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Exploration Drilling - Guidance on Discharge to Surface and Groundwater

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1 SUMMARY

Under the **European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010)** certain types of direct discharge to groundwater may be permitted subject to prior authorisation *“provided such discharges, and the conditions imposed, do not compromise the achievements of the environmental objectives established for the body or groundwater into which the discharge is made”*. Exploration drilling is one of the exempt activities listed under Regulation 8.

This draft guidance document produced by the Exploration and Mining Division (EMD), outlines procedures and risk assessments to be carried out for exploration drilling to comply with groundwater regulations.. The procedures outlined in the document will also assist with the screening process required as part of the **European Communities (Birds and Natural Habitats) Regulations, 2011** (S.I. No. 477 of 2011) for prospecting activities. The principle objective of the document is to outline the necessary measures to be adopted during drilling to protect sensitive receptors such as groundwater wells and surface water bodies from any potential contamination.

1.1 Risk Assessment Approach

Three essential steps are outlined as part of a risk assessment including:

1. Assess the nature of the discharge activity and carry out a risk screening to determine the degree of risk posed by the discharge activity on groundwater quality and receptors from direct (Step 1A) and indirect discharge (Step 1B).
2. From the risk screening, determine an appropriate level of technical assessment (Step 2) that is needed to address questions about site suitability and estimation of loading and attenuation.
3. Conduct technical assessment (Step 3).

Step 1 involves assessing the distances to sensitive receptors, the volumes of drill waters required for drilling, the likely pathways to groundwater and surface water and the scale of the exploration activity (number of planned drillholes). The main risk is considered to be related to the use of surface water as a drilling fluid and the potential to introduce pathogens into the groundwater body.

Step 2 involves determining the level of assessment required.

- **Negligible risk, no further work necessary, document findings.**
- **Where risk is deemed to be low, a Stage 1 assessment is required;**
- **Where risk is deemed to be moderate, a Stage 2 assessment is required;**
- **Where risk deemed to be high, a Stage 3 assessment is required.**

Step 3, depending on the level of risk, various levels of technical assessments are required relating to the aquifer properties and distances to sensitive receptors.

| Negligible | Consider nature of activity and distances to receptors. |
|-------------------|--|
| Stage 1 | Basic assessment of aquifer properties. Examine zones of contribution to wells. |
| Stage 2 | Assess travel time and groundwater velocities. Assess receptors and zone of contribution. Assess impacts of abstraction on surface water bodies. |
| Stage 3 | Assess aquifer properties, permeability, flow direction, surface water abstraction impacts. Develop conceptual model. |

1.2 Standard Operating Procedures

Standard Operating Procedures (SOP) for exploration drilling are required for dealing with direct discharge down the borehole and indirect discharge on surface. These SOPs should be based on best practice. In many instances a closed loop system is operated where drill water is recycled through sedimentation tanks or sumps. This is considered to be best practice and significantly reduces the risks to groundwater and surface water bodies. For some grassroots drilling, drill water is not recycled and may be discharged through sumps or settlement tanks. Direct discharge to a stream or river is not acceptable. SOPs can include, but are not be limited to:

| | |
|--|---|
| Drill water source can be | Treated water from a mains supply; Clean/treated surface waters; Groundwater of a satisfactory quality from an existing well in the aquifer |
| Additives | Use appropriate additives in broken or fractured bedrock to prevent ingress into the aquifer; Ensure additives are non-hazardous, non – toxic and biodegradable. |
| Setback distance from wells/spring supplies | At least 100m from a domestic supply and 300m from a public or group water scheme supply. If in a karst area with conduit flow then re-evaluate distance based on risk assessment. Holes should also be an adequate distance from sensitive receptors (including SACs and surface water receptors where there is a large component of groundwater flow to surface waters). Setback distances will be site specific. |
| Site setup | Oil matting Spill kits Proper storage of fuel |
| Percolation area | Assess aquifer vulnerability (GSI) and ensure adequate protection of groundwater body. Ensure adequate setback from surface water Ensure no discharge to ground via karst features such as dolines and swallow holes. Ensure adequate treatment of discharge by allowing percolation through a vegetated buffer zone. Ensure adequate treatment through sumps (sufficient residence time) and modify or recirculate waters as required. If subsoil thickness is not adequate for recharge to the aquifer, or the area is underlain by low permeability soils (high runoff coefficient), an alternative treatment system may be required, such as settlement tanks. |
| Decommissioning | Advice on decommissioning boreholes and backfilling is also outlined. |

2 Introduction

This document provides guidance on the hydrological and hydrogeological assessments required for exploration drilling programmes taking into account the objectives and requirements of the European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010) (Groundwater Regulations). In the context of pressures on groundwater quality, exploration drilling is not considered to be a major threat. However, there are now clear requirements to carry out an impact assessment for activities that are discharging to groundwater bodies.

Under Regulation 8 of the Groundwater Regulations direct discharges to groundwater are prohibited. Certain types of direct discharge may be permitted subject to prior authorisation *“provided such discharges, and the conditions imposed, do not compromise the achievements of the environmental objectives established for the body or groundwater into which the discharge is made”*. Exploration drilling is one of the exempt activities listed under Regulation 8.

Under Regulation 14 of the Groundwater Regulations certain direct and indirect discharges to groundwater may be exempted (includes activities listed under Regulation 8) from the environmental objectives for groundwater under conditions (technical rules) that can be established by the Environmental Protection Agency (EPA). Exploration drilling will be subject to such conditions (technical rules).

Regulation 4 places a duty on public authorities to promote compliance with the Groundwater Regulations. Exploration and Mining Division (EMD), in consultation with the EPA, has established the technical rules in this guidance document.

This document outlines the required assessment process and establishes the technical rules required to obtain approval for exploration drilling. The assessment is carried out by the holder of the Prospecting Licence (PL) and submitted to EMD.

Exploration drilling involves both direct and indirect discharges to groundwater:

- Direct discharge is through the drill hole annulus and
- Indirect discharge generally takes place at surface through a percolation area used for the return drill water or through sumps.

The principal risk to groundwater receptors relates to the introduction of microbial pathogens into the aquifer through the drill hole as a result of using surface water streams and rivers as a source of drill water. The principal receptors are domestic, group and public well supplies. In many drilling operations, the objective is to operate a closed loop system where the return water is recycled for reuse with no losses to the aquifer. The return water is collected in a sedimentation tank and then the decanted water is pumped to a second

tank for reuse as drill fluid. If the water is returned without loss, then only occasional topping up is required from the surface water source to take account of small losses. In other situations the water can be lost and continuous topping up is required with discharge to the aquifer.

The Environmental Protection Agency (EPA) has published '*Guidance on the Authorisation of Discharges to Groundwater*', outlining detailed technical assessments required to authorise discharge to groundwater –. The Source-Pathway-Receptor (SPR) model is adopted and develops a framework for the process that includes guidance on:

- Risk screening for potential impact to groundwater based on pollutant load;
- Levels of technical assessment for different types of discharge;
- Predicting impact.

The procedures and assessment methodology outlined in the EPA document forms the basis for the assessments carried out in this guidance appraisal document.

2.1 Scope of this Guidance Document

The purpose of this document is to provide guidance on the assessment of discharge to groundwater for exploration drilling programmes in order to ensure compliance with the objectives of the Groundwater Regulations (S.I. No. 9 of 2010) by outlining a risk based approach based on the Source-Pathway-Receptor model. A wide range of hydrogeological conditions exist in Ireland. It is, therefore, not possible to be prescriptive, but rather to give an overall consistent approach and outline the underlying procedures that should be followed to protect groundwater aquifers from contamination including:

- Assessment of the risk posed by discharges to groundwater from exploration drilling activities taking into account the likely pollutant concentrations;
- An assessment of the appropriate SOPs for the drilling technique and geological environment;
- A risk based assessment tool to predict the scale of the likely impacts.

3 Exploration Drilling – Water Volumes

The drilling water normally used for exploration drilling is sourced from surface water bodies such as streams, rivers or small drainage ditches. The water is pumped from source at a rate of 1L/sec (approximately) for the duration of the drilling. The actual volumes of water used in drilling will depend on the hole size and can range from 0.16 l/s for AQ core to 1.3 l/s for PQ core (NQ 0.4 l/s, BQ 0.26 l/s). In some situations, such as directional drilling, larger volumes of water are required (4 l/s).

In addition, in certain instances drilling additives are added to the water and injected into the drill hole to cope with difficulties encountered in different geological formations that are related to core recovery and loss of circulation. The constituent elements of these additives are discussed later.

3.1 Water Circulation

A schematic representation of the water movement is shown in Figure 1.

