



Chapter 11

Hydrogeology

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11. HYDROGEOLOGY

11.1 Introduction

This chapter of the Environmental Impact Assessment Report (EIAR) sets out the relevant legislation, policy, and guidance (Section 11.2), the methodology used in the assessment (Section 11.3), describes the existing hydrogeological environment (i.e., baseline conditions) (Section 11.4), examines the predicted impacts of the proposed development (Section 11.5), describes measures to mitigate identified significant effects (Section 11.6), monitoring measures (Section 11.7) and details the residual effects (Section 11.8).

This chapter should be read in conjunction with the following Chapters and their Appendices, which present related impacts arising from the proposed development and proposed mitigation measures to amend the predicted impacts:

- Chapter 4 - Description of the Proposed Development.
- Chapter 8 - Biodiversity.
- Chapter 9 - Land and Soils.
- Chapter 10 - Hydrology.

11.2 Legislation, Policy and Guidance

11.2.1 Legislation

This hydrogeology and groundwater assessment has been undertaken in accordance with the requirements of the Planning and Development Act 2000 (as amended) and the EU EIA Directive (2011/92/EU as amended by 2014/52/EU).

The assessment considers all relevant legislative requirements relating to groundwater protection, including:

- European Communities Directive 2000/60/EC (Water Framework Directive).
- European Communities (Water Policy) Regulations 2003 (S.I. No. 722 of 2003).
- European Communities Environmental Objectives (Surface Waters) Regulations 2009 (S.I. No. 272 of 2009).
- European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010).
- European Communities (Drinking Water) Regulations 2014 (S.I. No. 122 of 2014).
- European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477 of 2011).

11.2.2 Policy

The assessment also considers relevant national, regional, and local policy frameworks, including:

- Clare County Development Plan 2023–2029 including the Settlement Plans for Kilrush, Moyasta and Kilkee as contained in Volume 3(d) of the plan.
- National Planning Framework (Project Ireland 2040).
- National Development Plan 2021–2030.
- Strategy for the Future Development of National and Regional Greenways, Department of Transport 2018.

- Code of Best Practice for National and Regional Greenways, Department of Transport 2021 / updated 2022.
- Southern Regional Assembly – Regional Spatial and Economic Strategy (RSES).

11.2.3 Guidelines

The following guidelines were used in carrying out the assessment of hydrogeological impacts:

- Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA)) (2009), *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*.
- Transport Infrastructure Ireland (TII) Transport Infrastructure Ireland (TII) (2025) 'Water Impact Assessment of Proposed National Roads – Standard (PE-ENV-01201)'.
- Transport Infrastructure Ireland (TII) (2025) 'Water Impact Assessment for National Roads, Light Rail, Metro and Rural Cycleways – Overarching Technical Document (PE-ENV-01202)'.
- Environmental Protection Agency (EPA) (2022), *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports*.
- Environmental Protection Agency (EPA) (2015), *Advice Notes for Preparing Environmental Impact Statements*.
- Institute of Geologists of Ireland (IGI) (2013), *Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements*.
- Environmental Protection Agency (EPA) (2003), *Advice Notes on Current Practice in the Preparation of Environmental Impact Statements*.
- Environmental Protection Agency (EPA) (2002), *Guidelines on the Information to be Contained in Environmental Impact Statements*.
- Transport Infrastructure Ireland (TII) (2020), *Environmental Operating Plan (EOP) Guidance*.
- Office of Public Works (OPW) / CFRAM (2018–2020), *Flood Risk Management Plans and datasets*.
- Environmental Protection Agency, 2013. *Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites*.

11.3 Methodology

11.3.1 Study Area

The proposed development comprises a walking and cycling amenity greenway primarily along the general route of the abandoned West Clare Railway between Kilrush and Kilkee in County Clare. Chapter 4 Description of the Proposed Development provides further detail, along with Figure 1.1 in Volume 3 of this EIAR.

11.3.2 Assessment Methodology

A phased approach was adopted for this EIAR in accordance with Environmental Protection Agency (EPA) and Institute of Geologists of Ireland (IGI) guidelines as set out above and is described in the following sections.

Element 1: An initial assessment and impact determination stage was carried out to establish the location, type and scale of the proposed development, the baseline conditions, and the type of hydrogeological environment, to establish the activities associated with the proposed development and to undertake an initial assessment and impact determination. This element

of the assessment also included developing the Conceptual Site Model (CSM) for the site and the receiving environment.

This stage of the assessment included a desktop study that comprised a review of published environmental information for the site. The study area, for the purposes of assessing the baseline conditions for this chapter of the EIA, extends beyond the site boundaries to include a 2km radius of the proposed development site.

Potential environmental receptors outside of this radius that are potentially hydrogeologically connected with the site were also considered. The extent of the wider study area was based on the Institute of Geologists of Ireland (IGI) Guidelines (IGI, 2013) that recommends a minimum distance of 2km radius from the site. This broader area is necessary to identify and evaluate all potential receptors that could be affected by the proposed development, either directly or indirectly. The distinction between the proposed development site and the study area is crucial.

The site of the proposed development is the focal point of the proposed development, while the study area includes any potential hydrogeological connections to sensitive receptors including habitats that might experience secondary effects.

The desk study involved collecting all the relevant data for the site and surrounding area including published information and details pertaining to the proposed development provided by the Applicant and the design team.

The **Element 1** stage of the assessment was completed by DNV and included the review of the following sources of information:

- Environmental Protection Agency (EPA) webmapping (EPA, 2025).
- Geological Survey Ireland (GSI) Datasets Public Viewer and Groundwater webmapping (GSI, 2025).
- National Parks and Wildlife Services (NPWS) webmapping (NPWS, 2025).
- Ordnance Survey Ireland (OSI) webmapping (OSI, 2025).
- Water Framework Directive Ireland (WFD) webmapping (WFD, 2025).
- Office of Public Works (OPW) database on historic flooding and the Catchment Flood Risk Assessment and Management (CFRAM) maps (OPW, 2025).
- Information provided by the design team pertaining to the design proposals for the proposed development.

Element 2: Involves direct and indirect site investigation and studies stage where necessary to refine the CSM developed as part of Element 1 and evaluate the potential impacts associated with the proposed development. Based on a review of the information compiled and reviewed in Element 1, it was determined that a direct or indirect site investigations and studies stage was not required as there was sufficient information regarding the proposed development and the hydrogeological conditions in the vicinity of the site to inform the impact assessment of the proposed development on the receiving hydrogeological environment.

