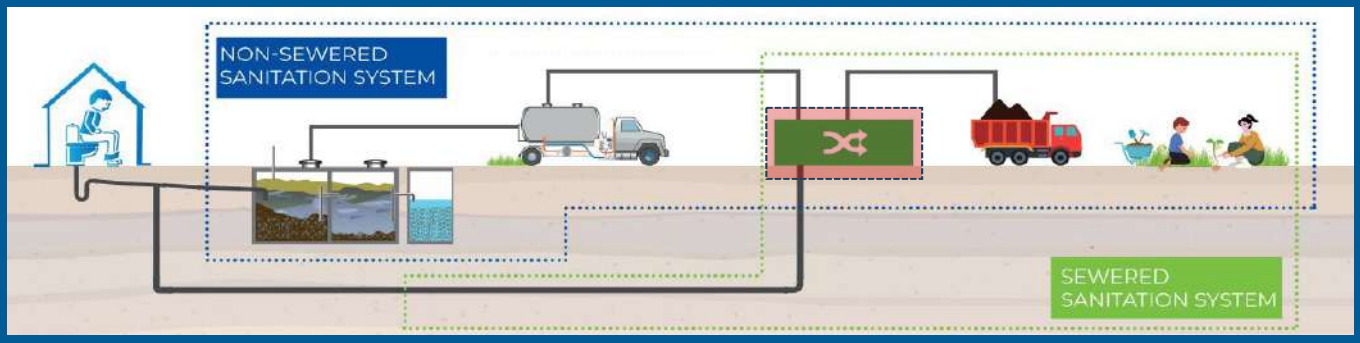
Government of Nepal
Ministry of Water Supply
National Water Supply and Sanitation Research,
Innovation and Capacity Development Center

CONTAINMENT IMPROVEMENT

Power Point Presentation
Slide Notes For Participants



2025

Material and Learning Application

Table of Contents

Introduction

This document, power point presentation with slide notes, is a supporting document for the trainers/ presenter to conduct the “Containment Improvement” training. This is a compilation of all the slides to be presented in the training along with the notes for the trainer as of what to describe while presenting the particular slide.

Objective

The main objective of the document is to guide the content that a presenter would be discussing on each slide. To this, it also provides a preview of all the slides contained in the training along with the slide notes.

How to Use ?

The document consists of slides from all session. Slide notes for each slide is presented just below the slide itself. The trainer or presenter cango through the notes and describe the slides as per the information provided in the slide notes.

For the effective use of the document, trainer or presented is recommended to use simultaneously with the ‘Trainer Manual’ with instructions.

Lesson Plan 1: Training Opening

Slide 1

Slide 2

Slide 3

Training Structure

1 Opening

2 Sanitation: Context

3 Containment and its Types

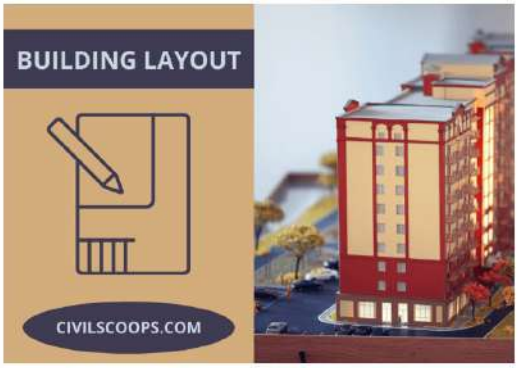
4 Containment Improvement

5 Closing

Slide 4

Building Layout

- Bathroom Location
- Emergency Exits
- First Aid



Slide 5

Introduction

- Groups: 4/5
- Story with name of all group member
- Other information (if possible)

Slide 6

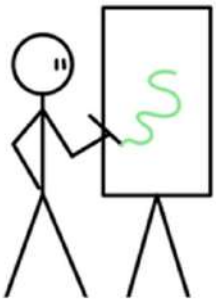
Introduction

- Bingo card with human characteristics, personalities and life facts
- Network and coordinate
- One with matching characteristics, ask to sign in the bingo card

Slide 7

Learning Expectations

- One learning outcomes from each participant



Slide 8

Pre-test

5-10 minutes

Slide 9

Orientation Format and Agenda

- Experiential, hands-on and learn by doing
- Individual and group activities
- Case studies and learning from others' experience
- Open discussion, questions and answers
- Develop a sense of community and network within the group

Slide 10

Thank you!
धन्यवाद !

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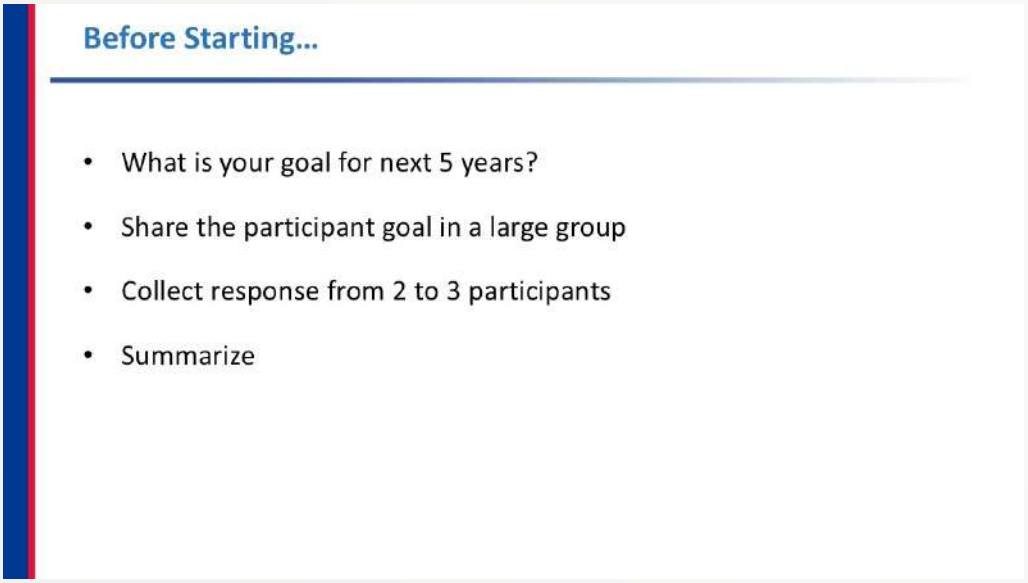
Lesson Plan 2: Sanitation: The Context

Slide 1

Slide 2



Summarize participant response as individual have their own goals, Nepal government has made the goal on sanitation (national and international)

Slide 3

Training Structure

Slide 4

Learning Outcomes

- Discuss about the sanitation status of Nepal
- Explain the importance of containment

Slide 5

Presentation Outline

- Sanitation
- Sanitation coverage in Nepal

Slide 6

Sanitation

- **WHO defined Sanitation** as the provision of facilities and services for the safe management of human excreta from the toilet to containment and storage and treatment onsite or conveyance, treatment, and eventual safe end-use or disposal.
- It also encompasses hygiene education and behavioral practices to reduce health risks.

Let's start with basic idea, Sanitation and move towards the two main term, "total sanitation" and "SDG" indicated by the honorable PM.
What does sanitation mean? (collect responses and present idea on sanitation with following slide)
Where are we in terms of sanitation? (next slide)

Slide 7

Importance of Sanitation

- Proper sanitation reduces the spread of waterborne diseases such as cholera, diarrhea, dysentery, and typhoid.
- Access to clean toilets and handwashing facilities minimizes infections and promotes better health.
- Poor sanitation leads to groundwater and surface water pollution, affecting drinking water and ecosystems.
- Access to safe and private sanitation facilities promotes dignity, particularly for women, girls, and vulnerable groups.

Slide 8

National context – ODF Declaration

What is ODF?

- It refers to a situation where every individual in a community uses safe and hygienic sanitation facilities, such as toilets, and no one practices open defecation.
- All human waste is safely contained and not exposed in the environment.
- ODF improved public health by reducing the spread of diseases caused by faecal contamination.
- ODF is a critical milestone

Slide 9

National context – ODF Declaration

1st Country in South Asia to declare ODF

Date: 30 September 2019 (2076 Ashoj -13)

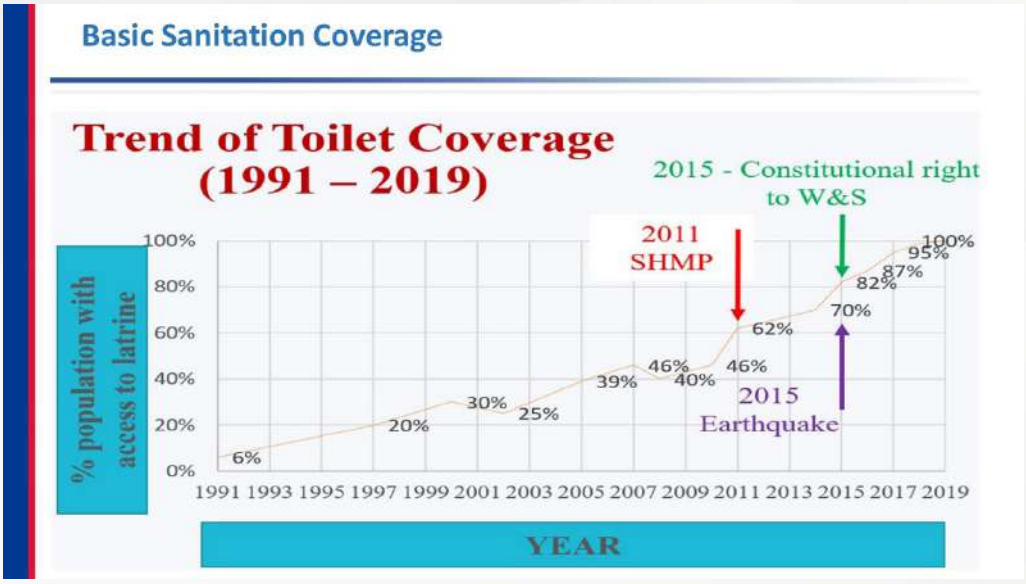
Hon. K.P. Sharma Oli, Prime Minister, Nepal

With Due Respect to the Declaration of 753 Palikas and 77 Districts as Open Defecation Free, I declare Nepal as Open Defecation free Country. Besides, I call upon the people of Nepal to move towards total sanitation country and achieve the target of the Sustainable Development Goals by 2030.

Slide 10

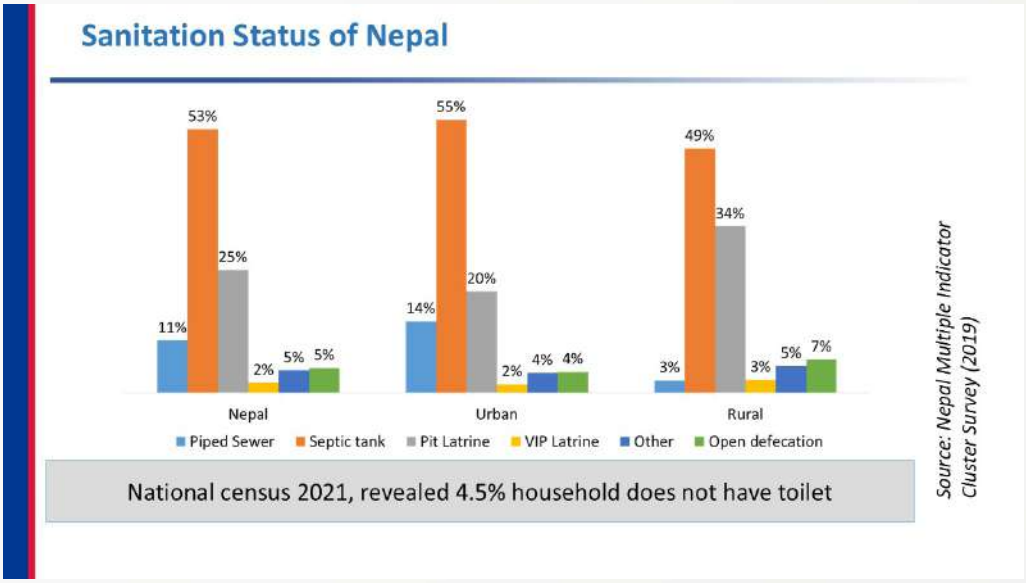
Let's start with basic idea, Sanitation and move towards the two main term, "total sanitation" and "SDG" indicated by the honorable PM.
What does sanitation mean? (collect responses and present idea on sanitation with following slide)
Where are we in terms of sanitation? (next slide)

Slide 11



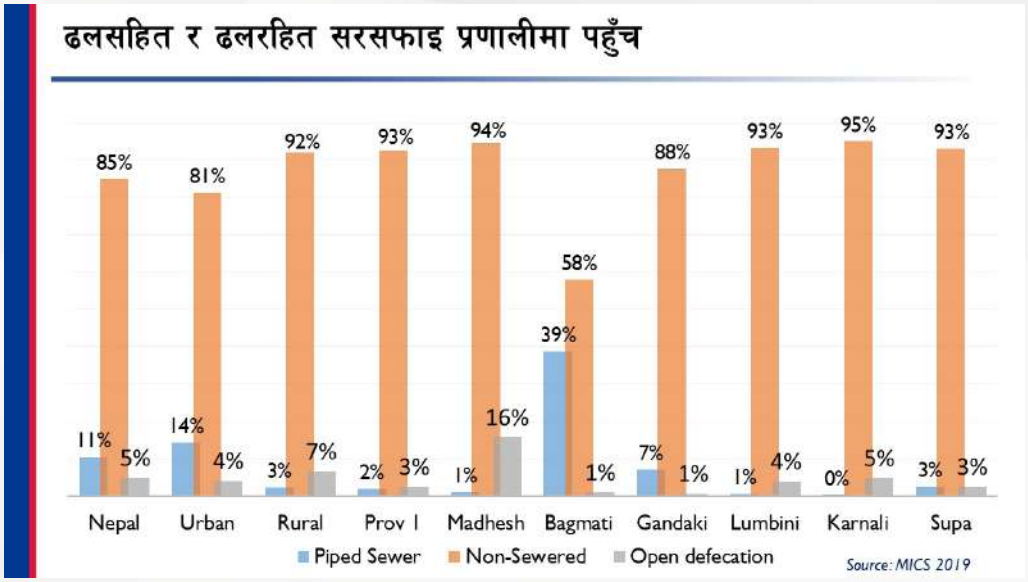
This graph presents the trend of basic sanitation coverage, along with the milestones in the sector, that is, the endorsement of 'sanitation and hygiene master plan, 2011' and water and sanitation as a constitutional rights in 2015. The graph also presents the progress in the sector from the year 2015.

Slide 12



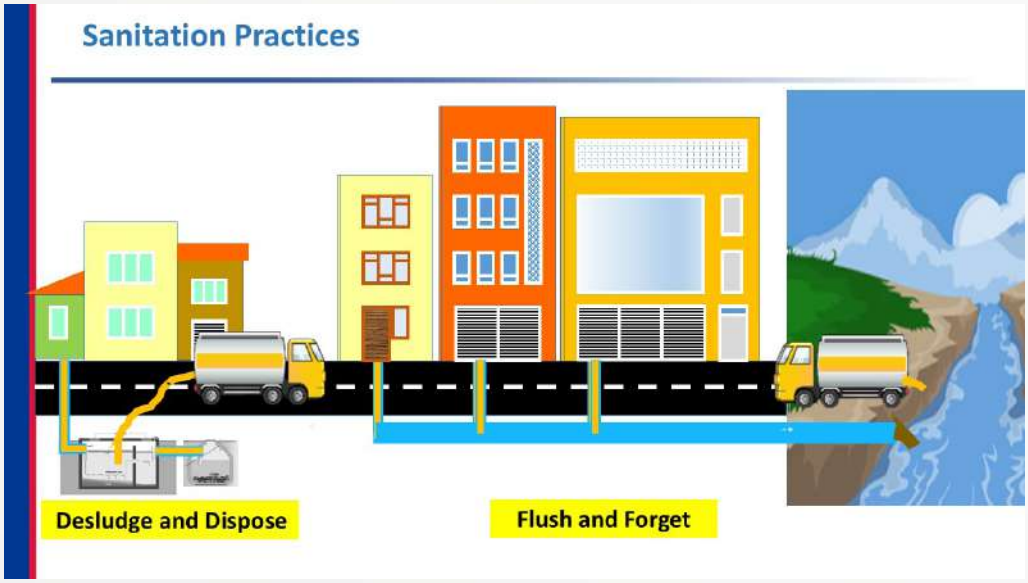
So, as per the context of Nepal, what is the overview of data in urban and rural context as per the sewer or non-sewer system

Slide 13



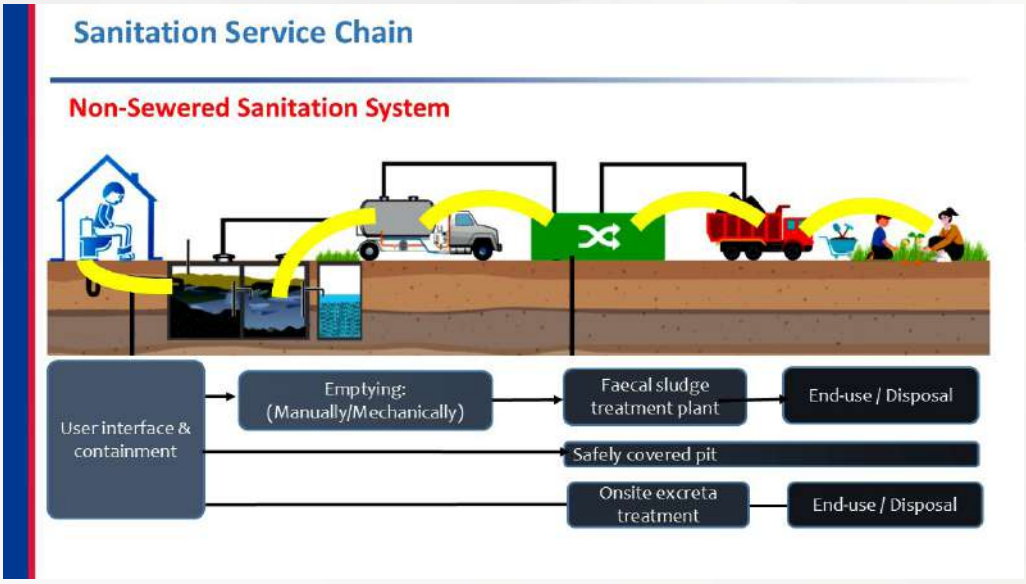
As we see the coverage of the existing sewer connection, the graph represents that very large portion of the population are using non sewered sanitation services.
Except for the Bagmati province of Nepal, all province have less than 10% coverage of sewer connection.