The water circulation is as follows:

- Water is pumped from a nearby stream to the drill site.
- Containers (1m³ approximately) are used to store the water on site and supply the drill rig.
- Water is pumped down the drill stem and also allowed to flow down the outside of the drill rods.
- Returned water is then either:
 - Treated through a sump (or a number of sumps) and allowed to percolate to ground, or
 - Directed to a percolation area where it is finally discharged to groundwater.

Note In some cases the water may also flow across a vegetated strip to promote additional filtration. Direct discharge of untreated drill water to surface water bodies is not an acceptable practice. The percolation area and the sumps should be positioned so that direct discharge to streams is prevented

3.2 Drilling Additives and Drill Grease

The drilling water may comprise water or water mixed with one or several additives. It has a number of functions including:

- Carrying the drill cuttings to surface;
- Ensuring clean water that is essential for wireline drilling;

- Suspending and releasing cuttings (if cuttings settle it will lead to loss of drilling efficiency and stuck drill string);
- Controlling formation pressures and preventing waters entering the wellbore;
- Sealing permeable formations and maintaining wellbore stability;
- Cooling and lubricating the drill bit;
- Minimising formation damage and not allowing mud to infiltrate the formation matrix and reduce porosity;
- Transmitting power to down the hole drill motors (directional drilling).

The additives are also used to ensure a closed loop system to reduce loss to the aquifer.

The principal drilling fluid is water. However, it is sometimes necessary to use additives to form the required properties to achieve the above objectives. The use of additives can be specific to certain geological formations that are problematical, and many of the additives have distinct properties that deal with specific problems encountered while drilling. These additives can also minimise environmental and human impacts. Many of the additives are readily biodegradable. It is considered beyond the bounds of this document to produce a listing of all acceptable additives and their properties. Any additives used, however, should have no negative consequences for the quality objectives outlined in the Groundwater Regulations (S.I. No. 9 of 2010). The additives should be biodegradable, non-hazardous and non-toxic. The names of any likely additives that may be used should be submitted to EMD with a relevant material safety data sheet in advance of the use of the additive. The concentrations of additives used during drilling must be in line with the manufacturer's recommendations. Discussion on the use of any additives should take place prior to use between the driller and client company representative. A record of the use of additives should be made, detailing;

- Concentrations used;
- Depths at which they were applied;
- Amount and the depth of any losses.

This information should be attached to the drill logs.

Another potential source of contamination is the drill rod grease. Non-toxic, biodegradable, alternatives to conventional greases are readily available.

For the purpose of the remainder of this risk assessment it is assumed that any additives and drill rod greases are non-hazardous, biodegradable and non-toxic.

4 Risk to Groundwater from Exploration Drilling

The risks to groundwater quality from exploration drilling activities relate to the potential introduction of pollutants as direct inputs through the drill hole into the geological formation waters, and as indirect inputs through the percolation areas and sumps.

The risks to groundwater include:

- Direct
 - Introduction of contaminants such as pathogens and nutrients from river water;
 - Introducing a new pathway linking aquifers or fissures that were previously not hydraulically linked;
 - Suspended solids generated during drilling clogging pathways;
 - Introduction of additives from the drilling waters.
- Indirect
 - Leaks and spills of mineral based oils and fuels from the drill site machinery;
 - Microbial pathogens entering aquifer through sumps and percolation area.

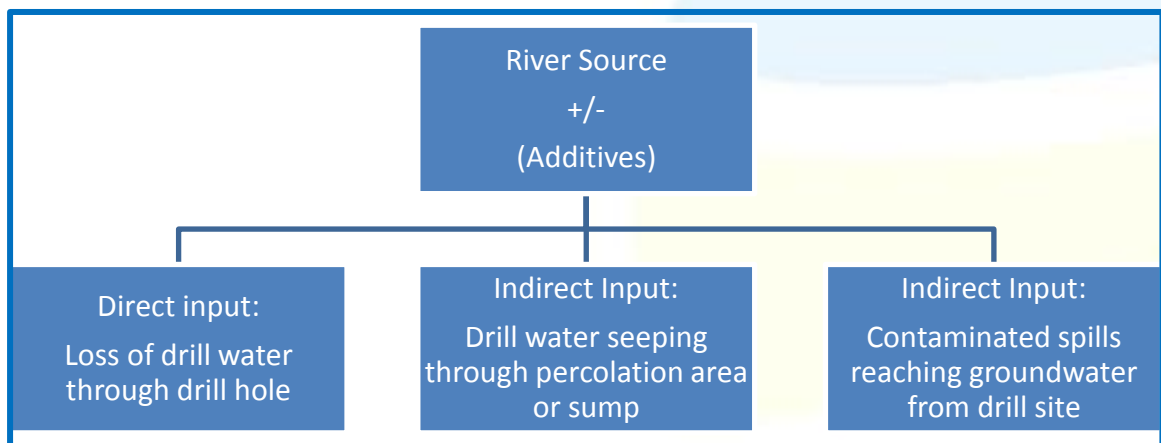


Chart 1 Possible sources of groundwater contamination from typical drilling setup.

The possible receptors include:

- Surface water bodies including streams, ditches, rivers and lakes ;
- Aquifers;
- Private groundwater supplies;
- Public and group groundwater supplies; and
- Groundwater dependent ecosystems.

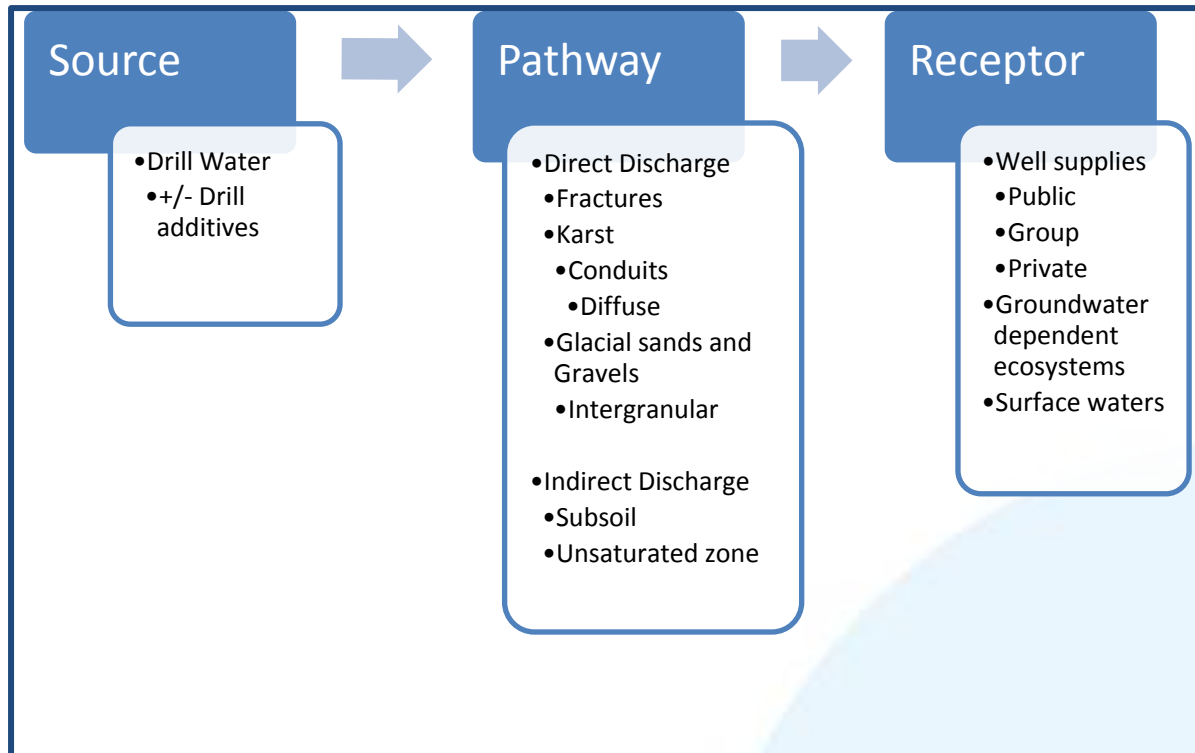


Chart 2 SPR Model during Exploration Drilling

4.1 Discussion Exploration Drilling and Discharge

Volumetric consideration

The volumes of water used in exploration drilling depend on the methodology adopted.

