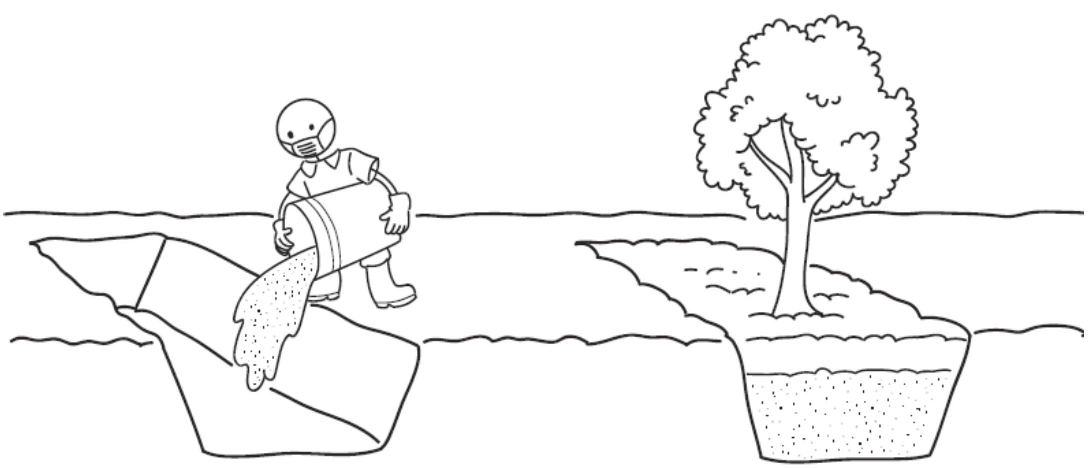
CAWST
Centre for Affordable Water and Sanitation Technology

Technical Brief: Sanitation System – Fecal Sludge Disposal

User Interface → Excreta Storage → Emptying and Transport → Treatment → **Use or Disposal**

Contents



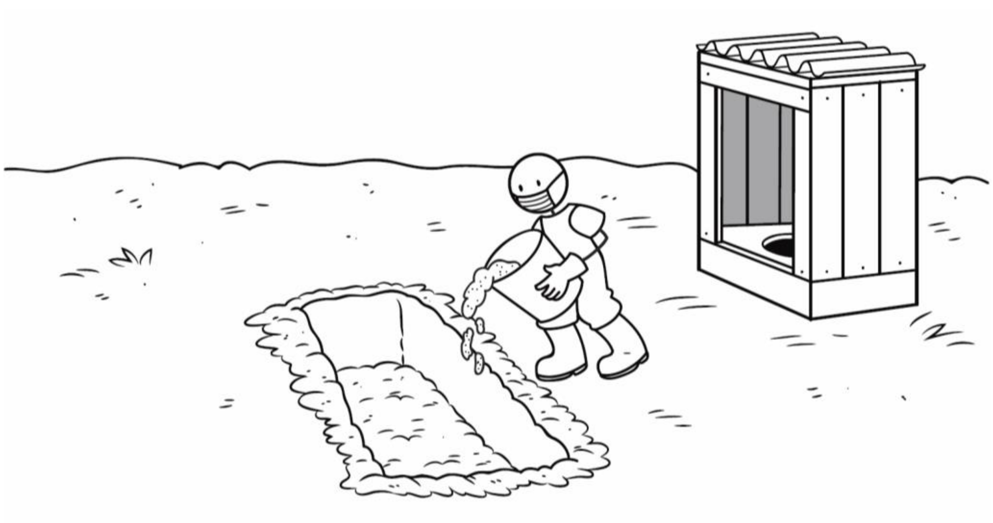
Technical Brief: Fecal Sludge Disposal

1 Introduction

A sanitation system deals with human excreta from the time it is generated until it is used or disposed of safely. The fifth component of the sanitation system addresses how fecal sludge can be disposed of to minimize public health and environmental risks. The capacity to treat and use fecal sludge often does not exist. This leads to harmful sludge being dumped around the home or into a nearby water source. Alternatively, fecal sludge can be safely and simply disposed of by burying it.

