Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

CODE OF PRACTICE

WASTEWATER TREATMENT SYSTEMS

for

SINGLE HOUSES

(P.E < 10)

Consultation Draft 2007

CODE OF PRACTICE

WASTEWATER TREATMENT SYSTEMS FOR SINGLE HOUSES (P.E. <10)

Published by the Environmental Protection Agency, Ireland.

ISBN
Price €€

TABLE OF CONTENTS

PREFACE

The purpose of this document is to provide guidance on the provision of wastewater treatment and disposal systems for single houses with a PE less 10. Guidance is provided on

- Site suitability assessment;
- Selection of appropriate wastewater treatment system;
- Design criteria for conventional septic tank systems and secondary treatment systems; and
- Installation, operation and maintenance of the selected system.

The Wastewater Treatment Manual: Treatment Systems for Small Communities, Business, Leisure Centres and Hotels should be used for any development with greater than 10 PE.

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

This code of practice will replace the guidance document Standard Recommendation No.6 1991 issued by the National Standards Authority of Ireland when the Department of Environment, Heritage and Local Government call up the code of practice in the Building Regulations.

This code of practice has been prepared having regard current standards and guidelines and will assist planning authorities, developers, system manufacturers, system designers, system installers and system operators to deal with the complexities of on-site systems for single houses. Where reference in the document is made to proprietary equipment, this is intended as indicating equipment type and is not to be interpreted as endorsing or excluding any particular manufacturer or system.

Site suitability assessors should carry out all assessments in accordance with the guidance provided in this code of practice. The site suitability assessment methodology set out in this document should be used by planning authorities to satisfy the requirements of Article 22 (c) of the Planning and Development Regulations 2006. There is also an obligation on the proposed house developer/owner to ensure that any planning application submitted should include an assessment of the site and recommendations in accordance with the guidance provided in this code of practice. In addition, it is essential that the wastewater treatment system installed on site complies with the conditions of planning and that the system is properly installed and maintained in accordance with the guidance in Chapter 7.

The key messages of the code of practice are:

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

- The need for design of on site wastewater disposal systems specific to the local conditions
- The need for follows through by the developer/occupier – ie installation/commissioning/maintenance as per design and attendant recommendations/conditions – otherwise breaches of various legislative codes is occurring.

Chapter 1 of this Code of Practice (CoP) contains an introduction to wastewater treatment and the types of on-site treatment systems available for a single house.

Chapter 2 outlines the steps, which should be taken to characterise a site and in selecting the most appropriate wastewater treatment system. Characterisation of a site is divided into a desk study followed by an on-site assessment. The on-site assessment is subdivided into a visual assessment, a trial hole and a percolation test. The significance of the information collected during the desk study and the on-site assessment is summarised at the end of this chapter. It also outlines a methodology for selecting the on-site treatment system and the optimum discharge route, which allows a recommendation for the most appropriate treatment system to be made.

Chapter 3 provides information on the design, construction and maintenance of a conventional septic tank system, i.e. septic tank and percolation area.

Chapter 4 provides filter systems, including intermittent filters, constructed wetlands and other filter systems.

Chapter 5 provides information on mechanical aeration systems, such as Biofilm Aerated Filter (BAF) Systems, Rotating Biological Contactors (RBC) Systems, Sequencing Batch Reactor (SBR) Systems and membrane filtration systems.

Chapter 6 outlines details of tertiary treatment systems, including polishing filters, constructed wetlands and packaged treatment systems, which are required to be installed following the secondary treatment stage in all cases.

Chapter 7 sets out the minimum maintenance requirements for conventional septic tanks, filter and mechanical aeration systems, as well as for tertiary treatment systems and polishing filters.

Groundwater protection responses developed for on-site systems for single houses (DELG/EPA/GSI, 2000) have been modified to take account of new research findings and changes to the code of practice. These responses are contained in Appendix A and should be consulted.

A site characterisation form for use with this code of practice is included in Appendix B.

Procedures for carrying out of percolation tests can be found in Appendix C.

A form to assist in the evaluation of secondary wastewater treatment systems is contained in Appendix D.

Appendix E sets out the procedure to be followed to classify subsoils in accordance with BS5930: 1999.

Photographs of plants indicative of drainage conditions are contained in Appendix F.

Appendix G contains the main findings from ERTDI funded research into wastewater by the Department of Civil Engineering, National University of Ireland, Galway and the Department of Civil, Structural and Environmental Engineering Trinity College Dublin between 1995 and 2005.

In the course of the revision of the manual regard was had to a range of information sources including; new research sponsored by the EPA in order to address information gaps and undertaken by TCD and NUI Galway, feedback from FAS training courses which were run between 2000-2006, the publication by CEN of the EN12566 series of standards, comments from a range of interested parties, and comments which were sought from the Department of the Environment, Heritage and Local Government (DoEHLG), National Standards Authority of Ireland (NSAI), An Bord Pleanála, Domestic Effluent Trade Association (DETA), Geological Survey of Ireland (GSI), a representative of the Environment sub-committee of the City and County Managers Association (CCMA), as well as information supplied by the commercial sector.

The Agency welcomes any suggestions, which users of the Code of Practice wish to make. These should be returned to the Office of Environmental Enforcement at the Agency office McCumiskey House, Richview, Clonskeagh Rd., Dublin 14, on the enclosed User Comment Form at the rear of this document.

ACKNOWLEDGEMENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

C	Capacity
°C	Degrees Celsius
Agency	Environmental Protection Agency
BAF	Biofilm aerated filters
BOD_5	Biological Oxygen Demand (5 day)
CEN	Comité Européen de Normalisation (European Committee for Standardisation)
COD	Chemical oxygen demand
C_u	Uniformity co-efficient
DoEHLG	Department of Environment, Heritage and Local Government
d	Day
DO	Dissolved oxygen
DWF	Dry weather flow
EPA	Environmental Protection Agency
FOG	Fats, oils and grease
FWS	Free-water surface
g	Gram
GSI	Geological Survey Of Ireland
h	Hour
kg	Kilogram
ISO	International Organisation for Standardisation
l	Litre
m	Metre
m^3	Cubic metres
m/s	Metres per second
mg	Milligram
mm	Millimetre
NHAs	National Heritage Areas
NUI	National University of Ireland
P.E.	Population equivalent
PFP	Preferential flow paths
RBC	Rotating biological contactors
s	Second

SACs	Special Areas of Conservation
S.I.	Statutory instrument
SBR	Sequencing batch reactor
SFS	Sub-surface flow system
SS	Suspended solids
TSS	Total suspended solids
TWL	Top water level

1. INTRODUCTION

Key message

A policy and legislative framework is in place which requires that new houses in unsewered areas be subject to a site suitability assessment and that an appropriate system be correctly installed and maintained to protect our environment and in particular water quality. Homeowners are responsible for their wastewater treatment systems and thus should ensure that all planning requirements and guidance in this code of practice is followed.

1.1 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 1500 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 water quality, is a central objective in the assessment, design, installation and maintenance of new wastewater disposal systems in unsewered areas. This code of practice 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 sites for new houses in unsewered rural areas must be suitable to the installation and operation of on site wastewater treatment systems and taking into account local ground conditions. This code of practice contains an assessment methodology for the determination of site suitability.

The Department of Environment, Heritage and Local Government also 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 ground water quality, the importance of good siting and design of necessary development in rural areas and the then current standards for onsite 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 development in rural areas and this code of practice presents comprehensive recommendations for the attainment of such high standards in line with the regulatory and policy frameworks.

1.2 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 disposal systems will be a key element of such decision making processes in unsewered areas. This code of practice provides the methodology for undertaking such site suitability assessments in accordance with the overall regulatory and policy framework set out by the Department of the Environment Heritage and Local Government relating to the planning system.

Assessment of site suitability under this code of practice 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 prepared by GSI and river basin management plans produced under the E.U. 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 water bodies;
- 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 is 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 foul odours can be generated. Inadequately treated wastewater through poor siting, design and/or construction may lead to contamination of our groundwaters and surface waters, which in many areas are also used as drinking water supplies. In some cases both the wastewater treatment system and the private drinking water supply 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 conditions 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.

1.3 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 groundwater 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 is as follows:

- Local Government (Water Pollution) Act, 1977 (SI No 1 of 1977).
- Local Government (Water Pollution)(Amendment) Act, 1990 (SI No 21 of 1990).

- Local Government (Water Pollution) Regulations, 1978 (SI No 108 of 1978).
- Local Government (Water Pollution) Regulations, 1992 (SI No 271 of 1992).
- Local Government (Water Pollution) (Amendment) Regulations, 1996 (SI No 184 of 1996).
- Local Government (Water Pollution) (Amendment) Regulations, 1999 (SI No 42 of 1999).
- Protection of Groundwater Regulations, 1999 (SI No 41 of 1999).

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).

The primary responsibility for protecting waters against pollution rests with any person who is carrying on an activity, which presents a threat to water quality.

The six documents commonly used in relation to the design of on-site systems in Ireland are:

- EN 12566, Small Wastewater Treatment Systems for up to 50 PT Parts 1-7;
- EPA: 2000, Wastewater Treatment Manual: Treatment Systems for Single Houses;
- SR6: 1991, Septic tank systems: Recommendations for domestic effluent treatment and disposal from a single dwelling house (National Standards Authority of Ireland);
- BS 6297: 1983, Design and installation of small sewage treatment works and cesspools (British Standards Institution). This publication deals mainly with the design of small sewage treatment works serving small communities, not primarily concerned with septic tank systems;
- EPA 1999, Wastewater Treatment Manuals - Treatment Systems for Small Communities, Business, Leisure Centres and Hotels; and
- US EPA/625/R-92/005 Manual: Wastewater Treatment/Disposal for Small Communities.

This code of practices is the most up to date guidance and replaces that previously issued by the Agency.

Septic tanks installed on or after 1 June 1992 must comply with Part H of the National Building Regulations. Technical Guidance Documents A-M contains general advice on compliance with the Building Regulations (Section 3 of 1990 Act and Section 7 of 1997 Act) (SI No 497 of 1997). The relevant Technical Guidance Document (TGD) - H (Drainage and Waste Water Disposal) calls up the following standards:

- Septic tanks serving single houses: Irish Standard Recommendations SR6 of 1991 for Domestic Effluent Treatment and Disposal from Single Dwellings, issued by the National Standards Authority of Ireland (NSAI); and
- Septic tanks serving groups of houses: British Standard B.S. 6297: 1983 (incorporating amendment No. 1 of 1990), a Code of Practice for the Design and Installation of Small Sewage Treatment Works, issue by the British Standards Institution (BSI).

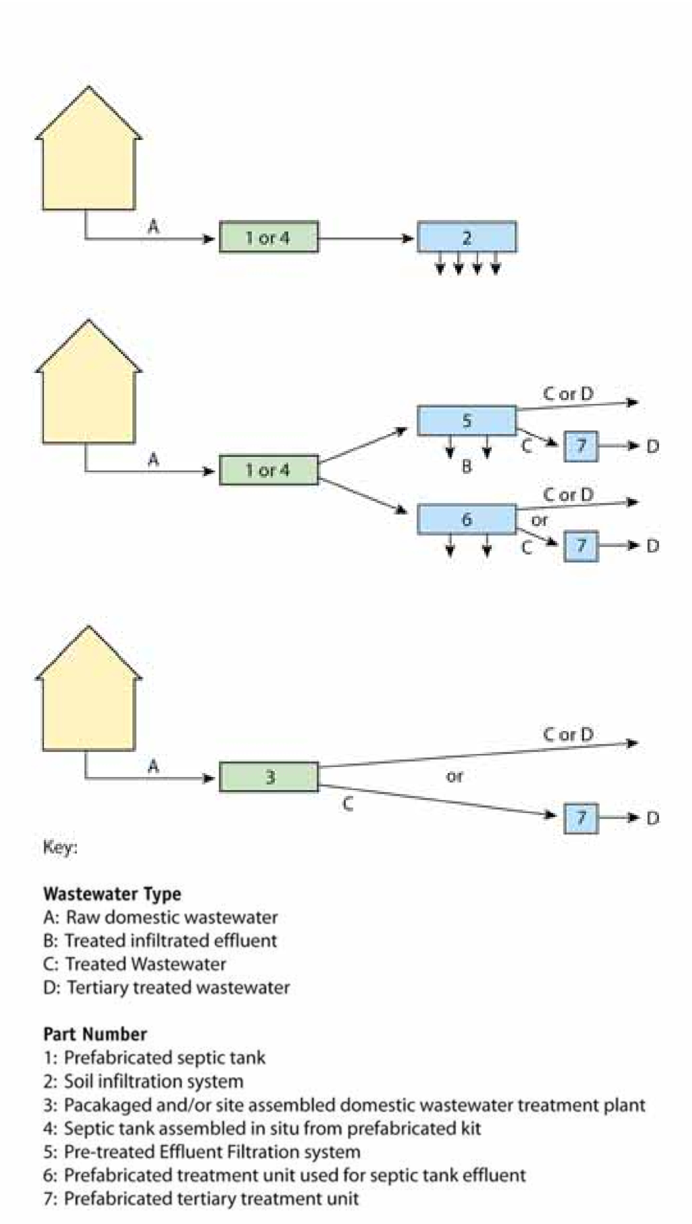
Certification (Irish Agrement Board certification or other accepted appropriate form of certification) has been the accepted method of proving the acceptability of other packaged context.

It is the DoEHLG to amend Technical Guidance Document H to provide for the use this Code of Practice as the main reference. NSAI has undertaken to withdraw SR6 in this context.

At a European level, work is being completed on the development of standards (EN 12566 series) for Small Wastewater Treatment Systems up to 50 PT. The EN12566 series of standards voluntary standards and codes developed by CEN and published (or to be published) by NSAI. Their content has been taken into account in the preparation of this document. En 12566 consists of a number of parts (Figure 1), which deal with a range of products including prefabricated septic tanks, soil infiltration systems, packaged and/or site assembled domestic wastewater treatment plants and packaged filtration systems, etc. The normative requirements in the standard, at the date of publication, have been incorporated into this code of practice. The code of practice 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.

- EN 12566-1:2000: Small Wastewater Treatment Systems up to 50 PT – Part 1: Prefabricated Septic Tanks (published by the NSAI as an Irish standard 7th July 2004).
- EN/TR 12566-2: 2005 Small Wastewater Treatment Systems up to 50 PT – Part 2: Soil infiltration systems (published by the NSAI as an Code of Practice 5th August 2005).
- EN 12566-3:2005 Small Wastewater Treatment Systems up to 50 PT – Part 3: Packaged and/or site assembled domestic wastewater treatment plants (published by the NSAI as an Irish standard 21st October 2005).
- EN12566-5 – To be published as a Technical Report.
- EN 12566-6 – To be published in early 2008.
- Parts 4 and 7 are still in preparation.

FIGURE 1: METHODS OF WASTEWATER TREATMENT IN LINE WITH EN 12566.



The Department of Environment, Heritage and Local Government issued another 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 EN 12566-3 has been adopted by the European Standards Committee (CEN) and transposed in Ireland by the NSAI as I.S. EN 12566-3:2005. The 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 2nd Edition of the EPA Wastewater Treatment Manual: Treatment Systems for Single Houses (now the Code of Practice: Wastewater Treatment Systems for 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 Agrement

Board (IAB). They are Biochemical Oxygen Demand – 20 mg/l; Suspended Solids – 30mg/l; and Ammonia as NH_4 – 20mg/l.

Two main research projects undertaken by Department of Civil Engineering, NUI Galway (1995-1997) and more recently by the Department of Civil, Structural and Environmental Engineering, Trinity College, Dublin (2000 –2005) underpin the guidance presented in this code of practice. A summary of the main findings of these projects is presented in Appendix G.

1.3.1 Characteristics of Wastewater from a Single House System

For the purposes of this code of practice, a single house system refers to a system serving a dwelling house of up to ten people with toilet, living, sleeping, bathing, cooking and eating facilities. For dwellings with greater than 10 people (i.e. guest houses or cluster developments) the reader is referred to the EPA manual – Wastewater Treatment Systems for Small Communities, Leisure Centres and Hotels (1999) and any further guidance developed by the EPA in relation to Section 4 discharges to surface waters or groundwater.

Under no circumstances should rainwater, surface water or run-off from paved areas be discharged to on-site single house treatment systems. To control the quantity of wastewater generated in a household, water usage reducing measures should be adopted

The strength of the inflow in terms of BOD (Biochemical Oxygen Demand) into an on-site system will largely depend on the water usage in the house; for example, houses with dishwashers may have a wastewater BOD strength reduced by up to 35% due to dilution even though the total BOD load to the treatment system (kg/day) remains the same. Household garbage grinders/ sink macerators can increase the BOD loading rate by up to 30%. Their use is not recommended for dwellings, as they result in additional maintenance requirements due to increased solids, increase in electricity usage and do not encourage recycling i.e. composting of organic wastes. If installed, the treatment plant should be specifically designed to deal with the additional loading The treatment systems covered by this Code of Practice are not appropriate for the disposal of waste oil and fats. These waste materials should be collected and disposed of by another appropriate method. Grease traps should be installed prior to the septic tanks.

Table 1 gives a range of typical concentration values for a number of parameters in domestic wastewater.

TABLE 1: TYPICAL CHARACTERISTICS OF DOMESTIC WASTEWATER FROM A SINGLE DWELLING

Parameter	Typical concentration (mg/l unless otherwise stated)
Chemical Oxygen Demand COD (as O_2)	400
Biochemical Oxygen Demand BOD_5 (as O_2)	300
Total solids	200
Total Nitrogen (as N)	50
Total Phosphorus (as P)	10
Total coliforms (MPN/ 100 ml)[1]	10^7 - 10^8

In order to calculate wastewater capacities and daily flows a value of 180 lcd should be used to ensure that adequate treatment is provided.

[1] MPN Most Probable Number

1.4 WASTEWATER TREATMENT SYSTEMS PERFORMANCE

1.4.1 Conventional Septic Tank Systems

The performance of conventional septic tank systems in treating domestic effluent relies primarily on the soil adsorption capability of the percolation area. This is designed on a prescriptive basis (see Section 3.3), which from research and experience, is considered to achieve a satisfactory effluent quality. An effectiveness requirement is usually not stated.

1.4.2 Secondary Treatment Systems

EN 12566-3 and prEN 12566-6 specify the test procedures to be followed in the measurement of a range of parameters relevant to treatment efficiency for packaged and/or site assembled treatment plant and for prefabricated treatment units for septic tank effluent, respectively. These standards do not specify quality levels to be achieved under any of these parameters. However, the standards provide for the declaration of test performance in relation to some or all of the parameters, as may be required by national regulations. Table 2 sets out performance requirements for specific parameters from this range, which are considered to be the minimum acceptable levels that should be achieved by these types of plantIn nutrient sensitive locations the local authority should require more stringent performance standards, this is of particular importance in areas with high nitrate and/or phosphorus levels in groundwater or surface waters.

TABLE 2: WASTEWATER TREATMENT PERFORMANCE STANDARDS

Parameter	Minimum Percentage Removal of raw effluent for secondary treatment systems	Standard (mg/l) [2]	Comments
BOD (mg/l)	85%	20	
COD (mg/l)	70%	-	
Suspended Solids (mg/l)	60%	30	
NH_3 –N (mg/l)	-	10	Unless otherwise specified
Total Nitrogen[3] (mg/l)	20%	5[4]	Only for nutrient sensitive sites
Total Phosphorous[4] (mg/l)	-	2[5]	Only for nutrient sensitive sites
Total Coliform	99.9%	-	

1.5 CRITERIA FOR SELECTION

When selecting a treatment system to treat wastewater from single houses, the system chosen:

- Should protect public health;

---

[2] 95%ile compliance is required

[3] Only required to be achieved in nutrient sensitive waters

[4] 24 hour composite samples

- Should not adversely affect the environment;
- Should be easy to maintain and be properly installed;
- Should have a long (> 25 years) lifespan; and
- Should be economical (see Appendix D for Secondary Treatment Systems).

1.6 WASTEWATER TREATMENT SYSTEMS

This section gives an overview of the main categories of wastewater treatment systems available, more detailed descriptions are given in the following chapters.

1.6.1 Conventional Septic Tank System

A conventional septic tank system (Chapter 3) 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 the secondary treatment of the wastewater and it is the percolation area that 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. As the wastewater flows into and through the subsoil, it undergoes surface filtration, straining, physico-chemical interactions and microbial breakdown. After flowing through a suitably designed percolation area the wastewater is suitable for discharge.

In the absence of a connection to a sewer system, one of the most appropriate and cost effective means of treating wastewater in a suitable site is a properly constructed and maintained conventional septic tank system. Failure to function properly is generally due to poor construction, installation, operation, maintenance to location in an area of unsuitable subsoil, or to the use of a soakaway instead of a properly designed percolation area.

1.6.2 Secondary Treatment: Filter Systems

These include intermittent soil filters, sand filters, peat filters and other filters using materials such as plastic or other media (Chapter 4). Intermittent soil filters comprise suitable soils placed often in the form of a mound, through which septic tank effluent is filtered and purified.

Intermittent 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 over-ground, or over-ground. The latter two constructions are commonly referred to as mound systems.

Fibrous peat and plastic media for the other filters are usually installed in prefabricated containers (prefabricated intermittent filters). Filter systems using other media may be considered on a case by case basis and if the system complies with all relevant standards.

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 x10^{-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.

1.6.3 Secondary Treatment: Mechanical Aeration Systems

In recent years, many different types of mechanical aeration systems (Chapter 6) have come on the market. These may offer solutions for the treatment of household wastewater, particularly in situations where conventional septic tank systems are inappropriate. Examples of these systems include:

- Biofilm Aerated Filter (BAF) systems;
- Rotating Biological Contactor (RBC) systems;
- Sequencing Batch Reactor (SBR) systems; and
- Membrane Filtration systems.

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

1.7 SITE CHARACTERISATION

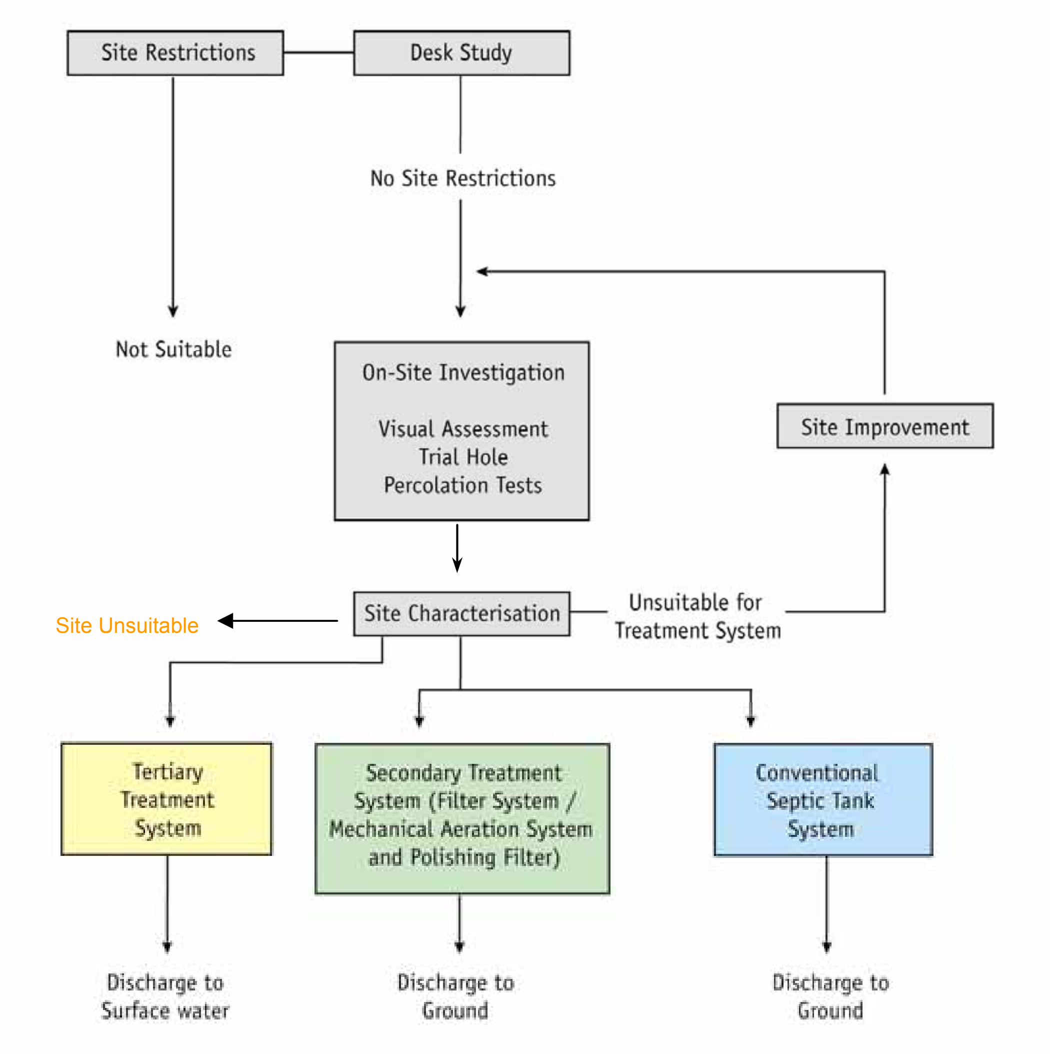
The objective of a site characterisation is to obtain sufficient information to determine if an on-site system can be developed on the site. Characterising the site involves a number of stages and should include:

- A desk study, which collects any information that may be available on maps etc. about the site;
- A visual assessment of the site, which defines the site in relation to surface features; A trial hole to evaluate the soil structure, depth to bedrock and water table;
- Percolation tests that give an indication of the permeability of the site;
- Assessment of data obtained;
- Conclusion on the suitability of the site; and
- Recommendation of a wastewater treatment system including design details.

Figure 2 below summarises the protocol to be followed to select and design an on-site system.

The remainder of this code of practice elaborates on the procedures to be followed in the carrying out of a site characterisation, the selection of a treatment system, its design and installation and its maintenance.

