Chapter 11
Hydrogeology

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11. HYDROGEOLOGY

11.1 Introduction

This chapter has assessed the potential effects on hydrogeology arising from the DART+ Coastal North project ("the Proposed Development") during the Construction and Operational Phases based on the draft Railway Order, Chapter 4 (Description of Proposed Development) and Chapter 5 (Construction Strategy).

This chapter should be read in conjunction with the following chapters, which present related impacts arising from the Proposed Development:

- Volume 2, Chapter 8 (Biodiversity);
- Volume 2, Chapter 9 (Land and Soils); and,
- Volume 2, Chapter 10 (Water).

11.2 Legislation, Policy and Guidance

The key legislation and guidance referenced in the preparation of the EIAR is outlined in Chapter 1 (Introduction) (Sections 1.5, 1.6 and 1.7) in Volume 2 of this EIAR.

11.2.1 Legislation

This chapter of the EIAR has been prepared in accordance inter alia with the Transport (Railway Infrastructure) Act 2001 (as amended) ("the 2001 Act"). The European Union (Railway Orders) (Environmental Impact Assessment) (Amendment) Regulations 2021 (S.I. No. 743 of 2021) gives further effect to the transposition of Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment as amended by Directive 2014/52/EU ("the EIA Directive") by amending the 2001 Act. Section 39 of the 2001 Act provides for the contents of an EIAR.

An examination, analysis and evaluation is carried out by An Bord Pleanála in order to identify, describe and assess, in the light of each individual case, the direct and indirect significant effects of the proposed railway works, including significant effects derived from the vulnerability of the activity to risks of major accidents and disasters relevant to it, on: population and human health; biodiversity, with particular attention to species and habitats protected under Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora ("the Habitats Directive") and Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds ("the Birds Directive"); land, soil, water, air and climate; material assets, cultural heritage and the landscape, and the interaction between the above factors.

Specific to hydrogeology, the following legislation, guidance and planning framework relevant to the consideration of hydrogeology has informed the assessment as outlined below:

- Directive 2013/39/EU of the European Parliament and of the Council of 12 August 2013, amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy;
- Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration ("daughter' to Directive 2000/60/EC) ("the Groundwater (Daughter) Directive");
- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy ("the Water Framework Directive");
- European Communities (Water Policy) Regulations, 2003 (S.I. No. 772 of 2003); and
- The Water Environment (Abstractions and Associated Impoundments) Act, 2022 (not commenced at time of writing).

The implementation of the Water Framework Directive (WFD) has resulted in the repeal and/or replacement of other European legislation of relevance to consideration of the water environment. Most notably, this includes the following:

- Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances , repealed in 2013; and,
- Council Directive 76/464/EEC of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community, repealed in 2013.

A brief summary of the relevant guidance and legislation is provided in the following section.

11.2.1.1 EU Water Framework Directive

The Water Framework Directive came into force on 22 December 2000 and its primary objective is for all waters to achieve 'Good' ecological status by 2015, and by 2027 at the latest. The Water Framework Directive also promotes the sustainable use of water resources, defines a management and reporting system based on River Basin Districts (RBDs) and sets environmental objectives which take account of the full range of pressures on the aquatic environment (including pollution, abstraction, flow regulation, habitat impact etc). The Directive's 'water environment' includes rivers, lakes, transitional waters, groundwater and coastal waters.

11.2.1.2 Groundwater Directives (80/68/EEC) and (2006/118/EC)

Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances provided a groundwater protection framework before the Groundwater (Daughter) Directive. Council Directive 80/68/EEC aimed to protect groundwater from pollution by controlling discharges and disposal of certain dangerous substances to groundwater. The Directive was transposed into Irish Law by the Protection of Groundwater Regulations, 1999 (S.I. No. 41 of 1999). It was repealed by the Water Framework Directive in 2013.

In Ireland, the original Council Directive 80/68/EEC was primarily transposed into national legislation through:

- The Local Government (Water Pollution) Act, 1977 to 1990;
- The Local Government (Water Pollution) Regulations, 1978 (S.I. No. 108 of 1978);
- The Protection of Groundwater Regulations, 1999 (S.I. No. 41 of 1999). This was repealed and replaced by the Waste-Water Discharge (Authorisation) Regulations, 2007 (S.I. No. 684 of 2007) in 2013; and,
- The Local Government (Water Pollution) (Amendment) Regulations, 1999 (S.I. No. 42 of 1999). These were repealed and replaced by the European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010), with the repeal taking effect in December 2013.

11.2.1.3 European Communities Environmental Objectives (Groundwater) Regulations 2010

The purpose of the European Communities Environmental Objectives (Groundwater) Regulations is to transpose the requirements of the Water Framework Directive and the Groundwater (Daughter) Directive into national legislation and provide for transitional arrangements from the repealed Groundwater Directive (Council Directive 80/68/EEC). These regulations have been transposed into national legislation through the European Communities Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010), as amended, and the European Union Environmental Objectives (Groundwater) Amendment) Regulations 2016 (S.I. No. 366 of 2016).

11.2.2 Policy

Relevant policy documents that have informed this chapter include:

- Dublin City Development Plan 2016-2022;
- Dublin City Development Plan 2022-2028;
- Fingal Development Plan 2023-2029;
- Draft Fingal Development Plan 2023-2029;
- Meath County Development Plan 2021-2027; and,
- Louth County Development Plan 2021-2027.

11.2.3 Guidance

The assessment has had due regard to relevant guidelines that include the following:

- Environmental Protection Agency (EPA) (2022). Guidelines on the information to be contained in Environmental Impact Assessment Reports (EIAR);
- Institute of Geologists of Ireland (IGI) (2013). Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements;
- National Roads Authority (NRA) (2009). Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Strive Report Series No. 100. Evaluating the Influence of Groundwater Pressures on Groundwater-Dependent Wetlands. Strive EPA Programme 2007 - 2013 (EPA 2011); and,
- Environmental Research Centre Report Series No. 12. A Framework for the Assessment of Groundwater-Dependent Terrestrial Ecosystems under the Water Framework Directive. Strive EPA Programme 2007 – 2013 (EPA 2008).

Though the NRA is now known as Transport Infrastructure Ireland (TII), for the purpose of this chapter the guidelines mentioned above are referred to as the NRA Guidelines.

11.3 Methodology

The general approach adopted within this impact assessment is as follows:

- Define the appropriate study area required to allow consideration of potential effects;
- Characterise baseline conditions within the study area relevant to the consideration of hydrogeology;
- Consultation; and,
- Assessment of whether the Proposed Development will result in any likely significant effect(s).

11.3.1 Study Area

The Proposed Development extends for approximately 50km along the existing railway line which runs through County Dublin (Dublin City and Fingal) into counties Meath and Louth, which are mostly urban, suburban, and agricultural areas.

The southern part of the Proposed Development is in a more densely populated, commercial, and urbanised area, starting from north of Connolly Station in Dublin City Centre. Farther out along the route, land use transitions to agriculture either side of the existing transport corridor, with several towns located along the route. The end of the Proposed Development is located in the large urban centre of Drogheda in County Louth.

The study area is also affected by the historic developments of the original railway line which masks the original context of the natural ground conditions. As a result of the existing railway corridor and tight constraints on these lines, the study area is taken as no more than a 100m corridor along most of the existing railway lands.

As outlined in Chapter 4 (Description of the Proposed Development), the Proposed Development has been divided into five zones (Zones A to E), which are summarised below.

- Zone A – North of Connolly Station to south of Howth Junction & Donaghmede Station (refer to Chapter 4, Section 4.6);
- Zone B – South of Howth Junction & Donaghmede Station to north of Malahide Viaduct. (Including Howth Branch) (refer to Chapter 4, Section 4.7);
- Zone C – North of Malahide viaduct to south of Gormanston Station (Fingal boundary) (refer to Chapter 4, Section 4.8);
- Zone D – South of Gormanston Station (Fingal border) to Louth/Meath border (refer to Chapter 4, Section 4.9); and
- Zone E – Drogheda MacBride Station and surroundings (refer to Chapter 4, Section 4.10).

11.3.2 Data Collection

11.3.2.1 Desk Study

The following publicly available data sources [Accessed: April 2023] will be used to classify the regional and site setting, which will be used to support the characterisation of the study area and the surrounding area:

- Environmental Protection Agency (EPA) maps and datasets - https://gis.epa.ie/EPAMaps/;
- EPA Catchments - https://www.catchments.ie/;
- EPA online resources including the Hydronet WebApp - https://epawebapp.epa.ie/hydronet/;
- GeoHive Historical Map Viewer – https://www.map.geohive.ie;
- Geological Survey of Ireland (GSI) maps and datasets - https://www.gsi.ie/;
- National Parks and Wildlife Services (NPWS) - http://webgis.npws.ie/npwsviewer/; and
- Open-source mapping including Google Earth and OpenStreetMap.

11.3.2.2 Ground Investigations

The site-specific ground investigation work and associated historical ground investigation reports have informed the conceptualisation and characterisation of groundwater conditions and risks. Chapter 9 (Land and Soils) details the historical and site-specific ground investigations.

11.3.2.3 Consultation

Consultation was carried out with Uisce Éireann regarding groundwater supplies in the study area and with the Geological Survey of Ireland in relation to relevant datasets.

11.3.3 Assessment Methodology

The potential impact of the Proposed Development on the hydrogeological environment has been assessed by classifying the importance of the relevant attributes and quantifying the likely magnitude of impact on these attributes. The rating criteria for assessing the importance of hydrogeological features within the study area are detailed in Table 11-1 whilst the rating criteria for quantifying the magnitude of impacts are detailed in Table 11-2. The significance of potential impacts on the hydrogeological environment is based on the impact assessment criteria presented in Table 11-3.

The significance takes into account both the importance of an attribute and the magnitude of the potential impacts from the Proposed Development on the hydrogeological attribute.

The impact assessment for this chapter has been carried out in accordance with the NRA Guidelines (NRA, 2008a) and the IGI Guidelines (IGI, 2013). This IGI guidance outlines a 13-step methodology that is divided across four distinct elements:

- Initial assessment;
- Direct and indirect site investigation;
- Mitigation measures, residual effects, and final impact assessment; and,
- Completion of the hydrogeological section of the EIAR.

11.3.3.1 Initial Assessment

The ‘initial assessment’ presents a description of the past and present uses of the land across the relevant site and route which may have a bearing on the Proposed Development. This includes a detailed description of the nature of the hydrogeological conditions beneath the relevant sites and route based on existing literature as well as site specific and neighbouring site investigation data.

11.3.3.2 Direct and Indirect Site Investigation

Chapter 9 (Land and Soils) provides a summary of the data available from the historic and site-specific investigations carried out in relation to the Proposed Development. The information gathered on the receiving environment during ground investigations corresponds to the second element of the methodology, 'Direct and Indirect Site Investigation and Studies'.

11.3.3.3 Mitigation Measures, Residual Effects, and Final Impact Assessment

The outcome from examining this available data is a Conceptual Site Model (CSM). The CSM is a summary of the geological and hydrogeological conditions beneath the Proposed Development that considers the likely significant effects of the Proposed Development.

A 'Feature Importance Ranking' is then assigned to each feature which has the potential to be affected by the Proposed Development based on the guidance from the NRA and IGI. This facilitates the assessment of likely significant impacts which has been undertaken in accordance with the guidance outlined in Section 11.2.3.

Section 11.8 outlines the 'Mitigation Measures' associated with the works in accordance with the above methodology. The final impact assessment includes a description of any residual impacts. The significance of any residual impact is determined based on the same methodology and reported.