Element 3: Evaluation of mitigation measures, residual impacts and final Impact assessment was based on the outcome of the information gathered in Element 1 of the assessment. Mitigation measures to address all identified adverse impacts that were identified in Element 1 of the assessment were considered in relation to the construction phase and operational phase of the proposed development. These mitigation measures were then considered in the impact assessment to identify any residual impacts.

Element 4: Completion of the Hydrogeology Chapter of the EIAR in which includes all associated figures and documents.

11.3.3 Description of the Importance of the Receiving Environment

The Transport Infrastructure Ireland (TII) criteria for rating of the importance of hydrogeological features at the site as documented in the National Roads Authority Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (NRA, 2009), are summarised in Table 11-1.

Table 11-1 Criteria for Rating Site Importance of Hydrogeological Features

Importance	Criteria	Typical Example
Extremely High	Attribute has a high quality or value on an international scale.	Groundwater supports river, wetland or surface water body ecosystem protected by European Union (EU) legislation e.g., SAC or SPA status.
Very High	Attribute has a high quality or value on a regional or national scale.	Regionally Important Aquifer with multiple wellfields. Groundwater supports river, wetland, or surface water body. Ecosystem protected by national legislation – e.g., NHA status. Regionally important potable water source supplying >2500 homes. Inner source protection area for a regionally important water source. Quality Class A (Biotic Index Q4, Q5). Flood plain protecting more than 50 residential or commercial properties from flooding.
High	Attribute has a high quality or value on a local scale.	Regionally Important Aquifer. Groundwater provides large proportion of baseflow to local rivers. Locally important potable water source supplying >1000 homes. Outer source protection area for regionally important water source. Inner source protection area for locally important water source. Quality Class B (Biotic Index Q3-4). Flood plain protecting between 5 and 50 residential or commercial properties from flooding. Locally important amenity site for wide range of leisure activities.
Medium	Attribute has a medium quality or value on a local scale.	Locally Important Aquifer. Potable water source supplying >50 homes. Outer source protection area for locally important water source. Quality Class C (Biotic Index Q3, Q2- 3). Flood plain protecting between 1 and 5 residential or commercial properties from flooding.

Importance	Criteria	Typical Example
Low	Attribute has a low quality or value on a local scale.	Poor Bedrock Aquifer. Potable water source supplying <50 homes. Locally important amenity site for small range of leisure activities. Local potable water source supplying <50 homes. Quality Class D (Biotic Index Q2, Q1). Flood plain protecting 1 residential or commercial property from flooding.

11.3.4 Description and Assessment of Potential Impacts

Impacts will vary in quality from negative, to neutral or positive. The effects of impacts will vary in significance on the receiving environment. Effects will also vary in duration. The terminology and methodology used for assessing the 'impact' significance and the corresponding 'effect' throughout this chapter is described in Table 11-2 in accordance with EPA, 2022 Guidelines on the Information to be Contained in EIARs.

Table 11-2 Criteria for Assessment of Potential Impacts Terminology and Methodology

Quality of Effects/Impacts	Definition
Negative	A change which reduces the quality of the environment
Neutral	No effects or effects that are imperceptible, within the normal bounds of variation or within the margin of forecasting error.
Positive	A change that improves the quality of the environment
Significance of Effects / Impacts	Definition
Imperceptible	An effect capable of measurement but without significant consequences.
Not Significant	An effect which causes noticeable changes in the character of the environment but without significant consequences.
Slight Effects	An effect which causes noticeable changes in the character of the environment without affecting its sensitivities.
Moderate Effects	An effect that alters the character of the environment in a manner that is consistent with existing and emerging baseline trends.
Significant Effects	An effect which, by its character, magnitude, duration, or intensity alters a sensitive aspect of the environment.
Very Significant	An effect which, by its character, magnitude, duration, or intensity significantly alters a sensitive aspect of the environment.
Profound Effects	An effect which obliterates sensitive characteristics.
Extend and Context of Effects	Definition
Extend	Describe the size of the area, the number of sites and the proportion of a population affected by an effect.
Context	Describe whether the extent, duration or frequency will conform or contrast with established (baseline) conditions

Probability of Effects	Definition
Likely Effects	The effects that can reasonably be expected to occur because of the planned project if all mitigation measures are properly implemented.
Unlikely	The effects that can reasonably be expected not to occur because of the planned project if all mitigation measures are properly implemented.
Duration of Effects / Impacts	Definition
Momentary	Effects lasting from seconds to minutes
Brief	Effects lasting less than a day
Temporary	Effects lasting one year or less
Short-term	Effects lasting one to seven years
Medium-term	Effects lasting seven to fifteen years
Long-term	Effects lasting fifteen to sixty years
Permanent	Effects lasting over sixty years
Reversible	Effects that can be undone, for example through remediation or restoration
Types of Effects	Definition
Indirect Effects	Effects on the environment, which are not a direct result of the project, often produced away from the project site or because of a complex pathway
Cumulative Effects	The addition of many minor or insignificant effects, including effects of other projects, to create larger, more significant effects.
“Do-nothing” Effects	The environment as it would be in the future should the subject project not be carried out
“Worst-case” Effects	The effects arising from a project in the case where mitigation measures substantially fail.
Indeterminable Effects	When the full consequences of a change in the environment cannot be described.
Irreversible Effects	When the character, distinctiveness, diversity or reproductive capacity of an environment is permanently lost
Residual Effects	The degree of environmental change that will occur after the proposed mitigation measures have taken effect.

Plate 11-1 identifies how comparing the character of the predicted effect to the sensitivity of the receiving environment can determine the significance of the effect.