This Technical Brief introduces two fecal sludge disposal options appropriate for households and communities: (1) simple pit and (2) deep row entrenchment. It gives guidance on how to locate a disposal site to minimize groundwater contamination, and discusses other measures to protect public health. As well, this Technical Brief introduces the safe disposal of urine and menstrual hygiene products.

This document provides a technical overview and is not a design manual. An experienced professional should be consulted for the design of specific disposal technologies.



CAWST focuses on the planning, design and implementation of on-site sanitation projects for low-income communities not connected to a sewer. For such communities, household or decentralized sanitation offers a hygienic and affordable solution.

CAWST's free, open content resources and schedule of international training workshops can be found at: https://resources.cawst.org and www.cawst.org/training.

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2 Fecal Sludge Disposal

The simplest way to dispose of fecal sludge is to safely bury it. This method contains and controls fecal sludge to reduce the risk of contaminating water sources. Pits and trenches can be dug at the household and community level.

A goal of any disposal site is to reduce the chance of fecal sludge contaminating groundwater. There is always a risk that pathogens and other contaminants (like nitrogen) from fecal sludge will contaminate wells, boreholes and springs if they are constructed too close. Latrines should be designed and located so that the risk of groundwater contamination is minimized.

Effluent from a disposal site moves through the soil until it enters the groundwater. It then moves through the soil (or rock) with the groundwater flow. As the liquid moves through the soil, pathogens will be filtered out and naturally die-off over time. If there is not enough soil between the disposal site and the groundwater; however, then the pathogens will reach the groundwater. If the contaminated groundwater reaches a well, spring or borehole, these drinking water sources will become contaminated.

What About Disposing of Fecal Sludge in a Sewered System?

Fecal sludge should not be disposed in a sewered system. Yet, illegally dumping fecal sludge into the sewer system is common in low-income countries because it is easy to access and there are usually no other disposal options.

Fecal sludge has a higher solids content than wastewater and it can clog the sewers. As well, it can lead to severe disruptions of the wastewater treatment facility. This is because fecal sludge has different characteristics than wastewater.

See CAWST's Technical Brief: What is Fecal Sludge for more information on the differences between fecal sludge and wastewater.

(Strande, Ronteltap & Brdjanovic, 2014)

2.1 Simple Pit

Simple pits can be dug by hand. They do not have to be perfectly shaped or lined like most latrine pits. The size of the pit or trench will depend on the quantity of fecal sludge. Households may choose to dig a trench instead of a pit if they are planning to plant several trees on top of it.

The disposal site is usually located near the latrine to reduce the hassle of transportation. If the latrine was not sited properly in the first place, digging a pit near the latrine will further increase the risk of groundwater contamination.

The fecal sludge is simply dumped into the pit. It is then backfilled with 0.5 metres of soil. Do not step on or build anything on top of the full pit. The soil is unstable as the sludge settles over time. As well, build a fence or clearly mark the location. See CAWST's Latrine Construction Manual to learn more about pit excavation and safety precautions.

