Development of an Inspection Regime for On-Site Domestic Wastewater Treatment Systems.

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ABSTRACT

The overall purpose of this study was to develop a thorough inspection regime for onsite wastewater treatment systems, which is practical and could be implemented on all site conditions across the country. With approximately 450,000 onsite wastewater treatment systems in Ireland a risk based methodology is required for site selection. This type of approach will identify the areas with the highest potential risk to human health and the environment and these sites should be inspected first.

In order to gain the required knowledge to develop an inspection regime in-depth and extensive research was carried out. The following areas of pertinent interest were examined and reviewed, history of domestic wastewater treatment, relevant wastewater legislation and guidance documents and potential detrimental impacts. Analysis of a questionnaire from a prior study, which assessed the resources available and the types of inspections currently undertaken by Local Authorities was carried out. In addition to the analysis of the questionnaire results, interviews were carried out with several experts involved in the area of domestic wastewater treatment. The interview focussed on twelve key questions which were directed towards the expert's opinions on the vital aspects of developing an inspection regime.

The background research, combined with the questionnaire analysis and information from the interviews provided a solid foundation for the development of an inspection regime. Chapter 8 outlines the inspection regime which has been developed for this study. The inspection regime includes a desktop study, consultation with the homeowners, visual site inspection, non-invasive site tests, and inspection of the treatment systems. The general opinion from the interviews carried out, was that a standardised approach for the inspections was necessary. For this reason an inspection form was produced which provides a standard systematic approach for inspectors to follow. This form is displayed in Appendix 3.

The development of a risk based methodology for site selection was discussed and a procedure similar in approach to the Geological Survey of Irelands Groundwater Protection Schemes was proposed. The EPA is currently developing a risk based methodology, but it is not available to the general public yet. However, the EPA provided a copy of a paper outlining the key aspects of their methodology. The methodology will use risk maps which take account of the following parameters: housing density, areas with

inadequate soil conditions, risk of water pollution through surface and subsurface pathways.

Sites identified with having the highest potential risk to human health and the environment shall be inspected first.

Based on the research carried out a number of recommendations were made which are outlined in Chapter 10.

The principle conclusion was that, if these systems fail to operate satisfactorily, home owners need to understand that these systems dispose of the effluent to the 'ground' and the effluent becomes part of the hydrological cycle; therefore, they are a potential hazard to the environment and human health. It is the owners, their families and their neighbours who will be at most immediate risk.

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ABBREVIATIONS

Agency	Environmental Protection Agency
BAF	Biological Aerated Filters
BOD_5	Biochemical Oxygen Demand (5day)
BS	British Standard
C	Capacity
°C	Degrees Celsius
CEN	European Committee for Standardisation
COD	Chemical Oxygen Demand
CoP	Code of Practice
EPA	Environmental Protection Agency
ECJ	European Court of Justice
g	Gram
GIS	Geographic Information System
GSI	Geological Survey of Ireland
GWPR	Groundwater Protection Response
GWPS	Groundwater Protection Scheme
H	Hour
kg	Kilogram
I.S.	Irish Standard
l	Litre
m	Meter
m^3	Cubic metres
mg	Milligram
mm	Millimetre
m/s	Metres per second
MRP	Molybdate Reactive Phosphate
NSAI	National Standards Authority of Ireland
OSWWTS	On-site wastewater treatment system
p.e.	Population equivalent

RBC	Rotating Biological Contactors
s	Second
SBR	Sequencing Batch Reactor
SS	Suspended Solids
TGD	Technical Guidance Document
WFD	Water Framework Directive
WT	Water Table

DEFINITIONS

BOD	BOD is a measure of the rate at which micro-organisms use dissolved oxygen in the biochemical breakdown of organic matter in wastewater under aerobic conditions. The 5 day BOD test determines the organic strength of a wastewater and is established by measuring the dissolved oxygen concentration before, and after, the 5 day incubation period in the dark at 20°C. An inhibitor may be introduced to prevent nitrification from occurring.
Biofilm	A thin layer of micro-organisms and organic polymers joined to a medium such as soil, peat, sand and inert plastic material.
Biological Aerated Filter (BAF)	A treatment system usually consisting of a primary settlement chamber, an aerated biofilm and, in some cases, a secondary settlement chamber. This treatment system is similar to the percolating filter treatment system except that the media are commonly submerged (termed SAF) and forced air is applied.
Biomat	A biologically active layer that covers the bottom and sides of percolation trenches and penetrates a short distance into the percolation soil. It includes complex bacterial polysaccharides and accumulated organic substances as well as micro-organisms.
COD	COD is a measure of the amount of oxygen used 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.
Distribution Box	A tank device between the septic tank and the percolation area, set up to distribute the treated wastewater in approximately equal quantities through all the percolation pipes leading from it.
Extended Aeration	An activated sludge process where a long aeration period enables a decrease of organic material in the sludge.
Groundwater Protection Scheme	A scheme containing two main constituents: a land surface zoning map which includes the hydrogeological elements of risk and a groundwater protection response for different activities.
Infiltration System	Consists of percolation areas and polishing filters that releases partially treated and treated effluent into the ground.
Organic matter	Chiefly composed of proteins, carbohydrates and fats. Most of the organic matter in domestic wastewater is biodegradable. A measure of the biodegradable organic matter can be obtained using the BOD test.
Pathogenic organisms	The possible disease-producing micro-organisms which can originate in domestic wastewaters. Organisms, such as *Escherichia coli*, and faecal *streptococci*, which have the same enteric source as the pathogens are used to specify whether or not pathogens may be existing in the wastewater.

Peat filter	A wastewater filtering system consisting of peat media used to treat wastewater from a primary settlement tank (usually a septic tank) by biological and physical means.
Percolation area	A system comprising of trenches with pipes and gravel aggregates, installed for the purpose of acquiring wastewater from a septic tank or other treatment system and delivering it into soil for final treatment and disposal. This system is also called a soil infiltration system (EN 12566).
Polishing filter	A polishing filter is a kind of infiltration system and can decrease micro-organisms and phosphorus (depending on soil type) in otherwise good quality wastewater effluents.
Population equivalent (p.e.)	Population equivalent, conversion value which aims at evaluating non-domestic pollution in reference to domestic pollution fixed by EEC directive (Council Directive 91/271/EEC concerning Urban Waste Water Treatment) at 60 g/day related to BOD_5
Primary treatment	The primary treatment period of treatment removes material that will either float or readily settle out by gravity. It includes the physical method of screening, comminution, grit removal and sedimentation.
Secondary treatment	The secondary treatment stage of treatment by biological processes, such as activated sludge or other (even non-biological) processes giving equivalent results.
Septic tank system	A septic tank is a wastewater treatment system for primary treatment, followed by a percolation system in the soil providing secondary and tertiary treatment.
Sludge	The solids that settle to the bottom of the primary and secondary settlement tank.
Suspended Solids (SS)	SS is commonly used to measure the quality of a wastewater, SS includes all suspended matter, both organic and inorganic.
Tertiary treatment	Tertiary treatment (advanced treatment) is a supplementary treatment process which results in more extensive purification than that obtained by applying primary and secondary treatment.
Wastewater	The discharge from sanitary appliances, e.g. bathroom toilets, showers, kitchen sinks, washing machines, dishwashers, fittings, etc.

1.0 Introduction

1.1 General

An on-site wastewater treatment system is the principal method used for the treatment and disposal of domestic sewage wastewater from houses in rural areas and suburban areas which are not provided with public sewer connections.

On-site wastewater treatment accounts for over thirty per cent of households in Ireland and in most cases the system of choice has been the Septic Tank System. There are in excess of 450,000 on-site wastewater treatment systems installed in Ireland serving a population of approximately 1.5 million. These systems are discharging approximately 100 million cubic meters of wastewater to the soil annually.

In a lot of cases a lack of understanding of the treatment and disposal processes has resulted in poor design, siting and installation, all of which leading to health and environmental concerns, including:

- Surface ponding;
- Surface water pollution;
- Groundwater contamination;
- Odour Nuisance. (Moore & Daly 2010)

The Environmental Research Unit published a survey in 1990 stating that in thirty nine per cent of cases of one-off dwellings there was non-conformity with effluent treatment and disposal conditions attached to the Planning Permissions and in fourteen per cent of the cases, the non-conformity was classified as significant with a general absence of percolation areas, (Environmental Research Unit, 1990).

Certain areas in Ireland have been have been identified where more than fifty per cent of wells have been contaminated either chemically or biologically or both at some stage. On-site wastewater treatment systems are a commonly reported source of contamination.

The issue can arise where effluent is unable to soak into the ground resulting in ponding at the surface of the ground which eventually makes its way into ditches and small streams giving rise to public health and nuisance problems.

It is clear that proper site assessment, design, location, installation and maintenance are all important elements, which must be considered for satisfactory performance of on-site wastewater treatment systems. (Moore & Daly, 2010)

In October 2009 the European Court of Justice (ECJ) ruled that Ireland had not put legislation in place to meet the requirements set in the EU Waste Framework Directive and in particular Article 4 and 8.

Article 4: requires that *"waste is recovered or disposed of without endangering human health and without using processes or methods which could harm the environment and in particular:*

- *Without risk to water, air, soil, and plants and animals;*
- *Without causing a nuisance through noise or odours;*
- *Without adversely affecting the countryside or places of special interest"*

Article 8: In order to comply with the measures in accordance with Article 4 *any installation or undertaking treating, storing or tipping waste on behalf of third parties must obtain a permit from the relevant competent authority referred to in Article 5, concerned in particular with the type and quantity of waste to be treated,*

- *General technical requirements;*
- *Precautions to be taken;*
- *The information to be made available at the request of the competent authority concerning the origin, destination and treatment of waste and the type and quantity of such waste.* (Council Directive 75/442/EEC, 1975)

If Ireland were not to put legislation in place to address the non compliances they would be subjected to financial penalties in the order of €2.7 million lump sum and daily penalties of €26,173 (Keegan, 2012).

Since then the Irish Government has published the Water Services (Amendment) Act 2012. This Act sets the legal framework for the development of a national inspection plan for onsite wastewater treatment systems (OSWWTS). The Act outlines the duties of homeowners, appointment of inspectors and the power of inspectors. The Act states that the Environmental Protection Agency (EPA) is responsible for the development of an inspection regime and training course for inspectors. The EPA is currently developing these and inspections are expected to commence in 2013.

1.2 Aims & Objectives

The overall aims of this project are to:

- Develop an inspection regime for OSWWTS which is practical, thorough and can be used for inspections in any site conditions.
- Examine how a risk based site selection methodology should be developed to assist with the implementation of a national inspection plan.

1.2.1 Objectives

The objectives to achieve the stated aims are as follows:

- Compile an extensive literature review, by reviewing the relevant wastewater documents and legislation outlining the importance of correctly sited, installed operated and maintained OSWWTS.
- To outline the reasons why Ireland have to develop and implement a national inspection plan for OSWWTS.
- Review the progress to date regarding the proposed national inspection plan which is scheduled to commence in 2013.
- Analyse the results from a questionnaire sent to Local Authorities assessing the resources available and the level of inspections currently being undertaken by Local Authorities.
- Ascertain fundamental criteria that must be considered when developing an inspection regime by carrying out interviews with experts currently working and carrying out research in the domestic wastewater sector.
- To combine the information from the background research, questionnaire and interviews to aid with the development of an inspection regime.
- Develop an inspection form which will provide a standardised, systematic approach for inspections to be carried out.

1.3 Procedure to achieve objectives

In order to achieve the aims and objectives outlined, extensive background research had to be undertaken, first to establish what information already existed and where to access this information. The main sources of information came from the college library, internet, other institutions and organisations with information and interviews carried out with experts involved in the area of domestic wastewater treatment.

1.3.1 Library

The college library contains a considerable collection of environmental data with various reference locations. By investigation of the information available in the library, extracts were referenced to assist in the compilation of the project e.g. previous theses, British Standards methods etc.

1.3.2 Institutions and Organisations

Some of the most useful sources of information with regard to this project were institutions and organisations such as Geological Survey of Ireland, Environmental Protection Agency, FÁS, Irish Agrément Board who are continuously involved in real projects and research. These institutions were able to provide up to date documentation related to the study.

1.3.3 Questionnaire & Interviews

The results of a questionnaire carried out for a dissertation titled "An examination of how existing Onsite Wastewater Treatment Systems are assessed by Local Authorities in Ireland" (O'Brien, 2012) were analysed in order to develop an understanding of the process which is in place for inspections and try and determine areas which could be improved. A copy of the questionnaire can be seen in Appendix 1.

Interviews were carried out with several experts who are both working and carrying out research in the area of domestic wastewater treatment. A copy of the questions asked during the interviews can be found in Appendix 2. The interview consisted of twelve questions which were directed towards the expert's personal opinion on the key aspects for the development of an inspection regime.

2.0 History of Domestic Wastewater Treatment

2.1 Introduction

The use of septic tanks as a method of domestic wastewater treatment can be traced back to France in the middle of the 19^{th} century where John Louis Mouras and Abbe Moigno made the discovery that a 'box' located between a house and its cesspool trapped excrement, reduced the quantity of solids and produced a clarified liquid that more quickly entered the soil (Payne & Butler, 1995).

In the late 1800's, some developments were made for wastewater treatment and the septic tank made its first appearance in America in 1883 where civil engineer Edward Philbrick introduced a two-chamber tank with an automatic siphon used for intermittent effluent disposal in Boston.

In 1895 Englishman Donald Cameron introduced to England the type of septic tank, which is still in use today and are "of a form instantly recognisable by those early sanitary engineers" (Payne and Butler, 1995).

During the early years of the twentieth century, on-site wastewater management was a trial and error process and since septic tanks were usually installed in sparsely populated rural areas, septic tanks received little attention or maintenance. Over the past 50 years, there has been little alteration to septic tanks apart from minor changes in design and operation. (Moore & Daly, 2010)

2.2 Septic Tanks

A septic tank is, in effect, a chamber where the suspended solids in wastewater settle out of suspension to form a sludge which then undergoes anaerobic breakdown. This process does not provide full treatment and cannot produce an effluent of a standard allowed by the Code of Practice; the septic tank effluent is a highly polluting liquid containing faecal bacteria and elevated levels of nitrogen, phosphorous, organic matter and other constituents (Daly, 1993). Therefore, septic tank treatment needs to be followed by a percolating filter or by the provision of a percolation area in which the effluent from the septic tank percolates into the soil through a network of pipes (Gray, 2004).

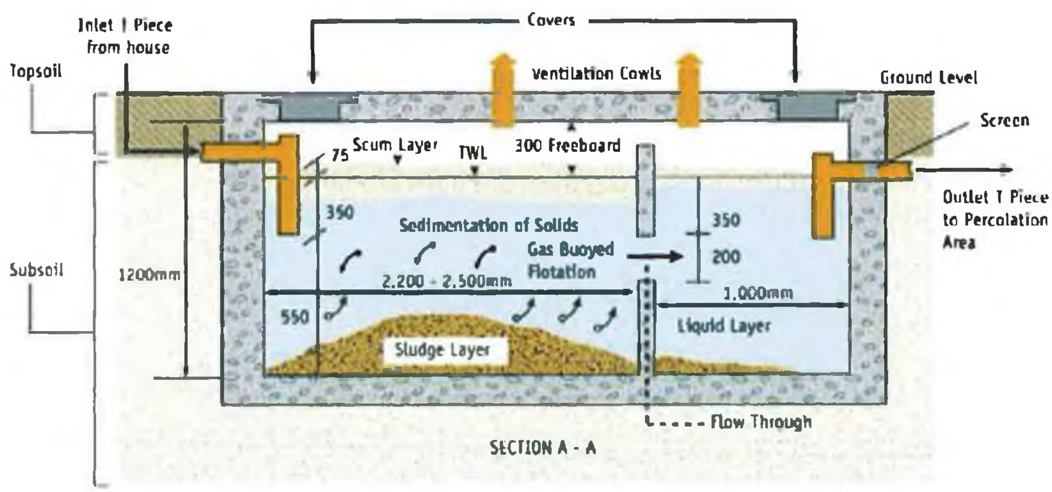

Figure 2.1: Septic Tank (EPA, 2009)

Baffle walls or partition walls are used to prevent the settled and floating solids from entering the percolation area where treatment and disposal takes place. A well constructed septic tank that is being maintained properly and working well can eliminate up to 50% of the solids and between 15-30% of the pollutant load in terms of biochemical oxygen demand (Patterson *et al*, 1971 and Goldstein & Wenk, 1972).

Septic tanks consist of three different layers: a scum layer at the top of the clarified liquid and a sludge layer in the bottom of the tank. T-Shaped pipes are used for the wastewater entering and leaving the tank, this is to prevent the disturbance of the scum layer or solids been carried out of the tank.

The solids that settle to the bottom of the tank need to be desludged on a regular basis and the EPA Code of Practice for Wastewater Treatment and Disposal systems serving Single houses recommends desludging of the septic tank is carried out at least once in every 12 month period. The tank must have a large enough capacity to store the solids and allow additional solids to settle. Anaerobic bacteria can help to digest some of the solids but various gases can be produced during this process. These gases are dangerous and volatile and are capable of damaging the tank structure and pipework.

For conventional septic tanks the percolation area is the most important section as this is where the majority of the treatment occurs. It is often mistakenly thought that the septic tank treats the sewage and the subsoil disposes of the treated effluent.

In Ireland a large number of conventional septic tank systems do not function properly. The main reasons for malfunctioning septic tanks are as follows: poor construction and installation of the tank and/or poor construction of the percolation area; or percolation areas in low permeability soils where the effluent can not filter through the subsoil and ponding occurs. Poor maintenance and lack of desludging of the septic tank on a yearly basis can lead to a lower standard of treatment. However, in the absence of a connection to a mains sewer system, a conventional septic tank which is well constructed and well maintained is one of the most cost effective ways of treating wastewater (Moore & Daly, 2010).

2.2.1 Percolation Area

The percolation area is the most important component of a septic tank system as it provides the majority of the treatment of the septic tank effluent. The primary function of the septic tank, which is installed upstream of the percolation area, is to pre-treat the wastewater and avoid the carry-over of solids which could clog the treatment and percolation area.

The main purpose of the percolation area is to make sure that the effluent from the septic tank is absorbed by the subsoil and does not pond on the ground surface or flow directly into any stream, rivers, lakes etc or make its way into groundwater.

Effluent from septic tanks contains many pathogenic organisms and the subsoil in the percolation area can provide a barrier from direct human contact. If a percolation area fails, ponding can occur on the ground surface and can constitute a risk to public health.

Most of the treatment takes place in the subsoil and the effluent must remain in the subsoil for a sufficient length of time for the pollutants to be removed fully. As the effluent passes through the subsoil it undergoes surface filtration, physio-chemical interactions and microbial breakdown. This treatment removes harmful bacteria and disease causing components. After this treatment the wastewater is now ready for discharge to the percolation area.

The percolation area provides aerobic treatment, which is the most complete treatment that the effluent can undergo in the subsoil. However, this will only take place where the subsoil is dry or damp but not completely saturated. Such unsaturated conditions are aerobic because air and oxygen can enter and help to remove pollutants from the effluent (Moore & Daly, 2010).

Research which has been carried out has determined that in excess of 90% removal efficiencies can be accomplished for organic constituents such as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), suspended solids, viruses and microorganisms by filtration, sorption and biodegradation methods (USEPA, 1980; Jenssen and Siegrist, 1990; Van Cuyk *et al.*, 2001).

It is of key importance that the effluent from the septic tank is applied to the subsoil in a suitable manner. The effluent should be distributed to the subsoil by a system of field trenches which should be long, narrow and level to ensure the effluent is distributed evenly (Moore & Daly, 2010). Figure 2.2 below illustrates a typical septic tank and percolation area layout.

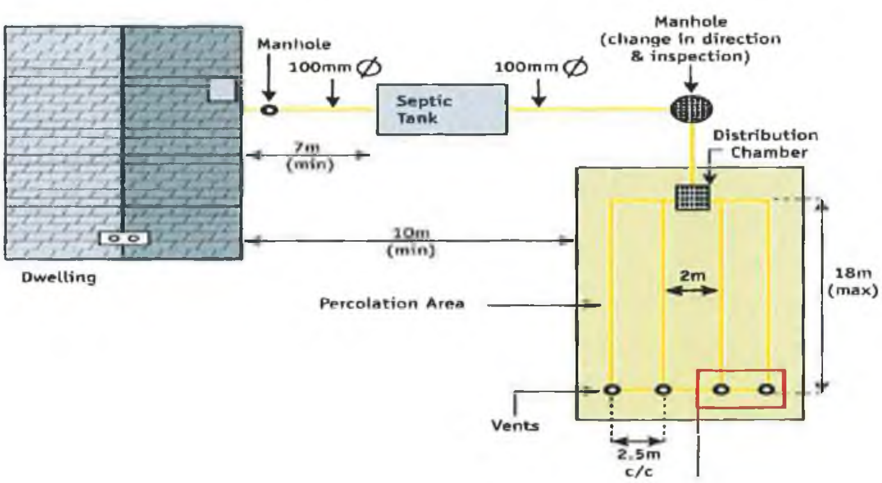

Figure 2.2: Layout of Septic Tank system (EPA, 2009)

2.2.2 Soakaways

At this point it is important to make the distinction between percolation areas and soakaways. Soakaways are in essence deep holes in the ground into which the effluent from the septic tank flows for disposal. Since the effluent is discharged over a small area there is a high risk of clogging, ponding, or the treatment capacity of the soil being exceeded which could result in the contamination of groundwater. Due to the nature of a soakaways construction (i.e. excavation) the depth of the treatment medium (i.e. subsoil) is being reduced between the source and target/groundwater. Soakaways are not, therefore, "a satisfactory alternative to percolation areas" (NSAI, 1991) and should not be used.

2.3 Secondary Treatment Processes

Certain sites are not suitable for septic tank systems due to low permeability soils which lead to inadequate treatment taking place in the percolation area. In cases like this a filter such as an intermittent sand filter or peat filter can be constructed downstream of the septic tank. The effluent from the septic tank would pass through one of these filters and on to a polishing filter before disposal. A more common solution is the installation of a packaged wastewater treatment system which should provide a good quality effluent for disposal. These systems normally consist of a primary settlement tank and aeration tank followed by a secondary clarification tank. The aeration tank contains the aerobic micro-organisms either in suspension or attached to a biomedia which is responsible for the digestion of the organic matter.

The type of treatment system adopted is dependent on a number of criteria, including siting, design, operational and management issues that need to be addressed in order to obtain adequate treatment performance. Although some regulatory control is evident, siting and design factors have been major causes of poor system performance.

Historically, the operational and maintenance procedures are often neglected leading to poor system performance and subsequent failure. In view of the need to safeguard public health, protect the environment and ensure compliance with relevant legislation particularly the Building Regulations from 1991 to date, which require improvements in the location and control of on-site wastewater treatment systems and also compliance with the EPA Code of Practice "Wastewater Treatment and Disposal Systems Serving Single Houses (p.e.$\leq$10)"

Wastewater effluents from dwellings contain many harmful substances that are potentially detrimental to human health and the environment. Pathogenic bacteria, infectious viruses, protozoa, organic matter, ammoniacal compounds and a variety of toxic chemicals are all found in significant amounts in wastewater (Tipperary CoCo, 1998).

2.3.1 Secondary Treatment: Packaged Wastewater Systems

> "*Packaged wastewater systems use media and mechanical parts to enhance the treatment of domestic wastewater. As with filter systems, they require polishing filters to allow for further treatment of the wastewater and to convey the treated wastewater to groundwater. These systems should be certified to specific performance criteria and may be suitable in areas where a septic tank is not acceptable. The code of practice provides general guidance on the location, design, installation and maintenance of these systems*" (EPA, 2009).

Secondary or proprietary treatment system may have a valuable application for smaller sites, sites with low permeability subsoils and where the watertable is high. However, these systems should not be seen as an instant solution for all problem sites. It is essential that proper site evaluation is carried out for all such cases, that the systems proposed are designed to the relevant standards and that the necessary operational and maintenance procedures are put in place (Moore & Daly, 2010).

A treatment system should meet the requirements of I.S. EN 12566-3:2005 *Small Wastewater treatment systems for up to 50 PT,* as per the guidance provided in the Code of Practice published by the EPA in 2009 or a system may have been issued building product certification from the Irish Agrément Board. Such certification meets the requirement outlined in the Building Regulations (EPA, 2009).

