7 Land, Soils and Geology

7.1 Introduction

This chapter comprises an assessment of the land, soils and geology within the vicinity of the site and the surrounding environs. The potential impacts posed by the construction and operational phases of the Proposed Development are investigated, and suitable mitigation measures are recommended to minimise impacts on the local soil and geological receptors.

The objectives of this chapter are:

- To provide a baseline assessment of the receiving environment in terms of land, soils and geology.
- To identify any potential negative impacts posed by the construction and operational phases of the Proposed Development.
- To propose suitable mitigation measures to prevent or reduce the significance of the negative effects identified.
- To consider any significant residual effects of cumulative impacts posed by the Proposed Development.

7.2 Consultation

ORS have been commissioned to assess the potential impacts of the Proposed Development in terms of Land, Soils, and Geology during the construction and operational phases.

The principal members of the ORS EIA team involved in this assessment include the following persons:

- **Project Scientist and Lead Author:**
  Jack Wilton – B.Sc. (Microbiology), M.Sc. (Environmental Sustainability). Current Role: Environmental Consultant. Experience *ca*. 3 years

- **Project Scientist & Reviewer:**
  Anna Quaid - B.Sc. (Environmental Science), M.Sc. (Applied Environmental Science), Current Role: Environmental Consultant. Experience ca. 4 years.

- **Project Coordinator and Reviewer:**
  Oisín Doherty – B.Sc. (Geography with Environmental Science), MSc. (Environmental Management), CEnv, MIEnvSc. Current Role: Chartered Environmental Consultant. Experience *ca.* 15 years.

Consultation between ORS and other members of the planning/design team was made in order to obtain information required to assess the potential construction and operational phase impacts on local Land, Soils, and Geology.

7.3 Assessment Methodology and Significance Criteria

The methodology used to produce this chapter included a review of relevant legislation and guidance, a desk study, a site walkover, an intrusive investigation (in the form of trial pits, and laboratory tests), an evaluation of potential effects, an evaluation of significance of the effect and an identification of measures to avoid and mitigate effects.

This chapter was carried out in accordance with the following guidance documents:

- EPA, (2022). Guidelines on the Information to be Contained in Environmental Impact Assessment Reports.
- EPA, (2004). Land spreading of Organic Waste – Guidance on Groundwater Vulnerability Assessment of Land.
- EPA, (2004). Guidance Note on Storage and Transfer of Materials for Scheduled Activities.
- EPA, (2012). Guidance to Licensees on Surrender, Cessation and Closure of Licensed Sites.
- European Commission, (2017). Environmental Impact Assessment of Projects Guidance on the preparation of the Environmental Impact Assessment Report.
- Institute of Geologists Ireland, (2013). Guidelines for Preparation of Soils, Geology and Hydrogeology Chapters in Environmental Impact Statements.
- National Road Authority, (2008). Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.
- Transport Infrastructure Ireland, (2019). Cross Sections and Headroom, Design Standards (DN-GEO-03036)
- CIRIA, (2001). C532 - Control of Water Pollution from Construction Sites – Guidance for consultants and contractors.
- UK CIRIA Report C552 (2001). Contaminated Land Risk Assessment: A Guide to Good Practice
- IGI, (2002). Geology in Environmental Impact Statements – a Guide (Institute of Geologists of Ireland.
- Department Agriculture, Food and Marine, (2017). Nitrate Explanatory Handbook for Good Agricultural Practice For The Protection Of Waters Regulations 2018
- DAFM, (2022). Code of Good Practice for Poultry Litter Hauliers - Legal Obligations and Good Practice Guidelines for Poultry Litter Hauliers in Relation to the Use and Disposal of Poultry Litter.
- Nitrates Directive (91/676/EEC)
- Groundwater Directives (80/68/EEC) and (2006/118/EC).
- EU Soil Strategy 2030
- EU Common Agricultural Policy
- Waste Management Act 1996.
- Möller, K., and Müller, T. (2012). Effects of anaerobic digestion on digestate nutrient availability and crop growth: a review. Engineering in Life Sciences, 12(3), 242-257.
- Doyeni MO, Stulpinaite U, Baksinskaite A, Suproniene S, Tilvikiene V. (2021) The Effectiveness of Digestate Use for Fertilization in an Agricultural Cropping System. Plants (Basel). 2021 Aug 22;10(8):1734.

7.3.1 Desktop Study

A desk study was undertaken in order to collate and review background information in advance of the site survey and to develop a baseline of the land, soil and geology. The following documents and sources were referenced:

- Geological Survey of Ireland (GSI) maps and datasets
- Environmental Protection Agency (EPA) maps, datasets and reports
- National Parks and Wildlife Service (NPWS) maps and datasets

- Ordnance Survey of Ireland (OSI) maps and datasets
- Met Eireann meteorological data
- Office of Public Works (OPW) maps and datasets
- Limerick City & County Development Plan (CDP) 2022-2028
- Strategic Environmental Assessment CDP 2022-2028
- Review of the County Geology of Ireland: Limerick
- Aerial Photography from ESRI (ArcGIS).
- 1:50,000 Discovery Series Maps and 6" maps (Geohive)
- Teagasc ISIS GIS maps
- General Soil Map of Ireland 2nd Edition, (1980), The National Soil Survey, An Fóras Taluntais
- An Foras Talúntais (1966). Soils of County Limerick
- An Foras Talúntais (1980). Soil associations of Ireland and their land use potential.
- Water Action Plan 2024: A River Basin Management Plan for Ireland.
- County Limerick Groundwater Protection Scheme – Main Report (1994).

7.3.2 Field Survey

Fieldwork commissioned in November 2024 consisted of the following elements:

- Trial Pit Excavations
- BRE Digest 365 Percolation/Soakaway Testing

A site walk-over was conducted by ORS geotechnical consultants on the 22nd of November 2024 to verify the finding of the desktop study and identify baseline features on the Proposed Development site including:

- Drainage patterns and distribution
- Exposures
- Drainage Infrastructure
- Flora and fauna identification and distribution
- Identification of "Poached" ground.

7.3.3 Impact Assessment Methodology

Chapter 1: Introduction of the EIAR outlines the impact assessment methodology and rationale applied to each chapter of the study. This section describes some further criteria applied to the assessment of soil and geological receptors.

Risk Appraisal Methodology

The Conceptual Site Model (CSM) identifies potential contaminants, receptors and exposure pathways that may be present based on the construction and operational phase of the Proposed Development. The identification of potential "contaminant linkages" is a key aspect of the evaluation of potentially contaminated land and in quantifying the potential risk associated with Proposed Developments. As such this assessment has been undertaken in line with the Source - Pathway - Receptor Model as per the "Guidelines on the information to be contained in Environmental Impact Assessment Reports" 2022 and IGI 2013 guidance notes. At the impact assessment stage, any potential beneficial or adverse impacts associated with the development are identified and assessed with reference to the baseline environment. This requires consideration of:

- Quality of effects (sensitivity of receptor)
- Significance of effects (severity)
- Description of extent and context of effects (character/ magnitude)
- Probability of effects
- Duration and frequency of effects
- Type of effect (direct, indirect, residual, etc.)

Table 1.1 in **Chapter 1** presents the criteria for the description of effects, as outlined in the EPA guidance report 2022.

Evaluation of Geological Receptors

The 13-step approach to impact assessment proposed in the IGI guidelines (2013) is adopted for the evaluation of potential effects. The baseline environment is assessed by characterising the site topographical, geological and geomorphologic regimes from the data acquired. Following on from the identification of the baseline environment, the available data is utilised to identify and categorise potential effects on the soils and geological environment as a result of the Proposed Development.

These assessments include:

- Undertaking preliminary materials calculations in terms of volumetric soil and subsoil excavation and reuse associated with development design,
- Assessing ground stability risks,
- Assessing the combined data acquired and evaluating any likely effects on the soils, geology, and ground stability,
- Identifying effects and considering measures that would mitigate or reduce the identified effect.

The significance of effects of the Proposed Development has been assessed in accordance with the EPA Guidelines on the information to be contained in Environmental Impact Assessment Reports, 2022. The effects associated with the Proposed Development are described with respect to the EPA guidance in the relevant sections of this chapter.

Magnitude and Significance of Impact

An impact rating has been developed for each of the phases of the Proposed Development based on the Institute for Geologists Ireland (IGI) Guidance for the preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements. In line with the IGI Guidance the receiving environment (Geological Features) was first identified. Using the National Road Authority (NRA) (2008) rating criteria the importance of the geological features is rated in **Table 7.1** followed by an estimation of the magnitude of the impact (**Table 7.2**). This determines the significance of the impact prior to application of mitigation measures as set out in **Table 7.3**.

Table 7.1: Sensitivity/ Value of the Site's Geological Features (NRA, 2008)

Magnitude	Criteria	Example
Very High	Attribute has a high quality, significance, or value on a regional or national scale. Degree or extent of soil contamination is significant on a national or regional scale. Volume of peat and/or soft organic soil underlying the site is significant on a national or regional scale	Geological feature on a regional or national scale (NHA). • Large existing quarry or pit. • Proven economically extractable mineral resource
High	Attribute has a high quality, significance, or value on a local scale. Degree or extent of soil contamination is significant on a local scale. Volume of peat and/or soft organic soil underlying the site is significant on a local scale	Contaminated soil on site with previous heavy industrial usage • Large recent landfill site for mixed wastes • Geological feature of high value on a local scale (County Geological Site) • Well drained and/or high fertility soils • Moderately sized existing quarry or pit • Marginally economic extractable mineral resource
Medium	Attribute has a medium quality, significance, or value on a local scale. Degree or extent of soil contamination is moderate on a local scale. Volume of peat and/or soft organic soil underlying the site is moderate on a local scale	Contaminated soil on site with previous light industrial usage • Small recent landfill site for mixed wastes • Moderately drained and/or moderate fertility soils • Small existing quarry or pit • Sub- economic extractable mineral resource
Low	Attribute has a low quality, significance, or value on a local scale. Degree or extent of soil contamination is minor on a local scale. Volume of peat and/or soft organic soil underlying the site is small on a local scale	Large historical and/or recent site for construction and demolition wastes • Small historical and/or recent landfill site for construction and demolition wastes • Poorly drained and/or low fertility soils • Uneconomic extractable mineral resource

The assessment of the severity / magnitude of an impact incorporates the timing, scale, size, and duration of the potential effect. The magnitude criteria for geological effects are defined in **Table 7.2**.

Table 7.2: Severity/ Magnitude of Impact on Geological Features (NRA, 2008)

Magnitude	Criteria	Description and Example
Large Adverse	Results in loss of attribute	Loss of high proportion of future quarry or pit reserves • Irreversible loss of high proportion of local high fertility soils • Removal of entirety of geological heritage feature • Requirement to excavate / remediate entire waste site • Requirement to excavate and replace high proportion of peat, organic soils and/or soft mineral soils beneath alignment
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	• Loss of moderate proportion of future quarry or pit reserves • Removal of part of geological heritage feature • Irreversible loss of moderate proportion of local high fertility soils • Requirement to excavate / remediate significant proportion of waste site • Requirement to excavate and replace moderate proportion of peat, organic soils
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	• Loss of small proportion of future quarry or pit reserves • Removal of small part of geological heritage feature • Irreversible loss of small proportion of local high fertility soils and/or • high proportion of local low fertility soils • Requirement to excavate / remediate small proportion of waste site • Requirement to excavate and replace small proportion of peat, organic soils and/or soft mineral soils beneath alignment
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	No measurable changes in attributes
Minor Beneficial	Results in minor improvement of attribute quality	Minor enhancement of geological heritage feature
Moderate Beneficial	Results in moderate improvement of attribute quality	Moderate enhancement of geological heritage feature
Major Beneficial	Results in major improvement of attribute quality	Major enhancement of geological heritage feature

Based on the determination of the findings from the above **Tables** (**7.1** and **7.2**) the following matrix is used to establish the significance of the impact.

Table 7.3: Rating the Significance of the Impact in Geology (NRA, 2008)

Importance of Attribute	Magnitude of Impact			
	Negligible	Small Adverse	Moderate Adverse	Large Adverse
Very High	Imperceptible	Significant/ Moderate	Profound/ Significant	Profound
High	Imperceptible	Moderate/ Slight	Significant/ Moderate	Profound/ Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/ Moderate

7.4 Description of the Receiving Environment

7.4.1 Background

This section of the chapter provides the baseline information in terms of geomorphology (landscape and topography), superficial and solid geology. The regional review of geological and hydrogeological conditions covers a zone of at least 2km from the Proposed Development site, as suggested in the IGI guideline.

The Proposed Development occupies a total area of 5.29 Ha and is situated in the townlands of Cappanihane, Bruree, Co. Limerick. The Proposed Development is situated on a greenfield site to the north of the R518 regional road with extensive agricultural lands to the north, east, west and south of the site. The R518 regional road is a two-lane road located adjacent to the southern boundary of the site and runs from east to west. The R518 road is adjoined at the southwest corner of the Proposed Development by the L8658, a two-lane local road which runs from north to south along the western boundary of the Proposed Development. The site entrance will be constructed along the western boundary of the site and will connect the facility to the local road to the west and the wider road network of the surrounding area. The Proposed Development lies approximately 9.8km northwest of Charleville town centre.

The underlying geology has a major influence on topographical, hydrogeological and hydrological features within the Proposed Development vicinity, hence this chapter is closely linked to **Chapter 8 – Hydrology and Hydrogeology**.

The receiving environment is described below for the Proposed Development under the following headings:

- Topography
- Drift (Quaternary) Geology
- Bedrock Geology
- Soils and Subsoils

7.4.2 Topography

Co. Limerick possesses a varied landscape which is important not just for its intrinsic value and beauty, but also because it provides for local residents and visitors, both in terms of a place to live and for recreational and tourism purposes. The range of different landscapes found in Co. Limerick each have varying visual and amenity values, topography, exposure and contain a variety of habitats. Each landscape type also has varying capacity to absorb development relative to its overall sensitivity. The landscape in Co. Limerick contains views and prospects worthy of protection.

The Landscape Character Assessment undertaken to inform the review of the Limerick County Development Plan 2022-2028 has divided the county into 14 no. Landscape Character Units based on the local landscape features which include:

1. Agricultural Lowlands
2. Ballyhoura / Slieve Reagh
3. Galtee Uplands
4. Knockfierna
5. Lough Gur
6. Shannon ICZM
7. Slieve Felim
8. Southern Uplands
9. Tory Hill
10. Western Uplands
11. Catherdavin
12. Southern Environs
13. Castletroy
14. City

The proposed site is located in the <u>Agricultural Lowlands</u> character area. See **Figure 7.1** overleaf.

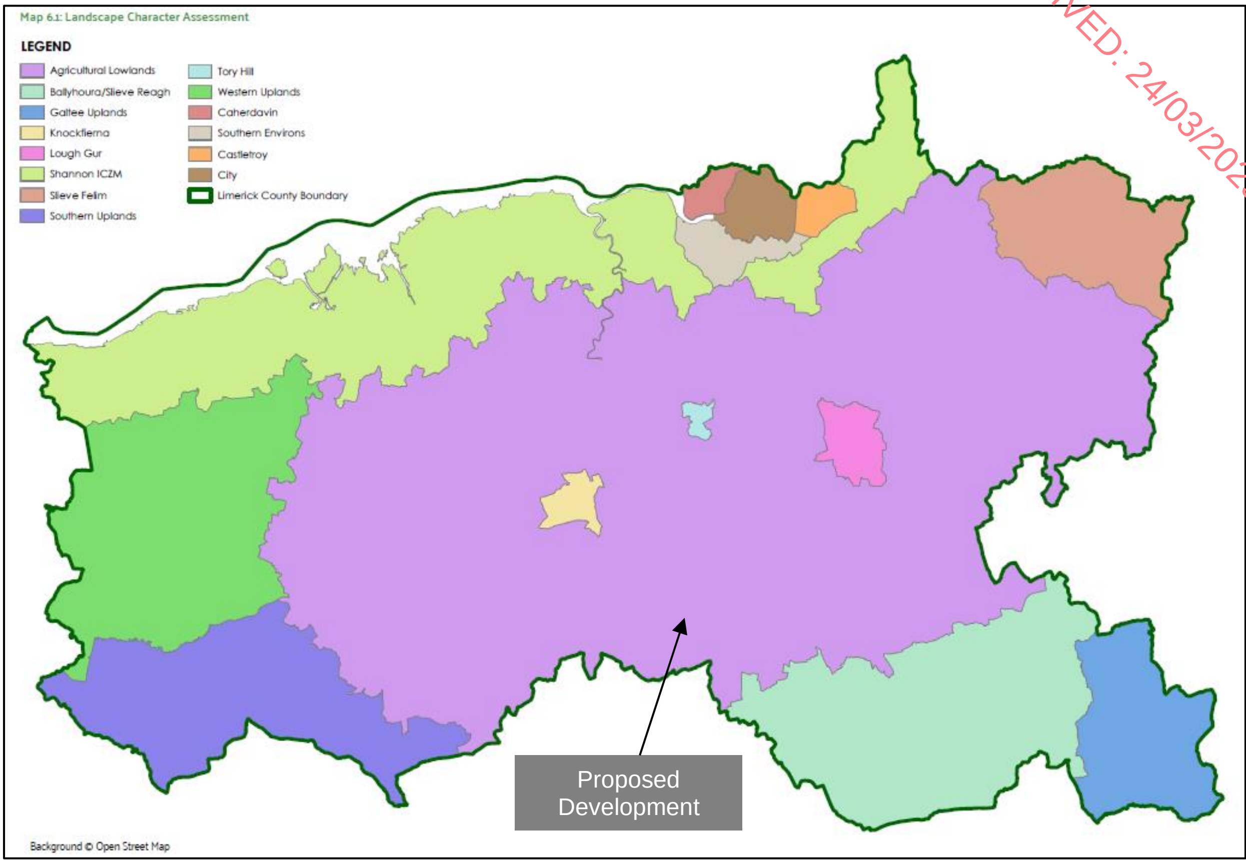

Figure 7.1: Landscape Types (Map 6.1 of Chapter 6 of the Limerick County Development Plan 2022-2028, Volume 1)

The Agricultural Lowlands landscape character area in which the Proposed Development is located is described within the 2022-2028 CDP as:

"*The largest of the Landscape Character Areas in Limerick and comprises almost the entire central plain. This landscape is a farming landscape and is defined by a series of regular field boundaries, often allowed to grow to maturity. This well-developed hedgerow system is one of its main characteristics. In terms of topography, the landscape is generally rather flat with some locally prominent hills and ridges. The pastoral nature of the landscape is reinforced by the presence of farmyards*."

According to the GSI Viewer the physiographic unit in which the Proposed Development is located is characterised as "*flat to gently undulating glacial sediments*", in keeping with the Landscape Character Type description for the area.

The topography of the site is relatively uniform, as can be seen in **Figure 7.2** overleaf. The highpoint on site is *ca*. 92.53m AOD which occurs at the northwestern corner of the site. A slight gradient from here exists, falling to the southeast. Along the western site boundary, there is a slight gradient from north to south and the topography varies from 92.47m in the northwest boundary to 92.31m AOD at the southwestern boundary of the site. The land initially rises from 91.91m AOD at the northeastern corner of the site to 92.37m AOD at central part of the eastern site boundary before falling to 92.14m AOD at the southeastern boundary. Across the centre of the Proposed Development an existing drain occurs running from west to east, dividing the site into north and south. This drain connects to the drainage network along the road to the west. Additionally, another drain branches off perpendicularly, running from north to south. At the centre of the site along the route of the drain, the topography drops to a low of 90.62m AOD. The site is heavily vegetated along the eastern boundary beyond which occurs the Lower Ballyteige watercourse, a tributary of the Maigue River. The topography of the region to the east of the site begins to rise again beyond the banks of the adjacent watercourse.

Figure 7.2: Topographical map of the landscape surrounding the site (topographic-map.com)

7.4.3 Receptors

Designated Sites

Figure 7.3 displays the spatial distribution of the Special Areas of Conservation (SAC), Special Protection Areas (SPA) and Natural Heritage Areas (NHA) within the wider region. SAC are prime wildlife conservation areas in the country which are considered to be important on a national and European scale. Sites are selected and designated under the EU Habitats Directive and have been transposed into Irish law under EC (Birds and Natural Habitats) Regulation 2011 (S.I. No. 477/ 2011). Likewise, an SPA is an area selected for conservation due to its importance in the protection of rare or vulnerable bird species, migratory species, and wetlands. Sites are selected and protected under the EU Birds Directive.

The closest designated sites to the Proposed Development include the Heathfield Wood pNHA (Site Code:001434) located *ca.* 8.7km west of the site and the Tory Hill SAC (Site Code: 000439) *ca.* 11.2km northeast of the site. There are designated sites within a 2km radius of the site.

