HYDROLOGY, HYDROGEOLOGY AND DRAINAGE

8.1 INTRODUCTION

8.1.1 Background and Objectives

Dr. Robert Meehan was retained on behalf of Stephen Ward Planning and Development Consultants Limited in September 2024, to undertake an assessment of the potential likely and significant effects of the proposed Large Scale Residential Development (LRD) by Lagan Homes Ballycullen Limited (Proposed Project) on a site south of Stocking Avenue, in the townland of Woodtown, Ballycullen, Dublin 16 (*Irish Transverse Mercator Grid Reference 712000 725740*), where it is proposed to construct a residential development comprising a number of accommodation unit types, on the Hydrology, Hydrogeology and Drainage aspects of the receiving environment.

The Proposed LRD Project is described in full in Chapter 3 of this EIAR.

Where the 'proposed LRD Site' is referred to it refers to the entire site boundary encompassing the proposed

- 4 no. Type A1 dwelling houses (three-bedroomed, semi-detached),
- 10 no. Type A2 dwelling houses (three-bedroomed, end of terrace),
- 6 no. Type B1 dwelling houses (three-bedroomed, semi-detached),
- 36 no. Type B2 dwelling houses (three-bedroomed, end of terrace),
- 16 no. Type C1 dwelling houses (four-bedroomed, semi-detached),
- 8 no. Type C2 dwelling houses (four-bedroomed, semi-detached),
- 1 no. Type C3 dwelling house (four-bedroomed, detached),
- 19 no. Type D dwelling houses (two-bedroomed, mid-terrace),
- 9 no. Type E1 dwelling houses (four-bedroomed, detached),
- 28 no. Type E2 dwelling houses (four-bedroomed, semi-detached),
- 30 no. Type F dwelling houses (three-bedroomed, semi-detached),
- 30 no. Type G dwelling houses (3-bedroomed, mid-terrace)
- 108 no. Type 1 Apartments (one-bedroomed),
- 63 no. Type2 Apartments (two-bedroomed),
- 88 no. Type 3 Apartments (two-bedroomed), and
- 46 no. Type 4 Apartments (three-bedroomed)
- A creche

and all ancillary site works.

This report provides a baseline assessment of the environmental setting and description of the Proposed Project, as described in Chapter 3, in terms of Hydrology, Hydrogeology and Drainage, and discusses the potential likely and significant effects that the construction and operation of the Proposed Project will have. Where required, appropriate mitigation measures to avoid any identified significant effects to Hydrology, Hydrogeology and

Drainage (i.e. natural water resources) are recommended and the residual effects of the Proposed Project post-mitigation are assessed.

The Proposed Project study area with regard Hydrology, Hydrogeology and Drainage is defined by the EIAR Site Boundary. The full extent of the area which is the subject of the investigations is identified in **Figure 1** below as a red outline, which is a site covering c. 10.36 hectares. Through the desk study and investigations undertaken and having regard to other environmental and design considerations a suitable design of the Proposed Project was subsequently identified for the site, which includes the absence of basement storeys and associated inherent construction mitigation measures. This has also in turn informed the extent and level of detail of this report on Hydrology, Hydrogeology and Drainage (again for the site outlined in red below). Because the regional hydrology and hydrogeology has a bearing on the site hydrology and hydrogeology, in this case, the study area is larger than the application site; thus, much of the baseline data presented in this chapter extends beyond the application site itself.

The objectives of the assessment are:

- Produced a baseline study of the existing water environment (surface water and groundwater natural resources) in the area of the proposed LRD Project;
- Identify likely significant effects of the Proposed Project on surface water and groundwater natural resources during the construction and operational phases of the proposed LRD Project;
- Identify mitigation measures to avoid, reduce or offset significant negative effects;
- Assess significant residual effects, and;
- Assess the cumulative effects of the proposed LRD Project itself, as well as other local developments (as described in Chapter 2 of this EIAR).

The Water Study Area for assessing the potential zone of impact and cumulative effects assessment is the Liffey River catchment. The Liffey River catchment is shown on **Figure 2** below (Regional Hydrology Map).

8.1.2 Statement of Authority

EurGeol. Dr. Robert Meehan, PGeo. is a specialist geological, hydrological, hydrogeological and environmental sole trader who delivers a range of water and environmental management consultancy services to the private and public sectors across the Republic of Ireland. Robert began working a as a self-employed Consultant Geologist in 2003, with his office located in Navan, County Meath.

Robert's core areas of expertise and experience includes soils, subsoils, geology, hydrogeology and hydrology. Robert routinely completes impact assessments for land, soils and geology, hydrology and hydrogeology for a large variety of project types including housing developments, large-scale infrastructure projects and quarry enterprises.

Robert Meehan (B.A., Ph. D, PGeo., EurGeol.) is an Environmental Geologist / Hydrogeologist with over 30 years' environmental consultancy experience in Ireland. Robert initially worked for Geological Survey Ireland (GSI, 1993 – 1998) on the initiation of Groundwater Protection Schemes across the country, and then worked for Teagasc between 1998 and 2006 completing the first countrywide mapping of subsoil (and related soils) coverage, which is that still used today in all Environmental Impact Assessments across the country. Since beginning life as a consultant while with Teagasc in 2003, Robert has completed numerous hydrological and hydrogeological impact assessments of various types of development in Ireland. He has also worked for GSI on their National Groundwater Protection Scheme, as well as Irish Geological Heritage Audits of all counties across Ireland. Robert acts as a consultant to the EPA on on-site waste water treatment systems, and was a co-author of the current Code of Practice (Domestic Waste Water Treatment Systems, 2021). Robert has been a lead trainer on the (formerly FAS, now Water Services Training Group) course on 'Site Assessment for On-Site Waste Water Treatment Systems' since in's inception in 1998. Robert has managed the geological and hydrogeological aspects of EIAR assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in geological and hydrogeological site investigations, site suitability assessments for on-site waste water, geological heritage mapping and appraisal, wetland hydrology and hydrogeology, water resource assessments, surface water drainage and SUDs design, and surface water/groundwater interactions.

8.1.3 Relevant Legislation

The EIAR is prepared in accordance with the requirements of European Union Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (the 'EIA Directive') as amended by Directive 2014/52/EU. The requirements of the following legislation are complied with:

- The Planning and Development Act 2000 (as amended);
- Planning and Development Regulations, 2001 (as amended);
- S.I. No 296/2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 which transposes the provisions of the EIA Directive as amended by the Directive 2014/52/EU into Irish Law;
- S.I. No. 94/1997: European Communities (Natural Habitats) Regulations, resulting from EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and 79/409/EEC on the conservation of wild birds (the Birds Directive);
- S.I. No. 293/1988: Quality of Salmon Water Regulations;
- S.I. No. 272/2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009 and S.I. No. 722/2003 European Communities (Water Policy) Regulations which implement EU Water Framework Directive (2000/60/EC) and provide for implementation of 'daughter' Groundwater Directive (2006/118/EC). Since 2000 water management in the EU has been directed by the Water Framework Directive (WFD). The key objectives of the WFD are that all water bodies in member states achieve (or retain) at least 'good' status by 2015. Water bodies comprise both surface and groundwater bodies, and the achievement of 'good' status for these depends also on the achievement of 'good'

status by dependent ecosystems. Phases of characterisation, risk assessment, monitoring and the design of programmes of measures to achieve the objectives of the WFD have either been completed or are ongoing. In 2015 it replaced a number of existing water related directives, which are successively being repealed, while implementation of other Directives (such as the Habitats Directive 92/43/EEC) will form part of the achievement of implementation of the objectives of the WFD;

- S.I. No. 41/1999: Protection of Groundwater Regulations, resulting from EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive);
- S.I. No. 294/1989: Quality of Surface Water Intended for Abstraction (Drinking Water), resulting from EU Directive 74/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (repealed by 2000/60/EC in 2007);
- S.I. No. S.I. No. 99/2023: European Communities Environmental Objectives (Drinking Water) (Amendment) Regulations 2023;
- S.I. No. 287/2022: European Communities Environmental Objectives (Groundwater) (Amendment) Regulations 2016;
- S.I. No. 9/2010: European Communities Environmental Objectives (Groundwater) Regulations 2010;
- S.I. No. 272/2009: European Communities Environmental Objectives (Surface Water) Regulations 2009;
- S.I. No. 77/2019: European Communities Environmental Objectives (Surface Water) (Amendment) Regulations 2019, and;
- The Heritage Act 1995, as amended.

8.1.4 Relevant Guidance

The Hydrology, Hydrogeology and Drainage chapter of this EIAR was prepared in accordance with, where relevant, the guidance contained in the following documents:

- Environmental Protection Agency (2022): Guidelines on the Information to be contained in Environmental Impact Assessment Reports;
- European Commission (2017): Environmental Impact Assessment of Projects – Guidance on the Preparation of the Environmental Impact Assessment Report;
- Institute of Geologists Ireland (2013): Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements;
- National Roads Authority (2008): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;

- Forestry Commission (2004): Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh;
- Coillte (2009): Forest Operations & Water Protection Guidelines;
- Forest Services (Draft) Forestry and Freshwater Pearl Mussel Requirements – Site Assessment and Mitigation Measures;
- Forest Service (2000): Forestry and Water Quality Guidelines. Forest Service, DAF, Johnstown Castle Estate, Co. Wexford;
- COFORD (2004): Forest Road Manual – Guidelines for the Design, Construction and Management of Forest Roads;
- Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Watercourses;
- Good Practice During Wind Farm Construction (Scottish Natural Heritage, 2010);
- PPG1 - General Guide to Prevention of Pollution (UK Guidance Note);
- PPG5 – Works or Maintenance in or Near Watercourses (UK Guidance Note);
- CIRIA (Construction Industry Research and Information Association) 2006: Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006);
- CIRIA 2006: Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors. CIRIA C532. London, 2006.
- Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (DoHPLG, 2018); and,
- Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU), (European Commission 2017).

8.2 ASSESSMENT METHODOLOGY

8.2.1 Desk Study

A desk study of the Site was completed in advance of undertaking the walkover survey, mapping and site investigations. This involved collecting all relevant geological, hydrological, hydrogeological and meteorological data for the Site and Water Study area. This included consultation with the following data sources:

- the Environmental Protection Agency's online environmental database (www.epa.ie);

- Geological Survey Ireland's (GSI's) Groundwater and Geology Databases (www.gsi.ie/ geology or www.gsi.ie/groundwater);
- Geological Survey Ireland's Geological Heritage site mapping (www.gsi.ie/geoheritage);
- GSI's Bedrock Geology 1:100,000 Scale Map Series, Sheet 16 (Geology of Kildare - Wicklow). Geological Survey Ireland (GSI, 1994);
- Environmental Protection Agency (2022): Guidelines on the Information to be contained in Environmental Impact Assessment Reports;
- EPA/Water Framework Directive Map Viewer (www.catchments.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 16 (Geology of Kildare - Wicklow). Geological Survey Ireland (GSI, 1994);
- Geological Survey Ireland (2003) – Kilcullen Groundwater Body Initial Characterization Reports;
- General Soil Map of Ireland (Teagasc, 1980, 2nd edition, viewable on www.epa.ie); and,
- Aerial Photography, 1:5,000 and 6 inch sheet base mapping.
- OPW Past Flood Event Mapping (www.floodinfo.ie); and,
- OPW Flood Extents Mapping and National Indicative Fluvial Mapping (www.floodinfo.ie/map/floodmaps).

8.2.2 Baseline Monitoring and Site Investigations

Walkover surveys, including geological/hydrological/hydrogeological baseline monitoring and site investigations, were undertaken by Robert Meehan (refer to Section 1.2 above for qualifications and experience) on 6th and 7th November 2024.

Intrusive Site Investigations had previously been conducted across the site area by Ground Investigations Ireland, The Grange, 12th Lock Road, Lucan, County Dublin, on 21st September 2006, and by Waterman Moylan Ltd., Block S, EastPoint Business Park, Alfie Byrne Road, Dublin D03 H3F4, on 16th February 2024.

The objectives of the intrusive site investigations included mapping the distribution and depth of mineral subsoils at the proposed LRD Site along with assessing the mineral subsoil / bedrock conditions at key Proposed Project locations. These data were used to inform the final layout design.

Site investigations to address the Land, Soil and Geology section of the EIAR included the following:

- Walkover surveys and geological mapping of the Site area were undertaken to assess ground conditions;

- A total of 26 no. deep trial pits excavated inside the proposed LRD Site boundary, and 2 no. excavated just outside of it at the southeast, to determine the thickness and geomorphology of mineral subsoils overlying the Site;
- Measurement of flow in streams flanking the site and that running through the site; and
- Mineral subsoils were logged according to the British Standard BS: 5930 Subsoil Classification scheme.

As there is an absence of peat of any depth across all portions of the site (see following Sections), and as the soil and subsoil is all mineral, the requirement for a Peat Stability Risk Assessment Report and Peat Management Plan does not arise.

8.2.3 Impact Assessment Methodology

The desk study investigations commissioned were to characterise the detailed three-dimensional soils, subsoils and bedrock geology of the proposed LRD Site, as well as resultant interpreted hydrogeology (see Chapter 8). As well as this, an assessment as to whether there would be any impact on any SACs, SPAs, NHAs or pNHAs around the site, was an inherent part of this study. The resulting report provided the resultant description of the geological character of the lands, and details the nature, extent and complexity of the geological material from the surface downwards through the mineral subsoil to the bedrock. As part of this desk study mapping and modelling exercise, field investigations were undertaken and involved a detailed walk over of the site and its surrounding environs, and mapping of salient features.

Overall therefore, the results of the desk study, visual assessment of the site, groundwater and surface water level analysis and trial pit analysis (see Chapter 7) have been collated to conclude that the lands could be used for the construction of the proposed LRD development, as well as the associated drainage scheme, and assert that there will be no detrimental impact on the soils and subsoils geology, or hydrogeology and drainage on the site (Chapter 8) or at any nearby SACs, SPAs, NHAs or pNHAs, from the construction of same.

The rating of potential environmental impacts on the soils and geology environment is based on **Table 8.1** following which takes account of the quality, significance, duration and type of impact characteristic identified.

The appraisal methodology is completed in accordance with the Environmental Protection Agency (EPA) document '*Guidance on the Information to be contained in Environmental Impact Statements*' (EPA, 2002), the Institute of Geologists of Ireland (IGI) publication '*Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapter of Environmental Impact Statements*' (2013) and the EPA document entitled '*Guidelines on the information to be contained in Environmental Impact Assessment Reports*' (2022) classification of environmental impacts. In addition, the document entitled '*Guidelines on Procedures for Assessment and Hydrogeology for National Road Schemes*' by the National Roads Authority (NRA, 2009) is referenced where the methodology for assessment of impact is appropriate.

In EIA assessment, consideration is given to both the importance of an attribute and the magnitude of the environmental impacts of the proposed activities on that cited attribute. These impact ratings presented in below are in accordance with impact assessment criteria provided in the EPA (2022) publication.

Impact characteristic	Term	Description
Quality	Positive	A change which improves the quality of the environment
	Neutral	A change which does not affect the quality of the environment
	Negative	A change which reduces the quality of the environment
Significance	Imperceptible	An impact capable of measurement but without noticeable consequences
	Slight	An impact which causes noticeable changes in the character
Impact	Moderate	An impact that alters the character of the environment in a manner consistent with existing and emerging trends
	Significant	An impact, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment
	Profound	An impact which obliterates sensitive characteristics
	Short term	Impact lasting one to seven years
Duration	Medium-term	Impact lasting seven to fifteen years
	Long-term	Impact lasting fifteen to sixty years
	Permanent	Impact lasting over sixty years
	Temporary	Impact lasting for one year or less
	Cumulative	The addition of many small impacts to create one larger, more significant impact
Type	'Do Nothing'	The environment as it would be in the future should no development of any kind be carried out
	Indeterminate	When the full consequences of a change in the environment cannot be described
	Irreversible	When the character, distinctiveness, diversity, or reproductive capacity of an environment is not permanently lost
	Residual	Degree of environmental change that will occur after the proposed mitigation measures have taken effect
	Synergistic	Where the resultant impact is of greater significance than the sum of its constituents
	'Worst Case'	The impact arising from a development in the case where the mitigation measures may substantially fail

Table 8.1 Glossary of potential impacts following EPA (2002, 2022) Guidance documents.

The duration of each impact is considered to be either temporary, short-term, medium term, long-term, or a permanent impact. Temporary impacts are considered to be those which are construction related and last less than one year. Short term impacts were seen as impacts lasting one to seven years; medium-term impacts lasting seven to fifteen years; long-term impacts lasting fifteen to sixty years; and permanent impacts lasting over sixty years.

The NRA criteria for rating the magnitude and significance of impacts at EIA stage on the geological related attributes are also relevant in determining impact assessment and area presented in **Table 8.2** below.

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute	Loss of high proportion of future quarry or pit reserves
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Loss of moderate proportion of future quarry or pit reserves
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Loss of small proportion of future quarry or pit reserves
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	No measurable changes in attributes
Minor Beneficial	Results in minor improvement of attribute quality	Minor enhancement of geological heritage feature
Moderate Beneficial	Results in moderate improvement of attribute quality	Moderate enhancement of geological heritage feature
Major Beneficial	Results in major improvement of attribute quality	Major enhancement of geological heritage feature

Table 8.2 Criteria for rating impact magnitude at EIS stage – Estimation of magnitude of impact on soil / geology attribute (NRA, 2009).

The guideline criteria (EPA, 2022) for the assessment of likely significant effects require that likely effects are described with respect to their extent, magnitude, type (i.e. negative, positive or neutral) probability, duration, frequency, reversibility, and transfrontier nature (if applicable). The descriptors used in this environmental impact assessment report are those set out in the EPA (2022) Glossary of effects as shown in Chapter 1 of this EIAR. In addition, the two impact characteristics proximity and probability are described for each impact and these are defined in **Table 8.3** following.

Impact Characteristic	Degree/ Nature	Description
Proximity	Direct	An impact which occurs within the area of the proposed project, as a direct result of the proposed project.
	Indirect	An impact which is caused by the interaction of effects, or by off-site developments.
Probability	Unlikely	A low likelihood of occurrence of the impact.
	Likely	A medium likelihood of occurrence of the impact

Table 8.3 Additional Impact Characteristics

In order to provide an understanding of this descriptive system in terms of the geological/hydrological environment, elements of this system of description of effects are related to examples of potential likely significant effects on the geology and morphology of the existing environment, as listed in **Table 8.4**.