Disposing sludge in a simple pit

Planting a tree in the pit

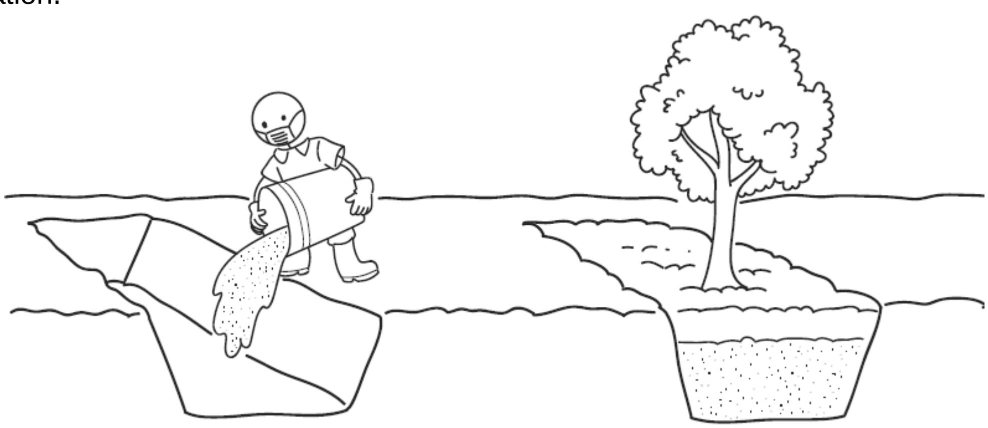
You can also plant a tree on top of the full pit. It reduces the risk of nutrients infiltrating into the groundwater and clearly marks the location of the pit. The nutrients from the sludge also help the tree to grow faster. Disposal pits can be used to reforest an area, provide a sustainable source of fresh fruit or fuel wood, and prevent people from falling into old pits. This is similar to the Arborloo latrine where the full pit is simply covered with soil and the superstructure moved to a new site. See CAWST's Fact Sheet: Arborloo for more information.

Most countries do not have legislation for using simple pits to dispose of fecal sludge.

2.2 Deep Row Entrenchment

Deep row entrenchment consists of digging deep trenches, filling them with fecal sludge, and covering them with soil. Trees are then planted on top, which can provide a source of fruit or fuel. Deep row entrenchment can be considered as both a treatment and disposal option, so it is also addressed in CAWST's Technical Brief: Fecal Sludge Treatment Technologies. Deep row entrenchment was first used for wastewater treatment and has been adapted in South Africa for fecal sludge disposal (Strande et al., 2014).

A long trench is easier to dig and fill up than a deep pit. The trench is dug manually or using an excavator. A trench is typically 0.6 metres wide and 1.2–1.5 metres deep (Still & Foxon, 2012). The length and the depth will depend on the groundwater level and volume of sludge. The trench should be lined, for example with clay, to further reduce the risk of groundwater contamination.



Disposing fecal sludge in deep trenches

The fecal sludge is simply dumped into the trench that remains open until it is full. After every dumping, a layer of soil is placed on top of the sludge to reduce smells and flies. The full trench must be backfilled with soil.

Similar to a simple pit, do not build anything afterwards on top of the full trench. The soil is unstable as the sludge settles over time. Also, do not step on the trench for the first few months, and build a fence or clearly mark the location. See CAWST's Latrine Construction Manual to learn more about excavation and safety precautions.

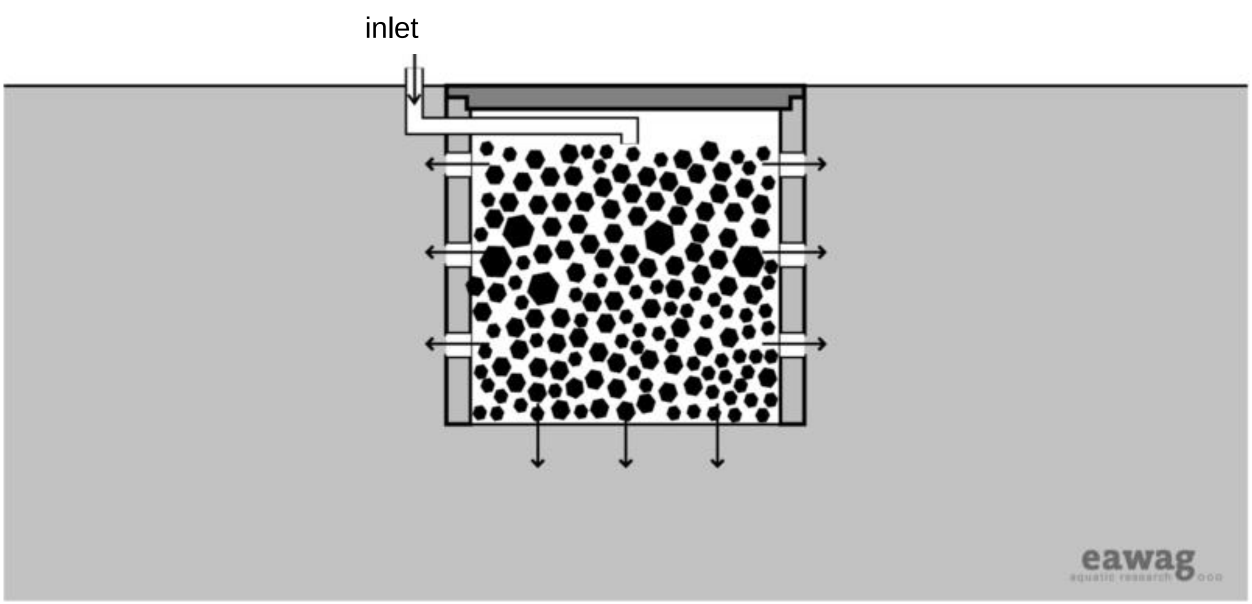
Most countries do not have legislation for deep row entrenchment to dispose of fecal sludge.