Table 11-1 Estimation of importance of Hydrogeological Attributes (NRA 2009)

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 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 – NHA status Regionally important potable water source supplying >2500 homes Inner source protection area for regionally important water source
High	Attribute has a high quality, significance or value on a local scale. D	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
Medium	Attribute has a medium quality, significance or value on a local scale.	Locally Important Aquifer Potable water source supplying >50 homes Outer source protection area for locally important water source
Low	Attribute has a low quality, significance, or value on a local scale.	Poor Bedrock Aquifer Potable water source supplying <50 homes

Table 11-2 Criteria for rating the impact significance at EIAR stage – Estimation of Magnitude of Impact on Hydrogeology Attributes (NRA 2009)

Magnitude of Impact	Criteria	Typical Example
Large Adverse	Results in loss of attribute and /or quality and integrity of attribute	Removal of large proportion of aquifer Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems Potential high risk of pollution to groundwater from routine run-off Calculated risk of serious pollution incident >2% annually
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute.	Removal of moderate proportion of aquifer Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems Potential medium risk of pollution to groundwater from routine run-off Calculated risk of serious pollution incident >1% annually
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute.	Removal of small proportion of aquifer Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems Potential low risk of pollution to groundwater from routine run-off Calculated risk of serious pollution incident >0.5% annually
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity.	Calculated risk of serious pollution incident <0.5% annually

Table 11-3 Significance of Impact (NRA 2009)

Significance	Description
Imperceptible	An effect capable of measurement but without significant consequences.
Slight	An effect which causes noticeable changes in the character of the environment without affecting its sensitivities.
Moderate	An effect that alters the character of the environment in a manner that is consistent with existing or emerging baseline trends.
Significant	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 most of a sensitive aspect of the environment.
Profound	An effect which obliterates sensitive characteristics.

11.3.4 Difficulties Encountered/Limitations

No difficulties were encountered in the preparation of this Chapter.

Based on the results from the investigations commissioned and the desk study of existing information (as described in Section 11.3.2), the information on the baseline conditions (as described in Section 11.4.1) is deemed sufficient.

11.4 Receiving Environment

11.4.1 Current Baseline

For the purpose of the discussion on hydrogeology, a general overview of the entire study area is provided, with reference to the project zones where relevant. This chapter should be read in conjunction with Chapter 9 (Land and Soils), as it provides relevant descriptions of the geology within the study area.

11.4.2 Aquifer Classification

An underground water bearing rock or unconsolidated materials (gravel or sand) from which groundwater can be extracted in useful amounts is known as an aquifer. GSI classifies aquifers based on their groundwater resource potential into three main groups, regionally and locally important and poor categories. These are further subdivided into nine aquifer categories based on the type of openings through which groundwater flows, as summarised in Table 11-4.

Table 11-4 GSI Aquifer Classification, Description, and Codes

Aquifer Type	Description	Subcategory	Code
Regionally Important Aquifers	Aquifer capable of supplying regionally important abstractions or producing excellent yields of >400m^3/day. Bedrock aquifers have a continuous area >25km^2 with groundwater mainly flowing through fractures, fissures, joints, or conduits.	Regionally Important Karstified Bedrock Aquifer - Karstified bedrock dominated by diffuse flow. Karstified bedrock dominated by conduit flow	Rkd Rkc
		Regionally Important Fissured Bedrock Aquifer	Rf
		Regionally Important Sand/Gravel Aquifer	Rg
Locally Important Aquifers	Aquifers capable of producing good yields, 100-400m^3/day and capable of supplying locally important abstractions.	Locally Important Bedrock Aquifer, Generally Moderately Productive	Lm
		Locally Important Bedrock Aquifer, Moderately Productive only in Local Zones	Ll
		Locally Important Karstified Bedrock Aquifer	Lk
		Locally Important Sand/Gravel Aquifer	Lg

Aquifer Type	Description	Subcategory	Code
Poor Aquifers	Bedrock aquifer capable of supplying small abstractions, or moderate to low yield, <100m^3/day. Characterised by poorly connected network of fractures, fissures, and joints.	Poor Bedrock Aquifer, Generally Unproductive except in Local Zones	Pl
		Poor Bedrock Aquifer, Generally Unproductive	Pu

The GSI 1:100,000 bedrock aquifer map and 1:40,000 sand and gravel aquifer map show the study area is predominantly underlain by locally important aquifers and poor aquifers, see Volume 3A, Chapter 11: Figure 11.1. Bedrock discussed in this section refers to the Hydrostratigraphic Rock Unit Groups which group bedrock formations based on their hydrogeological properties. The Hydrostratigraphic Rock Unit maps are presented in Volume 3A, Chapter 11: Figure 11.2. Further information on the geological formations is provided in Chapter 9 (Land and Soils).

11.4.2.1 Zone A

Zone A is underlain by Dinantian Upper Impure Limestones which contains two aquifer types; a Locally Important Bedrock Aquifer (Ll) which is Moderately Productive only in Local Zones in the southern part of Zone A and a Poor Bedrock Aquifer (Pl) which is Generally Unproductive except in Local Zones in the northern part of Zone A.

There is also a sand and gravel aquifer located within Zone A. The Liffey Locally Important Gravel Aquifer (Lg) is mapped across a small section in the south of Zone A.

11.4.2.2 Zone B

There are two aquifer types which are widespread in Zone B; a Locally Important Bedrock Aquifer (Ll) which is Moderately Productive only in Local Zones and a Poor Bedrock Aquifer (Pl) which is Generally Unproductive except in Local Zones. The Pl and Ll aquifers are both associated with the Dinantian Upper Impure Limestones. In addition, the Ll aquifer is associated with both Dinantian Lower Impure Limestones and Dinantian Pure Unbedded Limestones. Both aquifers have a network of faults running northwest-southeast or northeast-southwest direction.

11.4.2.3 Zone C

Zone C is underlain by mainly either a Locally Important Bedrock Aquifer (Lm) which is Generally Moderately Productive or a Poor Aquifer (Pl) which is generally unproductive except for Local zones. The Lm and Pl aquifers are both associated with the Dinantian Upper Impure Limestones. In addition, the Lm is associated with Dinantian Sandstones and Ordovician Volcanics while the Pl is associated with Silurian Metasediments and Volcanics and Namurian Undifferentiated, Shales and Limestones groundwater rock units. At Skerries Station, the area is underlain by a karstified Locally Important Aquifer (Lk), associated with Dinantian Pure Bedded Limestones.

11.4.2.4 Zone D

Zone D is underlain by four bedrock aquifer types from south to north:

- Poor Bedrock Aquifer (Pu) which is Generally Unproductive in the southern part of Zone D which is associated with Silurian Metasediments and Volcanics;

- Poor Bedrock Aquifer (Pl) which is Generally Unproductive except for Local Zones which is associated with Silurian Metasediments and Volcanics;
- Regionally Important Aquifer (Rkd) Karstified (diffuse) around Laytown which is associated with Dinantian Pure Bedded Limestones; and
- Locally Important Bedrock Aquifer (Lm) which is Generally Moderately Productive south of Drogheda associated with Dinantian Upper Impure Limestones.

There is also a sand and gravel aquifer located within Zone D. The area just south of Laytown Station down to Gormanston Station lies over a Locally important gravel aquifer (Lg).

11.4.2.5 Zone E

Zone E is primarily underlain by the Dinantian Upper Impure Limestones which are classified as a Locally Important Bedrock Aquifer (Lm) which is Generally Moderately Productive. A small area of Granites & other Igneous Intrusive rocks located at Marsh Road are classified as a Poor Bedrock Aquifer (Pl) which is Generally Unproductive except in Local Zones.

Table 11-5 Summary of Aquifer Types within the Study Area

Feature	Description	Location	Importance	Justification
Regionally Important Aquifer (Rkd)	Karstified bedrock which is dominated by diffuse flow	Around Laytown in Zone D	High	Attribute has a high quality or value on a local scale
Locally Important Aquifer (Lk)	Locally important karstified aquifer	Skerries, Zone C	Medium	Attribute has a medium quality, significance or value on a local scale.
Locally Important Bedrock Aquifer (Lm)	Locally Important Bedrock Aquifer which is Generally Moderately Productive	Zone C to E	Medium	Attribute has a medium quality, significance or value on a local scale.
Locally Important Bedrock Aquifer (Ll)	Locally Important Bedrock Aquifer which is Moderately Productive only in Local Zones	Zone A, Zone B and Zone C	Medium	Attribute has a medium quality, significance or value on a local scale.
Locally Important Gravel Aquifer (Lg)	Locally Important Gravel Aquifer	Southern part of Zone A and within Zone D south of Laytown	Medium	Attribute has a medium quality, significance or value on a local scale.
Poor Bedrock Aquifer (Pl)	Poor Bedrock Aquifer which is Generally Unproductive except in Local Zones	Zone A to Zone E	Low	Attribute has a low quality, significance, or value on a local scale.

Feature	Description	Location	Importance	Justification
Poor Bedrock Aquifer (Pu)	Poor Bedrock Aquifer which is Generally	Southern part of Zone D	Low	Attribute has a low quality, significance, or value on a local scale.

11.4.3 Groundwater Levels

The following site-specific ground investigations were completed to inform the design of the Proposed Development and the EIAR (see Chapter 9 (Land and Soils) in Volume 2 of this EIAR for further details):

- Part A –Drogheda MacBride Station and Depot;
- Part B – Drogheda to Malahide; and
- Part C – Malahide to Howth.

The scope of work included the installation of groundwater monitoring boreholes. Forty groundwater monitoring standpipes were installed in the boreholes to provide information on groundwater levels in the various strata. The location of the groundwater monitoring wells is presented on Volume 3A, Chapter 11: Figure 11.3. Monitoring of groundwater levels has been undertaken between August 2022 and September 2023. There are no groundwater monitoring locations in Zone A as the scale of work in this area is minor.

Overall groundwater levels across the Proposed Development with the exception of boreholes monitoring clay only range from 0.48m below ground level (mbgl) (37.59mOD) to 10.50mbgl (21.08mOD). Groundwater levels in the bedrock range from 0.48mbgl (37.59mOD) to 5.63mbgl (2.03mOD) and groundwater levels in the subsoil range from 0.72 (4.32mOD) to 10.50mbgl (21.08mOD). Water levels recorded in clay are not included as they are not considered to represent the water table. A summary of the groundwater levels recorded in all standpipes not installed in clay during the ground investigation is provided in Table 11-6.

Groundwater loggers were installed in eight of the forty groundwater installations, as indicated on Table 11-6. The hydrographs for the logger data are presented in Appendix A11.1 in Volume 4 of this EIAR. The level logger data indicates that groundwater levels and responses to rainfall events vary across the Proposed Development.

The level logger data shows a relatively rapid response to rainfall events in boreholes NA-BH004, located in Zone E which has a response zone in the subsoils. This rapid response is not observed across the other boreholes where a generally more muted response to rainfall events is evident, as can be seen in NA-BH045 in Zone C with a response zone in the subsoil, NA-BH087 in Zone C with a response zone in the rock and NA-BH222 in Zone E with a response zone in the subsoil and rock.

The hydrograph for NA-BH297, located in Zone B with a response zone in the sand, gravel and silt, shows the groundwater in the borehole to be tidally influenced. The borehole is located in the thin strip of land located in Malahide Estuary and approximately 0.5km north of Malahide Station. In addition, the hydrograph for NA-BH274, located in Zone C with a response zone in the gravel and sands, shows that the groundwater in the borehole appears to be slightly tidally influenced. The borehole is located approximately 1.15km to the northwest of Rogerstown Estuary at Rush and Lusk Station.