There are a number of proprietary treatment systems available on the market and include the following generic treatment processes.

- Biological/Submerged aerated filter (BAF/SAF) systems;

- Rotating biological contactor (RBC) systems;
- Sequencing Batch Reactor (SBR) systems;
- Peat filter media system;
- Plastic, textile and other media systems;
- Membrane bioreactor (MBR) systems.

2.3.2 Biological Aerated Filter (BAF)

A BAF system may consist of a primary settlement tank, an aerated submerged biofilm filter and a secondary settlement tank. To assist desludging, and to avoid sludge rising due to de-nitrification, solids are transferred from the secondary settlement tank to the primary settlement tank.

Micro-organisms attach themselves to the media in the secondary treatment stage. The media has a large specific surface area (m^2/m^3) and consists of either granular or plastic materials; in the case of granular materials back washing may be necessary to prevent clogging (EPA, 2009).

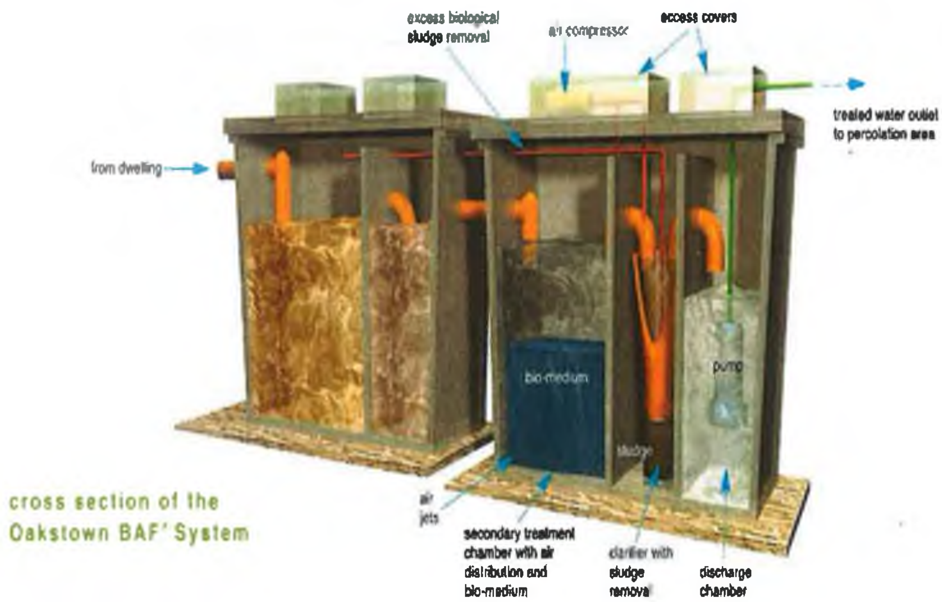

Figure 2.3: BAF Sewage Treatment System (O'Reilly Oakstown, 2010).

2.3.3 Rotating Biological Contactor (RBC)

An RBC system comprises of a primary settlement tank, a secondary treatment chamber and secondary settlement tank. In the RBC system micro-organisms attach themselves to an inert media surface (the disc) which is attached to a shaft that is rotated by an electric motor. These media are partly submerged in the wastewater. Over time a biofilm develops on the media which in turn treats the wastewater. The settled sludge from the treatment chamber is often pumped back to the primary settlement chamber for storage.(EPA, 2009)

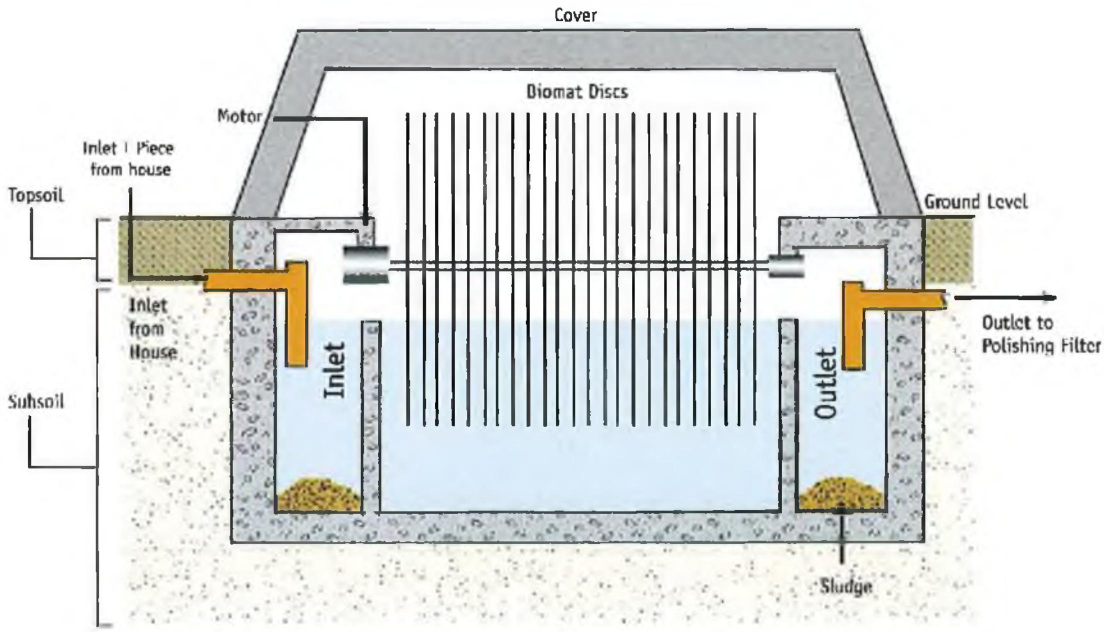

Figure 2.4: Rotating Biological Contactor **(EPA, 2009)**

2.3.4 Sequencing Batch Reactor (SBR)

The SBR process makes use of a fill and draw reactor with complete mixing during the batch reacting step (after filling) and where the following steps of aeration and clarification occur in the same tank. All SBR systems have five similar steps in common carried out in the following order; (1) fill, (2) react (aeration), (3) settle (sedimentation/clarification) (4) draw (decant), and (5) idle.(Metcalf and Eddy, 2003). Wastewater enters the reactor during the fill stage and is aerobically treated during the react stage, the biomass settles during the settle stage and the supernatant is decanted during the draw stage, during the idle stage sludge is withdrawn from the reactor and the cycle commences again with a new fill stage. (EPA, 2009)

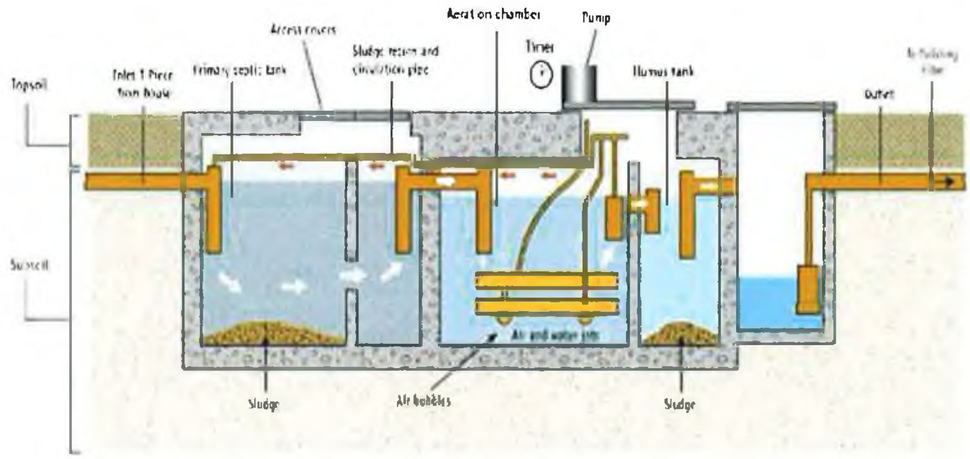

Figure 2.5: Schematic of a Sequencing Batch Reactor (SBR) system (EPA, 2009)

2.3.5 Peat Media Filter System

According to *"Wastewater treatment manuals-treatment systems for single houses 2000"* fibrous peat filters are used as intermittent open filters to treat septic tank wastewater. Modules are filled with compressed peat fibres. The compressed peat has a thickness of about 0.7m and a dry density of about 200kg/m^3. Commercial peat filters are sized at 1m^2/person. Hydraulic loading rates vary depending on the type of peat being used.

The effluent from the septic tank enters into a pump sump and from here it is pumped and evenly distributed over the surface of the biofibrous media. The effluent then percolates down through the media and emerges as a treated liquid at the base of the unit. This treatment is achieved by a combination of treatment processes i.e. physical, chemical and biological interactions between the pollutants and peat media (Irish Agrément Board, 1995).

Figure AC: Peat filter systems **(Bord na Móna, 2011).**

2.4 Tertiary Treatment Systems

The term tertiary treatment system includes packaged tertiary treatment systems and polishing filters. Tertiary treatment systems offer supplementary treatment to wastewater from secondary treatment systems. Polishing filters can lower the number of micro-organisms present in the treated wastewaters coming from secondary treatment systems while other packaged tertiary treatment systems can offer a further reduction in micro-organisms and nutrients. The treatment standards to be achieved by tertiary systems are dependent on the sensitivity of the receiving waters. As with all wastewater treatment systems they need to be sited, installed and maintained in accordance with the guidance of the CoP 2009 and with any manufacturer's specifications. (EPA, 2009)

3.0 Potential Detrimental Impacts

3.1 Introduction

The principal reasons why domestic effluent should be disposed of in an appropriate manner are health and environmental concerns. In the past, society has learned how such effluent can spread disease, pollute water resources and cause nuisance.

Effluents from domestic on-site wastewater treatment systems contain many substances that are unwelcome and potentially harmful to human health and to the environment. The following infectious agents can all be found in significant amounts in domestic wastewater, pathogenic bacteria, infectious viruses, protozoa, putrescible organic matter and toxic chemicals. Apart from the directly harmful substances, wastewater is also a source of nutrients which can lead to eutrophication in receiving waters. Domestic effluent is comprised of at least 99% water and this water must be returned to the water cycle. For this reason the water contamination aspect alone can be noted as a considerable health and environmental risk. Other risks can arise from direct human contact and from pests and vermin (Moore & Daly, 2010).

Table 3.1 below outlines the main potentially infectious agents present in domestic wastewater.

Organism	Disease	Remarks/Symptoms
Bacteria:		
Campylobacter	Gastroenteritis	Diarrhoea
Escherichia coli	Gastroenteritis	Diarrhoea
Legioella pneumpophila	Legionnaires Disease	Malaise, myalgia, fever, headache.
Leptospira (spp)	Leptospirosis	Jaundice, fever (Weil's disease)
Salmonella	Salmonellosis	Food poisoning
Salmonella typhi	Typhoid Fever	High fever, Diarrhoea, ulceration of small intestine
Shigella	Shigellosis	Bacillary dysentery
Vibrio cholerae	Cholera	Extremely heavy Diarrhoea. Dehydration
Yersinia enterocolitica	Yersiniosis	Diarrhoea
Protozoa:		
Balantidium coli		Diarrhoea, dysentery
Cryptosporidium parvum		Diarrhoea
Cyclospora cayetanensis		Severe Diarrhoea, nausea and vomiting for extended periods
Entamoeba histolytica		Prolonged Diarrh0ea with bleeding, abscesses of the liver and small intestine
Giardia Lamblia		Mild to severe Diarrhoea, nausea, indegestion
Helminths:		
Ascaris lumbricoides	Ascariasis	Roundworm Infestation
Enterobious vermicularis	Enterobiasis	Pinworm
Fasciola hepatica	Fascioliasis	Sheep liver fluke
Hymenolepis nana	Hymenolepiasis	Dwarf Tapeworm
Taenia saginata	Taeniasis	Beef Tapeworm
T. solium	Taeniasis	Pork Tapeworm
Trichuris trichiura	Trichuriasis	Whipworm
Viruses:		
Adenovirus (31 types)	Respiratory Disease	
Enteroviruses (eg.,polio, echo, and coxsackie viruses)	Gastroenteritis, heart anomalies, meningitis	
Hepatitis A	Infectious hepatitis	Jaundice, fever
Norwalk agent	Gastroenteritis	Vomiting
Parvovirus (2 types)	Gastroenteritis	
Rotavirus	Gastroenteritis	

Table 3.1: Infectious Agents potentially present in untreated domestic wastewater (Metcalf and Eddy, 2003)

3.2 Health Concerns

Table 3.1 above outlines the infectious agents potentially present in a domestic effluent. Some of the more common human and animal pathogens found in sewage are the bacterial pathogens such as Salmonella, Shigella, enteropathogenic and enterotoxigenic E.Coli, Vibrio, Campylobacter, Listeria and Leptospira (Moore & Daly, 2010).

3.2.1 Bacterial Infections

Bacteria are one of the most common causes of infection associated with wastewater. Primarily, bacteria are removed through filtration, adsorption, and natural die-off. As previously mentioned the percolation area provides the most important microbiological treatment and much of the removal of bacteria takes place at the biomat (interface of soil and percolation trench) where clogging by groups of bacteria and organic matter, result in a substantial reduction in the quantity of bacteria entering into the soil. Where the biomat is unsaturated, bacteria are not usually transported any more than a meter (Moore & Daly, 2010).

In 1981 Craun published a study stating that there were 224 reported outbreaks of waterborne diseases affecting 48,193 people between 1971 and 1978 in the USA. The number of reported outbreaks of waterborne diseases has risen from an average of 15 per year prior to 1970 to an average of 34 per year. Craun states that of these reported outbreaks, almost half were attributed to groundwater pollution with seepage from septic tanks accounting for 40% of the cases.

In an Irish context, microbiological water quality of the private group water schemes improved from 2009 -2010. Nonetheless, 56 schemes (11.6%) were found to be contaminated with E. coli at least once during 2010 down from 87 (17%) in 2009. There has been a slight improvement in microbiological water quality in small private supplies in 2010. 72 (7.4%) supplies were found to be contaminated with E.coli at least once during 2010, down from 83 (8.6%) in 2009 (EPA, 2010).

In 2009, 87 private group water schemes (17%) were found to be contaminated with E.coli at least once during 2009 down from 134 (24.9%) in 2008. Regarding small private supplies 83 supplies (8.6%) were found to be contaminated with E. coli at least once during 2009 down from 113 (12.1%) in 2008 (EPA, 2009).

In 2007, 184 group water schemes (31.4%) were found to be contaminated with E. coli at least once during 2007 a drop from 2006 when 246 group water schemes were found to be contaminated (EPA, 2008).

In 2005, the proportion of private group water schemes contaminated with E. coli remained unchanged from 2005 where 246 schemes were found to be contaminated (EPA, 2006).

The reason for the improvement of water quality in recent years is possibly as a result from increased monitoring and inspection.

E. coli

E. coli is among some of the more well known bacterial infections associated with wastewater. E. coli is an indicator organism, where the presence of these bacteria in drinking water indicates that the water has been contaminated with either human or animal waste. E. coli occurs naturally in the gut of humans and animals and is harmless, however, in other parts of the body can cause serious illness such as severe and bloody diarrhoea which can result in a condition called Haemolytic Uraemic Syndrome which can cause kidney failure.

One of the distressing characteristics of these bacteria is the reasonably low dose level required for infection to occur. As low as ten organisms can cause serious illness. Once infection occurs in humans it is inevitable that organisms will be excreted in the faeces and in turn making its way to the wastewater treatment plant. With such low dosage levels required it can be seen that even treated effluent has the potential to spread the infection (Kumar, P 2002).

3.2.2 Viral Infections

Viruses are much smaller organisms than bacteria and are much harder to filter out of effluent. Viruses are not filtered out by the soil and instead have a positive charge and can be retained by the negatively charged soil particles. The most notable viral infections associated with wastewater are polio and hepatits (University of Nebraska – Lincoln. 2011).

3.2.3 Parasitic Protozoan Infections

As well as the beneficial organisms that degrade and remove wastes from effluent many viruses, pathogenic bacteria and parasites exist in wastewater. The protozoans Cryptosporidium parvum and Giardia lamblia are of great concern due to their significant impact on immune compromised individuals.

These organisms are found in nearly all wastewaters and can form protective cysts in order to survive under unfavourable conditions. Both resist disinfection, however, one of the best ways of removing protozoa from wastewater is through sand or soil filtration (Metcalf and Eddy, 2003). This points to the importance of well constructed percolation areas in a domestic setting. For this reason it can be appreciated the increased risk of parasitic protozoan infections when effluent makes its way into a water source for example in fissured rock or sandy conditions. UV filtration is more commonly used in municipal wastewater treatment plants to treat parasitic protozoan infections.

Cryptosporidium

Cryptosporidium parvum is quickly becoming a prevalent cause of diarrhoeal illness and is estimated to be the second largest cause of such illnesses. In Ireland the incidence of cryptosporidium is increasing and several outbreaks associated with water supplies have occurred with the first outbreak in Mullingar in 2002 and since then in Ennis, Roscommon, Carlow, Portlaw and most recently in Galway in 2007 (EPA, 2009B)

Cryptosporidium is a parasitic cyst (oocyst) which causes diarrheal illness and can be found in humans, farm animals, pets, birds and fish. Cryptosporidium multiplies in the intestinal tract of the host and large numbers of cryptosporidium oocysts are excreted in the faeces (Galway Water Solutions, 2007)

With regard to causing illness it has been estimated that only 30 oocyst are required to cause illness. The risk of contamination is very high when you consider that animals or humans can shed anything up to 100 oocysts per gram of faeces. Cryptosporidium is very resilient and is unaffected by normal dosings of chlorine, it can remain in moist soil for months and up to a year in clean water. Therefore, problems are most likely to occur:

- In karst limestone areas;
- Where effluent flows to water sources directly;
- Where there are preferential flow paths. (Moore & Daly, 2004).

3.3 Environmental Concerns

3.3.1 Nitrogen

Nitrogen occurs as ammonia (NH_3^+), ammonium (NH_4^+), organic N, nitrate (NO_3^-) and nitrite (NO_2^-) in OSWWTS. Sedimentation only removes 10% of the total N in raw wastewater. The remaining 90% discharges to the percolation area for treatment where several other mechanisms exist in the subsoil for transformation, retention and movement of nitrogen, including nitrification, denitrification, adsorption onto soils, plant uptake and dilution into the groundwater. How effectively N is assimilated in the subsoil is determined by a number of factors such as the redox status of the subsoil, its microbial composition and the composition of the organic matter (Wilhelm et al, 1994b). NH_4^+ is the principal form of nitrogen in OSWWTS. Adsorption of NH_4^+ can occur under anaerobic conditions where there is no opportunity for conversion to nitrate which is an oxygen dependent process. The process of NH_4^+ adsorption is not only dependent on the number of soil cation exchange sites available to the effluent, but also on the affinity of these sites to NH_4^+ ions (Fourie and van Ryneveld, 1995). Often only temporary adsorption of ammonium occurs as it can be easily oxidised to nitrate under aerobic conditions (Beal e al, 2005).

Normally NH_4^+ is easily oxidised to NO_3^- within a few hundred millimetres of the subsoil by nitrifying bacteria under aerobic conditions and this process normally occurs within a few hours or a few days (Wilhelm et al., 1994b; Barret et al, 1999). This is known as nitrification and can be limited by low temperatures, insufficient oxygen or lack of alkalinity (Gill et al, 2004). Nitrites are easily and quickly converted to NO_3^- and consequently are not normally found in high concentrations.

Studies have shown that almost full nitrification occurs in unsaturated sandy soils (Robertson et al, 1991). The product of nitrification is nitrate; this is very soluble and does not interact abiotically with soil components under aerobic conditions travelling through the soil almost unimpeded. Previous studies by Robertson et al have found NO_3^- plumes extending more than 100 m from an OSWWTS. NO_3^- is a bioavailable form of N, therefore, it can be taken up by plants and micro-organisms. However, plant uptake is not considered to be an efficient N removal pathway as the volume of N released by OSWWTS often exceeds that which can be normally utilised by nearby plants.

Nitrogen can lead to environmental pollution of aquatic environments. In particular it can be responsible for the eutrophication of salt waters and in some cases fresh waters.

3.3.2 Phosphorous

Most of the phosphorous (P) in OSWWTS effluent is in the form of orthophosphate (PO_4^{3}). Polyphosphate and organic phosphorous in OSWWTS are converted to PO_4^{3-} by adsorption, precipitation and biological immobilisation (Wilhelm et al, 1994b). Precipitation reactions are mainly responsible for P attenuation where PO_4^{3-} reacts with aluminium (AL^{3+}), calium (Ca^{2+}), manganese (Mn^{2+}) and iron (Fe^{3+}) in the presence of oxygen, to create a range of low solubility minerals such as hydroxyapatite, variscite, and vivianite. Therefore, retention of P is more likely to occur in an aerobic unsaturated environment (Beal et al, 2005). Phosphate becomes adsorbed by soil minerals due to the presence of strongly charged positive surfaces making this P unavailable for plant uptake. Adsorbed P has been known to migrate into the centre of minerals that adsorbed them, becoming less available (Troeh and Thmpson, 2005). The type of reactions occurring will vary depending on the subsoil type and are closely related to pH. For example, in acidic environments most reactions involve adsorption to AL, Fe or Mn, whereas in alkaline or calcareous subsoils, precipitation reactions forming calcium phosphate minerals or adsorption to iron impurities on the surface of carbonate clays will occur (Gill et al, 2004).

In 1998 Robertson et al, reviewed the behaviour of phosphate discharging from ten septic tanks in Canada. At six of these sites which where mainly on calcareous sands it was recorded that relatively large PO_4^{3-} plumes were present (> 10m in length) which had PO_4^{3-} concentrations between 0.5 – 5 mg L^{-1}. At the four other sites, however, which were recorded as being noncalcareous and had silt and clay rich subsoil had smaller plumes (within 3m of the percolation area). Most studies indicate that P removal in subsoil absorption is generally efficient (Reneau et al, 1989). However, in saturated soils, desorption of PO_4^{3-} precipitates, which have been created under aerobic conditions can occur. As a result these PO_4^{3-} ions may become available for subsequent adsorption and precipitation. Therefore phosphorous retention may be reduced in subsoils which are exposed to alternate wetting and drying cycles and will also be affected by soil pH (Ptack, 1998).

3.3.3 Nutrient enrichment

Poorly performing OSWWTS have the potential to be one of the many sources of nutrients in groundwater and surface water. The excessive input of nutrients such as nitrogen and phosphorous to water bodies can cause nutrient enrichment which is more well known as eutrophication (Vollenweider 1971). A number of pieces of EU legislation refer to the problem of eutrophication, however, only two provide a definition of the term. The Urbam Wastewater Directive (91/271/EEC) identifies eutrophication as "*the enrichment of water nutrients, especially compounds of N and/or P, causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned*".

A range of negative ecological effects can result from nutrient enrichment, primarily an excessive growth and proliferation of plants including phytoplankton. This can result in a loss of water clarity along with a reduction in available oxygen. Diminished oxygen levels can cause problems for fish and other aquatic organisms. This can lead to an increased mortality of certain taxa and overall changes in the composition of aquatic communities. Excessive growth of algae can lead to taste and odour problems. Algal blooms can also produce toxins and certain groups of cyanobacteria and dinoflagellates can produce neurotoxins and hepatoxins. These often result in greater costs at water treatment works in order to make water potable (Vollenweider 1971).

Phosphorous pollution from OSWWTS is not generally considered as a problem for surface water or groundwater as normally it is effectively retained in the subsoil through adsorption and precipitation. Therefore, it is not likely that the maximum allowable concentration of drinking water (2.2 mg/l a per the European Communities (Quality of Water Intended for Human Consumption) Regulations 1988) will be reached. Nonetheless, it is worth pointing out that, concentrations of total P as low as 20 μg/l, and orthophosphate in excess of 30 μg/l can result in eutrophication (Lucey et al, 1999).

