Chapter 11
Hydrogeology

Contents

11. Hydrogeology

11.1. Introduction

This chapter of the Environmental Impact Assessment Report (EIAR) identifies, describes and presents an assessment of whether the proposed Project will result in any likely significant effect(s) on the existing hydrogeological environment. The assessment will examine the potential impacts during the construction and operational phases.

This Chapter should be read in conjunction with the following chapters, which present related impacts arising from the proposed Project:

- Chapter 8 Biodiversity
- Chapter 9 Land and Soils
- Chapter 10 Water (Including Hydrology and Flood Risk)

11.2. Legislation, Policy and Guidance

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

11.2.1. Legislation

This Chapter of the EIAR has been prepared in accordance inter alia with the Transport (Railway Infrastructure) Act 2001 as amended. The European Union (Railway Orders) (Environmental Impact Assessment) (Amendment) Regulations 2021 (S.I. No. 743 of 2021) gives further effect to the transposition of the EIA Directive (EU Directive 2011/92/EU as amended by Directive 2014/52/EU) on the assessment of the effects of certain public private projects on the environment by amending the Transport (Railway Infrastructure) Act 2001 ('the 2001 Act'). Section 39 of the 2001 Act provides for the contents of an EIAR. An examination, analysis and evaluation is carried out by An Bord Pleanála in order to identify, describe and assess, in the light of each individual case, the direct and indirect significant effects of the proposed railway works, including significant effects derived from the vulnerability of the activity to risks of major accidents and disasters relevant to it, on: population and human health; biodiversity, with particular attention to species and habitats protected under the Habitats and Birds Directives; land, soil, water, air and climate; material assets, cultural heritage and the landscape, and the interaction between the above factors. This Chapter of the EIAR identifies, describes and presents an assessment of the likely significant effects of the proposed project on hydrogeology. The assessment will examine the potential impacts during the construction and operational phases of the proposed Project. The EIAR takes into account the available results of other relevant assessments under European Union or national legislation with a view to avoiding duplication of assessments.

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

- Directive 2013/39/EU of the European Parliament and of the Council of 12 August 2013, amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy;
- Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration (daughter to 2000/60/EC) (Groundwater Daughter Directive);
- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (Water Framework Directive); and,
- European Communities (Water Policy) Regulations, 2003 (Statutory Instrument [S.I.] No. 772 of 2003).

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

- The Groundwater Directive (80/68/EEC), repealed in 2013; and,
- The Dangerous Substances Directive (76/464/EEC), repealed in 2013.

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

11.2.1.1. EU Water Framework Directive

The EU Water Framework Directive (WFD) 2000/60/EC came into force on 22 December 2000 and its primary objective is for all waters to achieve 'Good' ecological status by 2015, and by 2027 at the latest. The WFD also promotes the sustainable use of water resources, defines a management and reporting system based on River Basin Districts (RBDs) and sets environmental objectives which take account of the full range of pressures on the aquatic environment (including pollution, abstraction, flow regulation, habitat impact etc).

The WFD 'water environment' includes rivers, lakes, transitional waters, groundwater and coastal waters up to 1 nautical mile (nm) from the coastline (12 nm for chemical status, (i.e., for territorial waters)).

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

Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances provided a groundwater protection framework before the Groundwater Directive 2006/118/EC (commonly referred to as the "Groundwater Daughter Directive").

The Groundwater Directive (80/68/EEC) aimed to protect groundwater from pollution by controlling discharges and disposal of certain dangerous substances to groundwater. The Directive was transposed into Irish Law by the Protection of Groundwater Regulations, 1999 (S.I. No. 41 of 1999). It was repealed by the Water Framework Directive 2006/60/EC (WFD) in 2013.

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

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

11.2.1.3. European Communities Environmental Objectives (Groundwater) Regulations 2009

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

11.2.2. Policy

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

- Project Ireland 2040 (National Planning Framework and National Development Plan 2021 – 2030);
- Dublin City Development Plan 2022-2028
- Park West – Cherry Orchard Local Area Plan (LAP) 2019;
- Adamstown Strategic Development Zone Planning Scheme 2014;
- Clonburris Strategic Development Zone Planning Scheme 2019;
- Celbridge Local Area Plan 2017-2023;
- South Dublin County Development Plan 2022-2028; and
- Kildare County Development Plan 2017-2023 (and draft plan 2023-2029 as available).

11.2.3. Guidance

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

- Environmental Protection Agency (EPA). Guidelines on the information to be contained in Environmental Impact Assessment Reports, (EPA, 2022);
- Environmental Protection Agency (EPA, 2013). Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites;

- Environmental Protection Agency (EPA, 2011). Guidance on the Authorisation of Discharges to Groundwater;
- National Roads Authority (NRA). Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (NRA, 2009);
- National Roads Authority (NRA, 2008). 'Environmental Impact Assessment of National Road Schemes – A Practical Guide';
- Environment Agency (EA) UK. Guidance on Land Contamination Risk Management (LCRM), 2020;
- Environment Agency UK (EA, 2004). The Model Procedures for the Management of Land Contamination (CLR 11); and,
- Institute of Geologists of Ireland (IGI) (2013). Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements.

11.3. Methodology

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

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

11.3.1. Study Area

The potential effect that the proposed Project may have on the hydrogeological regime of the site represents the principal consideration for this assessment. To understand the nature of the hydrogeological regime relevant to the site, the spatial scope of the study area must be sufficiently large to enable the general hydrogeological setting and associated Conceptual Site Model (CSM) to be defined. As such, the study area relevant to consideration of hydrogeology extends outside of the proposed Project red line boundaries, to include a 250m buffer zone from the centre of the rail corridor, within the wider groundwater catchment area in which the site is located.

In addition to the 250m buffer zone, the proposed Project has been divided into four distinct geographic zones along the length of the rail corridor (Zones A to D) as outlined in Chapter 4 Project Description. A description of the geology of each of these four zones within study area is provided in Chapter 9 Land and Soils. The study area as it relates to the groundwater properties assessed is provided in Figure 11-1 to Figure 11-5. A description of the surface water environment including hydrology and flood risk is provided in Chapter 10 Water (Including Hydrology and Flood Risk) of this EIAR.

The Zone of Influence (ZoI) for this assessment will be extended to include potential receptors of the proposed Project. This includes the Dublin Groundwater Body which is currently of 'Good' Water Framework Directive Status for the 2013 – 2018 monitoring round. The WFD requires that all Member

States implement the necessary measures to prevent deterioration of the status of all water bodies (surface waters including rivers, lakes, transitional and coastal, as well as groundwater) and to protect, enhance and restore all waters with the aim of achieving at least 'Good' Status. The ZoI will also cover the Locally Important Bedrock Aquifer within the Lucan Formation as the groundwater within the aquifer has value in the local area for abstraction purposes.

11.3.2. Survey Methodology

11.3.2.1. Desk Surveys

The following publicly available data sources [Accessed: April 2021] will be used to classify the regional and site setting, which will be used to support the characterisation of the study area and the surrounding area:

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

11.3.2.2. Field Surveys

The following site-specific investigation work and associated reporting as outlined in Table 11.1 has informed conceptualisation and baseline characterisation of the study area.

Table 11.1: Summary of Site-Specific Survey Data

Report	Extent of Survey
DART+ South West Trackside Ground Investigation Factual Report, Causeway Geotech Ltd., March 2022 (Draft)	The Trackside Ground Investigation (GI) Factual Report was prepared by Causeway Geotech Ltd. (Causeway), the ground investigation subcontractor. TUC-TYPSA-ATKINS Joint Venture (TTA-JV) is the Main Contractor with responsibility for the GI along the 20km corridor from Hazelhatch Station to Glasnevin Junction. The site investigation works were completed between 28th June 2021 and 6th February 2022. This report provides full details of the investigative methods employed during the works including borehole drilling techniques, dynamic probes, standpipe installation (for groundwater monitoring) and track bed vacuum inspection pits. Summary details and results of geotechnical and environmental laboratory testing carried out is presented in full. The Causeway report also includes details of Archaeological monitoring at certain locations, conducted by Shanarc Archaeology.
DART+ South West Ground Investigation Report, TTA JV, December 2021	The Ground Investigation Report (GIR) completed on behalf of Iarnród Éireann (IE) which addresses the geotechnical aspects of the design and construction of the DART+ South West. This report is based upon a comprehensive ground investigation completed along the project corridor. The Ground Investigation (GI) works were carried out by Causeway and staged in three defined areas within the rail corridor; Area 1, 2 and 3. Area 1 is between Glasnevin

Report	Extent of Survey
	Junction to Heuston Station, Area 2 is between Heuston Station and Inchicore Railway Works, and Area 3 is between Inchicore Railway Works and Hazelhatch Station. GI works included a variety of investigative methods such as cable percussive boreholes with rotary follow-on, windowless sampling, dynamic probing, vacuum excavated trial pits with associated geotechnical and geochemical laboratory testing. A geophysical survey and utility survey were also carried out in selected project areas as part of the GI works. The geophysical survey was carried out via Electrical Resistivity Tomography (ERT) and the utility survey was conducted via Ground Penetrating Radar (GPR). A summary of the ground conditions encountered is provided (including groundwater) followed by the geotechnical properties of subsurface materials. An assessment of earthworks material to be excavated as part of the project is included, with the majority of excavated material expected to be classified as inert Class 2C Glacial Till. The GIR contains detailed drawings identifying all ground investigation locations.
DART+ South West Geotechnical Design Report, TTA JV, September 2022	This report focuses on the preliminary geotechnical design details relating to key project elements including bridges (6 no.), retaining wall structures, track bed design and building design. This design report incorporates the findings of the GIR. A general design overview is presented for each element with further consideration given to ground and groundwater conditions, impacts on construction methods, geotechnical parameters, foundations, settlement and earthworks/ground movements. Section 3.2.2 of this report discusses ground conditions, including groundwater, encountered during the trackside GI. Additional localised ground condition summaries, including depths to groundwater, are provided for specific project elements, e.g., bridge structures and retaining walls, throughout Sections 2 and 3.

