The Environmental Protection Agency

CODE OF PRACTICE
Wastewater Treatment and Disposal Systems Serving Single Houses
(p.e. $\leq$ 10)

Office of Environmental Enforcement

Environmental Protection Agency

The Environmental Protection Agency (EPA) is a statutory body responsible for protecting the environment in Ireland. We regulate and police activities that might otherwise cause pollution. We ensure there is solid information on environmental trends so that necessary actions are taken. Our priorities are protecting the Irish environment and ensuring that development is sustainable.

The EPA is an independent public body established in July 1993 under the Environmental Protection Agency Act, 1992. Its sponsor in Government is the Department of the Environment, Heritage and Local Government.

OUR RESPONSIBILITIES

LICENSING

We license the following to ensure that their emissions do not endanger human health or harm the environment:

- waste facilities (e.g., landfills, incinerators, waste transfer stations);
- large scale industrial activities (e.g., pharmaceutical manufacturing, cement manufacturing, power plants);
- intensive agriculture;
- the contained use and controlled release of Genetically Modified Organisms (GMOs);
- large petrol storage facilities;
- waste water discharges.

NATIONAL ENVIRONMENTAL ENFORCEMENT

- Conducting over 2,000 audits and inspections of EPA licensed facilities every year.
- Overseeing local authorities' environmental protection responsibilities in the areas of - air, noise, waste, waste-water and water quality.
- Working with local authorities and the Gardaí to stamp out illegal waste activity by co-ordinating a national enforcement network, targeting offenders, conducting investigations and overseeing remediation.
- Prosecuting those who flout environmental law and damage the environment as a result of their actions.

MONITORING, ANALYSING AND REPORTING ON THE ENVIRONMENT

- Monitoring air quality and the quality of rivers, lakes, tidal waters and ground waters; measuring water levels and river flows.
- Independent reporting to inform decision making by national and local government.

REGULATING IRELAND'S GREENHOUSE GAS EMISSIONS

- Quantifying Ireland's emissions of greenhouse gases in the context of our Kyoto commitments.
- Implementing the Emissions Trading Directive, involving over 100 companies who are major generators of carbon dioxide in Ireland.

ENVIRONMENTAL RESEARCH AND DEVELOPMENT

- Co-ordinating research on environmental issues (including air and water quality, climate change, biodiversity, environmental technologies).

STRATEGIC ENVIRONMENTAL ASSESSMENT

- Assessing the impact of plans and programmes on the Irish environment (such as waste management and development plans).

ENVIRONMENTAL PLANNING, EDUCATION AND GUIDANCE

- Providing guidance to the public and to industry on various environmental topics (including licence applications, waste prevention and environmental regulations).
- Generating greater environmental awareness (through environmental television programmes and primary and secondary schools' resource packs).

PROACTIVE WASTE MANAGEMENT

- Promoting waste prevention and minimisation projects through the co-ordination of the National Waste Prevention Programme, including input into the implementation of Producer Responsibility Initiatives.
- Enforcing Regulations such as Waste Electrical and Electronic Equipment (WEEE) and Restriction of Hazardous Substances (RoHS) and substances that deplete the ozone layer.
- Developing a National Hazardous Waste Management Plan to prevent and manage hazardous waste.

MANAGEMENT AND STRUCTURE OF THE EPA

The organisation is managed by a full time Board, consisting of a Director General and four Directors.

The work of the EPA is carried out across four offices:

- Office of Climate, Licensing and Resource Use
- Office of Environmental Enforcement
- Office of Environmental Assessment
- Office of Communications and Corporate Services

The EPA is assisted by an Advisory Committee of twelve members who meet several times a year to discuss issues of concern and offer advice to the Board.

CODE OF PRACTICE

WASTEWATER TREATMENT AND DISPOSAL SYSTEMS SERVING SINGLE HOUSES

(p.e. $\leq$ 10)

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DISCLAIMER

CODE OF PRACTICE

WASTEWATER TREATMENT AND DISPOSAL SYSTEMS SERVING SINGLE HOUSES (p.e. ≤ 10)

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In order to examine the position in relation to on-site systems (in Ireland and internationally) and to produce draft guidelines for their future use, a research project in relation to on-site systems was part-financed by the European Union through the European Regional Development Fund as part of the Environmental Monitoring, R&D sub-programme of the Operational Programme for Environmental Services, 1994–1999. The sub-programme was administered on behalf of the Department of the Environment and Local Government by the Environmental Protection Agency, which has the statutory function of co-ordinating and promoting environmental research. The study *Small Scale Wastewater Treatment Systems* was co-ordinated by the Department of Civil Engineering, NUIG, from 1995 to 1997.

In late 2000, as part of the Environmental Research, Technological Development and Innovation (ERTDI) programme 2000–2006, the EPA approved a further research project to be undertaken by the Department of Civil, Structural and Environmental Engineering at TCD. The Irish Government under the National Development Plan 2000–2006 financed the ERTDI programme. This later project was entitled *Establishment of the Hydraulic Performance and Efficiencies of Different Subsoils and the Effectiveness of Stratified Sand Filters* (2000-MS-15-M1). This project was later extended to examine the efficiencies of subsoils for on-site wastewater treatment and disposal with respect to endocrine disrupting chemicals. A further research project by TCD on *The Effective Distribution of On-Site Wastewater Effluent into Percolation Areas via Distribution Boxes and Treatment by Reed Beds Compared to Attenuation of Pollutants in Sandy Subsoils* (2005–MS-15) has recently been completed.

The NUIG and TCD researchers are internationally recognised for their work on wastewater treatment systems and have published in peer-reviewed international journals and presented their findings at international conferences. The findings of the research were used to inform the requirements of the CoP.

The Agency also wishes to acknowledge the contribution of the various sections of the Department of the Environment, Heritage and Local Government (DoEHLG), National Standards Authority of Ireland (NSAI), Irish Agrément Board (IAB), An Bord Pleanála, Domestic Effluent Trade Association (DETA), Geological Survey of Ireland (GSI), the County and City Managers Association, Local Authority personnel, River Basin District Project co-ordinators, Fisheries Boards, Irish On-Site Wastewater Association (IOWA) as well as the tutors and participants of the FÁS Site Characterisation courses and comments by practitioners in the field and the numerous individual contributors during the consultation period 20th July to 10th September 2007.

Finally, the authors would also like to acknowledge the assistance of EPA colleagues Dr Matthew Crowe, Mr Donal Daly, Mr Brendan Wall and Mr Leo Sweeney.

Yellowstone Communications Design produced the graphics and its input is acknowledged.

Abbreviations

Agency	Environmental Protection Agency
BAF	Biological aerated filters
BOD_5	Biochemical oxygen demand (5 day)
BS	British Standard
C	Capacity
°C	Degrees Celsius
CEN	Comité Européen de Normalisation (European Committee for Standardisation)
CEN/TR	Technical report prepared by CEN
CEN/TS	Technical specification prepared by CEN
COD	Chemical oxygen demand
CoP	Code of Practice
C_u	Uniformity co-efficient
DoEHLG	Department of the Environment, Heritage and Local Government
DO	Dissolved oxygen
DWF	Dry weather flow
EN	European Standard (note, *prEN* indicates draft standard)
EPA	Environmental Protection Agency
FETAC	Further Education and Training Awards Council
FOG	Fats, oils and grease
FWS	Free-water surface
g	Gram
GSI	Geological Survey of Ireland
GWPR	Groundwater protection response
GWPS	Groundwater protection scheme
h	Hour
K	Hydraulic conductivity
kg	Kilogram
I.S.	Irish Standard
ISO	International Organisation for Standardisation
l	Litre
lcd	Litres *per capita* per day
m	Metre
m^3	Cubic metres
mg	Milligram
mm	Millimetre
MPN	Most probable number
m/s	Metres per second
NHA	National Heritage Area
NSAI	National Standards Authority of Ireland
NUI	National University of Ireland
p.e.	Population equivalent
PFP	Preferential flow path
PSD	Particle size distribution

PT	Population total (Population equivalent)
RBC	Rotating biological contactors
s	Second
SAC	Special Area of Conservation
SBR	Sequencing batch reactor
SFS	Subsurface flow system
S.I.	Statutory Instrument
SPA	Special Protection Area
SS	Suspended solids
T/P	The T-value (expressed as min/25 mm) is the time taken for the water level to drop a specified distance in a percolation test hole. For shallow subsoils the test hole requirements are different and hence the test results are called P-values. For further advice see Annex C.
TSS	Total suspended solids
TWL	Top water level
WT	Water table

Preface

The Agency is authorised under Section 76 of the Environmental Protection Agency (EPA) Act, 1992 (as amended), to prepare and publish codes of practice for the purpose of providing guidance with respect to compliance with any enactment or otherwise, for the purposes of environmental protection. This Code of Practice (CoP) replaces previous guidance issued by the Agency in 2000 and incorporates requirements of the new European standards from the 12566 series, EPA research findings and feedback on previous EPA guidance and research reports. The document is published as a CoP under Section 76 of the Environmental Protection Agency Act, 1992 (as amended), and shall be received in evidence without further proof.

This CoP will replace the guidance document Standard Recommendation I.S. SR 6:1991 issued by the National Standards Authority of Ireland when the Department of the Environment, Heritage and Local Government incorporates the CoP in the Building Regulations.

When on-site systems fail to operate satisfactorily they threaten public health and water quality. When domestic wastewater is not absorbed by the soil it can form stagnant pools on the ground surface. In such failures, humans can come in contact with the wastewater and be exposed to pathogens; also foul odours can be generated. In addition, inadequately treated wastewater through poor siting, design and/or construction may lead to contamination of our groundwaters and surface waters, which in many areas are also used as drinking water supplies. It is essential that this effluent is properly treated and disposed of.

The key messages of the CoP are:

- The importance of proper site assessment, taking account of not only local conditions specific to the proposed site but also of wider experience in the area, patterns of development, provisions of the development plan and other policies, etc.

- The need for design of on-site wastewater disposal systems specific to the local conditions

- The need for follow-through by the builder/homeowner/supervisory authority – i.e. installation/commissioning/maintenance as per design and attendant recommendations/conditions – otherwise breaches of various legislative codes are occurring.

The purpose of this CoP is to provide guidance on the provision of wastewater treatment and disposal systems for new single houses with a population equivalent (p.e.) of less than or equal to 10 and contains the following:

- An assessment methodology to determine site suitability for on-site wastewater treatment systems and to identify minimum environmental protection requirements

- A methodology to select suitable wastewater treatment systems for sites in un-sewered rural areas

- Information on the design and installation of septic tank systems, filter systems and packaged treatment systems

- Information on tertiary treatment systems, and

- Maintenance requirements.

This CoP has been prepared having regard to current standards and guidelines and will assist planning authorities, builders, system manufacturers, system designers, system installers and system operators to deal with the complexities of on-site systems for single houses.

Site suitability assessors should carry out all assessments in accordance with the guidance provided in this CoP. The site suitability

assessment methodology set out in this document should be used by planning authorities to satisfy the requirements of Article 22 (c) of the Planning and Development Regulations, 2006. There is also an obligation on the proposed house builder/owner to ensure that any planning application submitted should include an assessment of the site and recommendations in accordance with the guidance provided in this CoP. In addition, it is essential that the wastewater treatment system installed on site complies with the conditions of planning and that the system is properly installed and maintained in accordance with the guidance in Sections 11 and 12.

The CoP is divided into two parts: Part One sets out requirements for on-site wastewater systems used to treat and dispose of domestic wastewater from single houses. Guidance on good practice is included in Part Two and informs the implementation of the requirements of Part One.

The figures and diagrams in this CoP are for illustration purposes to assist the users of this code. They should not be considered as substitutes for detailed design drawings.

The code will be subject to ongoing review. The Agency welcomes any suggestions, that users of the CoP wish to make. These should be returned to the Office of Environmental Enforcement at the Environmental Protection Agency Regional Inspectorate, McCumiskey House, Richview, Clonskeagh Rd, Dublin 14.

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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

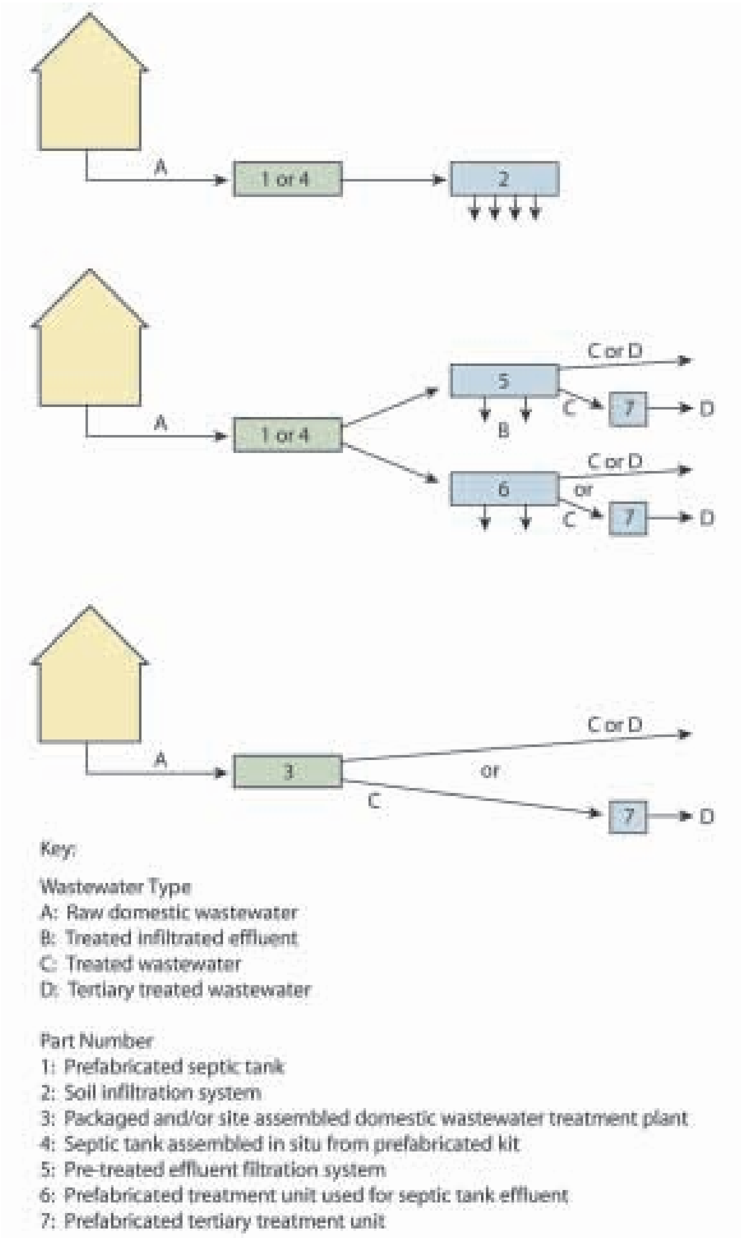


FIGURE 5.1. METHODS OF WASTEWATER TREATMENT IN LINE WITH EN 12566.

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 un-sewered 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.

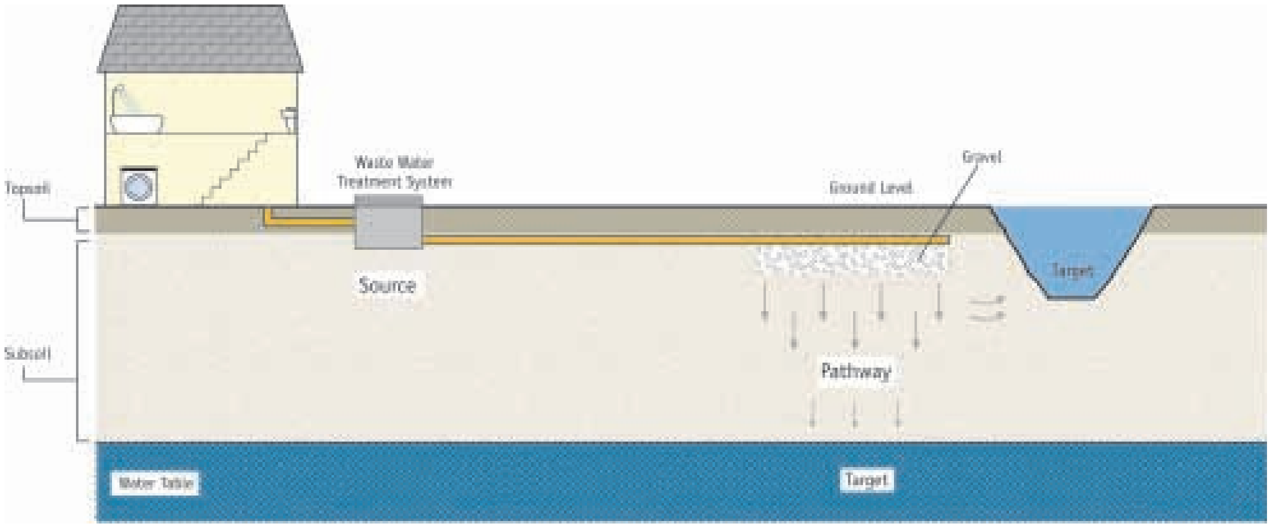


FIGURE 6.1. SCHEMATIC OF SOURCE–PATHWAY–TARGET MODEL.

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

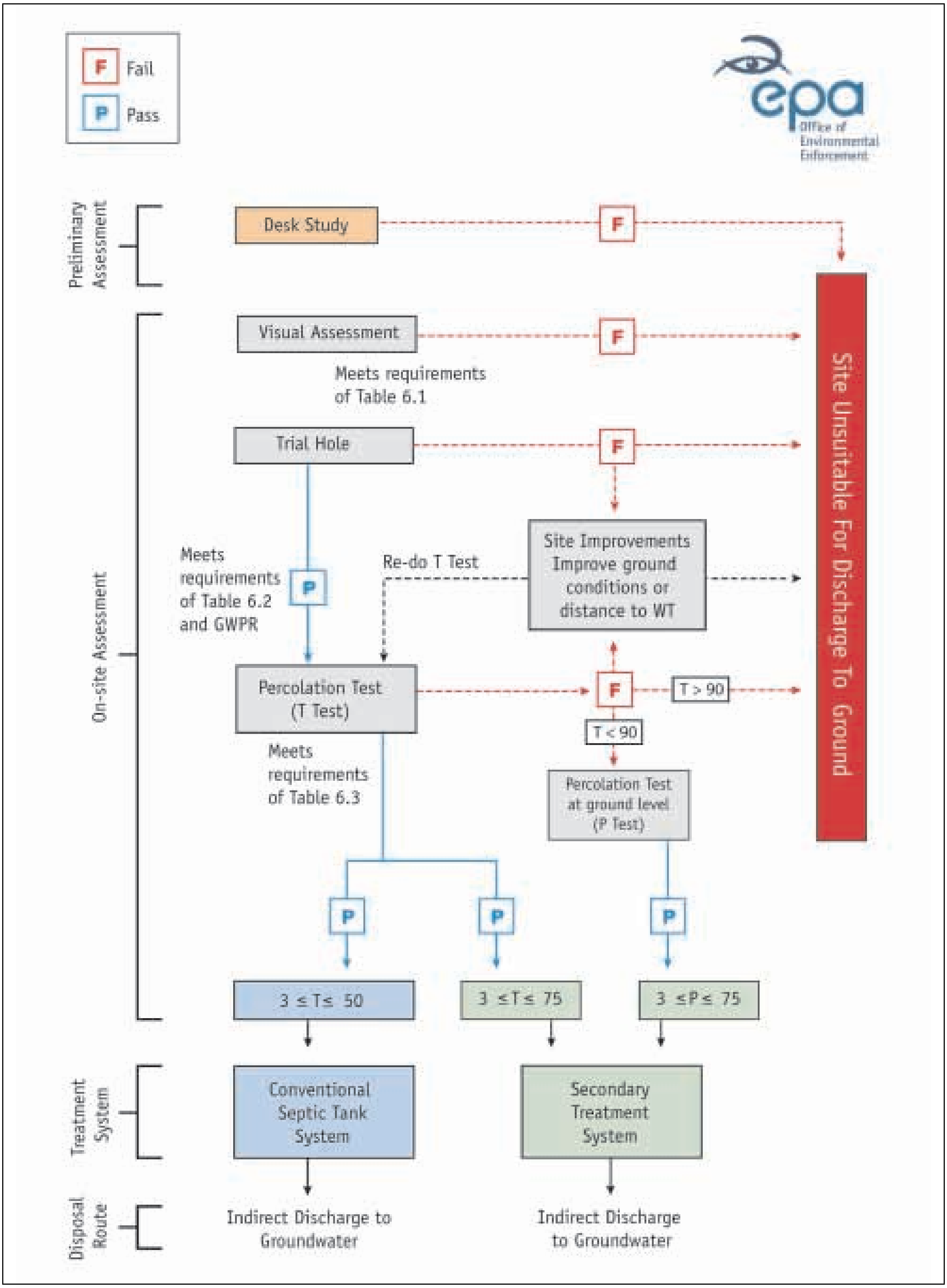


FIGURE 6.2. A GENERAL GUIDE TO THE SELECTION OF AN ON-SITE WASTEWATER TREATMENT SYSTEM DISCHARGING TO GROUND.

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.
T not possible due to high water table	If the subsoil is classified as CLAY, carry out a particle size distribution and refer to I.S. CEN/TR 12566-2:2005.

[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 bedrock, which may result in ponding on-site. In these cases, site improvement works are

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

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

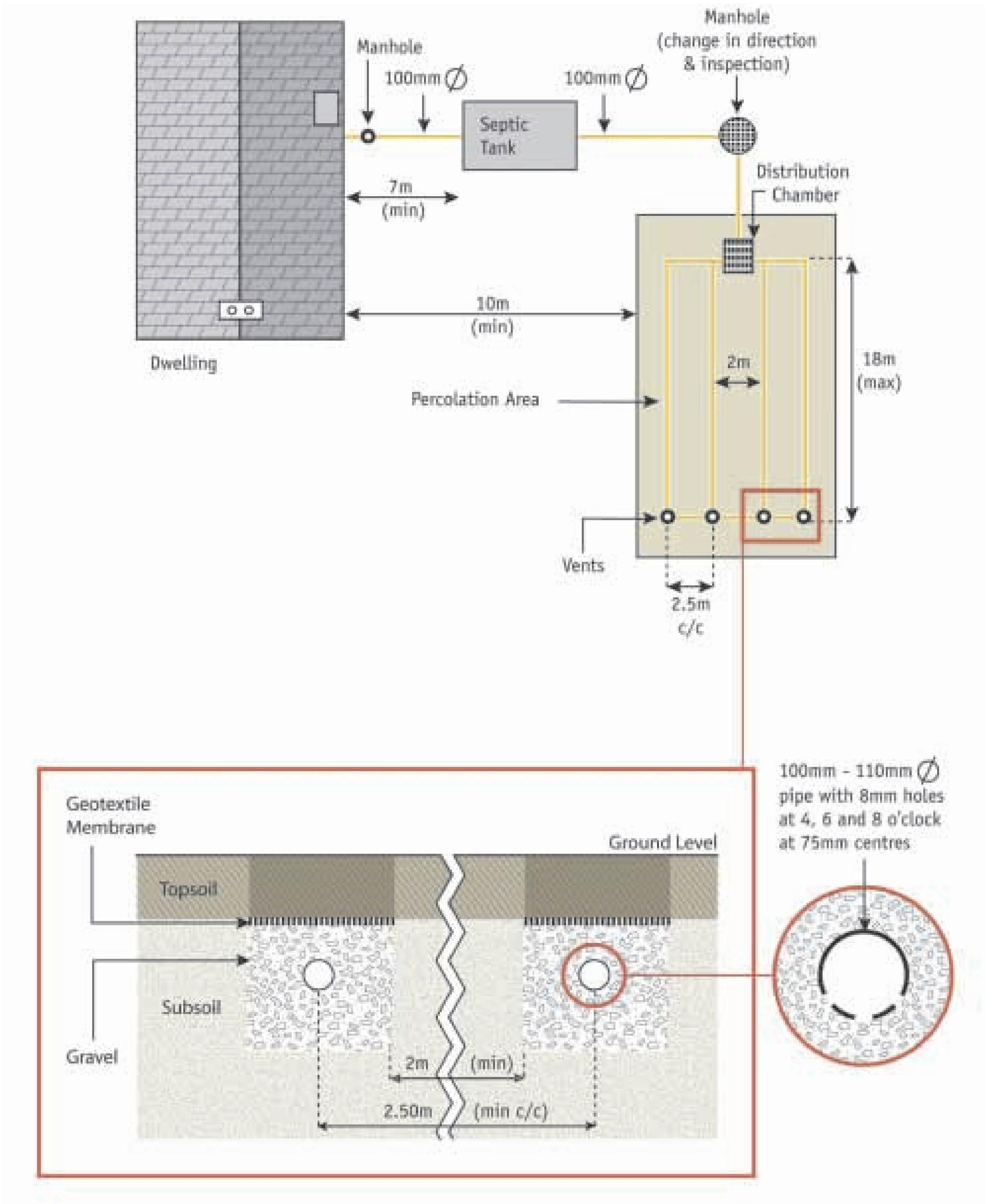


FIGURE 7.1. PLAN AND SECTION OF LAYOUT OF SEPTIC TANK SYSTEM.