4.0 Regulatory and Planning Aspects

The key legal measures, which are related to on-site domestic wastewater systems, are:

- The Public Health (Ireland) Act, 1878;
- The Water Pollution Acts,1977 and 1990;
- The Planning and Development Act, 2000;
- The Building Regulations 1991;
- The Building Regulations 2010

4.1 The Public Health Act Ireland, 1878

Regardless of the age of this Act, it is still relevant where a nuisance occurs or where a situation arises which is detrimental to public health. Such a situation could relate to a poorly designed or inadequately constructed septic tank or other on-site wastewater treatment system where ponding can result. When these nuisances and public health threats occur, they are usually investigated by an Environmental Health Officer who make suitable recommendations or draft notices to the Sanitary Authority which can result in a formal Statutory Notice being served by the County Secretary. However, this Act is seldom enforced when dealing with groundwater pollution problems (Moore & Daly, 2010).

4.2 The Water Pollution Acts, 1977 and 1990

To discharge any trade or sewage effluents to "waters" a discharge licence is required. These licences are granted by the relevant Local Authority.

The Local Government (Water Pollution) Regulations from 1977 outline the exempted effluents which do not require a discharge licence. On-site wastewater treatment systems for single dwellings (approx $1m^3$/day) seldom require licences where discharge is to groundwater. Effluent discharge to surface waters whether it is trade or domestic effluent clearly requires a licence (Government of Ireland, 1977).

4.4 The Building Regulations 1991

These building regulations came into operation on 1st June, 1992 and applied to all new buildings and to extensions, material amendments, and certain changes of existing building use. These regulations applied across all local authority areas and took the place of the Building Bye-Laws which were used in the larger urban authority areas. To aid designers, constructors and installers, the Department of the Environment published Technical Guidance Documents (TGDs) for each part of the first schedule to the regulations. The parts which were relevant to on-site wastewater treatment systems were:

- Part D: Materials and Workmanship
- Part H: Drainage and Waste Disposal

Part D stated that all work which the regulations apply to shall be carried out "with proper materials and in workmanlike manner" Proper materials are those which are "fit for the use for which they are intended and for the conditions in which they are to be used" and includes materials which:

- Have a CE mark; or
- Comply with:
  - European Technical Approval
  - National Technical Specification
- Comply with:
  - An appropriate Irish Standard
  - An Agrément Board Certificate
  - A different national technical specification of another EU Member state

Technical Guidance Document H dealt with part H of the first schedule; Drainage and Waste Disposal. Works that are carried out in accordance to Technical Guidance Document H are *prima facie* judged to be in compliance with the requirements of the relevant regulations. Section 2 of this document deals with septic tanks and made reference to:

- S.R.6: 1991-"Septic Tank Systems, Recommendations for Domestic Effluent Treatment and Disposal from a single Dwelling house"

- B.S. 6297: 1983 – "Design and Installation of Small Sewage Treatment Works and Cesspools"

Therefore, works that were carried out in accordance with S.R.6 are *prima facie* judged to be in compliance with the requirements of part H of the regulations.

S.R.6:1991 was prepared by a committee of Technical officers brought together by the National Standards Authority of Ireland (NSAI) and it offers standard recommendations. S.R.6:1991 differed from the 1975 edition in relation to the following:

- The introduction of visual assessments for site suitability.
- The specifying of site test requirements
- Greater emphasis on groundwater

However, it must be noted that whereas part H2 in the regulations makes specific reference to Septic Tanks, this does not prohibit the treatment of domestic sewage by any other means (Government of Ireland, 1991).

4.5 The Building Regulations 2010

The 2010 building regulations apply to works or buildings in which a material change of use occurs, where the works or change of use takes place on or after June 1st 2011. Technical Guidance Document H – Drainage and Waste Water Disposal published in 1997 is superseded by these regulations.

The TGD of relevance when discussing domestic wastewater is Part H – Drainage and Waste Water Disposal. This TGD is separated into two sections, Section 1 is occupied with the requirements in H1 (drainage systems) taking into account all the foul wastewater drainage both over and under ground and surface water drainage.

Section 1 of TGD Part H sets out the following legislative requirements relating to disposal of effluent as can be seen in table 4.1 below.

Drainage systems.	H1	(1)	A building shall be provided with such a drainage system as may be necessary for the hygienic and adequate disposal of foul wastewater from the building
		(2)	A building shall be provided with such a drainage system as may be necessary for the adequate disposal of surface water from the building.
		(3)	No part of a drainage system conveying foul wastewater shall be connected to a sewer reserved for surface water and no part of a drainage system conveying surface water shall be connected to a sewer reserved for foul wastewater.
Wastewater treatment systems.	H2	(1)	A wastewater treatment system shall be so designed, sited and constructed that: (a) it is not prejudicial to the health of any person, (b) it does not cause a risk to public health or the environment, (c) it prevents unauthorised access but allows adequate means of access for emptying and maintenance, (d) it will function to a sufficient standard for the protection of health in the event of a system failure, (e) it has adequate capacity, (f) it is impermeable to liquids, and (g) it is adequately ventilated
		(2)	Information on the wastewater treatment system and any continuing maintenance required to avoid risk to health and the environment shall be provided to the owner.
Definitions for this Part.	H3		In this Part – "combined drain" means a single private drain used for the drainage of two or more separate premises as defined in section 10 of the Local Government (Sanitary Services) Act 1948 (No. 3 of 1948); "drain" in relation to a building means any pipe, forming part of the drainage system of the building, which is either - (a) wholly underground, or (b) a continuation, in the direction of flow, of part of a drainage system that has been underground, and includes a "combined drain"; "drainage system", in relation to a building, means the system of pipes and drains used for the drainage of the building, including all other fittings, appliances and equipment so used but excluding subsoil water drains; "domestic wastewater" means water discharged from kitchens, laundry rooms, lavatories, bathrooms, toilets and similar facilities (soil water and wastewater); "foul wastewater" means any wastewater comprising domestic wastewater and / or industrial wastewater; "industrial wastewater / trade effluent" means wastewater discharge resulting from any industrial or commercial activity; "sewer" has the same meaning as in the Local Government (Sanitary Services) Acts 1878 to 1964; "surface water" means water from precipitation which has not seeped into the ground and which is discharged to the drain or sewer system directly from the ground or from the exterior building surfaces; "soil water" means water containing excreted matter, whether human or animal; "wastewater" means used water not being soil water or trade effluent.

Table 4.1: Legislative requirements regarding disposal of effluent.

TGD H, Section 2 is concerned with wastewater treatment systems and defines a wastewater treatment system as:

"a septic tank system or packaged wastewater system. In general a septic tank system is 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. A packaged wastewater treatment system, generally uses media and mechanical parts to enhance the treatment of the domestic wastewater and is followed by a polishing filter."

TGD H 2010, replaces the building regulations from 1991 and 1997. One of the key differences in TGD H 2010 is that it states that the design and installation of wastewater treatment systems for domestic dwellings should comply with the relevant sections of the Environmental Protection Agency's (EPA) Code of Practice (CoP) 2009 Wastewater Treatment and Disposal Systems serving Single houses. The CoP has superseded previous guidance given in SR 6:1991 Septic Tank Systems – Recommendations for domestic effluent treatment and disposal from a single dwelling house. TGD H 2010, also introduces guidance on rainwater and greywater harvesting systems and requires wastewater products to comply with the harmonised EN 12566 standards and their National Annexes (Government of Ireland., 2010).

4.6 Geological Survey of Ireland (GSI)

Groundwater is an important natural resource; it provides 20-25% of drinking water in Ireland and is important in sustaining river flows and maintaining wetlands during dry periods. In Ireland groundwater is protected by means of European Community and national legislation. The Local Authorities and Environmental Protection Agency are in charge of enforcing this legislation. Groundwater Protection Schemes are a realistic and effective way of protecting groundwaters and preventing pollution.

Groundwater Protection Schemes are county based projects carried out by Geological Survey of Ireland (GSI) in cooperation with the respective local authority. The key objective of the groundwater protection scheme is to safeguard the quality of the groundwater for the benefit of present and future generations. The scheme does not have any statutory authority but offers guidelines and a structure for decision making for the Local Authorities when carrying out their duties. Since 2003, the Department of Environment, Heritage and Local Government has suggested that groundwater protection schemes are integrated into County Development Plans.

According to the GSI the main threat to groundwater is caused by:

A. Point contamination sources e.g. Septic tank effluents, Farmyard effluents, leakages and spillages.
B. Diffuse sources e.g. spreading of fertilizers and pesticides

To date, point sources have been identified as causing most of the contamination problems. However, diffuse sources are having an increasing effect on groundwater (GSI, 2004).

4.6.1 Groundwater Contamination Prevention

For the GSI prevention of groundwater pollution and contamination is vitally important and is a key aim for the following reasons:

- Once contamination of a groundwater occurs, the effects last far longer than surface water contamination (months, years and even decades) because ground water moves slowly. Remediation tends to be very expensive and not practical. It can be impractical and a poor environmental strategy to provide comprehensive treatment of groundwater in order to remove certain pollutants. Therefore, the best solution (and preferable option) is to reduce the risk of groundwater pollution rather than trying to remediate its consequences. The old adage i.e. "Prevention is better than cure".

- Groundwater provides the base flow to surface water systems, many of which are used for recreational purposes and also for water supply. In many rivers at least 50% of the annual flow is provided from groundwater and in "low flow" periods up to 90% is groundwater. Therefore, the protection of groundwater quality is vital for sustaining surface water quality.

- It is an offence to pollute groundwater under the Local Government (Water Pollution) Acts of 1977 and 1990 (GSI, 2004).

4.7 Water Framework Directive

The European Union (EU) passed a piece of legislation on the 22nd December 2000, entitled the Water Framework Directive (WFD). This has been one of the most important pieces of water quality legislation to be produced by the EU over the past two decades and has revolutionised the way our important resources are managed.

European water legislation, prior to the WFD, set objectives aimed at protecting certain uses of the water environment from the effects of pollution and protecting the water environment from harmful chemical substances. The WFD carries many of these objectives forward. However, it has also introduced additional and more extensive ecological objectives that are put in place to defend or restore the structure and function of aquatic ecosystems.

The directive has established a unique, integrated method for the protection, improvement and sustainability of rivers, lakes, estuaries, coastal waters and groundwaters within Europe. It compels us to manage all impacts - physical, polluting or otherwise on our water resource. The key objective of the WFD is to achieve a "good" ecological status for all waters by 2015.

4.7.1 The Water Framework Directive and its relationship with other legislation

In the future the WFD, due to its broad-spanning nature, will ultimately replace a number of the other water quality directives such as those on "Surface Water Abstraction" and "Freshwater Fisheries". The implementation of other quality directives such as the "Integrated Pollution Prevention and Control", "Urban Wastewater Treatment", "Habitats and Nitrates Directives" will shape some of the basic measures for the WFD. (Water Framework Directive, 2000).

Unsewered wastewater treatment systems constitute a significant diffuse pressure acting on water. The pressure on groundwater is described as widespread in the Water Framework Directive National Summary Characterisation Report of 2004. With regard to surface water, the relative contribution of unsewered systems in terms of nutrient load amounts to 3% for nitrate and 7% for phosphorous, while pathogens have been identified as a particular risk (ESB International, 2008).

The need for further study of unsewered systems was identified during the preparation of the WFD Characterisation Report, to better understand their potential impact on soils, groundwater and surface water downstream. While guidance has been provided by Environmental Protection Agency (EPA) and Geological Survey of Ireland (GSI), additional procedures are required to assist local authorities in regulation, monitoring and enforcement of unsewered systems (ESB International, 2008).

5.0 Current Regulation

5.1 Introduction

In June, 2000 the Environmental Protection Agency published a wastewater treatment manual titled "Treatment Systems for Single Houses". The EPA then published a Draft Code of Practice for Wastewater Treatment Systems for Single Houses (PE<10) in 2007 and, after a consultation period, the Code of Practice (CoP) was revised and the final version was published in 2009. This Code of Practice has superseded the SR6:1991 in the building regulations.

5.2 Code of Practice

As the CoP is the guidance document currently in use, it is the most important document to examine in detail. The most important points from the CoP, which are of importance when formulating an inspection regime and investigating standards that must be met are summarised below.

The key objectives of the CoP are to outline:

- The significance of proper site assessment, in relation to local conditions specific to the planned site and also to wider experience in the area requirements of the development plan, patterns of development, and other policies.

- The necessity for design of on-site wastewater treatment systems related to the local conditions.

- The need for the continued assessment by the builder/homeowner etc. as per design and attendant recommendations, otherwise violations of various legislative codes occur.

5.2.1 Wastewater Characteristics

The strength of the influent in terms of BOD entering an on-site treatment system largely depends on the amount of water used in the house (i.e. houses using dishwaters may have a wastewater BOD reduced by up to 35% due to dilution even though the overall BOD load to the system (kg/day) stays the same). Sink macerators can increase the wastewater BOD by up to 30%, and their use is not recommended for dwellings. Single house treatment systems are not equipped to deal with excess quantities of waste oils and fats and therefore, these should be disposed of by another method.

Table 5.1 below shows the range of influent characteristics for raw domestic wastewater from I.S EN 12566-3:2005. The CEN standard states that wastewater treatment systems are required to be tested using influents in this range. Typically, in Ireland, wastewaters are at the more concentrated level of the characterised influent in I.S EN 12566-3:2005.

In order to ensure adequate treatment is provided a loading of 150 l/person/day should be used to calculate wastewater capacities (EPA, 2009).

Parameter	**Typical Concentration (mg/l unless otherwise stated)**
Chemical Oxygen Demand COD (as O_2)	300-1000
Biological Oxygen Demand BOD(as O_2)	150-500
Suspended Solids SS	200-700
Ammonia (as NH_4-N)	22-80
Total Phosphorous (as P)	5-20
Total Coliforms (MPN/100ml)[1]	10^6-10^9

Table 5.1: Range of raw domestic wastewater influent characteristics (EPA, 2009)

5.2.2 On-site wastewater treatment system performance

A well constructed septic tank that is being maintained properly and working well can eliminate up to 50% of the solids and between 15-30% of the pollutant load in terms of biochemical oxygen demand (Patterson *et al*, 1971 and Goldstein & Wenk, 1972).

The level of performance achieved by a septic tank type treatment system in treating domestic wastewater relies mainly on the soil attenuation capability of the percolation area. Contaminant attenuation starts in the septic tank and continues through the distribution pipe work, the surface of the biomat, the unsaturated soils, and the saturated area.

Most wastewater treatment systems do not remove significant amounts of nitrogen or phosphorus. Septic tanks are capable of removing a limited amount of nitrogen but high density installation of such systems can lead to contamination (Wakida and Lerner, 2005).

For secondary treatment systems compliance with phosphorus limits can be achieved by dosing chemical coagulants into influent in order to precipitate phosphates. Research by Hellstrom and Jonsson in 2003 states that more than 90% of the total phosphorus load can be removed this way. However, dosing of domestic treatment plants is not common practice in Ireland. The CoP addresses the most common forms of domestic wastewater treatment in Ireland and does not address chemical dosing instead phosphorous treatment normally takes place in the percolation area. Therefore, the research carried out by Bicki et al in 1985 is more appropriate to the Irish setting which states if the soil conditions below the percolation trenches are aerobic and unsaturated, phosphorous concentrations can be reduced by 85-95%.

5.2.3 Performance Standards

I.S EN 12566-3:2005 and prEN 12566-6 outline the test procedures to be adhered to in the measurement of a range of parameters related to treatment efficiency for site assembled or packaged treatment systems for septic tank effluent. These standards do not set out an exact treatment efficiency to be achieved for any of these parameters. However, these standards provide for the declaration of test performance with respect to some or all of the parameters, as may be expected by the national regulations.

Table 5.1 shows the influent characteristics for the testing of these systems however, due to the higher concentrated influent in Ireland, wastewater treatment plants being tested for use in Ireland should be tested to the I.S EN 12566-3:2005 standard using the higher values for influent wastewater and their performance documented in terms of percentage removal efficiency for the complete test parameters. The system should be designed for 60g BOD/person/day and an influent test range of 300-500 mg/l.

Table 5.2 sets out minimum performance effluent standards for specific parameters for these types of treatment systems (EPA, 2009).

The CoP states that "Compliance with the standard should be at a sampling chamber following the treatment process". This statement is relatively unclear, following the treatment process could mean after the effluent has been treated in the treatment tank or after the effluent has passed through the percolation area. There are problems with this statement no matter which approach is taken.

The treatment performance standards set in Table 5.2 below are achievable from a secondary treatment system if the statement is understood to mean that the sample should be taken from a sampling chamber or distribution box after the treatment tank and before the percolation area. However, a sample taken after an effluent has passed through a septic tank and before it has passed through the percolation area is very unlikely to comply with the stated standards. Instead the Biochemical Oxygen Demand and Suspended Solids would be expected to range between 80-180 mg/l and 50-100 mg/l respectively.

If the statement is understood to mean that the samples should be taken after the effluent has passed through the percolation area, then the problem arises, how such a sample can be collected. The 2010 building regulations outlines that sampling chambers should be provided at end of each percolation trench. The problem with this is, a sample retrieved from this kind of chamber has not undergone any soil filtration. In order to get a sample of effluent which has undergone the relevant treatment through the soil some kind of sump would be needed under the percolation area and this is not a practical or guaranteed solution. The reason why this would not provide a representative sample is due to the ingress of groundwater which inevitably would dilute the treated effluent.

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

Table 5.2: On-site domestic wastewater treatment minimum performance standards ***(EPA, 2009)***

In areas where strict objectives have to be met to comply with the WFD Local Authorities may set stricter performance standards for nitrogen and phosphorus.

5.2.4 Site Characterisation

All sites for proposed single houses with no sewer lines available applying for planning permission are required to have a site suitability assessment carried out by a competent person in accordance to Section 6 and Annex C in the CoP.

A site assessment is carried out in order to determine if a site is suitable or not for an on-site wastewater treatment system. This assessment also helps to predict the wastewater flow through the subsoil and into the subsurface materials. Site characterisation is carried out by completing a desk study and then an on-site assessment. To assist in the selection of an on-site treatment system and to standardise the assessment process a site assessment form has been prepared and is available in Annex C of the CoP. A similar kind of form will need to be prepared to assist and standardise the septic tank inspections.

5.2.4.1 Desk Study

As part of the desk study the following information should be gathered and analysed:

- **Maximum number of residents:** This information can be found under general details and can be calculated using the number and size of bedrooms eg. Single room = 1 person, Double room = 2 people.
- **Proposed water supply:** The proposed type of water supply is needed to determine whether an on-site well is being used or not.
- **Hydrological aspects:** This includes locating any water courses, beaches, shellfish areas or wetlands.
- **Hydrogeological aspects:** These include:
    - Soil type – type of drainage and depth to water table. This information is available from Teagasc.
    - Subsoil type - type of drainage and depth to water table. This information is available from Teagasc and GSI.
    - Location of Karst features. This information is available from the GSI karst database.
    - Aquifer type – importance of groundwater eg. Regionally or locally important. This information is available from the GSI.

- Vulnerability mapping is also available from GSI.
- The groundwater protection response matrix should also be used to determine a response and see if a site is suitable for an on-site treatment system.

5.2.4.2 On-site Assessment

Annex C2 in the CoP outlines a detailed method for conducting the on-site assessment and addresses:

- Visual assessment;
- Trial Hole assessment;
- Percolation test;
- Discharge route.

5.2.4.3 Visual assessment

The function of the visual assessment is to:

1. Determine the potential suitability of the site;
2. Determine if there are any potential targets at risk such as wells or water courses;
3. Collect adequate information including photographic evidence to assist in making a decision on the suitability of the site for the treatment and discharge of wastewater and an adequate location for the proposed treatment system.

During the visual assessment it is imperative that all potential targets are identified and the required separation distances are adhered to as stated in Table 5.3 below. An on-site wastewater treatment system should not be sited in a flood plain, frequently wetted or waterlogged area. All of the information gathered during the visual assessment should be used to determine the correct locations for trial holes and percolation tests.

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

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

Table 5.3: Minimum separation distances

5.2.4.4 Trial Hole Assessment

The function of the trial hole assessments are to establish:

1. The depth of the water table;
2. The depth to bedrock;
3. The soil and subsoil characteristics.

The information from the trial hole assessment should be used to predict the treated effluents flow through the subsoil. The trial holes should be excavated to a minimum of 1.2 m below the invert level of the lowest percolation trench. The following soil characteristics must be assessed; texture, structure, presence of preferential flow paths, density, depth to water table and bedrock.

5.2.4.5 Percolation tests

The function of the percolation tests is to assess the hydraulic assimilation capacity of the subsoil. The ability of the subsoil to absorb water is tested by recording the time period for the water level to drop by a given distance. The aim of the percolation test is to establish the ability of the subsoil to hydraulically transmit the treated effluent from the wastewater treatment system through the subsoil to the groundwater. Theses tests also give an indication of the retention time of the treated effluent in the upper subsoil layers and in turn give an indication of the subsoils ability to treat the effluent.

Percolation tests consist of two types of test: - the T – test and the P – test. T – tests are conducted at the invert level of the percolation trench while P – tests are carried out at the ground surface. A minimum of three test holes per percolation test should be excavated and tested at each site.

Where a site is thought to be borderline, then both T and P percolation tests should be carried out at the same time. Table 5.4 below outlines the T and P values which determine whether a site is suitable or unsuitable.

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

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

Table 5.4: Interpretation of percolation test results.

5.2.4.6 Discharge Route

The discharge route of the treated effluent must be decided on prior to choosing or designing a particular type of treatment. The discharge of any wastewater effluent to waters requires a licence under the Water Pollution Acts 1977-1990 as discussed earlier. It is clearly outlined in the CoP that soakpits are not adequate to treat effluent from septic tanks and percolation areas must be used. Soakpits or soakaways do not comply with the requirements set in the CoP.

5.3 Operation and Maintenance of Wastewater Treatment Systems

"Maintenance of all wastewater treatment systems is essential to ensure ongoing treatment of wastewater. Homeowners should obtain the appropriate documentation including manufacturer's instructions on the system from the builder/supplier and should take all steps to ensure that their system is properly operated and maintained." (EPA, 2009).

Suitable site selection, choice of the treatment system and the correct installation are important steps to provide for the treatment of domestic wastewater from a single house. Ultimately, it is the responsibility of the homeowner for the installation, operation and maintenance of their wastewater treatment system. Section 70 of the Water Services Act 2007 outlines a "duty of care" on the owner of the wastewater treatment unit to make sure it is kept so as not to:

"cause, or be likely to cause, a risk to human health or the environment, including waters, the atmosphere, land, soil, plants or animals, or create a nuisance through odours. An authorised person appointed by a water services authority may direct the owner or occupier to take such measures as are considered by the authorised person to be necessary to deal with the risk. Refusal to comply with such a direction or obstruction of the authorised person is an offence."(EPA, 2009).

It is the owner's/builder's responsibility to install suitable wastewater treatment systems accurately and in accordance with the manufacturer's specifications, planning permission and any other conditions outlined in the building regulations and the recommendations set out in the CoP.

All inspections and maintenance work should be carried out by trained persons in accordance with the manufacturer's guidelines, relative health and safety legislation, waste disposal legislation etc.

The maintenance that the treatment system receives after it is installed is important to ensure human health and the environment is protected once the house is occupied.

Conventional septic tank treatment systems and packaged treatment systems require a different approach for proper maintenance to be provided. In general septic tanks do not require the use of mechanical or electrical parts or sensitive equipment like the type that may be used in secondary or tertiary treatment units, unless the effluent needs to be pumped to the percolation area.

For septic tank systems, visual inspection of the system on a recurring basis, along with regular frequent desludging, is necessary to determine if the system works efficiently. If it is deemed to be malfunctioning remedial works are necessary.

Packaged systems' maintenance should be conducted in accordance with the manufacturer's guidelines. Filter systems both secondary and tertiary treatment systems require the maintenance of pumps and distribution systems. Packaged treatment systems such as BAF's, RBC's, SBR's, and SAF's operate on the precise functioning of mechanical and/or electrical components such as pumps and compressors. Regular visual inspections should be carried out on the system; however, the replacement or repair of components (which may have become worn out over time) will also be necessary. Different manufacturers will design and organise their systems in different ways so the maintenance routine will vary for different systems. For this reason, home owners are often advised to purchase a maintenance contract with the manufacturer to ensure their treatment system is operating efficiently. The desludging should be carried out once per year or else in compliance with the manufacturer's specification.

A schedule for inspection and minimum maintenance and monitoring is shown on table 5.5 below.

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

Table 5.5: Installation, Inspection and Monitoring Schedule

A = Competent person/Service provider, B = System supplier (EPA, 2009).

