Haiti Health Initiative

IMPV School in Timo, Haiti

Latrine Design Basis Report

Draft 1 | July 15, 2019

Job number

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Document verification

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Job title		IMPV School in Timo, Haiti			**Job number**
Document title		Latrine Design Basis Report			**File reference**
Document ref					
Revision	**Date**	**Filename**			
Draft 1	Sept 2019	**Description**	Initial draft of latrine design report for IMPV School in Timo, Haiti.		
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1 Introduction and Scope

Haiti Health Initiative (HHI) has contacted Arup to develop the design of the Institution Mixte de la Perfection de Viciere (IMPV) school in Timo, Haiti. The project aims to bring a much-needed new school facility in the remote, mountainous community of Timo. The school will be attended by around 225 students between the ages of 3 and 15. The scope of work includes design of the school buildings, design of the latrine block, and overall site grading design.

To date, preliminary earthworks have taken place, which included the construction of retaining walls around the perimeter of the site as well as levelling of the ground surface. The next stage of works is the construction of the latrine block. Due to availability of funding, the design and construction of the latrine block will precede that of the school itself. The targeted completion date of the latrines construction is March 2020.

This Latrine Design Basis Report summarizes Arup's proposed latrine design, outlining all design considerations and assumptions as well as providing guidance on maintenance and care of the latrines.

2 Site Considerations

Timo is a remote community of 1,200 residents located approximately 70km from Haiti's capital, Port-au-Prince. The IMPV School site is located 3 km away from the nearest road which passes through the town of Tom Gato / Fondwa (see Figure 1). The footpath is the primary means of access to site, and students typically walk up to 1 hour from their homes to reach the school.

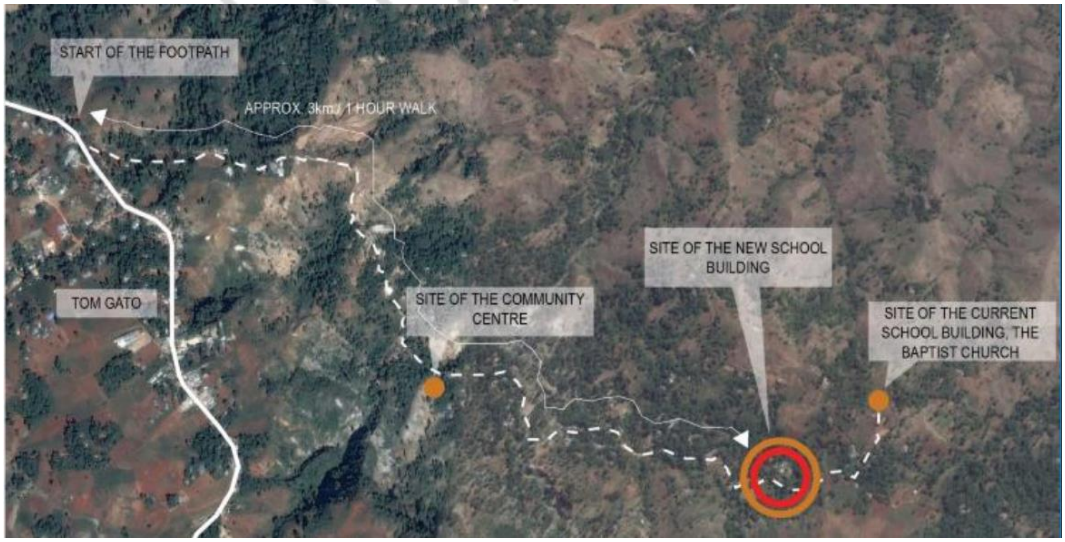

Figure 1: Location of IMPV School Site

Haiti is prone to seismic activity and tropical storms. This, in addition to the remoteness of the site, presents challenges to the design. The design team at Arup is placing these challenges at the heart of the design of the school buildings and latrine block, particularly within the structural and civil engineering design. The structural design of the latrine block and school building will incorporate seismic and hurricane design factors, and the site drainage design will consider high rainfall rates associated with storm events.

The school site is perched atop a hill that lies within a valley (see

Figure 2~~Figure 2~~). Due to its location, the design team believes that the risk of potential landslides from neighboring hills impacting the school site is low.

The site is located approximately 500m away from, and downstream of, Kamatin Spring, the nearest freshwater source. Water is supplied to site from Kamatin Spring via an unburied HDPE pipe. Generally, water delivered to site from this spring will be used in the handwashing stations of the latrines and the school's kitchen. It is understood that the water pressure in distribution pipes that deliver water from this spring to Timo and its surrounding areas is high, to the extent that pressure-reducing valves have been installed along the network. The pressure of the water arriving on site is estimated to be 40 psi due to the presence of a pressure-reducing valve just upstream of the site.