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 20 l/m^2/day is recommended for

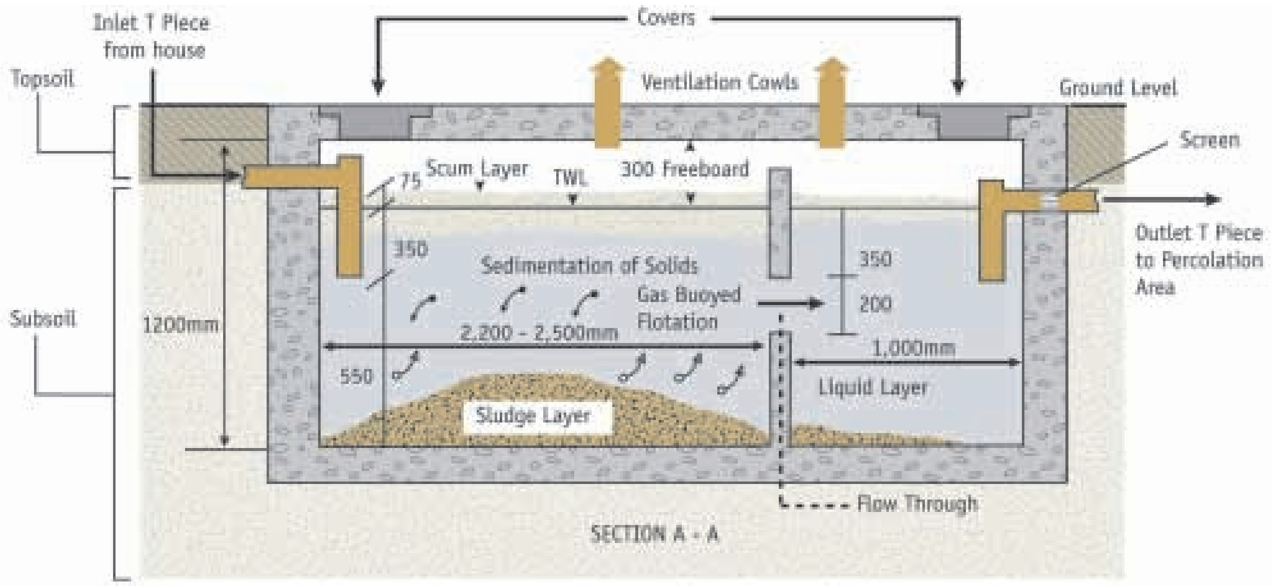


FIGURE 7.2. LONGITUDINAL SECTION OF A TYPICAL SEPTIC TANK (ALL DIMENSIONS IN MM).

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

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.

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.

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

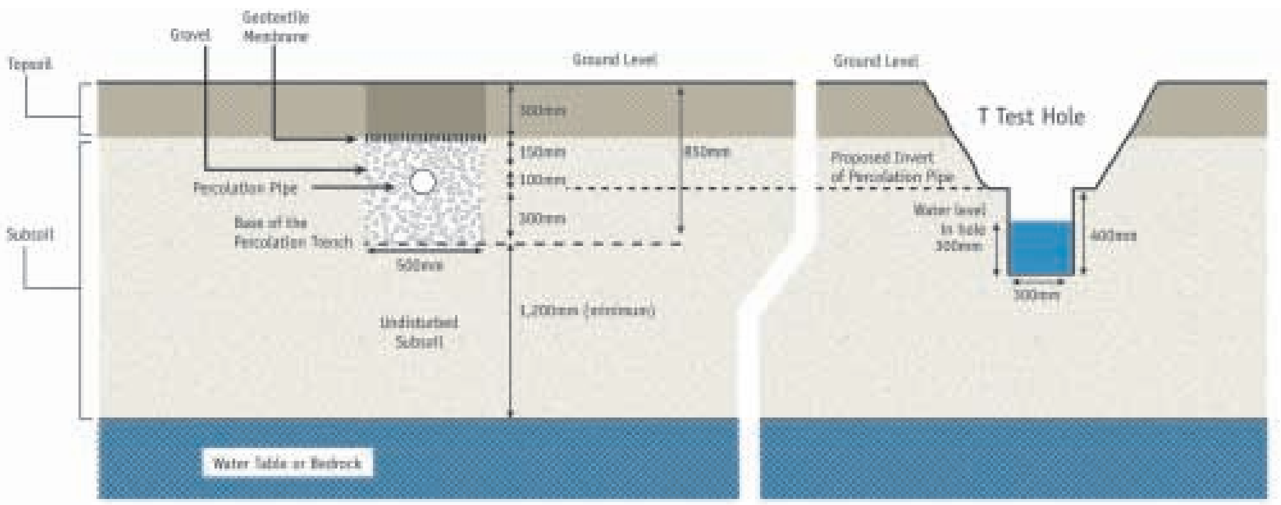


FIGURE 7.3. SECTION OF A PERCOLATION TRENCH.

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).

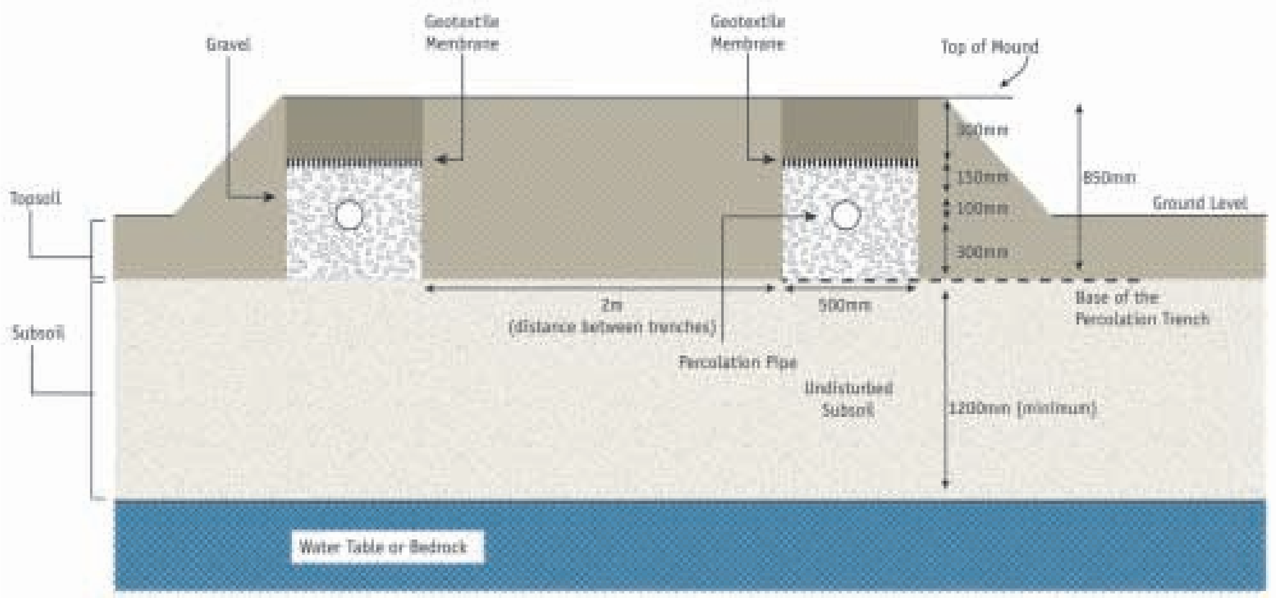


FIGURE 7.4. RAISED PERCOLATION AREA.

(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

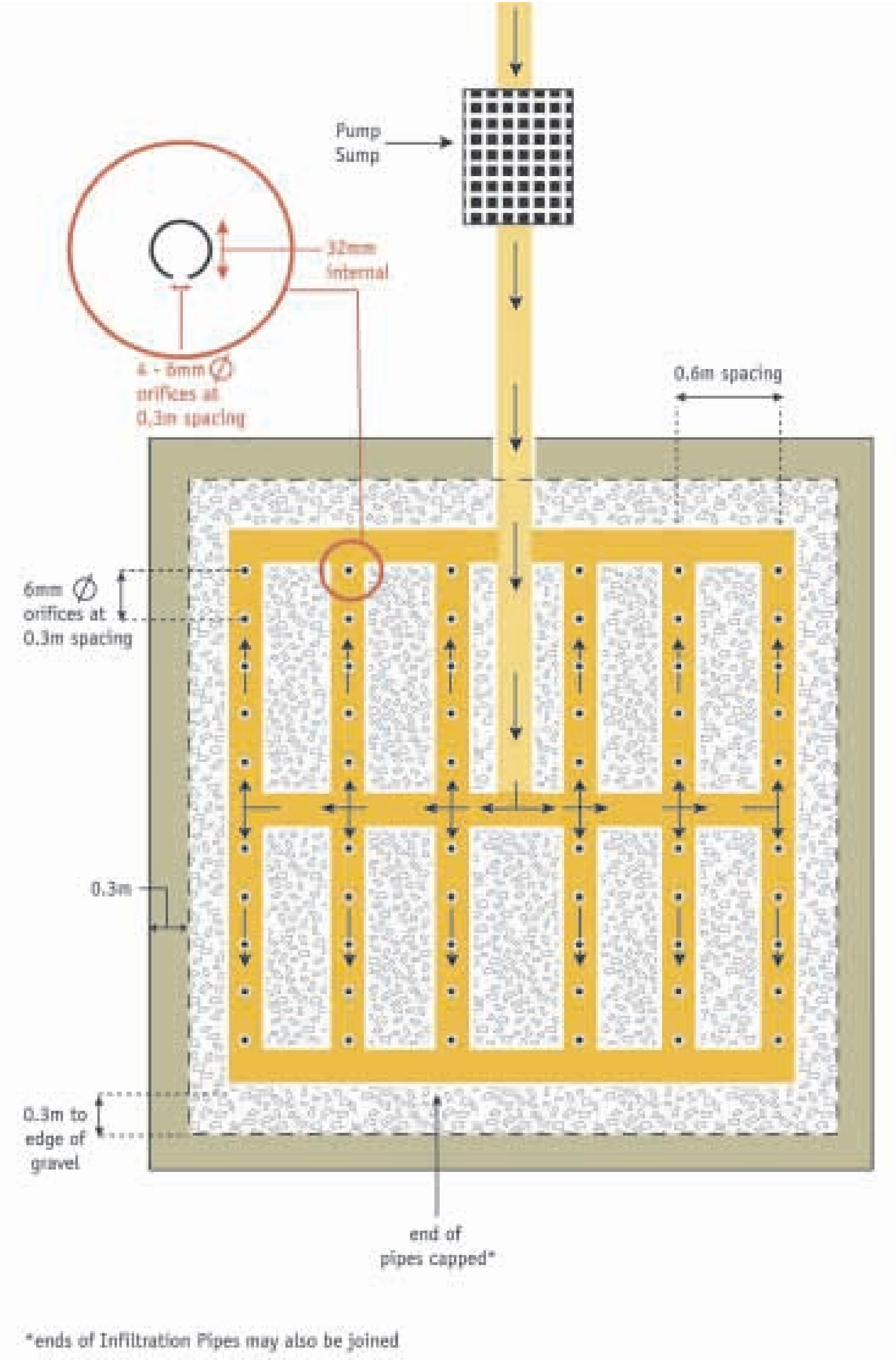


FIGURE 8.1. ILLUSTRATION OF A PUMPED DISTRIBUTION SYSTEM.

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.

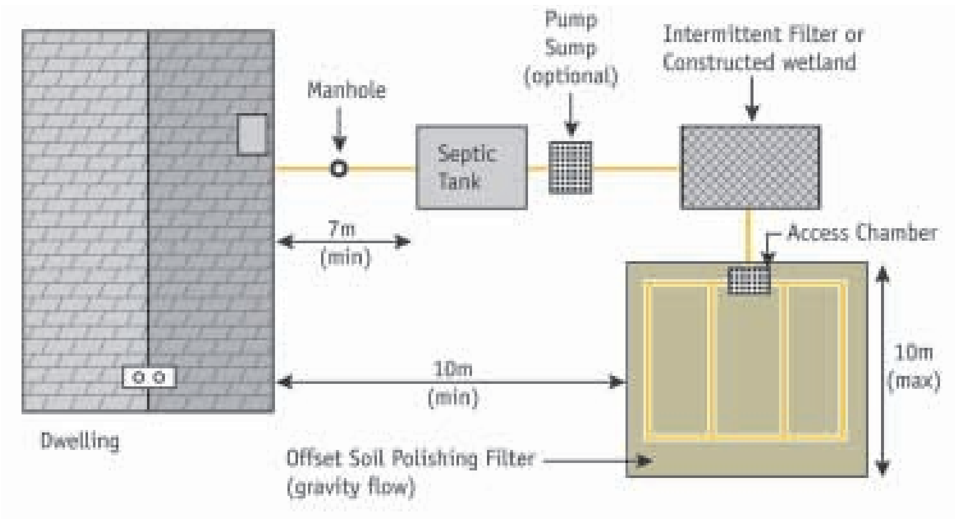


FIGURE 8.2. ILLUSTRATION OF INTERMITTENT FILTER SYSTEM OR CONSTRUCTED WETLAND SYSTEM.

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).

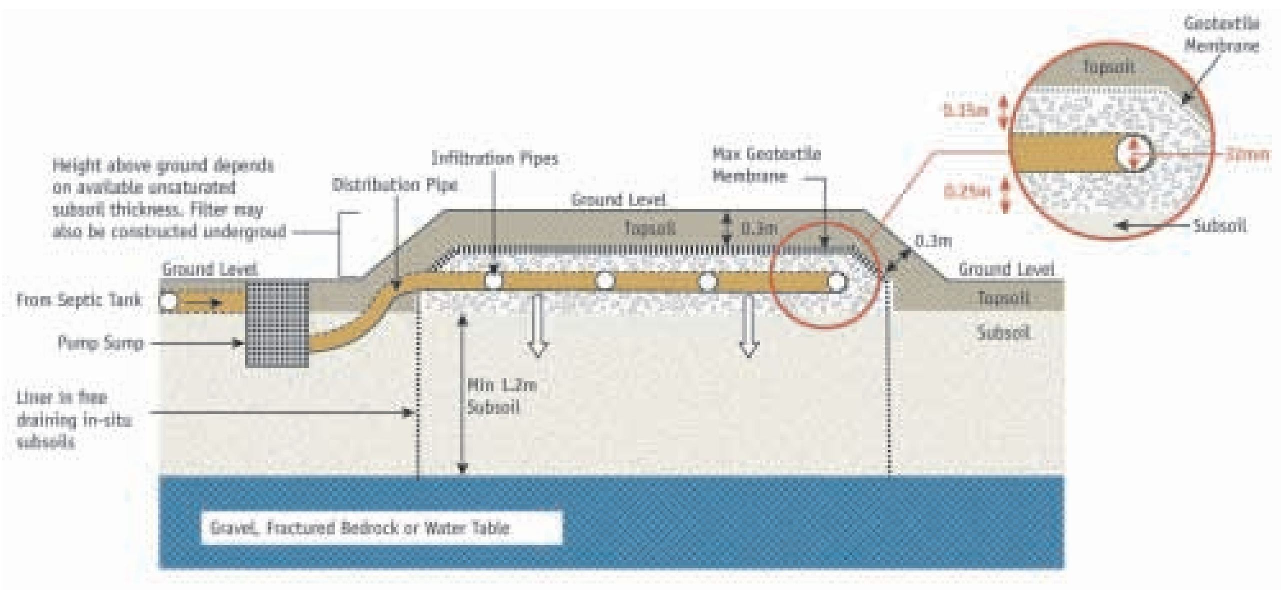


FIGURE 8.3. SCHEMATIC DIAGRAM OF AN INTERMITTENT SOIL FILTER.

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.

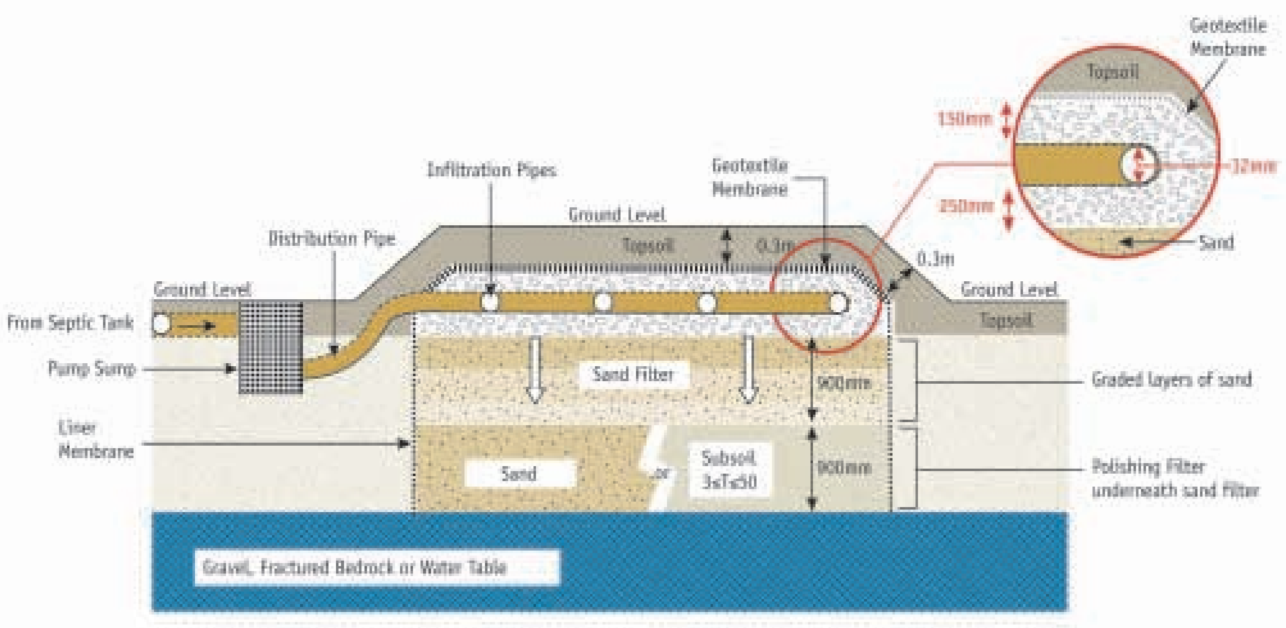


FIGURE 8.4. INTERMITTENT SAND FILTER SYSTEM WITH UNDERLYING SAND/SUBSOIL POLISHING FILTER.

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.

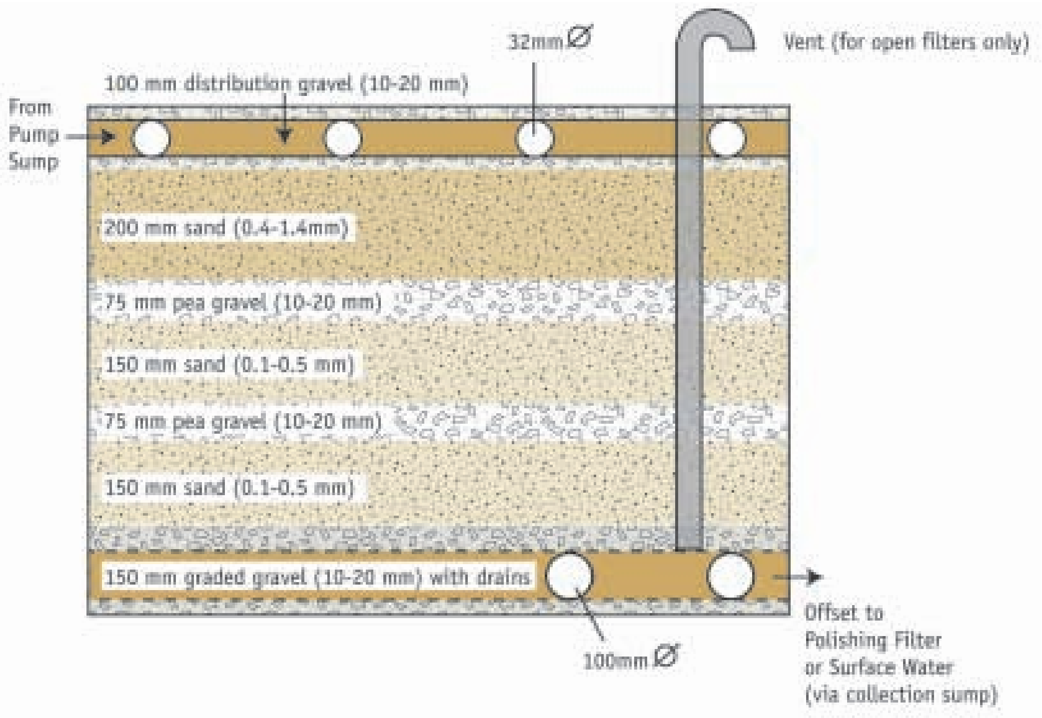


FIGURE 8.5. SCHEMATIC CROSS SECTION OF STRATIFIED SAND FILTER.

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

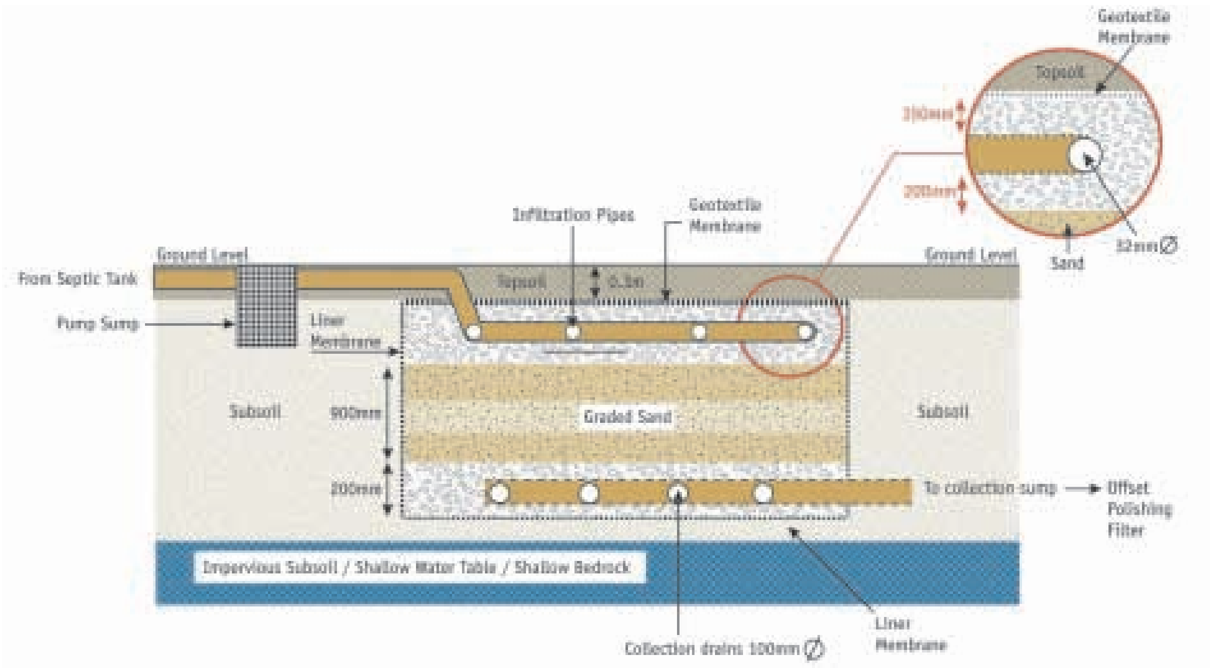


FIGURE 8.6. INTERMITTENT SAND FILTER OVERLYING IMPERVIOUS SUBSOIL/BEDROCK WITH OFFSET POLISHING FILTER.

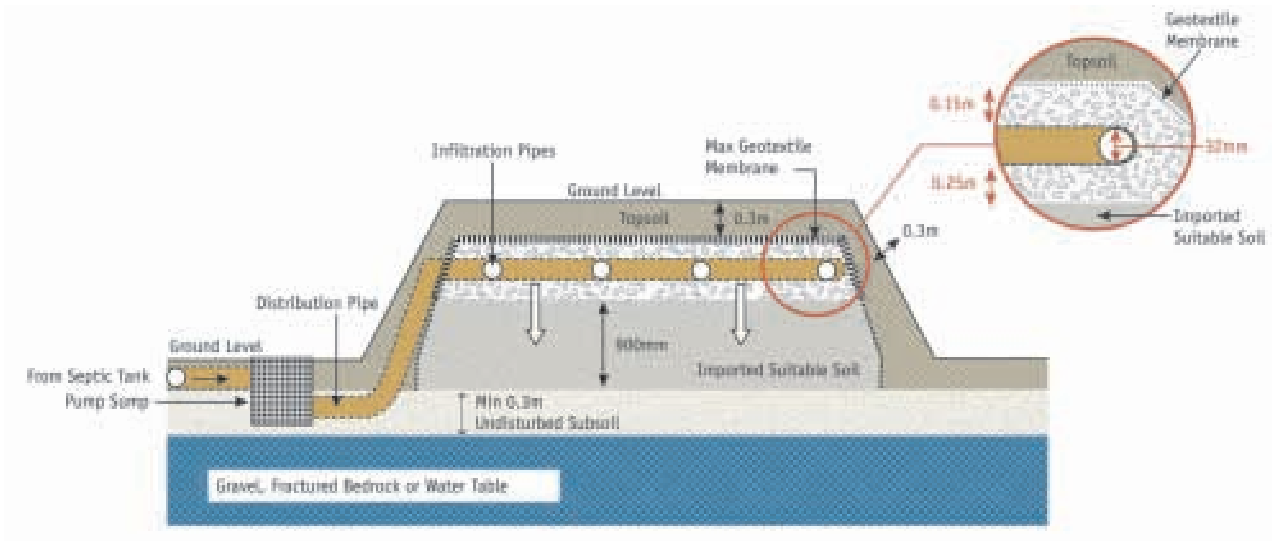


FIGURE 8.7. INTERMITTENT SOIL FILTER (ABOVE GROUND).