11.3.1. Models / Tools Used in Assessment

No modelling software/tools were used in the hydrogeology assessment.

11.3.2. Assessment Methodology

11.3.2.1. Key Parameters for Assessment

A description of the proposed Project is provided in Chapter 4 Project Description, and details concerning the proposed construction methodologies are provided in Chapter 5 Construction Strategy. The key activities that have potential to result in likely significant effects on hydrogeology are outlined below:

Construction Phase

- Local alterations to the water table and groundwater flow patterns during dewatering activities;
- Short-term effects on groundwater quality and recharge through the infiltration of surface water run-off within or adjacent to construction areas;
- Accidental emission / release of potentially hazardous substances (principally hydrocarbons), resulting in a short-term localised effect on groundwater quality;
- Accidental emissions and release of potentially hazardous substances during construction that may affect the quality of groundwater, most notably associated with cement, concrete materials (high alkalinity run-off), temporary oils and fuel particularly where below ground excavations are required;

- Potential to encounter contaminated land which could be disturbed during the construction works;
- Excavation of contaminated land and proposed remediation strategy; and,
- Potential impacts to water abstractions for private wells.

Operation and Maintenance Phase

- Accidental emission / release of potentially hazardous substances (principally hydrocarbons), resulting in a short-term localised effect on groundwater; and,
- Spills of fuel oils, solvents and lubricating oils may occur through ongoing operation and maintenance of substations.

11.3.2.2. Assessment Criteria and Significance

The significance of an impact is defined by first considering the importance of the attribute impacted and secondly the magnitude of the impact. In accordance with the IGI Guidelines, the importance of hydrogeological attributes (rating criteria) is defined in accordance with the Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (hereafter referred to as the 'NRA Guidelines') (2009). This guidance uses the same significance terminology as the EPA and includes intermediate steps for rating site importance (Table 11.2) and magnitude of impact (Table 11.3) and then significance (Table 11.4).

Table 11.2: Rating Criteria for Site Importance of Hydrogeological Attributes (NRA, 2009)

Importance	Criteria	Typical Examples: Hydrogeology
Extremely High	Attribute has a high quality or value on an international scale.	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation e.g. SAC or SPA status.
Very High	Attribute has a high quality or value on a regional scale.	Regionally Important Aquifer with multiple wellfields. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – NHA status. Regionally important potable water source supplying >2500 homes. Inner source protection area for regionally important water source.
High	Attribute has a high quality or value on a local scale.	Regionally important aquifer. Groundwater provides large proportion of baseflow to local rivers. Locally important potable water source supplying >1000 homes. Outer source protection area for regionally important water source. Inner source protection area for locally important water source.
Medium	Attribute has a medium quality or value on a local scale.	Locally important aquifer. Potable water source supplying >50 homes.

Importance	Criteria	Typical Examples: Hydrogeology
		Outer source protection area for locally important water source.
Low	Attribute has a low quality or value on a local scale.	Poor bedrock aquifer. Potable water source supplying <50 homes.

Table 11.3: Rating Criteria for Magnitude of Impact on Hydrogeological Attributes (NRA, 2009)

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

Table 11.4: Rating of Significant Environmental Impacts (NRA, 2009)

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

11.3.3. Consultation

The overall project stakeholder and public consultation undertaken in respect of the Project is set out in the Public Consultation No. 1 Findings Report (for PC1) and Public Consultation No. 2 Findings Report (for PC2) which are included in Volume 4, Appendix 1.3 and 1.4. All feedback was collated, including feedback specific to the EIAR topic 'Hydrogeology'. This feedback has informed this chapter including the baseline and impact assessment presented.

Specific consultation was also undertaken with key stakeholders in relation to EIA Scoping. A summary of the issues raised in relation to the scope of the EIA is included in Volume 4, Appendix 1.2. Feedback on the scope and level of detail of the assessment, data sources and methodologies as they pertain to the EIAR topic 'Hydrogeology' have been reviewed and have influenced this chapter of the EIAR.

Specific consultation was also undertaken with representatives of various Departments in Kildare, South Dublin and Dublin City Councils. This included a combination of presentations, workshops and meetings to discuss the project, technical design issues and environment and planning matters.

Nine pre-application meetings were held with ABP to explain the project and present technical and environmental information. A summary of the information presented, and the environmental issues discussed at the nine meetings is provided in Volume 4, Appendix 1.6. Feedback relevant to the topic 'Hydrogeology' has been reviewed and has influenced this chapter of the EIAR.

11.3.4. Difficulties Encountered / Limitations

This Chapter of the EIAR has been prepared based upon review of currently available information and in accordance with current best practice and relevant guidelines.

There were no technical difficulties or otherwise encountered in the preparation of this chapter of the EIAR.

Site-specific groundwater monitoring data was provided for review by the design team and is used to inform this assessment. In addition, significant site-specific ground investigation and geotechnical reports prepared by the Geotechnical Design Team for the proposed Project, as referenced in Table 11.1 have been reviewed as part of this assessment, and relevant details included as appropriate throughout.

11.4. Receiving Environment

11.4.1. Current Baseline

The proposed Project has been divided into four distinct geographic zones along the length of the corridor (Zones A to D) as outlined in Chapter 4 Project Description and summarised below. The proposed Project is described from west to east along the railway corridor.

- Zone A: Hazelhatch & Celbridge Station to Park West & Cherry Orchard Station (refer to Section 4.6);
- Zone B: Park West & Cherry Orchard Station to Heuston Station (incorporating Inchicore Works) (refer to Section 4.7);
- Zone C: Heuston Yard & Station (incorporating New Heuston West Station) (refer to Section 4.8);
- Zone D: Liffey Bridge to Glasnevin Junction (Phoenix Park Tunnel Branch Line) (refer to Section 4.9).

For the purpose of the discussion on the hydrogeology, a general overview of the entire study area is provided, with reference to the project zones where relevant. Due to the relatively large scale of the hydrogeology environment e.g., bedrock aquifers and groundwater bodies (GWB), in terms of the overall proposed Project, a breakdown of the receiving environment by project zone has not been carried out. This chapter should be read in conjunction with Chapter 9 Land and Soils, as it provides relevant descriptions of the geology within the study area.

11.4.1.1. Hydrogeology

11.4.1.1.1. Water Framework Directive Groundwater Bodies

Groundwater Bodies (GWB) have been designated for the purpose of the Water Framework Directive (WFD) (Directive 2000/60/EC). GWBs are subdivisions of large geographical areas of aquifers that allow more effective management to protect the groundwater and linked surface water or groundwater dependent features.

The entire route of the proposed Project is underlain by the Dublin Groundwater Body (GWB) (EPA Code: IE_EA_G_008), there are no additional GWBs considered within his report. This GWB is a poorly productive bedrock aquifer, extends over and area of 837km^2, spanning much of Dublin City and County, and extending into Counties Kildare and Meath (Figure 11-1). The GWB itself is nutrient sensitive and expected to flow towards the River Liffey and Liffey Estuary, both of which are surface waters in nutrient sensitive areas (according to the Urban Wastewater Treatment Directive).

The area of the GWB beneath Dublin City will have different recharge processes than the rural areas of the GWB. The urban area of Dublin City is considered to act as an impermeable surface overlying the aquifers present, which prevents the area from receiving recharge. Limited recharge may occur in areas such as parks, squares and gardens. In rural areas, diffuse recharge will occur via rainfall percolating through the subsoil. The proportion of the effective rainfall that recharges the aquifer is largely determined by the thickness and permeability of the soil and subsoil, and by the slope. Due to the generally low permeability of the aquifers within this GWB, a high proportion of the recharge will

then discharge rapidly to surface watercourses via the upper layers of the aquifer, effectively reducing further the available groundwater resource in the aquifer.

The variation in recharge rates (expressed as millimetres per year [mm/yr]) within the study area is illustrated on Figure 11-2. Recharge rates are generally low within the study area due to low permeability of subsoils, with average values ranging from a high of 256mm/yr (at Islandbridge, Zone B/C) to a low of 44mm/yr (e.g., at Hazelhatch, Zone A).

The GWB will discharge directly to the Irish Sea along the coast and there will also be discharge to surface waters if they are in hydraulic continuity with the aquifer. The general groundwater flow direction in this aquifer is towards the coast and also towards the River Liffey and Dublin City. Groundwater circulation from recharge to discharge points will more commonly take place over a distance of less than one kilometre. The majority of groundwater flow will be a rapid flow into the upper weathered zone but flow in conduits is commonly recorded at depths of 30 metres below ground level (mbgl) to 50mbgl.

The WFD Status of the Dublin GWB is currently 'Good', based upon monitoring data from the 3rd WFD Cycle 2013 to 2018. The current EPA risk classification of the GWB (3rd Cycle) is 'Not at Risk'. The Dublin GWB has historically achieved 'Good' WFD Status, from both 1st Cycle (2004-2009) and 2nd Cycle (2010-2015).

11.4.1.2. Groundwater Vulnerability

In accordance with the Water Framework Directive (2000/60/EC) it is necessary to understand the groundwater vulnerability of the site, which is defined as the tendency and likelihood for general contaminants to reach the water table after introduction at the ground surface. The GSI Vulnerability Mapping Guidelines are outlined in Table 11.6. Groundwater vulnerability classifications are based on the type and thickness of subsoils and the presence of karst features.

Table 11.5: GSI Vulnerability Mapping Guidelines

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability (Type and Thickness)			Unsaturated Zone	Karst Features
	High Permeability (Sand/Gravel)	Moderate Permeability (e.g. sandy subsoil)	Low Permeability (e.g. clayey subsoil, clay, peat)	(Sand/Gravel Aquifers Only)	(<30m Radius)
Extreme (E)	0 – 3.0m	0 – 3.0m	0 – 3.0m	0 – 3.0m	-
High (H)	>3.0m	3.0 – 10.0m	3.0 – 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0 – 10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

Between Hazelhatch and the M50 (Zone A) the linear route of the railway line traverses across regions of High and Extreme vulnerability classifications with bedrock at or close to the surface around Adamstown Station and Clondalkin & Fonthill Station. This is in line with the findings of the trackside

Ground Investigation (GI) which reported shallow depths to bedrock in Zone A, particularly to the east of Adamstown Station (minimum depth to bedrock of 0.5mbgl).

