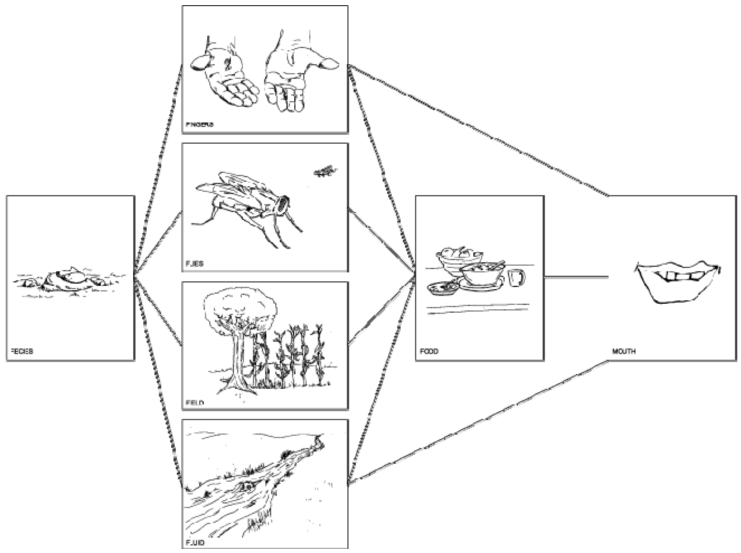
There are different ways feces can get to the mouth. Some ways are: fingers, flies, fluids and food.

As you say each example, show the poster to the group and place it on the ground following the diagram shown below.



We will use tape (or string) to show the different ways pathogens take from feces to the mouth. **Watch** an example of one pathway and then we will **observe** as people show other pathways.

Show an example of a pathway; narrate as you lay down the tape. Then ask participants to show other pathways. Participants may think of more pathways that are shown in the diagram.



- Which ways are common in the areas where you work?

3. Block the disease pathways- 15 minutes

We will now explore behaviors that can block the pathogens. We have different posters that show behaviors which block pathogens. Here is an example:

Choose an example blocking poster and explain the poster to participants before setting it on a pathway.

Pass out blocking posters, one for every few participants.

With the people next to you, **discuss** what behavior the poster shows and which pathway it may block.

When it is your turn, **describe** your poster and **lay** it down on the diagram where you think it will block pathogens. After, the class will have time to respond.

Give participants time to discuss. If disagreements arise, encourage the groups to reach a consensus or compromise. The point of the activity is to start discussion about behaviors that block disease, not to arrive at the "right answer".

- Which pathways do you think will be the most difficult to block? Why?

Read a definition of the following behaviors. **Call out** which pathways on the diagram are related to each behavior.

Hygiene Behaviors: Cleanliness behaviors including personal and food safety, keeping latrines clean, keeping water safe.

Sanitation Behaviors: Safe disposal of human excreta and wastewater.

Safe Water Behaviors: Using safe water source and water purification.

Look at this statistic connecting water, sanitation, and hygiene.

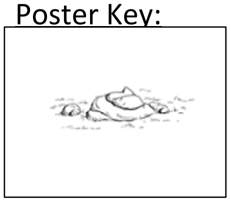
Investments in water quality and quantity can reduce childhood deaths caused from diarrhea by 15-20%, better hygiene like washing hands and handling food safely reduces it by 35%, and improved sanitation reduces it by 40%.

Wateraid http://www.wateraid.org.uk/site/what_we_do/how_we_work/109.asp

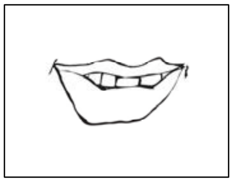
We'll **hear** your reactions.

Poster Set

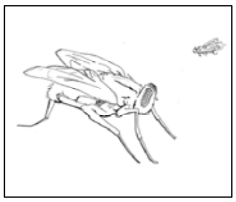
Poster Key: | Description:



Feces

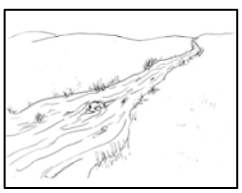


Mouth



Flies

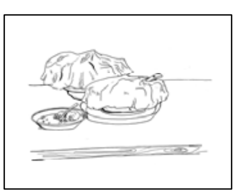
Fields



Water

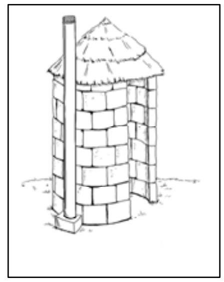
Food

Basic Pit Latrine



Covered food

Poster Key: | Description:

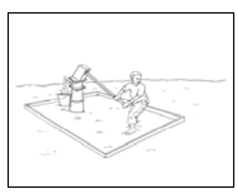


Ventilated Improved Pit Latrine

People cleaning latrine

Biosand filter

Handwashing



Hand pump

Washing vegetables

Sanitation Perceptions

Purpose
Participants will share their sanitation experience. They will also share community perceptions of sanitation.

Objectives
By the end of this lesson, participants will have:
- **Shared** their experience regarding sanitation
- **Shared** common community perceptions of sanitation, specifically latrines

Materials
- Markers
- Flipchart paper
- Tape

Preparation
- None

Time
45- 60 minutes

Steps
1. Share Common Practices
2. Share Common Perceptions
3. Share your Experience

1. Share Common Practices - 10 minutes

We would like to learn more about the sanitation practices in this area, and your experiences while working to improve sanitation and hygiene here.

- ➢ What types of sanitation practices are common here?

Inquire about men, women and children's practices. What is common in schools? What about urban and rural practices?

2. Share Common Perceptions – 20-30 minutes

In small groups, **discuss** what people in this area think about latrines. Then on a piece of paper, **record** the advantages or benefits people think latrines have. On the same piece of paper, **record** the disadvantages people think latrines have.

Advantages	Disadvantages

Give each group a piece of flipchart paper to record their findings. Give each group time to share with the class.

2. Share your Experience– 20-30 minutes

Earlier, you all shared what you professions are. Let's **hear** more about your experience working to improve sanitation where you work.

- What have been your experiences working to improve sanitation?
- How might those relate to the perceptions of people regarding sanitation?

Thank you for sharing your experience with us. This helps us have a better idea of what sanitation issues and perceptions are common here.

Latrine Types

Pit Latrines

Purpose

Participants will understand the basic components of the pit latrine and the materials that can be used to construct these components.

Objectives

By the end of this lesson, participants will have:

- **Discussed** reasons why pit latrines are not operated and maintained properly
- **Examined** the function of the pit, lining, slab, mound, and superstructure
- **Sketched** a typical latrine that utilizes locally appropriate materials

Materials

- Posters of a pit latrine and the components: pit, slab, and superstructure
- Flipchart paper
- Markers

Preparation

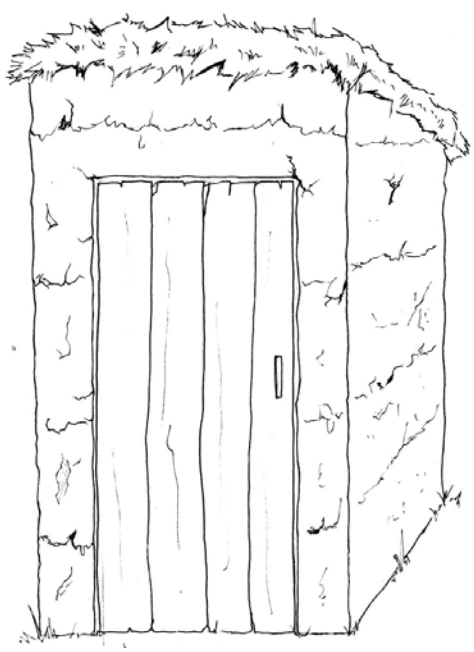
- Have a volunteer draw a large picture of a pit latrine on a piece of newsprint. Use the main image on page 22 as a guide.

Time

45 minutes

Steps

1. Pit Latrine Perceptions- 10 minutes
2. Pit latrine components- 20 minutes



1. Pit Latrine Perceptions- 10 minutes

In the last activity, we learned how important latrines are for preventing diarrheal disease. However, many people do not view latrines as safe, hygienic places that improve health.

With a partner, **look** at the cartoon and **discuss** the following questions:

- What is happening and why does it happen?
- From your experience, what are the things that cause situations like this? Make a list of your findings.

Caption: "Remember, always use a latrine for better health."

(Reference unknown)

After a few minutes, we'll **hear** a sample of your findings.

____

____

____

____

2. Pit Latrine Components- 20 minutes

There are many reasons why latrines don't work properly. Some problems are related to latrine design and construction; some are related to social and cultural factors; some are related to poor hygiene and lack of latrine maintenance. In this training module, we will focus on the technical aspects of adequate sanitation, looking at design, construction, and environmental factors.

The main components of a pit latrine are: the pit, the lining, the slab, the mound, and the superstructure (latrine shelter).

In small groups, **look** at the picture of a basic pit latrine and **read** the details for each pit latrine component (next page).

Discuss the following:

- How do these technical aspects complement what you already know about pit latrines?
- Which of these technical points is new information?
- What questions do you have about this information?

Write down any questions your group has in the space below.

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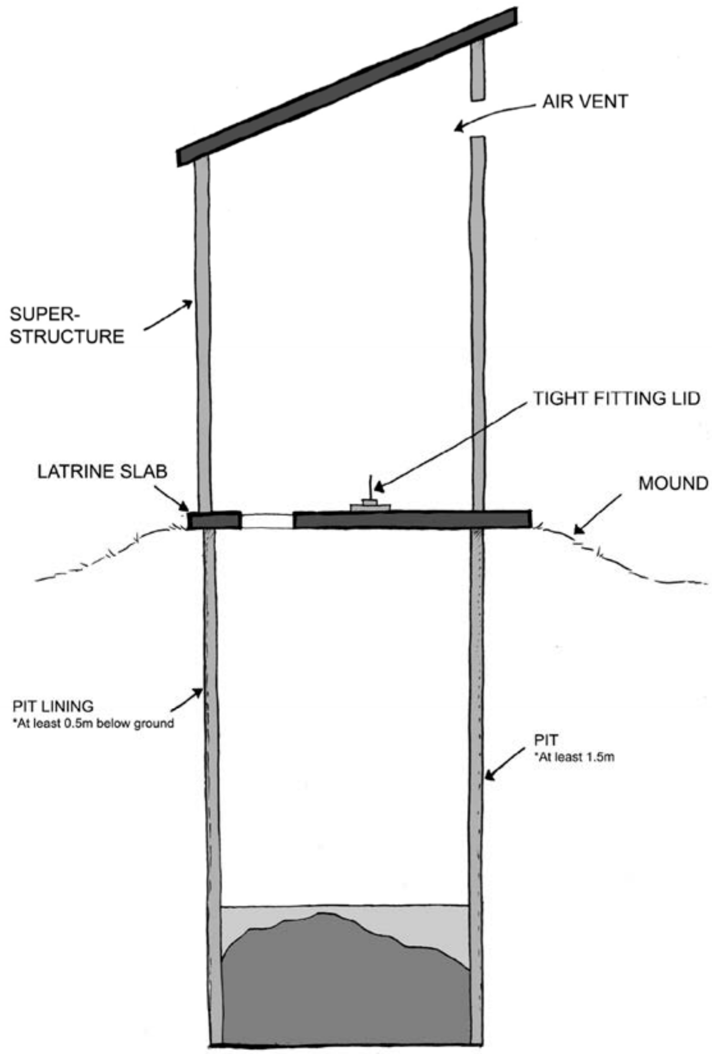


Pit

- The pit stores and processes excreta (feces and urine)
- The typical pit is 2.5-4 meters deep and 1-1.5 meters wide
- The pit shape can be square or circular, though circular is less likely to collapse
- The pit should only be filled to within the top 0.5 meter. When the slab and superstructure are removed, the 0.5 meter space should be filled with a soil cap to keep humans, animals, and surface water from coming into contact with the pit contents

Lining

- Lining keeps the pit walls from collapsing
- Line and completely seal the top 0.5 meter of the pit as a foundation to support the slab and superstructure, to support loose topsoil at the surface, to keep surface water and burrowing animals from getting into the pit
- Stable soil: only need to line the top 0.5 meter
- Unstable soil: need to line the entire pit
- Below the top 0.5 meter of completely lined pit holes, the walls must be porous to allow the pit liquids to drain into the soil. Holes can be made in brick lining by not filling in all of the gaps with mortar

Slab

- Slabs provide a cover to the pit and a place to squat or sit while relieving oneself
- Must be strong enough to support the weight of the user and depending on the design, the weight of the superstructure
- Slabs made of concrete or plastic have a smooth surface that is easy to clean
- Tight fitting lids are used on slabs to minimize odors and flies

Mound

- The mound around the slab keeps surface water from flowing into the pit
- The mound should raise the slab at least 15 cm above the surrounding ground

Superstructure

- The superstructure gives the user privacy and protects them from the weather
- Can be made from the same local materials that are used to build houses
- Should have air vents covered with fly-screen

3. Pit Latrine Materials- 15 minutes

Pit latrine components can be constructed from different materials.

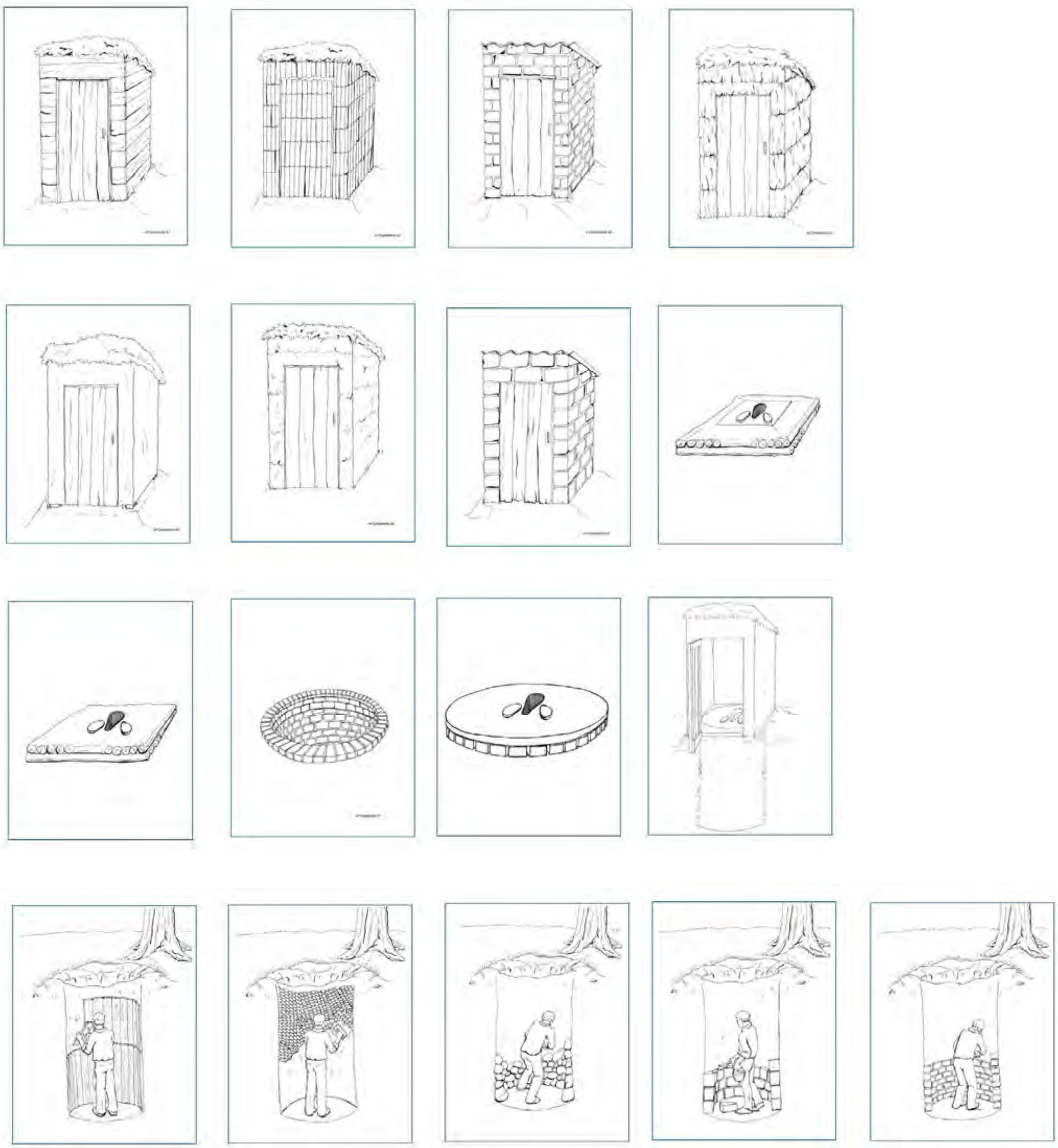
In your small groups,

1. **Look** at the posters showing designs that use different materials.
2. **Select** the materials that you think are most appropriate for the communities where you work.
3. **Add** any materials that are missing from the posters.
4. On newsprint, **draw** a latrine built with these materials. For example, you may choose to sketch a latrine with no lining, a concrete slab, and a grass superstructure with a corrugated tin roof.

Each group will **share** their drawing.

- Why are these materials appropriate and effective in this area?

Poster Set



The above posters are a basic sampling of the types of posters from which you can select for use in this lesson. You can also draw additional ones that are relevant to your people group or select posters from other lessons or sources.

VIP Latrines

Purpose
Participants will be familiar with the operation of the ventilated improved pit latrine (VIP).

Objectives
By the end of this lesson, participants will have:

- **Discussed** the features of the ventilated-improved pit (VIP) latrine
- **Analyzed** obstacles to using VIP latrines in local communities
- **Created** a song or poem to help remember how VIP latrines control flies and odors

Materials
- Poster of VIP latrine design
- Flipchart paper
- Markers
- Tape

Preparation
- Have a volunteer draw a large picture of the ventilated-improved pit latrine (VIP) on a piece of flipchart paper. Use the image on page 31 as a guide.

Time
45 minutes

Steps
1. Introduce VIP Latrine- 15 minutes
2. Discuss challenges of VIP Latrine- 15 minutes
3. Show how VIP latrines reduce flies and odors- 15 minutes

1. Introduce VIP Latrine 15 minutes

- Would someone please review how a basic pit latrine works?

One modification to the basic pit latrine is the ventilated improved pit latrine, or VIP latrine. The VIP latrine has design features that both control odors and flies.

- What do you know about VIP latrines?

With a partner, **read** and **discuss** the description of how VIP latrines control odors. **Circle** anything that you find interesting or have a question about. We'll hear your comments.

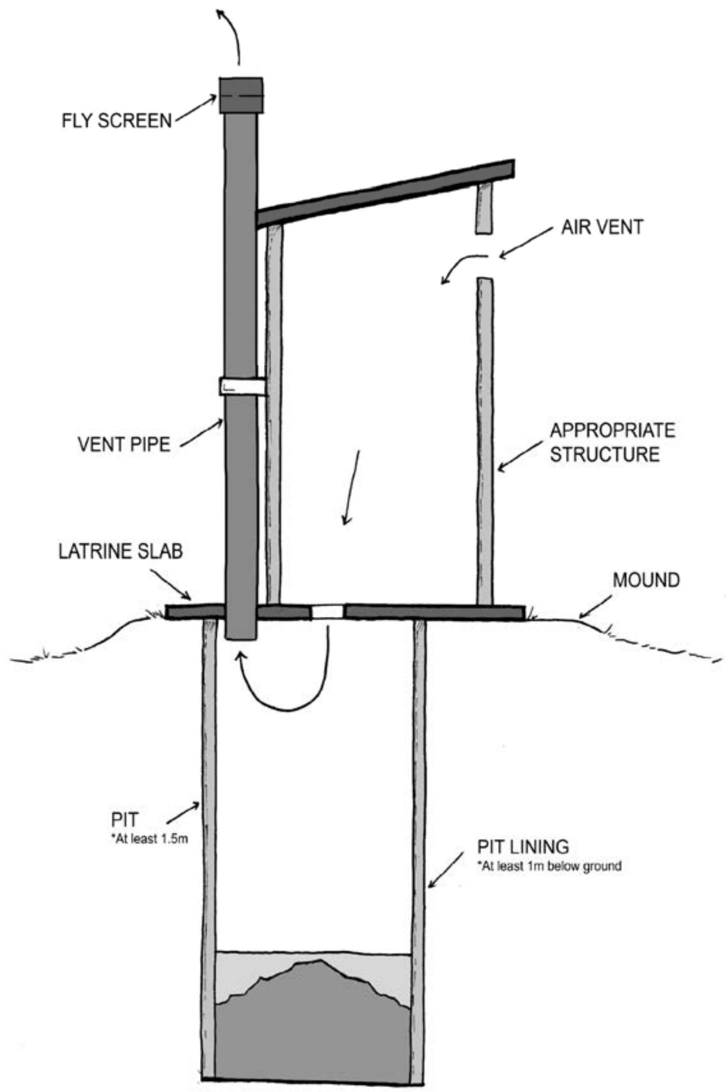
VIP Latrine Odor Control

When the wind blows across the top of the vent pipe, air is drawn out of the pit through the vent pipe. Because the hole in the slab is not capped with a lid as it is in the basic pit latrine, air is drawn from the superstructure into the pit. Because the air is constantly moving down the pit hole and up the vent pipe, foul odors should not enter the superstructure.

It is important that the vent pipe be at least 100 mm in diameter to permit sufficient airflow. The top of the vent pipe must also extend at least 0.5 meters above the top of the superstructure. The outlet of the vent pipe should not be close to trees or buildings that could slow down the air flow. In addition, a cap should not be placed on the top of the vent pipe as it will restrict airflow. To permit enough air to move through the slab hole, the superstructure must have a vent opening of sufficient size. A 15 cm x 1 m vent opening in the superstructure should be adequate. Ideally this opening will be on the side of the superstructure that faces prevailing winds. If possible, vents should be placed up high, above the level of the door. Vents near the floor may decrease privacy.

VIP Latrine Fly Control

The VIP also controls flies. Flies in the superstructure are drawn into the pit by the smell of human excreta. The superstructure is kept semi-dark so that once the flies are in the pit, they will be drawn to the brightest light, which is at the top of the vent pipe. The flies will fly up the vent pipe but be trapped by the corrosion-resistant screen attached over the outlet. They will die and fall back into the pit. If the door of a VIP latrine is left open, the bright light will attract flies from the pit back into the superstructure and the fly problem will remain.



2. Discuss challenges of VIP Latrine- 15 minutes

Many people do not understand how the VIP controls flies and odors, so that when they construct their latrine it does not function correctly. The most common problems are:

- Buying a smaller diameter pipe to minimize cost, thereby reducing airflow
- Putting a cap on the top of the vent pipe (different than the fly screen), thereby reducing airflow
- Small, or no vents in the superstructure
- Windows in the superstructure that let in too much light

  - What other problems with VIP latrines have you encountered?

Turn to a partner and **explain** how the VIP latrine works.

In small groups, **discuss** the following questions:

- From what you know about VIP latrines and from your experience, what might be some obstacles to promoting VIP latrines in communities where you work?

- How should families decide whether to construct a basic pit latrine or a VIP latrine?

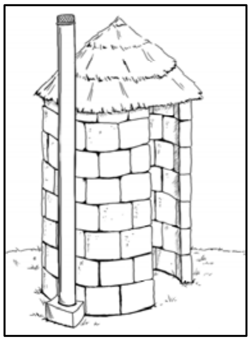
We'll hear a sample of your answers.

4. Show how VIP latrines reduce flies and odors- 15 minutes

In the same small groups, **create** a song or poem that communicates how VIP latrines reduce flies and odors.

We'll hear from each group.

Poster Set

Poster Key:	Description:
	Ventilated Improved Pit Latrine (VIP)

The above posters are a basic sampling of the types of posters from which you can select for use in this lesson. You can also draw additional ones that are relevant to your people group or select posters from other lessons or sources.

How Pit Latrines Work

Purpose

Participants will understand basic operation of a pit latrine.

Objectives

By the end of this lesson, participants will have:

- **Discussed** the processes that occur in the pit and surrounding soil to store and process human excreta.
- **Identified** the rate of reduction of excreta added to a pit.

Materials

- Plastic beverage bottles, preferably 2 liter size (1-2)
- 500 ml plastic bottles (1-2)
- Sandy soil
- A sharp tool to cut the bottles in half and punch holes in the bottoms,
- Bits of grass and paper
- Water
- 55 gallon drums (2)
- Jerricans (3-4)
- Diagram of bottle setup
- Flipchart paper
- Markers
- Tape

Preparation

- Have a volunteer help set up the bottle as shown in the diagram. If the group is large, set up two bottles.

Time

45 minutes

Steps

1. Pit Latrine Demonstration
2. Calculate Excreta Production

Optional Activity:
Use 2, 55-gallon drums and 3-4 jerry cans to visually show how 365 liters (100 gallons) of sludge built up over time can be condensed to 60 liters (16 gallons) or use piles of dirt, leaves, etc. to demonstrate the same comparison.

Set up two 55 gallon drums side by side to represent the volume of excreta that one person adds to a pit latrine each year. Also find 3, 5-gallon (or 4, 4-gallon) jerry cans to represent the amount of sludge that is created from the larger volume.
Note: it is best to do the pit demonstrations out doors. This will help make clean-up easier and changing location helps the participants remain engaged.

1. Pit Latrine Demonstration

Watch a simple demonstration of how a pit latrine works.

Hold the pit latrine model so participants can see.

This small 500 ml plastic bottle represents the pit of a latrine. You can see that the pit is dug into the ground. Every day, people use the latrine, adding liquid and solid excreta.

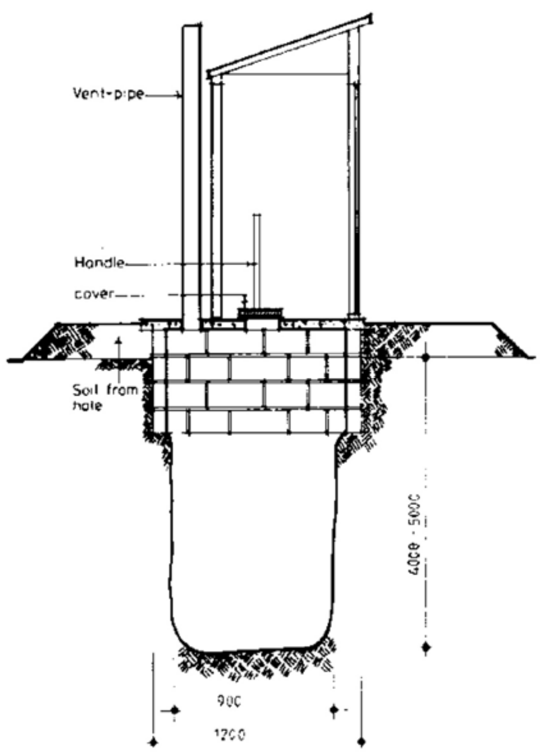
Pour water into the "pit"

As you can observe, the liquids drain from the pit into the surrounding soil and the solids stay in the pit.

Ask volunteer to take the model around the circle so participants can see inside the "pit"

Liquids make up the largest volume of wastes deposited in a pit. When pit latrines fail, it is generally because the pit cannot adequately handle large amounts of liquid. It is also the liquid that creates the greatest risk to health and groundwater contamination.

Through decomposition and several other processes that occur in a pit, harmful bacteria are reduced and the solids are compressed to a much smaller amount than what was originally deposited in the pit. The solids that build up in the latrine over time are called sludge.



2. Calculate Excreta Production

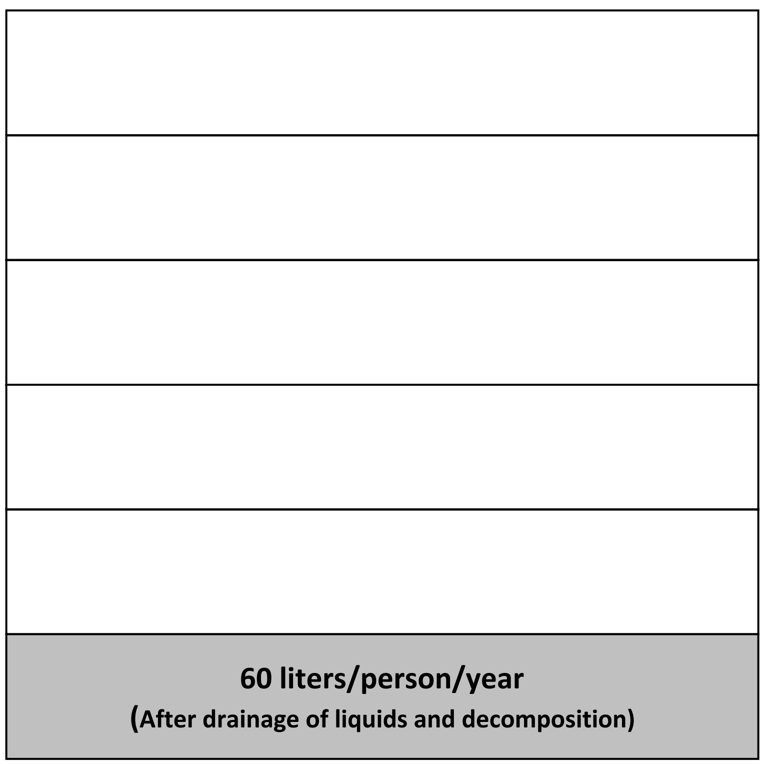
Assuming that the average person produces about one (1) liter of excreta (feces and urine) per day, in one year they would deposit 365 liters into a pit latrine. This large rectangle represents the amount of excreta that a person would add to a pit latrine in one year.

Indicate to the flipchart with the Human Excreta Production chart.

Over time, most of the liquid drains into the ground and is processed by the soil. Decomposition and other processes will reduce the amount of solids to about 60 liters per person, per year in a dry pit latrine. This means that each person contributes about 60 liters of sludge build up in the pit every year. A dry pit latrine is one in which water is not deposited through flushing, bathing, or household cleaning.

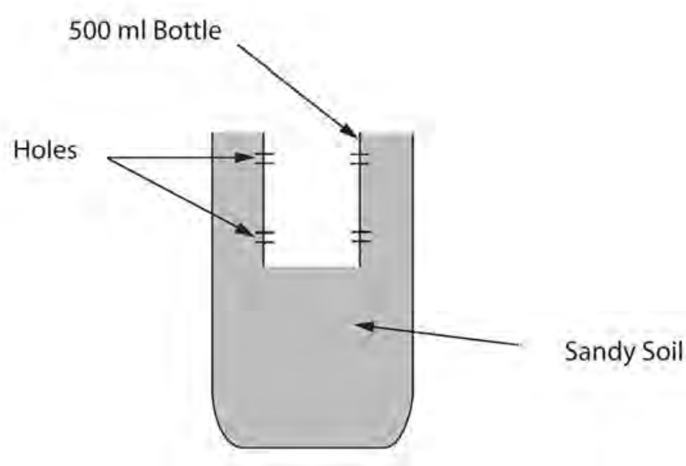
- What questions or comments do you have?

Human Excreta Production
Approximately 365 liters/person/year

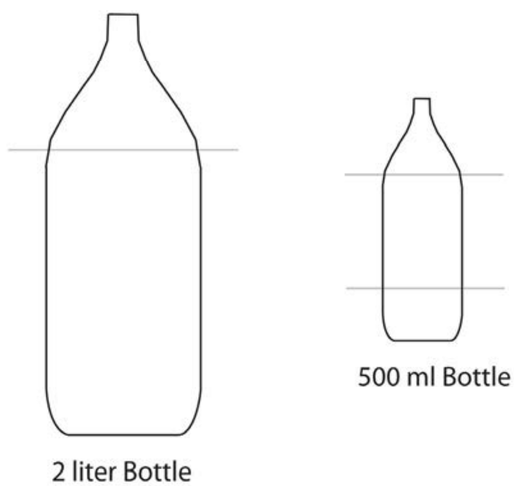


> *Optional activity:*
> *Here is another way to compare the sludge built up over time to the excreta added. This 365 liters (100 gallons) shown by the two barrels is reduced, over time, to 60 liters (16 gallons).*

Pit Latrine Model



Bottle Setup



Cutting Directions

Pour Flush Latrines

Purpose

Participants will be familiar with the operation of the pour flush latrine.

Objectives

By the end of this lesson, participants will have:

- **Explored** the design features of several types of pour flush latrines.
- **Brainstormed** advantages and challenges of using pour flush latrines.
- **Determined** areas where pour flush latrines would work well.

Materials

- Posters of pour flush latrine designs
- Flipchart paper
- Markers

Preparation

- Have a volunteer draw a large picture of the following latrines on a piece of newsprint. Use the posters below as a guide, including the text labels.
  - Pour Flush Latrine
  - Pour Flush Latrine – Offset Twin-Pit Pour Flush Latrine
- Title a flipchart: "Good characteristics for pour flush latrines

Time

45 minutes

Steps

1. Review Pour Flush Latrine Designs- 10 minutes
2. Brainstorm Advantages and Challenges- 15 minutes
3. Determine Location Characteristics- 20 minutes

1. Review Pour Flush Latrine Designs- 10 minutes

Hang up the large drawings of a pour flush latrine and a basic latrine.

Study this drawing of a pour flush latrine.

- What differences do you see between this latrine and a basic pit latrine?

Pour flush latrines use water traps or seals.

Indicate to water trap.

A person relieves him or herself and pours water into the water trap to flush excreta into the pit.

- What do you know about pour flush latrines?
- Are pour flush latrines common in this area?

Hang up the offset pour flush latrine flipchart.

This type of pour flush latrine has a pit that is not directly under the structure. We call this an offset pour flush latrine. Excreta is flushed down this pipe to the pit. This type of pit makes it possible for the latrine to be located inside a home, while the pit can be located outside.

Hang up the twin-pit pour flush latrine flipchart.

This type of pour flush latrine has two offset pits. Only one pit is used at a time. When the first pit is almost full, excreta is directed to the other pit. The first pit can then be empited or allowed to decompose.

- What questions do you have about these three types of pour flush latrines?

2. Brainstorm Advantages and Challenges- 15 minutes

We are going to divide into small groups. Your group will be given one of these latrines. In your groups, **list** the advantages and challenges of using your type of pour flush latrine.

Be **prepared** to present to the class.

Give each group a piece of flipchart to list their findings. Have each group share with the class.

3. Determine Location Characteristics- 20 minutes

Hand each person half a sheet of paper. Hang up "Good characteristics of pour flush latrines" flipchart

By yourself, **think** about places that would be good for poor flush latrines.

- What characteristics would this place have?
- What people would use pour flush latrines?
- What cultural practies might work well with pour flush latrines?

These questions are just meant to get the participants thinking. They do not have answer each one.

On your paper, **write** one characteristic you thought of. All at once, we will **tape** these to the flipchart.

At one time, have everyone tape their paper to the flipchart titled "Good characteristics for pour flush latrines". After, read each one out loud or ask a volunteer to.

- Based on these characteristics, what areas, would be good for pour flush latrines?

This question is meant for discussion. Facilitators may bring up the question "is this a good area for pour flush latrines? Why or why not?"

Thank you for your thoughts and valuable discussion!

Background Information

Pour flush latrines

Pour flush latrines require a special pan which conains a water seal or trap, to be attached to the defecation hole. The seals come in different designs, more of which can be read about in the technical section of this manual. 2-3 liters of water is required to flush excreta through the seal into the pit. The amount of water required may increase if the pit is offset.

These pans generally reduce odor and thus reduce fly activity making them an attractive option. However, in places where water is scarce, this would not be a wise choice because water is required for flushing. In fact, one of the main problems that occurs with pour flush latrine is clogging due to not flushing with water. People sometimes try to clear the seal with a stick and end up breaking the seal.

Offset Pour Flush Latrines

Pipes connect the water seal with the offset pit. These can be made from various materials including: plastic, fired clay or asbestos cement[1]. Pipes should be smooth and straight, as roughness or curves may lead to blockage.

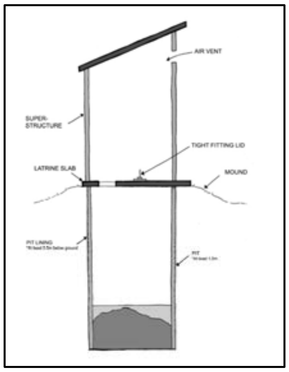
Twin-pit Pour Flush Latrines

There is meeting point formed in the shape of a “Y” where excreta can be directed to either one pit or to the other. Make sure that one side is blocked off, enabling excreta to only flow to one pit at a time. When using a twin-pit, it may be wise to buy or construct a pan where the seal is a separate part. This design allows the user to choose the direction from which the pipe can be connected to the seal.

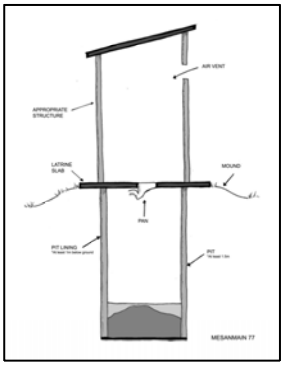
[1] Richard Franceys et al., *A Guide to the Development of On Site Sanitation* (Geneva: WHO, 1992,) 23,52-55.

Poster Set

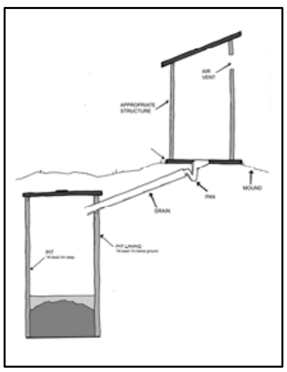
<u>Description</u>



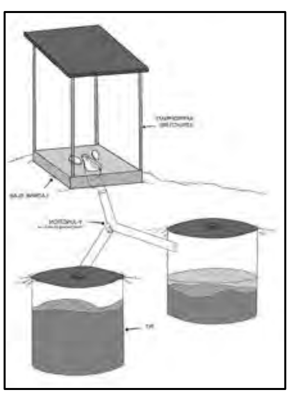
Basic Pit Latrine



Pour Flush Latrine



Pour Flush Latrine – Offset



Twin-Pit Pour Flush Latrine

The above posters are a basic sampling of the types of posters from which you can select for use in this lesson. You can also draw additional ones that are relevant to your people group or select posters from other lessons or sources.

Composting Latrines

Purpose

Participants will be introduced to different types of composting latrines and brainstorm ways to address the challenges of using composting latrines.

Objectives

By the end of this lesson participants will have:

- **Discussed** the main factors involved in composting
- **Reviewed** the basic operation of several types of composting latrines
- **Explored** benefits and challenges of using composting latrines

Materials

- Markers
- Flipchart paper
- Composting latrine sets for "gallery walk"

Preparation

- Ask two volunteers to prepare the skit.
  SEE END OF LESSON FOR SKIT
- Each composting latrine set will have a page of information, an illustration of the latrine, and a photograph of the latrine. Each set will have a number in the bottom-left corner that corresponds to the sequence in which the participants should read each set. Poster sets can be found at the back of the manual.
  Sequence of sets:
  - Arborloo
  - Fossa-Alterna
  - Twin-pit Dry Composting
  - Solar Dry Composting
- Post composting latrine sets around the room in sequence.

Note: Additional composting information is located in the Appendix.

Time

60 minutes

Steps

1. Review- 5 minutes
2. Drama: Composting Latrines-15 minutes
3. Effective composting- 25 minutes
4. Benefits and challenges of composting latrines- 15 minutes

1. Review- 5 minutes

As we have discussed in previous lessons, latrines are essential for blocking the transmission of disease. Human excreta contains bacteria, viruses and other pathogens that are extremely harmful. However, God has created processes in nature that can change harmful human waste into relatively harmless compost.

Turn to a partner and **answer** this question:

- How do latrines block the transmission of disease?

2. Drama: Composting Latrines- 15 minutes

Observe the following skit about composting latrines.

- What did you see happening?

- What experience have you had with composting latrines?

Composting is basically the breaking down of organic material through natural processes. When we talk about composting in relation to sanitation, we sometimes refer to it as “ecological sanitation” or “Ecosan”.

Given the right conditions, harmful, disease causing pathogens in human excreta can be reduced to a harmless level.

3. Effective composting- 25 minutes

Effective composting takes place when three main elements are addressed: time, temperature and tasks.

Time refers to the time needed to allow the contents of a pit to break down; this varies depending on the latrine design. When pit contents are removed, they should be dry and odorless.

Temperature refers to the level of heat inside the pit. A high level of heat will kill pathogens faster.

Tasks are actions that can be done to the pit contents to improve the rate of decomposition. These vary depending on the type of latrine.

Depending on the group, you may need to walk through and describe each type of latrine to the participants.

Around this room are pictures of composting latrines and information about each. **Walk** around the room, taking time to read about the different composting latrines. Be sure to **identify** the three factors (time, temperature, and tasks) for each latrine.

Afterward, we'll hear your thoughts and discuss any questions you have.

4. Benefits and challenges of composting latrines- 15 minutes

There are benefits and challenges to using composting latrines. In small groups, **list** some potential benefits and challenges to using composting latrines.

Be **prepared** to share your list with the class.

Break participants into four groups, two groups can list benefits, two can list challenges. If time, compile responses to make one list for benefits, and one for challenges.

Choose a member of your group to share your list with the class.

- What are your questions?

Drama

(Person 1 enters, as person 2 is pretending to shovel the contents of a composting latrine.)

Person 1: What are you doing?

Person 2: I'm emptying one of the chambers of my composting latrine, and I'm going to mix the compost into the soil in my orchard.

Person 1: Do you mean that you can use the contents of your latrine as fertilizer?

Person 2: Yes, are you interested in learning how to build one?

Person 1: Uhh, I don't know. I'm not sure how safe if would be to handle human waste.

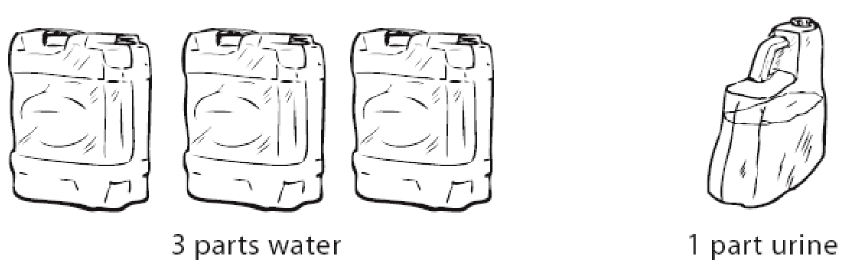
Background Information

Definition of Pathogen
Any disease-producing agent, esp. a virus, bacterium, or other microorganism.

Using Decomposed Excreta[2]
Decomposed excreta is rich in nutrients (NPK – nitrogen, phosphorous, and potassium) and organic material. The organic material in compost acts as soil conditioner. It also improves the structure and water holding capacity of sandy soils and adds structure and permeability to clay soils. Composted excreta, on its own or combined with other biodegradable material, enhances the fertility of topsoil.

Urine as Fertilizer[3]
Urine is a high quality, low cost alternative to the application of nitrogen-rich mineral fertilizer in plant production. The application of urine should be done as close to the ground as possible, incorporating it into the soil, preventing nitrogen loss. Urine is therefore preferably mixed with soil, or watered into it. The amount applied and the frequency of application depends on the nitrogen need of the plant and its root size. In general, recommendations available for the use of nitrogen fertilizers give a good starting point for how to use urine. The risk of disease transmission through handling and using human urine are related mainly to fecal cross-contamination.

When using urine as fertilizer:
- Dilute urine using three parts water to one part urine
- Do not fertilize plants more than three times a week with diluted urine



[2] Peter McIntyre, ed., *Smart Sanitation Solutions* (Netherlands Water Partnership. 2006), 49.
[3] Jeff Conant, *Sanitation and Cleanliness for a Healthy Environment* (Hesperian Foundation, 2005),40-43.

Background Information

Arborloo Composting Latrine

Description:
Arborloo latrines use one shallow pit (1 meter deep) for the composting of excreta. Instead of a pit lining, a removable cement or brick ring is placed around the edge of the pit. The structure and slab are also moveable and rest on the cement ring.

After the pit is three quarters full, the ring, slab and structure are moved to a new pit. The remaining pit is then topped with soil and a tree can be planted.

Time:
Pit contents are not stored. When pit is three quarters full, top with soil and plant a tree.

Temperature:
Because pit contents are not removed, no specific temperature is needed to compost.

Tasks:
- Add a layer of leaves to the bottom of the pit before using
- After each use, add ash or soil to aid in composting
- When the contents of the pit start to pile, stir them down with a stick
- When the pit is nearly full, cover it with leaves and good soil – at least 150 mm deep
- Wait until the pit has settled and the rains have come before planting a young tree
- (Guava, Mango and Avocado trees work well, and fruit is safe to eat)
- Water the tree and protect it from animals.
- Do not throw rubbish into the pit
- Sweep and wash the slab often, be careful not to get too much water in the pit

Twin-pit Composting Latrine (Fossa-Alterna)

Description:
The Fossa- Alterna uses two alternating pits for the composting of excreta. The pits are shallow and partially lined. While in use, a slab and movable superstructure are placed over the pit. The dormant pit is covered by a water-tight lid.

When the pit in use is three-quarters full, the slab and structure are moved to the empty pit. The full pit is then topped with soil and covered with the water-tight lid and left to decompose. If desired, this pit can be left uncovered and flowers or vegetables can be planted in the top soil. Liquids will drain out of the pit walls and, if organic matter has been added throughout use, excreta will break down into usable fertilizer.

When the second pit is nearly full, the first can be emptied and its contents used in a garden or stored for later use.

Time:
Pit contents should be stored for six to twelve months. When removed, contents should resemble soil and there should be no offensive odors.

Temperature:
Temperature inside of the pit is sufficient for decomposition without added heat.

Tasks:
- After each use, add leaves, ash or soil.
    - While the first pit is decomposing, cover with a water-tight lid or plant vegetables or flowers in the top soil and water occasionally; this will help with composting.
- Excessive moisture should not be allowed into the pit while composting is taking place.
- Elevated pit linings or a ring beam can be constructed to protect pit from overflowing.
- Allow the composting pit to sit for at least six to twelve months before emptying.
- Do not throw trash or feminine products into the pit. Toilet paper, however, is okay to put into the pit.
- Sweep and wash the slab often, be careful not to get too much water in the pit.
- Wash hands after handling pit contents.

Twin-Pit Dry Composting Latrine

Description:
Much like the Fossa Alterna, twin-pit dry composting latrines use alternating pits. The main difference with dry composting latrines is that urine is diverted. Because of the design of a dry composting latrine, liquids that enter the pit will not seep into the ground as they do with the Fossa Alterna and Arborloo, making urine diversion necessary. Urine is diverted from the latrine into a seepage pit or stored for later use as fertilizer.

Two pits are constructed above ground, therefore avoiding groundwater contamination. A large slab with two defecation holes, one over each pit, sits directly over the pits. The pits, slab and structure are made to be permanent.

While the first pit is in use, the second is covered. When the first pit is nearly full, it is covered and the second pit can then be used. When the second pit is nearly full, the first can be emptied and its contents used in a garden or stored for later use.

Time:
Store pit contents for one year. When removed, contents should resemble soil and there should be no offensive odors.

Temperature:

It is important for these pits to stay warm and moist. Warmth will insure that pathogens are killed faster, and a small amount of moisture will provide oxygen that will help decomposition.

Tasks:

- Divert urine from the pit (a special bowl or pan can be used for this).
- After each use, add ash or soil to aid in composting.
- When the contents of the pit start to pile, stir them down with a stick, this will help provide oxygen.
- Do not throw trash or feminine products into the pit. Toilet paper is okay.
- Sweep and wash the slab often; be careful not to get too much water in the pit. Too much liquid will harm the process.
- Secure doors to protect the contents of the pit.
- Store pit contents for about one year, until contents are the texture of soil and are odorless.
- Mix decomposed pit contents with soil before using in a garden.
- A vent pipe can be added to increase circulation and help dry out pit contents
- Pay attention to the moisture content of the pit. Too much liquid will harm the composting process. The same will occur if the contents are too dry. While composting, contents should have the consistency of a wrung-out sponge or rag. If too dry, add a cup of water periodically and stir the pit. If too moist, add ash and turn the pile.
- Wash hands after handling pit contents.

Solar Dry Composting Latrines

Description:
Solar dry-composting latrines are similar to twin-pit dry composting latrines, except that they have metal panels installed as the emptying doors on the back of the latrine. These doors tilt horizontally in order to allow the sun to heat them. As the sun warms the metal doors, the temperature and ventilation inside the pit increases the amount of pathogens killed.

Time:
Store pit contents for one year. When removed, contents should resemble soil and there should be no offensive odors.

Temperature:
The emptying doors absorb heat from the sun, thus increasing the temperature inside the pit. This will kill pathogens faster, but it may also dry out the pit. If the pit becomes too dry, add a cup of water periodically and turn the pile.

Tasks:

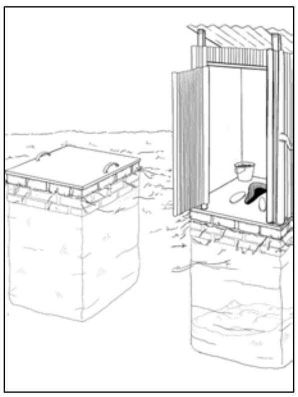
- Paint the emptying doors black; this helps absorb more heat
- Secure doors to protect the contents of the pit
- See twin-pit dry composting latrines for more tasks

Poster Set

Arborloo information

Illustrations

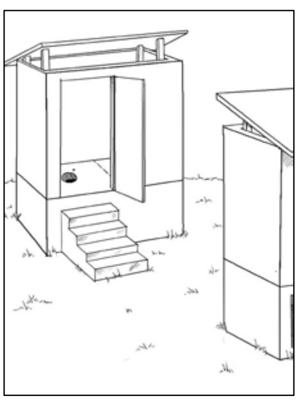
Photographs



Fossa-Alterna information

Illustrations

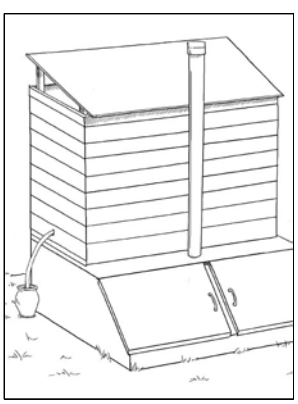
Photographs



Twin Pit latrine information

Illustrations

Photographs



Solar dry composting information

Illustrations

Photographs

The above posters are a basic sampling of the types of posters from which you can select for use in this lesson. You can also draw additional ones that are relevant to your people group or select posters from other lessons or sources.

Arborloo Latrine

Purpose
Participants will become familiar with the operation of the Arborloo composting latrine.

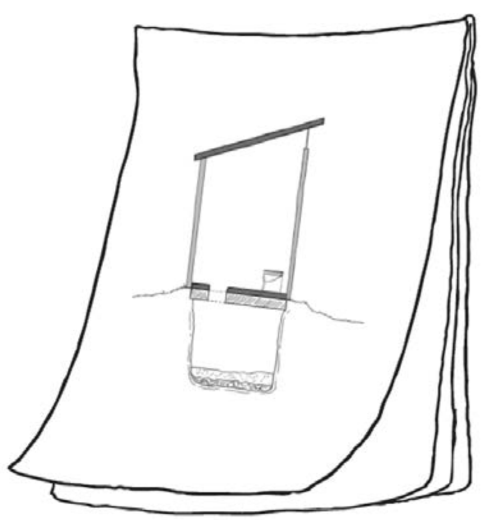
Objectives
By the end of this lesson, participants will have:
- **Reviewed** how an Arborloo latrine works
- **Heard** about the main components of the Arborloo latrine
- **Created** a promotional skit, song or poster for an Arborloo latrine

Materials
- Flipchart paper
- Markers
- Posters:
    - Arborloo latrine poster
    - Arborloo latrine ring
    - Cement slab
    - Wood and mud slab
    - People moving an Arborloo latrine structure

Preparation
- Draw an Arborloo latrine on a flipchart using the Arborloo latrine poster.