FIGURE 2: ON-SITE ASSESSMENT SUMMARY



2. SITE CHARACTERISATION

Key Message

All sites, subject to planning in unsewered rural areas, should have a site suitability assessment carried out by a suitably qualified person in accordance with the guidance in this chapter.

2.1 INTRODUCTION

The purpose of a site assessment is to determine the suitability of the site for a wastewater treatment system. The assessment will also help to predict the wastewater flow through the subsoil and into the subsurface materials. The site characterisation process outlined here is applicable to the development of a single house and more extensive site characterisation is required for cluster and large-scale developments.

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

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 retain the wastewater for a sufficient length of time, and it should be largely unsaturated and hence aerated.

Only after a site assessment has been completed can an on-site system be chosen. The information collected in the evaluation will be used to select the on-site system. Each local authority should satisfy themselves that the persons carrying out the assessments are competent to do so (e.g. FETAC certified).

In designing a wastewater treatment system to treat and dispose of the wastewater, three factors should be considered:

- Are there any site restrictions on the site?
- Is the site suitable to *treat* the wastewater? (Attenuation)
- Is the site able to *dispose* of the wastewater? (Hydraulic load)

To assess the factors a site characterisation is undertaken. This includes:

1. A desk study; and, if there are no site restrictions,

2. An on-site evaluation, consisting of:

- A visual assessment;
- A trial hole; and
- Percolation tests

3. Conclusion and recommendation (selection and design of a wastewater treatment system).

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

2.2 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 site restrictions.

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 material related to the hydrological, hydrogeological and planning aspects of the site, which may be available. The density of existing housing and performance of the existing wastewater treatment systems may influence the system recommended and should be noted at this stage. In addition, the location of any archaeological or natural heritage sites in the vicinity of the proposed site should be identified. The local authority heritage officer should be consulted to determine the significance of any archaeological sites located in the vicinity. Hydrological aspects include locating the presence (if any) of streams, rivers, lakes, beaches, shellfish areas and/or wetlands while hydrogeological aspects include:

- Soil type – drainage and water table (information from Teagasc, EPA);
- Subsoil type – drainage and water table (information from Teagasc, GSI, EPA);
- Location of karst features (information from the karst database, GSI);
- Aquifer type – importance of groundwater and type of flow (this incorporates bedrock type) (information from the GSI);
- Vulnerability (– information from GSI); and
- Groundwater protection responses (GWPR) for on-site systems for single houses (Appendix A).

Each site is specific and local factors and previous experience of the operation of wastewater treatment systems in the area should be taken into account in using this guideline information.

The Groundwater Protection Schemes (GWPS) provide guidelines for developers in assessing groundwater vulnerability and for the planning authorities in carrying out their groundwater protection functions. It provides 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. 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 (see Appendix A). 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 Groundwater Protection Responses should be noted at this stage.

2.2.1 Interpretation of the Desk Study Results

The information collected from the desk study should be examined and the following should be considered for all treatment options:

Groundwater Protection Response (GWPR) Zoning: Zoning for groundwater protection schemes outlines the aquifer classification in the general area and the vulnerability of the groundwater. The groundwater protection responses 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;

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

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

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

2.3 ON-SITE ASSESSMENT

2.3.1 Visual Assessment

The purposes of the visual assessment are to:

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

The factors examined during a visual assessment and their significance are summarised in Table 3. The principal factors, which should be considered, are listed below:

Landscape position: Landscape position reflects the location of the site in the landscape e.g. crest of hill, valley, slope of hill. Sites which 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.

Slope: It is more difficult to install pipe work 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 perpendicular to 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%).

Proximity to surface features: Minimum separation distances, as set out in the following chapters 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 4.

Existing dwellings and wastewater treatment systems: The performance of existing systems should be examined and the cause of problems identified and remediated. 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 and in areas where the background nitrate concentrations are already elevated. It is estimated that a 6PE wastewater treatment system (without specially designed nutrient removal) will increase the nitrate levels by 21mg/l NO_3 per hectare[5].

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 (Appendix A). Wastewater treatment systems do not pose a risk to decommissioned wells if they have been properly sealed off in accordance with BS5930 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.

[5] Section13.2.14 Site Suitability Assessments for On-site Wastewater Management FAS Course Manual Vol. 2.

Drainage: A high density of streams or ditches tends to indicate a high water table and potential risk to surface water. Low density of streams 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. Density of housing should also be noted.

Vegetation indicators: Rushes, yellow flags (irises) and alders indicate poor percolation characteristics or high water table levels. Grasses, trees and ferns may indicate suitable percolation characteristics. Plants and trees indicating good drainage and poor drainage are illustrated in Appendix F.

Ground condition: 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.

Minimum separation distances: The minimum separation distances, as set out in Table 4 should be checked at this stage of the assessment.

TABLE 3: 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 runoff 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 too high of a nutrient loading rate for the locality and/or potential nuisance problems
Land use and type of grassland surface (if applicable)	Indicator of rate of percolation or groundwater levels
Vegetation Indicators	Indicator of the rate of percolation or groundwater levels
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 and heritage features	Indicates targets at risk

2.3.2 Interpretation of the Visual Assessment

It is critical that all potential targets are identified at this stage. The minimum separation distances that should be used in the visual assessment are set out in Table 4. These apply to all on-site wastewater treatment systems. If any of these requirements cannot be met, on-site wastewater systems cannot be developed on the site. The recommended minimum distances from wells and springs should satisfy the requirements of the groundwater protection response (Appendix A), which should have been reviewed during the desk study and confirmed during the on-site assessment. All the information obtained during the visual assessment should be used to site the trial hole and percolation test holes.

TABLE 4: MINIMUM SEPARATION DISTANCES IN METRES

Type of system	Wells[6]	SW soak - aways[7]	Watercourse / stream	Heritage features, NHA/SAC[8]	Lake or Foreshore	Any Dwelling house	Site boundary	Trees[9]	Road	Slope break / cuts
Septic tank; prefabricated intermittent filters; mechanical aeration	-	5	10	-	50	7	3	5	4	4
In situ intermittent filters; percolation area; polishing filters	-	5	10	-	50	10	3	5	4	4

2.3.3 Trial Hole Assessment

The purposes of the trial hole are to determine:

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

The trial hole will help to predict the wastewater flow through the subsoil. It should be as small as practicable, e.g. 1.0 metre x 0.75 metre in plan, and should be excavated to a depth of at least 1.2 m below the invert of the lowest percolation trench. The health and safety[10] 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 exist in some situations. All appropriate health and safety precautions should be taken.

---

[6] See Appendix A

[7] The soakaway for surface water drainage should be located down gradient of the percolation area or polishing filter.

[8] The distances required are dependent on the importance of the feature. Therefore, advice should be sought from the Local Authority planning section (conservation officer and heritage officer) and from DoEHLG, specifically the Archive unit of National Monuments Section and the National Parks and Wildlife Service.

[9] Tree roots may lead to the generation of preferential flow paths.

[10] 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

The trial hole should be located adjacent to but not within the proposed percolation area/polishing filter. In the case of a level site the depth of the trial hole should be a minimum of 2.1 m below ground surface. Where the site overlies a regionally important aquifer the trial hole should be excavated to a minimum depth of 3m. In the case of a sloping site it is essential that an estimate of the depth of the invert of the percolation trench be made beforehand. The hole should remain open for 48 hours 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 soil characteristics assessed are: texture, structure, presence of preferential flow paths, density, compactness, colour, layering, depth to bedrock and depth to the water table. Photographic evidence of the trial hole and its profile should be provided to the relevant authorities.

If items of suspected archaeological interest are discovered, contact should be made with the relevant authorities.

Depth to bedrock and depth to water table: For conventional septic tank systems a depth of 1.2m 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 0.9m 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 - an indicator of seasonally high water tables. For further details see the Groundwater Newsletter No 45 issued by the Geological Survey of Ireland, (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 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 encountered in the trial hole should be described in Section 3.2 of the Site Characterisation Form.

A guide to assist the classification of soil/subsoils is included in Appendix E. Various soil/subsoil texture classifications schemes exist; Table 5 indicates some typical percolation rates for different subsoil types. The secondary constituents of the subsoil may have an effect on the percolation test results.

TABLE 5: SUBSOIL CLASSIFICATION AGAINST T-VALUES FOR 400 T-TESTS (JACKSON, 2005).

BS5950 Soil classification	T-value
GRAVEL	3 to 10
SAND	4 to 15
SILT	12 to 33
SILT / CLAY	15 to 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 have a large 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 (see Appendix E for full classification)

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 reddish brown or rusty staining) of the soil layers can indicate the height of the water table in winter. Mottling in a grey matrix (grey with reddish brown mottles) indicates aeration along old root channels and cracks while the matrix remains reduced.

Layering: 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).

The observations made from the trial hole and its significance are summarised in Table 6 below. The depth of the test hole is dependent on the subsoil characteristics present in the trial hole.

TABLE 6: 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; silts and clays are generally unsuitable
Mottling	Indicates seasonal high water tables or very low permeability

	subsoil
Depth to bedrock	Subsoil should have 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)

2.3.4 *Interpreting the Trial Hole Test Results*

Table 7 sets out the subsoil characteristics, which indicate satisfactory percolation and other characteristics necessary for the treatment of wastewater. The percolation characteristics will be confirmed later by examining the percolation test results.

TABLE 7: TRIAL HOLE – SITE REQUIREMENTS WHICH INDICATE ADEQUATE PERCOLATION CHARACTERISITICS

Subsoil characteristics	Requirements
Minimum depth of unsaturated permeable subsoil below base of all percolation trenches for conventional septic tank systems, i.e., minimum depth of unsaturated subsoil to bedrock and the water table.	1.2 m[11]
Minimum depth of unsaturated permeable subsoil below the base of the polishing filter for secondary treatment systems, i.e., minimum depth of unsaturated subsoil to bedrock and the water table.	0.9 m[11]
Texture of unsaturated soil/subsoil	GRAVEL[12] SAND SILT SILT/CLAY[12] CLAY[12]
Structure of unsaturated soil/subsoil	Granular, blocky, structure and single grain
Colour of unsaturated soil/subsoil	Greyish brown, reddish brown, and yellowish brown; grey in the case of many free draining limestone soils

[11] Greater depths/thicknesses may be required depending on the Groundwater Protection Responses (Appendix A).

[12] May not always be within the acceptable range.

Bulk density of unsaturated soil/subsoil	Uncompact to firm

2.3.5 Percolation Tests

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

There are two basic types of percolation test: the T-test and the P-test. The detailed methodology for the carrying out of these percolation tests is given in Appendix C. The result of the percolation test is expressed as either the “T” value or the “P” value. A minimum of three test holes should be excavated and tested at each site.

The T-Test:

The T-test is used to test the suitability of the subsoil, beneath the invert of the proposed percolation pipe[13] or polishing filter distribution system[14], 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 pipe work 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 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[15] or a polishing filter[16]discharging at ground surface. Situations where a P-Test might be considered include:

- Where the T-test shows that the site is not suitable for treating effluent from a conventional septic tank ($50 \leq T \leq 90$) and consideration is being given to an alternative treatment system which would discharge to ground through a polishing filter, and,

[13] A percolation pipe may be used for distribution of the effluent in either a conventional septic tank system (see Chapter 3) or a gravity-fed soil polishing filter (see section 6.2.1.3)

[14] See Chapter 6

[15] See Section 3.3.4

[16] See Chapter 6

Where the visual assessment and trial hole investigation indicate limiting factors for installation of a conventional septic tank such as a high water table or shallow bedrock, and an alternative treatment system that would discharge to ground through a polishing filter is being considered.

Standard and Modified T and P-Tests:

The standard percolation test (Step 4 Appendix C) should be carried out on all sites where the subsoil characteristics indicate that the percolation result will be less than 50. In the case of a CLAY or SILT/CLAY subsoil then a modified percolation test should be carried out. This test is outlined as Step 5 in Appendix C and is a modification of the standard test whereby an approximation of the percolation rate for high T and P values can be made in a shortened timeframe thus reducing the time spent on site.

Location of Test Holes:

Percolation test holes should be located adjacent to; but <u>not within</u>, 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 of 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. Where unsaturated subsoil depth is limiting, it may be possible to choose a percolation pipe invert level, which is near or at the ground surface, in order to fully exploit the available subsoil depth. In such cases it will be necessary to provide protection for the percolation pipe-work, when installed, by placing soil over the pipe-work in sufficient quantities (minimum of 150mm gravel and 300mm topsoil) to ensure that damage due to activities on the surface does not occur.

Other Permeability Testing:

In the case where there is shallow bedrock present then an assessment of the permeability of the bedrock will also have to be made to ensure that ponding does not result. In the case of shallow bedrock the assessor will have to demonstrate that the bedrock is able to take the hydraulic load from the proposed wastewater treatment system. This is particularly necessary in areas of un-weathered granite and other low permeability bedrock.

In the case where there is a high water table present then it is critical to assess the subsoil layer just above the water table by carrying out a percolation test, thus determining whether or not the water table is due to a low permeability subsoil or a naturally high water table due to the site's hydrological location (refer to Groundwater Newsletter No 45 issued by the Geological Survey of Ireland (2006)). In situations, where the T-test is in excess of 90 then irrespective of the P-test result the site is unsuitable for discharge of treated effluent to ground as it is likely ultimately to result in ponding due to the impervious nature of the underlying subsoil (or bedrock).

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

The subsoil classifications from the trial hole should be confirmed by the percolation test results. If there is not a good correlation then further examination should be undertaken to determine which assessment provides the accurate assessment of the suitability of the site to treat and dispose of the effluent. An integrated approach is required when carrying out the assessment.

2.3.6 Interpretation of the Percolation Tests

Table 8 outlines the interpretation of the percolation test results.

TABLE 8: INTERPRETATION OF PERCOLATION TEST RESULTS

Percolation Test Result	Interpretation
T <1	Retention time in the subsoil insufficient to provide satisfactory treatment. Site is unsuitable for conventional wastewater treatment system. P-test should be undertaken to determine whether the site is suitable for a Secondary Treatment System with a polishing filter at ground surface or over ground. Sites may be suitable for discharge to surface water in accordance with Water Pollution Act licence.
1 ≤ T ≤ 50	Site is suitable for the development of a conventional septic tank system or a Secondary Treatment System discharging to groundwater.
T value between 50 -75	Wastewater from a conventional septic tank system is likely to cause ponding at the surface of the percolation area. Not suitable for a conventional septic tank system. May be suitable for a secondary treatment system with a polishing filter at the depth of the T-Test hole.
75 ≤ T ≤ 90	Wastewater from a conventional septic tank system is likely to cause ponding at the surface of the percolation area. Not suitable for a conventional septic tank system. Site unsuitable for polishing filter at the depth of the T-Test hole. P-Test should be undertaken to determine whether the site is suitable for a Secondary Treatment System with polishing filter, i.e., 1≤ P ≤ 75, at ground surface or over ground.
T > 90	Site is unsuitable for development of any wastewater treatment system discharging to ground. Site may be suitable for treatment system discharging to surface water in accordance with Water Pollution Act licence.
T<1 and P <1	Retention time in the subsoil insufficient to provide satisfactory treatment. Site is unsuitable for any treatment system without carrying out significant site improvement works.
P >75 and 75<T< 90	Site is unsuitable for development of a wastewater treatment system discharging to ground.
P > 75 and T>90	Site is unsuitable for development of a wastewater treatment system discharging to ground. Site may be suitable for a discharge to surface water in accordance with Water Pollution Act licence.

2.4 INTEGRATION OF THE DESK STUDY AND ON-SITE ASSESSMENT INFORMATION

Table 9 summarises the information that can be obtained from the data collected from the desk study and the on-site assessment. This information is used to characterise the site and used later to choose and design an on-site system. An integrated approach will ensure that the targets at risk are identified and protected.

TABLE 9: 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	Site restrictions
Depth to bedrock	Sufficient subsoil to allow treatment of wastewater	Depth to bedrock
Texture; Structure; Bulk density; Layering;	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 septic tank effluent	Depth of the water table
Drainage (permeability); Percolation test;	Identifies suitable soils that have adequate but not excessive percolation rates	T Test value or P Test value

To assist in the selection of the on-site system and to standardise the assessment process, a site characterisation form has been prepared (Appendix B). The completed form including photographic evidence, site plans and design details should accompany all planning applications for on-site systems for single houses. A review section is included at the end of the form and the planning authority may complete this.

2.5 SELECTING AN APPROPRIATE WASTEWATER TREATMENT SYSTEM

The information collected from the desk study and on-site assessment should be used in an integrated way to determine whether an on-site system can be employed as a favourable effluent treatment and disposal option. If so, the type of system that is appropriate, and the optimal final disposal route for the treated wastewater is determined at this stage. Depending on the characteristics of the site, more than one option may be available. In choosing the appropriate system for a site, the assessor should have regard to the guidance provided in Chapters 3, 4, 5 and 6 of this Code of Practice. As there is no minimum site size specified in this code of practice, the issue of density should be dealt with using a precautionary approach and on a case by case basis bearing in mind the existing groundwater quality, and minimum separation distances in Table 4 and the dilution calculations in Section 2.7.1.

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 Appendix D.

- Certification of the system

Currently Irish legislation requires that a wastewater treatment system to be used for the treatment of effluent from a single house be certified by the Irish Agrement Board or other specified certification system, for details on the exact procedures refer to Part D of the Building Regulations, 1997 (S.I. No. 497 of 1997) and any amendments. in order to ensure compliance to water quality, planning and building regulations, an appropriate certification body should certify such systems.

- Wastewater Treatment Performance requirements

The standards set in Table 2 (Section 1.4) apply to these systems.

- Degree of environmental protection required

Having completed the site assessment as outlined in Chapter 2 a decision will need to be made on the degree of environmental protection required.

- 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.

- 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 appropriately qualified technicians.
  - Ease of access to the system in order to perform maintenance e.g. de-sludging.
  - Frequency of maintenance required.

- Anticipated Life-time of the system
- Track record of the system

2.6 SITE IMPROVEMENT WORKS

In certain circumstances a site, which 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 pre-treated wastewater from a treatment system. It may be possible in some such cases to render the site suitable for development after the carrying out of specific engineering works on the site known as 'site improvements'. Site improvement works should only be attempted under the supervision of a chartered engineer or other suitably qualified professional as such works are technically difficult to carry out correctly. A constructed soil filter system (raised mound) is not considered to be site improvement works as it is itself a treatment system.

The option to carry out site improvements might be considered in circumstances where a high water table is a problem (i.e., within 300mm of the ground surface). 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 are available in drainage manuals[17].

In other cases such as where the site is overlain by insufficient depth of subsoil (i.e. less than 300mm) 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 300mm 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 litres 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 minutes and 2 hours.

However, in many cases site improvements works will not be acceptable and in such cases the site is unsuitable for discharge to ground and may be deemed unsuitable. Examples of sites where site improvement works will not be successful are:

- Sites where the slope exceeds 1:8.
- Sites where T is greater than 90, indicating a high risk of ponding.
- Site where the separation distances cannot be satisfied.

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

2.7 FACTORS TO CONSIDER IN CHOOSING THE DISCHARGE ROUTE

Once the on-site treatment system has been decided upon, the disposal route of the treated wastewater needs to be considered (Figure 2). For septic tank systems with a soil percolation area the treated wastewater will be discharged to the groundwater. In the case of filters, mechanical aeration systems and wetland systems, where the final discharge is to groundwater, a polishing filter is required.

---

[17] Mulqueen, Rodgers, Hendrick, Keane, McCarthy (1999). Forest Drainage Engineering. COFORD Dublin.

The discharge of any sewage effluent to "waters[18]" requires a licence under the Water Pollution Acts 1977-1990. The local authorities process licence applications. Domestic sewage, however, not exceeding 5 m^3/day, which is discharged to an aquifer from a septic tank or other disposal unit, by means of a percolation area, soakage pit or other method is not subject to the licensing provisions of the 1977-1990 Acts. If an on-site system does not comply with all the conditions above, a discharge licence is required for the treated effluent. However, it should be noted that a "soakage pit" or similar method is not an acceptable means for treating septic tank effluent and does not comply with the requirements set out in this document.

2.7.1 Discharges to Groundwater

In cases where the total hydraulic load exceeds 5m^3/day (approximately 28 PE) for a discharge to groundwater a Water Pollution Act discharge licence is required. As this code of practice deals with discharges for less than 10 PE the requirements for such a discharge licence are not expanded upon here.

2.7.1.1 Dilution Calculations for Discharges to Groundwater

In high density areas or where the receiving groundwater already has relatively high levels of nitrate or phosphorous then an 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[19] to assess the impact of effluent on nitrate concentrations in water:

Assumptions:

Recharge (rainfall – (evapotranspiration + runoff)) = 13.7m^3/d/ha (500mm/yr)

Average nitrogen (N.) concentrations in domestic wastewater treatment effluent = 50mg/l N

Average flow from septic tank (4 persons) = 0.72m^3/d

Average Nitrogen concentration in recharge = 0.1mg/l N

No denitrification occurs[20].

Nitrate concentration resulting from 1 on-site system/ha =

(Av. Nitrate conc. in septic tank effluent x flow) + (Av Nitrate conc. in recharge x recharge) divided by Flow plus recharge

$$= \frac{(50 \times 0.72) + (0.1 \times 13.7)}{(0.72 + 13.7)}$$

$$= 2.59\text{mg/l N or } 11.47\text{mg/l } NO_3$$

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 Eireann. This calculation

[18] includes any (or any part of any) river, stream, lake, canal, reservoir, aquifer, pond, watercourse or other inland waters, whether natural or artificial

[19] Section 13.2.14.6 Site Specific Evaluation, Site Suitability Assessments for On-site Wastewater Management FAS Course Manual Vol. 2

[20] 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',

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.

2.7.2 Discharges to Surface Water

Most sites fail the site suitability assessment because of hydraulic reasons. 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 and the local authorities should assess the impact of the discharge from the on-site system on the receiving water.

The parameters to be examined should include:

- Flow;
- BOD;
- Nitrates;
- Ammonium;
- Phosphates; and
- Micro organisms.

When assessing the impact of an on-site system on the receiving waters, local authorities should consider the beneficial uses of the receiving water. The principal beneficial uses of surface waters are: water intended for human consumption after treatment, agriculture, bathing, boating, coarse fishery, cooling, game fishery, general amenity or industry. Principal beneficial uses of groundwater are: agriculture, drinking water and industry. Once the beneficial use of the water has been established, local authorities should consult relevant Regulations, water quality management plans and any published standards to obtain the relevant discharge standard. The treated wastewater from the on-site system should comply with the water quality standard set for the receiving waters.

Furthermore, in deciding what proportion of the assimilative capacity may be allocated to an individual discharge it is essential to consider existing and possible future discharges and water uses. It is therefore considered appropriate that all discharges calculated to raise the BOD5 of the receiving water, outside the mixing zone, by more than 1 mg/l should be considered a prompt for further investigation.

2.8 RECOMMENDATIONS

At this stage of the process the site characterisation is complete; the types of wastewater treatment systems and the discharge options that are suitable for the site are known. The site assessor should now make a recommendation as to the most appropriate wastewater treatment system for the particular site under assessment including discharge route. The conclusions of the site characterisation will dictate the type of system and the design requirements. In all cases, the minimum design requirements should be included in the site characterisation report. Where there are limiting site factors present then additional attention should be given to providing cross sections indicating invert levels of pipework, etc. The design information should clearly show where the wastewater treatment system should be installed and also highlight any special conditions taking into account that the site assessor may not be the person actually installing the system. The type, location and installation requirements for each system should be very clearly set out in the report. If additional pages are required then attach to the end of the site characterisation form.

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

3. CONVENTIONAL SEPTIC TANK SYSTEMS

Key Message
Conventional septic tanks comprise of a septic tank and percolation area. The majority of the treatment occurs in the percolation trenches and the underlying subsoil. These systems provide effective treatment and disposal of domestic wastewater when properly sited, installed and are maintained in accordance with the advice in this code of practice.

3.1 INTRODUCTION

A conventional septic tank system comprises a septic tank with treatment and distribution of the effluent by means of a percolation area. Septic tanks are primary settlement tanks providing a limited amount of anaerobic digestion. The percolation pipes may be subsurface or at ground level using only in-situ subsoil for treatment.

3.2 SEPTIC TANKS

IS EN 12566 Small Wastewater Treatment Systems up to 50 PT – 'Part 1: Prefabricated septic tanks' is a product standard developed by CEN and published by NSAI. The standard specifies a range of requirements and test methods in relation to septic tank design and performance, some of which are referred to in the following paragraphs.

The attributes of septic tanks are outlined in Table 10. The following guidance on the general design of conventional rectangular septic tanks should help ensure best performance.

- Septic tanks should comprise of two chambers and have a minimum length to width ratio of 3:1 in order to promote settlement of suspended solids;
- Larger septic tanks are better than smaller tanks 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; and
- 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.
- T-pieces to be installed as they assist to prevent odours.

Septic tanks should be able to:

- Withstand corrosion;
- Safely carry all lateral and vertical soil pressures; and

- Accommodate water pressure from inside and outside the tank without leakage occurring.

Septic tanks should be watertight to prevent wastewater escaping to the soil outside, and to prevent surface water and groundwater from entering the tank.

TABLE 10: ATTRIBUTES OF A TYPICAL SEPTIC TANK

A properly constructed septic tank will:
Retain and remove 50% or more solids; outflow from tank contains about 80 mg/l suspended solids
Allow some microbial decomposition
Accept sullage (i.e. water from baths, wash hand basins etc.)
Accept water containing detergents
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 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

3.2.1 Septic Tank Design Capacity

The septic tank should be of sufficient volume to provide a retention time for settlement of the suspended solids while reserving an adequate volume for sludge storage (Figure 3). The volume required for sludge storage is the determining factor in sizing the septic tank and this sizing depends on the potential occupancy of the dwelling, which can be estimated from the maximum number of people that the house can accommodate, and this is determined from the number and type of bedrooms. The minimum size for a single bedroom can be taken as $6.5m^2$ and of a double bedroom as $10.2m^2$.

