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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/newapproach/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[a]		Resource protection area Aquifer category						
			Regionally important		Locally important			Poor aquifers	
	Inner (SI)	Outer (SO)	Rk	Rf/Rg	Lk	Lm/Lg	Ll	Pl	Pu
Extreme (X and E)	R3[2]	R3[1]	R2[2]	R2[2]	R2[2]	R2[1]	R2[1]	R2[1]	R2[1]
High (H)	R2[4]	R2[3]	R2[1]	R1	R2[1]	R1	R1	R1	R1
Moderate (M)	R2[4]	R2[3]	R1	R1	R1	R1	R1	R1	R1
Low (L)	R2[4]	R1	R1	R1	R1	R1	R1	R1	R1

[a]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; Lk, Locally Important Karstified 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

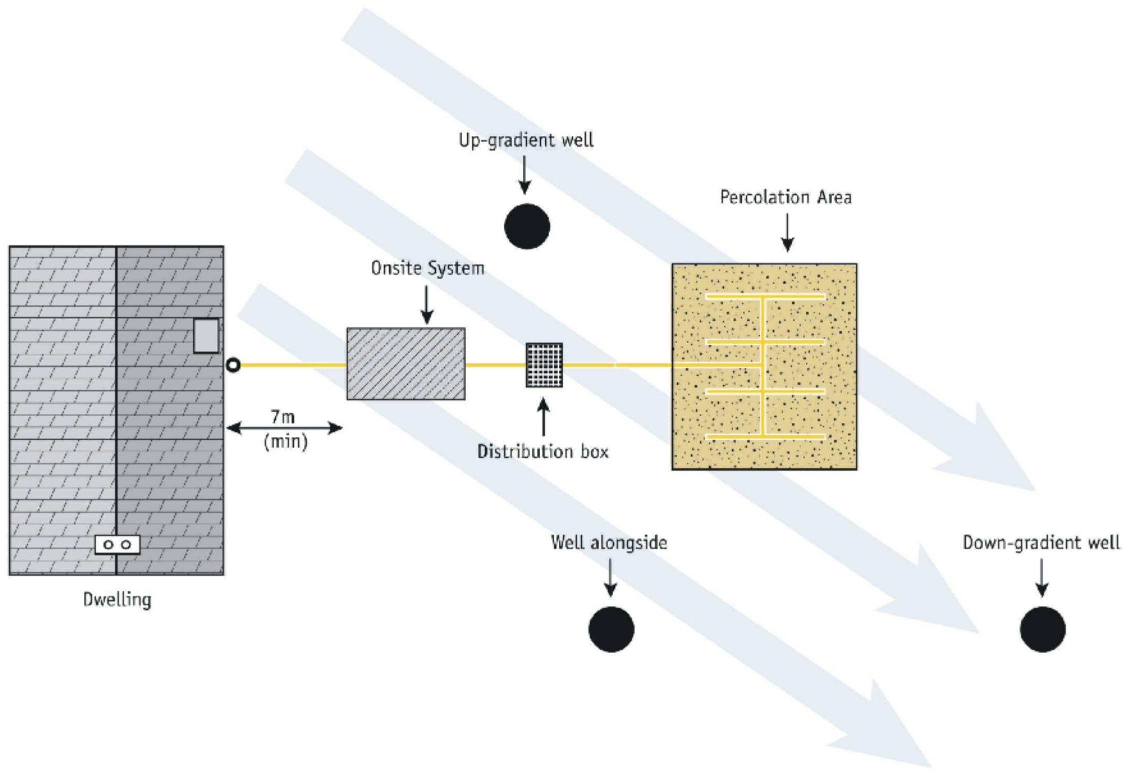


FIGURE B.1. RELATIVE LOCATION OF WELLS.

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

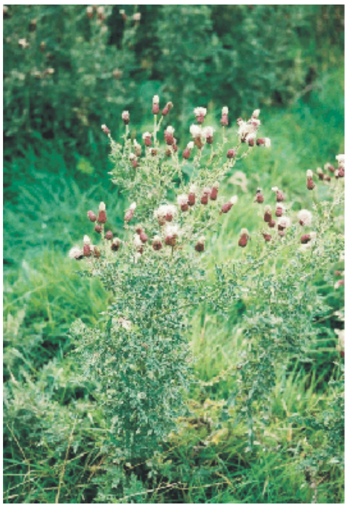
The trial hole should be located adjacent to but **not within** the proposed percolation area/ polishing filter, as the disturbed subsoil will provide a preferential flow path in the final percolation area.