Table 11-6 Groundwater levels recorded in all Strata, with the exception of Clay, along the Proposed Development

Zone	Installation Monitoring	Groundwater Installations (BH Name)	Depth to Groundwater Level (mbgl)			Groundwater Level (mOD)		
			Average	Min	Max	Average	Min	Max
B	Sand, Silt & Gravel	NA-BH297*	2.22	1.80	2.57	1.28	0.93	1.70
C	Sand	NA-BH045*	2.54	2.09	2.79	6.72	6.47	7.17
	Gravel	NA-BH050	1.06	0.77	1.32	17.29	17.03	17.58
		NA-BH059	1.93	1.88	2.00	17.44	17.36	17.48
	Gravel & Mudstone	NA-BH056	2.46	2.26	2.58	14.41	14.29	14.61
	Gravel & Sand	NA-BH058	8.97	8.92	9.02	9.54	9.49	9.59
		NA-BH080	4.39	3.50	5.22	1.71	0.88	2.60
		NA-BH274*	1.05	0.60	1.49	18.95	18.51	19.40
	Gravel, Sand & Rock	NA-BH085*	1.61	1.09	2.02	7.00	6.59	7.53
	Mudstone & Sandstone	NA-BH069	1.32	0.48	1.95	36.75	36.12	37.59
	Mudstone	NA-BH079	5.04	4.01	5.63	2.62	2.03	3.65

Zone	Installation Monitoring	Groundwater Installations (BH Name)	Depth to Groundwater Level (mbgl)			Groundwater Level (mOD)		
			Average	Min	Max	Average	Min	Max
	Limestone	NA-BH082	1.84	1.05	2.60	7.47	6.71	8.26
	Sandstone	NA-BH087*	1.10	0.78	1.26	7.57	7.42	7.90
D	Sand & Gravel	NA-BH033	0.88	0.72	1.09	4.16	3.95	4.32
	Silt	NA-BH225	3.03	0.95	4.20	14.66	13.49	16.74
	Sand	NA-BH234*	3.04	5.41	2.57	13.16	10.79	13.63
	Gravel	NA-BH263	1.07	0.95	1.20	23.34	23.21	23.46
	Limestone	NA-BH023	4.00	3.82	4.12	26.59	26.47	26.77
E	Gravel	NA-BH010	8.58	6.50	10.50	23.00	21.08	25.08
		NA-BH303	8.46	8.30	8.63	23.11	22.94	23.27
	Sand & Gravel	NA-BH017	6.56	6.30	6.81	28.31	28.06	28.57
	Sand	NA-BH213	6.47	5.63	7.40	26.99	26.06	27.83
	Gravel, Limestone & Shale	NA-BH222*	1.59	1.21	1.76	20.88	20.72	21.26

Zone	Installation Monitoring	Groundwater Installations (BH Name)	Depth to Groundwater Level (mbgl)			Groundwater Level (mOD)		
			Average	Min	Max	Average	Min	Max
	Made Ground, Clay, Sand & Silt	NA-BH004*	2.35	1.45	3.17	28.57	27.75	29.42
	Gravel & Mudstone	NA-BH301	1.54	1.17	2.60	2.22	1.16	2.59
	Andesite	NA-BH018	1.10	0.70	1.45	28.66	28.31	29.06

* Logger installed.

11.4.4 Groundwater Bodies and Groundwater Quality

Groundwater bodies (GWB) were delineated and described by the GSI in 2004 (EPA, 2015) as Water Framework Directive (WFD) groundwater management units to manage and protect groundwater and linked surface waters. The various groundwater bodies underlying the Proposed Development are summarized in Table 11-7 and presented in Volume 3A, Chapter 11: Figure 11.4.

Regional groundwater flow is generally eastwards towards the coast. However, generally local groundwater flow paths will flow towards the closest surface water feature. The groundwater quality across the region is generally classified as good with the exception of the Bettystown groundwater body which is poor.

11.4.4.1 Zones A and B

Zone A and B traverse the Dublin Groundwater Body (IE_EA_G_008). This GWB covers an area of 837km^2 covering the Greater Dublin City area and extending southwest towards Kildare. Groundwater flow in this GWB is primarily along joints, fractures and major faults. Flow is greatest in the upper 10m of the aquifer in the weathered zone and connected fractured zone beneath. Along the coast the GWB will mainly discharge directly to the Irish Sea. Inland, the GWB will discharge to overlying gravel aquifers and rivers where they are in hydraulic continuity with the aquifer.

The WFD status for the Dublin groundwater body is ‘good’ and is currently under ‘review’ regarding the risk of not maintaining that status.

Groundwater quality analysis was carried out in Malahide (BH297) adjacent to the Malahide estuary, Malahide Wastewater Treatment Plant and the existing railway. Results indicate elevated levels of ammoniacal nitrogen, chloride, manganese, magnesium, potassium, sodium, sulphate and total dissolved solids, see Groundwater Quality Results (Volume 4: A11.2).

11.4.4.2 Zone C

There are six groundwater bodies underlying Zone C; Swords GWB (IE_EA_G_011), Waste Facility (W0009-02) (IE_EA_G_088), Lusk-Bog of the Ring (IE_EA_G_014), Balrothery (IE_EA_G_043), Balbriggan (IE_EA_G_039) and Duleek (IE_EA_G_012).

The Swords GWB underlies the southern part of Zone C to Rush. This GWB covers 199km^2 of mainly low-lying area. Groundwater flow occurs along fractures and joints. Groundwater recharge occurs by diffuse recharge through the subsoil. However, due to the low permeability of the aquifer not all recharge can be accepted and rejected recharge discharges to local surface waterbodies and directly to the coast. The WFD status for the Swords GWB is ‘good’ and it is not at risk of failing to meet its WFD objectives.

The Waste Facility GWB underlies a small area to the northwest of Rogerstown Estuary in Zone C. The Waste Facility GWB does not have a GSI description or summary of characterisation. The WFD status for the Waste Facility GWB is ‘good’ and it is not at risk of failing to meet its WFD objectives.

The Lusk-Bog of the Ring GWB, north of Swords GWB covers an area of 209km^2 and is mainly low lying with some areas of higher elevations along the centre of the GWB. Groundwater flow in this GWB is mainly along fractures. Recharge occurs through both diffuse and point recharge with the discharge occurring directly to the Irish Sea in the east and also to the north and south via baseflow to surface water bodies. The WFD status for Lusk-Bog GWB is 'good' and it is at risk of failing to meet its WFD objectives.

Balrothery GWB north of the Lusk-Bog of the Ring GWB is situated to the north and east of Skerries and covers 14.5km^2. Groundwater flow occurs mostly in the upper 10m, the weathered bedrock zone. Recharge of the Balrothery GWB occurs diffusely through the subsoil and rock outcrops however due to the low permeability of the bedrock, groundwater pathways are relatively short, and the rejected groundwater is discharged to the closest watercourse. The WFD status of this GWB is 'good' and it is not at risk of failing to meet its WFD objectives.

The Balbriggan GWB is located at the northern end of Zone C around Balbriggan, covering 16km^2. The bedrock within this GWB is of moderate permeability, with flow occurring in the upper 30m in the weathered zone and underlying fractured zone. Recharge occurs diffusely through the subsoil and outcrops with discharge occurring to the overlying rivers and streams in the area as baseflow. The WFD status of this GWB is 'good' and it is not at risk of failing to meet its WFD objectives.

The Duleek GWB covers an area of 114km^2. Groundwater flow in this GWB occurs in the upper weathered bedrock zone of a few metres and a connected fractured zone below. Low permeability bedrock in the Duleek GWB results in a high proportion of the recharge being rejected and discharged relatively rapidly to surface waterbodies. Recharge occurs diffusely through subsoils and rock outcrops mainly in the uplands with discharge occurring at the rivers and streams which traverse the GWB and directly to the Irish Sea. Discharge may enter the overlying gravel aquifer (Lg) from the underlying Poor bedrock aquifer, however the relationship between the two aquifers is not fully understood. The WFD status of this GWB is 'good' and it is not at risk of failing to meet its WFD objectives.

Groundwater quality analysis was carried out across Zone C and indicates widespread exceedances of groundwater screening standards for ammoniacal nitrogen and manganese. Elevated concentrations of contaminants including Total Petroleum Hydrocarbons (TPHs), various metals (arsenic, nickel, zinc, iron) and other inorganic substances (potassium, chloride, barium, magnesium, potassium, sodium and sulphate) were identified at the historic landfill site (Balleally) at Rogerstown Park (NA-BH079 and NA-BH080).

Groundwater quality close to the urban areas of Skerries contains elevated TPHs (NA-BH056) and inorganic contaminants including nickel, cadmium, potassium, barium and zinc (NA-BH058, NA-BH062 and NA-BH069). Groundwater within the urban area of Balbriggan (NA-BH045) also indicates elevated concentrations of TPHs while the groundwater quality around Donabate (NA-BH085 and NA-BH087) and Baldongan Road (NA-BH069) contains elevated cadmium, nickel, and zinc. Groundwater Quality Results are presented in Appendix A11.2 in Volume 4: of this EIAR.

11.4.4.3 Zone D

Zone D traverses across two groundwater bodies, Duleek (IE_EA_G_012) to the south and Bettystown (IE_EA_G_016) to the north.

The Bettystown GWB is situated north of Zone D and covers 77km2. It is bounded by the Irish Sea to the east and River Boyne catchments to the north. The GWB is relatively low lying with elevations falling towards the Irish Sea. Groundwater recharge occurs in areas of thin subsoil in the northwest and more permeable soils in the southwest. The bedrock comprises high permeability karstified limestone where groundwater flow is through karstified fractures, joints and major faults. The majority of flow is in the upper 30m which comprises of a weathered zone connected to an underlying fractured zone. Regional groundwater flow is towards the River Nanny and the coast, but on a local scale, groundwater discharges to the watercourses which traverse the GWB. The WFD status for Bettystown GWB is 'poor' and it is at risk of failing to meet its WFD objectives.

Groundwater quality analysis was carried out across Zone D and indicates exceedances in ammoniacal nitrogen, barium, manganese and potassium. TPHs and arsenic were identified west of the urban area of Bettystown (NA-BH225). Groundwater Quality Results are presented in Appendix A11.2 in Volume 4 of this EIAR.

11.4.4.4 Zone E

Zone E is underlain by the Drogheda GWB (IE_EA_G_025). This GWB covers 49 km2 of low-lying flood plain associated with the River Boyne. The GSI GWB description notes that the GWB predominantly comprises highly permeable karstified limestone with moderate to good secondary permeability. Structural deformities in the impure limestones (Lm aquifer) have caused the bedrock to be more permeable than typically would be expected and indicate that the bedrock will not act as an impediment to groundwater flow. Recharge to the GWB is mostly in the east and north and is both diffuse recharge through the subsoil and point recharge from the solution enlarged fractures. Groundwater flows towards the coast and discharges in the River Boyne and at the coast directly. Groundwater flow mostly occurs in the upper 30m within the weathered bedrock, which is connected to the underlying fractured zone, however deep-water strikes may also be encountered down to 50m. The WFD status for Drogheda GWB is 'good', although it is at risk of failing to meet its WFD objectives.

Groundwater quality analysis carried out in Zone E indicates widespread elevated concentrations of ammoniacal nitrogen with localised areas of elevated manganese and potassium. TPHs were identified in borehole NA-BH213 to the north of the Commuter Railcar Service Depot at Drogheda MacBride Station. Di-N-Butyl Phthalate and arsenic were identified east of overbridge OBB80B (NA-BH018). Groundwater Quality Results are presented in Appendix A11.2 in Volume 4 of this EIAR.

Table 11-7 Groundwater Water Bodies along the Proposed Development

Zone	Groundwater Body Name (Code)	Status	Risk
A & B	Dublin (IE_EA_G_008)	Good	Review*
C	Swords (IE_EA_G_011)	Good	Not at risk
	Waste Facility (IE_EA_G_088)	Good	Not at risk
	Lusk-Bog of the Ring (IE_EA_G_014)	Good	At risk
	Balrothery (IE_EA_G_043)	Good	Not at risk
	Balbriggan (IE_EA_G_039)	Good	Not at risk
	Duleek (IE_EA_G_012)	Good	Not at risk
D	Duleek (IE_EA_G_012)	Good	Not at risk
	Bettystown (IE_EA_G_016)	Poor	At risk
E	Drogheda (IE_EA_G_025)	Good	At risk

* The Groundwater Body Water Framework Directive Risk was not stated at the time of preparing this Chapter and is presented on the EPA website as 'Review'.

11.4.5 Groundwater Recharge

Recharge is the amount of rainfall that replenishes the aquifer. It is a function of the effective rainfall (i.e. rainfall minus evaporation and run off), the permeability and thickness of the subsoil and the aquifer characteristics. Recharge for the poor aquifer (Pl) within the study area is capped at 100 mm/yr, which reflects the low permeability of the aquifer and its limited capacity for water storage. The recharge for the locally important aquifer (Ll) is capped at 200mm/yr. The locally important gravel aquifer (Lg) within the study area also generally has a recharge rate below 200mm/yr, see Volume 3A, Chapter 11: Figure 11.5.

A review of the GSI recharge database across each of the five zones of the study area shows the average recharge range is mainly between 51-100mm/yr with several small areas of higher recharge up to 351-400mm/yr.

- Zone A and B consist of mainly low recharge of between 51-100mm/yr with some areas with lower recharge of 1-50mm/yr and high recharge of 151-200mm/yr;
- Zone C is characterised by low average annual recharge of 1-100mm/yr with some localised areas of higher recharge of up to 350mm/yr;
- Zone D generally has a recharge rate of less than 100mm/yr. Higher recharge rates of up to 300mm/yr are evident around Laytown; and
- Zone E contains average recharge rates of less than 100mm/yr.