Slide 14



In general, in either system, waste is simply being transferred and is being disposed without any treatment, that is, flush and forget.
The ground reality of today is, either, the waste is drained through the sewer line or is being accumulated in the storage tank, the end-product is disposed into the water bodies or in the open environment without any further treatment which is creating a chaos in the public health.

Slide 15

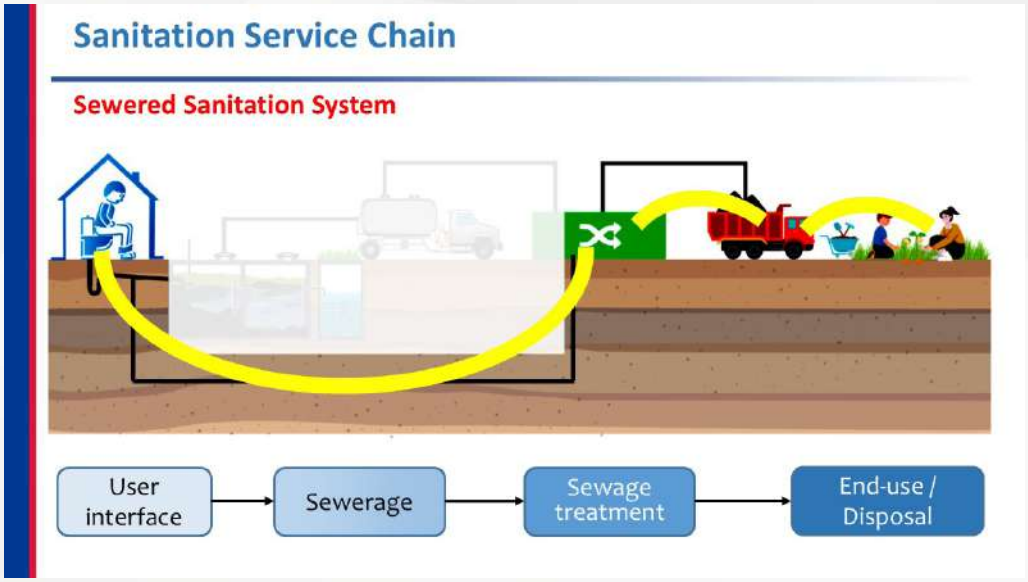


So, to explain the whole concept clearly, let's see the whole chain of sanitation. Explain sanitation system as it is a chain of services starting from the origin of waste/ waste generation to the end use or disposal. The whole sanitation system comprises of 5 components namely:

1. User interface- where the waste is generated
2. Containment- where the waste is contained or stored
3. Emptying and transportation- how the waste is then transferred from the containment
4. Treatment- the waste is treated to reduce/ eliminate the harm/ impact it might create to the environment and human health
5. Reuse and safe disposal- how the treated waste is further disposed or is reused

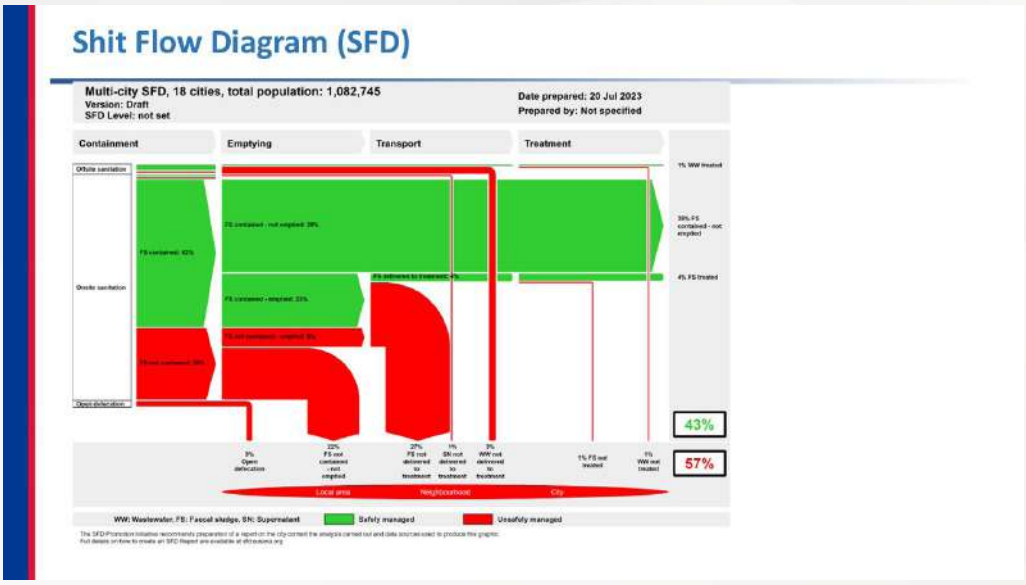
The whole chain of this is termed as sanitation service chain.

Slide 16



The whole idea of sanitation service chain might be a bit different for the toilets/ sanitation facilities connected to a sewer network, where there is lack of containment and the waste is directly transferred to next component of the sanitation service chain, that is, treatment and then to safe disposal or reuse.

Slide 17

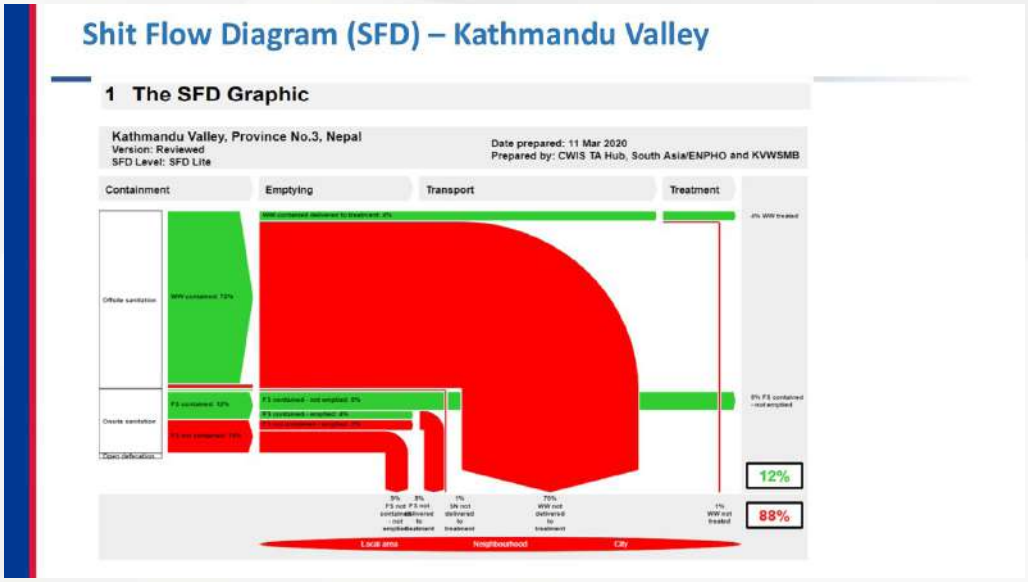


Overview of Sanitation Status- SFD of Nepal
This SFD represents the sanitation practices of flush and forget of whole Nepal.

SFD or shit flow diagram is a graphical representation of the sanitation status where the green color denotes the safely managed sanitation while the red, the color for danger represents unsafely managed sanitation.
This is the draft SFD of Nepal based on the data collected from 18 cities which shows the overview of the sanitation condition. The green colored arrow depicts the safely managed sanitation in Nepal which is presented as 43% while the rest red color coded is unsafely managed one.

Now, if the condition of Nepal is this, ask participants what they think about the condition of Kathmandu valley, the capital of the country. Do they think the situation is better or worse, take 3 to 4 thoughts and proceed following slide

Slide 18



SFD for Kathmandu Valley

While this particular SFD shows the condition of Kathmandu, the capital of the nation, where 88% population do not treat and dispose waste.
Here, in the graph represents the situation of Kathmandu valley where, only 12% population treat the fecal sludge while the rest is disposed in water bodies, or openly.
Here, the green color representing the safely managed sanitation is seen very minimal while the red block covers almost all part of the SFD.
One more fact is that, the 12% population who safely disposed waste is also not true at all, but in actual, only 4% population treat the fecal sludge safely while the 8% is contained in a containment that has not been emptied yet and believed to be safe.

However, (next slide)

Slide 19

Some Findings

- A large-scale study of bacterial contamination of drinking water and its public health impact in Nepal
  - Study conducted during 2009-2011
  - 3 ecological belts, 5 development regions of Nepal
  - Total water samples- 506
  - Findings:
  - More than 50% of all collected samples were contaminated with fecal coliform
  - Both, total coliform and fecal coliform were highest in Far-Western Development Region (96.7% and 65.5%, respectively)

Some of the study conducted in the area presents that…

a. 56.5% of all samples were contaminated with fecal coliform

b. 88.5% of the samples were contaminated with total coliform

Slide 20

Some Findings

- A study conducted in Kathmandu Valley
  - *66% (197/300) samples were contaminated with E. Coli*
- Next study carried in mid 2015, of underground water source
  - 89% of the samples were contaminated with *E. Coli*
  - 100% of shallow water source were contaminated with *E. Coli*
  - 80% of deep source were contaminated with *E. Coli*
- Another study in Biratnagar, Morang
  - 45.45% of total samples (110) were contaminated with fecal coliform

Slide 21

Some Findings

	Far-Western	Mid-Western	Western	Central	Eastern
Total Coliform (positive rate)	96.7	93.3	89.2	87.0	74.6
Fecal Coliform (positive rate)	65.5	63.5	55.9	53.2	52

	Terai	Hilly	Mountain
Total Coliform (positive rate)	84.1	90.7	89.7
Fecal Coliform (positive rate)	49.7	58.0	66.2

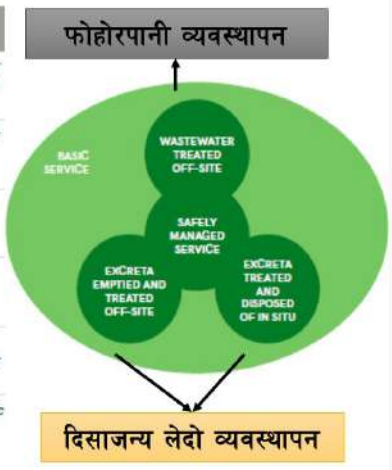
These findings are of serious public health concern with regard to both endemicity and outbreak of waterborne diseases in the country

Slide 22

Sustainable Development Goals

SERVICE LEVEL	DEFINITION
SAFELY MANAGED	Use of improved facilities that are not shared with other households and where excreta are safely disposed of in situ or transported and treated offsite
BASIC	Use of improved facilities that are not shared with other households
LIMITED	Use of improved facilities shared between two or more households
UNIMPROVED	Use of pit latrines without a slab or platform, hanging latrines or bucket latrines
OPEN DEFECATION	Disposal of human faeces in fields, forests, bushes, open bodies of water, beaches or other open spaces, or with solid waste

Note: improved facilities include flush/pour flush to piped sewer systems, septic tanks or pit latrines; ventilated improved pit latrines, composting toilets or pit latrines with slabs.



Linking the information to the other term defined by honorable PM the SDG, it is explained as:
This not only speaks about the toilet and containing the feces but also present that the excreta thus collected in the containment, when the containment is full, it should also be disposed/ managed safely, most possibly, reused safely.

To this, the enabling environment is also created by the goals and targets set by the nation as SDG.

Slide 23

Enabling environment

- Building code-
  - Emphasize the importance of building codes and by-laws
- By-Laws related to sanitation as a whole including FSM, WWM, SWM

- Ensure proper enforcement and adherence to regulations
- Strengthen governance mechanisms for effective enforcement
- Implement penalties for non-compliance

In addition to this, the act and governance also supports for the containment improvement.
Emphasize the importance of building codes and by-laws Ensure proper enforcement and adherence to regulations.

Slide 24

Community Awareness

- Communication plan
- Establish Communication channels between the municipality and the community
- Regular meeting and/ or forums to address concerns and feedback
- Conduct workshops, community awareness campaign/ community engagement activities, pamphlets distribution etc.

Other means are …
If these all are there to support as an enabling environment, let's go through the different types of containment and means to upgrade it.

Slide 25

Inform participants that they are going for a group discussion. For this participants will be divided into 4-5 groups (limiting 5 people in each group). Participants are to discuss on ideas and come up with solutions to improve the mentioned condition.
Provide 5 minutes time and after the time ask a group to present their findings and ask other groups to add on additional points.

Make sure to collect all the ideas and paste the ideas related to containment improvement in a row and other ideas differently.

Inform participants that among all the ideas presented, the ideas related to the containment are the parts that can be taken immediately as these interventions are not that costly in compared to the FSTP/ WWTP construction. Hence, can be intervened immediately.

Slide 26

Key Messages

- ODF declaration was the biggest achievement for sanitation sector in Nepal which not only reflected the combined efforts in the sector, but the declaration also marks the way forward to total sanitation and safely managed sanitation.
- Though the attainment of ODF, the sanitation situation is still a major concern as depicted by the SFD, and the results from most of the studies concluding most of the water sources being contaminated with fecal coliform.
- Hence, the governance part should be focused on all local government level along with the strict enforcement of it

Slide 27

References

- Source: Pant, B.R. Ground water quality in the Kathmandu valley of Nepal. *Environ Monit Assess* **178**, 477–485 (2011). https://doi.org/10.1007/s10661-010-1706-y
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- https://iwaponline.com/ws/article-abstract/14/3/390/25415/Seasonal-variation-in-the-microbial-quality-of

Slide 28

Thank you!

धन्यवाद !