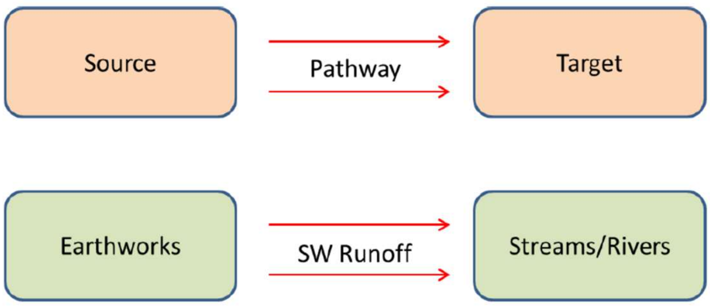
Impact Characteristics	**Potential Hydrological Impacts**	
Quality	**Significance**	**Potential Hydrological Impacts**
Negative only	Profound	Widespread permanent impact on: • The extent or morphology of a cSAC. • Regionally important aquifers. • Extents of floodplains. Mitigation measures unlikely to remove impacts.
Positive or Negative	Significant	Local or widespread time-dependent impacts on: • The extent or morphology of a cSAC / ecologically important area. • A regionally important hydrogeological feature (or widespread effects to minor hydrogeological features). • Extent of floodplains. Widespread permanent impacts on the extent or morphology of an NHA/ecologically important area. Mitigation measures (to design) will reduce but not fully remove impact – residual impacts will occur.
Positive or Negative	Moderate	Local time-dependent impacts on: • The extent or morphology of a cSAC / NHA / ecologically important area.

		• A minor hydrogeological feature. • Extent of floodplains. Mitigation measures can mitigate the impact OR residual impacts occur, but these are consistent with existing or emerging trends
Positive, Negative or Neutral	Slight	Local perceptible time-dependent impacts not requiring mitigation.
Neutral	Imperceptible	No impacts, or impacts which are beneath levels of perception, within normal bounds of variation, or within the bounds of measurement or forecasting error.

Table 8.4 Impact Descriptors relating to the Receiving Environment

8.2.4 Overview of Impact Assessment Process

The conventional source-pathway-target model (see following) was applied to assess potential impacts on downstream environmental receptors (see below as an example) as a result of the Proposed Project.



Where potential impacts are identified, the classification of impacts in the assessment follows the descriptors provided in the Glossary of Impacts contained in the following guidance documents produced by the Environmental Protection Agency (EPA):

- Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (2022)

The description process clearly and consistently identifies the key aspects of any potential impact source, namely its character, magnitude, duration, likelihood and whether it is of a direct or indirect nature.

Step 1	Identification and Description of Potential Impact Source: This section presents and describes the activity that brings about the potential impact or the potential source of pollution. The significance of effects is briefly described.	
Step 2	Pathway / Mechanism:	The route by which a potential source of impact can transfer or migrate to an identified receptor. In terms of this type of development, surface water and groundwater flows are the primary pathways, or for example, excavation or erosion are physical mechanisms by which a potential impact is generated.
Step 3	Receptor:	A receptor is a part of the natural environment which could potentially be impacted upon, e.g. human health, plant / animal species, aquatic habitats,

		soils/geology, water resources, water sources. The potential impact can only arise as a result of a source and pathway being present.
Step 4	Pre-mitigation Impact:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impact before mitigation is put in place.
Step 5	Proposed Mitigation Measures:	Control measures that will be put in place to prevent or reduce all identified significant adverse impacts. In relation to this type of development, these measures are generally provided in two types: (1) mitigation by avoidance, and (2) mitigation by engineering design.
Step 6	Post Mitigation Residual Impact:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impacts after mitigation is put in place.
Step 7	Significance of Effects:	Describes the likely significant post mitigation effects of the identified potential impact source on the receiving environment.

Table 8.5 Impact Assessment Process

In order to provide an understanding of the stepwise impact assessment process applied below (Section 8.5 following), a summary guide has first been presented above that defines the steps (1 to 7) taken in each element of the impact assessment process. The guide also provides definitions and descriptions of the assessment process and shows how the source-pathway-target model and the EPA impact descriptors are combined.

Using this defined approach, this impact assessment process is then applied to all construction and operation and decommissioning activities which have the potential to generate a source of significant adverse impact on the geological and hydrological/ hydrogeological (including water quality) environments.

8.2.5 Limitations and Difficulties Encountered

No limitations or difficulties were encountered during the preparation of the Land, Soils and Geology Chapter of this EIAR. The site investigations and follow up monitoring carried out were thorough and exhaustive.

8.3 EXISTING ENVIRONMENT

8.3.1 Site Description and Topography

The Site is located in the northern foothills of the Dublin – Wicklow Mountains, in the townland of Woodtown, approximately 1.5 kilometres southeast of the centre of the town of Firhouse and immediately south of Ballycullen, in south central County Dublin (see **Figure 8.1**). The site lies at ground surface elevations between approximately 106 and 126 mAOD, and is bounded by the Ballycullen Road at the west and the Regional R115 road approximately 150 m to the southwest. The existing Abbott's Grove and Stocking Wood housing developments are immediately adjacent at the northwest and northeast of the site, respectively (see **Figure 8.1**). The site itself is made up of two long, west-southwest to east-northeast oriented fields, and the entrance to the proposed LRD site is proposed from the existing road at Abbott's Grove, at the northwest, into the (current) western field.

The Ordnance Survey Ireland 1:50,000 Discovery Series Map shows a multi-contoured topography in and around the site (**Figure 8.1**) and though no streams or other watercourses are shown as flowing through or adjacent to the site on this map, it is noted that a number of small, unnamed, potentially ephemeral streams seem to flow northwards through the centre of the site, as well as along it's eastern boundary, on the six inch to one mile map sheets of the locality, from the 1840's.

The proposed LRD Site itself is situated on the northern lower backslope of a high, unnamed, dome-shaped ridge feature at Woodtown, which itself is a spur-ridge off the northeastern side of Mountpelier Hill. The dome-shaped ridge on which the site is located rises to 208 m elevation AOD approximately 850 m southeast of the site, with Mountpelier Hill rising to 383 mAOD 2 kilometres south-southwest of the site (**Figure 8.1**).

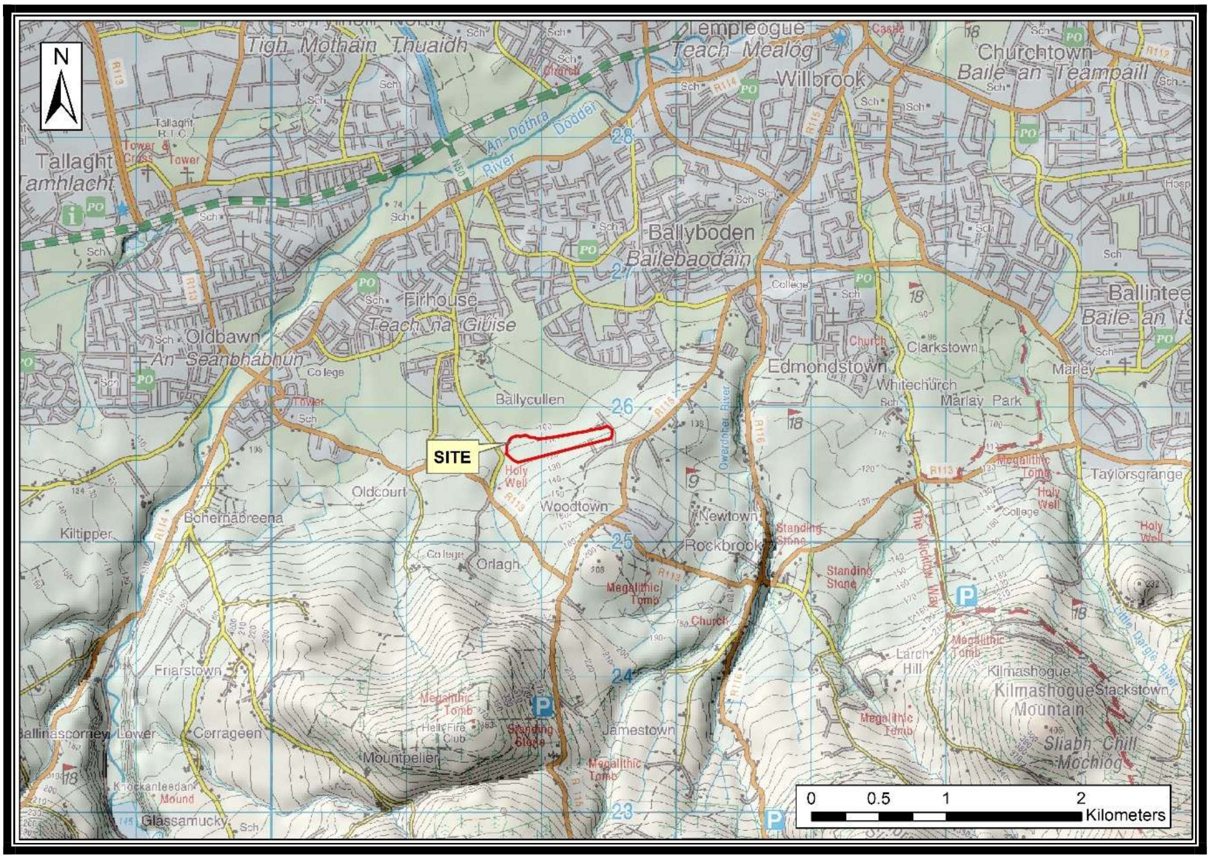


Figure 8.1 Geological and Hydrological Study Area, Application Site Area and Surrounding Features. Grid squares are 1 km distance (O.S. Licence EN 057925).

The overall form / geometry of the site itself is of a ridge or 'bank' type feature along the lower backslopes of much higher, bedrock-cored ridges, undulating with gentle to moderate slopes. Currently (January 2025) the site itself is comprised completely of agricultural pasture, with a narrow band of broadleaf forestry running north to south through the central portion of the site and bounding the two component fields, and a mature hedgerow / treeline along the eastern boundary. Both of these belts of trees and shrubs are incised by shallow stream channels. Pockets of scrub vegetation also occur at the northeastern extreme of the site, and the site is bounded by fences and walls elsewhere. To the north, west and east, the land in the housing estates has a concrete, tarmacadam or hardstand cover, and to the south and in a narrow area at the north centre of the site, pasture also occurs. There are currently no buildings across any locality within the site confines. The northwestern edge of the site comprises a relatively high, cliffed slope at the edge of Abbott's Grove, generally 4 m – 5m high.

Plate 8.1 View of the western field on the site, from the west

Plate 8.2 View of the eastern field on the site, also from the west

Plate 8.3 The cliffed edge of the northwestern end of the site at the edge of Abbot's Grove (at the proposed road entrance)

8.3.2 Water Balance

Long term Average Annual Rainfall (AAR) and evaporation data was sourced from Met Éireann. The 30-year annual average rainfall (1981 - 2010) recorded at Ballyboden rainfall station (Station I.D. 6623), located 880 metres northeast of the proposed LRD Site, are presented in **Table 8.6**. This is the most appropriate station to use with respect to distance (from the proposed LRD Site) and elevation. The average annual rainfall from 1981 to 2010 was 706 mm/year.

Met Éireann also provide a grid of average annual rainfall for the entire country for the period of 1991 to 2020. Based on this more site-specific modelled rainfall values, the average annual rainfall at the proposed LRD Project site ranges from 921 to 1,017 mm/year. The mid-point between 921 and 1,017 mm/ year (1991 to 2020 data) i.e. 969 mm/year, was considered to be the most accurate estimate of average annual rainfall from the available sources.

Station		**X – Co-ordinate**		**Y – Co-ordinate**		**Elevation (mAOD)**		**From**		**To**		
Ballyboden		713026		726528		107		1967		present		
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
91.64	63.15	68.76	62.13	67.06	63.70	46.02	68.17	67.54	76.64	87.73	94.28	856.62

Table 8.6 Local Average Long-Term Rainfall Data (1981-2010)

The closest synoptic[1] station is at the Phoenix Park, approximately 10 kilometres north of the proposed LRD Site, but the nearest synoptic station with potential evapotranspiration (PE) data readily available is at Dublin Airport, which is 16 kilometres to the north-northeast. Daily rainfall and daily potential evapotranspiration data at the Dublin Airport synoptic station are available since 1942. The long-term average PE for this station is 548 mm/year. This value is used as a best estimate of the proposed LRD Site PE. Actual Evaporation (AE) at the proposed LRD Site is estimated as 520.6 mm/year (which is 0.95 × PE).

The effective rainfall (ER) represents the water available for runoff and groundwater recharge. The ER for the Site is calculated as follows:

Effective rainfall (ER) = AAR – AE

= 969 mm/year – 520.6 mm/year

ER = 448.4 mm/year

[1] Meteorological station at which observations are made for synoptic meteorology and at the standard synoptic hours of 00:00, 06:00, 12:00, and 18:00.

According to the GSI subsoil permeability mapping, the majority of the proposed LRD Site (66%) is mapped as being underlain by "Moderate" permeability subsoils, while the other 34% (at the northwestern end) is mapped as being underlain by "Low" permeability subsoils.

Based on recharge coefficient estimates from the GSI, an estimate of 60% recharge is assigned for a large proportion (66%) of the proposed LRD Site (mapped by GSI as "moderate permeability subsoil overlain by poorly drained gley soil"), while areas mapped as "low permeability subsoil" (34% of site area) are assigned recharge coefficients of 7.5% to 15%.

The weighted average recharge coefficient for the proposed LRD Site is calculated to be 44%. The Site hydrology is therefore characterised by naturally (relatively) high surface water runoff rates (56%) and lower groundwater recharge rates. The relatively high drainage density (see next Section) across the site is reflective of the relatively low groundwater recharge rates.

Therefore, annual recharge and runoff rates for the proposed LRD Site are estimated to be 197 mm/year and 251.4 mm/year respectively.

Climate change projections for Ireland are provided by Regional Climate Models (RCM's) downscaled from larger Global Climate Models (GCM's). Projections for the period 2041-2060 (mid-century) are available from Met Eireann. The data indicates a projected decrease in summer rainfall from 0 to 13% under the medium-low emission range scenario and an increase in the frequency of heavy precipitation events of ~20%. In total the projected annual reduction in rainfall near the proposed LRD Project site is -10% under the medium-low emission scenario and -8% under the high emissions scenario.

In addition to average rainfall data, extreme value rainfall depths are available from Met Éireann. **Table 8.7** below presents return period rainfall depths for the area of the proposed LRD Site. These data are taken from https://www.met.ie/climate/services/rainfall-return-periods and they provide rainfall depths for various storm durations and sample return periods (1-year, 10-year, 30-year and 100-year). The 10-year rainfall depths are the basis of the proposed LRD Project drainage hydraulic design as described further below.

	Return Period (years)			
Storm Duration	**1**	**10**	**30**	**100**
5 minutes	3.6	7.3	9.9	13.7
15 minutes	5.8	12.0	16.3	22.5
30 minutes	7.8	16.1	21.9	30.2
1 hour	10.6	21.7	29.5	40.7
6 hours	22.8	46.7	63.4	87.5
12 hours	30.6	62.8	85.3	117.6

24 hours	41.2	84.5	114.7	158.2
2 days	50.8	98.4	130.4	175.3

Table 8.7 Return Period Rainfall Depths (mm) for the proposed LRD Project Site

8.3.3 Regional and Local Hydrology

The Site is located in the regional River Liffey and Dublin Bay Catchment within Hydrometric Area 09 of the Eastern River Basin District (ERBD). A regional hydrology map is shown as **Figure 8.2**.

On a more local scale the proposed LRD Site is located in the Dodder_SC_010 surface water subcatchment. The proposed LRD Site drains to the River Dodder, which is located approximately 1.85 kilometres downstream (northwest) of the Site, *via* a number of stream tributaries.

8.3.4 Project Site Existing Drainage

8.3.4.1 Drainage Regime

The proposed LRD Site is drained by a network of 2 no. tributary streams (1st/2nd order) that flow northwards in the central portion of the proposed LRD Site and along the Site's eastern boundary. These two streams merge together at the northeastern corner of the Knocklyon Wilderness and Wetland Park, to the north of the proposed LRD Site and just south of the M50, where the stream becomes culverted beneath housing estates north of the M50 in Scholarstown.

A third stream also flows northwards along the Ballycullen Road, but outside the site, and approximately 40 m west of the site boundary, a deep drainage ditch (1 m to 1.5 m deep) conduits runoff from the western portion of the site towards this, and runs along the proposed LRD Site's western boundary.

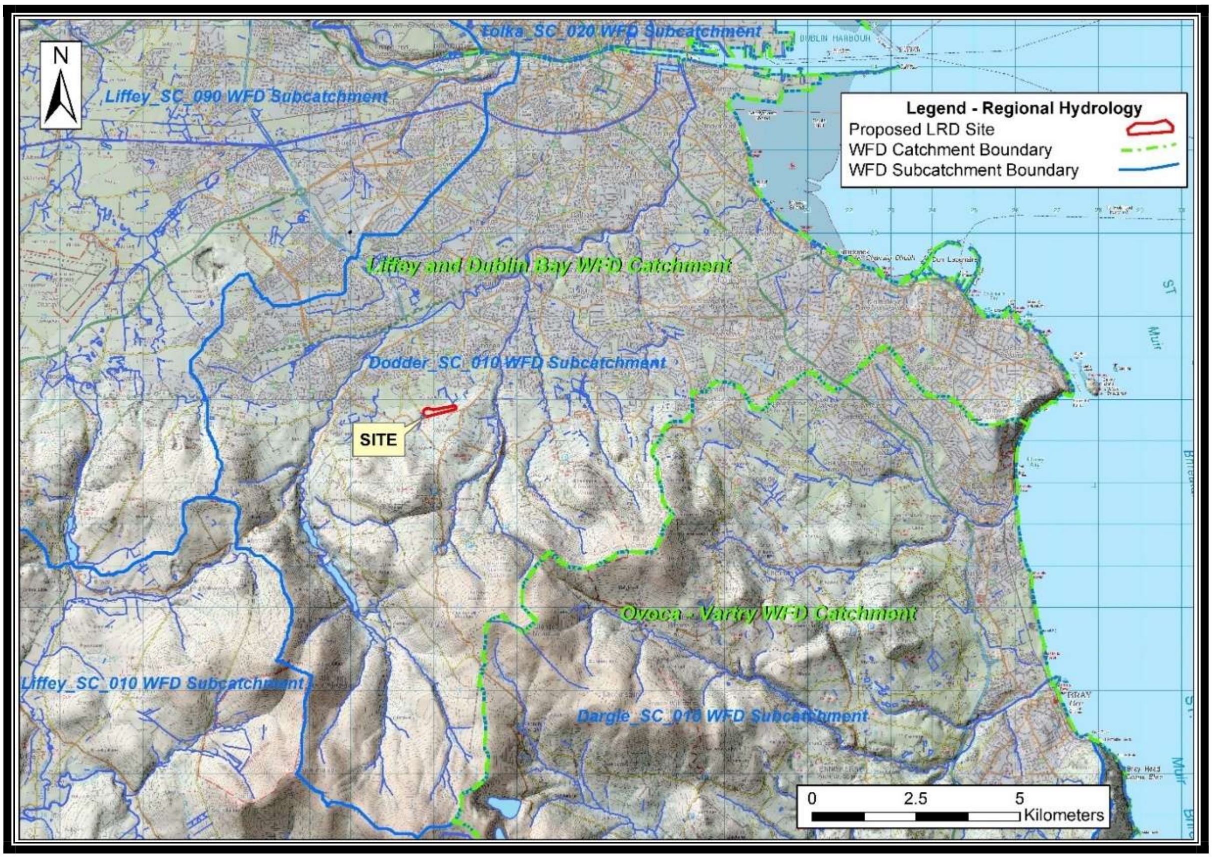


Figure 8.2 Regional Hydrology Map around the proposed LRD Site. Grid squares = 1 km distance (O.S. Licence EN 057925).

