Chapter 18

Land, Soils, Geology and Hydrogeology

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18.1 Introduction

This chapter of the Environmental Impact Assessment Report (EIAR) identifies, describes and presents an assessment of the likely significant effects of the N2 Slane Bypass and Public Realm Enhancement Scheme ('the Proposed Scheme') on Land, Soils, Geology and Hydrogeology during both the construction and operational phases of the Proposed Scheme. The assessment presented is based on the information provided in **Chapter 4 – Description of the Proposed Scheme** and **Chapter 5 – Description of Construction Phase**. The assessment presented is further informed by the following EIAR chapters:

- **Chapter 15 – Biodiversity: Terrestrial Ecology:** Impact pathways for terrestrial biodiversity;
- **Chapter 16 – Biodiversity: Aquatic Ecology:** Impact pathways for aquatic biodiversity;
- **Chapter 17 – Water:** Direct or indirect effects on the groundwater environment depending on the degree of interaction between surface water and groundwater;
- **Chapter 20 – Material Assets: Agriculture:** Impacts on agriculture as a function of the quality of land and soils and landtake; and
- **Chapter 23 – Material Assets: Waste Management:** Reuse of soils.

18.2 Methodology

18.2.1 Legislation, Policy and Guidance

18.2.1.1 Legislation

European Legislation

In addition to the EIA Directive and Habitats Directive (see **Chapter 2 – Background and Need for the Scheme, and Chapter 15 – Biodiversity: Terrestrial Ecology**), the following European legislation has been considered during the preparation of this chapter:

- 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); and
- 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).

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.

National Legislation

The following national legislation has been considered during the preparation of this chapter:

- Local Government (Water Pollution) Acts 1977 to 1990;
- Environmental Objectives (Groundwater) Regulations 2010 (S.I. No. 9 of 2010), as amended;
- Environmental Objectives (Groundwater) (Amendment) Regulations 2016 (S.I. No. 366 of 2016);
- European Communities (Water Policy) Regulations 2003 (S.I. No. 722 of 2003), as amended;

- Environmental Objectives (Surface Waters) Regulations 2009 (S.I. No. 272 of 2009), as amended; and
- Drinking Water Regulations 2014 (S.I. No. 122 of 2014), as amended.

18.2.1.2 Policy

The Proposed Scheme is located in the administrative area of Meath County Council (MCC) and the Meath County Development Plan 2021-2027 has been considered in the preparation of this chapter. The chapter also considers the River Basin Management Plan (2022-2027), which is currently available in draft.

18.2.1.3 Guidance

The impact assessment has had regard to the general guidance regarding the undertaking of an EIA [as presented in **Section 1.3.3** of **Chapter 1 – Introduction** and the following topic specific guidance in relation to land, soils, geology and hydrogeology:

- Guidance on Land Contamination Risk Management (Environment Agency UK. 2020);
- Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites (EPA, 2013);
- Guidance on the Authorisation of Discharges to Groundwater (EPA, 2011);
- Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (NRA, 2009);
- The Model Procedures for the Management of Land Contamination (CLR 11) (Environment Agency UK. 2004); and
- Geology in Environmental Impact Statements – A Guide (Institute of Geologists of Ireland (IGI), 2013).

18.2.2 Zone of Influence

The land, soils, geology and hydrogeology study area extends outside the footprint of the Proposed Scheme to include a 1 km buffer zone from the centreline to examine the potential impacts on adjacent soils and land (**Figure 18.1**). To further examine the potential impacts on groundwater, a wider zone of influence for bedrock aquifers and groundwater bodies was also considered.

This includes the three groundwater bodies (GWBs) traversed by the Proposed Scheme - the Wilkinstown, Trim and Donore GWBs which are all currently at ‘Good’ 2013 – 2018 WFD Status. The Water Framework Directive (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 EPA WFD status classifications and risk of not achieving status are assigned to these water bodies as a whole; degradation in water quality in one section of the water body could result in a lower status of the entire water body.

The ZoI also covers the bedrock aquifers traversed which have value in the local area for abstraction purposes. These aquifers are addressed in the baseline section of this chapter.

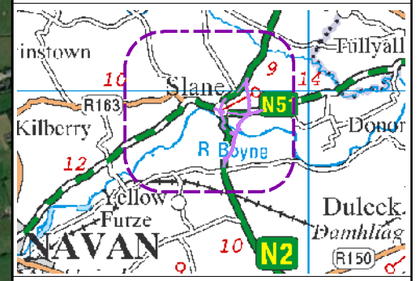
N

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- Proposed Scheme Boundary
- Proposed Scheme
- Study Area

0 0.25 0.5 1
Kilometres



Client
Meath County Council

N2 Slane Bypass and Public Realm Enhancement Scheme

Title
Figure 18.1

Land, Soils, Geology and Hydrogeology Study Area

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Issue Details

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Approved: NO'N	**Projection:** ITM

18.2.3 Sources of Information to Inform the Assessment

The following publicly available data sources have been used to classify the regional and local setting, which are used to support the characterisation of the land, soils, geology and hydrogeology study area:

- Environmental Protection Agency (EPA) Catchments and online resources that include Hydronet (EPA Hydronet) and HydroTool (EPA HydroTool) and GIS maps – accessed October 2021;
- EPA Catchment Science and Management Unit 3rd Cycle Draft Boyne Catchment Report. Available at https://www.catchments.ie/ - accessed March 2022;
- GeoHive geospatial data hub. Available at https://www.geohive.ie/.accessed October 2021;
- Geological Survey of Ireland (GSI) data, maps, reports and research. Available at https://www.gsi.ie/ - accessed October 2021;
- Google Maps. Available at https://www.google.ie/maps/ October 2021;
- Meath County Development Plan (2021-2027);
- National Parks & Wildlife Service maps, data, reports and research. Available at https://www.npws.ie/ - accessed October 2021; and
- Irish Water Slane Public Water Supply Zone - Drinking Water Quality Results 2019-2022 - https://www.water.ie/help/water-quality/results/ - accessed March 2022.

A site walkover was undertaken by an RPS Geo-Environmental Consultant in February 2023 to assess the accessible areas in the vicinity of the study area in regard to land, soils, geology and hydrogeology.

The following unpublished site-specific investigation reporting has informed conceptualisation and baseline characterisation for land and soils:

- Site Investigations for Phase 3 – Design and EIAR:
  - Geotechnical Design Report (RPS, Apr. 2021a);
  - Ground Investigation Report (RPS, Apr. 2021b);
  - Geotechnical Factual Report (GII, Feb. 2021); and
  - Geophysical Survey Report (Minerex, Feb. 2021).
- Site Investigations for Phase 2 – Option Selection:
  - Ground Investigation Report (RPS, Feb. 2019); and
  - Geotechnical Factual Report (IGSL, Sept. 2018).

18.2.4 Key Parameters for Assessment

A description of the works is provided in **Chapter 4 – Description of the Proposed Scheme** and **Chapter 5 – Description of the Construction Phase**. The key activities that have potential to result in likely significant effects on land, soils, geology and hydrogeology are outlined below.

- Loss of soil reserves through the construction of hardstanding, piling and structures, this includes compaction, sealing, erosion and loss of organics.
- Localised ground subsidence or settlement from excavations and induced ground vibrations from drilling / piling works.
- Accidental emission / release of potentially hazardous substances (principally hydrocarbons), resulting in a short-term localised effect on soil.
- Accidental emissions and release of potentially hazardous substances during construction that may affect the quality of soils, 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 soil which could be disturbed during the construction works.

- Short-term effects upon groundwater recharge through the infiltration of surface run-off within or adjacent to construction areas.
- Impacts on surface waters as a result of stormwater run-off causing soil erosion and sedimentation to ground waterbodies.
- Potential impacts to geological heritage areas.

18.2.4.1 Conceptual Site Model

A Conceptual Site Model (CSM) is a representation of the characteristics of the site. It shows the possible relationships between sources, pathways and receptors. As per the IGI's Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements (IGI, 2013), an initial CSM has been developed to highlight the Source-Pathway-Receptor model for assessing impacts. The CSM is presented in **Table 18-1**.

Table 18-1: Conceptual Site Model

Source	Pathway	Receptor	Assessment
Construction Phase			
Accidental Emissions and Release of Potentially Hazardous Substances	Percolation from a spill at the surface into the underlying soil	Soil	The soil receptors are documented in **Section 18.3.1.2**. As stated in the NRA guidance document (NRA, 2009), well drained and/or highly fertility soils are considered High importance and poorly drained and/or low fertility soils are considered Low importance. Therefore, the significance of impact will be greater in areas of well drained/high fertile soils.
	Percolation followed by vertical and horizontal groundwater flow	Bedrock Aquifers	The bedrock aquifer receptors are documented in **Section 18.3.1.4**. The significance of the impact is dependent on the aquifer classification. The impact will be greater in areas where the site is underlain by a Regionally Important Aquifer.
		Public Water Supplies	This Source-Pathway-Receptor linkage refers to the Slane Public Water Supply (**Section 18.3.1.4.4**) located approx. 350 m upstream of the existing N2 River Boyne bridge. Impacts are predicted to be localised to the footprint of the Proposed Scheme; therefore, an impact is not considered likely on the Slane PWS.
Infiltration of Surface Run-off	Surface water drainage/run-off followed by percolation and vertical and horizontal groundwater flow	Bedrock Aquifers	The bedrock aquifer receptors are documented in **Section 18.3.1.4**. The significance of the impact is dependent on the aquifer classification. The impact will be greater in areas where the site is underlain by a Regionally Important Aquifer.
		Public Water Supplies	This Source-Pathway-Receptor linkage refers to the Slane Public Water Supply (**Section 18.3.1.4.4**) located approx. 350 m upstream of the existing N2 River Boyne bridge. Impacts are predicted to be localised to the footprint of the Proposed Scheme; therefore, an impact is not considered likely on the Slane PWS.
Loss of Soil Reserves	Removal of soils	Soil	The soil receptors are documented in **Section 18.3.1.2**. As stated in the NRA guidance document (NRA, 2009), well drained and/or highly fertility soils are considered High importance and poorly drained and/or low fertility soils are considered Low importance. Therefore, the significance of impact will be greater in areas of well drained/high fertile soils.
	Removal of rock	County Geological Site	This Source-Pathway-Receptor linkage will only be relevant where cutting activities remove rock within the boundary of the Boyne Valley County Geological Site (**Section 18.3.1.2.4**).
	Removal of soils (i.e. from cutting) and a loss of overburden (reducing natural attenuation between the surface and bedrock aquifer)	Bedrock Aquifers	The bedrock aquifer receptors are documented in **Section 18.3.1.4**. The significance of the impact is dependent on the aquifer classification. The impact will be greater in areas where the site is underlain by a Regionally Important Aquifer.

Source	Pathway	Receptor	Assessment
Operational Phase			
Accidental Emissions and Release of Potentially Hazardous Substances	Percolation from a spill at the surface into the underlying soil	Soil	The soil receptors are documented in **Section 18.3.1.2**. As stated in the NRA guidance document (NRA, 2009), well drained and/or highly fertility soils are considered High importance and poorly drained and/or low fertility soils are considered Low importance. Therefore, the significance of impact will be greater in areas of well drained/high fertile soils.
	Percolation followed by vertical and horizontal groundwater flow	Bedrock Aquifers	The bedrock aquifer receptors are documented in **Section 18.3.1.4**. The significance of the impact is dependent on the aquifer classification. The impact will be greater in areas where the site is underlain by a Regionally Important Aquifer.
		Public Water Supplies	This Source-Pathway-Receptor linkage refers to the Slane Public Water Supply (**Section 18.3.1.4.4**) located approx. 350 m upstream of the existing N2 River Boyne bridge. Impacts are predicted to be localised to the footprint of the Proposed Scheme; therefore, an impact is not considered likely on the Slane PWS.