Between Park West & Cherry Orchard Station to Heston Station (Zone B) the groundwater vulnerability classification is predominantly Moderate vulnerability. Isolated areas of High vulnerability are identified at Cherry Orchard, east of the M50, and at Islandbridge, west of Heuston Station.

The eastern portion of the linear route in Dublin City (Zones C and D) largely traverses a region of Low groundwater vulnerability between Kilmainham and Cabra. Isolated areas of Moderate vulnerability are reported at Heuston Station (Zone C) and to the northwest of Glasnevin Junction (Zone D). The groundwater vulnerability designation within the study area is shown in Figure 11-3.

The site-specific data from the Ground Investigation Report (GIR) indicates that water strikes were recorded in several historic exploratory boreholes within the study area, with groundwater levels generally in the range of 5.0 to 8.4mbgl. Groundwater seepage was also reported at several historic boreholes on the western portion of the site (Zone A) from depths of 0.5 to 5.0mbgl.

Based on recent site-specific data from the GI works (June 2021 to February 2022) no significant groundwater strikes were recorded in the majority of boreholes advanced within the study area. Isolated groundwater seepage was recorded at a number of locations throughout the four project zones. Within Zone A, groundwater seepage, where encountered, was at relatively shallow depths ranging from 0.5 to 1.5mbgl. Seepage was most frequently observed in the Dublin Boulder Clay (Zones B, C and D) at depths of between 4.1 and 13.8mbgl. The GIR indicates that this seepage is likely representative of a perched water table in these locations.

Eighteen (18) groundwater monitoring standpipes (50mm diameter) were installed as part of the GI works at depths ranging from 6.00 to 19.50mbgl, within Zones B and D of the study area. These standpipes are used to provide more accurate detail concerning groundwater levels and quality. Limited monitoring of groundwater levels has been undertaken at these locations to date (between October 2021 and April 2022). Groundwater levels reported to date range from 2.05 to 9.45mbgl within Zone B, and 2.27 to 4.76mbgl within Zone D. A summary of the depths to groundwater recorded at these locations to date is provided in Table 11.7.

Table 11.6: Depth to Groundwater Summary

EIA Zone	Borehole Reference	Depth to Groundwater Oct '21 – Feb '22		Location Description
		Min (mbgl)	Max (mbgl)	
Zone B	BH-SAR-001	7.19	7.87	Approx. 20m S of Sarsfield Road Underbridge (UBC4)
Zone B	BH-KYB-003	2.05	2.55	Approx. 30m ENE of Khyber Pass Footbridge (OBC5)
Zone B	BH05-RW2-KNP	2.24	3.22	Approx. 150m E of Le Fanu Road Bridge (OBC7)
Zone B	BH03-RW2-KNP	5.37	6.17	Approx. 150m E of Le Fanu Road Bridge (OBC7)
Zone B	BH02-RW1-KD	3.25	3.25	Approx. 60m ENE of Le Fanu Road Bridge (OBC7)

EIA Zone	Borehole Reference	Depth to Groundwater Oct '21 – Feb '22		Location Description
		Min (mbgl)	Max (mbgl)	
Zone B	BH-LEF-002	4.27	4.27	Approx. 30m N of Le Fanu Road Bridge (OBC7)
Zone B	BH-LEF-004	3.02	3.02	Approx. 25m S of Le Fanu Road Bridge (OBC7)
Zone B	RC-SCR-001	9.45	9.45	Approx. 20m W of South Circular Road (R111) Bridge (OBC1A)
Zone B	BH-KYM-002	3.76	3.76	Approx. 25m N of Kylemore Road (R112) Bridge (OBC5A)
Zone B	BH-KYM-003	5.90	5.90	Approx. 40m SSE of Kylemore Road (R112) Bridge (OBC5A)
Zone D	RC-GSWR-006	1.39	4.25	Approx. 25m E of Blackhorse Avenue (R806) Road Bridge (OBO4)
Zone D	RC-GSWR-017	2.38	2.51	Approx. 125m WSW of Twin Arches (OBO8) Tunnels / Royal Canal
Zone D	RC-GSWR-015	1.15	4.79	Approx. 20m W Fassaugh Avenue Road Bridge (OB07)
Zone D	RC-GSWR-016	4.19	4.50	Approx. 140m NNE Fassaugh Avenue Road Bridge (OB07)

11.4.1.3. Aquifer Designation

The GSI provide a general hydrogeological classification based on the geological setting. The GSI aquifer categories are intended to describe both resource potential (Regionally or Locally Important, or Poor) and groundwater flow type and attenuation potential (through fissures, karst conduits or intergranular).

The regional aquifer designation is presented on Figure 11-4. One gravel aquifer is identified within the study area (Zones C and D), the Liffey, extending east from Islandbridge to the coast, over an area of 7 square kilometres (km^2). This aquifer is classified as a locally important gravel aquifer (Lg), which may supply Excellent yields but its relatively small size limits the available recharge.

The regional bedrock aquifers are Locally Important (LI) or Poor (PI) bedrock aquifers. There are multiple north-south, and east-west striking bedrock faults, north west of Dublin City which are present in the bedrock aquifers.

The underlying Lucan Formation (see bedrock geology as described in Chapter 9 Land & Soils) is classified as a Locally Important (LI) bedrock aquifer which is moderately productive only in local zones. LI bedrock aquifers are aquifers with a limited and relatively poorly connected network of fractures, fissures and joints giving a low fissure permeability which generally decreases with depth. Higher permeability exists in the upper bedrock weathered zone and along fault zones. 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.

11.4.1.4. Public and Private Water Supplies

The GSI database records identify two mapped groundwater wells within the study area (a 250m buffer from the rail corridor) of the proposed Project. The properties of the GSI listed wells are summarised in Table 11.8 and presented on Figure 11-5. Historic data related to the borehole (ID: 2923SEW026) in the vicinity of Le Fanu Road Bridge (Zone B) indicates that depth to rock is 16.7m and yield class was 'excellent'. This was an historic abstraction point for industrial usage. A depth to rock of 9.5m was reported at the borehole (ID: 2923SEW024) in the vicinity of Glasnevin Cemetery Road Bridge (Zone D) with yield class given as 'poor'. This previous well's use type is not known.

Table 11.7: GSI Listed Wells

GSI Code	Drill Date	Approx. Distance from Rail Corridor	Total Depth (m)	Depth to Rock (m)	Yield (m^3/d)	Yield Class	Usage
2923SEW026	October 1985	230m south of Le Fanu Road Bridge	66.7	16.7	1200.0	Excellent	Industrial Use
2923SEW024	March 1998	150m northeast of Glasnevin Cemetery Road Bridge	90.0	9.5	16.5	Poor	Unknown

There are no GSI listed Public Supply Source Protection Areas or Group Scheme Preliminary Source Protection Areas in the vicinity of the linear route.

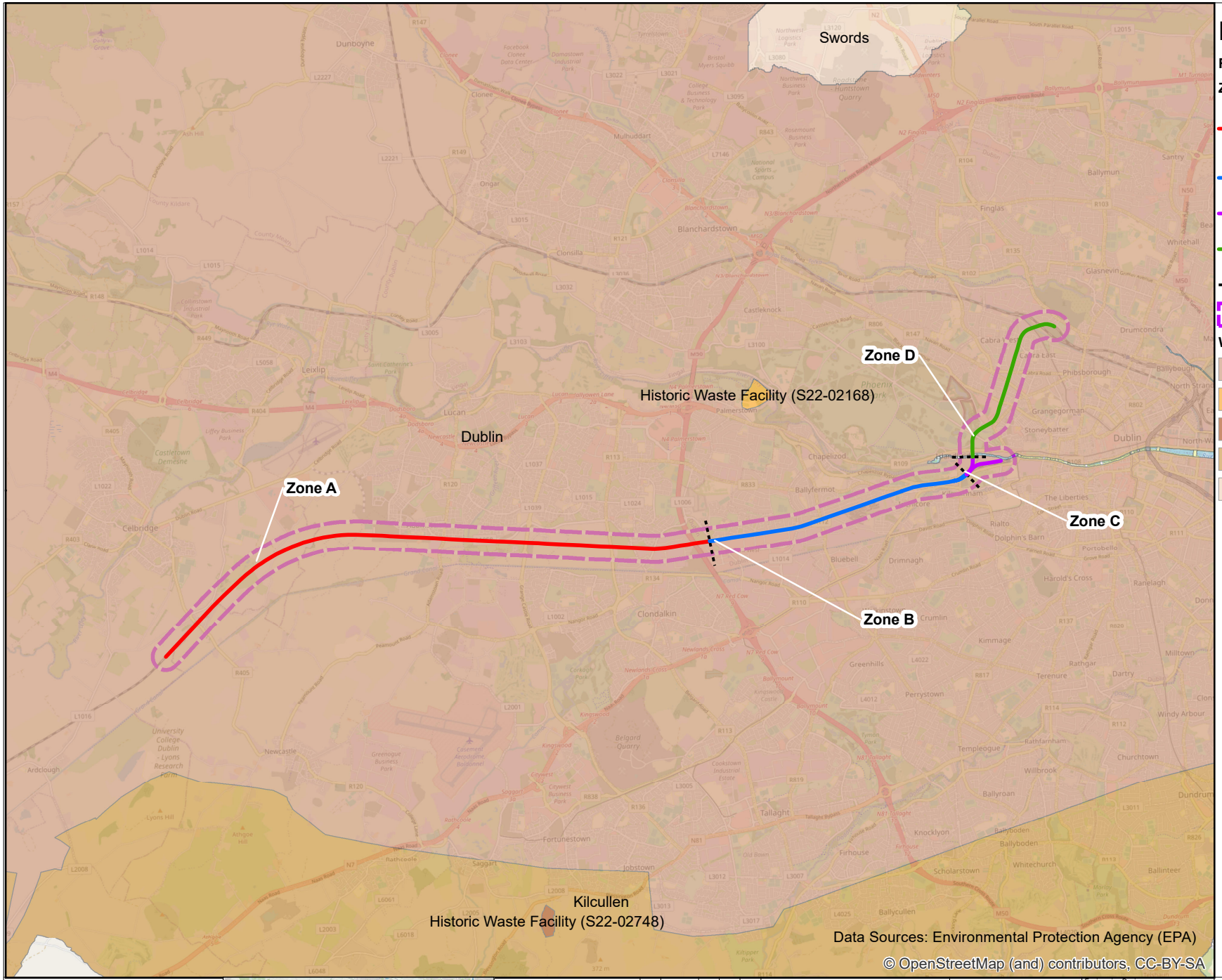
There is a potential for private wells to exist within the study area which are not listed by the GSI, however this is considered unlikely through assessing the aerial imagery and land use within the study area. Should further private wells be identified their location and status will be confirmed and recorded, and appropriate mitigation measures put in place to ensure there is no impact to supply or quality.

