REPUBLIC OF NAMIBIA

MINISTRY OF AGRICULTURE, WATER AND FORESTRY

DEPARTMENT OF WATER AFFAIRS and FORESTRY

CODE OF PRACTICE: VOLUME 8

DRY SANITATION SYSTEMS

GENERAL GUIDELINES

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PREFACE

Sanitation plays a pivotal role in economic development of Namibia because increasing the coverage of improved sanitation facilities will contribute significantly to the health of the population which in turn drives the nation's economy. The Namibia National Sanitation Strategy for the 2010 to 2015 has been developed, setting out a course of actions and activities for the implementation of sanitation in a coordinated manner.

As this strategy was developed through a comprehensive consultation process with various partners and stakeholders, the previous uncoordinated approach to sanitation implementation experienced in the past has already improved through initiatives that have brought about a more uniform, consistent and higher quality approach. The major investment in sector capacity building and development that is needed to enhance the delivery of the implementation programme will in turn support the achievement of Vision 2030 and the WATSAN Millennium Development Goals.

A series of Sanitation Codes of Practice have been developed to give further guidance on the planning and implementation of alternative types of sanitation facilities. The additional Sanitation Codes of Practice have filled the gaps in the existing Water Supply and Sanitation Codes of Practice that have been developed over the past two years by the Directorate of Resource Management within the Department of Water Affairs and Forestry of the Ministry of Agriculture, Water and Forestry. The most updated list is given below:

Volume No.	Description	Originator*
1	Septic Tank Systems	DRM
2	Pond Systems	DRM
3	Biological Filtration Systems (Trickling Filters)	DRM
4	Biological Treatment Activated Sludge Processes	DRM
5	Bottled Water: Bottled Natural Waters; Processed Water; Mineral Water; Carbonated Water; Flavoured Water	DRM
6	Wastewater Reuse: Greywater, Reclaimed Domestic Effluent; Industrial Effluent	DRM
7	Disposal of Water and Wastewater Solids	DRM
8*	Dry Sanitation Systems	DWSSC
9*	Wet Sanitation Collection, Conveyance and Treatment Systems	DWSSC
10*	Re-use of Sanitation Waste Products	DWSSC

* - It is recommended that Codes of Practice 8 to 10 should be used together because of the close links between them all.

- DRM – Directorate of Resource Management
- DWSSC – Directorate of Water Supply and Sanitation Coordination

It is intended that the Codes of Practice will become obligatory for Ministries, Regional and Local Authorities, Communities, Private and Non-Government Organisations and Donors to follow to achieve the initiatives set out in the five year National Sanitation Strategy.

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DEFINITIONS

General:

Aerobic Treatment:	Treatment of wastewater with the help of micro-organisms that rely on oxygen;
Disposal:	Discharge, deposition or dumping of any liquid or solid waste onto land or water;
Dry Sanitation:	Disposal of human excreta without the use of water for flushing;
Excreta:	Faeces and urine;
Groundwater:	Any water resource found within the bedrock, below the surface of the ground;
Improved Sanitation Facilities	Defined according to the World Health Organisation Joint Monitoring Programme for WATSAN
Liner:	Layer of impenetrable material/sheeting placed in a waste collection pit to prevent infiltration of waste into the ground. May be made of building construction materials, synthetic materials, or a combination thereof;
Pathogens:	Micro-organisms such as bacteria, viruses and protozoa that cause disease;
Pit Latrine:	A form of sanitation facility with a pit for accumulation and decomposition of excreta from which liquid can infiltrate;
Sanitation Facilities:	Interventions (usually construction of facilities such as latrines) that improve the management of excreta and promote sanitary (healthy) conditions;
Soak Pit/Soak-Away:	A pit usually situated to receive effluent from a septic tank and designed so that the effluent slowly seeps into the ground through perforated sides and bottom;
Superstructure:	Screen or building enclosing latrine to provide privacy and protection for users;
Suction truck:	A vehicle used for sludge removal from septic tanks and lined latrine pits;
UDDT:	Urine Diversion Dry Toilet
Vent Pipe:	A pipe that facilitates the escape of gases and odours from a latrine or septic tank;
VIP:	Ventilated Improved Pit Latrine = dry latrine system with dark interior and screened vent pipe to reduce odour and fly nuisance;
VIDP:	Ventilated Improved Double Pit Latrine = dry latrine system identical to VIP, except with two collection pits;
Water Resource:	Includes a watercourse, an aquifer, the sea and meteoric water

1. INTRODUCTION

In Namibia, a significant number of people living in the rural communal areas still have no access to improved sanitation facilities and often have no other option but to practice open defecation. A situation report that was prepared as part of the development of a five-year National Strategy for Sanitation in Namibia (Italtrend, 2009) revealed that 67% of the population living in rural areas do not have access to improved sanitation and practice open defecation. Widespread evidence exists of the causal links between lack of safe sanitation and public health problems including diseases such as diarrhea, typhoid, giardiasis and cholera, amongst others. In addition, poor sanitation has a negative impact on the environment, in particular causing contamination of water sources particularly at times of flooding. Such contamination in turn increases the risk of disease for people who use this water untreated, especially in informal urban communities where population densities are high. With water availability in Namibia already limited, it is imperative that available water sources are protected and used wisely. It is thus important that the available water resources are managed and protected in such a way as to achieve sustainable water supplies for the future.

Possible risks and hazards related to poor sanitation and hygiene include:

- Water-borne diseases such as diarrhea and cholera, etc;
- Diseases caused by helminth eggs, bacterial spores, and/or protozoa infections;
- Aesthetic issues like odour pollution and attraction of flies, due to improper waste management;
- Environmental issues including groundwater contamination, endangering of marine life and pollution of water bodies used for recreational purposes;

To minimise the risks mentioned above, proper awareness about the dangers of poor sanitation must be communicated through community health promotion campaigns and improved household hygiene practices are encouraged. Access to hand washing facilities must be obligatory for all recommended dry sanitation system designs.

It is often believed that good sanitation is synonymous with water-borne (wet) sanitation. This is not the case and even highly developed countries with an abundance of fresh water such as Norway and Sweden are now increasingly implementing dry sanitation systems (Jenssen, 2005). However, effective sanitation should focus not only on infrastructure but also on human hygiene behaviour change through health promotion to ensure long-term improvement and protection of public health. Water-borne systems require large capital investment, a reliable supply of water and a high level of expertise for operation and maintenance.

Capital investment for water-borne collection, conveyance and treatment systems can range from N$ 30,000 to N$ 80,000 per household connection depending on circumstances compared with a range of N$ 3,000 to N$ 8,000 per household connection for dry sanitation facilities. In addition, community water-borne systems take a long time to implement and are often not the most suitable technology option offering a sustainable solution for either urban but more especially rural agricultural communities in Namibia. In the urban context, a combination of wet and upgradable dry sanitation technologies are often the most practical and economically sustainable solution for Namibian circumstances.

In addition to promoting access to acceptable sanitation facilities, the need to ensure that such facilities are durable, affordable and within the operation and maintenance capabilities of the local authorities is of utmost importance. In areas where water availability and/or resources for operation and maintenance are limited, various dry sanitation options can be considered to provide a viable solution for the provision of safe and effective sanitation. The use of such dry sanitation systems must provide a high level of human dignity, as well as prevent adverse effects on public health and the environment. Globally, awareness about the need to provide safe, healthy and affordable sanitation is increasing with initiatives such as the Water, Sanitation and Hygiene Programme funded by the Bill and Melinda Gates Foundation investing vast resources in the development of effective solutions to try to address global sanitation issues (Bill and Melinda Gates Foundation, 2011).

In order to provide guidance in good practice in Namibia, this code of practice addresses dry sanitation systems, with emphasis on advantages and disadvantages as well as applicability to different types of physical conditions. The purpose of this document is to provide comparative information about different types of dry sanitation so that the user can make educated decisions regarding the optimum choice of a system for alternative situations.

The code of practice only contains safe and effective dry sanitation options that are recommended for use by single households throughout Namibia. When deciding on the appropriate sanitation technology for a specific application, planners or decision makers are recommended to use the planning tool in Appendix A of this document. Note that this document only deals with improved dry sanitation facilities and dry sanitation systems that are not recommended are excluded from this document. Table 1 categorises sanitation systems into improved sanitation facilities and non-improved sanitation facilities (note that the table contains both dry and wet sanitation systems, whilst this document only discusses dry sanitation systems):

Table 1: Improved and Non-improved Sanitation Systems (MAWF National Sanitation Strategy, 2010)

Improved Sanitation Facilities	Non-Improved Sanitation Facilities
• Flush, pour flush to water-borne sewerage • Flush, pour-flush to conservancy/septic tanks • Flush, pour flush to pit latrine • VIP latrines and pit latrine with slab • Composting toilet	• Shared toilet (public and shared between households) • Bucket • Pit latrine without slab/open pit • Open defecation

The National Sanitation Strategy recommends that all sanitation systems should be designed to serve individual households with improved facilities and therefore this code of practice excludes dry sanitation facilities covering:

1. Communal toilets – not recommended for households and usually unhygienic.
2. Chemical toilets – expensive and often temporary.
3. Unimproved pit latrine – environmentally unacceptable and commonly susceptible to odour problems/insect infestation.
4. Bucket toilet system – socially, environmentally and hygienically unacceptable.

It is intended that in the future, a separate code of practice will be prepared for schools and clinics where it maybe necessary to use communal dry sanitation facilities in particular circumstances.

2. TECHNICAL REVIEW

2.1 System Selection

There are many different dry sanitation systems available on the market and buyers often base their choice of system only on factors such as cost and availability, whilst ignoring the appropriateness of the system for their specific conditions. This should, however, be the most important factor to be considered, since experience has shown that sanitation systems that work well under certain conditions do not necessarily function well at all under other conditions. Factors such as a high ground water table, potential for flooding and soil conditions should always play a major role in choosing the correct sanitation system. For example, in areas where there is a high risk of flooding, waste collection tanks or containers should be watertight (e.g. HDPE tanks, various local manufacturers) and built above ground to prevent contamination by storm water. When deciding on which system is most appropriate for certain physical conditions, community members or the prospective customers are encouraged to refer to the Sanitation Services Planning Tool for Rural and Urban Areas (DAWF, 2011), which will help the buyer to make an informed decision on the choice of system (see Appendix A).