Water lost during drilling enters the groundwater system, and it is this element of the exploration drilling process that is of primary concern and requires attention. If a closed loop system is in operation then risks to groundwater systems are minimised. If all the water during a conventional diamond drill coring activity is lost, then volumes of 30 m³/d (approx.) could enter the bedrock aquifer. The actual volumes will be a function of the drilling procedure, core size and drilling duration (Table 1). Discharges to the groundwater system, however, are temporary, lasting in most instances only a few days or weeks, depending on the depth of borehole and complexity of ground conditions intersected. In the case of directional drilling, the volume of water lost to the groundwater system can be of the order of 140m³/d. However, such techniques are generally employed at depths in excess of 500m and are hence below the depths of most potential water well receptors. Directional drilling is a temporary activity rarely exceeding a few days. Additionally, the use of drilling additives will significantly increase volumes of return water in areas of cavities and fractures by sealing the drill hole.

Table 1 Drill water losses

| Scenarios | Flow - cubic metre / day | | |
|----------------------|--------------------------|----------|----------|
| | 100% Loss | 50% loss | 10% loss |
| Best - 8hrs @ 1L/s | 28.8 | 14.4 | 2.88 |
| Worst - 10hrs @ 4L/s | 144 | 72 | 14.4 |

In the case of indirect discharge, water returned from drilling will be managed through sumps or allowed to percolate across a vegetated surface such that the groundwater and surface water bodies are protected.

Quality considerations

The level of assessment is not solely based on volumetric considerations – the nature of the drill water and its pollutant concentration is an essential element. River water is the primary source of drill water, to which various drilling fluid additives may be added. River water is a potential source of bacteria, nutrients and other contaminants. The additives normally used in drilling are non-hazardous and should not pose a pollution threat. If additives are used then they should be considered as part of the risk assessment procedure.

4.2 Receptors

The following section looks at the potential receptors and considers the likely impacts. For all of these receptors it is assumed that the drilling fluid is non-toxic and non-hazardous.

4.2.1 Groundwater Supplies

Potential impacts on public or private supplies relate to the direct discharge of drilling water that may flow toward a groundwater well carrying bacteria or other pollutants. The principal risk is microbial contamination from the surface water used. Other potential impacts on water supplies include migration of fine particles mobilised during drilling, particularly in karst or highly fractured aquifers. There is a recommended setback distance of 100m from private supplies and 300m from public supplies. In karst aquifers this distance may not be sufficient and an evaluation of the available data and information may be required to further quantify the impact. Karst aquifers are outlined by the Geological Survey of Ireland and further information may be obtained from their website (<http://www.gsi.ie/mapping.htm>). Other SOPs may include the treatment of the supply from the stream or river prior to use (e.g. UV purification) or to use a treated source (e.g. tankering in treated water using sanitised bowsers). Where an advanced exploration programme is planned, then it may be feasible to use groundwater as a source, if it is of suitable quality, by extracting from a previously drilled hole. The previously drilled hole should be constructed to water well standards, such that potentially more contaminated shallow groundwater is cased-off

Local surface water features.

The most likely impact on surface waters relates to drill water with high suspended solid concentrations reaching the surface water body without any treatment. No direct discharge to surface water is permitted and adequate treatment must be provided through the use of a percolation area or a series of appropriately sited sumps. Drill water can be further treated by discharging across a vegetated strip. Various company internal best practice documents for exploration drilling integrate a setback distance from a surface water body (e.g. >25m). During heavy rainfall, it is possible that the sumps and percolation area may be inundated. This can be dealt with by a large setback distance and also the dilution effects of larger stream flow and the rainfall. Percolation tests may be required for sensitive locations in areas of low permeability soils to ensure no discharge containing unacceptable levels of suspended solids reaches the river.

In light of SOPs the impact on surface water bodies is considered to be negligible.

4.2.2 Groundwater Aquifer

Impacts relate to the direct discharge of drilling waters through fissures and cavities and indirect discharge through the percolation areas.

Discharge through bore hole.

As surface water quality is generally of poorer quality than groundwater, impacts relate to the introduction of bacteria and nutrients principally to the aquifer from the surface water body. Other components can include suspended solids that could result in the loss of permeability through clogging of pathways, or migration of suspended solids from surface waters or derived from the rock during drilling, to sensitive receptors (e.g. drinking water sources). Taking account of the travel time of bacteria in groundwater, it is considered that this impact would be on a very local scale unless large volumes are lost during drilling. If this is likely to occur (fractured ground) then a reassessment of the risk should take place. If the assessment indicates that groundwater quality is likely to be compromised then more appropriate procedures must be implemented.

Percolation areas

The percolation areas should be constructed in locations where groundwater is protected through an adequate thickness of subsoil (i.e. areas of low to moderate vulnerability). In this situation the particulate matter and possible pollutants will be filtered before entering the groundwater aquifer and thus impacts will be insignificant. Karst features such as sink holes or enclosed depressions should be avoided, and if the area has an extreme vulnerability rating, then more appropriate procedures must be required prior to discharge, e.g.

settlement tanks, flocculation. If there is inadequate percolation in areas of low permeability then more appropriate procedures must be used.

4.2.3 Special Areas of Conservation

Drilling carried out in areas adjacent to sensitive water courses, such as pearl mussel rivers, must be undertaken in such manner as to ensure adequate protection of the habitat. Pearl Mussel Rivers and sensitive water courses are outlined in the National Parks and Wildlife Services website (<http://www.npws.ie/protectedsites/>). Depending on local conditions, measures may include increased setback distances, or use of settlement tanks. This ensures that sensitive water courses such as pearl mussel river habitats are not impacted. EMD may consult with NPWS prior to commencement of drilling activities in such sensitive locations. A screening report for Appropriate Assessment will also need to be submitted by the licensee, which unequivocally demonstrates that there will be no likely significant effect on the site. If a significant effect cannot be ruled out then further detailed assessment will be required.

Drilling submissions will also be assessed to determine whether screening under the EIA Directive is required. EIA Criteria Assessment Tables and relevant supporting documentation should be submitted to EMD with all drilling applications.

This document is dealing with groundwater discharges principally; a separate document will deal with guidance for Appropriate Assessment for prospecting activities. A brief description is given in Appendix III.

4.3 Risk Assessment Procedure

Considering the nature of the exploration drilling the following procedure is recommended.

The risk assessment includes three steps.

1. Assess the nature of the discharge activity and carry out a risk screening to determine the degree of risk posed by the discharge activity on groundwater quality and receptors from direct (Step 1A) and indirect discharge (Step 1B).
2. From the risk screening, determine an appropriate level of technical assessment (Step 2) that is needed to address questions about site suitability and estimation of loading and attenuation.
3. Conduct technical assessment (Step 3).

The indirect and direct discharges are treated separately.

4.3.1 Step 1a – Assess the Nature of the Discharge Activity and Carry Out Risk Screening – Direct Discharge

Parameters for exploration drilling discharge

The table below outlines the main aspects of the nature of the discharge activity to be considered. The nature of the activity is defined by the distance to receptors, the volumes of drill water required for drilling and the scale of the planned exploration activity.

| | |
|--|---|
| Determine distance to sensitive receptors. | <ul style="list-style-type: none"> • Wells • SACs |
| Volumes required for drilling | <ul style="list-style-type: none"> • Conventional Drilling • Directional Drilling • Other |
| Determine scale of exploration activity | <ul style="list-style-type: none"> • Grassroots exploration – 1 to 3 planned drill holes per catchment. • Intermediate Scale 3 – 10 drill holes • Advanced > 10 drill holes |

Table 2 Nature of Exploration Drilling Activity

Carry out screening assessment

The following is a list of considerations related to the nature of the discharge activity using the SPR approach for direct discharge.

Source

- *Volume: Define volumes on maximum and minimum rates (m^3/d) and assuming water loss.*
 - Abstraction rates from rivers typically 1L/s (30 m^3/d approx. 8 to 10 hours per day).
 - Directional Drilling rates require 4L/s (140 m^3/d approx. 8 to 10 hours per day.)

Note: The above volumes will be considerably less if water is recirculated and a closed loop system is in place. The above represents a worst case scenario and in most cases the volumes will be significantly less.

