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PART ONE: CODE OF PRACTICE

1 Scope

To protect the environment and, in particular, water quality, houses in un-sewered areas must be on suitable sites and must have an appropriate wastewater treatment system that is correctly installed and maintained. Homeowners and builders who propose to build houses in un-sewered areas are required to undergo site assessments to ensure that the site is suitable for an off-mains system. They are responsible for their wastewater treatment systems and should follow all planning requirements and guidance provided in this code of practice. The primary responsibility for protecting waters against pollution rests with any person who is carrying on an activity that presents a threat to water quality.

This Code of Practice (CoP) is published under Section 76 of the Environmental Protection Agency Act, 1992 (as amended). Part One sets out requirements for new on-site wastewater systems used to treat and dispose of domestic wastewater from single houses with a population equivalent (p.e.) less than or equal to 10. It sets out a methodology that should be followed to allow site conditions to be assessed, and an appropriate wastewater treatment system to be selected, installed and maintained, and it should be implemented in full. Guidance on good practice is included in Part Two; it should be considered as general guidance as site conditions determine particular site requirements. The guidance informs the implementation of the requirements of Part One. The code's requirements should be supplemented as required by technical skilled advice based on knowledge of sewage works practice and local conditions.

Annex A provides the policy and legislation background to the development of this CoP.

This code replaces previous guidance issued by the Agency in 2000 and incorporates the requirements of the Comité Européen de Normalisation (European Committee for Standardisation) (CEN) European standards prepared by CEN TC 165 and called the EN 12566 series of standards: *Small Wastewater Treatment Systems for up to 50 PT*, research findings and feedback on previous guidance documents. Following the guidance contained within the code does not remove your obligation to comply with relevant legislation and to prevent pollution from your site.

Innovative products and technologies, not specifically covered by national or European harmonised standards, should be certified (certification may include a European Technical Approval, an Agrément Certificate or equivalent), be fit for the purpose for which they are intended, the conditions in which they are used, and meet the performance requirements of this CoP.

Where reference in the document is made to proprietary equipment, this is intended to indicate equipment type and is not to be interpreted as endorsing or excluding any particular manufacturer or system.

This CoP also provides guidance to local authorities where an existing system is proposed to be upgraded. For dwellings with greater than 10 people (i.e. guest houses or cluster developments), the reader is referred to BS 6297:2007+A1:2008 *Code of practice for the design and installation of drainage fields for use in wastewater treatment* and EN 12255 series *Wastewater Treatment Plants*, the Environmental Protection Agency (EPA) manual *Wastewater Treatment Systems for Small Communities, Leisure Centres and Hotels* (1999) and any further guidance developed by the EPA including guidance in relation to Section 4 discharges to surface waters or groundwater.

2 References

The titles of the publications referred to in this code are listed in Annex I. The following referenced documents are required for the application of this document. For undated references the latest edition of the referenced document applies.

- I.S. EN 12566-1:2000/A1:2004 *Small Wastewater Treatment Systems for up to 50 PT – Part 1: Prefabricated Septic Tanks* (published by the NSAI[1] as an Irish Standard).
- I.S. CEN/TR 12566-2:2005 *Small Wastewater Treatment Systems for up to 50 PT – Part 2: Soil Infiltration Systems* (published by the NSAI as a Code of Practice).
- I.S. EN 12566-3:2005 *Small Wastewater Treatment Systems for up to 50 PT – Part 3: Packaged and/or Site Assembled Domestic Wastewater Treatment Plants* (published by the NSAI as an Irish Standard).
- I.S. EN 12566-4:2007 *Small Wastewater Treatment Systems for up to 50 PT – Part 4: Septic Tanks Assembled in situ from Prefabricated Kits* (published by CEN).
- I.S. CEN/TR 12566-5:2008 *Small Waste-water Treatment Systems for up to 50 PT – Part 5: Pre-treated Effluent Filtration Systems* (published by CEN as a technical report).
- prEN 12566-6 *Small Wastewater Treatment Systems for up to 50 PT – Part 6: Prefabricated Treatment Units for Septic Tank Effluent* (in preparation).
- prEN 12566-7 *Small Wastewater Treatment Systems for up to 50 PT – Part 7: Prefabricated Tertiary Treatment Units* (in preparation).

Refer to Annex A.3 *Legislative Provisions* for further information on these standards.

1. National Standards Authority of Ireland (NSAI).

3 Definitions

Activated sludge treatment:	Activated sludge is a process in sewage treatment in which air or oxygen is forced into sewage liquor to develop a biological floc, which reduces the organic content of the sewage.
Aquifer:	Any stratum or combination of strata that stores or transmits groundwater.
Bedrock:	The solid rock beneath the soil and superficial rock. A general term for solid rock that lies beneath soil, loose sediments, or other unconsolidated material (subsoil).
Biochemical oxygen demand (BOD):	BOD is a measure of the rate at which micro-organisms use dissolved oxygen in the biochemical breakdown of organic matter in wastewaters under aerobic conditions. The BOD_5 test indicates the organic strength of a wastewater and is determined by measuring the dissolved oxygen concentration before and after the incubation of a sample at 20°C for 5 days in the dark. An inhibitor may be added to prevent nitrification from occurring.
Biofilm:	A thin layer of micro-organisms and organic polymers attached to a medium such as soil, sand, peat, and inert plastic material.
Biological aerated filter (BAF):	A treatment system normally consisting of a primary settlement tank, an aerated biofilm and, possibly, a secondary settlement tank. The system is similar to the percolating filter system except that the media are commonly submerged (termed SAF) and forced air is applied.
Biomat:	A biologically active layer that covers the bottom and sides of percolation trenches and penetrates a short distance into the percolation soil. It includes complex bacterial polysaccharides and accumulated organic substances as well as micro-organisms.
Chemical oxygen demand (COD):	COD is a measure of the amount of oxygen consumed from a chemical oxidising agent under controlled conditions. The COD is greater than the BOD as the chemical oxidising agent will often oxidise more compounds than micro-organisms.
Collection chamber:	A chamber receiving treated wastewater from the collection layer and discharging through the pipe to an outfall or polishing filter/tertiary treatment system.
Collection pipe:	A perforated pipe placed at the bottom of a trench, within the collection layer connected to the collection chamber.
Competent person:	A person with the necessary training, skills and practical experience to enable the required work (i.e. site characterisation or system installation or maintenance) to be carried out.
Constructed wetlands (CW):	A wetland system supporting vegetation, which provides secondary treatment by physical and biological means to effluent from a primary treatment step. Constructed wetlands may also be used for tertiary treatment.
C_u:	The uniformity co-efficient is a measure of the particle size range. $C_u < 5$ – very uniform; $C_u = 5$ – medium uniform; $C_u > 5$ – non-uniform.
Distribution box/device:	A chamber between the septic tank and the percolation area, arranged to distribute the tank wastewater in approximately equal quantities through all the percolation pipes leading from it.
Distribution layer:	A layer of the system composed of granular fill material in which pretreated effluent from the septic tank is discharged through infiltration pipes.
Distribution pipe:	A non-perforated pipe used to connect the distribution box to an infiltration pipe.
Extended aeration:	An activated sludge process where a long aeration phase enables reduction of organic material in the sludge.
Geotextile:	Man-made fabric, which is permeable to liquid and air but prevents solid particles from passing through it and is resistant to decomposition.
Groundwater protection response:	Control measures, conditions or precautions recommended as a response to the acceptability of an activity within a groundwater protection zone as set out in the GSI/EPA/DoELG document *Groundwater Protection Responses for On-Site Systems for Single Houses.*

Groundwater protection scheme (GWPS):	A scheme comprising two main components: a land surface zoning map which encompasses the hydrogeological elements of risk and a groundwater protection response for different activities.
Hydraulic conductivity:	The volume of water will move in a porous medium in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow. In contrast to permeability, it is a function of the properties of the liquid as well as of the porous medium.
Infiltration system:	Comprises percolation areas and polishing filters that discharge partially treated and treated effluent into the ground.
Mottling:	The occurrence of reddish/brown spots or streaks in a matrix of dark grey soil; the reddish/brown spots or streaks are due to intermittent aeration and the grey colours may be due to anaerobic conditions.
Nutrient-sensitive locations:	These are locations, which include rivers designated as nutrient sensitive under the Urban Waste Water Treatment Regulations and groundwater bodies, where a programme of measures are needed to achieve the objectives of the Water Framework Directive.
Organic matter:	Mainly composed of proteins, carbohydrates and fats. Most of the organic matter in domestic wastewater is biodegradable. A measure of the biodegradable organic matter can be obtained using the BOD test.
Ortho-phosphorus:	Ortho-phosphorus is soluble reactive phosphorus and is readily available for biological uptake.
Pathogenic organisms:	Those potential disease-producing micro-organisms which can be found in domestic wastewaters. Organisms, such as *Escherichia coli*, and faecal streptococci, with the same enteric origin as the pathogens are used to indicate whether pathogens may be present or not in the wastewater.
Peat filter:	A filter system consisting of peat used to treat wastewater from a primary settlement tank (usually a septic tank) by biological and physical means.
Perched water table:	Unconfined groundwater separated from an underlying body of groundwater by an impervious or perching layer.
Percolating filter system:	A wastewater treatment system consisting of primary settlement and biological treatment (effected by distributing the settled liquid onto a suitable inert medium to which a biofilm attaches) followed by secondary settlement.
Percolation area:	A system consisting of trenches with pipes and gravel aggregates, installed for the purpose of receiving wastewater from a septic tank or other treatment device and transmitting it into soil for final treatment and disposal. This system is also called a soil infiltration system (EN 12566), drain field, seepage field or bed, distribution field, subsurface disposal area, or the treatment and disposal field.
Percolation pipe:	A perforated pipe through which the pretreated effluent from the septic tank is discharged to the filtration trench or bed.
Polishing filter:	A polishing filter is a type of infiltration system and can reduce micro-organisms and phosphorus (depending on soil type) in otherwise high quality wastewater effluents.
Population equivalent (p.e.):	Population equivalent, conversion value which aims at evaluating non-domestic pollution in reference to domestic pollution fixed by EEC directive (Council Directive 91/271/EEC concerning Urban Waste Water Treatment) at 60 g/day related to BOD_5.
Population total (PT):	Sum of population and population equivalent (p.e.).
Preferential flow:	A generic term used to describe the process whereby water movement follows favoured routes through a porous medium bypassing other parts of the medium. Examples include, pores formed by soil fauna, plant root channels, weathering cracks, fissures and/or fractures.
Pretreated effluent:	Wastewater that has undergone at least primary treatment.
Primary treatment:	The primary treatment stage of treatment removes material that will either float or readily settle out by gravity. It includes the physical processes of screening, comminution, grit removal and sedimentation.

Raised percolation area:	This is a term used to describe a percolation area where the percolation pipes are laid at a depth between 800 mm below ground surface and the ground surface itself. The *in situ* soil and subsoil are used to treat the effluent and material is brought in to provide protection for the pipework.
Reed bed:	An open filter system planted with macrophytes (reeds).
Rotating biological contactor (RBC):	A contactor consisting of inert media modules mounted in the form of a cylinder on a horizontal rotating shaft. Biological wastewater treatment is effected by biofilms that attach to the modules. The biological contactor is normally preceded by primary settlement and followed by secondary settlement.
Sand filter:	A filter system consisting of sand used to treat wastewater from a primary settlement tank (usually a septic tank) by biological and physical means.
Secondary treatment:	The secondary treatment stage of treatment by biological processes, such as activated sludge or other (even non-biological) processes giving equivalent results.
Septic tank system:	A wastewater treatment system that includes a septic tank mainly for primary treatment, followed by a percolation system in the soil providing secondary and tertiary treatment.
Sludge:	The solids that settle in the bottom of the primary/secondary settlement tank.
Soil structure:	The combination or arrangement of individual soil particles into definable aggregates, or peds, which are characterised and classified on the basis of size, shape, and degree of distinctiveness.
Soil texture:	The relative proportion of various soil components, including sands, silts, and clays, that make up the soil layers at a site.
Soil (topsoil):	The upper layer of soil in which plants grow.
Submerged aerated filter (SAF)	See biological aerated filter (BAF).
Subsoil:	The soil material beneath the topsoil and above bedrock.
Suspended solids (SS):	Includes all suspended matter, both organic and inorganic. Along with the BOD concentration, SS is commonly used to quantify the quality of a wastewater.
Swallow hole:	A depression in the ground communicating with a subterranean passage (normally in karst limestone) formed by solution or by collapse of a cavern roof.
Tertiary treatment:	Tertiary treatment (advanced treatment) additional treatment processes which result in further purification than that obtained by applying primary and secondary treatment.
Total nitrogen:	Mass concentration of the sum of Kjeldahl (organic and ammonium nitrogen), nitrate and nitrite nitrogen.
Total phosphorus:	Mass concentration of the sum of organic and inorganic phosphorus.
Trench:	Also referred to as a percolation trench, means a ditch into which a single percolation pipe is laid, underlain and surrounded by gravel. The top layer of gravel is covered by soil.
Unsaturated soil:	A soil in which some pores are not filled with water; these contain air.
Wastewater:	The discharge from sanitary appliances, e.g. toilets, bathroom fittings, kitchen sinks, washing machines, dishwashers, showers, etc.
Water table:	The position of the surface of the groundwater in a trial hole or other test hole.

4 Wastewater Characteristics

For the purposes of this CoP, a single-house system refers to a system serving a dwelling house of up to 10 people with toilet, living, sleeping, bathing, cooking and eating facilities.

The strength of the inflow in terms of biochemical oxygen demand (BOD) into an on-site system will largely depend on the water usage in the house; for example, houses with dishwashers may have a wastewater BOD strength reduced by up to 35% due to dilution even though the total BOD load to the treatment system (kg/day) remains the same. Household garbage grinders/sink macerators can increase the BOD loading rate by up to 30% and their use is not recommended for dwellings, as they result in additional maintenance requirements due to increased solids, increase in electricity usage and do not encourage recycling, i.e. composting of organic wastes (Carey *et al.,* 2008). The treatment systems covered by this CoP are not appropriate for the disposal of excessive quantities of waste oil and fats. These waste materials should be collected and disposed of by another appropriate method.

Under no circumstances should rainwater, surface water or run-off from paved areas be discharged to on-site single-house treatment systems. However, grey waters (washing machine, baths, showers, etc.) must pass to the treatment system. To control the quantity of wastewater generated in a household, water conservation measures should be adopted.

Table 4.1 gives the range of influent characteristics for raw domestic wastewater from I.S. EN 12566-3:2005. The CEN standard requires that wastewater treatment systems must be tested using influents in this range. Research in Ireland indicates that Irish domestic wastewater is at the more concentrated level of the characterised influent in I.S. EN 12566-3:2005, which in turn produces a typically concentrated effluent (see Table B.1 in Annex B).

The total design wastewater load should be established from the maximum population that can inhabit the premises, based on number and size of bedrooms. In order to calculate wastewater capacities, a typical daily hydraulic loading of 150 l/person should be used to ensure that adequate treatment is provided.

Table 4.1. Range of raw domestic wastewater influent characteristics (I.S. EN 12566-3:2005).

Parameter	Typical concentration (mg/l unless otherwise stated)
Chemical oxygen demand (COD) (as O_2)	300–1000
Biochemical oxygen demand (BOD_5) (as O_2)	150–500
Suspended solids	200–700
Ammonia (as NH_4-N)	22–80
Total phosphorus (as P)	5–20
Total coliforms (MPN/100 ml)[1]	10^6–10^9

[1]Not from I.S. EN 12566-3:2005. (MPN, most probable number.)

5 On-Site Wastewater Treatment System Performance

The EN 12566 series of standards consists of a number of parts – refer to Fig. 5.1 for their applications. The normative requirements of the standards, at the date of publication, have been incorporated into this CoP.

A treatment system should meet the requirements of I.S. EN 12566-3:2005 and be followed by a disposal system designed to prEN 12566-7 or as per the guidance provided within this code. Alternatively a treatment system should consist of a product meeting the requirements of I.S. EN 12566-1:2000/A1:2004 or I.S. EN 12566-4:2007 followed by a disposal system meeting the requirements of I.S. CEN/TR 12566-2:2005 or I.S. CEN/TR 12566-5:2008 or followed by a product meeting the requirements of prEN 12566-6 or as per the

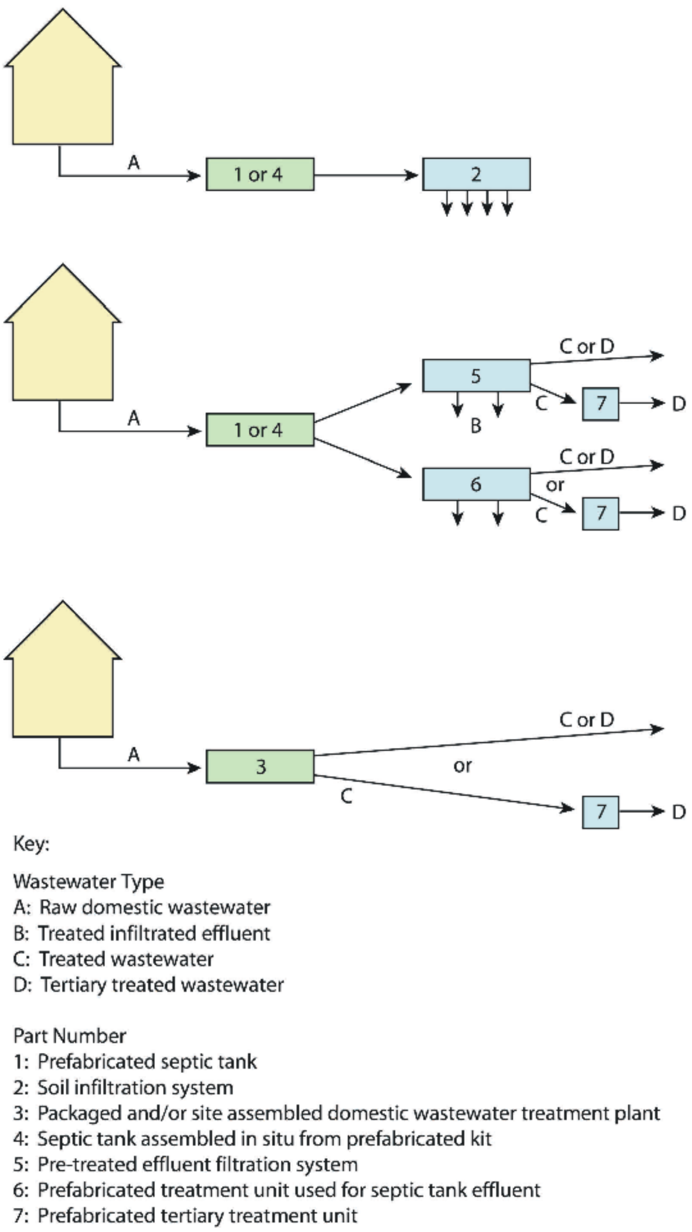


FIGURE 5.1. METHODS OF WASTEWATER TREATMENT IN LINE WITH EN 12566.

guidance provided within this code. A tertiary treatment system meeting the requirements of prEN 12566-7 might be added to the total system where higher levels of treatment are required by the local authority.

The performance of septic tank systems in treating domestic effluent relies primarily on the soil attenuation capability of the percolation area. Contaminant attenuation begins in the septic tank and continues through the distribution pipework, the surface of the biomat, the unsaturated soils and in the saturated zone. Research in the US indicates that filtration, microstraining, and aerobic biological decomposition processes in the biomat and infiltration zone remove more than 90% of BOD and suspended solids (SS) and 99% of the bacteria (University of Wisconsin-Madison, 1978) and similar results were found by the Colorado School of Mines (Van Cuyk *et al.,* 2005). These findings are supported by Irish EPA funded research projects (2001-MS 15-M1 and 2005-W-MS 15) undertaken by TCD. These septic tank systems are designed on a prescriptive basis (see Section 7), and are considered to achieve a satisfactory effluent quality, and treatment efficiency is usually not stated.

In general, wastewater treatment systems do not provide for the removal of significant amounts of nitrogen or phosphorus.

While septic tank systems can remove a limited amount of nitrogen but high-density installation of wastewater treatment systems can cause contamination (Wakida and Lerner, 2005).