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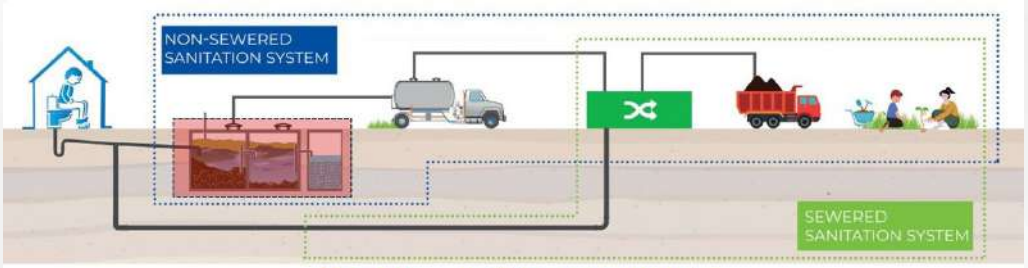
Lesson Plan 3: Containment and its types

Slide 1



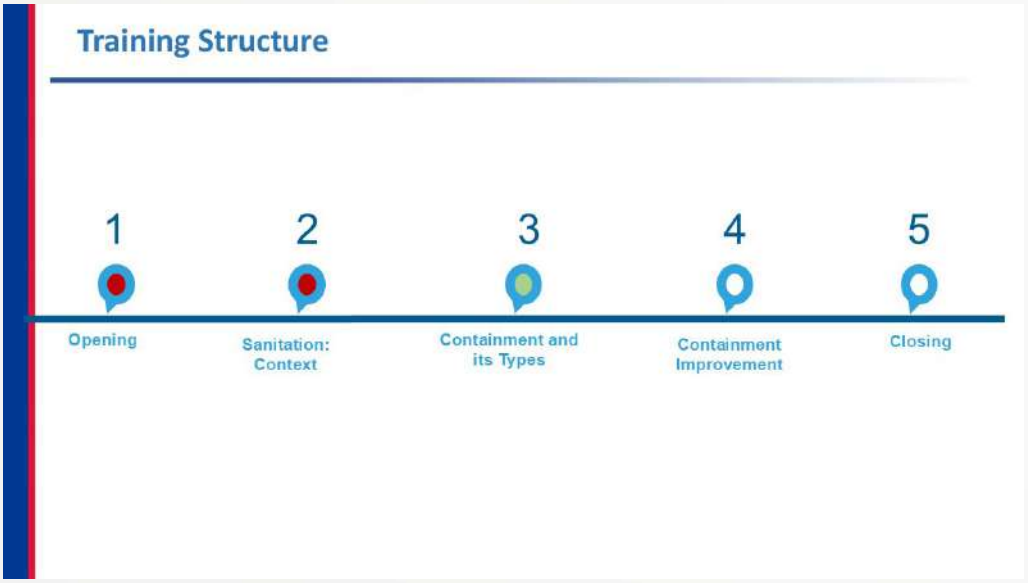
Containment Improvement

Containment and its types

Resource person

Government of Nepal
Ministry of Water Supply
National Water Supply and Sanitation Research, Innovation and Capacity Development Center

Slide 2



Slide 3

Learning Outcomes

- Define proper containment and how it contributes to safely managed sanitation
- Explain the pros and cons of each type of containment focusing on the challenges of each containment

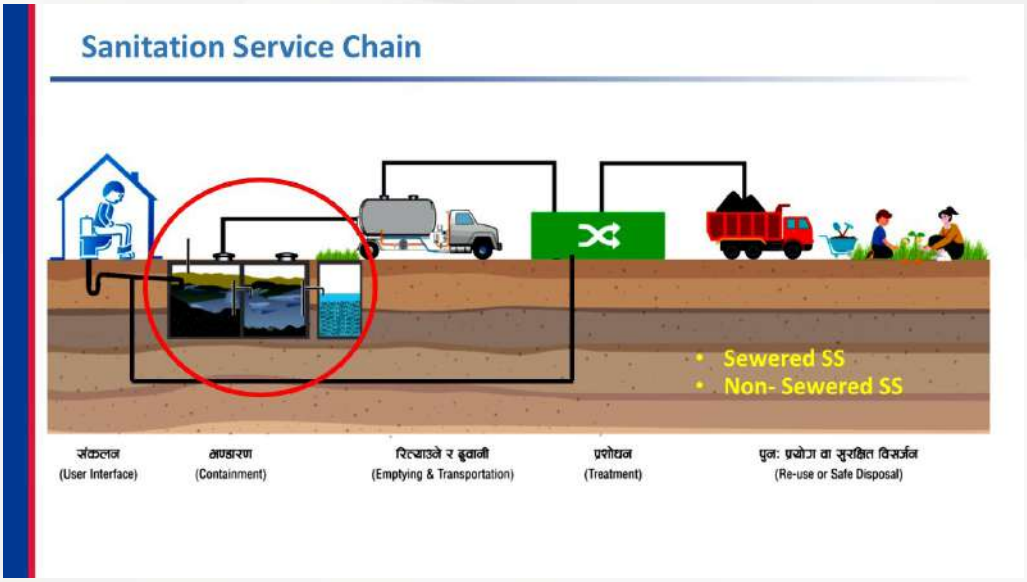
Linking to earlier session, where the need to update the sanitation technology was highlighted, inform participants that the particular session will be discussing on it.

Slide 4

Presentation Outline

- Containment and its types
  - Single Pit
  - Twin pits
  - EcoSan Vault
  - Biogas Digester
  - Septic Tank

Slide 5



As discussed in earlier session, SSC means the whole chain of services starting from the origin of waste/ waste generation to the end use or disposal. The whole sanitation system comprises of 5 components namely:

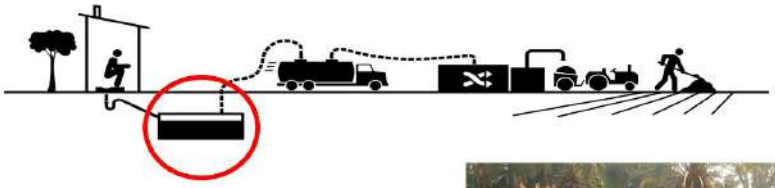
1. User interface
2. Containment
3. Emptying and transportation
4. Treatment
5. Reuse and safe disposal

The system defines the fate of fecal sludge generated. The first two components of the SSC influence the rest of the components. However, the first component, that is, user interface/ toilet has been a topic of discussion for long and as we have achieved significantly on the matter, hence will be discussing further on the second component of the SSC, that is,
ontainment.

Explain that the main objective of discussing this is to contribute in safely managed sanitation.

Slide 6

Containment



- Technologies that **store the products** generated at the User Interface
- Some of the containment designed **for storage as well as treatment**

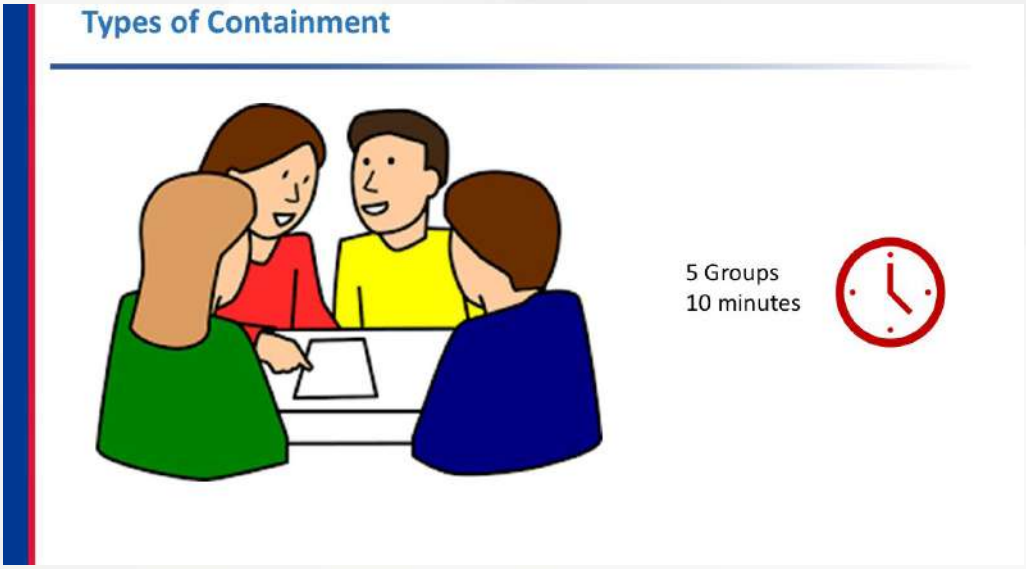
Describes the ways of collecting, storing, and sometimes treating the products that are generated at the User Interface
To this also explain how a proper containment contributes to the safely managed sanitation.
Proper containment not only contains the faeces but it also contributes to the safe environment by not contaminating it to its surrounding and overall protects the health of public

Slide 7

Types of Containments

- Simple pit/ Dry pit
- Improved/ Simple Lined Pit
- Ventilated Improved Pit
- Offset Pit
- Twin Pits
- Ecosan Vault
- Biogas Digester
- Septic Tank
- Various safe containments such as
  - RCC readymade septic tank
  - Readymade plastic septic tank
  - Ready to install eco septic tank
  - Johkasou
  - Newly invented technologies

Slide 8



Inform participants that they are going for a group discussion. For this participants will be divided into 4 groups. Assign each group a type of containment. To this, each group will have an information sheet related to the assigned topic/ type of containment and they are to note the highlights of each type of containment.
For this, groups will have 7 to 10 minutes time and after the time they are to present it to the large groups. Once the group with a definite type of containment have presented, present the slides of same topic and summarize the information.
Repeat the process for the other groups/ type of containment.

Slide 9

Slide 10

Simple Pit

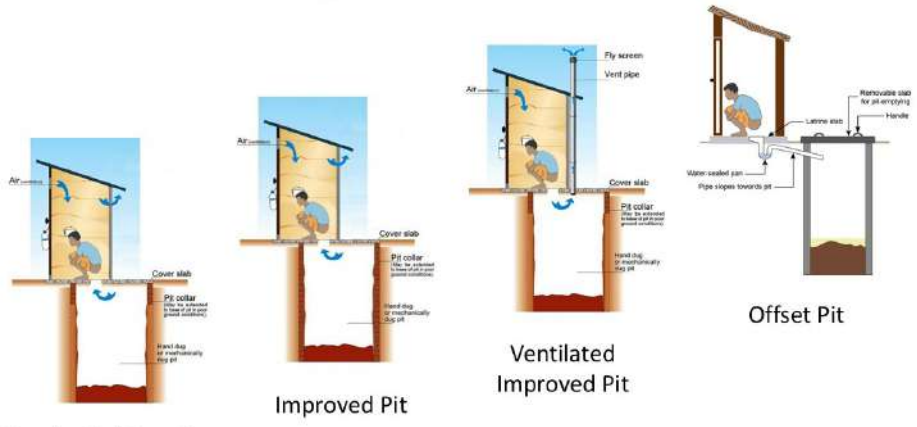
Introduction

- Most widely used sanitation technology
- Excreta, along with anal cleansing materials are deposited into a pit
- If the pit is to be reused, it should be lined
- Pit lining materials can include brick, rot-resistant timber, concrete, stones, or mortar plastered onto the soil

Best suited to rural and peri-urban areas where there is appropriate soil for digging and absorbing the Effluent from the pit.
This system should be chosen only where there is either space to continuously dig new pits or when there is an appropriate manner of emptying and disposing of the Faecal Sludge. This system is also best suited to areas that are not prone to heavy rains or flooding, which may cause the pits to overflow. Some Greywater in the pit may help degradation, but excessive additions of Greywater may shorten the life of the pit.

Slide 11

Pits and its types

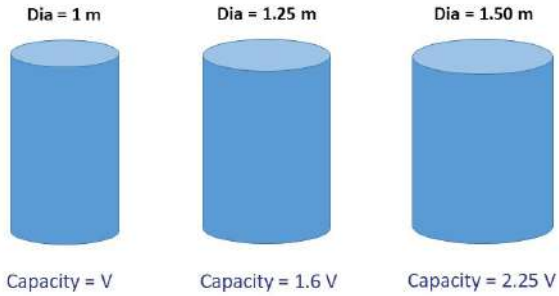


Simple pit/Dry pit should be

- At least 20-30m away from water source
- At least 2-5 m above ground water table Expalin the above types of pits.

Slide 12

Pit Diameter – Pit Capacity



Increase in diameter of pit significantly increases design life

Just make the point that if ring is bigger, it will last long.

Slide 13

Simple Pit

Design Considerations

- The volume of the pit should be designed to contain at least 1,000 L
- Typically, the pit is at least 3 m deep and 1 m in diameter
- If the pit diameter exceeds 1.5 m, there is an increased risk of collapse.
- Depending on how deep they are dug, some pits may last 20 or more years without emptying
- When it is not possible to dig a deep pit or the groundwater level is too high, a raised pit can be a viable alternative

Slide 14

Simple Pit

Costing

- The cost of the pits depend on construction materials used and area of installation.
- Present the tentative cost estimate of the related areas.

Slide 15

Single Pit

Costing (rate analysis, Dullu municipality 2080/81)

S. No.	Construction materials	Estimated cost
1	Stone	90,314
2	Bricks	86,559
3	Concrete rings	22,085

Slide 16

Simple Pit

Applicability

- Appropriate for rural and peri-urban areas where emptying is difficult.
- Best for water scarce areas and areas with low ground water table.
- Not suited for rocky or compacted soils or for areas prone to frequent flooding
- Improvement to open defecation but possess health risks so it should be constructed at an appropriate distance from homes to minimize fly and odour nuisances.

Slide 17

Single Pit

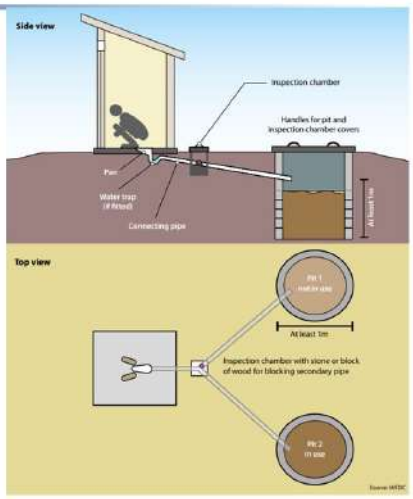
- **Pros**
  - Can be built and repaired with locally available materials
  - Does not require a constant source of water
  - Can be used immediately after construction
  - Low (but variable) capital costs depending on materials
- **Cons**
  - Flies and odours are normally noticeable
  - Sludge requires secondary treatment and/or appropriate discharge
  - Costs to empty may be significant compared to capital costs
  - Low reduction in BOD and pathogens with possible contamination of groundwater

Slide 18

Twin Pits

Introduction

- Designated as improved pit latrine
- Generally known as Sulav Toilet
- Consists of two alternating pits laid at 1m distance that are connected to a pour flush toilet
- Junction chamber is provided to divert flow



This is a water-based system utilizing the Pour Flush Toilet (pedestal or squat pan) to produce a partially digested, humus-like Product, which can be used as a soil amendment.

Slide 19

Twin Pits

Working principle

- The excreta deposited in the toilet pan reaches the junction chamber through a water seal trap.
- A junction chamber, Y junction is connected with two underground leach pits by two separate drain pipes.
- Only one pit is utilized at a time, as the Y junction is closed off for the other pit.
- When the active pit becomes full, it is sealed, and the other pit is put into use.

Slide 20

Twin Pits

Working principle

- The bottom of the pit is not cemented and also the wall is honey combed.
- The liquids from the excreta get leached into the soil.
- The sealed pit containing solid part undergoes a decomposition process involving composting and anaerobic digestion.
- After a period of approximately two years, the sludge in the sealed pit matures can be utilized as a nutrient-rich soil amendment in agricultural practices

Slide 21

Twin Pits

Working principle

Slide 22

Twin Pits

Design parameters of twin pits

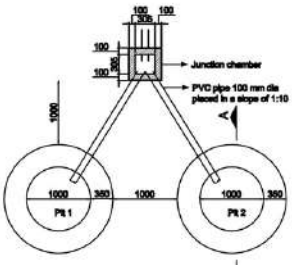
- The size of the twin pits depends on
  - Sludge storage volume
  - Sludge accumulation rate
  - Number of users
  - Desludging period

Slide 23

Twin Pits

Sizing of twin pits

Number of users	5	10	15
Diametre, d (m)	1	1.4	1.6
Height/Depth, h (m)	1.3	1.4	1.5



Twin pit: Plan (All dimensions are in mm)

Note:
The above design is for the desludging period of 2 years.
The height/depth is the distance from the bottom of the pit to the invert level of the incoming pipe
300 mm to be added in height/depth for freeboard

Slide 24

Twin Pits

Costing of twin pit for 5 number of users, diameter = 1m and height = 1.3m
(rate analysis Dullu municipality,2080/81)

S. No.	Construction materials	Estimated cost
1	Stone	79,852
2	Bricks	1,17,781
3	Concrete rings	37,845

Slide 25

Twin Pits

Applicability

- Best suited to rural and peri-urban areas
- Clayey or densely packed and rocky soils are not appropriate
- Not appropriate for areas with a high groundwater table or where is frequent flooding
- The dewatered solid material can be removed manually and reused in the form of compost.

In the case of the double pits, the system will depend on soil which can continually and adequately absorb moisture; clayey or densely packed soils are not appropriate. The material that is removed should be in a safe, useable form, although the task of removing, transporting and using it may not be favourable in some circumstances.

Slide 26

Twin Pits

Pros and Cons

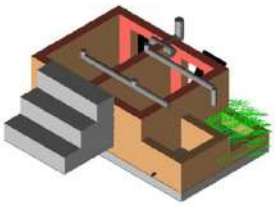
- **Pros**
  - Can be built and repaired with locally available materials
  - Since, double pits are used alternately, their life is virtually unlimited
  - Excavation of humus is easier than faecal sludge and can be reused as soil conditioner
  - Flies and odours are significantly reduced (compared to pits without a waterseal)
  - Low (but variable) capital costs depending on materials; no or low operating costs if self-emptied
  - Moderate reduction in pathogens
- **Cons**
  - Excreta require manual removal
  - Clogging is frequent when bulky cleansing materials are used
  - Higher risk of groundwater contamination due to more leachate than with waterless systems

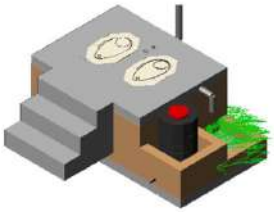
Slide 27

Dry Ecosan Toilet

Introduction

- Also called Urine Diverting Dry Toilet
- Operates without water
- Divert the urine away from the faeces
- Constructed above ground
- The use of two alternating vaults allows the faeces to dehydrate in one vault while the other vault fills.





Slide 28

Dry Ecosan Toilet

Design Considerations

- A vent pipe is required to remove humidity from the vaults and control flies and odours.
- The chambers should be airtight for proper functioning of the ventilation
- If ash or lime are used as cover material, minimum storage time is 6 months otherwise the storage should be for at least 1 year or up to 2 years depending on the climatic conditions.

Slide 29

Dry Ecosan Vault

Applicability

- Suitable for rural to dense urban areas
- Can be used anywhere, but it is especially appropriate for
  - rocky areas where digging is difficult
  - a high groundwater table
  - in water-scarce regions
- Anal Cleansing Water should never be put into Dehydration Vaults

This system can be used anywhere, but it is especially appropriate for rocky areas where digging is difficult, where there is a high groundwater table, or in water-scarce regions.
Anal Cleansing Water should never be put into Dehydration Vaults, but it can be diverted and put into a Soak Pit
the chambers should be watertight and care should be taken to ensure that no water is introduced during cleaning.
Also important is a constant supply of ash, lime, or dry earth to cover the Faeces to minimize odours and provide a barrier between the Faeces and potential vectors (flies).