3 Urine Disposal

Urine is normally sterile (contains no pathogens) when it leaves the human body. There are only a few pathogens, such as *Schistosoma haematobium* and *Salmonella typhi*, which can be excreted in urine. However, most pathogens found in urine are caused by fecal cross-contamination. This means the urine came into contact with feces.

Source separated urine can be disposed of into the ground using a soak pit or infiltration trench. A soak pit is a dug pit that allows urine to be safely infiltrated into the ground. Trenches can be used in situations where a soak pit is unable to infiltrate the total amount of urine. In some cases, a urine diverting latrine can be connected directly to a soak pit or a trench rather than collecting the urine first in a container.

For more information, see CAWST's Technical Brief: Greywater Management and Technical Brief: Design Calculations for Soak Pits and Infiltration Trenches.



Urine can be disposed of in a soak pit (Credit: Tilley, Ulrich, Lüthi, Reymond & Zurbrügg, 2014)

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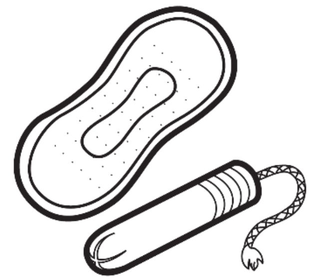
4 Menstrual Hygiene Waste Disposal