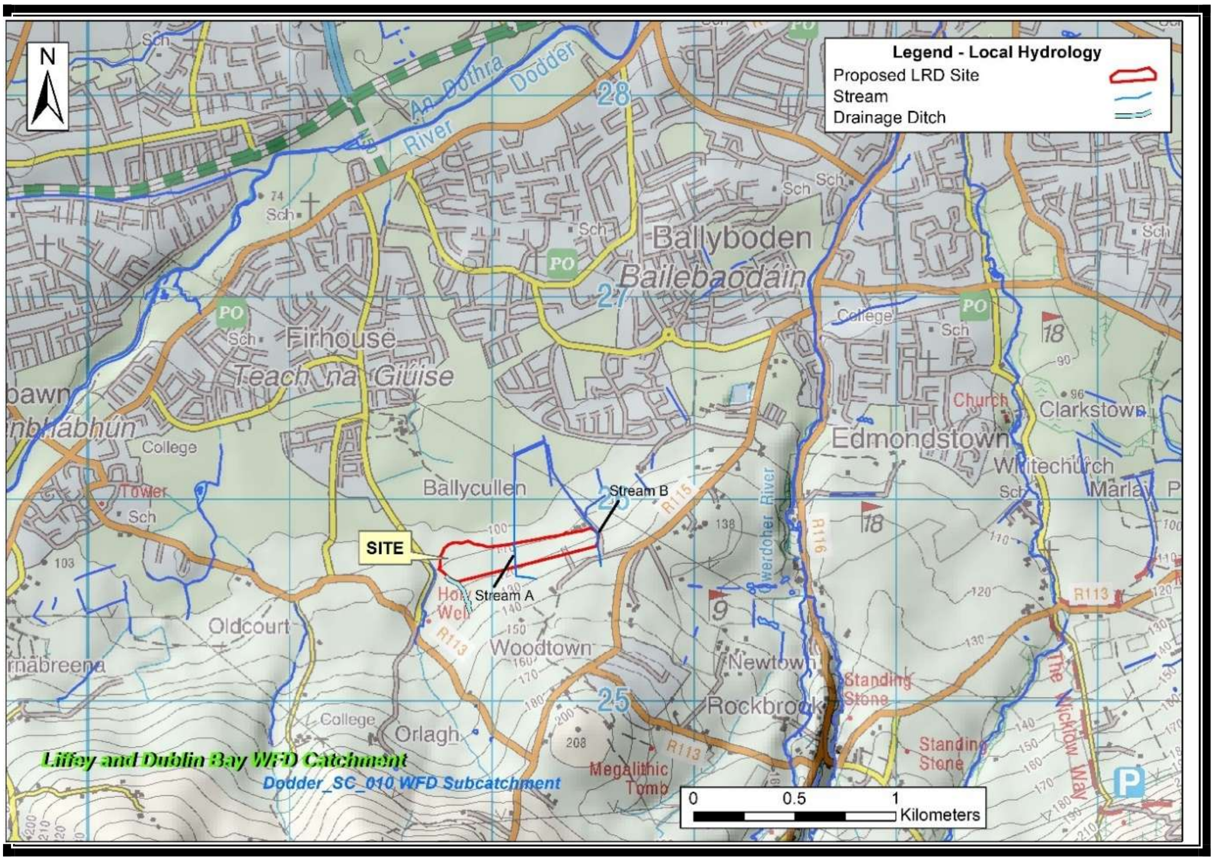


Figure 8.3 Local Hydrology Map around the proposed LRD Site. Grid squares = 1 km distance (O.S. Licence EN 057925).

A local hydrology / Site Drainage map is shown as **Figure 8.3**.

In terms of the detailed hydrological stream characteristics at the proposed LRD Site locality, the larger of the 2 no. tributary streams (referred to as Stream B, see **Figure 8.3**) draining the Site rises to the southeast of the Site and flows in a northerly direction along the eastern boundary of the Site. Approximately one-third of the area of the proposed LRD Site drains overland towards Stream B. The stream exits a culvert at the southeastern corner of the site, and enters one at the northeastern corner, where it begins passage under the Stocking Wood Manor housing development.

The second of the tributary streams (Stream A) flows into the central portion of the site from the south, and then flows northerly through the central portion of the Site before exiting the site and eventually merging with Stream B. The flow in Stream A largely comprises groundwater discharge from a spring along the Woodtown Manor road approximately 200 m to the southeast of the proposed LRD Site.

Both streams flow through channels incised into glacial till subsoil.

Aside from these two streams draining the proposed LRD Site as described above, the stream 40 m west of the Site flowing northwards along the Ballycullen Road is culverted and disappears subsurface at the entrance to the Abotts Grove Park Housing Development, and continues to flow beneath surface through a wide swathe of housing developments and 'Made' ground in Ballycullen, Firhose and Knocklyon (see **Figure 8.3**).

There are some other short (owing again to subterranean culverting) stream channels to the northeast of the site, as well as further west, and then the two main hydrological conduits in the area are the Owendoher River approximately 1 kilometre to the east, and the River Dodder approximately 1 kilometre to the northwest (**Figure 8.3**).

8.3.4.2 Surface Water Flow Measurements

Given that the site is underlain by non-karstified bedrock (see Section 3.5 in Chapter 7 "Land, Soils and Geology"), there is no possibility of losing streams or reaches along any of the surface water courses in the locality.

Flow Monitoring Location (FML) details and flow measurements for Streams A and B are shown in **Table 8.8** below. The FML locations are shown in **Figure 8.4**.

Location	Watercourse	07/11/2024	13/03/2025
		Flow (m^3/s)	Flow (m^3/s)
Flow_Loc_1	Stream A	0.00265	0.00127
Flow_Loc_2	Stream B	0.00112	0.00086
Flow_Loc_3	Stream B	0.00454	0.00271

Table 8.8 Surface Water Flow Monitoring Data for the proposed LRD Project Site

Flows were measured on 2 no. occasions (dates and flows shown in **Table 8.8** above) and all measurements for Stream B show an increase in flow at the downstream location (Flow_Loc_2 to

Flow_Loc_3) which suggests there are no detectable losing reaches along Stream B within the proposed LRD site, as would be expected given the non-calcareous and non-karstic nature of the bedrock geology. Also, as outlined in Chapter 7 “Land, Soils and Geology”, Streams A and B are underlain by glacial till subsoil which is of ‘Moderate’ subsoil permeability, and would thus have a natural barrier preventing any surface water leakage from the stream into the underlying glacial deposits/bedrock aquifer.

The depths to bedrock across the proposed LRD Site as a whole were found to be relatively deep, being a minimum of 0.4 m deep and a maximum of >4.4 m deep. The individual depths to bedrock at the trial pit point localities are shown in **Figure 7.4** of the “Land, Soils and Geology” Chapter 7.

Across the majority of the site, the till subsoil was found to be directly underlain by bedrock described as either schist or shale in the Site Investigation reports. In one trial pit (TP20, 2006) interbedded layers of SAND and GRAVEL were encountered at depth, between 1.3 m and 4.0 m below ground (and just above bedrock).

The till deposits are typically comprised of slightly sandy gravelly CLAY, with some cobbles and boulders. The confirmed depth of glacial tills in grassland areas on the proposed LRD Site are therefore between 0.4 m (TP5, 2006) and > 4.4 m deep (TP6, 2024).

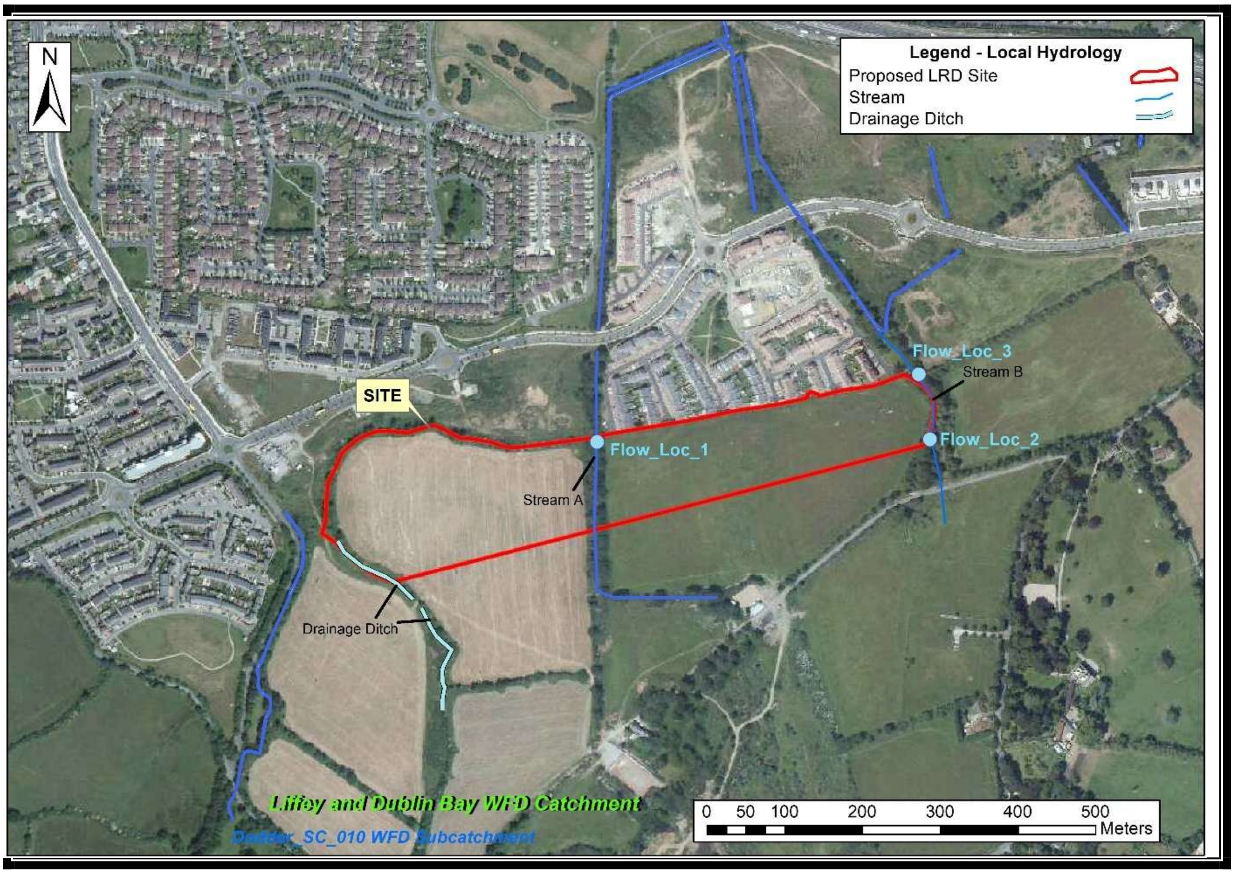


Figure 8.4 Site Drainage Hydrology Map of the proposed LRD Site and it’s environs, showing surface water monitoring locations (O.S. Licence EN 057925).

Plate 8.4 Till subsoil exposed along the banks of Stream A, flowing through thew central portion of the proposed LRD site; note again here the complete absence of bedrock outcrop along the channel sides and in the stream base.

8.3.5 Flood Risk Assessment

This section is a summary of a site-specific flood risk assessment (FRA) undertaken for the Site. The full FRA report, completed by Waterman Moylan, is enclosed with this application.

The FRA was carried out at the early design stage of the proposed LRD Project design in order to ensure as much of the proposed infrastructure was placed outside of any potential mapped flood zones.

OPW's River Flood Extents Mapping, National Indicative Fluvial Mapping, Past Flood Event mapping (https://www.floodinfo.ie/map/floodmaps/), historical mapping (i.e. 6" & 25" base maps) and GSI Groundwater/Surface Water Flood Maps were consulted to identify those areas of the Site as being potentially at risk of fluvial, pluvial and surface water flooding. A number of walkover surveys were also conducted as part of the site-specific FRA.

No recurring flood incidents within the Site boundary were identified from OPW's Past Flood Event Mapping (see **Figure 8.5**), and in fact none occur within 2 kilometres of the proposed LRD Site boundary either.

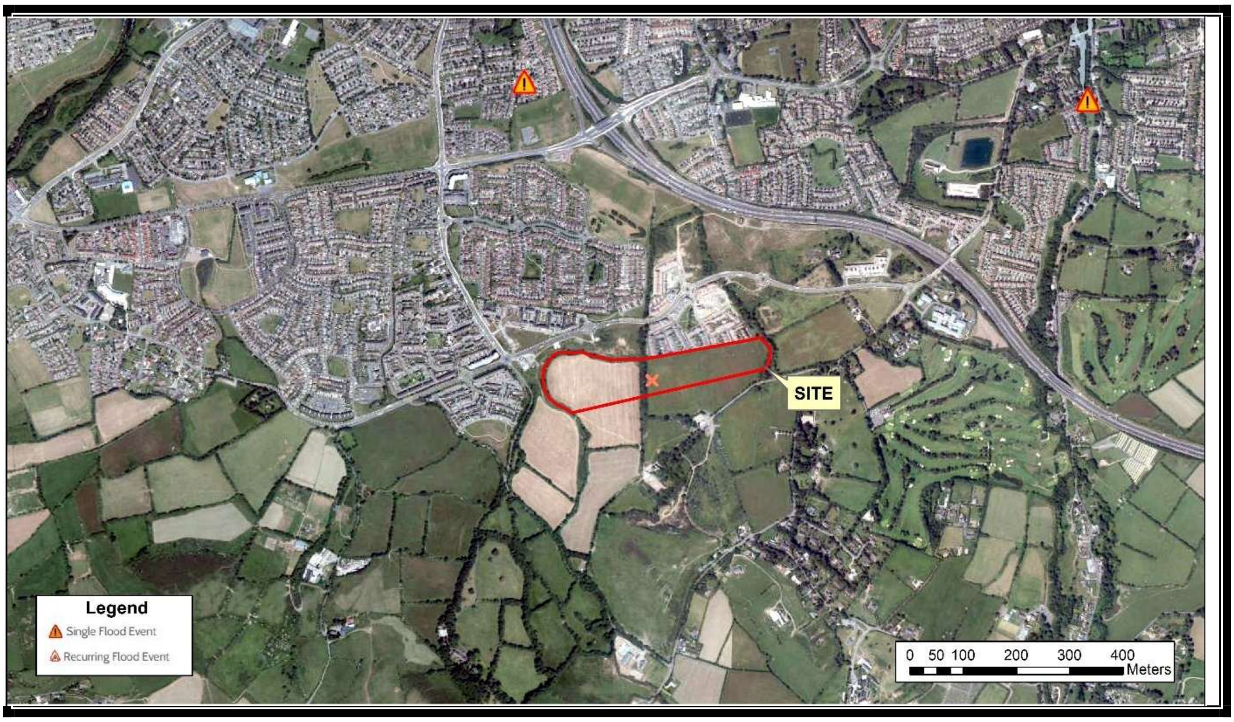


Figure 8.5 OPW Past Flood Event Mapping around the proposed LRD Site (O.S. Licence EN 057925).

The closest mapped flood events are both Single Flood Events, along the Owendoher River approximately 1.5 kilometres to the northeast of the proposed LRD Site, on Edmondstown Road in November 2000, and at Castlefield, Glenvara and Glenlyon, just under 1 kilometre north of the proposed LRD Site, in October 2011.

Figure 8.6 OPW National Indicative Flood Mapping for the region around the proposed LRD Site (O.S. Licence EN 057925).

As stated above, there are no mapped recurring fluvial flood events within 2 kilometres of the proposed LRD Site, and in particular none downstream of the proposed Site along the streams running through it or adjacent to it.

Identifiable map text on local available historical 6" or 25" mapping for the proposed LRD Site area do not identify any lands that are "Liable to Floods".

There is no OPW River Flood Extents Mapping available for the area of the Site and therefore the National Indicative Fluvial Mapping (NIFM) was consulted which has estimated current and future scenario 100-year and 1000-year fluvial flood zones for the streams adjacent to the proposed LRD Site.

Based on the National Indicative Fluvial Mapping (NIFM) as shown in **Figure 8.6** above, there are no 100-year or 1000-year flood zones associated with the environs of the site, and neither are there with any reaches of Streams A or B. The nearest most extensive mapped fluvial flooding zones occur just under 2 kilometres northwest of the site, along the River Dodder in Oldbawn.

Thus, no elements of the proposed development are located inside an NIFM flood zones.

The GSI Groundwater Flood Maps and Winter 2015/2016 Surface Water Flooding Maps have no groundwater flood zones mapped within the confines of or adjacent to the proposed LRD Site either.

All potential vulnerable LRD infrastructure, including all dwelling houses and apartments, and all ancillary site works are located above the mapped 1000-year flood level and therefore all this infrastructure is located outside any potential flood zones. This is also expected given the site elevation and topography (see also Chapter 7 "Land, Soils and Geology").

8.3.6 Surface Water Quality

In the presence of pollution, characteristic and well-documented changes are induced in the flora and fauna of surface waters. Particularly well documented are the changes brought about by organic pollution in the macroinvertebrate community i.e., the immature aquatic stages of aerial insects (mayflies, stoneflies, etc.) together with *Crustacea* (e.g., shrimps), *Mollusca* (e.g. snails and bivalves), *Oligochaeta* (worms) and *Hirudinea* (leeches) (EPA, 2005). The changes are due to the varying sensitivities of the different components of the community to the stresses caused by pollution. The EPA scheme of Biotic Indices or Quality (Q) Values uses the macroinvertebrate community structure to rank water quality. The relationship between the Q value, water quality and WFD Status is outlined in **Table 8.9**.

