Technical guidelines

Technical guidelines for construction of institutional and public toilets


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Technical guidelines for construction of institutional and public toilets

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1 Introduction

Purpose
This document provides technical guidelines for designing, constructing and maintaining institutional and public toilets. While toilet design should always be adapted to the local context and national standards, the aim of this document is to provide practical guidance that:

- is generally applicable across different countries and contexts
- highlights critical features that must be included to avoid mistakes
- is easily understood by both designers and builders

Audience
These guidelines have been created for WaterAid country offices and partner organisations. They may also be useful for:

- local authorities in towns and cities in charge of public and institutional toilets
- national governments
- public and private service providers
- NGOs, donors and civil society organisations

Document structure
Institutional and public toilets are built in different locations. For institutional toilets, this document focuses on health facilities and schools (though the guidelines can be applied to other institutions), while public toilets may be built in a variety of locations where people pass through, for example, markets, train and bus stations, parks, religious sites, or areas homeless people visit. Although the location can affect certain aspects, particularly the costs and models for operation and maintenance, in many ways the key design and construction requirements are similar. Therefore, this document is structured in a way that combines aspects applicable to all institutional and public toilets, while highlighting key differences where necessary. It should be read in conjunction with two other WaterAid guidelines:

- Guidelines for sustainable and inclusive school WASH (2018)[1]
- Female-friendly public and community toilets: A guide for planners and decision makers (2018)[2]

Feedback
This is a pilot document for practical use and we would welcome your feedback, for example, on whether you are finding the guidelines useful (and which sections in particular) and any recommendations for things to add or remove. Please email feedback to psusupport@wateraid.org. Based on this the guidelines will be reviewed in June 2020.

2 Pre-design planning

At a glance: Summary of things to consider at pre-design stage

- Have you identified and involved all the stakeholders in the design?
- Have you identified all relevant national (and international) standards?
- Does your design need approval by government agencies?
- Have you planned the number of facilities based on the population and national standards?
- Have you checked your preferred design against local conditions (for example, maximum groundwater level, water use vs water availability, emptying service available)?
- Is it clear who will take on the financial and operational aspects of ongoing maintenance and repair? Is this possible, given local technical constraints?
- Have you specified good quality materials and fittings?

2.1 Who to involve

It is critical to identify and involve the stakeholders in the design. Enabling dialogue between them will help develop relationships, raise awareness of the challenges and barriers, create ownership, and ensure facilities are constructed that meet people's needs, demands and desires. This process will also minimise the need for changes and avoid problems later. There are two main groups you need to consider - the users and the duty bearers.

People may not use the new facilities if they do not think it meets their needs. Therefore, find out what potential users prefer in terms of the 'user interface'. Doing this should improve levels of ownership, participation in operation and maintenance, and even willingness to pay to use (for public toilets) or maintain the toilets.

The duty bearers also need to be involved from the beginning. Otherwise, government workers, institutional staff, or contractors may not fully understand the design rationale and local regulations, even though they are often the ones supervising and certifying a project.

Table 1: Involvement of stakeholders at pre-design stage

What is the issue	Guidance
User preferences vary a lot from context to context	**Don't assume anything, even if you are from the local area** Carry out some local research on user preferences with different groups of people who will use the toilet. Note that this could also involve introducing people to technical options that they had previously not been aware of. Questions could include: • the type of slab/pan preferred • if the squatting/sitting direction is important • the type of door needed • the preferred location and layout • if water, paper or other materials are used for anal cleansing **Make sure all potential users from the community are involved** Some people will have specific needs to consider. In particular, consult women (they may speak more openly if they are consulted separately from men), children, older people and those with disabilities. If there are already institutional or public toilets in the area, ask for feedback on what users like or dislike about them.
Duty bearers and active agents in the operation and maintenance of the facilities need to be involved from the beginning	**Create effective partnerships by communicating with government, institutions, contractors, private companies and NGOs** Involve anyone at this stage who will be involved later in the supervision or certification of the construction, and also operation and maintenance. Explain the technical design and rationale, especially if certain elements are new to the area. Research local codes, practices and design guidelines, and establish connections with the respective governing authorities and duty bearers. In some cases, legislation dictates what technology can or cannot be used in the jurisdiction. Talk to any NGOs and other relevant organisations (e.g. disabled persons groups) active in the region to share knowledge and experiences and avoid repeating mistakes.

2.2 How many facilities?

Calculate the number of toilet cubicles and related facilities required at the pre-design stage to:

- check if the required number will be possible in terms of cost, land required and logistical capacity for construction
- ensure the toilets are convenient to use (queuing may lead to people using unsafe alternatives)

Note that accessible toilets are those for anyone who has specific requirements over and above the general accessibility requirements of the majority population. They should be single occupancy toilets with more space and various adaptations and can be gender-neutral (or gender separated if there is enough space and budget). Typically, these toilets might be used by:

- those with physical mobility restrictions (for example, wheelchair users, people with age related disabilities, those temporarily affected by illness or injury that affects their mobility, pregnant women or those being cared for due to age or illness)
- those in need of third gender (or gender-neutral) facilities – these are suitable in some contexts/locations. Consultation with transgender or third gender groups would be essential to ensure that this is their preferred option and that it would not increase their risk of violence.

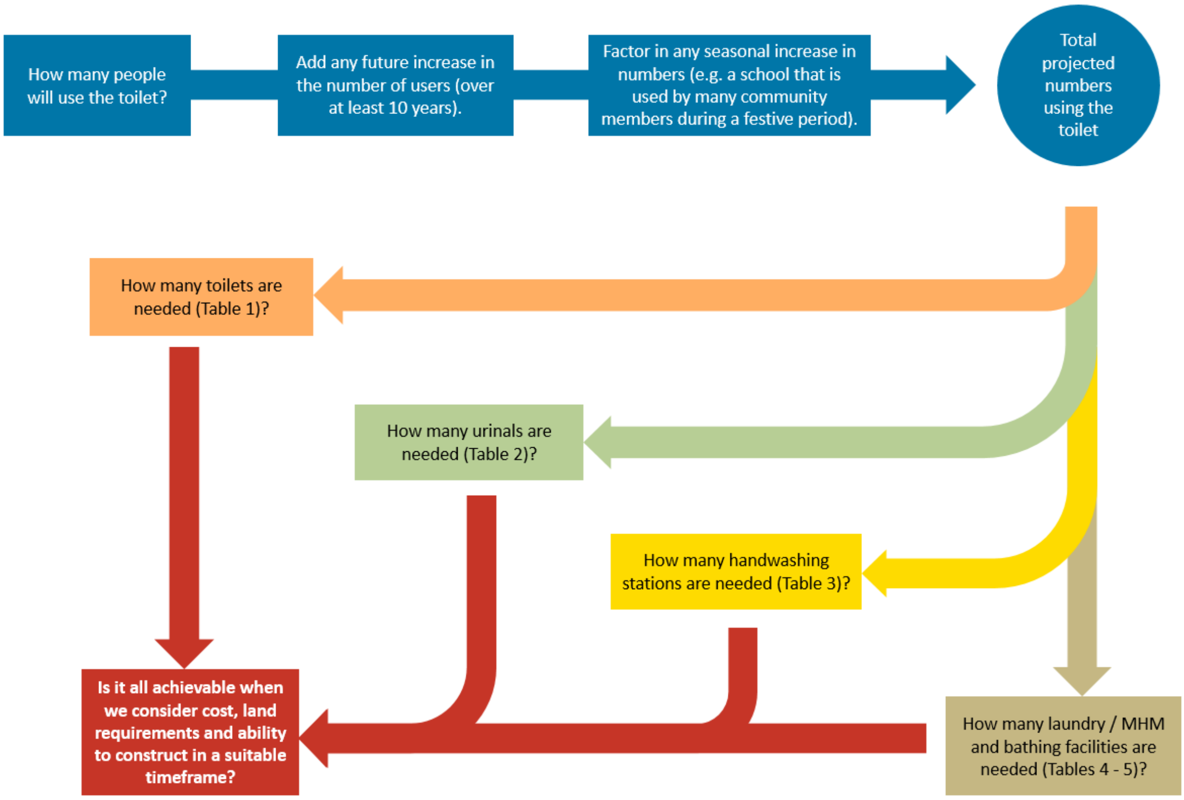
Planning starts with knowing how many people the facilities will be serving (for example, how many patients, visitors and staff there might be in a health centre – both men and women), then applying standard factors for the number of people. The first task would be to check if local or national standards exist where you are operating, and, where these do exist, if following them is required by governing bodies. Where local standards are limited or not available, see the recommendations based on the available literature in Annex 1. A decision-making flow chart for this is shown in Figure 1.

Keep in mind that sanitation for institutions and public areas is not limited to toilets alone – there are also related structures that need to be included:

- **Urinals**: usually included in male toilets but they are possible for female toilets too. The advantages of adding urinals are:
    - they reduce the number of toilets you need to construct
    - they are easier to clean and maintain than toilets
    - separating urine from faeces increases the life of latrine pits and reduces smells (since urine is not a public health risk, safe disposal is easier and a covered soakpit is adequate)
- **Handwashing stations**: essential for controlling disease transmission
- **Bathing/ laundry areas**: sometimes forgotten about but highly recommended, especially in community toilet blocks where people have no facilities at home, and always required in health care facilities

- **Menstrual hygiene management (MHM) areas**: a clean space with soap and water in which to change menstrual materials and wash (this could be inside the toilet cubicle as long as it is clean, light and provides enough space). A safe disposal facility for menstrual materials is also required, such as a covered bin (with provision for collection and disposal) or a direct connection to a small, onsite incinerator
- **Drainage** for wastewater

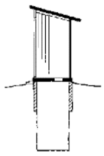
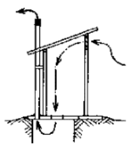
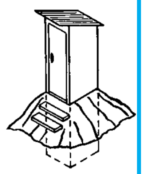
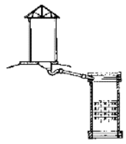
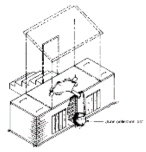
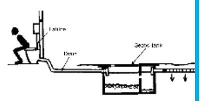
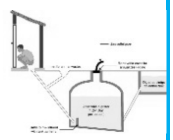
Figure 1: Planning based on population numbers



2.3 Type of toilet design

A wide variety of designs exist – common designs are shown in Table 2. Note that there is a design summary for ventilated improved pit (VIP) and urine-diverting dry toilet (UDDT)/composting latrines in Annex 7 and references to further information for other specific designs (for example, biodigester, raised latrines).

Table 2: Common toilet designs[3]

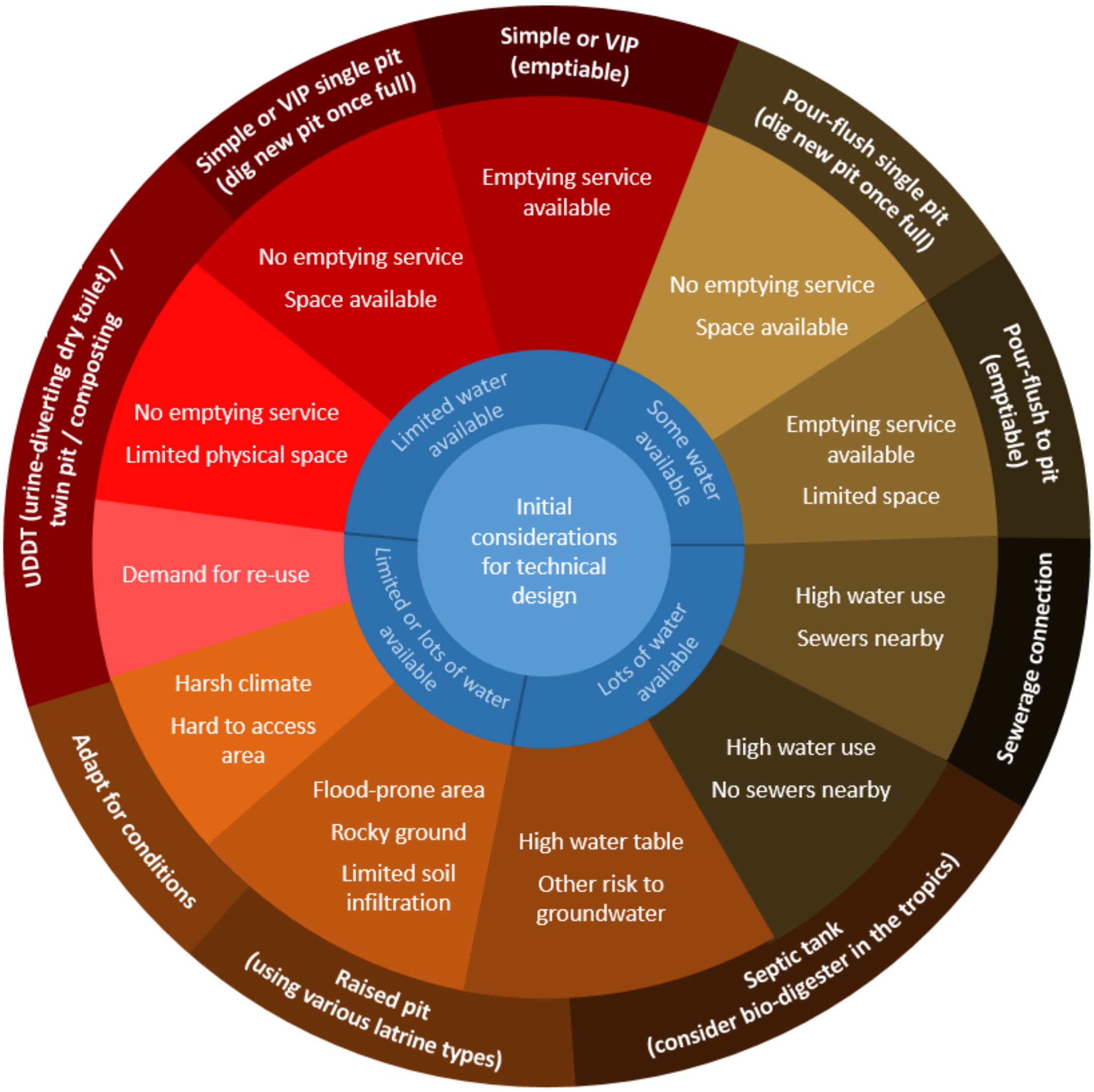
Simple pit	VIP	Raised[4]	Pour-flush (offset pit)	UDDT / twin pit / composting	Septic tank	Biodigester[5]
						