The tank capacity may be calculated from the following formula:

$$C = 180 \cdot P + 2000$$

where

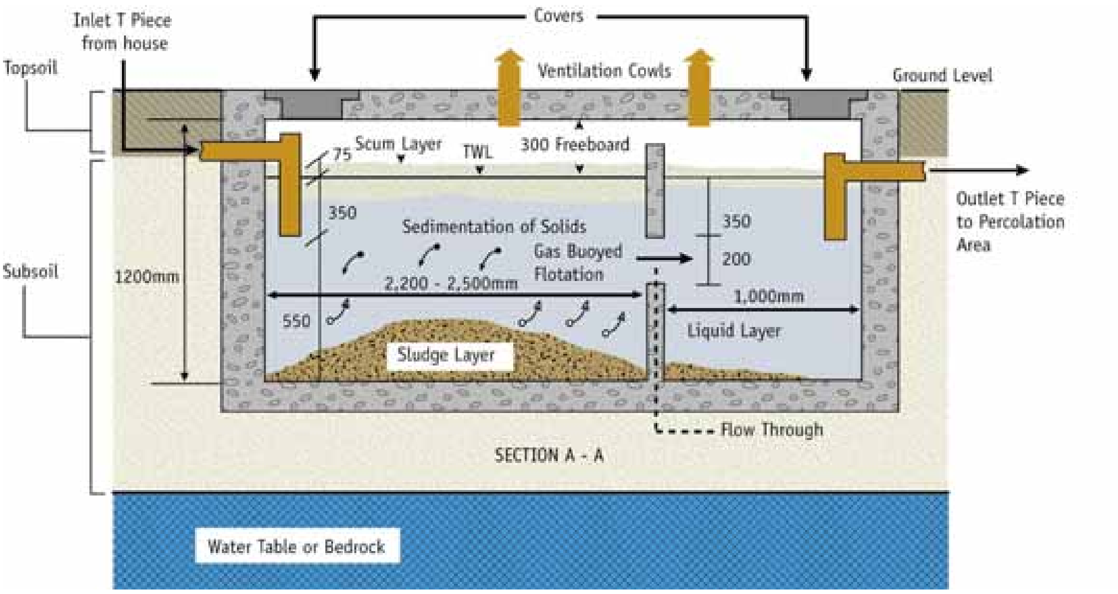
C = the capacity of the tank (litres)

P = the design population with a minimum of 4 persons

A minimum capacity of 2720 litres (2.72 m^3) should be provided. This assumes that de-sludging of the septic tank is carried out at least once in every 24-month period (see Chapter 7).

When kitchen grinders are installed, additional sludge solids are discharged with the wastewater and de-sludging intervals of septic and primary tanks need to be increased, therefore these are not recommended for single houses.

FIGURE 3: LONGITUDINAL SECTION OF A TYPICAL SEPTIC TANK (ALL DIMENSIONS IN MM)



3.2.2 *Septic Tank Design Features*

Typical design features of a concrete septic tank system are outlined in Table 11.

A septic tank should be watertight up to the top of the tank. Methods employed to test such tanks should be in accordance with EN 12566:1. All joints in the tank should be sealed properly, including tank joints (sections and covers), inlets, outlets and risers. The joints should be clean and dry before applying the joint sealer.

The volume of water filled up to the outlet should be at least the nominal capacity claimed by the manufacturer.

Septic tanks should be securely covered to prevent unauthorised access and ensure operational safety. Access should be given to the inlet and outlet areas for routine maintenance sampling, removal of sludge, maintenance etc.

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

A plan and section of a conventional septic tank system layout is given in Figure 4 and a distribution box is detailed in Figure 5.

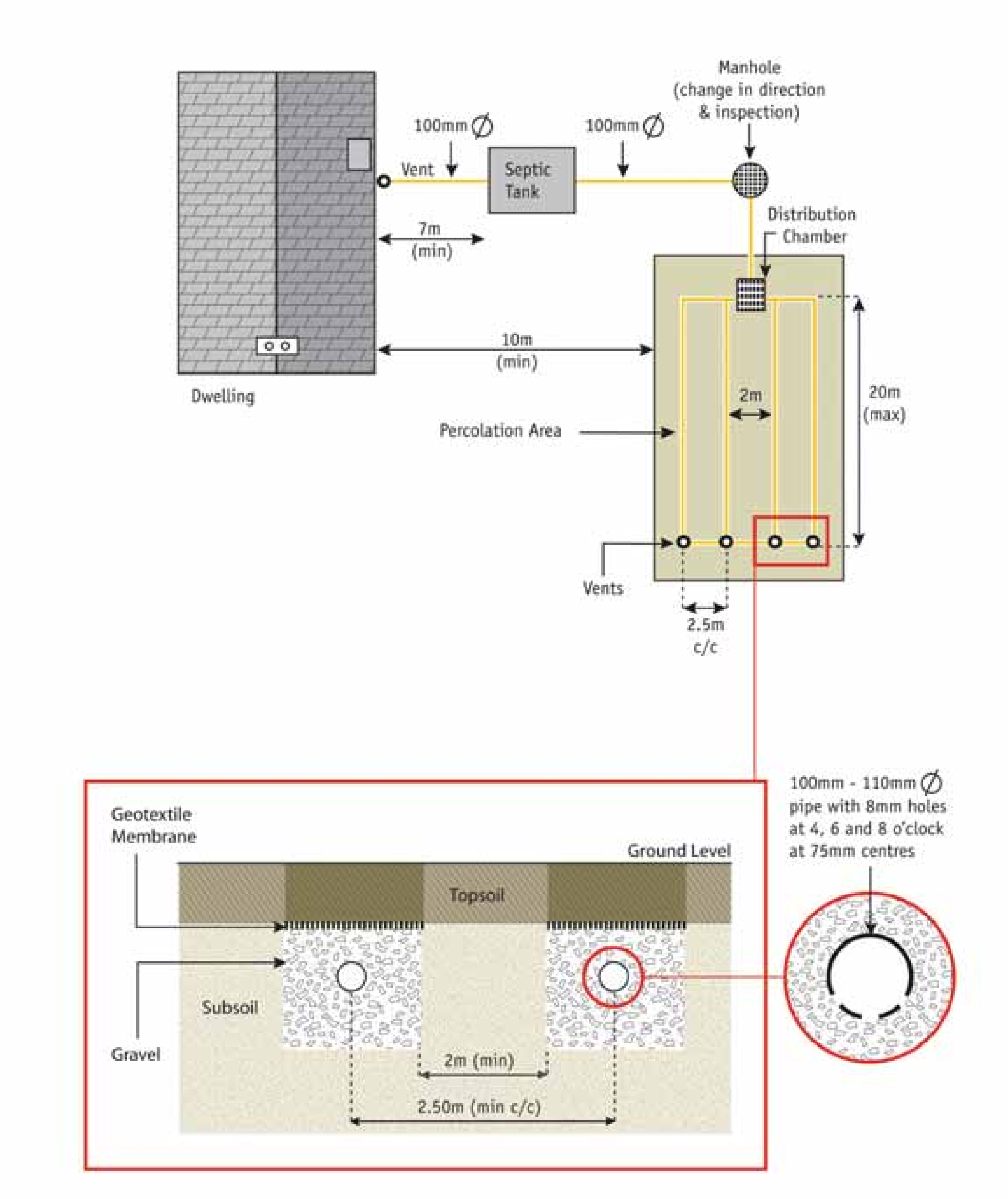
In addition to the general requirements above prefabricated tanks should be manufactured from suitable materials (e.g. pre-cast concrete, glass reinforced plastic, glass reinforced concrete) and the requirements stated above for capacity, hydraulics, strength and water-tightness should be observed. In the case of light prefabricated tanks, attention should be paid to the risk of flotation of the tanks as a result of groundwater pressure or surface run-off gaining access to the excavation. Quality control for compliance with EN 12566:1 is required to be demonstrated by the manufacturer of the septic tank.

TABLE 11: DESIGN FEATURES OF A CONCRETE SEPTIC TANK

Tank characteristics	Recommended requirements
Tank capacity	2720 litres for 4 persons
Tank length to width ratio	3 : 1
Number of compartments	2
Volume of inlet compartment	2/3 to 3/4 of the total tank capacity
Concrete compressive strength	35 N/mm^2 at 28 days, minimum
Wall thickness	100 mm minimum reinforced concrete or equivalent
Roof thickness	125 mm minimum
Interior height	1.2 m minimum
Liquid depth	0.9 m minimum
Freeboard (roof height above liquid)	300 mm
Baffle wall liquid opening	450 mm to centre of opening from floor of tank
Inlet and outlet pipes	Minimum internal diameter of 100 mm, ensuring no surcharging or backflow of inlet pipe occurs
Bottom end of T-piece	550 mm above floor of tank
Difference in elevation of inlet and outlet	75 mm
Joints	watertight
Ventilation	100 mm diameter pipe in roof with a cowl in each chamber (EN 12056-2)
Access covers	600 mm x 600 mm (2 no.) (EN 124:1994)

The construction of block work in-situ tanks is not recommended due to the difficulty in carrying out water tightness tests on-site and the difficulties in their general construction.

FIGURE 4: PLAN AND SECTION OF A CONVENTIONAL SEPTIC TANK SYSTEM



3.2.3 *Installation of Septic Tanks*

Important installation considerations include tank location, bedding and backfilling, water tightness, and flotation prevention.

- Prior to installation the use of grease traps should be considered.
- Manufacturers should provide installation instructions with each septic tank including details of data for plant installation, pipe connections, commissioning and start up process, and these should be adhered to.
- The tank should be located where it can be easily accessed for sludge removal and away from depressions where water can collect. The minimum distances required should be observed.

- The tank should rest on a uniform bearing surface and the underlying soils should be capable of bearing the weight of the tank and its contents. After setting the tank, levelling and joining the drains from the house and the tank outlet to the distribution box, the excavation around the tank can be backfilled. Backfilling should not proceed until the joints and the tank have been sealed and tested for water tightness. The back fill material should be free flowing and be added in lifts to ensure that the tank remains level. Backfilling around pre-fabricated tanks should be carried out in accordance with manufacturer's specifications and standard engineering practices.
- Provisions should be made so that flotation of tanks does not occur either during construction or subsequent to commissioning of the treatment system.
- Recommended minimum distances of separation of septic tanks and percolation areas and filters from a variety of features are shown in Table 5 and in the groundwater protection response. Provision should be made for access for a sludge tanker and maintenance equipment to de-sludge the tank. Care should be taken to ensure that septic tanks are not located where they may be subjected to loads from vehicular traffic movements.
- Installation should be supervised and certified by a suitably qualified professional.

3.2.3.1 Drain from house to septic tank

The drain to the septic tank should be at least 100 mm in diameter. It may be of earthenware, concrete, uPVC or similar materials. It should be jointed to give a watertight seal and should be laid to the minimum gradients listed in Table 12.

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

TABLE 12: MINIMUM GRADIENTS FOR DRAIN TO SEPTIC TANK

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

3.2.3.2 Drain from septic tank to percolation area

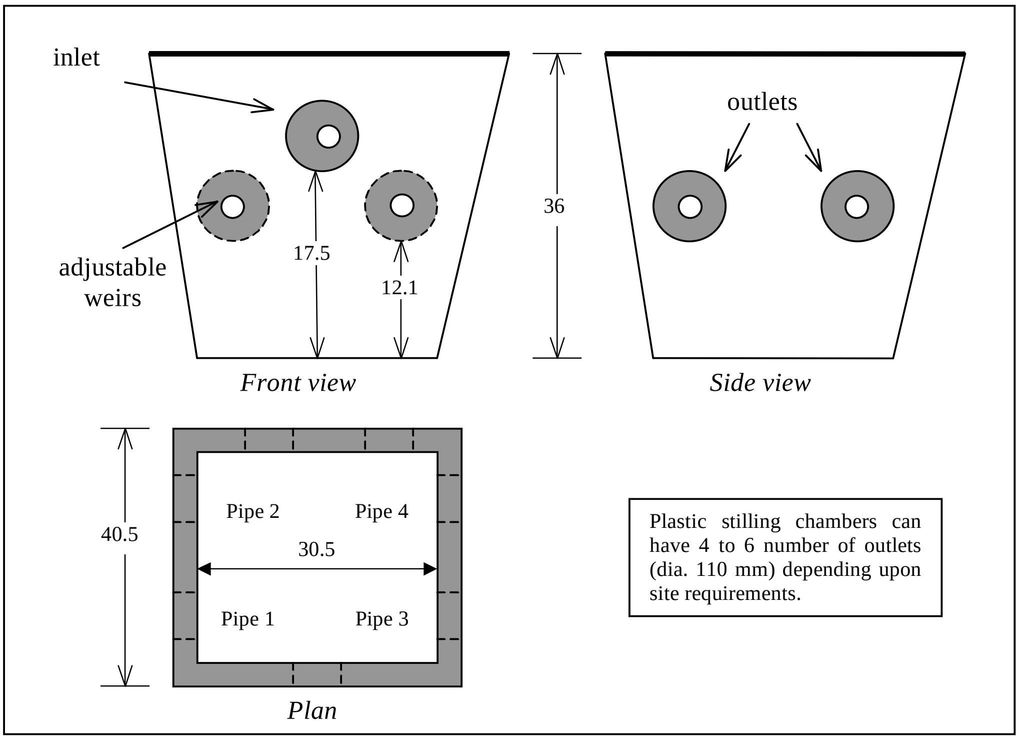
The flow of the effluent from the septic tank to the percolation area should take place via a distribution box. The drain from the septic tank to the distribution box should be 100-110 mm in diameter and should be made of earthenware, concrete, uPVC or similar materials. The slopes of the pipe from tank to distribution box required are given in Table 13. It is essential that the pipe is sealed into the septic tank to prevent effluent from escaping from the system.

The distribution box (Figure 5) comprises a chamber, which divides the effluent from the septic tank equally between the percolation pipes supplying the percolation area. The box is a key part of the overall installation and careful attention should be paid to its selection. It should be designed and constructed to ensure equal distribution among the various percolation pipes. The distribution box should be laid on a stable foundation. It should be accurately levelled to ensure that the incoming effluent is evenly split and evenly diverted to the outlet percolation pipes. If necessary, special fittings, such as weirs or tipping buckets, may be used to facilitate this. The distribution box requires ongoing maintenance and should be inspected regularly.

Apart from the existing distribution box (chamber), various other types of distribution devices are available on the market such as specialised Tee-splitters (with or without baffles). The use of Swept-Tees (commonly available in builder's suppliers) is prohibited since their function is to combine two flow streams into one and not to split the flow into two parts.

The distribution box should be provided with inspection covers and located such that it is easy to open, inspect and if necessary, clean the inside of the box. Access and inspection covers should be visible and flush with the ground surface without allowing the entry of surface water. Regular inspections should be carried out to ensure that the effluent entering the box is allowed to pass through to the percolation pipes without obstruction by extraneous materials and that the level conditions of the box are maintained.

FIGURE 5: SECTION AND PLAN OF STILLING CHAMBER DISTRIBUTION BOX



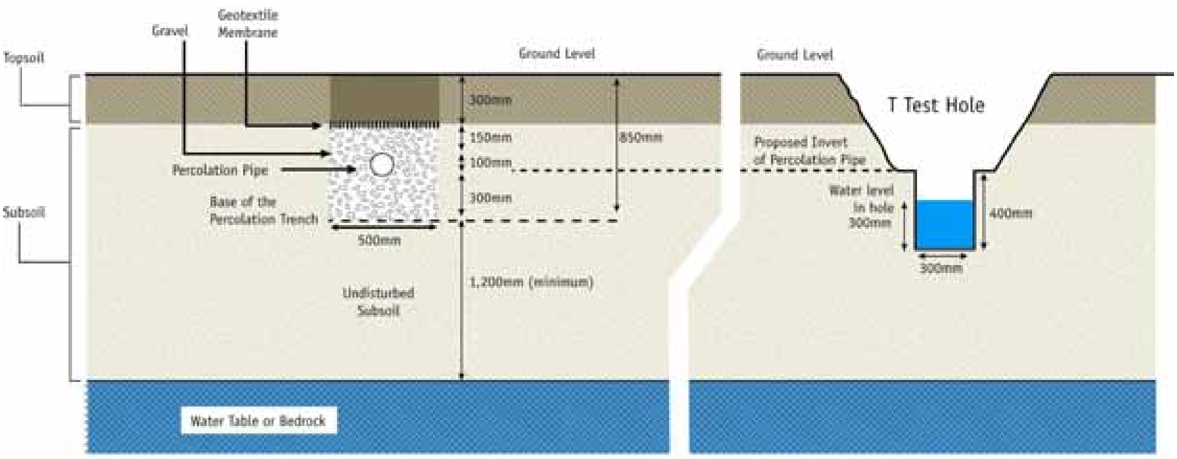
3.3 PERCOLATION AREAS

3.3.1 General

The most important component of a conventional septic tank system is the percolation area as it provides the majority of the treatment of the wastewater effluent. Septic tanks remove most of the suspended solids and grease from the wastewater, but it is in the percolation area that the wastewater gets most of its treatment. I.S. EN/TR 12566-2:2005 Small Wastewater Treatment Systems for up to 50 PT- Part 2 Soil Infiltration Systems has been published by the NSAI as a Code of practice giving guidance for soil infiltration systems to be used with small wastewater treatment systems. The contents of that document have been taken into account in the preparation of this Code of Practice. Where the detailed guidance in the two documents differs, e.g. in relation to separation distances appropriate for plant, percolation areas etc., the guidance given in this document is considered more appropriate to the Irish situation and should be followed.

In the conventional percolation trench method, the wastewater is allowed to flow by gravity into a distribution box, which distributes the flow evenly into the several percolation pipes in the percolation trenches. The depth to the invert of the percolation trench may vary and is dependent on the T test location, layering of the subsoil and any other limiting factors such as water table and depth to bedrock (Figure 6). Wastewater flows out through orifices in the percolation pipes into a gravel underlay, which then distributes it on to the soil, where it undergoes biological, physical and chemical interactions that treat the contaminants. For effective treatment, the wastewater should enter the soil; if the base or walls of the percolation trench are compacted or glazed or otherwise damaged during excavation, they should be scratched with a steel tool such as a rake to expose the natural soil surface. It is equally important that the wastewater remains long enough in the soil; the hydraulic loading and the rate of flow into the sides and base of the trench control the residence time.

FIGURE 6: SECTION OF A PERCOLATION TRENCH



3.3.2 *Precautions*

Siting, construction and installation practices are critical to the performance of percolation areas. Satisfactory performance depends on maintaining soil porosity and construction activities can significantly reduce the porosity and cause systems to hydraulically fail soon after being brought into service. Good construction practices should carefully consider site preparation (before and during construction) and equipment use. The minimum separation distances specified in Table 4 should be adhered to.

3.3.2.1 Siting Issues

The risk of polluting groundwater wells is minimised when the percolation area is hydraulically downgradient of any groundwater sources. The minimum separation distances for wells specified in Appendix A should be adhered to in all cases. Water mains, service pipes, access roads, driveways, paved areas or land drains should not be located within the percolation area. A buffer strip of 1m around the percolation area should be observed. The layout of the percolation pipes should make optimum use of the available site and be consistent with the recommendations in Figure 4, Figure 6, Table 4 and Table 13.

TABLE 13: DETAILS OF A TYPICAL PERCOLATION TRENCH (GRAVITY FED)

Percolation trench characteristics	Recommendations
Slope of pipe from tank to distribution box	1 in 40 for earthenware or concrete, 1 in 60 for uPVC
Slope of percolation trench from distribution box	1 in 200
Length of percolation pipe in each trench	20 m maximum
Minimum separation distance between percolation trenches	2 m (2.5 m centre to centre)
Diameter of pipe from septic tank to distribution box	100 - 110mm
Percolation pipes[21]	100-110mm bore, perforated (typically at 4, 6 and 8 o'clock) smooth wall PVC drainage pipes with perforations of 8 mm diameter at about 75 mm centres along the pipe; or Pipes with similar hydraulic properties.
Width of percolation trench	500mm
Depth of percolation trench	About 800mm[22] below ground surface depending on site
Backfilling of percolation trench (see Figure 7)	300 mm of 8 to 32 mm washed gravel or broken stone aggregate on invert; pipe laid at a 1 in 200 slope surrounded by 8 to 32 mm clean washed gravel or broken stone aggregate and with 150 mm of similar aggregate over pipe; geotextile layer followed by topsoil to ground surface.
Geotextile	Geotextile should be in accordance with EN ISO 10319
Access/inspection points and Vents	These are recommended for the ends of the percolation pipes, the covers should be visible and installed to prevent entry of water. They may also be used for rodding/scouring purposes

The growth of any type of tree or plant, which develops extensive root systems, should be limited to a minimum distance of 5 m from the percolation area. This restriction also applies to the cultivation of crops necessitating the use of machinery, which is likely to disturb the percolation trenches.

3.3.2.2 Construction and Installation Issues

The site of the percolation area should be staked and roped off before any construction activities begin to make others aware of the site and to keep traffic and materials off the site. Earth moving machinery should not circulate over the percolation area before or more importantly after pipework and backfilling of trenches

[21] Before installation the holes in the percolation pipe should be inspected to check that they are the correct size and free from debris.

[22] The percolation pipes may be located at a shallower depth, provided that a minimum of 450mm of material is placed above the pipes to provide the required protection against damage from above.

has been completed. The area should be clearly marked for the duration of any subsequent site works.

There should be a maximum of 5 trenches attached to each distribution box when designing a gravity system.

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

Earthworks should normally be carried out on dry ground. Trenches should be backfilled as soon as possible after excavation.

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

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

Cutting and drilling of pipes should be carried out to ensure a clean and smooth finish. Before installation, the holes in the percolation pipes should be inspected.

Percolation pipe types and gradients should be inspected prior to backfilling. Installation should be supervised and certified by a chartered engineer or other suitable qualified professional.

In impervious soils, shallow interceptor drains, the depth of which depends on the depth to the impervious layer, should cut off all surface run-off and seepage from the surrounding soil. The interceptor drain should be 2 m distant from the upgradient side and parallel to the side edges of the percolation area (not downgradient). These drains comprise land drainage pipes overlain to ground surface with permeable gravel or broken stone aggregate. These interceptor drains are brought to the nearest watercourse or stream into which they outfall.

3.3.3 Hydraulic Loading Rates

The hydraulic loading through the trench base and sidewalls of the percolation trench is controlled by the biomat (see Figure 7 below) on the floor and sides of the trench rather than by the subsoil itself in the case of all suitable subsoils. The biomat is a biologically active layer, which contains complex bacterial polysaccharides and accumulated organic substances and micro-organisms which treat the effluent. The percolation rates, measured as they are on virgin subsoil using clean water, cannot be used for the design of the hydraulic distribution system and length of percolation trench. The length of percolation trench is calculated as a function of the number of persons for which the house is designed. A loading rate of 20 $l/m^2.d$ is recommended for wastewater being discharged into a percolation area to take into account the effect of the biomat. The minimum length of percolation trench required is given in Table 14.

FIGURE 7: ILLUSTRATION OF BIOMAT FORMATION ON THE BASE OF A PERCOLATION TRENCH

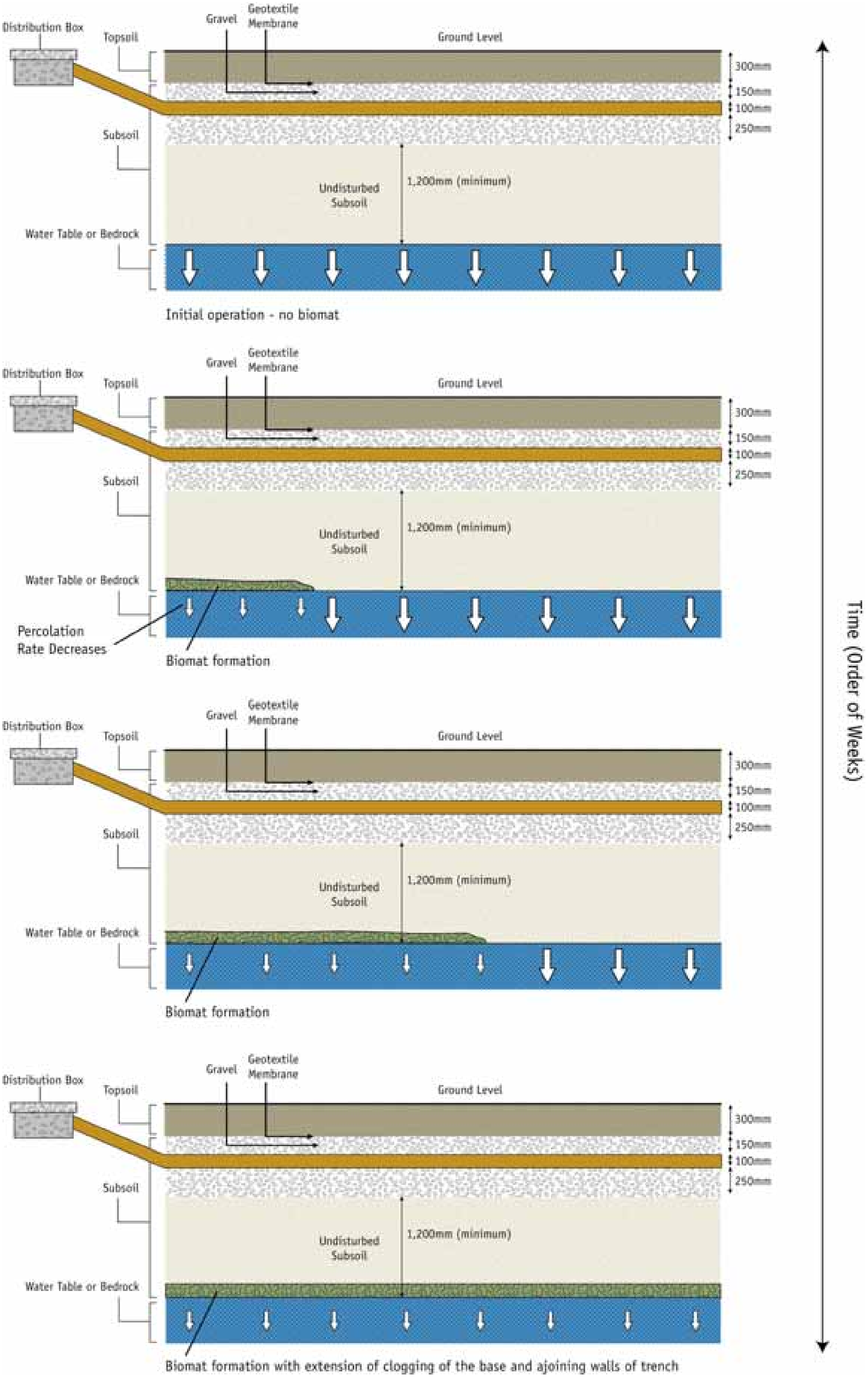


TABLE 14: MINIMUM PERCOLATION TRENCH LENGTH

Number of people in the house	Required length of trench[23] (m)
3	54
4	72
5	90
6	108
7	126
8	144
9	162
10	180

3.3.4 Raised Percolation Areas

Raised percolation systems can be installed in some cases where the site conditions permit. This is where the pipes are laid at other depths from 800mm below ground surface up to the ground surface and the mounded element comprises only the percolation trenches (i.e., the gravel bed, percolation pipes, gravel protection layer and top soil). The in-situ soil and subsoil is used to treat the effluent from the septic tank. The distribution is by gravity only via a distribution box without any pumping. Where the site contours allow it is possible to build a mounded percolation area, which is gravity fed and the minimum requirements are the same as for a conventional percolation area (Table 13 and Figure 8). The sizing should be determined from Table 14.