Biotic index	Water quality	WFD status
Q2, Q1-2, Q1	Seriously Polluted	Bad status
Q3, Q2-3	Moderately Polluted	Poor status
Q3-4	Slightly Polluted	Moderate status
Q4	Unpolluted	Good status
Q5, Q4-5	Unpolluted	High status

Table 8.9 Relationship between the Q value, water quality and WFD Status (after EPA, 2005, 2011)

The EPA monitors Q values within the Liffey and Dublin Bay Catchment at 179 monitoring stations. Neither Stream A or Stream B, which pass through the proposed LRD Site, are monitored by the EPA.

EPA Q-rating data (https://www.catchments.ie/data) are available though for the Mount Venus Road Tributary of the Owendoher River (1.2 kilometres southwest of the site) and the River Dodder at Friarstown (2.9 kilometres west-southwest of the site). Both of these sites have 'High' status river waters (Last sampling date was 1991 for both). Moving downstream along both rivers, the Q value reduces to 'Good' along the Owendoher at Edmondstown (sampled 2020), and at Oldbawn on the Dodder (sampled 2022), respectively (see **Figure 8.7** following).

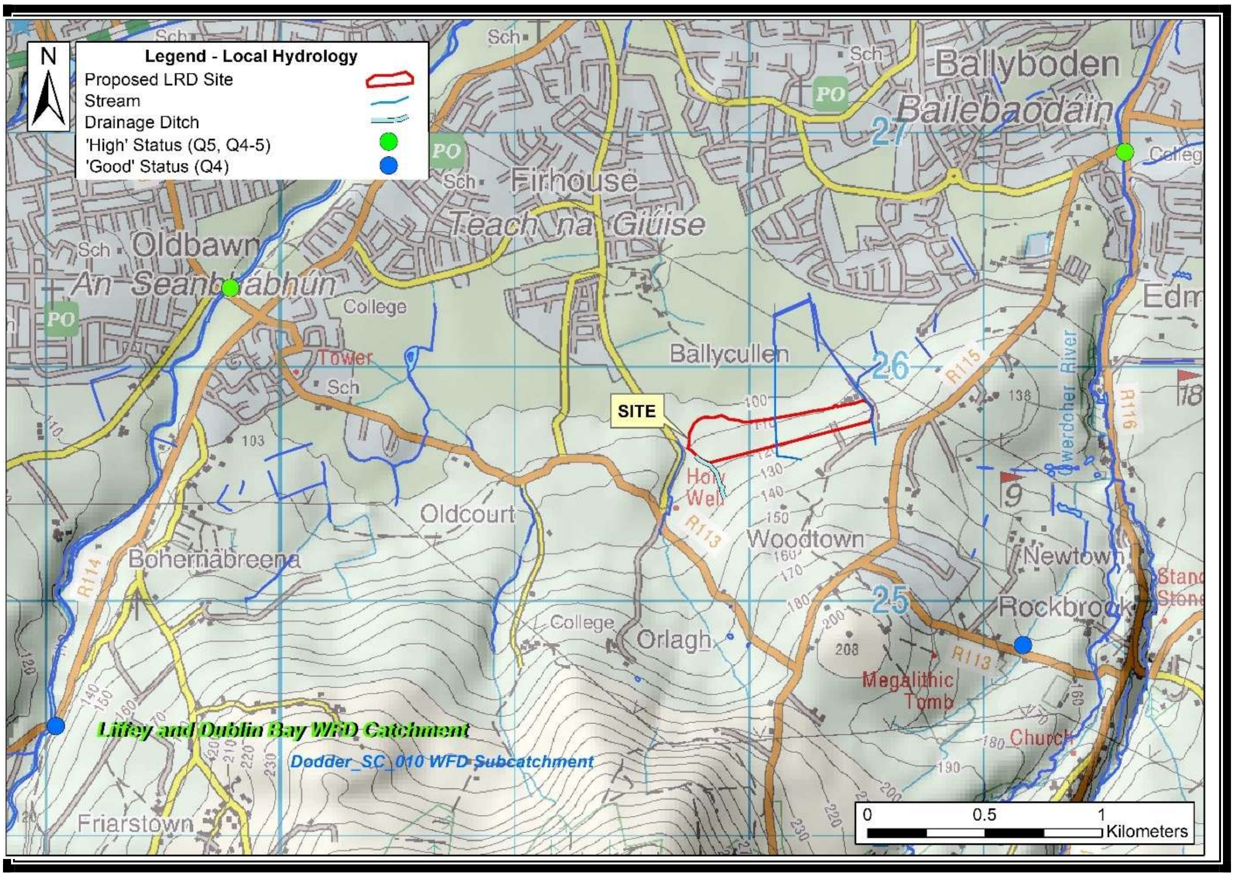


Figure 8.7 Surface water monitoring stations and Q values last recorded (1991 for 'High' status sites, 2020 / 2022 for 'Good' status sites) in the vicinity of the proposed LRD Site (O.S. Licence EN 057925).

8.3.7 Regional and Local Hydrogeology

The bedrock of the Butter Mountain Formation which underlies the Site (see Chapter 7) is classified by the GSI as a Locally Important Bedrock Aquifer – Bedrock that is Moderately Productive only in Local Zones (Ll, see **Figure 8.8**).

Groundwater is defined as water that moves through and is stored within sub-terrain geological strata. The aquifer potential of a bedrock unit is determined by the groundwater productivity, and the productivity is determined based on hydraulic characteristics compiled from borehole data throughout the country. These impure slate rocks are generally devoid of intergranular permeability. Groundwater flows through fissures, faults, joints and bedding planes.

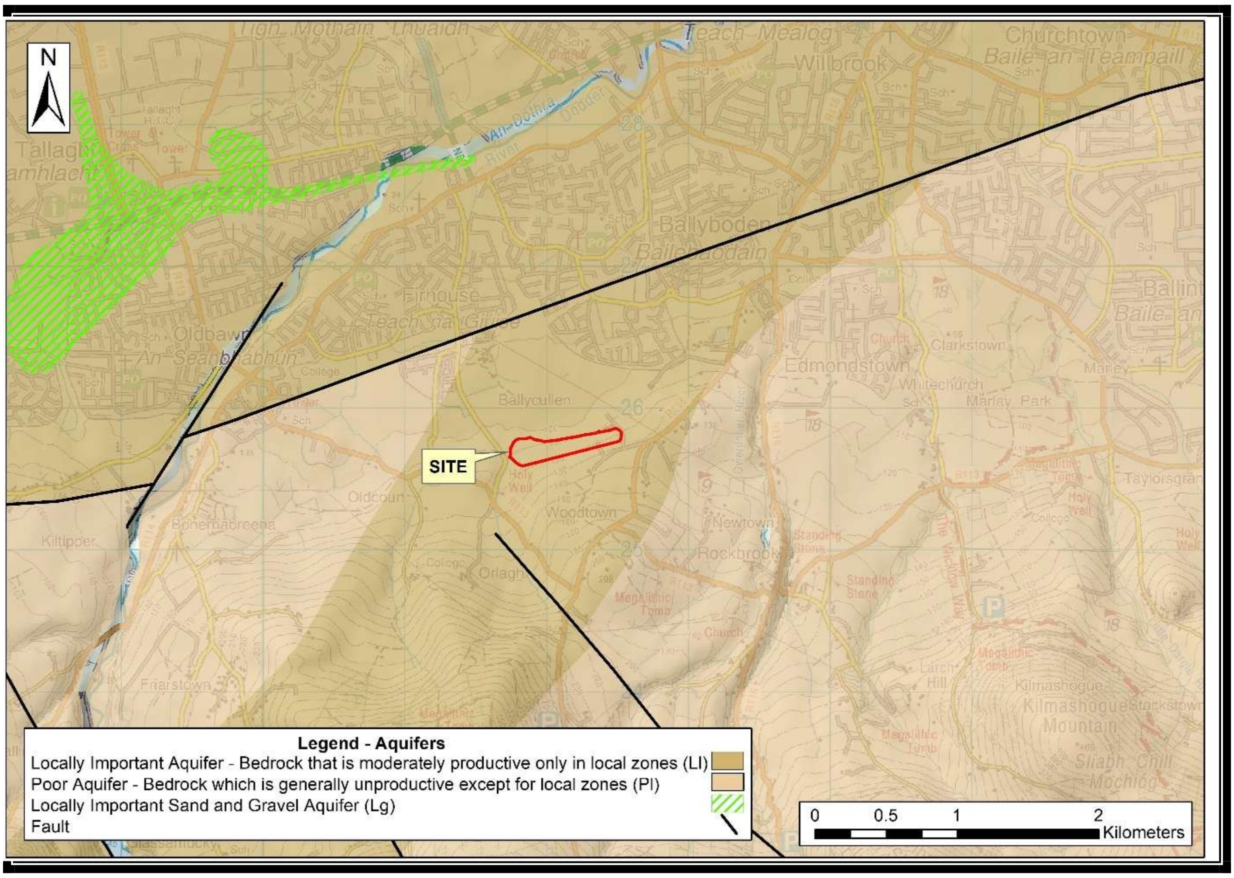


Figure 8.8 Aquifer map of the proposed LRD Site and it's environs (O.S. Licence EN 057925).

An aquifer map was published by the GSI as part of the characterisation of the Eastern River Basin District for the EU Water Framework Directive. The dark blue to grey slates of the Butter Mountain Formation are poorly permeable and relatively unproductive. The aquifer map therefore indicates that the Butter Mountain Formation is classified as a Locally Important Bedrock Aquifer – Bedrock that is Moderately Productive only in Local Zones, which is generally unproductive except for local zones (Ll, see **Figure 8.8**), where a limited and relatively poorly connected network of fractures, fissures and joints exists, giving a low fissure permeability which tends to decrease further with depth. A shallow zone of higher permeability may exist within the top few metres of more fractured/weathered rock, and higher permeability may also occur along fault zones. These zones may be able to provide larger 'locally important' supplies of water. In general, the lack of connection between the limited fissures results in relatively poor aquifer storage and flow paths that may only extend a few hundred metres.

'Karstification' is the process whereby limestone is slowly dissolved away by percolating waters. It most often occurs in the upper bedrock layers and along certain fractures, fissures and joints, at the expense of others. Karstification frequently results in the uneven distribution of permeability through the rock, and the development of distinctive karst landforms at the surface (*e.g*. swallow holes, caves, dry valleys), some of which provide direct access for recharge/surface water to enter the aquifer. The landscape is characterised by largely underground drainage, with most flow occurring through the more permeable, solutionally-enlarged, interconnected fissure/conduit zones, which may be several kilometres long. Groundwater velocities through fissures/conduits may be high and aquifer storage is frequently low. Groundwater often discharges as large springs (>2,000 m^3/d), which range from regular and dependable to highly variable ('flashy'). There is strong interconnection between surface water and groundwater. The degree of karstification ranges from slight to intense. GSI recognises two types of karst aquifer: those dominated by diffuse flow (Rkd) and those dominated by conduit flow (Rkc). As above, the bedrock aquifer beneath the proposed LRD Site locality is dominated by a poorly developed fracture flow system, and as the Butter Mountain Formation bedrock is non-calcareous, there are no karst features anywhere within several kilometres of the site.

In areas underlain by 'Locally Important' aquifers, groundwater flow directions broadly follow topography. Thus, in the area of the proposed LRD Site, groundwater would flow generally northwards.

The proposed LRD Site is also located in the Kilcullen Groundwater Body (IE_EA_G_003) which has a mapped surface area of 630.49 km^2 (see **Figure 8.9** following).

The bedrock type of the Kilcullen GWB is predominantly either Granites of the Leinster Chain or Silurian or Ordovician Metasediments, the latter which also underlies the proposed LRD Site.

The Groundwater body summary sheet, produced by the GSI for the Kilcullen Groundwater Body, of which the Ballycullen proposed LRD Site forms part, states that there are no large scale abstractions in the area around the site.

The majority of groundwater flow in this aquifer will thus take place in the upper 3 m of the bedrock. This will be lateral flow towards discharge point such rivers and streams. Deeper groundwater flow is possible and deep-water strikes are often encountered (between 10 and 40 m bgl) but they are more isolated features located along open fractures, which allow groundwater flow. Regional groundwater flow paths are not considered to develop, as the rocks do not have sufficient transmissivity to transport water over long distances. Typical groundwater flow paths will be in the order of a couple of hundred metres, with discharge occurring to the closest surface water feature.

Overall, groundwater flow directions within the GWB are reported to be towards the north, with all groundwater flowing towards and discharging to the River Liffey (GSI, 2004).

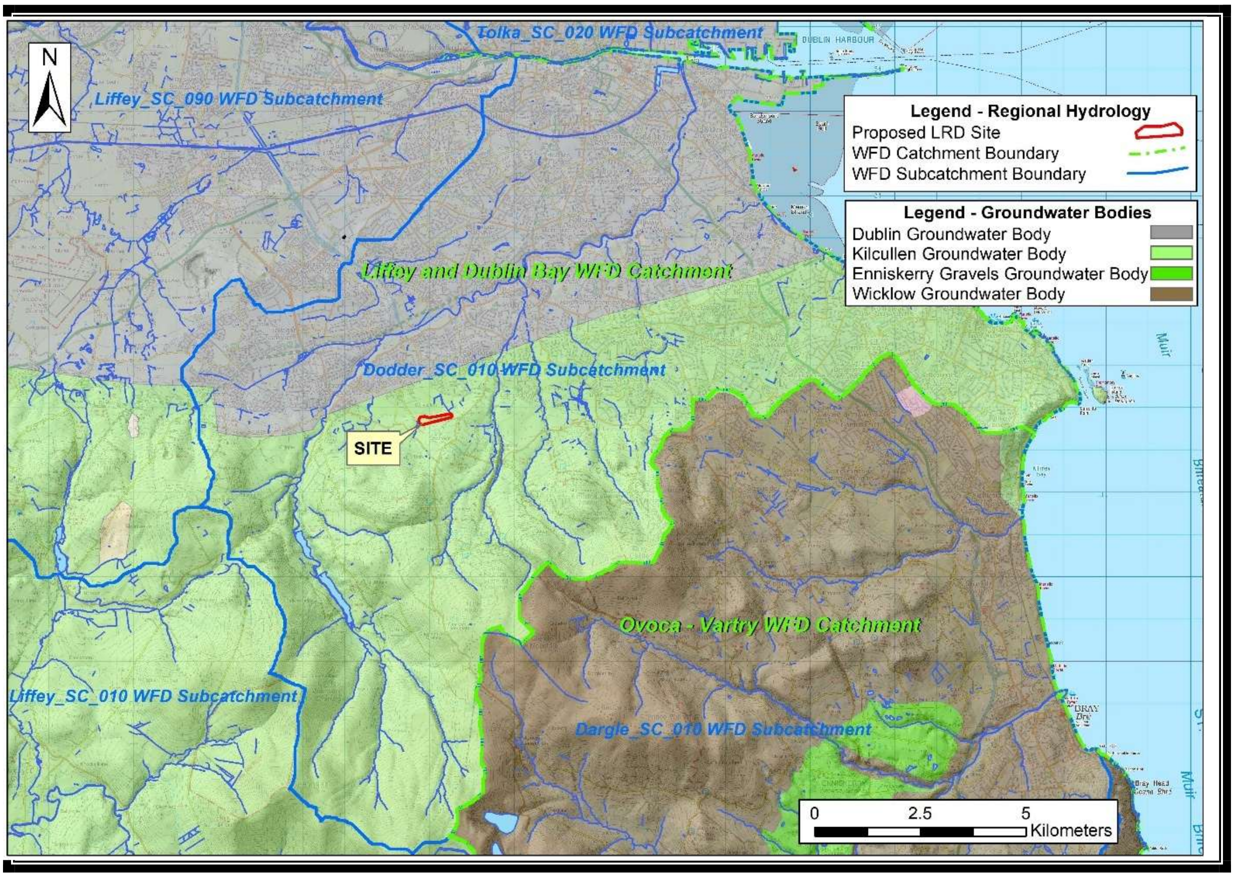


Figure 8.9 Groundwater Bodies (GWBs) around the proposed LRD Site, with surface water catchments and subcatchments also shown (O.S. Licence EN 057925).

Diffuse recharge occurs over the GWB via rainfall percolating through the permeable subsoil, and this type of recharge is dominant in this GWB.

There are no GSI mapped groundwater Source Protection Areas (SPAs) within 3 kilometres of the Site relating to Group Water Scheme (GWS) or Public Water Supply (PWS) sources.

It is also worth noting that the overall surface water drainage pattern of stream A and Stream B flowing through and/or within the proposed LRD Site, and in the general area of the site, is in a northerly direction.

8.3.8 Site Hydrogeology

8.3.8.1 Introduction

Refer to the Land, Soils, and Geology (Chapter 7) for more comprehensive information relating to the intrusive site investigations conducted at the Site.

In order to determine the full geological profile (soil, subsoil and bedrock) at the proposed LRD Site, extensive ground investigations were carried out in September 2006 and February 2024 to determine the geological and hydrogeological setting of the proposed LRD Site.

A total of 26 no. deep trial pits excavated inside the proposed LRD Site boundary, and 2 no. excavated just outside of it at the southeast, to determine the thickness and geomorphology of mineral subsoils overlying the Site. Of these, 20 no. trial pits were dug in 2006, with a further 8 no. in 2024.

Figure 8.10 Location of trial pits excavated across the proposed LRD Site area.

Trial pit logs are attached as Appendix 7-1 in the "Land, Soils and Geology" Chapter, and the locations of the investigation points are shown on **Figures 10** and **11**. Refer to **Table 10** for a summary of the investigation trial pitting.