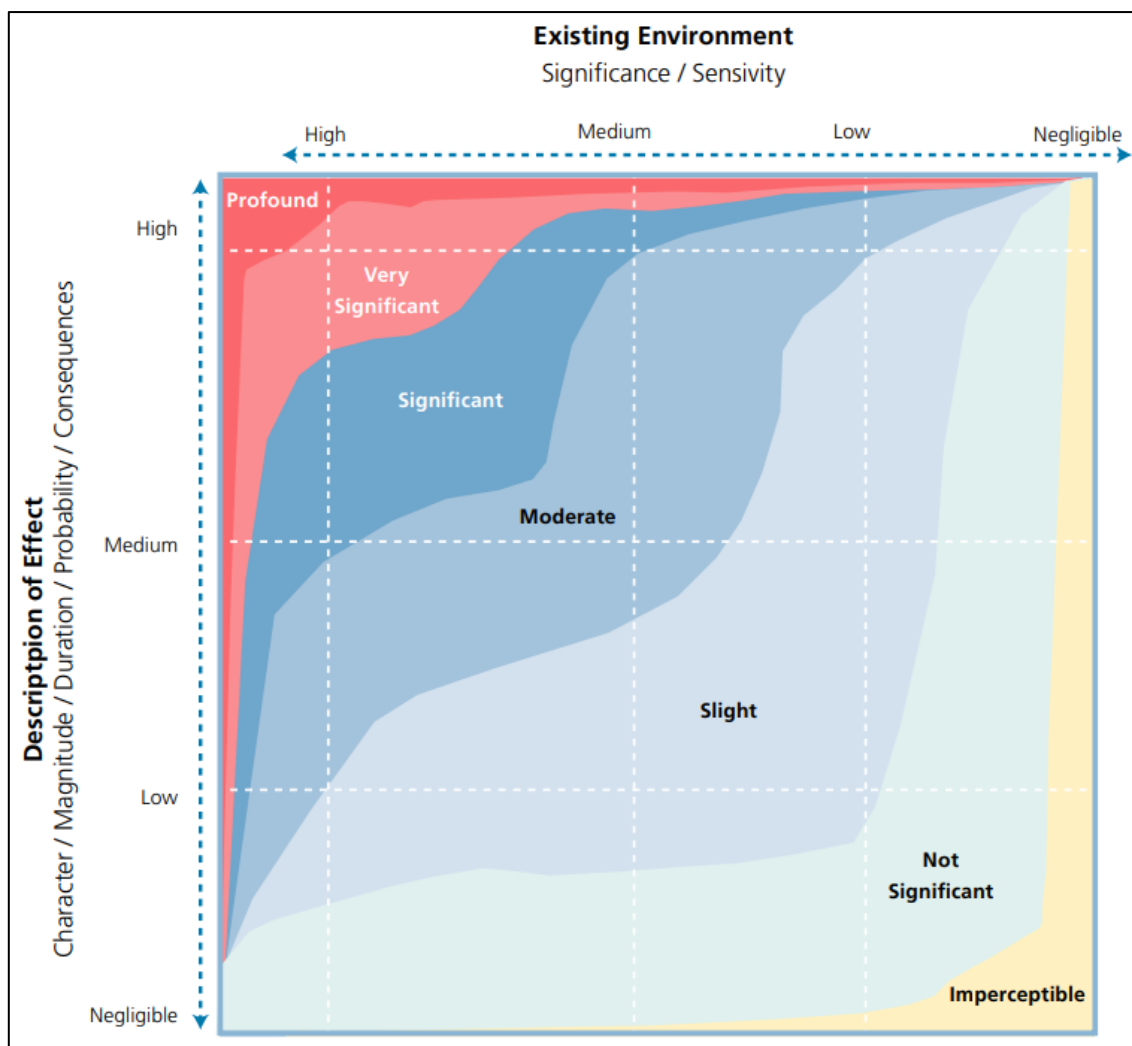


Plate 11-1 Determining Significance (EPA, 2022)

11.3.5 Difficulties encountered

There were no difficulties encountered during preparation of this chapter of the EIAR.

11.4 Receiving Environment

11.4.1 Site Surveys/Investigations

Preliminary ground investigations were completed in March 2026 (refer to Appendix 9.1 in Volume 4 of this EIAR). These comprised a combination of boreholes, trial pits, slit trenches, in-situ testing and laboratory analysis. The results show variable ground conditions along the route, with sequences of made ground, peat, soft silts, and gravels overlying glacial till and locally competent clay or gravel strata. Groundwater was encountered at depths typically 0.4–2.5 m bgl.

11.4.2 Groundwater Body and Flow Regimes

The EPA (EPA, 2025) maps the bedrock aquifer beneath the site as the Kilrush Groundwater Body (GWB) (EU Code: IE_SH_G_123). The Kilrush GWB comprises an area of approximately 400km² and extends over Southern Clare and the Shannon Estuary.

The groundwater body is bounded to the south by the Shannon Estuary and to the west by the Atlantic coast. The northern and eastern boundaries are in-line with surface water catchment divides. The Kilrush GWB is elongated east-west.

The Kilrush GWB Report (GSI, 2025) identifies the main recharge mechanism for the aquifer as diffuse recharge, which will occur over the entire groundwater body via rainfall infiltrating to ground through the subsoil, where overlying subsoils are thinner. The main discharges from this GWB occur to the streams crossing into the sandstone and shale rock units, seeps and small springs and generally the unconfined groundwater flow paths are short (30-300m). However, confined flow paths may be significantly longer.

The Kilrush GWB predominantly consists of low permeability rocks, where groundwater flow occurs in fractures, joints and faults in the upper part of the aquifer and in coarser layers in zones of enhanced permeability. This zone, extending to approximately 10m depth below ground, includes the weathered zone and a connected fractured zone below this which generally follows topography. Water levels at greater depths (i.e., up to 18 metres below ground level (mbgl)) have also been recorded, suggesting the presence of hydraulically isolated zones from the rest of the aquifer. Notably, the most productive fractures are associated with deeper water strikes, occurring at depths of roughly 30–90 metres.

11.4.3 Aquifer Classification

The GSI provides a methodology for aquifer classification based on resource value (regionally important, locally important and poor) and vulnerability (extreme, high, moderate or low). Resource value refers to the scale and production potential of the aquifer whilst vulnerability refers to the ease with which groundwater may be contaminated by human activities (vulnerability classification is primarily based on the permeability and thickness of subsoils).

The bedrock aquifer beneath the site is classified by the GSI (GSI, 2025) as a Locally Important Aquifer (LI) which is moderately productive only in local zones.

Locally important aquifers are capable of supplying locally important abstractions (e.g. smaller public water supplies, group schemes), or 'good' yields (100-400 m³/d). Groundwater flow occurs predominantly through fractures, fissures and joints. However, the lack of connection between the limited fissures results in relatively poor aquifer storage and flow paths that may only extend a few hundred metres. Due to the low permeability and poor storage capacity, the aquifer has a low 'recharge acceptance' (GSI, 2017).

It is noted that there are no gravel aquifers mapped by the GSI (GSI, 2025) along the proposed development. The bedrock aquifer map is presented in Figure 11.1 in Volume 3 of this EIAR.

11.4.4 Groundwater Vulnerability

The vulnerability categories, and methods for determination, are presented in the Groundwater Protection Schemes publication (DEHLG/EPA/GSI, 1999) and summarised in Table 11-3. The publications state that 'as all groundwater is hydrologically connected to the land surface, it is the effectiveness of this connection that determines the relative vulnerability to contamination. Groundwater that readily and quickly receives water (and contaminants) from the land surface is considered to be more vulnerable than groundwater that receives water (and contaminants) more slowly and in lower quantities. The travel time, attenuation capacity and quantity of contaminants are a function of the following natural geological and hydrogeological attributes of any area.

