323761 Cooloo Windfarm, County Galway: Hydrogeological Review

Client: An Coimisiún Pleanála

Dated: 08 September 2026

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1. Introduction

1.1 Background

As part of the examination and analysis of Chapter 9 (Hydrology and Hydrogeology) of Environmental Impact Assessment Report (EIAR) received for this case, An Coimisiún Pleanála requires technical expertise in Water (Hydrology & Hydrogeology) to support the EIA and AA, if required, having regard to relevant legislation and best practice guidance.

1.2 Proposed Works

An Environmental Impact Assessment Report (EIAR) has been prepared by MKO Planning and Environmental Consultants (MKO) on behalf of Neoen, who applied to An Coimisiún Pleanála (ACP) for planning permission to construct a renewable energy development which comprises 9 no. wind turbines, and associated infrastructure in the townland of Cooloo and adjacent townlands, near Abbeyknockmoy in Co. Galway. The general locality and the EIAR site boundary are shown on Figure 1.

ACP have requested a "request for examination and analysis" (review) of the following to inform the EIA and AA to be completed by ACP as part of their determination of the application:

1. Examination and analysis of the information presented by the applicant relating to Hydrology & Hydrogeology namely:
    - The relevant chapters in the EIAR (Chapters 4, 8 and 9) and associated appendices and other chapters within the EIAR which may be referenced within and may be of relevance.
2. Provide an independent professional appraisal of the information provided by the applicant in view of current best practice taking account of observations made by relevant prescribed body/public submissions and the applicants response to same.
3. This assessment should be proportional to the development proposed with a focus on the likely significant effects.
4. The examination and assessment should consider the following and highlight any departures from best practice: (in the EIAR as it relates to Hydrology & Hydrogeology and associated appendices and documents):
    - Approach and methodology
    - Field survey results and evaluation
    - Likely significant effects and cumulative effects with other windfarms
    - Likely effectiveness of mitigation measures, residual impacts
5. Provide an independent appraisal of the assessment presented in the relevant elements of Chapter 9 of the EIAR and associated appendices(and other chapters within the EIAR which may be referenced within Chapter 9 and may be of relevance) and any submissions of relevance and the applicant's response to same.
6. Advise on any additional measures that could be conditioned as part of a planning permission (if necessary).

1.3 Scope of Report

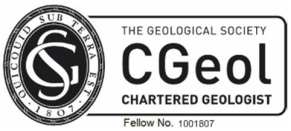
As requested, this report relies on factual information presented by MKO in their EIAR Chapter 1 (Introduction), Chapter 4 (Description of the Proposed Project), Chapter 8 (Land Soils And Geology) and Chapter 9 (Hydrology and Hydrogeology), together with the Non-Technical

Summary (NTS). The response to third party submissions dated February 2026 (Ref. 190723-Cooloo WF Submissions Response F - 2026.02.27) Appendix 2 has been reviewed, as have submissions from third parties, including those from Barnaderg Gortbeg GWS (prepared by Dr Pamela Bartley). The information submitted has been taken as true and accurate, notwithstanding any inconsistencies or limitations evidenced.

The scope of the review is limited to consideration of the information submitted within the context of questions posed by ACP as detailed in section 1.2 of this report. The objective of this report is to provide a technical narrative that ACP can use to assist them in their determination and preparation of an EIA (Environmental Impact Assessment) and AA (Appropriate Assessment) if required.

This report has been prepared by James Dodds BSc (Hons), DUC, MSc, CGeol, FGS, FIQ.

James Dodds has been identified on the list of technical experts as a suitable External Consultant to undertake this role. He was previously engaged on the Galway Bypass project in 2021 and 2025, and prepared and was the lead author of reports for the same. He is a UK-based independent hydrogeologist and natural water consultant who has been practicing since 1986 and has operated in many different countries and across a wide range of industries. He regularly acts in the planning and other regulated arenas across a wide range of industries.



James Dodds has no connection with any of the parties, witnesses or advisors that could lead to a conflict of interest with regard to the matters under consideration in this review. More specifically, he has had no direct contact with any parties in relation to this case prior to instruction.

James Dodds visited the Site and its environs on 20th May 2026 with Brid Maxwell and Jim Egan (ACP) to assist with an understanding of the site context and the broader setting. This did not comprise any surveys, data collection, or any repetition of the Applicant's field survey programme.

1.4 Declarations

I (James Dodds) have prepared this report and confirm and it has been prepared and is given in accordance with the guidance of my professional institution namely The Geological Society of London.

I confirm that the contents of this Report are true to the best of my knowledge and belief and contain my own professional opinions.

I understand that my duty is to help the Inspector to achieve the overriding objective by giving independent assistance by way of objective, unbiased opinion on matters within my expertise. I confirm that I have complied with and will continue to comply with that duty.