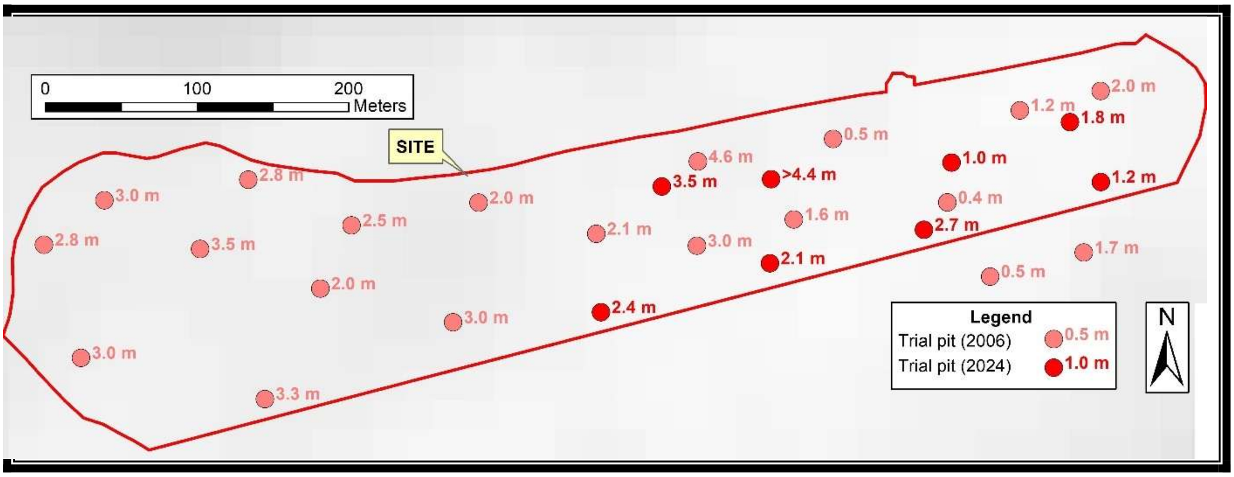


Figure 8.11 Point depths to bedrock at trial pit localities excavated across the proposed LRD Site area.

8.3.8.2 Site Investigation Summary

Bedrock was confirmed in 27 of the 28 trial pits excavated on the site.

Water table was met in one trial hole excavated during infiltration testing at the site, in the western extreme of the site (Trinity Green, 2020). The water level was at 1.4 m bgl and mottling was observed above this to 1.0 m depth below ground. Trinity Green considered that this was a localised, perched water table. 'Trickles' of water were also met in two trial holes at the eastern extreme of the site (Waterman Moylan, 2024). As both of these localities are relatively low-lying and close to expected discharge zones near watercourses, this is expected. It is also expected that water might be perched above the bedrock in the winter time, given the 'Poor' Aquifer status of the bedrock beneath the site (see Section 8.3.7 above).

The depths to bedrock across the proposed LRD Site as a whole were found to be relatively deep, being a minimum of 0.4 m deep but a maximum of >4.4 m deep. The individual depths to bedrock at the trial pit point localities are shown in **Figure 8.11**.

Across the majority of the site, the till subsoil was found to be directly underlain by bedrock described as either schist or shale in the Site Investigation reports. In one trial pit (TP20, 2006) interbedded layers of SAND and GRAVEL were encountered at depth, between 1.3 m and 4.0 m below ground (and just above bedrock).

The till deposits are typically comprised of slightly sandy gravelly CLAY, with some cobbles and boulders (**Table 8.5**).

The confirmed depth of glacial tills in grassland areas on the proposed LRD Site are therefore between 0.4 m (TP5, 2006) and > 4.4 m deep (TP6, 2024). In contouring the depths to bedrock, the subsoil depths deepen generally westwards across the proposed LRD Site, and there does seem to be a bedrock 'high' where bedrock is generally close to the surface in the east central portion of the site (**Figure 8.12**). This bedrock deepens rapidly to deep depth of over 4 m in the east central portion of the site (**Figure 8.12**).

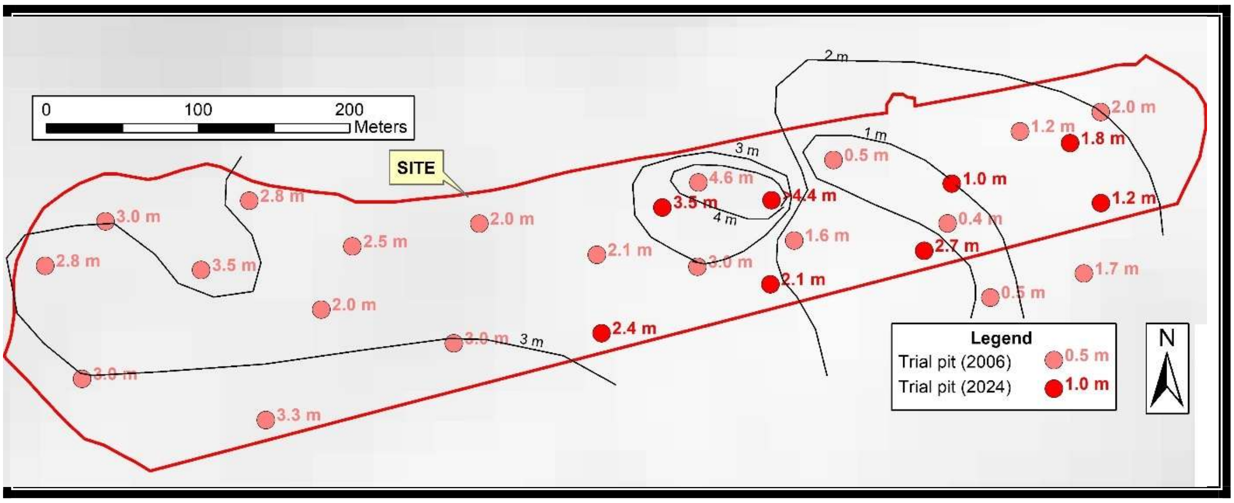


Figure 8.12 Interpreted depth to bedrock contour map across the proposed LRD Site area.

As the proposed LRD Site is entirely underlain by mineral subsoil, no peat probing to determine peat thickness or morphology / composition was required to be carried out across the site.

All depths to bedrock have been considered in the proposed finished floor levels, and associated cut and fill element for site preparation, across the site, and the deepest areas of cut, in the east central, north central and southwestern portions of the site (4.846 m bgl, 3.148 m bgl and 2.198 m bgl) have all been sited in the localities with the deepest soil and subsoil above bedrock (see detail in accompanying sheets of Cut and Fill Analysis by Waterman Moylan). Thus, it is envisaged that minimal elements of excavation to and into the bedrock substrate will be completed during construction works on the site.

No drilling was undertaken on the site to characterise the subsurface deep substrate, as all of the proposed houses and apartments on the LRD site will be constructed at a shallow depth only, and no cut and fill will be completed below depths of 5 m below ground level.

As can be seen from the trial pit results (Table 10), there is no recorded confining layer between the glacial till deposits and the underlying weathered bedrock/competent bedrock layers. As such the interpretation is that the bedrock and glacial till deposits are connected, albeit that connection is somewhat limited by the moderate permeability characteristics recorded in the glacial till deposits.

Location	Date excavated	Depth of trial pit (m)	Depth to bedrock (m)	Glacial till thickness (m)	Glacial till description
TP1	21st September 2006	2.20	2.00	2.00	slightly sandy silty gravelly CLAY
TP2	21st September 2006	2.00	1.70	1.70	slightly sandy silty gravelly CLAY
TP3	21st September 2006	1.90	1.20	1.20	slightly sandy gravelly CLAY
TP4	21st September 2006	1.50	0.50	0.50	slightly sandy gravelly CLAY/SILT
TP5	21st September 2006	0.90	0.40	0.40	sandy gravelly SILT
TP6	21st September 2006	1.40	0.50	0.50	sandy CLAY
TP7	21st September 2006	2.00	1.60	1.60	sandy gravelly CLAY
TP8	21st September 2006	3.90	3.00	3.00	slightly sandy silty gravelly CLAY
TP9	21st September 2006	4.90	4.60	4.60	slightly sandy silty gravelly CLAY
TP10	21st September 2006	3.30	2.10	2.10	slightly sandy gravelly CLAY
TP11	21st September 2006	3.70	2.00	2.00	sandy gravelly CLAY
TP12	21st September 2006	3.40	3.00	3.00	slightly sandy gravelly CLAY
TP13	21st September 2006	3.80	2.50	2.50	sandy gravelly CLAY
TP14	21st September 2006	3.00	2.00	2.00	slightly sandy gravelly CLAY
TP15	21st September 2006	3.80	3.30	3.30	sandy gravelly CLAY
TP16	21st September 2006	3.80	3.50	3.50	slightly sandy gravelly CLAY
TP17	21st September 2006	3.50	2.80	2.80	sandy gravelly CLAY
TP18	21st September 2006	3.50	3.00	3.00	sandy gravelly CLAY
TP19	21st September 2006	3.50	3.00	3.00	slightly sandy slightly gravelly CLAY
TP20	21st September 2006	4.00	2.80	1.30	sandy gravelly CLAY over SAND/GRAVEL
TP1 ('24)	16th February 2024	3.60	1.20	1.20	No description given
TP2 ('24)	16th February 2024	2.00	1.80	1.80	No description given
TP3 ('24)	16th February 2024	1.10	1.00	1.00	No description given
TP4 ('24)	16th February 2024	3.10	2.70	2.70	No description given
TP5 ('24)	16th February 2024	2.60	2.10	2.10	No description given
TP6 ('24)	16th February 2024	4.40	>4.40	>4.40	No description given
TP7 ('24)	16th February 2024	3.80	3.50	3.50	No description given
TP8 ('24)	16th February 2024	2.80	2.40	2.40	No description given

Table 8.10 Summary depth to bedrock and subsoil data from trial pitting across the proposed LRD Site

Given that all trial pits on the site were backfilled following excavation, no medium or long-term groundwater level monitoring was carried out on the site. As all trial pits were dry, excepting the locality with the perched water unit in the western extreme of the site, it is assumed that groundwater levels are generally at depths below 3 m – 4 m across the entire proposed LRD Site area.

8.3.8.3 Groundwater Levels and Flows

Given that the depths to groundwater table across the site are all well below the level of foundations / cuttings / incisions in to the subsurface on the site, and as the potential impacts of the proposed LRD development on the groundwater in the locality will be low, no groundwater level monitoring network was established at the site.

Nonetheless, information determined by the intrusive investigations across the site, and known, on groundwater levels and flows, can ne summarise as follows:

- Any perched water levels within the till subsoils are isolated from the underlying, deep groundwater system;
- There is a low density of manmade drains and natural watercourses draining the ground surface of the proposed LRD Site;
- There are significant depths of overburden (glacial tills) recorded above the bedrock across the majority of the proposed LRD site;

- Groundwater levels below the subsoils and below the grassland areas remain at depth throughout the year; and,
- There is no significant underground drainage occurring because of the absence of karstified bedrock.

In addition, this indicates that there is substantive recharge/vertical groundwater flow from the glacial deposits down into the underlying bedrock aquifer at the proposed LRD site. This is also confirmed by the low stream density and man-made drainage density at the Site. The general absence of these implies there is no need to drain surface water, as it can recharge/drain readily to the underlying locally important groundwater system.

Therefore, the majority (60% based on GSI recharge rates) of the rainfall that infiltrates into the glacial tills at the site is more likely to move laterally at depth and discharge into the local streams that flow through the proposed LRD Site (i.e. Streams A and B) having recharged vertically into the underlying bedrock aquifer.

8.3.9 Groundwater Vulnerability

Groundwater vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities. The vulnerability category is based on the relative ease with which infiltrating water and potential contaminants may reach groundwater in a vertical or sub-vertical direction. The permeability and thickness of the subsoil, which influence the attenuation capacity of subsoil, are important aspects in determining the vulnerability of groundwater.

A groundwater protection scheme has been completed at a scale of 1:40,000 for South County Dublin by Geological Survey Ireland, and the groundwater vulnerability of the area around the proposed LRD Site has been determined on a precise empirical basis.

With respect to depth-to-bedrock, the proposed LRD Site is situated in an area where bedrock is mapped as being greater than 3 m and less than 5 m from the land surface, while the depth to bedrock is interpreted to increase towards the north into the lowlands. Thus, the depth-to-bedrock at the proposed LRD Site is interpreted to be at least 3 m thick by the GSI, increasing to 5 m and eventually to 10 m at the western extremity of the site. With such a depth-to-bedrock, the groundwater vulnerability is interpreted to range from 'High' to 'Low' (**Figure 8.13)**. Given the depths to bedrock encountered across the site during the Site Investigations (Trinity Green, 2020; Waterman Moylan, 2024) , this vulnerability rises to 'Extreme' or 'High' in a site-specific scale. Hence the design of the proposed LRD ensures no deep excavations into the bedrock across the site.

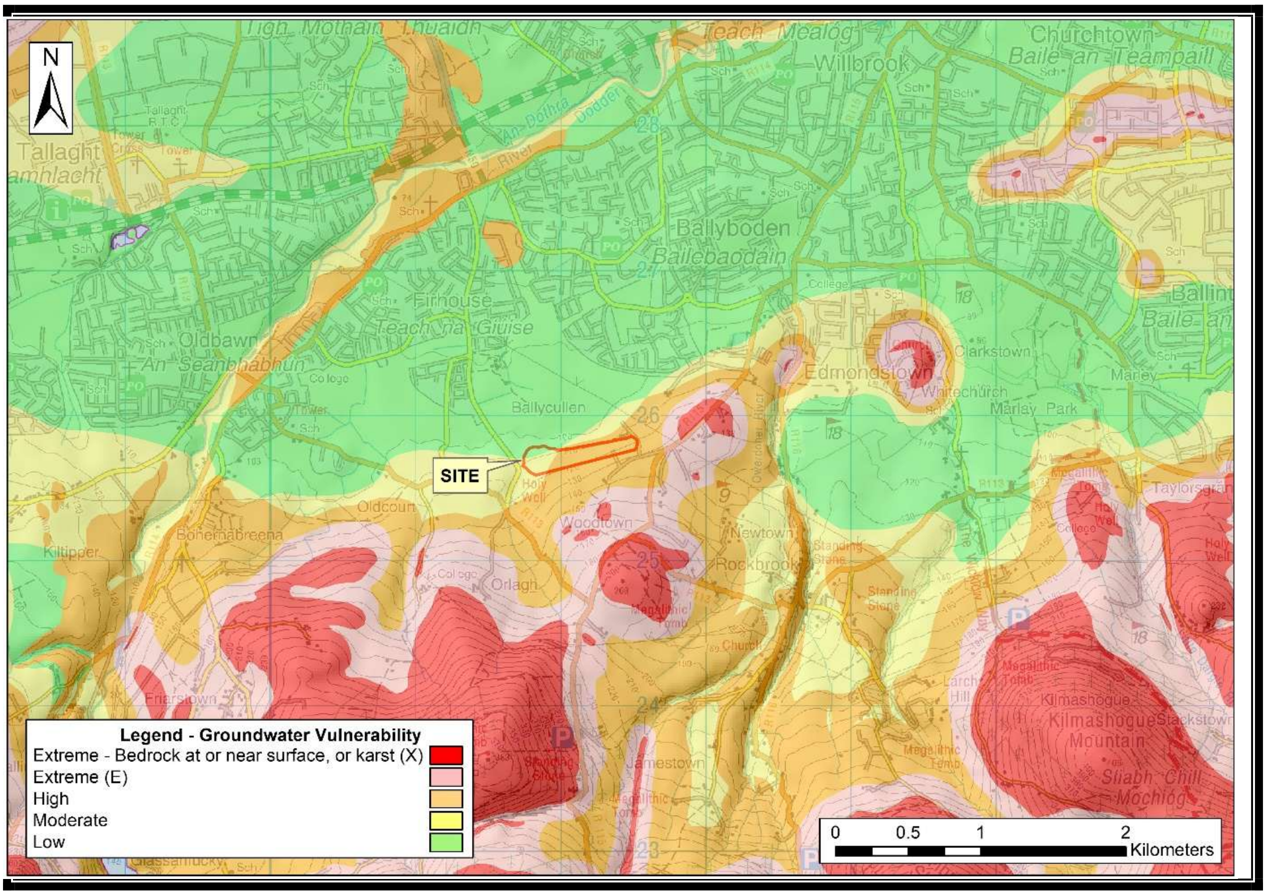


Figure 8.13 Groundwater Vulnerability map of the site and its environs (after www.gsi.ie)

8.3.10 Groundwater Quality Hydrochemistry

No groundwater sampling was carried out anywhere within the site confines, as the proposed development will all be sited above, and will not affect, the groundwater table beneath the site.

8.3.11 Groundwater Body and Status

The descriptions of groundwater bodies throughout Ireland are available from the GSI website: www.gsi.ie and the ‘status’ is obtained from the EPA Catchments / Water Framework Directive website: www.catchments.ie.

The subject site and the surrounding localities are located within the Kilcullen Groundwater Body which is categorised at ‘Good Status’ by the EPA, which is defined based on the quantitative status and chemical status of the GWB. The assigned risk status (WFD 3rd Cycle) is ‘At Risk’. The main groundwater pressures are reportedly due to agriculture and other anthropogenic pressures.

8.3.12 River Water Body Status, and Risk

The Local River and Stream Waterbody status and WFD risk classification are available from (www.catchments.ie) and are summarised in **Table 8.11** below. These risk classifications are also shown on **Figure 8.13** following.

European Code	SWB Name	Ecological Status	Overall Status	Risk Status	Pressure Category
IE_EA_09D010620	Dodder_040	Moderate	Moderate	At Risk	Hydromorphology

Table 8.11 River Waterbody Status and Risk near the proposed LRD Site

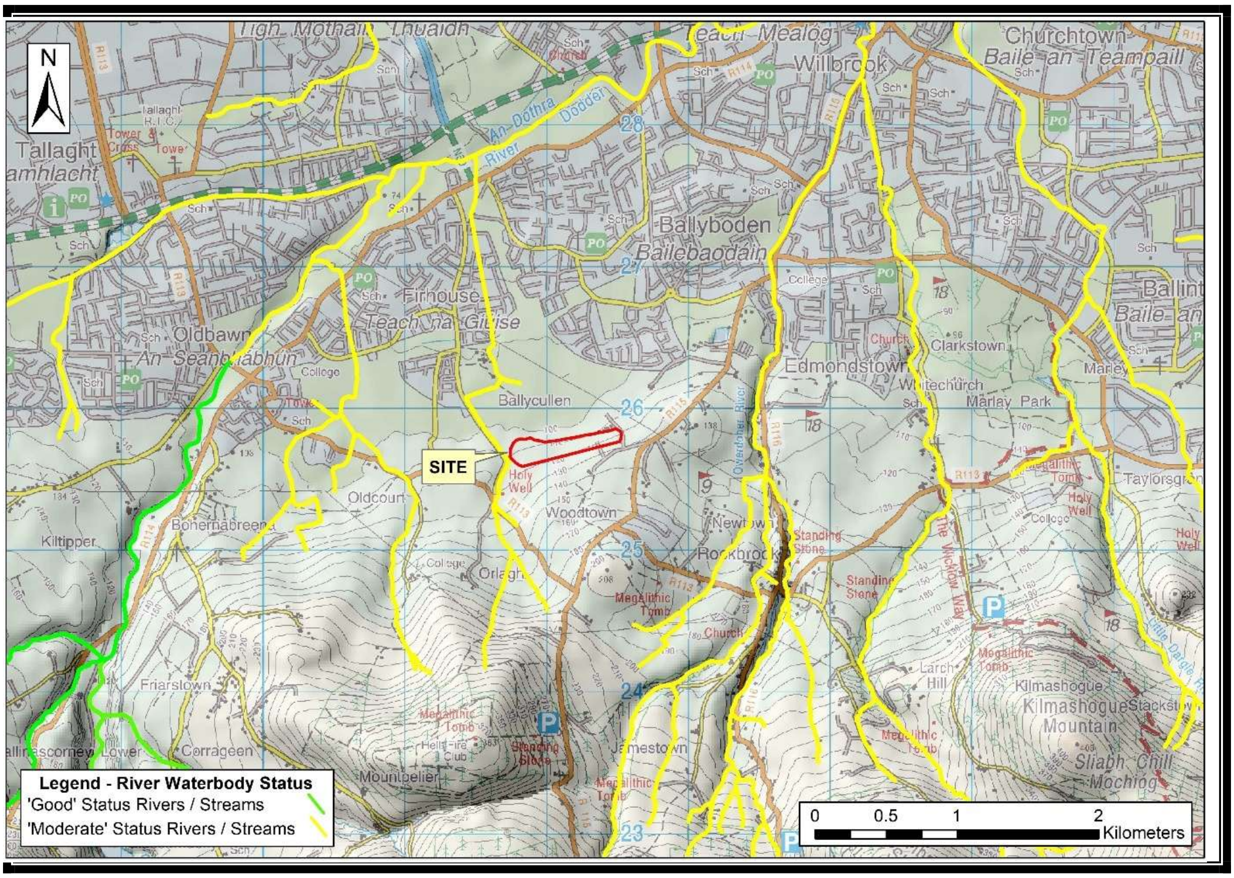


Figure 8.14 River Waterbody Status around the proposed LRD Site (after www.epa.ie). Note that only the culverted stream at the western end of the site is included in the EPA's Monitoring Programme for the locality / area, and the streams flowing through the site (Streams A and B of Figure 4) are not monitored by the EPA.