Taking into consideration the 'Source-Pathway-Receptor' model, the closest waterbody is the Lower Ballyteige watercourse, a tributary of the Maigue River, located beyond the eastern boundary of the Proposed Development. The watercourse runs south to north, eventually curving and continuing to flow eastwards where it joins the Glenma stream *ca.* 2km downstream. The Glenma stream adjoins the Maigue stream *ca.* 3km downstream. The Maigue stream is hydrologically connected to the Lower River Shannon SAC, discharging into this designated site *ca.* 17km downstream. Thus, there is hydrologic connectivity between the site and the aforementioned SAC. Given the topography of the site, where a slight gradient exists to the southeast, the surrounding lands drain into the adjacent watercourse. Therefore, the stream will receive discharge of surface-water runoff from site. This stream is likely to act as a pathway or receptor of pollution associated with the site. An appraisal of the potential effects of the Proposed Development on the constitutive characteristics of European sites identified within 15km of the Proposed Development is set out in the Natura Impact Statement which accompanies the planning application for this project.

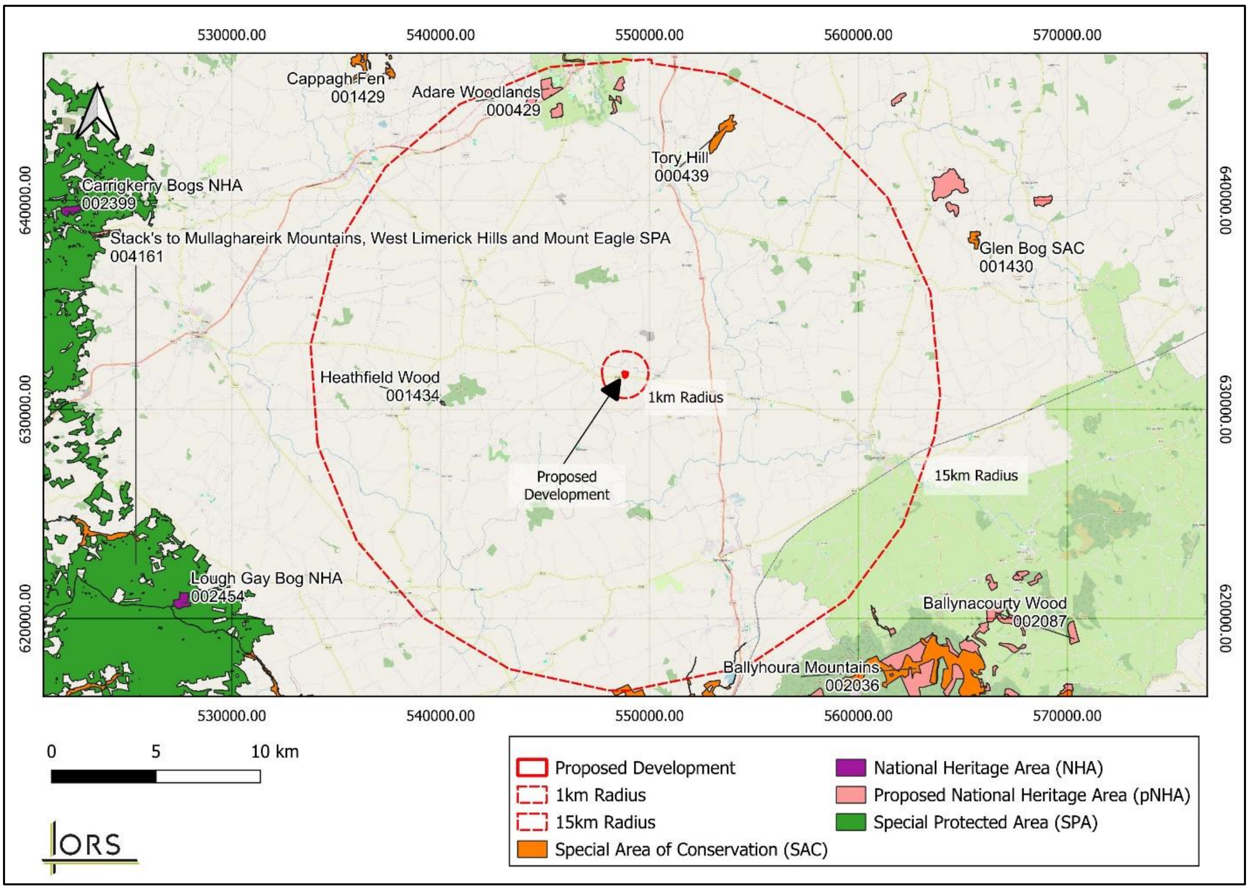

Figure 7.3: SPA, SAC and NHA sites within a 1km and 15km radius of site

Geological Heritage

The Irish Geological Heritage (IGH) Programme identifies and selects a complete range of sites that represent Ireland's geological heritage under sixteen themes ranging from karst features to hydrogeology. The IGH Programme is a partnership between the GSI and the National Parks and Wildlife Service (NPWS) and sites identified as important for conservation are conserved as Natural Heritage Areas (NHA).

Reference to the GSI online database confirms the proposed site is not within a geological heritage site and that there are <u>no designated sites within the 2 km study area</u> of the Proposed

Development. The closest site is Knocksouna, which is described as "*a series of warm water springs and a high, bedrock crag to their north.*" located approximately 8.1km southeast of the site, which is outside the 2km study area. **Figure 7.4** below indicates the Geological Heritage Sites within the wider region.

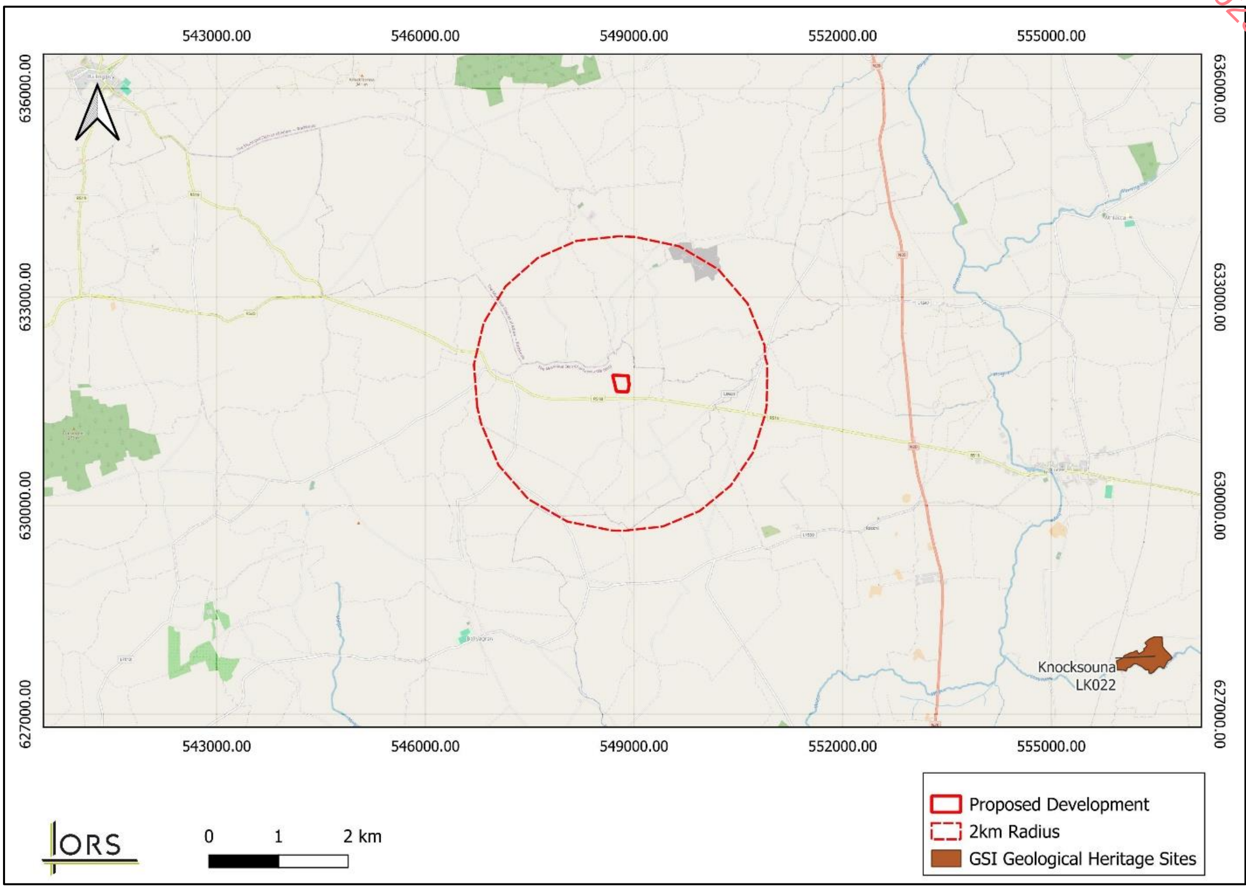

Figure 7.4: Geological Heritage Sites within the vicinity of the site

7.4.4 Drift (Quaternary) Geology

Drift is a general term applied to all mineral material (clay, silt, sand, gravel and boulders) transported by a glacier and deposited directly by or from the ice or as fluvioglacial deposits. It generally applies to deposits laid down during the Pleistocene (Quaternary) glaciations. Drift can also be included under Holocene (Quaternary) deposits. The drift geology of the area principally reflects the depositional process of the last glaciation. Typically, during the ice advance, boulder clays were deposited, sub-glacially as lodgement till over the eroded rock head surface, whilst moraine granular deposits were laid down at the glacier margins. Subsequently, with the progressive retreat of the ice sheet from the region, granular fluvio-glacial deposits were laid down in places by melt waters discharging from the front of the glacier.

The Proposed Development is located within a wider lowland landscape which comprises the largest landscape character unit of county Limerick, covering almost all of the central plain of the county. This agricultural lowland region extends towards the edge of Limerick City in the north, towards the County Cork border in the south, the County Tipperary border in the east and to the uplands region beyond Newcastle West in the western extent of the county. The uplands in the region occur in the western, southwestern and southeastern extents of Limerick. The Western Uplands and Southern Uplands landscape character areas rise along the Kerry border region to the west and southwest. In the southeast of the county the Ballyhoura / Slieve Reagh uplands and Galtee Uplands landscape character areas rise along the border with County Cork and County Tipperary. The Slieve Felim Uplands occur in the northeastern extent of the county. Knockfierna and Tory Hill are distinct hill features, rising in the centre of the agricultural lowland plain, at the centre of County Limerick. The Shannon Coastal zone comprises a large area of northern Limerick and is bounded on its northern side by the Shannon Estuary, while its southern boundary is defined by the gradually rising ground, which leads onto the agricultural zone and the western hills to the southwest. The landscape in the immediate vicinity of the Proposed Development site is a lowland region ringed by rounded mountains and a mountain ice-sculpted ridge as shown in **Figure 7.5** below.

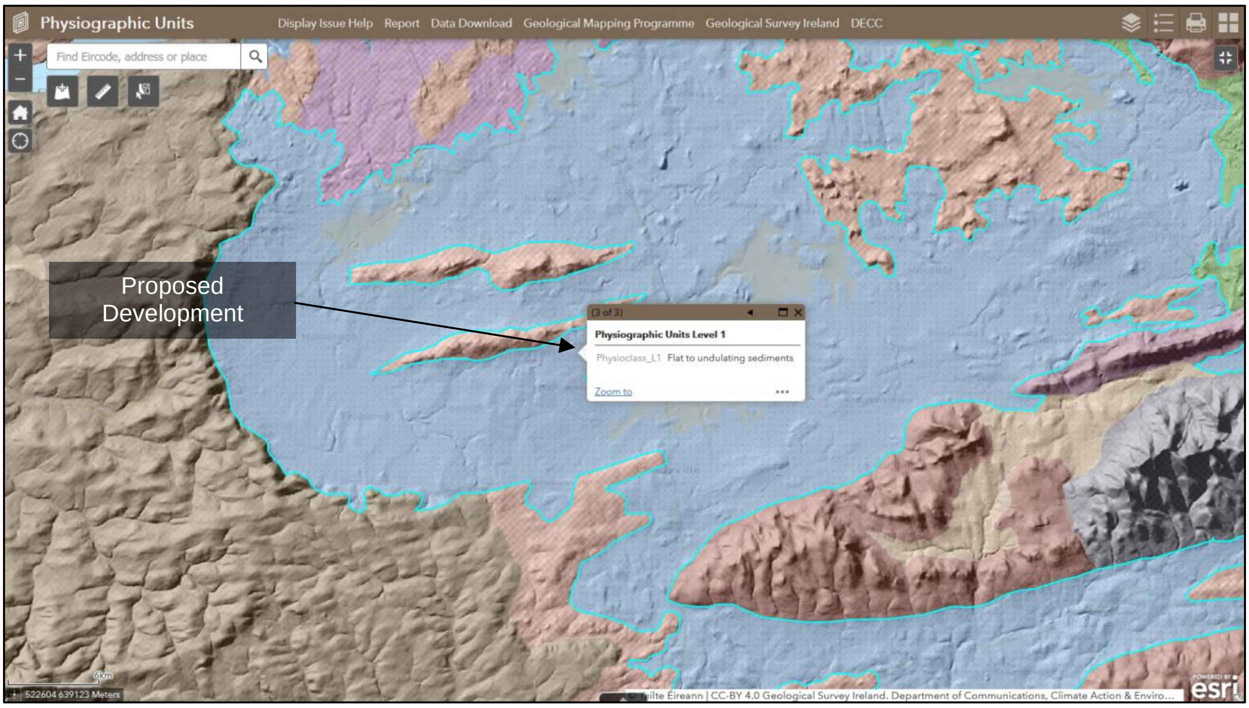

Figure 7.5: Physiographic Character of the site and surrounding landscape

The Second Edition General Soil Map of Ireland describes this region as belonging to the “Flat Undulating Lowland” broad physiographic division. The site appears to rest at the intersection of two soil associations which include;

- no. 34 of which the principal soil is “*Minimal Grey Brown Podzolics (70%)”,* associated soils including “*Gleys (20%)*” and *“Brown Earths (10%)”*
- no. 39 of which the principal soil is “*Gleys (75%)”,* associated soils including “*Acid Brown Earths (15%)*” and *“Peaty Gleys (10%)”.*

Parent material is proposed to consist of Limestone Glacial Till for both associations. According to GSI data, the entirety of the Proposed Development overlays till derived from Devonian sandstones (TDs). In view of the Proposed Development, the soils which are likely to be affected by the development are characteristic in the local and regional context and occur in abundance.

Much of County Limerick is underlain by Carboniferous limestone, which contributes to the region's karst landscape. While the drift layer often masks the bedrock, its composition (calcareous or non-calcareous) can reflect the underlying geology. Cappanihane, like much of County Limerick, features extensive glacial till, a mix of clay, silt, sand, gravel, and boulders, deposited by the retreat of glaciers. These deposits are often poorly sorted and represent the material carried and deposited directly by ice sheets during the Midlandian glaciation.

7.4.5 Bedrock Geology

Regional Bedrock Geology

Originally Ireland was composed of two 'halves' separated by a sea called the Iapetus, with the country split in a north-east to south-west direction from Clogher head to Dingle. The northwestern part of the island was located on the continent of Laurentia, with the southeastern part of the island located on Gondwana. The collision of these two continents resulted in the folding of both of these plates. This folding resulted in the formation of the mountain ranges located throughout Ireland today, which run in a northeast to southwest axis.

The scenic landscapes in the Limerick area formed over hundreds of millions of years by various geological processes, each one leaving its mark in the physical geography of the county. Careful examination of the rocks in the region shed light on the evolution of Limerick's terrain.

Rocks can be divided into three main groups, sedimentary, igneous and metamorphic. The first two of the three rock groups are exposed throughout Limerick. Sedimentary rocks are laid down in rivers, lakes or seas as particles of material such as sand or mud and then hardened by compaction and lithification into sandstones, siltstones, mudstones and limestones. Fossils, often preserved in these rocks, can give an idea of when the rock formed and what the climate and environment were like at the time of formation. Igneous rocks crystallise from magma originating deep beneath the Earth's surface and may be extrusive (i.e. lava flows at the Earth's surface) or intrusive (emplaced within the Earth's crust, below the surface). Metamorphic rocks are sedimentary or igneous rocks that have been altered by changes in temperature and/or pressure – this latter rock type is not present at any point beneath Limerick's landscape.

At any one locality there is usually more than one rock type, or lithology, and they are generally inter-layered. Ranges of lithologies over a small area are largely consistent and sequences of rock often share common characteristics allowing them to be grouped together as packages or geological units. The most important of these 'units' is the formation, which is defined as a sequence of related rock types differing significantly from adjacent sequences.

The bedrock geology of Co. Limerick comprises a series of rocks ranging in age from Silurian (438 million years old) to the Westphalian of the Upper Carboniferous (300 million years old). The rocks deposited in this period consist of both sedimentary – limestones, sandstones and shales – and igneous (volcanic) rocks.

The landscape of Co. Limerick reflects the varied underlying geology. The mountains to the north-east and south-east of the county are composed largely of the resistant Old Red Sandstone with older, less competent Silurian rocks in the core, while the younger, softer and soluble Carboniferous limestones underlie an extensive low lying plain, which is interrupted by three narrow ridges of folded Old Red Sandstone. The limestone plain passes westwards to a steep escarpment (west of Newcastlewest), which marks the upland areas of the younger

Upper Carboniferous sandstones and shales. The volcanic rocks are also well defined in the east around Herbertstown and Pallasgrean. These rocks were folded and faulted throughout the county. However, the intensity of rock deformation decreases moving northwards.

The landscape of County Limerick is a mix of lowland and upland terrain. The core portions of the Ballyhoura Mountains, Slieve Felim Mountains and the Galtees, are formed of the oldest rocks in the county. These older rocks crop out in several areas towards the centre of these mountain ranges where erosion has stripped away the younger rocks. These grey mudstones, siltstones and sandstones are Silurian in age and were deposited on a deep ocean floor. Surrounding these, and also forming the Corronoher and Knockfeerina Ridges, are conglomerates and sandstones of Devonian age, laid down by flash floods in a poorly vegetated river environment. Both Silurian and Devonian rocks are partly preserved because they were lifted up by Earth movements in both the Caledonain and Variscan orogenies, approximately 490 to 390 and 380 to 290 million years ago.

Soon after the start of the Carboniferous Period, sea levels rose to flood across the low plains of Limerick. The first of the marine rocks to be deposited were dark grey fossiliferous mudstones, but above these is a series of thick grey limestones which underlie much of the low ground across the county. At certain levels these limestones are quite fossiliferous, with shells of brachiopods and nautiloids, corals, fragments of crinoids, and rarer fossils such as trilobites. Mostly these limestones accumulated as horizontal layers on a fairly shallow ‘shelf’ sea floor although some of the younger layered limestones, around 325 million years ago, are much darker in colour and were deposited in considerably deeper water. Although the limestones mostly form low ground across the centre and east of the county, they are well exposed in various working and disused quarries and on some of the low hills in both the centre and south of the county.

Although the Carboniferous Period was dominated by warm-water sedimentation on the continental shelf, it also saw a series of volcanic eruptions. Thick flows of basalt and beds of tuff were deposited on the sea floor and today form layers on and between the limestone strata. Thick basalt lava flows form the huge rock outcrop upon which Carrigogunnell Castle stands, near Mungret. Most of the Carboniferous volcanic rocks occur in the area between Pallas Green and Fedamore, as lava flows and tuff layers interbedded with limestone. The volcanic magma was also intruded as dykes along faults or fractures and as fillings or plugs to volcanic vents. These intrusions, typically composed of resistant trachyte, now form small, sharp peaks, such as those at Knockderk and Kilteely. Apart from the Antrim Basalts, which include the Giant’s Causeway, the Limerick Volcanics constitute the most extensive and best-preserved example of a volcanic episode in Ireland.

Only in and around the Mullaghereirk Mountains and the adjacent Abbeyfeale Plateau are there younger rocks, from the Upper Carboniferous Period, when the shallow sea was filled with deltas and swamps. The delta deposits solidified to form sandstone and the vegetation in the swamps eventually matured into coal. The land surface was then uplifted and over a period of nearly 300 million years many of the rocks formed in the preceding 200 million years were eroded away, and the land surface reduced down to its present level.

The most significant force to shape the form of the county as we see it today was the Ice Age which ended approximately 11,500 years ago. Large ice sheets several hundred metres in thickness covered the county for tens of thousands of years and eroded the rocks beneath. Only the highest points in the Galtee Mountains, and Black Rock and Seefin Mountains in the Ballyhouras, poked up above the ice as nunataks. As the ice eventually melted away, the meltwaters reorganised the sediments into iconic landforms like drumlins, eskers and moraines. Drumlins occur in the northcentral part of Limerick, and eskers were formed by sub-glacial rivers, that is, they flowed in tunnels at the base of the ice sheets. Some eskers are small and local within Limerick, such as the Carrigkerry Esker, but the majority that traverse the county form extended networks and cross several counties. Other iconic landforms created by the ice sheet in Limerick include the crag and tail at Tory Hill, and the deep meltwater channels at Galbally and the Clare Glens.

Since the Ice Age, much of the exposed limestone in Limerick has developed into what is termed karstified bedrock. Water solution of the rock formed underground cavities linked to the surface by swallow holes. Geological processes continue to modify the landscape today, as manifested by events such as seasonal flooding of the Shannon and many of Limerick's other major rivers.