18.2.5 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. The importance of geological and 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 (2009) (NRA, 2009). This guidance uses the same significance terminology as the EPA and includes intermediate steps for rating site importance (**Table 18-2**) and magnitude of impact (**Table 18-3**), and then significance of impact (**Table 18-4**). For the purposes of this assessment, a rating of moderate and above is considered significant in EIA terms.

Table 18-2: Rating Criteria for Site Importance of Geology and Hydrogeology Attributes (NRA, 2009)

Importance	Criteria	Typical Examples	
		Soils and Geology	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.	Geological feature rare on a regional or national scale (NHA).	Regionally Important Aquifer with multiple wellfields.
High	Attribute has a high quality or value on a local scale.	Large existing quarry or pit.	Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – NHA status.
Medium	Attribute has a medium quality or value on a local scale.	Proven economically extractable mineral resource.	Regionally important potable water source supplying >2,500 homes.
Low	Attribute has a low quality or value on a local scale.	Contaminated soil on site with previous heavy industrial usage.	Inner source protection area for regionally important water source.

Table 18-3: Rating Criteria for Magnitude of Impact on Geological and Hydrogeological Attributes (NRA, 2009)

Importance	Criteria	Typical Examples	
		Geology	Hydrogeology
Large Adverse	Results in loss of attribute.	Loss of high proportion of future quarry or pit reserves. Irreversible loss of high proportion of local high fertility soils. Removal of entirety of geological heritage features. Requirement to excavate / remediate entire waste site.	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.	Loss of moderate proportion of future quarry or pit reserves. Removal of part of geological heritage feature. Irreversible loss of moderate proportion of local high fertility soils. Requirement to excavate / remediate significant proportion of waste site. Requirement to excavate and replace moderate proportion of peat, organic soils and/or soft mineral soils.	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 of loss of small part of attribute.	Loss of small proportion of future quarry or pit reserves. Removal of small part of geological heritage feature. Irreversible loss of small proportion of local high fertility soils and/or high proportion of local low fertility soils. Requirement to excavate / remediate small proportion of waste site. Requirement to excavate and replace small proportion of peat, organic soils and/or soft mineral soils.	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 not of sufficient magnitude to affect either use or integrity.	No measurable changes in attributes.	Calculated risk of serious pollution incident <0.5% annually.
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 18-4: Rating of Significant Environmental Impacts (NRA, 2009)

Importance	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

18.2.6 Data Limitations

This Chapter of the EIAR has been prepared based upon the best 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 ground investigation and geotechnical reports prepared by RPS, GII and IGSL, as referenced in **Section 18.2.3** were reviewed as part of this assessment, and relevant details included as appropriate throughout.

18.3 Description of Existing Environment (Baseline Scenario)

18.3.1 Current Baseline Environment

Sections 18.3.1.1 to **18.3.1.4** describe the topography, soils geology and hydrogeology baseline for the Proposed Scheme. The environmental receptors are outlined in **Section 18.3.1.6**.

18.3.1.1 Topography and Land Use

The lands through which the Proposed Scheme traverses are predominantly greenfield lands; the public realm proposals occur within Slane village which is mainly comprised of urban fabric. The general topography of the lands tends to fall towards the River Boyne, on both the northern and southern sides of the river. The lowest elevation of the Proposed Scheme is approximately 15 mAOD at the River Boyne, this rises up to approximately 70 mAOD to the south of the Proposed Scheme and 80 mAOD to the north of the Proposed Scheme. The topographic gradient is greatest approaching the River Boyne and becomes shallower with distance from the River Boyne.

The typical use of the greenfield lands through which the route of the Proposed Scheme traverses is for agriculture purposes. These lands are noted to be crossed by several existing ditches of varying depths, which are used to provide drainage to the lands.

As stated in **Chapter 23**, there are two unlicensed and disused legacy dump sites close to Slane village, located in the Fennor and Slane Castle townlands (approximately 970 m and 2.3 km respectively) to the west of the Proposed Scheme, both of these sites are classed as ‘Low Risk’ by Meath County Council.

There are no known former industrial land uses in the study area.

18.3.1.2 Soils and Geology

18.3.1.2.1 Teagasc Soils (Soils)

The Teagasc Soil (Soils) types within the land, soils, geology and hydrogeology study area are displayed in **Figure 18.2**. According to the GSI, the regional soils vary over a short distance. Slane village is underlain by built land (Made Ground) and the River Boyne is underlain by alluvial mineral soils (AlluvMIN).

The area South of the River Boyne is underlain by shallow well-drained (mainly acidic) mineral soil (AminSW), shallow well-drained (mainly basic) mineral soil (BminSW, with isolated regions of shallow poorly drained mineral soil – AminSP) and deep well-drained (mainly acidic) mineral soil (AminDW). Approximately 1 km south of the River Boyne are regions of deep well-drained (mainly basic) mineral soils (BminDW) and shallow well-drained (mainly basic) mineral soil (BminSW) in the rendzinas/lithosols soil group.

North of the River Boyne there are more regions underlain by Made Ground. The soils underlying the area north-west of the River Boyne include AminDW with smaller areas of AminSW and BminSW. The soils underlying the area north-east of the River Boyne include BminDW with smaller areas of BminSW.

18.3.1.2.2 Quaternary Sediments (Subsoils)

The Quaternary sediments (subsoils) underlying the land, soils, geology and hydrogeology study area are displayed in **Figure 18.3**.

According to the GSI, the regional subsoils are varied. The River Boyne is typically underlain by alluvium subsoils. To the south of the River Boyne there is an area sub-parallel to the River Boyne underlain by gravels derived from Lower Palaeozoic sandstones and shales (GLPSsS) and a larger area to the south comprised of till derived from Lower Palaeozoic sandstones and shales (TLPSsS). South of the TLPSsS are areas of till derived from limestone subsoil (TLs) and regions where bedrock outcrop or subcrop is at or close to the surface. There are also tills derived from Namurian sandstones and shales subsoils (TNSSs) south of the River Boyne.

North of the River Boyne there are tills derived from TLPSsS and gravels derived from limestone subsoils (GLs) adjacent to the river. Further north of the river are tills derived from TLs and TLPSsS subsoils.

18.3.1.2.3 Bedrock Geology

The regional bedrock geology is displayed in **Figure 18.4**. The regional geology has been determined from the GSI's online Spatial Data and Resources viewer and is summarised in **Table 18-5**.

The Proposed Scheme is situated within a fault zone with a mix of predominantly north-south and east-west trending faults mapped by the GSI. The bedrock in the north of the site was formed in the Ordovician period and is the oldest bedrock in the study area and tends to get relatively younger towards the south within the Carboniferous bedrock. Where structural data is available, bedrock is often dipping between 30-50° to the south.

Table 18-5: Regional Geological Sequence

Unit Name	Description	System – Series
Donore Formation	The formation consists mainly of interbedded shale and subordinate basinal limestone. Sandstone is present in the upper part (Redmountain Member).	Carboniferous - Namurian
Loughshinny Formation	Dark micrite & calcarenite, shale.	*N/A*
Mattock Member	It is characterised by intermittent slumps and boulder conglomerate beds among turbiditic calcarenites. The boulder beds contain some 1 m sized clasts of mudmound micrite and corals. Clasts of Platin Formation have also been recognised.	Carboniferous - Dinantian
Fennor Formation	The formation is coarser grained than most of the Boyne Formation and includes common slumps and debris flows. Rees divided this into two members, the lower consists of limestone breccias and pale grey, thickly bedded, coarse grained turbidites.	Carboniferous - Dinantian

Unit Name	Description	System – Series
Kiln Hill Member	This member consists of thickly bedded, shelf-derived, pale grey, peloidal and crinoidal turbidites, with occasional micrites and interbedded shales. Soft sediment slides are common locally.	Carboniferous - Dinantian
Boyne Formation	It consists mainly of calciturbidites; shales or micrites are locally predominant.	Carboniferous - Dinantian
Mooretown Formation	Crinoidal wackestone-packstone beds surrounding the Waulsortian Limestones (described below).	Carboniferous - Dinantian
Waulsortian Limestones	Sometimes informally called "reef" limestones, although inaccurate. Dominantly pale grey, crudely bedded or massive limestone.	Carboniferous - Dinantian
Slane Castle Formation	Argillaceous bioclastic limestone and interbedded shales that are laterally equivalent to the Ballysteen Limestone.	Carboniferous - Dinantian
Knockerk Formation	This formation was originally separated into four members: a sandstone member consisting of tuffaceous sandstones with minor shales. The sandstones are locally fossiliferous, early Caradoc brachiopods.	Ordovician - Caradoc
White Island Bridge Formation	This Formation is composed of interbedded lapilli tuff, crystal tuffs, volcanic breccia, basic lavas, turbidite sandstones and graptolitic siltstones.	Ordovician - Llanvirn
Hill Of Slane Formation	Massive to bedded lapilli tuffs.	Ordovician - Llanvirn

18.3.1.2.4 Geological Protected Sites

The GSI online database indicates that the Proposed Scheme traverses the Boyne Valley Audited Site (MH011) that formed during the last Ice Age (before circa 10,000 years ago). The site is a glacial U-shaped valley with characteristic depositional and erosional features associated with ice flow and glacial meltwater located along the River Boyne.

The site is currently a County Geological Site (CGS) but may be recommended for Geological Natural Heritage Area (NHA) status. The site is a nationally important example of a glacially derived valley, with easily accessible features along both sides of the Boyne River. Many of the important glacial features detailed above already lie within the Boyne Woods NHA (Site Code: 001592) and the River Boyne and River Blackwater SAC (Site Code: 002299).

18.3.1.2.5 Geohazards

According to the GSI online database, there are no geohazards mapped by the GSI within the 1 km study area.

N

Soil Description

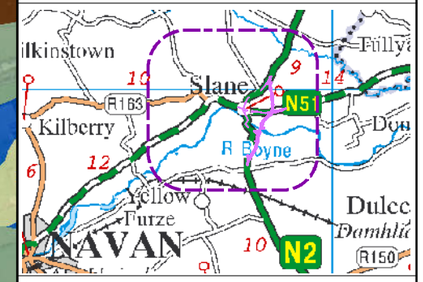
- AlluvMIN - Mineral Alluvium
- AminDW - Acid Brown Earths/ Brown Podzolics
- AminPD - Surface Water/ Groundwater Gleys Acidic
- AminSP - Surface Water/ Groundwater Gleys Shallow
- AminSRPT - Podzols Peaty
- AminSW - Lithosols/ Regosols
- BminDW - Grey Brown Podzolics/ Brown Earths Basic
- BminPD - Surface Water/ Groundwater Gleys Shallow Basic
- BminPDPT - Peaty Gleys
- BminSP - Surface Water/ GroundwaterGleys Shallow
- BminSW - Rendzinas/ Lithosols
- FenPt - Fen Peat
- Cut - Cut Bog
- Lacustrine
- Made Ground
- Water

Legend

- Proposed Scheme Boundary
- Proposed Scheme
- Study Area

Data Source: EPA, GSI, Forest Service and Teagasc 2006 Soil Mapping 1:50000.

