The Environmental Protection Agency

EPA DRINKING WATER ADVICE NOTE
Advice Note No. 7:
Source Protection and Catchment Management to protect Groundwater Supplies

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1 INTRODUCTION

GROUNDWATER is a major natural resource in Ireland providing between 20 and 25 per cent of drinking water supplied in Ireland. In certain counties, particularly in the midlands, the proportion is much greater, for example North Cork 70%, Roscommon 70%, Offaly 47%, and Laois 34%[1]. In rural areas not served by public or group water schemes, groundwater is usually the only source of supply. Many thousands of wells – at least 100,000 and perhaps over 200,000 (Wright, 1999) – have been drilled, and several hundred new wells are drilled each year.

1.1 OVERVIEW

Microbial pathogens originate in animal faeces, i.e. from humans, cows, pigs etc. The main sources of microbial pathogens that are a risk to drinking water sources are on-site wastewater treatment systems (e.g. septic tank systems), farmyard run-off, grazing animals and the land-spreading of manure or slurry. *E. coli* in raw water is taken as an indicator organism, the presence of which in drinking water indicates that the supply has become contaminated with human or animal waste or that the disinfection system is not operating adequately. The presence of a single *E. coli* bacteria in a drinking water supply is a breach of the Drinking Water Regulations (S.I. No. 278 of 2007).

Cryptosporidium, which is a protozoan parasite, has a ubiquitous occurrence in the environment, its persistence, and resistance to chemical disinfection has made this parasite one of the critical pathogens for drinking water supplies. Numerous outbreaks of illness caused by *Cryptosporidium* in drinking water have been reported worldwide since its first recognition as a waterborne agent in 1984. Most of these were attributed to insufficiencies or failures in water treatment and distribution, but more importantly many occurred in systems that were regarded as safe and complied with the microbiological standards. 12% of groundwater supplies in the US were contaminated with *Cryptosporidium* and/or *Giardia* [Hancock et al., 1997], mostly in infiltration galleries and horizontal wells (impacted by surface water contamination) (WHO, 2009).

The majority of public supplies in Ireland reliant on groundwater have chlorine disinfection treatment only. Chlorination is the most common form of disinfection treatment and it does not inactivate or remove *Cryptosporidium*, if it is present in the untreated water source. Groundwater protection measures and the location of boreholes in low vulnerability areas can mean that the natural geology of the area provides a barrier against *Cryptosporidium* therefore making expensive treatment unnecessary.

1 Data taken from the 2009 drinking water returns for the 'The Quality of Drinking Water in Ireland Report, 2010'.

This advice note is intended to provide an outline of the key groundwater protection policies, guidance and related legislation that Water Services Authorities (WSA) should have regard to when developing measures to protect groundwater used for drinking water. The advice note covers the following specific areas;

- National Groundwater Monitoring Programme
- Groundwater Protection Plans
  - Zone of Contribution (ZoC)
  - Source Protection Zones (SPZ)
  - Inner Protection Areas
  - Outer Protection Areas
  - Groundwater Protection Responses
  - Setback distances to protect springs, wells and boreholes
- Risk Assessment
- Catchment Management

All the above groundwater protection measures and policies need to be integrated by the WSA and brought together as part of the development of a Drinking Water Safety Plan for each drinking water supply. The use of Drinking Water Safety Plans in the context of groundwater supplies is also covered in this advice note though it should be noted that *Advice Note No.8 – Developing Drinking Water Safety Plans* provides more detail on this matter. A glossary of commonly used groundwater protection terms is also provided.

1.2 THE NATIONAL GROUNDWATER MONITORING PROGRAMME (NGMP)

The Hydrometric and Groundwater Section of the Office of Environmental Assessment (OEA), EPA have commenced a programme to delineate the Zones of Contributions (ZoCs) for all groundwater monitoring points in the National Groundwater Monitoring Programme and in some cases develop Source Protection Zones (SPZs). There are 280 groundwater monitoring points in the NGMP, of which 152 are public water supplies (PWS) and 34 are group water schemes (GWS), the remainder are not used for water supply and consist of springs and newly installed monitoring wells. It is intended that all of the groundwater monitoring points will have a ZoC and in some cases a SPZ delineated. The complete reports will be provided to Water Services Authorities in tandem with the publication of this Advice Note.

