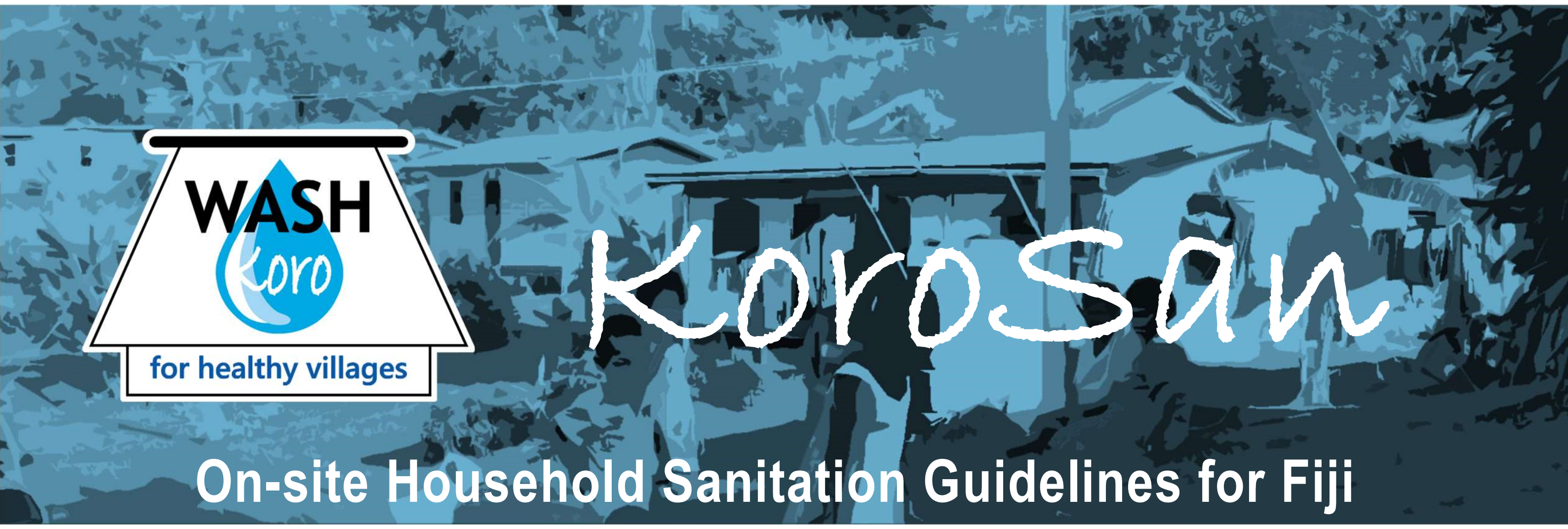

#4 LAND APPLICATION SYSTEM OPTIONS FOR DOMESTIC WASTEWATERS

1 PURPOSE

A safe, sustainable, effective and affordable sanitation system is an essential service for the health and wellbeing of all people. This guideline deals with land application systems for septic tank treated wastewater discharges from rural dwellings, clusters of dwellings, schools or community buildings in Fiji that are not serviced by a reticulated sewer service. It does not deal with effluent from more advanced treatment systems. The information provided will assist with the selection, design, siting, operation and servicing of a suitable land application system.

The land application systems described in this guideline receive the wastewater from a septic tank or other primary treatment systems. They are designed to provide safe and convenient treatment and disposal by promoting sustainable infiltration of the discharge into the soil. This avoids direct contamination of nearby waterways and reduces the potential for exposure of people and animals to highly contaminated septic tank discharges.

For a land application system to work effectively and sustainably, wastewaters need to be first treated in an appropriate primary treatment system such as a septic tank (see KoroSan #3) and be tailored to the local site and soil characteristics (see KoroSan #2). For land application of only greywater refer to KoroSan #7.

The designs provided in this guideline conform with performance recommendations in the joint Australian and New Zealand Standard, AS/NZS1547:2012.

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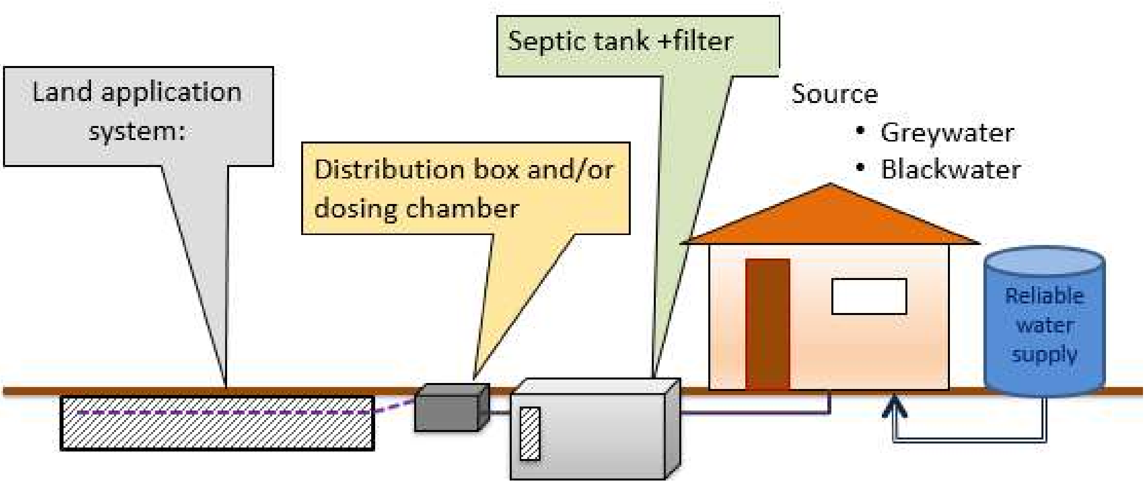
2 WHAT IS A LAND APPLICATION SYSTEM?

Effective land application is an essential part of an on-site wastewater management service. Septic tanks remove solids and floating scum from wastewater, but their effluent is still highly contaminated and contains high concentrations of faecal microorganisms. Land application systems provide additional treatment by filtration through soil, sand or other media, to encourage sustainable infiltration and disposal into the soil. This reduces organic matter and nutrient concentrations, and filters out harmful microorganisms in the effluent. As well as reducing wastewater pollutant levels, properly functioning land application systems reduce the potential for human contact with contaminated water and the pollution of nearby rivers, streams, drains, lagoons, wetlands and beach areas.

Figure 1. The basic components of an on-site wastewater management service



3 OPTIONS FOR LAND APPLICATION SYSTEMS

There are a range of different land application system options. The aim is to select a land application system that is sustainable, effective and affordable, with the primary aim of eliminating or substantially reducing risks to human health and to the local environment. Before choosing the preferred system, it is important to carry out an appropriate site and soil assessment to determine which options are suitable for the conditions -refer to KoroSan #2.

Three of the more common land application system used for the management of septic tanks effluents are:

A. Soak pit.

B. Soakage trench (or leach field)

C. Sand trench or bed (or discharge control trench/bed).

For more difficult sites (e.g., high groundwater, limited land area) there are other more appropriate land application system options, for example; raised (Wisconsin) mound, engineered mound, evapotranspiration beds and subsurface drip irrigation fields. These systems are more complicated and expensive to construct, and require specialist design.

3.1 SOAK PIT

The simplest and lowest cost land application system is the soak pit. Soak pits are covered pits dug into the ground, that allow water to slowly soak into the ground. They are either filled with large rocks, or open chambers lined with porous rock or block walls where there is a risk of soil collapse (e.g., sandy soils).

Soak pits should only be installed where soils are free-draining, where the highest ground water levels are more than 4 m below the base of the pit (>6 m below ground level), and drinking water wells or nearby waterways or beaches are not at risk. Care should be taken to ensure that surface water (and roof water) cannot flood into the soak pit during rainfall events. Intercepting field drains may be required to divert surface and subsurface water away from the soak pit (Refer to Drawing D6.3)

In poorly draining soils, soak pits will gradually block and fail, causing effluent to rise to the surface contaminating surrounding soils and flowing to nearby water courses. As soak pits present a high risk of failure, special care is needed to ensure that blockage does not result in a saturated soil surface or ponding where people and domestic animals can be exposed to the poorly treated effluent, or it finds its way into surface waters.

The design details of the soak pit have been illustrated in Section 11.1. Drawing D1.2 shows a design for a typical soak pit for a single dwelling in a stable soil. The soils in which the soak pit is dug must be free-draining, as explained in Section 4. Refer to KoroSan #2 to determining whether your soil is "free-draining" and how to determine groundwater depth. For further details on siting soak pits refer to Section 5 and Table 4.

Note in the photo to the right, the walls have been lined with plastic to prevent soil washing into the soak pit over time, which could cause clogging of the space between the rocks, contributing to soakage failure. Lining with geofabric, or constructing rock or block walls are alternative options.

Figure 2. Soak pit under construction.

3.2 CONVENTIONAL SOAKAGE TRENCH IN FREE TO MODERATE DRAINING SOILS

For many sites a soak pit is not a suitable land application system because, either the soils are poorly draining or the risk of groundwater and drinking water contamination is too high. In such situations, a common alternative is the soakage trench, which is a long trench back-filled with washed stones or gravel. As effluent flows out of the septic tank it drains into the trench and soaks into the trench's soil base and side walls. It is very important that the trench base is perfectly level and follows the contour of the land.

The dimensions of the trench vary depending on the design daily effluent volume (Vd, L/day) and the long-term soakage rate of the soils in which the trenches are dug. Appropriate design loading rates (DLR) for the 3 main soil categories are given in Table 5. For example, a typical soakage rate for a soil with moderate drainage capacity is 12 mm/day (which is the same as 12L/day per m^2 of trench base area), while a typical soakage rate for a free-draining soil is 25 mm/day (25L/day per m^2 of trench base area). . Design effluent volumes can be calculated by multiplying the expected daily flow per person by the maximum dwelling occupancy. For more details refer to Table 2 of KoroSan #2.

Example 1: Conventional soakage trench for blackwater (toilet only); 8 people in a moderate drainage soil (12 mm/day)

If a land application system is required to treat effluent from a blackwater septic tank (toilet(s) only) for a house with a maximum capacity of 8 people, then based on design volumes of 45 L/day per person (Table 2, KoroSan #2), the daily volume of effluent would be 360L/day. The trench base area will need to be 360/12= 30m^2.