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

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.

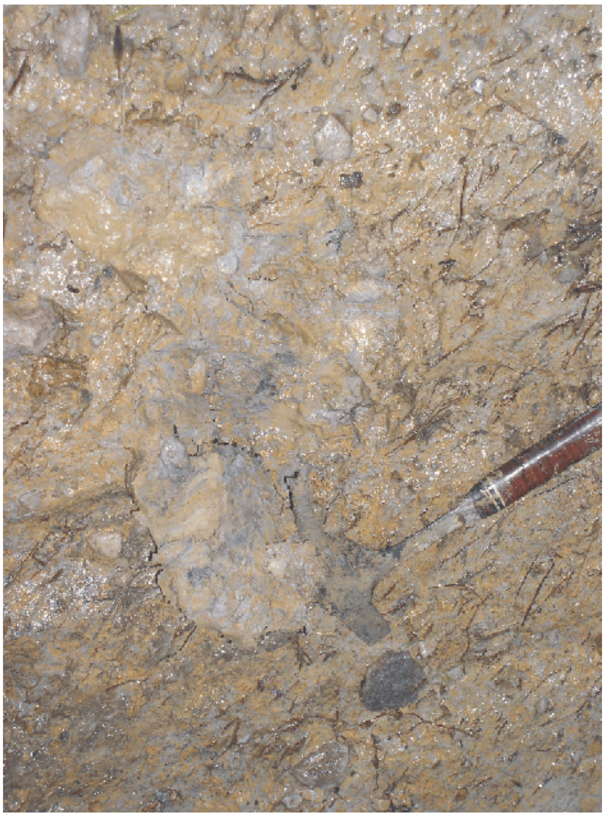


FIGURE C.2. CLOSE-UP OF MOTTLING IN TRIAL HOLE.

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

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.