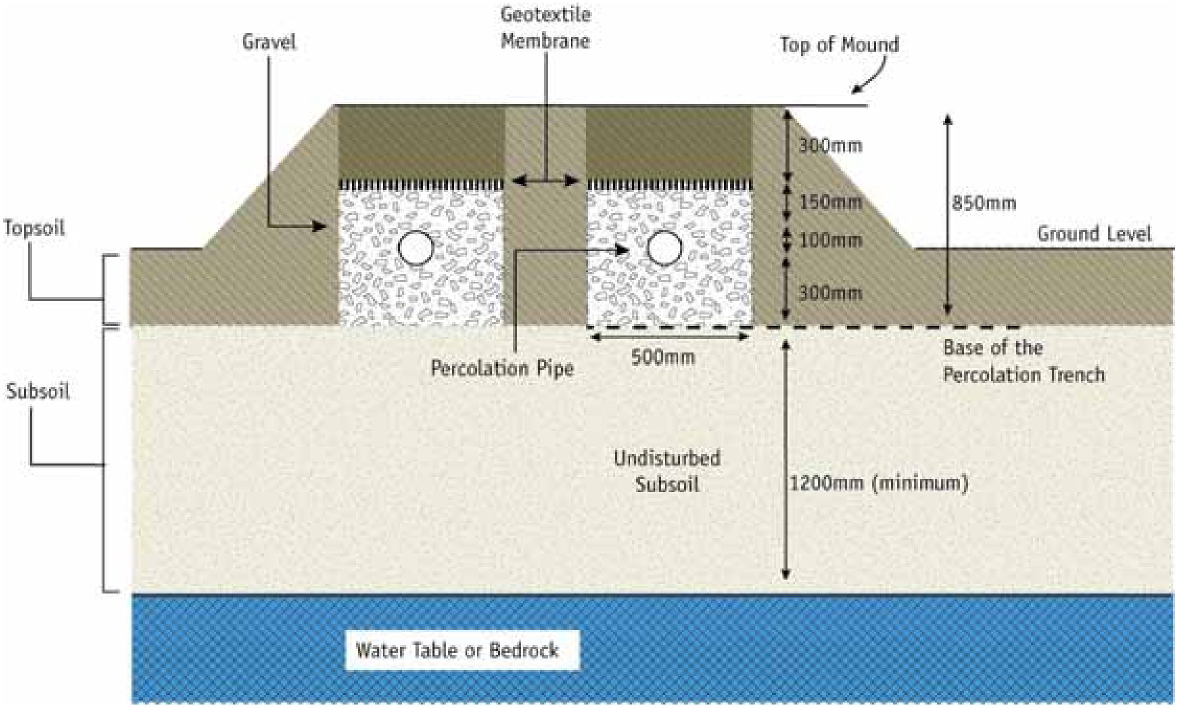
In addition to the normal requirements the following site conditions should exist.

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

Where the ground conditions do not allow for a gravity fed system then the distribution system is the same as that outlined for an intermittent soil filter in Chapter 4.

[23] Trench width is 500mm.

FIGURE 8: RAISED PERCOLATION AREA



4. SECONDARY TREATMENT – FILTER SYSTEMS

Key Message

Secondary Treatment – Filter Systems comprise systems that use different media to treat domestic wastewater. A polishing filter is to be installed after these systems to allow for further treatment of the wastewater and to convey the treated wastewater into the ground. These systems may be suitable in areas where a conventional septic tank is not acceptable. The code of practice provides general guidance on the siting, design, installation and maintenance of these systems.

4.1 INTRODUCTION

This chapter deals with the topic of filter systems including intermittent filter systems and constructed wetland systems, while mechanical aeration systems are discussed in Chapter 6. A critical aspect of intermittent filter systems is the filter is dosed using a pumped distribution system (Figure 9). The use of a dosing system is recommended to provide efficient distribution of effluent across the full length of the infiltration pipes.

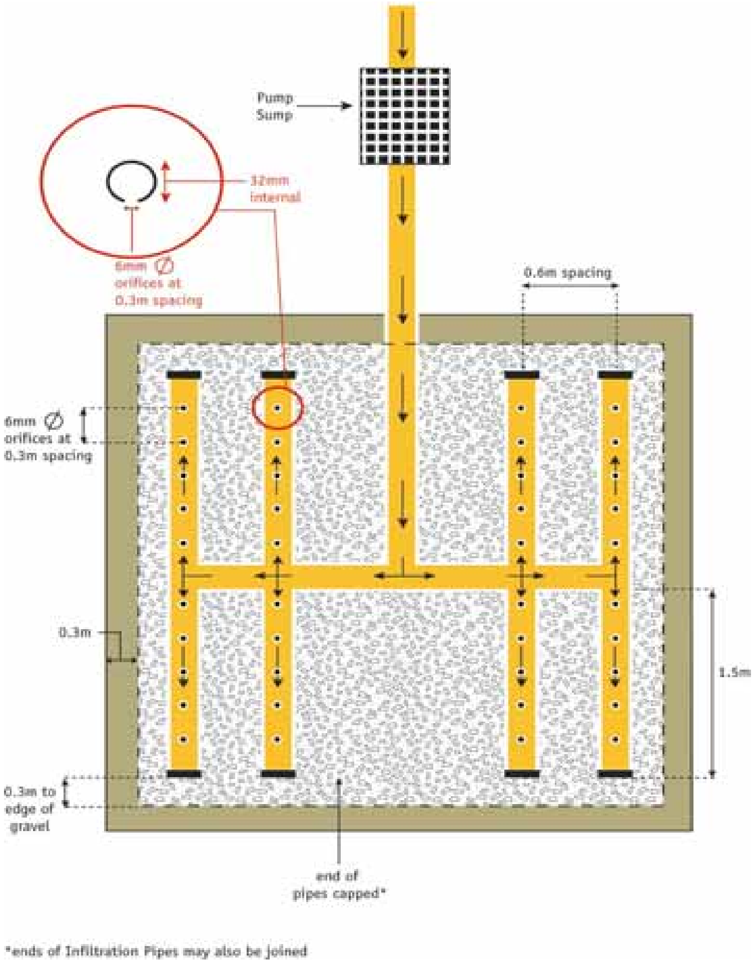
An intermittent filter system comprises a septic tank followed by a pumping chamber, which transfers the partially treated effluent onto the filter at regular intervals (minimum of 4 times per day). This filter may comprise of soil, sand, peat or other media. The partially treated effluent is treated in the intermittent filter and then discharged to ground via a polishing filter or surface water. The maintenance requirements for these systems are set out in Chapter 7.

A constructed wetland system comprises a septic tank followed by a constructed wetland and polishing filter. Pumping may or may not be required for a constructed wetland system dependent on the slope and wetland configuration.

A range of configurations may be considered, for example:

- An intermittent soil filter system (soil polishing filter is in-built);
- An intermittent sand filter followed by a polishing filter (may be in-built or offset);
- 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 followed by a polishing filter.

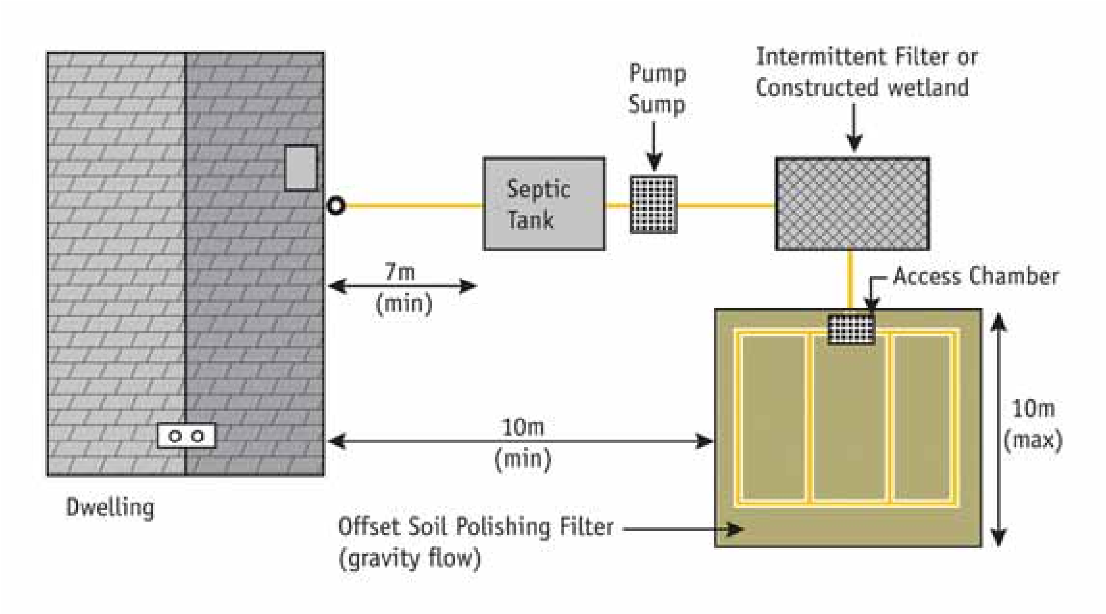
FIGURE 9: ILLUSTRATION OF THE PUMPED DISTRIBUTION SYSTEM



The purpose of the polishing filter is to provide additional treatment of the effluent and to reduce pollutants such as micro-organisms and also provide for the hydraulic conveyance of the treated effluent to ground. In some cases a polishing filter may be replaced by a packaged tertiary treatment system. The conditions of a water pollution discharge licence will dictate the effluent quality that the wastewater treatment system will have to achieve prior to its discharge to surface water and this may require some form of tertiary treatment either by a polishing filter or a package system. Polishing filters and package tertiary treatment systems are dealt with in Chapter 6. Appendix D should be completed prior to deciding on a particular type of secondary treatment system.

The typical layout for the treatment of wastewater using an intermittent filter or a constructed wetland is illustrated in Figure 10. The site conditions will influence the requirement for pumping the wastewater through the different treatment units; however, intermittent filters and most polishing filters will require pumping.

FIGURE 10: ILLUSTRATION OF AN INTERMITTENT FILTER OR CONSTRUCTED WETLAND SYSTEM



4.2 SITE CONDITIONS FOR ALL FILTER SYSTEMS

Recommended minimum distances of separation of filter systems should be as listed in Table 4. The recommended minimum distances from wells should satisfy the requirements of the groundwater protection response specified in Appendix A, which should have been consulted as part of the site characterisation. The groundwater protection responses may also dictate that subsoil depths in excess of those indicated in this code of practice may be required.

Water mains, service pipes, access roads, driveways, paved areas or land drains should not be located within the intermittent filter system or associated polishing filter area. A buffer strip of 1m around the intermittent filter and polishing filter should be observed.

The site of the intermittent filter and associated polishing filter area should be staked and roped off before any construction activities begin to make others aware of the site and to keep traffic and materials off the site. Earth moving machinery should not circulate over the associated polishing filter area before or more importantly after pipework and backfilling has been completed. The area should be clearly marked for the duration of any subsequent site works.

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

Cutting and drilling of pipes should be carried out to ensure a clean and smooth finish. Infiltration pipe type and gradients should be inspected prior to backfilling. Construction and installation should be supervised and certified by a chartered engineer or other suitable qualified professional (see DOEHLG SP5/03).

In impervious soils, shallow interceptor drains, the depth of which depends on the depth to the impervious layer, should cut off all surface run-off and seepage from the surrounding soil. The interceptor drain should be 2 m distant from the upgradient side and parallel to the side edges of the percolation area (not downgradient). These drains comprise land drainage pipes overlain to ground surface with permeable gravel or broken stone aggregate. These interceptor drains are brought to the nearest watercourse or stream into which they outfall.

4.3 INTERMITTENT SOIL FILTER SYSTEMS

Intermittent soil filter systems may be used in situations where difficult site conditions are encountered, such as, shallow water table, insufficient subsoil depth or a failure of a T percolation test. An intermittent soil filter system may be developed through the use of imported soil with favourable characteristics or may be developed through the use of in situ soil where the upper layer has been removed and replaced by a gravel distribution layer. In both cases the septic tank effluent is distributed over the filter using a pressure distribution system (Figure 9).

An intermittent soil filter may be placed in or on the ground in a number of different design formats. Typical design and operational requirements are noted in Table 15.

- It may be placed in the ground with a distribution system installed at a shallow depth.
- It may be arranged with the distribution system located at ground level (Figure 11).
- It may be raised with the distribution system above the normal ground level.

FIGURE 11: SCHEMATIC DIAGRAM OF AN INTERMITTENT SOIL FILTER

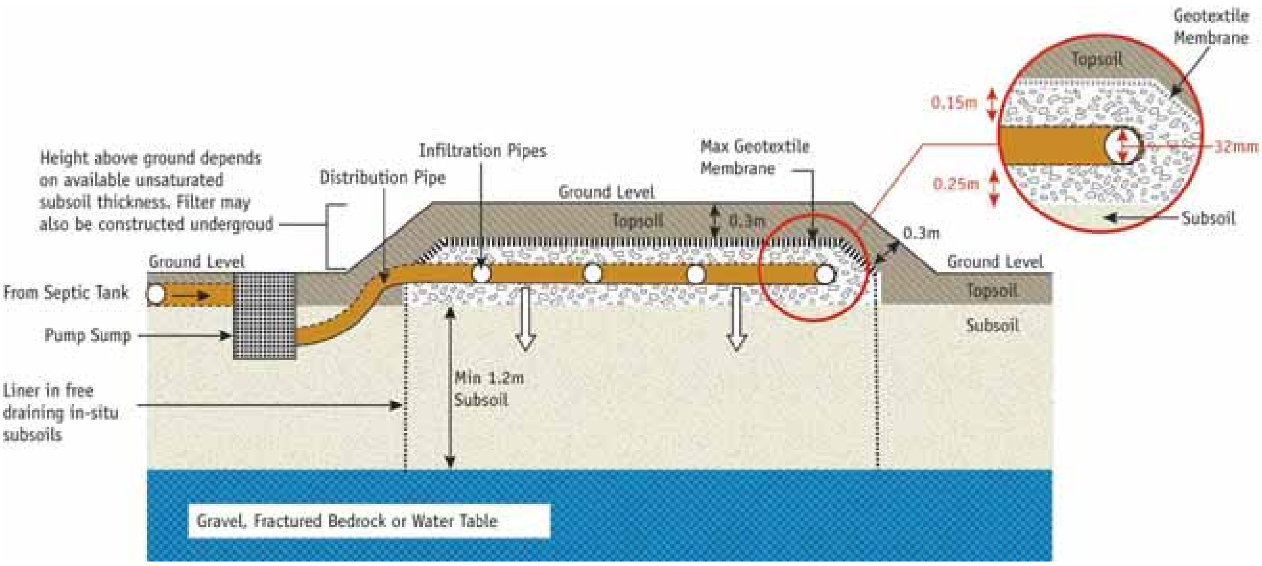


TABLE 15: INTERMITTENT SOIL FILTER DETAILS

Soil Filter characteristics	Requirements
Minimum soil thickness beneath invert of distribution system	1.2m [24]
Soil percolation value [25]	In-situ material should have a P/Test value between 1 and 50 Imported material or mounded systems should have a percolation rate between 1 and 30.
Hydraulic loading	4 l/m^2/d on plan area of filter
Design criteria[26]: Soil Layers Gravel Protection Layer Infiltration Laterals Gravel Distribution Layer Lateral centres separation Geotextile	 Lifts of 300mm of soil (lightly compacted if imported) 150 mm of 8-32 mm washed gravel or broken stone 32 mm ∅ PVC with 3-5 mm orifices[27] at 0.6 m spacings 250mm of 8-32 mm washed gravel or broken stone 0.6 m In accordance with EN ISO 10319
Underdrain/collection system (required where T>90)	Washed durable gravel or stone 8 – 32 mm Slotted or perforated Drain pipe∅ 75 – 100mm Slope 0 – 1%
Dosing frequency	4 times per day
Pumping system	Pumps should be installed in a separate pumping chamber and only suitable wastewater treatment pumps with a minimum free passage of 10mm should be used.
Side Sealing: Mound system Below ground system	 Top soil on top and the vertical sides should be protected by an impermeable film 200µm thick HDPE or alternative material with similar strength. Impermeable liner as above in free draining in-situ subsoils.
Base sealing:	No sealer required. Ground base layer in mound systems to be ploughed/tilled [28]
Covering	Geotextile over the gravel distribution layer 300mm topsoil over geotextile

[24] Greater thickness may apply - consult the Groundwater Protection Response.

[25] If constructing a mound system then the imported subsoil should have a T Test value between 1 and 30.

[26] Due to variations in the discharge rating of pumps available on the market, it is important to correctly match the orifice diameter and the lateral diameter in the distribution system to the pump, thus ensuring even and effective distribution of the hydraulic load across the filter area

[27] The infiltration pipe should be laid with the holes facing downwards EN/TR 12566:2.

[28] In the case of mound systems, the base should be roughened to minimise compaction and smearing of the soil (EN/TR 12566:2)

4.4 INTERMITTENT SAND FILTER SYSTEMS

Intermittent sand filters are effective and easy to operate. The area required to accommodate typical intermittent sand filter is significantly less than that required for an intermittent soil filter or a soil percolation area.

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

- Soil covered intermittent sand filters may be underground, part underground and part over-ground (Figure 12) or over-ground. The latter two constructions are commonly referred to as mound systems.
- Open intermittent sand filters are constructed similar to the covered sand filters, but without the soil cover i.e. the gravel distribution layer is exposed at the surface to allow for inspection and periodic maintenance. They are preferably underground with the top of the gravel at ground surface.

Intermittent sand filters are single-pass slow sand filters, which support biofilms. Typical design details are shown in Table 16. They consist of a number of beds of graded sand commonly 700 - 900 mm deep, underlain normally by a layer of filter gravel about 200 mm thick to prevent outwash or piping of the sand. A stratified sand filter is illustrated in Figure 13 below.

FIGURE 12: INTERMITTENT SAND FILTER SYSTEM WITH UNDERLYING SAND/SUBSOIL POLISHING FILTER

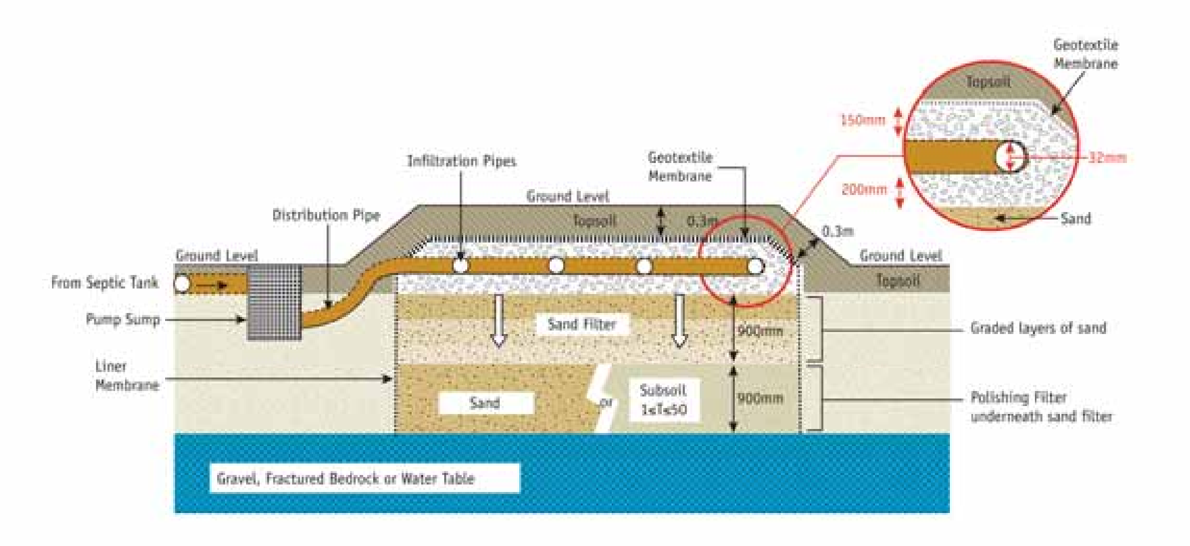
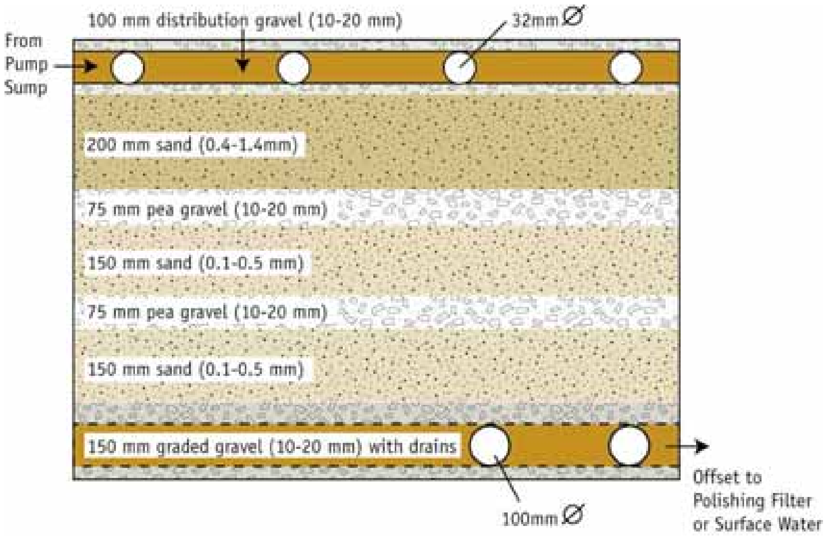


FIGURE 13: SCHEMATIC CROSS SECTION OF STRATIFIED[29] SAND FILTER



In a typical arrangement septic tank wastewater is pumped intermittently a minimum of 4 times per day onto the surface of the sand bed through 32 mm diameter lateral pipes with orifices, embedded in a 100 mm thick layer of distribution gravel. Even distribution across the entire surface area of the intermittent sand filter is critical. In soil covered filters, a geotextile is used to separate the soil cover from the distribution gravel. The wastewater from the septic tank flows through the sand bed where it receives treatment. The wastewater treatment takes place under predominantly unsaturated and aerobic conditions. In a soil covered filter, both the distribution gravel over the sand and the drain filter gravel (where present) under the sand are vented; the vents are extended vertically above ground or mound level and capped with a cowl or grid. In an open filter only the drain filter gravel (where present) is vented. Phosphorous removal is dependent on sand mineralogy, it should be noted that the ability of any sand to remove phosphorus is finite. In areas where waters are phosphorus sensitive the use of a sacrificial filter, which is periodically replaced, may be recommended.

[29] Nichlos, D. J., Wolf, D.C., Gross, M. A., and Rutledge, E. M., Renovation of Septic Tank Effluent in a Stratified Sand Filter. ASTM STP 1324. American Society for Testing and Materials 1997.

TABLE 16: INTERMITTENT SAND FILTER DETAILS

Sand filter characteristics	Requirements
Minimum sand thickness	0.7 – 0.9m
Sand grain sizes	Soil covered – 0.7 to 1.0 mm Open filters - 0.4 to 1.0 mm
Hydraulic loading	30 l /m^2/d (based on plan area)
Design criteria:[30] Sand Layers Gravel Protection Layer Infiltration Laterals Gravel Distribution Layer Lateral centres separation	 A number of beds of graded sand 150 mm of 8-32 mm washed gravel or broken stone 32 mm ∅ PVC with 3-5 mm orifices[31] at 0.6m spacings 250mm of 8-32 mm washed gravel or broken stone 0.6 m
Underdrain/collection system (required where T>90 or offset polishing filter)	Washed durable gravel or stone 8 – 32 mm Slotted or perforated Drain pipe∅ 75 – 100mm Slope 0 – 1%
Dosing frequency (controlled by on/off levels on pump)	Minimum of 4 times per day
Pumping system	Pumps should be installed in a separate pumping chamber and only suitable wastewater treatment pumps with a minimum free passage of 10mm should be used.
Side Sealing: Mound system Below ground system	 Topsoil on top and the vertical sides should be protected by an impermeable film 200µm thick HDPE or alternative material with similar strength. Impermeable liner as above in free draining in-situ subsoils.
Base sealing: Underlying polishing filter Offset polishing filter	 No sealer required. Ground base layer in mound systems to be ploughed/tilled [32] Impervious soil or synthetic liner with collection system
Covering:	

[30] Due to variations in the discharge rating of pumps available on the market, it is important to correctly match the orifice diameter and the lateral diameter in the distribution system to the pump, thus ensuring even and effective distribution of the hydraulic load across the filter area.

[31] The infiltration pipe should be laid with the holes facing downwards EN/TR 12566:2.