Wind and solar effects have also been incorporated into the overall site layout of the school buildings and latrine block. The latrine block is located downwind of the school buildings to divert odours away from site. Additionally, the ventilating side of the pits will face west to improve ventilation within the latrines, as solar radiation heats the air in the vent pipe and causes it to rise.

The current sanitation practices observed in Timo are also being considered in the design proposal. Currently, the main sanitation practice in Timo is open-pit latrines, with some instances of open defecation observed among children. The typical household shares a latrine with 3 or 4 other nearby households.

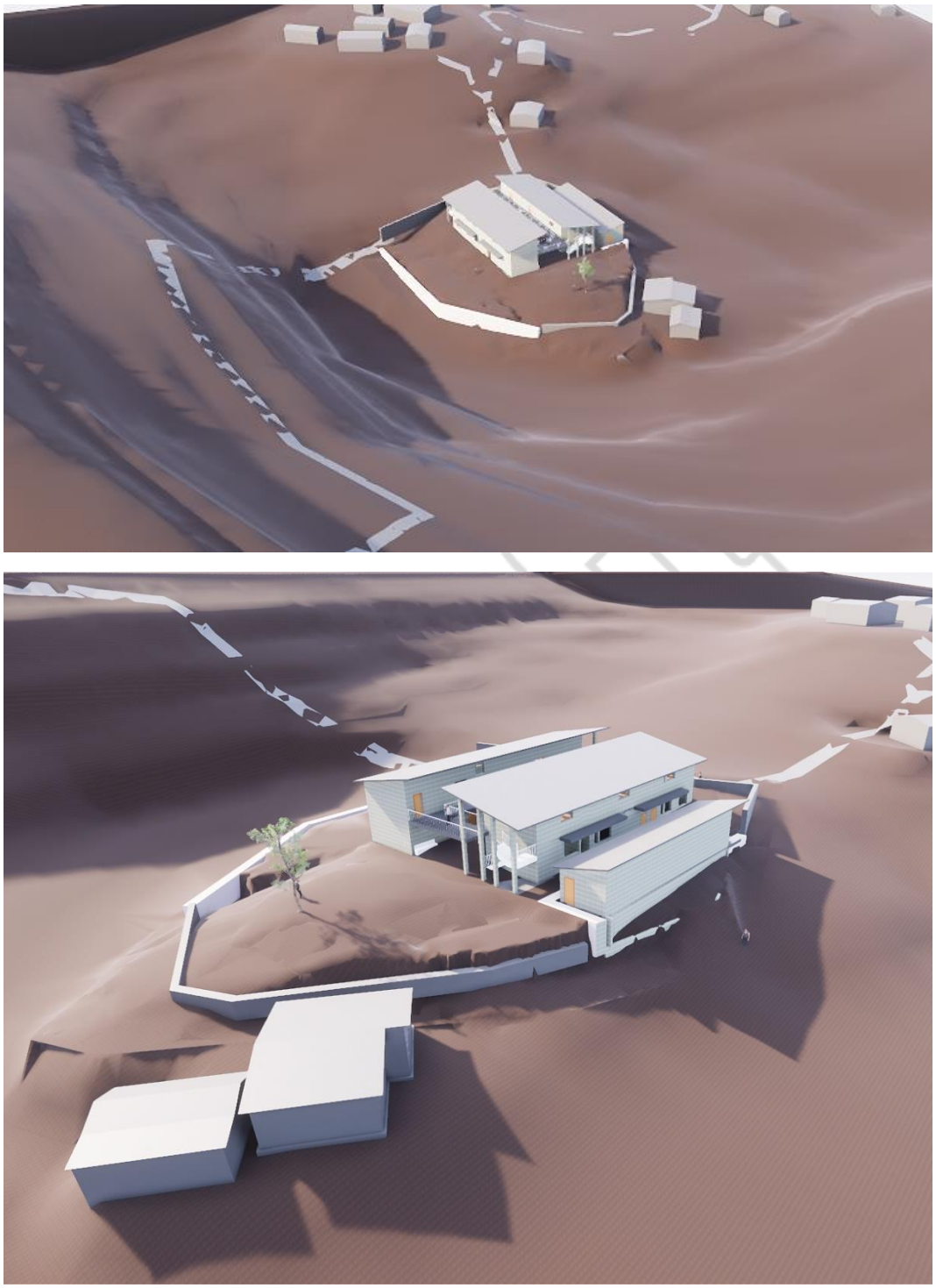

Figure 2: 3D Views of the IMPV School Project Site

3 Proposed Design Solution

3.1 Ventilated Improved Pit (VIP) Latrines

After undertaking a review of various toilet systems and assessing the site conditions of the IMPV School site, the team has concluded that double ventilated improved latrines would be the most optimal proposal for this site. VIP latrines are a tried-and-tested method of providing sanitation in isolated areas. They have a proven track record of successful installation around the world.