0 0.25 0.5 1 Kilometres



Client
Meath County Council

N2 Slane Bypass and Public Realm Enhancement Scheme

Title
Figure 18.2

Teagasc Soil Types

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Issue Details

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Status: A1	**Rev:** C01	**Model File Identifier:** MDT0806-RPS-01-N2-M2-C-XM1001 MDT0806-RPS-01-PR-M2-C-XR9000
Drawn: NR		**Date:** 24/05/2023
Checked: MK		**Scale:** 1:22,000 (A3)
Approved: NO'N		**Projection:** ITM

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Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

N

Parent Material

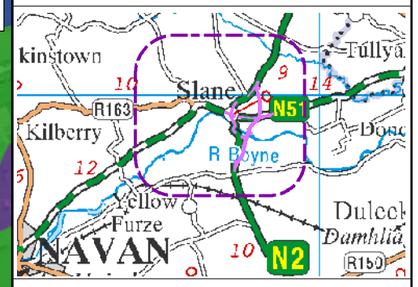
- A - Alluvium
- Cut - Cut Peat
- FenPt - Fen Peat
- GLPSsS - Sandstone and shale Sands and Gravels (Lower Palaeozoic)
- GLs - Limestone Sands and Gravels (Carboniferous)
- KaRck - Karstified Limestone Bedrock at Surface
- TBi - Basic Igneous Till
- TLPSsS - Sandstone and Shale Till (Lower Palaeozoic)
- TLs - Limestone Till (Carboniferous)
- TNSSs - Shale and Sandstone Till (Namurian)
- Laucstrine
- Rock
- Made Ground
- Water

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- Proposed Scheme Boundary
- Proposed Scheme
- Study Area

0 0.25 0.5 1
Kilometres



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Title
Figure 18.3

Subsoil Types

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Issue Details

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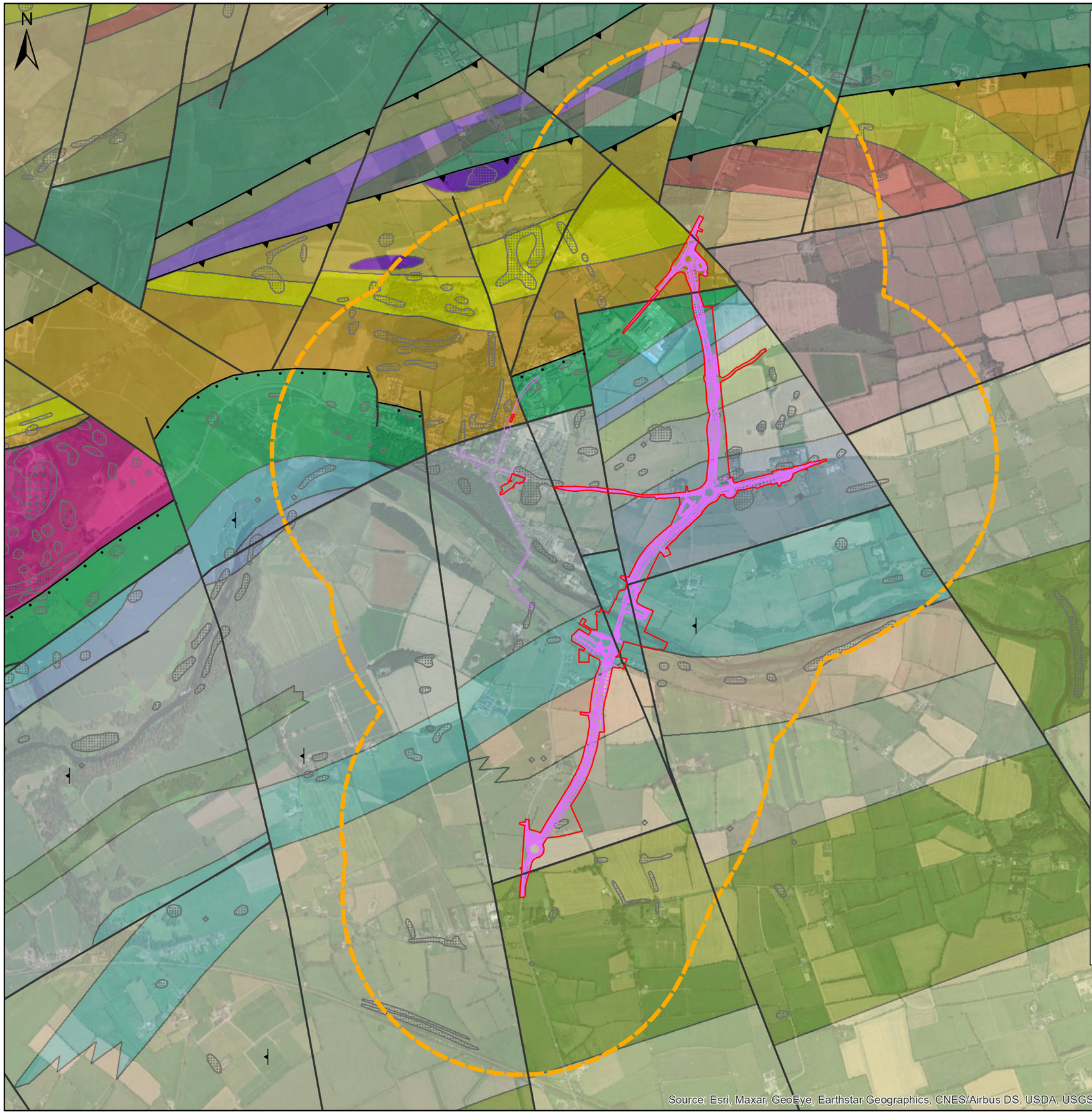


First folliation parallel to bedding
Fault
Synclinal Axis
Thrust, barbs on hanging-wall side
Unconformity, dots on younger side
Bedrock Outcrop

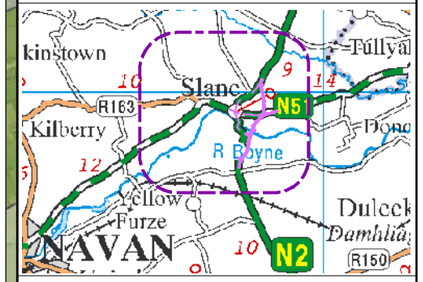
Bedrock Units (1:100k)

- Broomfield Formation
- Brittstown Formation
- Bryanstown Formation
- Boyne Formation
- Beauparc Member (Boyne Formation)
- Kiln Hill Member (Boyne Formation)
- Fennor Formation
- Loughshinny Formation
- Mattock Member (Loughshinny Formation)
- Mooretown Formation
- Navan Beds
- Slane Castle Formation
- Waulsortian Limestones
- Clogherhead Formation
- Balrickard Formation
- Donore Formation
- Walshestown Formation
- Collon Formation
- Carrickdexter Formation
- Fieldstown Formation
- Glaspistol Formation
- Hill of Slane Formation
- Knockerk Formation
- Oriel Brook Formation
- Rathkenny Formation
- St. Mary's basalts
- White Island Bridge Formation

Legend

Proposed Scheme Boundary
Proposed Scheme
Study Area

0 0.25 0.5 1
Kilometres



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Title
Figure 18.4

Bedrock Geology

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18.3.1.3 Site-specific Investigations

A number of site investigation reports have been used to inform the baseline section of this chapter; refer to **Section 18.2.3**.

18.3.1.3.1 Phase 2 – Route Selection Stage

A Phase 2 factual Ground Investigation Report was prepared for the Proposed Scheme (IGSL, September 2018). Site works were located in townlands both to the east and west of Slane village. The geotechnical investigation comprised machine-excavated trial pitting in addition to cable percussion boring and rotary coring. Geotechnical laboratory testing was carried out on selected disturbed bulk soil samples and on rock core samples. Soil testing included particle size distribution, Atterberg limits, California bearing ratio (CBR), moisture condition value (MCV), pH and water-soluble sulphate analysis.

A Geotechnical Interpretative Report was also prepared (RPS, 2019) for the bypass optioneering stage. The report found that typically, the study area is underlain by approximately 0.3 m of topsoil underlain by glacial soils (typically firm to stiff sandy slightly gravelly SILT/CLAY with medium to high cobbles and boulders). The glacial soils are frequently underlain with a mixture of silty gravelly SAND and sandy silty GRAVEL, which are generally well-draining granular materials. However, as the Proposed Scheme has a relatively large area, soil, subsoil and geology type are expected to vary across the entire site.

18.3.1.3.2 Phase 3 – Design & EIA Stage

A Phase 3 Ground Investigation Report was prepared for the Proposed Scheme (GII February 2021). The purpose of the ground investigation was to investigate subsurface conditions utilising a variety of investigative methods in accordance with the project specification. The investigation found the strata generally consisted of the following:

- **Topsoil:** Topsoil was encountered in all the exploratory holes and was present to a maximum depth of 0.5 m.
- **Cohesive Deposits**: Cohesive deposits were encountered beneath the Made Ground and were described typically as brown sandy gravelly CLAY with occasional cobbles and boulders. The secondary sand and gravel constituents varied across the site and with depth, with granular lenses occasionally present in the glacial till matrix. The strength of the cohesive deposits typically increased with depth and was firm or firm to stiff and stiff deeper than 1.0 to 1.5 m below ground level (bgl) in the majority of the exploratory holes. These deposits had some occasional or frequent cobble and boulder content were noted on the exploratory hole logs.
- **Granular Deposits:** Granular deposits were encountered within a number of trial pits (TP) and were typically described as grey-brown clayey gravelly fine to coarse SAND or sandy GRAVEL. The secondary sand/gravel and silt/clay constituents varied across the site and with depth while occasional, some or frequent cobble content was also present. It should be noted that some of the trial pits where granular deposits or groundwater were encountered, experienced instability. This was described either as side wall spalling or as side wall collapse in the remarks section at the base of the trial pit logs.
- **Bedrock:** The rotary boreholes recovered varied rock types from across the site including limestone mudstone, sandstone and breccia. This which corresponds to the geological mapping that shows the area to be highly faulted with varied lithologies.

The geotechnical testing carried out on soil samples recovered generally confirm the descriptions on the logs with the primary constituent of the cohesive deposits found to be a CLAY of low to intermediate plasticity. The particle size distribution tests confirmed that generally the granular deposits are well-graded with percentages of silt/clay typically between 7% and 36%, with a gravel content of typically 38% to 61%, and a sand content of typically 13% to 54%.

Groundwater strikes were noted on the exploratory hole logs where they occurred and where possible drilling was suspended for twenty minutes to allow the subsequent rise in groundwater to be recorded. The exploratory holes did not remain open for sufficiently long periods of time to establish the hydrogeological regime and groundwater levels would be expected to vary with the tide, time of year, rainfall, nearby construction and other factors. For this reason, standpipes were installed in boreholes (BH) BH319A, BH317A, BH315 and BH305A to allow the equilibrium groundwater level to be determined.

Further to this a Phase 3 Ground Investigation Report was prepared (RPS, February 2021) which separated the ground materials into the profile outlined in **Table 18-6**.