The majority of the Proposed Development is located entirely within a narrow terrane of Dinantian (early) Sandstones, Shales and Limestones which runs from west to the northeast. The terrane stretches from Mayne (W) to the northeast past Castletown, continuing towards the site location at Cappanihane and terminates at Coolrus (NE). **Figure 7.6** below indicates the hydrostratigraphic rock unit groups within the vicinity of the Proposed Development and the wider region.

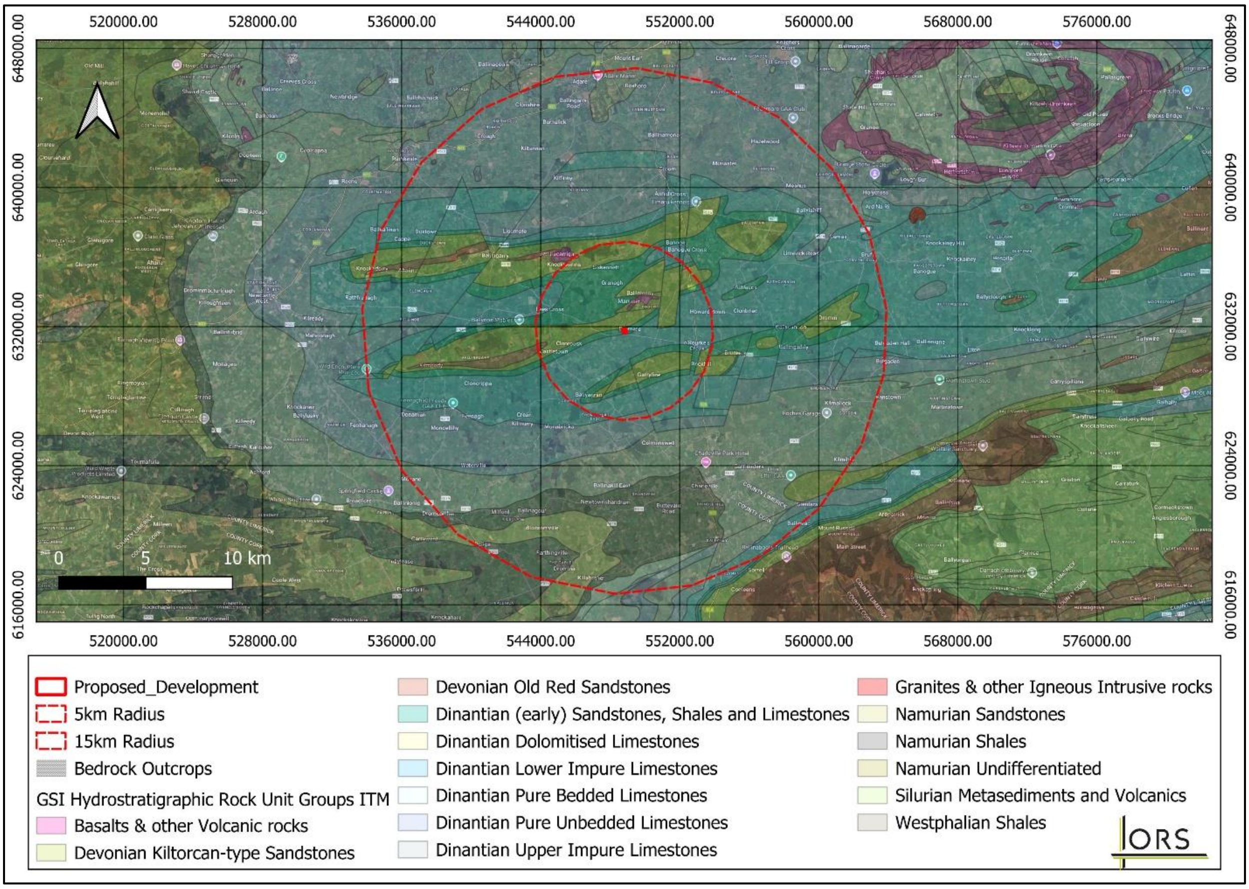

Figure 7.6: Hydrostratigraphic Rock Unit Groups Within Co. Limerick (GSI)

Local Bedrock Geology

Bedrock is defined as a consolidated aggregate of minerals underlying the ground surface and any soils present. Above the bedrock is usually an area of broken and weathered unconsolidated rock in the basal subsoil. Sedimentary rock lies in beds which may comprise different rock types and which may be horizontal or inclined, so that the rock encountered at the ground surface may change over a short distance.

According to the Geological Survey of Ireland and the National Draft Generalised Bedrock Map, the bedrock within the 2km study area of the Proposed Development, which extends to the southwest and northeast is comprised of sandstones, shales and limestones from the early Dinantian period. The area to the south of this formation is underlain by impure limestones of the Dinantian period which extends to the southwest and to the east beyond the 2km study area. To the south, within this region of impure limestone is a formation of the aforementioned Dinantian sandstones, shales and limestones beyond which occurs a region of Devonian Kiltorcan-type Sandstones. These old red sandstones also occur to the north and northeast of the 2km study radius along which occur a number of bedrock outcrops. In the northeast of the 2km study radius, a portion of the bedrock in the region is identified as basalts & other Volcanic rocks along which a number of bedrock outcrops also occur.

The formation underlying the Proposed Development is referred to as the “Lower Limestones and Shales”. The 1:100,000 Bedrock Solid Geology Map indicates that the bedrock type in this formation is sandstone, mudstone and thin limestone. The lithological description of the formation is as follows:

“*the standard succession for this unit is in the Limerick Province where it is based on coastal sections on the Shannon Estuary and on the Pallaskenry borehole (LI-68-10). It comprises the Mellon House, Ringmoylan, Ballyvergin and Mallymartin formations”*.

This formation is bordered to the north by an Old Red Sandstone Formation, described as “*red clastics*”. A number of exposures are located along this formation, the closest of which is located *ca.* 450m to the northeast. Beyond this Old Red Sandstone formation is a wide terrane of Lower Limestone Shales. To the northeast, within the Old Red Sandstone formation is a Volcaniclastic Formation, described as Volcaniclastic rocks among the Dinantian limestones.

To the south is Ballysteen formation. The 1:100,000 Bedrock Solid Geology Map indicates that the bedrock type in this formation is Fossiliferous dark grey muddy limestone. The lithological description of the formation is as follows:

“*Irregularly bedded and nodular bedded argillaceous bioclastic limestones (wackestones and packstones), interbedded with fossiliferous calcareous shales. It represents a widespread development throughout Westmeath and Longford”.*

Exposeres of the formation occur *ca. 75*0m to the southwest of the Proposed Development. The regional bedrock formations and linework occurring within the 2km study area of the Proposed Development and the wider surrounding area are illustrated in **Figure 7.7** overleaf.

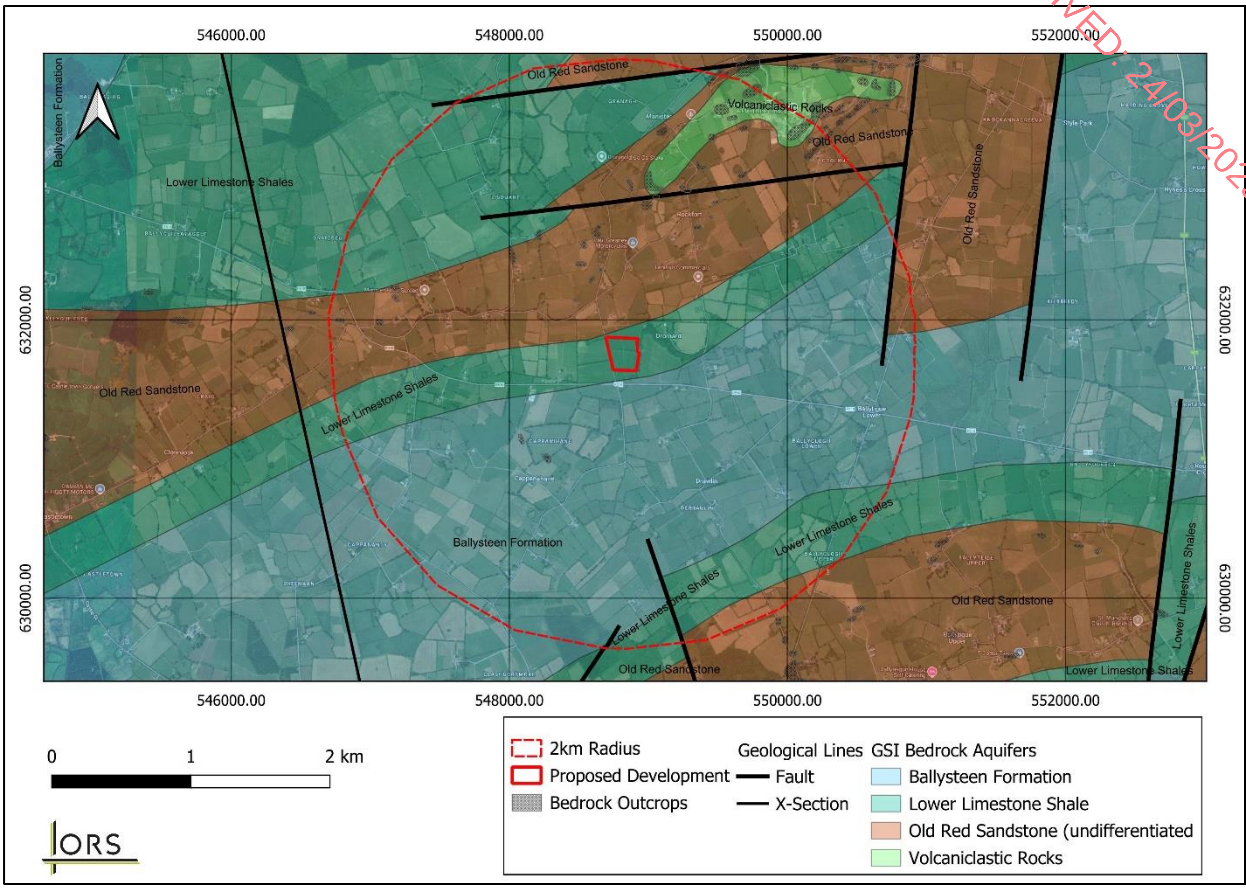

Figure 7.7 Regional Bedrock Formations (GSI)

The bedrock geology and linework available from the GSI map viewer indicates that there are a number of geological linework (e.g. unconformity, faults etc.) within the 2km study area. The closest unconformity is located *ca.* 950m north of the site and runs from west to east. The unconformity (Fault) separates two Old Red Sandstone (undifferentiated) formations and marks the beginning of the Volcaniclastic Rocks formation which extends north-eastwards and terminates below another (Fault) unconformity which runs parallel to the aforementioned fault line.

Depth to Bedrock

According to the GSI database, there are approximately **19 groundwater wells within the 2km study area**. These groundwater wells are defined as a mix of dug wells and boreholes. The details of groundwater wells within 2km of the Proposed Development are outlined in **Table 7.5** overleaf. The distances provided are taken from the nearest point of the site to the relevant well. **Figure 7.8** overleaf superimposes the approximate location of the groundwater wells listed in **Table 7.5** relative to the groundwater vulnerability rating of the area. The Proposed Development boundary is marked out in red. Groundwater wells within the wider area have a varying yield class ranging from excellent to poor. The lands on which the site location has been proposed have been assigned variety of vulnerability rating of moderate. The recorded depth to bedrock encountered for the corresponding wells in 2km study area are generally between 1.8 to 40.2 metres below ground level (bgl). The majority of subject site is situated above the Ballingarry Groundwater Body which is designated by the Geological Survey of Ireland (GSI) National Draft Bedrock Aquifer Map as a Regionally Important Aquifer - Fissured bedrock (Classification reference - Rf). A portion of the southern site boundary lies within the Hospital Groundwater Body which is designated by the Geological Survey of Ireland (GSI) National Draft Bedrock Aquifer Map as a Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones (Classification reference - Ll).

Table 7.5: Groundwater Wells with 2km of the Proposed Development (GSI Well Database)

GSI Reference	Easting Northing	Well Type	Depth (m bgl)	Depth to Rock (m)	Well Use	Yield m^3/d	Proximity to site
1413SWW065	149320 130890	Dug well	3.4	3.4	Unknown	55.0	0.3km SE
1413SWW050	149590 130920	Borehole	17.7	-	Unknown	33.0	0.91km SE
1413SWW047	149420 130240	Borehole	24.4	12.2	Unknown	28.0	1.39km SE
1413SWW096	150700 131200	Borehole	45.1	3.1	Unknown	-	1.29km E
1413SWW067	150700 131370	Dug well	9.1	-	Unknown	-	1.27km E
1413SWW126	150580 131140	Borehole	62.2	24.4	Domestic use only	54.5	1.67km E
1413SWW127	148800 133600	Borehole	73.2	40.2	Domestic use only	545.0	1.26km N
1413SWW075	242320 118000	Borehole	15.5	-	Unknown	28.0	0.94km NW
1413SWW061	146870 132590	Borehole	46.3	6.1	Unknown	27.3	1.51km NW
1413SWW062	146870 132640	Dug well	1.8	0.6	Unknown	43.6	1.51km NW
1413SWW132	147740 131290	Borehole	25.0	-	Unknown	44.0	0.59km W
1413SWW076	147320 131280	Borehole	13.4	-	Unknown	44.0	1.06km SW
1413SWW058	146500 131250	Borehole	38.1	9.1	Unknown	27.3	1.82km W
1413SWW059	146500 131300	Borehole	21.3	-	Unknown	27.3	1.82km W
1413SWW060	146500 131350	Borehole	30.5	30.5	Unknown	21.8	1.82km W
1413SWW078	148130 130370	Borehole	29.3	-	Unknown	39.0	0.89km SW
1413SWW069	148130 130320	Dug well	5.5	5.5	Unknown	27.0	0.94km SW
1413SWW123	148500 130480	Borehole	36.6	13.4	Unknown	43.6	1.12km SW
1413SWW017	148000 129500	Dug well	1.8	1.8	Unknown	77.00	1.73km SW

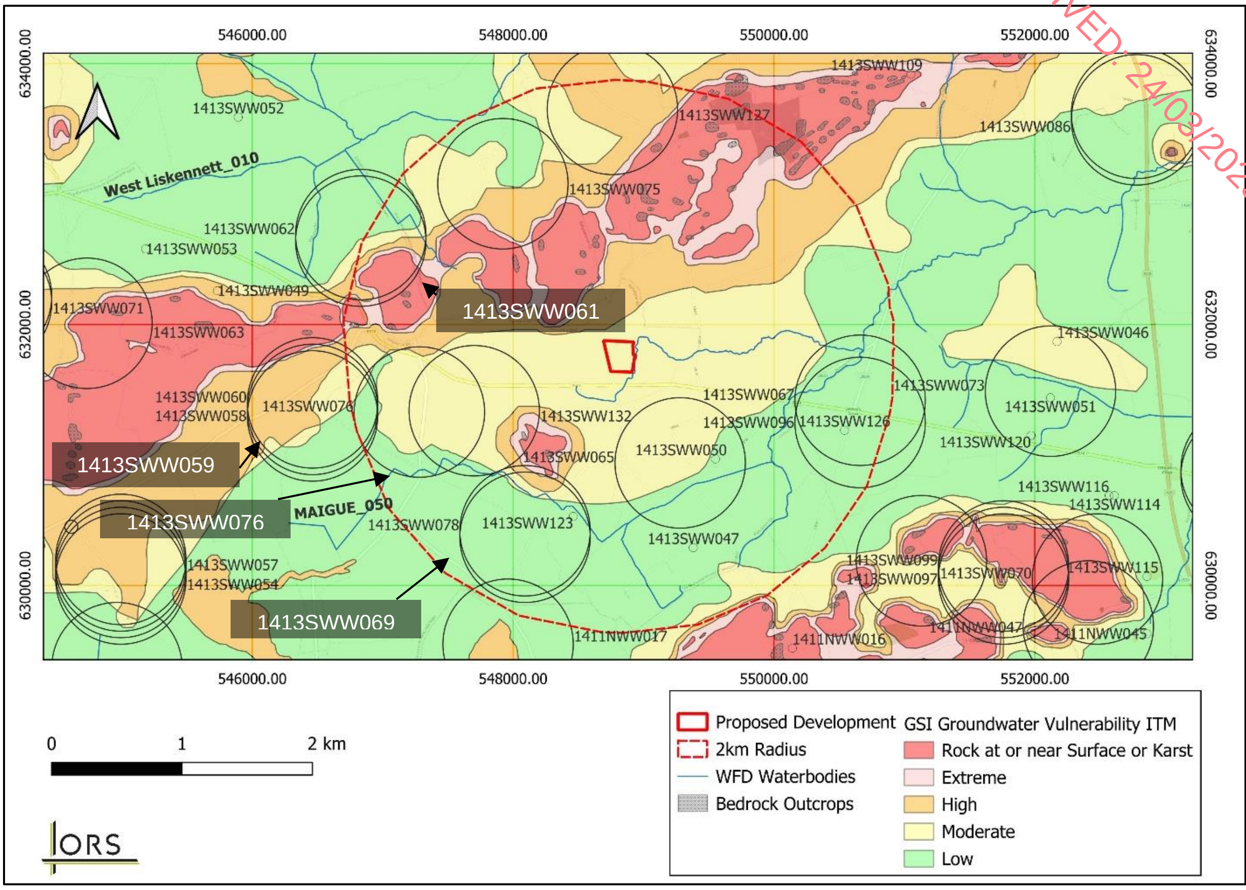

Figure 7.8: Groundwater Vulnerability and location of Groundwater Wells (GSI Maps)

Karst Features

Karst areas are characterised by landforms of dissolution. Karst aquifers can be particularly vulnerable to pollution and karst features can also give rise to flooding. **Figure 7.9** overleaf presents the approximate location of karstic features relative to the location of the proposed site. There are no karstic features located within the proposed boundaries of the Proposed Development or within the immediate vicinity of the site. There are no karstic features located within the 2km study area.

Examples of karst landforms are found to the northwest of the Proposed Development site, within the boundaries of Limerick County. Karstic features are common in this region *ca.* 7.5km to the northwest due to the underlying limestone bedrock of the Walusortian Limestone and Dinantian (Undifferentiated) formations underlying the region as well as the presence of numerous faults at the intersection of these rock unit formations. The closest Turlough can be found *ca.* 21km northeast of the Proposed Development site. County Limerick has a low density of karst features in comparison to the surrounding counties of Clare and Cork due to the presence of sandstones, shales, volcanics and impure limestones which underlie much of Limerick.

Tracing of underground flows has been undertaken by GSI and indicates interconnectivity between karst features *ca.* 170km to the northeast of the study area. Traced groundwater movement through karst features to the northeast were found to have an east to west flow, towards the development. No connectivity was confirmed with the closest karst features to the development and no karst features have been identified within 5km of the Proposed development to date.

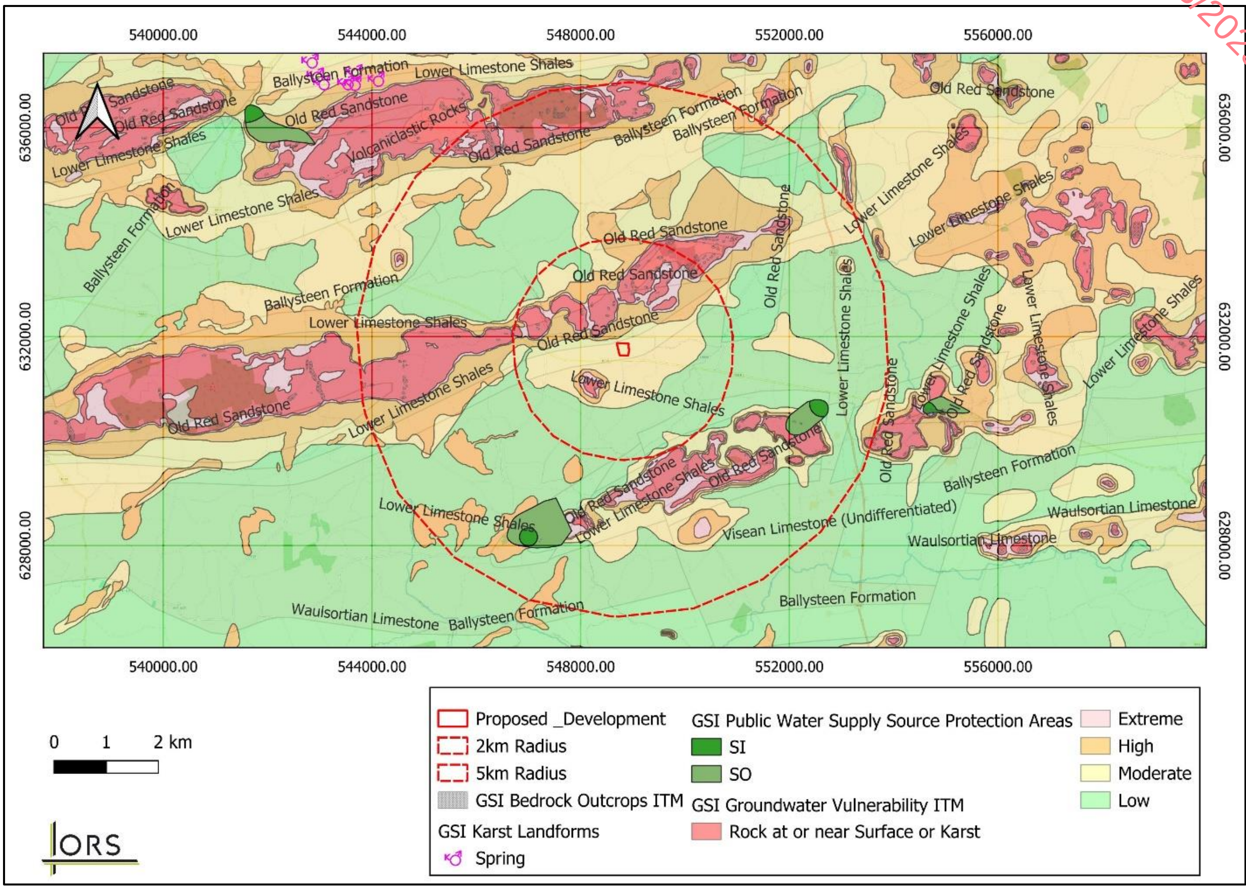

Figure 7.9: Karst Features, Vulnerability, And Groundwater Source Protection Areas Overlaying Regional Bedrock Formations and Outcrop Extents. (GSI)

Mineral Aggregate Resources

There are no active quarries on or adjacent to the Proposed Development. The nearest active quarry recorded on the GSI's online database is Ballinruane Quarry, operated by Shelton Contracting Ltd. *ca.* 8.5km west of the site in Gortroe, Castletown, Kilmallock, Tipperary. Ballinruane Quarry specializes in the extraction and processing of sandstone and has an annual output of approximately 30,000 tonnes. The quarry's operations focus exclusively on the construction sector, providing sandstone and drainage stone. Equipment on-site, includes excavators, rock breakers, crushing systems, and mobile dry screening plants.