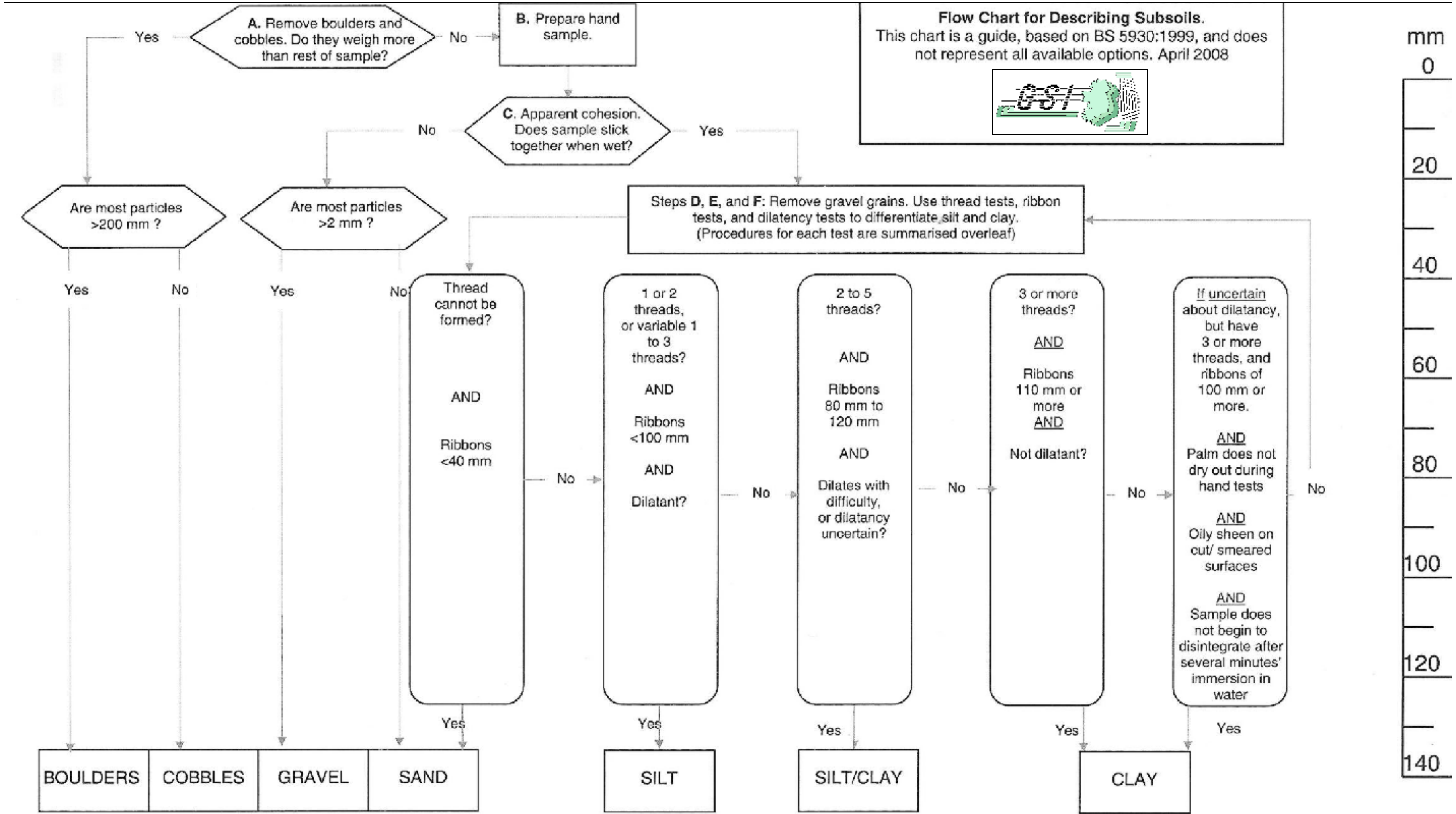
Colour: Colour is a good indicator of the state of aeration of the soil/subsoil. Free-draining soils/subsoils are in an oxidised state and exhibit brown, reddish brown and yellowish brown colours. Many free-draining soils of limestone origin with deep water tables are grey at depth (due to the colour 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.

BOULDERS, COBBLES and GRAVEL:
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.

SAND:
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.

SILT, CLAY and SILT/CLAY:
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.

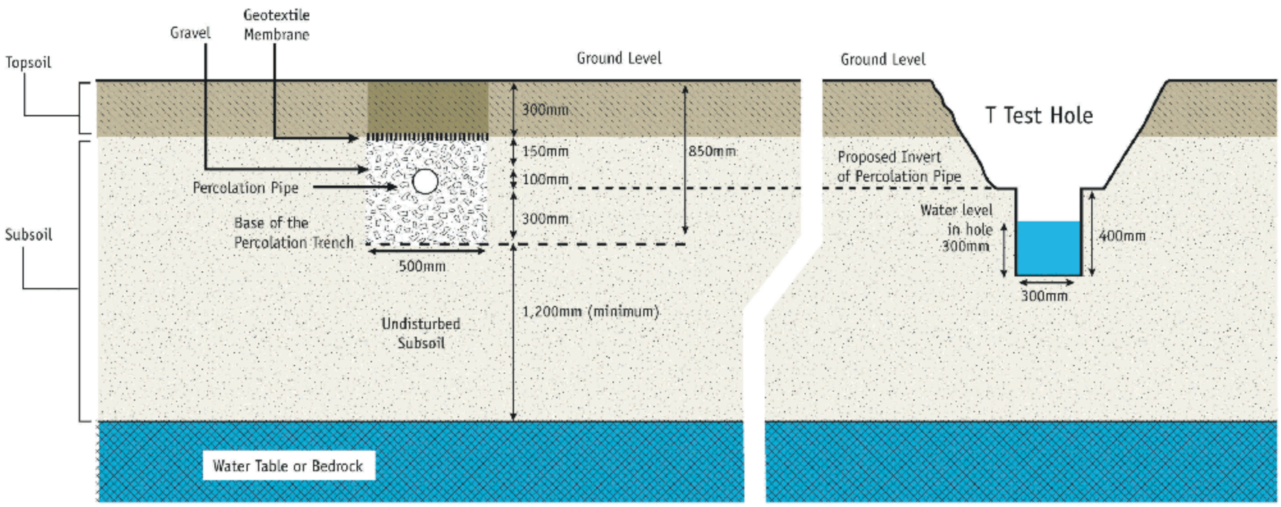


FIGURE C.3. IDEALISED CROSS SECTION OF THE T-TEST HOLES AND THE PROPOSED PERCOLATION TRENCH.