Double VIP latrines are comprised of two identical sealed pits, supported by stable foundations and covered with concrete slabs, and ventilation pipes that extend above the roof of the latrines to draw away unpleasant odours (see **Error! Reference source not found.**~~Figure 3~~).

Some of the benefits offered by VIP latrines include:

a) Stability: VIP latrines are built on strong foundations and with concrete cover slabs, providing strength and stability to the structure.

b) Ventilation: continuous airflow through the latrine block along with the provision of vent pipes ensure that unpleasant odours are drawn away from the site by wind.

c) Hygiene: the vent pipes are fitted with fly screens that prevent flies from breeding in the pits. Any flies that make their way into the dark pits become drawn towards the light at the top of the vent pipes, thereby trapping themselves in the screens.

d) Privacy and security: the walls of the latrines provide privacy to the users. This benefit is particularly important for female users.

e) Affordability: VIP latrines are a low-cost solution that can make use of locally available materials.

f) Simplicity: the design of VIP latrines is simple, making these latrines easily replicable should other communities wish to do so.

g) Production of humus: the waste that collects within the pits will transform into a nutrient-rich humic material after a couple of years of decomposition. This humus is hygienically safe to excavate, since the conditions of the latrine pits are not favorable for pathogen survival. The humus can be used for agricultural purposes as fertilizer or soil conditioner. This can be an educational feature of the latrines, supporting the IMPV school's curriculum on sustainable agriculture.

h) Functionality: The double-pit system allows for the latrines to be in continuous use. Once one pit becomes full, it will be covered and put temporarily out of use while the second is put into service. By the time the

second pit becomes full, the first one will be ready to be emptied and put back into use. This cycle can be repeated indefinitely.