Pit, supporting structure, slab, shelter	Like a simple pit except with vent pipe, darkened interior	As simple pit or VIP except pit extends above ground	Water for flushing creates a seal between shelter and pit	A dry toilet where urine is diverted and two chambers allow for composting	Watertight settling tank which partially treats excreta, with an outlet for treated liquid to soak away into the ground	Sealed container for partial treatment of excreta, but where gas produced is collected and used

In some situations, you may find you have a wider choice of technical designs due to fewer physical constraints (for example, in a rural area where there is a lot of available space and the water table is deep). On the other hand, in some situations, your technical choice can be limited by certain conditions. Figure 2 shows some of the things that might have an impact on your choice of technology, which you may have to consider at the pre-design stage. Note that where there is a (functioning) sewerage system nearby, the best long-term option is to connect toilets to sewers.

Other general aspects to consider at this stage include:

- local government guidelines relating to latrine type, utilities and waste disposal
- replicability – if you aim to encourage others to replicate your design, then you need to ensure your design appeals to the community, uses locally available skills and materials, and is affordable. (WaterAid uses WASH projects in institutions to demonstrate to governments best-practice designs and approaches that could be scaled-up nationwide.)

Figure 2: Initial considerations for the technical design



2.4 Sustainability – planning for future operation and maintenance

At the pre-design stage, it is important to think ahead to how the type of toilet you design is going to be operated on a long-term basis. While the initial capital costs of institutional and public toilets are often paid for by a larger organisation (for example, local government or a donor), for every type of toilet there will also be ongoing and significant maintenance/ replacement costs that need to be planned for and managed by the institution.

Ongoing costs include daily costs, such as staff salaries, soap, toilet paper and cleaning materials (defined as operational expenditure, OpEx) and also periodic costs, such as the cost of emptying a toilet after a certain number of years (defined as capital maintenance expenditure, CapManEx). It is important to consider these costs as part of the design, and that the institution is informed, prepared and has assessed if there are sufficient financial resources to afford them.

Technical note:
Capital costs are the initial costs to build the toilet.

Ongoing costs are those needed to ensure the toilet continues to function – so can include smaller daily costs related to things like cleaning, as well as larger costs related to repairs or emptying.

Life-cycle costs include both of these and are the costs not just for a few years but indefinitely.

Analysing costs based on sanitation type, however, is not always straightforward. While sanitation options can be ranked by lifecycle costs (which include the initial capital cost),[6] the operation and maintenance portion of these costs for each technology type will vary based on the context. You will need to make a judgement about likely ongoing costs based on your situation. Table 3 highlights some issues to consider related to ongoing costs, which may influence design decisions.

Table 3: Designing for operation and maintenance

What is the issue	Guidance
At the onset, it needs to be clear who is responsible for operation and maintenance, what it will cost, and if it is affordable	**Communicate about ownership and costs early on** The issue of who will be responsible for future operation is not always discussed and perceptions may vary between the donor and institution. To encourage ownership at the start, you will need to explain very clearly to the institution and local government about who will be responsible for the operational and replacement costs and estimate what those are likely to be. Based on this discussion it may be necessary to modify the design to ensure it is financially sustainable.
Operating and service requirements need to be technically viable	**Check that the technical requirements for the design can be met** Check there is enough water available for the design you propose. For example, more water will be used with pour-flush toilets than simple pit latrines, and more again for flush

	toilets. If water is available, check if it is affordable – you can calculate the annual cost to the institution for water needs. For toilets that need emptying, you need to establish if there is a local emptying service provider. If there is such a service, check the cost and frequency of emptying required (for frequency, you can calculate this using information in the following pit design and septic tank design sections). If there is no such service, a non-emptiable toilet design is preferable. For emptying, keep in mind that you may need an access point and a large enough turning area for vacuum trucks. Although it is not possible to meet this requirement in every location, it still needs to be carefully considered. Public toilets, for example, will probably need emptying on a regular basis (every three to six months for the most frequently used toilets), so easy access by trucks will make things much simpler. **Technical note:** Desludging is the removal of (untreated and partially treated) excreta from the pit or tank, and transport to an off-site treatment and disposal facility.
The design and choice of materials will determine the design life and maintenance costs of the structure	**Design and budget for a robust construction using high quality materials and fittings** The type of design, materials and fittings will determine the ongoing maintenance costs as well as the design life (the designer should estimate how many years the structure will last before it needs decommissioning and replacing). Avoid over-designing but simple improvements can substantially reduce future maintenance and reduce replacement frequency (for example, quality of doors, hinges or support rails, materials that will not stain or corrode or are harder to vandalise). Good levels of site supervision are also needed to ensure the quality of what is built (covered in the Construction section).

3 Design

At a glance: Summary of things to consider at design stage
• When siting the toilet, have you considered user safety, land ownership, groundwater contamination risk, availability of water, ease of access to the toilet, existing infrastructure, challenging local climatic conditions, government regulations, and relevant cultural, aesthetic or health factors? • Is the toilet design suitable for use by anyone (men, women, older people, those with disabilities, children)? • Do you know what type of lining method and materials you will use? • Have you sized the pit according to the number of users, sludge accumulation rate and number of years of use, while accounting for a volume to remain for backfilling? • Do you have a slab design (reinforcement bar arrangement, drop-hole and footrest design)? • Does the toilet design prevent flies entering the pit (either with a water seal, hole cover, or through VIP design)? • For septic tanks, have you gone through the tank sizing procedure and calculated the wastewater infiltration trench needed? • Have you considered constructing urinals? • Have you designed the handwashing areas? • Have you made provision for menstrual hygiene management? • Have you included areas for bathing and laundry where needed?

3.1 Geographical location and site layout

It is critical that you locate facilities so that everyone can use them in a safe and secure way. This means designing the toilet carefully by considering both the geographical location (see Table 4 and Figure 4) and the layout of the toilet block (see Figure 5).

Table 4: Siting the toilet block

What is the issue	Guidance
User security and protection	**Choose a location that ensures all users are safe, especially women and girls** Separate male and female blocks where possible. Choose a visible location, not in remote/ dark/ narrow areas. Have adequate lighting levels for walkways and open areas.

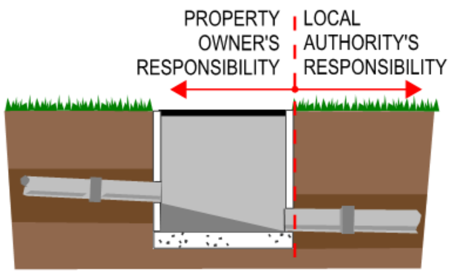
<table>
<tr><td></td><td>To get the right balance between privacy and safety, consult local people who will often know which areas or compounds are dangerous for them.</td></tr>
<tr><td>Land ownership</td><td>Verify who the land-owner is and obtain their permission

Find out who the landowner is for the proposed toilet site. Check any official legal documentation to clarify boundaries.

Get a written agreement from the landowner at this stage, and certainly before construction starts.

Make sure all aspects of the system are considered, e.g. if installing a septic tank and soakaway system, be sure to know whose land the pipes/ tank/ soakaway/ access road is in, and how responsibility and access for maintenance will be managed in the future (see Figure 3).

Figure 3: Land ownership


</td></tr>
<tr><td>Groundwater contamination risk</td><td>Carry out a groundwater contamination risk assessment where local groundwater is used for drinking

Check the minimum vertical and horizontal separation from the groundwater table/ sources. Whether groundwater will be contaminated depends on a variety of factors, and a simple rule of thumb (e.g. 30 m distance used in Sphere Standards) cannot always be relied on to be accurate. You need to assess the risk to groundwater using the decision flow chart in Annex 2.</td></tr>
<tr><td>Water availability</td><td>Ensure water will be accessible at the toilet location

A water supply needs to be provided (for flushing, cleaning, anal cleansing, handwashing, menstrual hygiene management). If a water source is not close by, consider rainwater harvesting – in this case, it might influence the toilet location if gutters from nearby buildings are directed to the toilet block.

If the water source is further away, consider who will actually be tasked with collecting the water and whether this is realistic – there will be negative implications if the journey time for</td></tr>
</table>

	refilling will be too long (i.e. less water will be used for essential tasks like cleaning, hands will not be washed all the time, pour-flush toilets won't be flushed at times and might become blocked).
Ease of access between the institution and the toilet	**For institutional toilets, locate toilets as close as possible to the institution to make them convenient, while increasing the likelihood of good maintenance** For healthcare facilities with inpatient facilities, toilets and showers should be attached to the institution building in order to be close to the wards. This might also make sense in other special circumstances (e.g. places where it is very cold or with a high rainfall, or for accessible toilets). Where toilets cannot be attached to the institution, aim for a maximum distance of 30 m from the institution.[7] For these toilets, you should avoid steep, uneven or otherwise hazardous access paths. Paths should preferably be paved or made with gravel/ murram to avoid them becoming muddy during the rainy season. For accessible toilets (regardless of exact location), ensure a smooth, gently graded path (ideally with a gradient of no more than 5%)[8] with no steps or obstructions.
Existing infrastructure	**Check existing roads and services when siting toilets** Establish where any underground services (water, sewerage, electricity, gas, telecommunications) are prior to construction through consultation with local authorities. Check road access to the site for toilets that need to be emptied by truck. Check if toilets should have an external lock so they can be closed outside of operating hours to prevent misuse by the surrounding community – particularly where facilities are near to a public path or road and there is no boundary fence.
Challenging climatic conditions	**Integrate disaster risk reduction (DRR) principles to mitigate climatic conditions like flooding or high wind speeds** Site the toilet in a location that will reduce the risk of damage in future (see Annex 8 for a checklist in challenging conditions). In areas with high wind speeds, site the toilet in an area with more protection from the prevailing wind.

	In areas prone to flooding, avoid building in natural drainage channels and site the toilet above previous flood levels.
Government requirements	**Consult government guidance related to location** Check if there are government requirements related to accessibility and location (e.g. signage, or rules about building near to a public right of way). In addition, environmental impact assessments (EIAs) may be a legal requirement and could result in modifications to design or location.
Cultural, aesthetic and health considerations	**Check the location against cultural norms, aesthetics and health** For cultural or religious norms (e.g. distance from a shrine or temple), this should become clear during consultation with users. In terms of aesthetics and health, the toilet should not be too close to areas of food preparation (at least 8 m away from kitchens), be downwind of where people work/ eat/ sleep, be separate from play areas (for schools), and minimise animal/ pest access to the toilet block.