Time
50 minutes

Steps
1. Review the Arborloo- 5 minutes
2. Detail of Arborloo Latrine-15 minutes
3. Promote the Arborloo- 30 minutes



1. Review the Arborloo- 5 minutes

In the last lesson, we reviewed different types of composting latrines. Now we will look closer at the most basic type of composting latrine, the Arborloo.

With a partner, **review** how an Arborloo composting latrine works.

Hang up flipchart of Arborloo

Could someone please **share** with the class how an Arborloo composting latrine works?

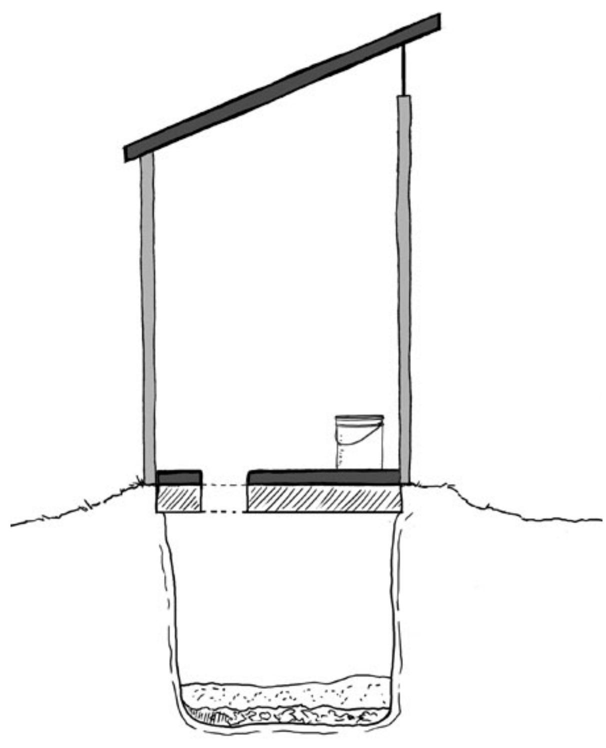
2. Detail of Arborloo Latrine- 15 minutes

Let's **discuss** the Arborloo in more detail.

The technical components of an Arborloo are:

Indicate the corresponding label as the latrine features are described.

- Pit
- Ring
- Slab
- Superstructure



The pit:

- Arborloo latrines are designed for a temporary location. Because of this, the pit is shallow, only 1 to 1.5 meters deep.

The ring:

Have a facilitator walk around with the poster of an Arborloo latrine ring.

- The purpose of the ring is to support the slab and superstructure. Therefore the material should be strong enough to support the weight of the slab and superstructure
- The ring is re-useable, it moves to the next pit site along with the superstructure and slab
- The ring can be made with handles for easy lifting

The slab:

Have a facilitator walk around with the posters of a cement and a wooden slab.

- The slab should fit on top of the ring
- The slab should be made of materials that are easily cleaned, sturdy and able to be moved

The superstructure:

Have a facilitator walk around with the poster of people moving a superstructure.

The superstructure can be made from whatever local materials are available, keeping a few things in mind:

- The superstructure should provide privacy and protection
- The superstructure should be able to be easily moved

  - ➢ What are some common materials, locally available, that you could be used for a superstructure?

Some additional things that could be added to the Arborloo would be a container for cleansing materials, a bucket to keep ash and leaves, and a stick for stirring the pit's contents.

  - ➢ What questions do you have about the Arborloo?

3. Promote Arborloo- 30 minutes

God made natural processes that destroy harmful germs and transform waste products into excellent soil. However, not everyone may have this viewpoint of composting latrines.

Listen to the following case study about how a village in Tanzania reacted to composting latrines.

Read or ask a volunteer to read the following case study to the class.

Case Study[4]

In one Tanzanian village, community members originally rejected an EcoSan [composting] latrine project because of a taboo against handling human excreta. Then a villager accidentally dug into an old pit latrine and found that the contents were decomposed and harmless. After this, there was great support for EcoSan [composting] latrines."

Promotion can be a powerful tool that can encourage people to use composting latrines.

In small groups, **create** a song, skit or poster that promotes the use of Arborloo composting latrines.

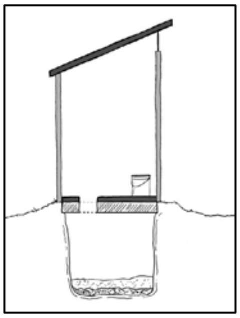
Think back to some of the benefits you discussed in the previous lesson. You may want to use some of those in your promotion.

Present your promotion to the class.

- What questions do you have?

[4] Berry Jackson, *A Review of EcoSan Experience in Eastern and Southern Africa* (Water and Sanitation Program, 2005), 7-8.

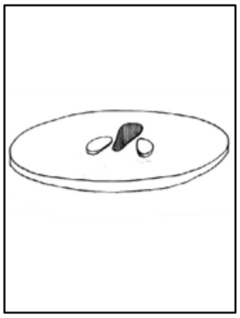
Poster Set



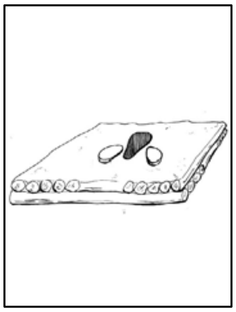
Arborloo latrine

Arborloo ring

Arborloo structure



Cement slab



Mud and wood slab

The above posters are a basic sampling of the types of posters from which you can select for use in this lesson. You can also draw additional ones that are relevant to your people group or select posters from other lessons or sources.

Latrines for People with Special Needs

Purpose
Participants will explore ways to design latrines for people with special needs.

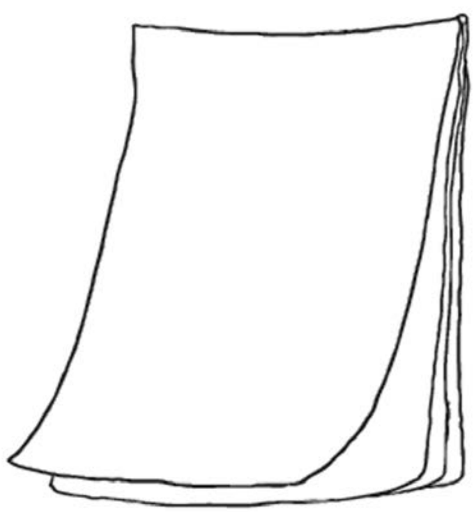
Objectives
By the end of this lesson, participants will have:
- **Reviewed** social and technical factors to consider when designing a latrine for people with special needs
- **Designed** a latrine for people with special needs
- **Discussed** the importance of caring for those with special needs

Materials
- Flipchart paper
- Markers
- Posters

Preparation
- Draw a basic pit latrine on a flipchart.

Time
60 minutes

Steps
1. Introduction
2. Challenges of people with special needs-15 minutes
3. Social considerations- 5 minutes
4. Technical considerations- 30 minutes
5. Care for those with Special Needs- 15 minutes



1. Introduction

When we talk about people with special needs we are focusing on men, women and children who experience metal or physical limitations, which may inhibit them from practicing good sanitation behaviors.

A few examples of people with special needs are:

- An elderly person who has trouble walking or bending.
- A pregnant woman who has a difficult time squatting.
- A person with who is blind and can't find his or her way to the latrine.
- A person who is unable to walk and uses crutches or a wheelchair.

There are 580 million disabled people in the world. It is estimated that the majority live in low-income countries. Of the children within that population, 90 percent will not survive beyond the age of twenty. [5]

2. Challenges of people with special needs- 15 minutes

Take a moment to **think** about someone you know with special needs.

What challenges might they face practicing good sanitation behaviors?

Turn to the person next to you and **share** your thoughts. We'll hear a few samples.

Ask a scribe will write these on a flipchart.

[5] Bob Reed, *Low-Cost Sanitation* (UK: WEDC Loughborough University (2003), 176- 177.

3. Social considerations- 5 minutes

Designing a latrine for someone with special needs can present a challenge.

There are several social factors to consider when designing latrines for people with special needs.

Here are a few:

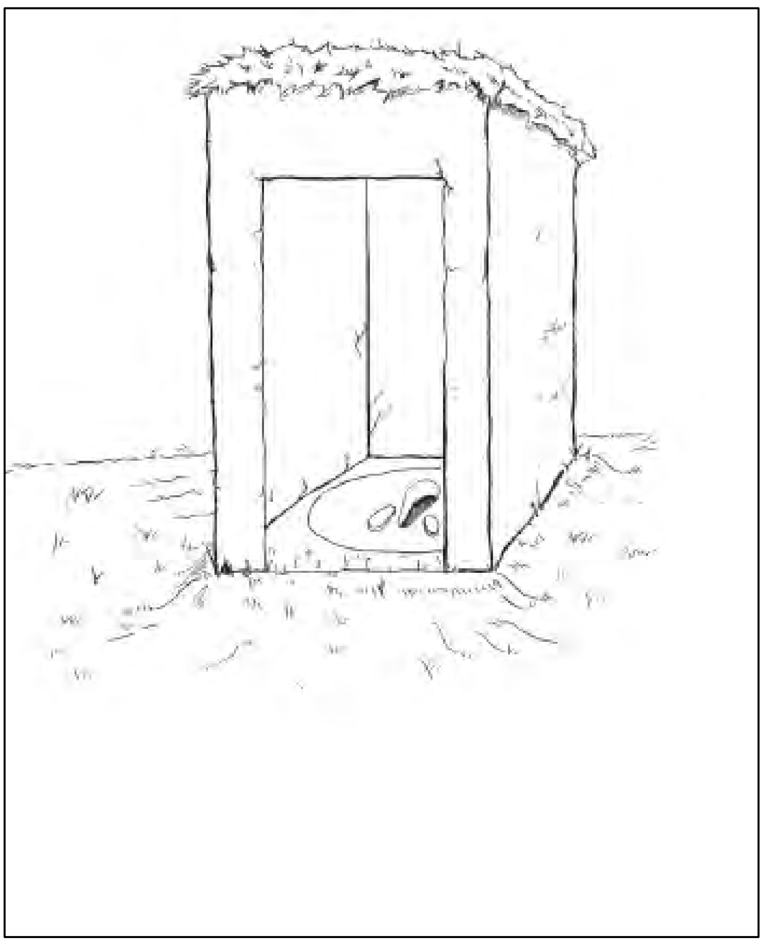
- Accessibility
- Cost
- Cultural Acceptability
  Is the latrine acceptable to the cultural context?
- Local Attitudes and Beliefs
  Does the latrine ensure privacy, comfort, convenience, and personal dignity?
- Gender Appropriateness
  Does the latrine meet the needs of men and women?
- Level of Hygiene
  How does the latrine account for cleanliness or odor?

4. Technical considerations[6]- 30 minutes

There are many different technical adaptations that can be made to latrines in order to address the sanitation practice of those with special needs.

Let's review some of the important technical factors regarding latrine design for people with special needs. During this time, we will be modifying a latrine for a person with special needs using an illustration.

Hang up flipchart with a drawing of a basic pit latrine.



[6] Hazel Jones and Bob Reed, *Water and Sanitation for Disabled People and Other Vulnerable Groups: Designing Services to Improve Accessibility.* (UK: WEDC, 2005), 41-48.

This is Mary

Walk around the circle with a poster of Mary, the woman in the wheelchair.

After meeting with Mary and talking with her about the challenges she faces practicing good sanitation, we discovered several things we did not know about her.

Because of her wheelchair, Mary is unable to use most latrines in her village. She cannot fit her wheelchair inside the latrines, and is unable to squat over the hole without something to support her.

The ground outside the latrine is often muddy and her wheelchair gets stuck easily. If she does get into the latrine, there is no way for her to shut and lock the door, and she is unable to ensure her privacy.

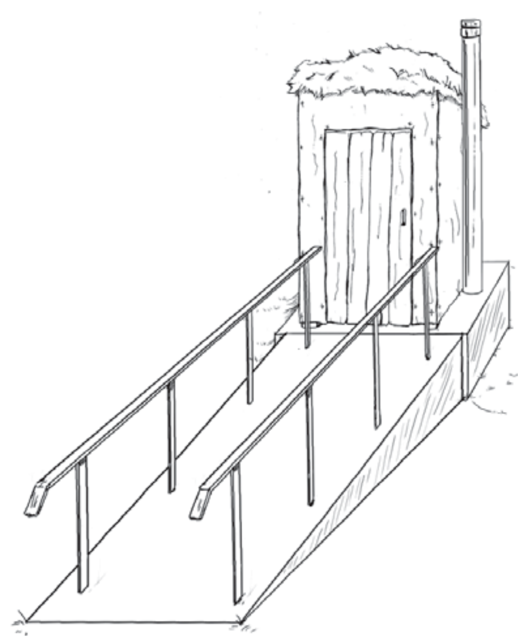
As we review the technical information, we will work as a class to modify this latrine for Mary. In your manuals, you have this same illustration that you can modify as well.

Outside Access

If a person cannot reach the latrine, due to a poorly designed walkway the latrine may be inaccessible for them. To address this, we must look at some important factors:

1. An access path from the house to the latrine should:

- Be firm, relatively smooth and well-drained
  - concrete or crushed stone works well for this
  - elevating the path helps with drainage
- Be wide enough so user will not fall off
  - normal width for most access paths is 1 meter, however some wheelchairs are wider and require more space.
- Be easy to locate
  - if user is blind, a guiding rail that leads to the latrine can be constructed



2. If ground is sloping or the latrine has been elevated, a ramp may be required. The ramp should:

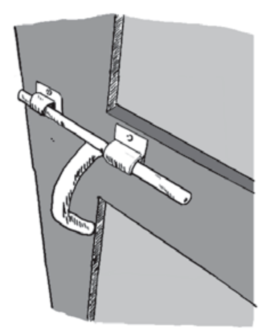
- Have side rails.
- Be gentle sloping.
- Be wide enough for user not to fall off
  - When wheelchair users push themselves up a ramp, they do not always move in a straight line. More space or rails mar be added to ensure they will not fall off the ramp.
- They should also have a flat, sturdy space in front of the door
  - The user should be able to open the door while remaining on the flat area outside the latrine.
  - The space should be 0.5 meters wider than the door.

3. Attention should be paid to the placement of the latrine in relation to other buildings and water sources. The latrine should be
  - At least 15 meters from a water source.
  - 6 meters from other buildings.
    - A user with a severe disability may need the latrine to be located closer to their home.

  - ➢ What can be done to this latrine to improve its outside access to Mary?

Ask someone to draw the modifications on the flipchart.

Latrine Doors



Latrine doors need to be wide enough for users and easy to open, close, lock and unlock. Here is a list of suggestions:

- The door should open <u>out.</u>
- Horizontal rails connected to the inside of the door make it easier to pull closed.
- Vertical rails are accessible to people of any height.
- Diagonal rails may be a compromise between the two.
- Slide bolts or latches can provide an easy means of privacy.
- Door should be light enough to open easily.
- Hinges should not enable the door to slam on the user.

Horizontal Door Rail

  - ➢ What can be done to improve this latrine's doors for Mary?

  - ➢ Would someone please draw these modifications on the illustration?

Inside the Latrine
A user with special needs may require a variety of adaptations to the inside of a latrine. We will look at several different solutions:

- Space inside of latrine should be big enough for wheelchair users to turn 180 degrees when the door is closed.
    - Enough space beside the hole or seat for the user to maneuver a wheelchair. Some users transfer from the side.
    - Enough space in front of the hole for a wheelchair incase the user prefers to transfer from the front.
- The floors should be smooth and easy to clean; concrete works well for this.

- Raised seats can help those who have trouble squatting. Depending on the cultural practice, seats can be permanent or portable
- Rails positioned around the defecation hole can help users support themselves
    - Check with the user to learn which direction to face the rails.
- A bucket for solid waste.
    - Possibly a wash station to help users clean themselves.

➢ What can be done to make the inside of this latrine more accessible for Mary?

Ask someone to draw the modifications on the flipchart.

➢ What are your questions regarding this information?

Think back to the person you know who has special needs and the challenges he or she have practicing good sanitation behaviors.

➢ Which of these latrine modifications might work for him or her?

➢ What are ways to assist people with special needs that we haven't talked about?

5. Care for those with Special Needs- 15 minutes

- Why is it important for us to care for those with special needs?

Allow time for discussion

- Would someone read the following scripture from the apostle Paul?

As you listen, **consider** how this scripture encourages us to provide for the sanitation needs of those with disabilities.

Acts 20:35

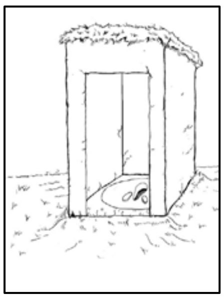
"In everything I did, I showed you that by this kind of hard work we must help the weak, remembering the words the Lord Jesus himself said: 'It is more blessed to give than to receive.'"

- How do Paul's words relate to our work with sanitation?

Background Information

Participation of those with Special Needs:
When designing a latrine for a person with special needs, it is crucial that he or she participate in the process. Because it is the person's needs that are being addressed, learn about the challenges that he or she faces practicing good sanitation behaviors. Ask for the person's opinion regarding the latrine design and placement. After designing the latrine, review it with the person to make sure it meets his or her specific needs before construction begins.

Poster Set



Modified Latrine

Woman in Wheelchair

The above posters are a basic sampling of the types of posters from which you can select for use in this lesson. You can also draw additional ones that are relevant to your people group or select posters from other lessons or sources.

Latrine Siting

Latrine Location

Purpose

Participants will be able to choose locations for latrines that minimize the risk of contaminating water sources, and are culturally and socially acceptable.

Objectives

By the end of this lesson, participants will have:

- **Measured** and **paced out** the minimal separation distance between latrines and water sources
- **Discovered** technical and social considerations that may affect latrine location

Materials

- Flipchart paper
- Markers
- 15 meters of string or rope
- Picture of water source
- Picture of latrines
- Tape

Preparation

- Have the group assemble in an area where the 15-meter string/rope can be stretched out fully and hooked on a wall or between two trees. Ask someone to tape the picture of the pit latrine at the end of the string (0 meters) and the water source picture at 15 meters. Tape the picture of the house at the 6 meter mark between the latrine and the water source.

Time

45 minutes

Steps

1. Introduction
2. Safe distance from latrine to water source-15 minutes
3. Distance from latrine to house-10 minutes
4. Things to consider for latrine location-15 minutes

1. Introduction

In this lesson, we will discuss how far latrines need to be located from water sources. In an introductory lesson, we saw how important latrines are in keeping feces from contaminating surface water such as lakes and streams. In communities that draw water from the ground, there is also a risk that latrines will contaminate the groundwater.

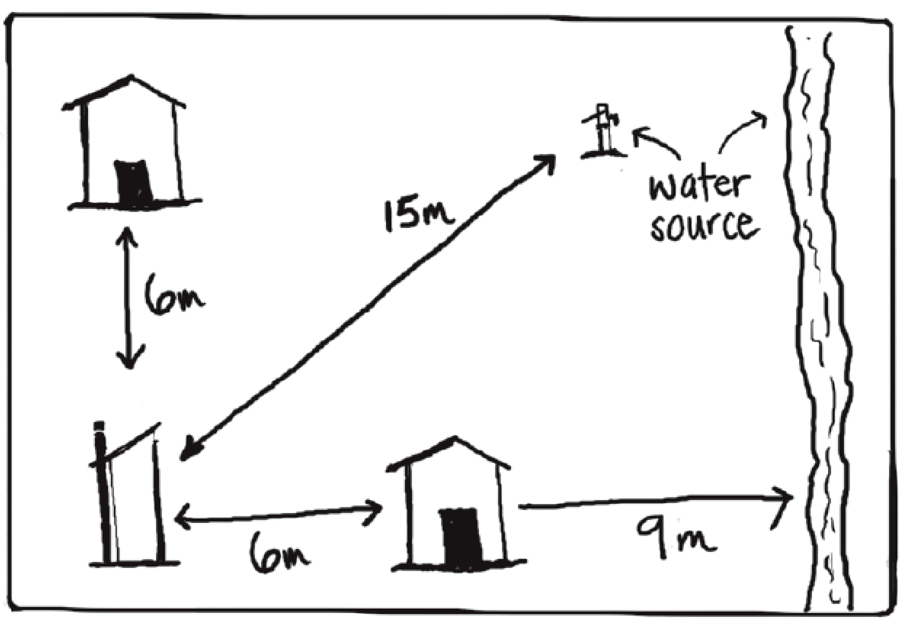
2. Safe distance from latrine to water source - 15 minutes

Most of us don't carry tape measures along with us, so let's **pace off** how many steps it takes each of us to walk 15 meters. Let's do it a couple of times and remember how many steps it required for you - everyone will have a different number.

Now we'll **pace off** in another direction away from the measured string. Without looking at anyone else, **count off** the number of steps it takes you to walk 15 meters. When you are done measuring, **stay** where you are. We will **use** the string to see who is the closest to 15 meters.

Write down how many steps it takes you to walk 15 meters.

STEPS TO WALK 15 METERS = ____________



3. Distance from latrine to house- 10 minutes

Pit latrines and other latrines that have some odor should also be located away from the house about 6 meters. We can **pace off** 6 meters by walking a few steps less than half of the number we used for 15 meters.

4. Things to consider for latrine location- 15 minutes

With a neighbor, **discuss** other important things to consider when a family chooses a location for their latrine. There might be cultural, social, or other technical considerations for latrine location.

For example, a family might locate a latrine away from the road so that people passing by don't see them walking to or from the latrine.

Write down your responses. We'll hear a sample.

____
____
____
____
____
____

Optional activity:

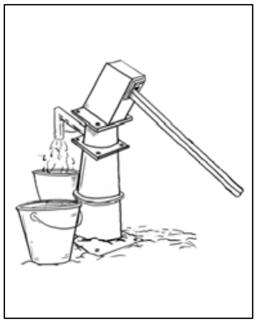
In small groups, **choose** one of the cultural, or technical considerations.

Draw a map of a compound where the latrine is:

- 15 meters away from water sources
- 6 meters away from buildings
- The cultural and technical consideration you chose is observed.

Share your map with the group.

Poster Set

Poster Key:	Description:
	Drinking Source
	Pit Latrine
	House

The above posters are a basic sampling of the types of posters from which you can select for use in this lesson. You can also draw additional ones that are relevant to your people group or select posters from other lessons or sources.

Groundwater

Purpose

Participants will understand the basics of the water cycle and specifically how groundwater forms and flows.

Objectives

By the end of this lesson, participants will have:

- **Reviewed** the water cycle with an emphasis on groundwater

Materials

- Plastic beverage bottles, preferably 2 liter size (2-3)
- Fine sand
- Coarse sand
- Clay (if available)
- Gravel
- "Local" soil
- A large basin (only if inside)
- Water
- Poster of water
- Cycle
- Diagram of bottle
- Setup
- Flipchart paper
- Markers
- Tape

Preparation

- Have a volunteer help setup the bottles as shown in the diagram.
- Draw a large poster of the water cycle using the attached picture as a guide.

Note: It is best to do the demonstration outdoors. This will help make clean-up easier, and changing location helps the participants remain engaged.

Time

45 minutes

Steps

1. The Water Cycle- 15 minutes
2. Vertical Flow- 15 minutes
3. Horizontal Flow- 15 minutes

1. The Water Cycle – 15 minutes

In this activity, we are going to **review** the water cycle with the goal of understanding how groundwater forms and flows.

- What forms of water are common here?
  (for example, ponds, rainwater, rivers, etc.)

Pit latrines can contaminate groundwater, so we need to understand how water moves underground through soil. We'll start our **discussion** of the water cycle by looking at rain.

Rain water lands on the earth and can do one of three things:

Indicate to #2 on the water cycle poster.

- It can form a puddle or pool
- It can flow along the top of the earth as surface run-off
- It can soak into the ground and become groundwater

Surface water flows downhill and collects in larger bodies of water like ponds, lakes, and oceans.

Indicate to #6 on the water cycle poster.

Groundwater also flows downhill below the surface of the earth to points of discharge such as springs, wells, and rivers. Because groundwater moves through soil and rock it travels much slower than surface run-off.

Indicate to #3 on the water cycle poster.

Clouds are formed through evaporation and transpiration (water vapor given off by plants). As the clouds become rain (or snow), the water cycle continues.

Indicate to #4 and #1 on the water cycle poster.

Listen to Ecclesiastes 1:7

Ecclesiastes 1:7

All streams run to the sea,
but the sea is not full;
to the place where the streams flow,
there they continue to flow.

- What insights does this passage offer on the water cycle?

2. Vertical Flow- 15 minutes

Next, we are going to **look** at what happens when water soaks into the ground.

Use the vertical flow bottle for this example.

We are going to **pour** water through this soil and observe what happens as the water encounters different types of soil.

- In your community, how does the soil type change as you dig deeper? What differences in soil type have you noticed while digging pits, drilling wells, or by looking at exposed cliffs?

- What did you observe as the water was poured into the bottle?

When rain soaks into the ground, it flows down until it encounters soil or rock that it cannot pass through. When the groundwater fills all of the spaces, or pores, between the soil particles it forms an aquifer. The top of an aquifer is called the water table.

3. Horizontal Flow- 15 minutes

Next, to demonstrate how groundwater can flow laterally, we are going to pour water in the horizontal bottle filled with sand and gravel. The bottle is tilted slightly to represent a slight hill.

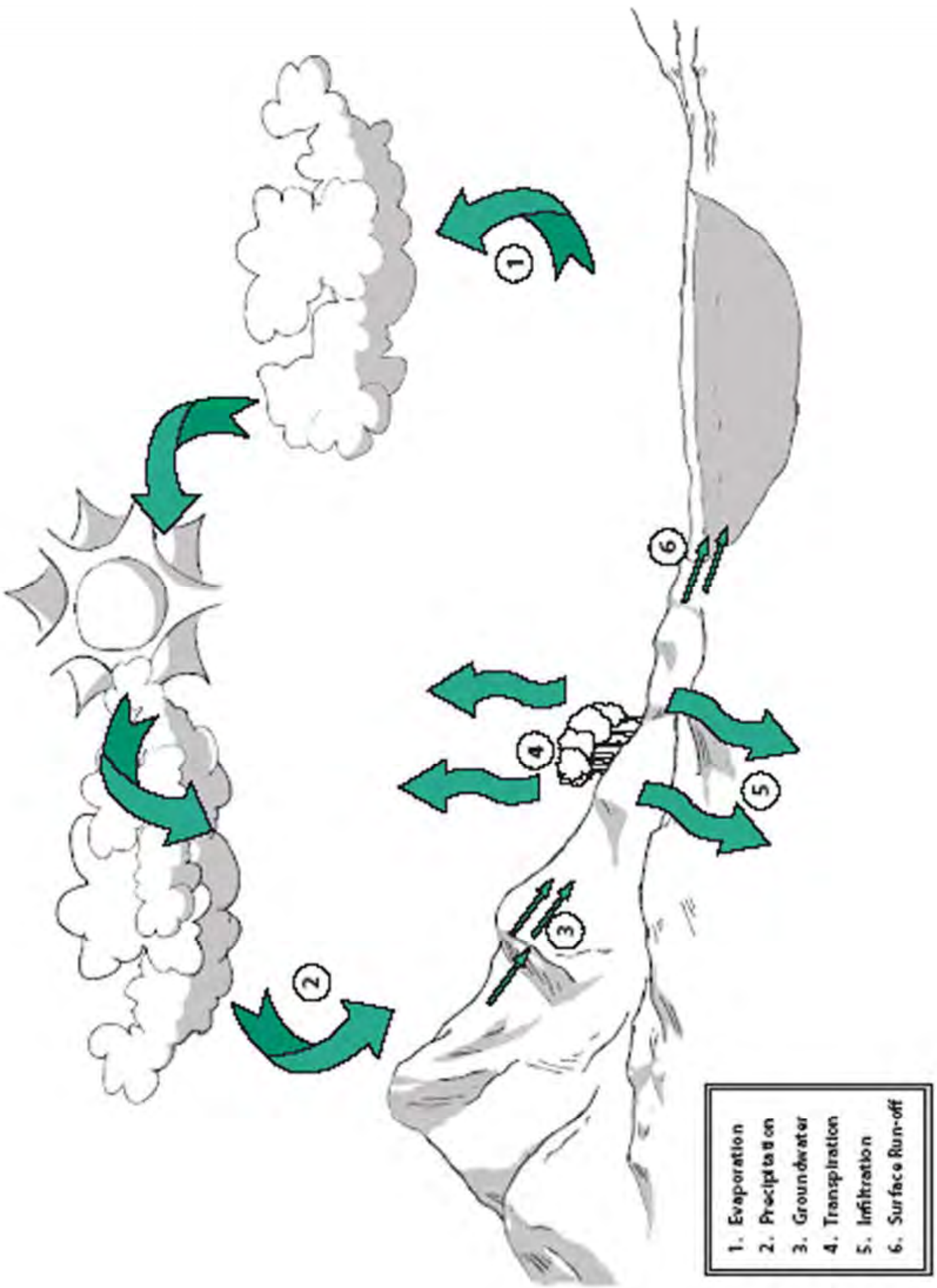
Use the horizontal flow bottle for this example.

- What did you observe as the water was poured into the bottle?

Groundwater flows through the soil particles and moves laterally. The water table (the top of the aquifer) usually follows the slope of the surface above it. Because water flows downhill, the groundwater will then flow underground from a high point to a lower point. However, this is a very slow process – not like a river or stream. It is typically measured in only centimeters or meters per day.

- What questions do you have about the water cycle or how water moves underground?

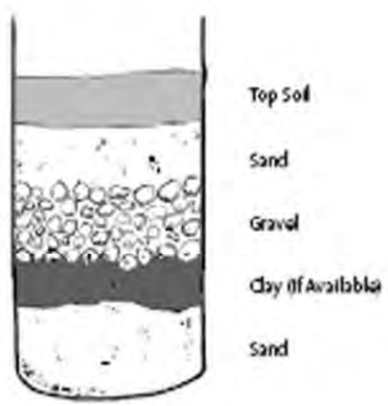
In the next activity, we will look at how liquid from a pit latrine can enter into the water cycle and contaminate water.


1
2
3
4
5
6
1. Evaporation
2. Precipitation
3. Groundwater
4. Transpiration
5. Infiltration
6. Surface Run-off

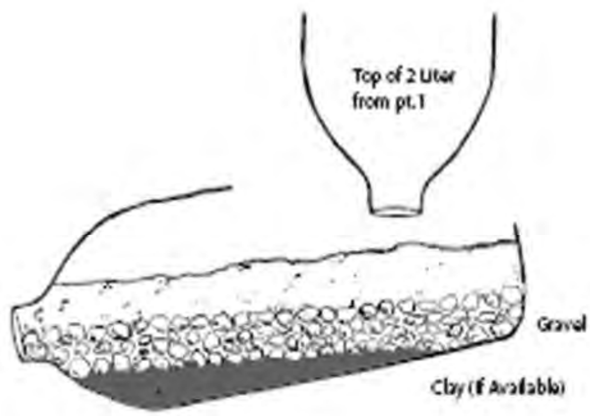
Part 1
Vertical Flow

Part 2
Horizontal Flow

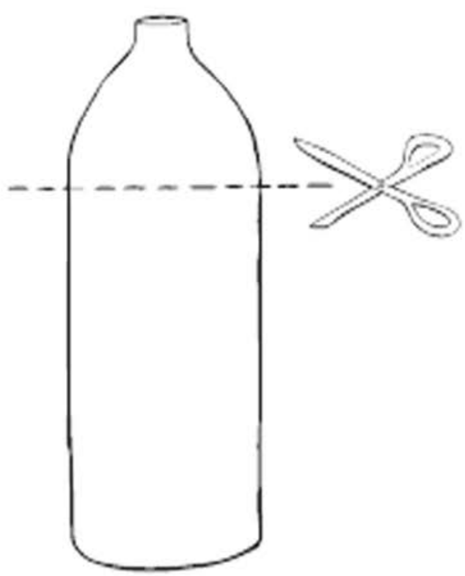
BOTTLE SETUP pt. 1



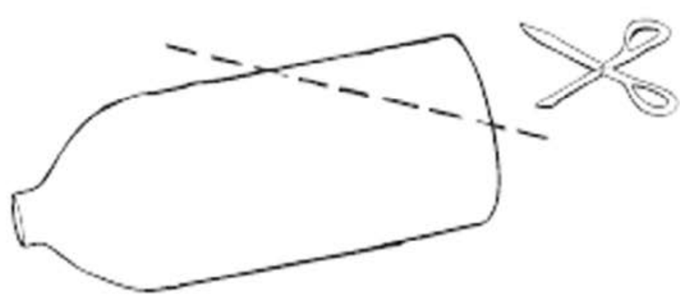
BOTTLE SETUP pt. 2



CUTTING DIRECTIONS pt. 1



CUTTING DIRECTIONS pt. 2



Pathways – Latrine to Water Source

Purpose

Participants will understand how latrine liquid can enter into groundwater and surface water.

Objectives

By the end of this lesson, participants will have:

- **Examined** the different contamination pathways between latrines and water sources

Materials

- Flipchart paper
- Markers
- Tape

Preparation

- Draw figures 1,2, and 3 on flipcharts

Time

45 minutes

Steps

1. Introduction- 15 minutes
2. Groundwater Contamination- 15 minutes
3. Surface Water Contamination- 15 minutes

1. Introduction – 15 minutes

In this activity, we will look how pit latrine effluent can enter the water cycle and contaminate groundwater and surface water. (Effluent is the term given to liquid waste or sewage.)

Respond as a group to these questions:

- In the communities where you work, what is the likelihood that latrines are contaminating water sources?

- What are the indicators (evidence) that this is occurring?

2. Groundwater Contamination - 15 minutes

Referring back to the Disease Pathways diagram, we remember that the goal of latrines is to keep feces from coming into contact with water that might be used for human consumption. However, pit latrines can still pose a risk to groundwater. Effluent in a pit will soak into the surrounding soil and can contaminate groundwater, as shown in the drawings below.

In the first case, the latrine pit is dug above the water table but the effluent seeps down through the soil and contaminates the aquifer.

Indicate to the flipchart as you read.

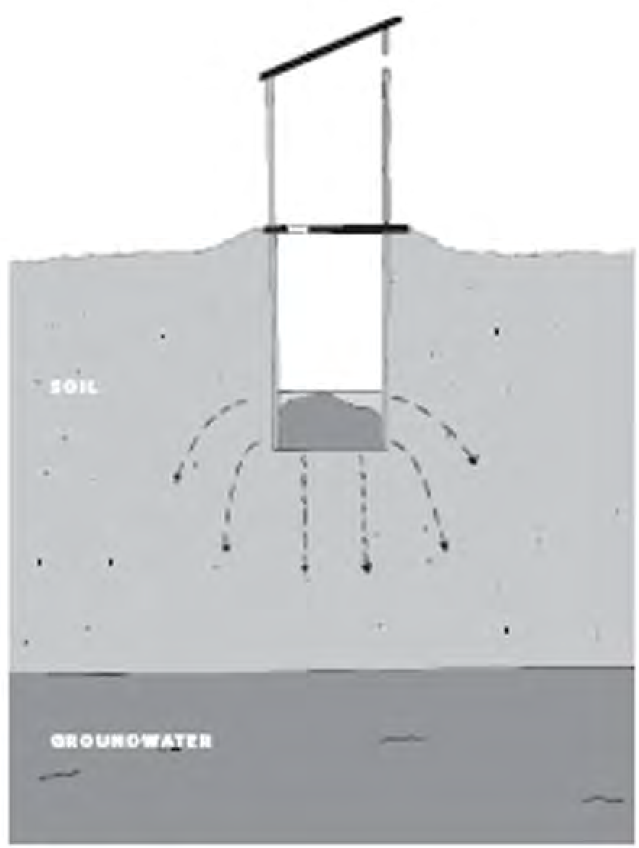


Figure 1. Latrine pit above water table

In the second case, the latrine pit is dug below the water table so the effluent flows right into the aquifer and contaminates it.

Indicate to the flipchart as you read.

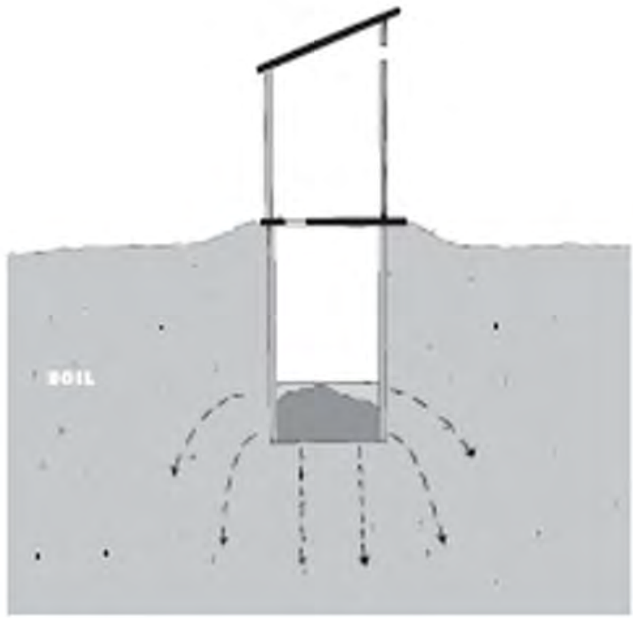


Figure 2. Latrine pit below water table

Effluent from a pit moves downhill and therefore, whenever possible, pit latrines should be constructed downhill from a well or spring.

Call out any questions you have.

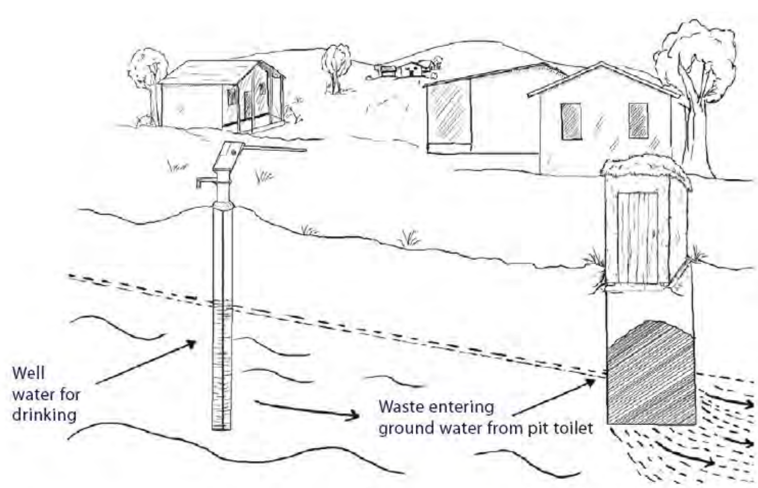


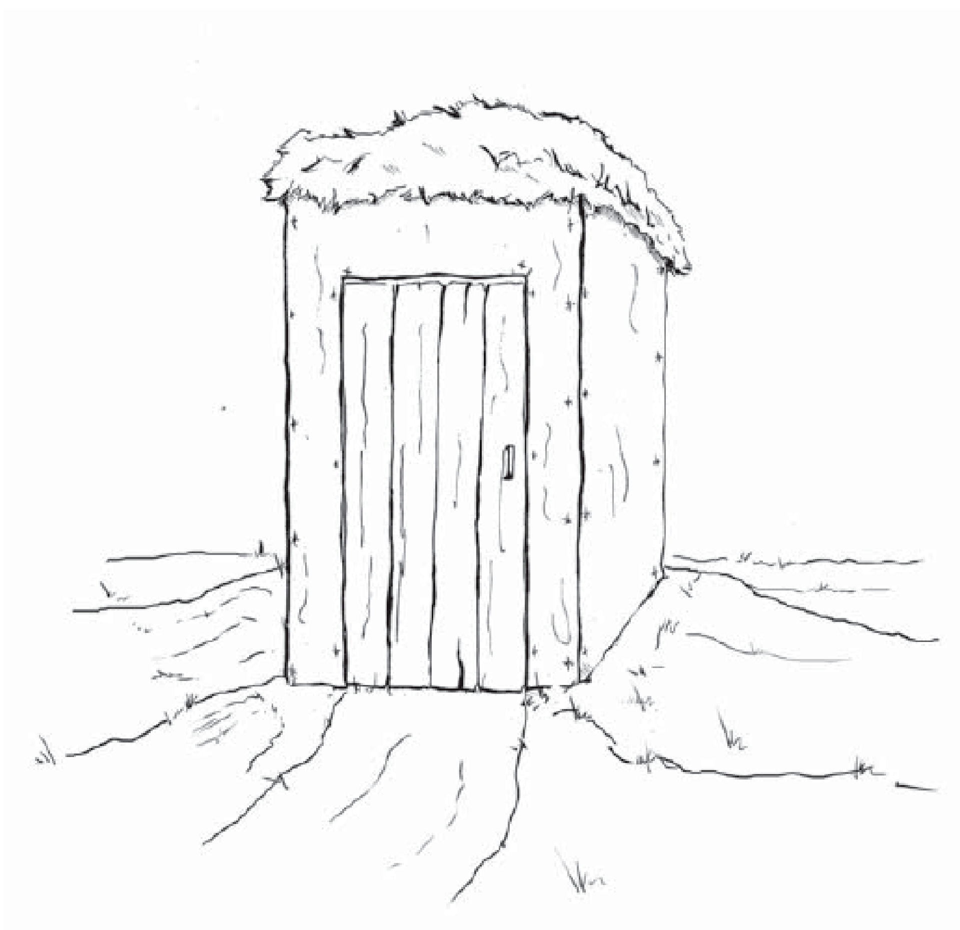
Figure 3. Effluent moving downhill

3. Surface Water Contamination - 15 minutes

Another way that latrine effluent can enter the water cycle and contaminate sources of water is when pit latrines are constructed in areas prone to flooding. Pit latrines fill up with surface run-off and the pit contents overflow and contaminate the area around people's homes and nearby rivers and streams.

- If flooding is a problem in the area where you are working, what solutions have people found to this problem?

In the next set of activities, we will look in greater depth at the risks that latrine effluent presents to safe water sources.



Soils and Drainage[7]

Purpose

Participants will understand how to identify different soil types and how different soils absorb liquid waste.

Objectives

By the end of this lesson, participants will have:

- **Observed** how different soils affect the flow of liquid
- **Utilized** physical testing to identify soils suitable for pit latrine construction

Materials

- Plastic beverage bottles, preferably 2 liter size (5-10)
- 500 ml plastic bottles 3-5
- Fine sand
- Coarse sand
- Clayey soil
- Gravel
- A sharp tool to cut the bottles in half and punch holes in the bottoms
- Water
- Diagram of bottle setup
- Flipchart paper
- Markers
- Tape

Preparation

- Have a volunteer help setup the bottles for as shown in the diagram. Also verify beforehand that the holes punched in the bottles are of sufficient size and quantity to allow for a relatively quick drainage of water.
- Setup several stations where participants can come to identify different soil types. Put samples of dry soil in half-bottles (2 liter size), one type per bottle. Also have a bottle of water at each station so that participants can dampen a sample of soil in their hands.

Note: It is best to do the pit demonstration outdoors. This will help make clean-up easier, and changing location helps the participants remain engaged.

Time

60 minutes

Steps

1. Introduction
2. Liquid Drainage in Pits- 15 minutes
3. Identifying Soil Type-15 minutes
4. Test Soil- 15 minutes
5. Appropriate Soil for Pit Latrine Construction- 15 minutes

[7] Bob Reed, *Low-Cost Sanitation* (UK: WEDC Loughborough University, (2003), 15-17

1. Introduction

- What types of soils are common here?
- What are some of the challenges people have with the soil here?

When constructing pit latrines, soil can have a big effect on the latrine's capacity and the potential contamination of nearby groundwater. In the first part of this activity, we will **observe** how soil types affect the speed at which liquid travels through the ground.

Ask 2 volunteers to hold the half bottles of gravel and fine sand, and 2 volunteers to pour water that the same time.

2. Liquid Drainage in Pits- 15 minutes

Now, two participants will **pour** a cup of water in the two half-bottles of soil. These bottles represent two pit latrines excavated in different types of soil. They will do it quickly and at the same time so that we can compare the time that it takes for water to begin to drain from the bottom of the bottles.

- What did you observe?

For the next part, we'll have a volunteer **add** water to the half-bottle with finer soil.

- What did you observe?

While there are several factors that can contribute to a pit overflowing with liquid, the type of soil that the pit is dug into plays a major role in the pit's ability to hold liquid and to let it drain.

Next, we will **look** at how to identify soil types.

3. Identify Soil Type– 15 minutes

Granular soils are comprised of particles that allow liquid to pass through them in the spaces between the particles. Fissured soils are dense and liquid moves along cracks. As we saw in the previous demonstration, the size of the particles determines how fast liquid will move through granular soils.

The texture determines how well a soil will hold water, and how well it will drain water. The larger the particle size, the easier it is for water to drain through the soil. Coarse sands will provide good drainage for water, while clays will drain water much more slowly.

4. Test Soil– 15 minutes

One way to determine soil type is to physically handle it and analyze the texture. Soil can be a mixture of sand, silt, and clay plus decomposed organic material. The process below will help us determine which components (sand, silt, and clay) are present in the soil.

Process:

- **Take** a small handful of soil from one of the sample bottles. **Wet** the sample with water and then squeeze out all of the water. **Form** the soil into a ball in the palm of your hand as best as you can.

- First, **look** at how the soil holds together:

  Medium or coarse sand: If the particles don't stick together.
  Fine sand: If the particles stick together but don't form a ball.

- Second, if particles form a ball, **rub** the soil between your thumb and fingers:

  Sandy: If the soil still feels gritty.
  Silty: If the soil feels smooth without being shiny when rubbed.
  Clay (high content): If the soil molds easily, is very sticky when wet, and is shiny.

Based on its texture, what type of soil is your sample?

SOIL TYPE = ________________________________

In the space below, **describe** the types of soil you tested.

____
____
____

5. Appropriate Soil for Pit Latrine Construction- 15 minutes

In previous lessons, we saw how latrine effluent may contaminate nearby groundwater. God has created processes that help soil reduce the amounts of harmful microbes in the latrine effluent but these processes take time. **The slower that the contaminated liquid moves in the soil, the more likely it is that contaminants will be removed.** The contaminants are removed through filtration, some die-off, and some are eaten by other microbes.

In the first step of this lesson, we saw that the "pit" with the smaller particles took longer to drain. Because the liquid is moving more slowly through the soil, natural processes are given more time to purify the liquid and it is less likely that the effluent will contaminate local groundwater.

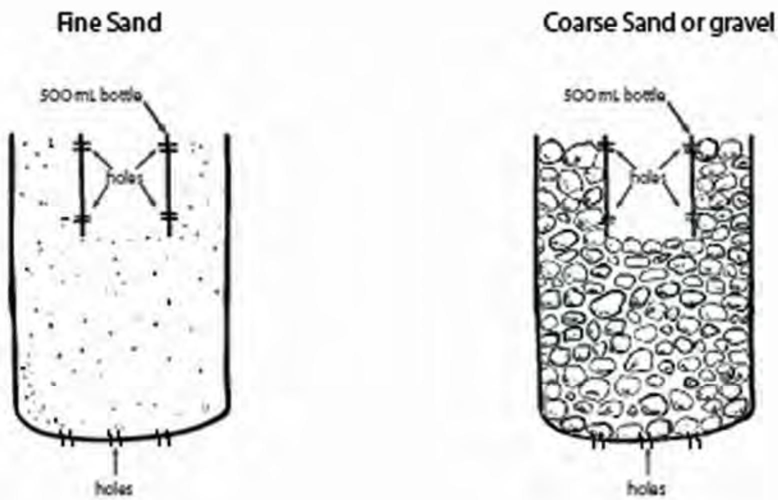
Take out a small sample from each of the 'pits' from Part I of this activity and place it in front of the bottle.

Review these questions with a partner.

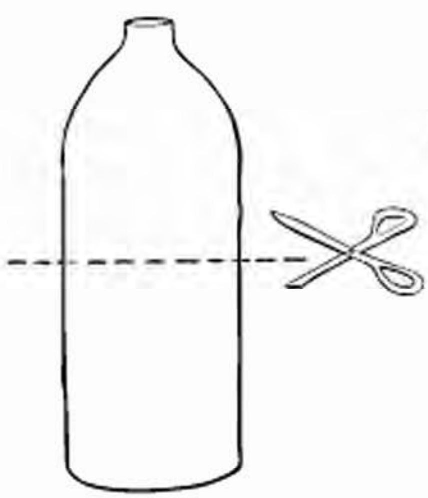
- How does the size of the soil particles relate to the speed at which latrine effluent moves underground?
- What are some problems that might arise with constructing a latrine in coarse gravel? In heavy clay?

In the next activity, we'll learn skills to help us better assess whether it is likely that particular latrine is contaminating a specific water source.

BOTTLE SET UP



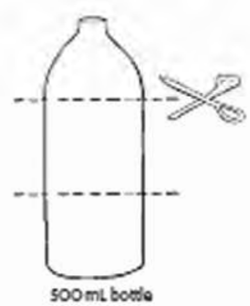
CUTTING DIRECTIONS



Notes:

1. holes in the bases of the 2 liter bottles need to be relatively the same size.

2. A third 2 liter bottle may be used if clayey soil is available.



Latines and Groundwater I[8]

Purpose
Participants will look at the importance of vertical separation between the pit and the water table.

Objectives
By the end of this lesson, participants will have:
- **Explored** the concept of vertical separation between a latrine pit and the water table, and assessed the contamination risk in a sample problem

Materials
- Flipchart paper
- Markers
- Tape

Preparation
- Draw a pit latrine on a piece of flipchart paper. Be sure to leave room around the base to show the water table and surrounding soil.
- On a piece of newsprint, write "Soil Filter" at the top and copy the equation for the soil filter (Step #2, below) under it.

Time
45 minutes

Steps
1. Introduction
2. Water Table- 15 minutes
3. Soil Filter- 15 minutes
4. Soil Type- 15 minutes

1. Introduction

In previous activities, we saw how latrine effluent soaks into the ground, but that the soil can filter out some of the harmful microbes if the effluent doesn't move too quickly. Now, we are going to determine whether the thickness of a particular soil is sufficient to decrease the risk of groundwater contamination.

[8] Bob Reed, *Low-Cost Sanitation* (UK: WEDC Loughborough University, (2003), 21-26.

2. Water Table– 15 minutes

Hang up the flipchart with the picture of a latrine.

As a group, **call out** responses to these questions:

- How deep do you have to dig to find groundwater in the communities where you work?
- Does the water level in the well(s) change in the rainy season from the level in the dry season?
- How deep are the pits for your latrines?

Note these levels on a picture of a pit latrine.

3. Soil Filter- 15 minutes

If we know how deep the groundwater level is at its highest, and we know how deep pits are dug, we can calculate the thickness of the soil between the pit and the groundwater. We call this the soil filter (shown in picture below)

Soil Filter = (Depth of groundwater at the highest level) – (Depth of pit)

Let's do an example.

- What is the deepest pit you know of?

Fill in the first line of the soil filter equation.

- What is the depth of the water table at its highest?