The equation for required base area Ab [m^2] of the soakage trench is:

$$\mathbf{A_b\,[m^2] = V_d\,[L/day]\,/\,DLR\,[mm/day]}$$

Worked Example 1:

V_d = 360 L/day

DLR = 12 mm/day (same as L/m^2.day)

A_b = 360/12 = 30 m^2

If, in the above example, the trench width is 600mm (0.6m), then the total length of trench required is 30/0.6 = 50 m.

Because trenches should not be longer than about 20 m, it is appropriate to recommend three 17 m (50/3) trenches (0.6 m wide) in parallel. Alternatively, if we dug wider trenches (say 0.8m) the total required trench length calculates out to be 26.7/0.8=38m. Therefore, two 19m trenches would be required. The recommended maximum width of these types of soakage trench is 800mm.

Example 2: Combined wastewater (black and greywater) for 6 people in a free-draining soil (25 mm/day)

If a land application system is required to treat a combined wastewater (toilet, shower, sinks and washing machine) for a septic tank discharge for a house with a maximum capacity of 6 people, then based on a combined design volume of 180 L/day per person (Table 2, KoroSan #2), the daily volume of effluent would 1080L/day. The trench base area will need to be 1080/25= 43.5m^2.

The equation for required base area Ab [m^2] of the soakage trench is:

$$A_b\,[m^2] = V_d\,[L/day]/DLR[mm/day]$$

Worked Example 2:
V_d = 1080L/day DLR = 25 mm/day (same as L/m^2.day) A_b = 1080/25 = 43.5 m^2
If, in the above example the trench width is 800mm (0.8m), then the total length of trench required is 43.5/0.8 = 54.4 m.
Because trenches should not be longer than 20m, it is appropriate to recommend three 18.1 m (54.4/3) trenches (0.8 m wide) in parallel.

3.2.1 TRENCH LAYOUT

As noted in Example 2, the recommendation is that the length of a conventional soakage trench should be no more than 20 to 25m. The base of the trench must also be perfectly level. For the higher wastewater loads more than one trench is required. When this is the case it is necessary to install a distribution box (see photo) to evenly split the outflow from the septic to each of the trenches. Refer Section 11.3 for drawings of the distribution box.

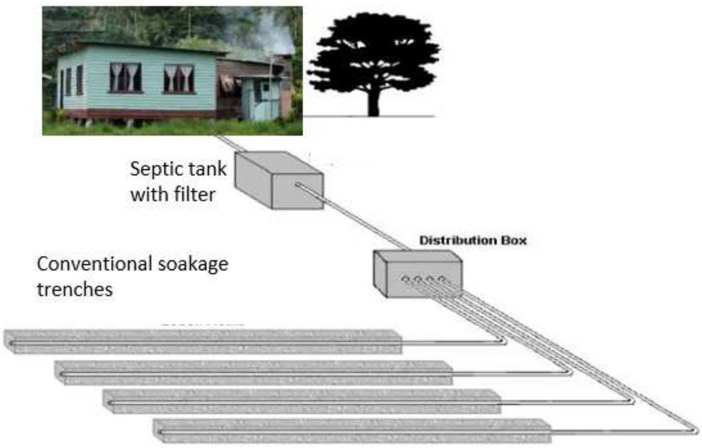
The distribution box must have a secure lid but be accessible for servicing. Care must also be taken to ensure there is no risk of surface waters leaking into the distribution box.

Distribution box to evenly split flow between soakage trenches. Note the flow deflector in front of inlet pipe. A T-pipe can be used instead to perform the same function.

Figure 3. Distribution Box

Dimensions of trenches can be modified within the constraints of these guidelines to fit the shape of the available site. Figure 4 illustrates a soakage field with four soakage trenches for septic effluent. Drawing D2.2 (Section 11) provides the cross-section detail of the conventional seepage trench, based on recommendations in the Australian and New Zealand Standard, AS/NZS1547:2012, Figure L1.

Figure 4. On-site wastewater management service showing underground septic tank and soakage trench field. The base of the trenches should be filled with washed stones or gravel.



For both free-drainjng and moderately-draining soils, Table 1 provides the trench length required per occupant for a 600mm wide trench for both blackwater only and for combined black and greywater systems.

Table 1. Conventional soakage trench length

L/person/day	Trench width = 600mm	
	Free-draining soils DLR 25 mm/day	Moderately-draining soils DLR 12 mm/day
	Trench length (m)/occupant	
45 (Blackwater only)	3	6.25
180 (Greywater + blackwater)	12	25

Over time the soil surfaces within the trench may block due to the build-up of bacterial slime (anaerobic biofilm) and organic matter. There are three measures that can be adopted to minimise this risk of blockage:

- Installation of a septic filter (always recommended; see KoroSan #3).
- Good venting within the trench to enable air to enter and circulate.
- Dose loading to provide more even distribution of the applied effluent along the full length of the trench.

Conventional soil soakage trenches should only be installed in free or moderate draining soils. Refer to KoroSan #2. If the soils are poorly draining, sand trenches (with under-drainage if required) should be used instead. See Section 3.4.

The design details of soil soakage trenches are illustrated in Section 11.2.

Refer to Section 6 for siting of conventional trenches.

3.3 SAND FILTRATION TRENCHES/BEDS FOR FREE-DRAINING SOILS

For site conditions that are unfavourable for conventional soakage trenches or soak pits, (refer to Section 4), a sand filtration trench or bed may be a suitable land application system. The sand filtration trench or bed[1] is based on the design recommended for the discharge control trench described in AS/NZS 1547:2012, Figure L4.

[1] A **trench** is typically no more than 1m wide while a **bed** is effectively a wide trench, wider than 1m and typically 2.4m wide or more.

Filter grade sand must be used in sand filtration beds and trenches. . This is a coarse clean sand, free of fines[2]. Refer to Section 7 for the specifications. Specialist advice may need to be sought to ensure the correct sand is used. The effluent from the septic tank must be spread evenly over the surface of the sand bed/trench. This requires the use of a dose loading device, such as a Flout or pump. This replaces the need for a distribution box. After passing through the filter sand the wastewater is of much improved quality. This not only means that many of the pathogens and some of the nutrients have been removed, but also this higher quality wastewater will not clog the soil to the same extent and will infiltrate more quickly into the trench (or bed) base and walls. A shallow layer of leaf mulch or palm leaves should be placed on the surface of the sand filter to assist the development of an active community of worms and insects. The mixing and grazing activity of this community helps to maintain the porosity of the surface layers of the sand filter.

Wherever possible it is preferable to dose load effluent to a trench or bed using a gravity device such as a Flout rather than a pump (Refer to Section 3.6). Installation of a pump is likely to be more expensive than a Flout, and it requires electricity which incurs ongoing costs. Pumps can also fail and will need servicing or replacing. However, pump dosing means the sand filtration bed, does not have to be downslope of the dosing device, which provides more options for its location. For a Flout to work effectively the sand bed will need to be lower (by about 600-800mm) than the septic tank outlet to provide enough fall across the Flout. Refer to Drawings D4.4, Section 11.

The sand trench should only be installed where soils are free or moderate draining soils. Refer to KoroSan #2. If the soils are very poorly draining, sand trenches with under-drainage should be used. See Section 3.4.

The length of the sand filtration trench, depends on:

- The design loading rate to the surface of the sand bed – value recommended is 40L/m^2.day
- The design daily wastewater volume discharging from the septic tank
- Width of the sand trench

Typically, the sand trench width is 0.8m. Assuming a daily blackwater volume of 45L/occupant and 140L/occupant for greywater, the trench length per occupant is:

For blackwater only (45L/occupant)	Length = 45/(40x0.8) = 1.4 m per occupant
For black and grey water (180L/occupant)	Length = 180/(40x0.8) = 5.6 m per occupant

Refer also to Table 4. The design details of sand trenches have been illustrated in Section 11.4.

[2] If the in-situ base soil is a sand that meets the required specifications, then there is no need to import filter grade sand.

3.4 SAND FILTRATION TRENCH OR BED WITH UNDERDRAINAGE

For sites where the soils are silty and/or clay soils with imperfect or poor drainage capacity, it will be necessary to install under-drains to void flooding the trench which would result in its failure. The quality of the under-drainage, filtered through the sand filter, will be significantly better than septic tank effluent, provided appropriate filter grade sand is used and the sand trench or bed is dose loaded. However, the under-drainage must still be managed as a potential health risk. It will contain reduced concentrations of faecal bacteria and other potential pathogens, but will still be contaminated.

The design details of sand trenches with under-drainage have been illustrated in Section 11.6

The discharge from the under-drain must be managed safely. The daily volume of under-drainage will be significantly less than the daily volume from the septic tank due to both seepage into the bottom of the trench or bed and evapotranspiration from the top of the trench. Options for management of the under-drainage are described and assessed in Table 2.

Table 2. Options for management of sand filtration trench under-drainage.

Option description	*Risks*	*Measures to reduce the risk*
1. Discharge to a stream or drain	Not recommended. The stream or drain will become contaminated with low levels of potential pathogens and elevated nutrients.	Discourage public access and use of the stream or drain; especially children. Plant the drain with water-tolerant plants to create vegetative filter.
2. Discharge to a soak pit (see Section 3.1)	This is the preferred option provided groundwater wells or bores are not within 50m. Soak pit will flood if soils are poorly draining, groundwater levels are high or surface water can enter the pit.	Avoid using soak pits in clay soils. Look for options to place soakage pit in more free-draining soils and pipe underdrainage discharge to it. Use larger soak pits Ensure toilet (and tap fittings etc., where connected) are not leaking causing excess discharge volumes Reduce potential for other surface- and ground-waters to enter the soak pit.
3. Discharge to planted swale or constructed wetland	The swale/wetland will be a wet area with potential, but reduced, health risks to people who come into contact with it.	Prevent access by children Make adults aware of the health risks and the need for good hygiene practice. Place away from areas used by people and fence where necessary

3.5 SITES WITH HIGH GROUNDWATER

Where ground water is high, special measures may be required. Refer to KoroSan #2 for advice on how to assess groundwater levels. Other toilet options (see KoroSan #1) or specialist assistance may be needed.

3.6 DOSING OPTIONS

Dosing is required for sand trenches and beds to provide even application of the applied wastewater over the sand bed. Dosing is desirable for conventional soakage trenches, although not essential. The two most common dosing devices are the pump and the Flout. Self-starting dosing siphons are also available, but, in our experience, are less reliable than Flouts. If dosing is required and sufficient fall is not available for a Flout or siphon, then a pump will be needed.