Table 18-6: Phase 3 (Design and EIA) Ground Investigation Summary

Material	Extent	Thickness (m)	Description
Topsoil	Whole of the site, except for roads and residential areas	Up to 0.5 m	Brown, slightly sandy, slightly gravelly clay with roots
Made ground	In existing roads and earthworks	Up to 2 m	Sandy clay or gravel with cobbles or concrete.
Alluvium	At the base of the Boyne River Valley	Up to 2 m	The geophysical reports describe the alluvium as soft clay and silt. There are no descriptions of alluvium within the SAC because intrusive ground investigations have not been undertaken in the Boyne River Valley Special Area of Conservation.
Glaciofluvial terrace gravel	On the steep slope on the south side of the Boyne River Valley	–	There are no descriptions of alluvium because intrusive ground investigations have not been undertaken in the River Boyne and River Blackwater Special Area of Conservation. Published surficial geology maps describe the glaciofluvial terrace gravel as derived from sandstones and shales.
Glacial till	Whole of the site, except for rock outcrops	Up to 25 m (typically 2 m to 10 m)	Soft to very stiff, brown, slightly sandy, slightly gravelly clay or silt with cobbles. Low to medium plasticity.
Coarse soil	Intermittent within and below the glacial till	Up to 5 m (typically 1 m to 2 m)	Clayey, sandy gravel with cobbles. Sand is fine to coarse. Gravel is subangular, fine to coarse and of various lithologies.
Rock	Whole of the site, generally underlying, then surficial deposits, except where exposed in rock outcrops	–	Strong, grey, limestone. Thinly laminated.

There is one karst feature mapped by the GSI in the vicinity of the site, a swallow hole in Crewbane. From the published data and the ground investigations, a list of areas with possible karst features is compiled in **Table 18-7**.

Table 18-7: Areas of Possible Karst Features

Location	Evidence of possible karst
Ch. 50 to 200	• Limestone outcrop
Ch. 400 to 500	• Geophysical evidence of ‘clay-filled very weathered limestone’
Ch. 520 and Ch. 800	• Abrupt change in geophysical interpretation with no faults recorded on geological maps
Ch. 630 to 820	• Limestone outcrop from Ch. 550 to Ch.750 • Geophysical evidence of ‘clay-filled very weathered limestone’ • BH304 records clay within rock, within cut
Ch. 950 to 1600 (including the bridge across the River Boyne)	• Geophysical evidence of ‘clay-filled very weathered limestone’ • Identified as a ‘Locally Important Aquifer – Karstified’ on the Groundwater Resources layer • BH305A at Ch. 980 records clay-filled cavity in rock at 17.4 mbgl (6 m below toe of cut)
N51 East	• Limestone outcrop • There is a swallow hole recorded 300m south.

Location	Evidence of possible karst
	• There are irregular landforms within the earthworks footprint at Ch. 200. These may be associated with historic quarrying but will need to be investigated for possible karst.
Ch. 1710 and Ch. 1810	• Abrupt change in geophysical interpretation with no faults recorded on geological maps
Ch. 1990 to 2160	• Geophysical evidence of 'clay-filled very weathered limestone'
Ch. 2500	• Abrupt change in geophysical interpretation with no faults recorded on geological maps
Ch.2500 to Ch.2600	• Limestone outcrop • BH317A at Ch. 2510 records clay-filled cavity in rock at 11.4 mbgl to 14.2 mbgl (6 m below toe of cut)
Ch. 3400 to 3500 and N2 West, off the North Roundabout	• Karstified bedrock outcrop

Groundwater has been measured in 6 no. standpipes. It is between 1.6 mbgl and 17 mbgl. Groundwater strikes are mostly within 5 m of the ground surface. It is expected that the design groundwater level will be within 1 m or 2 m of the surface across most of the site.

A geophysical survey report was also prepared (Minerex Geophysics Limited, February 2021) for Phase 3. The main objectives of the first survey were to determine the ground conditions under the site, determine the depth to rock and the overburden thickness, to estimate the strength/stiffness/compaction of overburden and the rock quality, to establish the presence of faults and fracture zones, to detect possible karstified rock and to determine the s-wave velocity and the small strain shear modulus. The second survey in the flood plain aimed at revised pier locations and to determine the electrical ground conductivity in the floodplain and interpret any soft ground from this.

A Geotechnical Design Report was also prepared (RPS, April 2021), outlining the earthworks, structures, drainage, design, ground treatment and geotechnical risk register. The report states that *agriculture activities may lead to pesticide contamination however this is unlikely. There is also a possibility of coal tar in existing roads. Asphalt road surfaces laid down in the 1980s or earlier may contain coal tar which was commonly used as a binder in road construction, before being superseded by bitumen. There are also no obviously elevated results from contamination tests carried out during ground investigations.*

18.3.1.4 Hydrogeology

18.3.1.4.1 Groundwater Vulnerability

In accordance with the WFD, it is necessary to understand the groundwater vulnerability of the study area, 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 18-8**. Groundwater vulnerability classifications are based on the type and thickness of subsoils and the presence of karst features.

Table 18-8: 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 – 3.0 m	0 – 3.0 m	0 – 3.0 m	0 – 3.0 m	–
High (H)	>3.0 m	3.0 – 10.0 m	3.0 – 5.0 m	>3.0 m	*N/A*
Moderate (M)	*N/A*	>10.0 m	5.0 – 10.0 m	*N/A*	*N/A*
Low (L)	*N/A*	*N/A*	>10.0 m	*N/A*	*N/A*

The groundwater vulnerability designation in the vicinity of the site is shown in **Figure 18.5**. The Proposed Scheme overlies regions of Moderate to Extreme groundwater vulnerability. Regions of High and Extreme groundwater vulnerability are common adjacent to the River Boyne.

The existing N2 route through Slane village traverses across large regions of High and Extreme groundwater vulnerability. The proposed bypass route traverses across areas of Moderate, High and Extreme groundwater vulnerability, with the Moderate classification being in the northern-most and central parts of the scheme, and in small parts of the southern section of the route. The site investigation found topsoil and made ground underlain by alluvium, glaciofluvial terrace gravel, glacial till and coarse soil deposits between 2 m and 25 m prior to encountering rock. Groundwater was measured at the site between 1.6 mbgl and 17 mbgl, demonstrating a varied groundwater vulnerability across the site.

Groundwater vulnerability within the landtake boundary for the Proposed Scheme can be affected by the removal of soil, subsoil and bedrock during construction operations, altering the characteristics of the unsaturated zone.

18.3.1.4.2 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 poorly productive) and groundwater flow type and attenuation potential (through fissures, karst conduits or intergranular).

The aquifers in the vicinity of the Proposed Scheme are displayed in **Figure 18.6** and the type of aquifer are defined in **Table 18-9**. The figure shows that the central region of the site has more productive locally important karstified and bedrock aquifers, whereas the south and north of the site are less productive poor aquifers, or locally important aquifers that are moderately productive only in local zones.

Table 18-9: Aquifer Descriptions

Aquifer Type	Description (Source: GSI)	Associated Bedrock
Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones (Ll)	Similar to a Locally Important Bedrock Aquifer, Moderately Productive only in Local Zones (Ll), but with fewer and more poorly connected fractures, fissures and joints, and with less permeable and/or more limited zones of higher permeability. Overall permeability, storage capacity, recharge acceptance, length of flow path and baseflow are likely to be less than in Ll aquifers.	Balrickard Formation Donore Formation White Island Bridge Formation Hill of Slane Formation Knockerk Formation
Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones (Ll)	Aquifer with a limited and relatively poorly connected network of fractures, fissures and joints, 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. Due to the low permeability and poor storage capacity, the aquifer has a low 'recharge acceptance'. Some recharge in the upper, more fractured/weathered zone is likely to flow along the relatively short flow paths and rapidly discharge to streams, small springs and seeps. Groundwater discharge to streams ('baseflow') can significantly decrease in the drier summer months.	Waulsortian Limestones Slane Castle Formation Navan Beds
Locally Important Aquifer – Karstified (Lk)	Essentially similar to the Regionally Important Karstified Bedrock Aquifer (Rk), but with a smaller continuous area (<c. 25 km^2). Although the properties imply that this aquifer can supply 'excellent' yields, the smaller size limits the amount of recharge available to meet abstractions. An Rk aquifer is defined as follows - '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	Fennor Formation

Aquifer Type	Description (Source: GSI)	Associated Bedrock
	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).	
Locally Important Aquifer - Bedrock which is Generally Moderately Productive (Lm)	Aquifer in which the network of fractures, fissures and joints, through which groundwater flows, is reasonably well connected and dispersed throughout the rock, giving a moderate permeability and groundwater throughput. Aquifer storage is moderate and groundwater flow paths can be up to several kilometres in length. There is likely to be a substantial groundwater contribution to surface waters ('baseflow') and large (>2,000 m^3/d), dependable springs may be associated with these aquifers.	Loughshinny Formation Mattock Member Kiln Hill Member Boyne Formation

18.3.1.4.3 WFD Groundwater Bodies

Groundwater Bodies (GWB) have been designated for the purpose of the WFD. GWB 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 site of the Proposed Scheme is underlain by three individual GWB, the Wilkinstown, Trim and Donore GWB. The details of the GWB are summarised in **Table 18-10** and displayed in **Figure 18.7**.

The risk of the GWB refers to the risk for each water body of failing to meet its WFD objectives by 2027. The risk of not meeting WFD objectives has been determined by the EPA through assessment of monitoring data, data on the pressures, and data on the measures that have been implemented. Water bodies that are *At Risk* are prioritised for the implementation of measures in the National River Basin Management Plans. The risk assessment was completed in 2020 by the EPA Catchments Unit in conjunction with other public bodies and was primarily based on monitoring data up to the end of 2018.

The status of the GWB refers to status results based on the assessment of groundwater chemical and quantitative figures in Ireland. This is drawn from representative monitoring points selected specifically for the WFD groundwater monitoring programme.