- *Determine the nature of the drilling water*
 - The discharge must not contain hazardous substance from additive or primary sources. This should be established by examination of the drill water source and by confirming that any additives:

1. Are non-hazardous based on EPA classification
(<http://www.epa.ie/pubs/reports/water/ground/classificationofhazardousandnon-hazardoussubstancesingroundwater.html>)
2. Are non-toxic.
3. Have no negative impact on water quality
 - It may be assumed that all surface water streams and rivers contain pathogens.
 - If using groundwater as a source then it can be considered as best practice.
- *Determine scale of drilling programme base on planned number of drillholes*
 - 1- 3 grassroots
 - 3 – 10 intermediate
 - >10 Advanced

Pathway

- *Determine the nature of the pathways and aquifer type (based on GSI classification maps).*
 - The pathways will be a function of groundwater flow type and may include:
 - Fissure/fracture flow
 - Karst Fissure/Epikarst/Conduit/Diffuse flow. (Karst aquifers are defined as those that are referred to as karst in the GSI aquifer maps).
 - Sand and gravel intergranular flow
 - *Aquifer resource value and flow type - aquifers may be subdivided into 3 types for this assessment*
 - Regionally Important
 - Locally Important
 - Poor

Receptors

- *Location: the discharge activity should be located away from sensitive receptors.*
 - Are the proposed drill holes located within 100m of a private well or 300m from a public supply or group water scheme? In general domestic wells have small extraction rates but commercial wells will be significantly higher. The Geological Survey of Ireland has completed Groundwater Protection Schemes for many of the local authorities. These include delineation of source protection zones – an assessment of the land area that contributes to some boreholes or springs. This is based on bacteria travel time – bacteria will live for 50 days approximately. The travel time may however vary considerably and can be much faster in karst areas for example. These areas are most prone to bacterial contamination. Due to the heterogeneity of most Irish

aquifers, and the large variation in groundwater velocities around a well, a travel time of 100 days is recommended.¹

- Presence of, and proximity to, other features of interest, such as special areas of conservation, groundwater dependent ecosystems and zones of contribution to existing abstraction points. Specific attention should be given to water dependent Annex I habitats and Annex II species.

Further information on groundwater dependent ecosystems is given in the EPA website (<http://erc.epa.ie/safer/iso19115/displayISO19115.jsp?isoID=289>).

Risk assessment may, in advanced exploration programmes, involve the development of a hydrogeological model involving a suitably qualified person. A full listing of sources of information required for the above assessments and conceptual models are presented in the EPA guidance document 'Guidance on the Authorisation of Discharge to Groundwater' Version 1 December 2011.

A summary of the screening process is outline in Table 3.

| Parameter | Consider | Comments Exploration Activity |
|-----------------|--|--|
| Source | <ul style="list-style-type: none"> • Pollutant type • Discharge rate • Presence or absence of hazardous substances in the input. | <ul style="list-style-type: none"> • Pathogens in surface water. • 30 – 140m³/d depending on drilling method.* • Non-hazardous |
| Pathway | <ul style="list-style-type: none"> • Flow regime (fissure, karst, conduit, intergranular) • Aquifer type - Regionally, locally important or poor aquifer | <ul style="list-style-type: none"> • GSI aquifer classification maps. |
| Receptor | <ul style="list-style-type: none"> • Proximity to sensitive receptors | <ul style="list-style-type: none"> • Check distance to wells and other sensitive receptors |

Table 3 Risk Assessment Screening – Direct Discharge to groundwater

*Discharge Rate. The above discharge rates are assuming that all water is lost during drilling. This is not always the case (discussed earlier) and loss of drill water is often temporary. In many cases drill water is returned to surface and is in turn discharged to groundwater indirectly through the percolation area or through the sump area. The proportion of drill

¹ Further information on source protection zones is documented in 'Groundwater Protection Schemes (1999)', DELG, EPA, GSI. If a simple fixed radius method is used to define the source protection zone then a distance of 300m is normally used around public wells. The distance may be increased in karst aquifers and reduced in granular aquifers and around low yielding wells. In karst areas it is not usually feasible to delineate 100 day time of travel boundaries due to large variations in permeability and high flow velocities.

water lost during drilling is a function of many factors but the use of additives can be beneficial as it can result in increased water returns.

4.3.2 Step 1b – Assess the Nature of the Discharge Activity and Carry Out Risk Screening – Indirect Discharge Percolation Area.

Carry out screening assessment

The following is a list of considerations related to the nature of the discharge activity using the SPR approach for indirect discharge. A summary of the screening process is outlined in Table 4.

Key parameter

- There must be adequate attenuation potential within the soil overburden so that groundwater quality objectives are met.

Source (as above)

- *Volume: Define volumes on maximum and minimum rates (m^3/d).*
 - Discharge rates $30 m^3/d$ typically but up to $140m^3/d$.
 - Assume maximum return for percolation areas and sump
- *Determine the nature of the return drill water.*
 - Assume that all surface water streams and rivers contain pathogens.

Pathway

- Pathway is a function of aquifer vulnerability i.e. subsoil thickness and permeability below the percolation area or sump. A minimum of 1m of subsoil is required for non karst areas or 2m in karst areas.
- Percolations tests may be required in areas of low permeability.

Receptors

- A setback of 25m for the percolation area is required from any surface water features – this may be increased if surface water features are sensitive (e.g. pearl mussel rivers). This may also be increased if soils have high permeability to allow for longer residence time. Drilling waters may also be captured and treated (by flocculants) in bowzers or sedimentation tanks.
- There shall be no discharge to karst features such as swallow holes or dolines and a setback of a minimum of 25m from these features is recommended (but may be greater if local topography or dry channels tilt towards the karst features).
- Minimum distance of 100m for domestic ($<10m^3/d$) and 300m for group or private wells ($> 10m^3/d$).

| Parameter | Consider | Comments Exploration Activity |
|-----------------|---|---|
| Source | <ul style="list-style-type: none"> Pollutant type Discharge rate Presence or absence of hazardous substances in the input. | <ul style="list-style-type: none"> Pathogens in surface water. 30 – 140m³/d depending on drilling method. Non-hazardous |
| Pathway | <ul style="list-style-type: none"> Aquifer vulnerability | <ul style="list-style-type: none"> GSI vulnerability classification maps. Minimum subsoil depth 1m in non karst and 2m in karst |
| Receptor | <ul style="list-style-type: none"> Streams Karst features Wells | <ul style="list-style-type: none"> Check distance to wells and sensitive receptors Ensure no direct percolation into karst features |

Table 4 Risk Assessment Screening – indirect discharges to groundwater

Based on the above assessment the risk is defined as Negligible, Low, Moderate or High risk (Table 5). Exploration drilling may fall into a low or moderate risk requiring a technical assessment only. It is unlikely to fall into a high risk unless large volumes of polluted river water are lost during drilling.

4.3.3 Step 2 – Determine the Appropriate Level of Technical Assessment

Based on the risk screening, different levels of technical assessment may be required.

- If the risk is considered to be negligible then no further work is required and a brief report outlining step 1 and step 2 findings is submitted to EMD.
- Where risk is deemed to be low a stage 1 assessment is required;
- Where risk is deemed to be moderate, a stage 2 assessment is required;
- Where hazardous substances may be involved and/or risk is otherwise deemed to be high, a stage 3 assessment is required.

The processes and requirements for each stage are discussed below and summarised in Chart 3. The assessment is for direct discharge only. The previous section covers the indirect discharge in sufficient detail.

| |
|---|
| <ul style="list-style-type: none"> Negligible risk no further work, document findings. |
| <ul style="list-style-type: none"> Where risk is deemed to be low, a Stage 1 assessment is required; |
| <ul style="list-style-type: none"> Where risk is deemed to be moderate, a Stage 2 assessment is required; |
| <ul style="list-style-type: none"> Where risk deemed to be high, a Stage 3 assessment is required. |

4.3.4 Step 3 - Technical Assessment

It is not possible to be prescriptive about every situation and the following table is an **indicative guide only**. In certain instances where an impact cannot be ruled out, monitoring of the well may be required before, during and after drilling. In such situations it is advisable to consult a hydrogeology specialist.

The following table lists examples of different exploration activities and the technical assessment requirements for the various levels of assessment

| Level of Assessment | Nature of Activity and Geological/Ecological Conditions | Tests/Calculations Requirements |
|-------------------------------------|--|--|
| Negligible | <ul style="list-style-type: none"> ➤ > 100m from domestic receptor ➤ > 300m from group or public water supply borehole or spring ➤ No sensitive ecological receptors ➤ 1 Drillhole Planned ➤ Poor or locally important aquifer | <ul style="list-style-type: none"> ➤ No receptor ➤ No pathway ➤ No impact |
| Stage 1 Assessment Low risk | <ul style="list-style-type: none"> ➤ > 100m from domestic receptor ➤ > 300m from group or public ➤ No sensitive ecological receptors ➤ 1 to 3 Drillholes Planned ➤ Poor aquifer | <ul style="list-style-type: none"> ➤ Basic assessment of aquifer properties. ➤ 300m unless local indications indicate otherwise |
| Stage 2 Assessment Moderate Risk | <ul style="list-style-type: none"> ➤ > 100m from domestic receptor ➤ > 300m from group or public ➤ No sensitive ecological receptors ➤ Regionally important aquifer fissure flow ➤ 1- 10 drillholes planned | <p>Aquifer Properties</p> <ul style="list-style-type: none"> ➤ Determine permeability and travel velocity ➤ Assess receptors based on high velocities <p>Surface waters</p> <ul style="list-style-type: none"> ➤ Ensure no significant impact on surface waters from abstraction. |
| Stage 3 Assessment High risk | <ul style="list-style-type: none"> ➤ Advanced exploration programme > 10 drillholes ➤ > 100m from domestic receptor ➤ > 300m from group or public ➤ Karst aquifer. ➤ Fissure and Conduit flow ➤ Sensitive water course < 100m from percolation zone. | <ul style="list-style-type: none"> ➤ Aquifer Properties <ul style="list-style-type: none"> ○ Permeability ○ Flow Direction ○ Groundwater gradient ➤ Conceptual Model ➤ Conduct percolation tests if required ➤ Assess significance of abstraction impact on surface waters ➤ Calculate travel velocities based on aquifer properties. |

Table 5 Requirement for Different Technical Assessment Levels

Note on Technical assessment

There may be a requirement to carry out a stage 3 assessment in certain situations such as:

- Planned drill hole is less than the recommend distance from well supplies.
- There are groundwater dependent ecosystems such as turloughs, fens and flushes within the catchment of the planned drillholes.
- A single drill hole is planned but the aquifer is a karst aquifer with conduit flow close to well supplies.