2.2 Soil Infiltration

Systems such as pit latrines where the waste collection pit maybe unlined will cause liquid waste to infiltrate or percolate into the ground. Final disposal of effluent by means of soil percolation systems is not encouraged. It is recommended that all pits should be constructed incorporating a thick plastic liner or constructed from watertight materials. This is because only partial or no treatment of the collected waste is achieved before liquid starts to infiltrate into the soil. For example, ammonia nitrogen (major contaminant in urine) is not converted to nitrate and nitrite due to a lack of oxygen and therefore remains in the final effluent (see Code of Practice Volume 10: Re-use of Sanitation Waste Products (DAWF, 2011). This renders the effluent toxic, even for plants. Also, soil percolation systems often become clogged after a couple of years of use because the micro pores in the soil block up due to fine suspended solids or micro-organisms filling these pores over time.

Care must be taken to ensure that the final effluent does not surface again or that there is a risk that it infiltrates and contaminates an underground aquifer. The suitability of the soil for liquid waste infiltration must first be determined. The following section deals with tests to establish if the soil, that will contain the percolation system, is suitable for such a purpose. Further information on this topic can be obtained from Code of Practice Volume 1: Septic Tank Systems (DAWF, 2008).

2.2.1 Percolation Tests

There are no simple tests to accurately assess the suitability of a soil to absorb pit latrine effluent. Indications can be obtained by visual inspection of the soil, i.e. whether it has a sandy or clayey nature, or if a percolation test may be carried out.

The relative proportions of sand, silt and clay determine the texture of the soil and influence its absorptive capacity. The larger and more uniform the soil particles, the larger the pores and the faster the percolation rate. Yellow or reddish-brown soils generally indicate good absorptive properties while a dull grey or a mottled colour usually indicates unfavourable conditions for percolation systems. In a geological formation such as limestone or dolomite (typically in the Kartsfeld-Area around Grootfontein, Otavi, Outjo etc.) in which the formation of faults or channels is likely, the disposal of polluted effluent into the soil can easily lead to the liquid finding its way into fresh water aquifers or underground fossil bodies of water.

A percolation test is more reliable than a visual inspection. The length of time required for the test varies depending on the soil type, thus sufficient tests should be carried out in separate holes to assure that the results are valid. Percolation tests are performed as follows:

- A test hole of 300 mm diameter is excavated to the depth of the proposed sanitation sub-structure;
- Soak the surrounding ground by adding water to the hole for at least four hours;
- Allow the hole to drain and refill with 150 mm of water;
- Note the time taken for the water to seep away;
- Calculate the average time for the water to drop 10 mm – this is called the Percolation Time;
- From the percolation time an indication of the sidewall area to be provided in a percolation trench can be obtained from the following table (Table 2):

Table 2: Allowable rate of human waste application to percolation trench to determine sidewall area required (Water Institute of Southern Africa, 1998)

Percolation time (minutes/10 mm fall)	Rate of pit latrine effluent application to sidewall area of percolation trench (people/m² per day)*
1	85
2	55
4	30
10	20
24	10
more than 24	Soil unsuitable for percolation

* Unit indicates the number of people that produce human waste that can be percolated per square meter per day (based on 2 l/d combined urine and faeces produced per person).

Note: Trench bottom area should be neglected since it gets clogged very rapidly.

2.2.2 Infiltration Area

The final effluent from a pit latrine system should not reach a public watercourse, aquifer or accumulate on the surface where it could be accessible to humans, animals or even plants. Where the final effluent is to be used for gardening and/or limited agricultural application additional treatment needs to be provided e.g. in stabilisation ponds or advanced treatment systems.

Where only a limited area for percolation is available, the maximum daily discharge from a septic tank system into this area can be determined using percolation test figures as shown in Table 3.

Table 3: Allowable rate of human waste application to determine volume of effluent that can be discharged within a certain infiltration area (Drews, 1964)

Percolation rate (minutes/25 mm fall)	Maximum rate of effluent application to subsoil infiltration areas (people/m² per day)*
1 or less	85
5	55
10	30
15	25
30	15
60	10
more than 60	soil impermeable - unsuitable for percolation

* Unit indicates the effluent arising up to the total number of people shown that can be percolated per m² per day (based on 2 l/d combined urine and faeces produced per person).

2.3 Recommended Toilet Systems

There are many dry sanitation technologies on the market, but only four types are recommended, *viz*:

- Composting Toilets;
- Ventilated Improved Double Pit (VIDP) Latrines;
- Dehydrating Toilets;
- Urine Diversion Dry Toilets (UDDT).

The above systems will now be described in more detail, with the advantages and disadvantages given. For each system, the choice of toilet pedestal ("seat") depends on the preference of the users including children friendly or on the manufacturer's availability. Concrete pedestals will be more durable than plastic materials, but they might be more expensive to install and can become infected with human waste over time.

Other variations of these systems are given in Appendix B for the reader/designer/user to choose which systems to install. A self-built guide for individuals that wish to finance and build their own systems is also available from the Ministry of Agriculture, Water and Forestry.

2.3.1 Composting Toilet

2.3.1.1 System Description

Composting toilets generally operate using a managed form of aerobic digestion, whereby organic matter is decomposed by micro-organisms in the presence of oxygen (see Figure 1). This process occurs freely in nature and can be observed, for example, in forests where tree leaves and animal wastes are slowly converted to a stable soil-like material called humus.

The aerobic process itself generates very few objectionable odours and is thus well suited to composting toilet systems. The toilet systems are generally designed and built to maximise the speed of aerobic digestion and to minimise the odour production. Many composting toilet systems can reduce the volume of the human waste to 5 - 10 % of its original volume.

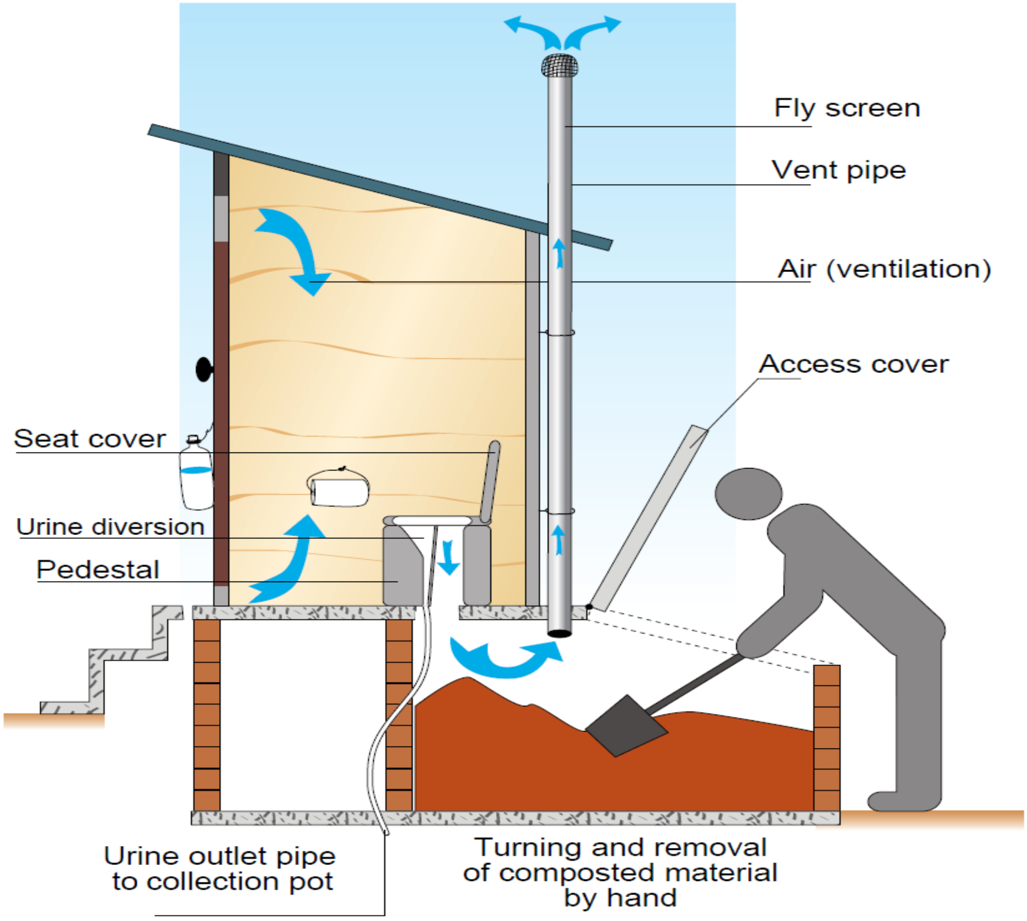

Figure 1: Composting Toilet System (National Sanitation Task Team, 2002)

In addition, most composting toilet systems can also accept kitchen waste, thereby reducing household waste while aiding the composting process. However, care should be taken to avoid non-decomposing materials such as plastics from being added to the disposal pit.

With aerobic digestion based toilet systems, the humus that is produced as an end-product of the process that can be beneficially used as a soil-additive for trees and non-edible plants. The humus contains large amounts of valuable nutrients that are required for plant growth. Human waste is thus dealt with in an environmentally-friendly, productive and sustainable manner.

Many composting toilet systems speed up the composting process by separating urine from solid faecal matter, which allows solids to dry much quicker and reduces objectionable odours. Also, separating urine from solid waste will make it much easier, more efficient by minimising residual waste and more hygienic to remove composted material from the collection chamber. Users of urine diversion toilets need to be properly informed about the correct use of the toilet as part of the community health hygiene promotion interventions. Incorrect use thereof can lead to blockages and significantly decreased performance of the drying process (see Section 2.4).

When choosing a composting toilet system, only those systems that either have two separate waste collection chambers (not illustrated on Figure 1) or those that have access to the collection chamber via an access cover should be considered. Single-chamber systems without an access cover are not recommended since mixing and removal of composted material can then not be achieved. Double-chamber systems do not necessarily have to have an access cover since the contents of one chamber can be left to dry out and compost while the other chamber is in use. It is again stressed, that a hand washing facility needs to be installed within the sanitation facility.

2.3.1.2 Advantages and Disadvantages

The advantages of composting toilet systems are as follows:

- Human waste is composted and can be reused beneficially as a soil additive for trees and non-edible plants;
- Human waste becomes a resource instead of a problem that needs to be treated or disposed of. Therefore, no treatment or disposal facilities are needed if waste is composted and reused. Transport of waste from the toilet system to a treatment disposal facility is therefore not required.
- Composting toilets do not need water for flushing and the compost produced does not contaminate water sources. Water, a scarce natural resource in Namibia, is therefore preserved;
- Many composting toilets can accept kitchen waste, thereby reducing household waste while aiding the composting process.