Figure 4: Geographic location and siting

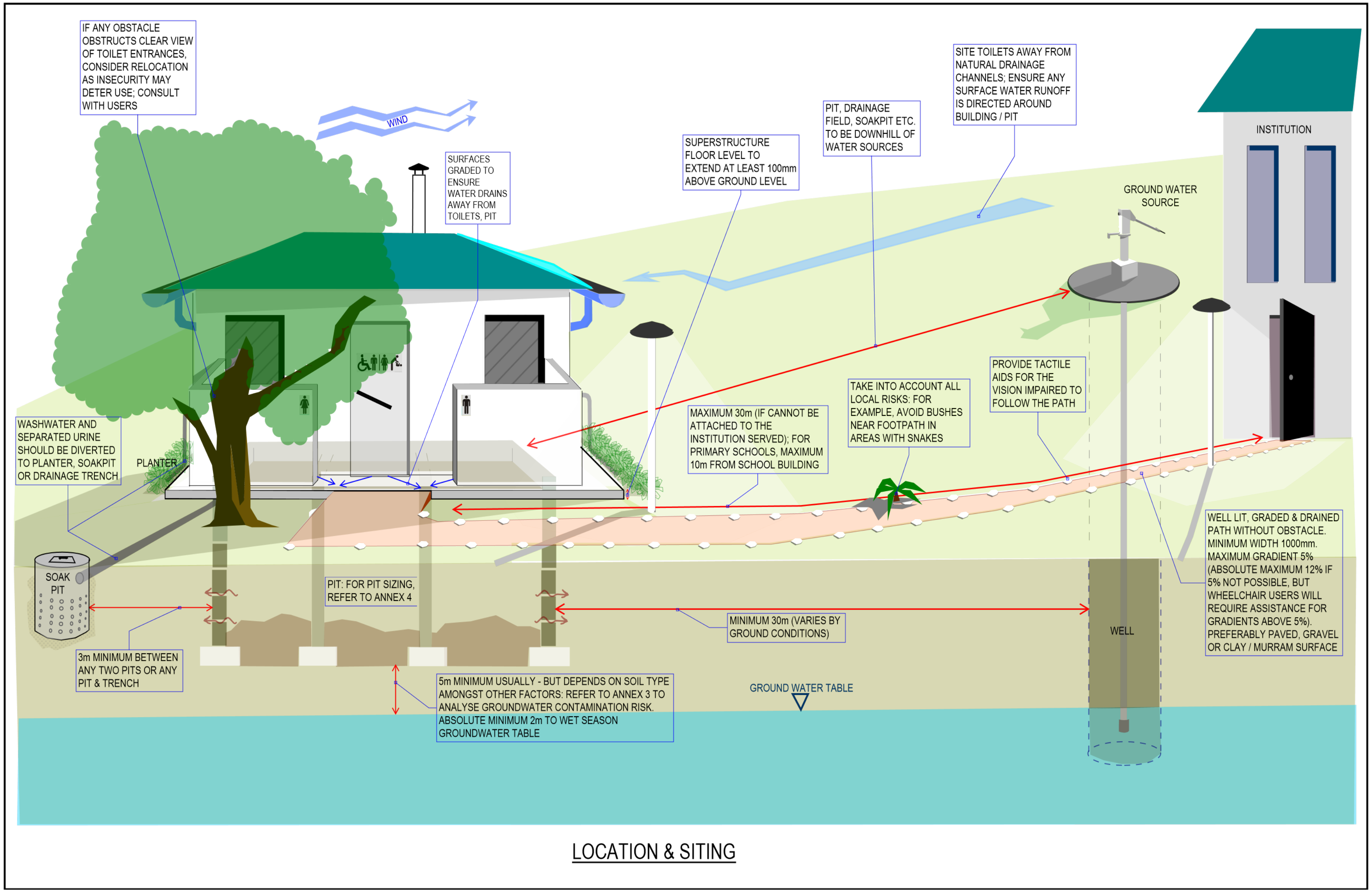
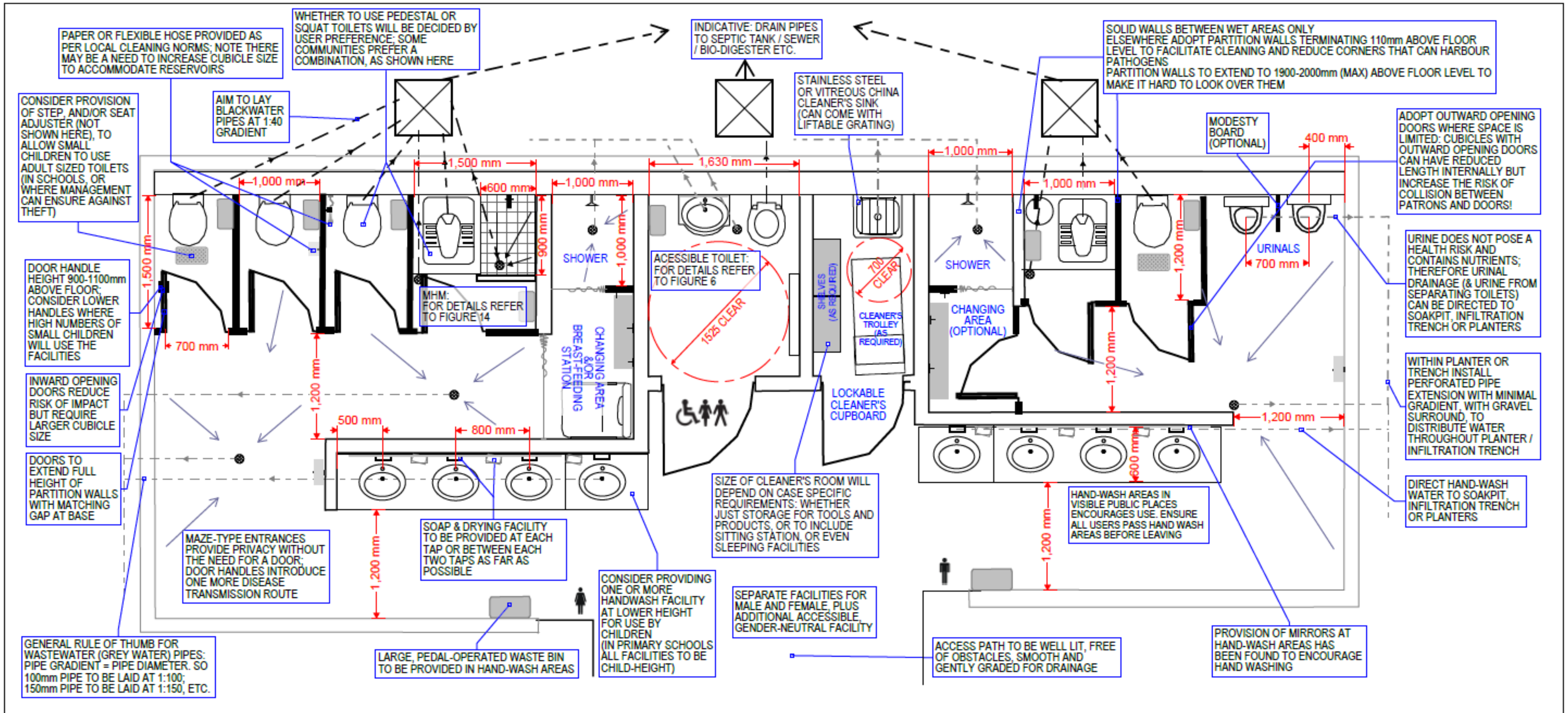


Figure 5: Site layout



LEGEND

- SOLID WALL (CAN BE STRUCTURAL)
- PARTITION WALL (NOT STRUCTURAL)
- GREY (& URINAL) WATER DRAIN PIPE WITH FLOW DIRECTION
- BLACK WATER DRAIN PIPE WITH FLOW DIRECTION
- WASTE BIN
- SOAP DISPENSER
- HAND-WASH POINT
- HAND DRYING MATERIALS
- OPTIONAL: SINGLE SHARED TOILET PAPER DISPENSER
- SHOWER CURTAIN (OR DOOR, CONSULT ON USER PREFERENCE)
- TAP & BUCKET PROVIDED AS APPROPRIATE
- ALL SURFACE FINISHES TO FALL TOWARDS DRAIN POINTS
- DRAIN POINT
- INSPECTION CHAMBER (PIT WITH SEALABLE COVER TO BE PROVIDED AT PIPE JUNCTIONS)
- BENCH WITH WALL-MOUNTED HOOKS ABOVE (OPTIONAL)
- STEP PROVIDED FOR USE BY SMALL CHILDREN (OPTIONAL)
- FLEXIBLE HOSE/SHOWER FOR WATER WASHING (ANAL CLEANSING)

NOTES

1. THIS LAYOUT IS ONE OF A LARGE NUMBER OF POSSIBILITIES, PROVIDED TO HIGHLIGHT KEY GUIDELINES
2. ALL DIMENSIONS IN MILLIMETRES; DIMENSIONS SHOWN HERE ARE RECOMMENDED MINIMUMS - INCREASE AS SPACE ALLOWS
3. NOTE THERE ARE 2:1 FEMALE TO MALE CUBICLES, AS IN ANNEX 1
4. NOTE THERE IS ONE HANDWASH FACILITY FOR EVERY TOILET FACILITY, AS IN ANNEX 1
5. FOR SCHOOLS THERE SHOULD BE SEPARATE MALE AND FEMALE ACCESSIBLE FACILITIES
6. THE TOILET FACILITIES SHOWN HERE ARE WATER FLUSHED; IF WATER FOR WASHING OR FLUSHING IS NOT AVAILABLE, ALL TOILET FACILITIES INDICATED ABOVE TO BE REPLACED WITH SIMPLE SLAB OR PEDESTALS DIRECTLY ABOVE A PIT; VIP LATRINES OR UDDT FACILITIES SHOULD BE CONSIDERED. PIPES WOULD THEN BE ONLY FOR DRAIN POINTS AND URINALS
7. DRAIN PIPES ARE SHOWN (INDICATIVE ONLY) HERE BUT WATER SUPPLY PIPES, POWER SUPPLY AND OTHER UTILITIES ARE NOT
8. STRUCTURAL WALLS EXTEND ALL THE WAY FROM FLOOR TO CEILING
9. ALL CUBICLE DOORS TO LOCK INTERNALLY. ONLY CLEANER'S ROOM DOOR AND EXTERNAL DOORS, IF ANY, TO LOCK FROM THE OUTSIDE
10. ALL ITEMS, INCLUDING BINS, SOAPS, DRYING TOWELS ETC., TO BE THEFT AND VANDAL RESISTANT AS FAR AS PRACTICAL
11. IN SELECTING FACILITY MATERIALS, CONSIDER LONGEVITY - OFTEN PREFERRED MATERIALS MAY BE MORE FRAGILE

3.2 Accessible toilet design

In addition to the general layout shown in Figure 5, there are also some additional design considerations for accessible toilets, which include bathing areas,[9] in Figures 6 and 7.[10]