There is an active mineral locality located *ca.* 2km northeast of the Proposed Development, which is described as "non-metallic" and "roadstone quarry in basaltic ash within old red sandstone". Within the wider region several metallic mineral localities are identified, the closest of which includes lead (Pb) located *ca.* 13km to the east.

Radon

Radon is a naturally occurring radioactive gas formed by the radioactive decay of uranium and thorium which may be present in varying quantities in rocks, soils and groundwater. Classified by IARC (International agency for research on cancer) as Group 1 - carcinogenic to humans - Radon is second only to smoking as the leading cause of lung cancer. It is estimated that some 250 lung cancer cases each year in Ireland are linked to radon exposure and accounts for more than half of the total radiation dose received by the Irish population (EPA, 2016). The acceptable level, or Reference Level, for homes and schools in Ireland is 200 becquerel per cubic metre (Bq/m^3). For workplaces the Reference Level is 400 Bq/m^3

Consultation with the EPA's online Radon Map shows a prediction of the number of homes in a given grid square that exceed the national Reference Level (200 bequerel per cubic metre (Bq/m^3)). Grid squares in which the predicted percentage of homes is 10% or greater are called High Radon Areas.

The EPA's Radon Map shows that the majority of the site is located across a Moderate Radon area, with 5% houses in the vicinity of the site estimated to have radon levels above the Reference Level. A portion of the southern site boundary is located within a High Radon area, with 10% houses in the vicinity of the site estimated to have radon levels above the Reference Level. As such all-office and canteen structures on site should be fitted with radon barriers to minimise staff exposure. Testing of radon in the workplace is a legal requirement in these zones.

Seismic Activity

No seismicity data is available from GSI online resources. Seismic activity is recorded by the Irish National Seismic Network. The Geophysics Section of the School of Cosmic Physics, Dublin Institute for Advanced Studies, has been recording seismic events in Ireland since 1978. **Figure 7.10** below illustrates historical and recorded seismic events since 1980. Ireland is not considered an area to be of high seismic risk. As can be seen below, there is no significant seismic activity recorded within the vicinity of the Proposed Development.

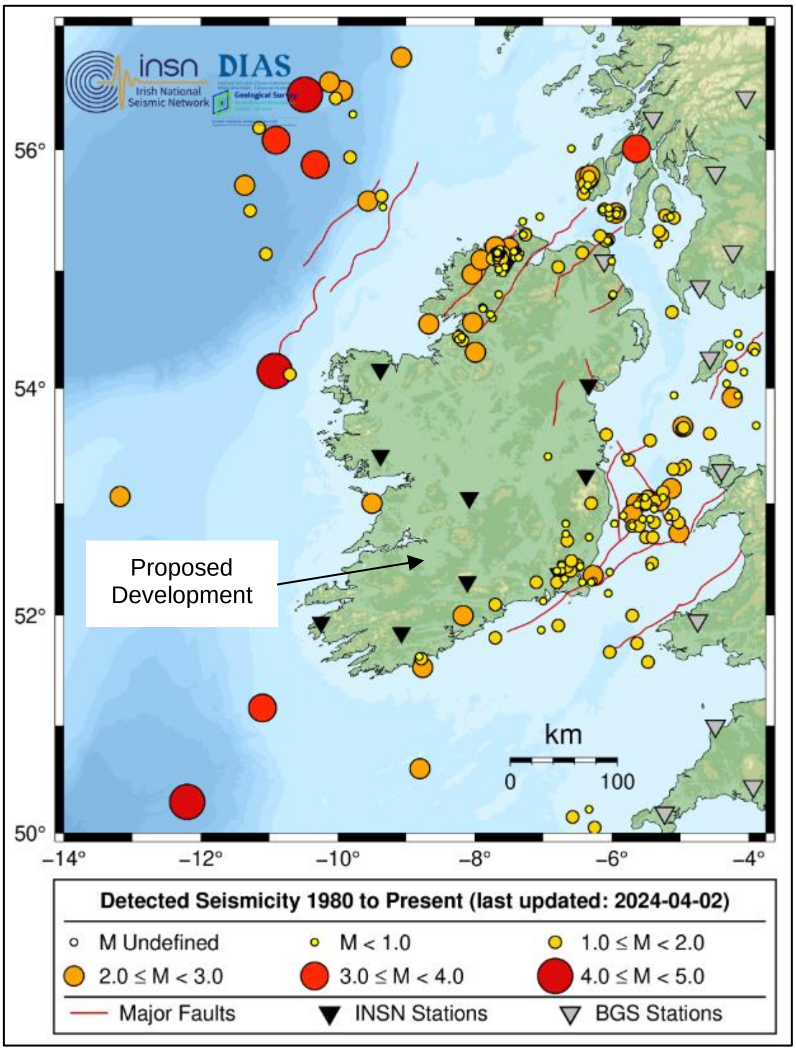

Figure 7.10: Recorded seismic activity in Ireland since 1980.

7.4.6 Soils and Subsoils

Soils can be referred to as topsoil or subsoil. Topsoil is the active layers at ground level where living organisms are found. Changes in soil characteristics are delineated in "horizons". Topsoil is referred to as horizons 'A' and 'B'. Subsoil is the loose uncemented (unlithified) sediments present between the soil 'B' horizon and bedrock. Subsoils are termed the 'C' horizon.

Regional Soil and Subsoil

The formation of soil is dependent upon geology, climate, vegetation, altitude, and landform shape. Soil landscapes found in Ireland are a consequence of the changing climatic conditions over the last 100,000 years (the last glacial age was *ca*.12,000 years ago) and the management of land by farmers.

The soils in Co. Limerick are mainly derived from a mixture of non-calcareous, noncalcareous, volcanic rock, mineral alluvium and peat materials. The soils range from blanket peat; cut over raised peat, fen peat; mineral poorly drained (mainly acidic) (AminPD); deep well drained mineral (mainly acidic) (AminDW); shallow well drained mineral (mainly basic) (BminSW);

mineral poorly drained (mainly basic) (BminPD); deep well drained mineral (mainly basic) (BminDW); (AminPDPT), shallow poorly drained mineral (mainly acidic) (AminSP); lacrustine type soils (Lac); peaty poorly drained mineral (mainly acidic) (AminPDPT); shallow, rocky, peaty/non-peaty mineral complexes (mainly basic) (BminSRPT) and alluvium (AlluvMIN) as shown in **Figure 7.11**.

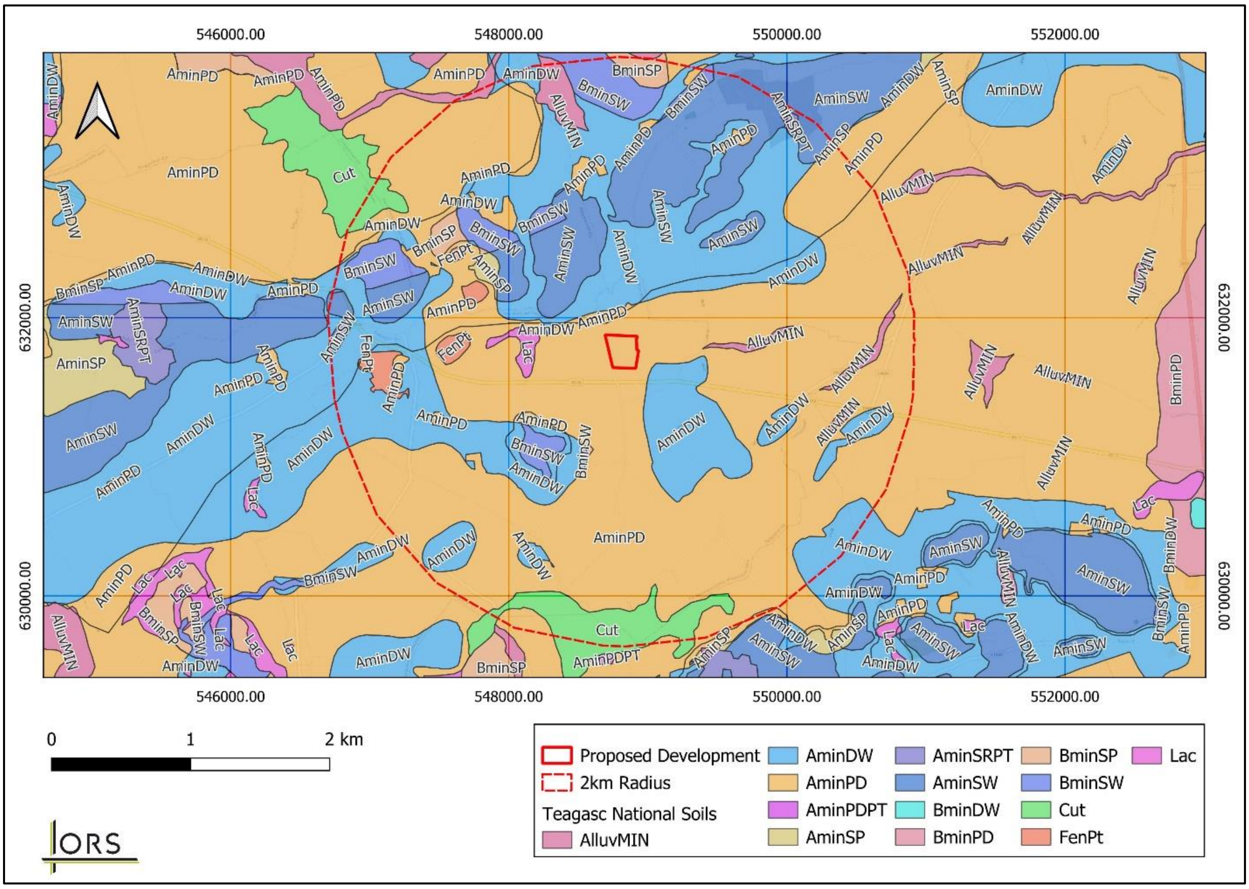

Figure 7.11: National Soil Map of County Limerick

The Quaternary Drift of the Proposed Development is described as till derived from Devonian sandstones (TDSs). The subsoils across the majority of the site are described as being of low permeability and are overlain by poorly drained gley soil (mainly acidic). The National Soil Survey of Ireland describes this region as comprising Clayey drift with limestones.

In view of the Proposed Development, the soils which are likely to be affected by the development are characteristic in the local and regional context and occur in abundance.

Local Soil and Subsoil

GSI online mapping indicates that the site overlies mineral poorly drained (mainly acidic) (AminPD) derived mainly from non-calcareous parent materials. The soil groups associated with this category are surface water Gleys and groundwater Gleys. A number of bedrock outcrops are noted towards the southwest of the site and to the northeast. A number of bedrock regions in the surrounding area of the Proposed Development are also noted and are classified as belonging to soil groups of Luvisols, Gleys Brown Podzolics and peat soils.

The soils in the greater surrounding area are categorized as Acid Brown Earths and Brown Podzolics *ca.* 0.1km east, 0.3km north and 0.5km southwest. A pocket of Rendzinas, Lithosols is noted *ca.* 0.7km to the southwest. Deposits of Basin Peat occur *ca.* 1.1km to the west. A number of deposits which are described as belonging to "Variable" soil groups occur in the wider area and are described as Alluvium or as Lake Sediments.

The Irish Soil Information System (SIS) project has developed a national association soil map for Ireland at a scale of 1:250,000, together with an associated digital soil information system, providing both spatial and quantitative information on soil types and properties across the country. This resource groups similar soil groups together into 11 soil 'Great Groups' and associated 'Sub-Groups', allowing for the taxonomical classification of soil types throughout Ireland. The site overlies the Howardstown Series. Under the SIS classification system, this soil is a member of the great group *7 - Surface Water Gley* with the soil sub-group classified as *Humic Surface-water Gleys*. The soil associations present around the Proposed Development locality are represented in **Figure 7.12** below**.**

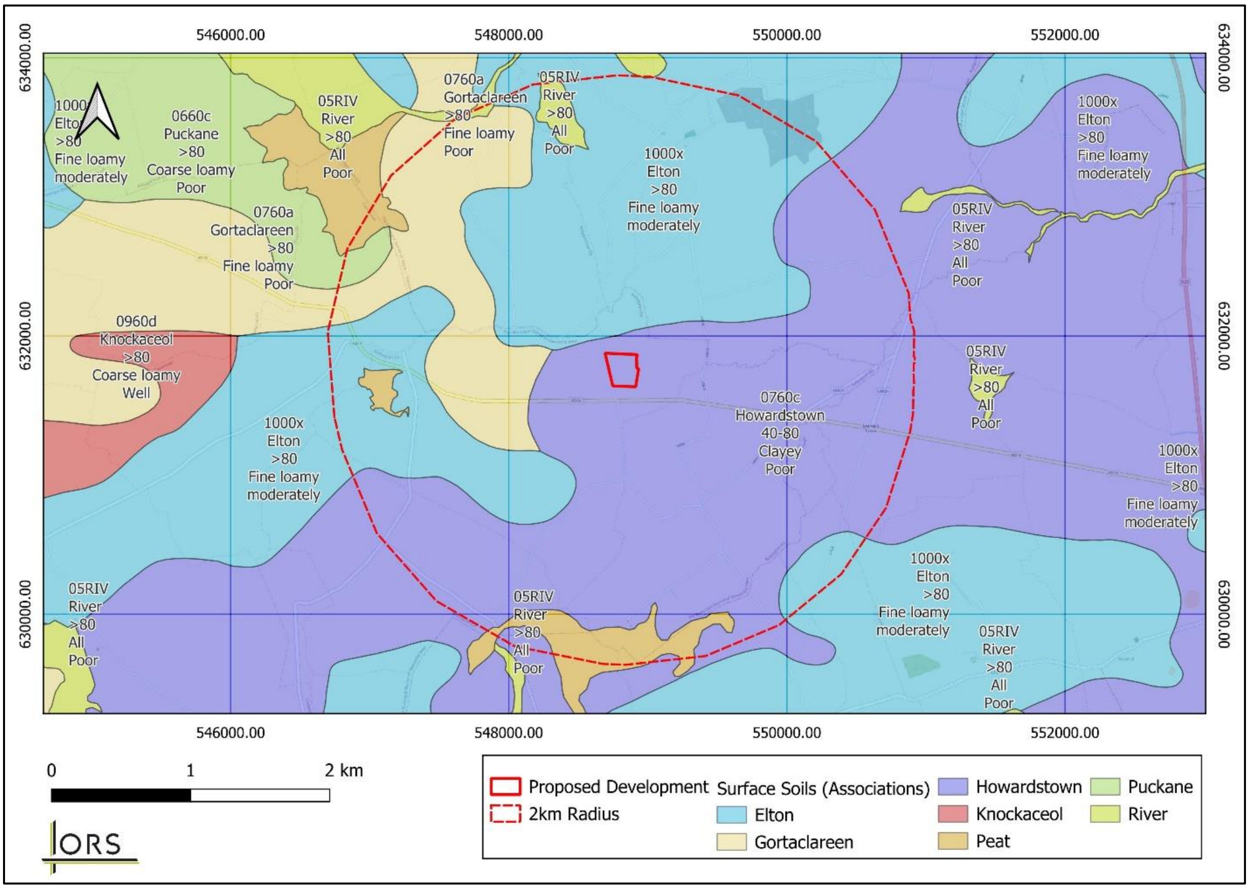

Figure 7.12 Irish Soil Information System (ISIS) Map – Surface Soils. Map detailing soil associations underlying the site (EPA and Teagasc)

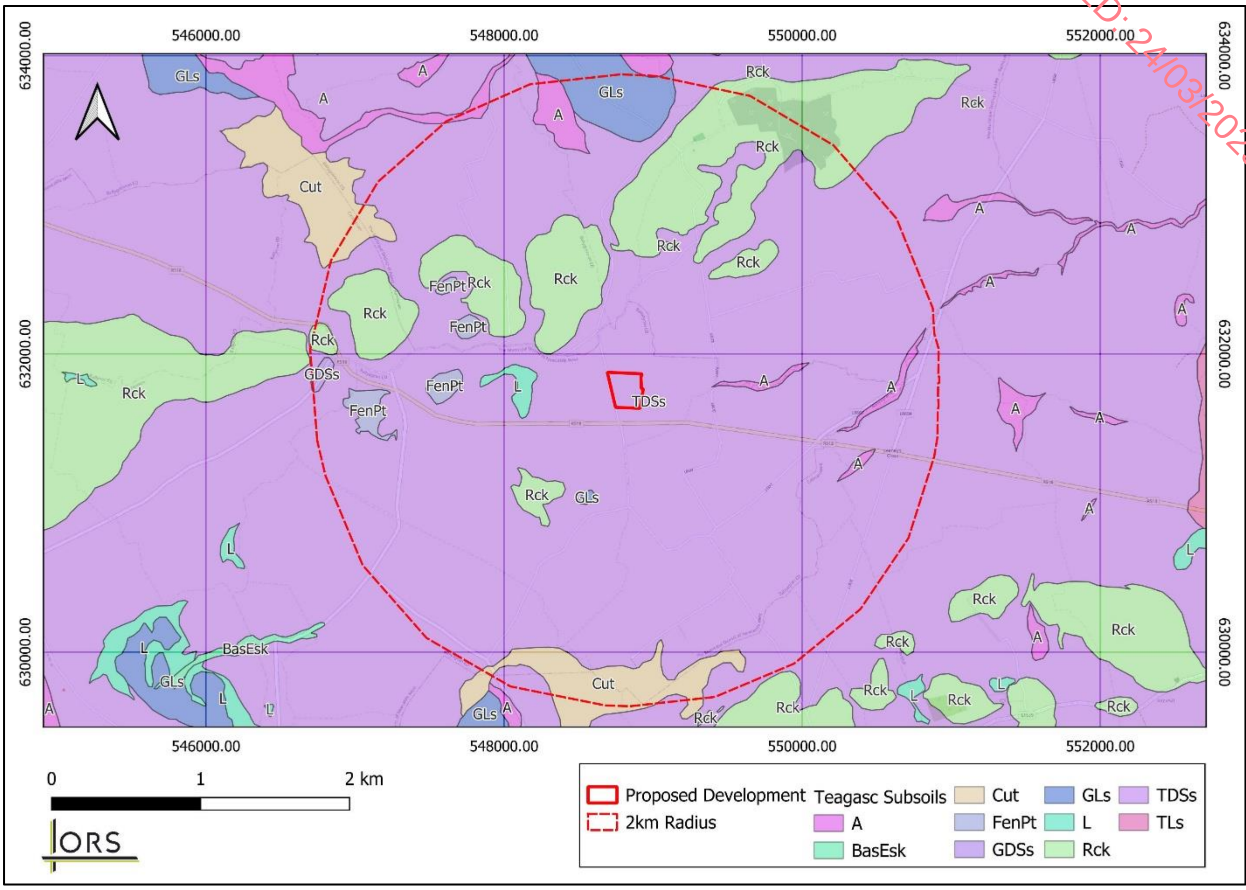

Figure 7.13 Teagasc Subsoil Map detailing subsoil types underlying the site

With respect to **Figure 7.13** the respective subsoil codes represent the following subsoil / quaternary sediment types:

- A = Alluvium
- BasEsk = Eskers comprised of gravels of basic reaction
- Cut = Cutover Peat
- FenPt = Fen Peat
- GDSs = Gravels derived from Devonian sandstone
- GLs = Gravels derived from limestones
- L = Lacustrine sediments
- Rck = Bedrock outcrop or subcrop
- TDSs = Till derived from Devonian sandstone
- TLs = Till derived from limestones

The Teagasc representative soil profile description for the 'Howardstown' association notes it as having a clayey texture. The association is broadly described as clayey drift with limestones. A humic layer is noted from 0-19cm bgl. Texture remains consistent throughout the four distinct soil horizons, with an exception in the 19-30cm range being described as clay loam instead of clay. The proportion of stones increases with depth from few to abundant to many. A detailed representative soil profile description from the Teagasc SIS database of the "Howardstown" soil association is included in **Appendix 7.1**. This representative soil description available for the

'Howardstown' series is taken from a site in Roscommon and not from the subject site. Thus, the specific composition of soil on the site at Cappanihane will differ somewhat from the representative soil profile.