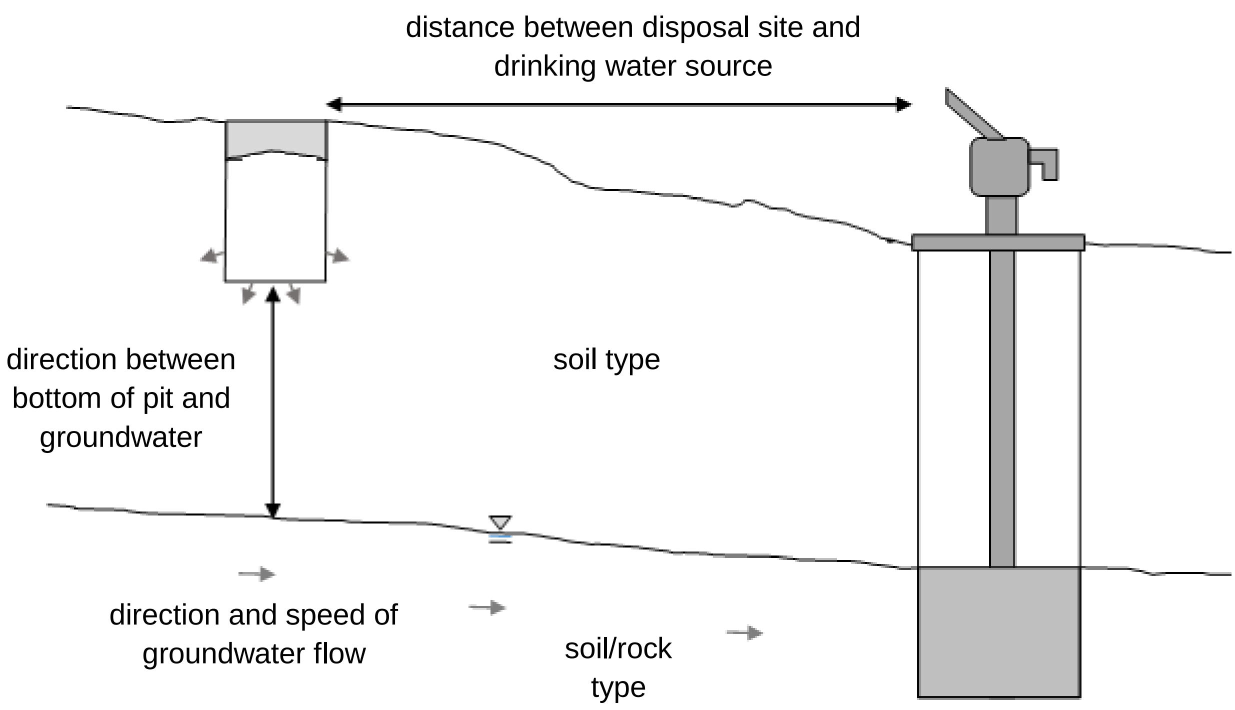


Women and girls need to use clean material to absorb or collect their menstrual blood. Sanitary pads or tampons are most commonly used and these are normally changed around four times a day during menstruation. Some sanitary pads are meant for single use and are disposed of afterwards, while others can be washed and reused. It is estimated that most women will use between 7,000 to 10,000 sanitary pads or tampons in their life. On average, a woman throws away 125 to 150 kg of sanitary pads, tampons and applicators in her lifetime (House, Mahon, & Cavill, 2012)

To manage menstruation hygienically and with dignity, it is essential that women and girls have a way to safely dispose of non-reusable sanitary products at home, in schools and in public places. Furthermore, products need to be safely disposed of to limit health risks, environmental contamination, and to stop users from throwing them in latrines. Two possible disposal options are incineration and burying. To find out more about these options, see CAWST's Technical Brief: Solid Waste Management.

5 Siting Disposal Sites

There are several technical and environmental factors that influence whether pathogens from a disposal site will contaminate a water source. One important factor is the distance between the bottom of the pit or trench and the groundwater. Another is the distance between the disposal site and the water source. The diagram below shows the factors that influence whether a disposal site may contaminate groundwater. Each of the factors in the diagram is described below in more detail.



Factors that influence groundwater contamination (Credit: Adapted from Sugden, 2006)

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1. How much water is in the fecal sludge

General rule: The less liquid in the sludge, the lower the risk of contamination.

- Sludge from wet latrines (like a pour flush latrine) and sludge that has been mixed with water to make emptying easier contain large volumes of liquid. This liquid infiltrates into the ground and carries pathogens through the soil.
- Sludge from dry latrines (like a ventilated improved pit latrine) infiltrate smaller amounts of liquid into the ground, reducing the risk that pathogens will travel far through the soil and contaminate groundwater.
- Wet sludge can be dewatered before disposal.

2. Distance between the bottom of a disposal site and the highest annual groundwater level

General rule: The greater distance between the bottom of a pit or trench and the groundwater, the lower the risk of contamination. The bottom of the disposal site should be at least 2 metres above the highest annual groundwater level (Franceys, Pickford, & Reed, 1992).

- Pathogens will infiltrate directly out of the disposal site into the groundwater if the bottom of the pit is built in the groundwater table.
- The bottom of the disposal site should be at least 2 metres above the highest groundwater level (in the wet season). As the water and pathogens move through the soil over this distance, some will become trapped, and some will die before reaching the groundwater.
- Bury the fecal sludge in the dry season, if possible.

3. Soil type

General rule: The smaller the soil grain size, the lower the risk of contamination. Sludge should be buried in fine-grained soils.