Slide 30

Dry Ecosan Vault

- Also important is a constant supply of ash, lime, or dry earth to cover the faeces
  - to minimize odours
  - provide a barrier between the faeces and potential vectors (flies)
- The increase in pH will also help to kill organisms
- The success of this system depends on
  - the efficient separation of urine and faeces
  - the use of a suitable drying agent
  - a dry, hot climate can also contribute considerably to the rapid dehydration of the faeces

Slide 31

Dry Eco-San

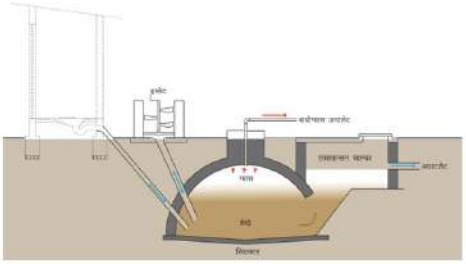
- **Pros**
  - Since double vaults are used alternately, their life is virtually unlimited
  - Does not require a constant source of water
  - No real problems with odours and vectors (flies) if used and maintained correctly (i.e. kept dry)
  - Significant reduction in pathogens
  - Can be built and repaired with locally available materials
  - Low capital and operation costs
  - Suitable for all types of users (sitters, squatters, washers, wipers)
- **Cons**
  - Requires education and acceptance to be used correctly
  - Is prone to clogging with faeces and misuse
  - Required constant source of cover material

Slide 32

Biogas Digester

Introduction

- Anaerobic treatment technology that produces (a) a digested slurry (digestate) that can be used as a fertilizer and (b) biogas that can be used for energy.
- Is an airtight chamber that facilitates the anaerobic degradation of blackwater, sludge, and/or biodegradable waste.



Slide 33

Biogas Digester

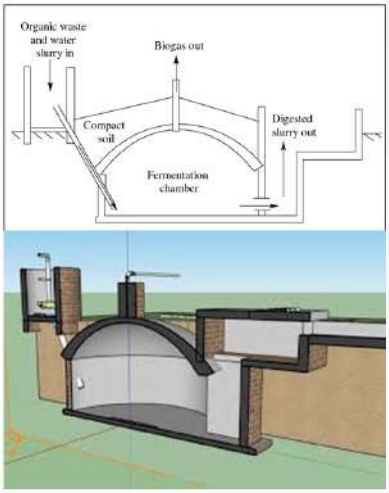
An Anaerobic Biogas Reactor is a chamber or vault that facilitates the anaerobic degradation of blackwater, sludge, and/or biodegradable waste. It also facilitates the separation and collection of the biogas that is produced. The tanks can be built above or below ground. Prefabricated tanks or brick-constructed chambers can be built depending on space, resources and the volume of waste generated.

Slide 34

Biogas Digester

Design considerations

- Brick-constructed domes or prefabricated tanks, installed above or below ground, depending on space, soil characteristics, available resources and the volume of waste generated
- The hydraulic retention time (HRT) in the reactor should be a minimum of 15 days in hot climates and 25 days in temperate climates.
- For highly pathogenic inputs, an HRT of 60 days should be considered.



Once waste products enter the digestion chamber, gases are formed through fermentation. The gas forms in the sludge but collects at the top of the reactor, mixing the slurry as it rises.
Gases are formed through fermentation. The gas forms in the sludge but collects at the top of the reactor, mixing the slurry as it rises.
As gas is generated it exerts a pressure and displaces the slurry upward into an expansion chamber. When the gas is removed, the slurry will flow back down into the digestion chamber. The pressure generated can be used to transport the biogas through pipes

Slide 35

Biogas Digester

- Gases are formed through fermentation.
- The gas forms in the sludge but collects at the top of the reactor.
- As gas is generated it exerts a pressure and displaces the slurry upward into an expansion chamber.
- The slurry that is produced is rich in organics and nutrients, but almost odorless and partly disinfected
- Complete pathogen destruction would require thermophilic conditions
- Depending on the design and the inputs, the reactor should be emptied once every 6 months to 10 years

Slide 36

Biogas Digester

Applicability

- Can be applied at household level, in small neighbourhoods or for the stabilization of sludge at large wastewater treatment plants
- The highest levels of biogas production are obtained with concentrated substrates, which are rich in organic material
- less appropriate for colder climates as the rate of organic matter conversion into biogas is very low below 15 °C

Slide 37

Biogas Digester

- **Pros:**
  - Generation of a renewable, valuable energy source
  - Low capital costs; low operating costs
  - Underground construction minimizes land use
  - Long life span
  - Can be built and repaired with locally available materials
  - No electrical energy required
  - Small land area required (most of the structure can be built underground)
- **Cons**
  - Requires expert design and skilled construction
  - Gas production below 15°C is not economically feasible
  - Digested sludge and effluent still requires treatment

An Anaerobic Biogas Reactor is a chamber or vault that facilitates the anaerobic degradation of blackwater, sludge, and/or biodegradable waste. It also facilitates the separation and collection of the biogas that is produced. The tanks can be built above or below ground. Prefabricated tanks or brick-constructed chambers can be built depending on space, resources and the volume of waste generated.

Slide 38

Standard Septic Tank

What is standard septic tank?

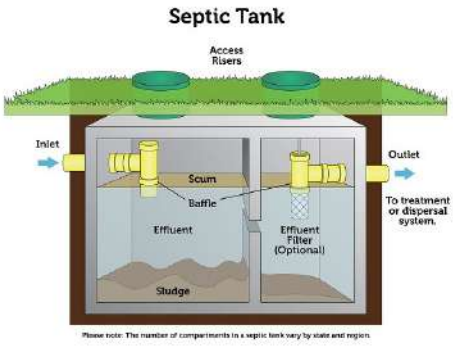
https://www.youtube.com/watch?v=-qIxyxsNqhI

Slide 39

Standard Septic Tank

Introduction

- Watertight underground tanks used for storage and treatment of domestic wastewater
- Semi treatment technology
- Efficiency; 30-40% of BOD removal and 40-60% of TSS



Slide 40

Standard septic Tank

Key features of Septic Tank

- Consist of at least two chambers separated by a baffle wall
- Water sealed
- Outlet connected to soak-pit/ leachate field/sewer

A Septic Tank is a watertight chamber made of concrete, fibre glass, PVC or plastic, for the storage and treatment of blackwater and greywater. Settling and anaerobic processes reduce solids and organics, but the treatment is only moderate.
Septic Tanks can be installed in every type of climate although the efficiency will be affected in colder climates. Even though the Septic Tank is watertight, it should not be constructed in areas with high groundwater tables or where there is frequent flooding.

Slide 41

Standard Septic Tank

Working principle of Septic Tank

- During the storage, heavy solids settle down at the bottom of the tank and the lighter solids float above liquid
- During the storage period, anaerobic digestion take place inside it and biodegradable solids are converted into sludge and gases.

Slide 42

Septic tank (working principle)

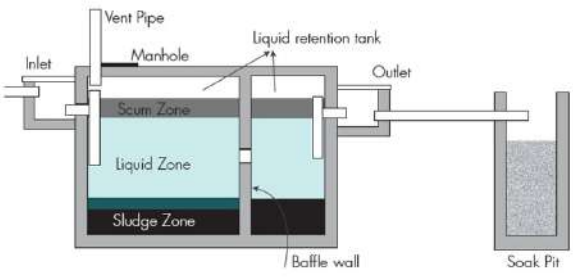
Septic tank is one of the infrastructure for containment of the FS. Around 30-40% waste is treated in the septic tank, hence the septage (FS) needs to be taken for further treatment. One of the major component of the septic tank is soak-pit.
The minimum depth of the septic tank should be 1.2 meters while the first compartment of the septic should be of 2/3 of the total length leaving 1/3 of the total length for the second compartment.
Septic tank is one of the major option in all urban areas including some slums.

Slide 43

Standard septic tank

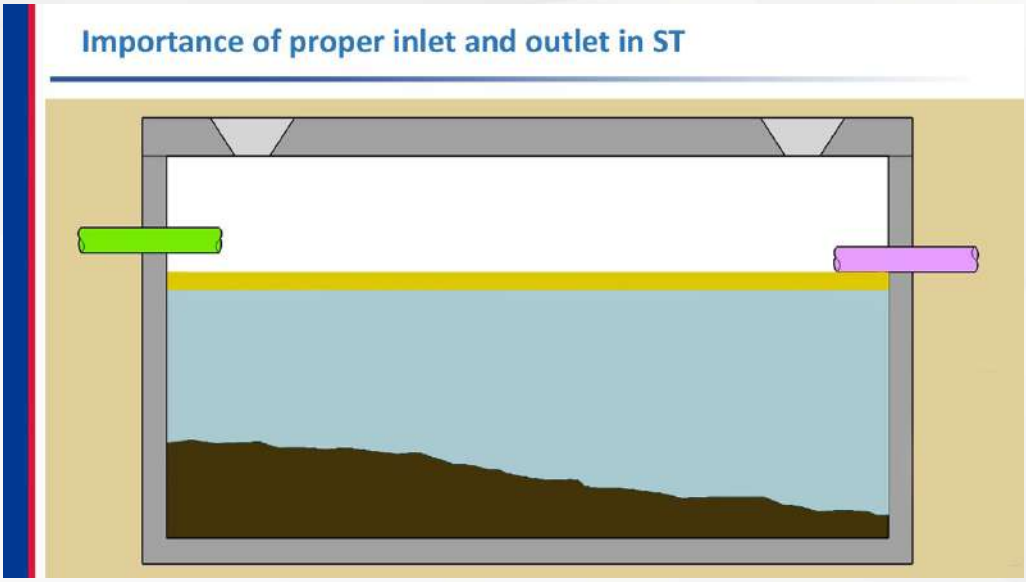
Key Components of Septic tank

- Inlet
- Outlet
- Manhole
- Liquid retention tank
- Baffle wall
- Soak pit
- Vent pipe

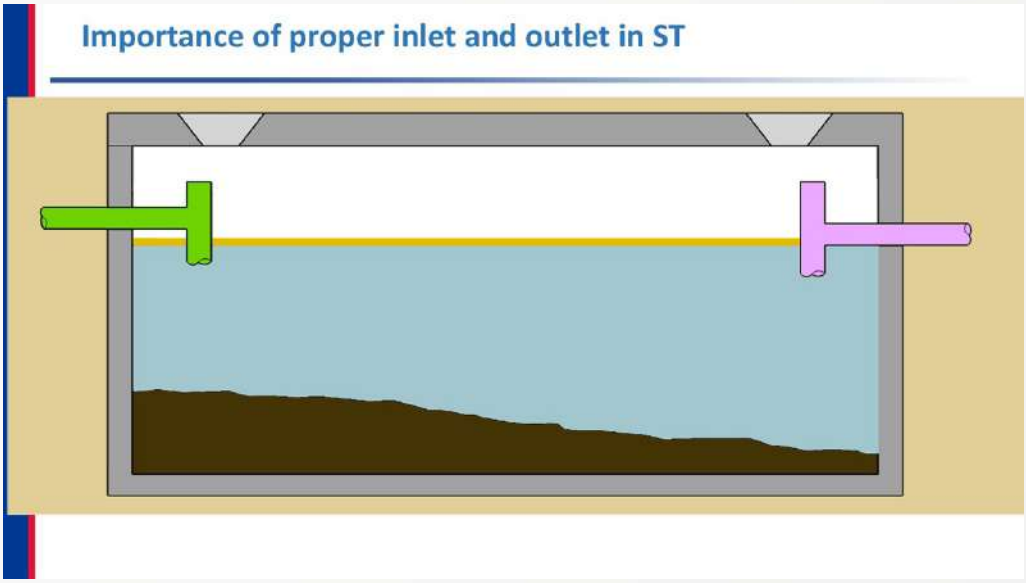


Note: Detail about the soak pit

Slide 44

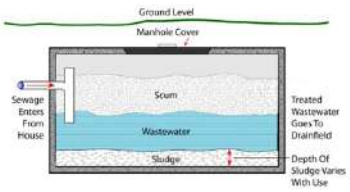


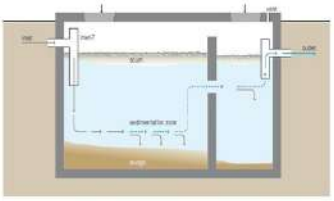
Slide 45



Slide 46

All Rectangular tank is not septic tank





- Only collect and store
- Does not have outlet
- Need frequent desludging
- Is single chambered
- Leaky tank

- Treat wastewater up to 40%
- Has an outlet connected to Soak pit/sewer
- Need less desludging
- At least double chambered
- Water seal

Slide 47

Standard septic tank

Design principles of Septic tank

- provide sufficient hydraulic retention time to settle down the heavy solids of sewage and stabilization of liquid;
- ensure stable quiescent hydraulic conditions for efficient settling and floatation
- provide adequate volume of septic tank for accumulation of sludge and scum for desludging period.

Slide 48

Standard septic tank

Design Considerations

- The design of a septic tank depends on
  - ➢the number of users
  - ➢ the amount of water used per capita
  - ➢ the average annual temperature
  - ➢ the desludging frequency and
  - ➢the characteristics of the wastewater
- The retention time should be 48 hours to achieve moderate treatment.

Slide 49

Standard septic tank

Design Steps

- Step 1. Determination of wastewater volume
- Step 2. Determination of peak flow
- Step 3. Determination of liquid volume
- Step 4. Determination of Sludge and Scum volume
- Step 5. Determination of volume f septic tank
- Step 6. Sizing of Septic tank

The detail design of the septic tank will be done in design exercise session.

Slide 50

Size of Septic tank as per users

Design Parameters of standard septic tank are as follows:

- Volume of wastewater = volume of wastewater produced in a day
- Hydraulic retention time = 24 hours
- Desludging period = 2 years
- Temperature = 20°C

Table 1: Minimum size of septic tank for Terai region

No of users	5	10	15	20	25	50	75	100	150	200	250	300
Length of the 1st Compartment (L1)	0.9	1.3	1.5	1.7	1.8	2.3	2.9	2.8	3.5	4.0	4.5	4.9
Length of the 2nd Compartment(L2)	0.5	0.7	0.8	0.9	0.9	1.2	1.4	1.4	1.7	2.0	2.2	2.4
Breadth(b) in m	0.7	1.0	1.2	1.3	1.4	1.8	2.1	2.1	2.6	3.0	3.4	3.7
Heigth (H) in m	1.3	1.3	1.3	1.4	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0
Total Volume m3	1.30	2.60	3.60	4.70	5.70	9.50	13.50	17.60	27.00	36.00	45.60	54.00

Slide 51

Size of Septic tank as per users

Table 2: Minimum size of septic tank for Himalayan region

No of users	5	10	15	20	25	50	75	100	150	200	250	300
Length of the 1st Compartment (L1)	1.0	1.3	1.6	1.8	2.0	2.6	2.9	3.1	3.9	4.5	5.0	5.5
Length of the 2nd Compartment(L2)	0.5	0.7	0.8	0.9	1.0	1.3	1.4	1.6	1.9	2.2	2.5	2.7
Breadth(b) in m	0.7	1.0	1.2	1.4	1.5	2.0	2.4	2.4	2.9	3.4	3.8	4.1
Heigth (H) in m	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0
Total Volume m^3	1.60	3.00	4.30	5.70	6.80	11.70	15.50	22.60	33.60	45.60	57.00	67.20

Table 3: Minimum size of septic tank for Hilly region

No of users	5	10	15	20	25	50	75	100	150	200	250	300
Length of the 1st Compartment (L1)	0.9	1.3	1.5	1.8	1.9	2.4	3.0	2.9	3.6	4.1	4.7	5.3
Length of the 2nd Compartment(L2)	0.5	0.7	0.8	0.9	0.9	1.2	1.5	1.5	1.8	2.1	2.3	2.7
Breadth(b) in m	0.7	1.0	1.2	1.3	1.4	1.8	2.2	2.2	2.7	3.1	3.5	4.0
Heigth (H) in m	1.4	1.4	1.4	1.4	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0
Total Volume m3	1.40	2.80	3.90	4.90	5.90	9.70	14.90	19.40	29.20	38.40	49.00	64.00

Slide 52

Materials required for construction of standard septic tank

Table: For Terai region

Brick structure

SN	Materials and Manpower	Unit	Total Number of users											
			5	10	15	20	25	50	75	100	150	200	250	300
1	Brick	nos	577	835	975	1,920	2,164	2,992	3,716	4,360	5,572	6,546	10,126	11,127
2	Cement	Bags	8	12	15	24	27	38	49	54	81	99	136	153
3	Sand	cum	1	1.5	1.8	3	3.4	4.7	6.1	6.8	9.8	11.9	16.6	18.6
4	Aggregate	cum	0.5	0.8	1	1.5	1.7	2.6	3.6	3.4	6.5	8.2	10.9	12.5
5	Rebar	kg	32	54	68	100	112	337	464	450	830	1,052	1,396	1,607
6	Form work	sqm	1.7	2.9	3.7	4.5	5.1	7.9	11.3	10.9	17.1	22	27	31.6
7	pipe with fittings	Rm	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
8	Skilled Manpower	md	5	8	10	15	17	25	32	37	52	63	86	96
9	Unskilled Manpower	md	12	19	23	36	41	61	80	91	136	168	228	257