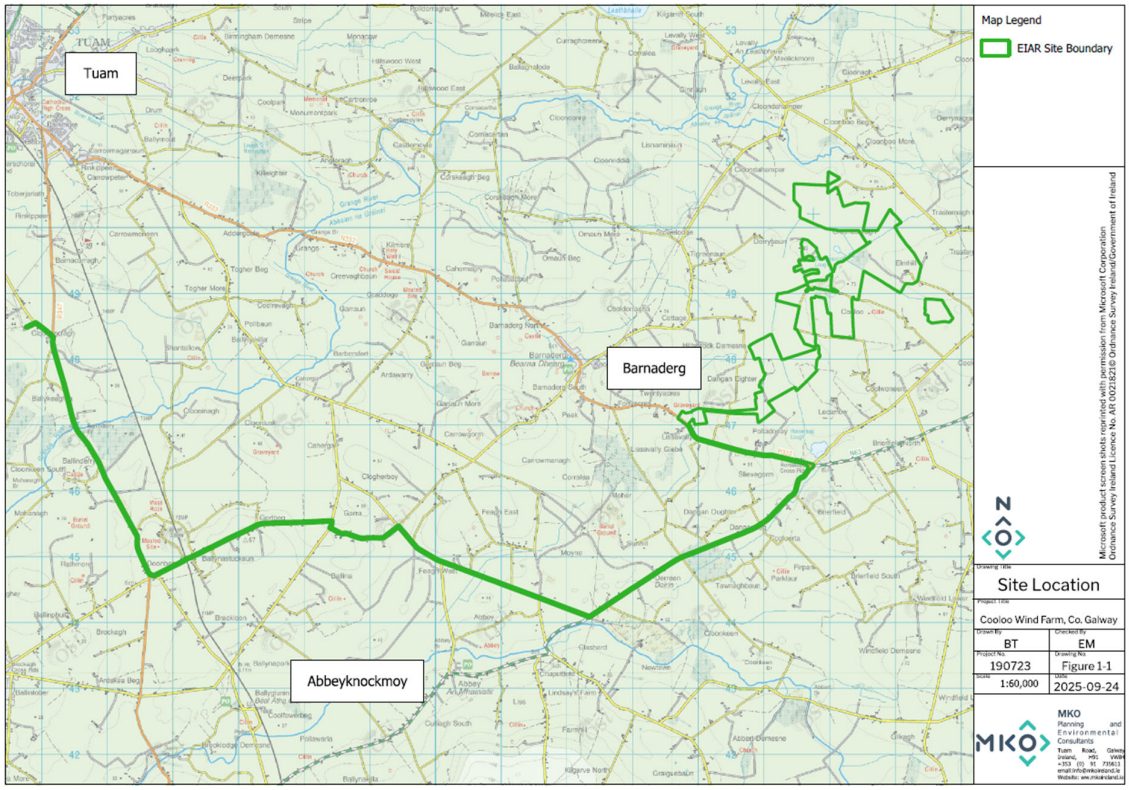


Figure 1 Location

2. Hydrological & Hydrogeological Setting

In reviewing the documentation the following nomenclature has been used. Where 'the Site' is referred to, this relates to the primary study area for the Proposed Project EIAR, as delineated by the EIAR Site Boundary (Figure 1) and includes both the Wind Farm site and Grid Connection. Where 'the Site' is referred to, this refers to turbines and associated foundations and hard-standing areas, meteorological mast, access roads, temporary construction compound, underground cabling, peat and spoil management, site drainage, biodiversity enhancement, turbine delivery route (TDR) accommodation works and all ancillary works and apparatus, as well as the 110kV onsite substation and battery energy storage system.

2.1 Baseline & Site Investigation

The site investigations to inform Chapters 8 and 9 of the EIAR included the following:

- Desk study of background geological (including GSI record of 1 no. rotary core borehole (GSI-17-003), soil and topographic information.
- Walkover surveys and geological mapping of the Site area were undertaken to assess general ground conditions.
- A total of 306 no. peat probes were undertaken to determine the thickness and geomorphology of peat overlying parts of the Site.
- Trial pitting (26 no.) and gouge cores (10 no.) to investigate soil, peat and mineral subsoil lithology logged according to BS: 5930 and Von Post Scale, as well as depth to bedrock.
- Field based karst feature mapping and follow-up surveys.
- Investigation drilling (2 no. boreholes) to determine the geological profile (i.e. peat, mineral subsoil and bedrock profile) and groundwater conditions.
- 2D Resistivity (ERT) survey (4 no. lines) and Seismic survey (1 no. line but did not provide additional information over the ERT).
- Subsoil analysis (25 no. Atterberg limit tests, 28 no. moisture content test and 26 no. particle size distribution tests).
- Continuous groundwater level monitoring at the 2 no. investigation boreholes between October 2022 and February 2025.
- 2 no. rounds, field hydrochemistry measurements (electrical conductivity, pH, dissolved oxygen and temperature).
- 2 no. rounds, surface water and 1 no. round, groundwater sampling.
- Spot surface water flow measurements of the primary watercourses that drain the Site.

Based on Chapter 1 of the EIAR, the EIAR site boundary extends to some 355 ha (3.55km^2).

The Site comprises a rural landscape characterised by areas of intact raised bog, cutover raised bog, forestry, agricultural grassland and scrubland. The topography of the Proposed Wind Farm site is undulating with gentle slopes typical of a low-lying raised bog setting with surrounding local hills. The elevation of the Site ranges from approximately 65m OD (metres above Ordnance Datum) to 80m OD. The 70mOD contour[1], describes the Site with slopes falling to the north and

[1] Ordnance Survey Ireland 1:50 000 6th Edition sheet 39

southeast from a high point located centrally within the Site which also forms the surface water catchment divide between the Grange River to the north and the Abbert River to the south.

2.2 Hydrology

Figure 9.1 (Chapter 9) shows the general drainage directions local to the Site.

Regionally, the drainage from the Site to the south is via two small tributaries (the Lecarrow stream and the Forty Acres stream)of the Abbert River which lies some 5km from the centre of the Site. Drainage to the north is via a small tributary (the Dangan Eighter stream) of the Grange River which lies some 3km from the centre of the Site. Both the Abbert and Grange rivers are themselves tributaries of the Clare (Galway) River some 13km west of the Site. The Site falls within the Lough Corrib catchment, which supports salmonid species. Lough Corrib is located approximately 23km to the west of the Site.

The closest designated site to the Site is Lough Corrib SAC (Site Code: 000297) which includes the Grange and Abbert rivers immediately downstream of the Site.

The Proposed Grid Connection cable route intersects Lough Corrib SAC where it crosses over the Grange River via an existing bridge on the R347 approximately 9km to the west of the Proposed Wind Farm site. Other bog and lough SACs are outside the catchment of the Site.

Killaclogher Bog NHA is located approximately 4km to the southeast of the Proposed Wind Farm site and while it is located upstream of the Site in the Abbert River catchment, the local groundwater flow directions have not been established, and therefore its location relative to groundwater flow is not known.

2.3 Geology

The majority of the Site is underlain by cutover raised peat which in turn is surrounded and underlain by limestone Tills. Below the limestone Tills lie the limestones of the Burren Formation (a Visean Limestone comprising a pale grey clean skeletal limestone), with the northern tip of the Site (T7) underlain by the Croghan Limestone Formation (dark cherty limestone and shale) . The geology strikes in an east north east – west south west direction (ENE – WSW) with a shallow dip (c. 3^{o}) to the south south east (SSE).

The limestone Tills comprise predominantly clays and silts, but may contain sand and/or gravel lenses and/or clasts of limestone.

Peat depth (thickness) has been measured and interpolated within and close to the EIAR boundary. Thickness ranges from c. 7m to 0m. The thickest peat is to the north west of T9 and north of T5. The largest number of probes c. 180 reported peat thickness of 0 – 0.5m, although there was a c. 165 with reported thickness of between 0.5 & >6m.

The mid Carboniferous limestone sequence is classified by GSI as a regionally important aquifer – karstified (conduit). While impure and shaley limestones are less susceptible to karst development, the limestones of the Burren Formation are susceptible to karst development (a process whereby fissures, faults and joints are enlarged by dissolution). There are no exposures of bedrock at the Site, as the area is covered by peat and/or limestone Till.

2.4 Hydrogeology

The characterisation of the Clare-Corrib GWB (Groundwater Body) in which the Site sits was presented by GSI in 2004[2]. While the characterisation covers a large area, it provides a useful baseline summary, against which site specific studies can be compared.

The hydrogeological setting comprises four important layers. The top layer comprises the peat and mineral soils, the second layer the limestone Till, the third layer any karstified/weathered limestone (and any epikarst[3] if it is present), and the fourth layer is the unweathered limestone. The base of the active hydrogeological zone is the base of layer 3, with layer 4 being of very low or effectively no permeability (layer 3 is taken to include any karst conduit structures).

The important aspect of the hydrogeological setting is the connectivity between the different layers, and the connectivity with streams, rivers, loughs and turloughs at the surface.

Groundwater actively flows to the 'hydrological base', that is rivers that have a strong sustained flow during dry weather (baseflow), strong permanent springs and turloughs (in karst settings), and the sea. In this setting the hydrological base will be the Grange River to the north and the Abbert River to the south. Locally, the Lecarrow stream, the Forty Acres stream (which both drain toward the Abbert River) and the Dangan Eighter stream (which drains toward the Grange River), may interact with the limestone groundwater, but it is more likely that these small streams drain the peat and limestone Till. Examination of the Ordnance Survey Ireland 1:50,000 scale map suggests a hydrological base at about 60mOD to the north (the approximate elevation of the Grange River) and about 50mOD to the south (the approximate elevation of the Abbert River. Horseleap Lough located 450m south east from T1 and connected to the Lecarrow stream lies at c. 60mOD.