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 $T_{100} \le 210$ 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)				T- Value Hole 2= (t_2)				T- Value Hole 3= (t_3)			

Result of Test: T = ________ (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.

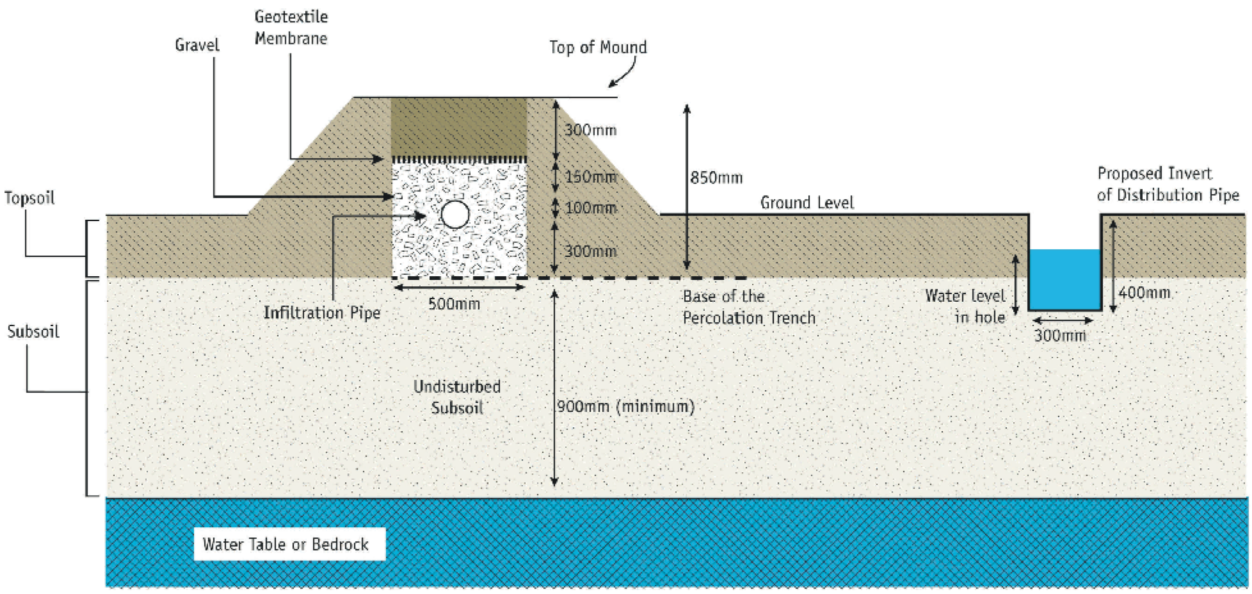


FIGURE C.4. CROSS SECTION OF THE P-TEST HOLES AND THE PROPOSED PERCOLATION TRENCH.

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.

APPENDIX B: 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							

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.

3.2 Trial Hole (contd.) Evaluation:

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]			
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 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}			

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									
2									
3									
Average Δt Value									
	Average Δt/4 = [Hole No.1]		(t_1)	Average Δt/4 = [Hole No.2]		(t_2)	Average Δt/4 = [Hole No.3]		(t_3)

Result of Test: T = (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)				T- Value Hole 2= (t_2)				T- Value Hole 3= (t_3)			

Result of Test: T = (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} < 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									
2									
3									
Average Δp Value									
	Average Δp/4 = [Hole No.1]		(p_1)	Average Δp/4 = [Hole No.2]		(p_2)	Average Δp/4 = [Hole No.3]		(p_3)

Result of Test: P = (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)				P- Value Hole 1= (p_2)				P- Value Hole 1= (p_3)			

Result of Test: P = (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, test 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]

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 ☐

Discharge Route

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 | **Package Treatment Systems**