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)

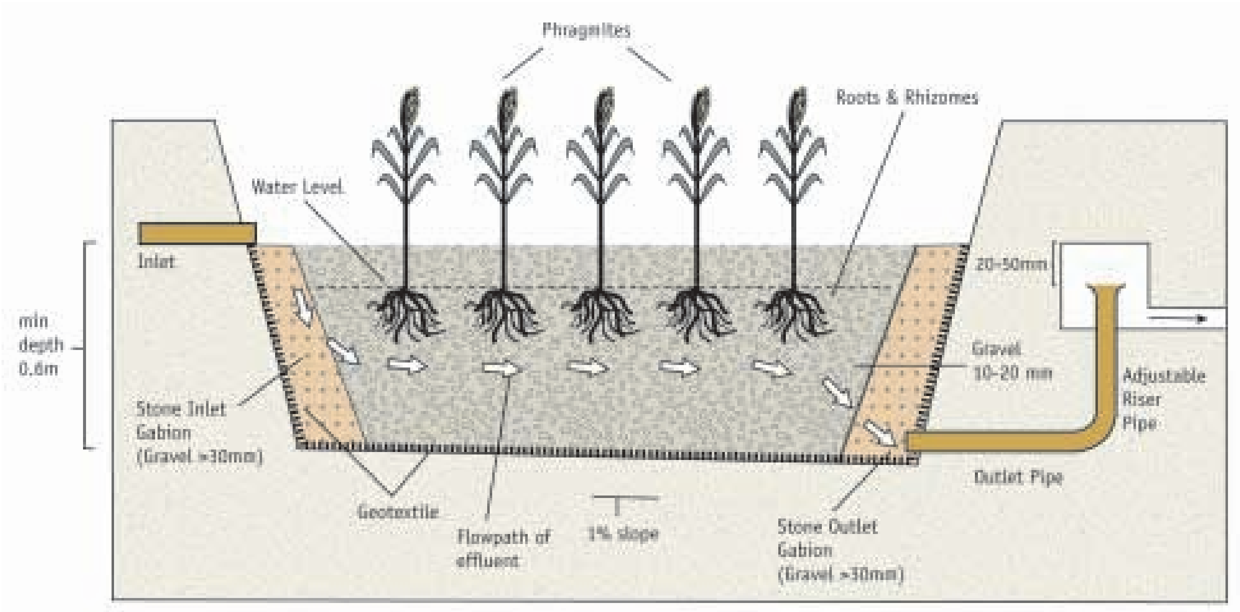


FIGURE 8.8. HORIZONTAL SUBSURFACE FLOW REED BED.

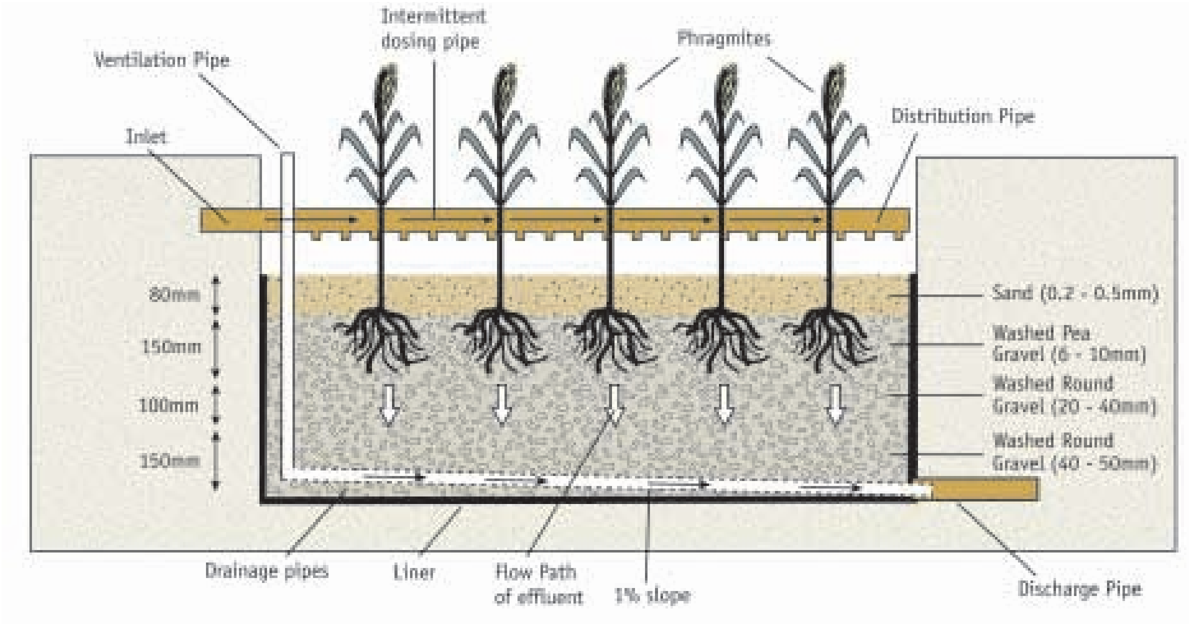


FIGURE 8.9. VERTICAL SUBSURFACE FLOW REED BED.

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

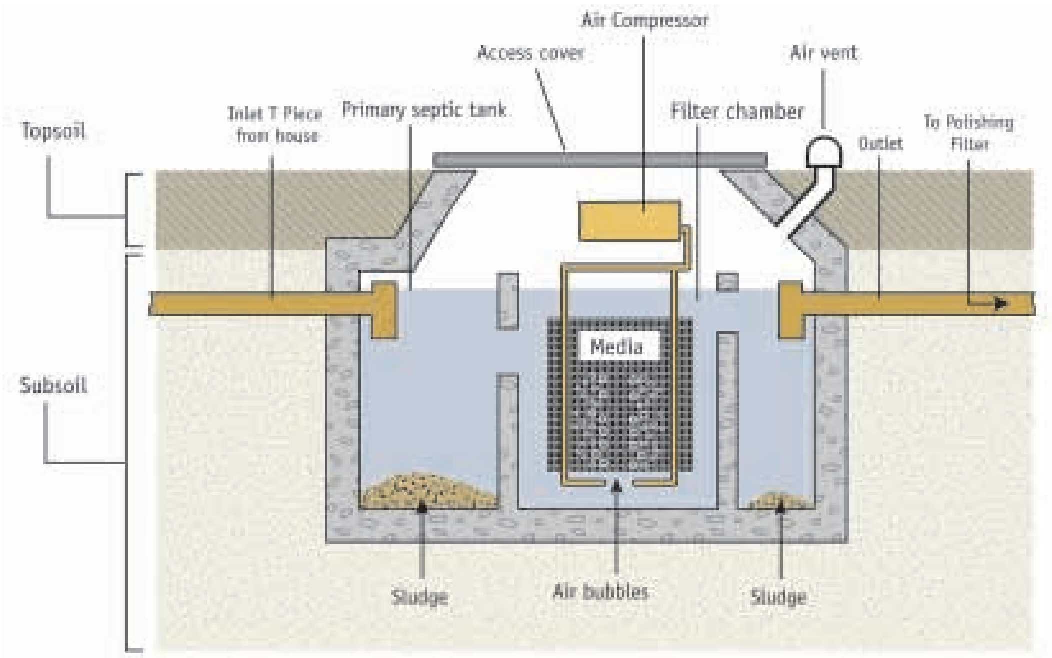


FIGURE 9.1. SCHEMATIC OF A BIOLOGICAL AERATED FILTER SYSTEM (BAF).

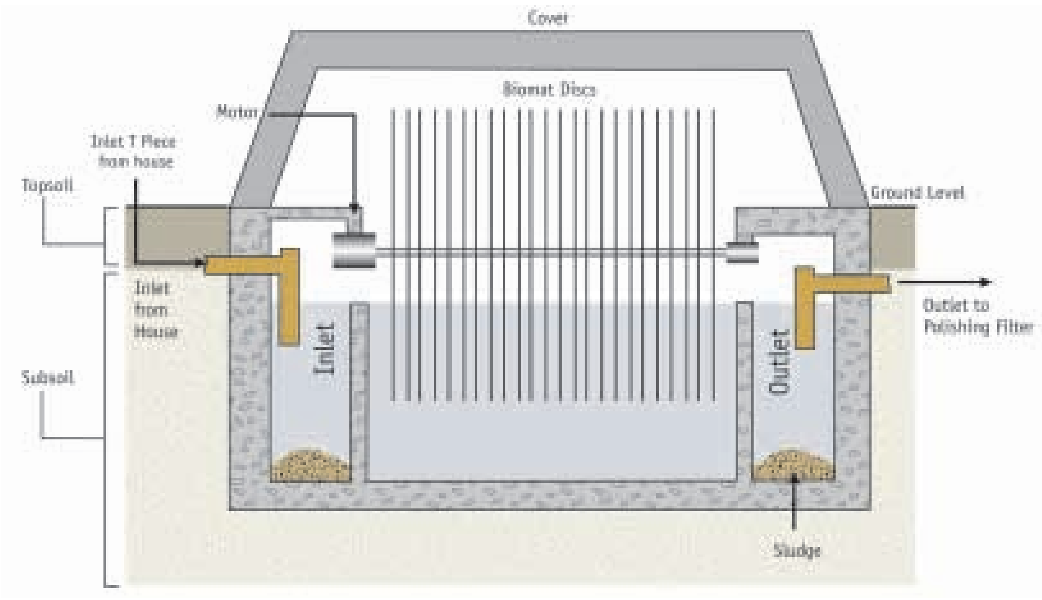


FIGURE 9.2. SCHEMATIC OF A ROTATING BIOLOGICAL CONTACTOR (RBC) SYSTEM.

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.

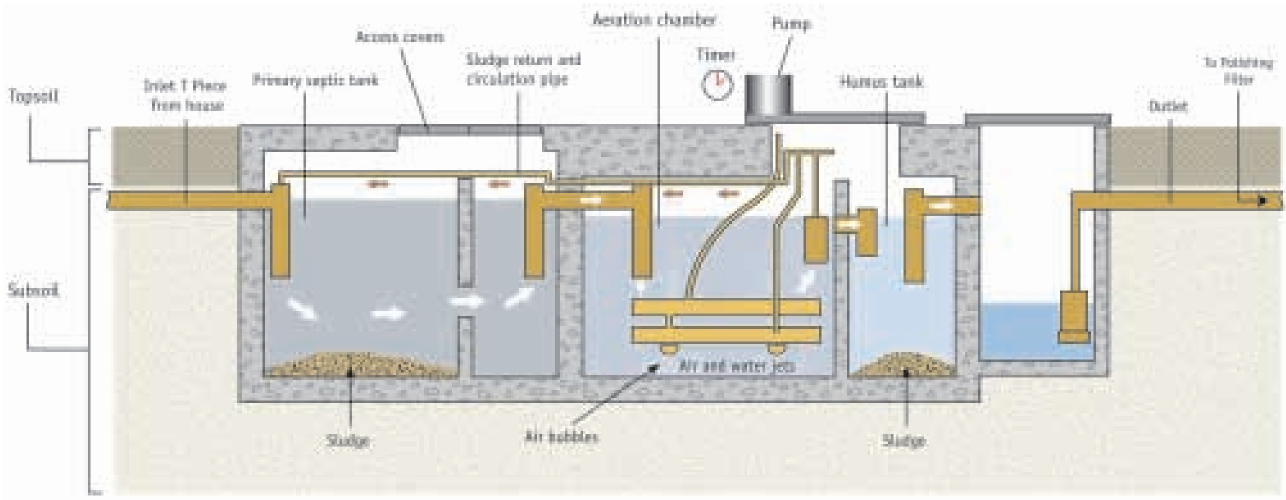


FIGURE 9.3. SCHEMATIC OF A SEQUENCING BATCH REACTOR (SBR) SYSTEM.

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

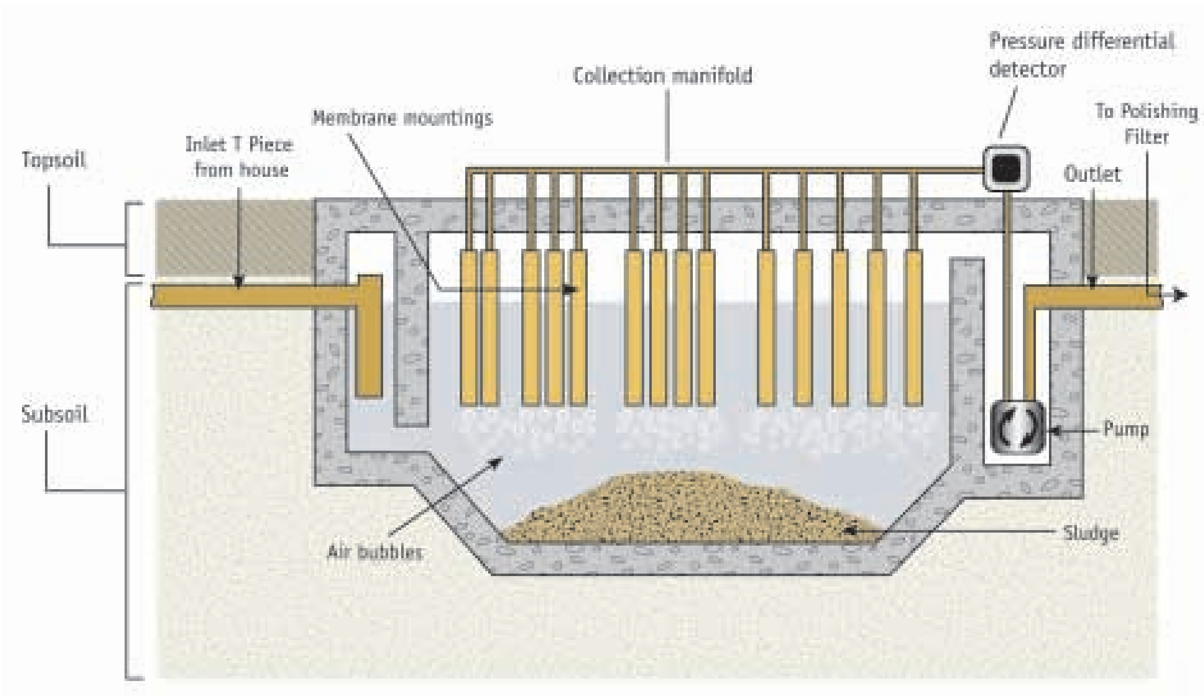


FIGURE 9.4. SCHEMATIC LAYOUT OF A MEMBRANE FILTRATION SYSTEM.

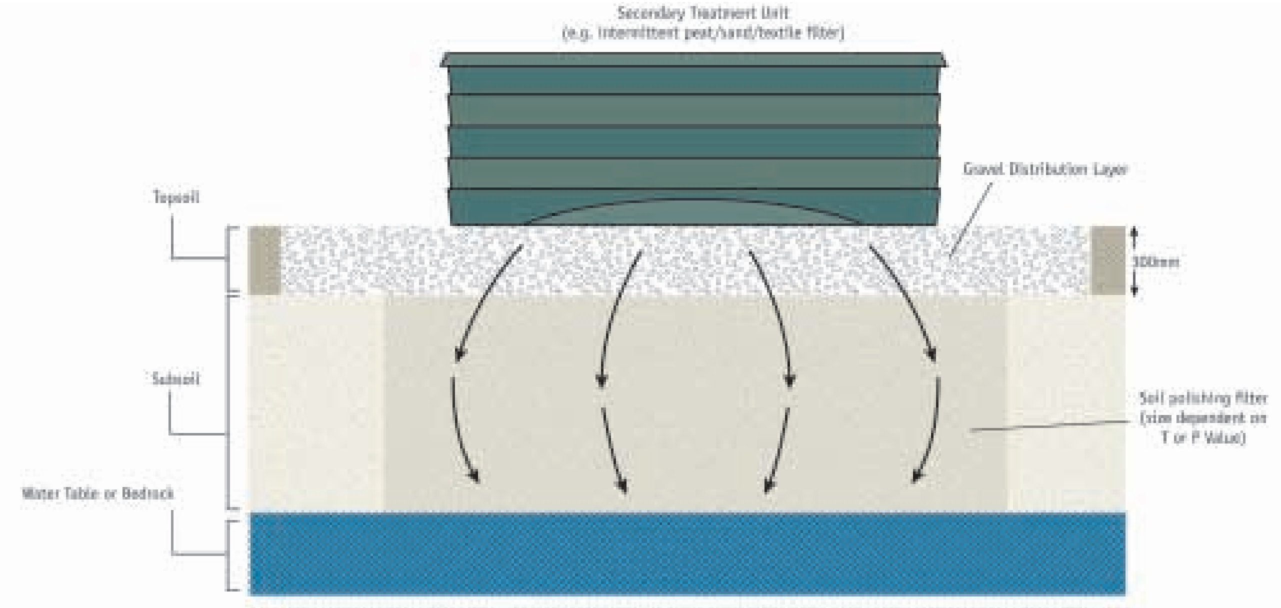


FIGURE 9.5. SCHEMATIC OF A PACKAGED PEAT FILTER SYSTEM.

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.

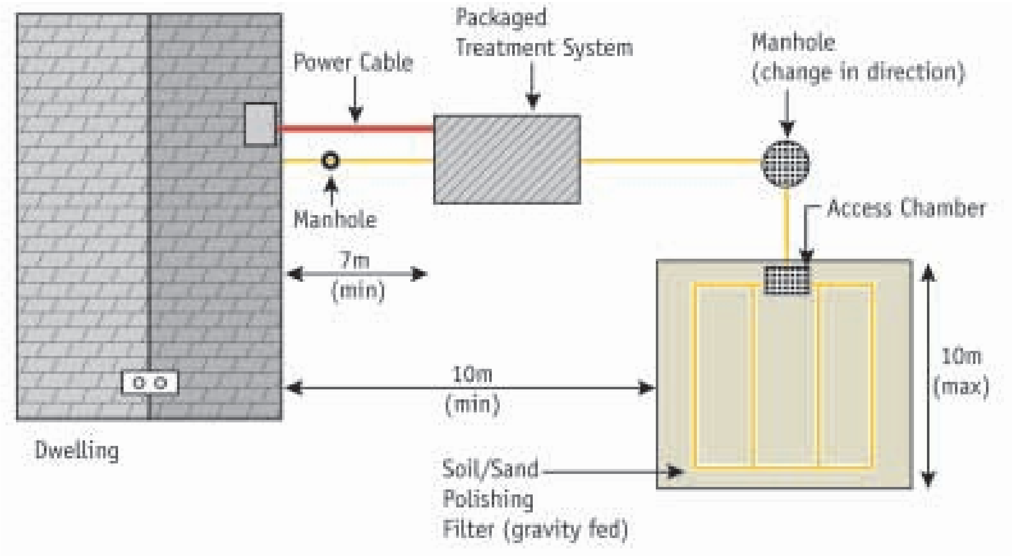


FIGURE 9.6. ILLUSTRATION OF A PACKAGE SYSTEM AND POLISHING FILTER SYSTEM.

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 200-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 1–75 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 7.2, 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	≥45	≤50	≥36
21–40	≤10	≥90	≤25	≥72
41–50	≤5	≥180	≤25	≥72
51–75	≤3	≥240	≤16	≥90

[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

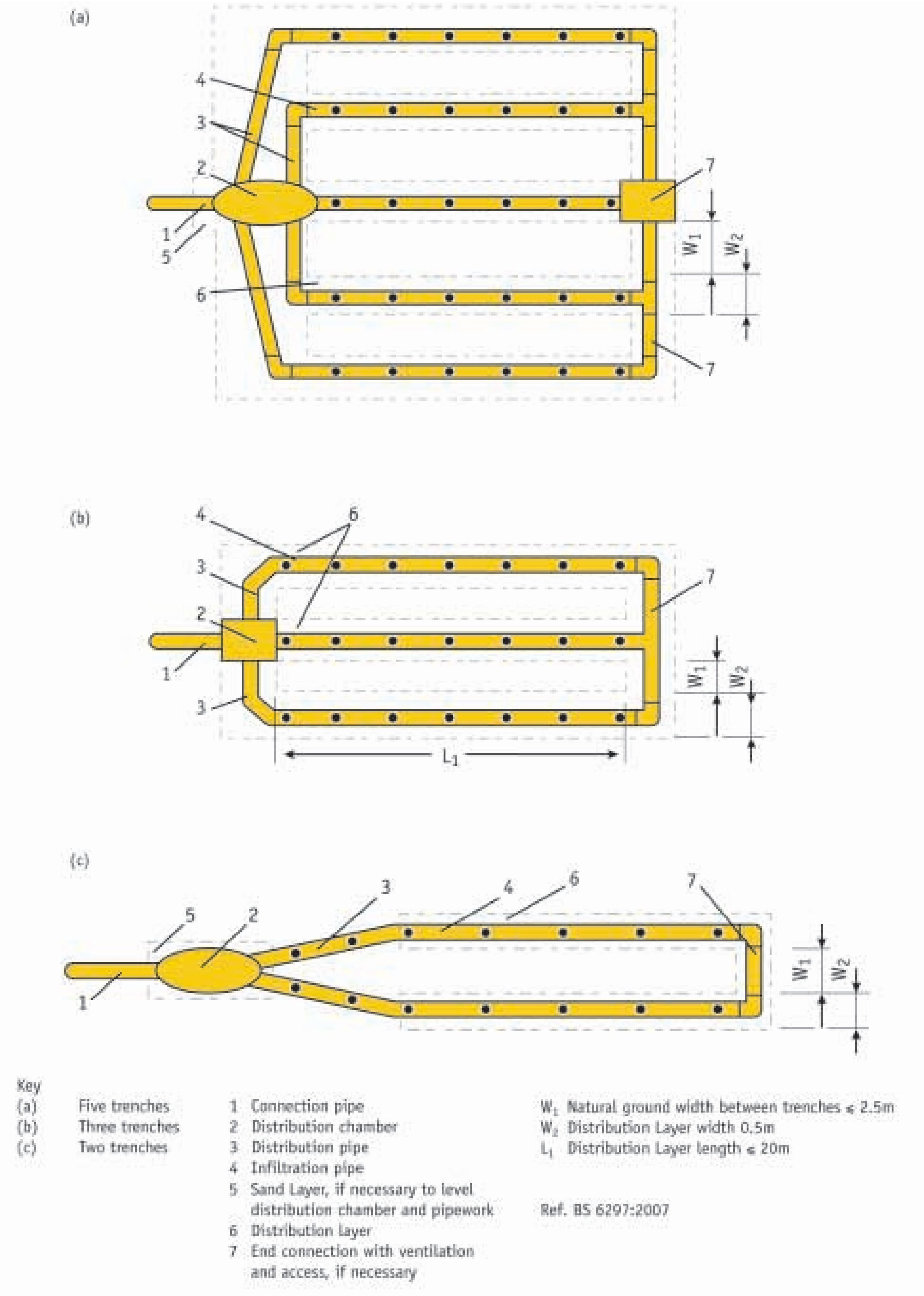


FIGURE 11.1. INFILTRATION TRENCHES – LAYOUT EXAMPLES.

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.

PART TWO: GUIDANCE

Annex A Policy Background

A.1 General

The 2006 census indicated that around 40% of the population of Ireland lived outside of the main cities and towns with a population of 1,500 and over. Unlike other, more urbanised, European countries, around a third of the population of Ireland lives in the open countryside in individual dwellings not connected to a public sewer. The wastewater from such rural settlement patterns is disposed of to systems of various types designed to treat the wastewater at or near the location where it is produced. Ireland enjoys a high-quality environment and the conservation and enhancement of our environment is a key objective for the future. It is correspondingly vital that the protection of our environment and specifically ground and surface water quality, is a central objective in the assessment, design, installation and maintenance of new wastewater disposal systems in un-sewered areas. This code of practice (CoP) establishes an overall framework of best practice in meeting the above objective.

The Minister for the Environment published planning guidelines under Section 28 of the Planning and Development Act 2000 on *Sustainable Rural Housing* in 2005. The guidelines establish an overall national-level policy framework for future housing development in rural areas, which has been adopted into the majority of county development plans. In particular, the guidelines highlight that those sites for new houses in un-sewered rural areas must be suitable for the installation and operation of on-site wastewater treatment systems and take into account local ground conditions. This CoP contains an assessment methodology for the determination of whether or not a site is deemed suitable.

The Department of the Environment, Heritage and Local Government (DoEHLG) issued a *Circular Letter* (SP 5/03) to planning authorities on 31 July 2003. This Circular drew the attention of planning authorities to the vital importance of sound development plan policies relating to the protection of surface and groundwater quality, the importance of good location and design of necessary development in rural areas, and the then current standards for on-site wastewater treatment systems.

The overall regulatory and policy framework at national level is therefore clear on the need for the application of high standards in the assessment of, provision and maintenance of effective on-site wastewater disposal systems for new housing developments in rural areas and this CoP presents comprehensive recommendations for the attainment of such high standards in line with the regulatory and policy frameworks.