Figure 6: Accessible toilet layout

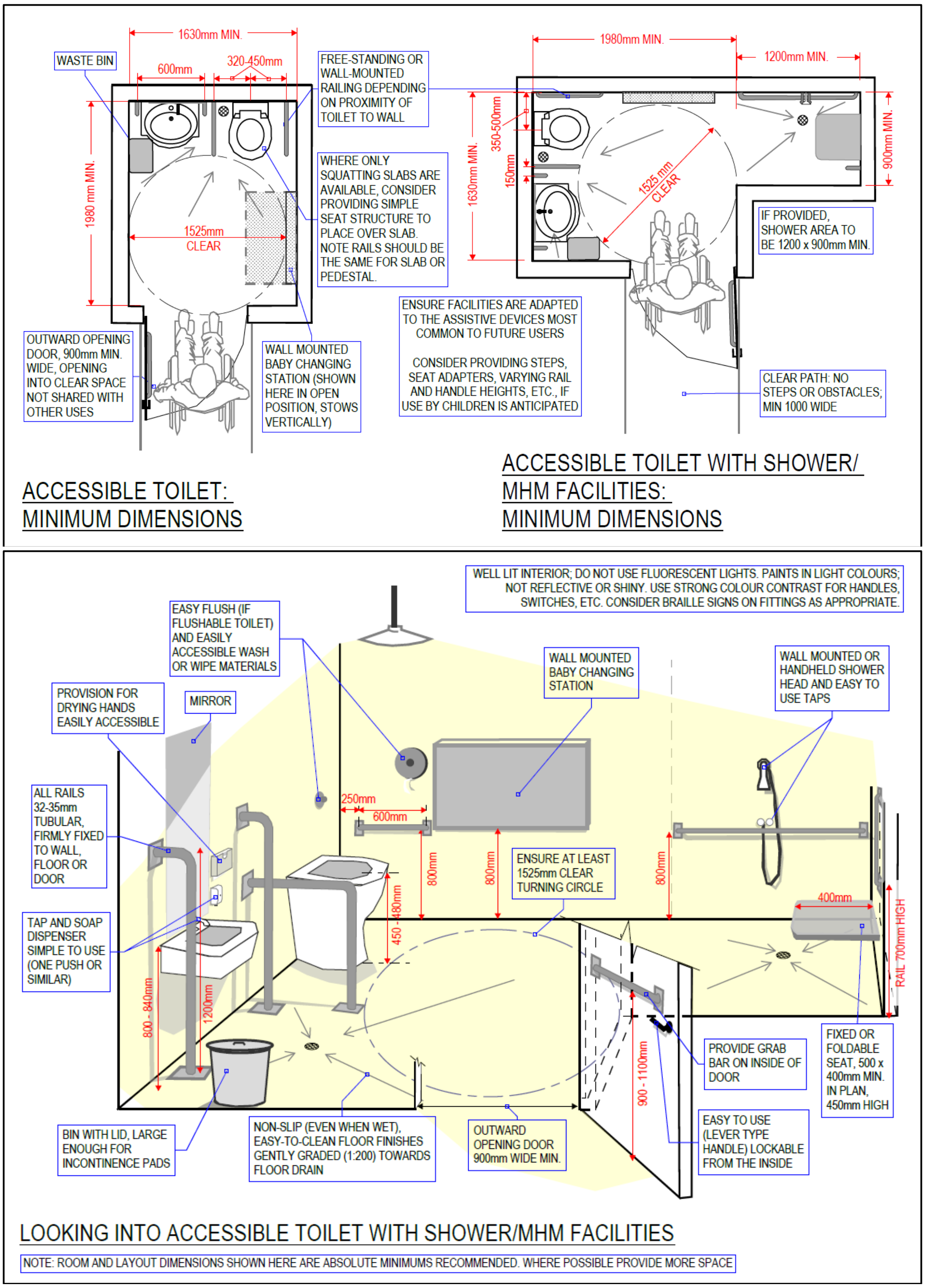
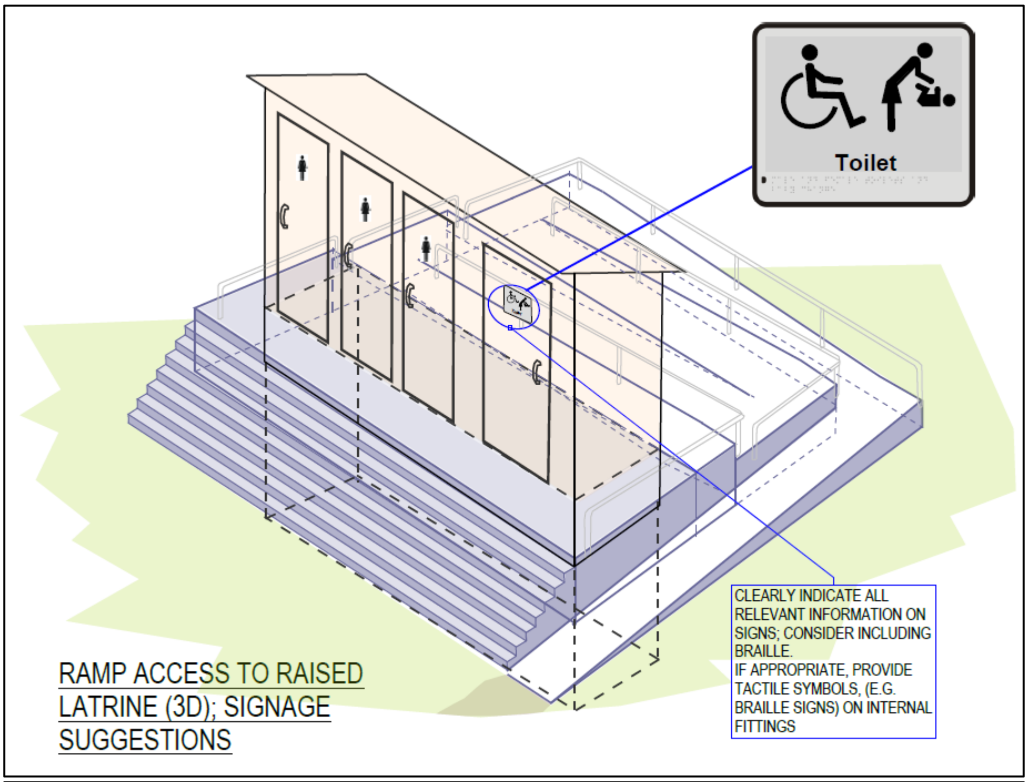
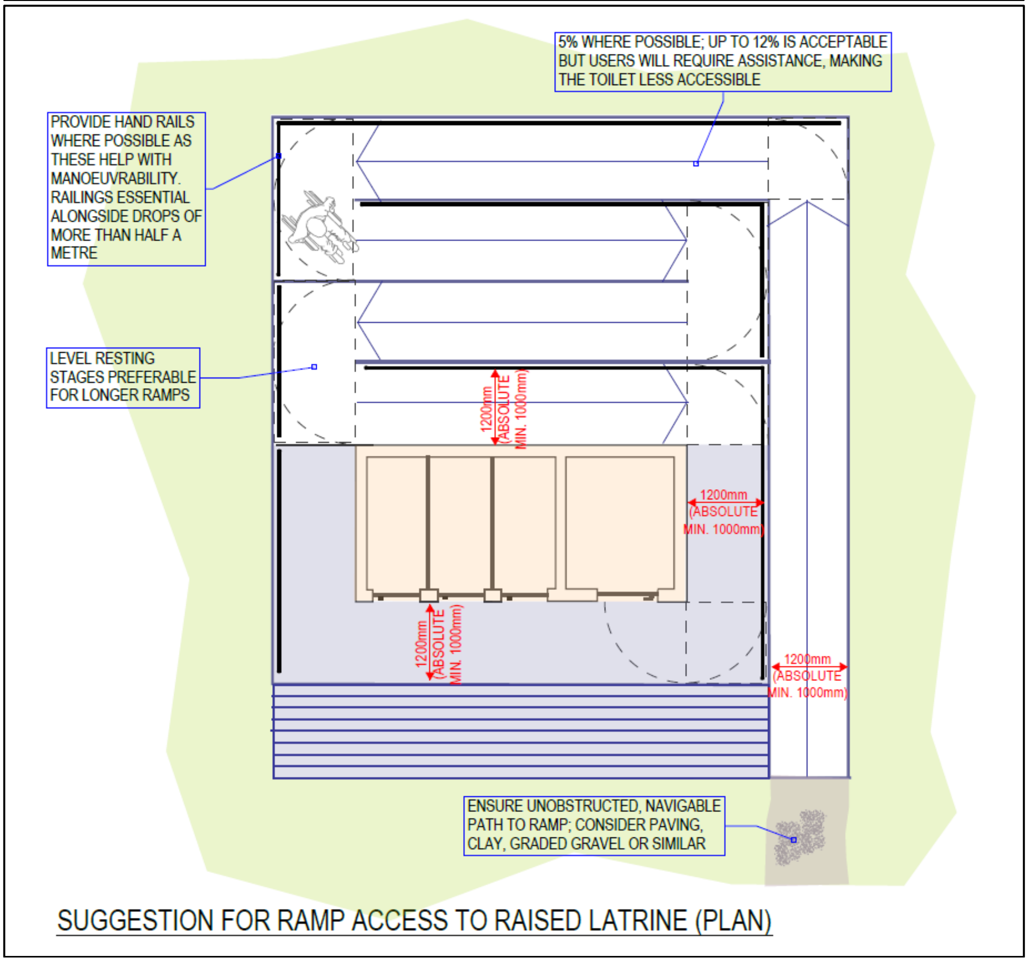


Figure 7 : Accessible toilet ramp access

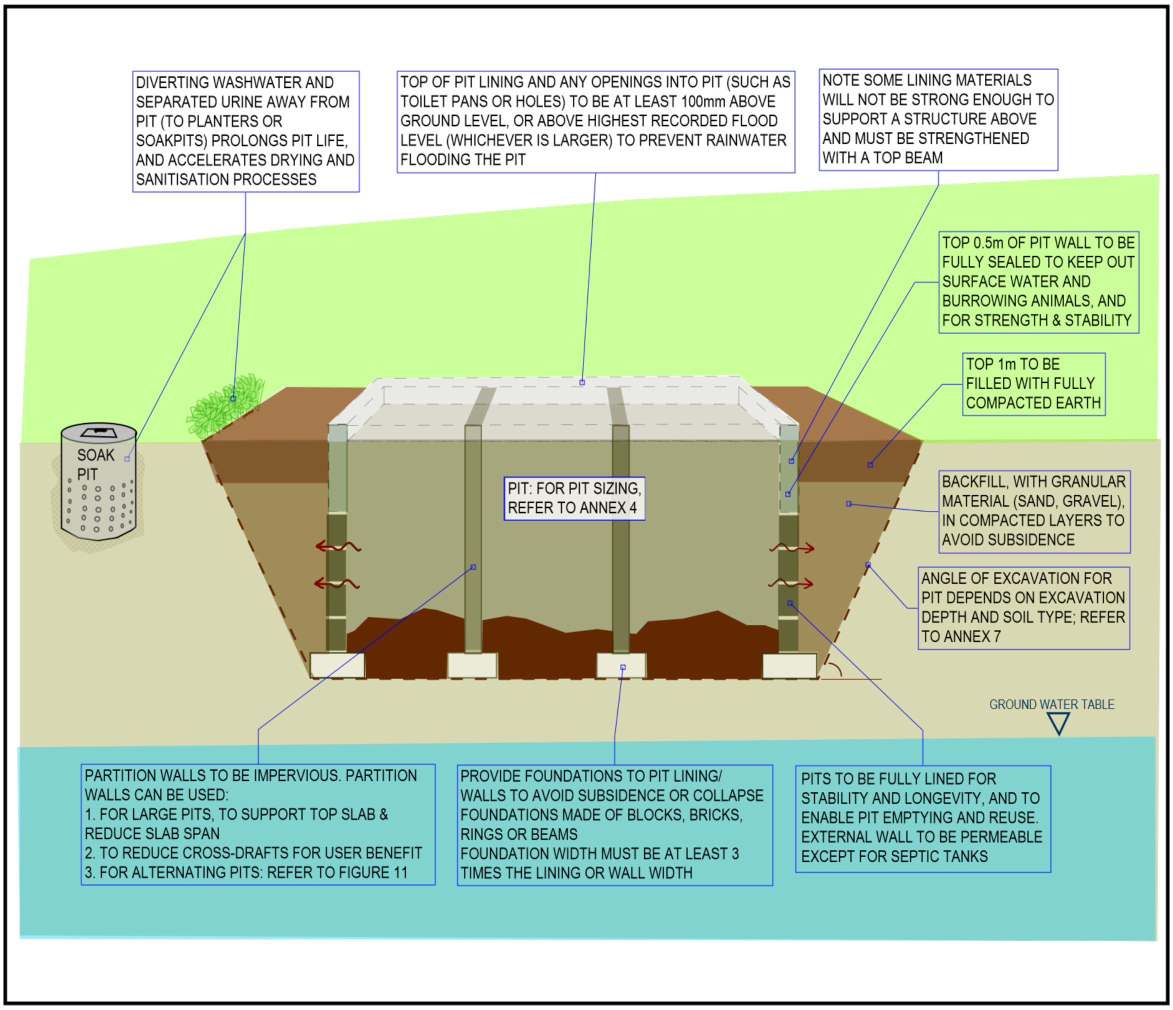




3.3 Toilet pit design

There are some key aspects to consider in the design of a toilet pit. These are largely related to maintaining the structural integrity of the pit and include the type of lining, infiltration potential, and minimising surface water ingress (see Figure 8).

Figure 8: Toilet pit design



There are many different lining materials and methods that can be used for toilet pits. Usually we want a permeable lining material that allows moisture to leach out from the pit, but also allows moisture to come in if needed (for example, where the water table rises, to avoid the lining floating). Exceptions to this are:-

- for the top 0.5m of lining below ground level, which should always be sealed to prevent surface water ingress[11]
- where a sealed tank is required (for example, a sealed cesspit designed to protect groundwater, or a septic tank which is designed to hold wastewater)

Note that where a sealed tank is installed, a vent pipe is essential – for other pits it is optional (but if installed it must have a fly screen).

Other criteria that will narrow down the lining options available:

- For those pits that are designed to be emptied, the lining needs to be robust (so that it will not be affected by the emptying process), as well as long-lasting (for economic reasons). This means some lining options will probably not be appropriate (for example, oil drums or iron sheets that are prone to corrosion, wood or bamboo that will rot, sandbags that will probably degrade over time).
- Pit size is important for toilets with a high number of expected users – so linings which limit pit size might be less appropriate.

Technical note:
On-site sanitation pit options can be categorised as leach pits, septic tanks or cesspits. Leach pits are the most common type, where liquids leach into the ground from the (permeable) pit directly. Septic tanks, by contrast, are watertight tanks that do not allow leaching – wastewater percolates into the ground through a separate soakaway system. Cesspits do not allow any infiltration of liquids, either direct from the pit or via a soakaway (and therefore need more frequent emptying).

3.4 Toilet pit sizing

Part of toilet pit design is knowing how deep the pit should be – this will depend on several parameters that affect sludge volume, plus the extra 0.5m depth needed to allow for backfilling (see Figure 9). A formula[12] for the total volume, V(m^3) that you need to dig from ground level is:

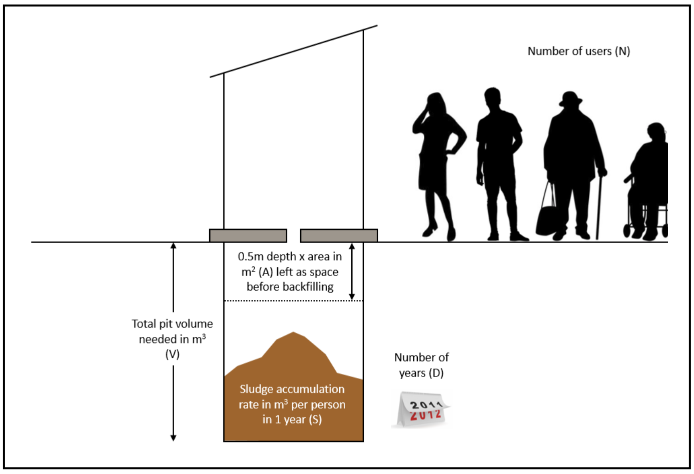
$$V = N \times S \times D + (0.5 \times A)$$

where:

N = number of users
S = sludge accumulation rate in m^3/person/year
D = design life in years
A = pit area in m^2

Note that this is for the volume of sludge (interior dimension of pit), so if you are lining it you will need to dig wider to allow for this.