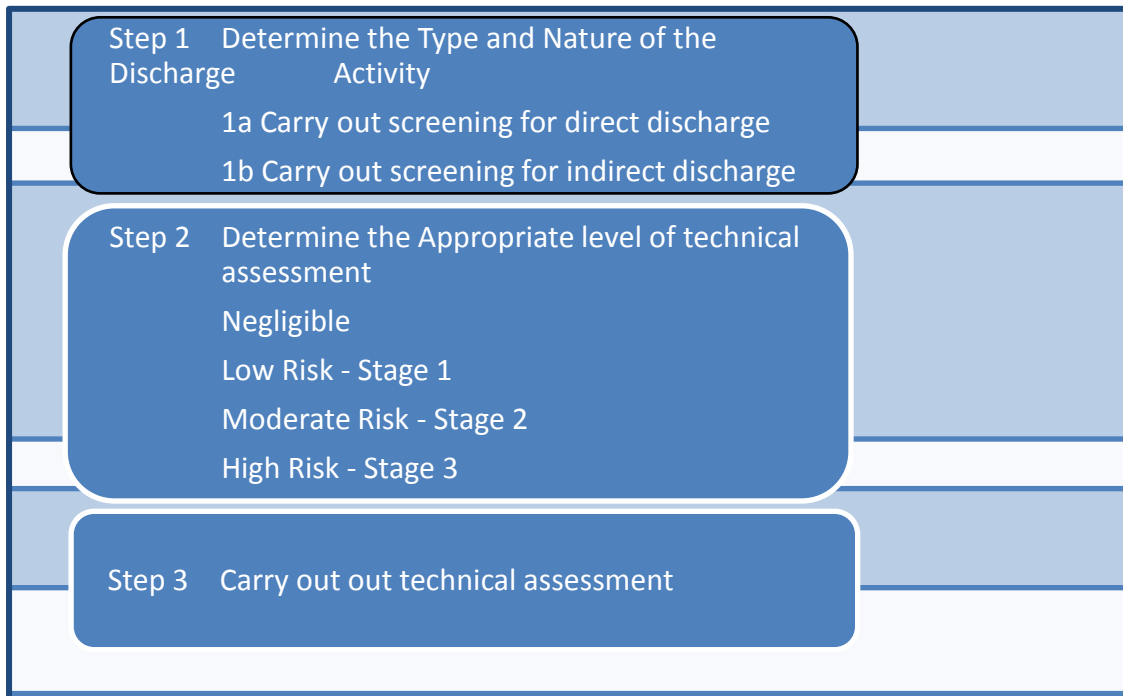


Chart 3 Summary of Risk Screening process

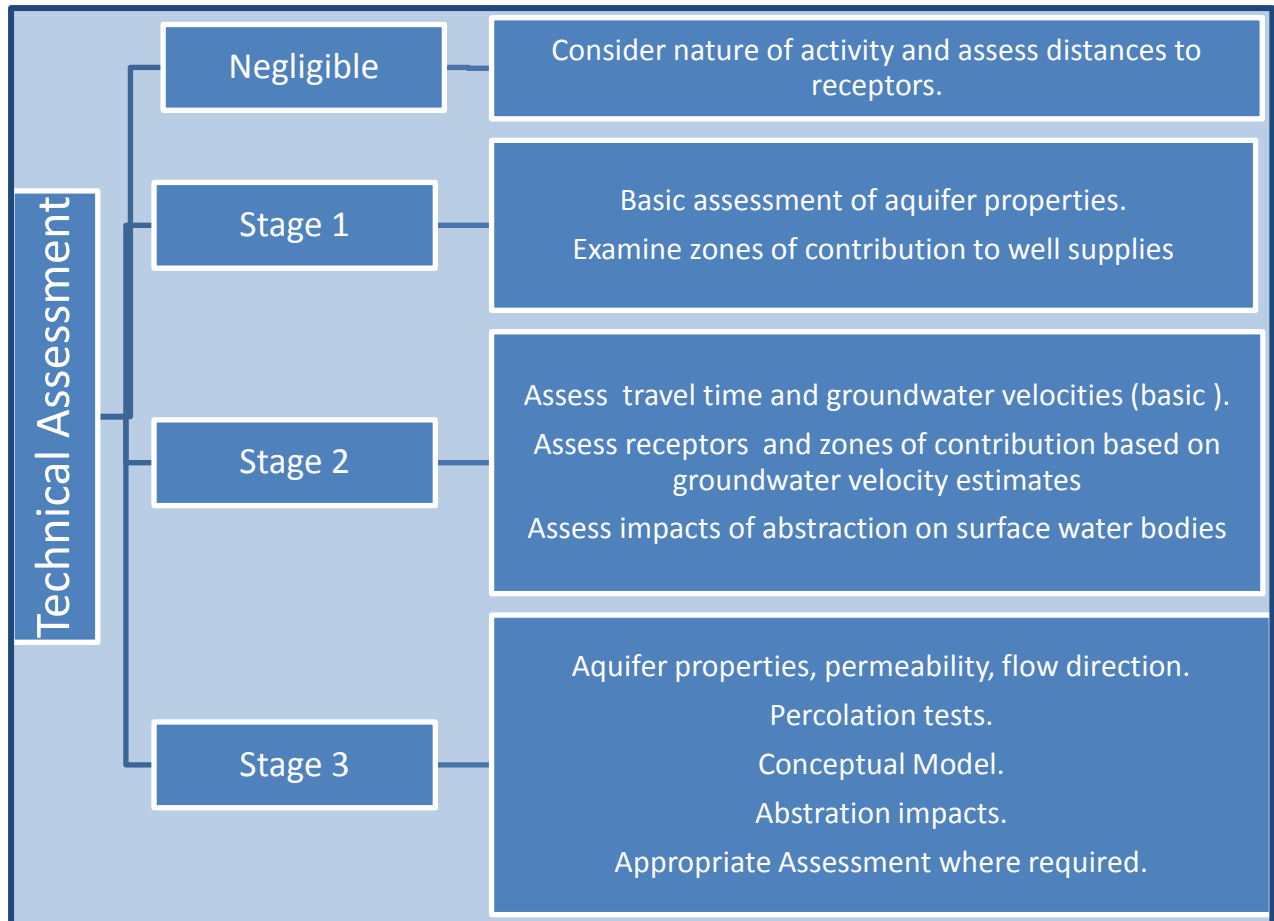


Chart 4 Technical assessment requirements summary

4.4 STANDARD OPERATING PROCEDURES (SOP)

4.4.1 Direct Discharge

The principal SOPs relate to the use of drill water and set back distances from well and spring drinking water supplies and surface waters. For advance exploration programmes, it may be possible to use groundwater as a source by extracting water from previously drilled drillholes provided that the extracted groundwater is not itself contaminated by bacterial or inorganic compounds above relevant environmental objectives or drinking water limits (Threshold Values from the European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010); and/or the drinking water limits from the Drinking Water Regulations (SI No. 278 of 2007)). The use of groundwater from one hole to drill another ensures the water is of a consistent nature.