A.2 Planning Authorities

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

Planning authorities therefore have a key role in making decisions on the suitability of sites for development, and the assessment of the suitability of particular sites for on-site wastewater treatment and disposal systems will be a key element of such decision-making processes in un-sewered areas. This CoP provides the methodology for undertaking such site suitability assessments in accordance with the overall regulatory and policy framework set out by the DoEHLG relating to the planning system.

Assessment of site suitability under this CoP should have regard to policies contained in the development plans as referred to above and any other relevant parallel documents such as groundwater protection schemes (GWPSs) prepared by the Geological Survey of Ireland (GSI) and river basin management plans produced under the Irish transposition of the EU Water Framework Directive.

Many on-site wastewater treatment systems are available for single houses and are designed to:

- Treat the wastewater to minimise contamination of soils and waterbodies
- Prevent direct discharge of untreated wastewater to the groundwater or surface water
- Protect humans from contact with wastewater
- Keep animals, insects, and vermin from contact with wastewater, and
- Minimise the generation of foul odours.

Public health specifically and water quality in general are threatened when on-site systems fail to operate satisfactorily. System failures can result in wastewater ponding or forming stagnant pools on the ground surface when the wastewater is not absorbed by the soil. In such circumstances of system failure, humans can come in contact with the ponded wastewater and be exposed to pathogens and also foul odours can be generated. Inadequately treated wastewater through poor location, design and/or construction may lead to contamination of our groundwater and surface waters, which in many areas are also used as drinking water supplies. In some cases, both the wastewater treatment system and the private drinking water supply source are located on the one site; therefore, it is essential that the effluent is properly treated and disposed of. It is the responsibility of the homeowner to ensure that the wastewater treatment system is installed in accordance with the planning permission and any relevant conditions attached thereto, and that it is properly maintained on a regular basis to ensure that it does not cause pollution of the environment or of drinking waters.

A.3 Legislative Provisions

Wastewater treatment systems are designed to discharge treated effluent to waters; in Ireland most of the small-scale on-site systems discharge to ground *via* percolation through the soil and subsoil. In all cases, the requirements of the water protection legislation shall be complied with. The main water protection legislation includes:

- Water Services Act, 2007 (S.I. No. 30 of 2007)
- Local Government (Water Pollution) Act, 1977 (S.I. No. 1 of 1977).
- Local Government (Water Pollution) (Amendment) Act, 1990 (S.I. No. 21 of 1990)
- Local Government (Water Pollution) Act, 1997 (Water Quality Standard for Phosphorus) Regulations, 1998 (S.I. No. 258 of 1998)
- Local Government (Water Pollution) Regulations, 1978 (S.I. No. 108 of 1978)
- Local Government (Water Pollution) Regulations, 1992 (S.I. No. 271 of 1992)
- Local Government (Water Pollution) (Amendment) Regulations, 1996 (S.I. No. 184 of 1996)
- Local Government (Water Pollution) (Amendment) Regulations, 1999 (S.I. No. 42 of 1999)
- Protection of Groundwater Regulations, 1999 (S.I. No. 41 of 1999)
- Fisheries (Consolidation) Act (Amendment) 1959.

In addition, the following European legalisation provides protection to groundwater:

- Council Directive on the protection of groundwater against pollution caused by certain dangerous substances (80/68/EEC)

- Council Directive concerning the protection of waters against pollution caused by nitrates from agricultural sources (91/676/EEC)

- Directive 2000/60/EC of the European Parliament and Council establishing a framework for Community action in the field of water policy (2000/60/EC) (commonly referred to as the Water Framework Directive), and

- Directive 2006/118/EC of the European Parliament and Council on the protection of groundwater against pollution and deterioration (2006/118/EC).

At European level, work is being completed on the development of the EN 12566 series of standards for *Small Wastewater Treatment Systems for up to 50 PT*. The EN 12566 series of standards is developed and published by Comité Européen de Normalisation (European Committee for Standardisation) (CEN) and adopted by the National Standards Authority of Ireland (NSAI). Their content has been taken into account in the preparation of this document.

I.S. EN 12566-1:2000/A1:2004, I.S. EN 12566-3:2005 and I.S. EN 12566-4:2007 are construction product standards within the terms of the Construction Products Directive and, as such, any requirements regarding the specification and performance of products covered by these standards and referenced in Annex ZA of the standard, must be based on the content of the standard and the tests and procedures defined in the standards. prEN 12566-6 and prEN 12566-7, when adopted, will also be construction product standards and similar considerations will apply.

The CoP cross-references the appropriate sections of the standard; however, the reader is referred to the individual parts of the standards/technical reports for full details. The status of the individual parts is listed below:

- 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 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/TR12566-5:2008 *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).

Some of these standards apply to (or will apply to) products that are deemed to be construction products for the purposes of the Construction Products Directive and are know as harmonised European Standards (hENs), e.g. I.S. EN 12566-1:2000/A1:2004, I.S. EN 12566-3:2005 and I.S. EN 12566-4:2007, etc. At the end of a set co-existence period, existing conflicting national standards must be withdrawn and all relevant products being placed on the market should comply with the harmonised parts of the standard and meet the performance requirement as set out in Part One of this CoP. The coexistence period for harmonised European Standards can be found on the European Commissions NANDO database (http://ec.europa.eu/enterprise/new approach/nando/).

In the case of a hEN not yet being 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 as set out in Part One of this CoP.

The DoEHLG issued a *Circular Letter* (BC16/2006) in November 2006 providing interim advice to local authorities in relation to European Standards for domestic wastewater treatment plants. It advises that I.S. EN 12566-3:2005 has been adopted by CEN and transposed in Ireland by the NSAI as I.S. EN 12566-3:2005. Wastewater treatment plants are deemed to be construction products for the purposes of the Construction Products Directive (89/106/EEC) and the requirements of that directive apply to these systems. It also indicates that the Second Edition of the Environmental Protection Agency (EPA) Wastewater Treatment Manual: *Treatment Systems for Single Houses* (now the *Code of Practice: Wastewater Treatment and Disposal Systems Serving Single Houses*) will provide guidance on performance levels that can be generally applied; in their absence it refers to the wastewater treatment performance standards of the Irish Agrément Board (IAB). They are biochemical oxygen demand – 20 mg/l, suspended solids – 30 mg/l, and ammonia as NH_4 – 20 mg/l.

Annex B Groundwater Protection Response

B.1 Background

The primary responsibility for groundwater protection rests with any person who is carrying on an activity that poses a threat to groundwater. Groundwater in Ireland is protected under European Community and national legislation. Local authorities and the Environmental Protection Agency (EPA) have responsibility for enforcing this legislation. In 1999, the GSI, in conjunction with the Department of Environment and Local Government (DoELG) and the EPA, issued guidelines on the preparation of GWPSs to assist the statutory authorities and others to meet their responsibility to protect groundwater (DoELG/EPA/GSI, 1999a,b). A GWPS incorporates land surface zoning and groundwater protection responses (GWPRs).

This document is concerned with GWPRs for the siting of on-site wastewater treatment systems for a dwelling house of up to 10 people with facilities for toilet usage, living, sleeping, bathing, cooking and eating. The GWPRs outline acceptable on-site wastewater treatment systems in each groundwater protection zone (DoELG/EPA/GSI, 2001) and recommend conditions and/or investigations depending on the groundwater vulnerability, the value of the groundwater resource and the contaminant loading. It should be noted that these responses update the responses issued in 2001 and relate to discharges from single houses to groundwater. Less stringent responses may be appropriate for discharges to surface waters.

In Ireland, wastewater from approximately 400,000 dwellings is treated by on-site systems. On-site systems can be subdivided into two broad categories: septic tank systems and mechanical aeration systems.

A septic tank system consists of a septic tank followed by a soil percolation area. As an alternative to a percolation area the effluent from a septic tank can be treated by filter systems such as:

- A soil percolation system in the form of a mound
- An intermittent sand filter followed by a polishing filter
- An intermittent peat filter followed by a polishing filter
- An intermittent plastic or other media filter followed by a polishing filter, or
- A constructed wetland or reed bed, followed by a polishing filter.

Mechanical aeration systems include biofilm aerated (BAF) systems, rotating biological contactor (RBC) systems, and sequencing batch reactor (SBR) systems. The effluent from a mechanical aeration system should be treated by a polishing filter to reduce micro-organisms, and in some soil conditions phosphorus. On-site wastewater systems are the primary method used for the treatment and disposal of domestic wastewater in rural areas. These systems are also used in urban areas, which are not connected to public sewer systems. On-site domestic wastewater treatment systems are often located close to private or public wells.

When choosing the location and type of on-site system, builders should have regard to any nearby groundwater source, the groundwater as a resource and the vulnerability of the underlying groundwater. The GWPRs in this guidance combine these factors to produce a response matrix.

The objectives of these GWPRs are:

- To reduce the risk of pollutants reaching drinking water supplies
- To reduce the risk of pollution of aquifers
- To minimise pollution of domestic wells, and

- To provide advice where it is proposed to locate domestic wells in the vicinity of existing wastewater treatment systems and *vice versa*.

The risk from on-site wastewater treatment systems is mainly influenced by:

- Its proximity to a groundwater source
- The groundwater vulnerability
- The value of the groundwater resource
- The depth of the water table
- The groundwater flow direction, and
- The type of on-site system and the quality of the final effluent.

The use of these GWPRs allows decisions to be made on the acceptability or otherwise of on-site wastewater treatment systems from a hydrogeological point of view.

These GWPRs should be read in conjunction with *Groundwater Protection Responses for On-Site Wastewater Systems for Single Houses* (DoELG/EPA/GSI, 2001). Other published responses in this series are *Groundwater Protection Responses for Landfills* (DoELG/EPA/GSI, 1999a) and *Groundwater Protection Response to the Landspreading of Organic Wastes* (DoELG/EPA/GSI, 1999b).

B.2 Effluent from On-site Wastewater Treatment Systems for Single Houses: a Potential Hazard for Groundwater

The typical characteristics of domestic wastewater are outlined in Table B.1. Particular contaminants of concern are pathogenic organisms and nitrates.

B.3 Pathogenic Organisms

Pathogenic organisms can cause gastroenteritis, polio, hepatitis, meningitis and eye infections. Organisms such as *Escherichia coli*, streptococci and faecal coliforms, with the same enteric origin as pathogens, indicate whether pathogens may be present or not in wastewater.

B.4 Nitrates

Nitrate in excess concentrations in water may constitute a risk to human health and the environment. Nitrogen enters on-site wastewater treatment systems mainly as organic nitrogen, which means that the nitrogen is part of a large biological molecule such as a protein. Bacteria and other microbes oxidise or mineralise the organic nitrogen to ammonia, which is further oxidised to nitrites and nitrates.

TABLE B.1. CHARACTERISTICS OF DOMESTIC WASTEWATER FOR A SINGLE HOUSE.

Parameter	Typical mean influent concentration (mg/l)[1]
Chemical oxygen demand (COD) (as O_2)	956
Biological oxygen demand (BOD_5) (as O_2)	318[2]
Total suspended solids	200[3]
Ammonia (NH_4-N)	70
***Ortho*-phosphorus (PO_4-P)**	18
Total coliforms[4] (MPN/100 ml)	4.1×10^7
***Escherichia coli*[4] (MPN[5]/100 ml)**	7.1×10^5

[1]Back-calculated septic tank influent concentrations (mean) from 2000-MS-15-M1 and 2005-W-MS-15.
[2]BOD:COD ratio of 1:3 from 2005-W-MS-15.
[3]EPA, 2000.
[4]Median values.
[5]Most probable number (MPN/100 ml).

B.5 Groundwater Protection Response Matrix for Single House Systems

The reader is referred to the full text in *Groundwater Protection Responses for On-Site Systems for Single Houses* (DoELG/EPA/GSI, 2001) for an explanation of the role of GWPRs in a GWPS.

A risk assessment approach is taken in the development of this response matrix. A precautionary approach is taken because of the variability of Irish subsoils, bedrock and the possibility that the treatment system may not function properly at all times. Where there is a high density of dwellings in the vicinity of public, group scheme or industrial water supply sources, more restrictive conditions may be required or the development may need to be refused. The density of dwellings and associated treatment systems may impact on the groundwater because of the cumulative loading, particularly of nitrate. This should be taken into account especially where the vulnerability of the groundwater is high or extreme.

The potential suitability of a site for the development of an on-site system is assessed using the methodology outlined in Section 6. The methodology includes a desk study and on-site assessment (visual, trial hole test and percolation tests). The GWPRs set out in Table B.2 should be used during the desk study assessment of a site to give an early indication of the suitability of a site for an on-site system. Information from the on-site assessment should be used to confirm or modify the response. In some situations, site improvement works, followed by reassessment of the groundwater responses, may allow a system to be developed. Site improvements are dealt with in Section 6.5.

Where groundwater protection zones have not yet been delineated for an area, the responses below should be used in the following circumstances:

- Where on-site systems are proposed in the vicinity of domestic wells
- Where on-site systems are proposed in the vicinity of sources of water with an abstraction rate above 10 m^3/day (e.g. public, group scheme and industrial supply wells and springs)
- Where groundwater is extremely vulnerable (based on the visual assessment and trial hole test), and
- Where there are karst features such as swallow holes, caves, etc.

The appropriate response to the risk of groundwater contamination from an on-site wastewater treatment system is given by the assigned response category (R) appropriate to each protection zone.

TABLE B.2. RESPONSE MATRIX FOR ON-SITE TREATMENT SYSTEMS.

Vulnerability rating	Source protection Area[1]		Resource protection area Aquifer category					
			Regionally improved		Locally improved		Poor aquifers	
	Inner (SI)	Outer (SO)	Rk	Rf/Rg	Lm/Lg	Ll	Pl	Pu
Extreme (E)	R3[2]	R3[1]	R2[2]	R2[2]	R2[1]	R2[1]	R2[1]	R2[1]
High (H)	R2[4]	R2[3]	R2[1]	R1	R1	R1	R1	R1
Moderate (M)	R2[4]	R2[3]	R1	R1	R1	R1	R1	R1
Low (L)	R2[4]	R1	R1	R1	R1	R1	R1	R1

[1]For public, group scheme or industrial water supply sources where protection zones have not been delineated, the arbitrary distances given in DoELG/EPA/GSI (1999a,b) of 300 m for the Inner Protection Area (SI) and 1,000 m for the Outer Protection Area (SO) should be used as a guide up-gradient of the source.

Rk, Regionally Important Karstified Aquifers; Rf, Regionally Important Fissured Bedrock Aquifers; Rg, Regionally Important Extensive Sand and Gravel Aquifers; Lg, Locally Important Sand/Gravel Aquifers; Lm, Locally Important – Bedrock Aquifer which is generally moderately productive; Ll, Locally Important – Bedrock Aquifer which is moderately productive in local zones; Pl, Poor – Bedrock Aquifer which is generally unproductive except for local zones; Pu, Poor – Bedrock Aquifer which is generally unproductive.

R1 Acceptable subject to normal good practice (i.e. system selection, construction, operation and maintenance in accordance with this CoP).

R2[1] Acceptable subject to normal good practice. Where domestic water supplies are located nearby, particular attention should be given to the depth of subsoil over bedrock such that the minimum depths required in Section 6 are met and that the likelihood of microbial pollution is minimised.

R2[2] Acceptable subject to normal good practice and the following additional condition:

1. There is a minimum thickness of 2 m unsaturated soil/subsoil beneath the invert of the percolation trench of a septic tank system

or

1. A secondary treatment system as described in Sections 8 and 9 is installed, with a minimum thickness of 0.3 m unsaturated soil/subsoil with P/T-values from 3 to 75 (in addition to the polishing filter which should be a minimum depth of 0.9 m), beneath the invert of the polishing filter (i.e. 1.2 m in total for a soil polishing filter).

R2[3] Acceptable subject to normal good practice, Condition 1 above and the following additional condition:

2. The authority should be satisfied that, on the evidence of the groundwater quality of the source and the number of existing houses, the accumulation of significant nitrate and/or microbiological contamination is unlikely.

R2[4] Acceptable subject to normal good practice, Conditions 1 and 2 above and the following additional condition:

3. No on-site treatment system should be located within 60 m of a public, group scheme or industrial water supply source.

R3[1] Not generally acceptable, unless:

A septic tank system as described in Section 7 is installed with a minimum thickness of 2 m unsaturated soil/subsoil beneath the invert of the percolation trench (i.e. an increase of 0.8 m from the requirements in Section 6)

or

A secondary treatment system, as described in Sections 8 and 9, is installed, with a minimum thickness of 0.3 m unsaturated soil/subsoil with P/T-values from 3 to 75 (in addition to the polishing filter which should be a minimum depth of 0.9 m), beneath the invert of the polishing filter (i.e. 1.2 m in total for a soil polishing filter)

and subject to the following conditions:

1. The authority should be satisfied that, on the evidence of the groundwater quality of the source and the number of existing houses, the accumulation of significant nitrate and/or microbiological contamination is unlikely

2. No on-site treatment system should be located within 60 m of a public, group scheme or industrial water supply source

3. A management and maintenance agreement is completed with the systems supplier.

R3[2] Not generally acceptable unless:

A secondary treatment system is installed, with a minimum thickness of 0.9 m unsaturated soil/subsoil with P/T-values from 3 to 75 (in addition to the polishing filter which should be a minimum depth of 0.9 m), beneath the invert of the polishing filter (i.e. 1.8 m in total for a soil polishing filter)

and subject to the following conditions:

1. The authority should be satisfied that, on the evidence of the groundwater quality of the source and the number of existing houses, the accumulation of significant nitrate and/or microbiological contamination is unlikely

2. No on-site treatment system should be

located within 60 m of a public, group scheme or industrial water supply source

3. A management and maintenance agreement is completed with the systems supplier.

The responses above assume that there is no significant groundwater contamination in the area. Should contamination by pathogenic organisms or nitrate (or other contaminants) be a problem in any particular area, more restrictive responses may be necessary. Where nitrate levels are known to be high or nitrate-loading analysis indicates a potential problem, consideration should be given to the use of treatment systems, which include a de-nitrification unit. Monitoring carried out by the local authority will assist in determining whether or not a variation in any of these responses is required.

Sites are not suitable for discharge of effluent to ground for very low permeability subsoils (where T > 90).

B.6 Additional Requirements for the Location of On-Site Treatment Systems Adjacent to Receptors at Risk, such as Wells and Karst Features

Table B.2 outlines responses for different hydrogeological situations, which may restrict the type of on-site treatment system, and should be satisfied in the first instance. Once a response has been determined for a site, the next step is to manage the risk posed to the features identified during the desk study and on-site assessment. These features include water supply wells and springs (public and domestic), and karst features that enable the soils and subsoil to be bypassed (e.g. swallow holes, collapse features).

Table B.3 provides recommended distances between receptors (see also Fig. B.1) and percolation area or polishing filters, in order to protect groundwater. These distances depend on the thickness and permeability of subsoil. The depths and distances given in this table are

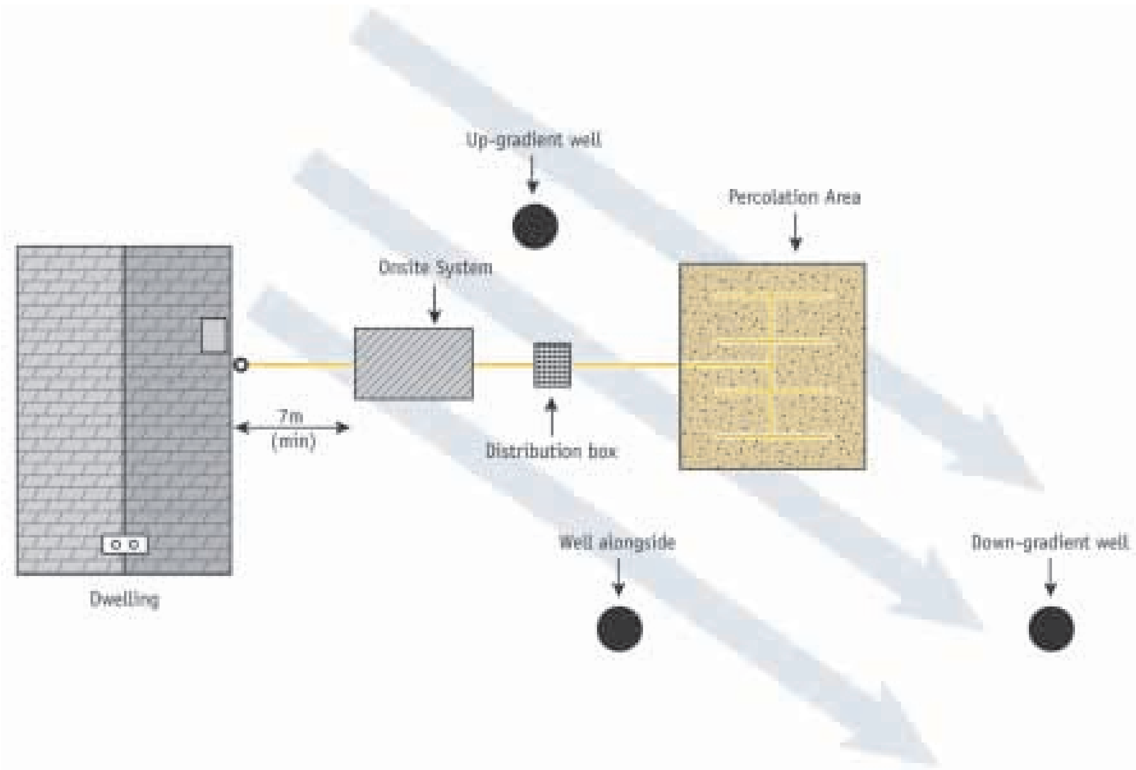


FIGURE B.1. RELATIVE LOCATION OF WELLS.

TABLE B.3. RECOMMENDED MINIMUM DISTANCE BETWEEN A RECEPTOR AND A PERCOLATION AREA OR POLISHING FILTER.

T/P-value[1]	Type of soil/subsoil[2]	Depth of soil/subsoil (m above bedrock) (see Notes 1, 2, 3, 6)	Minimum distance (m) from receptor to percolation area or polishing filter[5]				
			Public water supply	Karst feature	Down-gradient domestic well or flow direction is unknown (see Note 5)	Domestic well alongside (no gradient)	Up-gradient domestic well
>30	CLAY; sandy CLAY (e.g. clayey till); SILT/CLAY	1.2 >3.0	60	15	40 30	25	15
10–30	Sandy SILT; silty SAND; silty GRAVEL (e.g. sandy till)	1.2 >8.0	60	15	45 30	25	15
<10	SAND; GRAVEL; silty SAND	2.0[3] 2.0[4] >8.0[4]	60	15	60 40 30	25	15

[1]The T-value (expressed as min/25 mm) is the time taken for the water level to drop a specified distance in a percolation test hole. For shallow subsoils the test hole requirements are different and hence the test results are called P-values. For further advice see Annex C.
[2]BS 5930 descriptions.
[3]Water table 1.2–2.0 m.
[4]Water table >2.0 m.
[5]The distance from the percolation area or polishing filter means the distance from the periphery of the percolation area or polishing filter and not from the centre.

Notes:

1. Depths are measured from the invert level of the percolation trench.
2. Depths and distances can be related by interpolation: e.g. where the thickness of sandy CLAY is 1.2 m, the minimum recommended distance from the well to percolation area is 40 m; where the thickness is 3.0 m, the distance is 30 m; distances for intermediate depths can be approximated by interpolation.
3. Where bedrock is shallow (<2 m below invert of the trench), greater distances may be necessary where there is evidence of the presence of preferential flow paths (e.g. cracks, roots) in the subsoil.
4. Where the minimum subsoil thicknesses are less than those given above, site improvements and systems other than systems as described in Sections 8 and 9 may be used to reduce the likelihood of contamination.
5. If effluent and bacteria enter bedrock rapidly (within 1–2 days), the distances given may not be adequate where the percolation area is in the zone of contribution of a well. Further site-specific evaluation is necessary.
6. Where bedrock is known to be karstified or highly fractured, greater depths of subsoil may be advisable to minimise the likelihood of contamination.

based on the concepts of 'risk assessment' and 'risk management', and take account, as far as practicable, of the uncertainties associated with hydrogeological conditions in Ireland. Use of the depths and distances in this table does not guarantee that pollution will not be caused; rather, it will reduce the risk of significant pollution occurring.

Where an on-site system is in the zone of contribution of a well, the likelihood of contamination and the threat to human health depend largely on five factors:

1. The thickness and permeability of subsoil beneath the invert of the percolation trench
2. The permeability of the bedrock, where the well is tapping the bedrock
3. The distance between the well or spring and the on-site system
4. The groundwater flow direction, and
5. The level of treatment of effluent.

Annex C Site Characterisation

The key to installing a reliable on-site system that minimises the potential for pollution is to select and design a suitable treatment system following a thorough site assessment. For a subsoil to be effective as a medium for treating wastewater, it should be permeable enough to allow throughflow and remain unsaturated, whilst capable of retaining the wastewater for a sufficient length of time to allow attenuation in the aerobic conditions.

Only after a site assessment has been completed can an on-site system be chosen if the site has been deemed suitable. The information collected in the evaluation will be used to select the on-site system. The following sections elaborate on the requirements set out in Section 6 of the code. The relevant sections of the Site Characterisation Form should be completed in all cases.

C.1 Desk Study

The purposes of the desk study are to:

- Obtain existing information relevant to the site, which will assist in assessing its suitability
- Identify targets at risk, and
- Establish if there are restrictions relating to the site.