Table 8.11 and **Figure 8.14** above gives summary details of the river waterbodies in which the Proposed LRD Site are directly located.

The proposed LRD Site is wholly located within the Dodder_040 sub-basin.

In terms of Surface Waterbody River Risk Status, the majority of the rivers and streams around the site are 'At Risk', with only the Dodder itself and some of It's tributaries 'Not at Risk' or under 'Review' (see **Figure 8.15** following).

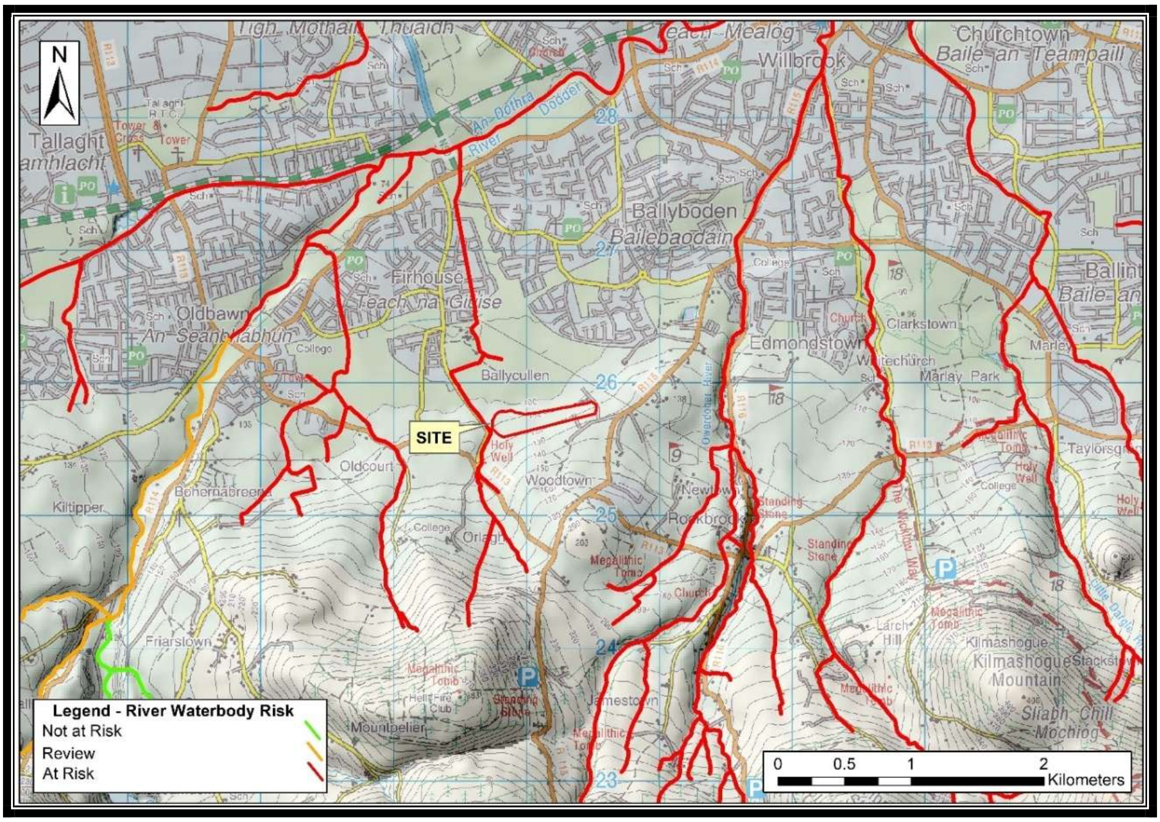


Figure 8.15 River Waterbody Risk around the proposed LRD Site (after www.epa.ie). Note again that only the culverted stream at the western end of the site is included in the EPA's Monitoring Programme for the locality / area, and the streams flowing through the site (Streams A and B of Figure 4) are not monitored by the EPA.

8.3.13 Designated Sites and Habitats

As iterated in Chapter 7 "Land, Soils and Geology", under the Irish legal framework specified habitats and species, and areas which contribute surface water or groundwater resources to drinking water, are given various levels of protection to maintain both healthy and sustainable ecosystems and drinking water. These include Natural Heritage Areas (NHAs), Proposed Natural Heritage Areas (pNHAs), Special Areas of Conservation (SAC) and Special Protection Areas (SPAs) (see **Figure 8.16** following).

The closest designated site to the proposed LRD Site is the Wicklow Mountains SPA which is just under 4 kilometres southeast of the site, and on higher ground there.

The Proposed Natural Heritage Areas of the Dodder Valley and the Glenasmole Valley occur just over 1.75 kilometres northwest and 3 kilometres west-southwest of the proposed LRD Site respectively.

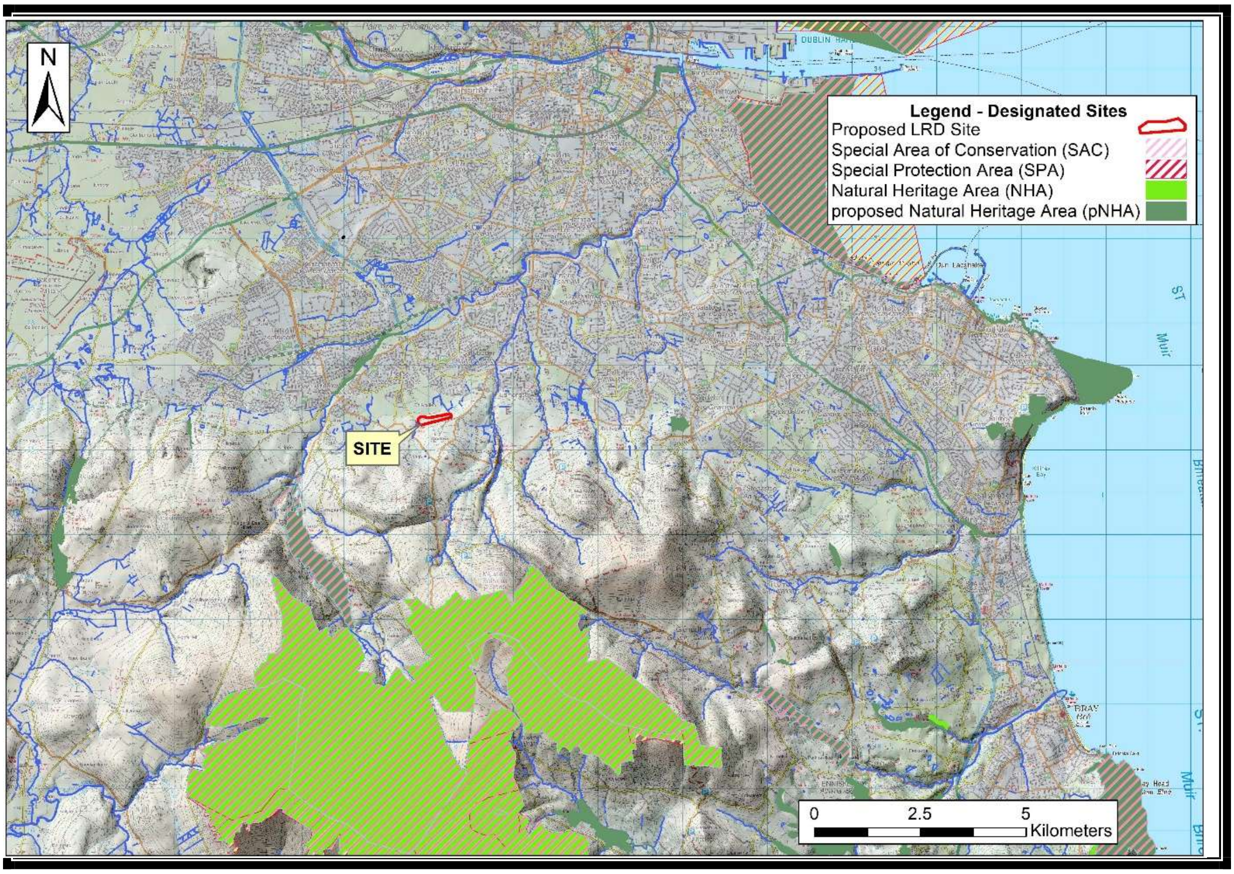


Figure 8.16 Designated Sites around the proposed LRD Site (datasets downloaded from www.npws.ie)

8.3.14 Water Resources

8.3.14.1 Public / Group Water Schemes

Public supply mains water supplies all of the area around the proposed LRD Site (see **Figure 8.17** following), and will also supply water to the Site.

There are no GSI mapped groundwater Source Protection Areas (SPAs) within 15km of the proposed LRD site relating to Group Water Scheme (GWS) or Public Water Supply (PWS) sources.

8.3.14.2 Private / Domestic Wells

A search of private well locations on GSI well database (www.gsi.ie) reveal no mapped private wells within 3 km of the Site.

In order to be conservative and following the worst case assumptions, it has been assumed that all dwellings in the surrounding lands not supplied by Mains Water have a private groundwater well. A number of private dwelling houses were identified along the local roads to the southeast and east of the proposed LRD Site (generally in the area to the south that is outside the area identified in **Figure 8.17** as being suppled by Public Supply Mains water, and is also up-gradient with respect to groundwater flow)

A field-scale assessment of private wells in the lands surrounding the Site has been completed and the closest well is approx. 150m south of (and up-gradient of) the proposed LRD Site.

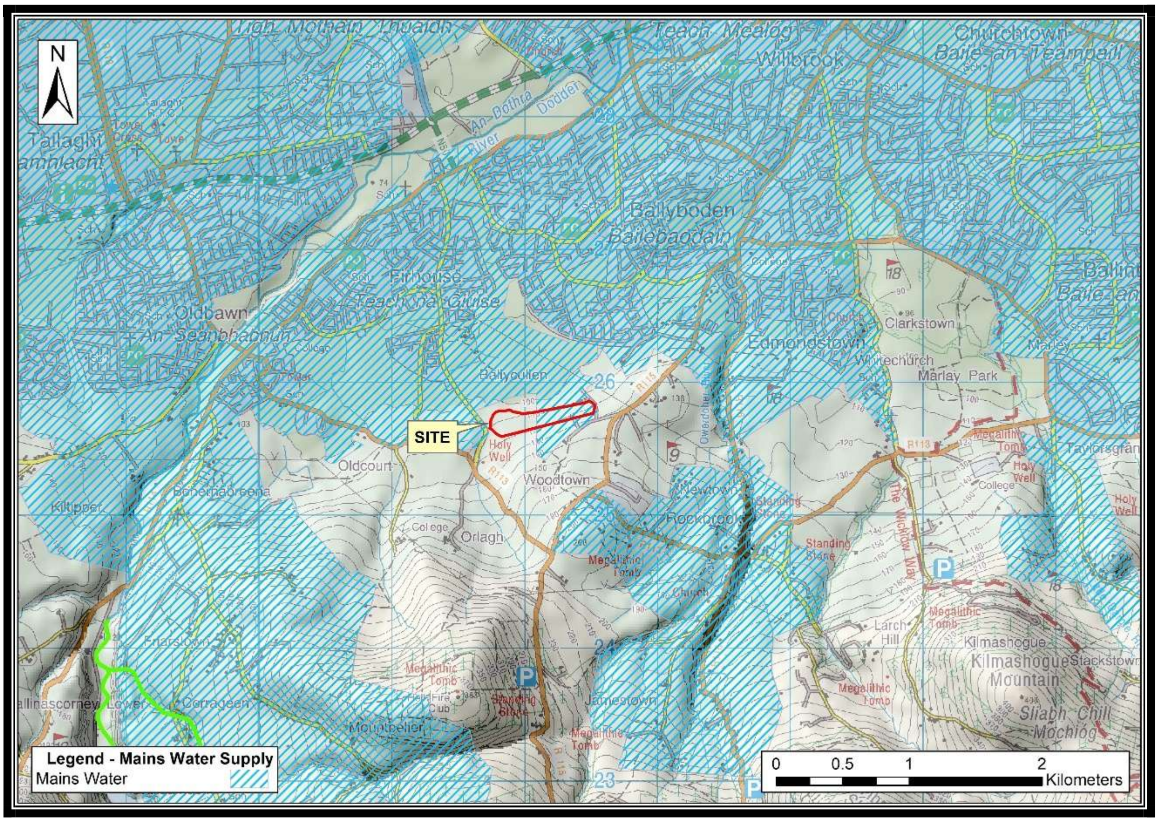


Figure 8.17 Areas supplied by Public Supply Mains water in the vicinity of the proposed LRD Site. Note that there are no Source Protection Zones or Zones of Contribution to groundwater wells or springs in the area of the map; neither are there any surface water Drinking Water Protected Areas.

8.3.14.3 Surface Water Resources

There are no river waterbodies in the vicinity of the proposed LRD Site which are identified as Drinking Water Protected Areas (DWPAs).

8.3.15 Receptor Sensitivity

Due to the nature of proposed LRD developments being near surface construction activities, impacts on groundwater are generally negligible and surface water is generally the main sensitive receptor assessed during impact assessments. The primary risk to groundwater at the Site would be from hydrocarbon spillage and leakages into excavations.

These are common potential impacts to all construction sites (such as road works and industrial sites). These potential contamination sources are to be carefully managed at the Site during the construction and operational phases of the development and mitigation measures are proposed below to deal with these potential minor impacts.

It is acknowledged that the Site is underlain by a Locally Important Aquifer, and the groundwater vulnerability rating of the Site ranges from Low to High. This is because the majority of the Site is covered by moderate permeability subsoil which is at least 3m thick. Thus, the relatively deep glacial deposits act as a protective cover to the underlying aquifer.

Any contaminants which may be accidentally released on-site are more likely to travel to nearby streams within surface runoff. The deep and moderate permeability of the glacial deposits means contaminants are unlikely to reach the bedrock and will instead disperse with the glacial deposits and would remain localised to the source or would be removed as runoff during wet periods.

The EIAR acknowledges that there are no sensitive water supply sources within the vicinity of the site. Furthermore, there are no hydraulic pathways between the Site and any Public Water Supply or Group Scheme Sources, or domestic wells (none occur down-gradient).

Mitigation measures will ensure that surface runoff from the developed areas of the Site will be of a high quality and will therefore not impact on the quality of downstream surface water bodies. Any introduced drainage works at the Site will mimic the existing hydrological regime thereby avoiding changes to flow volumes leaving the Site.

The large setback distance from sensitive hydrological features means they will not be impacted by excavations/drains etc. It also allows adequate room for the proposed drainage mitigation measures (discussed below) to be properly installed up-gradient of primary drainage features. This will allow attenuation of surface runoff to be more effective.

8.4 CHARACTERISTICS OF THE PROPOSED PROJECT

The proposed LRD Project construction will mainly involve removal of soils and mineral subsoils for access roads, underground cabling and pipework, hardstanding areas, house, duplex and simplex foundations, a construction compound and drainage works. Crushed rock for construction purposes will be sourced off-site from nearby commercial quarries.

The main characteristics of the proposed LRD Site could impact on hydrology and hydrogeology are the excavation of foundations and the ‘cut and fill’ sequence across the site.

Welfare facilities will be provided at the proposed LRD Site, along with a temporary construction compound.

8.4.1 Proposed Drainage Management

Runoff control and drainage management are key elements in terms of mitigation against impacts on surface water bodies. Two distinct methods will be employed to manage drainage water within the proposed LRD Site. The first method involves ‘keeping clean water clean’ by avoiding disturbance to natural drainage features, minimising any works in or around artificial drainage features, and diverting clean surface water flow around excavations, construction areas and temporary storage areas.

The second method involves collecting any drainage waters from works areas within the proposed LRD Site that might carry silt or sediment, and nutrients, to route them towards stilling ponds prior to controlled diffuse release over vegetated surfaces. There will be no direct discharges to surface waters.

During the construction phase all runoff from works areas (i.e. dirty water) will be attenuated and treated to a high quality prior to being released.

Due to the high to low groundwater vulnerability rating of the Site, and the absence of extensive areas of 'Extreme' groundwater vulnerability, and the poor surface water and bedrock aquifer interaction, no special design requirements are needed to prevent the ingress of surface water drainage into the groundwater system.