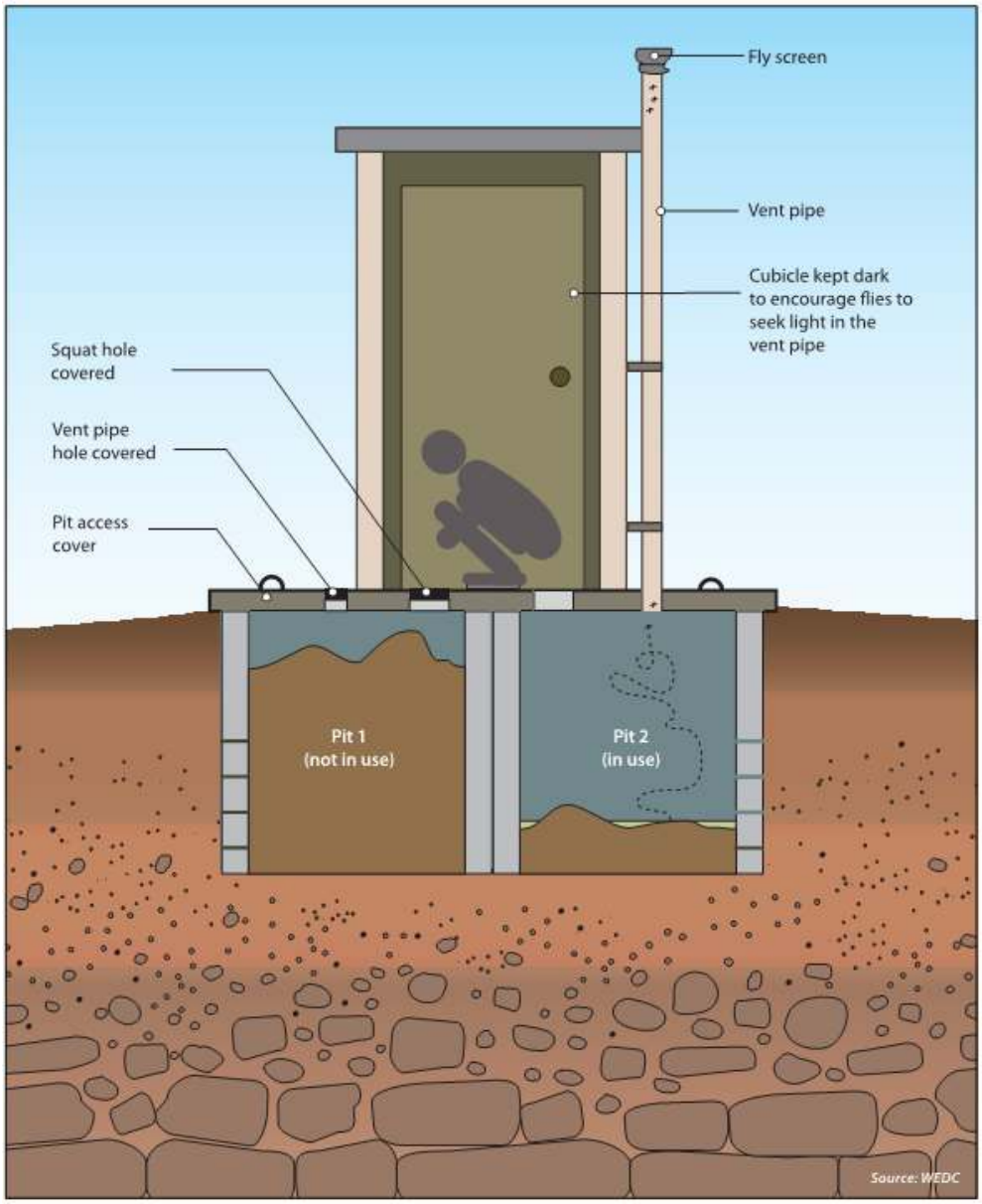

Figure 3: Double VIP Latrine (*WHO, 2018*)

3.1.1 Maintenance and Care of VIP Latrines

The success and viability of VIP latrines is dependent upon proper maintenance of the structures. Continuous maintenance and monitoring of the latrines are strongly encouraged. Among other things, the owners/maintainers of the latrines must endeavour to do the following:

a) Check the vent pipe regularly to ensure that it is straight,

b) Check the fly screen regularly and replace if torn or damaged,

c) Keep the latrine clean; this includes the exterior and interior spaces of the latrine block and particularly the floors and toilet seats,

d) Check for any damage or defects to the various components of the latrines, and fix/replace components as required,

e) Ensure the latrine doors are fitted properly and that locks are functional. Self-closing doors are ideal to keep the door closed when not in use, to keep the cubicle dark and ensure flies do not escape,

f) Ensure that the latrines are locked at night to prevent vandalism, and that the holes are covered overnight if possible to minimize foul odours in the early mornings,

g) Limit inputs into the latrine pits to urine, faeces, organics, and dry cleansing materials (e.g. toilet paper). As much as possible, prevent liquids from entering the latrine pits (including cleansing water), as the contents of the pit should remain dry.

h) Ensure that all latrines are being used as evenly as possible between the students (i.e. no single latrine cubicle is being used much more than another) so that the pits fill up at an even rate.

i) Avoid emptying the contents of a latrine for at least 6 months after the latrine is last used, as the excreta may still contain harmful pathogens. Two years is the minimum recommended storage time. During decomposition, leachate from the pit contents will permeate into the surrounding soil, filtering out harmful pathogens and killing them off. The required storage time of 2 years can be reduced if the pits remain well-aerated and free of moisture. In addition, organic material (e.g. leaves, coconut husks, woodchips) thrown into the pit can also enhance the decomposition process of the humus. That being said, caution should be exercised, as throwing in too much organic waste would cause the pits to fill up too quickly.

j) Although the pit humus will be generally safe to handle if left to decompose for at least 2 years, appropriate personal protection (e.g. gloves, face masks) is advised for anyone who will come into contact with the waste. This includes anyone involved in emptying the pits, transporting the humus, and/or applying the humus as soil fertilizer. If there is any doubt about the level of quality of the humus in the pits, it is advised to transport the waste to a dedicated composting facility (where available), or to permanently dispose of the waste by burying.

3.2 Handwashing Units

Supplying robust handwashing units in conjunction with the latrines is imperative in the promotion of good hygiene and prevention of the spread of disease within the school and, by extent, within the community of Timo. This section outlines the proposed methodology of supplying water to the handwashing units, as well as the recommended methods of promoting good hygiene habits among the users of the latrines.

3.2.1 Water Supply

The two main sources of water at IMPV School will be rainwater and spring water.

Spring water will be the primary supply of water for the handwashing units. This water is delivered to IMPV School by pipe from Kamatin Spring. The pressure of this water has been recorded to be 40 psi on site. The location of Kamatin Spring relative to IMPV, as well as the locations of other known taps in the area, is shown in Figure 4.

Figure 4: Map of Kamatin Spring Taps

Figure 5 illustrates the distribution network, indicating that the spring water supply to the school is the third known branch from the main distribution line.