11.4.6 Groundwater Vulnerability

Groundwater vulnerability represents the intrinsic geological and hydrological characteristics that determine the ease with which groundwater may be contaminated by human activities. The vulnerability is determined by the travel time and the attenuation capacity of the overlying deposits.

Groundwater vulnerability depends on type and thickness of subsoil, including subsoil permeability, and the presence of karst features. For example, bedrock with a thick, low permeability subsoil is less vulnerable than bedrock with a thin high permeability, gravel subsoil.

GSI groundwater vulnerability categorises groundwater vulnerability based on the subsoil permeability and depth to bedrock as defined by Table 11-8.

Table 11-8 GSI Groundwater vulnerability rating system (GSI).

Vulnerability Depth to Rock	Hydrogeological Conditions				
	Diffuse Recharge			Point Recharge	Unsaturated zone
	High permeability (sand/gravel)	Moderate Permeability (sandy subsoils)	Low Permeability (clayey subsoil, clay, peat)	(swallow holes, losing streams	(Sand/gravel aquifers only)
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
n/a = not applicable Release point of contaminants is assumed to be 1-2m below ground surface					

Groundwater vulnerability across the Proposed Development ranges from low to extreme, see Volume 3A, Chapter 11: Figure 11.6.

The GSI 1:40,000 groundwater vulnerability map classifies Zone A as predominantly low vulnerability. The area between Clontarf Road Station and Killester Station is classified as moderate to extreme vulnerability with areas of rock at or near surface.

Zone B is mapped as predominantly low vulnerability to the south of the zone between Howth Junction and Donaghmede Station and Portmarnock Station. Between Portmarnock Station and south of the Malahide Estuary and between Sutton station and Howth station the areas are classified as moderate to extreme vulnerability with areas of rock at or near surface.

The groundwater vulnerability in Zone C varies from low to extreme vulnerability with areas of rock at or near surface. The areas of low vulnerability are mainly to the south of Zone C with the vulnerability classification increasing to the centre and the north of the zone.

Zone D is mapped as predominantly high vulnerability to the south of Gormanston Station and between Gormanston and Laytown Stations. The area between Laytown and the northern end of Zone D is classified as low with some areas classified as up to extreme vulnerability with areas of rock at or near surface.

In Zone E, the area south of the River Boyne is low vulnerability, including the area surrounding Drogheda MacBride Station.

11.4.7 Karst Hydrogeological Features

Karst is a type of geological feature characterised by caves, caverns and other types of underground drainage resulting from the dissolution of the underlying bedrock. This typically occurs in areas of high rainfall with soluble rock.

There are no karst features identified within the study area in the GSI Karst database. However, there are Regionally and Locally Important Aquifers which display diffuse karstification underlying the study areas in Zones C south of Skerries and in Zone D in the vicinity of Laytown and Bettystown.

11.4.8 Groundwater Abstractions

Groundwater abstractions describe any large spring, well or borehole which is used as a groundwater abstraction source by domestic, agricultural, commercial, industrial, local authority or group water scheme users.

Uisce Éireann confirmed that there are no public supply groundwater abstractions in the vicinity of the study area. The GSI keeps a record of groundwater wells drilled, however the record does not state which wells are currently used for abstraction.

All groundwater abstractions within the study area are ranked as low importance in compliance with the NRA (2008a) guidance, and therefore are not considered further. Groundwater resources for the study area are shown on Volume 3A, Chapter 11: Figure 11.7 and summarised in Table 11-9. There are no abstractions identified in the study area for Zone A.

Table 11-9 Groundwater Abstractions. Source: GSI Groundwater well and Spring Data

GSI Name	Type	Drill Date	Yield (m^3/day)	Yield Class	Importance Rating
Zone B					
3223NWW003	Borehole	29/12/1899	220	Good	Low
Zone C					
3223NWW001	Borehole	29/12/1899	130	Good	Low
3225SWW013	Borehole	29/12/1899	55	Moderate	Low
3225SWW015	Borehole	24/6/1986	1091	Excellent	Low
Zone D					
2927SEW006	Unknown	29/12/1899	-	-	Low
2927SEW016	Borehole	22/3/1957	-	-	Low

GSI Name	Type	Drill Date	Yield (m^3/day)	Yield Class	Importance Rating
2927SEW028	Dug well	1/1/1963	-	-	Low
2927SEW027	Borehole	1/1/1958	8.7	Poor	Low
2927SEW030	Dug Well	12/6/1971	10.9	Poor	Low
2925NEW026	Dug Well	1/1/1964	-	-	Low
2925NEW027	Borehole	19/10/1953	65.5	Moderate	Low
Zone E					
2927SEW013	Dug well	1/7/1959	-	-	Low
2927SEW044	Dug well	1/2/1962	28	Poor	Low
2927SEW046	Dug well	1/2/1962	28	Poor	Low
2927SEW040	Dug well	1/2/1962	28	Poor	Low

The Geological Survey Ireland also maintain a record of Group Scheme and Public Supply Source Protection Areas also referred to collectively as Groundwater Protection Schemes (GWPSs). These denote an area which contributes groundwater to a spring or well. They are used when reviewing land use to keep potentially polluting practices e.g. landfill, septic tanks, slurry stores etc. away from the areas which supplies a spring or borehole used for human consumption. GWPSs are shown on Volume 3A, Chapter 11: Figure 11.1. There are no GWPSs within the study area, hence they are not considered further in this chapter.

11.4.9 Hydro-ecology Designated Sites

The National Parks and Wildlife Services (NPWS) is responsible for the designation of environmentally protected sites in Ireland and maintains a publicly available database of these sites. These sites include Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Natural Heritage Areas (NHAs). In addition to these sites, the NPWS also maintains a database of proposed Natural Heritage Areas (pNHAs).

Groundwater-dependent terrestrial ecosystems (GWDTEs) are habitats/species that are dependent on groundwater to maintain the environmental supporting conditions required to sustain that habitat and/or species (EPA, 2008). The groundwater dependency could be a direct input such as springs, turloughs or indirect influence in maintaining high and stable water levels within the habitat, such as with raised bogs (EPA, 2008).

Only the hydrogeology related impacts or groundwater dependant designated sites are assessed within this chapter. Impacts on the ecological aspects of these sites will be addressed in Chapter 8 (Biodiversity) in Volume 2 of this EIAR. The sites designated for environmental protection within the study area are shown on Volume 3A, Chapter 11: Figure 11.8 and are listed in Table 11-10.

11.4.9.1 Zone A

A small portion of the North Dublin Bay pNHA (000206) is situated approximately 25m south of the Proposed Development and 250m south of Clontarf Road Station. The pNHA is also designated an SPA (South Dublin Bay and River Tolka SPA - 004024) with conservation objectives relating to a number of Wetland and Waterbirds. However, the extent of the SPA does not overlap the study area.

The conservation objectives for North Dublin Bay pNHA relate to habitat areas such as an estuary with mudflats and sandflats not covered by seawater at low tide, however these are outside of the study area. As the primary source of water in the pNHA is the Irish Sea or River Tolka the pNHA is not groundwater dependent. There could be a hydraulic connection with the Proposed Development as groundwater from under the Proposed Development could discharge into the shore of the pNHA, however the point where water has the potential to discharge to the pNHA is outside of the study area, (130m south at its closest point), therefore the North Dublin Bay pNHA is not considered further in this assessment.

11.4.9.2 Zone B

The Baldoyle Bay SAC (000199) and pNHA (000199) and North-West Irish Sea SPA (004236) overlap the study area and are located adjacent to the Proposed Development to the north-east of Howth Station. Baldoyle Bay SAC and pNHA is also adjacent to the northern side of Sutton Station together with and Baldoyle Bay SPA (004016). The SAC, pNHA and SPA's conservation objectives collectively relate to habitat areas such as mudflats, sandflats and salt meadows and a number of species of wetland and waterbirds. As the primary source of water in the SAC's, SPA's & pNHA is the Irish Sea they are not considered to be groundwater dependent. Notwithstanding this, groundwater from under the Proposed Development has the potential to discharge into the shore of the SAC's, SPA's & pNHA.

The Sluice River Marsh (001763) is a pNHA that extends onto the east side of the railway at Portmarnock village where the River Sluice flows into Baldoyle Estuary about 0.5km south. The pNHA is adjacent to the eastern side of the Proposed Development. The Sluice River Marsh is an important relatively intact freshwater marsh habitat which supports a variety of species thus is recognised as rare in County Dublin (NPWS). The habitat includes wet grassland and wet woodland and scrub which may be groundwater dependant.

Malahide Estuary SAC (000205), pNHA (000205) and SPA (004025) overlaps or is adjacent to the Proposed Development to the north of Malahide Station. The SAC, pNHA and SPA is also approximately 50m to the north of the Construction Compound located to the south of the Malahide Yacht Club on Sea Road (L2130). The SAC and pNHA are approximately 10m to the west of the Construction Compound located to the south of the Malahide Yacht Club on Sea Road (L2130).

The conservation objectives for Malahide Estuary SAC, SPA and pNHA relate to habitat areas such as estuary with mudflats and sandflats not covered by seawater at low tide and a number of species of wetland and waterbird. Similar to the Baldoyle Bay SAC and SPA the main source of water for this SAC and SPA is the Irish Sea and Broadmeadow River hence this site is not considered to be groundwater dependant. However, groundwater from under the Proposed Development has the potential to discharge into the SAC and SPA.

11.4.9.3 Zone C

North of Donabate Station and south of Rush and Lusk Station, is Rogerstown Estuary SAC (000208), pNHA (000208) and SPA (004015) which is adjacent to either side of the Proposed Development. The conservation objectives for Rogerstown Estuary SAC, SPA and pNHA are similar to the Malahide Estuary and relate to habitat areas such as an estuary with mudflats and sandflats not covered by seawater at low tide and a number of species of wetland and waterbird. Similar to the other estuary SAC's and SPA's the main source of water for this SAC and SPA is the Irish Sea and the surface water features that drain into the estuary, hence this site is not considered to be groundwater dependant. However, groundwater from under the Proposed Development has the potential to discharge into the SAC and SPA.

In a few locations between Skerries Station and Gormanston Station the North-West Irish Sea SPA (004236) overlaps the east of the study area. At its closest point the SPA is adjacent to the Proposed Development. The conservation objectives for the North-West Irish Sea SPA relate to a number of species of waterbirds. The estuaries and coastal areas in the SPA provide safe feeding and roosting habitats for waterbirds. The Irish Sea is not considered to be groundwater dependant but groundwater from under the Proposed Development has the potential to discharge into the SPA.

11.4.9.4 Zone D

In the vicinity of Gormanston Station the North-West Irish Sea SPA (004236) overlaps the study area and is adjacent to the Proposed Development. In addition, to the south of Laytown Station the study area overlaps the River Nanny Estuary and Shore SPA (004158) and Laytown Dunes/Nanny Estuary pNHA (000554) which is reported by the NPWS to be part of the River Nanny Estuary and Shore SPA. As outlined above, the conservation objectives for the North-West Irish Sea SPA relate to a number of species of waterbirds and the shoreline areas they use for feeding and roosting. Similarly, the conservation objectives for the River Nanny Estuary and Shore SPA and pNHA relate to wetlands, waterbirds and the shoreline. The SPA's and pNHA are not considered to be groundwater dependant but groundwater from under the Proposed Development has the potential to discharge into them.

11.4.9.5 Zone E

The River Boyne and River Blackwater SAC (002299) and SPA (004232) is located along the freshwater portion of the Boyne River and its tributaries. At its closest point it is approximately 125m north of the Proposed Development and outside of the study area. It supports the groundwater-dependent terrestrial ecosystems [7230] Alkaline Fen habitat and the priority EU habitat [91E0] Alluvial Forests. The site also contains areas of marsh and wet grassland habitat and is a habitat for Kingfisher. As it is located outside of the study area it is not considered any further in this assessment.