The Colorado School of Mines, Golden, Colorado (Van Cuyk *et al*., 2005) observed high removals of phosphorus within soil infiltration systems throughout their study. As the finite sorption capacity of the upper layers of soil becomes exhausted, soils at greater depths will become increasingly more important for phosphorus attenuation as operational time extends for several years. Irish research by Gill *et al*. (2009a) also supports these findings.

For package wastewater treatment plants, compliance with phosphorus limits is usually achieved by dosing chemical coagulants into influent to precipitate phosphates, which settle out in the downstream settlement tank. Research shows that plants are capable of removing more than 90% of the total phosphorus load with adequate coagulant dosing and chemical precipitation (Hellström and Jonsson, 2003).

The absorption capacity of gravel media of reed beds becomes exhausted after an extended period (e.g. 6 months to 1 year). Soluble phosphorus can pass forward with the treated effluent flow unless special media with a high absorption capacity are used (Molle *et al*., 2003; Zhu *et al*., 2003; Gill *et al*., 2009b) and it is replaced regularly (e.g. every 5 years).

As phosphorus removal is dependent on the natural mineralogy of the soil into which the effluent is being discharged (both percolation area and polishing filter) and there is a finite capacity in the soil, this should not alone be relied upon in nutrient-sensitive areas. Secondary treatment systems may be modified to specifically improve their nutrient removal capacity. In addition, there are a number of proprietary (tertiary treatment) systems on the market that provide enhanced nutrient removal for nitrogen and phosphorus. These should be tested in accordance with the requirements of prEN 12566-7.

5.1 Performance Standards

I.S. EN 12566-3:2005 and prEN 12566-6 specify the test procedures to be followed in the measurement of a range of parameters relevant to treatment efficiency for packaged and/or site-assembled treatment plants and for prefabricated treatment units for septic tank effluent, respectively. These standards do not specify treatment efficiency to be achieved for any of these parameters. However, the standards provide for the declaration of test performance in relation to some or all of the parameters, as may be required by national regulations.

Table 4.1 sets out the influent characteristics for the testing of these systems. Due to the more concentrated influent in Ireland, wastewater treatment systems being tested for use on the Irish market should be tested according to the I.S. EN 12566-3:2005 standard using the upper values for influent sewage and their performance stated in terms of percentage removal efficiency for the entire test parameters. The design should be based on 60 g BOD/person/day and the recommended influent test range should be 300–500 mg/l.

Table 5.1 sets out performance effluent standards for specific parameters, which are considered to be the minimum acceptable levels that should be achieved by these types of treatment systems. Compliance with the standard should be at a sampling chamber following the treatment process.

Local authorities may set stricter performance standards and they should be conditional on the results of a proposed impact assessment on the receiving waters.

In nutrient-sensitive locations, the local authority should consider more stringent performance standards for nitrogen and phosphorus (Table 5.1), particularly where measures are needed to achieve the objectives of the Water Framework Directive.

Table 5.1. On-site domestic wastewater treatment minimum performance standards.

Parameter	Standard[1] (mg/l)	Comments
Biochemical oxygen demand (mg/l)	20	
Suspended solids (mg/l)	30	
NH_4 as N (mg/l)	20	Unless otherwise specified by local authority
Total nitrogen[2] as N (mg/l)	5[3]	Only for nutrient-sensitive locations
Total phosphorus[2] (mg/l)	2[3]	Only for nutrient-sensitive locations

[1]95 percentile compliance is required for site monitoring carried out after installation.
[2]Only required to be achieved in nutrient-sensitive locations.
[3]24-h composite samples.

6 Site Characterisation

All sites for proposed single houses in unsewered rural areas should have a site suitability assessment carried out by a competent person in accordance with the requirements of this section and the guidance in Annex C. Where sites are deemed unsuitable for discharge to ground, alternative options, if any, will need to be discussed with the local authority.

The purpose of a site assessment is to determine whether a site is suitable or not for an on-site wastewater treatment system. The assessment will also help to predict the wastewater flow through the subsoil and into the subsurface materials. The site characterisation process outlined here is applicable to the development of a single house only. More extensive site characterisation is required for cluster and large-scale developments.

Risk can be defined as the likelihood or expected frequency of a specified adverse consequence. Applied for example to groundwater, a risk expresses the likelihood of contamination arising from a proposed on-site treatment system (called the source or hazard). A hazard presents a risk when it is likely to affect something of value (the target, e.g. groundwater) (Fig. 6.1). It is the combination of the probability of the hazard occurring and its consequences that is the basis of risk assessment. Risk management involves site assessment, selection of options and implementation of measures to prevent or minimise the consequences and probability of a contamination event (e.g. odour nuisance or water pollution). The methodology for selection and design of an on-site system in this code embraces the concepts of risk assessment and risk management.

The objective of a site characterisation is to obtain sufficient information from an *in situ* assessment of the site to determine if an on-site domestic wastewater treatment system can be developed on the site. Each local authority should satisfy itself that any persons carrying out these assessments are competent to do so (e.g. FETAC[2] certified or equivalent[3]).

Under Article 22(2)(c) of the Planning and Development Regulations 2006, where it is proposed to dispose of wastewater other than

2. Further Education and Training Awards Council (FETAC).
3. The local authority should assess qualifications on a case-by-case basis and considering any developments in the training area.

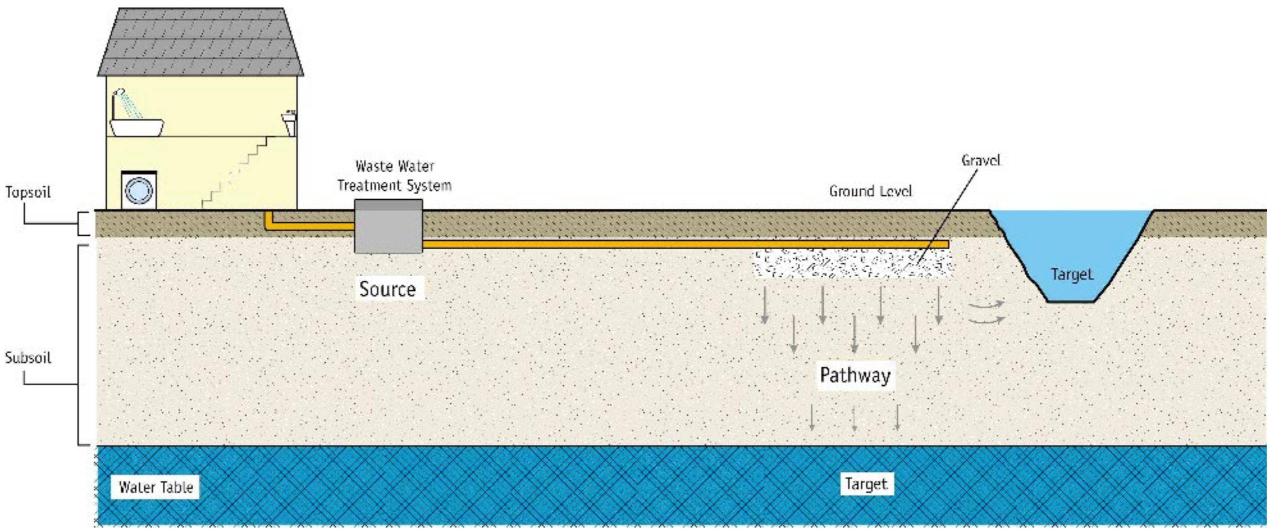


FIGURE 6.1. SCHEMATIC OF SOURCE–PATHWAY–TARGET MODEL.

to a public sewer from a development proposed as part of a planning application to a planning authority, the applicant must submit information on the type of on-site treatment system proposed and evidence as to the suitability of the site for the system proposed as part of that planning application.

To assist in the selection of the on-site system and to standardise the assessment process, a site characterisation form has been prepared (Annex C.3). The completed form including photographs, site plans (including finished floor and ground levels), cross sections and design details should accompany all planning applications for on-site domestic wastewater treatment systems for single houses.

In designing an on-site domestic wastewater treatment system to treat and dispose of the wastewater, three factors should be considered:

1. Are there any restrictions relating to the site?
2. Is the site suitable to treat the wastewater? (Attenuation)
3. Is the site able to dispose of the wastewater volumes? (Hydraulic load)

Characterising the site involves a number of stages and should include:

1. A desk study, which collects any information that may be available on maps, etc., about the site
2. On-site assessment:
   - A visual assessment of the site, which defines the site in relation to surface features
   - A trial hole to evaluate the soil structure, mass characteristics such as preferential flow paths, depth to bedrock and water table
   - Percolation tests that give an indication of the permeability of the subsoil
3. Assessment of data obtained
4. Conclusion on the suitability of the site
5. Proposed disposal route, and
6. Recommendation for a wastewater treatment system including on-site design requirements.

Figure 6.2 summarises the general process to be followed to select an on-site wastewater system discharging to ground and it is not intended to cover all scenarios.

6.1 Desk Study

The information collected from the desk study as set out in Annex C.1 should be examined and the following should be considered for all treatment options.

Maximum number of residents: This information is available under general details and should be calculated using the number and size of the bedrooms.

Proposed water supply: The proposed type of water supply is required to determine whether additional requirements are required.

Hydrological aspects include locating the presence (if any) of streams, rivers, lakes, beaches, shellfish areas and/or wetlands while **hydrogeological aspects** include:

- Soil type – type of drainage and depth to water table (information from Teagasc, EPA)
- Subsoil type – type of drainage and depth to water table (information from Teagasc, Geological Survey of Ireland (GSI), EPA)
- Location of karst features (information from the karst database, GSI)
- Aquifer type – importance of groundwater and type of flow (this incorporates bedrock type) (information from GSI)
- Vulnerability (information from GSI), and
- Groundwater protection responses (GWPRs) for on-site systems for single houses (Annex B).

Each site is specific and local factors and previous experience of the operation of on-site domestic wastewater treatment systems in the

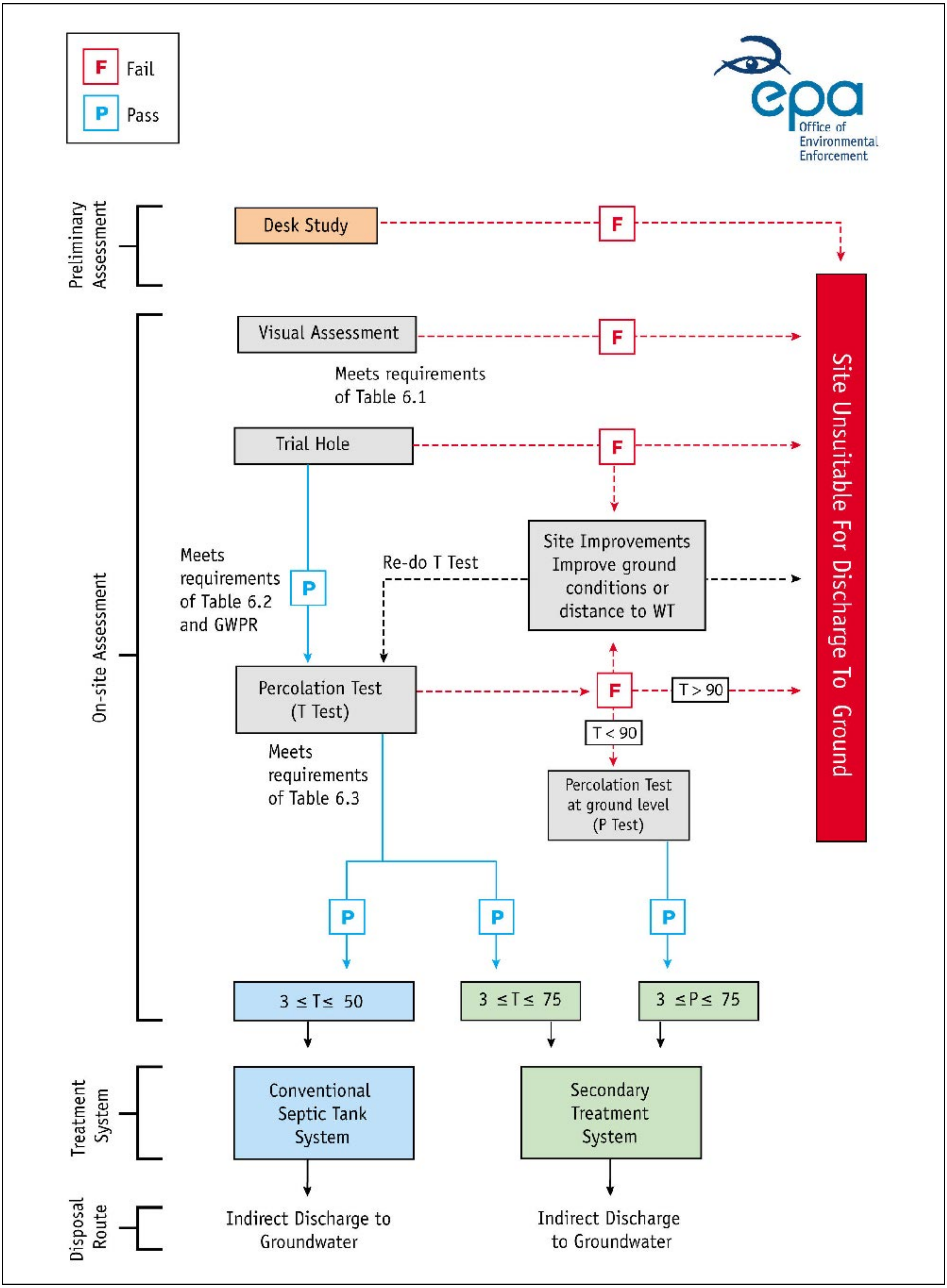


FIGURE 6.2. A GENERAL GUIDE TO THE SELECTION OF AN ON-SITE WASTEWATER TREATMENT SYSTEM DISCHARGING TO GROUND.

area (which could include checking the local authority database for failed sites or complaints), density of existing development (iPlan system) and any water quality data should be taken into account in using this guideline information.

Presence of significant sites: Determine whether there are significant archaeological, natural heritage and/or historical features within the proposed site. To avoid any accidental damage, a trial hole assessment or percolation tests should not be undertaken in areas that are at or adjacent to significant sites (e.g. archaeological features, National Heritage Areas (NHAs), Special Areas of Conservation (SACs), etc.), without prior advice from the local authority (e.g. heritage or conservation officer) or the Heritage Service and National Parks and Wildlife Service.

Nature of drainage: A high frequency of watercourses on maps indicates high or perched water tables.

Past experience: Is there evidence of satisfactory or unsatisfactory local experience with on-site treatment systems? Is there a very high density of existing on-site domestic wastewater treatment systems in the area? What are the background nitrate concentrations in groundwater?

6.2 On-Site Assessment

In addition to the requirements set out below, Annex C.2 provides more detailed guidance on how to carry out an on-site assessment.

6.2.1 Visual assessment

The purpose of the visual assessment is to:

1. Assess the potential suitability of the site
2. Assess potential targets at risk (e.g. adjacent wells), and
3. Provide sufficient information (including photographic evidence) to enable a decision to be made on the suitability of the site for the treatment and discharge of wastewater and the location of the proposed system within the site.

It is critical that all potential targets are identified at this stage. The minimum separation distances that should be used in the visual assessment are set out in Table 6.1. These apply to all on-site domestic wastewater treatment systems. If any of these requirements cannot be met, on-site domestic wastewater systems cannot be developed on the site. The recommended minimum distances from wells and springs should satisfy the requirements of the groundwater protection response (Annex B), which should have been reviewed during the desk study and confirmed during the on-site assessment. An on-site domestic wastewater treatment and disposal system should not be installed in a flood plain or in seasonally waterlogged, boggy or frequently wetted areas.

All the information obtained during the visual assessment should be used to assist in the location of the trial hole and percolation test holes.

6.2.2 Trial hole assessment

The purposes of the trial hole assessment are to determine:

- The depth of the water table
- The depth to bedrock, and
- The soil and subsoil characteristics.

The trial hole assessment will help to predict the wastewater flow through the subsoil. It should be as small as practicable, e.g. 1 × 6 m (to allow sloped access), and should be excavated to a depth of at least 1.2 m below the invert of the lowest percolation trench (or 2 m for GWPRs of $R2^2$ or higher). In the case of a sloping site, it is essential that an estimate of the depth of the invert of the percolation trench be made beforehand. Details on how to carry out the trial hole assessment are given in Annex C.2.

The soil characteristics that should be assessed are: texture, structure, presence of preferential flow paths, density, compactness, colour, layering, depth to bedrock and depth to the water table. The soil texture should be characterised using the classification included in Annex C.3.2. Every significant layer

TABLE 6.1. MINIMUM SEPARATION DISTANCES IN METRES.

	Septic tank, intermittent filters, packaged systems, percolation area, polishing filters (m)
Wells[1]	–
Surface water soakaway[2]	5
Watercourse/stream[3]	10
Open drain	10
Heritage features, NHA/SAC[3]	–
Lake or foreshore	50
Any dwelling house	7 septic tank 10 percolation area
Site boundary	3
Trees[4]	3
Road	4
Slope break/cuts	4

[1]See Annex B: *Groundwater Protection Response*.
[2]The soakaway for surface water drainage should be located down gradient of the percolation area or polishing filter and also ensure that this distance is maintained from neighbouring storm water disposal areas or soakaways.
[3]The distances required are dependent on the importance of the feature. Therefore, advice should be sought from the local authority environment and planning sections (conservation officer and heritage officer) and/or from the Department of the Environment, Heritage and Local Government (DoEHLG), specifically the Archive Unit of the National Monuments Section and the National Parks and Wildlife Service. If considering discharging to a watercourse that drains to an NHA/SAC the relevant legislation is Article 63 of the Habitats Directive. (NHA, National Heritage Area; SAC, Special area of Conservation.)
[4]Tree roots may lead to the generation of preferential flow paths. The canopy spread indicates potential root coverage.

encountered in the trial hole should be described in the Site Characterisation Form. (Further guidance is contained in Annex C and should be adhered to.)

Photographic evidence of the trial hole and its profile should be provided to the relevant authorities.

Where soil conditions are variable, further trial holes should be considered to help characterise the site and identify areas of improved drainage.

If items of suspected archaeological interest are discovered, the relevant authorities should be contacted.

6.2.2.1 Interpreting the trial hole test results

Table 6.2 sets out the subsoil characteristics that indicate the satisfactory characteristics necessary for the treatment of wastewater. The percolation characteristics will need to be

TABLE 6.2. DEPTH REQUIREMENTS ON-SITE FOR ON-SITE SYSTEMS DISCHARGING TO GROUND.

Subsoil characteristics	Minimum requirements
Minimum depth of unsaturated permeable subsoil below base of all percolation trenches for septic tank systems, i.e. minimum depth of unsaturated subsoil to bedrock and the water table	1.2 m[1]
Minimum depth of unsaturated permeable subsoil below the base of the polishing filter for secondary treatment systems, i.e. minimum depth of unsaturated subsoil to bedrock and the water table	0.9 m[1]

[1]Greater depths/thicknesses may be required depending on the groundwater protection responses (Annex B).

confirmed later by examining the percolation test results.

6.2.3 Percolation tests

A percolation (permeability) test assesses the hydraulic assimilation capacity of the subsoil, i.e. the ability of the subsoil to absorb water is assessed by recording the length of time for the water level to drop in the percolation hole by a specified distance. The objective of the percolation test is to determine the ability of the subsoil to hydraulically transmit the treated effluent from the treatment system, through the subsoil to groundwater. The test also gives an indication of the likely residence time of the treated effluent in the upper subsoil layers and therefore it provides an indication of the ability of the subsoil to treat the residual pollutants contained in the treated effluent.

There are two types of percolation test: the T-test and the P-test. The T-test is carried out at the depth of the invert of the percolation pipe and the P-test is carried out at the ground surface. Detailed guidance for the carrying out of these percolation tests is given in Annex C.2.3. The result of the percolation test is expressed as either the T-value or the P-value. A minimum of **three** test holes per percolation test should be excavated and tested at each site.

Where experience indicates that the site may be borderline, then both T and P percolation tests should be carried out at the same time.

In situations where the T-test is in excess of 90 then, irrespective of the P-test result, the site is unsuitable for discharge of treated effluent to ground as outlined in this code, as it is likely ultimately to result in ponding due to the impervious nature of the underlying subsoil (or bedrock). This guidance is consistent with Section 6.3 of I.S. CEN/TR 12566-2:2005. All T-tests, where depth to bedrock or water table permits, should be completed to establish this value (T > 90). The methodology for a shortened percolation test for low permeability subsoils is found in Annex C.2.3.

