Guidelines for on-site sewage systems in the Wellington Region

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ABOUT THIS GUIDE

This Guide has been prepared for staff of Wellington Regional Council and the territorial authorities of the Wellington Region. It contains information about the effects of discharging sewage to land from on-site sewage systems, the regional rules that apply to such discharges, and the kinds of systems that can be used to treat and dispose of sewage on-site.

This Guide was prepared with the assistance of Ian Gunn, of the University of Auckland, Jacalyn Scott of Jacalyn Scott Consulting, horizons.mw (the Manawatu-Wanganui Regional Council), and the staff of the Wellington Regional Council, Kapiti Coast District Council, Porirua City Council, Wellington City Council, Hutt City Council, Upper Hutt City Council, South Wairarapa District Council, Carterton District Council, and Masterton District Council.

This Guide is primarily for the use of territorial authority staff, both planning and technical, when they are assessing the suitability of on-site sewage system designs, or applications to subdivide or change a land use.

Designs for on-site sewage systems must be made by a Suitably Qualified Person. Staff of territorial authorities have total discretion over the criteria they use to decide who qualifies as a Suitably Qualified Person.

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Tables

1. INTRODUCTION

This Guide has been produced by the Wellington Regional Council in association with the territorial authorities of the Wellington Region. The Guide contains information about on-site sewage systems, how they work, and whether a system is going to be right for the site. Information in the Guide is consistent with the procedures and performance criteria in the NZ Standards and the Regional Plan for Discharges to Land for the Wellington Region.

Sections 2 to 7 of the Guide contain information about the legal requirements for on-site sewage disposal, the effects of on-site sewage disposal and how on-site sewage systems work, how to undertake a site assessment for on-site sewage systems, how to use the Model Designs to choose a suitable on-site sewage system, and how to install and maintain an on-site sewage system.

Section 8 of the Guide contains the Worksheets for people to use when selecting a system for a particular site, and drawings of the Model Designs. Copies of the regional rules that apply to sewage discharges on-site are in Section 9.

2. LEGAL REQUIREMENTS FOR ON-SITE SEWAGE SYSTEMS

2.1 Resource Management Act

The Resource Management Act (1991) restricts all discharges of contaminants to water, and to land where the discharge may enter water. Such discharges must be authorised by Regional Councils, unless they have formally transferred the function to another statutory body, such as a territorial authority (city and district councils).

The Wellington Regional Council has adopted regional rules about on-site sewage discharges in the Regional Plan for Discharges to Land. No ***discharge permit*** is required if the system complies with conditions stated in one of these rules.

If a discharge does not comply with a regional rule, and the owner does not have a discharge permit, the person causing the discharge can be prosecuted under the Act.

The Act restricts all subdivision of land. Subdivision can only be authorised by City and District Councils. City and District Councils must have regard to the potential effects of a proposed use of the land before they authorise a subdivision or a change in land use. The disposal of effluent on-site can cause adverse effects on people and the environment (see section 4 of this Guide) and these effects should be taken into account during assessment of land use consents. If necessary, the City or District Council can attach conditions about effluent disposal to a subdivision or land use consent.

2.2 Building Act, Health Act, Local Government Act

City and District Councils are responsible for all provisions in the Building Act, 1991, the Health Act, 1956 and the Local Government Act, 1974 that relate to on-site sewage disposal. City and District Councils are responsible for authorising ***building consents*** for on-site sewage systems.

On-site sewage systems cannot be used in areas where a sewer is available. If a sewer is available, the property must be connected to the sewer (section G13.3.3 of the Building Code). City and District Councils have discretion about the meaning of “available”.

City and District Councils have the power under section 33 of the Health Act to obtain a District Court Order to have required work carried out if an on-site sewage system causes a health hazard, or an offence to neighbours. The Council may require the owner to do the work at their own expense, or have the work done and recover costs from the owner.

Section 39 of the Health Act prohibits a person from selling or letting an unsewered property if the on-site sewage system does not comply with the Building Code, and the Building Act. Section 54 of the Health Act requires every person who removes and disposes of sludge from on-site sewage systems to have the written consent of the Medical Officer of Health.

City and District Councils have powers under section 459 of the Local Government Act to require people to connect private drains to public drains, watercourses or the sea, and states when City and District Councils cannot require such connections. Nothing in the Local Government Act overrides the Resource Management Act, and section 459 does not override the need to comply with the Building Code.

2.3 Types of permits

2.3.1 Building Consents

Building Consents are issued by District and City Councils. Building consents are required for the structure, i.e. the tank, associated with any sort of on-site sewage system. A building consent does not authorise any discharge from the tank.

2.3.2 Discharge Permits

Discharge permits are issued by the Wellington Regional Council. This function can be transferred to other public authorities through a public process set out in section 33 of the Resource Management Act.

Discharges to land: No discharge permit is required for discharges of sewage to land provided the discharge complies with the conditions in Rule 6 or 7 of the Regional Plan for Discharges to Land for the Wellington Region. No discharge permit is required for discharges of greywater to land provided the discharge complies with the conditions in Rule 4 of the Regional Plan for Discharges to Land for the Wellington Region.

Discharges to water: Every discharge of sewage and untreated greywater to water in the Wellington Region requires a discharge permit. This applies whether the water is in a river, lake, roadside drain or any other watercourse, or under the ground. Discharges of sewage into soakholes, without treatment in a soakage treatment area, are treated as discharges to water.

All regional plans for the Wellington Region, and a Guide to the regional rules, are available on the Council's website (www.wrc.govt.nz). The Consents Help Desk at Wellington (04-384 5708), or any member of the Planning and Resources staff at Masterton (06-378 2484) can send application forms to anyone who needs to apply for a discharge permit.

Discharge Permit requirements are in addition to any requirements set out in the Building Consent.

2.4 New Zealand Standards

Provisions in New Zealand Standards are not legal requirements and so they do not have statutory force unless compliance with a standard is required by regulation, for example, a regional rule. Regional rules that apply in the Wellington Region for discharges of sewage to land do not require compliance with any standard. This was because the standards for on-site sewage systems were not completed when the plan was being developed and rules in plans cannot refer to unpublished documents.

There are two New Zealand Standards with performance statements that cover the overall design and sustainable management of on-site domestic-wastewater systems. These are the *AS/NZS 1546.1:1998 On-site domestic wastewater treatment unit, Part 1: septic tanks,* and *AS/NZS 1547:2000 On-site domestic-wastewater management.* One more standard is in development. This is *AS/NZS 1546.2: Aerated wastewater treatment systems (in draft).*

Compliance with New Zealand Standards does not automatically mean compliance with legislation, although the codes have been written so that requirements in the Building Code are met. They have not been written to comply with the requirements of regional rules. Discharges from all systems must comply with the Resource Management Act (1991).

This Guide includes reference to performance criteria in *AS/NZS 1546.1:1998* and *AS/NZS 1547:2000.*

3. HOW ON-SITE SEWAGE SYSTEMS WORK

This section of the Guide contains a brief run down on the range of systems available, what happens in a septic tank and what happens in a soakage treatment area. This is so that any variations to recommendations in the Guide are made in the context of how the changes would affect the effects of the discharge.

3.1 The range of systems

Variations in on-site sewage system designs affect the efficiency and effectiveness of the sewage treatment process. This Guide focuses mainly on the standard septic tank with a soakage treatment area. This is because these are the most common and yet many texts contain little rationale for tank designs and little information about the degree of treatment achieved in the tank. For information about other sorts of systems check the manufacturers and the internet.

The United States Environment Protection Agency has prepared a series of fact sheets about on-site sewage systems, see [http://www.epa.gov/owm/decent/technology.htm].[1] These fact sheets provide summaries of technical information addressing advantages and disadvantages of each system, design criteria, performance, costs, examples of installations, references, etc. There is no charge for downloading these fact sheets from the web site. Fact sheet topics are:

- Aerobic treatment
- Chlorine disinfection
- Composting toilets
- Evapotranspiration systems
- High efficiency toilets
- Incinerating toilets
- Intermittent sand filters
- Low pressure pipe systems
- Mound systems
- Ozone disinfection
- Recirculating sand filters
- Septage treatment/disposal
- Septic system tanks
- Septic tank leaching chambers
- Types of filters
- Ultraviolet disinfection

A similar series of fact sheets is available free at the National Small Flows Clearinghouse [http://www.estd.wvu.edu/nsfc/NSFC_ETI.html] which is one of four federally funded programmes at the environmental services and training division of West Virginia University

[1] These web site addresses were correct on 20 November, 2000.

in the United States. The National Small Flows Clearinghouse provides a one-stop-shop for information to protect the environmental health of America's small communities.

3.2 The septic tank

On-site sewage systems are made up of two treatment processes. The first process happens in the tank, the second part of the process is in the soakage treatment area. Both parts are essential. The first part of the treatment process will be either ***anaerobic*** (without oxygen), or ***aerobic*** (with oxygen), or sometimes a combination of both.

The standard septic tank and the multi-chambered tanks with rock filters, are anaerobic. The "package plants", "aerated wastewater treatment systems" (AWTS) and "home aeration plants" are aerobic. Septic (anaerobic) systems are the most common on-site sewage system and so this Guide focuses on them.

Common septic tank sizes vary from 2700 litres to 4500 litres. They can be made from concrete, fibreglass or plastic. The design criteria are in the NZ Standard for on-site domestic wastewater treatment units, Part 1: septic tanks (AS/NZS 1546.1:1998). Recommended minimum tanks sizes from the Standard are in Table 2 of this Guide.

Key functions of the tank —

- separate solids from liquid
- break down organic matter (solids) in the sewage
- store the accumulated sludge.

3.2.1 Separation of solids and liquids

The first stage in a septic tank treatment process is sedimentation, where heavier solids settle on the bottom of the tank, and light particles, e.g., grease and fats, float and form a ***scum***. Any organic matter retained in the tank is broken down by bacteria and the end-products of this process are gases that escape from the tank, and ***sludge*** that remains in the tank. The aim is to keep scum and sludge in the tank.

Whenever any sewage is put into the tank, a corresponding amount of liquid effluent flows out of the tank into the soakage treatment area. Section 2.4.1.1 of AS/NZS 1546.1:1998 requires a tank capacity that provides for at least 24 hours wastewater retention. In this Guide we recommend that single tanks should be large enough to retain at least **twice** the daily flow discharged into it, as well as have enough storage space for up to four years of sludge. This allows enough space and time for the sedimentation process to be effective.

Wastewater retention times are influenced by the shape of the tank, as well as its size. Section 2.4.2 of AS/NZS 1546.1:1998 requires a minimum flow path of 1.2 metres between the inlet and outlet tees.

3.2.2 Decomposition of organic matter

Organic matter is measured in BOD (biochemical oxygen demand), which is a measure of how much oxygen is needed to break down organic matter, and so is an indirect measure of the organic matter itself. Poor effluent quality is characterised by BOD levels higher than 100 grams per cubic metre. Effluent from ordinary septic tanks is still reasonably high in dissolved BOD. Effluent from aerobic systems can have BOD levels as low as 20 grams per cubic metre but, like anaerobic systems, the quality depends on the operation and maintenance of the tank.

Organic matter decomposes in the tank into simple end products, mainly methane and carbon dioxide, which then escape from the tank as gases. Sewage effluent from the tank still contains undecomposed dissolved organic matter and suspended solids. These complete their degradation process in the soakage treatment area.

One way to improve the effluent quality, i.e. reduce organic matter, from an anaerobic system like a septic tank is to install an outlet filter. Slimes attached to the filter help break down organic matter before the effluent leaves the tank. Filters also damp hydraulic surges in the tank and so help prevent sludge carry over.

3.2.3 Retention of sludge

Sludge build up rates vary from 50 to 100 litres per person per year. The actual rate depends on inputs from the house, the age of the sludge, and whether sludge is being washed out with the effluent. The performance criteria for scum and sludge accumulation is 80 litres per person per year (AS/NZS 1546.1:1988, section 2.4.1.1). At this rate it would take four years for a 2700 litre tank serving four people to have sludge within 160 mm of the outlet pipe. Well before that happens, effluent discharged from the tank would be of poor quality, with high BOD concentrations. This is because there would not be enough detention time in the tank to allow organic matter in the incoming wastewater to settle, and because settled sludge would get disturbed and re-suspended by the inflow.

This is why 2700 litre tanks are not considered big enough for effective treatment. Modern tanks usually have a 3000 to 4500 litre capacity, and contain at least two settling chambers, either within a single tank or by joining two tanks together.

Multiple chambers and dual tanks improve the effluent quality because their improved sedimentation opportunities and decreased short-circuiting reduce the amount of organic matter in the effluent. Having a second tank means that if sludge and scum is flushed out of the first tank, it ends up in the second tank rather than in the soakage treatment area.

3.2.4 Destruction of pathogens

Pathogens are disease causing organisms, otherwise known as bugs and germs. An infected person excretes millions of pathogens every day. Pathogens entering a tank can be killed in the tank, discharged in the effluent, or concentrated in the sludge. They will not breed in the tank because the temperatures are generally too low (below 30° C).

Even a "high quality" effluent will contain pathogens, often at harmful concentrations, if there is an infected person contributing sewage to the system. There are four main kinds of pathogens that can infect people. For information about the illnesses and diseases each of these germs can cause, see section 4.2.2. The removal rate in on-site sewage treatment processes for each kind of germ is described here.

Viruses. Most viruses can survive the conditions in the tank and will pass through with the effluent unless they are trapped in solid matter and retained in the sludge. Many viruses present in raw domestic sewage are adsorbed onto or embedded into solids and so the removal rate of viruses in septic tanks is strongly associated with solids removal.

Bacteria. Pathogenic bacteria are more likely to be killed in the tank than viruses or protozoa because their cellular structure makes them more susceptible to the conditions in the tank.

Protozoa have a tough shell on the outside and can survive conditions in the tank. Once in the environment, they can survive in soil for months. Giardia and cryptosporidium are both protozoa. Cryptosporidium is not killed by chlorine.

Helminths (worms) can be divided into three groups: cestodes, or tapeworms; nematodes, or roundworms; and trematodes, or flukes. The helminths differ from other infectious organisms in that they have a complex body structure. They are multicellular and have partial or complete organ systems (*e.g.*, muscular, nervous, digestive, and reproductive). In calm conditions, most helminth eggs settle to the bottom of the tank and will be retained in the sludge.

The most common germs are bacteria and viruses, which tend to co-settle with the solids during the sedimentation process in the tank. Allowing adequate time for solids settling, and retaining sludge in the tank, are essential to the treatment process because they reduce the quantities of pathogenic organisms discharged to the environment.

3.2.5 Tank designs that optimise treatment

Aspects of tank designs that improve the solids separation, organic matter decomposition, and retention of sludge, scum, bugs and germs are —

- large tanks (to increase the hydraulic retention time and sludge storage capacity)
- dual or multi-chambered tanks (to increase the hydraulic retention time, decrease short-circuiting, and decrease re-suspended solids passing out with the effluent)
- outlet filters (to improve effluent quality by increasing degradation of organic matter - common filter media are rocks, plastic rings and screens)
- tee joints and baffles (to stop scum and sludge passing out of the tank).

3.3 The soakage treatment area

Whether the sewage is treated in an anaerobic system, like a septic tank, or an aerobic system, like an AWTS (aerated wastewater treatment system), effluent still needs to be safely disposed of through a soakage treatment area. The soakage treatment area is commonly a soil or sand-based system. It provides essential final treatment before the effluent reaches groundwater or surface water. Effluent distribution in the soakage treatment area is usually achieved by

- Soakage trenches – these are the most common. Pipes with small holes are laid in shallow trenches, which are filled with washed coarse gravel, and covered with soil.
- Low pressure effluent distribution. Small, pressurised pipes with little holes in them are laid in narrow trenches within topsoil. The pressurised pipes are sometimes put inside larger pipes with holes in them, such as drainage coils.
- Wisconsin mounds. Pipes are laid in mounds of sand that are specially built on top of the ground. These are good for areas where groundwater is within 600 mm of the ground surface.
- Irrigation areas. Effluent is irrigated through small emitters straight onto the soil surface. (This is not generally allowed unless the sewage has been treated in an aerobic system.)
- Evapo-transpiration seepage beds. Effluent is piped through special beds of plants that use the nutrients in the effluent to grow.

Alternative names for soakage treatment areas are soakage areas, disposal areas, drainage areas, effluent disposal fields and soakage trenches. These names carry a notion of either disposal or drainage, both of which are contrary to the intended purpose of this part of the on-site sewage system. This Guide uses the term “soakage treatment area” to shift the name association to one of treatment. The term “land treatment area”, which is gaining currency in larger sewage treatment systems, and “land application area” which is used in the Standards, are still not sufficiently well recognised by practitioners.

3.3.1 Getting the effluent from the tank to the soakage treatment area

Depending on site conditions, effluent can flow into the soakage treatment area under gravity, or it can be pumped. If the effluent flows naturally, without pumping, it generally doesn't spread out evenly in the soakage treatment area. Instead, almost all of it discharges at the beginning of the trench and eventually causes what is known as "creeping failure".

Creeping failure happens when a clogging layer progressively blocks up the trench. Eventually there is no soakage capability left anywhere in the trench and effluent collects on the ground surface. Creeping failure can be avoided by pumping the effluent throughout the soakage treatment area.

3.3.2 Treatment in the soakage treatment area

Effluent from both anaerobic (septic) and aerobic systems is still reasonably high in dissolved BOD and contains high concentrations of pathogens (disease causing organisms) and nitrogen compounds (mostly ammonia). Effluent undergoes final treatment in the soakage treatment area (STA) before soaking through the subsoil to groundwater.

Biochemical treatment in the STA is partly anaerobic and partly aerobic. The anaerobic treatment occurs in the biological mat at the bottom of the STA. The aerobic treatment occurs in the unsaturated zone below the STA. The effectiveness of the anaerobic treatment in the biological mat depends mostly on the effluent quality (see sections 3.2.2 and 3.2.3 above) and the effluent **application rate**. The effectiveness of the aerobic treatment in the unsaturated zone depends on the **depth** of the STA, the depth of unsaturated soil under the STA, and on the application rate.

3.3.3 Long Term Acceptance Rate

The effluent **application rate** is a measure of the amount of effluent discharged to a soakage treatment area over a particular time period. Also known as the "hydraulic load", the application rate affects how wet the soakage treatment area and the underlying soils become.

The application rate is expressed in millimetres per day (equivalent to litres/square metre per day). A household of four people creates about 800 litres (0.8 cubic metres) of sewage every day. If the soakage treatment area is 40 square metres, that equates to an effluent application rate of 20 millimetres per day (0.8 m^3 / day divided by 30 m^2 = 0.020 m/day or 20 mm/day). This is similar to heavy rainfall, and is too much for many soils to absorb.

A high application rate into poorly draining soils causes effluent to collect on the ground surface. This is a health hazard.

A high application rate into fast draining soils can cause saturated anaerobic conditions (without oxygen) in and under the soakage treatment area. Saturated conditions under a soakage treatment area give pathogens a better chance of survival, and allow them and other contaminants to get flushed through the soil to groundwater. This presents a health hazard to people who drink that groundwater.

High application rates, particularly if associated with poor effluent quality, speed up the growth of the clogging layer, or biological mat, that usually develops on the base of soakage treatment areas. The biological mat is a slime layer, which functions as a biofilter. The biological mat is effective in reducing BOD and destroying pathogens. Being less permeable than most soils, the biological mat will strain out bacteria and larger pathogens like giardia, preventing them being flushed through to groundwater.

