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6 SOILS AND GEOLOGY

6.1 Introduction

This Section focuses on the geology and soil environment and discusses the potential impacts associated with the proposed development during the construction and operational phases. It has been prepared on behalf of Sustainable Bio-Energy Ltd (SBE) in support of the proposed biogas plant development at Gort, Co. Galway at ITM grid reference 545442 703348 (the 'site').

For the purpose of the Environmental Impact Assessment (EIA) the following is defined:

- The term "Geology" refers to the bedrock and superficial deposits;
- The term "Soil" refers to the material produced largely by weathering and biological activity which are often principally derived from the underlying bedrock and superficial geology;

This Section on Geology and Soils involved the following:

- Review of development proposals;
- Review of site-specific reports
- Consultation with relevant statutory authorities to help establish baseline conditions and identify any significant concerns in the area;
- Consideration of potential interactions and identification of possible impacts;
- Assessment of impacts, within the context of the receiving environment including cumulative effects;
- Identification of measures and solutions to avoid, minimise and mitigate potential impacts; and,
- Assessment of residual impacts, taking account of mitigation measures.

6.2 Assessment Methodology and Significance Criteria

6.2.1 Assessment Methodology

This assessment has been undertaken in line with the Source – Pathway – Receptor Model as per the documents 'Guidelines on the Information to be contained in Environmental Impact Assessment Impact Assessment Reports Draft', August 2017 and 'Advice Notes for Preparing Environmental Impact Statements Draft', September 2015.

At the impact assessment stage, any potentially beneficial or adverse impacts associated with the development are identified and assessed with reference to the baseline environment. This requires consideration of:

- Sensitivity/value of the receptor;
- Magnitude of the impact;
- Impact duration;
- Whether impact occurs in isolation, is cumulative or is interactive; and
- Performance against environmental quality standards or other relevant thresholds.

6.2.2 Assessment Criteria and Impact Assessment Methodology

This assessment considers the potential risk to environmental receptors and the pathways by which the receptors may be affected. Definitions of the key descriptors are detailed below:

- Source: potential contaminant sources;
- Pathway: the mechanism by which the source may affect a receptor; and
- Receptor: identified features that may be affected, based on the sensitivity of the site.

The strength of the pathway between a source and a receptor is a function of the distance between the two and the ease or otherwise of the migration pathway. For example, on sites underlain by impermeable clays, the migration pathway via groundwater would be weak even over short distances, whereas within sands or gravels, the migration pathway would be strong for receptors in close proximity to a source and weak for receptors at some distance from the source.

The significance of predicted impacts likely to occur during all phases of the proposed development was determined by considering the value and sensitivity of the key attributes that may be affected and the magnitude of the predicted impact.

6.2.3 Determining the Value and Sensitivity of the Receptor through Baseline Studies

The value or sensitivity of a receptor is largely determined by its quality, rarity and scale. The determination of value or sensitivity takes into account the scale at which the attribute is important. For the purpose of assessing the significance of environmental impacts predicted as part of this assessment, the value of receptors is scaled based on the relative importance of the receptor defined as follows:

- LOCAL LEVEL: On the proposed application site or immediately adjacent to it;
- DISTRICT LEVEL: Beyond the Site boundary but within the district;
- COUNTY LEVEL: County Level e.g. Galway;
- REGIONAL LEVEL: Connacht/West of Ireland;
- NATIONAL LEVEL: Republic of Ireland;
- INTERNATIONAL LEVEL: European Community.

A receptors value and sensitivity must be defined using available guidance and professional knowledge and taking into account the site sensitivities. In some cases, the inherent value of the receptor has been recognised and been afforded a statutory designation (e.g. Special Areas of Conservation (SAC's)), which makes the value assignment more straightforward. The judgement of receptor significance is made on a case by case basis for each receptor or resource identified as having the potential to be subject to impacts associated with the proposed development.

Irrespective of its recognised value, all receptors/features would exhibit a degree of sensitivity to the changes imposed by new development. The 'sensitivity' element of the criterion ensures that this characteristic of each receptor is assessed. The classification for determining sensitivity of receptors is detailed in Table 6.1. This classification is used as a generic methodology and professional judgement has been applied in each case.

Table 6.1 Receptor Sensitivity and Typical Descriptors

Sensitivity	Descriptors
Very Low	Feature / receptor is generally insensitive to impact, no discernible changes e.g. soils are not in use, the land is used for industrial/commercial purposes and /or mainly covered by hard standing.
Low	Feature / receptor has some tolerance to accommodate the proposed change. It responds in a minimal way such that only minor changes are detectable e.g. landscaped areas.
Medium	Feature / receptor has a low capacity to accommodate the proposed form of change. It clearly responds to effects in a quantifiable manner e.g. low-grade agricultural land and recreational ground.
High	Feature / receptor has a very low capacity to accommodate the proposed form of change. The response is a major change e.g. agricultural land use for food production, allotments.

MAGNITUDE OF IMPACTS

Magnitude refers to the 'scale' or 'amount' of an impact. Key impacts have been identified and the likely magnitude of each potential impact has been determined through the

predicted change from the baseline conditions throughout the various phases of development. The magnitude of an impact is a measure of aspects such as the impacts:

- Extent (i.e. the geographical area over which the impact occurs);
- Duration (i.e. the time for which the impact is expected to last prior to recovery or replacement of the resource or feature: short, medium or long term);
- Likelihood (i.e. the probability that the impact will occur);
- Direct or Indirect (i.e. difficult to avoid); and,
- Reversibility (i.e. an irreversible (permanent) impact is one from which recovery is not possible within a reasonable timescale or for which there is no reasonable chance of action being taken to reverse it: Temporary or Permanent).

In order to help define the level of impact magnitude the following guidance (see Table 6.2) has been adopted for the purpose of providing a transparent assessment. The professional judgement of the technical author is used in the decision-making process when characterising impacts in accordance with the criteria set out in Table 6.2.

Table 6.2 Assessment Criteria for Magnitude

Magnitude	Assessment Criteria
No Change	• No loss or alteration of characteristics, features or elements; • No observable impact on receptors/features.
Negligible	• Noticeable, temporary (for part of the development duration) change; or • Barely discernible change for any length of time, over a small area, to any key characteristics or features. • Impact unlikely or rarely to occur. • Results in effects on attribute of insufficient magnitude to affect the use/integrity.
Slight	• Noticeable, temporary (during the project duration) change, over a partial area, to key characteristics or features. Impact will possibly occur. • Impact predicted to extend over a small area; • Impact predicted to affect small numbers of people; • Impact predicted to affect a small number of other receptors (ecological, businesses, facilities); • Impact not predicted to have trans-boundary effects, but possibility remains; • Slight but discernible change in environmental conditions predicted;

Magnitude	Assessment Criteria
	• Impact not predicted to entail unusual/complex effects for receptors; • Impact not predicted to affect particularly scarce features/resources; • Impact not predicted to result in breaches of legislation or statutory Environmental Quality Standard or Objectives; • Impact not predicted to result in loss of attribute; • Impact will continue for a short period of time only; • Impact will be temporary; • Impact will be intermittent and/or rare; • Impact will be reversible; • Impact will be possible to avoid, reduce, repair, or compensate for; or • Slight positive change in environmental conditions resulting in minor improvements in quality or value of a receptor.
Moderate	• Significant, permanent / irreversible changes, over the majority of the development area and potentially beyond, to key characteristics or features. Impact certain or likely to occur. • Impact predicted to extend over a moderate area; • Impact predicted to affect moderate numbers of people; • Impact predicted to affect some other receptors (ecological, businesses, facilities); • Impact unlikely to have trans-boundary effects, but possibility remains; • Moderate change in environmental conditions predicted; • Impact unlikely to entail unusual/complex effects for receptors but possibility remains; • Impact unlikely to affect particularly scarce features/resources but possibility remains; • Impact entails a low probability that breaches of legislation or statutory Environmental Quality Standard or Objectives will occur; • Impact unlikely to result in loss of attribute but possibility remains; • Impact will continue for a moderate period of time; • Impact will be semi-permanent; • Impact will be intermittent;

Magnitude	Assessment Criteria
	• Impact will be possible to avoid, reduce, repair, or compensate for; or • Notable positive change in environmental conditions resulting in measurable improvements in quality or value of a receptor.
Substantial	• Very significant, permanent / irreversible changes, over the whole development area and beyond (i.e. off-site), to key characteristics or features of character or distinctiveness. Impact certain or likely to occur. • Impact predicted to extend over a large or very large area; • Impact predicted to affect considerable numbers of people; • Impact predicted to affect considerable numbers of other receptors (ecological, businesses, facilities); • Impact predicted to have trans-boundary effects; • Significant change in environmental conditions predicted; • Impact will entail unusual/complex effects for receptors; • Impact will affect particularly scarce features/resources; • Impact entails a high probability that breaches of legislation or statutory Environmental Quality Standard or Objectives will occur; • Impact will result in total loss of attribute; • Impact will continue for extended periods of time; • Impact will be permanent rather than temporary; • Impact will be continuous rather than intermittent, or where intermittent, frequent rather than rare; • Impact will be irreversible; • Impact will be very difficult to avoid, reduce, repair, or compensate for; or • Significant positive change in environmental conditions resulting in major improvements in quality or value of a receptor.

IMPACT SIGNIFICANCE

Part 10 of 'The Planning and Development Regulations, 2001 as amended (hereinafter denoted as "the 2001 EIA Regulations") are concerned with 'significance' and the identification of *'significant environmental effects'*. Therefore, an assessment of significance is necessary in order to identify the main environmental effects of the proposed development and assist in determining what weight these effects should be given. Definitive guidance in the preparation of EIA in the soils and geological environment exists *in 'Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of*

Environmental Impact Statements', issued by the Institute of geologists of Ireland. From the guidance, a significant effect is defined as "an impact, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment".

It is widely recognised that 'significance' reflects the relationship between the magnitude of an impact and the sensitivity (or value) of the affected environmental receptor.

To assist in the assessment process, the Impact Significance Matrix (ISM) (Table 6.3) provides a transparent methodology to ensure consistency and ease of interpretation of the judgement of impact significance.

An initial indication of impact significance (adverse or beneficial) is gained by combining magnitude and sensitivity / value in accordance with the ISM provided. It should be noted that although the ISM provides a good framework for the consistent assessment of impacts across all environmental parameters, there is still an important role for professional judgement and further objective assessment to play in moderating an impact's significance. Given that the criteria represent levels on a continuum or continuous gradation, professional judgement and awareness of the relative balance of importance between magnitude and sensitivity / value is required.

Features to which legal designations apply have automatically been determined to be of high value (or of a higher value than non-designated features), and any impact tends to be of a greater significance than an impact of features to which no designation applies. Hence, for designated features, the use of the value criteria leads to an initial assumption that impacts will be of a high significance. Information on sensitivity can then be used to modify or maintain this initial assessment.

Table 6.3 Impact Significance Assessment

Magnitude[1]	Value/sensitivity of receptor			
	Very Low	Low	Medium	High
No Change	Negligible	Negligible	Negligible	Minor
Negligible	Negligible	Minor	Minor	Moderate
Slight	Minor	Minor	Moderate	Major
Moderate	Minor	Moderate	Major	Major
Substantial	Moderate	Major	Major	Major

Note 1 Refer to Table 6.2

Note 2 Refer to Table 6.1

Given the use of professional judgement in the assessment process, there may be some variation between subject areas (i.e. different environmental parameters) in the

significance rating process. This may be as a result of limited information on the sensitivity of features and / or the complexity of interactions that require assessment in determining the magnitude of change. However, the ratings derived through the impact assessment process, as set out in Table 6.3 can also be described in a generic fashion as given in Table 6.4. The following definitions are proposed in relation to the significance of environmental impacts predicted throughout this EIAR.

Table 6.4 Impact Significance Definitions

Level of Significance	Description
Negligible	No discernible effect. An impact that is likely to have imperceptible or insignificant impact.
Minor	Slight, very short or highly localised impact of no significant consequence. These effects may be raised as local issues but on their own are unlikely to be of importance in the decision-making process. When combined with other effects these could have a more material influence.
Moderate	Intermediate limited (extent / duration / magnitude) impact that may be considered as significant. These effects are likely to be important considerations at a local level. These could have influence on decision making especially when combined with other similar effects.
Major	Very large or considerable impact (extent/duration/magnitude). Effects, both adverse and beneficial, which are likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or, could result in exceedance of statutory objectives and / or breaches of [illegible]. In isolation, these could have a material influence on the decision-making process.

IMPACT MITIGATION MEASURES

In accordance with Part 10 of the 2001 EIA Regulations this EIAR includes a description of mitigation measures envisaged to prevent, remove and reduce the significant adverse effects from the development. Following the implementation of mitigation measures the identified impacts may be reduced to environmentally acceptable levels (or not).

It is best practice to consider mitigation measures for all impacts that are of a minor negative significance (i.e. slight, very short or highly localised impact of no significant consequence) or higher and this has been adopted for the purpose of this assessment.

The purpose of mitigation is to reduce the significance of the residual impact (see below) to a minor adverse or negligible level, which is a level that is expected to be acceptable by local authority, environmental regulators, and the public. Individual impacts assessed as being of minor adverse or negligible significance have not automatically been considered to require mitigation. However, where appropriate, and taking into account views and comments received through consultation, consideration has been given to the implementation of mitigation measures designed to reduce minor adverse impacts to a negligible level.

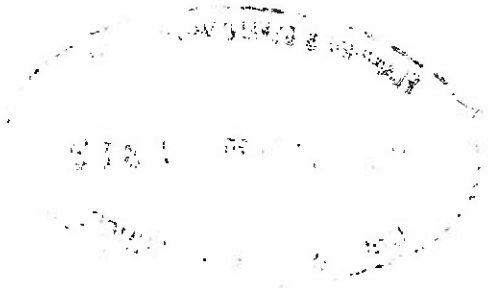
Mitigation measures can be incorporated at various stages in the proposed development. The preferred hierarchy of mitigation is as follows:

- Prevention: At the design stage: avoid, relocate, modify the design and / or do not process with the development;
- Reduction: introduce design modification or additional structures (e.g. screens), reduce size and scale of development etc.; and,
- Compensation or remediation: compensation to provide like-for-like replacement for any lost environmental elements. When adverse impacts are unavoidable, it may also be possible to limit the duration of an impact by undertaking remedial works. For example, the impact on the landscape of mineral extraction is largely unavoidable, but the land can be progressively restored following the completion of extraction to complement or enhance the character of the landscape.

6.2.4 Legislation and Guidance

Key legislation that is relevant to this Section on Geology and Soils is listed below:

- S.I. No. 349 of 1989, European Communities (Environmental Impact Assessment) Regulations, and subsequent amendments (S.I. No. 84 of 1994, S.I. No. 352 of 1998, S.I. No. 93 of 1999, S.I. No. 450 of 2000 and S.I. No. 538 of 2001).
- S.I. No. 473 of 2011, European Union (Environmental Impact Assessment and Habitats) Regulations 2011.
- S.I. No. 584 of 2011, European Union (Environmental Impact Assessment and Habitats) (No. 2) Regulations 2011.
- The Planning and Development Acts, 2000 to 2009, The Planning and Development (Amendment) Act 2010, S.I. 600 of 2001 Planning and Development Regulations and subsequent amendments including, S.I. No. 364 of 2005 and S.I. 685 of 2006.
- The following guidance is considered relevant:



- DoEHLG, 2010. Appropriate Assessment of Plans and Projects in Ireland - Guidance for Planning Authorities.
- Environmental Protection Agency, 2017. Guidelines on the information to be contained in Environmental Impact Statements (Draft).
- Environmental Protection Agency, 2015. Advice Notes on current practice (in the preparation of Environmental Impact Statements) (Draft).
- European Communities 2001. Assessment of plans and projects significantly affecting Natura 2000 sites - Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC.
- European Communities, 2000. Managing Natura 2000 Sites.
- Institute of Geologists of Ireland, 2002. Geology in Environmental Impact Statements, A Guide.
- National Roads Authority, 2008. Environmental Impact Assessment of National Road Schemes – A Practical Guide.
- National Roads Authority, 2008. Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

6.2.5 Desktop Study

The following site-specific resources were considered:

- Surface water sample analysed by Exova Jones Environmental (Ref: Test Report 17/18576 Batch 1);
- Proposed development plans;
- Site Photographs;
- Trial Pit logs completed by JBA Consulting in February 2018 (Ref: 2017s7157);
- Stormwater Assessment Report completed by JBA Consulting in April 2018 (Ref: 2017s7157) and updated in November 2019.
- Flood Risk Assessment completed by JBA Consulting in February 2018 (Ref: 2017s7157) and updated in November 2019.
- Hydrogeology and Hydrology Chapter of this EIAR

The following online resources were used in the writing of this EIAR:

- Geohive Map Viewer (Accessed 31.01.18)
- EPA Map Viewer (Accessed 30.01.18)
- GSI Map Viewer (Accessed 30.01.18)
- Catchments.ie Map Viewer (Accessed 30.01.18)
- National Parks and Wildlife Services – Protected sites synopses

- McNamara, M, E., 2009, The Geology of the Burren Region, Co. Clare, Ireland -part of the NPP-funded Northern Environmental Education Project
- Pracht, M. and Somerville, I.D., 2015. A revised Mississippian lithostratigraphy of County Galway (western Ireland) with an analysis of carbonate lithofacies, biostratigraphy, depositional environments and palaeogeographic reconstructions utilising new borehole data. Journal of Palaeogeography, 4(1), pp.1-26.
- GSI Report 2695 – Gas Pipeline to West Contract 2 Phase 2, August 2010
- Galway County Council Planning Portal (Accessed 31.01.18)

6.2.6 Field Work

JBA Consulting completed a site investigation comprising of two (2 no.) trial pits in February 2018 as part of Flood Risk Assessment and Stormwater Design works (Ref. Appendix 7.1 and 7.2). The trial pit logs have been provided at Appendix 6.2, and the information collected during the site investigation has been discussed in relevant sections of this report. Further field survey works was carried out by GDG in 2019 as part of the hydrogeological risk assessment works (refer to Chapter 7).

6.2.7 Consultation

A request for environmental information was submitted to the EPA and Galway County Council on 29th January 2018. The information provided has been presented in the relevant sections within this Section. Full consultation responses are included at Appendix 6.1.

6.3 Description of the Receiving Environment

6.3.1 Introduction

The proposed application site is located on lands off Kinincha Road to the north-west of Gort town in the townlands of Ballynamantan, Kinincha and Glenbrack and is centred at grid reference (ITM) 545442 703348. The proposed development seeks full planning permission for the construction a new biogas plant served by new laneway and entrance routing to the site from the N18.

The proposed application site includes the construction of the following components (as described in Section 2 of the EIAR):

- Main site entrance;
- Weighbridge;

- Office and control room building;
- Feedstock reception building;
- Odour control unit;
- Process drainage, stormwater drainage and foul drainage;
- Digesters, digestate storage vessels and pump houses within tank farm bund;
- Gas upgrading (biomethane and carbon dioxide) and processing plant /building;
- Gas flare and gas booster station;
- CHP unit and boilers;
- Lighting, fencing, and security gates.

6.3.2 Site Description

The proposed development is c. 10.1ha and located north-west of the town of Gort in the townlands of Ballynamantan, Kinincha and Glenbrack. Gort is located 32km south of Galway Gateway. The current site use is described as improved grassland pastures, used for agricultural grazing and equine purposes.

Currently, the site has been landscaped by the owner to facilitate a horse gallop, with access to stables and associated lunging ring. This site development was carried out around 2000 and included excavation of soils, removal of field boundaries, importation of screened fine soils, grass re-seeding and construction of perimeter track/fencing.

Access to the site is currently provided by the Kinincha Road and through an agricultural laneway from the N18/R458. The Kinincha road is bounded by stone walls and hedgerows. There are multiple areas with evidence of fly-tipping of household waste, as well as a bottle recycling station.

Gort municipal wastewater treatment plant is located 150m to the south of the site on the eastern side of Kinincha Road. The treatment plant has both primary and secondary treatment. Treated effluent is discharged into the nearby Cannahowna River.

Adjacent to the east of the site is a Council storage site (including shed). Planning information for the development indicate construction post 2010. The shed was built to be used to store materials, particularly salt for freezing roads, needed for the maintenance for the local road network. Photographs at the time of construction indicate that the land had been subject to a large degree of "fly tipping"/dumping waste.

A railway line runs north-south 500m east of the site. The M18 runs north-south 700m west of the site. Regional Road N18 /R458 runs parallel to the M18 and it is proposed to

access the development proposal by a constructing a new entrance and road from the N18/R458.

PROTECTED AREAS

The area surrounding the development site contains many protected areas. Figure 6.1 below provides a spatial distribution of SPA and SAC sites. A 5km buffer has been included. In Table 6.5, all protected sites that contain areas within 5km of the site are detailed. Additionally, turlough environments beyond the 5km buffer surrounding the site are included due to the sensitivity and widespread connectivity of the geological environment.

Figure 6.1 Protected Areas Surrounding Development Site

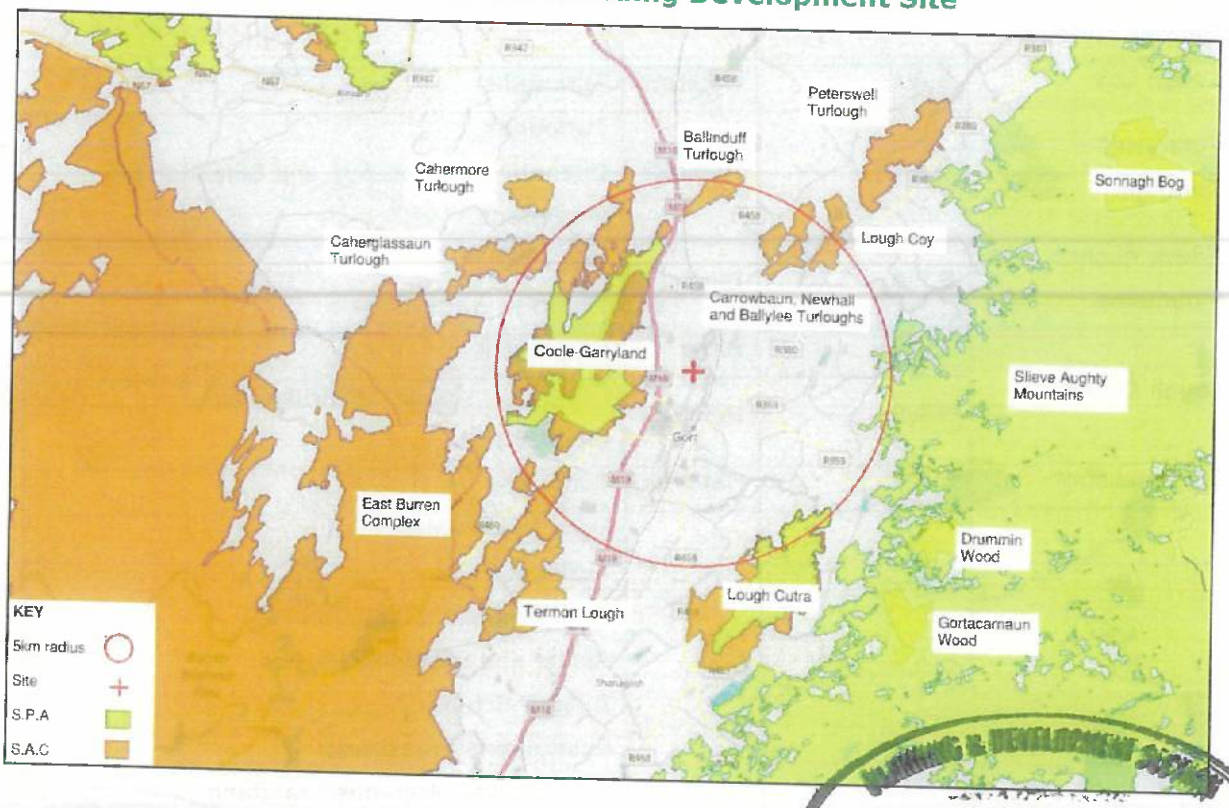


Table 6.5 Protected Environments

Name	Designation	Type	Reason for Protection
Coole Garryland	S.P.A	Birds	Whooper Swan
	S.A.C	Habitats	Natural Eutrophic Lakes, Turloughs
			Chenopodion rubri p.p. and Bidention p.p. Vegetation
			Juniper Scrub
			Orchid-rich Calcareous Grassland
			Limestone Pavement
			Yew Woodlands

Name	Designation	Type	Reason for Protection
Caherglassaun Turlough	S.A.C	Habitats	Turloughs Chenopodion rubri p.p. and Bidention p.p. vegetation Lesser Horseshoe Bat (Rhinolophus hipposideros)
Cahermore Turlough	S.A.C	Habitats	Turloughs
Ballinduff Turlough	S.A.C	Habitats	Turloughs
Carrowbaun, Newhall and Ballylee Turloughs	S.A.C	Habitats	Turloughs
Lough Coy	S.A.C	Habitats	Turloughs
Peterswell Turlough	S.A.C	Habitats	Turloughs Chenopodion rubri p.p. and Bidention p.p. vegetation
Slieve Aughty Mountains	S.P.A	Birds	Hen Harrier Merlin
Lough Cultra	S.P.A	Birds	Cormorant
	S.A.C	Habitats	Lesser Horseshoe Bat (Rhinolophus hipposideros
Termon Lough	S.A.C	Habitats	Turloughs
East Burren Complex	S.A.C	Habitats	Hard Water Lakes Turloughs Floating River Vegetation Alpine and Subalpine Heaths Juniper Scrub Calaminarian Grassland Orchid-rich Calcareous Grassland Lowland Hay Meadows Cladium Fens Petrifying Springs Alkaline Fens Limestone Pavement Caves Alluvial Forests Marsh Fritillary (Euphydryas aurinia) Lesser Horseshoe Bat (Rhinolophus hipposideros) Otter (Lutra lutra)

6.3.3 Soils and Subsoils

SOIL COVER

A review of the Teagasc Soils map on the GSI map viewer details that the soil cover is composed 'deep well drained soils' (BmindDW) (mainly basic), described as grey brown podzolics and brown earths (medium-high base status) within the northern area and shallow well drained soils (BminSW) (mainly basic), described as renzinas and lithosols across the remaining site area.