[32] In the case of mound systems, the base should be roughened to minimise compaction and smearing of the soil (EN/TR 12566:2)

Soil Covered: Open:	Geotextile (in accordance with EN ISO 10319) over the gravel distribution layer and 300mm topsoil over geotextile. None
Venting Soil covered: Open filter:	both distribution gravel and drain filter gravel are vented drain filter gravel is vented.
Access/inspection points	Recommended to be installed in the distribution system for rodding / scouring purposes

4.4.1.1 DESIGN CONSIDERATIONS

Sand selection is decided first and is based on grading curve characteristics. Effective grain sizes (D_{10}) for soil covered and open sand filters are in the range 0.7 - 1.0 mm and 0.4 - 1.0 mm respectively with uniformity coefficients (D_{60}/D_{10}) less than 4. The smaller the effective grain size, the higher the level of treatment, the lower the permissible hydraulic loading and the more frequent the need for maintenance. The lower the uniformity coefficient, the longer the filter's life-span and the less the potential for elutriation downwards of the finer particles which could result in clogging.

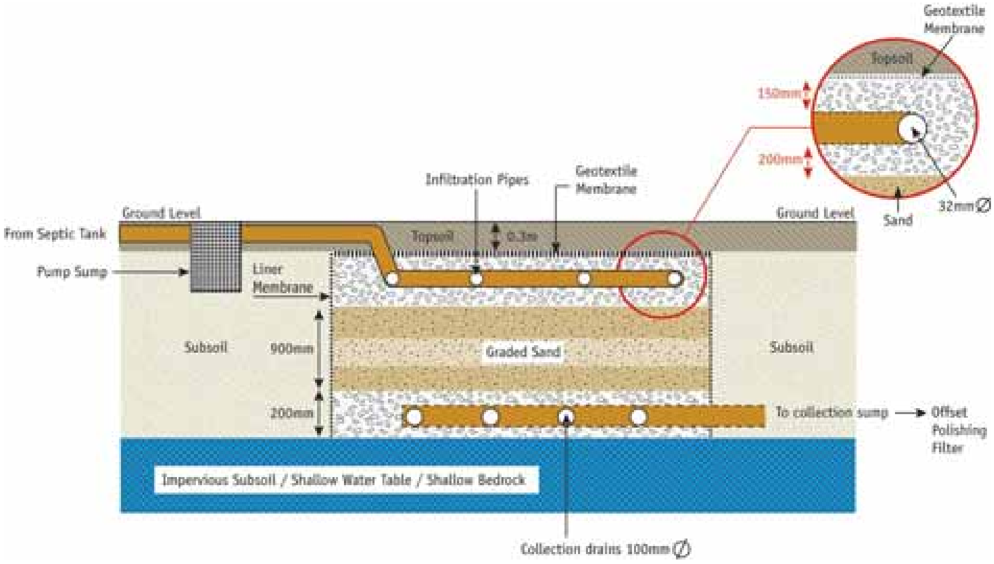
4.5 DRAINAGE AND SEALING OF SAND AND SOIL INTERMITTENT FILTER SYSTEMS

In low permeability soils, shallow interceptor drains, the depth of which depends on the depth to the impervious layer, should cut off all surface run-off and seepage from the surrounding soil. The interceptor drain should be 2 m distant from the upgradient side and parallel edges of the intermittent filter (not downgradient). These drains comprise land drainage pipes overlain to ground surface with permeable gravel or broken stone aggregate. These interceptor drains are brought to the nearest watercourse or stream into which they outfall.

In the case of over ground intermittent filters, the collector drains to remove the filtrate are excavated into the top of the impervious layer at appropriate spacings, drainage pipes are laid and backfilled with filter gravel to original ground surface.

An impermeable liner is used to seal off the sides of the intermittent filter to prevent possible bypass into gravelly soil when the filter is underground; this bypass could occur when a flooding dose is applied to the distribution gravel. Where the polishing filter is offset, the entire intermittent filter should be enclosed (Figure 14) in a leak proof liner and the treated effluent be collected in a collection chamber and discharged to a polishing filter or to surface water in accordance with a licence.

FIGURE 14: INTERMITTENT SAND FILTER OVERLYING IMPERVIOUS SUBSOIL/BEDROCK WITH OFFSET POLISHING FILTER



4.6 MOUNDED INTERMITTENT FILTER SYSTEMS

Where shallow or impervious soils exist, a mounded intermittent soil or sand filter as illustrated in Figure 15 may still be possible.

At a minimum, the following site conditions should exist, if not present then site improvements may be necessary see Section 2.6.

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

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

Where soil (1< T< 30) has to be imported, it should be placed in lifts in the proposed percolation area such that there is a minimum thickness of 2.0 m of unsaturated soil with drainage over the bedrock. The fill should be placed in layers not exceeding 300 mm thick and lightly compacted. Great care should be taken not to over compact the soil as this will lead to ponding.

After each lift is placed, percolation tests should be carried out. A 150 mm square hole is excavated to a depth of 150 mm[33] in the placed soil. After pre-soaking to completely wet the soil, 0.5 litres 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 minutes and 2 hours.

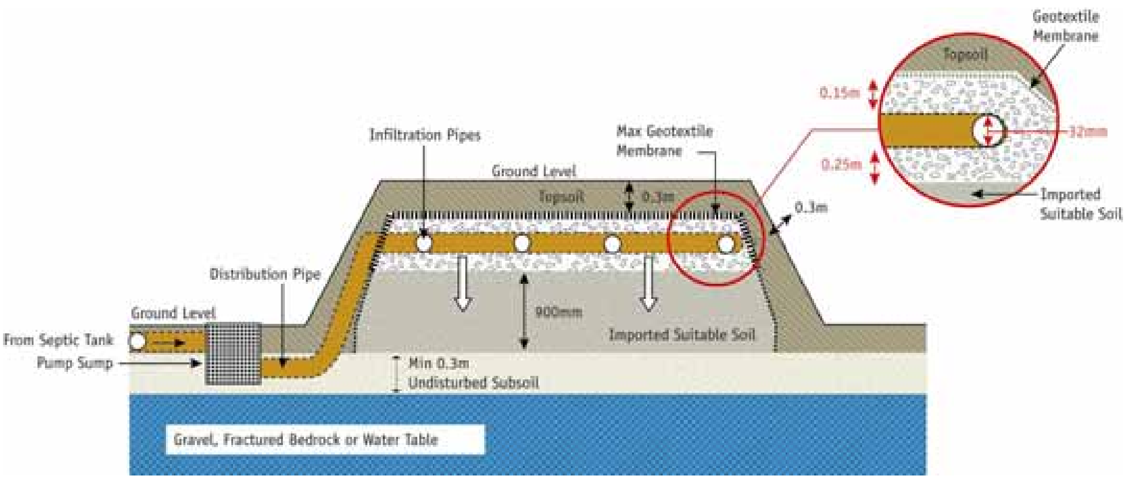
[33] Change is size of test hole will effect the validity of the results.

Where such soil filling is not feasible, a sand filter system may be constructed in accordance with criteria in Table 16 or alternative systems followed by a polishing filter may be suitable.

It may, depending on site conditions, be necessary to pump the septic tank effluent to a higher level before distribution over the infiltration area. There are two options for distribution of the septic tank effluent; dosing using a pumped distribution system (Figure 9 and Tables 15 and 16) or by pumping to a distribution chamber and then use a gravity fed system (Table 13 and 14).

In the case of a gravity system it is recommended to pump the effluent to a stilling chamber from where the effluent flows by gravity to a distribution device (as in Section 3.2). In this case the length of gravity pipe from the stilling chamber to the box should be greater than 3m in length. The effluent from the septic tank should not be pumped to an elevated distribution box and the effluent to be then gravity fed on the top of the mound. Pumping to a distribution box will not allow for even distribution of the effluent however, pumping to a sump/stilling chamber, which then discharges to a distribution box may be acceptable.

FIGURE 15: INTERMITTENT SOIL FILTER (ABOVE GROUND)



4.7 PREFABRICATED TREATMENT UNITS FOR SEPTIC TANK EFFLUENT

These systems may be described as pre-fabricated treatment units used for septic tank effluent. The CEN Technical Committee EN/TC165 is currently working on a technical standard (EN 12566:6) for the requirements, the methods, the marking and evaluation of packaged and/or site assembled secondary treatment units. The standards set in Table 2 (Section 1.3) apply to these systems. The range of factors to be taken into account when selecting a system is presented in Appendix D.

4.7.1 Peat Filter Systems

These systems may be described as pre-fabricated treatment units used for septic tank effluent. Fibrous peat filters are used as intermittent open filters to treat septic tank wastewater. The peat fibres are placed in modules and compressed. The thickness or depth of the compressed peat is about 0.7 m and its dry density is about 200 kg/m^3. The peat filter surface area should be 1 m^2/person. The hydraulic loading rate on peat filters may vary depending on the type of peat employed. Commercial available fibrous peat filters systems are designed at hydraulic loading rates in excess of 100 l/m^2/d.

To promote uniform distribution and to minimise the disturbance of the peat material a layer of lightweight coarse-grained aggregate such as shells may be placed on top. A pipe distribution network fitted with orifices or a spray irrigation system is used to evenly distribute the wastewater. Each module of a modular unit should be provided with a cover.

4.7.2 Other Intermittent Media Filter Systems

Other intermittent media filter systems may come on the market in the future. Where such products are introduced, independent evaluation should be carried out to verify the manufacturer's design loadings. Such systems will have to conform to national or European standards such as Agrèment or EN certification.

4.8 APPLICATION OF SEPTIC TANK WASTEWATER TO INTERMITTENT FILTERS

The wastewater should be applied uniformly to the surface of the filter at intervals such that the wastewater percolates down through the complete surface area of the filter at a rate, which optimises mass transfer conditions into the biofilm coating the media. Even distribution may be obtained by pumping the wastewater through evenly spaced lateral pipes with evenly spaced orifices embedded in distribution gravel. Dosing frequencies are related to the type of filter media. A dosing frequency of 4 times daily is recommended. Dosing tanks are sized for the maximum daily dose to be used.

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

The wastewater from the intermittent filter is normally collected in a chamber, from where it is discharged to a polishing filter. In some cases, the *in situ* topsoil underneath the intermittent filter may have sufficient depth on its own or with placed imported soil to act as a polishing filter.

In very permeable (gravelly) sites, the filtrate from the intermittent filter, after passing through a polishing filter, may percolate to the groundwater.

In impermeable sites, the filtrate from the intermittent filter, after passing through a polishing filter/package tertiary treatment system may discharge to surface water in accordance with a Water Pollution Act discharge licence.

4.9 CONSTRUCTED WETLANDS

4.9.1 Background

Constructed wetland is the generic term used to describe both reed bed systems (Gravel or Sand) and soil based constructed wetlands. A constructed wetland (a form of filter system) is another option for the treatment of wastewater from a septic tank. The main difference between a constructed wetland and other filter systems is the planting of vegetation in the media. Plants used are emergent macrophytes. The most notable of which is the common reed (*phragmites australis)* other plants species used are *iris, typha*, *sparganium, carex, schoenoplectus* and *acorus.* As the wastewater to be treated flows through the wetland, the micro-organisms that are attached to the root system of the reeds purify the wastewater by supplying oxygen to the bed of the wetland and the support media. Planting should occur in blocks of plant species and not be monoculture in nature thus providing diversification of plant species and at a density of 4-5 per m^2.

A soil based constructed wetland may also be described as a Free Water Surface (FWS) constructed wetland. They provide a good reduction of BOD and suspended solids through sedimentation and filtration as well as microbiological activity. Aerobic microbiological activity occurs within the root zone while anaerobic conditions exist below the root zone.

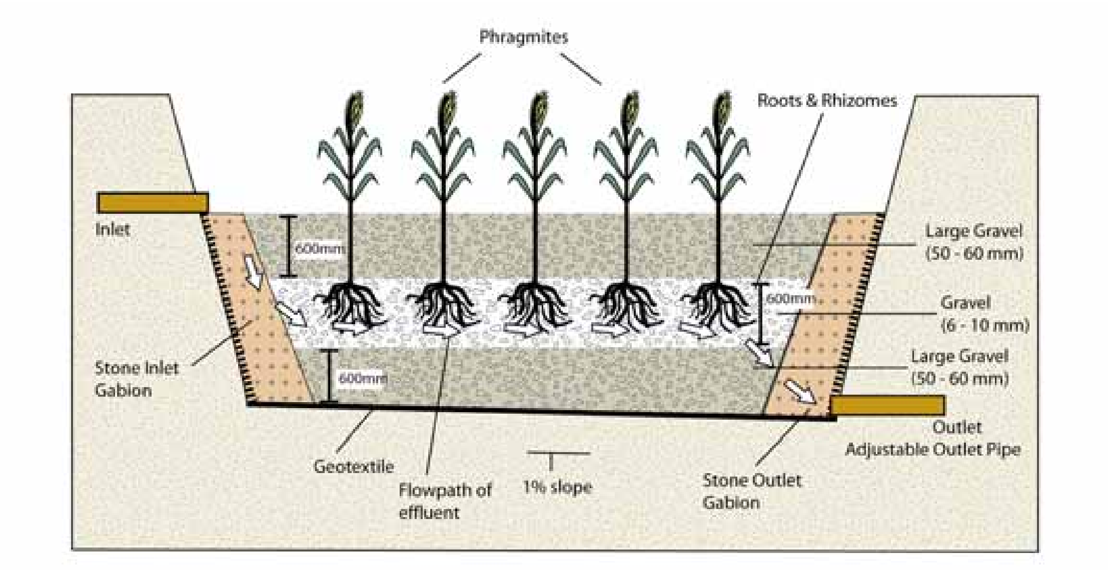
Reed beds can be sub divided depending on their media and flow type, i.e.,

- Sand based Vertical Reed Beds
- Gravel based Vertical Reed Beds
- Gravel based Horizontal Reed Beds

The mechanism and characteristics of each individual reed bed type play an important role in their treatment performance.

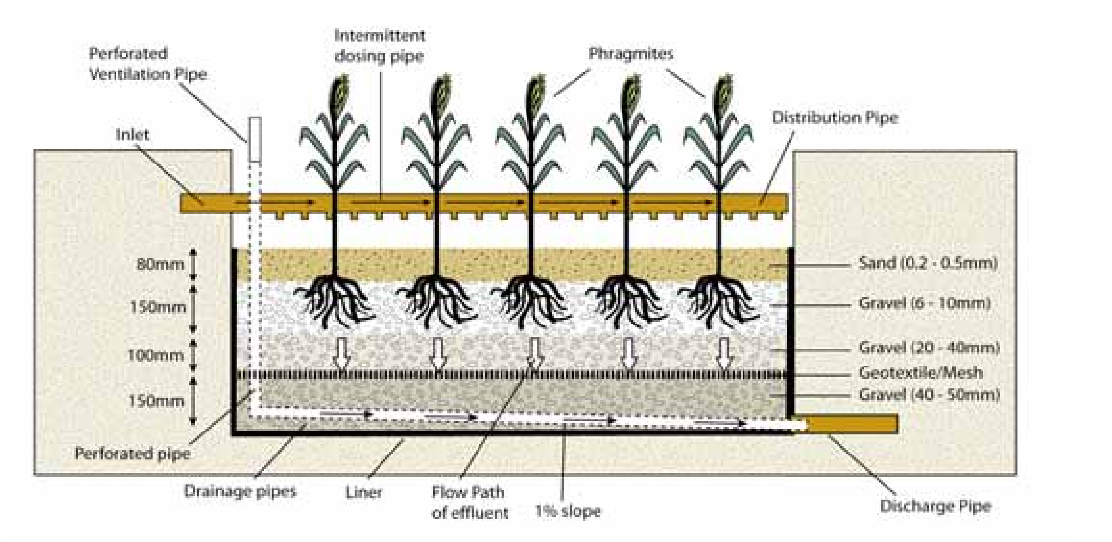
In a vertical-flow reed bed, wastewater is intermittently distributed uniformly over the media bed, and gradually drains vertically to a drainage collection network at the base of the support media. As the wastewater drains vertically, air re-enters the pores of the media, thus maintaining the aerobic conditions in the filter media and aiding the treatment. This helps especially in the breakdown of BOD and nitrification of ammonia nitrogen to nitrate. The media used in a vertical flow reed bed can be sand or gravel or a mixture. Figure 16 illustrates a typical cross section of a vertical flow gravel reed bed.

FIGURE 16: VERTICAL SUB-SURFACE FLOW REED BED



In a horizontal flow reed bed; wastewater is introduced at one end of a flat to gently sloping bed of reeds (slope 1%) and flows across the bed to the outlet pipe. If the surface of the wastewater is at or above the surface of the wetland media, the system is called a free-water surface (FWS) horizontal flow reed bed. By far the most common type of the sub-surface flow (SFS) type where the wastewater is maintained below the surface of the wetland media. If the surface of the wastewater is below the surface of the wetland media, the system is called a sub-surface (SFS) horizontal flow reed bed. An adjustable discharge outlet controls the level of the water in the horizontal flow reed bed. Attention should be paid to the bed's hydraulic distribution with respect to inlet configuration and aspect ratio. Figure 17 illustrates a sub-surface horizontal flow gravel reed bed.

FIGURE 17: SUB-SURFACE (SFS) HORIZONTAL FLOW REED BED



A hybrid system comprises mostly vertical reed bed and horizontal reed bed systems arranged in series to achieve higher treatment efficiency. They are good for total-N removal, as well as organic reduction and pathogen removal.

In the case of both reed bed systems and soil based constructed wetlands they should be sealed by a synthetic or geotextile clay liner or a natural clay liner (permeability k = 1.0 x 10^{-8} m/s). Only wastewater and grey water from the septic tank (or secondary treatment system) should be allowed to enter the wetland, i.e. no collected rainwater or surface water is permitted. In all cases these wetland systems should be fenced off or landscaped to prevent any unauthorised access particular by children or animals.

The design of a reed bed or soil based constructed wetland is site specific. A competent person should undertake the design and installation of a constructed wetland. The following provides general guidance on these types of systems but does not give all possible design options. The guidance EN 12566 'Small Wastewater Treatment Systems for up to 50 PE – Part 5: Pre-Treated Effluent Filtration Systems refers to construct wetlands and reed beds as open filters with reeds. EN 12566:5 is a useful reference for further details on reed bed systems but a specialist should always be consulted.

Small-Scale Constructed Wetland Treatment Systems-Feasibility, Design Criteria and O&M Requirements, Wallace, S. and Knight, R. (2007) should be consulted for guidance on soil based constructed wetlands.

4.9.2 Design Considerations

All constructed wetlands should be designed for a minimum of 5 P.E. for use as secondary wastewater treatment systems. Other design considerations are included in Table 17 below. The sizing of these treatment systems is ultimately dependent on the quality of the receiving waters and therefore increased sizes are required in nutrient sensitive areas.

TABLE 17: DESIGN CRITERIA FOR CONSTRUCTED WETLAND SYSTEMS

System Type	Area required[34]	Minimum System Size	Loading Rates	Length:Width Ratio
Vertical Sand Reed Bed	5 – 6 m^2/P.E.	20m^2	5 – 15 litres per m^2 per dose, for 2 – 5 doses per day.	2.5:1
Vertical Gravel Reed Bed	1.5 - 3m^2/ P.E	15m^2	8 litres per m^2 per dose.	2.5:1
Horizontal Gravel Reed Bed	5m^2/ P.E	25m^2	-	3:1
Soil Based Constructed Wetland	20 m^2/ P.E	100m^2	-	5:1

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

A polishing filter should follow these systems when the disposal route for the secondary treated effluent is to ground. Where these systems are being used as polishing filters, the design criteria are dependent on the influent characteristics and the receiving water quality requirements. In the case where these systems discharge directly to surface water a Water Pollution Act discharge licence is required

[34] Greater sizing may be required when discharging into nutrient sensitive waters or consideration could be given to ferric dosing.

5. SECONDARY TREATMENT - MECHANICAL AERATION SYSTEMS

Key Message
Mechanical Aeration Systems use media and mechanical parts to treat domestic wastewater. As with filter systems they require a polishing filter to allow for further treatment of the wastewater and to convey the treated wastewater into the ground. Regular maintenance of these systems is essential in order to ensure adequate treatment. These systems may be suitable in areas where a conventional septic tank is not acceptable. The code of practice provides general guidance on the siting, design, installation and maintenance of these systems.

5.1 INTRODUCTION

A European standard EN12566-3: 2005 Small Wastewater Treatment Systems up to 50 PT – Part 3: Packaged and/or site assembled domestic wastewater treatment plants was published by the NSAI as a national standard. A transitional arrangement is to be worked out for systems that have IAB Certification.

Mechanical aeration systems may be used to treat wastewater from a dwelling house where a site is unsuitable for a conventional septic tank system or they may be used as an alternative to septic tank systems on suitable sites. The effluent from all mechanical aeration systems should be treated on a polishing filter where the final discharge is to groundwater. Many systems are available on the market and include the following:

- Biofilm aerated filter (BAF) systems;
- Rotating biological contactor (RBC) systems;
- Sequencing batch reactors (SBR); and
- Membrane filtration systems.

Mechanical aeration systems differ from the simpler septic tank in a number of critical ways. They comprise a number of components some of which are mechanical and/or electrical. The systems are more complex and opportunities for breakdown are greater, therefore these systems require closer monitoring and more detailed maintenance than the simpler conventional septic tank systems. On the other hand, as a consequence of the more complex design and construction of mechanical aeration systems, they can produce a higher quality effluent in terms of organics and micro-organisms than a septic tank typically can. Mechanical systems are often more sensitive to grease loading so the use of a grease trap may be recommended. Their sludge storage capacity should be checked with the manufacturer at the time of purchase to establish the necessary frequency of de-sludging. It is recommended that tank should designed to store the sludge capacity for at least once per year and checked at least once per year. The capacity of the settlement compartment should be governed by that set out in Section 3.2.1.

5.2 LOCATION OF MECHANICAL AERATION SYSTEMS

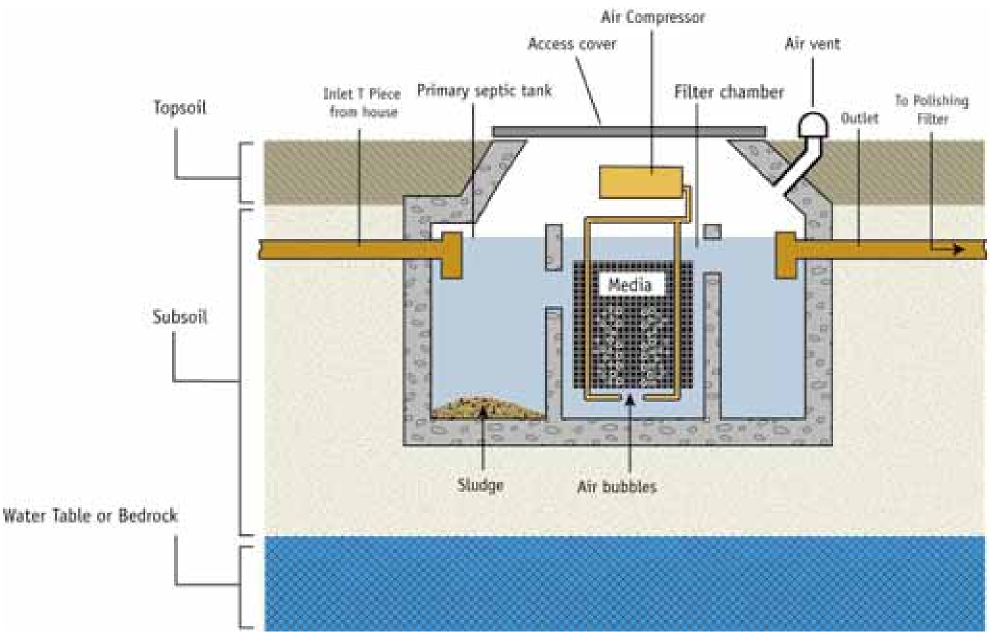
Recommended minimum distances of separation of mechanical aeration treatment systems should be as listed in Table 5. The recommended minimum distances from wells should satisfy the requirements of the groundwater protection response, which should have been consulted as part of the site characterisation. The groundwater protection responses may also dictate that subsoil depths for polishing filters in excess of those indicated in this code of practice may be required.

5.3 BIOFILM AERATED FILTER (BAF) SYSTEMS

A BAF system may consist of a primary settlement tank, an aerated submerged biofilm filter and a secondary settlement tank (Figure 18). Solids are sometimes returned from the secondary settlement chamber to the primary settlement chamber to facilitate de-sludging and to avoid sludge rising due to de-nitrification. There should be adequate sludge storage capacity in the primary settlement chamber. Normally BAF systems, which are used to treat wastewater from single dwellings, can be purchased as prefabricated units, with all chambers in one unit. BAF systems are normally constructed in either glass reinforced plastic (GRP), concrete or steel. The micro-organisms are attached to the filter media in the secondary treatment stage. The media normally have a high specific surface area (m^2/m^3) and can consist of plastic modules or a granular material. Where granular media are used the system may require backwashing to prevent clogging of pore spaces. The required surface area of the media can be determined using an organic loading rate of 5 g BOD/ m^2.d of settled sewage. For a single house with 4 persons, the required area is about 32 m^2 based on a per capita loading of 40 g BOD/d of settled sewage.