If the soakage treatment area itself is permanently saturated, the biological mat builds up and gets too thick to allow any drainage from the area. A biological mat is desirable, but excessive build-up of the mat prevents the treated effluent from soaking away. The appropriate balance involves finding the long-term acceptance rate of the soakage treatment area (LTAR).

The LTAR is determined by the permeability of the biological mat, provided underlying soil types have adequate basic permeability. Once the mat is established, the LTAR of sewage into permeable soils (except sandy gravel and gravel) eventually declines to about the same quantity, regardless of the difference in soil permeabilities in the beginning.

The low permeability of the mat must be allowed for when designing an on-site sewage system because effluent will not flow through the mat at the same rate as clean water flows through soils during percolation tests. The time for a biological mat to reach its LTAR depends on the rate of effluent application and the underlying soil type, and could be from one month to a year. Infiltration rates are generally about 15 - 25 mm/day for sands, and less than 10 mm/day for clays.

3.3.4 Shallow Soakage Treatment Areas

Shallow systems take advantage of the aerobic conditions and natural microbial activity in topsoil to provide the final treatment. Deep trenches are a waste of gravel.

Most soil organisms live in the top 200 mm of soil, and their numbers decrease rapidly with depth. Discharging sewage effluent deep into the soils (more than 300 mm) lessens the chance for the natural micro-organisms in the soil to destroy any disease-causing organisms (pathogens) that might be present on the effluent. If pathogens pass unharmed through the soakage treatment area and shallow soils they get flushed through to groundwater, where they can survive for months. This presents a health hazard to people who drink that groundwater. It may also present a health hazard to stock that drink the water.

Discharging effluent in the shallow soils increases the opportunity for nitrate to be taken up by plants (see section 4.2.3 below).

3.3.5 Destruction of pathogens

Pathogens are destroyed or removed in the biological mat and the topsoil. Some environmental factors influencing the survival of bacteria and viruses in soils are described in Table 1 below. Environmental factors will not kill pathogens or stop their movement if there are preferential flow paths through the soil such as large cracks, gravel seams, or underground drains. These flow paths allow pathogens to be transported quickly through the soil with minimal interaction with the soil particles and soil microbes.

Table 1 The influence of environmental factors on bacteria and viruses (NZLTC 2000. New Zealand Guidelines for Utilisation of Sewage Effluent on Land)

Factor	Influence on bacteria	Influence on viruses
Water content	Survival decreases with decreasing water content.	Survival decreases with decreasing water content.
Temperature	Longer survival at low temperatures. Pathogenic bacteria can survive for months at < 4° C.	Longer survival at low temperatures. Pathogenic viruses survive at ambient temperatures.
Sunlight	Survival decreases with exposure to sunlight at the soil surface.	Survival is thought to decrease with exposure to sunlight at the soil surface.
Soil pH	Shorter survival time in acid than alkaline soils. Indirectly influences survival by controlling adsorption on soil particles.	Indirectly influences survival by controlling adsorption on soil particles.
Biological factors	Increased survival in sterile soil. Introduced microbes are susceptible to predation, starvation and possibly antibiotic producing or lytic micro-organisms.	No clear trend.

3.3.6 Soakage treatment area designs that optimise treatment

Almost all final treatment occurs in the biological mat and in the shallow soils. The two keys to a successful soakage treatment area are to

- match the effluent application rate to the capacity of the soils to absorb it (Long Term Acceptance Rate, or LTAR)
- make the soakage treatment area as shallow as possible. Also known as the KISS principle (Keep Infiltration Systems Shallow).

4. THE ENVIRONMENTAL EFFECTS OF ON-SITE SEWAGE DISPOSAL

4.1 On-site sewage system use in the Wellington Region

Areas around the Region not serviced by reticulated sewage systems include

- Te Horo, Pekapeka and Paekakariki on the Kapiti Coast
- rural areas around the Pauatahanui Inlet near Porirua
- Makara and the Ohariu Valley
- Blue Mountains in Upper Hutt
- Lake Ferry in South Wairarapa
- All other parts of the Wairarapa except the towns of Masterton, Carterton, Greytown.

Each of these areas has very different environmental conditions, ranging from coastal sands, to peat, to gravel overlying shallow groundwater to impermeable clay. Many old on-site sewage systems installed in these areas decades ago are still being relied on even though their design, usually a single chambered septic tank with a short soakage trench, has been shown to be inadequate for many sites.

Upper Hutt City Council did a comprehensive investigation of on-site sewage systems on 48 properties in Blue Mountains in September 1998. Among their findings were that small section sizes (and subsequent building) on some properties resulted in small areas for effluent disposal, the winter water tables were within 500 mm of the ground surface for many sections, overland effluent flow was observed at 11 properties, eight properties had septic tanks with unacceptable levels of sludge and scum, and four properties had severely deficient tank sizes.

It is probable that similar investigations done elsewhere in the Region would uncover similar problems. While some problems with on-site sewage systems can be remedied with improved tank maintenance and upgrades of tanks or soakage treatment areas, some properties are simply too small to cope with the amount of effluent produced by a residential house. This can only be addressed at the subdivision stage. Upper Hutt City Council, for example, now commonly attaches conditions to subdivision consents stipulating specific requirements for effluent disposal.

4.2 Effects on people and the environment

Three significant contaminants in sewage are —

- organic matter (most of the solid matter)
- disease causing organisms (pathogens), for example, bacteria and viruses.

- nitrogen compounds (ammonia from anaerobic systems, nitrate from aerobic systems)

The environmental effects associated with these contaminants are —

- attraction of vermin and flies
- objectionable odour
- increased risk of disease in the community
- increased nitrate levels in groundwater, which can make it unsuitable for human consumption.

The septic tank and soakage treatment area combined should —

- retain and break down organic matter into harmless end products
- destroy disease causing organisms, or block transmission routes for these organisms between the on-site sewage system and people
- avoid nitrate leaching to groundwater, especially water used for water supply.

4.2.1 Effects of organic matter

The amount of organic matter in sewage is measured as BOD (biochemical oxygen demand). BOD is a measure of how much oxygen is needed to break down the organic matter, and so is an indirect measure of the organic matter itself. Effluent quality is expressed in terms of its BOD.

Poor quality effluent contains lots of organic matter, which will continue to degrade in the environment. The degradation process can cause objectionable odours.

Poor quality effluent also speeds up the development of the clogging layer at the bottom of the soakage treatment area.

4.2.2 Effects of pathogens

Pathogens are disease causing organisms, otherwise known as bugs and germs. An infected person excretes millions of pathogens every day. If pathogens are not destroyed or retained in the tank or the soakage treatment area they can infect anyone coming into contact with them. People can come into contact with them by—

- handling soil around a soakage treatment area, for example, when gardening
- stroking pets that roll around on a poorly drained (boggy) soakage treatment area
- drinking water, especially shallow groundwater, that is near a poorly designed soakage treatment area
- swimming, paddling and splashing around in rivers, lakes and the sea if soakage treatment areas discharge into them.

There are four main kinds of pathogens that can infect people. Any one or more of these pathogens may be present in sewage at any time. Their removal rate in on-site sewage treatment processes is discussed in section 3.2.4 above.

Viruses are the smallest kind of germ but probably cause the most sickness in New Zealand. There are hundreds of kinds of viruses. The flu, coughs and colds, measles, chicken pox, some food-poisoning type sicknesses, and more serious diseases like hepatitis and meningitis, are all caused by different sorts of virus. People can get infected from viruses quite easily because the infective dose can be as low as one single virus.

Bacteria are a common kind of germ. Some kinds of bacteria cause skin infections, some cause stomach upsets. Some, like campylobacter and salmonella, can cause serious diarrhoea and vomiting. Campylobacter is the most commonly notified disease in New Zealand, with New Zealand leading the world in reported cases. Health studies have not established whether our transmission routes are water borne or food borne, but the incidence of this disease has continued to rise over the last decade despite increases in hygiene standards.

Protozoa are a bigger and tougher kind of germ than bacteria or viruses. *Giardia* and *Cryptosporidium* are both protozoan parasites. Both cause diarrhoea, usually accompanied by abdominal cramps and other symptoms. Infection is usually by direct ingestion, either by eating contaminated food or water or touching the mouth with contaminated hands. The infective dose for giardia and cryptosporidium may be as low as one organism.

Helminths (worms) can be divided into three groups: cestodes (tapeworms); nematodes (roundworms); and trematodes (like sheep liver flukes). Roundworms, which are reasonably common in New Zealand, can cause gastro-enteritis.

There are far too many kinds of pathogens to measure their presence in sewage or drinking water directly. Instead, sewage and receiving environments are sampled for faecal coliforms. Faecal coliforms are a kind of bacteria that are present in the gut, and therefore the faeces, of all warm blooded animals, from humans to birds. Their presence is used to indicate the presence of faecal matter, and therefore the possible presence of pathogens. Faecal coliforms can be used as reasonably reliable indicators for the presence of bacterial pathogens, because their environmental survival characteristics and rates of removal and die-off in sewage treatment processes are broadly similar. Faecal coliforms are less effective as indicators of excreted viruses, and of very limited use for protozoa and helminths, for which no reliable indicators exist.

Regardless of the treatment process, people should regard all sewage effluent as being contaminated with pathogens. People handling sewage, or soil contaminated by sewage, should follow basic hygiene rules such as washing their hands, and not touching their eyes or mouth with dirty hands.

4.2.3 Effects of nitrogen

The amount of nitrogen in sewage can be estimated by assuming a loading of between 10 and 12 grams of nitrogen per person per day. About a third of the nitrogen in the sewage entering the tank accumulates in the sludge and in the scum mat. Most nitrogen entering the tank is reduced to ammonia in the anaerobic conditions of the septic tank and is discharged with the effluent. Ammonia is converted to nitrate fairly rapidly in most New Zealand soils. (Most nitrogen leaving aerobic systems has already been converted to nitrate.)

Nitrate in water can make it unsafe to drink. Nitrate levels in shallow groundwater in parts of the Kapiti Coast and in Wairarapa are already high. Effluent soakage from on-site sewage disposal could have contributed to this. The Wellington Regional Council has information about nitrate levels in groundwater throughout the Region.

Nutrients (both nitrate and phosphate) can cause prolific weed growths in lakes and streams. Weeds make swimming unpleasant and deprive fish and other aquatic species of oxygen in the water. The shallow water of Lake Wairarapa and many lowland streams are already rich in nutrients.

The concentration of nitrogen in septic tank effluent is typically 40 mg/l. For a four person household discharging 600 litres of effluent per day, this equates to 24 g N/day, or 8.76 kg N per year. If sewage is the only nitrogen loading on a one hectare lot, this equates to 8.76 kg N/ha per year. On five 2000 m^2 lots without any additional nitrogen load, this equates to 44 kg N/ha per year. This is less than a quarter of what is usually recommended as maximum nitrogen application rates for agricultural effluent (200 kg N/ha per year). Despite this, the effects on groundwater may be greater than agricultural effluent application. This is because of the intensity and depth of the application to soakage treatment areas.

The nitrogen load on a soakage treatment area is more similar to the nitrogen load from stock urine patches than to effluent or fertiliser spread uniformly around a site. Studies done on nitrogen leaching in dairy pasture indicate that there is a high potential for nitrogen leaching under stock urine patches because the nitrogen input is far higher than amount that can be taken up by pasture. Surplus nitrogen in the soil leaches to groundwater.

On top of that, septic tank effluent is often discharged too deep for plants to be able to use the nutrients. When nitrogen is discharged **onto** land, or into the topsoil, there are opportunities for plant uptake and volatilisation. Nitrogen discharged into the soil below the plant rooting zone has little chance of being used by plants. Most nitrate discharged deep in the soil will leach to unconfined groundwater. (“Unconfined” means not protected by an impermeable layer like fine silts or clay.)

Nitrate contamination of groundwater from soakage treatment areas can be controlled by requiring particular systems that avoid or mitigate nitrogen losses to groundwater in those areas (see section 5.2.8 the need for special systems). An alternative is for territorial authorities to establish minimum lot sizes in areas where groundwater is vulnerable.

5. SITE ASSESSMENT FOR ON-SITE SEWAGE TREATMENT SYSTEMS

The initial outlay for a conventional system designed to modern standards can be in the range of **$7,000 - $10,000** or more. Special systems for difficult sites could be **$15,000** or more. Owners of on-site sewage systems need to appreciate that installing an inadequate system is not cost efficient. Upgrading inappropriate, poorly performing systems can be a very costly and disruptive experience.

5.1 Assessment before subdivision or change in land use

The authorisation of subdivision and changes in land use, such as from rural to residential, is controlled by the City or District Council in its district plan. Like regional plans, district plans are prepared under the Resource Management Act, 1991. The City or District Council can decline subdivision applications if certain standards specified in their district plan are not met. Generally, district plans require a new lot in an unsewered area to cope with the disposal of all effluent on the site. A site's ability to do this depends on site constraints like high water tables, proximity to rivers, steep slopes and poorly draining soils.

Before granting a subdivision application, or a change in land use, the City or District Council must have regard to the potential effects of granting the application (see section 104 of the Resource Management Act, 1991). Sewage disposal on-site can cause adverse effects. It is not sufficient for City and District Councils to rely on the separate discharge permit authorisation process. Discharge permits can only be issued if the effects of the discharge can be managed by conditions attached to the permit. If there isn't enough room for the soakage treatment area (either on-site or on a dedicated site nearby) then a discharge permit may not be issued, even if the property has an authorised Land Use consent.

City and District Councils can include information on Land Information Memoranda about sewage effluent requirements. People buying undeveloped properties should check the LIM for such requirements.

5.1.1 Site constraints to consider

The constraint of poorly draining soils can sometimes be overcome by having very large soakage treatment areas, so the district or city council should consider the size of the site as part of the assessment of effects when approving a subdivision application. Another factor calling for a large soakage treatment area is the volume of effluent that can be produced. This is generally calculated from the number of bedrooms in the dwelling. If a very large house is planned for a site, the lot size will need to be big enough to accommodate a large soakage treatment area, even if the immediate occupancy of the house is only going to be two or three.

For large subdivisions, the developer should decide on the final section density before considering the most appropriate method of sewage treatment. This is especially important if a communal system is planned for because it may not be possible to find a suitable site for the communal system once the houses have been built.

Sections 3.5.3 and 3.5.4 of AS/NZS 1547:2000 describe the matters that developers and site assessors should do before getting an on-site system designed for the site. Sections 3.5.5 and 3.5.6 describe what designers and installers should do.

5.1.2 How much of the proposed site the soakage treatment area takes up

Soakage treatment areas generally range in size from 40 m^2 to 400 m^2, with the same area set aside as a reserve area in case of failure. Tables in the Model Designs can be used to work out the appropriate sizes for soakage treatment areas in most areas of the Region.

Soakage treatment areas

The size of a soakage treatment area depends on the volume of effluent to be discharged and the types of soil that the effluent is discharged into. The area (in square metres) is calculated by dividing the daily discharge (in litres per day) by the application rate (in mm per day). For example, if a four person household is discharging 700 litres of wastewater per day, and the design application rate is 20 mm/day (this is suitable for soils that are moderately well draining), then the required soakage treatment area is 700/20 = 35 square metres. Information about typical discharge volumes from houses and other places is given in Table 6. Suitable application rates are given with the Model Designs at the back of this Guide.

Reserve area

A reserve area, usually the same size as the soakage treatment area, is desirable if the system is likely to serve more people at a later date. For example, if the homeowner intends to live permanently in what is now a holiday house. Reserve areas also allow people to increase the size of a soakage treatment area, or replace it entirely, if problems develop in the future. Reserve areas must remain available and must not be built on or developed in any way that prevents them from being used as soakage treatment areas in future.

Reserve areas are essential if an on-site sewage system is installed without means to improve treatment performance. Means to improve treatment performance include water reduction devices in the house, multi-chambered large capacity tanks, outflow filters and gas baffles, and low pressure effluent dosing throughout the soakage treatment area.

Distances from buildings, neighbours, and watercourses

In most situations it is normal practice to locate all parts of the on-site sewage system, including the tank and the soakage treatment area, at least two metres from the house, and 1.5 metres from other buildings. These are known as buffer distances. City and District Councils have total discretion over the size of buffer distances from houses and other buildings.

Rules 6 and 7 in the Regional Plan for Discharges to Land require a 20 metre buffer distance between the soakage treatment area and any surface water body, farm drain, water supply race or the coastal marine area. If the on-site sewage system is in a water supply catchment, there has to be a 50 metre buffer distance. Soakage treatment areas inside these buffer zones require a discharge permit.

Buffer distances from bores are not specified in the regional rules. This is because suitable distances are very site specific and depend on the soil type, whether the bore penetrates a confined or unconfined aquifer, and whether the groundwater is flowing towards or away from the bore. Once contaminants in effluent reach groundwater, the groundwater can carry them hundreds of metres so stipulating a separation distance from bores may provide a false sense of security to people drinking water from the bore. The easiest pathway for sewage effluent to contaminate groundwater is via poorly sealed bores. Properly designed soakage treatment areas and properly sealed bores should protect groundwater more effectively than buffer distances.

When effluent is discharged **onto** land, the Wellington Regional Council requires a five metre buffer distance from property boundaries. Only aerobically treated sewage can be discharged onto land without a discharge permit; all other sewage must be discharged below the ground surface.

When working out how much of the site is available for the soakage treatment area, allow for the house, garage, driveway, any areas that vehicles might drive on, plus any buffers needed between the house, property boundary, rivers, lakes and the coastal marine area.

Effluent doesn’t have to be discharged beside the tank. If necessary, it can be pumped to more suitable areas away from the house or road frontage. Soakage treatment areas should not be located near environmentally or culturally sensitive sites.

5.2 Site assessment after subdivision or change in land use

Once the site has been subdivided or the land use approved the owners need to decide what sort of system they will install, and where they will put the soakage treatment area. Site assessment factors are given in Table 4.1C1 of AS/NZS 1547:2000. Two important assessment factors are the Site and Soil Properties (Appendix 4.1D) and the Soil Permeability Measurement – constant head test (Appendix 4.1F).

Essentially, a site assessment needs to answer the following questions—

- What sort of soil is available for the soakage treatment area?
- How fast does water seep through the soil (soil permeability)?
- How deep is the seasonal groundwater table across the site?

- Is there any geological feature that will stop effluent drainage, such as bedrock or an impermeable clay pan under the soil?
- Is there any river, lake or drain nearby?
- Is the site too steep (over 20°)?
- What are the local weather conditions likely to affect the design (high rainfall, shade, wind, etc.)?
- How much effluent will be discharged to the soakage treatment area each day?
- How much land is available compared to the required size of the system?

There is a ***Site Assessment Form*** at the back of this Guide. This should be completed by a ***suitably qualified person***. The results of the assessment can be used to find out if any of the Model Designs are appropriate. There is also a Site Information Sheet, and Site and Soil Evaluation Form in the Standard (figures 4.1C2 and 4.1C3, AS/NZS 1547:2000). Territorial authorities have the discretion to require applicants to use either of these forms.