In the case where there is a high water table present then it is critical to assess the subsoil layer just above the water table by carrying out a percolation test or particle size analysis of the subsoil, thus determining whether or not the water table is due to a low permeability subsoil or a naturally high water table due to the site's hydrological location.

The subsoil classifications from the trial hole should be confirmed by the percolation test results. If there is not a good correlation then further examination should be undertaken to determine which assessment accurately reflects the suitability of the site to treat and dispose of the effluent.

Percolation test holes should be located adjacent to, but **not within**, the proposed percolation area. It is important to note that the top of the percolation hole should be located as accurately as possible to the same level as the invert of the percolation pipe (as determined by the trial hole results).

In the case where there is shallow bedrock present then an assessment of the permeability of the bedrock has to determine whether the site can absorb the hydraulic load and that ponding will not result. Specialist advice may be needed to conduct the most appropriate tests dependent on the bedrock (e.g. pumping tests, falling head tests, etc.) in accordance with BS 5930. This is particularly necessary in areas of un-weathered granite and other low permeability bedrock.

6.2.3.1 Interpretation of the percolation tests

Table 6.3 outlines the interpretation of the percolation test results.

6.2.4 Integration of desk study and on-site assessment

The information gathered during the desk study and the on-site assessment is used to characterise the site and used later to choose and design an on-site system. An integrated approach will ensure that the target(s) at risk are identified and protected. To assist in the selection of the on-site system and to standardise the assessment process, a site characterisation form has been prepared (Annex C.3). The completed form including photographic evidence, site plans and design details should accompany all planning applications for on-site systems for single

Table 6.3. Interpretation of percolation test results.

Percolation test result	Interpretation
T > 90	Site is unsuitable for development of any on-site domestic wastewater treatment system discharging to ground. Site may be deemed suitable for treatment system discharging to surface water in accordance with Water Pollution Act licence.
T < 3	Retention time in the subsoil is too fast to provide satisfactory treatment. Site is unsuitable for secondary-treated on-site domestic wastewater systems. However, if effluent is pretreated to tertiary quality then the site will be hydraulically suitable to assimilate this hydraulic load. P-test should be undertaken to determine whether the site is suitable for a secondary treatment system with a polishing filter at ground surface or overground. Sites may be deemed suitable for discharge to surface water in accordance with Water Pollution Act licence[1].
3 ≤ T ≤ 50	Site is suitable for the development of a septic tank system or a secondary treatment system discharging to groundwater.
50 < T < 75	Wastewater from a septic tank system is likely to cause ponding at the surface of the percolation area. Not suitable for a septic tank system. May be suitable for a secondary treatment system with a polishing filter at the depth of the T-test hole.
75 ≤ T ≤ 90	Wastewater from a septic tank system is likely to cause ponding at the surface of the percolation area. Not suitable for a septic tank system. Site unsuitable for polishing filter at the depth of the T-test hole. P-test should be undertaken to determine whether the site is suitable for a secondary treatment system with polishing filter, i.e. 3 ≤ P ≤ 75, at ground surface or overground.
P < 3	Retention time in the topsoil/subsoil insufficient to provide satisfactory treatment. However, if effluent is pretreated to tertiary state then the site will be hydraulically suitable to assimilate the hydraulic load. Imported suitable material may be deemed acceptable as part of site improvement works
3 ≤ P ≤ 75	Site is suitable for a secondary treatment system with polishing filter at ground surface or overground. If the subsoil is classified as CLAY, carry out a particle size distribution and refer to I.S. CEN/TR 12566-2:2005.
T not possible due to high water table	

[1]Most local authorities do not grant water pollution discharge licences to single dwellings and the site assessor is advised to contact the Environment Section for advice.

houses. Note, if the GWPR is R2[3], the groundwater quality needs to be assessed (see Annex B).

6.3 Discharge Route

The disposal route of the treated wastewater needs to be considered prior to deciding on the type of treatment. For septic tank systems, the treated wastewater discharges *via* the unsaturated subsoil in the percolation area to groundwater. In the case of filters, wetland systems and packaged treatment systems, where there is an indirect discharge to groundwater, a polishing filter is required.

The discharge of any sewage effluent to waters[4] requires a licence under the Water Pollution Acts 1977–1990, and local authorities assess such applications. However, it should be noted that a soakage pit or similar method is not an acceptable means for treating septic tank effluent and does not comply with the requirements set out in this code.

The relevant local authority should consider the accumulative loading from on-site domestic wastewater treatment systems, particularly in areas of high-density one-off housing. Guidance on dilution calculations is included in Annex D.2.

Where sites are deemed unsuitable for the discharge of effluent to ground it is generally due to hydraulic reasons or high water tables. The failure could be as a result of impervious soil and/or subsoil and/or poorly permeable

4. Includes any (or any part of any) river, stream, lake, canal, reservoir, aquifer, pond, watercourse or other inland waters, whether natural or artificial.

bedrock, which may result in ponding on-site. In these cases, site improvement works are unlikely to render the site suitable for discharge to ground and the only possible discharge route is to surface water in accordance with a Water Pollution Act Licence[5].

Where it is proposed to discharge wastewater to any surface water, a Water Pollution Act discharge licence is required and the local authorities should assess the impact and suitability of the discharge from the on-site system to the receiving water. Guidance may be found in Annex D.2 of this CoP and in Section F.1 of the EPA *Waste Water Discharge Licensing Application Guidance Note* (2008).

6.4 Selecting an Appropriate On-Site Domestic Wastewater Treatment and Disposal System

The information collected from the desk study and on-site assessment should be used in an integrated way to determine whether an on-site system is feasible. If so, the type of system that is appropriate and the optimal final disposal route for the treated wastewater are determined at this stage. Depending on the characteristics of the site, more than one option may be available. In choosing the appropriate system for a site, the assessor should have regard to the guidance provided in this CoP.

When selecting a suitable wastewater treatment system, the designer should be satisfied that:

- The influent test load reflects the required design loadings, and
- The size of the treatment system selected is covered by the relevant test report.

A number of factors should be taken into account in the selection process and these are presented in Annex E.4.

As there is no minimum site size specified in this CoP, the issue of density should be dealt with using a precautionary approach by the local authority and on a case-by-case basis having regard to the existing groundwater quality, and minimum separation distances in Table 6.1 and the dilution calculations in Annex D.2.

5. Most local authorities do not grant discharge licences for single dwellings; it is advisable to consult with the Environment Section of the local authority prior to examining this route further.

6.5 Site Improvement Works

Site improvement works should only be carried out under the supervision of a competent person, as such works are technically difficult to carry out correctly. A constructed soil filter system (raised mound) is not considered to be site improvement works as it is itself a treatment system. Guidance on site improvement works is contained in Annex F.

In many cases, site improvement works will not be sufficient to enable the site to be used for a system incorporating discharge to ground and it may be deemed unsuitable. Examples of sites where site improvement works will not be acceptable are:

- Sites where the slope exceeds 1:8
- Sites where T is greater than 90, indicating a high risk of ponding
- Sites where T is greater than 90 in shallow subsoil and/or bedrock permeability is not sufficient to take the hydraulic load
- Water table <300 mm from surface where the subsoil/bedrock is impermeable
- Sites where the separation distances cannot be satisfied
- Sites where the bare bedrock is exposed.

Having carried out the required site improvement works the appropriate parts of the site characterisation form should be re-completed and an assessment of the overall suitability of the site can be made. A site cannot be deemed to have passed the on-site assessment if the recommendations include significant site improvement works. The site characterisation form and details of the site improvement works including additional testing results should be submitted to the planning authority.

6.6 Recommendations

At this stage of the process the site characterisation is complete; the types of on-site domestic wastewater treatment systems and the discharge options that are suitable for the site are known. In some cases, however, the site may be deemed unsuitable for the installation of an on-site domestic wastewater treatment system.

When a site is deemed suitable the site assessor should make a recommendation as to the most appropriate on-site domestic wastewater treatment system for the particular site under assessment including the discharge route.

The conclusions of the site characterisation will dictate the type and range of system(s) and the design requirements.

In all cases, the minimum construction/ installation requirements should be included in the site characterisation report.

Where there are limiting site factors present then additional attention should be given to providing cross sections indicating invert levels of pipework, etc.

The information should clearly show where the on-site domestic wastewater treatment system should be installed and also highlight any special conditions, taking into account that the site assessor may not be the person actually installing the system.

The type, location and installation requirements for each system should be very clearly set out in the report, highlighting the importance of site levels and integration of finished floor levels with the site assessment and cross sections showing drainage falls, soil depth below pipe inverts, etc.

If additional pages are required then attach them to the end of the site characterisation form.

In the case of selecting a system for a holiday home (see Annex G.5), consideration should be given to the selection of a system that can adequately deal with periods of inactivity, i.e. where the house is unoccupied for a prolonged period.

This CoP should be applied to all new development. However, existing on-site domestic wastewater treatment systems may fail to meet the performance requirements as set out in this CoP. When this occurs, corrective actions are necessary. Successful rehabilitation requires knowledge of the performance requirements, a sound diagnostic procedure, and appropriate selection of corrective actions. Variances to the CoP requirements may be considered by the local authority when it is satisfied that the proposed upgrade will provide improved treatment and reduced environmental impact. The failure of the existing treatment and disposal system needs to be clearly identified and corrective actions proposed having regard to the requirements of this CoP.

7 Septic Tank Systems

Septic tank systems comprise a septic tank and a percolation area. The majority of the treatment occurs in the percolation trenches and in the underlying subsoil. These systems provide effective treatment and disposal of domestic wastewater when properly sized, sited, installed and maintained in accordance with this code of practice. These systems require greater depths of subsoil and a larger percolation area than secondary treatment systems.

A septic tank system comprises a septic tank, with treatment and distribution of the effluent by means of a percolation area. Septic tanks are primary settlement tanks providing a limited amount of anaerobic digestion. The percolation pipes may be subsurface or at ground level using *in situ* subsoil for treatment. A septic tank should meet the requirements of I.S. EN 12566-1:2000/A1:2004 or I.S. EN 12566-4:2007, including their National Annexes, and should be followed by a disposal system meeting the requirements of I.S. CEN/TR 12566-2:2005, I.S. CEN/TR 12566-5:2008 or prEN 12566-6 or as per the guidance provided within this CoP.

7.1 Septic Tanks

I.S. EN 12566-1:2000/A1:2004 *Small Waste-water Treatment Systems for up to 50 PT – Part 1: Prefabricated Septic Tanks* is a product standard developed and published by CEN and adopted by the NSAI. The standard and its National Annex specify a range of requirements and test methods in relation to septic tank design and performance that the tank should conform to. As the standard and water tightness cannot be assured in line with I.S. EN 12566-1:2000/A1:2004, the construction of *in situ* septic tanks is not permitted in this code.

Septic tanks may be assembled on-site if they comply with the requirements of I.S. EN 12566-4:2007 *Small Wastewater Treatment Systems for up to 50 PT – Part 4: Septic Tanks Assembled in situ from Prefabricated Kits* and are installed in accordance with the manufacturer's instructions. A plan and section of a typical septic tank system layout is given in Fig. 7.1.

7.1.1 Septic tank design capacity

The septic tank should be of sufficient volume to provide a retention time for settlement of the SS, while reserving an adequate volume for sludge storage (Fig. 7.2). The volume required for sludge storage is the determining factor in sizing the septic tank. This sizing depends on the potential occupancy of the dwelling, which should be estimated from the maximum number of people that the house can accommodate, and the number and type of bedrooms. The minimum plan area for a single bedroom can be taken as 6.5 m^2 and for a double bedroom as 10.2 m^2.

The tank capacity should be calculated from the following formula:

$$C = 150 \times P + 2000$$

where C is the capacity (l) of the tank and P is the design population, with a minimum of four persons.

The septic tank installed should always equal or exceed this design capacity. A minimum capacity of 2,600 l (2.6 m^3) should be provided on sites where the population is less than four. This assumes that de-sludging of the septic tank is carried out at least once in every 12-month period. An effluent screen on the outlet is recommended.

In relation to tank size for prefabricated tanks, I.S. EN 12566-1:2000/A1:2004 states that nominal sizes should be expressed at 1 m^3 intervals with minimum nominal capacity being 2 m^3 (Table 7.1).

7.1.2 Hydraulic loading rates

The hydraulic loading through the trench base and sidewalls of the percolation trench is

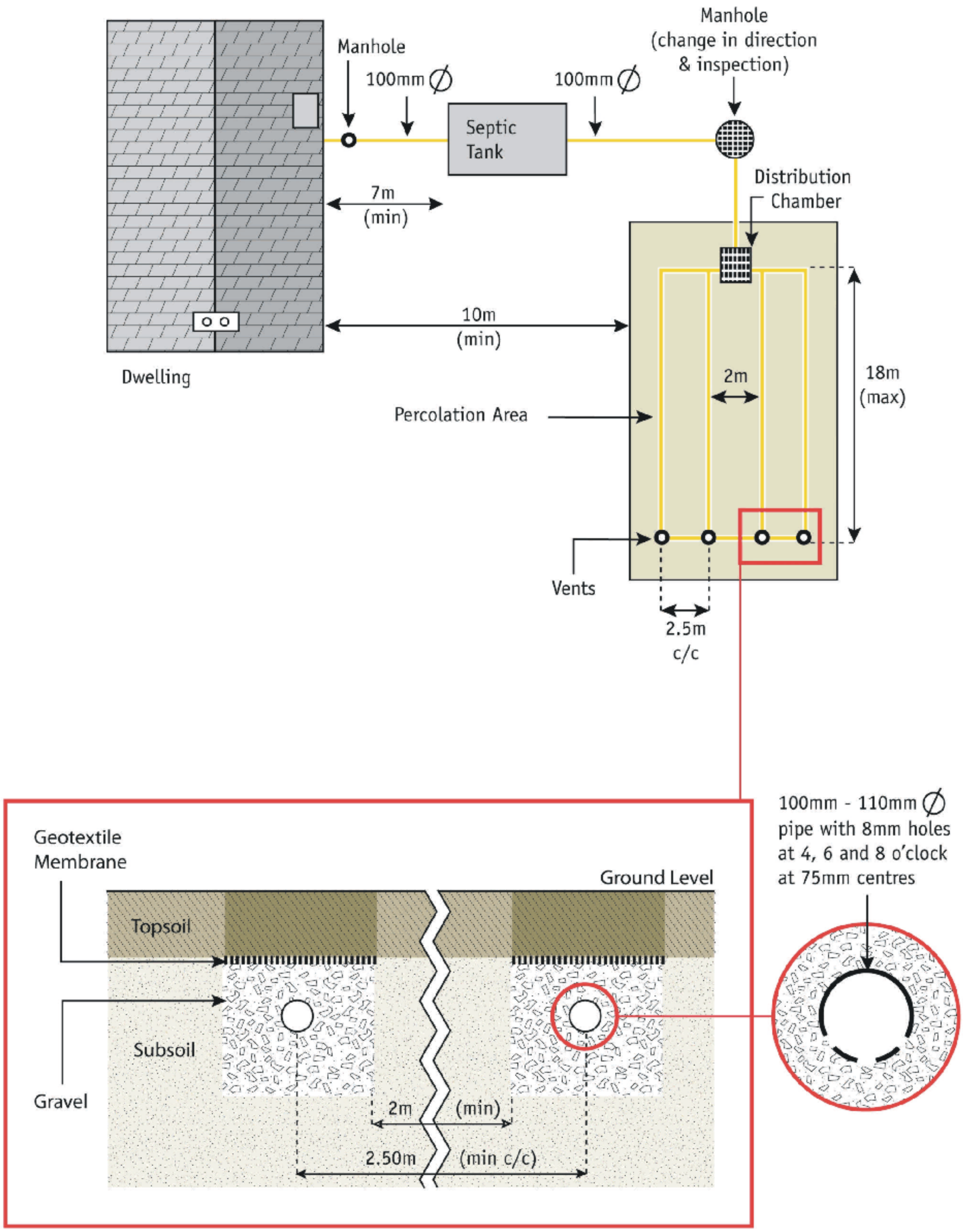


FIGURE 7.1. PLAN AND SECTION OF LAYOUT OF SEPTIC TANK SYSTEM.

controlled by the biomat on the floor and sides of the trench rather than by the subsoil itself (Annex E.1). The percolation rates, measured as they are on virgin subsoil using clean water, cannot be used for the design of the hydraulic distribution system and length of percolation trench. The length of percolation trench is calculated as a function of the number of persons for which the house is designed. A loading rate of 18 m/person is recommended

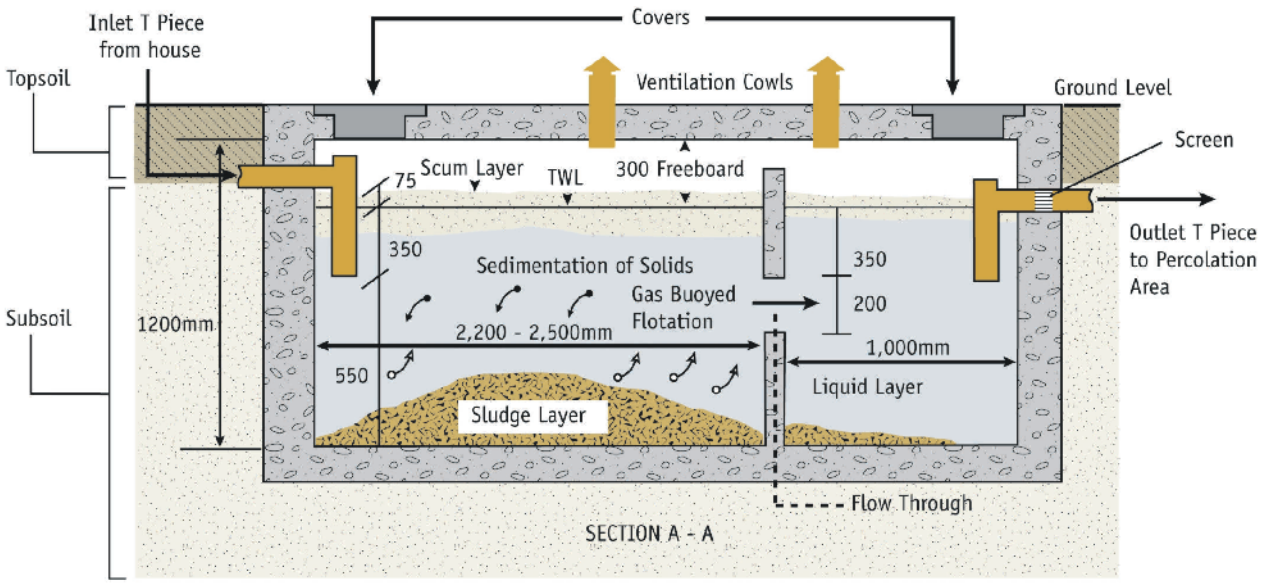


FIGURE 7.2. LONGITUDINAL SECTION OF A TYPICAL SEPTIC TANK (ALL DIMENSIONS IN MM).

TABLE 7.1. NOMINAL SEPTIC TANK CAPACITY FOR VARIOUS DESIGN POPULATIONS.

Number of persons served	Nominal capacity (m^3)
2–5	3
6–10	4

TABLE 7.2. PERCOLATION TRENCH LENGTH.

Number of people in the house	Minimum length of trench[1] (m)
4	72
5	90
6	108
7	126
8	144
9	162
10	180

[1]Trench width is 500 mm and no individual trench length should be more than 18 m.

for wastewater being discharged into a percolation area to take into account the effect of the biomat. The minimum length of the entire percolation trench required is given in Table 7.2.

7.2 Percolation Areas

7.2.1 General

The most important component of a septic tank system is the percolation area (also called an infiltration area) as it provides the majority of the treatment of the wastewater effluent. I.S. CEN/TR 12566-2:2005 *Small Wastewater Treatment Systems for up to 50 PT – Part 2: Soil Infiltration Systems* has been published by the NSAI as a technical report giving guidance for soil infiltration systems to be used with small wastewater treatment systems. The contents of that document have been taken into account in the preparation of this CoP. Where the detailed guidance in the two documents differs, e.g. in relation to separation distances appropriate for plant, percolation areas, etc., the guidance given in this document is deemed more appropriate to the Irish situation and should be followed. Installation guidelines and layout options are contained in Section 11.