It is vital that there is no deterioration in water quality in the streams that occur within the application site. This will protect both habitats and species that are sensitive to pollution. Therefore, strict controls of erosion, sediment generation and other pollutants associated with the construction process should be implemented, including the provision of attenuation measures, silt traps or geotextile curtains to reduce and intercept sediment release into any local watercourses. Guidelines in the following best practice documents should be adhered to:

- Construction Industry Research and Information Association (CIRIA) (2005) Environmental Good Practice on Site (C692)
- Construction Industry Research and Information Association (2001) Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors (C532)
- Construction Industry Research and Information Association (2000) Environmental Handbook for Building and Civil Engineering Projects (C512)
- Environmental Protection Agency (2015) List of Waste and Determining if Waste is Hazardous or Non-Hazardous
- Environment Agency et al. (2015) Guidance on the Classification and Assessment of Waste, Technical Guidance
- Environmental Protection Agency (2013) Guidance (and Templates) on the Management of Contaminated Land and Groundwater at EPA Licensed Site
- Environment Agency (2004) Model Procedures for the Management of Land Contamination (CLR11).
- All relevant guidelines within the document Inland Fisheries Ireland Requirements for the Protection of Fisheries Habitats during Construction and Development Works and River Sites (www.fisheriesireland.ie) and the updated guidelines entitled Guidelines on Protection of Fisheries

During Construction Works in And Adjacent to Waters (2016) should also be adhered to and theyinclude.

- The construction team must implement the following specific mitigation measures, and these measures should be incorporated into a Construction and Environment Management Plan. This CEMP must include measures to prevent the release of hydrocarbons, aggregates, polluting chemicals, sediment and silt and contaminated waters into water course on site.
- Surface waters from the construction site should be managed using a system of temporary on-site attenuation features, and these should be fitted with silt barrier devices.
- Silt fences and berms should be installed prior to the commencement of construction on site. These should be set back at a minimum of 10m from the streams on site. As the streams within the application site are associated with existing treelines and woodland habitats, the silt fences could be incorporated

into the protective fencing that is required for the woodland habitats. The silt fences should be sturdy and constructed of a suitable geotextile membrane to ensure that water can pass through, but that silt will be retained. An interceptor trench will be required in front of this interceptor fence. The silt fence must be capable of preventing particles of 425 ųm from passing though.

- The silt fences should be monitored daily to ensure that they remain functional throughout the construction of the proposed development. Maintenance of the fences should be carried out regularly.
- Fences should be inspected thoroughly after periods of heavy rainfall.

Discharge water generated during laying of concrete should be removed off site for treatment and disposal.

The following pollution control measures must also be employed on site:

- A dedicated re-fuelling location must be established on site, and this must be situated away from any watercourse on site.
- Spill kits stations must be provided at the fuelling location for the duration of the works.
- Staff must be provided with training on spill control and the use of spill kits.
- All fuel storage containers must be appropriately bunded, roofed and protected from vehicle movements.
- These bunds will provide added protection in the event of a flood event on site.
- All chemicals must be stored as per manufacturer' s instructions. A dedicated chemical bund will be provided on site.
- Storage of fuel, and servicing and refuelling of equipment or machinery must be at least 20m from ground clearance or rock-breaking activities.
- The dedicated refuelling area must be underlain by concrete hard standing. All fuel and oil tank should be inspected on a regular basis for signs of spillages, leaks and damage during use. A record of these inspections must be kept, and any improvements needed be carried out immediately.
- The risk of fuel spillages on a construction site is at its greatest when refuelling plant. Therefore, only designated trained and competent operatives should be authorised to refuel plant on site. Plant and equipment should be brought to a designated refuelling area rather than refuelling at numerous locations about the site.
- Chemicals used on site must be returned to the site compound and secured in a lockable and sealed container overnight in proximity to the fuel storage area.
- Drip trays must be utilised on site for all pumps situated within 20m away from ground clearance areas.
- Procedures and contingency plans must be established on site to address cleaning up small spillages as well as dealing with an emergency incident. A stock of absorbent materials such as sand, spill granules, absorbent pads and booms must be kept on site, on plant working near the river and at the refuelling area.
- Daily plant inspections must be completed by all plant operators on site to ensure that all plant is maintained in good working order. Where leaks are noted on these inspection sheets, the plant must be removed from operations for repairs.

- All personnel should observe standard precautions for handling of materials as outlined in the Safety Data Sheets (SDS) for each material, including the use of PPE. Where conditions warrant, emergency spill containment supplies should be available for immediate use.

Best practice concrete / aggregate management measures must be employed on site. These will include:

- A designated concrete wash out area should be set up on site; typically, this will involve washing the chutes, pumps into a designated IBC before removing the wastewater off site for disposal. These procedures should be covered during a Site Safety & Environmental Induction session.
- Best practice in bulk-liquid concrete management should be employed on site addressing pouring and handling, secure shuttering, adequate curing times etc.
- Stockpile areas for sands and gravel must be kept to a minimum size, well away from the drains and watercourses (minimum 50m).
- Where concrete shuttering is used, measures must be put in place to prevent against shutter failure and control storage, handling and disposal of shutter oils.
- Activities which result in the creation of cement dust must be controlled by dampening down the areas.
- Raw and uncured waste concrete must be disposed of by removal from the site.
- Stockpile areas for sands and gravel will be kept to a minimum size, well away from the watercourse on site.

There should be no disturbances of the habitats along the watercourses within the application site. All vegetation within the 10m buffer zone of the stream must be protected, outside of the point where the box culvert bridge is to be installed. Vegetation within these buffer zone should be retained and enhanced using suitable species and in accordance with any landscaping plan that has been produced for the site. A separate surface water pipe will cross the central woodland area. This will be situated in a tunnel that is bored under the stream.

8.5 LIKELY AND SIGNIFICANT IMPACTS ON HYDROLOGY, HYDROGEOLOGY AND DRAINAGE

The potential impacts of the proposed LRD Project and mitigation measures that will be put in place to eliminate or reduce them are set out below.

8.5.1 Do Nothing Scenario

If the proposed development does not go ahead, there would be no potential impacts on the hydrology, hydrogeology and drainage around and beneath the subject site (as well as on the land, soils and geology).

The area of the site, including the fields and hedgerows within, would continue as is on the site, with rainfall infiltrating to ground and surface water running into the stream watercourses, and the hedgerows would not be encroached upon. Agricultural practices would continue. This would have no impact on the underlying substrate, and there would be no change to the environmental profile of the site in relating to Land, Soils, Geology, Hydrology, Hydrogeology and Drainage.

8.5.2 Potential Impacts and Mitigation Measures – Construction Phase

The proposed development will include the following accommodation; 4 no. Type A1 dwelling houses (three-bedroomed, semi-detached), 10 no. Type A2 dwelling houses (three-bedroomed, end of terrace), 6 no. Type B1 dwelling houses (three-bedroomed, semi-detached), 36 no. Type B2 dwelling houses (three-bedroomed, end of terrace), 16 no. Type C1 dwelling houses (four-bedroomed, semi-detached), 8 no. Type C2 dwelling houses (four-bedroomed, semi-detached), 1 no. Type C3 dwelling house (four-bedroomed, detached), 19 no. Type D dwelling houses (two-bedroomed, mid-terrace), 9 no. Type E1 dwelling houses (four-bedroomed, detached), 28 no. Type E2 dwelling houses (four-bedroomed, semi-detached), 30 no. Type F dwelling houses (three-bedroomed, semi-detached), 30 no. Type G dwelling houses (3-bedroomed, mid-terrace), 108 no. Type 1 Apartments (one-bedroomed), 63 no. Type2 Apartments (two-bedroomed), 88 no. Type 3 Apartments (two-bedroomed), and 46 no. Type 4 Apartments (three-bedroomed) and creche, as well as all ancillary site works.

The site is located on the northern lower backslope of a high, unnamed, dome-shaped ridge feature at Woodtown, which itself is a spur-ridge off the northeastern side of Mountpelier Hill, from which views of the surrounding countryside at the northwest, north and northeast are attained.

The construction site will be accessed *via* the entrance to the proposed LRD site which is proposed from the existing road at Abbott's Grove, at the northwest, into the (current) western field of the two-field landholding that forms the site. There will be no basements in any of the houses on the site, and the foundation levels will be set just below existing ground levels, largely on the pre-existing, *in situ* mineral soil and/or mineral subsoil.

No parts of the proposed LRD Site are situated within a Source Protection Zone for a Public Drinking Water Supply, a Zone of Contribution to a Group Scheme, or a Drinking Water Protected Area abstracting from surface water.

Potential effects on groundwater quality with regard to contaminants such oils, fuels, cement and sediments (i.e. from rock breaking, compaction of foundations, and excavation works).

Quantity effects (i.e. flows/spring discharge volumes) are unlikely to arise as the excavations and cut-and-fill will all be above the groundwater table on the site.

The not-insignificant depth of overburden at the proposed LRD site would also ensure that access road construction, trenching for electrical cabling, temporary construction compounds and roadside drainage and attenuation (i.e. settlement ponds) would have no potential to disrupt groundwater flowpaths downslope. Trenching or drains will typically extend no more than 1.2m below ground level.

No point recharge features such as swallow holes, dolines etc are present at the ground surface on the proposed LRD Site, as the setting is within a non-karstified aquifer.

8.5.2.1. Earthworks (Removal of Vegetation Cover, Excavations and 'Cut-and-Fill') Resulting in Suspended Solids Entrainment in Surface Waters (Proposed Project)

There will be earthworks required for the proposed LRD Site and these are assessed herein.

Proposed Project construction phase activities that will require earthworks resulting in the removal of vegetation cover and excavation of mineral subsoil are detailed in Chapter 3 the Description of the Proposed Project. Potential sources of sediment laden water include:

- Drainage and seepage water resulting from infrastructure excavation;
- Stockpiled excavated material providing a point source of exposed sediment;
- Construction of the underground trench resulting in the entrainment of sediment from the excavations during construction; and,
- Erosion of sediment from emplaced site drainage channels.

These activities can result in the release of suspended solids to surface watercourses and could result in an increase in the suspended sediment load, resulting in increased turbidity which in turn could affect the water quality and fish stocks of downstream water bodies. Potential impacts could be significant if not mitigated.

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers (Dodder River and it's tributaries) and dependent ecosystems.

Pre-Mitigation Potential Effect: Indirect, negative, significant, long-term, likely effect on surface water quality.

Mitigation by Avoidance:

The key mitigation measure during the construction phase of the Proposed Project is the avoidance of sensitive aquatic areas where possible. From **Figure 8.16** it can be seen that all of the key areas of the Proposed Project infrastructure are actually significantly away from any delineated buffer zones with the exception of proposed new roads, and proposed stream crossings. Additional control measures, which are outlined further on in this section, will be undertaken at these locations.

The large setback distance from sensitive hydrological features means that adequate room is maintained for the proposed drainage mitigation measures (discussed below) to be properly installed and operated effectively. The proposed buffer zone will:

- Avoid physical damage to watercourses, and associated release of sediment;
- Avoid excavations within close proximity to surface water courses;
- Avoid the entry of suspended sediment from earthworks into watercourses; and,
- Avoid the entry of suspended sediment from the construction phase drainage system into watercourses, achieved in part by ending drain discharge outside the buffer zone and allowing percolation across the vegetation of the buffer zone.

Mitigation by Design:

- Source controls:
- Interceptor drains, vee-drains, diversion drains, flume pipes, erosion and velocity control measures such as use of sand bags, filter fabrics, and other similar/equivalent or appropriate systems.
- Small working areas, covering stockpiles, weathering off stockpiles, cessation of works in certain areas or other similar/equivalent or appropriate measures.
- In-Line controls:
- Interceptor drains, vee-drains, oversized swales, erosion and velocity control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles, silt bags, silt fences, sedimats, filter fabrics, and collection sumps, temporary sumps/attenuation lagoons, sediment traps, pumping systems, settlement ponds, temporary pumping chambers, or other similar/equivalent or appropriate systems.
- Treatment systems:
- Temporary sumps and attenuation ponds, temporary storage lagoons, sediment traps, and settlement ponds, and proprietary settlement systems.
- Monitoring:
- An inspection and maintenance plan for the on-site construction drainage system will be prepared in advance of commencement of any works. Regular inspections of all installed drainage systems will be undertaken, especially after heavy rainfall, to check for blockages, and ensure there is no build-up of standing water in parts of the systems where it is not intended.
- Any excess build-up of silt levels at dams, the settlement pond, or any other drainage features that may decrease the effectiveness of the drainage feature, will be removed. Checks will be carried out on a daily basis.
- During the construction phase field testing and laboratory analysis of a range of parameters with relevant regulatory limits and EQSs will be undertaken for each primary watercourse, and specifically following heavy rainfall events (as per the CEMP included with this EIAR).
- Residual Effect: The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The mitigation measures will ensure that surface water runoff from the site will be equivalent to baseline conditions and will therefore have no potential impact on the status, ecology or hydromorphology of downstream waters. The residual effects of the Proposed Project will be negative, imperceptible, indirect, short-term, likely effect on down-gradient rivers, water quality, and dependent ecosystems.
- Significance of Effects: For the reasons outlined above, no significant effects on the surface water quality will occur.

8.5.2.2. Potential Impacts on Groundwater Levels During Excavations (Proposed Project)

There will be excavations required for the proposed LRD Site (Proposed Project).

But groundwater level impacts will not be significant due to the local geological and hydrogeological regime as outlined below. The groundworks proposed do not require active dewatering (albeit some temporary displacement of local groundwater is likely to occur) and therefore has no potential to significantly affect groundwater levels during construction.

Pathway: Groundwater flowpaths.

Receptor: Groundwater levels (Kilcullen GWB and local bedrock aquifers).

Pre-Mitigation Potential Effect: Direct, negative, slight, brief, likely effect on local bedrock aquifers. No significant effects on the Kilcullen GWB will occur due to the small dewatering requirements.

Impact Assessment:

No groundwater level impacts are predicted from the construction of the proposed LRD due to the shallow nature of the excavations (i.e. mostly 0 -~3m). The deepest excavations will be required in the central portion of the site, ~4m, but these excavations will progress in a more horizontal manner rather than vertical deepening.

Residual Impact: Due to the prevailing geology at the Site, the local and temporary nature of the proposed works, the residual effects of the proposed LRD Project on groundwater levels will be negative, imperceptible, direct, brief and reversible.

Significance of Effects: For the reasons outlined above, no significant effects on groundwater levels and will occur.

8.5.2.3. Potential Release of Hydrocarbons During Construction and Storage (Proposed Project)

Hydrocarbons will be required for the proposed LRD Project and these are assessed herein.

Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a significant pollution risk to groundwater, surface water and associated ecosystems, and to terrestrial ecology. The accumulation of small spills of fuels and lubricants during routine plant use can also be a pollution risk. Hydrocarbon has a high toxicity to humans, and all flora and fauna, including fish, and is persistent in the environment. It is also a nutrient supply for adapted micro-organisms, which can rapidly deplete dissolved oxygen in waters, resulting in death of aquatic organisms.

Pathway: Groundwater flowpaths and site drainage network.

Receptor: Groundwater and surface water rivers and streams (Dodder River and it’s tributaries).

Pre-Mitigation Potential Effect:

Indirect, negative, slight, short term, unlikely effect to local groundwater quality.

Indirect, negative, moderate, short term, unlikely impact to surface water quality.

Proposed Mitigation Measures:

Mitigation measures proposed to avoid release of hydrocarbons at the site are as follows:

- On site re-fuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double-axel custom-built refuelling trailer will be re-filled off site, and will be towed around the site by a 4x4 jeep to where machinery is located. The 4x4 jeep will also carry fuel absorbent material and pads in the event of any accidental spillages. The fuel bowser will be parked on a level area in the construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant on site. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations;

- Onsite refuelling will be carried out by trained personnel only;
- A permit to fuel system will be put in place;
- Fuels stored on site will be minimised. Fuel storage areas if required will be bunded appropriately for the fuel storage volume for the time period of the construction and fitted with a storm drainage system and an appropriate oil interceptor;
- The plant used during construction will be regularly inspected for leaks and fitness for purpose; and,
- An emergency plan for the construction phase to deal with accidental spillages will be included within the Construction and Environmental Management Plan. Spill kits will be available to deal with and accidental spillage in and outside the re-fuelling area.

Residual Impact: The potential for the release of hydrocarbons to groundwater and watercourse receptors is a risk to surface water and groundwater quality, and also the aquatic quality of the surface water receptors. Proven and effective measures to mitigate the risk of releases of hydrocarbons have been proposed above and will break the pathway between the potential source and each receptor. The mitigation measures will ensure that surface water runoff from the site will be equivalent to baseline conditions and will therefore have no potential impact on the status or ecology of downstream waters. The residual effect of the proposed LRD Project will be negative, imperceptible, indirect, short-term, unlikely impact to local surface water and groundwater quality.

Significance of Effects: For the reasons outlined above, no significant effects on surface water or groundwater quality will occur.

8.5.2.4. Groundwater and Surface Water Contamination from Wastewater Disposal (Proposed Project)

Wastewater management will be required for the proposed LRD Site construction (Proposed Project) and is therefore assessed herein.

Release of effluent from domestic wastewater treatment systems has the potential to impact on groundwater and surface waters if site conditions are not suitable for an on-site percolation unit.

Pathway: Groundwater flowpaths and site drainage network.

Receptor: Groundwater quality and surface water quality (rivers (Dodder River and it’s tributaries).

Pre mitigation Effect:

Indirect, negative, significant, temporary, unlikely effect to surface water quality.

Indirect, negative, slight, temporary, unlikely effect to local groundwater.

Proposed Mitigation Measures:

- It is proposed to manage wastewater from the staff welfare facilities in the control buildings by means of a sealed storage tank, with all wastewater being tankered off site by permitted waste collector to wastewater treatment plants. It is not proposed to treat wastewater on-site.

Residual Effect: No residual effects of the Proposed Project.

Significance of Effects: No significant effects on surface water or groundwater quality will occur.

8.5.2.5. Potential Hydrological Effects on Designated Sites (Proposed Project)

Designated sites are located downstream of the proposed LRD Project, and are assessed herein.

The closest designated site to the Proposed Project site is the Wicklow Mountains SPA / NHA (Site Code: 0004040), but this is up-gradient of the site.

The proposed LRD does not intercepts any European Sites or NHAs / pNHAs, and none are situated down-gradient of the proposed LRD Site either (see **Figure 8.16**).

The groundwater flow direction in the area of the Site (i.e. northwards) mean designated sites such as the Wicklow Mountains SPA / NHA (to the south) and all to the northeast (including the South Dublin Bay SAC and the Sandymount Strand / Tolka Estuary SPA) have been screened out.

Pathway: Surface water and groundwater flowpaths.

Receptor: Down-gradient water quality and designated sites (South Dublin Bay SAC and the Sandymount Strand / Tolka Estuary SPA).

Pre-Mitigation Potential Effect: Indirect, negative, moderate, short-term, likely effect on the South Dublin Bay SAC and the Sandymount Strand / Tolka EstuarySPA and Indirect, negative, slight, short-term, unlikely effect on Wicklow Mountains SPA / NHA.