A review of the SIS National Soils map on the EPA maps viewer details that the soil cover is composed Faoldroim, defined as fine loamy drift with limestones across the entire site. The soil exhibits good drainage. River Alluvium is present along the banks of the Cannahowna River to the east of the site.

A raised embankment is situated along the site's western boundary. The material used to construct the embankment is understood to be reworked till sourced from within the site. The embankment is an engineered feature associated with the earthworks during the construction of the horse gallop (circa 2000). It is unknown whether any additional material was imported to the site to support the construction of the Horse Gallop.

DRIFT COVER

The GSI Quaternary Geology online viewer indicates that the majority of the site is underlain by *'till derived from limestones'*. The far north corner contains river alluvium. The southern area of the site is shown to be absent of quaternary sediments and is instead underlain by the outcropping bedrock geology of the Tubber Formation.

A review of the 'Teagasc Subsoils' map on the EPA maps viewer confirms that the soils are composed Limestone Tills (Carboniferous) within the northern area and surface bedrock (Limestone) across the southern site area.

TRIAL PITS

Two (2 no.) were excavated by JBA consulting on 6th February 2018. Trial Pit log information is summarised on Table 6.6 and presented at Appendix 6.2. The logs demonstrate that there is topsoil cover at each of the trial pit locations. Based on the limited trial pit information available, the thickness of soil cover generally reduces from north to south (0.75m at the proposed northern clean water storage pool to 0.3m at the proposed southern clean water storage pool). The drift deposits thickness also reduces from c.2m to 0.9m. On the basis of this information, it is expected that little or no soil/drift deposits will be present in the southernmost portions of the site. During the trial pit site

investigation, although the water table was not intercepted, the material encountered were described as being sandy in nature, therefore of higher permeability than clay rich till deposits and will subsequently have limited potential to restrict vertical infiltration of surface water.

Table 6.6 Trial Pit Log Summaries

Location	Depth (mbgl)	Description of Strata	Authors Interpretation	Water Table
Location 1 – Proposed soakaway location	0.00 – 0.75	Topsoil – Dry, dark brown	Topsoil	Not Encountered
	0.75 – 2.50	Loose brown/grey sandy soil – Large boulders present	Till	
	2.5 – 3.00	Loose, moist grey sand – Large boulders present	Till	
Location 2 – Between proposed southern attenuation pond and bend in swale	0.00 – 0.30	Topsoil – Dry, Dark brown	Topsoil	Not Encountered
	0.30 – 1.20	Sandy Clay – Dry, grey/brown	Till	
	1.20	Rock refusal	Tubber Formation	

A large-scale geotechnical investigation was undertaken by "Geotech Specialists" in support of a new gas pipeline project. Part of the pipeline runs though Gort. The line of boreholes/trial pits indicate that pipeline runs approximately 300-400m west of site. 2No. trial pits have been recorded within 1km of the site. The trial pits were only completed to 1.0 and 1.1mbgl respectively, within the superficial tills. Details of the trial pits are recorded in Table 6.7.

A copy of the geotechnical report can be viewed through using the GSI Geotechnical Viewer at http://spatial.dcenr.gov.ie/GeologicalSurvey/GeoTechnicalViewer/index.html.

Table 6.7 Trial Pits

ID	Location (from site)	TP No.	Top (mbgl)	Base (mbgl)	Colour	Major Lithology	Minor Lithology
112163	750m NW	TP2265	0.00	0.25	-	Top Soil	
			0.25	1.00	Greyish Brown	Sand	Slightly Clayey
112164	650m W	TP2266	0.00	0.30	-	Top Soil	-
			0.30	1.10	Light Grey	Sand	Gravelly

6.3.4 Bedrock Geology

REGIONAL SETTING

The rocks of the Burren region record a period of inactivity between the Caledonian and Variscan Orogenies. During this time, the environment was characterised by periods of large braided rivers, submarine basins and deltaic environments. The rock units show post depositional deformation from the Varsican orogeny. The region is distinct in Ireland due to the absence of widespread glacial drift. Detailed lithostratigraphy of the limestone units deposited during this time are detailed in Table 6.8.

Table 6.8 Rock Succession in Burren Area

Age		Formation	Formation Thickness	Sub-Unit	Sub-Unit Thickness	Lithology
Carboniferous	Visean	Slievenglasha Formation	91m	Lissylisheen Member	3m	- Wackestones and crinoidal packstones and grainstones
				Ballyelly Member	30m	- Medium-bedded nodular wackestones and thickly bedded crinoidal packstones, with chert-rich horizons.
				Fahee North Member	25m	- Dark grey, cherty, nodular wackestones and packstones
				Balliney Member	36m	- Cherty, interbedded crinoidal packstones and grainstones. - Darker, nodular wackestones; - Rugose corals dominate macrofauna.
		Burren Formation	370-390m	Ailwee Member (upper)	152m	- Thick (10-12 m) intervals of limestone and thin (<0.2m) clay bands. - Lower part contains few macrofossils; fragments of bryozoans occur. - Upper part is highly fossiliferous.
				Ailwee Member (lower)		

Age		Formation	Formation Thickness	Sub-Unit	Sub-Unit Thickness	Lithology
						- Capped by a palaeokarst surface, and overlain by a clay band
				Maumcaha Member	80m	- Pale-grey massive limestones; macrofossils are rare, but Koninckopora is abundant. - Capped by two clay bands and irregular palaeokarstic surface
				Hawkhill Member	135.5m	- Bryozoan-rich skeletal limestones. - Capped by chert-rich limestones and a dolomite horizon.
		Tubber Formation	300m	Castle Quarter Member	120m	- Light grey to medium grey shelf limestone, mainly calcarenites, with fasciculate lithostrotionids. - Topped by a dolomite bed
				Newton Member	25m	- Cherty limestone
				Tubber Formation		- Crinoidal medium-grey packstones and wackestones, sometimes with shaly partings, cherts and dolomite
	Tournasisan	Waulsortian Limestones	300-500m			- Massive, unbedded limestones/ mudstones
		Ballysteen Formation	100-200m			- Dark muddy limestone and shale - Regularly bedded and nodular bedded argillaceous bioclastic limestones (wackestones and packstones) - Interbedded with fossiliferous calcareous shale
		Lower Limestone Shale				- Sandstone, mudstone & thin limestone

SITE SPECIFIC BEDROCK GEOLOGY

The GSI 100k bedrock maps demonstrate that the development site is underlain by the Tubber Formation. The unit is Carboniferous in age and is 300m in thickness. The GSI viewer also highlights that the rock outcrops at the surface across much of the site. Outcrop of the units detailed in Table 6.8 are seen across the region, with older units to the east and younger units to the west. Therefore, the underlying succession at the site is likely to be consistent with the succession detailed in Table 6.8.

One of the two onsite trial pits, located at the south of the site, completed in February 2018 by JBA Consulting reached rockhead at 1.2mbgl. The other trial pit, located in the north of the site had not reached rockhead at the completed depth of 3mbgl.

There are no recorded boreholes on-site. Three (3 no.) boreholes are recorded within 1km of the site on the Geological Survey Ireland's online mapping. They are all deep bedrock boreholes. Although no logs are publicly available, the information available does record when rockhead was reached. All three boreholes are located adjacent to the river, and therefore superficial cover is likely thicker than adjacent land. Information on the location and depth of boreholes is presented in Table 6.9.

Table 6.9 Bedrock Borehole

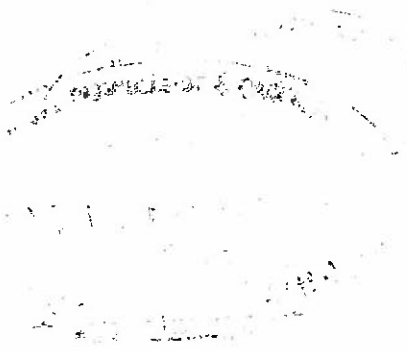
ID	Location (from site)	BH No.	Company	Date	Length	Rockhead	Lithology
3934	345m E	G-05-AMOC	AMOC	Unknown	147.4m	1.8m	Unknown
3935	230m E	G-06-AMOC	AMOC	Unknown	121.9m	1.9m	Unknown
3933	570m N/NE	G-04-AMOC	AMOC	Unknown	192.6m	2.1m	Unknown

6.3.5 Features of Geological Significance

Although the limestone underlying the site is not protected by an environmental designation, other local areas with the same outcropping limestone unit are protected due to the presence of limestone pavement- caves and turloughs. The sensitivity of this unit is additionally heightened due to the limited or absent drift geology cover to provide a geological barrier to protect the underlying bedrock.

The 500k Bedrock Geology map indicates the presence of a E/NE – S/SW trending fault feature, deep set within the bedrock, 800m south-east of the site boundary. This makes up a series of similarly trending faults across the region, localised predominantly on red sandstone bedrock members.

A review of the Geological Survey of Ireland (GSI) viewer has indicated that the site is situated within an area of *'County Council Quarry'*. The boundary is classified as "Heritage Sites Unaudited Boundary". Galway County Council map viewer (which contains quarry licence data) has no record of a quarry at the location. One historic quarry is present 3.5km south of the development site. Information available on the GSI viewer indicate



that the quarry was active between 1975 and 1995. The land is currently undeveloped fields.

A site of geological interest has been identified on the proposed site. The area of interest as a geological heritage site consists of peloidal limestones from the Tubber Formation. The county audit for Galway is currently underway to review identified County Geological Sites and produce a County Geological Site Report, this audit will also accurately define the boundaries of these sites. Currently (June, 2019) the County Geological Site within the bounds of the proposed development site has not undergone an audit and so a 200m buffer has been mapped around the area of interest in the absence of a more defined boundary. The Geological Survey have been contacted in regards to this site and they have advised that a review of potential heritage sites in Galway is currently underway and that it is currently unknown whether or not the identified site will remain as a heritage site. Head of Geological Heritage at the GSI has advised that development of sites adjacent to County Geological Heritage sites rarely causes a direct conflict of interest, especially in the case of sites identified as quarries, where any further excavation can be an advantage, providing additional information for GSI, or an agreement can be made to preserve a representative face of the quarry (refer to Chapter 7).)

6.3.6 Land Contamination

In order to evaluate the potential for land contamination associated with historical land use, historical maps were reviewed in order to identify potentially contaminative historical activities. Information on the site's history was obtained through an inspection of available historical maps (http://map.geohive.ie/) and aerial photography. The historical description below encompasses the period from 1837 to the present day. Historical land uses identified are presented on Table 6.10. There are no identified sources of contamination from historical land use within the site boundary or in adjacent land.

Table 6.10 Historical Land Use

Date	Description
1837-1842	The site at this time is Greenfield. Rock outcrops are mapped throughout the site. There are some mapped field boundaries. No Railway line is present and the current local road accessing the site is not present. There are no potentially contaminative land uses within the boundary or adjacent land.

1888-1913	The site at this time is Greenfield. Rock outcrops are mapped throughout the site. There are some mapped field boundaries. The railway line is now present east of the site and the local road for access to the site is present. There are no potentially contaminative land uses within the site boundary or adjacent land.
1995	A review of this map (aerial photo) indicates that the site area remains undeveloped at this time. No significant change is observed. There are no potentially contaminative land uses within the site boundary or adjacent land.
2000	A review of this map (aerial photo) indicates that the site has been subject to earth works since 1995. The photo appears to have been taken during the construction phase of the horse gallop. Bare soil is visible across the majority of the site. The Galway Co. Co. depot has been constructed to the east of the site. There are no potentially contaminative land uses within the site boundary or adjacent land.
2005	A review of this map (aerial photo) indicates that the horse gallop has been fully constructed and that the bare soil previously identified is now overlain by grass cover. There are no potentially contaminative land uses within the site boundary or adjacent land.

6.4 Impact Assessment

This section provides an assessment of the potential environmental impacts of the proposed development on the soils and geological environment during the construction and operational phases of the development.

Judgments made are based on an assessment of the magnitude of contamination sources, geotechnical hazards and mineral sterilisation as obtained from desk study, existing ground investigation and monitoring information, which form the baseline conditions and an assessment of the source – pathway – receptor philosophy and identified pollutant linkages.

The application site and the area within its immediate environs (i.e. existing application line boundary) have been considered in detail to assess the changes in ground conditions.

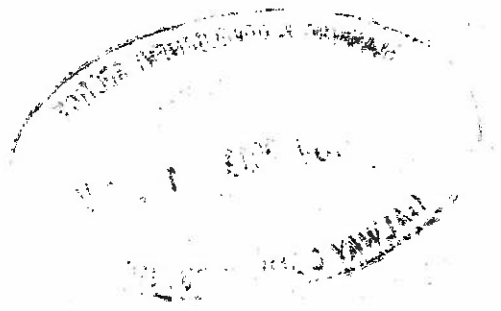
The receptors potentially at risk that could be present are indicated in Table 6.11 and their relative sensitivity is assessed to enable predicted impact to be determined.

RECEPTOR SENSITIVITY

The receptors considered for the risk assessment are detailed in the table below and considered in relation to their relative importance and receptor sensitivity; justifications for the classification are provided.

Table 6.11 Receptor Sensitivity

Receptor	Relative Importance	Receptor Sensitivity	Justification
Shallow Soils	Local Level	Low	The receptor does not make a significant contribution to local character or distinctiveness; The receptor is considered very local.
Underlying Drift Deposits (Till)	Local Level	Low	The proposed development is expected to cause a minimal change to the drift deposits underlying the site geology on site, e.g. although landscaping and earthworks will take place the underlying drift geology is expected to remain on site.
Bedrock Geology (Limestone)	County Level	Medium	Due to the limited superficial cover, the foundations of the development are likely to be directly in the fractured bedrock geology.



6.4.1 Construction Phase

The main potential environmental effects during the construction phase have been tabulated in Table 6.12.

Table 6.12 Construction Phase Potential Environmental Effects

Receptor & its corresponding sensitivity	Potential Environmental Effects	Magnitude of impacts	Impact of significance and discussion
Drift Deposits and Shallow Soils (Low)	Contamination of underlying drift deposits due to leaks from chemicals/ fuels stored on site.	Moderate	Moderate (without mitigation) Mitigation is proposed in Table 6.14.
	Loss of shallow soils and drift through construction onsite e.g. buildings, access roads and car park.	Negligible	Negligible No mitigation measures required.
Bedrock Geology (Medium)	Contamination of bedrock due to leaks from hazardous substances/ chemicals and fuels stored on site.	Moderate	Moderate (without mitigation) Mitigation is proposed in Table 6.14.
	Contamination of bedrock due to foundation construction and road works	Moderate	Moderate (without mitigation) Mitigation is proposed in Table 6.14.

6.4.2 Operational Phase

The main potential environmental effects during the operational phase have been tabulated in Table 6.13.

Table 6.13 Operational Phase Potential Environmental Effects

Receptor & its corresponding sensitivity	Potential Environmental Effects	Magnitude of impacts	Impact of significance
Shallow Soils and Drift Deposits (Low)	Contamination of underlying drift deposits and soils due to leak from chemicals/ fuels stored on site and used throughout the site operations e.g. paints, lubricants, oils.	Moderate	Moderate (without mitigation) Mitigation is proposed in Table 6.15.
	Contamination of underlying drift deposits and shallow soils due to leaks/spills from waste processing tanks and waste storage tanks	Moderate	Moderate (without mitigation) Mitigation is proposed in Table 6.15.
	The process of earthworks during the construction phase may have potential to cause erosion of exposed drift deposits.	Moderate	Moderate (without mitigation) Mitigation is proposed in Table 6.15.
Bedrock Geology (Medium)	Contamination of bedrock due to leak from chemicals/ fuels stored on site and used throughout the site operations e.g. paints, lubricants, oils.	Moderate	Moderate (without mitigation) Mitigation is proposed in Table 6.15
	Contamination of underlying drift deposits and shallow soils due to leaks/spills from waste processing tanks and waste storage tanks	Moderate	Moderate (without mitigation) Mitigation is proposed in Table 6.15

6.5 Mitigation Measures and Monitoring

6.5.1 Construction Phase

The main potential environmental effects during the construction phase have been tabulated in Table 6.14.

Table 6.14 Mitigation of Potential Environmental Effects

Construction phase Potential Environment effect	Impact of Significance	Receptor	Mitigation	Impact of Significance following mitigation
Contamination from spills or leaks of fuel/oil and hazardous substances used throughout the site operation e.g. paints, concrete, lubricants, adhesives, oils etc.	Moderate	Shallow Soils Drift Deposits Bedrock	• Dedicated area of hard standing for material deliveries; • Dedicated area of hard standing for vehicle wash-out; • Specific areas for oil storage and refuelling, separated a minimum of 10m from adjacent watercourses and comply with legislation, including providing bunds sized 10 contain 110% of fuel storage capacity • Use spill kits, fill point drip trays, bunded pallets and secondary containment units; • Enclosed and secured site and fuel storage areas will be secondarily secured; • Develop a Site Waste Management Plan • Develop a site-specific Incident Response Plan	Negligible
Contamination of bedrock due to foundation construction and road works	Moderate	Bedrock	• A suitable casing will be used where wet concrete is proposed to ensure protection of deeper sub surface deposits until concrete has set.	Negligible

6.5.2 Operational Phase

The main potential environmental effects during the operational phase have been tabulated in Table 6.15.

Table 6.15 Mitigation of Potential Environmental Effect

Construction phase Potential Environment effect	Impact of Significance	Receptor	Mitigation	Impact of Significance following mitigation
Contamination from spills or leaks of fuel/oil and hazardous substances used throughout the site operation e.g. paints, lubricants, adhesives, oils etc.	Moderate	Shallow Soils Drift Deposits Bedrock	• Dedicated area for material deliveries; • Dedicated area for vehicle wash-out; • Specific areas for oil storage and refuelling, separated a minimum of 10m from adjacent watercourses and comply with legislation, including providing sized 10 contain 110% of fuel storage capacity • Use spill kits, fill point drip trays, bunded pallets and secondary containment units; • Enclosed and secured site and fuel storage areas will be secondarily secured; • Develop a Site Waste Management Plan • Develop a site-specific Incident Response Plan	Negligible
Contamination due to leaks/spills from waste processing tanks and waste storage tanks	Moderate	Shallow Soils Drift Deposits Bedrock	• Use bunded tanks and overflow tanks • Use spill kits, fill point drip trays, bunded pallets and secondary containment units; • Develop a Site Waste Management Plan • Develop a site-specific Incident Response Plan	Negligible
Erosion of exposed drift deposits.	Moderate	Drift Deposits	• Areas of exposed drift deposits should be revegetated after the completion of development	Negligible

6.5.3 Decommissioning Phase

The decommissioning phase is described in Section 2.12 of this EIAR. Due to the similarity of potential impacts to construction phase works (in terms of disturbance through increased noise levels, ground clearance works, and reinstatement; and potential surface water quality impacts from ground disturbance, re-fuelling and the storage of potentially hazardous materials onsite) the implementation of all mitigation measures detailed in the construction phase (including due diligence surveys for protected species) will help ensure that all such impacts are avoided.

As part of EPA licensing requirements, an environmental liabilities risk assessment (ELRA) including a site closure and decommissioning plan will be prepared and updated periodically during operational life of the plant. This plan will further detail specifics associated with the decommissioning of the site including associated costs.

6.5.4 Cumulative Impacts

Within the European Commission - Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions, dated May 1999, cumulative effects are described as *"impacts that result from incremental changes caused by other development, plans or projects together with the proposed development or developments"*. No cumulative impacts exist for the receptors of the site (shallow soils, underlying drift and bedrock geology). This is due to all impacts of significance which were classified as minor or of greater significance (i.e. moderate or major) following mitigation are now considered to be negligible.

6.6 Residual Impacts

The proposed development will not have any significant residual effects on the geo-environment if all mitigation measures are implemented

The site development will result in the creation of low permeability and impermeable surfaces, limiting the potential for contamination of the subsurface.

The site is currently greenfield. The proposed development will result in physical disturbance to the existing soil profile. Since the site has limited agricultural potential, the residual effect is negligible.

6.7 Summary of Significant Impacts

This Section of the EIAR presents an assessment of the potential impacts regarding Geology and Soils from the proposed Gort Biogas Plant. The receptors for this

assessment are considered to be shallow soils, the underlying drift and bedrock geology. Whilst the development proposals have the potential to cause detriment to the sensitive receptors identified, the recommended mitigation measures will ensure that the risk of potential impacts are reduced to negligible.

6.8 Statement of Significance

The significance of impact upon shallow soils, drift deposits, and bedrock geology have been assessed for both during the construction and operational phases. The results of the assessment are presented on Table 6.12 and Table 6.13.

Where a potential impact has been identified, the significance of impact upon these receptors ranges from minor to moderate.

Where a potential impact has been identified, mitigation measures have been provided which if implemented reduces the impact of significance to 'negligible'. The mitigation steps are presented on Table 6.14 and Table 6.15.

6.9 Expected Effects Deriving from the Vulnerability of the Proposed Development to Risks of Major Accidents or Disasters that are Relevant to the Proposed Development

Given the geographic location of the proposal, the vulnerability of the proposed development to natural disasters such as earthquakes, fire, tidal or weather events is considered to be low. The risks associated with flooding, have been assessed in a by JBA Consulting (refer to Appendix 7.1).

In terms of accidents, it should also be noted that the infrastructure (listed in Section 6.4.1 and described in Section 2) in use on the site will be constructed in accordance with their respective guidance and or regulations which dictates their design, location, construction and maintenance to prevent water pollution. Notification in respect of each of these structures together with accompanying engineering certification will be required by the EPA in accordance with these regulations.

The activity (Biogas Plant) will operate in accordance with an Environment Health and Safety Management Plan, (required by the EPA as part of licensing). This requires daily inspections of all structures, plant and machinery and sets in place procedures for dealing with incidents such as spillages, power outages and plant closure. The vulnerability of the development to major accidents or disasters is therefore considered low.

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7 HYDROLOGY & HYDROGEOLOGY

7.1 Introduction

This Chapter focuses on the Hydrological and Hydrogeological environment and discusses the potential impacts associated with the proposed development during the construction and operational phases. While closely linked to the previous Chapter (Soils and Geology), the Chapter focuses on the water environment (surface water and groundwater) and the its interrelationship with the underlying limestone karst environment.

For the purpose of the Environmental Impact Assessment (EIA) the following is defined:

- The term "Hydrology" refers to surface waters;
- The term "Hydrogeology" refers to groundwater.

This chapter on Hydrology and Hydrogeology involved the following:

- Review of development proposals;
- Review of site-specific reports;
- Consultation with relevant statutory authorities to help establish baseline conditions and identify any significant concerns in the area;
- Consideration of potential interactions and identification of possible impacts;
- Assessment of impacts, within the context of the receiving environment including cumulative effects;
- Identification of measures and solutions to avoid, minimise and mitigate potential impacts; and,
- Assessment of residual impacts, taking account of mitigation measures.

7.2 Assessment Methodology and Significance Criteria

7.2.1 Assessment Methodology

This assessment has been undertaken in line with the Source – Pathway – Receptor Model as per the documents 'Guidelines on the Information to be contained in Environmental Impact Assessment Impact Assessment Reports Draft', August 2017 and 'Advice Notes for Preparing Environmental Impact Statements Draft', September 2015.

At the impact assessment stage, any potentially beneficial or adverse impacts associated with the development are identified and assessed with reference to the baseline environment. This requires consideration of:

- Sensitivity/value of the receptor;
- Magnitude of the impact;
- Impact duration;
- Whether impact occurs in isolation, is cumulative or is interactive; and
- Performance against environmental quality standards or other relevant thresholds

7.2.2 Assessment Criteria and Impact Assessment Methodology

This assessment considers the potential source of risk to environmental receptors and the pathways by which the receptors may be affected. Definitions of the key descriptors are detailed below:

- Source: potential contaminant sources;
- Pathway: the mechanism by which the source may affect a receptor; and
- Receptor: identified features that may be affected, based on the sensitivity of the site.

The strength of the pathway between a source and a receptor is a function of the distance between the two and the nature of the migration pathway. For example, on sites underlain by impermeable clays, the migration pathway via groundwater would be weak even over short distances, whereas within sands or gravels, the migration pathway would be strong for receptors in proximity to a source and weak for receptors at some distance from the source.