Table 11-3 Vulnerability Mapping Criteria (DEHLG/EPA/GSO, 1999)

Subsoil Thickness	Hydrogeological Requirements				
	Diffuse Recharge			Point Recharge	Unsaturated Zone
	Subsoil Permeability and Type			(Swallow Holes, Losing Streams)	(Sand and Gravel Aquifers Only)
	High Permeability (Sand and Gravel)	Moderate Permeability (Sandy Subsoil)	Low Permeability (Clayey Subsoil, Clay, Peat)		
0-3m	Extreme	Extreme	Extreme	Extreme (30m radius)	Extreme
3-5m	High	High	High	N/A	High
5-10m	High	High	Moderate	N/A	High
>10m	High	Moderate	Low	N/A	High

Notes: (i) N/A = not applicable (ii) Permeability classifications relate to the material characteristics as described by the subsoil description and classification method.

The GSI has assigned a groundwater vulnerability rating ranging from 'Low' (L) to 'Rock at or near Surface or Karst' (X) for the bedrock aquifer beneath the proposed development (refer to Table 11-4).

Table 11-4 Vulnerability Rating as per Scheme Chainage

Section	Vulnerability Rating
CH 0+00M to CH 1+350M	Low
CH 1+400M to CH 1+450M	Moderate
CH 1+500M to CH 1+550M	High
Ch 1+600M to CH 1+800M	Extreme
CH 1+850M	High
CH 1+900M to CH5 +900M	Moderate
Ch5 +950M to CH6+200M	High
CH6 +250M to CH13+100M + Moyasta trailhead	Moderate
CH13+150M to CH13+350M	High
CH13+400M to CH14+150M	Extreme
CH14+200M to CH14+250M	Rock at or near Surface or Karst
CH14+300M to CH14+850M	Extreme
CH14+90M to CH15+179M + Kilrush trailhead	Moderate

The groundwater vulnerability map is presented in Figure 11.2 in Volume 3 of this EIAR.

11.4.5 Flood Risk Assessment

The proposed development is in close proximity to tidal waterbodies including the Shannon estuary and several tributary watercourses. This combined with the low lying nature of the

subject lands results in several sections of the proposed route being subject to coastal flooding (in combination with fluvial flooding) in extreme events (CFRAM, 2025). The flood regime and associated risks are described in detail in Chapter 10 Hydrology of this EIAR and the appended Site Specific Flood Risk Assessment (ROD, 2025b).

11.4.6 Water Supply and Drinking Water Source Protection

The GSI groundwater wells and springs database (GSI, 2025) was utilised to identify registered wells and groundwater sources in the surrounding area. The groundwater sources recorded within a 2km radius of the site are presented in Figure 11.3 in Volume 3 of this EIAR and summarised Table 11-5.

There are no Groundwater Source Protection Areas (SPAs) or Group Water Scheme Preliminary Source Protection Area Zone of Contribution mapped by the GSI (GSI, 2025) within a 2km radius of the site.

There are no karst features mapped by the GSI (GSI, 2025) within a 2km radius of the site.

Table 11-5 GSI Registered Wells and Springs within 2km of Proposed Development

GSI Name	Source Type	Hole Depth (m)	Townland	Source Use	Yield Class
0815SEW017	Borehole	48.2	Leadmore East	Agricultural & domestic	Good
0815NWW023	Borehole	49.4	Lisluinaghan	Agricultural & domestic	Good
0815SWW061	Borehole	24.4	Lisdeen	Agricultural & domestic	Good
0815NWW014	Borehole	9.5	Lisluinaghan	Agricultural & domestic	Good
0815NWW015	Borehole	26.2	Lisluinaghan	Agricultural & domestic	Good
0815SEW011	Borehole	24.7	Kilrush	Agricultural & domestic	Good
0815NWW022	Borehole	27.4	Kildeema	Agricultural & domestic	Moderate
0815SWW048	Borehole	25.6	Clarefield	Agricultural & domestic	Moderate
0815SEW013	Borehole	45.7	Kilrush	Agricultural & domestic	Moderate
0815SWW037	Borehole	3.7	Dough	Agricultural & domestic	Moderate
0815NWW017	Borehole	22.3	Lismuse	Agricultural & domestic	Moderate
0815SWW054	Borehole	6.1	Rahaniska	Agricultural & domestic	Moderate
0815SWW002	Borehole	65.5	Clarefield	Agricultural & domestic	Moderate
0815SEW015	Dug well	2.4	Carrownacalla South	Agricultural & domestic	Poor

GSI Name	Source Type	Hole Depth (m)	Townland	Source Use	Yield Class
0815SEW016	Borehole	18.3	Carrownacalla	Agricultural & domestic	Poor
0815SEW020	Borehole	28	Leadmore	Agricultural & domestic	Poor
0815SEW021	Dug well	6.7	Ballyurra	Agricultural & domestic	Poor
0815SEW027	Dug well	4.3	Carnaun	Agricultural & domestic	Poor
0815SEW031	Dug well	3.7	Carnaun	Agricultural & domestic	Poor
0815SEW043	Borehole	1.2	Leadmore	Agricultural & domestic	Poor
0815SEW045	Dug well	23.8	Moanmore	Agricultural & domestic	Poor
0815SWW045	Dug well	4.9	Kilfearagh	Agricultural & domestic	Poor
0815SWW046	Borehole	4.3	Kilfearagh	Agricultural & domestic	Poor
0815NWW013	Dug well	5.5	Kildeema	Agricultural & domestic	Poor
0815SEW014	Dug well	8.8	Drimna	Agricultural & domestic	Poor
0815SWW043	Dug well	67.7	Knockroe	Agricultural & domestic	Poor
0815NWW016	Dug well	5.2	Lisluinaghan	Agricultural & domestic	Poor
0815NWW018	Dug well	4.3	Lisgurreen	Agricultural & domestic	Poor
0815NEW047	Borehole	47.2	Einagh	Agricultural & domestic	Poor
0815NEW048	Borehole	34.4	Einagh	Agricultural & domestic	Poor
0815SEW048	Borehole	26.8	Moyasta	Agricultural & domestic	Poor
0815SWW035	Borehole	3.1	Baunmore	Agricultural & domestic	Poor
0815SEW049	Dug well	26.5	Moyasta	Agricultural & domestic	Poor
0815SEW050	Borehole	17.7	Moyasta	Agricultural & domestic	Poor
0815NWW019	Dug well	9.8	Lisgurreen	Agricultural & domestic	Poor
0815SEW019	Dug well	3.7	Carrownacalla	Agricultural & domestic	Unknown