The EPA database indicates the parent material for the subsoils beneath the site are till derived chiefly from Devonian Sandstones (TDSs). The till is described as diamicton, which relates to its terrigenous sediment that is unsorted to poorly sorted and contains particles ranging in size from clay to boulders, suspended in an unconsolidated matrix of mud or sand. This unsorted matrix is due to glaciation. Areas of acid Brown Earths and Brown Podzolics are noted *ca.* 100m to the east, 300m to the north and *ca.* 650m to the southwest. The subsoil in the areas delineated as alluvium are described as having undifferentiated alluvium subsoils. Regions where bedrock is at or close to the surface are noted *ca.* 450m to the northwest of the Proposed Development in addition to some areas of peat subsoils *ca.* 1.05km to the west.

The existing site is used for agricultural purposes and due to its topography is suited to pastural grazing and silage production.

Licensed Sites

A review of the EPA and DCCAE website for existing and historic, licensed and illegal waste activities, mines and industries was carried out to identify any potential contamination sources present in the area and to identify any potential contaminating activities near the Proposed Development.

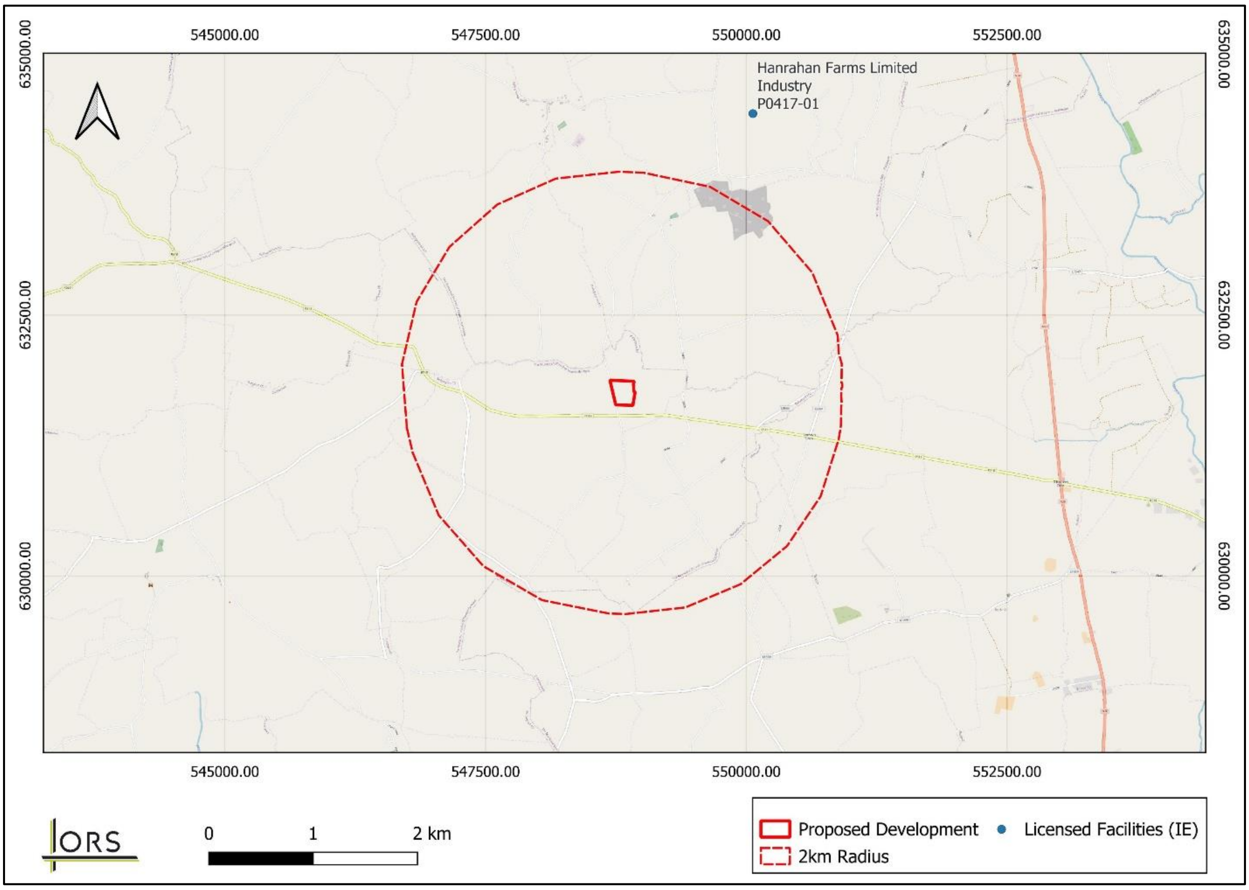

Figure 7.14 EPA licensed facilities within the vicinity of the Proposed Development

The desk study indicated that no illegal waste activities sites were present within a 2km radius of the proposed area. No Licensed Integrated Pollution Prevention Control (IPPC) facilities are located within the 2km study radius of the Proposed Development. The closest facility is located *ca.* 2.9km northeast of the Proposed Development, see **Figure 7.14**. The facility is identified as Hanrahan Farms Limited, which is classified as industry. Details of the licensed IPCC facilities in the wider region are outlined in **Table 7.7** below.

Assessment of historic orthographic maps show that the proposed site has remained as undeveloped greenfield since records were established. Some minor developments which include the establishment of several farm / residential units in the surrounding environment have occurred throughout the years. The predominant land-use within the vicinity of the site is agricultural greenfield.

No previous applications for permission on the site have been submitted. The details of significant licences granted in the immediate area of the development are outlined in **Table 7.7**. It is not foreseen that any these licensed facilities will have an effect on the Proposed Development.

Table 7.7: Licensed Integrated Pollution Prevention Control (IPPC) Facilities and Industrial Emissions License applications outside of the 2km study area

Licence Number	Major Class of Activity	Distance from site	Name	Licence Type & Status
P0417-01	Industry (6.2(a))	2.9km NE	Hanrahan Farms Limited	IEL / Licensed
P0386-04	Industry (7.2.1)	9.6km SE	Kerry ingredients (Ireland) Limited (Charleville)	IEL / Licensed
P0283-02	Industry (3.9)	11.1km SE	Brewery, Chemical and Dairy Engineering Limited	IPC / Licensed

There are no mapped current licensed/ unlicensed or historic waste facilities/ dump sites within the 2km study area of the Proposed Development. The closest facility is the Ballyguyroe Landfill located *ca.* 23.4km southeast of the Proposed Development. The facility is a licensed waste facility (W0002-02). Another facility, the Longpavement Landfill is located *ca.* 28.9km northeast of the site and is a licensed landfill (W0076-01). Given the significant distance (>15km) of the waste facilities in Co. Limerick to the Proposed Development, it is not foreseen that there will be any effect on the Proposed Development.

Historic Land Use

The historic maps indicate no obvious sources of contamination based on previous land use within the proposed site. The 25-inch historic maps (1863-1924) indicate that the area in the immediate vicinity of the Proposed Development site consists of agricultural lands. Two disused quarries are noted *ca.* 560m southwest and *ca*. 700m southwest of the Proposed Development. A disused lime kiln is also noted *ca.* 820m southwest of the site. A disused gravel pit is noted *ca.* 880m southwest of the Proposed Development. In subsequent maps of the area, none of these structures have had visibly lasting impressions or effects on the environment.

Table 7.8: Historical Land Use (https://geohive.ie/)

Date	Description
1837-1842	The proposed site and adjacent lands are greenfield. The Glenbrook House residence *ca.* 200m to the northeast is established. Additionally, there are a number minor developments in the wider area including a fort, a turret and a police barracks. The R518 road adjacent to the southern site boundary is not yet established, while the L8658 local road adjacent to the west of the site is established at this point.
1863-1924	The R158 road adjacent to the south is established. There have been adjustments to a number of the field boundaries in the wider area in addition to the establishment of additional farm / residential units. Two disused quarries are noted *ca.* 570m and 600m to the southwest and a disused lime kiln is noted *ca.*810m to the southwest. A disused gravel pit is noted *ca.* 830m to the southeast.
1995	The proposed site is greenfield. Further development of the surrounding area is evident, including the establishment of a residence beyond the R158 road to the south.
2000-2003	The proposed site is greenfield. With minor development in the surrounding area.
2013-2018	The proposed site is greenfield. No significant changes to the surrounding environs compared to previous years. The appears much the same as it does today.

Landslides

The GSI's online landslide database indicates there are no historic landslides recorded on the site. However, there is one historic landslide recorded *ca.* 1km southwest of the Proposed Decelopment. The event (ID: GSI_LS03-0009) is dated 6/6/1667 with an accuracy to 1-day and is described as:

"*The event lasted about half an hour. Cappanihane Bog Near Charleville. The bog was situated on the Estate of Brook Bridges*"

7.4.7 Ground Investigation

Ground investigation works were carried out by a chartered ORS environmental scientist for the Proposed Development at Cappanihane on the 22nd of November 2024. These investigations confirmed that the general geology and subsoil conditions corresponded to the conditions indicated in the geological mapping. The location and depth of the trial pits is shown on **Figure 7.15**, and details of each investigation location is presented in **Table 7.9**. Conditions on site were dry with snowfall on the ground during the time of trial pit investigations.

The depths of trial pits varied slightly from 2.4m to 3.4m bgl. Bedrock was not encountered across any of the trial pits 01 - 06. As stated in **Section 7.4.2** the topography peaks at 92.49m AOD along the northwestern boundary in the site with a gradual gradient (TP04 is in the middle of this gradient) south-eastwards to a low of 90.98m AOD (TP02). The site has a slight gradient from northwest to southeast, which remains relatively uniform across the site and increases slightly towards the eastern site boundary.

There was some variation in the soil profile across all six trial pits. Some similarities between profiles were also noted. The topsoil across all trial pits were all of a dark brown in colour with TP04 noted as containing a proportion of gravel. This topsoil was observed to overlay layers of CLAY (TP01, TP03 and TP06) or Gley soils (TP04 and TP05) with soil compaction and presence of cobbles observed to increase with trial pit depth. Clay at lower depth was observed to be impermeable. Mottling of soils was observed in TP01, TP02, TP06 and to a lesser extent in TP03. Bedrock was not encountered in any of the trial pit excavations.

The findings of the site investigation correlated with the GSI soil and subsoil database mapping. The predominant soil underlying the Proposed Development is a mineral (poorly drained, mainly acidic) derived from non-calcareous parent materials. The Proposed Development site is characterised by a poor draining bedrock (sandstone, mudstone, thin limestone), low permeability subsoil overlain by a poorly-drained topsoil. The GSI groundwater vulnerability matrix indicates that soil depth is between 3-8m in depth. The topsoil throughout the site is characterised as Brown Earth. The subsoil found throughout the trial pits exhibits a variety of characteristics and has variable textures consisting of clay/ loamy clay to gley. The findings of the trial pits are presented in **Table 7.9** overleaf.

The underlying bedrock across the site is a Dinantian sandstone, mudstone and shale. Bedrock was not encountered in any of the trial pits which ranged in depth from 2.4 to 3.4m deep. Instances of cobbles were observed from depths of 1.6m to 1.7m in the trial pits, with TP06 having small boulders present from 2.4m bgl. Groundwater infiltration was encountered at 1.0m bgl in Trial Pit 4. According to the EPA database, groundwater vulnerability for the site is described as moderate.

A site characterisation assessment (percolation assessment) was conducted by Coyle Environmental on the 22nd of November 2024. The assessment was conducted in TP-05 and has concluded that the Proposed Site has an R1 groundwater protection response, which is acceptable to normal good practice. The complete report is available in **Appendix 8.2**.

Figure 7.15: Location of Trial Pits (TP) and Site Characterisation Assessment

A summary of the soil profiles encountered during the ground investigation carried out as part of this report is given in **Table 7.9** below.

Table 7.9: Ground profile for each Trial Pit

Location	Depth (m)	Ground Profile	Comments
TP-01	0.0 – 0.3 0.3 – 1.8 1.8 – 2.4 2.4	Topsoil – Dark Brown Earths. LOAMY/CLAY. Gravel abundant, lighter brown colouring. Dark CLAY (more compact), mottling evident throughout the layer, abundant rounded large cobbles. End of TP.	Trial Pit located at proposed tank farm area. Fluctuating water table likely, evident through signs of mottling and saturated impermeable CLAY. Proximity to drainage, seasonal changes and lack of recent rainfall may contribute to not observing groundwater strike. No Bedrock encountered.
TP-02	0.00 – 0.2 0.2 – 1.7 1.7 – 2.75	Topsoil – Dark Brown Earths. Dark brown gravelly CLAY / Gley soils with higher silt content than other locations. Mottling (grey/orange) present throughout. Compacted impermeable CLAY with grey mottling throughout suggesting gleying of soils, evidence of seasonal	Trial Pit located at proposed digestate storage tank area. Fluctuating water table likely, evident through signs of mottling and saturated impermeable CLAY. Proximity to drainage, seasonal changes and lack of recent rainfall may contribute to not observing groundwater strike. No Bedrock encountered.

	2.75	high-water table. Occasional rounded large cobble present. The river to the east likely contributes to high water table & recharged by groundwater. End of TP.	
TP-03	0.00 – 0.3 0.3 – 2.1 2.1 – 2.4 2.4	Topsoil - Dark Brown Earths Compacted gravelly CLAY, mottling evident but not as much as other locations. High Large Rounded/ angular Cobble content, impermeable CLAY. End of TP	Trial Pit located at Digestate Treatment Building/ Feedstock building. Fluctuating water table likely, however determined to be lower than TP01/TP02, evident through weak signs of mottling and saturated impermeable CLAY/ Groundwater Gley soils. Proximity to drainage, seasonal changes and lack of recent rainfall (last 3 months below LTA) may contribute to not observing Groundwater strike. No Bedrock encountered.
TP-04	0.00 – 0.2 0.2 – 2.8 2.8	Topsoil – Dark Brown Gravelly Earths. GROUNDWATER observed @ 1.0mbgl. Impermeable sticky Groundwater Gley (characterised by grey colour and upper layers are oxidised & typical brown). End of TP.	Groundwater observed @ 1.0mbgl. Gleying is prominent in the subsoil, with greyish-blue colors throughout. Gleying typically caused by prolonged or permanent saturation from a high water table (with seasonal variation). No bedrock encountered.
TP-05	0.0 – 0.2 0.2 – 1.6 1.6 – 3.4 3.4	Topsoil – Dark Brown Earths Saturated Groundwater Gley soils, evident through grey colouring and lighter brown mottling (anaerobic soils). Compacted darker brown impermeable CLAY, small cobbles present End of TP.	Fluctuating water table likely evident through signs of gleys, mottling and saturated impermeable CLAY/ Groundwater Gley soils. Proximity to drainage Glossy sheen & mottled grey/ orange colour – evidence of saturated gley soils. Proximity to drainage (river to east), seasonal changes and lack of recent rainfall (last 3 months below LTA) may contribute to not observing Groundwater strike. No Bedrock Encountered.
TP-06	0.0 – 0.3 0.3 – 2.4 2.4 – 2.7 2.7	Topsoil – Dark Brown Earths Gravelly impermeable brown CLAY, small signs of mottling. Compacted darker brown impermeable CLAY, cobbles/ small boulders present End of TP.	Fluctuating water table likely evident through signs of saturated impermeable CLAY/ Groundwater Gley soils. Proximity to drainage (river to east), seasonal changes and lack of recent rainfall (last 3 months below LTA) may contribute to not observing Groundwater strike. No Bedrock Encountered.

7.5 Likely Significant Effects

The assessment focuses on predicted impacts in relation to soils and geology. The assessment relates to impacts occurring during both the construction and operational phases of the development.

For a risk from ground contamination to exist, a contaminant source, pathway for migration and viable receptor must exist. The presence of all three of these elements is known as a ‘pollutant linkage’. Based on the dataset obtained during the desk study, intrusive site investigation, and anecdotal evidence collected the following risk assessment has been carried out. This identifies the relevant sources, pathways and receptors (pollutant linkages) and assigns a qualitative risk classification of ‘Positive, Neutral or Negative/ Adverse’ risk to the identified Potential Pollutant Linkages (PPLs).

The likely potential pollutant linkages identified as a result of this assessment and specific for the site have been provided in the initial Conceptual Site Model (CSM). The model has been based upon the site setting at the time of the assessment, the land use (current and reasonably foreseen future use) of the surrounding area and the state of what the proposal is (i.e. development, ongoing use, etc.).

As well as identifying the potential pollutant linkages the model includes a preliminary assessment of risk based upon the probability of effect and the likely severity of effect in the context of the site setting and proposed future site use.

The criteria used for the risk assessment classifications in this report is detailed in the EPA guidance notes 2022, **Table 1.1** of **Chapter 1** in this report, and in the *CIRIA Report 552*.

7.5.1 Do-Nothing Scenario

If the Proposed Development does not proceed there would be no additional impact on the local soil, geology or geological heritage. The current rate of surface water percolation and runoff would continue to operate in its natural state.

Under the ‘Do Nothing’ scenario there would be no change to the current land use of the site which would remain as agricultural land.

In implementing this ‘Do-Nothing’ alternative, an Anaerobic Digestion Facility would not be developed and there would be no changes made to existing land-use practices. The site would likely continue to be used for agricultural purposes. Agricultural manures and slurries will be sourced from agricultural operators within a 15km radius of the Proposed Development. In the ‘Do-Nothing Scenario’ these agricultural wastes would not be treated locally through the AD process. Untreated and unpasteurised manures and slurries would continue to be applied direct to land at current volumes, with the continued addition of chemical fertiliser. Furthermore, the associated CH_4 emissions would not be captured within the AD process.

7.5.2 Receptor Sensitivity

The sensitivity of the receptors identified during the study of soil and geological features within the vicinity of the site are summarised in **Table 7.10**.

Table 7.10 – Receptor Sensitivity

Receptor	Receptor Importance	Receptor Sensitivity	Rationale
Topsoil	Local Level	Low	The local topsoil is a groundwater gley / surface water gley which is in abundance within the vicinity of the development. The site topsoil contains no known pollutants. The soil is of poor agricultural quality, being a poorly drained 'Gley' and would not be a highly sought-after topsoil for any infill agricultural lands.
Underlying Deposits	Local Level	Moderate	The development has been designed to utilise the existing site topography as far as possible **(ORS ref: 231240-ORS-ZZ-00-DR-AR-400 _Drainage layout),** minimising the disturbance to the subsoil to achieve the desired site levels. Where possible drift deposits will remain on site and be utilised as infill material. The underlying till deposit is a diamicton (poorly sorted containing particles ranging in size from clay to boulder) of Devonian sandstone parent material which is in abundance within the wider area. The development site is located across a GSI designated area of flat to undulating glacials sediments with a varying range in soil depth from moderate to deep.
Bedrock Geology	Regional Level	Moderate	The underlying bedrock formation for much of the site is characterised as Lower Limestone Shale and is described as sandstone, mudstone and shale. A portion of the southern boundary overlies bedrock of the Ballysteen Formation which is described as fossiliferous dark-grey muddy limestone. Karst features have not been recorded within the 5km study area of site but are found within the wider region to the northwest of the Proposed Development *ca.* 7.5km northwest of the site. Karst features are not prevalent throughout County Limerick as much of the County is underlain by Sandstone bedrock and impure limestones. This rock is in abundance with the wider region. It is not envisaged that bedrock will be encountered. The majority of the site is underlain by a Regionally Important Aquifer - Fissured bedrock. A portion of the southern boundary of the site is underlain by a Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones.

7.5.3 Sources - Construction Phase

The construction phase is likely to yield the most potential impacts on the surrounding land, soil and geology. Potential construction phase impacts are considered in detail below and summarised in **Table 7.11**.

The Proposed Development will result in the establishment of the site across elevations ranging from a low of 91.5m AOD at the location of the bunded area to the northeast of the site to 92.80m AOD. With the Reception Hall and processing areas located at 92.80m AOD and all Digesters and Pasteurisation Tanks at 91.5m AOD (see **Figure 7.16**). Given the sites current topography this will involve limited earthworks to both cut and fill the site to a level base upon which the development can be constructed.