PUMPS

Reliance on pumps should be avoided if possible. Operation of pumps requires an electricity supply. Power costs will need to be paid or alternative energy sources such as solar or wind will be required. Operation of the wastewater system will be more vulnerable to natural hazards like earthquakes, volcanoes, floods, tsunami and cyclones. Maintenance and servicing will be needed, with allowance for eventual replacement.

There are many different types of pumps. For septic tank effluent, it is important to use a pump specifically designed for this effluent. A submersible volute pump would be suitable. Do not use sump pumps designed for clean water.

Figure 5. Submersible volute pump

FLOUT

Flouts™ are gravity dosing devices suitable for Wastewater LAS. For a Flout to operate successfully, a suitable fall is required between the outlet of the septic inlet to the soakage trench. The required fall will depend on the distance between the Flout chamber inlet and the inlet to the trench or bed. The pipe grade to the trench needs to be at least 1:80 and the vertical distance between Flout chamber inlet and outlet needs to be at least 400mm. Refer to Drawing D4.4 Section 11.4 and the associated table to determine the fall required for successful operation of a Flout dosing system.

Flout set up:

- Install the Flout in a separate water-tight chamber outside the septic tank.
- The dose volume (in Litres) can be calculated as the drawdown (in mm) x plan area (in m^2) of the dose chamber.
- The drawdown can be varied by increasing or decreasing the length of the swing pipe (see Table 3 and Figure 6).
- The vent is to be at least 100mm above top water level in the Flout chamber and best located inside the chamber, but could also be located outside the chamber. The vent may be located outside of the chamber in which case it needs to be at least 200mm above top water level.

Table 3. Flout drawdown and swing arm length.

Swing pipe length L, mm	Drawdown, mm
0	160
50	201
125	278
150	307
175	340
200	374
250	448

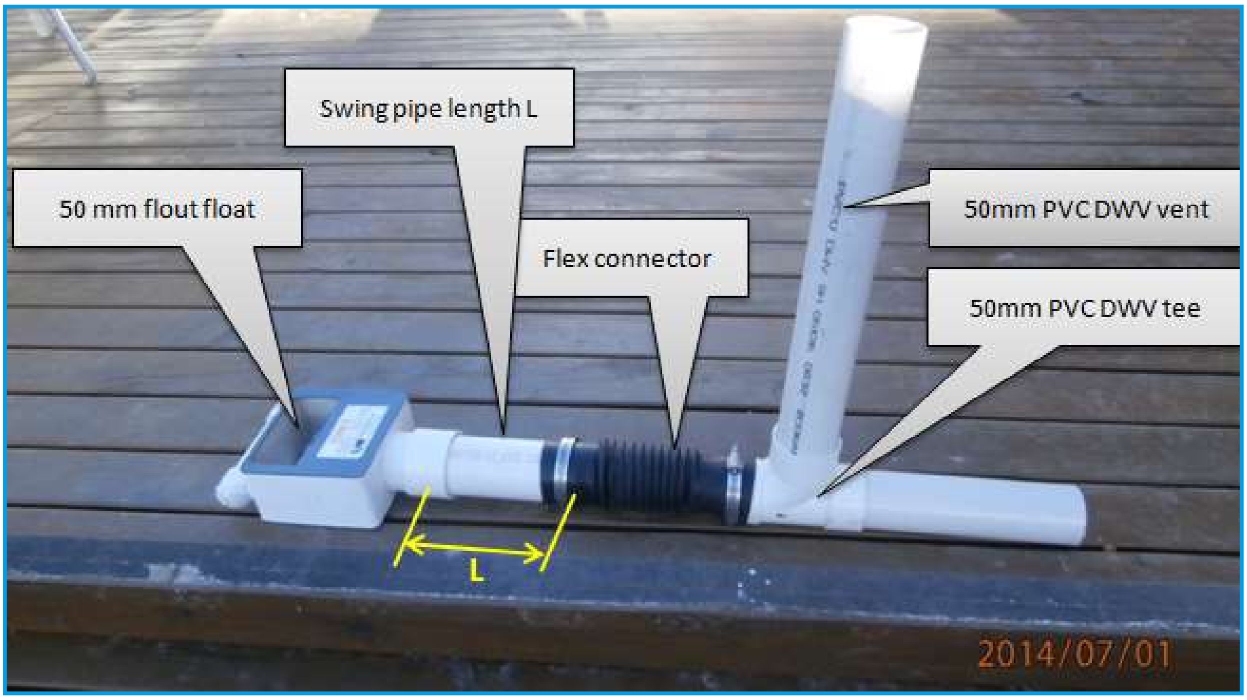


Figure 6. A 50mm dosing Flout.

4 CHOOSING AN APPROPRIATE LAND APPLICATION SYSTEM

The primary purpose of the land application system is to enable the safe absorption of the treated wastewater into the soil for the next 15 to 30 years. Safe absorption means that there is minimal health risk created by the land application system. Surface ponding and contamination of surface and ground water must be avoided especially if used for drinking (humans and animals), bathing, washing, food gathering and recreation.

KoroSan #1 provides advice on how to choose an appropriate on-site wastewater management system (OWMS) for a specific site. KoroSan #2 provides advice on how to carry out a site and soil assessment, and, in particular, how to determine soil drainage capacity.

Use the following simple flow diagram to begin the process of selection of a site specific wastewater land application system.

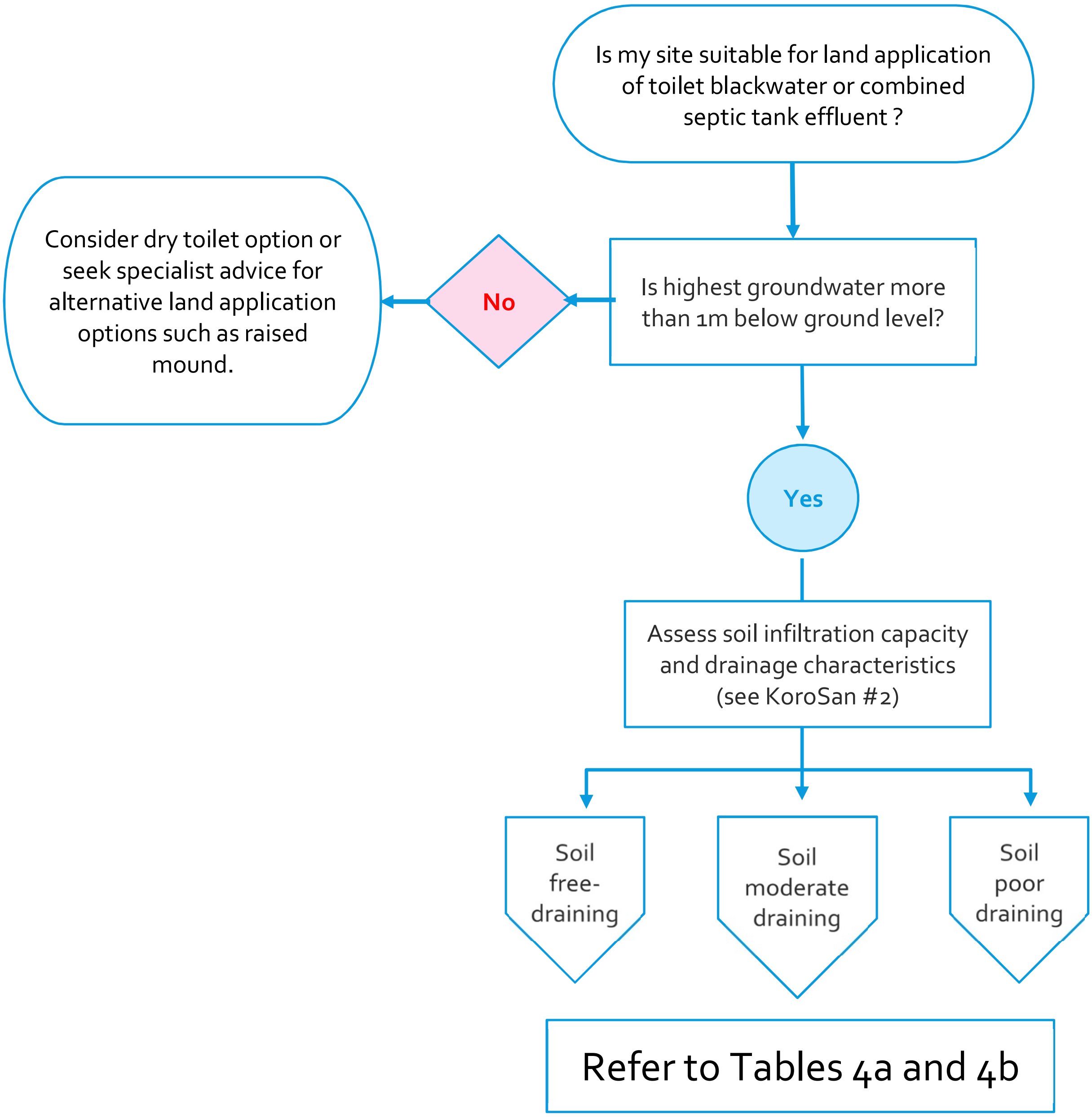


Table 4. Land application system selection based on soil and site assessment results

Table 4a. Land Application System (LAS) options considering groundwater height and proximity of drinking water bores

Highest ground-water level. **Note 1.**	Distance to nearest private and community drinking water bore		
	Less than 100m	100 – 300m	More than 300m
Less than 2m	Risk very high. Shift bore or consider dry toilets. Refer **Note 2**		Raised sand trench. Refer to **Note 3**
2m to 6 m	Risk very high. Shift bore or consider dry toilets. Refer **Note 2**	Sand trench. Refer to **Note 4**	Dose load to conventional trench. Refer to **Note 5**
Greater than 6m	Sand trench. Refer to **Note 4**	Dose load to conventional trench. Refer to **Note 5**	Soak pit or trickle load to conventional trench. Refer to **Note 6**