The disadvantages of composting toilet systems are as follows:

- Maintenance of composting toilets requires learning new practices that users might not be accustomed to. Ultimately, composting toilets require more responsibility by owners and users than conventional flush toilet systems. Most of the disadvantages of composting toilet systems are due to improper operation and maintenance and can be avoided if the system is used properly;
- If not properly maintained, cleaning of the toilet unit and removal of the end-product can be very unpleasant. Odour nuisance and health hazards are also associated with improper maintenance of these systems;
- Many composting toilet systems require the addition of some auxiliary material after each use to help with the composting process. Such material can include wood chips, kitchen waste or dry sand.
- Composting systems often require higher capital costs (see Appendix B). However, the elimination of costs for waste handling and collection will discount the capital costs over time.

2.3.1.3 Recommendations

Before purchasing composting toilet systems, users should ascertain whether the unit has sufficient capacity for its intended usage rate. Many systems are designed for use by only one or two persons whilst other designs can be chosen to accommodate up to 40 or more uses per day.

Due to the increased operation and maintenance responsibilities of many of these systems (e.g. wood chip addition or correct use of urine diversion toilet), it is recommended that these toilets should only be used in areas where the community are able and willing to use them correctly and where simple maintenance can be performed regularly.

The maintenance of a composting toilet system is relatively simple, with regular toilet cleaning and occasional compost removal being the only issues that need to be addressed. If the toilet is used correctly, the system has no significant disadvantages.

2.3.2 VIDP Latrine (Ventilated Improved Double Pit Latrine)

2.3.2.1 System Description

VIDP systems have been used successfully on a global scale in urban and peri-urban areas (see Figure 2). The toilet consists of two pits dug either mechanically or by hand above which the toilet hut is situated. A ventilation pipe that leads from the pit to above the roof of the hut allows odours to escape and minimises the attraction of flies. The ventilation pipe also allows air currents to flow through the pit, thereby allowing waste to dry quicker. The effectiveness of the pipe can be increased by painting it black. This will cause a temperature difference between the air in the pipe and its surroundings, which will lead to induced air currents. A fly screen at the top of the ventilation pipe will prevent flies and other insects from entering or exiting the pit. VIDP toilet systems generally require a concrete slab to be placed on top of the pits so that the hut structure has a solid foundation on which to stand on. The toilet itself can consist of a raised pedestal or a squat pan.

VIDP systems are very flexible and can be built with many different modifications and additions, according to the user's preferences and resource availability. For example, urine diversion toilets can be installed if re-use of urine is desired. Sanitation waste re-use is discussed in more detail in Code of Practice Volume 10 (DAWF, 2011). This would decrease the volume of waste entering the pit and would therefore extend the system's life before cleaning is required.

The VIDP system has two pits so that whilst one pit is in use, the contents of the other pit can dry and degrade to produce sanitised humus, which can then be re-used for composting purposes. Dry faeces can easily be identified as an odourless, flaky and soil-like material. A double-pit system will in effect function like a composting toilet (see Section 2.1). If there is no demand for re-use of waste products for composting purposes, the pit contents can be emptied and disposed of so that the pit can be used again. Alternatively, a full pit can be covered with earth and a new pit then dug. Hand-washing facilities should always form part of the system, irrespective of what other additions or modifications to the system are made.

2.3.2.2 Advantages and Disadvantages

The advantages of VIDP toilet systems are as follows:

- VIDP toilets do not need water for flushing. Water, a scarce natural resource in Namibia, is therefore preserved;
- VIDP toilets are simple to construct and can be built and repaired with locally available materials. Units do not have to be purchased pre-manufactured and can be assembled using cheap materials that are freely available at the envisaged site. Also, top structures can be constructed in such a way as to blend into the environment or to blend in with the local architecture;
- Capital and operation costs are relatively low. The only operating cost incurred with VIDP toilet systems is to empty the pit when full. The emptying process needs to be done mechanically and the waste transported to a suitable treatment or disposal site;

- VIDP latrines can be fitted with any type of user interface such as a raised pedestal or a squat pan and any form of anal cleansing can be used.

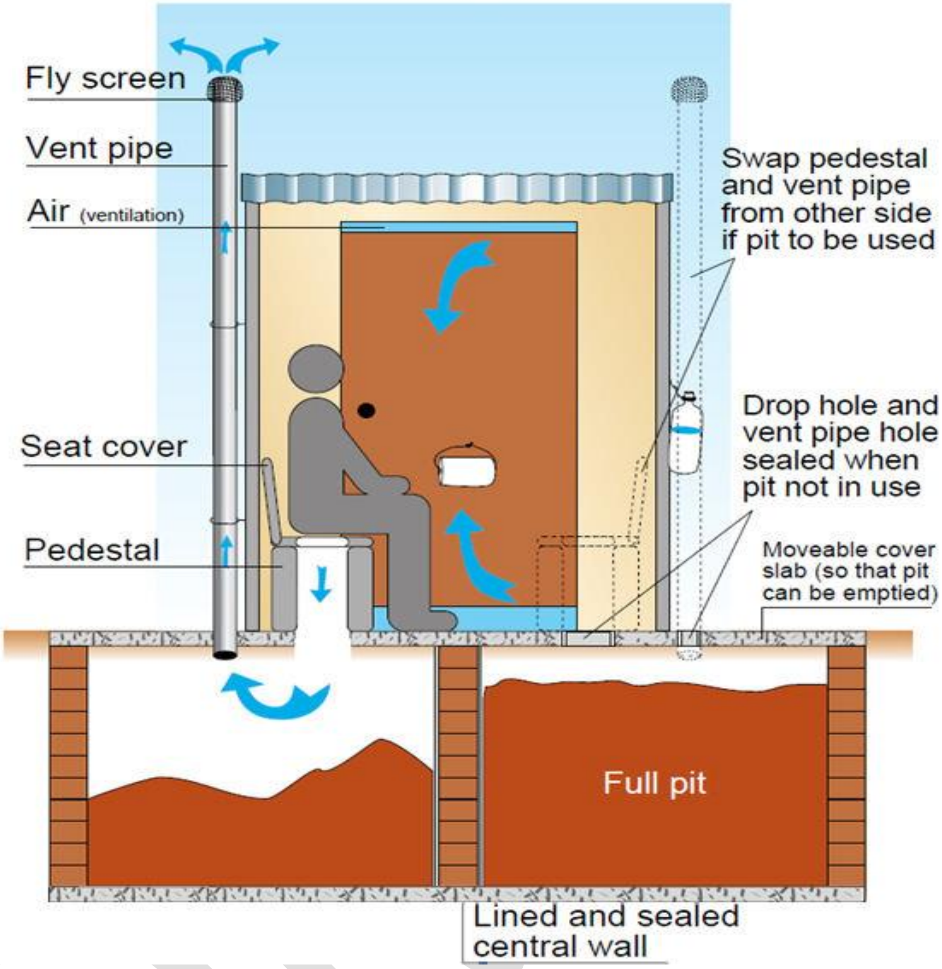

Figure 2: VIDP Latrine System (National Sanitation Task Team, 2002)

The disadvantages of VIDP toilet systems are as follows:

- The fact that waste is collected in the pit and accumulates over time means that the excreta pile will be visible when the toilet seat is lifted, except where a very deep pit is used;
- Unpleasant odours will normally be present to some degree, even where ventilation shafts are installed;
- In areas where flooding can occur or where shallow rock is present, the pit must be built above ground. This structure needs to be water tight and will be much more costly to build. Figure 3 shows such a system, where a watertight pit is built above ground. It is essential that the VIDP is always built above the maximum flood line.
- In areas where the water table is high or where water resource contamination might occur, the pit must be lined to prevent leakage into the ground.

2.3.2.3 Recommendations

It is highly recommended when installing a VIP, that wherever possible a double pit (VIDP) toilet system is designed. VIDP toilet systems are the most widely used dry sanitation system due to their simplicity. To save costs, households are encouraged to construct their own systems (or at least partially) with locally available materials as far as possible. When a pit is full it either needs to be emptied or another pit needs to be dug. Full pits can be left to dry out or can be used as a fertile site for the planting of a tree (ArborLoo concept).

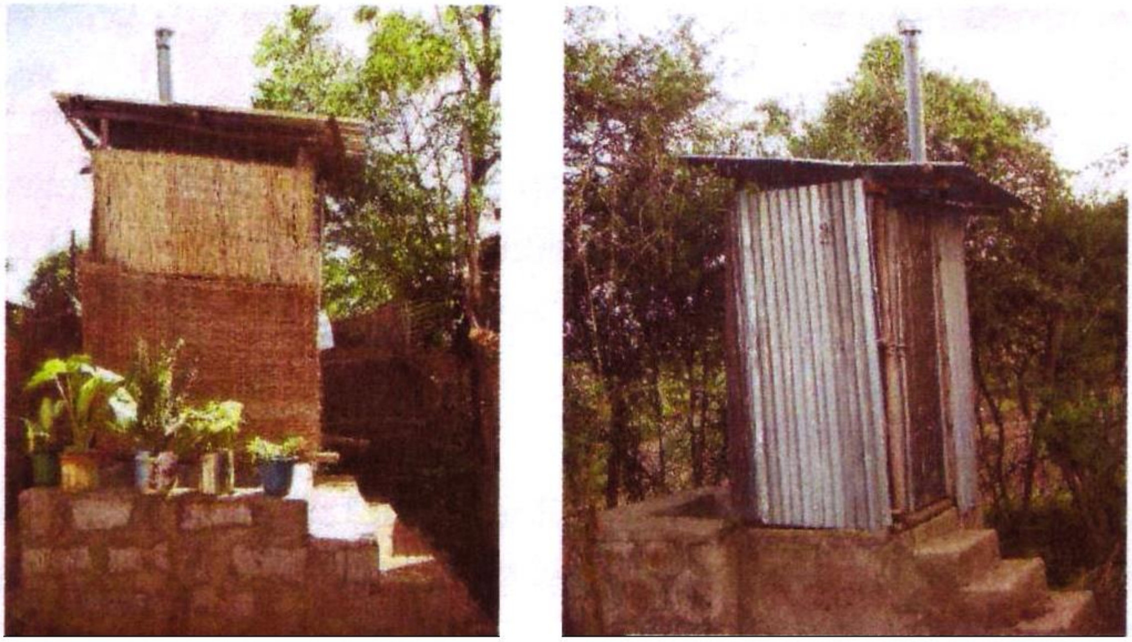

Figure 3: Fossa Alterna Toilets Above Ground (Stagl, 2010)

In areas where flooding or groundwater contamination can occur it is strongly recommended that the pit is lined and raised above the maximum flood line because it represents a large source of point pollution. The maintenance required on VIDP systems is very limited. The toilet pedestal or pan will need to be cleaned regularly, but the pit itself requires no maintenance until it is full. Toilet users may not need to receive much special training with regards to toilet use (unlike, for example with urine diversion toilets) and therefore improper use of the toilet will not have adverse effects on the system.