Media Type	Area (m^2)*	Depth of Filter	Invert Level	Type
Sand/Soil				
Soil				Capacity PE
Constructed Wetland				Sizing of Primary Compartment
Other				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 - N	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

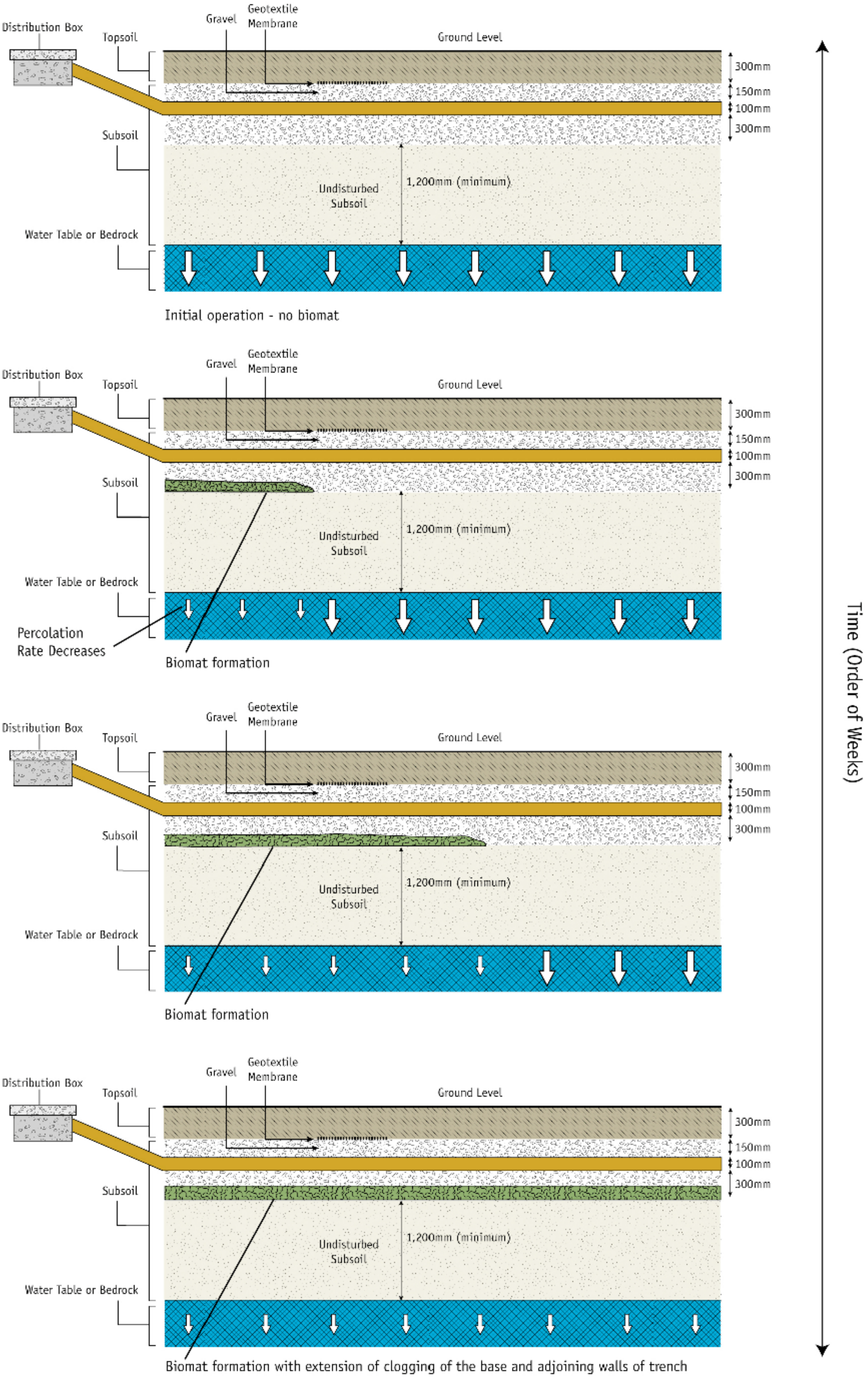


FIGURE E.1. ILLUSTRATION OF BIOMAT FORMATION ON THE BASE OF A PERCOLATION TRENCH.

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.

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