- Both the soil type around/beneath the disposal site and the soil/rock type in the groundwater table should be considered.
- Coarse-grained soils, such as sand and gravel, allow groundwater and pathogens to travel further and faster. The spaces between the soil grains may be too large to trap many of the pathogens.
- Fine-grained soils, such as fine sand, silt and clay, do not let groundwater travel as fast and pathogens do not travel as fast or as far through these soils. The smaller spaces between the soil grains mean more pathogens will be trapped as they move through the soil.
- Water moves very slowly through clay. Very little liquid will infiltrate out of disposal sites built in clay soil. Groundwater will take a long time to travel any distance through clay. The water in wet fecal sludge will therefore not infiltrate very fast. This means that the disposal site will fill up faster. Sludge should be dewatered before disposing it into clay soils.

4. Distance between disposal site and drinking water source

General rule: The greater the horizontal distance between the disposal site and the drinking water source, the lower the risk of contamination. 10 metres is the minimum distance and 30 metres is often recommended for household disposal sites (Harvey, 2007). Community disposal sites should be located further away from drinking water sources than a household disposal site.

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Community disposal sites receive fecal sludge from a whole community. The risk of contamination is higher. The distance will depend on various factors such as the lining of the disposal site, the soil type and national regulations.

- The greater the distance, the longer it will take for pathogens to travel. It is more likely the pathogens will die or be trapped before reaching the drinking water source.
- Minimum separation distances between the disposal site and drinking water source are recommended depending on the type of soil or rock, as shown in the following table.

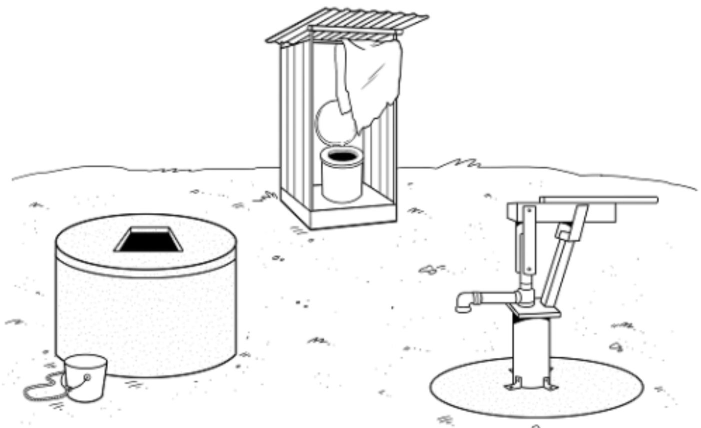
Table: Minimum Distance between a Household Disposal Site and Drinking Water Source

Soil/Rock Type	Description	Minimum Distance (metres)
Clay	Moist soil molds like plasticine, and feels sticky when wet.	10*
Silt	Moist soil forms a strong ball which smears when rubbed, but does not go shiny.	10*
Silt-sand	Moist soil forms a ball which easily deforms and feels smooth between the fingers, or still feels gritty when rubbed between the fingers.	15
Sand	Moist soil sticks together, but will not form a ball.	50
Gravel	Moist soil will not stick together.	500
Fractured rock	Rock with cracks in it through which groundwater flows.	Not recommended since water flows too fast through fractured rock

*10 metres is the minimum distance a latrine should be located from a drinking water source.

(Adapted from Harvey, 2007; Harvey, Baghri, & Reed, 2002)

A 30 metre separation distance between a household disposal site and drinking water source is often recommended. This distance is adequate in most circumstances. However, as with all general recommendations, there may be situations when a shorter distance will be acceptable or where the groundwater is contaminated despite the 30 metre separation. The soil and groundwater conditions should be assessed before siting a disposal pit or trench. The results could allow a shorter, safe separation distance or require a larger distance. Alternatives for the disposal site or the water supply should be considered, if the separation distance is not possible due to space constraints.



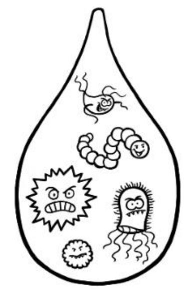
5. Direction of groundwater flow

General rule: Site disposal sites lower than the drinking water source.