The significance of predicted impacts likely to occur during all phases of the proposed development was determined by considering the value and sensitivity of the key attributes that may be affected and the magnitude of the predicted impact.

7.2.3 Determining the Value and Sensitivity of the Receptor through Baseline Studies

The value or sensitivity of a receptor is largely determined by its quality, rarity and scale. The determination of value or sensitivity takes into account the scale at which the attribute is important. For the purpose of assessing the significance of environmental impacts predicted as part of this assessment, the value of receptors is scaled based on the relative importance of the receptor defined as follows:

- LOCAL LEVEL: On the proposed application site or immediately adjacent to it;
- DISTRICT LEVEL: Beyond the site boundary but within the district;
- COUNTY LEVEL: County Level e.g. Galway;

- REGIONAL LEVEL: Connacht/West of Ireland;
- NATIONAL LEVEL: Republic of Ireland;
- INTERNATIONAL LEVEL: European Community.

A receptors value and sensitivity must be defined using available guidance and professional knowledge and taking into account the site sensitivities. In some cases, the inherent value of the receptor has been recognised and been afforded a statutory designation (e.g. Special Areas of Conservation (SAC's)), which makes the value assignment more straightforward. The judgement of receptor significance is made on a case by case basis for each receptor or resource identified as having the potential to be subject to impacts associated with the proposed development.

Irrespective of its recognised value, all receptors/features would exhibit a degree of sensitivity to the changes imposed by new development. The 'sensitivity' element of the criterion ensures that this characteristic of each receptor is assessed. The classification for determining sensitivity of receptors is detailed in Table 7.1. This classification is used as a generic methodology and professional judgement has been applied in each case.

Table 7.1 Receptor Sensitivity and Typical Descriptors

Sensitivity	Descriptors
Very Low	Feature / receptor is generally insensitive to impact, no discernible changes e.g. soils are not in use, the land is used for industrial/commercial purposes and /or mainly covered by hard standing.
Low	Feature / receptor has some tolerance to accommodate the proposed change. It responds in a minimal way such that only minor changes are detectable e.g. landscaped areas.
Medium	Feature / receptor has a low capacity to accommodate the proposed form of change. It clearly responds to effects in a quantifiable manner e.g. low grade agricultural land and recreational ground.
High	Feature / receptor has a very low capacity to accommodate the proposed form of change. The response is a major change e.g. agricultural land use for food production, allotments.

MAGNITUDE OF IMPACTS

Magnitude refers to the 'scale' or 'amount' of an impact. Key impacts have been identified and the likely magnitude of each potential impact has been determined through the predicted change from the baseline conditions throughout the various phases of development. The magnitude of an impact is a measure of aspects such as the impacts:

- Extent (i.e. the geographical area over which the impact occurs);
- Duration (i.e. the time for which the impact is expected to last prior to recovery or replacement of the resource or feature: short, medium or long term);
- Likelihood (i.e. the probability that the impact will occur);
- Direct or Indirect (i.e. difficult to avoid); and,
- Reversibility (i.e. an irreversible (permanent) impact is one from which recovery is not possible within a reasonable timescale or for which there is no reasonable chance of action being taken to reverse it: Temporary or Permanent).

In order to help define the level of impact magnitude the following guidance (see Table 7.2) has been adopted for the purpose of providing a transparent assessment. The professional judgement of the technical author is used in the decision-making process when characterising impacts in accordance with the criteria set out in Table 7.2.

Table 7.2 Assessment Criteria for Magnitude

Magnitude	Assessment Criteria
No Change	• No loss or alteration of characteristics, features or elements; • No observable impact on receptors/features.
Negligible	• Noticeable, temporary (for part of the development duration) change; or • Barely discernible change for any length of time, over a small area, to any key characteristics or features. • Impact unlikely or rarely to occur. • Results in effects on attribute of insufficient magnitude to affect the use/integrity.
Slight	• Noticeable, temporary (during the project duration) change, over a partial area, to key characteristics or features. Impact will possibly occur. • Impact predicted to extend over a small area; • Impact predicted to affect small numbers of people; • Impact predicted to affect a small number of other receptors (ecological, businesses, facilities); • Impact not predicted to have trans-boundary effects, but possibility remains; • Slight but discernible change in environmental conditions predicted; • Impact not predicted to entail unusual/complex effects for receptors; • Impact not predicted to affect locally scarce features/resources;

Magnitude	Assessment Criteria
	• Impact not predicted to result in breaches of legislation or statutory Environmental Quality Standard or Objectives; • Impact not predicted to result in loss of attribute; • Impact will continue for a short period of time only; • Impact will be temporary; • Impact will be intermittent and/or rare; • Impact will be reversible; • Impact will be possible to avoid, reduce, repair, or compensate for; or • Slight positive change in environmental conditions resulting in minor improvements in quality or value of a receptor.
Moderate	• Significant, permanent / irreversible changes, over the majority of the development area and potentially beyond, to key characteristics or features. Impact certain or likely to occur. • Impact predicted to extend over a moderate area; • Impact predicted to affect moderate numbers of people; • Impact predicted to affect some other receptors (ecological, businesses, facilities); • Impact unlikely to have trans-boundary effects, but possibility remains; • Moderate change in environmental conditions predicted; • Impact unlikely to entail unusual/complex effects for receptors but possibility remains; • Impact unlikely to affect particularly scarce features/resources but possibility remains; • Impact entails a low probability that breaches of legislation or statutory Environmental Quality Standard or Objectives will occur; • Impact unlikely to result in loss of attribute but possibility remains; • Impact will continue for a moderate period of time; • Impact will be semi-permanent; • Impact will be intermittent; • Impact will be possible to avoid, reduce, repair, or compensate for; or • Notable positive change in environmental conditions resulting in measurable improvements in quality or value of a receptor.
Substantial	• Very significant, permanent / irreversible changes, over the whole development area and beyond (i.e. off-site), to key characteristics or features of character or distinctiveness. Impact certain or likely to occur.

Magnitude	Assessment Criteria
	• Impact predicted to extend over a large or very large area; • Impact predicted to affect considerable numbers of people; • Impact predicted to affect considerable numbers of other receptors (ecological, businesses, facilities); • Impact predicted to have trans-boundary effects; • Significant change in environmental conditions predicted; • Impact will entail unusual/complex effects for receptors; • Impact will affect particularly scarce features/resources; • Impact entails a high probability that breaches of legislation or statutory Environmental Quality Standard or Objectives will occur; • Impact will result in total loss of attribute; • Impact will continue for extended periods of time; • Impact will be permanent rather than temporary; • Impact will be continuous rather than intermittent, or where intermittent, frequent rather than rare; • Impact will be irreversible; • Impact will be very difficult to avoid, reduce, repair, or compensate for; or • Significant positive change in environmental conditions resulting in major improvements in quality or value of a receptor.

IMPACT SIGNIFICANCE

Part 10 of 'The Planning and Development Regulations, 2001' (hereafter denoted as "the 2001 EIA Regulations") are concerned with 'significance' and the identification of *'significant environmental effects'*. Therefore, an assessment of significance is necessary in order to identify the main environmental effects of the proposed development and assist in determining what weight these effects should be given. Definitive guidance in the preparation of EIA in the soils and geological environment exists in *'Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements'*, issued by the Institute of geologists of Ireland. From the guidance, a significant effect is defined as "an impact, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment".

It is widely recognised that 'significance' reflects the relationship between the magnitude of an impact and the sensitivity (or value) of the affected environmental receptor.

To assist in the assessment process, the Impact Significance Matrix (ISM) (Table 7.3) provides a transparent methodology to ensure consistency and ease of interpretation of the judgement of impact significance.

An initial indication of impact significance (adverse or beneficial) is gained by combining magnitude and sensitivity / value in accordance with the ISM provided. It should be noted that although the ISM provides a good framework for the consistent assessment of impacts across all environmental parameters, there is still an important role for professional judgement and further objective assessment to play in moderating an impact's significance. Given that the criteria represent levels on a continuum or continuous gradation, professional judgement and awareness of the relative balance of importance between magnitude and sensitivity / value is required.

Features to which legal designations apply have automatically been determined to be of high value (or of a higher value than non-designated features), and any impact tends to be of a greater significance than an impact of features to which no designation applies. Hence, for designated features, the use of the value criteria leads to an initial presumption that impacts will be of a high significance. Information on sensitivity can then be used to modify or maintain this initial assessment.

Table 7.3 Impact Significance Assessment

Magnitude[1]	Value/sensitivity of receptor[2]			
	Very Low	Low	Medium	High
No Change	Negligible	Negligible	Negligible	Minor
Negligible	Negligible	Minor	Minor	Moderate
Slight	Minor	Minor	Moderate	Major
Moderate	Minor	Moderate	Major	Major
Substantial	Moderate	Major	Major	Major

Note 1 Refer to Table 7.2
Note 2 Refer to Table 7.1

Given the use of professional judgement in the assessment process, there may be some variation between subject areas (i.e. different environmental parameters) in the significance rating process. This may be as a result of limited information on the sensitivity of features and / or the complexity of interactions that require assessment in determining the magnitude of change. However, the ratings derived through the impact assessment process, as set out in Table 7.3 can also be described in a generic fashion as given in Table 7.4. The following definitions are proposed in relation to the significance of environmental impacts predicted throughout this EIAR.

Table 7.4 Impact Significance Definitions

Level of Significance	Description
Negligible	No discernible effect. An impact that is likely to have imperceptible or insignificant impact.
Minor	Slight, very short or highly localised impact of no significant consequence. These effects may be raised as local issues but on their own are unlikely to be of importance in the decision-making process. When combined with other effects these could have a more material influence.
Moderate	Intermediate limited (extent / duration / magnitude) impact that may be considered as significant. These effects are likely to be important considerations at a local level. These could have influence on decision making especially when combined with other similar effects.
Major	Very large or considerable impact (extent/duration/magnitude). Effects, both adverse and beneficial, which are likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or, could result in exceedance of statutory objectives and / or breaches of legislation. In isolation, these could have a material influence on the decision-making process.

IMPACT MITIGATION MEASURES

In accordance with Part 10 of the 2001 EIA Regulations, as amended, this Chapter of the EIAR includes a description of mitigation measures envisaged to prevent, remove and reduce the significant adverse effects from the development. Following the implementation of mitigation measures the identified impacts may be reduced to environmentally acceptable levels (or not).

It is best practice to consider mitigation measures for all impacts that are of a minor negative significance (i.e. slight, very short or highly localised impact of no significant consequence) or higher and this has been adopted for the purpose of this assessment.

The purpose of mitigation is to reduce the significance of the residual impact (see below) to a minor adverse or negligible level, which is a level that is expected to be acceptable by local authority, environmental regulators, and the public. Individual impacts assessed as being of minor adverse or negligible significance have not automatically been considered to require mitigation. However, where appropriate, and taking into account

views and comments received through consultation, consideration has been given to the implementation of mitigation measures designed to reduce minor adverse impacts to a negligible level.

- Mitigation measures can be incorporated at various stages in the proposed development. The preferred hierarchy of mitigation is as follows:
- Prevention: At the design stage: avoid, relocate, modify the design and / or do not process with the development;
- Reduction: introduce design modification or additional structures (e.g. screens), reduce size and scale of development etc.; and,
- Compensation or remediation: compensation to provide like-for-like replacement for any lost environmental elements. When adverse impacts are unavoidable, it may also be possible to limit the duration of an impact by undertaking remedial works. For example, the impact on the landscape of mineral extraction is largely unavoidable, but the land can be progressively restored following the completion of extraction to complement or enhance the character of the landscape.

7.2.4 Legislation and Guidance

Key legislation that is relevant to this Chapter on water is listed below:

- S.I. No. 349 of 1989, European Communities (Environmental Impact Assessment) Regulations, and subsequent amendments (S.I. No. 84 of 1994, S.I. No. 352 of 1998, S.I. No. 93 of 1999, S.I. No. 450 of 2000 and S.I. No. 538 of 2001);
- S.I. No. 473 of 2011, European Union (Environmental Impact Assessment and Habitats) Regulations 2011;
- S.I. No. 584 of 2011, European Union (Environmental Impact Assessment and Habitats) (No. 2) Regulations 2011;
- The Planning and Development Acts, 2000 to 2009, The Planning and Development (Amendment) Act 2010, S.I. 600 of 2001 Planning and Development Regulations and subsequent amendments including, S.I. No. 364 of 2005 and S.I. 685 of 2006;
- S.I. No. 9 of 2010 European Communities Environmental Objectives (Groundwater) Regulations 2010 and amendments (S.I. 389 of 2011 and S.I. 149 of 2012);
- S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations 2009 and amendment (S.I. 327 of 2012);
- S.I. No. 684 of 2007 Waste Water Discharge (Authorisation) Regulations, 2007, as amended (S.I 231 of 2010);
- S.I. No. 278 of 2007 European Communities (Drinking Water) (No.2) Regulations. Water Services Acts 2007 and 2012;

- S.I. No. 722 of 2003 European Communities (Water Policy) Regulations;
- S.I. No. 122 of 2010 European Communities (Assessment and Management of Flood Risks) Regulations 2010; and,
- S.I. No. 457 of 2008 European Communities (Environmental Liability) Regulations which bring into force the Environmental Liability Directive (2004/35/EC).

The following guidance is considered relevant:

- DoEHLG, 2010. Appropriate Assessment of Plans and Projects in Ireland - Guidance for Planning Authorities;
- Environmental Protection Agency, 2017. Guidelines on the information to be contained in Environmental Impact Statements (Draft);
- Environmental Protection Agency, 2015. Advice Notes on current practice (in the preparation of Environmental Impact Statements) (Draft);
- Environmental Protection Agency, 2011. Guidance on the Authorisation of Discharges to Groundwater;
- European Communities 2001. Assessment of plans and projects significantly affecting Natura 2000 sites - Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC;
- European Communities, 2000. Managing Natura 2000 Sites;
- Institute of Geologists of Ireland, 2002. Geology in Environmental Impact Statements, A Guide;
- National Roads Authority, 2008. Environmental Impact Assessment of National Road Schemes – A Practical Guide, and;
- National Roads Authority, 2008. Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

A hydrogeological risk assessment of the development proposal was carried out as part of the receiving environment. This assessment has been undertaken in line with the Source – Pathway – Receptor Model and is further detailed in Section 7.6.3.

7.2.5 Field Work

JBA Consulting completed a site investigation comprising of two trial pits in February 2018 as part of Flood Risk Assessment and Stormwater Design works (Ref. Appendix 7.1 and 7.2). The trial pit logs have been provided at Appendix 6.2, and the information collected during the site investigation has been discussed in relevant sections of this report. Further field survey works was carried out by GDG in 2019 as part of the

hydrogeological risk assessment works. A summary record of the walkover survey element of the GDG hydrogeological risk assessment is presented below (Plate 7.1-

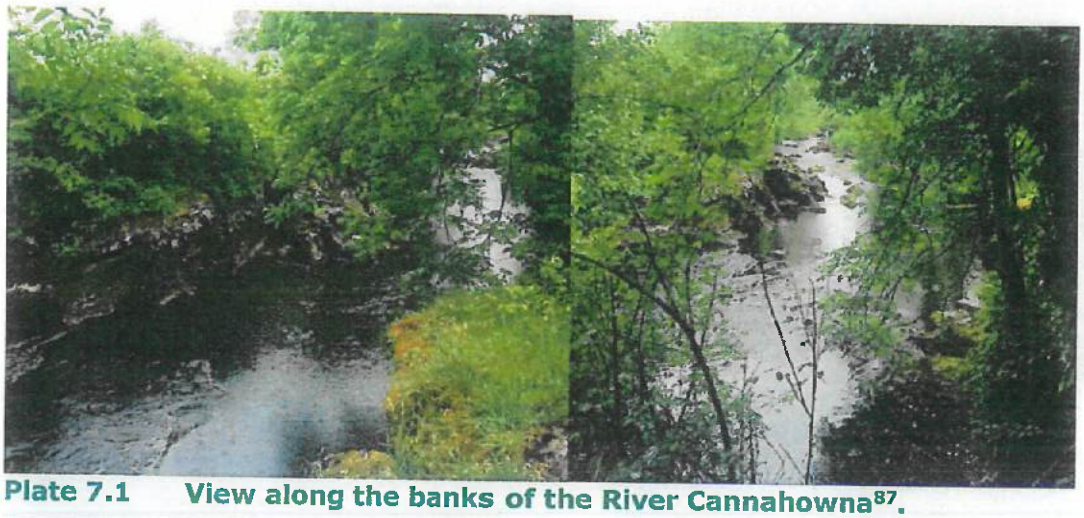


Plate 7.1 View along the banks of the River Cannahowna[87].

Plate 7.2 View of Access track constructed around the perimeter of the site[88]

[87] *Evidence of karst bedrock along the banks of the River Cannahowna adjacent to the eastern boundary of the site.*

[88] *Access track constructed around the perimeter of the site in circa 2000. The track is observed to be below the relative level of the site in the north eastern corner of the site with a small embankment along the track side.*

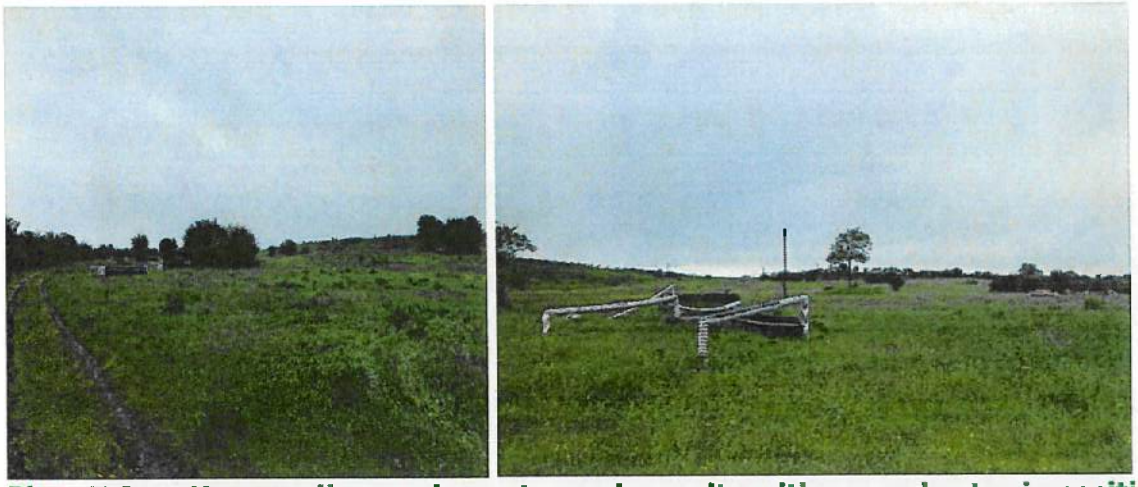


Plate 7.3 Horse gallop equipment remain on site with several gates in position around the site.

Plate 7.4 Telephone pole on site[89]

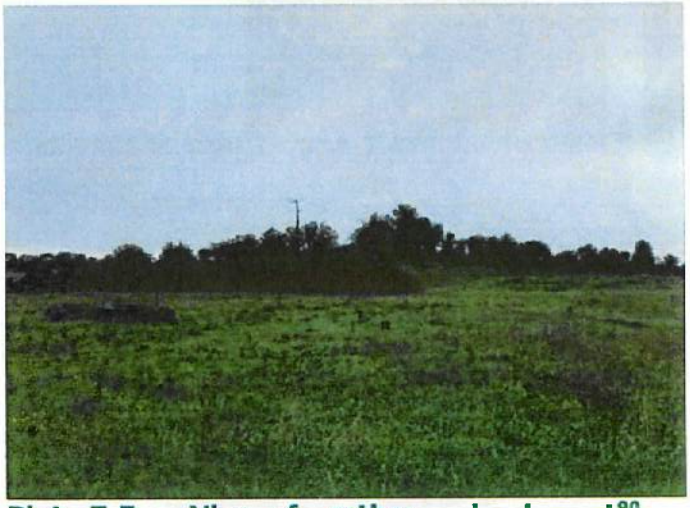


Plate 7.5 View of norther embankment[90]

[89] Telephone poles, one along the western boundary and a second in the south central portion of the site near the tree growing on top of a small man made mound. These poles are assumed to have been installed after the site had been developed and they give an indication of the overall height of the western embankment.

[90] The top of the northern embankment is observed to be defined by a significant growth of vegetation. This embankment is thought to be the point of interest as a County Geological Site discussed in the Hydrogeological Risk Assessment.

Plate 7.6 The southern boundary of the site[91]

Plate 7.7 The eastern boundary of the site[91]

7.3 Description of the Receiving Environment

7.3.1 Introduction

The proposed site is under development for the construction of a biogas facility. The 10.1 hectare site includes an entrance area and roadway from the N18/R458. Figure 7.1 shows the location of the proposed site. The site is situated on the outskirts of the urban centre of Gort town, approximately 1 kilometre north of the town centre. The eastern boundary

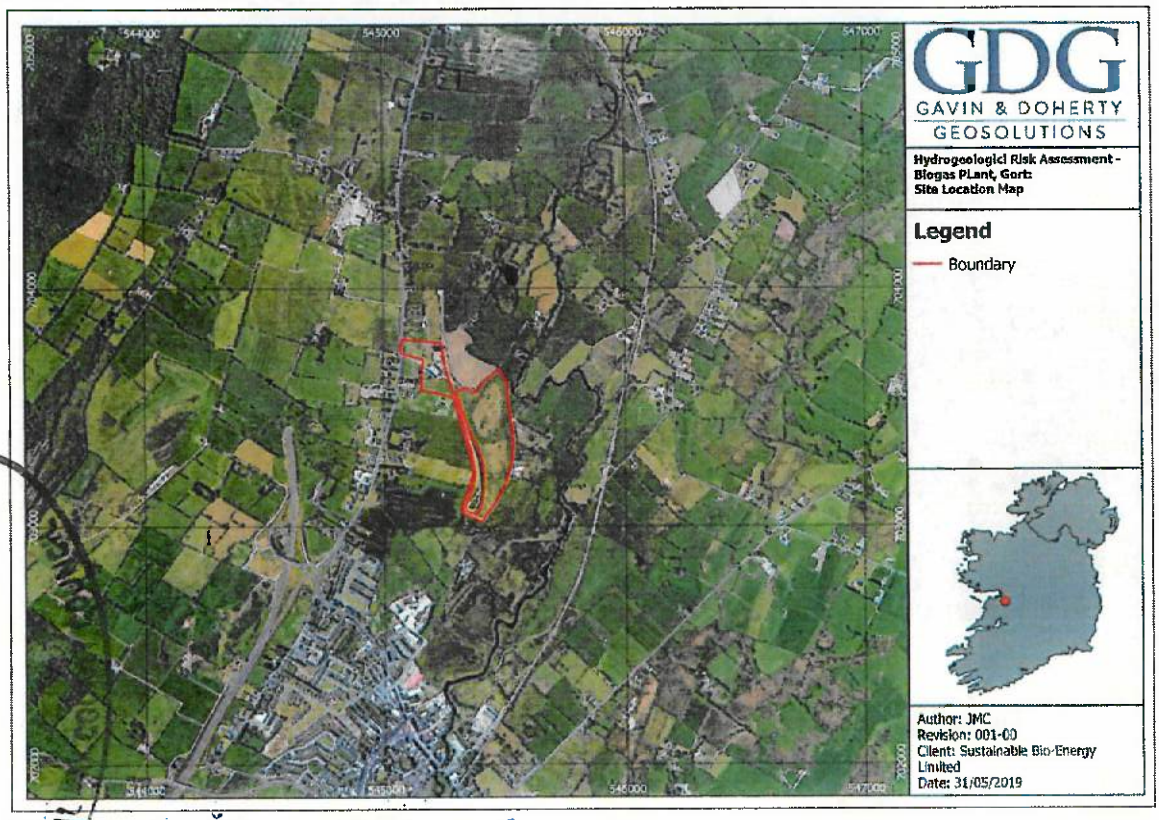
[91] *The southern and eastern boundaries of the site, unlike the western and northern boundaries, are open and not defined by embankments. Several small mounds with vegetation growth are observed sporadically across the site.*

of the site is defined by the Kinincha road, this road separates the site from the Cannahowna River and low land agricultural land, which has historically been prone to flooding. The northern, western and southern boundaries of the site are all bounded by agricultural land. A portion of the site extends further west to facilitate a roadway and entrance to the N18/R458.

7.3.2 Historical Land Use

Review of historical aerial imagery and mapping indicates that the site was historically used as agricultural land. Extensive landscaping of the site was undertaken in circa 2000 to lower sections of the site for development as a horse gallop. The site has since been predominantly utilised for equine purposes.

Figure 7.1 Site Location



7.3.3 Development Proposal

The site is currently being evaluated for the construction of a biogas facility. It is proposed that given the nature of the site and the proposed construction, the main element of the biogas plant will be constructed within a fully bunded area of the site. The site is currently enclosed on the western and northern boundaries by embankments which are a result of the development and lowering of the site in 2000 this leaves the eastern side topographically open. It is therefore proposed to construct a similar embankment down

the eastern boundary of the site. This will enclose development on all three sides, just leaving a space of approximately 60 metres open for the entrance driveway to the South. The current proposed construction also includes detail to lower the existing ground level of part of the site. Overall the proposed construction will include;

- Main site entrance;
- Weighbridge;
- Office and control room building;
- Feedstock reception building;
- Odour control unit;
- Process drainage, stormwater drainage and foul drainage;
- Digesters and storage tanks;
- Pump houses;
- Gas upgrading compression equipment /building;
- Gas flare and gas booster station;
- CHP and boiler house;
- Lighting fencing and security gates.