GSI Name	Source Type	Hole Depth (m)	Townland	Source Use	Yield Class
0815SEW026	Dug well	6.7	Leadmore	Agricultural & domestic	Unknown
0815SEW034	Dug well	4.3	Carnaun	Agricultural & domestic	Unknown
0815SEW044	Dug well	23.8	Moanmore	Agricultural & domestic	Unknown
0815SWW044	Dug well	4.3	Kilfearagh	Agricultural & domestic	Unknown
0815SEW051	Dug well	20.7	Carrownacalla South	Agricultural & domestic	Unknown
0815SWW047	Borehole	6.7	Kilkee Upper	Domestic use only	Moderate
0815SEW059	Unknown	15.2	Cappagh	Industrial use	Intermediate Spring
0815SEW010	Borehole	13.4	Kilrush	Industrial use	Moderate
0815SEW060	Borehole	0	Leadmore East	Other	Good
0815SWW049	Borehole	14	Termon	Other	Good
0815SEW058	Borehole	5.2	Ballyurra	Other	Unknown
0815SWW036	Dug well	4.3	Dough	Other	Unknown
0815NWW011	Dug well	1.8	Lismuse	Other	Unknown
0815SEW042	Borehole	3.7	Ballyurra	Public supply	Excellent
0815SWW062	Unknown	15.5	Kilkee Upper	Public supply	Unknown
0815NWW012	Dug well	4.3	Lismuse	Unknown	Unknown

11.4.7 Soils & Geology

The soils and geology at the site are described and assessed in Chapter 9 Land and Soils of this EIA and are summarised in Table 11-6, Table 11-7 and Table 11-8.

Table 11-6 Soils (EPA, 2025)

Description	Drainage	Percentage of Route Area
Surface-water Gley: Poorly drained mineral soil	Poor	63.73%
Peat soils	Poor	16.82%
Brown Earth: Well drained mineral soils	Well	7.77%
Tidal marsh	Other	6.75%
Water body - soil under lake, river or estuary	Other	3.01%
Dunes or blown sand	Other	1.85%
Urban - soil concreted over	Other	0.07%

Table 11-7 Subsoils (EPA, 2025)

Description	Code	Percentage of Route Area
Till type. Till is sediment deposited by or from glacier ice.	TNSSs	75.33%
Peat	BktPt	15.12%
Marine deposits, continually reworked by the sea.	Mesc	6.75%
Aeolian: materials deposited by wind action.	Ws	1.85%
Bedrock at surface.	Rck	0.89%
Concreted or artificial surface.	Made	0.07%

Table 11-8 Bedrock (EPA, 2025)

Description	Unit Name	Percentage of Route Area
Grey siltstone & sandstone	Gull Island Formation	90.15%
Sandstone, siltstone & mudstone	Central Clare Group	9.85%

It is noted that lands in the vicinity of the eastern trailhead at Kilrush are indicated to be partially reclaimed from the tidal margins of Kilrush harbour as per historic mapping. Targeted investigations were undertaken at this location to categorise the made ground at this location. Preliminary ground investigations were completed in March 2026 (refer to Appendix 9.1 in Volume 4 of this EIA). The made ground at the proposed Kilrush trailhead was investigated at locations BH-KTH01 (K-TH01), TP-KTH-01 and ST-14985 which show the soils to comprise very sandy, very silty GRAVEL with low to high cobble content and occasional inclusions indicative of construction debris such as glass and plastic. The ground at Moyasta is similar, but with particles of concrete blocks present. Further investigations will be prescribed, as required to inform the detailed design and check for pockets of material, particularly anywhere that will require excavation as part of the trailhead construction.

11.4.8 Nature Conservation Water Dependant Protected Areas

Designated protected areas for nature conservation were reviewed for groundwater dependence. The closest groundwater dependant site is Tullaher Lough and Bog SAC approximately 2km north of the proposed route at its closest point. There is no identified hydrological or hydrogeological connection with the site as it is in a separate catchment with both flow direction of watercourses and groundwater in the opposite direction (south-west) from the proposed development.

It is noted that the proposed development is in close proximity or crosses the River Shannon and River Fergus Estuaries Special Protection Area (SPA), Lower River Shannon Special Area of Conservation (SAC) and Poulinaherry Bay proposed Natural Heritage Area (pNHA). However, these sites have no explicit groundwater dependence that has potential to significantly be affected by the proposed development. Refer to Chapter 8 Biodiversity and Chapter 10 Hydrology of this EIA for further assessment on the likely effects to surface water and associated protected areas.

All other water dependant protected sites are considered sufficiently remote (both spatially and hydrogeologically) as to negate any potential effect.

11.5 Description of Potential Impacts

This section describes the potential construction and operational impacts associated with the proposed development before any mitigation measures are applied. Direct and indirect impacts will be addressed as well as the nature, extent and duration of the impacts.

11.5.1 Potential Construction Impacts

11.5.1.1 Hydrogeological Flow Regime

During the construction phase of the proposed development there will be no direct discharges to or abstractions from groundwater with the exception of rainfall which will infiltrate to ground. Water needs for construction activities will be limited to concrete truck chute washing, wheel wash, dust suppression and sanitary facilities. This water requirement will be imported to the site in bulk and stored at temporary compounds as such there is no pressure on surface or groundwater sources for water supply on site.

Throughout the construction phase, only limited excavation will be required for the construction of the proposed trailheads and the greenway where it passes through greenfield land, along public roads, or along the former West Clare Railway alignment.

At the trailheads, excavation of topsoil will typically be limited to a depth of approximately 0.3m. Along the greenway route, excavation will generally be restricted to topsoil stripping to a depth of around 150mm, undertaken only where necessary due to soft-ground conditions. The main exceptions to this are the construction of the retaining walls and agricultural passes as detailed in Chapter 4. These works will likely require excavation of both topsoil and subsoil to accommodate footings / foundations.

In addition to the above, several minor crossings will also be constructed as part of the proposed development (e.g., 2 no. Bridges at Lisdeen, Ch. 2100; 2 no. Bridges at Lisdeen, Ch. 2265; and culvert field crossing) and new watercourse/ drainage culverts along the scheme. These structures are considered minor in scale and are not expected to give rise to significant effects, particularly in the context of the overall extent of the proposed development and the sensitivity of the receiving environment.