5.2.1 Soil type

Soil type is the key criteria in AS/NZS 1547:2000 for designing for soakage treatment areas and for selecting the Model Designs suggested in this Guide. The types of soil, which range from sand to heavy clay, are described in Table 4.1D1 of the Standard. The assessment techniques are described in Appendix 4.1D of the Standard. For the purpose of design, soil types are categorised into six categories.

Sandy soils are generally very permeable and effluent will drain through the soil profile too quickly for any treatment to take place. Clay soils have poor drainage, but the soils are effective in removing pathogens.

5.2.2 Soil permeability

The soil permeability describes how quickly or slowly water can soak into the soil. This is generally assessed from soil percolation tests. The test for measuring soil permeability is described in Appendix 4.1F of AS/NZS 1547:2000.

The results of these tests are only indicative because percolation rates for wastewater are generally lower than the soil's percolation rate for clean water. This is because some soils, like clays, will swell and shrink according whether they are wet or dry, and because effluent causes a clogging layer to form at the bottom of the soakage treatment area.

Soil percolation tests can provide useful information though, as can information from locals about how long it takes the ground to dry out after it rains. Topsoil usually has the best drainage of all soil layers but deeper soils with lower hydraulic permeabilities will slow down the infiltration of effluent from the soakage treatment area.

Soils with low permeability (poor drainage) can only cope with effluent if it is applied at very low application rates (less than 5 mm per day).

Soils with high permeability (very good drainage) will cope with high application rates. But high application rates are not suitable for effluent treatment because they cause saturated anaerobic conditions (without oxygen) in and under the soakage treatment area. Saturated flow conditions in the subsoil allow rapid travel of an effluent plume that has undergone little or no treatment in the soakage treatment area. Pathogens and other contaminants get flushed through the soil to groundwater. Even unsaturated soils with high permeability allow effluent to travel quickly through the soils without any treatment.

5.2.3 Depth to groundwater

A general precaution in New Zealand is to have a minimum depth of 600mm of good quality soil below any soakage treatment area. This helps in-soil treatment of sewage effluent, and helps keep the zone under the soakage treatment area unsaturated.

High water tables can cause saturated conditions in and under the soakage treatment area. The phenomenon of groundwater mounding under the soakage treatment area causes a shallow depth to groundwater to become even shallower. This reduces, or even eliminates, the depth of the unsaturated zone where aerobic treatment takes place. Groundwater mounding is greatest over shallow aquifers with low permeability. Subdividing a single disposal field into widely separated smaller fields reduces mound heights more effectively than having a single long field, increasing field size (thereby decreasing the application rate), or intermittent dosing.

5.2.4 Impermeable layers

Impermeable layers like clay pans or bedrock will block effluent soakage. Depending on the depth of the impermeable layer, such sites would be unsuitable for standard on-site sewage systems.

5.2.5 Nearby watercourses

Many rivers in the Region are used as water supply for stock, and some are being managed by the Wellington Regional Council for contact recreation. A soakage treatment area within 20 metres of a river or farm drain requires a discharge permit. In water supply catchments, the required separation distance is 50 metres.

A separation distance from lakes, rivers and farm drains is required to decrease the opportunity for high numbers of pathogens to reach the water. Riparian margins are generally moist environments and these are not effective in pathogen destruction.

5.2.6 Site slope

Sites with steep slopes will affect the design of the soakage treatment area. It is essential that sloping sites are completely stable and that the application of additional moisture will not destabilise the soil. Sites with slopes over 20° are not suitable for on-site sewage disposal without specially designed systems.

5.2.7 Weather conditions at the site

Rainfall, wind, sun and shade can affect the performance of on-site sewage systems. For best results, the soakage treatment area should be in a place where it gets the least rain and the most wind and sun. This will encourage evapo-transpiration and improve the efficiency of the soil treatment process because conditions in and around the soakage treatment area will not be saturated. Saturated soils provide poor effluent treatment, and permanently wet soakage treatment areas clog up.

Shady soakage treatment areas may need to be larger than sunny areas and established with vegetation.

In areas with high rainfall and low winter evapo-transpiration the soakage treatment area will suffer from long wet periods unless precautions are taken. These can include

- importing soil or sand so that the soakage treatment area is above the ground surface
- constructing drainage trenches around the soakage treatment area
- spreading the effluent over a very large area to get application rates less that 5 mm/day (5 litres/square metre per day)
- planting high transpiration vegetation (but not trees) within and around the soakage treatment area
- reducing the amount of effluent by having water reducing devices in the house
- installing a separate system for greywater.

5.3 The need for special systems

Section 3.1 of this Guide describes where you can find information on the internet about special systems. These factsheets are also available from the Wellington Regional Council.

This Guide contains drawings of Model Designs for sites with free draining soils, poorly draining soils, and high water tables. These designs are indicative only and must be accompanied by a site assessment undertaken by a Suitably Qualified Person. Specially designed systems are necessary for sites with constraints like steep slopes, and impermeable layers.

If a site has free draining soils, like sands, sewage effluent should be kept in the topsoil long enough for treatment to take place before it drains to the water table. This is particularly important if anyone in the area uses bore water for drinking because pollutants can travel long distances once they reach groundwater.

If soils on the site drain slowly, surface ponding and effluent runoff to surface water need to be prevented. This happens with clay soils, but can also happen with the peat-sand soils in the dunelands of the Kapiti Coast.

Mounded systems

If the seasonal high groundwater table is close to the surface, then a mounded soakage treatment area may be necessary. In mounded systems, the depth of soil available for in-soil treatment is provided by bringing extra soil onto the site, creating mounds and placing the distribution pipes in them. The depth of soil below the pipes in the mound, plus the depth of natural soil must provide at least 600mm of soil above the water table throughout the year.

Evapo-transpiration seepage (ETS)

Evapo-transpiration is the removal of moisture by evaporation and transpiration by plants. The main factor affecting the evapo-transpiration rate is the weather, particularly wind and sun.

Vegetation is an important component of the system, with evapo-transpiration rates from planted beds considerably higher than from unplanted beds. Areas with high rainfall and low evaporation rates, such as those near the Tararua Range, are more likely to operate as soil infiltration (seepage) systems, with little help from plant transpiration. This is especially true in winter when evapo-transpiration rates from short grass can be less than 1 mm per day (one litre per square metre of grassed surface per day). The Kapiti Coast and the Wairarapa valley have the lowest rainfall in the Region and may be more suitable for evapo-transpiration seepage beds than elsewhere in the Region.

In summer, plant roots search out wetter areas if surrounding soils are dry. This can make them useful for handling peak loads, such as at camp sites, marae, baches, etc. Bushes and trees can improve evapo-transpiration rates significantly, but must be planted far enough away from the soakage area so that their roots don’t interfere with the distribution pipes.

Denitrification systems to avoid nitrogen pollution

One way to reduce nitrogen pollution from an on-site sewage system is to direct toilet wastes to a separate treatment system such as a composting toilet. Toilet waste contains about 75 percent of total nitrogen in domestic wastewater.

Nitrogen can also be removed by biological denitrification without separating the waste stream. The first step is nitrification, where ammonia (NH_4^+) is changed to nitrite (NO_2^-), then nitrate (NO_3^-). This process requires aerobic conditions (with oxygen). For denitrification, nitrate is converted to nitrogen gas (N_2). The denitrification process requires anaerobic conditions (without oxygen), and a carbon source. Once the nitrogen is in a gaseous form, it can escape to the atmosphere. Nitrogen gas is a natural component of air and is not harmful.

One biological denitrification system is the N-DN biofilter which is a recirculating trickling filter type plant, similar in concept, operation and performance to a recirculating sand filter.

Another system involves barrier trenches installed between the soakage treatment area and nutrient sensitive areas like wetlands, rivers or lakes. These are about one to two metres deep (depending on the depth to groundwater), filled with soil mixed with a solid organic carbon source such as sawdust or bark chips. These trenches may be added on after an anaerobic (septic) system because the ammonia in anaerobic effluent converts to nitrate fairly rapidly in most New Zealand soils provided the effluent is not discharged too deep. Alternatively, the layers can be installed under a coarse grained sand layer in the soakage treatment area or added to existing systems downstream of the effluent plume flowpath. Advantages of this system are that they require no energy input, they are simple to construct, and they don't require any change to the plumbing fixtures.

6. SELECTING A SYSTEM

6.1 Meeting requirements

The Wellington Regional Council and territorial authorities in the Wellington Region can require systems to comply with the performance criteria in the New Zealand Standards as a means of compliance with the Building Code, district bylaws and regional rules. Key performance criteria and recommended designs are in this section.

6.1.1 Septic tank capacity

Recommended minimum sizes and design criteria for septic tanks are in AS/NZS 1546.1:1998. The Standards require a minimum flow path of 1.2 metres between the inlet and outlet tees. Some territorial authorities in the Region require 4,500 litre tanks for any size house.

Small tanks may be cheaper to buy, but will cost more to maintain in the long term, and will not perform adequately. A cost-effective solution may be a large tank (3000 to 4500 litres) with an outlet filter, or a dual tank system. Two tanks are better than one.

Table 2 Recommended minimum tank sizes (Appendix B, AS/NZS 1546.1:1998)

Type of wastewater	Number of people		Number of bedrooms	
	1 – 5	6 – 10	1 – 3	4 – 6
All wastewater	3000 litres	4500 litres	3000 litres	4500 litres
Greywater only	1800 litres	2700 litres	1800 litres	2700 litres
Toilet waste only	1500 litres	2500 litres	1500 litres	2500 litres

Total wastewater flow to the system is calculated from an allowance of 200 litres per person per day (AS/NZS 1547:2000, section 2.4.2.1).

Sludge and scum accumulation rates are estimated as (AS/NZS 1547:2000, section 2.4.2.1):
(i) all-waste: 80 litres per person per year
(ii) greywater: 40 litres per person per year
(iii) toilet waste: 50 litres per person per year.

6.1.2 Soakage treatment area designs

Guidance on the selection of appropriate soakage treatment areas are given in AS/NZS 1547:2000 (see Sections 4.2A to 4.2D). The Model Designs in section 8 of this Guide are based on the guidance in the Standards. Territorial authorities have the discretion to require more stringent design criteria.

Rule 7 in the Regional Plan for Discharges to Land requires effluent to be evenly spread throughout the soakage treatment area. This is best achieved by distributing the effluent under pressure, and allowing between 1 and 1.5 metres between the distribution pipes.

6.2 About the Model Designs

The Model Designs provide a range of options that should suit most sites in the Region. They were developed by Ian Gunn, an engineer with considerable experience in on-site sewage systems and their operation in New Zealand conditions. Wellington Regional Council staff have assessed the designs for compliance with regional rules in the Regional Plan for Discharges to Land for the Wellington Region. Staff are satisfied that, if selected in accordance with a professional site assessment, and installed and maintained as recommended in this Guide, the discharge from the system will comply with the relevant rules.

The Model Designs have been developed for sites that do not have significant constraints. That is, they have a slope of no more than 20º, a section size of at least 1500m^2, and a household of no more than five people. Sites with significant constraints will require an individually designed system. It is possible to alter a model design instead of designing a completely new system, but this may require professional input from a Suitably Qualified designer. Territorial authorities have total discretion over who they accept as being a Suitably Qualified designer.

6.2.1 Selecting a Model Design for a site

The Site Assessment Form, Model Design selection tables, and Model Design Drawings are at the back of this Guide.

A Suitably Qualified Person must do a site assessment. This needs to answer all questions on the Site Assessment Form. The information about soil type and depth to groundwater are particularly important because these two factors influence the choice of design.

Tables 5 and 6 in section 8 of this Guide provide direction for which, if any, of the Model Designs are suitable for the site. The tables recommend eight Model Designs that will suit various site conditions. The Designs are divided into two groups according to available soil depth below the land application area.

Model Designs 1, 2, 3, 4, and 5 in Table 5 suit sites with at least 600mm of soil below the designed soakage system. This 600mm of soil must be free of any impermeable or highly permeable layer (such as clay or gravel) and be permanently unsaturated (based on the highest groundwater level reached in any year). Within this category, the final choice of Model Design depends on the soil type.

Model Designs 6, 7, and 8 in Table 6 suit sites with less than 600mm of permanently unsaturated and permeable soil below the bottom of the designed soakage system. The type of soil on these sites makes no difference to the system design because the soil is too shallow to provide adequate treatment. Within this category, the final choice of Model Design depends on user preference.

6.2.2 Alternatives or alterations to the Model Designs

There is a choice of components to incorporate into the design to allow for factors such as

- the environmental sensitivity of the site (for example, near a nutrient sensitive wetland, or over vulnerable groundwater)
- cultural sensitivity of the site (for example, near burial sites or marae)
- the frequency and type of use the system will have.

For example, a Model Design may state that the minimum requirement is for a single stage septic tank and outflow filter, plus absorption trenches. This system could be improved by using a multi-chambered tank that produces better quality effluent to extend the life of the soakage treatment area.

There are several options available for more novel ideas for treating and disposing of sewage waste. These include composting toilets, incinerators, reedbeds, greywater recycling (the separation, cleansing and re-use of wastewater not originating from toilets). Greywater recycling can be used in addition to septic tank systems to reduce wastewater input into the system, and has the added benefit of provided a water supply for gardens.

Alternative systems are described in the *New Zealand Manual of alternative wastewater treatment and disposal systems Volume II, Part A – On-site wastewater disposal from households and institutions* Auckland Regional Council Technical Publication 58. See section 3.1 of the Guide for directions of where to obtain more detailed information from the Internet.

7. INSTALLING AND MAINTAINING AN ON-SITE SEWAGE SYSTEM

7.1 The cost of an on-site sewage system

There are costs involved in almost every step of the process of choosing, designing, approving, installing and maintaining an on-site sewage system. Where possible, some ballpark costs each of these steps are given below.

7.1.1 The Site Assessment

On most sites, the Site Assessment will need to be done by a Suitably Qualified Person to the satisfaction of the Building Inspector from the City or District Council. A soil specialist will not be able to design a system, but their assessment can be used to select a Model Design.

7.1.2 The Design

- No charge if the Model Designs in this Guide are used.
- Without the Model Designs, a suitably qualified consultant usually costs in the order of $600 to $1,500, including the site assessment fee.

7.1.3 Building Consent fee

Building Consents are obtained from City and District Councils. The cost of making a Building Consent application varies among councils and will also depend on the size of the project. Fees are usually in the range of $100 - $500. For a system installed at the same time as building a dwelling, there will be one fee that covers the whole project.

7.1.4 Discharge Permit fee

Discharge permits are issued by the Wellington Regional Council. A discharge permit is only required if the discharge from the system does not comply with Rule 6 or 7 in the Regional Plan for Discharges to Land. Discharge permit requirements are in addition to the Building Consent. The Wellington Regional Council can transfer this function to another public authority, such as the City or District Council.

Discharge permit applications are either notified or non-notified. The Resource Management Act requires applications to be publicly notified if the adverse effects on the environment are more than minor, or people likely to be affected by the proposal have not given their written approval. Notification is not usually required for permit applications for on-site sewage systems.

The cost of making a discharge permit application is set in the Council's Charging Policy. For 2000-2001, an application fee to the Wellington Regional Council for a non-notified consent is $236.25. This is based on processing a relatively simple application. Processing costs are charged to applicant, so complicated applications are likely to cost more than this. Discharge permits will have conditions attached to avoid effects such as effluent runoff. The Council monitors compliance with these conditions and charges an annual fee for this. The annual charges are $30. All costs include GST. Any change to the Charging Policy are made through a publicly notified process.

7.1.5 The System

Table 3 Typical costs of Model Design Systems

Model Design Code	**SYSTEM COMPONENTS**		**Loading Method**	**System Used For**	**Cost Category**	**Annual operation and maintenance**
	Treatment Unit	**Land Treatment/ Application**			**Based on July 1999 prices**	**Based on July 1999 prices**
1	Improved septic tank	Sand filled treatment trenches	Pumping	Gravels, coarse sands, rapid drainage	$6,000 - $7,000	$75 - $100 (Clean filter & pump)
2	Improved septic tank	Low Pressure Piped (LPP) or Low Pressure Effluent Dosed (LPED)	Pumping	Sandy soils, very good drainage	$7,000 to $8,000	$75 - $100 (Clean filter & pump)
3 & 4	Improved septic tank	Conventional soakage trenches	Gravity	Good soils, adequate drainage	Under $3,500 - $4,000	$75 (Clean filter)
5	Improved septic tank	Evapo-transpiration/ seepage beds (ETS) or trenches	Pumping, siphon, or gravity	Moderate soils, slow drainage	$6,500 - $7,500	$75 - $100 (Clean filter & pump)
6	Improved septic tank	Sand filled mound [Wisconsin Mound]	Pumping	Shallow good to moderate soils above clay hardpan, rock, or shallow groundwater	$9,000 - $10,000	$75 - $100 (Clean filter & pump)
7	AWTS	Drip irrigation	Pumping	All soil and site conditions	$8,500- $10,500	$150 - $250 Manufacturer's agent
8	Improved septic tank plus sand contactor unit (either intermittent or recirculating filters)	Drip irrigation	Pumping	All soil and site conditions; water closet recycle	$10,000 - $11,000 $12,000 - $12,500	$100 - $150 for 1 yr pump guarantee $100 - $150 for 5 yr pump guarantee

7.2 Important principles for installing the septic tank

- The tank must be on a completely level base.
- In areas with high water tables, the tank must be held down in the ground. If this isn't done, it can float up when the sludge is pumped out causing the outlet pipes to break. Then if it settles back crookedly, it could crack when it refills with sewage.
- Avoid damaging the tank when back-filling the hole.
- Fill the tank with water as soon as possible after it's installed and before connecting it to the house drains. This safeguards both the drains and the tank from cracking. (The pressure of the surrounding earth pressing on an empty tank can crack it.)
- The tank access lids should be at ground level (fitted with risers if necessary), sealed to prevent stormwater and rainfall getting in, and be able to be accessed by the sludge Takeaway tanker.
- No tank access lids should be able to be opened by children.

7.3 Important principles for constructing the soakage treatment area

7.3.1 Before construction

Remove existing drainage lines. Any existing drains under the soakage treatment area must be removed and filled in. If this doesn't happen they can channel partially treated effluent straight into waterways. Discharges of sewage to water are illegal unless the person responsible for the discharge has a discharge permit (see section 2.3.2).

Existing drains can be difficult to find, but ask the previous owner and look for telltale signs such as small ridges or dips, green lines, broken pipes when excavating. Look for pipelines or mole drains when digging the test pit for the soil assessment. (A mole drain is a small tunnel of around 3-5cm diameter. There is no pipe, but in non-sandy soils the hole remains for a number of years.)

7.3.2 During construction

- On sloping sites, put the trenches or beds along the contour of a slope. If trenches are installed down the slope, effluent will collect at the bottom of the hill, and the trenches can become channels for surface water when it's raining. This can cause erosion or washouts.
- Digging machinery is not generally practical or safe on sites with slopes greater than 20°. These sites are not generally suitable anyway, and specially designed systems are essential.
- Mounds or ditches should be constructed around soakage treatment areas on hillsides to divert surface flows.