The local groundwater flow within the Carboniferous limestone will be controlled by the geology of the Carboniferous limestone sequence and degree of karstification. As the geological strike and structural trend is toward the WSW, and that karstification will generally follow this trend, then it would be expected that the regional groundwater flow direction would be toward the WSW in the southern part of the Site and toward the ENE in the northern part of the Site. It should not be assumed however, that the groundwater divide is synchronous with the topographic divide, particularly in a karst setting. Locally, the limestone groundwater level and flow direction will be modified by interaction with underlying karst, geological structures and interaction with surface water features. Groundwater level data that would define where the divide between flow to the WSW and ENE lies, or local variations and interaction with surface water, has not been collected.

Groundwater heads (levels) in the peat and limestone Till may be different from that in the Carboniferous limestone and will be controlled separately by local drainage to drains and streams that may be hydraulically isolated from the Carboniferous limestone. Water level data to determine these differences has not been collected.

Water levels recorded in BH1 (near T1) and BH2 (near T2) give values of c. 71mOD and c. 77mOD respectively. The construction of the boreholes is not provided and it is possible that the water levels reflect the groundwater level in the limestone Till/peat, rather than the Carboniferous limestone. If so, this would account for the high elevation[4] when compared to the hydrological base, and the subdued form of the hydrographs[5]. Because only two locations have

[2] 1st Draft Clare-Corrib GWB Description June 2004
[3] the highly weathered, porous upper layer of karst limestone
[4] Water level relative to OD
[5] Figure 9.9 Groundwater level plots for BH1 and BH2

been used to collect groundwater level data, information on groundwater flow directions and interaction with surface water features cannot be assessed. To do this a minimum of six locations would be required, with more than six needed to add refinement. Separate monitoring of the water level in the peat, limestone Till and Carboniferous Limestone would be needed to understand vertical hydraulic gradients and interaction between the layers.

2.5 Karst

Appendix 8.2 presents a karst assessment undertaken by Gavin & Doherty Geosolutions (GDG), which is supported by 9 appendices including Appendix G Site Reconnaissance and Ground Investigation. It is important to note that "*Gavin and Doherty Geosolutions (GDG) was commissioned in October 2024 by MKO to undertake a* ***Geotechnical*** *Karst Risk Assessment (KRA)*" (emphasis added), *"... to outline the potential for karst risk at the Proposed Wind Farm site, to develop a quantitative karst risk assessment, and to outline mitigation measures and recommendations for consideration at the detailed design and construction stages of the project."*[6]

The KRA concludes that "*A desk study, site walkovers, ground investigation campaigns, and a risk assessment were conducted to assess the potential karst risk at the Proposed Wind Farm site. The walkover inspections and GI campaign were conducted over a larger search area to assess karst risk across the local area immediately adjacent to the Proposed Wind Farm site. Consultation with the published geological maps indicates that the Proposed Wind Farm site is located in an area susceptible to the development of karst landforms. This is supported by the findings of both the desk study review of aerial and topographic imagery as well as the site walkovers. A total of 41 potential karst features have been identified within 1km of the Proposed Wind Farm site boundary, with 13 potential features identified within the EIAR boundary.*"

At section 1.4.3 the KRA lists the karst hazards that have been considered. These hazards are limited to geotechnical (stability) hazards, and do not consider hydrogeological (pathway/environmental) hazards. In their response to submissions[7], GDG re-iterate section 1.1 of the KRA by stating "*This assessment is limited to consideration of the geotechnical risks posed by karstic features to the Proposed Wind Farm. Consideration of the impact of the Proposed Wind Farm on the hydrology and hydrogeology of the Proposed Wind Farm site is outside the scope of this report*." GDG then refer to Chapter 9 of the EIAR for hydrogeological aspects of the karst.

Chapter 9 of the EIAR is wholly dependent on the site investigation undertaken by GDG and the information collected to assess the geotechnical risk. No additional work was undertaken to assess hydrogeological (pathway/environmental) risks, other than the collection of baseline water quality/chemistry data. Further, Chapter 9 relies on the karst hazard rating developed by GDG to assess geotechnical risk. The hazard rating does not consider hydrogeological (pathway/environmental) risk.

GSI classify the underlying limestone as a regionally important karstified (conduit) aquifer, and it must be recognised that the GSI mapping will not represent the total extent of karstification, but is a clear sign that karst process have been or are active and therefore buried karst features should be expected. By their very nature buried karst features are unpredictable in their position, orientation and size.

GDG identified 41 potential karst features within 1km of the Site boundary, based on GSI mapping, online aerial imagery (Bing & GoogleEarth), Ordnance Survey Ireland Orthophotos, historic OSI topographic maps and LiDAR survey data from 2022. Of these, 13 are in the EIAR

[6] Appendix 8.2 appendix G Executive Summary
[7] Technical Note TN-22098-01 dated 26/02/2026 Appendix 1 of MKO document 190723- Cooloo WF Submissions Response F - 2026.02.27

boundary and 11 (27% of the total potential features) were inspected. The identified features were classed as enclosed depressions/dolines, with two possible springs. Cover collapse dolines (enclosed depressions) are an indication that sufficient void space of sufficient size, exists in the underlying solution weathered limestone for overlying sediment to move into.

This is in the context of many more features in the wider setting[8], on the same or similar underlying geology.

Other than the field verification of 11 features, confirmation of karst features was limited to two deep investigation boreholes (BH1 and BH2), an existing GSI investigation borehole (whose purpose was not directly related to a karst investigation) and two sets of geophysical survey lines in one area.

In terms of interaction between the water environment and the development, the important aspect is the connectivity of the surface with the karst system. If there is connectivity, then the karst system provides a very fast pathway for contaminants to reach the surface water system and any private borehole that are down groundwater gradient of the Site. This is illustrated by Figure 9.12 GSI/EPA Mapped Groundwater Source Protection Areas (Chapter 9 of the EIAR) which shows the long traced pathways to local principal water supply sources. While these do not pass below the Site, they illustrate the presence of fast flow pathways in the same geology.

2.6 Conceptual Hydrogeological Model

The basic conceptual model is straight forward. There are three active hydrogeological layers (hydrostratigraphic layers): 1) Peat (including cutaway areas and 'virgin' areas); 2) The limestone Till (of varying thickness and composition but predominantly clay and silt); 3) Weathered / karstified Carboniferous limestone which regional evidence indicates has long fast flow pathways. The regional hydrological base locally is at c. 60mOD to the north and c. 50mOD to the south. The Site lies at an elevation in the region of c. 70mOD and therefore the local Carboniferous limestone water table (piezometric surface) is likely to be several meters below the ground surface, other than in the lower, and cut away areas of the Site where it is likely to be close to or possibly above, ground level. The groundwater level in the Peat and limestone Till may be at a different level from that in the Carboniferous limestone (and could be above or below the limestone groundwater level) and will be controlled by local drainage.