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

FIGURE 18: BIOFILM AERATED FILTER SYSTEM (BAF)

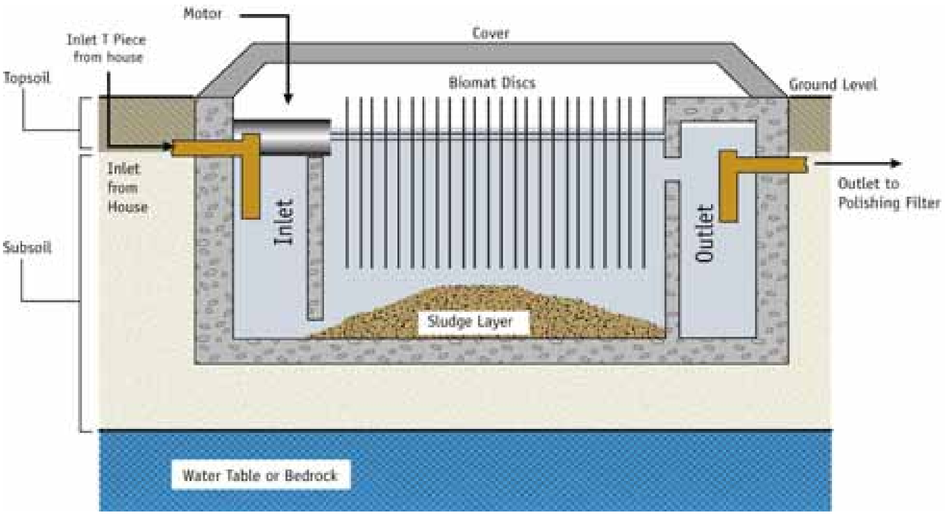


5.4 ROTATING BIOLOGICAL CONTACTOR (RBC) SYSTEMS

A rotating biological contactor (RBC) system consists of a primary settlement tank, a secondary treatment compartment and a secondary settlement tank (Figure 19). In this system the micro-organisms are attached to an inert media surface (the disc) and the inert media are mounted on a shaft that is rotated by an electric motor.

These media are partially submerged in the wastewater. A biofilm develops on the media over time; it is this biofilm, which treats the wastewater. The settled sludge in the secondary settlement tank is sometimes returned to the primary settlement tank. There should be adequate sludge storage capacity in the primary settlement chamber. RBC units can be purchased as packaged treatment units for single dwellings; these units normally contain all three compartments in one unit. The required surface area of the media can be determined using an organic loading rate of 5 g BOD/ m^2/d of settled sewage. For a single house with 4 persons, the required media surface area is about 32 m^2 based on a per capita loading of 40 g BOD/d of settled sewage. Grease should not be allowed to enter the contactor zone.

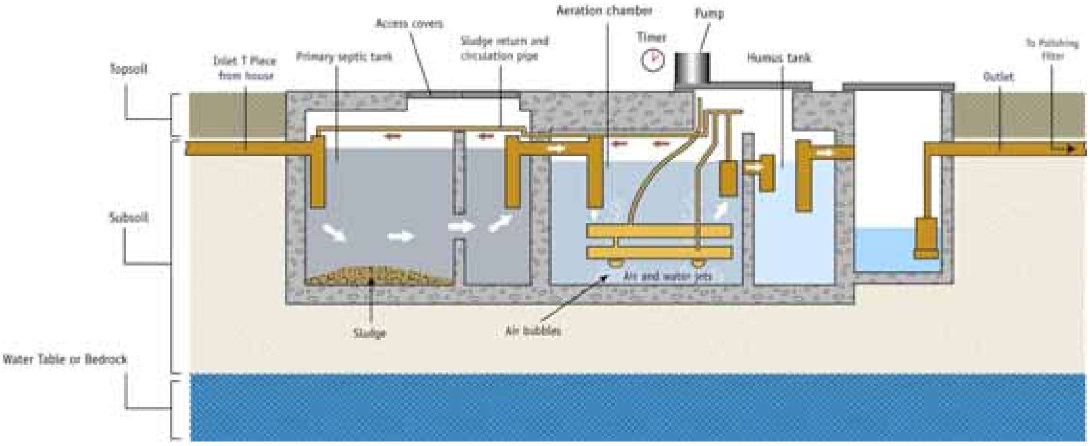
FIGURE 19: SCHEMATIC OF A ROTATING BIOLOGICAL CONTACTOR (RBC) SYSTEM



5.5 SEQUENCING BATCH REACTOR SYSTEM (SBR)

The sequencing batch reactor (SBR) (Figure 20) process is a form of activated sludge treatment in which aeration, settlement, and decanting can occur in a single reactor. The process employs a five-stage cycle: fill, react, settle, empty and rest. Wastewater enters the reactor during the fill stage; typically, it is aerobically treated in the react stage; the biomass settles in the settle stage; the supernatant is decanted during the empty stage; sludge is withdrawn from the reactor during the rest stage; and the cycle commences again with a new fill stage. For single house systems, a primary settlement tank precedes the reactor. Grease should not be allowed to enter the reactor.

FIGURE 20: SCHEMATIC OF A SEQUENCING BATCH REACTOR (SBR) SYSTEM



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

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

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

5.6 MEMBRANE FILTRATION SYSTEMS

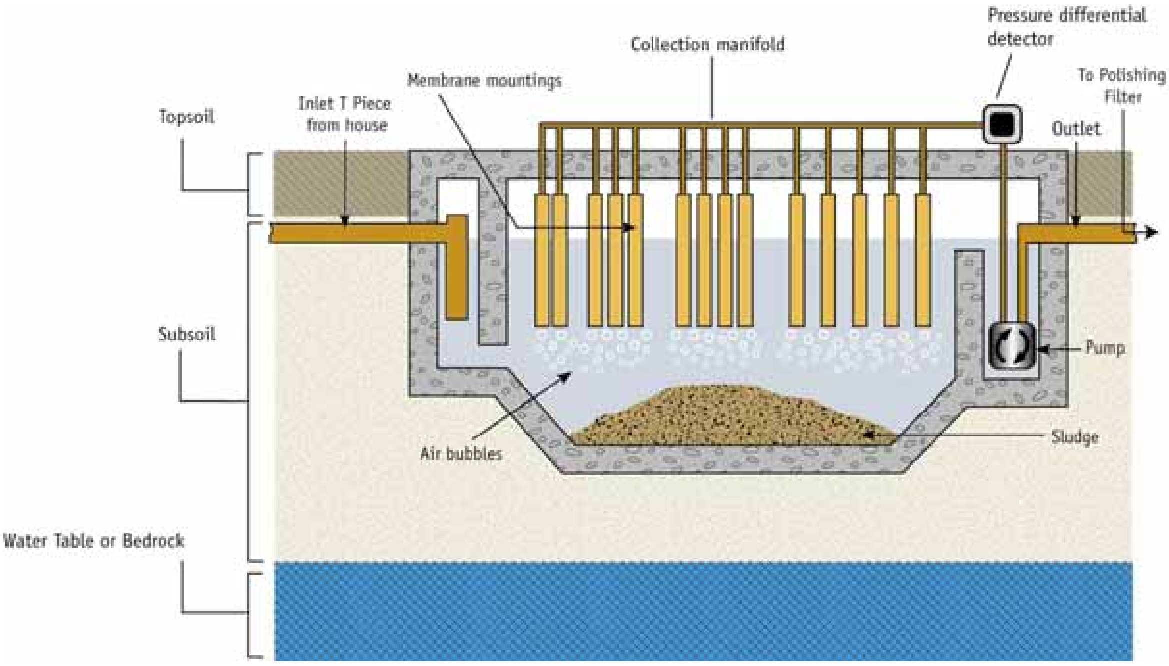
Membrane filtration systems treat effluent by the removal of both suspended solids and dissolved molecular material from the effluent as it passes across a specific membrane material (Figure 21). The system utilises a treatment tank with aeration and membrane filtration units. These systems usually produce very high quality effluents. The special membrane used is mounted on a support frame and in order for the effluent to progress from the inlet end of the system to the outlet end it should pass through the membrane unit. Aeration equipment fitted within the treatment unit performs a dual function – aerobic conditions are maintained and the membrane is constantly cleaned by the passage of air over its surface.

The integrity of the membrane filter fabric is critical to the proper operation of the system. This is monitored by way of a pressure differential detector and an associated alarm mechanism.

Should the membrane fabric be torn or damaged it is imperative that the system be subjected to maintenance/repair as soon as possible. These systems need to be cleaned and may require to be replaced on a regular basis

Grease and any materials with sharp edges should not be allowed to enter the treatment system.

FIGURE 21: SCHEMATIC LAYOUT OF A MEMBRANE FILTRATION SYSTEM



5.7 OTHER TREATMENT SYSTEMS

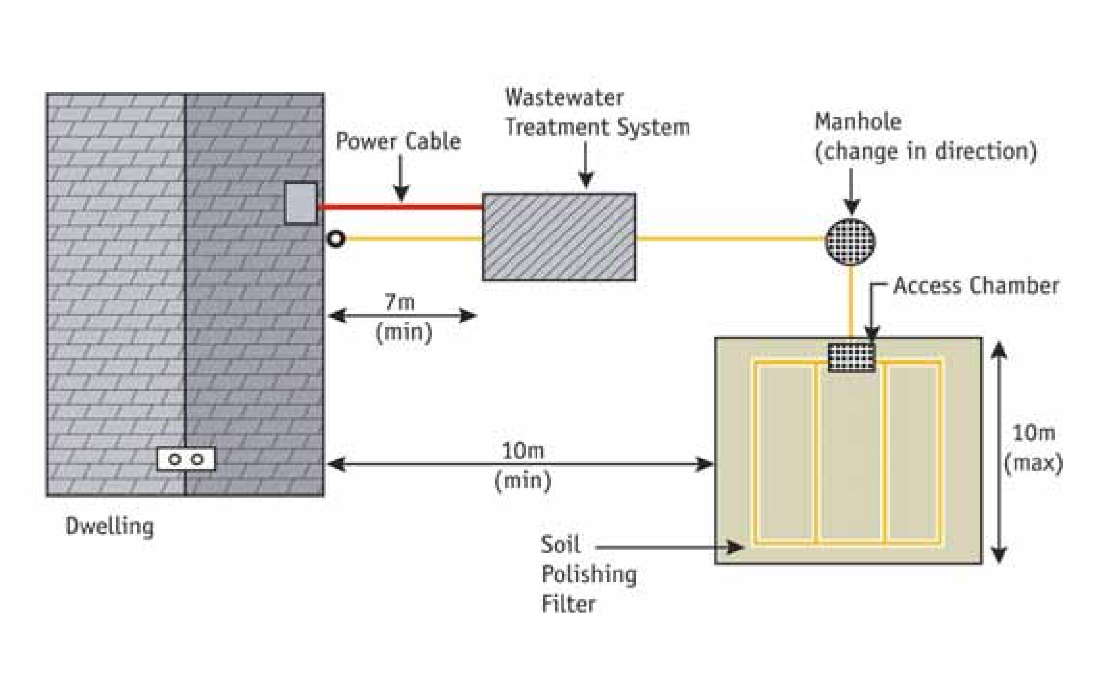
Other treatment systems may be introduced from time to time to treat wastewater. Such systems include other activated sludge systems, other membrane bioreactors or composting units. Where such products are introduced independent certification will be required prior to the use of these systems in association with single house developments. Such accreditation will be obtained either through the current Agrément Certification process or other specified certification system, for details on the exact procedures refer to Part D of the Building Regulations, 1997 (S.I. No. 497 of 1997) as amended, or under the forthcoming rules as set out in the EN12566-3:2005 standard. The Agency has no role in the assessment of wastewater treatment systems nor does it have a list of certified systems. The evaluation criteria set out in Appendix D should be consulted. Polishing filters should typically follow such systems to reduce micro-organisms to required levels.

5.8 POLISHING FILTERS FOR MECHANICAL AERATION SYSTEMS

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

For guidance on the proper design and the issues to be considered in the establishment of a polishing filter refer to Section 6. A typical layout for the treatment of wastewater using a mechanical aeration system is illustrated in Figure 22.

FIGURE 22: MECHANICAL AERATION AND POLISHING FILTER SYSTEM



6. TERTIARY TREATMENT SYSTEMS

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

6.1 INTRODUCTION

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

6.2 POLISHING FILTERS

Excepting intermittent soil filters, all intermittent filter systems, constructed wetlands and mechanical aeration systems require a polishing filter following the secondary treatment stage. The polishing filter can reduce micro-organisms and phosphorus (depending on soil type) in otherwise high quality wastewater effluents.

All polishing filters should have a minimum thickness of 900 mm of free-draining unsaturated soil or sand between the point of infiltration of the effluent and the water table and bedrock. They may be at ground surface or partially or totally above ground surface. Where the native soil at the site is impervious, a graded gravel layer with drains should underlie the polishing filter and the polished wastewater is then drained away in a suitable manner using a gravity or pumped sump arrangement to a watercourse (in accordance with a Water Pollution Act discharge licence). Where a polishing filter is constructed over ground or in contact with a very permeable gravel or sand stratum in the soil and is pressure dosed into surface distribution gravel, the sides of the filter should be enclosed by an impervious liner to prevent bypass of flooding doses directly to the ground surface or groundwater. Where grass growth can be accommodated and allowed there can be a large reduction in NO_3-N in the effluent.

The site conditions are the same as for percolation areas and reference should be made to Section 3.3.2

6.2.1 Soil Polishing Filters

Soil polishing filters may comprise *in situ* soil, improved soil and/or imported soil. These soils, which should have a minimum depth of 0.9m, should have percolation values (P or T) in the range of 1-75 for in-situ material and P/T value of 1-30 for imported material. Effluent may be loaded onto a soil polishing filter by any one of three arrangements (direct discharge, pumped discharge or gravity pipe discharge).

In typical layouts (Table 18), the soil polishing filter:

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

TABLE 18: DESIGN SPECIFICATIONS FOR SOIL POLISHING FILTERS

	Distribution by
Option 1: Direct Discharge	Gravel layer
Option 2: Pumped Discharge[35]	Typically 32 mm ∅ laterals with 3-5 mm ∅ orifices (0.6 m apart) at 0.6 m spacing between laterals. Over 100 – 200 mm layer of gravel.
Option 3: Gravity Discharge	Trenches: 500 mm wide at 2m spacing (2.5m centre to centre) Maximum trench length = 10m [36]

Recommended loading rates and design values for a 4-person house are given in Table 19. Areas and lengths for other person numbers are pro-rata, e.g., the requirements for an 8-person house will be twice that of a 4-person house.

TABLE 19: MINIMUM SOIL POLISHING FILTER AREAS AND PERCOLATION TRENCH LENGTHS REQUIRED FOR A 4-PERSON HOUSE

	Direct and pumped discharge (Options 1 and 2)		Percolation trench discharge (500mm wide) (Option 3)	
P/T values[37]	Loading rate on plan area ($l/m^2/d$)	Area required for 4 persons (m^2)	Loading rate on trench area ($l/m^2/d$)	Length required for 4 persons (m)
1 – 20	≤ 20	≥ 36	≤ 50	≥ 29
21 – 40	≤ 10	≥ 72	≤ 25	≥ 58
41 – 50	≤ 5	≥ 144	≤ 25	≥ 58
51 –75	≤ 3	≥ 240	≤ 16	≥ 90

[35] Due to variations in the discharge rating of pumps available on the market, it is important to correctly match the orifice diameter and the lateral diameter in the distribution system to the pump, thus ensuring even and effective distribution of the hydraulic load across the filter area.

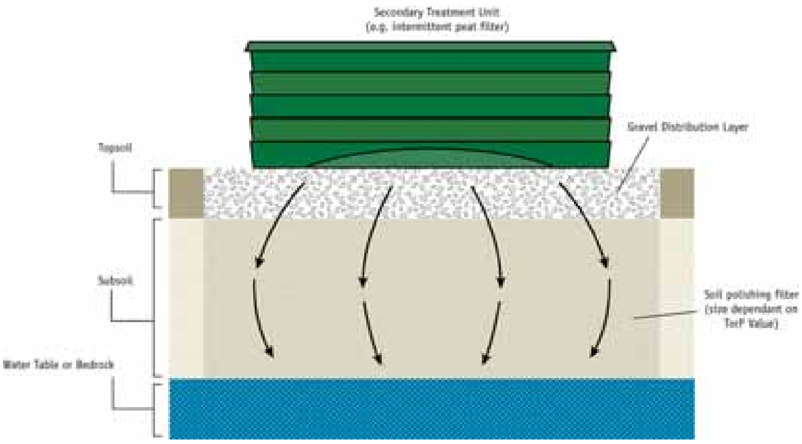
[36] In the case of polishing filters biomat formation is less extensive than is the case for percolation areas and thus shorter trench lengths are appropriate.

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

6.2.1.1 Option 1- Direct Discharge

In the case of spreading the effluent from a secondary unit over a polishing filter using a shallow distribution gravel and with direct discharge from the polishing filter to groundwater (Figure 23). The loading rates on the soil should conform with those recommended in Table 19.

FIGURE 23: OPTION 1 – DIRECT DISCHARGE



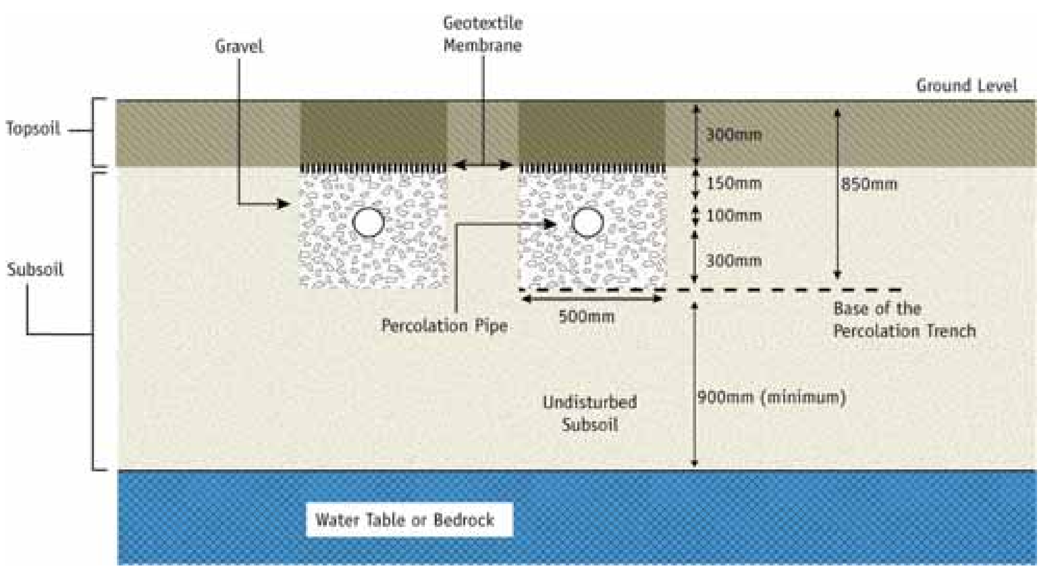
6.2.1.2 Option 2 - Pumped Discharge

The treated wastewater from the secondary treatment unit is pumped to a manifold and percolation pipes and details are in Table 19 above. In the case of hydraulic loading by pumping, loading rates should conform with those in Table 19.

6.2.1.3 Option 3 – Gravity Pipe Discharge

In the case of loading a percolation area with a P/T value of 1 – 75 through percolation trenches a greater area of polishing filter than for Options 1 and 2 is required. The length of percolation trench in a polishing filter for secondary treated wastewater from a 4-person household for the different percolation values is shown in Table 19 (see Figure 24). Treated wastewater from the secondary filter flows by gravity to a distribution box, which distributes the flow evenly into the several trenches that are a maximum of 10m in length.

FIGURE 24: SECONDARY TREATMENT UNIT FOLLOWED BY A POLISHING FILTER PERCOLATION TRENCH



6.2.2 Sand Polishing Filters

Sand polishing filters comprise single layer and stratified sand filters (Figure 25), they should be a minimum of 900mm in thickness. In a typical layout, three layers of sand comprising an upper layer of coarse sand and intermediate and lower layers of fine sand are separated from each other by a thin layer of washed pea-sized gravel or broken stone. The hydraulic loading should not exceed 60 l/m2 /d. The sand polishing filter can be soil covered and sown with grass.

The filter specifications of the range of sands suitable for the polishing filter sand layers are shown in Table 20. Where the filter is soil covered and sown with grass, sands at the upper end of the grading shown in Table 20 are recommended. Figure 13 is an example of a stratified sand filter that can also be used as a polishing filter.

FIGURE 25: SECONDARY TREATMENT UNIT FOLLOWED BY A SAND POLISHING FILTER

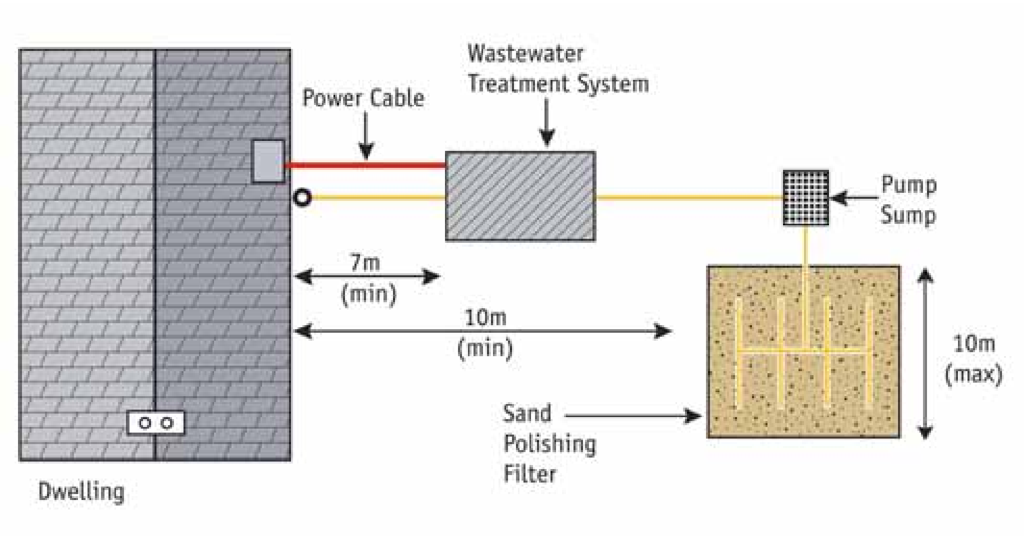


TABLE 20: DESIGN CRITERIA FOR AN INTERMITTENT SAND POLISHING FILTER

Design Factor	Design Criteria
Pre-treatment	Minimum of secondary treatment
Top coarse sand layer [38]	Effective size (D_{10}) 0.25-0.75 (mm); D_{60}/D_{10} (C_u) < 4
Fine sand layers	Effective size (D_{10}) 0.15-0.25 (mm); D_{60}/D_{10} (C_u) < 4

6.2.3 Disposal of Effluents from Polishing Filters

All intermittent filter systems, constructed wetlands and mechanical aeration systems require a polishing filter following the secondary treatment stage. The polishing filter produces a high quality effluent. The advice provided above allows effluent from a polishing filter to discharge to ground provided the subsoil has a P/T value greater than 1 and less than 75. The maximum pipe length is 10m for gravity fed systems.

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

6.3 CONSTRUCTED WETLANDS

Reed beds and constructed wetlands may also be used as tertiary treatment systems for domestic wastewater. They may include shallow vegetated surface flow wetlands. Refer to Section 5.10 for details on these systems

6.4 PACKAGED TERTIARY TREATMENT SYSTEMS

Tertiary treatment systems will be required where the wastewater treatment system is in a nutrient sensitive area or discharging to surface water. There are a number of different types of tertiary treatment systems on the market. The type of system to be used is dependent on the site conditions, the level of secondary treatment and the requirements of the receiving waters. Tertiary treatment systems may provide additional removal of phosphorus, nitrogen and pathogens from secondary treated effluent prior to discharge to the water body. Tertiary treatment systems include; Sand and Peat Filters, Constructed Wetlands, Ozone and UV Disinfection Systems, Membrane Filtration systems.

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

Tertiary treatment systems, which form part of systems covered under EN 12566: Part 3 and Part 6 should conform to the requirements of those standards.

7. MAINTENANCE OF SINGLE HOUSE WASTEWATER TREATMENT SYSTEMS

Key Message
Maintenance of all wastewater treatment systems is essential to ensure effective treatment of the domestic wastewater. Homeowners are responsible for the proper installation, operation and maintenance wastewater treatment system.

7.1 INTRODUCTION

The earlier chapters of this guidance document have been concerned with the assessment of sites for single house treatment systems and the selection of the most appropriate system for a given site - based on the results of the site assessment. Appropriate site selection, the careful choice of the treatment system to be employed on the site and the correct installation of the chosen system are critical steps to provide for the proper treatment of domestic effluent which will arise from the single house development.

The manner in which the treatment system is maintained after it is installed is of equal importance to ensure that the environment is protected on an on-going basis after the house is occupied.

Septic tank treatment systems will require a slightly different approach for proper maintenance than mechanical aeration systems. Septic tanks do not normally require the use of mechanical parts, electrical components or sensitive equipment of the type, which may be used in the more sophisticated systems. Therefore, in the case of septic tank systems visual inspection of the system on a periodic basis as well as regular de-sludging is often all that is required to ensure that the system continues to operate effectively. Guidance for the maintenance of septic tanks can therefore be seen as more universally prescriptive and the approaches taken to the maintenance of all septic tanks will be similar.

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

Mechanical aeration treatment systems, which may be used for either secondary or tertiary treatment (such as RBF’s, BAF’s, SBR’s and micro-filtration systems), rely on the precise functioning of mechanical and/or electrical components for proper operation. For this reason the level of maintenance required is more complex. Apart from carrying out periodic visual inspections of the system, there will also be a requirement to repair, service or even replace components, which become worn out through use, over time. Different manufactures will design and configure their products in different ways, so the maintenance regime will vary from system to system. With mechanical treatment systems the user is advised to consult the manufacturers instructions in all cases in order to decide on the appropriate maintenance approach to take, including de-sludging frequency.

Maintenance of wastewater treatment systems for use in holiday homes has been identified, as problem area as it is essential that the microorganism population in the biological zone of the treatment system remain active throughout the year to effectively deal with occasional loadings of wastewater. This activation should be maintained during periods when the holiday homes are unoccupied. There are no clear guidelines as to how this should happen and further research will be carried out in this area. However, frequent flushing of toilets and running the water taps by caretakers on a weekly basis may assist in ensuring that the system does not dry out. Also advice from the system manufacturer should also be sought.

7.2 MAINTENANCE OF CONVENTIONAL SEPTIC TANK TREATMENT SYSTEMS

A septic tank treatment system normally comprises a two-chambered tank followed by either a percolation area or some other form of filtration system (soil, sand or peat, or some combination of these materials). 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.

7.2.1 The 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 (every 2 years) are the only operation and maintenance requirements.