- Drill water source

One of the principal and most effective SOPs, if required, in relation to the direct discharge is to use either:

- Treated water from a mains supply;
 - Clean or treated surface waters;
 - Groundwater of a satisfactory quality from an existing well in the aquifer.
- Treatment of surface water supply
 - Risks to groundwater can be minimised by treating the surface water source prior to circulation. This can be achieved by the use of UV treatment system (e.g. Ultraviolet germicidal irradiation (UVGI)). Other methodologies will be evaluated on a case by case basis.
- Additives
 - Use appropriate additives in broken or fractured bedrock to prevent ingress into the aquifer;
 - Ensure additives are non-hazardous and biodegradable.
- Setback Distance
 - Well/Spring Supply
 - 100m domestic supply and 300m public or group water scheme supply. If in karst area with conduit flow then re-evaluate distance based on risk assessment.
 - Sensitive receptors (including SACs and surface water receptors where there is a large component of groundwater flow to surface waters)
 - Site specific and a function of the environmental quality objectives of the site.

4.4.2 Indirect Discharge

The operator shall prevent any silting/erosion of waterbodies and pollution of surface water that may adversely affect the quality or appearance of water or cause obstruction or interference with the flow.

Runoff from the site must not be discharged directly to nearby/adjacent waterbodies. Sediment/filter fences or other methods may be used to protect all waters.

Excess surface water runoff will be controlled by bunding, sheeting and sand bags to ensure it does not enter any watercourse or drains.

Sandbags or hay bales will be used to bund off relevant areas. Sediment from the borehole area will be collected and bagged for controlled disposal together with any residual material where required.

Establish site boundary markings to safeguard features of relevance, such as karst features – dolines and swallow holes.

- Site setup
 - Site setup is not covered in this document and best practice is outlined in 'Guidelines for Good Environmental Practice in Mineral Exploration' (EMD publication) in relation to:
 - Oil matting
 - Spill kits
 - Storage of fuel
 - All plant will be well maintained with any fuel or oil drips attended to on an ongoing basis. Oil mats will be placed below any areas of potential contamination. Any persistent problems that cannot be fixed immediately will have added safety of spillage trays placed at critical locations. Oil/fuel soak up granules will be present on site to deal with any incidents. All vehicles should carry spill kits and operators must be trained in their use. Fuel will be stored in bunded bowsers or tanks in suitable locations.
- Percolation area
 - Assess aquifer vulnerability and ensure adequate protection
 - Vulnerability low or moderate or a minimum subsoil of 1m in non karst areas and 2m in karst areas.
 - Ensure adequate setback from surface water
 - Ensure no discharge to ground via karst features such as dolines and swallow holes.
 - Ensure adequate treatment through percolation vegetated buffer zone.
 - Ensure adequate treatment through sumps (sufficient residence time) and modify or recirculate waters as required.
 - If subsoil thickness is not adequate for recharge to the aquifer, or the area is underlain by low permeability soils, an alternative treatment system is required, such as settlement tanks.

4.4.3 Hole Completion

Objectives

Drill holes must be decommissioned in a manner that will:

- Remove the hazard of an open hole;
- Prevent the borehole acting as a conduit for contamination to enter groundwater;
- Prevent the mixing of contaminated and uncontaminated groundwater from aquifers within the drilled strata;
- Prevent the flow of groundwater from one groundwater body to another; and
- Stop artesian flow.

The objective of decommissioning is to ensure no long term impact on the groundwater system. This means sealing off the different groundwater inflow zones to prevent cross-flow from one level to another. Particularly relevant is the subsoil-bedrock interface as, in most cases; the aquifer requiring protection will be the bedrock aquifer. Shallow groundwater has a higher potential for being polluted. Particular care should also be given to the upper fractured and weathered bedrock zone. This zone should also be backfilled. Backfilling materials should be clean (washed), inert, uncontaminated, excavated materials. Low permeability materials such as clay, bentonite or cement grout and concrete are inserted where impermeable barriers are required (e.g. in the upper weathered zone so that this high permeability zone does not link with any conduits in the borehole). This will prevent mixing between aquifers such as the till aquifer and the bedrock aquifer.

For artesian boreholes, the objective is to confine the flow to the horizon it came from. This could require lowering the groundwater for a period by:

- Pumping the borehole to produce a drawdown;
- Introduction of a precast plug at the appropriate level;
- Use of an inflatable packer and pressure grouting the void space.

The top of the borehole must be sealed to prevent surface water ingress. The borehole is finished with an impermeable plug or cap. The final 2 metres is filled with cement, concrete or bentonite grout with a concrete or cement cap. The final capping level should take into account future farming activities.

- Setback distance
- Subsoil
 - thickness
 - permeability
 - Percolation test if required
- Sensitive receptors
 - Wells/springs
 - Karst Features
 - Groundwater dependent ecosystems
- Surface water receptors
 - SAC
 - Annex II species

Indirect discharge



- Nature of drill water
 - Surface water
 - Groundwater
 - Volumes required
- Impact of abstraction on surface water
 - Sufficient flow volumes
- Distance to receptors
 - Domestic wells <10m³/d
 - Group or Public wells >10m³/d
- Aquifer
 - Type
 - Flow mechanism
- Basic velocity calculations
- Conceptual model
- Requirements for backfilling

Direct discharge



- Oil Mats
- Spill kits
- Storage bunding
 - Sand bags
 - Hay bales
- Silt fences
- Management of sediment generated
- Location of sensitive receptors
- Establish site boundary

Site Setup



Appendix I

4.5 Case Study 1 – 1 Drill Hole Poor Aquifer

- Case Study 1 – Grassroots exploration activity – 1 Drill hole planned in a Lower Palaeozoic poorly productive aquifer. There may be a requirement to use additives if broken and fractured ground is intersected.
- Determine the Type and Nature of the Discharge Activity

| | | |
|--|--|-------------------------------|
| Determine distance to sensitive receptors. | <ul style="list-style-type: none"> Wells SACs | Private well 350m No SACs |
| Volumes required for drilling | <ul style="list-style-type: none"> Conventional Drilling Directional Drilling Other | Conventional Diamond Drilling |
| Determine scale of exploration activity | <ul style="list-style-type: none"> Grassroots exploration – 1 to 3 planned drill holes Intermediate Scale > 3 drill holes Advanced > 10 | 1 Drill hole planned |

STEP 1a – Direct Discharge

| | | |
|----------|--|--|
| Source | <ul style="list-style-type: none"> Pollutant Type Discharge Rate | Surface water used for source 30m ³ /d |
| Pathway | Aquifer type and flow regime (fissure, karst, diffuse, intergranular) | Poorly productive aquifer Fissure flow |
| Receptor | <ul style="list-style-type: none"> Proximity to sensitive receptors Separation Distances Concentration of pollutants in discharge relative to receptor based water quality standard | No SACs Distance > 300m to any wells Concentration of bacteria will be higher but expected volumetric input low and temporary. |

STEP 1b – Indirect Discharge

| Parameter | Consider | Comments Exploration Activity |
|-----------|--|---|
| Source | As above | |
| Pathway | <ul style="list-style-type: none"> Aquifer vulnerability | Low vulnerability. Thick sequence of glacial till. |
| Receptor | <ul style="list-style-type: none"> Streams Surface Karst features Wells | <ul style="list-style-type: none"> Streams not sensitive (salmonid or SAC) No surface karst features No wells close to percolation area (>100m) |

- Based on the nature of the activity and the screening risk is considered negligible and no further assessment is required. Produce the above tables and submit to EMD for approval.

4.6 Case Study 2 - 3 Drill Holes Regionally Important Aquifer

- Case Study 2 – Grassroots exploration activity – 3 Drill holes planned in a Waulsortian regionally important aquifer. Examination of the GSI database indicates that there are not any prominent surface karst features but expecting to intersect karst features during drilling. There may be a requirement to use additives if broken and fractured ground is intersected.
- Determine the Type and Nature of the Discharge Activity

| | | |
|--|--|-------------------------------|
| Determine distance to sensitive receptors. | <ul style="list-style-type: none"> Wells SACs | Private well 150m No SACs |
| Volumes required for drilling | <ul style="list-style-type: none"> Conventional Drilling Directional Drilling Other | Conventional Diamond Drilling |
| Determine scale of exploration activity | <ul style="list-style-type: none"> Grassroots exploration – 1 to 3 planned drill holes Intermediate Scale > 3 drill holes Advanced > 10 | 3 Drill holes planned |

• STEP 1a – Risk Screening OF Direct Discharge

| | | |
|----------|--|--|
| Source | <ul style="list-style-type: none"> Pollutant Type Discharge Rate | Surface water used for source 30m ³ /d |
| Pathway | Aquifer type and flow regime (fissure, karst, diffuse, intergranular) | Regionally important aquifer Fissure flow but possibly conduit |
| Receptor | <ul style="list-style-type: none"> Proximity to sensitive receptors Separation Distances Concentration of pollutants in discharge relative to receptor based water quality standard | No SACs Distance > 150m to any wells Concentration of bacteria will be higher but expected volumetric input low and temporary. |

• STEP 1b – Indirect Discharge

| Parameter | Consider | Comments Exploration Activity |
|-----------|--|---|
| Source | As above | |
| Pathway | <ul style="list-style-type: none"> Aquifer vulnerability | Variable vulnerability – ensure minimum of 2m of subsoil for percolation area. Map for surface karst features and avoid any direct discharge to same. |
| Receptor | <ul style="list-style-type: none"> Streams Surface Karst features Wells | <ul style="list-style-type: none"> Streams not sensitive (salmonid or SAC) No surface karst features No wells close to percolation area (>100m) |

- Based on the nature of the activity and the screening Stage 2 assessment is required (based on the worst case scenario with volumes).