In the percolation trench, the wastewater is allowed to flow by gravity into a distribution device, which distributes the flow evenly into a minimum of four percolation pipes in the percolation trenches. The depth to the invert of the percolation trench may vary and is dependent on the T-test location, trial hole information, layering of the subsoil and any other limiting factors such as water table and depth to bedrock (Fig. 7.3). Wastewater flows out through orifices in the percolation pipes into a gravel underlay, which acts both to distribute and provide a medium for initial treatment of the effluent. The effluent then percolates into the soil/subsoil, where it undergoes further biological, physical and chemical interactions that treat the contaminants. For effective treatment, the wastewater should enter the soil; if the base or walls of the percolation trench are compacted or glazed or otherwise damaged during excavation, they should be scratched with a steel tool such as a rake to expose the natural soil surface. It is equally important that the wastewater remains long enough in the soil; the hydraulic loading and the rate of flow into the sides and base of the trench control the residence time.

7.2.2 Components of a percolation trench

The pipework and other materials in a traditional percolation trench (gravity fed) should meet the requirements set out in Table 7.3.

7.2.3 Raised percolation areas

Where site conditions are suitable, raised percolation systems may be installed. This is where the pipes are laid at other depths from 800 mm below ground surface up to the ground surface and the mounded element may comprise the percolation trenches (i.e. the gravel bed, percolation pipes, gravel protection layer and topsoil) (Fig. 7.4). The *in situ* soil and subsoil are used to treat the effluent from the septic tank. The distribution is by gravity only *via* a distribution box without any pumping. Where the site contours allow, it is possible to build a mounded percolation area, which is gravity fed, and the minimum requirements are the same as for a percolation area (Tables 7.2 and 7.3).

In addition to the normal requirements, as illustrated in Fig. 7.4, the following site conditions should exist:

- There are at least 1.5 m of undisturbed soil and subsoil naturally occurring above the bedrock (1.2 m subsoil plus 0.3 m distribution gravel for pipe at the surface).
- The maximum high groundwater level is at least 1.5 m below the original ground surface.
- The slope of the original ground surface over the proposed site does not exceed 1:8 (or 12%).
- The percolation test results are within the acceptable range.

Where the ground conditions do not allow for a gravity-fed system then the infiltration

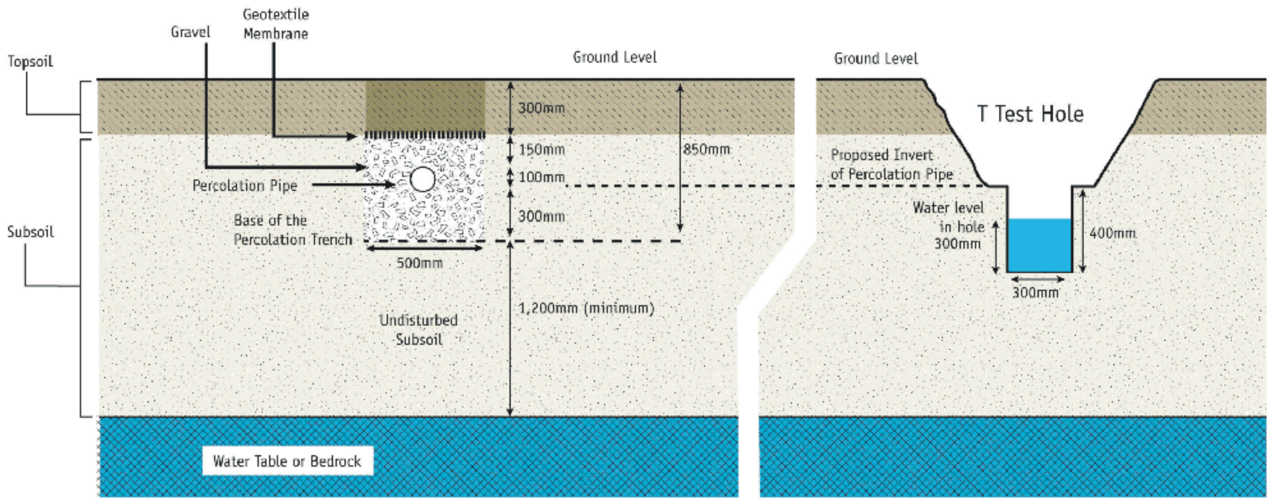


FIGURE 7.3. SECTION OF A PERCOLATION TRENCH.

TABLE 7.3. REQUIREMENTS OF A PERCOLATION TRENCH (GRAVITY FED).

Percolation trench characteristics	Requirements
Slope of pipe from tank to distribution box	1 in 40 for earthenware or concrete 1 in 60 for uPVC
Slope of percolation trench from distribution box	1 in 200
Length of percolation pipe in each trench	18 m maximum
Minimum separation distance between percolation trenches	2 m (2.5 m centre to centre)
Diameter of pipe from septic tank to distribution box	100–110 mm
Percolation pipes[1]	100 mm bore, perforated (typically at 4, 6 and 8 o'clock) smooth wall PVC drainage pipes with perforations of 8-mm diameter at about 75-mm centres along the pipe or Pipes with similar hydraulic properties
Width of percolation trench	500 mm
Depth of percolation trench	About 850-mm depth[2] below ground surface depending on site (as per Fig. 7.3)
Backfilling of percolation trench (see Fig. 7.1)	300 mm of 8- to 32-mm washed gravel on invert; pipe laid at a 1 in 200 slope surrounded by 8- to 32-mm clean washed gravel and with 150 mm of similar gravel over pipe; geotextile layer followed by 300 mm topsoil to ground surface
Geotextile	Geotextile should be in accordance with EN ISO 10319
Access/Inspection points and vents	These are recommended for the ends of the percolation pipes; the covers should be visible and installed to prevent entry of water. They may also be used for rodding/scouring purposes

[1]Before installation the holes in the percolation pipe should be inspected to check that they are the correct size and free from debris.
[2]The percolation pipes may be located at a shallower depth, provided that a minimum of 450 mm of material is placed above the pipes to provide the required protection against damage from above (Fig. 7.4).

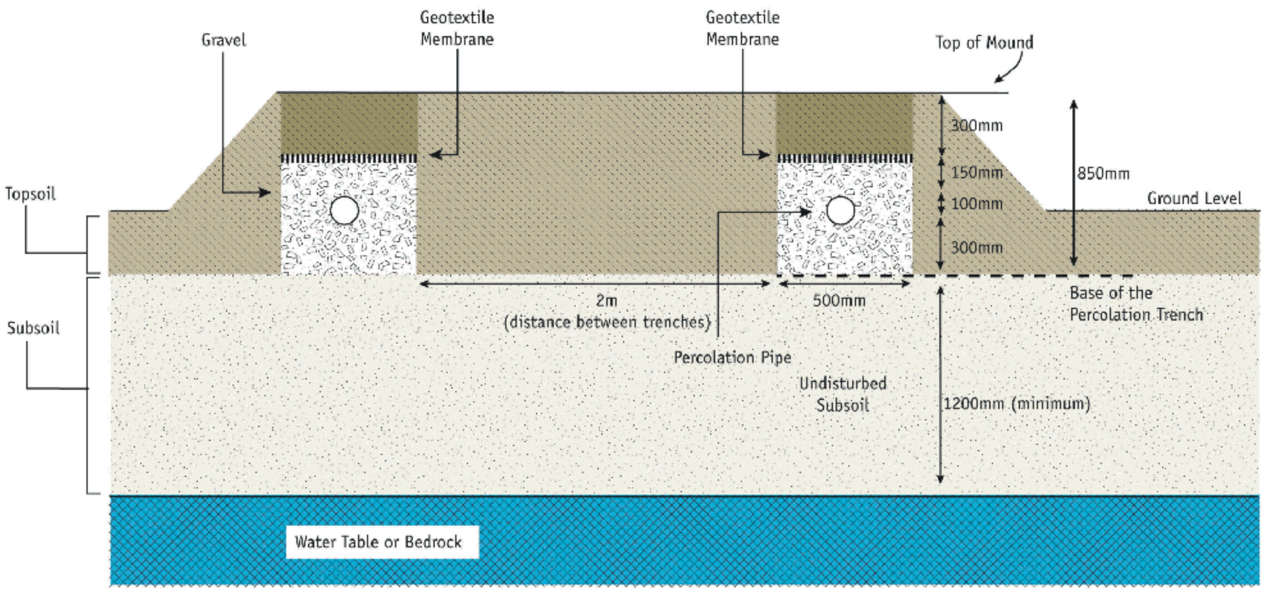


FIGURE 7.4. RAISED PERCOLATION AREA.

(distribution) system should be as outlined for an intermittent soil filter in Section 8.

7.2.4 Other infiltration systems

Other infiltration systems not covered by a national or harmonised European Standard, such as drip-feed systems, non-aggregate systems, leaching chambers, pressure manifold and rigid pipe pressure networks, should be certified (certification may include a European Technical Approval, an Agrément Certificate or equivalent), be fit for the purpose for which they are intended, the conditions in which they are used, and meet the performance requirements of this CoP for both percolation areas and polishing filters.

In all cases the manufacturer’s installation instructions should be followed, and an authorised contractor should install the systems.

8 Secondary Treatment: Systems Constructed On-Site

Secondary treatment filter systems comprise systems that use different media constructed on-site to treat domestic wastewater. A polishing filter is installed after these systems to allow for further treatment of the wastewater and to convey the treated wastewater to waters. These systems may be suitable in areas where a septic tank system is not acceptable. The code of practice provides general guidance on the location, design, installation and maintenance of these systems.

This section deals with the topic of filter systems constructed on-site including filter systems and constructed wetland systems, while packaged on-site domestic wastewater treatment systems are discussed in Section 9. Filter systems are used to provide additional treatment of the effluents from an upstream septic tank or package treatment unit. The filters can contain a variety of media, e.g. soil, sand, plastic, peat or gravel. They should be designed taking I.S. CEN/TR 12566-5:2008 and this CoP into account.

prEN 12566-6 and prEN 12566-7 are in preparation and will deal with the performance characteristics of prefabricated filters. In the interim, these products should be certified (certification may include a European Technical Approval, an Agrément Certificate or equivalent), be fit for the purpose for which they are intended, the conditions in which they are used and meet the performance requirements of this CoP.

A filter system comprises a septic tank followed by a pumping chamber, which transfers the partially treated effluent onto the filter at regular intervals. A critical aspect of filter systems is the need to dose the filter intermittently using a **pumped distribution** system (Fig. 8.1). This filter may comprise soil, sand, peat, textile or other media and is generally referred to as an intermittent filter system.

The partially treated effluent from a septic tank is further treated in the intermittent filter and then discharged to ground, *via* a polishing filter or packaged tertiary treatment system, or in some cases to surface water. The purpose of the 0.9-m deep polishing filter is to provide additional treatment of the effluent and to reduce pollutants such as micro-organisms and also provide for the hydraulic conveyance of the treated effluent to ground. If the effluent is to be discharged to surface water, the required effluent quality will be dictated by the conditions of a water pollution discharge licence and so some form of tertiary treatment either by a polishing filter or a packaged tertiary system (see Section 10) may be required.

In considering the construction of intermittent filter systems and constructed wetlands, the user should refer to the requirements of Section 11. The maintenance requirements for these systems are set out in Section 12.

In the case of all intermittent filter systems, the following applies:

- The wastewater from the intermittent filter is normally collected in a chamber, from where it is discharged to a polishing filter. In some cases, the *in situ* subsoil underneath the intermittent filter may have sufficient depth on its own or with placed imported soil to act as a polishing filter.
- In permeable sites, the filtrate from the intermittent filter, after passing through a polishing filter, may percolate into the groundwater.
- In impermeable sites, the filtrate from the intermittent filter, after passing through a polishing filter/package tertiary treatment system, may discharge to surface water in accordance with a Water Pollution Act discharge licence if permitted by the local authority.

A constructed wetland system comprises a septic tank followed by a constructed wetland

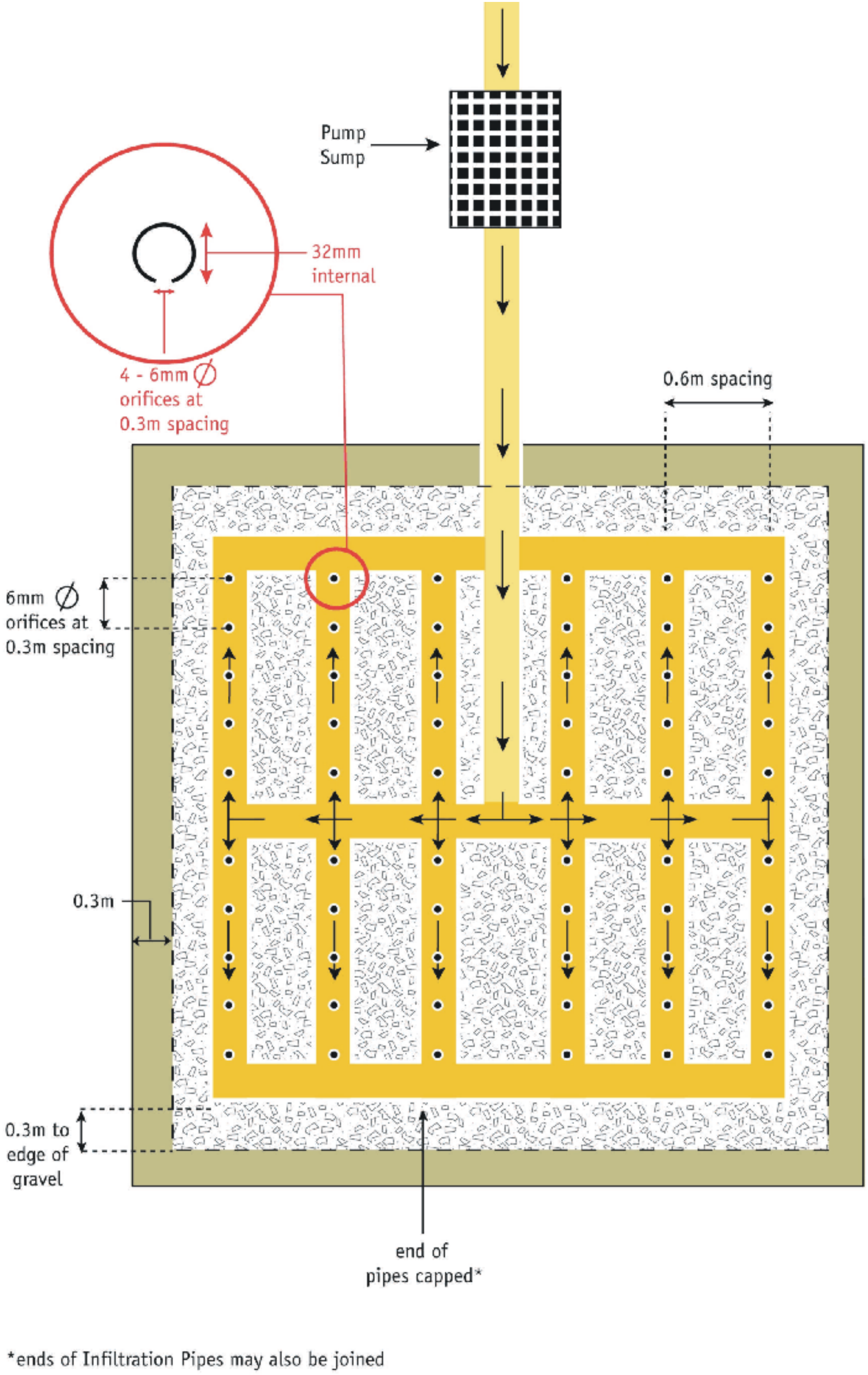


FIGURE 8.1. ILLUSTRATION OF A PUMPED DISTRIBUTION SYSTEM.

and polishing filter. Pumping may or may not be required for a constructed wetland system dependent on the slope and wetland configuration.

The typical layout for the treatment of wastewater using a filter or a constructed wetland system is illustrated in Fig. 8.2. Site conditions will influence the requirement for pumping the wastewater through the different treatment units; however, intermittent filters and some polishing filters will require pumping.

A competent person with relevant experience in the area should carry out the design and construction of filter systems.

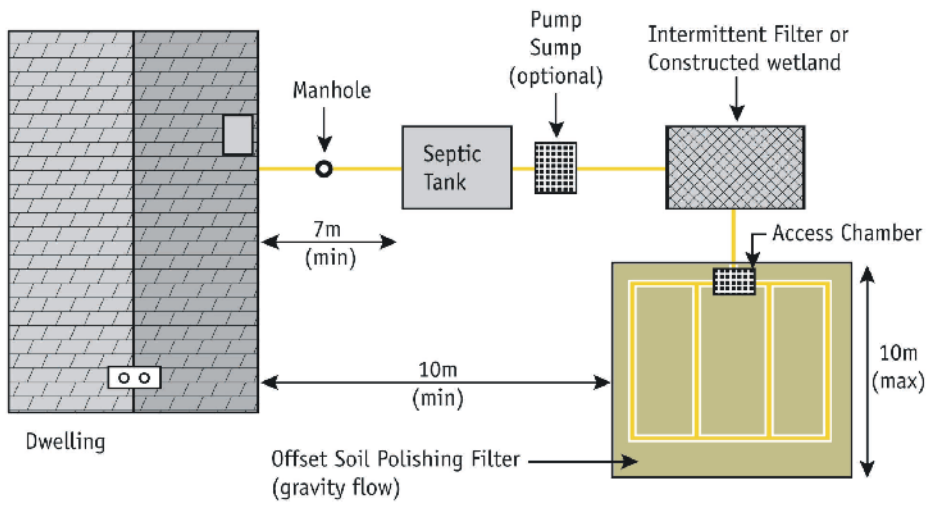


FIGURE 8.2. ILLUSTRATION OF INTERMITTENT FILTER SYSTEM OR CONSTRUCTED WETLAND SYSTEM.

8.1 Soil Filter Systems

Soil filter systems may be used in situations where difficult site conditions are encountered, such as a shallow water table, insufficient subsoil depth or insufficient percolation characteristics of native subsoil. A soil filter system may be developed through the use of imported soil with favourable characteristics or may be developed through the use of *in situ* soil where the upper layer has been removed and replaced by a gravel distribution layer. In both cases the septic tank effluent is distributed over the filter using a pressure (i.e. pumped) distribution system (Fig. 8.1).

A soil filter may be placed in or on the ground in a number of different design formats. Typical design and operational requirements are set out in Table 8.1.

- It may be placed in the ground with a distribution system installed at a shallow depth.
- It may be arranged with the distribution system at ground level (Fig. 8.3).

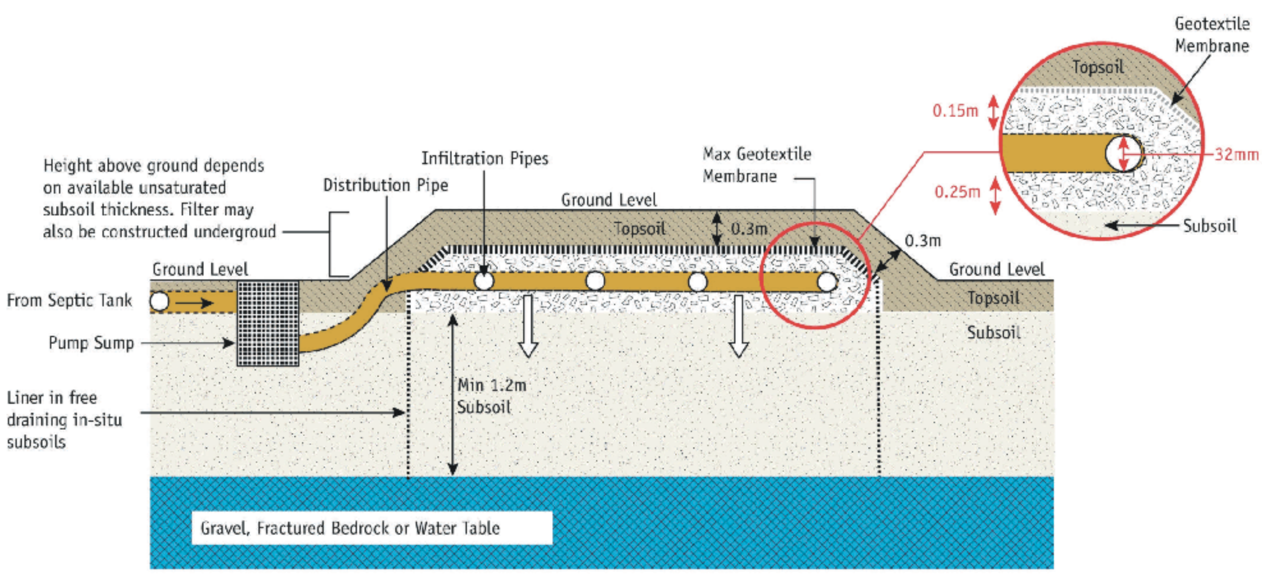


FIGURE 8.3. SCHEMATIC DIAGRAM OF AN INTERMITTENT SOIL FILTER.