11.4.1.5. Groundwater Flooding

The potential for groundwater related flooding may exist at locations where depths to groundwater are relatively shallow, and subsurface geology has a high permeability. The most common form of groundwater flooding is caused by prolonged rainfall events, typically seasonal, in low lying areas with shallow karst bedrock e.g., turloughs. The GSI have developed historic and predictive groundwater flood maps and a nationwide groundwater level monitoring network (focus on key karst sites).

No areas of historic groundwater flooding have been identified within the study area boundary based upon review of the GSI's historic flood maps. The nearest identified historic groundwater flooding location to the study area is located approx. 0.4km west of Hazelhatch & Celbridge Station (Zone A), with localised groundwater flooding recorded during Winter of 2015/2016. No further areas of historic groundwater flooding are identified within the vicinity of the study area.

Further details concerning flood risk (fluvial and pluvial) to the proposed Project including a Site-Specific Flood Risk Assessment (SSFRA) are provided in Chapter 10 Water (Including Hydrology and Flooding). The Site Specific Flood Risk Assessment (SSFRA) is provided under separate cover.



Legend

Rail Network Line

Zone

- Zone A: from Hazelhatch & Celbridge Station to Park West & Cherry Orchard Station
- Zone B: Park Wet & Cherry Orchard Station to Heuston
- Zone C: Heuston Station and Yard
- Zone D: From Liffey Bridge to Glasnevin Junction
- Zone Boundaries
- 250m Buffer Zone

WFD Groundwater Bodies (Cycle 3)

- Dublin
- Historic Waste Facility (S22-02168)
- Historic Waste Facility (S22-02748)
- Kilcullen
- Swords

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W E
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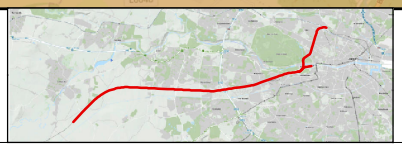

DART+ South West

NTA Údarás Náisiúnta Iompair National Transport Authority

Tionscadal Éireann Project Ireland 2040

Rev	Date	Drn	Chk'd	App'd	Description
v02	22/10/2022	IP	EH	CR	Groundwater Bodies
v01	31/03/2022	IP	EH	CR	Groundwater Bodies

Client: Iarnród Éireann Irish Rail

Engineering Designer: TYPSA, ATKINS, TUC RAIL

Supported by: rps

Date	Scale	Drawn	Checked	Approved
18/01/2023	1:100,000 @ A4	IP	EH	CR

Project Code	Issuer	QMS Code
5195886	TTA	

Project Title: DART + SOUTH WEST

Drawing Title: **Figure 11.1: Groundwater Bodies**

Drawing File Name	Version	Status
DP-04-23-DWG-EV-TTA-23745	v02	S3

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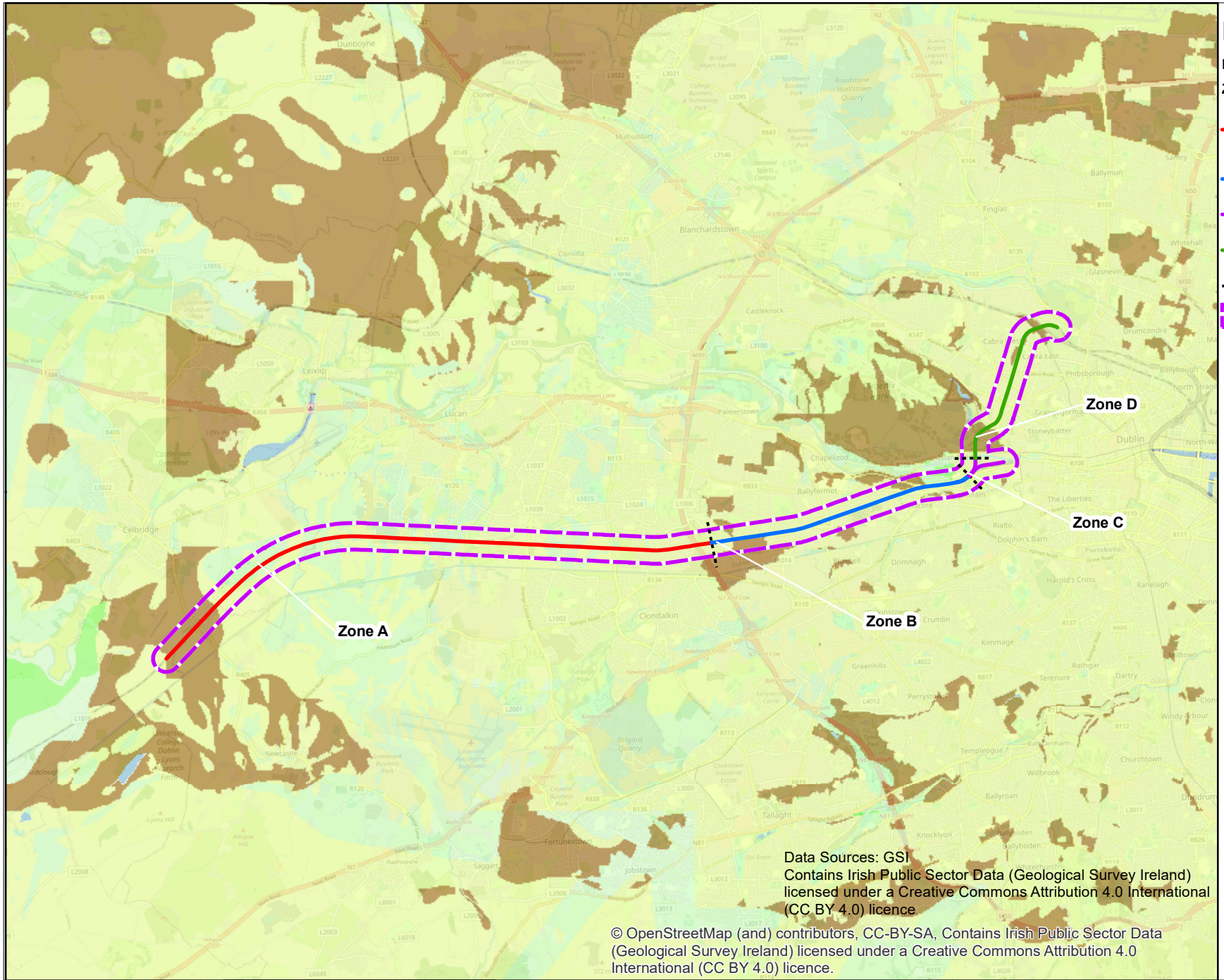


Legend

Rail Network Line

Zone

- Zone A: from Hazelhatch & Celbridge Station to Park West & Cherry Orchard Station
- Zone B: Park Wet & Cherry Orchard Station to Heuston
- Zone C: Heuston Station and Yard
- Zone D: From Liffey Bridge to Glasnevin Junction
- Zone Boundaries
- 250m Buffer Zone

Annual Recharge (mm)

- >2000 mm
- 1401-2000 mm
- 1001-1400 mm
- 901-1000 mm
- 801-900 mm
- 701-800 mm
- 601-700 mm
- 551-600 mm
- 501-550 mm
- 451-500 mm
- 401-450 mm
- 351-400 mm
- 301-350 mm
- 251-300 mm
- 201-250 mm
- 151-200 mm
- 101-150 mm
- 51-100 mm
- 1-50 mm
- 0 mm

N W E S

Data Sources: GSI
Contains Irish Public Sector Data (Geological Survey Ireland) licensed under a Creative Commons Attribution 4.0 International (CC BY 4.0) licence

DART+ South West

NTA Údarás Náisiúnta Iompair National Transport Authority

Tionscadal Éireann Project Ireland 2040

Rev	Date	Drn	Chk'd	App'd	Description
v02	26/10/2022	IP	EH	CR	Groundwater Recharge
v01	31/03/2022	IP	EH	CR	Groundwater Recharge