Figure 7.16: Site layout with proposed and existing site levels (Drawing No: 231240-ORS-ZZ-00-DR-AR-200)

The following sections outline the potential effects to Land, Soil and Geology posed by the proposed excavation and infilling of the site.

Topsoil Removal

The initial phase of construction will involve the removal and stockpiling of the topsoil. The pre-construction geotechnical site investigations conducted indicate a topsoil horizon of approximately 0.2 – 0.3m in depth of a brown topsoil with varying degrees of gravel content. This inert material will be stripped throughout the Proposed Development site and be stockpiled. For the gas pipeline route, the topsoil will be temporary stockpiled before being used to redress the installed pipe. The method of stripping will involve the use of a tracked excavator/ bulldozer along with the use of haul trucks.

Stockpiles in the absence of mitigation measures will be susceptible to erosion by climatic and hydraulic factors. Any excess topsoil will be removed from site and disposed of in accordance with current waste management regulations.

The most significant risk posed by the topsoil excavation is through the migration of silt, clay and other sediment off site through wind and water borne modes of transportation. If incorrectly stockpiled and under specific climatic conditions these sediments can find their way into nearby streams. In significant quantities they can pose a risk to aquatic life and result in a degradation of water quality, as outlined in **Chapter 8: Hydrology and Hydrogeology**.

In the absence of mitigation, the removal and stockpile of topsoil would result in a ***negative, moderate*** and ***reversible*** effect on soil.

Excavation/Subsoil Removal

Site investigations indicate a slight variation in the depth of the subsoil horizon. In Trial Pit 1 (TP01) the subsoil horizon was identified, with the topsoil overlaying a layer of loam/clay at 0.3m – 1.8m bgl containing abundant gravel with lighter brown colouring. Below this from 1.8m – 2.4m bgl was a layer of dark, more compact clay with evidence of mottling throughout and an abundance of large, rounded cobbles.

Trial Pit 2 (TP02) demonstrated a similar composition of topsoil overlying a layer of dark brown gravelly clay/gley at 0.2m – 1.7m bgl which contained a higher silt content than other trial pits and was mottled throughout. Below this from 1.7m – 2.75m bgl a compacted impermeable clay layer with gray mottling throughout (evidence of saturation) was observed with rounded cobbles. This evidence of high seasonal water table is likely due to the river to the east of the site. In Trial Pit 3 (TP03) the subsoil horizon was identified, with the topsoil overlaying a layer of compacted gravelly clay at 0.3m – 2.1m bgl with evident mottling albeit less than other locations. Below this horizon from 2.1m – 2.4m bgl was a layer of impermeable compact clay with an abundance of large, rounded/ angular cobbles. Trial Pit 4 (TP04) demonstrated a dark brown gravelly topsoil overlying a layer of impermeable sticky gley from 0.2m – 2.8m bgl. Groundwater ingress was observed at 1m bgl in TP04.

Trial Pit 5 (TP05) demonstrated a topsoil dark brown earth to 0.2m bgl overlying a layer of saturated gley soil to 1.6m bgl evident through mottling. Below this from 1.6 – 3.4m bgl a compacted dark brown impermeable clay layer with small cobbles was observed. Trial Pit 6 (TP06) demonstrated a similar topsoil overlying a layer of gravelly impermeable clay with small signs of mottling from 0.2m – 2.4m bgl. Below was a layer of impermeable compact dark brown clay with an abundance of cobbles and small boulders.

The development proposes installing the taller structures, tanks and digesters, at a lower elevation to minimise the visual impact. This will involve cutting into the existing topography, to the northeast of the centre of site. It is hoped to utilise excavated onsite subsoil material where possible for infilling.

Mechanical soil compaction will be undertaken to ensure soil stability throughout the site. Excess material will be transported off site for disposal.

The soils beyond *ca.* 0.3m below ground level have been found to be relatively consistent throughout consisting of compact or impermeable clay or gley soils. The site contains a heterogeneous moderately sorted drift of primarily a grey to dark brown clay with occasional cobbles or small boulders at greater depth. This till drift consists of clay-sized particles which present a moderate susceptibility of becoming entrained in surface water run-off. The moisture content of soils due to the fluctuating water table on site may mitigate the risk of stockpiled soils being blown out of a stockpile by moderate to strong breezes and thus carries a moderate risk of migrating into surface water receptors.

A site characterisation assessment (percolation assessment), **Appendix 8.2**, conducted by site assessor Patrik Mannion of Coyle Environmental on the 22nd of November 2024. In summary, the assessment conducted at TP-05 concluded that the Proposed Site has an R1 groundwater protection response, which is acceptable to normal good practice. The lower horizons of the subsoil (>1.0m bgl) were recorded as being compact with a firm texture and a blocky structure. Further compaction of this layer during excavation and construction works is possible and may increase surface water run off due to reduced infiltration rates resulting in increased sediment erosion on site. The excavation of and exposure of the subsoil layer during the construction phase will result in an increased risk to the groundwater vulnerability, as outlined in **Chapter 8**.

The preliminary Cut and Fill calculations (refer to Drawing No. 231240-ORS-ZZ-00-DR-CE-490) for the Proposed Development indicate that a total of **19,408.46** cu. M of material is to be excavated, with **5,759.07** cu. M required to infill the site to the proposed final topography. This results in a net surplus of **13,649.39** cu. M which will be redistributed on site in landscaping and earth berms within the site.

No soil is to be imported for use on site. All material will be transported to and from the site using registered hauliers and records of material movements will be record in accordance with the waste legislation and guidance notes.

In the absence of mitigation, the extraction and reduction in the subsoil horizon and alteration of the of subsoil horizons will have a ***negative, moderate*** and ***permanent*** effect on the subsoil.

Excavation of Bedrock

The GSI groundwater vulnerability maps have classed the entire site as overlaying an area of "moderate" vulnerability. Based off the groundwater vulnerability guidelines this would indicate a soil depth of *ca.* 3-8m. It should be noted that groundwater was observed at 1.0m bgl in trial pit 2 (TP02) located southeast of the centre of the site, although no bedrock was encountered. This is likely due to the poor drainage on site, given that the topography of the site is generally flat. Soils were observed to consist of saturated, compacted and impermeable clay / gley soils with a high water table, prone to fluctuations which was indicated by mottling throughout subsoil strata.

A potential effect of the construction stage could be the exposure of the underlying bedrock.

Excavations of up to **3.30**m bgl will be required to accommodate the below ground attenuation tank (a SUDS measure to account for 1:30 year runoff volumes) in the northeast bunded area of the site. Excavations of up to **1.58**m bgl will be required to reach the finished floor level (FFL) of the Digesters (**12, 13, 15, 16**), Digestate Storage Tank (**17**) to the northeast and the Reception Hall (**09**) west of bunded area (**52**). When excavation to FFL has been achieved, further earthworks will then follow to facilitate the construction of foundations and the installation of services/drainage infrastructure. Foundations of up to 0.5m below the FFL will be required along the structural outline of buildings.

It should be noted that the Digestion tanks (**12, 14, 15, 16**) and the Digestate Storage Tank (**17**), will all have a FFL of **91.5**m. Foundations and hard core will be a further *ca.* 0.7m below the FFL. These structures are planned for the northeast of the site where the currently ground level is furthest from the proposed ground level and will require the most significant excavations on site. Refer to the proposed Cut and Fill drawing in **Appendix 7.2** and relevant structural site layout drawings as referenced in Section 2.2, **Chapter 2 – Project Description.**

In the absence of mitigation, encountering bed rock will have a ***negative, significant***, and ***permanent*** effect.

Site Access and Virtual Pipeline

A virtual pipeline will be established on site, thus no excavations to establish pipeline infrastructure will be required. A ‘virtual pipeline’ refers to an alternative system for transporting biomethane where traditional pipeline infrastructure is unavailable. Instead of sending the biomethane through fixed pipelines, the biomethane is compressed, and transported in containers known as Multi Element Gas Containers (MEGC) by road.

During the initial stages of the construction phase, enabling works will consist of stripping and stockpiling of topsoil and subsoil at the proposed compound area, as outlined above. Similarly, excavations are required for the construction of the passing bays at the site entrance, located at the west of the site.

The site entrance will facilitate the connection of the proposed facility to the surrounding road network. The site entrance, located to the west, will join the L8658 local road which connects to the R518 *ca.* 80m south as well as a number of local roads *ca.* 500m north. See **Figure 7.16.**

Excavations may have an effect on exposed soil and subsoil with implications for the soil surface with regard to stock piling and mobile plant. Trenches will be backfilled shortly after excavation following the installation of each section of the site. Trenching along a road network will give rise to asphalt waste material. If unproperly managed these materials can pose a risk to the environment due to the presence of Polycyclic Aromatic Hydrocarbons (PAHs). PAHs are organic pollutants that persist in the environment and are considered potentially dangerous with side effects related to cancer development (A. Nagalli, 2015).

In the absence of mitigation, site access installation would have a ***negative, slight*** and ***temporary*** effect on the existing surface level materials and subsoil.

Construction of Built Structures

The construction of the Anaerobic Digestion Plant will result in the conversion of permeable soils to hard standing surfaces. This sealing/ capping of land has a long-term impact on the underlying soil's structure and function to the wider environment. It reduces the water infiltration to the underlying soil/ bedrock and alters the structure and functionality of the soil over time.

The construction of the built structures requires excavations of up to **3.30**m below current ground levels. As is common practice with the construction of foundations a compressed infill gravel base/ pad is required on top of which a concrete blinding is poured. Steel reinforcements will be installed, with shuttering erected around this to facilitate the final concrete pour. Infilling and compaction of excavations around structures is then conducted to ensure structural integrity. The infill material and concrete poses a risk of contaminating the subsoil and bedrock if installed in adverse weather conditions.

In total, the Proposed Development will result in the construction *ca.* 5,903 sq.m of hard standing, inclusive of built structures and concrete/ asphalt aprons.

The use of plant and machinery during the construction stage will involve the use of hydrocarbon-based fuels and oils. There is a risk of contamination to soils and eventual percolation to the underlying bedrock. Hydrocarbons should be stored in bunded facilities, and the use of hydrocarbons should be contained to bunded areas with spills cleaned up immediately.

In the absence of mitigation, the impact of the construction of built structures would have a ***negative, moderate*** and ***long-term*** effect.

Contaminated Soils

The excavation and construction activities will cause quantities of excavated materials to be reused on site or removed from site for disposal or recovery. The site is a greenfield and historical mapping does not suggest any incidences of land use which might result in the contamination of soils. Furthermore, a geotechnical site investigation conducted at the site in November 2024 did not detect any evidence of contaminated soils. It is not anticipated contaminated soils will be encountered during construction activities.

The construction management plan will include a set of procedures to be implemented in the incidence of contaminated soils encountered. Encountering contaminated soils would have a ***negative***, ***not significant*** and ***temporary*** effect.

Table 7.11 – Severity/ Magnitude of Impact during construction phase

Receptor	Potential Environmental Effects	Quality	Significance	Duration
Topsoil	Topsoil Removal	**Negative**	**Slight/ Moderate**	**Reversible**
	Passing Bays	**Negative**	**Slight**	**Temporary**
Underlying Deposits/ Subsoil	Construction of Built Structures	**Negative**	**Moderate**	**Long-term**
	Excavation/ Subsoil Removal	**Negative**	**Moderate**	**Permanent**
	Contaminated Soils	**Negative**	**Not Significant**	**Temporary**
	Passing Bays, Drainage Pipe	**Negative**	**Slight**	**Permanent**

Bed Rock Geology	Excavation of Bedrock	**Negative**	**Significant**	**Permanent**

7.5.4 Sources - Operational Phase

The operational phase effects anticipated and considered throughout the lifetime of the operation of the facility are considered below and summarised in **Table 7.12**.

It is not envisaged that there will be many potential sources of effects to soil, land or geology during the operation of the facility.

Hydrocarbon Contamination

It is proposed that the site will be frequented by numerous hauliers and farmers transporting both liquid and solid feedstocks for production of biomethane. There is a possible risk of vehicular accidents on the site which could result in the accidental release of hydrocarbons.

Mobile plant and fixed machinery are a potential source of contamination on site. Accidental leaks or spills of fuels and oils from hydraulics would be the source of such contaminates.

The 1,000L fuel tank is an obvious source of such contaminants and as such it will be bunded to comply with EPA guidelines.

Strict enforcement of traffic management measures, adherence to standard operating procedures (SOP's) for refuelling and regular inspection of bunds should eliminate the potential for such sources of contamination. On top of this, the process area will be bunded which will further reduce the possibility of such chemicals making contact with the local soil and geology.

In the absence of mitigation, hydrocarbon leaks and spills would have a ***negative, moderate* to *significant*** and ***long-term*** effect.

Leaks of Nutrient Laden Liquids/Solids

Accidental discharge, spills or leaks of digestate, sewage, nutrient rich liquids or solid wastes from the Reception Hall, Digesters or wastewater treatment system could pose a risk to the local soil. Such nutrient rich substances have a high Biological Oxygen Demand (BOD) and would pose a risk to groundwater and bedrock aquifers by potential introducing microbial contaminants and threatening aquatic life by consuming available dissolved oxygen in watercourses. The long-term threat to soil is considered to be less than hydrocarbons as such nutrient rich substances will be biodegraded in the soil and absorbed by flora. However, excessive volumes can be detrimental to soils by killing off the microbial and microorganism populations and stunting or killing plant growth by inhibiting the absorption of micro-nutrients. The overall effect is dependent on the volume and duration of such nutrient leaks.

In the absence of mitigation, nutrient leaks to the surrounding soil would have a ***negative, slight*** and ***short-term*** effect.

Land Spreading of Biobased Fertiliser

Utilising biobased fertiliser (digestate) offers several scientific benefits over the continued use of raw manures, slurries, and chemical fertilisers. These include balanced nutrient availability, slow-release nutrients, improved soil health and a reduction in pathogens and weeds when compared to slurries and manures. These advantages support sustainable agricultural practices whilst simultaneously improving soil conditioning.

Balanced Nutrient Availability: Biobased fertiliser typically contains a balanced mix of essential nutrients, including nitrogen (N), phosphorus (P), potassium (K), and micronutrients crucial for plant growth. This balanced nutrient profile contrasts with chemical fertilisers, which often supply only specific nutrients. Studies have shown that the diverse nutrient composition of digestate supports comprehensive plant nutrition, contributing to improved crop yields and overall plant health (Möller and Müller, 2012). Digestate is particularly rich in ammonium nitrogen (NH4-N), a form of N that is readily available for uptake by plants (Doyeni et al, 2021).

Slow-Release Nutrients: Biobased fertiliser releases nutrients gradually over time as it decomposes in the soil. This gradual release mechanism ensures a sustained supply of nutrients to plants, contrasting with untreated manures, slurries, and chemical fertilisers, which can be prone to leaching or volatilisation. The slow-release nature of digestate reduces the risk of nutrient loss and enhances nutrient uptake efficiency by plants (Yao et al., 2011). Digestion of livestock slurry has also been shown to increase the plant availability of nitrogen in slurry by *ca.* 10%.

Enhanced Soil Health: Rich in organic matter, Biobased Fertiliser improves soil structure, promotes water retention and stimulates microbial activity. These soil health benefits contribute to improved nutrient cycling, root development, and overall soil fertility (De Vries et al., 2015).

Pathogen and Weed Reduction: Manure and slurry may contain a range of bacterial, viral, and parasitic pathogens and land application of these organic fertilisers typically occurs without prior treatment. In contrast, Anaerobic Digestion, and subsequent pasteurisation of digestate significantly reduces the presence of pathogens and weed seeds, making it safer for agricultural use compared to untreated manures and slurries (Vinnerås et al., 2006).

The Proposed Development is designed to process up to 90,000 tonnes per annum of feedstock, primarily comprising locally sourced agricultural manures, slurries, food processing residues, and crop-based materials. At full capacity it is proposed that the total tonnages for transportation off-site from the Proposed Development as biobased fertiliser to local agricultural operators will be *ca*. 24,500 tonnes of Digestate Fibre and *ca*. 53,500 tonnes of Digestate Liquid Concentrate. Of the maximum 90,000 tonnes of annual feedstock intake to the Proposed Development, *ca*. 43,000 tonnes of untreated manures and slurries would normally be land spread locally with the remaining *ca.* 47,000 tonnes of feedstock being derived from silage and dairy/food/ drinks production residues. Following, digestate treatment and pasteurisation there will be 24,500 tonnes of solid and 53,500 tonnes of liquid biobased fertiliser. Approximately 78,000 tonnes of whole digestate will be generated. This represents a significant reduction, *ca*. 12,000 tonnes of waste per annum.

Post pasteurisation, the biobased fertiliser will meet the standard of an EU fertilising product under Regulation (EC) No 2019/1009 under the criteria outlined for Product Function Category (PFC) 3 B: Inorganic Soil Improver. The proposed operator will apply for End of Waste Criteria.

All biobased fertilisers will be used in accordance with S.I. 113 of 2022 European Communities (Good Agricultural Practice for Protection of Waters) Regulations, 2022).

The spreading of the biobased fertiliser on the customer farms will be done in accordance with the specific Nutrient Management Plan for that farm.

If appropriately managed land spreading of biobased fertiliser has the potential to have a ***positive, slight*** and ***long-term*** effect on nutrient management and soil quality.

Table 7.12 – Severity/ Magnitude of Impact during operation phase

Receptor	Potential Environmental Effects	Quality	Significance	Duration
Topsoil	Nutrient Leaks	**Negative**	**Slight**	**Short-term**
	Land Spreading of Digestate	**Positive**	**Slight**	**Long-term**
Bed Rock Geology	Hydrocarbon Contamination	**Negative**	**Moderate/ Significant**	**Long-term**

7.6 Mitigation Measures and Monitoring

This section highlights the mitigation measures proposed for the operation and construction stages of the Proposed Development to mitigate potential impacts to the near and wider environment.

7.6.1 Construction Phase

General Mitigation Measures

A Construction Environmental Management Plan (CEMP) will be prepared and implemented by the main contractor during the construction phase. This is a practical document which will include detailed procedures to address the main potential environmental impacts on site, encompassing soil, geology, noise, dust, air quality, surface and ground water, and highlights the proposed construction methods, activities and procedures. Refer to the preliminary CEMP report submitted in conjunction with this EIAR (**Document No.: 231240-ORS-XX-XX-RP-EN-13d-010**). The implementation and compliance with the conditions of the CEMP will be overseen by the Project Supervisor Construction Stage (PSCS) and/or onsite Environmental or Ecological Clerk of Works (ECoW) where necessary. Proposed mitigation measures include;

- Site preparation and construction must be confined to the Proposed Development only and it must adhere to all the mitigation measures outlined in this Chapter. Work areas should be kept to the minimum area required to carry out the proposed works and this area should be clearly marked out in advance of the proposed works.
- Prior to the commencement of developments on site, the PSCS/ ECoW will ensure that contractors will be made aware of the sensitive receptors identified in this chapter and the associated mitigation factors. A signed statement saying that they have taken on board the mitigation measures contained herein should be presented to the local authority along with the Notice of Commencement.
- A wheel wash/ power wash facility will be established at the site-setup stage of construction to limit the translocation of sediment onto the local road network.
- A best practice measure in reducing the risk of the translocation of invasive species all machinery initially arriving to site will be inspected. Any dirty equipment will be refused entry to site.
- All construction waste will be removed from site by a registered contractor to a registered site. Evidence of the movement and safe disposal of the construction waste will be retained and presented to the Local Authority upon request. Removal of the construction waste will occur as soon as possible after construction works.
- The following Guideline documents should be adhered to:
    - Construction Industry Research and Information Association (CIRIA) (2005) Environmental Good Practice on Site (C692).
    - Construction Industry Research and Information Association (2001) Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors (C532).
    - Construction Industry Research and Information Association (2000) Environmental Handbook for Building and Civil Engineering Projects (C512).
    - Environmental Protection Agency (2015) List of Waste and Determining if Waste is Hazardous or Non-Hazardous.
    - Environment Agency et al. (2015) Guidance on the Classification and Assessment of Waste, Technical Guidance WM3.

Topsoil Removal

The removal of topsoil is part of the first stage of the construction process. As mentioned above the initial phase will involve the stripping and stockpiling of the topsoil layer. This material will be reused on site as far as possible during the landscaping stage to remediate slopes and soils within the vicinity of the site, including the buffer zone.

Stockpiles in the absence of mitigation measures will be susceptible to erosion by climatic and hydraulic factors.

- Excavated topsoil will be stockpiled in an area abounded by silt fencing to contain/ reduce any sediment run-off during times of inclement weather.
- Driving machinery on topsoil stockpiles is not advised as it damages the soil structure, reduces porosity, and subsequent percolation rates, and can result in 'smearing' of the soil surface, which prevents water infiltration into the soil.
- Any excess topsoil will be removed from site and disposed of appropriately.
- Stockpiling and slight compaction of stockpiles to minimise both hydraulic and climatic erosion.
- Running stockpiles in the direction of prevailing wind to minimise windborne erosion rates, SW-NE. (EPA, 2013).
- Construction of silt fences around topsoil stockpiles to contain sediment run-off.
- Minimise the export of topsoil off site by incorporating in the final landscape design.
- Minimise handling and tracking of material to maintain optimum soil structure.
- Landscaping to take place as soon as possible to reduce exposure of subsoil and topsoil stockpiles.
- Works will be avoided during periods of extended rainfall.
- All topsoil generated from site works should be stored within the Proposed Development until it is required for landscaping. It must not be stored outside the Proposed Development boundaries and it must not be used for the infilling of any area outside of the Proposed Development. If there is more topsoil than is needed for landscaping, it must be removed from site by a registered contractor for appropriate use elsewhere. The end location of the topsoil must be identified and records presented to the local authority if requested.