An additional 40 PWS have the ZoC or SPZ delineated by the Geological Survey of Ireland (GSI) or consultants. The Office of Environmental Enforcement (OEE) carried out a desk-based risk screening of all groundwater derived PWS in the country and identified an additional 70 PWS[2] to be included in the ZoC delineation programme being lead by OEA. Therefore, nationally approximately 56% of the groundwater PWS will have ZoC or SPZ delineated by the EPA or consultants. In addition, where the ZoC reports have been completed additional work is needed to be undertaken by WSA on these to define the inner and outer source protection area and integration with the vulnerability information in order that SPZ can be developed.

Reports on the ZoCs that are being delineated at present for the EPA have been made available to all relevant WSAs and have been placed on the EPA website. The ZoCs have been delineated using the best available information and should be reviewed by local authorities to ensure that all relevant information has been used and is accurate[3] in the report.

This Advice Notes outlines the process of the preparation of groundwater protection plans and what actions should be taken following the preparation of the ZoC and SPZ reports.

2 The numbers included were dependent on financial resources available.

3 If any inaccuracies are found please contact OEA – Matt Craig m.craig@epa.ie or Anthony Mannix a.mannix@epa.ie with details.

2 GROUNDWATER PROTECTION PLANS

THE GEOLOGICAL SURVEY OF IRELAND (GSI) have prepared Groundwater Protection Plans (GWPP) and Source Protection Zones (SPZ) for many local authorities and for some Group Water Schemes and these are available from the GSI (GSI Web – Groundwater Protection Schemes). These GWPP and SPZ should be incorporated into the County Development Plans and used to assist in the assessment of the potential impact of development on groundwater. Catchment management is a fundamental element of the River Basin Management Plans that have been developed under the Water Framework Directive (WFD). The introduction of the Groundwater Protection Schemes (GWPS) guidance in 1999 (DoEHLG/EPA/GSI, 1999); the development of county GWPPs and the extensive vulnerability mapping as part of the Water Framework Direction, has heightened the awareness of the need to protect Irish groundwaters.

Circular letter SP 5/03 (2003) issued by the planning and spatial policy section of the Department of Environment, Community, and Local Government (DECLG) to all local authorities linked the need to protect groundwater with planning policy. It emphasised the need for information in development plans on the location and vulnerability of groundwater resources and clear policies on development in these areas. It made specific reference to 'source protection areas' and indicated that the development plans should show them as 'areas of sensitivity'. It also referred to the Groundwater Protection Response Matrix, which should be used to assist in decision making for certain types of activities.

In January 2010 another circular letter (PSSP 1-10) from by the DECLG reminded local authorities of the previous recommendations (SP 5/03) and specifically required local authorities to prepare Groundwater Protection Schemes and to incorporate them into their County Development plans 'as soon as practicable'. It also goes on to say that the 'Minister considers this essential to ensure that key aquifer and groundwater resources are identified and protected'.

Groundwater protection schemes comprise two components:

1. A land surface zoning map (or maps) called the groundwater protection zone map.
2. Groundwater protection responses for existing and new potentially polluting activities.