Inspections are performed to observe sludge and scum accumulations, structural soundness, watertightness, and condition of the inlet to, and outlet from the tank itself.

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.

7.2.1.1 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 30cm 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 10cm 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:

Use a 2m pole and wrap the bottom 1.2m 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 that than the coloration caused by the liquid waste.

7.2.1.2 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.

7.2.1.3 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.

7.2.1.4 Septic tank pumping & desludging:

Tanks should be pumped when sludge and scum accumulations exceed 30 percent 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 pumped every 2years, as a minimum. In cases where the septic tank is at, or near, its design load capacity, desludging should be done every year, or 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 appropriate legally certified service provider and reused or disposed of in accordance with national legislation in relation to waste disposal.

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.

7.2.2 The Distribution Box/Device

The effluent from the septic tank is typically conveyed to the percolation area through a distribution box (the D-box). The function of the D-box 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 six months. Build up of solids in the D-box should be removed to ensure that the flow through the box is not obstructed, and to ensure that the effluent passing through is evenly split between the outlet pipes. The D-box should be checked to ensure that it has not shifted on its foundation since the previous inspection. Such disturbance can result from over passing by heavy vehicles or through natural soil creep. Where such disturbance has taken place, a competent builder should reset the D-box on its foundation, and the level of the D-box should be rechecked as part of this measure. Any damage to the box itself, its internal pipework, the jointing to the external inlet & outlet pipes, or to the cover of the box should be made good as part of the maintenance procedure.

7.2.3 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 pipe-work the necessary repairs should be carried out by an appropriately qualified engineer / technician;
- 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.

7.3 MAINTENANCE OF FILTER WASTEWATER TREATMENT SYSTEMS

7.3.1 Soil and Sand Filters

Intermittent soil or sand filters require little control and maintenance. The main tasks are servicing of the dosing equipment and monitoring of the wastewater. In the case of sand filters, there is possible maintenance of the sand surface of open sand filters. Otherwise soil and covered sand filters are expected to work without maintenance throughout their working life. 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.

7.3.1.1 Mounded Filter Systems

For mound systems, regular maintenance is more essential. 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 in mounds due to excessive ponding within the absorption area or leaking out of the toe of the mound can occur. Ponding can occur where when 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. 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 three to five years or as required by manufacturer's specifications. The dosing chamber should be fitted with a high-level alarm to alert the homeowner to a possible pump failure or chocked distribution pipe work. 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.

7.3.2 Peat Filters

The surface of the peat filter should be examined periodically for signs of ponding. The peat media should not be disturbed as this may lead to channelling of effluent or flooding. For proprietary peat filter systems, it may be advisable that the peat media be inspected by the manufacturer from time to time to assess the quality of the media. 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 washwater and sludge be removed from the pump chamber.

7.3.3 Constructed Wetlands

Constructed wetlands are generally low maintenance systems, however some inspection and maintenance is needed to avoid the occurrence of problems within the system. It takes approximately two years or so for a constructed wetland to mature in relation to treatment capacity and the system should steadily improve with time. It takes approximately four weeks or so for the plants to settle in and establish once sown. Plants should be healthy and it is preferable to sow the plants before the growing season. Seedlings and ribosomes should not be planted. This is to ensure that the plants are given a chance to establish and will not become over whelmed 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 pipe work. Regular de-sludging of preliminary or secondary treatment systems prior to 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 or 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 pipe work 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 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 eliminated or minimised where possible.

7.3.4 Other Filters

Other filter systems should be operated and maintained in accordance with the manufacturers instructions.

7.4 MAINTENANCE OF MECHANICAL AERATION WASTEWATER TREATMENT SYSTEMS

It is not possible to be so prescriptive about the maintenance of mechanical aeration treatment systems or of other forms of proprietary mechanical treatments systems as it is for septic tank systems. These systems are configured in various ways and the frequency and the system manufacturer often dictates 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 Agrèment Certificate. In some (but not all) cases, maintenance may be offered by the manufacturer through a maintenance contract. Maintenance may also be available commercially by appropriately qualified service engineers.

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 engineers.

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

7.4.1 Checks which May be carried out by the user:

The warning alarm system.

- Many of the latest mechanical wastewater treatments systems are equipped with an alarm circuit. The purpose of this circuit is to alert the user to any malfunction, which 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 systems. This may be indicative of a breakdown of the aeration equipment and this should be investigated thoroughly by a qualified service engineer.
- 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 engineer.

7.5 POLISHING FILTERS

Where polishing filters have been installed in association with either filter systems or mechanical aeration wastewater treatment systems, these should be periodically inspected in accordance with the general principles outlined in Section 7.2.3 (Percolation Area) above. In addition, in situations 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.

8. REFERENCES AND FURTHER READING

Cooper, P.F., Job, G.D., Green, M.B. and Shutes, R.B.E. (1996). *Reed beds and constructed wetlands for wastewater treatment*. Water Research Centre, Swindon, U.K.

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

Department of Environment and Local Government, Environmental Protection Agency, Geological Survey of Ireland (2000). *Groundwater Protection Responses for On-site Systems for Single Houses*. Geological Survey of Ireland, Dublin.

EPA (1999). Wastewater Treatment Manuals: Treatment Systems for Small Communities, Business, Leisure Centres and Hotels.

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

Gill L.W., A. Hand, C. O'Súlleabháin (2005). Effective distribution of domestic wastewater effluent between percolation trenches in on-site treatment systems. *Water, Science and Technology* 51(10), 39-46

Gill, L.W., O'Súlleabháin, C., Misstear, B.D.R, Johnston, P.J., (2004) A comparison of stratified sand filters and percolation trenches for the treatment of domestic wastewater effluent. In, Proceedings of the 1st International Conference on Onsite Wastewater Treatment and Recycling (IWA). Freemantle, Australia : 11-13 February 2004.

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

Jackson, B.J. (2005). Investigation into the correlations between the BS5930 soil classifications and percolation tests used in site suitability assessments for on-site waste water effluent treatment. MSc thesis. Department of Civil, Structural and Environmental Engineering, Trinity College Dublin.

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

Mulqueen, J., Rodgers, M., (2001). *Percolation Testing and Hydraulic Conductivity of Soils for Percolation Areas*. Water Research Vol. 35, No. 16, pp. 3909-3915, 2001.

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

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

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

APPENDIX A: Groundwater Protection Responses for On-site Wastewater Treatment Systems for Single Houses

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. The Geological Survey of Ireland (GSI) in conjunction with the Department of Environment and Local Government (DELG) and the EPA have issued guidelines on the preparation of groundwater protection schemes to assist the statutory authorities and others to meet their responsibility to protect groundwater (DELG/EPA/GSI, 1999). A groundwater protection scheme incorporates land surface zoning and groundwater protection responses.

This document is concerned with groundwater protection responses 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 groundwater protection responses outline acceptable on-site wastewater treatment systems in each groundwater protection zone (as described in Groundwater Protection Schemes DELG/EPA/GSI, 1999) and recommend conditions and/or investigations depending on the groundwater vulnerability, the value of the groundwater resource and the contaminant loading. It will be noted that these responses relate to discharges 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 conventional septic tank system consists of a septic tank followed by a soil percolation area. As an alternative to a conventional 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, phosphorus and nitrate nitrogen.

On-site 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 systems are often located close to private or public wells.

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

The objectives of these groundwater protection responses 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 height 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 groundwater protection responses allows decisions to be made on the acceptability or otherwise of on-site wastewater treatment systems from a hydrogeological point of view.

These groundwater protection responses should be read in conjunction with Groundwater Protection Schemes (DELG/EPA/GSI, 1999). Other published responses in this series are Groundwater Protection Responses for Landfills and Groundwater Protection Response to the Landspreading of Organic Wastes.

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

The characteristics of domestic wastewater are outlined in Table 1.

Table 1: Characteristics of Domestic Wastewater.

Parameter	Typical concentration mg/l unless otherwise stated
COD (as O_2)	400
BOD_5 (as O_2)	300
Total solids	200
Total Nitrogen (as N)	50
Total Phosphorus (as P)	10
Total coliforms (MPN/ 100 ml)*	10^7 - 10^8

* Most probable number (MPN/100 ml).

Particular contaminants of concern are pathogenic organisms and nitrates.

Pathogenic organisms

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

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 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.

Groundwater Protection Response Matrix for Single House Systems

The reader is referred to the full text in Groundwater Protection Schemes (DELG/EPA/GSI, 1999) for an explanation of the role of groundwater protection responses in a groundwater protection scheme.

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 Chapter 2. The methodology includes a desk study and on-site assessment (visual, trial hole test and percolation tests). The groundwater protection responses set out in Table 2 below 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 may allow a system to be developed. In such situations, site improvement works followed by reassessment of the groundwater responses, may allow a system to be developed. Site improvements are dealt with in Chapter 2.6.

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 10m 3/d (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 2 Response Matrix for On-site Treatment Systems

VULNERABILITY RATING	SOURCE PROTECTION AREA*		RESOURCE PROTECTION AREA Aquifer Category					
			Regionally Imp		Locally Imp.		Poor Aquifers	
	Inner (SI)	Outer (SO)	Rk	Rf/Rg	Lm/Lg	Ll	Pl	Pu
Extreme (E)	$R3^2$	$R3^1$	$R2^2$	$R2^2$	$R2^1$	$R2^1$	$R2^1$	$R2^1$
High (H)	$R2^4$	$R2^3$	$R2^1$	R1	R1	R1	R1	R1
Moderate (M)	$R2^4$	$R2^3$	R1	R1	R1	R1	R1	R1
Low (L)	$R2^4$	R1	R1	R1	R1	R1	R1	R1

- *For public, group scheme or industrial water supply sources where protection zones have not been delineated, the arbitrary distances given in DELG/EPA/GSI (1999) of 300 m for the Inner Protection Area (SI) and 1000 m for the Outer Protection Area (SO) should be used as a guide up-gradient of the source.*

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

$R2^1$ 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 Chapter 2 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 conventional septic tank system;

OR

1) A treatment system other than a conventional septic tank system as described in Chapter 4 and 5 is installed, with a minimum thickness of 0.3 m unsaturated soil/subsoil with P/T values[1] from 1 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

[1] The T value (expressed as min/25mm) 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 Appendix C.

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 the public, group scheme or industrial water supply source.

R3[1] Not generally acceptable, unless:

A conventional septic tank system as described in Chapter 3 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 Chapter 2);

OR

A treatment system other than a conventional septic tank system, as described in Chapter 4 and 5, is installed with a minimum thickness of 0.3 m unsaturated soil/subsoil with P/T values from 1 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.

No on-site treatment system should be located within 60 m of the 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 treatment system other than a conventional septic tank system, as described in Chapter 4 and 5, is installed with a minimum thickness of 0.9 m unsaturated soil/subsoil with P/T values from 1 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 the 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.

Ponding may occur in areas of low permeability subsoils (T >50) and thus safeguards for surface waters should be put in place.

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

Table 2 above 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 3 below provides recommended distances between receptors (see also Figure 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 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:

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

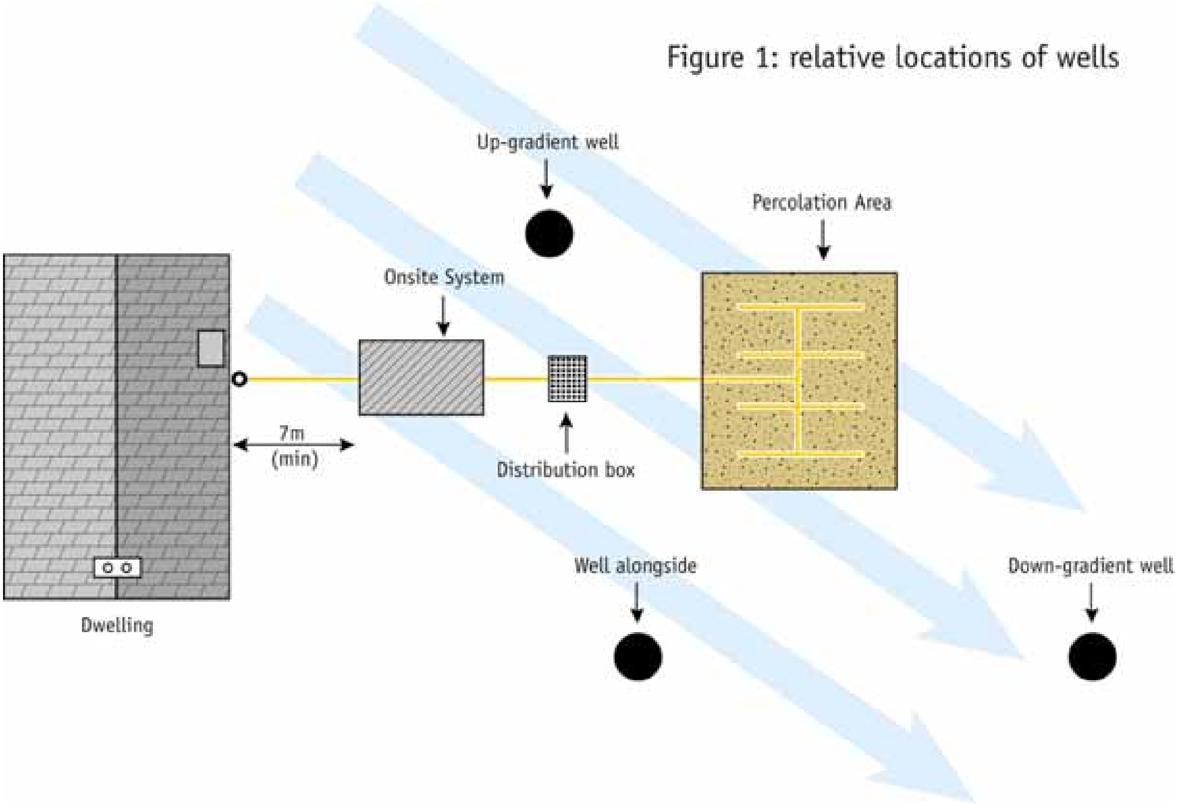
Table 3 Recommended Minimum Distance between a Receptor and a Percolation Area or Polishing Filter

T or P Value[1]	Type of soil/subsoil *	Depth of soil/subsoil (m) above bedrock (see note 1,2,3,6)	Minimum distance (m) from receptor to percolation area or polishing filter ****				
			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; silty, sandy CLAY (e.g. clayey till); CLAY/SILT.	1.2 >3.0	60	15	40 30	25	15
10 -30	Sandy SILT; clayey, silty SAND; clayey, silty GRAVEL (e.g. sandy till).	1.2 >8.0	60	15	45 30	25	15
<10	SAND; GRAVEL; silty SAND.	2.0** 2.0*** >8.0***	60	15	60 40 30	25	15

* BS5930 descriptions
** water table 1.2-2.0 m
*** water table >2.0 m
**** The distance from the percolation area or polishing filter means the distance from the periphery of the percolation area or polishing filter and not 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 silty, 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 that conventional systems, as described in EPA (2004), 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.



References

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

EPA, 2000. Wastewater Treatment Manuals: Treatment Systems for Single Houses, Environmental Protection Agency.

APPENDIX B: SITE CHARACTERISATION FORM

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, the Heritage Service or other relevant bodies.

1.0 GENERAL DETAILS (From planning application)

NAME & ADDRESS OF APPLICANT:					
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: (tick as appropriate)		**mains**	**private well/borehole**	**group well/borehole**	

2.0 DESK STUDY

SOIL TYPE	**Specify Type**		**AQUIFER CATEGORY**	**Regionally Important**	**Locally Important**	**Poor**
VULNERABILITY	**Extreme**	**High**	**Moderate**	**Low**	**High to Low**	**Unknown**
BEDROCK		**Name of Public/Group Scheme Water Supply within 1 km**				
Is there a GSI Groundwater Protection Scheme? (Y/N):		**Groundwater Protection Response:**		**Source Protection Area**	**SI**	**SO**
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 existing 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 (Distance to features should be noted in metres)	
HOUSES:	
SITE BOUNDARIES:	
ROADS:	
EXISTING LAND USE:	
OUTCROPS (BEDROCK AND/OR SUBSOIL):	
SURFACE WATER PONDING:	
LAKES:	
BEACHES/SHELLFISH AREAS/WETLANDS:	
KARST FEATURES:	
WATERCOURSE/STREAM*:	
DRAINAGE DITCHES*:	
WELLS*:	
SPRINGS*:	
VEGETATION INDICATORS:	
GROUND CONDITION:	

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

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

Depth of trial hole (m):		**Date and time of excavation:**		**Date and time of examination:**	
Depth from ground surface to bedrock (m) (if present):					
Depth from ground surface to water table (m) (if present):					

	Soil/Subsoil Texture & Classification*	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					

Other information							
Depth of water ingress:		**Rock type (if present):**		**Plasticity and dilatancy results:**	**3 samples to be tested for each horizon and results should be entered above for each horizon**	**Likely T value:**	

EVALUATION:

Note: Depth of percolation test holes should be indicated on Log above and recorded in this section

* See Appendix E for BS 5930 classification   ** All signs of mottling should be recorded

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

STEP 1 : TEST HOLE PREPARATION			
Percolation Test Hole	1	2	3
Depth from ground surface to top of hole (mm) (A)			
Depth from ground surface to base of hole (mm) (B)			
Depth of hole (mm) [B - A]			
Dimensions of hole [length x breadth (mm)]			
Each hole should be pre-soaked twice before the test is carried out. Each hole should be empty before refilling.			

STEP 2: PRE-SOAKING TEST HOLES			
Date and Time pre-soaking started			
If the water disappears in less than 10 minutes then proceed immediately to STEP 3.			

STEP3: MEASURING T_{100}			
Date of test			
Time filled to 400 mm			
Time water level at 350 mm			
Time water level at 300 mm			
Total time to drop 100 mm (T_{100})			
Average T_{100}			
If $T_{100} \leq 60$ minutes then go to STEP 4 If $T_{100} > 60$ minutes then go to STEP 5 If $T_{100} > 5$ hours then T-value > 90 ⇒ Site unsuitable for discharge to groundwater			

STEP 4 – Standard Method (where $T_{100} \leq 60$ minutes)									
Percolation Test Hole No.	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 T-Value									
AverageΔt/4 = [Hole No.1] __________(t_1)			Average Δt/4 = [Hole No.2] _________(t_2)				Average Δt/4 = [Hole No.3] ______(t_3)		

T value* = (t_1 + t_2+ t_2)/3 =_______(min/25 mm)
Result of Test : T =
COMMENTS:

STEP 5 – Modified Method (where $T_{100} > 60$ 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}
400 - 350	5.3				5.3				5.3			
350 - 300	6.9				6.9				6.9			
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 1= (t_2)				T- Value Hole 1= (t_3)			

T value* = (t_1 + t_2+ t_2)/3 =________(min/25 mm)
Result of Test : T =
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 base of hole (mm)			
Depth of hole (mm)			
Dimensions of hole [length x breadth (mm)]			
Each hole should be pre-soaked twice before the test is carried out. Each hole should be empty before refilling.			

STEP 2: Pre-Soaking Test Holes			
Date and Time pre-soaking started			
If the water disappears in less than 10 minutes then proceed immediately to STEP 3.			

STEP 3: MEASURING P_{100}			
Date of test			
Time filled to 400 mm			
Time water level at 350 mm			
Time water level at 300 mm			
Total time to drop 100 mm (P_{100})			
Average P_{100}			
If $P_{100} \leq 60$ minutes then go to STEP 4 If $P_{100} > 60$ minutes then go to STEP 5 If $P_{100} > 5$ hours then P-value > 90 $\Rightarrow$ Site unsuitable for discharge to groundwater			

STEP 4 – Standard Method (where $P_{100} \leq 60$ mins)									
Percolation Test Hole No.	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)	Δt (min)	Start Time (at 300 mm)	Finish Time (at 200 mm)	Δp (min)
1									
2									
3									
Average P-Value									
Average$\Delta p/4$ = [Hole No.1] __________(p_1)			Average $\Delta p/4$ = [Hole No.2] _________(p_2)				Average $\Delta p/4$ = [Hole No.3] ______(p_3)		

P value* = (p_1 + p_2+ p_2)/3 =________(min/25 mm)
Result of Test : P =
COMMENTS:

STEP 5 – Modified Method (where $P_{100} \leq 60$ mins)

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}
400 - 350	5.3				5.3				5.3			
350 - 300	6.9				6.9				6.9			
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)			

P value* = (p_1 + p_2+ p_2)/3 =_______(min/25 mm)
Result of Test : P =
COMMENTS:

Sketch of site showing measurement to Trial Hole location and Percolation Test Hole locations, wells and direction of groundwater flow (if known), proposed house (incl. distances from boundaries) adjacent houses, watercourses, significant sites and other relevant features. North point should always be included. [A copy of the site layout drawing should be used if available]

Submit Discovery Series 1:50,000 Map indicating overall drainage, groundwater flow direction and housing density in the area.

Note: 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).

Suitable for (delete as appropriate)****:

1. Conventional septic tank system (septic tank and percolation area)

2. Secondary Treatment System
    a. septic tank and intermittent filter system and polishing unit; or
    b. septic tank and constructed wetlands and polishing unit; or
    c. mechanical aeration system and polishing unit.

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

SUITABLE / **UNSUITABLE** (delete as appropriate) for discharge to **surface water**[39]

SUITABLE / **UNSUITABLE** (delete as appropriate) for discharge to **groundwater**

5.0 RECOMMENDATION:

Propose to install:____ _____

and discharge to surface water/groundwater (delete as appropriate)

Trench Invert level:______________ _____

Conditions (e.g. special works, site improvement works testing etc.……… ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

[39] 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

6.0 TREATMENT SYSTEM DESIGN DETAILS

<table>
<tr><td colspan="9">SYSTEM TYPE</td></tr>
<tr><td>Conventional Septic Tank System</td><td colspan="4">Secondary Treatment System</td><td colspan="4">Tertiary Treatment System</td></tr>
<tr><td>Tank Capacity (m^3)</td><td colspan="2">Filter Systems</td><td colspan="2">Mechanical Aeration Systems</td><td colspan="4">Polishing Filter</td></tr>
<tr><td></td><td>Media Type</td><td>Area (m^2)*</td><td>Type</td><td>Capacity (m^3)</td><td colspan="2">Area (m^2)*</td><td colspan="2"></td></tr>
<tr><td>Conventional Percolation Area (m^2)</td><td>Sand</td><td></td><td>Biofilm Aerated Filter</td><td></td><td colspan="4">Package Treatment System</td></tr>
<tr><td></td><td>Soil</td><td></td><td>Rotating Biological Contactor</td><td></td><td colspan="2">Capacity (m^3)</td><td colspan="2"></td></tr>
<tr><td>Mounded Percolation Area (m^2)</td><td>Constructed Wetland</td><td></td><td>Sequencing Batch Reactor</td><td></td><td colspan="4">Constructed Wetland</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Other</td><td rowspan="2"></td><td>Membrane Filtration</td><td></td><td colspan="2" rowspan="2">Area (m^2)*</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Other</td><td></td></tr>
<tr><td colspan="9">DISCHARGE ROUTE</td></tr>
<tr><td colspan="4">Surface Water</td><td colspan="5">Groundwater</td></tr>
<tr><td colspan="4">Discharge Rate (m^3/hr)</td><td colspan="5">Hydraulic Loading Rate ($l/m^2.d$)</td></tr>
<tr><td colspan="4"></td><td colspan="5"></td></tr>
<tr><td colspan="4">Treatment System Performance Standard (mg/l)</td><td>BOD</td><td>SS</td><td>NH_3</td><td>Total N</td><td>Total P</td></tr>
<tr><td colspan="4"></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="9">QUALITY ASSURANCE</td></tr>
<tr><td colspan="4">Installation
& Commissioning</td><td colspan="5">On-going
Maintenance</td></tr>
<tr><td colspan="4"></td><td colspan="5"></td></tr>
</table>

* The calculated percolation area or polishing filter area should be shown on site plan

7.0 SITE ASSESSOR DETAILS

Name:______________________________
Address:_______________________________

Qualifications/Experience:____________________ Date of Report:___________

Phone:_________________ Fax:_____________ e-mail_________________

Indemnity Insurance Number: ____________________

Signature:______________________________

APPENDIX C: PERCOLATION TESTS

INTRODUCTION

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 400mm 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 but less than 90.

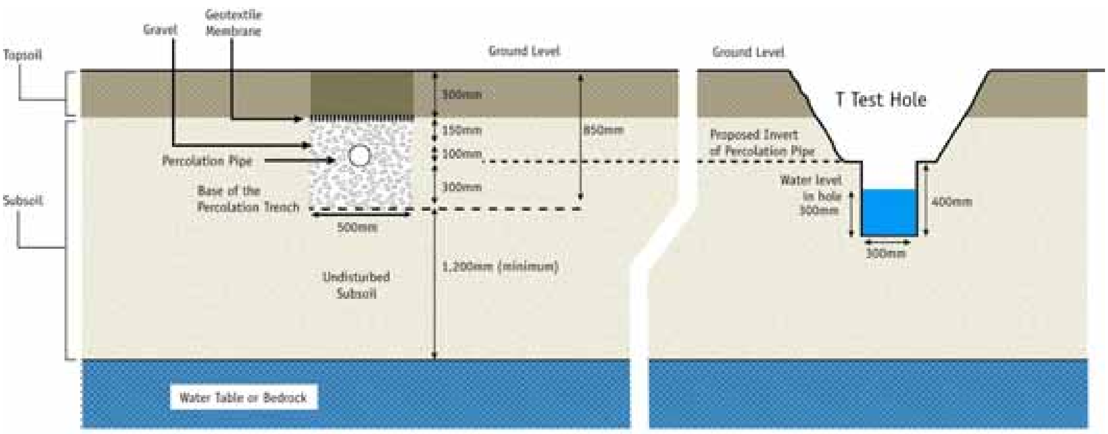
The standard percolation test method (Step 4) should be carried out on all sites where the subsoil characteristics indicate that the percolation result will be less than or equal to 50. In the case of a CLAY or SILT/CLAY subsoil then a modified percolation test should be carried out. This test is outlined 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 timeframe thus reducing the time spent on site.