TABLE 8.1. SOIL FILTER REQUIREMENTS.

Soil filter characteristics	Requirements
Minimum soil thickness beneath invert of distribution system	1.2 m[1]
Soil percolation value[2]	*In situ* material should have a P/T-value between 3 and 75
Hydraulic loading	4 l/m^2/day on plan area of filter
Design criteria[3]	
Soil layers	Lifts of 300 mm of soil (lightly compacted) when imported
Gravel protection layer	150 mm of 8- to 32-mm washed gravel
Infiltration laterals	32 mm ∅ PVC with 4- to 6-mm orifices[4] at 0.3-m spacings
Gravel distribution layer	250 mm of 8- to 32-mm washed gravel
Lateral centres separation	0.6 m
Geotextile	In accordance with EN ISO 10319
Underdrain/Collection system (required where T > 90 and proposed discharge is to surface water)	Washed durable gravel or stone 8–32 mm Slotted or perforated drain pipe ∅ 75–100 mm Slope 0–1%
Dosing frequency	Minimum of four times per day (at equal time intervals for optimum treatment efficiency)
Pumping system	Pumps should be installed in a separate pumping chamber and only suitable wastewater treatment pumps with a minimum free passage of 10 mm should be used
Zoned regions	It is recommended that the manifold is designed to operate in at least two separate zones within any one polishing filter. This design facilitates maintenance should any problem occur and also allows sequential loading to different zones
Access/Inspection points **Backpressure gauges**	Recommended to be installed in the distribution system for rodding/scouring purposes. These vertically attached pipes to the manifold should extend to an inspection chamber and can also be used as a point to measure the backpressure of the system
In-line filter	An in-line filter between the pump chamber and the infiltration pipe is recommended to prevent blockages in the orifices. It should be designed to have a mesh size of 10 mm
Side sealing	
Mound system	Topsoil on the top and the vertical sides should be protected by a geotextile
Below-ground system	Impermeable liner required in free-draining *in situ* subsoils
Base sealing	No sealer required. Ground base layer in mound systems to be ploughed/tilled[5]
Covering	Geotextile over the gravel distribution layer 300 mm topsoil over geotextile

[1]Greater thickness may apply – consult the groundwater protection response.
[2]If constructing a mound system then the imported subsoil should have an *in-situ* T-value between 3 and 30.
[3]Due to variations in the discharge rating of pumps available on the market, it is important to correctly match the orifice diameter and the lateral diameter in the distribution system to the pump, thus ensuring even and effective distribution of the hydraulic load across the filter area.
[4]The infiltration pipe should be laid with the holes facing downwards I.S. CEN/TR 12566-2:2005.
[5]In the case of mound systems, the base should be roughened to minimise compaction and smearing of the soil (I.S. CEN/TR 12566-2:2005).

- It may be raised with the distribution system above the normal ground level.

8.2 Sand Filter Systems

Intermittent sand filters are an effective form of on-site treatment. The wastewater treatment takes place under predominantly unsaturated and aerobic conditions.

Two types of intermittent sand filters are used, namely, soil covered and open.

1. Soil-covered intermittent sand filters may be underground, part underground and part overground (Fig. 8.4) or overground. The latter two constructions are commonly referred to as mound systems. Maintenance is an issue and needs to be considered in the selection process.

2. Open intermittent sand filters are constructed similar to the covered sand filters, but without the soil cover, i.e. the gravel distribution layer is exposed at the surface to allow for inspection and periodic maintenance. They are preferably underground with the top of the gravel at ground surface.

Intermittent sand filters are single-pass slow sand filters, which support biofilms. Typical design details are shown in Table 8.2. They consist of a number of beds of graded sand commonly 700–900 mm deep, underlain normally by a layer of filter gravel about 200-mm thick to prevent outwash or piping of the sand. A stratified sand filter is illustrated in Fig. 8.5 (Nichols *et al*., 1997). Phosphorus removal is dependent on sand mineralogy; it should be noted that the ability of any sand to remove phosphorus is finite (Zhu *et al*., 2003).

Even distribution across the entire surface area of the intermittent sand filter is critical. In soil-covered filters, a non-clogging geotextile is used to separate the soil cover from the distribution gravel. The wastewater from the septic tank flows through the sand bed where it is treated.

In a soil-covered filter, both the distribution gravel over the sand and the drain filter gravel (where present) under the sand are vented; the vents are extended vertically above ground or mound level and capped with a cowl or grid. In an open filter only the drain filter gravel (where present) is vented.

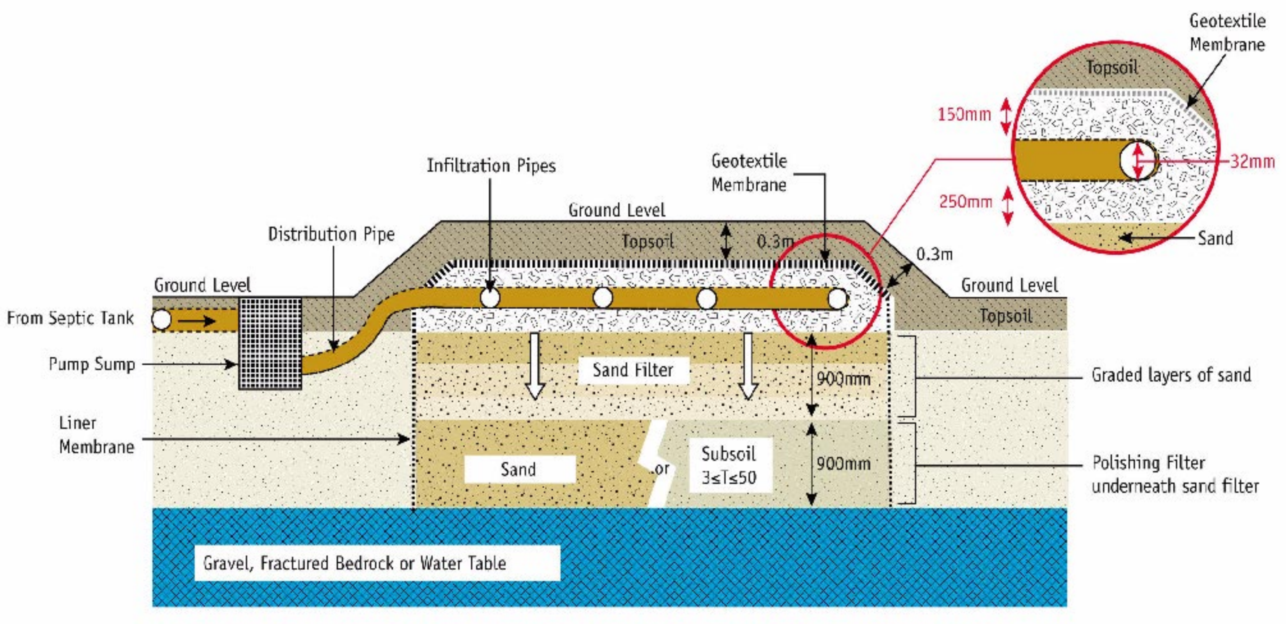


FIGURE 8.4. INTERMITTENT SAND FILTER SYSTEM WITH UNDERLYING SAND/SUBSOIL POLISHING FILTER.

TABLE 8.2. SAND FILTER REQUIREMENTS.

Sand filter characteristics	Requirements
Minimum sand thickness	0.7–0.9 m
Sand grain sizes	Soil covered – D_{10} range from 0.7 to 1.0 mm Open filters – D_{10} range from 0.4 to 1.0 mm Uniformity coefficients (D_{60}/D_{10}) less than 4
Hydraulic loading	20 l /m^2/day (based on plan area) if 3 < P/T < 20 10 l /m^2/day (based on plan area) if 21< P/T< 75
Design criteria[1]	
Sand layers	A number of beds of graded sand
Gravel protection layer	150 mm of 8- to 32-mm washed gravel
Infiltration laterals	32 mm ∅ PVC with 4- to 6-mm orifices[2] at 0.3-m spacings
Gravel distribution layer	250 mm of 8- to 32-mm washed gravel
Lateral centres separation	0.6 m
Underdrain/Collection system (required where T > 90 and required to discharge to surface water or offset polishing filter is proposed)	Washed durable gravel or stone 8–32 mm Slotted or perforated drain pipe ∅ 75–100 mm Slope 0–1%
Dosing frequency (controlled by on/off levels on pump)	Minimum of four times per day (at equal time intervals for optimum treatment efficiency)
Pumping system	Pumps should be installed in a separate pumping chamber and only suitable wastewater treatment pumps with a minimum free passage of 10 mm should be used
Side sealing	
Mound system	Topsoil on the top and the vertical sides should be protected by a geotextile
Below-ground system	Impermeable liner in free-draining *in situ* subsoils
Base sealing	
Offset polishing filter	Impervious soil or synthetic liner with collection system
Covering	
Soil covered	Geotextile (in accordance with EN ISO 10319) over the gravel distribution layer and 300 mm topsoil over geotextile
Open	None
Venting	
Soil covered	Both distribution gravel and drain filter gravel are vented
Open filter	Drain filter gravel is vented
Access/Inspection points	Recommended to be installed in the distribution system for rodding/scouring purposes

[1]Due to variations in the discharge rating of pumps available on the market, it is important to correctly match the orifice diameter and the lateral diameter in the distribution system to the pump, thus ensuring even and effective distribution of the hydraulic load across the filter area.
[2]The infiltration pipe should be laid with the holes facing downwards I.S. CEN/TR 12566-2:2005.

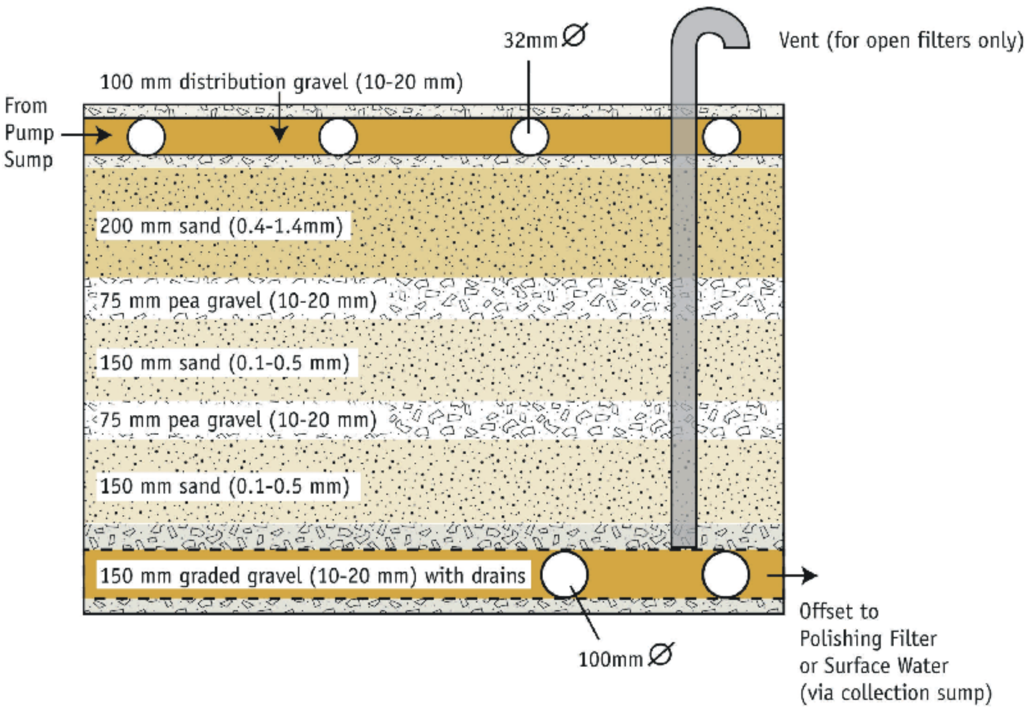


FIGURE 8.5. SCHEMATIC CROSS SECTION OF STRATIFIED SAND FILTER.

8.3 Drainage and Sealing of Filter Systems

In the case of overground intermittent filters, the collector drains to remove the filtrate are excavated into the top of the impervious layer at appropriate spacings and drainage pipes are laid and backfilled with filter gravel to original ground surface. The treated effluent should be collected in a collection chamber and discharged to a polishing filter or to surface water in accordance with a licence. The discharge of filtrate to surface water requires a water pollution discharge licence.

An impermeable liner is used to seal off the sides of the intermittent filter to prevent possible bypass into gravelly soil when the filter is underground; this bypass could occur when a flooding dose is applied to the distribution gravel. Where the polishing filter is offset, the entire intermittent filter should be enclosed (Fig. 8.6) in a leak-proof liner.

8.4 Mounded Intermittent Filter Systems

Where shallow bedrock or a high water table exists, a mounded intermittent soil or sand filter as illustrated in Fig. 8.7 may provide the required solution to the on-site treatment of wastewater.

At a minimum, the following site conditions should exist:

- There is at least 0.3 m of naturally occurring soil above the bedrock.
- The maximum high groundwater level is at least 0.3 m below the natural ground surface.
- The slope of the original ground surface over the proposed site does not exceed 1:8 (or 12%).
- The percolation test results for the underlying subsoil are within the acceptable range ($3 \leq T \leq 75$) or, where shallow bedrock is present, an assessment showing that the site can absorb the hydraulic load.

In the case of a soil filter, the following procedure should be followed:

- Where soil ($10 < T < 30$) has to be imported, it should be placed in lifts in the proposed percolation area such that there is

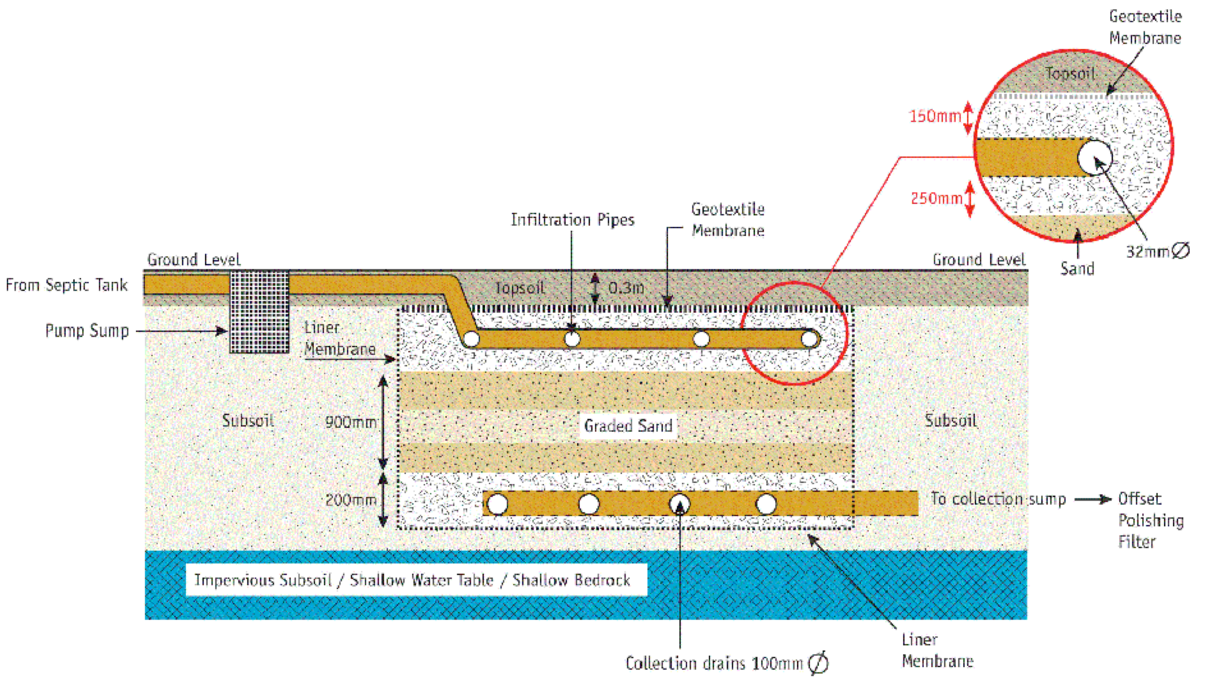


FIGURE 8.6. INTERMITTENT SAND FILTER OVERLYING IMPERVIOUS SUBSOIL/BEDROCK WITH OFFSET POLISHING FILTER.

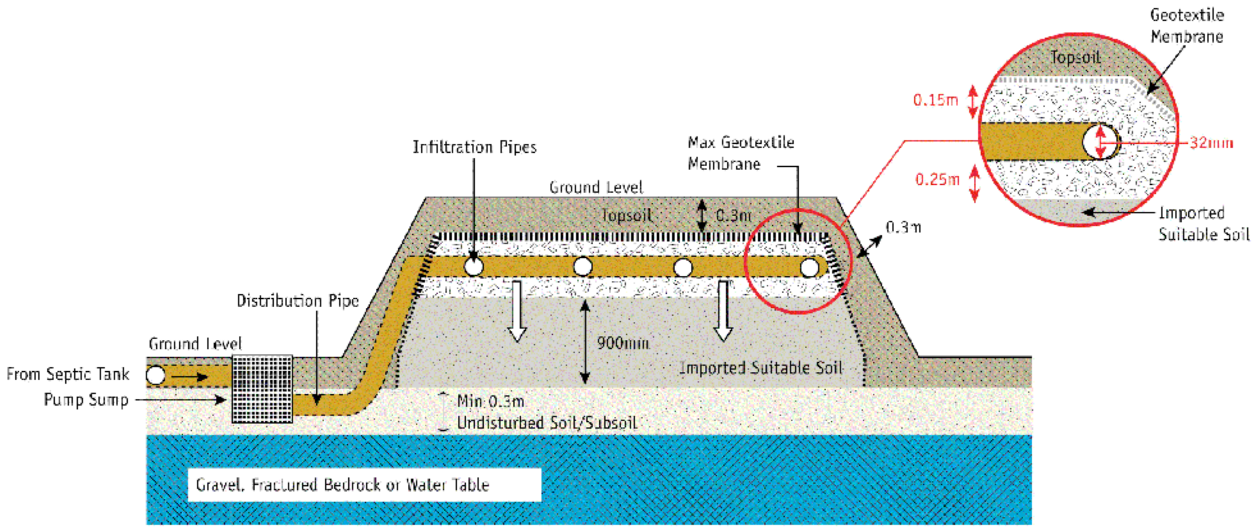


FIGURE 8.7. INTERMITTENT SOIL FILTER (ABOVE GROUND).

a minimum thickness of 1.2 m of unsaturated soil with drainage over the bedrock. The fill should be placed in layers not exceeding 300-mm thick and lightly compacted. Care should be taken not to over-compact the soil as this will lead to ponding.

- After each lift is placed, percolation tests should be carried out. A 150-mm square hole is excavated to a depth of 150 mm in the placed soil. After pre-soaking to completely wet the soil, 0.5 l of water is poured into the hole and the time in minutes for the water to soak away is recorded. This time should be between 10 min and 2 h.

Where soil filling is not feasible, a sand filter system may be considered in accordance with criteria in Table 8.2 or alternative systems followed by a polishing filter may be suitable.

It may, depending on site conditions, be necessary to pump the septic tank effluent to a higher level before distribution over the infiltration area. There are two options for distribution of the septic tank effluent: dosing using a pumped distribution system (Fig. 8.1 and Table 8.1) or by pumping to a distribution chamber and then use a gravity-fed system (Tables 7.2 and 7.3).