The CoP is setting a relatively high standard with regard to the procedure to be followed for site assessments and the maintenance that is required to be carried out by homeowners on their on-site wastewater treatment system.

It is clear that in order for a septic tank, secondary treatment or tertiary treatment system to operate at a high standard and provide a high level of treatment maintenance is essential. Maintenance is more straight forward for septic tank systems and normally only requires desludging which is recommended once every twelve months. With respect to secondary and tertiary treatment systems maintenance can be more complicated with mechanical and electrical components needing servicing along with desludging. Electrical and mechanical components which are not operating up to standard or in a lot of cases not operating whatsoever can cause far more severe impacts on the quality of treatment compared to a septic tank which may not have been desludged.

The old saying "out of sight out of mind" is quite suitable when discussing the maintenance of on-site wastewater treatment systems and in most cases maintenance and repair works are only carried out when something serious happens such as pipes blocking and backing up into the house.

Maintenance requirements were made in SR6 1975 and 1991 and in the EPA Treatment Systems for Single Houses 2000 manual. In recent years the importance of having a well maintained treatment system has become more well known and numerous county councils stipulate in the planning conditions that households must have a service contract with the manufacturer of the treatment system. Where the problem lies is that this requirement is seldom enforced after the planning permission has been granted. Homeowners may pay for one years service contract but in a lot of cases do not renew their subscription of the service contract. The only solution to this is for the local authorities to request receipts or certificates from homeowners and enforce penalties for non-compliance.

The CoP 2009 has provided a detailed and standardised methodology for carrying out site assessments. In theory if all sites had undergone this particular assessment and were carried out by a competent assessor then the number of on-site treatment systems sited on inappropriate site conditions should be dramatically less.

However prior to the code of practice and especially pre the EPA Treatment Systems for Single Houses 2000 manual, site assessments were less detailed and less particular.

In other words this means that sites were approved for on-site treatment systems which were not suitable. Once the inspections commence it is likely that a large number of inappropriate sites will be discovered which have been developed and are occupied now. This leads to the hard task of trying to recommend and carry out remedial works on a site that should never have had a treatment system installed in the first place.

In the past the same resources were not available for site assessments especially resources like the GSI, EPA and TEAGASC soil, subsoil, bedrock and vulnerability maps which give an in-depth view into what conditions are to be expected on the site.

It is good to see that a solid framework has been set in place for the future to avoid inappropriate siting of on-site wastewater treatment systems, however a large proportion of development which has taken place in this country has been before the more stringent 2009 site assessment procedures.

Using the GSI vulnerability maps the treatment systems which are located in areas mapped as highly vulnerable should be inspected firstly followed by the systems installed pre 2000 and of even more importance pre 1975 when no guidance was provided on the construction, installation or maintenance of septic tanks.

Some figures from the 2011 census displayed in table 5.6 below outline the scale of trying to implement an inspection regime and the large resources that will have to be allocated if such a regime is to be successful.

Population of Ireland	4,581,269
Number of households	1,649,400
Number on public sewerage scheme	1,092,418
Number with individual septic tank	437,652
Number with individual treatment system	50,259
Number with other sewerage facility	9,370
Number with no sewerage facility	2,555
Not stated	57,154
Number of private wells	161,532
Number supplied by private group schemes	45,774

Table 5.6: 2011 Census statistics (CSO, 2011)

Therefore a potential 556,990 sites will need to be inspected. Deciding what time frame to carry these out will determine the number of staff needed to carry out the inspections.

6.0 Necessity to Develop Inspection Regime

6.1 Introduction

Ireland has approximately 450,000 OSWWTS located around the country. As discussed in earlier chapters poorly performing or malfunctioning OSWWTS have the potential to cause a risk to human health and the environment. Measures need to be put in place to protect against detrimental impacts on human health and the environment caused by OSWWTS. A comprehensive OSWWTS inspection regime is a way of ensuring that OSWWTS are operating to an adequate standard.

The European Court of Justice (ECJ) ruled (C-188/08) that Ireland had not put legislation in place to comply with Article 4 and 8 of the Council Directive 75/442/EEC in October 2009. The Courts decided that Ireland had failed to meet its legal obligations and in particular requires systematic periodic check and inspections.

In July 2011 the European Commission (EC) put forward an application to the ECJ calling for financial penalties to be imposed on Ireland. These financial penalties consist of a €2.7 million lump sum and a daily penalty of €26,173 for as long as the infringement continues

The Irish governments' first step to addressing these requirements was the publishing of the Water Services Amendment Act on the 2nd of February 2012.

Article 4 and Article 8 of the EU Waste Framework Directive EC/75/442 are the two main points of concern in the directive which Ireland have not been complying.

Article 4: requires that *"waste is recovered or disposed of without endangering human health and without using processes or methods which could harm the environment and in particular:*

- *Without risk to water, air, soil, and plants and animals;*
- *Without causing a nuisance through noise or odours;*
- *Without adversely affecting the countryside or places of special interest"*

Article 8: In order to comply with the measures in accordance with Article 4 *any installation or undertaking treating, storing or tipping waste on behalf of third parties must obtain a permit from the relevant competent authority referred to in Article 5, concerned in particular with the type and quantity of waste to be treated,*

- *General technical requirements;*
- *Precautions to be taken;*
- *The information to be made available at the request of the competent authority concerning the origin, destination and treatment of waste and the type and quantity of such waste (EEC, 1975).*

6.2 Ireland's actions in response to non compliance issue

The owners of the 450,000 septic tanks or on-site wastewater treatment systems in Ireland will be obliged to pay a once-off registration fee (Groundwater Protection Services, 2010).

Environment Minister Phil Hogan said "We expect everybody in 2012 to register if they have a septic tank for a registration charge of no more than €50". "In 2013 and subsequent years inspections will be carried out by the local authorities with guidelines by the EPA and the Department of the Environment." "The whole purpose of it is that is to ensure that the areas that are of greatest threat to groundwater will be the ones that will be prioritised for inspection" he added.

A modest registration fee has been set at €5, which applies for the first 3 months of the registration period until 28 September 2012. After this period the registration will increase to €50 and all septic tanks and on-site wastewater treatment system must be registered by the 1st of February 2013. The fee is intended to cover the costs of administration by the water services authorities and the inspections to be carried out (Kildare CoCo, 2011).

In order to carry out an appropriate worthwhile inspection it is very unlikely that €50, not to mention €5 will cover the administration and inspection costs. In order to carry out the inspections inspectors will have to be trained, inspection equipment will need to be purchased, transport will have to be provided and potential laboratory testing will be required to test water and soil quality.

On June 19th Engineers Ireland hosted "Onsite Wastewater Treatment and Disposal Best Practice and Risk Management" seminar. John O'Rourke, BE, C.Eng, FIEI Senior Engineer with Roscommon County Council was a speaker at this seminar and made the comment that in his opinion the cost to employ an inspector and provide transport will cost in the region of €60,000 to €70,000 per annum per inspector. In order to cover this cost an inspector would need to inspect 3-4 sites per day at the €50 fee per site just to break even. It is likely that Local Authorities will require financial support from the Government if these inspections are to take place.

Inspections of septic tanks and other on-site treatment systems are expected to commence early in 2013 and it is expected that every system will have to be re-registered free of charge every 5 years (Groundwater Protection Services, 2010).

The main Irish Legislation regarding the on-site wastewater treatment system is the Water Services Act 2007 and The Water Services (Amendment) Act 2012. This new legislation has been designed to lessen the impact on home owners and there will not be an inspection charge. Section 70 of the Water Services Act 2007 had already placed a duty of care on the owner of the premises to ensure that their treatment system does not cause risk to human health or the environment or create a nuisance (Kildare CoCo, 2011).

It is interesting to note that in 2004 Cavan introduced Waste water treatment systems for single houses – Bye Laws 2004. These outlined the requirement for a comprehensive septic tank regime in County Cavan.

The Water Services Amendment Act was a belated response to the ECJ ruling in October 2009 which found Ireland with the exception of Cavan to be in breach of EU regulations on water quality back dating to 1975.

The ECJ outlined in their ruling that the example of Cavan County Council should be followed, who introduced these byelaws in 2004 in order to implement a system of management of all septic tanks and treatment systems which made sure inspections would be carried out at least every seven years.

The people of Cavan may feel slightly aggrieved with the fact of still having to pay the €50 registration fee for the national inspection regime. However they can take solitude given that the wastewater treatment systems in the county have been inspected and remedial works carried out where necessary meaning additional charges for repair and maintenance work is unlikely. (Collins, 2011).

6.3 Water Services (Amendment Act) 2012

The Water Services (Amendment Act) 2012 sets out the legislative framework in order for a national inspection regime to be developed and implemented. The overall goal of the new legislation apart from meeting the requirements of the ECJ ruling is to enhance and protect public health and the environment in unsewered areas. Responsibility for the protection of public health and the environment rests with everyone both rural and urban dwellers (EPS Water, 2011).

The beginning of this legislative document outlines several definitions, most notably defining "domestic wastewater treatment system" as any system involving, chemical, biological or thermal processes or a combination of the above used for the treatment or disposal of domestic wastewater and sludge. This definition takes into account all septic tanks and wastewater tanks receiving, storing, treating or disposing of domestic waste and all associated drains and pipework. It also takes account of all drains which discharge domestic wastewater whether or not they discharge to a treatment tank or not. This is a welcome definition as according to the 2011 Census 2555 people claimed to have no sewerage facility and 57,154 people did not state what kind of sewerage facility they have.

6.3.1 Register of OSWWTS

This piece of legislation sets the framework for developing and implementing the national inspection regime. Each Water Service Authority i.e. Each Local Authority will be responsible for establishing and keeping up to date a register of domestic wastewater treatment systems located in its functional area.

The owner of each household with an on-site domestic wastewater treatment system is obliged to apply to the Water Services Authority, to have the treatment system entered into the register of wastewater treatment systems. This application can be made in writing or electronic form and should contain the following information:

- Name of applicant and address of where they normally reside;
- The address at which the domestic wastewater treatment system is located;
- Any other information that maybe prescribed by the Water Service Authority;

- The prescribed fee. (It is clearly stated that the fee payable to the Water Service Authority shall not exceed €50)

Once the Water Service Authority receives the application and relevant information, the information shall be entered into the register and a certificate of registration shall be awarded. The certificate of registration shall remain valid for a period of 5 years.

An authorised person appointed by the Water Service Authority may request the owner of a treatment system to produce the certificate of registration in respect to the system. Failure to do so within 20 working days will be considered an offence.

6.3.2 Duties of owners of OSWWTS

The Water Services Amendment Act puts a clear onus on the duties of the owner of a premises connected to a domestic wastewater treatment system. It states that the owner shall:

- Ensure that the system does not cause, and is not likely to cause a risk to human health or the environment and in particular does not –
    - Generate a risk to water, air or soil or to plants and animals;
    - Cause a nuisance through noise or odours;
    - Cause an adverse affect to the countryside or places of special interest.
- Ensure that the treatment system is entered into the register of domestic wastewater treatment systems.

It is quite clear that the section above "duties of the owner" is directly related to Article 4 of the EU Waste Framework Directive EC/75/442 and while it is positive to see the non compliance being addressed, it is unclear if this is achievable.

Firstly, can any wastewater treatment system ever be considered not to constitute any form of risk? Even a perfectly designed, constructed, operated and maintained treatment system with ideal site characteristics presents a certain degree of risk in the eventuality of malfunction occurring. Obviously a well designed, constructed, operated and maintained system presents far less risk than a system that may not be well designed, constructed, operated and maintained or any of these individually, however a degree of risk still remains.

Secondly, a lot of responsibility is placed on the owner of the treatment system to ensure that the treatment system is operating to the relevant standards so as not to constitute a risk. An Inspector appointed by the Water Services Authority will have to hold a technical qualification, complete a specialised course designed by the EPA and have relevant industry experience to be considered competent. Therefore, the question lies, how can the majority of home owners bare the responsibility of ensuring that their treatment system is fit for purpose and not causing any risk to society or the environment? The answer to this is they cannot unless they are technically competent in wastewater treatment. Therefore, the majority of homeowner will require their OSWWTS to be maintained by a competent person. Maintenance contracts from the OSWWTS manufacturers will provide this service.

6.3.3 Sale of premises connected to OSWWTS

Another issue that will undoubtedly arise is where a house and treatment system has been sold from one party to another. In the instance of a treatment system requiring remedial works the problem of who bares the responsibility may arise. Conflict may occur when determining whether it should be the present owner, the initial owner or the engineer who signed off on the design and installation that is held responsible. This will unquestionably be a difficult situation to rectify and could lead to large numbers of legal proceedings. The old Latin saying Caveat emptor (buyer beware) could come into effect or the initial owner could be forced to cover the expenses of the remedial works. If the engineer who signed off on the design and installation is held responsible it will be hard to proceed any further as large numbers of these engineering companies no longer exist due to the current economic climate.

The act does not deal with this issue and only states that:

"A person who, on or after the prescribed date, sells a premises connected to a domestic wastewater treatment system, shall on the completion of the sale, furnish a valid certificate

of registration in respect of the treatment system concerned to the purchaser of the premises."

"A purchaser of a premises connected to a domestic wastewater treatment system shall, after the completion of the sale, notify the relevant water services authority of the change in ownership and the water services authority concerned shall update the register of domestic wastewater treatment systems accordingly."

6.3.4 Appointment of Inspectors

The Act states that the Agency shall only appoint a person to be an inspector where they meet particular requirements. In this case, the word Agency refers to the Environmental Protection Agency (EPA). To be appointed as an inspector the candidate must:

- Make an application to the Agency using the prescribed form and accompanied by the prescribed fee;
- Be the holder of a prescribed professional or technical qualification;
- Have satisfactorily completed a prescribed training course;
- Have the prescribed professional indemnity insurance;
- Have complied with any other requirements outlined by the Agency.

From examining these requirements it can be surmised that inspectors will be subcontracted by the Water Services Authority other wise professional indemnity would be provided by the water services authority and not each individual inspector.

After consultation with the Agency the minister may make regulations regarding:

- The class or classes of professional or technical qualifications needed to be held by an inspector;
- The class or classes of training course needed to be completed by an inspector;
- The type of professional indemnity insurance required to be held by an inspector;
- The fee that has to accompany the application form, however it shall not exceed €1000.

6.3.5 Powers of Inspectors

This act legislates the powers needed by inspectors in order to carry out inspections satisfactorily. The Act will give inspectors the power to:

- Enter and inspect any premises connected to an on-site wastewater treatment system;
- Inspect, examine or test the condition of a domestic wastewater treatment system, including all associated components and functions of the system such as, fixtures, fittings, drains or processes;
- Monitor domestic wastewater effluent which is contained in or discharged from a premises or wastewater treatment system;
- Retrieve samples of any substance which is stored or discharged to or from a wastewater treatment system;
- Take photographs;
- Carry out surveys, take any relevant measurements, make excavations, take samples and carry out subsoil investigations;
- Request information relating to the maintenance, servicing and operation of the treatment system from the owner or occupier;
- Request copies of records or other documents related to maintenance, servicing, operation and desludging of a treatment system;

An inspector does not have the authority other than with the consent of the occupier to enter into a private dwelling. For this reason cooperation of the owner of the premises would be advantageous. To inspect if the grey water is entering the septic tank or separate system taps inside the dwelling would need to be running. This point will be examined in further detail later in the study.

Any person who obstructs or impedes an inspector in the exercise of any of his or her powers is committing an offence. Any person who is guilty of an offence is liable, on summary conviction to a Class A fine. A Class A fine currently ranges between €4000 and €5000.

Before an inspection can be carried out the Agency or Water Service Authority are required to provide at least ten working days notice in writing. Once the inspection has been completed and where the inspector determines that the wastewater treatment system does not contravene the regulations set in the Water Services Amendment Act 2012 or cause risk, create a nuisance or adversely affect the countryside or area of special interest the treatment system is deemed to have passed the inspection. In this case the inspector shall within 21 days of the inspection notify the owner of the premises with the respective treatment system and the Water Service Authority.

Where the Inspector determines that the wastewater treatment system does not comply with the regulation set in the Water Services Amendment Act 2012 or constitutes risk, create a nuisance or adversely affect the countryside or area of special interest, the treatment system is deemed to have failed the inspection. In such a case the Inspector shall immediately notify the owner of the premises with the respective treatment system and notify the Water Service Authority within 21 days.

The Water Service Authority shall then issue an advisory notice within 21 days to the owner of the premises outlining:

- How the owner of the premises has contravened regulations;
- How the treatment system constitutes a risk to human health or the environment in particular:
    - Risk to water, air, soil or plants and animals;
    - Nuisance through noise or odour;
    - Adversely affects the countryside or places of special interest.
- Directions for the owner of the premises to remedy the matters outlined in the advisory notice by a specified date and may include measures to be taken to remedy and contraventions.

This final point could prove more difficult than the inspection itself. A high level of experience and technical qualifications will be needed in order to recommend practical solutions that both solve the problem and are cost effective. It must be noted that a large number of on-site wastewater treatment systems have been installed on sites which are not suitable for on-site treatment due to a number of reasons such as sub soil conditions, high water tables, sensitive receiving waters and so on. These sites were not suitable in the past and will not be suitable in the future. Therefore it is very difficult if not impossible to provide solutions to remedy these non compliances. It could be a case of just reducing the negative impacts on these legacy sites. If the Water Services Authority or the Inspector makes these recommendations which only reduce the impacts, then who will be liable for non compliance going forward the Water Service Authority or the owner of the premises and related treatment system? A legal clause will need to be developed stating that recommendations may need to be developed on further after a trial period.

6.3.6 National Inspection Plan

Finally, the Water Services Amendment Act 2012 directs how the national inspection plan will be developed. It states that the Agency shall make a national plan with regard to inspection and monitoring of domestic wastewater treatment systems. When making the plan the Agency shall have regard to:

- The relevant sections from the Water Services Amendment Act 2012;
- Relevant available information related to the specific types and locations of treatment systems;
- Specific qualitative quantitative criteria targets and indicators for inspections.

6.4 Role of the Agency

The Water Services Amendment Act 2012 refers to the Agency which in general terms refers to the Environmental Protection Agency (EPA). This Act requires the EPA to:

- Supervise and monitor the performance of the Water Services Authorities actions;
- Develop a national inspection plan;
- Develop a suitable training course for inspectors and appoint competent persons as inspectors of domestic on-site wastewater treatment systems;
- Establish and maintain a register of persons appointed as inspectors;
- Provide inspectors and Water Service Authorities with directions and instructions where necessary.

Figure 6.1: Roadmap to National Inspection Plan (Keegan, 2012).

The EPA and the Department of Environment, Community and Local Government have been liaising with the European Commission to ensure that the expectations of the implementation of the legislation are fulfilled.

A number of working groups have been developed including:

Training Working Group: This group has developed a tender specification for the development of guidance and the training of inspectors; however this is not available to the public yet.

Sludge Working Group: This group is focussed on the management and treatment of sludge arising from domestic wastewater treatment systems (Keegan, 2012).

The issue of sludge management will play a very important role in the national inspection plan and must not be neglected. However, the management and treatment of sludge from domestic wastewater treatment systems has a number of difficulties to overcome.

In a lot of cases neighbouring farmers desludge domestic wastewater treatment systems and simply land spread it. This does not and has not in the past complied with regulations; however, it has never been strictly enforced. With the proposed inspections and emphasis on Article 8 from the EU Waste Framework Directive, "waste has to be handled by a private or public waste collector" all waste sludge will have to be properly managed and treated. This inevitably means waste sludge from domestic wastewater treatment systems will have to be sent to municipal wastewater treatment plants for disposal. With approximately 450,000 on-site treatment systems of 3.5 m^3 capacity equating to 1.575 million m^3 of waste the issue becomes significant. This volume compares to over 1 million population equivalent. Therefore, the next important question is can the municipal wastewater treatment plants accommodate an additional 1 million PE (O'Rourke, 2012). This issue extends beyond the scope of this project, however the EPA will need to consider this issue and develop an appropriate solution. It is likely that further investment will be needed in the municipal wastewater treatment sector o accommodate the additional volume of sludge.

7.0 Local Authority & Expert Opinion

7.1 Introduction

During the early stages of this project it was planned to compile a questionnaire which would be sent to all of the Local Authorities in Ireland regarding the OSWWTS inspection methodologies currently in place. However, while carrying out background research a similar questionnaire which had already been sent to Local Authorities was discovered.

The questionnaire was compiled as part of a dissertation entitled "An Examination of How Existing Onsite Wastewater Treatment Systems are Assessed by Local Authorities in Ireland" (O'Brien, 2012).

The questionnaire, which can be seen in Appendix 1 was sent to thirty two of the thirty four Local Authorities in Ireland. Dublin City Council and Cork City Council were excluded as there are no septic tanks located in their functional area. Of the thirty two local authorities which received the questionnaire twenty three responded with two authorities stating that they do not carry out any domestic wastewater treatment system inspections. This means that twenty one local authorities completed the questionnaire. The findings from this questionnaire will be discussed under the following headings:

- Resources;
- Inspections;
- Cause of Non compliance;
- Resolving non compliance:
    - Proposal Assessment;
    - Sludge Disposal;
- Further Training and Guidance.

Only the results from questions relevant to this project will be discussed in this section.

7.2 Resources

Question 2, asks how many people are involved in investigating Septic tanks and onsite wastewater treatment systems. The results show that from the twenty one Local Authorities a total of fifty four people are involved in the investigation of problem and malfunctioning domestic wastewater treatment systems. This figure has been broken down further to show that only two staff are on a full time basis involved in dealing with existing treatment systems. The analysis shows that between full time and part time staff there is a cumulative of 7.35 equivalent full time staff involved in investigating problem and malfunctioning wastewater treatment systems for all of the twenty one Local Authorities which participated in the survey.

Of the twenty one local authorities only six carry out inspections on a proactive or planned basis. The remaining Authorities only inspect problem systems where a complaint has been made. These statistics clearly outline the limited nature of resources within local authorities.

This begs the question, when the national inspection plan is implemented, how will Local Authorities manage with already stretched resources. Five euro or even fifty euro registration per household is unlikely to cover the increased travel, subsistence and administrative cost of this work. Further study will need to be carried out on what the true cost of these inspections will be.

7.3 Inspections

7.3.1 Proactive Inspections

Six of the twenty one Authorities carry out proactive inspections i.e. inspections not due to complaints. The questionnaire asks, what is the basis for selecting sites for inspection? The responses indicate that regulatory aspects such as protection plans for drinking water and shellfish have a large bearing. Fifty per cent of the Authorities carrying out proactive inspections stated that areas in a drinking water supply area, Shellfish protection area or an area identified in the River Basin Management Plans, would constitute the domestic wastewater treatment systems in that area being inspected.

It is surprising to see that only one authority stated “areas identified as having high vulnerability or heavy soils” as a primary criteria for site selection.

This shows that the Local Authorities’ main concern is meeting regulatory requirements however risk based methodology produced by the EPA and GSI is likely to make areas of high vulnerability a priority to be inspected.

The six local authorities which carry out proactive inspections carry out:

- Visual inspection of the tank for signs of ponding.
- Examination of the curtilage of the dwelling.
- Check grey water drainage is connected to the system.
- Examination of adjoining land drains.

Five out of the six authorities check any desludging or maintenance records and only one of the authorities regularly carry out dye testing. Checking the level of sludge in treatment systems was not stated by any authority as part of inspection regime.

Measuring distances from percolation vents back to the treatment system in order to estimate the length of percolation runs was mentioned however only a small amount of percolation areas are vented.

7.3.2 Inspections as a result of complaints

Nineteen Authorities stated that they conduct inspections as a result of complaints. There are differences between these inspections and proactive inspections. All of the nineteen Local Authorities stated that the following elements are part of there inspection regime:

- Visual inspection of the tank and signs of ponding;
- Examination of adjacent land drains.

Most of the Authorities but not all of them carry out the following checks as part of their inspection:

- Check if the grey water pipework is connected to the treatment system;
- Examine the area around the house.

Compared to the proactive inspections, dye testing is much more common for the inspections as a result of complaints with fourteen of the nineteen Authorities routinely carrying out dye tests. Twelve of the Authorities check desludging records while only six check the sludge level in the system and less than six of the local authorities review planning permissions.