Hand-washing facilities should always form part of the system, irrespective of which other additions or modifications to the system are made.

Since a full pit can represent a large source of point pollution, care must be taken when siting the VIDP to ensure that it is above the maximum flood line.

2.3.3 Dehydrating Toilet

Dehydrating toilets are very similar to composting toilets (see Section 2.1); the only difference being the intended final use of the waste. For composting toilets (see Figure 4), waste is dried and composted with the help of materials like wood chips that keep the waste dry, thereby speeding up the composting process. The end product can then be used as a soil additive for composting purposes.

With dehydrating toilets, no additional additives are needed to speed up the composting process. The aim is merely to dry the solid waste, thereby reducing its volume. This means that a collection container of a given size can be used for longer than if the waste were not dried. Most dehydrating toilet systems make use of urine diversion toilets so that solid waste can dry quicker (see Section 2.4) and reduce the volume through the composting process.

The dehydration system will still function if urine and faeces are not separated, but the drying process will be significantly slower and will produce more unpleasant odours.

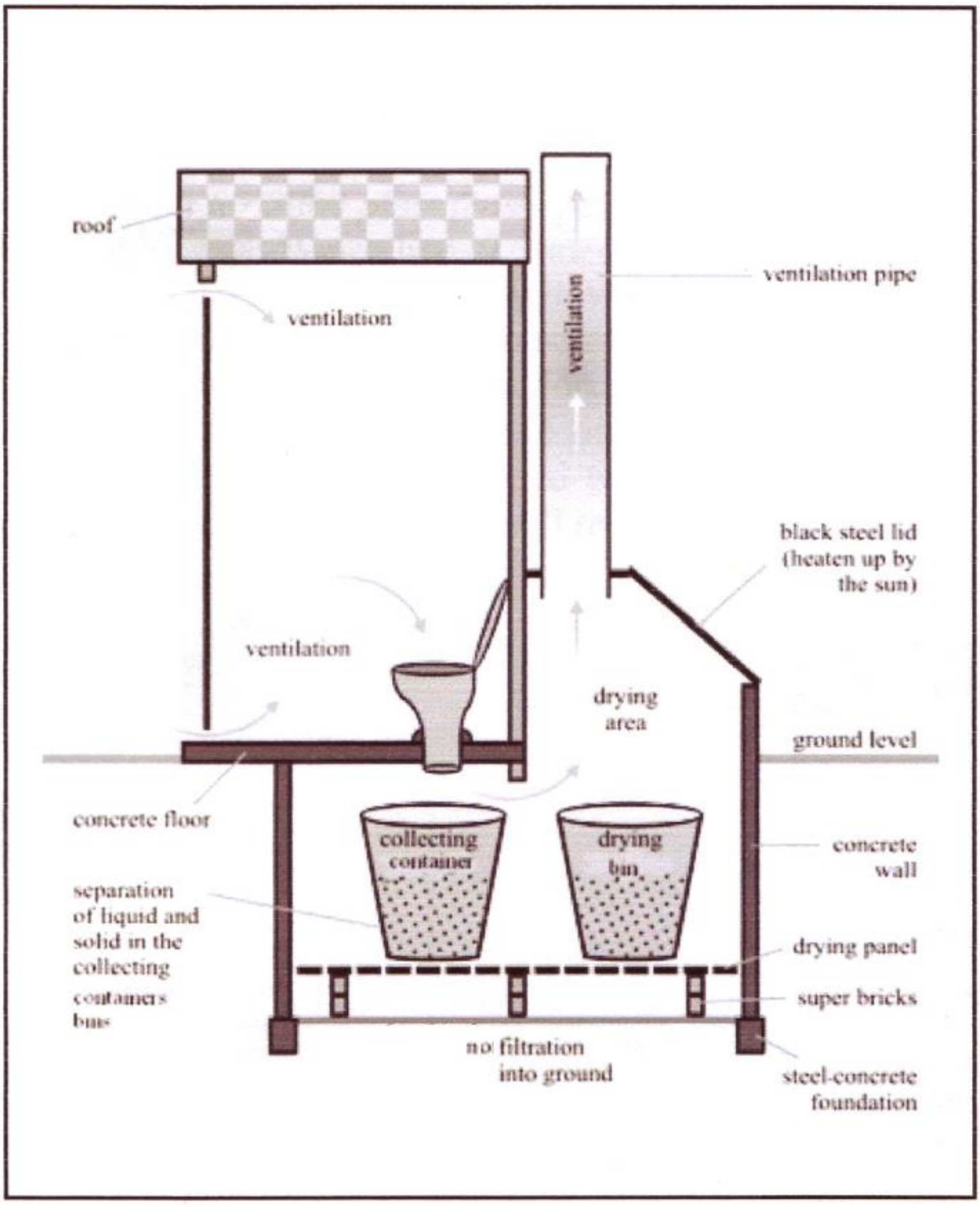

Figure 4: Otji-Toilet System (Stagl, 2010)

Maintenance of the dehydrating toilets is significantly less than for composting toilets, since moisture levels and composting agent additions do not need to be regulated. Dehydrating toilets usually have at least two waste collection containers so that one can be left to dry while another is in use. Once the waste has dried out sufficiently, the container can be emptied and reused. Users of urine diversion toilets need to be properly educated on the correct use of the toilet. Incorrect use thereof can lead to blockages and significantly decreased performance of the drying process.

Once the decomposed waste has been dried it can be safely discarded without fear of groundwater contamination. Alternatively, dried waste could be used as a soil additive for composting purposes, which would then mean that the toilet could be classified as a composting toilet (as mentioned the only difference between composting and dehydrating toilets is the intended final use of the waste product). Sanitation waste re-use is discussed in more detail in Code of Practice Volume 10 (DAWF, 2011). Advantages and disadvantages of dehydrating toilets are the same as for composting toilets (see Section 2.1.2), with the exception of the addition of a composting agent as a disadvantage, since this is not done for dehydrating toilets.

2.3.4 Urine Diversion Dry Toilet (UDDT)

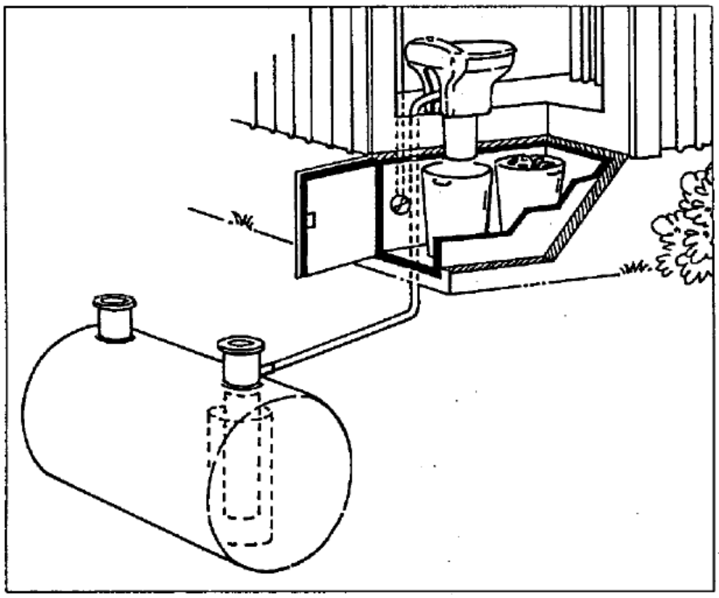

Figure 5: UDDT System (Jenssen, 2005)

2.3.4.1 System Description

UDDTs make use of a specially designed toilet pedestal that separates liquid and solid waste (see Figure 5). Urine is diverted from the front area of the toilet and drained to a suitable collection container or soak-away. Manufacturers claim that the pedestals are upto 80% efficient but some faecal contamination is possible. Urine collected can be stored for up to 6 months so that it can be safely re-used for composting purposes. Sanitation waste re-use is discussed in more detail in Code of Practice Volume 10 (DAWF, 2011). Faeces fall through a large chute in the back area of the toilet and are collected in a well-ventilated container or tank where it is left to dry. Solid waste that has been left to dry can be reduced to 5% of its original volume.

UDDTs are used in conjunction with other dry sanitation technologies to make them more efficient and sustainable. For example, a VIDP pit will take much longer to fill up if only solid waste is collected therein and urine is collected in another container or led to a soak-away. Solid waste will also be able to dry out much more quickly, which will decrease its volume by up to 95%. In addition, unpleasant odour production will be significantly reduced if liquid and solid waste is separated.

2.3.4.2 Advantages and Disadvantages

The advantages of the UDDT system are as follows:

- Both solid and liquid waste can be collected and re-used separately. If not separated, urine will evaporate or soak away and will thus not be re-usable for composting purposes;
- Odour production and fly attraction will be significantly reduced if liquid and solid waste are separated;
- UDDTs can be used in conjunction with any dry sanitation technology to make it more efficient and sustainable;
- Low capital and operation costs which can also depend also on the collection and storage technology that follows;
- Any form of anal cleansing can be used, as long as users are properly educated on the correct use of the UDDT.
- Urine is an extremely rich source of fertiliser and can be used as a soil additive so long as the storage and application restrictions are complied with.

The disadvantages of the UDDT system are as follows:

- UDDT system requires education and acceptance of users. The toilet itself might be different from what users are used to, due to the fact that urine is collected in the front part of the toilet and faeces in the back part;
- Incorrect use due to poor education or deliberate misuse due to lack of system acceptance can lead to clogging and malfunction of the system. Users must be aware that liquid and solid waste needs to be separated and that failure to do so will lead to decreased efficiency (liquid in solids collection container) or clogging (solids in liquid collection pipe). If used properly, the system has no disadvantages.
- If households wish to use the urine as a soil additive, the storage and application restrictions must be applied rigorously.

2.3.4.3 Recommendations

Due to the fact that incorrect use of the UDDT system can lead to clogging and complete malfunction of the toilet, it is recommended that households are properly educated before the toilet is put into operation.