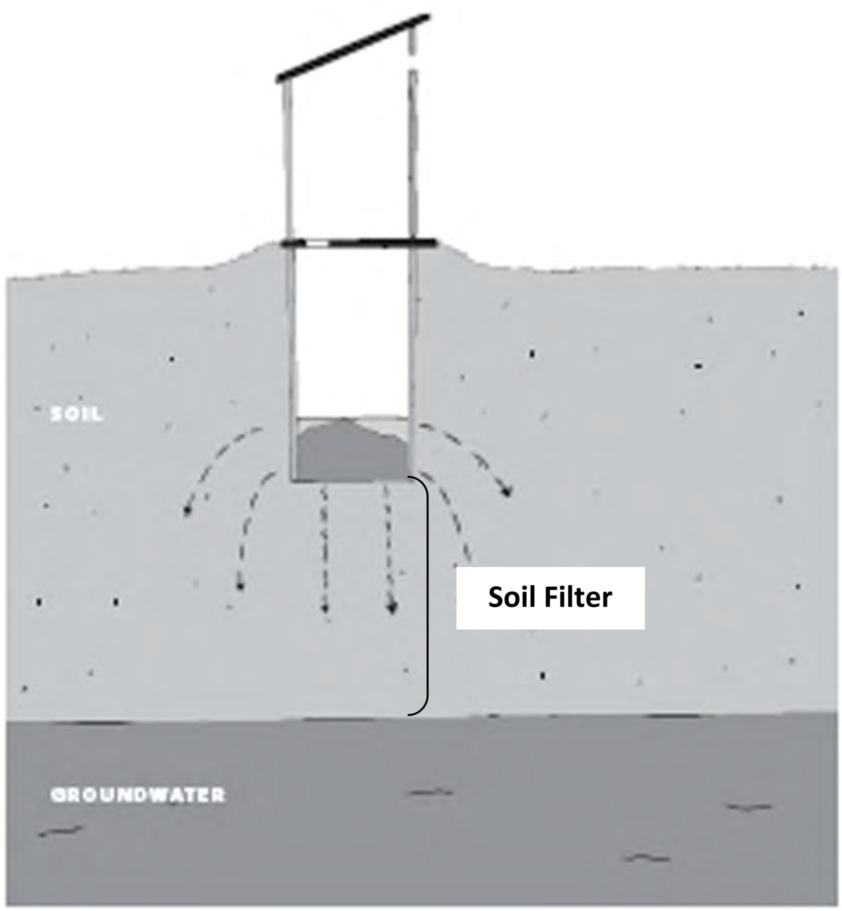
Fill in the second line of the soil filter equation. Ask a volunteer to solve the equation, or solve it with the class.

Now, **calculate** the soil filter for a community where you work based on the deepest pit used (or 3 meters if not pits), and the highest water table (probably near the end of the wet season).

Soil Filter = _______ – ________ = _______

Give the class time to find the soil filter for their community. Ask a few volunteers to share what they find.

If there is no soil filter, that is, the water table is above the bottom of the pit, then the pit latrine contaminates the groundwater. Even though the ground water below the pit is contaminated, Part II of this activity will explore ways to decrease the risk through a horizontal separation between the water source and the pit latrine.



4. Soil Type – 15 minutes

The amount of soil filter required to keep the pit latrine effluent from contaminating the groundwater depends on the type of soil between the pit and the groundwater.

In small groups, **read** the table below and study the pictures in Figures 2-4. **Draw** each example in the space below the table.

How Much Soil Filter?

- 2 meters of fine sand, silt, or clay between bottom of pit and water table (figure 2)
  = 2m soil filter
  (Soils that stick together when moist are fine sand, silt or clay.)

- 10 meters of medium sand between the bottom of pit and water table (Figure 3)
  = 10m soil filter
  (Medium sands don't stick together when wet but are still no larger than 0.5 mm in size.)

- Latrine with coarse sand, gravel, and fractured rock between the bottom of pit and the water table (Figure 4)
  = soil filter will not reduce contamination risk
  (Coarse sands, the smallest particle of this group, are 1 mm and larger in size.)
  Note: 1 mm is the thickness of a human fingernail.

Review the drawings with the class by drawing them on a flipchart.

In the next activity (Latrines and Groundwater Part II), we will look at ways to reduce the risk when the soil filter below the pit is not sufficiently thick to remove the contaminants from the latrine effluent.

Key:

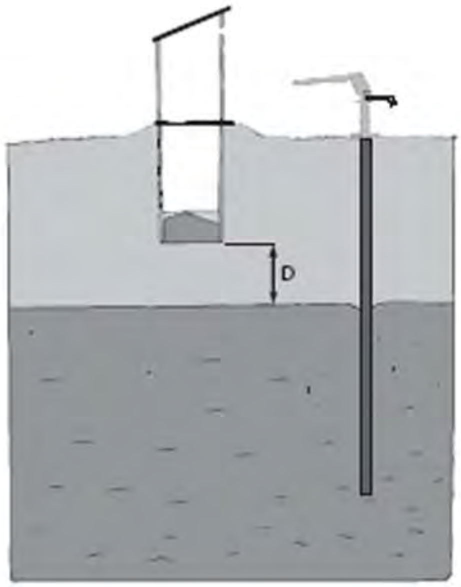


Figure 1: Water table below pit

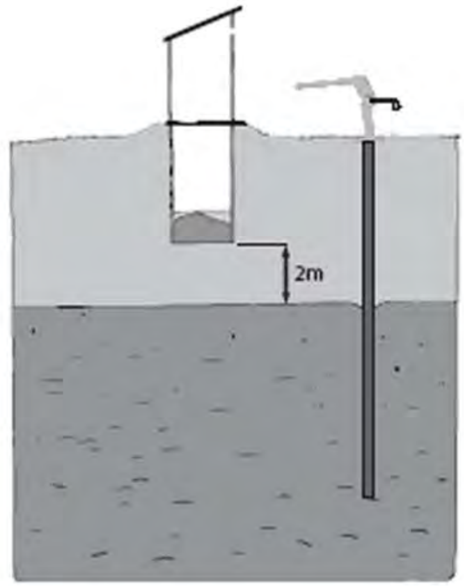


Figure 2: 2 meters of fine sand, silt or clay

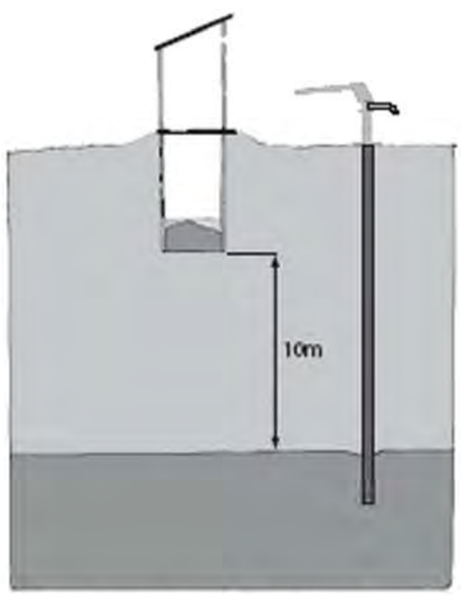


Figure 3: 10 meters of medium sand

Figure 4: Coarse sand, gravel, or fractured rock

(See Latrines and Groundwater II to address this.)

Background Information

Latrines and Groundwater I

This activity is Part I of a two-part lesson. Latrine siting is a complex topic not only because it requires some technical skill but also because it must take into consideration social, cultural, and land availability issues. The goal is to encourage communities to think about the potential risks to groundwater contamination before they choose which type of latrine to promote. This activity is best for trainers who will need to be able to assess more technical sanitation contamination/siting situations. It should be used after Groundwater and Soil and Drainage lessons so that participants have already seen how water travels through the ground at different speeds depending on the soil type.

A minimum vertical separation for fine sands, silt, and clay is often given as 5 meters; however, this is thought to be overly conservative by some sanitation experts, who believe that the overall improvements in health brought about by the implementation of on-site sanitation outweigh the potential risks to groundwater contamination (which can possibly be mitigated by other approaches.)

The term “soil filter” is used for simplicity even though other processes occur in the soil to reduce harmful microbes in addition to filtering (e.g., adsorption, predation, die-off, and dilution).

The risk analysis in this lesson is adequate for pit, VIP, pour flush (less than 10 users), and composting latrines. Septic tanks, aqua privies, and pour flush systems (communal) handle a much larger quantity of liquid and will likely pollute the groundwater regardless of the soil type or the vertical separation. Alternate methods of separation must be considered.

Latrines and Groundwater II[9]

Purpose
Participants will look at the importance of horizontal separation between a pit latrine and a water source.

Objectives
By the end of this lesson, participants will have:
- **Explored** the concept of horizontal separation between a latrine pit and a water source, and assessed the contamination risk in a sample problem

Materials
- Flipchart paper
- Markers
- Tape

Preparation
- Draw the two soil filter options on a flipchart (Figures 1 and 2).

Time
45 minutes

Steps
1. Introduction
2. Option 1 – Adequate Soil Filter- 5 minutes
3. Option 2 – No soil filter- 5 minutes
4. Horizontal Separation – 30 minutes

[9] Bob Reed, *Low-Cost Sanitation* (UK: WEDC Loughborough University, (2003), 21-26.

1. Introduction

- What have you learned so far about soils?
- What about how liquids drain from latrines?

These are review questions that will help prepare participants for the lesson.

We saw in the Groundwater activity that liquids can move horizontally and that latrines can contaminate water sources. We also saw in Soil and Drainage that soils with smaller particles slow down the movement of harmful liquids, giving the soil time to reduce the contaminants.

In the last activity, we looked at how far above the water table a pit latrine needs to be excavated. Now, we will look at how far away (distance) pit latrines need to be to protect safe water sources.

Hang up flipchart with 2 options.

We begin by **looking** at two options:

- Option 1: When the pit latrine is dug above the water table and there is an adequate soil filter.

- Option 2: When the soil filter is not adequate or when the pit extends below the water table.

2. Option 1: Adequate Soil Filter- 5 minutes

When the pit is dug above the water table and the depth of the soil filter is adequate to remove harmful pollutants, there is little risk that the latrine will contaminate a water source 15 meters away. This situation is shown in Figure 1.

While there is little risk of the pollutants reaching the water source, we should still maintain a minimum horizontal separation of 15 meters. There could be fissures or cracks in the soil, caused by construction, that allow the contaminated liquid from the latrine to travel directly to the water source.

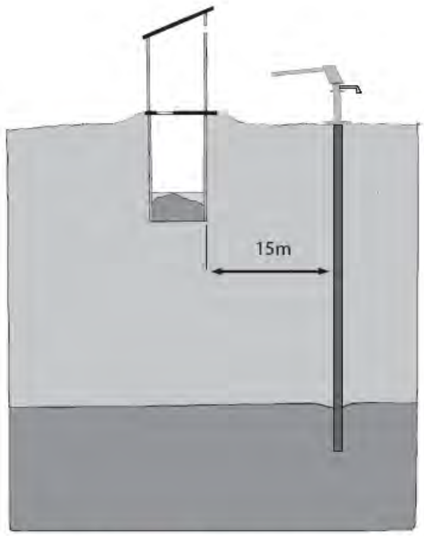


Figure 1 : Latrine with 15 meters separation

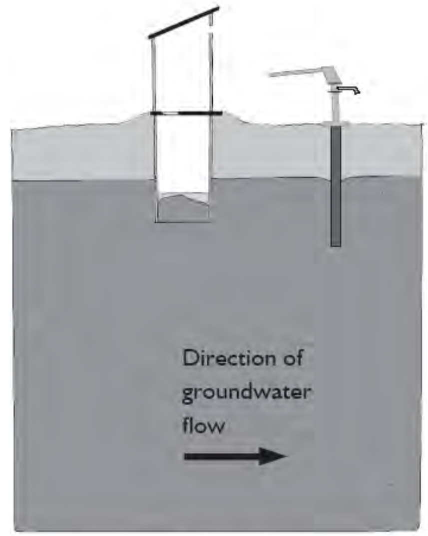


Figure 2 : Latrine with pit below water table

3. Option 2 - No soil filter- 5 minutes

When the pit is dug below the water table, contaminants from the latrine will enter the groundwater. This is shown in Figure 2. When there is not enough vertical separation between the bottom of the pit and the water table, contaminants from the latrine will enter the groundwater. Let's **look** at how horizontal separation can reduce the contamination at the water source, even when the groundwater below the pit is contaminated.

Note: the arrow in Figure 2 shows the direction of groundwater flow. In this case, the harmful latrine liquids are moving toward the hand pump. If the flow was reversed, the latrine effluent would be moving away from the hand pump and would pose little risk of contamination. However, a minimum horizontal separation of 15 meters should be maintained because of fissures or cracks in the soil caused by construction.

4. Horizontal Separation – 30 minutes

In small groups, **read** the table below and study the pictures in Figures 3-5. **Draw** each example in the space below the table.

How Much Horizontal Separation?

- 15 meters of fine sand, silt, or clay between pit and the water source (horizontal separation) - Figure 3.
- 50 meters of medium sand between pit and the water source (horizontal separation) - Figure 4.
- 500 meters of gravel between the pit and the water source (horizontal separation) – Figure 5

Review each figure with participants by drawing them on a flipchart.

- Which of the situations above would most likely represent the situation in the communities where you work?

Discuss this question with a partner:

- If it looks like the water source will be contaminated by pit latrines, what are some options for reducing the risk?

- *The latrine could be elevated to increase the vertical separation.*
- *A fine sand layer, 0.5 meters thick, could be used to line the pit, which would increase the travel time.*
- *Look at other types of latrines that do not put as much liquid into the ground.*
- *Move the water source, which is often a cheaper option than moving the latrines.*

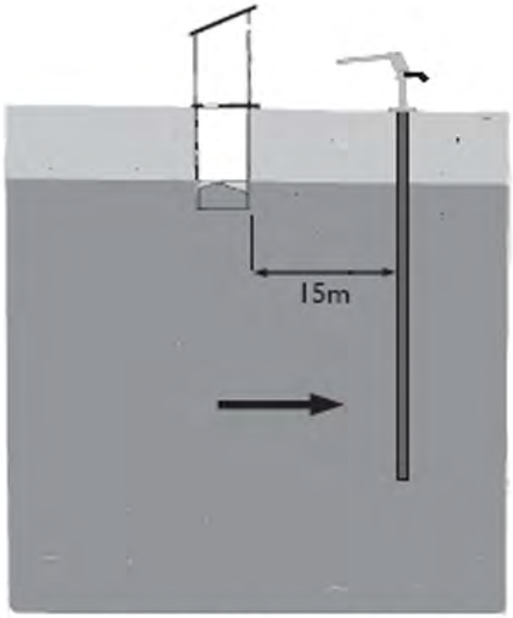


Figure 3: Latrine with 15 meters of fine sand, silt, or clay

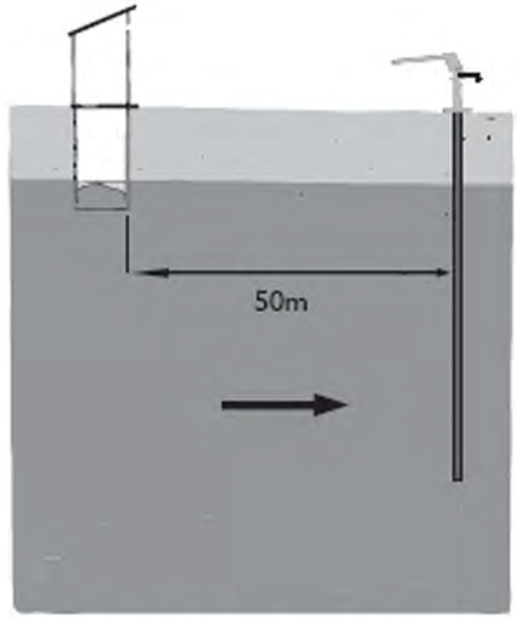


Figure 4: Latrine with 50 meters of medium sand

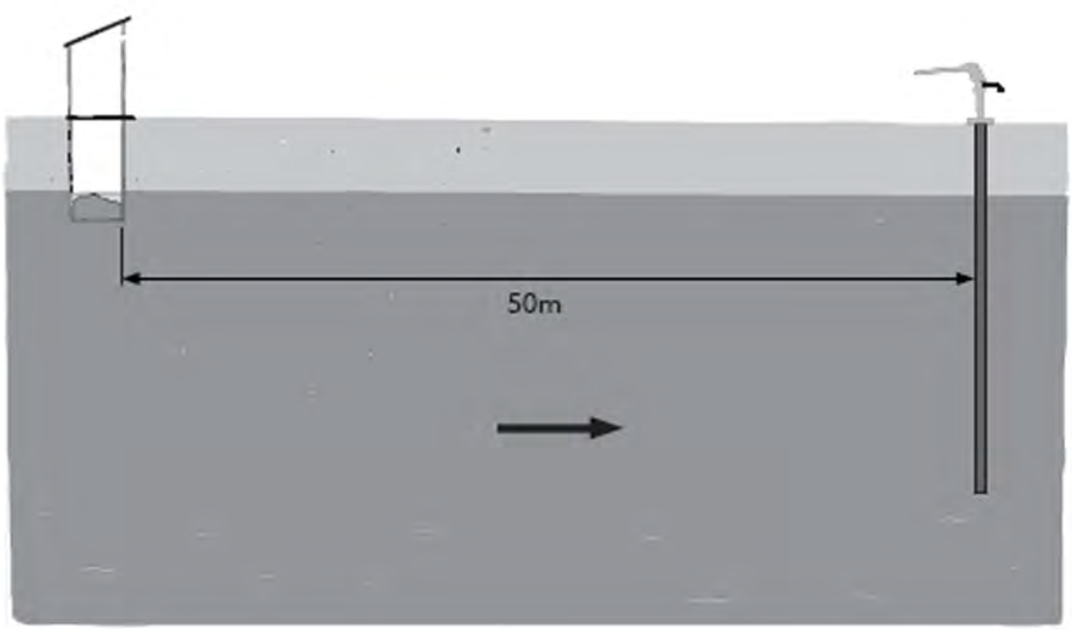


Figure 5 : Latrine with 500 meters of gravel.

Background Information

Latrines and Groundwater II

This activity is Part II of a two-part lesson. Latrine siting is a complex topic not only because it requires some technical skill but also because it must take into consideration social, cultural, and land availability issues. The goal is to encourage communities to think about the potential risks to groundwater contamination before they choose which type of latrine to promote. This activity is best for trainers who will need to be able to assess more technical sanitation contamination/siting situations. Part I focused on the vertical separation between the bottom of a pit and the water table. Part II looks at how horizontal separation between a pit latrine and water source is needed to reduce contaminants in latrine liquid (effluent).

The lateral separation between a water source and latrine has traditionally been given as 30 meters minimum. Recent studies and field evaluation, has shown that this might be too conservative given the necessity of adequate sanitation and the small plots on which many people live. Ten meters (10m) is often given as a minimum distance. However, in this curriculum fifteen meters (15m) will be used as a baseline because it has a greater margin of safety and also because it is more widely use in sanitation literature and promotion (after the 30m separation).

Encountering soil saturated with water while digging a pit is a clear indicator of the water table, as shown in the image below.

Groundwater flow

Groundwater tends to flow in the direction that the ground slopes, and it can flow from a recharge area to a discharge point. An example of this is the snow runoff from the mountains feeds into streams and rivers.

Homework – I & II

Objectives

Participants will look at several problems and analyze them using the tools learned in Latrines and Groundwater I & II.

Homework Problems for Latrines and Groundwater I & II

1.

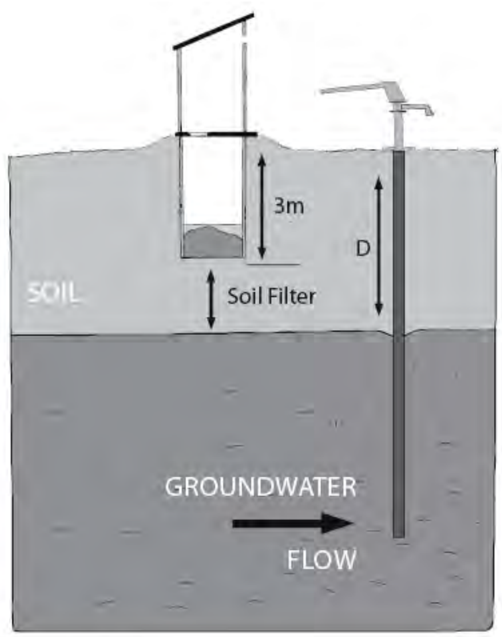


Figure 1

A. The depth to the water in the above well is not known or labeled. How would you measure it?

B. After the measurement, you discover the water is 7 meters deep. Calculate the vertical soil filter.

C. If the soil sticks together when it is moist but does not form a ball, is the soil filter thick enough to filter the latrine liquid waste?

2.

Figure 2

A. A moist soil sample sticks together in your hand, but will not form a ball. Is this latrine a safe distance from the hand pump?

B. A moist soil sample falls apart in your hand. Is this latrine a safe distance from the hand pump?

3. The soil is sandy but does not stick together when moist (Figure 3). Is the latrine a safe distance from the pump?

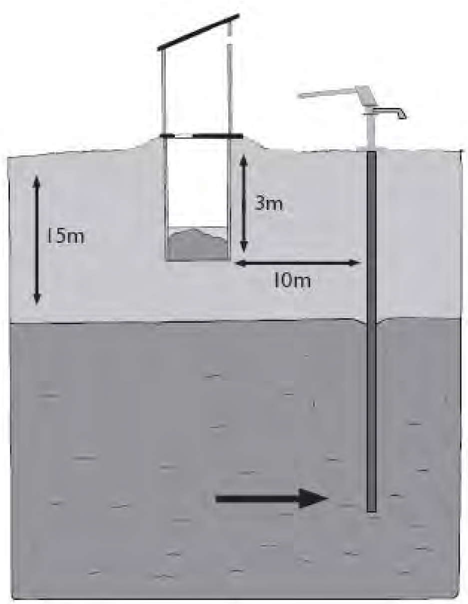


Figure 3

4. Is it likely that the water drawn from this hand pump would be contaminated from the pit latrine?

Figure 4

Field Visit Preparation

Purpose

Participants will discuss their field observations with the goal of gaining more insight into latrine design and construction.

Objectives

By the end of this lesson, participants will have:

- **Listed** the technical, environmental, and social factors of sanitation that might be observed on a field visit
- **Reviewed** specifications for locating latrines from the "Latrine Location" lesson
- **Reviewed** soil types from the "Soils and Drainage" lesson.

Note: the next two lessons are meant to be connected with a field visit to a nearby community. If this is not possible, the activities can be altered to visit a site in the area surrounding the training.

Materials

- Flipchart paper
- Markers
- Tape

Preparation

- None

Time

60 minutes

Steps

1. Introduction
2. Assessment Factors – 45 minutes
3. Review Latrine Location and Soil Specifications- 15 minutes

1. Introduction

In this activity, we will **create** a list of items to observe when conducting a community sanitation visit. Our emphasis will be on the technical, environmental and social factors that inform latrine design and construction.

2. Assessment Factors- 45 minutes

With a partner, **read** the following list of factors that might influence latrine design and construction in communities where your organization works. **Circle** those factors that you think are the most important to assess and add additional information as needed.

Depending on the group, the list may be read to the class.

Assessment Factors

- Religious beliefs
- Traditional beliefs
- Anal cleaning practices (for example, water, paper, leaves)
- Attitudes to handling or using excreta (as fertilizer)
- Stature and age range of the users
- Disabilities
- Preference to sit or squat
- Attitude to privacy
- Family relationships
- Occupations and lifestyle
- Water availability
- Locally available materials
- Housing density
- Soil conditions
- Groundwater level
- Climate
- Locally available skills
- Family size/number of users
- Existing sanitary practices
- Drainage patterns
- Potential for water pollution
- Latrine product availability (are there slabs available?)
- Attitudes to new ideas and innovation

For example, under 'Family Relationships,' you might want to find out if men are able to use the same latrine as their mothers-in-law. This is important to know because, if both are living on the same property, either two latrines will need to be built or someone might have to resort to open defecation.

We'll **hear** your responses and combine them on a piece of flipchart paper.

In the following space, **list** the main factors that the group came up with for assessing sanitation in the communities.

Review the lists that people create and combine them on a flipchart. Each person should have a list in their manual so they can refer to it during the field visit.

We will **refer** to these lists during our community field visits. When we return from the field visit, we will discuss the factors that you observed.

List of Factors to Assess on Field Visit

____
____
____
____
____
____
____
____
____

3. Reviewed Latrine Location and Soils Specifications- 15 minutes

In small groups, **review** the specifications for located a latrine. These are found in "Latrine Location". **Answer** the following:

- Latrines must be __________meters from buildings
- Latrines must be __________meters from all water sources

Next, **review** soil types in the lesson, "Soils and Drainage".

> ➢ What kinds of soils would be ideal for a pit latrine?

Review the answers with the class, and hear any questions they have before visiting the community.

Field Visit

Purpose

Participants will meet with locals and assess the site for latrine construction.

Objectives

By the end of this lesson, participants will have:

- **Recorded** observations from the field visit
- **Noted** the locations of buildings and water sources in proximity to the latrine site and determined if they are appropriate distances
- **Identified** the soil type at the latrine construction site, and determined if the soil is appropriate for a latrine

Materials

- Manual

Preparation

- None

Time

All day

Steps

1. Initial Meeting
2. Latrine Site
3. Soil Test
4. Discuss Site

1. Initial Meeting

Meet with the appropriate person(s). Be sure to observe any local customs.

Ask that person to lead the group to the desired site for latrine construction.

While in the community, **pay attention** to the assessment factors the class discussed. **Use** your observations from the site and conversations with locals to inform the assessment.

2. Latrine Site

At the latrine site, **ask** about local water sources.

- Where are they located? How far away?
- How deep is the groundwater in the dry season? What about in the wet season?

If the water source is less than 15 meters away, the site for the latrine will need to be changed.

Ask about the buildings nearby. If the nearest building is less than 6 meters away, you may consider changing the site of the latrine.

3. Soil Test

At the latrine site, **dig** a small hole with a stick. **Test** the soil and **determine** what kind of soil it is.

- Is this soil more like gravel, sand or clay?
- Will liquids filter through the soil at a fast or slow rate?
- Would a pit dug in this soil most likely collapse?

This question could be answered using other observations such as, other pits in the area that have not collapsed or other local information.

4. Discuss Site

Meet with the class while still near the latrine site.

As a class, let's **discuss** the latrine site.

- Should it be moved or should it remain the same? Why?

ANY CHANGE NEEDS TO BE DISCUSSED AND AGREED UPON BY THE COMMUNITY.

Thank the community for their time; **ask** if they have any questions.

Field Visit Debriefing

Purpose

Participants will discuss their field observations with the goal of gaining more insight into latrine design and construction.

Objectives

By the end of this lesson, participants will have:

- **Discussed** how the technical, environmental, and social factors of sanitation observed on the field visit impact latrine design and construction
- **Shared** the type of soil located at the site and the location of water sources and buildings in proximity to the latrine site.

Materials

- Flipchart paper
- Markers
- Tape

Preparation

- Prepare a flipchart with:

Soil Type:______________
Building Distance: ______________
Distance to Water Source:______________

Time

75 minutes

Steps

1. Introduction
2. Review Field Visit- 45 minutes
3. Record Latrine Location and Soil Type- 10 minutes
4. Group Discussion- 20 minutes

1. Introduction

In the first set of activities, we looked at some of the technical factors related to latrine design. Next, we visited communities to observe how people are designing and constructing latrines. In areas that have yet to start implementing sanitation, we may have observed factors that will be important to consider before they start building latrines. Now, we will discuss what we observed during these visits.

2. Review Field Visit- 45 minutes

With a partner, **discuss** the things that you observed and learned on the field visit related to latrine design and construction.

Review the list of items that we created in the previous activity to help you remember, or **consult** your own notes from the field visit.

We'll **hear** your responses and **combine** them on a piece of flipchart paper.

3. Record Latrine Location and Soil type- 10 minutes

Post the flipchart. Have the class discuss and fill in the answers.

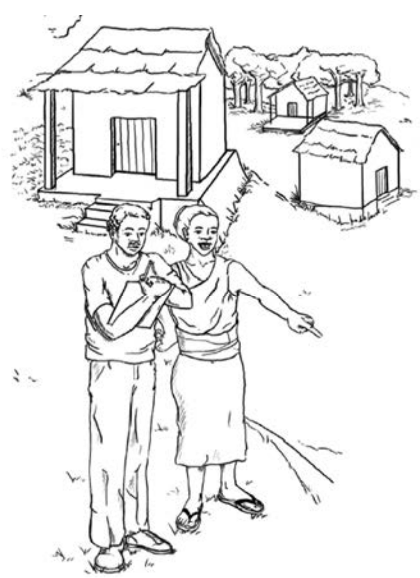
As a class let's **fill** out these flip charts.

4. Group Discussion- 20 minutes

As a group, let's **discuss** the following question:

- How will things that we have learned so far in the workshop and field visit affect how we approach latrine design and construction?

In the next activity, you will implement what you have learned, and what you already know from your past experience, by designing latrine.



Designing Pit Latrines

Purpose

Participants will look at the details of designing a pit, lining, slab, and superstructure for a basic pit latrine.

Objectives

By the end of this lesson, participants will have:

- **Evaluated** the criteria that determine the dimensions of a pit
- **Discussed** the type and amount of pit lining required for different soil conditions
- **Examined** the requirements for slab design and construction
- **Discussed** considerations for superstructure design

Materials

- Plastic beverage bottles, preferably 2 liter size (1-2)
- 500 ml plastic bottles (1-2)
- Sandy soil
- A sharp tool to cut the bottles in half and punch holes in the bottoms,
- Bits of grass
- Paper
- Water
- 55 gallon drums (2)
- Jerri cans (3-4)
- Diagram of bottle setup
- Flipchart paper
- Markers
- Tape

Preparation

- Make sure the posters from the lesson, Pit Latrines, are visible.

Time

75 minutes

Steps

1. Introduction
2. Pit Design- 15 minutes
3. Soil Cap- 5 minutes
4. Pit Lining Design- 15 minutes
5. Slab Design- 20 minutes

1. Introduction

In this activity, you will study some of the technical aspects of pit latrine design. You will look at design details for the basic components of a pit latrine: the pit, lining, slab, and superstructure.

2. Pit Design- 15 minutes

When determining the size to dig a pit, several factors need to be taken into account:

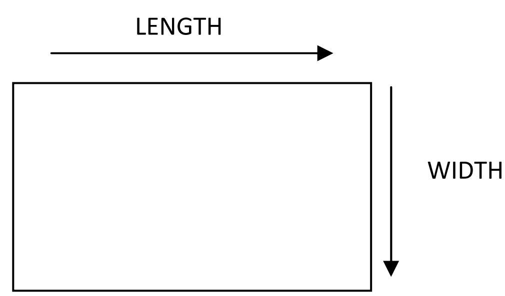
- How many people will use the latrine?
- How many years will the latrine be functional?
- What, in addition to excreta, will be added to the pit?
- Are there any limitations to pit shape and depth?

We learned the volume of sludge that a person contributes to a pit every year. The pit must be large enough to store the sludge produced by the whole family for long period of time, at least ten years. Formulas for calculating pit dimensions are given in the Appendix. The tables below show pit depths of standard sized pits for a family of six. The depths are shown for pits that last for 5, 10, 15, and 20 years.

Do not walk through the calculations unless the participants understand math concepts.

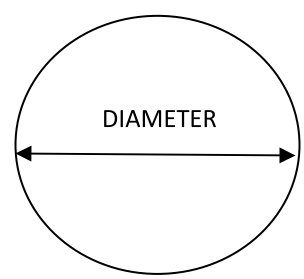
Rectangular Pit

Pit Dimensions	Pit Depth			
	5 years	**10 years**	**15 years**	**20 years**
1x1	2.3 deep	4.1	5.9	7.7
1.2x1.2	1.75	3.0	4.3	5.5
1.5x1.5	1.3	2.1	2.9	3.7
1.2x2	1.25	2.0	2.8	3.5



Circular Pit (diameter)

Pit Diameter	Pit Depth			
	5 years	**10 years**	**15 years**	**20 years**
1.1	2.4 deep	4.3	6.2	8.1
1.5	1.5	2.5	3.6	4.6



*Dimensions are for a family of 6

For example, a pit that is 1.5 meter wide, 1.5 meters long, and 2.9 meters deep will serve a family of six for 15 years.*

** If the family cleans themselves with non-degradable materials, the pit will fill up faster than 15 years. Also, this calculation assumes that large amounts of wash water are not added to the pit and that the soil surrounding the pit is porous enough to absorb the liquid in the pit.*

In your small groups, **analyze** the table and **answer** the following questions:

- What surprises you about the information in the table?
- What do you think is an ideal pit shape and size for your context? Why?

____

____

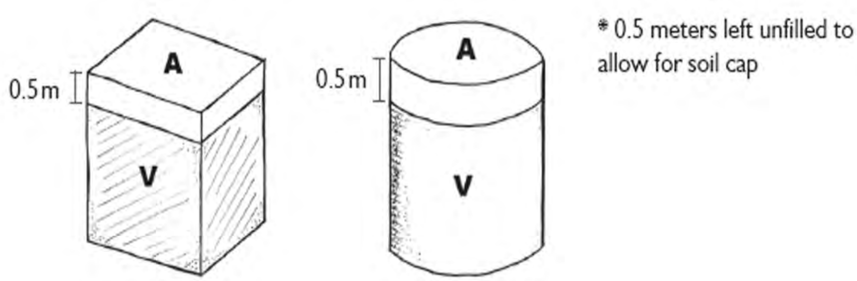
____

____

3. Soil Cap- 5 minutes

Soil Cap
The dimensions given in the previous table include an additional 0.5 meters at the top of the pit for a soil cap. When the pit is full to within 0.5 meters of the top, the slab and superstructure are removed and dirt is used to fill in the hole.

For example, a circular pit that is 1.5 meters in diameter and 2.5 meters deep will last a family of six, ten years. At ten years, the pit should still have 0.5 meters of depth remaining, which can be filled in with soil to cap the latrine.



V = Volume of sludge in stored in pit.
A = Area of pit

4. Pit Lining Design- 15 minutes

All pits need some amount of lining regardless of the type of soil where they are excavated. The top 0.5 meter of the pit should always be lined to support loose topsoil, to provide a foundation for the slab and superstructure, and to keep animals and surface water runoff out of the pit. The top 0.5 meter lining must be completely sealed with no cracks or holes.

- Do people in your communities line pits? Partially or fully? Do pits collapse?

It is often difficult to decide whether or not to line the pit below the top 0.5 meter. If the soil is composed of sand or gravel, the pit will likely need complete lining. If the soil has a high clay content, the pit may not need complete lining. It is best to check in the area to see if other unlined pits or hand-dug well excavations have remained intact. In a previous activity, we saw some of the materials that can be used to line a pit. A similar list is shown below:

Lining materials

- Brick
- Concrete rings
- Ferrocement reinforcement
- Concrete block
- Oil drums
- Compressed earth block
- Wood resistant to timber and termites

- What experience do you have with pit lining?

In your small groups, **discuss** the following questions:

- What do you think is an ideal material for pit lining in this area?
- How deep should pits be lined?
- What questions do you have about pit lining?

Listen to a sample of responses from groups.

3. Slab Design- 20 minutes

Some of this information may have been covered in this course prior to this lesson. If so, facilitators may have participants review what they know about the specific slabs. Be sure to point out important that has not been covered.

The latrine slab must be strong enough to support the weight of the user and, sometimes, the weight of the superstructure. The simplest slab design is to use termite-resistant timber to create a platform over the pit. This wood slab is often covered with soil, a mixture of soil and cow dung, or mud from anthills or termite mounds (Figure 1).

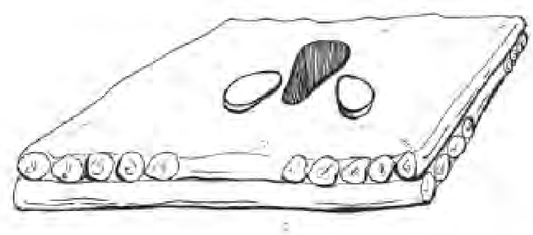


Figure 1: Wood slab

A slab should overlap the edges of a lined pit by 100 mm, and, if there is no lining, the slab should extend 200 mm beyond the edges of the pit (Figure 2).

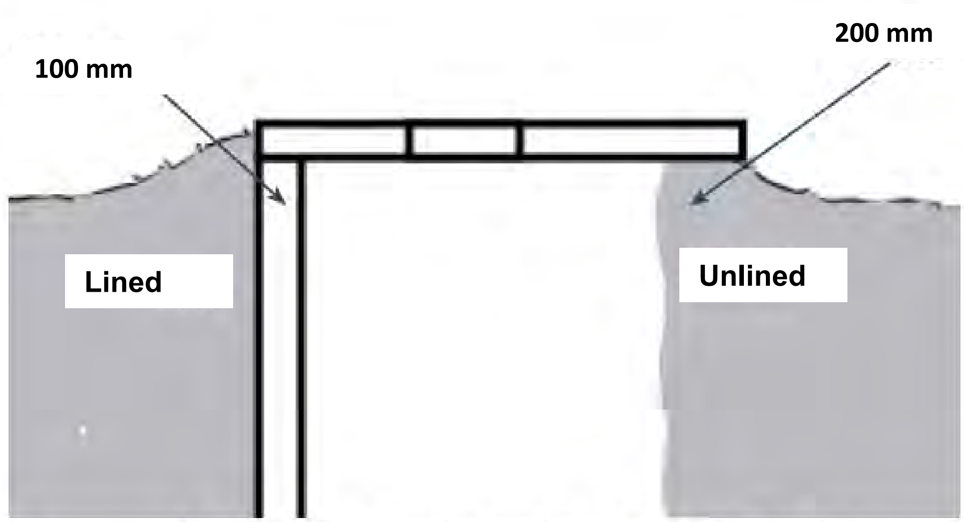


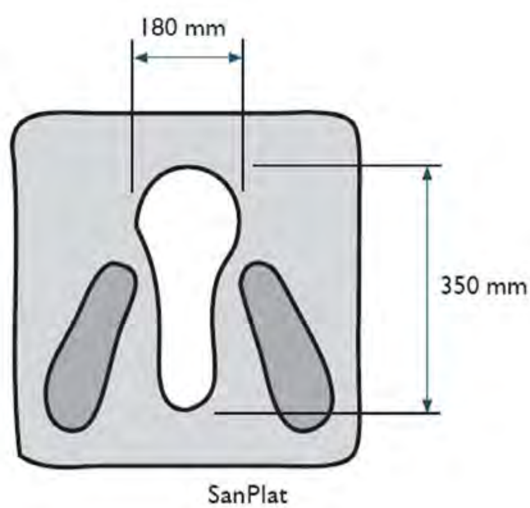
Figure 2: Slab overlap on lined and unlined pits

Reinforced concrete slabs are also very popular. The thicker and larger the slab is, the thicker the rebar must be and the more rebar is needed.

The high cost of cement is challenging to many families and they must seek other low-cost options for acquiring a slab. Small concrete slabs, commonly called SanPlats, are more affordable than full-size latrine slabs. SanPlats are made without rebar and are placed on top of wooden slabs to provide a floor that is easier to clean.

Foot pads are cast into most concrete latrine slabs. The foot pads help the user align themselves with the hole in the slab so that there is less chance of dirtying the floor.

The squat hole in the slab should not be too large or children will be afraid of falling into the pit.



Reminder: *In a previous activity we learned that a slab should be elevated at least 150 mm above the surrounding ground to keep surface water runoff from entering the pit.*

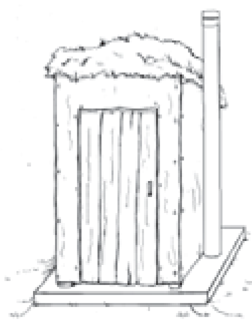
In your small groups, **discuss** the following questions:

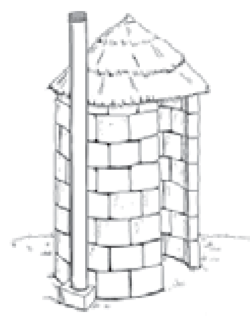
- What slab designs have been used in this area?
- What do think are good slab designs for this area? Why?
- What questions do you have about slab design?

Hear a sample of responses from groups.

6. Superstructure Design- 15 minutes

There are very few requirements for a superstructure of a basic pit latrine beyond that it should provide privacy and protection from rain. Most people prefer to use latrines that have good lighting, are kept clean and well maintained, and are not too cramped inside.





Latrine superstructure can have doors, or be designed in a spiral layout.

Basic pit latrines should have openings in the superstructure for venting and to provide some light. Vents should be covered with mesh to keep flies from entering the latrine.

In a previous activity, we saw some of the materials that can be used to build a superstructure. A similar list is shown below:

Superstructure materials
• Bricks • Mud and wattle • Ferrocement • Corrugated sheet metal • Concrete block • Bamboo • Compressed earth block • Wood • Stone

In your small groups, **discuss** the following questions:

- What superstructure designs have been used in this area?
- What has worked well with the current designs? What could be improved?

Thank you for your responses. In the next lesson we will practice designing latrines.

Latrine Design Project

Purpose
Participants will discuss their field observations with the goal of gaining more insight into latrine design and construction.

Objectives
By the end of this lesson, participants will have:
- **Integrated** pit latrine design information into a group latrine design project

Materials
- Flipchart paper
- Markers
- Tape

Preparation
- None

Time
90 minutes

Steps
1. Design a Latrine (90 minutes)

Depending on the partner and location, participants could work as a class to design a latrine to construct during the course. Usually the latrine is design with the field visit site in mind.

- If several types of slabs have been constructed prior to this activity, the class can break into groups and plan the lining, pit size (taking the slab into account) and structure material.
- If no construction has taken place or no construction is planned, have small groups practice designing all elements of a pit latrine.
- This lesson can also be done with participants' communities as the focus. Participants from similar areas can team up to design an ideal latrine for their specific communities.

1. Design a Latrine- 90 Minutes

Now you are going to use what you've learned and your experience to design a basic pit latrine. You will work in small groups to **design** a basic pit latrine using the following guidelines:

- Must use locally and readily available materials.
- Must be affordable for a family in the communities where you work.
- Must be able to be constructed with local labor.
- Must be a latrine that you would want your family to use. That is, you should take pride in your design.

Design Information
Number of user: 6 people
Desired life of latrine: 15 years
Cleaning material: Leaves, grass, paper

Walk around to each group and make sure participants understand the instructions. If help is needed with determining pit size, information can be found in the appendix.

Process:

- **Calculate** the size of the pit you want to excavate. You can use the table from the lesson on pit latrine design.

If constructing a demonstration latrine during the class, the pit may only need to be 1 to 1.5 meters deep.

- **Determine** what type of lining you will use for the pit. Will you line only the top 0.5 meters, or all the way down? If the soil is unstable and needs full lining does that alter what you chose for pit dimensions? Maybe it will be more cost effective to build a shallower pit.

- **Decide** what type of slab you will build. How you will you make sure that it seals the pit, is able to support the user, and can be kept clean? Don't forget to **design** a slight mound around the slab to keep surface water out of the pit.

- **Design** a simple superstructure that is accessible, provides security and privacy, and enough protection from wind and rain.

- **Sketch** a drawing of your latrine design including important size dimensions for the pit, lining, slab, mound, and superstructure.

- **Create** a list of materials needed for the latrine including quantities and costs for items that must be purchased.

Each small group will **present** their design to the whole group.

Planning for Implementation

Purpose

Participants will know the necessary steps for implementing a community sanitation program.

Objectives

By the end of this lesson, participants will have:

- **Identified** major steps to take to implement a successful sanitation program
- **Utilized** the five-finger questions to brainstormed how to carry out the major steps of their implementation plan

Materials

- "Now" and "future" drawings representing community implementation of a latrine program
- Flipchart paper
- Small sheets of paper
- Poster pens
- Tape to hang up flipchart paper

Preparation

- Prepare a flipchart with the "now" drawing in the upper left-hand corner and the "future" drawing in the right-hand corner. This can be used when the class compiles their steps to create one implementation plan.
- Draw a hand on the top of a flipchart. Label each finger with the following words:
    - What
    - How
    - Who
    - Where
    - When
- Under the hand write the five-finger questions:
    - What tasks need to be carried out to complete your step?
    - How will could those tasks be carried out? (What resources are needed?)
    - Who is going to carry them out? (Will they need training?)
    - Where is the work to be done?
    - When is the work going to be done? (How long will it take?)

Time

60 minutes

Steps

1. Introduction
2. Review the key components of a successful sanitation program- 5 minutes
3. Create steps to a sanitation program- 15 minutes
4. Compile implementation plans- 15 minutes
5. Utilize the five-finger planning method- 30 minutes

Before teaching this lesson, discuss with the partner what the plan for implementation is. The partner may already have a plan and may not need participants to develop one. If this is the case, facilitators could alter the lesson to make it work with the Partner's plan. If the partner does not have a plan, make sure it is appropriate for participants to be developing one for the project.

Introduction

In this lesson we will start discussing ways we can use what we've learned to start implementing sanitation projects in a community.

1. Review the key components of a successful sanitation program- 5 minutes

Walk around the room with the picture of the community "now".

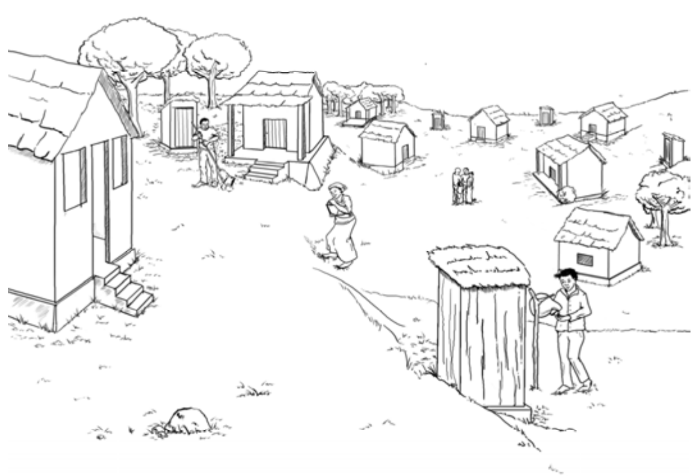
Here we have a community. You can see that there is a person here talking to the community about latrines. The community looks excited about the possibility of having their own latrines.

This picture represents "now". There is a high demand for latrines in the village; however latrine coverage in the village is low.

Walk around the room with the picture of the community in the "future".

Here is a picture of the community at the end of a successful sanitation program. The people have constructed latrines, and are using them. You can see that latrine coverage is now high.

In this training we have learned a lot about latrine design and construction. We can now work together to create a plan we could use to implement a successful sanitation program.



At the end of a successful sanitation program, the community will have:

- an understanding of the importance of using latrines,
- constructed latrines, and
- long-term knowledge of latrine maintenance.

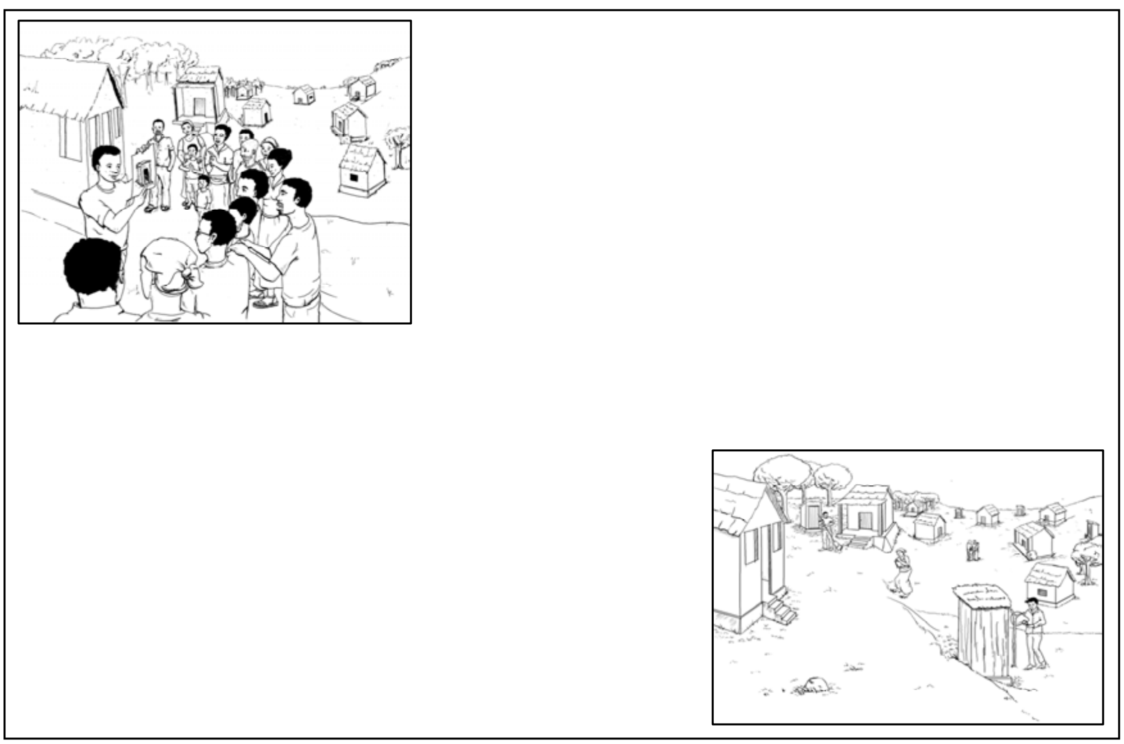
2. Create steps to a sanitation program- 15 minutes

In small groups, **brainstorm** what major steps you could take to implement a sanitation program, that meets the criteria. Remember, a sanitation program is more than constructing latrines. How could you also educate people about the importance of sanitation, different latrine types and maintenance?

Use sheets of paper to **make drawings** to represent the steps your group determines.

Tape the "now" drawing in the top left-hand corner of the flip chart and the "future" drawing in the bottom "right-hand" corner.

Be prepared to **share** your steps as a class.



Hear from each group.

3. Compile implementation plans- 15 minutes

As a class, let's work together to **create** one implementation plan using steps that different groups have mentioned.

- What should the first step be?

Read off what each group has chosen as their first step. Help the class decide on a first step for the compiled sanitation program. Go through each step until the class is satisfied with the implementation plan they have created.

- Would someone review the plan to the class?

Hang up the flipchart with the five-finger planning questions.

4. Utilize the five-finger planning method- 30 minutes

In small groups, take one of the steps listed and **answer** the "five-finger planning" questions:

1. **What** tasks need to be carried out to complete your step?
2. **How** will could those tasks be carried out? (What resources are needed?)
3. **Who** is going to carry them out? (Will they need training?)
4. **Where** is the work to be done?
5. **When** is the work going to be done? (How long will it take?)

Divide the class so that there is a group for each step.

Be prepared to **share** your step with the class.

Allow the class to discuss each step and come to agreement on the plan.

What did you **learn** from this lesson?

Latrine Construction

Below are a few suggested activities facilitators may use to help the students prepare for construction.

1. In small groups, have the students read through the instructions. Afterwards, ask some of the review questions found at the end of each step. Be sure to ask questions students are able to answer without having completed the construction.

2. Assign one group for every step. Ask each group to read through the instructions and create a drawing for the main points (one drawing per main point). The groups present to the class in order, and then quiz the class on their step using two to three review questions. Make sure they do not ask questions students cannot answer without having completed the construction.

3. Have the students read through instructions as homework. Ask them to write down any questions they have. Quiz them in small groups with some of the review questions.

*If there is anyone in the class with concrete experience, you may ask him or her to share some of their knowledge with the class.

Concrete slab construction should take place early enough in the class so the concrete has time to cure. Students can be broken into smaller groups that each make slabs or the whole class can make one together. Ideally, the latrine slab(s) could be made near or at the desired latrine location and could then be used for the constructed latrine.

Concrete Terminology

In this lesson, many words are used which are unique to concrete work. Different words may be used where you work, but the concepts will be the same. Concrete is a common material throughout the world and it is likely that in this class there are experts at working in concrete. So it is worthwhile to take some time to go over the words used in this lesson and match them to their local meanings.

Form - a frame that holds concrete in the shape that is desired for the finished product.

Level – To level a surface is to make it flat and even. A level surface is uniform; no part is higher or lower than another. The tools used to do this are a screed and a level.

Screed – a board, normally a little longer than the width of the form, used to level the wet concrete even with the top of the form (also used to mean the process of leveling the concrete).

Float – a small smooth board with a handle that is used to agitate the wet concrete to sink rocks below the surface, eliminate air pockets, bring water up to the surface, and to smooth the concrete (also used to mean the act of "floating the concrete").