Client: Iarnród Éireann Irish Rail

Engineering Designer: TYPSA, ATKINS (Member of the SNC-Lavalin Group), TUC RAIL

Supported by: rps

Date	Scale	Drawn	Checked	Approved
18/01/2023	1:100,000 @ A4	IP	EH	CR

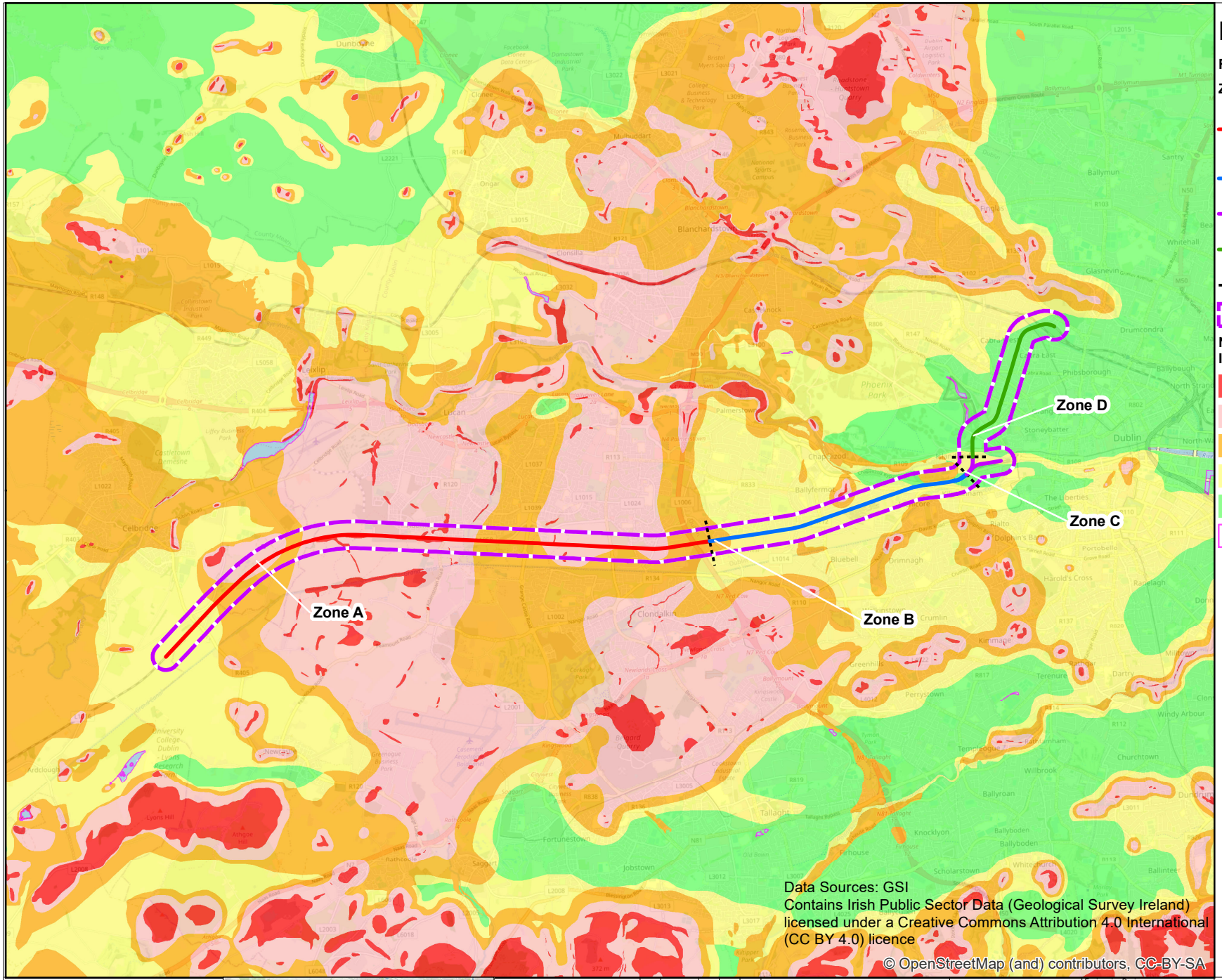
Project Code	Issuer	QMS Code
5195886	TTA	

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

Project Title: DART + SOUTH WEST

Drawing Title: **Figure 11.2: Groundwater Rechage**

Drawing File Name	Version	Status
DP-04-23-DWG-EV-TTA-23747	v02	S3



Legend

Rail Network Line

Zone

- Zone A: from Hazelhatch & Celbridge Station to Park West & Cherry Orchard Station
- Zone B: Park Wet & Cherry Orchard Station to Heuston
- Zone C: Heuston Station and Yard
- Zone D: From Liffey Bridge to Glasnevin Junction
- Zone Boundaries
- 250m Buffer Zone

National Groundwater Vulnerability Ireland

- Rock at or near Surface or Karst
- Extreme
- High
- Moderate
- Low
- Water

N W E S

DART+ South West

NTA Údarás Náisiúnta Iompair National Transport Authority

Tionscadal Éireann Project Ireland 2040

Rev	Date	Drn	Chk'd	App'd	Description
v02	26/10/2022	IP	EH	CR	Groundwater Bodies
v01	31/03/2022	IP	EH	CR	Groundwater Bodies

Client: Iarnród Éireann Irish Rail

Engineering Designer: TYPSA, ATKINS, TUC RAIL

Supported by: rps

Date	Scale	Drawn	Checked	Approved
18/01/2023	1:100,000 @ A4	IP	EH	CR

Project Code	Issuer	QMS Code
5195886	TTA	

Project Title: DART + SOUTH WEST

Drawing Title: **Figure 11.3: Groundwater Vulnerability**

Drawing File Name	Version	Status
DP-04-23-DWG-EV-TTA-23746	v02	S3

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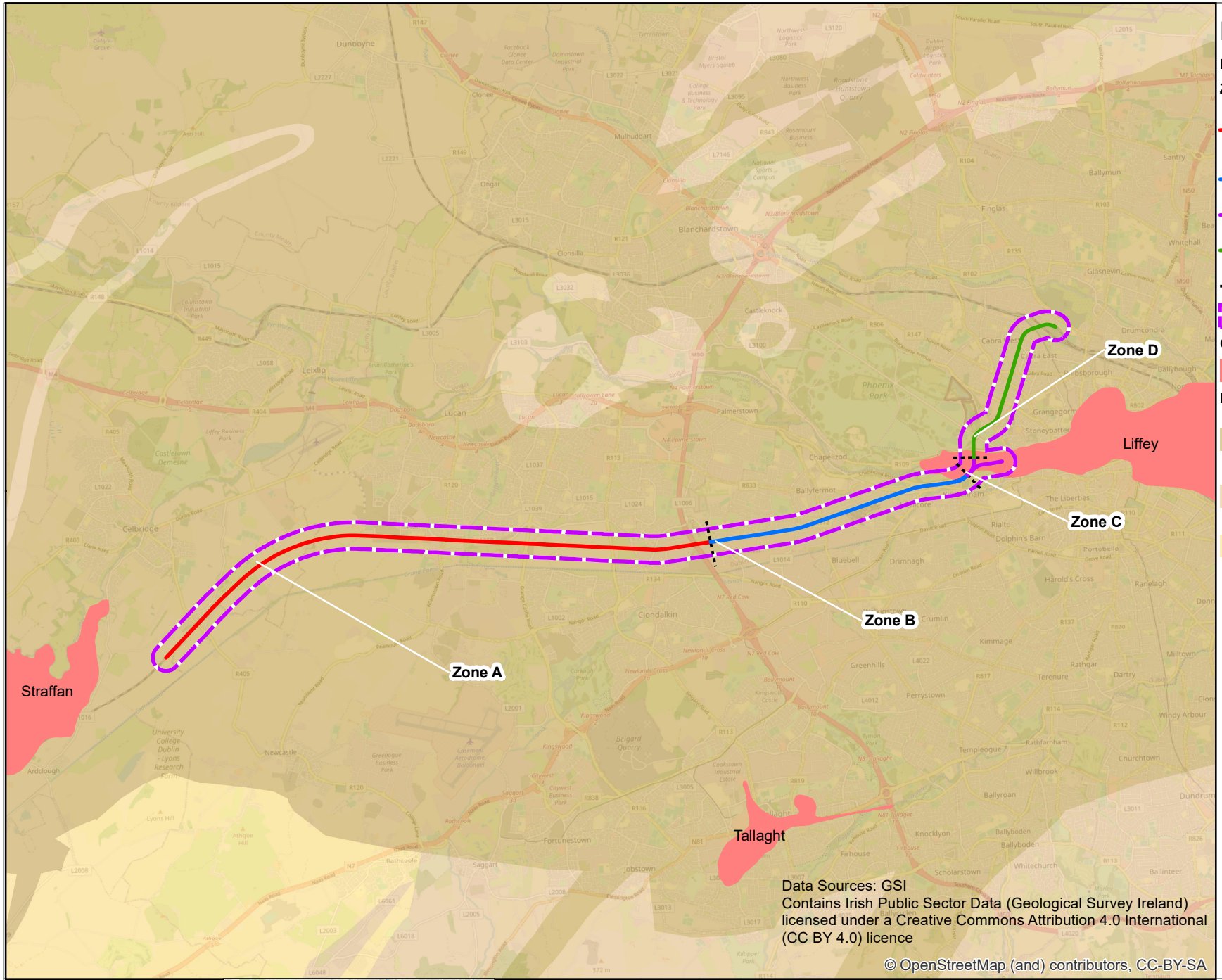


Legend

Rail Network Line

Zone

- Zone A: from Hazelhatch & Celbridge Station to Park West & Cherry Orchard Station
- Zone B: Park Wet & Cherry Orchard Station to Heuston
- Zone C: Heuston Station and Yard
- Zone D: From Liffey Bridge to Glasnevin Junction
- Zone Boundaries
- 250m Buffer Zone

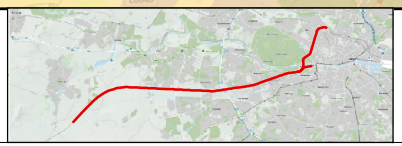
Gravel Aquifer

- Locally important gravel aquifer

Bedrock Aquifer

- LI - Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones
- PI - Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones
- Pu - Poor Aquifer - Bedrock which is Generally Unproductive

N W E S



DART+ South West

NTA Údarás Náisiúnta Iompair National Transport Authority

Tionscadal Éireann Project Ireland 2040

Rev	Date	Drn	Chk'd	App'd	Description
v02	26/10/2022	IP	EH	CR	Bedrock and Gravel Aquifers
v01	29/03/2022	IP	EH	CR	Bedrock and Gravel Aquifers