Regional horizontal groundwater flow directions in the Carboniferous limestone are likely to be generally towards the WSW in the southern part of the Site and toward the ENE in the northern part, but due to the nature of karst systems local variations to flow directions, including reversal of flow directions, should be expected. Groundwater flow directions in the limestone Till and the peat, will be controlled by local ditches and streams, and may be different from that in the Carboniferous limestone.

Vertical groundwater flow through the layers is conceptually likely to be downward due to the position in the upper part of local and regional catchments, but is likely to reverse toward the Grange and Abbert rivers, where limestone groundwater is likely to discharge. The extent of cutaway bog may also induce an upward gradient from the Carboniferous limestone into the peat.

Recharge comes from incident rainfall, and while there is an extensive till layer which limits recharge due to its generally low permeability, the presence of sinkholes and other enclosed depressions provide pathways through the till, allowing recharge to the limestone. Natural discharge of the recharge via groundwater flow will occur at springs and through baseflow into

[8] Figure 9-6 GSI Aquifer Mapping (Chapter 9 of EIAR)

the principal rivers and turloughs, as well as from groundwater abstraction from wells and boreholes.

Permanent flow in the Grange and Abbert Rivers, suggests connection to the limestone system and/or continuous drainage from the peat and/or till. Permanent flow in the 1st order streams and ditches that drain the site suggests active flow from the peat and/or limestone Till.

3. Appraisal

The appraisal has considered the information that has been presented in the EIAR in the context of the following three questions:

1. Does it provide a data set against which receptors can be identified?
2. Does it provide a data set against which affects and impacts can be measured?
3. Does it provide a data set against which a hydrogeological conceptual model can be developed, which allows hazards and risks to be identified and evaluated?

With respect to the hydrogeology the key components are described below, in general terms.

Guidance on the preparation of EIAR chapters on soils, geology and hydrogeology has been prepared by the Institute of Geologists Ireland[9] which is referenced in section 9.1.5 of the EIAR.

Figure 2 of that guidance is presented in Appendix A of this report. This development falls into Environment types B, D and E and includes the following activities:

- Earthworks
- Storage / transmission of leachable and/or hazardous materials
- Lowering of groundwater levels by pumping or drainage
- Discharges to ground
- Excavation of materials above the water table
- Excavation of materials below the water table

Thus, it can be considered that the Site is in a sensitive hydrogeological setting and the details setting out the investigation works as laid out in Appendix A of this report are appropriate.

3.1 Geology

The geology of the Site has been evaluated based on a desk study covering a range of sources, a site investigation which has focused on the shallow peat deposits through probing, trial pits, peat gouge coring and limited geophysics. These investigations concentrated on the 'overburden' geology down to the top of the bed rock. Depth to bedrock was only proved in 14 No. of 26 No. trial pits.

The results of these investigations have only been presented in summary tables and figures. No interpretation of the geological information gathered from the desk study, and collected from the site investigation has been interpreted and extrapolated across the Site. Thus, the geology related to hydrogeological risks associated with roads/tracks and wider potential pathways is not well defined.

Two (2) boreholes have been drilled to 20m in the southern part of the Site. No detailed geological or geotechnical logging of the arising from these two boreholes is presented other than comments from the drillers who constructed the holes. No purpose drilled boreholes have been constructed in the northern part of the Site. Figures or plans showing the distribution of the investigation boreholes and the results from them, in the wider geological context are not presented. No borehole geophysical data for these boreholes is presented. As such, a low level of confidence should be placed on the interpretation of the geology **at the site scale**.

[9] Institute of Geologists Ireland (2013): Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements

Geophysical surveys comprise four lines of ERT[10] – two close spaced parallel north south lines, and two closed spaced east west lines which intersect the north south lines. One seismic line was carried out for the purpose of correlating the resistivity data. All the survey lines are located together, close to the proposed wind turbine T04. The geophysical surveying results were consistent with data from one trial pit close to the survey lines. The surveying was not widespread over the Site. The geophysics was designed to investigate the shallow founding geology. It was not designed to examine deeper geological or karst structures. No karst features or karstified rock were identified by the geophysical survey, but the surveyors concluded that considering the increasing depth to bedrock to the west, the potential occurrence of karst further west could not be excluded.

In summary, the site derived geological and geotechnical data has focussed on the turbine foundations and ground stability but has not been extrapolated to the wider environment. The distribution of mapped karst features has not been used to inform the deeper geological interpretation. The hydrogeological impact measurement, hazard and risk identification, and impact evaluation are discussed in the hydrogeology section below.

While the geological information provides a data set that supports the foundation designs, and in that context it does provide a data set against which geologically controlled receptors can be identified.

Within a hydrogeological context, the site investigation does not provide a data set against which an evidenced based hydrogeological conceptual model can be developed, which would allow hazards and risks to be identified and evaluated, with appropriate mitigation and protocols to take account of low risk unknowns or unknowables.

3.2 Hydrology

3.2.1 Flood Risk

The hydrology within the EIAR is covered by Chapter 9 – Hydrology and Hydrogeology. Appendices 9.1 presents a flood risk assessment (although the report as submitted states it is draft, not final).

The flood risk assessment is based on OPW's River Flood Extents Mapping, National Indicative Fluvial Mapping, Past Flood Event mapping, historical mapping and GSI Groundwater/Surface Water Flood Maps, together with walk over surveys and site specific modelling.

The level of assessment is appropriate for the anticipated flood risk, and it provides a data set against which receptors can be identified, and affects/impacts can be measured.

The wider hydrological setting is presented and is described appropriately and provides a data set against which receptors can be identified.

3.2.2 Surface Water Quality

Surface water quality is presented in Chapter 9 based on the EPA biological Q-Rating for the Grange and Abbert rivers, and field and laboratory based water quality data based on sampling five locations (1 to the north, 3 to the south, and 1 at the crossing of the Grange River). The results show that generally the water quality indicates Good or High status (in EQS terms)[11], although exceedances were detected in the September 2025 data. Context with respect to antecedent weather conditions is not provided. It would be expected that the water quality is

[10] Electrical Resistivity Tomography
[11] S.I. No. 293/1988: Quality of Salmon Water Regulations and/or S.I. No. 272/2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009 (as amended)

generally Good or High status, but that direct rainfall runoff will contribute to exceedances of suspended solids, nitrogen compounds including ammoniacal nitrogen, phosphates and biological oxygen demand.

The level of assessment is appropriate, and it provides a data set against which receptors can be identified, and affects/impacts can be measured.

3.3 Karst

The presence of karst below the Site and in the local and regional setting is an important part of the setting of the Site and is fundamental to the EIAR process. While the karst setting is described in chapter 8, this is only in the context of the structural stability and is based on the geotechnical site investigation and the interpretation of the bed rock geology from only one formally logged borehole. The intersection of the bedrock head in trial pits is taken as evidence of no epikarst. Chapter 9 does not recognise the importance of karst pathways in the deeper limestone geology nor does it recognise the inherent uncertainty in the position, depth and extent of karst features. Chapter 9 does not recognise the importance of mapped and traced long distance karst connections in the same geology locally, and the concomitant significance to the development risks with respect to hydrogeology.