It is recommended that information sheets on the inside of the toilet facility with easily to understand illustrations and instructions are provided at the time of installation by the supplier/manufacturer, so that users are continually reminded of the correct use of the toilet. This sheet should be in the local vernacular and should be understandable to anyone using the toilet, regardless of the education level of the user.

The urine separation toilet system is highly recommended for Namibia because of its low water requirement for flushing. Also, these systems can first be installed to operate as individual, dry sanitation systems and later can be connected up to a potable water line and water-borne collection system with final effluent treatment to operate as a wet sanitation system.

Hand-washing facilities should always form part of the system, irrespective of which other additions or modifications to the system are made.

Since a full waste container can represent a source of point pollution, care must be taken to ensure that at times of flooding the container is moved above the maximum flood line to avoid any risk of pollution.

3. CONCLUSIONS

The extent of sanitation coverage in Namibia is very limited and many settlements are forced to make do without any sanitation facilities whatsoever. It is with this in mind that governing bodies and decision makers should strongly consider dry sanitation as a feasible option to provide safe and effective sanitation in areas where water is not available and water-borne systems are not feasible, where communities are either unwilling or cannot afford to pay for the very costly water-borne systems and/or the community is unable to operate and maintain complicated water-borne sanitation systems. In addition, the coverage of dry sanitation systems can be implemented quickly, once communities have been sensitised and are willing to participate.

The purpose of this document is to provide comparative information in the form of a code of practice about the alternative types of dry sanitation so that the user can make educated decisions regarding the optimum choice of a system for each specific situation. Consultants or contractors/suppliers, in collaboration with DWSSC, must perform the necessary area specific condition assessments at the planning stage before installing toilet systems.

For example, where groundwater contamination can occur, the waste collection tank or container must be suitably constructed or sealed with a thick plastic liner to prevent infiltration into the surrounding soil or to be at risk of becoming a point source of pollution at times of flooding.

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APPENDICES

APPENDIX A: Sanitation Services Planning Tool for Rural and Urban Areas

Guide to Planning Tools

1. Purpose of the Planning Tools:

Planning tools designed to help provide guidance for decision making are used once communities have been selected to be provided with improved sanitation services. The selection criteria would use processes such as the fair distribution planning and financial tool (also known as the equitable distribution tool) to identify priority regions and urban and rural communities.

Two Sanitation Services Planning Tools have been developed, *viz* for:

- Rural Areas;
- Urban Areas.

The Rural and Urban Sanitation Services Planning Tools were drawn up primarily as guidelines to provide sanitation facilities to serve individual households. The Tools are intended to used by:

- Planners (government and private) when considering new extensions (towns, villages and communities);
- Consultants and technical advisers when acting for their clients to select the most appropriate sanitation systems for their specific project conditions;
- Donor organisations and NGO's involved in sanitation throughout Namibia as a quick reference to assess the most appropriate technology to be employed for specific local conditions and areas they are active in;
- Municipalities, towns, villages and communities to make a quick assessment of the choice of appropriate technologies that could be promoted in their specific area;
- Communities or even individual households pre-dominantly in rural and urban communal areas that may wish to take the initiative and be informed about how to choose and implement the most suitable sanitation system to meet their circumstances;

These tools are not meant for Governmental Offices such as schools, clinics, police stations and regional offices. Here, shared facilities are likely to be provided.

2. Key to numbers in Planning Tool:

1) The planner/designer must obtain all design specifications of the existing sanitation system including any treatment facility, assess if there is spare capacity and get written permission of the owner that the new proposed system may be connected to the existing

system. Should the planner/designer not have the specialist knowledge to assess the capacity of the existing system, he/she must appoint a specialist consultant to do this assessment.

2) Water should only be considered to be “freely available” and “affordable” if:

- Department of Water Affairs must always be consulted to determine the safe yield of community or settlement existing water supplies to confirm the availability of additional supplies needed for the new sanitation services;
- There is a guaranteed water supply also in times of drought, e.g. a sufficient and shallow borehole or perennial running river;
- When a formal communal water supply institution exists such as a water point committee, latter must be consulted as part of the planning process including the water use for that specific community;
- In broad terms, a household should be willing to pay for at least 25 l/p/d (urban) of additional water if a water–borne system is selected;
- The tapping point for a household should preferably be within the dwelling but not be further than 30 m from the dwelling and should be easily accessible;
- Where there is energy required to transport the water supply to the dwelling, e.g. electricity or fuel for pumping, this source must be very reliable and affordable to the users.

3) <u>Operation and Maintenance:</u> The level of technical expertise and availability of technical resources within the community should be established before deciding on a potable water supply and distribution system where a new wet sanitation system is being considered.

4) <u>Cultural Aspects:</u> For dry and wet systems, only on-site systems should be considered, no shared, communal facilities should be implemented. These are classified as improved sanitation systems. Also, cultural habits such as different members of the same family that would not normally use the same toilet must be considered when consulting with the community. Cultural sensitivities must be included within any community participation approaches.

All toilet systems, dry or wet, should be installed with a hand-washing facility built-in next to the toilet. Where urine diversion, dry sanitation systems are selected, a separate urinal system maybe added.

5) <u>Environmental Impact:</u> Topography, climatic conditions, soil conditions, ground water table and raw water aquifers should be thoroughly investigated, including single households relying on e.g. pit latrines: Percolation tests and infiltration area sizing must be undertaken as per Code of Practice: Volume 1 – Septic Tank Systems (DWAF, 2008). Special consideration must also be given during times of high rainfall. Even when flooding only occasionally occurs (1 in 10-year flood), there will be a danger of sewage contaminating the surface run-off and this should be taken into account in the design and choice of sanitation technology selected.

6) Sanitation Technology - Flush Toilets: Where wet sanitation systems are chosen particularly for new housing developments only water-saving toilet systems should be considered. As a minimum they must be fitted with a two-volume (big/small) flushing mechanism or, alternatively, must be of the urine-separation type with separate flushing to each section of the toilet bowl.

7) Households: HH are regarded as typically a single family consisting of not more than 8 permanent members.

8) Affordability and Cultural Aspects: The final choice of a specific sanitation technology should lie with the end-user or community where a group of HHs are being served and will typically will depend on:
   - Cost;
   - Aesthetics;
   - Cultural and personal acceptability
   - Staged system where the option of upgrading is practical in the future.

9) Technical Appropriateness – Water-borne Collection systems: All collection systems should be be designed as gravity. Where pumped systems are necessary, the minimum number of transfer pumping stations should be installed. Ideally, the area to be serviced should slope towards a single low point where a treatment plant should ideally be installed. Water-borne collection systems are preferred in circumstances where the soil is such that trenching is easy and inexpensive.

   There are certain conditions under which a vacuum sewer collection system would be appropriate to install/use, such as rocky subsoil or flat terrain. This type of collection system requires a specialist technical operators to service and maintain the system. Such a system should only be considered as a last resort for small communities and, when selected, the appointment of a specialist service and maintenance contractor would be the preferred option.

10) Technical Appropriateness – Mechanical Collection: An able contractor would be one that has the financial means to acquire, operate and maintain a tanker with extraction pump (e.g. "Honeysucker"). The contractor must also be conscientious to empty tanks immediately when called out. In smaller, more isolated communities, other affordable options must be considered.

11) Technical Appropriateness – Final Treatment: For final treatment of sewage effluent collected using a wet sanitation system, a specialist designer must be consulted to provide the most appropriate final treatment system for that specific community. Where possible, reuse of treated effluent (for selected agricultural produce, gardening or lawns for sports fields) of the final effluent is recommended. However this is likely to require more costly advanced treatment processes. In addition, advance treatment systems will require access to a high level technical expertise which will impact on future operational and maintenance cost. In most instances, a service contractor will be required to manage, operate and maintain such treatment systems.

    When advanced treatment is considered, low-key technology that gives a final effluent suitable for reuse and conforming to the effluent standards such as new-generation trickling filters should be the first type of technology considered. Trickling filters are cheaper to build than evaporation ponds, have a much smaller footprint than even oxidation ponds (5% of area only required), need no specialist knowledge to operate, require little maintenance, need no adjustments to operating parameters and produce a final effluent conforming to current legislation for environmental standards in Namibia (General Standard). However, they need access to an energy source..

Where a community does not have access to technical expertise, ponds should be considered. In this case, strict adherence to the Code of Practice: Volume 2 – Pond Systems (DWAF, 2008) is required. Specifically, the following requirements need to be taken into consideration:

- The anaerobic pond must be lined with an impenetrable liner;
- No final effluent may be produced, i.e. all effluent must be evaporated;
- The ponds must be properly fenced-in and locked at all times;
- The distance to the closest residential area should not be less than 500 m and preferably 1 000m;
- If reuse is considered, maturation ponds of not less than 40 days' retention time must be added after the oxidation/facultative ponds.

12) Next Steps:

The future steps that are recommended to be followed once the steps in the planning tool have been undertaken are:

1. Ensure that Water Supply-Sanitation-Hygiene (WASH) principles using the National Saniation Strategy are followed. Hand-washing facilities should always be available at toilet facilities
2. Undertake initial planning with urban or rural communities
3. Carry out pre-planning baseline surveys of communities identified using planning tools
4. Use decision-making tools to compare and choose sanitation technologies for each HH. Discuss HH contributions.
5. Set up management information and performance monitoring
6. Develop and promote health promotion and later conduct hygiene awareness raising with the community including sharing information
7. Develop and facilitate a procurement and implementation programme to provide sanitation services
8. Monitor and assess the performance of the components of the next steps. Carry out a post-commissioning baseline survey
9. Continue to support communities through a mentoring process of advise and facilitation based on a comparison of the two baseline surveys