Client: Iarnród Éireann Irish Rail

Engineering Designer: TYPSA, ATKINS, TUC RAIL

Supported by: rps

Date	Scale	Drawn	Checked	Approved
18/01/2023	1:100,000 @ A4	IP	EH	CR

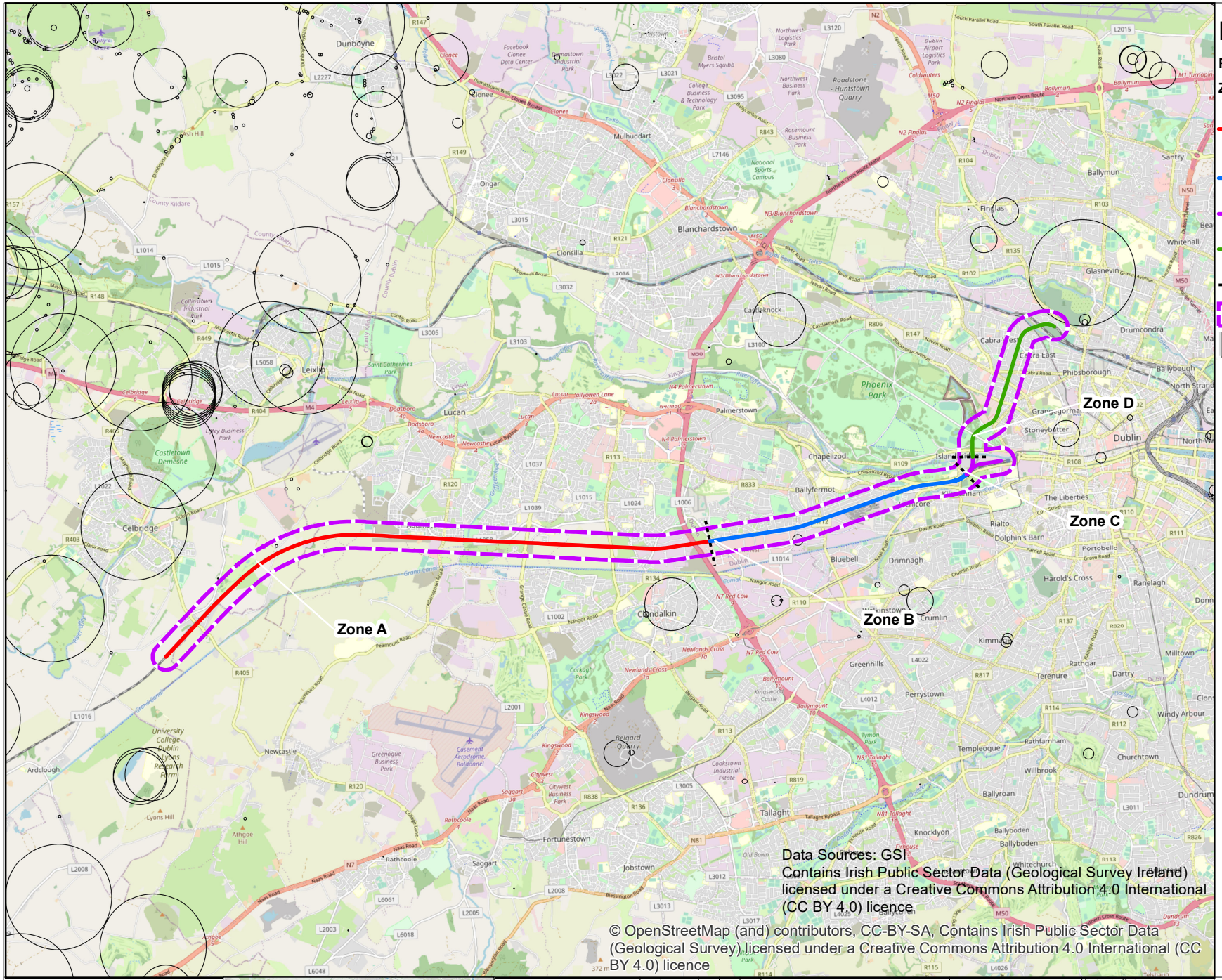
Project Code	Issuer	QMS Code
5195886	TTA	

Project Title: DART + SOUTH WEST

Drawing Title: **Figure 11.4: Aquifer Designation**

Drawing File Name	Version	Status
DP-04-23-DWG-EV-TTA-23744	v02	S3

DO NOT SCALE USE FIGURED DIMENSIONS ONLY



Legend

Rail Network Line

Zone

- Zone A: from Hazelhatch & Celbridge Station to Park West & Cherry Orchard Station
- Zone B: Park Wet & Cherry Orchard Station to Heuston
- Zone C: Heuston Station and Yard
- Zone D: From Liffey Bridge to Glasnevin Junction
- Zone Boundaries
- 250m Buffer Zone
- Groundwater Wells and Springs

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DART+ South West

NTA Údarás Náisiúnta Iompair National Transport Authority

Tionscadal Éireann Project Ireland 2040

Rev	Date	Drn	Chk'd	App'd	Description
v02	26/10/2022	IP	EH	CR	Groundwater Wells and Springs
v01	31/03/2022	IP	EH	CR	Groundwater Wells and Springs

Client: Iarnród Éireann Irish Rail

Engineering Designer: TYPSA, ATKINS, TUC RAIL

Supported by: rps

Date	Scale	Drawn	Checked	Approved
18/01/2023	1:100,000 @ A4	IP	EH	CR

Project Code	Issuer	QMS Code
5195886	TTA	

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

Project Title: **DART + SOUTH WEST**

Drawing Title: **Figure 11.5: Groundwater Wells and Springs**

Drawing File Name	Version	Status
DP-04-23-DWG-EV-TTA-23748	v02	S3

11.4.1.6. Designated Sites

Designated sites refer to Natural Heritage Areas (NHAs) and proposed Natural Heritage Areas (pNHA) that are deemed to be of national ecological importance and are afforded protection under the Wildlife (Amendment) Act 2000. European sites include Special Areas of Conservation (SACs) and Special Protection Areas (SPAs).

There are seven European sites down-gradient of the proposed Project within Dublin Bay (approximately 6.5km east of the eastern most region of the proposed route), three SPAs and four SCAs. The SPAs include North Bull Island (004006), South Dublin Bay and River Tolka Estuary (004024) and Howth Head Coast (004113). The SACs include Howth Head (000202), Rockabill to Dalkey Island (003000), North Dublin Bay (000206) and South Dublin Bay (000210).

There are three National sites in the vicinity of the proposed route. The Liffey Valley (000128) proposed Natural Heritage Area (pNHA) is located approximately 2km north of the proposed route at Ronanstown. The Royal Canal pNHA (002103) is adjacent to the proposed route at Cabra. The Grand Canal pNHA (002104) is approximately 0.5km – 1km south of the proposed route and runs sub-parallel to the route between Kilmainham and Hazelhatch.

North Bull Island is also a listed Ramsar site (406) as it is a small island built up over 200 years against a harbour wall with adjoining foreshore of sandy beaches, saltmarshes and mudflats. The Tolka Estuary is also a listed Ramsar site (832) as it is an intertidal system supporting a large bed of eelgrass (*Zostera noltii*) with extensive areas of sandflats.

A full evaluation of the European, National and Ramsar sites are included in Chapter 8 Biodiversity.

11.4.1.7. Environmental Receptors

The environmental receptors considered relevant to the assessment presented in this chapter and their respective sensitivity is summarised in Table 11.9.

Table 11.8: Environmental Receptors

Receptor	Key Receptor Attributes	Distance from Site Boundary	Receptor Importance
Dublin Groundwater Body	'Good' 2013-2018 WFD Status The GWB is nutrient sensitive Supports designated sites within Dublin Bay protected by EU legislation (e.g., SAC or SPA status)	GWB underlies the full site boundary	Extremely High
Locally Important Bedrock Aquifer	Locally Important Aquifer Site not located in Source Protection Zone	Underlies the majority of the site boundary	Medium
Locally Important 'Liffey' Gravel Aquifer	Locally Important Aquifer Site not located in Source Protection Zone	Underlies the eastern portion of Zone C and all of Zone D	Medium

11.4.2. Evolution of the Environment in the absence of the Project (Do Nothing)

Annex IV of the EIA Directive sets out the information required to be included in an EIAR. This includes:

> *"a description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the project as far as*

natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge".

In the event that the proposed Project does not proceed, an assessment of the future baseline conditions has been carried out and is described within this section.

In the "do-nothing" scenario the interventions for the modernisation of the railway corridor and areas outside of IE lands for the Project would not be undertaken and includes the continued use of the existing railway line. The baseline condition of hydrogeology will remain unaltered under such a scenario other than natural variation in these parameters with time.

11.5. Description of Potential Impacts

11.5.1. Potential Construction Impacts

Potential construction phase impacts on the receiving environment are described in the following section. The primary civil engineering (construction) works which may have potential temporary impacts on hydrogeology are summarised below.

- Ground investigation works for detailed design, further intrusive investigation required to advance the design for construction is likely to include additional boreholes and inspection pits/trial pits.
- Site enabling and preparation works including clearance works (removal of vegetation, trees etc.).
- The undertaking of earthworks including excavations at top or base of cut slopes, new (replacement) overbridges, construction of new retaining walls, topsoil stripping, the stockpiling of material and further processing and haulage by road and rail.
- The installation of temporary works compounds and associated infrastructure. The compounds vary in size and are located as close as possible to the rail corridor and areas where significant works are to be undertaken i.e. bridge replacement / upgrades. to facilitate the installation of the overhead line equipment (OHLE) system, track widening, or upgraded road tie-ins. Potential requirement for limited groundwater pumping/dewatering.
- Retaining structures including significant sections of bored piled walls with continuous flight auger (CFA) piling rigs, soil nailing and cantilever retaining walls.
- Permanent way construction, primarily excavations required for track lowering and widening through the four-tracking section of the scheme. Potential requirement for limited groundwater pumping.
- New track drainage works and upgrades to existing drainage systems including 3 no. new underground stormwater attenuation tanks. Potential requirement for limited groundwater pumping.
- Road reconstruction works including reinstatement of the carriageway as a result of the reconstruction works at overbridges.
- Electrification works including OHLE infrastructure (foundations, masts, wires etc.) and six (6) new substations (fenced compound surrounding building to house electrical switch gear) and

ancillary equipment rooms along the project route for signalling, telecoms and electrification infrastructure and controls.