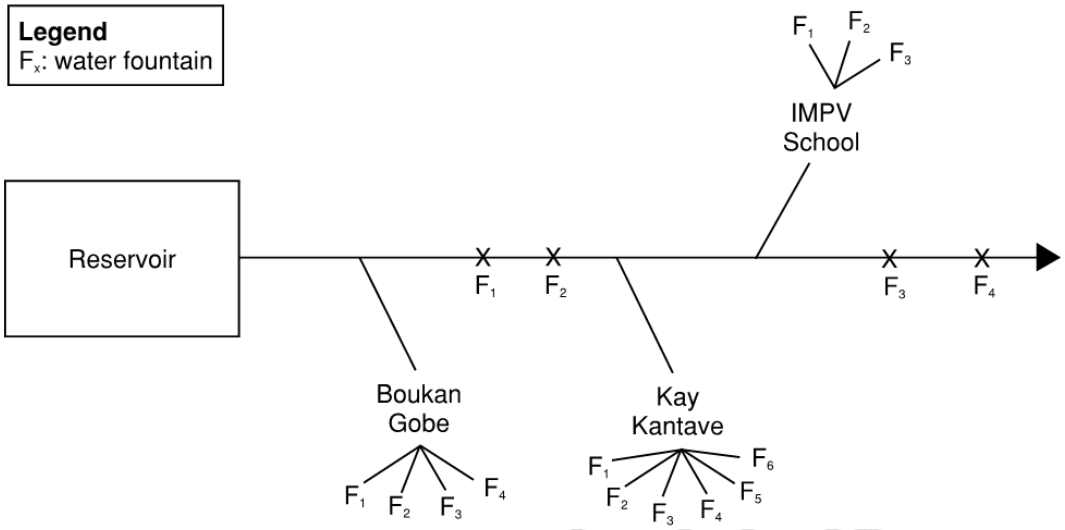

Figure 5: Kamatin Spring Distribution Network

In addition to spring water, rainwater will be collected on site and serve as a back-up supply for the handwashing units, in case spring water supply is ever interrupted. Rainwater can also be a source of water for cleaning and for irrigation. Collected rainwater will be stored in rainwater tanks. All three buildings (school buildings and latrine block) will have pitched roofs and gutters to collect rainwater and deliver it to the tanks.

The supply of rainwater and spring water will vary throughout the year. The seasons in Haiti are as follows:

a) Dry season: December to March,

b) Rainy season: March to December,

c) Hurricane season: June to September.

The school will be open for operation between September and June, coinciding with the dry and rainy seasons.

3.2.2 Rainwater Tanks

A total of three rainwater tanks are proposed on site; one at each building. The tank that will serve as back-up for the handwashing units will be located at the south end of the latrine block. The size of the tank will be dictated by the height of the latrine block roof.

The tank will have an overflow system to direct any excess rainwater away from building foundations. In addition, a first-flush diverter will be provided to remove any excess debris or sediment that accumulates in the rainwater collected from the

roofs. First-flush refers to the initial storm runoff generated atop a roof; it is typically dirtier than average because this runoff essentially washes the roof of all sediments that have accumulated on it since the last rainfall event. The diverter will have to be emptied after the first rainfall of the season. Figure 6 illustrates this process.