Finish – the final stage of adding a surface texture to the concrete. Concrete is most often given a smooth surface using a steel finishing trowel. But it can also be given a rough non-slip surface by brushing it with a broom. Finishing is done in several stages as the concrete begins to set up.

Edge – because the cured concrete will have a sharp edge that can cut bare feet, or crack off, an edging tool is used to make a shallow groove between the concrete and the form. An edging trowel has one edge that curves down to accomplish this.

Stages of concrete curing. Concrete does not "dry"- instead, it gains strength through a chemical reaction called "curing" that starts as soon as water is added. The following stages of curing are useful to understand when working with concrete:

<u>Wet</u> – very soft and easily poured or shaped (less than an hour after adding water).

<u>Set</u> – also called "green" concrete meaning that it is still slightly soft but will hold its shape when the form is removed (several hours old).

<u>Hardened</u> – can be walked on, but has not reached full strength (about a week old).

<u>Cured</u> – the concrete has reached at least 80% of full strength (at least a month old).

Concrete Slab Construction

The instructions for constructing a concrete slab are separated into steps, each containing instructions. There are seven main steps, and it would be wise to have the students review the information before construction begins.

1. Prepare Area and Work Materials
2. Construct Wooden Frame
3. Place Rebar
4. Mix Concrete
5. Pour the Concrete
6. Finish the Concrete
7. Cure the Concrete

Step 1: Prepare Work Area and Materials

Concrete Slab Construction Materials Checklist ***for a 1m x 1m x 6cm or 3.3ft x 3.3ft x 2.4in Concrete Slab**				
Materials	**Size**		**Quantity**	**Do I have this?**
	Metric	**US**		
General Materials				
measuring tape			1	
gloves	varies on number of participants and facilitators			
shovels	varies on number of participants and facilitators		2 at least	
Step 2: Frame				
Wood for frame (wood should be 2.5cm X 10cm, or 5cm X 10cm) (1 X 4in or 2 X 4in)	100cm	3.3ft	2	
Wood for frame	150cm	4.3ft	2	
Wood for squaring	150cm	4.3ft	1	
Wood for screeding	96 or 98cm	3.1 or 3.2ft	1	
Nails or Screws	depends on thickness of wood		12	
Motor oil or wax for coating frame and keyhole				
Sand for leveling				
Water for wetting sand				
Alternative framing option: Brick	10 cm x 20 cm	4 in x 8 in	20-24	
Step 3: Place Rebar				
Rebar 6mm diameter (3/8 in)	90cm (.9 m)	3 ft	10	
wire to tie rebar or twist ties	about 2.5 m	about 96 in	1	
handle wire	400mm long and 8-10mm thick	15.75in long and .31 in thick	4	
hacksaw (optional)	Only needed if cutting rebar		1	
Small rocks to set rebar on	Varies on slab size. The rebar should rest on the rocks and not the sand			
Step 4: Mix Concrete				
wheelbarrow (if available)	For mixing concrete		1	
buckets or other measurement			2- 4	

for concrete				
Cement	50 kilogram sack	110 lbs	1 bag (use about 0.6 of a bag)	
Sand	50 kilogram sack	110 lbs	2 bags (use about 1.2 of a bag)	
Aggregate	50 kilogram sack	110 lbs	2 to 3 bags (use about1.8 of a bag)	
water	Enough to mix the concrete to the appropriate consistency			
keyhole mold (approximately)			1	
Tin can or small container with flat, open bottom for testing concrete			1	
Vent Pipe (optional)	Diameter of at least 150mm, height depends on structure height, the vent pipe should be .5 meters above the tallest point of the structure		1	
Step 5: Pour Concrete				
Wooden Floats			2 to 3	
Step 6: Finish Concrete				
Metal Trowels			2	
Hammer			1	
Plastic bag			1	
foot rest molds			1	
Step 7: Cure Concrete				
Plastic sheets or cement bags	enough to cover base and top of slab			

Slab Size (in centimeters)			**Slab Volume**			
length	**width**	**height**	**volume**	**cement**	**sand**	**aggregate**
(cm)	**(cm)**	**(cm)**	**cubic cm***	**50 kg sacks**	**sacks**	**sacks**
100	100	6	60,000	0.6	1.2	1.8
100	100	8	80,000	0.8	1.6	2.4
110	110	8	96,800	0.9	1.9	2.8
120	120	8	115,200	1.1	2.3	3.4
125	125	8	125,000	1.2	2.4	3.7
130	130	8	135,200	1.3	2.6	4.0
140	140	8	156,800	1.5	3.1	4.6
150	150	8	180,000	1.8	3.5	5.3

NOTE: 25% excess has been added to avoid surprises.

1. Concrete should be poured in an area free from dirt, grass and other debris. Prepare an area by removing these things.

2. For mixing concrete, use a wheelbarrow or a cleared area. If available, place a sheet of plastic or a plywood on the ground for mixing the concrete. This will help keep unwanted organic material out of the mixture. It will also keep the water in the mix rather than being absorbed into the ground.

   Tip: Concrete may be mixed on bare ground, however, use caution. If soluble material such as grass or dirt is mixed in with the concrete, it will weaken the structure.

3. Many concrete recipes call for 1 part cement: 2 parts gravel: 3 parts sand. A “part” is a unit of measure you used consistently throughout the mixing process.

4. Determine a “part” or consistent unit of measure. It could be a bucket, a can, a bag/pocket, a wheelbarrow, or etc. As you mix the concrete, consistently use this unit of measure.

5. Estimate how much concrete you will need for the slab you wish to make. Prepare the appropriate amount of materials.

   Tip: To maintain its integrity, concrete must be mixed as a batch. If additional concrete is needed to finish the slab, do not add material to the existing mixture. It will be necessary to make a new batch.

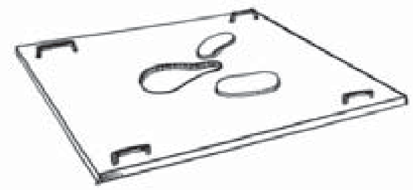
6. The water used to mix the concrete should not have debris. Do not use salt water to mix concrete.

Step 2: Construct Wooden Frame[10]

Square a Wooden Frame

Concrete needs to be poured in a frame to keep it from spreading. The goal is to create a strong frame that will result in smooth clean edges and keyhole. Clean edges and a clean keyhole are stronger and safer. They resist cracking, flaking and they are easier to clean.

This frame is for a slab with the dimensions of 100cm X 100cm.



The finished product: A square or rectangular slab.

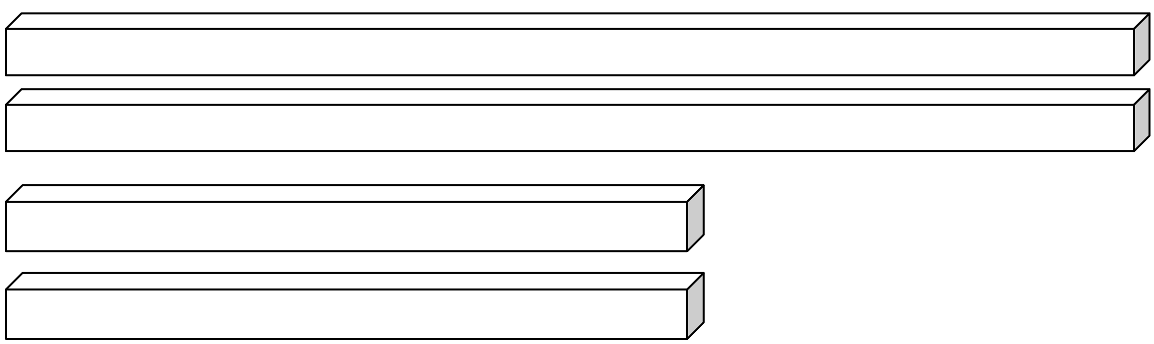
Instructions

1. Clear the ground. The wood frame for the concrete pour will be placed on the ground.

2. Make up the frame out of wooden boards with the dimensions described in the materials list. The wood should be straight. Low quality wood will work because the frame will eventually be discarded.

   Tip: the frame in this example DOES NOT have to be made up in the same place where the slab will be poured. It can be constructed anywhere on even ground and carried in place later.

3. Cut two pieces of wood exactly the length of the dimension of the slab. Cut another two pieces of wood longer than the dimensions.
4. Treat the wood by soaking it in water or painting it with used motor oil. This will keep the concrete from sticking to the fram.



Tip: Before nailing the wood together, look at the two edges of the board. Find the flattest edge of the board and place that edge on the ground. This will help ensure a level slab.

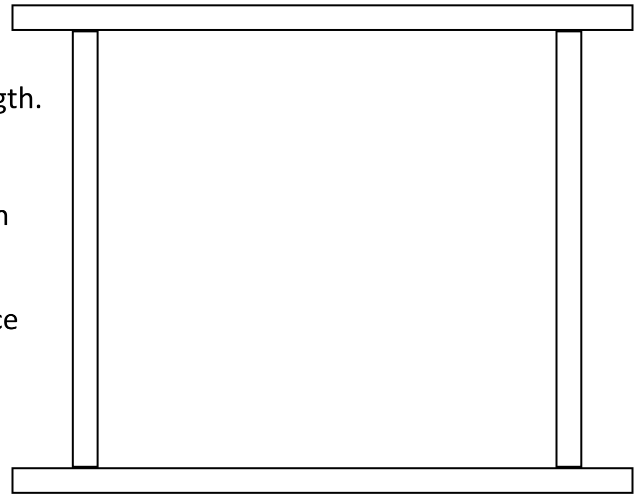
5. Look at the sides of the wood. Find the smoothest side and place it inside the frame. This will make the sides of the slab smooth.

[10] Bart and Linda Bergquist, *A Firm Foundation*. (10-11)

6. Nail the four pieces together, with the short pieces on the inside. Check to make sure the inside dimensions of the frame are the desired dimensions of the slab.

7. Ensure that the formwork frame is square. This can be done by making the diagonals equal length. Measure diagonally from corner to corner and then measure the other opposing two corners. The frame is square when the distance between the opposing diagonals are equal.

8. When the formwork frame is square, nail a piece of lumber on top of the formwork frame from corner to corner, to make sure the formwork frame remains square until pegged in place.



9. The formwork is now ready to be picked up and carried into position. First make sure that the ground has been cleared and leveled.

10. Square the frame once again. Measure your frame from inner corner to inner corner.

11. Using a shovel, pile dirt or lay rocks against the outside of your form. Use a large amount of dirt; the average concrete slab pour will put 22-34 kilograms (50 to 75 pounds) per square inch pressure on each foot of board. You do not want to risk your frame moving out of square.

Measure on the diagonal from corner to corner. If both sides are the same length, the frame is square

Tips:

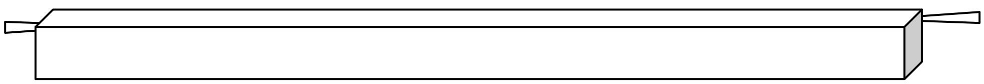
- Use clean wood. Do not use scrap wood to frame a slab. Old or rotten wood can break under pressure and cause what is known as a "blow-out" meaning your concrete has broken through the form.
- For a smooth key hole and frame;
    - Soak the boards and keyhole in water. This will cause the wood to expand. As the wood dries, it will more easily/cleanly pull away from the concrete.
    - Paint the frame and keyhole with used motor oil. Again, this will cause the wood to more cleanly pull away from the concrete
- You can brace your frame with rocks or bricks to help prevent it from moving in a concrete pour.

Leveling the Frame

It is important that the sand in the bottom of the frame is as level as possible so the slab will also be level and of equal thickness.

Instructions

1. Once the frame is constructed, lay it on flat, level ground and add sand to the bottom of the frame. The thickness between the sand and the top of the frame should be the desired thickness of the slab.
2. Lightly sprinkle the sand with water so the sand will pack down.
3. Make a sand screed to level the sand.
   Cut a board that is slightly shorter than the width of the slab frame. Drive the nails horizontally into each end of the screed. This will allow the screed board to roll smoothly across the sand. This will ensure a consistent depth of sand that ultimately creates a uniform depth of concrete.



Use a screed boarder to level the sand inside the frame.

Check for Understanding: framing

1. What is the first step in creating a concrete slab?

2. What materials are needed to build a slab?

3. What if you don't have these materials?

4. What types of boards will you need for a frame?

5. What side of the board should be placed on the ground?

6. How do you know what side of the board goes on the inside of the slab frame?

7. How do you make sure your frame is square?

8. How do you make sure the slab is level?

9. What if you have no hammer or nails to create the frame?

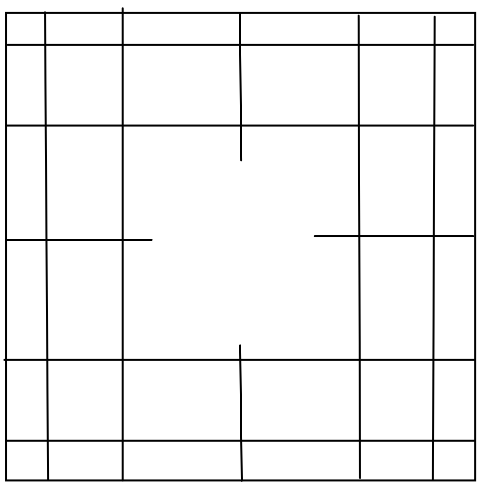
Step 3: Place the Rebar

Rebar creates strength in the slab.

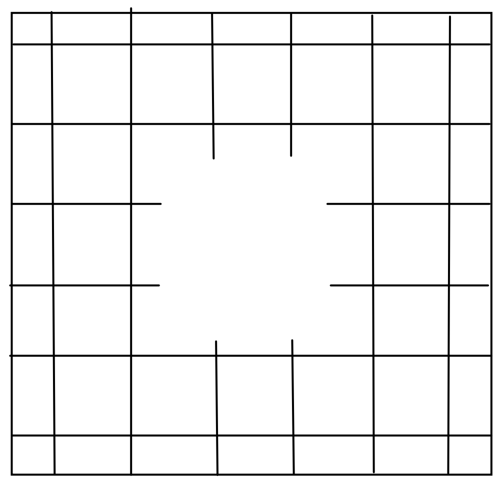
Rebar Size and Spacing[11]*

Slab thickness (mm)	Rebar diameter (mm)	Spacing of rebar (mm)
65- 80	6	150
	8	250

*These calculations are for a slab with the dimensions: 1x1m, 1.25x1.25m. Larger dimensions require a smaller amount of space between rebar, and possibly thicker rebar.



A 1x1m SLAB WITH 6mm DIAMETER REBAR



A 1x1 SLAB WITH 8mm DIAMETER REBAR

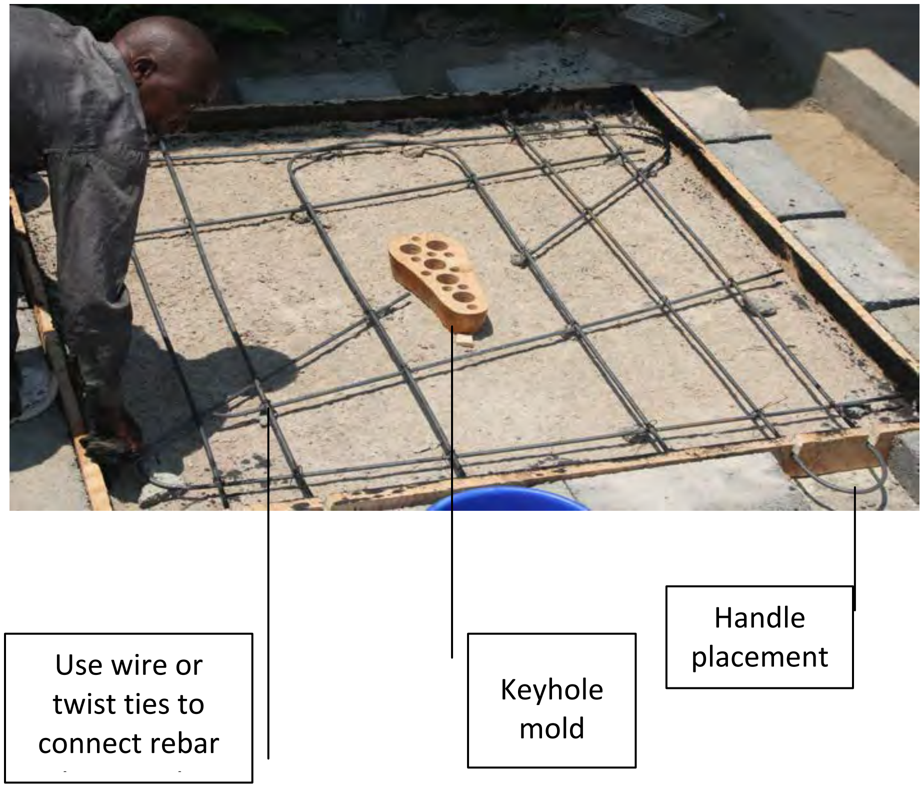
Instructions

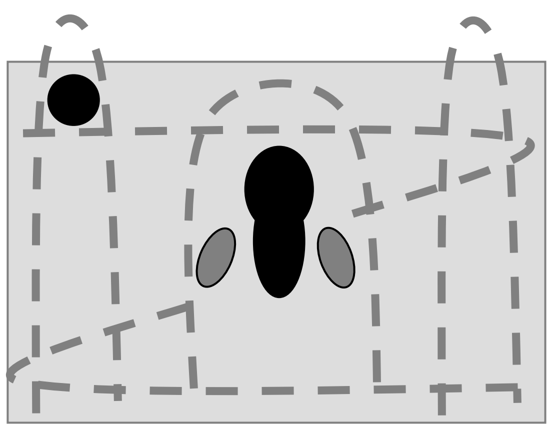
1. Use a hacksaw to cut the reinforcing wires or rebar and create a grid. Tie intersections together with wire. Or bend rebar in the pattern shown in the figure below.

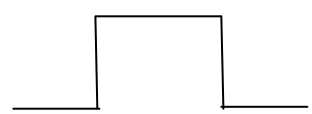
2. Make handles of wire 5- 8 millimeters thick, and tie them to the grid near the edges.

3. Place the rebar grid in the slab frame, and use rocks to support the rebar. Rebar should not sit directly on the sand.

[11] Richard Franceys et al., *A Guide to the Development of On Site Sanitation* (Geneva: WHO, 1992), 99-101.







WIRE HANDLE

Alternative: If a saw is not available, you can bend the rebar to create the figure above. Handles on the sides makes it possible to move the slab by dragging it.

Place Rebar Check for Understanding:

1. What is the importance of rebar?

---

2. Name important areas for the rebar to be placed?

---

3. What should you do if you do not have a hacksaw to cut the rebar?

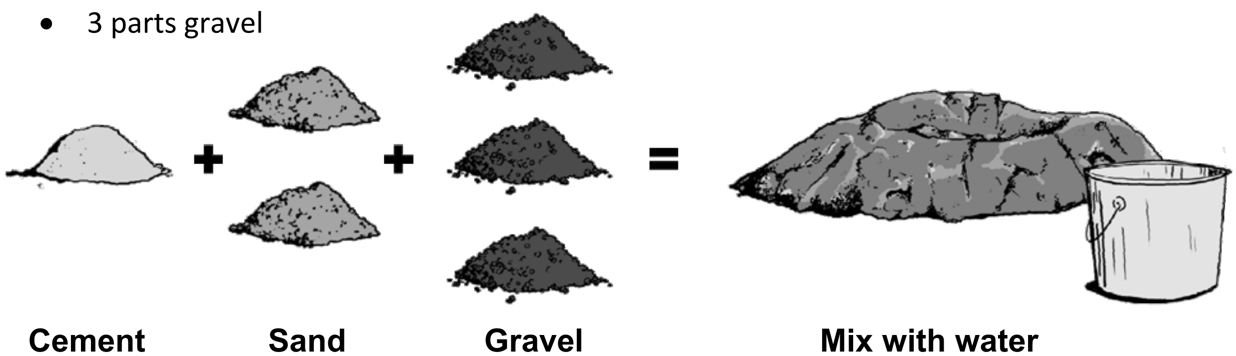
Step 4: Mix Concrete

Concrete is a mixture of cement, sand, gravel and water. A bag of cement should have the recipe for creating concrete. Concrete recipes vary by area. It is important to follow those instructions **exactly**.

Once the mixing process has started move quickly.

Instructions

1. Make sure all elements of your frame, the keyhole and vent pipe are in place before mixing.
2. Make sure the keyhole has been treated with motor oil.
3. Using the consistent unit of measure, or "part", measure out the cement, sand and gravel into one pile. Follow the recipe on the cement bag or the common recipe of:
   - 1 part cement
   - 2 parts sand
   - 3 parts gravel



4. Mix the cement, sand, and gravel together on a clean surface until completely blended.
5. Slowly add water, mixing as you go.
6. Concrete should be the consistency of soft, moist, dough; Not too stiff; Not too runny
7. Concrete needs to be the right consistency. If it's too dry it will cure too quickly and risk cracking. If it is too wet, pockets of water may form, which will also weaken the structure.

Tips:

- The higher the ratio of cement, the stronger the mix
- Accidentally mixing in soluble materials such as dirt or algae will weaken the concrete mixture
- Excess water creates a weak foundation prone to cracking
- Concrete that is too dry may cure to quickly and also be prone to cracking and breaking

- It is also very important to use clean sand and gravel. Even small amounts of dirt, silt, clay or bits of organic matter will weaken the concrete. If mixing concrete on the ground, take care not to mix dirt into the concrete.
- If there are several grades of cement available, always use the best grade. Cheap cement does not hold up to heavy use so it is not a bargain in the long run.

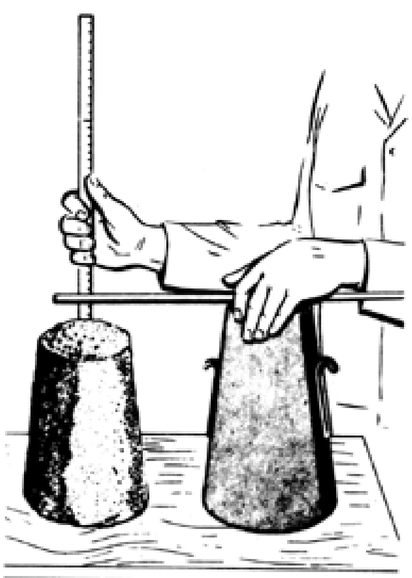
Test the Concrete

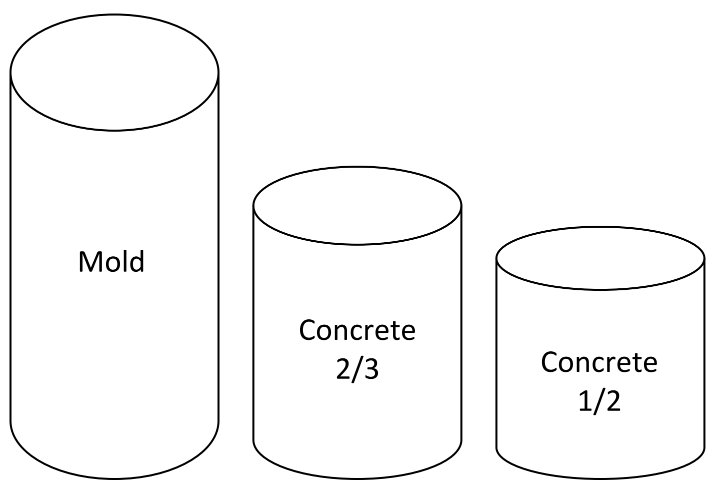
Perform a slump test. A slump test helps to ensure the concrete is of the right consistency.

Instructions

1. Before pouring the slab, place the concrete mixture into a tin can or conical mold.
2. Tip the can completely upside down so the concrete comes out in one cylinder shaped piece.
3. The amount by which the concrete drops below the mold height is measured and this represents the slump.
4. Place the tin can next to the cylinder of concrete and measure how far the concrete has slumped. The height of the concrete should be between 1/2 and 2/3 the height of the can/mold.
    - Any lower, the concrete is to wet and runny
    - Any higher, the concrete is too firm

[12]





[12] Image source: http://www.answers.com/topic/slump-test

Concrete Mixing Check for Understanding:

1. What is the common recipe for concrete?

---

2. What will you do if the concrete is too firm or sticky?

---

3. What will you do if the concrete is too runny?

---

4. What is the danger of mixing concrete on the bare ground?

---

5. What if there isn't enough concrete for the slab?

Step 5: Pour the Concrete[13]

Mixing, transporting, and handling of concrete should be carefully coordinated. Concrete should not be deposited more rapidly than it can be spread, and screeded.

Instructions

1. Pour concrete continuously starting at one edge of the slab and working it through the rest of the slab. Try to avoid pouring in separate piles.

   Tip: Concrete should not be dumped in separate piles and then leveled and worked together; nor should the concrete be deposited in large piles and moved horizontally into final position.

2. Once concrete is distributed throughout the slab, use a wooden float to vibrate the concrete; this will get rid of air bubbles. Concrete should reach the top edge of the slab.

3. Use a wooden board to screed the surface of concrete. Run the edge of the board along the surface in a sawing motion.

4. Use the float to move concrete around the keyhole. This will level the slab and remove excess concrete.

Tips:

- **Pour in a single batch**: Whenever possible, mix and pour the concrete in a single batch.
- If more concrete is required, quickly mix an entirely new batch. Pour the new mixture immediately adjoining the previously poured concrete.
- **Avoid a cold joint**. A cold joint is prone to breakage because it's the edge where 2 different pours occurred. Lightly blend the edges of the 2 pours with a stick, pole, trowel, or rake. Then, use a float or even a piece of flat wood to gently tamp down the concrete. This will merge the 2 pours as well as bring water to the surface.

[13] Source: http://www.cement.org/basics/concretebasics_placing.asp

Pouring the Concrete Check for Understanding

1. Why should concrete be poured in one pile?

2. What is a "cold joint"?

3. Why is it important to agitate or vibrate the concrete?

Step 6: Finish the Concrete

Finishing concrete is more of an art than a science. It must be done by feel.

Instructions

1. Smooth the surface with a wooden float.
2. Use the float to work the gravel/stones into the slab and allow the sand and cement to come to the surface. Apply pressure and vibration to the concrete. This will eliminate air pockets that could reduce the durability of the slab.
3. Using a finger to test the concrete. When the concrete is firm enough to be depressed to 1 cm, use a float to smooth the surface and any rough edges.
4. Use a trowel or edging tool to finish the sides of the slab.
5. Then lightly drag the edge of a metal trowel along the surface in a sweeping motion. This will get rid of any sharp edges or ridges.
6. Set the foot pads (see next section)
7. Repeat steps **1-3**
8. Allow concrete to set for about an hour. Remove the footrest frames.
9. Continue troweling the surface until the concrete shines

A wooden float is used to smooth and tamp down the concrete. Tamping brings the water to the surface, eliminates air bubbles, and creates a stronger slab. The smoother the concrete, the easier it will be to keep clean.

Finishing Concrete Check for Understanding:

1. Why would air pockets in the concrete be a problem?

2. How do you reduce the air pockets?

3. How do you finish the concrete? What tools do you use?

4. How do you know it is finished?

5. How do you create smooth, safe slab edges?

Set the Foot Pads

The foot pads help the user align themselves with the hole so users have better aim in hitting the keyhole.

Foot pads are added after the floating the concrete for the first time. The concrete beneath will be slightly firm but not yet set.

Instructions

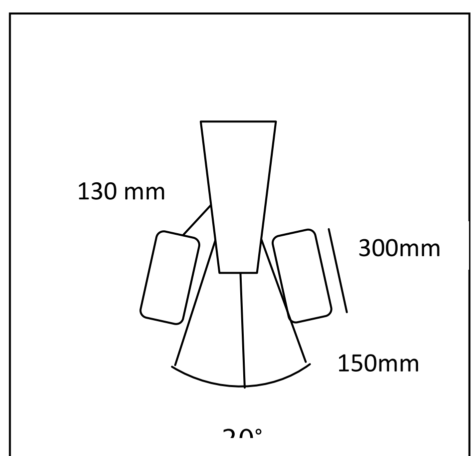
1. Align the foot pad molds with the keyhole.
2. Trace and scratch the surface below the area where the foot pads will be set.
3. Gently place the concrete into the foot pad molds

.

Set the foot pads. Align in front of the key hole.

The Goal: A clean keyhole!

To align footrests, use a wooden guide to determine where the footrests should be, or measure using this figure.[14]



[14] Richard Franceys et al., *A Guide to the Development of On Site Sanitation* (Geneva: WHO, 1992), 109-110.

Setting the Footpads Check for Understanding:

1. Where do you place the footrests?

2. What is the purpose of the footrest?

Finish the Keyhole

A clean, smooth keyhole is an essential component of a clean, safe latrine. A sharp keyhole is a hazard to the user. It may cut the user's foot and result in disease, possibly even death.

Instructions

1. Before the concrete is set, gently tap the keyhole mold with a hammer to reduce air bubbles
2. When the concrete is firm to the touch, remove the keyhole mold
3. Dampen a plastic bag with water. Gently smooth the edges of the keyhole. Push in any sharp or protruding rocks.
4. Lift a small amount of sand at the bottom of the keyhole and lightly smooth those edges of the keyhole.
5. Repeat this process until the keyhole is smooth and free of sharp edges

Remove the air holes from around the keyhole by gently tapping with a hammer. Air holes create rough edges.

Finishing the Keyhole Check for Understanding:

1. How do you make a smooth keyhole?

___

2. What is an easy way to smooth the keyhole once you've removed the mold?

___

Step 7: Cure the Concrete

If the concrete dries too fast, it may crack. Properly cured concrete ensures strength and durability.

Instructions

1. Sprinkle the slab lightly with water
2. Create a tent over the slab by crossing a few boards and draping with plastic, straw or cloth.
3. For the first 8 hours, do not allow the plastic to touch the concrete.
4. Once the surface has become firm, sprinkle lightly with water and place the plastic directly on the surface. Do not allow the slab to dry completely between moistening.
5. Keep moist for at least 7 days.

Tips

- It takes time and water for concrete to cure. It should be kept covered with plastic, or cloth and sprinkled with water once a day for seven days. After a week concrete has gained most of its strength but it takes about a month to cure to full strength.
- Cement will harden and lose strength if it has been stored for too long, especially in humid weather or if the bag has been previously opened. <u>Do not</u> use old cement that has formed hard chunks.
- Depending on the environment, it may take 28 days for the concrete to fully cure; however the slab can be moved before then.

Lightly sprinkle the concrete with water. Suspend a few boards over the slab and then drape with plastic until the concrete is firm.

Curing the Concrete Check for Understanding:

1. Once poured, how do you keep concrete from drying too fast?

SanPlat Construction

A SanPlat is an unreinforced concrete slab. It was created as an alternative for people who cannot afford full-scale concrete slabs. SanPlats are made to be placed on top of a wooden slab. They are easier to clean than wooden slabs and therefore help maintain a sanitary latrine.

Please review "Constructing a Concrete Slab" before constructing a SanPlat.

Step 1: Prepare Area and Work Materials

Concrete Slab Construction Materials Checklist
***For 1 SanPlat with the dimensions: 60x60x6cm**

Materials	Size		Quantity	Do I have this?
	Metric	US		
General Materials				
Measuring tape			1	
Gloves	varies on number of participants and facilitators			
shovels	varies on number of participants and facilitators		2 at least	
Step 2: Frame				
Wood for frame (wood should be 2.5cm X 10cm, or 5cm X 10cm) (1 X 4in or 2 X 4in)	60cm	2ft	2	
Wood for frame	100 cm	3.3ft	2	
Wood for squaring	100cm	3.3ft	1	
Wood for screeding	50 or 55cm	3.1 or 3.2ft	1	
Nails or Screws	depends on thickness of wood		12	
Motor oil or wax for coating frame and keyhole				
Sand for leveling				
Water for wetting sand				
Alternative framing option: Brick	10 cm x 20 cm	4 in x 8 in	20-24	
Step 3: Mix Concrete				
wheelbarrow (if available)	For mixing concrete		1	
buckets or other measurement for concrete			2- 4	
Cement	50 kilogram sack	110 lbs	1 bag	

			(use about 0.6 of a bag)	
Sand	50 kilogram sack	110 lbs	1 bag (use about 1.2 of a bag)	
Aggregate	50 kilogram sack	110 lbs	2 bags (use about1.8 of a bag)	
water	Enough to mix the concrete to the appropriate consistency			
keyhole mold (approximately)			1	
Tin can or small container with flat, open bottom for testing concrete			1	
Step 4: Pour Concrete				
Wooden Floats			2 to 3	
Step 5: Finish Concrete				
Metal Trowels			2	
Hammer			1	
Plastic bag			1	
foot rest molds			1	
Step 6: Cure Concrete				
Plastic sheets or cement bags	enough to cover base and top of slab			

Slab Dimensions (in centimeters)			**Quantity (from 50kg sack)**		
length	width	height	cement	sand	aggregate
(cm)	(cm)	(cm)	50 kg sacks	sacks	sacks
60	60	6	0.2	0.4	0.6
100	100	6	0.6	1.2	1.8
110	110	6	0.8	1.6	2.4
100	100	8	0.8	1.6	2.4
110	110	8	1.0	2.0	3.0
120	120	8	1.2	2.3	3.5
125	125	8	1.3	2.5	3.8
130	130	8	1.4	2.8	4.1
140	140	8	1.6	3.2	4.8
150	150	8	1.8	3.7	5.5

Tips:

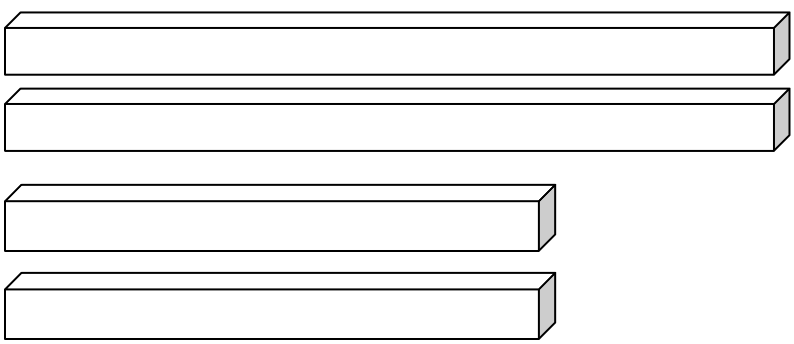
- Concrete will adhere to wood. If using wooden molds, you may want to soak the molds in water or motor oil to ensure easy removal. Plastic can also be used; however it will leave permanent marks in the cement which may create hard to clean spaces.
- A keyhole mold that is thicker than the slab can make removal easier.
- A keyhole cover will help prevent flies from entering the pit. It can be made of wood and have a handle, or can be made to be moved by a person's foot, to avoid getting germs on the hands.

Step 2: Construct a Wooden Frame

1. Make up the frame out of wooden boards with the dimensions described in the materials list. The wood should be straight and smooth.

   Tip: the frame in this example DOES NOT have to be made up in the same place where the slab will be poured. It can be constructed anywhere on even ground and carried in place later.

2. Cut two pieces of wood exactly the length of the dimension of the slab. Cut another two pieces of wood longer than the dimensions.



3. Place the flattest edge of the board on the ground, with the smoothest side of the board towards the inside.

4. Nail the four pieces together, with the short pieces on the inside. Check to make sure the inside dimensions of the frame are the desired dimensions of the slab.

5. Ensure that the formwork frame is square by measuring the diagonals. The frame is square when the distance between the opposing diagonals are equal.

6. If needed, nail a piece of lumber on top of the formwork frame from corner to corner, to make sure the formwork frame remains square until pegged in place.

7. Using a shovel, pile dirt or lay rocks against the outside of your form.

8. Level the frame using sand and a screed.

9. Set the keyhole in the center of the slab, with the largest part slightly farther back.

Tips:

- Use clean wood. Do not use scrap wood to frame a slab. Old or rotten wood can break under pressure and cause what is known as a "blow-out" meaning your concrete has broken through the form.
- For a smooth key hole and frame;
- Soak the boards and keyhole in water. This will cause the wood to expand. As the wood dries, it will more easily/cleanly pull away from the concrete.
- Paint the frame and keyhole with used motor oil. Again, this will cause the wood to more cleanly pull away from the concrete
- You can brace your frame with rocks or bricks to help prevent it from moving in a concrete pour.

Step 3: Mix the Concrete

1. Make a concrete mix of 1 part cement, 2 parts sand, 3 parts gravel, and water. (For mixing instructions see Step four in "Constructing a Concrete Slab")

2. Test the concrete.

Step 4: Pour the Concrete

1. Pour the concrete into the frame. Use a trowel to apply pressure and vibration to the concrete. This will eliminate air pockets that could reduce the durability of the slab.

2. Once concrete is distributed throughout the slab, use a wooden float to vibrate the concrete; this will get rid of air bubbles

3. Use a wooden board to screed the surface of concrete. Run the edge of the board along the surface in a sawing motion.

4. Use the float to move concrete around the keyhole. This will level the slab and remove excess concrete.

Step 5: Finish the Concrete

1. Smooth the surface with a wooden float.
2. Use the float to work the gravel/stones into the slab and allow the sand and cement to come to the surface. Apply pressure and vibration to the concrete. This will eliminate air pockets that could reduce the durability of the slab.
3. Using a finger to test the concrete. When the concrete is firm enough to be depressed to 1 cm, use a float smooth the surface and knock down any rough edges.
4. Then lightly drag the edge of a metal trowel along the surface in a sweeping motion. This will get rid of any sharp edges or ridges.
5. Set the foot pads (see next section)
6. Repeat steps **1-3**
7. Allow concrete to set for about an hour. Remove the footrest frames.
8. Continue troweling the surface until the concrete shines

Finish the Keyhole

1. Before they concrete is set, gently tap the keyhole mold with a hammer to reduce air bubbles
2. When the concrete is firm to the touch, remove the keyhole mold
3. Dampen a plastic bag with water.
4. Gently smooth the edges of the keyhole. Push in any sharp or protruding rocks.
5. Lift a small amount of sand at the bottom of the keyhole and lightly smooth those edges of the keyhole.
6. Repeat this process until the keyhole is smooth and free of sharp edges

Set the Foot Pads

1. Align the foot pad molds with the keyhole.
2. Trace and scratch the surface below the area where the foot pads will be set.
3. Gently place the concrete into the foot pad molds

Step 6: Cure the Concrete

1. Cover the concrete with wet cement sacks, wet cloth, or a plastic sheet and leave it overnight. Wet it several times a day to keep it damp for 7 days. Keeping it wet allows the concrete to dry slowly so that it reaches its maximum strength.

SanPlat Construction Check for Understanding

1. What are the differences between a concrete slab and a SanPlat?

2. How are SanPlat normally used?

Domed Slab Construction

Slabs without reinforcement can be made provided the slab is domed. The dome shape causes all the forces in the slab (apart from the rim) to be compressed so reinforcement is not needed. Although not essential, a couple of rounds of steel wire can be embedded in the concrete close to the rim, as this is the only part of the slab under tension. Domed slabs are cheaper than reinforced slabs but more care is required in their manufacture and transport. Such slabs have a typical diameter of 1.2-1.5 meters.[15]

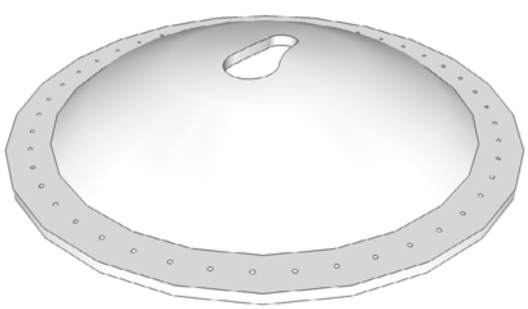
Before beginning this next section, **review the directions for mixing and pouring concrete from Constructing a Concrete Slab.** Most of the same construction principles will apply.

Step 1: Prepare Area and Work Materials

Concrete Slab Construction Materials Checklist ***for a 1m x 1m x 6cm or 3.3ft x 3.3ft x 2.4in Concrete Slab**				
Materials	**Size**		**Quantity**	**Do I have this?**
	Metric	**US**		
General Materials				
measuring tape			1	
gloves	varies on number of participants and facilitators			
shovels	varies on number of participants and facilitators		2 at least	
Step 2: Frame				
Bricks or blocks	4.5cm thick	1.8in thick	Enough to line the outside of the slab frame	
Metal girdle for framing slab	4 to 4.5cm thick, should make a diameter of 150cm	1.6 to 1.8in thick, should make a diameter of about 60in	1	
Sand and concrete screed	See instructions at end of the Domed slab instructions			
Sand for leveling				
Water for wetting sand				
Motor oil or wax for coating frame and keyhole				

[15] Björn Brandberg, *Latrine Building: A Handbook for Implementation of the SanPlat System* (London: ITDG Publishing, 1997), 61-66.

Step 3: Mix Concrete				
wheelbarrow (if available)	For mixing concrete		1	
buckets or other measurement for concrete			2- 4	
Cement	50 kilogram sack	110 lbs	1 bag	
Sand	50 kilogram sack	110 lbs	2 bags	
Aggregate	50 kilogram sack	110 lbs	2 to 3 bags	
water	Enough to mix the concrete to the appropriate consistency			
keyhole mold			1	
Tin can or small container with flat, open bottom for testing concrete			1	
Vent Pipe (optional)	Diameter of at least 150mm, height depends on structure height, the vent pipe should be .5 meters above the tallest point of the structure		1	
Step 4: Pour Concrete				
Wooden Floats			2 to 3	
Step 5: Finish Concrete				
Metal Trowels			2	
Hammer			1	
Plastic bag			1	
foot rest molds			1	
Step 6: Cure Concrete				
Plastic sheets or cement bags	enough to cover base and top of slab			

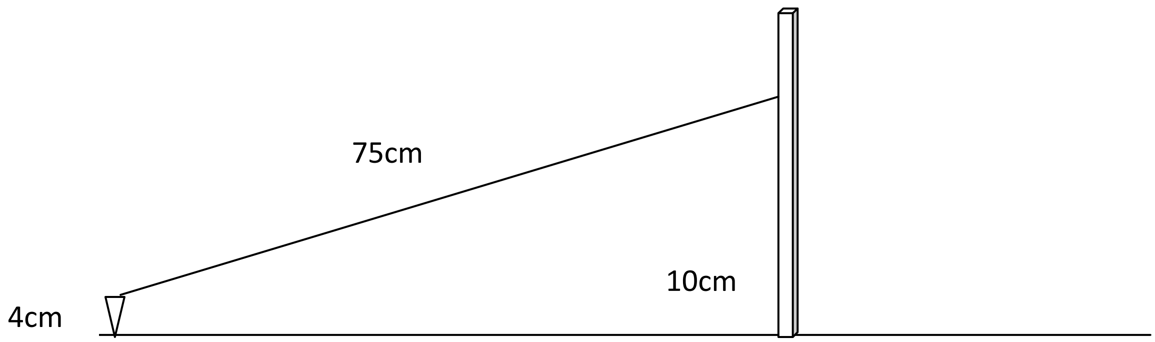


The integrity of the dome is found in its arched shape

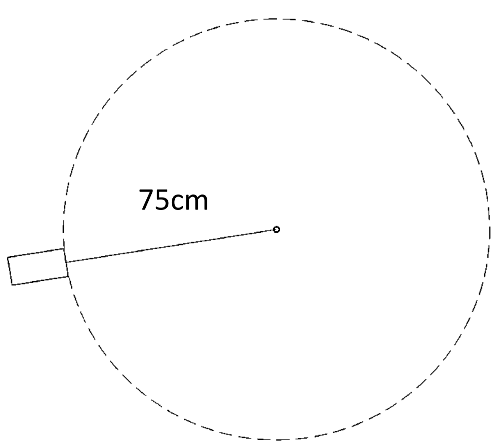
Step 2: Construct a Frame

1. Create a flat workspace. Lay sand down; put a long board on its edge and place a level on the top edge. Screed the sand using the board and level; this will give you a flat, level area to work with. Continue leveling a space large enough to accommodate the sand, forms, and the support blocks.
2. Make a circle. Once the leveled area is prepared, drive a steel take in the center of the prepared area. The distance between the ground and the top of the stake should be at least 15 cm.[16]

3. Mark the 10cm point on the stake, the distance from the ground to the mark should be 10cm. Tie a piece of twine or string to the 10cm mark. Measure the twine 75cm out from the stake to the ground.



4. At the end of the twine, set a nail 4cm from the ground to the screed. Tie the end of the twine to a nail, and drag the nail around the stake. This will create a perfect circle with a diameter of 150cm.



A compass can be improvised from a stake, twine, and a nail.

[16] Richard Franceys et. al., *A Guide to the Development of On Site Sanitation* (Geneva: WHO, 1992), 97.

5. Set concrete blocks or bricks around the outside of the circle, about 30mm from the line. Use the twine to measure from several different sides of the circle.

Tip: Using bricks that are about 4.5cm thick will allow the nail to ride on top of the edge and make the sand depth equal around the circumference.

6. When all blocks are in place, wrap the sheet metal forms against the block

Alternative: If no cinder blocks are available a packed sand dam may be formed into a backer to the sheet metal form.

Blocks Create a Frame for the Form

Place Metal Form Inside Brick Frame

Screeding the Sand

1. Once the blocks are set, and the metal frame is laid, fill the form with sand
2. Pour water onto the sand, until the sand is hard packed.
3. Place one end of a wooden screed at 10cm on the stake, the opposite end of the screed should be at the bottom of the metal frame. Turn the screed round the circle several times.
4. Continue adding sand and water, until the sand is of the desired height, 10cm. The sand dome should be hard enough to resist an impression
5. Having the sand dome formed, move the screed compass up 4 cm on the stake and move the set nail at the end down 4 cm.

Use the sand screed to shape
the sand into a dome.

Step 3: Mix Concrete

Pouring the Concrete

1. With duct tape, mark the stake 4cm above the sand, and mark the metal frame 4cm above the sand. This will help ensure that the final slab will be 4 m (approx. 2 inches) thick.
2. Review the step four in "Constructing a Concrete Slab". Follow those instructions exactly.

   Tip: If using fibers, place them in the dry mix and combine the dry content by turning over shovel full's at a time until all ingredients are fully mixed.

Step 4: Pour the Concrete

1. Pour the concrete into the domed frame. Be sure to leave room for the keyhole.
2. Rest the screed at the 4cm mark on the stake and the opposite end at the 4cm mark on the frame.
3. Screed the concrete until the top is a uniform depth and shape.

4. Once concrete is distributed throughout the slab, use a wooden float to vibrate the concrete; this will get rid of air bubbles.

5. Screed the surface of concrete again.

6. Use the float to move concrete around the keyhole. This will level the slab and remove excess concrete.

Shredding Fibers for the Dome

Use the concrete screed to
Contour the concrete to the form.

Step 5: Finish the Concrete

1. Move the screed around the circle several times while working all the air out of the cement.
2. When the dome is screeded smooth remove the screed compass, and place the prepared keyhole mold.

3. Place cement against the keyhole mold and using a float trowel work the air out from around the mold
4. If handles are to be installed place them in the soft cement mix and work the mix securely around the handle bases.
5. Use a margin trowel, move the cement away from the outer form.
   Alternative: A piece of thin sheet metal edge will work if a margin trowel is not available. This will make edging easier.
6. Place the foot pad molds on the dome above the keyhole. Follow instructions found in the "Concrete Slab Instructions".
7. Wait until the cement will take a fingerprint impression but no allow the finger to depress the cement.
8. Remove the blocks and the metal forms.
9. Use the float and trowel to smooth out the edge and fill any holes.
10. Remove the keyhole and foot molds.
11. Shine the surface of the dome with a float to bring the moisture to the surface and the trowel to smooth the surface. After another 15 to 20 minutes repeat the shining process.

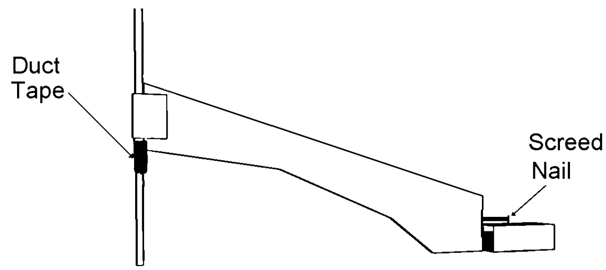
Shine the concrete

Step 7: Cure the Concrete

1. Cover the concrete with wet cement sacks, wet cloth, or a plastic sheet and leave it overnight. Wet it several times a day to keep it damp for 7 days. Keeping it wet allows the concrete to dry slowly so that it reaches its maximum strength.

Create a Sand Screed Compass

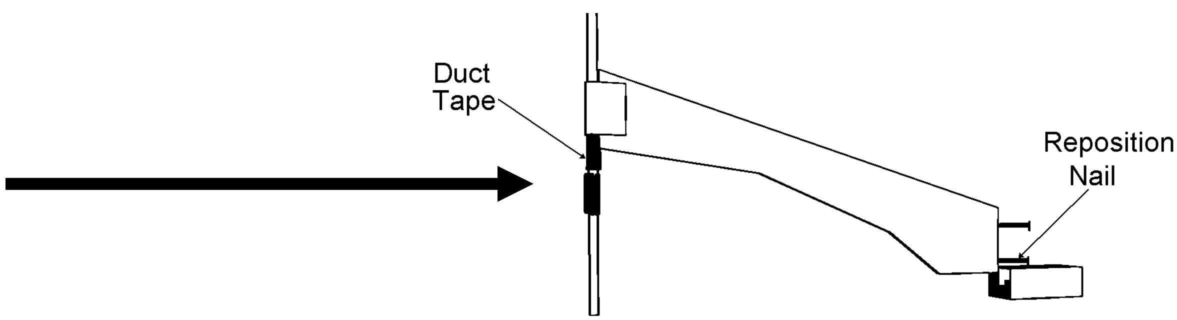
- To ensure a consistent dome height, create a screen compass
- This will require a stake (piece of rebar), board, tin, duct tape, and a small nail or brad (see diagram)



Build a sand screed using rebar, duct tape, tin, and a small nail or brad

Create a Concrete Screed Compass

- The concrete screed compass is used to contour the concrete to the sand form. The original sand screed above is modified by raising the pivot point of the compass approximately 4 cm. This is done by removing the duct tape and raising the board or metal and reaping into place.



Create a Concrete Screed by raising the pivot point 4 cm.

Concrete Ring Beam Construction

A ring beam is a square or circular piece of concrete with an open center. It is set onto the top of a pit to support the slab and shelter, and to keep the pit walls from collapsing. Ring beams can also be placed at the bottom of a pit to create stability and a level foundation for the lining. The ring beam described here can be used along with the concrete slab for all pit toilets. Adjust the size of the ring beam according to the width of the pit and slab.

Please review "Constructing a Concrete Slab" before constructing a ring beam. Many of the instructions are the same.