A desk study involves the assessment of available data pertaining to the site and adjoining areas that may determine whether the site has any restrictions. Information collected from the desk study should include any material related to the hydrological, hydrogeological and planning aspects of the site that may be available. The density of existing housing and performance of the existing wastewater treatment systems will affect existing groundwater quality and should be noted at this stage. In addition, the location of any archaeological or natural heritage sites (Special Area of Conservation (SAC), Special Protection Area (SPA), etc.) in the vicinity of the proposed site should be identified. The Local Development Plan and planning register can contain a wide range of planning and environmental information. The local authority heritage officer should also be consulted to determine the significance of any archaeological sites located in the vicinity.

The GWPSs provide guidelines for builders in assessing groundwater resources and vulnerability and for planning authorities in carrying out their groundwater protection functions. They provide a framework to assist in decision making on the location, nature and control of developments and activities (including single-house treatment systems) in order to protect groundwater. GWPR zoning outlines the aquifer classification in the general area and the vulnerability of the groundwater. The GWPRs will provide an early indication of the probable suitability of a site for an on-site system. The on-site assessment will later confirm or modify such responses. The density of on-site systems is also considered at this stage. The protection responses required to protect groundwater from on-site systems should be satisfied. Where no GWPS exists, interim measures, as set out in the *Groundwater Protection Schemes* should be adopted. If additional requirements are required then this should be noted in the comments section. Also, if there are existing or proposed wells in the area then the minimum distances set out in the GWPRs should be noted at this stage. Note, if the GWPR is $R2^3$ or higher, the groundwater quality needs to be assessed.

C.2 On-site Assessment

C.2.1 Visual assessment

The factors examined during a visual assessment and their significance are summarised in Table C.1. The principal factors that should be considered are as follows:

Landscape position: Landscape position reflects the location of the site in the landscape,

TABLE C.1. FACTORS TO BE CONSIDERED DURING VISUAL ASSESSMENT.

Factor	Significance
Water level in ditches and wells	Indicates depth of unsaturated subsoil available for treatment or polishing of wastewater
Landscape position	May indicate whether water will collect at a site or flow away from the site
Slope	Pipework, surface water run-off and seepage. Influences the design of the system
Presence of watercourses, surface water ponding	May indicate low permeability subsoil or a high water table
Presence and types of bedrock outcrops	Insufficient depth of subsoil to treat wastewater allowing it to enter the groundwater too fast
Proximity to existing adjacent percolation areas and/or density of houses	May indicate a high nutrient-loading rate for the locality and/or potential nuisance problems. The location of storm water disposal areas from adjacent houses also needs to be assessed with regard to its impact on the proposed percolation area
Land use and type of grassland surface (if applicable)	Suggests rate of percolation or groundwater levels
Vegetation indicators	Suggest the rate of percolation or groundwater levels. The presence of indicator plants should not be taken as conclusive evidence that the site is suitable for a drainage system, but they might indicate where any subsequent soil investigations could take place
Proximity to wells on-site and off-site, water supply sources, groundwater, streams, ditches, lakes, surface water ponding, beaches, shellfish areas, springs, karst features, wetlands, flood plains and heritage features	Indicates targets at risk

e.g. crest of hill, valley, slope of hill. Sites that are on level, well-drained areas, or on convex slopes are most desirable. Sites that are in depressions, or on the bottom of slopes or on concave slopes are less desirable and may be unsuitable.

Slope: It is more difficult to install pipework and ensure that the wastewater will stay in the soil if the land has a steep slope. In some cases the pipes should be laid along the contours of the slope. Where there is surface water run-off and interflow, low-lying areas and flat areas generally receive more water. This accounts to some extent for the occurrence of poorly drained soils in low-lying areas. Soils with poor drainage, however, may also be found on good slopes where the parent material or the subsoil is of low permeability. Provision should be made for the interception of all surface run-off and seepage, and its diversion away from the proposed percolation area. Mound filter systems are prohibited on sites where the natural slope is greater than 1:8 (12%) as this will lead to hydraulic overloading at the toe of the mound down slope.

Proximity to surface features: Minimum separation distances, as set out in the following sections should be maintained from specified features. The presence/location of surface features such as watercourses, including ecologically sensitive receiving waters, site boundaries, roads, steep slopes, etc., should be noted. Minimum separation distances are set out in Table 6.1. Note, distances from lakes or rivers should be measured from the high water level or flood water level.

Existing dwellings and wastewater treatment systems: The performance of existing wastewater treatment and storm water disposal systems should be examined and the cause of problems identified and brought to the attention of the local authority to address remediation. Potential impacts from adjacent wastewater treatment systems should also be considered.

In addition, the implication of any potential impact due to the increased nutrient load on the groundwater quality in the area should be assessed. This is particularly true in areas of high-density housing (iPlan system) and in areas where the background nitrate concentrations are already elevated. It is estimated that a 6 p.e. wastewater treatment system (without specially designed nutrient removal) will increase the nitrate levels by 21 mg/l NO_3 per hectare[6].

Wells/Springs: Wells should be considered as targets at risk. The number of wells and the presence of any springs should be noted. The minimum distances of wells/springs from wastewater treatment systems and percolation areas/polishing filters are set out in the GWPR for wastewater treatment systems for single houses (Annex B). Wastewater treatment systems do not pose a risk to decommissioned wells if the wells have been properly sealed off in accordance with BS 5930 or other guidance document.

Groundwater flow direction: In general, groundwater flow direction can be inferred from topography on sloping sites and/or proximity to surface water features such as rivers or lakes. It should be indicated on the site plan.

Outcrops and karst features: The presence of vulnerable features such as outcrops, swallow holes, etc., should be determined and the distance between them and the proposed development noted.

Drainage: A high density of streams or ditches tends to indicate a high water table and potential risk to surface water. Low stream density indicates a free-draining subsoil and/or bedrock.

Land use: Current and previous land use should be noted, in particular any previous development on the site should be highlighted such as old building foundations, etc. Housing density should also be noted.

Vegetation indicators: Rushes, yellow flags (irises), alders and willow suggest poor percolation characteristics or high water table levels. Grasses, trees and ferns may suggest suitable percolation characteristics. Plants and trees suggest good drainage and poor drainage are illustrated in Fig. C.1.

Ground conditions: The ground conditions during the on-site investigation should be noted. Trampling damage by livestock can indicate impeded drainage or intermittent high water tables, especially where accompanied by widespread ponding in hoof prints. Evidence of infill material or made ground should also be noted which may indicate the presence of soils with poor percolation properties beneath.

Minimum separation distances: The minimum separation distances, as set out in Section 6 – Table 6.1, should be checked at this stage of the assessment.

C.2.1.1 Plants indicative of drainage conditions

Figure C.1 illustrates plants that indicate dry conditions (good drainage) and others that indicate wet conditions (poor drainage) throughout the year. Some of the photos illustrate the plants in flower – this aspect should be ignored. Plants in flower, or otherwise, do not change their indicator status. Note that alder is a tree.

C.2.2 Trial hole assessment

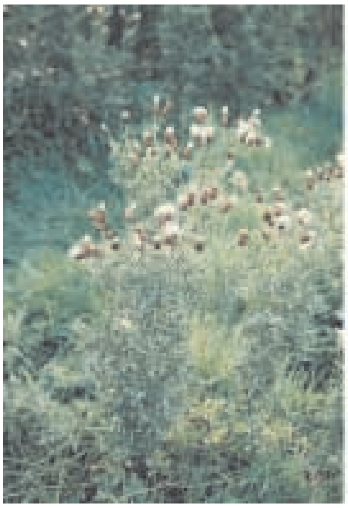
The trial hole should be located adjacent to but **not within** the proposed percolation area/ polishing filter, as the disturbed subsoil will provide a preferential flow path in the final percolation area.

The trial hole should remain open for a minimum period of 48 h to allow the water table (if present) to re-establish itself and be securely fenced off and covered over to prevent the ingress of surface water or rainwater. If on a sloping site then a small drainage channel should be dug on the up-slope side of the hole to prevent any surface water inflow into the trial hole.

The health and safety[7] aspects of placing a trial hole on the site should be borne in mind. A trial hole is a deep, steep-sided excavation, which may contain water and which may be difficult to exit from if improperly constructed. A risk of collapse of the side walls of the trial hole may

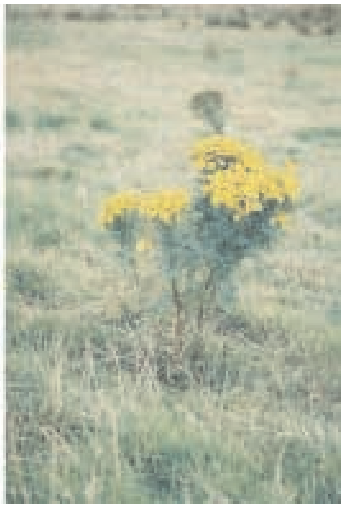
6. Section 13.2.14 *Site Suitability Assessments for On-Site Wastewater Management*, FÁS Course Manual, Vol. 2.

Dry conditions



Thistle

Bracken



Ragwort

Wet conditions

Alder

Iris

Rush

Willow

FIGURE C.1. INDICATOR PLANTS OF DRY AND WET CONDITIONS.

exist in some situations. All appropriate health and safety precautions should be taken. The depth of the percolation test hole is dependent on the subsoil characteristics present in the trial hole.

The soil and subsoil characteristics should be determined as per the code and the guidance below and documented in the Site Characterisation Form.

The observations made from the trial hole and their significance are summarised in Table C.2.

Depth to bedrock and depth to water table: For septic tank systems a depth of 1.2 m of suitable free-draining unsaturated subsoil, to the bedrock and to the water table below the base of the percolation trenches, should exist at all times to ensure satisfactory treatment of the wastewater. In the case of secondary treatment systems a minimum of 0.9 m unsaturated subsoil is required. Sites assessed in summer when the water table is low, should be examined below the proposed invert of the percolation pipe for soil mottling (Fig. C.2) –- an indicator of seasonally high water tables. For further details see the Groundwater Newsletter No. 45 issued by the GSI (Daly, 2006).

Soil texture: Texture is the relative proportions of sand, silt and clay particles in a soil. The relative proportions of these constituents are determined using the British Standard

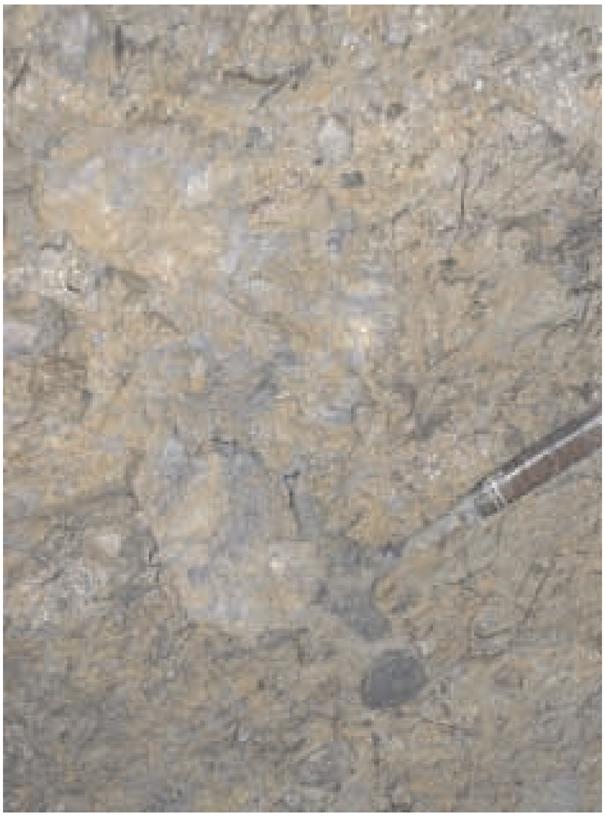


FIGURE C.2. CLOSE-UP OF MOTTLING IN TRIAL HOLE.

BS 5930:1999 *Code of practice for site investigations*. The rate and extent of many important physical processes and chemical reactions in soils are governed by texture. Physical processes influenced by texture include drainage and moisture retention, diffusion of gases and the rate of transport of contaminants. Texture influences the biofilm surface area in which biochemical and chemical reactions occur. The soil texture should be characterised using the BS 5930 classification. Every significant layer

7. Trial holes fall under the definition of construction work and all activities associated with them are subject to the Safety, Health and Welfare at Work (Construction) Regulations 2001 and amendments. Further information can be obtained from the Health and Safety Authority, 10 Hogan Place, Dublin 2.

TABLE C.2. FACTORS TO BE CONSIDERED DURING A TRIAL HOLE EXAMINATION.

Factors	Significance
Soil/subsoil structure and texture	Both influence the capacity of soil/subsoil to treat and dispose of the wastewater; subsoils with high clay content are generally unsuitable
Mottling (Fig. C.2)	Indicates seasonal high water tables or very low permeability subsoil
Depth to bedrock	Subsoil should be of sufficient depth to treat wastewater
Depth to water table	Saturated subsoils do not allow adequate treatment of wastewater
Water ingress along walls	Indicates high water table or saturated layers (e.g. perched water table)
Season	Water table varies between seasons (generally high in winter)

encountered in the trial hole should be described in the Site Characterisation Form.

A guide to assist the classification of soils/subsoils is included in Annex C.2.2.1. Various soil/subsoil texture classification schemes exist. Table C.3 indicates some typical percolation rates for different subsoil types but it is important to realise that the secondary constituents of the subsoil may have an effect on the percolation test results, as will structure and compactness.

TABLE C.3. SUBSOIL CLASSIFICATION AGAINST T-VALUES FOR 400 T-TESTS (JACKSON, 2005).

BS 5950 soil classification	T-value
GRAVEL	3–10
SAND	4–15
SILT	12–33
SILT/CLAY	15–43
CLAY	>37

Structure: Soil structure refers to the arrangement of the soil particles into larger units or compound particles in the soil. The soil particles, sand, silt, clay and organic matter, are generally clumped together to form larger units called peds. The shape and size of the peds can have a significant effect on the behaviour of soils. A ped is a unit of soil structure such as an aggregate, a crumb, a prism, a block or granules formed by natural processes. Soil texture plays a major part in determining soil structure. The structure of the soil influences the pore space, aeration and drainage conditions. The preferred structures from a wastewater treatment perspective are **granular** (as fine sand), blocky, structureless and single grain. Subsoils with extensive, large and continuous fissures and thick lenses of gravel and coarse sand may be unsuitable; this suitability will be assessed in the percolation test.

Peat soils when saturated are unsuitable for disposal of treated wastewater because they provide inadequate percolation and may result in ponding – particularly during the wintertime.

Soil compactness/density: This refers to how tightly the soil grains are packed together. It is commonly classified from un-compact to hard.

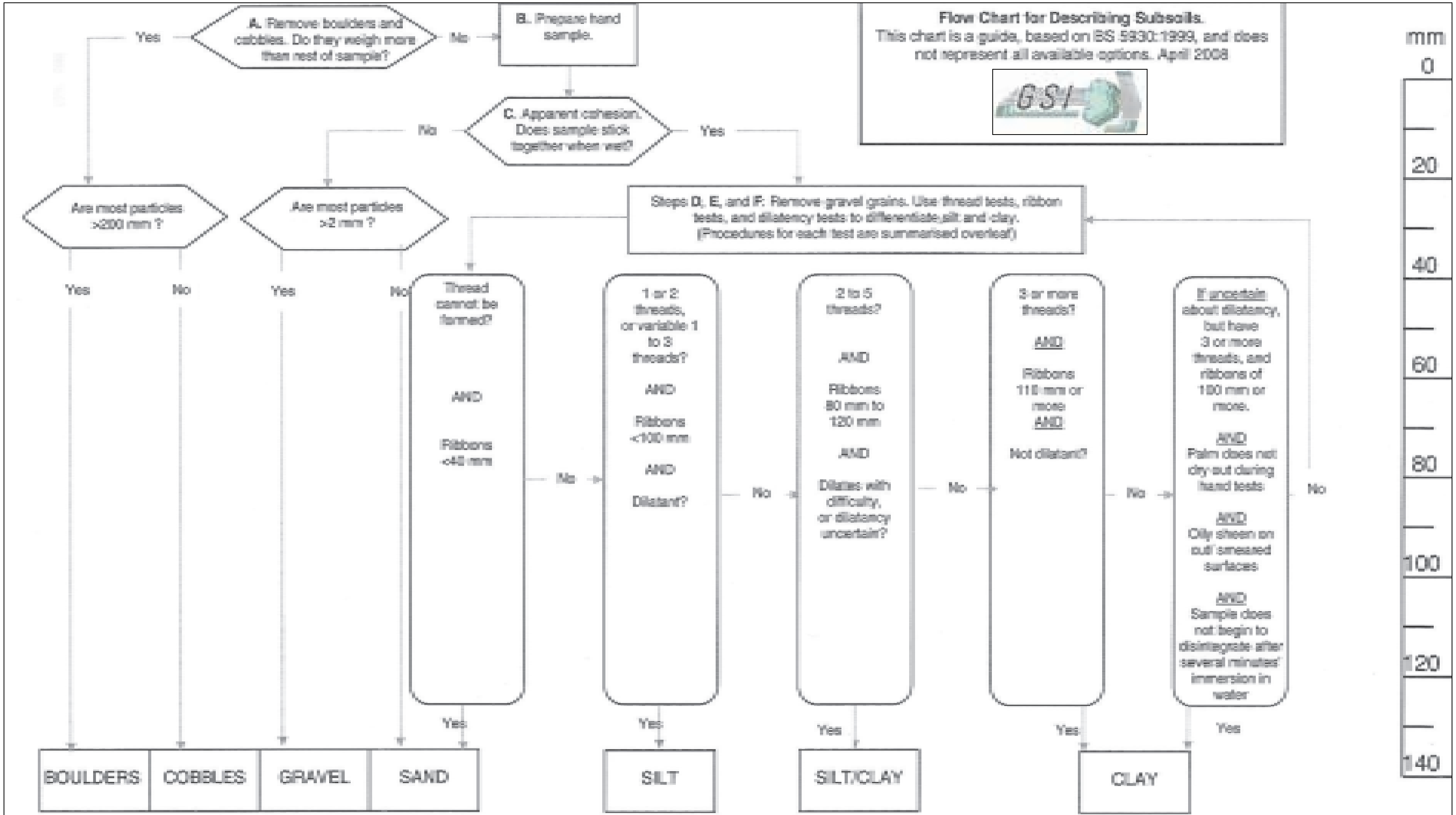
Colour: Colour is a good indicator of the state of aeration of the soil/subsoil. Free-draining soils/subsoils are in an oxidised state and exhibit brown, reddish brown and yellowish brown colours. Many free-draining soils of limestone origin with deep water tables are grey at depth (due to the colour of the parent material). Saturated soils/subsoils are in a reduced state and exhibit dull grey or mottled colours. Mottling (comprising a mix of grey and reddish brown or rusty staining) of the soil layers can indicate the height of the water table in winter.

Layering (stratification): This is common in soils, arising during deposition and/or subsequent weathering. In soils that are free draining in the virgin state, weathering can result in downward movement of some of the clay fraction leading to enrichment of a sub-layer with clay. In some areas a thin, hard, rust-coloured impervious layer can develop (iron pans) as a result of the downward leaching of iron and manganese compounds and deposition at shallow depth, which impedes downward flow. The underlying subsoil often has a satisfactory percolation rate. Such soils can often be improved by loosening or by breaking the impervious layer.

Preferential flow paths: Preferential flow paths (PFPs) are formed in soils by biological, chemical and physical processes and their interactions. Research in recent years indicates that PFPs can have a significant influence on the movement of ponded or perched water in soil/subsoils where free (non-capillary) water is in direct contact with PFPs. The presence of PFPs should be noted during the trial hole assessment because their presence may influence the percolation rate of the subsoil (e.g. roots, sand fingering, worm burrows). For example, a relatively high percolation rate (i.e. low T-value) could occur in a CLAY if it contains many/large PFPs.

C.2.2.1 Subsoil classification chart

See methodology overleaf to determine the subsoil classification.



Secondary Constituents
NB under BS 5930, determinations of secondary constituents are made using grain size data. The following guides are intended only for initial field studies.

<u>BOULDERS, COBBLES and GRAVEL:</u>
Remove particles belonging to the principal subsoil type and examine remainder of sample according to steps C to F above.

NB: More than 1 constituent can be named, if appropriate, but the terms "clayey" and "silty" are mutually exclusive under BS 5930:1999.

<u>SAND:</u>
Cohesive samples / readily dilatant → "silty"
Cohesive samples / dilates with difficulty → "clayey"
Gravels common → "gravelly"

NB: The terms "clayey" and "silty" are mutually exclusive under BS 5930:1999. "Gravelly" can be used with either term.

<u>SILT, CLAY and SILT/CLAY:</u>
Gritty feel and raspy sound → "sandy"
Gravels more than approximately 1/3 of total weight → "gravelly".

NB: Both "sandy" and "gravelly" can be used, if appropriate. However, the terms "clayey" and "silty" are mutually exclusive under BS 5930:1999.

Particle sizes as defined in BS 5930:1999.

Boulder	>200 mm	Larger than a soccer ball
Cobble	60–200 mm	Smaller than a soccer ball, but larger than a tennis ball
Gravel	2–60 mm	Smaller than a tennis ball, but larger than match heads
Sand	0.06–2 mm	Smaller than a match head, but larger than flour
Silt	0.002–0.06 mm	Smaller than flour (not visible to the naked eye)
Clay	<0.002 mm	Not visible to the naked eye.

A: Examine Boulders and Cobbles

Test adapted from the British Standards Institution BS 5930:1999 *Code of practice for site investigations* (1999).

- Using a hammer, trowel, or pick, clean off a portion of the trial pit wall.
- Examine whether the quantity of boulders/cobbles is dominant over finer material. This will usually be easily done by eye. If unsure, separate boulders/cobbles from finer material in two sample bags and compare weights by hand.

B and C: Preparation of Sample and Apparent Cohesion Test

Test taken from the British Standards Institution BS 5930:1999 *Code of practice for site investigations* (1999).

- Collect a hand-sized representative sample from the cleaned-off portion of the trial pit wall.
- Remove particles larger than 2 mm, as far as possible.
- Crush clumps of subsoil and break down the structure of the sample.
- Slowly add water (preferably as a fine spray), mixing and moulding the sample until it is the consistency of putty; it should be pliable but not sticky and shouldn't leave a film of material on your hands. Can the sample be made pliable at the appropriate moisture content?
- If it can, squeeze the sample in your fist – does it stick together?

D: Thread Test

Test adapted from a combination of the American Society of Testing and Materials Designation *Standard practice for description and identification of soils (visual–manual procedure)* (1984), and the British Standards Institution BS 5930:1999 *Code of practice for site investigations* (1999).

- Ensure the sample is of the consistency of putty. This is very important! Add extra water or sample to moisten or dry the sample.
- Check that no particles greater than 1 or 2 mm occur in the prepared sample.
- Gently roll a thread 3 mm in diameter across the width of the palm of your hand. Remove excess material.
- If a thread can be rolled, break it and try to re-roll without adding additional water.
- Repeat until the thread can no longer be rolled without breaking.
- Record the total number of threads that were rolled and re-rolled.
- Repeat the test at least twice per sample. Water can be added between each test repetition to return the sample to the consistency of putty.

E: Ribbon Test

Test adapted from the United States Department of Agriculture Soil Conservation Service *Soil Survey Agricultural Handbook* 18 (1993).

- Ensure the sample is of the consistency of putty. This is very important! Add extra water or sample to moisten or dry the sample.
- Check that no particles greater than 1 or 2 mm occur.
- Form your moist sample into a large roll in your hand, approximately the width of your thumb.
- Hold your hand and arm parallel with the ground. Using your thumb, press the sample over your index finger to form a uniform ribbon about thumb-width and 0.5 cm thick. Let this ribbon hang over your index finger and continue to extrude the ribbon between thumb and index finger until it breaks. Be careful not to press your thumb through the ribbon.
- Measure the total length of the formed ribbon when it breaks (i.e. from tip of thumb to end of ribbon).
- Repeat this test at least three times per sample to obtain an average ribbon value. Water can be added between each repetition to return the sample to the consistency of putty.

F: Dilatancy Test

Test taken from British Standards Institution BS 5930:1999 *Code of practice for site investigations* (1999).

- Wet the sample such that it is slightly more wet (and softer) than for a thread test, but not so wet that free water is visible at the surface.
- Spread the sample in the palm of one hand, such that no free water is visible at the surface.
- Using the other hand, jar the sample five times by slapping the heel of your hand or the ball of your thumb. Take note of whether water rises to the surface or not, and how quickly it does so.
- Squeeze the sample, again noting if the water disappears or not, and how quickly.
- Dilatant samples will show clear and rapid emergence of a sheen of water at the surface during shaking, and clear and rapid disappearance from the surface during squeezing. Non-dilatant samples will show no discernible sheen.
- Decide whether your sample has dilatancy. Beginners often find it quite difficult to determine the presence of a sheen, unless it is very obvious. It will become easier once samples with clear dilatancy are observed.

BS 5930:1999 CRITERIA FOR DESCRIBING DENSITY/ COMPACTNESS (FINE SUBSOILS).