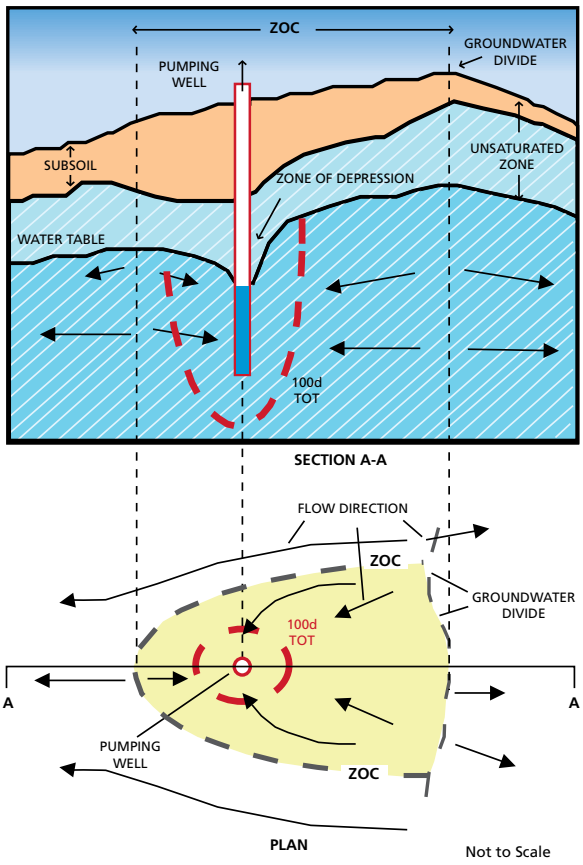
2.1 ZONES OF CONTRIBUTION

A zone of contribution (ZoC) (Figure 1) is defined as *the area surrounding a pumped well that encompasses all areas or features that supply groundwater recharge to the well. It is defined as the area required to support an abstraction from long-term groundwater recharge.*

The ZoC should be delineated for each groundwater source used for drinking water. The delineation of the ZoC requires information on the groundwater abstraction rate (including a safety factor); groundwater recharge rates and groundwater flow direction (Kelly, 2010). It is mainly a desk study 'rapid assessment' but site visits should also be carried out in some cases, along with consultation with local authority staff and hydrogeologists involved with the site or who have knowledge of the site.

The ZoC is prepared by a hydrogeologist using existing information. Every effort should be made to validate the information new information and to keep the key assumptions used to prepared the ZoC under review. In addition, as with all geological and hydrogeological maps, uncertainty is an inherent element in drawing boundaries because of the scale of the maps involved. Boundaries should be used as a guide but site specific information should be used to inform decision making.

Figure 1: Zone of Contribution (Source: (DoEHLG/EPA/GSI, 1999))



2.2 SOURCE PROTECTION ZONES

The catchment area around a groundwater source, which contributes water to that source (ZoC), can be defined as a source protection zone (SPZ) when the *Inner Protection Area (SI)* and the *Outer Protection Area (SO)* are delineated.

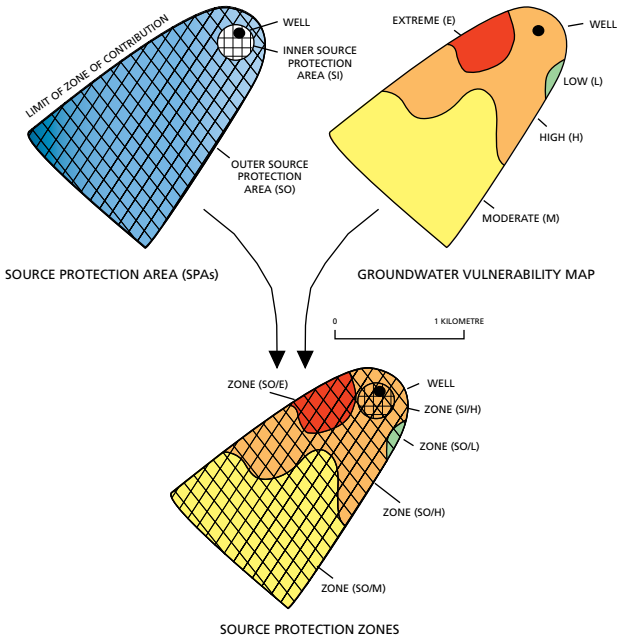
The SI is designed to protect the source against the effects of human activities that may have an immediate effect on the source, in particular in relation to microbiological pollution. It is defined by a 100-day time of travel (TOT) from any point below the water table to the source. The SO covers the remainder of the zone of contribution of the groundwater source. It is defined as the area needed to support an abstraction from long-term groundwater recharge i.e. the proportion of effective rainfall that infiltrates to the water table (DoEHLG/EPA/GSI, 1999).