The assessment of karst is based on a thorough assessment of remotely sensed and mapped data sets, but field verification is limited. Geophysical surveys are only located in one small area, as is the borehole drilling. There is inconsistency in the karst interpretation and links to the conceptual model and risk assessment. There is a strong reliance placed the presence of shale bands in the limestone, with very little evidence to support departure from the background desk study GSI information.

The EIAR recognises the presence of many dolines but their significance, and the significance of many more mapped features in the wider setting, underlain by the same or similar geology is dismissed. For collapse dolines to occur there must be a mechanism for the material in the superficial deposits to be washed somewhere. There must be sufficient volume of void space for the material to fill or a pathway for the material to be flushed away. This has to be a deeper karst system. The site investigation borehole drilling and geophysics was not designed to investigate such pathways across the site. The unpredictability of karst structures within the subsurface means that they are difficult to intercept with boreholes and the lack of interception should not be interpreted as a lack of features.

In summary, the conclusions drawn regarding karst are inconsistent with the evidence; and the recommendations relate only to foundation design and do not take account of the link between karst and hydrogeological (pollution) risks.

The resulting concern is that the assessment dismisses karst as a hydrogeological issue and therefore no protection against contamination entering karst fast flow pathways is offered.

The site investigation does provide a data set against which receptors can be identified, but does not provide a data set against which karst related pathways can be ruled out. As such, affects and impacts related to possible karst pathways cannot be measured. The way in which the karst related data has been interpreted means that it does not appropriately inform a conceptual model which allows hydrogeological hazards, pathways and risks to be identified and evaluated.

3.4 Hydrogeology

The hydrogeology of the Site is described based on a desk study evaluation supported by only two purpose drilled hydrogeological investigation boreholes. Reference[2] provides a useful

detailed regional setting of the hydrogeology. The GSI vulnerability rating for the Site ranges from 'Low' to 'Extreme'. The 'Low' vulnerability rating largely results from the presence of basin peat/cutover bog which covers a large portion of the north of the Site. The 'Moderate', 'High' and 'Extreme' rated areas are typically grassland. The proposed turbine location T1 and the temporary construction compound are located in an area mapped as 'High' vulnerability. Bedrock was confirmed in 14 no. of the 26 no. trial pits, which included 7 no. of the proposed 9 no. turbine locations (T1, T2, T3, T4, T5, T6 and T8). Depth to bedrock ranged from 0.8m to 3.6m which indicates a groundwater vulnerability rating of 'Extreme' to 'High'. Thus, the site investigation increased the vulnerability rating.

The aquifer vulnerability rating is based on the thickness and type of cover above the Carboniferous limestone aquifer. The development includes the removal of this cover to construct the turbine foundations.

The critical aspect of the hydrogeology is the connection through the hydrogeological layers and the pathways between the Site and the wider environment. The EIAR presents conclusions that there are not pathways from the surface to fast flow karst features. This conclusion is based on very limited data and is inconsistent with the aquifer vulnerability rating and the desk study data.

The information presented on the two purpose drilled hydrogeological boreholes does not include how they were completed and which hydrostratigraphic unit(s) is (or are) being monitored. Thus, a low level of confidence must be placed on the interpretation of the water level data.

Because the site investigation data is limited to essentially trial pitting, there is insufficient data to develop a conceptual hydrogeological model which provides a consistent interpretation of the desk study and site investigation information within a three dimensional geological and hydrological context, linking the Site to the wider environment and receptors. For example, the lack of spatially distributed groundwater level data means that the groundwater flow directions within the limestone aquifer, and the hydraulic relationship between the hydrostratigraphic layers cannot be determined. This is critical in providing an evidence base on which receptors that may be at risk can be identified; the assessment of risk to those receptors; and the design of mitigation related to any residual risks. Equally, the data collected on the Peat has not been considered within the context of water retention and flow within the site wide peat environment and the impacts that construction may have on the peatlands dependent on it.

No boreholes or samples from boreholes have been tested to provide values of permeability or other hydraulic properties of the hydrogeological layers.

The interaction between groundwater heads (levels) and the construction of the turbine foundations, has been largely dismissed based on an assumed low permeability of the limestone Till and/or the underlying limestone.

Extrapolation of a conceptual model across the site, which incorporates all the data has not been presented. Thus, the relationship between nearby lakes and the high groundwater levels that have been collected, have no context and associated construction and water management risks have not been considered. No assessment of the development and floating roads on peat drainage has been undertaken.

The lack of field based evidence to support a unified conceptual hydrogeological model means that there is a lack of evidence to support the conclusion that there is no risk to protected groundwater dependent features such as SAC rivers.

In summary, the site investigation concentrates on the shallow soils but it does not present field based data to support a consistent and robust interpretation within a hydrogeological setting at either the Site or local level. In order to identify receptors that may be at risk in a hydrogeological setting, it is necessary to establish the direction of groundwater flow and the interaction with surface water systems. The EIAR does not present the information required to generate groundwater level contours and from those, establish hydraulic gradients and directions of groundwater flow. As such it does not provide a data set against which receptors that may be at risk can be identified or a data set against which affects and impacts can be measured. A hydrogeological conceptual model has not been developed, which allows hazards, pathways and risks to be identified and evaluated.

3.5 Receptors

The principal receptors are:

- Lough Corrib SAC (Site Code: 000297) which includes the Grange River and the Abbert River. There are surface water connections (pathways) to the SAC. There may be groundwater pathways to the SAC. Field evidence is not provided to provide reasonable scientific proof that the SAC features are not at risk.
- Clare Corrib groundwater body. The groundwater body is a receptor in its own right and forms a pathway for contaminants to move to other receptors. The construction of the turbine foundations places cementious material directly into the Carboniferous limestone. Field data in terms of groundwater levels, vertical and horizontal hydraulic gradients and the investigation of deep karst, is not provided to give evidence that the groundwater body is not at risk.
- Mid Galway PWS and Barnaderg GWS sources. While the source protection/contribution areas are largely outwith the Site, the lack of groundwater level data and the determination of hydraulic gradient and groundwater flow direction, means that the interaction with these sources cannot be established with a high degree of confidence.
- Feigh East and West Group Water Scheme (GWS) SPA. Approximately 3km to the southwest of the Site. The Proposed Grid Connection cable route does not pass through the SPA. Groundwater level data is not presented to support the conclusions that "The borehole is located 220m from Proposed Grid Connection cable route at an up-gradient location with regard groundwater flow.". However, the depth of the source and the distance from the cable route reduces the risk to a minimum.
- If dwellings are reliant on shallow wells, seepage pits or similar they could be affected by surface water pathways. No census of private water supplies is presented. The lack of the development of groundwater contours means that the risk of development on any deep wells/boreholes cannot be assessed, although low yield domestic wells/boreholes greater than 100m from turbine bases and hardstandings are likely to be at a low risk. However, the risks associated with the cable installation can reasonably be taken as minimal as the cable route is within the curtilage of roads, and is at a shallow depth.

3.6 Hazards (Sources) and Pathways

3.6.1 Water Quantity

The proposed development does not depend on the abstraction of water (other than possible short term dewatering during construction), and while it has not been specifically assessed, there is likely to be a negligible effect on the quantity of recharge to groundwater or the volume of runoff to surface water. However, alteration of peat groundwater flow through increased

drainage, compaction or damming, represents a hazard to ecological features dependent on peat groundwater.