Level 2 assessment consists of:

- Assess travel time and groundwater velocities (basic).
 - Regionally important bedrock aquifer.
 - Darcy's law $Q = KiA$ where;
 - Q is groundwater flow rate in aquifer (m^3/d)
 - K is hydraulic conductivity (m/d)
 - i is hydraulic gradient
 - A is cross sectional area of part of the aquifer.
 - Estimated $K = 1m/d$
 - $i = 0.005$ (estimated)

Velocity

- $V = Ki/n$ where
 - V is flow velocity (m/d)
 - K as above hydraulic conductivity (m/d)
 - n is effective porosity (m/m)

Note Effective porosity is the fraction of the rock volume that is occupied by interconnected fractures – Values for fissured bedrock are between 0.01 and 0.03. This will be considerably larger for sand and gravel aquifers 0.1 to 0.2.

- **$V = 0.25m/d$**
- Travel time to e.g. 100m distant well is therefore 400 days.

The velocity is important when bacterial contamination is the main pollution concern. If a well is 100m away then the calculated travel time to the well is 400 days. With a life of 50 to 100 days the assessment indicates that there is no risk to the well from drilling. The above calculations are based on Darcy's law that contains many assumptions in relation to the aquifer properties. As Darcy's law is most applicable to sand and gravel aquifers it can only be used as a very general approximation.

In Karst limestone areas then flows can be in the region of 10 or in excess of 100m /d. The above calculations therefore are not valid.

- Assess receptors and zones of contribution based on groundwater velocities
- Assess impacts of abstraction on surface water bodies

4.7 Case Study 3 Advanced Exploration Programme Regionally Important Aquifer

- Case Study 3 – Advanced stage exploration activity – 15 Drill holes planned in a Waulsortian regionally important aquifer. Examination of the GSI database indicates that karst features are present. There will a requirement to use additives.
- Determine the Type and Nature of the Discharge Activity

| | | |
|--|--|--|
| Determine distance to sensitive receptors. | <ul style="list-style-type: none"> Wells SACs | Several private wells Some drilling close to SAC (with Turloughs) |
| Volumes required for drilling | <ul style="list-style-type: none"> Conventional Drilling Directional Drilling Other | Conventional Diamond drilling. 15 rigs. 450m ³ /d required for drilling with all 15 rigs. |
| Determine Scale of exploration activity | <ul style="list-style-type: none"> Grassroots exploration – 1 to 3 planned drill holes Intermediate Scale > 3 drill holes Advanced > 10 | 15 Drill holes planned for this phase. Early drilling has indicated fractured ground likely and loss of water expected |

Step 1 A – Risk Screening Of Potential Impact To Groundwater And Receptors

| | | |
|----------|--|---|
| Source | <ul style="list-style-type: none"> Pollutant Type Discharge Rate | Surface water used for source 450 m ³ /d |
| Pathway | Aquifer type and flow regime (fissure, karst, diffuse, intergranular) | Regionally important aquifer Fissure flow but possibly conduit |
| Receptor | <ul style="list-style-type: none"> Proximity to sensitive receptors Separation Distances Concentration of pollutants in discharge relative to receptor based water quality standard | SACs 400m to sensitive water course and groundwater dependent ecosystem (Turlough) Distance 120m to domestic well Concentration of bacteria will be higher and expected volumetric input is high calculations |

STEP 1b – Indirect Discharge

| Parameter | Consider | Comments Exploration Activity |
|-----------|--|---|
| Source | As above | |
| Pathway | <ul style="list-style-type: none"> Aquifer vulnerability | High vulnerability. |
| Receptor | <ul style="list-style-type: none"> Streams Karst features Wells | <ul style="list-style-type: none"> Map surface karst features and highlight to operators No wells close to percolation area (>100m) Streams sensitive (salmonid or SAC) so ensure sufficient set back distance Mitigate with settlement tanks if required. |

- | | |
|--|---|
| | <ul style="list-style-type: none"> • Carry out screening for appropriate assessment. |
|--|---|

- Based on the nature of the activity and the screening process a Stage3 assessment is required and existing information will be used to develop a conceptual model.

Aquifer Properties and Calculations – Conceptual Model

- As the travel time in a karst area is likely to be orders of magnitude higher than the previous example additional factors need to be considered: is the karst unsaturated or saturated (above the watertable or below), open karst verses infilled karst. If these parameters can not be determined then ensure that clean water is used for drilling, for example potable water.
- Calculations
 - In light of the turbulent flow nature of the aquifer a conceptual model will be more valuable than the Darcy type calculations.
 - The chemical loading can however be approximated based on abstraction rates, loss assumptions (based on earlier drilling records) and chemistry of the surface water supply.
- Travel time of any contaminants will clearly depend on whether a conduit is intersected. If intersected travel rate is in the order of 100m/day and possibly considerably larger

• Conceptual Model

A conceptual model is shown in Figure 2. The planned bore holes will extend down to base of reef and into the Ballysteen limestone. A sensitive receptor (abstraction well) is located 200m down gradient. The planned depth of the drill holes is beyond 400m. The potential impacts relate to possible contamination of the well during drilling. There will only be an impact if the conduits (as shown) are interconnected. This may not possible to determine and monitoring may be required during the drilling programme.

- Percolation Area
 - An assessment of the proposed percolation areas should ensure adequate sub soil cover and sufficient set back distance from karst features and surface water bodies. This should be carried out on a site by site basis. Sufficient soil cover should be > 2m of moderate permeability soil above bedrock. Set back distance should be at least 25m from karst features and surface water bodies.
- Standard Operating Procedures – Drill water
 - In light of the uncertainties in predicting impacts on abstraction wells the SOPs are to ensure no impact by using a clean treated surface source for drilling or using existing drill holes as a source of groundwater for the drill water. Depending on conditions the company should consider more appropriate SOPs depending on the local ground conditions.

Carry out Screening for appropriate assessment (see Appendix III).

In light of the above risk assessment an impact on the abstraction well cannot be ruled out. However with the SOPs implemented and monitoring proposals in place impacts can be minimised and drilling approved.