These inspections require a large number of site visits including initial inspection and revisiting to ensure remedial works have been completed. This alone uses up large resources in Local Authorities and figure 7.1 below illustrates he number of site visits made to site found to be non compliant.

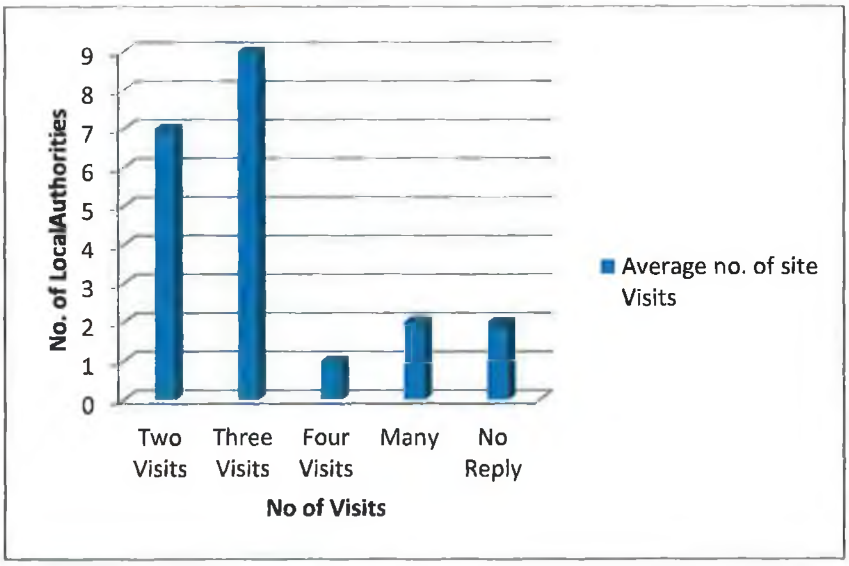

Figure 7.1: No. of site visits to non compliant sites (O'Brien, 2012).

7.4 Causes

Question ten on the questionnaire asks Local Authorities to rank from a list the most common causes of unsatisfactory domestic wastewater treatment systems encountered. The results with No.1 being the highest ranked cause are as follows:

1. Ground conditions unsuitable for the hydraulic loading from the system.
2. Septic Tank or treatment unit cracked and leaking.
3. Greywater connected to a soakaway and not to the treatment system.
4. Unlicensed direct discharge to surface water.
5. Pumps and other electrical or mechanical components faulty and not repaired.
6. System not desludged.
7. Percolation area compacted or built upon.

It is interesting to note, that the number one ranked cause of unsatisfactory performing wastewater treatment system is due to ground conditions unsuitable for the hydraulic loading from the system. This is of interest as in the proactive inspections areas of high vulnerability and heavy soils are ranked as one of the lowest criteria's for site selection.

This shows that a change is required in the inspection process in most Local Authorities. A standardised approach is needed to combat this and if the national inspection plan is formulated correctly these issues should be overcome.

7.5 Assessing Proposals

Another interesting finding from this questionnaire is when Local Authorities were asked to what standard remedial works should be assessed against. Forty eight per cent used the "Fit for Purpose" standard, thirty eight percent said Environmental Protection Agency 2009 Code of Practice for Single Houses and fourteen percent gave no response.

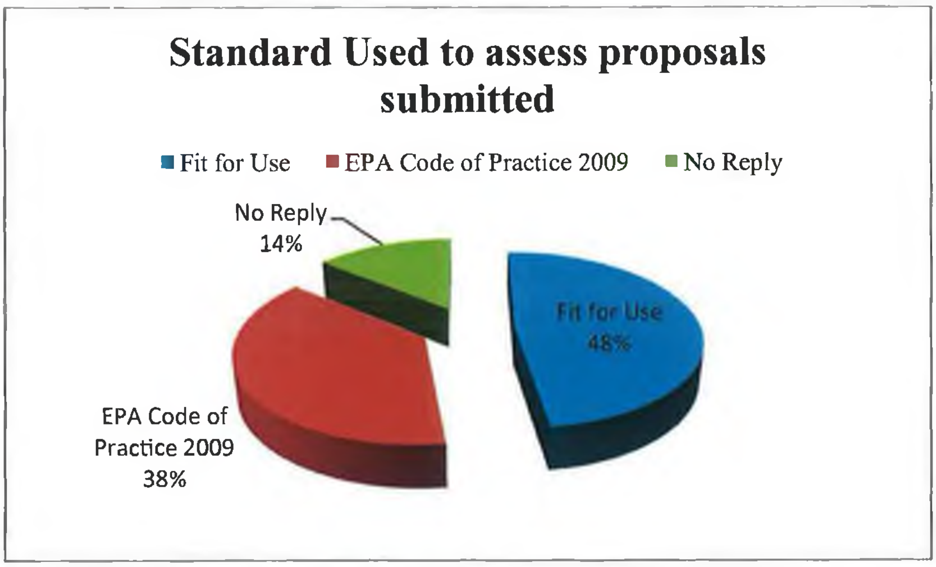

Figure 7.2: Breakdown of the standard used to assess proposals submitted (O'Brien, 2012).

The fit for purpose standard shows a practical approach which may be taken by Local Authorities and may be the most suitable standard to apply to legacy treatment systems where the standards set in the CoP are simply not achievable.

This is not in breach of the requirements of the CoP as Section 6.6 states:

"This CoP should be applied to all new development. However, existing onsite domestic wastewater treatment systems may fail to meet the performance requirements set out in

this CoP. When this occurs corrective actions are necessary. Successful rehabilitation requires knowledge of the performance requirements, a sound diagnostic procedure, and appropriate selection of corrective actions. Variances to the CoP requirements may be considered by the local authority when it is satisfied that the proposed upgrade will provide improved treatment and reduced environmental impact. The failure of the existing treatment and disposal system needs to be clearly identified and corrective actions proposed having regard to the requirements of this CoP"

Question thirteen asked the Local Authorities to rank from a list, what criteria are investigated when assessing a proposal. Table 7.1 below outlines the results with number 1 displaying the most highly ranked answer.

1.	**Public health issues e.g. drinking water wells**
2.	Surface and ground water quality
3.	Public nuisance
4.	Cost
5.	Type of system proposed and details of the proposal

Table 7.1: Main criteria applied when examining proposals (O'Brien, 2012).

These results suggest that addressing the consequences of poorly performing treatment systems is the key objective and that public health and water quality are to the forefront of concern.

When asked do you accept solution/systems that are non Irish Agrément or En 12566 certified. This issue is not altogether clear in the CoP and Building Regulations. Both documents state that all domestic treatment systems and works must comply with EN 12566 however they do not clearly state that treatment systems must be En certified. In terms of the results received from the questionnaire fifty seven percent of Local Authorities only accept treatment systems that are Irish Agrément Board or En 12566 approved. Twenty nine percent of the Authorities surveyed accept proposals of other systems that may have USEPA or other certification and no reply was received from fourteen per cent. The advantage to choosing Irish Agrement Board or EN certified treatment systems is that they have been tested in an Irish and European context.

7.6 Sludge Disposal

Question seventeen asks each Local Authority if they permit a farmer to spread their own septic tank/treatment system sludge on their own lands. It must be noted that this questionnaire was completed in early 2011 before the changes to the Water Services act was amended to meet the requirements of Article 8 of the EU Waste Framework Directive which provides that Member States shall take the necessary measures to ensure that any holder of waste:

- Has it handled by a private or public waste collector;
- Recovers or disposes of it himself in accordance with the provisions of this directive.

For this reason, it is likely that if the same question was asked now the response would be significantly different, with no Local Authorities permitting land spreading of untreated sludge. Nevertheless the results from the questionnaire are displayed on figure 7.3 below.

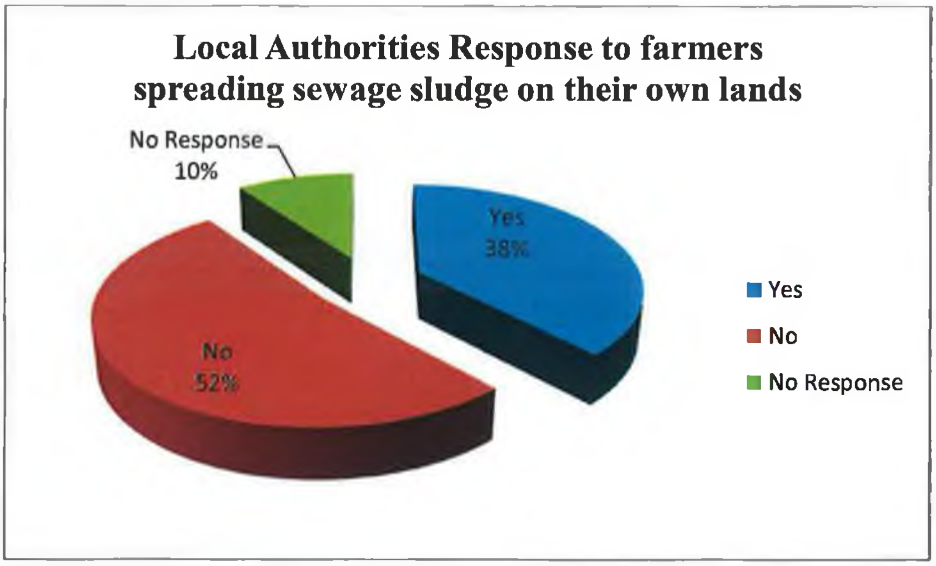

Figure 7.3: Percentage of Local Authorities that allow farmers to spread sludge on their own land (O'Brien, 2012).

It is of importance to note that the Local Authorities which did allow farmers to landspread their own sludge on their own lands did so on the condition that it as carried out in line with the "Use of Sewage sludge in Agriculture".

Local Authorities were also asked if they accepted sewage sludge from private contractors collecting from private dwellings. The response was eighty one per cent Yes, fourteen per cent No and no response from five per cent. The acceptance of sewage sludge from private collectors was subject to the spare capacity in wastewater treatment plants. This issue was discussed in Chapter 6 where the point was made that significant investment will be required in municipal wastewater treatment plants in order to accommodate approximately one million population equivalent additional sludge from domestic sewage treatment systems.

7.7 Further Training and Guidance

The questionnaire asked Local Authorities if they foresee Local Authorities carrying out inspections as part of the national inspection plan. Fifty two percent answered Yes, twenty nine percent answered No and nineteen per cent didn't know.

The Water Services Amendment Act 2012 has since addressed this although it is still not entirely clear. The Act states that an inspector shall have to hold the relevant technical qualifications, complete a specified course which is currently being developed by the EPA and have professional indemnity insurance. This would suggest that inspectors will be private contractors employed by Local Authorities and not current Local Authority staff.

Local Authorities were also asked if there were specific areas that they would like to see addressed in new guidance. The main areas of concern were:

1. Guidance on how to deal with sites with a limited or restricted area where an upgrade or new treatment system was needed particularly if no additional lands are available.
2. More guidance on proper installation practices for different systems.
3. Dealing with households who claim they can't afford to upgrade.

As discussed in Chapter 6 the main concerns are dealing with the remedial works. The inspection plan should be implemented with relative ease however the remedial works are likely to be more difficult to enforce.

7.8 Expert opinion

The results from the above questionnaire gave an insight into the thoughts and views of Local Authorities regarding OSWWTS inspections. It also assessed what measures are currently taken in Local Authorities regarding site selection for inspection and measures taken during an inspection.

The questionnaire assessed user opinion i.e. local authorities. It was felt that interviews with experts in the field could provide useful information when compiling an OSWWTS inspection regime. The interview questions were directed towards the experts own opinion on the key aspects to an inspection regime.

The following experts who all have vast experience and have carried out large amounts of research on OSWWTS kindly agreed to participate in these interviews.

- Dr. Raymond Flynn, Lecturer, School of Planning, Architecture, Civil Engineering, Queens University Belfast.
- Billy Moore, BE, MSc, MBA, Independent Environmental Consultant.
- Dr. Robert Meehan, EurGeol. PGeo, Independent Environmental Consultant.
- Coran Kelly, BSc, MSc, PGeo, Senior Hydrogeologist with Tobins.
- Dr. Cormac O'Suilleabhain Executive Engineer, Cork Couny Council.
- Dr. Phil Jordan, Professor of Catchment Science, School of Environmental Sciences, University of Ulster, Coleraine.

While carrying out the interviews it became evident that there was clear difference between what people think should happen and what may actually happen when developing an inspection regime. Funding appears to be the limiting factor with the development of the inspection regime. However, the interviews carried out focussed on the experts own personal opinion regarding the development of a thorough practical inspection regime not limited by funding.

Interestingly the opinion of the above experts was similar for certain questions and differed on certain points. Each person interviewed was asked the same twelve questions which are displayed below. The information from these interviews will be analysed on a question by question basis.

Interview Questions

1. What do you consider the main reasons for failure in OSWWTS?

2. What would you consider to be the most appropriate solution to rectify this?

3. Where sites are not suitable for OSWWTS due to high or low permeability subsoils what remedial works would you suggest to improve the situation?

4. How do you think the inspection regime should be tailored to deal with this?

5. Do you think the inspection regime should differ for different scenarios such as tank age, tank type, geology etc. or would this cause too much subjectivity, would a standardised approach be more suitable?

6. Do you think all OSWWTS should be inspected, if not what would you consider as the main criteria for selecting sites?

7. What do you think are the key elements that an inspection should consider?

8. What are the limiting factors, i.e. what determines if a tank or site passes or fails?

9. How many inspectors do you think should be appointed nationwide?

10. In your opinion what level of qualification and experience should an inspector have?

11. If a tank passes the inspection regime, after what period of time do you think it should be retested?

12. In your opinion, is a national inspection plan achievable and over what period of time would be acceptable for it to be implemented across the board?

Question 1: What do you consider the main reasons for failure in OSWWTS?

In general, this question was answered in a similar way by most of the experts. The biggest reason for failure of these systems was deemed to be inadequate ground conditions such as highly permeable subsoils or highly impermeable subsoils. Siting of OSWWTS in areas like this is as a result of incorrect site assessments or from times before site assessments were a requirement. However, it was felt that since the CoP was introduced in 2009 the standard of site assessments has increased.

Inadequate ground conditions are the main reason for failure in OSWWTS followed by poor design of tanks and percolation areas, poor installation which is often unsupervised, and poor maintenance.

In a lot of cases, it is a condition of the planning permission that the homeowner holds a service and maintenance contract for their OSWWTS. OSWWTS being maintained on a regular basis will perform to a higher standard than poorly maintained systems. Interestingly from surveys carried out it has been found that after 2 years only 20% of people renew their service and maintenance contracts. This means there is 80% non compliance. It is clear that enforcement of penalties is needed in this area.

Question 2: What would you consider to be the most appropriate solution to rectify this?

Question 1 showed that the main reason for failure of OSWWTS is inappropriate ground conditions. However, in this case the best practical solution has to be developed as you can't force people to move out of their house. Opinions differed slightly between the experts for this question. Some said trial holes should be dug to investigate the subsoil conditions before coming up with a solution. Another opinion was generic solutions need to be developed for each of the different scenarios in order for solutions to be implemented across the country.

One common recommendation that was made by all of the experts was that homeowners should be required to hold maintenance contracts for their OSWWTS, especially for mechanical systems.

Question 3: Where sites are not suitable for OSWWTS due to high or low permeability subsoils what remedial works would you suggest to improve the situation?

Opinions were relatively similar for this question and the following recommendations were made:

- Carryout trial hole test and percolation test to get accurate representation of subsoil characteristics.
- Install secondary treatment system to improve the quality of the effluent.
- Import soil and reconstruct percolation areas, either dug out or mounded.
- Discharge to surface waters is an alternative solution however, tertiary treatment will be required if this is to be carried out. A discharge licence will also be required. The general opinion was that a modified discharge licence should be developed. Modifications should include less stringent conditions on testing of water quality to once every 2 years provided maintenance contracts are held.

Another opinion was that before any remedial works are considered a risk assessment should take place considering the source – pathway – target model. There will always be a source which is the OSWWTS however if there is no pathway or no target such as a well or watercourse then there is no risk and hence there is no need to carry out remedial works.

Question 4: How do you think the inspection regime should be tailored to deal with this?

Again opinion differed slightly regarding this question. The first point that was made is that inspectors carrying out the inspections will need to be competent and understand clearly the areas of failure and the risk associated with each. Each expert agreed that the geology of the site is an important factor and needs to be considered however opinions differed on whether a trial hole needs to be carried out for each site. Some said trial holes were necessary on all sites, while others felt information from trial hole tests would be useful but not practical for every site due to associated costs and damage to landscaped grounds. For this reason the most appropriate solution regarding trial hole tests is only to carry them out where there is evidence of failure on the site.

Question 5: Do you think the inspection regime should differ for different scenarios such as tank age, tank type, geology etc. or would this cause too much subjectivity, would a standardised approach be more suitable?

The responses from this question were all reasonably similar. From a practical and working point of view inspections need to be carried out using a standardised approach.

There needs to be a standard approach so that inspections are carried out in a fair, regulated manner nationwide. Nevertheless the above features tank age, tank type, geology and so on need to be assessed on every site.

One expert felt that a screening system should be incorporated into the inspection regime which takes account of when the site assessment was carried out. For example where site assessments were carried out post 2009, then only a visual assessment of the site is needed. Where site assessments were carried out between 2000-2009 a visual assessment and possibly trial hole tests are needed and where site assessments were carried out pre 2000 a trial hole is automatically needed due to little enforcement during this period.

Question 6: Do you think all OSWWTS should be inspected and if not what would you consider as the main criteria for selecting sites?

The opinion on this topic was reasonably straight forward. The general consensus was that in an ideal world every single OSWWTS should be inspected, however, with approximately 450,000 OSWWTS in Ireland this is not practical.

Site selection for inspection should be based on the level of risk associated in different areas. A hierarchy should be formed with the sites having the highest risk inspected first. Factors which add to the risk of a site include high and low permeability soils, proximity of water courses, proximity of drinking water sources and housing density.

Question 7: What do you think are the key elements that an inspection should consider?

Answers to this question varied from anything that constitutes a risk to human health or the environment to more specific elements which should be assessed during the inspection. These elements included:

- Where the system is located, type of treatment, type of percolation used;
- Structural integrity of treatment system;
- Soakage characteristic;
- Evidence of ponding;
- Evidence of discharge to local water courses;
- Roof water connected to OSWWTS, Grey water connected to OSWWTS;
- Odours.

Question 8: What are the limiting factors, i.e. what determines if a tank or site passes or fails?

A site inspection should fail if risk to human health or the environment is detected during the inspection. If any of the elements inspected do not exist or are incorrectly designed or not operating appropriately then a site should fail with remedial works necessary.

Question 9: How many inspectors do you think should be appointed nationwide?

This will be dependent on the number of inspections that are carried out. From the expert opinion it is thought that an inspector would be only able to conduct 2-3 inspections per day between travelling to the site, conducting the inspection and completing the associated paperwork. Therefore if only 5% of the 450,000 OSWWTS were inspected in the first year approximately thirty to forty inspectors would be required.

Question 10: In your opinion what level of qualification and experience should an inspector have?

From the interviews it became clear that inspectors need to be competent. What would define a person as a competent inspector? According to the experts an inspector should be degree qualified in civil engineering, hydrology, geology or environmental science. They will also need to have completed the inspector's course which is currently being developed by the EPA and have 3-5 years experience in the wastewater sector. It was also thought that the site assessor course would be an advantage.

Question 11: If a tank passes the inspection regime, after what period of time do you think it should be retested?

Opinion varied on this issue and the responses are outlined in no particular order below:

- Dependent on the CEN guidance for each type of OSWWTS;
- Once every 5 years for a septic tank and once every 2 years for a secondary treatment system;
- Once every 2 years for older systems which are established and after 6 months for newer systems;
- Should be determined through risk assessment on a site specific basis;

- Once every ten years for septic tanks and once every year for secondary treatment systems.

Question 12: In your opinion, is a national inspection plan achievable and over what period of time would be acceptable for it to be implemented across the board?

All of the experts interviewed felt that the national inspection regime is achievable but the time frame is uncertain. Regarding the time frame, opinions varied from two years to twenty years with issues such as pressure from the EU and the Water Framework Directive being considered.

8.0 Development of an Inspection Plan

8.1 Introduction

One of the most important parts of the national inspection plan is determining which areas should be inspected first. The EPA, GSI and a number of expert external consultants have developed a risk based methodology to identify the areas that pose the greatest potential risk to human health, groundwater and surface water; however, this is still at draft stage and is not available to the public.

It is likely that the approach taken will be similar to some of the procedures from Groundwater Protection schemes. These schemes have been in operation since the mid 1980's and local authorities – Offaly, Wexford, north Cork, Galway and Louth have been successful implementing groundwater protection schemes. Vulnerable areas have been identified using these schemes and development in these areas is not permitted unless adequate measures are put in place to ensure the protection of groundwater. These were based on a simple scheme developed by Geological Survey of Ireland and were appropriate to the available hydrogeological information and planning needs at the time.

The level of available geological and hydrogeological information on which to base a groundwater protection scheme varies from area to area. Presently where the information is adequate, a comprehensive scheme, based on hydrogeological concepts is achievable (DOELG, EPA, GSI, 1999).

When the Groundwater Protection Scheme booklet was published in 1999 by the Department of the Environment and Local Government, EPA and GSI adequate geological information, particularly regarding subsoils was not available for large areas of the country. Over the past four years Tobins expert team of geologists and hydrogeologists along with the groundwater section of GSI have been updating the National Groundwater Vulnerability map and is due to be completed by the end of 2012.

The expert geologists and hydrogeologists have been mapping the subsoil permeability and depth to bed rock across an area of 37,000 km^2. This represents approximately 52% of the land area in the Republic of Ireland. This mapping represents the most detailed mapping carried out since the original geological mapping of the 19^{th} century. The fieldwork associated with the updating of the maps involves logging of available soil and subsoil exposures, assessment of natural and artificial drainage characteristics. To date the mapping team have logged over 1000 subsoil exposures and supervised over 1000 auger holes drilled by the GSI drill rig which drills a maximum of 12m or if rock is met before the 12m. The aim is to determine the depth to bedrock and British Standard tests are carried out to classify the subsoil (Tobin, 2012).

Therefore, this mapping and production of vulnerability mapping which is due to be completed late in 2012 should prove to be very beneficial in relation to the risk based methodology, determining the areas of high vulnerability i.e. high risk.

8.2 Risk and Risk Management

The Groundwater Protection Scheme defines risk as *"the likelihood or expected frequency of a specified consequence"* Applying this to groundwater, the likelihood of contamination from a polluting source or activities is called a hazard. A hazard is when the source presents a risk to something of value e.g. groundwater.

Risk = Probability of an event x consequential damage

The conventional source – pathway – target model for environmental management can be applied to groundwater risk management (DOELG, EPA, GSI, 1999).

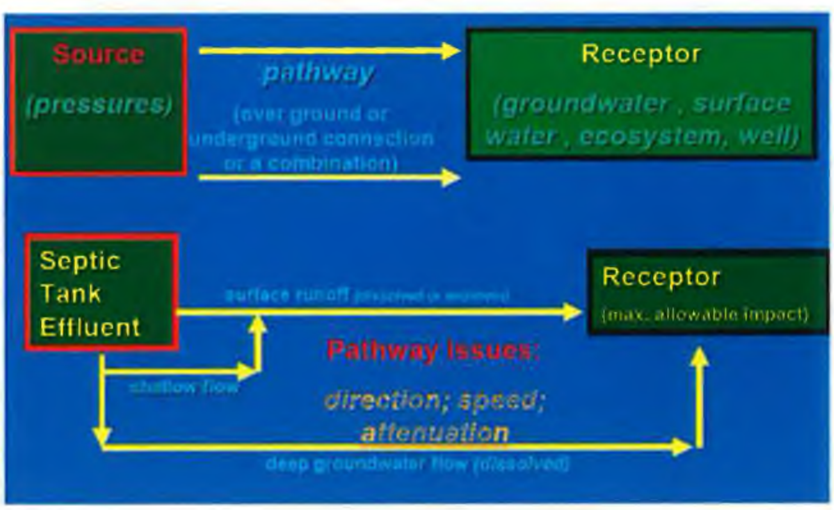

Figure 8.1: Source - Pathway - Target Model (Kelly, 2012)

The risk of pollution to groundwater is dependent on three elements:

1. The **hazard** caused by a potentially polluting activity, eg. A leaking septic tank.
2. The **vulnerability** of groundwater to contamination, i.e. the depth to bedrock, subsoil type, importance of underlying aquifer in a specific area.
3. The potential **consequences** of a contamination event.