A more detailed description of the proposed development is provided in Chapter 2 of this EIAR.

7.3.4 Protected Areas

The area surrounding the development site contains numerous protected areas. Figure 7.2 below provides a spatial distribution of Special Protection Areas (SPA) and Special Areas of Conservation (SAC) sites. A 5km radius buffer has been included. In Table 7.5, all protected sites that contain area within 5km radius of the site are detailed. Additionally, turlough environments out with the 5km buffer surrounding the site are included due to the sensitivity and widespread connectivity of the hydrogeological environment.

Figure 7.2 Protected Areas Surrounding Development Site

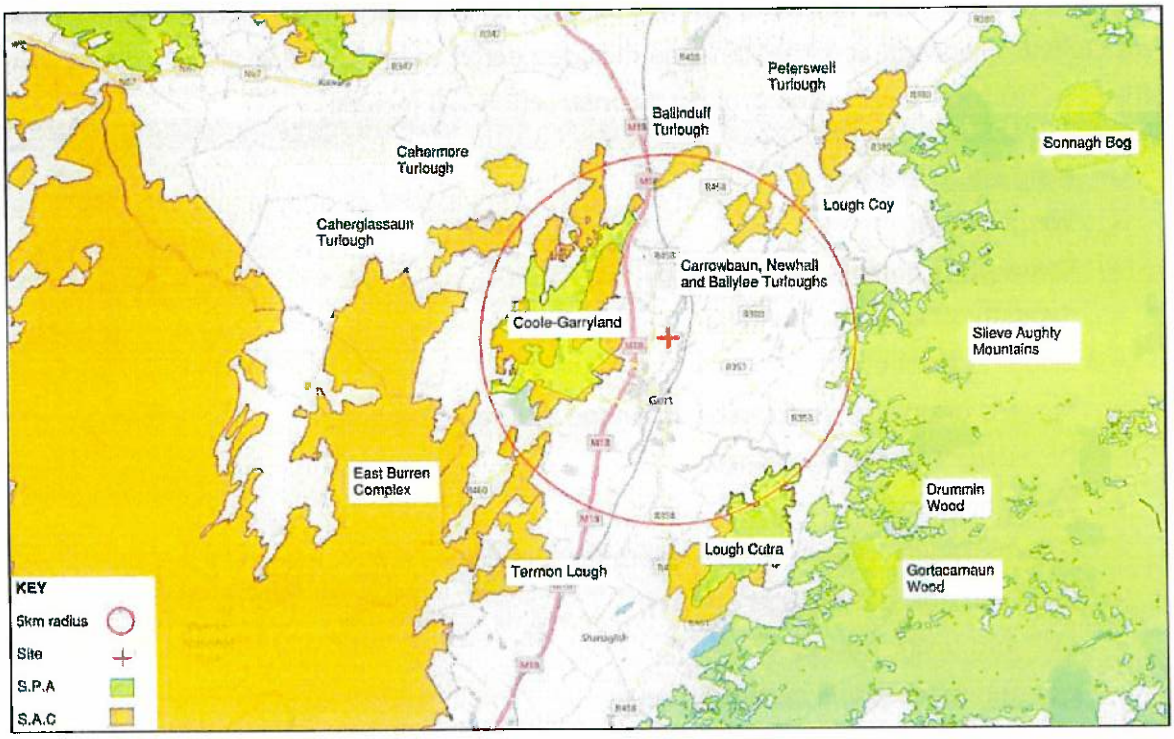


Table 7.5 Protected Environments

Name	Designation	Type	Reason for Protection
Coole Garryland	S.P.A	Birds	Whooper Swan
	S.A.C	Habitats	Natural Eutrophic Lakes, Turloughs Chenopodion rubri p.p. and Bidention p.p. Vegetation Juniper Scrub Orchid-rich Calcareous Grassland Limestone Pavement Yew Woodlands
Caherglassaun Turlough	S.A.C	Habitats	Turloughs Chenopodion rubri p.p. and Bidention p.p. vegetation Lesser Horseshoe Bat (Rhinolophus hipposideros)
Cahermore Turlough	S.A.C	Habitats	Turloughs
Ballinduff Turlough	S.A.C	Habitats	Turloughs
Carrowbaun, Newhall and Ballylee Turloughs	S.A.C	Habitats	Turloughs
Lough Coy	S.A.C	Habitats	Turloughs
Peterswell Turlough	S.A.C	Habitats	Turloughs Chenopodion rubri p.p. and Bidention p.p. vegetation
Slieve Aughty Mountains	S.P.A	Birds	Hen Harrier Merlin
Lough Cultra	S.P.A	Birds	Cormorant

	S.A.C	Habitats	Lesser Horseshoe Bat (Rhinolophus hipposideros
Termon Lough	S.A.C	Habitats	Turloughs
East Burren Complex	S.A.C	Habitats	Hard Water Lakes Turloughs Floating River Vegetation Alpine and Subalpine Heaths Juniper Scrub Calaminarian Grassland Orchid-rich Calcareous Grassland Lowland Hay Meadows Cladium Fens Petrifying Springs Alkaline Fens Limestone Pavement Caves Alluvial Forests Marsh Fritillary (Euphydryas aurinia) Lesser Horseshoe Bat (Rhinolophus hipposideros) Otter (Lutra lutra)

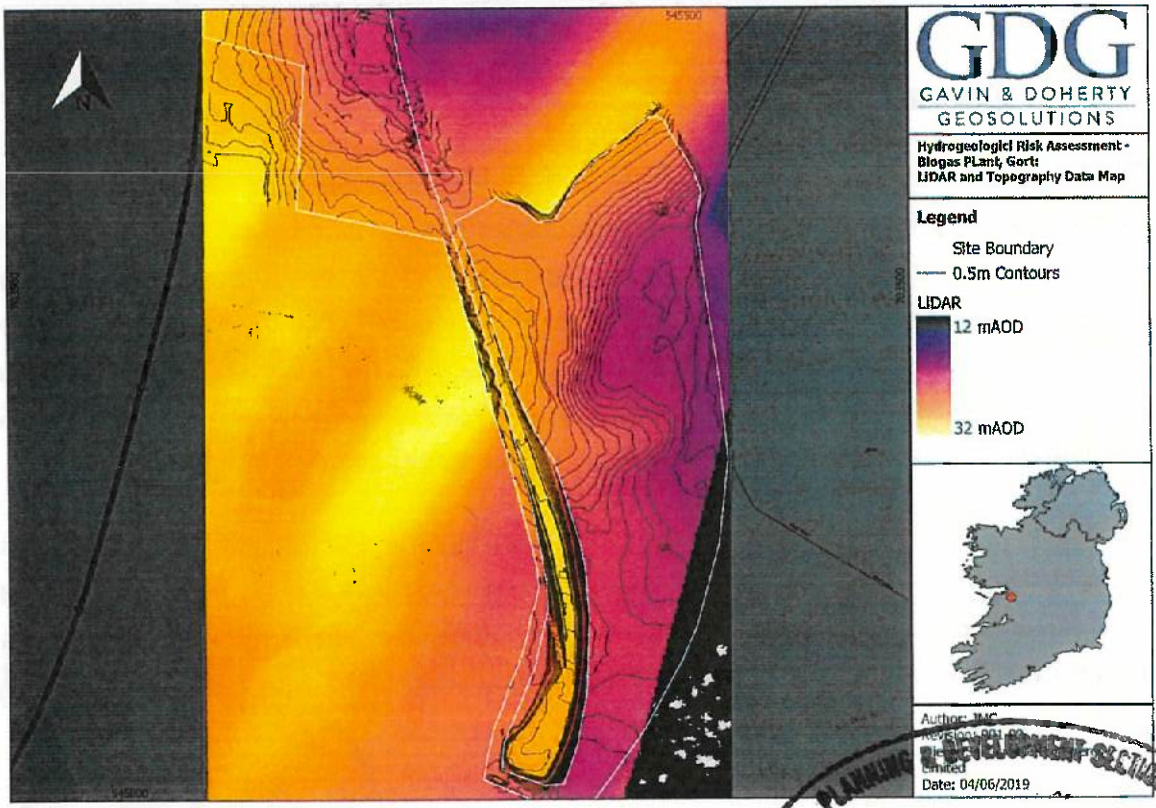
7.3.5 Topography

The topography associated with the site can be best described as gently undulating, gradually sloping from the north west to the south east. The site underwent extensive landscape works in 2000 which altered the topography of the site to its current state. A steep embankment is found along the western boundary. The northern boundary is defined by a smaller embankment topped with vegetation. The entire site is encompassed around the perimeter by an access track, this is considered to be a development feature associated with the construction of the horse gallop during 2000 (ref. Figure 7.3).

The topographical survey shows that elevation across the site ranges from 7.5mOD to 18.3mOD generally sloping from north west to south east (ref. Figure 7.4). The regional topography is dominated by large areas of low-lying ground between the hills of the East Burren Complex to the west and the Slieve Aughty Mountains to the east, this is colloquially referred to as the Gort Lowlands.

Figure 7.3 Embankments along the western (right) and northern (left) boundaries of the site.

Figure 7.4 Site Topography and LiDAR

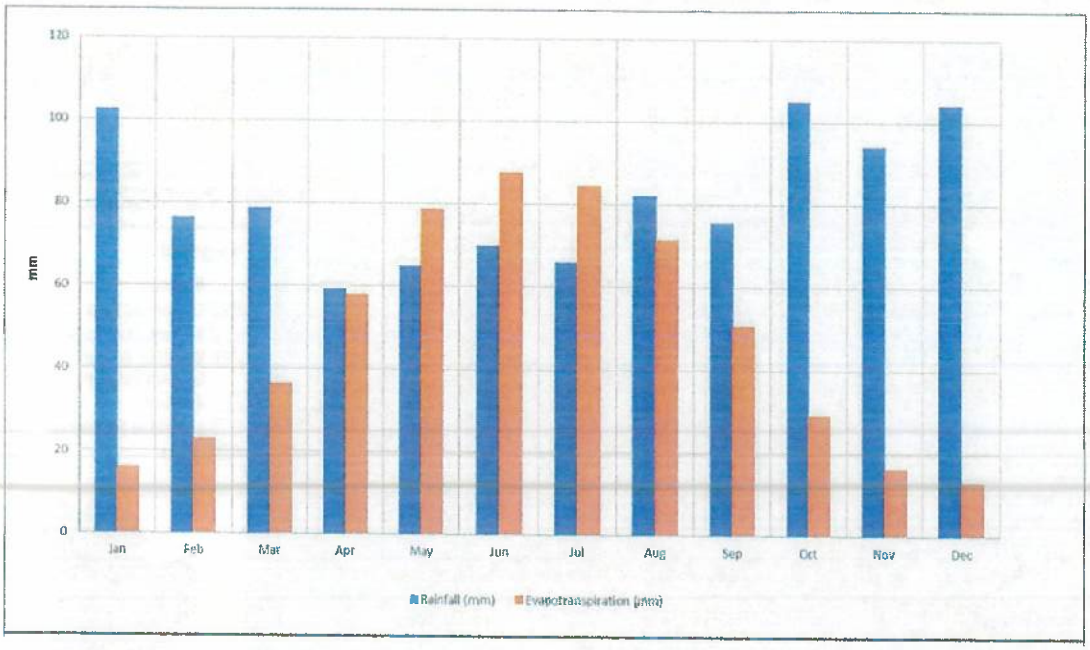


7.3.6 Rainfall and Evapotranspiration

The MET Eireann 'past weather monthly data' (https://www.met.ie/climate/monthly-data.asp) was consulted. Available 30-year average data indicates that mean annual

rainfall is expected to be in the region of 977.6mm/yr and annual potential evapotranspiration is expected to be in the region of 562.6mm/yr. This data reviewed was collected from the nearest meteorological station located at Shannon Airport, 40km south of the site. Monthly averages are presented graphically on Figure 7.5.

Figure 7.5 Average Monthly Precipitation and Potential Evapotranspiration



Geological Survey Ireland (GSI) online mapping indicates that effective rainfall at the site is 719mm/yr. The recharge co-efficient in the north of the site, where till is present above bedrock, is calculated as 60% resulting in recharge of 431mm/yr. The recharge co-efficient in the south of the site is 85%, where bedrock is at or close to the surface, resulting in recharge of 611mm/yr.

7.4 Geology

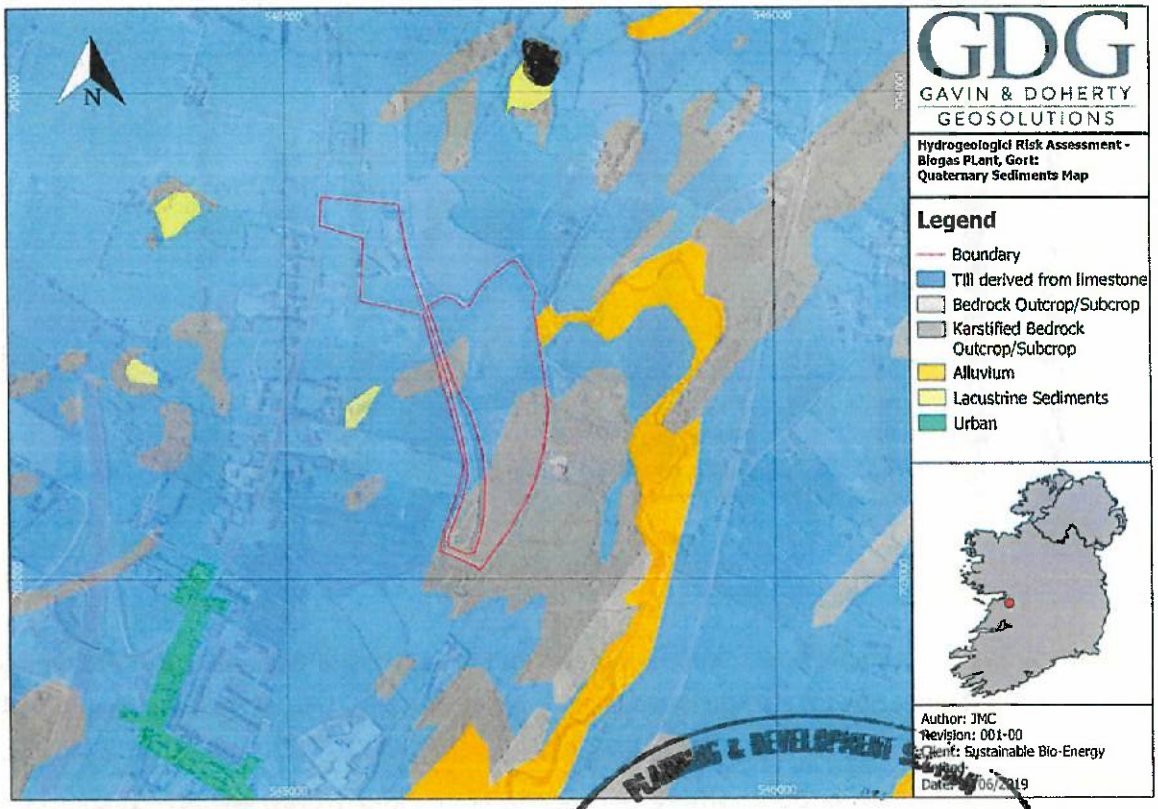
7.4.1 Quaternary Deposits

The Geological Survey of Ireland's '*The Quaternary geology of Ireland – Sediments Map*' is a representation of the superficial geology of Ireland at a scale of 1 to 50,000. The map shows the sediments mapped within 1 metre of the surface which were laid down during the Quaternary period as well as bedrock at or close to the surface, water bodies and made ground. The mapped sediments underlying the site are shown in Figure 7.6. The site is observed to consist of two mapped units;

- Till Derived from Limestone, and
- Karstified Bedrock Outcrop or Subcrop.

Two trial pits were excavated within the site bounds in 2018 (See Table 7.11 for Logs). Logs of these trial pits show the strata encountered within these shallow excavations are consistent with the quaternary sediments map with sandy soils and the presence of large boulders over limestone bedrock reported.

Figure 7.6 Quaternary Geology Map



7.4.2 Bedrock Geology

The bedrock geology underlying the site is mapped on the GSI 1:100,000 bedrock formations map. This data shows that the bedrock geology underlying the proposed site is predominantly mapped as the Tubber Formation with minor sections mapped as the Newtown Member, as seen in Figure 7.7.

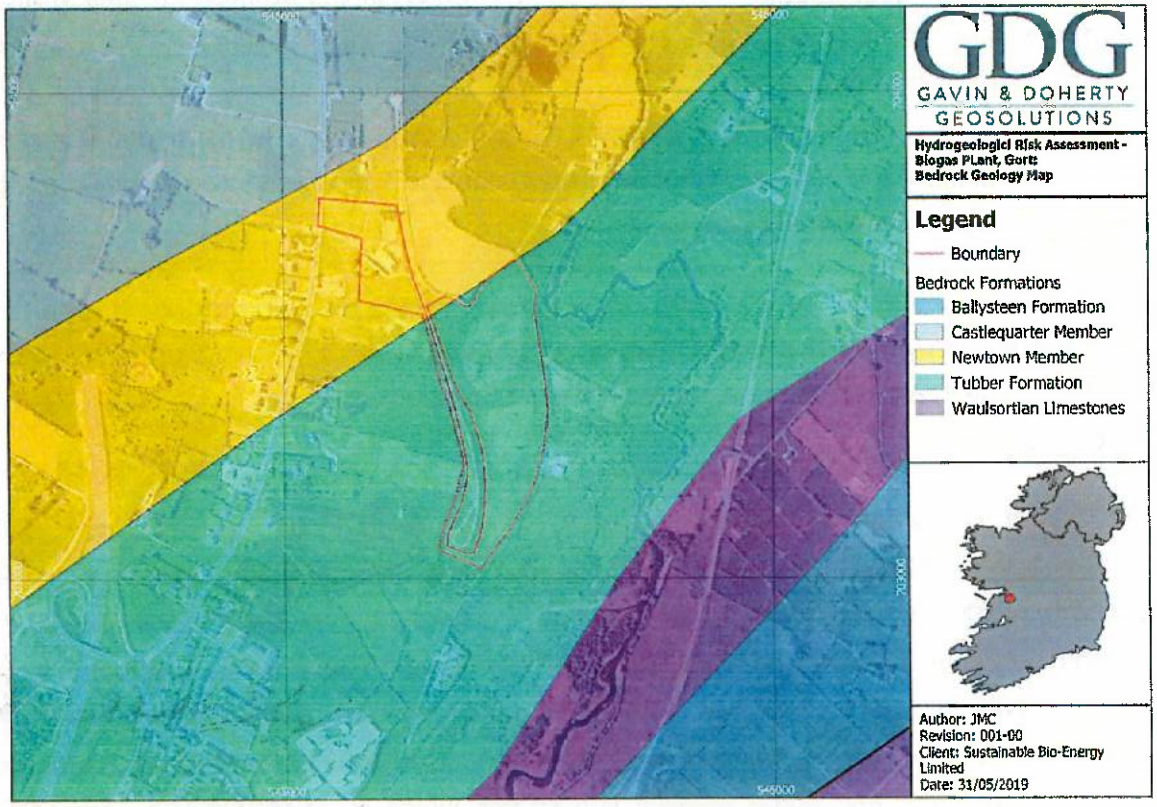
The Tubber Formation (C. MacDermot unpublished; Gallagher 1996) comprises the stratigraphical interval above the Waulsortian Limestones up to the base of the Burren Formation in the Burren region of Counties Clare and Galway. The formation is characterised by crinoidal medium-grey packstone and wackestone and sometimes has fine-grained limestone with shaly partings. The basal part of the formation consists mostly of fine- to medium-grained, moderately well-sorted, skeletal and peloidal packstone and grainstone with some coarse-grained bioclastic grainstone intervals (*Pracht & Somerville*

2014). An example of this succession can be identified within the mineral exploration borehole PA-97-05 located approximately 4km north west of the proposed biogas facility. Variations in thickness of the Tubber Formation are attributable to drape over the irregular top of the underlying Waulsortian Limestones. The formation grades up into cleaner, less cherty limestones. The presence of dolomite usually distinguishes the formation from the Burren Formation. The Tubber Formation ranges in age from latest Tournaisian to late Viséan (Chadian to Asbian substages).

The northern section of the site, with current development plans indicating an entrance and road way down to the biogas facility, is shown to be underlain by the Newtown Member. The Newtown Member is one of the differentiated strata that makes up the Tubber Formation.

The Tubber Formation is a geological sequence containing three member strata; The Castlequarter Member, The Newtown Member and The Fiddaun Member. The Castlequarter Member is described as a Light grey to medium grey shelf limestone, mainly calcarenites, with fasciculate lithostrotionids. This member is topped by a dolomite bed. The Newtown Member is described as a cherty limestone observed to have an average thickness of approximately 25 meters. The Fiddaun Member is described as a medium grey clean bioclstic and some peloidal llimestones which is dolomitised in part. The depositional setting of the formation occurred in a moderately shallow-water shelf, below fairweather wave-base but above storm wave-base. The presence of coarser-grained limestones with intraclasts and rounded bioclasts implies higher energy depositional conditions (*Pracht & Somerville 2014).* The Tubber Formation has been observed to have a maximum thickness of approximately 300m.

Figure 7.7 Bedrock Geology Map



7.4.3 Regional Karst

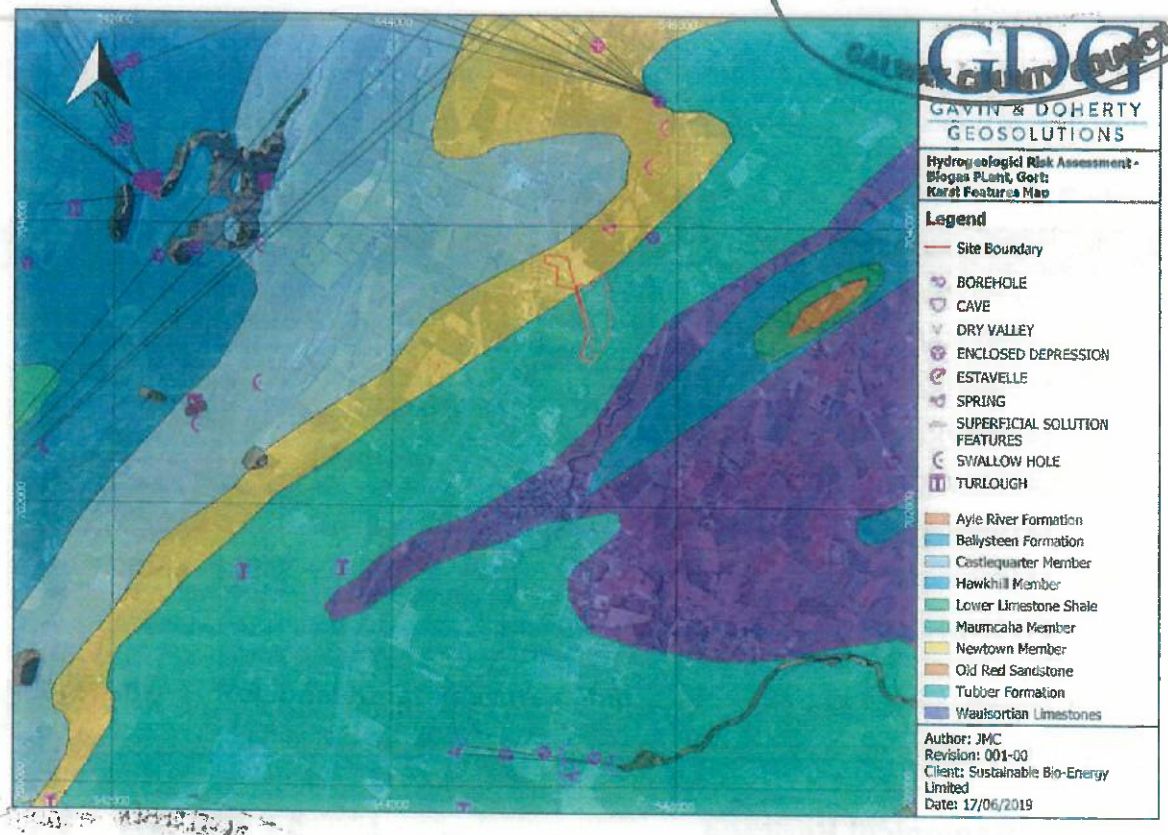
Karst landscapes develop through the process of karstification, this occurs primarily in soluble rocks such as limestone and dolomite. Karstification takes place due to calcite dissolution from meteoric water. As rain descends through the atmosphere it picks up additional CO_2 causing a chemical reaction within the soluble limestone, leading to the development of numerous surface and subsurface features.