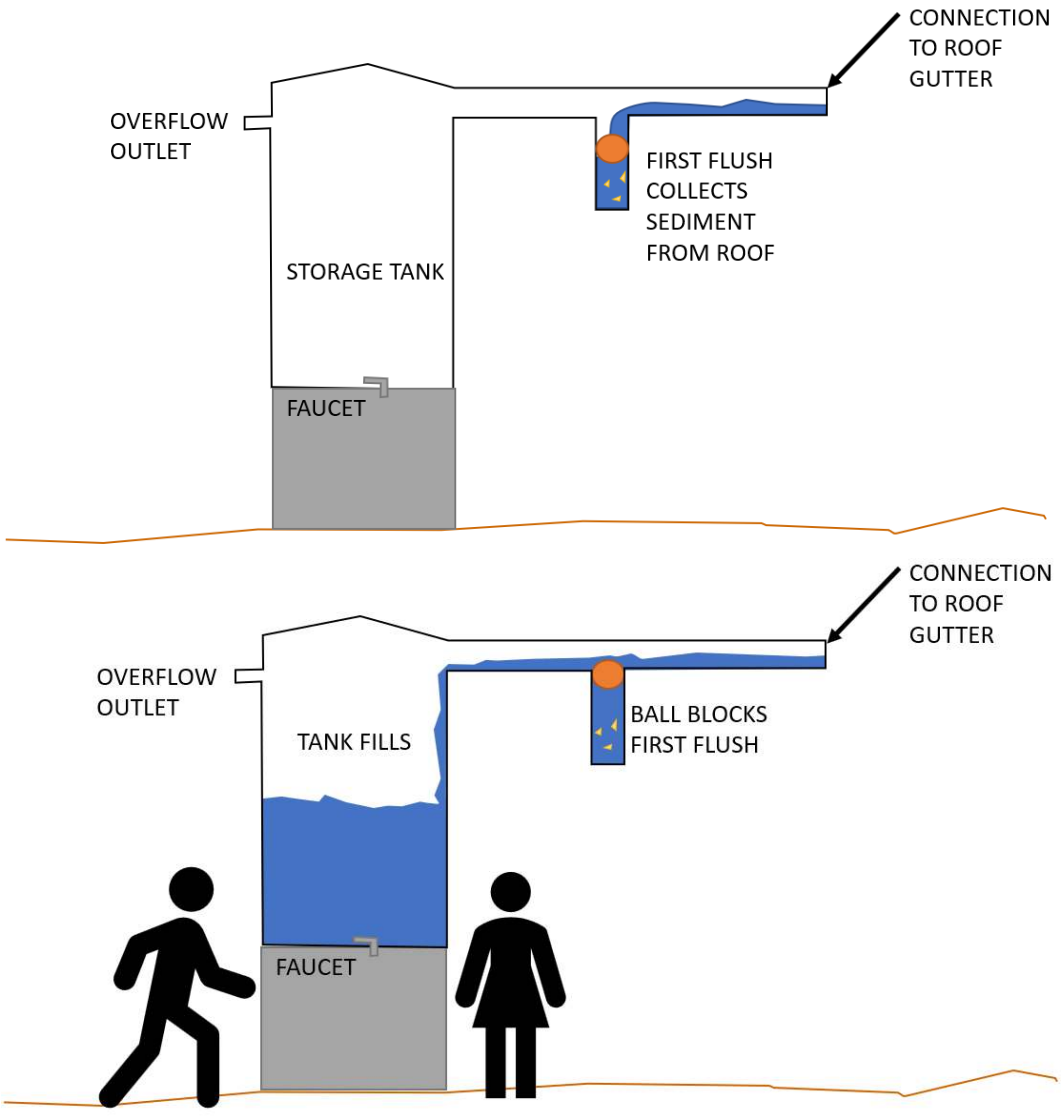

Figure 6: Rainwater Collection System

3.2.3 Greywater Disposal

Gently used water from washroom sinks is referred to as greywater. Greywater from the latrine handwashing units will be collected into a single PVC pipe and diverted away from the buildings, towards a soakaway pit that will be located in northeast corner of the school site, west of the playing area. The pit should be approximately 1.5m wide x 1.5m tall x 2m deep. As illustrated in Figure 7, the soakaway pit will

be filled with fine sand and gravel to promote infiltration of the greywater into the surrounding soils. A removable lid shall be used to seal the pit for future fill material replacement.

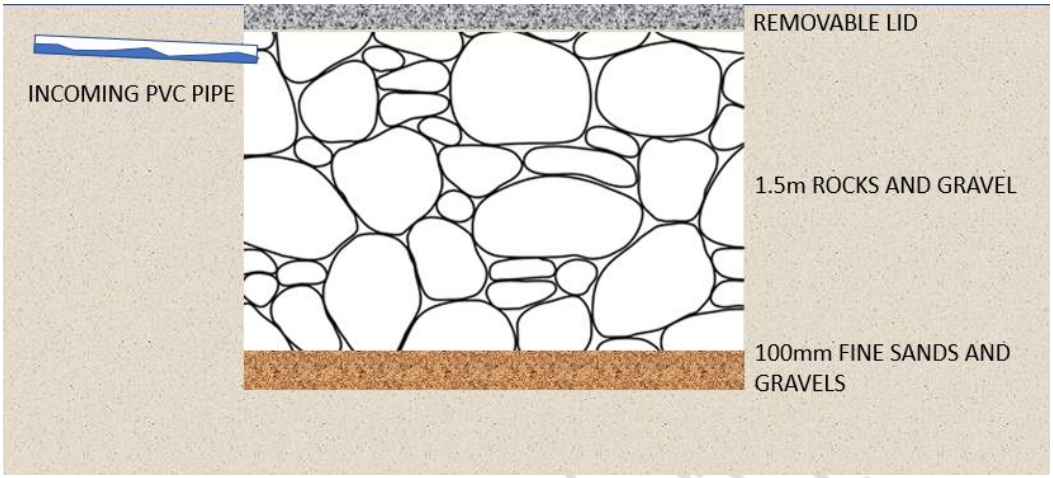

Figure 7: Soakaway Pit

3.2.4 Hygiene Promotion

The promotion of good hygiene is key to the success of sanitation facilities, and there is no better place to spread awareness of this than in a school. By doing so, students will not only learn how to maintain proper hygiene within the school, but they will also likely bring the habits they form at school to their homes, thereby helping to promote proper hygienic practices within the community of Timo and beyond.