There may be a requirement for localised dewatering where shallow groundwater is encountered during groundworks (e.g., for new bridge foundations). Excessive or prolonged dewatering/abstraction has the potential to temporarily depress groundwater levels in the vicinity of the abstraction point. However, any groundwater dewatering required for the proposed development will be temporary, small-scale and confined to the immediate working area, with associated effects limited to the vicinity of the excavation.

There will be no unauthorised discharge of water (groundwater) to ground, drains or water courses during the construction phase ensuring only clean / uncontaminated water will be released.

Overall, it is considered that the impact on hydrogeological flow regime during the construction phase of the proposed development is 'likely', 'neutral', 'slight' and 'short-term' and confined to a localised area.

11.5.1.2 Water Quality

There is potential for contamination to be encountered along the route of the former West Clare Railway corridor including the proposed trail heads, due to the historic land use (ROD, 2025a). Creosote (wood preservative), which contains a number of toxic chemical compounds, has been used historically on railway sleepers that form part of the railway track. The wooden sleepers have the potential to leach contamination into the underlying aquifer if

not properly managed. As detailed in the Outline Construction Environmental Management Plan (CEMP) (ROD, 2025c), the removal of wooden sleepers (where required) will be removed in accordance with all relevant waste management legislation. Made ground at the proposed trail heads has the potential to contain sources of contamination. Should contaminated soils be encountered during construction, the soils will be removed in accordance with best practice procedures and disposed of to an offsite licenced facility. Nonetheless, in an unmitigated scenario the works required to remove the sleepers and contaminated soils have the potential to mobilise contaminants and leach into the aquifer which may result in an 'unlikely', 'negative', 'moderate to significant' and 'short-term' impact on the receiving groundwater environment at the proposed development.

There is a potential risk associated with the cementitious materials used during construction works, including the construction of pavements and other structures (i.e., bridge foundations) and the accidental release of deleterious materials (e.g., fuels or other hazardous materials being used onsite), through the failure of secondary containment or a materials handling accident at the site, that have the potential to impact on the underlying groundwater beneath the site. The excavation works will be limited and therefore, the vulnerability of the groundwater beneath the proposed development will remain unchanged. All works will be undertaken in accordance with the CEMP (ROD, 2025b) which includes measures for handling, storage and clean-up of deleterious materials. Overall, the use of deleterious materials at the proposed development may result in an 'unlikely', 'negative', 'moderate to significant' and 'short-term' impact on the receiving groundwater environment.

Flood events during construction may have the potential to mobilise contaminants during the construction phase. All works will be undertaken in accordance with the CEMP and SSFRA (ROD, 2025b), with measures put in place to mitigate this risk (e.g., seasonal phasing of the works). In the absence of mitigation it is considered that this could result in an 'unlikely', 'negative', 'moderate to significant' and 'temporary' effect on the receiving hydrogeological environment depending on the nature of the incident.

As documented in Chapter 4 Description of the Proposed Development of this EIAR, the two proposed construction compounds will be located at the proposed trail head locations. Foul water discharge from the temporary welfare units (canteen facilities, toilet facilities, office accommodation and tool storage areas) at the construction compound will be tankered offsite in accordance with all relevant waste management legislation or discharged under temporary consent in accordance with the necessary consent/licence issued under by UE under Section 16 of the Local Government (Water Pollution) Acts and Regulations for any water discharges to sewer or from Fingal County Council under Section 4 of the Local Government (Water Pollution) Act 1977, as amended in 1990 for discharges to ground or surface water.

There will be no unauthorised discharge of water (groundwater or surface water runoff) to ground during the construction phase of the proposed development.

Therefore, as the necessary permits or authorisation will be obtained for the discharge of any water from the site, the potential impacts will have been adequately assessed and mitigated as part of the statutory consent and there will be a 'likely', 'neutral', 'imperceptible' and 'temporary' effect on the receiving hydrogeological environment.

11.5.1.3 Potential Operational Impacts

During the Operational Phase of the proposed development, there is limited potential for any adverse impact on the receiving hydrogeological environment at the site, taking into account the design and nature of the proposed development.

11.5.1.4 Hydrogeological Flow Regime

The change in land cover along the greenfield areas has the potential to alter infiltration patterns. However, the scale of the proposed interventions combined with the retention of existing vegetated boundaries and proposed drainage network minimises any potential effect. Additionally, as the bedrock aquifer underlying the site is a locally important aquifer (LI) (moderately productive only in local zones), the existing potential for infiltration and recharge may already be limited.

Existing drainage pathways will be maintained during the operational phase drainage network. Surface water runoff from the proposed greenway will be collected in over-the-edge drainage ditches running alongside the greenway. Further, permeable paving will be incorporated into the parking bays within both trailheads along with bioretention swales along the perimeter. Elsewhere, drainage design will be undertaken in line with the appropriate TII Standards.

Therefore, it is considered that the impact on groundwater flow from change of land cover and drainage associated with the proposed development is 'likely', 'neutral', 'imperceptible' and 'permanent'.

The limited foundations needed for structures along the greenway route have limited potential to impede local groundwater flow and movement through the site. Furthermore, given the shallow depth of the works, it is very unlikely that those structures will have a perceptible effect on groundwater flow.

Therefore, it is considered that the impact on groundwater flow from subsurface structures (i.e., structure foundations) is 'likely', 'neutral', 'imperceptible' and 'permanent'.

11.5.1.5 Water Quality

There will be no requirement for bulk storage of petroleum hydrocarbon-based fuels or deleterious chemicals during the operational phase of the proposed development.

Therefore, it is considered that the impact on the water quality from surface water runoff will be 'likely', 'neutral', 'imperceptible' and 'permanent'.

The proposed development will require the removal of potential sources of historic contamination (i.e., wooden railway sleepers and surrounding soils). Removing the source of potential contamination is considered to have a 'likely', 'positive', 'slight' and 'permanent' impact on the receiving groundwater environment.

11.6 Mitigation Measures

11.6.1 Construction Phase

An Outline Construction Environmental Management Plan (CEMP) has been prepared as part of the planning application for the proposed development and is included in Volume 4 Appendix 4.1 of this EIAR. Following appointment, the contractor will be required to further develop the CEMP to provide detailed construction phasing and methods to manage and prevent any potential emissions to ground with regard to the relevant industry standards (e.g., Guidance for Consultants and Contractors, CIRIA-C532', CIRIA, 2001).

The CEMP will be implemented for the duration of the Construction Phase, covering construction and waste management activities that will take place during the Construction Phase of the proposed development.