The Geological Survey of Ireland's Groundwater Section maintain a karst feature database whereby identified karst features are mapped. This data-set also contains traced underground connection of subsurface conduits within the karst aquifers. Many of these features and several tracer line studies are present in close proximity to the proposed biogas facility site as seen in Figure 7.8. The dominated Karst features in proximity to the proposed site include;

- **Spring:** A spring is a natural point of discharge where the water table intersects with the surface topography. Spring flows can vary due to changing weather conditions, particularly rainfall levels.

- **Swallow Hole:** Swallow holes are in essence the antithesis of a spring, where a spring acts as a point of discharge a swallow hole is a point in which water can flow underground.
- **Estevelle:** When a karst feature enables both water infiltration and discharge it is referred to as an estevelle.
- **Turloughs:** A turlough is a seasonal lake, which forms and retreats due to varying water levels controlled by karst features such as the aforementioned spring and changing weather conditions (rainfall).
- **Enclosed Depression:** These are the most common karst features found. An example of an enclosed depression would be a doline (sinkhole). Dolines are formed through either dissolution in the underlying rock or by the collapse of overlying material into a cave system.
- **Cave:** Underground cavern that is produced by karstification processes.

Figure 7.8 Regional Karst Features Map



Due to chemical and mechanical formation of karst features, they are less likely to develop in an impure limestone, limestone which has a degree of siliciclastic sediment mixed in, than they are within a pure limestone. This is evident in Figure 7.9 where most of the karst features are found within the Burren and Tubber Formations and their associated members while there are few mapped within the less pure Waulsortian Limestones.

Figure 7.9 Karst Bedrock observed along the banks of the Cannahowna River. (During Site Walk over 29/05/2019).

A desktop review of aerial photography combined with the site walk over identified potential unmapped karst features adjacent to the site associated with the Cannahowna River. The erratic flow path of the river in combination with the extensive exposed Karst limestone along its banks indicates the potential for unmapped swallow holes and ground water linkages to deeper conduits along the river bed.

Table 7.6 Mapped Karst Features Within 2.5km of the Site

ID	Feature Type	Proximity to Site (km)
1419NWK095	Spring	0.62 NNE
1419NWK098	Swallow Hole	1.43 NNE
1419NWK015	Enclosed Depression	0.67 NE
1419NWK014	Enclosed Depression	1.55 NNE
1419NWK096	Swallow Hole	1.49 NNE
1419NWK011	Cave	2.49 SE
1419NWK057	Swallow Hole	2.4 WSW
1419NWK056	Swallow Hole	2.32 WNW

Ground investigation undertaken as part of the N17/N18 Gort to [illegible] identified two additional karst features not currently included in the GSI karst database.

7.4.4 Geological Heritage

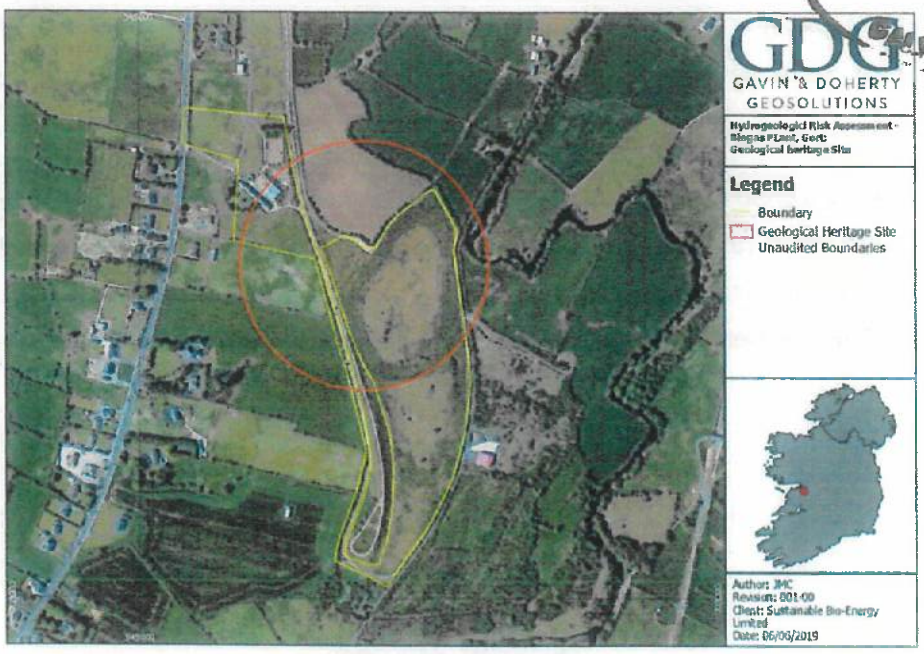
The Geological Survey of Ireland in conjunction with the Geoparks Network and GSNI have undertaken the programme "Geoheritage" dedicated to the protection and promotion of regions and features of geological importance throughout the country. The sites are identified as County Geological Sites for inclusion in County Development and Heritage

Plans. Site audits are carried out in partnership with the Heritage Council with the most significant County Geological Sites being recommended for promotion to a Natural Heritage Area.

A site of geological interest has been identified on the proposed site. The area of interest as a geological heritage site consists of peloidal limestones from the Tubber Formation. The county audit for Galway is currently underway to review identified County Geological Sites and produce a County Geological Site Report, this audit will also accurately define the boundaries of these sites. Currently (June, 2019) the County Geological Site within the bounds of the proposed development site has not undergone an audit and so a 200m buffer has been mapped around the area of interest in the absence of a more defined boundary, this is shown in Figure 7.10.

The Geological Survey have been contacted in regards to this site and they have advised that a review of potential heritage sites in Galway is currently underway and that it is currently unknown whether or not the identified site will remain as a heritage site. Head of Geological Heritage at the GSI has advised that development of sites adjacent to County Geological Heritage sites rarely causes a direct conflict of interest, especially in the case of sites identified as quarries, where any further excavation can be an advantage providing additional information for GSI, or an agreement can be made to preserve a representative face of the quarry.

Figure 7.10 County Geological Heritage Site Map



7.5 Hydrology & Hydrogeology

The hydrogeology and hydrology of the site is highly influenced by the underlying karst landscape in which it lies. The bedrock geology underlying the site shows extensive evidence of karstification (See Section 7.5.4 for more details). Figure 7.9 shows that the mapped geological bedrock units of the Tubber Formation and the Newtown Member which underlie the site are both classified as a regionally important karstified bedrock aquifer. An aquifer is defined as a subsurface layer of geological strata which allows either a significant flow of groundwater or the abstraction of significant quantities of groundwater. There are two types of recognised karst aquifer;

- those dominated by diffuse flow (Rkd), and
- those dominated by conduit flow (Rkc).

This aquifer has been designated as a regionally important karstified bedrock aquifer that is dominated by conduit flow (Rkc) therefore, there is a significant possibility of groundwater flow through subsurface conduits underlying the site.

The Geological Survey of Ireland have produced Groundwater Body (GWB) characterisation reports. These are based on the Water Framework Directive (WFD) which defines groundwater bodies as specific management units. These groundwater bodies are subdivisions of large geographical areas of aquifers so that they can be effectively managed in order to protect the groundwater and linked surface waters. The GWB descriptions were developed by Geological Survey Ireland and are based on a set of conceptual models that were developed to fit the range of hydrogeological settings in Ireland.

The site overlies the Kinvara/Gort GWB which occupies the area between Gort, Kinvara and Ardrahan. It is bounded to the west by the coastline along Kinvara. The eastern boundary is with the poor aquifer lithologies shown in Figure 7.11 which are delineated as the Derrybrien GWB. The northern and southern boundaries are surface water divides.

Figure 7.11 Bedrock Aquifer Map

The conceptual model for the Kinvara/Gort GWB indicates;

- A large number of karst features occur, including turloughs, caves, dolines, swallow holes and springs.
- The GWB is composed primarily of high transmissivity karstified limestone (Rkc). Transmissivity and well yields are variable.
- Groundwater flow is trimodal: (1) flow via the epikarst (1-10m depth). (2) flow via solutionally enlarged conduits and cave systems, up to 40 m below ground. (3) flow via smaller fractures and joints linked to the main conduit systems.
- Rapid groundwater flow velocities have been recorded through groundwater tracing.
- Recharge occurs via losing streams, point and diffuse mechanisms.
- In general, the degree of interconnection in karstic systems is high and they support regional scale flow systems. Flow paths are up to 10 kilometres in length.
- Surface water catchments are often bypassed by groundwater flowing beneath surface water channels and across surface water catchment divides. Discharge of groundwater from the Burren uplands is considered to discharge to Kinvara.

- Some areas are of extreme vulnerability due to the thin nature of the subsoil, as well as the frequency of karst features, allowing point recharge. Storativity is low and the potential for contaminant attenuation in such aquifers is limited.
- Kinvara Springs are the main outlet for the entire Kinvara-Gort Lowlands and the western uplands of Slieve Aughty. Rivers draining the Slieve Aughty uplands sink on reaching the limestone. Most of the groundwater that sinks focuses on the Coole Lough area, and from there water flows entirely underground in a northwesterly direction via a major cave system, discharging to a group of large springs located in the intertidal zone at Kinvara.
- There is a high degree of interaction between surface water and groundwater. In the eastern area water frequently sinks and rises before being transmitted underground mostly to Kinvara.
- The groundwater has a calcium bicarbonate signature. The water is saline up to several kilometres inland.

The Kinvara/Gort GWB characterisation report highlights the significant interconnectivity between surface water and groundwater in this area. The surface water features in close proximity to the site are limited to;

- The Cannahowna river which meanders erratically north south adjacent to the eastern boundary of the site;
- Ballynamantan Lough 360m north of the site and
- A small unnamed ponding of groundwater approximately 150m west of the site.

The Cannahowna River is heavily influence by the karstic landscape through which it runs. The river source is located at the north outlet of Lough Cultra as the Beagh River. The river flows in a westward direction for 3km. At the 'devils' punchbowl', the river sinks into a subterranean river, continuing to flow underground in a northwest direction for 1.4km. The river then re-emerges into the Cannahowna River and flows in a northerly direction through Gort town for 5km before again sinking into a subterranean river. From this point, the river flows in a north westerly direction, flowing both over ground and underground at different sections of the Kilchreest River before discharging into Coole Lough. Waters from Coole Lough drain via a series of turloughs and underground pathways, into Corranroe Bay (South of Kinvara), approximately 10km northwest of the site. This discharge of the river water into shellfish areas has resulted in additional controls to water quality standards. The River is also classified under Article 7 of the Water Framework Directive as 'water used for the abstraction of drinking water'.

The EPA has developed a 5-point system for the classification of river ecology ratings, where 1 is poor and 5 is excellent. National surveys of Irish rivers have taken place approximately every three or four years since 1971. There are three sample point locations between Lough Cultra and Coole Lough. Since the surveys began, the Cannahowna River at Old Mill monitoring point, located 300m east of the site has maintained a rating between 3-5No. The last survey was carried out on the river during 2015, during which it was awarded the rating of 4No. Detailed description of data is presented at Table 7.7.

Table 7.7 Surface Water Monitoring Points

Biological Quality Rating (Q Value)											
Location	Year										
	80	85	89	94	97	00	03	06	09	12	15
Cannahowna River @ Old mill, N. Gort	3-4	4	3	3-4	4-5	4	4	4	3	4	4
Cannahowna River @ Gort Bridge	5	4	4	4	-	4	4	4	4	-	4
Beagh River 1.5 km d/s Lough Cutra	-	-	4-5	4-5	4	4	4	4	4-5	4	3-4

Under the Water Framework, surface water bodies are given a status during each 6No. year cycle. These ratings are based on the ecological and chemical quality of the water. For the 2010 – 2015 period, Cannahowna River was assigned good status and Beagh River was assigned moderate status.

A water sample was taken from the Cannahowna River on 7th November 2017 and sent for analysis at Exova Jones Environmental Laboratories (now Element). The results of analysis shown at Table 7.8, along with drinking water standards and surface water Environmental Quality Standards (EQS). The results demonstrate an exceedance of Ammoniacal Nitrogen against the Surface water EQS.

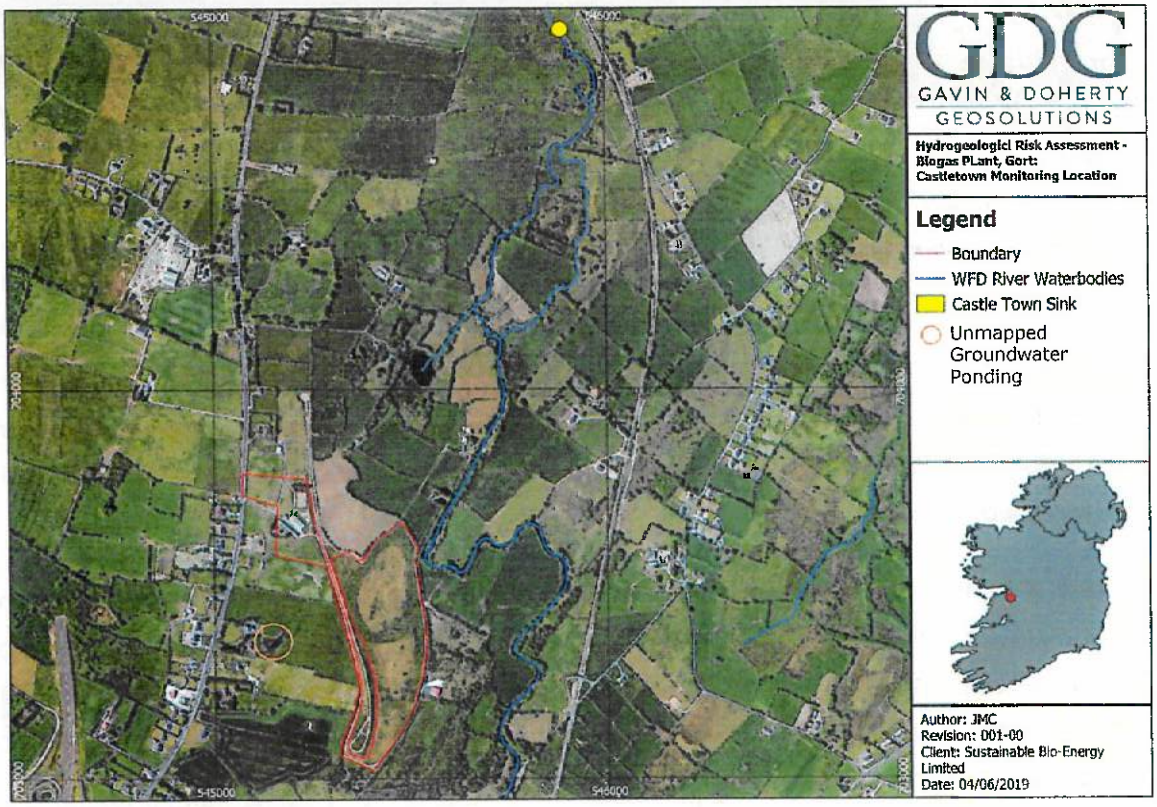
Table 7.8 Cannahowna River Sample Analysis

Parameter	Units	Value	Drinking Water Standards	EQS for Surface Water
Total Phosphorus	µg/l	48	-	-
Mineral Oil (C10-C40)	µg/l	<10	-	-
Sulphate (as SO4)	mg/l	<0.5	250	200
Chloride	mg/l	15.5	250	250
Nitrate (as NO3)	mg/l	1.5	50	50
Ammoniacal Nitrogen (as NH3)	mg/l	0.17	0.3 (Ammonium)	0.02
Total Alkalinity (as CaCO3)	mg/l	118	-	-
BOD (Settled)	mg/l	1	-	-
COD (Settled)	mg/l	49	-	-

Total Solids	mg/l	219	-	-
Total Suspended Solids	mg/l	<10	-	-

Exposed karst along the river banks observed during the site walk over and shown in Figure 7.7 indicate the river path is controlled by the bedrock formations. Approximately four kilometres north of the site, the Cannahowna river descends underground as it flows into Castletown Sink (Figure 7.12), from here the river has been traced to flow over 1km north west where it then emerges south of Kiltartan Church.

Figure 7.12 Surface Hydrology Map

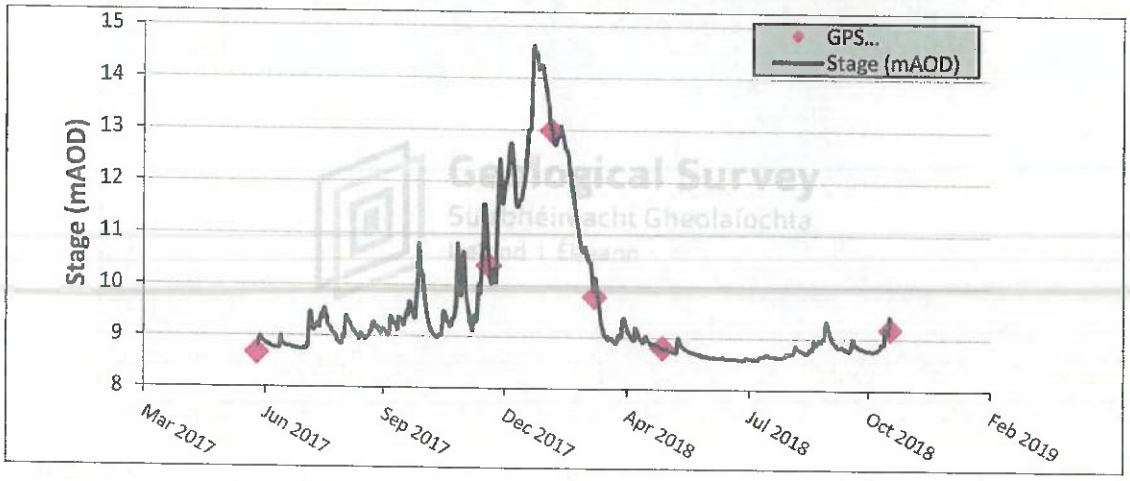


The Geological Survey of Ireland's karst database traced the sub surface connections of the Cannahowna river sinking at Castletown Sink. Nine subsurface traces from the sink to sampling locations have been confirmed, the furthest connection traced is to a cave in the townland of Carrowkilleen over 9.5km west where the connectivity to Castletown Sink was recorded at a rate of 100m/hr. This along with the exposed karstic bedrock along the river banks adjacent to the site indicates a high level of connectivity between surface water and groundwater in this area.

The Gort Lowlands have been subject to extensive hydrological and hydrogeological investigation over the past 30 years due primarily to this unique process of surface water and groundwater interaction as a result of the karstification of the limestone aquifer. Most recently the Geological Survey of Ireland in conjunction with Trinity College Dublin (TCD)

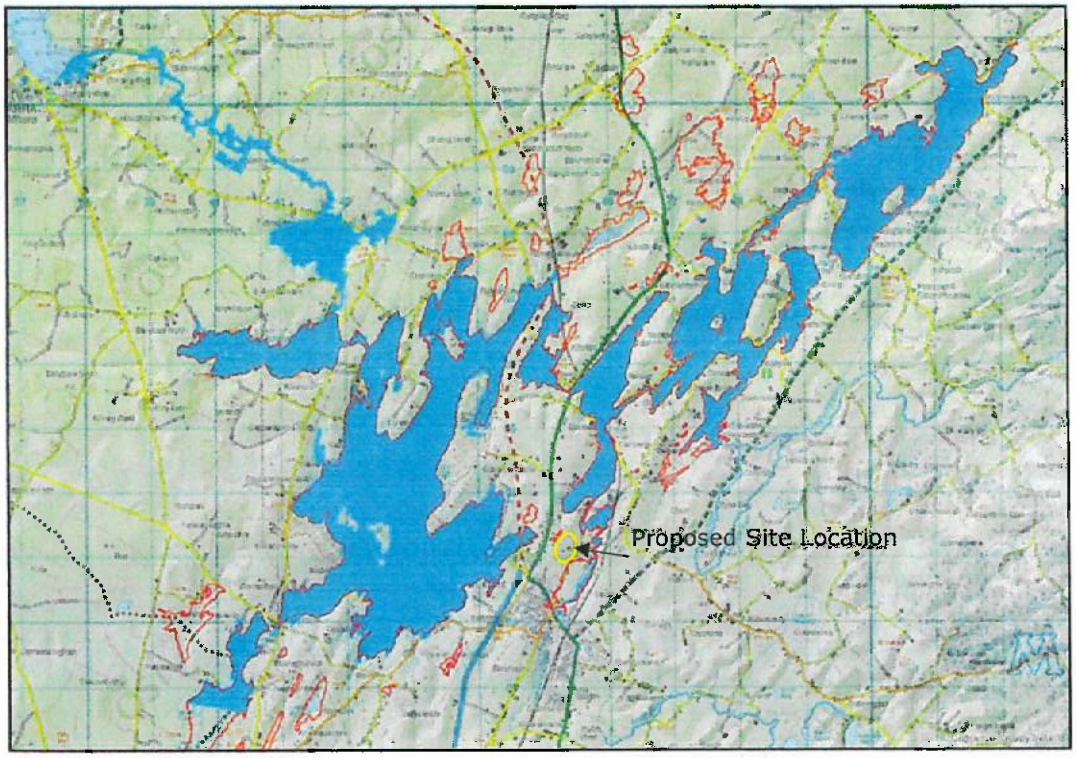
and the Office of Public Works (OPW), have developed the flood monitoring, mapping and modelling programme, GWFlood. GWFlood to date has focussed on collecting groundwater monitoring data to feed into groundwater models of the region which have been in development by TCD for over 10 years. The GSI have collected extensive amounts of groundwater monitoring data in the Gort Lowlands. One of the monitoring points for this programme is Castletown Sink. Figure 7.13 shows the water level variation at Castletown sink from June 2017 to November 2018. During this period the water level at the sink varied over 8 meters between 8.549 mAOD to 14.661 mAOD.

Figure 7.13 Water Level Monitoring Data for Castletown Sink



As part of the deliverables of the GWFlood programme a national historical flood map is being produced, this map is currently out for review by the Office of Public Works (OPW) and is not yet publicly available. Smaller scale maps produced specifically for the Gort Lowlands have however, been published and the most up to date publicly available modelled flood map is included in Figure 7.14.

Figure 7.14 Modelled flood extends (Blue) vs Surveyed Flood Extents (Red) (Morrissey et al, 2018)



This map shows the results of the modelled flood data (in blue) against surveyed historical flood levels (in red). The proposed development site is circled in yellow. Historical surveyed flood levels and the modelled flood levels in this region both show the site extent to be unaffected by regional flooding.

A detailed Flood risk assessment has been prepared for the site by JBA Consulting in February 2018 (Ref: 2017s7157) and updated in November 2019 (refer to Appendix 7.1). The report concludes that the site lies within Flood Zone C - Lowest probability of flooding; less than 0.1% from both rivers and coastal/tidal sources.

A review of historical aerial imagery and maps shows that the unnamed groundwater ponding observed 150 metres west of the site is persistent over time and is present in all available aerial imagery dating back to 1995 the surface water feature is also mapped on the historic 6-inch maps from 1837-1842. The persistent presence of water at this location and variation in water levels combined with the apparent absence of any inflow or out-flow of water indicates that this surface water feature is most likely a small groundwater fed ephemeral lake or Turlough.

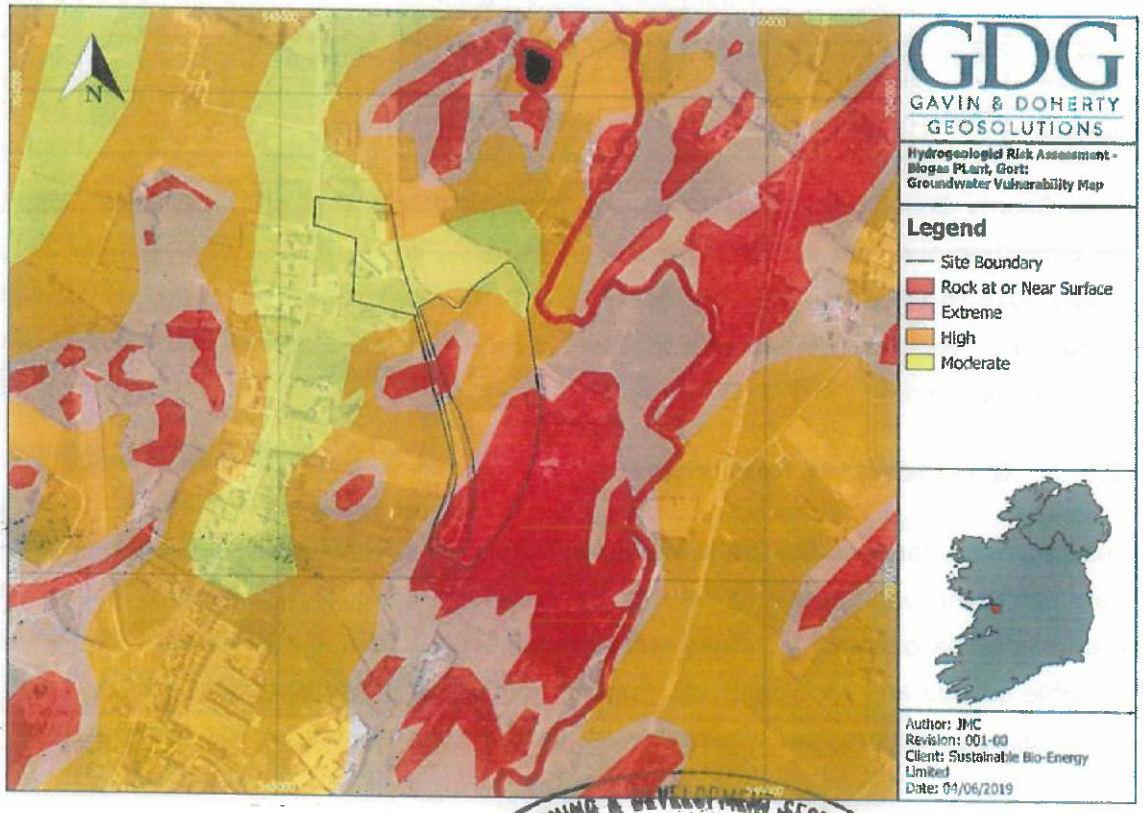
To the north of the site there are several other surface water features associated with the Cannahowna River. Ballynamantan Lough is a small water body approximately 360 meters

north of the site and is included as a mapped lake under the Water Framework Directive. This small Lough is fed by a karst ground water spring before flowing into the Cannahowna River.