Term	Field test
Uncompact	Easily moulded or crushed in fingers
Compact	Can be moulded or crushed by strong finger pressure
Very soft	Finger easily pushed up to 25 mm
Soft	Finger pushed up to 10 mm
Firm	Thumb makes impression easily
Stiff	Can be indented slightly by thumb
Very stiff	Can be indented by thumbnail
Hard	Can be scratched by thumbnail

BS 5930:1999 CRITERIA FOR DESCRIBING DISCONTINUITIES.

Term	Mean spacing (mm)
Very widely	>2,000
Widely	2,000–600
Medium	600–200
Closely	200–60
Very closely	60–20
Extremely closely	<20
Fissured	Breaks into blocks along unpolished discontinuities
Sheared	Breaks into blocks along polished discontinuities

C.2.3 Percolation testing

The percolation test comprises the measurement of the length of time for the water level to fall a standard distance in the percolation test hole. There are two variations to the percolation test, i.e. the T-test and the P-test. The T-test is used to test the suitability of the subsoil at depths greater than 400 mm below the ground level. The P-test is carried out at ground level, where there are limiting factors, such as high water table or shallow bedrock or where the T-test result is outside the acceptable range (>50 for septic tank effluent; >75 for secondary-treated effluent) but less than 90.

The T-test: The T-test is used to test the suitability of the subsoil, beneath the invert of the proposed percolation pipe or polishing filter distribution system, to hydraulically transmit the treated effluent from the treatment system. The precise depth at which the percolation pipe will be located (and, by consequence, the top of the T-test percolation test hole) will depend on the most suitable subsoil layer for treatment and disposal and the depth of topsoil at the site but will normally be at least 450 mm below the ground level, to provide adequate protection for the percolation pipework and to ensure that the percolation pipe is discharging into the subsoil layer. The assessor will decide the actual depth at which the percolation pipe will be located, based on the results of the visual assessment and the trial hole investigation. This in turn will dictate the depth from ground surface to the top of the T-test percolation hole.

A T-test should be conducted at all sites where depth to bedrock or water table permits because if a 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 it will ultimately result in ponding due to the impervious nature of the underlying subsoil (or bedrock).

The P-test: The P-test is carried out at ground level to establish a percolation value for soils that are being considered to be used for constructing a mounded percolation area or a polishing filter discharging at ground surface. Hence, the situation where a P-test might be considered is where the T-test shows that the site is not suitable for treating effluent from a conventional septic tank (such as a high water table or shallow bedrock or 50 ≤ T ≤ 90) and consideration is being given to an alternative treatment system which would discharge effluent at ground surface through the soil polishing filter.

Standard and modified T and P-tests: The standard percolation test method (Steps 1–4) should be carried out on all sites where the subsoil characteristics indicate that the percolation result will be less than or equal to 50. In the case of CLAY or SILT/CLAY subsoil then a modified percolation test should be carried out. This test is outlined in Step 5 and is a modification of the Standard Method whereby an approximation of the percolation rate for high T-values can be made in a shortened time frame thus reducing the time spent on-site.

Note: Any material that falls into the bottom of the test holes during the carrying out of the test should be removed prior to being re-filled.

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. Further, attention should be given to the impact of slope and subsoil layering on the location of the invert of the percolation pipe.

C.2.3.1 Percolation test (T-test) procedure

The top of the T-test holes should be at the same depth as the invert of the proposed percolation pipes.

Step 1: Three percolation test holes are dug adjacent to the proposed percolation area, but not in the proposed area. Each hole should be ***300 mm × 300 mm × 400 mm deep***[8] below the proposed invert level of the percolation pipe (Fig. C.3). The dimensions of the holes should be noted in the Site Characterisation Form. The bottom and sides of the hole should be scratched with a knife or wire brush to remove any compacted or smeared soil surfaces and to expose the natural soil surface.

8. Change in the size of the test hole will affect the validity of the results.

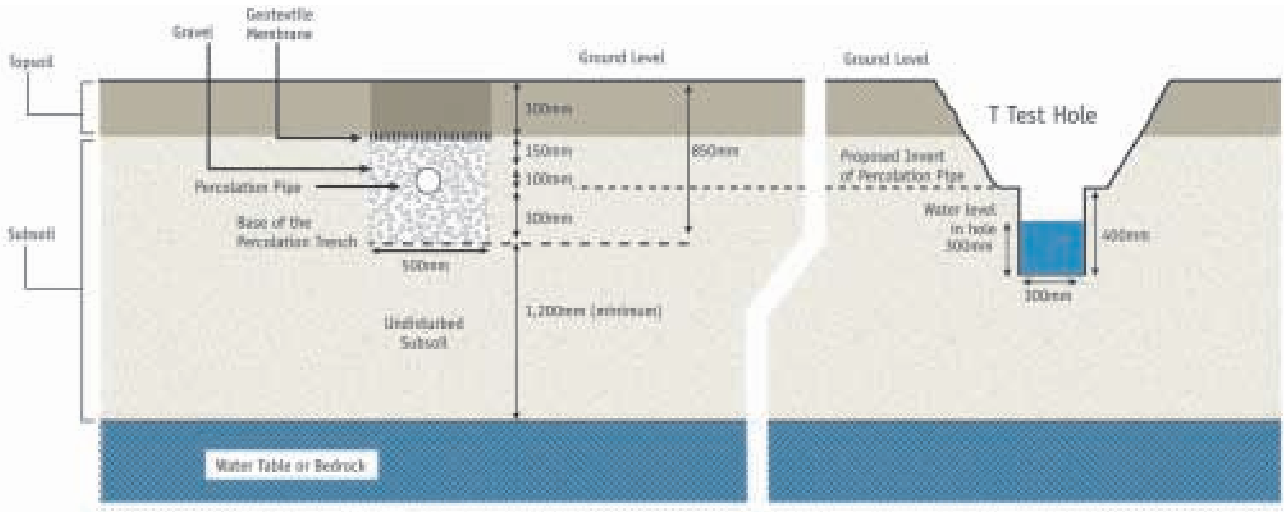


FIGURE C.3. IDEALISED CROSS SECTION OF THE T-TEST HOLES AND THE PROPOSED PERCOLATION TRENCH.

Step 2: Each test hole should be pre-soaked 4–24 h before the start of the percolation test by carefully pouring clean water into the hole so as to fill it to the full height of ***400 mm***.

The water should be allowed to percolate fully (or as far as possible for the more slowly draining subsoils) and then refilled again to 400 mm that evening and allowed to percolate overnight before proceeding to Step 3 (the start of the test) the next morning.

If the water in the hole fully percolates in less than 10 min then repeat the pre-soak immediately before proceeding to Step 3.

Step 3: After the hole has been pre-soaked (Step 2), it is filled once again to the full height of 400 mm. The time that the hole is filled is noted. The water should be allowed to drop to the 300-mm level and the time noted (Table C.4).

There are three possible scenarios at this stage of the test, namely:

- *Scenario 1* – If the initial drop from the 400-mm to the 300-mm level *is greater than* **5 h** this means that the T-value will be greater than 90. There is no requirement to complete the test and the site is not suitable for discharge to ground.
- *Scenario 2* – If the initial drop from the 400-mm to the 300-mm level *is less than or equal to* **210 min** then the test should be continued using the *Standard Method* (Table C.5) given in Step 4.

Step 3: Measuring T_{100}

Percolation Test Hole No.	1	2	3
Date of test			
Time filled to 400 mm			
Time water level at 300 mm			
Time to drop 100 mm (T_{100})			
Average T_{100}			

TABLE C.4. STEP 3 OF PERCOLATION TEST (T-TEST) PROCEDURE.

Step 4: Standard Method (where $T_{100} \leq 210$ minutes)

Percolation Test Hole	1			2			3		
Fill no.	Start Time (at 300 mm)	Finish Time (at 200 mm)	Δt (min)	Start Time (at 300 mm)	Finish Time (at 200 mm)	Δt (min)	Start Time (at 300 mm)	Finish Time (at 200 mm)	Δt (min)
1			0.00			0.00			0.00
2			0.00			0.00			0.00
3			0.00			0.00			0.00
Average Δt Value			0.00			0.00			0.00
	Average Δt/4 = [Hole No.1]		0.00 (t_1)	Average Δt/4 = [Hole No.2]		0.00 (t_2)	Average Δt/4 = [Hole No.3]		0.00 (t_3)

Result of Test: T = 0.00 (min/25 mm)

Comments:

TABLE C.5. STANDARD METHOD.

- *Scenario 3* – If the initial drop from the 400-mm to the 300-mm level *is greater than* **210 min** then the test should be continued using the *Modified Method* (Table C.6) given in Step 5. This test method should only be used for sites that have subsoils with slow percolation characteristics.

Step 4: Standard Method Continue to let the level of water drop to the 200-mm level, recording the times at 300 mm and 200 mm. The time to drop the 100 mm is calculated (Δt). The hole is then refilled again to the 300-mm level and the time for the water level to drop to 200 mm is recorded and Δt is calculated (Table C.5). The hole should then be refilled once more and the time recorded for the water level to drop to 200 mm and Δt calculated. This means that three tests are done in the hole and the hole is refilled twice. The average Δt is calculated for the hole. The average Δt is divided by 4, which gives a T-value for that *hole*. This procedure is repeated in each of the test holes. The T-values for each hole are then added together and divided by 3 to give an overall T-value for the *site*.

Step 5: Modified Method Continue to let the level of water drop to 100 mm, recording the time at 250 mm, 200 mm, 150 mm and 100 mm (T_m) (Table C.6). The time factor (T_f) is then divided by the time for each drop to give a modified hydraulic conductivity (K_{fs}). The equivalent percolation value (T-value) is then calculated by dividing 4.45 by the K_{fs}. Take the average of the four values from 300 mm to 100 mm. This is repeated for each percolation *hole* and the T-values for each hole are added together and divided by 3 to give the overall T-value for the *site*.

C.2.3.2 Test results

A proposed percolation area whose T-value is less than 3 or greater than 50 should be deemed to have failed the test for suitability as a percolation area for a septic tank system. However, if the T-value is greater than 3 and less than or equal to 75, the soil may be used as a polishing filter. T-values greater than 90 indicate that the site is unsuitable for discharge to ground, irrespective of the P-test result, and therefore the one option available is to discharge to surface water in accordance with a Water Pollution Discharge licence.

Step 5: Modified Method (where T_{100} > 210 minutes)

Percolation Test Hole No.	1				2				3			
Fall of water in hole (mm)	Time Factor = T_f	Time of fall (mins) = T_m	K_{fs} = T_f / T_m	T - Value = 4.45 / K_{fs}	Time Factor = T_f	Time of fall (mins) = T_m	K_{fs} = T_f / T_m	T - Value = 4.45 / K_{fs}	Time Factor = T_f	Time of fall (mins) = T_m	K_{fs} = T_f / T_m	T - Value = 4.45 / K_{fs}
300 - 250	8.1				8.1				8.1			
250 - 200	9.7				9.7				9.7			
200 - 150	11.9				11.9				11.9			
150 - 100	14.1				14.1				14.1			
Average T- Value	T- Value Hole 1= (t_1)			0.00	T- Value Hole 1= (t_2)			0.00	T- Value Hole 1= (t_3)			0.00

Result of Test: T = 0.00 (min/25 mm)

Comments:

TABLE C.6. MODIFIED METHOD.

C.2.3.3 Percolation test (P-test) procedure

To establish the percolation value for soil polishing filters and to determine the discharge route for secondary-treated effluent where shallow subsoil exists, a modification of the percolation test as described above is required. The modification relates to the depth of the percolation test hole; the test hole is dug to 400 mm below the ground surface and not at the invert of the percolation pipes. A percolation test carried out at the ground surface is known as a P-test and the procedure is the same as for the T-test outlined above except that the P-test results are expressed as P-values. Figure C.4 illustrates the cross section of the test holes and the proposed infiltration layout.

C.2.4 Integration of desk study and on-site assessment

Table C.7 summarises the information that can be obtained from the data collected from the desk study and the on-site assessment.

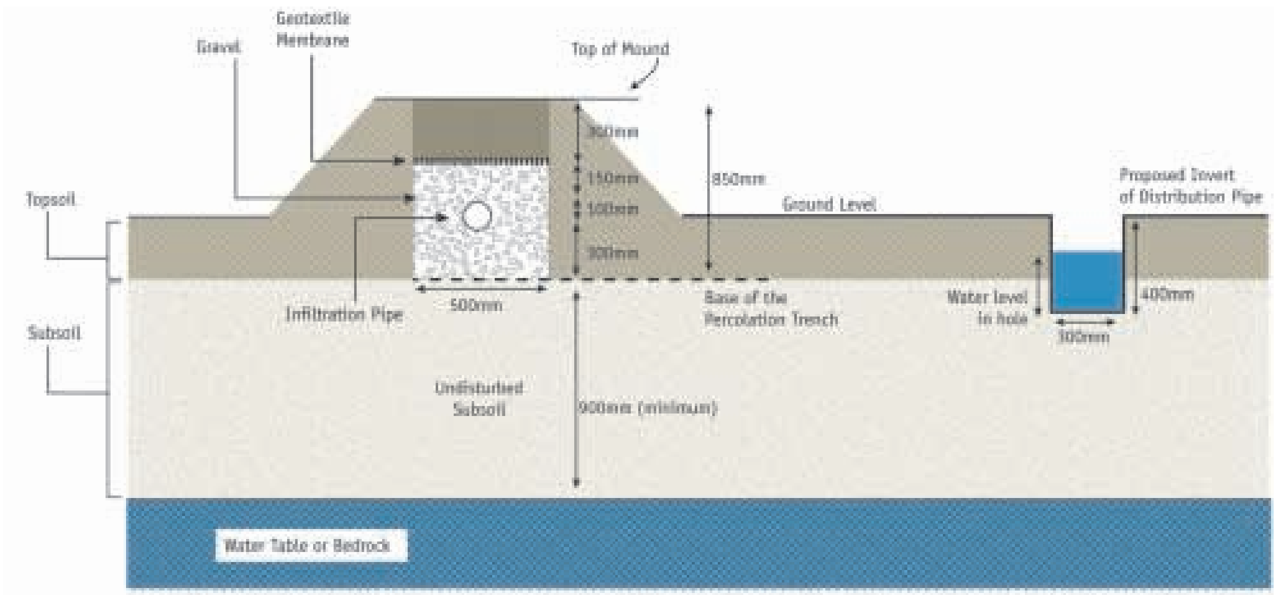


FIGURE C.4. CROSS SECTION OF THE P-TEST HOLES AND THE PROPOSED PERCOLATION TRENCH.

TABLE C.7. INFORMATION OBTAINED FROM DESK STUDY AND ON-SITE ASSESSMENT.

Information collected	Relevance	Factor determined
Groundwater Protection Response Zoning **Hydrological features** **Density of existing houses** **Proximity to significant sites** **Experience of the area** **Proximity to surface features**	Identifies groundwater protection requirements and targets at risk Potential cumulative nutrient loading Additional hydraulic loading from storm water disposal Performance of existing systems/complaints	Site restrictions
Depth to bedrock	Sufficient subsoil needed to allow treatment of wastewater	Depth to bedrock
Texture **Structure** **Bulk density** **Layering** **Preferential flow paths**	Indicators of the suitability of the subsoil for percolation and of its percolation rate	Suitability of subsoil
Colour **Mottling** **Depth to water table**	A minimum thickness of unsaturated soil is required to successfully treat wastewater effluent	Depth of the water table
Drainage (permeability) **Percolation test**	Identifies suitable soils that have adequate but not excessive percolation rates	T-value or P-value

C.3 Site Characterisation Form

The following relates to an electronic form, which may be downloaded from www.epa.ie.

SITE CHARACTERISATION FORM

COMPLETING THE FORM

Step 1:

Goto Menu Item **File, Save As** and save the file under a reference relating to the client or the planning application reference if available.

Clear Form

Use the **Clear Form** button to clear all information fields.

Notes:

All calculations in this form are automatic.

Where possible information is presented in the form of drop down selection lists to eliminate potential errors.

Variable elements are recorded by tick boxes. In all cases only one tick box should be activated.

All time record fields must be entered in twenty hour format as follows: HH:MM

All date formats are DD/MM/YYYY.

All other data fields are in text entry format.

This form can be printed out fully populated for submission with related documents and for your files. It can also be submitted by email.

Section 3.2

In this section use an underline _____ across all six columns to indicate the depth at which changes in classification / characteristics occur.

Section 3.4

Lists supporting documentation required.

Section 4

Select the treatment systems suitable for this site and the discharge route.

Section 5

Indicate the system type that it is proposed to install.

Section 6

Provide details, as required, on the proposed treatment system.

SITE CHARACTERISATION FORM

File Reference: ______

1.0 GENERAL DETAILS (From planning application)

Prefix: ______ First Name: ______ Surname: ______

Address: ______

Site Location and Townland: ______

Telephone No: ______ Fax No: ______

E-Mail: ______

Maximum no. of Residents: ______ No. of Double Bedrooms: ______ No. of Single Bedrooms: ______

Proposed Water Supply: Mains ☐ Private Well/Borehole ☐ Group Well/Borehole ☐

2.0 GENERAL DETAILS (From planning application)

Soil Type, (Specify Type): ______

Aquifer Category: Regionally Important ☐ Locally Important ☐ Poor ☐

Vulnerability: Extreme ☐ High ☐ Moderate ☐ Low ☐ High to Low ☐ Unknown ☐

Bedrock Type: ______

Name of Public/Group Scheme Water Supply within 1 km: ______

Groundwater Protection Scheme (Y/N): ______ Source Protection Area: SI ☐ SO ☐

Groundwater Protection Response: ______

Presence of Significant Sites (Archaeological, Natural & Historical): ______

Past experience in the area: ______

Comments:

(Integrate the information above in order to comment on: the potential suitability of the site, potential targets at risk, and/or any potential site restrictions).

______

Note: Only information available at the desk study stage should be used in this section.

3.0 ON-SITE ASSESSMENT

3.1 Visual Assessment

Landscape Position: ______

Slope: Steep (>1:5) ☐ Shallow (1:5-1:20) ☐ Relatively Flat (<1:20) ☐

Surface Features within a minimum of 250m (Distance To Features Should Be Noted In Metres)

Houses: ______

Existing Land Use: ______

Vegetation Indicators: ______

Groundwater Flow Direction: ______

Ground Condition: ______

Site Boundaries: ______ Roads: ______

Outcrops (Bedrock And/Or Subsoil): ______

Surface Water Ponding: ______ Lakes: ______

Beaches/Shellfish: ______ Areas/Wetlands: ______

Karst Features: ______ Watercourse/Stream*: ______

Drainage Ditches*: ______ Springs / Wells*: ______

Comments:
(Integrate the information above in order to comment on: the potential suitability of the site, potential targets at risk, the suitability of the site to treat the wastewater and the location of the proposed system within the site).

*Note and record water level

3.2 Trial Hole (should be a minimum of 2.1m deep (3m for regionally important aquifers))

To avoid any accidental damage, a trial hole assessment or percolation tests should not be undertaken in areas, which are at or adjacent to significant sites (e.g. NHAs, SACs, SPAs, and/or Archaeological etc.), without prior advice from National Parks and Wildlife Service or the Heritage Service.

Depth of trial hole (m): ______

Depth from ground surface to bedrock (m) (if present): ______

Depth from ground surface to water table (m) (if present): ______

Depth of water ingress: ______

Rock type (if present): ______

Date and time of excavation: ______ ______

Date and time of examination: ______ ______

	Depth of P/T Test*	Soil/Subsoil Texture & Classification**	Plasticity and dilatancy***	Soil Structure	Density/ Compactness	Colour****	Preferential flowpaths
0.1 m							
0.2 m							
0.3 m							
0.4 m							
0.5 m							
0.6 m							
0.7 m							
0.8 m							
0.9 m							
1.0 m							
1.1 m							
1.2 m							
1.3 m							
1.4 m							
1.5 m							
1.6 m							
1.7 m							
1.8 m							
1.9 m							
2.0 m							
2.1 m							
2.2 m							
2.3 m							
2.4 m							
2.5 m							
2.6 m							
2.7 m							
2.8 m							
2.9 m							
3.0 m							

Evaluation:

Likely T value: ______

Note: *Depth of percolation test holes should be indicated on log above. (Enter P or T at depts as appropriate).
** See Appendix E for BS 5930 classification.
*** 3 samples to be tested for each horizon and results should be entered above for each horizon.
**** All signs of mottling should be recorded.

3.3(a) Percolation ("T") Test for Deep Subsoils and/or Water Table

Step 1: Test Hole Preparation

Percolation Test Hole	1	2	3
Depth from ground surface to top of hole (mm) (A)			
Depth from ground surface to base of hole (mm) (B)			
Depth of hole (mm) [B - A]	0	0	0
Dimensions of hole [length x breadth (mm)]	x	x	x

Step 2: Pre-Soaking Test Holes

Date and Time pre-soaking started						

Each hole should be pre-soaked twice before the test is carried out. Each hole should be empty before refilling.

Step 3: Measuring T_{100}

Percolation Test Hole No.	1	2	3
Date of test			
Time filled to 400 mm			
Time water level at 300 mm			
Time to drop 100 mm (T_{100})	0.00	0.00	0.00
Average T_{100}			0.00

If T_{100} > 300 minutes then T-value >90 – site unsuitable for discharge to ground
If T_{100} ≤ 210 minutes then go to Step 4;
If T_{100} > 210 minutes then go to Step 5;

Step 4: Standard Method (where $T_{100} \leq 210$ minutes)

Percolation Test Hole	1			2			3		
Fill no.	Start Time (at 300 mm)	Finish Time (at 200 mm)	Δt (min)	Start Time (at 300 mm)	Finish Time (at 200 mm)	Δt (min)	Start Time (at 300 mm)	Finish Time (at 200 mm)	Δt (min)
1			0.00			0.00			0.00
2			0.00			0.00			0.00
3			0.00			0.00			0.00
Average Δt Value			0.00			0.00			0.00
	Average Δt/4 = [Hole No.1]		0.00 (t_1)	Average Δt/4 = [Hole No.2]		0.00 (t_2)	Average Δt/4 = [Hole No.3]		0.00 (t_3)

Result of Test: T = 0.00 (min/25 mm)

Comments:

Step 5: Modified Method (where $T_{100} > 210$ minutes)

Percolation Test Hole No.	1				2				3			
Fall of water in hole (mm)	Time Factor $= T_f$	Time of fall (mins) $= T_m$	$K_{fs} = T_f / T_m$	T – Value $= 4.45 / K_{fs}$	Time Factor $= T_f$	Time of fall (mins) $= T_m$	$K_{fs} = T_f / T_m$	T – Value $= 4.45 / K_{fs}$	Time Factor $= T_f$	Time of fall (mins) $= T_m$	$K_{fs} = T_f / T_m$	T – Value $= 4.45 / K_{fs}$
300 - 250	8.1				8.1				8.1			
250 - 200	9.7				9.7				9.7			
200 - 150	11.9				11.9				11.9			
150 - 100	14.1				14.1				14.1			
Average T- Value	T- Value Hole 1= (t_1)			0.00	T- Value Hole 1= (t_2)			0.00	T- Value Hole 1= (t_3)			0.00

Result of Test: T = 0.00 (min/25 mm)

Comments:

3.3(b) Percolation ("P") Test for Shallow Soil / Subsoils and/or Water Table

Step 1: Test Hole Preparation

Percolation Test Hole	1	2	3
Depth from ground surface to top of hole (mm)			
Depth from ground surface to base of hole (mm)			
Depth of hole (mm)	0	0	0
Dimensions of hole [length x breadth (mm)]	x	x	x

Step 2: Pre-Soaking Test Holes

	1		2		3	
Date and Time pre-soaking started						

Each hole should be pre-soaked twice before the test is carried out. Each hole should be empty before refilling.

Step 3: Measuring P_{100}

Percolation Test Hole No.	1	2	3
Date of test			
Time filled to 400 mm			
Time water level at 300 mm			
Time to drop 100 mm (P_{100})	0.00	0.00	0.00
Average P_{100}			0.00

If P_{100} > 300 minutes then T-value >90 – site unsuitable for discharge to ground
If $P_{100} \leq$ 210 minutes then go to Step 4;
If P_{100} > 210 minutes then go to Step 5;

Step 4: Standard Method (where $P_{100} \leq 210$ minutes)

Percolation Test Hole	1			2			3		
Fill no.	Start Time (at 300 mm)	Finish Time (at 200 mm)	Δp (min)	Start Time (at 300 mm)	Finish Time (at 200 mm)	Δp (min)	Start Time (at 300 mm)	Finish Time (at 200 mm)	Δp (min)
1			0.00			0.00			0.00
2			0.00			0.00			0.00
3			0.00			0.00			0.00
Average Δp Value			0.00			0.00			0.00
	Average Δp/4 = [Hole No.1]	0.00 (p_1)		Average Δp/4 = [Hole No.2]	0.00 (p_2)		Average Δp/4 = [Hole No.3]	0.00 (p_3)	

Result of Test: P = 0.00 (min/25 mm)

Comments:

Step 5: Modified Method (where $P_{100} > 210$ minutes)

Percolation Test Hole No.	1				2				3			
Fall of water in hole (mm)	Time Factor = T_f	Time of fall (mins) = T_m	$K_{fs} = T_f / T_m$	P – Value = 4.45 / K_{fs}	Time Factor = T_f	Time of fall (mins) = T_m	$K_{fs} = T_f / T_m$	P – Value = 4.45 / K_{fs}	Time Factor = T_f	Time of fall (mins) = T_m	$K_{fs} = T_f / T_m$	P – Value = 4.45 / K_{fs}
300 - 250	8.1				8.1				8.1			
250 - 200	9.7				9.7				9.7			
200 - 150	11.9				11.9				11.9			
150 - 100	14.1				14.1				14.1			
Average P- Value	P- Value Hole 1= (p_1)			0.00	P- Value Hole 1= (p_2)			0.00	P- Value Hole 1= (p_3)			0.00

Result of Test: P = 0.00 (min/25 mm)

Comments:

3.4 The following associated Maps, Drawings and Photographs should be appended to this site characterisation form.

1. Discovery Series 1:50,000 Map indicating overall drainage, groundwater flow direction and housing density in the area.
2. Supporting maps for vulnerability, aquifer classification, soil, bedrock.
3. North point should always be included.
4. (a) Sketch of site showing measurements to Trial Hole location and
   (b) Percolation Test Hole locations,
   (c) wells and
   (d) direction of groundwater flow (if known),
   (e) proposed house (incl. distances from boundaries)
   (f) adjacent houses,
   (g) watercourses,
   (h) significant sites
   (i) and other relevant features.
5. Cross sectional drawing of the site and the proposed layout[1] should be submitted.
6. Photographs of the trial hole, text holes and site (date and time referenced).