Notes

1	Groundwater (GW) refers to subsurface water stored in an aquifer and currently or potentially extractable for human or stock consumption, or emerging to a surface water body. Ground water depth will vary from day to day. (Refer to KoroSan #2). It is important to consider only the highest groundwater level. Interpretation is likely to require qualified and experienced advice. Set back distances have been determined based on recommendations for avoiding virus transmission (Ref: Moore et al 2010)
2	High groundwater with nearby bores used as a drinking water source are very high risk circumstances. Sanitations options are: a. Install a suitable dry toilet such as an elevated composting toilet (Refer to **Live and Learn 2011**). (The VIP, ecoVIP2 and pour flush toilets are unsuitable in conditions of high groundwater) b. Install a holding tank and pump out and cart off site when full which is a very expensive option c. Install high technology treatment plant with disinfection (e.g. UV), which is a very expensive option
3	The sand trench is to be dose loaded. The trench is to be raised to achieve at least 1m setback for the base of the sand trench and the highest groundwater level. Requirements in **Table 4b** must be applied.
4	Sand trench is to be dose loaded. Requirements in **Table 4b** must be applied.
5	Requirements in **Table 4b** must be applied.
6	If the soils are either moderate or poor drainage, soak pits are not recommended. Refer to **Table 4b** for options**.**

Table 4b. Land Application System (LAS) options based on soil drainage characteristics

<table>
<tr><th rowspan="2">Land application design option</th><th rowspan="2">Drawing</th><th colspan="3">Soil drainage category[1]</th></tr>
<tr><th>Free draining</th><th>Moderate draining</th><th>Poor draining</th></tr>
<tr><td>Soak pit</td><td>D1</td><td>Acceptable. Subject to Table 4a requirements</td><td colspan="2">Not recommended</td></tr>
<tr><td>Conventional trench, trickle load[2] or dose load[3]</td><td>D2</td><td colspan="2">Acceptable. Subject to requirements of Table 4a</td><td rowspan="3">Not recommended</td></tr>
<tr><td>Sand filter trench, no under-drain, dose loaded</td><td>D4</td><td colspan="2" rowspan="2">Acceptable.</td></tr>
<tr><td>Raised sand filter trench, no under-drain, dose loaded</td><td>D5</td></tr>
<tr><td>Sand filter trench with under-drain, dose loaded</td><td>D6</td><td>Not required</td><td>Optional, subject to requirements of Table 4a</td><td>Only acceptable option</td></tr>
</table>

1. Refer to KoroSan#2 for advice on determination of soil drainage capacity
2. “Trickle load” means the discharge, from the septic tank outlet, to the land application system is unaided by, for example a pump or Flout. Outflow (effluent) is displaced inflow to the septic tank
3. Dose load” means the discharge, from the septic tank outlet, to the land application system is aided by, for example by a pump or Flout.

5 WHERE SHOULD I SITE A LAND APPLICATION SYSTEM?

Restrictions and set-back distances for land application systems are specified in Table 4a. Other setback requirements are summarised in Figure 7. Other factors to consider when site a land application system include the following:

- Check for other buried services; water supply pipelines, stormwater pipes, power and telecommunication cables.
-
- Setback from bores are as required in Table 4a.
- Soakage trenches and beds must be positioned along the contour to ensure the base of the trench is perfectly level.
- If a sand trench with underdrainage is required, consider where the underdrainage will be disposed to. Avoid causing any health or environmental risks.

Where NOT to site a land application system:

- Areas used for growing, processing or storing food.
- Public areas where villagers and children gather, play and recreate.
- Areas subject to flooding and tidal surges and surface flooding after heavy rainfall.
- Areas where ground water is less than 1m below ground-level at any time throughout the year.
- Areas where soils become wet and saturated at any time and are wetlands.
- Areas where surface and subsurface water drain after a rainfall event. This can be diverted by the installation of interception field drains (Refer to Section 11, Drawing D6.3)
- Setback from bores less than those recommended in Table 4a.
-
- Closer than 5m to a house
- On land that slopes more than 15° (25%).
- Land with many large tree roots (It may be appropriate to remove trees and their root system).
- Near stock grazing areas or near pig pens

All other sites are likely to be suitable. The area of land required for an effective land application system is discussed in the following Section 6.

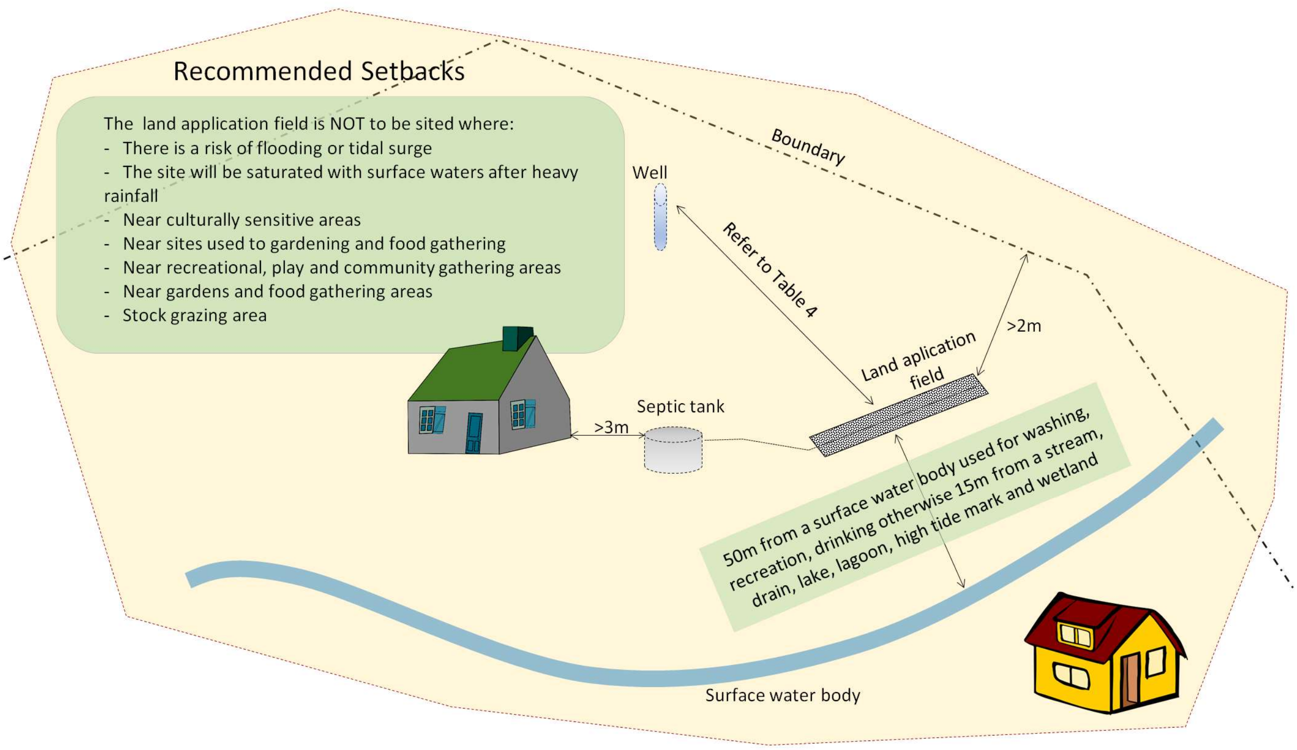
6 SIZING THE LAND APPLICATION SYSTEM

Examples of the dimensions of a conventional seepage trench and sand filtration trench for two different daily loads; 360 and 640 L/day are shown in Table 5. 360 L/day represents the blackwater volume from a dwelling with eight permanent occupants. 630 L/day represent 2 dwellings with 8 and 6 permanent occupants with septic tanks connecting into the same land application system.

Table 5. Examples of land application system dimensions for two daily volumes of blackwater.

Soil type	Daily Loading	Conventional soakage trench 25 mm/day			Sand filtration trench 40 mm/d		
		Width	Number of trenches	Length	Width	Number of trenches	Length
Free-draining	360 L/day	600 mm	1	24 m	800mm	1	11 m
	630 L/day	600 mm	2	21 m	800mm	2	10 m
		Conventional soakage trench 12 mm/day			Sand filtration trench with under-drainage 25mm/day		
Moderate-draining	360 L/day	600 mm	2	25 m	800mm	1	18 m
	630 L/day	600 mm	4	22 m	800mm	2	16 m
		Conventional soakage trench			Sand filtration trench with under-drainage 25 mm/day		
Poor-draining	360 L/day	*Not applicable*			800mm	1	18 m
	630 L/day				800mm	2	16 m

Figure 7. Recommended restrictions and setbacks for Land Application Systems.



7 LAND APPLICATION SYSTEM MATERIALS AND CONSTRUCTION

7.1 MATERIALS

The key materials required for the different land application systems are described below:

Geofabric	Also known as filter cloth or bidum, this is a fabric used in drainage and roading construction to retain soil fines as water drains through the cloth. It comes in different grades. A medium grade filter cloth is sufficient for the land application systems for wastewater. The purpose is to prevent soil fines migrating into the soakage and sand trenches, over time, eventually causing it to clog
Polyethylene sheet	Polyethylene sheet can also be used instead of the geofabric. If used, a heavier grade (120 micron) is recommended.
PVC and PE pipe and fitting	Low pressure (wastewater pipe) polyethylene or PVC pipes, with appropriate fittings are required. If pumped systems or steep slopes are involved pressure pipe and fittings may be required. If uncertain seek specialist advice.
Filter sand	This is a particular grade of sand suitable for filtering of wastewater providing pathogen reduction with low risk of blockage. The specifications of filter grade sand: • Free of clay, limestone and organic material • Medium sand, 0.25 - 1.0mm • Coefficient of uniformity $(Cu) < 4$, and • Less than 3% fines (≤ 0.74mm) (Ref: AS/NZS1547: 2012. N3.2.2) **Specialist advice may need to be sought to determine the sand grade.**
Washed aggregate	The washed aggregate (10mm to 50mm range) is to be free of fines and structurally stable (i.e., not "rotten" rock which will disintegrate with wetting)

7.2 WORKMANSHIP

All pipe work, tank construction or sanitary fixtures and fittings installed in connection with any septic tank, water carriage or similar system should be carried out by or under the supervision of a suitably qualified and experienced tradesperson.

7.3 HEALTH AND SAFETY

There are a number of important health and safety issues to be considered. These include:

- Working with and around excavation equipment.
- Loading, unloading and installing heavy items.
- Working in excavated pits and confined spaces.
- Working around electrical cable and equipment and other (buried) services.
- Working with sewage.