In the case of a gravity system, it is recommended to pump the effluent to a stilling chamber from where the effluent flows by gravity to a distribution device (as in Section 11). In this case, the length of gravity pipe from the stilling chamber to the box should be greater than 3 m. The effluent from the septic tank should not be pumped to an elevated distribution device and then gravity fed on the top of the mound. Pumping to a distribution device will not allow for even distribution of the effluent; however, pumping to a sump/stilling chamber, which then discharges to a distribution device, may be acceptable. The pumping chamber should be fitted with a high-level alarm to alert the homeowner to a possible pump failure or blocked distribution pipework, and vertical monitoring tubes (piezometers) should be inserted to determine if the mound starts to become saturated and to back up (see Section 12 on maintenance).

8.5 Application of Wastewater to Filter Systems

The wastewater from the on-site wastewater treatment system should be applied uniformly to the surface of the filter at intervals such that the wastewater percolates down through the complete surface area of the filter at a rate that optimises distribution (and treatment) onto the biofilm coating the media. Even distribution may be obtained by pumping the wastewater through evenly spaced lateral pipes with evenly spaced orifices embedded in distribution gravel, as detailed in Tables 8.1 and 8.2. Dosing frequencies are related to the type of filter medium. A minimum dosing frequency of four times daily is recommended, which should ideally be applied at equal intervals by means of a timer. Dosing tanks (pump sumps) should be sized according to the volume of effluent production equivalent to one day's volume from the household.

Other configurations and design distribution system specifications, such as rigid pipe pressure networks, may be considered on a case-by-case basis. The design should be in accordance with best practice and in line with published design manuals.

8.6 Constructed Wetlands

Constructed wetland is the generic term used to describe both (gravel- and sand-based) horizontal and vertical flow reed bed systems and soil-based constructed wetlands. A constructed wetland (a form of filter system) is another option for the treatment of wastewater from a septic tank. The main difference between a constructed wetland and other filter systems is the planting of vegetation in the media where the thick root mass acts as a pathway for the transfer of oxygen from the atmosphere to the root zone (rhizosphere).

Plants used are emergent macrophytes, the most notable of which is the common reed (*Phragmites australis).* Other plants species used are *Iris, Typha*, *Sparganium, Carex, Schoenoplectus* and *Acorus.* Planting should occur in blocks of plant species at a density of four to five plants per metre squared. A mixing of plant species is also encouraged to promote diversification in the system. Constructed wetlands can be designed to fit aesthetically within the landscape.

The mechanism and characteristics of each individual reed bed type play an important role in their treatment performance. The most common type of reed bed is the subsurface horizontal flow reed bed (i.e. a subsurface flow system, SFS) where the wastewater is maintained below the surface of the wetland media. It can further be subdivided depending on medium selection and direction of flow:

- Horizontal flow reed beds (with gravel)
- Vertical flow reed beds (with gravel)
- Vertical flow reed beds (with sand).

In a horizontal flow reed bed, wastewater is introduced at one end of a flat to gently sloping bed of reeds (slope 1–2%) and flows across the bed to the outlet pipe. This adjustable discharge outlet controls the level of the water in the horizontal flow reed bed. Particular attention should be paid to the bed's hydraulic distribution with respect to inlet configuration and aspect ratio. Horizontal subsurface flow reed beds are regarded as especially good in the removal of BOD_5, SS and pathogenic organisms. Figure 8.8 illustrates a typical gravel-based horizontal subsurface flow reed bed.

In a vertical flow reed bed, wastewater is intermittently dosed uniformly over the media bed on an intermittent basis by a network of pressurised distribution pipes. It gradually drains vertically into a drainage collection network at the base of the support media. These drainage pipes should be aerated by means of a perforated ventilation pipe extending into the atmosphere. As the wastewater drains vertically, air re-enters the pores of the media, thus maintaining the aerobic conditions in the filter media and aiding the treatment. As a result, vertical flow reed bed systems are much more effective than horizontal flow reed beds not only in reducing BOD_5 and SS levels but also in nitrifying ammonia nitrogen to nitrate. The media used in a vertical flow reed bed can be sand or gravel or a mixture of both. Figure 8.9 illustrates a typical cross section of a vertical flow reed bed with a mixture of sand and gravel.

A soil-based constructed wetland may also be described as a free water surface (FWS) constructed wetland as the surface of the wastewater is at or above the surface of the support media. These systems promote more superior ecological diversity and aesthetics than their reed bed counterparts but need to be significantly larger to provide the same degree of treatment as their subsurface counterparts. A reduction in BOD_5 and SS is provided through sedimentation and filtration.

Hybrid reed bed systems are the most efficient at removing all contaminants and normally incorporate one or two stages of vertical flow, followed by one or more stages of horizontal flow in series, and may be designed to achieve higher treatment efficiency. These are particularly suitable for total-N removal, as well as organic reduction and pathogen removal.

In the case of both reed bed systems and soil-based constructed wetlands they should be sealed by a synthetic or geotextile clay liner or a natural clay liner (permeability $k = 1.0 \times 10^{-8}$ m/s). Only wastewater and grey water from the septic tank (or secondary treatment system)

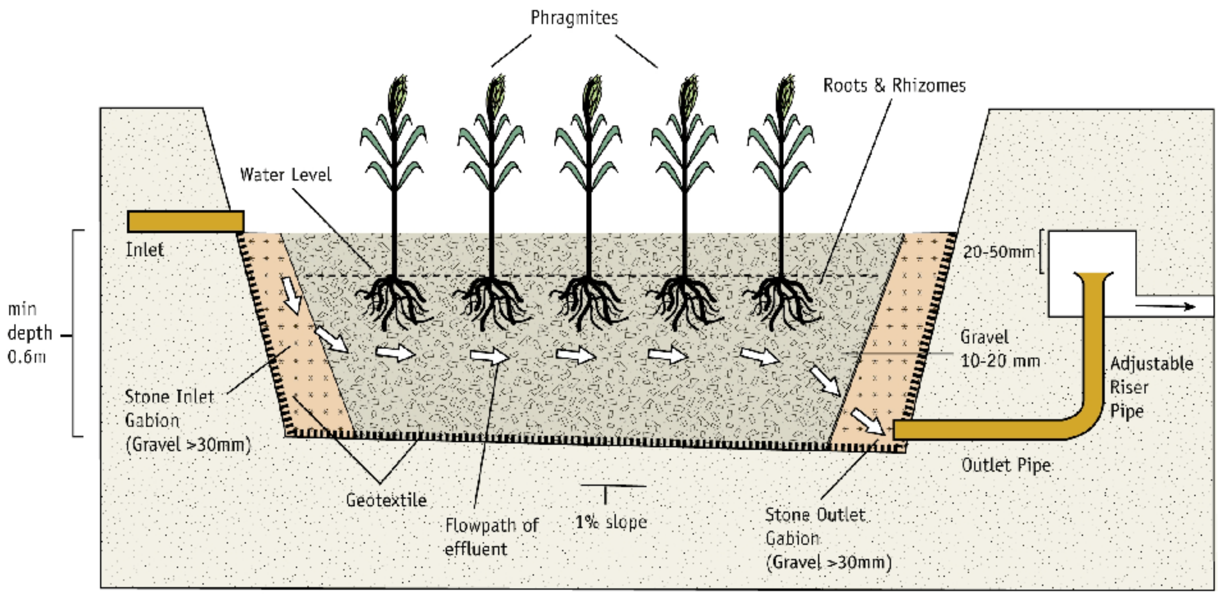


FIGURE 8.8. HORIZONTAL SUBSURFACE FLOW REED BED.

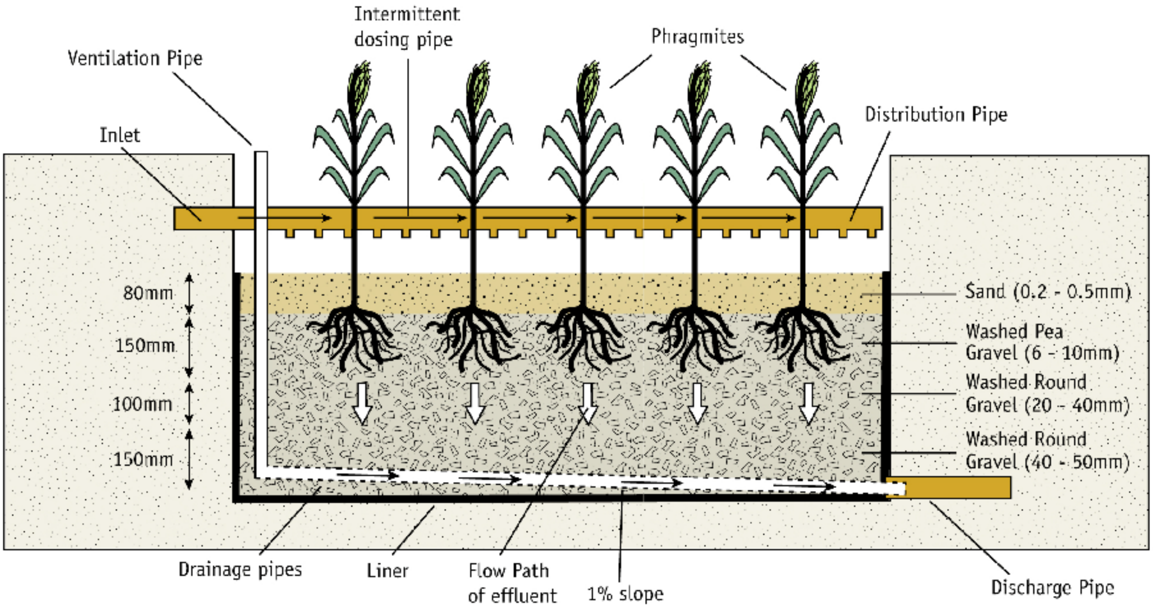


FIGURE 8.9. VERTICAL SUBSURFACE FLOW REED BED.

should be allowed to enter the wetland, i.e. no collected rainwater or surface water is permitted. In all cases these wetland systems should be fenced off or landscaped to prevent any unauthorised access particularly by children or animals.

The design of a reed bed or soil-based constructed wetland is site specific. A competent person should undertake the design and installation of a constructed wetland. The following provides general guidance on these types of systems but does not give all possible design options. The guidance EN 12566 *Small Wastewater Treatment Systems for up to 50 PT – Part 5: Pre-Treated Effluent Filtration Systems* refers to constructed wetlands and reed beds as open filters with reeds. I.S. CEN/TR 12566-5:2008 is a useful reference for further details on reed bed systems but a specialist should always be consulted. All constructed wetlands require periodic maintenance, which is detailed in Section 11.

8.6.1 Design Considerations

All constructed wetlands should be designed for a minimum of 5 p.e. for use as secondary wastewater treatment systems. Other design considerations are included in Table 8.3. The sizing of these treatment systems is ultimately dependent on the quality of the receiving water

TABLE 8.3. CRITERIA FOR CONSTRUCTED WETLAND SYSTEMS RECEIVING SEPTIC TANK EFFLUENT.

System type	Area required	Minimum system size	Loading rates	Length/Width ratio
Horizontal flow reed bed – gravel (SFS)	5 m^2/p.e.	25 m^2	–	3:1
Vertical flow reed bed – gravel (SFS)	1.5–3 m^2/p.e.	15 m^2	8 l/m^2 per dose (maximum)	2.5:1
Vertical flow reed bed – sand (SFS)	5–6 m^2/p.e.	25 m^2	5–15 l/m^2 per dose for 2–5 doses per day	2.5:1
Soil-based constructed wetland (FWS)	20 m^2/p.e.	100 m^2	–	5:1

and therefore increased sizes are required in nutrient-sensitive areas.

For systems on sloping ground, it can be beneficial to divide the required bed area into a number of smaller beds. Multiple beds necessitate additional controls, but increase flexibility of use and enable resting and maintenance of beds to be more easily carried out. Other treatment equipment, e.g. storage ponds, maturation ponds, willows, etc., may be added to the system to enhance further treatment. The landscape setting may influence the design of these systems to provide secondary or tertiary treatment of wastewater.

A polishing filter should follow these systems when the disposal route for the secondary-treated effluent is to groundwater. In the case where these systems discharge directly to surface water, a Water Pollution Act discharge licence is required.

9 Secondary Treatment: Packaged Wastewater Systems

Packaged wastewater systems use media and mechanical parts to enhance the treatment of domestic wastewater. As with filter systems, they require a polishing filter to allow for further treatment of the wastewater and to convey the treated wastewater to groundwater. These systems should be certified to specific performance criteria and may be suitable in areas where a septic tank is not acceptable. The code of practice provides general guidance on the location, design, installation and maintenance of these systems.

A treatment system should meet the requirements of I.S. EN 12566-3:2005 *Small Wastewater Treatment Systems for up to 50 PT – Part 3: Packaged and/or Site Assembled Domestic Wastewater Treatment Plants* and be followed by a disposal system meeting the requirements of I.S. CEN/TR 12566-2:2005 or I.S. CEN/TR 12566-5:2008 or as per the guidance provided within this CoP. Packaged wastewater systems may be used to treat wastewater from a dwelling house. The effluent from all packaged systems should be treated on a polishing filter where the final discharge is to groundwater, or a treatment system could also comprise a product meeting the requirements of I.S. EN 12566-3:2005, followed by a reed bed or system meeting the requirements of prEN 12566-7 with demonstrated performance requirements producing the required effluent quality for direct disposal to surface water with an appropriate discharge licence.

Many systems are available on the market and include the following generic treatment processes:

- Activated sludge (incl. extended aeration) systems
- Biological/Submerged aerated filter (BAF/SAF) systems
- Rotating biological contactor (RBC) systems
- Sequencing batch reactor (SBR) systems
- Peat filter media systems
- Plastic, textile and other media systems
- Membrane bioreactor (MBR) systems.

Where such products are used they should conform to the relevant Part of the EN 12566 series of standards. prEN 12566-6 and prEN 12566-7 are in preparation and will deal with the performance characteristics of prefabricated filters. Where the relevant part of EN 12566 is not yet available, products should be certified (certification may include a European Technical Approval, an Agrément Certificate or equivalent), be fit for the purpose for which they are intended, the conditions in which they are used and meet the performance requirements of this CoP.

Packaged wastewater treatment systems comprise several components some of which are mechanical and/or electrical. These systems require regular monitoring and maintenance. Generally such systems produce a higher-quality effluent in terms of organics and micro-organisms as compared with septic tank systems. Mechanical systems are often more sensitive to grease loading so the use of a grease trap may be recommended. Their sludge storage capacity should be checked with the manufacturer at the time of purchase to establish the necessary frequency of de-sludging. It is recommended that the tank should have the capacity to store at least 1 year's sludge production and be de-sludged once per year. All wastewater treatment systems should be provided with an alarm to indicate operation failure in line with the requirements of I.S. EN 12566-3:2005.

9.1 Location of Packaged Wastewater Systems

Recommended minimum distances of separation of packaged wastewater treatment systems and infiltration areas should be as listed earlier in Table 6.1. The recommended minimum distances from wells should satisfy the requirements of the GWPR (see Annex B), which should have been consulted as part of the site characterisation. The GWPRs may also necessitate that subsoil depths for polishing filters/infiltration systems in excess of those indicated in this CoP may be required.

9.2 Biological Aerated Filter (BAF) Systems

A BAF system may consist of a primary settlement tank, an aerated submerged biofilm filter and a secondary settlement tank (Fig. 9.1). Solids are sometimes returned from the secondary settlement chamber to the primary settlement chamber to facilitate de-sludging and to avoid sludge rising due to de-nitrification. Normally BAF systems, which are used to treat wastewater from single dwellings, can be purchased as prefabricated units, with all chambers in one unit. BAF systems are normally constructed in glass-reinforced plastic, concrete or steel.

The micro-organisms are attached to the filter media in the secondary treatment stage. The media normally have a high specific surface area (m^2/m^3) and can consist of plastic modules or a granular material. Where granular media are used the system may require backwashing to prevent clogging of pore spaces.

Normally the BAF system provides carbonaceous oxidation but can be designed to provide nitrification. Grease should not be allowed to enter the aerated zone.

9.3 Rotating Biological Contactor (RBC) Systems

An RBC system consists of a primary settlement tank, a secondary treatment compartment and a secondary settlement tank (Fig. 9.2). In this system the micro-organisms are attached to an inert media surface (the disc) and the inert media are mounted on a shaft that is rotated by an electric motor. These media are partially submerged in the wastewater. A biofilm develops on the media over time; it is this biofilm that treats the

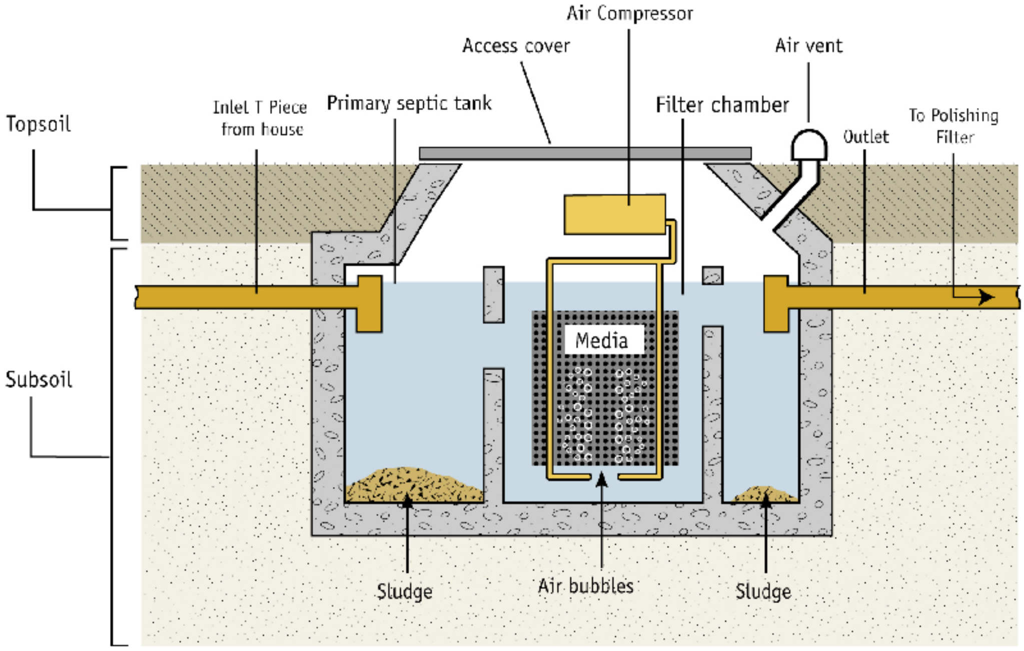


FIGURE 9.1. SCHEMATIC OF A BIOLOGICAL AERATED FILTER SYSTEM (BAF).

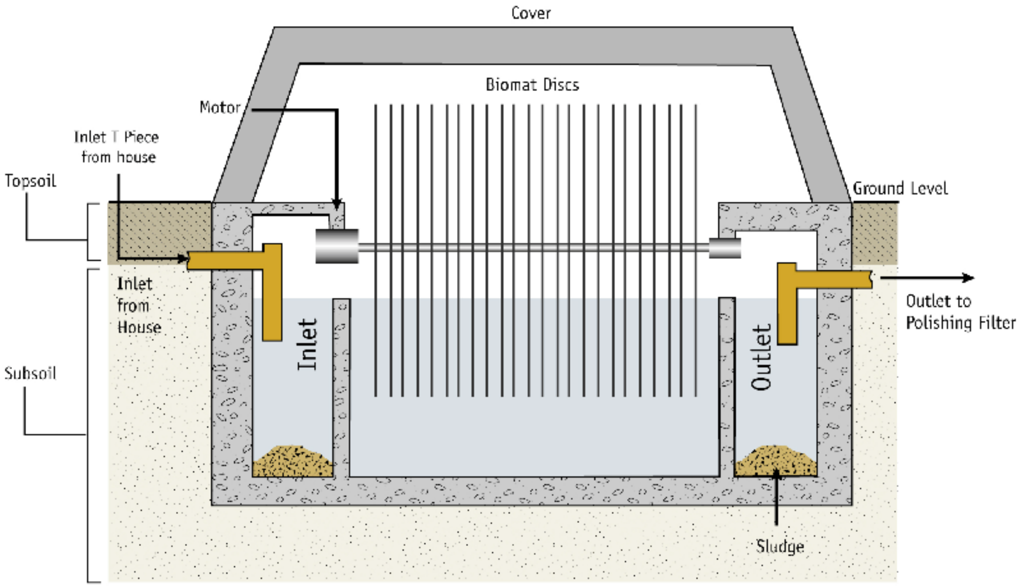


FIGURE 9.2. SCHEMATIC OF A ROTATING BIOLOGICAL CONTACTOR (RBC) SYSTEM.

wastewater. The settled sludge in the secondary settlement tank is sometimes returned to the primary settlement tank. RBC units can be purchased as packaged treatment units for single dwellings; these units normally contain all three compartments in one unit. Grease should not be allowed to enter the contactor zone.