Table 11-10 Summary of designated sites which are groundwater dependant or could receive groundwater from the site within or downgradient of the Proposed Development

Designated Site (Code)	Status	Description	Location	Importance	Justification
Zone B					
Baldoyle Bay	SAC (000199), pNHA (000199) and SPA (004016)	Mudflats, sandflats, saltmarshes not groundwater dependant and wetland and waterbirds	North-east of Howth Station and Sutton Station	Extremely High	Attribute has a high quality or value on an international scale.
North-West Irish Sea	SPA (004236)	A number of different species of waterbirds	North-east of Howth Station	Extremely High	Attribute has a high quality or value on an international scale.
Malahide Estuary	SAC (000205), pNHA (000205) and SPA (004025)	Mudflats, sandflats, saltmarshes not groundwater dependant and wetland and waterbirds	Overlaps or in the vicinity of the site to the north of Malahide Station	Extremely High	Attribute has a high quality or value on an international scale.
Sluice River Marsh	pNHA (001763)	Wet grassland and wet woodland and scrub	Zone B, east of Portmarnock	Very High	Attribute has a high quality or value on a regional or national scale.
Zone C					
Rogerstown Estuary	SAC (000208), pNHA (000208) and SPA (004015)	Mudflats, sandflats, saltmarshes not groundwater dependant	North of Donabate Station and south of Rush and Lusk Station	Extremely High	Attribute has a high quality or value on an international scale.
North-West Irish Sea	SPA (004236)	A number of different species of waterbirds	A few locations between Skerries Station and Gormanston Station	Extremely High	Attribute has a high quality or value on an international scale.
Zone D					
North-West Irish Sea	SPA (004236)	A number of different species of waterbirds	In the vicinity of Gormanston Station	Extremely High	Attribute has a high quality or value on an international scale.

Designated Site (Code)	Status	Description	Location	Importance	Justification
River Nanny Estuary and Shore	SPA (004158)	Wetlands, waterbirds and the shoreline	To the south of Laytown Station	Extremely High	Attribute has a high quality or value on an international scale.
Laytown Dunes/Nanny Estuary	pNHA (000554)	Wetlands and waterbirds and the shoreline	To the south of Laytown Station	Very High	Attribute has a high quality or value on a regional or national scale.

11.4.10 Summary of Key Features

The feature importance ranking based on the Guidelines for the Preparation of Soil, Geology, and Hydrology Chapters of Environmental Impact Statements (IGI, 2013) and Guidelines on procedures for Assessment and Treatment of Geology, Hydrology, and Hydrogeology for National Road Schemes (NRA, 2008) are summarized below.

Features with an importance ranking of low are not considered further as they will not result in a significant effect according to Box 5.4 of the NRA Guidelines (NRA, 2008a). These are however summarised in Table 11-11 for completeness. Features with an importance ranking of medium or higher are summarised in Table 11-12 and the impact of the Proposed Development on these features is assessed in Section 11.7.

Table 11-11 Summary of Hydrogeology features with low importance within the Study Area

Category	Feature	Location	Description	Importance	Justification for Importance rating
Aquifers	Poor Bedrock Aquifer (Pl)	Zone A to Zone E	Poor Bedrock Aquifer which is Generally Unproductive except in Local Zones	Low	Attribute has a low quality, significance, or value on a local scale.
	Poor Bedrock Aquifer (Pu)	Southern part of Zone D	Poor Bedrock Aquifer which is Generally	Low	Attribute has a low quality, significance, or value on a local scale.
Groundwater Abstractions	3223NWW003	Zone B	Borehole	Low	Attribute has a low quality, significance, or value on a local scale.
	3223NWW001	Zone C	Borehole	Low	Attribute has a low quality, significance, or value on a local scale.
	3225SWW013	Zone C	Borehole	Low	Attribute has a low quality, significance, or value on a local scale.
	3225SWW015	Zone C	Borehole	Low	Attribute has a low quality, significance, or value on a local scale.
	2927SEW006	Zone D	Unknown	Low	Attribute has a low quality, significance, or value on a local scale.
	2927SEW016	Zone D	Borehole	Low	Attribute has a low quality, significance, or value on a local scale.
	2927SEW028	Zone D	Dug well	Low	Attribute has a low quality, significance, or value on a local scale.
	2927SEW027	Zone D	Borehole	Low	Attribute has a low quality, significance, or value on a local scale.
	2927SEW030	Zone D	Dug Well	Low	Attribute has a low quality, significance, or value on a local scale.
	2925NEW026	Zone D	Dug Well	Low	Attribute has a low quality, significance, or value on a local scale.
	2925NEW027	Zone D	Borehole	Low	Attribute has a low quality, significance, or value on a local scale.

Category	Feature	Location	Description	Importance	Justification for Importance rating
	2927SEW013	Zone E	Dug well	Low	Attribute has a low quality, significance, or value on a local scale.
	2927SEW044	Zone E	Dug well	Low	Attribute has a low quality, significance, or value on a local scale.
	2927SEW046	Zone E	Dug well	Low	Attribute has a low quality, significance, or value on a local scale.
	2927SEW040	Zone E	Dug well	Low	Attribute has a low quality, significance, or value on a local scale.

Table 11-12 Summary of Hydrogeology features with medium to high importance within the Study Area

Category	Feature	Location	Description	Importance	Justification for Importance rating
Aquifers	Regionally Important Aquifer	Around Laytown in Zone D	Karstified bedrock which is dominated by diffuse flow (Rkd)	High	Attribute has a high quality or value on a local scale
	Locally Important Aquifer	Zone C	Locally important karstified aquifer (Lk)	Medium	Attribute has a medium quality, significance or value on a local scale.
	Locally Important Bedrock Aquifer	Within Zone D south of Drogheda	Locally Important Bedrock Aquifer (Lm) which is Generally Moderately Productive	Medium	Attribute has a medium quality, significance or value on a local scale.
	Locally Important Bedrock Aquifer	Zone A, Zone B and Zone C	Locally Important Bedrock Aquifer (Ll) which is Moderately Productive only in Local Zones	Medium	Attribute has a medium quality, significance or value on a local scale.
	Locally Important Gravel Aquifer	Southern part of Zone A and within Zone D south of Laytown	Locally Important Gravel Aquifer (Lg)	Medium	Attribute has a medium quality, significance or value on a local scale.

Category	Feature	Location	Description	Importance	Justification for Importance rating
Hydro-ecology Designated Sites	Baldoyle Bay SAC (000199), pNHA (000199) and SPA (004016)	North-east of Howth Station and Sutton Station	Mudflats, sandflats, saltmarshes not groundwater dependant and wetland and waterbirds	Extremely High	Attribute has a high quality or value on an international scale.
	North-West Irish Sea SPA (004236)	North-east of Howth Station, A few locations between Skerries Station and Gormanston Station and In the vicinity of Gormanston Station	A number of different species of waterbirds	Extremely High	Attribute has a high quality or value on an international scale.
	Sluice River Marsh pNHA (001763)	Zone B, east of Portmarnock	Wet grassland and wet woodland and scrub	Very High	Attribute has a high quality or value on a regional or national scale.
	Malahide Estuary SAC (000205), pNHA (000205) and SPA (004025)	Overlaps or in the vicinity of the site to the north of Malahide Station	Mudflats, sandflats, saltmarshes not groundwater dependant and wetland and waterbirds	Extremely High	Attribute has a high quality or value on an international scale.
	Rogerstown Estuary SAC (000208), pNHA (000208) and SPA (004015)	North of Donabate Station and south of Rush and Lusk Station	Mudflats, sandflats, saltmarshes not groundwater dependant	Extremely High	Attribute has a high quality or value on an international scale.
	River Nanny Estuary and Shore SPA (004158)	To the South of Laytown Station	Wetlands, waterbirds and shoreline	Extremely High	Attribute has a high quality or value on an international scale
	Laytown Dunes/Nanny Estuary pNHA (000554)	To the south of Laytown Station	Wetlands, waterbirds and shoreline	Very High	Attribute has a high quality or value on a regional scale

11.5 Conceptual Site Model

A written description of the conceptual site model (CSM) was developed based on all publicly available data along with the project-specific ground investigation data and is presented below for each zone.

11.5.1.1 Zone A

Zone A contains a Locally Important Bedrock Aquifer (Ll) and a Poor Bedrock Aquifer (Pl) which are situated wholly within the Dublin Groundwater Body. Groundwater flow is greatest in the upper 10m of the aquifer with flow typically to the east. Flow paths are relatively short and discharge to the closest surface water feature. The Liffey Sand and Gravel Aquifer (Lg) is also located within Zone A and likely discharges to the Liffey and the coast. The Liffey Locally Important Gravel Aquifer (Lg) and Locally Important Bedrock Aquifer (Ll) are of Medium importance. The area is urbanized with a lot of hard standing, thus, recharge in the zone is low. Zone A is considered a discharge area with likely relatively shallow groundwater levels and recharge typically occurring upgradient in the catchment.

11.5.1.2 Zone B

There are two aquifer types in Zone B, the Locally Important Bedrock Aquifer (Ll) and the Poor Bedrock Aquifer (Pl). Both aquifers have a network of faults running northwest- southeast direction and are situated wholly within the Dublin Groundwater Body. Groundwater flow is greatest in the upper 10m of the aquifer with flow typically to the east. Flow paths are relatively short and discharge to the closest surface water feature including the shoreline in places. The Locally Important Bedrock Aquifer (Ll) is of medium importance. The area is mostly urbanized with significant areas of hard standing, thus, recharge in the zone is low. Groundwater levels in Zone B are relatively shallow.

The Sluice River Marsh is a pNHA located to the east side of the railway at Portmarnock and features a groundwater-dependent terrestrial ecosystems, thus, has an importance of Very High. Groundwater flow through the habitat is likely to be from the south and south-west flowing towards the Sluice River.

11.5.1.3 Zone C

Zone C is predominantly underlain by a Locally Important Bedrock Aquifer (Lm) and a Poor Aquifer (Pl). At Skerries Station, the area is underlain by a karstified Locally Important Aquifer (Lk). Groundwater flow in the Lm and Pl aquifers is predominantly along fractures and joints and in the upper weathered bedrock zone. Groundwater recharge mostly occurs by diffuse recharge through the thin and/or permeable subsoil or where there is rock outcrop. Rainfall which cannot infiltrate into the bedrock aquifer discharges to local surface waterbodies and directly to the coast. Groundwater flow paths are relatively short and discharge to surface water features or the coast. Groundwater flow is greatest in the upper 10m of the aquifer and in mainly in the upper weathered zone and in fractures and faults. Groundwater levels in Zone C are relatively shallow.

11.5.1.4 Zone D

Zone D is underlain by Poor Bedrock aquifers (Pu and Pl), Locally Important Bedrock aquifer (Lm), Regionally Important Bedrock aquifer (Rkd) and a Locally Important Gravel aquifer (Lg). Groundwater flow in the Lm, Pu and Pl bedrock aquifers is predominantly in the upper weathered bedrock zone of a few metres and a connected fractured zone below. Groundwater flow in the Rkd aquifer is influenced by karst features including swallow holes and karstified conduit flow in the bedrock. Regionally groundwater flow is towards the coast, although on a local scale, groundwater discharges to nearby watercourses. Discharge from the Pl aquifer may also enter the Lg aquifer where flow is intergranular. Groundwater levels in Zone D are relatively shallow.

11.5.1.5 Zone E

Zone E is primarily underlain by a Locally Important Bedrock Aquifer (Ll). Groundwater flow is typically in the upper 30m, although deep water strikes may also be encountered down to 50mbgl. Groundwater flows towards the coast and discharges in the River Boyne and at the coast directly. Groundwater levels in Zone E are expected to be relatively shallow.

11.6 Characteristic of the Proposed Development

A detailed description of the Proposed Development and construction activities are provided in Chapter 4 (Description of the Proposed Development) and Chapter 5 (Construction Strategy) in Volume 2 of this EIAR.

This section outlines the key design features, characteristics and construction activities of the Proposed Development of relevance to hydrogeology.