Good data exists on the karstified nature of the region around the town of Gort. The significant karstification of the bedrock formations results in an intrinsic interconnectivity of surface water and groundwater in the area. Therefore, there can be little distinction between any adverse effects on the hydrogeological and hydrological environment. Groundwater Vulnerability:

The Geological Survey Ireland's groundwater vulnerability map dataset represents the geological and hydrogeological characteristics of a site that determine the ease of which potential pollutants or contaminants can enter the groundwater. The vulnerability category assigned to a site or an area is based on the relative ease with which infiltrating water and potential contaminants may reach groundwater in a vertical or sub-vertical direction. The vulnerability data is based upon several intrinsic geological and hydrogeological characteristics including depth to bedrock, bedrock lithology, soil and subsoil type as well as ground water recharge. Figure 7.15 shows the groundwater vulnerability associated with the site. All land area is assigned one of the following groundwater vulnerability categories: Rock near surface or karst (X) Extreme (E) High (H) Moderate (M) Low (L).

Figure 7.15 Groundwater Vulnerability Map



A review of the EPA map viewer has shown that the bedrock beneath the site is classified as a Regionally Important Karstified Bedrock Aquifer. Regionally important aquifers are capable of supplying regionally important abstractions, or excellent yields (>400m3/d). This aquifer covers the area where the bedrock geology is Dinantian Pure Bedded Limestones.

Approximately 240m south east of the site, the bedrock is classified as locally important which is moderately productive only in certain zones. This aquifer unit includes Dinantian Pure Unbedded Limestones, and Lower Dinantian Impure Limestones.

The groundwater quality status classification for 2010-2015 classified the groundwater beneath the site as "poor" due to the chemical quality of water. The annual averages for water quality reported in sampling from the groundwater body are presented in table 7.9. Ammonia and Ortho-phosphate are shown to exceed the indicative quality threshold in 2007 and 2010 respectively (highlighted in orange).

Table 7.9 Groundwater Chemical Status 2007 – 2015

Parameter	Unit	Indicative quality threshold	'07	'08	'09	'10	'11	'12	'13	'14	'15
Ammonia	mg/l	0.065	0.108	0.064	0.064	0.020	0.033	0.036	0.009	0.031	0.040
Chloride	mg/l	24	18.60	15.85	10.20	12.67	14.75	14.49	18.33	19.0	22.0
Conductivity (@ 25oC)	uS/cm	800	232	229	235	214	304	244	255	215	255
Nitrate	mg/l	37.5	2.19	1.40	1.69	2.56	1.5	1.19	1.98	1.71	2.38
Ortho-phosphate	mg/l	0.035	0.017	0.009	0.013	0.055	0.014	0.007	0.008	0.012	0.012

Galway County Council provided further groundwater quality from the Gort Water Supply River Extraction and Gort Public Water Supply Borehole for April 2009 to November 2015 and July 2016 to December 2017 respectively. Full water quality results are provided at Appendix 6.1. Results demonstrate that water quality is generally of good quality only occasionally exceeding the indicative quality threshold for ammonia in both locations.

7.5.1 Groundwater Recharge:

Groundwater recharge is the primary method by which water enters an aquifer. This occurs mainly through downward movement of surface water to groundwater. Both point and diffuse recharge occur. Diffuse recharge occurs via rainfall percolating through the permeable subsoil and rock outcrops. Point recharge occurs by means of swallow holes, collapse features/dolines, and where flow is concentrated in the epikarst. Streams flowing

off the non-limestone rocks sink on meeting the limestone, thus the majority of the swallow holes are located near the inland boundaries of the Kinvara/Gort GWB.

The groundwater recharge in a region depends mainly on the precipitation change during the major recharge season. Data acquired by the Geological Survey of Ireland shows the average recharge rate for the region in light green to be 431mm/yr with a recharge coefficient of 60%, this is shown in Figure 7.14. The hydrogeological setting has been described as having "moderate permeability subsoil, overlain by well-drained soil". While the darker regions have an average recharge rate of 611mm/yr with a recharge coefficient of 85%.

Figure 7.16 Groundwater Recharge Map

7.5.2 Ground Investigations

Two trial pits were excavated onsite in early 2018 and a geophysical survey was undertaken in May 2019. The following sections outline all available data at the proposed site and the adjacent area.

PREVIOUS GROUND INVESTIGATIONS

Quality borehole data in the region is limited. Within a 5km radius of the site there are 14 boreholes drilled that have encountered bedrock (see Figure 7.17). Table 7.10 below

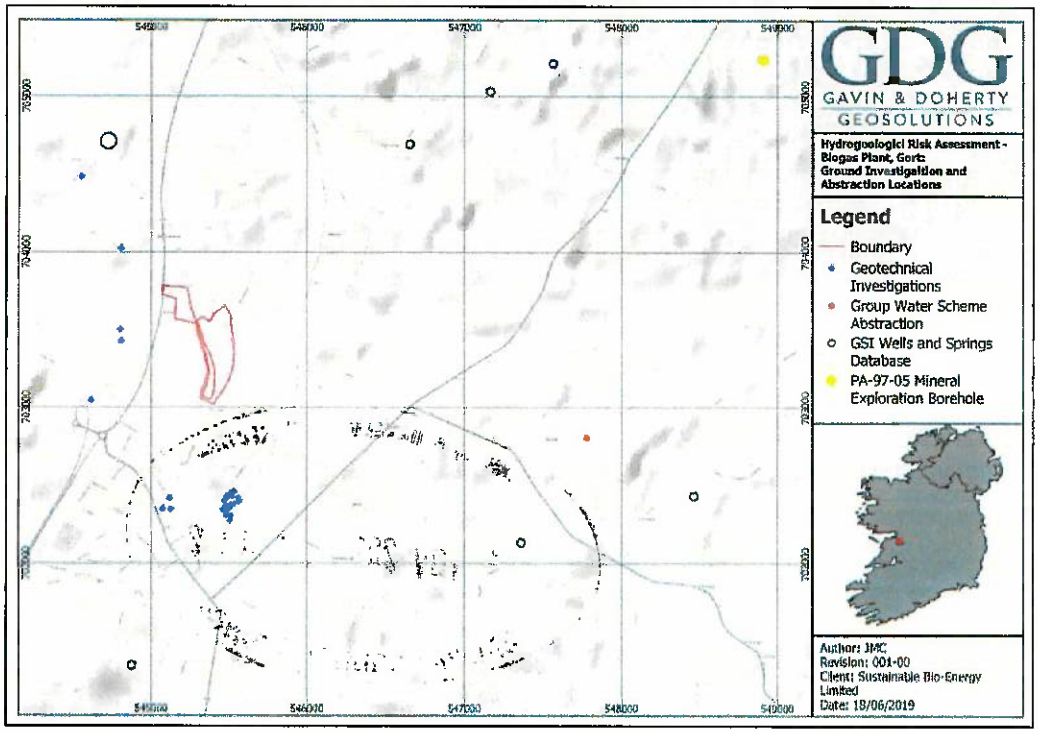
outlines the total depth of each of these boreholes, the depth at which each borehole encountered bedrock and the proximity of the boreholes to the site. In each case no detailed lithological description of bedrock was taken.

Table 7.10 Bedrock Boreholes

Borehole ID	Total Depth (m)	Depth to Bedrock (m)	Proximity to Site (km)
134627	7.8	3.5	0.575 SSE
134628	2.3	1.2	0.647 SSE
134629	8.7	7	0.696 SSE
112166	2.6	2.6	1.44 SW
111880	4.5	4.3	3.02 N
111929	10.3	8.95	3.04 N
111882	5.4	5.2	1.64 NNW
112509	15	9	2.96 NNW
111883	6.3	6	1.67 NNW
112513	8.3	4.1	2.2 NNW
112512	7	6	2.32 NNW
112511	10	6.81	2.54 NNW
111926	8.3	4.7	3.34 NNE

In 1997 BHP Billiton (now known as BHP Group) drilled a borehole to a depth of 19m, PA-97-05. The borehole is located approximately 4km NE of the site. Bedrock was encountered at a depth of 6m and consists of wavy bedded crinoidal calcarenites interbedded with fossiliferous shales. Occasional siliceous nodular developments were encountered at 16.75m with dips observed to be 25° - 30°.

Figure 7.17 Ground Investigation and Water Abstraction Locations



Two trial pits were excavated on site in February 2018 by JBA consulting. The subsurface strata encountered is summarised in Table 7.11.

Table 7.11 Trial Pit Log Summaries

Location	Depth (mbgl)	Description of Strata	Authors Interpretation	Water Table
Location 1 – Proposed Soakaway location	0.00-0.75	Topsoil – Dry, dark brown	Topsoil	Not Encountered
	0.75-2.50	Loose brown/grey sandy soil – Large boulder present	Till	Not Encountered
	2.50-3.00	Loose, moist grey sand – Large boulder present	Till	Not Encountered
Location 2 – Between proposed southern attenuation pond and bend in swale	0.00-0.30	Topsoil – Dry, dark brown	Topsoil	Not Encountered
	0.30-1.20	Sandy Clay – dry grey/brown	Till	Not Encountered
	1.20	Rock refusal	Tubber Formation	Not Encountered

7.5.3 Abstraction Borehole & Well Data

The underlying bedrock geology of the site is designated as a regionally important karstified bedrock aquifer that is dominated by conduit flow. Several groundwater abstraction have been identified from this bedrock aquifer and summaries of abstraction point data is provided in Table 7.12 and Table 7.13

Table 7.12 Galway County Council Abstraction Database

ID	Type	Abstraction (m^3/d)	Easting	Northing
Coole GWS	Groundwater Borehole	6.3m^3/day	144596	204596
Gort Public Supply	Groundwater Borehole	A portion of 260^3/day	145469	201409
Gort Public Supply	Groundwater Borehole	A portion of 260^3/day	145510	201507
Gort Public Supply	Groundwater Borehole	A portion of 260^3/day	145680	201596

Table 7.13 Groundwater, Springs and Wells

GSI ID	ID (Type)	Owner	Depth (m)	Coordinate		Use	Abstracion	Yield
				E	N			
1419NW W015	GY022(CoCo) [Borehole]	Gort Public Scheme	-	144910	201310	Public Supply	995m³/day	-
1419NW W007	GY128 (CoCo) GY011 (DOE)GAL 139(EPA) [Spring]	Ballyanen GORT GWS	-	146690	204660	Group Scheme	84m³/day	131m³/d
1419NW W005	GY261 (CoCo)GAL180(EPA) [Borehole]	COOLE GWS	73.1	144760	204680	Group Scheme	7m³/day	196m³/d
1419NW W008	GY486(CoCo)GY199(DOE)GAL238(EPA)	RAKERIN, ANNAGH GWS	36.6	148500	202400	Group Scheme	15m³/day	104m³/d
1419NWW010	GY230(CoCo)GAL170(EPA)	CLOONDINE GWS	44.8	147400	202100	Group Scheme	6.5m³/day	-
1419NWW012	GY128(CoCo)GAL139(EPA)GY011(DOE)	BALLYANEEN NORTH GWS	41.1	147200	205000	Group Scheme	-	16.35m³/day
1419NWW013	GY128(CoCo)GAL139(EPA)GY011(DOE)	BALLYANEEN EAST GWS	45.4	147600	205180	Group Scheme	-	16.36m³/day

7.5.4 Karst Evaluation

GEOPHYSICAL SURVEY RESULTS

A comprehensive geophysical survey of the site was undertaken to determine the extent of karstified bedrock below the site in order to better determine any risk to the hydrogeological environment. This section provides a summary of this survey. These survey works included;

- **Ground Conductivity** – this ground investigation method typically captures data form a range of 0-6 meter below ground level. Interpretation of soil type and shallow bedrock zones can be made.
- **Electrical Resistivity** Tomography – resistivity readings down to approximately 15 meters below ground level can be made in order to construct factual cross sections of bedrock profiles, bedrock variation as well as faults or fissure zones within the bedrock.
- **Seismic Refraction** - Seismic Velocity data can be used to interpret the weathering and degree of fracturing of the sub-surface bedrock. It can also give an indication as to the stiffness of the overburden deposits.

Data acquisition on site on the 29th of May 2019.

This full suite of data collection took place over three days. The location of the ground conductivity points, resistivity lines and seismic lines are shown in Figure 7.18.

Depth to bedrock across the site is observed to vary considerably. Figure 7.19 and Figure 7.20 show the depth to weathered limestone and the depth to competent limestone, respectively. The survey, Figure 7.21, shows a variability in the overburden above the weather limestone of 0 to 10 meters. The survey shows the depth to competent bedrock across the site to range between 0 and 14 meters below ground level. Resistivity and seismic cross section indicate that the weather bedrock layer seems to range in thickness of between 1 to 4 meters. This is illustrated in Figures 7.18 to 7.21

Figure 7.18 Geophysical Survey Location

Figure 7.19 Depth to Weathered Bedrock

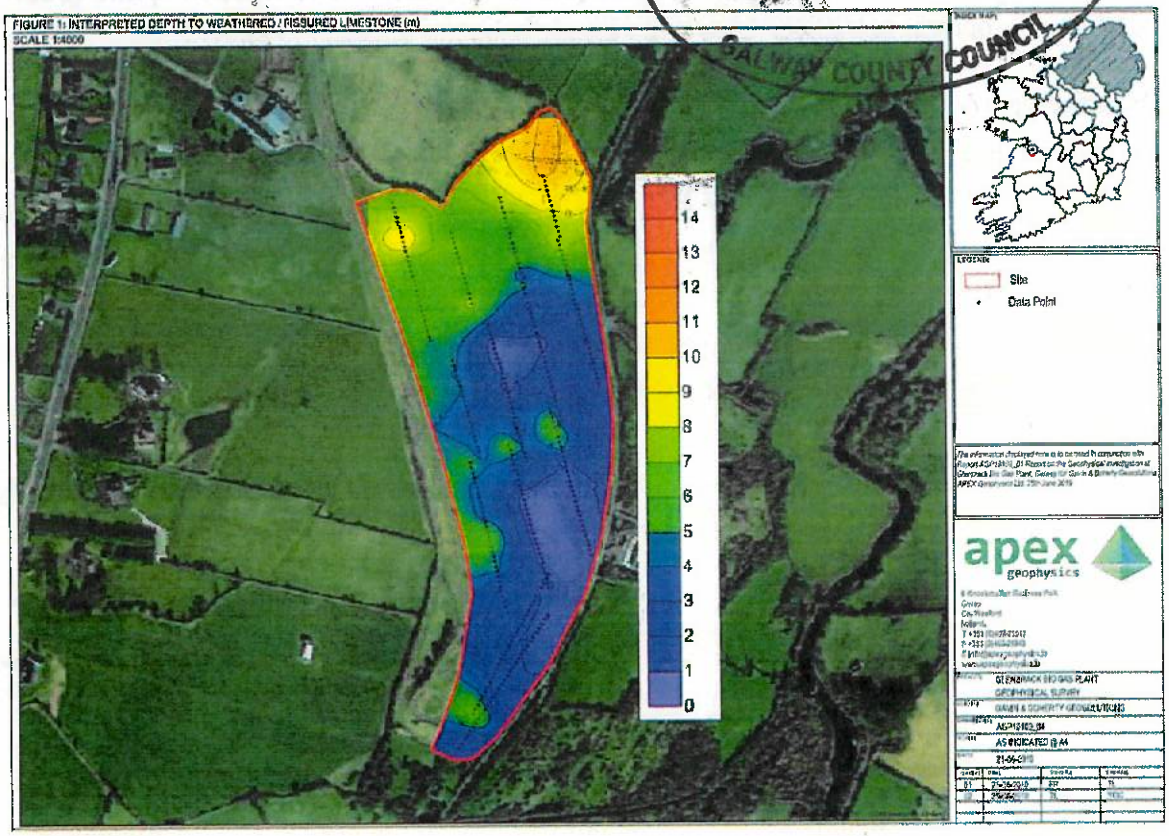


Figure 7.20 Depth to slightly weathered – Competent bedrock

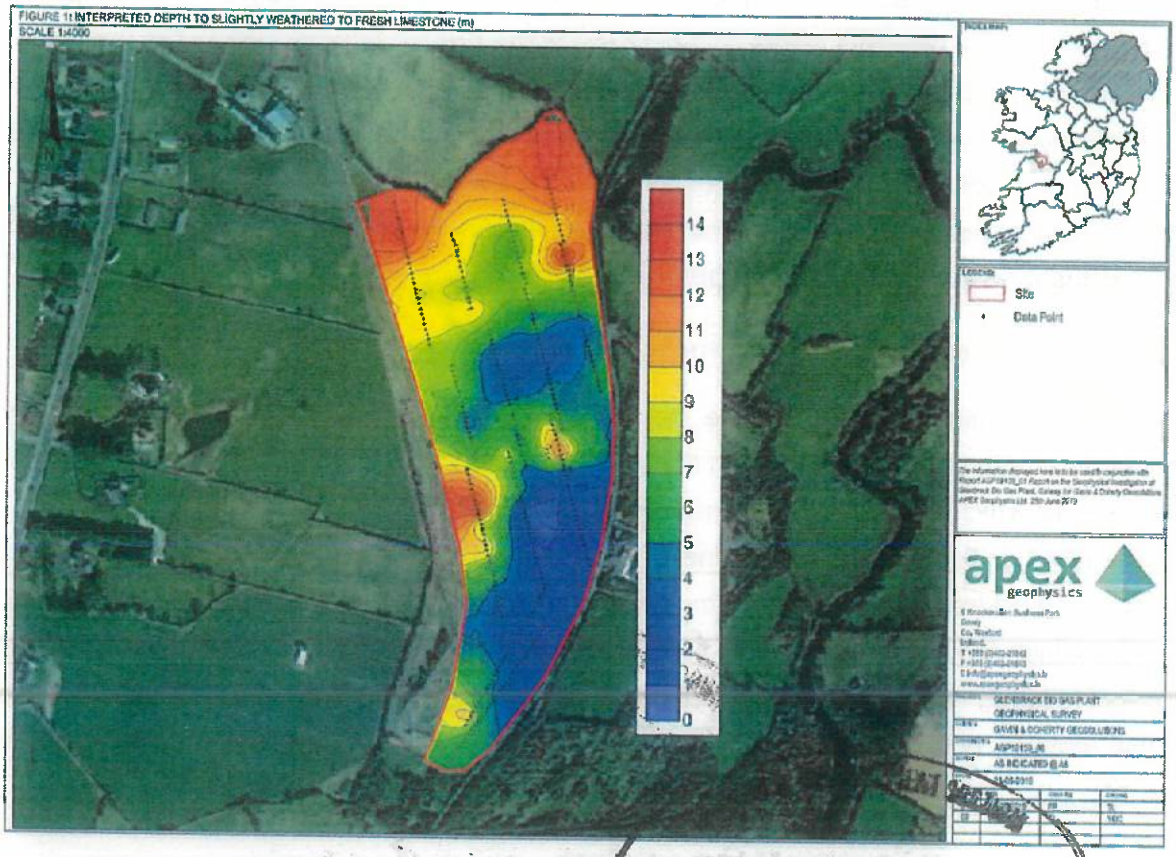
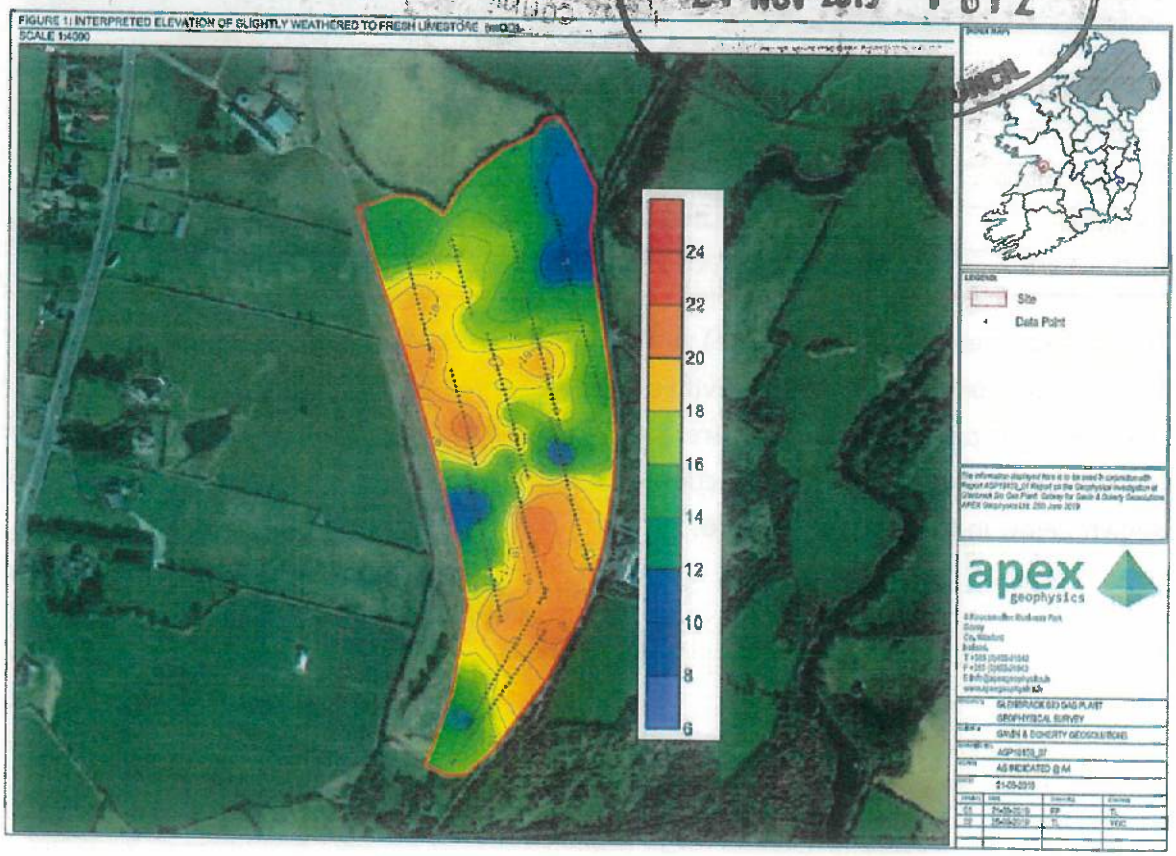


Figure 7.21 Bedrock Elevation Map



This significant variability in overburden thickness across a relatively small area can be attributed to the previous works on site to lower the ground level as well as the undulating nature of the bedrock beneath the site in part due the karstification processes. The interpreted elevation of competent bedrock can be seen in Figure 7.21. Geophysical cross sections R7, R9, R11, R12, and R13 all highlight the undulating and karstified nature of the bedrock beneath the site. The geophysical survey undertaken highlighted several karst features within the bedrock profile beneath the site.

SUMMARY OF GEOPHYSICAL FINDINGS

The most significant karst feature picked out by the survey is seen is the resistivity/ seismic profile section R6 shown in Figure 7.16. This section shows a vertical area of low resistivity which persists over 20 metres below ground level. This area is interpreted as weathered or fissured limestone and is likely to represent a significant fissure within the limestone bedrock. In general, any decrease in resistivity within limestone bedrock (in areas which are not interpreted as a change in lithology) may be interpreted as an area of possible karst. Irregular bedrock topography and lower than normal seismic velocities can also indicate possible karstic conditions. Resistivity interpretation is presented in Table 7.14.

Table 7.14 Resistivity Interpretation

Resistivity (Ohm-m)	Interpretation
150 - 250	Sandy Gravelly CLAY
250 - 500	Clayey SAND/GRAVEL
500 - 1275	Weathered / Fissured LIMESTONE
1275 - 10000	Slightly Weathered to fresh LIMESTONE
>10000	LIMESTONE with open fissures / voids
175 - 1275	DOLOMITE / Muddy LIMESTONE

High resistivities (>10,000 Ohm-m) within limestone bedrock are typically indicative of air filled fissures or voids. High resistivities were observed on ERT profiles across the central and southern parts of the site. Areas where karstified bedrock has been observed are highlighted in geophysical cross sections R6, R7, R10, R12, R13. These cross sections are shown below in Figures 7.22 – 7.26.