Figure 9: Pit volume required



If you want to know what pit depth you need for a certain number of users and design lifespan, it might be easier to calculate the depth required for the sludge volume first, and then add the top 0.5m after. A method for this is shown in Annex 3, including an Excel calculation tool you can use.

This calculation method can be used in different ways – for example:
- While deeper pits last longer, sometimes you may need to limit the pit depth because of health and safety considerations for the construction team – particularly in unstable soils. In this case, you can modify one of the parameters to see the impact (for example, reduce the number of users, reduce the interval between emptying, or widen the pit area).
- In rocky ground or areas with a high water table where you might not be able to dig down, the depth calculation will still be valid, but you may have to construct some of that depth above ground.

However, in some circumstances this design procedure alone will not be enough to check that pits will last as long as envisaged. This is typically where other waste is likely to be added to the pit – for example, menstrual hygiene materials, plastic bottles (where water is brought in for anal cleansing), or other rubbish. For institutional toilets, check if the institution has a solid waste management strategy.

Where you find something might be a problem, you should plan how to mitigate it (for example, by increasing pit volume, through education, or in health centres constructing separate pits for medical waste and placentas).

3.5 Septic tank design

Septic tanks are used in conjunction with flushing toilets and tend to be useful especially where there is a lot of other wastewater produced (for example, water from laundry) or a high groundwater table. They are also sometimes required before connection to a mains sewer, to reduce the risk of blockage.

The design logic of a septic tank is to retain wastes within a watertight holding tank for a period of time – wastewater remains in this tank between one and three days, during which time partial treatment of the wastes occurs. Wastewater that then exits the tank has a lower (but still very significant) pathogen load, and therefore subsequently needs to be infiltrated into the ground through an infiltration trench or soakpit (or, where available, wastewater can be discharged into a sewerage system). Solids build up within the tank as a sludge that must be periodically emptied (and safely treated or disposed of offsite). Depending on the specific circumstances, this period can be anything from six months to ten years or more.

To function properly, a septic tank must be well designed. Examples of potential problems are:
- If the wastewater entering the tank has been underestimated or the tank has been undersized, the retention time will reduce, meaning treatment effectiveness will reduce.
- In high groundwater areas, if the tank is lighter than the groundwater it displaces, it might float.

- If an infiltration trench or soakaway pit is not included in the design, effluent from the septic tank will discharge directly to the ground or a surface water channel, creating a public health risk. This might also happen with a badly designed infiltration trench that may not be able to soak away all the wastewater. So, do not ignore the infiltration mechanism in your design.

Key aspects of septic tank and infiltration trench design are shown in Figures 10 and 11. Also a detailed design procedure is given in Annex 4, including an Excel calculation tool you can use.

Figure 10: Septic tank design

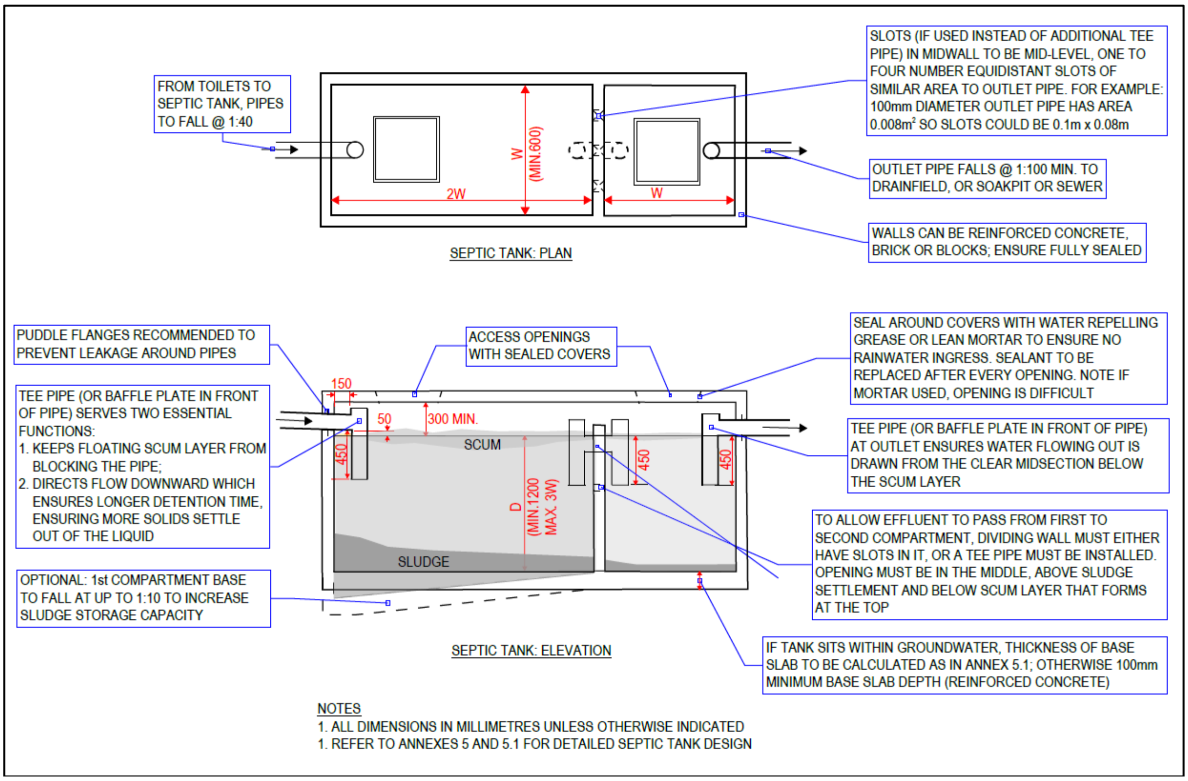
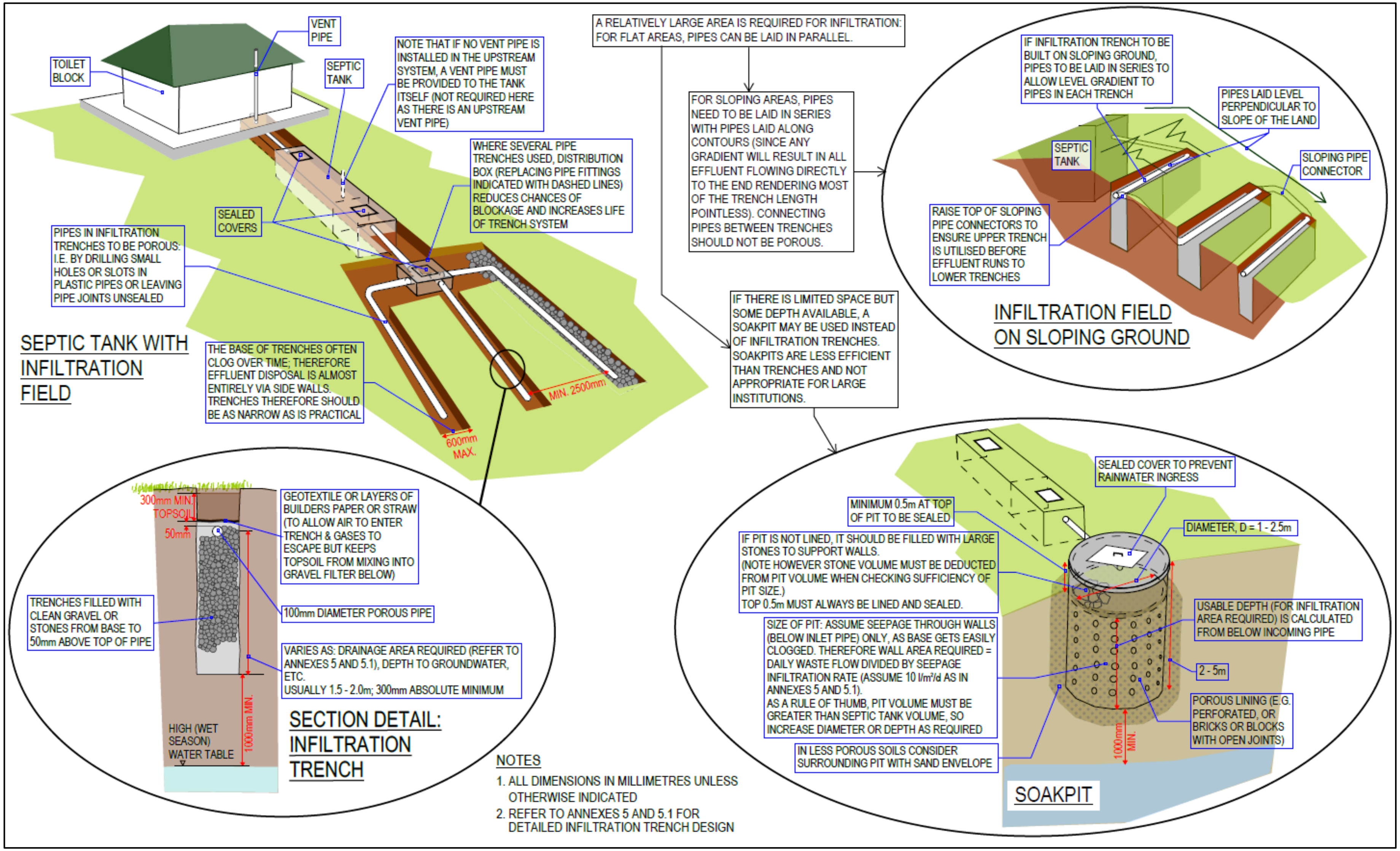


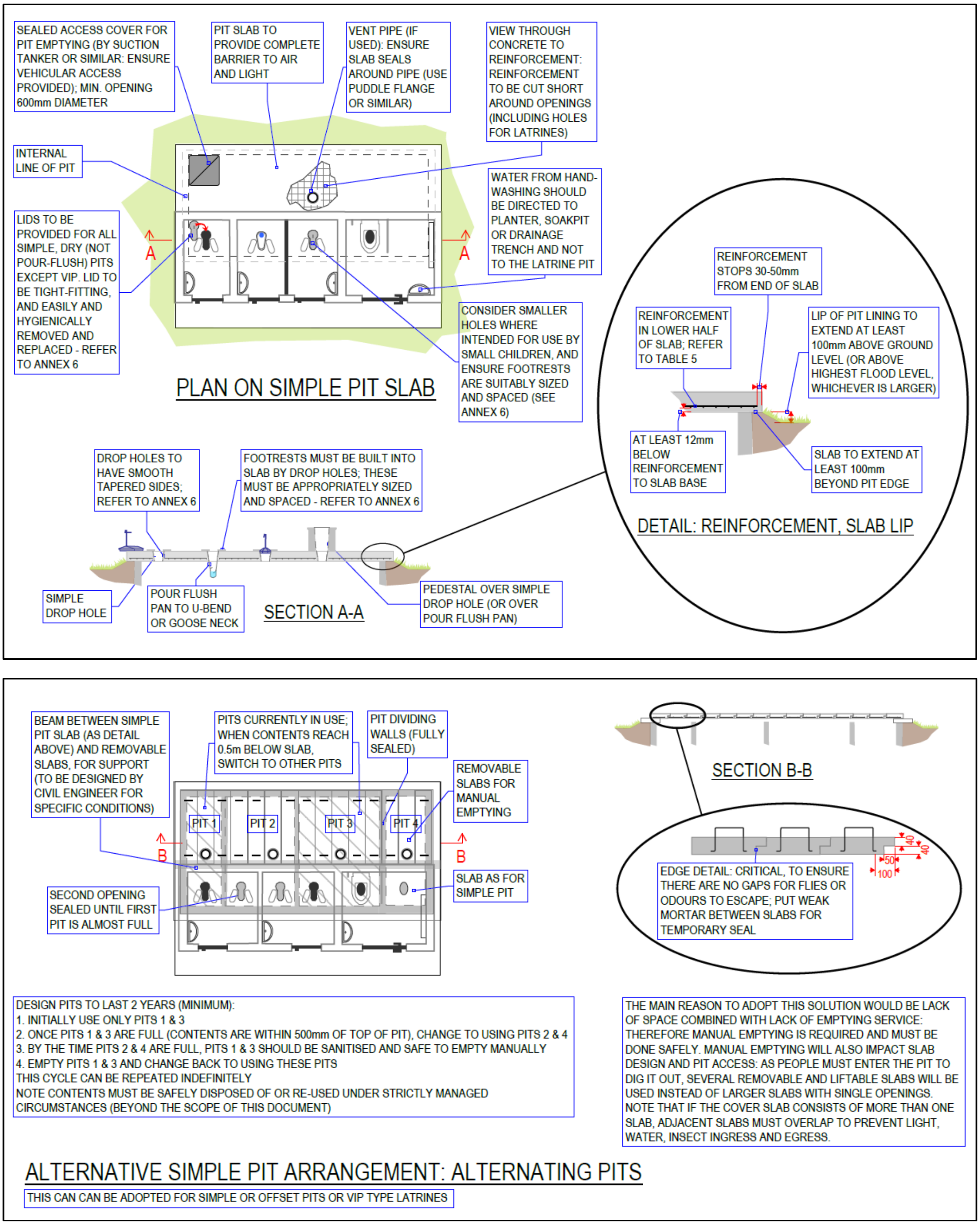
Figure 11: Infiltration field design



3.6 Cover slab design

The design of the cover slab is critical, so that slabs that span over a pit are structurally sound while allowing for emptying where required (see Figures 12 and 13).