- Heavy machinery should not be used on the soakage treatment area, or the spaces between beds and trenches. Heavy machinery can compact the soil which reduces the effluent infiltration rate.
- Never excavate wet soils because the trench edges are likely to smear making it difficult for effluent to seep through. Soils just below the surface must be crumbly and not too wet.
- If the trench bottom or edges do get smeared, dig them over by hand.
- Cover newly dug areas if it rains, to prevent them from smearing.
- Avoid compacting or smearing trench surfaces when filling them with gravel and sand.
- Make the bottom of the soakage treatment area completely level, otherwise effluent will flow to the lowest point and eventually the soil will block up and cause ponding in this area. Pipes should also be level, unless over 15 metres long, when they should be laid at a slight slope (1 in 200).
- Pressure distribution systems should be laid in place within the excavated soakage treatment area, and pump-tested with clean water to make sure that the effluent will be evenly distributed. Minor adjustment to hole spacing and valve settings can easily be done and the system re-tested before filling it in.
- Topsoil spread over the soakage treatment area should be mounded over narrow trenches or spread uniformly over mounded fill, then carefully compacted by hand and sown immediately with grass.
- If vegetation is going to be planted to encourage evapo-transpiration, sow grass first and then plant the larger plants. Start using the system immediately to provide nutrients and liquids to the new plants.
- Never install effluent distribution pipes deeper than 20 cm, unless the ground is likely to freeze, in which case, bury them more than 30 cm deep.

Where pipes are parallel, their centres should be:

- at least 3 metres apart, if the seasonal high water table comes to within 600mm of the base of the gravel in the distribution bed
- at least 1.5 metres apart, if the seasonal high water table is deeper than 600mm below the base of the gravel in the distribution bed.

7.3.3 After construction

Divert all water away from the soakage treatment area. Make sure that no water can run onto the soakage treatment area because this can saturate the soil and limit its ability to treat the effluent.

Surface water can come from

- rainwater running off roofs, driveways or paved areas
- overflow from the water tank
- hill areas that drain onto the soakage treatment area

To intercept surface water flows, create a diversion channel or grass covered ridge around each of the edges. Direct the water well away from the soakage treatment area.

To intercept groundwater moving toward the soakage treatment area, construct a gravel or aggregate filled cut-off trench on the uphill side of the area. Divert the collected water to a separate clean-water soakhole or to a place that is well away from the soakage treatment area.

7.3.4 Protect existing vegetation

If there are shrubs or scrub on the section, put the distribution lines or shallow trenches amongst them to avoid major construction disturbance to the site. This keeps the soil and vegetation characteristics of the site, while maximising soakage and evapo-transpiration opportunities.

Nutrients in the effluent can encourage weed growth. To avoid weeds, establish a good, thick grass cover at the beginning.

7.3.5 Establishing new vegetation for evapo-transpiration beds

Evapo-transpiration beds use plants to help suck up moisture and nutrients that might otherwise pond on the ground surface or soak away and pollute groundwater.

- On grassed sites, the surface of the soakage treatment area should be tilled to a depth of 150 mm. Long grass should be mown first, then the remaining vegetation turned in. A heavy duty rotary hoe or a light digger may be necessary.
- If the evapo-transpiration bed is to be put in amongst existing vegetation, the ground should be tilled lightly by hand, leaving plants undisturbed.
- Plant the area densely as soon as possible. Usually it is best to plant the surface of the mounded trench or bed with grasses (for example sedges and rushes) and to plant the natural soil surrounding the beds or downslope of the contour trenches with bigger plants (for example giant umbrella sedge or raupo). Shrubs can be planted in the natural soil between the beds.
- Raupo, toetoe, cabbage trees, karamu, and koromiko are all tolerant of damp ground and occasional waterlogging. Harakeke (swamp flax), is suited to areas where the soil is damp all year round. Check the *Regional Good Plant Guide* (Wellington Regional Council), and *Growing Native Plants in Kapiti* (Kapiti Coast District Council), for more information about native species suitable for the area.
- The plants may need watering if homeowners are away for long periods during dry spells, like summer holidays.

7.4 Managing the on-site sewage system

7.4.1 Ways to get the best performance out of the tank

Reduce sludge build up

Sludge is a mixture of partially decomposed organic matter, dead bacteria, and anything that is not biodegradable. If a lot of organic matter (like from a kitchen sink waste grinder) is put into the tank, lots of bacteria are needed to break it down. After the bacteria die, they end up contributing to the volume of sludge (yes, there are billions of them). Inorganic rubbish put into the tank (like dirt and plastic) also contributes to the volume of sludge. Lots of sludge means the tank needs to be emptied more often, and the filters need to be cleaned more often.

People can reduce sludge build up in the tank by —

	Do		Don't
✔	Scraping all dishes to remove fats and food particles before washing	✘	Not using a kitchen sink waste disposal unit
✔	Shaking sand and dirt from clothes before putting them in the washing machine	✘	Not putting coffee grounds, sanitary napkins, disposable nappies, etc into the system

Reduce unnecessary inputs of water to the tank

Most water used in the house ends up as wastewater discharged down the drain. If less water is used, less wastewater is discharged. With lower volumes of wastewater passing through the tank, the wastewater detention time in the tank is longer, giving more time for solids to settle. Also, lower volumes passing through the system mean a lower hydraulic load on the soakage treatment area. This means the soakage treatment area doesn't get so wet.

People can reduce water input to the tank by —

	Do		Don't
✔	Controlling the use of water by installing water reduction devices like dual-flush toilets, low-flow shower heads, spray nozzle taps etc	✘	Not doing all the laundry in one day
✔	Having showers instead of baths	✘	Not emptying lots of water into the system from spa pools and the like
✔	Fixing leaking taps	✘	Not letting stormwater into the tank, either from the roof or from the surrounding land

Some water reduction devices are described in Table 4 below.

Table 4 Water Reducing fixtures

What it is	How it works	Water use figures (litres)	
Toilets		**Water-saver**	**Conventional**
Air assisted	Compressed air aids in flushing	2.3	18 – 27
Composting	Doesn't use water		
Low flush	Gravity flush, only uses 1.6 gallons per flush		
Shallow trap	redesigned fixture; uses 3.5 gallons per flush		
Cistern inserts (bricks, plastic bottles etc)	These displace water in the toilet cistern; reducing the volume used per flush		
Showers			
Low-flow shower heads	Redesigned shower heads; reduce water use without affecting the quality of the shower	9.5	18 – 27
Shower flow-control inserts	Usually neoprene washers placed inside shower arms; restrict flow of water		
Taps			
Tap-flow control aerators	Attach to end of tap to restrict flow	bathroom 2.3 kitchen 6.8	bathroom 18–27 kitchen 18 – 27
Spray taps	Replace taps in lavatory sinks; produces a shower type spray that uses less water. Washing up is quicker too.		
Clothes washers			
Front-loading washers	Tumbling action requires less water	100-150	Toploader 182-250
Top-loading washers with suds savers	Wash water can be reused		

Keep the bacteria working

Bacteria decompose most of the solid material discharged into the tank. These bacteria are sensitive to pH changes, for example from strong detergents and household cleaners, and to toxic chemicals. To keep these bacteria alive —

Do	Don't
✔ use bio-degradeable detergents and cleaners	✘ don't pour toxic chemicals like paints, thinners, oils, or pesticides down the drain
✔ check all cleaners to see if they are suitable for septic tanks	✘ don't use huge amounts of cleaners

Be alerted to system failure

Pumped systems should be fitted with alarms, such as a buzzer. Failed pumps should be fixed immediately to avoid flooding the tank and the drains in the house.

7.4.2 Ways to get the best performance out of the soakage treatment area

Soakage treatment areas are designed to provide final treatment and safe effluent disposal. Having a properly designed area is a great start, but it must be properly maintained. The soakage treatment area must be kept in lawn or plantings and not used in a way that can damage or compact it. Planted borders or low hedges can be used to separate it from the rest of the property.

Marking where the pipes are laid is very useful if owners want to plant trees, change the system or locate damaged pipes later. Installing mushroom vents at the ends of the distribution lines is a good way of marking the system, as well as providing monitoring access for checking effluent levels in the soakage system. To protect this area and help give it a long and useful life —

Do	Don't
✔ maintain and protect all plants and landscaping that is part of the soakage treatment area	✘ don't build driveways or buildings on top of the soakage treatment area, or drive over it
✔ keep livestock off the soakage treatment area because they can damage distribution pipes and compact the soil	✘ don't grow deep rooting trees or shrubs over the soakage treatment area
✔ plant borders or low hedges around the soakage treatment area to separate it from the rest of the property	✘ don't let rainwater flow onto the soakage treatment area from roofs, driveways, or uphill areas
✔ alternate between two areas every three to six months (if the system was designed to do this)	✘ don't let effluent pond on the ground surface. If this happens, the soakage treatment area is blocked and to be fixed or replaced.

Reduce the amount of effluent applied to the soakage treatment area

One way to reduce the total volume of effluent is to reduce water use in the house. Another way is to separate the greywater (wastewater from laundry, baths and showers) from the toilet wastewater. The main system then treats only toilet and kitchen wastewater.

Greywater can be collected in a separate tank, and discharged into its own soakage treatment area, or irrigated onto land. Discharges of up 2000 litres per day of greywater onto land do not require a discharge permit provided the discharge is more than 20 metres from a watercourse and does not pond on the ground surface or run off from the disposal area.

7.5 Monitoring and maintaining the tank

Like a car, some occasional but regular maintenance is needed so that the system operates effectively. Different people put different amounts and types of waste down their drains, so the performance of every on-site sewage system is different.

The most important chore is to check the levels of sludge and scum building up in the tank, and get it removed before it escapes to the soakage treatment area. Sludge and scum clog soakage treatment areas and cause effluent to collect on the ground surface, which is a health risk, and the area has to be replaced.

Sludge in aerobic systems builds up faster than in anaerobic (septic) systems. This is because aerobic bacteria have a faster growth rate than the anaerobic bacteria that do most of the degradation in septic tanks. People who install aerobic systems should get them emptied annually and need to be aware of this extra cost.

7.5.1 Finding the system

The septic tank is usually close to the house. Look for the fresh air inlet (‘mushroom’) in the lawn. Sometimes there are changes in the ground level over the tank (a mound or a dip). Sometimes grass doesn’t grow as well elsewhere because the soil is often thin over the tank.

If the septic tank is not obvious, follow the line of the house drain to the tank by probing the ground with a metal rod. Use the same method to trace the distribution pipes into the land application area. If there are still problems, ask a drainlayer.

7.5.2 Checking sludge and scum levels

Sludge and scum levels can be monitored by the homeowner. They need to check them at least every three years to see how fast they are accumulating. Systems serving 15 people or more need to be checked annually.

Ideally, people should get the sludge removed when it is more than 200 mm deep, rather than have set removal periods. This is because sludge degradation improves with time, especially after the first year. Emptying tanks too often simply increases the load on the district council's sewage treatment plant (because this is where all septic tank sludge is disposed of unless there is a specific discharge permit).

The primary chamber of any anaerobic tank will have a crust layer on the top and a sludge layer on the bottom. The tank should be cleaned out when the crust layer is more than 300mm thick, or the sludge is more than 200mm deep.

Crust

Use a hinge to fasten a small flat piece of wood or plastic (the flap) to the end of a stick that is at least a metre long. Suitable dimensions for the flap are about 100 x 50 x 5 mm. The hinge allows the flap to fold up along the stick or lie out at a 90 degree angle. Push the stick, flap first, down through the scum. The flap will fall into a horizontal position when it breaks through the scum layer. Pull the stick back up (gently) until you feel the flap has reached the bottom of the scum layer. Mark the place on the stick where it is level with the top of the scum. Pull the stick back out again. Measure the distance from the mark to the bottom of the stick. Try to do this test about halfway along the tank chamber.

Bottom Sludge

After checking the scum thickness, wrap several layers of white cotton fabric around another long stick, up to 750mm from the lower end. Push the stick through the hole cleared in the scum layer or through the outlet tee, until it reaches the bottom of the tank. Spin the stick a few times. Wait a minute and then carefully lift the stick out of the tank and note the sludge level indicated by the dark coating of sludge on the fabric.

If there are two chambers, the second chamber probably only needs to be emptied every second time. If the secondary chamber contains a plastic mesh, push the mesh aside, suck out the sludge and return the mesh to its original position.

Filters

Rock filters are becoming increasingly common because they improve the quality of the effluent and increase the life of the soakage treatment area. **Do not remove the rocks** from the filter because they are very important for slowing the rate of discharge from the tanks, and reducing the amount of suspended solids in the effluent.

To check the need for cleaning tanks with a rock filter, lift the central lid of the tank. Look for excessive bio-film (green algae/slime) and check that it is not washing off the stones into the outlet. The clear effluent on top of the stones should be about 50mm deep, so that dislodged biofilm will settle back when the flow stops, rather than flowing out of the outflow and blocking the distribution pipes.

If flow through the filter is restricted, and biofilm is excessive, the filter needs cleaning. Check the flow by turning on a tap in the house and watching the central pipe of the filter. If the water level in the pipe rises quickly then the filter is becoming blocked.

The first thing to do when cleaning the filter is to block the filter outlet. Then fill the filter chamber with water from a garden hose and lower a suction hose down the central pipe to the base of the filter. With the hose running to keep the filter filled, suction should be applied to draw the clean water down through the filter (in reverse direction to its normal upwards flow) for about two minutes. If the filter is badly choked do this several times. Enzyme products can be used to help break down the biofilm and reduce odour problems.

Any other type of filter should be cleaned according to the manufacturer's instructions. This usually involves removing the filter from its housing and hosing it back into the septic tank or the filter chamber. Leave a thin layer of bio-film because this is important for treating the effluent.

7.5.3 Estimating sludge and scum levels

Without regular tank inspections by dedicated homeowners, it is reasonable to remove sludge and scum every three to five years (for an average three-bedroom home). This is necessary because sludge build up reduces space in the tank, which then reduces settling time for incoming sewage. Accumulated sludge can get washed out with the liquid effluent, especially if there are no baffles or compartments.

Sludge and scum accumulation rates are estimated as (AS/NZS 1547:2000, section 2.4.2.1)
(i) all-waste: 80 litres per person per year
(ii) greywater: 40 litres per person per year
(iii) toilet waste: 50 litres per person per year.

AS/NZS 1547:2000 requires tanks to have sufficient capacity for wastewater to be retained in the tank for at least 24 hours, allowing for an average daily flow of 200 litres per person. Because of sludge and scum build up, a four person household served by a 3,000 litre tank will lose 320 litres of tank capacity every year and would need to be emptied after about 6 ½ years. The same tank serving five people will need to emptied after five years.

7.5.4 Removing sludge and scum

Removing sludge and scum from the tank must be done by a person holding a licence to carry out an "Offensive Trade" from the local Medical Officer of Health. Tank sludge cannot be discharged to land, even private property, without a discharge permit. Ask the Wellington Regional Council for information about applying sludge to land.

If the owners think they (or their tenants) may forget to get the tank emptied when it is due, they can take out an annual maintenance contract with a contractor. An advantage of taking out a maintenance contract is that they will have a good contact for servicing if there is any problem.

For package plants like Aerated Wastewater Treatment Systems, or septic tanks with sand filters, it is normal to take out a maintenance contract with a servicing agency (usually a representative of the supplier of the system). The contractor will need to be experienced in maintaining their type of system because there are many kinds of aerobic systems available throughout the Region.

7.6 Repair or upgrade of a failed system

Most systems fail because the tank or the soakage treatment area, or both, are too small.

Small tanks do not allow enough settling time, and do not have enough space to store accumulated sludge. If a small tank is working alone (i.e. no second tank, no filter), the effluent quality will be even worse because sludge will overflow from the tank with the effluent and end up in the soakage treatment area.

Small soakage treatment areas tend to stay almost permanently saturated. Saturated conditions mean that the aerobic conditions in the soil necessary for final treatment never happen. Also, the wetter the soil, the faster the clogging layer builds up. First of all, the pipe holes or soil at the beginning of the trench clog up. Then the effluent seeps out the next available hole with the same result. Eventually the entire field becomes blocked. This is known as creeping failure, and is common with simple trench systems.

But this isn’t the only problem. Before the field clogs up, the permanently wet conditions mean that most contaminants simply get flushed straight through to groundwater. This can make water from shallow bores in a wide area unsafe for drinking.

Every discharge from the tank to the trench happens in response to a discharge from the house. Small discharges into the trench will never reach the full extent of the soakage treatment area unless they are distributed under pressure.

All systems are likely to fail if groundwater reaches the soakage treatment area. This happens because the soakage treatment area gets saturated and makes the clogging layer build up too much.

A thorough site investigation should be done before any soakage treatment area is upgraded so that the new system doesn’t fail for the same reasons as the existing one.

7.6.1 Effects of failed systems

A failed septic tank is a serious health and environmental hazard and can lead to —

- infection for the homeowner
- pollution of beaches and streams
- contamination of drinking water supplies
- breeding of flies, mosquitoes and rodents
- risk of infection to pets and farm animals

7.6.2 Signs of system failure

Some obvious warning signs are —

- drains and toilets empty slowly
- there is a sewage smell near the septic tank or soakage treatment area
- puddles of effluent on the ground

7.6.3 Reasons for system failure

The reasons for these are —

- the tank is full of sludge
- the soakage treatment area is clogged

If the tank is full of sludge, it needs emptying. Unfortunately, if things have got this far, the soakage treatment area is probably clogged as well. Two reasons for clogged soakage treatment areas are **poor effluent quality** and **high application rates**

Poor quality effluent, i.e., effluent with a high concentration of organic matter (measured as Biochemical Oxygen Demand), is generally caused by —

- small single tanks that do not keep the sewage in the tank long enough to allow solids to settle
- sewage short circuiting in the tank between the inlet and outlet pipes
- large inflows disturbing accumulated sludge and washing it out with the effluent.

Septic tank design features that reduce the chance of this happening are —

- large tanks with at least two compartments
- inlet and outlet tees and baffles
- filters (either rock filters or outlet screens)
- sludge removal at least every three years.

High application rates (exceeding the Long Term Acceptance Rate) are generally the result of —

- small soakage treatment areas
- effluent only reaching the beginning of the soakage treatment area and not being spread around.

High application rates are avoided by distributing the effluent evenly throughout a large area. The area should be large enough that the daily discharge from the system divided by the area of soakage (square metres) provides an application rate of:

- 15 – 25 mm/day for fast draining soils;
- 10 - 15 mm/day for medium draining soils; and
- less than 5 mm/day for clay soils.

The Standard (AS/NZS 1547:2000) recommends that soakage treatment areas are designed to cope with a daily wastewater flow of 200 litres per person (see section 2.4.2.1 of the Standard). The Wellington Regional Council will accept systems designed in accordance with the Standard or with Technical Publication No. 58 from the Auckland Regional Council for compliance with Rule 7 of the Regional Plan for Discharges to Land (140 – 180 litres per person per day). Territorial authorities have the discretion to accept either criteria.

7.7 Checking a failed system

7.7.1 Inspect the septic tank

- Check for sludge build up in the tank. Sludge build up can cause both the distribution pipes and the soakage treatment area to clog up. The tank must be cleaned out by a person holding a licence to carry out an "Offensive Trade" from the local Medical Officer of Health
- Check if the filter needs cleaning (if there is one)
- Check the size of the tank. These days, single small tanks are rarely adequate for the volumes of wastewater discharged from a medium sized house
- Check that all pipes are connected and are in good condition

7.7.2 Inspect the soakage treatment area

If the soakage treatment area is wet or there are puddles of effluent nearby, there will be very little treatment happening in the soil. The wet area will have high numbers of bacteria and other germs so it is important to fix this.