The hazard is dependent on the level of contaminant loading, while the vulnerability of the groundwater dictates the likelihood of contamination if a pollution event occurs. The consequences to the target depends on the value of the groundwater which is usually denoted by the aquifer category (regionally important, locally important or poor) with regionally important having the highest value or the proximity to an important groundwater abstraction source for example a public well.

Figure 8.2 below illustrates how groundwater contamination may occur and demonstrates source – pathway – target.

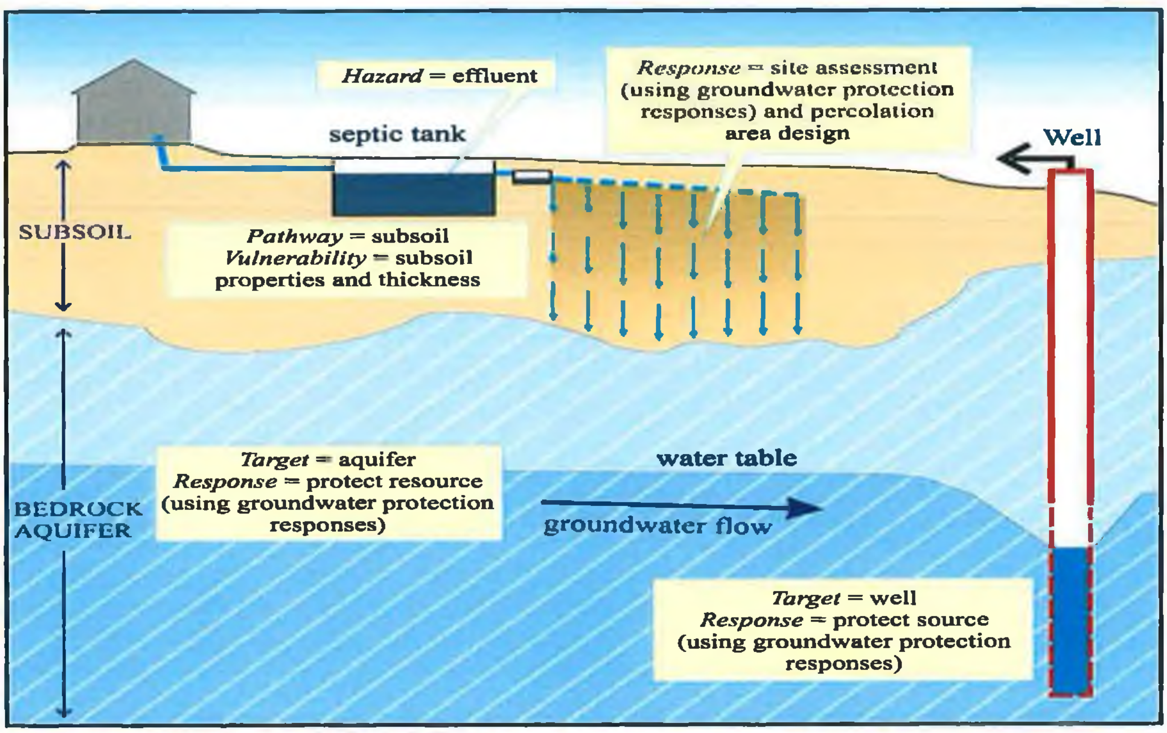

Figure 8.2: Schematic diagram showing how the elements of risk are applied to groundwater protection (DOELG, EPA, GSI, 1999).

8.3 Groundwater Protection Responses

As part of the Groundwater Protection Scheme groundwater protection responses were developed. The level of response is dependent on the various elements of risk: vulnerability, the value of the aquifer and the contaminant loading. By consulting the response matrix which is demonstrated in Table 8.1 below, it can be seen if a particular development is acceptable on the site.

VULNERABILITY RATING	SOURCE PROTECTION		RESOURCE PROTECTION						
			Regionally Imp.		Locally Imp.		Poor Aquifers		
	Inner	Outer	Rk	Rf/Rg	Lm/Lg	Ll	Pl	Pu	
Extreme (E)	R4	R4	R4	R4	$R3^{m}$	$R2^{a}$	R2	$R2^{h}$	↓
High (H)	R4	R4	R4	$R3^{n}$	$R3^{a}$	$R2^{a}$	$R2^{a}$	$R2^{a}$	↓
Moderate (M)	R4	R3	$R3^{m}$	$R2^{a}$	$R2^{a}$	$R2^{a}$	$R2^{a}$	R1	↓
Low (L)	$R3^{m}$	$R3^{a}$	$R2^{d}$	R2	$R2^{b}$	$R2^{a}$	R1	R1	↓
	→ →	→ →	→	→	→	→	→	→ →	

Table 8 .1: Groundwater Protection Responses (DOELG, EPA, GSI, 1999).

The matrix includes both the hydrogeological/geological and the contaminant loading aspects of risk assessment. The arrows indicate directions of decreasing risk, with down arrows showing the decreasing likelihood of contamination and right arrows showing the direction of decreasing consequence.

R1 Acceptable subject to normal good practice.

R2 Acceptable in principal, subject to conditions.

R3 Not acceptable in principal; some exceptions may be allowed subject to conditions.

R4 Not acceptable.

Table 8.2 below is another matrix table used to determine the vulnerability rating of a specific location. This table takes into account the depth of subsoil and type of subsoil. Subsoils with high permeability result in a higher vulnerability rating. However, where the subsoil is 3 metres or less regardless of the subsoil type receives an extreme vulnerability rating. This table can be particularly useful if used in conjunction with the depth to bedrock and subsoil type mapping that Tobin Consultants and GSI have almost completed (DOELG, EPA, GSI, 1999).

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Karst Features
	High permeability (sand/gravel)	Moderate permeability (e.g. Sandy subsoil)	Low permeability (e.g. Clayey subsoil, clay, peat)	(Sand/gravel aquifers only)	(<30 m radius)
Extreme (E)	0 - 3.0m	0 - 3.0m	0 - 3.0m	0 - 3.0m	-
High (H)	>3.0m	3.0 - 10.0m	3.0 - 5.0m	>3.0m	N/A
Moderate (M)	N/A	> 10.0m	5.0 - 10.0m	N/A	N/A
Low (L)	N/A	N/A	> 10.0m	N/A	N/A

Notes: (1) N/A = not applicable.
(2) Precise permeability values cannot be given at present.
(3) Release point of contaminants is assumed to be 1-2 m below ground surface.

Table 8.2: Vulnerability Mapping Guidelines (DOELG, EPA, GSI, 1999).

As discussed earlier, it is likely that the approach taken for the risk based methodology will be similar to some of the procedures from Groundwater Protection schemes. However, Groundwater Protection Schemes use the groundwater responses and vulnerability ratings to decide whether development is suitable in particular areas. For the purpose of the national inspection plan these procedures can be adapted and used slightly differently. Areas can be identified as extreme and high vulnerability or with R4 and R3 responses and domestic wastewater treatment systems in these areas should be at the top of the list for inspection.

In simple terms domestic wastewater treatment systems located in areas with subsoils of less than 3 metres, highly permeable subsoils, areas with regionally important aquifers or areas in close proximity to sources of public water supply should be prioritised for inspection as these are the systems presenting the greatest risk.

Having carried out interviews with several experts in relation to domestic wastewater treatment and asking what they think should be the main criteria for selecting sites to be inspected, the top rated response was geological conditions of sites such as areas of high and low permeability, however, housing density was deemed to be another very important criteria when selecting sites for inspection. Housing density can be related directly to the loading of pollutants in a specific area regardless of the geological conditions. Therefore housing density would need to be factored in when identifying areas which need to be selected for inspection, i.e. unsewered areas of high housing density should be a priority for inspection.

8.4 Insight into the EPA's risk based methodology

One of the original aims of this project was to compile a risk based methodology for site selection and section 8.1 to 8.3 outline the key areas which I felt should be considered, where such a methodology could be compiled similar to a Groundwater Protection Scheme. As was discussed earlier the EPA, GSI and a number of expert external consultants have developed a risk based methodology to aid with site selection. This document is currently at draft stage and is not available to the public yet. However, the EPA has kindly provided a copy of the paper "A Risk Based Methodology to Assist in the Regulation of Domestic Waste Water Treatment Systems" prior to its presentation. This paper refers to the risk based methodology document "A Risk Based Methodology to Assist in the Prioritisation of the Inspection of Domestic Wastewater Treatment Systems".

The paper states that the EPA have compiled a risk based methodology to take account of the relative risks to human health and the environment from pollutants such as microbial pathogens, molybdate reactive phosphate (MRP) and nitrate. The risk based methodology is based on the source – pathway – receptor model and uses available geological, hydrogeological and housing density data sets in a Geographic Information System (GIS). The methodology will use estimated load of pollutants produced by OSWWTS from housing density, average number of occupants per house, typical phosphorous (P) and nitrogen (N) load per person and typical reductions in concentrations in the tank component of the OSWWTS. Hydrogeological information and maps on soils, subsoils and bedrock are set to evaluate the movement and attenuation of pollutants arising from OSWWTS on and in these geological materials. The resultant pollutant load arising is applied to the land environment and three consequences are considered.

1. The area is capable of providing satisfactory treatment of the OSWWTS effluent in the subsoils.
2. Inadequate percolation may occur with the potential of ponding and movement into surface waters occurring.

3. Inadequate attenuation may occur with the potential of pollutants entering the groundwater without adequate treatment.

Where treatment and disposal of wastewater is not likely to be satisfactory, the resulting MRP and nitrate load is added to the effective rainfall in the case of surface water, and recharge in the case of groundwater, arising in 1 km^2 areas countrywide and a concentration is estimated for these areas. These concentrations then have to be compared to relevant environmental standards for phosphate and nitrate.

The risk is to be ranked into four categories countrywide (low, medium, high and very high) for both phosphate and nitrate, based on the estimated concentrations in each 1 km^2 grid area. Microbial pathogens are taken to be influenced by pathway factors in a similar manner to phosphates.

8.4.1 Risk Characterisation

The risk characterisation has been developed using a combination of the following Source-Pathway-Receptor elements:

- Pollutant load from each OSWWTS, calculated from typical discharge concentrations and volumes.
- Pathway susceptibility, which takes account of attenuation by physical biological and chemical processes. Only surface and subsurface pathways are considered.
- Collective load making its way into surface or groundwater derived from OSWWTS density and estimation of attenuation.
- Dilution of load at the receptor.

8.4.2 Receptors of concern

The receptors of concern in this methodology are human health from direct contact with microbial pathogens, surface water from eutrophication and polluted groundwater which may be used as a private water supply such as untreated well water.

8.4.3 Risk Ranking

GIS risk maps at 1:40000 scales have been developed displaying:

- Housing Density;
- Distribution of susceptibility categories for inadequate percolation;
- Relative risk of water pollution from MRP and Pathogens via the surface pathway;
- Relative risk of water pollution from MRP and pathogens via the subsurface pathway;

When deriving risk maps the comparison has to be made between predicted concentrations at the receptor and with appropriate environmental standards for MRP and nitrate. Microbial pathogens are considered to be influenced by pathway factors in a similar manner to MRP.

Two of the range boundaries for MRP are based on the environmental quality standard of 0.035 mg/l which forms the boundary between good and moderate status river bodies and 0.025 mg/l which forms the boundary between high and good status. The categories regarding nitrate are based on boundaries set by the European Environment Agency for cross European comparison. (EPA 2010)

The percentage areas country-wide in each relative risk category are given in tables 8.3 and 8.4 below.

Relative Risk Category	**MRP & Pathogens**	
	Streams via surface pathway	Streams and wells via subsurface pathway
Low	64.5	90.8
Moderate	10.5	4.2
High	6.5	1.9
Very High	18.5	3.1

Table 8.3: Percentage areas in the different relative risk categories nationally for MRP and Pathogens (EPA, 2012).

Relative Risk Category	Nitrate	
	Streams via surface pathway	Streams and wells via subsurface pathway
Low	99.0	99.8
Moderate	0.4	0.1
High	0.1	0.1
Very High	0.4	0.1

Table 8.4: Percentage areas in the different relative risk categories nationally for Nitrate (EPA, 2012).

8.4.4 EPA Risk Based Methodology Summary

1. The area of the country where there is "inadequate percolation" for some or all of the year due to poorly permeable soil, subsoil and/or bedrock is relatively large at 38%. These areas will provide significant challenges in terms of making certain that discharges from OSWWTS are treated satisfactorily to ensure that they do not pose a risk to human health and the Environment. However, the risk is dependent not only on a problematic pathway but also on the potential loading from the OSWWTS. When this is taking into account, it is derived that the risk arising from MRP and microbial pathogens is 'very high' in approximately 18% of the country.
2. Approximately 3% of the country is in the 'very high' risk category. In this area there is a threat to groundwater from phosphate, nitrate and/or microbial pathogens, however it is believed that practical engineering solutions could generally rectify or alleviate any potential problems. From this it is determined that OSWWTS cause a greater risk to surface water than to groundwater.
3. Microbial pathogens present a threat to human health in circumstances where there is a significant likelihood of direct contact either from effluent at the surface as a result of inadequate percolation and ponding or in untreated water from private wells in vulnerable areas as a result of inadequate attenuation.
4. The main pollutant causing a threat to the environment is phosphate. The threat is to surface water, either where there is inadequate percolation or inadequate attenuation prior to the entry of effluent into bedrock aquifers, particularly karstified (cavernous limestone) aquifers. The cumulative pollutant load arising

from OSWWTS will be minor compared to urban wastewater treatment systems or agriculture at river basin scale; however, it can be significant in certain physical settings at small catchment scale.

5. Nitrate from OSWWTS poses a low threat at catchment scale and at the scale of this assessment – km^2 – due to dilution; however, in certain circumstances, at site scale (a few hectares) a high density of house can cause localised plumes with elevated nitrate concentrations in groundwater.
6. The approach outlined in the paper, "A Risk Based Methodology to Assist in the Regulation of Domestic Waste Water Treatment Systems" and described in more detail in "A risk based methodology to assist in the prioritisation of the inspection of domestic wastewater treatment system" will enable the EPA and local authorities to adopt a risk-based approach to assist in the selection of wastewater treatment systems for inspections, whereby the level of inspection will be proportionate to the risk posed to human health and the environment.

Figure 8.3 below outlines the methodology for risk ranking.

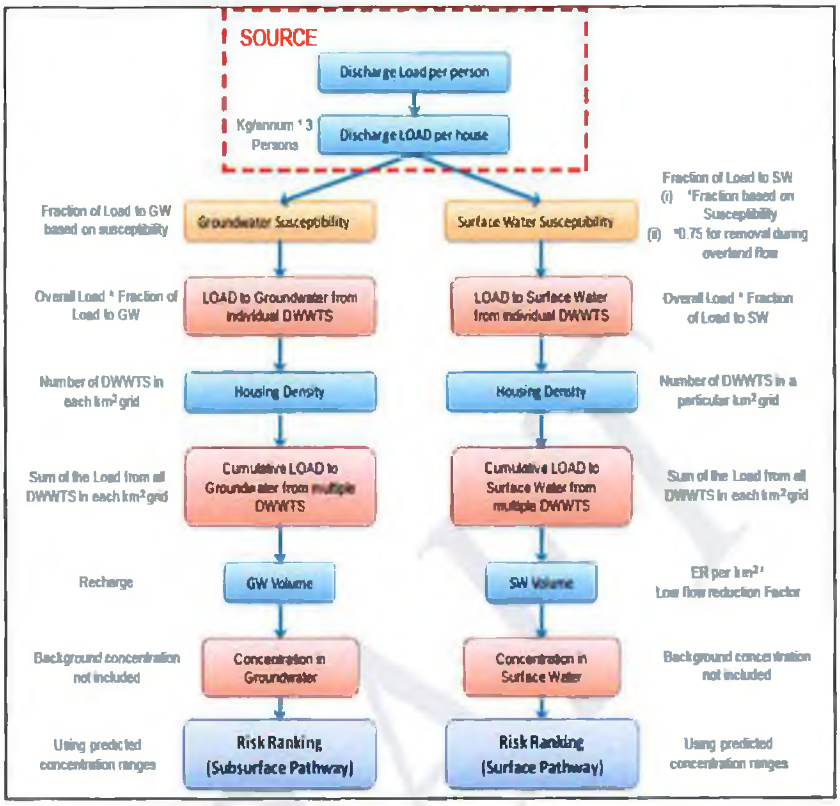

Figure 8.3: Outline of Methodology for risk ranking (EPA, 2012)

Note: Figures in section 8.4 are approximate and should not be taken as exact figures. A peer review of the paper was undertaken by Professor Phil Jordan, University of Ulster, and Mr. Tony Marsland, formerly groundwater Policy Manager, Environment Agency (England and Wales). Maps and data on which the methodology is based were obtained from geological survey of Ireland (subsoil permeability, groundwater vulnerability, aquifer, and recharge maps); Teagasc (soil and subsoil maps); and An Post Geodirectory (housing locations).

8.5 Development of an OSWWTS Inspection Regime

The main objective of this project is to develop a suitable, practical and thorough inspection regime which can be applied to all OSWWTS. In order to do this a large amount of background research was necessary to consider the different types of treatment systems, the detrimental impacts caused by poorly performing treatment systems both to people and the environment. The Regulatory and Planning aspects from the past and present were an important area to review in order to determine the standards which had to be met in the past and the standards which have to be complied with now. Prior to the 2010 building regulations the installation of OSWWTS had to comply with SR6 1991, however, TGD H of the 2010 building regulations states that the design and installation of wastewater treatment systems for domestic dwellings should comply with the relevant sections of the Environmental Protection Agency's (EPA) Code of Practice (CoP) 2009 Wastewater Treatment and Disposal Systems serving Single houses. For this reason EPA Code of Practice is the most important document to comply with when developing an inspection regime.

Finally Chapter 7 analyses a questionnaire compiled by Seamus O'Brien from North Tipperary County Council which was sent to all of the Local Authorities assessing their opinion on OSWWTS inspections. Chapter 7 also analyses the results of interviews that were carried out with several experts in the OSWWTS field. Both these sources of information will prove invaluable when developing an inspection regime with Local Authority and expert opinion considered.

When carrying out the interviews with the expert's one thing became obvious. What should happen and what is likely to happen in the national inspection plan are two different things, however there is one limiting factors for this which is funding. The resources are simply not available to carry out the national inspection plan as it should be in an ideal world.

For the purposes of this project, an inspection regime will be developed which will try and find the balance between what can be done and what should be done.

The general consensus from the expert opinion on the main reasons for failure of OSWWTS was:

1. OSWWTS installed in areas with unsuitable subsoil characteristics i.e. subsoils with inadequate percolation or inadequate attenuation.
2. Badly designed, installed and maintained OSWWTS.

8.5.1 Desktop Study

It becomes apparent, that the first critical stage of an inspection regime should be a desktop study where the following areas need to be investigated:

- The risk based methodology produced by the EPA and external consultants will need to be assessed along with the 1:40,000 scale risk maps. The intention is that these maps will be available at 1:40,000 scale for each local authority to help focus inspections on the relevant issues, such as the presence of ponding indicating inadequate percolation or the presence of outcropping bedrock indicating inadequate attenuation.
- Using information from Teagasc, the Environmental Protection Agency and Geological Survey of Ireland, the following features can be assessed on a broad scale:
    - Soil type – type of drainage and depth to water table;
    - Subsoil type – type of drainage and depth to watertable;
    - Depth to bedrock;
    - Location of karst features from the GSI karst database;
    - Aquifer type and importance and type of flow;
    - Vulnerability information;
    - Groundwater Protection Responses.

GIS data sets such as public sewer connections, public water supply sources and water bodies should also be investigated. Areas with public sewer connections need not be inspected, while OSSWTS located in close proximity to sources of public water supply should be towards the top of the hierarchy of inspection. This is because failing or poorly performing OSWWTS located in close proximity to sources of public water supply have the potential to cause detrimental health impacts to a large population. OSWWTS located in close proximity to water bodies such as streams, rivers and lakes also need to be considered carefully especially water bodies that have not yet met the 'good' water status for the Water Framework Directive where all water bodies must meet the 'good' water status by 2015.

Another element that should be considered during the desktop study is complaints that have been made in the past regarding poorly performing or failing OSWWTS or complaints of pollution associated with poorly performing treatment systems.

According to the Water Services Amendment Act 2012, the owner of each household with an on-site domestic wastewater treatment system is obliged to apply to the Water Services Authority, to have the treatment system entered into the register of wastewater treatment systems. This application can be made in writing or electronic form and should contain the following information:

- Name of applicant and address of where they normally reside;
- The address at which the domestic wastewater treatment system is located;
- Any other information that maybe prescribed by the Water Service Authority.

This register will provide a database of OSWWTS and shall be used to identify where each OSWWTS is located. However one hundred per cent compliance is unlikely and past planning permissions may have to be consulted to identify the locations of these systems.

From carrying out the interviews with experts, the point arose numerous times regarding the type and age of system which has been installed. Site assessments carried out post 2009 were carried out in accordance with the EPA CoP 2009 and are more thorough than previous assessments. For this reason, sites where the site assessment was carried out pre 2009 should be inspected first. The age and type of system is also critical when inspecting a site. The type of treatment system i.e. primary treatment or secondary treatment is important. While a secondary treatment system which is well maintained can easily meet the CoP performance standard of 20 mg/l BOD and 30 mg/l Suspended Solids, a poorly maintained secondary treatment system can result in a less well treated effluent than a poor performing septic tank.

The study entitled "Critical evaluation of On-site Wastewater Treatment Systems under Lightly and Heavily Loaded Conditions" (Carroll, 2011) was carried out in 2010/2011. Six weeks of testing was carried out in which five different types of on-site wastewater treatment systems were tested under light and heavy loading conditions. These systems were tested for Suspended Solids, Biochemical Oxygen Demand and Chemical Oxygen Demand in order to determine the level of treatment each treatment system was providing.

Table 8.5 summarises the type of treatment systems that were tested and its loading condition.

System No.	System Type	Loading Condition
1	Sequencing Batch Reactor	Lightly Loaded
2	Sequencing Batch Reactor	Heavily Loaded
3	Biological Aerated Filter	Lightly Loaded
4	Biological Aerated Filter	Heavily Loaded
5	Septic Tank	Lightly Loaded
6	Septic Tank	Heavily Loaded
7	Peat Filter	Lightly Loaded
8	Peat Filter	Heavily Loaded
9	Trickling Filter	Lightly Loaded
10	Trickling Filter	Heavily Loaded

Table 8.5: System Type and Loading Condition ***(Carroll, 2011).***

Table 8.6 below illustrates the results from each system after the 6 week period.

	Week 1			Week 2			Week 3			Week 4			Week 5			Week 6		
System	**S.S**	**BOD**	**COD**	**S.S**	**BOD**	**COD**	**S.S**	**BOD**	**COD**	**S.S**	**BOD**	**COD**	**S.S**	**BOD**	**COD**	**S.S**	**BOD**	**COD**
	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
1	42.00	3.29	17.30	/*	/*	/*	488.50	0.33	31.00	20.00	1.73	24.80	53.50	1.91	17.00	16.00	5.23	21.00
2	117.20	134	149.20	37.50	142.4	146.00	315.00	130.4	139.40	11.00	194.00	147.40	13.00	238.00	187.00	10.00	205.00	163.00
3	29.60	5.27	21.10	34.50	2.67	22.80	17.00	6.63	25.50	3.00	3.94	29.80	17.00	4.36	39.00	9.50	6.37	18.00
4	46.40	6.40	32.60	26.50	2.64	24.90	27.00	0.08	24.90	10.00	6.40	30.10	27.00	2.10	55.00	5.00	1.69	10.00
5	46.40	150	155.30	44.50	65.2	151.90	54.50	97.20	143.70	22.00	114.00	151.80	36.50	131.00	187.00	17.00	135.20	112.00
6	94.40	90	154.00	67.00	99.8	153.30	87.50	93.8	143.10	28.00	165.00	152.50	47.00	119.00	183.00	47.50	147.60	160.00
7	49.60	5.88	54.20	54.00	7.72	37.10	25.00	10.88	58.50	10.00	5.48	47.50	42.00	3.82	86.00	25.00	3.89	36.00
8	41.20	8.13	32.00	13.00	5.41	17.00	50.00	0.32	41.60	487.00	2.62	86.50	17.50	3.80	38.00	11.00	4.94	32.00
9	64.40	103	156.10	41.50	17.6	120.30	30.50	25.8	141.40	5.00	179.00	145.30	18.50	64.00	182.00	31.00	139.00	167.00
10	6.80	393	140.70	16.00	105.2	152.20	66.00	36.4	143.60	31.00	65.00	151.60	35.00	31.00	179.00	56.40	57.40	159.00

Table 8.6: Results Week 1-6 (Carroll, 2011).