Specific risks associated with water quantity are associated with construction. Although not anticipated, dewatering of gravity foundation pits may be required. If so, this would lead to increased discharge to surface water and could lead to a short term increase in flows in local ditches and/or a short term fall in the groundwater level in saturated peat. Both situations would be reversible.

Basal heave is a situation where the pressure of groundwater below the base of an excavation causes the groundwater to break through the base of the excavation leading to rapid inundation and the need for a high rate of dewatering. In order for this to occur, the groundwater level (pressure) must be above the base of the excavation and the low permeability layer that seals the groundwater out of the excavation must be capable of failing. In order to assess the risk of basal heave the groundwater level at the location of the excavation must be known. The consequence of failure is a much increased volume of pumping to dewater the excavation, which will require treatment and management to prevent pollution of surface water systems. Mitigation is provided through controlled pumping, monitoring and management. The EIAR assumes that the limestone groundwater levels will be below the base of the excavations, although field evidence for this is not presented, and the water level data that is presented is high, when considered against the assumed 'hydrological base'. The measured high levels have not been put in the context of the excavation depths. Despite this, the risks associated with water quantity from groundwater, are likely to be low if managed appropriately.

Interception of groundwater in cable trenches could divert flows and effect shallow wells and or springs. This risk has not been assessed, but is likely to be low due to the placement of cable trenches within roads and at a shallow depth. Mitigation could be included in the design by placing clay plugs within the trench backfill, to prevent the trenches creating drainage pathways.

3.6.2 Water Quality

The principal hazard with respect to water is quality. In general, the water quality hazards are those normally associated with construction activities such as mobilisation of suspended solids, release of high pH water and cement effluent during concrete placement in piles and foundation pits, grouting, fuel, oils and greases from plant and machinery. There is also a source associated with the movement and stockpiling of peat, and the generation of Dissolved Organic Carbon (DOC) in runoff. This can lead to "browning" of surface water systems, restricting light penetration, increase biochemical oxygen demand (BOD) and reducing dissolved oxygen, which harms aquatic organisms. High DOC levels in drinking water sources can react with disinfectants to form hazardous disinfection byproducts (DBPs), such as trihalomethanes. The risk of DOC has not been considered, although background drainage from the peatlands will be contributing to the back ground levels. Baseline data collection shows that BOD already exceeds the Good status limit at 3 out of 5 sampling points in the September data set.

3.6.3 Pathways

Surface water pathways directly connected to the SAC features exist between the Site and the features.

Groundwater pathways that could connect to the SAC features may exist. Desk based evidence shows that pathways within the Carboniferous limestone karst system have been proven in the area. Vertical pathways between the surface and the base of foundation excavations within the Site have been assumed to not exist, despite the presence of karst related structures within the

Site that have not been verified. Groundwater level data relating to the interaction between the peat, the limestone Till and the Carboniferous limestone have not been presented and therefore the groundwater pathways cannot be understood. An integrated conceptual model including groundwater contours to evidence the local groundwater flow regime in the Carboniferous limestone has not been provided.

The fact that the Site has the potential for direct pathways to SAC features means that there must be a very high level of confidence in the impact assessment. The risk to the SAC features is associated with pollution entering a fast flow, karst pathway that connects to the groundwater and or an SAC feature.

The likely significant effects analysis, relating to groundwater, is largely based on the conclusion that there is a disconnect between the construction activities and the karst limestone system, that is a pathway does not exist. This is based on only two purpose drilled hydrogeological investigation boreholes. The data presented on karst and the conclusions drawn are in conflict, in that the presence of surface expressions of karst are present on the Site and in the vicinity, but karst pathways are not considered to be present.

The likely significant effects analysis for the earthworks is based on controlling runoff as a result of rainfall. Discharge of runoff will be via a treatment train, and ultimately infiltration back into the peat and/or soil. Direct discharge of runoff to water courses is not proposed. It is proposed that work will be suspended if high rainfall is anticipated by monitoring of weather forecasts, to reduce the levels of suspended solids.

Runoff from the peat and spoil repository areas will be managed by placement outwith a 50m buffer zone of water courses and known surface expressions of karst, and routing of runoff via swales and stilling ponds to the on-site drains.

The design of the hard standings does not prevent infiltration through them into the underlying strata. Neither does the design allow for preventing infiltration or release of contaminated water from settlement ponds.

3.7 Summary

The site investigation data presented in Chapter 8 of the EIAR is focussed on the shallow soils and provides very little data on the Site level or local hydrogeology to support an integrated evidence based conceptual hydrogeological model that considers the relationship between the Site and local geology and hydrology in three dimensions, as well as the transient response of the groundwater system. Therefore there is insufficient evidence to provide high confidence in the conclusions, particularly with respect to the possible impacts on SAC features. This is demonstrated by consideration of Figure 2 of Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements, Institute of Geologists of Ireland 2013.

While conceptually the effectiveness of the proposed mitigation measures, and residual impacts related to groundwater are possibly correct, the low confidence in the field based evidence means that the justification for the mitigation measures and therefore residual impacts cannot be robustly defended.

The effectiveness of the proposed mitigation measures, and residual impacts related to surface water are appropriate on the basis that rainfall runoff is considered. However, no account is made of groundwater related risks during construction, which could impact on the surface water management system. Therefore the construction stage mitigation measures and subsequent residual impacts cannot be supported.

Permanent compounds and related drainage arrangements should be designed to prevent the infiltration of water to the ground and runoff managed in such a way as to allow discharge to be prevented in the event of a pollution event.

4. Responses

Submissions were received from prescribed bodies and third parties, including those, with reference to hydrogeological issues, from North East Galway Environmental Protection, National Office for Environmental Health Services (HSE), Inland Fisheries Ireland (IFI), Hydro-G (Dr Pamela Bartley). These submissions have been considered, as have other submissions from individuals and many present the same topics with respect to water. The key points made are summarised in the sections below.

4.1 North East Galway Environmental Protection

- Impact on water quality and effect on the Mid-Galway Public Water Supply (PWS).
- The limited scope of the Karst Risk Assessment and it's limited focus on hydrogeological issues.

4.2 National Office for Environmental Health Services

- The HSE submission was positive with regard the proposed project and determined the proposed mitigation measures would provide adequate protection of surface water and groundwater.

4.3 Inland Fisheries Ireland

- Impact on water quality and effect on fisheries, with salmonids referenced in particular.

4.4 Dr Pamela Bartley (Hydro-G)

- No assessment of groundwater flow systems has been submitted.
- The Geotechnical Karst Risk Assessment fails to convey the connection between the surface expression of karst with the known conduit system in the immediate vicinity of the PWS sources and two GWS sources.
- The potential for organic matter release from the bogs, during all phases of the project, to the drainage system has potential to react with the chlorination systems of the Water Treatment plants (WTPs) and has potential to create Trihalomethanes.
- The use of source protection zones (a water quality concept) to define groundwater capture zones (often a larger area).
- Risk of collapse of karst features due to construction loadings..
- A lack of mitigation related to impacts on the groundwater flow in the limestone (karst) aquifer.