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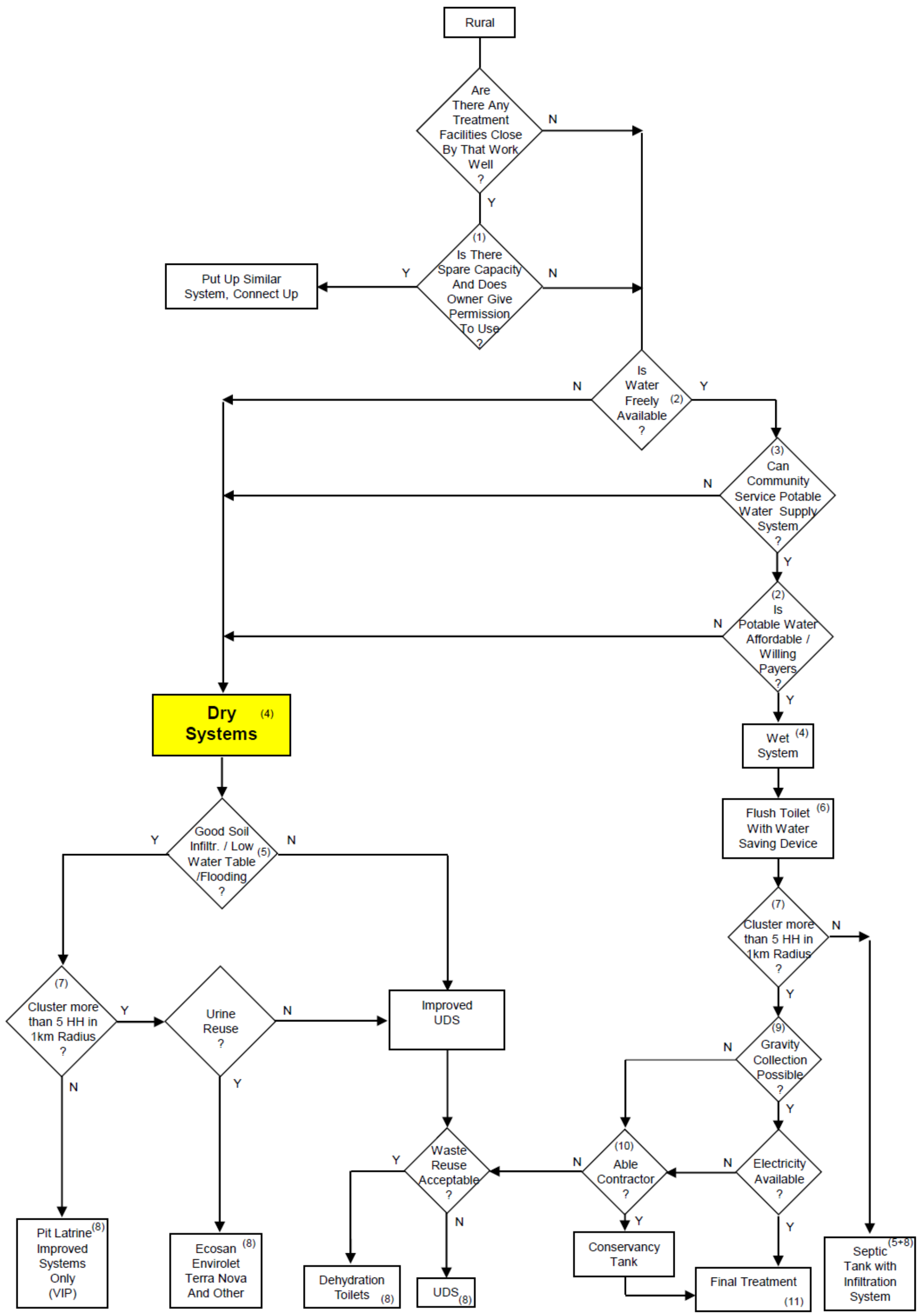
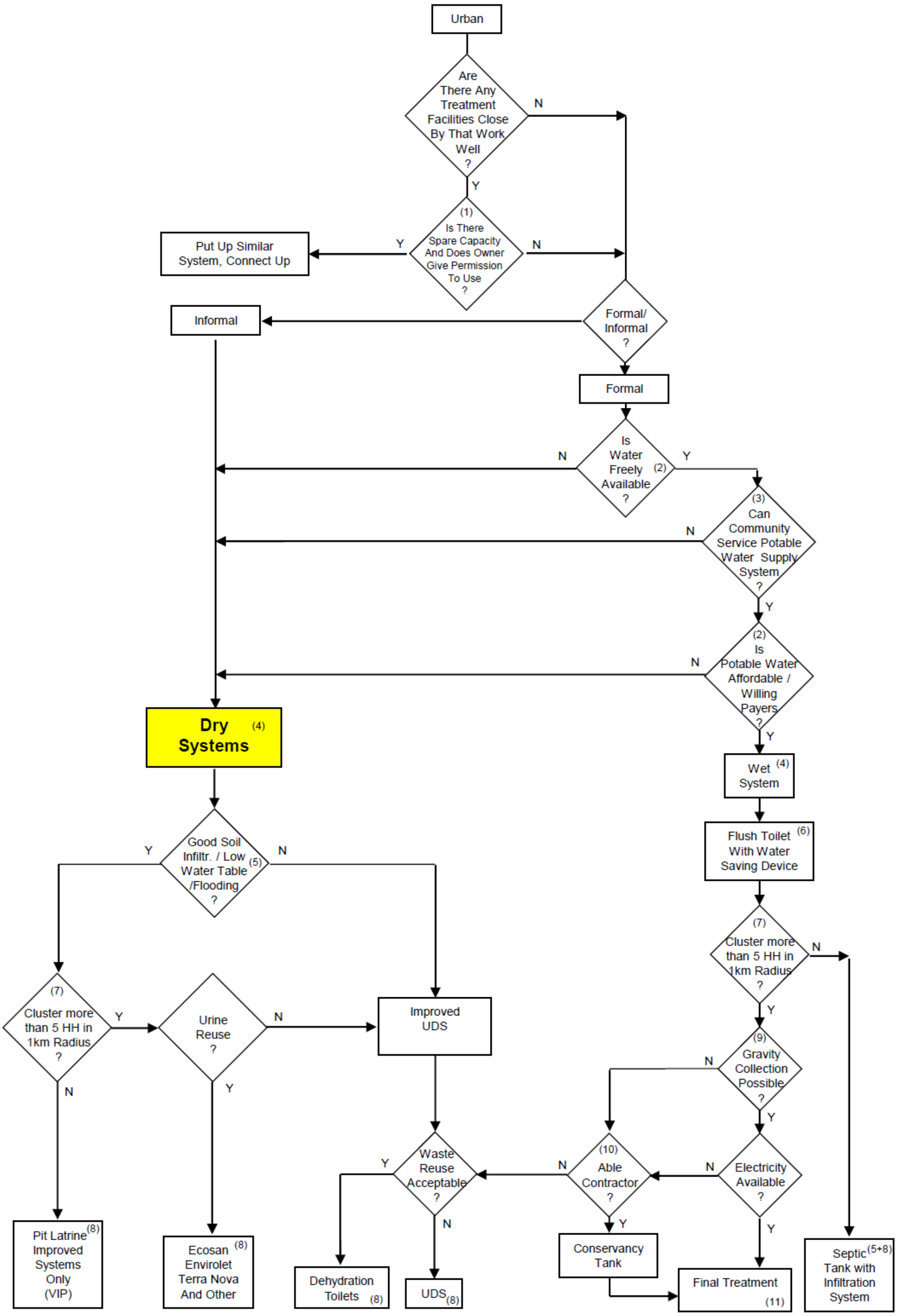
Sanitation Services Planning Tool : Rural Areas



HH = Households

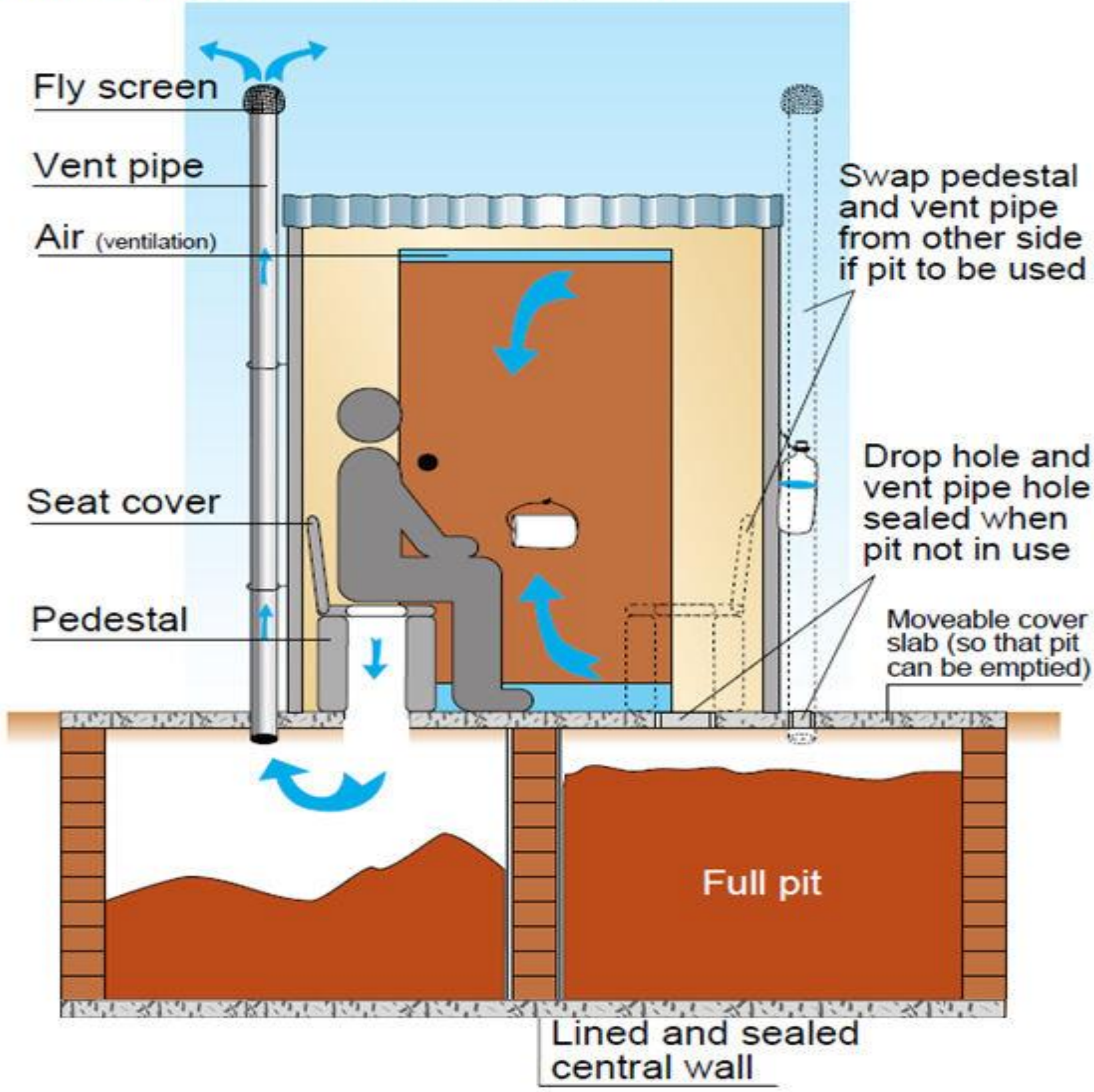
Sanitation Services Planning Tool : Urban Areas