Excavation

As with all greenfield site construction projects, civil earthworks are the first stage of the construction process. Excavation work to set the site levels, foundation, drainage and buried utilities is essential in facilitating the construction of the built structures. Excavation work will be conducted in stages to minimise the exposure of unprotected soil, subsoil and bedrock.

The development is proposed to be constructed within the range of the existing contours on site. This will limit the extent of significant earth works and greatly reduce the risk of encountering bedrock. Where possible excavated subsoil material will be reworked and used on site. A geotechnical investigation of the site will be required in order to assess the potential of the underlying soil, subsoil and bedrock for reuse.

Temporary excavations which are required for the installation of drainage, gas and buried networks will be excavated and backfilled within as short a timeframe as possible to minimise exposure of surfaces to erosion. Excavation stability is important, and deep excavations will employ the use of appropriate excavation techniques (e.g. temporary shoring) to ensure excavation wall stability.

The following measures will help mitigate the impacts during excavation:

- Excavation work will be conducted in stages to minimise the exposure of unprotected soil, subsoil and bedrock.
- Where possible excavated subsoil material will be reworked and used on site.
- A geotechnical investigation of the site will be required in order to assess the potential of the underlying soil, subsoil and bedrock for reuse.
- Stockpiling material in appropriate locations, away from water sources, with a silt fence surrounding it to reduce the rate of run-off from hydraulic conditions.
- Light compaction of stockpiles to minimise the rate of erosion from climatic methods.
- Stockpile heights should be kept to a minimum to ensure stockpile stability and minimise wind borne erosion.
- Excavations will be postponed in high rainfall conditions to reduce the risk of excavation collapse and erosion to soil and subsoil profiles.
- If extreme weather conditions are forecast high sediment stockpiles will be covered to minimise erosion.
- Excavations to be backfilled as soon as possible to prevent any infiltration of contaminants to the subsurface and bedrock.
- All temporary excavations will be conducted in a safe manner to ensure sidewall stability and prevent collapse of excavations. Mobile shoring equipment will be utilised to this end where required.
- All long-term soil stockpiles are to be planted with a vegetative cover to bind the soil and improve slope stability.
- Engineered retaining walls are to be installed where required to ensure stability of contiguous and Proposed Development topography.
- “Mole Plough” installation method will be utilised to install the discharge pipe to the Lower Ballyteige watercourse located to the east. This will limit trenching requirements and reduce the risk of sediment laden run-off.
- The timing of installation of the discharge pipe into the Lower Ballyteige watercourse must be scheduled to ensure no instream works are carried out during the closed season for instream works (October 1st to June 30th). IFI must be notified prior to works taking place. The timing of works shall be in accordance with to IFI (2016) Guidelines on the Protection of Fisheries during Construction Works in and Adjacent to Water. Works associated with the headwall construction should be supervised by an Ecological Clerk of Works (ECoW).

Soil Compaction

Heavy tracked and wheeled construction vehicles will be in use throughout varies stages of the construction process. The soil on site is noted as being un-compacted close to the surface in some areas, with compaction increasing with depth and as being of loamy clay to gley texture up to 1.8m bgl. To reduce compaction during construction the following mitigation measures will be undertaken:

- Construction of a hardcore gravel access road on and around the site.
- Confine site traffic to designated routes.
- Minimise traffic flows on site and establish a construction stage parking compound.
- Avoid the use of oversized machinery when and where possible.

- Prevent movement of vehicles on site during and after periods of rainfall.
- Driving machinery on topsoil stockpiles will be avoided as it damages the soil structure, reduces porosity, and subsequent percolation rates, and can result in 'smearing' of the soil surface, which prevents water infiltration.

Run-Off

Sediment laden run-off from exposed soil and stockpiles poses a risk to waterways and aquatic life. The main pollutants of site water are silt, fuel/oil, concrete and chemicals. There are a number of steps outlined below to eliminate contamination of site surface water runoff.

- As a standard best practice measure a silt fencing will be erected along the eastern extents of the Proposed Development site to limit accidental discharge of sediments into the adjacent Lower Ballyteige watercourse. The fencing is to be made of a permeable filter fabric (Hy-Tex Terrastop Premium silt fence, or similar), with the footing of the fencing to be buried into the ground and the visible fencing to be ca. 0.5m high.
- An interceptor trench will be installed in front of the silt fence.
- The silt fence will be visually inspected daily to ensure that they remain functional throughout the construction of the Proposed Development. Maintenance of the fences will be carried out regularly. Fences will be inspected thoroughly after periods of heavy rainfall.
- Excavated and/or imported material will be stockpiled and silt fencing will be constructed around stockpile locations to contain/ reduce any sediment run-off during times of inclement weather.
- Compacting of stockpiles will reduce the rate of airborne and hydraulic erosion.
- Stockpile areas for sands and gravel should be kept to minimum size, well away from storm water drains and gullies leading off-site.
- Silt Fences to be erected where excavation works are required in close proximity to water features and along depressions in land where there's increased surface water flow rates.
- Harmful materials such as fuels, oils, greases, paints and hydraulic fluids must be stored in bunded compounds well away from storm water drains and gullies. Refuelling of machinery should be carried out using drip trays.
- A temporary drainage system will be established complete with a settlement pond to remove contaminants from run-off, prior to discharge.
- Temporary staff welfare facilities will be installed on site at the pre-commencement stage. These will include toilet facilities. All foul discharges from welfare facilities will be collected in a septic storage tank. This tank will be regularly emptied, and the contents disposed of at a registered facility.

Concrete

The majority of subject site is situated above the Ballingarry Groundwater Body which is designated as a Regionally Important Aquifer - Fissured bedrock. A portion of the southern site boundary lies within the Hospital Groundwater Body which is designated as a Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones. The site is located over an area of "moderate" groundwater vulnerability (**Figure 7.8**) with an associated soil depth of 3-8m bgl. The site is also located adjacent to a waterbody which is hydrologically connected to a designated SAC, albeit at significant distance downstream through the wider river network.

Due to its elevated pH, unset concrete possesses a risk to adjacent soil, surface waters and the underlying groundwater body. The following mitigation measures are proposed to limit the accidental discharge of concrete and to minimise waste.

- **Concrete Washout Skip**: Chutes of concrete trucks are only to be washed out into an impermeable lined (polythene) skip. The washout water is to be treated prior to discharge.
- The concrete washout skip is to be located to the west of the site, away from the Maigue River adjacent to the east.
- Excavations lined with an impermeable liner are not permitted as concrete washout bays.
- Large excess loads of concrete are to be returned to the supplier or poured into concrete block moulds (Betonblock or similar design) in order to minimise waste and reduce the risk of contaminants leaching into the surrounding environment.
- Best practice in bulk-liquid concrete management should be employed on site addressing pouring and handling, secure shuttering, adequate curing times etc.
- Where concrete shuttering is used, measures will be put in place to prevent against shutter failure and control storage, handling and disposal of shutter oils.
- Activities which result in the creation of cement dust will be controlled by dampening down the areas.
- Raw and uncured waste concrete will be disposed of by removal from the site.

Construction Contaminants

A wide array of chemicals and materials will be used during the construction of the development. This includes hydrocarbons which can persist in the wider environment for decades. To mitigate the exposure of the surrounding soil and geology to these substances it is proposed to undertake the following:

- Fuels, oils and other environmental deleterious chemicals are to be stored in a bunded well-ventilated chemical stores.
- Use of such chemicals and fuels is to be contained to bunded areas, where possible.
- Fuel bowsers to be located in bunded areas which can cater for 110% of the primary vessel capacity.
- Any spills or leaks to the soil is to be immediately contained and the soil in question is to be removed by a licensed contractor and disposed of in a registered facility.
- Oil spill containment kits are to be situated near areas of potential spills.
- Regular inspections carried out on plant and machinery for leaks and general condition.
- Use of ready-mixed supply of wet cement products.
- Scheduling cement pours for dry days.
- Maintenance and repair works will be carried out at least 10m from any collection of surface water.
- No refuelling will be undertaken within 50m of the Maigue River.
- Ancillary machinery equipment such as hoses, pipes and fittings which contain hydrocarbons will be stored within a bund or drip tray.
- Any repair works required on machinery involving fuel and oil control will be carried out offsite where practical, if not possible then repairs will be undertaken on a clean hardcore area of site. Unless unavoidable, repair works carried out in the field where machinery is operational will use spill trays and absorbent materials to prevent release of contaminants to the ground.
- Daily checks prior to start-up of plant and machinery will minimise the risk of breakdown and associated contamination risks for on-site repairs. Daily pre-start checks will be undertaken and records maintained. A clean site policy and diligent housekeeping will also

reduce the potential of hydrocarbon release on-site.

Importation of Contaminated Materials

The Proposed Development will involve the importation of gravel and concrete.

- All material will be sourced and transported by registered suppliers.
- All materials will be inspected prior to acceptance on site.
- Any deliveries found to be contaminated will be refused access to deposit on site. Any contaminated materials accidentally deposited on site will be removed immediately from site. If this is not possible then it will be stored in a “quarantine zone”.
- The quarantine zone is to be lined with an impermeable liner which the material will be stored on. A cover will be placed over the liner to avoid hydraulic run-off of contaminated materials. The quarantine zone is to be fenced off and surrounded by silt fencing, as a secondary containment measure.

Excavation of Contaminated Soils

The existing site consists of open pastures. At no point in the site’s history was there any development present, hence excavation of contaminated soils is unlikely. Nonetheless, during construction:

- All excavated materials will be visually assessed for contamination.
- Any contaminated material detected will be sent for analysis to a suitable environmental laboratory and subsequently quantified, segregated and transported for disposal by a licenced contractor.

7.6.2 Operational Phase

The disturbance to soil and geology at the Proposed Development during the operational phase of the Anaerobic Digestion Facility is not foreseen to result in any significant impacts. The most significant threat to the underlying soil and geology is posed by the uncontrolled release of digestate or manure.

General Mitigation Measures

An Environmental Operating Plan (EOP) will be prepared and implemented by the plant management company during the operational phase. This is a practical document which will include detailed procedures to address the main potential effects on surface water and groundwater.

The proposed facility will operate under an Industrial Emissions Licence (IEL) issued by the Environmental Protection Agency (EPA). The licence will contain several conditions which the operator must remain in compliance with for the entire duration of the facility’s lifespan. Typical conditions relating to the protection of water receptors include:

- Emissions Limit Values for all emissions including surface water
- Monitoring requirements for surface waters
- Resource use and energy efficiency
- Waste management control and documentation

- Storage and transfer of substances
- Facility management
- Accident prevention and emergency response including fire water retention
- Operational Controls

Uncontrolled Releases and Spillage

Mitigation of relevance to the management of uncontrolled releases will include:

- Dedicated hard standing for off-loading areas, with a minimum separation distance from adjacent water courses.
- Use of spill kits, bunded pallets and secondary containment units, as appropriate.
- All bunds sized to contain 110% of the volume of the primary storage vessel.
- Environmental Management Plan (EMP) to include site specific standard operating procedures pertaining to waste management and emergency response.
- There will be no intentional discharge of untreated storm water to surface or ground waters during the operational phase. All stormwater discharges from site will be, with the exception of the roofs, directed through Class 1 petrol/oil interceptors prior to discharge to the Lower Ballyteige watercourse.
- The Digestion Tanks and Digestate Storage tanks will be located within a bunded location to the east of the site, this will act as a secondary containment in the event of loss of tank contents.
- All primary pipelines and bunded structures will be inspected and integrity tested prior to handover from the appointed construction contractor. All works will be installed to Construction Quality Assurance (CQA) plan.

Land Spreading of Biobased Fertiliser

To mitigate the risk to soil, groundwater and surface water features the following measures will be complied with:

- In order to avoid any reductions in water quality within the catchment as a whole, all biobased fertilisers must be used in accordance with S.I. 113 of 2022 European Communities (Good Agricultural Practice for Protection of Waters) Regulations, 2022).
- The spreading of the biobased fertiliser on the customer farms must be done in accordance with the specific Nutrient Management Plan for that farm.
- Application of biobased fertiliser to be conducted in compliance with the Nitrates Action Programme (e.g. prohibited periods and nitrogen application rates).
- All biobased fertiliser is to be pasteurised prior to removal from the Proposed Development to comply with Regulation (EU) 142/2011 on Animal By-Products in Organic Fertilisers.

7.6.3 Decommissioning Phase

The decommissioning phase will entail similar activities to the construction phase. The construction stage mitigation measures outlined in **Section 7.6.1** above will be undertaken to limit and avoid effects to the underlying soil from compaction and contamination. The goal of the decommissioning phases is to render the site safe both physically and environmentally so that it no longer poses a risk to the surrounding population and environment. A Closure, Restoration and Aftercare Management Plan (CRAMP) will be developed as a condition of the industrial emission licences and in compliance with the Guidance to Licensees on Surrender, Cessation and Closure of Licensed Sites set by the EPA (2012).

7.7 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 an Anaerobic Digestion Facility in the townland of Cappanihane, Bruree, Co. Limerick with other developments in the area is reviewed in this section with specific regard to the local and regional Land, Soil and Geology.

Excavated soils will be reused and repurposed for landscaping purposes and for the construction of earth berms on site. There will be no disposal of excess soil and subsoil from site to licensed facilities and so the Proposed Development will not have an effect on capacity at such sites. This will result in a **neutral** effect on such sites.

7.8 Residual Effects

According to Environmental Protection Agency guidelines, Residual Impact is described as 'the degree of environmental change that will occur after the proposed mitigation measures have taken place.' The mitigation strategy above recommends actions which can be taken to reduce or offset the scale, significance and duration of the effects on the surrounding land, soil and geology.

The purpose of this assessment is to specify mitigation measures where appropriate to minimise the 'risk factor' to all aspects of the soil and geological environment such as to minimise the potential for contamination effect to soil, groundwater or aquifers and reduce the risk of erosion and sediment run-off, etc. This 'risk factor' is reduced or offset by recommending the implementation of a mitigation strategy in each area of the study. On the implementation of this mitigation strategy, the potential for impact will be lessened.

A site-specific Construction Environmental Management Plan (CEMP) will be devised and implemented throughout the duration of the construction phase. This document will contain all the necessary procedures required to prevent and minimise any environmental risks posed by the project on the surrounding environment.

7.8.1 Construction Phase

A summary of the predicted impacts associated with the construction phase in terms of quality, significance, and duration, along with the proposed mitigation measures and resulting residual impacts are summarised in **Table 7.13**.

The overall impact anticipated by the construction phase of the project following the implementation of suitable mitigation measures is considered to be ***neutral to negative***, ***slight to significant*** and ***temporary to permanent***.

7.8.2 Operational Phase

A summary of the predicted impacts associated with the operational phase in terms of quality, significance, and duration, along with the proposed mitigation measures and resulting residual impacts are summarised in **Table 7.14**.

The overall impact anticipated by the operational phase of the project following the implementation of suitable mitigation measures is considered to be ***positive to neutral****,* ***imperceptible to slight****,* and ***temporary to long-term****.*

Table 7.13: Summary of predicted construction phase impacts, mitigation measures and residual impact

Potential Source	Environmental Receptor	Impact Description	Quality	Significance	Duration	Mitigation	Residual Impact
Topsoil Removal	**Topsoil** Soil structure, soil microorganism population, adjacent waterways	Erosion of stockpiles of exposed soils leading to migration of silt into surface water receptors via dust and run-off. Damage to soil structure	***Negative***	***Moderate***	***Reversible***	• Silt fencing and interceptor trench to be installed along the eastern extents of the site • Stockpiles of topsoil to be used in landscaping works as soon as is practicable • Silt fence erected along catchment lines • Silt fences to be installed around stockpile locations to reduce run-off rates and to prevent vehicles driving on stockpiles, damaging soil structure • Slight compaction of stockpiles to minimise run-off and airborne erosion • Running stockpiles in direction of prevailing wind, to reduce windborne erosion • Minimise handling of material • Keep stockpile heights low to minimise compaction and windborne erosion • Topsoil is to remain within the Proposed Development site • Wheel wash/ Power hose facility will be available on site to limit the migration of sediment off-site via vehicles • Machinery will be clean on arrival to site, and will undergo inspection • Site welfare facilities will be established prior to removal of topsoil	***Neutral, Slight, Reversible***

Potential Source	Environmental Receptor	Impact Description	Quality	Significance	Duration	Mitigation	Residual Impact
Excavations/ Subsoil Removal	**Subsoil** Adjacent waterways, Underlying Locally Important Aquifer / Regionally Important Aquifer	Reduction in subsoil horizon by up to **3.30**m will increase groundwater vulnerability and threaten Aquifer. Migration of silt into adjacent lands and waterways via dust and run-off	***Negative***	***Moderate***	***Permanent***	• Stockpiling material in appropriate locations, away from water sources, with silt fencing surrounding it to retard the rate of erosion from hydraulic conditions. • Light compaction of stockpiles to minimise the rate of erosion from airborne and hydrological methods. • Stockpile heights should be kept to a minimum to ensure stockpile stability and minimise wind borne erosion. • Excavations will be postponed in high rainfall conditions to reduce the risk of excavation collapse and erosion to soil and subsoil profiles. • If extreme weather conditions are forecast high sediment stockpiles will be covered/ dampened to minimise erosion. • Excavations to be backfilled as soon as possible to prevent any infiltration of contaminants to the subsurface and bedrock. • Excavate and backfill temporary excavations within a short timeframe to minimise exposure to erosion and contamination • Installation of silt fencing to capture hydraulic erosion • Risk of contaminating underlying exposed material 'naturally' mitigated by the presence of the of the low permeability subsoil throughout the site • "Mole Plough" installation method for piping proposed where applicable.	***Neutral, Slight, Permanent***
	Bedrock Locally Important Aquifer / Regionally Important Aquifer	Exposure of bedrock, and/or excavation of bedrock	***Negative***	***Significant***	***Permanent***		***Neutral, Moderate, Temporary***
Passing Bay, Drainage Pipe and Gas Pipeline	**Topsoil and Subsoil** Underlying Geology Moderately Productive Aquifer	Exposure and removal of soil and subsoil. Stockpiling of excavated and imported material. Migration of silt into adjacent lands Contamination of subsoil and underlying geology	***Negative***	***Slight***	***Permanent***	• "Mole Plough" installation method for piping proposed where applicable. • Excavations to be backfilled as soon as possible to prevent any infiltration of contaminants to the subsoil • Landscaping to take place as soon as possible to reduce weathering • Installation of drainage headwall to be undertaken outside of the closed season for instream works (October 1st to June 30th) • Ecological Clerk of Works will supervise the installation of the headwall and discharge pipe to the Lower Ballyteige watercourse	***Neutral, Slight, Long-term***

Potential Source	Environmental Receptor	Impact Description	Quality	Significance	Duration	Mitigation	Residual Impact
Construction of Built Structures	**Topsoil, Subsoil and Bedrock**	Conversion of permeable soil into hard standing. Compaction of soil and subsoil from plant machinery Contamination of subsoil and bedrock from hydrocarbons, concrete, etc.	***Negative***	***Moderate***	***Long-term***	• Construction of access roads to confine plant machinery to designated routes • Construction of site car park to reduce traffic and compaction on site • Chemicals/ hydrocarbons to be stored and used in bunded areas. • Spill kits to be located throughout site • Scheduling and use of ready mixed concrete on site • Chutes of concrete trucks are only to be washed out into an impermeable lined (polythene) skip which will be located in the east of the site • Excess concrete is to be returned to the supplier here possible. If not possible it will be poured into concrete block moulds (Betonblock or similar) to minimise waste and reduce the risk of contaminants leaching into the surrounding environment • Best practice concrete handling measures will be employed • Temporary site welfare facilities will be established • All foul effluent from welfare facilities will be collected in a septic tank prior to disposal at a register waste facility	***Neutral, Slight, Long-term***
Attenuation Pond	**Subsoil and Bedrock**	Anaerobic soils. Percolation of contaminants into the underlying locally important aquifer / regionally important aquifer	***Negative/ Neutral***	***Significant***	***Permanent***	• No soils will be imported to site. • Any contaminated materials will be refused entry to site • Quarantine zone will be available to isolate any contaminated soils identified. The area will have an impermeable linear, cover and surrounded by silt fencing • The pond will be lined with an impermeable geotextile liner to limit percolation of the contents into the underlying groundwater	***Neutral, Slight, Permanent***
Excavation of Contaminated Soils	**Topsoil, Subsoil and Bedrock**	Excavated materials, intended to be reused on-site for landscaping purposes and establishment of earth berms. Potential for soils to contain contaminants from accidental	***Negative***	***Not Significant***	***Permanent***	• Greenfield site with no previous industrial activities noted at the site meaning incidences of contaminated land unlikely • No contaminants identified during Site investigations	***Positive, Slight, Short-term***