Figure 12: Slab reinforcement, footrests and drop-holes



For reinforced concrete slabs (that is, any that will span over a pit), there are some important things to keep in mind for the design and construction:[13]

- There should be a rebar specification to follow according to the slab span, rebar thickness and slab thickness (see Table 5). For spans over 2m, you need to ask a civil engineer for advice. For reference, the size and spacing of steel in Table 5 has been calculated for grade 20 concrete and mild steel reinforcement, with characteristic yield stress of 210N/mm², or high-yield mesh, yield stress 485N/mm².
- Reinforcement bars should be placed within the lower part of the slab, with at least 12mm cover beneath each bar.
- Bars should be laid in both directions. Where the slab is rectangular, the bars that are parallel to the direction of the minimum span should be beneath the bars in the direction of the longer span.

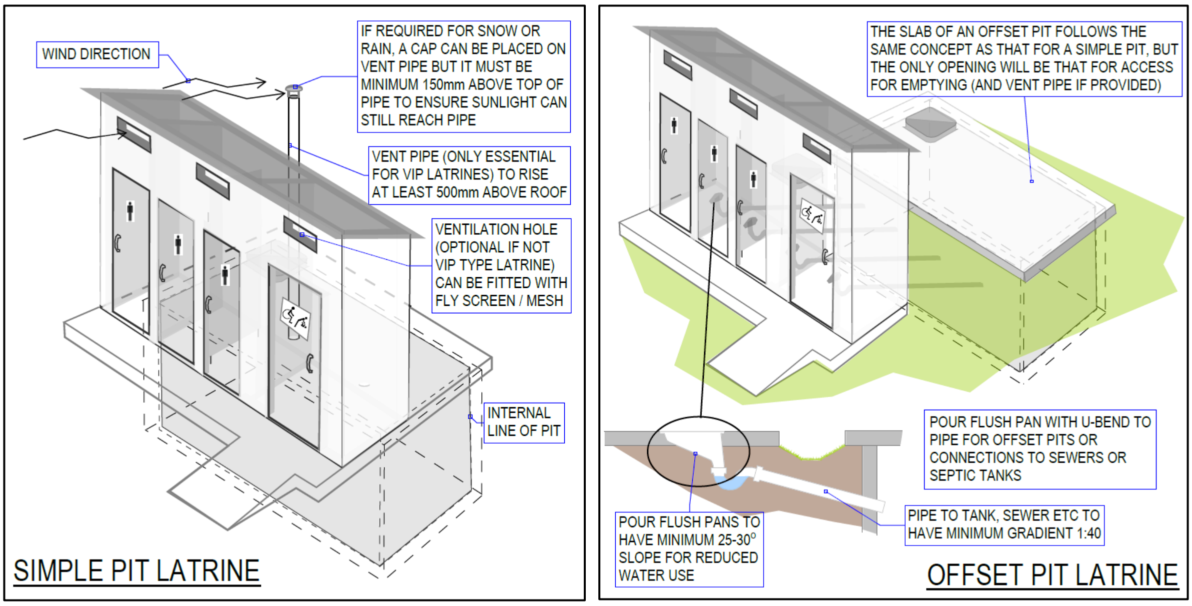
Table 5: Rebar spacing for slabs

Slab thickness	Rebar mm	Slab spans				
		1m	1.25m	1.5m	1.75m	2m
65mm	6	150	150	125	75	50
	8	250	250	200	150	125
80mm	6	150	150	150	125	75
	8	250	250	250	200	150

The design of the drop-hole and footrests is important for squatting toilets. For schools with children under eight years old, the size of the drop-hole might need to be reduced. Slabs should also have footrests built into the design – this helps keep the slab cleaner as it gives people a point of reference when squatting (especially for those who are visually impaired). A drop-hole and footrest design is given in Annex 5. For off-set (pour-flush) toilets, a pre-manufactured ceramic toilet pan is normally set into the concrete floor.

It is critical that a barrier is provided to prevent flies entering the pit – this is normally through a water seal (for offset pits) or a removable lid (for direct pits), or through a VIP design.

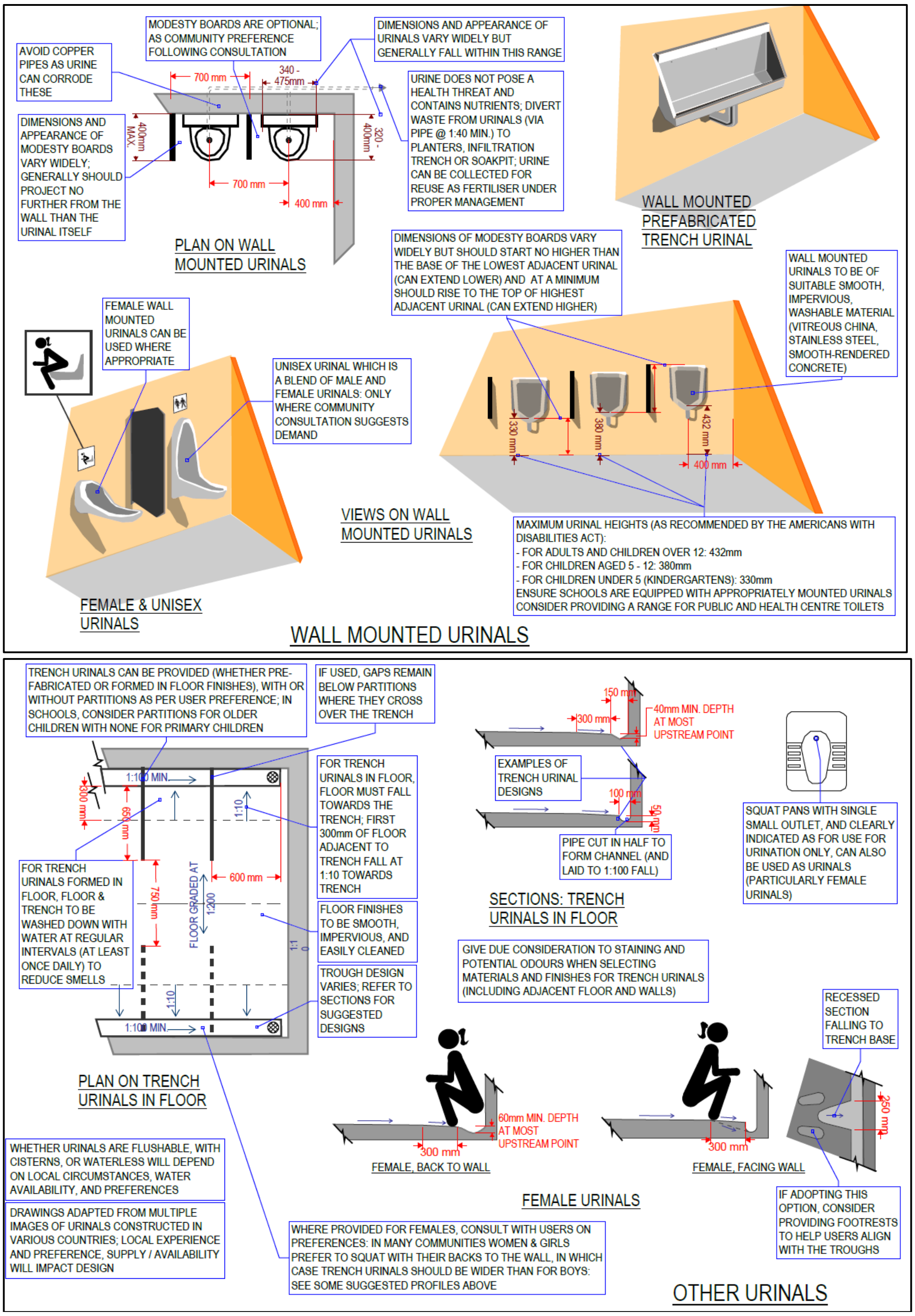
Figure 13: Slab design for simple vs offset pits



3.7 Urinal design

Urinals are usually included in male toilets, but they are possible for female toilets as well. The key aspects to the design of both wall-mounted and trench urinals are shown in Figure 14 (note, in some cultures, squatting urinals may also be preferred for males).

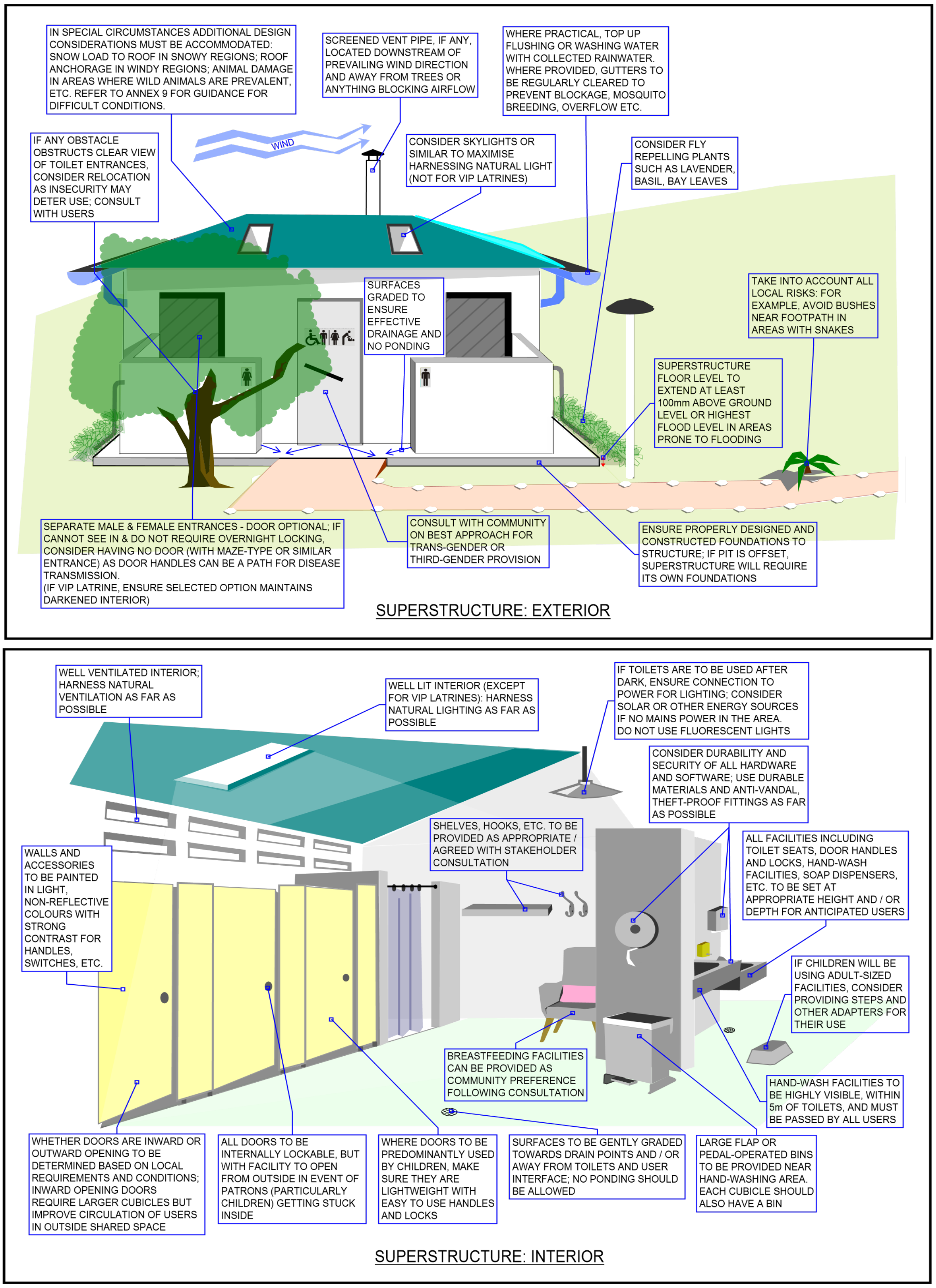
Figure 14: Urinal design



3.8 Superstructure

Key elements to consider for the design of the building, are summarised in Figure 15.