A project-specific Environmental Operating Plan (EOP) (Outline EOP included in Volume 4 Appendix 4.2 of this EIAR), will also be developed in accordance with the TII/NRA Guidelines for the Creation and Maintenance of an Environmental Operating Plan. The EOP will include procedures for the delivery of environmental mitigation measures and for addressing general day-to-day environmental issues that may arise during the construction phase of the proposed development.

The following best practice control measures have been included to ensure the avoidance of any potential impact on the receiving hydrogeological environment (i.e., groundwater) during the construction phase of the proposed development and will also be presented within the EOP.

11.6.1.1 Control and Management of Contaminated Soil

Contaminated soil may be encountered during groundworks at the site. Refer to Chapter 9 of this EIAR Land and Soils for details on the assessment and management of contaminated soils, including storage and removal off site. The removal of any residual contamination in soil will be undertaken under supervision of the Project Environmental Consultant as per the CEMP, and validated in accordance with relevant guidelines including EPA 'Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites' (EPA, 2013a) and guidance and standards current at the time of construction works to ensure that a 'clean edge' is reached in the area of excavation.

The removal of localised hotspots shall be undertaken prior to the bulk excavation works for structures or trailheads, utility infrastructure and other works to reduce the potential risks associated with exposure of soils to rainfall or surface runoff and leaching to groundwater.

Storage of stockpiled materials pending reuse onsite, where required, will be located away from the location of any sensitive receptors (watercourses and drains). For any excavated material identified for removal offsite, appropriate management measures will be implemented in accordance with the CEMP and Resource Waste Management Plan for the site. Refer to Chapter 9 Land and Soils) and Chapter 10 (Hydrology) of this EIAR for further details on the management of contaminated materials. In addition, an outline CEMP and RWMP are included in the appendices in Volume 4 of the EIAR.

11.6.1.2 Welfare Facilities

Welfare facilities have the potential, if not managed appropriately, to release organic and other contaminants to ground or surface water courses. Foul drainage from temporary welfare facilities during the construction phase of the proposed development will either be discharged to temporary holding tank(s), the contents of which will periodically be tankered off site to a licensed facility or discharged to public sewer in accordance with the necessary temporary discharge licences issued by UE.

11.6.1.3 Control of Groundwater

There will be no authorised discharge of water to ground during the construction phase. Where dewatering of shallow groundwater is required or where surface water runoff must be pumped from the excavations, water will be managed in accordance with best practice standards (i.e., CIRIA C750), the CEMP and regulatory consents to minimise the potential impact on the local groundwater flow regime within the soil and bedrock.

The appointed Contractor will ensure that the discharge of water to ground (where required) will be in accordance with the necessary discharge licences issued by the local authority under Section 4 of the Local Government (Water Pollution) Act 1977, as amended in 1990.

11.6.1.4 Concrete Works

The use of cementitious grout used during the Construction Phase of the proposed development will avoid any contamination of the receiving hydrogeological environment through the use of appropriate design and methods implemented by the appointed contractor and in accordance with the CEMP and relevant industry standards to prevent impact on groundwater quality such as the use of water compatible grout.

All ready-mixed concrete will be delivered to the construction site by truck. Concrete batching will take place offsite, wash down and wash out of concrete trucks will take place into a container located within a controlled bunded area which will then be emptied into a skip for appropriate compliant removal offsite in accordance with all relevant waste management legislation. Any excess concrete is not to be disposed of onsite.

Washing of tools or machinery with wet concrete will take place offsite at an appropriate dedicated wash facility that will pose no threat to receiving groundwaters.

11.6.1.5 Handling of Fuels, Chemicals and Materials

Fuelling and lubrication of equipment will be carried out in accordance with the procedures outlined in the Outline CEMP (ROD, 2025c), in a designated area of the site (where not possible to carry out such activities offsite).

Fuel will not be stored onsite for the duration of the construction phase. Fuel will only be brought to site via mobile fuel bowser. Any other lubricants, chemicals or hydraulic oils stored onsite will be stored in designated areas. These areas will be bunded on flat ground at the contractor's compound. All tank and drum storage areas will, as a minimum, be bunded to a volume not less than the greater of the following:

- 110% of the capacity of the largest tank or drum within the bunded area; or
- 25% of the total volume of substance that could be stored within the bunded area.

The main contractor will maintain an emergency response action plan and emergency procedures will be developed by the appointed contractor in advance of any works commencing. Construction staff will be familiar with the emergency response plan.

Strict supervision of contractors will be adhered to in order to ensure that all plant and equipment utilised on-site is in good working condition. Site personnel will be responsible for ensuring the regular maintenance of construction plant and equipment, to prevent leaks. Any equipment not meeting the required standard will not be permitted for use within the site.

Only emergency breakdown maintenance will be carried out on-site. Drip trays and spill kits will be available on-site to ensure that any spills from vehicles are contained and removed off-site.

Spill kits will be made available onsite and identified with signage for use in the event of an environmental spill or leak. A spill kit will be kept in close proximity to the fuel storage area for use in the event of any incident during refuelling or maintenance works. Heavy machinery used on the site will also be equipped with its own spill kit.

There may also be the requirement for use of portable generators or similar fuel containing equipment during the construction phase of the proposed development, which will be placed on suitable drip trays. Regular monitoring of drip tray content will be undertaken to ensure sufficient capacity is maintained at all times.

11.6.1.6 Emergency Procedures

Emergency procedures will be developed by the appointed Contractor in advance of works commencing and spillage kits will be available onsite including in vehicles operating onsite. Construction staff will be familiar with emergency procedures for in the event of accidental fuel spillages. Remedial action will be immediately implemented to address any potential impacts in accordance with industry standards and legislative requirements.

- Any required emergency vehicle or equipment maintenance work will take place in a designated impermeable area within the site.
- Emergency response procedures and contingency plans will be put in place, in the unlikely event of emergency accidents (i.e., spillages of fuels or lubricants).
- Spill kits, including oil absorbent material, will be provided and available onsite, so that any spillage of fuels, lubricants or hydraulic oils will be immediately contained.
- In the event of a leak or spill from equipment in the instance of a mechanical breakdown during operation, any contaminated soil will be removed from the proposed development site and compliantly disposed of offsite. Residual soil will be tested to validate that all potentially contaminated material has been removed. This procedure will be undertaken in accordance with industry best practice procedures, standards and EPA guidelines.
- All construction works staff will be familiar with the emergency procedures in the event of accidental fuel spillages.
- All construction works staff onsite will be fully trained on the use of equipment.
- The local authority and / or the EPA will be informed immediately of any spillage or pollution incident that may occur onsite during the construction phase.