Concrete structure

SN	Materials and Manpower	Unit	Total Number of users											
			5	10	15	20	25	50	75	100	150	200	250	300
1	Brick	nos	141	240	299	355	402	623	906	887	1,346	1,761	2,132	2,479
2	Cement	Bags	11	17	20	23	27	36	52	61	89	117	135	152
3	Sand	cum	1	1.6	1.9	2.2	2.6	3.6	5.1	5.7	8.5	11	12.9	14.6
4	Aggregate	cum	1.2	1.9	2.2	2.6	3	4.1	6	7	10.6	14.1	16.5	18.6
5	Rebar	kg	101	150	177	209	238	645	953	1,127	1,641	2,186	2,531	2,844
6	Form work	sqm	17.5	24.8	28.5	33.6	38.1	49.1	61.5	74.8	95.2	112.1	127	140.1
7	pipe with fittings	Rm	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
8	Skilled Manpower	md	5	8	9	11	13	21	29	34	49	62	72	81
9	Unskilled Manpower	md	13	21	25	30	35	53	76	89	133	173	204	232

Note: Stone construction work cannot be preferred in the context of Terai Region

Slide 53

Materials required for construction of standard septic tank

Table : For Himalayan region

Concrete structure

SN	Materials and Manpower	Unit	Total Number of Users											
			5	10	15	20	25	50	75	100	150	200	250	300
1	Stone	Cum	0.4	0.6	0.8	0.9	1.1	1.8	2.4	2.6	3.9	5.1	6.2	7.3
2	Cement	Bags	13	18	23	26	30	42	55	70	103	135	158	179
3	Sand	cum	1.2	1.8	2.3	2.7	3.1	4.5	5.9	7.2	10.7	14	16.5	18.8
4	Aggregate	cum	1.4	2	2.5	2.9	3.3	4.7	6.5	8.1	12.4	16.5	19.3	22
5	Rebar	kg	115	163	201	232	266	742	1,015	1,296	1,897	2,531	2,951	3,340
6	Form work	sqm	20.4	27.5	33	37.3	41.9	55.2	64.6	84.4	107.4	127	144.6	160.6
7	pipe with fittings	Rm	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
8	Skilled Manpower	md	6	9	11	13	14	24	32	40	57	74	86	97
9	Unskilled Manpower	md	16	23	29	34	40	63	82	106	158	206	245	281

Stone structure

SN	Materials and Manpower	Unit	Total Number of Users											
			5	10	15	20	25	50	75	100	150	200	250	300
1	Stone	Cum	6	7.6	8.9	9.9	10.9	14	16.1	20.6	32.8	37.8	42.5	46.6
2	Cement	Bags	19	26	31	35	40	54	64	77	132	158	182	205
3	Sand	cum	3.5	4.6	5.5	6.2	6.9	9.2	10.9	13.3	21.8	25.7	29.5	32.9
4	Aggregate	cum	1	1.4	1.8	2.1	2.4	3.5	4.4	4.6	9.4	11.7	14	16.1
5	Rebar	kg	64	92	115	134	156	458	570	608	1,203	1,503	1,798	2,078
6	Form work	sqm	2.1	3.4	4.4	5.3	6.4	9.9	12.8	13.7	21.6	27.8	34	40
7	pipe with fittings	Rm	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
8	Skilled Manpower	md	13	17	20	22	25	36	42	52	84	100	114	128
9	Unskilled Manpower	md	41	55	65	74	83	114	135	171	281	336	387	435

Slide 54

Materials required for construction of standard septic tank

Table : For Hilly region

Brick structure

SN	Materials and Manpower	Unit	Total Number of users											
			5	10	15	20	25	50	75	100	150	200	250	300
1	Brick	nos	863	1,206	2,544	2,923	3,291	4,586	5,763	6,773	8,676	10,151	15,521	18,029
2	Cement	Bags	8	12	20	23	26	41	54	59	86	104	143	172
3	Sand	cum	1	2	3	3	3.3	5	7	7	10	12	17	20
4	Aggregate	cum	1	1	1	2	1.7	3	4	4	7	9	12	15
5	Rebar	kg	30	51	82	101	112	433	606	588	943	1,192	1,591	1,993
6	Form work	sqm	1.6	2.9	3.7	4.7	5.3	9	12.8	12.4	18.2	23.2	29.1	37.2
7	pipe with fittings	Rm	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
8	Skilled Manpower	md	6	8	13	15	17	27	35	39	54	65	89	106
9	Unskilled Manpower	md	12	19	30	36	41	65	87	98	143	175	237	289

Concrete structure

SN	Materials and Manpower	Unit	Total Number of users											
			5	10	15	20	25	50	75	100	150	200	250	300
1	Brick	nos	208	354	442	584	651	1,000	1,468	1,438	2,276	2,869	3,531	4,455
2	Cement	Bags	12	18	21	28	31	42	60	70	120	144	168	202
3	Sand	cum	1.1	1.6	2	2.6	3	4	5.7	6.5	10.9	13.1	15.6	18.8
4	Aggregate	cum	1.3	1.9	2	3.2	4	4.8	7	8.1	14.7	17.7	20.8	25.1
5	Rebar	kg	110	157	184	259	285	766	1,117	1,326	2,356	2,804	3,282	3,919
6	Form work	sqm	19.5	26.1	30	35.1	40	51	64.5	78.3	100.7	117.3	134.5	156.9
7	pipe with fittings	Rm	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
8	Skilled Manpower	md	6	8	10	13	14	23	33	39	63	75	88	105
9	Unskilled Manpower	md	15	22	26	35	39	59	85	101	168	204	244	297

Slide 55

Materials required for construction of standard septic tank

Table : For Hilly region

Stone structure

SN	Materials and Manpower	Unit	Total Number of users											
			5	10	15	20	25	50	75	100	150	200	250	300
1	Stone	Cum	5.8	7.3	8.2	9.2	10.3	13	15.9	19.1	30.6	35	39.6	45.4
2	Cement	Bags	19	25	29	33	37	49	63	70	125	148	173	206
3	Sand	cum	3.4	4.5	5.1	5.8	6.5	8.5	10.7	12.2	20.4	23.9	27.6	32.5
4	Aggregate	cum	0.9	1.4	1.7	2	2.2	3.1	4.3	4.1	9	11	13.3	16.5
5	Rebar	kg	61	92	109	130	144	408	557	542	1,181	1,457	1,762	2,185
6	Form work	sqm	2.1	3.4	4.1	5.1	5.8	8.6	12.4	12	19.1	24.3	30.1	38.3
7	pipe with fittings	Rm	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
8	Skilled Manpower	md	12	16	18	21	23	33	42	48	79	93	108	127
9	Unskilled Manpower	md	40	52	60	69	78	104	133	157	262	310	360	428

Slide 56

Septic Tank

Cost of septic tank with soak pit for 10 users

Costing (rate analysis Dullu municipality,2080/81)

S. No.	Construction materials	Estimated cost
1	Stone	1,85,558
2	Bricks	1,94,829
3	Bricks in septic tank and Concrete rings in soak pit	1,85,189

Slide 57

Septic Tank

Applicability

- Mostly used at the household level
- Appropriate where there is a way of dispersing or transporting the effluent/ Accessible locations
- Not recommended to construct them in areas with high groundwater tables or where there is frequent flooding
- Can be installed in every type of climate

Slide 58

Septic Tank

Applicability

- Mostly used at the household level
- Appropriate where there is a way of dispersing or transporting the effluent/ Accessible locations
- Not recommended to construct them in areas with high groundwater tables or where there is frequent flooding
- Can be installed in every type of climate

Slide 59

Septic Tank

- **Pros**
  - Can be built and repaired with locally available materials
  - Long service life
  - No real problems with flies or odours if used correctly
  - Low capital costs, moderate operating costs depending on water and emptying
  - Small land area required
  - No electrical energy required
- **Cons**
  - Low reduction in pathogens, solids and organics
  - Effluent and sludge require secondary treatment and/or appropriate discharge
  - Requires constant source of water
  - Regular desludging must be ensured

Slide 60

Different types of safe containments

RCC readymade septic tank

Readymade plastic septic tank

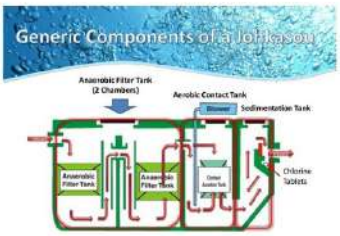
Ready to install eco septic tank

Slide 61

Different types of safe containments

Johkasou

- A facility that treats domestic wastewater (both black water and grey water)
- It is designed to treat in areas with no sewer system.
- The name "Johkasou" refers to purification tank in Japanese.



Slide 62

Key features of Johkasou

- Compact design suitable for households, small communities and institutions like schools and offices in rural and peri urban areas.
- Primarily used to treat wastewater for safe discharge into the environment or reuse.
- Rely on biological processes, often incorporating anaerobic and aerobic treatment chambers, to break down organic matter and remove pollutants.
- Regular maintenance and inspections are mandated to ensure proper functioning and compliance with environmental regulations.

Slide 63

Applicability of Johkasou

- Rural areas without centralized sewer systems.
- Locations with environmental or space constraints for traditional sewage systems.
- Temporary facilities or disaster relief settings.

Slide 64

Newly invented technologies

- Janicki Omniprocessor
  - https://www.youtube.com/watch?v=bVzppWSIFU0
- The Cranfield nanomembrane toilet
  - https://www.youtube.com/watch?v=jGPpXF7y9Rg

Slide 65

Key Message

- Which type of containment is best suited for each geographical reason and WHY?

4 Groups
5 minutes

In their groups, ask participants to discuss the best option for each type of geographical region (Terai, Hilly and Mountain) along with the rationale

Slide 66

References

- Compendium of Sanitation technologies
- FSM book
- CAWST , FSM trainer manual
- www.coursera.org
- www.commons.wikimedia,.org

Slide 67

Thank you!
धन्यवाद !

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National Water Supply and Sanitation Research, Innovation and Capacity Development Center
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Phone No:+977-1-6680171, +977-1-6680172
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Technical Support
Environment and Public Health Organization (ENPHO)
110/25 Adarsa Marg-1, Thapagaon, New Baneshwor
Tel: 977-1-5244641; 5244051; 5244992; 5244609
Email: enpho@enpho.org

Slide 68

For nontechnical participants

Slide 69

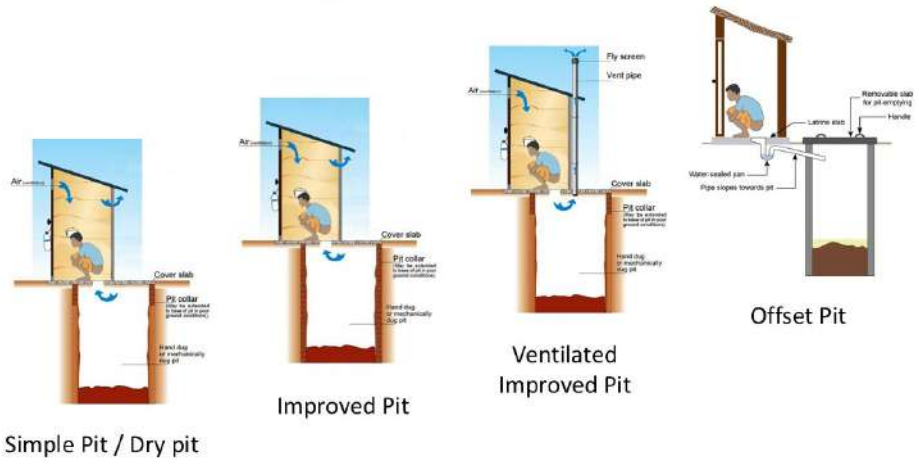
Simple Pit

- Most widely used sanitation technology
- Excreta, along with anal cleansing materials are deposited into a pit
- If the pit is to be reused, it should be lined
- Pit lining materials can include brick, rot-resistant timber, concrete, stones, or mortar plastered onto the soil

Best suited to rural and peri-urban areas where there is appropriate soil for digging and absorbing the Effluent from the pit.
This system should be chosen only where there is either space to continuously dig new pits or when there is an appropriate manner of emptying and disposing of the Faecal Sludge. This system is also best suited to areas that are not prone to heavy rains or flooding, which may cause the pits to overflow. Some Greywater in the pit may help degradation, but excessive additions of Greywater may shorten the life of the pit.

Slide 70

Pits and its types



Simple pit/Dry pit should be

- At least 20-30m away from water source
- At least 2-5 m above ground water table

Expalin the above types of pits.

Slide 71

Simple Pit

- Typically, the pit is at least 3 m deep and 1 m in diameter
- If the pit diameter exceeds 1.5 m, there is an increased risk of collapse.
- When it is not possible to dig a deep pit or the groundwater level is too high, a raised pit can be a viable alternative
- Appropriate for rural and peri-urban areas where emptying is difficult.
- Not suited for rocky or compacted soils or for areas prone to frequent flooding

Slide 72

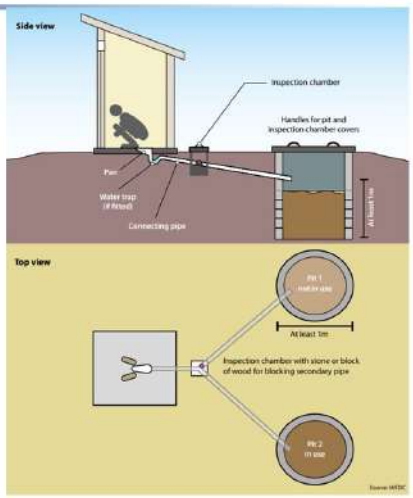
Single Pit

- **Pros**
  - ➢Can be built and repaired with locally available materials
  - ➢Does not require a constant source of water
  - ➢Can be used immediately after construction
  - ➢Low (but variable) capital costs depending on materials
- **Cons**
  - ➢Flies and odours are normally noticeable
  - ➢Sludge requires secondary treatment and/or appropriate discharge
  - ➢Costs to empty may be significant compared to capital costs
  - ➢Low reduction in BOD and pathogens with possible contamination of groundwater

Slide 73

Twin Pits

- Designated as improved pit latrine
- Generally known as Sulav Toilet
- Consists of two alternating pits laid at 1m distance that are connected to a pour flush toilet
- Junction chamber is provided to divert flow



This is a water-based system utilizing the Pour Flush Toilet (pedestal or squat pan) to produce a partially digested, humus-like Product, which can be used as a soil amendment.

Slide 74

Twin Pits

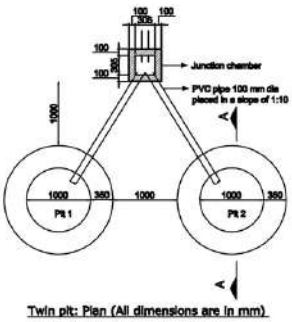
Working principle

Slide 75

Twin Pits

Sizing of twin pits

Number of users	5	10	15
Diametre, d (m)	1	1.4	1.6
Height/Depth, h (m)	1.3	1.4	1.5



Twin pit: Plan (All dimensions are in mm)

Note:
The above design is for the desludging period of 2 years.
The height/depth is the distance from the bottom of the pit to the invert level of the incoming pipe
300 mm to be added in height/depth for freeboard

Slide 76

Twin Pits

Applicability

- Best suited to rural and peri-urban areas
- Clayey or densely packed and rocky soils are not appropriate
- Not appropriate for areas with a high groundwater table or where is frequent flooding
- The dewatered solid material can be removed manually and reused in the form of compost.

In the case of the double pits, the system will depend on soil which can continually and adequately absorb moisture; clayey or densely packed soils are not appropriate. The material that is removed should be in a safe, useable form, although the task of removing, transporting and using it may not be favourable in some circumstances.

Slide 77

Twin Pits

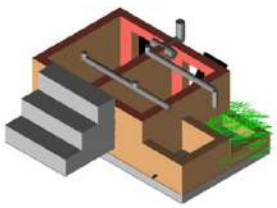
Pros and Cons

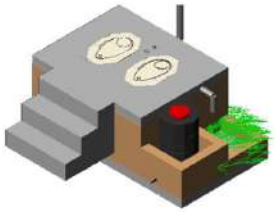
- **Pros**
  - Can be built and repaired with locally available materials
  - Since, double pits are used alternately, their life is virtually unlimited
  - Excavation of humus is easier than faecal sludge and can be reused as soil conditioner
  - Flies and odours are significantly reduced (compared to pits without a waterseal)
  - Low (but variable) capital costs depending on materials; no or low operating costs if self-emptied
  - Moderate reduction in pathogens
- **Cons**
  - Excreta require manual removal
  - Clogging is frequent when bulky cleansing materials are used
  - Higher risk of groundwater contamination due to more leachate than with waterless systems

Slide 78

Dry Ecosan Toilet

- Also called Urine Diverting Dry Toilet
- Operates without water
- The use of two alternating vaults allows the faeces to dehydrate in one vault while the other vault fills.
- If ash or lime are used as cover material, minimum storage time is 6 months otherwise 1-2 years depending on the climatic conditions.





Slide 79

Dry Ecosan Vault

- Suitable for rural to dense urban areas
- Can be used anywhere, but it is especially appropriate for
  - rocky areas where digging is difficult
  - a high groundwater table
  - in water-scarce regions
- Also important is a constant supply of ash, lime, or dry earth to cover the faeces

This system can be used anywhere, but it is especially appropriate for rocky areas where digging is difficult, where there is a high groundwater table, or in water-scarce regions.
Anal Cleansing Water should never be put into Dehydration Vaults, but it can be diverted and put into a Soak Pit
the chambers should be watertight and care should be taken to ensure that no water is introduced during cleaning.
Also important is a constant supply of ash, lime, or dry earth to cover the Faeces to minimize odours and provide a barrier between the Faeces and potential vectors (flies).