Step 1: Prepare Area and Work Materials

Concrete Ring Beam Construction Materials Checklist ***for a 1m x 1m x 6cm or 3.3ft x 3.3ft x 2.4in Concrete Slab**				
Materials	**Size**		**Quantity**	**Do I have this?**
	Metric	**US**		
General Materials				
measuring tape			1	
gloves	varies on number of participants and facilitators			
shovels	varies on number of participants and facilitators		2 at least	
Step 2: Frame				
Wood for frame (wood should be 2.5cm X 10cm, or 5cm X 10cm) (1 X 4in or 2 X 4in)	110cm	3.6ft	2	
Wood for frame	150cm	4.3ft	2	
Wood for frame	80 cm	2.6ft	4	
Wood for squaring	150cm	4.3ft	1	
Wood for screeding	15cm	5.9in	1	
Nails or Screws	depends on thickness of wood		16-20	
Motor oil or wax for coating frame and keyhole				
Sand for leveling				
Water for wetting sand				
Alternative framing option: Brick				
Step 3: Place Rebar				
Rebar 6mm diameter	90cm	3 ft	8- 10	

(3/8 in)				
wire to tie rebar or twist ties	about 2.5 m	about 96 in	1	
handle wire	400mm long and 8-10mm thick	15.75in long and .31 in thick	4	
hacksaw			1	
Small rocks to set rebar on	Varies on slab size. The rebar should rest on the rocks and not the sand			
Step 4: Mix Concrete				
Wheelbarrow (if available)	For mixing concrete		1	
Buckets or other measurement for concrete			2- 4	
Cement	50 kilogram sack	110 lbs	1 bag (use about 0.6 of a bag)	
Sand	50 kilogram sack	110 lbs	2 bags (use about 1.2 of a bag)	
Aggregate	50 kilogram sack	110 lbs	2 to 3 bags (use about1.8 of a bag)	
water	Enough to mix the concrete to the appropriate consistency			
Tin can or small container with flat, open bottom for testing concrete			1	
Step 5: Pour Concrete				
Wooden Floats			2 to 3	
Step 6: Finish Concrete				
Metal Trowels			2	
Hammer			1	
Plastic bag			1	
Step 7: Cure Concrete				
Plastic sheets or cement bags	enough to cover base and top of slab			

Tips:

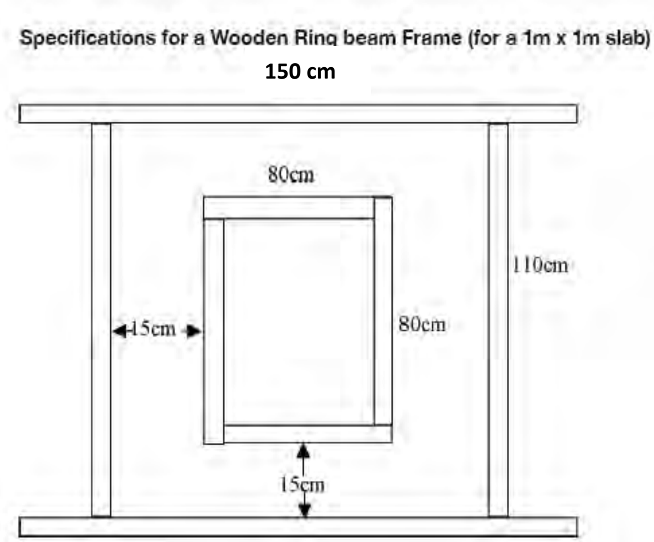
- Concrete will adhere to wood. If using wooden molds, you may want to soak the molds in water or motor oil to ensure easy removal. Plastic can also be used; however it will leave permanent marks in the cement which may create hard to clean spaces.

Instructions

1. Clear the work area of grass and other debris. Make the ground as level as possible.

Step 2: Construct a Wooden Frame

1. Make a mold of bricks, wooden boards, or both. For a slab that is 100 centimeters (1m) by 100 centimeters, the ring beam will be 110 centimeters by 110 on the outside, and 80 centimeters by 80 centimeters on the inside. The total thickness of the slab should be **6 centimeters** (or 8 if desired)
2. The inside frame can be made by following the figure to the right.
3. Square the frame and, if needed, nail a board to the top to keep the frame square.
4. Pile dirt or rocks around the outside of the frame.
5. Level the frame using sand and a screed.



Step 3: Place the Rebar

1. Bend four pieces of rebar so that they create a frame inside the ring beam, make sure the corners overlap each other. Tie together at the overlap. Make two of these, one for the outside rim and one for the inside.

If desired, make handles of wire 8 to 10 millimeters thick, and set them in the concrete between the corners and the center. The handles edges of the handles should be able to wrap around the rebar to insure that they do not pull out. Make sure the handles are not too close to the center of the beam. A concrete slab should be able to fit on top of a ring beam.

2. Place the rebar in the slab frame, and use rocks to support the rebar. Rebar should not sit directly on the sand.

Step 4: Mix Concrete

3. Make a concrete mix of 1 part cement, 2 parts sand, 3 parts gravel, and water. (For mixing instructions see Step four in "Constructing a Concrete Slab")

4. Test the concrete

Step 5: Pour the Concrete

1. Pour the concrete into the mold in and around the rebar.
2. Use a trowel to apply pressure and vibration to the concrete. This will eliminate air pockets that could reduce the durability of the slab.

3. Use a wooden board to screed the surface of concrete. Run the edge of the board along the surface in a sawing motion.

Step 6: Finish the Concrete

1. Smooth the slab with a wooden float. Be sure to smooth the edges of the keyhole and slab. The total thickness of the slab should be 6 centimeters (or, if desired, 8cm).

2. Once the concrete is firm to touch, remove the inner frame and smooth the edges with a wet plastic bag.

Step 7: Cure the Concrete

2. Cover the concrete with wet cement sacks, wet cloth, or a plastic sheet and leave it overnight. Wet it several times a day to keep it damp for 7 days. Keeping it wet allows the concrete to dry slowly so that it reaches its maximum strength.

3. When the ring beam is done curing, carry it to the site of the latrine. Level the ground, dig the appropriate sized pit and place the ring beam over it. Pack soil around the outside of the ring beam to set it in place.

Ring Beam Check for Understanding

1. What can ring beams be used for?

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2. What other materials could be used as a ring beam?

---

3. How does rebar fit into the ring beam?

---

4. Put these components in the proper order: ring beam, slab, pit.

Mud and Wood Slab Construction[17]

Wooden slabs are an affordable alternative to concrete slabs. Mud can be added to the top to create a flat floor; a SanPlat can be added as well as mud to create a floor that is easier to clean.

Step 1: Prepare Area and Work Materials

Wooden Slab Construction Materials Checklist
***for a 1m x 1m x 6cm or 3.3ft x 3.3ft x 2.4in Concrete Slab**

Materials	Size		Quantity	Do I have this?
	Metric	US		
General Materials				
Measuring tape			1	
gloves	varies on number of participants and facilitators			
Saw			1 or 2	
Hammers			1 or 2	
Step 2: Measure and Cut Wood				
Wood for slab	100 cm (1m) length	3.3 ft length	varies with width of wood	
Wood for keyhole (keyhole dimension are 350mm X 180mm)	325mm length	12.8in length	1-2, varies with width of wood	
Wood for lateral support	100cm (1m) length	3.3 ft length		
Step 3: Treat Wood				
Wood treatment- used motor oil, paint				
Brushes for painting				
Mud or soil from termite mound				
Step 4: Construct Slab				
Nails or Screws	varies with thickness of wood		As many needed to securely construct slab	

[17] Richard Franceys et al., *A Guide to the Development of On Site Sanitation* (Geneva: WHO, 1992), 107-108.

Tips:

- A soil and cement mixture can provide a hard, sanitary surface while helping to preserve the slab.
- Soil from termite mounds can provide a hard, practically waterproof surface for the slab.

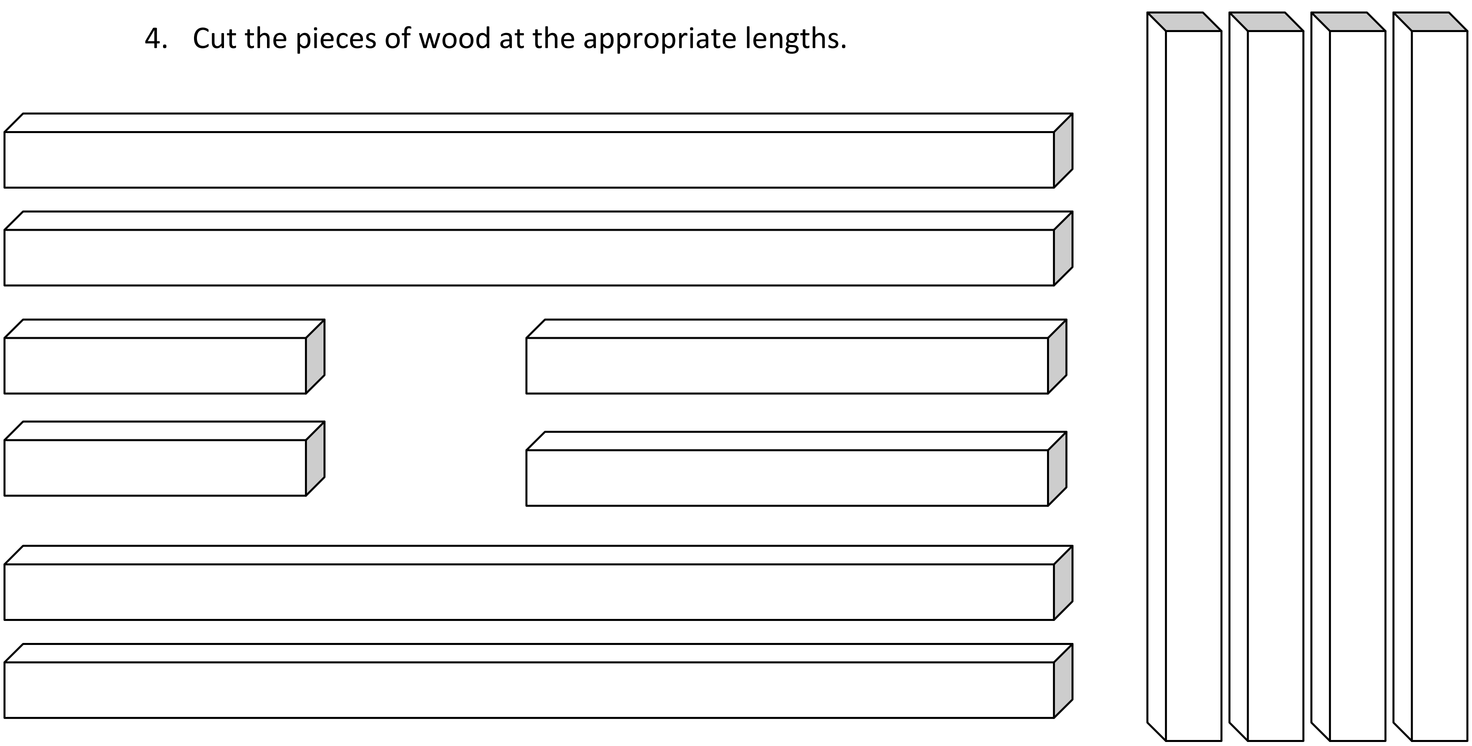
Step 2: Measure and Cut Wood

1. Measure pieces of wood to fit over the pit, with an over hang of 20 cm on each side. You can use the same dimensions as the concrete slab (usually about 1 meter by 1 meter). Wood can be round or flat, although flat is probably easier to clean. Make sure the type of wood is strong and durable.

2. Create a hole by measuring two pieces of wood ¼ of the size of the others, and another two pieces of wood half the size of the others. Place them in between the other pieces of wood.

3. Measure four or more pieces of wood for the lateral support. They should be at least as long as the slab is wide

4. Cut the pieces of wood at the appropriate lengths.



Step 3: Treat the Wood

1. Treat wood for termites by painting with used motor oil, or house paint.

Tip: Spreading ash or lime around the base of the pit before placing the wooden slab down can be effective as well. You could also cover the slab in plastic if available.

2. Allow the paint or oil to dry.

Step 4: Construct Slab

1. Lay pieces of wood, approximately a meter long, parallel to each other. This will create the top of the slab. The dimensions of the slab should be 1m x 1m, but it can be adjusted according to the pit size.

2. The smaller pieces of wood should be placed in the middle of the slab to create a defecation hole.

3. Place the four lateral supports horizontally across the slab, two on each side of the hole. Nail firmly to the top of the slab.

Step 5: Create Mud Floor

1. Mix mud and grass or straw and spread on slab to create a thick, flat layer. This helps with cleaning and stability while using.

2. Allow the mud to dry and become hard before moving over the pit.

Tip: Wood slabs must be checked often for termite damage and rotting. It is estimated that a wood slab may last a family for a year before replacing.

Mud and Wood Slab Check for Understanding

1. What can be done to the wood to help it resist termites?

---

2. How long does a wooden slab usually last?

---

3. What can be added to a wooden slab to make it easier to clean?

Pit Lining Instructions[18]

Pit Lining Materials Checklist *for a 1m x 1m x 6cm or 3.3ft x 3.3ft x 2.4in Concrete Slab				
Materials	**Size**		**Quantity**	**Do I have this?**
	Metric	**US**		
General Materials				
Measuring tape			1	
Gloves	varies on number of participants and facilitators			
Shovels	varies on number of participants and facilitators		2 at least	
Level			1	
Dug pit, partially lined	For a slab that is 1m X 1m, the pit should be 80cm			
Mortar (depending on lining material used)				
Lining material of choice				
Trowels			2 or 3	

Caution!

! If the pit is deeper than 1.5 meters, support the walls while digging to prevent a cave-in.

! **Do not** hand-dig a pit deeper than 3.5 meters.

[18] Richard Franceys et al., *A Guide to the Development of On Site Sanitation* (Geneva: WHO, 1992), 87-92.

Soil

- **Before** constructing, determine what type of soil exists in the planned location by digging down 1 meter. If needed, refer to “Soils and Drainage” lesson to identify soils.
- Do not dig pits in sandy soil. Try to avoid digging pits in clay as liquid will not filter out of the pit and the pit will fill at a faster rate.

Groundwater

- Follow the guidelines in the table below for an appropriate soil filter. If this is not possible, a new location or latrine design may be required.

How Much Soil Filter?

- 2 meters of fine sand, silt, or clay between bottom of pit and water table (figure 2)
= 2m soil filter
(Soils that stick together when moist are fine sand, silt or clay.)

- 10 meters of medium sand between the bottom of pit and water table (Figure 3)
= 10m soil filter
(Medium sands don’t stick together when wet but are still no larger than 0.5 mm in size.)

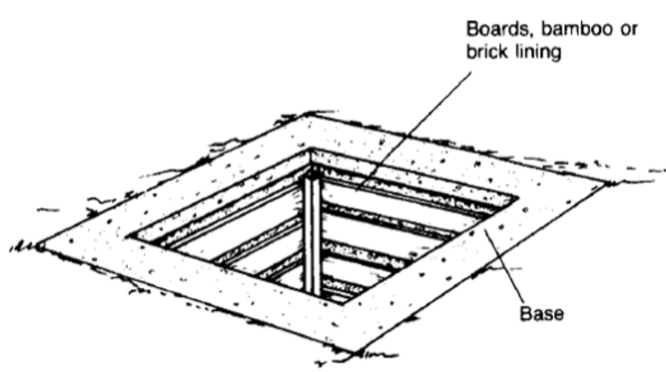
- Latrine with coarse sand, gravel, and fractured rock between the bottom of pit and the water table (Figure 4)
= soil filter will not reduce contamination risk
(Coarse sands, the smallest particle of this group, are 1 mm and larger in size.)
Note: 1 mm is the thickness of a human fingernail.

Locating

- All pits should be dug **at least 15 meters** from all water sources, preferably downhill.
- All pits should be dug **at least 6 meters** from buildings and **no more than 30 meters** from the building the latrine will serve.

Optional:

A concrete, brick, or wood ring beam can be constructed to frame the top of the pit. Instructions can be found in the Concrete Beam Instructions, but alterations may need to be made.

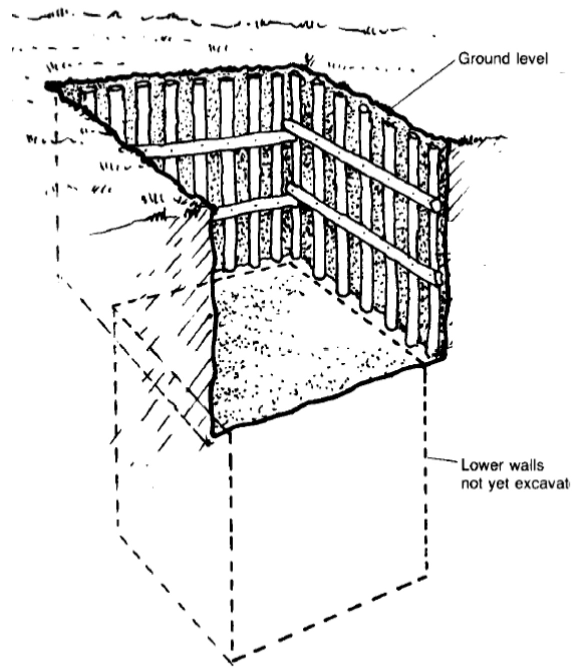


Brick, Stone or Block

- Mortar
- Concrete (for optional ring beam, see Concrete Ring Beam for instructions)
- Trowel
- Gloves
- Shovel
- Level

Partially lined pit

A pit can be lined partially when the soil is very sturdy (not sandy), or the consistency of clay.



1. Review pit design created during the Latrine Design Project or see Pit Design section in the Appendix.

[19]Note that the lining area will need to be wider than the pit in order for the pit to maintain the desired capacity.

2. The pit must be smaller in diameter than the slab by 100mm.
3. Dig .5 meter down, the partial depth of the pit.
4. Line the borders of the pit with brick.
5. Mix mortar using instructions found at the end of the Pit Lining section)
6. Use mortar to join the bricks together, use a level to make sure the bricks are even with each other.
7. Line to the top of the pit, the lining should go a little above the pit.
8. Allow mortar to dry.
9. If there is space between the lining and the surrounding ground, fill it in with clay or mortar.
10. Dig the rest of the pit within the lining.

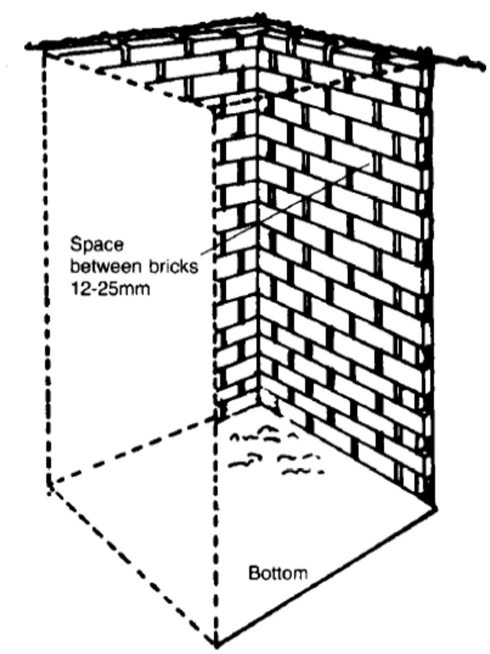
[19] *Water for the World: Constructing Pits for Privies, Technical Note No. SAN 1.C.2* (USA: National Demonstration Water Project, Institute for Rural Water and National Environmental Health Association, 1982), 8.

Fully Lined Pit

1. Review pit design created during the Latrine Design Project or see Pit Design section
2. Dig the entire depth of the pit.
3. Level the bottom and clear away loose dirt and rocks.
4. Line the border of the pit with bricks.
5. Mortar every other joint to allow for seepage holes, joints in the top .5 meter should be completely sealed with mortar.
6. Allow mortar to dry completely before backfilling with sand. The top .5 should be backfilled with clay or mortar.

NOTE: When you begin lining, if the soil seems soft or unstable, a ring beam can be made and placed at the bottom of the pit to create a solid foundation for the lining.

[20]



Workers lining a pit with bricks in Kenya.

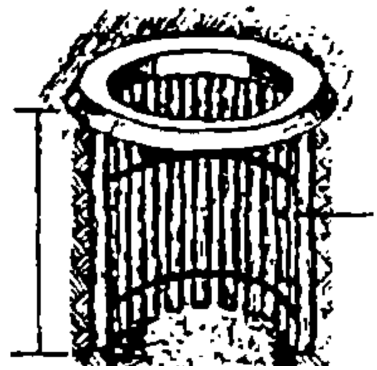
[20] *Water for the World: Constructing Pits for Privies, Technical Note No. SAN 1.C.2* (USA: National Demonstration Water Project, Institute for Rural Water and National Environmental Health Association, 1982) 3.

Wood

This lining material is not usually recommended due to the fact that most wood is subject to rot or termite attack. However, when treated with tar, used motor oil or other preservatives, hard woods can provide sufficient support for shallow or partially lined pits.

Circular Pits[21]:

For circular pits, logs can be vertically aligned along the sides of the pit and connected with metal supports as seen below. A concrete ring beam would help create stability at the top of the pit.



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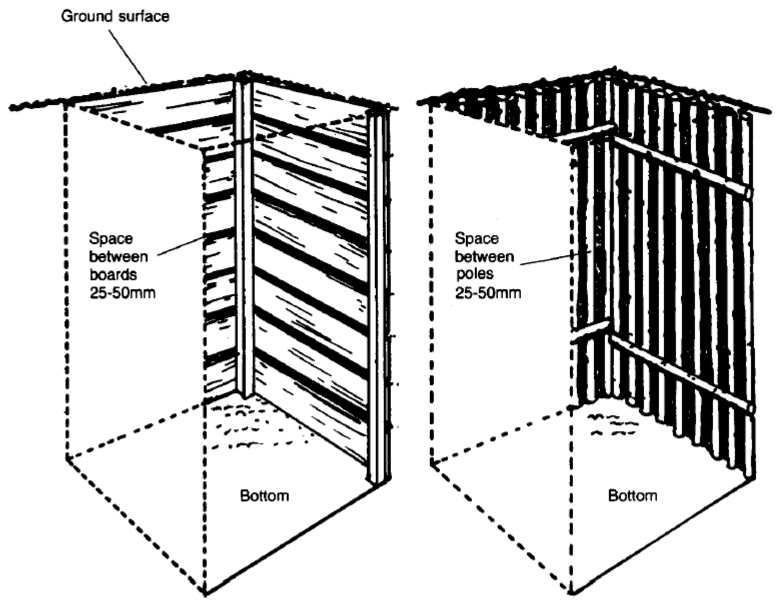
Square or Rectangular Pits:

Square or rectangular pits can be lined by creating a four-walled structure which can be inserted into the pit and backfilled with sand. Once again, a concrete ring-beam should be constructed to support the top of the pit.



Example of square or rectangular pits lined with wood.

Instructions for vertical lining[25]

4. Cut logs or wooden poles to a length equal to the depth of the pit.
5. Place the logs vertically along the sides of the pit. Logs should be 25 to 75mm apart.
6. Cut four poles equal to the length of the pit.
7. Nail or tie the poles horizontally across the vertical logs. Do this about .5 meter from the top of the pit, and at the bottom of the pit.

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[21] World Health Organization, "Fact Sheet 3.4: Simple Pit Latrines," World Health Organization, http://www.who.int/water_sanitation_health/hygiene/emergencies/envsanfactsheets/en/index2.html.

[22] *Water for the World: Constructing Pits for Privies, Technical Note No. SAN 1.C.2* (USA: National Demonstration Water Project, Institute for Rural Water and National Environmental Health Association, 1982), 3.

Instructions for horizontal lining[25]

1. Cut boards both the length and width of the pit.
2. Cut four long boards or beams to a length equal to the depth of the pit.
3. Place one long board or beam in each corner of the pit.
4. Place the shorter side boards horizontally along the pit walls and nail them to the corner beams.
5. Side boards should be placed 25 to 75mm apart.

Ferrocement

Materials:

- Steel wire mesh (chicken wire works well)
- Mortar
- Trowel
- Gloves
- Shovel
- Level

Partially and Fully Lined Pits:

1. Review pit design created during the Latrine Design Project or see Pit Design section
2. If partially lining the pit, dig .5 meters down, if fully lining the pit, dig the entire depth of the pit.
3. Level the bottom and clear away loose dirt and rocks.
4. Apply mortar to the walls of the pit; make a layer that is 12 mm thick.
5. Apply 2-3 layers of steel mesh, chicken wire works well.
6. You can keep the mesh in place by driving long staples through the mesh and mortar into the soil.
7. Below .5 meters, put spacers in the mesh before it is covered with mortar. Use short pieces of 20mm diameter sticks inserted into mesh through the first layer of mortar.
8. Apply a second layer of mortar and push firmly into the mesh; the layer should be 10mm thick. The mesh should be completely covered with mortar.

Precast Concrete or Fired Clay Rings

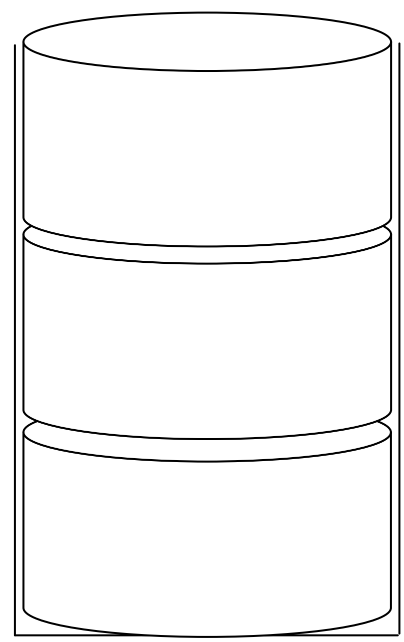
Materials:

- Precast concrete or fired clay rings- determine the amount of these based on the size of the rings and the depth of the pit.
- If lining the whole pit, some of the rings should have pores 25-50mm in diameter.
- Concrete for ring beam (optional, see Slab section for instructions)
- Mortar
- Trowel
- Gloves
- Shovel
- Level

Partially and Fully Lined Pits:

1. Review pit design created during the Latrine Design Project or see Pit Design section. A circular pit works best for concrete or clay rings.
2. If partially lining the pit, dig .5 meters down, place a ring inside the pit and dig the rest of the pit inside the border of the ring.
3. If fully lining the pit, dig the entire depth of the pit.
4. Level the bottom and clear away loose dirt and rocks.
5. Rings at the bottom of the pit should be porous, with holes between 25-50mm in diameter. If pores are not an option, the joints of the rings can be held open by brick or stones to allow for seepage.
6. Mortar or cement joints together.
7. Backfill behind the rings with sand.

   NOTE: If the ground at the bottom of the pit is soft, you may want to construct a concrete ring beam to use as a firm foundation for the lining.



Mixing Concrete Mortar

Mortar is an agent that adheres materials together like bricks or stones. Although it can be made from different ingredients, this manual will be describing how to make "concrete mortar" from cement, sand and water.

Mortar Materials Checklist				
Materials	**Size**		**Quantity**	**Do I have this?**
	Metric	**US**		
General Materials				
Measuring tape			1	
Gloves	varies on number of participants and facilitators			
Shovels	varies on number of participants and facilitators		2 at least	
Level			1	
Wheelbarrow (if available)	For mixing concrete		1	
Buckets or other measurement for mortar			2	
Cement	50 kilogram sack	110 lbs	1 bag	
Sand	50 kilogram sack	110 lbs	2 bags	
Water				

Things to note

- The common ratio for concrete mortar is 1:3, 1 part cement to 3 parts sand.
- Once mortar hardens, it can be difficult to remove. It is a good idea to keep an extra container with water around to place dirty tools in so the mortar will not stick to them.
- The consistency of mortar is important. When mixing, use a hoe or trowel to make ledges or cuts in the mortar. The consistency is good when the ledges stay up on their own. If not, add more cement and sand.
- If there are several grades of cement available, always use the best grade. Cheap cement does not hold up to heavy use so it is not a bargain in the long run.
- Sand should also be a higher grade. Make sure it does not contain a high amount of clay.
- Sand should not contain pebbles, rocks, or aggregate. If it does, use a sifter made out of wood and screen to remove them.

Basic steps for mixing concrete mortar

- Mix the dry components- 1 part cement and 3 parts sand. This can be done in a wheelbarrow or small container.
- Add water slowly, constantly mixing until all parts are damp but not runny. This can be done using a trowel, shovel or garden hoe.
- Apply mortar to desired area with a trowel.
- Cure the mortared area by keeping it moist for 7 days. This can be done by covering the area with burlap, plastic or cement bags. You can also use a spray bottle to periodically wet the mortared areas.

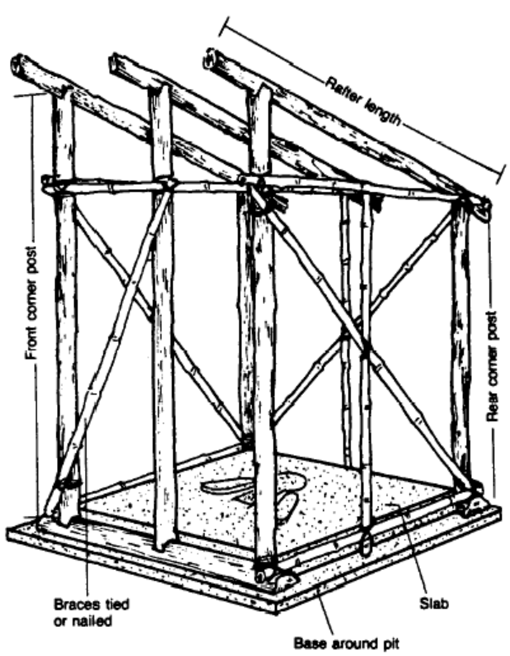
Basic Structure Construction

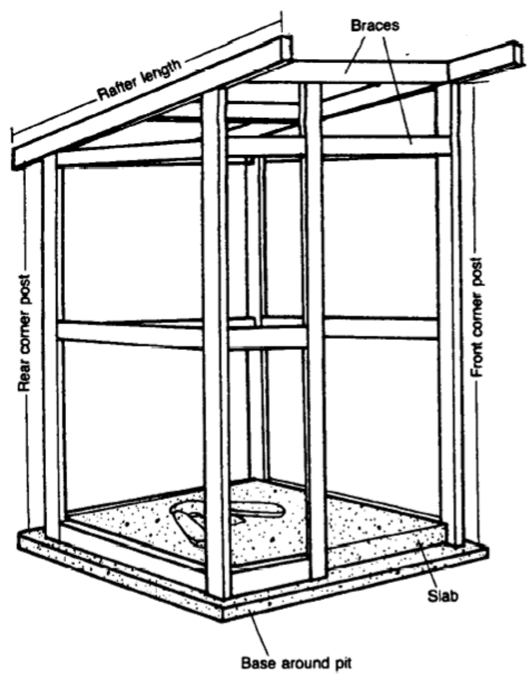
This section covers basic construction elements of a structure. **For detailed instructions to build structures for basic pit latrines and composting latrines see the Appendix.**

Structure Walls and Roof

The structure's sides should have horizontal support beams built. The roof should be supported as well by both horizontal and diagonal beams.

[23]





[23] *Water for the World: Constructing Privy Shelters, Technical Note No. SAN 1.C.3* (USA: National Demonstration Water Project, Institute for Rural Water and National Environmental Health Association, 1982), 6.

The Door

- The door should have horizontal and diagonal supports beams.
- Doors should be attached in such a way that they swing **out** rather than in.
- There should be a lock on the inside so privacy is insured. Unless absolutely necessary, locks should **not** be installed on the outside in order to avoid locking the user inside.
- Self-closing hinges help to keep the door closed.
- It is also important to provide as many hinges as necessary to keep the door firmly attached.

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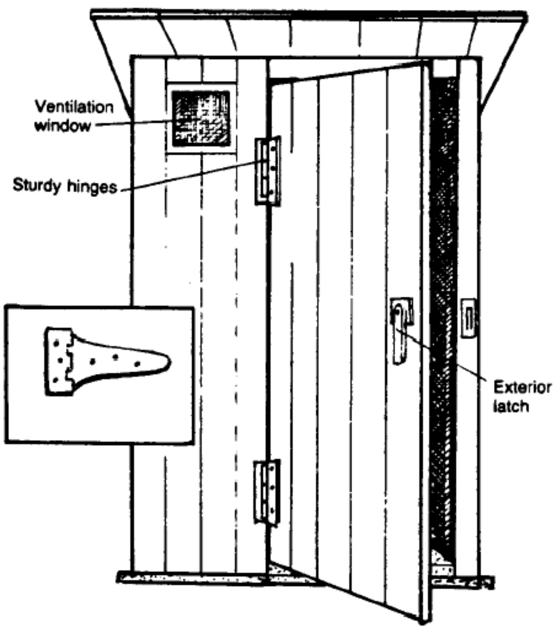
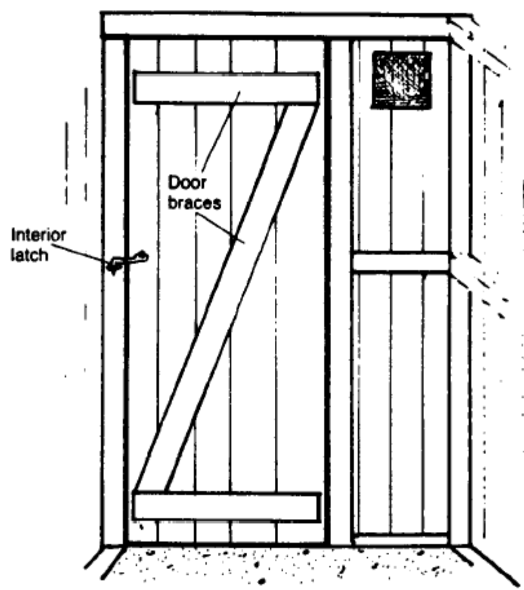


OUTSIDE

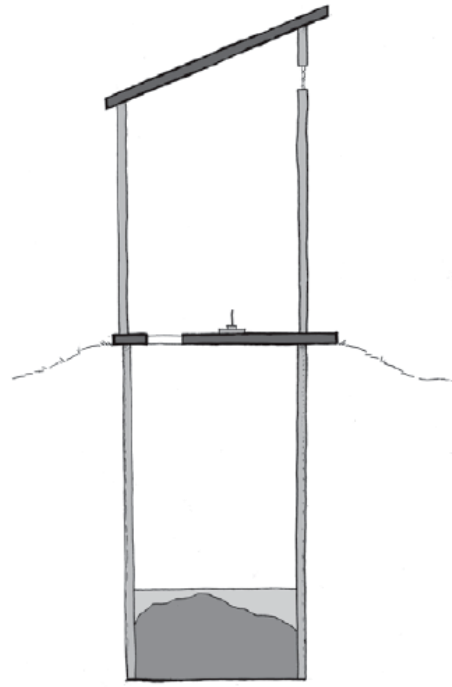


INSIDE

Appendix

Operation and Maintenance[24]

Basic Pit Latrine



Main O&M activities
Operation of pit latrines is quite simple, and consists of regularly cleaning the slab with water (and disinfectant) to remove any excreta and urine. The tight-fitting lid over the drop hole should be replaced after use, to ensure insect control and to reduce odors.

In addition, appropriate anal cleansing materials should be available in or near the latrine. Ash or sawdust can be sprinkled into the pit to reduce the smell and insect breeding. Non-biodegradable materials, such as stones, glass, plastic, rags, etc., should not be thrown into the pit, as they reduce the effective volume of the pit and hinder mechanical emptying.

Monthly maintenance includes checking the slab for cracks, checking the superstructure for structural damage, ensuring that the lid remains tight-fitting, and ensuring that the surface water continues to drain away from the latrine.

The pit is considered full when it is 0.5m from the top. Before the pit latrine becomes full, a decision must be made as to the location of a new pit. When the contents of the pit are 0.5m below the slab, a new pit should be dug and the old one covered with soil. Alternatively, the pit could be emptied mechanically.

When latrines are used by a single household, operation and maintenance tasks are implemented by the household or by hired labor. If several households use the latrine, arrangements for rotating the cleaning tasks have to be made, to avoid social conflict. Pits can only be emptied manually with a shovel if their contents have been left to decompose for about two years. Otherwise, when a pit is full, it must be emptied mechanically by a service, or a new pit has to be dug.

[24] Francois Brikke and Maarten Bredero. *Linking Technology Choice with Operation and Maintenance in the Context of Community Water Supply and Sanitation* (Geneva: WHO and IRC Water and Sanitation Centre, 2003), 103-128.

Operation and maintenance (O&M) technical requirements for a Basic Pit Latrine

Activity and frequency	Materials and spare parts	Tools and equipment
Daily		
Clean the drop hole, seat and shelter Clean the handle of the lid	Water, soap Water, soap	Brush Brush
Monthly		
Inspect the floor slab and lid		
Occasionally		
Repair the slab, lid, seat or superstructure	Cement, sand, water, nails, local building materials	Bucket or bowl, trowel, saw, hammer, knife
Periodically (Depending on size and number of users)		
Close the pit with soil, dig a new pit, Shift cover and superstructure	Soil, local building materials and nails (if available)	Shovels, picks, bucket, hammer, knife, saw, etc.
Empty the pit (if applicable)	By hand: water By mechanical means: water, spare parts for machinery	By hand: shovel, bucket By mechanical means: equipment for emptying the pit.

VIP Latrine

Main O&M activities

Operation of VIP latrines is quite simple and consists of regularly cleaning the slab with water and disinfectant, to remove any excreta and urine.

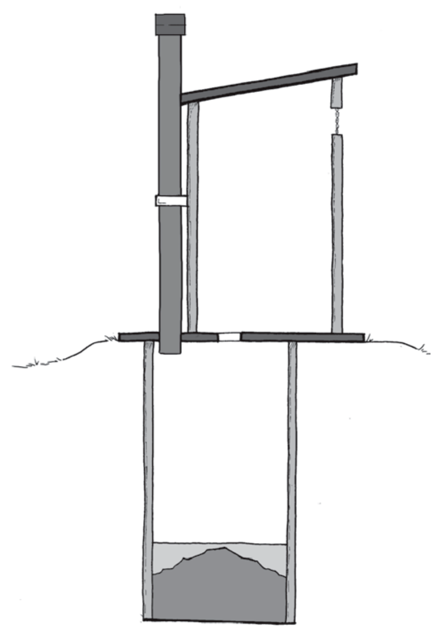
The door must always be closed so that the superstructure remains dark inside so that insects are only attracted to the light at the top of the vent pipe. The drop hole should never be covered as this would impede the airflow through the vent pipe.

Appropriate anal cleaning materials should be available for the latrine users. Non-biodegradable materials, such as stones, glass, plastic, rags, etc. should not be thrown into the pit, as they reduce the effective volume of the pit and hinder mechanical emptying.

Every month, the floor slab should be checked for cracks, and the vent pipe and fly screen inspected for corrosion or damage, and repaired if necessary. The superstructure may also need to be repaired (especially light leaks).

Rainwater should drain away from the latrine. When the contents of the pit are 0.5 m below the slab, a new pit should be dug and the old one covered with soil. Alternatively, the pit could be emptied mechanically.

Where latrines are used by a single household, operation and maintenance tasks are implemented by the household, or by hired labor. If several households use the latrine, arrangements have to be made to rotate the cleaning tasks, to avoid social conflicts.



If pits are not emptied mechanically, they can be emptied manually, but only after their contents have been left to decompose for about two years. Otherwise, new pits must be dug when a pit is full. If double-pit latrines are used, the users need to understand the concept of the system fully to operate it properly.

User education has to cover topics such as the reasons for using only one pit until the time for switch-over; the use of excreta as manure; and the need to leave the full pit for about two years before emptying. The users must also know how to switch pits and how to empty them, even if they do not do these tasks themselves. If these tasks are carried out by the private (informal) sector, the workers have to be educated about the system and its operational requirements.

Lifewater

O&M technical requirements for a VIP Latrine

Activity and frequency	Materials and spare parts	Tools and equipment
Daily		
Clean the drop hole, seat and shelter	Water, soap	Brush , bucket
Monthly		
Inspect the floor, slab, vent pipe and fly screen		
Every 1- 6 Months		
Clean the fly screen and the inside of the vent	Water	A twig or long flexible brush
Occasionally		
Repair the slab, seat, vent pipe, and fly screen or superstructure	Cement, sand, water, nails, local building material	Bucket or bowl, trowel, saw, hammer, knife
Periodically (Depending on size and number of users)		
Dig a new pit and transfer latrine slab and superstructure (if applicable)	Sand, possibly cement, bricks, nail and other local building materials	Shovels, picks, buckets, hammer, saw, etc
Switch to the new pit when the old pit is full		Shovels, buckets, wheelbarrow, etc
Empty the pit (if applicable)	By hand: water By mechanical means: water, spare parts for machinery	By hand: shovel, bucket By mechanical means: equipment for emptying the pit.

Double Vault Composting Latrine[25]

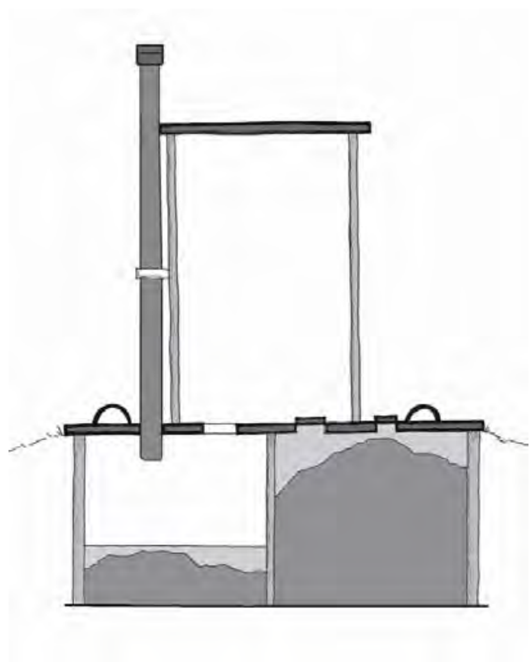
Main O&M activities
Initially, some absorbent organic material is put into the empty vault (layer of ashes or lime) to ensure that liquids are absorbed and to prevent the feces from sticking to the floor. After each use, or whenever available, wood ash and organic material are added.

It is essential that all liquids be kept out of the vault as they will mix with the feces, causing odors that attract flies and will upset the composting process. When urine is collected separately it is often diluted with 3–6 parts of water and used as a fertilizer. Water used for cleaning should not be allowed to go into the latrine as it will make the contents too wet.

The contents in the vault should be mixed periodically to level them out and to assist with the composting process. When the vault is three-quarters full, the contents are leveled with a stick, the vault is filled to the top with dry powdered earth, and the squat hole is sealed. The second vault is then emptied with a spade and bucket, after which the vault it is ready for use. The contents dug out of the second vault can be safely used as fertilizer.

To help keep down the number of flies and other insects, insect-repelling plants (such as citronella) could be grown around the latrine.

Certain cultures consider it taboo to use human excreta as fertilizer, there fore potential users of a vault latrine technology should be consulted extensively, to find out if the system is culturally acceptable, and if they are motivated and capable of operating and maintaining the system properly. The project agency will need to provide sustained support to ensure that users understand the system and operate it properly.

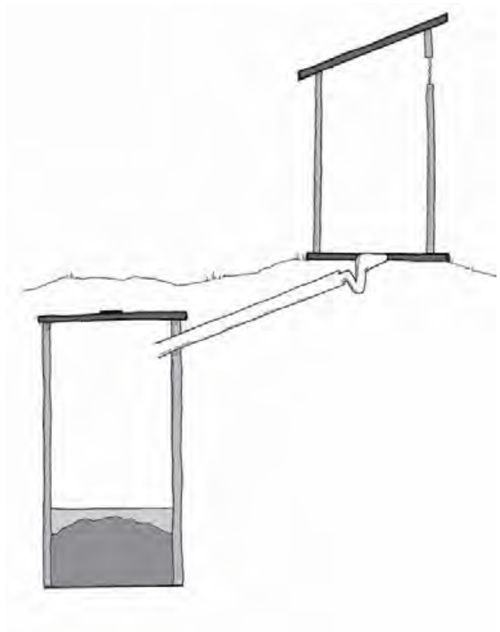


[25] Uno Winblad and Wen Kilama, *Sanitation Without Water* (London and Basingstoke: Macmillan Education LTD, 1985)

O&M technical requirements for a Double Vault Composting Latrine

Activity and frequency	Materials and spare parts	Tools and equipment
Daily		
Clean the toilet and superstructure, empty the urine collection pot	Water, lime and ashes	Brush, water container
After each defecation or whenever available		
Add ashes or other organic material	Wood ashes and organic material	Pot to contain the material, small shovel
Monthly		
Inspect the floor, superstructure and vaults		
When Necessary		
Repair the floor, superstructure or vaults Use humus as fertilizer	Cement, sand, water, nails, local building materials Humus	Bucket or bowl, trowel, saw, hammer, knife Shovel, bucket, wheelbarrow
Periodically (Depending on size and number of users)		
Close the full vault after leveling and adding soil	Water, absorbent organic material	Shovel and bucket
Empty the other vault, open its squat hole and add 10 cm of absorbent organic material before using		
Store humus or use it directly		

Pour Flush Latrine



Main O&M activities
Before use, the pan is wetted with a little water to prevent faeces sticking to the pan. After use, the pan is flushed with a few liters of water. If water is scarce, water already used for laundry, bathing, etc. may be used. No material that could obstruct the U-trap should be thrown into the pan.

The floor, squatting pan or seat, door handles and other parts of the superstructure should be cleaned daily with brush, soap and water. Wastewater from bathing or washing clothes should not be drained into the pit (except when used for flushing), but disposed of elsewhere. Excess water will fill the pit at a faster rate.

Monthly, the pan and U-trap should be checked for cracks, and the diversion box for blockage. If the excreta does not flush quickly, the PVC pipes or diversion box may become choked and they must be unblocked immediately using small shovels and long sticks.

When full, single pits should be abandoned and covered with at least 0.5 m of soil, and a new pit dug. If they are not to be abandoned, they should be emptied by mechanical means. A pit can only be emptied manually if the excreta have been left to decompose for at least 12–18 months. In this time, the excreta will have decomposed into harmless humus, which makes a good fertilizer.

In a double-pit system, users should regularly monitor the level of the pit contents. If one pit is almost full, the second pit should be emptied. Again, this can safely be done by hand, but only if the pit to be emptied has been properly closed for at least 12–18 months. The pipe leading to the full pit should then be sealed and the flow diverted to the emptied pit.

If latrines are used by a single household, operation and maintenance tasks are carried out by the household itself, or by hired labor. If several households use the latrine, arrangements should be made to rotate cleaning tasks among the households. The users need to understand the concept of the system fully to be able to operate it properly.

User education must include the reasons for using one pit at a time, the need to leave a full pit for about 12-18 months before emptying, and the use of excreta as manure. The users also need to know how to switch from one pit to another, and how to empty a pit, even if they do not perform these tasks themselves. If these tasks are carried out by the private (often informal) sector, the laborers should also be educated in the concept of the system and its operation and maintenance requirements.

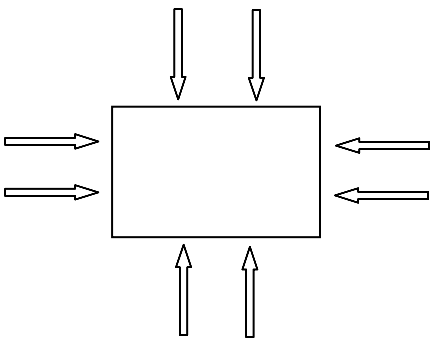
O&M technical requirements for a Pour Flush Latrine

Activity and frequency	Materials and spare parts	Tools and equipment
Daily		
Clean the squatting pan or seat and shelter	Water, soap	Brush, water container
Monthly		
Inspect the floor squatting pan or seat and U-trap for cracks Inspect the diversion box for blockage		
Occasionally		
Monitor the level of pit contents Unblock U-trap, PVC pipes or diversion box Repair the squatting pan or seat, U-trap, or shelter	Water Cement, sand, water, nails, local building materials	Flexible stick or other flexible tools Bucket or bowl, trowel, saw, hammer, knife
Periodically (Depending on size and number of users)		
Close a full pit with soil and dig a new pit (in the case of a single- pit system)	Soil, several local building materials, and nails	Shovels, picks, bucket, hammer, knife, saw, etc
Or empty the pit	By hand: water By mechanical means: water, spare parts for machinery	By hand: shovel, bucket By mechanical means: equipment for emptying the pit.
Divert excreta flush to the other pit (in the case of a double pit)	Water, sand, cement, bricks, clay, etc	Shovel, bucket

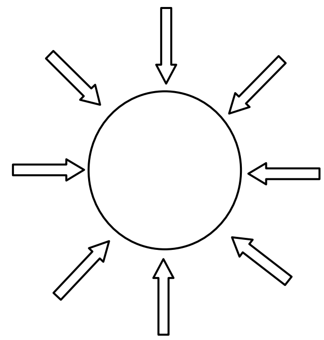
Basic
Pit Design

Pit Shape

Circular pits are less likely to collapse because the pressure from the surrounding soil is evenly spread. Rectangular pits tend to collapse more often because pressure is placed on the four walls. This leaves the corners to absorb stress.



Pressure from surrounding ground

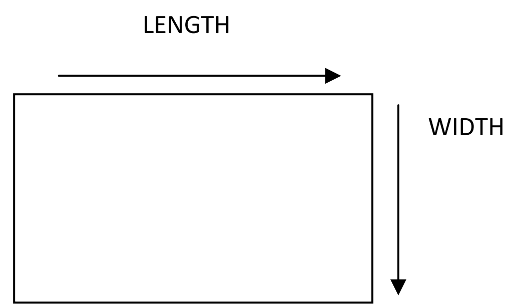


Pressure from surrounding ground

Pit Size*

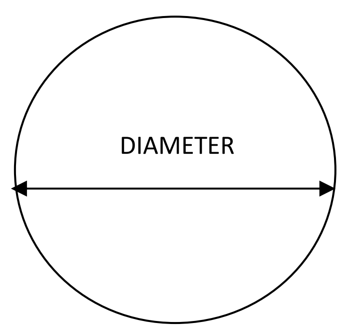
Rectangular or Square Pit (meters)

Pit Dimensions	Pit Depth			
	5 years	10 years	15 years	20 years
1x1	2.3 deep	4.1	5.9	7.7
1.2x1.2	1.75	3.0	4.3	5.5
1.5x1.5	1.3	2.1	2.9	3.7
1.2x2	1.25	2.0	2.8	3.5



Circular Pit (diameter)

Pit Diameter	Pit Depth			
	5 years	10 years	15 years	20 years
1.1	2.4 deep	4.3	6.2	8.1
1.5	1.5	2.5	3.6	4.6



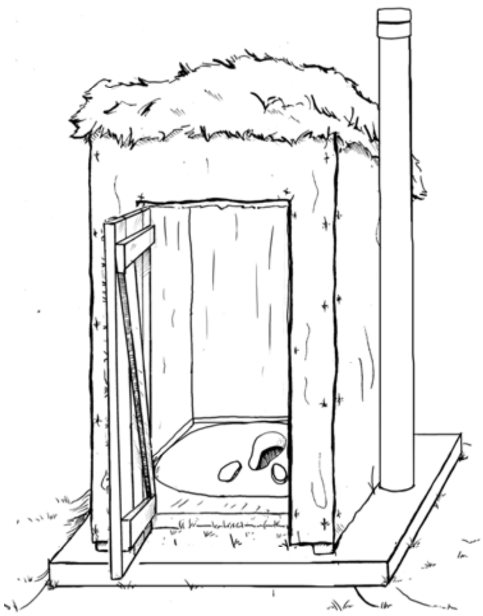
*Dimensions are for a family of 6
For calculations, see Basic Pit Calculations section

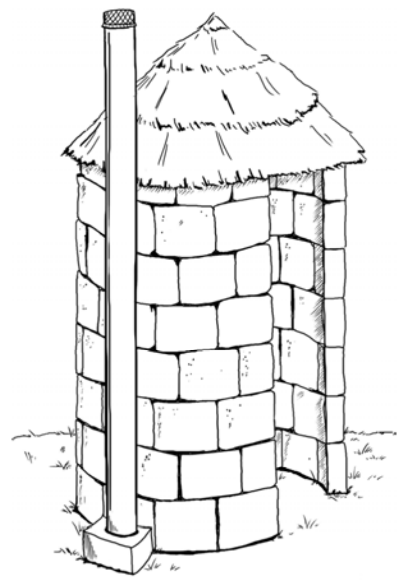
Structure Design[26]

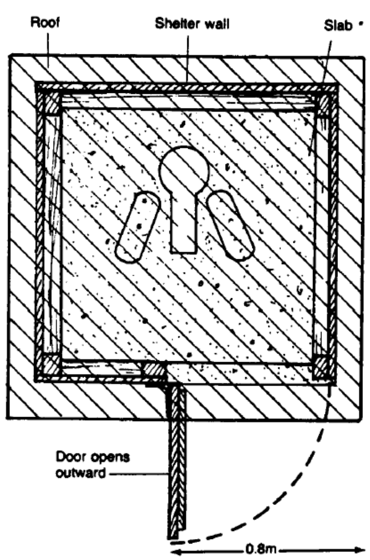
The following information provides various options for structure design however; cultural practices, local materials and personal preference all impact how a structure can be designed.