This procedure will be undertaken in accordance with industry best practice procedures and standards. These measures will ensure that there is minimal risk to the receiving hydrogeological environment associated with the construction phase of the proposed development. An outline CEMP and Incident Response Plan are included in the appendices in Volume 4 of this EIAR.

11.6.1.7 Flooding

The appointed Contractor will provide method statements for weather and storm surge forecasting and continuous monitoring of water levels in the adjoining water courses. The appointed Contractor will also provide method statements for the removal of site materials, fuels, tools, vehicles, and persons from flood zones in order to minimise the risk to persons working on the site as well as potential input of sediment or construction materials into the waterbodies during flood events.

11.6.2 Operation Phase

Based on the design of the proposed development, there are limited potential sources of contamination that would impact water quality and quantity (flow regime) during the operational phase. Surface water will be managed in accordance with the principles and objectives of nature based solutions to treat water prior to discharging offsite. Ongoing regular operational monitoring and maintenance of drainage measures will be incorporated into the overall management strategy for the proposed development. These measures will ensure that no adverse impacts on water quality or groundwater flow regime arise during the operational phase. Therefore, no additional hydrogeology-related mitigation measures are required for this phase of the proposed development.

11.7 Monitoring

During the construction phase of the proposed development, the following monitoring measures will be considered:

- Inspections will be undertaken during the works to ensure that measures that are protective of groundwater, outlined in this EIAR and the Outline CEMP (ROD, 2025c) are fully implemented and effective.
- Routine monitoring and inspections during refuelling, concrete works to ensure no impacts and compliance with avoidance, remedial and mitigation measures.
- Where original railway sleepers remain in place, they will either be removed in accordance with the relevant waste management legislation or reused as edging or landscaping features along the greenway route. The removal of any residual soil source will be validated in accordance with applicable guidance, including the EPA's Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites (EPA, 2013), as well as any other standards or guidance current at the time of construction. Prior to any reuse, a representative sample of the sleepers will be tested for creosote concentrations, and a suitability-for-reuse assessment will be undertaken in accordance with the appropriate engineering and environmental requirements.
- Discharges to ground (where required) will be monitored in accordance with statutory consents (i.e., discharge licence). Where required, water pumped from excavations will be treated and pumped to a holding area, where it will be sampled and tested by the contractor before discharge. Upon receiving analysis results and screening against required consent limits, the contractor will arrange for appropriate disposal in accordance with the temporary discharge consent.
- Continuous monitoring of water levels in the adjoining water courses will be undertaken throughout the construction phase.

11.8 Residual Effects

Residual Effects are defined as 'effects that are predicted to remain after all assessments and mitigation measures. They are the remaining 'environmental costs' of a project and are the final or intended effects of a development after mitigation measures have been applied to avoid or reduce adverse effects.

The predicted effects of the construction and operational phases are described in Table 11-9 in terms of quality, significance, extent, likelihood, and duration. The relevant mitigation measures are detailed, and the residual effects are determined which take account of the avoidance, remedial and mitigation measures.

With the implementation of the avoidance, remedial and mitigation measures detailed in Section 11.6, the residual effects regarding the construction and operational phases of the proposed development are considered 'imperceptible' to the receiving hydrogeological environment and considered non-significant in the context of the EIA Directive. Furthermore, the excavation and removal of creosote sleepers and potentially contaminated soil and subsoil will have a 'positive' impact on the quality of groundwater underlying the site.

There will be no effect to water quality and the existing WFD Status of groundwater bodies associated with the proposed development as a result of the proposed development, taking account of design avoidance and mitigation measures where required.

Table 11-9 Summary of Residual Effects

Activity	Attribute	Predicted Effect	Quality	Significance	Duration	Type	Mitigation	Residual Effect
Construction Phase								
Potential for contamination to be encountered along the route of the old Railway and trail heads	Groundwater Quality and WFD status	Removal of the wooden sleepers and soil has the potential to mobilise contaminants and leach into the aquifer.	Negative	Moderate to Significant	Short-term	Direct	Should contaminated soils be encountered during the removal of the sleepers, the soils will be removed in accordance with best practice procedures and disposed of to an offsite licenced facility.	Imperceptible
Potential uncontrolled release of deleterious hazardous materials including fuels, oils and other materials	Groundwater Quality and WFD status	Potential (albeit low) for uncontrolled release of deleterious materials including fuels and other materials being used onsite, through the failure of secondary containment or materials handling accident, to the receiving groundwater environment.	Negative	Moderate to Significant	Short-term	Direct	Refuelling of plant and storage of any deleterious materials will be undertaken in accordance with the requirements and procedures outlined in the CEMP and EOP and relevant industry standards.	Imperceptible
Introduction of Cementitious Materials to Groundwater	Groundwater Quality and WFD status	Potential release of cementitious material during construction works for pavements, etc.	Negative	Moderate to Significant	Short-term	Direct	All work will be carried out to avoid any contamination of the receiving water environment through the use of appropriate design	Imperceptible

Activity	Attribute	Predicted Effect	Quality	Significance	Duration	Type	Mitigation	Residual Effect
							and methods implemented by the appointed contractor and in accordance with the CEMP, EOP and relevant industry standards.	
Flooding of Site During Construction	Groundwater Quality and WFD status	Potential for impact on underlying groundwater bodies within a localised zone of the aquifer.	Negative	Moderate to Significant	Temporary	Direct	The main contractor will continuously monitor water levels in the Morningstar River and its tributaries. They will also provide method statements for the removal of site materials, fuels, tools, vehicles, and persons from flood zones.	Imperceptible
Operational Phase								
There will be no significant direct or indirect effect on the receiving hydrological and hydrogeological environment associated with the operational phase of the proposed development.								

11.9 Water Framework Directive

In the absence of any standard mitigation and avoidance measures there could be a potential impact on the water quality within receiving Kilrush GWB associated with the proposed development.

The standard mitigation measures including the implementation of a robust CEMP during the construction phase and the incorporation of nature based solutions in the drainage design, will prevent any impact on the receiving groundwater environment. Hence, the proposed development will not have any impact on compliance with the EU Water Framework Directive, the European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010), as amended and the EU Nature Restoration Regulation EU2024/1991.

Therefore, the proposed development will not cause a deterioration in the status of waterbodies hydrologically connected with the proposed development, taking account of design avoidance and mitigation measures that will be implemented. Furthermore, the proposed development will not jeopardise the objective to achieve 'good' groundwater body status.

11.10 References

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