- Groundwater usually flows downhill.
- In very flat areas, tests may need to be done to determine the direction of groundwater flow.
- If the disposal site is located downhill from the water source, then it is unlikely that contamination will be a problem.

(Adapted from Harvey, 2007; Sugden, 2006)

6 Monitoring Drinking Water Quality



For larger disposal sites, like deep row entrenchment, it is important to monitor the local groundwater and surface water quality. Wells, boreholes and nearby surface water bodies, especially those that are used for drinking water, should be monitored on a regular basis. This will help detect any potential contamination from the disposal site. If contamination is detected, the drinking water source should be closed off and the users should be warned. The main drinking water parameters to test for are fecal pathogens (like *Escherichia coli*) and nutrients (like nitrogen).

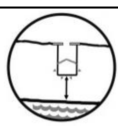
It is important to have a plan before you start doing water quality testing. Monitoring water quality can be an expensive and difficult task if it is done properly. Planning in advance and thinking through the process will save time, lower costs, and prevent surprises. Moreover, it gives a basis for the financial and human resources that will be needed to carry out your testing.

See CAWST's Introduction to Drinking Water Quality Testing resources for more information.

7 Risk Management

There are many protective measures that should be put in place when disposing of fecal sludge, to avoid spreading pathogens and to protect public health. These barriers focus on protecting people handling the fecal sludge, members of a household (particularly children), and the local community. This is often known as a multi-barrier approach.

Table: Barriers to Protect Health

Barriers to Protect Health		Action
	Use protective equipment	Wear protective equipment, such as clothing, gloves, shoes, and mask. Clean and disinfect the equipment used.
	Cover material	Cover the disposal site with at least 50 cm of soil. This creates a physical barrier between the fecal sludge, people and animals. It also limits the risk of fecal sludge resurfacing if there is heavy rainfall.
	Depth	The bottom of the disposal site should be 2 metres above the highest annual groundwater level.

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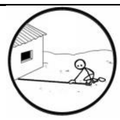
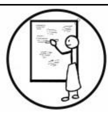
Barriers to Protect Health		Action
	Site	The disposal site should be located appropriately to minimize the risk of groundwater contamination (see section on siting disposal sites). The site should also be located away from where children play.
	Restrict access	Construct a fence to keep children and animals away from the disposal site. Display warning messages.
	Treatment	Treat fecal sludge before burying it. Dewater sludge if it is particularly wet. This will reduce the amount of water infiltrating into the soil.
	Wash hands	Wash hands with soap after handling fecal sludge, tools, and equipment.
	Clean tools	Disinfect the tools used for disposal and only use them for this activity. Safely store the tools so people do not touch them or use them for another purpose.
	Train	Train workers and families on safe disposal, including hygiene practices.

8 Knowledge Gap

Knowledge on the different methods of disposing of fecal sludge is limited. The main gaps are the following:

- Research has focused on disposing of domestic wastewater sludge from sewered systems. There is not much research on fecal sludge disposal from on-site sanitation, like pit latrines and septic tanks.
- Research has focused on treatment and use of fecal sludge. However, using fecal sludge is not always an option. There needs to be more research to create recommendations on how to safely dispose of fecal sludge.
- Research is also needed on how to safely dispose of non-reusable menstrual hygiene products. Although there is a growing amount of marketing for sustainable menstrual hygiene products (for example, cups), the disposal of non-reusable products remains an issue.

9 Definitions

Dewater: The process of reducing the water content of fecal sludge. Dewatered sludge may still have a significant moisture content, but it is typically dry enough to be handled as a solid (for example, shovelled).

Excreta: Urine and feces not mixed with any flushing water.

Fecal sludge: Also called sludge. Excreta from an on-site sanitation technology (like a pit latrine or septic tank) that may also contain used water, anal cleansing materials, and solid waste.

Pathogen: An organism that causes disease.

Sewered system: Also called a sewer system, sewerage system, sewers, connected sanitation, and networked sanitation. A sanitation system that transports wastewater through a pipe network (like a simplified sewer, solids free sewer or conventional sewer) to another location for treatment, use or discharge. This includes centralized systems and decentralized wastewater treatment systems.