Systems 5 and 6 are ordinary septic tanks (primary treatment) which both only received desludging once over a four to five year period. Results in table 8.6 show that treatment performance is relatively consistent over the six week testing period.

The rest of the treatment systems are mechanical secondary treatment systems. It is interesting to note that the degree of loading did not cause significant difference in the quality of treatment provided, but what could be seen were particular treatment systems operating to high and low standards.

Systems 3 and 4 the biological aerated filters and systems 7 and 8 which were peat filter systems performed consistently well over the six week period of testing. On the other hand systems 1 and 2 the sequenced batch reactor systems and systems 9 and 10 the trickling filters provided a very poorly treated effluent.

While maintenance was deemed to be a major issue for a lot of the poor performance, none of the above treatment systems were receiving regular maintenance. This gives the impression that certain mechanical systems are more durable than others and this must be considered when recommending OSWWTS for new builds and when remedial upgrades are being made (Carroll, 2011).

This testing confirms the point some of the experts were making, that a poorly maintained secondary treatment system can cause more of a risk to human health and the environment which can be seen if the test result from system 9 and 10 (Trickling filter) are compared to the test results from systems 5 and 6 (Septic tank).

8.5.2 Initial Inspection

Once the desktop study is completed and sites are selected for inspection, the inspector will then have to travel to the site to carry out the inspection. From the interviews carried out, the opinion is that an inspector should be degree qualified, completed the EPA inspector's course, have experience regarding inspections and possibly have completed the FÁS site assessor course. With this training and experience an inspector should be able to identify some of the characteristic suggested in the desktop study such as drainage type and permeability. This will be determined by visual inspection and should be carried out both on the way to the site and at the site location in a similar procedure to that of what

Tobins expert geologists and hydrogeologists use for updating the vulnerability maps. Several factors in the landscape need to be considered for this:

- The size of fields and use of land is the first thing to be considered. Normally large fields suggest good drainage in an area. For example large fields planted with crops tend to signify well drained soils compared to small grassland fields.
- The number of drains and ditches both in fields and along roads also gives a good indication to whether an area is well drained or poorly drained. Large amounts of drains and ditches signify that soils and subsoils in an area are poorly drained.
- Indicator plants for dry and wet conditions are one of the more obvious ways of assessing the drainage in an area and some of these indicator plants can be seen in plate 8.1 below.

The above observations are not an exact science, however combined with the information from the desktop study a relatively accurate assumption of the drainage and permeability of soils and subsoils in an area can be made without carrying out any invasive excavations/inspections.

Dry Conditions

Thistle

Bracken

Ragwort

Wet Conditions

Alder

Iris

Rush

Willow

Plate 8.1: Indicator Plants of Dry and Wet Conditions (EPA, 2009)

8.5.3 Site Inspection

Before an inspection can be carried out the Agency or Water Service Authority are required to provide at least ten working days notice in writing. It would prove advantageous if the homeowner was to be present during the inspection for several reasons which will be discussed; however, it is not essential.

On arrival to the site (providing that the homeowner is present), the inspector should meet the homeowner and record the following information:

- Homeowner name, address, phone number, email address;
- Number of occupants in the house;
- Year house built;
- Year OSWWTS installed or has it ever been upgraded (if they know);
- What type of OSWWTS is installed (if they know);
- Is there a percolation area or soakaway or neither (if they know)
- When was the OSWWTS last desludged and/or serviced, written proof necessary;
- Is there an on-site private drinking well;
- The inspector should record the GPS coordinates of the site in order to facilitate any future inspections that maybe necessary.

The next step of the inspection is to determine where exactly the OSWWTS is located. This can be as simple as looking out into the garden and seeing the covers of the OSWWTS as can be seen in plate 8.2 below.

Plate 8.2: Obvious OSWWTS locations

However, determining the location of the wastewater treatment system is not always so straight forward. Sometimes the system can be completely covered with clay and grass or even located in neighbouring fields as can be seen in plate 8.3.

Plate 8.3: Septic tank covered with clay (O'Rourke, 2012)

A cooperative homeowner may be able to outline where the tank is located and if not the inspector will be expected to use their training and experience to determine where the tank is located or if one even exists on the site.

If or when the location of the OSWWTS is determined, a sketch of the site layout and tank location should be carried out by the inspector.

Visual Inspection

Before the OSSWTS itself is inspected a visual inspection of the site should be carried out. The inspector needs to determine what kind of percolation is being provided if any. This can vary from site to site and can be difficult to determine without carrying out intrusive excavations. Sites with raised percolation beds, sand filters or constructed wetlands are easily identifiable, however, conventional percolation trenches or soakaways can be more difficult to recognise.

In the case of percolation trenches and soakaways the inspector maybe able to identify venting which may outline if and where these are located. In areas with low permeability subsoils and poor percolation, evidence of ponding may also indicate where the percolation area is located. Note: this is a major health and environmental risk. Plate 8.4 below illustrates ponding from a percolation trench. If ponding is detected this is a clear indicator of inadequate percolation. This would be cause for a site inspection to fail and would require remedial works such as imported clay and the construction of a raised percolation bed or extended percolation trenches or tertiary treatment followed by discharge into surface water.

Plate 8.4: Ponding from percolation area (Daly, 2005).

Ponding is as result of inadequate percolation, where the treated effluent in a percolation area is unable to percolate downwards through the subsoil and is forced upwards to the surface. This can also happen if the percolation area becomes blocked from poorly treated effluent or fats, oils and greases. Apart from ponding, blocked percolation areas or percolation areas with low permeability soils can cause OSWWTS to back up through the pipework as far as the house.

The inspector should identify any inspection chambers, manholes or AJ's (access junctions) both before and after the OSWWTS. The inspector then should examine the areas around these points for any evidence of overflow.

Any watercourses, drains, streams, rivers etc should be identified by the inspector, recorded on the site layout diagram and inspected for any signs of pollution. In a lot of cases where no percolation exists or where ground conditions are not suitable to provide adequate percolation areas, pipes can be found running from percolation areas or directly from the OSWWTS into adjacent drains, ditches, streams, rivers etc. This is unacceptable and should immediately constitute a site failing the inspection. Direct discharge of a partially treated effluent causes risk to water quality and risk to human health. Plate 8.5 below outlines a typical example of a pipe from OSWWTS discharging into a stream.

Plate 8.5: Discharge of partially treated effluent into stream (O'Rourke,2012)

Examining plate 8.5, it can be seen that the effluent discharges from the pipe and flows from left to right. A bluey/grey discoloration of the water and soil can be observed.

However, discharge into water courses may not always be as obvious as the one demonstrated above. Pipes will sometimes be hidden or in overgrown vegetation. Discharge/pollution may not be obvious in the watercourse either as discharge may only occur at certain periods in the day depending on the quantity of water used in the household or the cycle of mechanical systems for example sequence batch reactor systems only discharge to the percolation area at certain timed periods.

If the inspector suspects that discharge into a water body is occurring but there are no obvious signs water samples should be taken upstream and downstream of the OSWWTS or else dye testing could be used.

For sites containing private wells, the location of the well should be recorded on the site layout diagram. Separation distances should be measured between the well and OSWWTS.

The inspector should also observe and record if the well is situated upstream or downstream of the OSWWTS.

During the visual inspection of the site the inspector should be conscious of any odours existing. Odours from OSWWTS provide a nuisance and often suggest inadequate performance of an OSWWTS.

Auger Testing

As discussed earlier from the interviews with the experts and from the questionnaire sent to the Local Authorities, inappropriate geology and subsoils was shown to be the number one reason for failure of OSWWTS. Ideally when carrying out an OSWWTS inspection a trial hole should be dug to investigate the subsoil type and to assess if the site is suitable for the OSWWTS which is installed. However it is not practical to dig trial holes at each site for each inspection as this is costly to do and in a lot of cases these would have to be dug in the homeowner landscaped gardens.

Instead trial holes should only be used where there is clear evidence of failure and to aid inspectors issuing site appropriate recommendations for remedial works.

For this reason a more non-invasive method of determining the composition of the subsoil is required. Soil samples can be obtained using a hand auger as displayed in plate 8.6 below. Samples can be retrieved down to a depth of 1.5 meters. Provided that the sample extracted is a sample of subsoil and not topsoil British standard subsoil classification tests can be carried out.

Plate 8.6: Hand Auger in use

British Standard Subsoil classification tests

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.*

- Take the sample and remove particles larger than 2mm, as far as possible.
- Crush clumps of subsoil and breakdown the structure of the sample.
- Slowly add water preferably as a 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 and see if it sticks together.

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

- Ensure the sample is of the consistency of putty. Add extra water or sample to moisten or dry the sample.
- Ensure no particles greater than 1-2 mm in the prepared sample.
- Gently roll a 3mm diameter thread across the palm of your hand.
- If a thread can be rolled, break it and try to re-roll without the addition of water.
- Repeat until the thread can no longer be rolled without breaking.
- Record the number of threads rolled.
- Repeat the test at least twice per sample.

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

- Ensure the sample is of the consistency of putty. Add extra water or sample to moisten or dry the sample.
- Ensure no particles greater than 1-2 mm in the prepared sample.
- For your moist sample into a large roll in your hand approximately the thickness of your thumb.
- Using your thumb press the sample over your index finger to form a uniform ribbon about the width of our thumb and 0.5 cm thick. Let this ribbon hang over

your index finger and continue to extrude the ribbon between thumb and index finger until it breaks.

- Measure the total length of the formed ribbon when it breaks and repeat this test at least 3 times per sample.

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

- Wet the sample such that it is slightly wetter 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.
- Jar the sample five times by slapping the heel of your hand or the ball of your thumb. Assess whether the water rises to the surface or not, and how quickly it does so.
- Squeeze the sample, again assessing 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.

Using the data from the above four tests in conjunction with the British Standard subsoil classification chart displayed below, the subsoil can be classified.

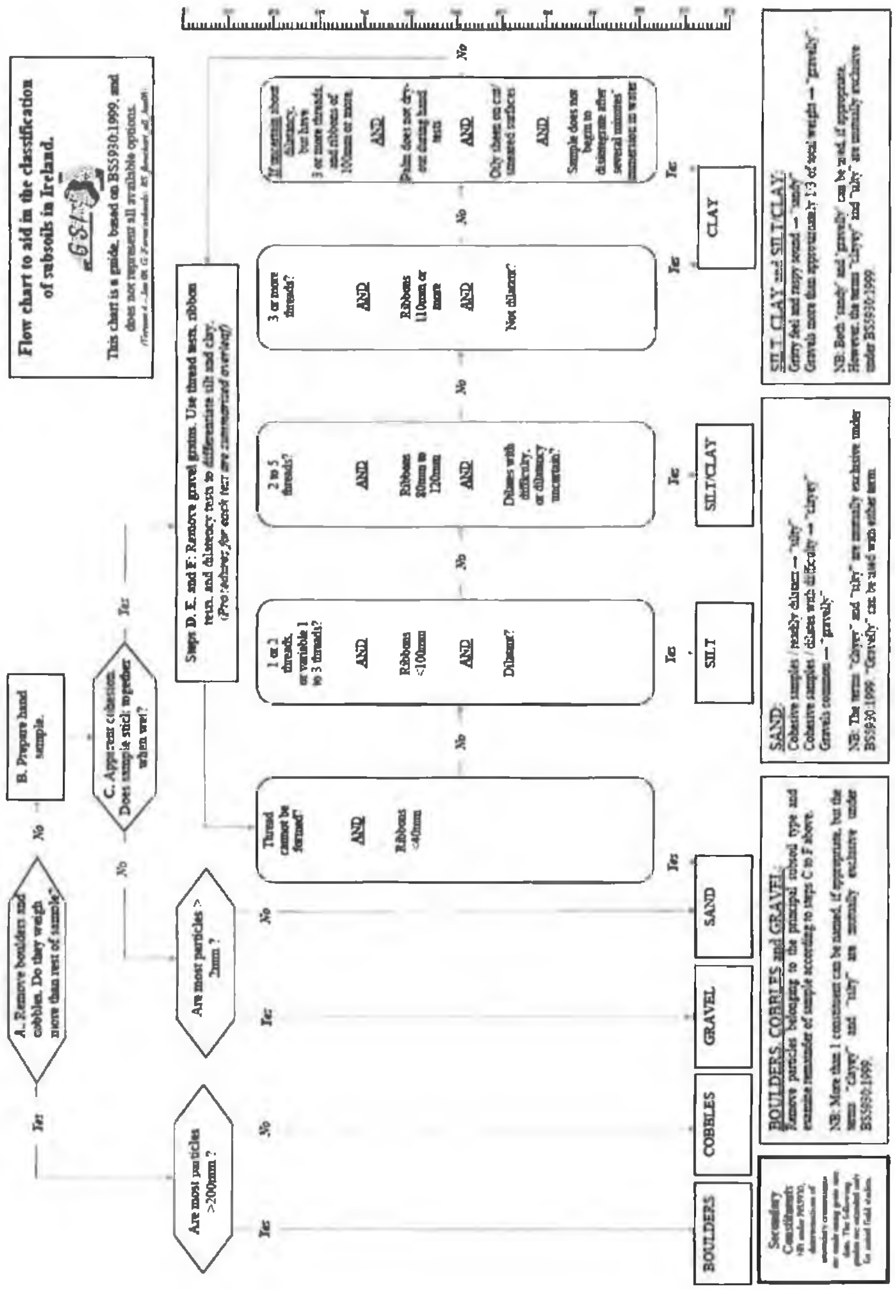

Figure 8.4: British Standard Subsoil Classification Chart

These tests are not an exact science, however combined with the information from the desktop study should give an indication of the site characteristic and if further investigation is required.

OSWWTS which have been poorly designed, constructed or installed have the potential to be leaking. OSWWTS constructed with blockwork are prone to leakage. An example of this can be seen in plate 8.6.

Plate 8.6: Poorly constructed Septic tank (Daly, 2005).

A leaking OSWWTS can produce a large environmental risk, however when the system is installed and backfilled it is next to impossible to diagnose the problem without carrying out intrusive excavations around the tank.

The hand auger could be used at each side of the tank to carry out a non-intrusive inspection. Samples retrieved using the hand auger could be assessed for any signs of contamination. If evidence is found of contamination, further more intrusive investigations could be carried out. Evidence of contamination may include odour and/or discolouration. Samples could also be compared to samples from other parts of the site. Protective gloves should be worn when carrying out this examination.

Note: when carrying out auger tests around OSWWTS tanks care should be taken not to damage any inlet or outlet pipes.

OSWWTS Inspection

At this point the inspector should have already located where the OSWWTS is on the site. The homeowner may have outlined to the inspector at the beginning of the inspection what kind of OSWWTS is installed or they may not know. Either way the inspector needs to confirm from inspection what type of system is installed. The inspector's knowledge and understanding of wastewater treatment systems is critical to determine this.

In the case of septic tanks, it is usually relatively easy to determine from the types of lids or by removing the inspection lids and examining the tank and observing no mechanical or electrical components.

Secondary treatment systems can be identified easily in some cases and not so easily in other cases. Secondary treatment systems often have distinctive lids or covers with company branding/logos.

Plate 8.7: Oakstown BAF, Kingspan RBC Secondary Treatment Systems

For example Plate 8.7 shows an Oakstown BAF treatment system and the Kingspan RBC system. These systems are easily identifiable from their covers however where unsure the inspector should open any inspection covers to determine what treatment processes are occurring.

A problem for both primary and secondary treatment systems is the use of incorrect lids and risers. The use of inappropriate lids such as pallets, railway sleepers etc. can often be seen. This causes to kinds of problems, firstly a risk to human safety and secondly more rainwater and surface water can enter the tank.

Plate 8.8: Inappropriate lids of septic tanks (O'Rourke, 2012).

Another issue arising is where OSWWTS have to be installed deep in the ground due to the levels on the site. Risers are provided by most manufacturers to raise the lids to ground level even though the tank maybe a couple of meters below ground level. Where these are used it is essential that the risers are properly sealed to avoid the ingress of water through the risers and into the OSWWTS. The risers also need to be raised to at least ground level to avoid surface water entering into the system.

Plate 8.9: Example of risers used to raise the level of the inspection covers to ground level

Next the operation of the OSWWTS needs to be inspected. The inspector should remove the inspection covers of the OSWWTS if not already removed.

The inspector should visually assess each chamber of the OSWWTS for any sign of malfunction. The inspector may need to use a flash lamp to aid with this. Unfortunately it will be very difficult for the inspector to inspect for items such as missing T-pieces on inlet and outlet pipes but the general structure of the system can be assessed for example whether baffle walls are present or in the case of mechanical treatment systems that pumps and compressors are present.

The level of sludge in the tank needs to be assessed. A piece of apparatus should be developed for determining this. A transparent pipe with a vacuum pump at the top could be developed to take a sample from the settlement chamber which would represent a cross section of the level of sludge in the tank. This would determine the level of sludge in the tanks and if desludging is required. From a maintenance point of view the Water Services Amendment Act outlines how often an OSWWTS needs to be desludged depending on tank size and number of occupants in the house.

Tank Size (Litres)	No. of People 1	2	3	4	5	6	7	8	9	10
2,250	5.8	2.6	1.5	1	0.7	0.4	0.3	0.3	0.1	
3,400	9.1	4.2	2.6	1.8	1.3	1	0.7	0.6	0.4	0.3
4,500	12.4	5.9	3.7	2.6	2	1.5	1.2	1	0.8	0.7
5,700	15.6	7.5	4.8	3.4	2.6	2	1.7	1.4	1.2	1
6,800	18.9	9.1	5.9	4.2	3.3	2.6	2.1	1.8	1.5	1.3
8,000	22.1	10.7	6.9	5	3.9	3.1	2.6	2.2	1.9	1.6

Table 8.7: Estimated desludging frequency per year (Government of Ireland, 2012).

The next part of the inspection is to determine what wastes are being piped to the OSWWTS. All wastewater from the dwelling should be directed to the OSWWTS, this includes wastewater from the toilets and grey water which comes from baths, showers, sinks, dishwasher and washing machine. No surface water from the roof should enter this system.

Firstly the inspector should run water into a gulley at the bottom of a downpipe from the gutters. The inspector should then monitor the manhole nearest to the OSWWTS for any flow. No flow should be observed if the surface water is not connected to the OSWWTS.

Note: Homeowners should be informed not to drain any water in the house during this inspection.

Provided there is cooperation from the homeowner the next thing that should be inspected is if grey water is being piped to the treatment system. Inform the homeowner to run a few taps inside the house. The inspector should monitor the manhole nearest to the OSWWTS for any flow. If the grey water is entering the OSWWTS flow of water should be observed.

With respect to secondary treatment systems which have electrical or mechanical parts it can be nearly impossible for an inspector to know if pumps and compressors are working efficiently or at all. If these components are not working correctly little or no treatment of the wastewater may be taking place. This has potential to cause risk to human health and the environment.

Most secondary treatment systems have control panels. These control panels show whether the systems are powered on or not and often have alarms to signify any malfunctions. These control panels are normally located either beside the fuse board in the dwelling or beside the fuse board in the garage. Permission from the homeowner will be required to inspect this.

As discussed above, it can be very difficult to assess the level of treatment being provided by the system and its mechanical components. The quality of the treated effluent can be used as a good assessment of how well the treatment system is performing. A treated effluent of poor quality would suggest that some of the key components are not working to the required standard and servicing maybe necessary.

Samples of treated effluent can be retrieved from either the final chamber of a treatment unit, a distribution box before the percolation area or else some systems have built in sampling bottles as illustrated in plate 8.10 below.

Plate 8.10: Sampling points

The CoP states the performance standards that a secondary treatment system should meet as no greater than 20 mg/l BOD and 30 mg/l Suspended Solids (SS). However, it is not practical to carry out laboratory testing on samples from every inspection.

Visual assessment of the samples can give an indication of the quality of the treated effluent to the inspector. Once the sample is retrieved it needs to be placed in a transparent container to be assessed. The colour of the sample combined with turbidity or presence of suspended solids should be considered. The odour from the sample should also be considered. The clearer and crisper the sample looks usually mean the better the quality of the sample.

Plate 8.11 below displays samples of treated effluent taken from ten OSWWTS as part of the thesis "Critical evaluation of On-site wastewater treatment systems under lightly and heavily loaded conditions"

Plate 8.11: Samples of treated effluent before incubation

After testing in the laboratory samples 3 and 4 from BAF treatment systems were best treated followed by samples 7 and 8 from Peat Filter treatment systems. It is quiet clear from the photographs that these samples look the clearest and least turbid. It is interesting to note that samples 3 and 5 are distinctively green in colour. After several weeks of testing it was discovered that this was as a result of the use of deodorant toilet cube blocks.

In order to reaffirm the point that a visual assessment of the treated effluent can give a good indication of the quality of the effluent plate 8.12 below shows the effluent samples before incubation more clearly.

Plate 8.12: Samples of treated effluent before incubation

The left hand picture clearly displays that sample 2 and sample 5 are a lot cloudier i.e. have high turbidity than sample 3 and 4 which are very clear.

The picture on the right hand side shows samples 9 and 10. These effluents are extremely poorly treated and it is clear from visually examining the samples that the OSWWTS are malfunctioning badly.

In cases where the inspector maybe unsure of the quality of the treated effluent a portable turbidity meter can be used.

The Hach TSS Portable Hand-held Turbidity, Suspended Solids, and Sludge Blanket Level Instrument's unique multi-beam alternating light method with infared diode system gives it a broad measuring range for both turbidity and suspended solids in one portable handheld instrument.

Plate 8.13: Hach TSS Portable Hand-held Turbidity, Suspended Solids, and Sludge Blanket Level Instrument (Hach, 2012)

The final area to be inspected is the distribution box after the treatment unit before the percolation area. Not all OSWWTS will have a distribution box but inspection of the distribution box can give an insight to how well the percolation area is performing. Distribution boxes should be installed level with an equal flow of treated effluent entering each outlet. The installation of distribution boxes should be inspected to ensure even distribution of flow to each percolation trench. Plate 8.14 below shows a properly installed distribution box.

Plate 8.14: Properly installed distribution box (Cooney, 2012)

A distribution box where the level of water is above the invert of the pipes suggest either the water table is higher than the pipes in the percolation trenches and the effluent cannot be distributed or else a blockage in the percolation area exists. Plate 8.15 demonstrates this below. In either case further investigation would be required in the form of invasive excavations.

Plate 8.15: Evidence of high water table or blocked percolation (Cooney, 2012)

A thorough inspection will be achieved if all the above aspects are considered. All failures or malfunctions should be recorded by the inspector and appropriate photographic evidence.

Note: When carrying out inspections all Health and Safety procedures should be adhered to.

The above section outlines all the aspects that should be considered when carrying out an inspection. In order to provide a standardised systematic approach for inspectors to follow, an inspection form was developed and can be seen in Appendix 3.

9.0 Discussion

This project is intended to evaluate the development of an inspection regime for on-site domestic wastewater treatment systems. The main aims of this report were to:

- Investigate the reasons why Ireland as a country has to develop a national inspection plan for the 450,000 domestic on-site wastewater treatment systems in unsewered areas of the country and how this is being enforced by the European Court of Justice.
- Ascertain fundamental criteria for developing an inspection plan by interviewing experts working and carrying out research in this field.
- Develop a thorough inspection regime which could be implemented across the country in a practical manner.
- Identify how a risk based site selection methodology should be developed in order to inspect the sites at the highest risk first.

In order to achieve these aims a large amount of background research was required to develop a comprehensive understanding of the history and operation of OSWWTS and the risks associated with inadequate wastewater treatment.