Potential Source	Environmental Receptor	Impact Description	Quality	Significance	Duration	Mitigation	Residual Impact
		spillages or legacy contamination and leach into surface water receptors				• Procedure in place for incidence of contaminated land within CEMP • Contaminated soils encountered to be tested, quantified, segregated and transported for disposal by a licenced contractor • Quarantine zone will be available to isolate any contaminated soils identified. The area will have an impermeable linear, cover and surrounded by silt fencing	

Table 7.14: Summary of predicted operational phase impacts, mitigation measures and residual impact

Potential Source	Environmental Receptor	Impact Description	Quality	Significance	Duration	Mitigation	Residual Impact
Hydrocarbon Contamination	Topsoil	Accidental release from vehicular crash, leaks from hydraulics, fuel tanks, fuel stores, bunds into the surrounding soil	***Negative***	***Moderate to Significant***	***Long-term***	• Drainage systems will be designed to attenuate excess surface water runoff with suitable storage volumes • Reduction of outflow rate to below the existing greenfield runoff rate before discharging • Installation of Sustainable Urban Drainage Systems (SuDS) features such as Sumps in gullies and catchpits collect silts in run-off from roads, filter drains and discharge bypass separators • Environmental Management System • Bunded production area • Regular inspection of bunds • TOC monitors and automated valve shut offs to avoid contamination accidentally being discharged from site.	***Neutral, Imperceptible, Long-term***
	Subsoil and Bedrock Poor Aquifer	Accidental releases outlined above percolating downwards into lower soil horizon and bedrock aquifer	***Negative***	***Moderate to Significant***	***Long-term***		***Neutral, Imperceptible, Long-term***
Nutrient Leaks	Topsoil	Accidental discharges of high BOD demanding digestate/ feedstock/ sewage into soil. Poses threat to adjacent surface water	***Negative***	***Moderate***	***Short-term***	• All sewage/ pipe/ tank infrastructure to be installed in accordance with the relevant industry standards and pressure tested/CCTV surveyed prior to commissioning to ensure absence of defects • Programme of inspection and maintenance to ensure any defects in tanks or bunds are repaired	***Neutral, Imperceptible to slight, Short-term***
	Subsoil and Bedrock Locally Important Aquifer / Regionally Important Aquifer	Leakage of high BOD sources outlined above into lower soil horizon and bedrock aquifer	***Negative***	***Slight***	***Short-term***	• The process area on site will be completely bunded. This will catch and retain and spills preventing percolation into the lower horizons • TOC monitors and automated valve shut offs to avoid contamination accidentally being discharged from site	***Neutral, Imperceptible to slight, Permanent***
Land Spreading of Digestate	Topsoil, Watercourses Animal welfare	Application of processed digestate to agricultural land Transmissible diseases	***Negative***	***Significant***	***Temporary***	• Biobased fertilisers will be used in accordance with S.I. 113 of 2022 European Communities	***Positive, Imperceptible, Temporary***

Potential Source	Environmental Receptor	Impact Description	Quality	Significance	Duration	Mitigation	Residual Impact
						(Good Agricultural Practice for Protection of Waters) Regulations, 2022). • Nutrient management plans to avoid excess fertiliser application • Farmers to comply with the Nitrates Action Plan • "Lay-off" period of 21 days for grazing or harvesting following application • Biobased fertiliser will be pasteurised in accordance with Regulation (EU) 142/2011 on use of animal by products as organic fertiliser	

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7.9 Monitoring

The Construction Environmental Management Plan (CEMP) and Environmental Operating Plan (EOP) will include provision for the monitoring of construction and operational related activities including the following:

- Water Quality Monitoring of the surface water receptors adjacent to the site boundary and discharge point
- Daily inspections for housekeeping and site cleanliness
- Continuous noise, vibration and dust monitoring
- Dust Suppression on dry days or during concrete cutting
- Risk assessment for the prevention of fuel spillages
- Monitoring of stockpiles to determine if further measures are required to prevent erosion
- Daily inspection of concrete washout and waste management facilities

Daily site inspections to ensure procedures outlined within the CEMP are adhered through throughout the site.

7.10 Summary of Significant Effects

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 ***slight to moderate***.

7.11 Statement of Significance

The significance of effect 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 7.11** and **Table 7.12**.

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

Where a potential effect has been identified, mitigation measures have been provided which if implemented reduces the effect of significance to ***imperceptible*** *to* ***moderate.*** The mitigation steps are presented in **Section 7.6** and summarised in **Table 7.13** and **Table 7.14**.

APPENDIX 7.1

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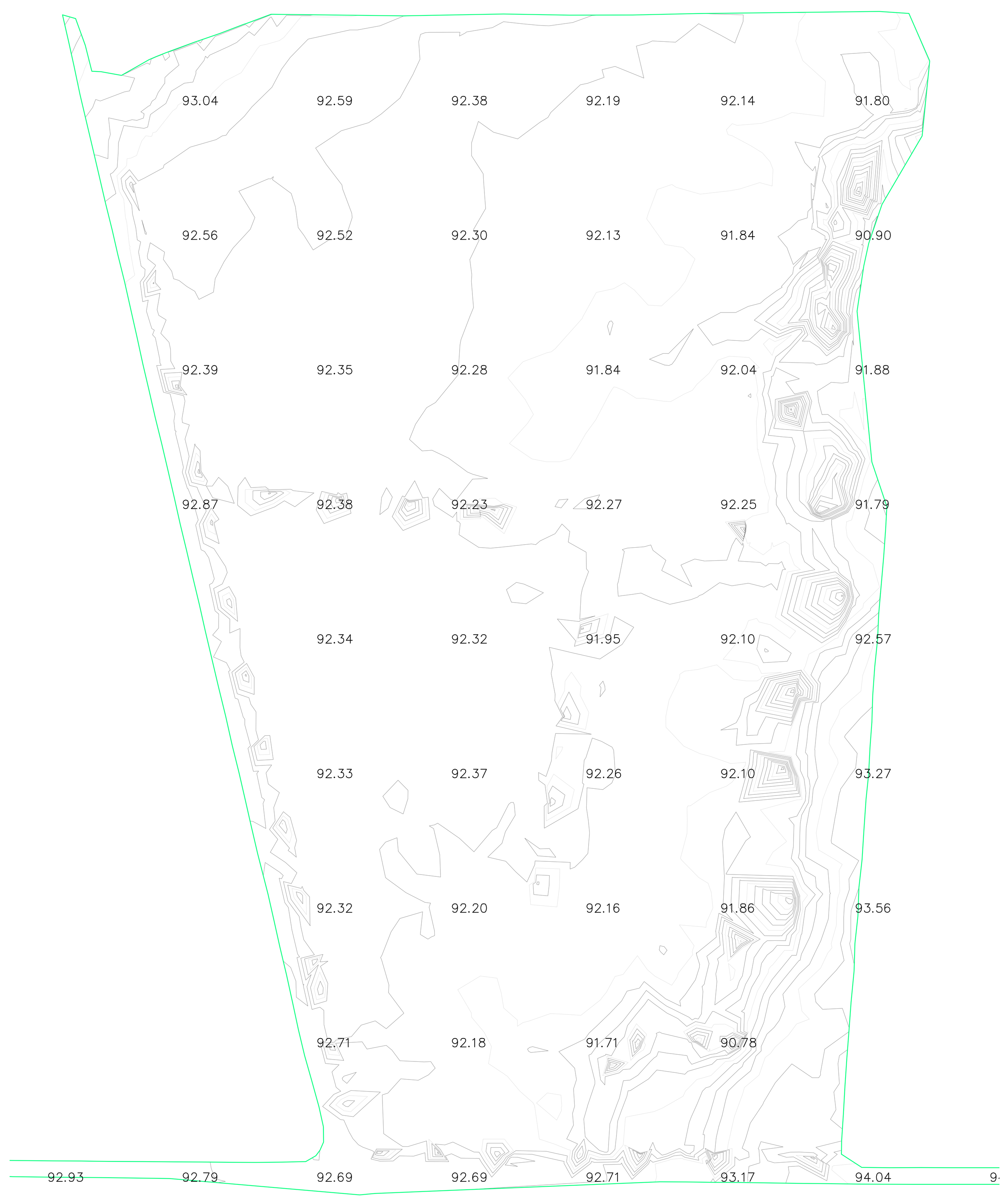

1 EXISTING GROUND LEVEL
SCALE: 1:1250

RECEIVED: 24/03/2025

2 CUT & FILL ANALYSIS PLAN
SCALE: 1:500

Elevations Table

Number	Minimum Elevation	Maximum Elevation	Area	Color
1	−4.00	−3.50	0.00	
2	−3.50	−3.00	249.28	
3	−3.00	−2.50	307.92	
4	−2.50	−2.00	158.39	
5	−2.00	−1.50	1782.25	
6	−1.50	−1.00	6685.67	
7	−1.00	−0.50	284.07	
8	−0.50	0.00	16695.30	
9	0.00	0.50	3129.58	
10	0.50	1.00	753.32	
11	1.00	1.50	227.45	
12	1.50	2.00	4.56	

Cut/Fill Summary

Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
ORS-CUT_FILL_SURFACE	1.000	1.000	30326.59sq.m	16386.58 Cu. M.	1310.25 Cu. M.	15076.33 Cu. M.<Cut>
Totals			30326.59sq.m	16386.58 Cu. M.	1310.25 Cu. M.	15076.33 Cu. M.<Cut>

GENERAL NOTES

1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL RELEVANT ENGINEER'S AND ARCHITECT'S DRAWINGS AND SPECIFICATIONS.
2. ALL LEVELS ARE IN METRES TO ORDNANCE DATUM, MALIN HEAD UNLESS NOTED OTHERWISE.
3. THE POSITION OF EXISTING SERVICES AS SHOWN ON THE DRAWING MAY NOT BE ACCURATE. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR LOCATING ALL EXISTING SERVICES ON THE SITE AND SHOULD CONTACT THE RESPECTIVE UTILITY PROVIDERS AND AUTHORITIES FOR THE MOST UP-TO-DATE INFORMATION BEFORE COMMENCING THE WORKS.
4. EXISTING LEVELS ARE INDICATIVE ONLY AND MUST BE CHECKED AND VERIFIED ON SITE PRIOR TO COMMENCEMENT.
5. PROPOSED MANHOLE COVER LEVELS ARE APPROXIMATE AND SHOULD BE ADJUSTED TO SUIT LOCAL FINISHES.
6. ALL SURFACE WATER DRAINAGE INFRASTRUCTURE SHALL BE CONSTRUCTED IN ACCORDANCE WITH LOCAL AUTHORITY REQUIREMENTS.
7. LOCKABLE TYPE GULLY TRAPS TO BE USED ON ALL SURFACE WATER DRAINS.
8. GULLY POSITIONS ARE APPROXIMATE ONLY AND SHOULD BE LOCATED AT LOW POINTS.
9. REFER TO ARCHITECTS' DRAWINGS FOR ALL ROOF DRAINAGE, STRIP DRAINS AND GULLY TRAPS BENEATH DOWNPIPES.
10. WHERE IT IS NOT POSSIBLE TO ACHIEVE MINIMUM COVER, PIPES SHOULD BE BEDDED AND SURROUNDED IN CONCRETE 150MM THICK, CLASS E IN ACCORDANCE WITH TII STANDARD CONSTRUCTION DETAIL CC-SCD-00521.
11. ALL WASTEWATER DRAINAGE INFRASTRUCTURE SHALL BE CONSTRUCTED IN ACCORDANCE WITH IRISH WATER STANDARDS. REFER TO IRISH WATER PUBLICATIONS “WASTEWATER INFRASTRUCTURE STANDARD DETAILS - IW-CDS-5030-01” AND “CODE OF PRACTICE FOR WASTEWATER INFRASTRUCTURE - IW-CDS-5030-03”
12. HYDRANTS TO BE ACCORDANCE WITH IRISH WATER STANDARD DETAILS STD-W-16 TO STD-W-19.
13. THRUST BLOCK ARRANGEMENTS SHALL COMPLY WITH IRISH WATER STANDARD DETAILS STD-W-28
14. REFER TO MECHANICAL AND ELECTRICAL ENGINEER'S DRAWINGS FOR INTERNAL DRAINAGE AND DETAILS OF SOIL AND VENT PIPES LEADING TO WASTEWATER DRAINAGE AJS.
15. ALL WATER INFRASTRUCTURE SHALL BE CONSTRUCTED IN ACCORDANCE WITH IRISH WATER STANDARDS. REFER TO IRISH WATER PUBLICATIONS “WATER INFRASTRUCTURE STANDARD DETAILS - IW-CDS-5020-01” AND “CODE OF PRACTICE FOR WATER INFRASTRUCTURE - IW-CDS-5020-03”
16. ALL PLANTING & TREES TO COMPLY WITH SEPERATION DISTANCES AS PER IRISH WATER STANDARD DETAILS FOR WASTEWATER, STD-WW-06 AND STD-WW-06A AND FOR WATER, STD-W-12 AND STD-W-12A
17. A METHOD STATEMENT SHALL BE SUBMITTED FOR APPROVAL PRIOR TO INSTALLATION AND TESTING
18. ALL PIPE DIAMETERS INDICATED ARE INNER DIAMETER.
19. THESE DRAWINGS ARE NOT TO BE USED FOR SETTING OUT PURPOSES. REFER TO ARCHITECTS DRAWINGS FOR SETTING OUT.

CIVIL SERVICES LEGEND

	PROPOSED TWIN WALL SURFACE WATER PIPES
	EXISTING SURFACE WATER PIPES
	PROPOSED PVC FOUL SEWER PIPES
	EXISTING FOUL SEWER PIPES
	PROPOSED PVC COMBINED SEWER PIPES
	EXISTING COMBINED SEWER PIPES
	PROPOSED Ø125mm PE WATERMAIN
	EXISTING WATERMAIN
	BOUNDARY LINE
	DENOTES 6m & 46m SEPARATION DISTANCE OF WATER HYDRANT
	PROPOSED SURFACE WATER MANHOLE
	PROPOSED FOUL SEWER MANHOLE
	EXISTING MANHOLE
G	GULLY
	FOUL SEWER INSPECTION CHAMBER
	STORM WATER INSPECTION CHAMBER
	WATERMAIN BOUNDARY BOX
	PROPOSED MANIFOLD SUPPLY
	PROPOSED AJ CHAMBER
C.L.	COVER LEVEL
I.L.	INVERT LEVEL
	ANCHOR/THRUST BLOCK
S.V.	SLUICE VALVE
Sc.V.	SCOUR VALVE
HYD.	HYDRANT
DRM	DRY RISING MAIN
A.V.	AIR VALVE
W.M	WATER METER
DP/MH	DROP MANHOLE

NOTES:
ALL LEVELS RELATE TO MALIN HEAD DATUM.

INFORMATION

Figured dimension only to be taken from this drawing.
All dimensions to be checked on site.
Consultants to be informed immediately of any discrepancies before work proceeds.

REV NO:	DATE:	REVISION NOTE:	DWN BY:	CKD BY:
P01	DD/MM/YYYY	ISSUED FOR ?????	XX	XX

UNCONTROLLED

N

CLIENT:	CYCLE 0
PROJECT:	ANAEROBIC DIGESTION FACILITY, CAPPANIHANE, CO. LIMERICK
TITLE:	CUT AND FILL ANALYSIS

DRAWN:	CHECKED:	APPROVED:	JOB NO:	REV:
JG	PM	MH	231240	P01
DATE: FEB. 2025	SCALE: 1:500		DRAWING NO: 231240-ORS-ZZ-00-DR-CE-480	

ORS
Mullingar | Dublin | Galway | Donegal | Cork | Waterford
T: +353 1 5242060 | W: www.ors.ie | E: info@ors.ie
ISO 9001:2015 QUALITY ASSURED COMPANY

APPENDIX 7.2

REPRESENTATIVE PROFILE DESCRIPTION

SERIES: HOWARDSTOWN

Reference profile: RPM99GJ02
County: Roscommon
Weather: Rain
Elevation: 74

TOPOGRAPHY
Position: Upper slope
Slope Form: Convex
Aspect: N

PARENT MATERIAL
Substrate Type: Drift
Substrate Subgroup: Limestones

TEXTURAL CRITERIA
Textural Class: Clayey
Texturally contrasting:

LAND USE
Land use: Grassland improved,
Human technologies: Fertilizer applications, Slurry applications, Not known
Vegetation: Grassland, Rushes

WATER TABLE None

ROCK OUTCROPS None

SURFACE STONE None

IRISH CLASSIFICATION (2013)
Soil subgroup: 07.6.0 Humic Surface-water Gley

National Soil Series: Howardstown
Clayey drift with limestones

DESCRIPTION

0 - 19 cm **Ap**

Humose: True. **MATRIX COLOR**: 75YR42. **STONES (%):** Few, 2-6 mm, Angular, Shale; 2-6 cm, Sub-angular, Sandstone. **TEXTURE:** Clay. **STRUCTURE:** Moderate, Crumb, Fine. **CONSISTENCY:** Friable. **PLASTICITY:** Slightly plastic. **STICKINESS:** Non-sticky. **ROOTS:** Common, Fine. **COATS:** Clay, Few, Faint, Broken. **PACKING DENSITY:** Medium. **POROSITY:** Medium. **MACROPORES:** Fine. **BOUNDARY:** Clear, Wavy.

19 - 30 cm **Ag**

MATRIX COLOR (Rubbed): 10YR43. **MOTTLE:** 25Y51, Abundant, Fine, Distinct, Sharp; 5YR58, Many, Fine, Prominent, Sharp. **STONES (%):** Common, 2-6 mm, Sub-angular, Sandstone; 6-20 cm, Angular, Chert. **TEXTURE:** Clay loam. **STRUCTURE:** Weak, Sub-angular blocky, Fine to medium. **CONSISTENCY:** Friable. **PLASTICITY:** Plastic. **STICKINESS:** Sticky. **ROOTS:** Few , Fine. **COATS:** Clay, Common, Distinct, Continuous. **ACCUMULATIONS (Fe/Mn):** 0-2%. **PACKING DENSITY:** Medium. **POROSITY:** Low. **MACROPORES:** Fine. **BOUNDARY:** Abrupt, Wavy.

30 - 49 cm **Bg**

MATRIX COLOR: 25Y52. **MOTTLE:** 5PB61, Abundant, Coarse, Prominent, Clear; 10YR66, Many, Medium, Prominent, Clear. **STONES (%):** Many, 2-6 mm, Sub-angular, Sandstone; 6-20 cm. **TEXTURE:** Clay. **STRUCTURE:** Massive. **CONSISTENCY:** Firm. **PLASTICITY:** Plastic. **STICKINESS:** Sticky. **ROOTS:** Very few, Fine. **COATS:** Clay, Many, Distinct. **PACKING DENSITY:** Medium. **POROSITY:** Very low. **MACROPORES:** Fine. **BOUNDARY:** Gradual, Irregular.

49 - 108 cm **BCg**

MATRIX COLOR: 25Y61. **MOTTLE:** N50, Abundant, Coarse, Prominent, Clear; 25Y66, Few, Fine, Prominent, Clear. **STONES (%):** Many, 2-6 mm, Sub-angular, Limestone; 6-20 cm, Angular, Sandstone. **TEXTURE:** Clay loam. **STRUCTURE:** Massive. **CONSISTENCY:** Firm. **PLASTICITY:** Very plastic. **STICKINESS:** Sticky. **ROOTS:** Very few, Very fine. **COATS:** Clay, Common, Distinct, Discontinuous. **HCl REACTION:** Strongly visible. **PACKING DENSITY:** High. **POROSITY:** Very low. **MACROPORES:** Fine.

LABORATORY ANALYSIS

Horizon	pH	Total (%)		Organic Carbon (%)	Loss-on-ignition (%)
		Nitrogen	Carbon		
1(Ap)	5.8	0.83	10.00	8.40	
2(Ag)	6.1	0.30	3.02	2.40	
3(Bg)	7.6	0.09	0.77	0.59	
4(BCg)	8.4	0.06	4.92	0.88	

EXCHANGEABLE COMPLEX					
CEC (cmol kg^{-1})	Exchangeable Bases (cmol kg^{-1})				Base Saturation (%)
	Na^{+}	K^{+}	Mg^{2+}	Ca^{2+}	
23.47	0.14	0.40	0.85	20.74	94
17.49	0.11	0.17	0.49	15.73	94
22.56	0.13	0.16	0.48	21.98	Sat.
22.51	0.08	0.16	0.56	27.46	Sat.

PARTICLE SIZE (%)			Textural Class USDA	Bulk Density g/cm^3	Standard Deviation
Sand 2000-50 µm	Silt 50-2 µm	Clay <2 µm			
29	29	42	Clay	0.59	0.09
35	25	40	Clay/Clay Loam	1.00	0.04
26	27	47	Clay	1.29	0.07
32	34	34	Clay loam	1.47	0.10