If the soil is wet only at the beginning of the soakage treatment area, the effluent is not being distributed throughout the whole area and "creeping failure" will eventually result.

If effluent is draining into any drains or rivers, the discharge is illegal. If this is happening there will be probably be green slimes growing at the point of discharge.

If any of these things are occurring, follow these steps—

- Verify the size of the soakage treatment area, and how effluent is being discharged into it (gravity or pumped)
- Work out if it is big enough for the amount of effluent being distributed to it

- Dig up a section and see if the pipe is blocked, if the holes are blocked, or if the soil is clogged

If the problem in the soakage treatment area cannot be solved by flushing the pipes out or replacing them, a new soakage will have to be installed. New systems can be installed

- In the reserve area set aside when the original soakage treatment area was installed, or
- Between the failed trenches or beds of the failed system

Alternatively, upgrade to an aerobic system and discharge onto land by drip irrigation.

Many soakage treatment areas fail because the effluent quality being discharged into them is very poor. If this is the case, improve the effluent quality by

- replacing the existing tank with a bigger tank
- connecting a second tank between the existing tank and the soakage treatment area
- installing an outflow filter (only an option where the existing tank is big enough and still in good condition. A separate pump chamber is usually required for outflow filters)

A pump chamber may be required to pump effluent to a new soakage treatment area.

8. WORKSHEETS AND DESIGNS

Site Assessment Form

Site information

Site address:
Site owner: Owner's address:
Survey plan details:
Lot number:
Site use (dwelling, café, farmstay, etc)

Site Assessor

Name:	
Designation:	
Organisation:	
Address:	
Phone: ( )	Fax: ( )
Email:	

Site Assessment

Date(s) of site visit(s)	
Weather (on day & preceding week):	
Groundwater Depth of seasonal watertable: WINTER Quality (such as existing microbiological or nitrate problems, if known)	 SUMMER

Drainage (flow direction shown on site plan)

Need for groundwater cut-off drains?

Need for surface water cut-off drains/diversion banks?

Soil type tests (minimum of 3 soil observation holes required to find out where the best soils for a soakage treatment area would be – see 4.1C3.1.1 of AS/NZS 1547:2000)

Bore log: Test hole:

Other (specify):

Reporting: (attach detailed soil report as appropriate)

Soil profile:

Soil depth:

Constraints for on-site sewage: (hardpan, swampy, gravel, other)

Estimated Soil Category (see Tables 4.1.1 and Clause 4.1.4.1 of AS/NZS 1547:2000)

Rapidly drained gravels and sands (Category 1)

Well drained sandy loams (Category 2)

Moderately well drained loams (Category 3)

Imperfectly drained clay loams (Category 4)

Poorly to very poorly drained light to heavy clays (Categories 5, and 6)

Distance to	Allowable Minimum	Available
River	20 metres (50 metres in water supply catchment)	
coastal marine area	20 metres	
farm drain etc	20 metres	
property boundary (if discharged **onto** ground, otherwise at the discretion of the territorial authority)	5 metres	
bore	discretion of territorial authority	
house and other buildings	discretion of territorial authority	
stands of trees	discretion of territorial authority	
driveway	discretion of territorial authority	

Ground slope

Is the slope more than 20°? YES / NO (delete one)

If YES, attach stability report and give details here of:

Author: Organisation:

Ground Cover (grass, shrubs, trees)

Site history (eg existing backyard, farm, bush, industrial)

Environmental concerns (e.g. wetlands intolerant of nutrient loads)

Assessment

Type of soakage treatment area considered best suited to the site and why (design attached showing plan view and cross-section view, with dimensions)

Size of soakage treatment area and application rate (design calculations attached)

Reserve area (shown on site plan)

Reserve area available for extensions: % of design area

Attachments

1. Site Plan, drawn to scale, showing
   - the location, or proposed location, of property boundaries, all structures, the soakage treatment area and reserve area, any rivers, artificial watercourse, and the coastal marine area
   - distances between the proposed soakage treatment area and property boundaries, structures, any river, artificial watercourse, and the coastal marine area
   - contour lines, or at least surface water drainage patterns
   - where soil tests were done.
2. Design calculations, including estimated daily wastewater flow, tank size, soakage treatment area and application rate.
3. Construction plan and specification showing invert and ground levels for installer (this can be added to the site plan)
4. Maintenance and operation schedule for the system owner.
5. Site stability report (if necessary).
6. Soil report (if necessary).
7. Discharge permit application (if necessary).

Model Design Selection Tables

Table 5 Model Designs for sites with adequate depth of soil

For the purposes of this Table, adequate soil depth means at least 600mm of soil below the designed soakage system. This 600mm of soil must be free of any impermeable or highly permeable layer (such as clay or gravel) and be permanently unsaturated (based on the highest groundwater level reached in any year).

Drainage Characteristics[2]	Model Design Code	Model Design Systems for the given site conditions
Free draining Soil Category 1- gravels and sands Soil Category 2 – sandy loams	1 (rapid draining) 2 (free draining)	Improved Septic Tank plus sand filled Treatment Trenches[3] Low Pressure Piped (LPP) or Low Pressure Effluent Dosed (LPED)
Moderately drained Soil Category 3 – loams Soil Category 4 – clay loams	3 (good to moderate draining) 4 (moderate to slow draining)	Improved Septic Tank plus gravity fed Conventional Soakage Trenches (aggregate filled)[4] Same system as above with increased number of trenches for moderate to slow draining soils
Poorly drained Soil Category 5 – light clays Soil Category 6 – medium to heavy clays	5 alternatively 7 or 8	Improved Septic Tank plus Evapo-transpiration/Seepage Beds (ETS) or Trenches For poor draining soils 7 & 8 would be used with a maximum application rate of 3mm/day

[2] Drainage characteristics are based on soil categories as described in the *Australian-New Zealand Standard – AS/NZS 1547:2000 On-site domestic-wastewater management.*
[3] This system requires at least 1500mm of soil above the groundwater or any impermeable layer, whereas 2 only requires a minimum of 1000mm.
[4] Aggregate provides no treatment of the effluent, whereas sand in trenches does provide treatment, hence ‘soakage’ trench rather than ‘treatment’ trench.

Table 6 Model Designs for sites without adequate depth of soil

For the purposes of this Table, **without adequate depth of soil** means sites with less than 600mm of permanently unsaturated and permeable soil below the bottom of the designed soakage treatment area. The type of soil on these sites makes no difference to the system design because the soil is too shallow to provide adequate treatment.

Code	Model Design System	Points to consider when making your choice	
6	Improved Septic Tank[5] plus pump-dosed, sand filled Mounds	This system produces a lower quality effluent than 7 and 8 and is therefore more suitable for less sensitive sites. The tank is also simpler but the land application system is more complex than for Designs 7 and 8.	This is the most expensive of the three options to establish because of the soil and sand required in the mound. However, ongoing maintenance costs are relatively low.
7	Aerated Wastewater Treatment System plus Drip Irrigation	Produces high quality effluent that can be used to feed a garden (using drippers under bark or similar, which is laid on the surface). This is a relatively cheap land application system because it does not involve any trenching, however, the treatment unit is more expensive than the tank in 6.	May be a lower cost option than 6 initially, but it is a more complex system requiring pumps, power and higher maintenance costs.
8	Improved Septic Tank, with a sand contactor unit, (either intermittent or re-circulating) plus Drip Irrigation	Produces very high quality effluent. This can be disinfected and recycled to flush the toilet. It can also be used without disinfection to feed the garden, as above. [6]	7 and 8 are of similar cost but usually less expensive than 6.

5 Improved Septic Tanks must have a filter, either screen or rock, and should have more than one chamber.

6 This will not require a Discharge Permit because the sand filter provides the aerobic treatment required in the regional rule for discharges of sewage **onto** land.

Wastewater flow design allowances

Table 7 Wastewater flow design allowances

SOURCE	Typical Wastewater Flow Allowance in Litres/Person/Day [Note 1]	
	On-site Roof Water Tank Supply	Reticulated Community or a Bore Water Supply
Households with standard facilities (including automatic washing machine)	140	180
Households with standard water reduction fixtures	115	145
Households with full water reduction facilities [Note 2]	80	110
Households with extra wastewater producing facilities (e.g. garbage grinder)	170	220
Households (blackwater only)	50	60
Households (greywater only)	90	120
Motels/Hotels		
- guests, resident staff	140	180
- non-resident staff	30	40
- reception rooms	20	30
- bar trade (per customer)	20	25
- restaurant (per diner)	20	30
Community Halls		
- banqueting	20	30
- meetings	10	15
Restaurants (per diner)		
- dinner	20	30
- lunch	15	25
Tea Rooms (per customer)		
- without restroom facilities	10	15
- with restroom facilities	15	25
School (pupils plus staff)	30	40
Rural Factories, Shopping Centres	30	50
Camping Grounds		
- fully serviced	100	130
- recreation areas	50	65

NOTES:

1. AS/NZS 1547:2000 recommends designing according to 200 litres per person per day for all domestic households.

2. Standard water reduction fixtures include dual flush 11/5.5 litre water closets, aerator faucets (taps) and reduced capacity automatic washing machines.

Source: Adapted from NZ Manual of Alternative Wastewater Treatment and Disposal Systems, Volume II, Part A, On-Site Wastewater Disposal from Households and Institutions (1989). Auckland Regional Council Technical Publication No. 58. Prepared by Ian Gunn, Auckland UniServices Ltd. University of Auckland. (Also used in Appendix 4.2D of AS/NZS 1547:2000.)

Model Designs selected according to Tables 5 and 6

Model Design 1 – Rapid Draining Soils
Improved Septic Tank (with effluent outlet filter) Pump Chamber and Sand Filled Treatment Trenches

Model Design 2 – Free Draining Soils
Improved Septic Tank and LPED (Low Pressure Effluent Dosing)

Model Designs 3 & 4 – Moderate Draining Soils
Improved Septic Tank With Aggregate Filled Soakage Trenches

Model Design 5 - Poorly Draining Soils
Improved Septic Tank (With Effluent Outlet Filter) Pump Chamber and Evapo Transpiration Seepage (ETS) Beds or Trenches

Model Design 6 – Shallow Moderate to Slow Draining Soils above Hardpan or Shallow Groundwater
Improved Septic Tank and Sand Filled Mound (Wisconsin Mound)

Model Design 7 – Poorly Drained Sites or Sites with Limited Topsoil
AWTS (Aerated Wastewater Treatment System) Pump Chamber and Drip Irrigation System

Model Design 8 – Poorly Drained Sites or Sites With Limited Topsoil
Improved Septic Tank, Sand Filter, Pump Chamber and Drip Irrigation System

Model Design 1 – Rapid Draining Soils

Improved Septic Tank with Pump Chamber and Sand Filled Treatment Trenches

Model Design 1 is suitable for rapid draining soils where the soils are basically just gravels and coarse sands (see Table 5). Where an adequate depth of good soil is free draining and on top of gravels and coarse sands, use Model Design 2.

This design is for a household of three bedrooms (5 people) with a maximum wastewater effluent production of 700 litres/day (140 litres per person).

Sizing the system to suit the soil type

Soil Condition	Design Loading Rate	Trench Length (each)	Number of Trenches	Soakage Treatment Area	Reserve Area (at 100%)
Rapid Drainage	20 mm/day	17.5 m	4	19.5 metres by 6 metres (117 square metres)	117 square metres

Notes:

(a) for design loading rate see AS/NZS 1547:2000, Table 4.2A1, category 1 soils, conservative application rate.

(b) The design loading rate is used to size the horizontal base area of trench system.

(c) 1 mm/day is equivalent to one litre of effluent spread over one square metre per day.

Adapting the system for the household size

Household Size	Trench System Details	Soakage Treatment Area Size
Two bedroom dwelling, four people or less using water conservation fixtures. Daily effluent volume of 450 litres/ day. Septic tank capacity: 3000 litres	Three of 15 m length	17 metres by 4.5 metres (76.5 square metres).
Five bedroom dwelling, standard fixtures, eight people or less, 1120 litres/day. Septic tank capacity: 4500 litres.	Five of 22.5 m length	24.5 metres by 7.5 metres (184 square metres).

Notes on Function

This trench system is designed to provide treatment of septic tank effluent that would otherwise soak rapidly down through these porous soil conditions directly into groundwater without any improvement in quality.

Design Notes

1. For a different number of household residents, calculate total daily wastewater effluent output at 140 litres/person/day for rainwater supply, and 180 litres per person/day for bore water or community supply.
2. To find trench bottom design area, divide total daily wastewater output in litres by soil loading rate in mm/day.
3. Total trench length in metres is found by dividing the area by 0.5 m (the width of the trench).
4. Find the overall soakage treatment area by multiplying the number of trenches by 1½ metres, and allowing a 1 metre clearance at each end of the trench system.
5. For more information about construction and installation of trenches see Appendix 4.5A of AS/NZS 1547:2000.

Pumping Requirements

The pump sump must provide storage of 300 litres per pumping cycle. The pump capacity must be for 150 - 200 litres/minute over 3 minutes. A 50 mm diameter manifold should join with the 30 mm distribution lines at a 50 mm valve. A backflow preventer must be installed on 50 mm rising main as it leaves the pump chamber.

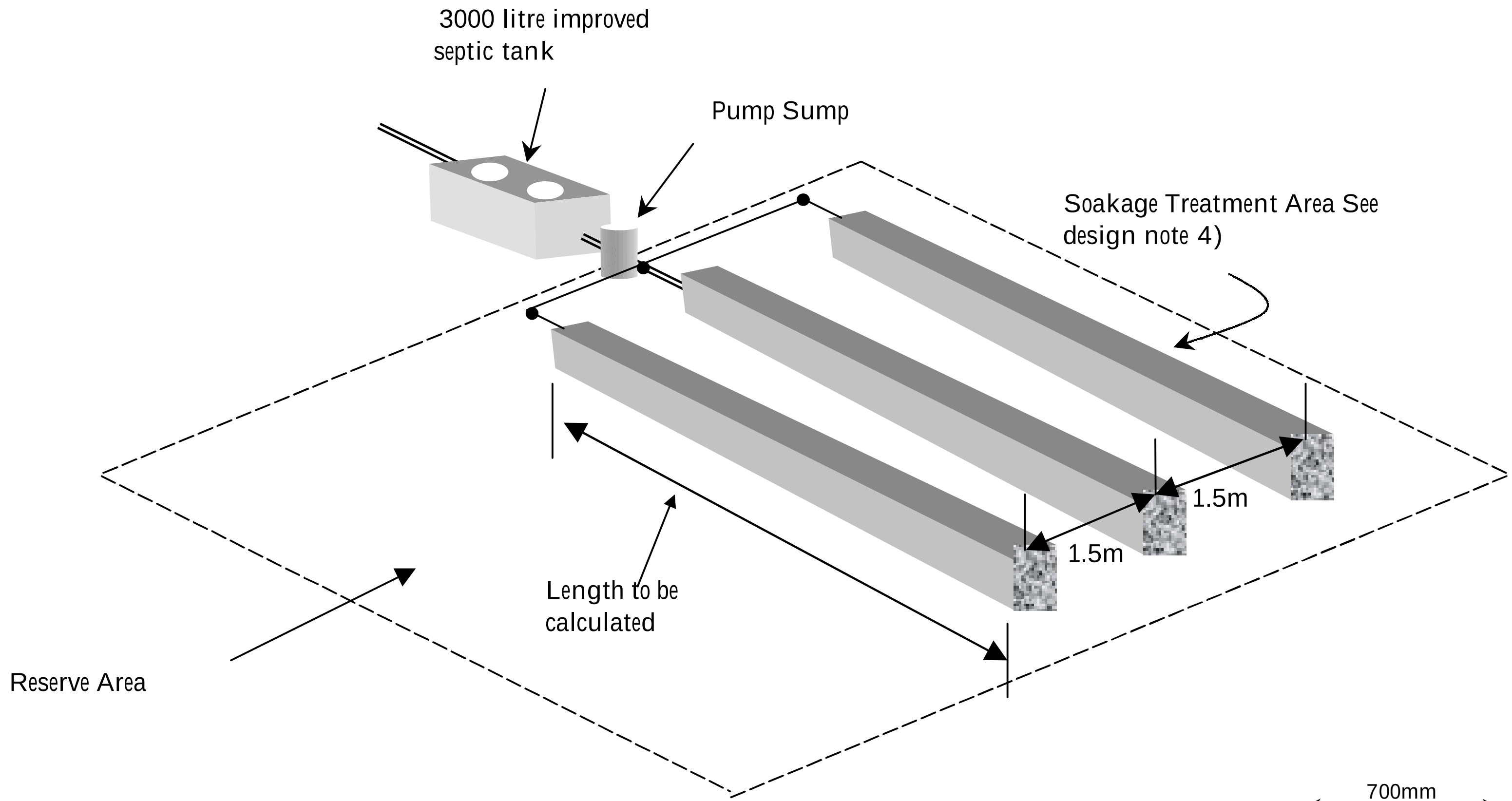
Installation notes

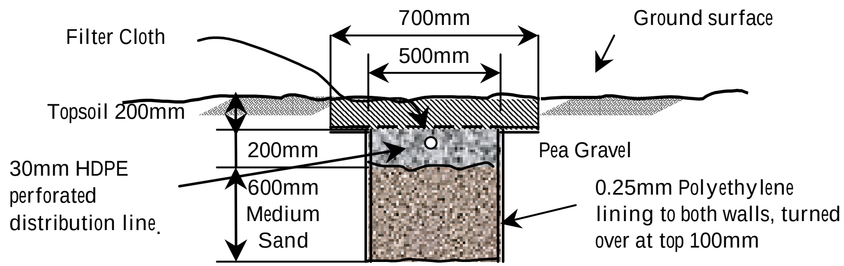
1. Groundwater to be at least 500 mm below base of trench (this means clearance to watertable from ground surface should be around 1500 mm).
2. Plastic lining to be laid against the walls of the trench prior to careful backfilling with the treatment sand. Plastic must not cover any of the base area.

Materials requirement for basic household system	**Quantity**
1. Length of 30 mm diameter pumped effluent distribution line in trench system (HDPE with 6 mm perforations at 800 mm spacing).	70 metres
2. Pea gravel surrounding distribution pipe.	7 cubic metres
3. Medium sand (0.3 to 1.0 mm effective size, U of < 4).	21 cubic metres
4. Polyethylene sheet 0.25 mm, 700 mm wide.	140 metres
5. Filter cloth 700 mm wide.	70 metres
6. Topsoil over filter cloth.	10 cubic metres

Model Design 1 – Rapid Draining Soils

System Layout (Indicative only)





Notes:

1. Check with your local Council for specific sizing criteria
2. Improved septic tank incorporates an effluent outlet filter
3. 30 mm diameter distribution line perforated with 6 mm holes at 800 mm spacing (design calculations required to confirm)

Model Design 2 – Free Draining Soils

Improved Septic Tank And LPED (Low Pressure Effluent Distribution)

Model Design 2 is suitable for free draining sand soils where adequate sand depth is available to treat the effluent prior to reaching groundwater. This will normally require one metre of uniform sand above the seasonally high watertable.

This design is for a household of three bedrooms (5 people) with a maximum wastewater effluent production of 700 litres/day (140 litres per person).