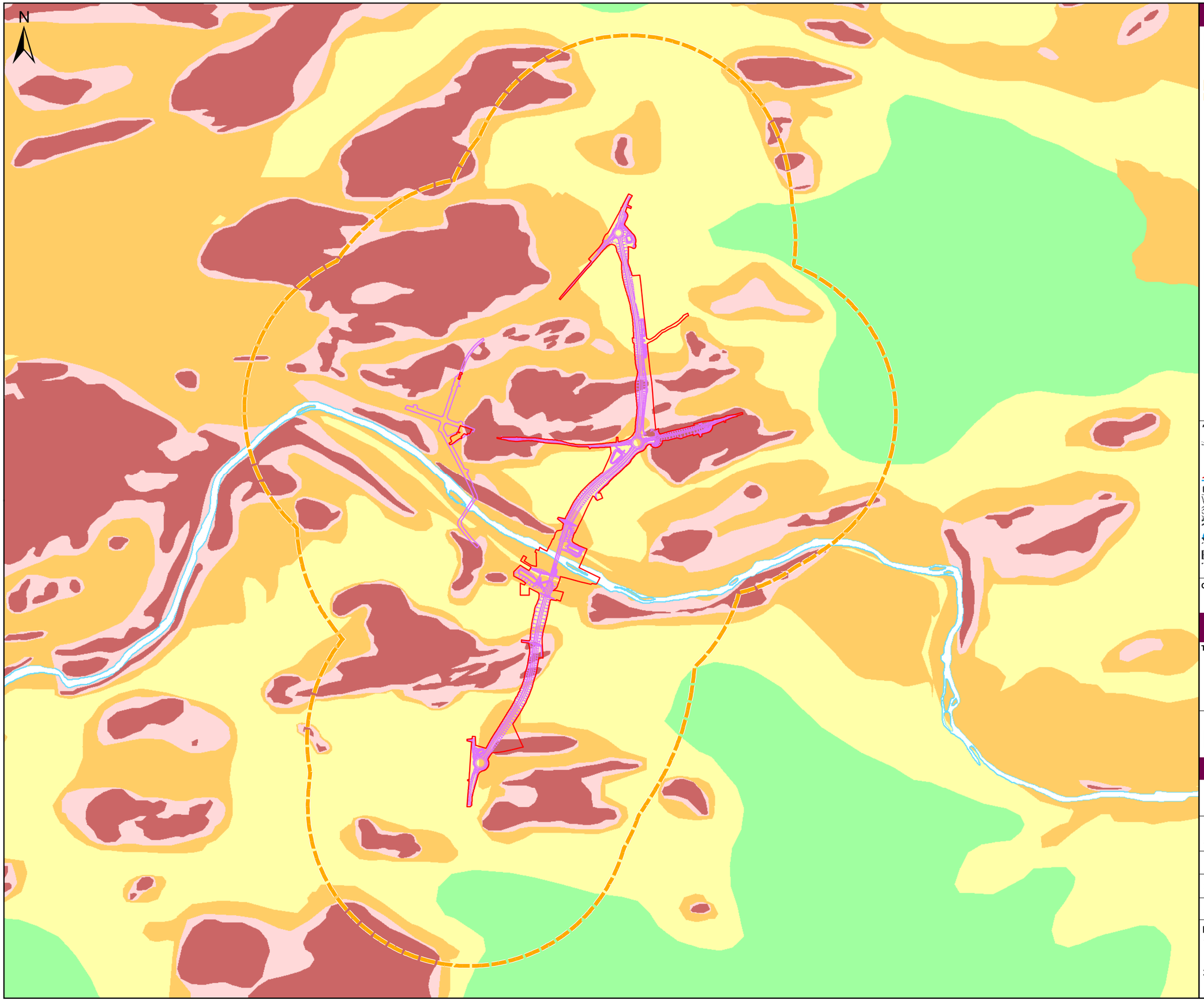
Table 18-10: Groundwater Bodies Summary

Name (Code)	Description	WFD Status (2016-2021)	Risk
Wilkinstown (IE_EA_G_010)	This GWB is located north of Drogheda in the northeast of the Boyne Catchment. The GWB is made up of Poor (Pl and Pu category) and locally important (Lm) aquifers (refer also to **Section 18.3.1.4.2**, Aquifer Designation). Water will enter this aquifer by diffuse recharge. The potential recharge will be highest in areas of thin or permeable subsoil e.g. at the tops of the many hills which are present in the area. It must be noted that not all of the potential recharge will reach the water table, as some will be rejected because the permeability of the rocks is low. The rejected recharge will run-off to the nearest surface water bodies. This accounts for the high drainage density seen in this area. Discharge from this aquifer is to the overlying rivers and streams in the area. There may also be direct discharge to the limestone aquifers to the south. Dry weather flow values for the aquifer are very low. This indicates that the aquifer does not have a large storativity to maintain	Review	At Risk

Name (Code)	Description	WFD Status (2016-2021)	Risk
	summer flows. Discharge to river systems will be rapid and most water will pass through an upper weathered zone straight through to the rivers. The majority of groundwater flow in this aquifer is considered to take place in an upper weathered zone. The EPA catchments.ie data page indicates that the GWB has failed its overall WFD status for 2016-2021 on the basis of its chemical status parameter (Drinking Water Protected Area test), with the reason being nutrients (i.e. nitrate [as NO_3]).		
Trim (IE_EA_G_002)	This GWB occupies an area of mostly undulating lowlands in Co. Meath, with some hillier areas located at the GWB boundaries. The GWB is mainly composed of locally important (Lm) aquifers with small areas of Ll, regionally important karstified aquifers (Rk) and Poor (Pl) aquifers. Two recharge mechanisms occur in this GWB: point recharge and diffuse recharge. Diffuse recharge occurs over the majority of the area, being higher in areas where subsoil is thinner and/or more permeable. Due to the karstic nature of the aquifer, it is possible to have point recharge, typically at swallow holes where a large amount of concentrated recharge occurs in a small area. The main discharge mechanism for this aquifer is as baseflow to the River Boyne and its tributaries. Discharge from the aquifer will also occur via springs, many of which are recorded in the GSI Karst database. The nature of groundwater flow in this aquifer will be determined by the degree of karstification and fracturing and the purity of the limestones. In highly karstified limestone, flow will be concentrated into conduits, which may draw water very deep underground. Groundwater and surface water are more closely linked at certain karst features such as springs and swallow holes.	Good	Not at Risk
Donore (IE_EA_G_021)	This GWB, in County Meath near Slane, is low-lying to the west, with higher elevations in the east. The River Boyne crosses onto this GWB. The GWB is composed of locally important aquifers (Ll). 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. Groundwater will discharge from this GWB to the streams overlying the aquifer where the rock is in hydraulic continuity with the riverbed. This discharge is the baseflow of the rivers, which supports summer flows. Groundwater movement in these rocks is expected to occur relatively rapidly and at shallow depths. The rock unit's permeability depends on the presence of faults and joints along which groundwater can flow.	Good	Not at Risk

Climatic and rainfall data for the site of the Proposed Scheme has been obtained and is described in detail in **Chapter 19 – Climate**.

Regional groundwater flow is generally towards the River Boyne and eastwards, but locally it is dependent on topography and moves in all directions to the meandering River Boyne. It is inferred that the river is in hydraulic continuity with the water table, at least in the vicinity of the Slane Public Water Supply (PWS) wells. The exact flow direction is difficult to assess due to the flat lying ground near the PWS wells. Groundwater gradients in the general area may range from approximately 0.01m to 0.04m. The steeper gradients occur from the valley sides, while along the river the gradients are quite shallow.



Legend

- Proposed Scheme Boundary
- Proposed Scheme
- Study Area

Groundwater Vulnerability Rating

- Extreme (Rock Near Surface/Karst)
- Extreme
- High
- Moderate
- Low
- Water

Data Source: GSI Groundwater Vulnerability 1:40000
Contains Irish Public Sector Data
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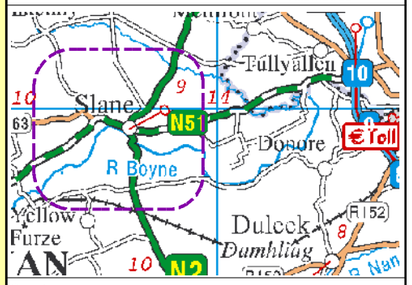

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Title
Figure 18.5

Groundwater Vulnerability

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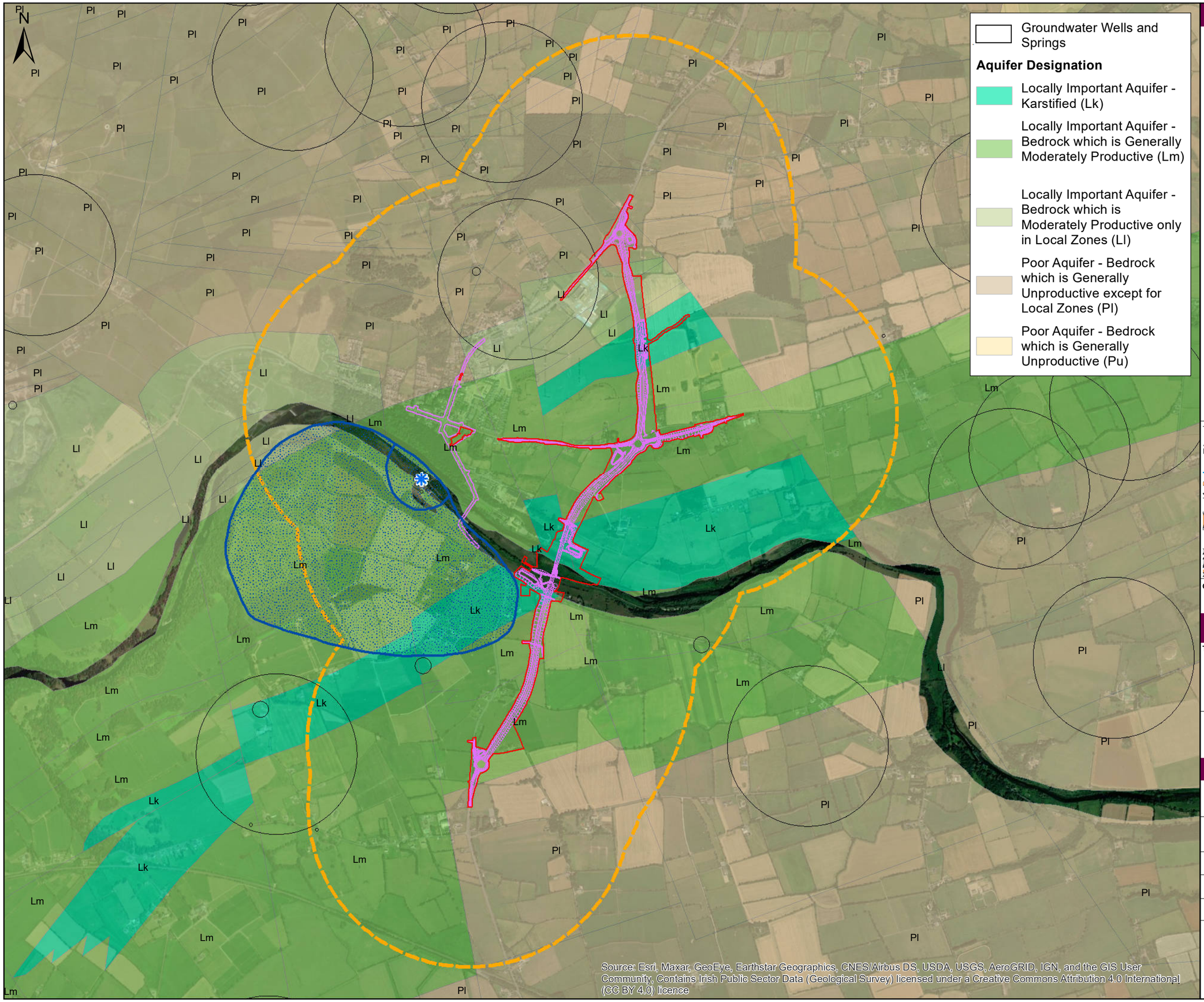
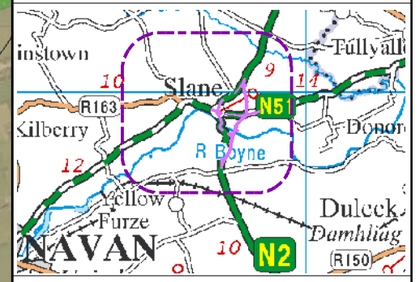


Legend

- Proposed Scheme
- Proposed Scheme Boundary
- Study Area for Land, Soils, Geology & Hydrogeology
- Abstraction for Public Water Supply
- Groundwater Source Protection Zone