Structure Shape

Common shapes for latrine superstructures are rectangular and circular. Either shape can be constructed with a door or in a spiral layout. Spiraled layouts work well for VIP latrines because light does not enter the structure even in the absence of a door.







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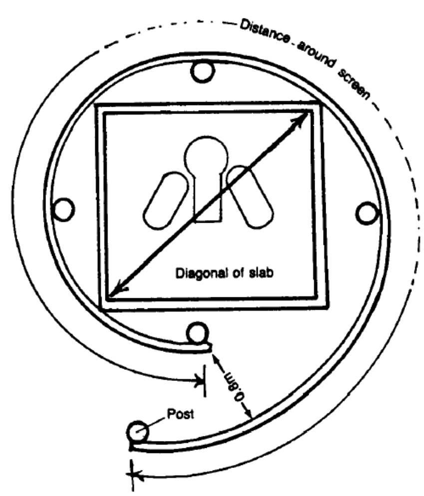


[26] Richard Franceys et al., *A Guide to the Development of On Site Sanitation* (Geneva: WHO, 1992), 116- 127.

[27] *Water for the World: Constructing Privy Shelters, Technical Note No. SAN 1.C.3* (USA: National Demonstration Water Project, Institute for Rural Water and National Environmental Health Association, 1982), 3.

Structure Size

The size of a latrine superstructure depends on the preferences of those using it. Helpful guidelines include:

- Users should have enough space to stand without feeling oppressed by the roof.
- Users should have enough space to sit or squat without touching or leaning on the sides of the structure.
- If the floor of the structure is too wide, users may decide to defecate on the floor, especially if the keyhole has become unclean. However, it must have enough space to allow the user to turn 180 degrees.
- Keep in mind people with special needs. If building a latrine for a wheelchair user, make sure the structure is wide enough for the wheel chair to turn 180 degrees.

Some people prefer smaller, shorter structures like this Ethiopian man and his son.

Materials

Materials used for a latrine superstructure are mainly dependant upon user preference, however cost and local availability play a role as well. Here are a few options:

- Simple walls
    - A simple fence around the slab can provide adequate privacy, although it will not protect the user from weather or control flies. It is a good option however if funding is not available for an improved structure
    - Woven reeds or palms can work for this, as can cloth bags sewn together and connected to wooden branches.

- Mud and wattle
    - This is a material commonly used for building homes and works just as well for latrines.
    - A wooden frame is set up, and a mud-straw mixture is used to fill in gaps between the wooden pieces. For added support, weave bamboo between the wood before adding the mud mixture.
    - If termites are a problem in the area, you may want to treat the wood with motor oil or paint before creating the frame.

VIP latrine made from mud and wattle.

- Concrete Blocks
    - These are more expensive, but are sturdy and long lasting.
    - Skill is needed to construct using this material, therefore a mason may need to be consulted.
    - Pay attention to the weight created by using these bricks. If the structure becomes too heavy, it may cause damage to the pit.

Kenyan latrine constructed with concrete blocks and lined with cement.

- Sun-dried bricks
  - Commonly known as adobe bricks, these are made from mixing mud and natural fibers. The mixture is placed in a wooden form and allowed to dry out of direct sunlight. The bricks can be joined together using mud mortar.
  - Pay attention to the weight created by using these bricks. If the structure becomes too heavy, it may cause damage to the pit.

- Stone
  - Stones are commonly used; however the weight they produce may be problematic for pits. They are recommended for offset pits.

- Ferrocement
  - Ferrocement serves as a strong, durable material for structures but can be costly due to the amount of cement used in the process.

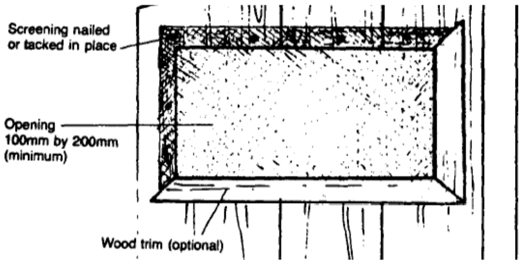
- Corrugated metal
  - This material is common for structures; it provides adequate privacy and protection from weather.
  - Overtime the metal does rust and holes are produced. Also, metal heats up quickly under the sun, which can increase odor and temperature inside the latrine.

Communal latrine in Ethiopia. The structure is made from corrugated metal.

Ventilation

Vents

- Vents can be made by constructing the roof about 100mm higher than the walls, or by cutting out sections of the wall.
- All vents should have screens to keep insects out.
- Vents should be 200mm wide and 100mm tall.[28]



[28] *Water for the World: Constructing Privy Shelters, Technical Note No. SAN 1.C.3* (USA: National Demonstration Water Project, Institute for Rural Water and National Environmental Health Association, 1982), 5.

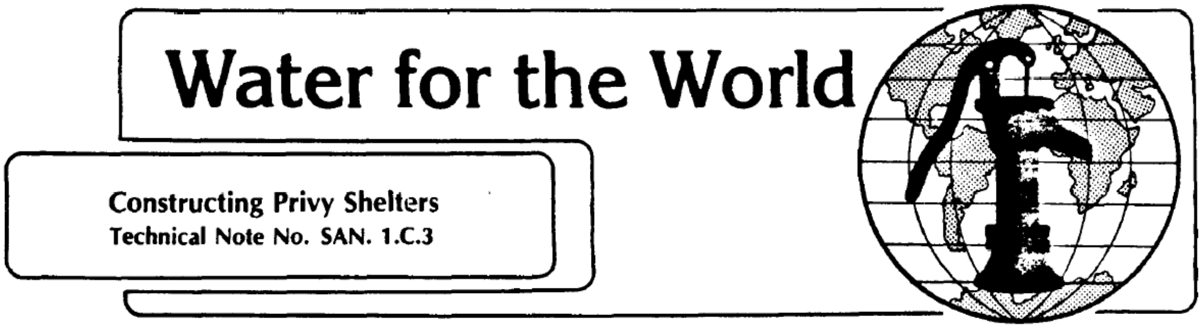
Screen

- Screens should have openings not larger than 2mm.
- Screens should not be able to rust. Copper, bronze, plastic or aluminum work well. Screens can also be painted to prevent rust.

Vent Pipes

- Vent pipes can be located inside or outside of the structure and should extend over the highest point of the roof by .5 meter.
- They can be manufactured or made locally using bamboo, reeds or poles.
- The internal diameter of the vent pipe should be at least 150mm.
- Mortar can be used to attach vent pipes to the hole in the slab that leads to the pit. Attach the pipe to the shelter wall or roof if needed.
- The top of the vent pipe must be covered with screen.

Water for the World[29]
Constructing Privy Shelters SAN 1.C.3



A privy shelter is a screen or structure that gives the person using the privy privacy. Depending on the design, a shelter can protect the user from the weather and keep out flies, rats, scavenging dogs, and other pests.

A properly constructed shelter can last 5 to 10 years or more. This technical note describes each step in building a shelter. Read the entire technical note before beginning construction.

Construction Steps
Depending on local conditions, availability of materials, and skills of workers, some construction steps will require only a few hours, while others may take a day or more.

For a simple screen shelter:

1. Assemble all laborers, supplies, tools, and drawings needed to begin construction. Study all drawings carefully.
2. Cut corner posts or uprights to the correct lengths.
3. Set corner posts firmly in the ground in a vertical position around the privy slab to a depth of .3 to .6m as shown in figure 9a. Thoroughly tamp the ground after the posts are in place.
4. Build or weave together the screening material and secure it to the corner posts with vine, wire, or equivalent. Begin at the end corner and be as high as the tops of the corner posts as shown in figure 9a.

[29] *Water for the World: Constructing Privy Shelters, Technical Note No. SAN 1.C.3* (USA: National Demonstration Water Project, Institute for Rural Water and National Environmental Health Association, 1982), 1-15.

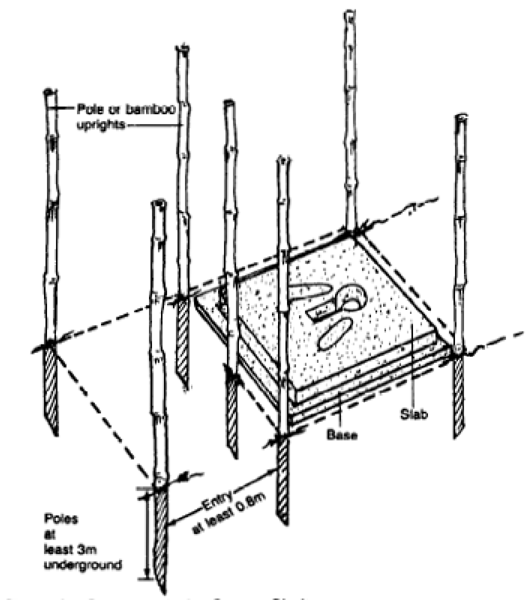


Figure 9a. Cornerposts for Screen Shelter

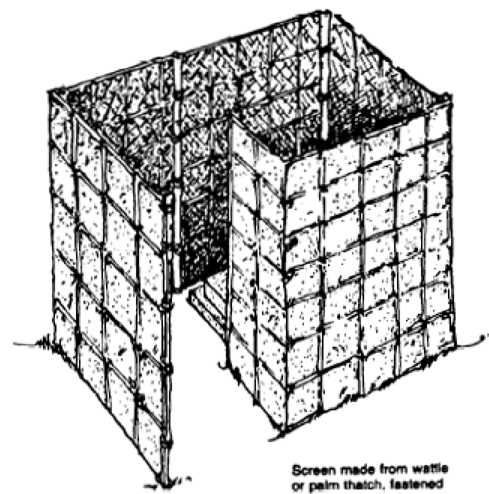
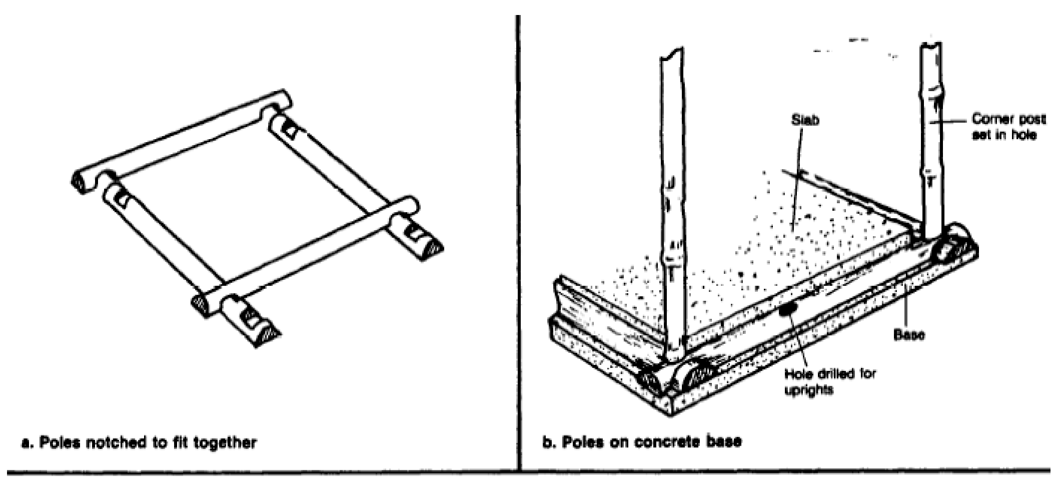


Figure 9b. Completed Screen Shelter

For a bamboo shelter with roof or roof and door:

1. Build a foundation around the privy slab form bamboo poles 50- 100mm in diameter. Notch the ends of the poles, fit them together, and tie them with wire or vine, as shown in figure 10a.
2. Drill or cut holes in the foundation for the corner posts. Erect the posts, making sure they are vertical, and secure them to the foundation with wire or vine. Leave at least .8m space for the entryway or doorway serve as the door frame.
3. Secure the crosspoles to the corner posts with wire or vine. The top crosspoles should be placed at the designed height of the walls. If the roof is raised for ventilation, the top crosspoles will be 100-150mm below the tops of the corner posts. For a shelter with a door, one crosspole will define the top of the doorway, which should be at least 2.0m high.



a. Poles notched to fit together

b. Poles on concrete base

Figure 10. Foundation for Bamboo Shelter

4. it
.3m beyond the front and rear walls.

5. Begin the screen wall, if there is one, by erecting two upright as shown in figure 11a. Bury the ends at least .3m in the ground and thoroughly tamp. Secure the crosspoles to the uprights.
6. Build the shelter walls and screening wall with bamboo, as shown in figure 11b. Secure the bamboo to the crosspoles and uprights with wire or vine.
7. Build the roof with bamboo strips and palm thatch. Start at the lower edge of the roof and work toward the higher edge, overlapping the thatch. The roof should extend about .3m beyond all walls.
8. Build a door, if there is one, with bamboo. Attach hinges, fasten the door to the door frame, and attach a latch.

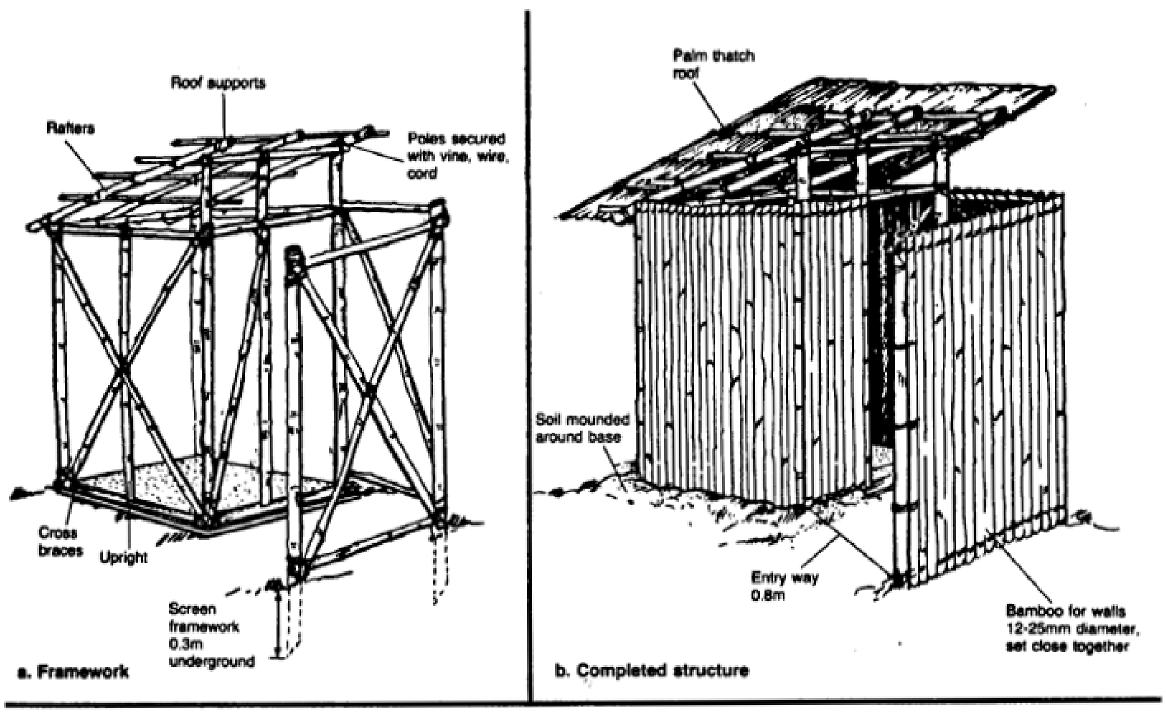


Figure 11. Construction of Bamboo Shelter with Screen and Roof

For a Wood Shelter with a Roof or Roof and Door:

1. Build a foundation around the privy slab from wood beams 50-100mm in diameter as shown in figures 13a and 13b.
2. Erect the corner posts and uprights, making sure they are vertical, and nail them securely to the foundation. Leave at least .8m space for the entryway or doorway, as shown in figure 14. For a shelter with a door, the corner post on each side of the doorway serve as the door frame.
3. Nail crossbraces to the inside edges of the corner posts. The top crossbrace should be at the designed height of the walls. If the roof is to be raised for ventilation, the top crossbraces will be 100-150mm below the tops of the corner posts. For a shelter with a door, one crossbrace will define the top of the doorway, which should be a least 2m high.
4. Nail the rafters on top of the cornerposts. The rafters should extend about .3m beyond the shelter walls.
5. Begin the screening wall, if there is one, by erecting two uprights as shown in figure 14. Bury the ends .3 to .6m in the ground and thoroughly tamp. Nail crossbraces to the inside edges of the uprights.
6. Build the walls and screening wall by nailing boards to the outside edges of the corner posts as shown in figure 15.
7. Build the roof by nailing crosspieces to the rafters, then nailing tin sheets to the crosspieces. Start from the lower edge of the roof and work toward the higher edge, overlapping the tin sheets as shown in figure 15. The roof should extend about .3m beyond all walls.
8. Build a door with wood boards. Attach the hinges, fasten the door to the door frame, and put on a latch.

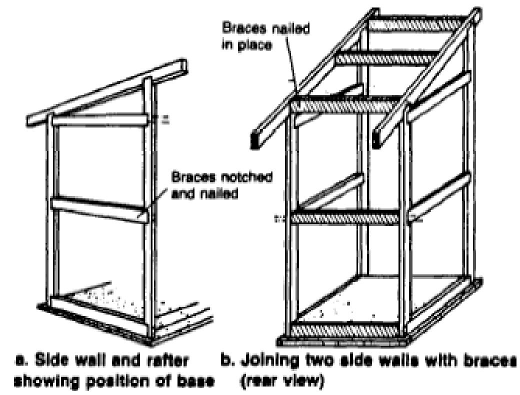


Figure 13. Framework for Wooden Shelter

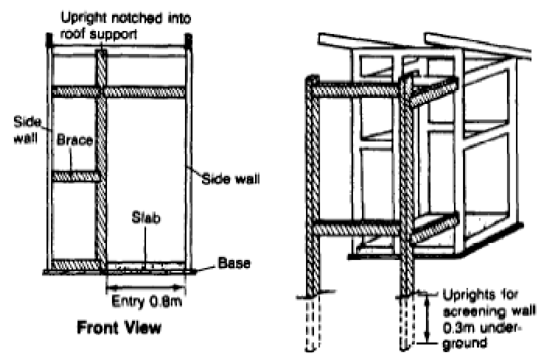


Figure 14. Framework for wooden shelter with screen

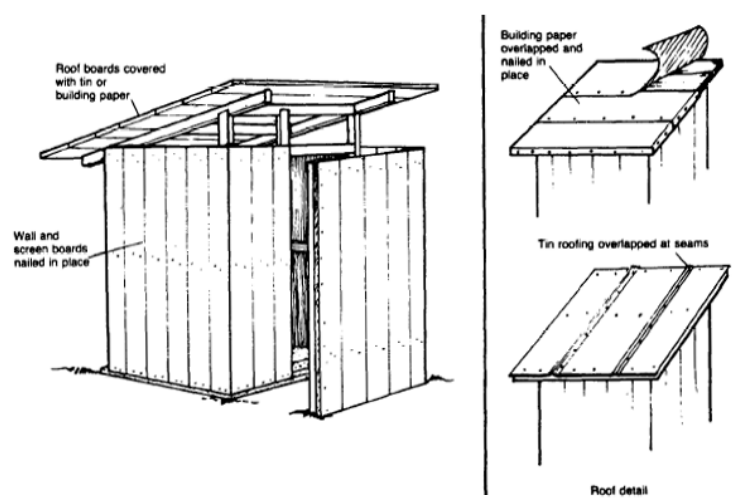


Figure 15. Completed Shelter

For a brick and mortar shelter with a roof or roof and door:
Since brick and mortar shelters should stand for more than 10 years, they are recommended for use with off-set pit privies or compost toilets, which generally last that long. Because of the weight of brick and mortar shelters, they are not recommended for use with ventilated pit privies in which the back wall of the privy rests on the privy slab.

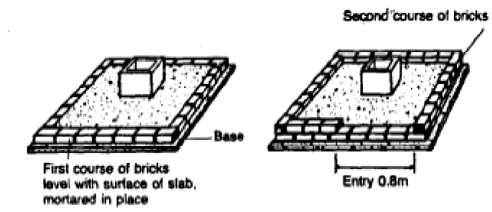


Figure 16. Foundation for Brick Shelter

1. Mortar a row of bricks to the base of the pit, mortaring the inside edge of the bricks to the privy slab.
2. Mortar a second row of bricks overlapping the first row as shown in figure 16. Leave at least .8m space for entry.
3. For a shelter with a door, build the door frame with wood beams 50mm thick by 100mm wide, and set it in place with a temporary brace as shown in figure 17. Fasten L-shaped metal strips to each side of the door frame with nails or screws. The horizontal part of the strip will be mortared between the rows of bricks to hold the frame in place. Attach a second pair of L-shaped strips when the walls reach about half their height, and a third pair when the walls reach nearly the total height.
4. Continue laying rows of bricks up to the design height of the walls, being careful to keep the walls vertical.
5. Place bolts about 12mm diameter by at least 100mm long in the top bricks near the corners of each wall as shown in figure 18. Mortar the bolts in place with the thread ends up.
6. Allow a day or two for the mortar to set. Remove the temporary brace.

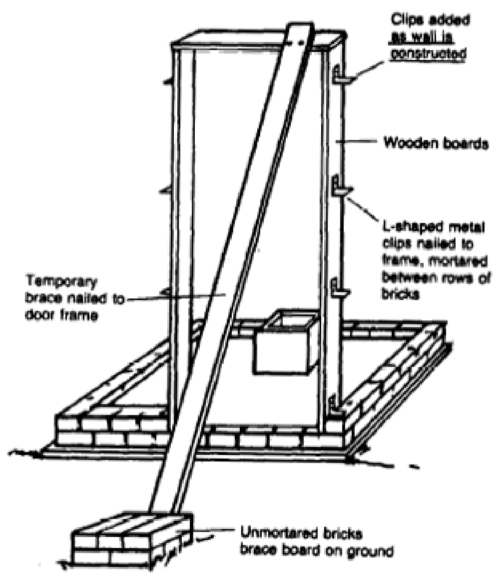


Figure 17. Framework for Entry or Door

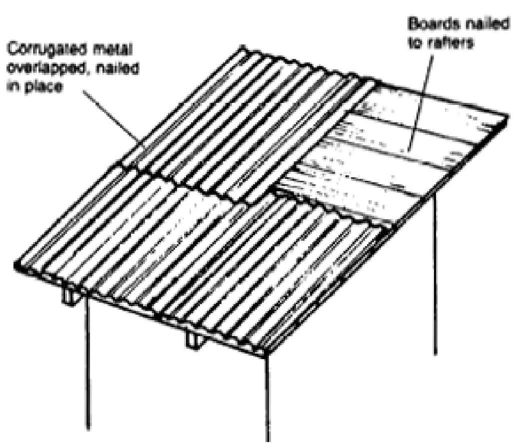


Figure 20. Corrugated Roofing

7. Drill or burn holes in wood beams 50mm thick by 100mm wide, matching the size and location of the holes to the bolts sticking up from bricks. Set them to the bolts securely using nuts.
8. Nail the top rafters to the top beams. The rafters should extend about .3m beyond the walls.
9. Build the roof by nailing crosspieces to the rafters and nailing corrugated metal sheets to the crosspieces. The furrows in the metal should be lined up in the direction of the roof slope. Start from the lower edge of the roof and work toward the higher edge, overlapping the corrugated sheets. The roof should extend about .3m beyond all walls.
10. Build a screening wall, if there is one, by nailing uprights to the wood beam foundation. Nail the crossbraces to the uprights and to the top beam of the shelter. Nail the boards to the uprights and to the top beam of the shelter. Nail the boards to the uprights.
11. Build a door, if one is planned, with wood boards. Attach hinges, fasten the door to the door frame, and put on a latch.

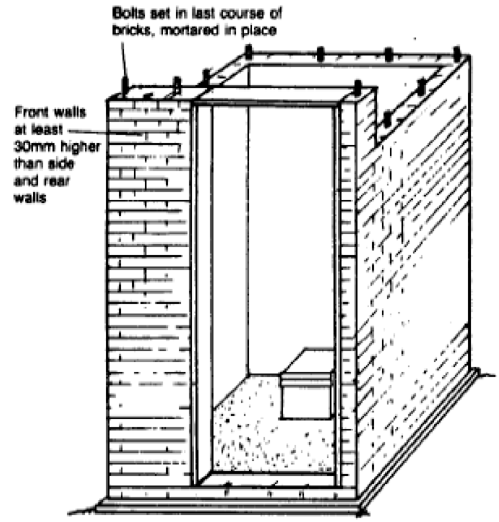


Figure 18. Constructing Brick Shelter

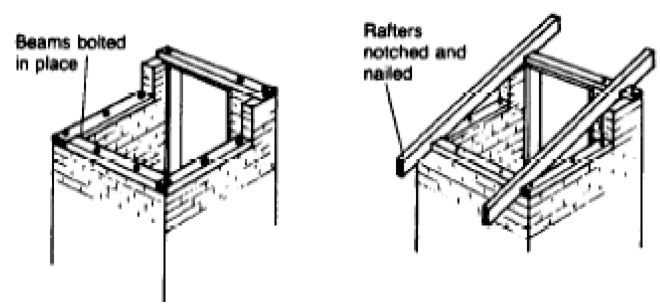
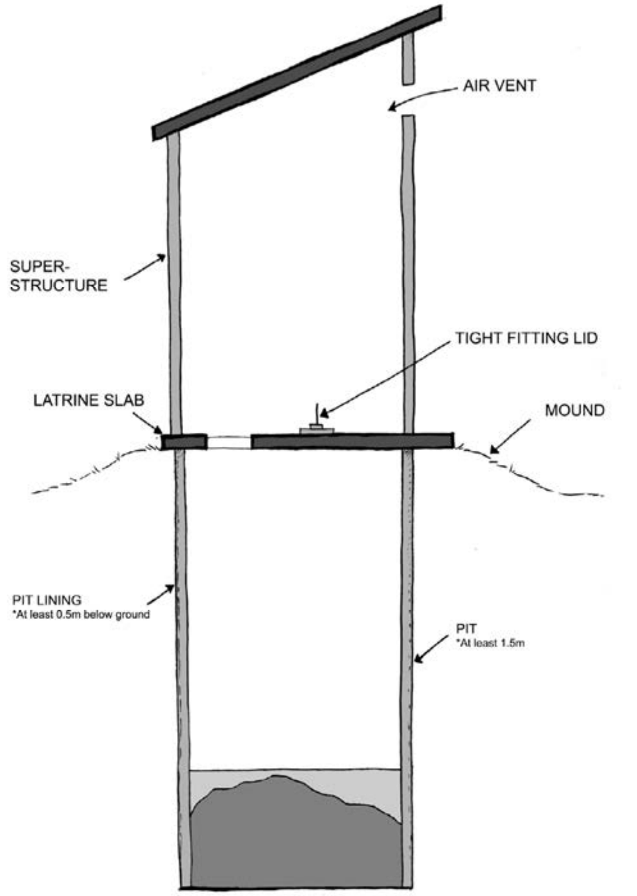


Figure 19. Roof for Brick Shelter

Basic Pit Latrine



General Information

The basic pit latrine should be the first latrine considered when promoting low-cost sanitation plan. It is cost effective for most communities and an important step in reducing the spread of diarrheal disease.

Advantages

- Low cost
- Easy to build
- Water needed for routine cleaning
- Built by householder

Disadvantages

- No odor control
- Attraction of flies if there is not a tight fitting cover over the defecation hole
- Poor design and construction causes the pit to collapse

Materials

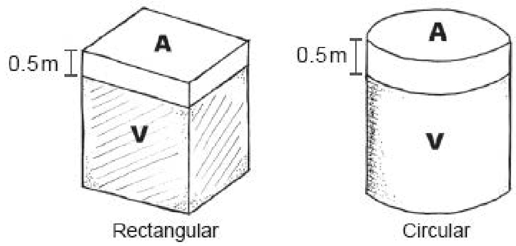
- **Lining:** brick, concrete block, stone, pole, bamboo
- **Latrine Slab:** wood, concrete
- **Concrete or Mortar:** cement, sand, gravel, water

Good for Areas With

- Groundwater depth greater than 3 meters
- Permeable soil
- Objection to the use of excreta as a fertilizer

Basic Pit Latrine

Pit Shapes



* 0.5 meters left unfilled to allow for soil cap

Pit Base Area: Rectangular	$A = L \bullet W$	A: Area of pit (m^2) L: Length of pit (m) W: Width of pit (m)
Pit Base Area: Circular	$A = d^2 \bullet \frac{3.14}{4}$	A: Area of pit (m^2) D: Diameter of pit (m)
Soil Seal Depth	0.5 meters	
Pit Volume	$V = \frac{N \bullet R \bullet Y}{1000} + 0.5 \bullet A$	V: Volume of pit (m^3) N: Number of users Y: Years in use A: Area of pit base (m^2) R: Sludge accumulation rate (liter/person/year)
Pit Depth	$D = \frac{V}{A}$	D: Depth of pit (m) V: Volume of pit (m^3) A: Area of pit (m^2)
Years in Use	$Y = \frac{(V - 0.5 \bullet A) \bullet 1000}{N \bullet R}$	V: Volume of pit (m^3) N: Number of users Y: Years in use (year) * If the pit size is fixed the years the pit is functional may be calculated.

Example

A family of 6 wishes to build a circular VIP latrine with a diameter of 1.3 meters that will last 10 years. The family has a separate bathing area and uses grass and leaves for cleaning.

Solution

1. Using ***Pit Base Area: Circular*** with a diameter of 1.3, we obtain:

$$A = d^2 \bullet 3.14/4 = (1.3\text{m})^2 \bullet 3.14/4 = \mathbf{1.33\ m^2}$$

2. From ***Pit Volume***:

$$V=\frac{(N \bullet R \bullet Y)}{1000}+(0.5\text{m}\bullet A)=\left[\frac{6\text{ people}\bullet (60\text{ liter/person/year})\bullet 10\text{ years}}{1000}\right]+(0.5\text{m}\bullet 1.33\text{ m}^2)= \mathbf{4.27\ m^3}$$

3. From ***Pit Depth***:

$$D = \frac{V}{A} = \frac{4.27\text{ m}^3}{1.33\text{ m}^2} = \mathbf{3.2\ m}$$

4. Final Design:

A circular pit with a diameter of 1.3 meters and depth of 3.2 meters.
The pit will last the family of six for 10 years.

Tables

Suggested Maximum Sludge Accumulation Rate[30]

Conditions	Sludge Accumulation Rate: R (liters/person/year)
Waste retained in water where degradable anal cleaning material is used (degradable material examples: leaves, paper, or cornhusks)	40
Waste retained in water where non-degradable anal cleaning material is used (non-degradable material examples: rocks, trash, or plastic)	60
Waste retained in dry conditions where degradable anal cleaning material is used	60
Waste retained in dry conditions where non-degradable anal cleaning material is used	90

Typical Pit Dimensions[31]

Circular Pit	Rectangular Pit		
Diameter (m)	Width (m)	Length (m)	Depth (m)
1.1 – 1.4	1.0 – 1.2	1.0 – 1.2	Minimum 1.5

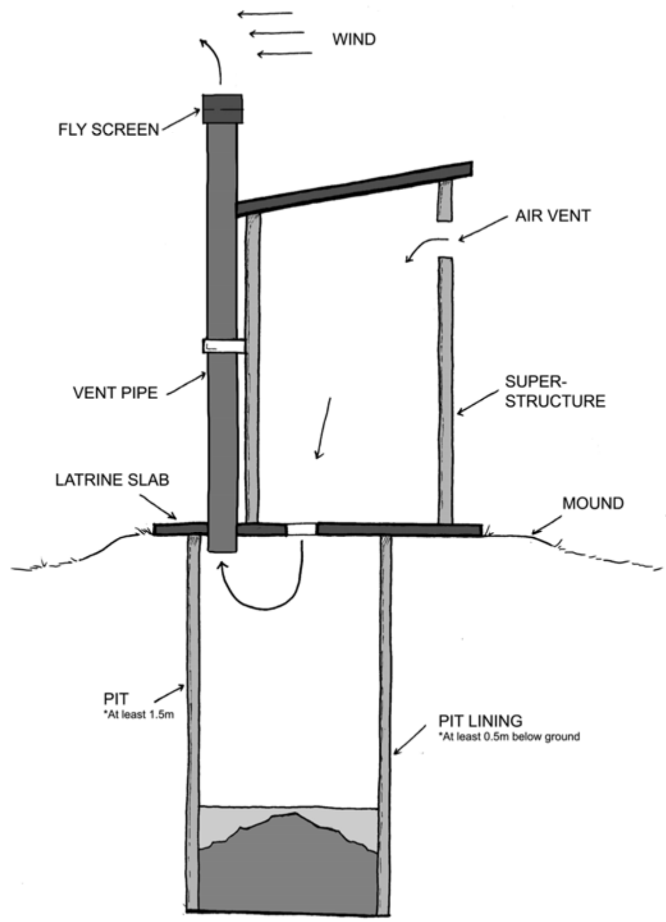
[30] Richard Franceys et al., *A Guide to the Development of On Site Sanitation* (Geneva: WHO, 1992), 34.

[31] *Water for the World: Designing Pits for Privies, Technical Note No. SAN 1.D.2* (USA: National Demonstration Water Project, Institute for Rural Water and National Environmental Health Association, 1982)

Ventilated Improved Pit Latrine

General Information

The Ventilated Improved Pit Latrine (VIP) is a modification on the basic pit latrine. The vent pipe and open defecation hole help to maintain a draft through the structure reducing odors. Flies are attracted to light at the top of the vent pipe and are trapped by the fly screen.



Advantages

- Low cost
- Built by householder
- Control of flies
- Odor control

Disadvantages

- No mosquito control
- Increase cost by putting in vent
- Super-structure to be kept dark
- Water needed for routine cleaning
- Misunderstanding of process limits needed air flow

Materials

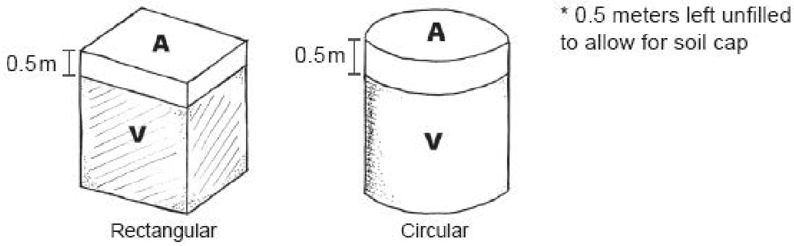
- **Lining**: brick, concrete block, stone, pole, bamboo
- **Latrine Slab**: wood, concrete
- **Concrete or Mortar**: cement, sand, gravel, water
- **Vent Pipe**: bamboo, mud and wattle, anthill soil, ferrocement, masonry, plastic
- **Fly Screen**

Good for Areas With

- Groundwater depth greater than 3 meters
- Permeable soil
- Object to the use of excreta as a fertilizer

Ventilated Pit Latrine

Pit Shapes



Pit Base Area: Rectangular	$A = L \bullet W$	A: Area of pit (m^2) L: Length of pit (m) W: Width of pit (m)
Pit Base Area: Circular	$A = d^2 \bullet \frac{3.14}{4}$	A: Area of pit (m^2) D: Diameter of pit (m)
Soil Seal Depth	0.5 meters	
Pit Volume	$V = \frac{(N \bullet R \bullet Y)}{1000} + 0.5 \bullet A$	V: Volume of pit (m^3) N: Number of users Y: Years in use A: Area of pit base (m^2) R: Sludge accumulation rate (liter/person/year)
Pit Depth	$D = \frac{V}{A}$	D: Depth of pit (m) V: Volume of pit (m^3) A: Area of pit (m^2)
Years in Use	$Y = \frac{(V - 0.5 \bullet A) \bullet 1000}{N \bullet R}$	V: Volume of pit (m^3) N: Number of users Y: Years in use (year) * If the pit size is fixed the years the pit is functional may be calculated.

Example

A family of 6 wishes to build a circular VIP latrine with a diameter of 1.5 meters that will last 15 years. The family will use the latrine as a bathing area and uses newspaper and corncobs for anal cleansing.

Solution

1. Using ***Pit Base Area: Circular*** with a diameter of 1.5m, we obtain:

$A = d^2 \bullet 3.14/4 = (1.5m)^2 \bullet 3.14/4 = \mathbf{1.77\ m^2}$

2. From ***Pit Volume***:

$$V = \frac{(N \bullet R \bullet Y)}{1000} + 0.5 \bullet A = \frac{[6\text{ people} \bullet (60\text{ liter/person/year}) \bullet 15\text{ years}]}{1000} + (0.5\text{m} \bullet 1.77\text{ m}^2) = \mathbf{6.29\ m^3}$$

3. From ***Pit Depth***:

$$D = \frac{V}{A} = \frac{6.29\text{ m}^3}{1.77\text{ m}^2} = \mathbf{3.6\ m}$$

4. Final Design:

A circular pit with a diameter of 1.5 meters and depth of 3.6 meters.
The pit will last the family of six for 15 years.

Tables

Suggested Maximum Sludge Accumulation Rate

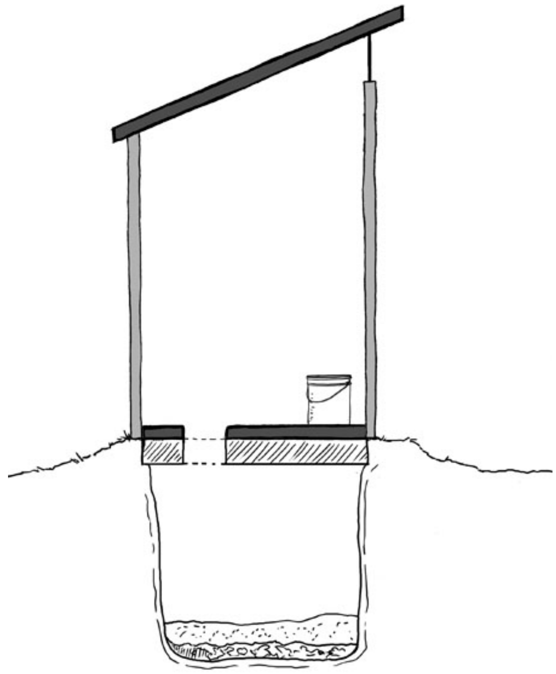
Conditions	**Sludge Accumulation Rate: R (liters/person/year)**
Waste retained in water where degradable anal cleaning material is used (degradable material examples: leaves, paper, or cornhusks)	40
Waste retained in water where non-degradable anal cleaning material is used (non-degradable material examples: rocks, trash, or plastic)	60
Waste retained in dry conditions where degradable anal cleaning material is used	60
Waste retained in dry conditions where non-degradable anal cleaning material is used	90

Typical Pit Dimensions

Circular Pit	Rectangular Pit		
Diameter (m)	Width (m)	Length (m)	Depth (m)
1.1 – 1.4	1.0 – 1.2	1.0 – 1.2	Minimum 1.5

Arborloo Latrine

General Information



Arborloo latrines use one shallow pit (1 meter deep) for the composting of excreta. Instead of a pit lining, a removable cement or brick ring is placed around the edge of the pit. The structure and slab are also moveable and rest on the cement ring.

After the pit contents are 0.5 meters from the top of the pit, the ring, slab and structure are moved to a new pit. The remaining pit is then topped with soil and a tree can be planted.

Advantages

- Inexpensive to construct and most components are re-usable
- No direct contact with excreta
- No water needed (except for cleaning)
- Orchard is developed over time

Disadvantages

- Ash, lime, sawdust, earth, or vegetable matter must be added regularly
- Space is required for planting trees after pit is three-fourths full
- Space is required to relocated the latrine on a regular basis

Materials

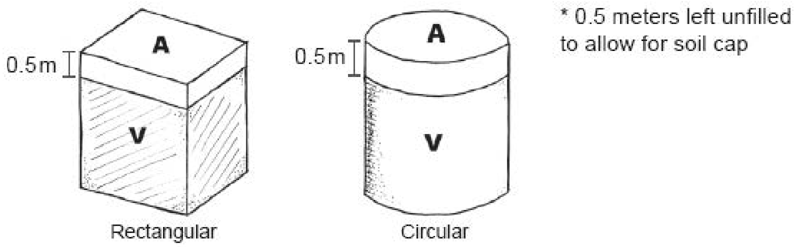
- **Ring**: cement or brick
- **Latrine Slab**: wood, mud, or reinforced concrete
- **Concrete or Mortar**: cement, sand, gravel, water

Good for Areas With

- Limited water supply
- Water is not used for anal cleaning
- Groundwater table is high
- Space for an orchard

Arborloo Latrine

Pit Shapes



Pit Base Area: Rectangular	$A = L \bullet W$	A: Area of pit (m^2) L: Length of pit (m) W: Width of pit (m)
Pit Base Area: Circular	$A = d^2 \bullet \frac{3.14}{4}$	A: Area of pit (m^2) D: Diameter of pit (m)
Soil Seal Depth	0.5 meters	
Pit Volume (when number of years is not known)	$V = L \bullet W \bullet D$	V: Volume of pit (m^3) L: Length of pit (m) W: Width of pit (m) D: Depth of pit (m)
Pit Depth	$D = \frac{V}{A}$	D: Depth of pit (m) V: Volume of pit (m^3) A: Area of pit (m^2)
Years in Use	$Y = \frac{(V - 0.5 \bullet A) \bullet 1000}{N \bullet R \bullet 1.5 \bullet 3}$ *A factor of 1.5 is used to increase the sludge accumulation rate to an excreta accumulation rate in the absence of local information. *A factor of 3 is used to account for the added volume of ash and other organic material.	V: Volume of pit (m^3) N: Number of users Y: Years in use (year) R: Sludge accumulation rate (liter/person/year)

Example

A family of four wishes to build an Arborloo latrine. The pit dimensions will be 1.2 m wide, 1.2 m long, and 1.5 m deep. They will use leaves as anal cleaning material, and after each use they will add ash. How many years will they be able to use their latrine?

Solution

1. Using ***Base Area: Rectangular*** with the dimensions 1.2m wide, 1.2m long and 1.5 deep, we obtain:

$A = L \bullet W = 1.2\text{m} \bullet 1.2\text{m} = \mathbf{1.44\ m^2}$

2. From ***Pit Volume***:

$$V = L \bullet W \bullet D = 1.2\text{m} \bullet 1.2\text{m} \bullet 1.5\text{m} = \mathbf{2.16\ m^3}$$

3. From ***Years in Use:***

$$Y = \frac{(V - 0.5 \bullet A) \bullet 1000}{N \bullet R \bullet 1.5 \bullet 3} = \frac{[2.16 - 0.5(1.44)] \bullet 1000}{4 \bullet 60 \bullet 1.5 \bullet 3} = \frac{(2.16 - 0.72) \bullet 1000}{1080} = \frac{1440}{1080} = \mathbf{1.33\ years}$$

4. Final Design:

An Arborloo latrine with a rectangular pit with a length of 1.2 m, a width of 1.2 m, and a depth of 1.5m will last a family of four about 1 year.

Tables

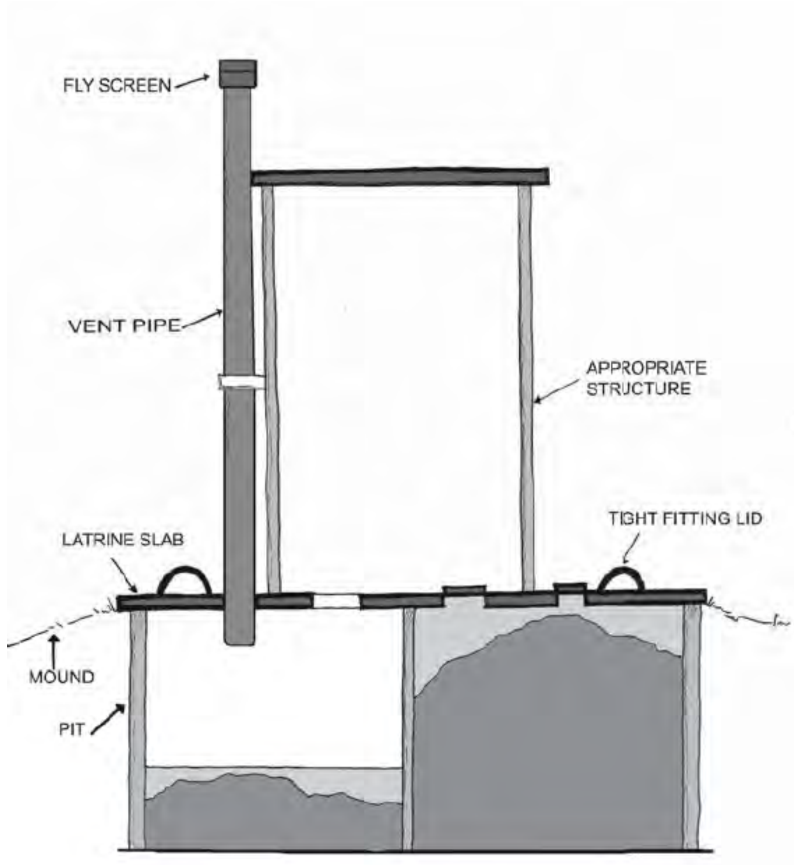
Suggested Maximum Sludge Accumulation Rate

Conditions	**Sludge Accumulation Rate: R (liters/person/year)**
Waste retained in water where degradable anal cleaning material is used (degradable material examples: leaves, paper, or cornhusks)	40
Waste retained in water where non-degradable anal cleaning material is used (non-degradable material examples: rocks, trash, or plastic)	60
Waste retained in dry conditions where degradable anal cleaning material is used	60
Waste retained in dry conditions where non-degradable anal cleaning material is used	90

Typical Pit Dimensions

Circular Pit	Rectangular Pit		
Diameter (m)	Width (m)	Length (m)	Depth (m)
1.1 – 1.4	1.0 – 1.2	1.0 – 1.2	Minimum 1.5

Advanced
Twin Pit Ventilated Latrine



General Information

The Twin Ventilated Improved Latrine (VIP) uses two shallow alternating pits. One pit can be used for two years while the full pit decomposes, inoculating all pathogenic organisms.

Advantages

- Built by householder
- Control of flies
- Easy removal of solids
- More or less permanent
- Contents safely used as soil conditioner after 2 years
-

Disadvantages

- No mosquito control
- Increase in cost by putting in vent
- Has to be kept dark
- Water needed for routine cleaning
- Misunderstanding of process limits needed air flow
- Twin pit is more expensive to build

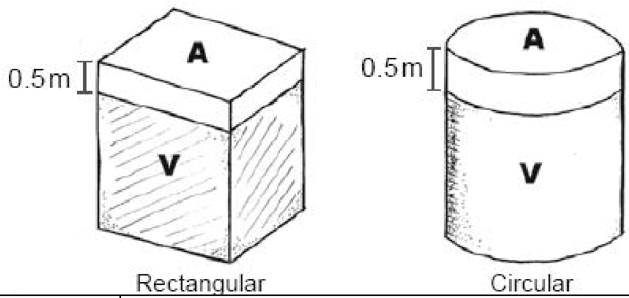
Materials

- **Lining**: brick, concrete block, stone, pole, bamboo
- **Latrine Slab**: wood, concrete
- **Concrete or Mortar**: cement, sand, gravel, water
- **Vent Pipe**: bamboo, mud and wattle, anthill soil, ferrocement, masonry, plastic
- **Fly Screen**

Good For Areas With

- Groundwater at depth greater than 3 meters
- Permeable soil
- Acceptance of using excreta as fertilizer/ soil conditioner

Pit Shapes



* 0.5 meters left unfilled to allow for soil cap

Pit Base Area: Rectangular	$A = L \bullet W$	A: Area of pit (m^2) L: Length of pit (m) W: Width of pit (m)
Pit Base Area: Circular	$A = d^2 \bullet \frac{3.14}{4}$	A: Area of pit (m^2) D: Diameter of pit (m)
Soil Seal Depth	0.5 meters	
Pit Volume	$V = \frac{(N \bullet R \bullet 1.5 \bullet 2\ \text{years})}{1000} + (0.5 \bullet A)$ *2 years is used for the life of each pit. After not being used for 2 years, the contents may safely be used as a soil conditioner. *A factor of 1.5 is used to increase the sludge accumulation rate to an excreta accumulation in the absence of local information.	V: Volume of pit (m^3) N: Number of users Y: Years in use A: Area of pit base (m^2) R: Sludge accumulation rate (liter/person/year)
Pit Depth	$D = \frac{V}{A}$	D: Depth of pit (m) V: Volume of pit (m^3) A: Area of pit (m^2)

Example
A family of 6 wishes to build a circular twin VIP latrine with a diameter of 1.4 meters. They have a separate bathing area and use paper for anal cleaning, each pit should take two years to fill.

Solution
1. Using ***Pit Base Area: Circular*** with a diameter of 1.4m for each pit we obtain:

$A = d^2 \bullet 3.14/4 = (1.4m)^2 \bullet 3.14/4 = \mathbf{1.54\ m^2}$

2. From ***Pit Volume***:

$$V=\frac{(N \bullet R \bullet 2 \bullet 1.5)}{1000}+0.5A=\left[\frac{6\ \text{people} \bullet (60\ \text{liter/person/year}) \bullet 1.5m \bullet 2\ \text{years}}{1000}\right]+[0.5 \bullet 1.54\ m^2]= \mathbf{1.85\ m^3}$$

3. From ***Pit Depth***:

$$D = \frac{V}{A} = \frac{1.85\ m^3}{1.54\ m^2} = \mathbf{1.2\ m}$$

4. Final Design:

Two circular pits with diameters of 1.4 meters and depths of 1.2 meters. The first pit should take about 2 years to fill. After the pit is ¾ full, it should be closed off and allowed to sit while the other pit is in use. Once the second pit is ¾ full (after about 2 years) the first will be ready to compost.

Tables

Suggested Maximum Sludge Accumulation Rate

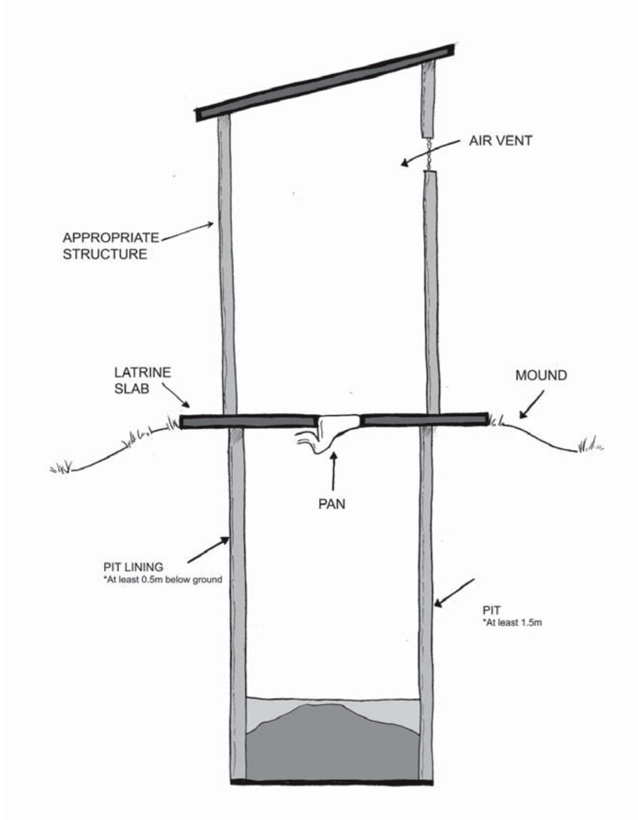
Conditions	Sludge Accumulation Rate: R (liters/person/year)
Waste retained in water where degradable anal cleaning material is used (degradable material examples: leaves, paper, or cornhusks)	40
Waste retained in water where non-degradable anal cleaning material is used (non-degradable material examples: rocks, trash, or plastic)	60
Waste retained in dry conditions where degradable anal cleaning material is used	60
Waste retained in dry conditions where non-degradable anal cleaning material is used	90

Note: The above figures are given in long term accumulation rates. In shallow pits (such as are used in twin pit latrines) these rates are too low. It is suggested that they are increased by 50%. To figure this into the calculation, multiply R by 1.5.