The construction phase does have the potential to affect hydrogeology and therefore effects considered for this chapter include:

- Infiltration of Surface Water Runoff
- Permanent Alteration to Groundwater Levels and Flows
- Accidental Emissions and Release of Potentially Hazardous Substances

11.5.1.1. Infiltration of Surface Water Runoff

Silt-laden water can arise from exposed ground e.g., excavations and soil stockpiles, during construction. Surface water run-off containing large amounts of silt could migrate into the groundwater which can cause significant pollution of water through the generation of suspended solids. This runoff also has the potential to pick up additional contaminants.

Where topsoil and other soils are to be stored on site, stockpiles with significant side slopes can create another source of sediment laden run-off. Once the slopes are built up, rainfall landing on the slope and runoff from the top of the stockpile can travel uncontrolled – potentially at high velocities – causing suspension of soil particles from the surface of the slope.

Short-term effects on groundwater quality can occur through the infiltration of surface run-off within, or adjacent to construction areas.

Magnitude of Impact

Dublin Groundwater Body

Silt-laden water can arise from exposed ground and soil stockpiles during construction of the proposed Project, particularly in areas of significant excavations and groundworks e.g., bridge construction. Surface water run-off containing large amounts of silt could migrate into the groundwater increasing the concentration of suspended solids and other contaminants, potentially putting the WFD status of this nutrient sensitive GWB under pressure.

Impacts from the construction phase are expected to be localised in nature and confined mainly to the pre-existing rail corridor, of short-term duration and with low risk of a serious pollution incident. The natural subsoil is likely to provide adequate attenuation and filtration, therefore, the magnitude is considered to be Negligible.

Bedrock and Gravel Aquifers

Silt-laden water can arise from exposed ground and soil stockpiles during construction of the proposed Project, particularly in areas of significant excavations and groundworks e.g., bridge reconstructions. Surface water run-off containing large amounts of silt could migrate into the groundwater increasing the concentration of suspended solids and other contaminants.

The impact is predicted to be localised due to the relatively small footprint of the proposed Project, confined largely as it is to the pre-existing rail corridor. The impact will be local, short term, intermittent and with moderate reversibility. The natural subsoil is likely to provide adequate attenuation and filtration, therefore, the magnitude is considered to be Negligible.

Sensitivity of the Receptor

Dublin Groundwater Body

The Dublin GWB currently has a 'Good' status under the WFD and groundwater flows indirectly support 7 no. European sites, downgradient of much of the study area, within Dublin Bay. Due to the GWB interactions with a number of designated EU sites it is of Extremely High importance. The GWB is also nutrient sensitive and therefore susceptible to groundwater contamination.

Bedrock and Gravel Aquifers

There is one Locally Important gravel aquifer (Liffey) and one locally important bedrock aquifer (Lucan Formation) underlying the site, as described in Section 11.4.1.1. Locally Important aquifers are of Medium importance as the attribute has a medium quality, significance or value on a local scale. The groundwater within the aquifers has some value in the local area for abstraction purposes, therefore, is susceptible to groundwater contamination.

Significance of the Effect

Dublin Groundwater Body

The magnitude of impact from infiltration of runoff is considered to be Negligible and the sensitivity of the receptor is considered to be Extremely High; therefore, the effect will be of imperceptible significance.

Bedrock and Gravel Aquifers

The magnitude of the impact is deemed to be Negligible, and the sensitivity of the receptor is considered to be Medium; therefore, the effect will be of imperceptible significance.

11.5.1.2. Permanent Alteration to Groundwater Levels and Flows

During construction activities proposed as part of the works, the potential need for groundwater pumping/dewatering exists, particularly in deeper excavations and new bridge construction works below the water table. Groundwater pumping is required in order to limit the impacts of seepage and maintain a safe and dry work zone. These activities have the potential to impact groundwater levels and flows, for example pumping may generate localised drawdown effects.

Magnitude of Impact

Dublin Groundwater Body

Potential impacts to existing groundwater levels and flow patterns caused by pumping within works zones are likely to be localised in nature, intermittent and of short-term duration. This may result in minor impacts upon the integrity of the GWB (e.g., affect levels locally) however as there are no identified public or private abstractions within the study area the magnitude is considered to be Negligible.

Bedrock and Gravel Aquifers

Potential impacts to existing groundwater levels and flow patterns caused by pumping within works zones are likely to be localised in nature, intermittent and of short-term duration. This may result in

minor impacts upon the integrity of the aquifers (e.g., affect levels locally) however as there are no identified public or private abstractions the magnitude is considered to be Negligible.

Sensitivity of the Receptor

Dublin Groundwater Body

The Dublin GWB currently has a 'Good' status under the WFD and groundwater flows indirectly support 7 no. European sites, downgradient of much of the study area, within Dublin Bay. Due to the GWB interactions with a number of designated EU sites it is of Extremely High importance. Considering the low permeability of the aquifers within the GWB, it is somewhat sensitive to alterations of flows and potential drawdown, as these may result in the reduction of the available groundwater resource in the aquifer.

Bedrock and Gravel Aquifers

One Locally Important gravel aquifer (Liffey) and one locally important bedrock aquifer (Lucan Formation) underlie the site. Locally Important aquifers are of Medium importance as the attribute has a medium quality, significance or value on a local scale. The groundwater within the aquifers have some value in the local area for abstraction purposes, therefore, are susceptible to alterations in levels or flow patterns.

Significance of the Effect

Dublin Groundwater Body

The magnitude of the impact from permanent alteration of groundwater levels/flows is considered to be Negligible and the sensitivity of the receptor is considered to be Extremely High; therefore, the effect will be of Imperceptible significance.

Bedrock and Gravel Aquifers

The magnitude of the impact is deemed to be Negligible, and the sensitivity of the receptor is considered to be Medium; therefore, the effect will be of Imperceptible significance.

11.5.1.3. Accidental Emissions and Release of Potentially Hazardous Substances

Accidental spillages of fuels, chemicals or other contaminants during construction works may result in localised contamination of groundwater (via migration through soil). This includes the disturbance of areas of potential soil contamination (as detailed in Section 9.4.1.5 of Chapter 9).

There is potential for accidental spillage of diesel fuel and/or hydraulic oil from on-site machinery during the construction phase. Construction phase storage of fuels and hazardous materials has the potential to impact groundwater quality if not stored correctly.

Magnitude of Impact

Dublin Groundwater Body

There is a low potential for hazardous substances (e.g., hydrocarbons) to contaminate groundwater within the GWB as a result of an accidental spill within the proposed Project boundary during the construction phase. A potential release could however lead to reduced groundwater quality. The impact is predicted to be localised due to the confined nature of the rail corridor. The impact will be local, short

term, intermittent and with moderate reversibility. The existing low permeability subsoil is likely to provide adequate attenuation, therefore, the magnitude is considered to be Negligible.

Bedrock and Gravel Aquifers

There is a low potential for hazardous substances (e.g., hydrocarbons, cement products) to contaminate groundwater within the underlying aquifers as a result of an accidental spill within the proposed Project boundary during the construction phase. A potential release could however lead to reduced groundwater quality. The impact is predicted to be localised due to the confined nature of the rail corridor. The impact will be local, short term, intermittent and with moderate reversibility. The existing low permeability subsoil is likely to provide adequate attenuation and there are no identified public or private source abstractions; therefore, the magnitude is considered to be Small Adverse.

Sensitivity of the Receptor

Dublin Groundwater Body

The Dublin GWB currently has a 'Good' status under the WFD and groundwater flows indirectly support 7 no. European sites, downgradient of much of the study area, within Dublin Bay. Due to the GWB interactions with a number of designated EU sites it is of Extremely High importance and also sensitive to nutrient loading. Considering the general low permeability of the subsoil and aquifers within the GWB it is considered to have low sensitivity to potential impact by contaminants.

Bedrock and Gravel Aquifers

The two identified locally Important aquifers are of Medium importance as the attribute has a medium quality, significance or value on a local scale. The groundwater within the aquifers may have some value in the local area for private abstraction purposes and therefore, are somewhat susceptible to potential contamination.

Significance of the Effect

Dublin Groundwater Body

The magnitude of the impact from accidental release of potentially hazardous substances is considered to be Negligible and the sensitivity of the receptor is considered to be Extremely High; therefore, the effect will be of Imperceptible significance.

Bedrock and Gravel Aquifers

The magnitude of the impact is deemed to be Small Adverse, and the sensitivity of the receptor is considered to be Medium; therefore, the effect will be of Slight significance.

11.5.2. Potential Operational Impacts

The operational phase (which includes railway maintenance operations) has the potential to affect hydrogeology. Effects considered for this phase include:

- Accidental emissions and release of potentially hazardous substances.

11.5.2.1. Accidental Emissions and Release of Potentially Hazardous Substances

Accidental spillages of fuels (e.g., diesel for portable generators), chemicals (e.g., herbicides for weed control) or other contaminants during operational/maintenance activities may result in localised

contamination of groundwater underlying the site, if materials are not stored and used in an environmentally safe manner.

The impact arising from any contamination event is likely to be low on a local scale due to the highly controlled, small-scale use of fuels and chemicals within the rail corridor during the operational stage, and the temporary duration of any maintenance activities.

The groundwater receptors will be impacted if contamination migrates through the natural ground into the underlying aquifers and groundwater body.

Magnitude of Impact

Dublin Groundwater Body

There is a low potential for hazardous substances (e.g., hydrocarbons) to contaminate groundwater within the GWB as a result of an accidental spill within the proposed Project boundary during the operational phase. A potential release could however lead to reduced groundwater quality. The impact is predicted to be localised due to the nature of operation and maintenance (O&M) works within the rail corridor. The impact will be short term, intermittent and with moderate reversibility, therefore, the magnitude is considered to be Negligible.

Bedrock and Gravel Aquifers

There is a low potential for hazardous substances (e.g., hydrocarbons) to contaminate groundwater within the underlying aquifers as a result of an accidental spill during the operational phase. A potential release could however lead to reduced groundwater quality. The impact is predicted to be localised due to the nature of O&M within the rail corridor. The impact will be local, short term, intermittent and with moderate reversibility. The existing low permeability subsoil is likely to provide adequate attenuation and there are no identified public or private source abstractions; therefore, the magnitude is considered to be Small Adverse.