It is beyond the scope of the guideline to present the details of working safely. If you require further information, contact your local government agency responsible for work safety. Alternatively, the following New Zealand website provides a range of relevant health and safety resources: http://construction.worksafe.govt.nz/quick-guide/

Health Risks

When carrying out commissioning and servicing of land application systems it is important to recognise that all wastewater poses a serious health risk and direct contact with skin must be avoided. It is important to always wear the appropriate protective footwear, gloves and clothing when carrying out maintenance. On completion of work always wash thoroughly using soap.

Ensure all children and animals are kept well clear of the system being serviced. Warn community members of the health risks associated with wastewater.

8 COMMISSIONING THE LAND APPLICATION SYSTEM

The commissioning requirements for a land application system depends on the design, but normally it is relatively straightforward. The key issues are:

- Once installed carry out a flow test to ensure:
    - There are no leaks.
    - There is even distribution over the soakage area (if appropriate).
- If there is a distribution box ensure that the flows are evenly split to each outlet and that there is no risk of surface water leakage into the splitter box after rainfall.
- If the land application system includes a Flout, ensure the flout Float is level and carry out a flow test to check it is operating correctly.
- If the land application system includes a pump, commission the pump and float switch in accordance to the pump manufacturer's recommendations.

9 OPERATION AND MAINTENANCE

Refer to KoroSan #5 for details of operation and maintenance of a land application system.

10 RISKS

Nuisance from land application system.

ODOURS

There should be very little risk of nuisance odours arising from a well-designed and maintained land application system. Odours are likely to indicate failure has occurred and/or venting has not been installed correctly. Assessment will be required to determine the cause of the odour and remedial action should be taken promptly.

EXPOSED EFFLUENT

Exposed effluent is a very high health risk. If it occurs, the area must be immediately isolated with barriers and warning signs to prevent any human or animal contact with the exposed effluent. The cause of the exposed effluent must be fixed as soon as possible by a qualified tradesperson. The exposed effluent may result from a failed or blocked land application system and consequent flooding and overflowing of the septic tank or dosing chamber, broken and leaking drains, or damaged and leaking septic tank.

MOSQUITO BREEDING

All effluent chambers must be sealed and vents screened to reduce the risk of mosquito breeding. Similarly, surface ponding must be prevented. If breeding areas do arise these should be sprayed with suitable insecticide and mosquito entry prevented.

Figure 8. Failure of a septic tank soak pit installed in inappropriate soil conditions. Note ponding of highly contaminated effluent on the soil surface.

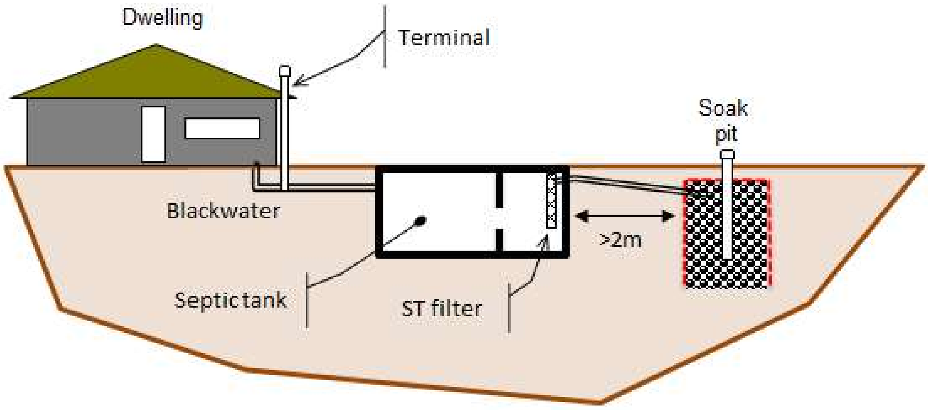
11 LAND APPLICATION SYSTEM DRAWINGS

The following drawings relate to Table 4.

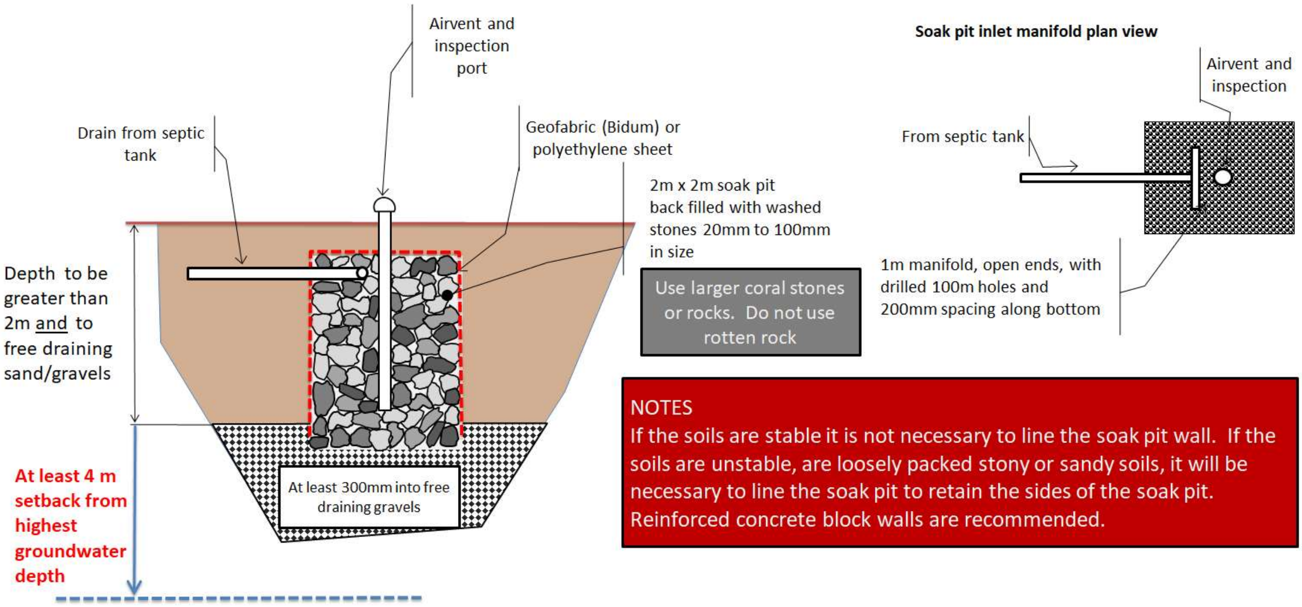
> Note.
> All drawings in this section are schematic. Engineering and construction details, which will be specific to site conditions, are not specified. It is the responsibility of a qualified design engineer to carry out a site and soil assessment (refer to KoroSan #2) and to provide these details for the specific site.

11.1 DRAWING D1: SOAK PIT

Drawing D1.1. Septic tank to soak pit on free-draining soils.

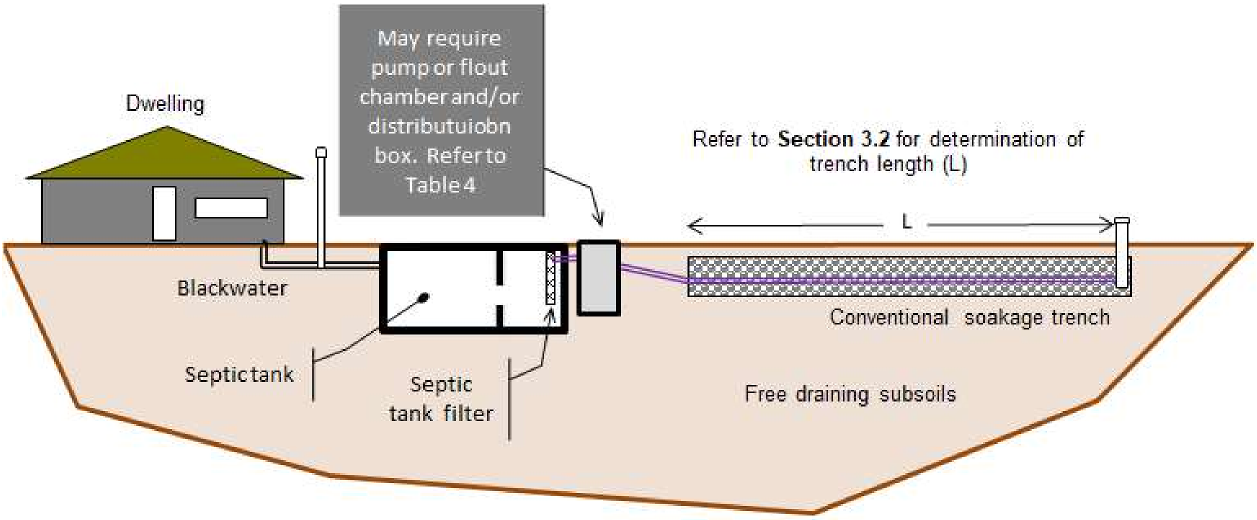


Drawing D1.2. Cross-section of soak pit.