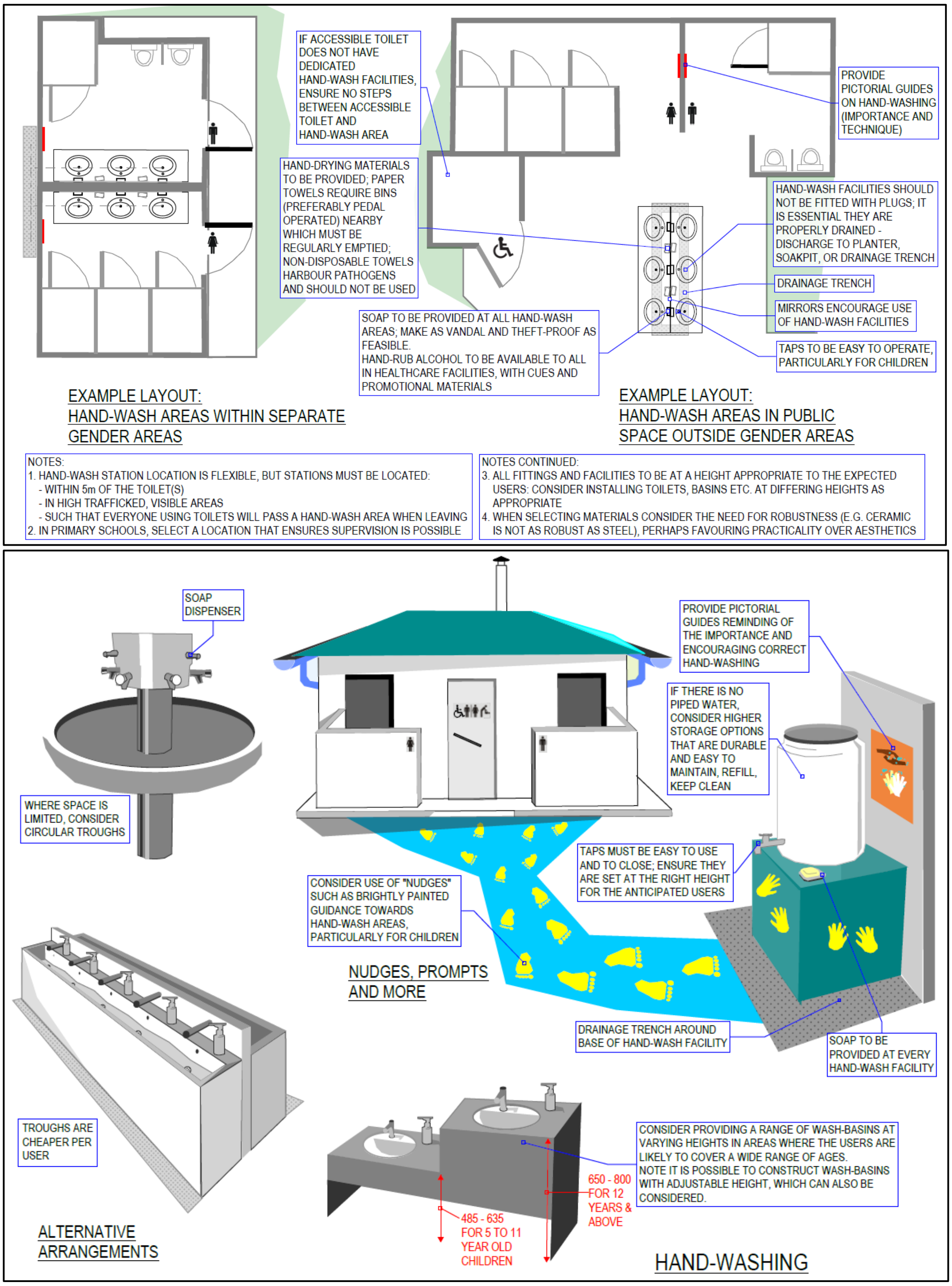
Figure 15 : Superstructure design



3.9 Handwashing

Handwashing stations are an essential part of toilet design in order to reduce disease transmission. While this requires behavioural change as well, good design can contribute to increased levels of handwashing. Key aspects are shown in Figure 16.

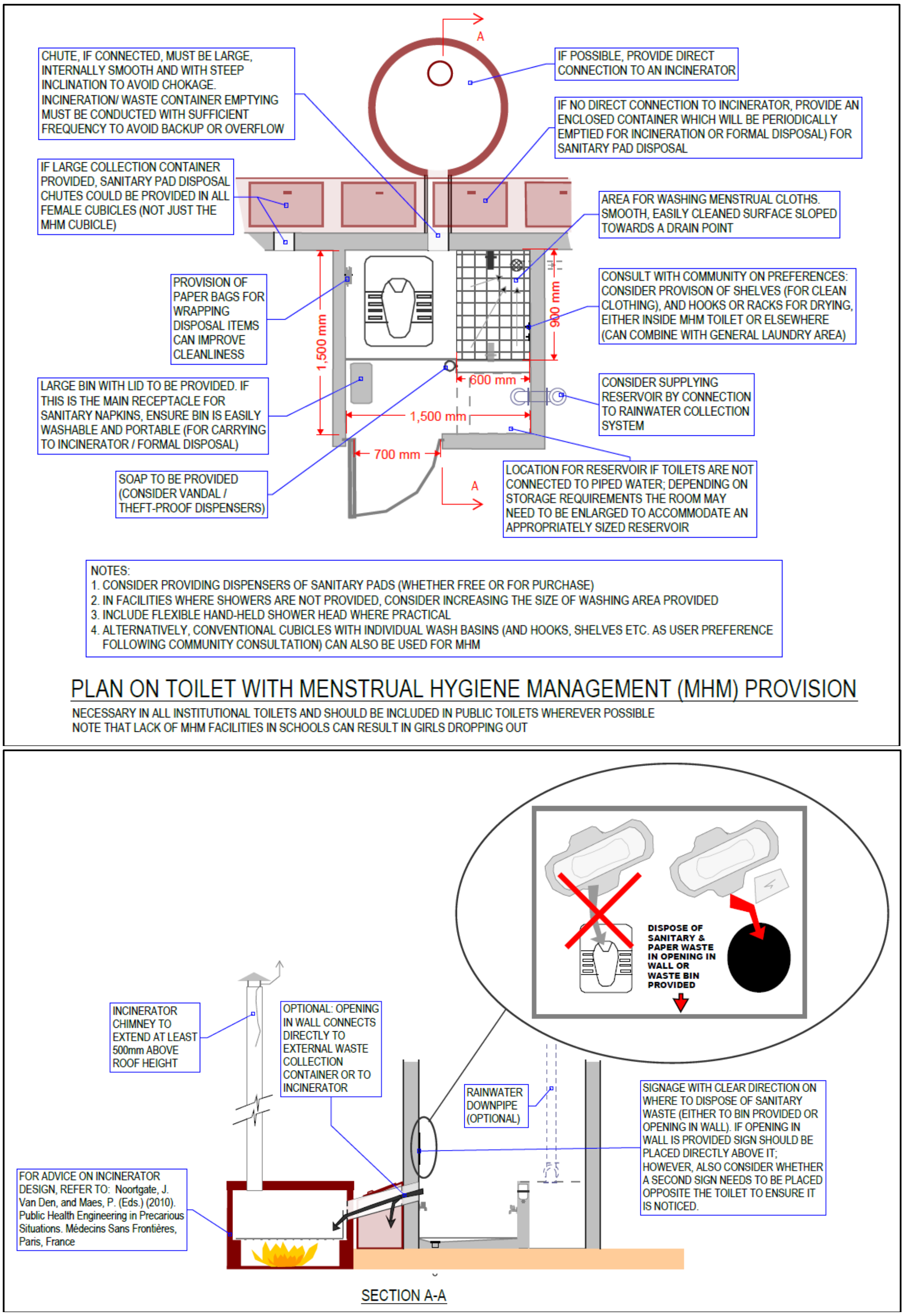
Figure 16: Design of handwashing stations



3.10 Menstrual hygiene management (MHM) facilities

Areas for MHM are needed for all institutions. Important design aspects are shown in Figure 17.

Figure 17: MHM design



MHM facilities are often combined with accessible toilets (as in Figure 6), but equally they can also be part of a standard design for women's toilets (see Figure 5). Key design aspects of an MHM facility include:

- clean space to change menstrual materials (this could be inside the toilet cubicle as long as it is clean, light and provides enough space for changing)
- soap and water in a private space (preferably inside the cubicle) so women can wash their hands and body if needed after changing materials, and wash reusable materials
- Disposal facilities for used menstrual materials, such as a covered, washable bin (including appropriate collection/final disposal mechanism) or incinerator

For incinerators, check national standards – in some countries, incinerators are not allowed in schools (for example, by health or environmental policy). What is important with incineration is also to know what materials are being burnt, what volume, and whether there are any taboos around burning materials soaked with menstrual blood (similarly depositing them in bins).

3.11 Bathing and laundry facilities

Bathing areas need to also be designed. There a few aspects to keep in mind here:

- These should be standard in institutions such as healthcare facilities and schools:
    - In healthcare facilities, the bathing areas should be as close to where care is being given as possible and should be available both to patients and carers, as well as staff.
    - In schools, showers and changing facilities for children should be separate from those used by staff.
- For public toilet blocks, it is not essential to install showers, yet where these can be provided they can give an additional service for which there is often high demand, particularly in areas with homeless people/street sleepers, households without facilities, or in transport hubs.
- Where hot water is not available and is preferred, water might be heated by solar thermal (for example, on the toilet block roof and stored in insulated tanks to minimise heat loss).
- Design the slab to be non-slip (for example, using matt-finish tiles or concrete that is not too smooth). Slabs should drain wastewater so that there is no standing water.
- Don't forget that a few wall-mounted aids can be very useful for users, for example:
    - a self-draining soap holder
    - a towel rail or hook, and clothes hooks/rails
    - a vertical mirror

Laundry areas should also be provided in all institutions wherever possible. For healthcare centres specifically:[14]

- The area required for a laundry facility in healthcare facilities should be about $0.1m^2$ for every 0.45kg of daily pressed laundry that is processed.
- There should be separate dirty and clean areas so there is no cross contamination of laundry.
- The space available is divided for different uses, probably along these approximate proportions: 50% for equipment, 20% for storing dirty laundry, 10% for storing clean laundry, 20% for support areas (hot water tanks, boilers, janitor storage).
- The laundry areas should have handwashing facilities. A good place to locate these is between the dirty and clean laundry areas.
- Surfaces should be smooth and easily to clean.
- Drainage will be needed in the drying area, where items might be dripping.
- Workers sorting dirty laundry should have adequate personal protective equipment (for example, gloves that are thick enough to minimise sharps injuries, and overalls).
- Where machines are used, damp laundry should not be left in them overnight.
- A temperature of at least 71°C for a minimum of 25 minutes is commonly recommended for hot water washing. However, this means the laundry takes a large percentage of the health centre’s hot water demand, so cold water washing (at 25°C) is also possible if the cycling of the washer, the wash detergent, and the amount of laundry additive are carefully monitored and controlled. Ironing also helps to reduce microbial activity.
- Consider good lighting, which is needed for workers to spot issues with laundry. Maximise natural daylight where possible to reduce energy costs associated with lighting.

4 Construction

At a glance: Summary of things to consider at construction stage
• What is the plan for supervision? Who will do it? How often? At what critical stages? (This includes not only the WaterAid/ partner staff, but also how often the contractor's supervisor is on site.) • Is what is being built the same as the design? • Is excavation work being done safely? • What is the quality of concrete like given what happens on site (materials used, ratios, mixing, pouring, finish, curing)? • How is water being drained during construction, and what is the plan for permanent site drainage?

Supervision at the construction stage is essential. You cannot rely solely on contracts, emails or paperwork to ensure that what is actually produced on site by a contractor is of good quality. Therefore, **designers and project managers must get on site at critical stages**, to ensure that all aspects of the design are being considered. This can be done through both announced visits and unannounced spot checks – the latter can be a good way to check things like safety of excavation, concrete ratios used, mixing, curing and casting.

A checklist of practical aspects related to construction on site is given in Table 6,[15] with further details on things to watch out for with concrete quality available in Annex 6. You should check that the contractor has WaterAid's policy on Health and Safety within construction projects, and has read and understands it.

Table 6: Checklist for construction on site

Does the construction match the design? **It is essential to have a good level of supervision of what happens on site, in order to check what was designed is being built, and to check the quality of construction.**
☐ Has the structure been set out according to the design drawings? ☐ Is the quality of material and fittings what was specified?
Digging/excavation **Digging below ground has inherent risks that you need to be prepared for.**
☐ Are workers wearing protective clothing (hard hat, boots, construction harness)? ☐ Are good quality construction buckets being used (with handles that will not break)?

- ☐ Have you made sure that nothing can fall into the pit or make the walls collapse (e.g. loose items like tools, or heaps of excavated material near the sides of the trench which can cause the sides to collapse, or lack of a fence or marking)?
- ☐ Is there a rotation of diggers (every 30 minutes) to prevent fatigue, and is there a second worker on the surface when a digger is in the excavation?
- ☐ For deeper pits, is there some ventilation? Is there a possibility that gases can collect in the excavation? Note: NEVER allow any engine to off-gas fumes into the excavation (e.g. from a nearby generator, or from a suction motor pump if you want to de-water a hole) – these fumes can be lethal.
- ☐ Is there a way to extract a worker in distress? Note: ALWAYS have a second worker at the surface, equipped to help in event of an accident, when a worker is inside the pit. A chest construction harness can be worn by the digger, attached to a carabiner clip and rope – this can help in case of emergency to extract the digger if they become unconscious.
- ☐ For pits over 1.2 m depth, or in unstable ground, are precautions being taken (over-excavation, temporary supports, lining or caisson)? Note: for pits over 1.2 m depth, limit pit depth or stabilise walls depending on ground conditions:
    - In stable ground, pits up to 1.2m deep can be dug and then lined from the bottom up.
    - For unstable ground or deeper pits, you need to be more cautious. Options include:
        - over-excavate the hole, with the sides of the excavation sloped to prevent collapse (so narrower at bottom). The slope will depend on the soil type – refer to this table.[16]
        - add temporary supports to support the sides until the lining is in place (e.g.100x100mm horizontal wooden struts spanning pit width, which are used to separate horizontal frames that hold back vertical sections of wooden planks against the pit walls).[17]
        - use a lining that is installed before or during excavation (e.g. driven sheet piles or caisson).