Treatment: Any process to inactivate pathogens, stabilize, dewater, or manage nutrients in fecal sludge.

Wastewater: Used water from any combination of domestic, industrial, commercial or agricultural activities, surface runoff (stormwater), and any sewer inflow (infiltration). Wastewater can be managed on-site or off-site. Wastewater managed off-site is often called sewage.

10 Additional Resources

CAWST Sanitation Resources. Available at: http://resources.cawst.org

- CAWST's education and training resources are available on a variety of sanitation topics including environmental sanitation; latrine design, siting and construction; fecal sludge management; and sanitation project implementation

CAWST Drinking Water Quality Testing Resources. Available at: http://resources.cawst.org

- CAWST's Drinking Water Quality Testing Manual is intended for water, sanitation and hygiene (WASH) practitioners in developing countries where there is limited access to resources. The Manual addresses characteristics of safe drinking water, planning for water quality testing, testing options (including portable field kits and laboratories), water quality parameters and test procedures, and interpreting test results.

Microbiological Contamination of Water Supplies, WELL Factsheet. Sugden, S. (2006). WEDC, Loughborough University, UK. Available at: www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets-htm/Contamination.htm

- This Fact Sheet describes pathogens in groundwater, factors affecting contamination of a water source by a pit latrine, ways to assess the risk of groundwater contamination, methods to reduce risk, and other issues to consider.

11 References

Franceys, R., Pickford, J. & Reed, R. (1992). A guide to the development of on-site sanitation. Geneva, Switzerland: World Health Organization. Retrieved from http://whqlibdoc.who.int/publications/1992/9241544430_eng.pdf

Harvey, P. (2007). *Excreta disposal in emergencies: a field manual*. Loughborough University, UK: Water, Engineering and Development Centre (WEDC). Retrieved from https://wedc-knowledge.lboro.ac.uk/details.html?id=14282

Harvey, P., Baghri, S. & Reed, B. (2002). *Emergency sanitation: Assessment and programme design.* Loughborough University, UK: WEDC. Retrieved from www.sswm.info/sites/default/files/reference_attachments/HARVEY%20et%20al%202002%20Emergency%20sanitation%20assessment%20and%20programme%20design_0.pdf

House, S., Mahon, T. & Cavill, S. (2012). *Menstrual hygiene matters: A resource for improving menstrual hygiene around the world.* London, UK: WaterAid. Retrieved from www.wateraid.org/what%20we%20do/our%20approach/research%20and%20publications/view%20publication?id=02309d73-8e41-4d04-b2ef-6641f6616a4f

Still, D. & Foxon, K. (2012). *Tackling the challenges of full pit latrines: How fast do pit toilets fill up? A scientific understanding of sludge build up and accumulation in pit latrines* (No. 1745/2/12). Gezina, South Africa: Water Research Commission. Retrieved from www.wrc.org.za

Strande, L., Ronteltap, M. & Brdjanovic, D. (2014). *Faecal sludge management: Systems approach for implementation and operation*. London, UK: IWA Publishing. Retrieved from www.sandec.ch/fsm_book

Sugden, S. (2006). *Fact Sheet: The microbiological contamination of water supplies.* Loughborough Univesity, UK: WEDC. Retrieved from www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets-htm/Contamination.htm

Tilley, E., Ulrich, L., Lüthi, C., Reymond, P. & Christian Zurbrügg. (2014). *Compendium of sanitation systems and technologies* (2nd Revised Edition). Dübendorf, Switzerland: Swiss Federal Institute of Aquatic Science and Technology (EAWAG). Retrieved from www.eawag.ch/en/department/sandec/publications/compendium/

WSP. (2015). Management of child feces: Current disposal practices. International Bank for Reconstruction and Development / The World Bank and UNICEF. Retrieved from www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2015/07/13/090224b082ff141f/2_0/Rendered/PDF/Management0of00t0disposal0practices.pdf

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