Sensitivity of the Receptor

Dublin Groundwater Body

The Dublin GWB currently has a ‘Good’ status under the WFD and groundwater flows indirectly support 7 no. European sites, downgradient of much of the study area, within Dublin Bay. Due to the GWB interactions with a number of designated EU sites it is of Extremely High importance and also sensitive to nutrient loading. Considering the general low permeability of the subsoil and aquifers within the GWB it is considered to have low sensitivity to potential impact by contaminants.

Bedrock and Gravel Aquifers

The two identified locally Important aquifers are of Medium importance as the attribute has a medium quality, significance or value on a local scale. The groundwater within the aquifers may have some value in the local area for private abstraction purposes and therefore, are somewhat susceptible to potential contamination.

Significance of the Effect

Dublin Groundwater Body

The magnitude of the impact from accidental release of potentially hazardous substances is considered to be Negligible and the sensitivity of the receptor is considered to be Extremely High; therefore, the effect will be of Imperceptible significance.

Bedrock and Gravel Aquifers

The magnitude of the impact is deemed to be Small Adverse, and the sensitivity of the receptor is considered to be Medium; therefore, the effect will be of Slight significance.

11.6. Mitigation Measures

A Construction Environmental Management Plan (CEMP) has been prepared and is included in Volume 4, Appendix 5.1 of this EIAR. Should planning consent be received for the project, the appointed Main Contractor(s) will assume responsibility for the CEMP including all environmental commitments arising from the EIAR and NIS and any further commitments or conditions from the statutory planning process. It is intended that the CEMP will be a "live" document which will be reviewed prior to and updated during construction according to changing site specific conditions on the project and to reflect current construction activities, manage environmental risks and mitigation.

The Main Contractor(s) will update the CEMP over the duration of pre-construction and construction of the works. The best practice measures and the site-specific mitigation measures as they relate to hydrogeology are outlined below.

11.6.1. Construction Phase

11.6.1.1. Infiltration of Surface Water Runoff

Excavated materials will be carefully managed in accordance with industry best practice during construction, to prevent any potential negative impact on the receiving environment.

- Excess material will be reused on-site or taken directly to an appropriately licenced facility avoiding contact with any open surface water drains.
- Excavated material will not be left uncovered to avoid run-off of silty water and trial pits will be backfilled at the earliest convenience to avoid leaving stockpiles exposed.
- Dust mitigation measures will be based upon the industry guidelines in the Building Research Establishment (BRE) document entitled 'Control of Dust from Construction and Demolition Activities'.
- Movement of material and trafficking will be minimised in order to reduce degradation of soil structure and generation of dust;
- Site roads shall be regularly cleaned and maintained as appropriate. Hard surface roads shall be swept to remove mud and aggregate materials from their surface while any un-surfaced roads shall be restricted to essential site traffic only;

- Any site roads with the potential to give rise to dust will be regularly watered, as appropriate, during dry and/or windy conditions (also applies to vehicles delivering material with dust potential);
- All vehicles exiting the site shall make use of a wheel wash facility prior to entering onto public roads, to ensure mud, dust and other materials are not tracked onto public roads;
- Wheel washes, in so far as is practicable, shall be self-contained systems that do not require discharge of the wastewater to water bodies;
- Public roads outside the site shall be regularly inspected for cleanliness and cleaned as necessary;
- Material handling systems and site stockpiling of materials shall be designed and laid out to minimise exposure to wind;
- Stockpiles will be fully managed through height restrictions, the following constraints will apply to temporary stockpiles:
    - Topsoil stockpiles will not exceed 2 metres in height and will have 1V:2H side slopes; and,
    - Rock stockpiles will not exceed 5 metres in height and will have 1V:2H side slopes.
- Water misting or sprays shall be used as required if particularly dusty activities are necessary during dry or windy periods; and,
- All vehicles which present a risk of spillage of materials, while either delivering or removing materials, will be loaded in such a way as to prevent spillage on to the public road.

Following erosion controls, sediment controls will be implemented to reduce whatever sediment has become suspended despite the erosion controls. The measures will include the use of settlement ponds, flocculation, check-dams or level spreaders, silt fencing and management of stockpiles as appropriate.

The CEMP will develop a programme of visual inspections and audits to ensure the above mitigation is fully implemented.

11.6.1.2. Permanent Alteration to Groundwater Levels and Flows

Additional consideration should be given to any areas of deep excavations or other works likely to extend below the water table during the construction phase. Pumping and removal of groundwater which could interfere with the existing groundwater flow regime should be considered only after ruling out feasibility of other options such as temporary cofferdams. A detailed method statement should be prepared in advance of works involving pumping of groundwater.

Dewatering or pumping rates will be controllable by inline valves or similar in order to limit the volumes removed and the impacts upon receiving drainage network. Quality of pumped waters, particularly in relation to suspended solids will be monitored regularly and additional settlement tanks, silt bags, filters or similar incorporated as needed in order to meet Irish Water or other discharge requirements.

No extracted or pumped groundwater will be discharged directly to surface waters in accordance with the Water Pollution Act 1977, as amended by the 1990 Act.

11.6.1.3. Accidental Emissions and Release of Potentially Hazardous Substances

The following mitigation measures are proposed during the construction phase to manage accidental emissions and release of potential hazardous substances:

- The storage and handling of oils, fuel, chemicals and hydraulic fluids will be in secure areas within the site compounds and will not occur within a minimum of 50m from watercourses;
- Storage of fuels, chemicals and lubricants at the Contractor's compound must be fenced off and have a lockable gate to prevent unauthorised access or vandalism.
- The principal control measures are as follows:
    - Protection measures will be put in place to ensure that all hydrocarbons used during the construction phase are appropriately handled, stored and disposed of in accordance to the TII/NRA document "Guidelines for the crossing of watercourses during the construction of National Road Schemes". All chemical and fuel filling locations will be protected from potential spillages through the provision of appropriate protection measures including bunded areas and double skinned bowser units with spill kits;
    - Storage tanks shall have secondary containment provided by means of an above ground bund to capture any oil leakage. Storage tanks and associated provision, including bunds, will conform to the current best practice for oil storage and will be undertaken in accordance with Best Practice Guide BPGCS005 – Oil Storage Guidelines (Enterprise Ireland);
    - Where required, the pouring of concrete, sealing of joints, application of water-proofing paint or protective systems and curing agents will be completed in the dry and allowed to cure for 48 hours in order to avoid pollution of watercourses;
    - The use and management of concrete in or close to watercourses will be carefully controlled to avoid spillage;
    - An Emergency Response Plan detailing the procedures to be undertaken in the event of a spillage of chemical, fuel or other hazardous wastes (e.g. concrete) to be in place prior to commencement of project. This Plan will contain at a minimum the following mitigation measures:
        - Carry out an investigation to identify the nature, source and cause of the incident and any emission arising therefrom;
        - Isolate the source of any such emission;
        - Evaluate the environmental pollution, if any, caused by the incident;
        - Identify and execute the measures to minimise the emissions/malfunction and the effects thereof;

- Identify the date, time and place of the incident;
- Notify the Agency and other relevant authorities; and,
- The licensee shall provide a proposal to the Agency for its agreement within one month of the incident occurring or as otherwise agreed by the Agency to identify and put in place measures to avoid reoccurrence of the incident and identify and put in place any other appropriate remedial action.

  - Relevant staff, including cover staff shall be trained in the implementation of the Emergency Response Plan and the use of any spill kit / control equipment as necessary; and,
  - Plant and equipment shall be maintained in place and in working order for the duration of the works.

- Site compounds/storage facilities will be located at least 25m away from surface waters. In addition, measures will be implemented to ensure that silt laden or contaminated surface water run-off from the compound does not discharge directly to the surface waters. Compounds shall not be constructed in lands at risk of flooding;
- All soiled construction run-off water will be passed through settlement ponds/silt traps and/or bunds prior to outfall to the receiving surface water where appropriate;
- Management of material deposition areas to prevent siltation of watercourse systems through run-off during rainstorms. It is recommended to construct collector ditches surrounding material stockpiles to contain run-off and direct it to the settlement ponds / silt traps before discharge to an adjacent watercourse; and
- Wheel wash facilities to be appropriately located to ensure wash waters are intercepted, contained and directed to settlement ponds / silt traps prior to discharge to surface waters.

11.6.2. Operational Phase

No operational phase mitigation measures are proposed beyond those contained within the existing Iarnród Éireann Environmental Management Policies and Process document (CCE-IMS-008).

11.7. Monitoring

Based on the conclusions of the impact assessment and residual effects, additional monitoring of groundwater quality, although informative, is not considered necessary.

11.8. Residual Effects

For the purposes of this assessment, a rating of moderate and above is considered significant in EIA terms. The significance of all impacts identified in Section 11.5 will be reduced to imperceptible with the implementation of the mitigation measures outlined in Section 11.6.

Proposed improvements in the ageing drainage infrastructure, treatment of localised areas of ground contamination and electrification of the northern tracks with new electric DART trains are likely to result

in a net long-term benefit to hydrogeology due to reduced contamination of groundwater from these sources.

11.9. Cumulative Effects

The cumulative assessment of relevant plans and projects is undertaken separately in Chapter 26 of this EIAR.

11.10. References

Environment Agency (EA, 2004). *The Model Procedures for the Management of Land Contamination* (CLR 11).

Environment Agency UK (EA, 2020). *Guidance on Land contamination risk management* (LCRM).

Environmental Protection Agency (EPA, 2011). *Guidance on the Authorisation of Discharges to Groundwater*.

Environmental Protection Agency (EPA, 2013). *Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites.*

Environmental Protection Agency (EPA, 2022). *Guidelines on the information to be contained in Environmental Impact Assessment Reports*.

Institute of Geologists of Ireland (IGI, 2013). '*Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements'*.

Institute of Geologists of Ireland (September 2002). '*Geology in Environmental Impact Statements – a Guide'*.

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