Typical Pit Dimensions

Circular Pit	Rectangular Pit		
Diameter (m)	Width (m)	Length (m)	Depth (m)
1.1 – 1.4	1.0 – 1.2	1.0 – 1.2	Minimum 1.5

Pour Flush Latrine



General Information

The Pour Flush Latrine is a modification on the Basic Pit Latrine. With the water seal in the pan, flies, and mosquitoes are controlled and unwanted smell is eliminated.

Advantages

- Control of flies and mosquitoes
- Odor control
- Pit contents not visible

Disadvantages

- Reliable supply of water must be available
- Solid anal cleaning material must not be used
- Lack of water during flushing causes blockage
- Water can accumulate in the pit if there is poor drainage

Materials

- **Lining**: brick, concrete block, stone, pole, bamboo
- **Latrine Slab**: wood, concrete
- **Concrete or Mortar**: cement, sand, gravel, water
- **Pan**: ceramic, fiberglass, concrete

Good For Areas With

- Groundwater depth greater than 3 meters
- Permeable soil
- Reliable water source

Pour flush Design[32]

General Information

Pour flush latrines require a special pan which conains a water seal or trap, to be attached to the defecation hole. There are several designs for these pans, which are described below. 2-3 liters of water is required to flush excreta through the seal into the pit. The amount of water required may increase if the pit is offset.

These pans generally reduce odor and thus reduce fly activity making them an attractive option. However, in places where water is scarce, this would not be a wise choice because water is required for flushing. In fact, one of the main problems that occurs with pour flush latrine is clogging due to not flushing with water. People sometimes try to clear the seal with a stick and end up breaking it.

Pour flush seals take a skilled craftsman to construct, therefore it is recommended that these be purchased locally. To attach a concrete, plastic or galvanized metal seal, secure the pour flush seal to the slab with cement mortar and allow two or three days to set before use.

Pans and Seals

Pans can be made from ceramic or fiberglass; the less course the material, the easier they are to keep clean. Usually pans can be installed directly into the defecation hole using mortar.

Pans are usually about 350mm in length. The seal volume is measured by the amount of water that remains within the seal when not in use. The deeper the seal, the more water required to flush. A general measurement for a seal depth is about 20-30mm.

"Gooseneck" Pan

The Gooseneck pan contains both the pan and the seal as one component. The design of this pan works well when excreta is discharged directly into the pit and not sent through a pipe to an offset pit. The curve of the seal enables excreta to travel directly into the pit rather than coming into contact with the pit lining, which could cause problems.

"P-trap" Seal

Sometimes seals are manufactured separately from the pans to allow users to choose where to place the offset pit. The P-trap has a sloped outlet which can be connected with a pipe to discharge to an offset pit. These can be connected by using a pipe joint. Having a separate seal can be beneficial when using two pits because the direction of the seal can be changed in order to discharge to the second pit.

[32] Richard Franceys et al., *A Guide to the Development of On Site Sanitation* (Geneva: WHO, 1992), 52- 55, 112-113.

"S-trap" Seal
The S-trap is another seal that is separate from the pan. This seal has a vertical outlet.

Pipes and Junction Points

Pipes connect the water seal with the offset pit. These should be no less than 75mm in diameter, and can be made from various materials including: plastic, fired clay or asbestos cement[1]. Pipes should be smooth and straight, as roughness or curves may lead to blockage. The end of the pipe should extend to the center of the pit as to not allow excreta to damage the lining.

When using two offset pits, there are two main choices for directing excreta to the pits. One pipe can be directed from the seal to the pit and then moved once the first pit is full. Another option is to connect one piece of pipe from the seal to a "Y" shaped junction point. Then connect two pipes from the junction point to the pits. Make sure that one direction of the "Y" is blocked off, enabling excreta to only flow to one pit at a time. When using an offset, it may be wise to buy or construct a pan where the seal is a separate component. This design allows the user to choose the direction from which the pipe can be connected to the seal.

Pour Flush Seal Diagrams[33]

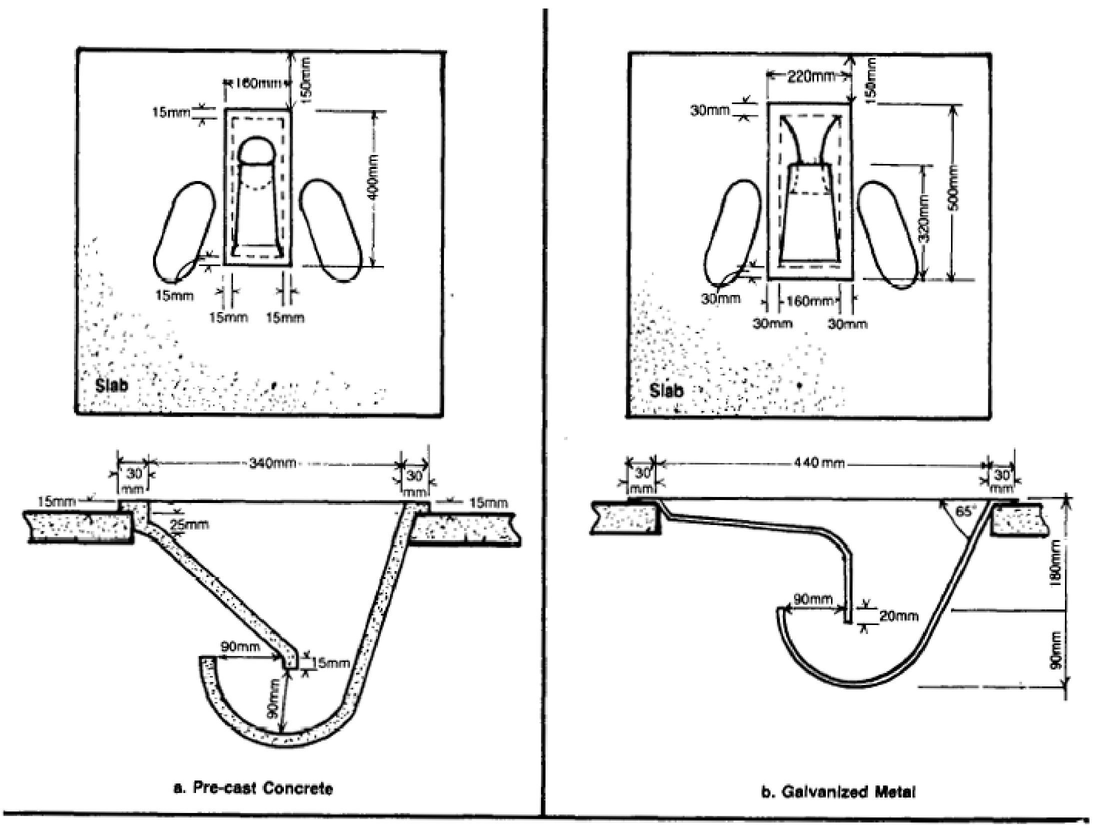
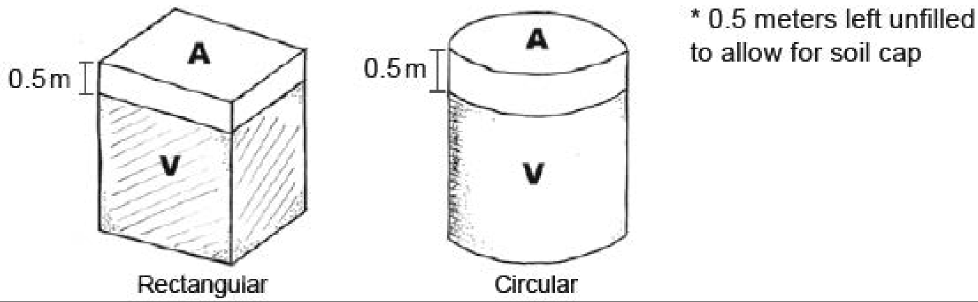


Figure 6. Pour-Flush Bowls for Squatting Slabs

[33] *Water for the World: Constructing Slabs for Privies, Technical Note No. SAN 1.C.1* (USA: National Demonstration Water Project, Institute for Rural Water and National Environmental Health Association, 1982), 4.

Pit Shapes



Pit Base Area: Rectangular	$A = L \bullet W$	A: Area of pit (m^2) L: Length of pit (m) W: Width of pit (m)
Pit Base Area: Circular	$A = d^2 \bullet \frac{3.14}{4}$	A: Area of pit (m^2) D: Diameter of pit (m)
Soil Seal Depth	0.5 meters	
Pit Volume	$V = \frac{(N \bullet R \bullet Y)}{1000} + (0.5 \bullet A)$	V: Volume of pit (m^3) N: Number of users Y: Years in use A: Area of pit base (m^2) R: Sludge accumulation rate (liter/person/year)
Pit Depth	$D = \frac{V}{A}$	D: Depth of pit (m) V: Volume of pit (m^3) A: Area of pit (m^2)
Years in Use	$Y = \frac{(V - 0.5 \bullet A) \bullet 1000}{N \bullet R}$	V: Volume of pit (m^3) N: Number of users Y: Years in use (year)

Example
A family of 6 wishes to build a circular pour flush latrine with a diameter of 1.3 meters that will last 15 years. The family has a separate bathing area and uses water for anal cleaning.

Solution
1. Using ***Pit Base Area: Circular*** with a diameter of 1.3m we obtain:

$$A = d^2 \bullet 3.14/4 = (1.3\text{m})^2 \bullet 3.14/4 = \mathbf{1.33\ m^2}$$

2. From ***Pit Volume***:

$$V = \frac{(N \bullet R \bullet Y)}{1000} + 0.5\text{m} \bullet A = \frac{6 \text{ people} \bullet (40 \text{ liter/person/year}) \bullet 15 \text{ years}]}{1000} + [0.5\text{m} \bullet 1.33\text{ m}^2] = \mathbf{4.27\ m^3}$$

3. From ***Pit Depth***:

$$D = \frac{V}{A} = \frac{4.27\text{ m}^3}{1.33\text{ m}^2} = \mathbf{3.2\ m}$$

4. Final Design:
A circular pit with a diameter of 1.3 meters and depth of 3.2 meters.
The pit will last the family of six for 15 years.

Tables

Suggested Maximum Sludge Accumulation Rate

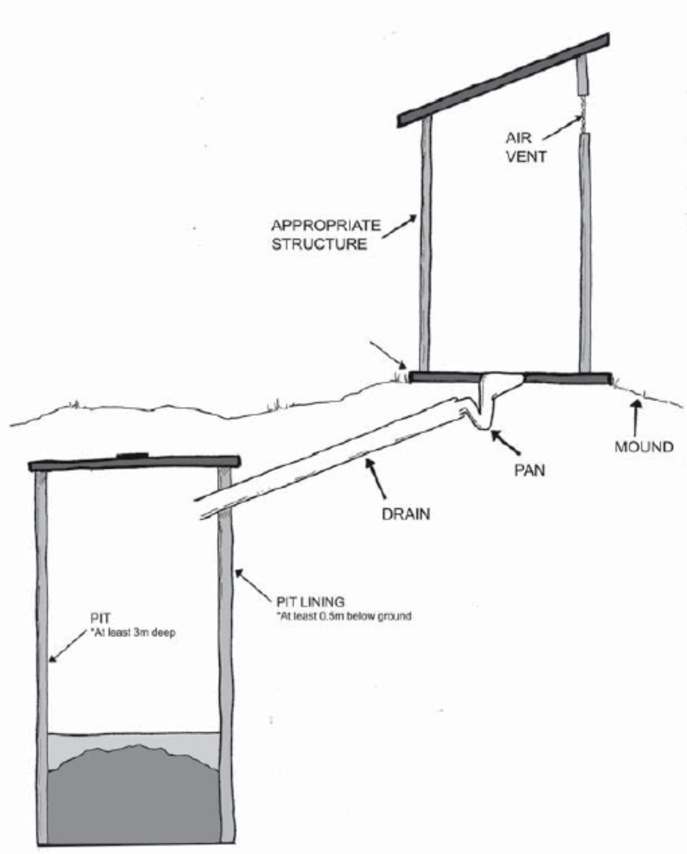
Conditions	**Sludge Accumulation Rate: R (liters/person/year)**
Waste retained in water where degradable anal cleaning material is used (degradable material examples: leaves, paper, or cornhusks)	40
Waste retained in water where non-degradable anal cleaning material is used (non-degradable material examples: rocks, trash, or plastic)	60

Typical Pit Dimensions

Circular Pit	Rectangular Pit		
Diameter (m)	Width (m)	Length (m)	Depth (m)
1.1 – 1.4	1.0 – 1.2	1.0 – 1.2	Minimum 1.5

Pour Flush-Offset Latrine

General Information



The Offset Pour Flush Latrine allows for the latrine to be placed inside or right next to the house. Once the pit is full it must be emptied, but this allows for a more or less permanent structure.

Advantages

- Control of flies and mosquitoes
- Odor control
- Pit contents not visible
- Latrine can be located inside
- Latrine can be permanent
- Ground supports pan

Disadvantages

- Reliable supply of water must be available
- Solid anal cleaning material must not be used
- Lack of water during flushing causes blockage
- Excreta being emptied from the full pit is fresh and potentially harmful, if not left for 12-18 months to decompose
- More expensive to build
- Water can accumulate in the pit if drainage is not adequate.

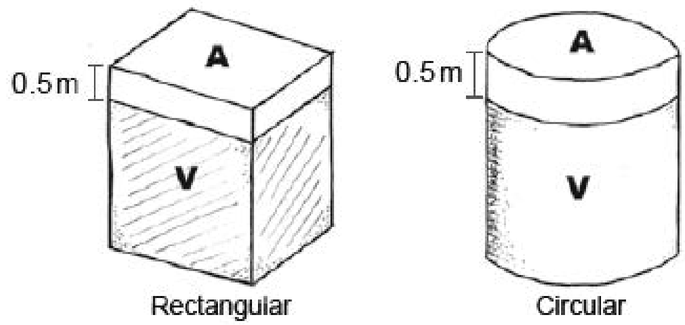
Materials

- **Lining**: brick, concrete block, stone, pole, bamboo
- **Latrine Slab**: wood, concrete
- **Concrete or Mortar**: cement, sand, gravel, water
- **Pan**: ceramic, fiberglass, concrete
- **Drain**: PVC pipe, brick

Good For Areas With

- Groundwater depth greater than 3 meters
- Permeable soil
- Reliable water source

Pit Shapes



* 0.5 meters left unfilled to allow for soil cap

Pit Base Area: Rectangular	$A = L \bullet W$	A: Area of pit (m^2) L: Length of pit (m) W: Width of pit (m)
Pit Base Area: Circular	$A = d^2 \bullet \frac{3.14}{4}$	A: Area of pit (m^2) D: Diameter of pit (m)
Soil Seal Depth	0.5 meters	
Pit Volume	$V = \frac{(N \bullet R \bullet Y)}{1000} + (0.5 \bullet A)$	V: Volume of pit (m^3) N: Number of users Y: Years in use A: Area of pit base (m^2) R: Sludge accumulation rate (liter/person/year)
Pit Depth	$D = \frac{V}{A}$	D: Depth of pit (m) V: Volume of pit (m^3) A: Area of pit (m^2)
Years in Use	$Y = \frac{(V - 0.5 \bullet A) \bullet 1000}{N \bullet R}$	V: Volume of pit (m^3) N: Number of users Y: Years in use (year)

Example
A family of 8 wishes to build a circular offset pour flush latrine with a diameter of 1.6 meters that will last 15 years. The family uses water for anal cleaning.

Solution
1. Using ***Pit Base Area: Circular*** with a diameter of 1.6m, we obtain:

$$A = d^2 \bullet 3.14/4 = (1.6\text{m})^2 \bullet 3.14/4 = \mathbf{2.0\ m^2}$$

2. From ***Pit Volume***:

$$V = \frac{(N \bullet R \bullet Y)}{1000} + 0.5 \bullet A = \frac{[8 \text{ people} \bullet (40 \text{ liter/person/year}) \bullet 15 \text{ years}]}{1000} + [0.5 \bullet 2.0\ \text{m}^2] = \mathbf{5.8\ m^3}$$

3. From ***Pit Depth***:

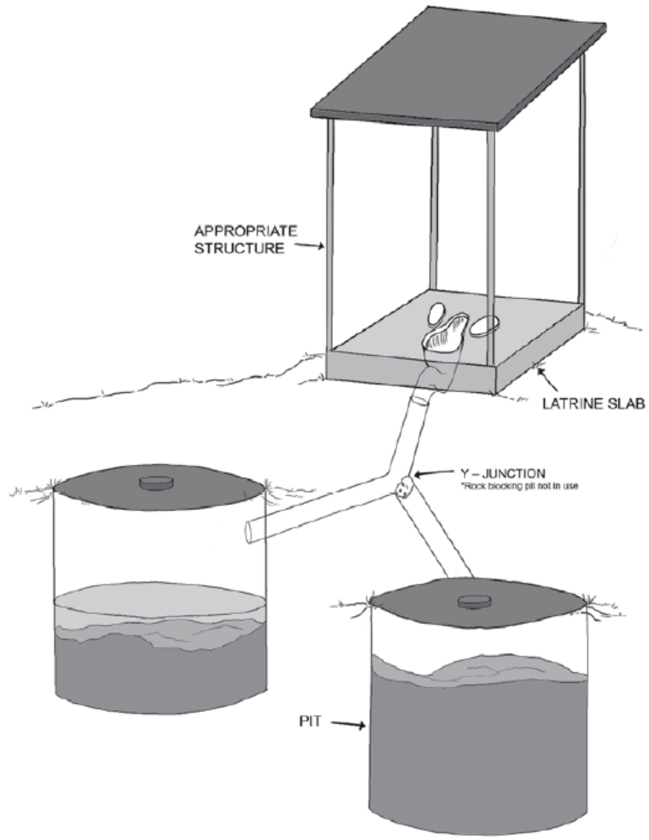
$$D = \frac{V}{A} = \frac{5.8\ \text{m}^3}{2.0\ \text{m}^2} = \mathbf{2.9\ m}$$

4. Final Design: *A circular offset pit with a diameter of 1.6 meters and depth of 2.9 meters. The pit will last the family of eight for 15 years.*

Twin Pour Flush Latrine

General Information

With the offset of the Twin Pour Flush Latrine, the latrine may be placed inside of the house. A diverter at the Y-Junction allows for the flow of the excreta to be directed to either pit. One pit can be used for two years while the full pit decomposes, inoculating all pathogenic microorganisms. This allows for a fairly permanent latrine.



Advantages

- Control of flies and mosquitoes
- Odor control
- Pit contents not visible
- Latrine can be located inside
- Can be permanent
- Ground supports pan
- Contents safely used as a soil conditioner after 2 years

Disadvantages

- Reliable supply of water must be available
- Solid anal cleaning material must not be used
- Lack of water during flushing causes blockage
- Excreta being emptied is fresh and potentially harmful, if not left for 12-18 months to decompose
- More expensive to build

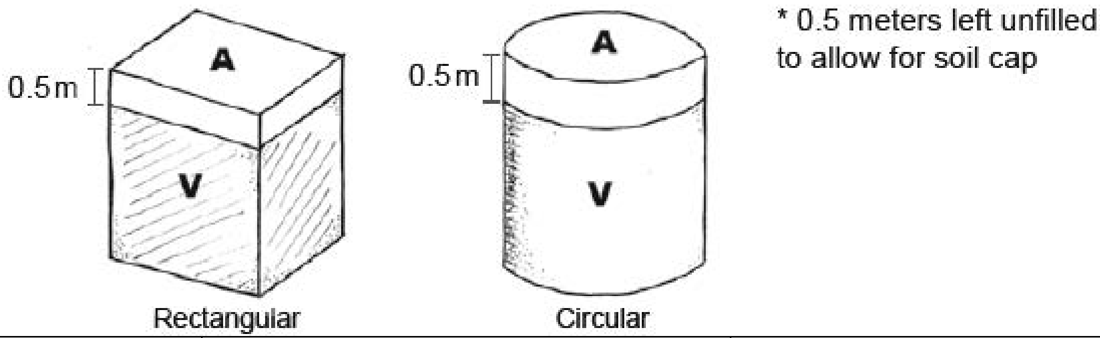
Materials

- **Lining**: brick, concrete block, stone, pole, bamboo
- **Latrine Slab**: wood, concrete
- **Concrete or Mortar**: cement, sand, gravel, water
- **Pan**: ceramic, fiberglass, concrete
- **Drain**: PVC pipe, brick

Good For Areas With

- Permeable soil
- Reliable water source
- Groundwater depth is greater than 3 meters
- Acceptance of using excreta as a fertilizer or soil conditioner

Pit Shapes



Pit Base Area: Rectangular	$A = L \cdot W$	A: Area of pit (m^2) L: Length of pit (m) W: Width of pit (m)
Pit Base Area: Circular	$A = d^2 \cdot \frac{3.14}{4}$	A: Area of pit (m^2) D: Diameter of pit (m)
Soil Seal Depth	0.5 meters	
Pit Volume	$V = \frac{(N \cdot R \cdot 1.5 \cdot 2\ \text{years})}{1000} + (0.5 \cdot A)$ *2 years is used for the life of each pit. After not being used for 2 years, the contents may safely be used as a soil conditioner. *A factor of 1.5 is used to increase the sludge accumulation rate to an excreta accumulation in the absence of local information.	V: Volume of pit (m^3) N: Number of users Y: Years in use A: Area of pit base (m^2) R: Sludge accumulation rate (liter/person/year)
Pit Depth	$D = \frac{V}{A}$	D: Depth of pit (m) V: Volume of pit (m^3) A: Area of pit (m^2)
Years in Use	$Y = \frac{(V - 0.5 \cdot A) \cdot 1000}{N \cdot R}$	V: Volume of pit (m^3) N: Number of users Y: Years in use (year)

Example
A family of 8 wishes to build a circular twin pour flush latrine. Each pit will have a diameter of 1.2 meters. They use corncobs for anal cleaning and will be using the latrine for bathing.

Solution
1. Using ***Pit Base Area: Circular*** with a diameter of 1.2m for each pit, we obtain:

$A = d^2 \cdot 3.14/4 = (1.2\text{m})^2 \cdot 3.14/4 = \mathbf{1.13\ m^2}$

2. From ***Pit Volume***:

$$V = \frac{(N \cdot R \cdot Y)}{1000} + 0.5\text{m} \cdot A = \frac{[8\ \text{people} \cdot (60\ \text{liter/person/year}) \cdot 1.5 \cdot 2\ \text{years}]}{1000} + (0.5 \cdot 1.13\ m^2) = \mathbf{2.0\ m^3}$$

3. From ***Pit Depth***:

$$D = \frac{V}{A} = \frac{2.0 \ m^3}{1.13 \ m^2} = \mathbf{1.8\ m}$$

4. Final Design:

Two circular pits with a diameter of 1.2 meters and depth of 1.8 meters. The first pit should take about 2 years to fill. After the pit is ¾ full, it should be closed off and allowed to sit while the other pit is in use. Once the second pit is ¾ full (after about 2 years) the first will be ready to compost.

Tables

Suggested Maximum Sludge Accumulation Rate

Conditions	Sludge Accumulation Rate: R (liters/person/year)
Waste retained in water where degradable anal cleaning material is used (degradable material examples: leaves, paper, or cornhusks)	40
Waste retained in water where non-degradable anal cleaning material is used (non-degradable material examples: rocks, trash, or plastic)	60

NOTE: The above figures are given in long term accumulation rates. In shallow pits (usually used in twin pit latrines) these rates are too low. It is suggested that they are increased by 50%. To figure this into the calculation, multiply R by 1.5.

Typical Pit Dimensions

Circular Pit	Rectangular Pit		
Diameter (m)	Width (m)	Length (m)	Depth (m)
1.1 – 1.4	1.0 – 1.2	1.0 – 1.2	Minimum 1.5

Composting[34]

What is Composting?
Composting is the controlled aerobic biological decomposition of organic matter to produce a soil conditioner.

The goal of a composting latrine is to break down human excrement, which contains harmful pathogens, into a stable, oxidized form. Microorganisms that exist in the pit, such as bacteria or fungi, compete for food sources. These sources could be organic matter like feces, toilet paper, and pathogens. Eventually, the food sources are exhausted and the microorganisms die off leaving the compost suitable for use.

Elements Needed for Successful Composting

- Provide a carbon source for the organisms.
  This will ensure a carbon to nitrogen balance and will encourage a large population that will help breakdown the pit contents.
    - Do this by mixing in organic material such as leaves, sawdust, straw or soil.

- Create an oxygen-rich environment.
  Air must reach the microorganisms in charge of composting. If the pile becomes solid or compact, oxygen molecules may not make their way down to reach the microorganisms at the bottom.
    - Mixing and turning the material on a regular basis will help with this.
    - Bulky organic items will also help circulate air. Wood chips and corn husks create spaces in the pile that can allow oxygen to pass through.
    - A vent pipe will help ensure air circulation in the pit.

- Regulate moisture levels in the pit.
  Too much liquid will deprive the organisms of oxygen. If the pit is too dry, matter will not decompose. A dehydrated pit creates a place for pathogens to lie dormant rather than destroying them. Moisture levels should be between 45-70 percent, much like the consistency of a wrung out sponge.
    - If the pile becomes too dry, adding a cup of water will help.

- Create a warm environment.
  Temperature plays a role in the speed of decomposition. If a pit is warm and moist, matter will decompose faster.
    - Solar panels installed as emptying doors, or doors painted black to absorb heat will help increase temperature. Make sure to turn the pile and add water periodically to keep a good amount of oxygen and moisture.

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[34] David Del Porto and Carol Steinfeld, *The Composting Toilet System Book: A Practical Guide to Choosing, Planning, and Maintaining Composting Toilet Systems, a Water-saving, Pollution-preventing Alternative 1st ed.* (Concord: The Center for Ecological Pollution Prevention, 1999), 19-25.

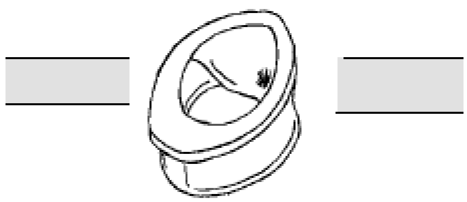
- Keep in mind the Carbon to Nitrogen Ratio.
  The ideal ratio for Carbon to Nitrogen is 25:1, this will provide the nutrients microorganisms need to grow and survive.
    - Urine is mostly nitrogen and could potentially create an imbalance in the ratio, however it will most likely seep from the pit, or evaporate. Adding a small handful of carbon-rich material such as leaves, sawdust, straw or soil after each use will help maintain the ratio, absorb excess moisture, and create oxygen flow without filling the pit too quickly.

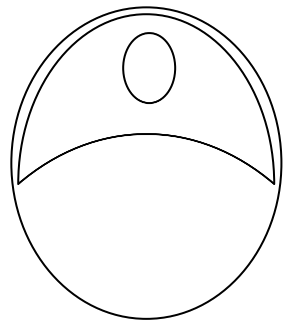
How Pathogens are Destroyed in a Composting Latrine

- Containment
    - When pathogens remain in a pit or container for an extended period of time they are unable to survive. The environment no longer meets their needs, and they are unable to spread to other hosts.
- Competition
    - Organisms in a composting latrine consider pathogens a food source. They will compete for food until all sources are exhausted and die off. At that time the matter is considered fully oxidized and safe for use.

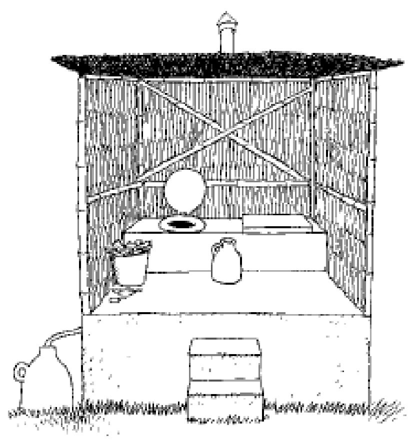
Urine Diversion[35]

Latrines that use urine for fertilizer must be equipped with a pan or slab that diverts urine from the pit. These can be designed a number of ways, however they usually have two holes, one at the front for urine and one at the back for feces to enter the pit.



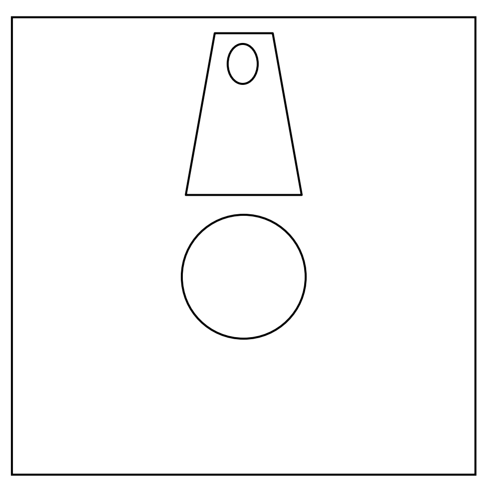


Urine travels through a tube or channel connected to the hole, to a container located outside the structure.



If seats are not available or accepted, slabs can also be constructed to separate urine and feces. One example of this is shown below.

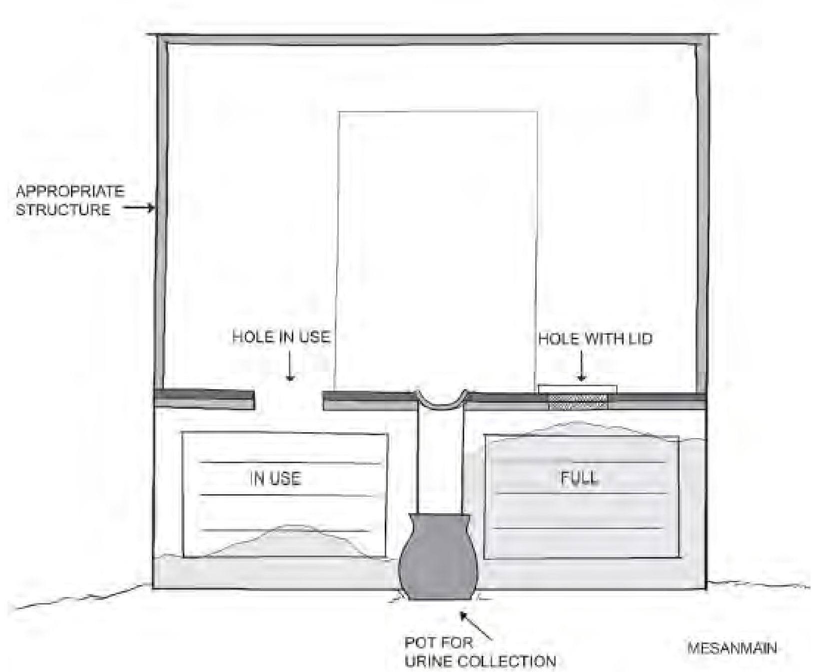
This front area of the slab is sloped towards the hole where urine is collected.



[35] Jeff Conant, *Sanitation and Cleanliness for a Healthy Environment* (Hesperian Foundation, 2005), 38.

Twin Pit Dry Compost Latrine

General Information



The Dry Compost Latrine produces soil conditioner in batches every two years. The urine is separated from the feces to keep the moisture content inside the vault down. After each use the feces are covered with ash, lime, sawdust, earth or vegetable matter. The urine may be used as a fertilizer if diluted with eight parts water.

Advantages

- Content may be used as a soil conditioner after 2 years
- No water needed (except for cleaning)
- No need to dig a pit
- Pit less likely to collapse
- Permanent structure
- Less possibility of groundwater contamination

Disadvantages

- Urine must be separated from feces
- Ash, lime, sawdust, earth, or vegetable matter must be added regularly
- Expensive construction
- More maintenance required
- Misunderstanding the process can lead to problems

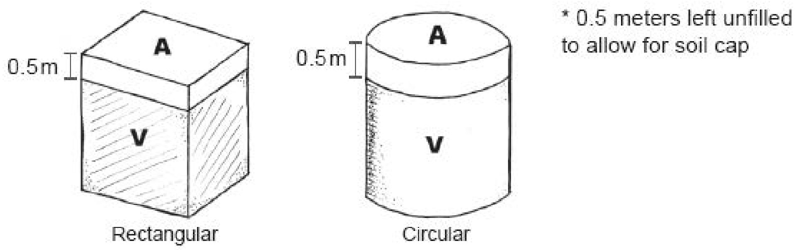
Materials

- **Lining**: brick, concrete block, stone, pole, bamboo
- **Latrine Slab**: wood, bricks, concrete block, stone
- **Concrete or Mortar**: cement, sand, gravel, water

Good for Areas With

- Acceptance of using excreta as fertilizer/soil conditioner
- Limited water supply
- Water is not used for anal cleaning
- Areas with a high water table
- Areas with impermeable soil

Pit Shapes



Pit Base Area: Rectangular	$A = L \bullet W$	A: Area of pit (m^2) L: Length of pit (m) W: Width of pit (m)
Pit Base Area: Circular	$A = d^2 \bullet \frac{3.14}{4}$	A: Area of pit (m^2) D: Diameter of pit (m)
Pit Volume	$V = \frac{(N \bullet R \bullet 1.5 \bullet 2\ \text{years} \bullet 3)}{1000} + (0.5 \bullet A)$ *2 years is used for the life of each pit. After not being used for 2 years, the contents may safely be used as a soil conditioner. *A factor of 1.5 is used to increase the sludge accumulation rate to an excreta accumulation in the absence of local information. *A factor of 3 is used to account for the added volume of ash and other organic material.	V: Volume of pit (m^3) N: Number of users Y: Years in use A: Area of pit base (m^2) R: Sludge accumulation rate (liter/person/year)
Soil Seal Depth	0.5 meters	
Actual Pit Volume	$V^* = \frac{4}{3} \bullet V$	V*: Actual Volume of pit (m^3) V: Volume of pit (m^3) *The Volume is increased due to the pit being sealed when ¾ full.
Pit Depth	$D = \frac{V^*}{L \bullet W}$	D: Depth of pit (m) V*: Actual volume of pit (m^3) L: Length of pit (m) W: Width of pit (m)

Example

A family of 2 wishes to build a twin dry composting latrine with a cross section of 1 meter. The family uses grass and leaves for anal cleaning.

Solution

1. Using ***Pit Base Area: Rectangular*** with a cross section of 1m, we obtain:

$A = L \bullet W = 1 \bullet 1 = 1$

2. Using ***Pit Volume*** we obtain:

$$V = \frac{N \bullet R \bullet 2\ \text{years} \bullet 1.5 \bullet 3}{1000} + (0.5 \bullet A) = \left[\frac{2\ \text{people} \bullet (60\ \text{liter/person/year}) \bullet 2\ \text{years} \bullet 1.5 \bullet 3}{1000}\right] + (0.5 \bullet 1) = \mathbf{1.58\ m^3}$$

3. From ***Actual Pit Volume***:

$$V^* = \frac{4}{3} \bullet V = \frac{4}{3} \bullet 1.58\ m^3 = \mathbf{2.11\ m^3}$$

4. From ***Pit Depth***:

$$D = \frac{V^*}{L \bullet W} = \frac{2.11\ m^3}{1m \bullet 1m} = \mathbf{2.11\ m}$$

5. Final Design:

A dual vault where each vault has a cross section of 1 meter by 1 meter and a depth of 2 meters. The compost will be produced in batches every two years.

Tables

Suggested Maximum Sludge Accumulation Rate

Conditions	**Sludge Accumulation Rate: R (liters/person/year)**
Waste retained in water where degradable anal cleaning material is used (degradable material examples: leaves, paper, or cornhusks)	60
Waste retained in water where non-degradable anal cleaning material is used (non-degradable material examples: rocks, trash, or plastic)	90

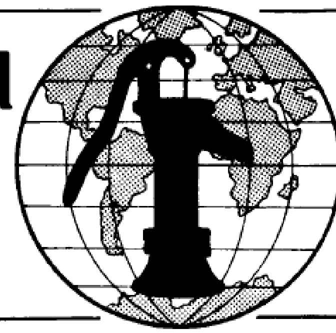
General Pit Dimensions

Width (m)	Length (m)
1.0 – 1.2	1.0 – 1.2

Water for the World[36]
Constructing Compost Toilets SAN 1.C.6

Water for the World

Constructing Compost Toilets
Technical Note No. SAN. 1.C.6



A compost toilet consists of a pair of waterproof vaults that receive excreta, ashes, sawdust, straw and grass. Each vault is equipped with a slab for defecating, a rear opening for removing compost, and a hole for a pipe. Constructing a compost toilet involves assembling all necessary labor, materials, and tools; building a base and double vault from concrete or brick and mortar; and installing vent pipes, covers for the rear openings, and a pair of slabs.

With careful maintenance, a properly constructed compost toilet can last 10-20 years or more. This technical note describes each step in constructing a compost toilet. Read the entire technical note before beginning construction.

Useful Definition Compost: A dark, fairly dry, crumbly, odorless material that is produced by sealing excreta, ashes, woodchips, straw, and vegetable wastes for 6 to 12 months in the vault of a compost toilet. Compost can be used to fertilize crops.

Construction Steps

Depending on local conditions, availability of materials, and skills of workers, some construction steps will require only a few hours, while others may take a day or more. Read the construction steps and make a rough estimate of the time required for each step. Draw up a work plan. You will then have an idea of when specific laborers, materials, and tools must be available during the construction process.

[36] *Water for the World: Constructing Compost Toilets, Technical Note No. SAN 1.C.6* (USA: National Demonstration Water Project, Institute for Rural Water and National Environmental Health Association, 1982), 1-7.

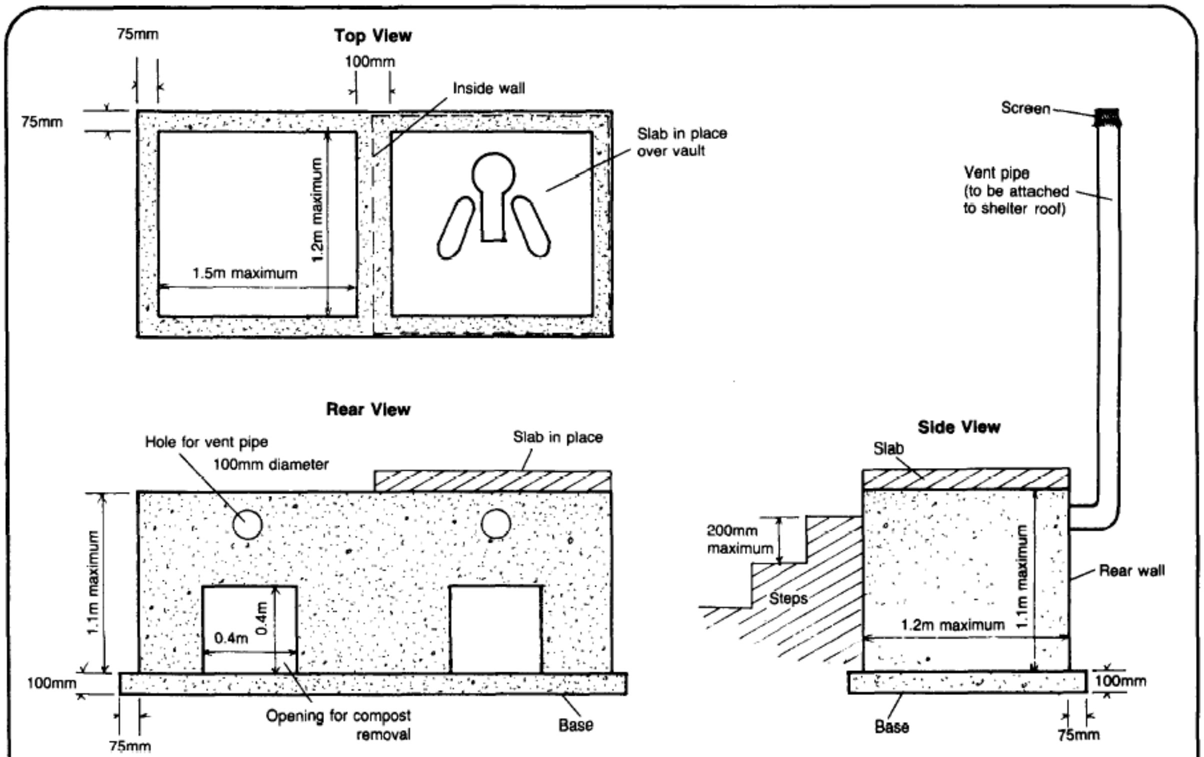


Figure 2. Compost Toilet

For a concrete compost toilet

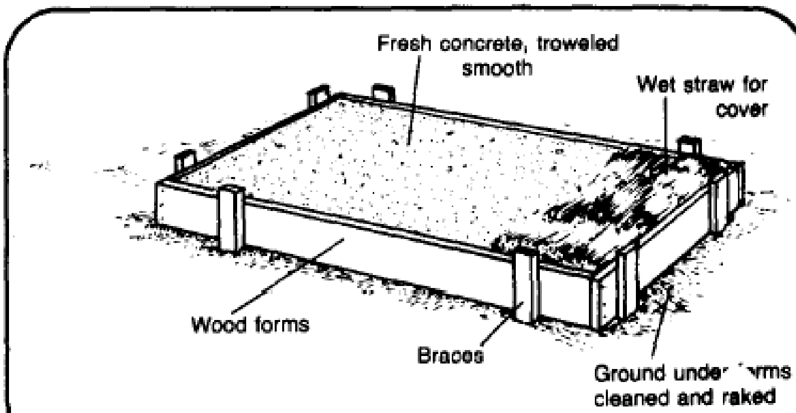


Figure 3. Concrete Base

5. Assemble all laborers, materials, tools and drawings needed to begin construction. Study all drawings carefully.
6. Prepared the site by removing vegetation and rocks and raking the ground smooth. Build the forms for the base of the toilet.
7. Mix the concrete to the correct proportions. **Follow instructions from Concrete Slab Construction.**
8. Remove the cover material and forms from the base. Build forms for the vault walls. Build and opening in the rear wall of each vault for compost removal. Set a section of vent pipe into the rear forms for installation of the vents. Secure reinforcing material in place inside the forms. Brace the forms to be certain that they hold together when the concrete is poured. See figure 4.

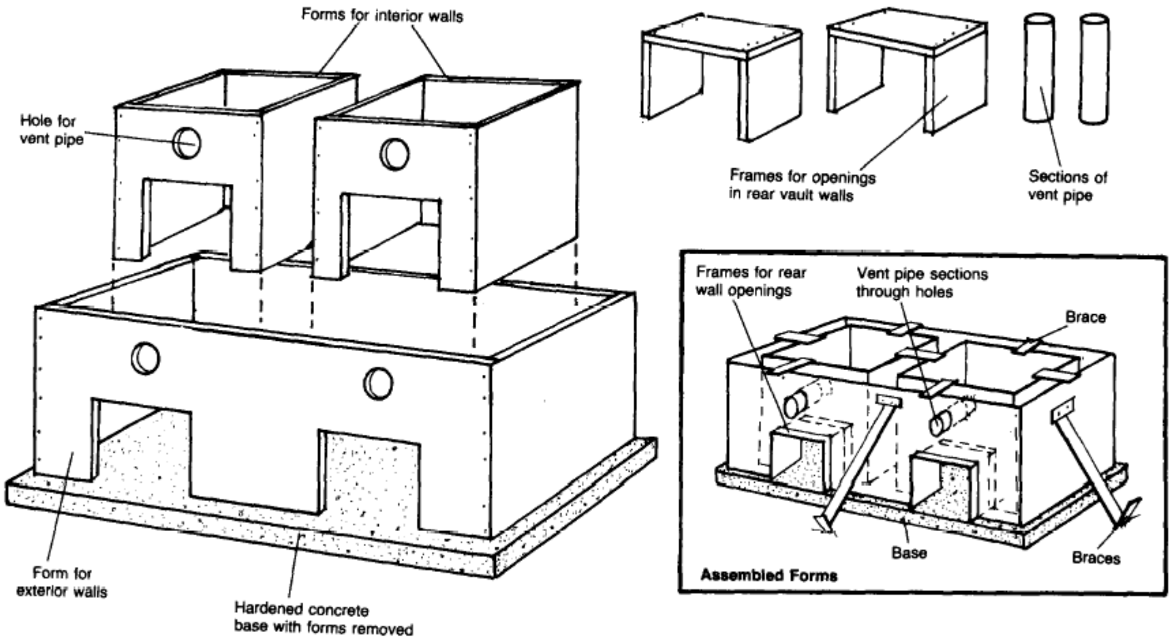


Figure 4. Forms for Concrete Walls

9. Pour concrete into the wall forms. The concrete must completely fill the forms. Use a steel rod or stout stick to work concrete between the reinforcing materials and the forms. Smooth the tops of the walls with a trowel. Cure concrete. See Figure 5a.
10. Remove the cover material and forms from the walls after curing is complete. Seal the bottom edges of the walls, inside and outside, with cement mortar made with one part cement to three parts sand and enough water to make a workable mix.

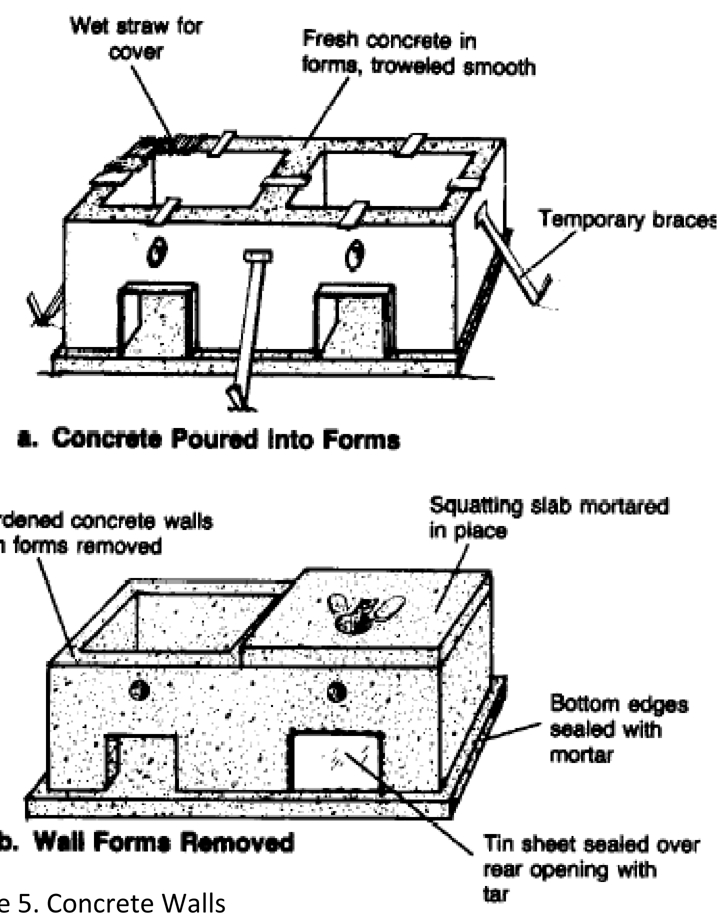


Figure 5. Concrete Walls

11. Cover the rear openings and seal with tar or equivalent. Be sure that the cover is several inches larger than the opening and that the opening is flush on all sides. This will help ensure the tar seal is strong enough to hold the weight of the accumulating compost. Do not use cement to seal the covers because eventually they will have to be removed. The covers may also need to be braced.
12. Mortar the slabs in place. See figure 5b.
13. Build steps leading up to the toilet. Use bamboo, wood, bricks, or other local materials. Be certain each step is no higher than 200mm.
14. Build a shelter: see "Constructing Privy Shelters" SAN 1.C.3.
15. Install the vent pipes and secure them to the rear wall or roof of the shelter. See figure 6.

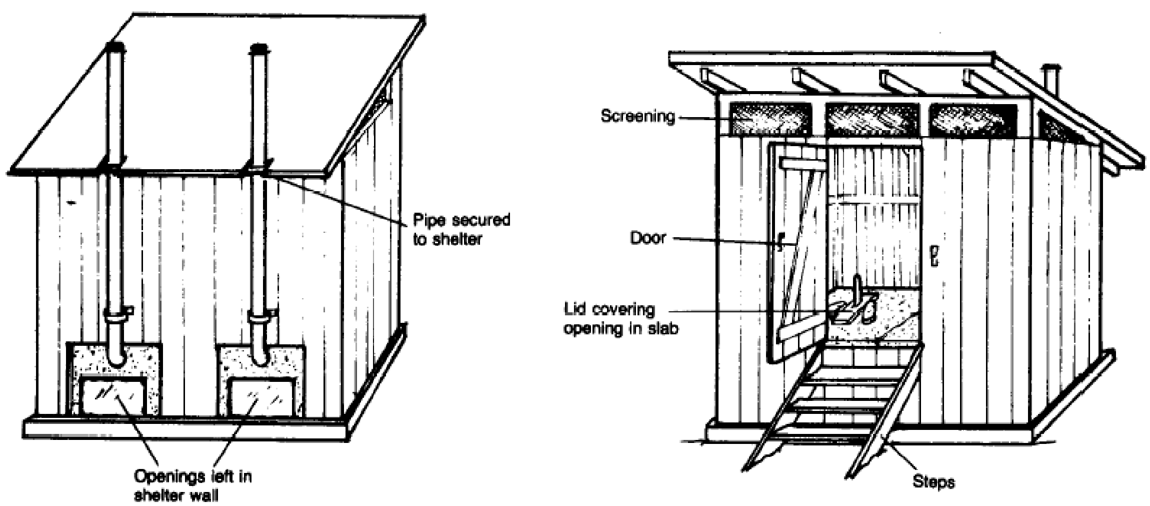


Figure 6. Completed Compost Toilet

For a Brick and Mortar Compost Toilet

1. Prepare the site and gather materials
2. Build the base from bricks and mortar.
3. Plaster the top of the base with a 12-25mm thick layer of cement mortar. Smooth with a trowel and cure for three days.

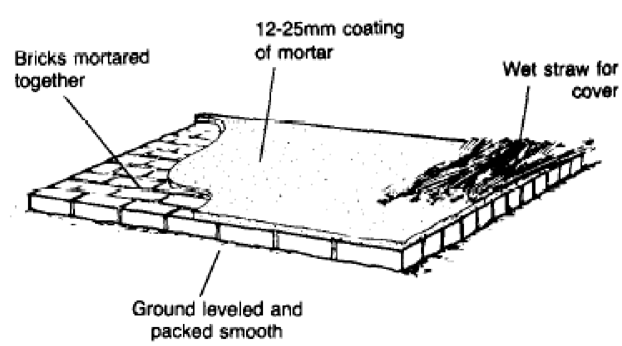


Figure 7. Brick and Mortar Base

4. Remove material used to cure, and begin laying up the walls, including the wall between the vaults. Build and install frames for the rear wall openings. Rust-proof metal is the best frame material, but wood, bamboo, or other local material can be used. See figure 8.
5. When the walls are 200 to 300mm short of their designed height, mortar sections of the vent pipe in place, lay bricks around the sections, and continue laying up the walls to their designed height. See figure 8.
6. Fill in any holes or openings in the top course of bricks with cement mortar. Allow 1 to 3 days for the walls to set.
7. Coat the insides of the walls with 12-25mm of cement plaster. Seal the bottom edges of the walls, inside and outside, with cement plaster. See figure 9.
8. Mortar the slab in place.
9. Build steps.
10. Build a shelter.
11. Install the vent pipe.