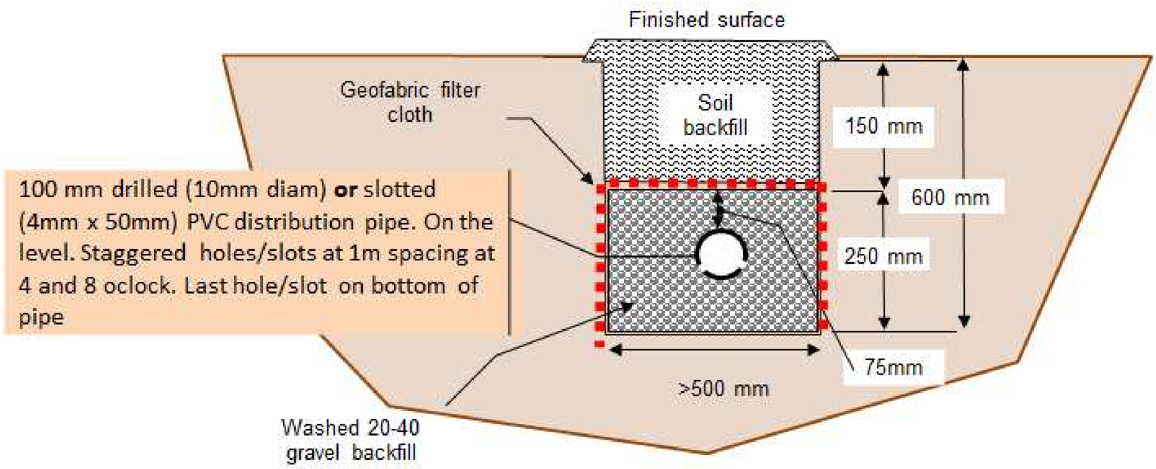


11.2 Drawing D2: Conventional Seepage Trench

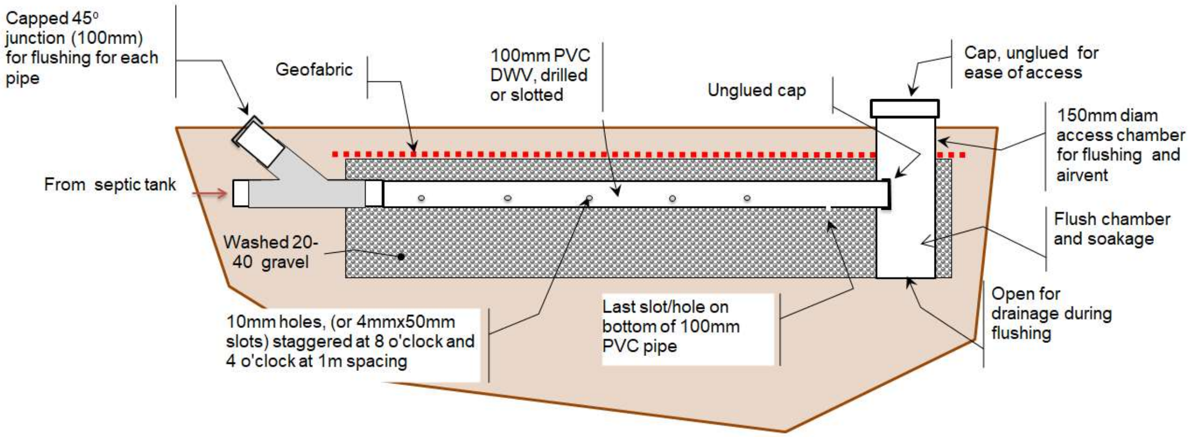
Drawing D2.1. Schematic layout



Drawing D2.2. Cross-section

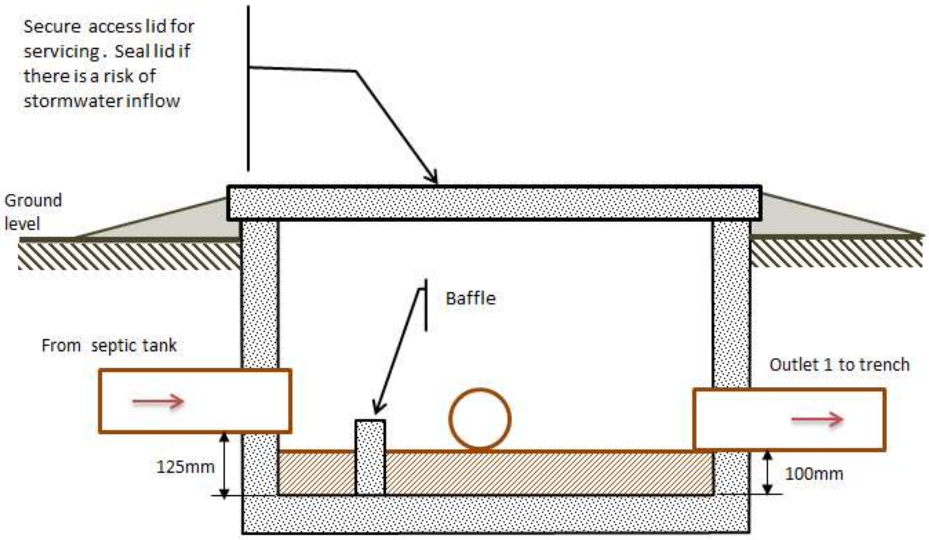


Drawing D2.3. End assembly

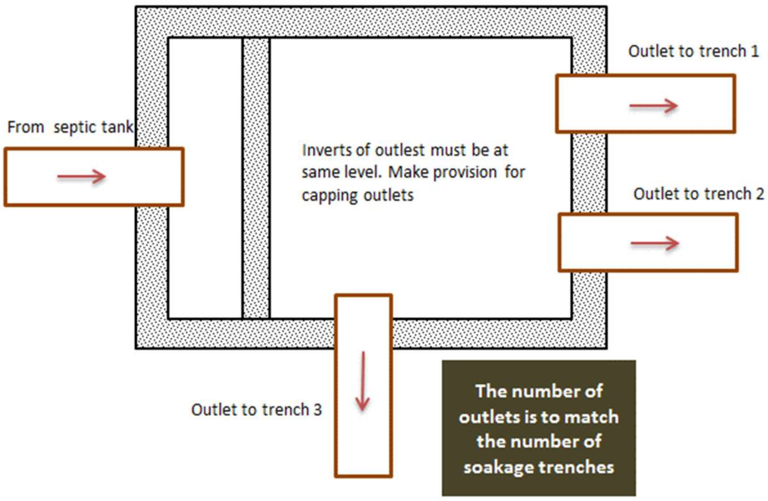


11.3 DRAWING D3: DISTRIBUTION BOX DETAILS

Drawing D3.1. Side elevation of the distribution box

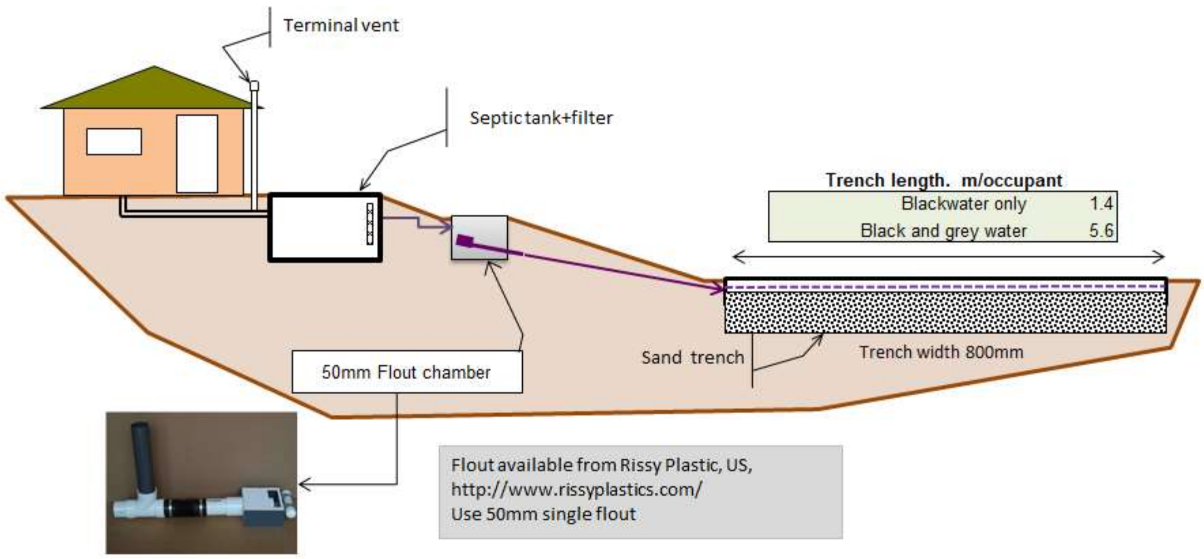


Drawing D3.2. Plan view of the distribution box.

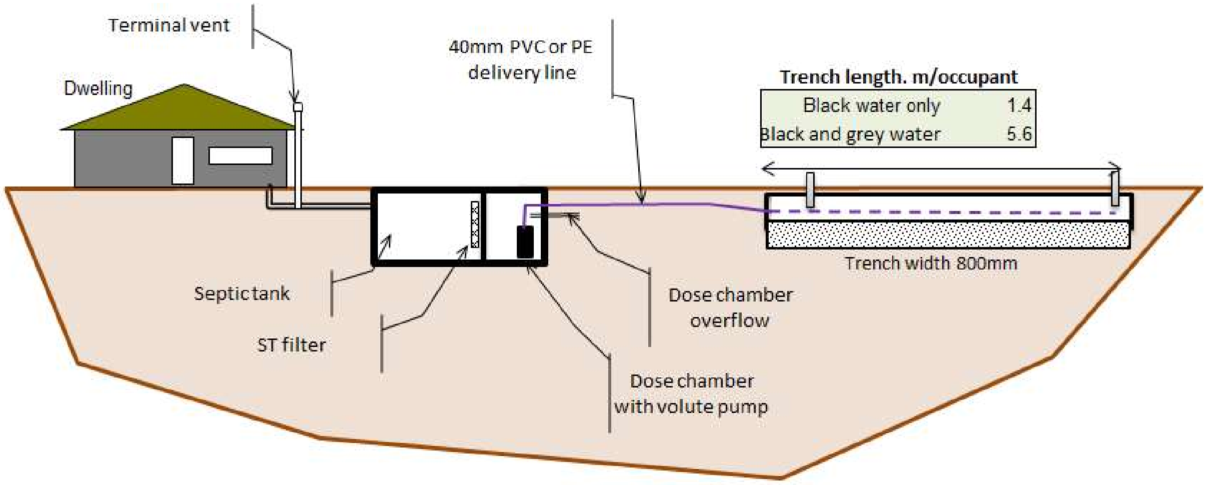


11.4 DRAWING D4: SAND FILTER TRENCH, DOSE LOADED ON FREE-DRAINING SOILS

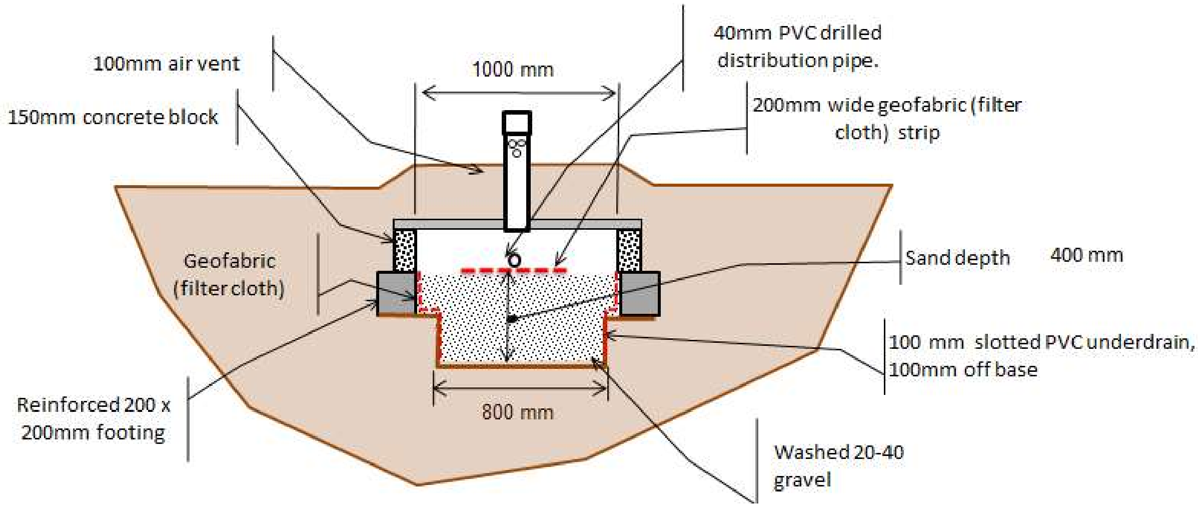
Drawing D4.1 Flout (gravity) dose loaded sand filter trench.