The associated vulnerability is superimposed on these sub-divisions, to give Source Protection Zones (Figure 2). The most up to date vulnerability maps are available from the GSI website. *Groundwater Public Viewer* The land area outside of the Source Protection Zones (SPZs) can be sub-divided into Resource Protection Zones and they are defined by the combination of aquifer categories and vulnerability ratings.

The objective of delineating the ZoC is to define approximate areas that contribute to an abstraction point. The objective of a SPZ is to geo-scientifically characterize the risk to groundwater within a ZoC of a given source (Kelly, 2010). This information should be used to manage and control activities which have the potential to impact on the quality of water to be abstracted for drinking water.

SPZs take into account the plan view but another critical aspect is the vertical dimension that is represented by the borehole itself. It is essential that the borehole and wellhead are properly constructed

Figure 2: Source Protection Zones (Source: (DoEHLG/EPA/GSI, 1999))



and that pollutants are prevented from entering the well and that it is protected against flooding and other accidently damage or vandalism.

Article 7 of the Water Framework Directive requires Member States (MS) to provide the necessary protection for waters used or to be used for drinking water and MS may establish 'safeguard zones' for those bodies of water, which are in effect the catchment area for the water supply. The SPZs could be considered as the basis for these safeguard zones in the future.

WSA should have regard to the advice within DoEHLG Circulars SP5/03 and PSSP1-10 and should begin delineation of SPZs for public water supplies that have ZoCs prepared. The SPZs should be delineated in accordance with the guidance in Groundwater Protection Schemes, 1999.

2.3 GROUNDWATER PROTECTION RESPONSES

A groundwater protection scheme consists of two closely interlinked components: (i) land surface (groundwater protection) zones as described above, and (ii) groundwater protection responses for potentially polluting activities, which give guidelines on the acceptability of the activities, investigation requirements and, where appropriate, the likely planning or environmental licensing controls. The objective of source protection zones is to provide protection by placing tighter controls on the activities within all or part of the zone of contribution (ZoC).

Groundwater protection responses have been developed for the following activities:

- Landfills
- Landspreading of Organic Wastes
- On-site wastewater treatment Systems for Single Houses
- Earth – Lined Stores
- Out-wintering Pads

These are available from the EPA, GSI and Department of Agriculture, Fisheries and Food (DAFF) websites. The control of activities within the ZoC should have regard to these groundwater protection responses.

2.4 SETBACK DISTANCES

The European Communities (Good Agricultural Practice for the Protection of Waters) Regulations (S.I. 101of 2009) were revised and replaced in December 2010 by the European Communities (Good Agricultural Practice for the Protection of Waters) Regulations (S.I. No. 610 of 2010). Some significant changes have been made to Article 17 and the setback distances or exclusion zones requirements.

Article 17 (2) of the Regulations specifies setback distances for application of organic fertiliser and soiled water on land in the vicinity of water abstraction points, such as wells, springs, watercourses and lakes. However, according to Article 17(3) some of these distances can be reduced to 30m (for an abstraction point in the case of any surface water, borehole, spring or well serving 10m³ or more per day, or 50 or more persons) or to 15m where the abstraction point provides for less than the above volume or persons. Article 17(4) requires a technical assessment of the conditions in the vicinity of the abstraction point be carried out by the local authority prior to any reduction in setback distances and that a determination be made by the local authority that the reduction does not give rise to a risk to the water supply or a potential danger to human health. The EPA has issued guidance that local authorities must follow in relation to the carrying out of a technical assessment under Article 17(12).

Article 17(6) of S.I. No. 610 of 2010 allows local authorities, following consultation with the Agency, to specify greater distances than those specified in sub-articles (2) and (3) where following prior investigations the local authority is satisfied that the distance is appropriate to protect the water supply. In addition, local authorities/WSA are required under sub-article (7) to specify an alternative distance following prior investigations where there has been an exceedance of a parameter specified in Part 1 of the Schedule in the Drinking Water Regulations (S.I. No. 278 of 2007) or where the quality of water constitutes a danger to human health and it appears to be due to landspreading of organic fertilisers or soiled water in the vicinity of the abstraction point or where landspreading presents a significant danger to human health. The EPA intends to issue an Advice Note for Local Authorities on Technical Investigations and Prior Investigations. Local Authorities should have regard to this advice note when it is issued.