Slide 80

Dry Eco-San

- **Pros**
  - Since double vaults are used alternately, their life is virtually unlimited
  - Does not require a constant source of water
  - No real problems with odours and vectors (flies) if used and maintained correctly (i.e. kept dry)
  - Significant reduction in pathogens
  - Can be built and repaired with locally available materials
  - Low capital and operation costs
  - Suitable for all types of users (sitters, squatters, washers, wipers)

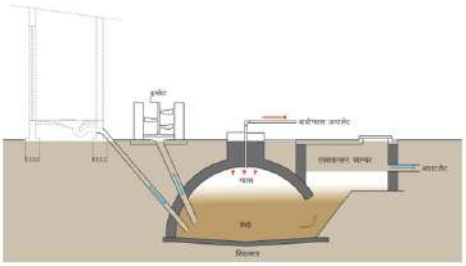
- **Cons**
  - Requires education and acceptance to be used correctly
  - Is prone to clogging with faeces and misuse
  - Required constant source of cover material

Slide 81

Biogas Digester

Introduction

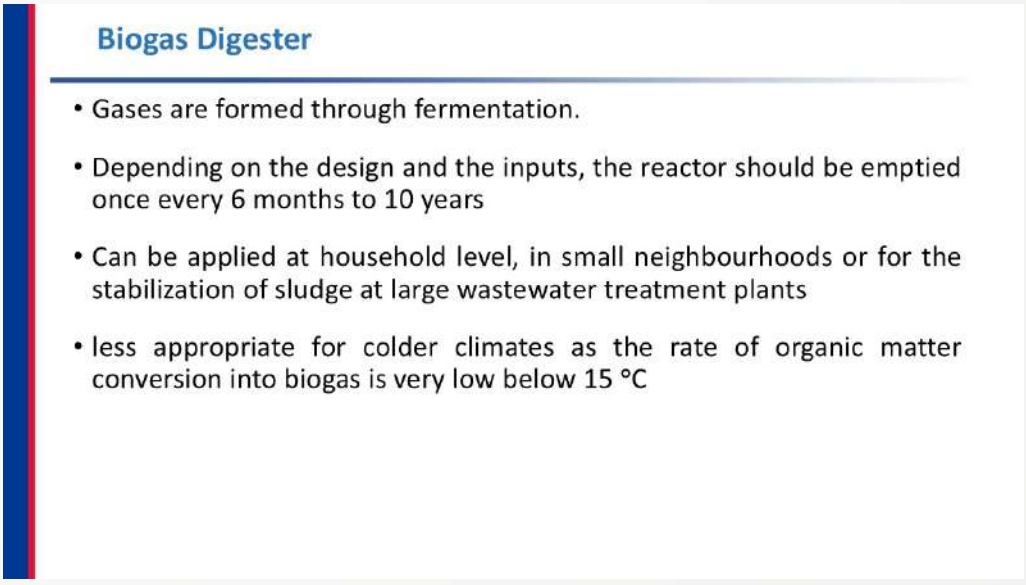
- Anaerobic treatment technology that produces (a) a digested slurry (digestate) that can be used as a fertilizer and (b) biogas that can be used for energy.
- Is an airtight chamber that facilitates the anaerobic degradation of blackwater, sludge, and/or biodegradable waste.



Slide 82

An Anaerobic Biogas Reactor is a chamber or vault that facilitates the anaerobic degradation of blackwater, sludge, and/or biodegradable waste. It also facilitates the separation and collection of the biogas that is produced. The tanks can be built above or below ground. Prefabricated tanks or brick-constructed chambers can be built depending on space, resources and the volume of waste generated.

Slide 83



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Slide 84

Biogas Digester

- **Pros:**
  - Generation of a renewable, valuable energy source
  - Low capital costs; low operating costs
  - Underground construction minimizes land use
  - Long life span
  - Can be built and repaired with locally available materials
  - No electrical energy required
  - Small land area required (most of the structure can be built underground)

- **Cons**
  - Requires expert design and skilled construction
  - Gas production below 15°C is not economically feasible
  - Digested sludge and effluent still requires treatment

Slide 85

Standard Septic Tank

What is standard septic tank?

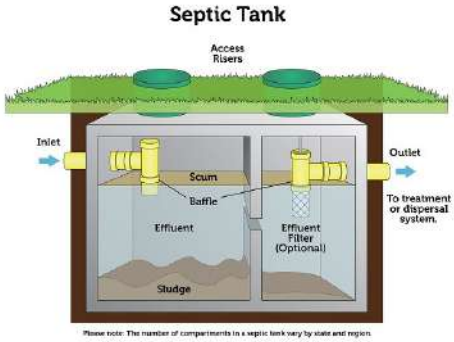
https://www.youtube.com/watch?v=-qIxyxsNqhI

Slide 86

Standard Septic Tank

Introduction

- Watertight underground tanks used for storage and treatment of domestic wastewater
- Semi treatment technology
- Efficiency; 30-40% of BOD removal



Slide 87

Standard septic Tank

Key features of Septic Tank

- Consist of at least two chambers separated by a baffle wall
- Water sealed
- Outlet connected to soak-pit/ leachate field/sewer

A Septic Tank is a watertight chamber made of concrete, fibre glass, PVC or plastic, for the storage and treatment of blackwater and greywater. Settling and anaerobic processes reduce solids and organics, but the treatment is only moderate.
Septic Tanks can be installed in every type of climate although the efficiency will be affected in colder climates. Even though the Septic Tank is watertight, it should not be constructed in areas with high groundwater tables or where there is frequent flooding.

Slide 88

Septic tank

Septic tank is one of the infrastructure for containment of the FS. Around 30-40% waste is treated in the septic tank, hence the septage (FS) needs to be taken for further treatment. One of the major component of the septic tank is soak-pit.

The minimum depth of the septic tank should be 1.2 meters while the first compartment of the septic should be of 2/3 of the total length leaving 1/3 of the total length for the second compartment.

Septic tank is one of the major option in all urban areas including some slums.

Slide 89

Size of Septic tank as per users

Design Parameters of standard septic tank are as follows:

- Volume of wastewater = volume of wastewater produced in a day
- Hydraulic retention time = 24 hours
- Desludging period = 2 years
- Temperature = 20°C

Table 1: Minimum size of septic tank for Terai region

No of users	5	10	15	20	25	50	75	100	150	200	250	300
Length of the 1st Compartment (L1)	0.9	1.3	1.5	1.7	1.8	2.3	2.9	2.8	3.5	4.0	4.5	4.9
Length of the 2nd Compartment(L2)	0.5	0.7	0.8	0.9	0.9	1.2	1.4	1.4	1.7	2.0	2.2	2.4
Breadth(b) in m	0.7	1.0	1.2	1.3	1.4	1.8	2.1	2.1	2.6	3.0	3.4	3.7
Heigth (H) in m	1.3	1.3	1.3	1.4	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0
Total Volume m3	1.30	2.60	3.60	4.70	5.70	9.50	13.50	17.60	27.00	36.00	45.60	54.00

Slide 90

Size of Septic tank as per users

Table 2: Minimum size of septic tank for Himalayan region

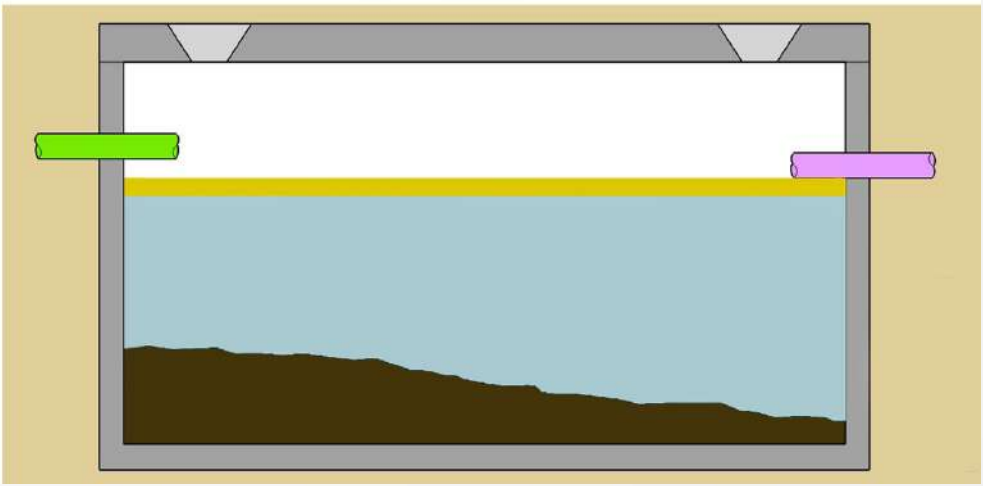
No of users	5	10	15	20	25	50	75	100	150	200	250	300
Length of the 1st Compartment (L1)	1.0	1.3	1.6	1.8	2.0	2.6	2.9	3.1	3.9	4.5	5.0	5.5
Length of the 2nd Compartment(L2)	0.5	0.7	0.8	0.9	1.0	1.3	1.4	1.6	1.9	2.2	2.5	2.7
Breadth(b) in m	0.7	1.0	1.2	1.4	1.5	2.0	2.4	2.4	2.9	3.4	3.8	4.1
Heigth (H) in m	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0
Total Volume m^3	1.60	3.00	4.30	5.70	6.80	11.70	15.50	22.60	33.60	45.60	57.00	67.20

Table 3: Minimum size of septic tank for Hilly region

No of users	5	10	15	20	25	50	75	100	150	200	250	300
Length of the 1st Compartment (L1)	0.9	1.3	1.5	1.8	1.9	2.4	3.0	2.9	3.6	4.1	4.7	5.3
Length of the 2nd Compartment(L2)	0.5	0.7	0.8	0.9	0.9	1.2	1.5	1.5	1.8	2.1	2.3	2.7
Breadth(b) in m	0.7	1.0	1.2	1.3	1.4	1.8	2.2	2.2	2.7	3.1	3.5	4.0
Heigth (H) in m	1.4	1.4	1.4	1.4	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.0
Total Volume m3	1.40	2.80	3.90	4.90	5.90	9.70	14.90	19.40	29.20	38.40	49.00	64.00

Slide 91

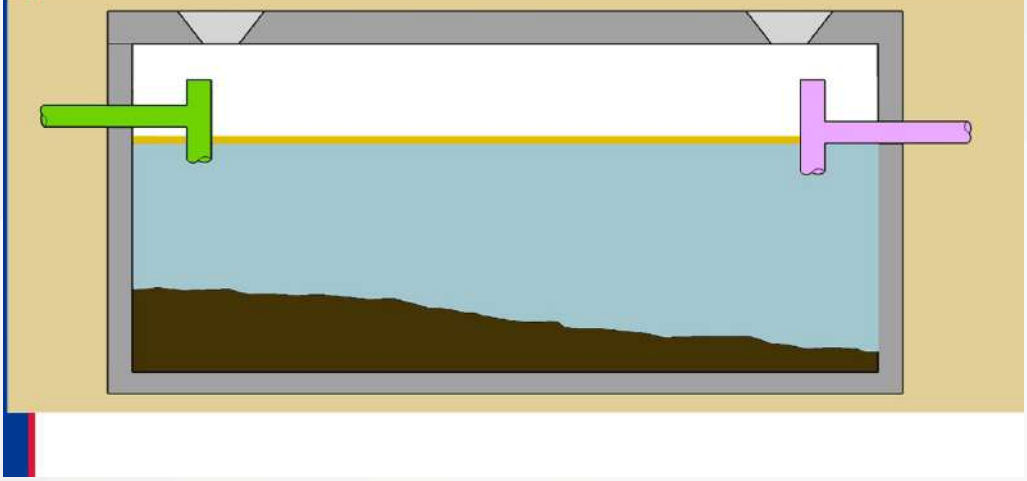
Importance of proper inlet and outlet in ST



A Septic Tank is a watertight chamber made of concrete, fibre glass, PVC or plastic, for the storage and treatment of blackwater and greywater. Settling and anaerobic processes reduce solids and organics, but the treatment is only moderate.
Septic Tanks can be installed in every type of climate although the efficiency will be affected in colder climates. Even though the Septic Tank is watertight, it should not be constructed in areas with high groundwater tables or where there is frequent flooding.

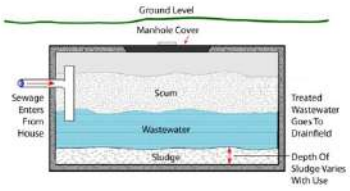
Slide 92

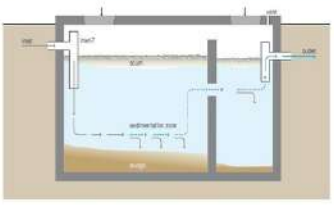
Importance of proper inlet and outlet in ST



Slide 93

All Rectangular tank is not septic tank





- Only collect and store
- Does not have outlet
- Need frequent desludging
- Is single chambered
- Leaky tank

- Treat wastewater up to 40%
- Has an outlet connected to Soak pit/sewer
- Need less desludging
- At least double chambered
- Water seal

Slide 94

Septic Tank

Applicability

- Mostly used at the household level
- Appropriate where there is a way of dispersing or transporting the effluent/ Accessible locations
- Not recommended to construct them in areas with high groundwater tables or where there is frequent flooding
- Can be installed in every type of climate

Slide 95

Septic Tank

- **Pros**
  - Can be built and repaired with locally available materials
  - Long service life
  - No real problems with flies or odours if used correctly
  - Low capital costs, moderate operating costs depending on water and emptying
  - Small land area required
  - No electrical energy required
- **Cons**
  - Low reduction in pathogens, solids and organics
  - Effluent and sludge require secondary treatment and/or appropriate discharge
  - Requires constant source of water
  - Regular desludging must be ensured

A Septic Tank is a watertight chamber made of concrete, fibre glass, PVC or plastic, for the storage and treatment of blackwater and greywater. Settling and anaerobic processes reduce solids and organics, but the treatment is only moderate.
Septic Tanks can be installed in every type of climate although the efficiency will be affected in colder climates. Even though the Septic Tank is watertight, it should not be constructed in areas with high groundwater tables or where there is frequent flooding.

Slide 96

Different types of safe containments

RCC readymade septic tank

Readymade plastic septic tank

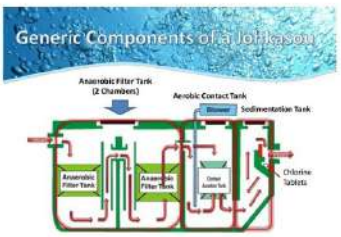
Ready to install eco septic tank

Slide 97

Different types of safe containments

Johkasou

- A facility that treats domestic wastewater (both black water and grey water)
- It is designed to treat in areas with no sewer system.
- The name "Johkasou" refers to purification tank in Japanese.



Slide 98

Key features of Johkasou

- Compact design suitable for households, small communities and institutions like schools and offices in rural and peri urban areas.
- Primarily used to treat wastewater for safe discharge into the environment or reuse.
- Rely on biological processes, often incorporating anaerobic and aerobic treatment chambers, to break down organic matter and remove pollutants.
- Regular maintenance and inspections are mandated to ensure proper functioning and compliance with environmental regulations.

Slide 99

Applicability of Johkasou

- Rural areas without centralized sewer systems.
- Locations with environmental or space constraints for traditional sewage systems.
- Temporary facilities or disaster relief settings.

A Septic Tank is a watertight chamber made of concrete, fibre glass, PVC or plastic, for the storage and treatment of blackwater and greywater. Settling and anaerobic processes reduce solids and organics, but the treatment is only moderate.
Septic Tanks can be installed in every type of climate although the efficiency will be affected in colder climates. Even though the Septic Tank is watertight, it should not be constructed in areas with high groundwater tables or where there is frequent flooding.