4.5 Applicant's Response

The Applicant provided a response to the submissions dated February 2026 (Ref. Cooloo Wind Farm (ACP Ref. 323761) 190723- Cooloo WF Submissions Response F - 2026.02.27). Appendix 1 includes a response from GDG and Appendix 2 a response from HES.

With respect to the Karst Risk Assessment and Hydrogeology, GDG respond with "Assessment of the hydrology and hydrogeology is considered in full in Chapter 9 – Hydrology and Hydrogeology. Assessment of the karst features within Appendix 8-2 is limited solely to geotechnical risk." and "This assessment [*sic. The KRA assessment*] is limited to consideration of the geotechnical risks posed by karstic features to the Proposed Wind Farm. Consideration of the impact of the Proposed Wind Farm on the hydrology and hydrogeology of the Proposed Wind Farm site is outside the scope of this report."

The HES responses are summarised as follows:

- Karst related issues were raised by North East Galway Environmental Protection, Hydro-G and others. HES state "*The assessment of no significant effects and in particular relating to hydrogeological effects, does not relying on mitigation alone to come to this conclusion, but in fact the geological and hydrogeological setting of the proposed wind farm site as determined by an array of site investigations which are described above in this submission. This also applies to the assessment of effects relating to Mid Galway PWS and Barnaderg GWS.*"
- With respect to IFI comments, HES state "*All of the IFI recommendations are already addressed in the EIAR and appropriate mitigation measures are proposed.*"
- An extensive set of responses to Hydro-G's submission is represented. In summary, HES state:

  "As outlined the Hydro-G submission includes several statements that are misleading and factually incorrect;

  The incorrect statements create uncertainty, may lead to confusion, and undermine the factual and science-based assessment presented in the EIAR; and,

  This section of the submission respectfully seeks to clarify or address statements made in this 3rd party submission that could be misleading, and/or where they are factually and/or scientifically incorrect."

  However, Hydro-G do make valid points with respect to, in particular, the lack of field based evidence to substantiate the applicants conclusions regarding groundwater flow and connectivity to karst conduit groundwater flow; potential for connectivity and contaminant transport to the Mid Galway and the PWS Barnaderg Gortbeg GWS; and a lack of field based evidence to understand the degree of groundwater and surface water interaction.

  The HES response largely justifies the applicants position based on the results of the site investigation.

- In their submission response summary, HES state (amongst other things):

  "Robust scientific reasoning has been provided in the EIAR to support the lack of potential effects on Mid-Galway PWS and Barnaderg (Gortbeg) GWS". While scientific reasoning has been applied, that reasoning is not supported with field evidence.

  "All investigations/assessments and hydrological conditions at the site indicate the lack of karst bedrock conduit system conveying large volumes of groundwater in the immediate vicinity Site towards the PWS and GWS sources". This is a key conclusion that underpins the hydrogeological risk assessment. However, it is fundamentally based on a lack of field based evidence.

  "Robust scientific reasoning has been also provided in the EIAR to support the lack of potential effects on Lough Corrib SAC and local wells". While scientific reasoning has been applied, that reasoning is not supported with field evidence. On that basis it cannot be considered to be robust and does not support a 'beyond reasonable scientific doubt' test.

In summary the response document largely re-states the conclusions drawn in the EIAR. No additional evidence is presented.

5. Conclusions

Chapters 8 and 9 of the EIAR and associated documents present a desk based review of the hydrogeological and hydrological setting of the proposed development.

The desk based review is supported by a site investigation including amongst other activities, walk over surveys, peat probing, trial pitting and borehole drilling. However, the site investigation is focussed on the geotechnical considerations of the shallow soils, with very limited data presented on the hydrogeology of the Site.

The assessment of water related risks associated with the grid connection is appropriate and is considered to be low.

An appropriate flood risk assessment has been undertaken, which demonstrates the low risk of flooding both on and from the development.

Risks associated with surface water quality have been appropriately assessed, and are considered to be low as long as the proposed mitigation is quantitatively designed and fully implemented.

Mitigation measures to prevent the discharge of contaminated water to surface water have been described, but have not been quantitatively designed.

An overarching, evidence based three dimensional and transient, consistent conceptual hydrogeological model that links the Site and the identified receptors is not presented.

The hydrogeology of the peat has not been considered.

Risks associated with effects on groundwater quantity are low.

The lack of an evidence based conceptual hydrogeological model means that the connectivity between the Site, the development and local groundwater linked receptors including SAC rivers, public and private wells/boreholes and a sensitive conduit flow karst aquifer cannot be established, and therefore risks associated with impacts from groundwater pollution cannot be assessed.

The risk assessment associated with the construction of the turbine foundations dismisses the risks associated with karst conduit flow in the underlying geology, based on very little evidence. If groundwater levels are low, then the risk associated with the introduction of cement based products cannot be determined; if groundwater levels are high then the risk associated with basal heave and high dewatering rates cannot be determined. Groundwater levels at the turbine locations have not been established.

A Natura Impact Statement (NIS) accompanies the EIAR. This report has been prepared to provide the competent authorities with the information necessary to complete an Appropriate Assessment screening and an Appropriate Assessment for the Proposed Project in compliance with Article 6(3) of the Habitats Directive. The NIS identified the potential for effect on Lough Corrib SAC. As such there is a high burden of proof required in ensuring that the Proposed Project, individually or in-combination with other plans or projects, will not adversely affect the integrity of any European Site.

The evidence presented does not robustly support the lack of potential effects on Lough Corrib SAC due to the lack of an overarching, field evidence based three dimensional and transient, consistent **conceptual** hydrogeological model that links the local and site level geology and hydrology.

Therefore it cannot be assumed beyond reasonable scientific doubt that the Proposed Project, individually or in-combination with other plans or projects, will not adversely affect the integrity of a European Site.

6. Conditions

If it is considered that planning permission can be granted, then it is important that suitable conditions covering (but not limited to) the following aspects are included:

- A quantitative water management plan is submitted and approved prior to commencement, covering but not limited to:
    - Design of piped drainage systems.
    - Design of runoff storage and settlement systems.
    - Design of permanent hard standings and runoff control preventing downward migration of infiltrating rainfall and discharge following a pollution event.
    - Details of foundation construction which prevents the creation of hydrogeological pathways to the underlying limestone aquifer.
    - Details of heave / breakthrough risk due to high groundwater heads below the limestone Till at the gravity foundation pit locations and permanent hardstandings.
- An assessment of hydrogeological risk and mitigation, supported by an overarching, evidence based, three dimensional and transient, consistent **conceptual** hydrogeological model which describes the hydrogeological pathways that link the development with identified receptors.
- A karst protection protocol is submitted and approved prior to commencement.
- A piling protocol is submitted and approved prior to commencement.