Background information was reviewed on the development of domestic wastewater treatment from the time of the first use of septic tanks which can be traced back to the middle of the 19th century in France. Septic tank systems only provide primary treatment where the suspended solids settle out of suspension to form a sludge which undergoes anaerobic breakdown. Septic tank effluent is a highly polluting liquid which contains faecal bacteria, nitrogen, phosphorous, organic matter and other constituents. A well maintained septic tank is capable of removing up to 50% of solids and between 15-30% of the pollutant load in terms of BOD. Septic tank effluent still poses a risk after being treated in the septic tank and needs to be followed by a percolation filter, where the effluent from the septic tank percolates into the soil through a network of pipes.

In recent decades secondary treatment systems have been developed. There are certain sites that are not suitable for septic tank systems due to low permeability soils which lead to inadequate treatment taking place in the percolation area. Properly maintained secondary treatment systems provide a higher degree of treatment than conventional septic tank systems and a properly sited, designed, constructed and maintained secondary treatment system is capable of meeting the requirement of the CoP for effluent quality of 20 mg/l BOD and 30 mg/l Suspended Solids.

The large range of treatment options mean that inspectors carrying out the OSWWTS inspections will need to be appropriately trained and competent in all aspects of wastewater treatment for the purposes of examining existing treatment systems and proposing remedial works.

One of the major reasons behind the national inspection plan is to eliminate risk to human health and the environment caused by poorly performing OSWWTS. Effluents from OSWWTS contain many substances that are potentially harmful to human health and the environment. The following infectious agents can all be found in significant amounts in domestic wastewater pathogenic bacteria, infectious viruses, protozoa, putrescible organic matter and toxic chemicals. All of these agents are potentially harmful to human health from direct contact or if water and food sources becoming contaminated. E.coli, salmonella and cryptosporidium are just some of the infections that can be caused from wastewater contamination. These infections have been well publicised in the media over recent years with numerous outbreaks recorded in water supplies across the country resulting in large communities being affected and a number of fatalities from such infections.

Apart from the directly harmful substances, wastewater is also a source of nutrients which can lead to eutrophication in receiving waters. Poorly performing OSWWTS have the potential to be one of the many sources of nutrients in ground and surface waters. A range of negative ecological effects can occur from nutrient enrichment such as excessive growth and proliferation of plants which results in loss of water clarity and a reduction in oxygen levels. This can lead to increased mortality of aquatic life an excessive growth of algae and lead to taste and odour problems in water.

With the increased pressure from the Water Framework Directive that all water bodies have "good" water status by 2015, it is imperative that all OSWWTS potentially causing a risk to human health or the environment are identified, inspected and remedial works carried out where necessary.

Regulatory and planning aspects were reviewed, which consider the regulations related to domestic wastewater treatment from the past and the present. The Water Pollution Act states that domestic wastewater with a volume less than 5 m^3/day, which is discharged from an OSWWTS through a percolation area into an aquifer does not require a discharge licence. However, discharge of wastewater effluent to a water body requires a discharge licence. Having carried out interviews with experts in the wastewater field, the general opinion was a modified less stringent discharge licence needed to be developed to accommodate sites which are not suitable for ground discharge due to unsuitable soil conditions. While a modified discharge licence is needed, tertiary treatment should be provided for any effluent which will be discharged to water bodies thus improving the standard of wastewater effluent further.

The building regulations from 1991 to 2010 referred to SR6 1991 for guidance on all aspects of wastewater treatment. The 2010 building regulations now refer to the EPA Code of Practice for Wastewater Treatment Systems for single houses, 2009 and this is the most up to date guidance manual. All new developments have to comply with the standards set in this guidance manual. This document outlines performance standards that should be met by OSWWTS, however, Section 6.6 states that OSWWTS installed pre 2009 may fail to meet these performance standards and in this case corrective actions must be taken which will provide improved treatment and reduced environmental impact.

Ireland is required to develop a National Inspection Plan in order to comply with the EU Waste Framework Directive in particular Articles 4 and 8 which require that waste is recovered or disposed of in a way which does not endanger human health or the environment. This should be done without:

- Risk to water, air, soil and plants and animals;
- Causing a nuisance through noise or odours;
- Adversely affecting country side or places of special interest.

However, even if an OSWWTS is perfectly designed, constructed, installed and maintained there is still some element of risk to the above. Treated effluent is being discharged to either the ground or into surface water and if malfunction occurs there is a risk to human health and the environment.

The ECJ ruled that if Ireland did not to put legislation in place to comply with Articles 4 and 8 of the Waste Framework Directive then financial penalties would be imposed on

Ireland consisting of a €2.7 million lump sum and €26,173 per day as long as the infringement continues.

The Water Services Amendment Act 2012 came into force in February 2012 and this piece of legislation set the legal framework for the development of a National Inspection Plan. This Act sets the framework for the appointment of Inspectors including the training process, powers of inspectors and the procedures to be followed for sites that both pass and fail the inspection. The inspector will be required to recommend remedial works where necessary and if homeowners do not comply they will be subject to Class A fines. The EPA is currently developing a training programme for inspectors and a national inspection plan.

Results from a questionnaire which was sent to Local Authorities were analysed. This questionnaire investigated what Local Authorities considered to be the main reasons for failure of OSWWTS, the types of inspections carried out and the resources available to Local Authorities. Interviews were then carried out with several experts in the domestic wastewater treatment field. These interviews focussed on the experts own personal opinions, including:

- The main reasons for the failure of OSWWTS;
- Solutions to rectify these;
- The key areas that need to be inspected;
- What an inspection should entail and the competency of inspectors.

The information from the questionnaire and the interviews proved to be very beneficial when developing an inspection regime.

As there are approximately 450,000 OSWWTS in Ireland a system needs to be developed to ensure the sites causing the most potential risk to human health and the environment are inspected first. The EPA, GSI and external consultants have developed risk based methodology in order to assist in site selection; however this is at draft stage and is currently not available to the public. Section 8.2 to section 8.4 discusses potential measures that could be used when developing a risk based methodology for site selection. These sections suggest using a procedure similar to how ground water protection schemes are implemented, taking account of subsoil maps, aquifer maps and vulnerability maps. Initial inspections should be focussed in high vulnerability areas and areas located in close proximity to drinking water sources. However, since this, the EPA kindly provided a copy of a draft paper which outlines the key aspects of the risk based methodology which they have developed. The EPA have developed risk maps which assess the following:

- Housing Density;
- Distribution of susceptibility categories for inadequate percolation;
- Relative risk of water pollution from MRP and Pathogens via the surface pathway;
- Relative risk of water pollution from MRP and pathogens via the subsurface pathway;

The risk of areas will be defined using the above parameters and areas with the highest risk will be inspected first.

The background research, questionnaire analysis and interviews with experts, formed the basis for developing an inspection regime. Past experience from completing the thesis "Critical Evaluation of On-site Wastewater Treatment Systems under Lightly and Heavily loaded Conditions" also helped in the development of the inspection regime.

The main aim of this project was to develop a thorough OSWWTS inspection regime which could be implemented in a practical manner. Information from both the questionnaire and the interviews showed that the main reason for poor performance of OSWWTS was due to inadequate soil conditions followed by poor design, installation and maintenance. For these reasons the first stage of the inspection plan is carrying out a desktop study to determine as much information about the site and system conditions before carrying out the site inspection. Information such as, soil type, depth to bedrock, proximity to water sources, age of dwelling and OSWWTS and past complaints should all be examined at the desktop study stage.

As many non invasive inspections as possible should be carried out during the site inspection due to the cost of carrying invasive inspections and the cost of repairing the associated damage. For this reason, the drainage characteristics should be assessed on the way to the site inspections and at the site. Drainage characteristics can help confirm the soil and permeability types outlined from the desktop study or else provide the basis for further inspection.

A three page inspection form was developed to provide a standardised, systematic approach to be taken by inspectors when carrying out the site inspection. Page one outlines the information that needs to be recorded from a consultation with the homeowner. Site address, GPS coordinates, contact details, number of occupants, system type and age, and maintenance records all need to be discussed with the homeowner. The homeowner may not be able to provide all of this information; however, all information will need to be confirmed by the inspector during the inspection.

Page two of the inspection form is divided into four parts dealing with the site inspection. Part 1 – Visual Site inspections outlines the feature that should be inspected during the visual assessment. The most important aspects of the visual inspection are determining where the OSWWTS is located, if there is a percolation area and what type it is. Evidence of pollution or risk to human health needs to be examined such as ponding, overflow or direct discharge into water bodies. Location of private wells and separation distances also need to be assessed.

Part 2 – Auger Test, this section deals with two aspects of the site inspection. A hand auger is a simple, cheap and relatively non invasive way of inspecting ground conditions. Subsoil samples can be retrieved using the hand auger and British Standard test can be carried out to characterise the type of subsoil and its permeability. The inspection plan suggests the use of the hand auger at each side of the OSWWTS tank to inspect for any leakage or contamination of soil. Sample taken from each side of the tank can be retrieved. These samples can be compared to other samples from around the site and the colour, smell and texture examined for any sign of contamination. The auger tests are a cheap and simple method to determine if more substantial invasive tests are required.

Part 3 – OSWWTS Inspection, this is possibly the most technical part of the inspection where the treatment system itself is assessed. Firstly, the type of treatment system needs to be identified which can be as simple as identifying the lids on the system or in other cases the treatment process will need to be analysed, either way the inspector needs to be competent. In the case of a septic tank, the level of sludge and the structural integrity of the tank are the only two things that can be examined. However, mechanical systems require a more thorough inspection and it can often be difficult to determine if each mechanical and electrical component is operating to an adequate standard. The inspection plan outlines that the best way of determining the performance of a treatment system is by assessing the quality of the treated effluent. The colour, turbidity and odour from the treated effluent give an indication as to whether the treatment system is operating poorly or not. If it is deemed to be providing poor treatment a full service of the system may be required. In cases where the inspector may not be sure of the quality of the treated effluent a handheld suspended solids meter can be used. Again inspectors need to be competent to retrieve the samples from the OSWWTS and assess their quality.

For systems that have a distribution box before the percolation area, a visual assessment of this can provide evidence of a blocked percolation area or a high water table if the level of the water raises much above the invert level.

A sketch of the site should be completed on page three of the inspection form. Details such as, OSWWT and percolation area location, well location, water body location, separation distances and any other important feature should be recorded on this.

The inspection plan which was developed provides a thorough inspection procedure which can be used for each site condition. Site inspections should not be subjective provided inspectors receive the same training and follow the same inspection procedure. The competency of inspectors shall be crucial when carrying out OSWWTS inspections and appropriate training will have to be provided if the national inspection plan is to be implemented in a fair and effective manner.

As discussed in earlier chapters, Ireland is legally required to implement a national inspection plan in order to comply with the ECJ ruling. The Water Services Amendment Act 2012 has set a good foundation to meet these requirements and is without a doubt a step in the right direction. The EPA is currently developing a National Inspection Plan, Risk Based Methodology for site selection and a training course for inspectors. From the interviews carried out, the general opinion is that the National Inspection Plan will be achievable but to what degree is unclear. With approximately 450,000 OSWWTS installed in Ireland it is likely to take up to twenty years or longer if every OSWWTS is to be inspected.

However, the issue of remedial works has the potential to cause more problems than the inspection itself. The most common reason given for OSWWTS failure from both the questionnaire and the interviews was unsuitable ground conditions. It is often the case that houses have been built on sites which are not suitable for onsite domestic wastewater treatment. No exact solution to rectify this entirely may exist and measures will have to be taken to reduce the risk to human health and the environment. It is the duty of the inspector to recommend what remedial works are necessary. Where the problem may arise is if the inspectors recommendations are carried but do not improve the situation on site. In this case, will the homeowner be liable to carry out a new set of recommendations after already doing what was asked of them or will the inspector be liable for not providing an adequate solution. This issue needs to be dealt with clearly to protect both parties. A possible solution may be to create a clause stating that recommended remedial works are subject to further investigation.

Remedial works will be difficult to determine for certain sites, however, this issue extends beyond the scope of this project and further research is needed in the area by the EPA and other bodies.

10.0 Conclusion & Recommendations

10.1 General

Onsite wastewater treatment systems are recognised as being an appropriate and effective means of treating daily household flows. Improper treatment of this waste or a system malfunction can lead to a risk of Public Health and environmental contamination.

The European Court of Justice ruled that Ireland were not complying with the EU Waste Framework Directive and in particular Article 4 and Article 8. If this non-compliance is not rectified Ireland will be subjected to substantial fines. Measures are currently being put in place to overcome this non compliance. Amendments were made to the Water Services Act and a National Inspection plan for OSWWTS is being developed by the EPA along with a training course for inspectors. There are approximately 450,000 OSWWTS in Ireland and for this reason a Risk Based Methodology has been developed to aid with site selection with sites at highest risk been inspected first.

The Aims and Objectives as outlined in section 1.2 have been achieved. One of the objectives was to ascertain fundamental criteria for the development of an inspection regime by interviewing experts in the field. The most critical findings from these interviews were:

- The main reasons for the failure of OSWWTS is inadequate soil and subsoil conditions, followed by poor siting, design, installation and maintenance.
- For sites with inappropriate ground conditions to provide adequate attenuation or percolation, the formation of a modified discharge licence needs to be considered.
- An inspection regime should take a standardised approach to limit any subjectivity, however all different scenarios and risks must be assessed.
- The competency of an inspector is critical and an inspector should meet a minimum of the following criteria, degree in Civil Engineering/Hydrology/Geology/ Environmental Science, completed the EPA Inspector course and have 3-5 years experience in the wastewater sector.
- Any factor that causes risk to human health or the environment should result in the site failing the inspection.

The main focus of this project was to develop an inspection regime for onsite domestic wastewater treatment systems. This was successfully achieved and a comprehensive inspection regime was developed. A large amount of background research on the history of wastewater treatment, risks to human health and the environment, regulatory and planning aspects was required to form a strong understanding of the key aspect to be considered when developing an inspection regime. The questionnaire analysis and interviews with experts also provided invaluable information regarding the development of an inspection procedure.

From carrying out interviews with experts in the wastewater field it was determined that a standardised approach is necessary if the inspections are to take place in a fair consistent manner. For this reason an inspection form was developed which can be seen in Appendix 3. This form provides a format in which the inspector can follow when carrying out an inspection.

Initially one of the main objectives was to develop a risk based method for site selection and a method similar to groundwater protection schemes was proposed. However the EPA made available a draft paper outlining how their risk based methodology will operate. Risk maps will be produced using the following parameters:

- Housing Density;
- Distribution of susceptibility categories for inadequate percolation;
- Relative risk of water pollution from MRP and Pathogens via the surface pathway;
- Relative risk of water pollution from MRP and pathogens via the subsurface pathway;

Sites which are deemed to present the highest risk to human health and the environment shall be inspected first.

10.2 Recommendations

In achieving the specified research aims and objectives the following are a list of recommendations:

- The inspection regime and form should be trialled by inspectors over a specified period and subjected to a consultation period where any issues with the regime can be addressed.
- Further research is necessary in the area of remedial works. A range of solutions should be developed to facilitate problems encountered in different site conditions.
- The issue regarding the liability when an inspector makes recommendations for remedial works needs to be further clarified to protect both the inspector and the homeowner.
- A manual should be developed for homeowners, outlining what an inspection shall consist of and instructions for what to do to ensure their OSWWTS is performing to an adequate standard. These manuals should be distributed to homeowners after they register their OSWWTS.
- Maintenance of onsite wastewater treatment systems is vital to ensure the OSWWTS is operating correctly; careful monitoring should take place and servicing on a yearly basis. For this reason all homeowners should be obliged to hold maintenance contracts as part of planning conditions.
- Enforce requirements for desludging and EPA Code of Practice in order to overcome the inherent risks associated with the poor performance of OSWWTS.

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APPENDIX 1

QUESTIONNAIRE

Q1. Name of your Local Authority? _______________

Q2. How many people are involved in investigating Septic tanks and Onsite Wastewater Treatment systems (OSWWTs?

Full Time: __________________

Part time (As part of their duties) _______________________

If part time what percentage of time is given to these investigations?

____

Q3. Are inspections of OSWWTs carried out on a planned (Proactive Basis)? No

(If No please go to Q7)

If Yes what is the basis for selecting sites for inspection?

- EPA Q value monitoring results ____
- History of complaints and non compliance in the area ____
- Drinking water supplies in the area ____
- Area identified in River Basin District Plans ____
- Area identified as having high vulnerability and heavy soils ____
- Other reasons (If other please give details) ____

____

____

____

Q4. How many planned inspections of septic tanks and OSWWTS are carried out each year?

Q5. Are these inspections carried out at specific times of the year?

____

Q6. What do **proactive site inspections** involve?

- Visual inspection of the tank location for signs of ponding Y/N
- Dye Testing Y/N
- Examination of the curtilage of the dwelling Y/N
- Check grey water drainage is connections. Y/N
- Examination of adjoining landdrains Y/N
- Checking of the septic tank/treatment system for levels of sludge Y/N
- Check to see if records of desludging available. Y/N
- Other checks (If other checks please give detail) Y/N

____

____

____

Q7. How many inspections are carried out as a result of complaints per year (on average)? _______

Q8. What do **complaint site inspections** involve?

- Visual inspection of the tank location for signs of ponding Y/N
- Dye Testing Y/N
- Examination of the curtilage of the dwelling Y/N
- Check to see where grey water drainage is connected to. Y/N
- Examination of adjoining landdrains Y/N
- Checking of the septic tank/treatment system for levels of sludge Y/N
- Check to see if records of desludging available. Y/N
- Other checks (If other checks please give detail) Y/N

____

____

____

Q9 How many visits are carried out to the site (including the initial inspection)?

- If found to be compliant. ____________________
- If found to be non compliant (On average ____________________

Q10 Please rank the following in terms of the causes of unsatisfactory OSWWTs that you have encountered?

- System not desludged ____
- Pumps and other electrical or mechanical components faulty and not repaired ____
- Unlicenced direct discharge to surface water ____
- Grey water connected to a soakaway and not to the treatment system ____
- Ground conditions unsuitable for the hydraulic loading from the system ____
- Percolation area compacted or built upon ____
- Septic tank or treatment unit cracked and leaking ____

Q11 Which of the following best describes the follow up activities involved in tackling non compliances
(If a number of the following steps are carried out please rank in order of greatest frequency e.g. 1, 2, 3)

- A programme of works is outlined to the householder and they are asked to complete them within a set timeframe and this is done in letter form. ____
- Proposals are requested from the property owner ____
- A notice is issued under Section 12 of Water Pollution Acts on the property owners to carry out certain works within a set timeframe ____

- A notice is issued under Section 23 of Water Pollution Acts requesting information to be submitted. ______

- In cases of discharge to a water course the property owner is prosecuted immediately under Section 3 of Water Pollution Acts. ______

Q12 If proposals are requested from the property owners which of the following standards are accepted? (Please Tick main approach taken)

- All proposals show compliance with 2009 EPA Code of Practice ________

- The owner or his agent cannot show compliance with the 2009 Code of Practice but the proposals are the best practical solution and show an improvement treatment onsite and is ""Fit for Purpose" ________

- Other (Please specify)

____

____

____

____

Q13 Which of the following are considered when assessing the proposals submitted? (If more than one factor is considered please rank in order of importance).

- Public Health issues e.g. drinking water wells ____
- Surface and ground water quality ____
- Cost ____
- Public Nuisance ____
- Type of system proposed & detail of the proposals ____
- Other (Please specify)

____

____

Q14 Do you accept technical solutions/systems to existing malfunctioning systems that are non Irish Agréement Board or EN12566 certified? Y/N (If yes please provide details)

Q15 The Environmental Protection Agency is presently developing a site inspection regime for the inspection of onsite waste water treatment systems. Do you envisage LA staff will carry out these assessments? Y/N

Q16 In addition to this new inspection regime, the EPA are to develop guidance and training for Local Authority staff. Are there any specific areas or issues you would like to see covered in this guidance that is not covered in existing guidance?

Q17 Does your Local Authority permit a farmer to spread their own septic tank/treatment system sludge on their own lands? Y/N (If yes please state any conditions/restrictions required)

Q18 Do wastewater treatment plants operated by your Local Authority accept sewage sludge from private contractors collected from private houses?

If No, are there private facilities in your Local Authority area for the disposal of this sludge?

(Please detail)

APPENDIX 2

INTERVIEW QUESTIONS

Interview Questions

1. What do you consider the main reasons for failure in OSWWTS?
2. What would you consider to be the most appropriate solution to rectify this?
3. Where sites are not suitable for OSWWTS due to high or low permeability subsoils what remedial works would you suggest to improve the situation?
4. How do you think the inspection regime should be tailored to deal with this?
5. Do you think the inspection regime should differ for different scenarios such as tank age, tank type, geology etc. or would this cause too much subjectivity, would a standardised approach be more suitable?
6. Do you think all OSWWTS should be inspected, if not what would you consider as the main criteria for selecting sites?
7. What do you think are the key elements that an inspection should consider?
8. What are the limiting factors, i.e. what determines if a tank or site passes or fails?
9. How many inspectors do you think should be appointed nationwide?
10. In your opinion what level of qualification and experience should an inspector have?
11. If a tank passes the inspection regime, after what period of time do you think it should be retested?
12. In your opinion, is a national inspection plan achievable and over what period of time would be acceptable for it to be implemented across the board?

APPENDIX 3

INSPECTION FORM

Inspection Form

Homeowner Consultation

Inspection Reference Number		Type of OSWWTS	
		Primary Treatment	Yes ☐ No ☐
		Secondary Treatment	Yes ☐ No ☐
Inspecion carried out by		Year of Installation	
GPS Coordinates		Percolation Area	Yes ☐ No ☐
		Soakaway	Yes ☐ No ☐
Date		Other	
Homeowner Name		Tertiary Treatment	Yes ☐ No ☐
		Description	
Address			
		Last time tank was desludged	
		Written Evidence	Yes ☐ No ☐
Telephone No.		Maintenance Contract	Yes ☐ No ☐
Mobile No.		Written Evidence	Yes ☐ No ☐
Email Address			
		Private well	Yes ☐ No ☐
		Other Information	
Year House Built			
Number of occupants			

Part 1 - Visual Site Inspection		Part 3 - OSWWTS Inspection	
Drainage Characteristics	Poorly Drained ☐ Well Drained ☐	Type of system installed Septic Tank ☐ None ☐	
Percolation Area	Yes ☐ No ☐	Secondary Treatment	Yes ☐ No ☐
Soakaway	Yes ☐ No ☐	Mechanical System	Yes ☐ No ☐
Raised Percolation Area	Yes ☐ No ☐	Capacity	
Tertiary Treatment	Yes ☐ No ☐	Appropriate lids/risers	Yes ☐ No ☐
Inspection/Sampling Chambers	Yes ☐ No ☐		
		Evidence of malfunction	Yes ☐ No ☐
Evidence of Ponding	Yes ☐ No ☐	Description	
Evidence of Overflow	Yes ☐ No ☐		
		Structural Integrity	
Presence of foul odours	Yes ☐ No ☐		
		Need for desludging	Yes ☐ No ☐
Adjacent Water Courses	Yes ☐ No ☐		
Appearance of Discharge	Yes ☐ No ☐	Surface water connected to OSWWTS	Yes ☐ No ☐
Evidence of Discharge	Yes ☐ No ☐	Grey water connected to OSWWTS	Yes ☐ No ☐
Private Well	Yes ☐ No ☐	Control Panel Malfunction	Yes ☐ No ☐
Upstream or downstream of OSWWTS	Upstream ☐ Downstream ☐	Description	
Seperation Distance			
		Treated effluent quality	Yes ☐ No ☐
Part 2 - Auger Test		Description	
B.S. Subsoil Characterisation		S.S using handheld meter	mg/l
Evidence of soil contamination adjacent to OSWWTS	Yes ☐ No ☐	Evidence of malfunction in distribution box	Yes ☐ No ☐
		Description	
		Part 4 - Conclusions	
		Further Investigation REQD	Yes ☐ No ☐
		Type of Investigation REQD	
		Assessment	Pass ☐ Fail ☐
		Observations	

Site Layout Diagram

N

Note: Site layout sketch should include: Location of OSWWTS & Percolation Area, Dwelling, Private well, adjacent houses, watercourses, any notable features or characteristics. Sketch should also contain any measurements taken such as length of percolation or seperation distances.