Where the distances are different to that specified in sub-article (2), local authorities are required under Article 17(10) to;

- notify the affected landowners, the Agency and the Department of Agriculture, Fisheries and Food;
- send a summary of the investigations to the EPA;
- make an entry into the register in accordance with Article 30(6);
- publish and maintain on the local authority website an updated schedule of setback distances specified for each drinking water supply.

The requirements of sub-article (10) apply to public supplies and group water supplies.

The development of ZoCs/SPZ would be necessary to provide the basis for application for alternative setback distances particularly for those required under sub-articles (6) and (7).

3 DRINKING WATER SAFETY PLAN (DWSP) APPROACH

THE EPA has advised WSA's to adopt a drinking water safety plan (DWSP) approach to ensuring that drinking water is both "safe" and "secure". The EPA contends that the most effective means of consistently ensuring the safety of a drinking water supply is through the use of a comprehensive risk assessment and risk management approach that includes all steps in the water supply from catchment to consumer.

3.1 A DWSP encompasses this approach and is based on the following World Health Organisation (WHO) approach of:

- Risk assessment of water supplies from catchment to consumer – Identification and assessment of all risks in the catchment, treatment plant and distribution network up to the consumers tap that may result in a risk to health and/or breach of required standard.
- Effective operational monitoring – Inspection of the catchment, reservoirs, treatment plant and distribution network to detect pollution, equipment failure or chemical dosing faults; followed by prompt and effective corrective actions where problems have been identified.
- Effective management – Competent management of the supply during normal and abnormal conditions, regular and accurate reporting of treatment plant operations, trained personnel and resources to deliver clean and wholesome drinking water.

Advice Note No.8 provides detailed guidance on the development of DWSPs, which builds on existing good water management practices. The delineation of the zone of contribution (ZoC) of a water supply allows the identification of hazards and assessment of risks to be focused within the catchment of the supply.

4 RISK ASSESSMENT AND CATCHMENT MANAGEMENT

While the delineation of the Zoc and SPZ of a water supply is an important component of the protection of drinking water, it will not, in itself protect or improve drinking water quality. This information must be used to assess risk and manage risks identified in the catchment. Risk assessment is a fundamental aspect of catchment management and is incorporated into the DWSP approach outlined in Advice Note No.8 – Developing Drinking Water Safety Plans. It allows for hazards to be identified and the natural vulnerability of groundwater to be determined. This information should be used to indicate the likelihood of aquifer contamination and the value of the receptor (water supply) to highlight the consequences if a contamination event was to occur.

4.1 An assessment should be made by the Water Services Authority (WSA) of the natural protection afforded to groundwater supplies by examining the pressures applied to the catchment of the source (i.e. hazard mapping) and the pathway element. The borehole construction and wellhead protection should be assessed to determine if it provides a direct pathway for contaminants to the groundwater source. This assessment should then enable a decision to be made whether the current level of water treatment is sufficient. In cases where the groundwater is under the influence of surface water and there is a history of microbial contamination in the untreated source water, these supplies should be considered as high risk in terms of Cryptosporidium, if full treatment is not in place. In such cases it is likely that additional treatment will be required to reduce the risk.

The following steps should be undertaken to effectively manage the catchment.

▼ Step 1: Source Protection Zones

The delineation of the ZoC is the first step in the development of a source protection zone for a water supply. The inner and outer zones of the ZoC then have to be defined by a competent hydrogeologist and then overlaid on the vulnerability maps. The Groundwater Protection Schemes document (DELG/EPA/GSI, 1999)[4] outlines the methodology to be used to delineate SPZs.

▼ Step 2: Hazard Mapping

Where the catchment area (ZoC) of the groundwater source has been delineated, WSAs should focus their resources on the identification of hazards within the catchment. Hazards such as farmyards, on-site wastewater treatment systems, industrial facilities, waste facilities, sheep dip facilities, agricultural practices (including likely pollutants and nutrient loading rates) and animal densities need to be examined and mapped on a prioritized basis. This links into the DWSP approach and the guidance produced on hazard identification.