[1] The calculated percolation area or polishing filter area should be set out accurately on the site layout drawing in accordance with the code of practice's requirements.

4.0 CONCLUSION of SITE CHARACTERISATION

Integrate the information from the desk study and on-site assessment (i.e. visual assessment, trial hole and percolation tests) above and conclude the type of system(s) that is (are) appropriate. This information is also used to choose the optimum final disposal route of the treated wastewater.

Not Suitable for Development ☐

Suitable for [1]		**Discharge Route** [2]
1. Septic tank system (septic tank and percolation area)	☐	
2. Secondary Treatment System		
a. septic tank and filter system constructed on-site and polishing filter; or	☐	
b. packaged wastewater treatment system and polishing filter	☐	

5.0 RECOMMENDATION

Propose to install: ______

and discharge to: ______

Trench invert level (m): ______

Site Specific Conditions (e.g. special works, site improvement works testing etc.

[1] note: more than one option may be suitable for a site and this should be recorded

[2] A discharge of sewage effluent to "waters" (definition includes any or any part of any river, stream, lake, canal, reservoir, aquifer, pond, watercourse or other inland waters, whether natural or artificial) will require a licence under the Water Pollution Acts 1977-90. Refer to Section 2.6.2.

6.0 TREATMENT SYSTEM DETAILS

SYSTEM TYPE: Septic Tank System

Tank Capacity (m^3) ______

Percolation Area		Mounded Percolation Area	
No. of Trenches		No. of Trenches	
Length of Trenches (m)		Length of Trenches (m)	
Invert Level (m)		Invert Level (m)	

SYSTEM TYPE: Secondary Treatment System

Filter Systems

Media Type	Area (m^2)*	Depth of Filter	Invert Level
Sand/Soil			
Soil			
Constructed Wetland			
Other			

Package Treatment Systems

Type ______

Capacity PE ______

Sizing of Primary Compartment ______ m^3

SYSTEM TYPE: Tertiary Treatment System

Polishing Filter: Surface Area (m^2)* ______

or **Gravity Fed:**

No. of Trenches ______

Length of Trenches (m) ______

Invert Level (m) ______

Package Treatment System: Capacity (pe) ______

Constructed Wetland: Surface Area (m^2)* ______

DISCHARGE ROUTE:

Groundwater ☐ Hydraulic Loading Rate * (l/m^2.d) ______

Surface Water ** ☐ Discharge Rate (m^3/hr) ______

TREATMENT STANDARDS:

Treatment System Performance Standard (mg/l)	BOD	SS	NH_4	Total N	Total P

QUALITY ASSURANCE:

Installation & Commissioning	On-going Maintenance

* Hydraulic loading rate is determined by the percolation rate of subsoil

** Water Pollution Act discharge licence required

7.0 SITE ASSESSOR DETAILS

Company:

Prefix: First Name: Surname:

Address:

Qualifications/Experience:

Date of Report:

Phone: Fax: e-mail

Indemnity Insurance Number:

Signature: ______________________________

Annex D Discharge Options

D.1 Water Pollution Licensing

The discharge of any sewage effluent to waters[9] requires a licence under the Water Pollution Acts 1977–1990. The local authorities process these licence applications. Direct discharges to groundwater of listed substances are prohibited by the Groundwater Directive (80/68/EEC). Discharges to groundwater referred to in this code are discharges *via* unsaturated subsoil and hence are considered indirect discharges.

D.2 Dilution Calculations

D.2.1 Dilution calculations for indirect discharges to groundwater

In high-density areas or where the receiving groundwater already has relatively high levels of nitrate or phosphorus then a simple dilution calculation should be carried out to assess the potential impact of the development of the receiving water prior to licence being granted. In all cases planning permission and a discharge licence (where required) need to be in place prior to development of the site. The following is an example of a dilution calculation[10] to assess the impact of effluent on nitrate concentrations in water (phosphorus calculations should be used in phosphorus-sensitive locations):

Assumptions:

- Recharge (rainfall – (evapotranspiration + run-off)) = 13.7 m^3/day/ha (500 mm/year)
- Average nitrogen (N) concentrations in domestic wastewater treatment effluent = 90 mg/l N
- Average flow from septic tank (4 persons) = 0.72 m^3/day
- Average nitrogen concentration in recharge = 0.1 mg/l N
- Assume that total-N load in septic tank effluent (in form of ammonium and organic N) is totally nitrified to nitrate in the subsoil and that no denitrification occurs[11]
- Nitrate concentration resulting from 1 on-site system/ha
  = (avg. total-N conc. in septic tank effluent × flow) + (avg. nitrate conc. in recharge × recharge) divided by flow plus recharge

$$= \frac{(90 \times 0.72) + (0.1 \times 13.7)}{(0.72 + 13.7)}$$

$$= 6.71 \text{ mg/l N or } 29.71 \text{ mg/l } NO_3$$

The only parameter that is needed to vary is recharge, which could be reduced in the drier counties. Recharge figures may be obtained from Met Éireann. This calculation can be combined with knowledge/existing water quality data. A decision can then be made as to whether or not the increased nitrogen levels are acceptable when compared to the relevant national standards.

D.2.2 Discharges to surface water

Where sites are unsuitable for discharge of effluent to ground it is usually 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 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.

Where it is proposed to discharge wastewater to any surface waters a licence is required

9. Includes any (or any part of any) river, stream, lake, canal, reservoir, aquifer, pond, watercourse or other inland waters, whether natural or artificial.
10. Section 13.2.14.6 *Site Specific Evaluation, Site Suitability Assessments for On-Site Wastewater Management,* FÁS Course Manual, Vol. 2.
11. ERTDI 27 – 2000-MS-15-M1 *An Investigation into the Performance of Subsoils and Stratified Sand Filters for the Treatment of Wastewater from On-Site Systems.*

(which is a separate procedure) and the local authorities should risk-assess the impact of the discharge from the on-site system on the receiving water including the assimilative capacity of the receiving water, the ongoing monitoring of the system performance, and a cost analysis. It should be noted that many local authorities currently do not favour granting discharge licences to surface waters for single houses. For further guidance please see the EPA *Waste Water Discharge Licensing Application Guidance Note* (2008) (available on www.epa.ie).

Annex E Wastewater Treatment and Disposal Systems

This section gives an overview of the main categories of wastewater treatment systems available; more detailed descriptions are given in this CoP. Where new and innovative products and technologies are proposed, the local authority should satisfy itself that the products/technologies have proven track records based on good science demonstrated in other jurisdictions. In the case of treatment systems such new systems should comply with the requirements of EN 12566 or equivalent.

E.1 Septic Tank System

A septic tank system (Section 7) comprises a septic tank followed by a soil percolation area. The septic tank functions as a two-stage primary sedimentation tank, removing most of the suspended solids from the wastewater. This removal is accompanied by a limited amount of anaerobic digestion, mostly during the summer months under warmer temperatures. The percolation area provides additional treatment (secondary and tertiary) of the wastewater and it provides the majority of the treatment. The wastewater from the septic tank is distributed to a suitable soil percolation area, which acts as a bio-filter. The biomat is a biologically active layer, which contains complex bacterial polysaccharides and accumulated organic substances and micro-organisms which treat the effluent. The biomat controls the rate of percolation into the subsoil (Fig. E.1). As the wastewater flows into and through the subsoil, it undergoes surface filtration, straining, physico-chemical interactions and microbial breakdown. Secondary-treated effluent has a lower organic loading than septic tank effluent, which leads to a reduction in lateral spread of the biomat. After percolating through a suitably designed and maintained percolation area, the wastewater is suitable for indirect discharge to ground.

Failure of a septic tank system to function properly is generally due to poor construction, installation, operation, lack of maintenance, installation in an area of unsuitable ground conditions, or the use of a soakaway instead of a properly designed percolation area.

The attributes of septic tanks are outlined in Table E.1. The following guidance on the general design of conventional rectangular septic tanks should help ensure best performance.

- Septic tanks should comprise two chambers and it is recommended that they have a minimum length to width ratio of 3:1 in order to promote settlement of suspended solids
- Oversized rather than undersized septic tanks are better because of greater settlement of solids and larger hydraulic retention time for liquid and solids
- Properly designed baffles provide quiescent conditions and minimise the discharge of solids to the percolation area
- The inlet and outlet of the septic tank should be separated by a long flow path for the wastewater; if the outlet is too close to the inlet, solids settlement and grease separation may be inadequate
- Access and inspection openings should be incorporated into the roof of the septic tank. The opening should be constructed to such standard and in such a manner that unintended access (for example by children) cannot occur, and
- T-pieces should be installed as they prevent solids carry-over into the effluent, assist in the formation of a surface scum layer which traps floating solids and grease and assist in preventing odours.

Septic tanks should:

- Be able to withstand corrosion from wastewater and gases
- Be able to safely carry all lateral and vertical soil pressures

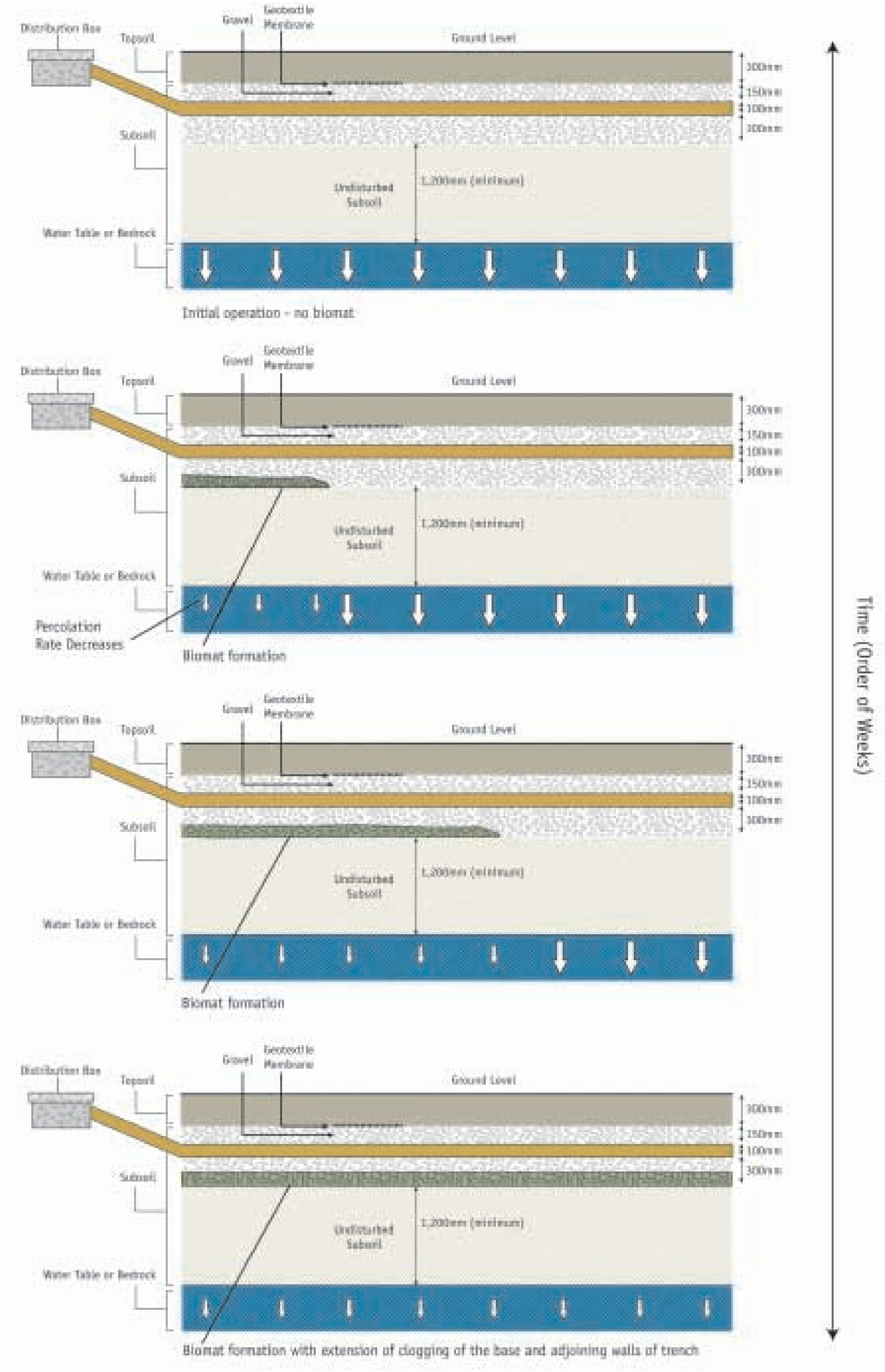


FIGURE E.1. ILLUSTRATION OF BIOMAT FORMATION ON THE BASE OF A PERCOLATION TRENCH.

TABLE E.1. ATTRIBUTES OF A TYPICAL SEPTIC TANK.

A properly constructed septic tank will:

- Retain and remove 50% or more solids
- Allow some microbial decomposition
- Accept sullage (i.e. water from baths, wash-hand basins, etc.)
- Accept water containing detergents (e.g. washing machine, dishwasher, etc.)
- Reduce clogging in the percolation area
- *Not* fully treat domestic wastewater
- *Not* work properly if not regularly maintained
- *Not* significantly remove micro-organisms
- *Not* remove more than 15–30% of the biological oxygen demand (BOD)
- *Not* operate properly if pesticides, paints, thinners, solvents, excess disinfectants or household hazardous substances are discharged to it
- *Not* accommodate sludge indefinitely
- *Not* operate properly if surface waters (i.e. roofs, parking areas, etc.) are discharged to it

- Be able to accommodate water pressure from inside and outside the tank without leakage occurring
- Should be watertight to prevent wastewater escaping to the soil outside, and to prevent surface water and groundwater from entering the tank, and
- All septic tanks should be followed by a percolation area that is in compliance with I.S. CEN/TR 12566:2.

E.2 Secondary Treatment: On-Site Filter Systems

Filter systems are used to provide additional treatment of upstream septic tank or packaged treatment systems. These include intermittently pumped (dosed) soil filters and sand filters (Section 8).

Soil filters comprise suitable soils placed often in the form of a mound (but may be underground or part below ground/part above ground), through which septic tank effluent is filtered and treated.

Intermittently dosed sand filters consist of one or more beds of graded sand underlain at the base by a gravel or permeable soil layer to prevent outwash or piping of the sand; soil-covered intermittent sand filters may be underground, part underground and part overground, or overground. The latter two constructions are commonly referred to as mound systems.

All intermittent filter systems should incorporate polishing filters to provide additional treatment of the effluent by reducing pollutants such as suspended solids, micro-organisms, and phosphorus (depending on the media). Polishing filters also provide for the hydraulic conveyance of the treated effluent to ground.

Constructed wetlands (reed beds) are considered to be another form of filter system and can also be used for the treatment of wastewater from single houses. Constructed wetlands should be underlain by either an impermeable geo-synthetic membrane or an impermeable clay liner ($k = 1 \times 10^{-8}$ m/s) to prevent leakage to the groundwater. Primary treatment by a septic tank is used prior to discharge to a constructed wetland. In the wetland, the wastewater from a septic tank undergoes secondary treatment by a combination of physical, chemical and biological processes that develop through the interaction of the plants (reeds), the growing media (gravel) and micro-organisms before discharge of the effluent to groundwater or

surface water. Guidance on soil-based constructed wetlands can also be found in Wallace and Knight (2007).

E.3 Secondary Treatment: Packaged Wastewater Treatment Systems

Section 9 provides detailed descriptions of packaged wastewater treatment systems. These systems may be used as an alternative to septic tank systems. Examples of these systems include:

- 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.

These systems should incorporate polishing filters before discharge of the effluent to groundwater or surface water.

E.4 Selection of a System

When selecting a wastewater treatment system a number of factors should be taken into account. The range of factors to be taken into account is presented in Table E.2.

Table E.2. Factors used to compare different wastewater treatment systems.

Factor	Treatment Option No. 1	Treatment Option No. 2
Is the treatment system certified to comply with National Standards (I.S. EN 12566-1:2000/A1:2004 for septic tanks or I.S. EN 12566-3:2005 for packaged systems or other)?		
Construction, installation and commissioning service is supervised		
Construction of percolation area or polishing filter is supervised		
Availability of suitable material for filter systems (soil/sand)		
Maintenance service available		
Expected life of the system		
Ease of operation and maintenance requirements		
Sludge storage capacity (m^3)		
Expected de-sludging frequency		
Access requirements for sludge removal		
Design criteria[1]		
Does the system incorporate fail-safe measures to prevent it discharging untreated sewage in the event of power breaks, product defect or failure to maintain?		
Capital cost		
Annual running cost		
Cost of annual maintenance service		
Performance: % reduction in BOD, COD, TSS % reduction total P and total N % reduction total coliforms		
Minimum standard BOD, SS, NH_4 Does it achieve the standards set out in Table 5.1?		
Additional costs prior to commissioning (including site improvements)		
Power requirements – single phase/three phase (kw/day)		

[1]In the case of biofilm systems, the organic and hydraulic loading rates in $g/m^2/day$ and $l/m^2/day$, respectively, should be quoted.
BOD, biological oxygen demand; COD, chemical oxygen demand; TSS, total suspended solids;

a. Certification of the system
   As per Part One of this CoP.

b. Wastewater treatment performance requirements
   The standards set in Table 5.1 (Section 5) apply to these systems.

c. Degree of environmental protection required
   Having completed the site assessment as outlined in Section 6, a decision will need to be made on the degree of environmental protection required.

d. Cost
   A single-house treatment system will entail capital, running and maintenance costs. In choosing a system due regard should be given to the overall relative costs.

e. Maintenance
   A number of issues related to the maintenance of the single-house wastewater treatment system will have to be considered such as:
   - Availability of competent persons and parts for the system
   - Ease of access to the system in order to perform maintenance, e.g. de-sludging
   - Frequency of maintenance required
   - Capacity to sample the effluent discharge
   - Sludge storage capacity.

f. Anticipated lifetime of the system.

g. Track record of the system.

Annex F Site Improvement Works

In certain circumstances a site that is intended for a single-house development will present particular difficulties arising out of the site assessment. Some sites may have a high water table, may have insufficient subsoil depth, or may have unsuitable subsoil for the purposes of treatment and percolation of the pretreated wastewater from a treatment system. It may be possible in some such cases to render the site suitable for development after carrying out specific engineering works on the site known as ‘site improvements’. The option to carry out site improvements might be considered in circumstances where a high water table is a problem. The conditions that give rise to a high water table are site specific; these include topography, nature of soils, bedrock and outfalls. Detailed design procedures appropriate for site improvement works are available in drainage manuals (Mulqueen *et al*., 1999).

In other cases, such as where the site is overlain by insufficient depth of subsoil or unsuitable subsoil, the site may be improved by the placement of suitable soil in lifts across the whole site rather than just infilling in the area around a proposed mound system. It is necessary to perform testing of each 300-mm layer as the process of emplacing lifts of soil progresses. 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.

Annex G Operation and Maintenance

G.1 Septic Tank Systems

The septic tank itself, the distribution system and the percolation area all require inspection to ensure effective operation of the system, and periodic maintenance to ensure that the system continues to work effectively over time.

G.1.1 Septic tank

The septic tank is a passive treatment unit that typically requires little operator intervention. Regular inspections (approximately every 6 months) and sludge pumping (at a minimum frequency once every year) are the minimum operation and maintenance requirements.

Inspections of septic tanks should include observation of sludge and scum accumulation, structural soundness, watertightness, and condition of the inlet and condition of the outlet from the tank.

> **Warning:**
> In performing inspections or other maintenance, a septic tank should not be entered. The septic tank is a confined space and entering can be extremely hazardous because of toxic gases and/or insufficient oxygen. Electrical appliances such as mains-powered lighting should not be used near a septic tank.

G.1.1.1 Sludge and scum accumulations

As wastewater passes through and is partially treated in the septic tank over the years, the layers of floatable material (scum) and settleable material (sludge) increase in thickness and gradually reduce the amount of space available for clarified wastewater. If the sludge layer builds up as far as the bottom of the effluent T-pipe, solids can be drawn through the effluent port and transported into the percolation area, thus increasing the risk of clogging. Likewise, if the bottom of the thickening scum layer builds downwards as far as the bottom of the effluent T-pipe, oils and other scum material can be drawn into the piping that discharges to the percolation field. The scum layer should not extend above the top or below the bottom of either the inlet or outlet T-pipes. The top of the sludge layer should be at least 30 cm below the bottom of either tee or baffle. Usually, the sludge depth is greatest below the inlet baffle. The bottom of the scum layer should not be less than 10 cm above the bottom of the outlet T-pipe or baffle. If any of these conditions are present, there is a risk that wastewater solids will plug the tank inlet or be carried out in the tank effluent and begin to clog the percolation area associated with the septic tank.

The depth of sludge can be checked using the following technique or any other appropriate method:

- Use a 2-m pole and wrap the bottom 1.2-m with a white rag
- Lower the pole to the bottom of the tank and hold there for several minutes to allow the sludge layer to penetrate the rag, and
- Remove the pole and note the sludge line, which will be darker than the coloration caused by the liquid waste.

G.1.1.2 Structural soundness and watertightness

Structural soundness and watertightness are best observed after sludge has been pumped from the tank. The interior tank surfaces should be inspected for deterioration, such as pitting, spalling, delamination, and so forth, and for cracks and holes. The presence of roots, for example, indicates tank cracks or open joints. These observations can be made with a mirror and bright light (such as a torch or flash lamp). Watertightness can be checked by observing the liquid level (before pumping), observing all joints for seeping water or roots, and listening for running or dripping water. Before pumping, the liquid level of the tank should be at the outlet invert level. If the liquid level is below the outlet invert, leaking is occurring. If it is above, the outlet is obstructed or the percolation area is flooded. A constant trickle from the inlet is an

indication that plumbing fixtures in the building served by the tank are leaking and need to be inspected, or that infiltration of groundwater into the inlet pipe is taking place.

G.1.1.3 Baffles and screens

The baffles should be observed to confirm that they are in the proper position, secured well to the piping or tank wall, clear of debris, and not cracked or broken. If an effluent screen is fitted to the outlet baffle, it should be removed, cleaned, inspected for irregularities, and replaced. Note that effluent screens should not be removed until the tank has been pumped or the outlet is first plugged.

G.1.1.4 Septic tank pumping and de-sludging

Tanks should be pumped when sludge and scum accumulations exceed 30% of the tank volume or are encroaching on the inlet and outlet baffle entrances. Periodic pumping of septic tanks is recommended to ensure proper system performance and reduce the risk of hydraulic failure. Septic tanks should be de-sludged at a minimum of once every year. In cases where the septic tank is at, or near, its design load capacity, de-sludging should be more often if the rate of sludge build-up requires more frequent removal. Accumulated sludge and scum material found in the tank should be removed by an appropriately permitted contractor (in accordance with the Waste Management (Collection Permit) Regulations 2001). The local authorities have a list of permitted contractors in the area. The permitted contractor will arrange for the disposal of the sludge in accordance with the national legislation (*via* either disposal to agriculture or disposal to a managed wastewater treatment municipal facility). Householders obtain a certificate from the permitted contractor each time their tank is de-sludged.

Sludge from a septic tank or a sewage treatment system that is intended to be landspread should be managed in accordance with the Waste Management (Use of Sewage Sludge in Agriculture) Regulations S.I. No. 148 of 1998 (and its amendment S.I. No. 267 of 2001). These regulations allow for the landspreading of sewage sludge on agricultural land providing that certain criteria are met and that it is carried out in accordance with the nutrient management plan for the lands in question.

G.1.2 The distribution device

The effluent from the septic tank is typically conveyed to the percolation area through a distribution device, housed in a distribution box. The function of the device is to evenly split the hydraulic flow of partially treated effluent into a number of approximately equal volumes for onward discharge to the individual percolation pipes in the percolation area.

The distribution box should be inspected at intervals of no greater than every 6 months. Build-up of solids in the distribution device should be removed to ensure that the flow through the device is not obstructed, and to ensure that the effluent passing through is evenly split between the outlet pipes. The distribution device should be checked to ensure that it has not shifted on its foundation since the previous inspection. Such disturbance can result from overpassing by heavy vehicles or through natural soil creep. Where such disturbance has taken place, a competent person should reset the distribution device on its foundation, and the level of the distribution device should be rechecked as part of this measure. Any damage to the box itself, its internal pipework, the jointing to the external inlet and outlet pipes, or to the cover of the device should be made good as part of the maintenance procedure.