Sizing the system to suit the soil type

Soil Condition	Design Loading Rate	LEPD Lines Length	Number of Lines	Soakage Treatment Area	Reserve Area (at 50%)
Free draining sand	5.0 mm/day	23 m	6	25 metres by 8 metres (200 square metres)	25 metres by 4 metres (100 square metres)

Notes:

(a) 1 mm/day is equivalent to one litre of effluent spread over one square metre per day.

(b) The 30 mm diameter perforated low pressure pipe is nested within 100 mm diameter draincoil to enable distribution of effluent along the full length of the shallow trench.

Adapting the system for the household size

Household Size	Trench System Details	Soakage Treatment Area Size
Two bedroom dwelling, four people or less using water conservation fixtures. Daily effluent volume of 450 litres/ day. Septic tank capacity: 3000 litres	Six lines, each 15 metres long	17 metres by 9 metres (155 square metres)
Five bedroom dwelling, eight people or less, 1120 litres/day. Septic tank capacity: 4500 litres.	Eight lines, each 28 metres long	30 metres by 11 metres (330 square metres)

Notes on Function

1. The nested LPED lines spread effluent uniformly along the full length of each trench enabling slow rate infiltration into the sandy soil to achieve effective treatment in a depth of 600 mm. The 5 mm/day design loading rate is based on the area enclosing the pumped distribution lines.
2. LPED has also been used as a trickle surface irrigation system in woodlots or bush where it is inappropriate to cut trenches into the root systems. Lines are pinned onto the natural ground and covered with mulch. The recommended design loading rate is 3 mm/day.

Design Notes

1. For other household numbers, calculate total daily wastewater effluent output at 140 litres/person/day for rainwater supply, and 180 litres/person/day for bore water or community supply.
2. To find the areal loading design area, divide total daily wastewater output in litres by soil loading rate in mm/day.
3. Find the overall soakage treatment area by allowing 1½ metre clearance on either side of the design area, and 1 metre clearance at each end of the system.

Pumping Requirements

1. Each dosing cycle to deliver a minimum of 10 times the volume of the 30 mm low pressure distribution line (to enable sufficient pressure development to ensure even spread throughout the system).
2. The pump sump to provide storage and pumping cycle provisions to be designed to fit the total daily flow through the selected orifice size and spacing.

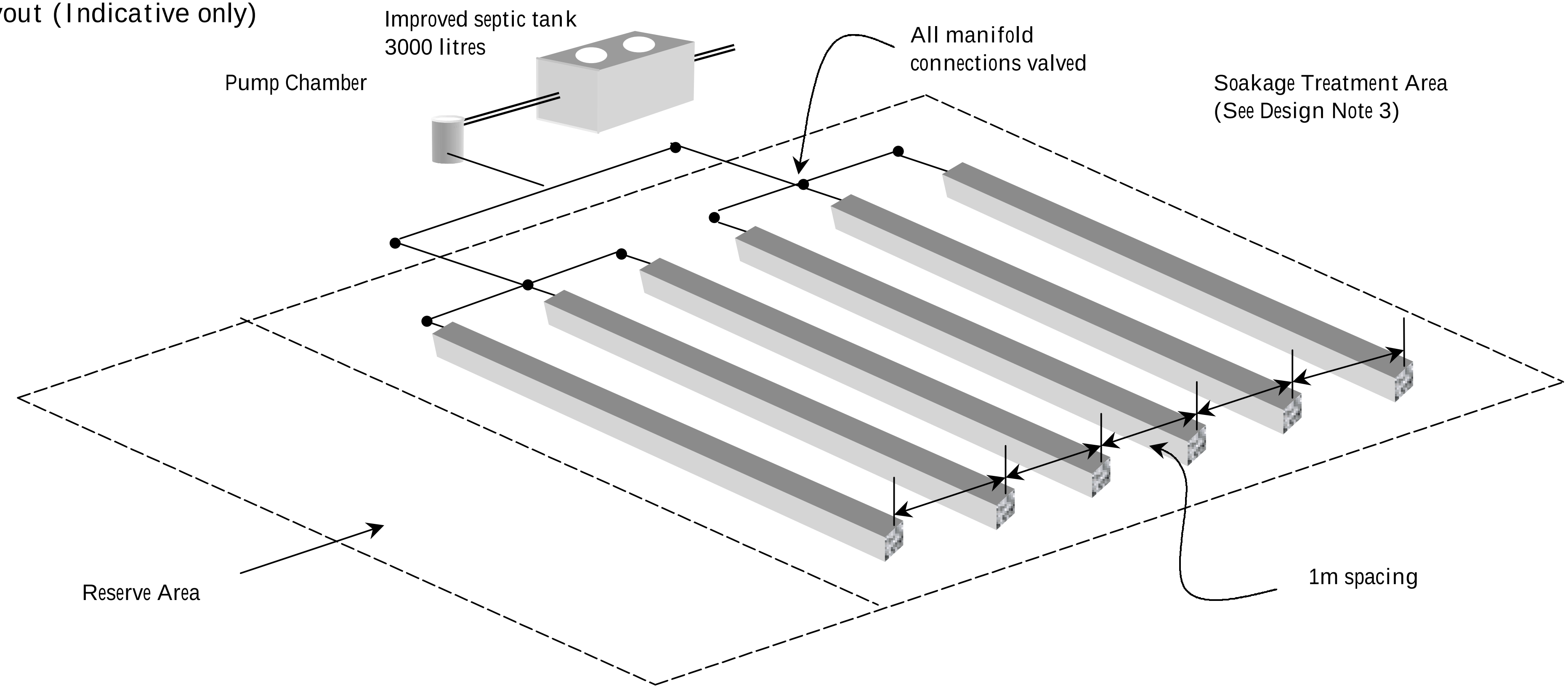
Installation Notes

1. Groundwater to be at least 600 mm below the base of the trenches (this means clearance to watertable from ground surface should be around 1000 mm).
2. During installation, the distribution system should be pump tested with clean water to make sure that even distribution is being achieved.

Materials requirement for basic household system	**Quantity**
1. Length of 30 mm diameter distribution line.	138 metres
2. Length of 100 mm draincoil.	138 metres
3. Capped end pieces to 30 mm low pressure pipe.	No 6
4. Pea gravel nested pipe surround.	4.5 cubic metres
5. Filter cloth.	28 square metres
6. Topsoil cover.	3 ½ cubic metres

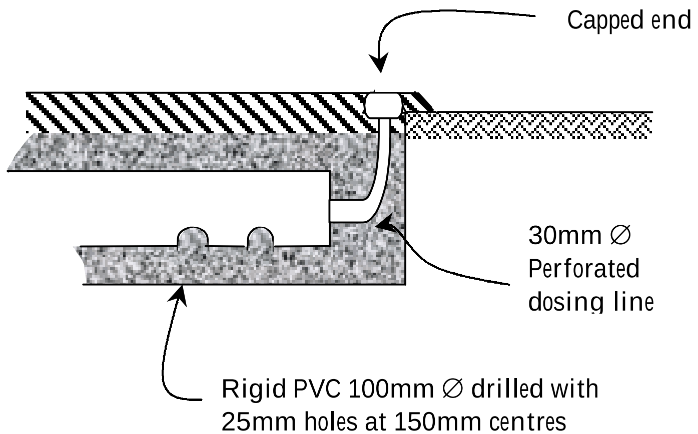
Model Design 2 – Free Draining Soils

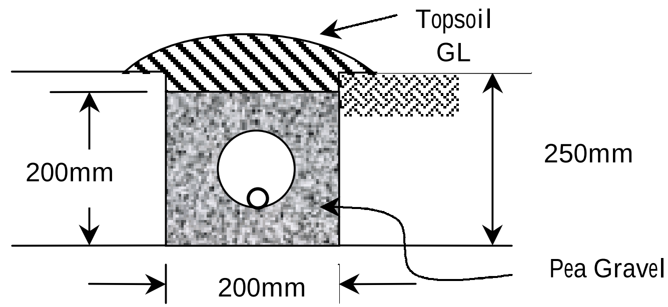
System Layout (Indicative only)



Notes:

1. Check with your local Council for specific sizing criteria
2. Improved septic tank incorporates an effluent outlet filter
3. 30 mm dosing line perforated with 6 mm holes at 1.5 m spacing over first 15 m and 1 m spacing over remaining length (design calculations required to confirm)





Model Designs 3 & 4 – Moderate Draining Soils

Improved Septic Tank with Aggregate Filled Soakage Trenches

Model Designs 3 and 4 are suitable for moderate draining soils. Use Model Design 3 for good to moderate draining soils and Model Design 4 for moderate to slow draining soils. Use these Designs where there is adequate soil depth available to provide treatment below the trenches (see Table 5).

These designs are for a household of three bedrooms (5 people) with a maximum wastewater effluent production of 700 litres/day (140 litres per person).

Sizing the system to suit the soil type

Soil condition	Design loading rate	Length of each trench	Number of trenches	Soakage treatment area	Reserve area (at 100%)
Good to moderate drainage	25 mm/day	21 m	3	23 metres by 6 metres (138 square metres)	138 square metres
Moderate to poor drainage	15 mm/day	20 m	5	22 metres by 10 metres (220 square metres)	220 square metres

Notes:

(a) for design loading rate see AS/NZS 1547:2000, Table 4.2A1, category 3 soils, maximum application rate.

(b) the design loading rate is used to size the base area of the trench system.

(c) 1 mm/day is equivalent to one litre of effluent spread over one square metre per day.

Adapting the system for the household size

Household size	Trench system details	Soakage treatment area
Two bedroom dwelling, four people or less using water conservation fixtures. Daily effluent volume of 450 litres/ day. Septic tank capacity: 3000 litres	Good to moderate drainage: 4 of 10 metres.	8 metres by 12 metres (96 square metres).
	Moderate to poor drainage: 3 of 22 metres.	6 metres by 24 metres (144 square metres).
Five bedroom dwelling, eight people or less, 1120 litres/day. Septic tank capacity: 4500 litres.	Good to moderate drainage: 5 of 20 metres.	10 metres by 22 metres (220 square metres).
	Moderate to poor drainage: 8 of 21	16 metres by 23 metres (368 square

Household size	Trench system details	Soakage treatment area
	metres.	metres)

Notes on Function

This system is designed for moderately drained soils with at least 600 mm of soil below the base of the designed soakage system. This soil must be free of any impermeable or highly permeable layer (such as clay or gravel) and be permanently unsaturated (based on the highest groundwater. For sites with additional soil constraints use Model Designs 6 - 8.

Design note

Find the overall soakage treatment area by allowing 1 ½ metre clearance on either side of the trenches and one metre clearance at each end of the trench system.

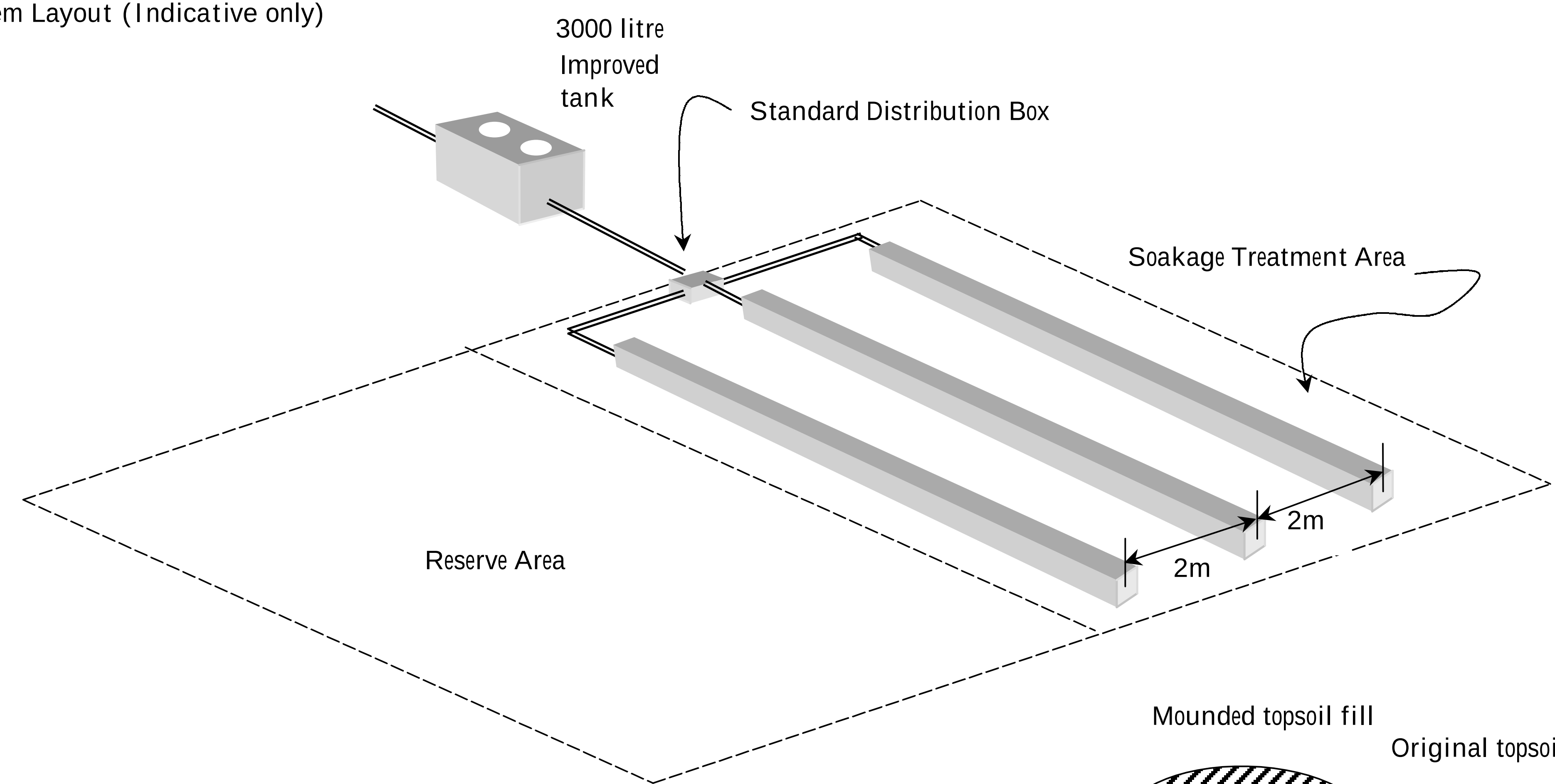
Installation Notes

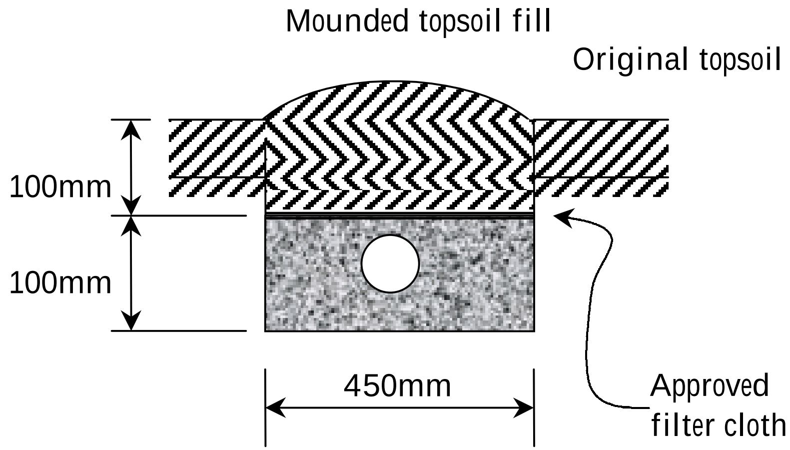
1. Groundwater to be at least 600 mm below the base of trench (this means that clearance to the water table from the ground surface should be around 1200 mm).
2. During excavation, make sure that soil is not too moist, and scarify the base and sides of the trench to make sure that all the smooth soil surface is broken up.
3. Place 50mm of sand over the base of trench before adding the distribution aggregate.
4. For more information about construction and installation of trenches see Appendix 4.5A of AS/NZS 1547:2000.

Materials requirement for basic household system	**Quantity**
1. Length of 100 mm diameter effluent distribution line in trench system (draincoil – or PVC with 20 mm holes at 100 mm spacing).	MD 3: 63 metres MD 4: 100 metres
2. 20 to 50 mm aggregate in trench around distribution pipe.	MD 3: 2.8 cubic metres MD 4: 4.5 cubic metres
3. Area of filter cloth to be laid over the distribution aggregate.	MD 3: 28 square metres MD 4: 45 square metres
4. Sand over base of trench.	MD 3: 1.4 cubic metres MD 4: 2.25 cubic metres
5. Topsoil over filter cloth and aggregate in the trench system.	MD 3: 3 cubic metres MD 4: 5 cubic metres
Note: Distribution box to be provided with three plastic levelling outlet devices to enable adjustment for equal flow to each of three trenches.	

Model Designs 3 & 4 – Moderate Draining Soils

System Layout (Indicative only)





Notes:

1. Check with your local Council for specific sizing criteria
2. Improved septic tank incorporates effluent outlet filter

Model Design 5 - Poorly Draining Soils

Improved Septic Tank with Pump Chamber and Evapo Transpiration Seepage (ETS) Beds or Trenches

Model Design 5 is suitable for 'slow to poor' draining soils where adequate soil depth is available below the trenches/beds. For 'poor' draining soils with adequate soil depth, use Model Designs 7 & 8, with a maximum application rate of 3mm/day (see Table 5).

This design is for a household of three bedrooms (5 people) with a maximum wastewater effluent production of 700 litres/day (140 litres per person).

Sizing the system to suit the soil type

Soil condition	Design loading rate	ETS bed lengths	Number of beds	Soakage treatment area	Reserve area (at 100%)
Slow to poor drainage	5 mm/day	16 m	6	18 metres by 21 metres (378 square metres)	18 metres by 21 metres (378 square metres)

Notes:

(a) for design loading rate see AS/NZS 1547:2000, Table 4.2A2, category 5 and 6 soils.

(b) the design loading rate is used to size the horizontal base area of the trench system.

(c) 1 mm/day is equivalent to one litre of effluent spread over one square metre per day.

Adapting the system to suit the household size

Household Size	ETS Bed Details	Soakage Treatment Area Size
Two bedroom dwelling, four people or less using water conservation fixtures. Daily effluent volume of 450 litres/ day. Septic tank capacity: 3000 litres	Four, each of 15 metres	17 metres by 15 metres (255 square metres)
Five bedroom dwelling, eight people or less, 1120 litres/day. Septic tank capacity: 4500 litres.	Eight, each of 19 metres	21 metres by 27 metres (567 square metres)

Notes on Function

The ETS bed system is designed to enable evapo-transpiration uptake of liquid, through grass and/or plants, at a rate 2 to 3 times more than pan evaporation. Soil infiltration occurs through the base of the bed at a rate determined by the soil type and condition.

Design Notes

1. For a different number of household residents, calculate total daily wastewater effluent output at 140 litres/person/day for rainwater supply, and 180 litres/person/day for bore water or community supply.
2. To find ETS bottom design area, divide total daily wastewater effluent output in litres by soil loading rate in mm/day.
3. To find the total length of bed required in metres divide the bottom design area by 1.5 m (the width of the bed).
4. Find the overall soakage treatment area by allowing 1½ m clearance on either side of beds, and 1 metre clearance at each end of the bed system.