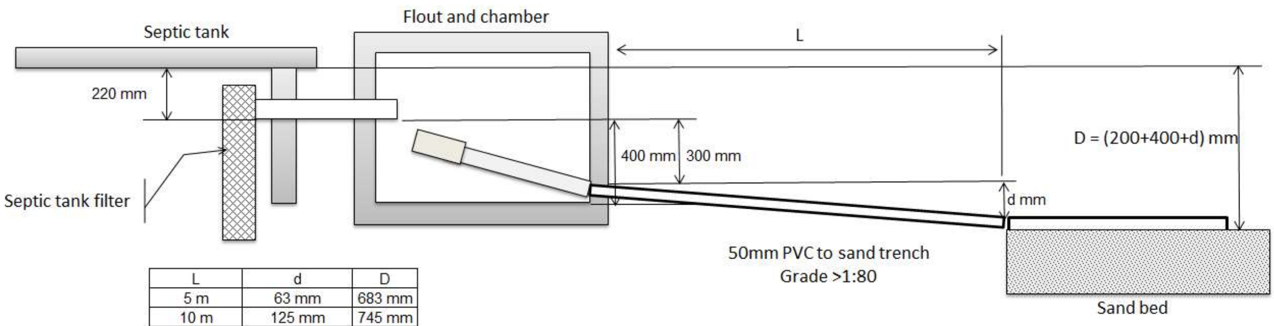
Drawing D4.2 Alternative pump dose loaded sand filter trench



Drawing D4.3. Cross-section of sand trench on free-draining soils



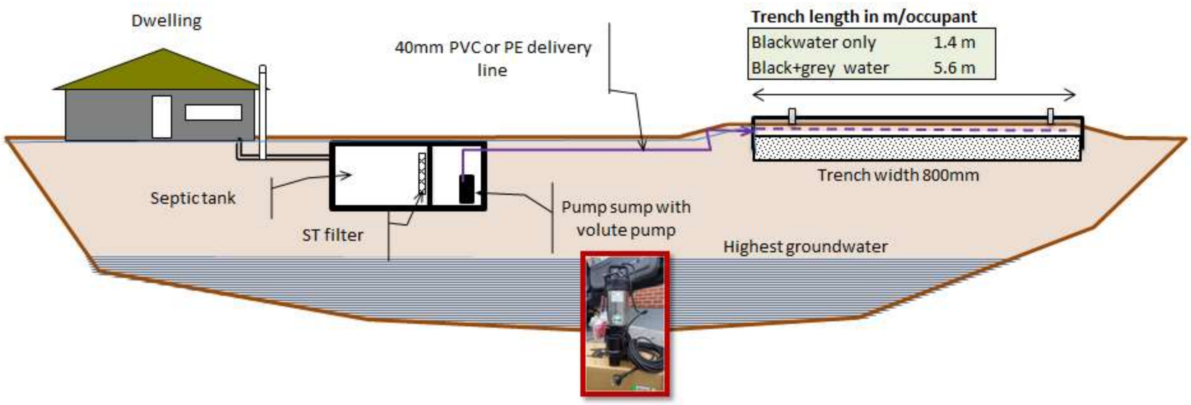
Drawing D4.4. Fall required for Flout dosing option.



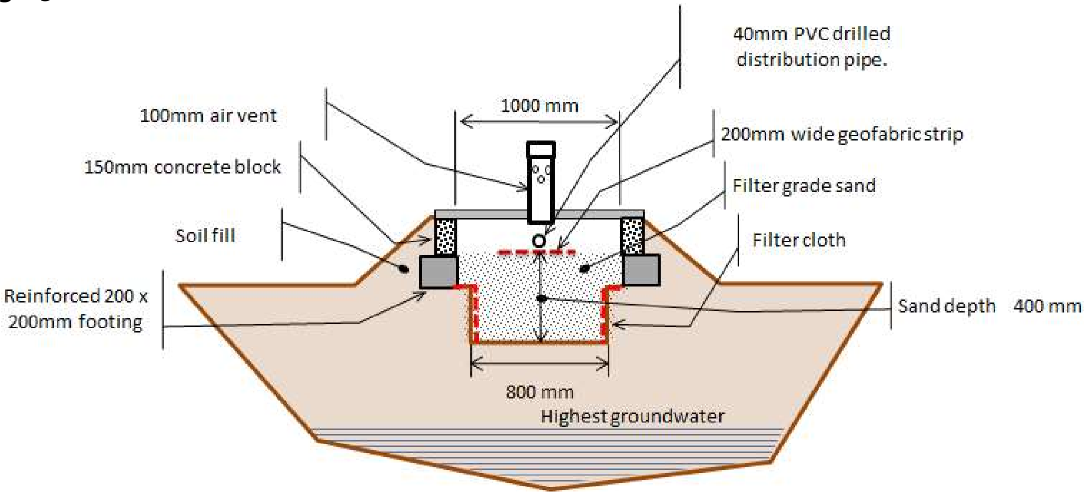
L	d	D
5 m	63 mm	683 mm
10 m	125 mm	745 mm
15 m	188 mm	808 mm
20 m	250 mm	870 mm
25 m	313 mm	933 mm

11.5 DRAWINGS D5: DOSE LOADED RAISED SAND FILTER TRENCH

Drawing D5.1. Schematic layout.