The design team strongly recommends that the IMPV School implements the promotion of good hygiene and overall cleanliness habits within the school curriculum. The amount and type of information taught to the students would vary depending on the student's age, but overall the content could include:

a) Explanations of the relationship between water-borne diseases (e.g. diarrhea, cholera) and poor water and sanitation habits,

b) Appropriate handwashing and cleanliness practices that students should follow to prevent infection; this includes handwashing after latrine use and before eating food,

c) Descriptions of signs and symptoms of diseases or infections, and where appropriate, methods to alleviate symptoms or treat infections.

Students could also be encouraged to participate in the cleaning of the latrine – for example, once a month and under supervision of a teacher – to further reinforce cleaning habits and instill a sense of responsibility within the students over the cleanliness of the latrines.

4 Design Considerations

The following design considerations are a collection of recommendations provided in multiple VIP latrine design and construction guidelines – including the World Health Organization (WHO) Guidelines on Sanitation and Health and the Water, Engineering and Development Centre (WEDC) publication "Sanitation for Primary Schools in Africa" – that are being incorporated in the design of the latrines at IMPV School:

a) The latrine pit walls will be made from concrete to provide structural stability. They will be designed to handle seismic risk.

b) The latrine floor slabs will also be made from concrete for ease of cleaning.

c) The bottom of the latrine pits will be partially exposed to the soil underneath to allow for the flow of leachate from the contents of the pit to the soils.

d) The site around the latrine block will be graded in such a way as to divert as much rainwater as possible away from the latrines to limit the amount of water seeping into the pits.

e) The bottom of the latrine pits should be at least 1.5m above the groundwater table. The groundwater level is currently unconfirmed at the school site, but local reports indicate that stormwater runoff drains relatively quickly through the ground on site and within Timo in general, implying that the soils are permeable, and that the groundwater table is sufficiently low.

f) The latrine pits should be located at a minimum horizontal distance of 15m from drinking water sources.

g) Inputs into the latrine pits must be limited to urine, faeces, organics, and dry cleansing materials (e.g. toilet paper) to prevent the pits from filling up too quickly and to maximize the yield of the humus. Appropriate containers will be provided for waste that should not be thrown into the pits (e.g. menstrual products).

h) To be able to empty the contents of the latrine pits, each pit must be fitted with an access door or cover. Due to the limited space available at IMPV School, access to the latrines will be made via doors installed on the sides of the latrine pits that face away from the school, taking advantage of the elevation difference between the finished grade of the school site and the surrounding landscape.

i) The recommended ratio of persons to latrine cubicle is:

    a. 1 latrine cubicle for every 25 girls,

    b. 1 latrine cubicle for every 50 boys,

    c. 1 latrine cubicle for every 10 staff members.

j) The recommended minimum number of latrines in total is 10; 4 for girls, 4 for boys, and 2 for staff.

k) One handwashing station is recommended for every 50 students.

l) The recommended rate of supply of water to the school for all uses, including drinking, handwashing, cleaning, and cooking, is between 10 and 15 L/day per student (Reed & Shaw, 2008). Approximately 5 L/day of this demand will be assumed for handwashing use.

m) The design of the latrines should consider implementing "female-friendly" measures designed to make females feel safe when using the latrines. The latrines at IMPV School will include the following measures:

    a. Separate and independently accessed blocks for boys, girls and staff,

    b. Clear markers that distinguish the girls' block from the boys' block,

    c. Walls around the latrine blocks for privacy,

    d. The girls' block will be separated from the boys' block by the staff latrines to provide an additional layer of privacy and security,

    e. The close proximity of the latrine block to the school buildings also adds a layer of safety,

    f. Additional facilities will be provided in the girls' latrines for the disposal and/or cleaning of menstrual products,

n) Similarly, the latrines will be designed to incorporate the needs and habits of the school children; for example:

    a. Toilet seats will be provided so that children will not have to squat over the pit holes (which some children may find to be scary),

    b. Sufficient lighting will be provided within the latrine blocks to promote a sense of security,

    c. Clearly-defined paths from the school buildings to the latrines will also be provided for this reason,

    d. The handwashing units and soap dispensers will be placed at appropriate heights for use by children: 60cm for younger students and 70cm for older ones and for adults,

    e. Signs, pictures, and/or illustrative diagrams are encouraged to be placed around the walls of the latrine blocks to illustrate good hygienic practices (e.g. handwashing and keeping the latrines clean)

o) Greywater from the handwashing units and wastewater from cleaning the latrines will be diverted away from the latrine block, via buried pipe, to a suitable drainage point (soakaway pit) on-site.