Appendix A

Figure 2

Guidelines for the Preparation of

Soils, Geology and Hydrogeology Chapters of

Environmental Impact Statements

Institute of Geologists of Ireland, April 2013

Figure 2 Activities /Environments Matrix

Activities

Environments

	Earthworks	Storage / transmission of leachable and/or hazardous materials	Lowering of groundwater levels by pumping or drainage	Discharges to ground	Excavation of materials above the water table	Excavation of materials below the water table	Land-spreading	Abstraction / Discharge of energy (heat) from/to the ground
Type A	Invasive site works to characterise nature[1] and thickness of soil and subsoil e.g. trial pits or augering.	Establish nature and quantity of leachable materials.	Establish details of borehole /spring construction or drainage system structure details (as appropriate).	Complete a Risk Assessment as per EPA (2011) Guidance on the Authorisation of Discharges to Groundwater[2]; Apply Tier 1, 2 or 3 Assessment as appropriate	Site works to characterise nature[1], thickness, permeability and stratification of soils and subsoils e.g. trial pits, augering.	Site works to characterise nature[1], thickness, permeability and stratification of soils and subsoils e.g. trial pits, augering.	Establish the type of waste to be landspread.	Provide details of type of system (open/closed, shallow/deep). The site works required and described below will reflect the design parameters of the system being installed.
		Site works to characterise nature[1], thickness, permeability and stratification of soils, subsoils and bedrock geology e.g. trial pits, boreholes.	Establish sustainable yield and proposed daily abstraction rate or drainage system invert levels (as appropriate).		Site works to fully characterise the bedrock geology and in order to to define the resource volume/weight according to The PERC Reporting Standard[3] e.g. trenching, drilling, geophysics.	Site works to fully characterise the bedrock geology and in order to to define the resource volume/weight according to The PERC Reporting Standard[3] e.g. trenching, drilling, geophysics.	Undertake a walkover survey of the site.	Site works to characterise nature[1], thickness, permeability and stratification of soils, subsoils and bedrock geology.
		Works to determine groundwater level, e.g.mapping, monitoring in stand pipes, piezom-eters, or boreholes.	Works to determine summer level of the water table, annual actual recharge and proposed maximum drawdown. Measurement of effects of change in water level on nearby abstractions.		Works to determine groundwater level, flow direction and gradient; e.g.monitoring in stand pipes, piezometers, or boreholes.	Works to determine groundwater level, flow direction and gradient; e.g.monitoring in stand pipes, piezometers, or boreholes.	Review Groundwater Protection Responses for Landspreading[4], and apply Departmental[5] and Regularory[6] guidelines and best practice.	Design parameters for the system will be required to be collected, however these are out of the remit of this document - although any information gathered for design purposes should be used in the EIS.
						Characterisation of groundwater chemistry and quality.	Assign a response category.	
						If lowering of groundwater levels is required, then proceed also as for activity Lowering of water levels by pumping of drainage.		
Type B	*In addition to all the above;*	*In addition to all the above;*	*In addition to all the above;*	*As above;*	*As above;*	*As above;*	*In addition to all the above;*	*In addition to all the above;*
	Works to determine groundwater level, flow direction and gradient; e.g. monitoring in stand pipes, piezometers, or boreholes.	Works to determine groundwater flow direction and gradient; e.g. monitoring in stand pipes, piezometers, or boreholes.	Works to determine aquifer properties, seasonal variations in water levels, extent of cone of depression or drawdown of surrounding water levels (as appropriate) and alterations in groundwater flow pattern.				Site works to characterise subsoil/soil characteristics e.g. trial pits or augering.	Characterise baseline temperature of soil / groundwater and groundwater hydrochemistry and quality.
	Works to determine groundwater - surface water interactions.	Works to determine groundwater - surface water interactions.	Works to determine groundwater - surface water interactions and measure effects of drawdown in water levels on hydraulically connected surface waters and springs.					Works to determine groundwater level e.g.monitoring in stand pipes, piezometers, or boreholes.
								If it is proposed to discharge to surface water, then characterisation surface water quality, baseline temperature and flow rates.
Type C	*In addition to all the above;*	*In addition to all the above;*	*In addition to all the above;*	*As above;*	*As above;*	*As above;*	*In addition to all the above;*	*In addition to all the above;*
	Identify location and abstraction rate of nearby groundwater abstractions.	Measure or determine rate of groundwater flow/travel time.	Installation of sufficient monitoring wells to provide groundwater flow direction, gradient, flow pattern and rate of flow/travel time.				Confirm subsoil permeability in laboratory. Delineate inner and outer source protection areas and source protection zones.	Works to determine thermal and hydraulic conductivity of soil, subsoil and bedrock.
			Identify nearby geothermal systems, and discharges to groundwater				Establish water quality of groundwater abstraction. Undertake risk assessment if appropriate.	Identify location and abstraction rate of nearby groundwater abstractions.
Type D	*In addition to all the above;*	*In addition to all the above;*	*In addition to all the above;*	*In addition to all the above;*	*In addition to all the above;*	*In addition to all the above;*	*As for Type C above*	*In addition to all the above;*
	Regional study of karst in an area, including identified karst features (both mapped and identified during site walkovers).	Full detailed hydrogeo-logical assessment required in this situation.	Geotechnical assessment of risk of landslide or subsidence.	Geotechnical assessment of risk of landslide or subsidence.	Full detailed hydrogeological assessment required in this situation.	Geotechnical assessment of risk of landslide or subsidence.		Geotechnical assessment of risk of landslide or subsidence.
	Map bedrock topography.	Geotechnical assessment of risk of landslide or subsidence.			Geotechnical assessment of risk of landslide or subsidence.			
	Geotechnical assessment of risk of landslide or subsidence.							
Type E	Full detailed hydrogeological assessment required in this situation.	Full detailed hydrogeological assessment required in this situation.	Full detailed hydrogeo-logical assessment required in this situation.	Complete a Risk Assessment as per EPA (2011); Apply Tier 1, 2 or 3 Assessment as appropriate.	Full detailed hydrogeological assessment required in this situation.	Full detailed hydrogeological assessment required in this situation.	*As for Type C above*	Full thermogeological and/or hydrogeological assessment required in this situation.

Type A	Passive geological / hydrogeological environments
Type B	Natural dynamic hydrogeological environments
Type C	Man-made dynamic hydrogeological environments
Type D	Sensitive geological / hydrogeological environments
Type E	Groundwater dependent eco systems

Where works are required to characterise, establish, measure, determine or otherwise provide information, the level of activity and detail required will be informed by a combination of a) the potential impact of the proposed development , b) the scale of the proposed development and c) the professional judgement of the project geoscientist. In addition, the works are likely to be iterative, with new works required in reponse to information acquired during any phase of works.

1 Characterisation of soil and sub-soils to be carried out in accordance with a recognised standard or nomenclature system e.g. BS5930:1990 for subsoils or EPA Code of practice for Environmental Risk Assessment for Unregulated Waste Disposal sites where relevant

2 EPA, 2011. Guidance on the Authorisation of Discharges to Groundwater - Version 1 December 2011. www.epa.ie

3 The PERC Reporting Standard

4 Groundwater Protection Schemes (DoELG/EPA/GSI, 1999)

5 Control of Farm Pollution (DAFF, 1992) and the Code of Good Agricultural Practice to Protect Waters from Pollution by Nitrates (DoE and DAFF, 1996)

6 Landspreading of Organic Waste - Guidance on Groundwater Vulnerability Assessment of Land (EPA 2004)