Slide 100

Newly invented technologies

- Janicki Omniprocessor
  - https://www.youtube.com/watch?v=bVzppWSIFU0
- The Cranfield nanomembrane toilet
  - https://www.youtube.com/watch?v=jGPpXF7y9Rg

Slide 101

Thank you!
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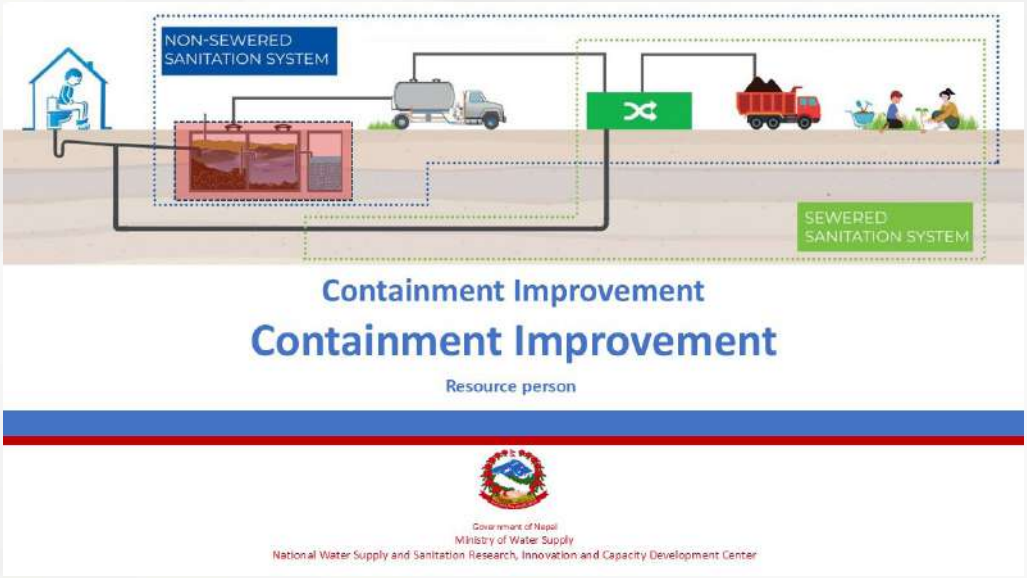
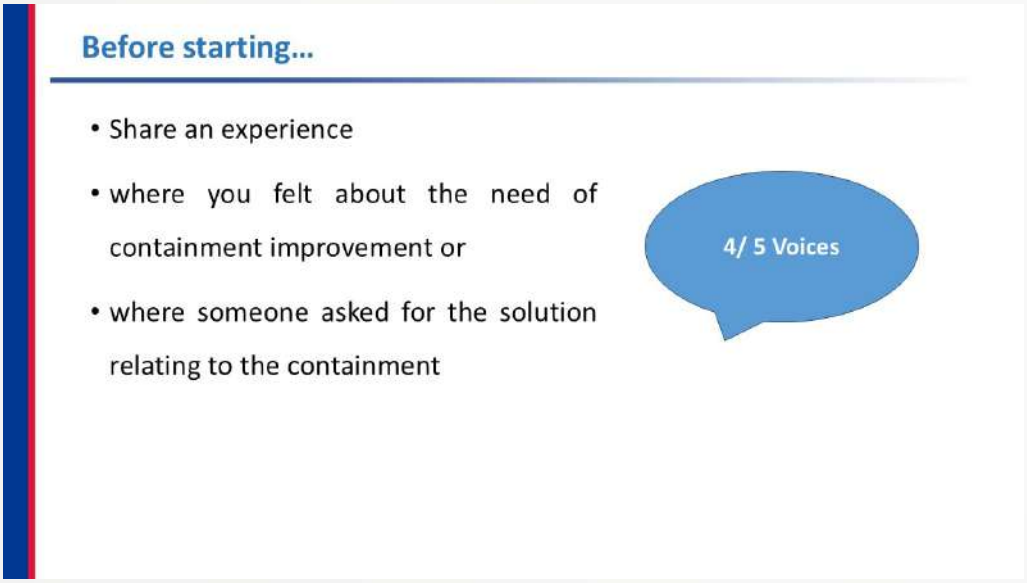
Lesson Plan 4: Containment Improvement

Slide 1

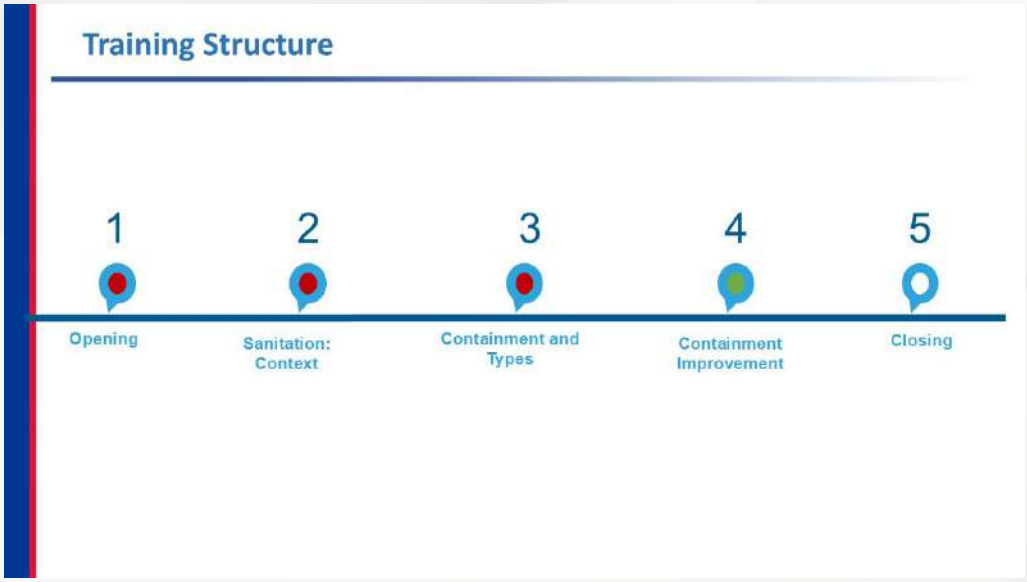


Slide 2

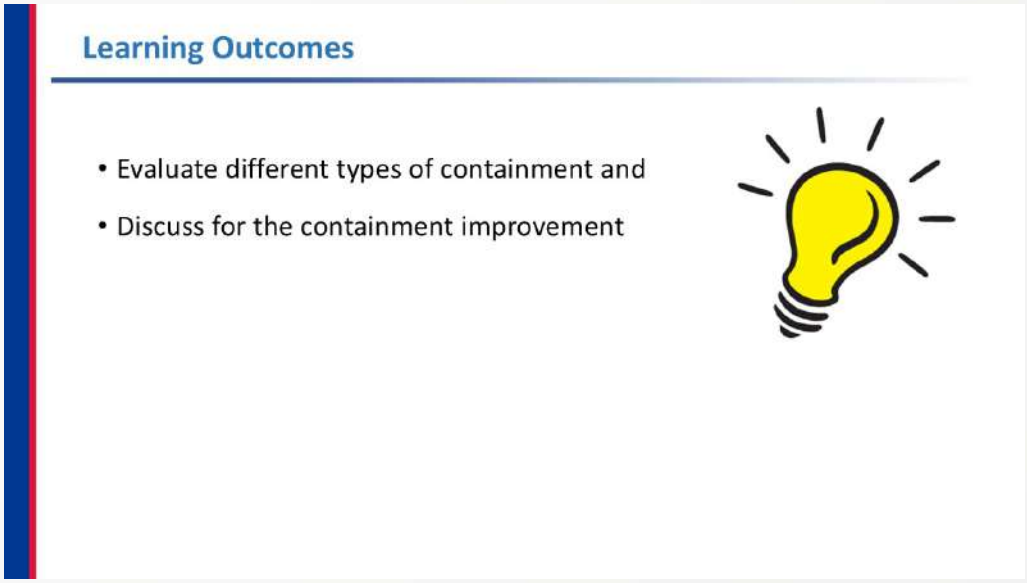


As the participants name the different types of containment, either paste a meta-card or a picture of respective one on a board.
Another option,
Present the different model that you have as the participants name different types of

Slide 3



Slide 4



Linking to earlier session, where the need to update the sanitation technology was highlighted, inform participants that the particular session will be discussing on it.

Slide 5

Presentation Outline

- Appropriate selection of containments as per ecological sites
- Containment Improvement by
  - Proper selection of containment and its design in new structures
  - Retrofit
  - Replacement
- Interventions for retrofit and replacement

Slide 6

Introduction

- Toilets constructed in ODF with on-site sanitation systems are filling up
- With this, the need for the safely managed sanitation of thus contained FS is of utmost importance
- One of the main challenge to meet SDG 6 by 2030 is the safely managed sanitation of human excreta
- Possible solutions include the construction of FSTP and improvement of onsite sanitation system
- Improvement of onsite sanitation system can be practiced immediately as compared to construction of FSTP

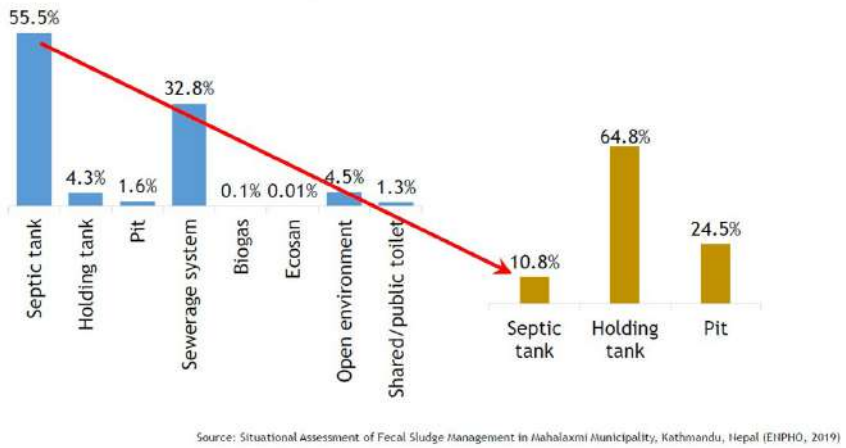
Slide 7

Key issues in existing containment structures

As per different studies conducted on sanitation facilities , only 5% of the existing containment are of proper type.

Slide 8

Understanding of Septic tanks



Source: Situational Assessment of Fecal Sludge Management in Mahalaxmi Municipality, Kathmandu, Nepal (ENPHO, 2019)

Case study of Mahalaxmi municipality
Discuss on legal provisions made by local government in adopting the safe containments.(the regulations related to construction of standard septic tanks in different local bodies)

Slide 9

Key issues in existing containment structures

- **Design and construction issues**
  - Adaptation of standard design
  - Inappropriate sizing
  - Poor structural integrity
  - Incorrect positioning of pipes
- **Selecting inappropriate containment system for specific site conditions**
- **Improper containments**

Slide 10

Understanding containment types as per geographical sites

- Geography and local climate play a significant role in determining the most appropriate type of containment system for faecal sludge.
- The Himalayan region experiences extreme cold temperatures, snow, and limited accessibility due to steep slopes and high altitudes. Containment systems in this area must account for freezing temperatures, difficult construction logistics, and the need to maintain a stable environment for waste containment.
- The Terai region is characterized by flat land, a high water table, and frequent flooding during the monsoon season. Containment solutions in this region must address the potential for groundwater contamination, flooding, and the high moisture content in the soil.
- The Hills region has rugged terrain with steep slopes and is prone to soil erosion, particularly during the monsoon season. Containment systems in this region must be stable, resilient to erosion, and easy to maintain in difficult-to-access locations.

In case of Nepal; provide an examples; hills (pit latrines, Biogas digester, twin pits), Himalayan (eco toilets, raised pits latrines, insulated vaults) and terai region (septic tank, flood resistant system)

Slide 11

Containment Improvement

- The process of **upgrading, retrofitting or replacing** the existing containment structures ensuring they are safely designed, constructed and protect public and environmental health.
- Improvement of onsite sanitation system can be done by:
  - **Proper selection of containment and its design in newly built structures**
  - **Retrofit**
  - **Replacement**

Slide 12

Containment Improvement

Proper selection of containment and its design in newly built structures

- The containment should be designed as per users – **proper sizing**.
- Should be placed at the **safe distance from the drinking water sources**.
- Selection of **appropriate technologies** as per site specific conditions.
- Should be compliance with the **standards**.

Slide 13

Containment Improvement

Retrofit

- Involves modifying or upgrading existing containment structures to improve their functionality, durability or environmental safety.
- Often preferred over replacement when minor improvements are sufficient or when cost limitations exist.
- Can be done either by adding components or by upgrading the existing one.

Conditions for retrofitting

- Minor structural cracks and leakages
- Inadequate volume
- Improper positioning of sanitary pipes

Retrofit
By adding soak-pit to existing holding tank
By adding another pit (twin pit) to the existing simple pit By making water seal to existing storage tank

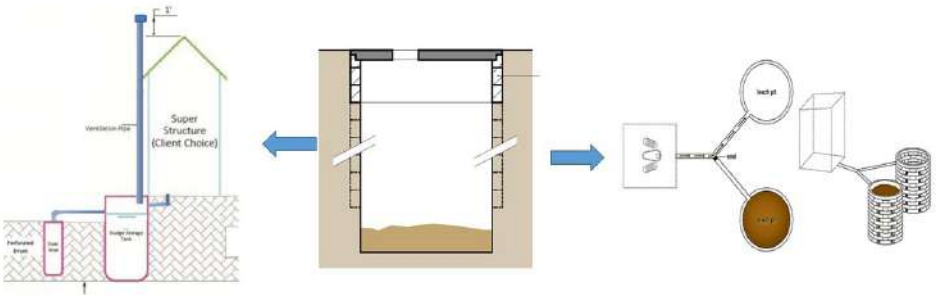
Slide 14

Examples of Retrofitting

- The addition of soak pit and lining of the existing pit make the single pit into sealed single pit with soak pit
- The holding tanks can be converted into septic tank by the addition of the chambers and soak pit.
- The addition of one pit to existing pit make the twin pits.
- The addition of appropriate size of inlet, outlet and vent pipes.
- Enzymes or bacterial additives can be introduced to improve the breakdown of sludge in septic tanks. They can increase the efficiency of existing systems and reduce the need for frequent emptying.

Slide 15

Examples of Retrofitting



Single pit to sealed single pit with soak pit or twin pits

Detail out the steps involved in changing the single pit to sealed single pit with soak pit or twin pits(rural settings)

Slide 16

Steps in converting Single pit to Twin pits

- **Site assessment and Planning**
  - Evaluate the space available around the existing pit.
  - Ensure a minimum distance of 1.5 meters between the two pits for structural stability.
  - Check the soil permeability and groundwater level.
  - Determine the required pit size based on household size and sludge accumulation rate.
- **Construction of the second pit**
  - Excavate a new pit of similar dimensions as the existing one.
  - Ensure both pits are unlined or semi-lined (brick honeycomb structure) to allow leachate to percolate into the surrounding soil.
  - Construct a brick or concrete pit lining to prevent collapse.
  - Provide a proper inter-pit distance to avoid cross-contamination.

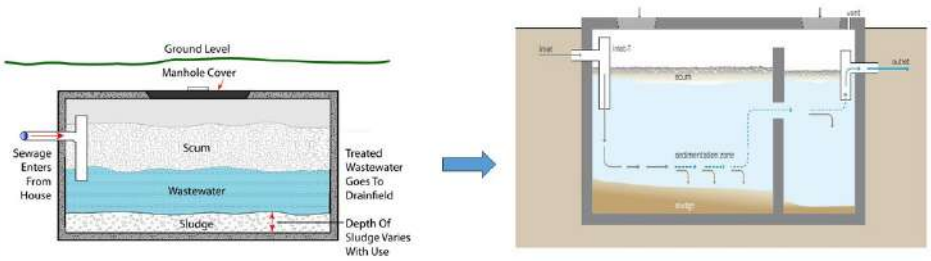
Slide 17

Steps in converting single pit to twin pits

- **Modifying the Superstructure and Junction Chamber**
  - Construct a Y-junction chamber to direct waste alternately to either pit.
  - Install two pipes from the chamber, each leading to one pit, with a provision for closing one pipe at a time.
  - Modify the toilet pan outlet to connect it to the junction chamber.
  - Ensure the chamber is sealed properly to prevent odor and vector breeding.
- **Switching Between Pits**
  - Use one pit at a time. Once the first pit is full (typically in 1.5 – 2 years), divert the flow to the second pit.
  - Allow the full pit to decompose for at least 1 year before emptying.
  - The decomposed faecal sludge can be safely removed and used as fertilizer.

Slide 18

Examples of Retrofitting



Holding tank to Septic tank

Detail out the steps and what can be the conditions of changing holding tanks to septic tanks(Urban settings)

Slide 19

Steps in converting Holding tank to Standard septic tank

- **Site assessment and Feasibility study**
  - Conduct a site survey to evaluate the existing holding tank capacity, water sealed, location and soil conditions.
  - Evaluate the space available for including soak pit or drain field.
  - Ensure the local regulations requirements related to installation of the containments.
  - Obtain necessary permits from local authorities.
- **Design considerations**
  - Determine the required septic tank size based on household wastewater generation.
  - Ensure the volume of the tank is appropriate.
  - Ensure proper piping systems and ventilations to manage inlet, outlet flow of wastewater and gases simultaneously.

Slide 20

Steps in converting Holding tank to Standard septic tank

- **Tank conversion and Construction**
  - Empty and clean the existing holding tank
  - Modify the holding tank by adding baffles, outlet pipe, ventilation pipe.
  - Seal the walls if required.
  - Install the manhole for inspection and desludging.
  - Construct the soak pit or leach field.
- **Testing**
  - Perform the leakage test by filling the tank and monitor for seepage.
  - Verify the functionality of inlet and outlet pipes to ensure proper flow.
  - Begin gradual usage of the new septic system to ensure stability.

Slide 21

Containment Improvement

Replacement

- Involves the complete removal and reconstruction of a containment system.
- Usually undertaken when the existing structure is beyond repair or unsuitable for local site conditions.

Conditions for replacement

- Severe structural damage
- Leakage and ground water contamination
- Inadequate size for increased occupancy
- Unsuitable soil conditions
- Unsafe design

Slide 22

Discussion as per Scenario

4 Groups
5 minutes

Divide into 4 groups
In their groups, provide a scenario to each group and ask to come up with ideas to improve the containment. Inform participants that they can come up with various ideas for containment improvement in a given scenario
Provide 5 to 7 minutes time
After the time ask each group to present their ideas along with the feedback from other groups after the presentation.
Summarize if needed.

Slide 23

Scenarios

- **Scenario 1**
  - The household has a holding tank. For now, they do not plan for replacement as it may cost them huge amount. What could be possible ideas to improve such containment.