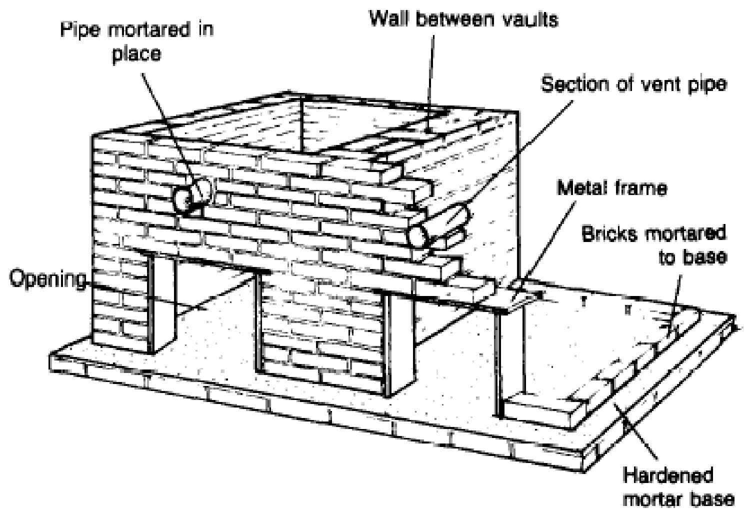


Figure 8. Brick and Mortar Vaults Under Construction

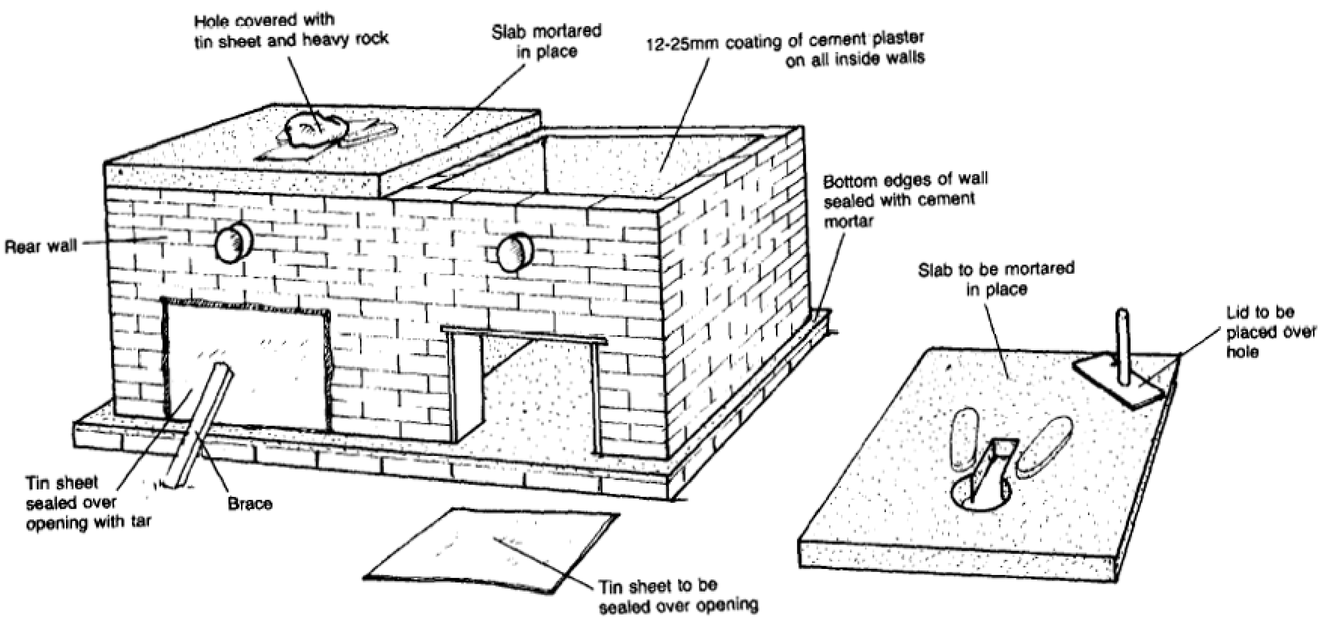


Figure 9. Brick and Mortar Walls Completed

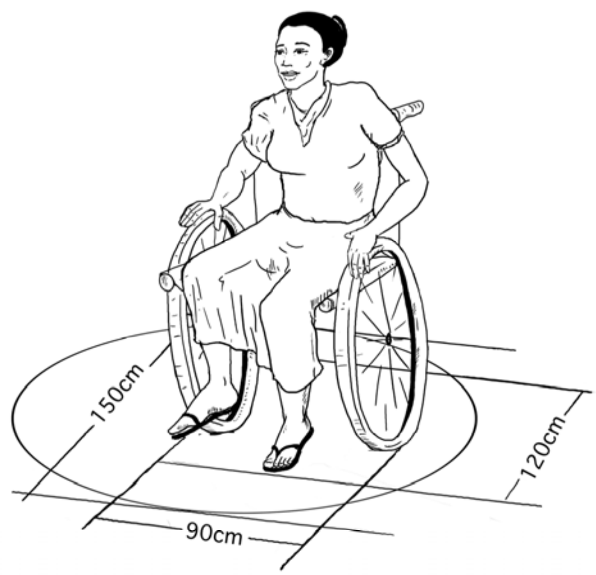
Latrines for People with Special Needs[37]

Inside the Latrine

User dimensions
Trying to accommodate all disabled people's needs is not always straight forward. Where a facility is for the use of one family, or a limited group of households, it is important to talk to all users to identify the range of needs and preferred solutions. The design and space requirements will depend on the kind of support users need for mobility. Dimensions of users and their equipment will vary from one person to another and from one country to another. If a variety of people with different needs use the facility, design for the biggest dimensions.

Wheelchair dimensions
Dimensions of wheelchairs depend on the design, and will affect the width of paths and doorways needed, the internal dimensions of bathrooms and toilets, and the location of handrails, etc.

Space allowance for wheelchair users



[37] Hazel Jones and Bob Reed, *Water and Sanitation for Disabled People and Other Vulnerable Groups: Designing Services to Improve Accessibility* (UK: WEDC Loughborough University, 2005), 41-48.

Outside Access

Getting there
It does not matter how well the facility is adapted if the disabled user cannot get to it in the first place. If the way leading to the latrine is rocky, muddy, or unmarked it may prove inaccessible for a user with special needs.

Proximity (how near it is)
A major factor in being able to reach a facility is how near it is. One of the simplest ways to achieve this is to locate a facility as near as possible to the disabled user.

If the facility cannot be nearby, many people can be helped by the provision of a place to rest on the way. The maximum distance that frail or elderly people can walk without a rest depends on many factors, including the slope and evenness of the ground. Some maximum walking distances are given in the table below.

Maximum Walking Distance	
Group	**Recommended distance limit without a rest**
People who are blind or with visual impairment	150m
Wheelchair users	150m
People with mobility impairment who do not require or use walking aid	100m
People with mobility impairment who use a walking aid	50m

Width of path, slope or step
In addition to proximity, the width, smoothness and gradient of the approach path are important.

The width of the path will depend on who will use it and what support they use. A public path should ideally be 180cm wide to accommodate all types of non-vehicular traffic without passing places. The absolute minimum width is 120cm wide, with places provided to allow people to pass each other. At a household level, the path width should take account of the widest user. For example, a wheelchair user needs a path of at least 90cm wide. But if an elderly grandmother in the same household needs the support of a family member when walking, the path should be wide enough for two people side by side, i.e. 120cm wide.

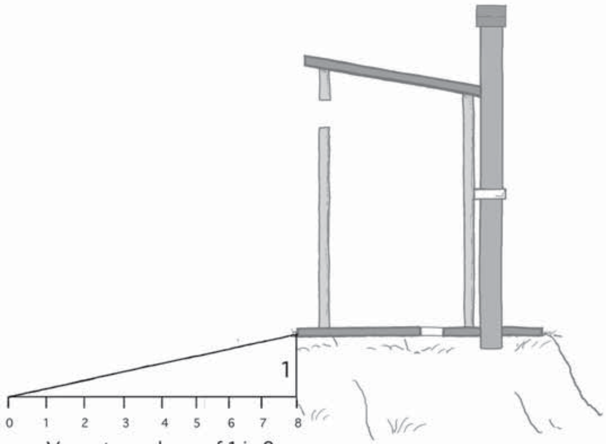
Path or Ramp Gradient

Where the path is not level, steps or a slope will be needed. The steepness of the slope (gradient) is important. The aim should be for independent mobility, i.e. for the disabled person to reach their destination without help. Slopes are measured in a ratio of rise over run. This means that whatever height or rise a slope has, there is a corresponding length or run. For example, a ratio in meters of 1:15 would mean for every meter of height added, 15 meters of length must be added as well. Slopes should be as gentle as possible - a gradient of 1 in 15 or gentler is ideal. Steep slopes (more than 1 :12) may be dangerous for many wheelchair users, who lack the strength to push themselves up a slope, and have difficulty in slowing down or stopping when descending. A steep gradient can cause the wheelchair to tip backwards when ascending.

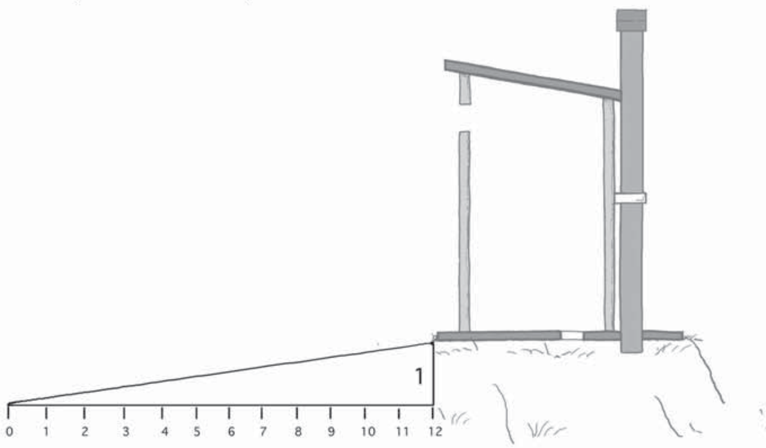
Where space permits, both steps and a ramp should be provided. If only one option is possible, this should be a ramp. If the slope is long, a level platform is needed at regular intervals where the user can rest.

In some situations, for example where space is limited, it may be necessary to use a short steep slope of 1 in 10 or steeper. In this case the slope should be no longer than 1 meter. This is not a recommended option. A steep slope is only useful for very strong users, or if there is always someone available to push the wheelchair. The table below suggests maximum gradients for slopes.

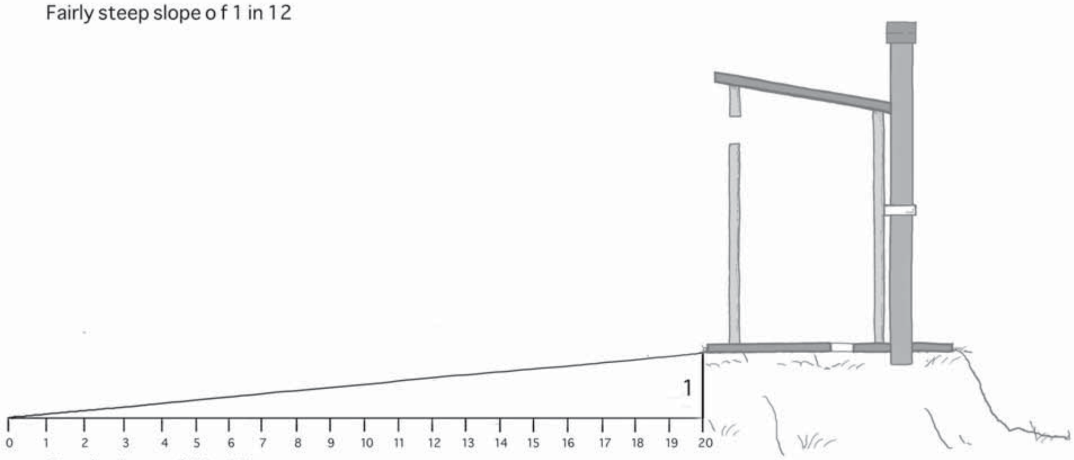
Slopes and recommended lengths for independent mobility			
Type	**Gradient (rise over run)**	**Maximum length of slope**	**Comments**
Very gentle slope	1:20 (5%)	10m	Ideal gradient.
Gentle slope	1:15 (6.6%)	5m	Possible for average wheelchair users. 1:15 or gentler is the recommended slope for public buildings.
Fairly steep slope	1:12 (8%)	3m	Possible for riders with strong arms. Maximum recommended gradient for independent mobility.
Very steep slope	1:10 (12% or more)	1m	Not recommended for independent mobility. May be dangerous, as wheelchair may tip backwards.



Very steep slope o f 1 in 8
(not recommended)

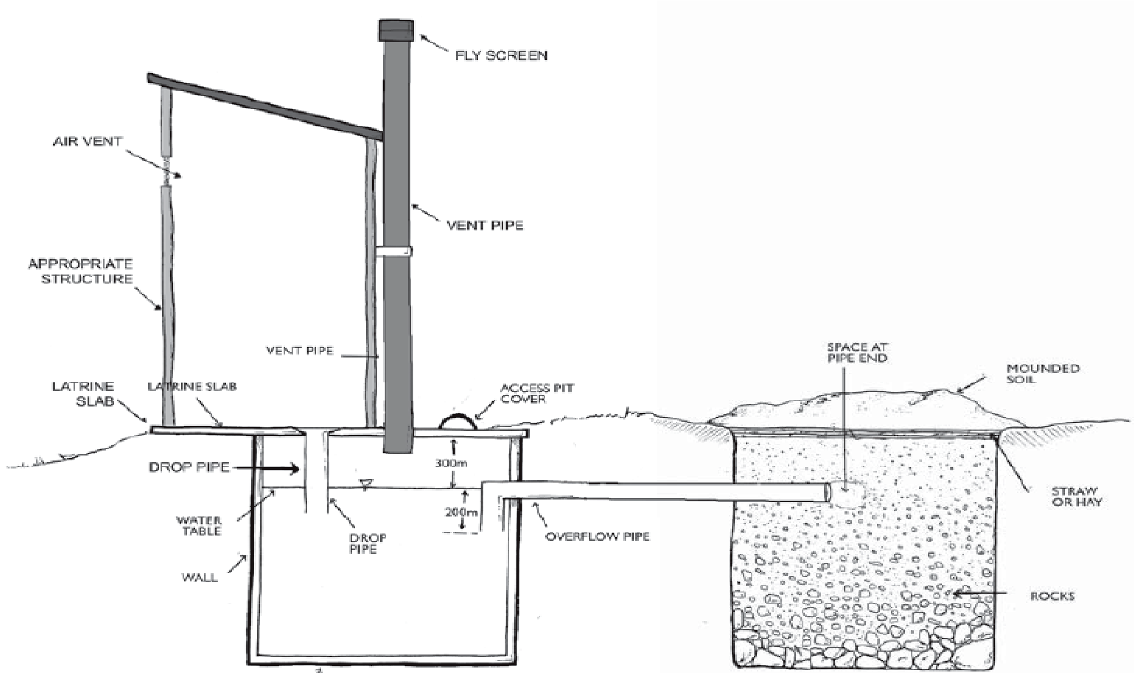


Fairly steep slope o f 1 in 12



Gentle slope o f 1 in 20

Aqua Privy Latrine



General Information

An Aqua Privy has a tank that functions like a septic tank but is located underneath the latrine slab. The water seal created by having the drop pipe below the water level provides control of odor, flies, and mosquitoes. Sludge settles to the bottom of the vault. Effluent is released through an overflow pipe to be treated in the adjacent soak pit.

Advantages

- Piped water does not need to be onsite
- Odor control if water seal maintained

Disadvantages

- Regular emptying of sludge required
- Permeable soil needed to dispose effluent
- Must have available water near site

Materials

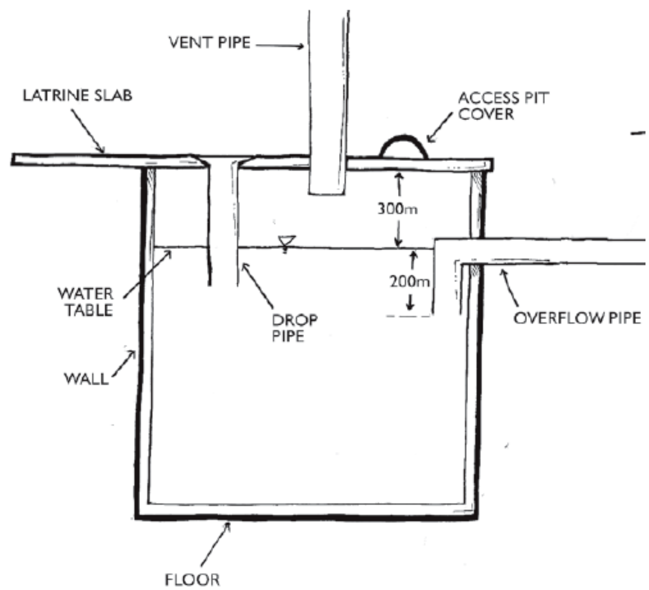
- **Vault Floor and Walls**: reinforced concrete, brick and mortar
- **Latrine Slab**: reinforced concrete
- **Concrete or Mortar**: cement, sand, gravel, water
- **Vent Pipe**: bamboo, mud and wattle, anthill soil, ferrocement, masonry, plastic
- **Overflow Pipe**: non-corrosive plastic, vitrified clay
- **Drop Pipe**: galvanized metal

Good For Areas With

- Aversion to pit latrine
- Limited space
- Small volume of sullage
- Use of pour flush pit latrine but too much liquid for pit to absorb

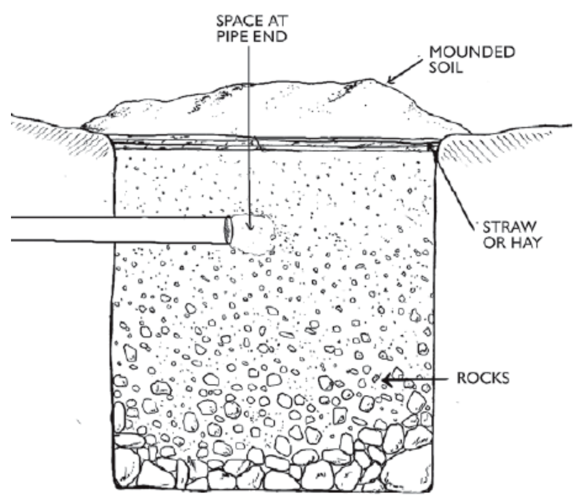
DETAIL: Vault

- Drop pipe must remain 75mm below the water level to ensure an adequate seal
- Drop pipe diameter of 100mm – 150mm
- Thickness of vault
    - Wall: 100m
    - Floor: 100mm
    - Latrine Slab: 75mm



DETAIL: Soak Pit

- Gradation of rock size may be used in layers of 40cm
- Largest rock should be the size of a fist and on the bottom of the soak pit
- Smallest size of rock should be pebbles making sure a space is left at the end of the pipe for proper draining from the aqua privy.



Calculating Tank Volume

Wastewater Flow	$q = \dfrac{0.9 \bullet Q}{1000 \text{ liters/m}^3}$	q: Wastewater flow (m^3/person/day) Q: Daily water consumption (liters/person/day) Note: Wastewater flow is 90% or.9 of the daily water consumption per person (Q).
Volume of Liquid	$X = N \bullet q$	A: Volume of liquid (m^3) N: Number of users q: Wastewater flow (m^3/person/day)
Volume of Sludge and Scum	$B = \dfrac{N \bullet P \bullet F \bullet R}{1000 \text{ liters/m}^3}$	B: Volume of sludge and scum (m^3) N: Number of users P: Period between desludging (year) F: Sizing factor R: Sludge accumulation rate (liter/person/year)
Tank Volume	$V = A + B$	V: Total tank volume (m^3) A: Volume of liquid (m^3) B: Volume of sludge and scum (m^3)
Tank Depth	$D = \dfrac{V+(0.3m)(L+w)}{(L+w)}$	D: Tank depth (m) V: Volume of liquid and sludge (m^3) L: Tank length (m) W: Tank width (m) Note: Choose a desired tank length and width, then use this equation to calculate tank depth. The 0.3m is used to account for space for air at the top of the tank.

Example

A family of six wishes to build an aqua privy. The water supply is 75 liters per person per day and they use toilet paper for cleaning. They will be desludging every 4 years, and the ambient temperature does not go below 15 ºC during the year.

Solution

1. Using ***Wastewater Flow*** we obtain:

$$q = \frac{0.9 \bullet Q}{1000 \text{ liters/m}^3} = \frac{0.9 \bullet 75 \text{ liters/person/day}}{1000 \text{ liters/m}^3} = \mathbf{0.07m^3/person/day}$$

2. From ***Volume of Liquid***:

$X = N \bullet q = 6 \text{ people} \bullet 0.07\ m^3/\text{person/day} = \mathbf{.42\ m^3/day}$

3. From ***Volume of Sludge and Scum:***:

$$B = \frac{N \bullet P \bullet F \bullet R}{1000 \text{ liters}/m^3} = \frac{6 \text{ people} \bullet 4 \text{ years} \bullet 1.0 \bullet 40 \text{ liters/person/year}}{1000 \text{ liters}/m^3} = \mathbf{0.96\ m^3}$$

4. With ***Tank Volume*** we obtain:

$V = X + B = .42m^3/\text{day} + 0.96\ m^3 = \mathbf{1.38\ m^3}$

5. Using ***Tank Depth*** we obtain:

$D=V+ (0.3)(L+W)= 1.38\ m^3 + (0.3m)(1.2m*1.2m)=\mathbf{1.26m}$

6. Final Design:

A tank with a cross section of 1.2 meters by 1.2 meters and a depth of 1.26 meters. The tank volume is 1.81 meters.

Calculating Pit Depth

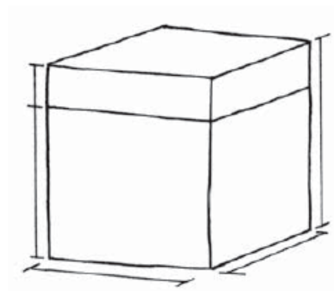
Pit Wall Surface Area	$Y = \frac{q \bullet N \bullet 1000 \text{ liters}/m^3}{I}$	W: Pit wall surface area (m^2) q: Wastewater flow (m^3/person/day) N: Number of users (people) I: Infiltration rate (liter/m^2/day)
Depth of Pit: Circular	$d = \frac{Y}{C \bullet \pi}$	d: Pit depth (m) W: Pit wall surface area (m^2) C: Pit diameter
Depth of Pit: Rectangular	$d = \frac{Y}{2 \bullet (w + l)}$	d: Pit depth (m) W: Pit wall surface area (m^2) w: Pit width (m) l: Pit length (m)
Total Pit Depth	$D = 0.5\ m + d$	D: Total pit depth (m) d: Pit depth (m)

Example
Design the soak pit required for the disposal of effluent from the Aqua Privy Example that has a diameter of 1.5 meters. The soil for the soak pit will form a ball when it is moist but still feels gritty.

Solution
1. Using ***Pit Wall Surface Area*** we obtain:

$$Y = \frac{q \bullet N}{I} = \frac{0.07\ m^3/\text{person/day} \bullet 6\ \text{people} \bullet 1000\ \text{liters}/m^3}{25\ \text{liters}/m^2/\text{day}} = \mathbf{16.8\ m^2}$$

2. From ***Depth of Pit: Circular*** we obtain:



$$d = \frac{Y}{C \bullet \pi} = \frac{16.8\ m^2}{1.5\ m \bullet \pi} = \mathbf{3.57\ m}$$

3. From ***Total Pit Depth*** we obtain:

$$D = 0.5\ m + d = 0.5\ m + 3.57\ m = \mathbf{4.07\ m}$$

4. Final Design:

A soak pit with a circular cross section with a 1.5 m diameter and a depth of 6.61 m.

Tables

Suggested Maximum Sludge Accumulation Rate

Conditions	Sludge Accumulation Rate: R (liters/person/year)
Waste retained in water where degradable anal cleaning material is used (degradable material examples: leaves, paper, or cornhusks)	40
Waste retained in water where non-degradable anal cleaning material is used (non-degradable material examples: rocks, trash, or plastic)	60
Waste retained in dry conditions where degradable anal cleaning material is used	60
Waste retained in dry conditions where non-degradable anal cleaning material is used	90

Sizing Factor[38]

Number of years between desludging	Value of F – *Ambient Temperature*		
	>20º C Throughout the year	>10º C Throughout the year	<10 º C Throughout the year
1	1.3	1.5	2.5
2	1.0	1.15	1.5
3	1.0	1.0	1.27
4	1.0	1.0	1.15
5	1.0	1.0	1.06
6 or more	1.0	1.0	1.0

38 Richard Franceys et al., *A Guide to the Development of On Site Sanitation* (Geneva: WHO, 1992), 62.

Soil Infiltration Rate of Wastewater[39]

Soil Type	Description	Infiltration Rate: R (liters/m^2/day)
Gravel, course and medium sand	Moist soil will not stick together	50
Fine and loamy sand	Moist soil sticks together but will not form a ball	33
Sandy loam and loam	Moist soil will form a ball but still feels gritty when rubbed between fingers	25
Loam, porous silt loam	Moist soil forms a ball which easily deforms and feels smooth between fingers	20
Silty clay loam and clay loam	Moist soil forms a ball which smears when rubbed but does not go shiny	10
Clay	Moist soil mould like plasticine and feels very sticky when wetter	<10

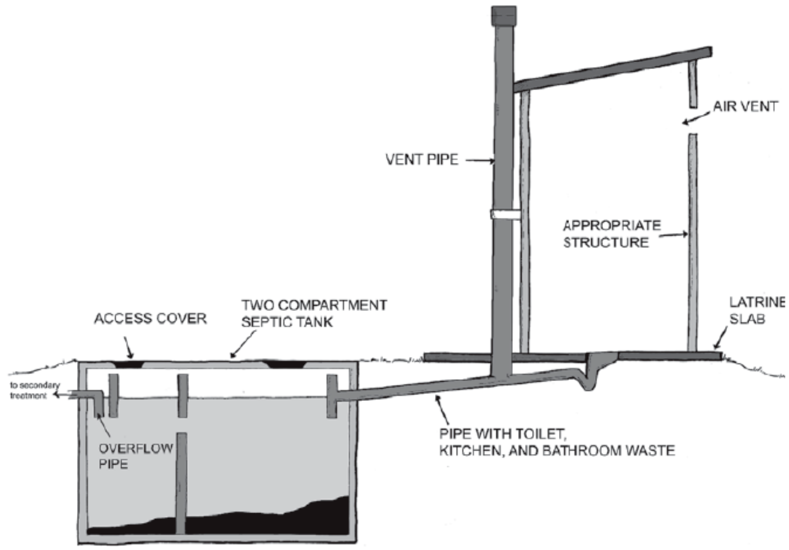
NOTE: Clay soil is unsuitable for soak pits and drainage trenches

[39] Bob Reed, *Low-Cost Sanitation* (UK: WEDC Loughborough University, 2003), 17.

Septic Tank Latrine

General Information

The Septic Tank is a two compartment chamber where sewage is partially treated before it is released into a drainage system for secondary treatment. The septic tank may be connected to a soak pit, leach line, or a sewer system.



Advantages

- Allows user a water closet
- Controls odor
- Can be used for toilet, kitchen and bathing water waste

Disadvantages

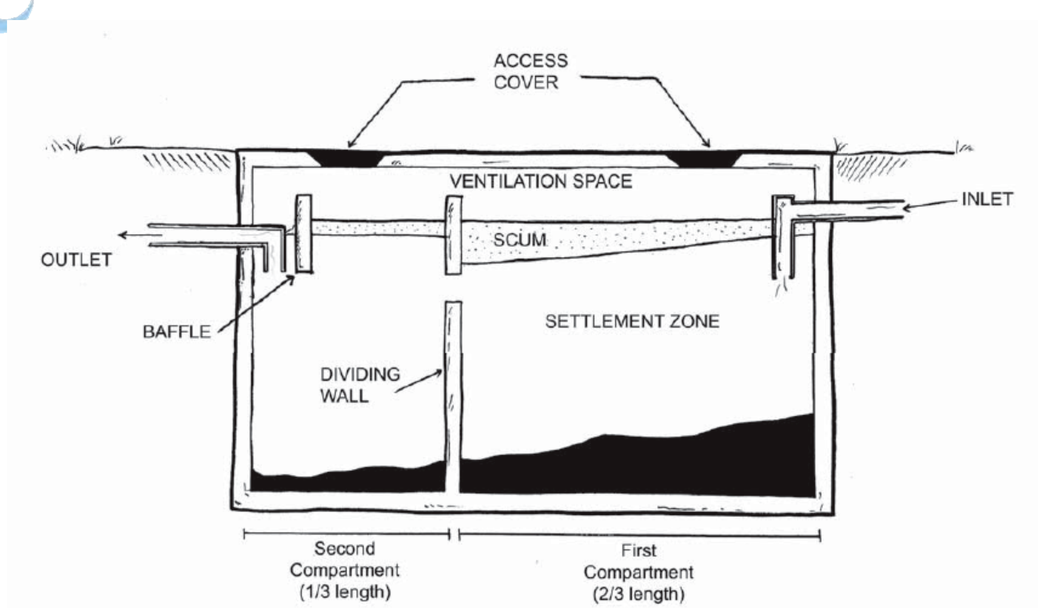
- Expensive
- Regular emptying of sludge required
- Permeable soil needed to dispose effluent
- Reliable water source required

Materials

- **Vault Floor and Walls**: reinforced concrete, brick and mortar
- **Latrine Slab**: reinforced concrete
- **Concrete or Mortar**: cement, sand, gravel, water
- **Vent Pipe**: bamboo, mud and wattle, anthill soil, ferrocement, masonry, plastic
- **Overflow Pipe**: non-corrosive plastic, vitrified clay
- **Drop Pipe**: galvanized metal

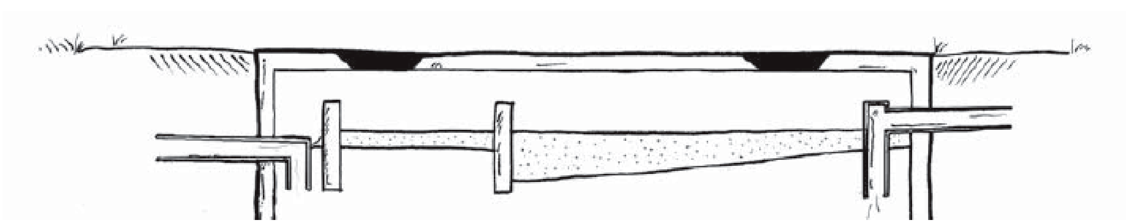
Good For Areas With

- Aversion to pit latrine
- Large volume of sullage
- Permeable soils



DETAIL: Vault

- Optimum depth of liquid from the tank floor to the bottom of the outlet pipe is 1.5 meters (minimum 1.2 meters).
- Tank width of minimum 0.6 meters
- Tank width should be half the length of the first compartment and equal to the length of the second compartment.



Lifewater International

Septic Tank

Wastewater Flow	$q = \frac{0.9 \; N \bullet Q}{1000 \text{ liters/m}^3}$	q: Wastewater flow (m^3/person/day) N: Number of users Q: Daily water consumption (liters/person/day)
Clear Liquid Retention Volume	$A = q \bullet \frac{t}{24 \text{ hr/day}}$	A: Retention volume (m^3) q: Wastewater flow (m^3/day) t: Retention time (hr)
Volume of Sludge and Scum	$B = \frac{N \bullet P \bullet F \bullet R}{1000 \text{ liters/m}^3}$	B: Volume of sludge and scum (m^3) N: Number of users P: Period between desludging (year) F: Sizing factor R: Sludge accumulation rate (liter/person/year)
Tank Volume	$V = Y + B$	V: Total tank volume (m^3) Y: Volume of liquid (m^3) B: Volume of sludge and scum (m^3)
Tank Cross Sectional Area	$T = \frac{V}{d}$	T: Tank cross sectional area (m^2) V: Total tank volume (m^3) d: Liquid depth (m)
Tank Width	$T = w \bullet L = w \bullet 3w$ $\rightarrow w = \sqrt{(T/3)}$	T: Tank cross sectional area (m^2) w: Tank width (m) L: Tank length (m) *NOTE: The *liquid depth* must be greater than the *tank width*. If not, increase the *liquid depth* and recalculate the *tank width*.
Tank Length	$L = 3 \bullet w$	L: Tank length (m) w: Tank width (m)
Tank Depth	$D = d + 0.3 \text{ m}$	D: Total tank depth (m) d: Liquid depth (m) * NOTE: 300 mm (0.3 m) of air space should be left between the bottom of the cover and the top of the liquid level.

Example

A household of 6 wishes to build a septic tank for their home. The water supply is 100 liters per person per day. The family uses toilet paper for cleaning and the tank will be desludged every 4 years. In the winter, the temperatures reach freezing. They plan to keep the liquid depth at 1.5 meters.

Solution

1. Using ***Wastewater Flow*** we obtain:

$$q = \frac{0.9 \bullet N \bullet Q}{1000 \text{ liters/m}^3} = \frac{0.9 \bullet 6 \text{ people} \bullet 100 \text{ liters/person/day}}{1000 \text{ liters/m}^3} = \mathbf{0.54\ m^3/day}$$

2. From ***Clear Water Liquid Retention Volume***:

$$A = q \bullet \frac{t}{24 \text{ hr/day}} = 0.54 \text{ m}^3\text{/day} \bullet \frac{24 \text{ hr}}{24 \text{ hr/day}} = \mathbf{0.54\ m^3}$$

3. From ***Volume of Sludge and Scum:***:

$$B = \frac{N \bullet P \bullet F \bullet R}{1000 \text{ liters/m}^3} = \frac{6 \text{ people} \bullet 4 \text{ years} \bullet 1.15 \bullet 40 \text{ liters/person/year}}{1000 \text{ liters/m}^3} = \mathbf{1.1\ m^3}$$

4. With ***Tank Volume*** we obtain:

$$V = Y + B = .54 \text{ m}^3 + 1.1 \text{ m}^3 = \mathbf{1.64\ m^3}$$

5. Using ***Tank Cross Sectional Area*** and ***Tank Width*** the tank dimensions are found:

$$T = \frac{V}{d} = \frac{1.64 \text{ m}^3}{1.5 \text{ m}} = \mathbf{1.09\ m^2}$$

$$T = w \bullet L = w \bullet 3w \rightarrow w = \sqrt{(T/3)} = \sqrt{(1.5 \text{ m} / 3)} = \mathbf{0.6\ m}$$

6. From ***Tank Length***:

$$L = 3 \bullet w = 3 \bullet 0.6 \text{ m} = \mathbf{1.8\ m}$$

7. From ***Total Tank Depth***:

$$D = d + 0.3 \text{ m} = 1.5 \text{ m} + 0.3 \text{ m} = \mathbf{1.8\ m}$$

8. Final Design:

Septic tank with a total depth of 1.8 meters, a width of 0.6 meters, a length of 1.8 meters, and a liquid depth of 1.5 meters.

Soak Pit

Pit Wall Surface Area	$Y = \frac{Q \bullet 1000 \text{ liter/ } m^3}{I}$	Y: Pit wall surface area (m^2) Q: Wastewater flow (m/day) I: Infiltration rate (liter/m^2/day)
Depth of Pit: Circular	$d = \frac{W}{C \bullet \pi}$	d: Pit depth (m) W: Pit wall surface area (m^2) C: Pit diameter
Depth of Pit: Rectangular	$d = \frac{Y}{2 \bullet (w + l)}$	d: Pit depth (m) Y: Pit wall surface area (m^2) w: Pit width (m) l: Pit length (m)
Total Pit Depth	D = 0.5 m + d Note: 0.5 meters is added to allow for earth coverage of the soak pit.	D: Total pit depth (m) d: Pit depth (m)

Example

Design the soak pit required for the disposal of effluent from the Septic Tank Example that has a diameter of 1.5 meters. The soil for the soak pit will stick together when it is moist, but will not form a ball.

Solution

1. Using ***pit wall surface area*** we obtain:

$$Y = \frac{Q \bullet 1000 \text{ liters/ } m^3}{I} = \frac{0.54\ m^3\text{/day} \bullet 100 \text{ liters/}m^3}{33 \text{ liters/}m^2\text{/day}} = \mathbf{16.4\ m^2}$$

2. From ***depth of pit: circular*** we obtain:

$$d = \frac{Y}{C \bullet \pi} = \frac{16.4\ m^2}{1.5\ m \bullet \pi} = \mathbf{3.48\ m}$$

3. From ***total pit depth*** we obtain:

$$D = 0.5\ m + d = 0.5\ m + 3.48\ m = \mathbf{3.98\ m}$$

4. Final Design:

A soak pit with a circular cross section with a 1.5 m diameter and a depth of 3.98 m.

Trench Wall Surface Area	$W = \dfrac{Q \bullet 1000 \text{ liters/ m}^3}{I}$	W: Trench wall surface area (m^2) Q: Wastewater flow (m^3/day) I: Infiltration rate (liter/m^2/day)
Length of Sidewall	$S = \dfrac{W}{T}$	S: Length of sidewall (m) W: Trench wall area (m^2) T: Trench depth below pipe (m)
Length of Trench	$L = \dfrac{S}{2}$	L: Length of trench (m) S: Length of sidewall (m)

Example
The same family has decided to look into using a drainage trench instead of a soak pit. The trench will measure 1.0 meters below the distribution pipe.

Solution
1. Using ***Trench Wall Surface Area*** we obtain:

$$W = \frac{Q \bullet 1000 \text{ liters/ m}^3}{I} = \frac{0.54 \text{ m}^3\text{/day} \bullet 1000 \text{ liters/ m}^3}{33 \text{ liters/m}^2\text{/day}} = \mathbf{16.4\ m^2}$$

2. From ***Length of Sidewall***:

$$S = \frac{W}{T} = \frac{16.4 \text{ m}^2}{1.0 \text{ m}} = \mathbf{16.4\ m}$$

3. From ***Length of Trench***:

$$L = \frac{S}{2} = \frac{16.4 \text{ m}}{2} = \mathbf{8.2\ m}$$

4. Final Design:

A drainage trench which is 8.2 meters long with the trench depth of 1.0 meter below the distribution pipe.

Tables

Suggested Maximum Sludge Accumulation Rate

Conditions	Sludge Accumulation Rate: R (liters/person/year)
Waste retained in water where degradable anal cleaning material is used (degradable material examples: leaves, paper, or cornhusks)	40
Waste retained in water where non-degradable anal cleaning material is used (non-degradable material examples: rocks, trash, or plastic)	60

Sizing Factor

Number of years between desludging	Value of F – *Ambient Temperature*		
	>20º C Throughout the year	>10º C Throughout the year	<10 º C Throughout the year
1	1.3	1.5	2.5
2	1.0	1.15	1.5
3	1.0	1.0	1.27
4	1.0	1.0	1.15
5	1.0	1.0	1.06
6 or more	1.0	1.0	1.0

Recommended Retention Time[40]

Daily Wastewater Flow: Q (m^3)	Retention Time: T (hours)
Less than 6	24
Between 6 and 14	33 -1.5Q
Greater than 14	12

[40] Bob Reed, *Low-Cost Sanitation* (UK: WEDC Loughborough University, 2003), 76.

Soil Infiltration Rate of Wastewater

Soil Type	Description	Infiltration Rate: R (liters/m^2/day)
Gravel, course and medium sand	Moist soil will not stick together	50
Fine and loamy sand	Moist soil sticks together but will not form a ball	33
Sandy loam and loam	Moist soil will form a ball but still feels gritty when rubbed between fingers	25
Loam, porous silt loam	Moist soil forms a ball which easily deforms and feels smooth between fingers	20
Silty clay loam and clay loam	Moist soil forms a ball which smears when rubbed but does not go shiny	10
Clay	Moist soil mould like plasticine and feels very sticky when wetter	<10

NOTE: Clay soil is unsuitable for soak pits and drainage trenches.

Additional Information
Explanation of Concrete Materials Estimate

Estimate of Materials Required

This table contains a rough estimate of cement, sand, and aggregate requirements for purchasing materials. An estimate of water is not included, void space is an estimate, and cement expansion and rebar volume is not included.

Slab Size (in centimeters)			Slab Volume	Cement Required	Material required with 25% buffer added		
length (cm)	width (cm)	height (cm)	volume cubic cm*	amount of 50 kg sacks	cement 50 kg sacks	sand sacks	aggregate sacks
100	100	6	60,000	0.5	0.6	1.2	1.8
100	100	8	80,000	0.6	0.8	1.6	2.4
110	110	8	96,800	0.8	0.9	1.9	2.8
120	120	8	115,200	0.9	1.1	2.3	3.4
125	125	8	125,000	1.0	1.2	2.4	3.7
130	130	8	135,200	1.1	1.3	2.6	4.0
140	140	8	156,800	1.2	1.5	3.1	4.6
150	150	8	180,000	1.4	1.8	3.5	5.3

Explanation of Solid Volume Produced

Material	Part	Cubic feet	Void Space	Solid Volume	
Cement	1	1.7	0%	1.7	50kg sack of cement
Sand	2	2.34	40%	1.4	
Aggregate	3	3.51	45%	1.9	
		Total= 7.02		Total= 4.5	Cubic feet of concrete
				0.13	Cubic meter of concrete
NOTE: 1 cubic foot= 94lb sack of cement= 110kilograms= 1.17 cubic feet				127,553	Cubic centimeters of concrete

Equations Used

Equations:		
Slab Cubic Volume =	Length x width x height	Cubic centimeters
Solid Volume =	(1-void space) x cubic feet	Cubic feet
Cement requirements=	Slab cubic volume /127,553	Cubic centimeters

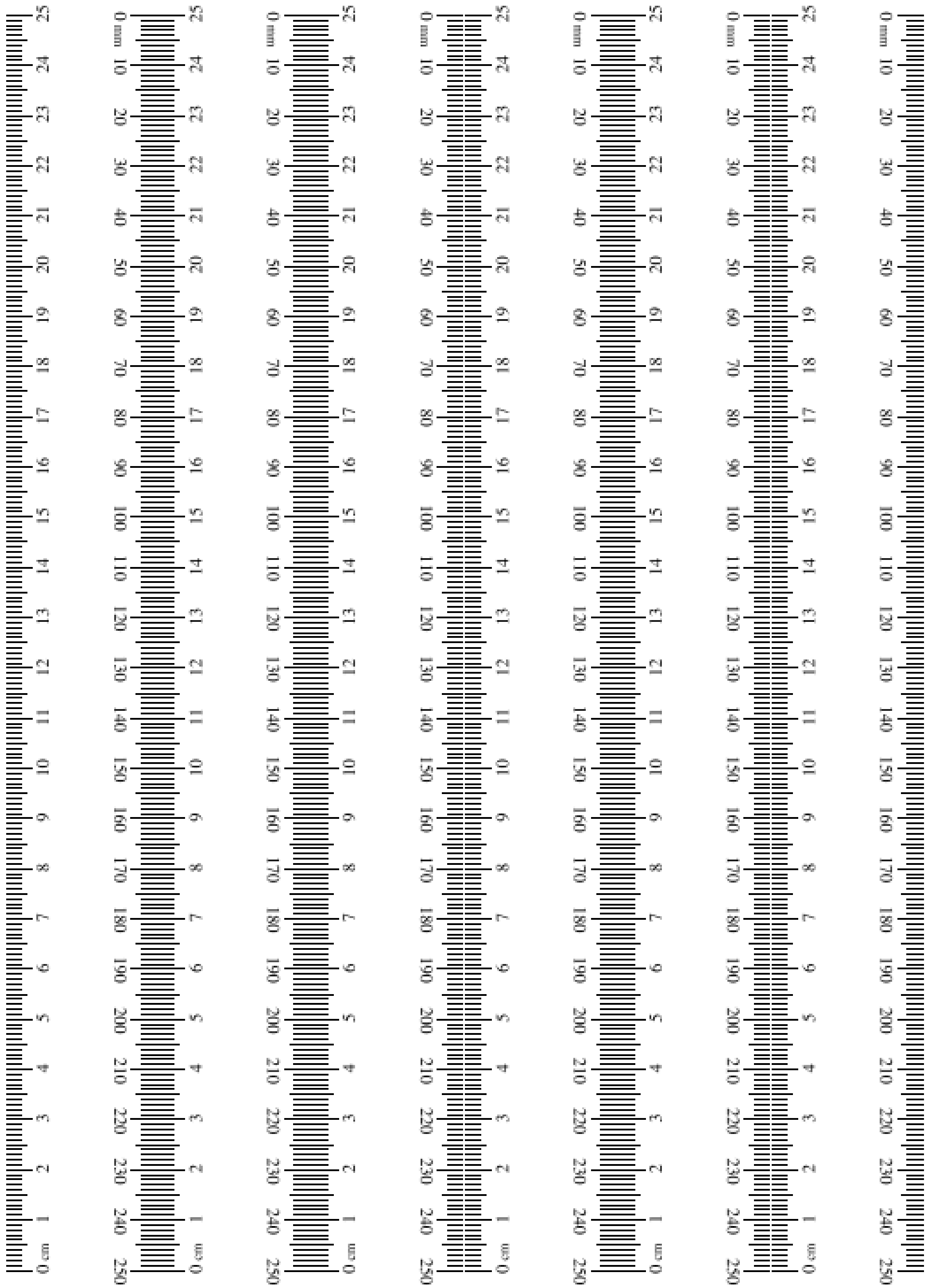
Adapted from:
http://www.dot.state.il.us/materials/pcclevel3.pdf
http://www.bridgestoprosperity.org/Attachments/ewbconcreteguidelines.pdf

Metric Conversion Table

Length		
	Metric	**Standard (US)**
	1 Millimeter (mm)	0.039 Inches (in)
	Centimeter (cm)	0.39 inches (in)
	Meter (ms)	3.28 Feet (ft)
	Meter (ms)	1.09 Yards (yd)
	Kilometers (km)	0.62 Miles (mi)

Area		
	Metric	**Standard (US)**
	Millimeter (mm^2)	0.0016 Square Inches (in^2)
	Centimeter (cm^2)	0.16 Square Inches (in^2)
	Square Meters (m^2)	10.764 Square Feet (ft^2)
	Square Meters (m^2)	1.195 Square Yards (yd^2)
	Hectares (ha)	2.47 Acres (ac)
	Square Kilometers (km^2)	0.386 Square Miles (mi^2)

Volume		
	Metric	**Standard (US)**
	Milliliters (mL)	0.034 Fluid Ounces (fl oz)
	Liters (L)	0.264 Gallons (gal)
	Cubic Meters (m^3)	35.314 Cubic Feet (ft^3)
	Cubic Meters (m^3)	1.307 Cubic Yards (yd^3)


0 mm 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250
0 cm 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Menstruation[41]

Sanitation facilities for women in schools and at home should provide private methods for disposal and washing of menstrual cloths.

Disposal

Disposal can be complicated because materials used during menstruation may not be biodegradable. Use the chart below as a guide[1].

Material used during menstruation	Facility	Disposal options
Natural fibers that are biodegradable (e.g. cotton, papyrus, etc)	Pit latrines	Dispose of in the pit
Natural fibers that are biodegradable (e.g. cotton, papyrus, etc)	Pour flush, septic tank or any other piped system	Collect separately, and dispose as solid waste
Non-biodegradable materials (e.g. plastic, artificial fibers)	Any latrine	Collect separately, and dispose as solid waste

Latrines should be equipped solid waste containers which are emptied often. Containers should have lids to discourage fly activity.

Washing Stations

Implementation of a washing station enables women to improve their hygienic practices and thus encourages a sense of dignity. A washing station designated for menstrual cloths must be equipped with clean water, soap and a place where cloths can be hung to dry if desired. This facility must be well maintained and cleaned often. In many countries, indicators of menstruation are considered taboo. For this reason, washing stations should be private, safe places where women and girls can wash and hang materials without being seen. Furthermore, stations should not be located far distances from schools or homes. Walking great distances to fetch water or to wash menstruation cloths puts women in a vulnerable position where they may be harassed or abused by people along the way

[41] Bob Reed, *Low-Cost Sanitation* (UK: WEDC Loughborough University, 2003), 120.

Works Cited

1. Pretty, Jules N., Irene Guijt, John Thompson, Ian Scoones. 1995. *Participatory Learning and Action: A Trainer's Guide*. London: IIED.

2. Wateraid. http://wateraid.org/international/what_we_do/how_we_work/integrated_projects/default.asp

3. McIntyer, Peter, ed., 2006. *Smart Sanitation Solutions*. Netherlands Water Partnership.

4. Esrey, Steven A., Ingvar Andersson, Astrid Hillers, and Ron Sawyer. 2000. *Closing the Loop: Ecological Sanitation for Food Security.* Mexico: UNDP, Sida.

5. Conant, Jeff. 2005. *Sanitation and Cleanliness for a Healthy Environment*. Berkeley, California: Hesperian Foundation. UNDP. Sida.

6. Jackson, Berry. 2005. *A Review of EcoSan Experience in Eastern and Southern Africa.* Water and Sanitation Program.

7. Reed, Bob.2003. *Low-Cost Sanitation*. UK: WEDC Loughborough University.

8. Brikke, Francois, and Maarten Bredero. 2003. *Linking Technology Choice with Operation and Maintenance in the Context of Community Water Supply and Sanitation.* Geneva: WHO and IRC Water and Sanitation Centre.

9. Winbald, Uno, and Wen Kilama. 1985. *Sanitation Without Water.* London and Basingstoke: Macmillan Education LTD.

10. Franceys, Richard, John Pickford, and Robert Reed. 1992. *A Guide to the Development of On Site Sanitation.* Geneva: WHO.

11. *Water for the World: Designing Pits for Privies, Technical Note No. SAN 1.D.2* (USA: National Demonstration Water Project, Institute for Rural Water and National Environmental Health Association, 1982)

12. *Water for the World: Constructing Slabs for Privies, Technical Note No. SAN 1.C.1* (USA: National Demonstration Water Project, Institute for Rural Water and National Environmental Health Association, 1982)

13. *Water for the World: Constructing Pits for Privies, Technical Note No. SAN 1.C.2* (USA: National Demonstration Water Project, Institute for Rural Water and National Environmental Health Association, 1982)

14. *Water for the World: Constructing Privy Shelters, Technical Note No. SAN 1.C.3* (USA: National Demonstration Water Project, Institute for Rural Water and National Environmental Health Association, 1982)

15. *Water for the World: Constructing Compost Toilets, Technical Note No. SAN 1.C.6* (USA: National Demonstration Water Project, Institute for Rural Water and National Environmental Health Association, 1982)

16. Jones, Hazel, and Bob Reed. 2005. *Water and Sanitation for Disabled People and Other Vulnerable Groups: Designing Services to Improve Accessibility.* UK: WEDC.

17. Del Porto, David, and Carol Steinfeld. 1999. *The Composting Toilet System Book: A Practical Guide to Choosing, Planning, and Maintaining Composting Toilet Sytems, a Water-saving, Pollution-preventing Alternative 1st ed.* Concord: The Center for Ecological Pollution Prevention.

18. Brandberg, Björn. 1997. *Latrine Building: A Handbook for Implementation of the SanPlat System*. London: ITDG Publishing.

19. World Health Organization. Fact Sheet 3.4: Simple Pit Latrines. http://www.who.int/water_sanitation_health/hygiene/emergencies/envsanfactsheets/en/index2.html.

20. Engineers Without Borders USA. Concrete Mixes Guideline- Draft, 2005. Engineers Without Borders USA. http://www.bridgestoprosperity.org/Resources/bridge-manuals/attachments/EWB-Concrete-Guidelines.pdf.