9.4 Sequencing Batch Reactor System (SBR)

The SBR (Fig. 9.3) process is a form of activated sludge treatment in which aeration, settlement, and decanting can occur in a single reactor. The process employs a five-stage cycle: fill, react, settle, empty and rest. Wastewater enters the reactor during the fill stage; typically, it is aerobically treated in the react stage; the biomass settles in the settle stage; the supernatant is decanted during the empty stage; sludge is withdrawn from the reactor during the rest stage; and the cycle commences again with a new fill stage. For single-house systems, a primary settlement tank precedes the reactor. Grease should not be allowed to enter the reactor.

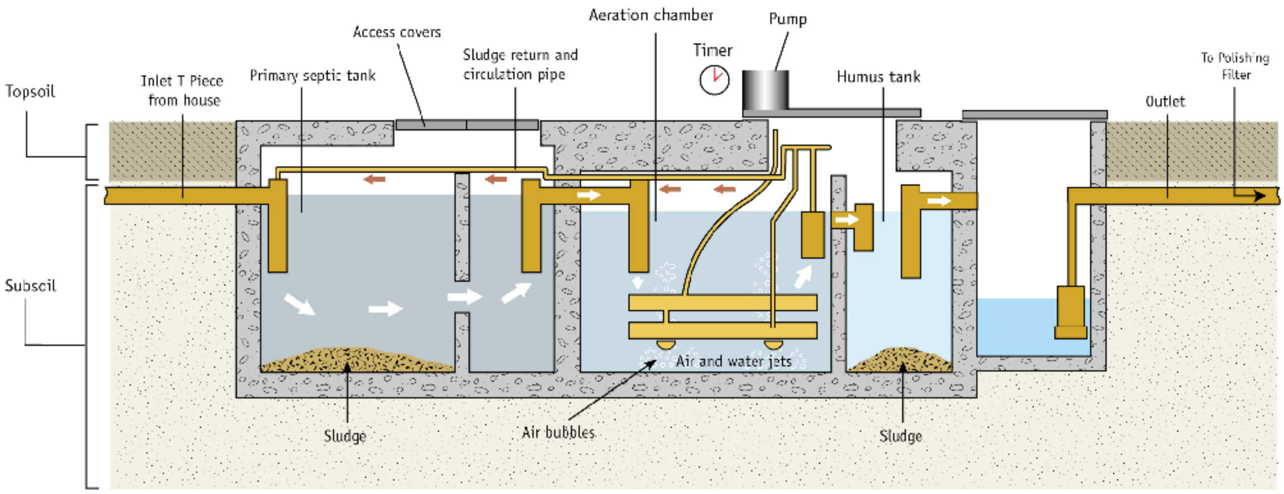


FIGURE 9.3. SCHEMATIC OF A SEQUENCING BATCH REACTOR (SBR) SYSTEM.

The successful operation of an SBR system is dependent on the reliable performance of a timing mechanism. It is important that regular checks be made to ensure that the treatment sequencing is occurring as designed.

Critical components of an SBR system include the aeration/mixing process, the decant process, and the control process. SBRs can be modified to improve the removal of nitrogen and phosphorus.

Since the SBR system provides batch treatment of wastewater, it can accommodate wide variations in flow rates that are typically associated with single houses.

9.5 Membrane Filtration Systems

Membrane filtration systems treat effluent by the removal of both suspended solids and dissolved molecular material from the effluent as it passes across a specific membrane material (Fig. 9.4). The system utilises a treatment tank with aeration and membrane filtration units. These systems usually produce very high quality effluents. The special membrane used is mounted on a support frame and, in order for the effluent to progress from the inlet end of the system to the outlet end, it should pass through the membrane unit. Aeration equipment fitted within the treatment unit performs a dual function – aerobic conditions are maintained and the membrane is constantly cleaned by the passage of air over its surface.

The integrity of the membrane filter fabric is critical to the proper operation of the system. Membrane failure is usually determined by light transmittance instrumentation and an associated alarm mechanism. The membrane fabric should be subjected to regular maintenance/repair and inspected for damage as the latter will impede performance.

These systems need to be cleaned (the frequency of which is determined by way of a pressure differential detector) and, according to the current industry standard, replaced once every 10 years on average.

9.6 Media Filter Systems

9.6.1 *Peat media filter systems*

Fibrous peat filters are used as intermittent open filters to treat septic tank wastewater (Fig. 9.5). A peat filter typically consists of a distribution system, the peat treatment media and a drain. Septic tank wastewater is

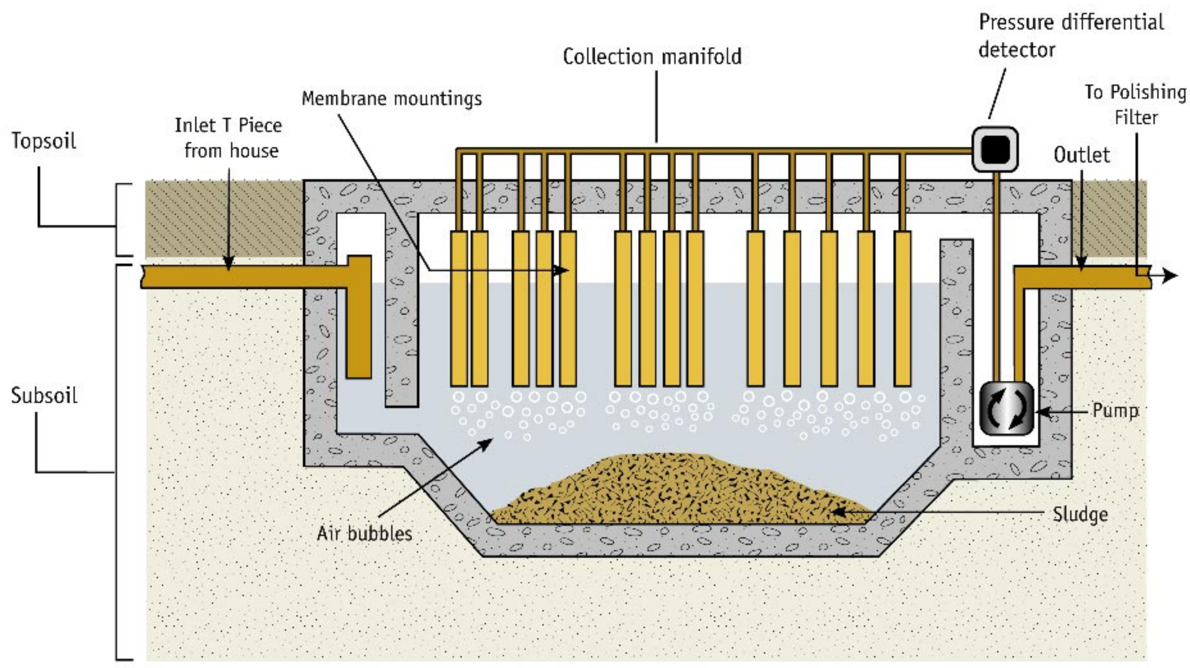


FIGURE 9.4. SCHEMATIC LAYOUT OF A MEMBRANE FILTRATION SYSTEM.

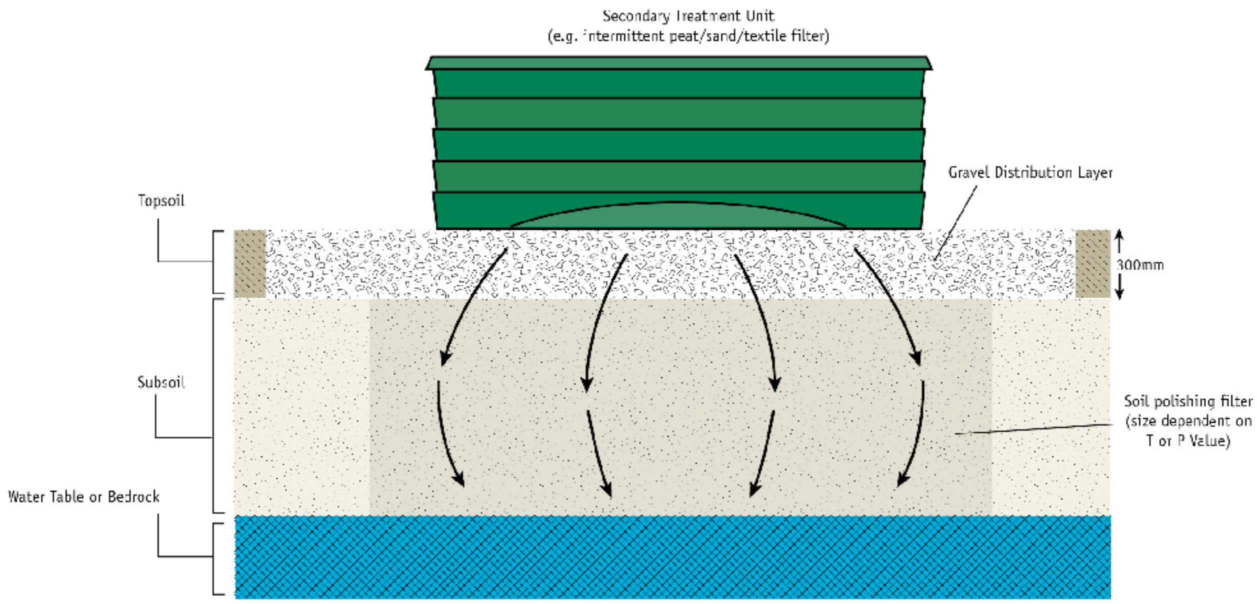


FIGURE 9.5. SCHEMATIC OF A PACKAGED PEAT FILTER SYSTEM.

intermittently dosed evenly, *via* a pipe distribution network fitted with orifices, onto the top peat media. The effluent then percolates through the peat, receiving treatment by passive biofiltration processes (filtration, absorption, adsorption, ion exchange, microbial assimilation). Peat is polar, has a high surface area and a highly porous structure. In addition, the low pH of the peat media, its trace hydrocarbons and indigenous microflora have some anti-microbial properties. Each module of a modular unit should be provided with a cover.

The hydraulic loading rate on peat filters may vary depending on the type of peat employed. Commercially available fibrous peat filter systems are designed at hydraulic loading rates in excess of 100 l/m^2/day but they require a polishing filter prior to discharge to ground.

9.6.2 Other media filter systems

Other intermittent media filter systems may come on the market in the future, for example textile filters. Where such products are used they should conform to the relevant part of EN 12566. prEN 12566-6 and prEN 12566-7 are in preparation and will deal with the performance characteristics of prefabricated filters. Where the relevant Part of EN 12566 is not yet available, products should be certified (certification may include a European Technical Approval, an Agrément Certificate or equivalent), be fit for the purpose for which they are intended, the conditions in which they are used and meet the performance requirements of this CoP.

9.7 Other Treatment Systems

Other treatment systems may be introduced from time to time to treat wastewater. Such systems include other activated sludge systems, SAFs, other membrane bioreactors or composting units. Such products should comply with I.S. EN 12566-3:2005.

The treated wastewater from packaged systems should be treated in a polishing filter system, the primary purpose of which is to reduce micro-organism numbers in the treated wastewater. If the packaged wastewater treatment system is poorly maintained and operated outside of optimal conditions the polishing filter may clog and fail to function properly leading to water pollution.

For guidance on the proper design and the issues to be considered in the establishment of a polishing filter refer to Section 10. A typical layout for the treatment of wastewater using a packaged wastewater treatment system is illustrated in Fig. 9.6.

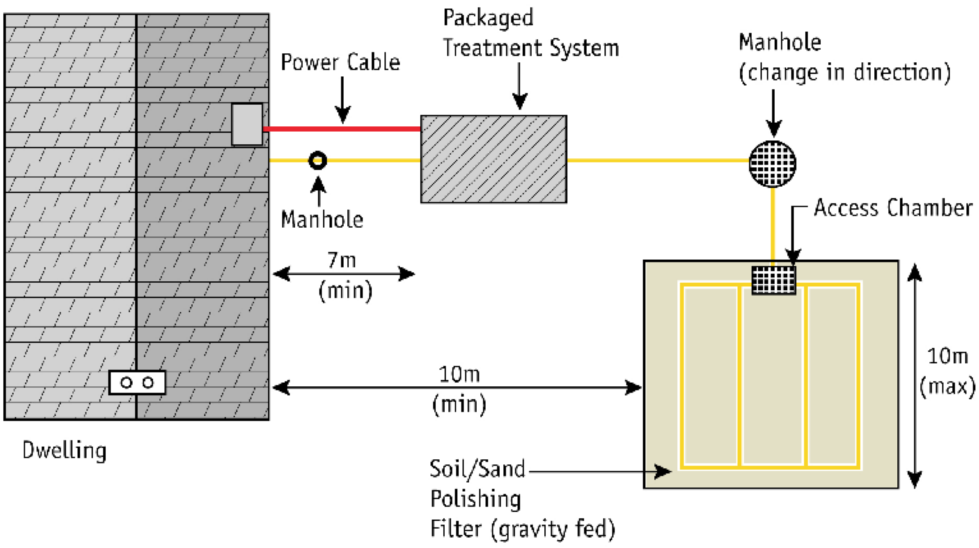


FIGURE 9.6. ILLUSTRATION OF A PACKAGE SYSTEM AND POLISHING FILTER SYSTEM.

10 Tertiary Treatment Systems

Tertiary treatment systems provide additional treatment to wastewater from secondary treatment systems. Polishing filters can reduce the number of micro-organisms present in the treated wastewater while other packaged tertiary treatment systems can further reduce nutrients and micro-organisms. The treatment standards to be achieved by these systems are dependent on the sensitivity of the receiving waters. As with all treatment systems they should to be sited, installed and maintained in accordance with the guidance in the code of practice and manufacturer's documentation.

The term tertiary treatment system includes polishing filters and packaged tertiary treatment systems. This section deals primarily with polishing filters, which provide a dual function of polishing the effluent and also disposing of the treated effluent into groundwater and surface water.

10.1 Polishing Filters

All filter systems (with the exception of soil filters), constructed wetlands and packaged wastewater systems require a polishing filter (also known as a type of infiltration system) following the secondary treatment stage. The polishing filter can reduce micro-organisms and phosphorus (depending on soil type) in otherwise high-quality wastewater effluents. However, it should be noted that the phosphorus adoption capacity of any polishing filter medium will become saturated with time and its removal efficiency will reduce. The long-term effectiveness of the media should be assessed and monitored where the filter is being used to reduce phosphorus (Zhu *et al.*, 2003).

All polishing filters should have a minimum thickness of 0.9 m of free-draining unsaturated soil or sand between the point of infiltration of the effluent and the water table and bedrock. They may be below, at ground surface or partially or totally above ground surface.

The polishing filter produces a high quality effluent as it contains a reduced organic load from secondary treatment systems compared with septic tank systems, and thus the biomat is less developed. This results in shorter trench lengths and overall area for polishing filters. The advice provided above allows effluent from a polishing filter to discharge to ground provided the subsoil has a T-value <90 and a P-value between 3 and 75. The maximum pipe length is 10 m for gravity-fed systems.

Where the native soil at the site is impervious, a graded gravel layer with drains should underlie the polishing filter and the polished wastewater is then drained away in a suitable manner using a gravity or pumped sump arrangement to a watercourse (in accordance with a Water Pollution Act discharge licence).

Where a polishing filter is constructed overground or in contact with a very permeable gravel or sand stratum in the soil and is pressure dosed into surface distribution gravel, the sides of the filter should be enclosed by an impervious liner to prevent bypass of flooding doses directly to the ground surface or groundwater.

Other types of infiltration systems may be used as polishing filters if they comply with the requirements referred to in Section 7.2.4. The location and installation of infiltration systems are discussed in Section 11.

10.1.1 Soil polishing filters

Soil polishing filters may comprise *in situ* soil, improved soil and/or imported soil. These soils, which should have a minimum depth of 0.9 m, should have percolation values in the range of 3–75 for *in situ* material and a P/T-value of 3–30 for imported material. Effluent may be loaded onto a soil-polishing filter by any one of three arrangements (direct discharge, pumped discharge or gravity pipe discharge).

In typical layouts the soil polishing filter:

- May underlie an intermittent filter with the effluent being spread out over a shallow distribution gravel layer immediately underlying the filter; any exposed polishing filter area may be soil covered and grassed (Option 1)
- May be offset from a secondary treatment unit; loading may be by a pumped arrangement (Option 2); the entire filter may be covered with soil and graded down, and
- May be offset from the secondary treatment system; loading may be fed by gravity into percolation trenches (Option 3).

Recommended loading rates and design values for a five-person house are given in Table 10.1. Areas and lengths for other person numbers are *pro rata*, e.g. the requirements for a 10-person house will be twice that of a five-person house.

a) Option 1 – Direct discharge

Direct discharge occurs where the treatment plant lies directly above the polishing filter and is distributed using a shallow distribution gravel and with direct discharge from the polishing filter to groundwater (Fig. 9.5). The loading rates on the soil should conform to those recommended in Table 10.1.

b) Option 2 – Pumped discharge

The treated wastewater from the secondary treatment unit is pumped to a manifold and percolation pipes using typically 32 mm ∅ laterals with 4–6 mm ∅ orifices (0.6 m apart) at 0.6 m spacing between laterals facing downwards over a 250-mm layer of gravel. The detail design should conform to best practice as outlined in design manuals. The loading rates should conform to those listed in Table 10.1.

c) Option 3 – Gravity discharge

In the case of loading a percolation area with a P/T-value of 3–75 through percolation trenches a greater area of polishing filter than for Options 1 and 2 is required. The length of percolation trench in a polishing filter for secondary-treated wastewater from a five-person household for the different percolation values is shown in Table 10.1 (see Fig. 9.6). Treated wastewater from the secondary filter should flow by gravity to a distribution box, which distributes the flow evenly into the several trenches which should be 500 mm wide at 2-m spacing (2.5 m centre to centre) and designed according to the criteria given in Table 7.3, with the exception that the maximum length of each trench should not exceed 10 m.

10.1.2 Sand polishing filters

Sand polishing filters comprise single layer and stratified sand filters; they should be a minimum of 900 mm in thickness. In a typical layout, three layers of sand, comprising an upper layer of coarse sand and intermediate and lower layers of fine sand, are separated from each other by a thin layer of washed pea-sized gravel or broken stone. The hydraulic loading should not exceed 60 l/m^2/day. The sand-polishing filter can be soil covered and sown with grass.

The filter specifications of the range of sands suitable for the polishing filter sand layers are shown in Table 10.2. Where the filter is soil

Table 10.1. Minimum soil polishing filter areas and percolation trench lengths required for a five-person house.

P/T-values[1]	Direct and pumped discharge (Options 1 and 2)		Percolation trench discharge (500 mm wide) (Option 3)	
	Loading rate on plan area (l/m^2/day)	Area required for five persons (m^2)	Loading rate on trench area (l/m^2/day)	Trench length required for five persons (m)
3–20	≤20	≥37.5	≤50	≥30
21–40	≤10	≥75	≤25	≥60
41–50	≤5	≥150	≤25	≥60
51–75	≤3	≥250	≤16	≥94

[1]The loading rate is dependent on the percolation rate and in the case of an imported mound then the higher of the P-value of the *in-situ* subsoil and of the imported material should be used to size the polishing filter.

TABLE 10.2. CRITERIA FOR SAND-POLISHING FILTER.

Design factor	Design criteria
Pretreatment	Minimum of secondary treatment
Top coarse sand layer[1]	Effective size (D_{10}) 0.25–0.75 (mm); D_{60}/D_{10} (C_u) < 4
Fine sand layers	Effective size (D_{10}) 0.15–0.25 (mm); D_{60}/D_{10} (C_u) < 4

[1]USEPA (1999). Wastewater Technology Fact Sheet. *Intermittent Sand Filters*. EPA 832-F-99-067.

covered and sown with grass, sands at the upper end of the grading shown in Table 10.2 are recommended. Figure 8.5 is an example of a stratified sand filter that can also be used as a polishing filter.