▼ Step 3: Pathway

The pathway element has to be taken into consideration for groundwater supplies as groundwater is afforded some protection by the overlying subsoils; however, there is the potential for direct access to groundwater in the immediate vicinity of the borehole if it has not been constructed in accordance with best practice. The subsoil permeability and thickness are described as vulnerability categories and are incorporated into the source protection zones. The type of recharge is also an important hydrogeological attribute that needs to be taken into account. In assessing the pathway factors, the technical specifications set out in "Groundwater Protection Schemes" (DELG/EPA/GSI, 1999) should be followed where relevant.

4 DELG/EPA/GSI, 1999. Groundwater Protection Schemes. Available on: www.gsi.ie.

Step 4: Receptor

The receptor factors relate to the inherent vulnerability of different types of water sources and the protection factors that may be incorporated into the supply. The following factors are important when considering the risk to the receptor:

- Whether the receptor is a shallow or deep borehole or a spring source;
- Details on the abstraction from the source;
- Summary of existing relevant water quality data; and
- Details on borehole logs, borehole construction and wellhead protection.

Step 5: Risk Assessment

The above elements should be combined in a risk assessment. The Drinking Water Safety Plan (DWSP) approach examines in detail the risk posed by the hazard in isolation of any existing control measures initially and then examines the effectiveness of the measures as a second step. A separate Advice Note has been published on Developing Drinking Water Safety Plans, which sets out the steps that should be taken to ensure the continuous supply of safe water and WSA should have regard to it.

Step 6: Control Measures

Information obtained through a desk study and walkover survey of the catchment area will inform the decision on the extent of measures, which are required to manage the risk. Some measures may already be in place and others may need to be put in place. Control measures may involve breaking the pathway (e.g. provision of adequate treatment) or removal of the source (e.g., restriction in land use in the catchment) or in some cases additional monitoring of the receptor (EPA, 2010). Control measures may include, for instance: control of land-use practices and in particular directing developments towards lower risk areas; suitable building codes that take account of the vulnerability and value of the groundwater; lining of landfill sites; installation of monitoring networks; specific operational practices. Control measures should be implemented on a prioritised basis depending on the relative risk score as identified in the DWSP.

5 GLOSSARY OF TERMS

Drinking Water Safety Plan – Is a plan that comprises system assessment and design, operational monitoring and management plans (including documentation and communication).

The objectives of a water safety plan according to the World Health Organisation (WHO) are to ensure safe drinking-water through good water supply practice, that is:

- to prevent contamination of source waters; to treat the water to reduce or remove contamination that could be present to the extent necessary to meet the water quality targets; and
- to prevent re-contamination during storage, distribution and handling of drinking-water.

Groundwater – Is, according to the Water Framework Directive (WFD), "all water, which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil."

Groundwater Protection Scheme – Is a scheme comprising two principle components: a land surface zoning map which encompasses the hydrogeological elements of risk; and a groundwater protection response matrix for different activities.

Hazard – Is a potential source of pollution.

Risk Assessment – Is the overall process of identifying all the risks to and from an activity and assessing the potential impact of each risk.

River Basin Management Plan – Is a detailed document describing the characteristics of the basin, the environmental objectives that need to be achieved and the pollution controls measures required to achieve these objectives through a specified work programme.

Safeguard Zones – Is a term used in the Water Framework Directive and refers to the catchment area of a water supply. These are delineated where improvements are necessary in the supply.

Source Protection Area – Is the catchment area around a groundwater source, which contributes water to that source (Zone of Contribution), divided into two areas; Inner Protection Area (SI) and the Outer Protection Area (SO).

Source Protection Zone – A source protection zone is generated by integrating the two elements of land surface zoning (SPA and vulnerability) – a possible total of eight source protection zones can be generated.

Vulnerability – Is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities.

Zone of Contribution – Is the area surrounding a pumped well or spring that encompasses all areas or features that supply groundwater recharge to the supply. It is defined as the area required to support an abstraction from long-term groundwater recharge.

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