Data Source: GSI Aquifers Bedrock Classes 1:100000
GSI Wells and Springs

0 0.25 0.5 1
Kilometres



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Title
Figure 18.6

Aquifer Designation

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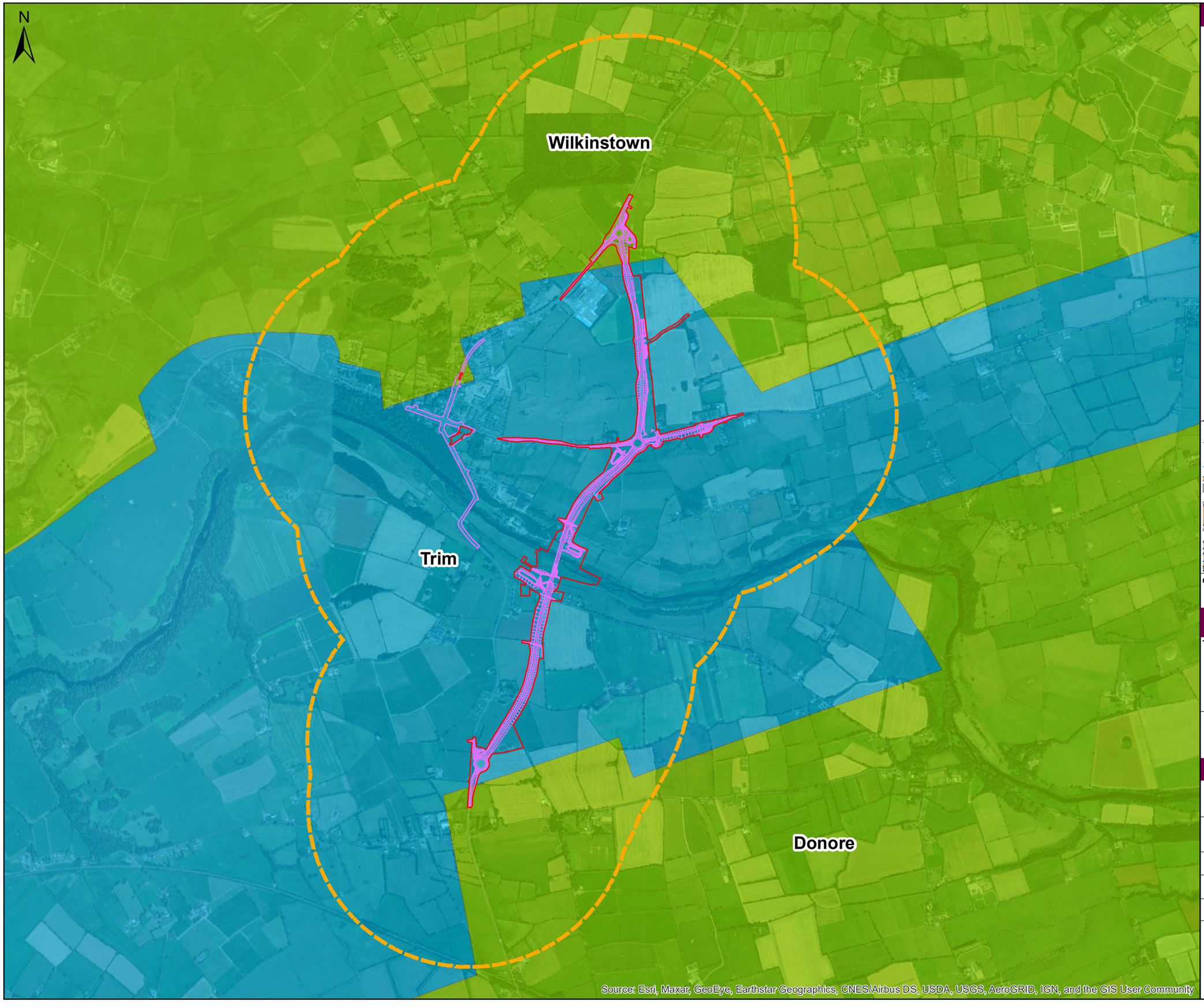


Legend

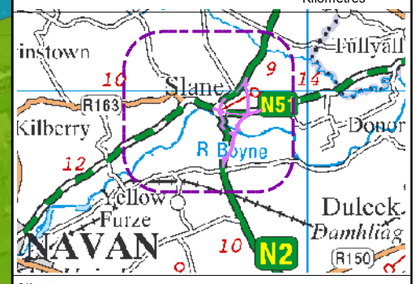
- Proposed Scheme Boundary
- Proposed Scheme
- Study Area

Groundwater Bodies

- Poorly productive bedrock
- Productive fissured bedrock

Data Source: Environmental Protection Agency (EPA)
WFD Ground Water Bodies - Cycle 3

0 0.25 0.5 1
Kilometres



Client
Meath County Council

N2 Slane Bypass and Public Realm Enhancement Scheme

Title
Figure 18.7

Regional Groundwater Bodies

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18.3.1.4.4 Public and Private Water Supplies

The GSI maintains a list of boreholes and wells within Ireland. The properties of the GSI listed wells in the vicinity of the site are summarised in **Table 18-11**.

Table 18-11: GSI Listed Wells in the Vicinity of the Site of the Proposed Scheme

GSI Name	Drill Date	Total Depth (m)	Depth to Rock (m)	Yield (m^3/d)	Yield Class	Usage
2927SWW037	June 1, 1995	137.2	7.6	430	Good	Other
2927SWW058	May 7, 1971	48.9	–	10	Poor	Domestic use only
2927SWW014	August 1, 1983	19.7	19.4	763	Excellent	Slane Water Supply
2927SWW012 (PW01)	November 1, 1987	38	16	2,088	Excellent	Slane Water Supply
2927SWW013 (PW02)	c.1988	24	19.5	1,640	Excellent	Slane Water Supply
2927SWW015	August 1, 1983	10.6	7.6	872	Excellent	Slane Water Supply
2927SWW026	May 1, 1963	7.2	–	–	–	Public supply (Co Co)
2927SWW064	February 1, 1962	14.6	–	28	Poor	Agri & domestic use
2927SWW028	Unknown	34	–	24	Poor	–
2927SWW044	September 25, 1959	–	–	–	–	Public supply (Co Co)

The existing N2 road immediately south of Slane village traverses the Outer Protection Area of the Slane PWS. The Inner Protection Area of the PWS is located approximately 150m northwest of the existing N2 road bridge crossing of the River Boyne. This source is the main public supply for Slane village and its surrounding hinterland and is managed by MCC and Irish Water. The supply consists of two production wells (PW), PW No.1 (drilled in November-December 1987) and PW No.2 (drilled circa 1988), located approximately 90m from the riverbank. The Proposed Scheme does not traverse the Inner Protection Area of the PWS and no significant construction works are proposed within the Outer Protection Area. It is noted that the Outer Protection Area which is most likely to be traversed by the Proposed Scheme is of Moderate vulnerability.

The primary issues that have the potential to impact the quality of the Slane PWS is the quality of surface waters in the River Boyne, within the zone of contribution (ZOC). Surface water quality may be affected in particular by surface run-off and from agricultural land use, septic tanks, industrial discharges and the sewage discharge point into the River Boyne upstream of the well field. The seasonal flooding of the river may also account for elevated background levels of nitrates, higher chloride values and changes in the conductivity, as reported by the GSI. Recent drinking water quality monitoring undertaken by Irish Water for the Slane PWS indicates that 100% of tests between 2019 and 2022 were within exceedance limits for chemicals, metals and other parameters, as well as bacteria and protozoa.

The supply is highly vulnerable to pollution due to the thickness and permeability of the subsoils in the immediate vicinity of the supply. The groundwater quality is also dependent on the river water quality as they are hydraulically connected.

There is also potential for private wells to exist within the study area which have not been identified by the GSI, however this is considered unlikely following review of available records, recent aerial imagery and liaison with local landowners.

18.3.1.5 Designated Sites

The following European Sites are located within the land, soils, geology and hydrogeology study area:

- River Boyne and River Blackwater SPA (Site Code: 004232); and
- River Boyne and River Blackwater SAC (Site Code: 002299).

There are no Natural Heritage Areas in the study area, however, the following proposed Natural Heritage Areas (pNHAs) are within the land, soils, geology and hydrogeology study area:

- Crewbane Marsh (Site Code: 000553);
- Rossnaree Riverbank (Site Code: 001589);
- Slane Riverbank (Site Code: 001591); and
- Boyne Woods (Site Code: 001592).

More information on the designated sites can be found in **Chapter 15 – Biodiversity (Terrestrial)** and **Chapter 16 - Biodiversity (Aquatic)**.

18.3.1.6 Environmental Receptors

The environmental receptors considered relevant to the assessment presented in this chapter and their respective sensitivity are summarised in **Table 18-12**.

Table 18-12: Environmental Receptors

Receptor	Key Receptor Attributes	Distance from the Proposed Scheme	Receptor Importance
Boyne Valley CGS	Geological feature of high value on a local scale (County Geological Site). The attribute has a high quality, significance or value on a local scale	Underlying the Proposed Scheme	High
Soil	Well drained and/or highly fertile soils. The attribute has a high quality, significance or value on a local scale	Underlying the Proposed Scheme	High
River Boyne and River Blackwater SAC and SPA	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation. The attribute has a high quality or value on an international scale	Underlying the Proposed Scheme	Extremely High *(see note)*
Bedrock Aquifers	Locally Important Aquifer. The attribute has a medium quality or value on a local scale	Underlying the Proposed Scheme	Medium
Slane Public Water Supply*	Potable water source supplying >50 homes. The attribute has a medium quality or value on a local scale	Inner zone of the PWS is located approximately 100 m west of the existing N2	Medium

Note: *The potential impacts to the River Boyne and River Blackwater SAC and SPA during the construction and operational phases have been considered in* ***Chapter 15 – Biodiversity: Terrestrial Ecology*** *and* ***Chapter 16 – Biodiversity: Aquatic Ecology****.*

** Private wells were not assessed as the GSI did not list any in the vicinity of the site. Furthermore, MCC do not hold any data regarding private wells.*

18.3.2 Evolution of the Environment in the Absence of the Proposed Scheme

The 'Do-Nothing' scenario or evolution of the environment in the absence of the project refers to a situation whereby the site of the Proposed Scheme would remain in its current condition. This would include the continued use of the existing N2 national route, and the adjacent townland and agricultural land would remain in its current condition. Under the 'Do-Nothing' scenario, the area will remain as predominantly greenfield sites for agricultural processes where there is little potential for adverse environmental impacts.

Regarding the water environment, trends in water quality are mixed; over the past 20 years, there has been a deterioration in the number of the highest quality water bodies, particularly rivers, and mixed progress in waters achieving the environmental objectives under the Water Framework Directive.

The current hydrogeological regime within the Study Area is not expected to change significantly in the absence of the Proposed Scheme. The increased traffic on local roads has the potential to have a detrimental impact due to increased pollutants in run-off discharges from roads to watercourses and subsequently groundwater bodies where existing roads have an inferior drainage network. The existing N2 has no pollution control measures in place, therefore, in the absence of the Proposed Scheme there will be less mitigation measures in place.

The majority of groundwater bodies (476 or 93%) were reported as having Good chemical status. The remaining groundwaters (38) were reported as having Poor chemical status, mainly due to historic

contamination from industrial and waste sources. The implementation of the 3rd Cycle River Basin Management Plan (2022-2027) aims to improve groundwater body quality and will continue to work to improve GWB quality even in the absence of the Proposed Scheme.

18.4 Description of Likely Significant Effects

Sections 18.4.1 and **18.4.2** provide a description of the likely significant effects of the Proposed Scheme on land, soils, geology and hydrogeology in cumulation with other existing development in the area. A description of the likely significant effects in cumulation with approved development i.e. development not yet built, is presented in **Section 18.4.3** based on the detailed methodology for CIA included in **Chapter 25**.

The impact interactions between land, soils, geology and hydrogeology and other environmental factors are identified and described in **Chapter 26** and assessed throughout **Sections 18.4.1 to 18.4.3**.