Note: Any silt/clay 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 (T-TEST) PROCEDURE

Step 1: Three percolation test holes are dug adjacent to the proposed percolation area, but not in the proposed area. Each hole should be ***300mm x 300mm x 400mm deep*** below the proposed invert level of the percolation pipe (Figure 1). 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.

FIGURE 1



Step 2: Clear water should be carefully poured into the hole so as to fill it to the full height of ***400mm.*** The water should be allowed to percolate fully. Once the hole is empty, it should be once again filled to the full height of 400mm and allowed to percolate fully. If the water in the hole fully percolates in less than 10 minutes then pre-soak again before proceeding to Step 3.

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

Percolation Test Hole No.	1			2			3		
	Start Time at 400 mm	Finish Time at 300 mm	Δt (min)	Start Time at 400 mm	Finish Time at 300 mm	Δt (min)	Start Time at 400 mm	Finish Time at 300 mm	Δt (min)
1									

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

- *Scenario 1*- If the initial drop from 400mm to 300mm is less than 60 minutes then the test is continued using the Standard Method (Table 1) given in Step 4.
- *Scenario2*- If the initial drop from 400mm to 300mm is greater than 60 minutes then the test is continued using the Modified Method (Table 2) given in Step 5.
- *Scenario 3*- If initial drop from 400mm to 300mm is greater than 5 hours this means that the T-value will be greater than 90 and the site is not suitable for discharge to groundwater.

Step 4: Continue to let the level of water drop to 200mm, recording the times at 300mm and 200mm. The time to drop the 100mm is calculated (Δt). The hole is then refilled again to the 300mm level and the time for the water level to drop to 200mm is recorded and Δt is calculated (Table 1). The hole should then be refilled once more and the time is recorded for the water level to drop to 200mm and Δt is 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 four, 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 three to give overall T-value for the site.

TABLE 1 – STANDARD METHOD

STEP 4: Standard Method (where $T_{100} \leq 60$ minutes)									
Percolation Test Hole No.	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 T-Value									
AverageΔt/4 = [Hole No.1] __________(t_1)			Average Δt/4 = [Hole No.2] _________(t_2)				Average Δt/4 = [Hole No.3] ______(t_3)		

T value* = (t_1 + t_2+ t_2)/3 =________(min/25 mm)
Result of Test : T =
COMMENTS:

Step 5: Continue to let the level of water drop to 100mm, recording the time at 250mm, 200mm, 150mm and 100mm (T_m) (Table 2). The time for each drop is multiplied by a time factor (T_f), which will 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 4 values from 300 to 100. This is repeated for each percolation hole and the T-values for each hole are added together and divided by three to give the overall T-value for the site. This test method should only be used for sites that have subsoils with a CLAY or SILT/CLAY classification.

TABLE 2 – MODIFIED METHOD

STEP 5: Modified Method (where $T_{100} > 60$ 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)			

T value* = (t_1 + t_2+ t_2)/3 =_______(min/25 mm)
Result of Test : T =
COMMENTS:

TEST RESULTS

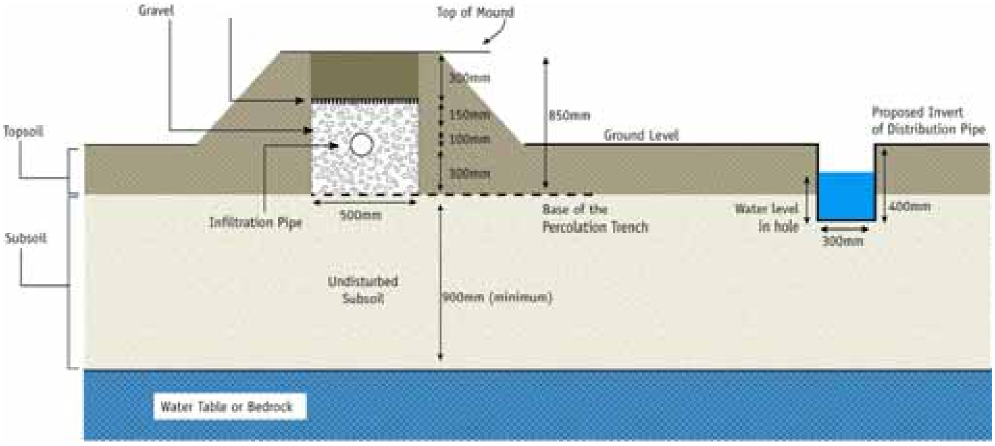
A proposed percolation area whose "T" value is less than 1 or greater than 50 should be deemed to have failed the test for suitability as a percolation area for a conventional septic tank system. However, if the T value is greater than 1 and less than or equal to 75, the soil may be used as a polishing filter. T values greater than 90 indicates that the site is unsuitable for discharge to groundwater irrespective of the P test result and therefore the only option available is to discharge to surface water in accordance with a Water Pollution Discharge licence.

PERCOLATION TEST (P Test) FOR SOIL POLISHING FILTERS

To establish the percolation value for soil polishing filters and to determine the discharge route for secondary treated effluent where shallow subsoils exist, a modification of the percolation test as described above is required.

Step 1: Three percolation test holes are dug adjacent to the proposed percolation area, but not in the proposed area. Each hole should be ***300mm x 300mm x 400mm deep*** below the ground surface (Figure 2). 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.

FIGURE 2



Step 2: Clear water should be carefully poured into the hole so as to fill it to the full height of ***400mm.*** The water should be allowed to percolate fully. Once the hole is empty, it should be once again filled to the full height of 400mm and allowed to percolate fully. If the water in the hole fully percolates in less than 10 minutes then pre-soak again before proceeding to Step 3.

Step 3: After the hole has been pre-soaked (Step 2), the hole is filled once again to the full height of 400mm. The time that the hole is filled is noted. The water should be allowed to drop to 300mm, with the time taken to reach 300mm being noted.

Percolation Test Hole No.	1			2			3		
	Start Time at 400 mm	Finish Time at 300 mm	Δt (min)	Start Time at 400 mm	Finish Time at 300 mm	Δt (min)	Start Time at 400 mm	Finish Time at 300 mm	Δt (min)
1									

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

- *Scenario 1*- If the initial drop from 400mm to 300mm is less than 60 minutes then the test is continued using the method given in Step 4.
- *Scenario 2*- If the initial drop from 400mm to 300mm is greater than 60 minutes then the test is continued using the method given in Step 5.

- *Scenario 3*- If initial drop from 400mm to 300mm is greater than 5 hours this means that the T-value will be greater than 90 and the site is not suitable for discharge to groundwater.

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

TABLE 3

STEP 4: Standard Method (where $P_{100} \leq$ 60 minutes)									
Percolation Test Hole No.	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)	Δt (min)	Start Time (at 300 mm)	Finish Time (at 200 mm)	Δp (min)
1									
2									
3									
Average P-Value									
AverageΔp/4 = [Hole No.1] __________(p_1)			Average Δp/4 = [Hole No.2] _________(p_2)				Average Δp/4 = [Hole No.3] ______(p_3)		
P value* = (p_1 + p_2+ p_2)/3 =________(min/25 mm) Result of Test : P = COMMENTS:									

Step 5: Continue to let the level of water drop to 100mm, recording the time at 250mm, 200mm, 150mm and 100mm (T_m) (Table 4). The time for each drop is multiplied by a time factor (T_f), which will give a modified hydraulic conductivity (K_{fs}). The equivalent percolation value ("P-value") is then calculated by dividing 4.45 by the K_{fs}. Take average of the 4 values from 300mm to 100mm. This is repeated for each percolation hole and the P-values for each hole are added together and divided by three to give the overall P-value for the site. This test method should only be used for sites that have subsoils with a CLAY or SILT/CLAY classification

TABLE 4

STEP 5 Modified Method (where $P_{100} > 60$ 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}
400 - 350	5.3				5.3				5.3			
350 - 300	6.9				6.9				6.9			
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 2= (p_2)				P- Value Hole 3= (p_3)			

P value* = $(p_1 + p_2 + p_2)/3$ =________(min/25 mm)
Result of Test : P =
COMMENTS:

TEST RESULTS

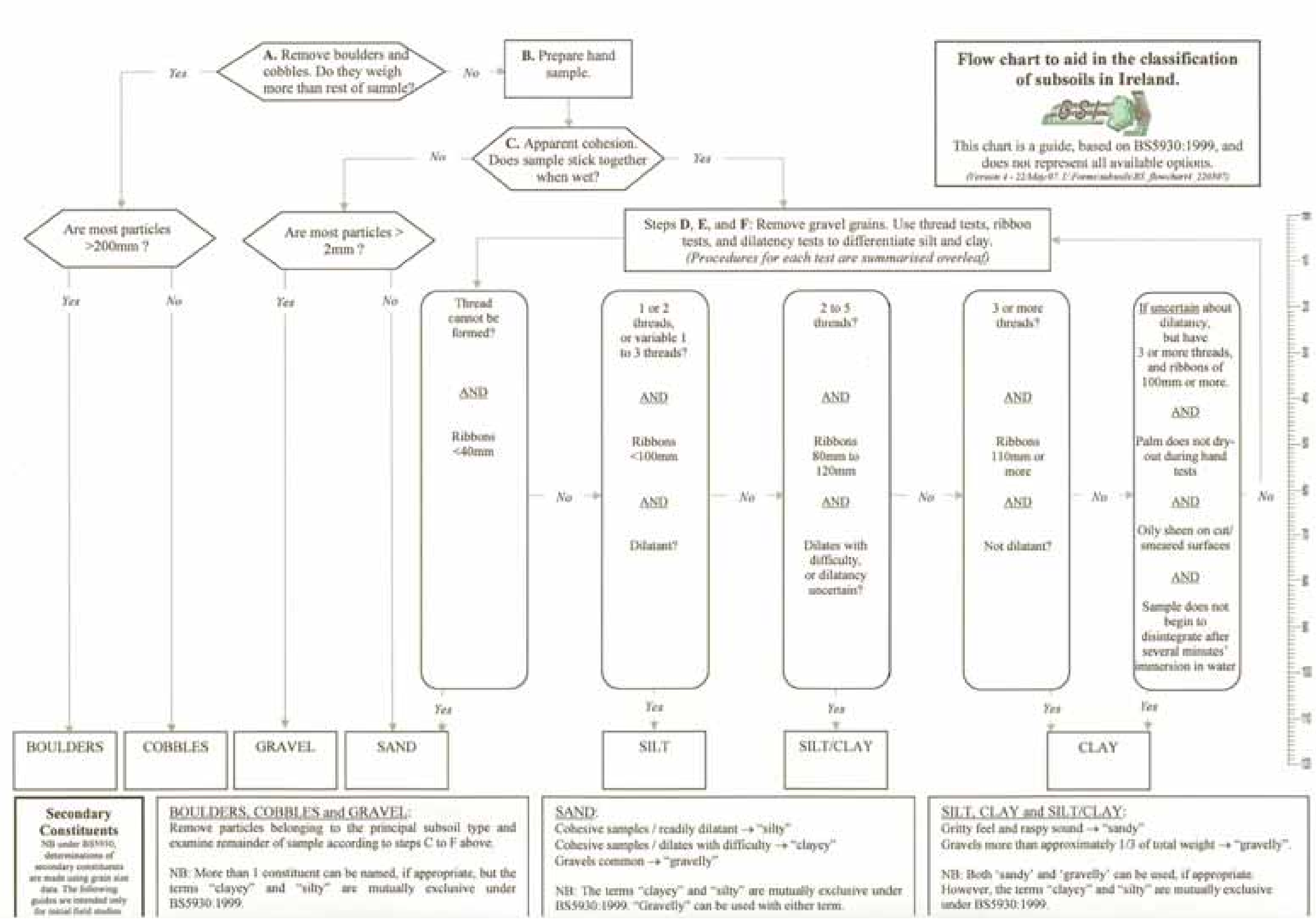
A proposed percolation area whose "P" value is less than 1 or greater than 50 should be deemed to have failed the test for suitability as a percolation area for a conventional septic tank system, or greater than 75 for a secondary treatment system. However, if the P value is greater than 1 and less than or equal to 75, the soil may be used as a polishing filter only in cases where the T value is less than 90.

APPENDIX D: EVALUATION OF Secondary Treatment SYSTEMS

Factor	Treatment Option No. 1	Treatment Option No. 2
Certification e.g. AGRÉMENT certification or other		
Construction, installation and commissioning service available		
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)		
Access requirements for sludge removal		
Design criteria*		
Capital cost		
Annual running cost /annum		
Cost of annual maintenance service		
Performance - % reduction in BOD, COD, TSS - % reduction Total P and Total N - % reduction faecal coliforms		
Minimum Standard BOD SS NH4		
Additional costs prior to commissioning (incld site improvements)		
Power requirements single phase/three phase Kw/d		

* in the case of biofilm systems the organic and hydraulic loading rates in $g/m^2.d$ and $l/m^2.d$ respectively should be quoted

APPENDIX E: SOIL/SUBSOIL CLASSIFICATION CHART



Particle Sizes as defined in BS5930:1999

Boulder	>200 m	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.

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 3mm 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.

B & 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?

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 0.5cm 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 3 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 5 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.

BS5930:1999 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 25mm
Soft	Finger pushed up to 10mm
Firm	Thumb makes impression easily
Stiff	Can be indented slightly by thumb
Very stiff	Can be indented by thumb nail
Hard	Can be scratched by thumb nail

BS5930: 1999 Criteria for describing discontinuities

TERM	*MEAN SPACING (MM)*
Very widely	>2000
Widely	2000-600
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

APPENDIX F: PLANTS INDICATIVE OF DRAINAGE CONDITIONS

The following illustrate plants, which indicate dry conditions throughout the year (good drainage); and indicate wet conditions through the year (poor drainage).

Some of the plates below 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.

DRY CONDITIONS

THISTLE

BRACKEN

RAGWORTH

WET CONDITIONS

ALDER

IRIS

RUSH

APPENDIX G: RESEARCH FINDINGS

In order to examine the current position relating to on-site systems (in Ireland and internationally) and to establish guidelines for their future use, so as to provide for sustainable development, a research study was carried out between 1995 and 1997 (as part of the Department of the Environment *Operational Programme for Environmental Services, 1994-1999).* This study was co-ordinated by the Department of Civil Engineering, The National University of Ireland, Galway under the direction of the Environmental Protection Agency (EPA) and was funded through the *Environmental Monitoring, Research and Development* Sub-programme of the Operational Programme.

Some of the findings of the research regarding single house treatment systems were:

- Conventional septic tank systems (septic tank and percolation area), properly installed and maintained, are satisfactory where suitable subsoil conditions exist;
- Where suitable subsoil conditions do not initially exist for treatment by means of a conventional septic tank system, site development works may improve the subsoil conditions and make the subsoil suitable in certain circumstances;
- In certain situations such as when unsuitable subsoil conditions exist, other systems, which include mechanical aeration or intermittent filters for secondary treatment and followed by a polishing filter can be used;
- All treatment systems including wastewater collection systems should be designed, constructed, commissioned and maintained in accordance with recognised standards; and
- All surface water and groundwater should be excluded from entering any treatment system.

In order to build on the findings of the earlier research and to address information gaps, which had been identified since the publication of the EPA Manual (2000), further research work was commissioned by the EPA in 2000. This work was carried out by the Department of Civil Structural & Environmental Engineering at Trinity College, Dublin under the Environmental Research, Technological Development and Innovation (ERTDI) Programme 2000-2006, which is financed by the Government under the National Development Plan (NDP). The main findings of this more recent research work are:

- Interpolated T test by NUI Galway gives a good approximation of T test results – this was examined at 2 sites.
- Subsoil thickness below the trench invert is of greatest importance for treatment and disposal of wastewater. Percolation pipes do not necessarily have to be at 0.8m below ground level but should be placed such that the groundwater is afforded adequate protection, i.e., minimum of 1.2m unsaturated subsoil for conventional septic tank systems and 0.9m for filter or mechanical aeration systems.
- Effective distribution of effluent to percolation area or polishing filter is of utmost importance for treatment within subsoil and filter media. Further research work is needed to improve knowledge of distribution boxes and how to ensure that they are installed correctly and work properly.

- Volumes of effluent generated per person at all four sites were found to be considerably less than 180 l/p/day (between 60 –110 l/p/day).
- 70 % reduction of organic, inorganic and bacteriological load was achieved at depth to 0.3m, however, there were significant differences between the septic tank system and the secondary treated effluent sites.
- On septic tank sites: 84% (ave) COD removal, 67% Total N removal and 88% ortho P removal by 0.3m depth
- On secondary treatment unit sites: 86% (ave) COD removal, 32% Total N removal and 22% ortho P removal by 0.3m depth
- Methods used assume isotropic and homogeneous properties of subsoil and therefore the effects of preferential flow need to be considered.
- NOTE: P removal dependent on subsoil properties and is not significantly affected by secondary treatment step.
- Most bacteria removed at 0.9m (99.99% removal of bacteria in most cases – results in 100/100ml) but isolated incidences of enteric bacteria at greater depth).
- Reduction in organic load in effluent from secondary treatment systems inhibited biomat formation and effluent distribution was confined to <10 m (~ 5m after one year) of trench length, resulting in load being concentrated over short distance and smaller area.
- At the four study sites, septic tank treatment systems performed at least as well as secondary treatment systems.
- Stratified sand filter systems perform well as secondary treatment systems but would not generally be recommended to be used as a polishing filter.
- In sand filters P removal is dependent on the mineralogy of the sand, but capacity for P removal is finite.
- For intermittent sand filters (i.e., in the treatment sequence after a septic tank) the loading should not exceed 30 l/m^2/day, based on bacterial breakthrough and ponding issues on sites with T values of 50 or less.
- For sand polishing filters the loading should not exceed 60 l/m^2/day, based on ortho P breakthrough.

Further work by Department of Civil Engineering, NUI Galway

- Interpolated method for T test where high values i.e., greater than 50 are expected.
- Modified sand filter specification.
- Polishing filters for secondary treatment systems are suitable where the T or P value is between 1 – 75, due to less extensive biomat development.

Ongoing research is being carried out by Trinity College Dublin in to the effectiveness of reed bed systems both as secondary treatment systems and as polishing filters. This research may for the basis for further supplementary guidance.

GLOSSARY

Activated sludge treatment:	Activated sludge is a process in sewage treatment in which air or oxygen is forced into sewage liquor to develop a biological floc, which reduces the organic content of the sewage.
Aquifer:	Any stratum or combination of strata that stores or transmits groundwater.
Bedrock:	A general term used for the rock, usually solid, that underlies soil or other unconsolidated material (subsoil).
Biochemical oxygen demand (BOD):	BOD is a measure of the rate at which micro-organisms use dissolved oxygen in the biochemical breakdown of organic matter in wastewaters under aerobic conditions. The BOD_5 test indicates the organic strength of a wastewater and is determined by measuring the dissolved oxygen concentration before and after the incubation of a sample at 20°C for five days in the dark. An inhibitor may be added to prevent nitrification from occurring.
Biofilm aerated filter (BAF):	A treatment system normally consisting of a primary settlement tank, an aerated biofilm and, possibly, a secondary settlement tank. The system is similar to the conventional percolating filter system except that the media are commonly submerged and forced air is applied.
Biofilm:	A thin layer of micro--organisms and organic polymers attached to a medium such as soil, sand, peat, and inert plastic material.
Biomat:	A biologically active layer that covers the bottom and sides of percolation trenches and penetrates a short distance into the percolation soil. It includes complex bacterial polysaccharides and accumulated organic substances as well as micro-organisms.
Chemical oxygen demand (COD):	COD is a measure of the amount of oxygen consumed from a chemical oxidising agent under controlled conditions. The COD is greater than the BOD as the chemical oxidising agent will often oxidise more compounds than micro-organisms.
Collection Chamber:	Chamber receiving treated wastewater from the collection layer and discharging through the pipe to an outfall or polishing filter/tertiary treatment system.
Collection Pipe:	Perforated pipe placed at the bottom of a trench, within the collection layer connected to the collection chamber.
Constructed wetlands (CW):	A wetland system supporting vegetation, which provides secondary treatment by physical and biological means to effluent from a primary treatment step. Constructed wetlands may also be used for tertiary treatment.
Conventional septic tank system:	A wastewater treatment system that includes a septic tank mainly for primary treatment, followed by a percolation system in the soil providing secondary and tertiary treatment.
C_u:	Uniformity co-efficient is a measure of the particle size range. Cu<5 – very uniform; Cu = 5 – medium uniform; Cu >5 – non-

uniform.

Distribution box/device: A chamber between the septic tank and the percolation area, arranged to distribute the tank wastewater, in approximately equal quantities, through all the percolation pipes leading from it.

Distribution layer: Layer of the system composed of granular fill material in which pre-treated effluent from the septic tank is discharged through infiltration pipes.

Distribution pipe: Non-perforated pipe used to connect the distribution box to a infiltration pipe.

Geotextile: Manmade fabric, which is permeable to liquid and air but prevents solid particles from passing through it and is resistant to decomposition.

Groundwater protection response: Control measures, conditions or precautions recommended as a response to the acceptability of an activity within a groundwater protection zone as set out in the DoEHLG/EPA/GSI document *Groundwater Protection Responses for On-site Systems for Single Houses*.

Groundwater protection scheme: A scheme comprising two main components: a land surface zoning map which encompasses the hydrogeological elements of risk and a groundwater protection response for different activities.

Mottling: The occurrence of reddish/brown spots or streaks in a matrix of dark grey soil; the reddish/brown spots or streaks are due to intermittent aeration and the grey colours may be due to anaerobic conditions.

Organic matter: Mainly composed of proteins, carbohydrates and fats. Most of the organic matter in domestic wastewater is biodegradable. A measure of the biodegradable organic matter can be obtained using the biochemical oxygen demand (BOD) test.

Orthophosphorus Orthophosphorus is soluble reactive phosphorus and is readily available for biological uptake.

Pathogenic organisms: Those potential disease-producing micro-organisms which can be found in domestic wastewaters. Organisms, such as *E. coli*, and *faecal streptococci*, with the same enteric origin as the pathogens are used to indicate whether pathogens may be present or not in the wastewater.

P.E. Population equivalent, it may also be referred to as P.T in the CEN standards.

Peat filter: A filter system consisting of peat used to treat wastewater from a primary settlement tank (usually a septic tank) by biological and physical means.

Perched water table: Unconfined groundwater separated from an underlying body of groundwater by an impervious or perching layer.

Percolating filter system: A wastewater treatment system consisting of primary settlement and biological treatment (effected by distributing the settled liquid onto a suitable inert medium to which a biofilm attaches) followed by secondary settlement.

Percolation pipe:	Perforated pipe through which the pre-treated effluent from the septic tank is discharged to the filtration trench or bed.
Percolation area:	A system consisting of trenches with pipes and gravel aggregates, installed for the purpose of receiving wastewater from a septic tank or other treatment device and transmitting it into soil for final treatment and disposal. This system is also called a soil infiltration system (EN12566), drain field, seepage field or bed, distribution field, subsurface disposal area, or the treatment and disposal field.
Pre-treated effluent:	Wastewater that has undergone at least primary treatment.
Preferential flow:	A generic term used to describe the process whereby water movement follows favoured routes through a porous medium bypassing other parts of the medium. Examples include, pores formed by soil fauna, plant root channels, weathering cracks, fissures and/or fractures.
Primary treatment:	Primary treatment reduces oils, grease, fats, sand, grit, and coarse (settleable) solids.
Raised Percolation Area	This is a term used to describe a conventional percolation where the percolation pipes are laid at a depth between 800mm below ground surface and the ground surface itself. The in-situ soil and subsoil is used to treat the effluent and material is brought in to provide protection for the pipework.
Reed bed:	Open filter system planted with macrophytes (reeds).
Rotating Biological Contactor (RBC):	A contactor consisting of inert media modules mounted in the form of a cylinder on a horizontal rotating shaft. Biological wastewater treatment is effected by biofilms that attach to the modules. The biological contactor is normally preceded by primary settlement and followed by secondary settlement.
Sand filter:	A filter system consisting of sand used to treat wastewater from a primary settlement tank (usually a septic tank) by biological and physical means.
Secondary Treatment:	Is designed to substantially reduce the biodegradable content of the sewage such as are derived from human waste, food waste, soaps and detergent through aerobic biological processes.
Sludge:	The soilds which settles in the bottom of the primary/secondary settlement tank.
Soil structure:	The combination or arrangement of individual soil particles into definable aggregates, or peds, which are characterised and classified on the basis of size, shape, and degree of distinctiveness.
Soil texture:	The relative proportion of various soil components, including sands, silts, and clays, that make up the soil layers at a site.
Soil (topsoil):	The upper layer of soil in which plants grow.
Subsoil:	The soil material beneath the topsoil and above bedrock.

Suspended solids (SS):	Includes all suspended matter, both organic and inorganic. Along with the BOD concentration, SS is commonly used to quantify the quality of a wastewater.
Tertiary treatment:	The final treatment stage to raise the effluent quality to the standard required before it is discharged to the receiving environment (sea, river, lake, ground, etc.).
Total nitrogen:	Mass concentration of the sum of Kjeldahl (organic and ammonium nitrogen), nitrate and nitrite nitrogen.
Total phosphorus:	Mass concentration of the sum of organic and inorganic phosphorus.
Trench:	Also referred to as a percolation trench, means a ditch into which a single percolation pipe is laid, underlain and surrounded by gravel. The top layer of gravel is covered by soil.
Unsaturated soil:	A soil in which some pores are not filled with water; these contain air.
Wastewater:	The discharge from sanitary appliances, e.g. toilets, bathroom fittings, kitchen sinks, washing machines, dishwashers, showers etc.
Water table:	The position of the surface of the groundwater in a trial hole or other test hole.

USER COMMENT FORM

NOTE: Completed comments to be forwarded to:

The Office of Environmental Enforcement, Environmental Protection Agency, McCumiskey House, Richview, Dublin 14

Document Title: Code of Practice: Wastewater Treatment Systems for Single Houses (PE <10)

COMMENT FORM

Code of Practice: Wastewater Treatment Systems for Single Houses (PE <10)

Comments From:
Name

No.	Section	Page	Para.	Comment	Your proposal for modification	Rationale / supporting data