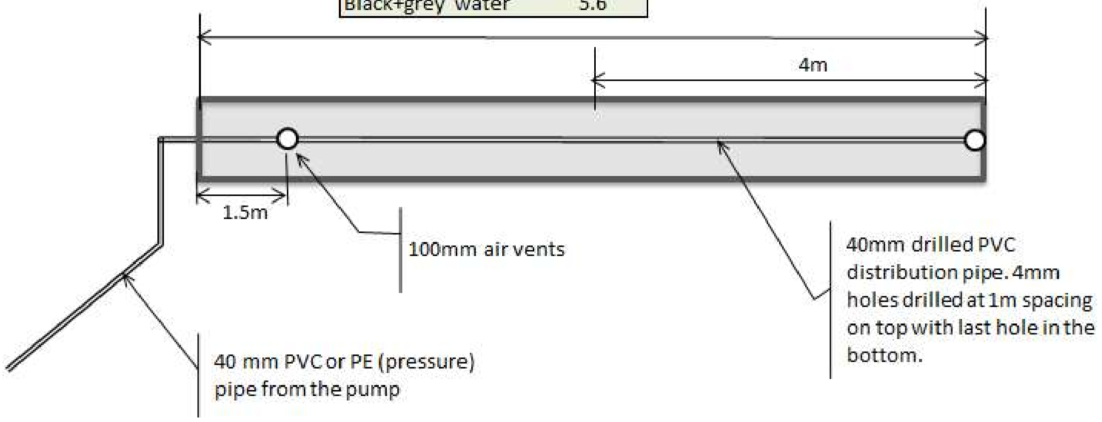
Drawing D5.2. Cross-section



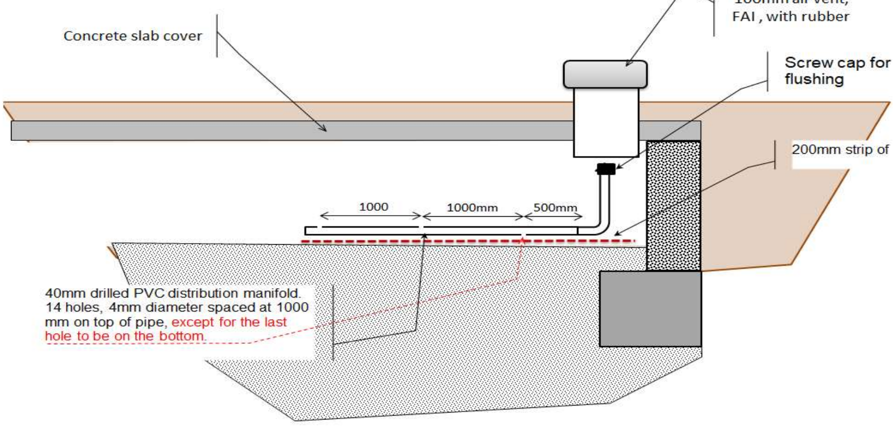
Drawing D5.3. Plan view

Trench length. m/occupant

Blackwater only	1.4
Black+grey water	5.6



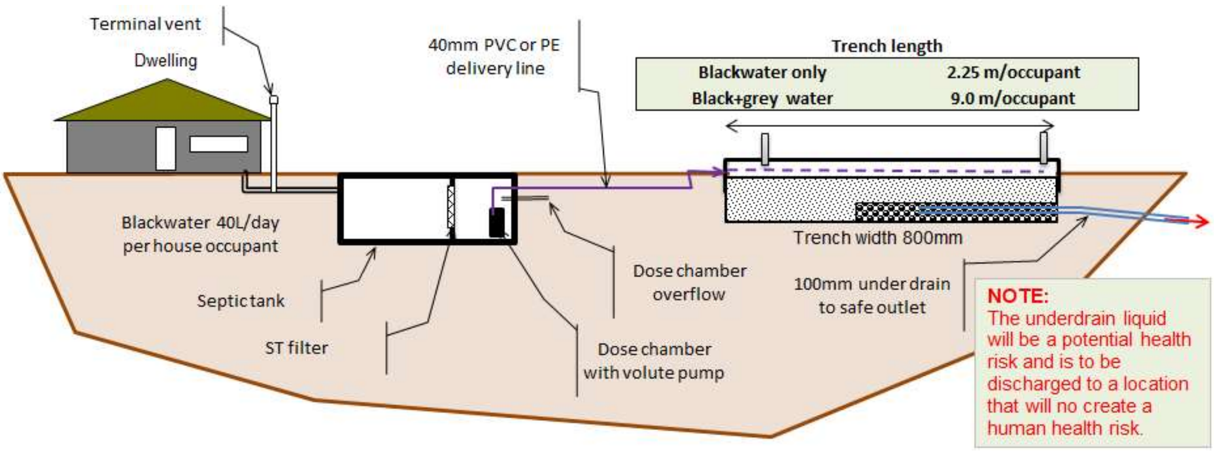
Drawing D5.4. End assembly



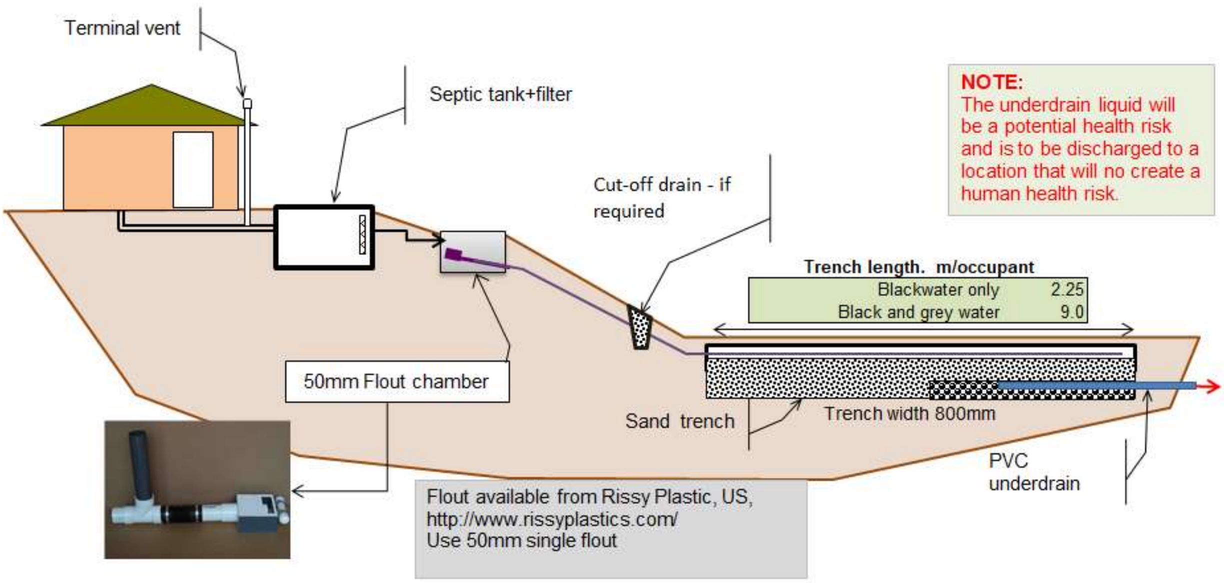
Refer to **Drawings D5.2 and D5.3** for plan details of the distribution pipe and flushing requirements.

11.6 DRAWING D6: SAND FILTER TRENCH WITH UNDER-DRAIN

Drawing D6.1. Pump dose loading to a sand filter trench with under-drain

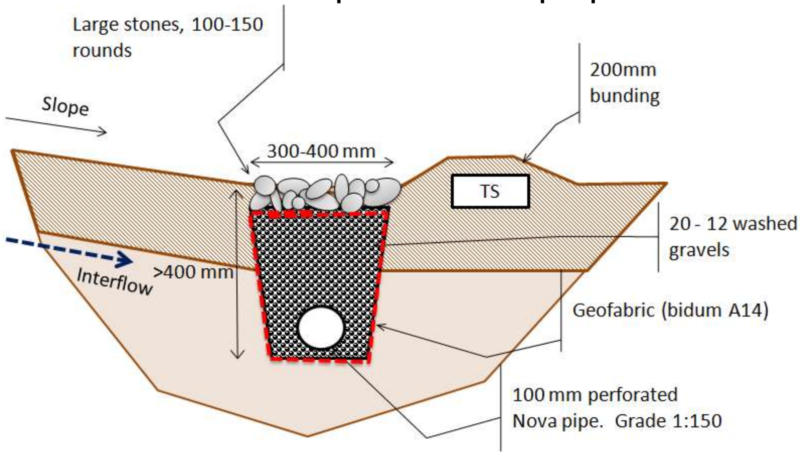


Drawing D6.2. Gravity (Flout) dose loading to a sand filter trench with under-drain.

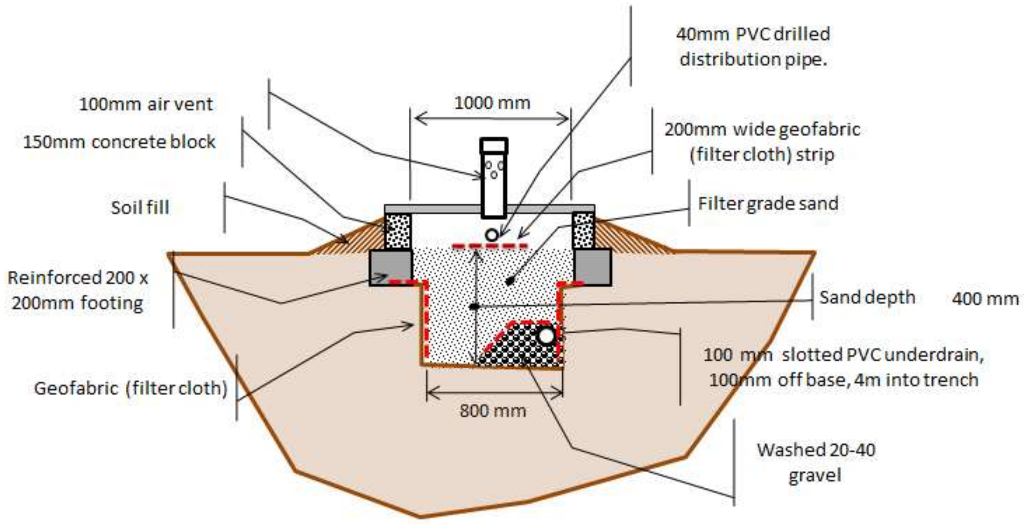


Refer to **Drawing D4.4** for determination of fall requirements for gravity dosing using a Flout.

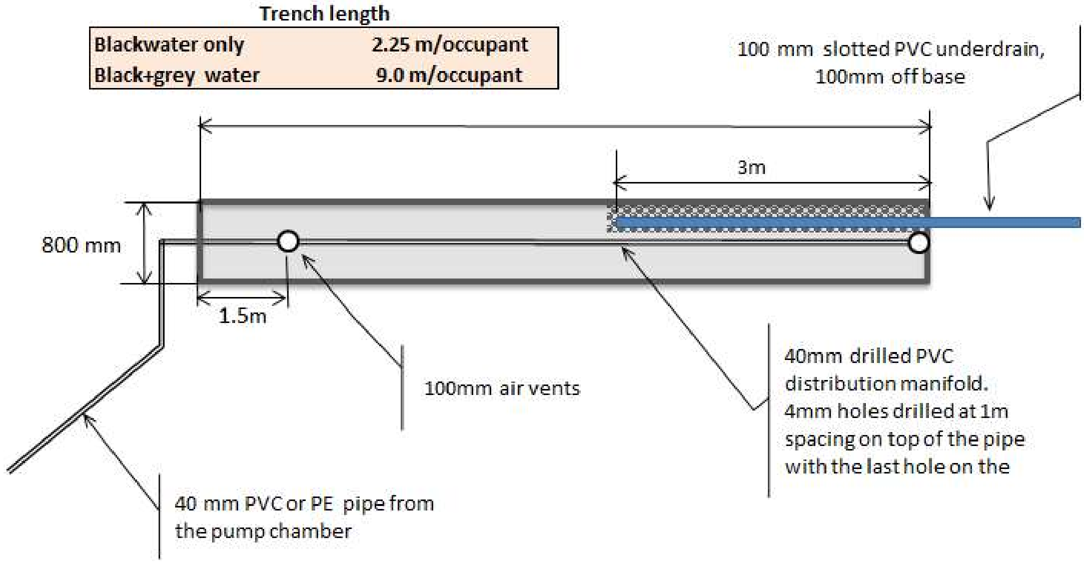
Drawing D6.3. Cross-section detail of interceptor field drain upslope of sand filter trench.



Drawing D6.4. Cross-section of sand filter trench with under-drain



Drawing D6.4. Plan view of the sand trench with under-drain



Refer to Drawing D5.4 for details distribution pipe and flushing requirements.

12 REFERENCES

AS/NZS 1547:2012. On-site domestic wastewater management. Australian and New Zealand Standards. https://www.standards.govt.nz/

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Moore C., Nokes C., Low B., Close M., Pang L., Smith V., Osbaldiston S. 2010. Guidelines for separation distances based on virus transport between on-site domestic wastewater systems and wells. ESR Client Report No. CSC1001. Environmental Science and Research Limited, Porirua, NZ. https://envirolink.govt.nz/assets/Envirolink/Guidelines-for-separation-distances-based-on-virus-transport-.pdf

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The Department of Water and Sewage.
The Ministry of Health, or your local
Provincial Council

KoroSan Guidelines

The WASH w project has produced the following series of technical and participatory guidelines to help mobilise villages and settlements to improve their water supply, sanitation and hygiene. These guidelines may be freely disseminated provided the source is acknowledged.

KoroSan #	Title
1	Choosing a village wastewater management service
2	Site, soil and wastewater flow assessment
3	Septic tank construction using concrete blocks.
4	Land application systems
5	Maintaining your septic tank and land application system
6	Water-less ecoVIP2 toilet
7	Greywater management
8	Village participation in water and sanitation actions

KoroSan – for healthy villages