Pumping Requirements

The pump sump must provide storage of 300 litres per pumping cycle. The pump capacity must be for 150 – 200 litres/minute over 3 minutes. A 50 mm diameter manifold should join with the 30 mm distribution lines at a 50 mm valve. Backflow preventer to be installed on 50 mm rising main as it leaves the pump chamber.

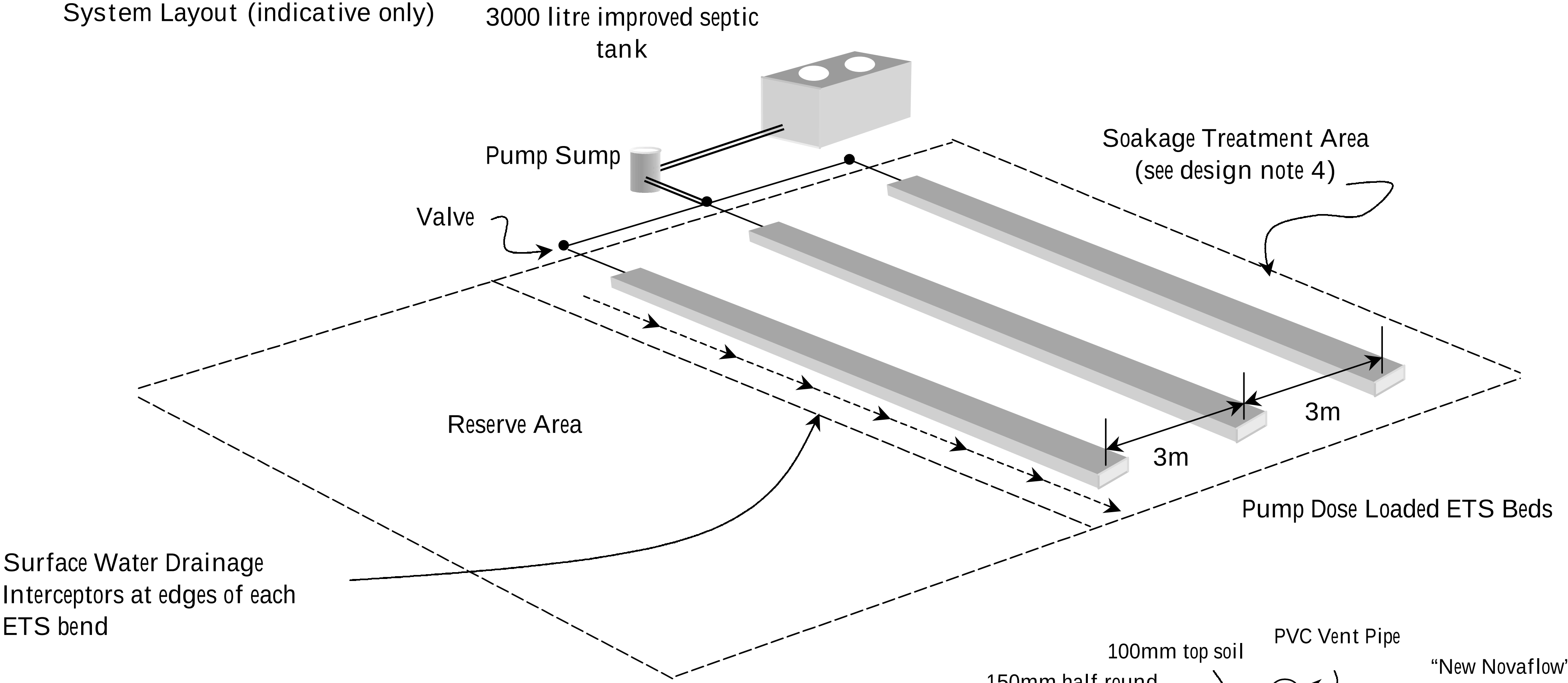
Installation notes

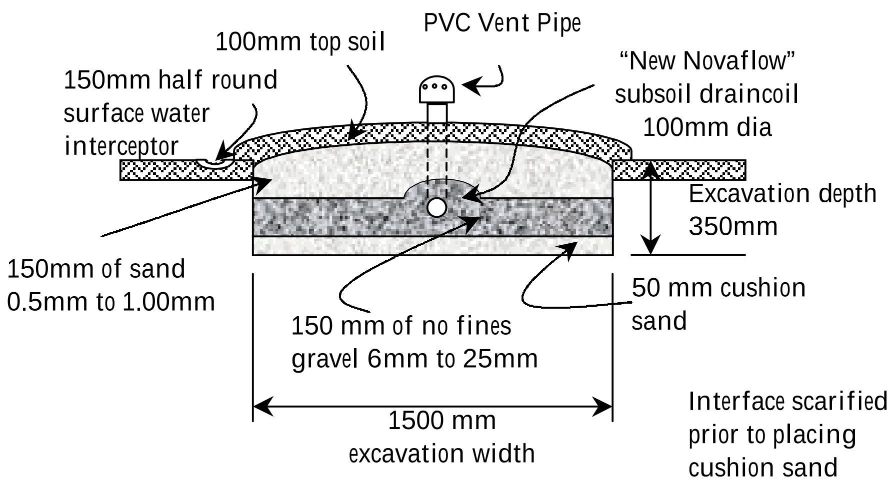
1. Groundwater to be at least 600 mm below the base of the bed (this means that clearance to the water table from the ground surface should be around 1.0 metre).
2. Place 50 mm of cushion sand over base of bed before carefully adding distribution gravel and then sand.
3. For more information about construction and installation of ETS beds see Appendix 4.5A of AS/NZS 1547:2000.

Materials requirement for basic household system	**Quantity**
1. Length of 100 mm draincoil.	96 metres
2. Cushion sand.	7.2 cubic metres
3. No fines gravel, 6 mm to 25 mm.	22 cubic metres
4. Medium sand (0.5 to 2.0 mm effective size).	22 cubic metres
5. Topsoil.	14 cubic metres
6. Half round tile surface water interceptors each side of beds.	216 metres

Model Design 5 - Poorly Draining Soils

System Layout (indicative only)





Notes:

1. Check with your local Council for specific sizing criteria
2. Improved septic tank incorporates effluent outlet filter

Model Design 6 – Shallow Moderate to Slow Draining Soils above Hardpan or Shallow Groundwater

Improved Septic Tank and Sand Filled Mound (Wisconsin Mound)

Model Design 6 provides for in-mound treatment of septic tank effluent before it disperses into the shallow soil layer above clay hardpan or high water table. Some 300 mm of original soil depth is required.

This design is for a household of three bedrooms (5 people) with a maximum wastewater effluent production of 700 litres/day (140 litres per person).

Notes on Function

1. The 50 mm/day loading rate dosed into the aggregate distribution bed allows the septic tank effluent to spread sideways by capillary action while seeping slowly through the 600 mm of treatment sand.
2. The resulting high quality effluent spreads into the natural soil and seeps sideways through the soil evenly around the edges of the mound.

Sizing the system to suit the soil type

Soil condition	Design loading rate	Dosing lines lengths	Number of lines	Treatment, basal and soakage treatment area	Reserve Area
Shallow moderate to slow draining soil over hardpan or shallow groundwater	12 mm/day basal area *50 mm/day into aggregate distribution bed.*	7.8 m	3 of 30 mm diameter perforated lines in an 1800 mm distribution bed	Internal treatment area 5.5 m by 11.5 m (63 square metres). Fill basal area 6.6 m by 12.6 m (83 square metres). Soakage treatment overall area (3 m absorption area allowance) 12.6 m by 18.6 m (235 square metres).	18.6 by 12.6 m (235 square metres)

Notes:

(a) for design loading rate see AS/NZS 1547:2000, Table 4.2A3, category 4 and 5 soils.

(b) the 30 mm diameter perforated low pressure dosing lines have shielded perforation holes and end elbow pieces with capped riser at top of mound level (as for LPED, Model 2 dosing lines)

(c) 1 mm/day is equivalent to one litre of effluent spread over one square metre /day.

Adapting the system to suit the household size

Household Size	System Details	Basal and soakage treatment area size
Two bedroom dwelling, four people or less using water conservation fixtures. Daily effluent volume of 450 litres/ day. Septic tank capacity: 3000 litres	Three lines in1200 mm wide distribution bed 7.5 m length.	Basal length 12 m, width 6 m, overall enclosing area 18 by 12 m (216 m^2)
Five bedroom dwelling, eight people or less, 1120 litres/day. Septic tank capacity: 4500 litres.	Three lines in1800 mm wide distribution bed 12.4 m length.	Basal length 17.2 m, width 6.6 m, overall enclosing area 23.2 by 12.6 m (295 m^2)

Design Notes

1. Calculate total daily wastewater effluent output at 140 litres/person/day for rainwater supply, and 180 litres/person/day for bore water or community supply.
2. To find the mound basal area, divide the total daily wastewater output in litres by design loading rate in mm/day. Then allow 600 mm all round for the 3 to 1 slope effect of the 200 mm distribution bed.
3. Find the overall soakage treatment area by allowing 3 m clearance on either side of the design area, and 3 m clearance at each end of the mound to provide for treated effluent absorption in the soil surrounding the mound.

Pumping Requirements

The pump sump to provide storage and pumping cycle provisions to be designed to fit the total daily flow through the selected orifice size and spacing.

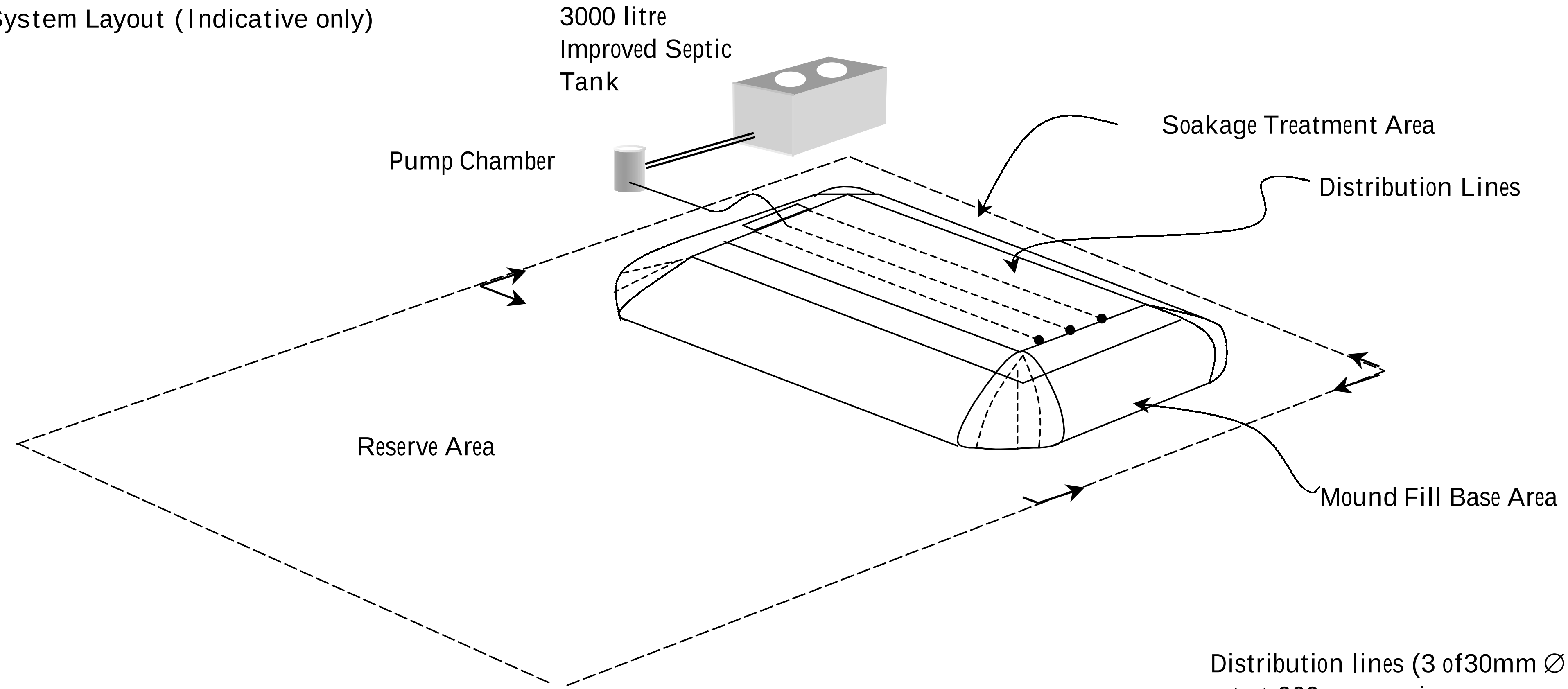
Installation Notes

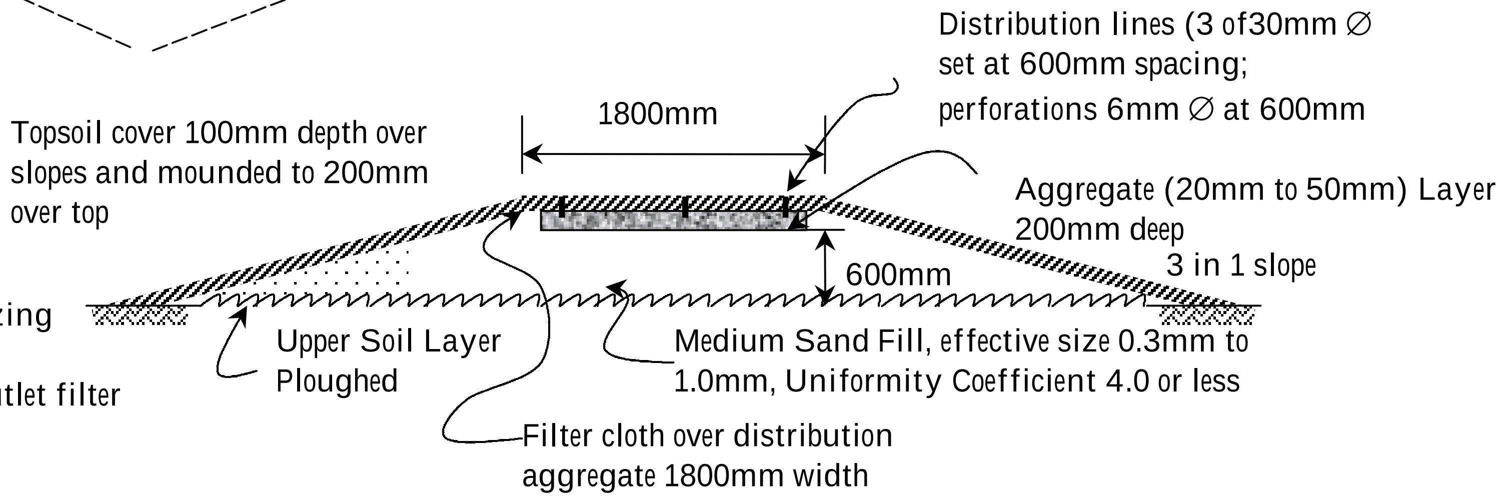
1. Groundwater or hardpan no closer than 300 mm below the base of the mound.
2. The natural soil on which the mound is to be placed should be ploughed or disc ploughed prior to laying the medium sand fill.
3. During installation, the dosing system should be pump tested with clean water to ensure even distribution is being achieved.
4. For more information about construction and installation of mounds see Appendix 4.5B AS/NZS 1547:2000.

Materials requirement for basic household system	**Quantity**
1. Length of 30 mm distribution line.	24 metres
2. Distribution aggregate.	3 cubic metres
3. Filter cloth.	14 square metres
4. Medium sand fill.	31 cubic metres
5. Topsoil cover.	11.5 cubic metres

Model Design 6 – Shallow Moderate to Slow Draining Soils above Hardpan or Shallow Groundwater

System Layout (Indicative only)





Notes:

1. Check with your local Council for specific sizing criteria
2. Improved septic tank incorporates effluent outlet filter

Model Design 7 – Poorly Drained Sites or Sites with Limited Topsoil

AWTS (Aerated Wastewater Treatment System) Pump Chamber and Drip Irrigation System

Model Design 7 is suitable for 'slow to poor' draining soils, where adequate soil depth is available to treat the effluent, or for any other site where insufficient topsoil is available. Model Designs 6 and 8 are alternative designs for 'slow to poor' draining sites with insufficient topsoil include (see Table 5). For 'poor' draining soils, use either this design or 8, with a maximum application rate of 3 mm/day.

This design is for a household of three bedrooms (5 people) with a maximum wastewater effluent production of 700 litres/day (140 litres per person).

Sizing the system to suit the soil type

Soil Condition	Design loading rate	Drip irrigation lengths	Number of lines	Soakage Treatment Area	Reserve Area
Poorly draining	3 mm/day	23 m	10	25 metres by 13 metres (325 square metres)	Size not specified but some allowance should be made for extending the system

Notes: (a) pressure compensating drip emitters allow the system to be installed on variable ground levels.

(b) 1 mm/day is equivalent to one litre of effluent spread over one square metre per day.

Adapting the system to suit the household size

Household Size	System Details	Soakage Treatment Area Size
Two bedroom dwelling, four people or less using water conservation fixtures. Daily effluent volume of 450 litres/ day. Septic tank capacity: 3000 litres	Eight lines, each of 19 metres	21 metres by 11 metres (230 square metres)
Five bedroom dwelling, eight people or less, 1120 litres/day. Septic tank capacity: 4500 litres.	Twelve lines, each of 33 metres	33 metres by 15 metres (495 square metres)

Notes on Function

The subsurface drip emitter lines irrigate high quality effluent into the topsoil layer at between 50 to 100 mm below ground level. The effluent nutrients stimulate grass growth and evapo-transpiration.

Design Notes

1. For other household numbers, calculate total daily wastewater effluent output at 140 litres/person/day for rainwater supply, and 180 litres/person/day for bore water or community supply.
2. To find the irrigation design area, divide total daily wastewater output in litres by soil loading rate in mm/day.
3. Drip emitter spacing is normally 1 metre, but 600 mm spacing is recommended where shallow topsoil overlies clay.
4. Find the overall soakage treatment area by allowing 1½ m clearance on either side of the irrigation area, and 1 metre clearance at each end of the system.