- Extension of existing 1500V DC electrification between Malahide and Drogheda. This entails the installation of foundations for the Overhead Line Equipment (OHLE) masts, and substations;
- Upgrades to signalling equipment and associated power supply installations between Dublin City Centre and Malahide, inclusive of the Howth Branch, to accommodate the proposed infrastructure works;
- Improvements/modifications to bridges spanning the railway arising from track reconfigurations and/or meeting required electrical clearances, most notably the works at UBK01 and OBB80/80A/80B are being replaced and upgraded;
- Undertaking localised bridge modifications to enable OHLE to be fixed to bridges carrying the railway;
- Modifications to existing depots at Drogheda and Fairview to support the new train fleet, including the provision of additional train stabling at Drogheda;
- Ancillary civil, drainage and landscaping works in areas of intervention.
- Utility diversions including underground and overhead diversions.
- Infrastructure works to facilitate the increase in service frequency and capacity, in specific areas of intervention as outlined below:
    - works around Howth Junction & Donaghmede Station;
    - works around Clongriffin Station including the new Mayne River Bridge;
    - works around Malahide Station and Viaduct;
    - works to the existing user worked level crossing south of Donabate; and
    - works around Drogheda MacBride Station;
- Modification to existing tracks and platforms, include the addition of new tracks to stable and facilitate the turn back and through running of trains; and
- Construction Compounds, including the site clearance and access required to enable construction.

As discussed in Chapter 4 (Description of the Proposed Development), the Overhead Line Equipment (OHLE) required for the electrification will consist of OHLE wires, masts and other infrastructure that will be erected along the line and through stations, from north of Malahide to Drogheda. Typical spacing between OHLE support structures will be between 40m and 50m, with a maximum spacing of 65m. The locations of these support structures will be finalised during detailed design stage, and it is assumed that where the new electrification works are required a support structure will be needed. From Chapter 5 (Construction) Section 5.3.8.2, the OHLE support foundations being considered for the project, are either concrete bored piles or shallow foundations such as concrete footings. As the foundation type has not been finalised for each location, the "worst case" scenario in terms of hydrogeological impact has been assessed for the foundation type. Thus, it is assumed that the foundations will require; a degree of earthworks, piling into rock and pouring concrete in-situ.

11.7 Description of Potential Impacts

11.7.1 Do Nothing Scenario

The Do-Nothing scenario considers the current potential effect of the existing operational train line on the groundwater environment. Typical activities include the use of the line by diesel trains as well as their maintenance. In addition, Iarnród Éireann carries out minor works to maintain the existing mainline infrastructure.

The use of diesel-powered trains on the line or the use of fuels and chemicals during routine maintenance presents a slight risk of an adverse impact on groundwater quality from leaks, drips and spills. Considering that the trains are maintained, and the routine maintenance comprises minor works the risk of a serious adverse impact on groundwater quality is considered to be negligible. Consequently, the significance of this potential adverse impact on groundwater quality for the do-nothing scenario is considered to be imperceptible.

11.7.2 Construction Phase

The construction activities associated with the Proposed Development are described in detail in Chapter 5 (Construction Strategy) in Volume 2 of this EIAR.

The potential hydrogeology effects during the Construction Phase for the relevant construction activities described in Section 11.6 are presented in this section, along with their impact significance. These potential effects also relate and interact with other environmental factors which are described within the EIAR. Specific interactions are outlined in the Chapter 26 (Cumulative Effects) in Volume 2 of this EIAR.

11.7.2.1 Zone A

Construction activities in Zone A include internal modifications to Fairview Depot and may have the following potential effects on hydrogeology as discussed below and summarised in Table 11-13.

- Loss or damage of proportion of aquifer;
- Damage of the aquifer due to accidental spills; and
- Change to groundwater regime.

Though the magnitude of the impact may vary depending on the scale of activities and location of the Proposed Development relative to the impacted important feature, in order to ensure a robust assessment, only the maximum magnitude or "worst case" of the impact of the Proposed Development is considered.

11.7.2.1.1 Loss or Damage of Proportion of Aquifer

The removal of a proportion of an aquifer can reduce its ability to provide baseflow to groundwater dependant habitats and or water supplies and results in an irreversible loss of the in-situ characteristics of the hydrogeology.

Excavations associated with the works at Fairview Depot comprise shallow excavations which are likely to be above or only slightly below the groundwater table. The volume of aquifer removed will be insufficient to affect the overall integrity of the underlying aquifer. Therefore, the magnitude of the loss or damage of the Locally Important aquifers (Locally Important Bedrock Aquifer (LI) and Gravel Aquifer (Lg)) due to the construction works in Zone A is considered to be negligible and the significance of this impact is considered to be imperceptible.

11.7.2.1.2 Damage of the aquifer due to accidental spills or mobilisation of contaminated groundwater

Potential pollutants associated with construction activities (i.e. fuel and lubricants etc.) will be stored at designated compounds, at Fairview Depot in Zone A. If potential spills or leaks from the associated construction equipment do occur, they may potentially contaminate the groundwater beneath the site. Likewise, the mobilisation of contaminants into the aquifer through the disturbance of contaminated groundwater during excavation will reduce the quality of the groundwater within the aquifer. These are potential temporary effects.

There is a medium risk of pollution to groundwater as a result of accidental spills or the mobilisation of contaminated groundwater. Therefore, the magnitude of this potential impact on the Locally Important aquifers (Locally Important Bedrock Aquifer (LI) and Gravel Aquifer (Lg)) is moderate adverse leading to a significance rating of moderate.

11.7.2.1.3 Change to Groundwater Regime

Localised pumping of excavations may be required as part of the Construction Phase in order to allow works to be carried out in dry excavations. This could lead to a temporary change in the groundwater levels and flow within the locally important aquifer underlying the Fairview Depot.

If pumping is required, it is expected to be limited, localised and temporary, the magnitude of this impact is considered negligible. As the importance of the Locally Important aquifers (Locally Important Bedrock Aquifer (LI) and Gravel Aquifer (Lg)) is medium, the resulting significance is imperceptible and therefore will not be considered further.

Table 11-13 Summary of potential Construction Phase effects in Zone A of the Proposed Development

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
Loss or Damage of Proportion of Aquifer									
Locally Important Aquifer (Ll)	Bedrock which is moderately productive only in local zones	Fairview Depot	Medium	Loss or damage of proportion of aquifer through excavation	Negative	Permanent	Local	Negligible	Imperceptible
Locally Important Gravel Aquifer (Lg)	Locally Important Gravel Aquifer	Fairview Depot	Medium	Loss or damage of proportion of aquifer through excavation	Negative	Permanent	Local	Negligible	Imperceptible
Damage of the Aquifer due to Accidental Spills									
Locally Important Aquifer (Ll)	Bedrock which is moderately productive only in local zones	Fairview Depot	Medium	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate Adverse	Moderate
Locally Important Gravel Aquifer (Lg)	Locally Important Gravel Aquifer	Fairview Depot	Medium	Loss or damage of proportion of aquifer through excavation	Negative	Permanent	Local	Negligible	Imperceptible

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
Change to Groundwater Regime									
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones	Fairview Depot	Medium	Change to groundwater regime	Negative	Temporary	Local	Negligible	Imperceptible
Locally Important Gravel Aquifer (Lg)	Locally Important Gravel Aquifer	Fairview Depot	Medium	Loss or damage of proportion of aquifer through excavation	Negative	Permanent	Local	Negligible	Imperceptible

11.7.2.2 Zone B

The majority of the construction works in Zone B will be carried out at Howth Junction and Donaghmede Station, Clongriffin Station and Malahide. Works in Zone C which may impact the hydrogeological features of importance include excavation and earthworks associated with:

- piling, in-situ concreting and Construction Compound at Howth Junction and Donaghmede Station;
- the construction of a retaining wall at Clongriffin Station, the new Mayne River Bridge and the works related Construction Compound;
- the construction of a reinforced earth wall, embankments and trackwork for the Malahide Turnback and Construction Compounds at Malahide; and
- the OHLE works between Malahide Station and the northern boundary of Zone B, north of the Malahide Estuary.

Construction activities in Zone B will have the following potential effects on hydrogeology as discussed below and summarised in Table 11-14.

- Loss or damage of proportion of aquifer;
- Damage of the aquifer due to accidental spills;
- Change to groundwater regime; and
- Loss or damage of Hydro-ecology Designated Sites.

Though the magnitude of the impact may vary depending on the scale of activities and location of the Proposed Development relative to the impacted important feature, in order to ensure a robust assessment, only the maximum magnitude or “worst case” of the impact of the Proposed Development is considered.

11.7.2.2.1 Loss or Damage of Proportion of Aquifer

The majority of the construction works in Zone B will be carried out at Howth Junction and Donaghmede Station, around Clongriffin Station, the new Mayne River Bridge and around the Malahide estuary. The proposed works which may permanently remove small portions of the bedrock aquifer include piling works and potential excavation where rock is close to surface. These activities are localised, are likely to be above or only slightly below the groundwater table and considered insufficient to affect the overall integrity of the underlying aquifer. Therefore, the magnitude of the loss or damage of the Locally Important aquifer due to the construction works in Zone B is considered to be negligible and the significance of this impact is considered to be imperceptible.

11.7.2.2.2 Damage of the Aquifer due to Accidental Spills

There is a medium risk of pollution to groundwater as a result of accidental spills leading to the mobilisation of contaminated groundwater. Therefore, the magnitude of this potential impact on the Locally Important aquifer (LI) is moderate adverse leading to a significance rating of moderate.

11.7.2.2.3 Change to Groundwater Regime

If pumping is required, it is expected to be limited, localised and temporary, the magnitude of this impact is considered negligible. As the importance of the locally important aquifer is medium the resulting significance is imperceptible and therefore will not be considered further.

11.7.2.2.4 Loss or Damage of Hydro-ecology Designated Sites

The Baldoyle Bay SAC (000199) and pNHA (000199) and North-West Irish Sea SPA (004236) overlap the study area and are located adjacent to the Proposed Development to the north-east of Howth Station. Baldoyle Bay SAC and pNHA is also adjacent to the northern side of Sutton Station together with the Baldoyle SPA (004016). While these sites are not groundwater dependent, groundwater from the study area will discharge into them. The closest construction works in Zone B will be at Clongriffin Station and Howth Junction and Donaghmede Station hence any potential impacts through pumping or impacts on groundwater quality caused by construction will be negligible and the significance imperceptible.

The Sluice River Marsh (pNHA) is located approximately 2km north of Clongriffin station and 3.5km south of the Malahide site and is noted as being of very high importance. The railway line passes the western boundary of the Sluice River Marsh, north of Portmarnock Station, however, there are no proposed changes along this section of the railway line or at Portmarnock Station. The closest construction works in Zone B will be carried out at the Mayne River Bridge, Clongriffin Station and Malahide.

The groundwater flow into the Sluice Marsh is from the south and south-east of the habitat. Construction as part of the Proposed Development is not located within this catchment area and therefore the magnitude of loss or damage to the habitat through pumping of groundwater or an accidental spillage during construction related activities or temporarily due to mobilisation of contaminants during the removal of contaminated soil is considered negligible resulting in an imperceptible significance.

Malahide Estuary SAC, pNHA and SPA overlaps or is located in the vicinity of, the site to the north of Malahide Station including the Construction Compound located to the south of the Malahide Yacht Club on Sea Road (L2130). While Malahide Estuary is not groundwater dependent, groundwater from the study area will discharge into it. Works within the Proposed Development will take place in in the vicinity of and overlapping Malahide Estuary. Consequently, there is the low potential for accidental spillage during construction related activities or mobilisation of contaminants during the removal of contaminated soil both of which could impact the water quality under the Proposed Development and potentially could discharge into Malahide Estuary.

Any impacts from the migration of contamination would be buffered to an extent by attenuation through the subsurface but could potentially result in a negative, short-term or temporary, localised, small impact. As Malahide Estuary is extremely important this impact could result in a potentially significant impact.