Type of soil	Slope (x : y)
Solid rock, shale or cemented sand and gravels	0 : 1
Compact angular gravels	½ : 1
Recommended slope for average soils	1 : 1
Compact sharp sand	1½ : 1
Well-rounded loose sand	2 : 1

- ☐ Is the backfilling being done together with compaction in layers (to avoid future subsidence)?

Concrete quality

Concrete production methods need to result in strong concrete, which means increased longevity of the structure and reduced burden for maintenance and repairs.

☐ Is the correct amount of water being used when concrete is mixed?
☐ Is the gravel size a maximum of 20 mm?
☐ Are materials used clean and non-salty?
☐ Is the concrete mixed on a hard surface or on a soil surface?
☐ Is the correct ratio being used for the application?
☐ Are the materials being mixed well?
☐ Is there sufficient compaction when pouring concrete?
☐ Is the concrete being sufficiently cured? Is the curing period long enough, and is enough water being used regularly enough (especially in hot weather)? Is the concrete protected against the weather?
☐ Is the concrete finish fit for purpose (e.g. smooth for toilet slab, non-slip for shower slab, sloped to drain)?
☐ Does the drop-hole position look correct?

Site management

Good management of the site is needed during the construction process, and the longer-term need for drainage requires consideration.

☐ Has any provision been made to avoid surface water running into the excavation temporarily during construction? Note: during construction, we need to design temporary site drainage in the following situations:
- To avoid any surface water running into excavations or tanks (to avoid providing water that insects can breed in).
- When constructing a tank below groundwater level, you will need to dewater the excavation. In this case, digging a sump on one side of the excavation, that is deeper than the bottom of the tank foundation, will provide a place from which you can pump out groundwater. You will need to continue to pump the water during the time when the concrete is initially setting, which is typically up to eight hours.[18]

☐ Is it clear in the design where the wastewater is going to drain to? Note: structures we construct will use water for various purposes (e.g. cleaning, showers) and so they will have drains in the design. So, there should be a drainage design linking the structure to where the drains will feed into. But if there is no design, refer back to the design team.
☐ For the finished structure, do you know how water will drain around the site away from the structure? Note: you need to design ground site drainage around the structure that ensures the ground is efficiently drained indefinitely. This can be as simple as ensuring the floor is raised and that the ground falls away from facilities.
☐ Overall, is the site tidy, with adequate measures for safety and security?
☐ Has excavated material been transported to an agreed and appropriate location?

5 Construction contract

5.1 Writing a good contract

A comprehensive and clear contract is very important, otherwise you may have no legal basis to refer to if problems arise and ultimately this will affect the quality of construction and/or lead to expensive modifications later. Every contract will be specific for the job and context. Key questions to check against your own contract are:

- Are the drawings and specifications clear and comprehensive? You cannot expect a contractor to produce a good design, if the design is not good.
- Is the contract too long or overly wordy? The contract should state conditions and expectations in a clear, concise way.[19]
- Is the programme reasonable at this time of year (seasons, festivals), and will it allow fair working conditions and sensible working hours? For this you should really liaise with the contractor to check it is achievable.
- Can the contract be understood locally? It should be understandable in the local language – if it needs to be translated, ensure it has been properly checked that what has been translated is what was meant.
- Related to the points above, have you talked through all key points and expectations with the contractor before starting work?
- How does the contract stand in relation to local laws? Make it clear that where a contract is stricter than local laws, the contract has priority.
- Is it clear in the contract that there should be no child labour? The contractor needs to be made to understand this clearly – don't assume they will read the small print.
- Are your milestones clear? Each milestone must be separately approved. The contractor should provide the following as set out in the contract: site drawings, materials specifications, method statements (to include health and safety). **The contractor must not proceed with works until each milestone is signed off by the site supervisor.**
- Is the contract clear on completion and payment dates (by milestone), and also the defects liability period?
- Do you have a process for documenting any changes agreed during construction?
- What is your strategy in case health and safety procedures are not kept on site? A good idea is to have something in the contract where the supervisor can shut down works at any time if health and safety is deemed inadequate. This should continue until the situation is rectified and should be at no cost to the client.
- Have you included all local authority requirements and approvals in the programme? You need to ensure that construction does not proceed if approvals are outstanding.

5.2 Managing the contractor and other stakeholders

The site supervisor must understand exactly what is being constructed, and the rationale for it – this is so that they clearly understand any details they are not used to. This person must always be present during construction, or at least as much as pre-agreed in the contract.

Everything should be documented from start to finish – this includes making sure that meetings are minuted, submissions are signed off and recorded, the programme is monitored, tasks are signed off, and any changes are formally recorded and signed by all relevant parties.

But the success of a project will not only hinge on supervising the contractor but will also depend on other stakeholders. Here it is all about maintaining good communication and relations between all parties, including the client, contractor, local authorities, government officials, institution staff and local community. A couple of things that might help this include:

- scheduling intermittent public consultations, which will help keep communication open and provide an opportunity to resolve any disputes, answer questions, and respond to complaints
- encouraging the contractor in advance to employ members of the community to carry out manual labour, where this is used. This should boost local employment and engender a sense of participation and ownership, ensuring that the local community is on board. This is important since the relationship between the community and contractor can sometimes be a problem.

6 Operation and maintenance

This section provides checklists to refer to when handing over facilities to the institution and establishing appropriate management arrangements.[20] Note that for healthcare facilities, there are specific environmental cleaning protocols that will need to be followed according to the situation – these are outside the scope of this document. Also note that the responsibility for ongoing operation and maintenance, along with any financial burden (for example, costs associated with safe disposal of faecal sludge) should have been made clear during the pre-planning phase.

Table 7: Checklist for operation and maintenance

Repairs and ongoing operations and maintenance
☐ Ensure sufficient annual budget allocation for toilet operations (including cleaning), maintenance and repairs.
☐ Establish a solid waste disposal system for paper (if the used paper cannot be flushed) and sanitary materials.
☐ Have designated people responsible for cleaning the toilet areas (see toilet cleaning checklist).
☐ Allocate responsibility for other non-cleaning maintenance to certain staff within the institution. Periodically, they will need to monitor certain things and organise repairs or action where needed. Things to monitor include: - checking sludge levels in septic tanks or pits – emptying should be organised when tanks or pits are ¾ full - monitoring the desludging process – this can be messy, and supervision is needed so that any contaminated areas can be cleaned up afterwards - checking the state of insect mesh over vent pipes – these corrode over time - checking the state of concrete slabs – cracks or other problems might appear
☐ Establish a process for users reporting faults or hazards – and a target time for repairing faults (e.g. within a 48-hour period).
☐ Contact providers of desludging, transport and disposal for toilets that require emptying, to establish a relationship with the institution.
Anti-social behaviour (public toilets) **Unattended public toilets can be seen as threatening places, which puts people off using them and which in turn invites more antisocial activity for example, drug taking or dealing, vandalism, sexual activity, disorderly conduct, groups of men hanging around, and theft of things like soap, toilet paper and fittings. Some ideas to prevent this:**
☐ Employ paid attendants or cleaning staff who can play a role in deterring vandalism and inappropriate behaviour. Public toilets should ideally be attended

during opening hours in order to provide a safe space, as well as to keep up with all the cleaning tasks that are needed to make public toilets attractive to use. Where this is not possible, at least ensure very regular inspections so that the public is confident using them.

☐ Where there is evidence of drug taking, consider a sharps disposal box (for needles, syringes or lancets) to reduce the risk of injury from sharps that have been inappropriately disposed of, and ensure a system is in place to collect the sharps and dispose of them safely.

☐ Use materials that are resistant to graffiti where possible.

Toilet cleaning

☐ Have designated people responsible for cleaning the toilet areas and a procedure to inspect and maintain them during the day.

☐ Train toilet cleaning attendants to do the task required – training might include:
- how to clean and with what tools
- understanding cleaning equipment for toilet areas is not to be used in any other setting
- cleaning equipment is to be cleaned regularly in a designated cleaners' area (but never in a washbasin used for handwashing or food preparation)
- where to drain water
- safe use of chemicals if used
- protocols for disposing of different types of solid waste
- specific cleaning procedures following different spills (e.g. vomit, faeces, urine or blood)

☐ Provide a written/illustrated cleaning schedule for cleaning tasks, including what tasks are required, and what frequency is expected for undertaking each task. Tasks typically include:
- cleaning all toilet equipment at least twice a day
- cleaning washbasins at the start of each day
- cleaning items with frequent hand contact, such as flush handles, taps, doorknobs and waste bins at the start of each day
- filling handwashing containers
- replacing soap
- restocking anal cleansing materials
- restocking menstruation and incontinence materials where supplied
- disposing of different types of solid waste

☐ Implement a system to monitor the cleanliness of toilet areas such as regular checks. These checks could be recorded on a monitoring sheet. Any monitoring system must have a link to action for immediate cleaning if necessary.

☐ Consider an air freshener where appropriate to make toilets more pleasant to use – dried sprigs of lavender can work also to repel flies.

7 References

[1] WaterAid (2018) *Guidelines for sustainable and inclusive school WASH.*
[2] WaterAid, WSUP and UNICEF (2018) *Female-friendly public and community toilets: A guide for planners and decision makers*.
[3] All images except for biodigester (which is from Open University - www.open.edu/openlearncreate/mod/oucontent/view.php?id=80510&printable=1) are from: Franceys R, Pickford J and Reed R (1992) *A guide to the development of on-site sanitation.* WHO.
[4] For information on raised pits, see: Reed B (2014) *Pit latrines for special circumstances*. WEDC, Loughborough University, UK.
[5] For information about biodigester design, refer to:

- Ashley B, Chikwati F, John J et al (2011) *Biodigester toilet.*
- Tilley E, Ulrich L, Lüthi C et al (2014) *Compendium of sanitation systems and technologies.* 2nd revised edition. EAWAG, Dübendorf, Switzerland.

[6] Daudey L (2017) The cost of urban sanitation solutions: A literature review. *Journal of Water, Sanitation and Hygiene for Development* (2017) 8 (2): 176-195. Available at: https://iwaponline.com/washdev/article/8/2/176/39027/The-cost-of-urban-sanitation-solutions-a
[7] Bouman D, Holtslag H and Claasen F (2012) *WASH technology options for school facilities.* EMF, ARC, Aqua for All, The Netherlands.
[8] Bouman D, Holtslag H and Claasen F (2012) *WASH technology options for school facilities.* EMF, ARC, Aqua for All, The Netherlands .
[9] For more information on accessible design, see: Jones H and Wilbur J (2014) *Compendium of accessible WASH technologies.* WaterAid/WEDC, Loughborough University, UK.
[10] Dimensions in the accessible toilet drawings come from a variety of sources, including:

- Bobrick (2010) *Planning guide for accessible restrooms.* ADA Standards for Accessible Design. Bobrick, North Hollywood, USA.
- CBM (2008) *Promoting access to the Built Environment Guidelines*. CBM, Bensheim, Germany.
- Hall DJ (Ed) (2000) *Architectural graphic standards*. 10th Edition. The American Institute of Architects. Wiley.

[11] Reed RA and Shaw RJ (2008) *Sanitation for primary schools in Africa.* WEDC, Loughborough University, UK.
[12] Information from: Harvey P (2007) *Excreta disposal in emergencies: A field manual.* WEDC, Loughborough, UK.
[13] Franceys R, Pickford J and Reed R (1992) *A guide to the development of on-site sanitation.* WHO, Geneva, Switzerland.
[14] This information comes from the following sources:

- Woodson S (2007) Design and construction of a healthcare laundry. *NLM Journal*, vol 5, no 3.

- www.cdc.gov/infectioncontrol/guidelines/environmental/background/laundry.html

[15] Some information in this table came from: Meuli C, Wehrle H, Muller K et al (2000) *Building construction.* Series of manuals on drinking water supply. Volume 3. SKAT, St. Gallen, Switzerland.
[16] See www.engineeringtoolbox.com
[17] Further information in:
- Harvey P (2007) *Excreta disposal in emergencies: A field manual.* WEDC, Loughborough, UK. p127.
- Meuli C, Wehrle H, Muller K et al (2000) *Building construction.* Series of manuals on drinking water supply. Volume 3. SKAT, St. Gallen, Switzerland. pp26–27.

[18] Meuli C, Wehrle H, Muller K et al (2000) *Building construction.* Series of manuals on drinking water supply. Volume 3. SKAT, St. Gallen, Switzerland. p8.
[19] A good example of a simple one-page contract can be found in: WaterAid (2006) *Step by step implementation guidelines for public toilets*. WaterAid, Dhaka, Bangladesh.
[20] For more guidance, refer to: Toubkiss J (2010) *How to manage public toilets and showers.* CMS/pS-Eau.

A full annotated bibliography is also provided in Annex 10.