Impact Assessment & Proposed Mitigation Measures:

Drainage mitigation measures for surface water quality protection during the construction phase are summarised again below: (Please refer to Section 5.2.1 above for the full description of these measures and how they will be applied).

- The proposed mitigation measures which will include 50m buffer zones for avoidance of sensitive hydrological features (streams and rivers);
- Pre-construction drainage control measures;
- Robust drainage control measures (i.e. interceptor drains, swales, settlement ponds and treatment trains) will ensure that the quality of runoff from the proposed LRD Project area will be very high; and,
- Best practice measures with regard use of oils, fuels (Section 5.2.3).

Residual Impact: No effects on local designated sites from the proposed LRD Project.

Significance of Effects: No significant impacts on local designated sites will occur.

8.5.2.6. Potential Effects on Local Groundwater Well Supplies from Excavations (Proposed Project)

There will be excavations required for the proposed LRD Project and these are assessed herein in terms of effect on groundwater sourced water supplies.

In the area of the Proposed Project site, private dwelling houses (potential well locations) are mainly located along public roads to the south and east of the proposed LRD Site which is up-gradient to the direction of groundwater flow in the area of the proposed LRD Site (i.e. northerly/north-westerly).

There are therefore no risks to down-gradient wells.

Pathway: Groundwater flowpaths.

Receptor: Private Groundwater Supplies.

Pre-Mitigation Potential Impact: Negative, imperceptible, indirect, short-term, unlikely effect on local wells.

Impact Assessment:

I am satisfied that the proposed LRD Project site will not impact in any significant way on any potential down-gradient private wells, owing to their absence, as well as the large set back distances between the proposed LRD Site and all potential well locations.

8.5.2.7. Effects of Construction Works on the WFD Status of Downstream Waterbodies P.roposed Project)

The proposed LRD Project has the potential to effect WFD status, and this is assessed herein.

WFD status and Risk Results for downstream river waterbodies and the underlying Kilcullen GWB are presented in Sections 8.3.12 and 8.3.13 above.

Due to the high to low groundwater vulnerability rating of the Proposed Project site (and the absence of bedrock at or near surface and thus 'Extreme' groundwater vulnerability across the sites), the potential to negatively affect the WFD status of the Kilcullen GWB is very low, even in the absence of mitigation.

Without mitigation the proposed construction works do have the potential to adversely impact on surface water quality which may negatively impact on the WFD status of these downstream surface waterbodies.

The understanding of the objectives of the WFD is that surface waters, regardless of whether they have 'Poor' or 'High' status, should be treated the same in terms of the level of protection and mitigation measures employed, i.e. there should be no negative change in status at all. This is reflected in the strict mitigation measures in relation to maintaining a high quality of surface water from the proposed LRD Project will ensure that the status of surface waterbodies in the vicinity of the proposed LRD Project will be at least maintained regardless of their existing status.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters (Dodder River and it's stream tributaries) and associated dependent ecosystems.

Pre-Mitigation Potential Impact: Indirect, negative, slight, temporary, unlikely effect on river waterbody status. No effects Kilcullen GWB WFD status will occur.

Proposed Mitigation Measures:

Comprehensive surface water mitigation and drainage controls are outlined in Section 5.2 above. These will ensure the protection of surface water quality and flows in all downstream receiving watercourses.

Residual Impact: The potential for the release of suspended solids, hydrocarbons, cement-based products or altered flows to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigation measures have been proposed and will break the pathway between the potential pollutant sources and the receptor. The mitigation measures will ensure that surface water runoff from the site will be equivalent to baseline conditions and will therefore have no potential impact on the status, ecology or hydromorphology of downstream waters. The residual effect of the proposed LRD Project is negative, imperceptible, indirect, short-term, unlikely impact on down gradient rivers, water quality, and dependent ecosystems. No effects on the status of the Kilcullen GWB will occur.

Significance of Effects: For the reasons outlined above, and with the implementation of the proposed mitigation, no significant effects on waterbody WFD status will occur.

8.5.3 Potential Impacts and Mitigation Measures – Operational Phase

8.5.3.1 Removal of Vegetation Cover and Progressive Replacement of Natural Surface with Low Permeability Surfaces (Proposed Project)

Hardstand emplacement will be required at the proposed LRD Site, and is assessed herein.

The potential for increased surface water runoff is the primary potential impact during the operational phase of the proposed LRD.

Progressive replacement of the vegetated surface with impermeable surfaces will decrease the permeability of the ground within the proposed LRD Site footprint (i.e., hardstandings, and to a lesser extent the new access roads).

Overall there is a negligible increase in average runoff expected and results from a relatively small area of the overall proposed LRD Project site being developed.

Pathway: Site drainage network.

Receptor: Surface waters (Dodder River and it’s tributaries) and dependent ecosystems.

Pre-Mitigation Potential Impact: Negative, imperceptible, indirect, long-term, likely effect on all downstream surface water bodies.

Proposed Mitigation by Design:

The proposed drainage philosophy outlined in Section 5.2.1 states that runoff control and drainage management are key elements in terms of mitigation against impacts on surface water bodies. Two distinct methods will be employed to manage drainage water within the proposed LRD Project. The first being 'keeping clean water clean' and the second involving the collection of any drainage waters in the proposed, designed surface water network. The second method relates to proposed design measures that will prevent road surface and other hardstand areas acting as preferential flowpaths. All development site runoff will be collected, attenuated, treated and then released in a diffuse and regular manner that does not significantly change the natural drainage regime/hydrology of the site.

The operational phase drainage system of the proposed LRD Project will be installed and constructed in conjunction with the road and hardstanding construction work as described below and as shown on the drainage drawings submitted with this planning application:

- Interceptor drains will be maintained up-gradient of all proposed infrastructure to collect clean surface runoff, in order to minimise the amount of runoff reaching areas where suspended sediment could become entrained.

- Swales/road side drains will be used to collect runoff from access roads and hardstanding areas of the site, likely to have entrained suspended sediment'.

- These measures will ensure all surface water runoff from new road surfaces will be captured and treated prior to discharge/release.

- Residual Impact: Direct, negative, neutral, long term, likely effect of the proposed LRD Project on surface waters.

Significance of Effects: No significant effects on surface water quantity will occur during the operational phase of the Proposed Project.

8.5.3.2 Runoff Resulting in Suspended Solids Entrainment in Surface Waters

Site runoff will occur at the proposed LRD Site and is assessed herein.

During the operational phase, the potential for silt-laden runoff is very low.

There is a very low likelihood of the release of suspended solids to surface water and low potential increase in the suspended sediment load,

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers (Dodder Reiver and it's stream tributaries) and associated dependent ecosystems.

Pre-Mitigation Potential Effect: Negative, slight, indirect, temporary, likely effect on surface water quality.

Proposed Mitigation Measures:

The mitigation measures outlined in Sections 8.5.2.2 and 8.5.2.3 will ensure all surface water runoff from new road surfaces and hardstand areas within the proposed LRD will be captured and treated prior to discharge/release.

Post-Mitigation Residual Effects: With the implementation of the proposed drainage measures as outlined above, and based on the post-mitigation assessment of runoff, residual effects are - Negative, imperceptible, indirect, temporary, unlikely effect on downstream water quality.

Significance of Effects: For the reasons outlined above, no significant effects on the surface water quality will occur.

8.5.4 Risk of Major Accidents and Disasters

Due to the nature of the proposed LRD Project site, i.e. absence of soft peat deposits, there is no risk of peat movement occurring. As well as this, all excavations are relatively shallow and will be completed using the Mitigation Methodologies outlined in Chapter 7 'Land, Soils and Geology' e.g. in dry weather, etc.

The residual effect of a landslide occurring is thus determined to be imperceptible.

Flooding can result in downstream Major Accidents and Disasters. But owing to the relatively small scale of the proposed LRD Project footprint, the naturally moderate runoff rates, the avoidance of fluvial flood zones (see Section 8.3.5) and with the implementation of the proposed mitigation measures, the increased flood risk associated with the proposed LRD Project is imperceptible.

8.5.5 Human Health Effects

Potential health effects arise mainly through the potential for surface and groundwater contamination which can have negative effects on public and private water supplies. The proposed LRD Project is not a recognized source of pollution (e.g. it's not a waste management site, or a chemical plant), and so the potential for effects during the operational phase is very low. Notwithstanding this, the proposed LRD Project design and mitigation measures ensures that the potential for effects on the water environment as a whole will be insignificant.

Hydrocarbons will be used onsite during construction, but the volumes will be small in the context of the scale of the proposed LRD Project and will be handled and stored in accordance with best practice mitigation measures. The potential residual effects associated with surface water or groundwater contamination and subsequent health effects are imperceptible.

Flooding of property can cause inundation with contaminated flood water. Flood waters can carry waterborne disease and contamination/effluent. Exposure to such flood waters can cause temporary health issues.

A detailed Flood Risk Assessment for the proposed LRD Site has been carried out and accompanies this application t, and is summarised in Section 8.3.5. This Flood Risk Assessment demonstrates that the risk of the proposed LRD Project contributing to downstream flooding is imperceptible. On-site (construction and operation phase) drainage control measures will ensure no downstream increase in local flood risk.

8.5.6 Cumulative Effects

This section presents an assessment of the potential cumulative effects associated with the Proposed Project and other developments (existing and/or proposed) on the hydrological and hydrogeological environment.

The main likelihood of cumulative effects is assessed to be hydrological (surface water quality) rather than hydrogeological (groundwater). Due to the local hydrogeological setting (i.e. low permeability peat and glacial tills) and the near-surface nature of construction activities, cumulative effects with regard groundwater quality or quantity arising from the Proposed Project are assessed as not likely, as set out in Chapter 3 of this EIAR. Please see Chapter 2 for cumulative assessment methodology.

The primary potential for cumulative effects will occur during the construction phase of the proposed LRD Project as this is when earthworks and excavations will be undertaken at the Site. The potential for cumulative effects during the operational phase of the Proposed Project will be significantly reduced as there will be no exposed excavations, there will be no sources of sediment to reach watercourses, there will be no use of cementitious materials and fuels/oil will be kept to a minimum at the site.

The cumulative Water Study area is delineated by a 15 km buffer around the proposed LRD Site. Outside of this buffer, no cumulative hydrological effects are likely owing to the very high dilution effects afforded by such a large regional catchment, subsequent large surface water flows and the natural attenuation afforded by the Dodder River itself.

8.5.6.1. Cumulative Effects with Housing Developments, Schools, Sports Pitches and Neighbourhood Centres

A detailed cumulative assessment has been carried out for all planning applications (granted and awaiting decisions) within the cumulative assessment area described above.

There are applications are for new residential units, as well as for Sports Pitches and Neighbourhooed Centres. Based on the scale of the works, their proximity to the proposed LRD Site and the temporal period of likely works, no cumulative effects will occur as a result of the Proposed Project (construction and operational phases).

PA. Ref. No.	Applicant	Description	Decision
LRD24A/0007	Capami Limited	523 no. residential units	Granted.
SD23A/0260	Ardstone Homes Limited	Construction of 75 no. residential units	Granted
ABP-311141-21 (SA21A/0137)	The Minister for Education & Skills	Provision of a temporary two-storey post-primary school.	Granted
ABP-309836-21	Ardstone Homes Limited	SHD – 241no. residential units in 5no. apartment blocks and a community building.	Granted

ABP-310398-21	Ardstone Homes Limited	SHD – 114no. Build to Rent apartments in 6no. blocks.	Granted
ABP-310337-21 (SD20A/0149)	Capami Ltd	LED floodlighting system and all associated ducting, column foundations and bases and fixtures for a permitted sports pitch.	Granted
SD19A/0345	Ardstone Homes Limited	Neighbourhood Centre comprising a single storey convenience retail unit and a three storey building comprising a creche.	Granted
ABP-302414-18 (SD18A/0204)	Jones Investments Ltd	65no. residential units and outline permission for a primary school and post primary school.	Refused
ABP-247693-16 (SD16A/0059)	Capami Ltd	Playing pitch and associated site works. Site south of Oldcourt Road and east of Oldcourt Lane,	Granted

Table 12 Significant Projects within a 15 km radius of the proposed LRD Site

8.5.7 Post Construction Monitoring

Due to the nature of the proposed LRD Project site, there will be no requirements for any monitoring of the site post construction.

REFERENCES

Building Research Establishment (1991). BRE Digest 365. Soakaway design. 8pp.

British Standards, BS5930 (1999). Code of Practice for Site Investigations.

Clark, C.D. and Meehan, 2001. Subglacial bedform geomorphology of the Irish Ice Sheet reveals major configuration changes during growth and decay. Journal of Quaternary Science, 16(5), p. 483-496.

Daly, D. and Craig, M. (2009). Chemical and Quantitative Status of Groundwater Bodies. A Measure of the Present, A Signpost to the Future. IAH Irish Group. Proceedings 29th Annual Groundwater Conference, International Association of Hydrogeologists, Irish Group, Tullamore, April 21-22, 2009.

DELG/EPA/GSI (1999). Groundwater Protection Schemes. Document prepared jointly by the Geological Survey of Ireland (GSI), the Environmental Protection Agency, and the Department of Environment, Heritage and Local Government.

Environmental Protection Agency (2002). Guidance on the Information to be contained in Environmental Impact Statements. Environmental Protection Agency, Dublin, 45 pp.

Environmental Protection Agency (2005). Water Quality in Ireland 2005: Key Indicators of the Aquatic Environment. EPA, Johnstown Castle, Wexford. 32pp.

Environmental Protection Agency (2011). Water Framework Status Update based on Monitoring Results 2007-2009. Aquatic Environment Unit, Office of Environmental Assessment of the Environmental Protection Agency. Ecological Status and Chemical Status of Surface Waters and Chemical and Quantitative Status of Groundwaters. *Prepared in fulfilment of Articles 24 and 25 of SI 272 of 2009. 21 June 2011*.

Environmental Protection Agency (2022). Guidelines on the information to be contained in Environmental Impact Assessment Reports. Environmental Protection Agency, Dublin, 90 pp.

European Communities Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (Habitats Directive).

European Communities Environmental Objectives (Natural Habitats) Regulations, 1997 (S.I. No. 94 of 1997) (Natural Habitat Regulations).

European Communities Environmental Objectives (Water Policy) Regulations, 2003 (S.I. No. 722 of 2003) (Water Policy Regulations).

European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010) (Groundwater Regulations).

Fitzsimons, V., Daly, D. and Deakin, J. (2003). Draft GSI guidelines for assessment and mapping of groundwater vulnerability to contamination. Groundwater Section, Geological Survey of Ireland.

Forest Service, Department of the Marine and Natural Resources (2000). Code of Best Forest Practice: Ireland. Forest Service, Dublin, 101 pp.

Gardiner, M. and Radford, T. (1980). Soils Associations of Ireland and their land-use potential. An Foras Taluintais, Dublin.

Geological Survey of Ireland (1871). Bedrock Geology Manuscript Sheets.

Geological Survey of Ireland (2025). Online Quaternary Sediments map viewer. www.gsi.ie

Government of Ireland, 2009. European Communities Environmental Objectives (Surface Waters) Regulations (S.I. No. 272/2009).

Government of Ireland, 2010. European Communities Environmental Objectives (Groundwater) Regulations (S.I. No. 9/2009).

Government of Ireland, 2014. European Union (Drinking Water) Regulations 2014 (S.I. No. 122/2014).

Government of Ireland, 2019. European Union Environmental Objectives (Surface Water) Amendment Regulations (S.I. No. 272/2009).

Harned, D.A., and Daniel, C.C., III (1992). The transition zone between bedrock and regolith: Conduit for contamination?, in Daniel, C.C., III, White, R.K., and Stone, P. A., eds., Ground water in the Piedmont, Proceedings of a Conference on Ground Water in the Piedmont of the Eastern United States, Charlotte, N.C., Oct. 16-18, 1989: Clemson, S.C., Clemson University, p. 336-348.

Institute of Environmental Management & Assessment (1999). Draft Guidelines on Public Participation in Environmental Decision Making. Institute of Environmental Management and Assessment, Lincoln, UK.

Institute of Geologists of Ireland (2013). Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapter of Environmental Impact Statements. Institute of Geologists of Ireland, Dublin. 50pp.

Kilroy, G., Dunne, F., Ryan, J., O'Connor, A., Daly, D., Craig, M., Coxon, C., Johnston, P. and Moe, H. (2008). A Framework for the Assessment of Groundwater – Dependent Terrestrial Ecosystems under the Water Framework Directive.Environmental Research Centre Report Series No. 12.

McConnell, B. and Philcox, M.E. (1994). Geology of Kildare - Wicklow: A Geological Description to accompany the Bedrock Geology 1:100,000 Scale Map Series, Sheet 16, Kildare - Wicklow. With contributions from K. Claringbold, W. Warren and G. Wright. Geological Survey of Ireland, Dublin.

Meehan, R., Gallagher, V., Parkes, M., and Gatley, S. (2013). The Geological Heritage of Monaghan. An audit of County Geological Sites in County Monaghan. Geological Survey of Ireland, 137 pp.

National Roads Authority (2009). Guidelines on Procedures for Assessment and Hydrogeology for National Road Schemes. National Roads Authority, Dublin, 189 pp.

Official Journal of the European Communities (2000). 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 (OJ L 327) 22 December 2000.

Ó Súilleabháin, C. (2000). Assessing the Boundary between High and Moderately Permeable Subsoils. Unpublished M.Sc. thesis, Trinity College Dublin.

Ó Súilleabháin, C. (2004). The Attenuation Capacity of Different Subsoils Receiving Domestic Wastewater Effluent. Ph.D. Thesis, Trinity College Dublin.

Teagasc (2006a). Digital soil map of County Dublin. Prepared as part of the EPA Soil and Subsoil Mapping Project, Teagasc, Kinsealy, Dublin.

Teagasc (2006b). Digital subsoil map of County Dublin. Prepared as part of the EPA Soil and Subsoil Mapping Project, Teagasc, Kinsealy, Dublin.

Trinity Green (2020). Soil Infiltration Test for Design of Soakaway at Woodtown, Ballycullen. Report for submission to South Dublin County Council, 24 pp.

UK TAG (2008). Application of Groundwater Standards to Regulation. UK Technical Advisory Group Paper 11b(iii). Available on the www.wfduk.org website.

UK TAG (2011). Defining & Reporting on Groundwater Bodies. UK Technical Advisory Group. Working Draft Paper. Water Services National Technical advisory Group.

Waterman Moylan (2024). Technical Note on site at Woodtown, Ballycullen, Dublin 16. 4 pp.

Wright, G.R. and Gately, C. (2002). Kilcullen Groundwater Body. Geological Survey of Ireland, 5 pp.