Table 11-14 Summary of potential Construction Phase effects in Zone B of the Proposed Development

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
Loss or Damage of Proportion of Aquifer									
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones	Howth Junction and Donaghmede Station, Clongriffin Station, Malahide & OHLE works	Medium	Loss or damage of proportion of aquifer through excavation or piling.	Negative	Permanent	Local	Negligible	Imperceptible
Damage of the aquifer due to accidental spills									
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones	Howth Junction and Donaghmede Station, Clongriffin Station, Malahide & OHLE works	Medium	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate Adverse	Moderate
Change to Groundwater Regime									
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones	Howth Junction and Donaghmede Station, Clongriffin Station, Malahide & OHLE works	Medium	Change to groundwater regime	Negative	Temporary	Local	Negligible	Imperceptible

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
Loss or damage of a Hydro-ecology Designated Sites									
Baldoyle Bay	SAC, pNHA and SPA	North-east of Howth Station and north of Sutton Station	Extremely high	Loss or damage of a habitat through contamination	Negative	Temporary	Local	Negligible	Imperceptible
North-West Irish Sea	SPA	North-east of Howth Station	Extremely High	Loss or damage of a habitat through contamination	Negative	Temporary	Local	Negligible	Imperceptible
Sluice River Marsh	pNHA	2km north of Clongriffin station	Very High	Loss or damage of a groundwater dependant habitat through pumping or contamination	Negative	Temporary	Local	Negligible	Imperceptible
Malahide Estuary	SAC, pNHA and SPA	Overlaps or in the vicinity of the site to the north of Malahide Station	Extremely high	Loss or damage of a habitat through contamination	Negative	Temporary/ short-term	Local	Small	Significant

11.7.2.3 Zone C

The Construction Phase works in Zone C include excavation and earthworks associated with the OHLE works (including the substations) across the length of Zone C and the Construction Compounds at Donabate, Rogerstown Park, Rush and Lusk Station, OBB44, Skerries South, Skerries North and Balbriggan. Minor excavations may also be required to accommodate line lowering works at OBB39 (carrying Station Road / R128), OBB44 (carrying Tyrellstown Big) and OBB55 (carrying Lawless Terrace/R127).

Construction activities in Zone C will have the following potential effects on hydrogeology as discussed below and summarised in Table 11-15.

- Loss or damage of a proportion of the aquifer;
- Damage of the aquifer due to accidental spills; and
- Change to groundwater regime,

Though the magnitude of the impact may vary depending on the scale of activities and location of the Proposed Development relative to the impacted important feature, in order to ensure a robust assessment, only the maximum magnitude or "worst case" of the impact of the Proposed Development is considered.

11.7.2.3.1 Loss or Damage of Proportion of Aquifer

The proposed works in Zone C which are likely to remove small portions of the bedrock aquifer include piling works and potential excavation where rock is close to surface. These activities are localised and considered insufficient to affect the overall integrity of the underlying aquifer. Therefore, the magnitude of the loss or damage of the Locally Important aquifers due to the construction works in Zone C is considered to be negligible and the significance of this impact is considered to be imperceptible.

11.7.2.3.2 Damage of the Aquifer due to Accidental Spills or Mobilisation of Contaminated Groundwater

There is a medium risk of pollution to groundwater as a result of accidental spills leading to the mobilisation of contaminated groundwater. Therefore, the magnitude of this potential impact on the Locally Important aquifers (LI) is moderate adverse leading to a significance rating of moderate.

11.7.2.3.3 Change to Groundwater Regime

If pumping is required it is expected to be small, limited, localised and temporary. The magnitude of this potential impact on the Locally Important aquifers is considered negligible and the resulting significance is imperceptible and therefore will not be considered further.

11.7.2.3.4 Loss or Damage of a Hydro-ecology Designated Site

North of Donabate Station and south of Rush and Lusk Station, is Rogerstown Estuary SAC, pNHA and SPA which overlaps the site. In addition the North-West Irish Sea SPA is adjacent to the Proposed Development or within the study area in a few locations between Skerries Station and Gormanston Station. While Rogerstown Estuary and the North-West Irish Sea designated sites are not groundwater dependent, groundwater from the study area will discharge into them. Works within the Proposed Development will take place in areas directly adjacent to both the Rogerstown Estuary and North-West Irish Sea sites. Consequently, there is the low potential for accidental spillage during construction related activities or mobilisation of contaminants during the removal of contaminated soil both of which could impact the water quality under the Proposed Development and potentially could discharge into the SAC and SPA.

Any impacts from the migration of contamination would be buffered to an extent by attenuation through the subsurface but could potentially result in a negative, short-term or temporary, localised, small impact. As Rogerstown Estuary and the North-West Irish Sea designated sites are extremely important this impact could result in a potentially significant impact.

Table 11-15 Summary of Potential Construction Phase effects in Zone C of the Proposed Development

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
Loss or Damage of Proportion of Aquifer									
Locally Important Aquifer (Ll)	Bedrock which is moderately productive only in local zones	Smaller areas within Zone C	Medium	Loss or damage of proportion of aquifer through excavation	Negative	Permanent	Local	Negligible	Imperceptible
Locally Important Aquifer (Lm)	Bedrock which is Generally Moderately Productive	Widespread	Medium	Loss or damage of proportion of aquifer through excavation.	Negative	Permanent	Local	Negligible	Imperceptible
Locally Important Aquifer (Lk)	Locally Important Aquifer – Karstified	Skerries	Medium	Loss or damage of proportion of aquifer through excavation.	Negative	Permanent	Local	Negligible	Imperceptible
Damage of the Aquifer due to Accidental Spills									
Locally Important Aquifer (Ll)	Bedrock which is moderately productive only in local zones	Smaller areas within Zone C	Medium	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate adverse	Moderate
Locally Important Aquifer (Lm)	Bedrock which is Generally Moderately Productive	Widespread	Medium	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate adverse	Moderate
Locally Important Aquifer (Lk)	Locally Important Aquifer – Karstified	Skerries	Medium	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate adverse	Moderate

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
Change to Groundwater Regime									
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones	Smaller areas within Zone C	Medium	Change to groundwater regime	Negative	Temporary	Local	Negligible	Imperceptible
Locally Important Aquifer (Lm)	Bedrock which is Generally Moderately Productive	Widespread	Medium	Change to groundwater regime	Negative	Temporary	Local	Negligible	Imperceptible
Locally Important Aquifer (Lk)	Locally Important Aquifer – Karstified	Skerries	Medium	Change to groundwater regime	Negative	Temporary	Local	Negligible	Imperceptible
Loss or Damage of a Hydro-ecology Designated Site									
Rogerstown Estuary	SAC, pNHA and SPA	North of Donabate Station and south of Rush and Lusk Station	Extremely High	Loss or damage of a habitat through contamination	Negative	Temporary/ short-term	Local	Small	Significant
North-West Irish Sea	SPA	A few locations between Skerries Station and Gormanston Station	Extremely High	Loss or damage of a habitat through contamination	Negative	Temporary/ short-term	Local	Small	Significant

11.7.2.4 Zone D

The Construction Phase works in Zone D include excavation and earthworks associated with the OHLE works (including the substations) across the length of the zone and Construction Compounds at Gormanston, UBB72 (Laytown Viaduct), Bettystown and OBB78 (carrying Colpe Road). Excavations may also be required to accommodate line lowering works at OBB78 Colpe Road Bridge.

Construction activities in Zone D will have the following potential effects on hydrogeology as discussed below and summarised in Table 11-16.

- Loss or damage of a proportion of the aquifer;
- Damage of the aquifer due to accidental spills;
- Change to groundwater regime; and
- Loss or damage of a hydro-ecology designated site.

Though the magnitude of the impact may vary depending on the scale of activities and location of the Proposed Development relative to the impacted important feature, in order to ensure a robust assessment, only the maximum magnitude or "worst case" of the impact of the Proposed Development is considered.

11.7.2.4.1 Loss or Damage of Proportion of Aquifer

The proposed works in Zone D which may remove small portions of the Locally Important (Lg and Lm) and Regionally Important (Rkd) aquifers are the piling works or potential excavation works into rock that may occur for the OHLE works (including the substations) if rock is close to surface. These activities are localised, are likely to be above or only slightly below the groundwater table and considered insufficient to affect the overall integrity of the underlying aquifers and therefore are considered to have a negligible impact. The significance rating of this negligible impact is considered to be imperceptible and will not be considered further.

11.7.2.4.2 Damage of the Aquifer due to Accidental Spills or Mobilisation of Contaminated Groundwater

If potential spills or leaks from the associated construction equipment or the mobilisation of contamination does occur, it may potentially contaminate the groundwater beneath the site. These are potential temporary effects and the magnitude of this potential impact on the Locally Important (Lg and Lm) and Regionally Important (Rkd) aquifers could potentially be moderate adverse. As the Locally Important aquifers are considered of medium importance the resulting significance rating of this impact is moderate. As the Regionally Important aquifer is considered of high importance the resulting significance rating of this impact is significant.

11.7.2.4.3 Change to Groundwater Regime

If pumping is required it is expected to be limited, localised and temporary and the magnitude of this impact is considered negligible. The significance rating of this negligible impact is considered to be imperceptible and will not be considered further.

11.7.2.4.4 Loss or Damage of a Hydro-ecology Designated Site

In the vicinity of Gormanston Station the North-West Irish Sea SPA (004236) overlaps the study area and is adjacent to the Proposed Development. In addition, to the south of Laytown Station the study area overlaps the River Nanny Estuary and Shore SPA (004158) and Laytown Dunes/Nanny Estuary pNHA (000554). While the North-West Irish Sea, River Nanny Estuary and Shore and Laytown Dunes/Nanny Estuary sites are not groundwater dependent, groundwater from the study area will discharge into them. Works within the Proposed Development will take place in areas directly adjacent to these features. Consequently, there is the low potential for accidental spillage during construction related activities or mobilisation of contaminants during the removal of contaminated soil both of which could impact the water quality under the Proposed Development and potentially could discharge into these features.

Any impacts from the migration of contamination would be buffered to an extent by attenuation through the subsurface but could potentially result in a negative, short-term or temporary, localised, small impact. As the North-West Irish Sea, River Nanny Estuary and Shore and Laytown Dunes/Nanny Estuary sites are extremely important this impact could result in a potentially significant impact(s).

Table 11-16 Summary of Potential Construction Phase effects in Zone D of the Proposed Development

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
Loss or Damage of Proportion of Aquifer									
Locally important aquifer (Lg)	Locally important gravel aquifer	South of Laytown to Gormanston	Medium	Loss or damage of proportion of aquifer through excavation or piling.	Negative	Permanent	Local	Negligible	Imperceptible
Locally Important Aquifer (Lm)	Bedrock which is Generally Moderately Productive	North of Bettystown to Drogheda	Medium	Loss or damage of proportion of aquifer through excavation.	Negative	Permanent	Local	Negligible	Imperceptible
Regionally Important Aquifer (Rkd)	Karstified aquifer with diffuse flow	Laytown to Bettystown	High	Loss or damage of proportion of aquifer through excavation or piling.	Negative	Permanent	Local	Negligible	Imperceptible
Damage of the Aquifer due to Accidental Spills									
Locally important aquifer (Lg)	Locally important gravel aquifer	South of Laytown to Gormanston	Medium	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate	Moderate
Locally Important Aquifer (Lm)	Bedrock which is Generally Moderately Productive	North of Bettystown to Drogheda	Medium	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate	Moderate
Regionally Important Aquifer (Rkd)	Karstified aquifer with diffuse flow	Laytown to Bettystown	High	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate	Significant

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
Change to Groundwater Regime									
Locally important aquifer (Lg)	Locally important gravel aquifer	South of Laytown to Gormanston	Medium	Change to groundwater regime	Negative	Temporary	Local	Negligible	Imperceptible
Locally Important Aquifer (Lm)	Bedrock which is Generally Moderately Productive	North of Bettystown to Drogheda	Medium	Change to groundwater regime	Negative	Temporary	Local	Negligible	Imperceptible
Regionally Important Aquifer (Rkd)	Karstified aquifer with diffuse flow	Laytown to Bettystown	High	Change to groundwater regime	Negative	Temporary	Local	Negligible	Imperceptible
Loss or Damage of a Hydro-ecology Designated Site									
River Nanny Estuary and Shore SPA	SPA	To the south of Laytown Station	Extremely High	Loss or damage of a habitat through contamination	Negative	Temporary /short-term	Local	Small	Significant
North-West Irish Sea	SPA	In the vicinity of Gormanston Station	Extremely High	Loss or damage of a habitat through contamination	Negative	Temporary /short-term	Local	Small	Significant
Laytown Dunes/Nanny Estuary	pNHA	To the south of Laytown Station	Very High	Loss or damage of a habitat through contamination	Negative	Temporary /short-term	Local	Small	Significant

11.7.2.5 Zone E

The Construction Phase works in Zone E which may impact hydrogeology include excavation and earthworks associated with:

- OHLE works across the length of the zone;
- the piled foundations and Construction Compounds for the OBB80/80A/80B (carrying Railway Terrace Bridge) and the UBK01 (Dublin Road Bridge) works;
- the construction of a retaining wall and foundations for Platform 4, Navan Line; and
- the construction of the Drogheda substation and Construction Compounds.