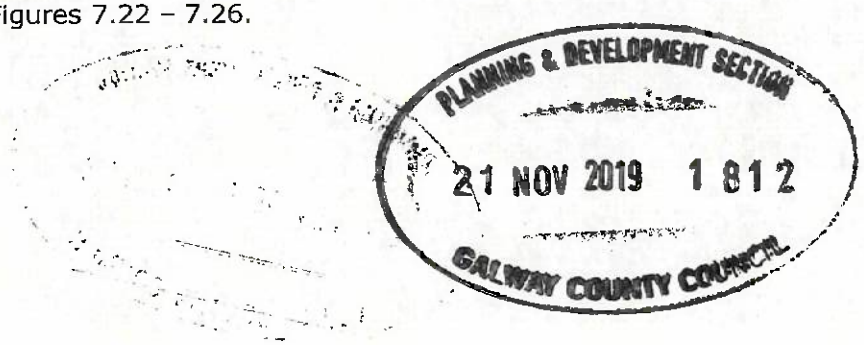


Figure 7.22 Cross Section R6 highlighting potential Karst fissure

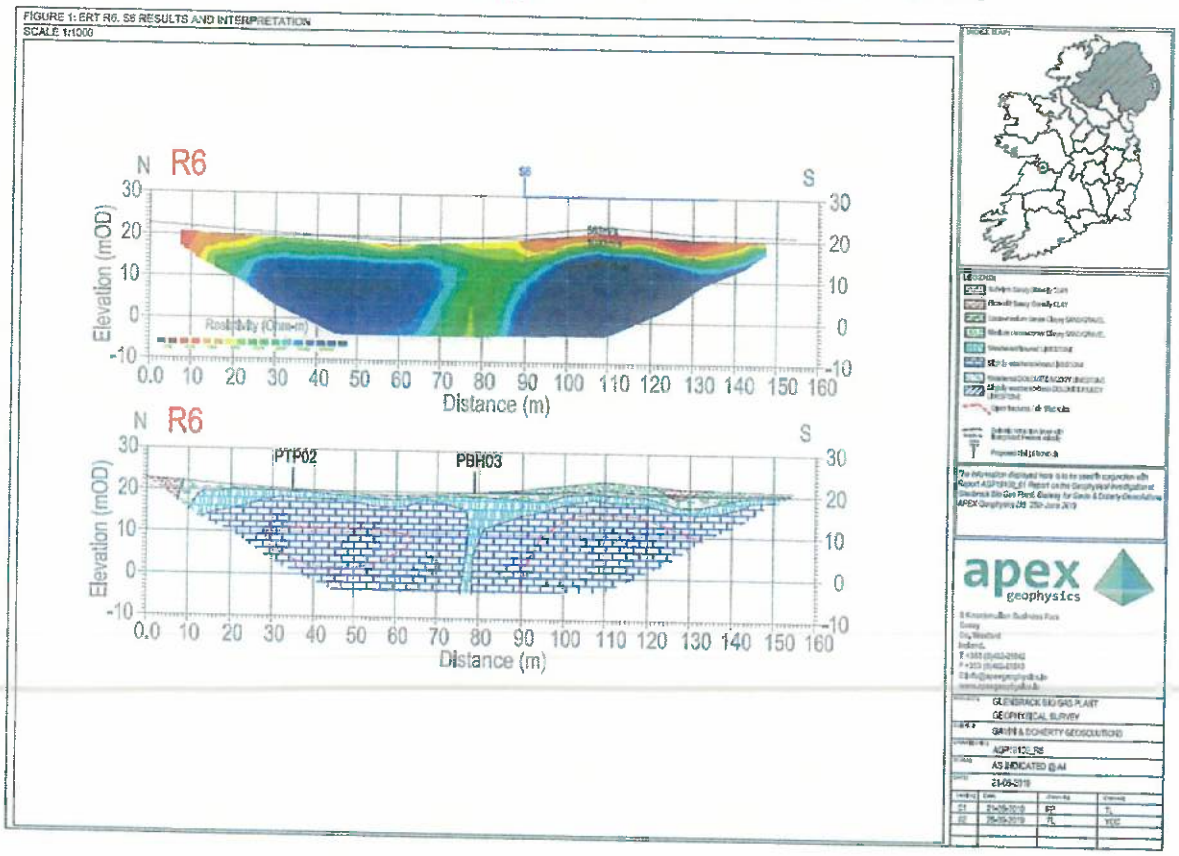


Figure 7.23 Cross Section R7 highlighting potential Karst fissure

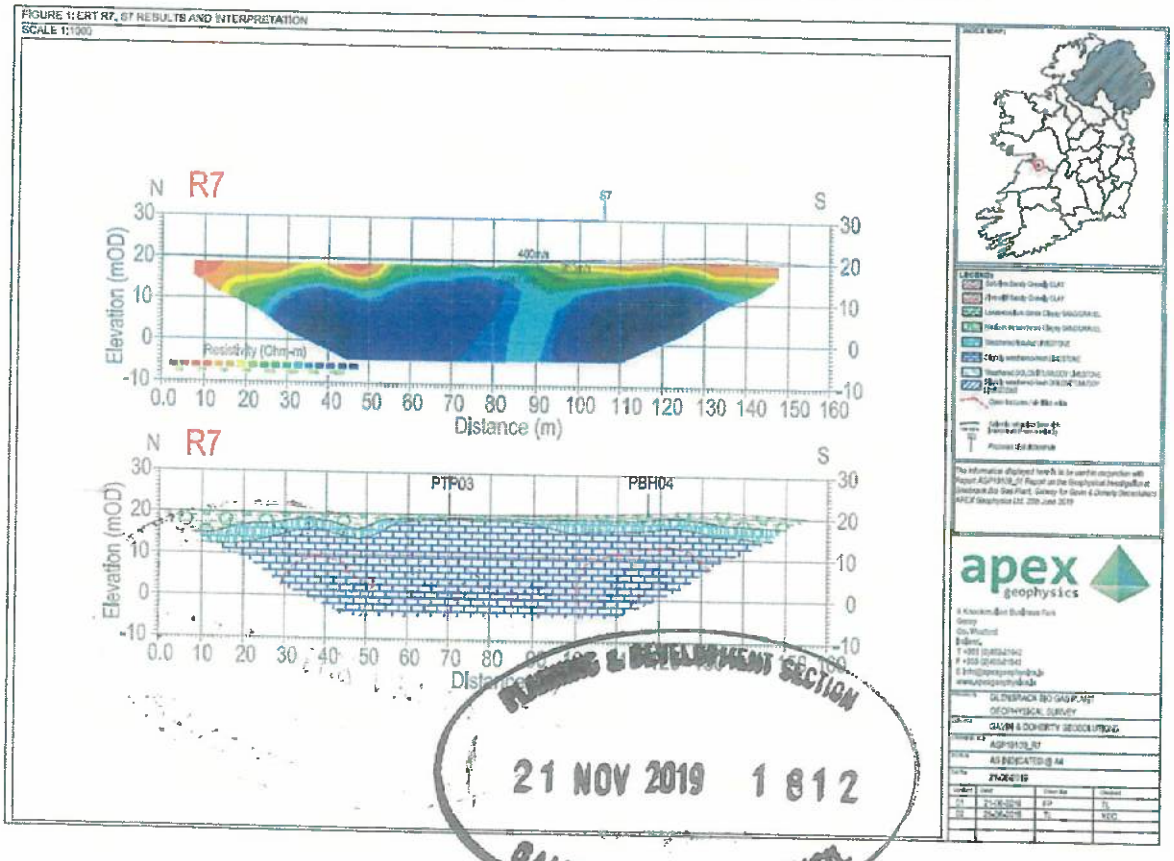


Figure 7.24 Cross Section R10 highlighting potential Karst fissure

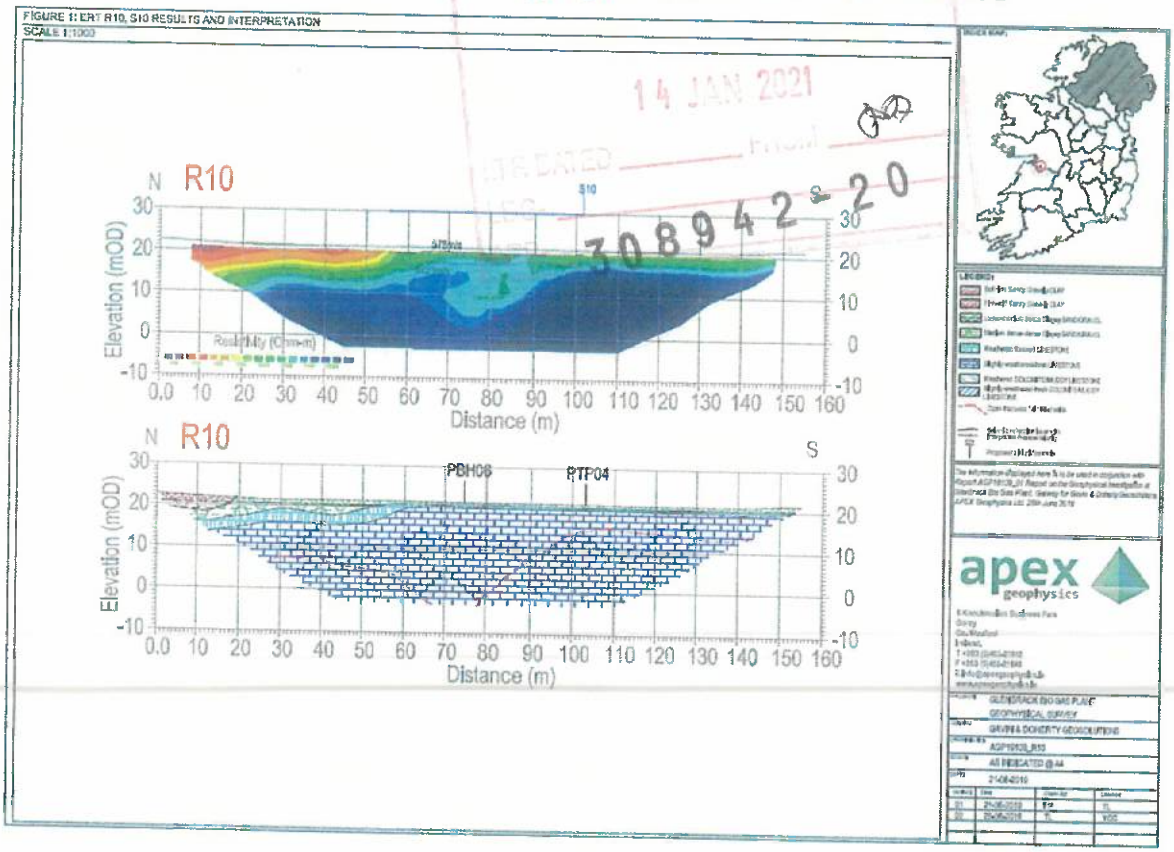


Figure 7.25 Cross Section R12 highlighting potential Karst fissure

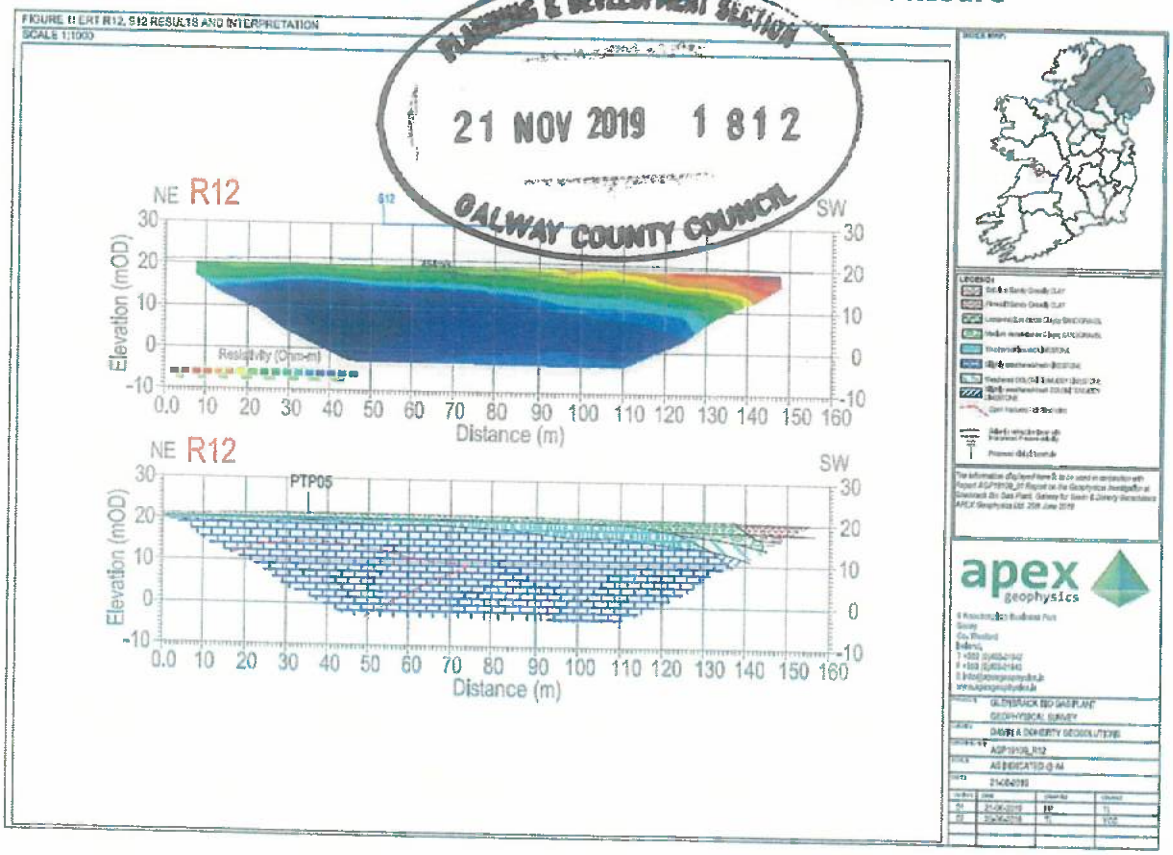
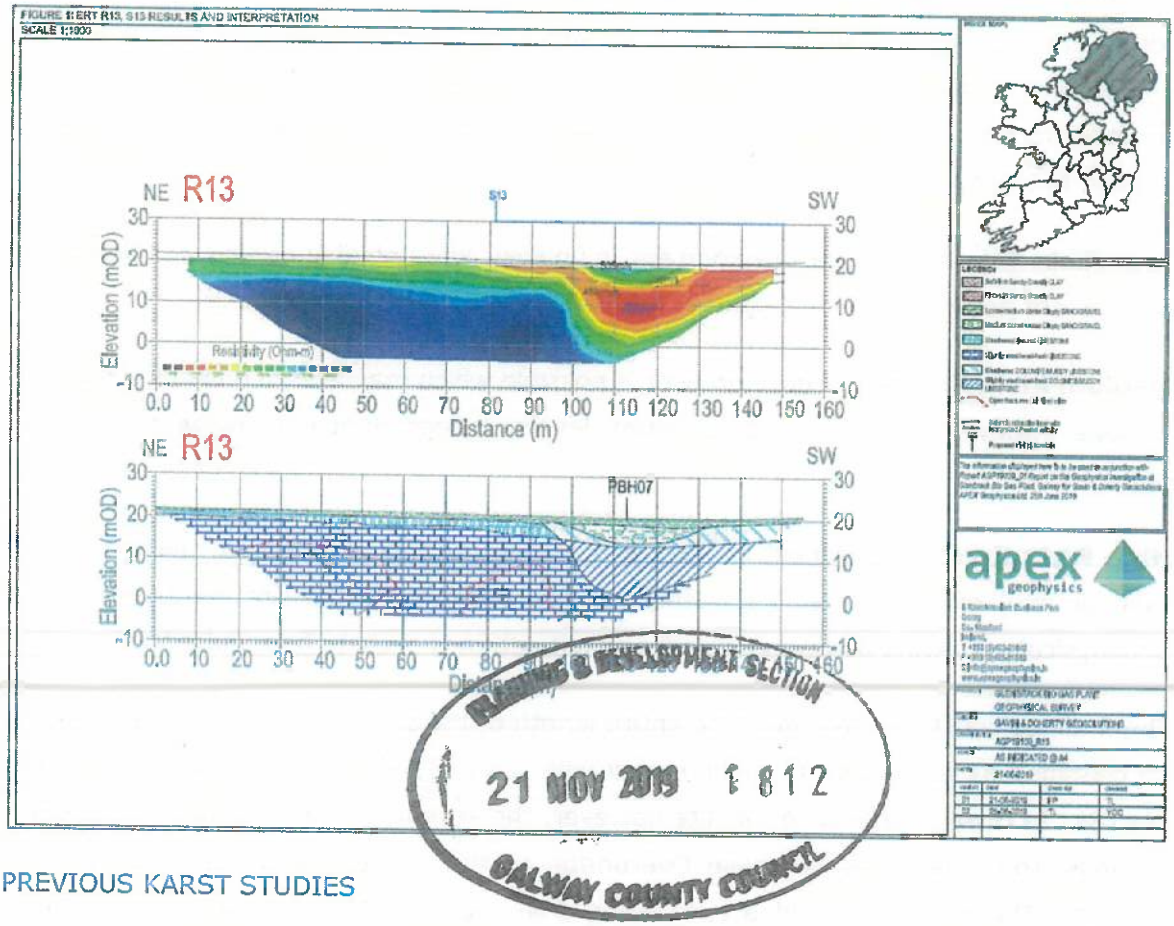


Figure 7.26 Cross Section R13 highlighting potential Karst fissure.



PREVIOUS KARST STUDIES

The GSI have undertaken several different studies looking at aspects of the karstification of the regional landscape. The GSI are currently partaking in an ongoing mapping project in which karst features are identified in the field and added to the GSI's database. In conjunction with the mapping project, extensive dye tracing surveys are also being implemented. These surveys reveal information about underground connections, groundwater velocities, flow directions and aquifer properties.

Extensive evaluation of karst features in region was undertaken in 2014/2015 by ARUP in conjunction with HalcrowBarry. In accordance with the project Works Requirements and the requirements of HD22/08 of the Design Manual for Roads and Bridges Arup prepared a detailed Ground Investigation Report (GIR) for the N17/N18 Gort to Tuam PPP Scheme. This investigation included a section of the M18 which lies approximately 500m due west to the proposed biogas facility site.

As a part of the GIR for the M18 a comprehensive karst risk assessment was carried out. The purpose was to identify areas where karst features could affect the stability of structures in the area. The karst risk was assessed on a number of geological and evidence-based risks including, underlying rock type, thickness of overburden/depth to

bedrock, overburden cover type, proximity to known karst features, logged feature in rotary core boreholes, Anomalies noted in geophysical survey, low blow counts in SPTs and buried topsoil. Ranks were then assigned to each of these parameters and multiplied together to form a karst risk assessment matrix. Ratings of low, medium and high were applied to the matrix.

Low Risk: Significant karst development is unlikely and unstable ground and significant cavities are not anticipated. Mitigation measures are unlikely to be required.

Medium Risk: Some karst development is possible which may lead to unstable ground or cavities. Following inspection of formation levels. Design mitigation measures may be required.

High Risk: Karst development is likely and active unstable ground and cavities already exist or may exist. Detailed assessment of the data, additional site investigation and geophysical surveying is recommended and mitigation is likely to be required.

The findings concluded that over the entire length of the scheme much of the area would be classified as being high or medium risk with a small percentage considered as being low risk. In close proximity to the site however, the scheme is observed to be split into 6 sections from the Coole Demense Overbridge to the end of the Scheme at the Gort Junction. These sections had a risk rating from Low to High Risk with the majority designated as Medium Risk. In addition to the production of the Karst risk assessment the M17/18 GIR also Identified two additional Karst features within 2km of the proposed site. The newly discovered karst features not included in the GSI karst database included;

- A karst spring approximately 600 meters west of the site and
- An enclosed depression approximately 1.1 kilometres north west of the site.

The two additional karst features can be seen in Figure 7.27.

Figure 7.27 Additional Karst Features

KARST MITIGATION

Geophysical surveying has identified karstified bedrock across the southern and central sections of the site. Pre-construction ground investigations will inform the detailed design and the exact foundation solution required in order to mitigate against karstified bedrock impacting on the foundation and bund integrity of the biogas facility. The ground investigations that will take place as part of the detailed design of the facility will give an adequate evaluation of the karst bedrock which in turn will allow appropriate mitigation measures to be implemented to ensure the integrity of the foundation and bund design. Mitigation measure against settlement on site due to karstified bedrock will involve

founding the foundations of the biogas facility in competent bedrock. Founding of the structure on competent bedrock will mitigate against any possible settlement of the structure as a result of karst processes.

7.6 Impact Assessment

This section provides an assessment of the potential environmental impacts of the proposed development on the geological and hydrogeological environment during the construction and operational phases of the development. Findings from the hydrogeological risk assessment carried out in respect of the proposal are included.

Judgments made are based on an assessment of the magnitude of contamination sources, geotechnical hazards and mineral sterilisation as obtained from desk study, existing ground investigation and monitoring information, which form the baseline conditions and an assessment of the source – pathway – receptor philosophy and identified pollutant linkages.

The application site and the area within its immediate environs (i.e. 1km of planning application line boundary) have been considered in detail to assess the changes in ground conditions. The receptors potentially at risk that could be present are indicated below and their relative sensitivity is assessed using the criteria listed in Table 7.15 to enable predicted impact to be determined.

7.6.1 Receptor Sensitivity

The receptors considered for the risk assessment are detailed in the table below and considered in relation to their relative importance and receptor sensitivity (using the criteria listed in Table 7.15 to enable predicted impact); justifications for the classification are provided.

Table 7.15 Receptor Sensitivity

Receptor	Relative Importance	Receptor Sensitivity	Justification
Groundwater	County Level	High	Due to the limited superficial cover present onsite there is a direct pathway between the site and groundwater. Large areas of protected land that include Turloughs are fed at least in part by groundwater are located downstream of the site. Additionally, the surface water and groundwater environment in the region are in direct hydraulic connection, and the current 'good status' of the Cannahowna River should be protected.

Receptor	Relative Importance	Receptor Sensitivity	Justification
Surface Water	County Level	High	The Cannahowna River directly east of the site carries water to areas of protected land present west of the site. Additionally, there are a significant number of underground pathways where surface water is moved into the groundwater system which is water source for Turlough present across the region. Groundwater sourced from the Cannahowna River can discharge to the Kinvara Bay Shellfish protected area through traced underground connections. The current 'good status' of the Cannahowna River is to be protected

7.6.2 Construction Phase

The main potential environmental effects during the construction phase have been tabulated below.

Table 7.16 Construction Phase Potential Environmental Effects

Receptor and its corresponding sensitivity	Potential Environmental Effects	Magnitude of impacts	Impact of significance and discussion
Surface Water (High)	Contamination from spills or leaks of fuel/oil and hazardous substances stored onsite e.g. paints, lubricants, adhesives, oils etc.	Moderate	Major (without mitigation) Mitigation is proposed in Table 7.19.
	Earthworks have the potential to cause disturbance of contaminated soil and subsequent surface water pollution.	No change	Negligible No mitigation measures required The impact is considered reasonable as there are no known sources of contamination within the soils on-site.
Groundwater (High)	Increased vulnerability of the aquifer as a result of soil removal.	Negligible	Moderate (without mitigation) Mitigation is proposed in Table 7.19.
	Contamination from spills or leaks of fuel/oil and hazardous substances stored onsite e.g. paints, lubricants, adhesives, oils etc.	Moderate	Major (without mitigation) Mitigation is proposed in Table 7.19.

Receptor and its corresponding sensitivity	Potential Environmental Effects	Magnitude of impacts	Impact of significance and discussion
	Contamination of groundwater by concrete, cement paste or grout.	Moderate	Major (without mitigation) Mitigation is proposed in Table 7.19.
	Decreased infiltration due to increase in hard standing onsite	No Change	Negligible No mitigation measures required The impact is considered reasonable due to the direct hydraulic connection between the groundwater and surface water environments
	Dewatering at the site causing a reduction in water table and change in local groundwater flow patterns	No Change	Negligible No mitigation measures required
	Earthworks have the potential to cause disturbance of contaminated soil and subsequent groundwater pollution.	No change	Negligible No mitigation measures required The impact is considered reasonable as there are no known sources of contamination within the soils on-site.

7.6.3 Operational Phase

HYDROGEOLOGICAL & HYDROLOGICAL RISK ASSESSMENT

The concepts of Risk, Risk Assessment and Risk Management have become important tools in the area of environmental protection. The determination of potential environmental risk is useful in that it provides a logical framework for considering the impact of potentially polluting activities on the environment. This framework enables a more rigorous systematic approach to decision making. In reality it is putting a recognised framework to what Is done intuitively, but by being systematic. To this end a Source – Pathway – Receptor qualitative method risk assessment has been prepared to determine the likelihood of identified risks to groundwater due to the construction and operation of a biogas facility.

Assessment Methodology

The risk assessment has been undertaken in general accordance with;

- The EPA's IPC Guidance Note on Storage and Transfer of Materials for Scheduled Activities (Document No. 010607-22-RP-001 B) dated 11th June 2004 and
- CIRIA Report C736: Containment Systems for the prevention of pollution dated 2014.