10.2 Constructed Wetlands

Reed beds and constructed wetlands may also be used as tertiary treatment systems for domestic wastewater. They may include shallow vegetated surface flow wetlands. Refer to Section 8.6 for details on these systems. Table 10.3 provides recommendations for the design of wetland systems as tertiary treatment systems.

10.3 Packaged Tertiary Treatment Systems

Packaged tertiary treatment systems (where permitted) will be required in a nutrient-sensitive area or where the discharge is to surface water. There are a number of different types of tertiary treatment systems on the market. The type of system to be used is dependent on the site conditions, the level of secondary treatment and the requirements of the receiving waters. Tertiary treatment systems may provide removal of phosphorus, nitrogen and pathogens from secondary-treated effluent prior to discharge to the waterbody. Tertiary treatment systems include sand, peat or textile filters, packaged reed beds, ozone and UV disinfection systems, membrane filtration systems and specifically designed nutrient removal systems.

prEN 12566-7 will be concerned with tertiary packaged and/or site-assembled tertiary treatment units for the treatment of secondary effluent. It will be concerned with the requirement standards, test methods, marking, and evaluation of conformity for tertiary systems that have received secondary-treated effluent. The manufacturer of any system has to make a declaration as to the tertiary treatment efficiency of any packaged system.

Tertiary treatment systems, which form part of systems covered under I.S. EN 12566-3:2005 and prEN 12566-7, should conform to the requirements of those standards.

Where the standards are not yet available, products should be certified (certification may include a European Technical Approval, an Agrément Certificate or equivalent), be fit for the purpose for which they are intended, the conditions in which they are used and meet the performance requirements of this CoP.

TABLE 10.3. CRITERIA FOR TERTIARY TREATMENT.

System type	Area required[1]	Minimum system size	Loading rates	Length/Width ratio
Horizontal flow reed bed – gravel (SFS)	1 m^2/p.e.	5 m^2	–	3:1
Vertical flow reed bed – gravel (SFS)	1 m^2/p.e.	5 m^2	8 l/m^2 per dose (maximum)	Can vary (but must ensure equal distribution)
Vertical flow reed bed – sand (SFS)	3 m^2/p.e.	15 m^2	5–15 l/ m^2 per dose, for 2–5 doses per day	Can vary (but must ensure equal distribution)
Soil-based constructed wetland (FWS)	10 m^2/p.e.	50 m^2	–	5:1

[1]Greater sizing may be required when discharging to nutrient-sensitive waters.
SFS, subsurface flow system; FWS, free-water surface.

11 Construction and Installation Issues

Correct construction and installation of all wastewater treatment and disposal systems, including septic tanks, package systems and infiltration systems, are essential to ensure effective treatment of domestic wastewater. Homeowners are ultimately responsible for the operation and maintenance of their wastewater treatment system (Section 70 of the Water Services Act, 2007). However, the onus is on the owner or builder to construct and install the wastewater treatment system in accordance with the manufacturer's instructions, planning permission and any relevant conditions attached thereto, and building regulations, and for ensuring that the wastewater treatment and disposal systems comply with appropriate standards and guidelines.

All materials used in the construction of the works should comply with the requirements of the Building Regulations, 1991 (and subsequent amendments), and the relevant Technical Guidance Documents.

11.1 Septic Tanks and Pipework

Manufacturers should provide installation instructions with each septic tank, including details of data for plant installation, pipe connections, commissioning and start-up process, and these should be adhered to.

Recommended minimum distances of separation of septic tanks and percolation areas and filters from a variety of features are shown in Table 6.1 and in the GWPR.

Methods employed to test such tanks should be in accordance with I.S. EN 12566-1:2000/A1: 2004.

Septic tanks should be securely covered to prevent unauthorised access and ensure operational safety.

Provision should be made for access for a sludge tanker and maintenance equipment to de-sludge the tank. Care should be taken to ensure that septic tanks are not located where they may be subjected to loads from vehicular traffic movements.

The tank should rest on a uniform bearing surface and the underlying soils should be capable of bearing the weight of the tank and its contents. After setting the tank, levelling and joining the drains from the house and the tank outlet to the distribution box, the excavation around the tank can be backfilled. Backfilling should not proceed until the joints and the tank have been sealed and tested for water tightness. The backfill material should be free flowing and be added in lifts to ensure that the tank remains level. Backfilling around prefabricated tanks should be carried out in accordance with manufacturer's specifications and standard engineering practices.

Provisions should be made so that flotation of tanks does not occur either during construction or subsequent to commissioning of the treatment system.

If excessive quantities of waste oil and fats are likely to be disposed of in the effluent then the use of grease traps should be considered prior to installation.

Installation should be supervised and certified by a competent person and work documented for future evidence.

11.1.1 Drain from house to septic tank

The drain to the septic tank should be at least 100 mm in diameter. It may be of earthenware, concrete, uPVC or similar materials. It should be jointed to give a watertight seal and should be laid to the minimum gradients listed in Table 11.1.

It should be vented by means of a vent pipe above the eaves of the house. A manhole should be provided for rodding the drain (and at any change in drain direction) and should be located within 1 m of the septic tank. The drain should include, at an appropriate location, an access junction to facilitate a future connection to a sewer network.

11.1.2 Drain from septic tank to percolation area

The flow of the effluent from the septic tank to the percolation area should take place *via* a distribution device. The drain from the septic tank to the distribution device should be 100 mm in diameter and should be made of earthenware, concrete, uPVC or similar materials. The required slopes of the pipe from tank to distribution device are given in Table 7.3. It is essential that the pipe be sealed into the septic tank to prevent effluent escaping from the system.

A typical distribution device comprises a chamber, which divides the effluent from the septic tank equally between the percolation pipes supplying the percolation area. The device is a key part of the overall installation and careful attention should be paid to its selection. It should be designed and constructed to ensure equal distribution among the various percolation pipes. The distribution chamber should be laid on a stable foundation. It should be accurately levelled to ensure that the incoming effluent is evenly split and evenly diverted to the outlet percolation pipes. This is achieved by different technologies such as weirs or tee-splitters or optimally by tipping buckets. The distribution device requires ongoing maintenance and should be inspected regularly.

The use of an *ad hoc* combination of sewer pipe and ancillary junctions (e g. swept tees, etc., which are commonly available in builder's suppliers) to create the flow split is not recommended. The distribution device should be provided with inspection covers and located such that it is easy to open, inspect and, if necessary, clean the inside of the box. Access and inspection covers should be visible and flush with the ground surface without allowing the entry of surface water. Regular inspections should be carried out to ensure that the effluent entering the box is allowed to pass through to the percolation pipes without obstruction by extraneous materials and that the level conditions of the box are maintained.

TABLE 11.1. GRADIENTS FOR DRAIN TO SEPTIC TANK.

Drainpipe material	Minimum
Earthenware	1 in 40
Concrete	1 in 40
uPVC	1 in 60

11.2 Secondary Treatment: Package Wastewater Systems

All packaged wastewater systems should be installed in accordance with the manufacturer's instructions. Installation should be supervised and certified by a competent person and the work documented for future evidence.

11.3 Infiltration Systems

Infiltration systems comprise percolation areas, filter systems constructed on-site, and polishing filters that discharge to ground. The percolation area is an integral part of a septic tank system. A filter system constructed on-site is a secondary treatment system and comprises different filter media, while a polishing filter is the distribution mechanism of a secondary treatment system, be it a filter system or a package treatment system. While these infiltration systems have different design criteria and components, the construction and installation factors for both are the same and therefore are dealt with below. Refer to Sections 7, 8 and 10 for the detailed design of percolation areas and polishing filters, respectively. Construction and installation methods employed should be in accordance with I.S. CEN/TR 12566-2:2005 or I.S. CEN/TR 12566-5:2008. Location, construction and installation practices are critical to the performance of infiltration systems.

11.3.1 Location of infiltration systems

The risk of polluting groundwater wells is minimised when the infiltration system is hydraulically down gradient of any groundwater sources. Recommended minimum distances of separation of infiltration systems are listed in Table 6.1. The minimum separation distances for wells specified in Annex B should be adhered to in all cases. The GWPRs may also dictate that subsoil depths in excess of those indicated in this CoP may be required.

Storm-water drains, water mains, service pipes, soakaways, access roads, driveways, paved areas or land drains should not be located within or around the infiltration area.

A buffer strip of 1 m around the infiltration area should be observed. The layout of the infiltration system should make optimum use of the available site.

The growth of any type of tree or plant that develops extensive root systems should be limited to a minimum distance of 3 m from the infiltration area. This restriction also applies to the cultivation of crops necessitating the use of machinery that is likely to disturb the infiltration area.

11.3.2 Site works

The site of the infiltration system should be staked and roped off before any construction activities begin to make others aware of the site and to keep traffic and materials off the site. Trenches should be backfilled as soon as possible after excavation.

Earth-moving machinery should not circulate over the infiltration area before or, more importantly, after pipework and backfilling of trenches has been completed. The area should be clearly marked for the duration of any subsequent site works.

Satisfactory performance of infiltration systems depends on maintaining soil porosity. Construction activities can significantly reduce the porosity and cause systems to hydraulically fail soon after being brought into service. Good construction practices should carefully consider site preparation (before and during construction) and equipment use.

Earthworks should ideally be carried out during periods of dry weather. Excavation activities can cause significant reduction in soil porosity and permeability. Compaction and smearing of the soil infiltrative surface occur from equipment traffic and vibration and scraping actions of the equipment. All efforts should be made to avoid any disturbance to the exposed infiltration surface. Any smeared areas should be scarified with a rake and the surface gently raked. The gravel should be placed using buckets rather than from the truck itself.

11.4 Installation

Attention should be given to the impact of slope and subsoil layering on the location of the invert of the percolation pipe. Where unsaturated subsoil depth is limiting, it may be possible to choose a percolation pipe invert level that is near or at the ground surface in order to fully exploit the available subsoil depth. In such cases it will be necessary to provide protection for the percolation pipework, when installed, by placing soil over the pipework in sufficient quantities (minimum of 150 mm gravel and 300 mm topsoil) to ensure that damage due to activities on the surface does not occur.

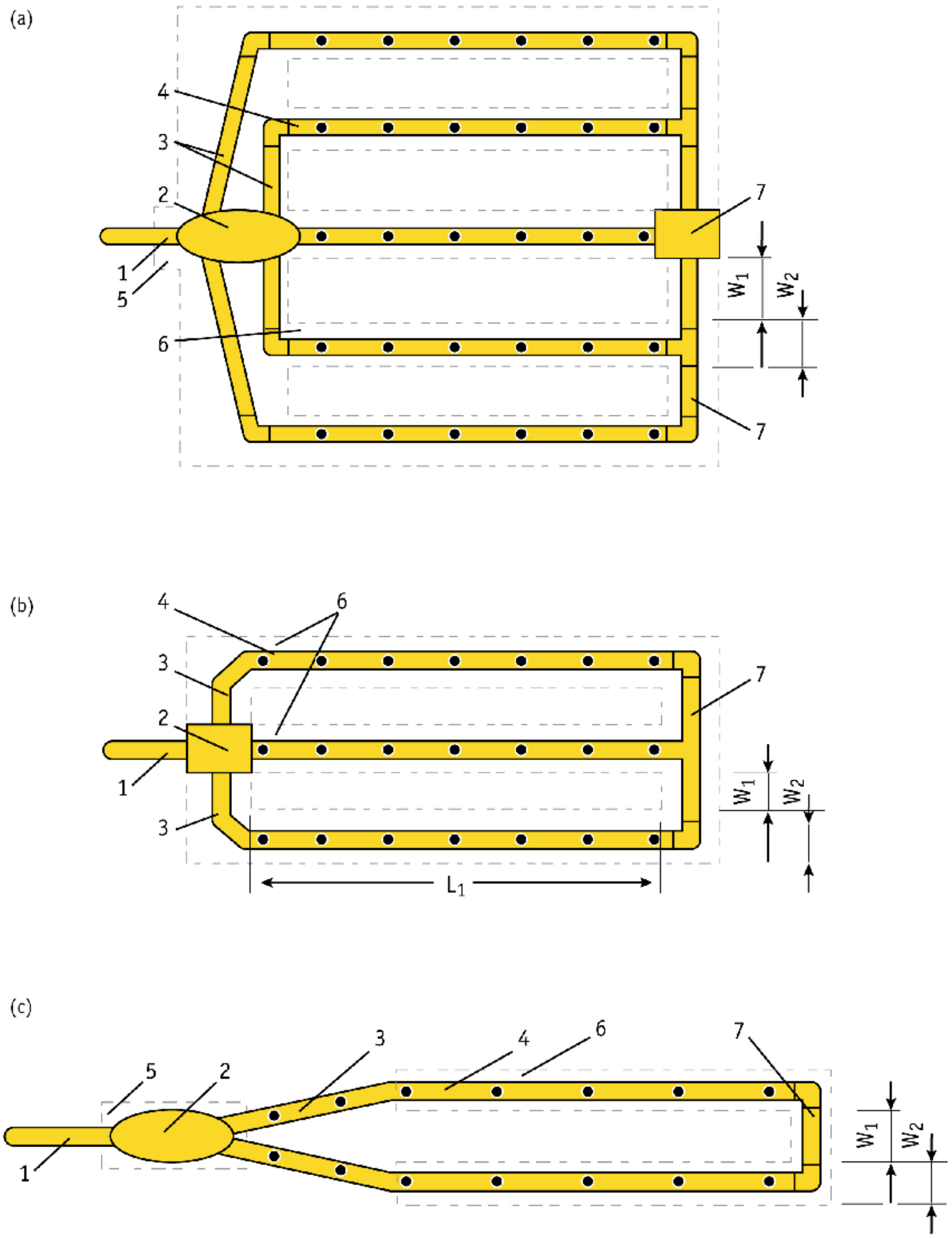
There should be a maximum of five trenches attached to each distribution box when designing a gravity system for a percolation area. Figure 11.1 contains alternative layouts to that in Section 7, which may be considered depending on the site layout.

On sloping sites (slope >1:20 or 5%) the pipework should be installed parallel to the contour to aid distribution of the treated effluent.

Land drainage pipes **are not** suitable for use in a percolation trench and are prohibited. They have narrow slots and have been proven to clog; they have been designed to encourage water to move into the pipes and not to distribute effluent out of the pipe.

Cutting and drilling of pipes should be carried out to ensure a clean and smooth finish. Before installation, the holes in the infiltration pipework should be inspected. Infiltration pipe types and gradients should be inspected prior to backfilling.

In areas of relatively low permeability soils, shallow interceptor drains, the depth of which depends on the depth to the impervious layer, should cut off all surface run-off and seepage from the surrounding soil. The interceptor drain should be 2 m distant from the up-gradient side and parallel to the side edges of the infiltration area (not down gradient). These drains



Key

(a) Five trenches
(b) Three trenches
(c) Two trenches

1 Connection pipe
2 Distribution chamber
3 Distribution pipe
4 Infiltration pipe
5 Sand Layer, if necessary to level distribution chamber and pipework
6 Distribution layer
7 End connection with ventilation and access, if necessary

W_1 Natural ground width between trenches ≤ 2.5m
W_2 Distribution Layer width 0.5m
L_1 Distribution Layer length ≤ 20m

Ref. BS 6297:2007

FIGURE 11.1. INFILTRATION TRENCHES – LAYOUT EXAMPLES.

Derived from Fig. 5 in I.S. CEN/TR 12566-2:2005.

comprise land drainage pipes overlain to ground surface with permeable gravel or broken stone aggregate. These interceptor drains are brought to the nearest watercourse or stream into which they outfall. Construction and installation should be supervised and certified by a competent person and the work documented for future evidence.

12 Operation and Maintenance of Wastewater Treatment Systems

Maintenance of all wastewater treatment systems is essential to ensure ongoing treatment of wastewater. Homeowners should obtain the appropriate documentation including manufacturer's instructions on the system from the builder/supplier and should take all steps to ensure that their system is properly operated and maintained.

12.1 Introduction

Appropriate site selection, choice of the treatment system and the correct installation are critical steps to provide for the treatment of domestic effluent from a single house. Homeowners are ultimately responsible for the installation, operation and maintenance of their wastewater treatment system. Section 70 of the Water Services Act, 2007 places a 'duty of care' on the owner of a wastewater treatment system to ensure that it is kept so as not to "*cause, or be likely to cause, a risk to human health or the environment, including waters, the atmosphere, land, soil, plants or animals, or create a nuisance through odours. An authorised person appointed by a water services authority may direct the owner or occupier to take such measures as are considered by the authorised person to be necessary to deal with the risk. Refusal to comply with such a direction or obstruction of the authorised person is an offence*."

The onus is on the owner or builder to install suitable wastewater treatment systems correctly and in accordance with the manufacturer's instructions, planning permission and any relevant conditions attached thereto, building regulations and the recommendations set out in this code. Builders should provide information for the operation and maintenance of the system to the house purchaser. All inspection and maintenance work should be carried out by competent persons in accordance with the recommendations herein, the manufacturer's instructions where available, relevant health and safety legislation, waste disposal legislation, etc. The homeowner should be discouraged from undertaking maintenance or accessing the wastewater treatment system itself for safety reasons.

The manner in which the treatment system is maintained after it is installed is of equal importance to ensure that the environment and human health are protected on an ongoing basis after the house is occupied.

Septic tank treatment systems will require a different approach for proper maintenance than packaged treatment systems. Septic tanks do not normally require the use of mechanical parts, electrical components or sensitive equipment of the type that may be used in the more advanced systems unless the effluent is being pumped to an intermittent dosing system. Therefore, in the case of septic tank systems, visual inspection of the system on a periodic basis as well as regular de-sludging is required to ensure that the system continues to operate effectively. Guidance for the maintenance of septic tanks can therefore be seen as more universally prescriptive and the approach taken to the maintenance of all septic tanks will be similar. In the case of packaged systems the operation and maintenance of the system in all cases should be carried out in accordance with the manufacturer's instructions.

Filter systems (secondary and tertiary treatment systems) require that the pumps and distribution systems be adequately maintained.

Packaged treatment systems, which may be used for either secondary or tertiary treatment (such as RBCs, BAFs, SAFs, SBRs and MBR systems), rely on the precise functioning of mechanical and/or electrical components for proper operation. Apart from carrying out periodic visual inspections of the system, there will also be a requirement to repair, service or even replace components that become worn out through use over time. Different manufacturers will design and configure their products in different ways, so the maintenance regime will vary from system to system. With mechanical treatment systems the user is advised to consult with the manufacturers in all cases in order to decide on the appropriate maintenance requirements. The de-sludging frequency should be once per year.

Maintenance of wastewater treatment systems for use in holiday homes has been identified as a problem area as after prolonged periods of disuse the micro-organisms may die off and not provide adequate treatment of the wastewater. Therefore it is essential that the micro-organism population in the biological zone of the treatment system remains active throughout the year to effectively deal with occasional loadings of wastewater. This activation should be maintained during periods when the holiday homes are unoccupied and advice from the system manufacturer should be sought.

A schedule for installation, inspection, minimum maintenance and monitoring is set out in Table 12.1. A competent person is required to carry out this schedule of work and advances in this area are necessary to ensure that there is an effective operation and maintenance management programme for on-site wastewater treatment systems in place. The homeowner should maintain a documented record of all inspections and maintenance interventions.

TABLE 12.1. INSTALLATION, INSPECTION AND MONITORING SCHEDULE.

System type	Certificate of installation	Minimum frequency of inspection	Minimum frequency of maintenance[1]	Minimum frequency of monitoring
Septic tank system	A	Every 12 months by homeowner or A	De-sludge every 12 months	Not applicable
Secondary treatment: filter system or package treatment plant	B or A	Every 6–12 months by B or A or as per manufacturer's instructions	De-sludge every 12 months by B or A	Every 12–24 months, or in accordance with licence or planning permission and any relevant conditions attached thereto or as per manufacturer's recommendations

A = Competent person/Service provider. B = System supplier.
[1]An alternative frequency may be proposed following the site inspection.

12.2 Record Keeping

Records of installation should be kept in accordance with this code as well as of all maintenance undertaken on the wastewater treatment and disposal systems, including contractor's details to demonstrate a 'duty of care'. All de-sludging of septic tank or treatment system and system inspections should be documented. The documentation should be transferred to any new homeowner.