HH = Households

APPENDIX B: National Sanitation Task Team "Sanitation Technology Options"

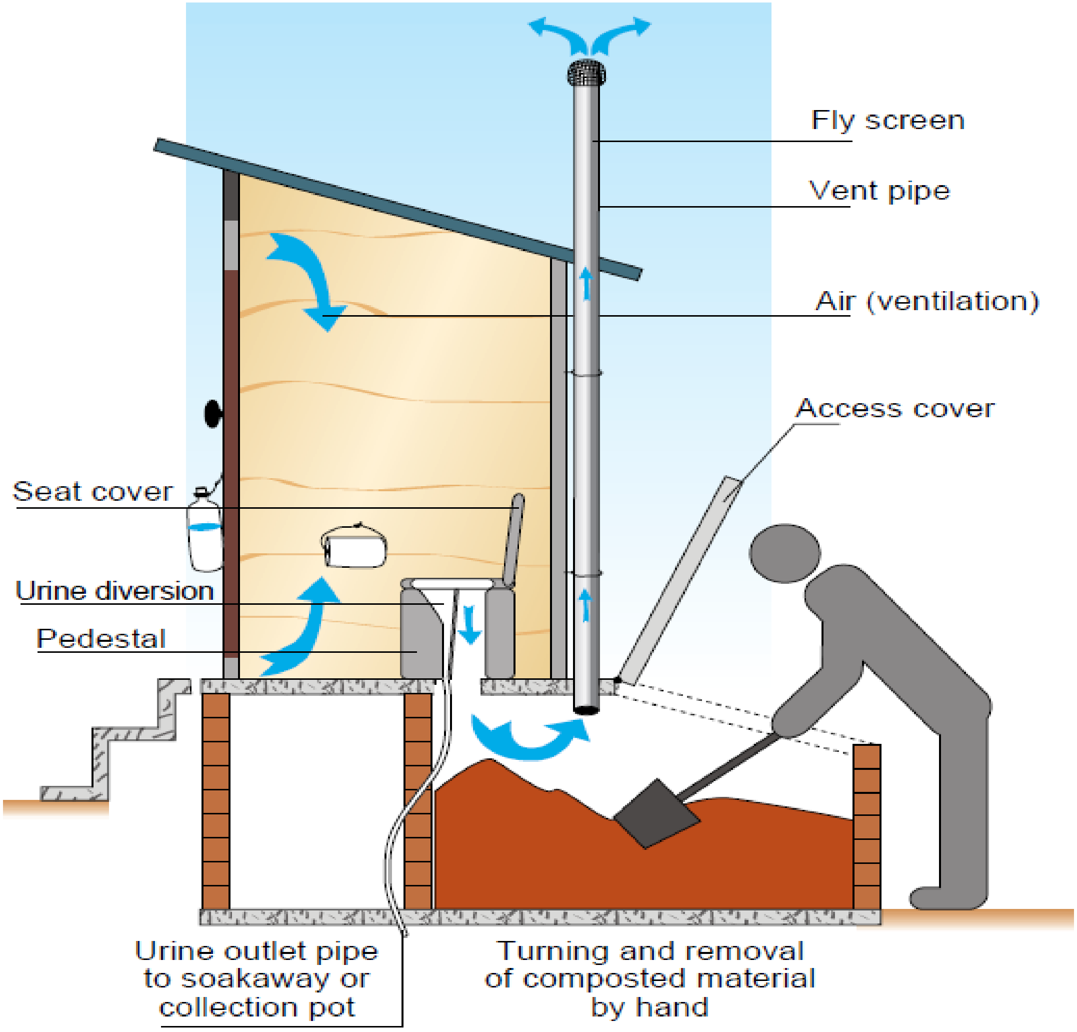
Ventilated Improved Double Pit (VIDP) toilet



A single top-structure over 2 shallow pits, side by side. Only one pit - vented by a pipe protected with a fly screen - is in use at any time. Generally lined and the central wall fully sealed to ensure isolation of one pit from the other.

Principles of operation	Operational and institutional requirements	Costs (excluding transport)	Experience and comment
As for the VIP toilet. One pit is used until filled to within about half a metre of the top. The defecation and vent pipe holes are then completely sealed and the other pit used. The contents of the first pit are dug out after a period of ***at least*** two years, once the contents have become less harmful.	As for the VIP toilet, except that promotion of manual emptying by the householder is usual, and use of decomposed waste as a soil conditioner possible. Suitable disposal site necessary.	Capital: R2 500-R4 500 depending on householder input. Operating: R35-R135 every 2 years depending on local government involvement, householder willingness to handle waste, disposal options.	Resistance to handling of decomposed waste and timely changeover of pits by householders has often been overcome through education and over time - both internationally and in SA. This VIP alternative is often applicable where rocky or groundwater conditions prohibit deep excavation.

Composting/urine diversion (UD) toilet



A single top-structure over a sealed container, which could be one of two chambers side by side (as for the VIDP), with access for the removal of decomposed waste. A vent pipe may be installed to encourage drying of the waste.

Principles of operation	Operational and institutional requirements	Costs (excluding transport)	Experience and comment
Waste is deposited in the chamber and dry absorbent organic material, such as wood ash, straw or vegetable matter is added after each use to deodorise decomposing faeces and/or control moisture and facilitate biological breakdown (composting). Urine may be separated/diverted through use of specially adapted pedestals. This may be collected and used as a fertiliser. In desiccation systems, ventilation encourages the evaporation of moisture.	Does not accept domestic wastewater. Ensure ease of access by householder and promotion of manual 'turning' of compost and removal of composted/desiccated material. Suitable disposal site/area necessary.	Capital (variable depending on system and householder input): R3 000-R4 000 for commercial systems. Operating: R35-R500 per annum, depending on local government involvement and householder willingness to handle waste, and disposal options.	Control of moisture content is vital for proper operation. Contents often become too wet, making the vault difficult and unhygienic to empty, as well as malodorous. UD systems in SA still being monitored but appear to be accepted by certain communities and working without significant problems. Burning of compost prior to removal also being tested in SA. Proprietary systems have been piloted in SA, generally with inconclusive results as to their likely success on a large scale and under varying conditions. User educational requirements and continuous input significant for proper operation in terms of the composting process.

APPENDIX C: Dry Sanitation Technology Table

Name	Process Description	Most Appropriate Application	Features	Comments
Composting Toilets				
EcoSAN waterless toilet	The human excrement falls down a vertical chute and into one end of a specially designed helical screw conveyor. Every time the toilet lid is lifted, a mechanism rotates the conveyor. With each rotation the human excrement slowly moves along, taking approximately twenty five days before falling into a reusable collection bag. It takes about six months for the bag to fill with dry and odourless waste. Through the uniquely designed ventilation pipe, adequate airflow is provided for the dehydration / evaporation, deodorising process. Human excrement consists of roughly 95% moisture. As the solids dry in the conveyer the urine and moisture is vented into the atmosphere. The solid waste then dries into a compost-like material, roughly 5 - 10% of it's original mass.	Quite flexible	Indoor or outdoor installation; objects like beverage cans, disposal nappies or other objects accidentally dropped down the chute will not block the system (not advisable to do this); each toilet comes standard with a mounted urinal; high usage volume units can be supplied with collection drums instead of bag (drum needs to be emptied regularly); Extractor fan options are wind turbine, solar fan or electric fan;	Might be difficult and expensive to import complete units, as the assembled toilet system is quite bulky; Cannot be self-manufactured; Possible income generation by using dry waste as fertilizer; Cultural aspect of re-using human waste might be an issue
Envirolet Waterless Remote Composting Toilet Systems	An HDPE tank below the toilet collects waste material and stores it for sufficiently long periods of time for waste decomposition to occur. Ventilation is achieved through an electrically powered ventilation shaft.	Single households, since the maximum capacity of one unit is 8 persons. Must be constructed on raised platform in areas where flooding is likely to occur		Designed for single household with maximum of 8 people so number of persons using the facility would have to be regulated; Possible income generation by using dry waste as fertilizer; Cultural aspect of re-using human waste might be an issue
TerraNova - Composting Toilet	The system has a large tank below the toilet(s), with waste entering the tank through vertical down pipes from the toilet(s). Human excreta, toilet paper and organic waste are stored in the tank for a minimum of 2 years, during which time they are converted to reusable compost. Ventilation is achieved via a vertical ventilation shaft that leads above the roof.	Suitable for high loading rates as occurring in public toilets in settlements or leisure facilities. Intake capacity is about 40 uses/day per tank, more capacity can be achieved by installing more tanks. Must be constructed on raised platform in areas where flooding is likely to occur	Produces reusable compost (about 40 litres/person per year)	Suitable for public areas; Requires addition of structural material (bark, chaff) and composting aids (minerals activators) to regulate the composting process; Maintenance and operation costs might be an issue; Possible income generation by using dry waste as fertilizer; Cultural aspect of re-using human waste might be an issue