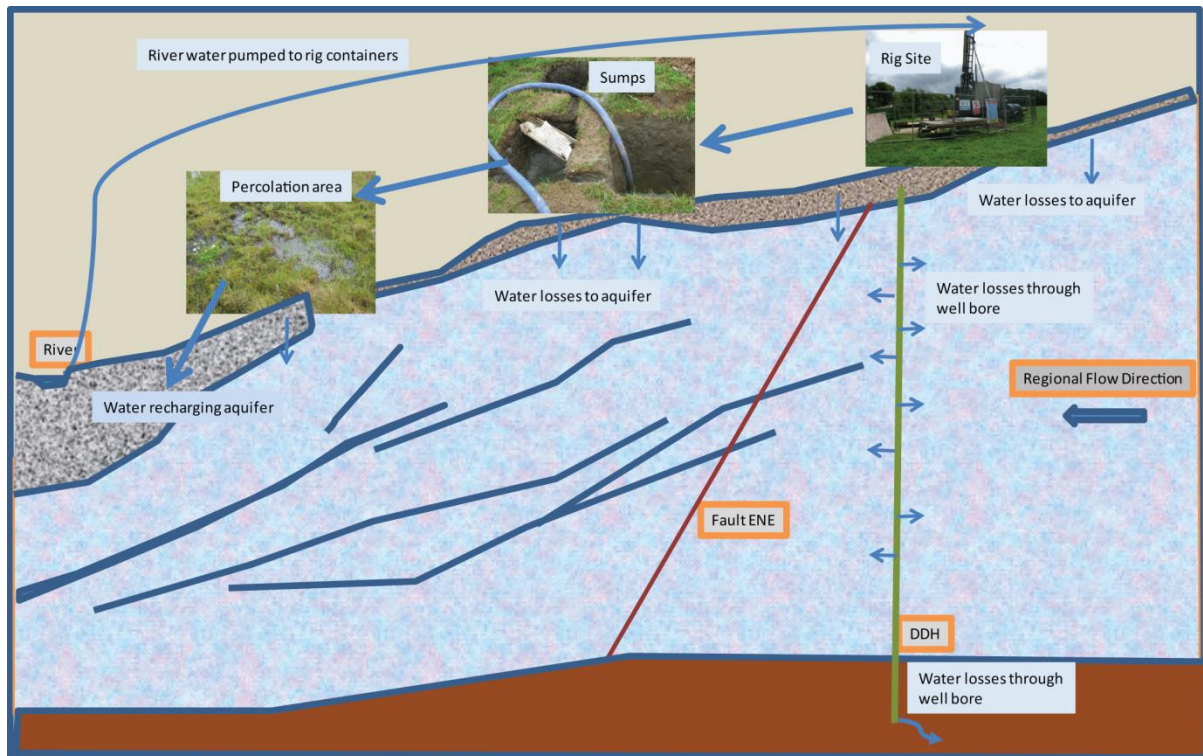


Figure 1 Water Circulation

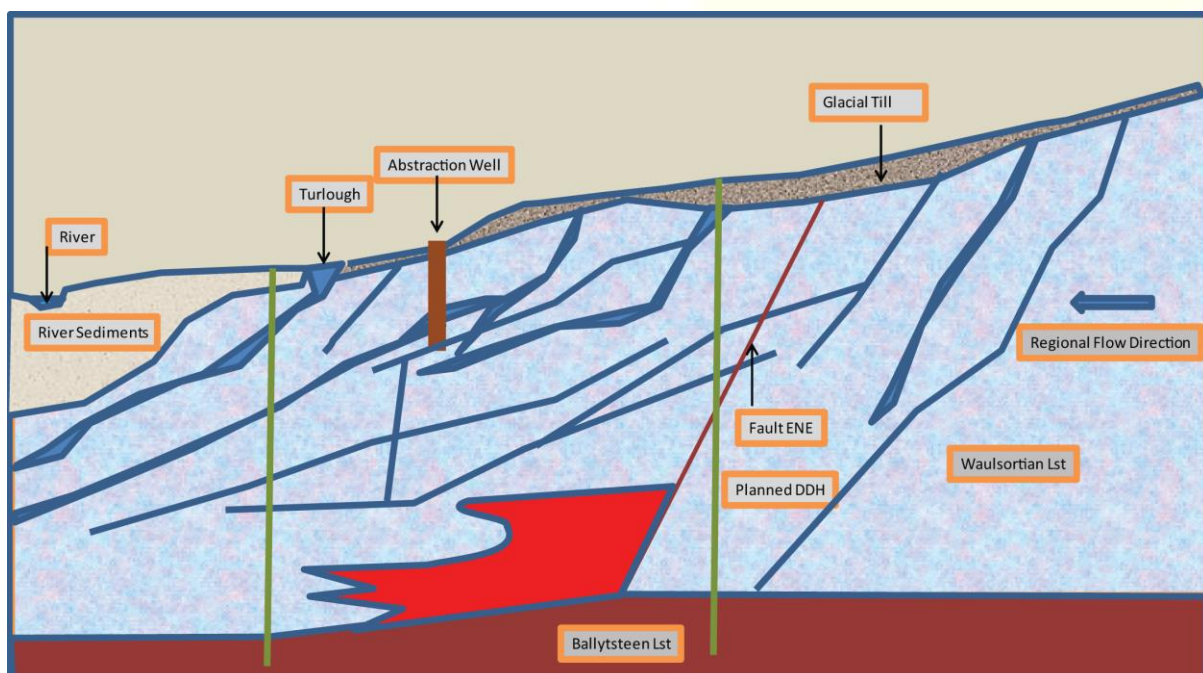


Figure 2 Conceptual Model

5 Appendix II Legislative Context

5.1 Groundwater Quality Objectives

Of particular relevance to any activity that discharges to groundwater is Regulation 4 of the Groundwater Regulations (S.I. No. 9 of 2010) which outlines the core objectives. This regulation requires public authorities to promote compliance with the requirements of the regulations and where necessary to implement measures to:

- *Prevent or limit, as appropriate, the input of pollutants into groundwater and prevent the deterioration of the status of all bodies of groundwater;*
- *Protect, enhance and restore all bodies of groundwater and ensure a balance between abstraction and recharge of groundwater with the aim of achieving good groundwater quantitative status and good chemical status by not later than 22 December 2015;*
- *Reverse any significant and sustained upward trend in the concentration of any pollutant resulting from the impact of human activity in order to progressively reduce pollution of groundwater;*
- *Achieve compliance with any standards and objectives established for a groundwater dependent protected area included in the register of protected areas established under Regulation 8 of the 2003 Regulations (S.I. NO. 722 of 2003) by not later than 22 December 2015, unless otherwise specified in the Community legislation under which the individual protected areas have been established.*

Regulation 7 of the regulations states that “Point source and diffuse discharge sources liable to cause groundwater pollution shall be controlled so as to prevent or limit the input of pollutants into groundwater”.

The prevent objective relates to hazardous substances and all necessary and reasonable measures should be taken to avoid the entry of such substances into groundwater and avoid any significant increase in concentration in groundwater even at a local scale.

The limit objective relates to non-hazardous substances whereby all necessary measures should be taken to limit inputs into groundwater to ensure that such inputs do not cause deterioration in status of groundwater bodies, or significant and sustained upward trends in groundwater concentrations.

5.2 Groundwater Inputs

The Groundwater Regulations define an input of pollutants as the direct or indirect introduction of pollutants into groundwater as a result of human activity.

Direct inputs include situations where the source of pollution:

- Bypasses the unsaturated zone (e.g. direct input through a borehole);
- Is directly in contact with the groundwater table (saturated zone); and /or
- Is periodically in contact with the groundwater table due to seasonal fluctuations.

Indirect inputs include situations whereby:

- Pollutants percolate/infiltrate to the groundwater table through an unsaturated zone; and
- The source of pollution is located above the groundwater table all year round.

5.3 Exemptions

Under Regulation 14 of the Groundwater Regulations the EPA may establish detailed technical rules under which new inputs may be exempted from the requirement that all measures be carried out to meet the 'prevent and limit' objective. Such activities (listed under Regulation 8) include:

- *Injection of water containing substances resulting from the exploration and extraction of hydrocarbons or mining activities, and injection of water for technical reasons, into geological formations from which hydrocarbons or other substances have been extracted or into geological formations which for natural reasons are permanently unsuitable for any other purpose. Such injections shall not contain substances other than those resulting from the above operations.*
- *The reinjection of pumped groundwater from mines and quarries or associated with the construction or maintenance of civil engineering works.*
- *Discharge resulting from construction, civil engineering and building works and similar activities on, or in the ground which come into contact with groundwater. Such activities may be treated as having been authorised provided that they are conducted in accordance with general binding rules which are applicable to such activities.*

Under Regulation 8 certain direct discharges to groundwater may be permitted subject to a requirement for prior authorisation, provided that such discharges and the conditions imposed, do not compromise the achievement of the environmental objectives established for the body of groundwater into which the discharge is made.

Finally, in relation to exemptions, Regulation 14 (b) a general 'de minimus' exemption can be granted if the regulatory bodies are satisfied that inputs of pollutants will not result in

deterioration of groundwater quality, and/or are of a magnitude and persistence that would not result in a sustained increase in groundwater concentrations.

6 Appendix III Appropriate Assessment

6.1 Appropriate Assessment – Stages

Department of Culture, Heritage and the Gaeltacht guidelines ([DoELHG, 2009](#)) outlines the European Commission's methodological guidance (EC, 2002) promoting a four-stage process to complete the AA. The first stage, termed AA screening, is to determine, on the basis of a preliminary assessment and objective criteria, whether a plan or project, alone and in combination with other plans or projects, could have significant effects on a Natura 2000 site in view of the site's conservation objectives.

Screening for prospecting activities is carried out by EMD, the Public Authority, based on the information supplied in an AA Screening Report (AASR) by the prospecting licence holder. EMD may request further information from the exploration company to enable it to carry out the screening process.

The AASR should include the following items:

- i. Description of the plan, including location maps.
- ii. Identify all relevant Natura 2000 sites and outline their qualifying interests and conservation objectives
- iii. Assess any likely effects, either direct, indirect or cumulative
- iv. Provide a conclusion on whether the plan will have a likely significant effect on the European Site or Sites

If a significant effect cannot be ruled out then a Stage II Appropriate Assessment and a **"Natura Impact Statement"** is required under **European Communities (Birds and Natural Habitats) Regulations, 2011**.