A hazard or in this case a source of contamination or negative impact on existing hydrogeological conditions presents a risk when it is likely to affect something of value, which in this case is groundwater and/or surface water environments. It is the probability of the hazard occurring and its consequences that is the basis of a risk assessment.

The conventional Source-Pathway-Receptor model for environmental management can be applied to identify potential sources, receptors and pathways, and hence potential pollutant linkages between the propose biogas plant site and the underlying hydrogeological environment.

For a particular contaminant to present a risk to receptors, three components must be present:

- **Source** - An entity or action that releases contaminants into the environment.
- **Pathway** - A mechanism by which receptors can become exposed to contaminants.
- **Receptors** - The human or environmental component at risk of experiencing an adverse response following exposure to a contaminant.

A qualitative risk assessment outlining the potential source/pathway/receptor relationships are presented in Table 6.6 below. This assessment has been informed by the hydrogeological information collected to date in relation to the site, and incorporated into previous sections of this report. This assessment includes evaluation of the potential environmental impacts of both the construction and operational phases of the proposed development.

Sources

The sources considered under this assessment include potential contamination hazards from both the construction and operational phase. They include;

- **S1 Effluent** – Effluent, process effluents or dirty storm water
- **S2 Digestate Fertilizer** – A by product of the industrial processes on site.

- **S3 Feedstock** – Raw materials for the industrial processes on site which include agricultural wastes such as animal manure /dung and slurries, energy crops (e.g. grass silage), food wastes, catering wastes, vegetable and fruit residues, agricultural by-products and organic farm based wastes.
- **S4 Other Hazardous Material** – other hazardous material may include paints, lubricants, fuels, oils etc used during the construction or operational of the proposed development.

Pathways

The pathways are the critical element in assessing the potential risk to the receptors as they act as pollutant linkages between the potential sources of contamination and the receptors. The listed pathways comprise of any means by which sources may contaminate the listed receptors. The pathways considered under this risk assessment include;

- **P1** – Infiltration of sources into the soil and subsoil across the site
- **P2** – Infiltration of sources into the Karst Bedrock across the site
- **P3** - The degradation of or compromise in integrity of the concrete used to construct bunding and hardstanding areas.
- **P4** – Corrosion or cracking of piping used for effluent/ process connections.

Receptors

The receptors considered for the risk assessment are;

- **R1 - Groundwater:** Due to the limited cover of superficial deposits at the proposed site in part due to previous development at the site, there is a direct pathway between the site and groundwater, allowing for potential contamination.
- **R2 - Surface Water:** The Cannahowna River to the east of the site is of hydrological importance as it discharges into Kinvara Bay. There are also a number of underground pathways where surface water is moved into the groundwater system, these act as a source for many of the turloughs in the area.

Due to the extensive karstification of the underlying limestone formations in the area the groundwater and surface water show a very high level of interconnectivity and therefore the inclusion of surface water as a receptor has been adopted. A high degree of overlap is present in the determination of risk and appropriate mitigation of each receptor due to this significant interconnectivity.

Risk Assessment

The risk of adverse environmental effects on the hydrogeology underlying the site have been reviewed and a determination of risk has been applied to each. This determination

takes into account the impact of the environmental effect, the sensitivity of the receptor and the magnitude of impact of the potential environmental effect. Each potential source/pathway/receptor route has been assessed to which ratings of low, medium and high risk have been applied. The risk ratings adopted are as follows;

- **Low Risk:** Likelihood of adverse effect on the hydrogeological and hydrological environmental conditions is unlikely.
- **Medium Risk:** Likelihood of adverse effect on the hydrogeological and hydrological environmental conditions is possible.
- **High Risk:** Likelihood of adverse effect on the hydrogeological and hydrological environmental conditions is probable.

Table 7.17 below, outlines all Source – Pathway – Receptor relationships and their associated risk without mitigation measures and also the associated residual risk with the specified mitigation measures applied. The mitigation measures outlined in Table 7.17 are further detailed in Section 7.7 (Mitigation).

Table 7.17 Hydrogeological Risk Assessment

Potential Sources	Receptor/Pathway Assessment			Risk	Mitigation Measures	Residual Risk
		R1	R2			
S1 Effluent	P1	✓	✓	High	Current Facility design stipulates no process effluent discharge. Process effluent will be reused and process effluent will not be connected to sewer mains.	Low
	P2	✓	✓	High	Current Facility design stipulates no process effluent discharge. Process effluent will be reused and process effluent will not be connected to sewer mains.	Low
	P3	✓	✓	High	Current Facility design stipulates the feedstock delivery area will be within an air tight building designed with effluent wash-down drainage to underground effluent storage tanks. Mitigation in additional those already stipulated includes a programme of effluent storage tank integrity testing to be undertaken as part of licensing (EPA) requirements.	Low
	P4	✓	✓	High	Current design stipulates that all connections and fill points will be designed to be within the bunded area with no pipework penetrating the bund wall.	Low
S2 Digestate	P1	✓	✓	High	Fully bunded site built to best practice guidelines. Feedstock delivery areas in hardstanding areas only.	Low
	P2	✓	✓	High	Fully bunded site built to best practice guidelines. Feedstock delivery areas in hardstanding areas only.	Low
	P3	✓	✓	High	Current Facility design stipulates the feedstock delivery area will be within an air tight building designed with effluent wash-down drainage to underground effluent storage tanks. Mitigation in additional those already stipulated includes a programme of effluent storage tank integrity testing to be undertaken as part of licensing (EPA) requirements.	Low
	P4	✓	✓	High	Current design stipulates that all connections and fill points will be designed to be within the bunded area with no pipework penetrating the bund wall	Low
S1 Feedstock	P1	✓	✓	High	Fully bunded site built to best practice guidelines. Digestate contained in Digesters and Digestate	Low

Potential Sources	Receptor/Pathway Assessment	R1	R2	Risk	Mitigation Measures	Residual Risk
					Storage tanks these will be built to the best practice guideline s and contained within the bunded area of the site.	
	P2	✓	✓	High	Fully bunded site built to best practice guidelines. Digestate contained in Digesters and Digestate Storage tanks these will be built to the best practice guideline s and contained within the bunded area of the site.	Low
	P3	✓	✓	High	Mitigation in additional those already stipulated in the EIAR include a programme of bunding ,piping and storage tank integrity testing being undertaken.	Low
	P4	✓	✓	High	Current design stipulates that all connections and fill points will be designed to be within the bunded area with no pipework penetrating the bund wall	Low
S2 Other Hazardous Material	P1	✓	✓	High	All potentially polluting substances such as oils, chemicals and paints used during construction will be stored in designated storage areas. These will be bunded to a volume of 110% capacity of the largest tank/container within the bunded area with all filling and draw-off points fully located within the bunded area.	Low
	P2	✓	✓	High	All potentially polluting substances such as oils, chemicals and paints used during construction will be stored in designated storage areas. These will be bunded to a volume of 110% capacity of the largest tank/container within the bunded area with all filling and draw-off points fully located within the bunded area.	Low
	P3	✓	✓	High	Mitigation in additional those already stipulated in the EIAR include a programme of bunding ,piping and storage tank integrity testing being undertaken.	Low
	P4	✓	✓	High	Current design stipulates that all connections and fill points will be designed to be within the bunded area with no pipework penetrating the bund wall	Low

The main potential environmental effects during the operational phase have been tabulated below.

Table 7.18 Operational Phase Potential Environmental Effects

Receptor and its corresponding sensitivity	Potential Environmental Effects	Magnitude of impacts	Impact of significance and discussion
Surface Water (High)	Contamination of underlying drift deposits and soils due to leak from chemicals/ fuels stored on site and used throughout the site operations e.g. paints, lubricants, oils.	Moderate	Major (without mitigation) Mitigation is proposed in Table 7.20.
	Contamination of surface water due to leaks/spills from waste processing tanks and waste storage tanks	Moderate	Major (without mitigation) Mitigation is proposed in Table 7.20.
Groundwater (High)	Contamination of underlying drift deposits and soils due to leak from chemicals/ fuels stored on site and used throughout the site operations e.g. paints, lubricants, oils.	Moderate	Major (without mitigation) Mitigation is proposed in Table 7.20.
	Contamination of groundwater due to leaks/spills from waste processing tanks and waste storage tanks	Moderate	Major (without mitigation) Mitigation is proposed in Table 7.20.
	Decreased infiltration due to increase in hard standing onsite	No change	Negligible No mitigation measures required The impact is considered reasonable due to the direct hydraulic connection between the groundwater and surface water environments

7.7 Mitigation Measures and Monitoring

The main potential environmental effects during the construction phase have been tabulated below.

7.7.1 Construction Phase

Table 7.19 Mitigation of Potential Environmental Effects

Potential Environment effect	Impact of Significance	Receptor	Phase	Mitigation	Impact of Significance following mitigation
Contamination from spills or leaks of fuel/oil and hazardous substances stored onsite e.g. paints, lubricants, adhesives, oils etc.	Moderate	Surface Water Groundwater	Construction	• Dedicated area of hard standing for material deliveries separated a minimum of 10m from adjacent watercourses; • Dedicated area of hard standing for vehicle wash-out; • Specific areas for oil storage and refuelling, separated a minimum of 10m from adjacent watercourses and comply with legislation, including providing bunds which contain 110% of on-site fuel storage capacity; • Use spill kits, fill point drip trays, bunded pallets and secondary containment units; • Enclosed and secured site and fuel storage areas will be secondarily secured; • Develop a Site Waste Management Plan; • Develop a site-specific Incident Response Plan; • Works involving the use of chemicals which	Negligible

				are potentially harmful to the aquatic environment will be undertaken in a contained or lined area; • Excavation and disposal off-site of contaminated soils (where required).	
Contamination of groundwater by concrete, cement paste or grout.	Moderate	Groundwater	Construction	• A suitable casing will be used where wet concrete is proposed to ensure protection of groundwater until concrete has set.	Negligible
Increased vulnerability of the aquifer as a result of soil removal.	Negligible	Groundwater	Construction	• Land disturbance is expected to be minimised and quickly re-stabilised during the construction; • Due to the limited soil and superficial cover present onsite, it is not thought that large quantities of soils and superficial deposits will be moved during construction; • During construction, areas where the bedrock aquifer is exposed should be protected from surface activities through utilisation of appropriate surface coverings.	Negligible

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7.7.2 Operational Phase

The main potential environmental effects during the operational phase have been tabulated below.

Table 7.20 Mitigation of Potential Environmental Effect

Potential Environment effect	Impact of Significance	Receptor	Phase	Mitigation	Impact of Significance following mitigation
				• Completely bunded site; • Dedicated area of hard standing for material deliveries separated a minimum of 10m from adjacent watercourses;	
Contamination from spills or leaks of fuel/oil and hazardous substances stored onsite e.g. paints, lubricants, adhesives, oils etc.	Moderate	Surface Water Groundwater	Operational	• Dedicated area of hard standing for vehicle wash-out; • Specific areas for oil storage and re-fuelling, separated a minimum of 10m from adjacent watercourses and comply with legislation, including providing bunds which contain 110% of on-site fuel storage capacity; • Site drainage network designed in consideration of SuDS principles. Stormwater moving through 'dirty' site areas (e.g. parking, deliveries) to pass through oil interceptor prior to entering	Negligible

Potential Environment effect	Impact of Significance	Receptor	Phase	Mitigation	Impact of Significance following mitigation
				attenuation pools; • Use spill kits, fill point drip trays, bunded pallets and secondary containment units; • Enclosed and secured site and fuel storage areas will be secondarily secured; • Develop a Site Waste Management Plan; • Develop a site-specific Incident Response Plan; • Works involving the use of chemicals which are potentially harmful to the aquatic environment will be undertaken in a contained or lined area.	
Contamination of surface water due to leaks/spills from waste processing tanks and waste storage tanks	Moderate	Groundwater Surface Water	Operational	• Use bunded tanks and overflow tanks; • Use spill kits, fill point drip trays, bunded pallets and secondary containment units; • Develop a Site Waste Management Plan in accordance with PPG 6; • Develop a site-specific Incident Response Plan.	Negligible

RISK ASSEMENT MITIGATION MEASURES

The mitigation measures outlined in Table 7.17 to 7.20 are based upon the proposed development A summary of these mitigation measure are presented below;

- Dedicated area of hardstanding for material deliveries separated a minimum of 10m from adjacent watercourses;
- Dedicated area of hard standing for vehicle wash-out;
- Specific areas for oil storage and refuelling, separated a minimum of 10m from adjacent watercourses and comply with legislation, including providing bunds sized to contain 110% of fuel storage capacity;
- Use of spill kits, fill point drip trays, bunded pallets and secondary containment units;
- Enclosed and secured site and fuel storage areas will be secondarily secured;
- Develop a Site Waste Management Plan;
- Develop a site-specific Incident Response Plan;
- Works involving the use of chemicals which are potentially harmful to the aquatic environment will be undertaken in a contained or lined area;
- Excavation and disposal off-site of contaminated soils (where required);
- A suitable casing will be used where wet concrete is proposed to ensure protection of groundwater until concrete has set;
- There will be no direct discharges to soils or surface water bodies during the operational phase of the development;
- A tank farm bund has been designed in accordance with best practice to contain any spillages /escape of organic materials. A second outer concrete bund, which encompasses areas where processing relating activities will be carried out is also included within the design;
- The digester and digestate storage vessels will be constructed in concrete (cast insitu) to ensure integrity of the structure. Integrity testing of all structures will be undertaken as part of commissioning works;
- Land disturbance is expected to be minimised and quickly re-stabilised during the construction;
- Due to the limited soil and superficial cover present onsite, it is not though that large quantities of soils and superficial deposits will be moved during construction;
- During construction, areas where the bedrock aquifer is exposed should be protected from surface activities;
- There will be no direct discharge to watercourses, including land drains;
- All outflows from drainage associated with the [illegible] will be by diffuse overland drainage at appropriate locations. The karst nature of the area means that there

will be no on-site holding of any effluent or construction run-off potentially containing chemical pollutants or cementitious material excepting within appropriately bunded / contained areas;

- Disturbed ground within the site will be actively revegetated with appropriate site typical vegetation immediately post construction, in line with the Landscape Planting Scheme;
- Works relating to the widening of the road will be subject to the requirements of ' Guidelines on protection of Fisheries during Construction Works in and Adjacent to Waters' (IFI 2016);
- A Construction Environmental Management Plan will be developed for the construction period. This will include details of the implementation and monitoring of environmental control measures to be applied during the construction process to ensure no potential for impact on groundwater or neighbouring watercourses and
- no effluent discharge, with a sealed effluent and water system whereby the plant is connected to the Gort foul sewer, process effluent is fully captured and removed from the site where not reused.

Several mitigation measures in addition to those specified in the EIAR are recommended following the outcome of the 2019 hydrogeological risk assessment. The additional mitigation measures include;

- Programme of regular integrity testing of bunding;
- Programme of regular integrity testing of hardstanding areas;
- Programme of regular integrity testing of storage vessels and pipework;
- Groundwater monitoring boreholes installed on site to ensure regular access and assessment of both water levels in the case of rising water levels in times of regional flooding as well as regular water testing to further ensure the integrity of the constructed mitigation.
- Incident response plan will include provision for total contamination clean up in the event of a spill.
- Determination of potential structure settlement should be determined after the completion of further ground investigation. The necessity for measures such as piled foundations to mitigate against settlement that may cause cracking of hardstanding/ bunded areas should be assessed prior to construction.

Given the extensive mitigation measures embedded in the design and outlined in the operational procedures of the biogas facility alongside the additional mitigation measures specified in this section, it has been determined that the overall risk of adverse effects to

the groundwater and surface water receptors through contamination from potential sources is *'Low Risk'*.

Given the sensitivity of the receptors combined with the major impact of potential environmental effects on these receptors the overall designation of 'Low Risk' is highly dependent on the mitigation measures outlined. In the absences of any outlined mitigation measures the hydrogeological risk to a given receptor can be deemed 'High Risk'. Therefore, the current overall designation of *'Low Risk'* is only applicable in the case that all design and procedural mitigation measures are adhered to.

7.8 Cumulative Effects

Within the European Commission - Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions, dated May 1999, cumulative effects are described as *"impacts that result from incremental changes caused by other development, plans or projects together with the proposed development or developments"*.

The cumulative effects of the proposed construction and operation of a biogas facility near Gort town with other developments in the area is reviewed in this section with specific regard to the local and regional hydrology and hydrogeology. The developments of critical concern for potential cumulative effects are 1) The Gort Waste Water Treatment Plant and 2) the newly built M18 motorway.

7.8.1 M18 Motorway

The M18 Motorway run north south immediately west of Gort town and exactly 480 metres west of the proposed biogas plant site.

The risk to hydrology and hydrogeology from the development of the motorway has been comprehensively assessed and mitigation has been addressed. The N17 / N18 Gort to Tuam PPP Scheme, Part 1 of Schedule 4 Construction Requirements, Section 1.4.1.24. This document states;

> *"Notwithstanding any other provisions of the Agreement the drainage Design shall for the protection of aquifers include all of the following:*
>
> *(a) measures to prevent migration of potentially contaminated surface water runoff into any underlying karst aquifers and the like, and*
>
> *(b) in areas of karst aquifers the carriageway drainage Design shall include a sealed drainage system and any further measures to prevent carriageway runoff seeping into karst aquifers."*

The N17 / N18 Gort to Tuam PPP Scheme, Construction Requirements Annex 4 to Part 2, Amendments to Standards, Addenda and Advice Notes, lists the documents that were adopted in respect to the design and construction of the scheme. This list contains the Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes. This document contains a list of groundwater mitigation measures to be considered for road construction schemes, these measures are listed below;

- where possible, re-align the road down-gradient or an appropriate distance up-gradient of the source protection area for high yielding water supply springs and wells and natural hydrogeological features;
- where possible, minimise the depth of road cutting within a source protection area or zone of contribution to minimise the impact on groundwater flows to downgradient springs, wells, wetlands and other hydrogeological features;
- where possible, minimise the depth of road cutting in order to ensure that its zone of contribution does not extend upgradient to a hydrogeological feature or wetland;
- where it is not possible to avoid running the road through the vulnerable part of the source protection area for a high yielding water supply well, spring or other hydrogeological feature, provide sealed drains or positive drainage systems;
- provide sealed drains or positive drainage systems along sections of road overlying the vulnerable parts of locally important or regionally important aquifers;
- provide site-specific measures to protect relatively small natural hydrogeological features such as springs, seeps or wetlands;
- assess the potential impact of re-grading small streams on nearby wells or springs;
- replace wells or provide alternative water supplies where low yielding wells have to be replaced;
- ensure that all surface water run-off discharged to groundwater via soakaways is passed through systems for settlement or filtration of suspended solids with the parallel effect of removing contaminants (certain heavy metals and hydrocarbons) associated with the suspended solids;
- groundwater monitoring may be appropriate in certain instances, instead of automatically providing specific mitigation measures. In these circumstances however, thresholds should be set that will trigger the introduction of pre-defined mitigation measures;
- specifying regular monitoring of groundwater during the construction period and for a defined period thereafter, following opening of the road scheme;

- all wells abandoned as part of the road scheme should be sealed and abandoned in accordance with Well Drilling Guidelines produced by the Institute of Geologists of Ireland. Ground investigation boreholes should be backfilled using bentonite or cement bentonite grout in accordance with the Specification and Related Documentation for Ground Investigation published by the Institution of Engineers of Ireland, and
- abandon obsolete ground investigation boreholes / water supply wells and springs in accordance with the appropriate guidelines.

Given the extensive measures undertaken in the design and construction of the M18 Motorway scheme to protect and mitigate against any potential groundwater contamination the cumulative effects of this development with the proposed construction of a biogas facility can be deemed negligible.

7.8.2 Gort Waste Water Treatment Plant

Gort is serviced by a public wastewater collection network with both primary and secondary treatment. The Gort Waste Water Treatment Plant (WWTP) is located on the Kinincha Road approximately 500 meters to the north of the town and 150 meters south of the proposed site. The treated effluent from the WWTP is finally discharged into the Cannahowna/Gort River. The cumulative effects of the proposed biogas plant development and the Gort WWTP on the local and regional hydrogeology is reviewed in this section.

In order to prevent impact on groundwater conditions, the proposed construction and operation of a biogas plant at the site currently incorporates significant embedded mitigation. This includes no effluent discharge, with a sealed effluent and water system whereby the plant is connected to the Gort foul sewer, process effluent is fully captured and removed from the site where not reused, and storm water is kept within a bunded sustainable drainage system, including swales and attenuation ponds. These embedded mitigation factors combined with managed mitigation measures detailed earlier in this chapter. Any cumulative effect on the local and regional hydrogeology from the proposed biogas plant and Gort WWTP will be limited to the effluent discharge from the proposed foul drain connected from the administration /control buildings of the biogas plant to the public sewer which routes towards the Gort wastewater treatment plant. Given no discharge will result from the construction and operation of the biogas facility, exceedance of capacity at the Gort WWTP due to the foul drain connection is therefore the only potential cumulative impact on the local and regional hydrogeology.

In March 2017 Irish water issued a press release stating that '*Irish Water has been granted planning permission for essential upgrade works to the Gort Water Treatment Plant'.*

A pre-connection enquiry letter was sent to Irish Water in January 2018 as part of the development proposal in respect of a sewer and water connection. A response letter was received on the 24th January 2018 which states the following:

"Based upon the details you have provided with your pre-connection enquiry and on the capacity currently available as assessed by Irish Water, we wish to advise you that, subject to a valid connection agreement being put in place and conditions outlined below, your proposed connection to the Irish Water network can be facilitated.

The pre connection enquiry submission received indicates that an domestic type effluent is proposed to be discharged to the Irish Water wastewater network via a pumping station and rising main. Your foul drainage connection design should allow for a gravity network for as long as levels will permit to reduce the rising main distance. A pumping station and rising main connection can be facilitated subject to the condition that the effluent retention time in the rising main and pumping station is not greater than 12 hours. This is a requirement to ensure that septicity is prevented at the discharge manhole to the IW network. You will require to provide details of the gravity network and pumping station/rising main design at connection application stage and to provide detail on how Irish Water's requirements in relation to effluent retention times are met. A water supply demand of 0.042 l/sec has been indicated in the pre connection enquiry submission received. A watermain connection can be facilitated to the Irish Water 100mm diameter network at a point approximately 100m from the development. The confirmation of feasibility to connect to the Irish Water infrastructure does not extend to your fire flow requirements. To guarantee a flow to meet the Fire Authority requirements you should provide adequate fire storage capacity within your development".

Given the nature (domestic) and volume of effluent requiring disposal to the sewer it is deemed unlikely that the connection of the control buildings to the foul sewers running to the Gort WWTP will exceed the capacity of the treatment plant. The cumulative impacts on the regional hydrogeology from the proposed biogas plant development and the Gort WWTP can be deemed negligible due to the embedded and managed mitigation measures included in the design of the proposed development.

7.9 Residual Impacts

The proposed development will not have any significant residual effects on the geological environment if all mitigation measures are implemented

The site development will result in the creation of low permeability and impermeable surfaces, limiting the potential for contamination of the subsurface.

The site is currently greenfield. The proposed development will result in physical disturbance to the existing soil profile. Since the site has limited agricultural potential, the residual effect is negligible.

7.10 Summary of Significant Impacts

The receptors for this assessment are considered to be shallow soils, the underlying drift, bedrock geology and waters. Whilst the development proposals have the potential to cause detriment to the sensitive receptors identified, the recommended mitigation measures will ensure that the risk of potential impacts are reduced to negligible.

7.11 Statement of Significance

The significance of impact upon shallow soils, drift deposits, and bedrock geology have been assessed for both during the construction and operational phases. The results of the assessment are presented on Table 7.19 and Table 7.20.

Where a potential impact has been identified, the significance of impact upon these receptors ranges from minor to moderate.

Where a potential impact has been identified, mitigation measures have been provided which if implemented reduces the impact of significance to ***'negligible'***. The mitigation steps are presented in Section 7.7.

7.12 Expected Effects Deriving from the Vulnerability of the Proposed Development to Risks of Major Accidents or Disasters that are Relevant to the Proposed Development

Given the geographic location of the proposal, the vulnerability of the proposed development to natural disasters such as earthquakes, fire, tidal or weather events is considered to be low. The risks associated with flooding, have been assessed in a dedicated chapter within the EIAR.

In terms of accidents, it should also be noted that the infrastructure (listed in Section 7.4.1) in use on the site will be constructed in accordance with their respective guidance and or regulations which dictates their design, location, construction and maintenance to prevent water pollution. Notification in respect of each of these structures together with

accompanying engineering certification will be required by the EPA in accordance with these regulations.

The operation of the facility in accordance with the Environment Health and Safety Management Plan which will be in place at the site (required for Waste Management licence application purposes) requires daily inspections of all structures, plant and machinery and sets in place procedures for dealing with incidents such as spillages, fire, power outages and plant closure. The vulnerability of the development to major accidents or disasters is therefore considered low.

HYDROGEOLOGICAL RISK ASSESSMENT REFERENCES

The following presents a list of references and guidance used in the preparation of this assessment:

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