5 Calculations

Approximately 225 students are anticipated to attend IMPV School along with 14 staff members. The students will range in age from 3 to 15. The gender split among students will vary each year, but in general, the split is anticipated to be 50-50.

5.1 Quantity of Latrines

A total of 10 latrines will be provided: 4 for girls, 4 for boys, and 2 for staff. This is equivalent to the total number recommended in the WHO sanitation guidelines. Assuming a 50-50 split between girls and boys, this quantity of latrines is equivalent to 1 latrine per 28 girls (113 girls to 4 latrines), 1 latrine per 28 boys (113 boys to 4 latrines), and 1 latrine per 7 staff members (14 staff members to 2 latrines).

5.2 Size of Latrines

The size of the latrine pits varies along the block depending on the spacing of the walls. The smallest pit is 0.8m wide, 2.1m long and 2.1m deep, giving a total volume of 3.528m^3 (equivalent to 3,528 L). Assuming that the average person generates 40-60 L/year of waste (WHO, 2018), and provided a 300mm clearance at the top of the pit (underneath the floor slab of the latrine cubicle), it will take 2.2 years for this latrine pit to become full, calculated as follows:

$$\text{time to fill latrine pit} = \frac{\text{total volume (L)}}{\text{number of students} \times \text{rate of use } \left(\frac{\text{L}}{\text{yr} \cdot \text{students}}\right)}$$

$$= \frac{0.8\text{m} \times 2.1\text{m} \times 1.8\text{m} \times 1000\ \text{L/m}^3}{\frac{225\ \text{students}}{8\ \text{student pits}} \times \frac{50\ \text{L}}{\text{yr} \cdot \text{student}}}$$

$$= 2.2\ \text{years}$$

With this pit volume, a full pit can be left untouched for at least 2.2 years while its contents decompose. This calculation assumes a conservative estimate of 50 L/year per student, and that waste is distributed evenly throughout the year among all the latrines in service. The other, larger pits can be left untouched for even longer. The minimum recommended amount of decomposition time per pit will be provided with the drawings.

The smallest staff latrine pit will fill up after 8.3 years of use.

$$\text{time to fill latrine pit} = \frac{3{,}500\ L}{\frac{14\ \text{staff}}{2\ \text{staff pits}} \times \frac{60\ \text{L}}{\text{yr} \cdot \text{staff}}} = 8.3\ \text{years}$$

5.3 Water Pressure at Handwashing Units

To follow.

5.4 Rainwater Accumulation

To follow.

6 Structural Design

The latrine block is a hybrid reinforced masonry/reinforced concrete structure and a separate canopy and storage area for rainwater harvesting. The structural system is described as follows:

1. Main Latrine Block
    a. Reinforced masonry shear walls and internal walls
    b. Reinforced concrete ground slab
    c. Reinforced concrete columns
    d. Metal roofing supported by timber framing
2. Canopy Structure
    a. Reinforced concrete slab on grade
    b. Timber columns and framing
    c. Metal roof deck

Further to the typical design requirements stipulated by the National Building Code of Canada (NBCC 2015), there are additional structural design requirements that have to be taken into consideration for the latrine blocks. Firstly, as part of the latrine block system is below grade, the external masonry walls act both as retaining walls and seismic/wind-force resisting walls. Secondly, the external walls are exposed to unbalanced lateral loads - hydrostatic pressure due to water on one side and the contents of the latrine pits on the other side. Furthermore, masonry and concrete elements will be exposed to groundwater and contaminants from the latrine pits. Therefore, durability and permeability are of particular significance for the design of these elements so that their structural integrity is not compromised during the design life of the building.

7 Geotechnical Design

Prior to construction, groundwater levels in the surrounding area must be verified in order to mitigate the risk of contaminating groundwater supply. It is typically

recommended to ensure at least a minimum horizontal distance of 30 meters between a pit and water source and a vertical distance of 2 meters between the pit and the groundwater table.

8 Electrical Design

To follow.

9 Conclusion

Double ventilated improved latrines have been chosen as the optimal latrine choice for the IMPV school site following a study of various toilet systems and assessment of the site conditions. This report, to be read in conjunction with the architectural drawings, summarizes the overall design of the latrine block, including the design of the latrine pits, handwashing units, and greywater disposal strategy.

References

Reed, R.A. and Shaw, R.J. (2008) *Sanitation for Primary Schools in Africa*. WEDC, Loughborough University, UK.

World Health Organization (2018). *Guidelines on Sanitation and Health*. Geneva, Switzerland. Licence: CC BY-NC-SA 3.0 IGO.