Construction activities in Zone E will have the following potential effects on hydrogeology as discussed below and summarised in Table 11-17.

- Loss or damage of a proportion of the aquifer;
- Damage of the aquifer due to accidental spills; and
- Change to groundwater regime.

Though the magnitude of the impact may vary depending on the scale of activities and location of the Proposed Development relative to the impacted important feature, in order to ensure a robust assessment, only the maximum magnitude or "worst case" of the impact of the Proposed Development is considered.

11.7.2.5.1 Loss or Damage of Proportion of Aquifer

The proposed works in Zone E which are likely to remove small portions of the bedrock aquifer are the piling works or potential excavation works into rock that may occur for the substations or the OBB80/80A/80B and UBK01 if rock is close to surface. These activities are localised, are likely to be above or only slightly below the groundwater table and considered insufficient to affect the overall integrity of the underlying Locally Important (Lm) aquifer and therefore are considered to have a negligible impact. The significance rating of this negligible impact is considered to be imperceptible and will not be considered further.

11.7.2.5.2 Damage of the Aquifer due to Accidental Spills

There is a medium risk of pollution to groundwater as a result of accidental spills leading to the mobilisation of contaminated groundwater. Therefore, the magnitude of this potential impact on the Locally Important aquifer (Ll) is moderate adverse leading to a significance rating of moderate.

11.7.2.5.3 Change to Groundwater Regime

If pumping is required, it is expected to be limited, localised and temporary and the magnitude of this impact is considered negligible. The resulting significance is imperceptible and therefore will not be considered further.

Piled foundations, in particular contiguous piles can act as a permanent barrier to groundwater flow. Altering groundwater flow can lead to localised changes in the water table, increasing the water table up-hydraulic gradient of the piles and depressing it down-hydraulic gradient. Considering the scale of the Locally Important aquifer compared to the likely size of any piled foundations any effect on groundwater levels is anticipated to be negligible. The resulting significance is imperceptible and therefore will not be considered further.

Table 11-17 Summary of Potential Construction Phase effects in Zone E of the Proposed Development

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
Loss or Damage of Proportion of Aquifer									
Locally Important Aquifer (Lm)	Bedrock which is Generally Moderately Productive	Widespread	Medium	Loss or damage of proportion of aquifer through excavation.	Negative	Permanent	Local	Negligible	Imperceptible
Damage of the aquifer due to accidental spills									
Locally Important Aquifer (Lm)	Bedrock which is Generally Moderately Productive	Widespread	Medium	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate adverse	Moderate
Change to Groundwater Regime									
Locally Important Aquifer (Lm)	Bedrock which is Generally Moderately Productive	Widespread	Medium	Change to groundwater regime	Negative	Temporary	Local	Negligible	Imperceptible

11.7.3 Operational Phase

11.7.3.1 Accidental Emissions and Release of Potentially Hazardous Substances

The Operational Phase similar to the Do-Nothing scenario has the potential to present a slight risk of an adverse impact on groundwater quality from leaks, drips and spills. However, the increased use of electric trains and reduction in trains running on diesel will reduce the risk of groundwater pollution by a negligible amount.

As the trains will be maintained and the routine maintenance comprises minor works the risk of a serious adverse impact on groundwater quality is considered to be negligible. Consequently, the significance of this potential adverse impact on groundwater quality for the Operational Phase is considered to be imperceptible.

11.8 Mitigation Measures

The following sections outline the mitigation measures designed to avoid or minimise those effects identified in Section 11.7 for the construction and Operational Phases of the Proposed Development.

11.8.1 Construction Phase

The mitigation strategy outlined in this section will be implemented during the Construction Phase of the Proposed Development. The strategy will be incorporated into the overall Construction Environmental Management Plan (CEMP), which is included as Appendix A5.1 (CEMP) in Volume 4 of this EIAR.

Construction techniques that comply with the requirements of statutory bodies (County Councils and EPA) in terms of noise, vibration, soil and groundwater contamination, and disposal of possible contaminated material for both soil and rock cuttings will be adopted. A summary of the pre-mitigation and post-mitigation effects is presented on Table 11-18 to Table 11-22.

11.8.1.1 Damage to the Aquifer or Sites designated for Environmental Protection including Hydro-ecology due to Accidental Spills

Good construction management practices, as outlined in the CIRIA guidance Control of Water Pollution from Construction Sites – Guidance for consultants and contractors (Masters-Williams *et al*., 2001) will be employed by the appointed contractor to minimise the risk of transmission of hazardous materials as well as pollution of adjacent watercourses and groundwater. The construction management of the site will take account of these recommendations to minimise as far as possible the risk of soil, groundwater and surface water contamination.

Measures to be implemented to minimise the risk of spills and contamination of soils and waters include:

- Employing only competent and experienced workforce, and site-specific training of site managers, foremen and workforce, including all subcontractors, in pollution risks and preventative measures;

- Ensure that all areas where liquids (including fuel) are stored, or cleaning is carried out, are in designated impermeable areas that are isolated from the surrounding area and within a secondary containment system, e.g. by a roll-over bund, raised kerb, ramps or stepped access;
- The location of any fuel storage facilities shall be considered in the design of the Construction Compound. These are to be designed in accordance with relevant guidelines and codes of best practice and will be fully bunded;
- Good housekeeping at the site (daily site clean-ups, use of disposal bins, etc.) during the entire Construction Phase;
- All concrete mixing and batching activities will be located in areas away from watercourses and drains;
- Potential pollutants to be adequately secured against vandalism;
- Provision of proper containment of potential pollutants according to codes of best practice;
- Thorough control during the entire Construction Phase to ensure that any spillage is identified at an early stage and subsequently effectively contained and managed; and
- Spill kit to be provided and to be kept close to the storage area. Staff to be trained on how to use spill kits correctly.

An Environmental Incident Response Plan will be implemented by the appointed contractor, which will identify the actions to be taken in the event of a pollution incident. It will address such aspects as containment measures, emergency discharge routes, a list of appropriate equipment and clean-up materials and notification procedures to inform the relevant environmental protection authority. Refer to Appendix A5.1(CEMP) in Volume 4: of this EIAR.

Sediment control methods are outlined in the Surface Water Management Plan in Appendix A5.1: (CEMP), and these will be implemented by the appointed contractor.

The CEMP also addresses good construction management practices that will be employed to prevent the risk of pollution of the existing land, soils, geology and hydrogeology during construction.

11.8.2 Operational Phase

With the implementation of the proposed design, no additional mitigation measures for hydrogeology are considered necessary for the operation of the Proposed Development.

In the Operational Phase the infrastructure will be maintained by Iarnród Éireann and will be subject to their management procedures to ensure that the correct measures are taken in the event of any accidental spillages, and this will reduce the potential for any impact.

11.9 Residual Effects

11.9.1 Construction Phase

With the efficacious implementation of the above mitigation measures, there will be no significant residual impacts on the hydrogeology as a result of the construction of the Proposed Development. A summary of the predicted Construction Phase impacts with a significance rating of moderate or significant in Zones A to E following the Implementation of Mitigation and Monitoring Measures are presented in Table 11-18 to Table 11-22.

Table 11-18 Summary of Potential Construction Phase impacts in Zone A following the Implementation of Mitigation Measures

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Pre-mitigation Magnitude	Pre-mitigation Significance	Post-mitigation Magnitude	Post-mitigation Significance
Damage of the aquifer due to accidental spills											
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones	Fairview Depot	Medium	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate Adverse	Moderate	Negligible	Imperceptible

Table 11-19 Summary of Potential Construction Phase impacts in Zone B Following the Implementation of Mitigation Measures

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Pre-mitigation Magnitude	Pre-mitigation Significance	Post-mitigation Magnitude	Post-mitigation Significance
Damage of the Aquifer due to Accidental Spills											
Locally Important Aquifer (Ll)	Bedrock which is moderately productive only in local zones	Howth Junction and Donaghmede Station, Clongriffin Station, Malahide & OHLE works	Medium	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate Adverse	Moderate	Negligible	Imperceptible
Malahide Estuary	SAC, pNHA and SPA	Overlaps or in the vicinity of the site to the north of Malahide Station	Extremely high	Loss or damage of a groundwater dependant habitat through contamination	Negative	Temporary /short-term	Local	Small	Significant	Negligible	Imperceptible

Table 11-20 Summary of Potential Construction Phase impacts in Zone C Following the Implementation of Mitigation Measures

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Pre-mitigation Magnitude	Pre-mitigation Significance	Post-mitigation Magnitude	Post-mitigation Significance
Damage of the Aquifer due to Accidental Spills											
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones	Smaller areas within Zone C	Medium	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate adverse	Moderate	Negligible	Imperceptible
Locally Important Aquifer (Lm)	Bedrock which is Generally Moderately Productive	Widespread	Medium	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate adverse	Moderate	Negligible	Imperceptible
Locally Important Aquifer (Lk)	Locally Important Aquifer - Karstified	Skerries	Medium	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate adverse	Moderate	Negligible	Imperceptible
Rogerstown Estuary	SAC, pNHA and SPA	North of Donabate Station and south of Rush and Lusk Station	Extremely High	Loss or damage of a groundwater dependant habitat through contamination	Negative	Temporary /short-term	Local	Small	Significant	Negligible	Imperceptible
North-West Irish Sea	SPA	A few locations between Skerries Station and	Extremely High	Loss or damage of a habitat through contamination	Negative	Temporary /short-term	Local	Small	Significant	,	Imperceptible

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Pre-mitigation Magnitude	Pre-mitigation Significance	Post-mitigation Magnitude	Post-mitigation Significance
		Gormanston Station									

Table 11-21 Summary of Potential Construction Phase impacts in Zone D Following the Implementation of Mitigation Measures

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Pre-mitigation Magnitude	Pre-mitigation Significance	Post-mitigation Magnitude	Post-mitigation Significance
Damage of the Aquifer due to Accidental Spills											
Locally important aquifer (Lg)	Locally important gravel aquifer	South of Laytown to Gormanston	Medium	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate adverse	Moderate	Negligible	Imperceptible
Locally Important Aquifer (Lm)	Bedrock which is Generally Moderately Productive	North of Bettystown to Drogheda	Medium	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate adverse	Moderate	Negligible	Imperceptible
Regionally Important Aquifer (Rkd)	Karstified aquifer with diffuse flow	Laytown to Bettystown	High	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate adverse	Significant	Negligible	Imperceptible
Loss or Damage of a Hydro-ecology Designated Site											

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Pre-mitigation Magnitude	Pre-mitigation Significance	Post-mitigation Magnitude	Post-mitigation Significance
River Nanny Estuary and Shore SPA	SPA	To the south of Laytown Station	Extremely High	Loss or damage of a habitat through contamination	Negative	Temporary/ short-term	Local	Small	Significant	Negligible	Imperceptible
North-West Irish Sea	SPA	In the vicinity of Gormanston Station	Extremely High	Loss or damage of a habitat through contamination	Negative	Temporary / short-term	Local	Small	Significant	Negligible	Imperceptible
Laytown Dunes/Nanny Estuary	pNHA	To the south of Laytown Station	Very High	Loss or damage of a habitat through contamination	Negative	Temporary / short-term	Local	Small	Significant	Negligible	Imperceptible

Table 11-22 Summary of Potential Construction Phase impacts in Zone E Following the Implementation of Mitigation Measures

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Pre-mitigation Magnitude	Pre-mitigation Significance	Post-mitigation Magnitude	Post-mitigation Significance
Damage of the Aquifer due to Accidental Spills											
Locally Important Aquifer (Lm)	Bedrock which is Generally Moderately Productive	Widespread	Medium	Damage of proportion of aquifer through contamination.	Negative	Temporary	Local	Moderate adverse	Moderate	Negligible	Imperceptible

11.9.2 Operational Phase

No significant residual impacts on hydrogeology as a result of the Operational Phase of the Proposed Development have been identified.

11.10 Monitoring

No monitoring is required for the Construction or Operational Phases of the Proposed Development.

11.11 Cumulative Effects

The cumulative assessment of the relevant plans and projects is undertaken in Chapter 26 (Cumulative Effects) in Volume 2 of this EIAR.

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