Pumping Requirements

The pump sump to provide storage and pumping cycle provisions to be appropriate to the requirements of the supplier of the drip emitter system

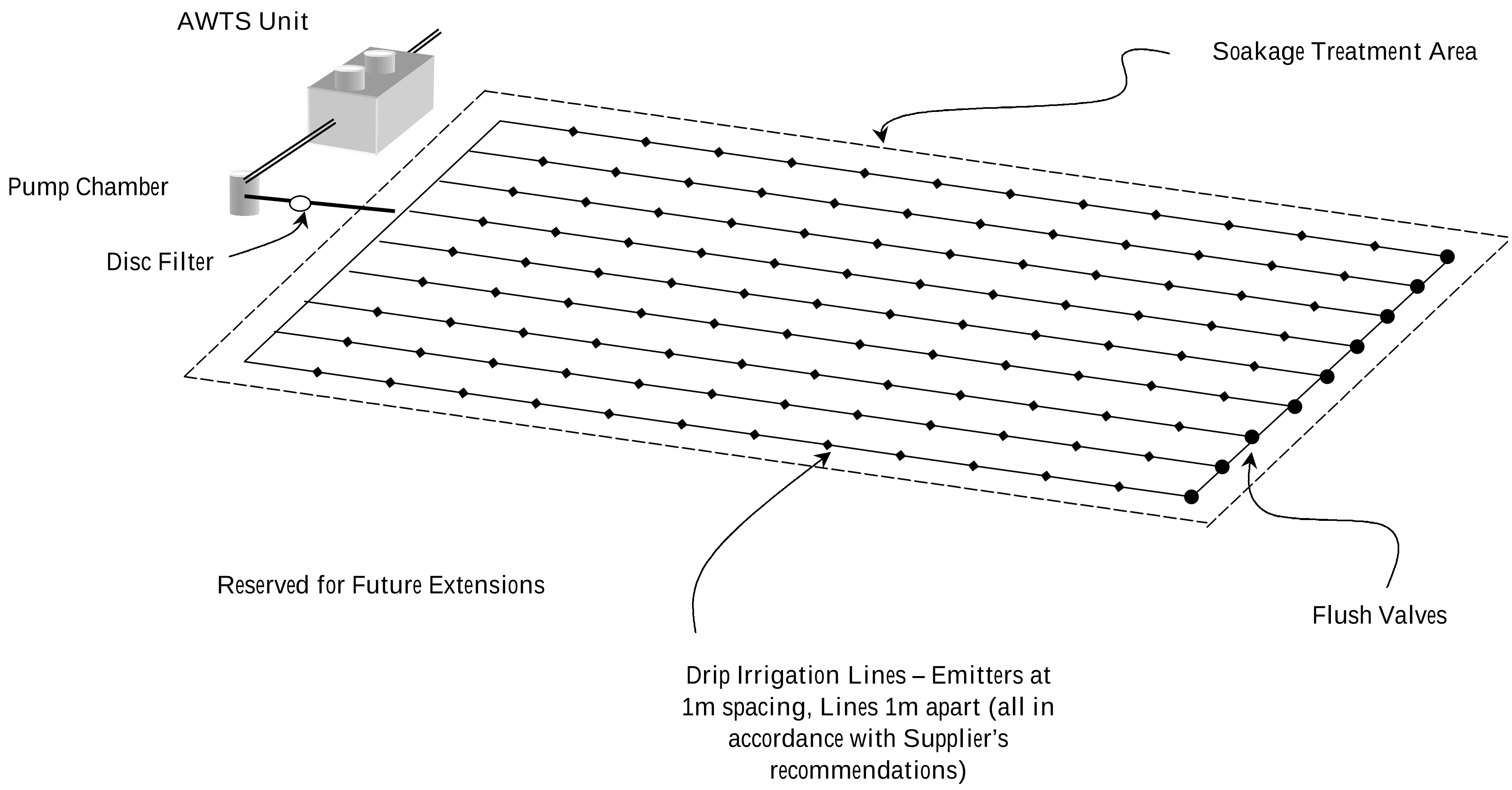
Installation Notes

1. Groundwater to be at least 300 mm below the irrigation lines (this means that clearance to the water table from the ground surface should be around 500 mm).
2. System installation guidelines are provided by the supplier of the drip emitter system.
3. A reserve area is normally not required for this type of system. If adjacent land is available, some should be reserves for possible future extensions.

Materials requirement for basic household system	**Quantity**
1. Length of drip emitter line.	230 metres
All in-line disc filters, air release and drain valves, plus backflow preventers, to specifications of supplier of the drip emitter system.	

Model Design 7 – Poorly Drained Sites or Sites with Limited Topsoil

System Layout (Indicative only)



Notes:

1. Check with your local Council for specific sizing criteria

Model Design 8 – Poorly Drained Sites Or Sites With Limited Topsoil

Improved Septic Tank, Sand Filter, Pump Chamber and Drip Irrigation System

Model Design 8 is suitable for 'slow to poor' draining soils, where adequate soil depth is available to treat the effluent, or for any other site where insufficient topsoil is available. Alternative Designs for 'slow to poor' draining sites with insufficient topsoil include Model Designs 6 and 7 (see Table 5). For 'poor' draining soils use either this design or 7, with a maximum application rate of 3mm/day.

This design is for a household of three bedrooms (5 people) with a maximum wastewater effluent production of 700 litres/day (140 litres per person).

Sizing the system to suit the soil type

Soil condition	Design loading rate	Drip irrigation lengths	Number of lines	Soakage treatment area	Reserve area
Poorly draining	3 mm/day	23 m	10	25 metres by 13 metres (325 square metres)	Size not specified but some allowance should be made for extending the system

Notes: (a) pressure compensating drip emitters allow the system to be installed on variable ground levels.

(b) 1 mm/day is equivalent to one litre of effluent spread over one square metre per day.

Adapting the system to suit the household size

Household Size	System Details	Soakage Treatment Area Size
Two bedroom dwelling, four people or less using water conservation fixtures. Daily effluent volume of 450 litres/ day. Septic tank capacity: 3000 litres	Eight lines, each of 19 metres	21 metres by 11 metres (230 square metres)
Five bedroom dwelling, eight people or less, 1120 litres/day. Septic tank capacity: 4500 litres.	Twelve lines, each of 33 metres	33 metres by 15 metres (495 square metres)

Notes on Function

1. The subsurface drip emitter lines irrigate high quality effluent into the topsoil layer at between 50 to 100 mm below ground level. The effluent nutrients stimulate grass growth and evapo-transpiration.

2. As a water conservation measure, the high quality effluent may be disinfected and recycled to flush water closets. The size of the irrigation area may be reduced accordingly by around 30%.

Design Notes

1. For other household numbers, calculate total daily wastewater effluent output at 140 litres/person/day for rainwater supply, and 180 litres/person/day for bore water or community supply.
2. To find the irrigation design area, divide total daily wastewater output in litres by soil loading rate in mm/day.
3. Drip emitter spacing is normally 1 metre, but 600 mm spacing is recommended where shallow topsoil overlies clay.
4. Find the overall soakage treatment area by allowing 1½ m clearance on either side of the irrigation area, and 1 metre clearance at each end of the system.

Pumping Requirements

The pump sump to provide storage and pumping cycle provisions to be appropriate to the requirements of the supplier of the drip emitter system.

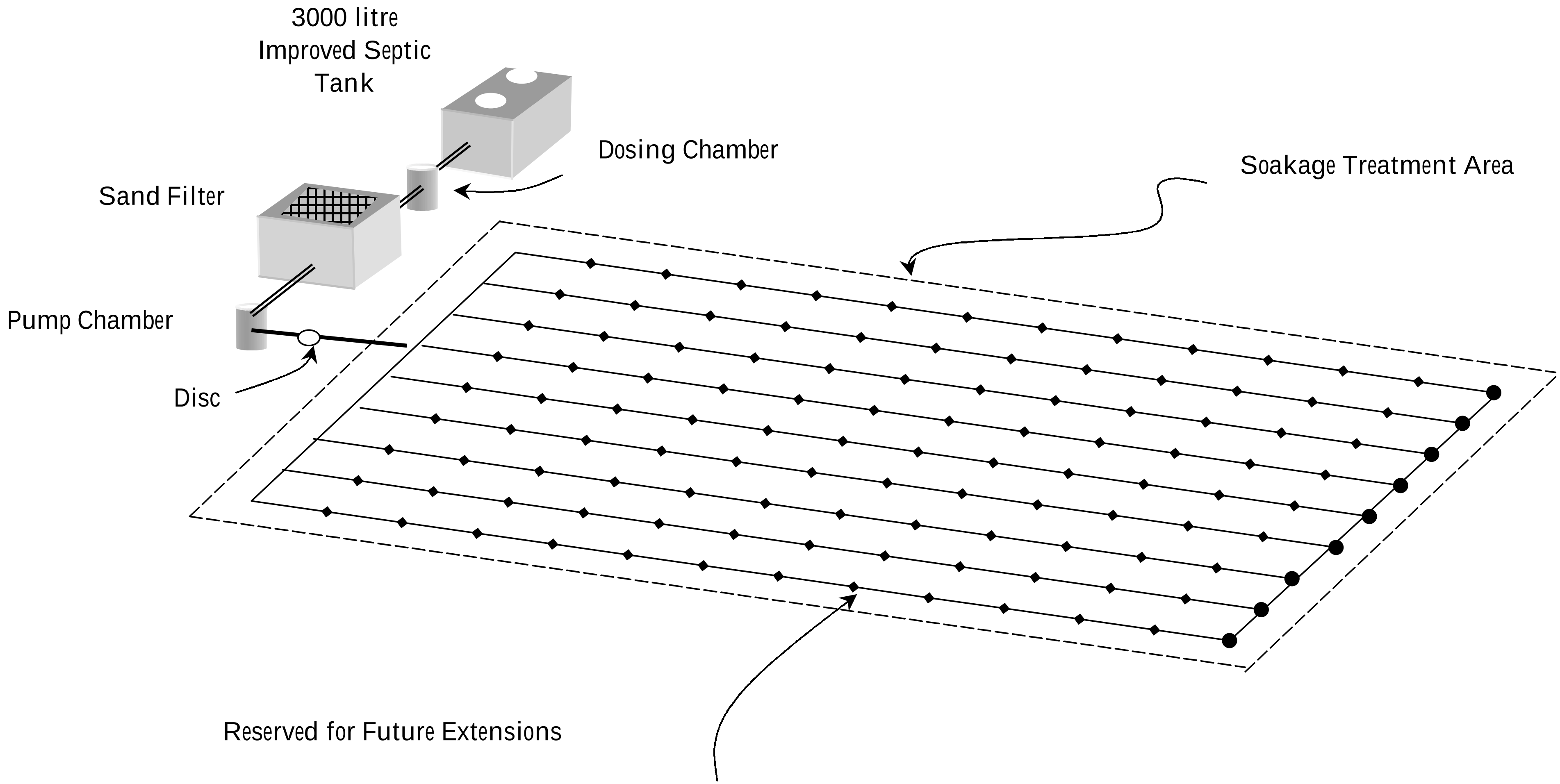
Installation Notes

1. Groundwater to be at least 300 mm below the irrigation lines (this means that clearance to the watertable from the ground surface should be around 500 mm).
2. System installation guidelines are provided by the supplier of the drip emitter system.
3. A reserve area is not normally required for this type of system. If adjacent land is available, a portion should be reserved for possible future extensions.

Materials requirement for basic household system	**Quantity**
1. Length of drip emitter line.	230 metres
All in-line disc filters, air release and drain valves, plus backflow preventers, to specifications of supplier of the drip emitter system.	

Model Design 8 – Poorly Drained Sites Or Sites With Limited Topsoil

System Layout (Indicative only)



Notes:

1. Check with your local Council for specific sizing criteria
2. Improved septic tank incorporates an effluent outlet filter

9. REGIONAL RULES

The regional rules controlling the discharge of sewage to land are in the Regional Plan for Discharges to Land. **Rule 5** of the Regional Plan for Discharges to Land applies to discharges from pit latrines. **Rule 6** of the Regional Plan for Discharges to Land applies to discharges of aerobically treated sewage (such as from package plants) into or onto land. **Rule 7** of the Regional Plan for Discharges to Land applies to discharges of sewage from septic tanks and other domestic systems into, but not onto, land. The rules are reproduced below. For information about these rules, contact the Resource Consent Help Desk at the Wellington Regional Council (04-384 5708 Wellington, or 06-378 2484 Wairarapa).

Rule 5 Pit latrines

The discharge into land of effluent from a pit latrine is a **Permitted Activity** provided

(a) the latrine is located more than 20 metres from any surface water body, farm drain, water supply race, the coastal marine area, or bore, more than ten metres from the property boundary, and more than five metres from any dwelling on the same site;

(b) surface water cannot drain into the latrine;

(c) the water table is at least 1,000 mm below the bottom of the latrine;

(d) the soil type does not comprise gravels, coarse/medium sands, scoria, fissured rock, or other such materials likely to permit free travel of excreta residues away from the vault chamber; and

(e) waste in the latrine does not accumulate to closer than 300 mm of the ground surface.

Explanation. *This rule applies to discharges from pit latrines (also known as long-drops or privies). These toilet systems are commonly used in remote locations, or as temporary facilities where connection to a sewer is not possible. The design of any on-site sewage system is controlled by district councils under the Building Code ("G13.3.4 Where no sewer is available, an adequate on-site disposal system shall be provided for foul water ..."). Also, where a sewer connection is available, the drainage connection shall be made to the sewer (see G13.3.3 of the Building Code).*

Permission may be required from the relevant district council in respect of the Building Regulations, 1992 or other legislation or bylaws administered by them. See, for example, the Porirua City Council General Bylaw 1991 Part 8: Management and operation of effluent disposal systems. "Water body" is defined in the Act, and reproduced in the Interpretation in section 3.

Rule 6 Aerobically treated sewage discharged on-site

The discharge of aerobically composted sewage, or aerobically treated sewage effluent, onto or into land is a **Permitted Activity** provided

(a) the discharge is more than 20 metres from any surface water body, farm drain, water supply race, or the coastal marine area;

(b) the discharge is more than 5 metres from any neighbouring property boundary; and

(c) for aerobically composted sewage
  (i) the sewage originates from a composting toilet system;
  (ii) the material has been subject to aerobic composting decomposition for at least 12 months from the last addition of raw sewage;
  (iii) for at least 12 months after application, only people operating or maintaining the system have access to the disposal area; and
  (iv) compost is not applied to any food crop for animal or human consumption; and
  (v) the composted sewage is ploughed into the soil, or buried to a depth of up to 200 mm.

(d) for aerobically treated sewage effluent onto land
  (i) the application rate throughout the disposal area is not greater than 5 mm/day;
  (ii) the maximum discharge does not exceed 2000 litres per day;
  (iii) the carbonaceous five day Biochemical Oxygen Demand concentration in the effluent discharged from the system is not greater than 20 mg/litre;
  (iv) the discharge does not cause ponding on or runoff from the disposal area;
  (v) the discharge is not by way of spray irrigation or other method that produces any aerosol discharge to air;
  (vi) people (except persons involved with maintaining/managing the system) are prevented from entering the disposal area for a period of at least 48 hours following the last application of effluent; and
  (vii) stock are prevented from entering the disposal area for a period of at least six months following the last application of effluent; and
  (viii) there is no discharge of any effluent to a water body.

(e) for aerobically treated sewage effluent into land
  (i) the application rate throughout the disposal area is not greater than 15 mm/day;
  (ii) the maximum discharge does not exceed 2000 litres per day;
  (iii) the discharge does not cause ponding on or runoff from the disposal area; and
  (iv) there is no discharge of any effluent to a water body.

Explanation. *This rule allows discharges of well-treated sewage effluent and sewage compost* ***above or below*** *the soil surface. Note that Rule 7 of the Plan allows discharges of all sewage effluent (but not sewage sludge) subject to conditions, but does not allow discharges* ***above*** *the soil surface.*

Aerobically composted sewage may be applied onto land in accordance with this rule, but the sewage must not originate from any sewage treatment system other than a composting toilet system. That is, composted sewage from composting toilets, such as those in the Conservation Estate and Regional Parks, may be discharged to land in accordance with this rule, but *composted sewage from community systems may not. The reasons for this distinction are given in section 8 of the Plan.*

This Rule does not exempt sewage disposal systems from compliance with provisions in a district plan, or requirements imposed under the Building Act, 1991, or the Building Regulations, 1992, or the Health Act, 1956. Compliance with the conditions in this rule means that the discharge from the system can proceed without the need for a resource consent from the Regional Council. The onus will be on the owner of the system to demonstrate that the conditions in this rule will be met. Where the conditions cannot be met, a resource consent will be required in accordance with Rule 8.

The conditions for compliance with Rule 6 (d) are more restrictive than for Rule 6 (e) because sewage discharges onto land can allow transmission routes for disease to become established. The allowable application rate for discharges into land is higher than for discharges onto land. This is to recognise that there would be fewer adverse effects if effluent accumulates in the disposal field of subsurface systems.

Rule 7 On-site sewage treatment and disposal

The discharge into or onto land of any water or contaminants other than septage, from on-site sewage treatment and disposal systems is a **Permitted Activity** if:

EITHER

(1) the system is already in use at the time this Rule comes into force; and

(2) the discharge does not exceed 1300 litres per day (calculated as a weekly average);

provided

(a) the discharge shall consist only of contaminants normally associated with domestic sewage;

(b) no stormwater shall be allowed to enter the system;

(c) there shall be no direct discharge from the system to groundwater, surface water, or above the soil surface; and

(d) the system shall be maintained on a regular basis.

(e) the discharge is more than 50 metres from any surface water body, farm drain, or water supply race in any catchment being managed for water supply in the Regional Freshwater Plan (see Appendix 6 of the Regional Freshwater Plan); and

(f) the discharge is more than 20 metres from any surface water body, farm drain, water supply race, or the coastal marine area in all other areas.

OR

(3) the system is a new or upgraded system; and

(4) the discharge does not exceed 1300 litres per day (calculated as a weekly average); and

(5) the system shall be installed on the same property as the premises to which the system is connected; and

(6) there shall be no direct discharge above the soil surface;

provided that conditions (a)-(f) above and the following conditions are complied with:

(g) a site investigation shall be carried out. The matters to be addressed in a site investigation are set out in Appendix 5 of this Plan;

(h) the system shall be designed, constructed and operated to meet the following performance criteria:

 (i) the system shall be designed with sufficient effluent retention time to enable adequate treatment in relation to any constraints identified in the site investigation;

 (ii) the effluent shall be evenly distributed to the entire filtration surface of the disposal field;

 (iii) the bottom of the effluent disposal system shall be sufficiently above the groundwater at its highest level, in relation to any constraints identified in the site investigation, to prevent any contamination of groundwater;

 (iv) the area available for treatment shall be appropriate for the volume of the discharge and any constraints identified in the site investigation.

The Council will accept as compliance with criteria (h)(i)-(iv) an effluent treatment and disposal system designed, constructed, and operated in accordance with the principles and procedures outlined in Technical Publication No. 58 "On-Site Wastewater Disposal from Households and Institutions" (Second Edition, Auckland Regional Council, 1994).

Explanation. *Rule 7 applies to discharges from on-site sewage treatment and disposal systems. These include septic tank/effluent disposal field systems, evapotranspiration systems, and community systems serving a number of houses. The on-site systems may be new (i.e., constructed after this Plan becomes operative) or existing systems, and may serve dwellings, institutions, workplaces, or clusters of dwellings, so long as the daily discharge volume is less than 1300 litres. This is equivalent to the amount of effluent produced by a large household.*

This rule does not apply to septage (solid materials collected from septic tanks), or the compost from a composting toilet when discharged to land, or to systems designed to discharge above the soil surface (e.g., where effluent is used for irrigation) or to systems which are located on a separate legal property to that on which the premises creating the discharge. These activities are addressed by Rules 6, and 8.

The conditions relate to "good practice". The specific maintenance requirements which comprise "good practice" will vary depending on the type of system used and the volume and quality of effluent produced. All such requirements should be made available by the manufacturer or designer of the system at the time of installation. For example, regular desludging will be necessary to ensure that the system does not overflow.

New and upgraded systems (new systems are those installed after the date on which this plan became operative, and upgraded systems are those which were installed and in use before the Plan became operative, and subsequently require improvement to avoid, remedy or mitigate any adverse environmental effects being caused by the system) must also comply with the specified design criteria and be designed to reflect any constraints identified in the site investigation. Systems designed and installed in accordance with the principles and procedures outlined in the specified guidelines, are deemed to comply with these design criteria.