SAWI Biocom Bark Chip Toilet	The system has a container inside the toilet housing which accumulates solid and liquid wastes separately in two chambers. Bark chips are used as an additive in the composting process. The bottom chamber collects urine and needs to be filled with bark chips before the first use while bark chips need to be added to the top chamber after each defecation. Tannins in the bark chips are released by a natural biological process and suppress odours. Ventilation shaft ensures oxygen can reach the waste, resulting in a gradual composting process. Collection container has to be emptied regularly onto a compost heap.	Small unit, most appropriate for single households or weekend homes, not applicable for public use with high loading rates. Requires bark chip addition after each use. Must be constructed on raised platform in areas where flooding is likely to occur	Mobile unit also available (does not have a ventilation shaft, comes with decomposable collection bags)	Requires regular maintenance (removing full container and emptying onto compost heap); requires bark chip addition after each use; Not recommended for use as public toilet with high loading rates; Maintenance and operation costs might be an issue; Possible income generation by using dry waste as fertilizer; Cultural aspect of re-using human waste might be an issue
Solien Energy Solutions Waterless Composting Toilet	The unit uses solar-power to provide heat that aids in the decomposition of waste material. Solids are broken down to form compost that can be used for fertilisation purposes. No further information available.		Excess energy captured by the solar panel can be used to provide lighting within the unit.	Possible income generation by using dry waste as fertilizer; Cultural aspect of re-using human waste might be an issue
SEPARETT Villa Separation Toilet	Same principle as for the TerraNova toilet, except that urine is separated from solid waste. Separated urine can then be used as a compost additive or fertilizer. Removing the liquid waste, decreases the collection tank capacity required for solid waste collection.		Produces reusable compost (about 40 litres/person per year)	Collection, treatment and application of urine and compost must be well operated, operations costs might therefore be an issue; Possible income generation by using dry waste as fertilizer; Cultural aspect of re-using human waste might be an issue
African Sanitation Toilet	No information available			Factory can manufacture about 20 000 units per month (according to manufacturer); Possible income generation by using dry waste as fertilizer; Cultural aspect of re-using human waste might be an issue
Flush Toilets with Flush Water Recycling				
EnviroFlush	Solid and liquid waste is flushed into a digestive tank containing bacteria. The water then flows into a settling chamber followed by a filtration chamber. The manufacturer claims that water exiting the filtration chamber is pathogenic free and can be used for toilet flushing or irrigation. This claim however seems extremely doubtful, since disinfection (pathogen destruction) is achieved through disinfection and not merely by anaerobic digestion and filtration.	System uses water-borne flush system requiring a pump and is therefore not recommended for very dry or rural areas. Also, to recycle pathogen-free water for flushing purposes, chemical dosing would be required. Again, not applicable for rural areas (regular maintenance required). Must be constructed on raised platform in areas where flooding is likely to occur	Flush water recycling (however, manufacturers claim that recycled water is pathogen-free is unrealistic)	For recycling flush water a pump is required to elevate the "pathogen-free" water into a storage tank. Disinfection required. System requires water

Namibia Sanitation Toilet Recycle Unit	Similar to the "EnviroFlush" system described above. Wastewater is treated biologically in an anaerobic tank followed by two aerobic chambers. The treated water is then pumped to an elevated storage tank and used again for flushing. The water is, however, not disinfected.	System uses water-borne flush system requiring a pump and is therefore not recommended for very dry or rural areas. Also, to recycle pathogen-free water for flushing purposes, chemical dosing would be required. Again, not applicable for rural areas (regular maintenance required). Must be constructed on raised platform in areas where flooding is likely to occur	Flush water recycling (however, water would have to be chemically disinfected which would require maintenance)	Pump required for pumping treated water into elevated storage tank. Disinfection required. Maintenance and operation costs might be an issue. System requires water
VIP Toilets				
SanPlat	Sanplats are small concrete squatting slabs which can be put on top of traditional latrines to make them more hygienic. They are available in various different sizes.	For use with new or existing pit latrines.	Key-hole shaped drop-hole ensures safety of use even for small children; footholes make it easier to use the toilet in the dark; available as plastic or concrete units	Not a sanitation system in itself, but can be used in conjunction with pit latrines to make them more hygienic. ArborLoo concept can be incorporated. When the pit is full, the hut housing the toilet can be moved to a new location and a tree planted in the old pit.
Red Cross Latrine	The Red Cross VIP consists of a concrete slab for the latrine as well as a superstructure consisting of corrugated sheets. The NRCS encourages community interaction and invloves the community in the construction process. The community must dig the pit for the latrine after which the red cross installs the slab and superstructure.	Very flexible, must be constructed on raised platform in areas where flooding is likely to occur	Unit has a ventilation pipe and plastic toilet pedestal with seat. A concrete lining for the pit is an optional extra.	According to the NRCS, involving the community in the construction process results in better long-term operation and maintenance of the toilets, since the community feel a greater responsibility towards something that it helped build.
Amalooloo Sustainable Ecological Sanitation System	System consists of a concrete pit, concrete superstructure with ventilation pipe and plastic toilet pedestal (urine diversion unit). Each unit also comes with a hand-wash facility that is simultaneously used for toilet cleaning purposes.	Very flexible, must be constructed on raised platform in areas where flooding is likely to occur	Concrete slabs are pre-cast and are easy to assemble so no specialised construction or installation team is required.	All toilet components are produced in South Africa. If demand is high enough, NSS would be willing to open a manufacturing facility in Namibia. Urine re-use needs to be re-investigated since urine is not stored in the current toilet design. Urine needs to be stored for at least 6 months before re-use for agricultural purposes can be considered.
Envirosan Plastic Injection Moulded Sanitation Products	Envirosan has a number of systems, each consisting of a VIP toilet with optional additional extras. A basic VIP toilet consists of a superstructure constructed over a lined and sealed pit. The system includes a ventilation pipe. Envirosan supplies various systems: basic VIP, VIP with urine diversion, double-chamber VIP with urine diversion, as well as urine diversion with removable bin. Each unit also contains a hand-wash facility.	Very flexible. must be constructed on raised platform in areas where flooding is likely to occur	Various options available, including basic VIP, double-chamber VIP, urine diversion VIP, and urine diversion VIP with removable bin.	Complete units and a multitude of different options and accessories (e.g. toilet seats, bins and lids) are available as pre-manufactured units from well established company in South Africa. ArborLoo concept can be incorporated. When the pit is full, the hut housing the toilet can be moved to a new location and a tree

				planted in the old pit.
Toilet SA VIP Toilets	A wall mounted reservoir is used for flushing purposes (only about 350 mL of water per flush is needed). A large pit below the toilet unit is used to collect the faecal matter, while urine is separated from solid waste and can be collected or led to a soak-away location.	Seems appropriate for high capacity areas such as informal settlements or leisure facilities, must be constructed on raised platform in areas where flooding is likely to occur	Ventilation shaft; hand-washing basin with flush valve; can be supplied with a water-harvesting roof with storage tank	ArborLoo concept can be incorporated. When the pit is full, the hut housing the toilet can be moved to a new location and a tree planted in the old pit.
Dehydration Toilets				
EnviroLoo	The system separates liquid and solid waste using a custom designed ceramic toilet bowl. Liquid waste drains to the bottom of the container while solids remain on a drying plate within the container. The sun heats up a black inspection cover, resulting in ventilation by convection, with odours being expelled through an extraction shaft. This movement of air within the container also dehydrates the solid waste to about 5% of its original volume in addition to causing the liquid at the bottom of the container to evaporate.	Areas with consistent exposure to direct sunlight; rural and urban application possible, must be constructed on raised platform in areas where flooding is likely to occur	Sun-based ventilation system, different models for specific usage ranges	Dried solids need to be removed regularly and garden compost added after removal; Maintenance and operation costs might be an issue
Aqua Conservation Services Dry Toilet	Solid waste is collected in a black dome fitted with a ventilation pipe. Heated air causes odours to rise and escape through the ventilation pipe, as well as accelerating the waste drying process. Urine is lead to a soak-away so that solid waste can dry out more quickly.	Areas with consistent exposure to direct sunlight; rural and urban application possible, must be constructed on raised platform in areas where flooding is likely to occur	Sun-based ventilation system, urine diversion	Dried solids need to be removed regularly and garden compost added after removal; Maintenance and operation costs might be an issue
SolarSan Dehydrating Waterless Toilet	The toilet station separates faecal matter from urine. Urine can be diverted to a soak away or collected and used as fertilizer. The faecal matter is collected on a conveyor consisting of continuous abutting scraper elements. The faecal matter is deposited directly into the scraper rings, which are then moved around by means of a shuttle. The shuttle is attached to lever, which is pulled by the user after each use. After each use the faecal matter is transported around the housing until it reaches a sump, where it falls through a hole in the housing onto a bag that has been inserted into the sump. By the time the faeces reach the sump they will be dried out. The more frequently the toilet is used, the less time is available for drying of faecal matter. The system is thus sensitive to loading rates. A solar and wind powered ventilation system ensures that odours are removed.	System needs wind and solar radiation for proper ventilation	The rotational system ensures that a clean scraper ring is available for each new user. Thus there is not direct visual contact with faecal matter that has previously been collected.	Designed for single household with maximum of 8 people. Has been continuously used by up to 40 people, resulting in faecal matter not drying properly before being collected in the sump. The sump will need to be emptied regularly if unit is overloaded; Maintenance and operation costs might be an issue

Otji Toilet	A perforated container under the toilet pot separates solids from liquids. Liquids run through perforated concrete panel under the container and filtrates into the ground. When container is full (ca 6 months) it is replaced with a new bin and the old one is left to dry out until it is needed again. Rotation of containers ensures indefinite reusability. A sun based ventilation system at the back of the toilet provides fresh air by convection, which keeps the toilet dry and odourless. Units must therefore be placed in areas that receive sun throughout the day and must not be placed close to trees or houses which could prevent direct exposure to sunlight.	Areas with consistent exposure to direct sunlight	Sun-based ventilation system; collection bin reusability; indoor or outdoor installation (indoor set-up has solar panel); build-it-yourself construction kits available	Locally manufactured in Namibia, possibility of long waiting times for delivery after order placement; can be self-manufactured
Other				
JoJo Toilet	The JoJo toilet consists of a hut with two containers, one with a toilet seat and one with a lid. When one container is full, the lid and seat are interchanged. The full container then needs to be emptied. Note that tanks are situated physically inside the hut, not buried below the hut.			High risk of odour and fly nuisance, since the containers are situated within the toilet hut and there is no ventilation system. The containers do not drain into the ground which means that raw excreta are collected until the container is full.
Gendarme Sanitation System	The toilet is designed to simulate the natural process of biologically breaking down organic matter. Solid and liquid waste is collected in two tanks in which anaerobic biological decomposition occurs. The tanks are filled with water upon installation and no further water is required for flushing (flushing is done using a mechanical suction lever). The two container-system results in a relatively long retention time of water in the system. By the time it overflows into the environment, anaerobic digestion will have occurred.	Very flexible. Requires sub-terraneous tanks, so might be problematic for areas with very hard rock or areas with high water tables. Must be constructed on raised platform in areas where flooding is likely to occur	Flushing using a mechanical lever (no water), combined tank capacity of max 1500 l	Process very similar to septic tank system. Water is treated anaerobically and then discharged to the environment.
Eco-Lily	'Eco-Lily' from Ethiopia is a urinal made out of a common liquid container with a used light bulb acting as a floating 'odour-lock' to reduce smells. According to the information brochure, the system is to be used by men and women. Units can be self-built or purchased pre-manufactured.	Wall-mounted units next to urine dispersion toilets. Most appropriate for male toilets.		Does not seem to be appropriate for female use

Note: Since the details on this table are subject to regular updating and amendment, please refer to the full document for further details, available from MAWF.