- **Scenario 2**
  - A small family of 3 members had constructed a simple pit latrine during the ODF. Now as the family members are growing, they are inclined towards cattle raring and farming as well. While thinking back, they wants to upgrade their toilet and its containment for the utmost benefit as per the current situation. What would you suggest for the improvement and why?

Slide 24

Scenarios

- **Scenario 3**
  - With the improvement in their economic status, a family is planning to upgrade their toilet as well. Previously, they had constructed a twin pit, but with the space limitation and unwillingness to emptying and transportation of FS in every 6 months to 1 year, the family is planning for the replacement of the containment. What would you suggest the family and why?

- **Scenario 4**
  - A family had constructed a twin pit during the ODF campaign knowing the benefit of it. However, they forgot to consider their area which was flood prone. Now they are regretting their decision and are looking for the suggestions to improve the containment. What would you suggest and why?

Slide 25

Key Messages

- Appropriateness of a technology is defined by the need and various other aspects like parameters and criteria
- The means to improve the existing containment is basically done by 3 ways:
  - **Selection of appropriate sanitation system**
  - **Retrofit - adding components, upgrading existing one**
  - **Replace - updating the whole containment as per the context**

Slide 26

References

- Compendium of Sanitation technologies
- FSM book
- CAWST , FSM trainer manual
- www.coursera.org
- www.commons.wikimedia,.org
- www. cawst.org
- www.eawag.ch
- https://www.youtube.com/watch?v=9H_3i2A-onw&t=8s
- https://www.youtube.com/watch?v=-qIxyxsNqhI
- https://www.youtube.com/watch?v=bVzppWSIFU0
- https://www.youtube.com/watch?v=tRzEtOHLeBk
- https://www.youtube.com/watch?v=jGPpXF7y9Rg

Slide 27

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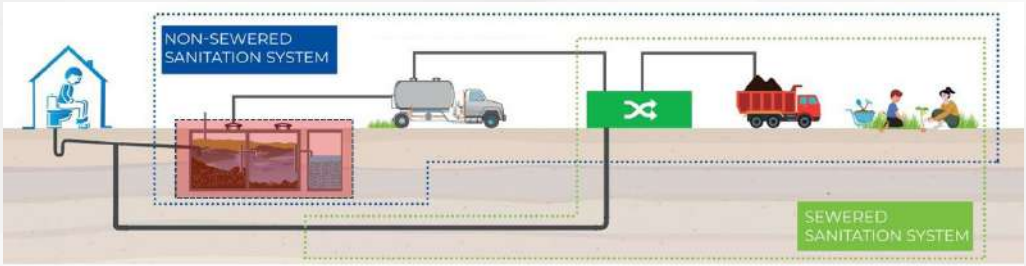
Lesson Plan 5: Training Closing

Slide 1



Containment Improvement

Training Closing

Resource person

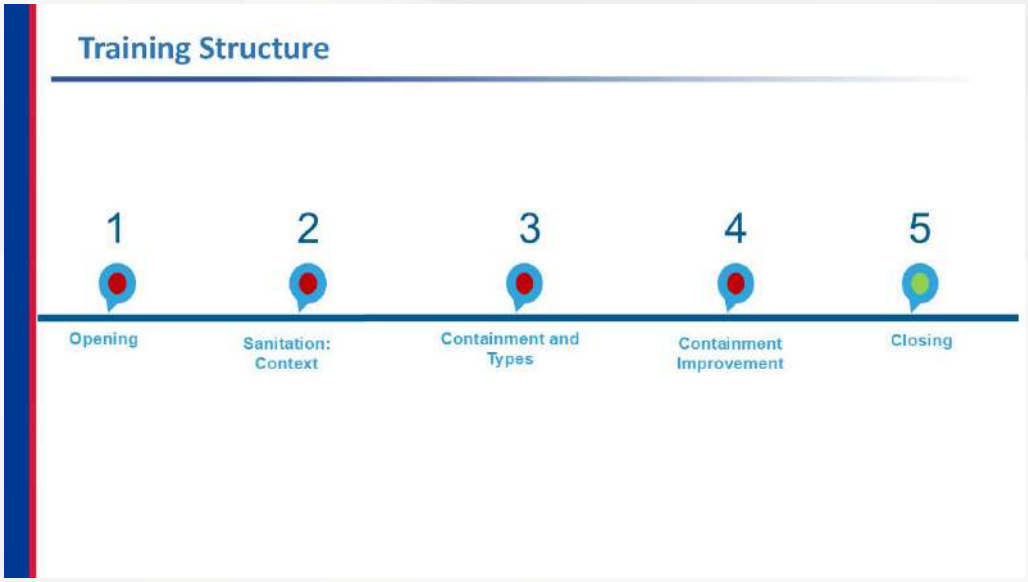
Government of Nepal
Ministry of Water Supply
National Water Supply and Sanitation Research, Innovation and Capacity Development Center

Slide 2

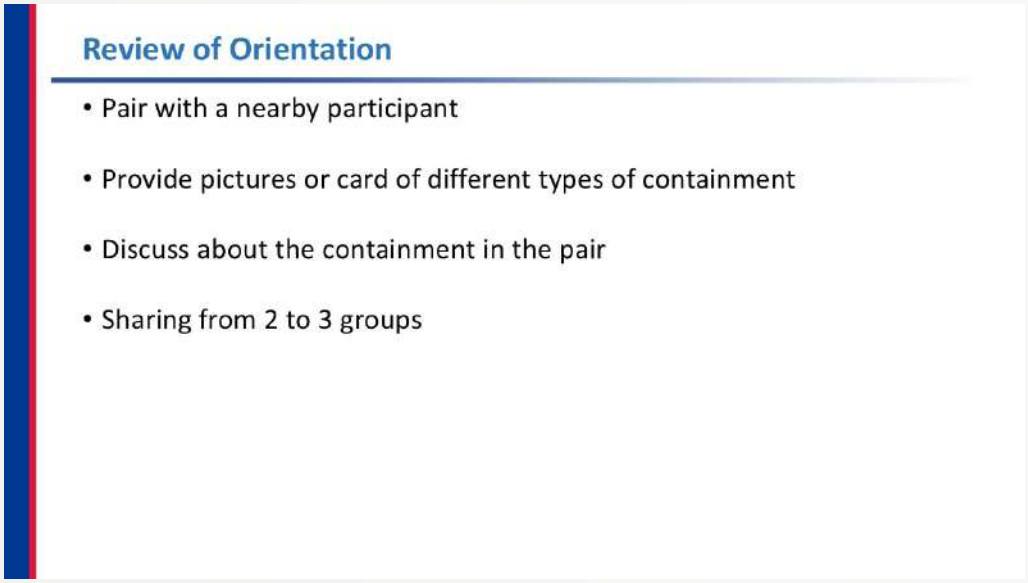
Learning Outcomes

- Evaluate whether learning expectation were met
- Analyze the orientation and provide feedback

Slide 3



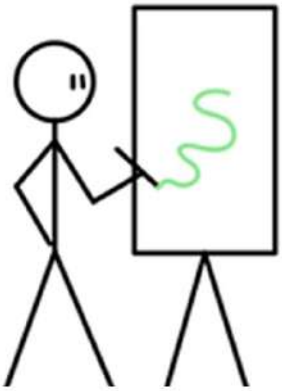
Slide 4



Slide 5

Learning Expectations

- Revisit learning expectation collected in the opening session



Slide 6

Post-test

5-10 minutes

Slide 7

Training Evaluation

- Training evaluation form
- 2 voices from the participant

5-10 minutes

Slide 8

Certificate Distribution

- In pair sharing
- Face each other
- Hand over certificate to the following participant and congratulation for the completion of the event and
- Best wishes for future endeavor with the knowledge

Slide 9

Certificate Distribution

- Congratulation for the completion of the event
- Best wishes for future endeavor with the knowledge

Slide 10

Group Photo

- Closing Remarks
- Group photo
- End the training

Slide 11

Thank you!
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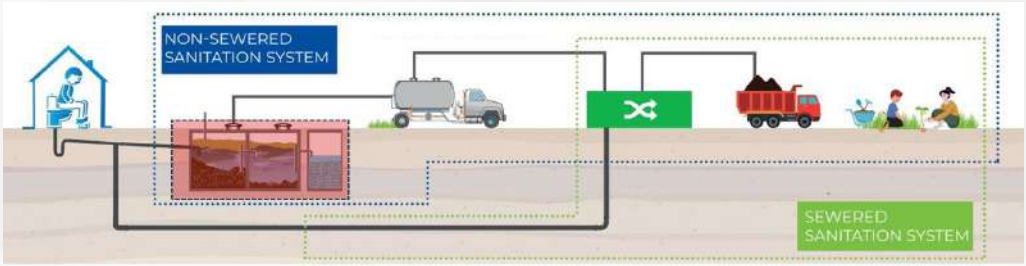
Hands on Exercise (Standard Septic Tank)

Slide 1



Containment Improvement

Hands on exercise(Standard septic tank)

Resource person

Government of Nepal
Ministry of Water Supply
National Water Supply and Sanitation Research, Innovation and Capacity Development Center

Slide 2

Design steps of standard septic tank

- **Step 1. Determination of wastewater volume**

➢Can be determined using two methods; theoretical calculation and actual measurement.

➢In actual measurement, volume of wastewater is determined by measuring existing flow of wastewater at outfall.

➢In theoretical calculation, volume of wastewater is calculated based on the numbers of users (n) and specific water consumption (q).

Volume of Wastewater = Q = n x q x fc (m3/d)

Note: Fc is conversion factor, in Nepal, conversion factor is normally taken as 80% of total water consumption.

Slide 3

Design steps of standard septic tank

- **Step 2. Determination of peak flow**

  Peak Flow = Qp = Q/tPEAK

- **Step 3. Determination of liquid volume**

  Liquid volume (VL) = Qp x tHRT

- **Step 4. Determination of Sludge and Scum volume**

  Sludge and Scum Volume = Vs + Vsc = n x fs x Vsa x t

- **Step 5. Determination of volume of septic tank**

  Volume of Septic Tank = V = VL + Vs + Vsc

- **Step 6. Sizing of Septic tank**

  Liquid volume (VL) = Qp x tHRT

Flow of wastewater does not remain same all the time and is fluctuated based on the water consumption. Water consumption is generally higher in morning, midday, and evening due to various activities such use of toilet, food preparation, bathing, face washing, brushing, utensil cleaning etc. Therefore, these periods are known as peak hour
(tPEAK) and the flow that takes place within this period is called peak flow (Qp)

Slide 4

Design steps of standard septic tank (sample design)

Design of a Septic tank			
Description	**Quantity**	**Unit**	**Remarks**
Given parameter,			
Number of users, n	10	No.	
Specific water consumption, q	100	lpcd	
Average temperature (For Terai region), T	20	°C	
Chosen parameter			
Hydraulic retention time, tHRT	24	hr	
Peak hour, tPEAK	12	h/d	
Type of wastewater to be treated is combined.			
Step 1: Determination of wastewater volume			
Volume of Wastewater Q = n x q x fc	0.8	m3/d	In Nepal, conversion factor (fc) is normally taken as 80% of total water consumption.
Step 2: Determination of Peak Flow			
Peak flow Qp = Q/tPEAK	0.07	m3/h	
Step 3: Determination of Liquid Volume			
Liquid volume VL = Qp x tHRT	1.6	m3	

Slide 5

Design steps of standard septic tank

Table 1 Matrix to determine value of the sizing factor (fs)

Desludging period (in years)	Value of fc Ambient temperature		
	>20°C	>10°C	<10°C
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

Source: A Guide to the Development of On-site Sanitation, © WHO, 1992

Slide 6

Design steps of standard septic tank

Step 4: Determination of Sludge and Scum Volume		
As per the formula suggested by Pickford (1980), Sludge and **Scum Volume Vs + Vsc = n x fs x Vsa x t**		
From the matrix (See table 1), fs for temperature 20oC and desludging period 2 years is 1 and Vsa = 40 litres per person per year for combined (black water and grey water) wastewater.		
fs	1	
Vsa	40	l
t	2	
Vs + Vsc	0.8	m3
Step 5: Determination of Volume of Septic Tank		
Volume of Septic Tank V = VL + Vs + Vsc	2.4	m3

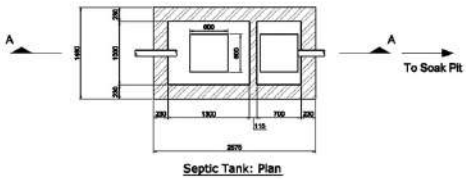
Slide 7

Design steps of standard septic tank

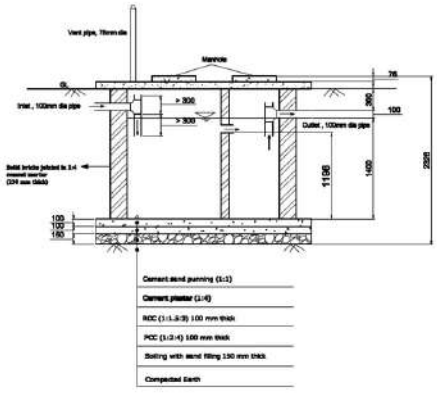
Step 6 Sizing of Septic Tank			
Volume of Septic Tank V = L x B x H			
Let's assume liquid depth septic tank = H = 1.4 m and ratio of Length to Breadth is 2			Liquid depth generally considered between 1.2 to 2.2 m. The minimum liquid depth of 1.2 is essential for anaerobic digestion process while water depth higher than 2.2 may create practical hassles during operation and maintenance. Ideally, length to breadth ratio of septic tank should be 2-4.
H	1.4	m	
V=L*B*H			
2.4=2B*B*1.3			
B*B	0.857143		
B	0.92582		
L	1.85164		
Adopt			
B	1	m	
L	2	m	
Since Length of first compartment of septic tank (L1) = 2/3 of total length (L)			
Length of first compartment, L1	1.3	m	
Take L1	1.3	m	
Length of second compartment of septic tank (L2) = 1/3 of total length (L) or L - L1			
Length of second compartment of septic tank (L2) =	0.7	m	

Slide 8

Design steps of standard septic tank



Septic Tank: Plan



Septic Tank: Section A-A (All dimensions are in mm)

Slide 9

Design steps of soak pit

- **Step 1. Determination of inflow**

  ➢Volume of incoming effluent is considered as equal as the incoming volume of wastewater of septic tank.

- **Step 2. Determination of wall surface area of soak pit**

  ➢Surface area (As) of soak pit is determined putting the value of incoming effluent volume (V) and the infiltration rate (IR) of soil in the following formula.

  Surface area = As = V/IR

- **Step 3. Sizing of soak pit**

  ➢Depth and diameter of soak pit is calculated using the surface area determined above

  Surface area of soak pit = As = 2*3.14*R*H

Note: For soak pits or pit latrines to function correctly the infiltration rate for clean water
should be at least 120 litres/m2/day.

Slide 10

Design steps of soak pit

Table 3: Soil infiltration rates

Soil type	Description	Infiltration rate (litres/m² per day)
Gravel, coarse and medium sand	Moist soil will not stick together	1,500 - 2,400
Fine and loamy sand	Moist soil sticks together but will not form a ball	720 -1,500
Sandy loam and loam	Moist soil forms a ball but still feels gritty when rubbed between fingers	480 - 720
Loam, porous silt loam	Moist soil forms a ball which easily deforms and feels smooth between fingers	240 - 480
Silty clay loam and clay loam	Moist soil forms a strong ball which smears when rubbed but does not go shiny	120 - 240
Clay	Moist soil mould like plasticine and feels very sticky when wetter	24 -120

Source: Reed and Dean, 1994

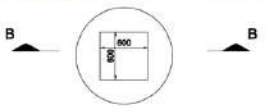
Slide 11

Design steps of soak pit (sample design)

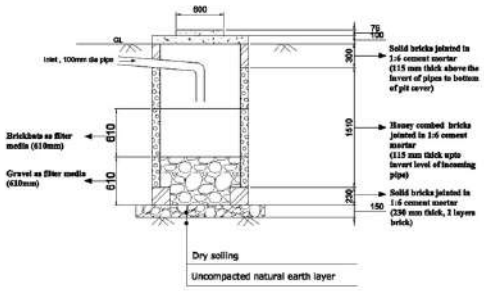
Design of Soak pit			
Description	**Quantity**	**Unit**	**Remarks**
Given parameter,			
Flow of effluent, n	0.8	m3/d	Volume of incoming effluent is considered as equal as the incoming volume of wastewater of septic tank.
Chosen parameter			
Infiltration capacity of site, IR	120	ltrs/m2/day	From table
Step 1: Determination of flow			
Volume of effluent, V	0.8	m3/d	
Step 2: Determine wall surface area of soak pit			
Surface area,As = V/IR	6.67	m2	
Step 3: Sizing of soak pit			
Surface area of soak pit, As = 2*3.14* RH			
Assuming, radius of pit, r	0.61		
Height of pit, H	1.740280533		as per compendium of sanitation systems and technologies, soak pit should be between 1.5 and 4m deep.
Therefore, diamter of pit	1.22		
Adopt,			
Diameter of the pit is 1.22 m and height of the pit is 1.74 m			

Slide 12

Design steps of soak pit (sample design)



Soak Pit: Plan



Soak Pit: Section B-B (All dimensions are in mm)

Slide 13

Thank you!
धन्यवाद !

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