G.1.3 The percolation area

The percolation area requires little in the way of regular maintenance in situations where a proper site assessment has been carried out prior to installation, where the system has been installed correctly, and where no physical damage has been done to the surface after installation. The percolation area should be kept free from disturbance from vehicles, heavy animals, sports activities or other activities likely to break the sod on the surface. If the area has been grassed then the excess growth of grass can be mown and removed periodically. The use of gardening tools, which might break the surface, should be avoided.

The percolation area should be inspected at 6-monthly intervals to ensure that no surface damage has taken place. The aeration/vent pipes should be inspected to ensure that they are still in place and intact. If possible, the inside of the vents should be examined to verify that they are dry and free from obstruction. The surface of the ground in the percolation area should be walked and examined to ensure that it is free from surface or superficial damage and to ensure that ponding of effluent is not occurring.

Where any damage is observed the following procedures should be followed:

- Where ponding of effluent is noted at the surface it may be necessary to excavate the percolation area to investigate the reason for the hydraulic failure of the distribution system
- Where such ponding is due to damage of the percolation pipework the necessary repairs should be carried out by a competent person
- Any damage to aeration/vent pipes should be made good, and
- The surface of the ground over the percolation pipes should be reinstated and re-vegetated, and further damage to the ground surface should be avoided by controlling activities on the surface.

G.2 Filter Wastewater Treatment Systems

G.2.1 Intermittent soil and sand filters

The main tasks are servicing of the dosing equipment (pump and distribution manifold) and monitoring of the wastewater. In the case of sand filters, there is possible maintenance of the sand surface of open sand filters. When de-sludging the septic tank, the pump sump should also be de-sludged. After de-sludging the chamber, the pump unit should be hosed down and the washwater and sludge be removed from the pump chamber. The distribution manifold needs to be cleaned periodically (at least once every 6–12 months) and so needs to be designed to facilitate such an operation. The use of backpressure gauges and zoned regions will facilitate the maintenance of distribution manifolds.

The performance of the pump system should be checked, including the pump sump, pump base, the float position and operation, a check for blockages and volume delivered.

G.2.2 Mounded filter systems

The most common failures in mound systems are the granular fill material/filter material interface in the mound. The quantity and quality of wastewater or the fill material can lead to potential failures. Failures due to compaction and ponding are often seen as leakage at the interface between the soil and filter material. Hydraulic failure can occur in mounds due to excessive ponding within the absorption area or leaking out of the toe of the mound. Ponding can occur where a flow rate across the granular fill/filter material interface is less than the flow rate from the dosing chamber. This may be due to a number of causes, namely:

- Restricted clogging of the distribution pipes
- The filter material is too fine
- The loading rate is too great, or
- A combination of these factors.

Particular care should be taken to avoid compaction or disturbance of the area over and around the infiltration system. The dosing chamber should be kept clear of obstruction and should be checked for correct distribution and the outlets should be adjusted if necessary. All electrical and mechanical devices should be serviced in accordance with the manufacturer’s instructions. Monitoring tubes should be installed to allow for the inspection of the mound without unearthing the filter material or removing the access port. These should be 100-mm diameter vertical pipes with 6- to 8-mm diameter holes (or slots) drilled down the length and covered with geotextile for soil filters. Any progressive increase in the depth of water in the monitoring tubes may indicate a problem. The dosing chamber should be pumped out at least once every 3–5 years or as required by the manufacturer’s specifications. The pump chamber (sump) should be fitted with a high-

level alarm to alert the homeowner to a possible pump failure or blocked distribution pipework. Grass and other vegetation covering the mound should be maintained, in order to maximise water uptake and to prevent erosion. Trees or shrubs with extensive root systems should not be planted on or near the mound, as they may clog the drainage pipes or cause short-circuiting of the filter material.

G.2.3 Constructed wetlands

Constructed wetlands require some inspection and maintenance to avoid the occurrence of problems within the system. It takes approximately 4 weeks or so for the plants to settle in after planting and they generally become fully established within the first 2 years. Plants should be healthy and it is preferable to plant before the growing season. Seedlings and rhizomes should be planted to ensure early establishment and to stop them becoming overwhelmed by weeds. The wetland should be kept moist during periods of dry weather especially during the first year or so, to ensure plant health. This is only needed if water is not discharging from the outlet due to percolation through clay substrates or due to high plant evapotranspiration rates combined with low summer use.

Routine inspections are necessary to ensure appropriate flows through the inlet distributor and outlet collector piping, as well as for the detection of leakage from the pipework. Regular de-sludging of preliminary or secondary treatment systems upstream of the wetland is needed to prevent sludge carry-over and accumulation at the wetland inlet. Grass and wetland vegetation should be checked to identify any visible signs of plant stress or disease. Common symptoms of plant stress are grass yellowing and leaf damage. A specialist or the system supplier should be consulted if signs of plant stress are spotted. Flow distribution within the cells should be inspected from time to time in order to detect channel formation or short-circuiting, especially in horizontal flow systems. The planting of additional vegetation or filling soil in any channels that have formed can correct this. All pipework and pumps should be checked regularly to ensure that they are operating properly and that there are no signs of clogging.

Flow meters and timers should be checked to ensure that the right amount of effluent is being applied to the system. In order to maximise the healthy bacterial activity and overall effectiveness of the treatment system, the use of bleaches and other toxic chemicals from the wastewater stream should be minimised or eliminated if possible.

G.3 Packaged Wastewater Treatment Systems

Packaged wastewater treatment systems are configured in various ways and the system manufacturer often dictates the frequency and method of maintenance. When seeking specific guidance for the maintenance of such systems the user should consult the instructions provided by the manufacturer, or refer to any information provided about the maintenance of the system in the appropriate Agrément Certificate or standard. In some (but not all) cases, maintenance is offered by the manufacturer through a maintenance contract. Maintenance may also be available commercially by appropriately qualified service providers.

In general, it is possible to comment on the key items of mechanical and electrical equipment included in many such treatment systems, and some direction in regard to maintenance can be provided.

> **Warning**
> Proprietary wastewater treatment systems, which incorporate mechanical and/or electrical components, are generally not user serviceable. Such units may be powered by mains electricity, and unqualified persons should not attempt to perform maintenance on them. To avoid serious injury or electrocution, servicing should only be carried out by qualified service providers.

G.3.1 Checks that may be carried out by the user

- The warning alarm system:
  - Many of the latest packaged wastewater treatment systems are equipped with an alarm circuit. The purpose of this circuit

  is to alert the user to any malfunction that has been diagnosed in the treatment system by the built-in system monitoring devices.

  - Where the facility to do so has been incorporated, the user should periodically check the alarm circuit to ensure that the system alarm is working properly. In most cases, it will be possible to perform this check within the user's house or from a control box outside the house.

- Visual inspection:
  - The user of a mechanical wastewater treatment system should carry out a periodic visual inspection of the external elements of the treatment unit and polishing filter.

- Odour observation:
  - While carrying out the visual inspection the user should note any unusual odours emanating from the mechanical aeration system. For example, pungent sulphide-like (bad egg) odours may indicate anaerobic conditions in the treatment system. This may be indicative of a breakdown of the aeration equipment and this should be investigated thoroughly by a qualified service provider.

- Noise:
  - While carrying out the visual inspection the user should note any unusual noises from the mechanical aeration system. For example, unusual noises coming from the treatment system may indicate that there are problems with the mechanical components (pump or aerator). Such problems may be associated with partial blockages or component wear and should be investigated thoroughly by a qualified service provider.

G.3.2 Proprietary filters

For proprietary peat filter systems, it is advisable that the manufacturer/competent person assesses the quality of the media from time to time. The surface of the peat filter should be examined periodically for signs of ponding and, where evident, the manufacturer/installer should be contacted. The peat media should not be disturbed as this may lead to channelling of effluent or flooding. When de-sludging the septic tank, the pump chamber should also be de-sludged. After de-sludging the chamber, the pump unit should be hosed down and the wash water and sludge be removed from the pump chamber.

G.4 Polishing Filters

Where polishing filters have been installed with either filter systems or packaged wastewater treatment systems, these should be periodically inspected in accordance with the general principles outlined in Section 7. In addition, where polishing filters are situated above ground level, checks should be carried out to ensure that no effluent is escaping from the filter above ground or at the interface with the ground surface.

G.5 Holiday Homes

When choosing a wastewater treatment system for holiday homes, consideration should be given to the selection of a system that can adequately deal with periods of inactivity (i.e. when the house is unoccupied for prolonged periods). Systems that are capable of recirculating the effluent would be appropriate. It is recommended that biodegradable cleaning agents be considered for use in holiday homes. All systems should be operated and maintained in accordance with the manufacturer's instructions.

Annex H References and Reading Material

BS 5930:1999 *Code of Practice for Site Investigations*. British Standards Institution, UK.

BS 10175:2001 *Investigation of potentially contaminated sites – Code of Practice*. British Standards Institution, UK.

Building Research Establishment (BRE) (1991). *Soakaway Design*. Building Research Establishment (BRE) Publications, BRE Press, UK.

Carey, C., Phelan, W. and Boland, C. (2008). *Examining the Use of Food Waste Disposers* (2005-WRM-DS-23-M1). Environmental Protection Agency, Johnstown Castle Estate, Wexford, Ireland.

CEC (1980). *Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances*. Council of the European Communities, O.J. L 20/43.

CEC (2000). *Council Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy*. Council of the European Communities O.J. L 327.

CEN (2002). *Wastewater Treatment Plants – Part 1. European Standard*. I.S. EN 12255-1:2002. European Committee for Standardization. Brussels, Belgium.

CEN (2005a). *Small wastewater treatment systems for up to 50 PT – Part 2: Soil Infiltration Systems*. Technical Report I.S. CEN/TR 12566-2:2005. European Committee for Standardization. Brussels, Belgium.

CEN (2005b). *Small wastewater treatment systems for up to 50 PT – Part 3: Packaged and/or Site Assembled Domestic Wastewater Treatment Plants*. European Standard I.S. EN 12566-3:2005. European Committee for Standardization. Brussels, Belgium.

CEN (2005c). *Small wastewater treatment systems for up to 50 PT – Part 6: Prefabricated Treatment Units for Septic Tank Effluent*. European Standard prEN 12566-6. European Committee for Standardization. Brussels, Belgium.

Cooper, P.F., Job, G.D., Green, M.B. and Shutes, R.B.E. (1996). *Reed Beds and Constructed Wetlands for Wastewater Treatment*. Water Research Centre, Swindon, UK.

Daly, D. (2006). *Site Suitability for On-Site Wastewater Treatment Systems – the Role of the Water Table.* Groundwater Newsletter No. 45 issued by the Geological Survey of Ireland, Dublin, Ireland.

DELG (Department of Environment and Local Government) (1992). Environmental Protection Agency Act, 1992. Statutory Number 7 of 1992. Government Publications Office, Dublin 2, Ireland.

DELG/EPA/GSI (Department of Environment and Local Government/Environmental Protection Agency/ Geological Survey of Ireland) (1999). *Groundwater Protection Schemes*. Geological Survey of Ireland, Dublin, Ireland.

DoEHLG (Department of the Environment, Heritage and Local Government) (2003). Protection of the Environment Act, Statutory Instrument, Number 27 of 2003. Government Publications Office, Dublin 2, Ireland.

DoEHLG (Department of the Environment, Heritage and Local Government) (2005). Safety, Health and Welfare at Work Act, Statutory Number 10 of 2005 Government Publications Office, Dublin 2, Ireland.

DoELG/EPA/GSI (Department of Environment and Local Government/Environmental Protection Agency/ Geological Survey of Ireland) (1999a). *Groundwater Protection Responses for Landfills*. Geological Survey of Ireland, Dublin, Ireland.

DoELG/EPA/GSI (Department of Environment and Local Government/Environmental Protection Agency/ Geological Survey of Ireland) (1999b). *Groundwater Protection Responses to the Landspreading of Organic Wastes*. Geological Survey of Ireland, Dublin, Ireland.

DoELG/EPA/GSI (Department of Environment and Local Government/Environmental Protection Agency/ Geological Survey of Ireland) (2001). *Groundwater Protection Responses for On-Site Systems for Single Houses*. Geological Survey of Ireland, Dublin, Ireland.

EPA (1999). *Wastewater Treatment Manuals: Treatment Systems for Small Communities, Business, Leisure Centres and Hotels*. Environmental Protection Agency, Johnstown Castle Estate, Wexford, Ireland.

EPA (2000). *Wastewater Treatment Manuals: Treatment Systems for Single Houses*. Environmental Protection Agency, Johnstown Castle Estate, Wexford, Ireland.

EPA (2008), *Waste Water Discharge Licensing Application Guidance Note*. Environmental Protection Agency, Johnstown Castle Estate, Wexford, Ireland.

Gill, L.W., Hand A. and O'Súilleabháin C. (2004). Effective distribution of domestic wastewater effluent between percolation trenches in on-site treatment systems. *Water Science and Technology* 51(10): 39–46.

Gill, L.W., O'Súilleabháin, C., Misstear, B.D.R. and

Johnston, P.J. (2004). A comparison of stratified sand filters and percolation trenches for the treatment of domestic wastewater effluent. *Proceedings of the 1st International Conference on Onsite Wastewater Treatment and Recycling (IWA).* Freemantle, Australia: 11–13 February 2004.

Gill, L.W., O'Súilleabháin, C., Misstear, B.D.R. and Johnston, P.J. (2005). *An Investigation into the Performance of Subsoils and Stratified Sand Filters for the Treatment of On-Site Wastewater.* 2001-MS15-M1: Synthesis Report, Environmental Protection Agency, Johnstown Castle Estate, Wexford, Ireland.

Gill, L.W., O'Súilleabháin, C., Johnston, P.M. and Misstear, B.D.R. (2005). *An Investigation into the Performance of Subsoils and Stratified Sand Filters for the Treatment of Wastewater from On-Site Systems*. Synthesis Report, Environmental Protection Agency, Johnstown Castle Estate, Wexford, Ireland.

Gill, L.W., O'Súilleabháin, C., Misstear, B.D.R. and Johnston, P.J. (2007). The treatment performance of different subsoils in Ireland receiving on-site wastewater effluent. *Journal of Environmental Quality* 36(6): 1843–1855.

Gill, L., Ó'Luanaigh, N., Patel, T., Misstear, B. and Johnston, P. (2009a). *The Treatment of On-Site Wastewater in Rapid Percolating Subsoils and Reed Beds and Investigation into the Effective Distribution of Effluent Across Percolation Areas.* Environmental Protection Agency, Johnstown Castle Estate, Wexford, Ireland. (in press)

Gill, L.W., O'Súilleabháin, C., Misstear, B.D.R. and Johnston, P. (2009b). Comparison of stratified sand filters and percolation trenches for on-site wastewater treatment. *Journal of Environmental Engineering* ASCE/January 2009: 8–16.

Grant, N. and Griggs, J. (2001). *Reed Beds for the Treatment of Domestic Wastewater.* Building Research Establishment (BRE) Publications, BRE Press, UK.

Gray, N.F. (1995). Composition of septic tank effluent. *The GSI Groundwater Newsletter* 27: 8.

Hellström, D. and Jonsson, L. (2003). Evaluation of small wastewater treatment systems. *Water Science & Technology* 48(11–12): 61–68.

Jackson, B.J. (2005). *Investigation into the Correlations between the BS5930 SOIL CLASSIFICATIONS and Percolation Tests Used in Site Suitability Assessments for On-Site Waste Water Effluent Treatment.* MSc Thesis. Department of Civil, Structural and Environmental Engineering, Trinity College Dublin, Ireland.

Kadlec, R. and Knight, R. (1996). *Treatment Wetlands.* CRC Press, Boca Raton, FL, USA.

Kadlec, R.H., Tanner, C.C., Hally, V.M. and Gibbs, M.M. (2005). Nitrogen spiraling in subsurface-flow constructed wetlands: implications for treatment response. *Ecological Engineering* 25: 365–381.

Molle, P., Liénard, A., Grasmick, A. and Iwema, A. (2003). Phosphorus retention in subsurface constructed wetlands: investigations focused on calcareous materials and their chemical reactions. *Water Science & Technology* 48(5): 75–84.

Mulqueen, J. and Rodgers, M. (2001). Percolation testing and hydraulic conductivity of soils for percolation areas. *Water Research* 35(16): 3909–3915.

Mulqueen, J., Rodgers, M., Hendrick, E., Keane, M. and McCarthy, R. (1999). *Forest Drainage Engineering.* COFORD, Dublin, Ireland.

Nichols, D.J., Wolf, D.C., Gross, M.A. and Rutledge, E.M. (1997). *Renovation of Septic Effluent in a Stratified Sand Filter.* ASTM STP 1324. American Society for Testing and Materials, PA, USA.

O'Súilleabháin, C., Gill, L.W., Misstear, B.D.R. and Johnston, P.M. (2008). Fate of endocrine-disrupting chemicals in percolating domestic wastewater effluent. *Water and Environment Journal* (in press).

Patel, T., O'Luanaigh, N. and Gill, L.W. (2008). A comparison of gravity distribution devices used in on-site domestic wastewater treatment systems. *Journal of Water, Air & Soil Pollution* 191(1–4): 55–69.

Phelps, R.D.S. and Griggs, J. (2005). *Mound Filter Systems for the Treatment of Domestic Wastewater.* Building Research Establishment (BRE) Publications, BRE Press, UK.

University of Wisconsin-Madison (1978). *Management of Small Wastewater Flows.* EPA 600/7-78-173. US Environmental Protection Agency, Office of Research and Development, Municipal Environmental Research Laboratory, Cincinnati, OH, USA.

US EPA (1992). *Wastewater Treatment/Disposal for Small Communities.* Manual No. EPA/625/R-92/005. US Environmental Protection Agency, USA.

US EPA (1993). *Subsurface Flow Constructed Wetlands for Wastewater Treatment: A Technology Assessment.* EPA/832/R/93/001. USEPA Office of Water, Washington, DC, USA.

US EPA (2002). *Onsite Wastewater Treatment Systems Manual.* No. EPA/625/R-00/008, Office of Water, Office of Research and Development, US Environmental Protection Agency, USA.

Van Cuyk, S., Siegrist, R., Lowe, K., Drewes, J., Munakata-Marr, J. and Figueroa, L. (2005). *Performance of engineered treatment units and their effects on biozone formation in soil and system purification efficiency.* National Decentralized Water Resources Capacity Development Project (NDWRCDP) Research Project (WU-HT-03-36).

Submitted by the Colorado School of Mines, Golden, Colorado, USA.

Wakida, F.T. and Lerner, D.N. (2005). Non-agricultural sources of groundwater nitrate: a review and case study. *Water Research* 39: 3–16.

Wallace, S. and Knight, R. (2007) *Small-Scale Constructed Wetland Treatment Systems – Feasibility, Design Criteria and Operational & Monitoring Requirements*. IWAP ISBN 1-84339-728-5.

Zhu, T., Mæhlum, T., Jenssen, P.D. and Krogstad, T. (2003). Phosphorus sorption characteristics of a light-weight aggregate. Water Science & Technology 56(5): 93–100.

An Ghníomhaireacht um Chaomhnú Comhshaoil

Is í an Gníomhaireacht um Chaomhnú Comhshaoil (EPA) comhlachta reachtúil a chosnaíonn an comhshaol do mhuintir na tíre go léir. Rialaímid agus déanaimid maoirsiú ar ghníomhaíochtaí a d'fhéadfadh truailliú a chruthú murach sin. Cinntímid go bhfuil eolas cruinn ann ar threochtaí comhshaoil ionas go nglactar aon chéim is gá. Is iad na príomh-nithe a bhfuilimid gníomhach leo ná comhshaol na hÉireann a chosaint agus cinntiú go bhfuil forbairt inbhuanaithe.

Is comhlacht poiblí neamhspleách í an Ghníomhaireacht um Chaomhnú Comhshaoil (EPA) a bunaíodh i mí Iúil 1993 faoin Acht fán nGníomhaireacht um Chaomhnú Comhshaoil 1992. Ó thaobh an Rialtais, is í an Roinn Comhshaoil agus Rialtais Áitiúil a dhéanann urraíocht uirthi.

ÁR bhFREAGRACHTAÍ

CEADÚNÚ

Bíonn ceadúnais á n-eisiúint againn i gcomhair na nithe seo a leanas chun a chinntiú nach mbíonn astuithe uathu ag cur sláinte an phobail ná an comhshaol i mbaol:

- áiseanna dramhaíola (m.sh., líonadh talún, loisceoirí, stáisiúin aistrithe dramhaíola);
- gníomhaíochtaí tionsclaíocha ar scála mór (m.sh., déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta);
- diantalmhaíocht;
- úsáid faoi shrian agus scaoileadh smachtaithe Orgánach Géinathraithe (GMO);
- mór-áiseanna stórais peitreail;
- scardadh dramhuisce.

FEIDHMIÚ COMHSHAOIL NÁISIÚNTA

- Stiúradh os cionn 2,000 iniúchadh agus cigireacht de áiseanna a fuair ceadúnas ón nGníomhaireacht gach bliain.
- Maoirsiú freagrachtaí cosanta comhshaoil údarás áitiúla thar sé earnáil - aer, fuaim, dramhaíl, dramhuisce agus caighdeán uisce.
- Obair le húdaráis áitiúla agus leis na Gardaí chun stop a chur le gníomhaíocht mhídhleathach dramhaíola trí comhordú a dhéanamh ar líonra forfheidhmithe náisiúnta, díriú isteach ar chiontóirí, stiúradh fiosrúcháin agus maoirsiú leigheas na bhfadhbanna.
- An dlí a chur orthu siúd a bhriseann dlí comhshaoil agus a dhéanann dochar don chomhshaol mar thoradh ar a ngníomhaíochtaí.

MONATÓIREACHT, ANAILÍS AGUS TUAIRISCIÚ AR AN GCOMHSHAOL

- Monatóireacht ar chaighdeán aeir agus caighdeáin aibhneacha, locha, uiscí taoide agus uiscí talaimh; leibhéil agus sruth aibhneacha a thomhas.
- Tuairisciú neamhspleách chun cabhrú le rialtais náisiúnta agus áitiúla cinntí a dhéanamh.

RIALÚ ASTUITHE GÁIS CEAPTHA TEASA NA HÉIREANN

- Cainníochtú astuithe gáis ceaptha teasa na hÉireann i gcomhthéacs ár dtiomantas Kyoto.
- Cur i bhfeidhm na Treorach um Thrádáil Astuithe, a bhfuil baint aige le hos cionn 100 cuideachta atá ina mór-ghineadóirí dé-ocsaíd charbóin in Éirinn.

TAIGHDE AGUS FORBAIRT COMHSHAOIL

- Taighde ar shaincheisteanna comhshaoil a chomhordú (cosúil le caighdéan aeir agus uisce, athrú aeráide, bithéagsúlacht, teicneolaíochtaí comhshaoil).

MEASÚNÚ STRAITÉISEACH COMHSHAOIL

- Ag déanamh measúnú ar thionchar phleananna agus chláracha ar chomhshaol na hÉireann (cosúil le pleananna bainistíochta dramhaíola agus forbartha).

PLEANÁIL, OIDEACHAS AGUS TREOIR CHOMHSHAOIL

- Treoir a thabhairt don phobal agus do thionscal ar cheisteanna comhshaoil éagsúla (m.sh., iarratais ar cheadúnais, seachaint dramhaíola agus rialacháin chomhshaoil).
- Eolas níos fearr ar an gcomhshaol a scaipeadh (trí cláracha teilifíse comhshaoil agus pacáistí acmhainne do bhunscoileanna agus do mheánscoileanna).

BAINISTÍOCHT DRAMHAÍOLA FHORGHNÍOMHACH

- Cur chun cinn seachaint agus laghdú dramhaíola trí chomhordú An Chláir Náisiúnta um Chosc Dramhaíola, lena n-áirítear cur i bhfeidhm na dTionscnamh Freagrachta Táirgeoirí.
- Cur i bhfeidhm Rialachán ar nós na treoracha maidir le Trealamh Leictreach agus Leictreonach Caite agus le Srianadh Substaintí Guaiseacha agus substaintí a dhéanann ídiú ar an gcrios ózóin.
- Plean Náisiúnta Bainistíochta um Dramhaíl Ghuaiseach a fhorbairt chun dramhaíl ghuaiseach a sheachaint agus a bhainistiú.

STRUCHTÚR NA GNÍOMHAIREACHTA

Bunaíodh an Ghníomhaireacht i 1993 chun comhshaol na hÉireann a chosaint. Tá an eagraíocht á bhainistiú ag Bord lánaimseartha, ar a bhfuil Príomhstiúrthóir agus ceithre Stiúrthóir.

Tá obair na Gníomhaireachta ar siúl trí ceithre Oifig:

- An Oifig Aeráide, Ceadúnaithe agus Úsáide Acmhainní
- An Oifig um Fhorfheidhmiúchán Comhshaoil
- An Oifig um Measúnacht Comhshaoil
- An Oifig Cumarsáide agus Seirbhísí Corparáide

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag ball air agus tagann siad le chéile cúpla uair in aghaidh na bliana le plé a dhéanamh ar cheisteanna ar ábhar imní iad agus le comhairle a thabhairt don Bhord.

Office of
Environmental
Enforcement

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