18.4.1 Construction Phase

The key civil engineering works for the Proposed Scheme which will have potential for impact on the land, soils, geology and hydrogeology receiving environment during construction are summarised below:

- Ground Investigation works as part of the pre-main construction works (enabling works) including any additional boreholes and trial pits required to provide further confirmation of the existing ground conditions;
- Site preparation works including clearance works;
- The installation of a temporary works compound and associated infrastructure;
- The undertaking of earthworks including a significant section of cutting to facilitate the low-profile bridge design. This results in a significant surplus of material arising, which will need to be removed from the site to a suitable location to enable sustainable onward reuse. Material arising is expected to be inert and of a quality that can be used for earthworks construction (refer also to **Chapter 23 – Material Assets: Resource and Waste Management**);
- Excess material (soil, stone, rock) will require temporary stockpiling and further on-site processing (rock crushing and grading) prior to haulage off-site;
- Piling works will consist of temporary driven sheet piles necessary to construct the River Boyne bridge foundation, and large diameter bored pile foundations down to rock, with 7 No. required at each of the four bridge abutments (14 piles total);
- Limited dewatering including of groundwater ingress will take place from within constructed cofferdams at bridge foundations and piers. Groundwater ingress will be pumped out via bowser and taken off-site to a suitably licensed facility for treatment/ disposal;
- Drainage works including construction of 6 No. attenuation ponds as part of the permanent mainline drainage works and construction of groundwater filter drains (herringbone drains) on embankment slopes; and
- The generation of dust and debris during construction (the detailed assessment of impacts from dust during construction and operation are covered in **Chapter 10 – Air Quality**).

The full construction phase details are available in **Chapter 5 – Description of the Construction Phase**.

The key pathways for impact include:

- Accidental Emissions and Release of Potentially Hazardous Substances;
- Infiltration of Surface Run-Off; and
- Excavation and removal of soils (Loss of Soil Reserves).

18.4.1.1 Accidental Emissions and Release of Potentially Hazardous Substances

Accidental spillages of fuels, chemicals or other contaminants during construction may result in localised contamination of soils and groundwater underlying the site if materials are not stored and used in an environmentally safe manner. This includes the disturbance of unknown contamination leading to the

contamination of soil and groundwater during the construction phase. There is also a risk of release of potentially hazardous substances from imported material which has not been appropriately screened.

The majority of the traffic movement associated with the Proposed Scheme will be over the existing roads, and temporary access roads. During the construction phase, vehicles will move traverse and excavate greenfield lands. There is potential for accidental spillage of diesel fuel and hydraulic oil from site machinery during the construction phase. The storage of fuels and hazardous materials has the potential to impact soil quality if not stored correctly during the construction stage.

Magnitude of Impact

Soil

The potential for potentially hazardous substances contaminating the soil as a result of an accidental spill within the Proposed Scheme boundary during the construction phase can contribute to reduced soil quality. The impact is predicted to be localised to the footprint of the Proposed Scheme and construction compounds (main and satellite). In the absence of mitigation measures the impact to soils is considered to be a moderate negative impact of temporary duration if accidental emissions or a release of potentially hazardous substances were to occur.

Bedrock Aquifers

The potential for potentially hazardous substances contaminating the soil and underlying groundwater as a result of an accidental spill within the Proposed Scheme boundary during the construction phase can contribute to reduced groundwater quality.

The impact is predicted to be localised to the footprint of the Proposed Scheme and construction compounds (main and satellite). The impact will be local, short-term, intermittent and with moderate reversibility. Attenuation within the adjacent shallow subsoils is likely to provide adequate protection of deeper bedrock aquifers, therefore, the magnitude is considered to be negligible.

Slane Public Water Supply

The potential for potentially hazardous substances (e.g., hydrocarbons) contaminating the soil and underlying groundwater as a result of an accidental spill within the Proposed Scheme boundary during the construction phase could contribute to reduced groundwater quality.

The impact is predicted to be localised to the footprint of the Proposed Scheme and construction compounds (main and satellite) and is primarily associated with fuel storage and handling. Potential pollution by hydrocarbons during the construction phase can be readily prevented by best practice in terms of site layout including fuel storage and best practice construction management in relation to vehicle and plant maintenance and refuelling. The volumes of potentially hazardous substances stored within the works zone will be kept to a minimum, and as such, impacts to groundwater are unlikely.

The impact will be local, short-term, intermittent and with moderate reversibility. Attenuation within the adjacent subsoils is likely to provide an adequate buffer to the PWS Zone of Influence, therefore, the magnitude is considered to be negligible.

Sensitivity of the Receptor

Soil

The soils and subsoils underlying the site vary, a full analysis of soil and subsoil types are available in **Section 18.3.1.2**. Soils and subsoil have significance on a local scale; therefore, the greenfield nature of the proposed route would have high local value.

The receptor is of High importance as the receptor includes well-drained and/or highly fertile soils which have high quality, significance or value on a local scale. As significant portions of the bypass element of the Proposed Scheme traverse greenfield sites, the extent of existing contamination is low on a local scale.

Bedrock Aquifers

There are multiple locally important bedrock aquifers underlying the site, these are described in **Section 18.3.1.4.2**. 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 groundwater contamination.

Slane Public Water Supply

The Slane PWS inner zone is located approximately 100m west of the existing N2. This attribute is of Medium importance as it is a potable water source supplying >50 homes with medium quality or value on a local scale.

Significance of the Effect

Soil

The magnitude of the impact is deemed to be moderate and the sensitivity of the receptor is considered to be high and therefore the effect will be of **significant/moderate adverse significance** without mitigation, which causes noticeable changes in the character of the environment without affecting its sensitivities on soil quality.

Bedrock Aquifers

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

Slane Public Water Supply

The construction stage has been designed to minimise as far as possible the risk of a contaminant release in the vicinity of the PWS Zone of Influence (see **Chapter 5**). In addition, regular monitoring of the works by an Environmental Clerk of Works (ECoW) is specified, which includes checks of fuel storage areas and containment measures (see mitigation set out in **Chapter 16**).

The magnitude of the impact is deemed to be Negligible and the sensitivity of the receptor is considered to be Medium and therefore, as per the NRA's assessment criteria the effect will be of **imperceptible significance**.

18.4.1.2 Infiltration of Surface Run-Off

Construction vehicles may produce sediment run-off during the haulage of materials, which can infiltrate and cause short-term effects on groundwater quality.

Silt-laden water can also arise from exposed ground 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.

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. As with the earthworks slopes above, once the slopes are built up, rainfall landing on the slope and run-off from the top of the stockpile travel uncontrolled down the slope – 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

Bedrock Aquifers

Silt-laden water can arise from exposed ground and soil stockpiles during construction from the Proposed Scheme alignment and associated construction compounds. Surface water run-off containing large amounts of silt could migrate into the groundwater increasing the concentration of suspended solids.

The impact is predicted to be localised to the footprint of the Proposed Scheme and construction compounds (main and satellite). 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.

Slane Public Water Supply

Silt-laden water can arise from exposed ground and soil stockpiles during construction from the Proposed Scheme alignment and associated construction compounds. Surface water run-off containing large amounts of silt could migrate into the groundwater increasing the concentration of suspended solids.

The impact is predicted to be localised to the footprint of the Proposed Scheme and construction compounds (main and satellite). 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

Bedrock Aquifers – As outlined in Section **18.4.1.1**.

Slane Public Water Supply – As outlined in Section **18.4.1.1**.

Significance of the Effect

Bedrock Aquifers

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

Slane Public Water Supply

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

18.4.1.3 Loss of Soil Reserve

The proposed construction phase will result in the removal of soil from the proposed boundary which includes greenfield soils that have a high local value.

The loss of soil reserves will have an impact on the bedrock aquifers underlying areas of cutting. Where cutting is required, soil overburden, which provides natural attenuation between surface waters and the bedrock is removed. This can lead to a reduction in water quality percolating into the underlying bedrock aquifer.

Impacts are principally associated with the effects of the proposed cuttings and the potential for accidental spillages entering the groundwater environment as the excavation for cuttings will increase the vulnerability of the underlying aquifer.

Magnitude of Impact

Soil

The removal of soil will result in the irreversible loss of a moderate proportion of local high fertility soils.

The impact is predicted to be localised to the footprint of the Proposed Scheme and construction compounds (main and satellite). The impact to soils is considered a moderate negative impact of permanent duration.

Boyne Valley County Geological Site

The proposed route intersects the Boyne Valley County Geological Site in the area south of the River Boyne, a glacial U-shaped valley with characteristic depositional and erosional features associated with ice flow and glacial meltwater.

The proposed works will not significantly alter the CGS, therefore, this is considered a negligible magnitude impact.

Bedrock Aquifers

The loss of soil between surface waters and the bedrock aquifers will result in a reversable loss of overburden that provides a layer of protection to groundwater through natural attenuation. Natural attenuation is the combination of physical, chemical, and biological processes in the subsurface that can reduce the risk posed by contamination. The proposed works will not expose groundwater at the surface; therefore, a level of natural attenuation will still be present at the site.

During construction, excavation for cuttings will increase the local vulnerability. This would increase the ease at which recharge can percolate downward. The excavation of bedrock in the cuttings has the potential to reduce the storage volume within the aquifer.

The soil volume proposed to be excavated will be relatively small in comparison the to the overall aquifer area, such that the impact will be of negligible magnitude (NRA, 2008) and unlikely to affect either use or integrity.

Sensitivity of the Receptor

Soil

The soils and subsoils underlying the site vary, a full analysis of soil and subsoil types are available in **Section 18.3.1.2**. Soils and subsoil have significance on a local scale; therefore, the greenfield nature of the proposed route would have high local value.

The receptor is of High importance as the receptor includes well-drained and/or highly fertile soils which have high quality, significance or value on a local scale. As significant portions of the bypass element of the Proposed Scheme traverse greenfield sites, the extent of existing contamination is low on a local scale.

Boyne Valley County Geological Site

The County Geological Sites (CGSs) in the vicinity of the proposed boundary are described in **Section 18.3.1.2.4**. The Boyne Valley geological feature is classed as high sensitivity as it has high value on a local scale.

Bedrock Aquifers – As outlined in **Section 18.4.1.1**.

Significance of the Effect

Soil

The magnitude of the impact is deemed to be moderate, and the sensitivity of the receptor is considered to be high and therefore the effect will be of **significant/moderate adverse significance** without mitigation, which causes noticeable changes in the character of the environment without affecting its sensitivities on soil quality.

Boyne Valley County Geological Site

The magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high and therefore the effect will be of **imperceptible significance**.

Bedrock Aquifers

The magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is considered to be high, and therefore the effect will be of **imperceptible significance**.

18.4.2 Operational Phase

The operational phase (which includes maintenance operations) has the potential to affect land, soils, geology and hydrogeology. Effects considered for this phase include:

- Accidental emissions and release of potentially hazardous substances during operation or maintenance that may affect the quality of groundwater and/or soils, most notably associated with temporary oils and fuel particularly where below ground excavations are required.

18.4.2.1 Accidental Emissions and Release of Potentially Hazardous Substances

Accidental spillages of fuels, chemicals or other contaminants during operational/maintenance activities may result in localised contamination of soils and 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 moderate on a local scale due to the use of the new bypass during the operational stage and the temporary duration of any maintenance activities.

The soil receptor will be impacted by a source of contamination migrating through into the urban and natural ground. The groundwater receptors will be impacted if contamination migrates through the natural ground into the underlying aquifer and groundwater body.

Magnitude of Impact

Soil

The potential for potentially hazardous substances contaminating the soil as a result of an accidental spill within the Proposed Scheme boundary during the operational phase can contribute to reduced soil quality.

During the operational phase, there is a low risk of a release of potentially hazardous substances e.g., fuels from a road traffic accident. A spillage risk assessment calculation has been carried out as part of the drainage design and is detailed in **Chapter 4 – Description of the Proposed Scheme**. This assessment found the risk of serious spillage to be less than 1% annual probability of occurrence.

Potential impacts will be localised to the footprint of the Proposed Scheme, have a low probability of occurrence, and therefore the magnitude is considered to be small adverse for soil.

Bedrock Aquifers

The potential for potentially hazardous substances contaminating the soil and underlying groundwater as a result of an accidental spill within the Proposed Scheme boundary during the operational phase can contribute to reduced groundwater quality.

The impact is predicted to be localised to the footprint of the Proposed Scheme. The proposed operations are unlikely to generate hazardous substances. The impact will be local, short term, intermittent and with moderate reversibility. Attenuation within the natural subsoil and surface water bodies is likely to provide adequate attenuation, therefore, the magnitude is considered to be negligible.

Slane Public Water Supply

The potential for potentially hazardous substances contaminating the soil and underlying groundwater as a result of an accidental spill within the Proposed Scheme boundary during the operational phase can contribute to reduced groundwater quality.

The impact is predicted to be localised to the footprint of the Proposed Scheme. The proposed operations are unlikely to generate hazardous substances. The impact will be local, short term, intermittent and with moderate reversibility. Attenuation within the natural subsoil and surface waterbodies is likely to provide adequate attenuation, therefore, the magnitude is considered to be negligible.

Sensitivity of the Receptor

Soil

The soils and subsoils underlying the site vary, a full analysis of soil and subsoil types are available in **Section 18.3.1.2**. Soils and subsoil have significance on a local scale; therefore, the greenfield nature of the proposed route would have high local value.

The receptor is of High importance as the receptor includes well-drained and/or highly fertile soils which have high quality, significance or value on a local scale. As significant portions of the bypass element of the Proposed Scheme traverse greenfield sites, the extent of existing contamination is low on a local scale.

Bedrock Aquifers

There are multiple locally important bedrock aquifers underlying the site, these are described in **Section 18.3.1.4.2**. 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 groundwater contamination.

Slane Public Water Supply

The Slane PWS inner zone is located approximately 100m west of the existing N2. This attribute is of Medium importance as it is a potable water source supplying >50 homes with medium quality or value on a local scale.

Significance of the Effect

Soil

The magnitude of the impact is deemed to be small and the sensitivity of the receptor is considered to be high and therefore the effect will be of **slight/moderate adverse significance** without mitigation, which causes noticeable changes in the character of the environment without affecting its sensitivities on soil quality.

Bedrock Aquifers

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

Slane Public Water Supply

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

18.4.3 Cumulative Impact

A cumulative impact assessment (CIA) has been undertaken to consider potential for cumulative impact of the Proposed Scheme with other approved development. The detailed methodology for the CIA is described in **Chapter 25 – Cumulative Effects**. The assessment has considered cumulative sources and impact pathways which could impact on land, soils, geology and hydrogeology.

The projects listed in **Appendix 25.2** have been assessed. Each project has been considered on a case-by-case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/ temporal scales involved. Each project has been considered on a case by case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved. The specific projects screened-in for land, soils, geology and hydrogeology are outlined in **Table 18-13**.

Table 18-13: Projects Screened-in for Potential Cumulative Effects on Land, Soils, Geology and Hydrogeology

Project Code	Project	Project Type	Potential for Cumulative Effect
PR 3	Ledwidge Hall, Drogheda Road, Slane *(now constructed)*	Residential Development	The construction phase of this project has the potential to cause cumulative impacts with the Proposed Scheme if the construction phases coincide. The operational phase of this project has no impact receptor pathway to cause cumulative effects on the identified potential impacts for the Proposed Scheme.
PR 4	Ledwidge Hall Green, Drogheda Road, Slane *(now constructed)*	Residential Development	The construction phase of this project has the potential to cause cumulative impacts with the Proposed Scheme if the construction phases coincide. The operational phase of this project has no impact receptor pathway to cause cumulative effects on the identified potential impacts for the Proposed Scheme.
PR 6	Conyngham Arms Hotel, Main Street, Slane	Hotel	The construction phase of this project has the potential to cause cumulative impacts with the Proposed Scheme if the construction phases coincide. The operational phase of this project has no impact receptor pathway to cause cumulative effects on the identified potential impacts for the Proposed Scheme.
PR 7	Slane Wastewater Treatment Plant, Castle Hill, Navan Road, Slane	Wastewater Treatment Plant	The construction phase of this project has the potential to cause cumulative impacts with the Proposed Scheme if the construction phases coincide. The operational phase of this project has no impact receptor pathway to cause cumulative effects on the identified potential impacts for the Proposed Scheme.

The identified projects have been screened-in on the basis that they are within the 1 km ZoI of the Proposed Scheme and have a construction element that could result in accidental emissions and release of potentially hazardous substances, infiltration of surface run-off and a loss of soil reserve which could result in cumulative impacts if the construction phase of the Proposed Scheme were to coincide in the absence of mitigation measures.

The Proposed Scheme together with projects identified in **Table 18-13** may lead to the decrease in soil quality and water quality in the underlying bedrock aquifers and Groundwater Bodies. The impact is predicted to be localised due to the small area of the projects identified. The projects are not expected to generate hazardous substances or significant suspended solids. The impact will therefore be local, short term, intermittent and high reversibility. Attenuation within the natural subsoil and surface waterbodies is likely to provide adequate attenuation, therefore, the magnitude is considered to be negligible.

As the magnitude of the impact is deemed to be negligible, the cumulative effect will be of imperceptible significance and not considered significant in EIA terms.

Chapter 18, **Section 18.5** outlined mitigation measures to avoid adverse impacts relating to construction which makes the impacts from accidental emissions and release of potentially hazardous substances and suspended sediments insignificant on ground and water quality.

There are no operational cumulative impacts anticipated for the identified projects and the Proposed Scheme.

18.5 Mitigation Measures

18.5.1 Construction Phase

18.5.1.1 Accidental Emissions and Release of Potentially Hazardous Substances

The following mitigation measures will be implemented 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 50 m of watercourses.
- All hydrocarbons used during the construction phase shall be 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” (NRA, 2008).
- All chemical and fuel filling locations shall be protected from potential spillages through the provision of appropriate protection measures including but not limited to 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, shall 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, 2017).
- The pouring of concrete, sealing of joints, application of water-proofing paint or protective systems and curing agents will be completed in the dry weather conditions 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 on hardstanding areas using dedicated concrete washout areas/boxes to avoid spillage.
- An Emergency Response Plan (ERP) detailing the procedures to be undertaken in the event of a spillage of chemical, fuel or other hazardous wastes (e.g. concrete) shall be in place prior to commencement of the proposed Scheme. These procedures to be undertaken shall at a minimum include the following:
  - 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 Environmental Protection Agency and other relevant authorities; and
  - MCC and the appointed contractor during the construction phase shall provide a proposal to the Environmental Protection 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 ERP and the use of spill kit / control equipment.

- Plant and equipment shall be maintained in place and in working order for the duration of the works.
- The main and satellite compounds have been located to ensure they are more than 50 m from any watercourse and away from zones at risk of flooding. 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.
- As outlined in **Chapter 5 – Description of the Construction Phase**, the construction methodology has been developed in order to ensure there will not be any uncontrolled run-off or spillage to the River Boyne or its tributaries, including the European designated sites associated with the river; refer to **Chapter 5**, **Section 5.4**. 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 will prevent siltation of watercourse systems through run-off during rainstorms. Collector ditches shall be put in place surrounding material stockpiles to contain run-off and direct it to the settlement ponds / silt traps before discharge to an adjacent watercourse.
- As noted in **Chapter 5 – Description of the Construction Phase**, wheel wash run-off will be stored in an onsite storage tank and will be disposed of by permitted waste haulage company at a permitted or licensed facility.

18.5.1.2 Infiltration of Surface Run-off

Excavated materials will be carefully managed in accordance with the TII Specification for Road Work, to prevent any potential negative impact on the receiving environment and the excess material will be 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 as per those specified in **Chapter 10 – Air Quality, Section 10.5.1**.

18.5.1.3 Loss of Soil Reserves

Excavated soil is to be managed for onward reuse at licenced facilities. Mitigation measures relating to the use of soils as a resource are specified in **Chapter 23 – Material Assets: Resource Waste Management**.

Following the removal of overburden, the mitigation measures stated in **Sections 18.6.1.1** and **18.6.1.2** shall apply in order to protect bedrock aquifers.

18.5.2 Operational Phase

The Proposed Scheme will include designed in measures including oil interceptors and will undergo routine maintenance as outlined in **Chapter 4**.

In order to prevent fuels, oils or other potentially hazardous substances, arising from accidental spillages on the Proposed Scheme, impacting soils and/or groundwater in the vicinity, **Chapter 4** specifies, as part of the design, installation of 7 no. Class 1 oil/petrol bypass interceptors upstream of where the drainage collection system discharges into the retention/attenuation ponds. All mainline run-offs will be treated in attenuation facilities as identified in **Chapter 4**.

Further, **Chapter 17 – Water**, **Section 17.5.2**, specifies that in the event that an accidental release of potential pollutants occurs during the operational phase, an emergency response plan will be followed to minimise potential contamination of watercourses/groundwater; refer to **Section 4.4.11.12 Environmental Emergency Procedures**.

No further operational phase mitigation measures are proposed.

18.6 Residual Effects

The significance of all impacts identified in **Section 18.4** will be reduced to **imperceptible** with the implementation of the mitigation measures outlined in **Section 18.5**.

18.7 Monitoring

Based on the conclusions of the impact assessment and residual effects, specific monitoring of land, soils, geology or hydrogeology is not considered necessary. It is noted however that construction phase monitoring by a full-time ECoW is specified in **Chapters 15** and **16** to ensure implementation of mitigation measures for surface waters and habitats. This monitoring will also serve to ensure compliance with mitigation measures related to land, soils, geology and hydrogeology.

No operational phase monitoring is proposed.

18.8 Chapter References

EC (2006) Thematic Strategy for Soil Protection [SEC(2006)620] [SEC(2006)1165] /* COM/2006/0231 final.

Enterprise Ireland (2017) Best Practice Guide BPGCS005 – Oil Storage Guidelines.

Environment Agency UK (2020) Guidance on Land Contamination Risk Management (LCRM).

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

EPA (2013) Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites.

EPA (2011) Guidance on the Authorisation of Discharges to Groundwater.

Geological Survey Ireland (GSI). (2004) Slane Water Supply, Groundwater Source Protection Zones.

Goldman, S.J., Jackson, K. and Bursztynsky, T.A. (1986) Erosion and Sediment Control Handbook. McGraw-Hill.

Ground Investigations Ireland (2021). Slane Bypass Phase 3 Ground Investigation Report (February 2021).

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

IGI (2002) Geology in Environmental Impact Statements – A Guide. Institute of Geologists of Ireland.

IGSL (2018) Geotechnical Factual Report (September 2018).

MCC (2021) Meath County Development Plan 2021-2027.

Minerex (2021) Geophysical Survey Report (February 2021).

NRA (2009) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

NRA (2008) Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes.

RPS (2021a) Geotechnical Design Report (April 2021)

RPS (2021b) Ground Investigation Report (April 2021).

RPS (2019) Ground Investigation Report (February 2019).